UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

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Re: Tampered Diesel Pickup Trucks: A Review of Aggregated Evidence from EPA Civil Enforcement Investigations

Messrs. Sloan, Keogh, and Miller,

I hope this letter finds you well. First, I want to thank you for your continued partnership in our work for cleaner air, which concerns a wide range of sources of air pollution.

I am writing on the specific issue of tampering and aftermarket defeat devices. I have discussed this subject with your organizations and members many times over recent years, and I know you share the agency's concern with this illegal activity. In those discussions, people often asked about how prevalent tampering is, and how much excess air pollution comes from tampered vehicles and engines. While we acknowledge that it remains difficult to provide comprehensive answers to these questions, EPA has been able to gain some insights on them through our enforcement work concerning tampering and aftermarket defeat devices for diesel pickup trucks.

We drafted the enclosed Report to help states better understand in quantitative terms the extent of tampering and aftermarket defeat devices that the EPA's civil enforcement personnel are seeing in the course of our work. This Report focuses on excess oxides of nitrogen (NOx) and particulate matter (PM) from tampered diesel pickup trucks. Technical experts in the EPA's Air Enforcement Division aggregated and analyzed a portion of the evidence agency personnel have obtained in recent years through civil enforcement investigations. This evidence is from both resolved cases and ongoing cases.

We then estimated the excess air pollution based on actual emissions testing of tampered diesel pickup trucks.

Our enforcement work concerning tampering and aftermarket defeat devices is ongoing, focused on many types of vehicles and engines, and as you know is the subject of a National Compliance Initiative. The agency is continuing to build on recent successes in its civil enforcement program. In the past few years, the EPA has resolved more than 70 civil enforcement cases that have addressed more than one million aftermarket defeat devices.

As you know, the civil enforcement of the Clean Air Act prohibitions on tampering and aftermarket defeat devices are known as "direct implementation" because they cannot be delegated to states (unlike the stationary source provisions of the Act). Many states, however, have laws prohibiting tampering, operating tampered vehicles, or selling tampered vehicles. Federal enforcement is generally focused on upstream manufacturers and suppliers of aftermarket defeat devices. Downstream, state compliance and enforcement efforts could help to curtail demand for these illegal products. Partnering with states is a core objective of our National Compliance Initiative because we believe that state efforts could complement EPA's work and help to reduce noncompliance. Indeed, federal-state partnerships are how we have successfully dealt with gross emitters on our roads for decades.

My colleagues throughout EPA's regional offices are already in contact with many states about tampering and aftermarket defeat devices, and these interactions are generating constructive dialogue, exchange of information and training, and in some cases assistance on inspections. We will continue our outreach, and we encourage states to connect with their regional counterparts to further this exchange. I am also happy to serve as a point of contact on these issues and to connect states with the appropriate regional personnel.

I trust the information in the enclosed report is helpful. Please do not hesitate to contact me with questions or for further discussion and collaboration. I can be reached at (202) 564-6850 or belser.evan@epa.gov.

Sincerely,

EVAN BELSER

Digitally signed by EVAN BELSER
Date: 2020.11.20 16:36:53 -05'00'

Evan Belser
Deputy Director, Air Enforcement Division, Office of Civil Enforcement
Chair, Steering Committee, EPA National Compliance Initiative, Stopping Aftermarket Defeat Devices for Vehicles and Engines

Enclosure:
Tampered Diesel Pickup Trucks: A Review of Aggregated Evidence from EPA Civil Enforcement Investigations

Enclosure
Tampered Diesel Pickup Trucks: A Review of Aggregated Evidence from EPA Civil Enforcement Investigations

1. EXECUTIVE SUMMARY

The Air Enforcement Division (AED) of the United States Environmental Protection Agency (EPA) created this Report to convey to our state partners some information about the impact of tampering and aftermarket defeat devices on air quality. While this Report does not provide an estimate of the prevalence of tampering, it does quantify the scale and air quality impact of the tampering of diesel pickup trucks that the agency has identified in recent civil enforcement efforts. Specifically, AED analyzed evidence obtained by EPA civil enforcement personnel during many investigations conducted over approximately five years, involving tampering of Class 2b and 3 diesel pickup trucks that occurred after 2009 and before 2020.

Based on this analysis, for the cases that EPA has investigated (further described in Sections 3 through 5), AED estimates that the emissions controls have been removed from more than 550,000 diesel pickup trucks in the last decade. As a result of this tampering, more than 570,000 tons of excess oxides of nitrogen (NO_x) and 5,000 tons of particulate matter (PM) will be emitted by these tampered trucks over the lifetime of the vehicles. These tampered trucks constitute approximately 15 percent of the national population of diesel trucks that were originally certified with emissions controls. But, due to their severe excess NO_x emissions, these trucks have an air quality impact equivalent to adding more than 9 million additional (compliant, non-tampered) diesel pickup trucks to our roads. This Report describes these estimates in greater detail and explains AED's underlying analysis.

Contact Information:

- Questions about this Report can be directed to Jason Gumbs, Engineer, Air Enforcement Division, Office of Civil Enforcement, Office of Enforcement and Compliance Assurance, United States Environmental Protection Agency. Mr. Gumbs can be reached at 202-343-9271 or gumbs.jason@epa.gov.
- EPA welcomes tips and other information about potential tampering and aftermarket defeat devices. Please send any such information to tampering@epa.gov.

2. BACKGROUND

2.1. EMISSIONS CONTROLS ON VEHICLES AND ENGINES

To protect human and environmental health, the Clean Air Act authorizes the EPA to set emissions standards for many categories of vehicles and engines, including "motor vehicles" such as cars and trucks. To comply with these emissions standards, motor vehicle manufacturers develop and incorporate emissions control technologies in the design of the motor vehicles they certify with the EPA for sale in the United States (EPA-certified motor vehicles). Figure 1 shows how vehicle manufacturers employ a wide variety of elements of design to control emissions. Examples include:

- Software in the electronic control unit (ECU) that governs engine fueling strategies, ignition timing, and other conditions in the engine's combustion cycle that determine the amount of pollution formed in the engine;
- Exhaust gas recirculation (EGR) systems (commonly managed by software in the ECU) that recirculate part of an engine's exhaust back through the engine to reduce the formation of NO_x in the engine;
- A variety of *aftertreatment* systems (commonly managed by software in the ECU) that treat exhaust from the engine to reduce the amount of pollution emitted into the ambient air (*e.g.*, NO_X adsorption catalysts (NACs), diesel particulate filters (DPFs), and selective catalytic reduction systems (SCR)); and
- Onboard diagnostic (OBD) systems that continually monitor sensors, actuators, and emissions aftertreatment systems in order to notify vehicle operators when repairs are needed.

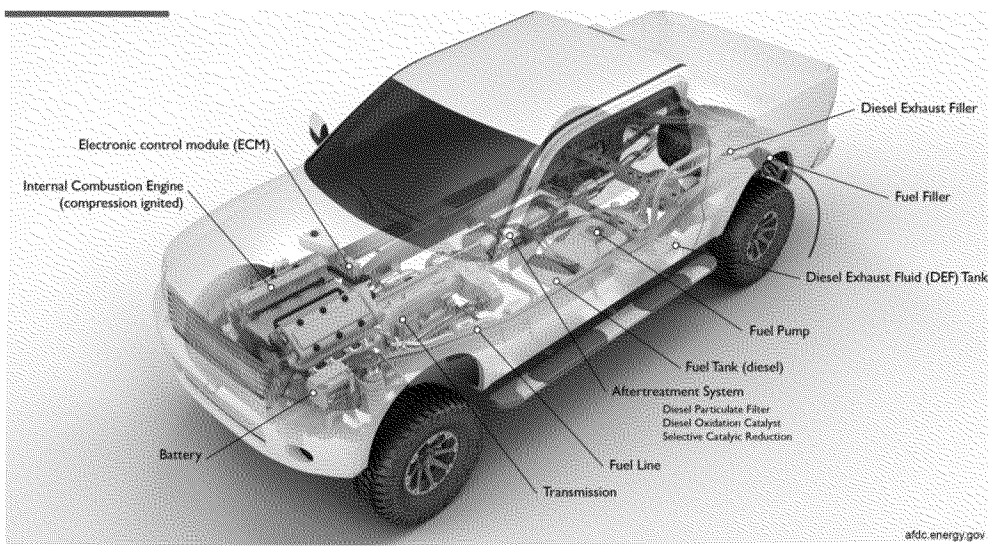

Figure 1. Modern Diesel Class 2b or 3 Diesel Pickup Truck Configuration

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These technologies have flourished in recent decades, and now make it possible for cars and trucks to emit far less air pollution than in the past. For example, modern diesel pickup trucks emit 0.2 grams per mile of NO_x, as compared to approximately 50 times that amount which was standard in the 1980s. Even as people are driving more today than in the 1980s, emissions controls have yielded steep reductions in the overall amount of NO_x, PM, and other forms of air pollution from these vehicles. Over that same time period, remarkably, manufacturers have also more than doubled standard horsepower and torque on diesel pickup trucks. In these ways, emissions controls and technological advances are keystones in the success of the nation's efforts to reduce harmful air pollution from vehicles and engines.

2.2. TAMPERING AND AFTERMARKET DEFEAT DEVICES

The Clean Air Act prohibits tampering with emissions controls, as well as manufacturing, selling, and installing aftermarket parts that defeat those controls (commonly known as "aftermarket defeat devices").[1] The Act authorizes the EPA to enforce these prohibitions.

Unfortunately, the EPA has found numerous companies and individuals that have manufactured, sold, and installed both hardware and software specifically designed to defeat required emissions controls on motor vehicles.

Tampered vehicles contribute substantial excess pollution that harms public health and impedes efforts by the EPA, states, tribes, and local agencies to plan for and attain air quality standards. The emissions impact of tampering depends on the original vehicle design and the extent of the vehicle modifications. For example, air pollution from a diesel pickup truck increases drastically (tens or hundreds of times, depending on the pollutant) when its emissions controls are

[1] The Act's prohibitions against tampering and aftermarket defeat devices are set forth in section 203(a)(3) of the Act, 42 U.S.C. § 7522(a)(3), as follows:

- **Tampering:** CAA § 203(a)(3)(A), 42 U.S.C. § 7522(a)(3)(A), 40 C.F.R. § 1068.101(b)(1): "[The following acts and the causing thereof are prohibited–] for any person to remove or render inoperative any device or element of design installed on or in a motor vehicle or motor vehicle engine in compliance with regulations under this subchapter prior to its sale and delivery to the ultimate purchaser, or for any person knowingly to remove or render inoperative any such device or element of design after such sale and delivery to the ultimate purchaser;"
- **Aftermarket Defeat Devices:** CAA § 203(a)(3)(B), 42 U.S.C. § 7522(a)(3)(B), 40 C.F.R. § 1068.101(b)(2): "[The following acts and the causing thereof are prohibited–] for any person to manufacture or sell, or offer to sell, or install, any part or component intended for use with, or as part of, any motor vehicle or motor vehicle engine, where a principal effect of the part or component is to bypass, defeat, or render inoperative any device or element of design installed on or in a motor vehicle or motor vehicle engine in compliance with regulations under this subchapter, and where the person knows or should know that such part or component is being offered for sale or installed for such use or put to such use;"

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removed.[2,3] Even when the filters and catalysts remain in the vehicle's exhaust system, EPA testing has shown that simply using a tuner to recalibrate the engine can triple emissions of NO_x.[4]

The term "aftermarket defeat devices" refers to parts and components for EPA-certified vehicles or engines where a principal effect of the part or component is to bypass, defeat, or render inoperative any emissions-related element of design of that vehicle or engine. In this Report, the term is synonymous with the parts and components prohibited by section 203(a)(3)(B) of the Act, 42 U.S.C. § 7522(a)(3)(B). A closely related term, "tampering," refers to the actual removal or rendering inoperative of emissions-related elements of design. In this Report, the term is synonymous with the conduct prohibited by section 203(a)(3)(A) of the Act, 42 U.S.C. § 7522(a)(3)(A).

The most common types of aftermarket defeat devices are software files, known as "tunes," and the hardware, known as "tuners," used in tandem with the tunes to interface with and reprogram the vehicle's or engine's original software to change the engine functions and calibrations. One example of an aftermarket defeat device is a *delete tune.* Delete tunes reprogram engine functions and override the OBD system so the tampered vehicle will operate without any diagnostic trouble codes (DTCs) or the "check engine" light (even though the vehicle's aftertreatment systems may be partially or completely removed). Other common types of violations include hardware designed to physically defeat emissions controls, components to disable EGR systems, and hollow "straight pipes" to replace the original exhaust systems comprised of aftertreatment systems.

People tamper vehicles and engines for a variety of reasons. First, some remove emissions controls to avoid the cost and time required to maintain emissions controls. Second, others tamper to increase fuel economy or power, or to customize their vehicle. Because vehicle and engine manufacturers balance numerous and competing considerations (including compliance with emissions standards) in the design and calibration of their products, modification of emissions-related elements of design generally disrupts that balance and causes an increase in emissions of regulated air pollutants.

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[2] Eastern Research Group, Inc., *Investigation Summary Report: H&S Performance, SCT Performance, and Spartan Diesel Technologies* (July 2, 2014), *download report at* https://foiaonline.gov/foiaonline/api/request/downloadFile/TD52%20H%26S%20SCT%20and%20Spartan%20Investigation%20Summary%20Report%202014_Redacted.pdf/1143438fdd9d-47d6-a84d-fae665f8d632

[3] Eastern Research Group, Inc., *Investigation Summary Report: H&S Performance* (Sept. 26, 2013), *download report at* https://foiaonline.gov/foiaonline/api/request/downloadFile/TD17%20H%26S%20Investigation%20Summary%20Report%202013_Redacted.pdf/e13e0be36ed9-4ce8-9daa-0676ff64fb5f

[4] Eastern Research Group, Inc., *Summary Report: Derive Entities Emissions Testing* (April 12, 2016), *download report at* https://foiaonline.gov/foiaonline/api/request/downloadFile/TD91%20Derive%20Systems%20Emissions%20Testing%20Report_2016_Redacted.pdf/dc5bbf8f61e6-4749-8842-1cd8ae223764

2.3. NATIONAL COMPLIANCE INITIATIVE

The EPA enforces the Clean Air Act's prohibitions on tampering and aftermarket defeat devices.[5] The agency is focused on holding accountable those who manufacture and sell aftermarket defeat devices, tamper with commercial fleets of vehicles, and service shops that routinely delete emissions control equipment. Figure 2 shows an overview of the aftermarket industry in terms of how defeat devices are manufactured, sold, sometimes resold, and installed.

The EPA has made *Stopping Aftermarket Defeat Devices for Vehicles and Engines* a National Compliance Initiative for 2020 – 2023.[6] Under this Initiative, EPA personnel are providing compliance assistance and taking enforcement actions to secure compliance and prevent future violations.

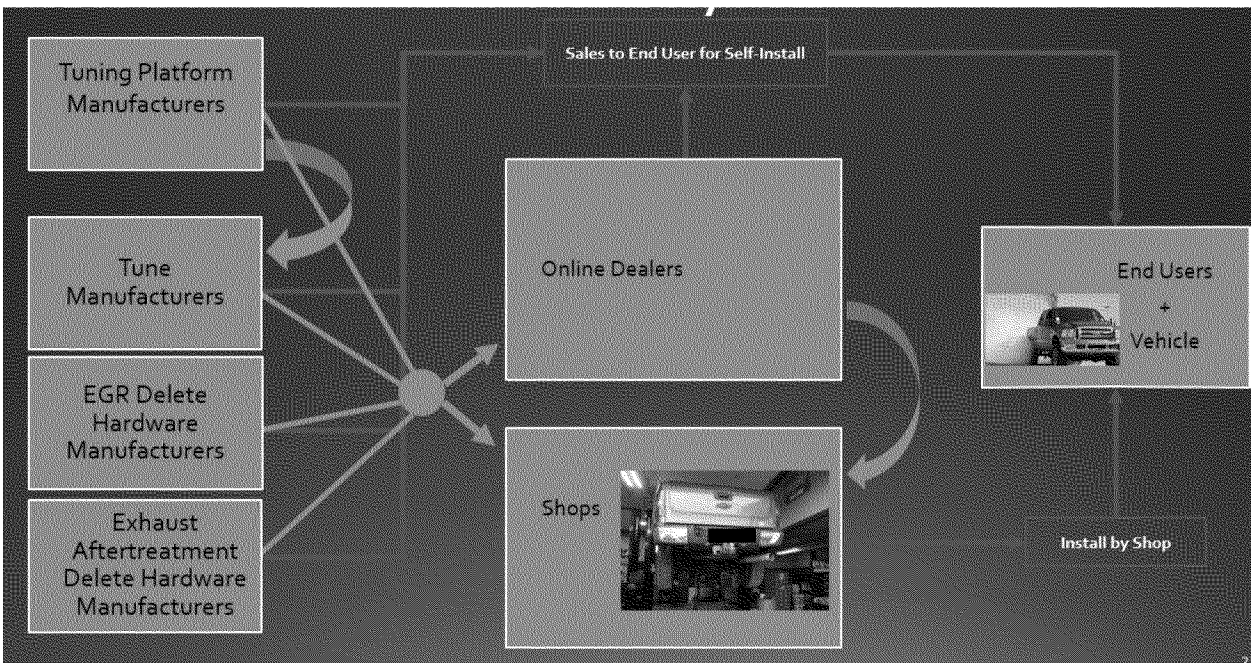

Figure 2. Overview of the Defeat Device Industry

[5] The EPA may bring civil enforcement actions for violations of section 203(a)(3) under its administrative authority or by referring matters to the United States Department of Justice. CAA §§ 204, 205, 42 U.S.C. §§ 7523, 7524. Violations are subject to injunctive relief under section 204 of the Act, 42 U.S.C. § 7523. Persons violating section 203(a)(3) may be subject to a civil penalty of up to $48,192 (for manufacturers and dealers) or $4,819 (for individuals) for each act of tampering, and $4,819 for each aftermarket defeat device. These amounts periodically increase with inflation. 40 C.F.R. § 19.4.

[6] USEPA, National Compliance Initiative: Stopping Aftermarket Defeat Devices for Vehicles and Engines, https://www.epa.gov/enforcement/national-compliance-initiative-stopping-aftermarket-defeat-devices-vehicles-and-engines, https://www.epa.gov/newsreleases/epa-highlights-enforcement-actions-against-those-who-violate-defeat-device-and

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3. SCOPE AND UNDERLYING EVIDENCE OF THIS REPORT

Based on EPA experiences in the past, it has been extremely difficult to accurately quantify national rates of tampering, national sales of aftermarket defeat devices, and the emissions impact from this conduct. One reason it is difficult to estimate the full extent of tampering nationwide is that AED has reason to believe this conduct occurs within most or all categories of vehicles and engines, including commercial trucks, passenger vehicles, pickup trucks, motorcycles, forestry equipment, and agricultural equipment. Many retailers are online operations that sell nationwide, and some portions of the aftermarket industry operate in a secretive manner such that the nature and extent of their operations are not reflected in their business records.

Considering these challenges and data gaps, the EPA does not have national estimates for the quantity of aftermarket defeat devices in the United States, the proportion of the vehicle and engine population that is tampered, or the amount of excess air pollution from tampered vehicles and engines. This Report *does not* provide any such estimates.

Rather, this Report shows the reader what EPA is seeing in its enforcement work—significant amounts of excess air pollution caused by tampering. As detailed below, this Report provides an analysis of evidence EPA civil enforcement personnel have collected in recent investigations. The scope of this analysis is further limited to include only Class 2b and 3 diesel pickup trucks (8,500 to 14,000 pounds gross vehicle weight rate (GVWR)). There are many types of vehicles and engines subject to the Clean Air Act but tampering and aftermarket defeat devices appear to be especially common within Class 2b and 3 diesel pickup trucks. While case evidence for Class 2a (e.g., Ram 1500's) and Class 4 and higher (big rigs) is available from EPA's enforcement cases, the EPA focused this Report on Class 2b and 3 trucks.

The evidence underlying this Report has been obtained by EPA civil enforcement personnel during many investigations conducted over approximately five years, involving tampering that occurred after 2009 and before 2020. Evidence includes information about the design and function of aftermarket parts, and sales records that show the overall volume of parts sold. EPA personnel obtained this evidence from civil investigative work, including on-site inspections, information requests, and interviews.[7] When compiling available information for this Report, the AED primarily relied on records containing total sales quantities for a company over a specified time period. Sales records were analyzed from 26 companies to develop a list of defeat device purveyors (see Table 1 in Section 4 below). EPA also obtained evidence from purchasing suspected aftermarket defeat devices and conducting emissions testing of diesel pickup trucks, both in stock configurations and without their certified emissions controls using aftermarket tuning devices.[8]

This Report reflects only tampering that involves the complete removal and disablement of emissions controls hardware. This is known as a "full delete" of emissions controls. Other types of tampering are common, such as installing tunes, but leaving emissions controls hardware

[7] CAA §§ 114, 208, 307; 42 U.S.C. §§ 7414, 7542, 7607 (granting EPA investigatory authority).

[8] Summary reports of this testing are cited above in footnotes 3, 4, and 5.

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intact and operational. While any type of tampering is illegal, tampering involving the complete removal or disablement of emissions controls hardware is the primary focus of this Report because AED believes it has the greatest impact on air quality.

Some of the evidence used in this evaluation is part of ongoing enforcement cases, containing confidential business information or personally identifiable information. As such, the EPA will not publish the underlying evidence. For publicly available information on individual cases, readers may review EPA's online listing of resolved Clean Air Act civil enforcement cases concerning vehicles and engines.[9]

4. METHOD OF ANALYSIS

This section explains AED's methods for aggregating and analyzing the underlying evidence. This was accomplished using two steps: (1) Estimating Number of Deleted Class 2b and 3 Diesel Trucks, and (2) Estimating Excess Emissions from the Deleted Class 2b and 3 Diesel Trucks.

4.1 Method for Estimating Number of Deleted Class 2b and 3 Diesel Trucks

AED quantified the number of deleted Class 2b and 3 diesel vehicles in the enforcement dataset nationally (Section 4.1.1) and at the state level and county level (Section 4.1.2). These are estimates of the number of vehicles deleted using aftermarket defeat devices that were subject to EPA civil investigations and are not estimates of the total number of deleted vehicles nationwide.

4.1.1 National Estimate of the Number of Deleted Vehicles in the Enforcement Dataset

AED began with the fundamental assumption that each delete tune or delete tuner sold equates to one unique vehicle being deleted. This assumption is safe because, to our knowledge, delete tuner manufacturers restrict tuners and tunes so they can be installed on only one vehicle at a time. For example, to install a delete tune, a user must typically provide the vehicle identification number (VIN) of a particular vehicle to unlock the software. Additionally, the act of deleting emissions controls from a diesel vehicle almost always requires the use of some type of tune or tuner. In other words, the vehicle's software generally must be altered in order to remove the emissions controls hardware.

AED compiled a list of all known delete tuning product lines regardless of the status of any EPA investigation of the products. Next, AED searched all available evidence to identify sales data for each product line and assigned one of the following flags to the sales data: 1) Sales data reported directly by a tuning manufacturer, 2) sales data reported indirectly through a parts distributor, and 3) sales data not available. Table 1 summarizes EPA's inventory of delete tuning product lines and deleted vehicles by data source. It is common for third-party distributors to sell parts to other third-party distributors before the final sale to the ultimate purchaser. AED avoided double counting by using only one data source for each tuning product line even if multiple companies

[9] US EPA, Clean Air Act Vehicle and Engine Enforcement Case Resolutions, https://www.epa.gov/enforcement/clean-air-act-vehicle-and-engine-enforcement-case-resolutions.

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reported sales of the same tuning products. Table 1 shows that the EPA has identified at least 12 delete tuning product lines from eight different tuning manufacturers that are completely excluded from this analysis.

Table 1. Summary of Available Data Sources for Class 2b and 3 Delete Tuning Products

Sales Data Source	Number of Unique Delete Tuning Manufacturers	Number of Different Delete Tuning Product Lines
1-Directly from Tuner Manufacturer	12	18
2-Indirectly from Part Distributors	16	27
3-No Data Available	8	12
Total	**32** [a]	**57**

a—The number of unique delete tune manufacturers (32) is less than the aggregate of delete tune manufacturers from all data sources (36) because the EPA collected information for different tuning product lines from the same manufacturer using multiple sales data sources.

AED extrapolated the count of deleted vehicles by:

a. Estimating the representativeness of the data source. Due to the lack of sales information, it is impossible to precisely estimate the actual representativeness of data obtained from third-party distributors. To simplify this step, AED used either a 25%, 50%, or 75% value for all third-party distributor data sources (Data Source 2 in Table 1 above). The EPA determined the representativeness values based on the number of other distributors who also offered the same product for sale. For example, if EPA could only verify one or two other websites offering the delete tuning product for sale, the agency assumed the highest representativeness option of 75%, which results in less extrapolation in step #2 (see below).

b. Dividing the total number of reported delete tune sales by the percentage of representativeness to yield the "extrapolated" delete tune sales.

A vehicle group is a combination of the model year (or range of model years), where the vehicle make, model, displacement, and certified emissions controls are substantially similar. Excess emissions are mostly dependent on the emissions controls that are removed or disabled from a vehicle. Emissions controls vary by vehicle group. In the process of compiling tuning products sales data, AED assigned vehicle groups to each unique delete tuning product. This step was necessary to quantify tampering by vehicle model, and subsequently to calculate excess emissions (see Section 4.2.2). AED used one of the following methods to assign vehicle groups:

a. Many tuning products are functionally designed to operate only with one specific vehicle group (e.g., 2008 to 2010 Ford 6.4 L Powerstroke F250/F350s). For these products, AED assigned the appropriate vehicle group. AED used the specific vehicle group whenever possible (i.e., if a part is advertised to work on a specific vehicle group).

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b. Other tuning manufacturers sell products that contain delete tunes compatible with multiple vehicle groups made by different vehicle manufacturers. For some of these products, AED reviewed individual invoices that included the tuning product in question along with vehicle-specific hardware (straight pipes, EGR delete hardware). AED assumed the tuning device was used on the same vehicle group as the hardware. Sales data was summed up for each of the vehicle groups to create a vehicle group distribution profile for that tuning product. Lastly, AED applied the distribution profile to the total number of sales for the product line.

c. For all other products that work with multiple vehicle groups, AED divided the sales data evenly among the compatible vehicles. Generally, AED used this method only for products that work with multiple vehicle groups by the same manufacturer. For example, if a tuning device worked with all Ford diesel pickup trucks, including the 2003-2007 Ford Powerstroke, 2008-2010 Ford Powerstroke, and 2011 and newer Ford Powerstroke, the sales were evenly distributed among the three compatible vehicle groups.

Figure 3 summarizes how often AED used each of the three methods above to assign vehicle groups.

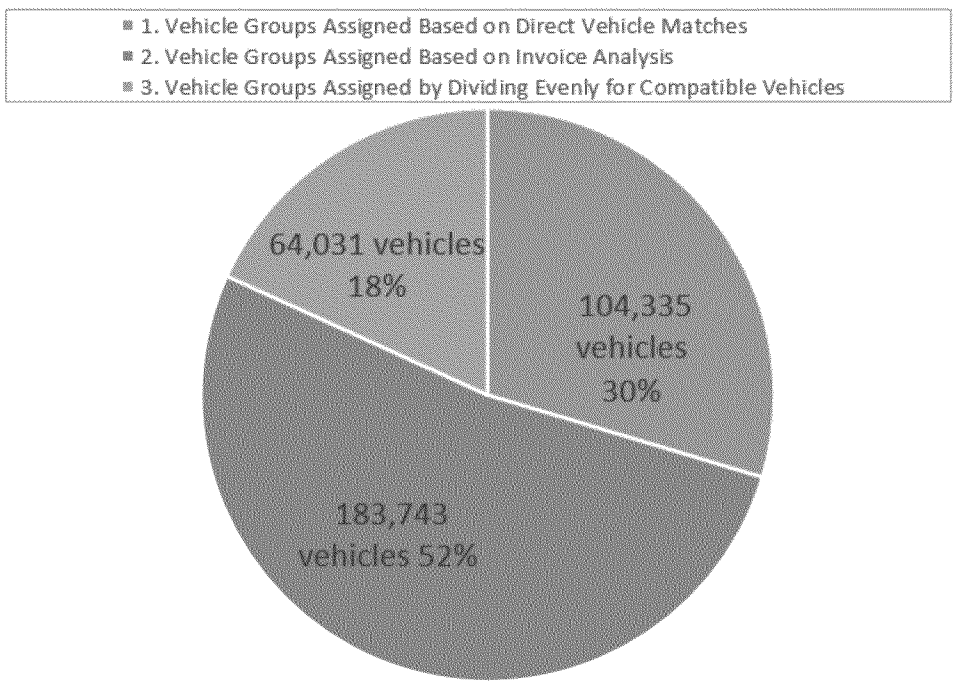

Figure 3. Breakdown of Vehicle Group Assignment Method for Confirmed Delete Tuner Sales

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4.1.2 State and County Estimates

AED identified 18 enforcement cases where detailed invoice sales data were available. These enforcement cases included product identification, customer name, and customer location (city, state, zip). AED estimated the numbers of deleted Class 2b and 3 vehicles by state by:

a. Identifying all products that disable emissions controls in the invoice data.

b. Identifying all customer names in the invoice data that appeared to be online distributors of parts.

c. Creating a state-by-state distribution based on the number of unique invoices: (1) that contained delete parts, (2) that contained a valid state name for the customer location, and (3) where the customer was not an online retailer. Invoices representing sales to online retailers were excluded because the parts were likely to have been sold to a different customer located in a different and unknown state. AED identified over 150,000 unique invoices that met these criteria and assumed each one of these unique invoices represented the location for one deleted vehicle.

d. Applying the distribution profile to the nationwide number of deleted trucks from Section 4.1.1 to estimate the number of deleted vehicles by state.

4.2 Method for Estimating Excess Emissions

AED estimated excess emissions using the equation below. The equation was applied separately to each delete tuning manufacturing product line. The first variable in this equation (the number of deleted vehicles by vehicle group) was taken directly from the National Estimate of the Number of Deleted Vehicles in the Enforcement Dataset (Section 4.1.1). The other two variables, remaining vehicle miles traveled (VMT) and emission rates, are discussed in the following two subsections.

$$Excess\ Emissions = \sum_{\text{Veh Group}}^{\text{Pollutant}} \text{\# of Vehicles} \times \left(Emissions\ Rate_{Tampered} - Emissions\ Rate_{Untampered}\right) \times Remaining\ VMT$$

Where,

- # of Vehicles – Number of deleted vehicles by Vehicle Group.
- Remaining VMT – VMT after the point of tampering for the remaining service life.
- Emissions Rate Tampered – Vehicle-specific emissions factor when vehicles are completely deleted.
- Emissions Rate Untampered – Vehicle-specific emissions factor when vehicles are in stock configuration.

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4.2.1 VMT

VMT represents the expected number of miles driven each year for a given type of vehicle. VMT varies by the Department of Transportation (DOT) vehicle class and by vehicle age. As vehicles age, annual VMT decreases based on the assumption that older vehicles will be driven less. *Survival rate* is a metric to account for the number of vehicles still on the road over the course of a specific time period. The survival rate is a value between 0 and 1 that represents the fraction of vehicles from a certain model year that are still on the road each year. This value decreases over time to account for vehicles that are totaled or removed from service. Survival rates also vary by the DOT vehicle class.

For this Report, AED relied on VMT and survival rate schedules specified for Class 2b and 3 in EPA's *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Highway Heavy-Duty Engines (Table 6-4, Table 6-5).*[10] These schedules provide VMT and survival rates through 30 years of service life. For each unique delete tuning product line, AED applied these VMT and survival rates as follows:

a. AED estimated the average model year for the vehicle group compatible with the delete tune (e.g., 2009 for 2008 to 2010 Ford F250/F350's with the 6.4-liter Powerstroke).

b. AED estimated the vehicle age at the time of tampering based on the difference between the sales data calendar year and the average model year for each vehicle group. For example, if sales data were reported for 2016 calendar year, the vehicle group representing 2008 to 2010 Ford F250/F350 vehicles (average model year of 2009) would be seven years old at the time of tampering.

c. AED estimated the remaining VMT (miles) for each tampered vehicle by integrating the VMT profile (miles per year), starting from the vehicle's age when tampering occurred to the end of the vehicle's service life. Figure 4 provides an example of this methodology for vehicles tampered at age three and eight. Figure 5 in Section 5 shows that over 50 percent of the deleted vehicles in this estimate are tampered by age three, and over 85 percent are tampered by age eight. Unlike traditional excess emissions models that apply survival rates starting in year 1 of the vehicle's age, AED assumed a survival rate of 1 until the point of tampering because the vehicle is inherently still in service if it is being tampered. After tampering, AED assumed a decreasing survival rate based on the incremental change in reported survival rates for vehicles of the same age that were never tampered.

[10] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10020UG.PDF

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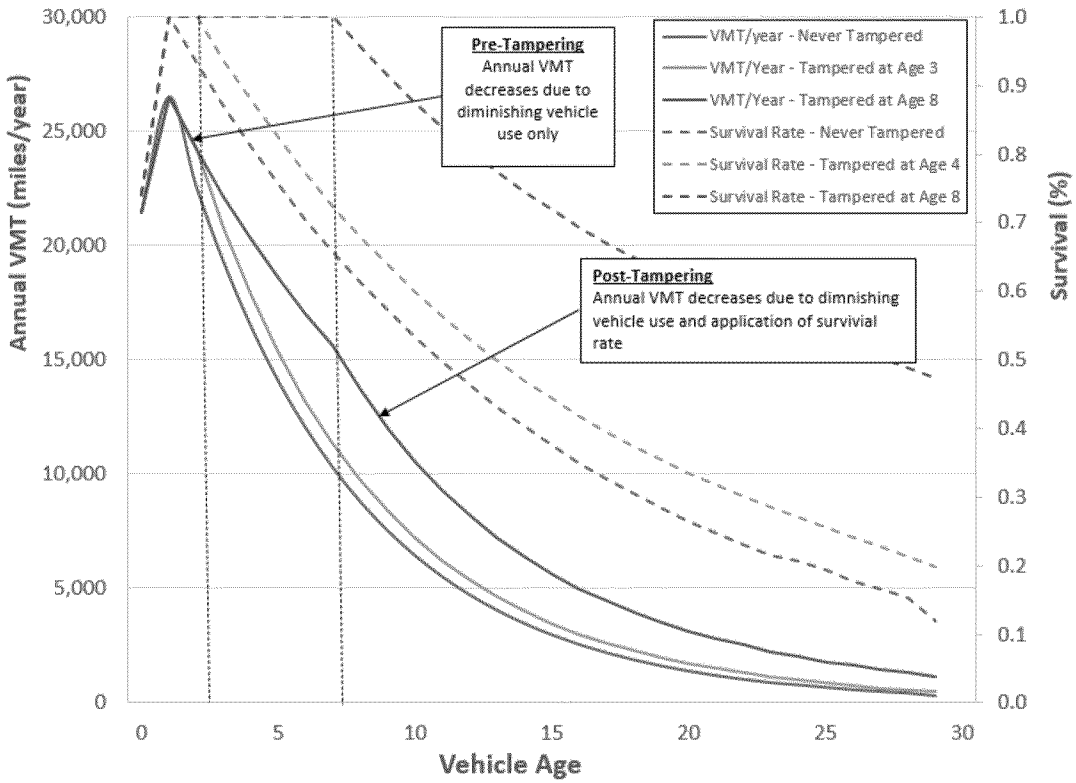

Figure 4. VMT Profile Example

4.2.2 Emission Rates

AED used two methods to determine emission rates. Wherever possible, AED used chassis dynamometer test results from testing a vehicle tampered using delete tuning products where all emissions controls were removed. On average, AED observed that Class 2b and 3 diesel trucks emitted 30 to 300 times higher NO_x and 15 to 40 times higher PM (depending on the drive cycle, when all emissions controls are removed or disabled (EGR, DPF, DOC, NAC or SCR)). The considerable increase in emissions reverted the vehicle back to 1980s-era emissions levels. Over the Federal Test Procedure (FTP) drive cycle, the tampered NO_x emissions rate ranged from approximately eight to ten grams per mile.[11]

Where emissions test data was not available, AED used emissions levels for each pollutant as certified by vehicle and engine manufacturers. For example, a 2009 GM 3500 with a 6.6 Liter Duramax diesel engine was certified at 1.2 grams per brake horsepower hour (g/bhp-hr) for NO_x using EGR, DOC, and DPF. AED assumed this certification level for NO_x for untampered vehicles in this group. For tampered vehicles in this group, AED assumed 3.6 g/bhp-hr, the certification level for 2002 model year 6.6 Liter Duramax diesel engines which were the last Duramax engines to be certified without EGR, DOC, or DPF. In terms of estimating excess emissions, this is a significantly more conservative approach than using emissions testing results.

[11] This is based on "hot start" FTP74 tests. The true FTP certification test requires a cold start. As such, these results are not directly comparable to emissions standards or certification levels. See footnote 2, above.

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5. FINDINGS

AED estimates that the emissions controls have been removed from more than 550,000 diesel pickup trucks in the last decade. As a result of this tampering, more than 570,000 tons of excess oxides of nitrogen (NOx) and 5,000 tons of particulate matter (PM) will be emitted by these tampered trucks over the lifetime of the vehicles. These tampered trucks constitute approximately 15 percent of the national population of diesel trucks that were originally certified with emissions controls. Table 2 through Table 4 summarize AED's findings. Table 2 shows results based on "confirmed" data available to EPA, while Table 3 shows the same metrics based on "confirmed" plus "extrapolated" data.[12] These findings are based on 45 different delete tuning product lines manufactured by 28 different companies. It is worth highlighting that these results exclude vehicles deleted using 12 other delete tuning product lines identified by the EPA, for which no data was available. By following the methodology discussed in Section 4, AED took every effort to avoid double counting deleted vehicles in these tables.

Table 2 through Table 4 also include an estimate of the number of Class 2b and 3 diesel vehicles that are effectively added to the road as a result of the deleted vehicles (Columns called "*Vehicles Added to the Road Based on Excess NO_x*"). AED estimated these values by multiplying the number of deleted vehicles by the ratio of total NO_x emissions emitted by a deleted vehicle over its entire service life to the total NO_x emissions emitted by a vehicle that is never deleted. AED estimates that the 557,000+ deleted Class 2b and 3 diesel vehicles is equivalent to adding more than 9 million Class 2b and 3 diesel vehicles to the road.

Figure 5 shows the deleted vehicle distribution based on the vehicle age at which tampering occurs. The available evidence shows that approximately 50 percent of tampering occurs when vehicles are three years of age or less and over 85 percent of tampering occurs by age eight.

The state- and county-level results are based on AED's review of over 150,000 unique invoices containing delete tuning or hardware. AED took every effort to exclude invoices showing product sales to online distributors in order to avoid biased results toward states and counties where online retailers are physically located because the ultimate customers are typically located in many different states – not just the state where the online retailer is located.

- Table 5 shows the estimated number of deleted Class 2b and 3 diesel vehicles by state.
- Figure 6 through Figure 9 show the state-level results using EPA's Geo Platform.
- Figure 10 shows the number of invoices containing delete tuning or hardware parts by county. AED assumed each unique invoice represents the location for one deleted vehicle. Invoices showed sales of delete parts in all 50 states and approximately 83 percent of counties in the United States.

[12] Generally, extrapolated results represent sales data AED reasonably expects to be missing from the underlying data sources. Section 4 explains how AED determined the "extrapolated" results.

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- Figure 11 through Figure 14 show county-level results for select regions designated as non-attainment with EPA's 8-hour ozone standards.

Table 2. Summary of "Confirmed" Class 2b and 3 Diesel Vehicles Deleted from 2009 through 2019

Certified Vehicle Emissions Controls Deleted	Number of Deleted Trucks	Excess NO_x (tons) [a]	Excess PM (tons) [a]	Vehicles Added to Road Based on Excess NO_x [b]
EGR+DOC (2003-2006 MY)	57,246	13,525	0	17,020
EGR+DOC+DPF (2008-2010 MY)	100,246	52,106	1,455	152,271
EGR+DOC+DPF+NAC (2007-2012 MY)	78,142	91,146	753	1,610,005
EGR+DOC+DPF+SCR (2010+ MY)	116,478	191,090	1,316	3,971,253
Total Deleted Vehicles	***352,109***	***347,867***	***3,524***	***5,750,549***

See Section 4.1.1 for detailed explanations of "confirmed" versus "extrapolated" data.
a—These columns represent the excess emissions anticipated over the remaining service life of the vehicle after tampering occurs.
b—Based on the number of deleted vehicles multiplied by the ratio of NO_x emitted from a deleted vehicle over its entire life compared to NO_x emitted from a vehicle that is never deleted.

Table 3. Summary of "Confirmed and Extrapolated" Class 2b and 3 Diesel Vehicles Deleted from 2009 through 2019

Certified Vehicle Emissions Controls Deleted	Number of Deleted Trucks	Excess NO_x (tons) [a]	Excess PM (tons) [a]	Vehicles Added to Road Based on Excess NO_x [b]
EGR+DOC (2003-2006 MY)	72,904	16,770	0	21,016
EGR+DOC+DPF (2008-2010 MY)	129,555	65,114	1,823	184,871
EGR+DOC+DPF+NAC (2007-2012 MY)	150,954	159,001	1,313	2,623,886
EGR+DOC+DPF+SCR (2010+ MY)	204,066	329,539	2,270	6,889,968
Total Deleted Vehicles	***557,478***	***570,423***	***5,407***	***9,719,741***

See Section 4.1.1 for detailed explanations of "confirmed" versus "extrapolated" data.
a—These columns represent the excess emissions anticipated over the remaining service life of the vehicle after tampering occurs.
b—Based on the number of deleted vehicles multiplied by the ratio of NO_x emitted from a deleted vehicle over its entire life compared to NO_x emitted from a vehicle that is never deleted.

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Table 4. Summary of Class 2b and 3 Diesel Vehicles Deleted from 2009 through 2019

Certified Vehicle Emissions Controls Deleted	Confirmed [a]		Confirmed + Extrapolated [a]	
	Number of Deleted Trucks	Vehicles Added to Road Based on Excess NO_x	Number of Deleted Trucks	Vehicles Added to Road Based on Excess NO_x
Total Deleted Vehicles	352,109	5,750,549 [b]	557,478	9,719,741[b]
Percent of 2016 Class 2b and 3 Diesel Fleet [c]	6 %	98 %	10 %	166 %
Percent of 2016 Class 2b and 3 Diesel Fleet, 2003 model year or newer [d]	9 %	152 %	15 %	257 %

a—See Section 4.1.1 for detailed explanations of "confirmed" versus "extrapolated" data.
b—These values are based on the number of deleted vehicles multiplied by the ratio of NO_x emitted from a deleted vehicle over its entire life compared to NO_x emitted from a vehicle that is never deleted.
c—The percentages in this row are based on approximately 5.8 million class 2b and 3 diesel vehicles registered in the U.S. as of 2016. 2016 was selected for this calculation because the Agency had readily available registration data for this calendar year.
d—The percentages in this row are on approximately 3.8 million class 2b and 3 diesel vehicles registered in the U.S. as of 2016, that are 2003 model year or newer. Pre-2003 diesel vehicles were likely not to be certified with any emissions controls like EGR, DOC, DPF, or SCR.

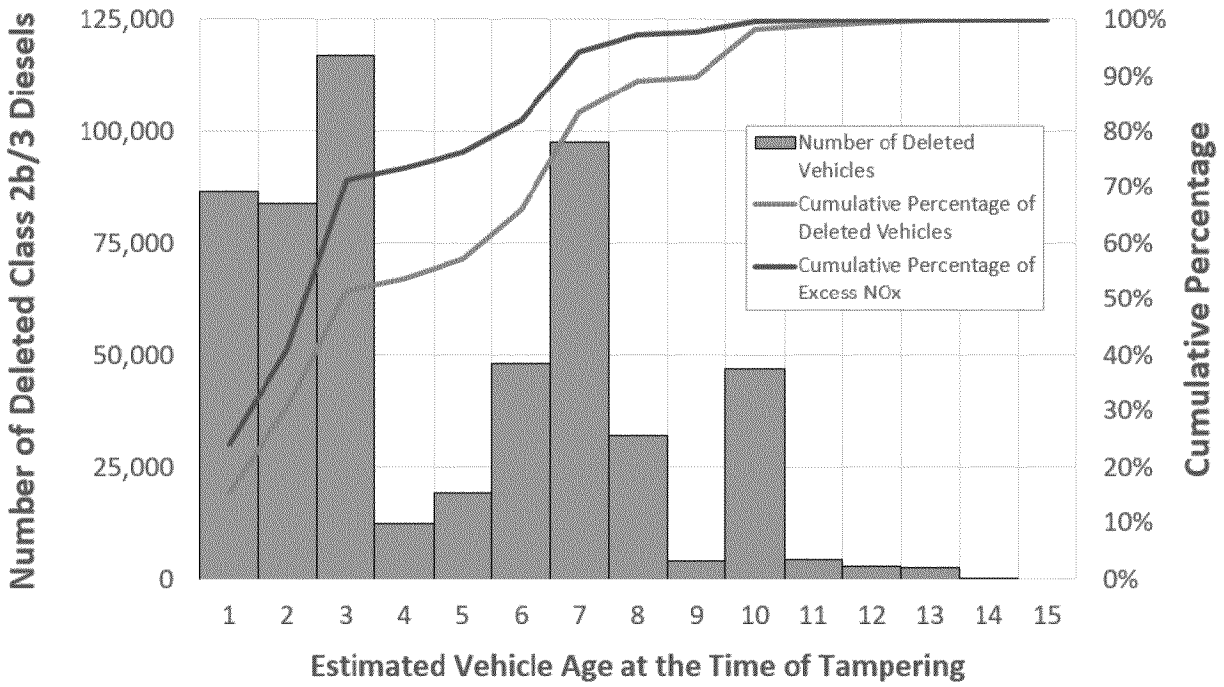

Figure 5. Number of Deleted Class 2b and Diesels by Vehicle Age

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Table 5. Observed Class 2b and 3 Tampering from 2009 through 2019 by State

State	Estimated Deleted Vehicles	Estimated Registered Diesel Vehicles (2016)	Estimated Deleted Vehicles, % of Total 2016 Fleet	Estimated Registered Diesel Vehicles (2016), 2003+ MY Only	Estimated Deleted Vehicles, % of Total 2016 Fleet, 2003+ MY Only	Estimated Excess NO_x from Class 2b and 3 Vehicles Deleted (tons)	Estimated Excess PM from Class 2b and 3 Vehicles Deleted (tons)
NORTH DAKOTA	7,901	42,389	18.6%	30,907	25.6%	8,085	77
IDAHO	13,474	89,880	15.0%	55,183	24.4%	13,787	131
WYOMING	8,619	60,803	14.2%	43,159	20.0%	8,819	84
MAINE	2,794	20,738	13.5%	13,511	20.7%	2,859	27
VERMONT	1,718	12,768	13.5%	8,988	19.1%	1,758	17
MICHIGAN	18,382	140,885	13.0%	87,406	21.0%	18,809	178
WEST VIRGINIA	5,336	41,286	12.9%	26,426	20.2%	5,460	52
WASHINGTON	23,646	183,479	12.9%	108,030	21.9%	24,195	229
NEW HAMPSHIRE	2,748	21,622	12.7%	14,334	19.2%	2,812	27
ILLINOIS	18,245	144,196	12.7%	95,433	19.1%	18,669	177
KENTUCKY	11,821	93,931	12.6%	54,128	21.8%	12,096	115
OHIO	19,459	160,536	12.1%	95,798	20.3%	19,911	189
OREGON	17,436	146,318	11.9%	85,300	20.4%	17,841	169
INDIANA	14,134	119,371	11.8%	71,071	19.9%	14,462	137
ALABAMA	11,962	101,156	11.8%	62,898	19.0%	12,240	116
NEW MEXICO	8,935	79,903	11.2%	53,799	16.6%	9,143	87
TENNESSEE	14,084	128,017	11.0%	73,850	19.1%	14,412	137
MONTANA	9,199	84,114	10.9%	53,605	17.2%	9,412	89
NEVADA	6,966	64,815	10.7%	44,112	15.8%	7,128	68
IOWA	8,798	82,149	10.7%	55,617	15.8%	9,002	85
MISSOURI	15,359	144,439	10.6%	90,418	17.0%	15,716	149
ALASKA	3,783	35,863	10.5%	21,067	18.0%	3,870	37
KANSAS	8,302	79,604	10.4%	49,537	16.8%	8,495	81
PENNSYLVANIA	18,146	176,756	10.3%	110,551	16.4%	18,567	176
SOUTH CAROLINA	7,477	73,890	10.1%	44,277	16.9%	7,651	73
MINNESOTA	10,607	104,892	10.1%	66,706	15.9%	10,854	103
OKLAHOMA	15,252	151,357	10.1%	103,592	14.7%	15,607	148
FLORIDA	24,619	246,883	10.0%	162,943	15.1%	25,191	239
VIRGINIA	11,832	118,906	10.0%	72,247	16.4%	12,107	115
NEW YORK	13,611	137,966	9.9%	87,351	15.6%	13,927	132
COLORADO	16,348	168,555	9.7%	108,022	15.1%	16,728	159
GEORGIA	15,210	157,047	9.7%	97,756	15.6%	15,564	148
MISSISSIPPI	6,447	67,411	9.6%	41,564	15.5%	6,596	63
MARYLAND	6,779	72,795	9.3%	49,642	13.7%	6,936	66
WISCONSIN	10,374	112,004	9.3%	71,895	14.4%	10,615	101
NORTH CAROLINA	13,810	153,823	9.0%	92,973	14.9%	14,130	134

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Table 5. Observed Class 2b and 3 Tampering from 2009 through 2019 by State

State	Estimated Deleted Vehicles	Estimated Registered Diesel Vehicles (2016)	Estimated Deleted Vehicles, % of Total 2016 Fleet	Estimated Registered Diesel Vehicles (2016), 2003+ MY Only	Estimated Deleted Vehicles, % of Total 2016 Fleet, 2003+ MY Only	Estimated Excess NO_x from Class 2b and 3 Vehicles Deleted (tons)	Estimated Excess PM from Class 2b and 3 Vehicles Deleted (tons)
TEXAS	64,758	754,102	8.6%	542,198	11.9%	66,262	628
LOUISIANA	11,413	133,442	8.6%	95,826	11.9%	11,678	111
ARIZONA	11,478	135,061	8.5%	90,494	12.7%	11,744	111
NEBRASKA	5,309	62,547	8.5%	40,866	13.0%	5,433	51
DELAWARE	924	11,286	8.2%	7,658	12.1%	945	9
SOUTH DAKOTA	3,741	46,168	8.1%	30,879	12.1%	3,827	36
ARKANSAS	5,840	78,589	7.4%	50,332	11.6%	5,976	57
CONNECTICUT	2,992	40,475	7.4%	23,363	12.8%	3,062	29
MASSACHUSETTS	3,859	52,778	7.3%	33,693	11.5%	3,949	37
UTAH	8,103	112,467	7.2%	76,577	10.6%	8,292	79
HAWAII	1,057	15,195	7.0%	9,993	10.6%	1,082	10
RHODE ISLAND	626	9,024	6.9%	5,200	12.0%	641	6
NEW JERSEY	4,905	87,048	5.6%	53,862	9.1%	5,019	48
CALIFORNIA	8,859	480,539	1.8%	322,678	2.7%	9,065	86
Totals	**557,478**	**5,839,268**	**9.55%**	**3,787,715**	**14.72%**	**570,423**	**5,407**

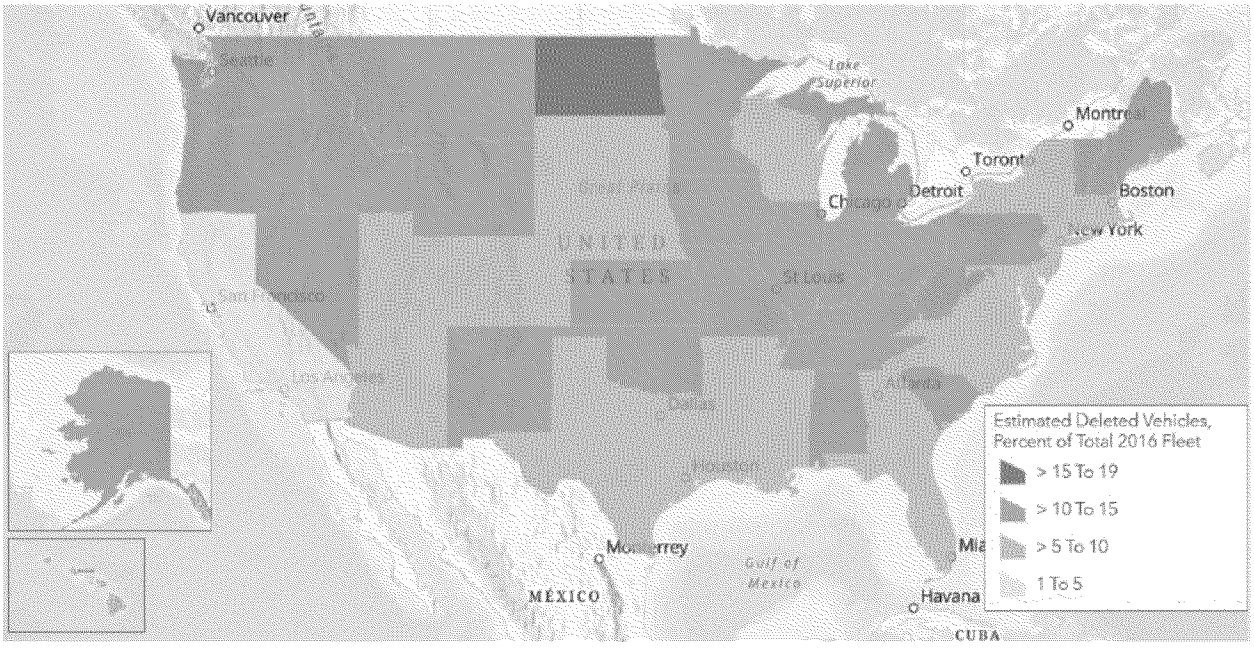

Figure 6. Estimated Deleted Vehicle as a Percent of Total 2016 Class 2b and 3 Diesel Vehicles

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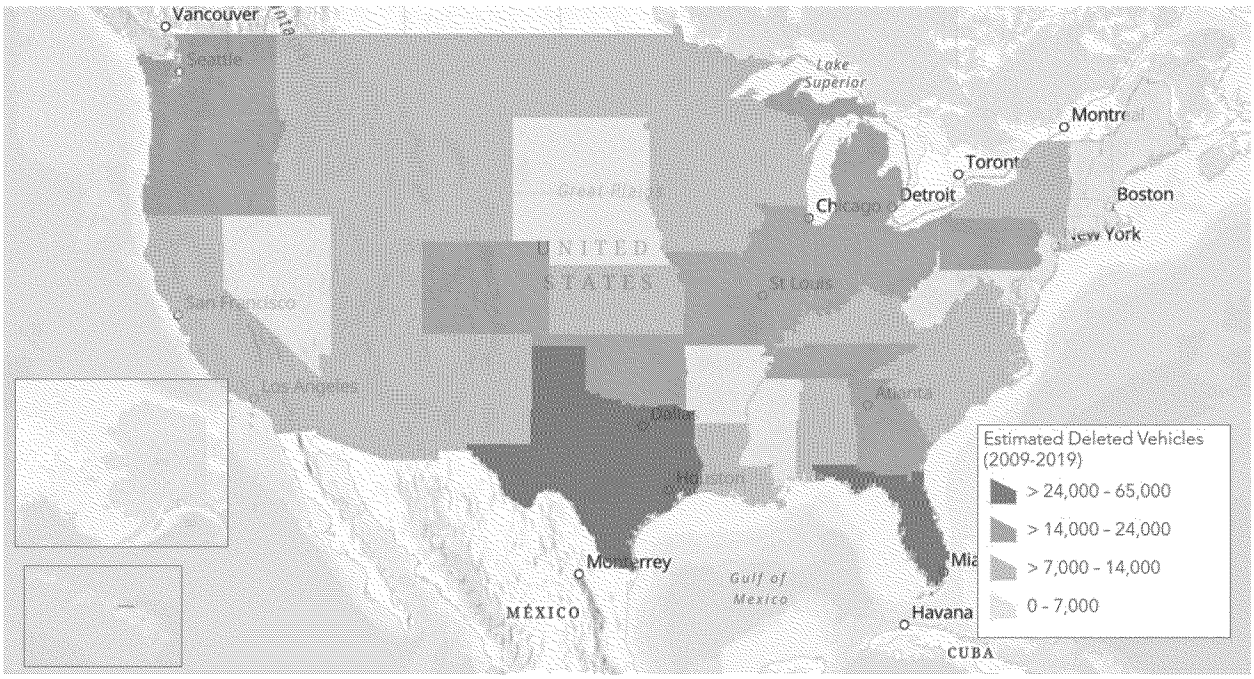

Figure 7. Estimated Number of Class 2b and 3 Diesel Vehicles Deleted

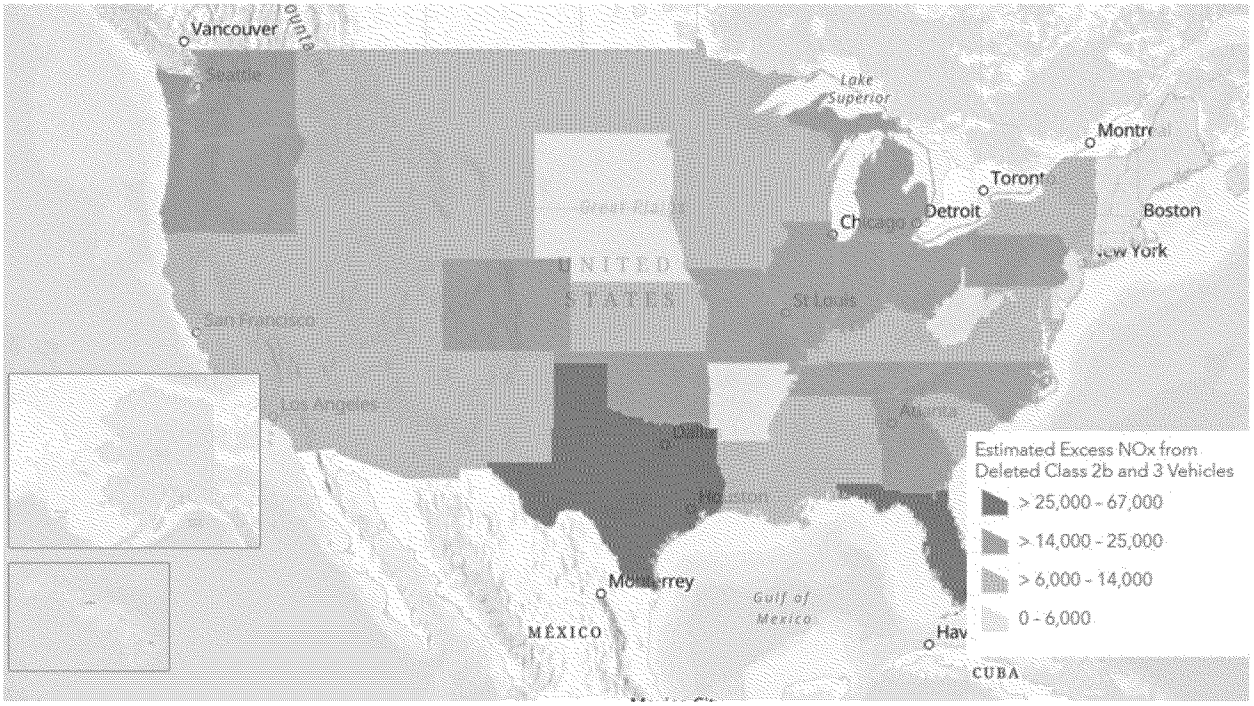

Figure 8. Estimated Excess NO_x Caused by Deleted Class 2b and 3 Diesel Vehicles

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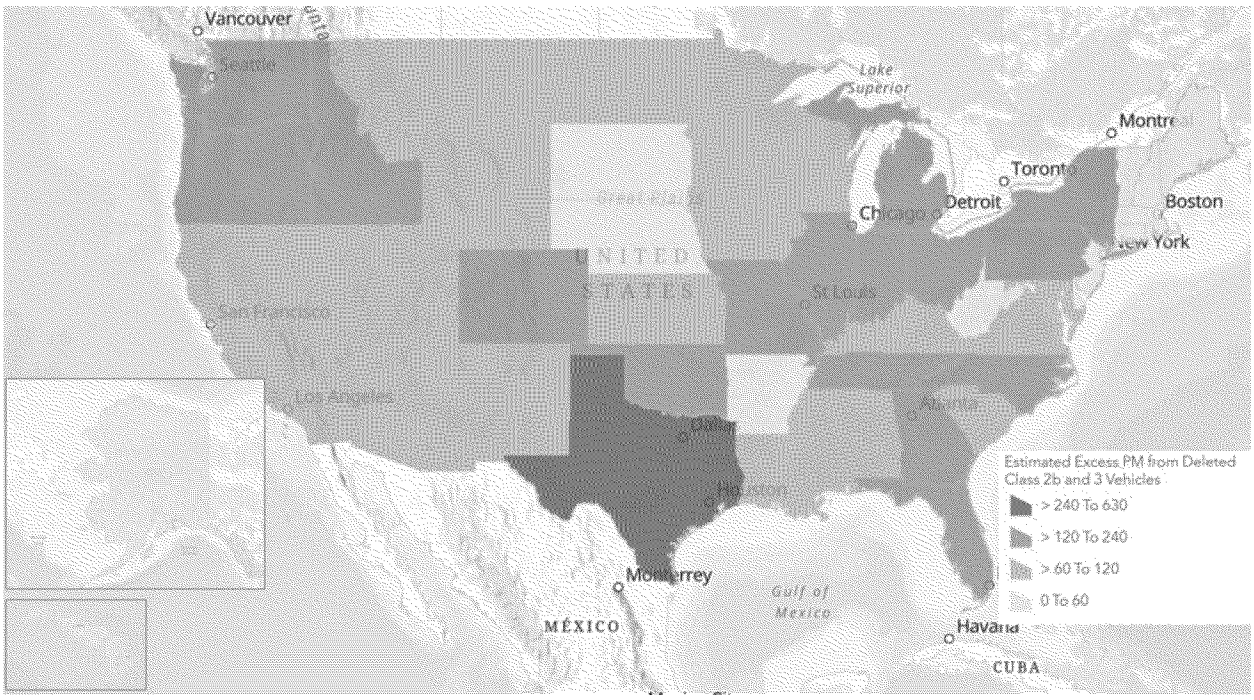

Figure 9. Estimated Excess PM Caused by Deleted Class 2b and 3 Diesel Vehicles

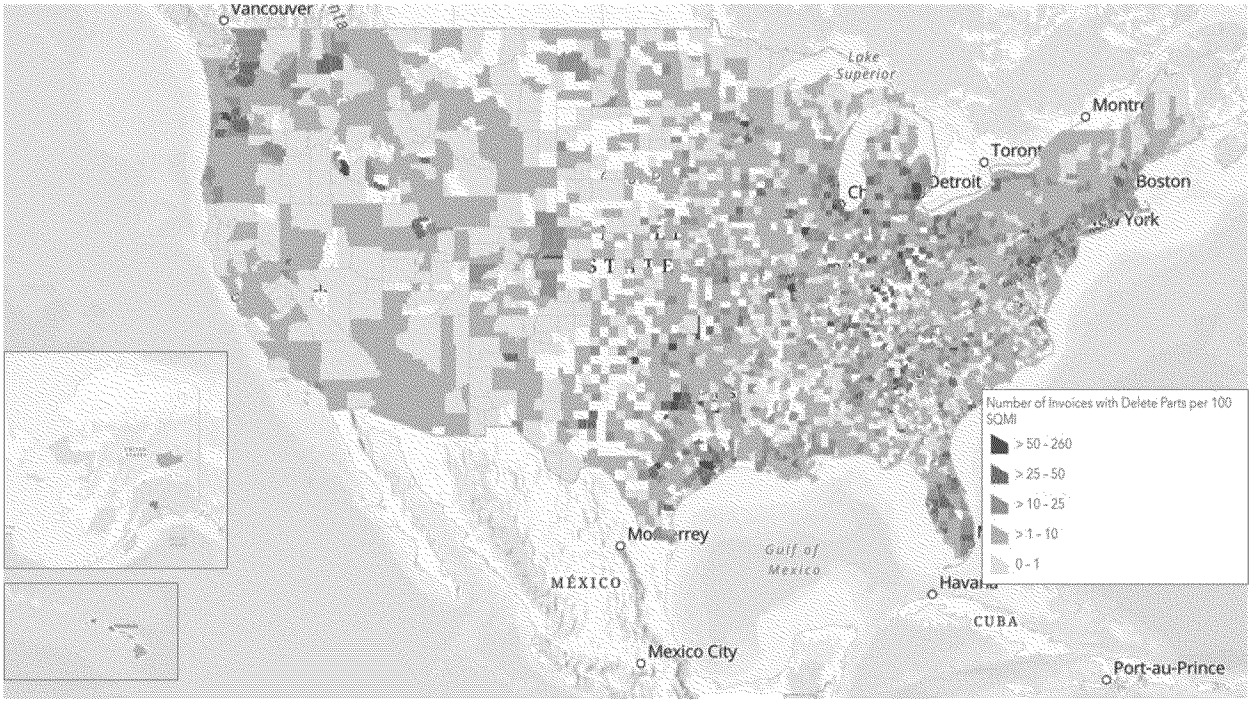

Figure 10. Number of Unique Invoices Containing Delete Parts Per 100 Square Miles by County

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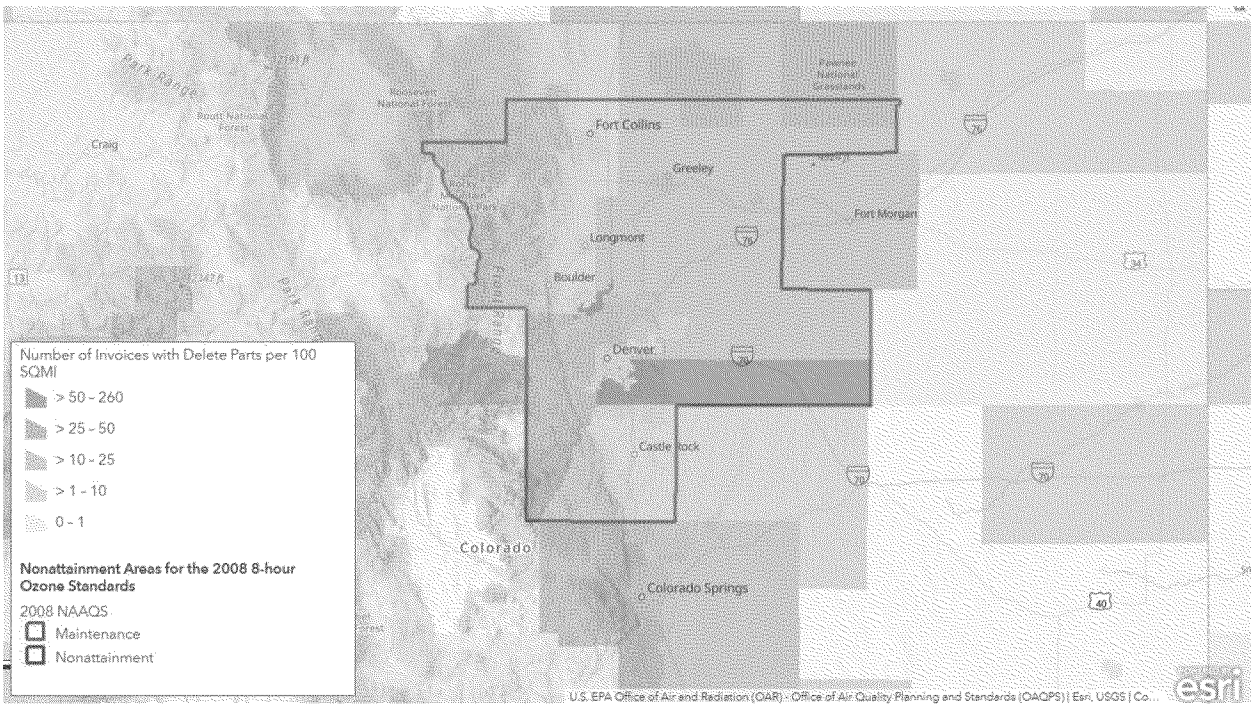

Figure 11. Number of Unique Invoices Per 100 Square Miles Containing Delete Parts – Denver Area

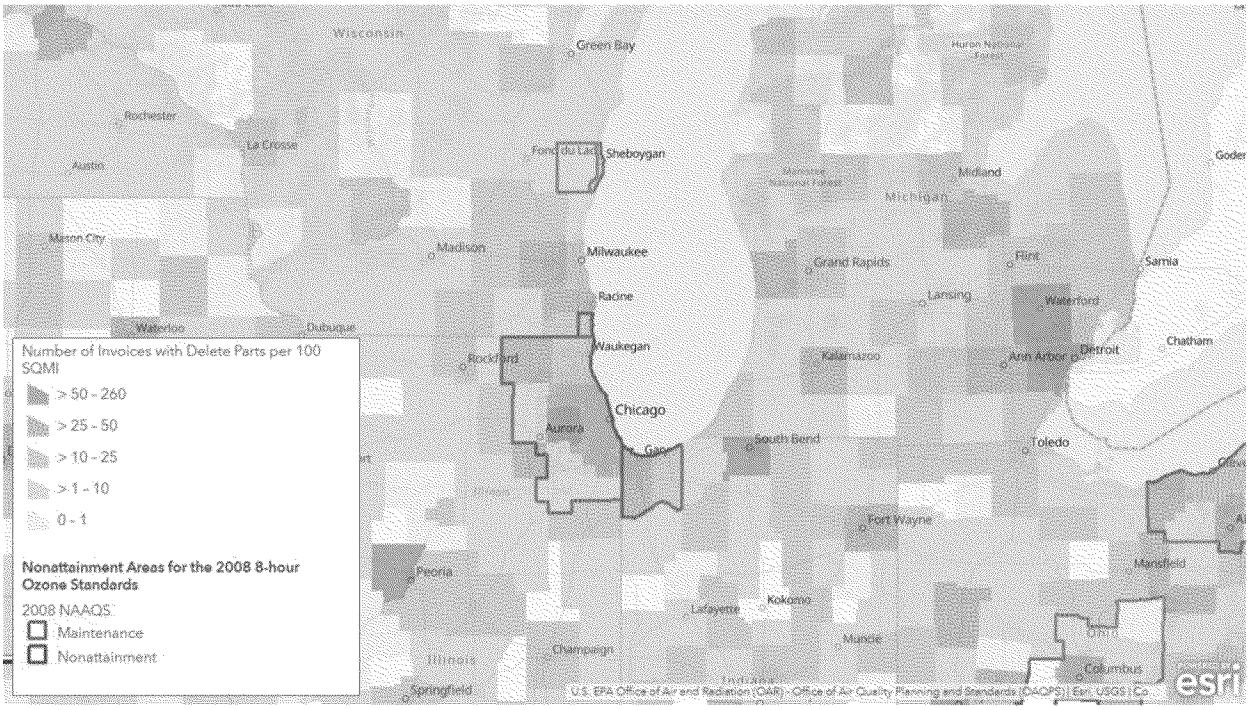

Figure 12. Number of Unique Invoices Per 100 Square Miles Containing Delete Parts – Chicago Area

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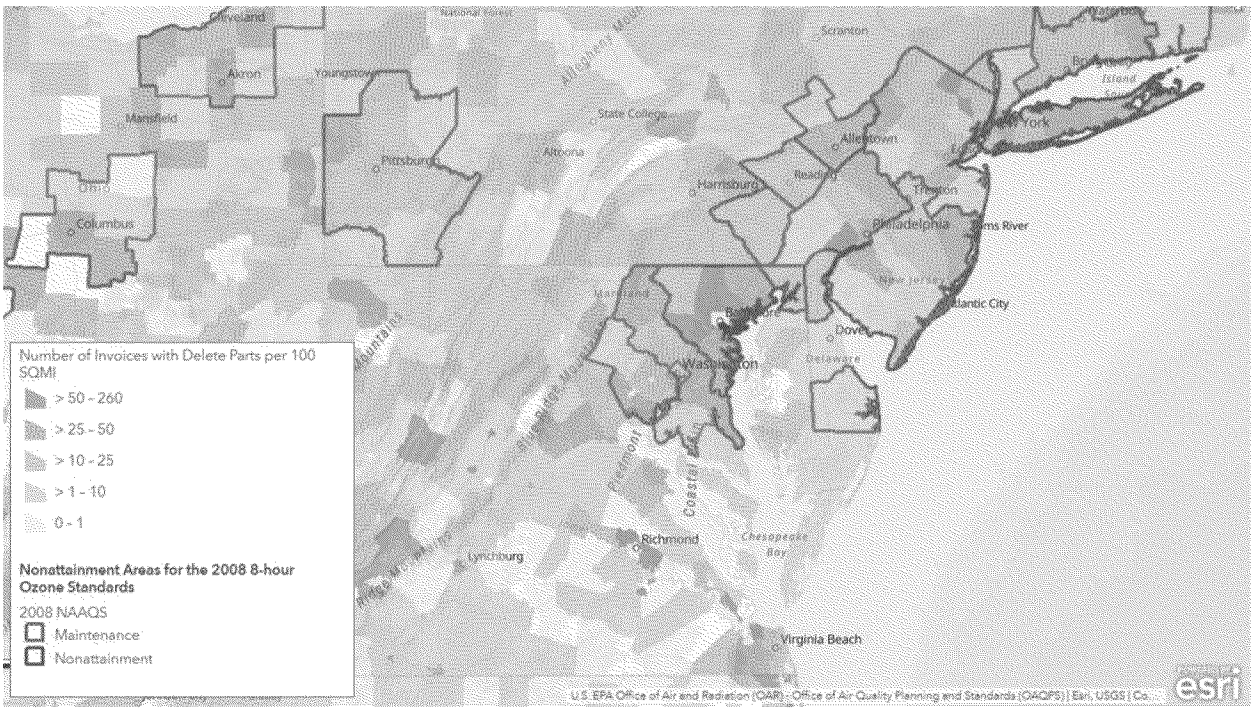

Figure 13. Number of Unique Invoices Per 100 Square Miles Containing Delete Parts – Mid-Atlantic Region

Figure 14. Number of Unique Invoices Per 100 Square Miles Containing Delete Parts – Eastern Texas and Louisiana

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