WEIGH-IN-MOTION (WIM) AND NATIONAL BRIDGE INVENTORY (NBI) DATA INFORMED BRIDGE MONITORING

by

NATALIE M. DOKER

(Under the Direction of Mi Geum Chorzepa)

ABSTRACT

As Georgia's bridge infrastructure ages, it is important to ensure a high level of safety is maintained. A previous reliability analysis of Georgia's bridges is further investigated to assess the accuracy of live load data as well as what structural conditions most affect a bridge's operating rating and ultimately, its reliability index. Live loads were determined using the data collected by Weigh-in-Motion systems while bridge operating ratings were determined using data recorded in the National Bridge Inventory. A quality control analysis is performed for all WIM sites active in Georgia between 2019 and 2021. An analysis is also conducted to determine which bridge elements most affect a bridge's operating rating. Finally, an analysis is performed on a sample of the previously determined low reliability index bridges in Georgia to determine what variables are most likely the cause of a low reliability index.

INDEX WORDS: Bridge, Live load, Load rating, National Bridge Inventory (NBI), Operating rating, Reliability index, Weigh-in-Motion (WIM)

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1.0 | INTRODUCTION

As Georgia's bridge infrastructure ages, it is important to ensure a high level of safety is maintained. A reliability analysis is one way of providing assurance that live loads experienced by a bridge do not exceed its capacity. A reliability index gives a numerical representation of the reliability analysis by using live load and capacity data to calculate the area of overlap between the two. Bridges with a reliability index (RI) value between 2.0 and 5.0 are considered safe, meaning these bridges do not require further investigation and analysis. Bridges with a RI below 2.0 cannot be considered safe and require immediate investigation.

A reliability analysis of Georgia's bridges was performed by University of Georgia Ph.D. student, Ananta Sinha, in his dissertation titled "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" [1]. He found that a high percentage of Georgia's bridges have a RI below 2.0 and recommended that a further analysis be performed to assess the accuracy of bridge load rating/capacity data as well as vehicle weight/live load data. "If the bridge load rating is accurate, vehicle weight data will need to be reviewed. If vehicle weight data is accurate, the bridge load rating will need to be reviewed in light of heavy vehicles observed in the WIM data" [2].

Within this thesis, all bridges in Georgia with a reliability index (RI) below 2.0 are analyzed to determine if live load increases or capacity reductions are a major cause. Weigh-In-Motion (WIM) data, specifically axle weight data, was used to determine live load inputs for the reliability

analysis. National Bridge Inventory (NBI) data, specifically operating rating data, was used to determine capacity inputs for the reliability analysis.

The following chapters will detail a quality control analysis of each WIM site to assure the data used in the reliability analysis was accurate. Any sites containing anomalies will be recommended for recalibration and the bridges that used its live load data will require another iteration of reliability analysis once the anomalies are controlled. The NBI's operating rating data will also be analyzed to determine what variables cause a change in a bridge's operating rating. NBI condition ratings, element data condition states, and Georgia Department of Transportation (GDOT) inspection reports will provide the variables of analysis.

2.0 | LITERATURE REVIEW

The reliability analysis of Georgia's bridges is based on reliability index calculations. Variables needed for the calculation include live loads placed on the bridge and the bridge's capacity. Axle weight data collected by weigh-in-motion (WIM) systems is used as live load input. Operating rating data collected in the National Bridge Inventory (NBI) is used as capacity input. The following subchapters provide background on WIM systems and NBI data. The calculation process for reliability index is also detailed and followed by the results of the reliability analysis on Georgia's bridges performed by Ananta Sinha in 2022 [1].

2.1 Weigh-In-Motion (WIM) Systems

Weigh-in-motion (WIM) systems are defined as "the sensors and other components that estimate the gross vehicle weight of a moving vehicle as well as the portion of this weight that is carried by the tires of each wheel assembly, axle, and axle group on the vehicle" [3]. Various other data is also capable of being collected or calculated by the system such as vehicle speed, lane of operation, date and time of passage, number and spacing of axles, and vehicle classification according to axle arrangement. This collected data is stored and shared for various uses by many controlling and supporting agencies such as U.S. state Departments of Transportation and the Federal Highway Administration (FHWA). A WIM system at a specific site is called a WIM station.

2.1.1 WIM System Background

The need for WIM systems and the monitoring of vehicle axle weights first arose with the creation of the U.S. Interstate Highway System (IHS) by President Dwight D. Eisenhower. Researchers

noted that the size and weight of traffic would directly affect pavement design and therefore the pavement's health and longevity. Eisenhower recognized this and its impact on federal funding of the IHS's making and maintenance. He therefore instated the Federal-Aid Highway Act of 1956 simultaneously with the creation of the IHS. This Act "instituted size and weight limits for vehicles using federally funded highways" as well as "a matching funds system (90% federal to 10% state) for interstate constructions" [3].

The first method of incorporating vehicle axle weights into pavement design was the concept of the 18,000 lb. Equivalent Single Axle Load (ESAL). This was developed from the AASHO Road Test that began testing in October of 1958 and finished in November of 1960 in Ottawa, Illinois. The goal of the test was to monitor how axle loads affected pavement performance and to develop relationships to aid in pavement design. Variables monitored included pavement material, thickness, surface, base, subbase, soil, etc. Results included relationships between axle loads, axle load accumulation, and performance. The standard measure of a vehicle's axle weight was also determined to be 18,000 pounds which created the concept of the 18,000 lb. ESAL. While this concept was very useful in pavement design equations, some recognized it had potential to be problematic given that traffic is comprised of vehicles with varying weights which also vary by location. This directly produced the need for a Weigh-in-Motion system that could collect site-specific traffic data.

One major researcher of this topic was Clyde E. Lee. He began studying portable electronic scales for weighing vehicles in motion as a graduate student at Mississippi State College in 1956. His system included strain-gauge load cells between steel plates, an amplifier system, and a recording device (a strip chart recorder for permanent records). By 1966, he received U.S. Patent

No. 3,266,584 for “Vehicle Weighing Scale with Overlapped Load Bearing Plates” while at the University of Texas as an assistant professor.

In the following years, issues with WIM systems would need to be addressed such as sensor durability, accuracy, calibration, data collection, and data evaluation. Solutions were found through technology advancements and standardization. Technology advancements from the 1950s to today’s modern WIM systems included better sensors, better computers, high-speed Internet, and wireless communications. These all heightened the level of data WIM systems are able to collect as well as the ability to analyze the collected data.

The first American Society for Testing and Materials (ASTM) standard for WIM was ASTM E-1318 “Standard Specification for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Methods”. The creation of ASTM E-1318 in 1990 was led by Dr. Clyde E. Lee. Other standardizations were a result of the Long-Term Pavement Performance (LTPP) program which began in 1987 and is continued today by the FHWA. The program aims to learn more about pavement performance by monitoring pavement test sections to the end of their design life. A subset of these test sections includes WIM systems. In 1996, the issues of accuracy, calibration, and missing data were recognized in WIM systems by the LTPP program. Moving forward, the program developed protocols to obtain “research-quality data”. By 2003, the program felt their protocols and equipment were sufficiently producing research-quality data. This allowed for verification of the ASTM E-1318 standard and the development of an American Association of State Highway and Transportation Officials (AASHTO) standard – AASHTO M 331-17 “Standard Specification for Smoothness of Pavement in Weigh-in-Motion (WIM) Systems”. Other results of the LTPP program were field protocols for WIM calibration and validation, a vehicle

classification table, and default inputs for AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG) and AASHTOWare Pavement Mechanistic-Empirical (ME) Design Software.

2.1.2 WIM Data Use

With advances in WIM technology, the range of data collected has proven to be beneficial in the applications of pavement design, bridge design, asset management, load ratings, commercial vehicle weight enforcement, and freight planning and logistics.

Pavement design in the 1960s until around 1993 only used the concept of the 18,000 lb. ESAL and empirical performance equations developed in Ottawa, Illinois in the 1950s. Due to this method being developed with only the specific conditions available at the time, it often produces pavements that are over-designed in modern conditions. The National Cooperative Highway Research Program (NCHRP) funded the research program NCHRP 1-37A in 1998 to develop new and more mechanistic ways of designing pavement. The program resulted in MEPDG software in 2004. The same year, AASHTO endorsed the software as AASHTO MEPDG. It has been updated multiple times since and the current edition is called AASHTOWare Pavement ME Design. These MEPDG programs use traffic axle load spectra which is defined as "a measurement of all axle loads measured and binned by axle group for the 13 vehicle classifications specified in the FHWA Traffic Monitoring Guide across time (classes 1 to 3 are usually not included in pavement design as the weights and consequent pavement damage are minimal)" [3]. Figure 1 details the 13 vehicle classes as defined by the FHWA. This measurement therefore aids in monitoring vehicle axle configuration and weight on an hourly, daily, monthly, and seasonal basis. Agencies are able to use this detailed, site-specific data to design pavements that are neither under- or over-designed. That ultimately saves the roadway's controlling agency time and money.

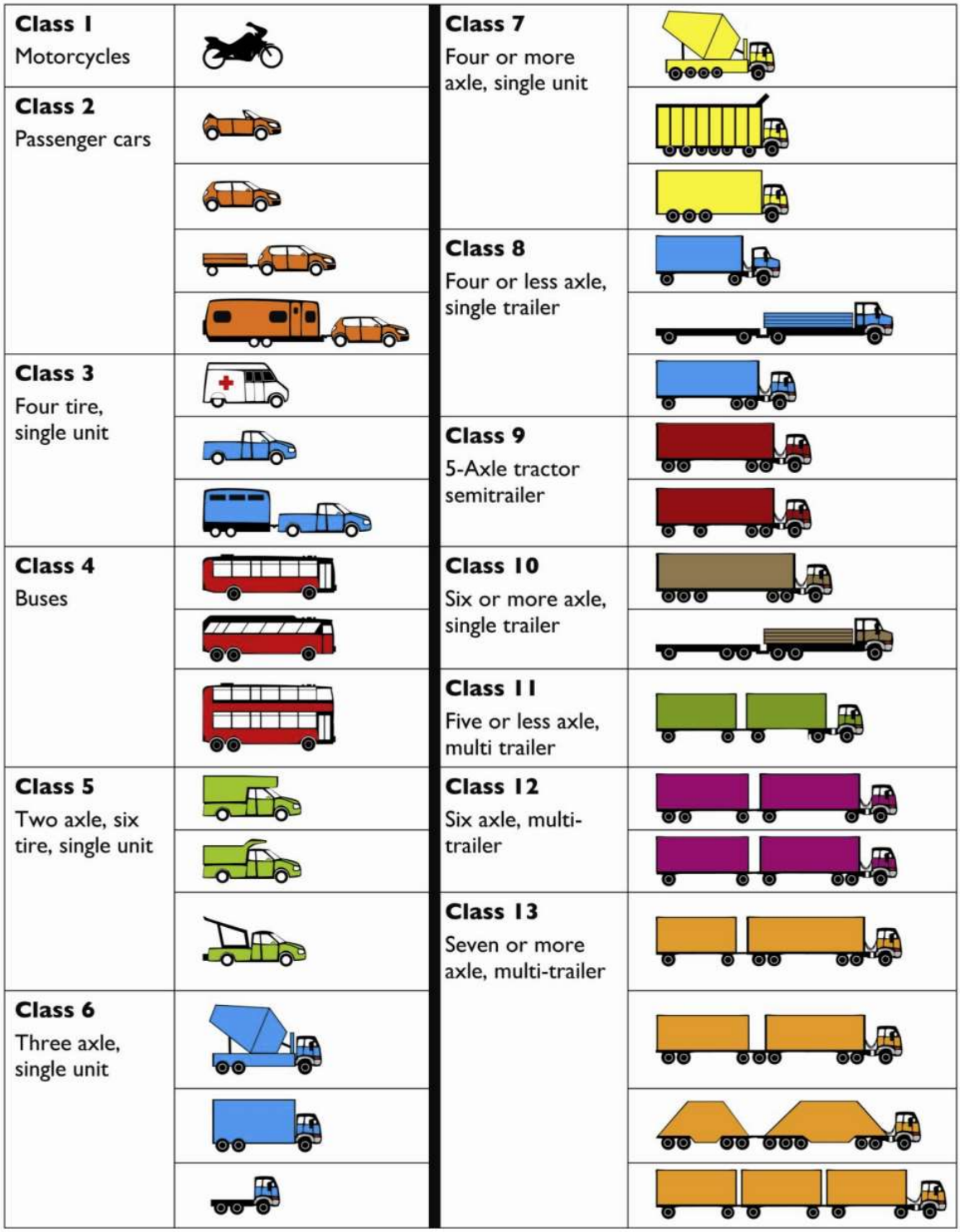


Figure 1. Illustration. FHWA 13 Vehicle Category Classification [4].

A 2020 NCHRP survey [3] of 52 responding agencies including U.S. state DOTs, New York City DOT (NYCDOT), and Canadian provincial DOTs, showed that WIM data was being used for pavement design by 83% of the agencies. Over 60% of them used WIM to monitor average daily traffic (ADT) counts for pavement design. Half of them used WIM to calculate ESALs, the average ten heaviest wheel loads daily (ATHWLD), or percentage of tandem axles for use in pavement design or load zone roadway analysis. More details of the survey question and how the agencies use WIM data in pavement design are shown in Figure 2.

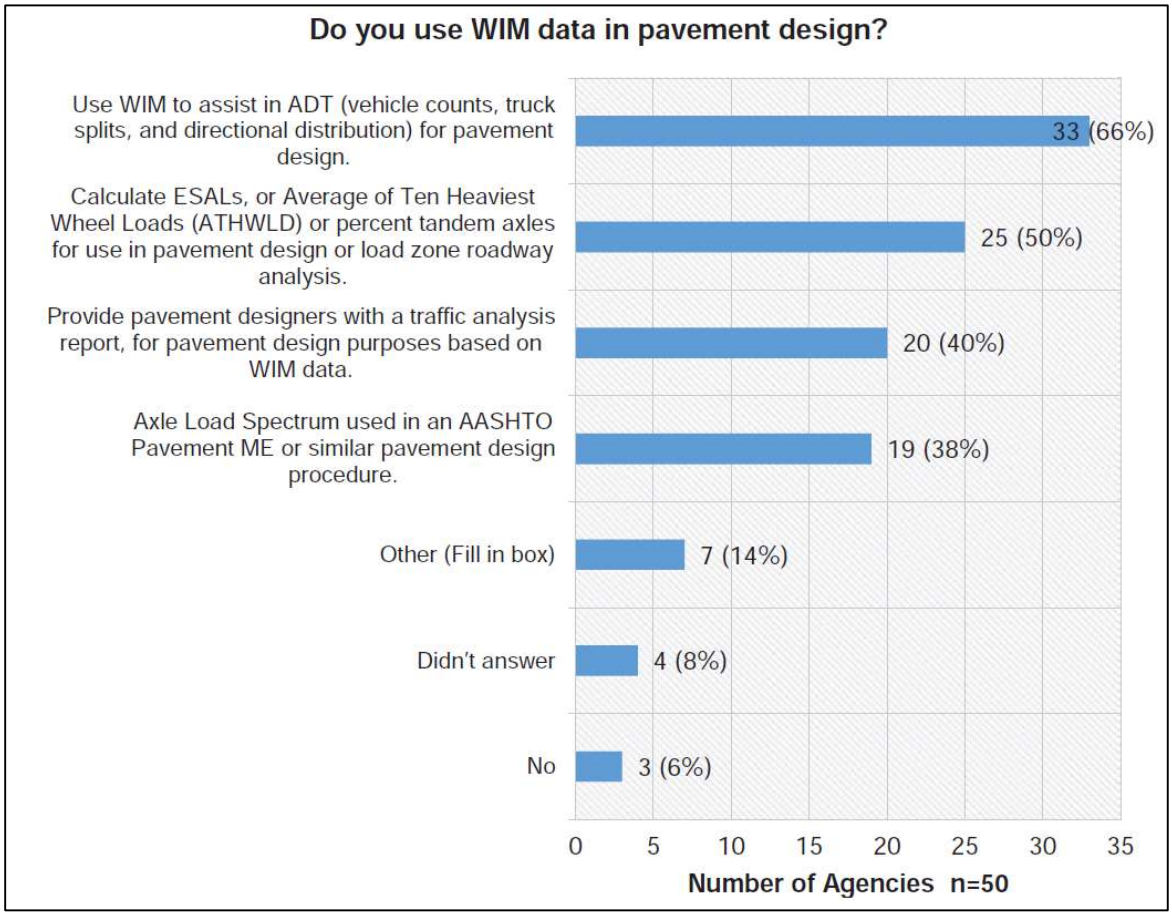


Figure 2. Chart. How Agencies Use WIM in Pavement Designs [3].

Bridge design in the United States has used the AASHTO Load and Resistance Factor Design (LRFD) method since 2007. The live load factors used in this method were developed using truck data recorded in Ontario, Canada in 1975. Site-specific live load data can be used in LRFD, however the cost of obtaining the data with a WIM system often outweighs the cost savings it would produce. Certain cases such as signature bridges and bridges in port areas could save a substantial amount of money even with the cost of obtaining WIM data, though. The 2020 NCHRP survey [3] of 52 agencies showed that 38% of the agencies used ADT counts from WIM data in their bridge design. A considerable amount of the agencies (48%) either did not use WIM data in their bridge design at all or chose not to answer the question. This statistic makes sense considering that WIM systems often do not provide a cost savings in bridge design. More details of the survey question and how the agencies use WIM data in bridge design are shown in Figure 3.

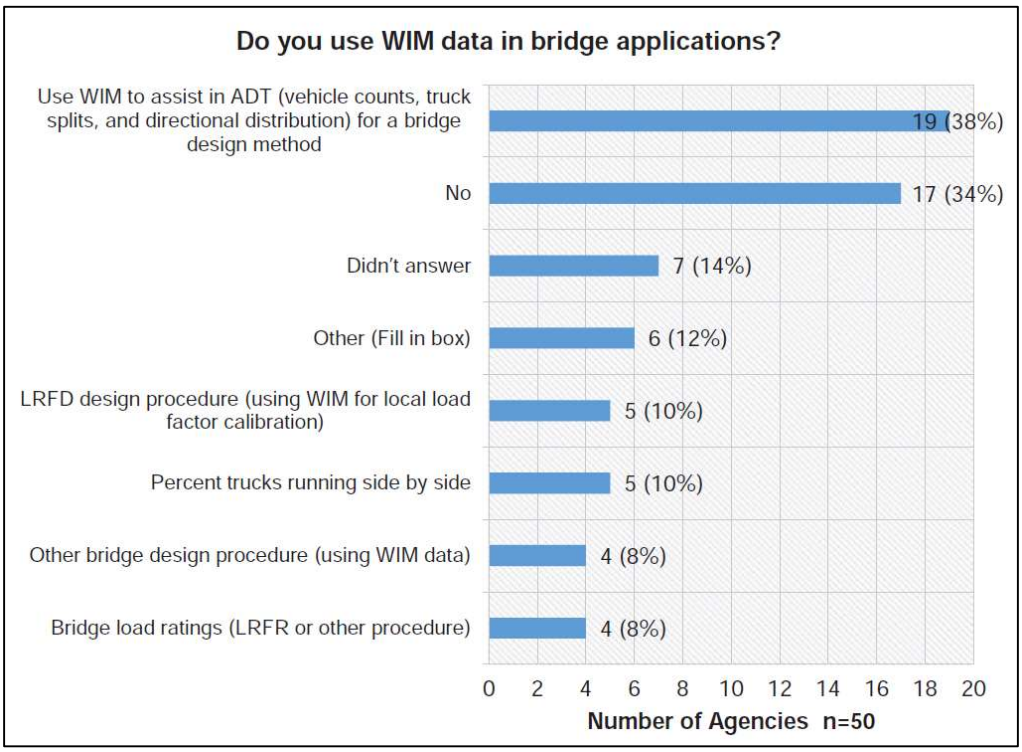


Figure 3. Chart. How Agencies Use WIM Data in Bridge Applications [3].

WIM data can also aid in asset management and load ratings. The Highway Performance Monitoring System (HPMS) managed by the FHWA is a national high-level asset management system including traffic and performance data. U.S. state DOTs are required to report certain data to the FHWA for the HPMS. WIM data could meet these data report requirements as well as aid in individual agencies' asset management systems. For example, Texas uses WIM systems to monitor freight movements across the Texas-Mexico border to ensure that Mexican trucks travelling in the United States comply with U.S. weight limits [3]. New York DOT (NYDOT) also uses their WIM data to monitor how many overweight trucks travel on their roads and bridges [3]. They use this data to estimate how much damage excessive vehicle weight causes. In 2015, researchers used WIM data to find that 18% of trucks travelling in New York are overweight while 6% of trucks are illegally overweight. This would cause an estimated $100 million of damage to roads and bridges. NYDOT funds WIM data as well to also produce site-specific load factors for use in Load and Resistance Factor Rating (LRFR). This allows them to design and construct understrength bridges that can still handle New York's traffic.

The 2020 NCHRP survey [3] of 52 agencies showed that 44% of agencies do not use WIM data for any asset management or load rating. However, 38% of agencies do use WIM data for pavement management. More details of the survey question and how the agencies use WIM data in asset management and load ratings are shown in Figure 4.

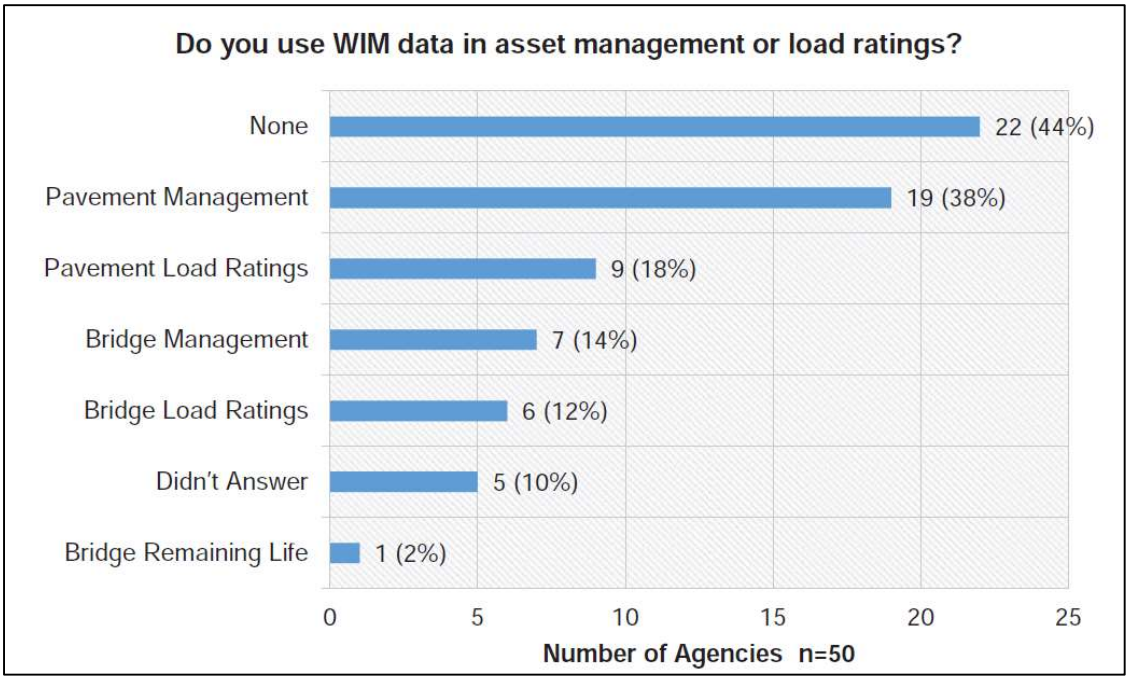


Figure 4. Chart. How Agencies Use WIM Data in Asset Management or Load Ratings [3].

Enforcing load limits is an important factor in prolonging the useful life of pavement. This responsibility is sometimes given to U.S. state DOTs, but is more often the responsibility of law enforcement agencies. Static weigh stations are a common tool used to weigh commercial vehicles. WIM systems could be utilized in addition to the static weigh stations to save time. WIM stations could be strategically installed a few miles before static weigh stations. This would allow the monitoring agency to pre-select possible overweight vehicles after passing over the WIM station and direct them to the static stations. This pre-selection process saves time by only stopping the commercial trucks that are likely overweight. Norway uses Virtual Weigh Stations (VWS) to implement pre-selection [3]. VWS is defined as "a WIM system augmented with additional sensors and cameras that may include over-height detection and image capture of license plates or DOT numbers for identification" [3]. These systems are more suited for law enforcement purposes than

a regular WIM system or static weigh stations because they are able to capture license plate information and images while vehicles are in motion.

The 2020 NCHRP survey [3] of 52 agencies showed that 44% of DOT agencies have weight enforcement responsibilities and 26% have law enforcement responsibilities as detailed in Figure 5. The 52 agencies were then asked if they used WIM data to support weight enforcement and 62% answered that they do, as detailed in Figure 6.

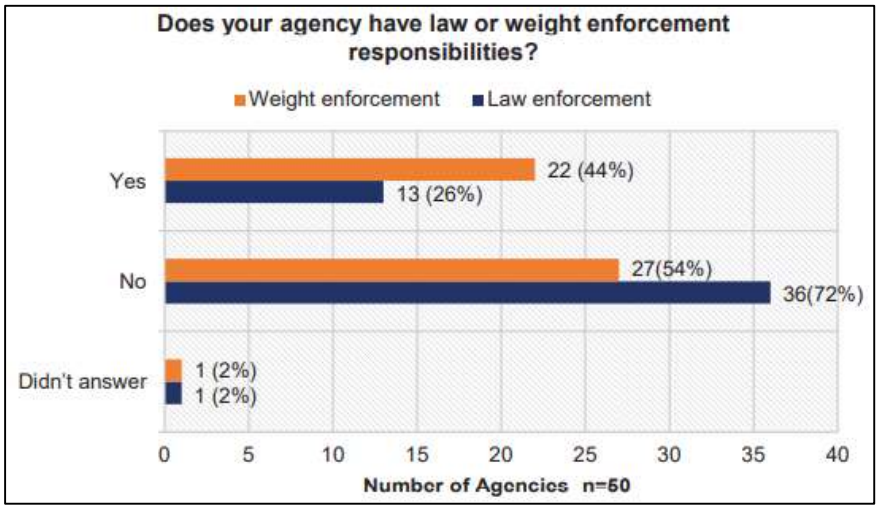


Figure 5. Chart. Number of Agencies with or without Law or Weight Enforcement Responsibilities [3].

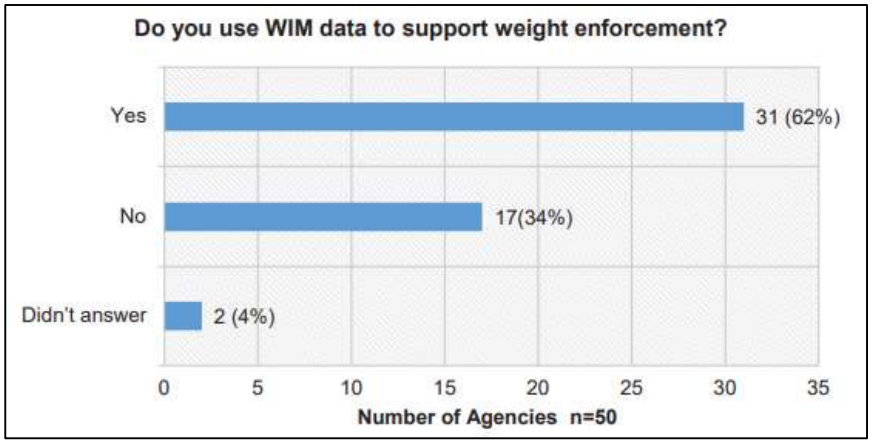


Figure 6. Chart. Number of Agencies Using WIM Data to Support Weight Enforcement [3].

Freight planning and logistics applications are fairly new to utilizing WIM data. State DOTs often purchase freight data from third parties. Freight data would include variables such as freight volume, weight, value, origin-destination, and routing. A study done by the Transportation Research Board (TRB) in 2005 noted that there was a lack of data available to agencies to aid in freight planning and logistics [3]. Agencies reported that they lacked WIM data, automated vehicle classification data, and freight data. There are agencies that are currently researching ways to utilize WIM systems for collecting this needed data. Florida performed a study in 2018 on commodity flows in and out of Florida including direction, volume, and value [3]. The researchers combined the FHWA's Freight Analysis Framework, the Transearch database owned by IHS Global Insight, and Florida DOT (FDOT) WIM and vehicle classification databases to develop loaded and unloaded freight data. This allowed FDOT to better understand freight movements and infrastructure demands. NYCDOT currently uses WIM to develop freight plans including specifying truck routes and encouraging off-hours delivery. This exemplifies how WIM can be used for traffic control which could also aid in traffic emissions mitigation.

The 2020 NCHRP survey [3] of 52 agencies showed that 42% of agencies use WIM data to monitor freight movements. A large percentage of agencies, 38%, don't use WIM data for freight planning or logistics at all. More details of the survey question and how the agencies use WIM data in freight planning and logistics are shown in Figure 7.

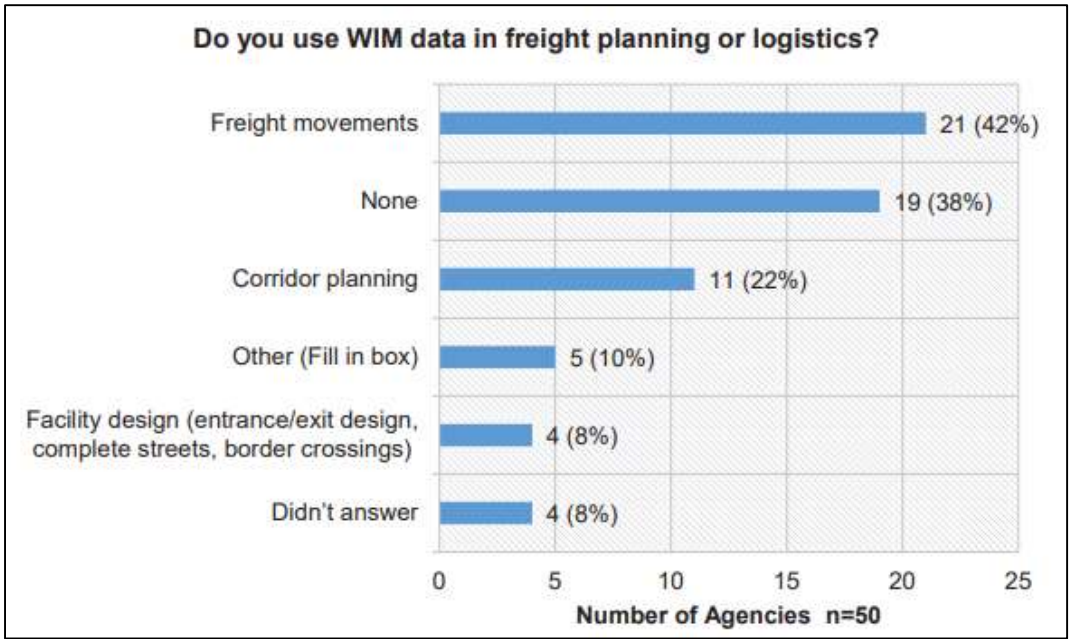


Figure 7. Chart. How Agencies Use WIM Data in Freight Planning or Logistics [3].

2.1.3 Quality Assurance and Quality Control

Quality assurance (QA) is defined as "WIM data management focused on providing confidence that the proposed WIM data quality requirements will be met" [5]. Quality control (QC) is defined as "WIM data management aimed at meeting proposed quality requirements" [5]. Therefore, QC is a part of QA.

The 2020 NCHRP survey [3] of 52 agencies showed that 88% of agencies perform QC on all of their WIM data. More details of the survey question answers are shown in Figure 8.

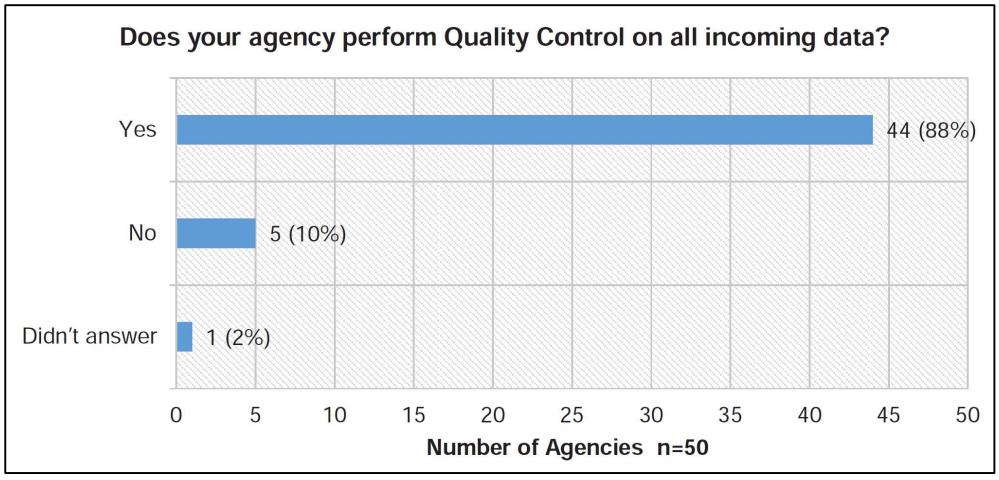


Figure 8. Chart. Number of Agencies That Perform WIM Data Quality Control [3].

QA consists of data checks in the field as well as data analyses in the office. Each Department of Transportation (DOT) agency follows a QC protocol as part of their overall QA plan. The Georgia Department of Transportation's Research Project (RP) 18-36 ("Development of Weigh-in-Motion Data Quality Control Algorithms and Procedures") [5] details current QC protocols and makes recommendations to improve them. GDOT's RP 18-36 includes a detailed draft of Georgia's "Weigh-in-Motion (WIM) Data Quality Control Guide". As of 2019, GDOT's Office of Transportation Data (OTD) manages WIM data including performing QA and QC procedures. In the future, they hope to have a third-party vendor handle QA and QC procedures. Recommendations to improve Georgia's QC process include:

- Perform off-site (in-office) QC data checks annually.
- Obtain 97% usable data from all sites.
- Employ only piezoelectric quartz sensors or an equivalent.
- Employ sensors that collect weight and axle spacing data in all lanes of a site.
- Use axle weight as well as axle number and spacing to classify vehicles.

- Adopt and document a consistent vehicle classification system.
- Provide well-documented maintenance logs to all involved parties.

2.1.4 Calibration

A major objective of Quality Control (QC) procedures is to identify the need for calibration at WIM sites. Calibration is the comparison of measured values obtained by a WIM device to a standard of known accuracy. This is often achieved by driving a Class 9 truck of a known weight and known axle spacing through a WIM site and comparing the collected data values to the truck's known values. The comparison allows for the calculation of a calibration factor which is applied to the WIM system's data collection process. This comparison and calibration factor process is then iterated until the data collected is accurate to a pre-specified tolerance. GDOT currently hires Southern Traffic Services, Inc. (referred to as the vendor) to install, maintain, and calibrate Georgia's WIM sites [5]. Each DOT and agency performs calibration at different intervals although it is required by ASTM E 1318-09 to calibrate Type I WIM systems yearly [5]. The 2020 NCHRP survey [3] of 52 agencies showed that 46% of agencies calibrate their WIM systems annually and 16% calibrate theirs semiannually or more often than annually. It also shows that only 54% of agencies calibrate their WIM systems when installed. More details of the survey question answers are shown in Figure 9.

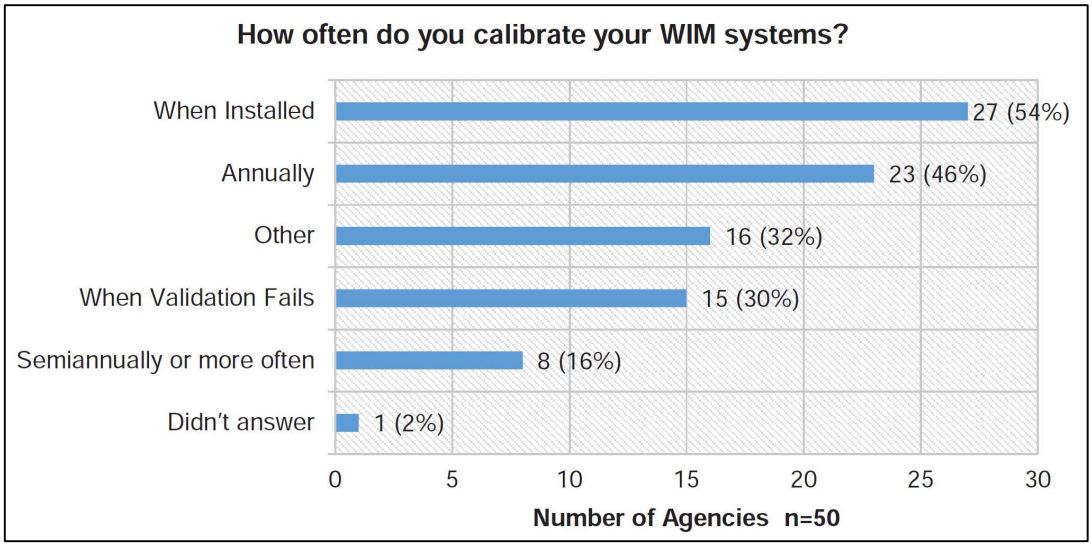


Figure 9. Chart. Calibration Frequency [3].

Recommendations to improve Georgia's calibration process made by GDOT's research team in Research Project 18-36 include:

- Include third-party observation of calibration.
- Use 3 Class 9 trucks and implement 3-5 varied speeds in calibration process.
- Employ image processing tool to capture axle spacings.
- Utilize static weigh station data to calibrate at smaller intervals.
- Include visualization techniques using R or Python coding.
- Employ performance-based approach to decide when calibration will be performed.
- Annually calibrate 3 to 5 randomly chosen WIM sites in addition to performance-based approach calibration.
- Maintain well-documented reports/logs of calibration process.
- Monitor monthly weight shifts for Class 9 single axle load spectra.

    - Weight shift of 5% or less is acceptable; weight shifts of more than 5% indicate a need for recalibration within 3 months.
- Establish and monitor month-long Comparison Data Sets (CDS) after each calibration.
- Establish and monitor year-long CDS.

Comparison Data Sets (CDS) consist of the data collected immediately following a calibration either for a period of one month or one year. The year-long CDS will begin in the first January following calibration. These data sets are compared to the data set collected in the previous period in an attempt to indicate any persistent issues. CDS can be utilized to highlight common inconsistencies in Georgia's WIM sites.

2.2 National Bridge Inventory

Safety inspections are performed on the United States' bridges at least once every 24 months. The findings of these inspections are recorded according to the Federal Highway Administration's (FHWA) "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges" [6] and stored in the National Bridge Inventory (NBI). Information on 116 items is stored in the NBI. Details of how each item is recorded is given in the FHWA's coding guide [6]. The analysis performed in this thesis will include the following NBI data items:

- Structure number (item 8).
- Year built (item 27).
- Year reconstructed (item 106).
- Deck condition rating (item 58).
- Superstructure condition rating (item 59).
- Substructure condition rating (item 60).

- Operating rating (item 64).
- Scour critical rating (item 113).

2.2.1 Condition Ratings

General condition ratings (GCRs) are given to NBI items such as bridge decks (NBI item 58), superstructures (NBI item 59), and substructures (NBI item 60). GCRs are given as a number from 0 being failed condition to 9 being excellent condition. Note that a condition rating of N for deck, superstructure, or substructure indicates that the structure is a culvert. The bridge as a whole is then given a rating of good, fair, or poor based on the minimum of the GCR of the 3 bridge items deck, superstructure, and substructure. A rating of good has a minimum GCR of 7, 8, or 9. A rating of fair has a minimum GCR of 5 or 6. A rating of poor has a minimum GCR of 4 or lower [6]. Figure 10 provides a graphic describing what each GCR code means about a bridge's condition.

Code	Description
9	**EXCELLENT CONDITION**
8	**VERY GOOD CONDITION**—No problems noted.
7	**GOOD CONDITION**—Some minor problems.
6	**SATISFACTORY CONDITION**—Structural elements show some minor deterioration.
5	**FAIR CONDITION**—All primary structural elements are sound but may have some minor section loss, cracking, spalling, or scour.
4	**POOR CONDITION**—Advanced section loss, deterioration, spalling, or scour.
3	**SERIOUS CONDITION**—Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	**CRITICAL CONDITION**—Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present, or scour may have removed substructure support. Unless closely monitored, the bridge may have to be closed until corrective action is taken.
1	**IMMINENT FAILURE CONDITION**—Major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put it back in light service.
0	**FAILED CONDITION**—Out of service. Bridge is beyond corrective action.

Figure 10. Illustration. National Bridge Inventory General Condition Rating Descriptions [7].

Deck condition ratings are based on inspection reports which take note of cracking, scaling, spalling, leaching, chloride contamination, potholing, delamination, and full or partial depth failures in concrete decks [6]. Steel grid decks are inspected for broken welds, broken grids, section loss, and growth of filled grids from corrosion [6]. Timber decks are inspected for splitting,

crushing, fastener failure, and deterioration from rot [6]. The deck condition rating does not consider the condition of the wearing surface/protective system, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rail, and scuppers, although, their condition is noted within inspection reports. “Decks integral with the superstructure will be rated as a deck only and not how they may influence the superstructure rating (for example, rigid frame, slab, deckgirder or T-beam, voided slab, box girder, etc.). Similarly, the superstructure of an integral deck-type bridge will not influence the deck rating” [6].

Superstructure condition ratings are based on signs of distress of the structural members noted during inspection including cracking, deterioration, section loss, and malfunction and misalignment of bearings. The rating does not consider the condition of bearings, joints, paint system, etc., although, their condition is noted within inspection reports. “On bridges where the deck is integral with the superstructure, the superstructure condition rating may be affected by the deck condition. The resultant superstructure condition rating may be lower than the deck condition rating where the girders have deteriorated or been damaged” [6]. Special attention should be given to fracture critical components. Fracture critical members have 3 components: made of steel, in tension, and are non-redundant [8]. If a single fracture critical member were to fail, it would be very likely that the entire structure would fail as well.

Substructure condition ratings include bridge components such as piers, abutments, piles, fenders, and footings. Inspection reports look for signs of distress of those components including cracking, section loss, settlement, misalignment, scour, collision damage, and corrosion [6]. The substructure condition rating is determined independent of the deck and superstructure. Integral-abutment wingwalls to the first construction or expansion joint are included in the evaluation. For non-integral superstructure and substructure units, the substructure is considered to be the portion

below the bearings. For structures where the substructure and superstructure are integral, the substructure is considered to be the portion below the superstructure [6].

2.2.2 Operating Rating

Operating rating or capacity rating is defined as "the absolute maximum permissible load level to which the structure may be subjected for the vehicle type used in the rating" [6]. It is recorded as item 64 in the NBI. It is a 3-digit number ranging from '000' to '999' which represents "the total mass in metric tons of the entire vehicle measured to the nearest tenth of a metric ton (with an assumed decimal point)" [6]. Note that the method of coding requires MS loading which is the metric equivalent to HS loading. For example, MS18 which has a mass of 32.4 metric tons is coded as '324'. If a bridge cannot carry a minimum of 2.7 metric tons of live load, the operating rating is coded as '000' and should be closed. A temporary bridge would also be coded as '000'. If a bridge is under sufficient fill meaning the live load is insignificant in the structure's load capacity, it's operating rating will be coded as '999'.

Note that there are multiple load rating methods available including load factor (LF), allowable stress (AS), and load and resistance factor rating (LRFR). The FHWA uses the LF method as the standard for determining operating ratings reported to the NBI [6]. However, highway agencies can choose to use any of the methods to establish load limits for purposes of load posting. NBI item 63 indicates which load rating method was used by the number 1, 2, 3, 4, or 5.

Table 1 provides the corresponding code and description for item 63. The LF method and code '1' are most often seen as it is the FHWA's preferred standard.

Table 1. NBI Item 63 – Method Used to Determine Operating Rating [6].

Code	Description
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor Rating (LRFR)
4	Load Testing
5	No rating analysis performed

2.2.3 Scour Critical Bridges

NBI item 113 details the vulnerability of a bridge to scour. Scour is defined as "erosion of streambed or bank material due to flowing water; often considered as being localized" [9]. "A scour critical bridge is one with abutment or pier foundations which are rated as unstable due to (1) observed scour at the bridge site or (2) a scour potential as determined from a scour evaluation study" [6]. Scour analyses should be conducted by hydraulic, geotechnical, or structural engineers and they should follow the guidelines given by the FHWA Technical Advisory 5140.23 titled, "Evaluating Scour at Bridges" [9].

The scour analysis will determine a rating factor between 0 being failed and 9 being excellent condition.

Table **2** provides a description of codes 0 through 9 as well as the codes N, U, and T. Figure 11 provides a visual of the rating factors 3, 5, and 8. Note that if the scour analysis determines a rating factor of 4 or below, the bridge's substructure condition rating (item 60) "may need to be revised to reflect the severity of actual scour and resultant damage to the bridge" [6].

Table 2. NBI Item 113 – Scour Critical Bridges Rating Factors [6].

Code	Description
N	Bridge not over waterway.
U	Bridge with "unknown" foundation that has not been evaluated for scour. Since risk cannot be determined, flag for monitoring during flood events and, if appropriate, closure.
T	Bridge over "tidal" waters that has not been evaluated for scour, but considered low risk. Bridge will be monitored with regular inspection cycle and with appropriate underwater inspections. ("Unknown" foundations in "tidal" waters should be coded U.)
9	Bridge foundations (including piles) on dry land well above flood water elevations.
8	Bridge foundations determined to be stable for assessed or calculated scour conditions; calculated scour is above top of footing. (Figure 11 Example A)
7	Countermeasures have been installed to correct a previously existing problem with scour. Bridge is no longer scour critical.
6	Scour calculation/evaluation has not been made. (Use only to describe case where bridge has not yet been evaluated for scour potential.)
5	Bridge foundations determined to be stable for calculated scour conditions; scour within limits of footing or piles. (Figure 11 Example B)
4	Bridge foundations determined to be stable for calculated scour conditions; field review indicates action is required to protect exposed foundations from effects of additional erosion and corrosion.
3	Bridge is scour critical; bridge foundations determined to be unstable for calculated scour conditions: - Scour within limits of footing or piles. (Figure 11 Example B) - Scour below spread-footing base or pile tips. (Figure 11 Example C)
2	Bridge is scour critical; field review indicates that extensive scour has occurred at bridge foundations. Immediate action is required to provide scour countermeasures.
1	Bridge is scour critical; field review indicates that failure of piers/abutments is imminent. Bridge is closed to traffic.
0	Bridge is scour critical. Bridge has failed and is closed to traffic.

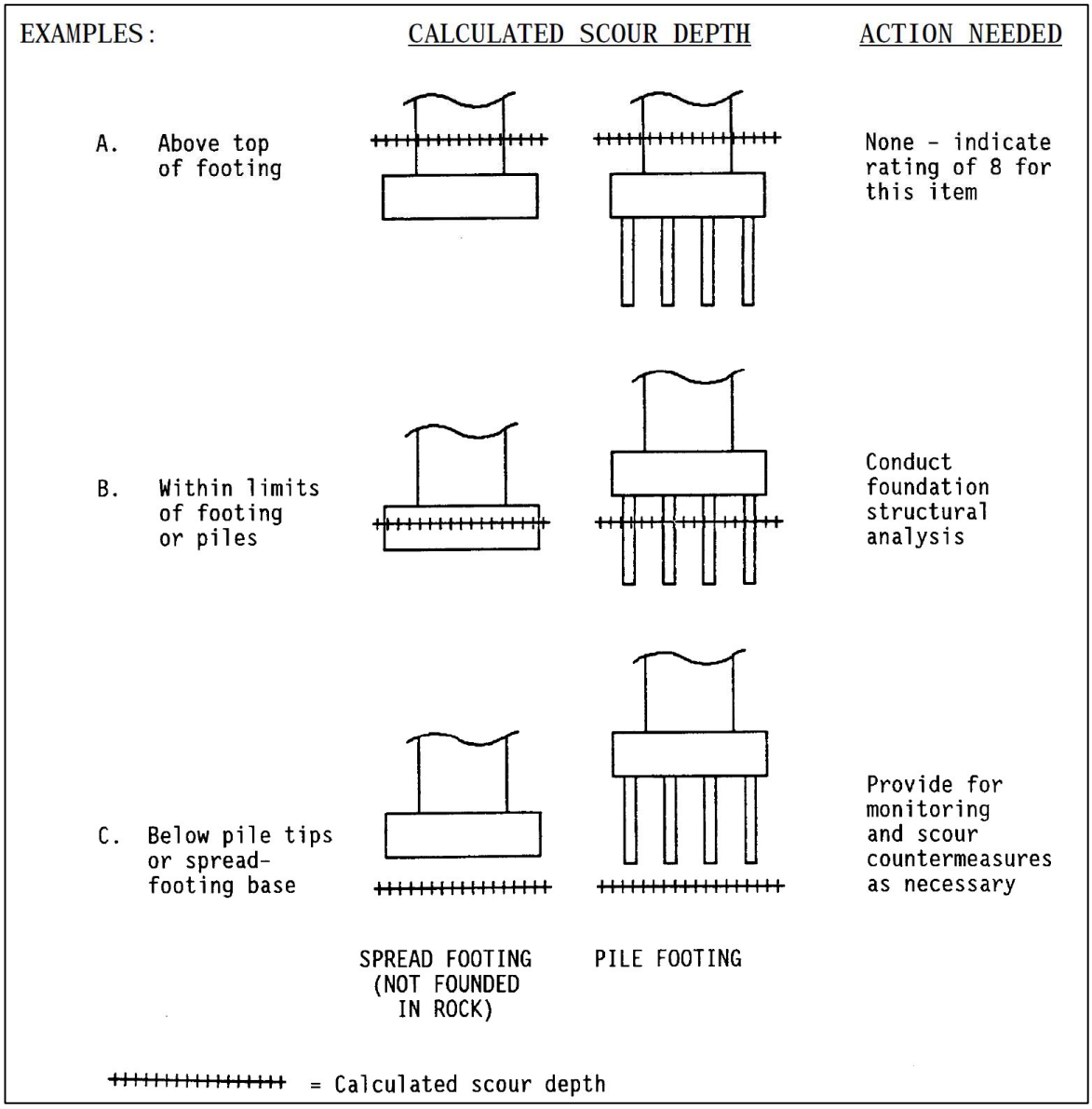


Figure 11. Illustration. NBI Item 113 – Visual of Select Scour Critical Bridge Rating Factors [6].

2.2.4 National Bridge Inventory Element Data

Element level bridge inspection techniques were introduced in the early 1990s [10]. It provides greater detail to an inspection which allows condition data to better represent the severity of bridge

condition deficiencies. Due to this, it has been adopted by the majority of U.S. state Departments of Transportation.

Each bridge element quantity is recorded in its appropriate unit (linear feet (LF), square feet (SF), or each (EA)). Every unit of the element is then inspected and given a condition state. There are four condition states (CS) as shown in Table 3. Good is represented by CS1, fair by CS2, poor by CS3, and severe by CS4.

Table 3. National Bridge Inventory Bridge Element Condition States.

Condition State	Description
1	Good
2	Fair
3	Poor
4	Severe

There are three types of elements: National Bridge Elements (NBEs), Bridge Management Elements (BMEs), and Agency-Developed Elements (ADEs). NBEs "represent the primary structural components of bridges necessary to determine the overall condition and safety of the primary load carrying members" [11]. NBEs are the elemental breakdown of bridge deck, superstructure, substructure, and culvert if applicable. Bridge rails and bearings are also considered NBEs [11].

Table 4 reflects this, showing the element number (EN) for all elements considered National Bridge Elements (NBEs).

Table 4. NBE Element Numbers (EN) [10].

Element	Units	Element Number (EN)					
		Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Deck/Slab							
Deck	SF		13	12	31		60
Open Grid Deck	SF	28					
Concrete Filled Grid Deck	SF	29					
Corrugated or Orthotropic Deck	SF	30					
Slab	SF			38	54		65
Top Flange	SF		15	16			
Superstructure							
Closed Web/Box Girder	LF	102	104	105			106
Girder/Beam	LF	107	109	110	111		112
Stringer	LF	113	115	116	117		118
Truss	LF	120			135		136
Arch	LF	141	143	144	146	145	142
Main Cable	LF	147					
Secondary Cable	EA	148					149
Floor Beam	LF	152	154	155	156		157
Pin, Pin and Hanger Assembly	EA	161					
Gusset Plate	EA	162					
Substructure							
Column	EA	202	204	205	206		203
Column Tower (Trestle)	LF	207			208		
Pier Wall	LF			210	212	213	211
Abutment	LF	219		215	216	217	218
Pile Cap/Footing	LF			220			
Pile	EA	225	226	227	228		229
Pier Cap	LF	231	233	234	235		236
Culvert							
Culvert	LF	240	245	241	242	244	243
Bridge Rail							
Bridge Rail	LF	330*		331	332	334	333
Bearing							
Elastomeric	EA	310					
Movable (roller, sliding, etc.)	EA	311					
Enclosed/Concealed	EA	312					
Fixed	EA	313					
Pot	EA	314					
Disk	EA	315					

Other	EA	316

*Element 330 - Metal Bridge Rail may include steel or aluminum rails.

Bridge Management Elements (BMEs) "include components of bridges such as joints, wearing surfaces, and protective coating systems and deck/slab protection systems that are typically managed by agencies utilizing Bridge Management Systems (BMSs)" [11]. The element number for all BMEs recorded in NBI's element data are shown in Table 5. These are not intended for use with national policymaking and therefore, can be used and modified as each agency sees fit. The NBI Element Data provides an Element Parent Number (EPN) alongside BMEs. The EPN listed with each BME should be the element number of the NBE that it is being protecting. For example, a steel protective coating (EN 515) that is a protective system for a steel beam would have the EPN 107.

Table 5. BME Element Numbers (EN) [10].

Element	Units	Element Number (EN)
Joint		
Strip Seal	LF	300
Pourable	LF	301
Compression	LF	302
Assembly with Seal (Modular)	LF	303
Open	LF	304
Assembly without Seal	LF	305
Other	LF	306
Wearing Surfaces and Protective Coatings		
Wearing Surfaces	SF	510
Steel Protective Coating	SF	515
Concrete Protective Coating	SF	521

Agency-Developed Elements (ADEs) are custom elements that "provide flexibility for an agency in accordance with the defined element framework that may be sub-elements of NBEs or BMEs, or may be ADEs without ties to the other elements" [11] previously defined. Any agency

can define an ADE based upon their needs. Element numbers 800 and above are reserved for ADEs.

In summary, the NBI Element Database includes the following data:

1. State Code (NBI Item 1)
2. Structure Number (NBI Item 8)
3. Element Number (EN)
4. Element Total Quantity
5. Element Condition State One (CS1)
6. Element Condition State Two (CS2)
7. Element Condition State Three (CS3)
8. Element Condition State Four (CS4)
9. Element Parent Number (EPN)

NBEs and BMEs will be included in the NBI Element Database, however ADE data will have to be accessed through the agency utilizing them. Appendix A provides a table and flowchart of all elements and their element numbers that could be listed in the NBI Element Data. AASHTO's "Manual for Bridge Element Inspection" [11] provides detailed element descriptions including all possible defects. Specific defects are not recorded in the NBI Element Data, however, should be noted in the full inspection report.

Table 6 shows an example NBI Element dataset that includes all details previously defined.

Table 6. NBI Element Data Example [10].

STATE	STRUCNUM	EN	EPN	TOTALQTY	CS1	CS2	CS3	CS4
1	14277	12		16217	0	16000	217	0
1	14277	510	12	15783	15083	500	0	200
1	14277	107		2054	1044	1000	10	0
1	14277	515	107	15728	0	5628	10000	100
1	14277	205		8	4	4	0	0
1	14277	210		54	44	5	5	0
1	14277	215		182	140	30	12	0
1	14277	234		150	105	30	12	0
1	14277	304		158	100	58	0	0
1	14277	310		40	30	5	5	0
1	14277	331		412	360	40	12	0

2.3 Reliability Analysis of Georgia's Bridges

The live load or traffic weight bridges carry continues to increase over time while an aging bridge's capacity will decrease. If that trend is sustained, bridges will present a large safety risk and eventually fail. A reliability analysis can assess a bridge's probability of failure and allow the asset manager to maintain an acceptable level of safety. University of Georgia Ph.D. student, Ananta Sinha, was able to perform a reliability analysis of Georgia's bridges with results detailed in the Georgia Department of Transportation's Research Paper 20-04 titled "Phase-II Weight-In-Motion (WIM) Data Synthesis and Validation" [12]. Sinha used WIM and NBI data from the last three years, 2019 to 2021, to conduct the data-driven reliability analysis. The WIM data was used to estimate live load factors for the bridges and predict future live load factors. The goal of the analysis was to identify WIM sites associated with bridges showing an unacceptable risk.

2.3.1 Reliability Index

Data-driven reliability analyses determine probability of failure through the calculation of a reliability index. The reliability index for a bridge requires knowing its load effect and strength. The load effect or applied live loads can be found using WIM data, specifically axle weight data. The strength or capacity can be found using NBI data, specifically operating ratings.

To calculate the reliability index, a limit state function (g) must first be defined. The load effect on a bridge (Q) is subtracted from the strength (R) as exhibited in the formula below.

$$g = R - Q \tag{1}$$

In general, "structural behavior is considered as satisfactory if $g > 0$, and unacceptable when $g \leq 0$" [12]. Note that Q and R are both random variables, meaning their absolute values cannot be determined with absolute certainty. To overcome this, the First Order Second Moment (FOSM) method of probabilistic analysis is utilized [12]. This method will provide the probability of failure (p_f) and is calculated using the mean and standard deviation of both R and Q as well as the normal distribution function (ϕ). The calculation is as follows:

$$p_f = \phi\left(-\frac{\mu_R - \mu_Q}{\sqrt{{\sigma_R}^2 + {\sigma_Q}^2}}\right) \tag{2}$$

The probability of failure (p_f) can then be used to find the reliability index, denoted below as β.

$$\beta = \phi^{-1}(1 - p_f) \tag{3}$$

Bridges are designed for a reliability index of 3.5, however a reliability index ranging between 2.0 and 5.0 is acceptable. A reliability index of less than 2.0 is unacceptable and the bridge will require immediate attention to assess why it "can no longer meet the load carrying capacity required for current traffic" [12]. The WIM and NBI data should also be investigated for accuracy.

2.3.2 Methodology of Reliability Analysis of Georgia's Bridges

This analysis made the following assumptions to determine the reliability index of bridges in Georgia:

a) "WIM truck weight and NBI capacity are random quantities, and a normal distribution is used to represent weight data.

b) Operating load rating is taken as the mean of a load capacity distribution, and the standard deviation is assumed to be 10 percent of the mean value. This is a fairly conservative approach but recognizes that the load rating provided in the NBI is not an absolute measure but is expected to vary due to uncertainties associated with parameters used for bridge load rating." [12]

Live load demands are taken from 15 WIM sites and capacities are taken from the NBI's operating rating data. The reliability analysis includes truck traffic only (class 4 or greater vehicles). Each bridges' analysis uses weight data from the nearest WIM site based on satellite coordinates as shown by Sinha in the map provided in Figure 12.

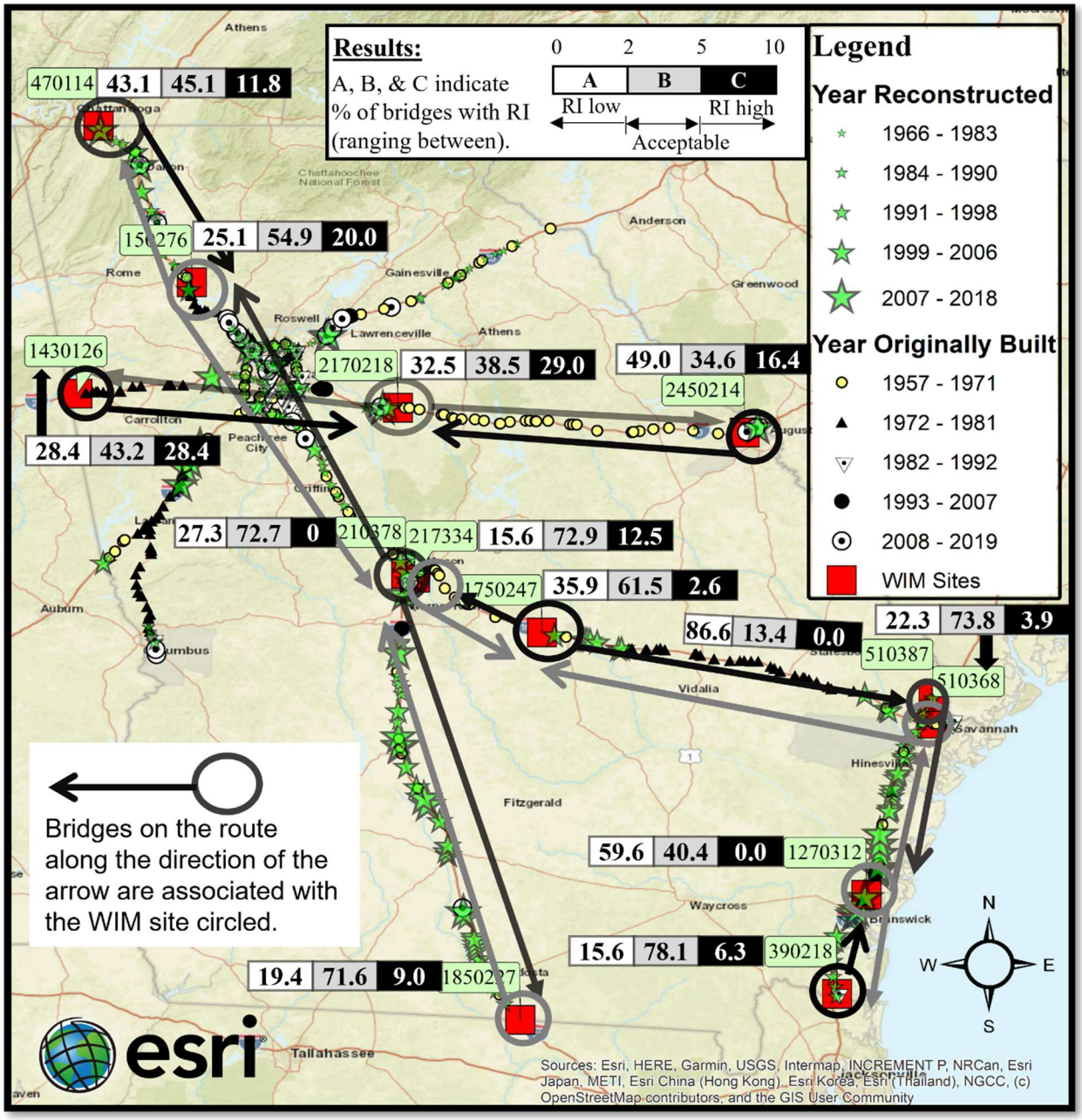


Figure 12. Image. Map showing locations of old and reconstructed bridges in Georgia.

2.3.3 Results of Reliability Analysis of Georgia's Bridges

As shown in Figure 12, bridges are associated with a WIM site based on the geographic information system (GIS) coordinates obtained from the NBI database. A histogram representing

gross vehicle weight (GVW) distribution is plotted for site 0210378 as shown in Figure 13. (Note that all tables and figures included in this section were created by Ananta Sinha for his dissertation.) A curve representing the distribution of bridge capacities is also shown in Figure 14 for each bridge that is located between two WIM sites. In Figure 14, the thin dashed gray line shows the capacity of a bridge in 2021, and the thin solid black line shows the capacity when the bridge was constructed. The purpose of this plot is to show the reduction (or increase) of load carrying capacities over time. The blue solid (thick) line shows the live load on a bridge observed in the WIM data, and the red dashed (thick) line shows the bridge capacity when a reliability index of 2.5 is selected for the live load distribution observed in the WIM data.

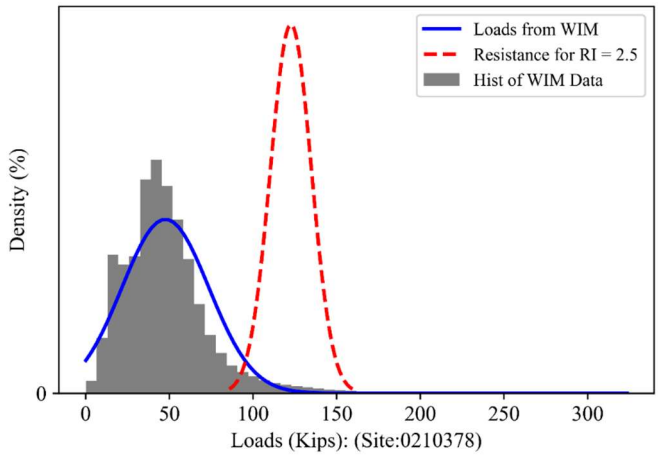


Figure 13. Graph. WIM live load histogram fitted with a normal distribution.

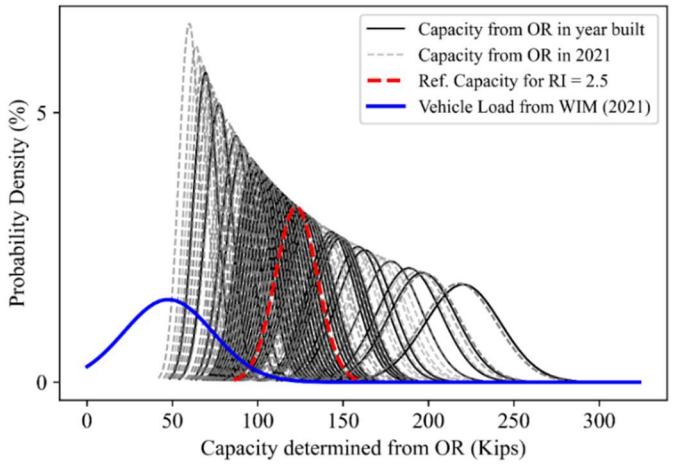


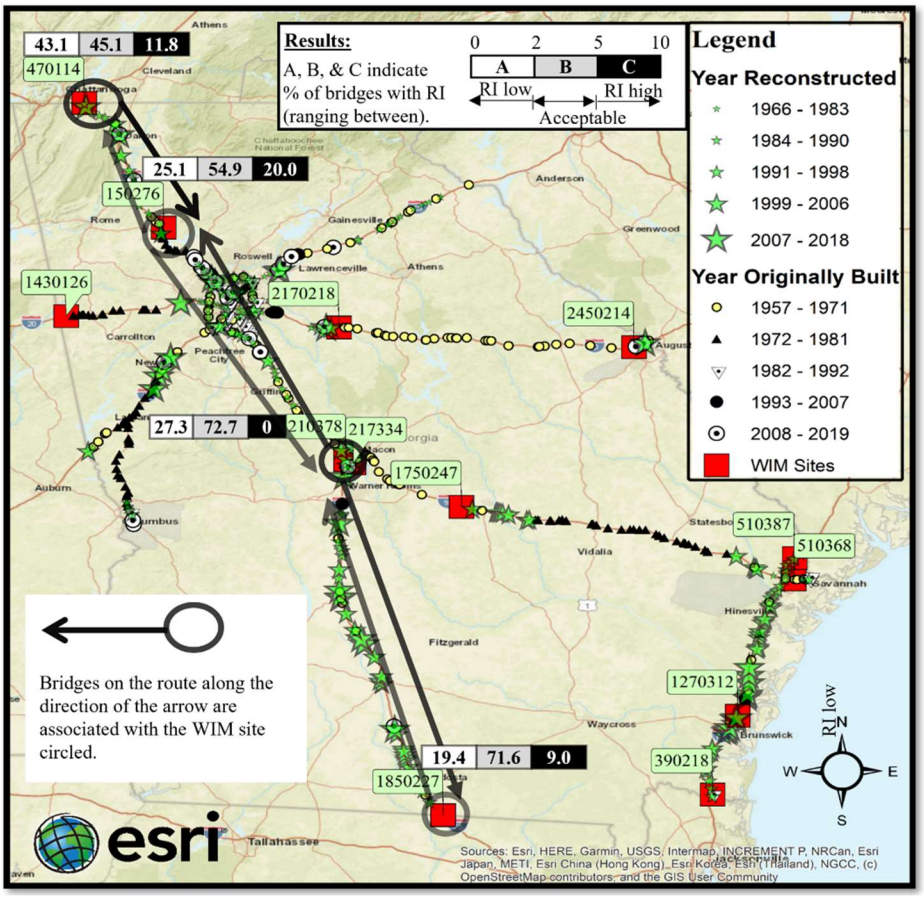
Figure 14. Graph. Load and capacity curves of selected bridges (site 021-0378).

The Reliability Index (RI) is calculated along with the probability of failure for each bridge using equations (2) and (3). As shown in Table 7, a significant number of bridges have an RI less than 2.0, which requires a review of either the operating load ratings or the weight data available in the WIM data sets.

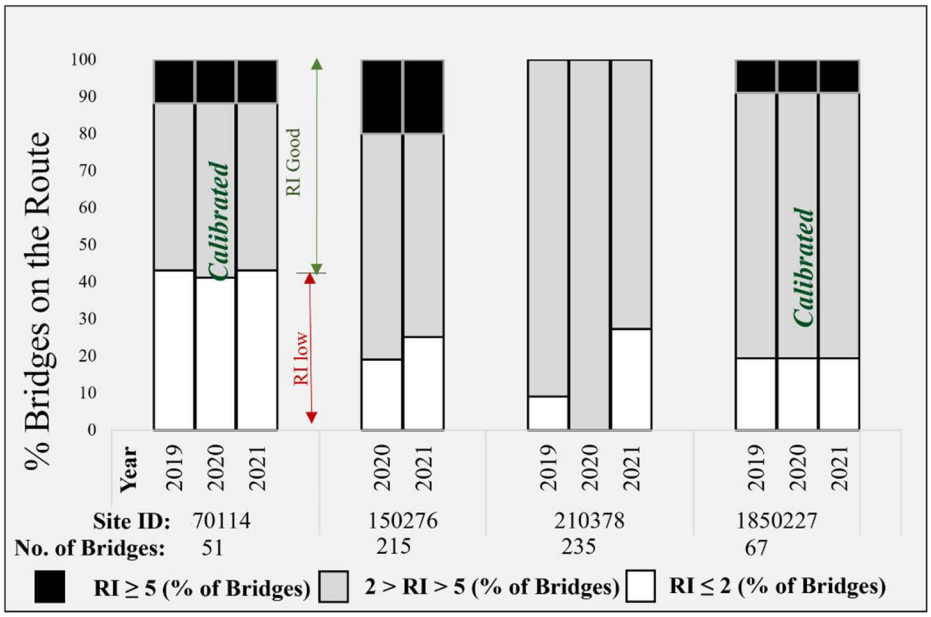
Table 7. Reliability indices of bridges in Georgia in 2021

Route	Site ID	Site Name	Site Description	% Bridges with RI		
				<2.0	2.0-5.0	>5.0
I-16	217334	021-w334	I-75 N of I-475 Split Dr, Macon	14.6	72.9	12.5
	1750247	175-0247	I-16, 1.4 miles East of SR 338 MP 43	35.9	61.6	2.6
	510368	051-0368	I-16 East of Dean Forest exit	22.3	73.8	3.9
I-20	1430126	143-0126	I-20 between Alabama SL & SR 100 Veterans Mem Hwy	28.4	43.2	28.4
	2170218	217-0218	I-20 West of SR 11 between SR 142 and SR 11	32.5	38.5	29.1
	2450214	245-0214	I-20 Columbia Co Line & SR 415 Bobby J. Expressway	49.1	34.6	16.4
I-75	470114	047-0114	I-75 between SR 146 & Tennessee SL	43.1	45.1	11.8
	150276	015-0276	I-75 just above SR 20	25.1	54.9	20.0
	210378	021-0378	I-475 (SR 408) between I-75 & SR 22 South of SR 22	27.3	72.7	0.0
	1850227	185-0227	I-75/SR401 @Florida SL, Lake Park, Lowndes Co	19.4	71.6	8.9
I-95	510387	051-0387	I-95, 2 miles North of SR 21 @ South Carolina SL	86.6	13.4	0.0
	1270312	127-0312	I-95 SR 27 & Golden Isles Parkway SR 25 Spur M	59.6	40.4	0.0
	390218	039-0218	I-95 between Florida SL & St Mary's Rd, Kingsland, GA	15.6	78.1	6.3

To observe the change in RI over time, coupled stacked bar charts are created for different routes, shown in Figure 15 to Figure 18. The x-axis in Figure 15 represents the year in which the WIM data were observed at multiple WIM sites. The y-axis represents the percentage of bridges with RIs in three different categories when analyzed with the associated WIM site data: the white stack represents the percentage of bridges with an RI less than 2.0, the gray stack represents the percentage of bridges with an RI greater than or equal to 2.0 and less than 5.0, and the black stack represents the percentage of bridges with an RI greater than or equal to 5.0.

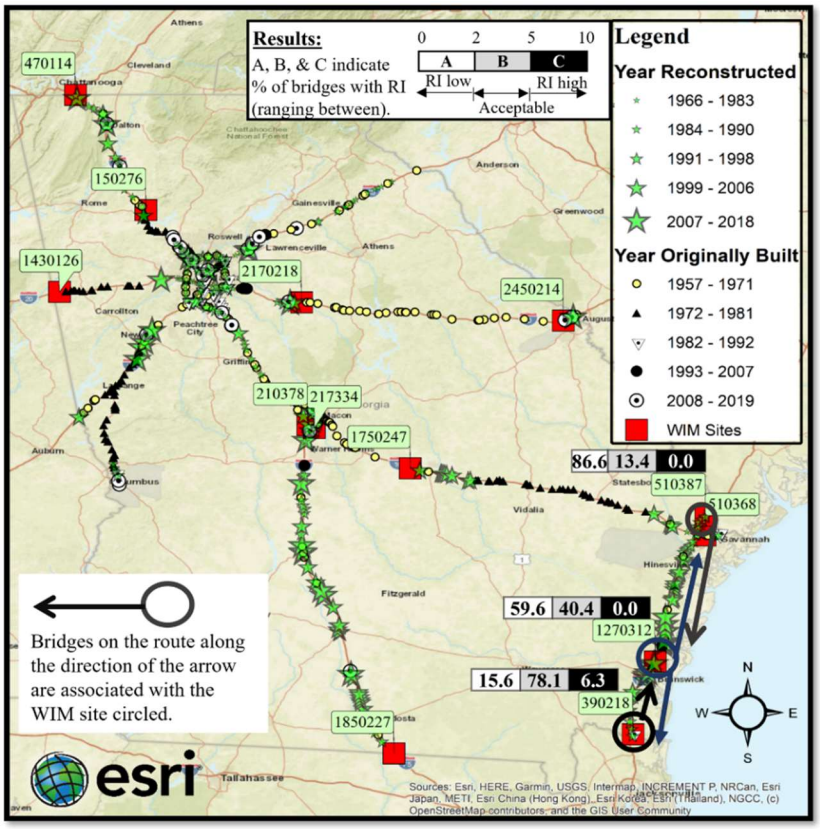


(a) Map showing bridges by construction year.

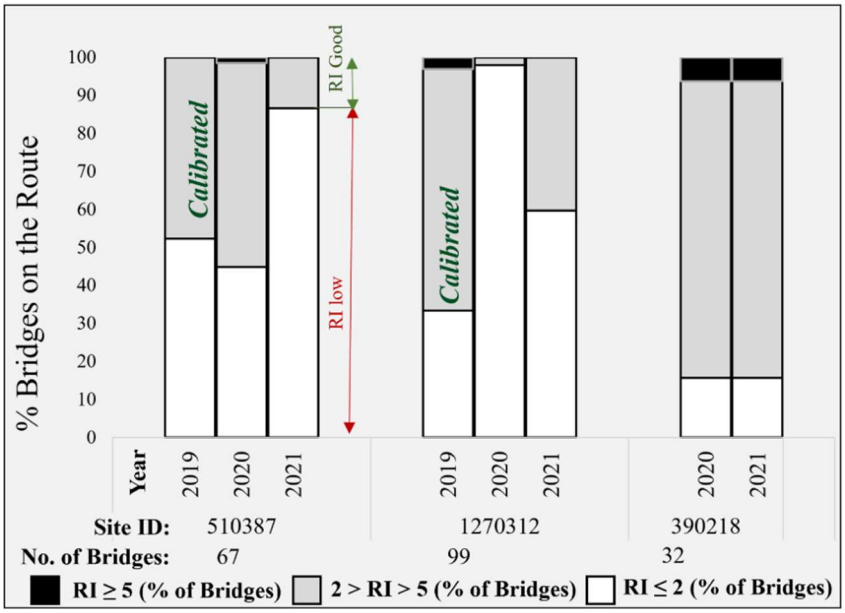


(b) Bar charts showing percentage of bridges.

Figure 15. Multiple elements. Reliability analysis for I-75 route.

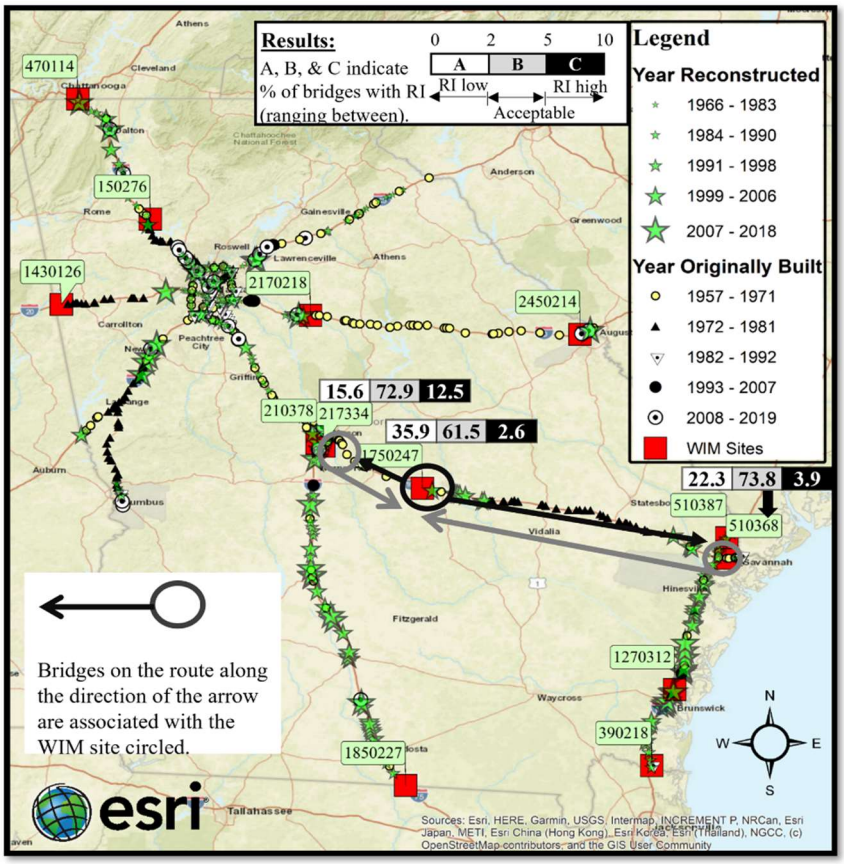


(a) Map showing bridges by construction year.

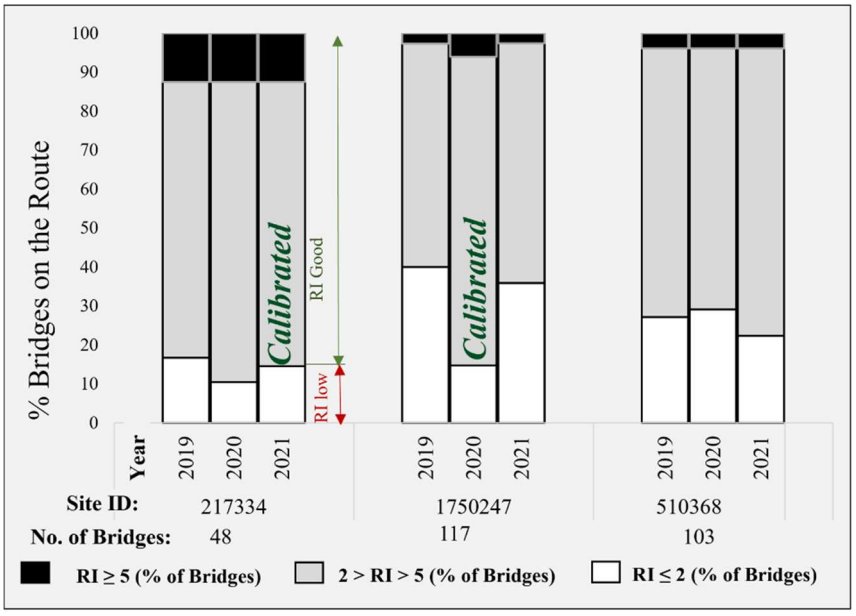


(b) Bar charts showing percentage of bridges.

Figure 16. Multiple elements. Reliability analysis for I-95 route.

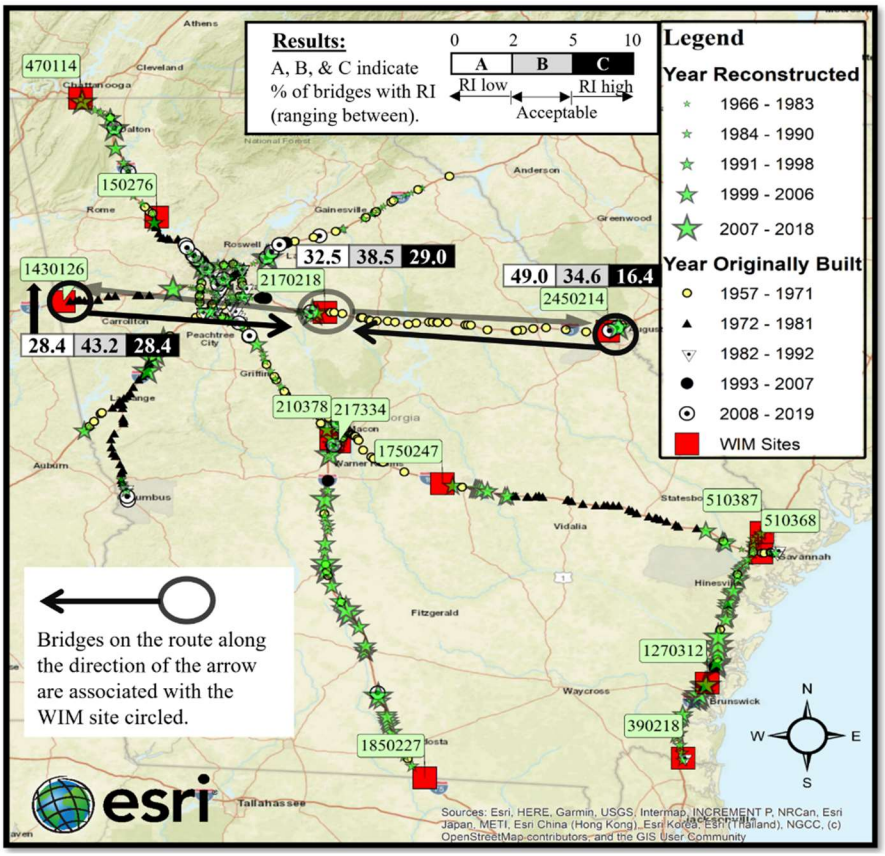


(a) Map showing bridges by construction year.

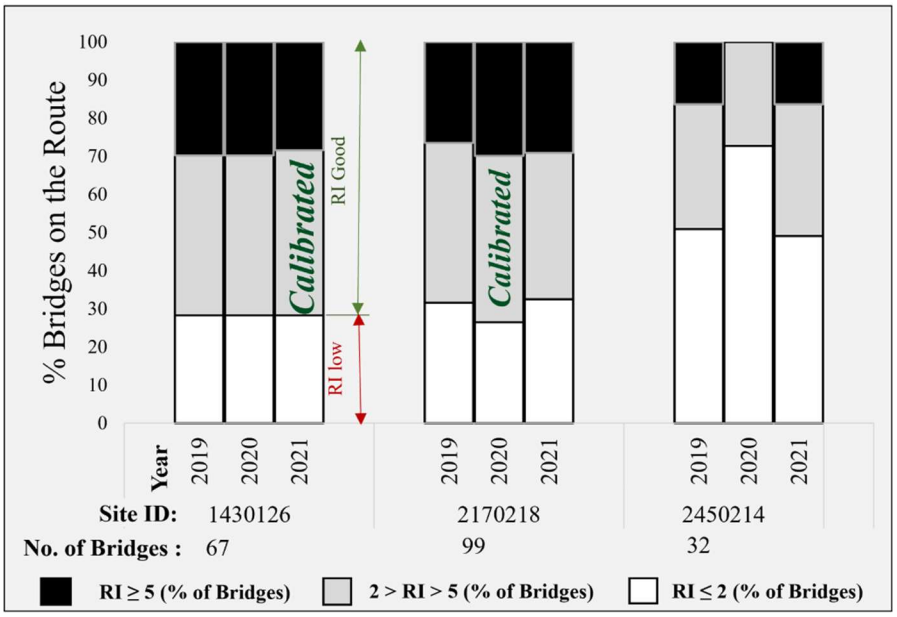


(b) Bar charts showing percentage of bridges.

Figure 17. Multiple elements. Reliability analysis for I-16 route.



(a) Map showing bridges by construction year.



(b) Bar charts showing percentage of bridges.

Figure 18. Multiple elements. Reliability analysis for I-20 route.

To observe the relationship between the time of construction and bridge capacity, Figure 19 is plotted. The design vehicle used in this study is an HL-93 truck, which has a GVW of 80 kips. Some bridges at site 0210378 on the I-75 route have a capacity less than 80 kips and were constructed before 1980. Some bridges have a capacity as low as 50 kips even after reconstruction.

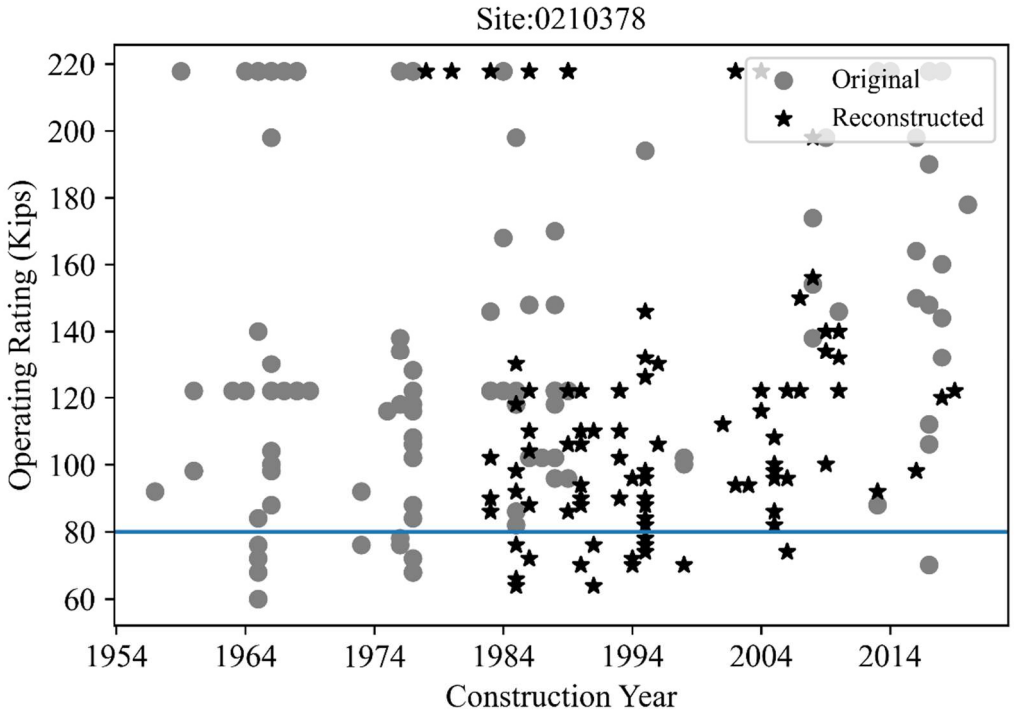
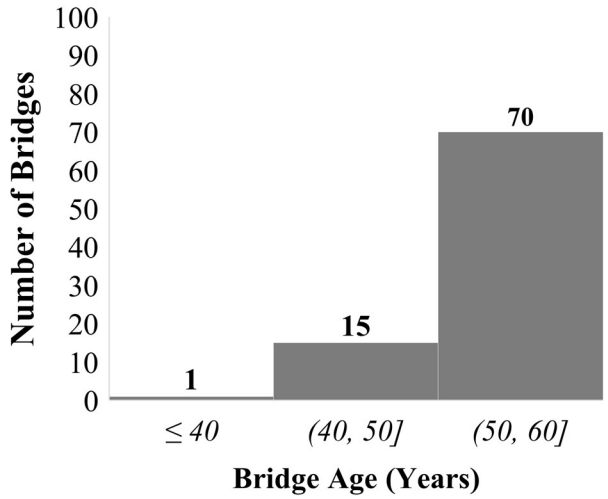
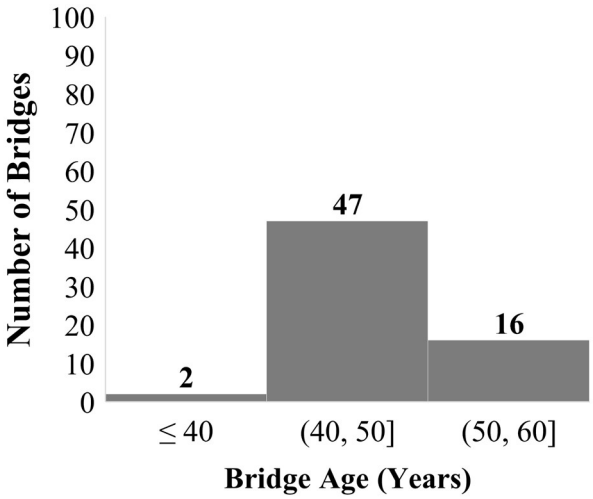


Figure 19. Graph. Operating rating versus year of construction/reconstruction.

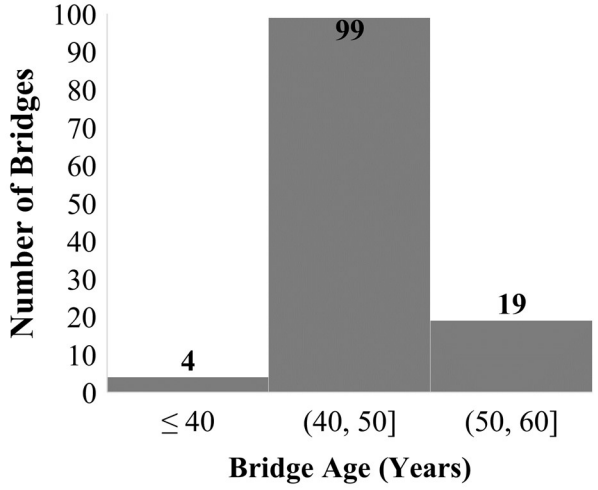
In Figure 20, bridges with a low reliability (RI < 2.0) are presented by age groups. Notably, most of the bridges with a low RI are 40 years old or older. Figure 20 shows the correlation between RI and bridge age for the routes studied.



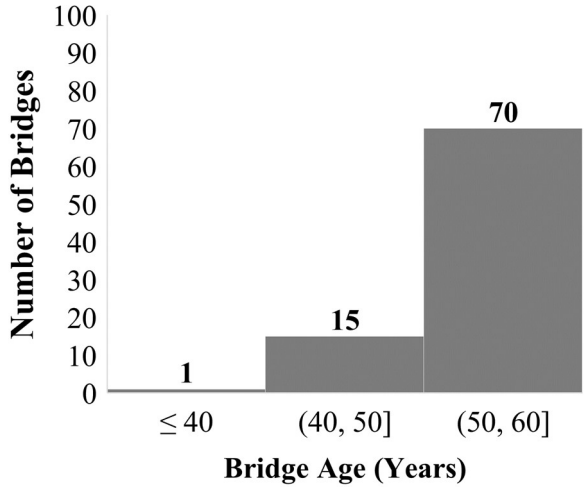
(a) Bridges with low RI (< 2.0) on I-75 route



(b) Bridges with low RI (< 2.0) on I-16 route



(c) Bridges with low RI (< 2.0) on I-95 route



(d) Bridges with low RI (< 2.0) on I-20 route

Figure 20. Graphs. Number of low reliability bridges by age groups.

Figure 21 is created using the ArcGIS application to show the locations of bridges with low RIs on main interstate routes in Georgia. Bridges with an RI less than 2.0 are shown in red circles, and bridges with an RI greater than 2.0 are represented with green stars.

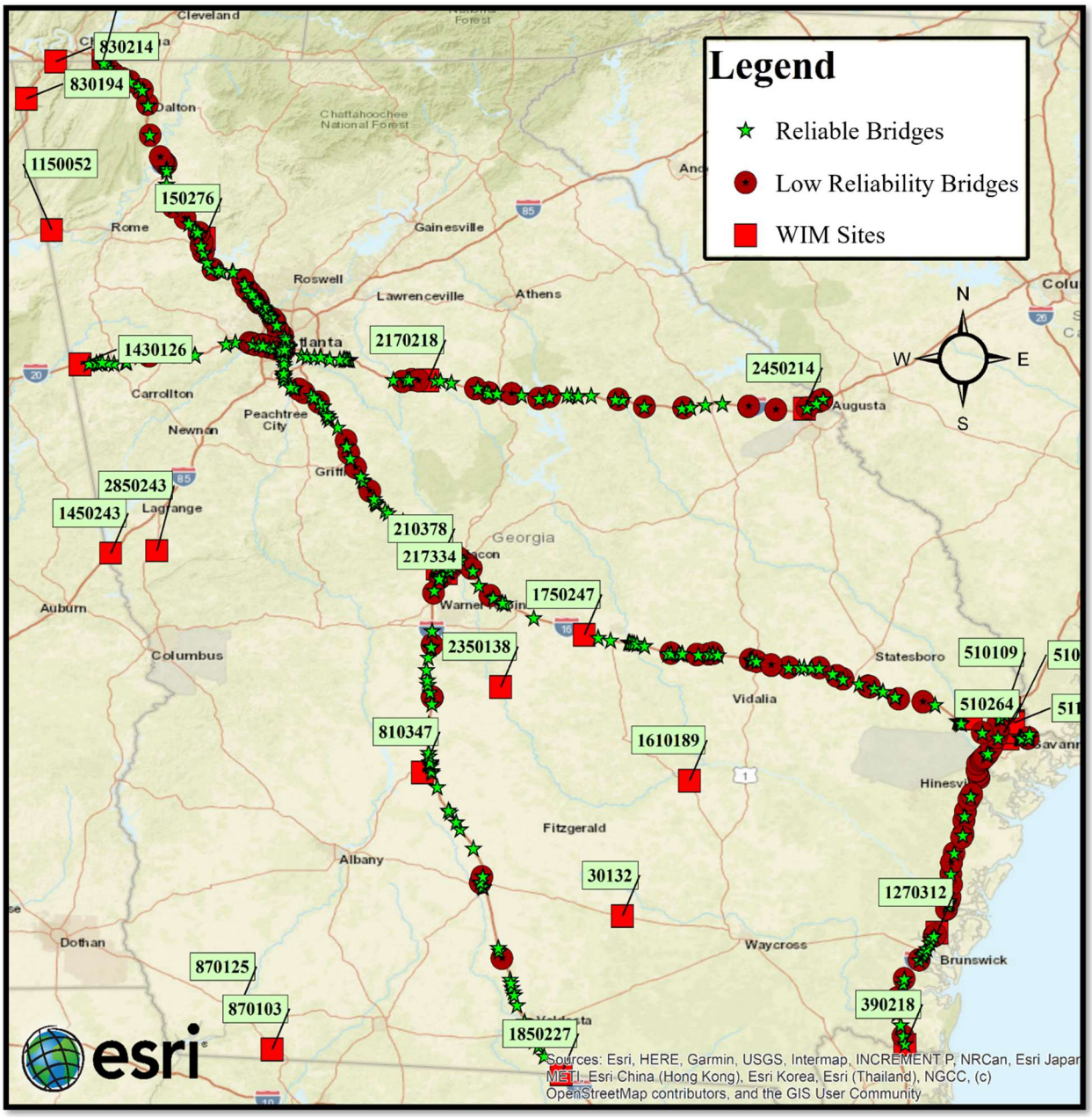
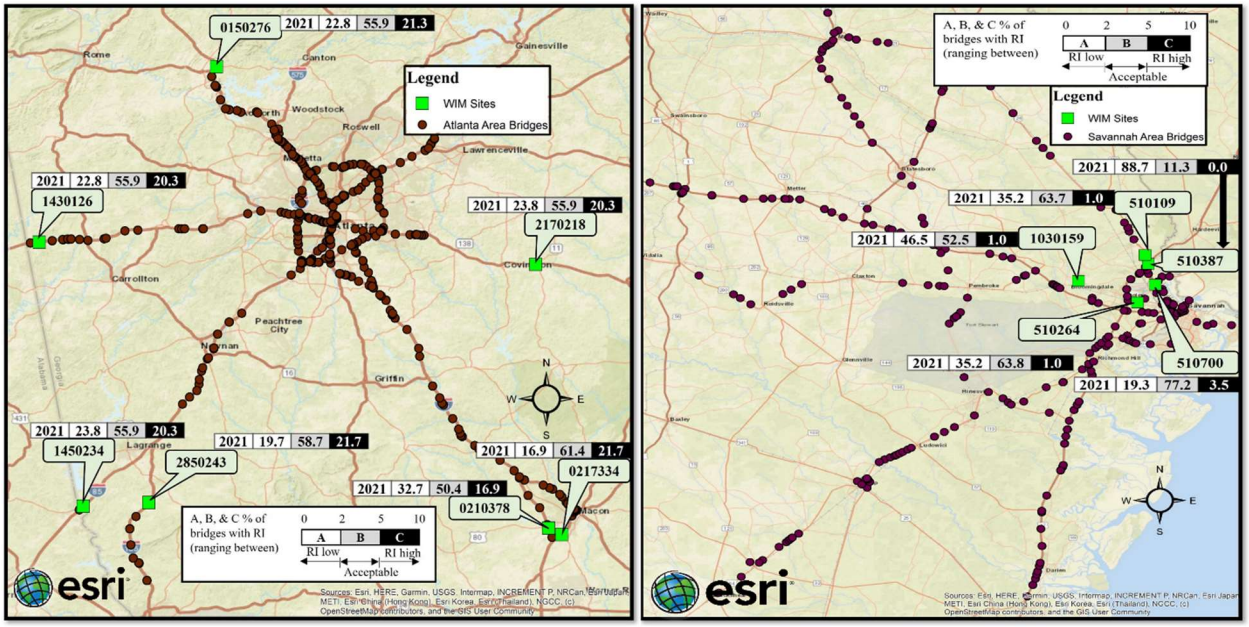


Figure 21. Map. Locations of low and high reliability bridges along Georgia interstate routes.

RIs for bridges in the vicinity of Atlanta and Savannah are also determined. Figure 22 presents a map showing Atlanta- and Savannah-area bridges as well as the adjacent WIM sites. The bridges shown in Figure 22 (a) and (b) are paired with the WIM sites in the vicinity of Atlanta and Savannah, respectively. Some of the WIM sites in the Savannah area show extremely high live loads and hence are associated with bridges with low reliability. Both areas, Atlanta and Savannah, need further investigation into traffic logistics, such as the transportation of commercial goods, and other factors, including the locations of distribution centers, to better assess the reliability of their bridges.



(a) (b)

Figure 22. Images. Reliability indices for bridges in the Atlanta and Savannah areas.

3.0 | PROBLEM STATEMENT

3.1 Scope of Study and Objectives

As Georgia's bridges experience deterioration due to age, they are also experiencing an increase in heavyweight traffic. This presents a concern for safety as the risk of failure increases. A reliability analysis previously conducted by UGA Ph.D. student, Ananta Sinha, provides the reliability indices for all of Georgia's bridges including the last three years of Weigh-in-Motion (WIM) and National Bridge Inventory (NBI) data [12]. This study will further investigate the bridges having a reliability index below 2.0.

First, the WIM data used will be checked for accuracy through a quality control analysis. Any sites containing anomalies will be recommended for recalibration and/or maintenance and the bridges that used its live load data will require another iteration of reliability analysis once the anomalies are controlled. Second, bridge operating ratings found in the NBI will be analyzed alongside NBI condition ratings, NBI element data condition states, and Georgia Department of Transportation (GDOT) inspection reports. The goal of this analysis is to determine what bridge elements have the highest influence on its bridge's operating rating and in turn its bridge's reliability index.

The ultimate goal of this study is to determine if inaccuracies in live load data and/or specific bridge elements have a high impact on bridge reliability analyses. These results will enable the owners and asset managers to make better informed decisions for their bridges resulting in a higher level of safety.

4.0 | METHODOLOGY

4.1 WIM Quality Control Analysis

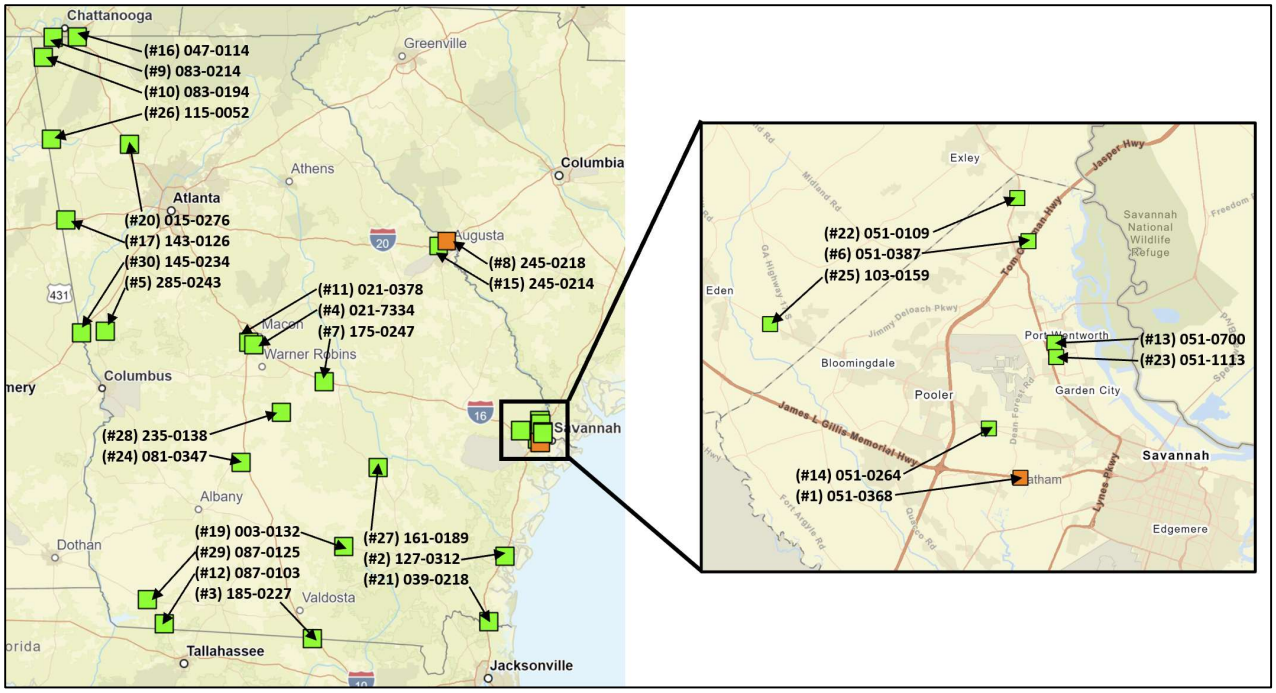
Yearly raw WIM data is provided by the Georgia Department of Transportation (GDOT) in a CSV file for each site in January of each year. Using RStudio 3.2, an RScript previously created Dr. Chorzepa's team is able to read in each site and year's CSV file and knit the WIM data quality control (QC) summaries into a PDF file. Jupyter Notebook using Anaconda Python 3.7 was also previously used by Dr. Chorzepa's team to create a script that summarizes WIM data. The python summary output for each site in each year is provided by Dr. Mi Geum Chorzepa and included within the PDF knitted in R. The python output is used to cross-check selected numerical summaries as well as provide charts supplemental to those generated by the R script.

Each PDF contains numerical and graphical summaries. Numerical summaries featuring measurements such as mean, standard deviation, and percentage proportion are presented in tabular form whenever possible. Graphs show anomalies and features (of a distribution) that are not evident from numerical summaries. Histograms and boxplots, for example, show a distribution of vehicle weights or axle spacings. The data summarized includes the below items.

1. Graphical Summary - Proportions (%) of Vehicle Class and AADTT
2. Numerical Summary - Vehicle Class Counts and Proportions
3. Graphical Summary - Vehicle Class Proportion (%) and ADTT by Lane
4. Numerical Summary - Vehicle Class Proportions (%) in Each Lane
5. Graphical Summary - Vehicle Class Proportion (%) and ADTT by Month

6. Numerical Summary - Vehicle Class Proportion (%) by Month
7. Graphical Summary - Axle Weight and Spacing Distributions by Class
8. Graphical Summary - Gross Vehicle Weight and Length
9. Numerical Summary - % Vehicle Counts with GVW and Length Exceeding a Threshold
10. Graphical and Numerical Summary of GVW Distribution for Each Class
11. Graphical Summary of Axle Spacings for Class 9
12. Graphical Summary of (Annual) Single Axle Load Spectra for Class 9 Vehicles
13. Graphical Summary of (Annual) Tandem Axle Load Spectra for Class 9 Vehicles
14. Numerical Summary - Proportions of Axle Spacing Qualifying Single Axle (Class 9 Only)
15. Graphical Summary of Headway (or Gap) between Vehicles for Class 9
16. Graphical Summary of Speed (mph) and Weight Variation by Month
17. Numerical Summary of the WIM Data
18. Summary Developed Using Python to Cross-Check the Findings in R

There are 18 WIM sites that were active between 2019 and 2021 and 12 that were only active in 2021. Figure 23 shows the location, site ID, and item number of all 30 WIM sites. The QC analysis outputs (R and Python summaries) are reviewed including numerical and graphical summaries and, in turn, a summary table is created for each WIM site to streamline the findings. The QC summary tables are used to highlight any notable anomalies. These anomalies may include a high number of unusable entries, speeds over 80 mph, gross weight over 80,000 lbs, days not being recorded, and so on.



Note: Labels are of the form {(Item #) Site ID}; Green boxes represent active sites and orange boxes represent inactive sites as of 2022. [14]

Figure 23. Illustration. Map of WIM Sites Included in Quality Control Analysis.

The anomalies noted in all of the WIM site's QC summary tables are then compiled into a table that allows for a quick understanding of the results. This will be presented as the WIM site QC analysis findings in Chapter 5. Any sites containing anomalies will be recommended for recalibration and/or maintenance as will be detailed in Chapter 6.

The reliability analysis of Georgia's bridges performed by UGA Ph.D. student, Ananta Sinha, provided 5 WIM sites with a high percentage of associated low reliability bridges. As detailed in Table 7, these sites are 175-0247, 245-0214, 047-0114, 051-0387, and 127-0312. If any of these WIM sites see a large number of anomalies, it is possible inaccurate WIM data caused the high percentage of low reliability bridges. Conclusions similar to this will be detailed in Chapter 6.

4.2 Analysis of Operating Rating Reductions in Low Reliability Index Bridges

Based on the findings of the reliability analysis of Georgia's bridges presented in Section 2.3.3, all low reliability bridges will be further investigated for operating rating reductions. Variables of interest taken from the National Bridge Inventory (NBI) include:

- Structure ID (item 8)
- Year Built (item 27) or Reconstructed (item 106)
- Operating Rating (item 64)

The operating rating for each low RI bridge between 2005 and 2022 will be analyzed for reductions. Inspection reports provided by GDOT through their website 'InspectX' in combination with NBI element data will then be analyzed to form an understanding of why the operating rating of a given bridge decreased. A summary table of the bridges that experienced a reduction will be presented for review. This will provide knowledge of common causes of operating rating reduction and thus low reliability bridge indexes.

4.2.1 Detailed Sample Bridge Analysis Employing NBI Data and Inspection Reports

This section will include details of the operating rating reduction analysis for a select number of bridges. The sample will be selected from the population of low reliability bridges Ananta Sinha provided. This list contains 646 unique bridges, many of which have multiple reliability indices due to them being on multiple Weigh-in-Motion site routes. The 10 bridges with the highest operating rating reductions between 2005 and 2022 will create the sample. RStudio 4.0.2 will be used to organize the population data and select the 20 bridges included in the sample.

The sample analysis will include NBI data, NBI element data, and GDOT inspection reports. Using RStudio 4.0.2 and data found in FHWA's NBI ASCII database, a plot of changes

occurring in operating rating between 2005 and 2022 for a given bridge will be created. Four plots of 2005 to 2022 data will follow, showing the changes in deck condition rating, superstructure condition rating, substructure condition rating, and scour critical rating. A red line vertical line will begin in the plot of operating ratings where a change occurs and continue through the remaining four plots. This will effectively visualize what changes occurred in the condition ratings and scour critical rating at the time operating rating changed.

Data from FHWA's NBI Element database will then be analyzed in the years where operating rating changes were seen as well as the year before and after the change. The element data will be organized in RStudio 4.0.2. The program will then be used to create tables of each given bridge's elements. These tables will include the element number, element name, condition state 1 through 4 percentages, total quantity, and units of the quantity. A health index will then be calculated for each element in each year it has data recorded. The following formula is used to calculate element health index:

*Element Health Index = (%CS1)*1.0 + (%CS2)*0.4 + (%CS3)*0.1 + (%CS4)*0.0*

Elements that worsened or improved between the years analyzed will be noted as a possible cause for the operating rating change. It is important to note that Georgia has NBI element data recorded for the years 2016 to 2022.

Lastly, GDOT's inspection reports will provide details of damage and deterioration for each bridge element. The reports in the years where operating rating changes occurred as well as the years around the change will be closely analyzed. Photos from the inspection reports will provide a visual of the deterioration the data represents. Damage and deterioration in any elements of the bridge will be noted and photographs provided whenever available. Most bridges have

inspection reports available dating back to 2004 or 2005 and then every other year after that is provided up to 2021 or 2022.

These detailed bridge analyses will provide informed conclusions on why the sample bridges' operating ratings reduced and why a low reliability index was calculated.

4.2.2 Element Health Index versus Operating Rating Data Analysis

The relationship between operating rating and element condition states (characterized as health index) is also analyzed with the goal of determining what bridge elements most affect a reduction in operating rating. Simple scatterplots are made to study the relationship.

RStudio 4.0.2 is utilized to organize National Bridge Inventory (NBI) data as well as NBI Element data. Georgia has NBI Element data available for 2016 to 2022, thus the range of data included in this analysis is restrained to those 6 years. The variables extracted from the NBI Element Data are as follows:

1. "STRUCNUM" (Structural Number/ID)
2. "EN" (Element Number)
3. "TOTALQTY" (Element's Total Quantity)
4. "CS1" (Element's Quantity in Condition State One = Good)
5. "CS2" (Element's Quantity in Condition State Two = Fair)
6. "CS3" (Element's Quantity in Condition State Three = Poor)
7. "CS4" (Element's Quantity in Condition State Four = Severe)

Variables 3 through 7 can then be used to calculate the percent of the total quantity within each condition state. After converting to percentages, the health index of a given element on a given bridge can be calculated. The following formula is used to calculate element health index:

*Element Health Index = (%CS1)*1.0 + (%CS2)*0.4 + (%CS3)*0.1 + (%CS4)*0.0*

The difference in 2 consecutive years of a given bridge's specific element health index is then calculated. This is referred to as "Delta Health Index" or "ΔHealth Index".

Any reduction or increase in any element's health index between 2016 and 2022 is recorded. Looking at the corresponding structure number/ID as well as consecutive years, the corresponding operating ratings for the given 2 years are extracted from the NBI data (variable "OPERATING_RATING_064"). The percent change of operating rating for those consecutive years is then calculated with the following formula:

$$\left(\frac{\left(Operating\ Rating_{latter\ year}\right) - \left(Operating\ Rating_{earlier\ year}\right)}{Operating\ Rating_{earlier\ year}}\right) \times 100$$

Each corresponding Δhealth index and percent change in operating rating is then plotted and presented as figures. The x-axis of the plot (ΔHealth Index) shows a reduction in health index from one year to the next with a value below 0.0 (negative value) and an increase in health index with a value above 0.0 (positive). The y-axis of the plot (% Change in Operating Rating) similarly shows a reduction in operating rating from one year to the next with a value below 0.0 (negative value) and an increase in operating rating with a value above 0.0 (positive). A red dotted line is added at both axes 0.0 values to better visualize trends.

5.0 | FINDINGS

5.1 WIM Quality Control Analysis

This chapter provides the findings of a quality control (QC) analysis of 30 of Georgia's Weigh-in-Motion (WIM) sites. Any sites containing anomalies will be recommended for recalibration and/or maintenance and should not be used in bridge reliability analyses until the anomalies are controlled. If any of the sites found to contain anomalies were used in Sinha's reliability analysis, another iteration should be done once the anomalies are controlled. This will ensure accurate results are found.

5.1.1 Summary of Quality Control Results

This quality control analysis uses and produces a large amount of data. It is not practical to review every QC summary PDF created in R to deduce practical conclusions. Instead, results are summarized by WIM site into tables. Appendix B provides one WIM site's QC summary PDF as an example.

Out of the 30 total WIM sites, 18 have data available from 2019 to 2021. The remaining 12 sites have data available only for 2021. All gathered results are compiled over 21 tables, which is still impractical to quickly review and draw conclusions. Therefore, the 21 tables showing all results are provided in Appendix C. These tables are further summarized into Table 9 and Table 10 given in this section. They highlight the anomalies found in the QC analysis of all 30 of Georgia's WIM sites. Table 8 details what is considered an anomaly for each variable.

Table 8. QC Analysis Anomaly Definitions.

QC Measure	Considered Anomaly When
No. of unusable entries (% of the raw data)	> 5.0%
No. of zero/invalid weight (% of the raw data)	> 1.0%
No. of unidentified class (% of usable data)	> 1.0%
No. of missing classification	
No. of missing axle spacing (% of usable data)	> 1.0%
No. or entries > 80mph (% of usable data)	> 10.0%
No. of missing speed (% of usable data)	> 0.1%
No. of gross weight > 80,000lbs (% SB/EB usable data)	> 1.0%
No. of gross weight > 80,000lbs (% NB/WB usable data)	> 1.0%
No. of vehicle length > 100ft (% SB/EB usable data)	> 1.0%
No. of vehicle length > 100ft (% NB/WB usable data)	> 1.0%
No. of missing headway (% of usable data)	> 10.0%
No. of days recorded	< 365 (< 366 in 2020 for leap year)
No. of days in the usable data (%)	< 99.0%
No. of hours in the usable data (%)	< 90.0%
No. of seconds in the usable data (%)	< 90.0%

Table 9. Summary of Anomalies in QC Results for Georgia WIM Sites (Item #1-12).

Item #	Site ID	Year	No data available	NO ANOMALIES	No. lanes collecting only class information*	QC Measures											
						(%) Unusable entries	(%) Zero/Invalid weight in usable data	(%) Missing axle spacing in usable	(%) Entries > 80mph in usable data	(%) Missing speed in usable data	(%) GVW > 80,000 lbs (SB/EB)	(%) GVW > 80,000 lbs (NB/WB)	(%) Missing headway in usable	No. days recorded**	(%) Days recorded in usable data	(%) Hours recorded in usable data	(%) Sec. recorded in usable data
1	051-0368	2019		X													
		2020		X													
		2021												159			
2	127-0312	2019			3/8	13.0	12.9		12.1								68.8
		2020			5/8				12.0		4.9		11.3				51.5
		2021			5/8						1.8		10.4				49.3
3	185-0227	2019			2/6			9.9	18.2	9.9							73.2
		2020			2/6			3.74	19.1	3.3							73.8
		2021			2/6	52.9	52.8		10.7				11.9				38.1
4	021-7334	2019		X													
		2020		X													
		2021		X													
5	285-0243	2019				47.0	46.9	2.2	18.5	1.5				348	79.9	80.1	59.5
		2020			2/4				15.5								71.2
		2021			2/4				13.5								69.9
6	051-0387	2019			1/6	15.9	15.9					1.6		275			86.7
		2020			2/6				11.3								85.2
		2021			2/6		3.4	4.1	12.3	3.5	1.7						80.6
7	175-0247	2019				54.9	54.9		12.5		1.2	2.3		355	75.2	74.9	51.6
		2020			2/4				13.8		1.3						68.8
		2021			2/4		2.7	4.0	14.1	2.8	2.8						63.1
8	245-0218	2019			1/6	7.1	6.9					2.0					82.7
		2020			3/6									71			75.8
		2021	X														
9	083-0214	2019					2.6	2.5		2.2	3.0	3.7					
		2020					1.4	1.5		0.9	3.3	2.6					
		2021				9.4	8.8	9.75		6.6	2.4	1.4			97.8		
10	083-0194	2019							12.2		2.7	3.8					
		2020							13.8								
		2021					1.9	1.9	15.4			1.8					
11	021-0378	2019							28.3								
		2020							31.7					123			
		2021				26.7	26.5		15.7		1.7						85.7
12	087-0103	2019											16.8				
		2020											19.1				
		2021											17.4				

*Data collected by lanes instrumented for class-only collection was excluded from analysis. Written as (# lanes excluded / # total lanes).

**365 possible days recorded for 2019 & 2021; 366 possible days recorded for 2020 due to it being a leap year.

Table 10. Summary of Anomalies in QC Results for Georgia WIM Sites (Item #13-30).

Item #	Site ID	Year	No data available	NO ANOMALIES	No. lanes collecting only class information*	QC Measures Containing Anomalies											
						(%) Unusable entries	(%) Zero/Invalid weight in usable data	(%) Missing axle spacing in usable	(%) Entries > 80mph in usable data	(%) Missing speed in usable data	(%) GVW > 80,000 lbs (SB/EB)	(%) GVW > 80,000 lbs (NB/WB)	(%) Missing headway in usable	No. days recorded*	(%) Days recorded in usable data	(%) Hours recorded in usable data	(%) Sec. recorded in usable data
13	051-0700	2019									1.1	2.5					
		2020									1.1	2.2	10.4	358			
		2021									1.3	1.1					
14	051-0264	2019			2/4												60.8
		2020			2/4						1.1		10.4				60.4
		2021			2/4												60.0
15	245-0214	2019			4/8									177			72.4
		2020			4/8						2.9	1.5		240			70.9
		2021			2/8									123			
16	047-0114	2019		X													
		2020		X													
		2021		X													
17	143-0216	2019				17.9	17.7	59.4	17.1	7.7	1.1			363	94.2		84.9
		2020	X														
		2021			2/4						3.7	1.3		276			62.3
18	217-0218	2019			2/4			2.18						275			68.3
		2020			2/4			1.79									68.9
		2021			2/4			1.82									67.9
19	003-0132	2021			2/4						3.0	1.4	26.5				75.3
20	015-0276	2021			2/6						1.4						82.9
21	039-0218	2021			2/6						1.1						85.7
22	051-0109	2021								0.4							
23	051-1113	2021									1.7	2.4	17.5				
24	081-0347	2021			2/4					0.5	1.6		18.8				67.7
25	103-0159	2021					1.1			0.4	2.6	1.5		183			
26	115-0052	2021				5.3	5.2			0.6	1.8			183	96.2		
27	161-0189	2021			2/4					0.1	2.3		20.1				67.3
28	235-0138	2021								0.7	1.4	1.9		185			
29	087-0125	2021			2/4			1.3					10.2				82.2
30	145-0243	2021				6.2	6.1	1.1	24.6					184			

*Data collected by lanes instrumented for class-only collection was excluded from analysis. Written as (# lanes excluded / # total lanes).

**365 possible days recorded for 2019 & 2021; 366 possible days recorded for 2020 due to it being a leap year.

5.1.2 Analysis of Entries with Zero Weight

Many of the WIM sites were found to have lanes that did not record vehicle classification data. Any entries recorded by these lanes were classified as zero/invalid weight. These findings were discussed with the vendor and confirmed that data collection in some of the lanes is inactive and thus should be ignored. Such lanes are considered to have a "class-only" collection instrumentation. The results of an analysis to determine all class-only lanes is detailed in this section.

The number of entries per lane can be found in the WIM site summary PDFs in the sections "7.2 Numerical Summary - Vehicle Class Counts and Proportions" as well as "7.18 Summary Developed Using Python to Cross-Check the Findings in R". The Python output provided the total # of entries per lane and the R numerical summary showed which lanes had zero vehicles classified. Table 11 shows the 16 WIM sites that had lanes that could not record vehicle classification data. Table 12 through

Table 24 show the details of the missing lane vehicle classification data. Many of the sites only recorded data on one-third or one-half of the total lanes. This presents a concern of whether the traffic load is being fully represented by the recorded WIM data at these sites.

The erroneous entries from these lanes were excluded from the analysis summarized by Table 9 andTable 10. Any sites with excluded data were noted in the column "No. of lanes collecting only class information".

Table 11. Summary of WIM Sites with Lanes Unable to Record Vehicle Class Data.

	Adjusted WIM Site	Total # Lanes	Lanes Missing Data (% of total # lanes)		
			2019	2020	2021
1	127-0312	8	5,7,8 (37.5%)	3,4,5,7,8 (62.5%)	3,4,5,7,8 (62.5%)
2	185-0227	6	5,6 (33.3%)	5,6 (33.3%)	5,6 (33.3%)
3	285-0243	4	none	2,4 (50%)	2,4 (50%)
4	051-0387	6	6 (16.7%)	3,6 (33.3%)	3,6 (33.3%)
5	175-0247	4	-	2,4 (50%)	2,4 (50%)
6	245-0218	6	2 (16.7%)	2,3,6 (50%)	No data.
7	051-0264	4	2,4 (50%)	2,4 (50%)	2,4 (50%)
8	245-0214	8	1,4,5,8 (50%)	1,4,5,8 (50%)	4,8 (25%)
9	143-0126	4	-	No data.	2,4 (50%)
10	217-0218	4	2,4 (50%)	2,4 (50%)	2,4 (50%)
11	003-0132	4	No data.	No data.	2,4 (50%)
12	015-0276	6	No data.	No data.	3,6 (33.3%)
13	039-0218	6	No data.	No data.	3,6 (33.3%)
14	081-0347	4	No data.	No data.	2,4 (50%)
15	161-0189	4	No data.	No data.	2,4 (50%)
16	087-0125	4	No data.	No data.	2,4 (50%)

Notes: (-) indicates no lanes were missing data.; (No data.) indicates no data was recorded at the WIM site in the given year.

Table 12. Summary of 2019–2021 Lane Entries for Site 127-0312.

Site 127-0312	2019	2020	2021
Python Output			
Lane 1 - # of entries	1,786,615	1,607,289	1,806,136
Lane 2 - # of entries	2,612,064	2,436,803	2,697,037
Lane 3 - # of entries	4,030,941	2,663,322	4,158,814
Lane 4 - # of entries	2,504,985	1,577,013	2,851,535
Lane 5 - # of entries	722,330	651,193	710,723
Lane 6 - # of entries	3,214,117	2,789,894	3,371,331
Lane 7 - # of entries	4,271,637	3,636,388	4,157,400
Lane 8 - # of entries	2,276,026	1,865,151	2,388,264
# of missing lane entries	7,269,993	10,393,067	14,266,736

Notes: R output with NO data in given lane is highlighted.

Table 13. Summary of 2019–2021 Lane Entries for Site 185-0227.

Site 185-0227	2019	2020	2021
Python Output			
Lane 1 - # of entries	2,592,487	2,425,316	2,110,427
Lane 2 - # of entries	3,582,618	3,417,386	4,167,103
Lane 3 - # of entries	1,919,769	1,736,246	2,606,971
Lane 4 - # of entries	2,536,822	2,143,815	2,237,942
Lane 5 - # of entries	3,698,419	3,211,011	3,822,991
Lane 6 - # of entries	2,051,724	1,741,415	2,851,497
# of missing lane entries	5,750,143	4,952,426	6,674,488

Notes: R output with NO data in given lane is highlighted.

Table 14. Summary of 2019–2021 Lane Entries for Site 245-0243.

Site 285-0243	2019	2020	2021
Python Output			
Lane 1 - # of entries	2,492,918	2,290,515	2,575,621
Lane 2 - # of entries	1,417,120	1,248,301	1,613,417
Lane 3 - # of entries	2,496,710	2,121,333	2,555,171
Lane 4 - # of entries	1,360,328	1,220,119	1,550,047
# of missing lane entries	*	2,468,420	3,163,464

Notes: R output with NO data in given lane is highlighted.; (*) indicated R output shows data for all lanes.

Table 15. Summary of 2019–2021 Lane Entries for Site 051-0387.

Site 051-0387	2019	2020	2021
Python Output			
Lane 1 - # of entries	1,895,416	2,329,023	2,595,870
Lane 2 - # of entries	3,638,856	4,257,848	4,883,126
Lane 3 - # of entries	2,578,085	2,906,590	3,736,593
Lane 4 - # of entries	2,943,896	3,582,561	3,403,494
Lane 5 - # of entries	3,437,472	3,771,833	4,271,238
Lane 6 - # of entries	1,796,690	2,052,297	2,815,757
# of missing lane entries	1,796,690	4,958,887	6,552,350

Notes: R output with NO data in given lane is highlighted.

Table 16. Summary of 2019–2021 Lane Entries for Site 175-0247.

Site 175-0247	2019	2020	2021
Python Output			
Lane 1 - # of entries	2,673,824	2,506,644	2,669,305
Lane 2 - # of entries	1,712,864	1,522,917	1,823,415
Lane 3 - # of entries	2,591,241	2,472,294	2,369,125
Lane 4 - # of entries	1,871,766	1,664,082	2,013,856
# of missing lane entries	*	3,186,999	3,837,271

Notes: R output with NO data in given lane is highlighted.; (*) indicated R output shows data for all lanes.

Table 17. Summary of 2019–2021 Lane Entries for Site 245-0218.

Site 245-0218	2019	2020
Python Output		
Lane 1 - # of entries	5,413,071	1,049,948
Lane 2 - # of entries	4,840,187	784,628
Lane 3 - # of entries	2,620,559	497,361
Lane 4 - # of entries	3,844,997	688,281
Lane 5 - # of entries	4,155,678	745,039
Lane 6 - # of entries	994,172	176,146
# of missing lane entries	4,840,187	1,458,135

Notes: R output with NO data in given lane is highlighted.

Table 18. Summary of 2019–2021 Lane Entries for Site 083-0214.

Site 083-0214	2019	2020	2021
Python Output			
Lane 1 - # of entries	5,288,881	4,860,547	4,997,899
Lane 2 - # of entries	6,892,604	6,279,583	7,055,705
Lane 3 - # of entries	5,519,958	5,068,480	5,510,451
Lane 4 - # of entries	6,925,267	5,990,721	6,892,350
# of missing lane entries	*	*	*

Notes: R output with NO data in given lane is highlighted.; (*) indicated R output shows data for all lanes.

Table 19. Summary of 2019–2021 Lane Entries for Site 083-0214.

Site 083-0214	2021
Python Output	
Lane 1 - # of entries	3,790,109
Lane 2 - # of entries	4,912,237
Lane 3 - # of entries	3,987,608
Lane 4 - # of entries	3,694,382
Lane 5 - # of entries	5,247,124
Lane 6 - # of entries	3,654,793
# of missing lane entries	*

Notes: R output with NO data in given lane is highlighted.; (*) indicated R output shows data for all lanes.

Table 20. Summary of 2019–2021 Lane Entries for Site 051-0264.

Site 051-0264	2019	2020	2021
Python Output			
Lane 1 - # of entries	2,224,590	2,115,556	2,492,131
Lane 2 - # of entries	1,871,420	1,782,644	2,218,232
Lane 3 - # of entries	1,889,034	1,825,358	2,118,608
Lane 4 - # of entries	1,814,648	1,752,917	2,184,634
# of missing lane entries	3,686,068	3,535,561	4,402,866

Notes: R output with NO data in given lane is highlighted.

Table 21. Summary of 2019–2021 Lane Entries for Site 245-0214.

Site 245-0214	2019	2020	2021
Python Output			
Lane 1 - # of entries	2,349,402	2,903,975	1,723,388
Lane 2 - # of entries	2,271,795	2,807,922	1,594,744
Lane 3 - # of entries	1,702,258	1,964,591	1,220,781
Lane 4 - # of entries	441,831	476,224	373,044
Lane 5 - # of entries	2,310,825	2,691,642	1,488,207
Lane 6 - # of entries	1,906,342	2,280,344	1,322,992
Lane 7 - # of entries	2,005,706	2,243,977	1,429,117
Lane 8 - # of entries	794,832	835,071	658,201
# of missing lane entries	5,896,890	6,906,912	1,031,245

Notes: R output with NO data in given lane is highlighted.

Table 22. Summary of 2019–2021 Lane Entries for Site 143-0216.

Site 143-0216	2019	2021
Python Output		
Lane 1 - # of entries		2,897,791
Lane 2 - # of entries		2,696,431
Lane 3 - # of entries		2,705,611
Lane 4 - # of entries		2,620,566
# of missing lane entries	*	5,316,997

Notes: R output with NO data in given lane is highlighted.; (*) indicated R output shows data for all lanes.

Table 23. Summary of 2019–2021 Lane Entries for Site 217-0218.

Site 217-0218	2019	2020	2021
Python Output			
Lane 1 - # of entries	4,280,724	5,036,262	5,495,205
Lane 2 - # of entries	3,263,504	3,536,358	4,287,611
Lane 3 - # of entries	3,831,233	4,489,277	4,937,534
Lane 4 - # of entries	3,772,284	4,131,299	4,860,096
# of missing lane entries	7,035,788	7,667,657	9,147,707

Notes: R output with NO data in given lane is highlighted.

Table 24. Summary Lane Entries for Sites with 2021 Data Only.

2021	Site 003-0132	Site 015-0276	Site 039-0218	Site 081-0347	Site 161-0189	Site 087-0125
Python Output						
Lane 1 - # of entries	635,397	3,934,963	5,163,395	960,612	883,309	1,804,512
Lane 2 - # of entries	243,005	5,923,060	4,516,112	628,804	566,117	503,936
Lane 3 - # of entries	650,873	5,002,966	3,529,396	1,090,023	986,596	1,727,778
Lane 4 - # of entries	226,451	4,500,518	3,765,908	506,585	464,029	478,713
Lane 5 - # of entries	-	5,865,935	5,556,464	-	-	-
Lane 6 - # of entries	-	4,793,786	4,002,010	-	-	-
# of missing lane	469,456	9,796,752	7,531,406	1,135,389	1,030,146	982,649

Notes: R output with NO data in given lane is highlighted.

Many of the WIM sites had a high number of zero/invalid weight entries even with the exclusion of class-only instrumented lanes. These sites are listed in **Error! Reference source not found.**.

Table 25. Summary of WIM Sites with High % of Zero/Invalid Weight Entries.

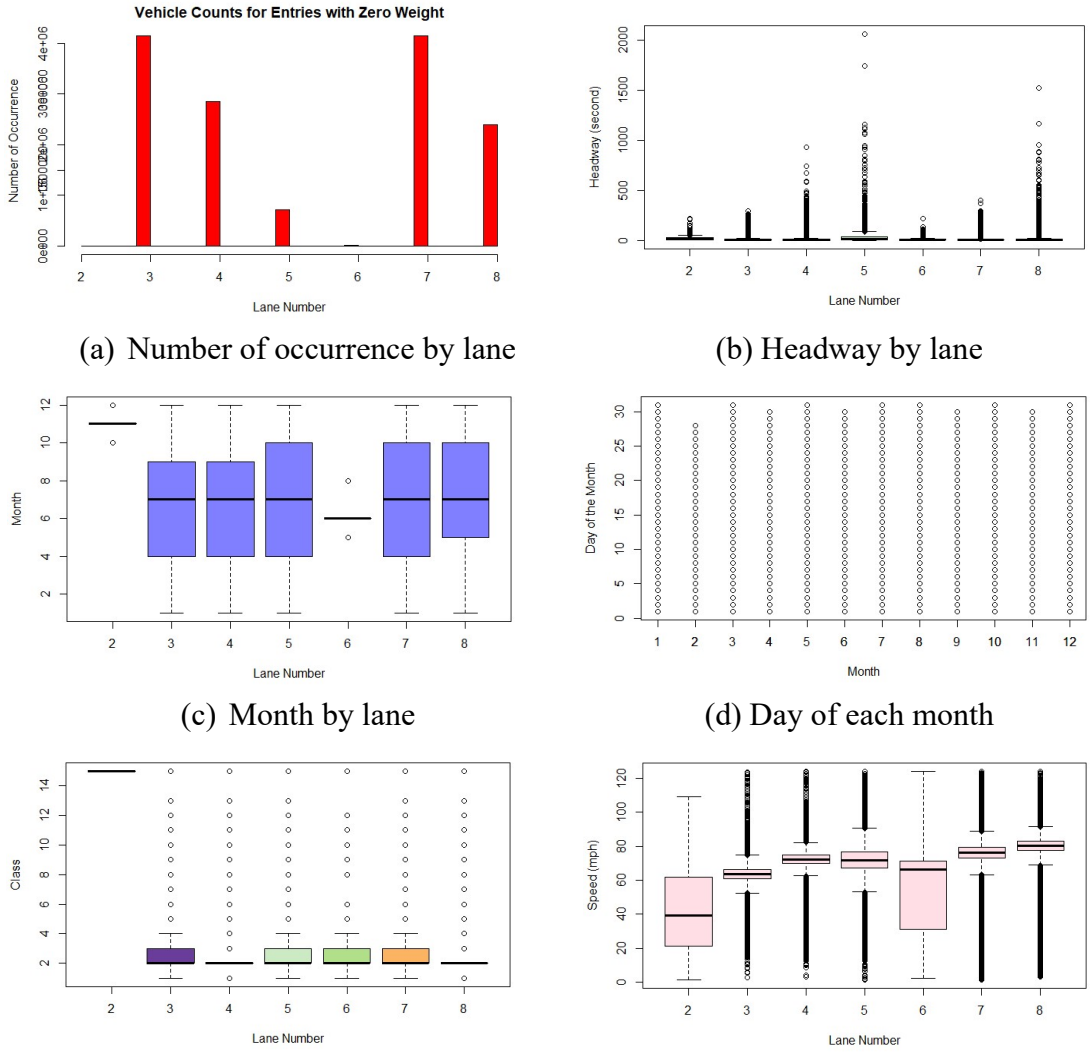
	WIM Site	# of Zero/Invalid Weight (% of Total Entries)		
		2019	2020	2021
1	127-0312	1,826,276 (12.9%)	(< 1.0%)	(< 1.0%)
2	185-0227	(< 1.0%)	(< 1.0%)	5,875,846 (52.8%)
3	285-0243	3,645,492 (46.9%)	(< 1.0%)	(< 1.0%)
4	051-0387	2,301,012 (15.9%)	(< 1.0%)	508,699 (3.4%)
5	175-0247	4,856,154 (54.9%)	(< 1.0%)	137,761 (2.7%)
6	245-0218	1,173,808 (6.9%)	(< 1.0%)	(< 1.0%)
7	083-0214	632,576 (2.6%)	315,878 (1.4%)	2,161,389 (8.8%)
8	083-0194	(< 1.0%)	(< 1.0%)	112,696 (1.9%)
9	021-0378	(< 1.0%)	(< 1.0%)	6,699,218 (26.5%)
1	143-0216	2,215,271 (17.7%)	(< 1.0%)	(< 1.0%)
1	103-0159	(< 1.0%)	(< 1.0%)	22,203 (1.1%)
1	115-0052	(< 1.0%)	(< 1.0%)	65,115 (5.2%)
1	145-0243	(< 1.0%)	(< 1.0%)	463,077 (6.1%)

Notes: Red text indicates % of Total Entries > 2%.

Three sites are selected from Table 11 and are discussed to illustrate the existence of zero weights in the data. When zero weight entries exist in several lanes, all available data was processed even though the lanes are no longer considered active by the vendor. The study team discussed the findings with the vendor and confirmed that data collection in some of the lanes is inactive and thus should be ignored. Such lanes are considered to have a "class-only" collection instrumentation.

Site 127-0312

Figure 24 presents the analysis results for entries with zero weight. The zero-weight data mainly comes from lanes 3, 4, 5, 7, and 8 each month (January through December) of 2021. Speed, class, and headway are not associated with zero weight. All entries recorded in lanes 3, 4, 5, 7, and 8 were classified as zero weight entries. It is likely that these lanes are not instrumented to record vehicle classification data. Thus, the entries recorded by these lanes were excluded from the analysis.



(a) Number of occurrence by lane

(b) Headway by lane

(c) Month by lane

(d) Day of each month

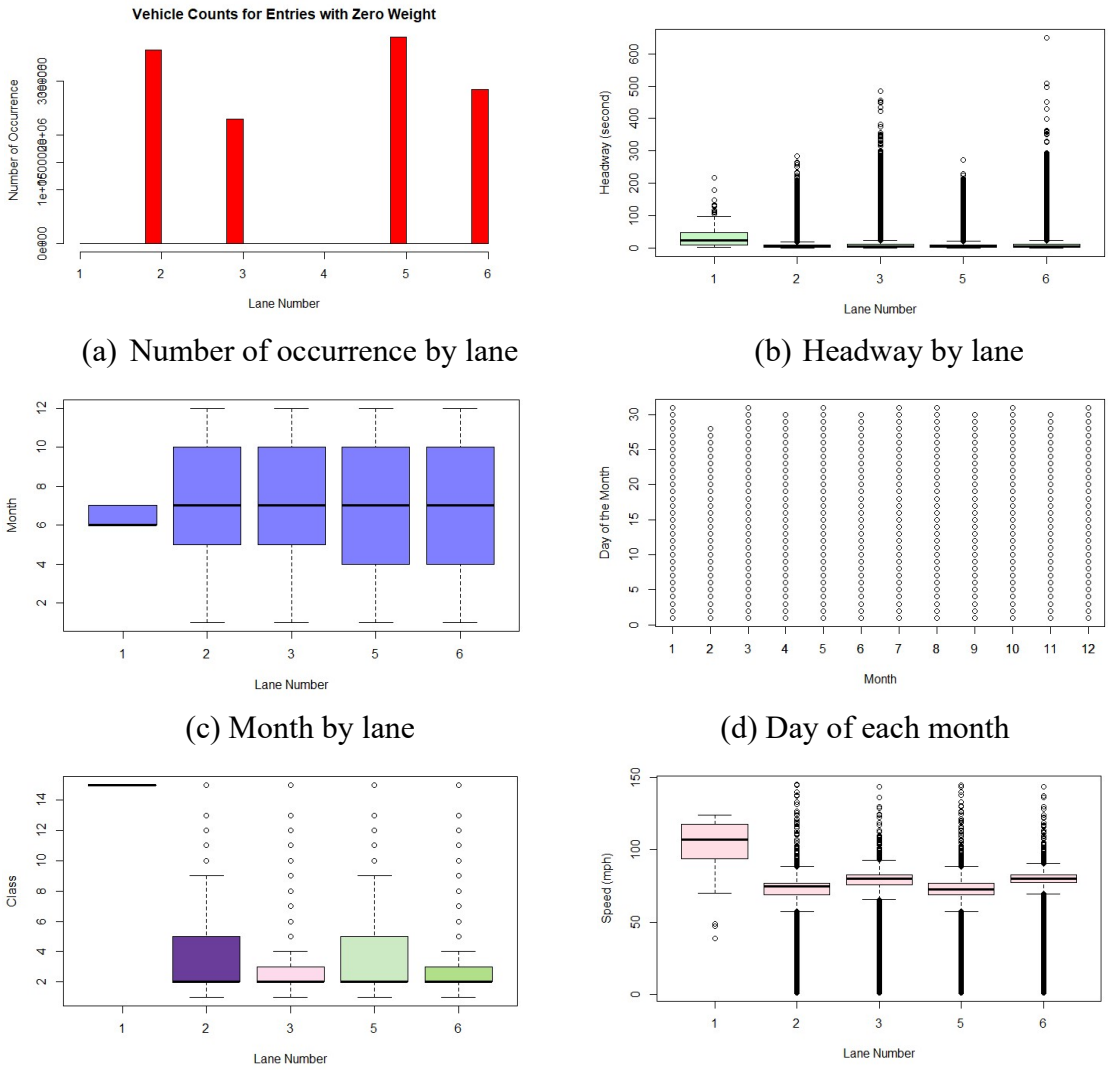
(e) Class by lane

(f) Speed by lane

Figure 24. Graphs. Analysis of Zero Weight Data for Site 1270312.

Site 185-0227

Figure 25 shows the results for the analysis of the zero weight entries. These entries mainly come from lanes 2, 3, 5, and 6, which were collected during every month (January through December) of 2021. Speed, class, and headway are not associated with zero weight.



(a) Number of occurrence by lane

(b) Headway by lane

(c) Month by lane

(d) Day of each month

(e) Class by lane

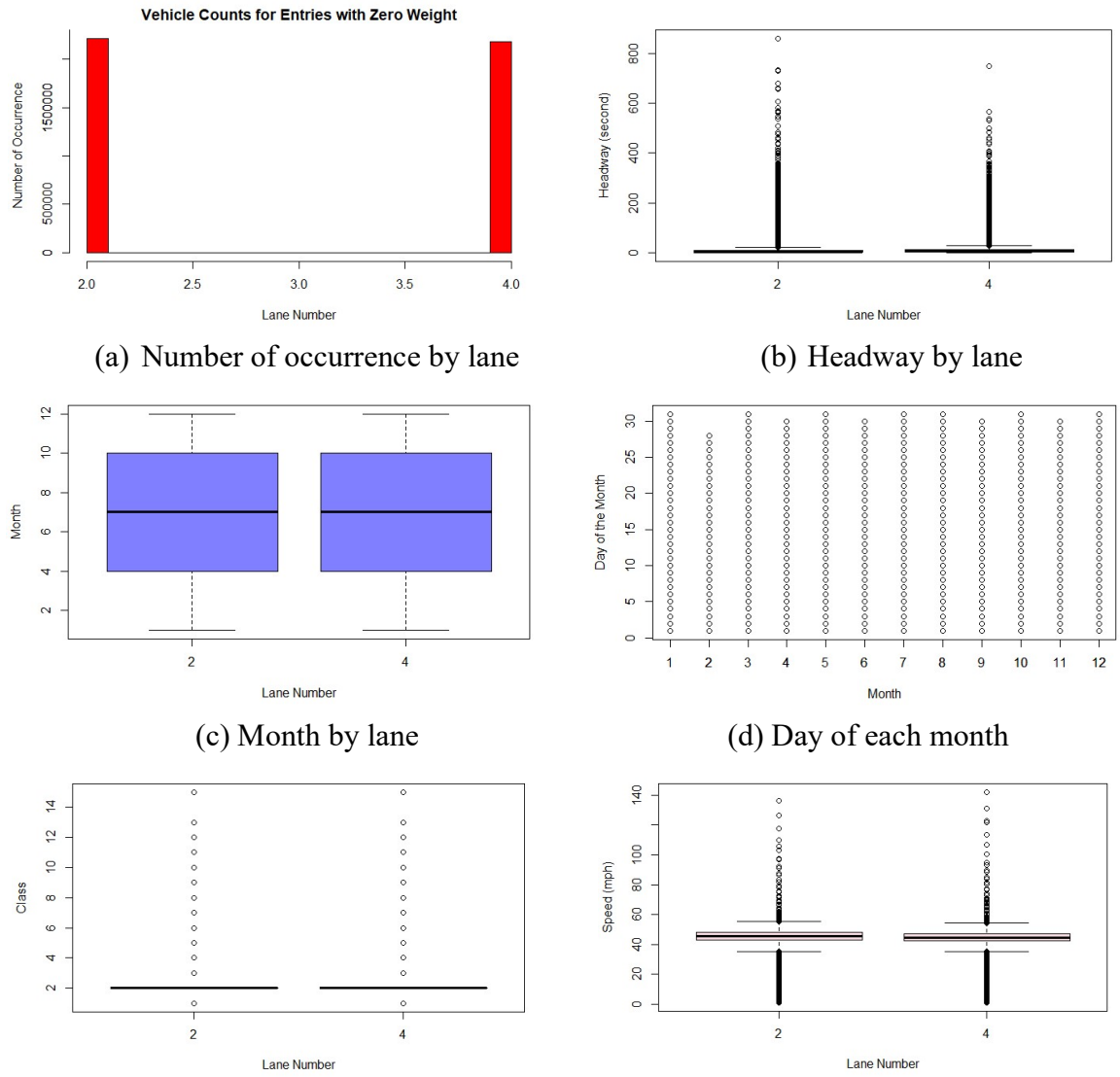
(f) Speed by lane

Figure 25. Graphs. Analysis of Zero Weight Data for Site 185-0227.

According to this analysis, all entries recorded in lanes 5 and 6 were classified as zero weight entries due to the lanes likely not being instrumented to record vehicle classification data. The entries recorded by lanes 5 and 6 were excluded from the analysis. Vehicle weight data does exist for lanes 2 and 3; however, a significant number of weight entries still have a zero value. These entries were included in the analysis. The zero-weight data from lanes 2 and 3 constitute 53 percent of the raw data and almost 100 percent of the unusable data.

Site 051-0264

Figure 26 shows the results of analyzing zero weight entries. These entries mainly come from lanes 2 and 4, which were collected during every month (January through December) of 2021. Speed, class, and headway are not associated with zero weight. All entries recorded in lanes 2 and 4 were classified as zero weight entries due to the lanes likely not being instrumented to record vehicle classification data. The entries recorded by lanes 2 and 4 were excluded from the analysis. The zero weight entries collected in those lanes increased the proportion of unusable data to 48.7 percent.



(a) Number of occurrence by lane

(b) Headway by lane

(c) Month by lane

(d) Day of each month

(e) Class by lane

(f) Speed by lane

Figure 26. Graphs. Analysis of Zero Weight Data for Site 051-0264.

5.1.3 Analysis of Gross Vehicle Weight

Gross vehicle weight (GVW) is analyzed by creating boxplots of GVW by lane, scatterplots of class 9 GVW and speed, and boxplots of class 9 GVW by month. The monthly variation in GVW is reviewed to observe a temperature sensitivity in the absence of temperature data. The monthly variation is further reviewed for each lane in the section “Weight Shift and Noticeable Spread.”

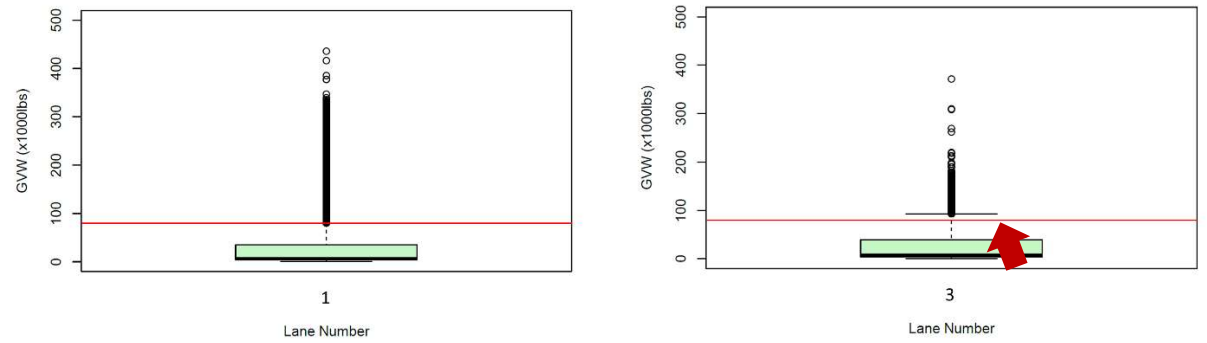
Boxplots of GVW by lane show that three sites (175-0274, 083-0214, 127-0312) recorded GVW reaching far beyond the upper whisker (Q3+1.5IQR).

Site 175-0274

Figure 27 (a) and (b) show a boxplot of GVW in each traffic direction, with the red lines indicating the 36,287 kg (80,000 lb) weight limit. Lane 3, the WB slow lane, recorded GVW reaching far beyond the upper whisker (Q3+1.5IQR). Although the number of overweight vehicles appears high in these scatter plots, the percentage of vehicles exceeding the 36,287 kg (80,000 lb) limit ranges between 0 percent and 3 percent (see Appendix C).

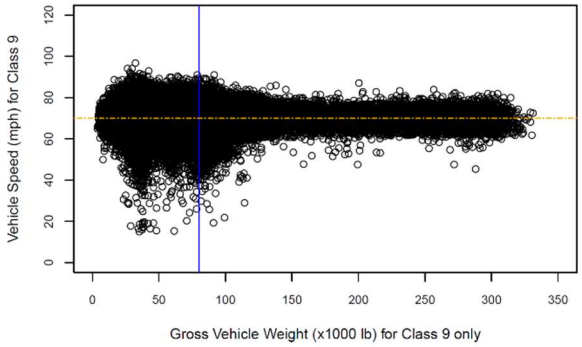
Figure 27 (c) and (d) show scatter plots of class 9 GVW. The vertical blue lines indicate the 36,287 kg (80,000 lb) limit, and the dotted orange lines indicate the legal speed limit. The vehicles in the upper right quadrant exceed the legal weight and speed limits. According to these plots, as class 9 vehicles become heavier, the driving speed does not appear to decrease significantly. This indicates that increase in speed did not have a direct correlation with increase in vehicle weight although speed in general affects weight in the WIM data.

Figure 27 (e) and (f) show boxplots of class 9 GVW by month. Although no significant month-to-month variation is observed, the median and the number of outliers increases between June and July.

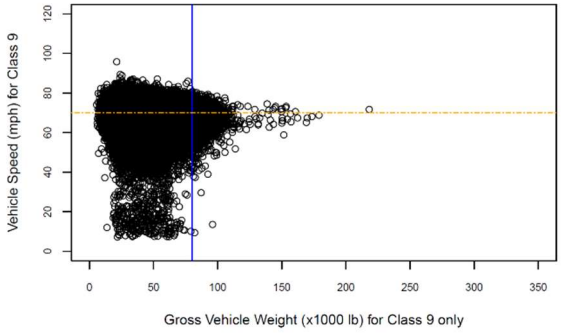


(a) EB lanes, GVW by lane

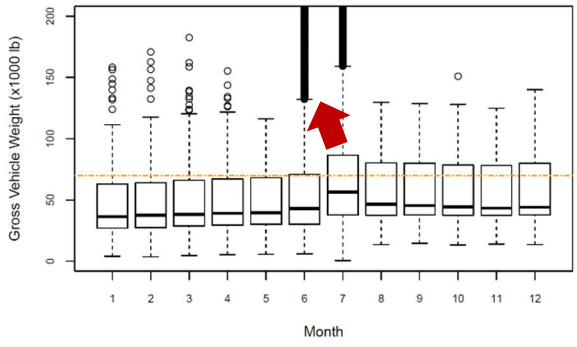
(b) WB lanes, GVW by lane



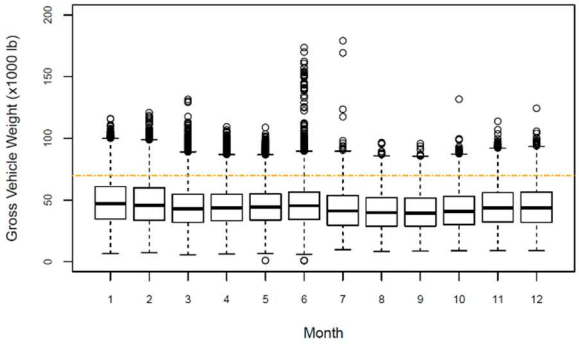
(c) EB lanes, GVW vs. speed



(d) WB lanes, GVW vs. speed



(e) EB lanes, GVW by month



(f) WB lanes, GVW by month

Figure 27. Graphs. Analysis of Gross Vehicle Weight for Site 175-0274.

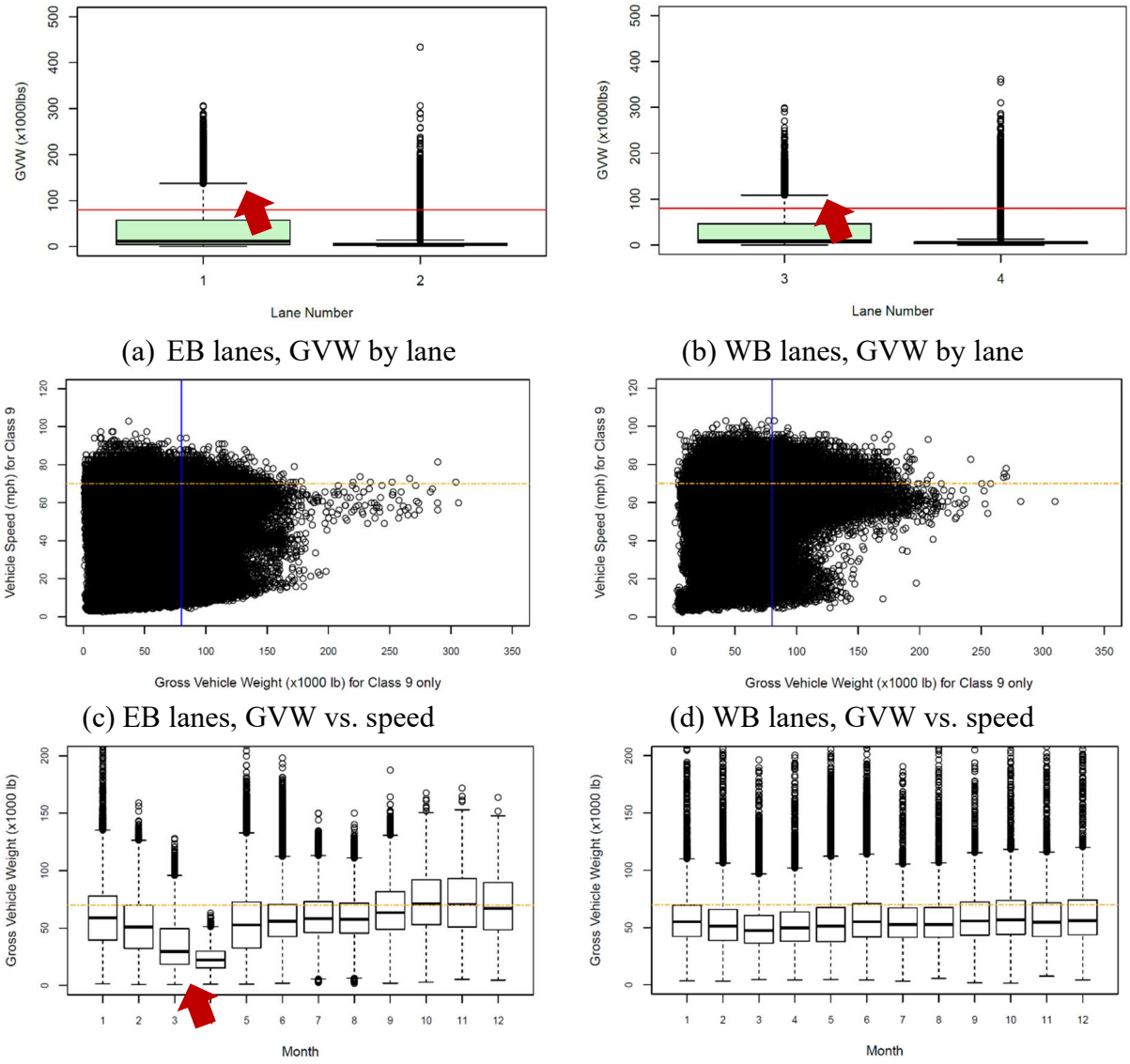
Site 083-0214

Figure 28 (a) and (b) show a boxplot of GVW in each traffic direction, with the red lines indicating the 36,287 kg (80,000 lb) weight limit. Lanes 1 and 3, the slow lanes in each direction, recorded GVW reaching far beyond the upper whisker (Q3+1.5IQR). Although the number of overweight

vehicles appears high in these scatter plots, the percentage of vehicles exceeding the 36,287 kg (80,000 lb) limit ranges between 2 percent and 4 percent (see Appendix C).

Figure 28 (c) and (d) show scatter plots of class 9 GVW. The vertical blue lines indicate the 36,287 kg (80,000 lb) limit, and the dotted orange lines indicate the legal speed limit. The vehicles in the upper right quadrant exceed the legal weight and speed limits. As anticipated, as class 9 vehicles become heavier, the driving speed appears to decrease. This indicates that increase in speed did not have a direct correlation with increase in vehicle weight.

Figure 28 (e) and (f) show boxplots of class 9 GVW by month. According to these plots, class 9 weight decreases in March and April in the EB direction.



(a) EB lanes, GVW by lane

(b) WB lanes, GVW by lane

(c) EB lanes, GVW vs. speed

(d) WB lanes, GVW vs. speed

(e) EB lanes, GVW by month

(f) WB lanes, GVW by month

Figure 28. Graphs. Analysis of Gross Vehicle Weight for Site 083-0214.

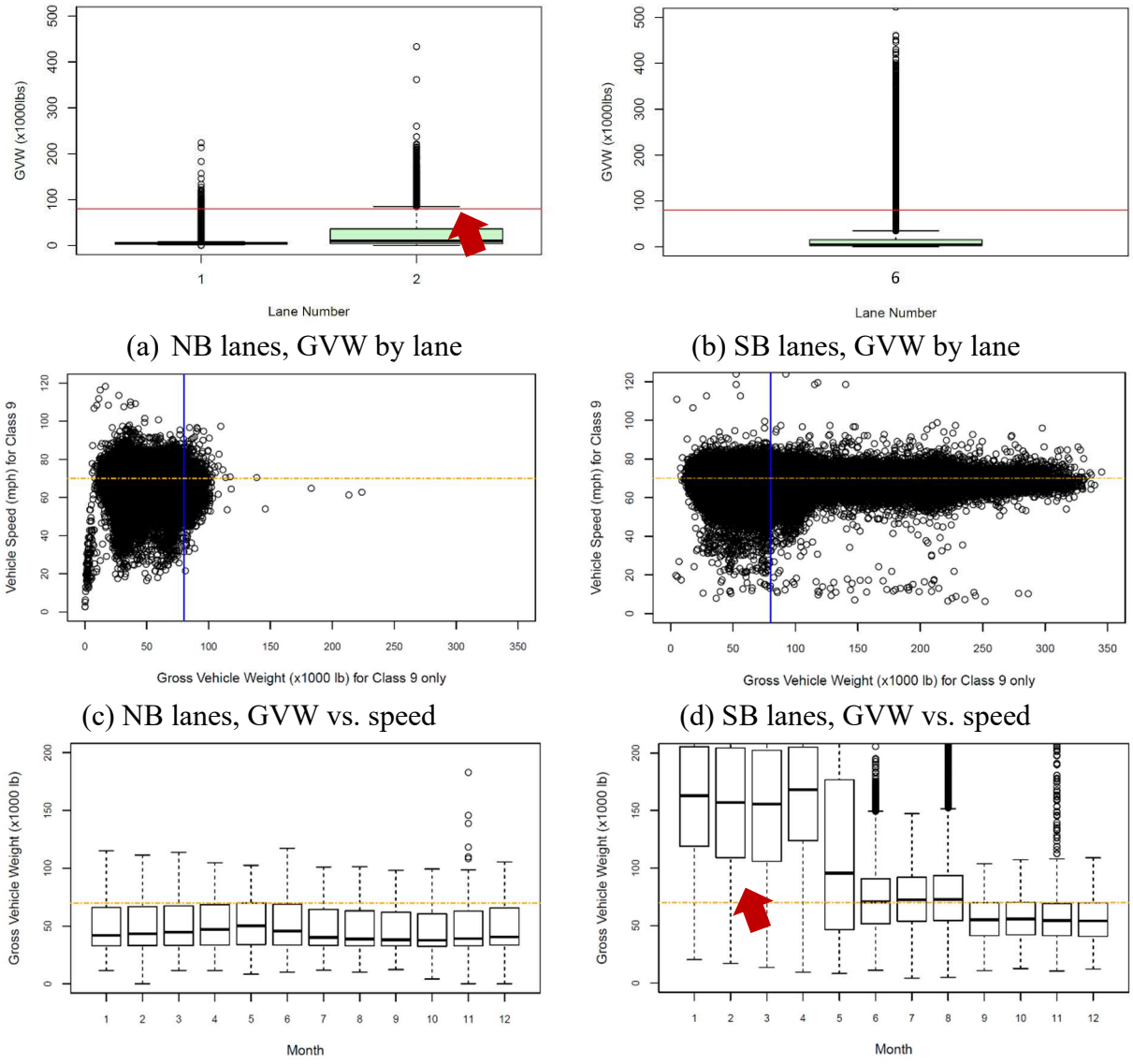
Site 127-0312

Figure 29 (a) and (b) show a boxplot of GVW in each traffic direction, with the red lines indicating the 36,287 kg (80,000 lb) weight limit. Lane 2, the NB center right lane, recorded GVW reaching beyond the upper whisker (Q3+1.5IQR). Although the number of overweight vehicles appears

high in these scatter plots, the percentage of vehicles exceeding the 36,287 kg (80,000 lb) limit ranges between 0 percent and 5 percent (see Appendix C).

Figure 29 (c) and (d) show scatter plots of class 9 GVW. The vertical blue lines indicate the 36,287 kg (80,000 lb) limit, and the dotted orange lines indicate the legal speed limit. The vehicles in the upper right quadrant exceed the legal weight and speed limits. Similar to site 175-0274, as class 9 vehicles become heavier, the driving speed does not appear to decrease significantly. This indicates that increase in speed did not have a direct correlation with increase in vehicle weight.

Figure 29 (e) and (f) show boxplots of class 9 GVW by month. According to these plots, class 9 weight greatly increases in the SB direction from January through April, then continually decreases until December.



(a) NB lanes, GVW by lane

(b) SB lanes, GVW by lane

(c) NB lanes, GVW vs. speed

(d) SB lanes, GVW vs. speed

(e) NB lanes, GVW by month

(f) SB lanes, GVW by month

Figure 29. Graphs. Analysis of Gross Vehicle Weight for Site 127-0312.

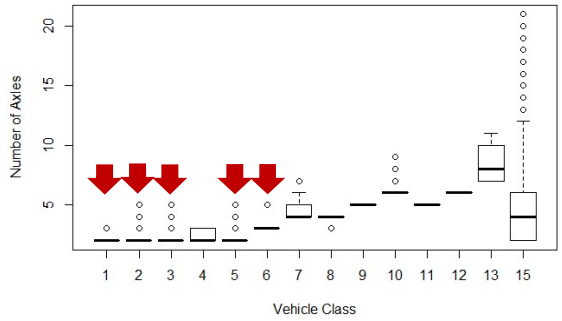
5.1.4 Analysis of Vehicle Class and Axle Spacing

The relationship between vehicle class and axle spacing at sites 185-0227, 175-0247, and 051-0700 is further analyzed through boxplots of axle counts by vehicle class. Overall, the results indicate that class 15 has the highest median count and spread in vehicle counts. That is, unclassified vehicles have a wide range of axle counts. Class 1 should have two axles; however,

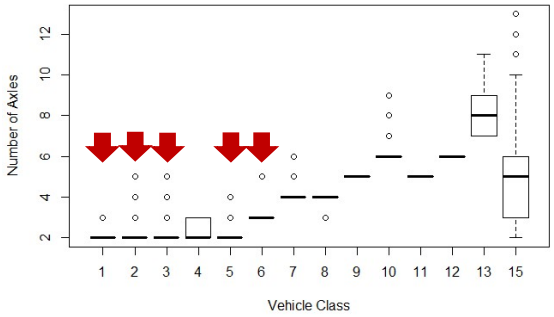
in the WIM data, third axles are observed. Classes 2 and 3 should have as many as four axles; however, fifth axles are observed. In addition, while classes 5 and 6 should have two and three axles, respectively, third, fourth and fifth axles are observed for class 5, and fourth and fifth axles are observed for class 6. Finally, classes 7 and above appear to have the number of axles specified by the FHWA vehicle classification system.

Site 185-0227

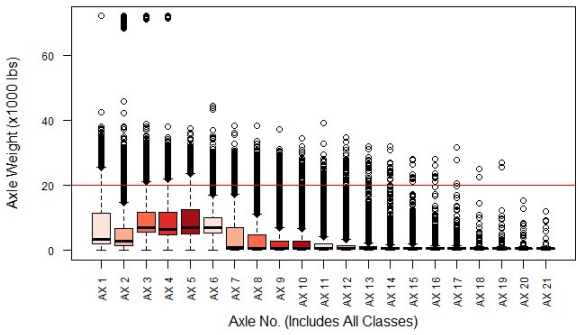
Figure 30 shows boxplots of axle counts by vehicle class. The data indicate that class 15 (unclassified vehicles) has the highest median count and spread in vehicle counts. Class 1 should have two axles; however, in the WIM data, third axles are observed. Classes 2 and 3 should have as many as four axles; however, fifth axles are observed. In addition, while classes 5 and 6 should have two and three axles, respectively, fourth and fifth axles are observed for class 5, and fourth and fifth axles are also observed for class 6. Finally, classes 7 and above appear to have the number of axles specified by the FHWA vehicle classification system.



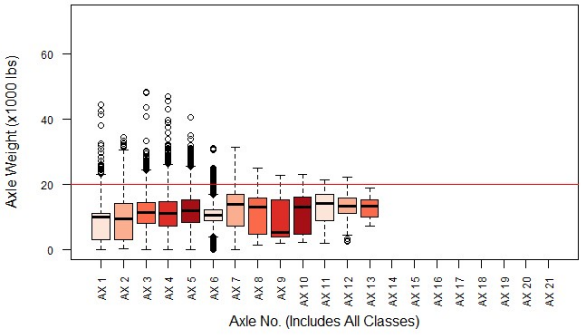
(a) NB lanes



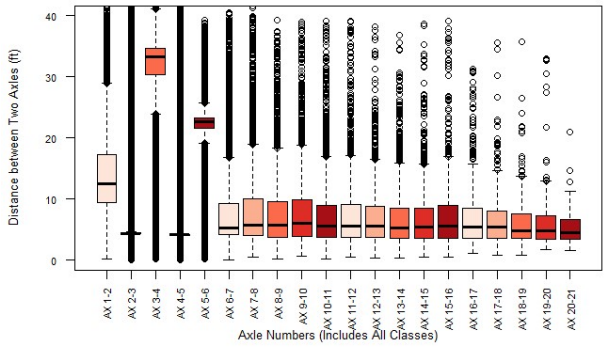
(b) SB lanes



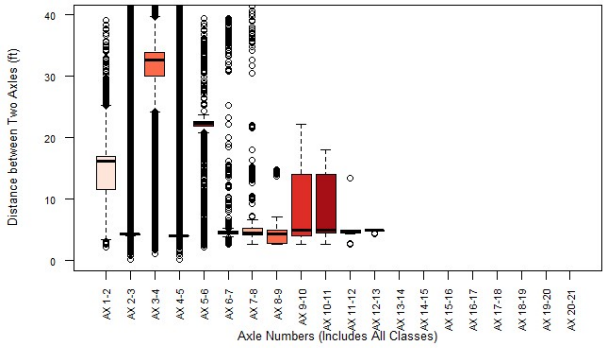
(c) Axle weight (x1000 lb), NB lanes



(d) Axle weight (x1000 lb), SB lanes



(e) Axle spacing, NB lanes

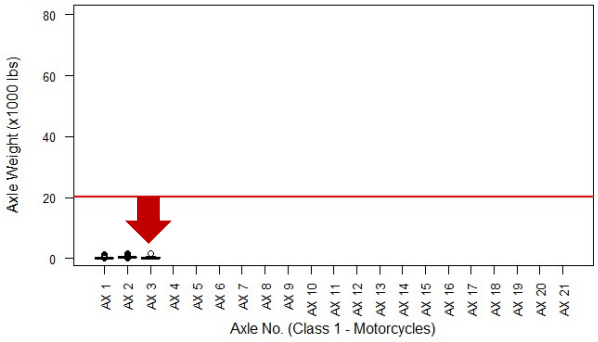


(f) Axle spacing, SB lanes

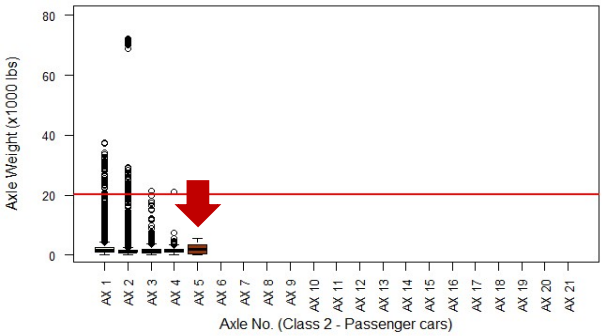
Figure 30. Graphs. Analysis of Vehicle Class and Axle Spacing for Site 185-0227.

Weight Distribution by Class

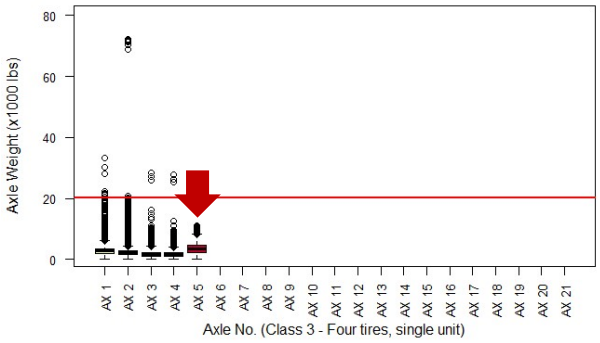
To further illustrate weight distribution by vehicle class, Figure 31 and Figure **32** show boxplots of the number of axles recorded for each class in the NB direction. The data presented in these figures agrees with that of Figure 30.



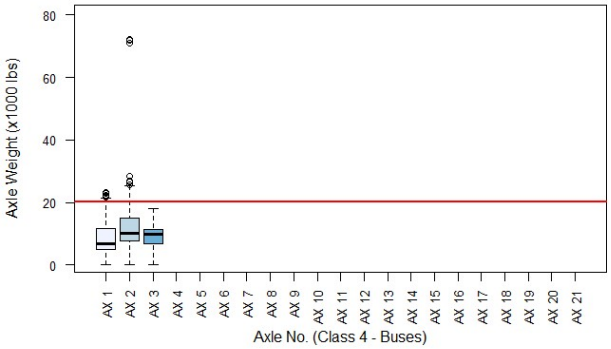
(a) Class 1 – motorcycles



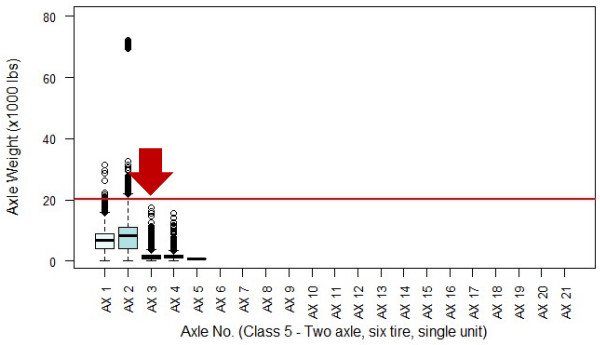
(b) Class 2 – passenger cars



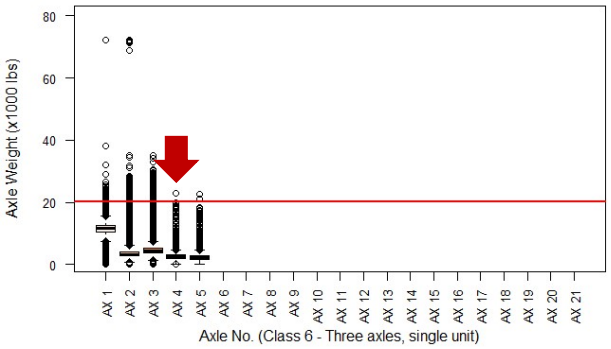
(c) Class 3 – four tires, single unit



(d) Class 4 – buses

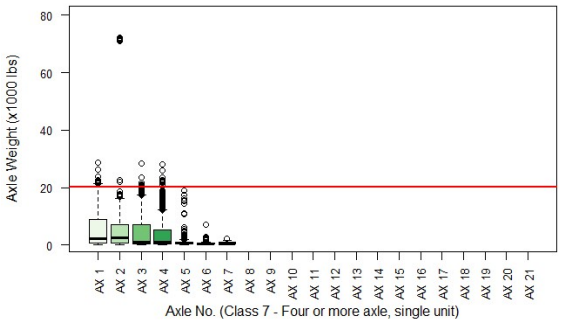


(e) Class 5 – two axle, six tire, single unit

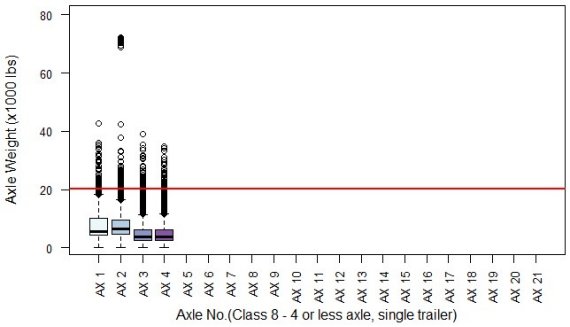


(f) Class 6 – three axles, single unit

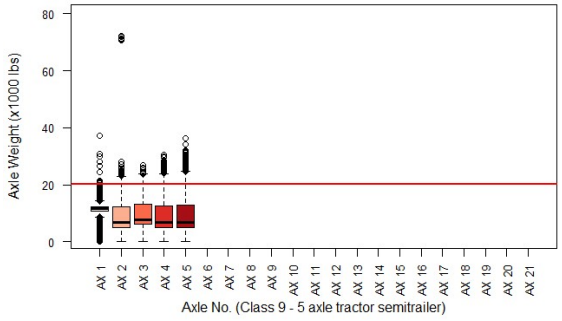
Figure 31. Graphs. Weight Distribution by Class for Site 185-0227 NB (classes 1–6).



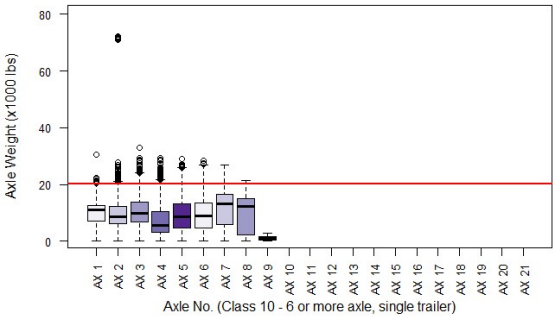
(a) Class 7 – four or more axle, single unit



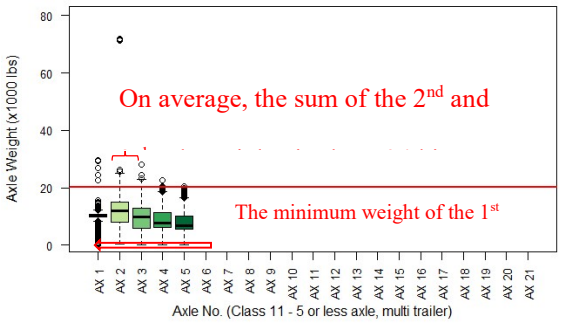
(b) Class 8 – four or less axle, single trailer



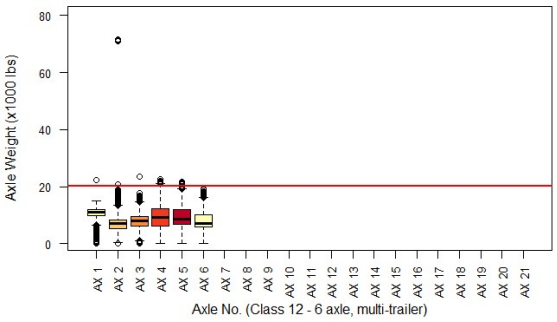
(c) Class 9 – five axle tractor semi-trailer



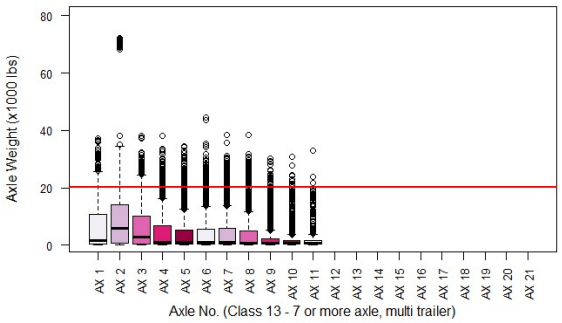
(d) Class 10 – six or more axle, single trailer



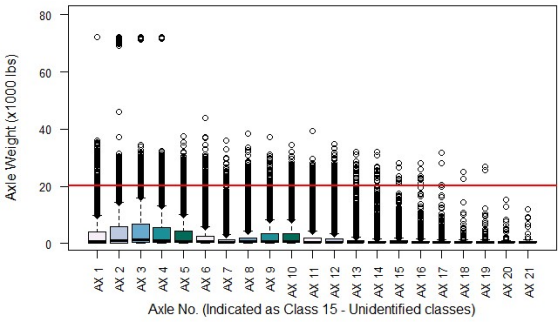
(e) Class 11 – five or less axle, multi-trailer



(f) Class 12 – six axle, multi-trailer



(g) Class 13 – seven or more axle, multi-trailer

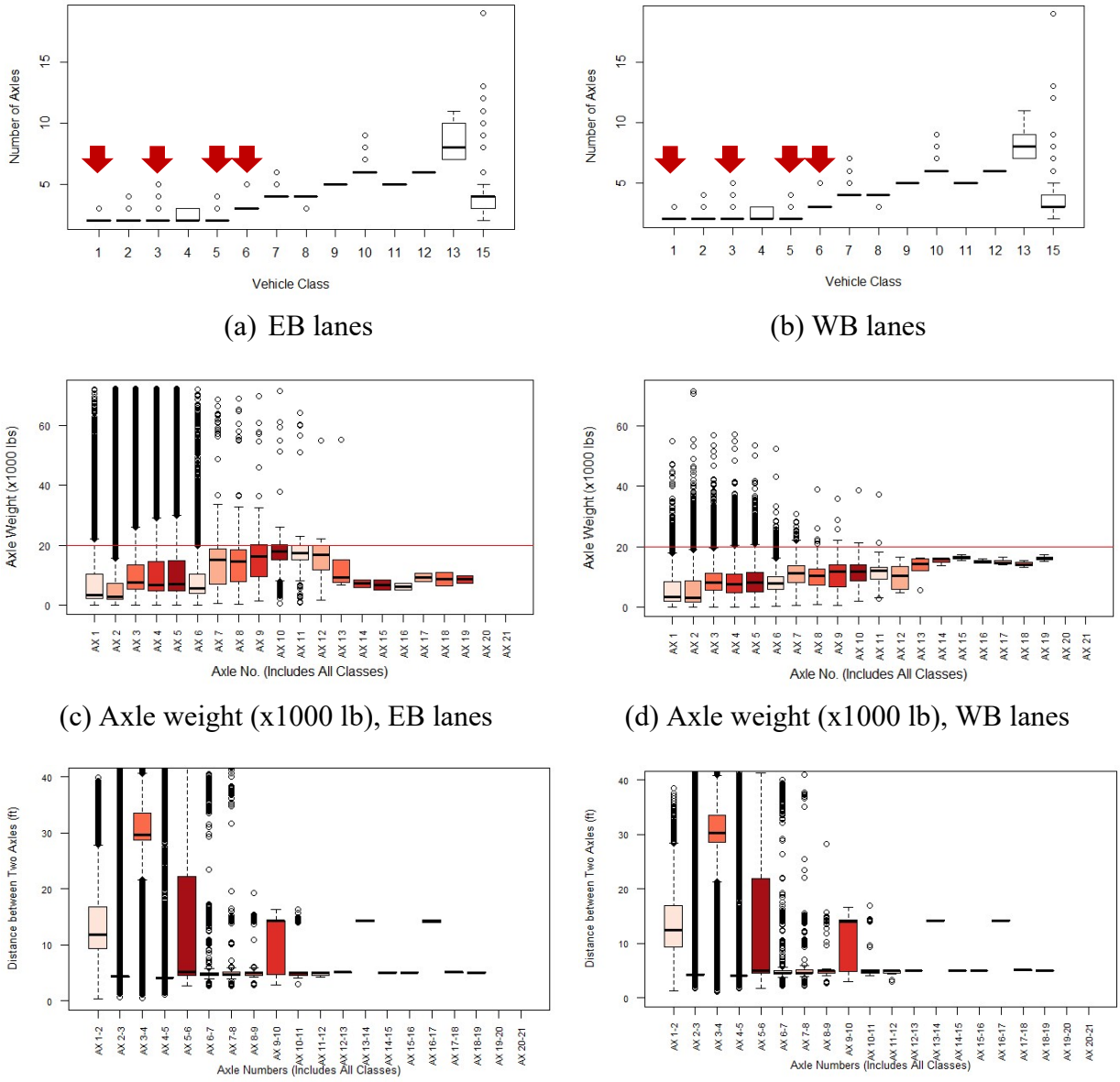


(h) Class 15 – unidentified classes

Figure 32. Graphs. Weight Distribution by Class for Site 185-0227 NB (classes 7–15).

Site 175-0247

Figure 33 shows boxplots of axle counts by vehicle class. The data indicate that class 15 (unclassified vehicles) has the highest median count and spread in vehicle counts. Class 1 should have two axles; however, in the WIM data, third axles are observed. Class 3 should have as many as four axles; however, fifth axles are observed. In addition, while classes 5 and 6 should have two and three axles, respectively, third and fourth axles are observed for class 5, and fourth and fifth axles are observed for class 6. Finally, classes 7 and above appear to have the number of axles specified by the FHWA vehicle classification system.



(a) EB lanes

(b) WB lanes

(c) Axle weight (x1000 lb), EB lanes

(d) Axle weight (x1000 lb), WB lanes

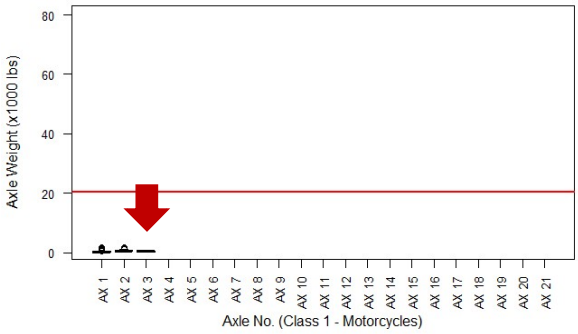
(e) Axle spacing [13], EB lanes

(f) Axle spacing [13], WB lanes

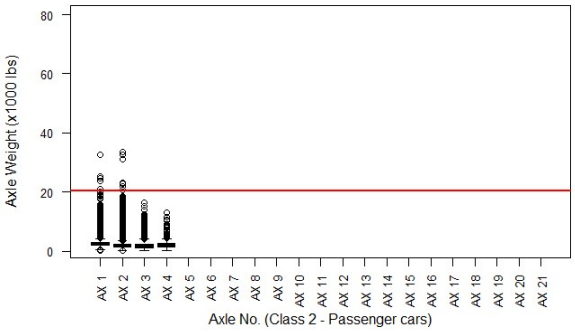
Figure 33. Graphs. Analysis of Vehicle Class and Axle Spacing for Site 175-0247.

Weight Distribution by Class

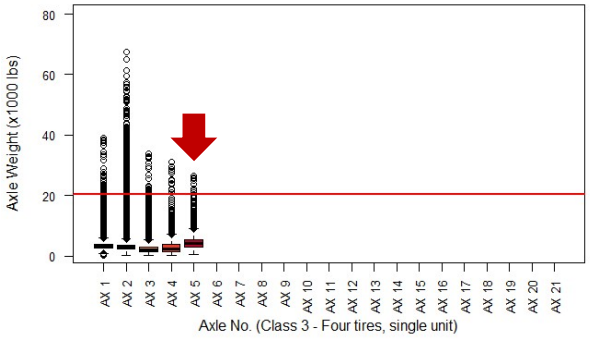
To further illustrate weight distribution by vehicle class, Figure 34 and Figure **35** show boxplots of the number of axles recorded for each class in the EB direction. The data presented in these figures agrees with that of Figure 33.



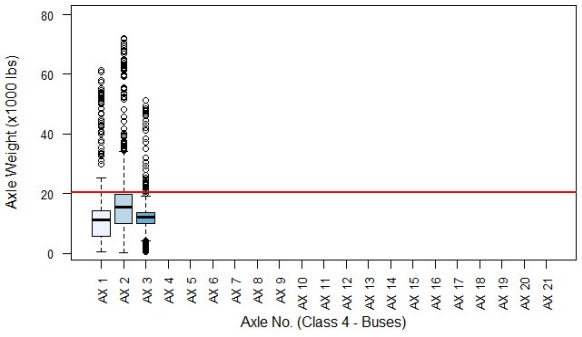
(a) Class 1 – motorcycles



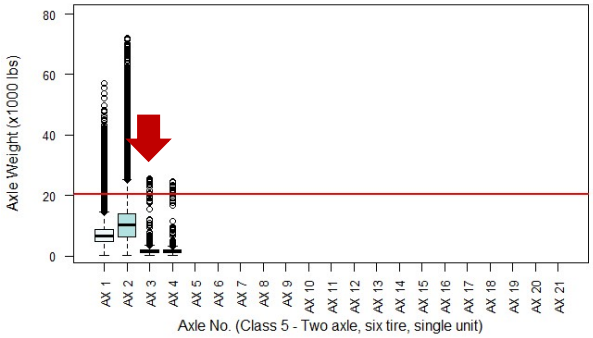
(b) Class 2 – passenger cars



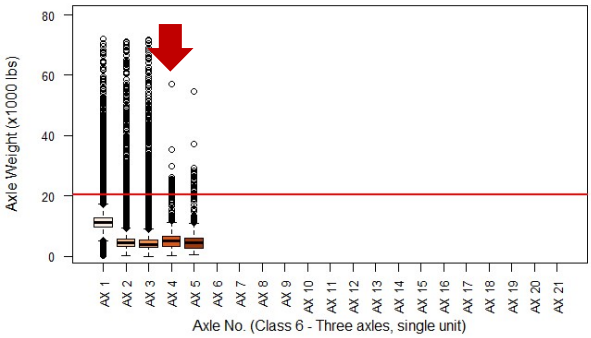
(c) Class 3 – four tires, single unit



(d) Class 4 – buses

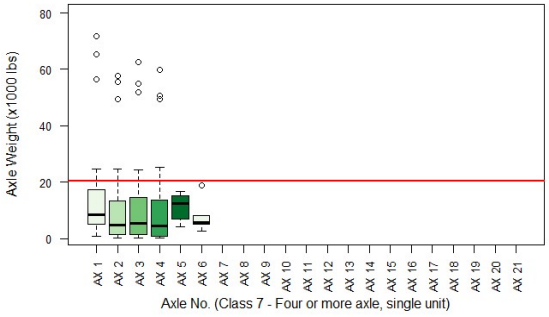


(e) Class 5 – two axle, six tire, single unit

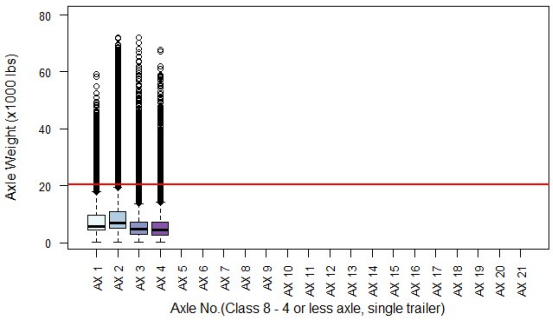


(f) Class 6 – three axles, single unit

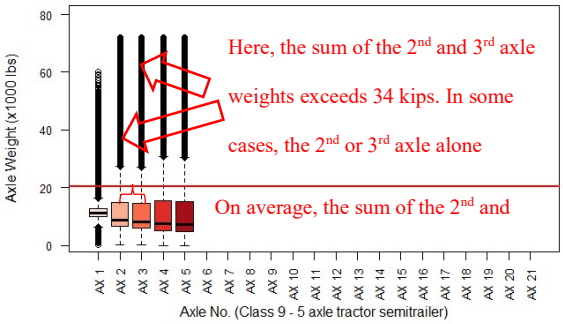
Figure 34. Graphs. Weight Distribution by Class for Site 175-0247 EB (classes 1–6).



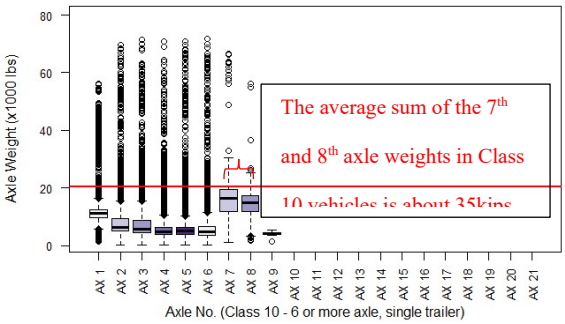
(a) Class 7 – four or more axle, single unit



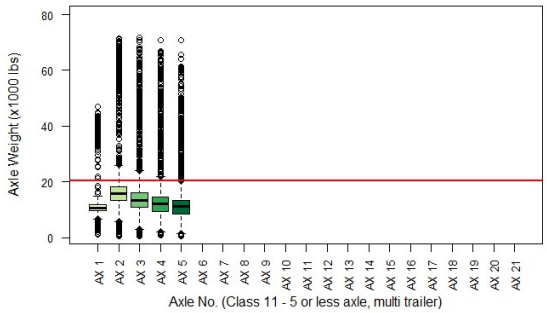
(b) Class 8 – four or less axle, single trailer



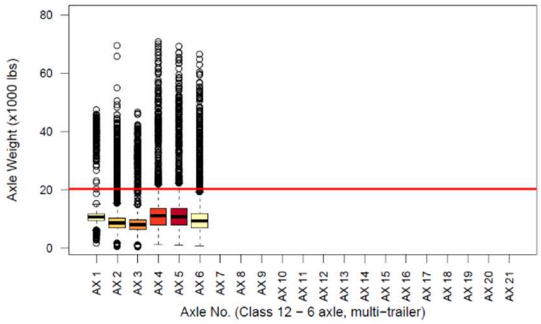
(c) Class 9 – five axle tractor semi-trailer



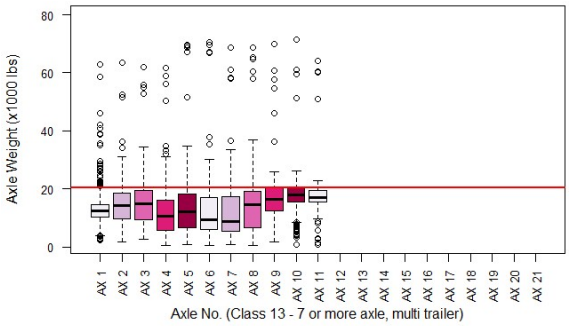
(d) Class 10 – six or more axle, single trailer



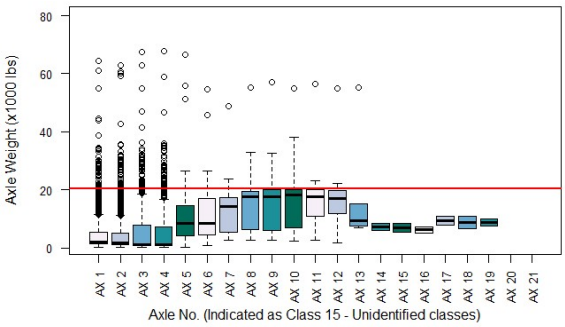
(e) Class 11 – five or less axle, multi-trailer



(f) Class 12 – six axle, multi-trailer



(g) Class 13 – 7 or more axle, multi-trailer

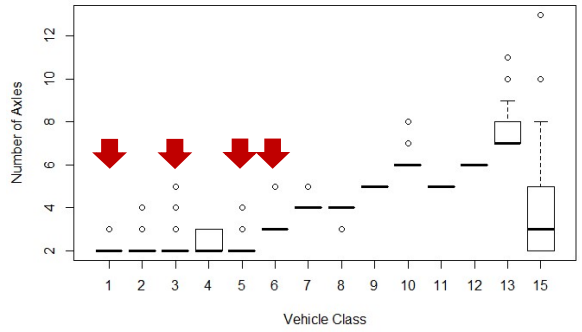


(h) Class 15 – unidentified classes

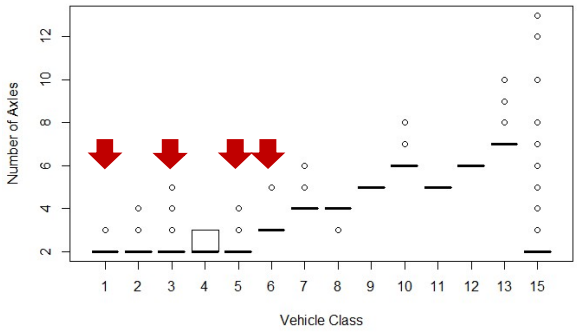
Figure 35. Graphs. Weight Distribution by Class for Site 175-0247 EB (classes 7–15).

Site 051-0700

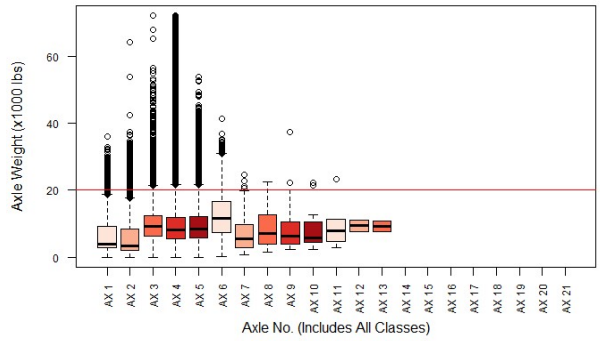
Figure 36 shows boxplots of axle counts by vehicle class. The data indicate that class 15 (unclassified vehicles) has the highest median count and spread in the vehicle counts. Class 1 should have two axles; however, in the WIM data, third axles are observed. Class 3 should have as many as four axles; however, fifth axles are observed. In addition, while classes 5 and 6 should have two and three axles, respectively, third and fourth axles are observed for class 5, and fourth and fifth axles are observed for class 6. Like the two sites presented above, classes 7 and above appear to have the number of axles specified by the FHWA vehicle classification system.



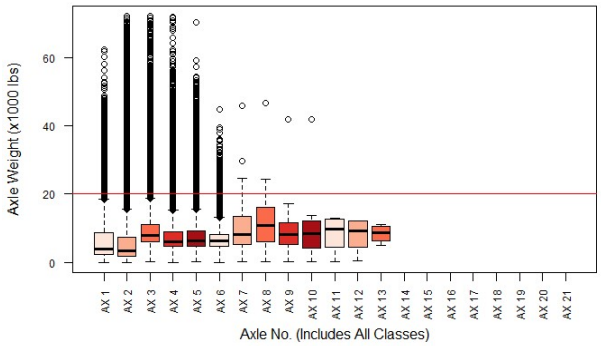
(a) NB lanes



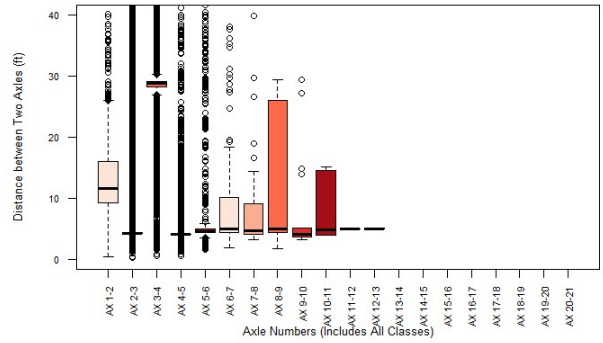
(b) SB lanes



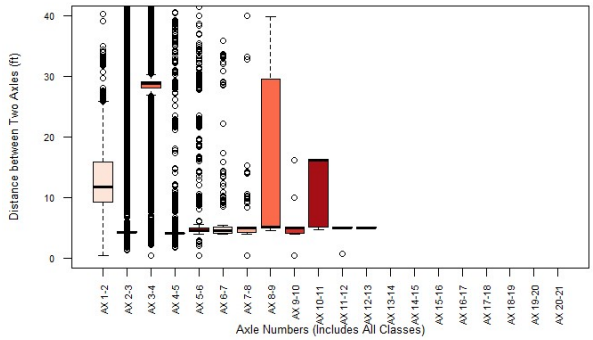
(c) Axle weight (x1000 lb), NB lanes



(d) Axle weight (x1000 lb), SB lanes



(e) Axle spacing, NB lanes

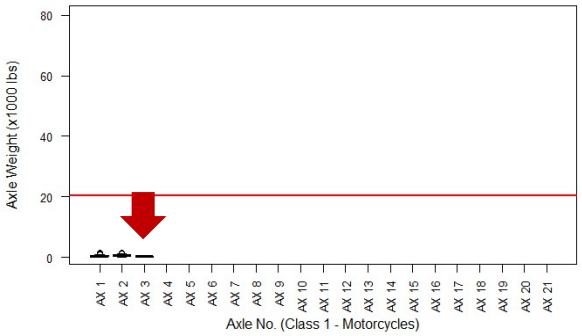


(f) Axle spacing, SB lanes

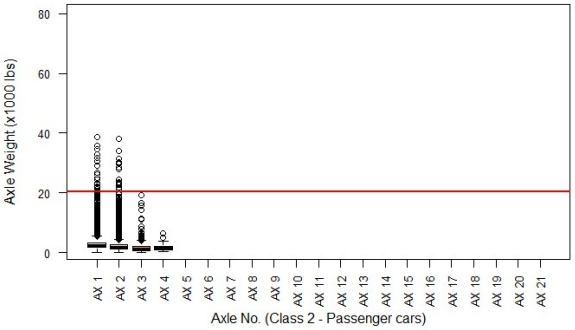
Figure 36. Graphs. Analysis of Vehicle Class and Axle Spacing for Site 051-0700.

Weight Distribution by Class

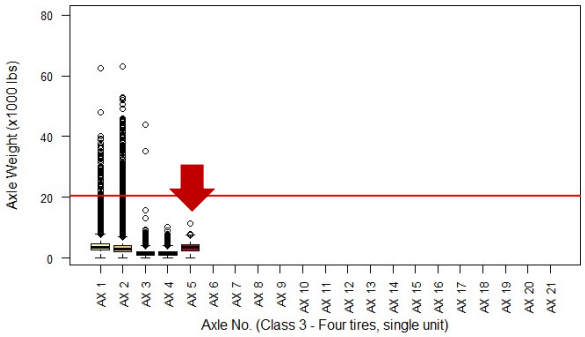
To further illustrate weight distribution by vehicle class, Figure 37 and Figure 38 show boxplots of the number of axles recorded for each class in the SB direction. The data presented in these figures agrees with that of Figure 36.



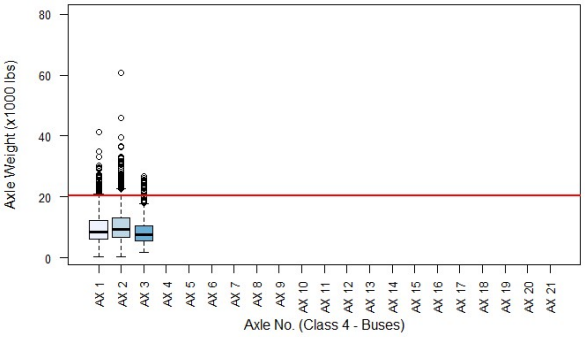
(a) Class 1 – motorcycles



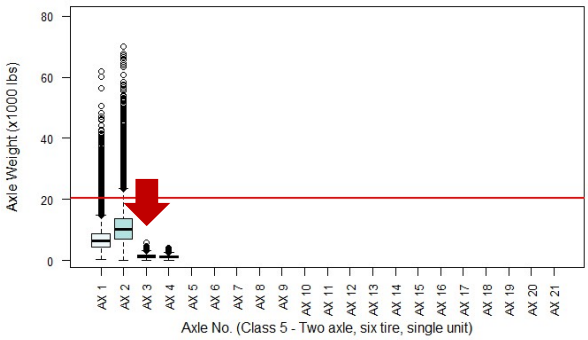
(b) Class 2 – passenger cars



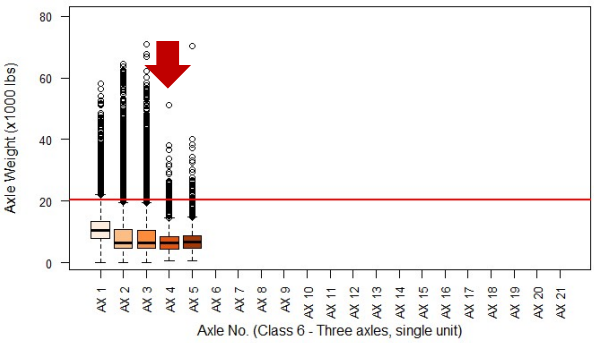
(c) Class 3 – four tires, single unit



(d) class 4 – buses

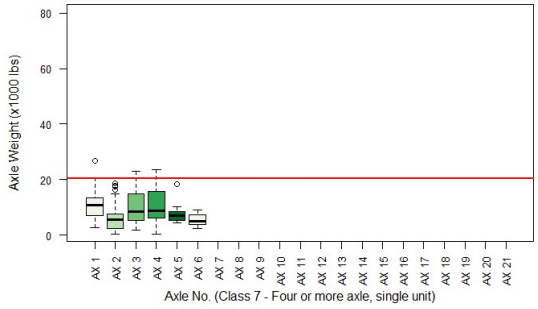


(e) Class 5 – two axle, six tire, single unit

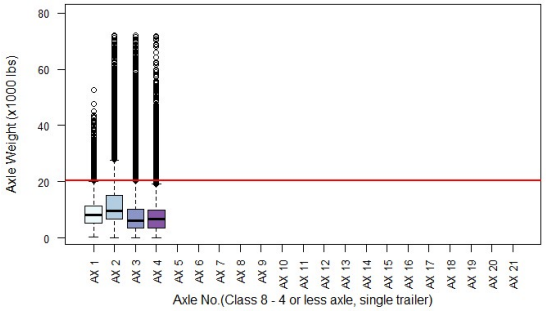


(f) Class 6 – three axles, single unit

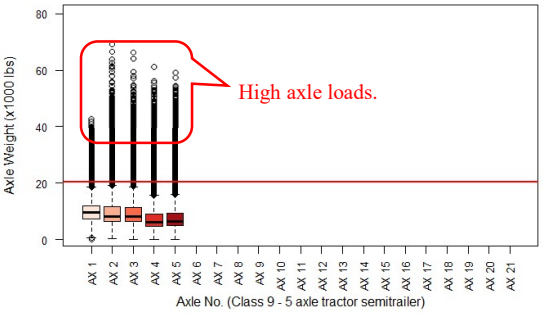
Figure 37. Graphs. Weight Distribution by Class for Site 051-0700 SB (classes 1–6).



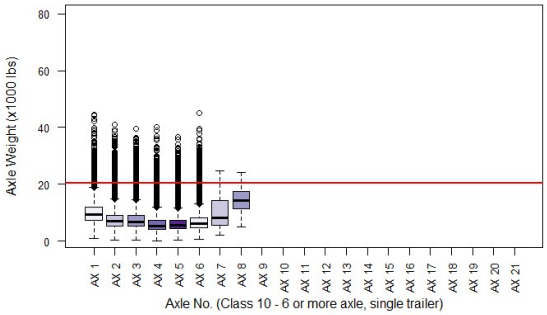
(a) Class 7 – four or more axle, single unit



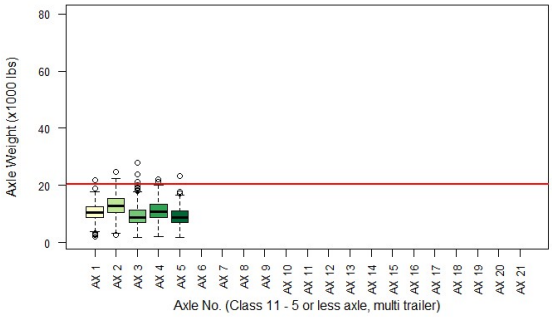
(b) Class 8 – four or less axle, single trailer



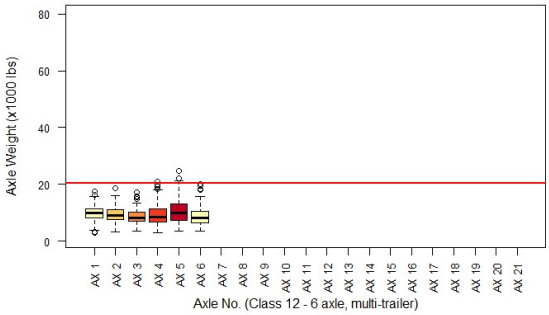
(c) Class 9 – five axle tractor semi-trailer



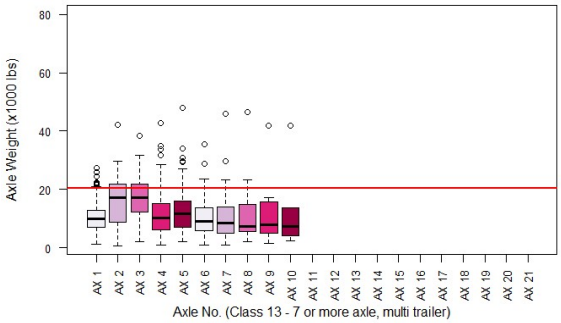
(d) Class 10 – six or more axle, single trailer



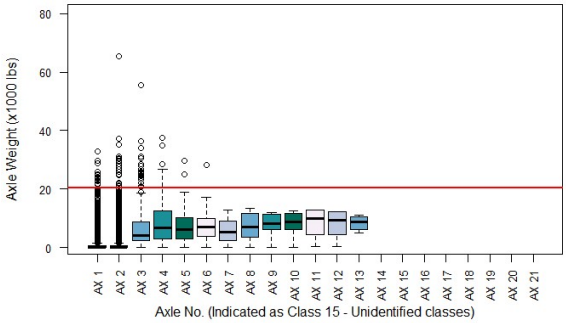
(e) Class 11 – five or less axle, multi-trailer



(f) Class 12 – six axle, multi-trailer



(g) Class 13 – seven or more axle, multi-trailer



(h) Class 15 – unidentified classes

Figure 38. Graphs. Weight Distribution by Class for Site 051-0700 SB (classes 7–15).

5.1.5 Analysis of Weight Shift and Noticeable Spread

The weight shift observed in each lane can help identify sensors requiring calibration and/or maintenance and sensors that are reading consistent and reasonable vehicle weights. Single axle load distribution should generally show a single mode. Multiple modes are observed at some locations. Additionally, a significant monthly shift in single axle weight is observed particularly at sites 127-0312, 083-0214, and 143-0126.

The tandem axle load spectra for class 9 vehicles is also analyzed. The graphical representations are expected to show a bi-modal distribution. The tandem axle load of a vehicle allowed to drive without a permit is 15,422 kg (34,000 lbs). Sites 127-0312, 083-0214, and 143-0126 in particular have a higher frequency of tandem axle loads exceeding 15,422 kg (34,000 lbs).

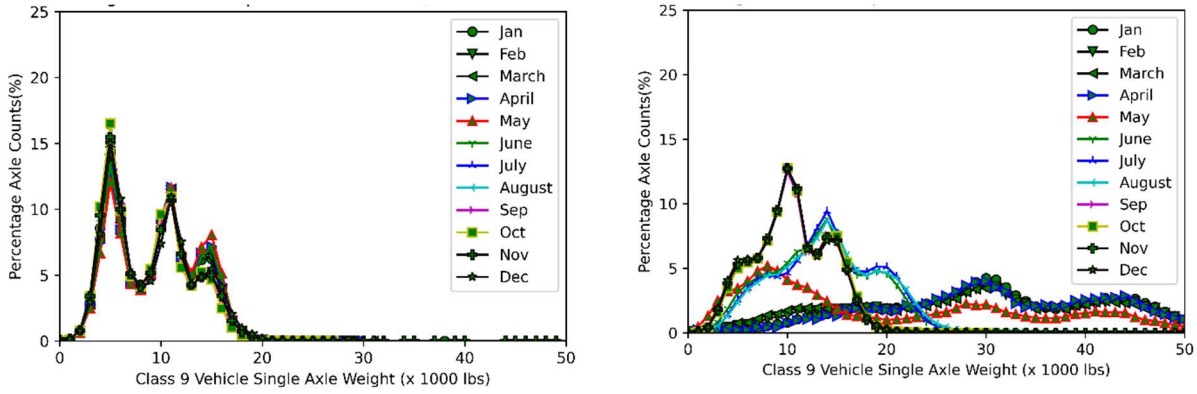
Class 9 axle spacing spread is analyzed, as well, and overall is higher than expected. Box-histogram plots of the distance between the third and fourth axles for class 9 vehicles illustrate this finding for sites 127-0312, 083-0214, and 143-0126.

Lastly, daily truck traffic spread is analyzed. Sites 127-0312, 083-0214, and 143-0126 show that the mean of daily truck traffic observations and AADTT counts (i.e., the total number divided by the number of days) are significantly different. This AADTT information captures unusual truck traffic volume and/or maintenance activities that may exist at the site.

Site 127-0312

Class 9 Single Axle Load Spectrum

Figure 39 shows the single axle load spectrum by month for each direction. The SB lanes show monthly gross weight shifts and anomalies as illustrated in Figure 39 (b).

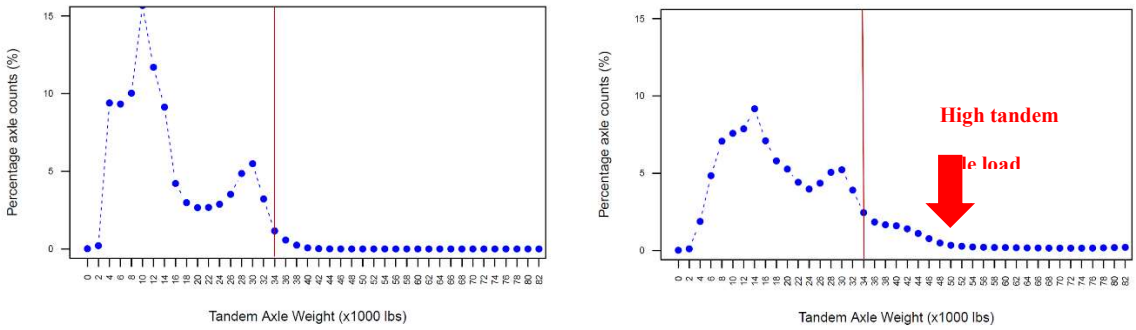


(a) NB lanes (b) SB lanes

Figure 39. Graphs. Monthly Class 9 Single Axle Weight Deviations by Traffic Direction (Site 127-0312).

Class 9 Tandem Axle Load Spectrum

Site 127-0312 has a higher frequency of tandem axle loads exceeding 15,422 kg (34,000 lbs). As evident in Figure 40, the tandem axle load distribution is overall bi-modal; however, the distribution is right-skewed overall. This tandem axle weight in the x-axis is intentionally placed on a different scale to observe the full spectra of loads, and the 15,422 kg (34,000 lb) limit is indicated with a red vertical line unless all tandem axle loads are well within 15,422 kg (34,000 lbs).

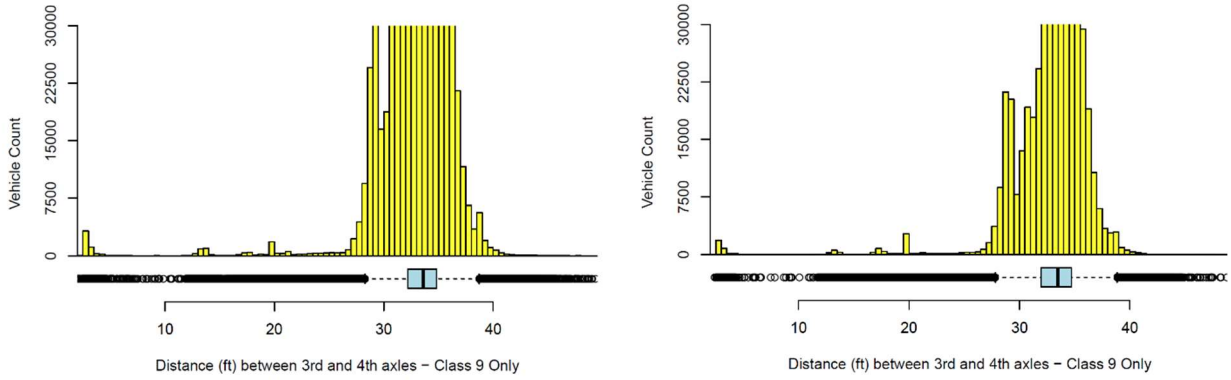


(a) NB lanes (b) SB lanes

Figure 40. Graphs. Class 9 Tandem Axle Load Spectrum by Traffic Direction (Site 127-0312).

Class 9 Axle Spacing Spread

Overall, the spread in the axle-spacing data for class 9 vehicles is higher than expected at site 127-0312. For instance, the distance between the third and fourth axles for class 9 vehicles is expected to range between 61 cm (2 ft) and 2,286 cm (75 ft). In the box-histogram plot in Figure 41 below, however, spacings appear outside of this range. The scale for the y-axis is intentionally limited to 30,000 whereas the x-axis scale changes as the distance varies among sites.

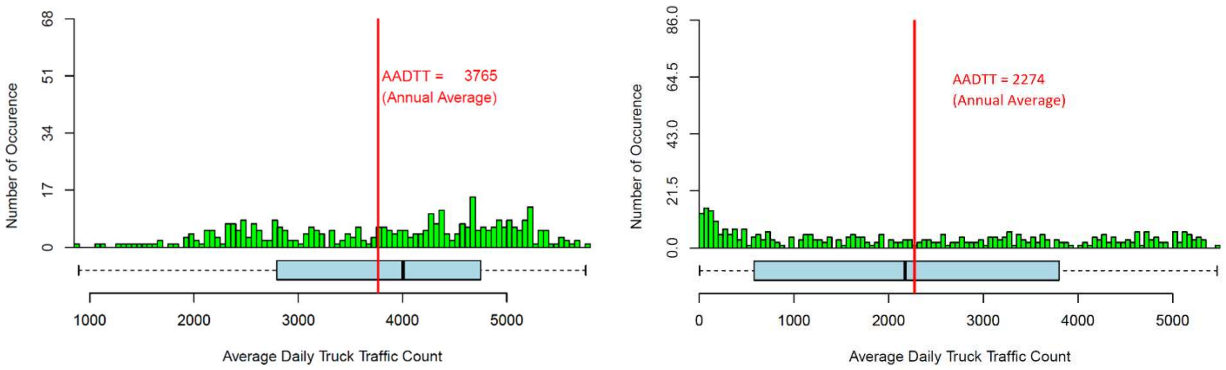


(a) NB lanes (b) SB lanes

Figure 41. Graphs. Distance between Third and Fourth Axles for Class 9 Vehicles by Traffic Direction (Site 127-0312).

Daily Truck Traffic Spread

Figure 42 shows the spread in daily truck traffic distribution when usable data is analyzed. The mean of daily truck traffic observations and AADTT counts (i.e., the total number divided by the number of days) are significantly different. At site 127-0312, the daily truck traffic spread is higher in the SB lanes than in the NB lanes, which may mean that some NB data may have been unusable and thus removed.



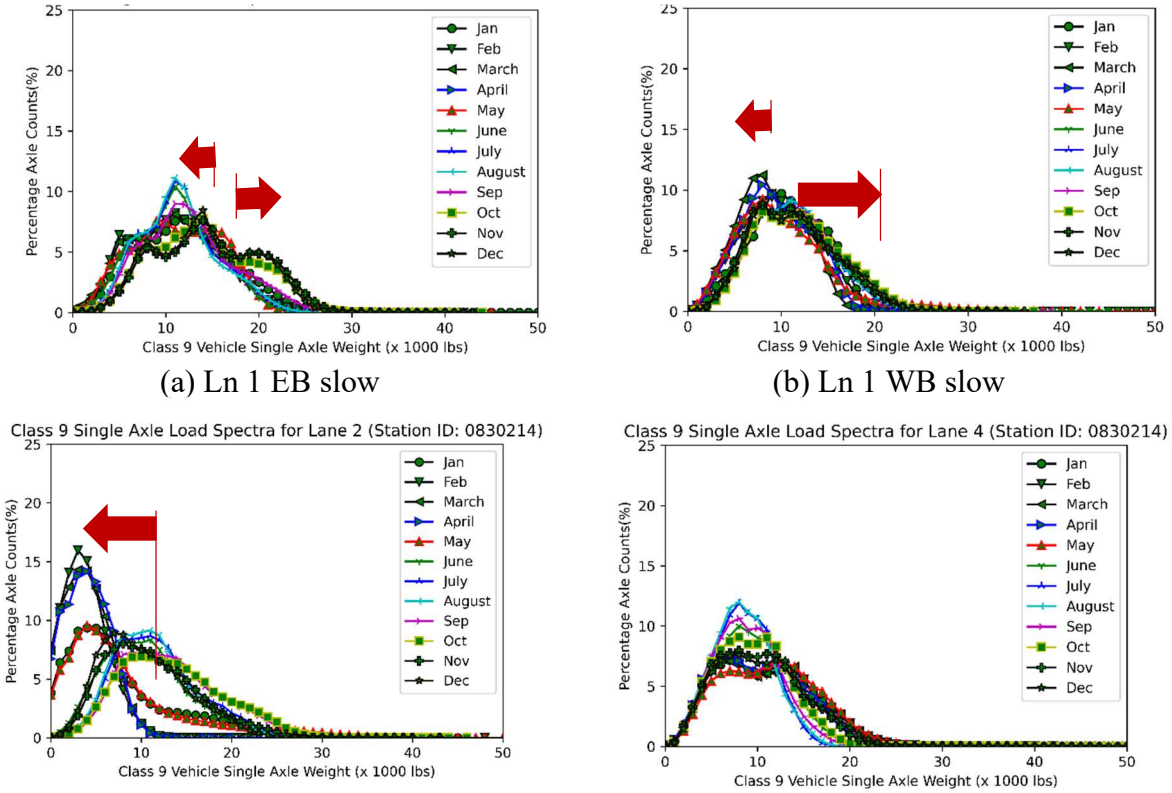
(a) NB lanes (b) SB lanes

Figure 42. Graphs. Frequency of Average Daily Truck Traffic Count by Traffic Direction (Site 127-0312).

Site 083-0214

Class 9 Single Axle Load Spectrum

The EB lanes show monthly single axle weight shifts and anomalies as illustrated in Figure 43.



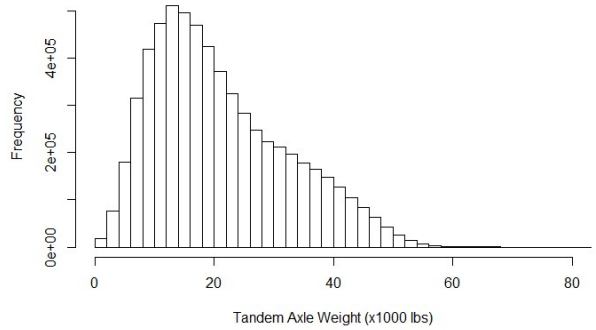
(a) Ln 1 EB slow (b) Ln 1 WB slow

(c) Ln 2 EB fast (d) Ln 2 WB fast

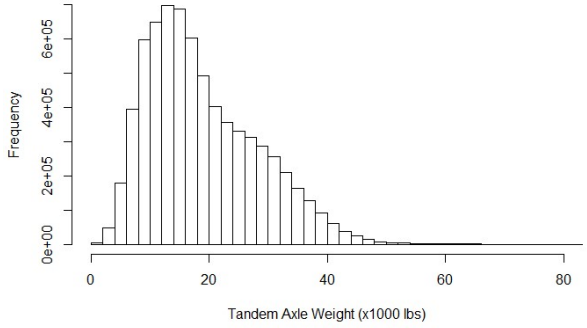
Figure 43. Graphs. Monthly Class 9 Single Axle Load by Lane (Site 083-0214).

Class 9 Tandem Axle Load Spectrum

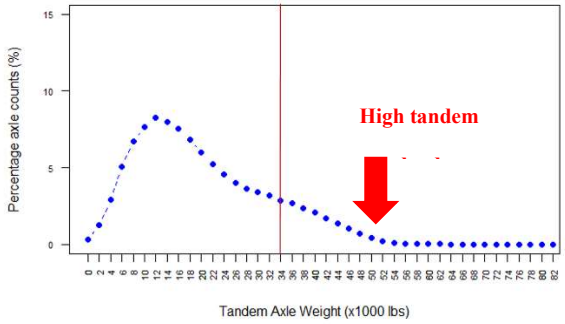
Site 083-0214 has a higher frequency of tandem axle loads exceeding 15,422 kg (34,000 lbs). As evident in Figure 44, the tandem axle load distribution should be bi-modal; however, the distribution with a single peak is right-skewed. This tandem axle weight in the x-axis is intentionally placed on a different scale to observe the full spectra of loads, and the 15,422 kg (34,000 lb) limit is indicated with a red vertical line. There is a significant number of tandem axle counts greater than the limit.



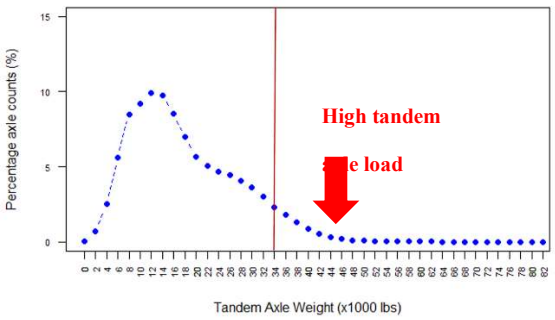
(a) EB lanes, site 083-0214



(b) WB lanes, site 083-0214



(c) EB lanes, site 083-0214

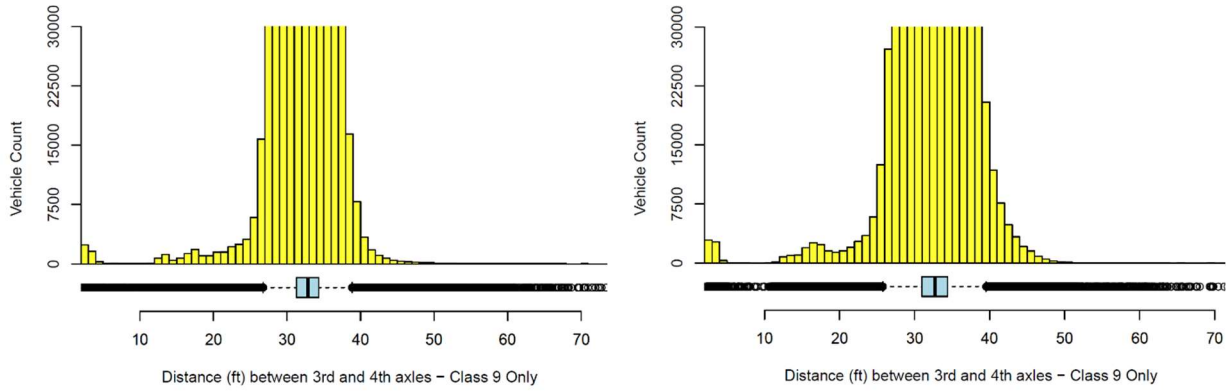


(d) WB lanes, site 083-0214

Figure 44. Graphs. Class 9 Tandem Axle Load Spectrum by Traffic Direction (Site 083-0214).

Class 9 Axle Spacing Spread

Similar to site 127-0312, the spread in the axle-spacing data for class 9 vehicles is slightly higher than expected at site 083-0214. For instance, the distance between the third and fourth axles for class 9 vehicles is expected to range between 61 cm (2 ft) and 2286 cm (75 ft). In the box-histogram plot in Figure 45 below, however, spacings appear outside of this range. The scale for the y-axis is intentionally limited to 30,000 whereas the x-axis scale changes as the distance varies among sites.

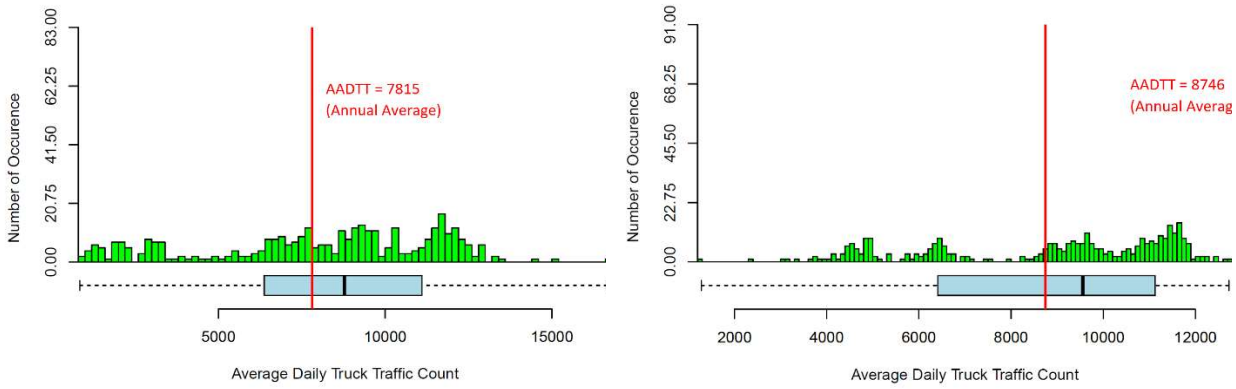


(a) EB lanes, site 083-0214 (b) WB lanes, site 083-0214

Figure 45. Graphs. Distance between Third and Fourth Axles for Class 9 Vehicles by Traffic Direction (Site 083-0214).

Daily Truck Traffic Spread

Figure 46 shows the spread in daily truck traffic distribution when the usable data is analyzed. The mean of daily truck traffic observations and AADTT counts (i.e., the total number divided by the number of days) are significantly different. At site 0830214, the daily truck traffic spread is higher in the WB lanes than in the EB lanes, which means that some EB data may be or have been unusable and thus removed.



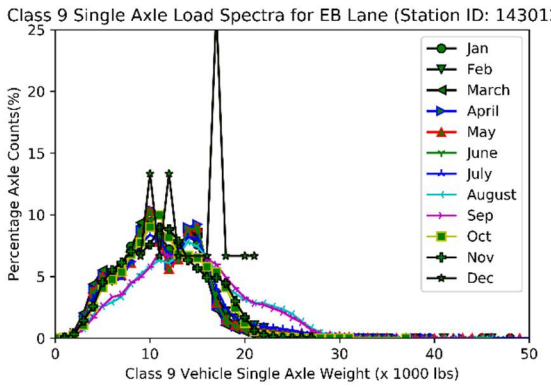
(a) EB lanes, site 083-0214 (b) WB lanes, site 083-0214

Figure 46. Graphs. Frequency of Average Daily Truck Traffic Count by Traffic Direction (Site 083-0214).

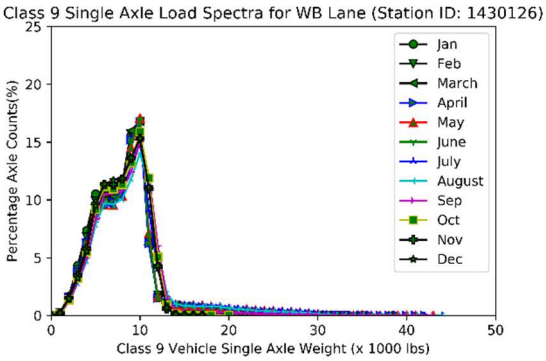
Site 143-0126

Class 9 Single Axle Load Spectrum

The EB lanes show monthly class 9 single axle weight shifts and anomalies as illustrated in Figure 47. There was no data available for 2020. This site was last calibrated in 2021.



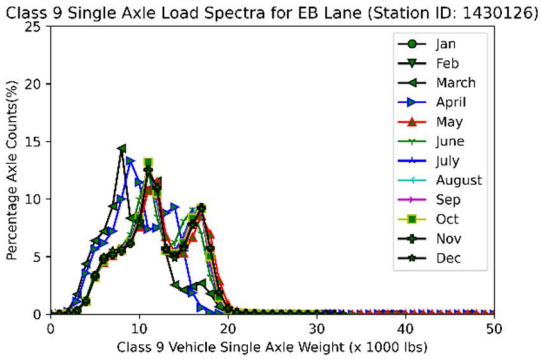
(a) EB lanes – 2019 data



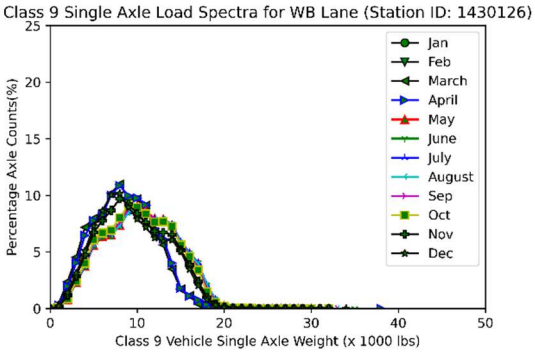
(b) WB lanes – 2019 data

No data available.
(c) EB lanes – 2020 data

No data available.
(d) WB lanes – 2020 data



(e) EB lanes – 2021 data

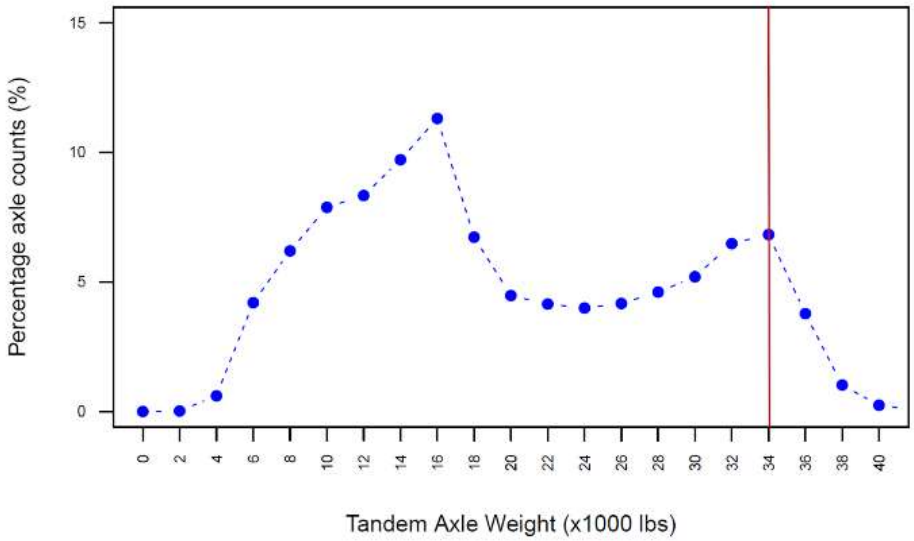


(f) WB lanes – 2021 data

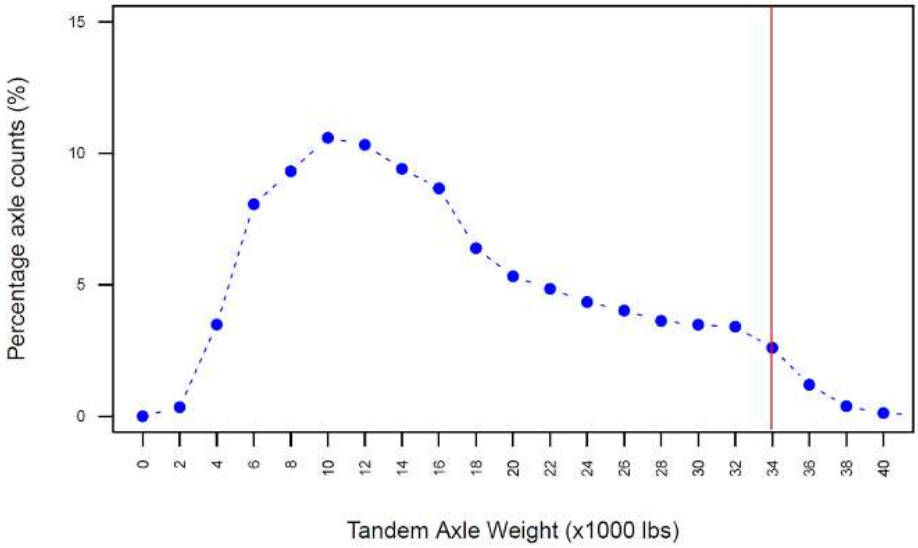
Figure 47. Graphs. Monthly Class 9 Single Axle Load by Traffic Direction for 2019–2021 (Site 143-0126).

Class 9 Tandem Axle Load Spectrum

As evident in Figure 48, site 143-0216 in particular has a higher frequency of tandem axle loads exceeding 15,422 kg (34,000 lbs). This tandem axle weight in the x-axis is intentionally placed on a different scale to observe the full spectra of loads, and the 15,422 kg (34,000 lb) limit is indicated with a red vertical line.



(a) EB lanes, site 143-0216



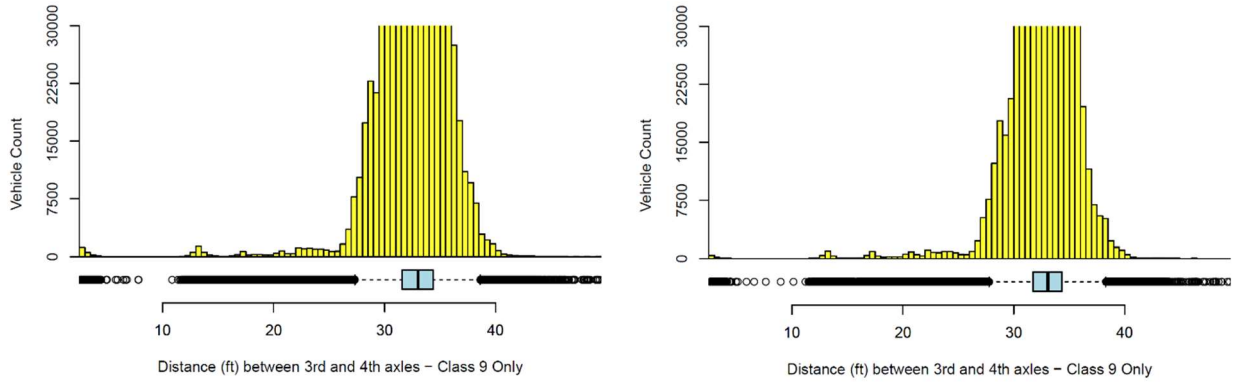
(b) WB lanes, site 143-0216

Figure 48. Graphs. Class 9 Tandem Axle Load Spectrum by Traffic Direction (Site 143-0216).

Class 9 Axle Spacing Spread

Overall, the spread in the axle-spacing data for class 9 vehicles is within the expected range at site 143-0126. For instance, the distance between the third and fourth axles for class 9 vehicles is expected to range between 61 cm (2 ft) and 2286 cm (75 ft). In the box-histogram plot in Figure 49

below, axle spacings appear to be within this range. The scale for the y-axis is intentionally limited to 30,000 whereas the x-axis scale changes as the distance varies among sites.

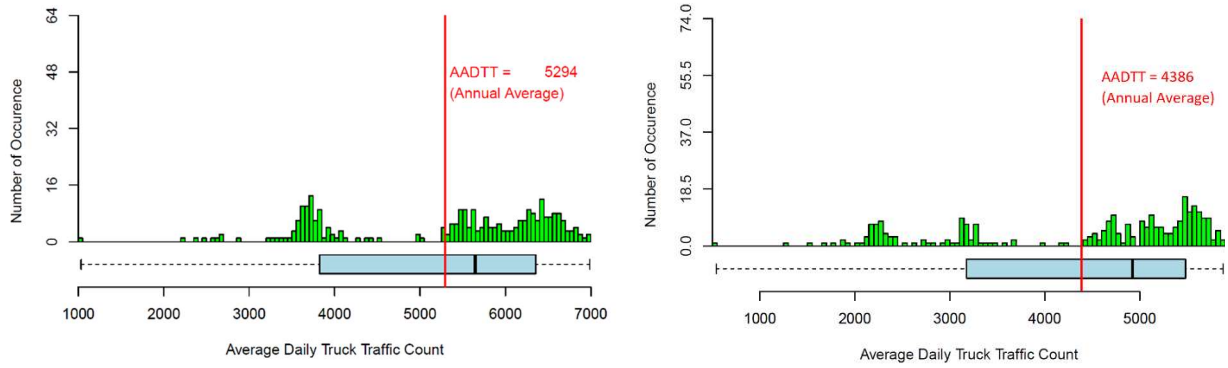


(a) EB lanes, site 143-0216 (b) WB lanes, site 143-0216

Figure 49. Graphs. Distance between Third and Fourth Axles for Class 9 Vehicles by Traffic Direction (Site 143-0216).

Daily Truck Traffic Spread

Figure 50 shows the spread in daily truck traffic distribution when usable data is analyzed. The mean of daily truck traffic observations and AADTT counts (i.e., the total number divided by the number of days) are significantly different. At site 143-0216, the daily truck traffic is almost evenly spread in the EB and WB lanes.



(a) EB lanes, site 143-0216 (b) WB lanes, site 143-0216

Figure 50. Graphs. Frequency of Average Daily Truck Traffic Count by Traffic Direction (Site 143-0216).

5.2 Analysis of Operating Rating Reductions in Low Reliability Index Bridges

This section analyzes a sample of low reliability index bridges in Georgia. The sample bridges are selected from the reliability analysis results found by Ananta Sinha [1]. Variables used in the analysis include each structure's ID, reliability index, year of construction or reconstruction, percent reduction in the operating rating, and the year(s) the reduction happened. All variables outside of the reliability index are found in the NBI database between 2005 and 2022. All low reliability bridges are analyzed to determine if a reduction in operating rating occurred. The 10 bridges with the highest reductions occurring between 2005 and 2022 are then analyzed to determine possible causes. Operating rating reductions that used differing operating rating methods year-to-year were excluded from the analysis. Bridges that did not have inspection reports available were also excluded. A summary of the 10 bridges selected for the sample is shown in Table 26. Note that "Year 2" indicates the year prior to the operating rating reduction and "Year 1" indicates the subsequent year. "Operating Rating 1" correlates to "Year 1" and "Operating Rating 2" correlates to "Year 2".

Table 26. Summary of Sample Bridges for Analysis.

Index	Structure #	Year 1	Year 2	Operating Rating 1	Operating Rating 2	OR % Change from Year 1 to 2
1	000000005100540	2016	2015	11.7	41.4	-71.7391
2	000000006301050	2006	2005	30.6	89.1	-65.6566
3	000000005101010	2009	2008	19.8	54	-63.3333
4	000000002100760	2009	2008	32.4	83.7	-61.2903
5	000000008902850	2011	2010	27.9	70.2	-60.2564
6	000000010700720	2006	2005	29.7	71.1	-58.2278
7	000000002100740	2009	2008	35.1	83.7	-58.0645
8	000000010700710	2006	2005	29.7	70.2	-57.6923
9	000000002100730	2009	2008	37.8	83.7	-54.8387
10	000000005101140	2011	2010	36	77.4	-53.4884

5.2.1 Detailed Sample Bridge Analysis Employing NBI Data and Inspection Reports

Detailed summaries are compiled for each bridge in the sample. The detailed summaries include plots and tables of NBI data between 2005 and 2022 as well as NBI element data between 2016 and 2022. GDOT inspection report findings are also included, with any damage or deterioration of bridge elements noted. Photos showing damage and deterioration are selected from the inspection reports and presented to visually supplement the data.

The detailed summaries include a large amount of information, therefore, the full summary for all sample bridges can be reviewed in Appendix D. Results of the detailed bridge summaries are gathered in

Table 27 to allow for accelerated review. Elements that had a health index reduction over 5% are listed. Areas of the given bridge with notable damage or deterioration in the inspect reports are also listed below.

Table 27. Sample Analysis of Low Reliability Bridges in Georgia Findings.

Structure #	Operating Rating Reduction	Health Index Reduction (> 5%)			Inspection Report Areas of Concern		
		Deck & Misc.	Super structure	Sub structure	Deck	Super structure	Sub structure
(1)* 05100540	71.74% (2016)	-	Steel Truss	RC Column, RC Pier Wall, RC Pile	Asphalt overlay, Steel concrete filled grating, Joints, Rail	RC beams, Steel truss	RC Pile, RC Column, RC Pier Wall, RC Abutment, RC Pier Cap, RC Footing
(2)* 06301050	65.66% (2006)	-	-	RC Column, RC Abutment	RC Deck, Joints	PSC beams	RC Column, RC Abutment, RC Pier Cap
(3)* 05101010	63.33% (2009)	-	Steel Girder/ Beam	-	RC Deck	Steel girder/ beam	RC Column, RC Abutment, RC Pier Cap
(4) 02100760	61.29% (2009)	RC Top Flange	-	-	RC Deck, Approach slabs	PSC beams, RC beams	RC Abutment, RC Pier Cap, PSC Pile
(5) 08902850	60.26% (2011)	-	-	-	RC Deck, Approach slabs	PSC beams	RC Abutment, RC Pier Cap, Road under
(6)* 10700720	58.23% (2006)	Pourable Joint	-	PSC Pile	RC Deck, Joints, Approach slabs, Guardrail	PSC beams (bearing area as well)	RC Pier Cap, PSC Pile, RC Abutment
(7)* 02100740	58.06% (2009)	Pourable Joint	-	PSC Pile (low HI)	RC Deck, Joints, Rails, Approach slabs	PSC & RC beams	RC Pier Cap, PSC Pile, RC Abutment
(8) 10700710	57.69% (2006)	RC Deck, Pourable Joint	-	PSC Pile	RC Deck, Joints, Approach slabs, Rail	PSC beams (bearing area as well)	PSC Pile RC Pier Cap
(9) 02100730	54.84% (2009)	RC Deck, RC Top Flange, Pourable Joint	-	PSC Pile (low HI)	RC Deck, Joints, Approach slabs	PSC & RC beams	PSC Piles, RC Pier cap, RC Abutment
(10) 05101140	53.49% (2011)	Pourable Joint	-	-	RC Deck, Joints, Approach slabs	-	RC Pier Cap, RC Column

*Note: Photos of damage/deterioration noted are provided in Figures 51-55.

Figure 51 through Figure 54 are a visual supplement to the typical concerns noted for 5 of the bridges in Table 27. Steel deterioration can be seen including cracks, rust, paint loss, and section loss. Concrete deterioration is also seen including various types of cracking, spall with and/or without exposed rebar, efflorescence, scale/abrasion/erosion, and delamination.

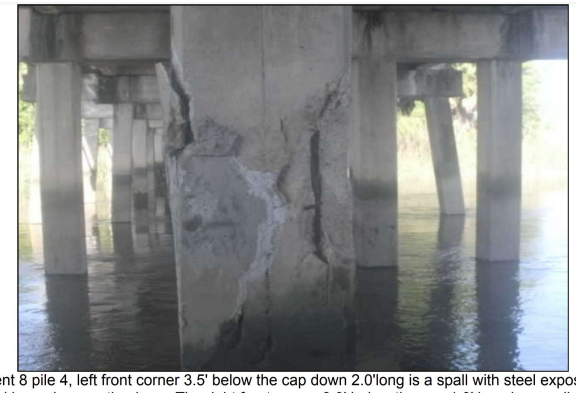
TURN SPAN CONCRETE BUSTING UP.

BENT 12 CONCRETE AND XJS MATERIAL INLAY.

Photo 28 - Section loss in the bottom flange of Stringer 10-10 between Floor Beams 10-1 and 10-2

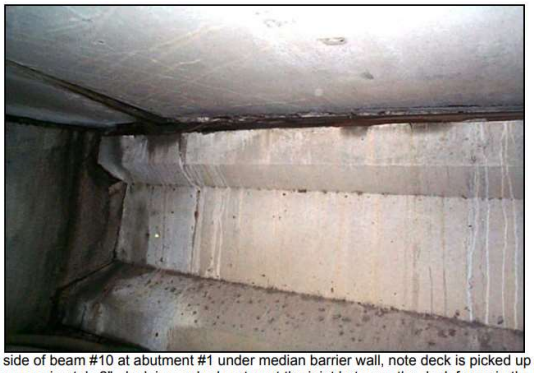
Photo 29 - Typical crack in stringers (Stringer 10-4 at Floor Beam 10-4 shown)

Spall/delamination in the lower west edge of Bent 14 cap



Bent 8 pile 4, left front corner 3.5' below the cap down 2.0'long is a spall with steel exposed. Steel has minor section loss. The right front corner 3.0' below the cap 1.0' long is a spall which is being held in place by an epoxy patch at the bottom of the spall. There is steel exposed with up to minor section loss.

Figure 51. Images. Typical Damage and Deterioration in Structure #051-0054-0 (Index 1).



Right side of beam #10 at abutment #1 under median barrier wall, note deck is picked up over beam approximately 2", deck is cracked on top at the joint between the deck forms in the right side of the photo. No change 2013.

Bent #3 forward side left of column #4. 2' L Typical for crack at bent #2 forward side Left of column #4. 18" L

Void under cap at abutment #1 Void is 6' under x 4'D x 10'L

Span 1 slope erosion

Column 6 at bent 3, corner spall

Figure 52. Images. Typical Damage and Deterioration in Structure #063-0105-0 (Index 2).

Spall with exposed rebar

Bent 2 cap spall

Busted up curb.

Figure 53. Images. Typical Damage and Deterioration in Structure #051-0101-0 (Index 3).

Typical leveling nut under beam bearing plate at Bent 4

Missing sealant in Abutment 6 expansion joint

Transverse crack and pothole at west approach roadway

Typical scaling in the bottom of piles.

Heavy scaling in the rear approach slab.

Figure 54. Images. Typical Damage and Deterioration in Structure #107-0072-0 (Index 6).

Photo 03 - Typical cracks in original beams over the abutments

Photo 04 - Typical adhesion loss to expansion joint sealant

Photo 05 - Spall in east lane of south approach slab at approach roadway end

Photo 06 - Spall in east lane of north approach slab at approach roadway end

Photo 07 - Cracks in north approach slab

2 sq. ft. spall at abutment 1

Figure 55. Images. Typical Damage and Deterioration in Structure #021-0074-0 (Index 7).

5.2.2 Element Health Index versus Operating Rating Data Analysis

The relationship between operating rating and element condition states (characterized as health index) is analyzed with the goal of determining what bridge elements most affect a reduction in operating rating. Based on the elements typically seen in Georgia's bridges the following elements are chosen for the analysis:

1. EN12 (RC Deck)
2. EN107 (Steel Girder)
3. EN109 (PSC Girder)
4. EN205 (RC Column)
5. EN210 (RC Pier Wall)
6. EN215 (RC Abutment)
7. EN220 (RC Pile Cap/Footing)
8. EN227 (RC Pile)
9. EN234 (RC Pier Cap)

Simple scatterplots are created of delta(Δ) element health index and percent change in operating rating using RStudio 4.0.2. The x-axis of the plot (ΔHealth Index) shows a reduction in health index from one year to the next with a value below 0.0 (negative value) and an increase in health index with a value above 0.0 (positive). The y-axis of the plot (% Change in Operating Rating) similarly shows a reduction in operating rating from one year to the next with a value below 0.0 (negative value) and an increase in operating rating with a value above 0.0 (positive). A red dotted line is added at both axes 0.0 values to better visualize trends.

Four plots are made for each bridge element as shown in Figure 56 through Figure 64. Three of the plots show biannual findings. The top-left plot shows the data for 2017 and 2018. The top-

right plot shows the data for 2019 and 2020. The bottom-left plot shows the data for 2021 and 2022. Finally, the bottom-right plot shows all of the data for the years between 2016 and 2022.

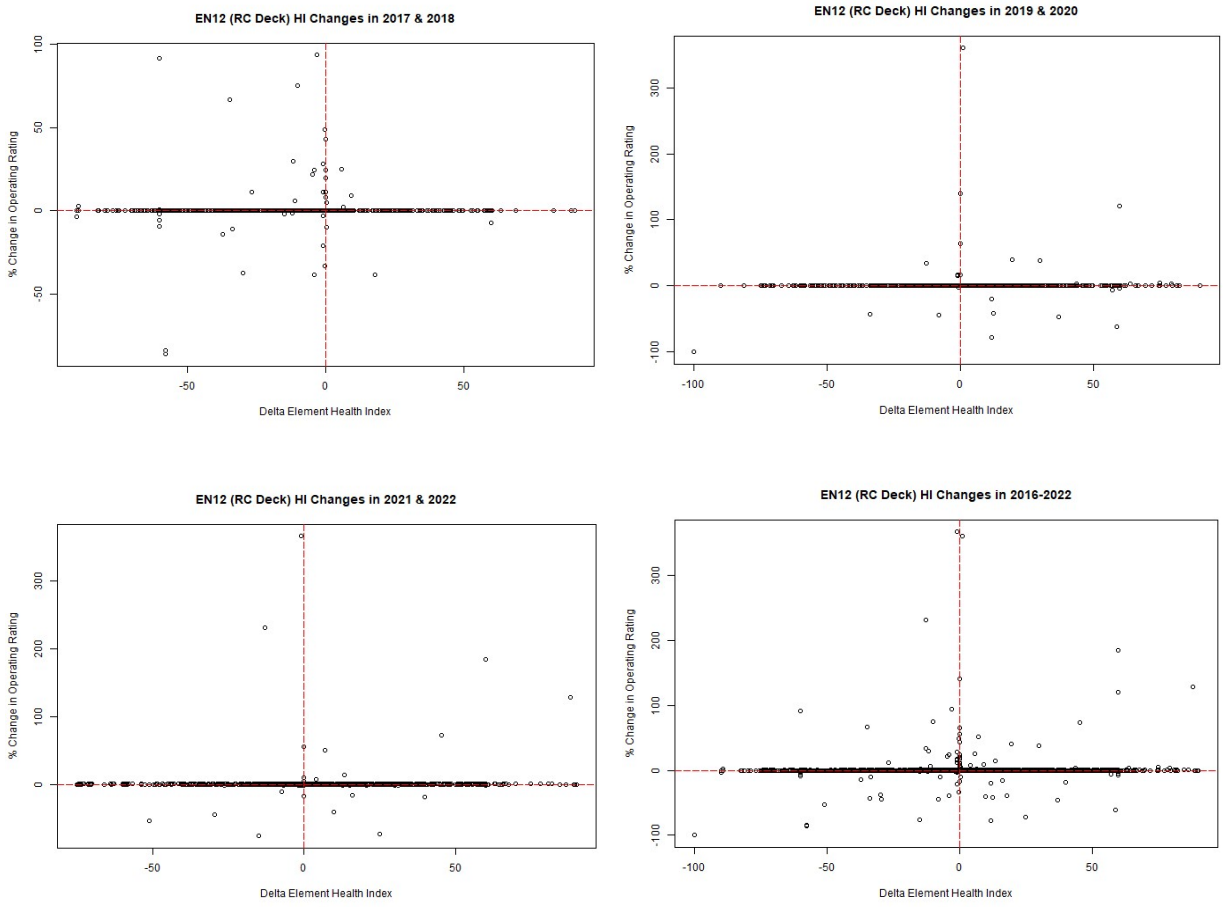


Figure 56. Graphs. EN12 (RC Deck) ΔElement Health Index vs Percent Change in Operating Rating.

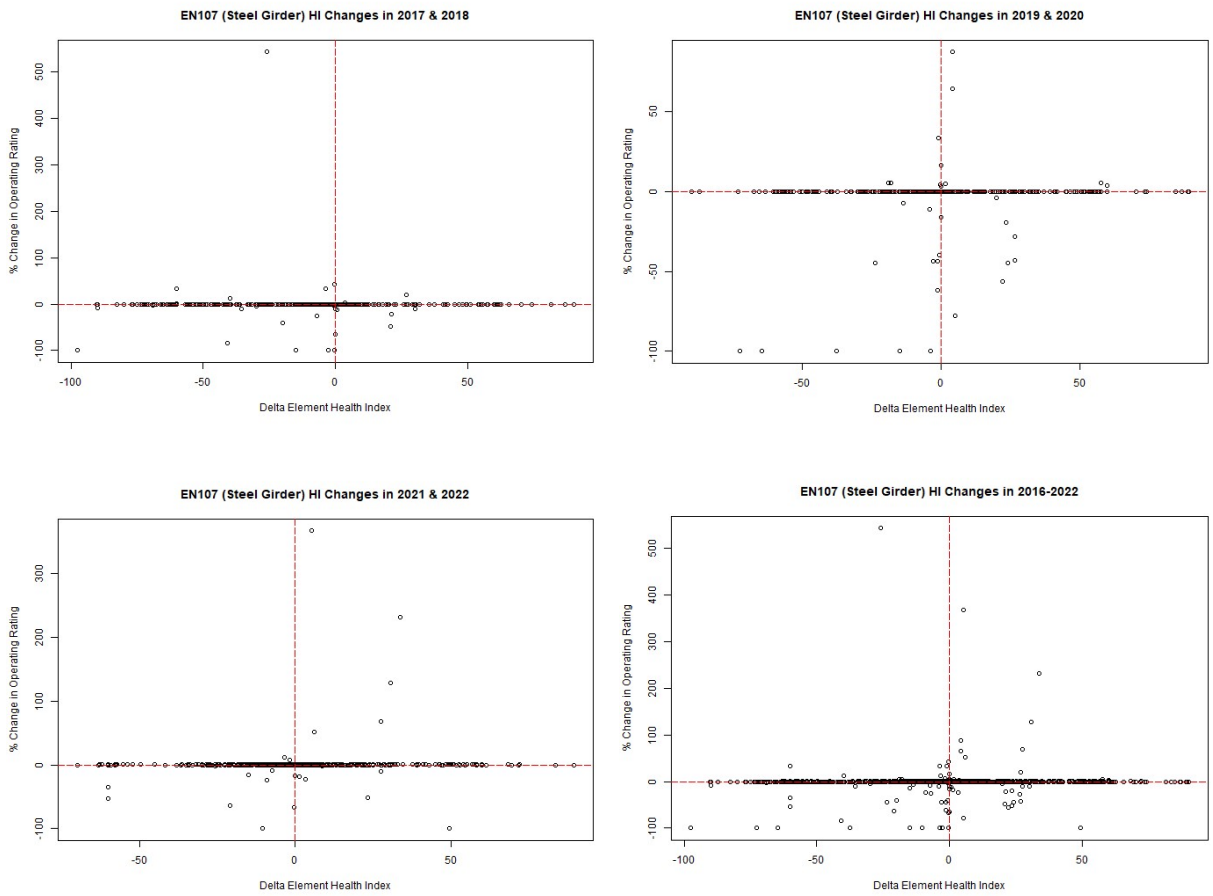


Figure 57. Graphs. EN107 (Steel Girder/Beam) ΔElement Health Index vs Percent Change in Operating Rating.

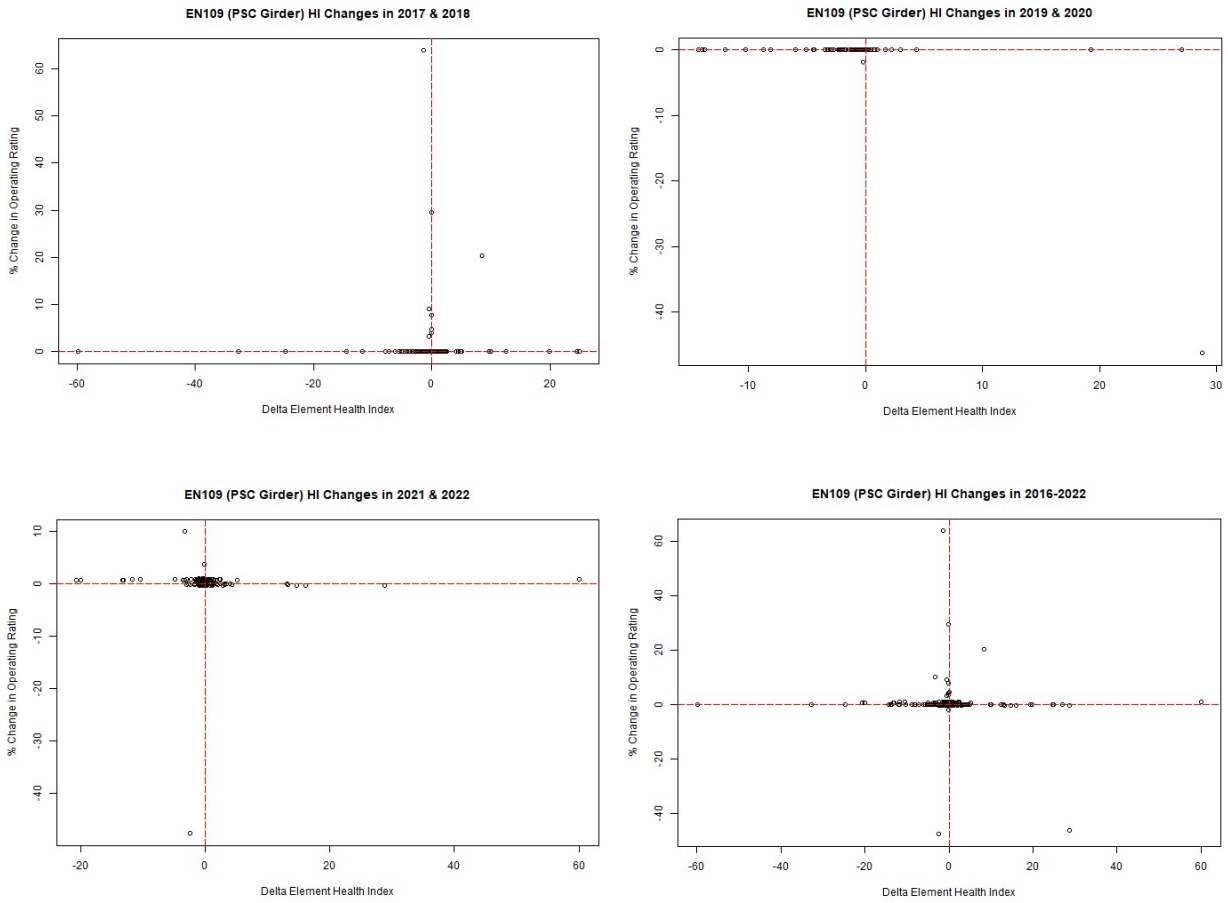


Figure 58. Graphs. EN109 (PSC Girder/Beam) ΔElement Health Index vs Percent Change in Operating Rating.

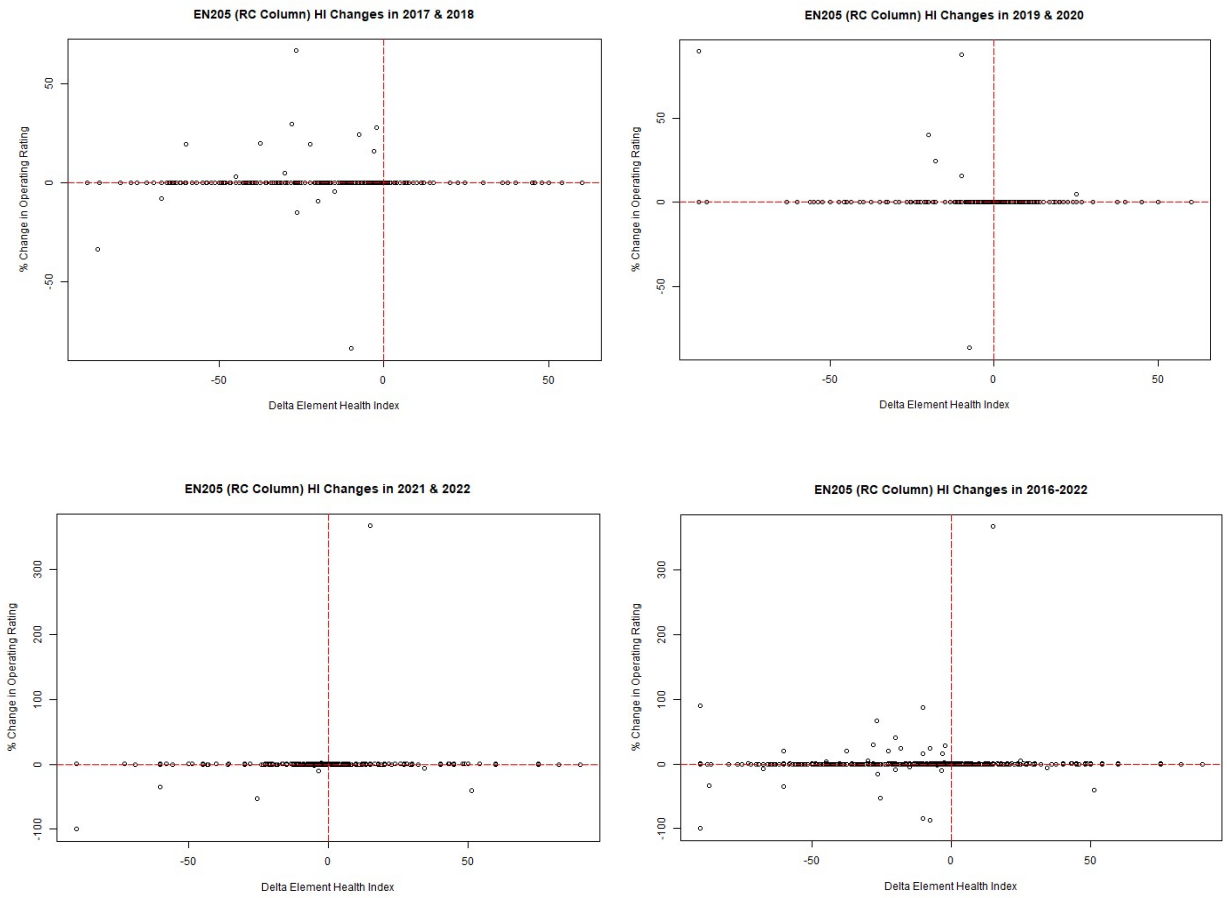


Figure 59. Graphs. EN205 (RC Column) ΔElement Health Index vs Percent Change in Operating Rating.

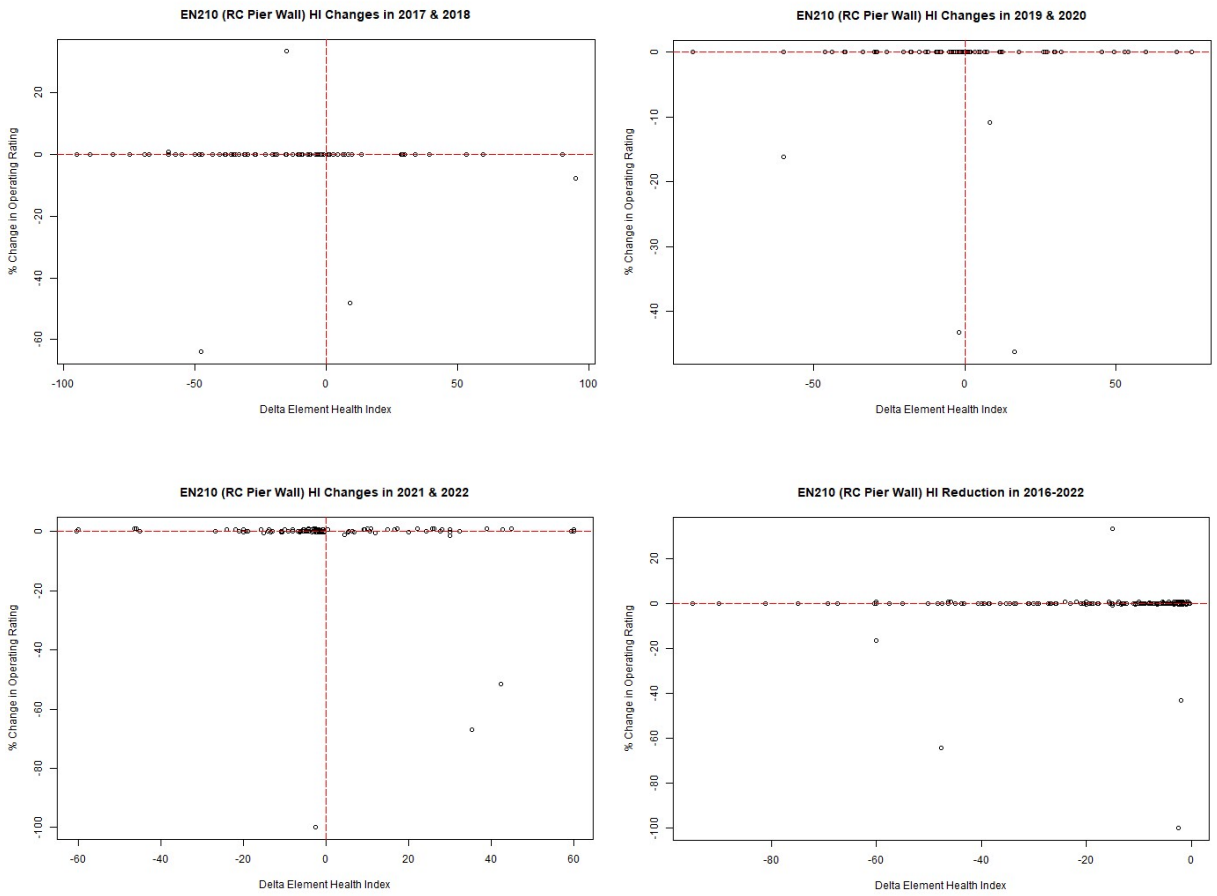


Figure 60. Graphs. EN210 (RC Pier Wall) ΔElement Health Index vs Percent Change in Operating Rating.

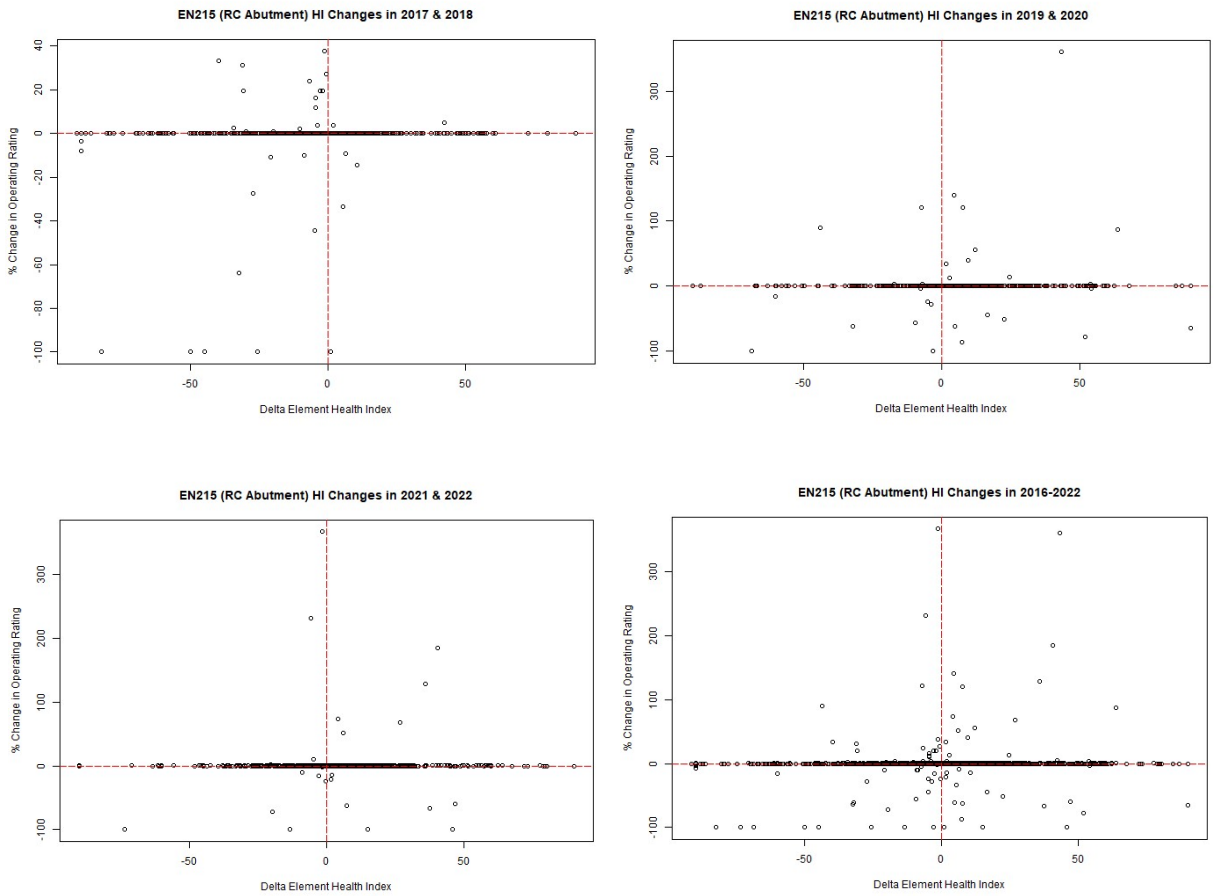


Figure 61. Graphs. EN215 (RC Abutment) ΔElement Health Index vs Percent Change in Operating Rating.

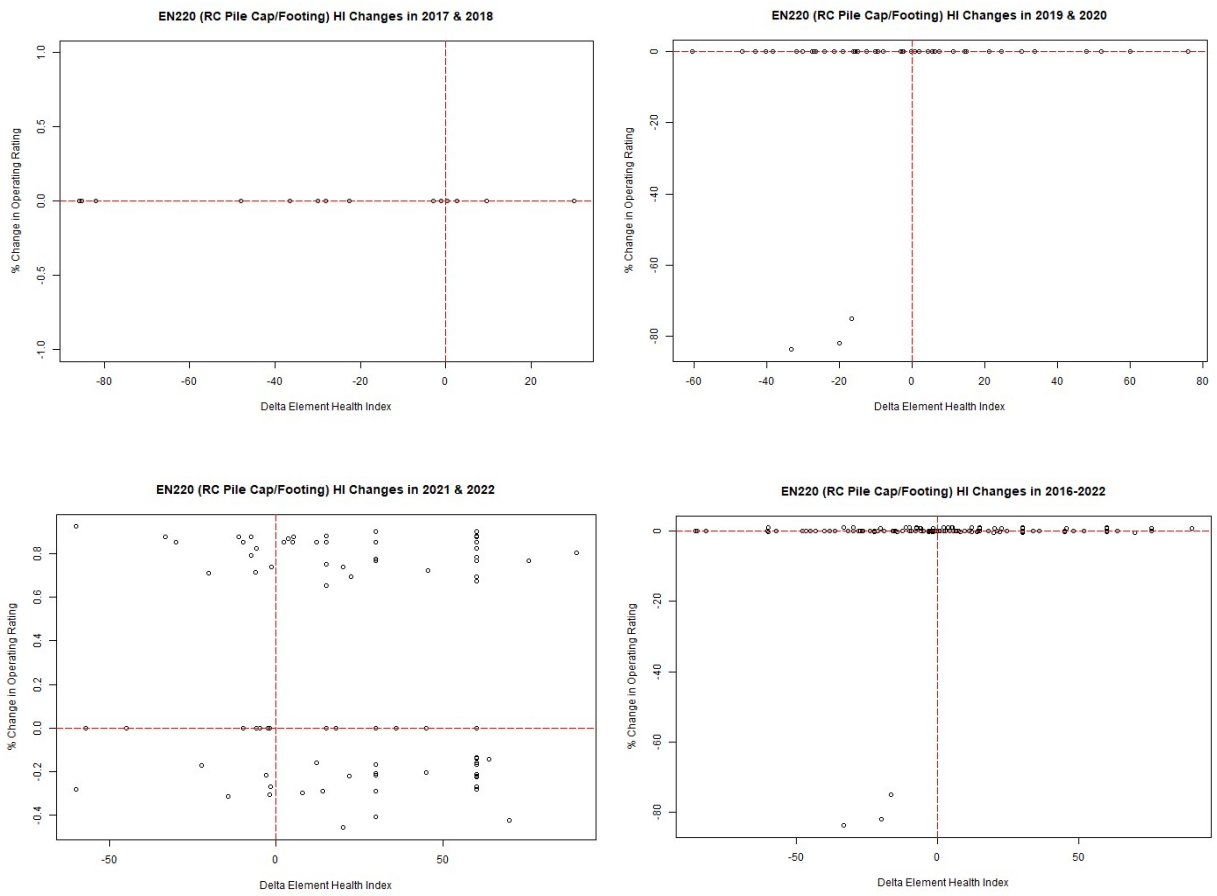


Figure 62. Graphs. EN220 (RC Pile Cap/Footing) ΔElement Health Index vs Percent Change in Operating Rating.

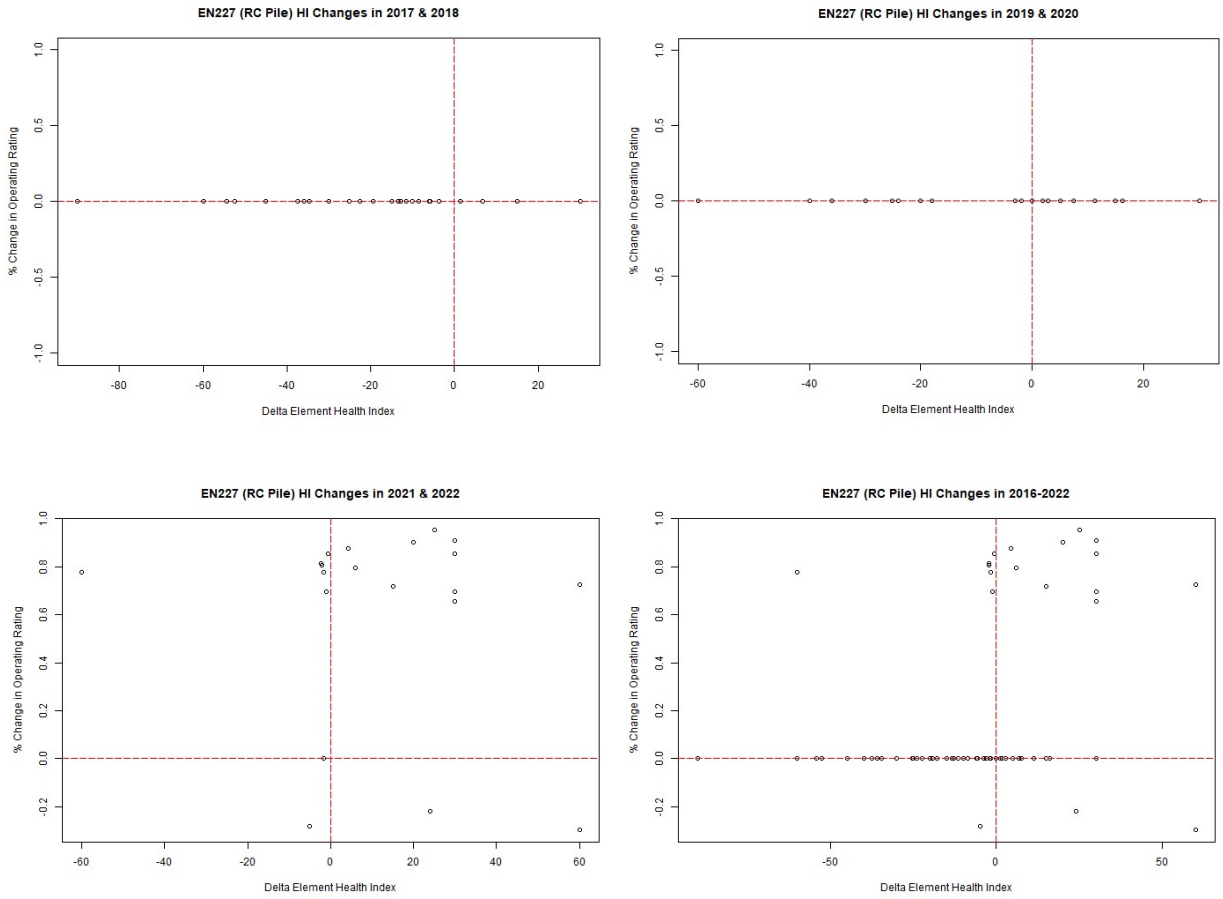


Figure 63. Graphs. EN227 (RC Pile) ΔElement Health Index vs Percent Change in Operating Rating.

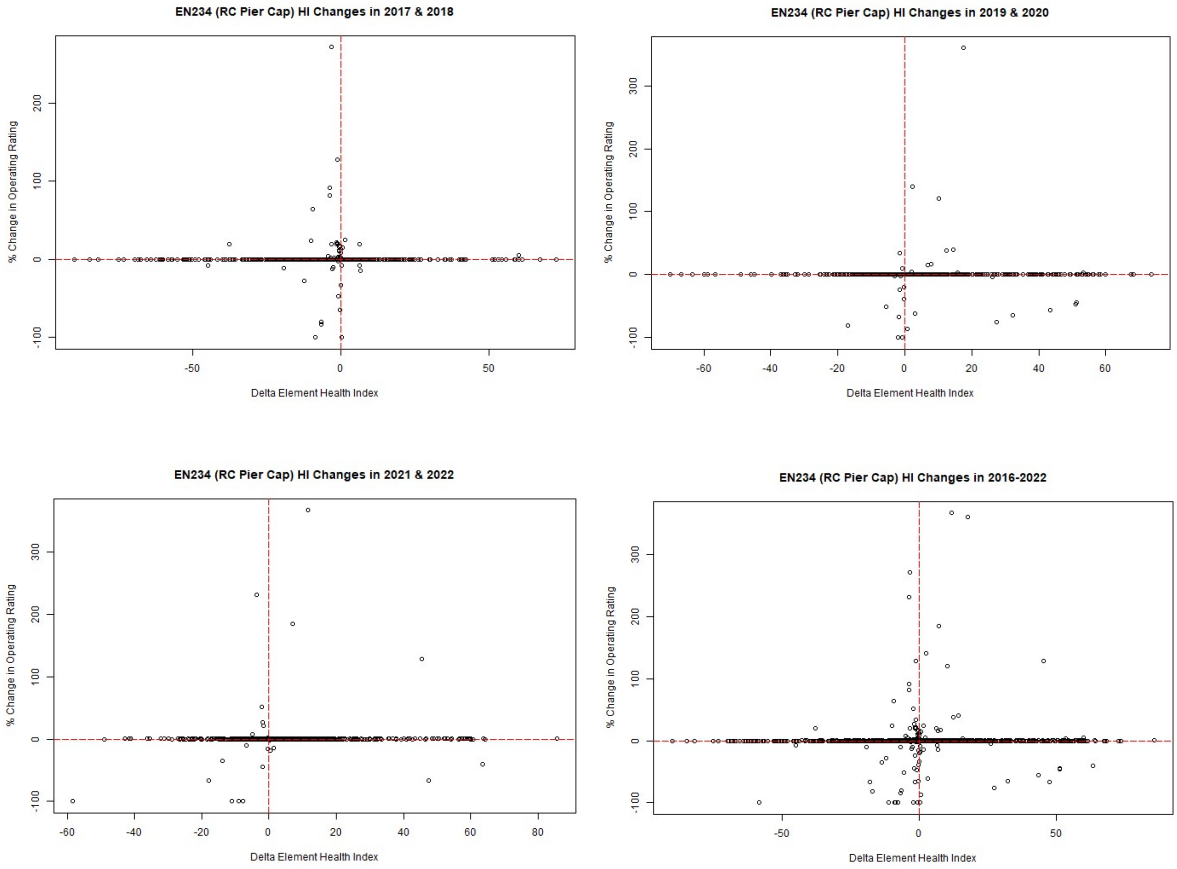


Figure 64. Graphs. EN234 (RC Pier Cap) ΔElement Health Index vs Percent Change in Operating Rating.

6.0 | CONCLUSIONS AND RECOMMENDATIONS

6.1 WIM Quality Control Analysis

Table 28 provides a summary of the WIM quality control analysis findings and recommended actions.

Table 28. Summary of Findings and Recommended Actions.

Site ID	Items	2019	2020	2021	Comment/Action Recommended
051-0368 (Inactive)	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	Y	Y	Monthly weight deviation < 30%
	Calibrated	N	N	N	No action needed. Inactive in 2021.
127-0312	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	Y	N	N	Monthly weight deviation < 30%
	Calibrated	Y	N	N	Review SB lanes only
185-0227	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	Y	Y	Y	Monthly weight deviation < 30%
	Calibrated	N	Y	N	No action needed.
217-0334	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	Y	Y	Y	Monthly weight deviation < 30%
	Calibrated	N	N	Y	No action needed.
285-0243	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	Y	Y	Closely monitor
051-0387	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	Y	Y	N	Monthly weight deviation < 30%
	Calibrated	Y	N	N	Review SB lanes only
175-0247	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	Y	N	Calibrate all lanes
245-0218 (Inactive)	Classification	Y	Y	No data	Unidentified class < 1%
	Weight	N	Y	No data	Monthly weight deviation < 30%
	Calibrated	N	N	NA	No action needed. Inactive in 2020.
083-0214	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	N	N	Review EB lanes only

Notes: N – No; Y – Yes; NA – Not Applicable; Red text indicates WIM sites recommended for calibraion (both lanes); Blue text indicates a recommended action for WIM sites with weight anamalies in one traffic direction; Green text indiates a recommended action for WIM sites with weight anamalies but calibrated in 2021.

Table 28, continued. Summary of Findings and Recommended Actions.

Site ID		2019	2020	2021	Recommended Actions
083-0194	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	N	N	Calibrate all lanes
021-0378	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	N	N	Calibrate all lanes
087-0103	Classification	No data	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	NA	N	N	Review SB lanes only
051-0700	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	N	N	Calibrate all lanes
051-0264	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	N	Monthly weight deviation < 30%
	Calibrated	N	N	N	Calibrate all lanes
245-0214	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	Y	Y	Monthly weight deviation < 30%
	Calibrated	N	N	N	No action needed
047-0114	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	Y	Y	Y	Monthly weight deviation < 30%
	Calibrated	N	N	N	No action needed
143-0126	Classification	Y	No data	Y	Unidentified class < 1%
	Weight	Y	No data	Y	Monthly weight deviation < 30%
	Calibrated	N	NA	Y	Closely monitor
217-0218	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	N	N	Y	Monthly weight deviation < 30%
	Calibrated	N	Y	N	No action needed.
003-0312	Classification	No data	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	NA	N	N	Calibrate all lanes
015-0276	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	No data	N	Y	Calibrate all lanes
039-0218	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	Y	Y	Monthly weight deviation < 30%
	Calibrated	No data	N	N	No action needed
051-0109	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	No data	N	N	Review SB lanes only

Notes: N – No; Y – Yes; NA – Not Applicable; Red text indicates WIM sites recommended for calibraion (both lanes); Blue text indicates a recommended action for WIM sites with weight anamalies in one traffic direction; Green text indiates a recommended action for WIM sites with weight anamalies but calibrated in 2021.

Table 28, continued. Summary of Findings and Recommended Actions.

Site ID		2019	2020	2021	Recommended Actions
051-1113	Classification	No data	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	Y	N	N	Calibrate all lanes
081-0347	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	No data	N	Y	Closely monitor
103-0159	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	No data	N	Monthly weight deviation < 30%
	Calibrated	No data	No data	N	Review EB lanes only
115-0052	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	No data	Y	Monthly weight deviation < 30%
	Calibrated	No data	No data	N	No action needed
161-0189	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	N	N	Monthly weight deviation < 30%
	Calibrated	No data	N	N	Calibrate all lanes
235-0138	Classification	Y	Y	Y	Unidentified class < 1%
	Weight	No data	No data	N	Monthly weight deviation < 30%
	Calibrated	No data	No data	N	Calibrate all lanes

Notes: N – No; Y – Yes; NA – Not Applicable; Red text indicates WIM sites recommended for calibraion (both lanes); Blue text indicates a recommended action for WIM sites with weight anamalies in one traffic direction; Green text indiates a recommended action for WIM sites with weight anamalies but calibrated in 2021.

It is recommended that GDOT's Office of Transportation Data (OTD) encourage the WIM vendor to prioritize calibrating WIM systems in both traffic directions at the following nine sites: 175-0247, 083-0194, 021-0378, 051-0700, 051-0264, 003-0312, 051-1113, 161-0189, and 235-0138. Sites 143-0126 and 015-0276 have been excluded because they were calibrated in 2021, but their weight data will need to be closely monitored moving forward.

If resources allow, an additional six sites may receive a calibration in the traffic direction noted in square brackets below. These sites are listed in order of priority: 051-0109[SB], 127-0312 [SB], 103-0159[EB], 083-0214[EB], 051-0387[SB], and 087-0103[EB]. Similarly, sites 285-0243[NB] and 081-0347[EB] have been excluded from the above summary because they were calibrated in 2021 but will have to be closely monitored.

Annual WIM data QC checks appear to be the most practical at this point. In a future study, monthly or biannual WIM data QC checks may be considered to more frequently identify WIM sites in need of a calibration. Due to the growing number of WIM sites, mobilizing a calibration vehicle every month may not be practical; however, to avoid the loss of usable data and increase data reliability, practical solutions must be developed to avoid a situation where the vendor leaves a WIM system with a significant weight drift, if any, for an extended period of time.

Similar to the approach used by 15 other state DOTs, calibrating WIM systems when a QC validation fails appears to be the most practical solution given the growing number of WIM locations. Mobilizing a large vehicle for calibration is costly, and an annual or biannual calibration of all WIM systems appears too burdensome at this point.

The frequency of WIM system calibration and its maintenance should not be the sole metric for WIM data quality. Rather, with a deeper understanding of the challenges that arise in the field when installing, maintaining, and calibrating WIM systems, the research team encourages the WIM vendor to make sustainable improvements in WIM data quality even though the data may not meet some of the QC measures recommended by other state DOTs. Such incremental changes over the long-term will likely improve the quality of WIM data despite the absence of regularly scheduled calibrations for WIM systems. Based on a review of the WIM data QC analysis results, calibration in response to need or performance is deemed constructive.

A third party or a GDOT personnel should observe the vendor's WIM system calibration and support (or approve) a calibration report to increase accountability. Additionally, while other DOTs, such as FDOT, require at least two different vehicles (i.e., with different axle spacings and weigh distributions) to calibrate WIM systems, the WIM vendor currently uses only one vehicle

to calibrate WIM systems in Georgia (see section 2.1). Based on a review of the WIM data obtained from the calibrated sites, a two-truck process is not critical particularly when resources are limited but is strongly encouraged to increase the accuracy of WIM data for both vehicle classification and weight.

Regardless, the mean error in axle weight measurements (e.g., single and tandem axle spectra) of calibration trucks should ultimately remain below 10 percent between calibration visits (e.g., annual visits) to ensure good quality data for MEPDG applications.

WIM data exceeding quality control limits needs to be further investigated to uncover possible field maintenance and/or calibration problems. Routine calibration of WIM systems based on the QC results is vital for collecting consistent data. The research team strongly believes that there is no substitute for experienced personnel with adequate equipment and due diligence to maintain and calibrate WIM systems.

It is recommended that the research team and OTD accomplish the following:

- continue monitoring WIM data and conduct regular QC reviews. Currently, most of the WIM sites have one to three years of reasonably usable data. By addressing the weight drift issue presented in this report, the WIM data should become more reliable. A yearly CDS may then be established.

- conduct reliability analyses for both pavement and bridge assets using past and evolving WIM data. This process will help the research team identify the most important factors for conducting data QC checks and predict growth and patterns observed in axle configurations and load spectra. Data is more valuable when used by other offices at GDOT and

stakeholders to make better, data-driven decisions. With evolving data over five years, investigating the feasibility of predicting vehicle patterns for Georgia is possible.

6.2 Analysis of Operating Rating Reductions in Low Reliability Index Bridges

The analysis components (NBI data, NBI element data, and GDOT inspection reports) each have some degree of misrepresentations. The NBI data seems to be out of date, meaning many of its variables are no longer well kept. The condition ratings recorded in the NBI data do not appear to provide insights into how a bridge's operating rating may fluctuate. Due to this, the condition rating data is excluded from the summary table.

The NBI element data was relatively more insightful but was only well documented in certain bridges. Element data is also only available for Georgia's bridges back to 2016. It is likely that as the practice of recording bridge element data progresses in the future, the documentation will improve and will provide more insightful data. The current available data on the chosen sample of bridges with a low RI does not show a strong trend on different types of defects or deterioration.

The GDOT inspection reports provided the best documentation of each bridge through photos. Certain bridge inspection reports had more detail as well as better photos than others. All of the reviewed inspection reports appear to replicate the previous years' remarks and rarely make note of new findings. This appears to be the most commonly observed practice when no noticeable changes are observed during inspection. For some bridges, the same photos appeared to be used repeatedly instead of providing current photos. The information provided in the inspection reports for the chosen sample of bridges does, however, show some apparent trends with deterioration. All of the low reliability bridges chosen show early signs of deterioration with their reinforced

concrete (RC) deck, superstructure beams (both steel and concrete), RC pier caps, and RC abutments. A majority of the bridges also have signs of accelerated deterioration in joints and concrete piles. Steel deterioration in the sample bridges includes cracks, rust, paint loss, and section loss. Concrete deterioration includes various types of cracking, spall with and/or without exposed rebar, efflorescence, scale/abrasion/erosion, and delamination.

The information gathered from these three sources does not always agree. This is likely due to findings not being well documented and/or certain data being allowed to fall out-of-date. It is recommended that inspection reports show greater detail including updates to past remarks and biannually updated photos and date-marking all comments and photos. The NBI element data is collected when performing these inspections. Therefore, if the inspection process were to be improved, the element data and associated practice guidelines will be as well. The NBI element data should be used in conjunction with inspection reports including updated photos in bridge analysis again in the next 5 to 10 years to observe any improvements in the insight it provides associated with low reliability bridges. With the proposed active calibration of WIM sensors and improved documentation of bridge inspection outcomes, a more apparent trend in bridge deterioration is expected to be seen regardless of the cause - an increase in live loads or a decrease in element condition rating.

Based on review of the element health index versus operating rating data analysis results, the following elements appeared to most affect operating/load rating (presented in order of greatest to least effect based on visual observation):

1. EN234 (RC Pier Cap)
2. EN215 (RC Abutment)

3. EN12 (RC Deck)
4. EN107 (Steel Girder)
5. EN205 (RC Column)

The following elements do not appear to affect operating/load rating as much:

- EN210 (RC Pier Wall)
- EN227 (RC Pile)
- EN109 (PSC Girder)
- EN220 (RC Pile Cap/Footing)

These results paired with the results of the sample bridge analysis conclude that the bridge elements which most affect bridge operating rating and in turn, reliability index are reinforced concrete (RC) pier caps, RC abutments, RC decks, steel girders, and RC columns.

With this conclusion in mind, it is recommended that bridge owners take special care to keep these elements healthy. Therefore, the overall bridge health will remain high and in turn hold higher operating/load ratings as well as reliability indices.

6.3 Future Work

Another reliability analysis should be performed on Georgia's bridges in the future when the WIM site anomalies previously identified are controlled and GDOT's inspection process is improved. Improving the quality of WIM data and bridge data collected and maintained by GDOT will directly improve the accuracy of bridge reliability analyses. In turn, maintenance decisions can confidently be made by bridge owners using accurate analysis results.

Another analysis looking at a sample of Georgia's low reliability bridges with high operating rating reductions should be performed in the future. This study performed a

comprehensive analysis of 10 bridges. A larger sample of bridges would likely provide better insight into factors causing operating rating reductions and low reliability indices.

Another analysis to determine what bridge elements most impact a bridge's operating rating should also be performed in the next 5 to 10 years. There is currently 7 years (2016-2022) of NBI element data available in Georgia. When more yearly data is available, more accurate analysis results can be found. This study was able to look at 9 common bridge elements in Georgia, however, it is recommended that a future study be done to determine how any given bridge element will impact an overall bridge's operating rating. Results would greatly improve the maintenance decision process for bridge owners.

It should also be noted that many of the low reliability bridges that also saw large operating rating reductions were in the Savannah, Georgia area. This introduces the hypothesis that coastal bridges are more susceptible to damage and deterioration and in turn drops in operating rating as well as reliability index. It is recommended that a study be done to analyze how geographic location can impact a bridge's operating rating and reliability index.

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APPENDICES

Appendix A. Bridge Elements in NBI Element Data.

Table A.1. NBI Bridge Elements [10].

Element	Units	Element Number					
		Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Deck/Slab							
Deck	SF		13	12	31		60
Open Grid Deck	SF	28					
Concrete Filled Grid Deck	SF	29					
Corrugated or Orthotropic Deck	SF	30					
Slab	SF			38	54		65
Top Flange	SF		15	16			
Superstructure							
Closed Web/Box Girder	LF	102	104	105			106
Girder/Beam	LF	107	109	110	111		112
Stringer	LF	113	115	116	117		118
Truss	LF	120			135		136
Arch	LF	141	143	144	146	145	142
Main Cable	LF	147					
Secondary Cable	EA	148					149
Floor Beam	LF	152	154	155	156		157
Pin, Pin and Hanger Assembly	EA	161					
Gusset Plate	EA	162					
Substructure							
Column	EA	202	204	205	206		203
Column Tower (Trestle)	LF	207			208		
Pier Wall	LF			210	212	213	211
Abutment	LF	219		215	216	217	218
Pile Cap/Footing	LF			220			
Pile	EA	225	226	227	228		229
Pier Cap	LF	231	233	234	235		236
Culvert							
Culvert	LF	240	245	241	242	244	243
Bridge Rail							
Bridge Rail	LF	330*		331	332	334	333
Joint							
Strip Seal	LF	300					
Pourable	LF	301					
Compression	LF	302					
Assembly with Seal (Modular)	LF	303					
Open	LF	304					
Assembly without Seal	LF	305					
Other	LF	306					
Bearing							
Elastomeric	EA	310					
Movable (roller, sliding, etc.)	EA	311					
Enclosed/Concealed	EA	312					
Fixed	EA	313					
Pot	EA	314					
Disk	EA	315					
Other	EA	316					
Wearing Surfaces and Protective Coatings							
Wearing Surfaces	SF	510					
Steel Protective Coating	SF	515					
Concrete Protective Coating	SF	521					

*Element 330-Metal Bridge Rail may include steel or aluminum rails.

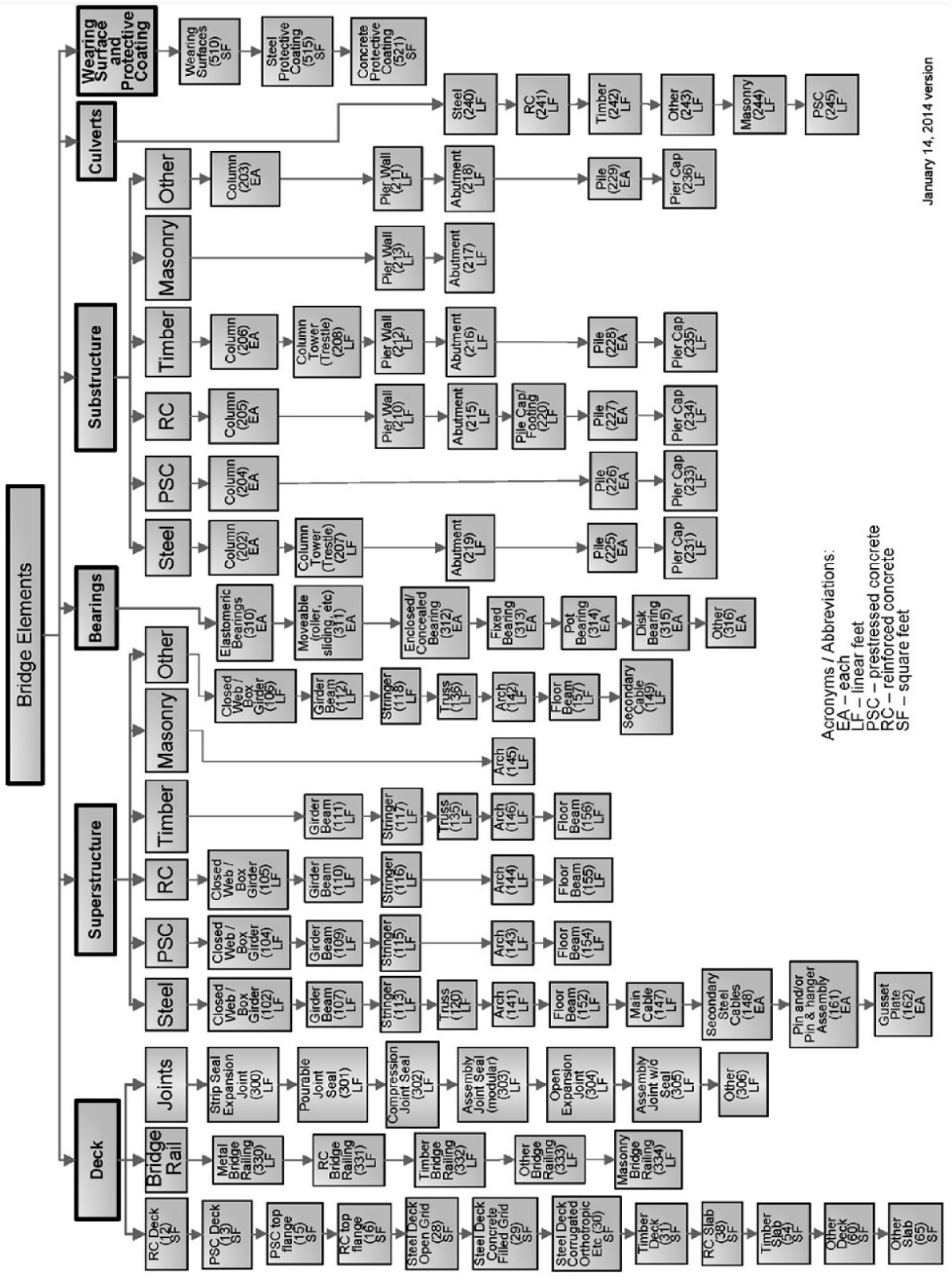

Figure A.1. Chart. NBI Bridge Element Flowchart [10].

Appendix B. Example Weigh-in-Motion Quality Control Analysis Summary PDF

Appendix A-4

WIM Site ID 021-7334 (2019)

R-markdown Summary and Supporting Details

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A-4.1 DATA EXPLORATION

This WIM site (ID 021-7334 or indicated as '0217334') dataset contains 4,169,343 vehicle passing entries, of which 4,168,709 entries are identified as complete cases and are used for the analysis presented below. A total of 1,928,616 and 2,240,093 data points are used for the North Bound (NB) and South Bound (SB) traffic, respectively. There are 0 entries with unidentified traffic direction (or indicated as "Channel"). These entries are excluded from the summaries presented below. Additional 0 entries with a missing vehicle class and 0 entries with zero weight have been excluded from the analysis. The excluded data constitute 0.0% of this site dataset.

This WIM site dataset includes vehicle passing records from 3 lanes in each direction of traffic flow, a total of 6 lanes. The dataset contains vehicle passing records from Jan. 1, 2019 to Dec. 31, 2019, a total of 365 days. Figure A.1 shows the site location, and the speed limit of this site is 65 mph.

Sections A-4.2 through A-4.6 provide a brief (3-page) summary of a statistical analysis performed using the computing environment R. Section A-4.7 presents detailed graphical and numerical summaries.

A-4.2 PROPORTIONS OF VEHICLE CLASS

This dataset contains approximately 64.8% Class 2 (e.g., passenger) vehicles, 22.1% Class 3 (e.g., 4-tire pick-up) vehicles, 7.5% Class 9 (5-axle freight container) vehicles, and 1.8% Class 5 (e.g., two-axle truck) vehicles. The NB and SB data contain 8.0% and % Class 9 vehicles, respectively.

In the dataset, the Class 15 code is assigned to vehicles that are not identified by 13 vehicle classifications (see Figure A.2). On average, less than 0.1% of the data represent unclassified vehicles.

Table A.1 - Summary of % Vehicle Class Proportions in Each Traffic Direction.

Traffic Dir. - Class	1	2	3	4	5	6	7	8	9	10	11	12	13	15
NB	0.5	64.1	22.2	0.2	1.8	1.1	0.0	1.6	8.0	0.1	0.1	0.2	0.0	0.0
SB	0.6	65.7	21.9	0.2	1.9	0.9	0.0	1.4	6.9	0.2	0.1	0.1	0.0	0.0
NB and SB Combined	0.6	64.8	22.1	0.2	1.8	1.0	0.0	1.5	7.5	0.2	0.1	0.2	0.0	0.0

A-4.2.1 Percentage Vehicle Counts by Class in Each Lane

There are inconsistencies in the lane naming conventions among WIM sites. Therefore, it is important to review the following designations.

Table A.2 - Lane Designations.

Lane Number	Lane Name
1	Ln 1 NB(CTR)
2	Ln 2 SB(CTR)

Table A.3 - Summary of % Vehicle Class Proportions in Each Lane.

The vehicle counts in each class do not significantly vary by lane.

Lane No.-Class	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Lane 1	0.5	64.1	22.2	0.2	1.8	1.1	0.0	1.6	8.0	0.1	0.1	0.2	0.0	0.0
Lane 2	0.6	65.7	21.9	0.2	1.9	0.9	0.0	1.4	6.9	0.2	0.1	0.1	0.0	0.0

A-4.2.2 Percentage Vehicle Counts by Class in Each Month

The overall vehicle counts for each class do not significantly vary month-to-month. The percentage of Class 9 vehicles slighly reduces in April for EB only and increases in January in both East and West bound lanes.

Table A.4 - Summary of % Vehicle Class Proportions by Month (NB).

$Month - Class$	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Jan	0.4	63.8	22.7	0.2	1.8	1.1	0.0	1.4	8.2	0.1	0.1	0.2	0.0	0.0
Feb	0.5	63.9	22.5	0.2	1.8	1.1	0.0	1.5	8.1	0.1	0.1	0.2	0.0	0.0
Mar	0.5	63.9	22.5	0.3	1.8	1.1	0.0	1.9	7.8	0.1	0.1	0.2	0.0	0.0
Apr	0.6	63.5	22.3	0.2	1.9	1.2	0.0	1.9	7.9	0.1	0.1	0.2	0.0	0.0
May	0.6	63.8	22.3	0.2	1.7	1.1	0.0	1.7	8.1	0.1	0.1	0.1	0.0	0.1
Jun	0.6	63.8	21.8	0.2	1.5	1.0	0.0	1.8	8.8	0.1	0.2	0.2	0.0	0.0
Jul	0.6	63.9	22.1	0.2	1.6	1.0	0.0	1.8	8.4	0.1	0.1	0.2	0.0	0.0
Aug	0.7	65.8	22.0	0.2	2.0	0.9	0.0	1.3	6.7	0.2	0.0	0.1	0.0	0.0
Sep	0.7	65.8	21.8	0.2	1.9	1.0	0.0	1.5	6.6	0.2	0.1	0.1	0.0	0.0
Oct	0.6	64.9	21.7	0.3	2.0	1.0	0.0	1.7	7.3	0.2	0.1	0.1	0.0	0.0
Nov	0.6	65.9	21.8	0.3	1.9	0.8	0.0	1.7	6.7	0.2	0.1	0.1	0.0	0.0
Dec	0.5	66.8	21.5	0.3	1.9	0.8	0.0	1.5	6.4	0.2	0.0	0.1	0.0	0.0

Table A.5 - Summary of % Vehicle Class Proportions by Month (SB).

$Month - Class$	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Jan	0.6	65.6	22.0	0.2	2.2	0.9	0.0	1.3	6.9	0.2	0.1	0.1	0.0	0.0
Feb	0.6	65.7	22.1	0.2	2.0	0.9	0.0	1.3	6.9	0.2	0.1	0.1	0.0	0.0
Mar	0.6	65.8	22.2	0.2	1.9	0.9	0.0	1.3	6.6	0.2	0.1	0.1	0.0	0.0
Apr	0.7	65.4	22.0	0.2	2.1	1.0	0.0	1.3	7.0	0.2	0.1	0.1	0.0	0.0
May	0.7	65.7	21.7	0.2	2.0	1.0	0.0	1.3	7.1	0.2	0.0	0.1	0.0	0.0
Jun	0.7	65.6	22.0	0.2	1.7	0.9	0.0	1.4	7.1	0.2	0.0	0.1	0.0	0.0
Jul	0.7	65.6	22.0	0.2	1.7	0.9	0.0	1.4	7.1	0.2	0.1	0.1	0.0	0.0
Aug	0.7	65.8	22.0	0.2	2.0	0.9	0.0	1.3	6.7	0.2	0.0	0.1	0.0	0.2
Sep	0.7	65.8	21.8	0.2	1.9	1.0	0.0	1.5	6.6	0.2	0.1	0.1	0.0	0.1
Oct	0.6	64.9	21.7	0.3	2.0	1.0	0.0	1.7	7.3	0.2	0.1	0.1	0.0	0.0
Nov	0.6	65.9	21.8	0.3	1.9	0.8	0.0	1.7	6.7	0.2	0.1	0.1	0.0	0.2
Dec	0.5	66.8	21.5	0.3	1.9	0.8	0.0	1.5	6.4	0.2	0.0	0.1	0.0	0.0

A-4.3 AADT and AADTT

The average annual daily traffic (AADT) and average annual daily truck traffic (AADTT) for each traffic direction are summarized below and compared with average daily traffic and truck taffic (ADT and ADTT) distributions in Section A-4.7.1(d).

Table A.6 - Summary of AADT and AADTT.

Traffic Direction	AADT	AADTT
North Bound (NB)	6137	806
South Bound (SB)	5284	620
NB and SB Combined	11421	1426

A-4.4 SPACINGS BETWEEN AXLES

The spacings between axles vary among vehicle classes. No spacing between the 5th and 6th axles is recorded for 5-axle (Class 9) vehicles, whereas the 3rd and 4th axle loads are recorded for 2-axle (Class 5) vehicles and the 5th axle load is recorded for 3-axle (Class 6) vehicles. Section A-4.7.7 presents the graphical summaries and A-4.7.18(b) for a numerical summary of the number of axles for each vehicle class.

A-4.5 AXLE WEIGHT

A-4.5.1 Gross Vehicle Weight and Length

There are less than 1.13% vehicles that exceed the gross vehicle weight (GVW) of 80,000 lbs. There are approximately 0.01% vehicles with length exceeding 100 ft. Sections A-4.7.8 and A-4.7.9 include graphical and numerical summaries of GVW.

A-4.5.2 Single-Axle Load Spectra

Section A-4.7.12 shows the single-axle load spectra for Class 9 vehicles. There are 0.02% (Class 9) single axles that have a weight greater than 20,000 lbs.

A-4.5.3 Tandem-Axle Load Spectra

Section A-4.7.13 presents the tandem axle load spectra for Class 9 vehicles. There are 8.75% (Class 9) tandem axles that have a combined weight greater than 34,000 lbs.

A-4.6 SUMMARY OF FINDINGS

There are no significant analmalies from this wim site. Graphical and numerical summaries which support the sections above are shown in Section A-4.7.

(Important Items to Note In Reviewing Section A-4.7)

- The proportion (~8.75%) of Class 9 vehicles with the tandem axle weight exceeding 34,000 lbs needs to be reviewed. See Section A-4.7.13.
- The speed vs. weight plot for Class 15 (un-classified) vehicles needs to be reviewed. See Section A-4.7.16.
- The site contains six lanes across the highway, however data was onlt collected for the center lane for the NB (lane 1) and the center lane for the SB (lane 2).

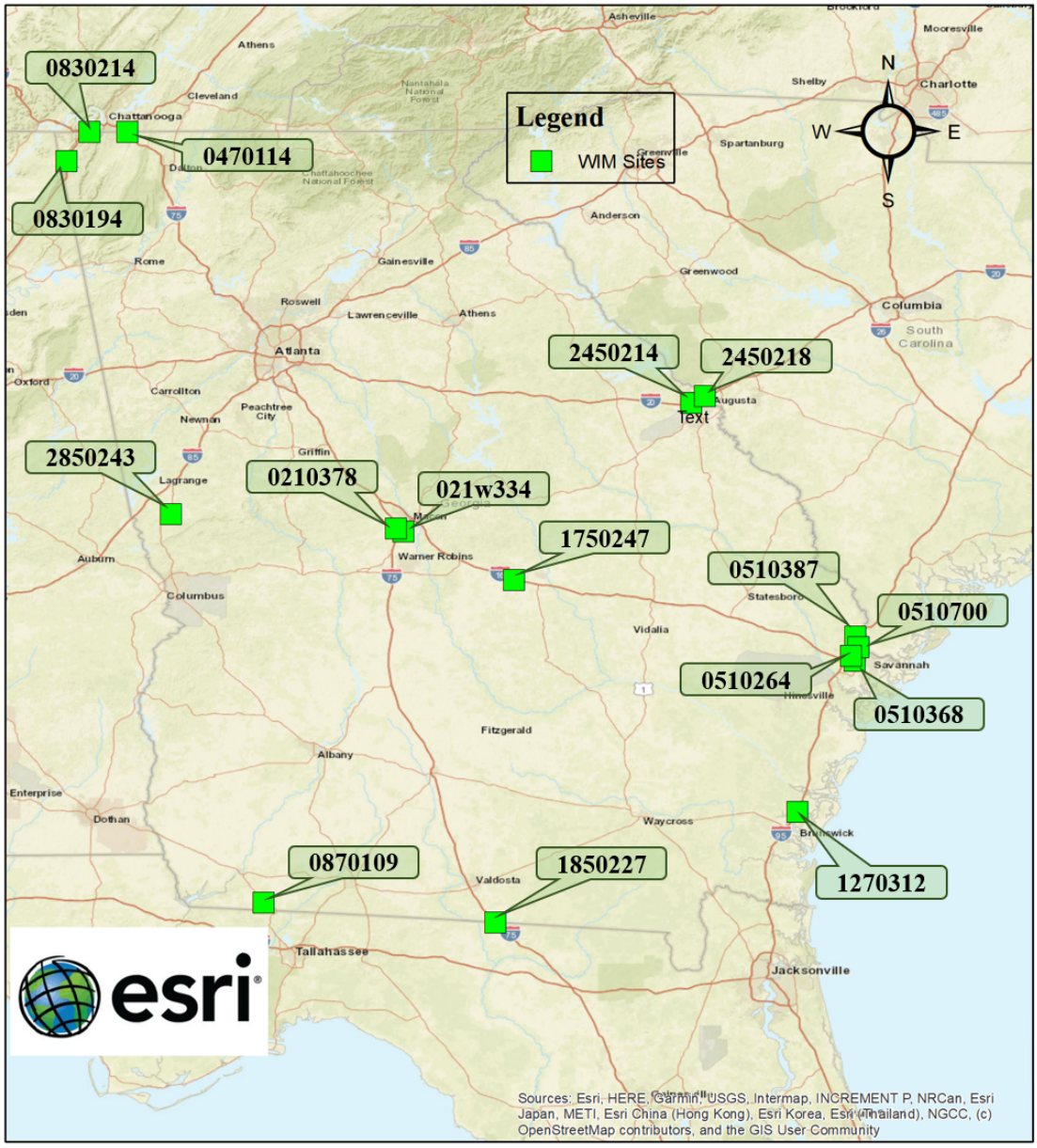


Figure A.1 - WIM Site Locations.

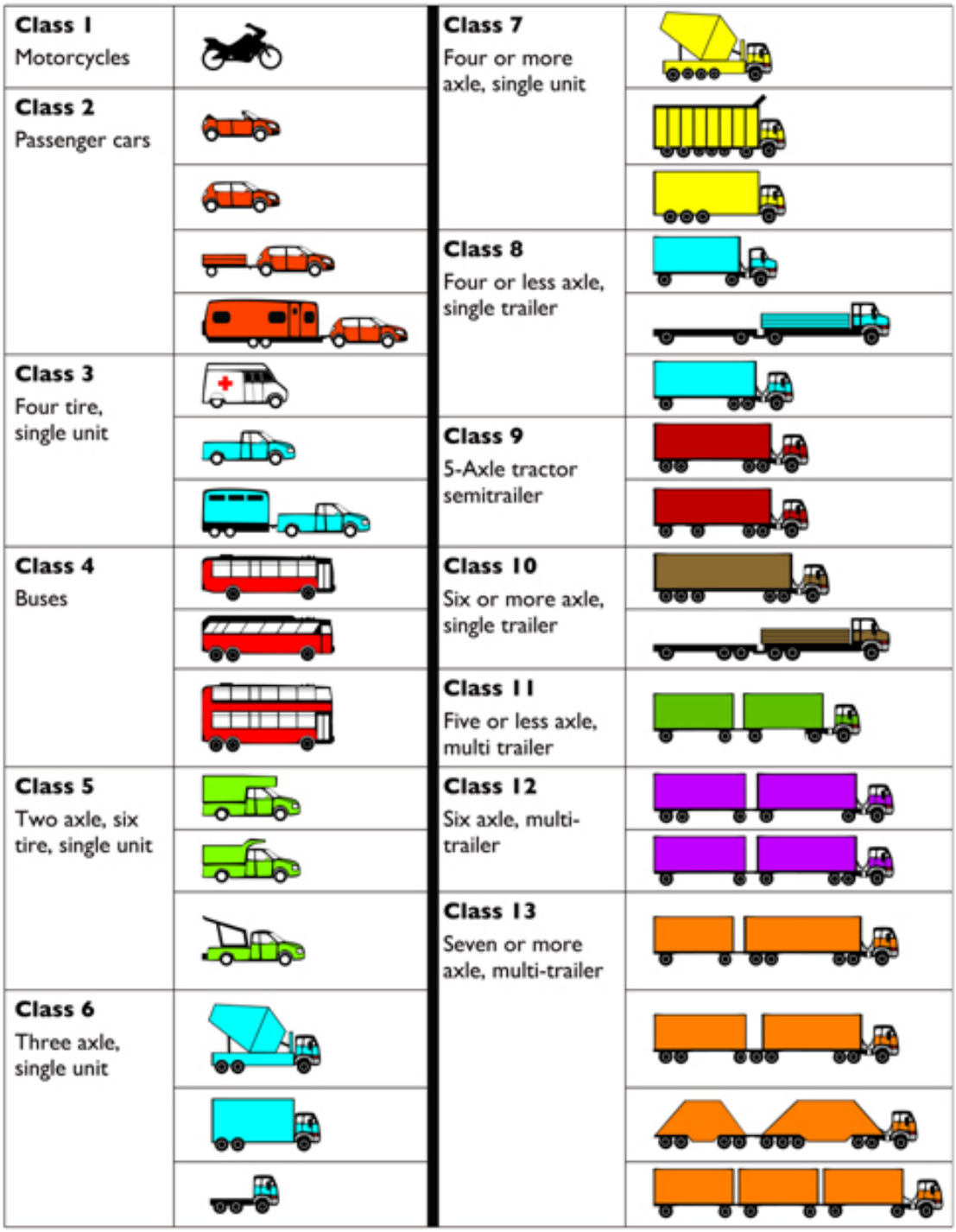


Figure A.2 - Vehicle Classification.

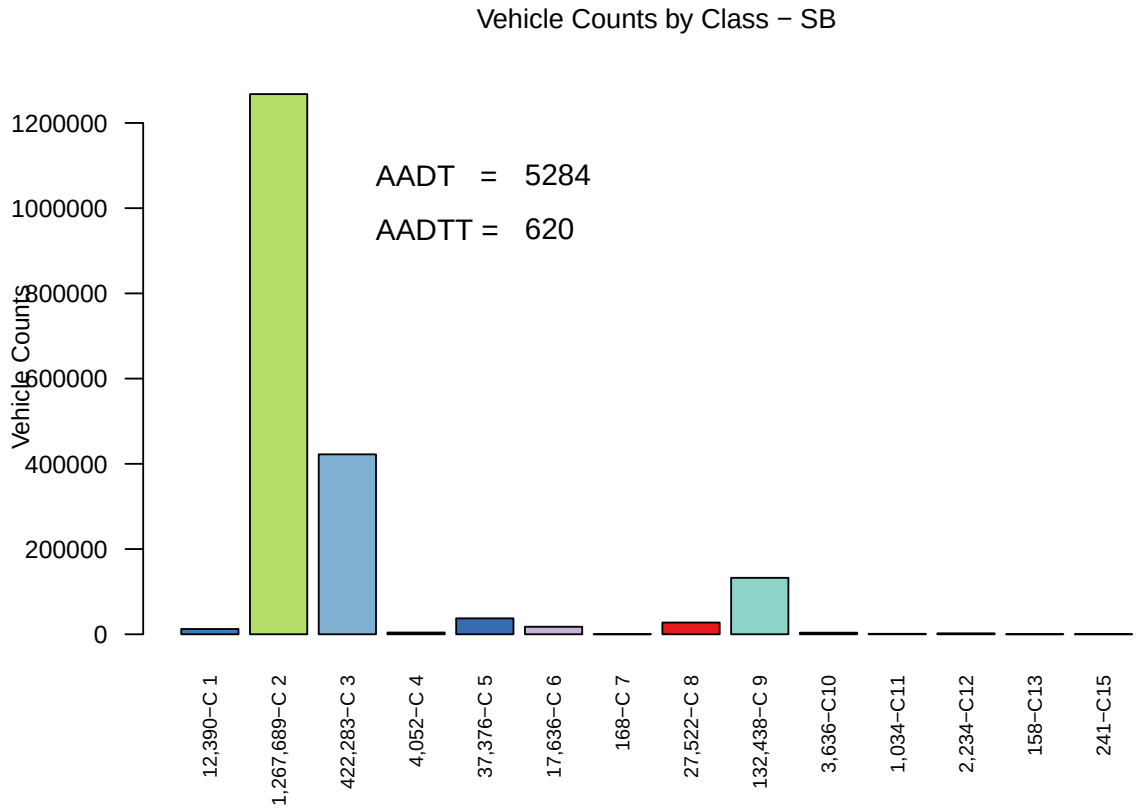
(Source) https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_2013/images/figurec-1.jpg

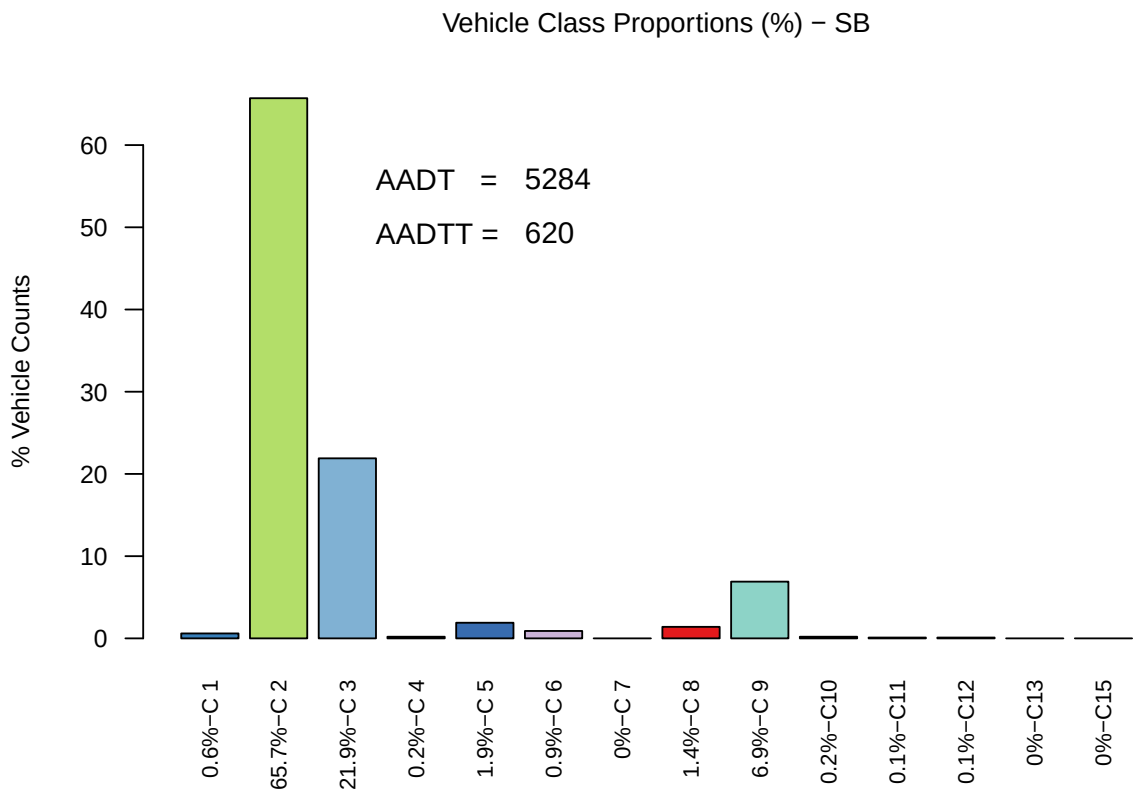
A-4.7 DETAILED GRAPHICAL AND NUMERICAL SUMMARIES

A-4.7.1 Graphical Summary - Proportions (%) of Vehicle Class and AADTT

A-4.7.1(a) Direction 1 - Vehicle class counts, proportions, and AADTT

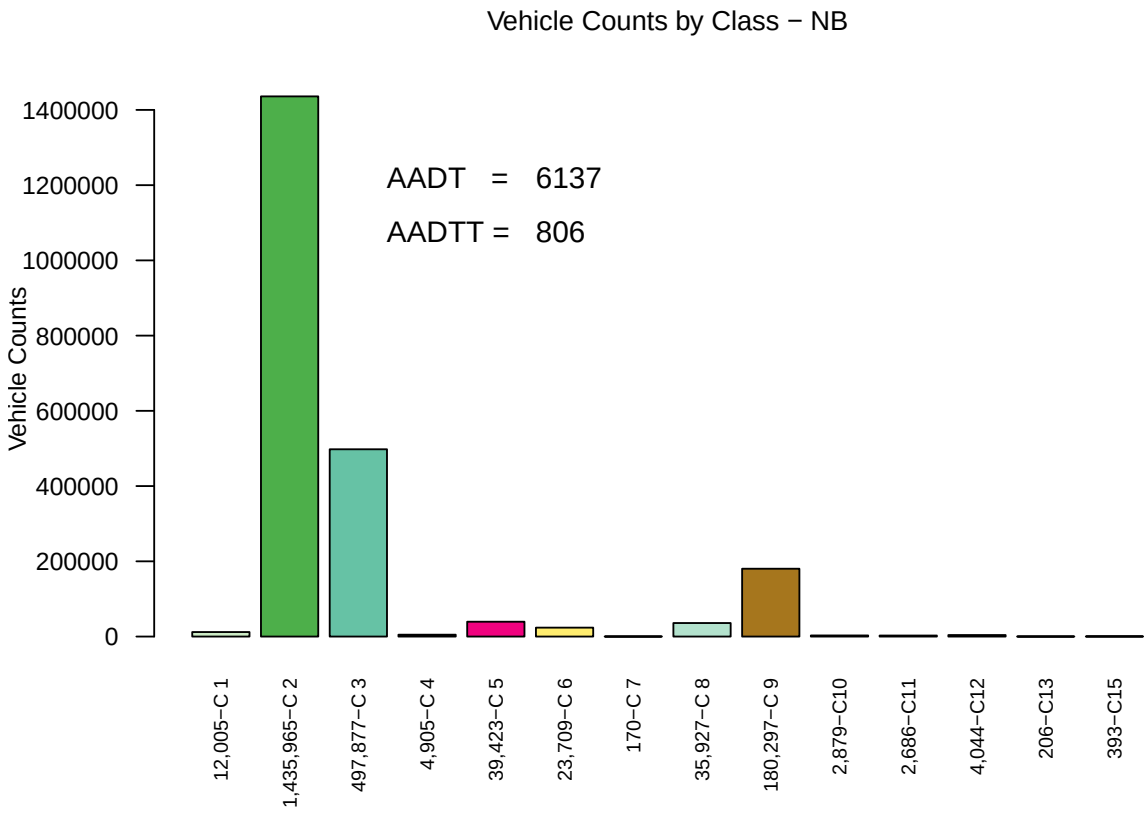
```
## Histograms
```

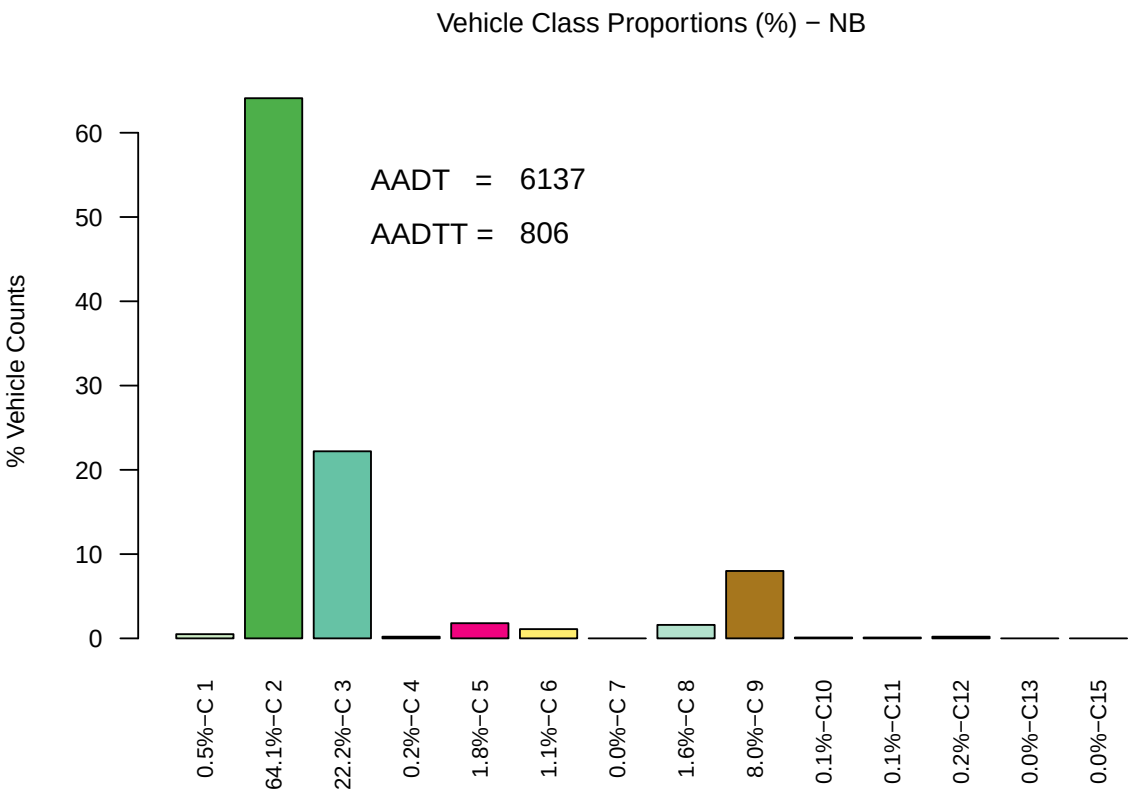



Vehicle Class Proportions (%) − SB
% Vehicle Counts
60
50
40
30
20
10
0
AADT = 5284
AADTT = 620
0.6%−C 1
65.7%−C 2
21.9%−C 3
0.2%−C 4
1.9%−C 5
0.9%−C 6
0%−C 7
1.4%−C 8
6.9%−C 9
0.2%−C10
0.1%−C11
0.1%−C12
0%−C13
0%−C15

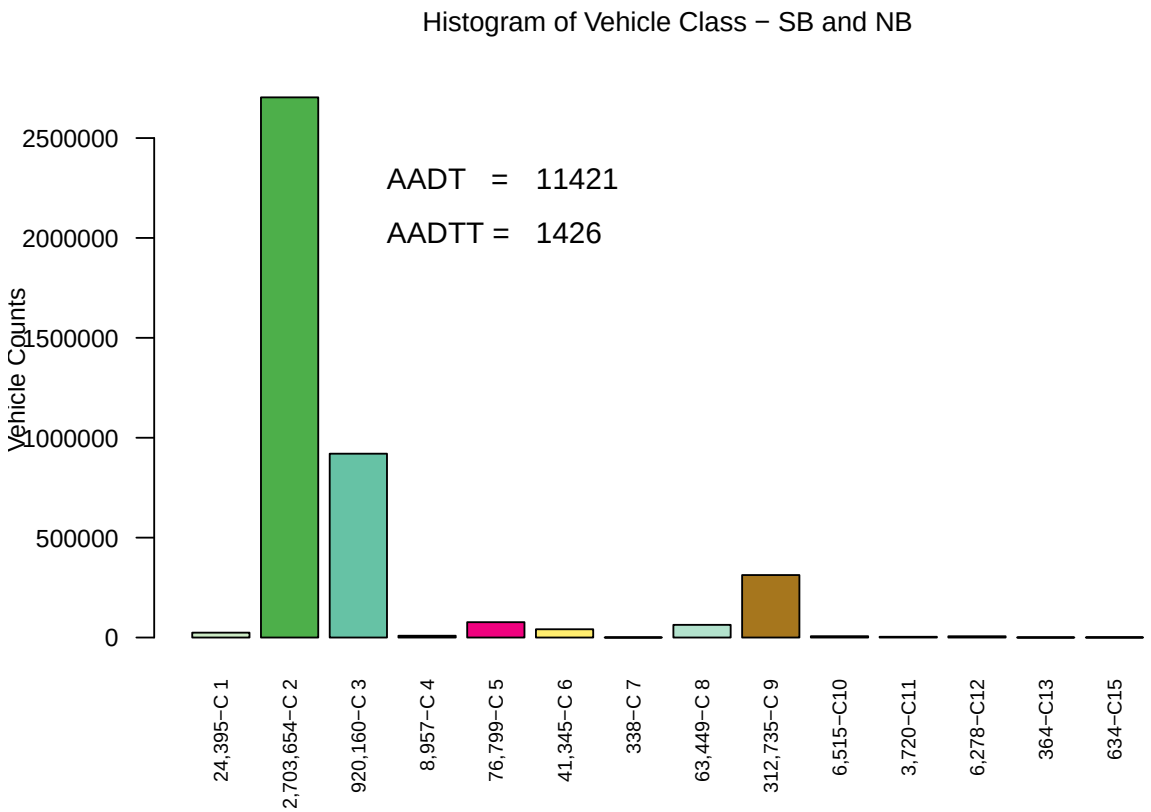
A-4.7.1(b) Direction 2 - Vehicle class counts, proportions, and AADTT

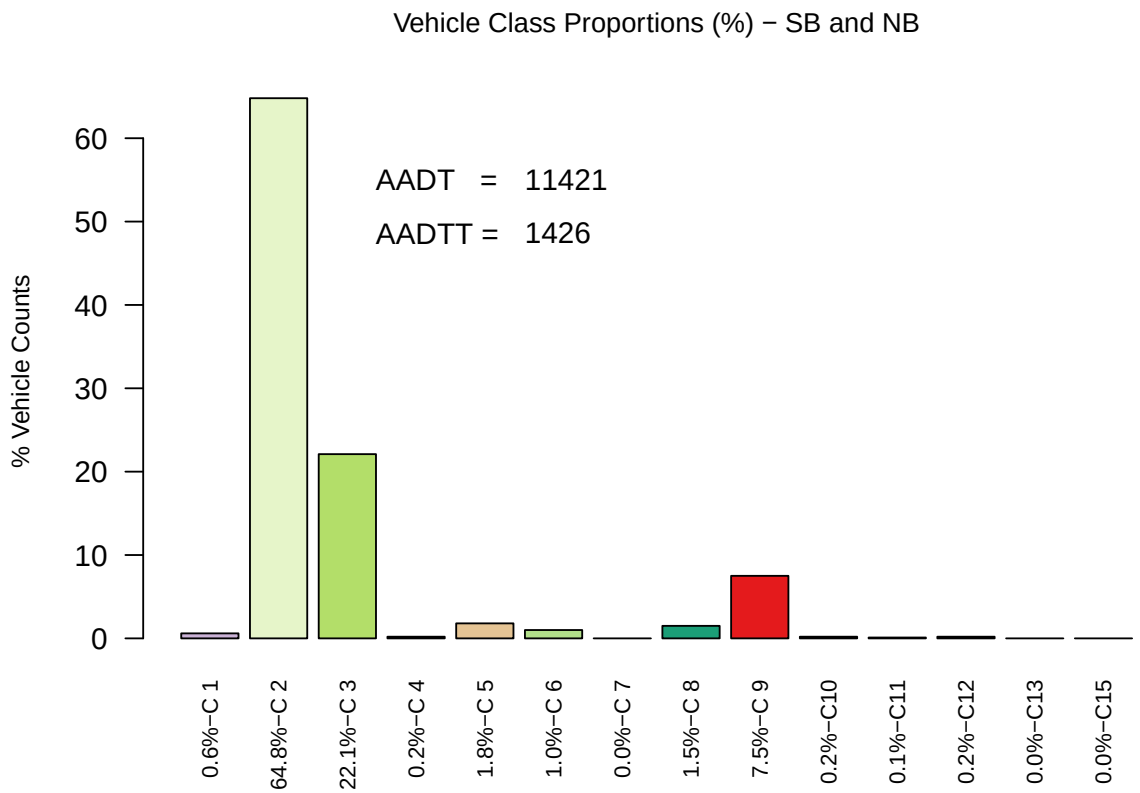
```
## Histograms
```




Vehicle Class Proportions (%) − NB
% Vehicle Counts
60
50
40
30
20
10
0
AADT = 6137
AADTT = 806
0.5%−C 1
64.1%−C 2
22.2%−C 3
0.2%−C 4
1.8%−C 5
1.1%−C 6
0.0%−C 7
1.6%−C 8
8.0%−C 9
0.1%−C10
0.1%−C11
0.2%−C12
0.0%−C13
0.0%−C15

A-4.7.1(c) Directions 1 and 2 Combined - Vehicle class proportions and AADTT

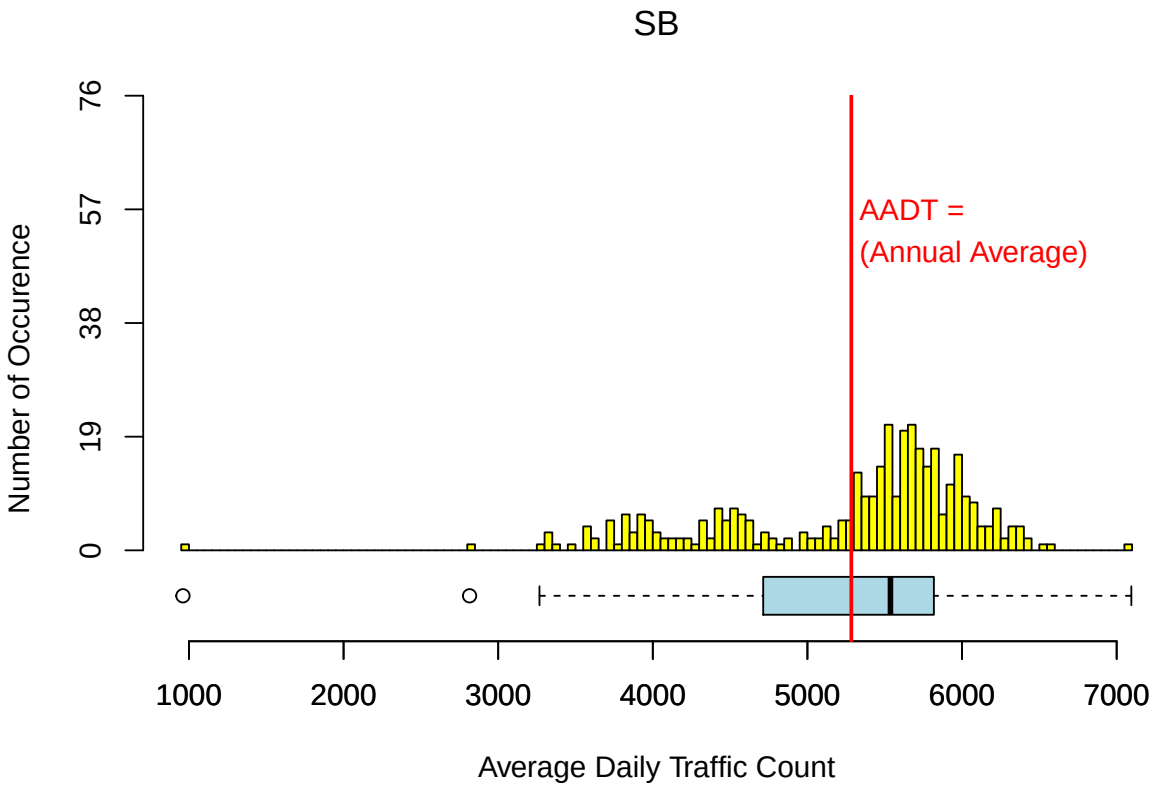



Vehicle Class Proportions (%) − SB and NB
AADT = 11421
AADTT = 1426
% Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.8%−C 2
22.1%−C 3
0.2%−C 4
1.8%−C 5
1.0%−C 6
0.0%−C 7
1.5%−C 8
7.5%−C 9
0.2%−C10
0.1%−C11
0.2%−C12
0.0%−C13
0.0%−C15

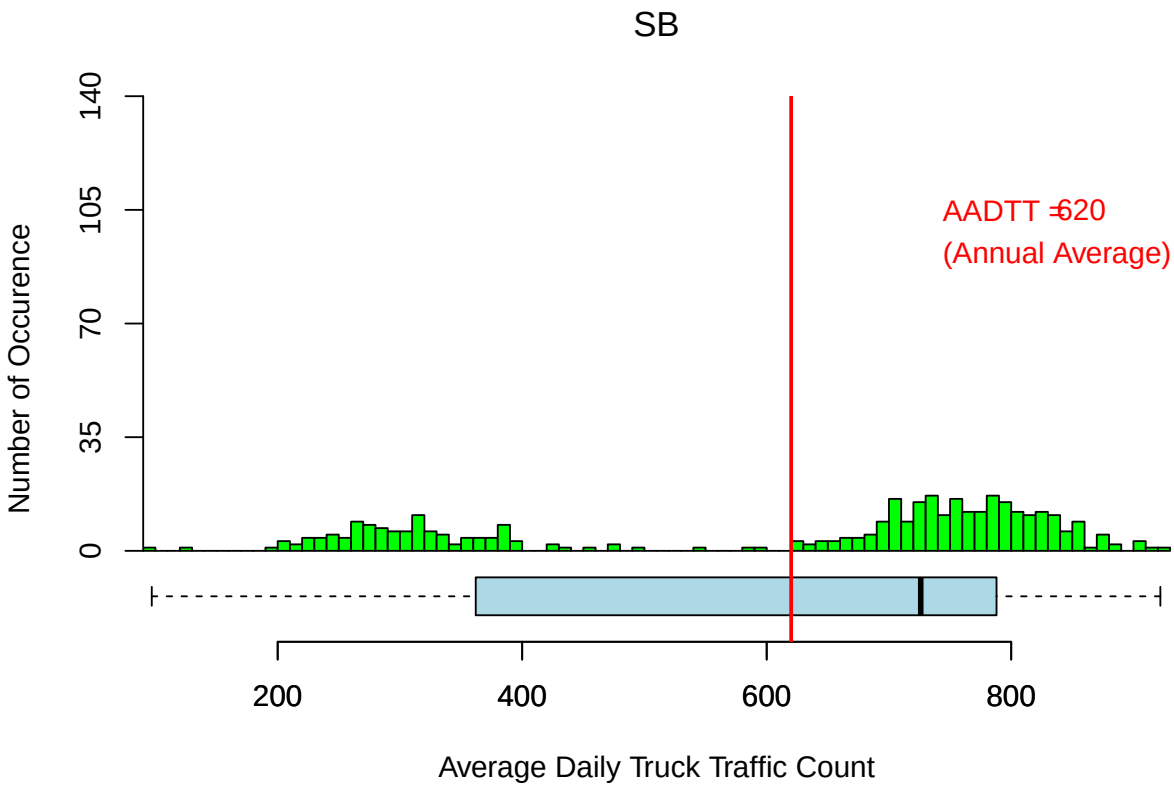
A-4.7.1(d) Comparison between Average Daily and Average Annual Daily

Direction 1

```
## ADT vs. AADT:
```



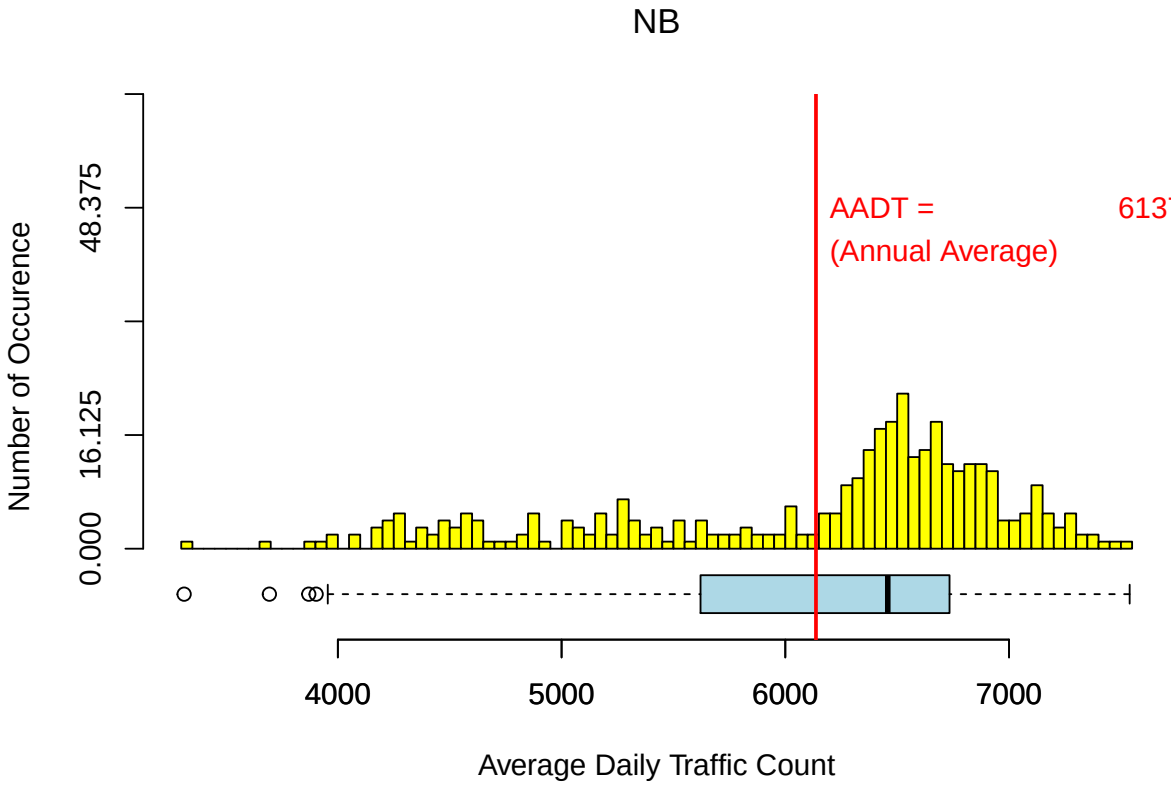

```
##
##  Numerical summary of ADT - SB :

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     961    4714    5537    5285    5818    7095

##
##  Compare the daily mean with the annual daily average.
##  AADT: 5284
```



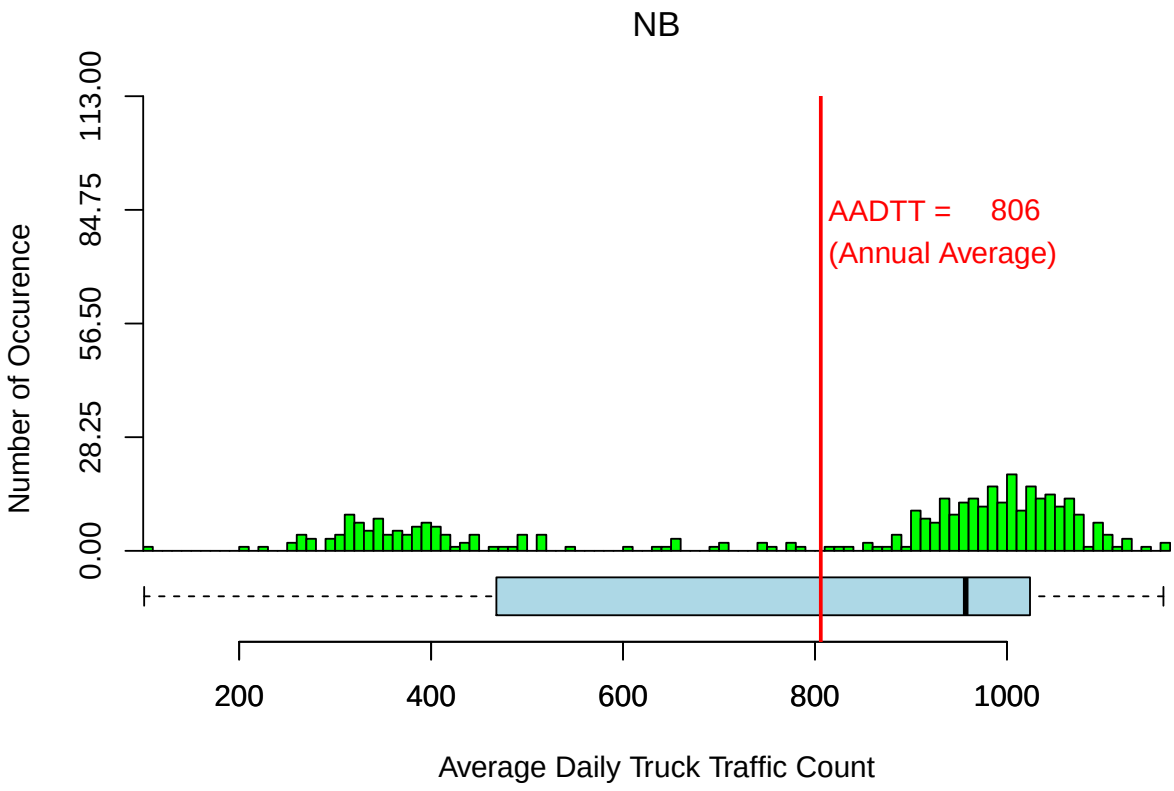

```
##
##  Numerical summary of ADTT - SB :

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    97.0   362.0   726.0   620.5   788.0   922.0

##
##  Compare the daily mean with the annual daily average.
##  AADTT 620
```

Direction 2

```
## ADT vs. AADT:
##
```




```
##
##  Numerical summary of ADT - NB :

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    3313    5621    6458    6138    6734    7539

##
##  Compare the daily mean with the annual daily average.
##  AADT: 6137
```




```
##
##  Numerical summary of ADTT - NB :

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   101.0   468.0   957.0   807.2  1024.0  1163.0

##
##  Compare the daily mean with the annual daily average.
##  AADTT 806
```

A-4.7.2 Numerical Summary - Vehicle Class Counts and Proportions.

Note: Vehicle counts are rounded to the nearest thousand. Due to rounding, vehicle counts less than 1,000 are indicated as 0.

```
##  (a) The total number of entries in the dataset:  4169343

##  (b) The number of vehicles recorded with no classification:  0

##  (c) The number of vehicles with zero weight: 0

##  (d) The number of vehicles not considered for computing AADT
##   due to missing traffic directions: 0

##  (e) The number of vehicles not considered for computing AADT
##   due to Class 15 identification: 634

##  (f) The number of vehicles accounted for computing SB AADT: 1928616

##  (g) The number of vehicles accounted for computing NB AADT: 2240093

##
##  The sum of Items (b) through (g) above is 4169343
##  , which is equal to the total number of entries shown in Item (a).

##
##  The number of unusable entries:

## [1] 634

##
##  % unusable data:

## [1] 0

##
##  The number of days recorded:

## [1] 365

##
##  The number of days included in the analysis - considered complete data:
```



```
## [1] 365
```

```
##
##  % days in the usable data:

## [1] 100

##
##  The number of days recorded:

## [1] 8760

##
##  The number of unique hours included in the analysis:

## [1] 8760

##
##  % hours in the usable data:

## [1] 100

##
##  The number of seconds recorded:

## [1] 3967976

##
##  The number of seconds included in the analysis:

## [1] 3967976

##
##  % seconds in the usable data:

## [1] 100

##
##  The number of vehicles with speed>80mph:

## [1] 316499

##
##  % Entries with speed>80mph:
```



```
## [1] 7.6
```

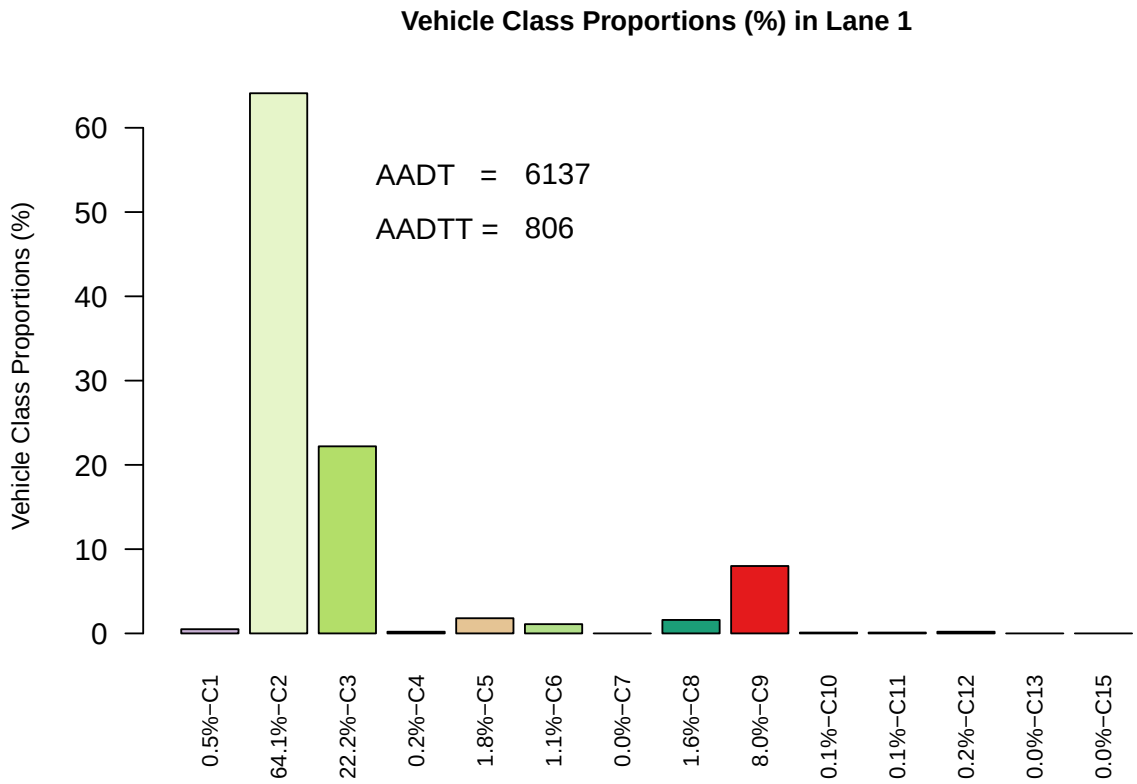
```
##
##  Vehicle counts (x1000) by class:

## [ SB ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##   12 1268  422    4   37   18    0   28  132    4    1    2    0    0

## [ NB ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##   12 1436  498    5   39   24    0   36  180    3    3    4    0    0

## [ SB and NB Combined]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##   24 2704  920    9   77   41    0   63  313    7    4    6    0    1

##
##  Vehicle class proportions (%) by class:

## [ SB ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##  0.6 65.7 21.9  0.2  1.9  0.9  0.0  1.4  6.9  0.2  0.1  0.1  0.0  0.0

## [ NB ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##  0.5 64.1 22.2  0.2  1.8  1.1  0.0  1.6  8.0  0.1  0.1  0.2  0.0  0.0

## [ SB and NB Combined]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##  0.6 64.8 22.1  0.2  1.8  1.0  0.0  1.5  7.5  0.2  0.1  0.2  0.0  0.0

##
##  Compare daily average vs. annual daily average traffic counts:
```

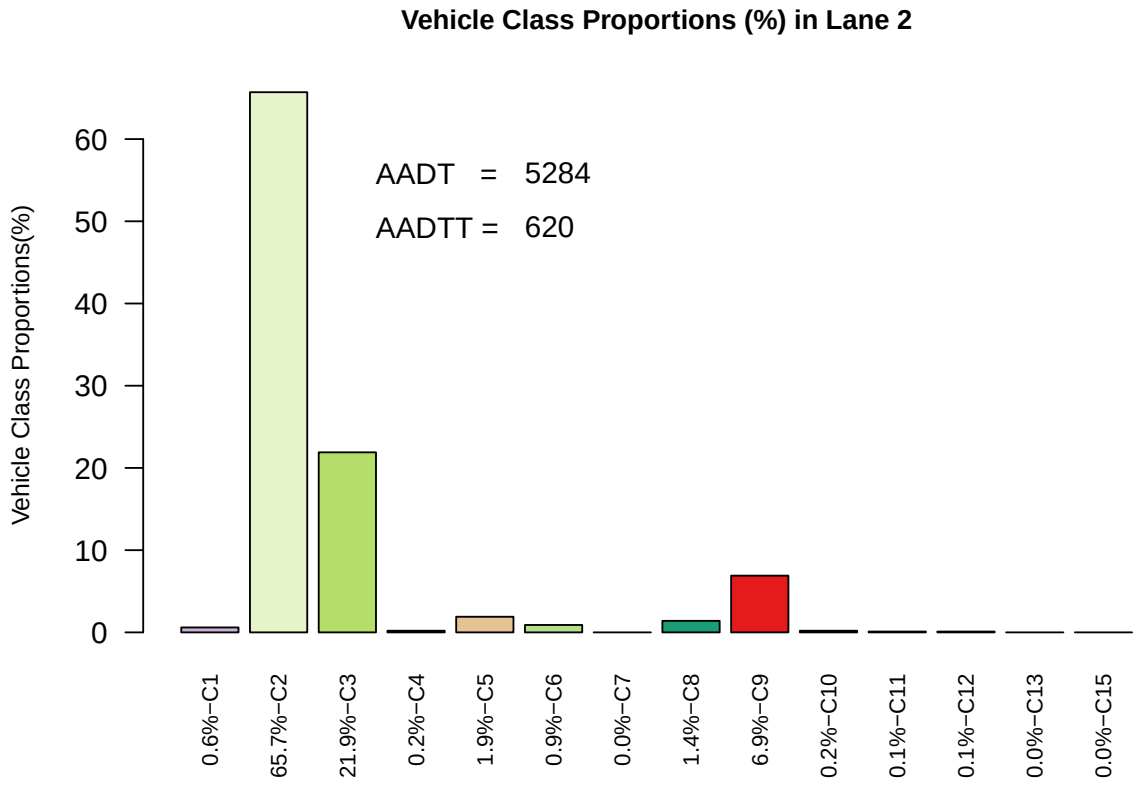
```
##     ADT AADT ADTT AADTT
## SB 5285 5284  621   620
## NB 6138 6137  807   806

##
##  * (Important Note): Class 15 indicates vehicles that were not
##  identified by 13 vehicle classifications.
##  SB - South Bound
##  NB - North Bound
##  EB - East Bound
##  WB - West Bound
##  ADT - Average Daily Traffic
##  ADTT - Average Daily Truck Traffic
##  AADT - Average Annual Daily Traffic
##  AADTT - Average Annual Daily Truck Traffic
```

A-4.7.3 Graphical Summary - Vehicle Class Proportion (%) and ADTT by Lane.

A-4.7.3(a) Vehicle Class Proportion (%) by Lane

```
## Bar plots
```

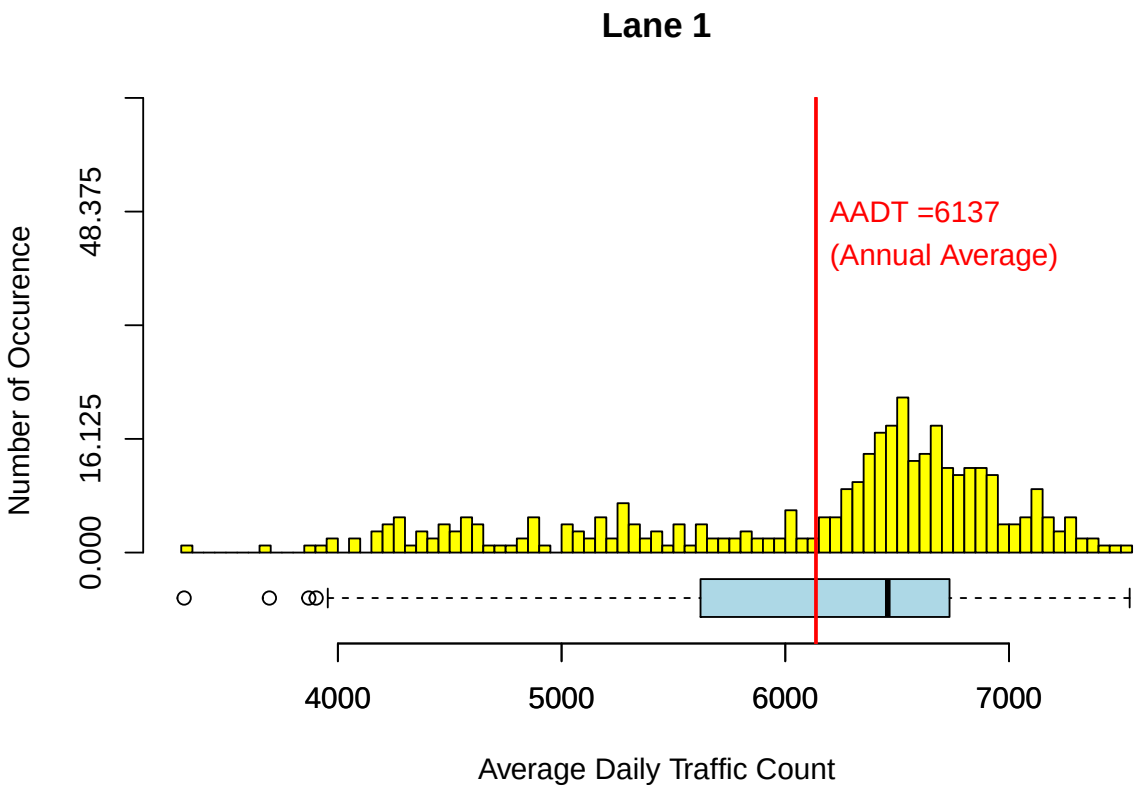




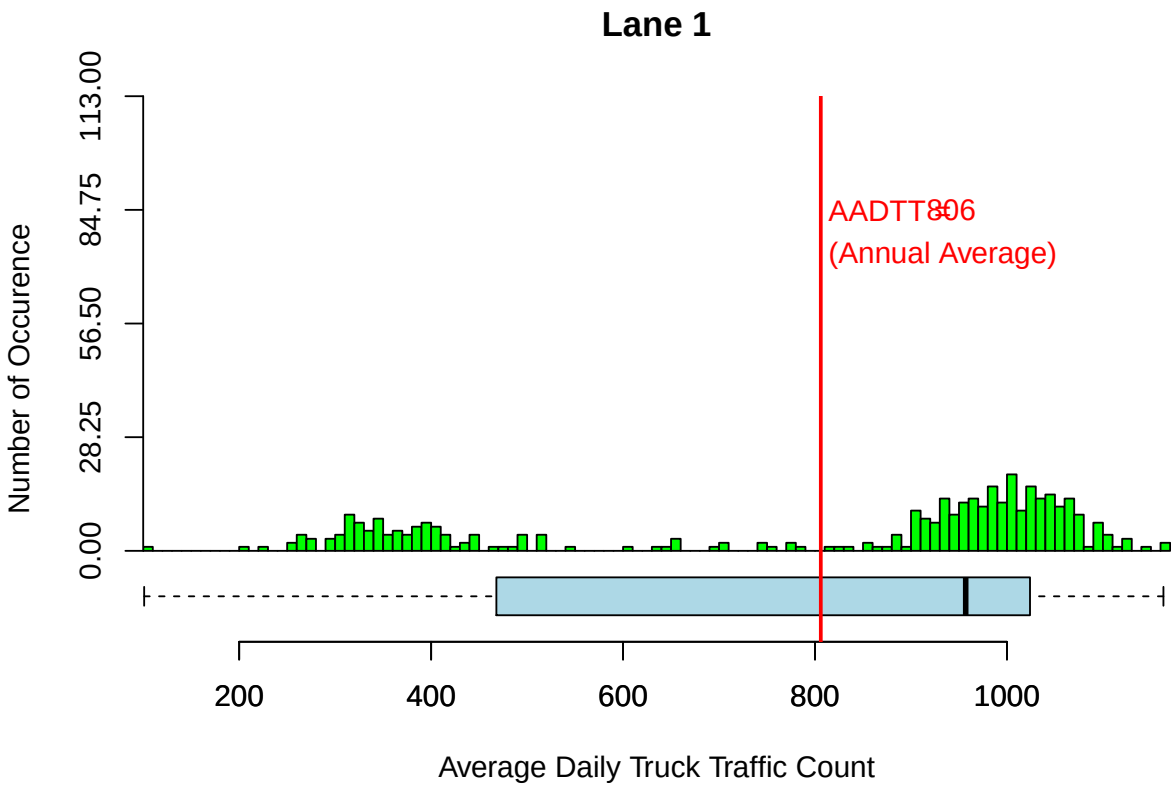

```
## Lane 3 data do not exist.

## Lane 4 data do not exist.

## Lane 5 data do not exist.

## Lane 6 data do not exist.

## Lane 7 data do not exist.

## Lane 8 data do not exist.
```

A-4.7.3(b) Comparison between Average Daily and Average Annual Daily

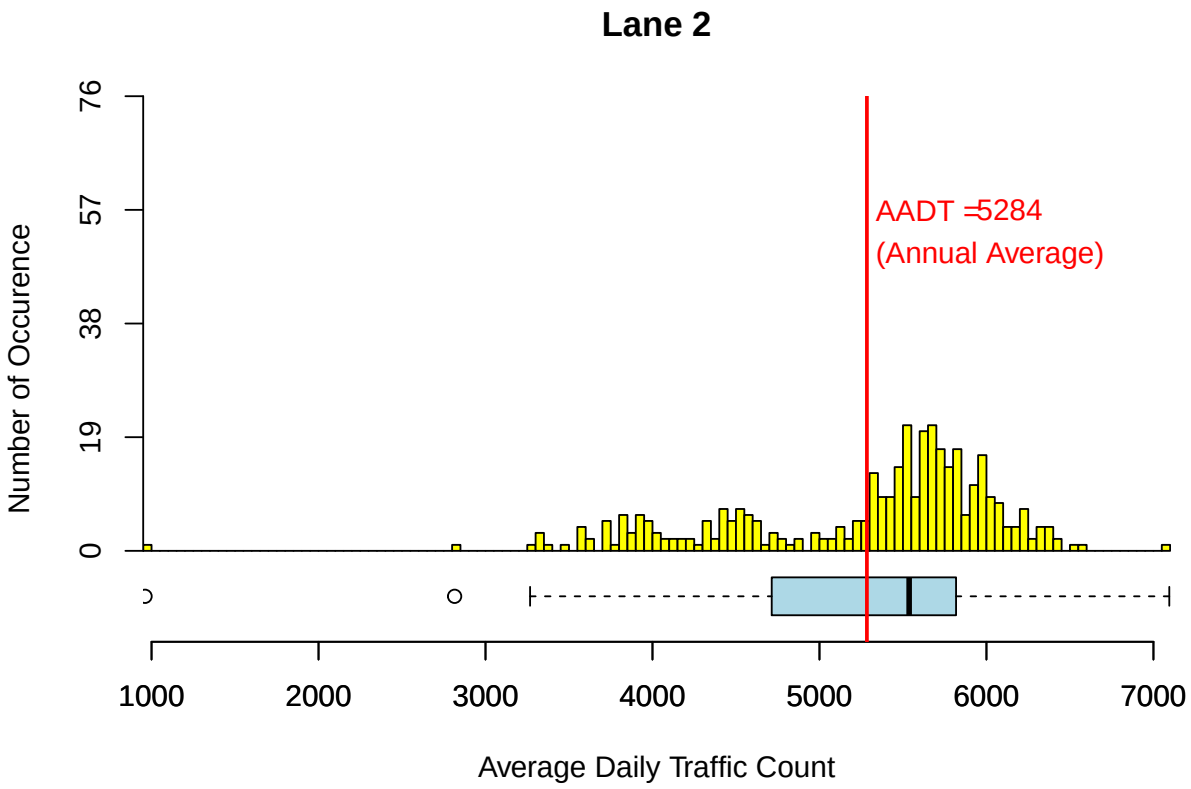
```
## ADT vs. AADT
```



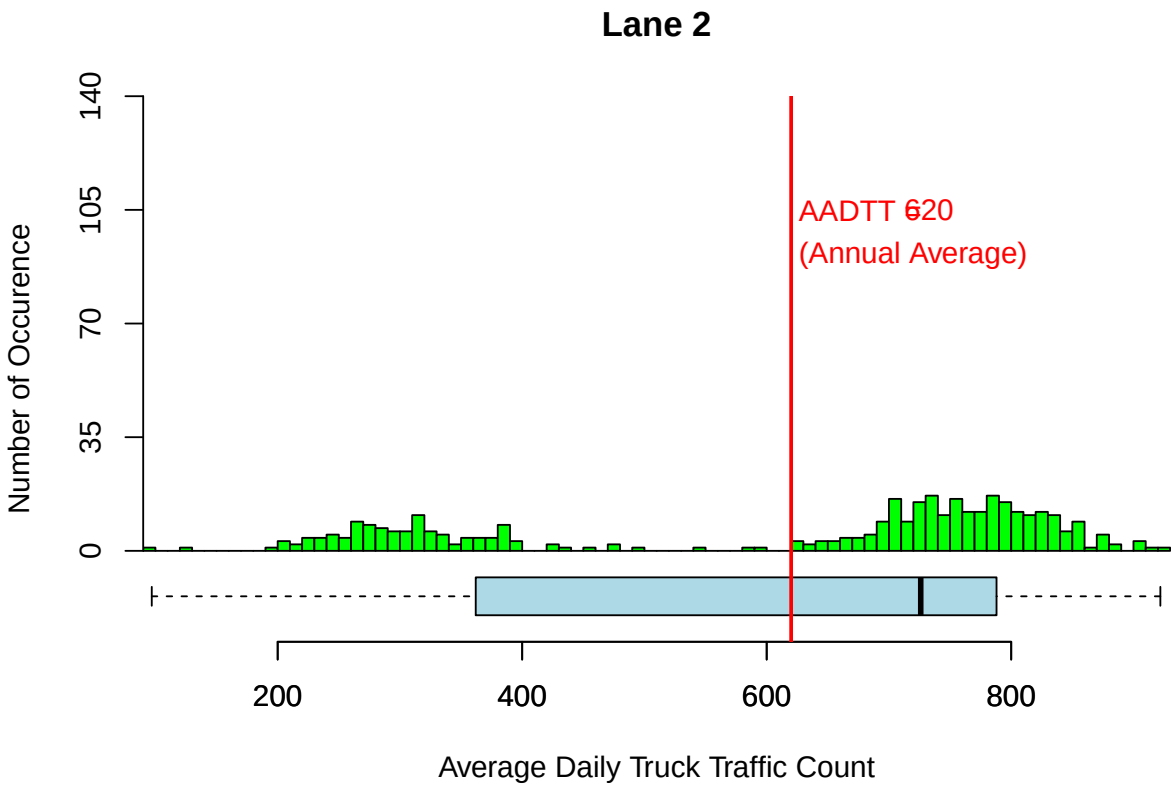

```
##
##  Numerical summary of ADT - Lane 1:
##
##  Compare the daily mean with the annual daily average.
##  AADT: 6137
```




```
##
##  Numerical summary of ADTT - Lane 1:
##
##  Compare the daily mean with the annual daily average.
##  AADTT 806
```




```
##
##  Numerical summary of ADT - Lane 2:
##
##  Compare the daily mean with the annual daily average.
##  AADT: 5284
```




```
##
##  Numerical summary of ADTT - Lane 2:
##
##  Compare the daily mean with the annual daily average.
##  AADTT 620

## Lane 3 data do not exist.

## Lane 4 data do not exist.

## Lane 5 data do not exist.

## Lane 6 data do not exist.

## Lane 7 data do not exist.

## Lane 8 data do not exist.
```

A-4.7.4 Numerical Summary - Vehicle Class Proportions (%) in Each Lane.

A-4.7.4(a) Vehicle Class Proportion (%) by Lane *Note: Due to rounding, vehicle counts less than 1,000 are indicated as 0.*

```
##
##  Vehicle counts (x1000) by class in each lane:

## [ Lane 1 ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##   12 1436  498    5   39   24    0   36  180    3    3    4    0    0

## [ Lane 2 ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##   12 1268  422    4   37   18    0   28  132    4    1    2    0    0

## [ Lane 3 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0

## [ Lane 4 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0

## [ Lane 5 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0

## [ Lane 6 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```
## [ Lane 7 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0

## [ Lane 8 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```
##
##  % vehicle class proportions in each lane:

## [ Lane 1 ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##  0.5 64.1 22.2  0.2  1.8  1.1  0.0  1.6  8.0  0.1  0.1  0.2  0.0  0.0

## [ Lane 2 ]

##
##    1    2    3    4    5    6    7    8    9   10   11   12   13   15
##  0.6 65.7 21.9  0.2  1.9  0.9  0.0  1.4  6.9  0.2  0.1  0.1  0.0  0.0

## [ Lane 3 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##

## [ Lane 4 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##

## [ Lane 5 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##

## [ Lane 6 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##

## [ Lane 7 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##

## [ Lane 8 ]

##
##  1  2  3  4  5  6  7  8  9 10 11 12 13 15
##
```

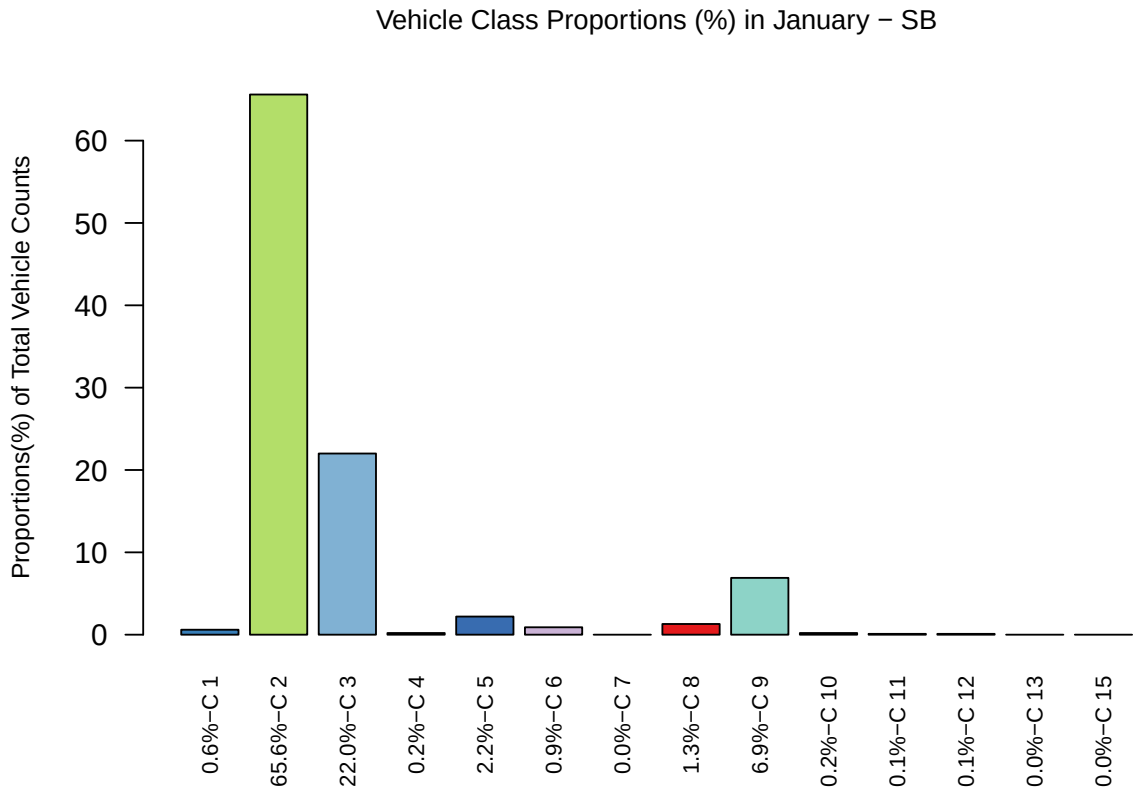
A-4.7.4(b) Comparison between Average Daily and Average Annual Daily

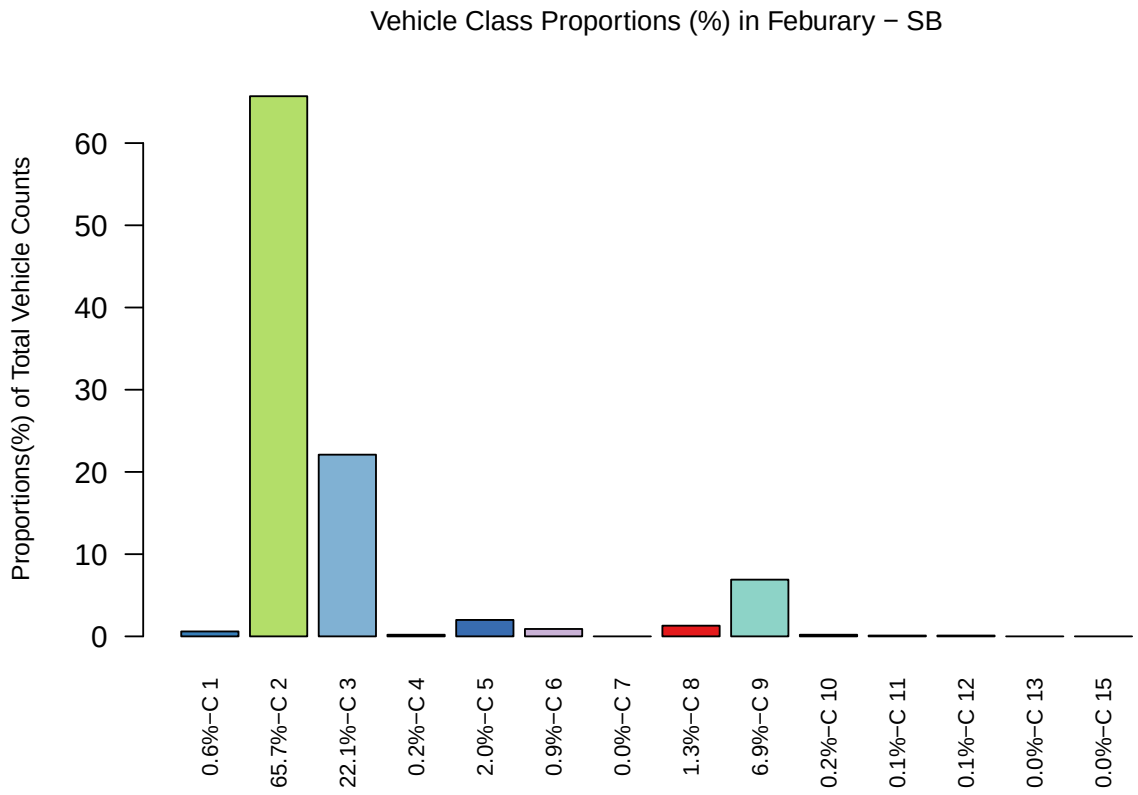
```
##
##  Summary of Average Daily and Annual Average Daily Traffic in Each Lane:

## Lanes 3 and 4 data do not exist.

## Lanes 5 and 6 data do not exist.

## Lanes 7 and 8 data do not exist.

##    ADT AADT ADTT AADTT
## 1 6138 6137  807   806
## 2 5285 5284  621   620
```

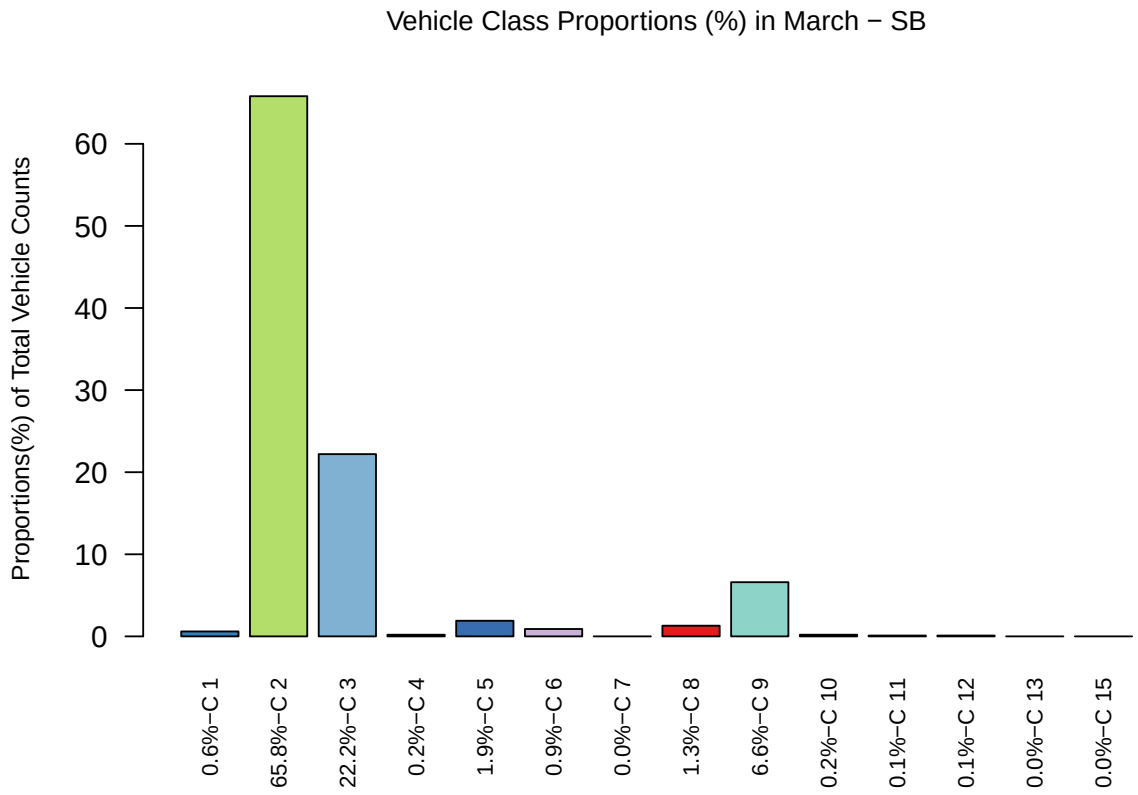
A-4.7.5 Graphical Summary - Vehicle Class Proportion (%) and ADTT by Month.

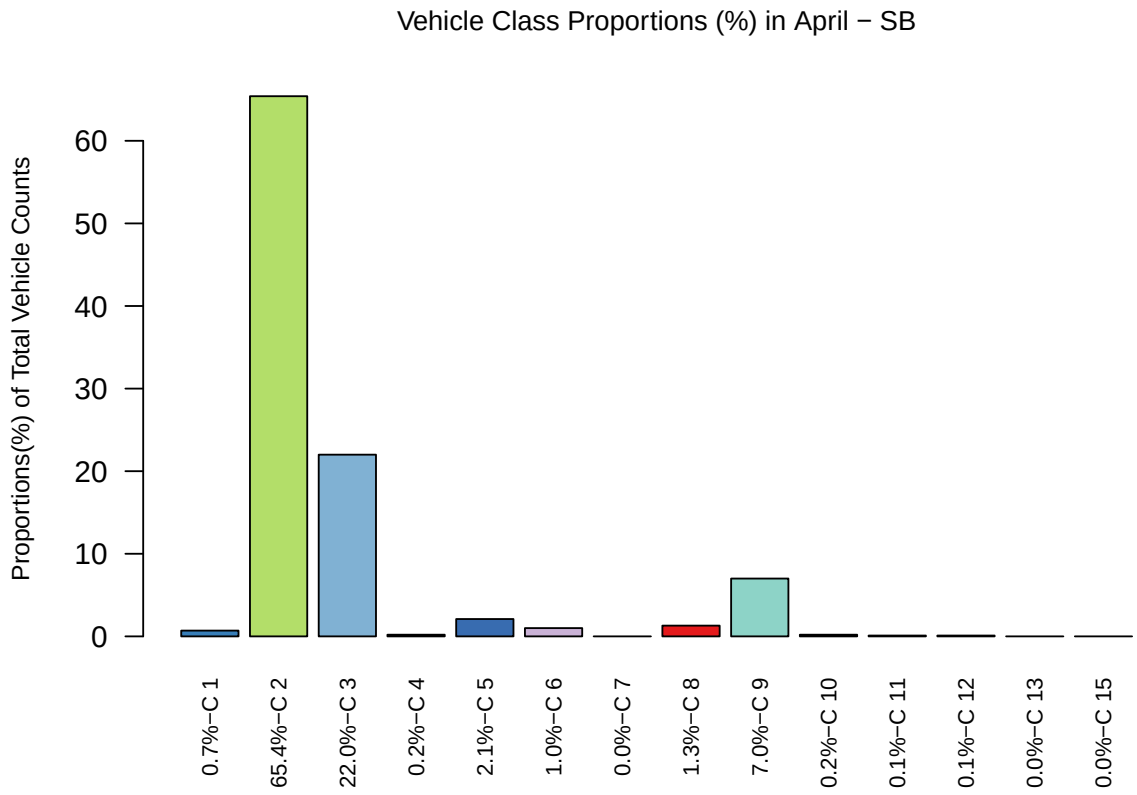
A-4.7.5(a) Direction 1 - Class Proportions by Month

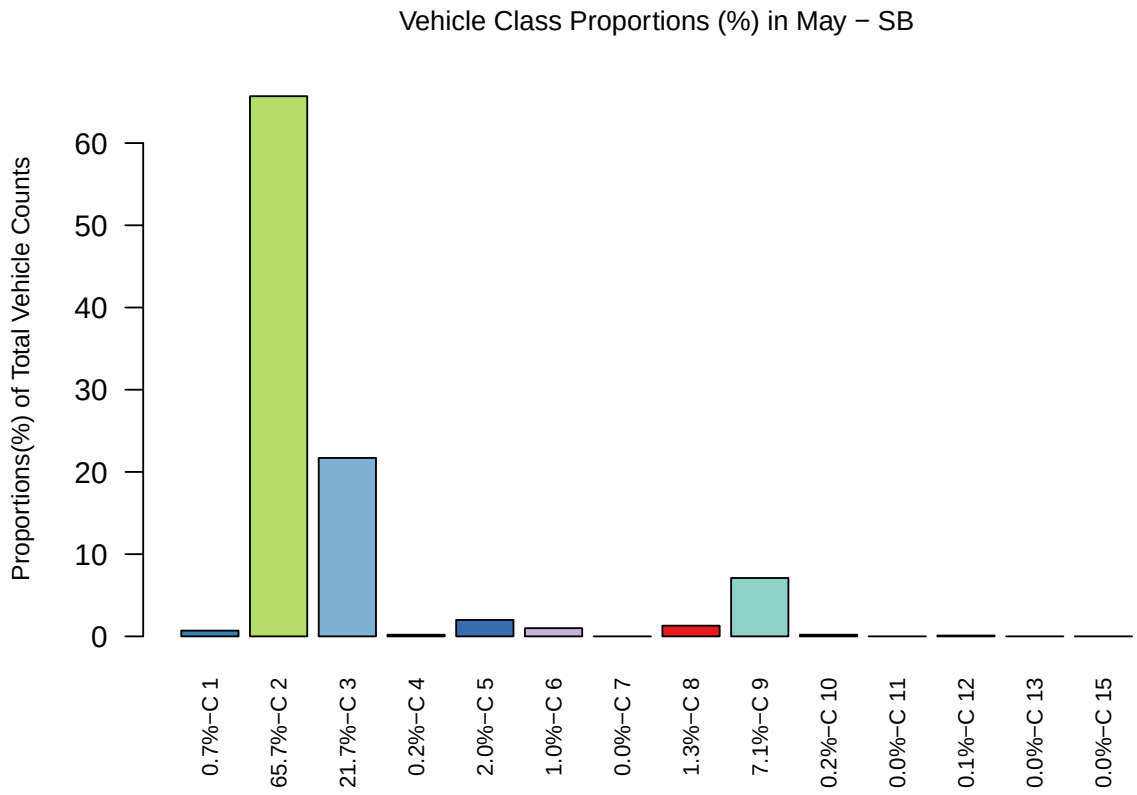
```
##
##  Bar plots
```

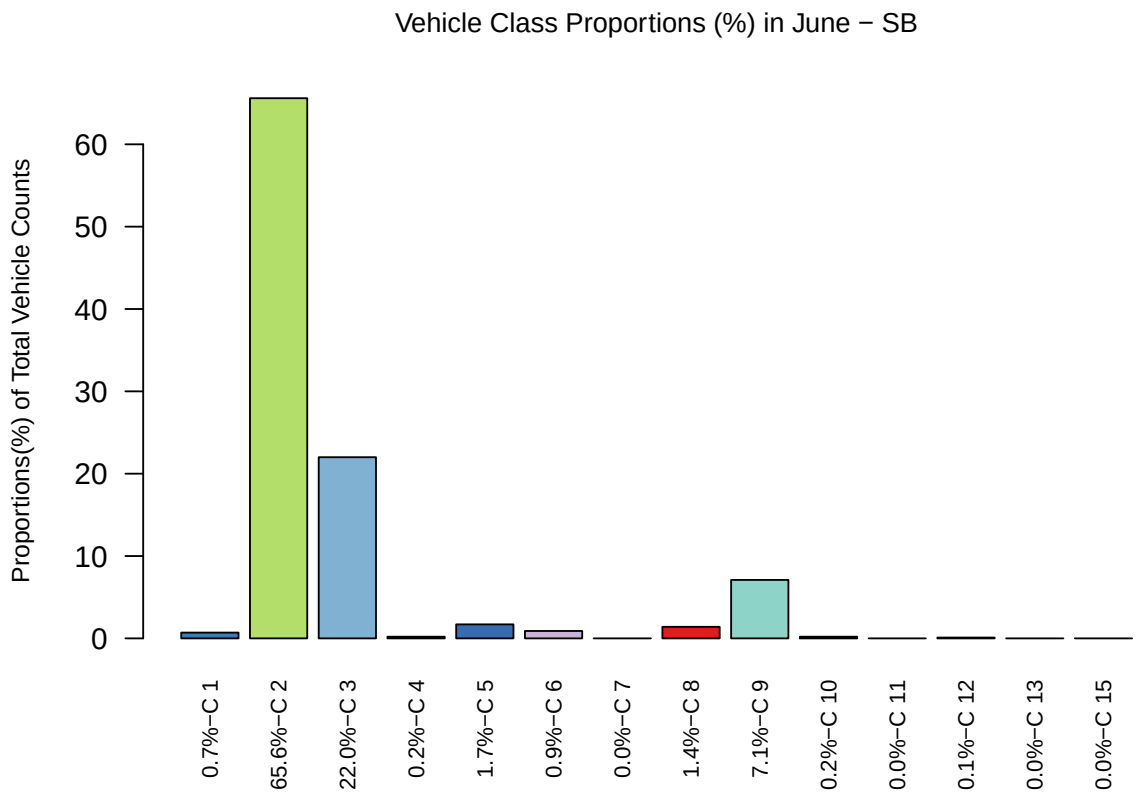


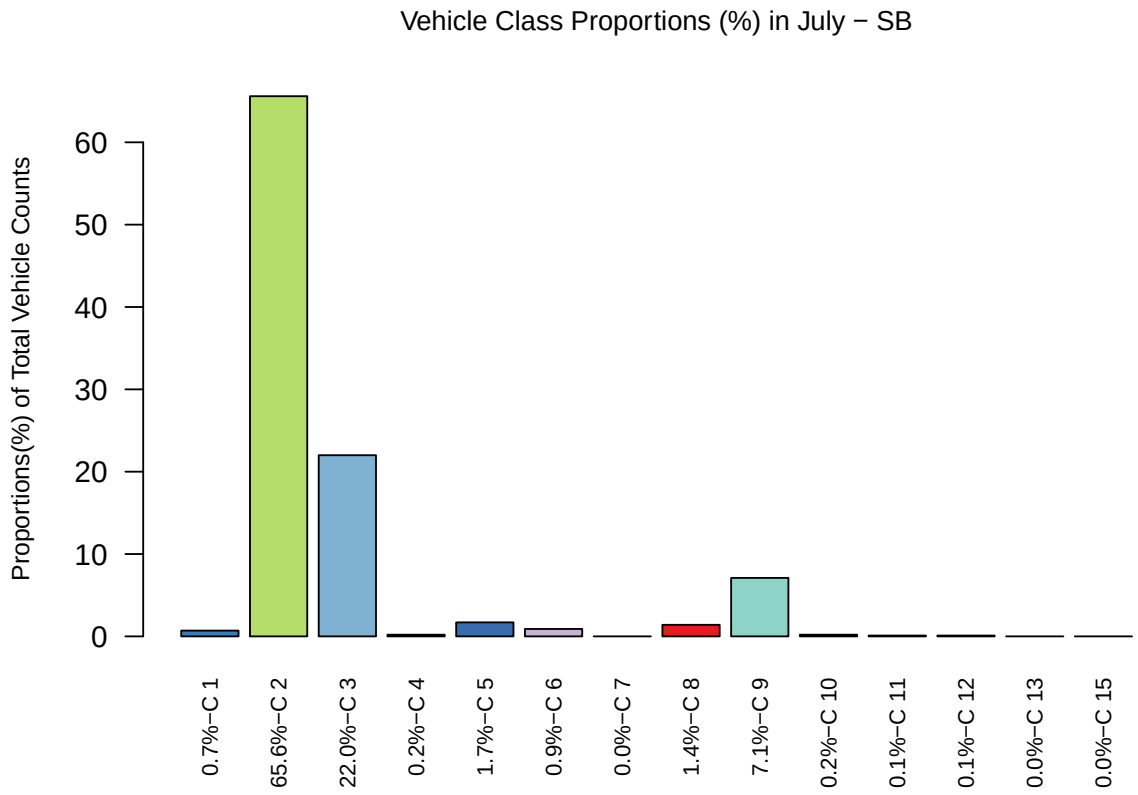

Vehicle Class Proportions (%) in Feburary − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
65.7%−C 2
22.1%−C 3
0.2%−C 4
2.0%−C 5
0.9%−C 6
0.0%−C 7
1.3%−C 8
6.9%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

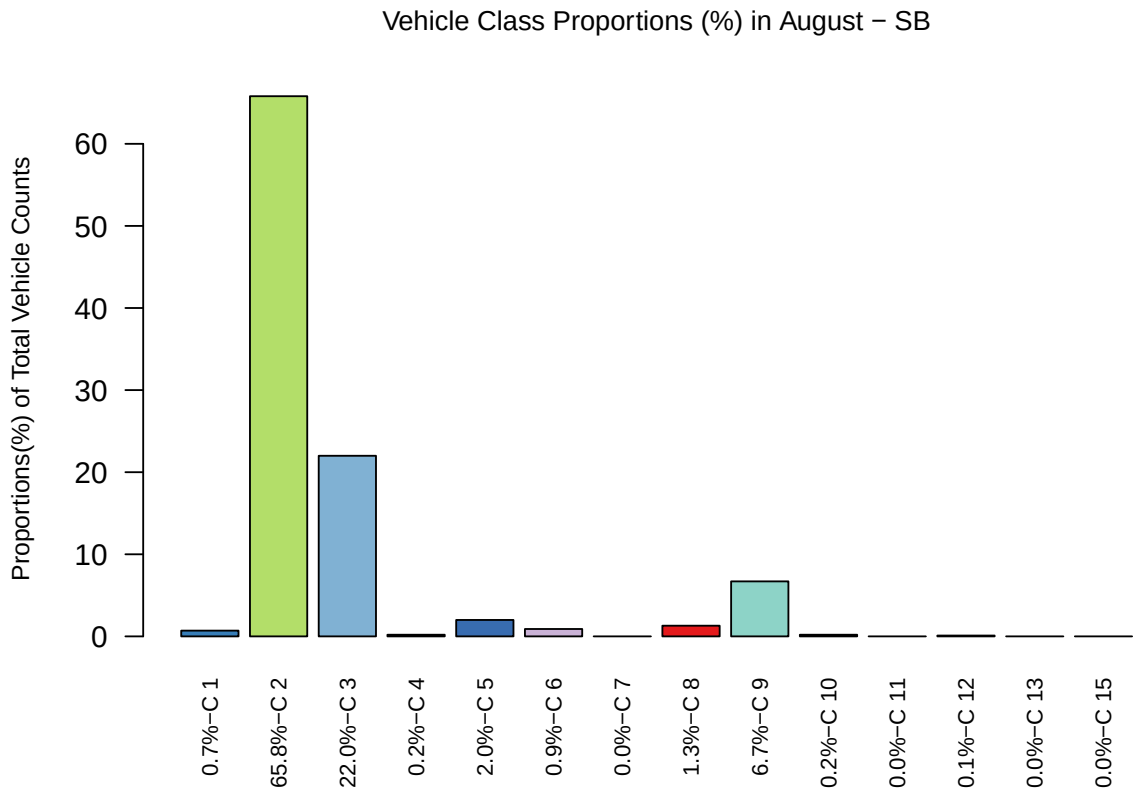

Vehicle Class Proportions (%) in March − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
65.8%−C 2
22.2%−C 3
0.2%−C 4
1.9%−C 5
0.9%−C 6
0.0%−C 7
1.3%−C 8
6.6%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

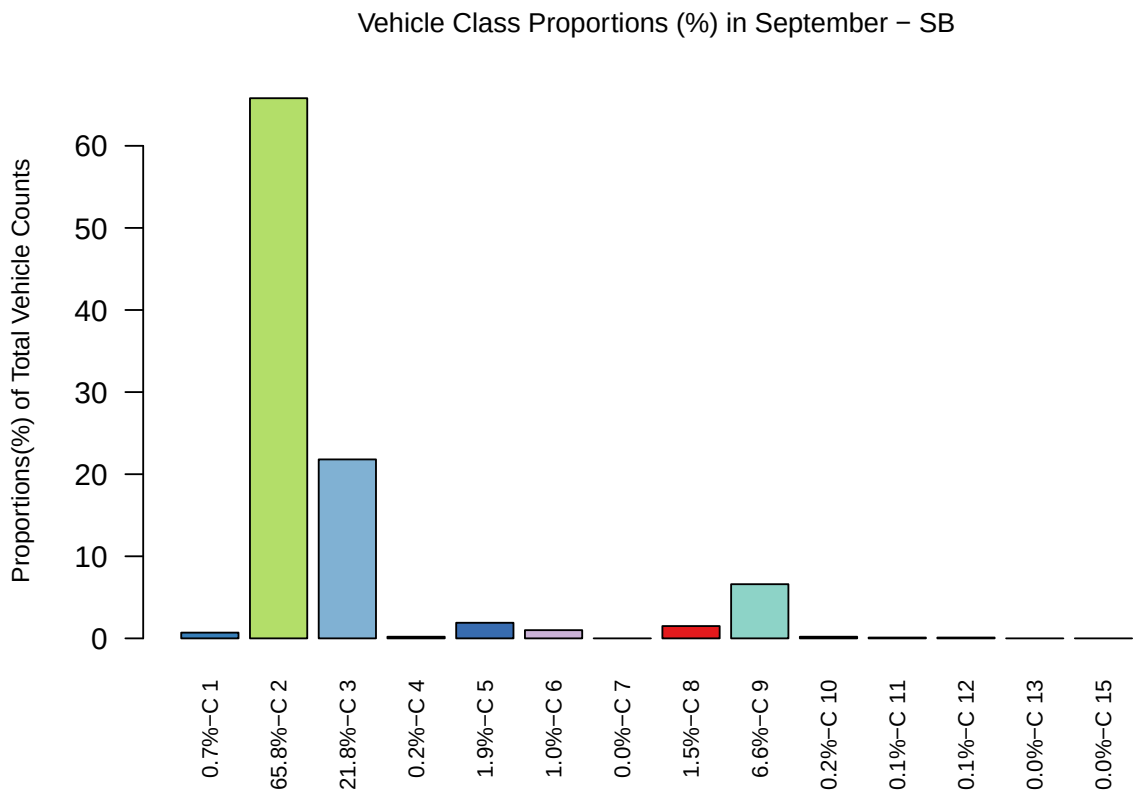

Vehicle Class Proportions (%) in April − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.7%−C 1
65.4%−C 2
22.0%−C 3
0.2%−C 4
2.1%−C 5
1.0%−C 6
0.0%−C 7
1.3%−C 8
7.0%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

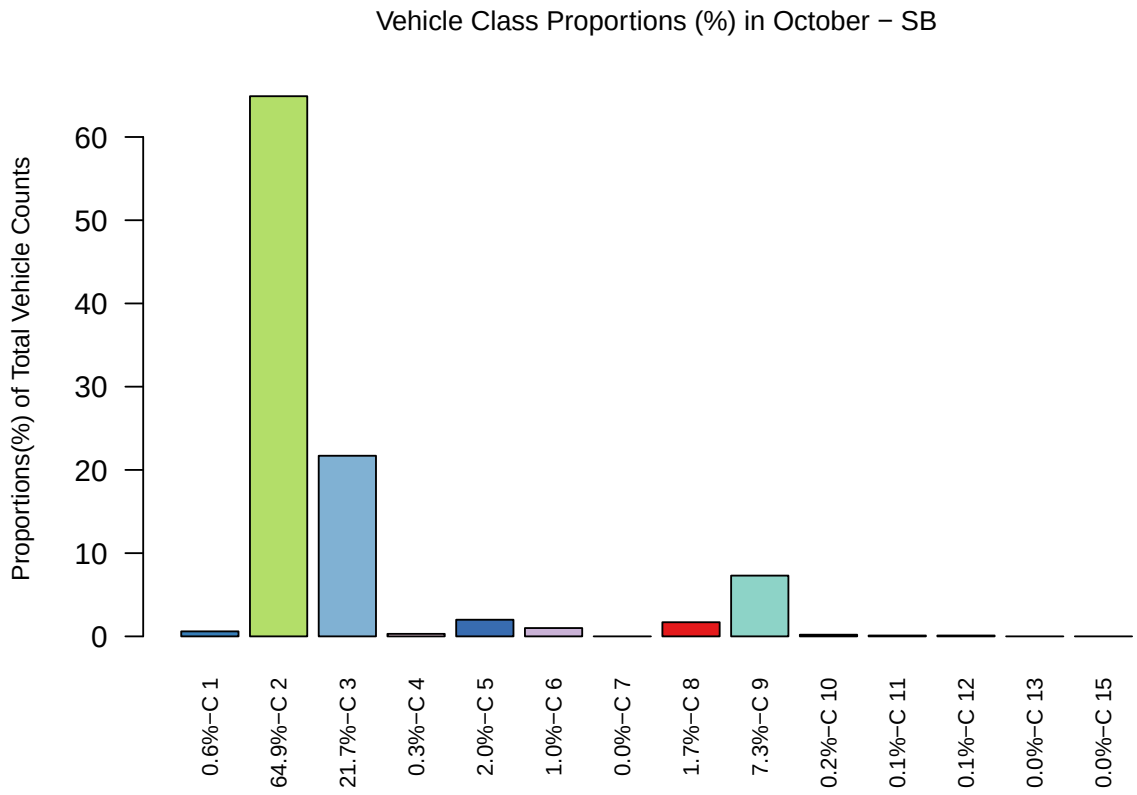

Vehicle Class Proportions (%) in May − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.7%−C 1
65.7%−C 2
21.7%−C 3
0.2%−C 4
2.0%−C 5
1.0%−C 6
0.0%−C 7
1.3%−C 8
7.1%−C 9
0.2%−C 10
0.0%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

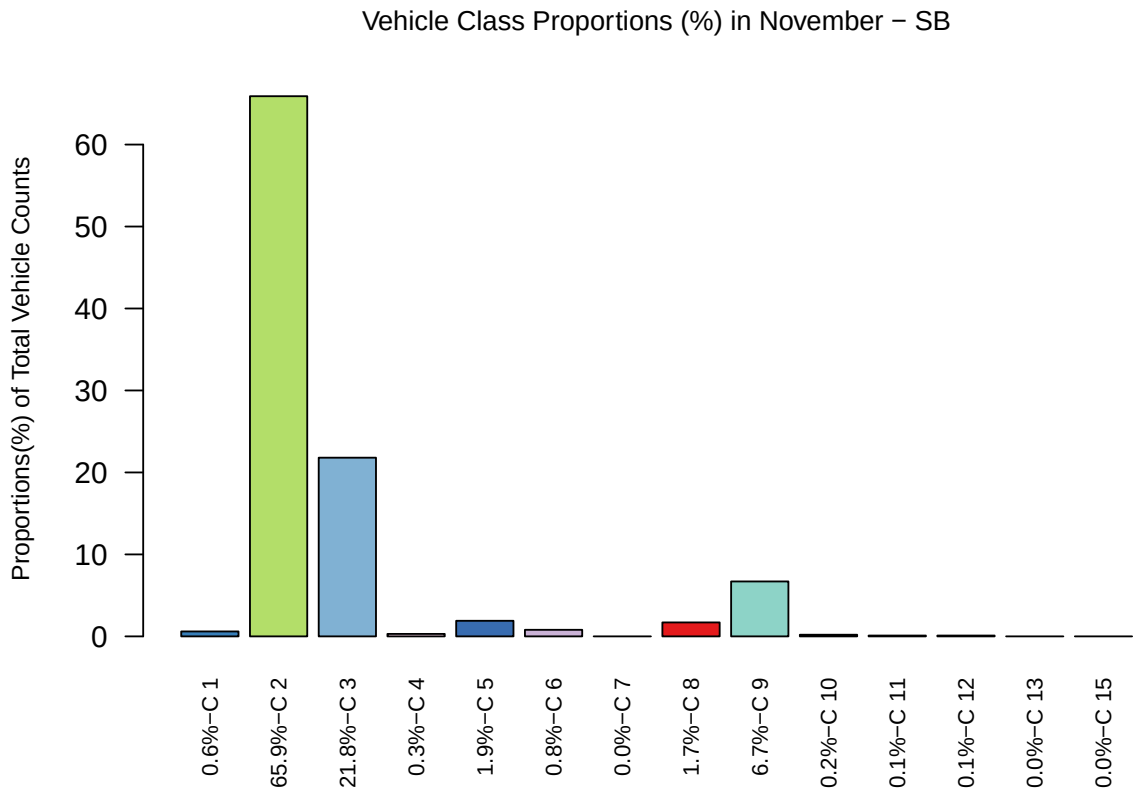

Vehicle Class Proportions (%) in June − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.7%−C 1
65.6%−C 2
22.0%−C 3
0.2%−C 4
1.7%−C 5
0.9%−C 6
0.0%−C 7
1.4%−C 8
7.1%−C 9
0.2%−C 10
0.0%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

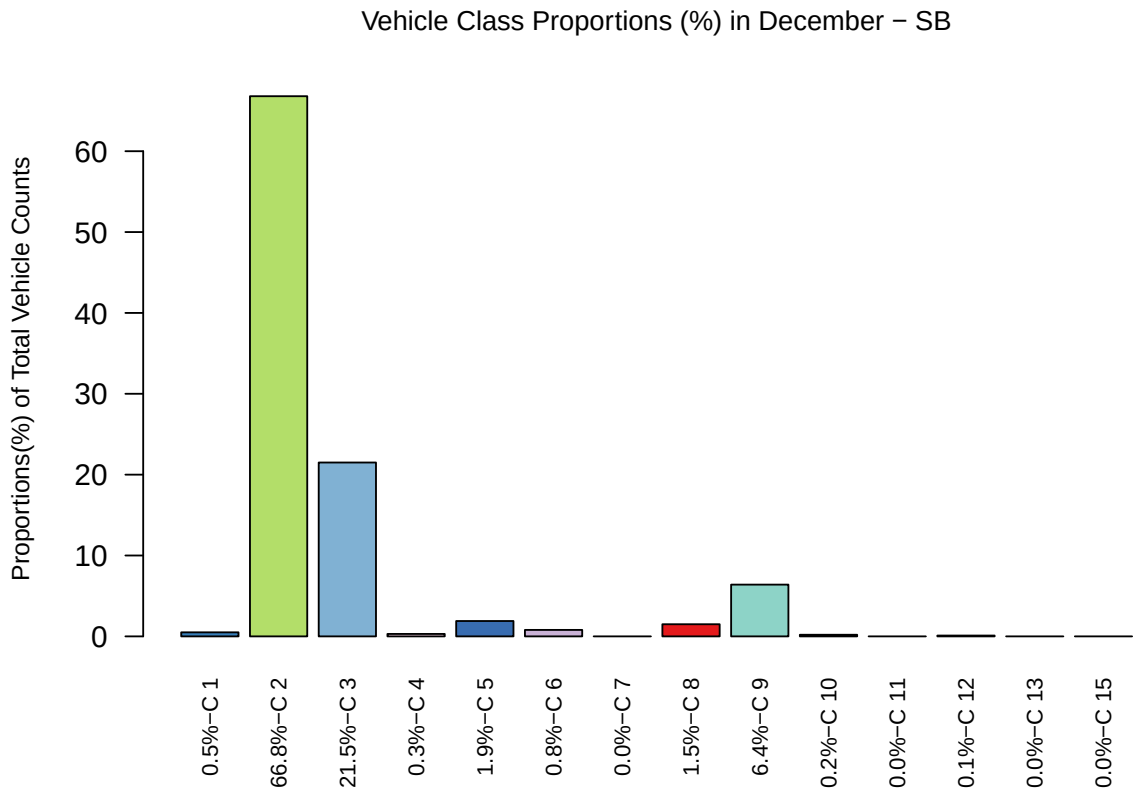

Vehicle Class Proportions (%) in July − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.7%−C 1
65.6%−C 2
22.0%−C 3
0.2%−C 4
1.7%−C 5
0.9%−C 6
0.0%−C 7
1.4%−C 8
7.1%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in August − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.7%−C 1
65.8%−C 2
22.0%−C 3
0.2%−C 4
2.0%−C 5
0.9%−C 6
0.0%−C 7
1.3%−C 8
6.7%−C 9
0.2%−C 10
0.0%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

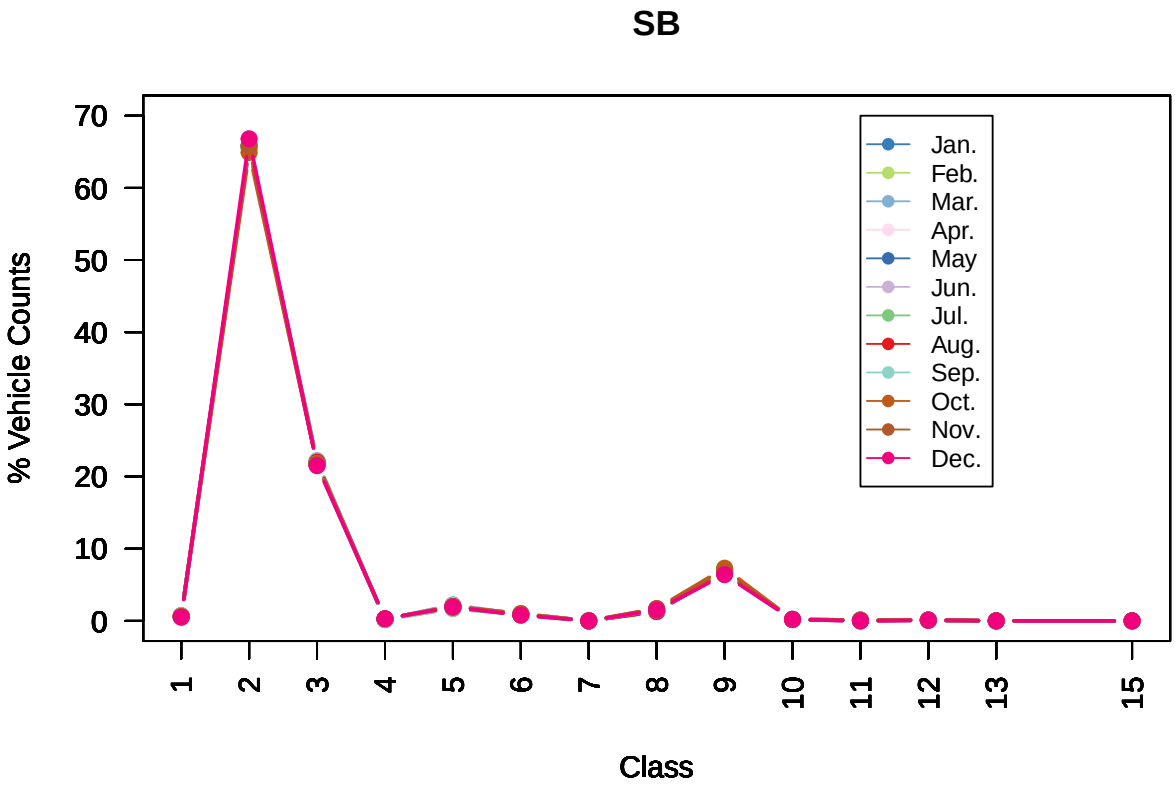

Vehicle Class Proportions (%) in September − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.7%−C 1
65.8%−C 2
21.8%−C 3
0.2%−C 4
1.9%−C 5
1.0%−C 6
0.0%−C 7
1.5%−C 8
6.6%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in October − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.9%−C 2
21.7%−C 3
0.3%−C 4
2.0%−C 5
1.0%−C 6
0.0%−C 7
1.7%−C 8
7.3%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in November − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
65.9%−C 2
21.8%−C 3
0.3%−C 4
1.9%−C 5
0.8%−C 6
0.0%−C 7
1.7%−C 8
6.7%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

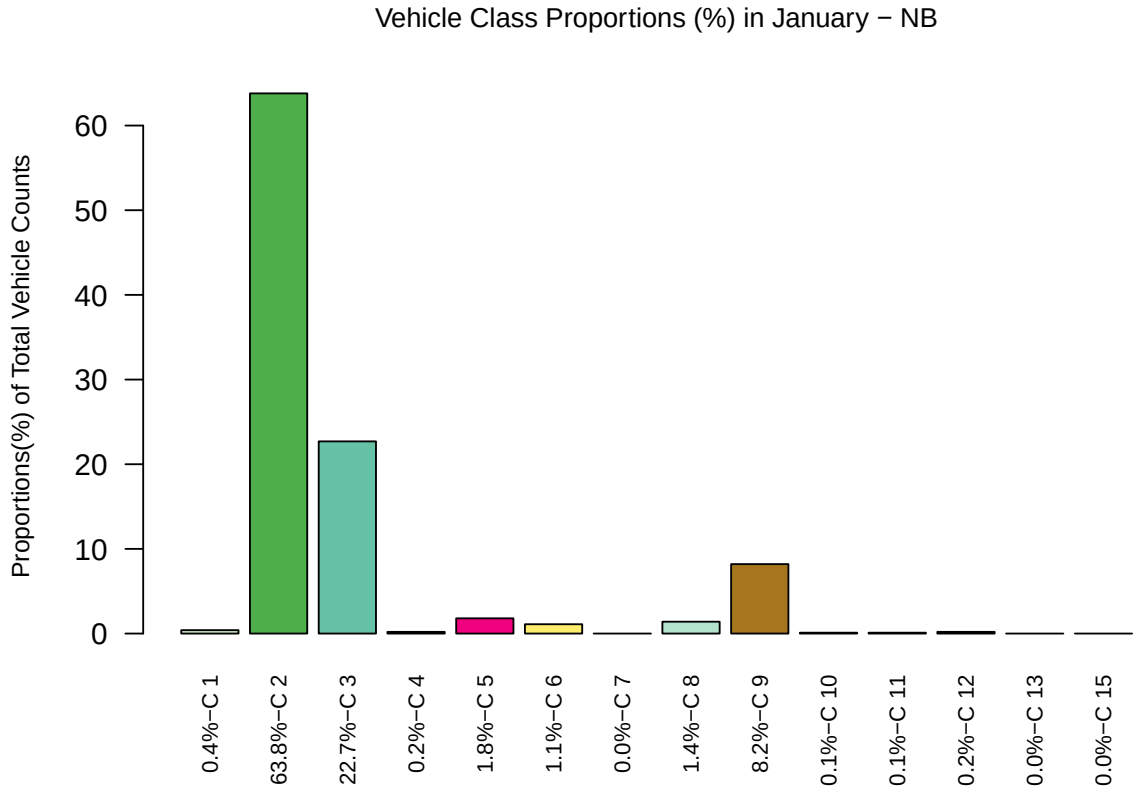

Vehicle Class Proportions (%) in December − SB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
66.8%−C 2
21.5%−C 3
0.3%−C 4
1.9%−C 5
0.8%−C 6
0.0%−C 7
1.5%−C 8
6.4%−C 9
0.2%−C 10
0.0%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

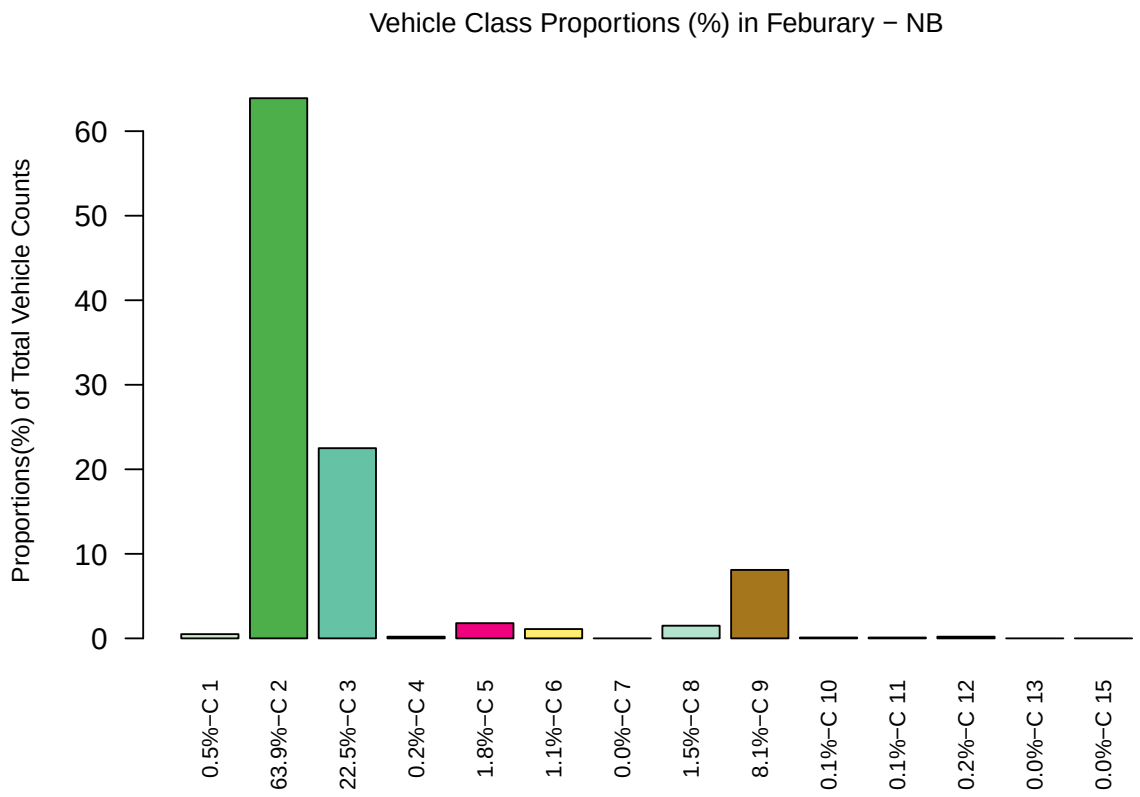
```
##
##  Direction 1 - January through December:
```

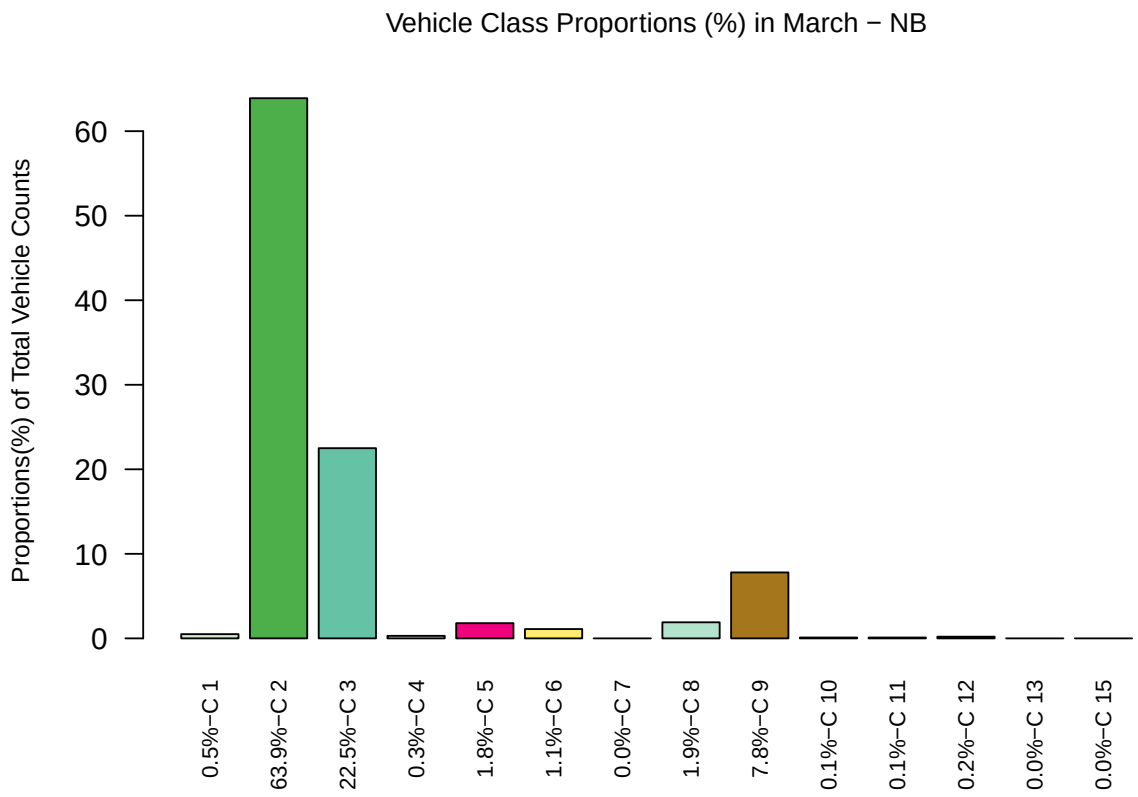


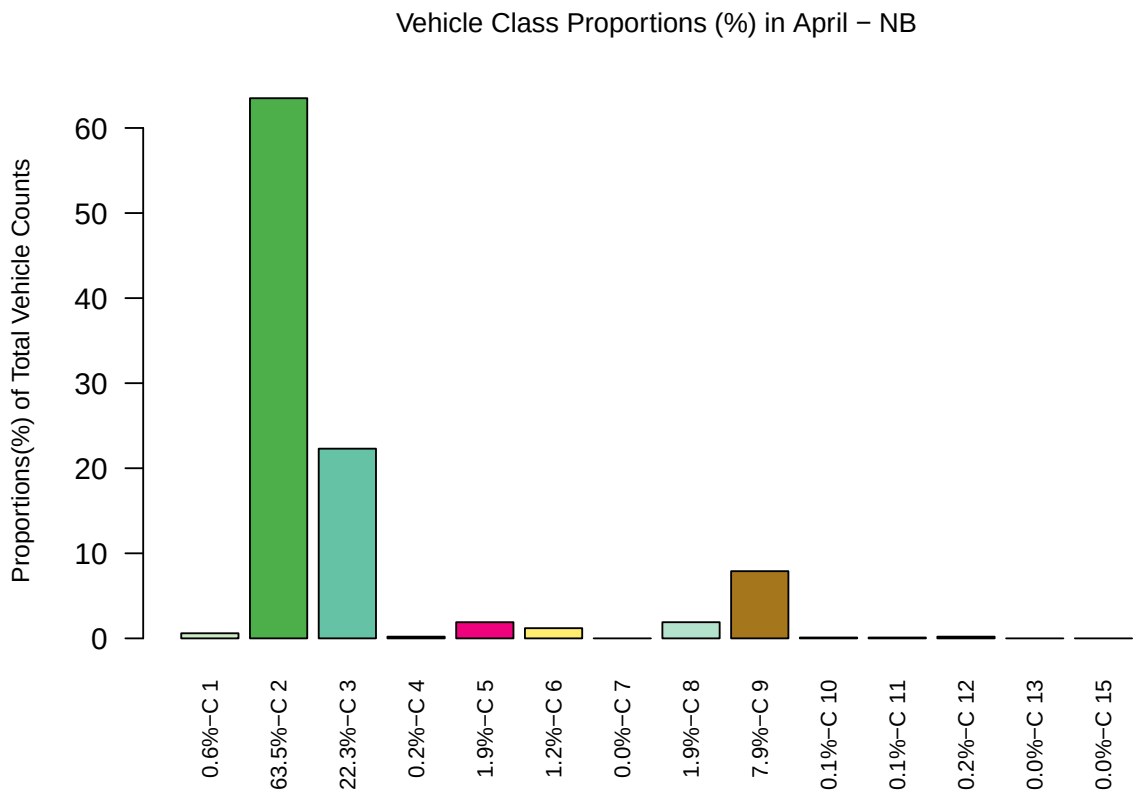
A-4.7.5(b) Direction 2 - Class Proportions by Month

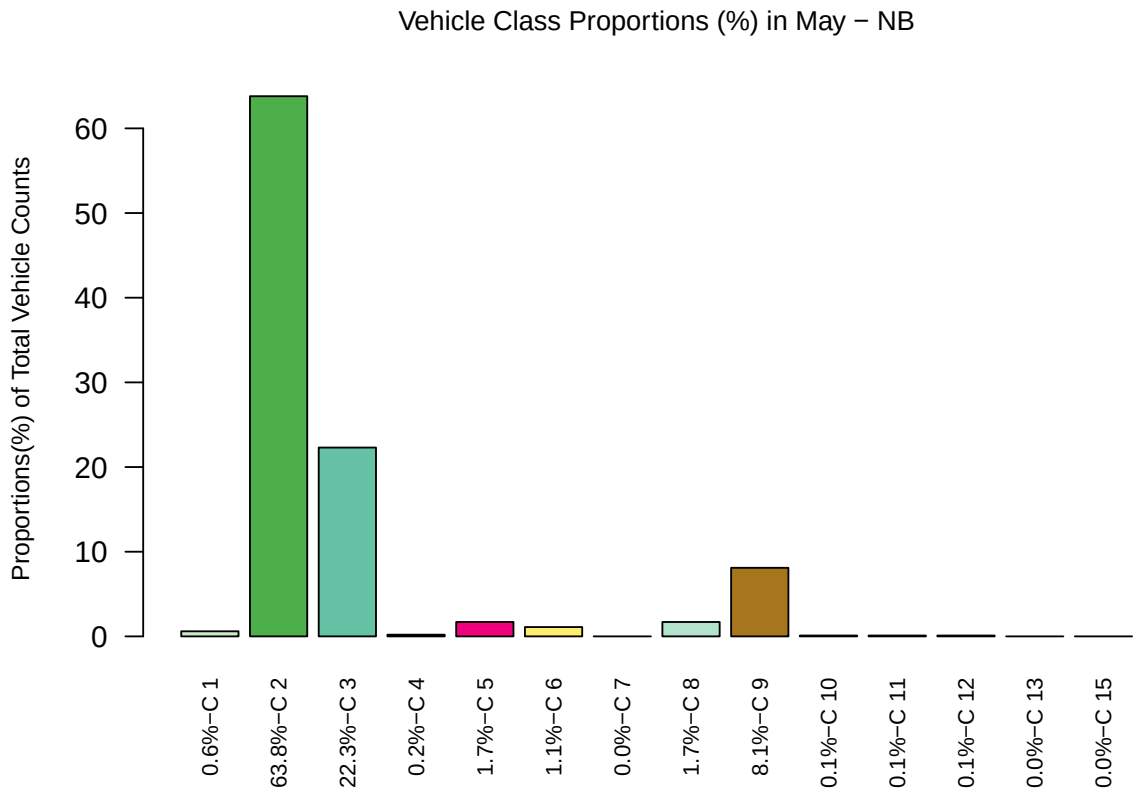
```
## Bar plots
```

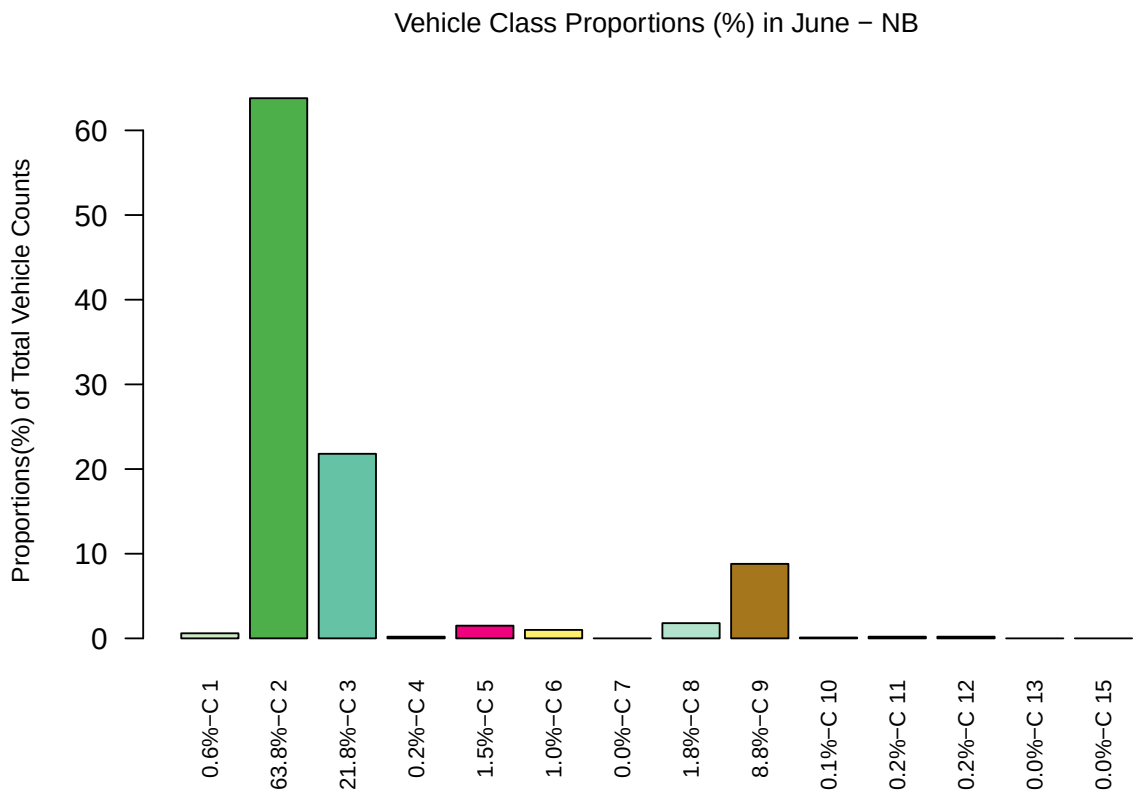


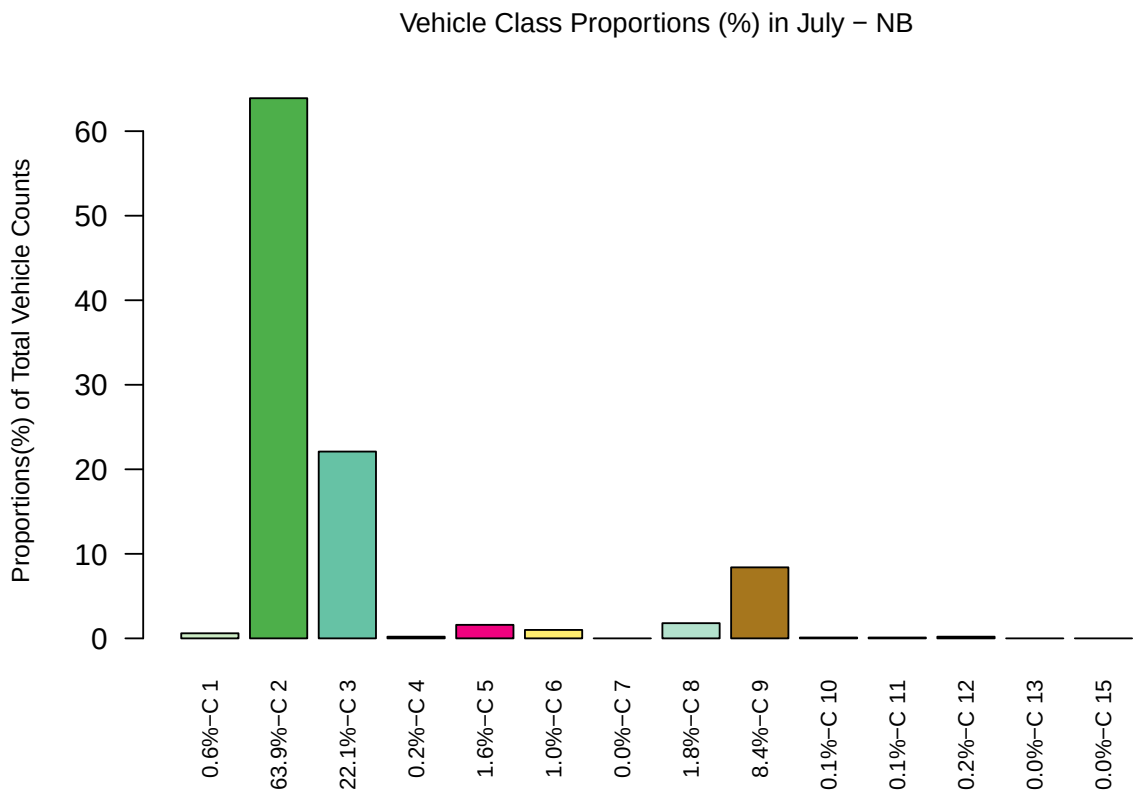

Vehicle Class Proportions (%) in Feburary − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
63.9%−C 2
22.5%−C 3
0.2%−C 4
1.8%−C 5
1.1%−C 6
0.0%−C 7
1.5%−C 8
8.1%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

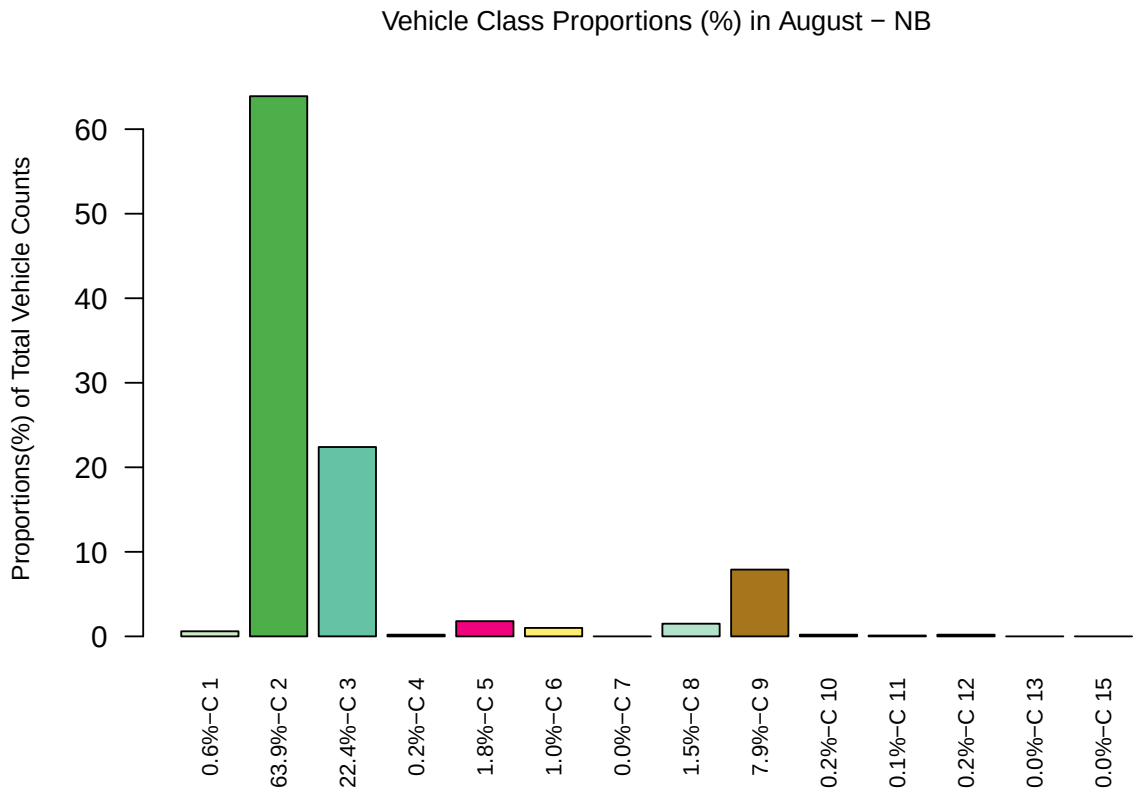

Vehicle Class Proportions (%) in March − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
63.9%−C 2
22.5%−C 3
0.3%−C 4
1.8%−C 5
1.1%−C 6
0.0%−C 7
1.9%−C 8
7.8%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

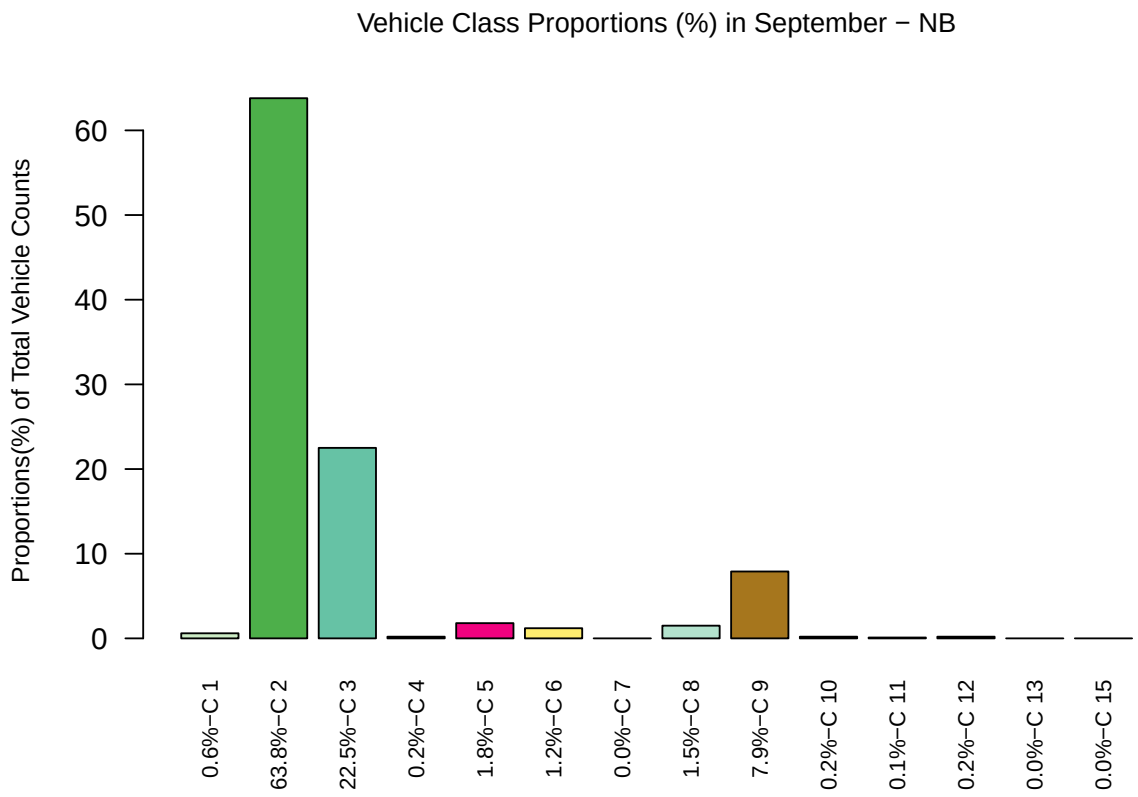

Vehicle Class Proportions (%) in April − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
63.5%−C 2
22.3%−C 3
0.2%−C 4
1.9%−C 5
1.2%−C 6
0.0%−C 7
1.9%−C 8
7.9%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

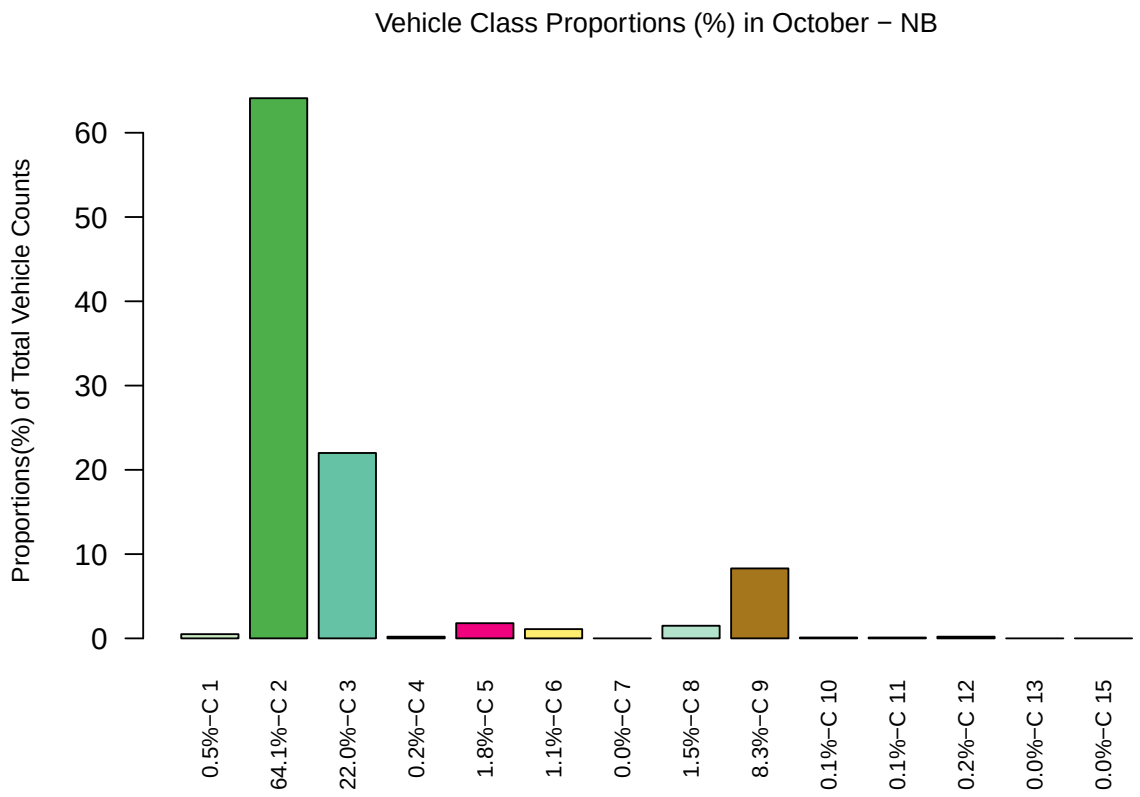

Vehicle Class Proportions (%) in May − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
63.8%−C 2
22.3%−C 3
0.2%−C 4
1.7%−C 5
1.1%−C 6
0.0%−C 7
1.7%−C 8
8.1%−C 9
0.1%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

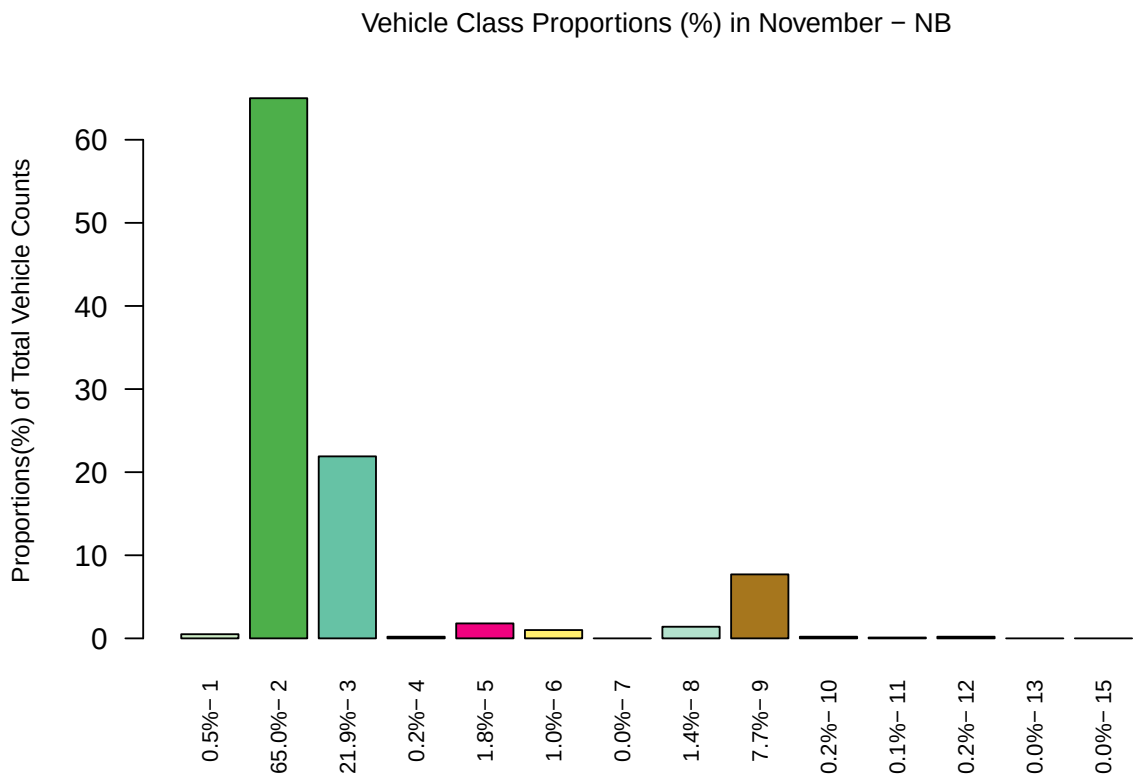

Vehicle Class Proportions (%) in June − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
63.8%−C 2
21.8%−C 3
0.2%−C 4
1.5%−C 5
1.0%−C 6
0.0%−C 7
1.8%−C 8
8.8%−C 9
0.1%−C 10
0.2%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

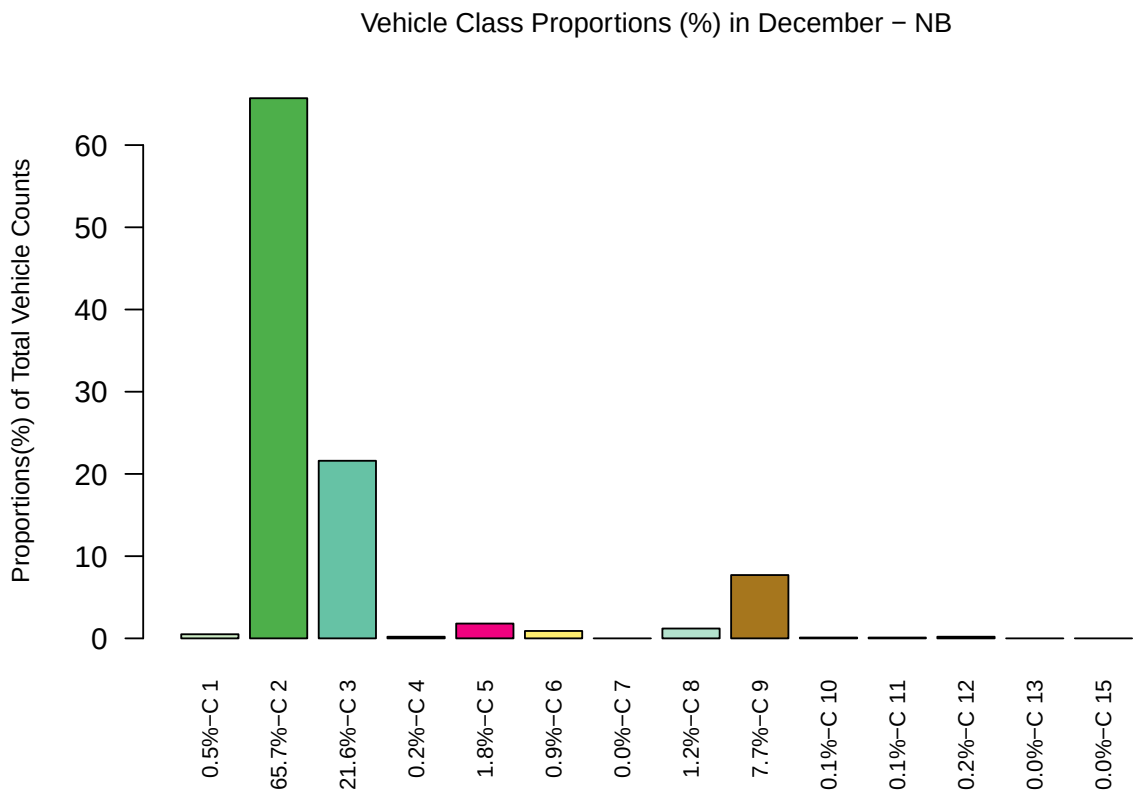

Vehicle Class Proportions (%) in July − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
63.9%−C 2
22.1%−C 3
0.2%−C 4
1.6%−C 5
1.0%−C 6
0.0%−C 7
1.8%−C 8
8.4%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in August − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
63.9%−C 2
22.4%−C 3
0.2%−C 4
1.8%−C 5
1.0%−C 6
0.0%−C 7
1.5%−C 8
7.9%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

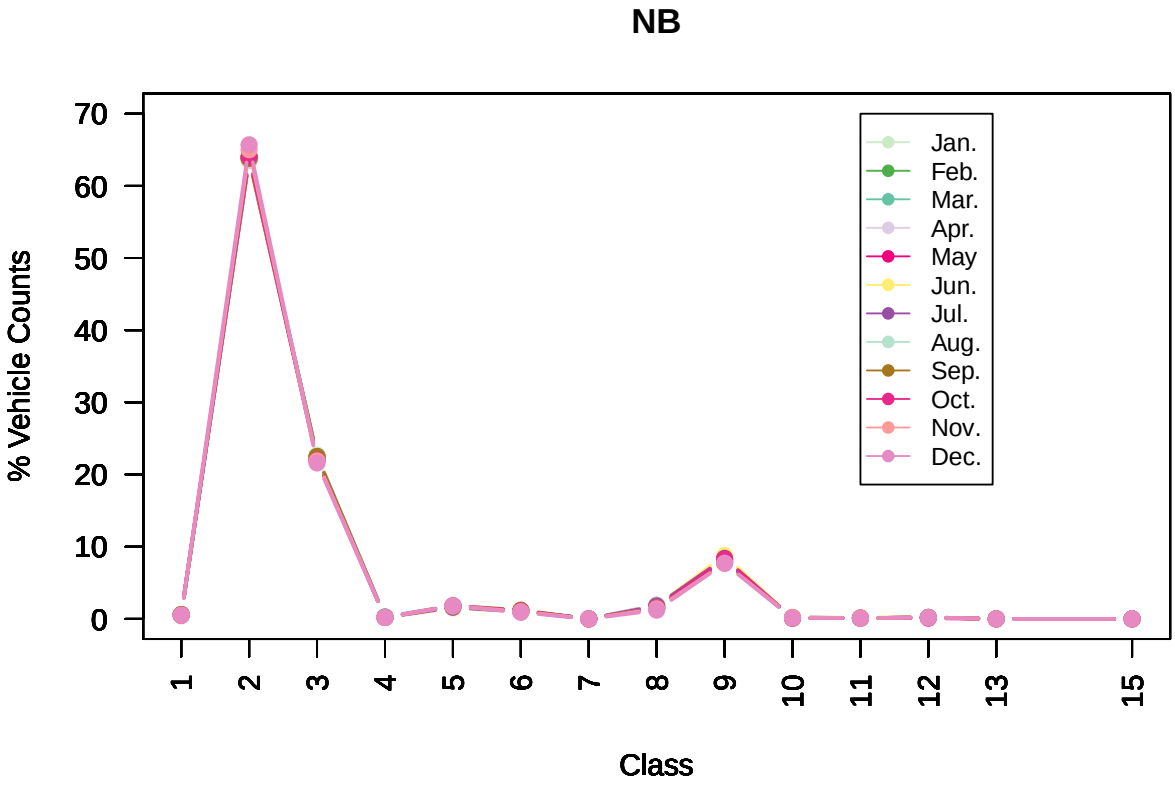

Vehicle Class Proportions (%) in September − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
63.8%−C 2
22.5%−C 3
0.2%−C 4
1.8%−C 5
1.2%−C 6
0.0%−C 7
1.5%−C 8
7.9%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in October − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
64.1%−C 2
22.0%−C 3
0.2%−C 4
1.8%−C 5
1.1%−C 6
0.0%−C 7
1.5%−C 8
8.3%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in November − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%− 1
65.0%− 2
21.9%− 3
0.2%− 4
1.8%− 5
1.0%− 6
0.0%− 7
1.4%− 8
7.7%− 9
0.2%− 10
0.1%− 11
0.2%− 12
0.0%− 13
0.0%− 15

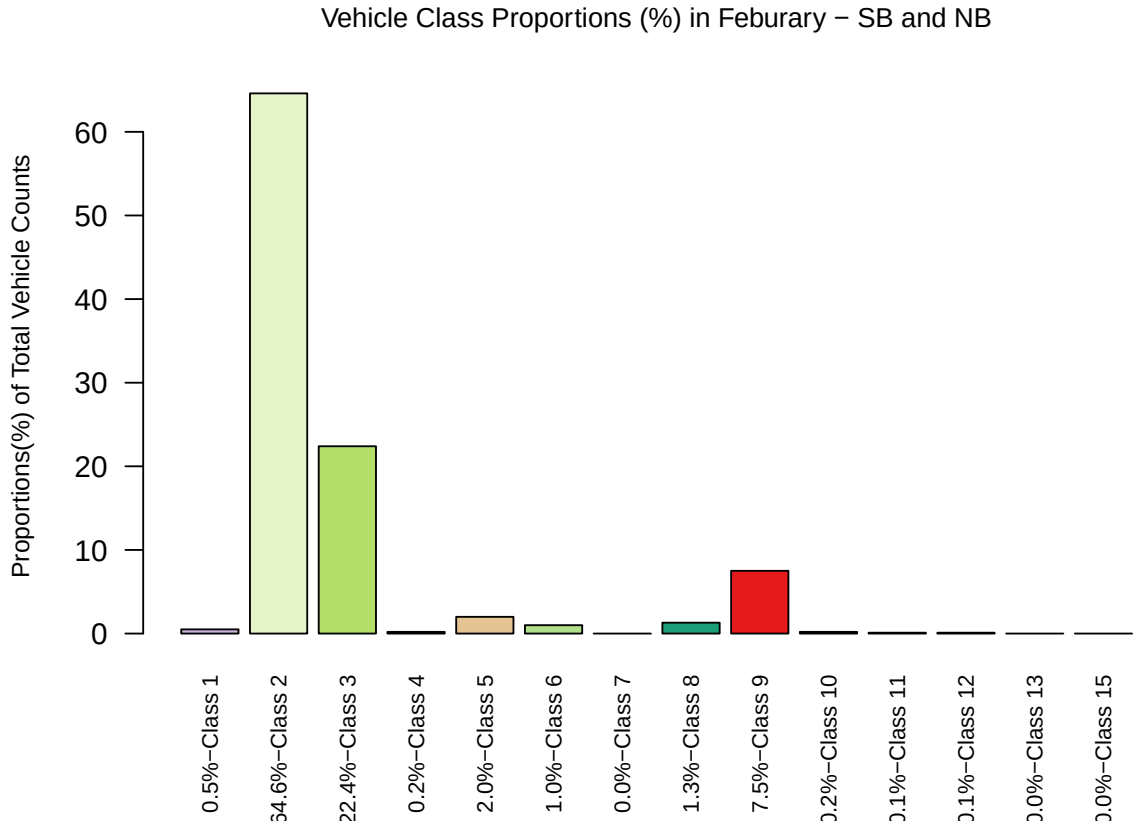

Vehicle Class Proportions (%) in December − NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
65.7%−C 2
21.6%−C 3
0.2%−C 4
1.8%−C 5
0.9%−C 6
0.0%−C 7
1.2%−C 8
7.7%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

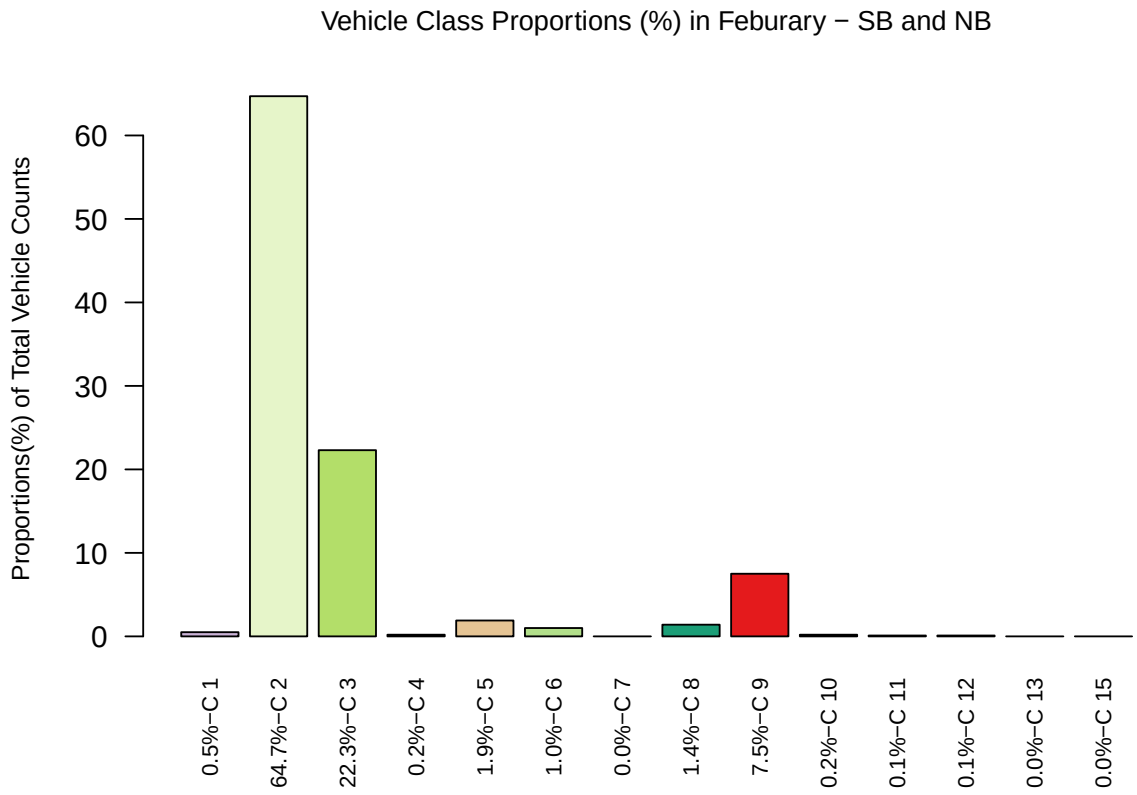
```
##
##  Direction 2 - January through December:
```

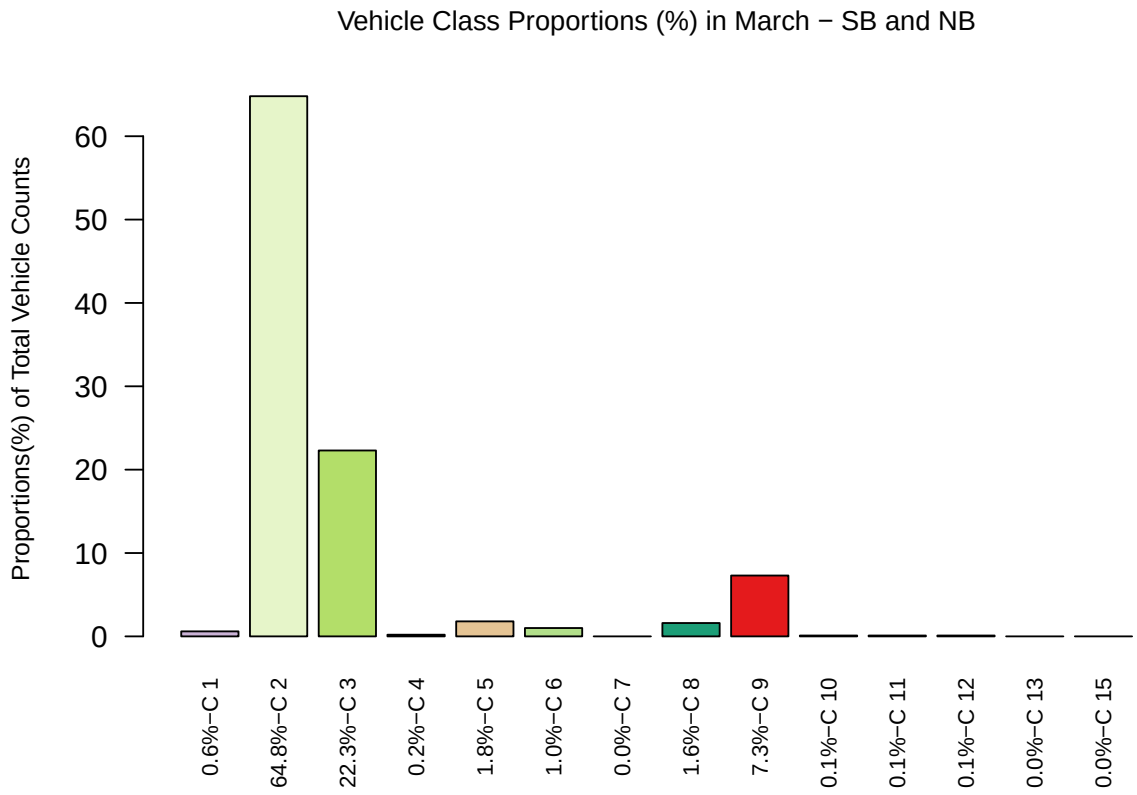


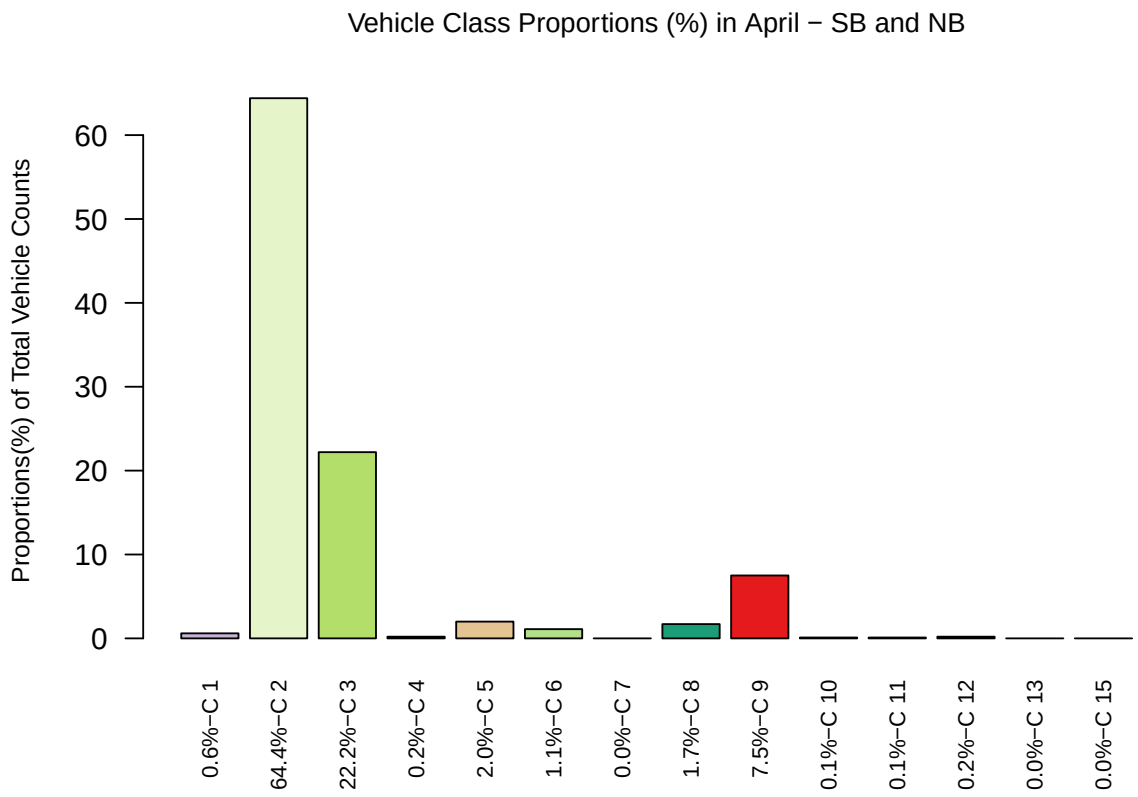
A-4.7.5(c) Both 1 and 2 Directions - Class Proportions by Month

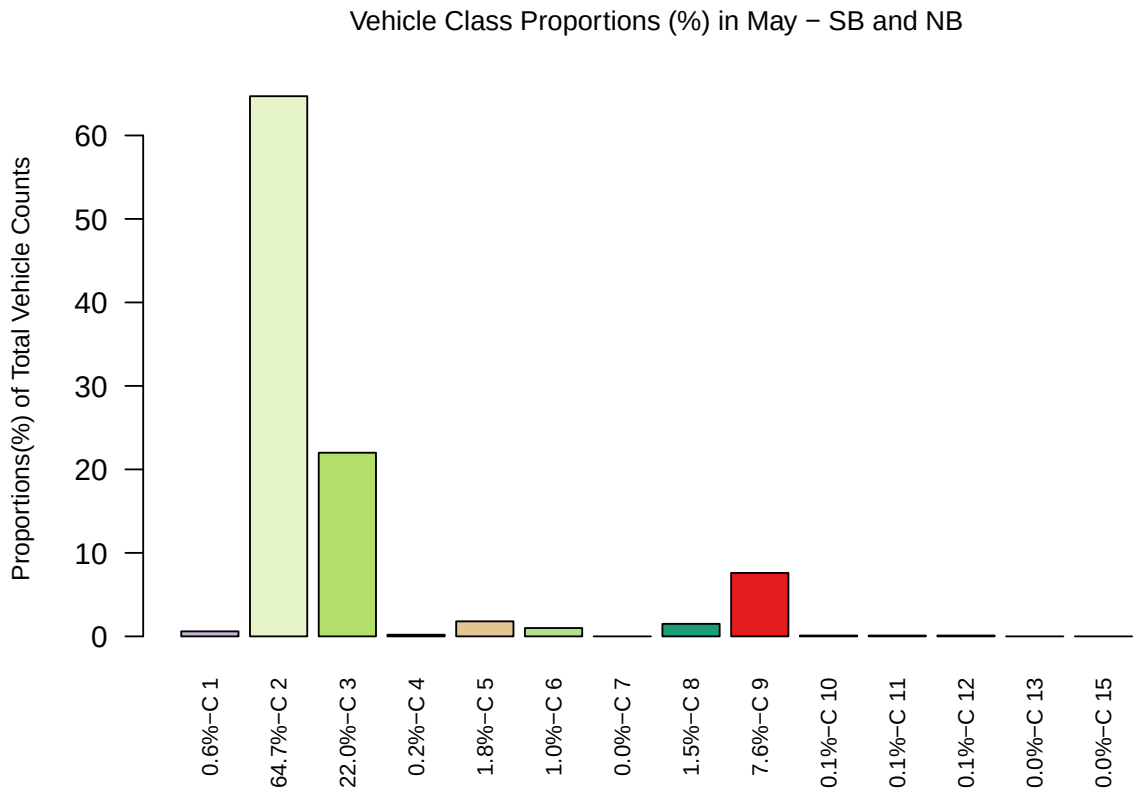
```
## Bar plots
```

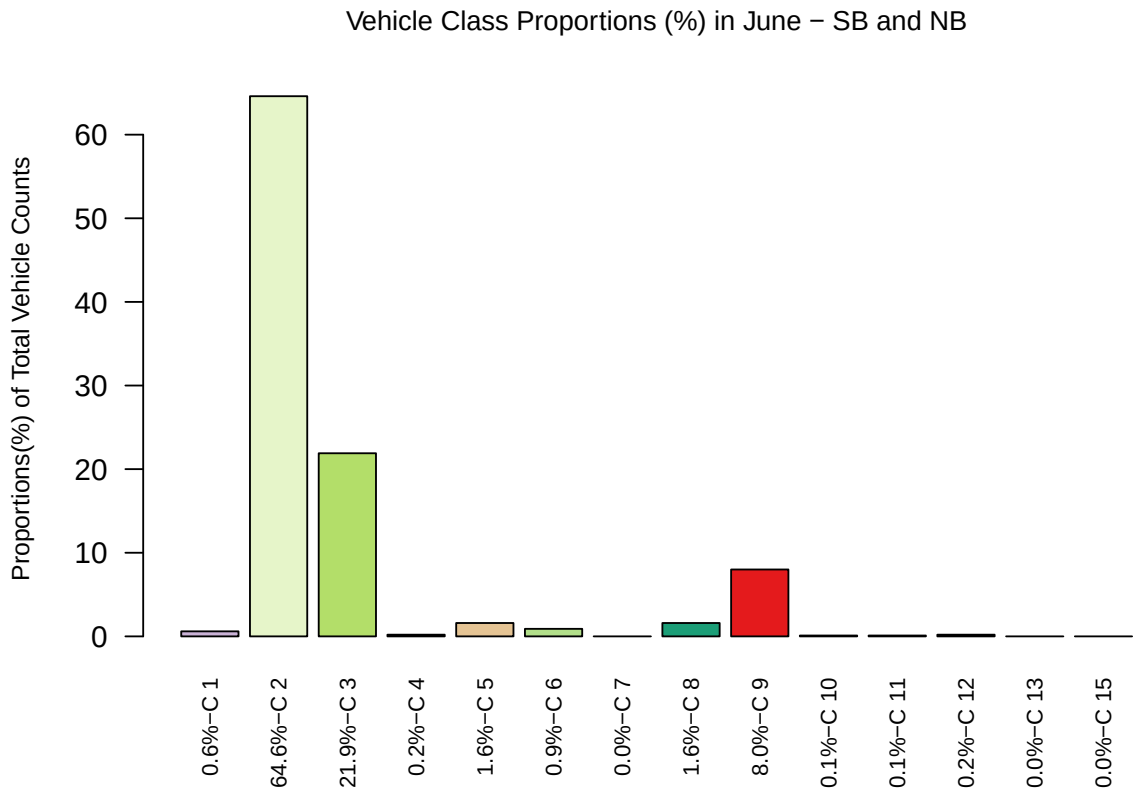


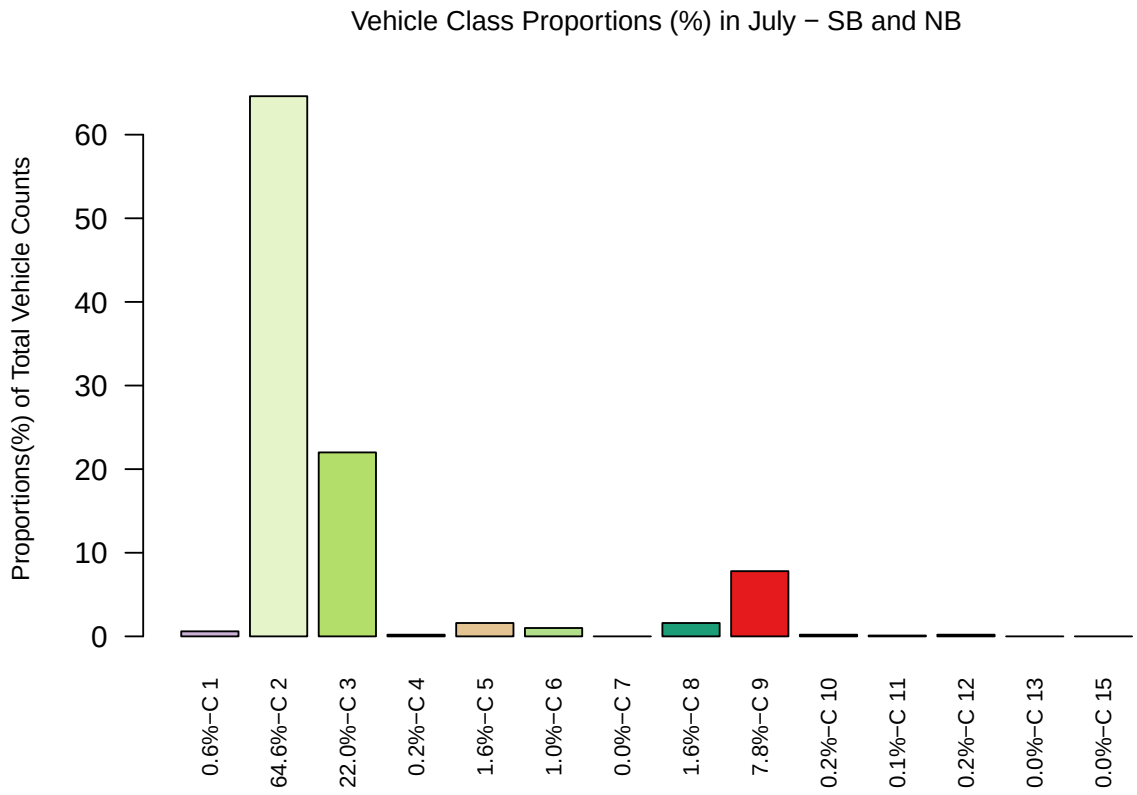

Vehicle Class Proportions (%) in Feburary − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
64.7%−C 2
22.3%−C 3
0.2%−C 4
1.9%−C 5
1.0%−C 6
0.0%−C 7
1.4%−C 8
7.5%−C 9
0.2%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

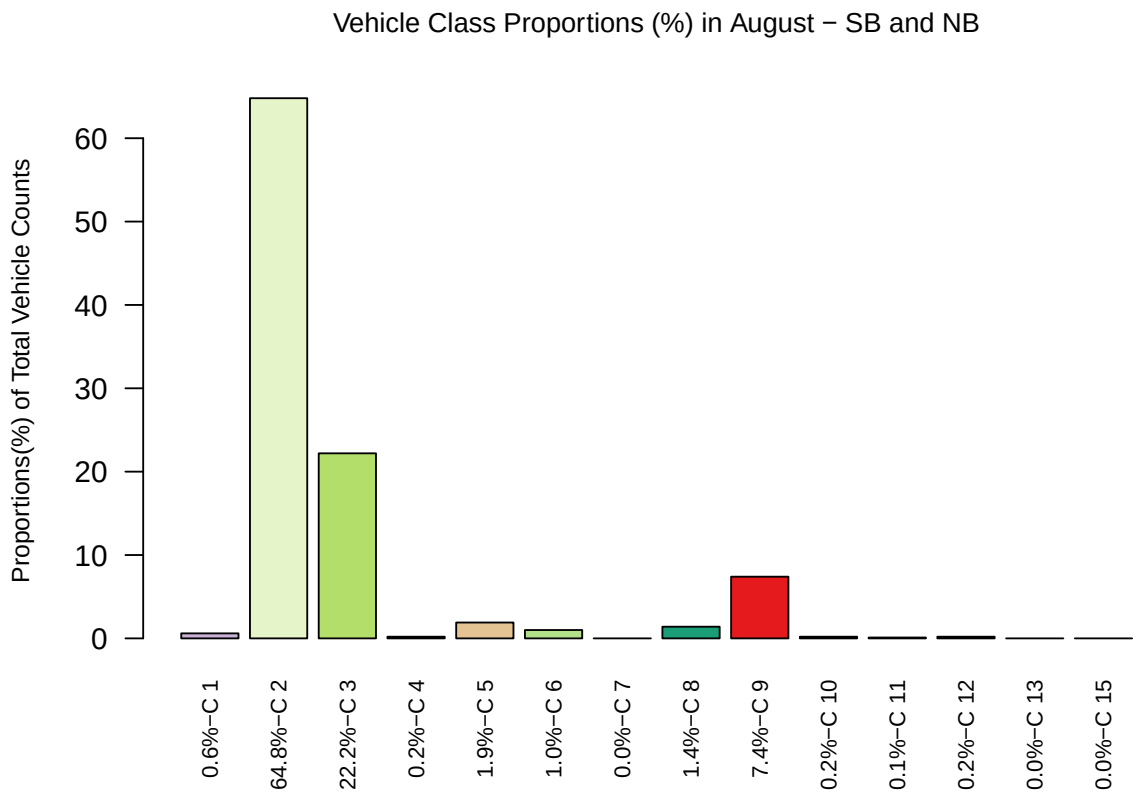

Vehicle Class Proportions (%) in March − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.8%−C 2
22.3%−C 3
0.2%−C 4
1.8%−C 5
1.0%−C 6
0.0%−C 7
1.6%−C 8
7.3%−C 9
0.1%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

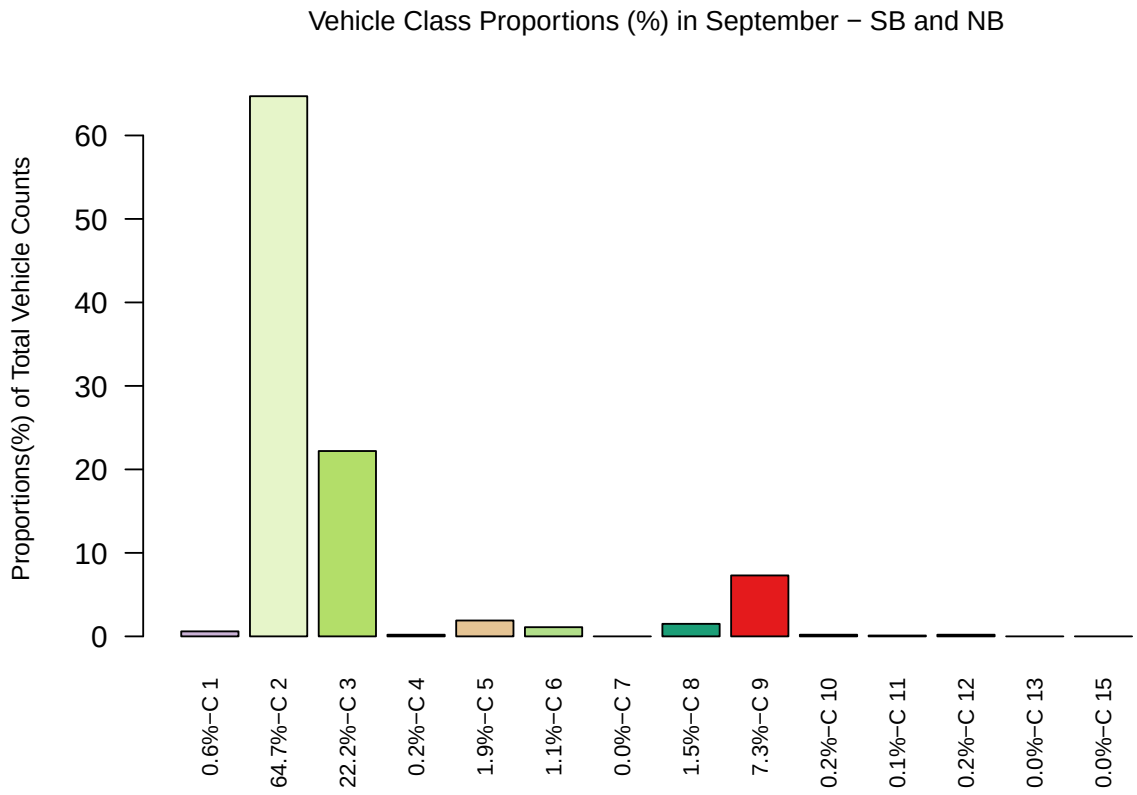

Vehicle Class Proportions (%) in April − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.4%−C 2
22.2%−C 3
0.2%−C 4
2.0%−C 5
1.1%−C 6
0.0%−C 7
1.7%−C 8
7.5%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

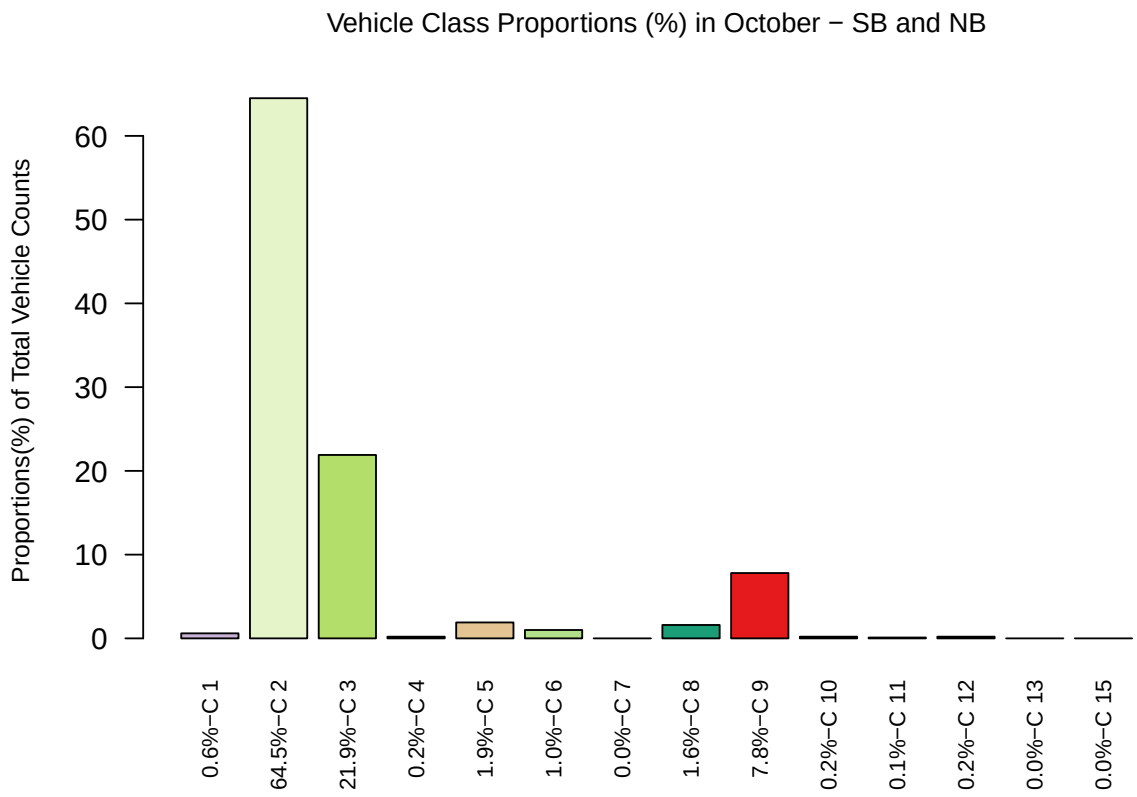

Vehicle Class Proportions (%) in May − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.7%−C 2
22.0%−C 3
0.2%−C 4
1.8%−C 5
1.0%−C 6
0.0%−C 7
1.5%−C 8
7.6%−C 9
0.1%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

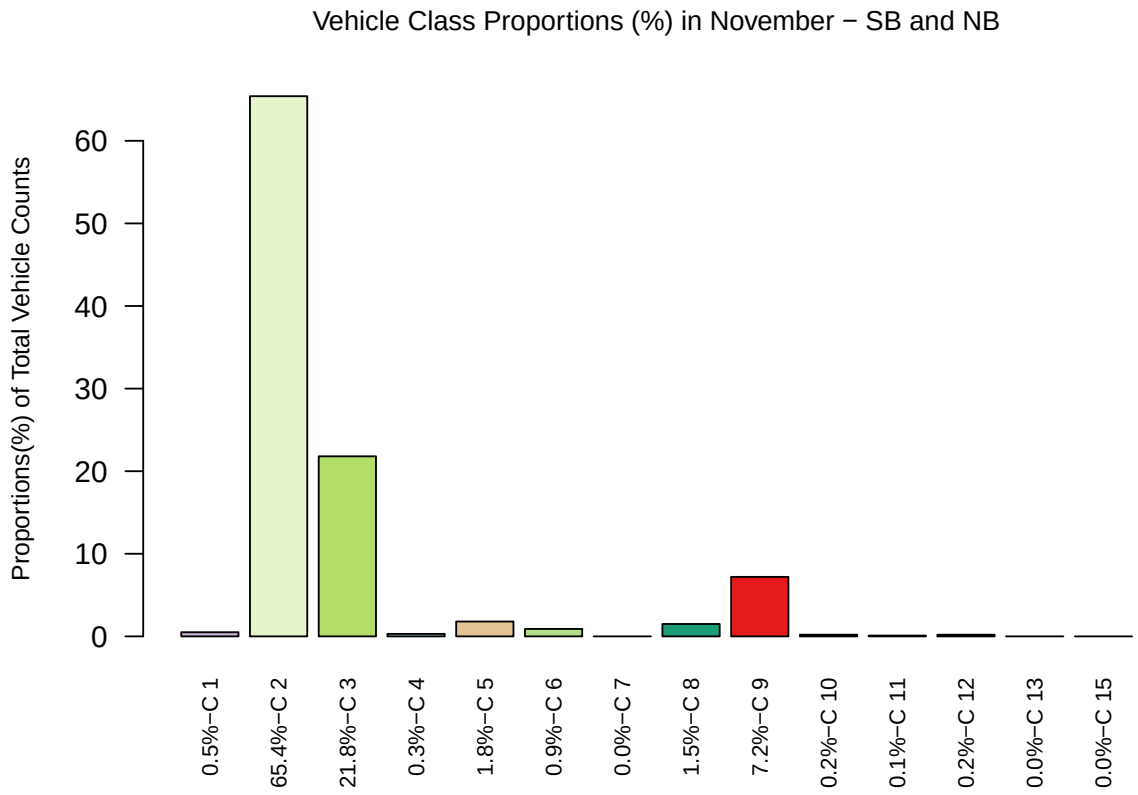

Vehicle Class Proportions (%) in June − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.6%−C 2
21.9%−C 3
0.2%−C 4
1.6%−C 5
0.9%−C 6
0.0%−C 7
1.6%−C 8
8.0%−C 9
0.1%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

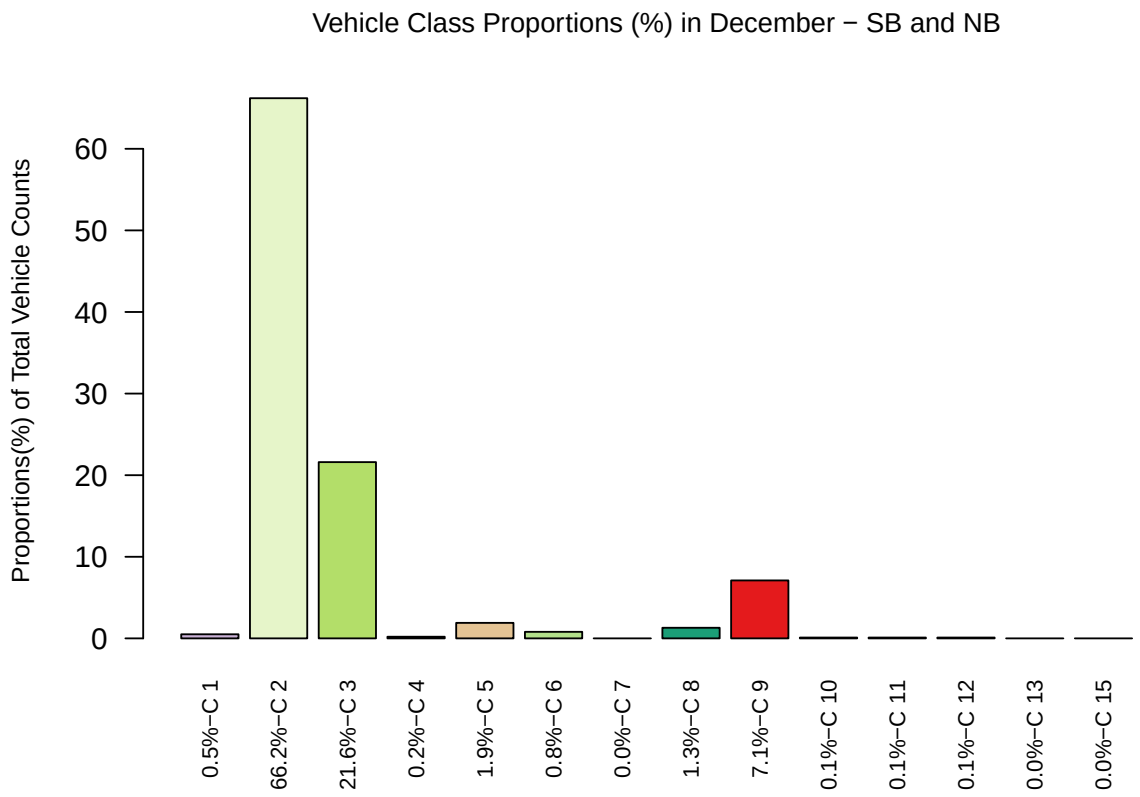

Vehicle Class Proportions (%) in July − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.6%−C 2
22.0%−C 3
0.2%−C 4
1.6%−C 5
1.0%−C 6
0.0%−C 7
1.6%−C 8
7.8%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in August − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.8%−C 2
22.2%−C 3
0.2%−C 4
1.9%−C 5
1.0%−C 6
0.0%−C 7
1.4%−C 8
7.4%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

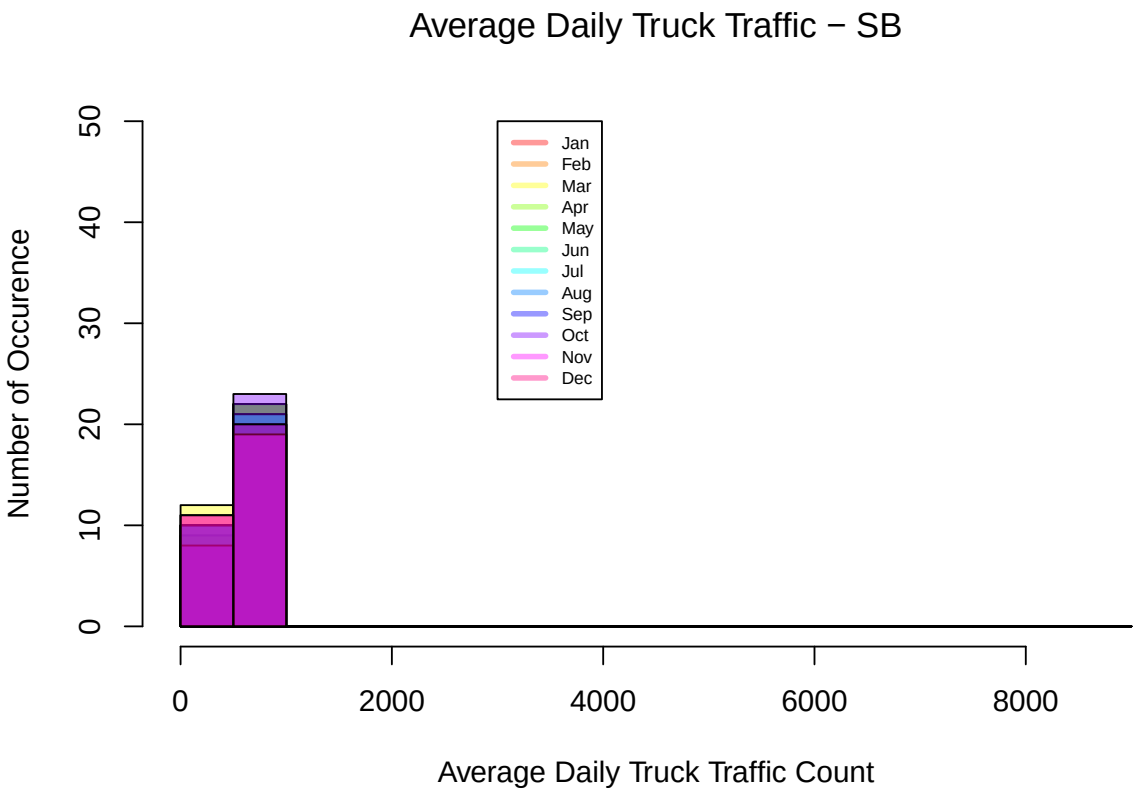

Vehicle Class Proportions (%) in September − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.7%−C 2
22.2%−C 3
0.2%−C 4
1.9%−C 5
1.1%−C 6
0.0%−C 7
1.5%−C 8
7.3%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in October − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.6%−C 1
64.5%−C 2
21.9%−C 3
0.2%−C 4
1.9%−C 5
1.0%−C 6
0.0%−C 7
1.6%−C 8
7.8%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15

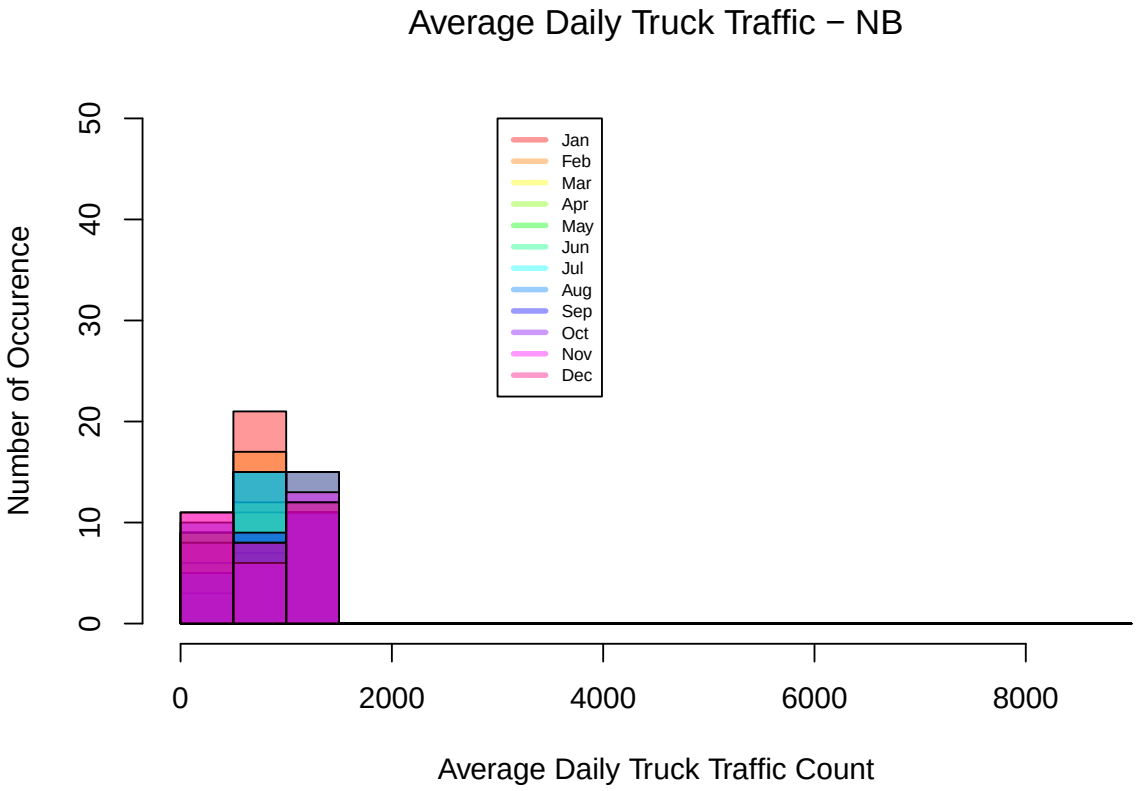

Vehicle Class Proportions (%) in November − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
65.4%−C 2
21.8%−C 3
0.3%−C 4
1.8%−C 5
0.9%−C 6
0.0%−C 7
1.5%−C 8
7.2%−C 9
0.2%−C 10
0.1%−C 11
0.2%−C 12
0.0%−C 13
0.0%−C 15


Vehicle Class Proportions (%) in December − SB and NB
Proportions(%) of Total Vehicle Counts
0
10
20
30
40
50
60
0.5%−C 1
66.2%−C 2
21.6%−C 3
0.2%−C 4
1.9%−C 5
0.8%−C 6
0.0%−C 7
1.3%−C 8
7.1%−C 9
0.1%−C 10
0.1%−C 11
0.1%−C 12
0.0%−C 13
0.0%−C 15

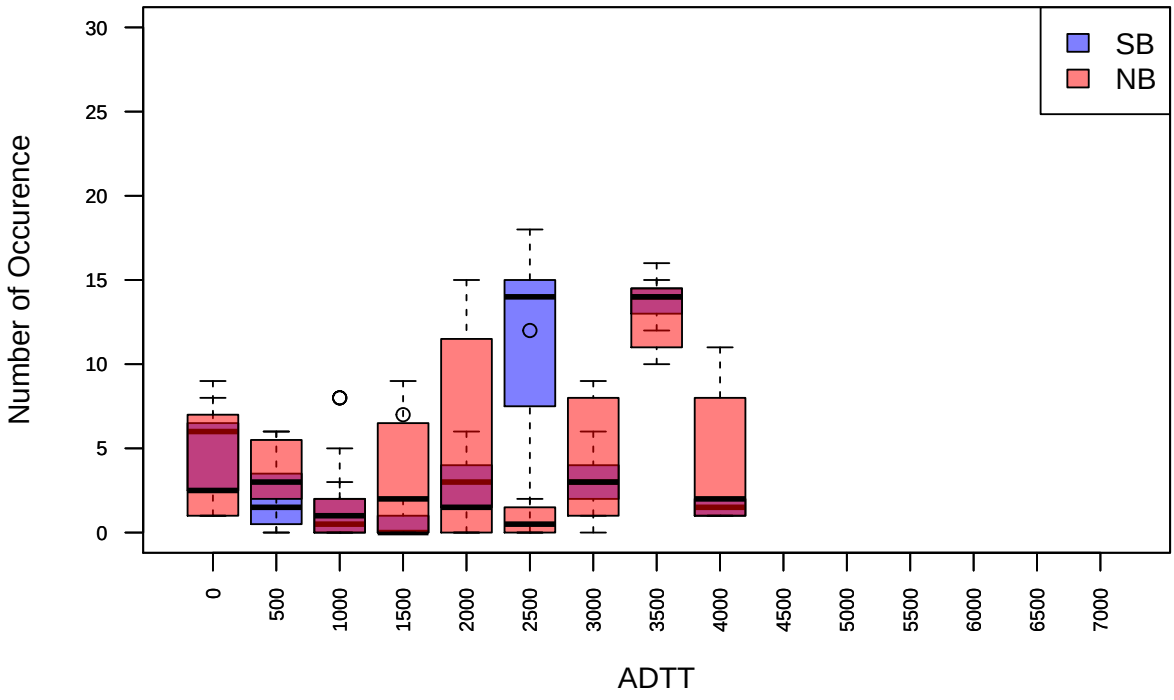
A-4.7.5(d) Review Average Daily Vehicle and Truck Counts



Direction 1


Average Daily Truck Traffic − NB
Number of Occurence
0
10
20
30
40
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0
2000
4000
6000
8000
Average Daily Truck Traffic Count

Direction 2


SB
NB
Number of Occurence
ADTT
0
5
10
15
20
25
30
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000

A-4.7.6 Numercial Summary - Vehicle Class Proportion (%) by Month

A-4.7.6(a) Direction 1 - Class Proportions by Month

```
## SB - Vehicle Class Proportions (%) by Month:
```

```
##                       1    2    3   4   5   6 7   8   9  10  11  12 13 15
## pct.class.dir1.Jan 0.6 65.6 22.0 0.2 2.2 0.9 0 1.3 6.9 0.2 0.1 0.1  0  0
## pct.class.dir1.Feb 0.6 65.7 22.1 0.2 2.0 0.9 0 1.3 6.9 0.2 0.1 0.1  0  0
## pct.class.dir1.Mar 0.6 65.8 22.2 0.2 1.9 0.9 0 1.3 6.6 0.2 0.1 0.1  0  0
## pct.class.dir1.Apr 0.7 65.4 22.0 0.2 2.1 1.0 0 1.3 7.0 0.2 0.1 0.1  0  0
## pct.class.dir1.May 0.7 65.7 21.7 0.2 2.0 1.0 0 1.3 7.1 0.2 0.0 0.1  0  0
## pct.class.dir1.Jun 0.7 65.6 22.0 0.2 1.7 0.9 0 1.4 7.1 0.2 0.0 0.1  0  0
## pct.class.dir1.Jul 0.7 65.6 22.0 0.2 1.7 0.9 0 1.4 7.1 0.2 0.1 0.1  0  0
## pct.class.dir1.Aug 0.7 65.8 22.0 0.2 2.0 0.9 0 1.3 6.7 0.2 0.0 0.1  0  0
## pct.class.dir1.Sep 0.7 65.8 21.8 0.2 1.9 1.0 0 1.5 6.6 0.2 0.1 0.1  0  0
## pct.class.dir1.Oct 0.6 64.9 21.7 0.3 2.0 1.0 0 1.7 7.3 0.2 0.1 0.1  0  0
## pct.class.dir1.Nov 0.6 65.9 21.8 0.3 1.9 0.8 0 1.7 6.7 0.2 0.1 0.1  0  0
## pct.class.dir1.Dec 0.5 66.8 21.5 0.3 1.9 0.8 0 1.5 6.4 0.2 0.0 0.1  0  0
```

A-4.7.6(b) Direction 2 - Class Proportions by Month

```
## NB - Vehicle Class Proportions (%) by Month:
```

```
##                       1    2    3   4   5   6 7   8   9  10  11  12 13 15
## pct.class.dir2.Jan 0.4 63.8 22.7 0.2 1.8 1.1 0 1.4 8.2 0.1 0.1 0.2  0  0
## pct.class.dir2.Feb 0.5 63.9 22.5 0.2 1.8 1.1 0 1.5 8.1 0.1 0.1 0.2  0  0
## pct.class.dir2.Mar 0.5 63.9 22.5 0.3 1.8 1.1 0 1.9 7.8 0.1 0.1 0.2  0  0
## pct.class.dir2.Apr 0.6 63.5 22.3 0.2 1.9 1.2 0 1.9 7.9 0.1 0.1 0.2  0  0
## pct.class.dir2.May 0.6 63.8 22.3 0.2 1.7 1.1 0 1.7 8.1 0.1 0.1 0.1  0  0
## pct.class.dir2.Jun 0.6 63.8 21.8 0.2 1.5 1.0 0 1.8 8.8 0.1 0.2 0.2  0  0
## pct.class.dir2.Jul 0.6 63.9 22.1 0.2 1.6 1.0 0 1.8 8.4 0.1 0.1 0.2  0  0
## pct.class.dir2.Aug 0.6 63.9 22.4 0.2 1.8 1.0 0 1.5 7.9 0.2 0.1 0.2  0  0
## pct.class.dir2.Sep 0.6 63.8 22.5 0.2 1.8 1.2 0 1.5 7.9 0.2 0.1 0.2  0  0
## pct.class.dir2.Oct 0.5 64.1 22.0 0.2 1.8 1.1 0 1.5 8.3 0.1 0.1 0.2  0  0
## pct.class.dir2.Nov 0.5 65.0 21.9 0.2 1.8 1.0 0 1.4 7.7 0.2 0.1 0.2  0  0
## pct.class.dir2.Dec 0.5 65.7 21.6 0.2 1.8 0.9 0 1.2 7.7 0.1 0.1 0.2  0  0
```

A-4.7.6(c) Directions 1 and 2 Combined - Class Proportions by Month

```
## SB and NB - Vehicle Class Proportions (%) by Month:

##                 1    2    3   4   5   6 7   8   9  10  11  12 13 15
## pct.class.Jan 0.5 64.6 22.4 0.2 2.0 1.0 0 1.3 7.5 0.2 0.1 0.1  0  0
## pct.class.Feb 0.5 64.7 22.3 0.2 1.9 1.0 0 1.4 7.5 0.2 0.1 0.1  0  0
## pct.class.Mar 0.6 64.8 22.3 0.2 1.8 1.0 0 1.6 7.3 0.1 0.1 0.1  0  0
## pct.class.Apr 0.6 64.4 22.2 0.2 2.0 1.1 0 1.7 7.5 0.1 0.1 0.2  0  0
## pct.class.May 0.6 64.7 22.0 0.2 1.8 1.0 0 1.5 7.6 0.1 0.1 0.1  0  0
## pct.class.Jun 0.6 64.6 21.9 0.2 1.6 0.9 0 1.6 8.0 0.1 0.1 0.2  0  0
## pct.class.Jul 0.6 64.6 22.0 0.2 1.6 1.0 0 1.6 7.8 0.2 0.1 0.2  0  0
## pct.class.Aug 0.6 64.8 22.2 0.2 1.9 1.0 0 1.4 7.4 0.2 0.1 0.2  0  0
## pct.class.Sep 0.6 64.7 22.2 0.2 1.9 1.1 0 1.5 7.3 0.2 0.1 0.2  0  0
## pct.class.Oct 0.6 64.5 21.9 0.2 1.9 1.0 0 1.6 7.8 0.2 0.1 0.2  0  0
## pct.class.Nov 0.5 65.4 21.8 0.3 1.8 0.9 0 1.5 7.2 0.2 0.1 0.2  0  0
## pct.class.Dec 0.5 66.2 21.6 0.2 1.9 0.8 0 1.3 7.1 0.1 0.1 0.1  0  0
```

A-4.7.6(d) Average Daily Truck Traffic Distribution by Month

```
##
##  SB - Frequency of Average Daily Truck Counts (bins with 500 increments):
##
```

	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
Jan	7	1	1	0	6	14	2	NA	NA	NA	NA	NA	NA	NA	NA
Feb	6	2	0	0	5	13	2	NA	NA	NA	NA	NA	NA	NA	NA
Mar	1	0	3	7	1	0	3	14	2	NA	NA	NA	NA	NA	NA
Apr	7	1	0	1	2	13	6	NA	NA	NA	NA	NA	NA	NA	NA
May	6	3	0	0	1	16	5	NA	NA	NA	NA	NA	NA	NA	NA
Jun	4	6	0	0	3	14	3	NA	NA	NA	NA	NA	NA	NA	NA
Jul	5	4	1	0	5	14	2	NA	NA	NA	NA	NA	NA	NA	NA
Aug	6	2	1	0	3	18	1	NA	NA	NA	NA	NA	NA	NA	NA
Sep	6	4	0	0	3	14	3	NA	NA	NA	NA	NA	NA	NA	NA
Oct	8	0	0	0	3	16	4	NA	NA	NA	NA	NA	NA	NA	NA
Nov	1	0	8	2	0	0	4	15	NA	NA	NA	NA	NA	NA	NA
Dec	1	1	8	1	2	2	3	12	1	NA	NA	NA	NA	NA	NA

```
##
##  NB - Frequency of Average Daily Truck Counts (bins with 500 increments):
##
```

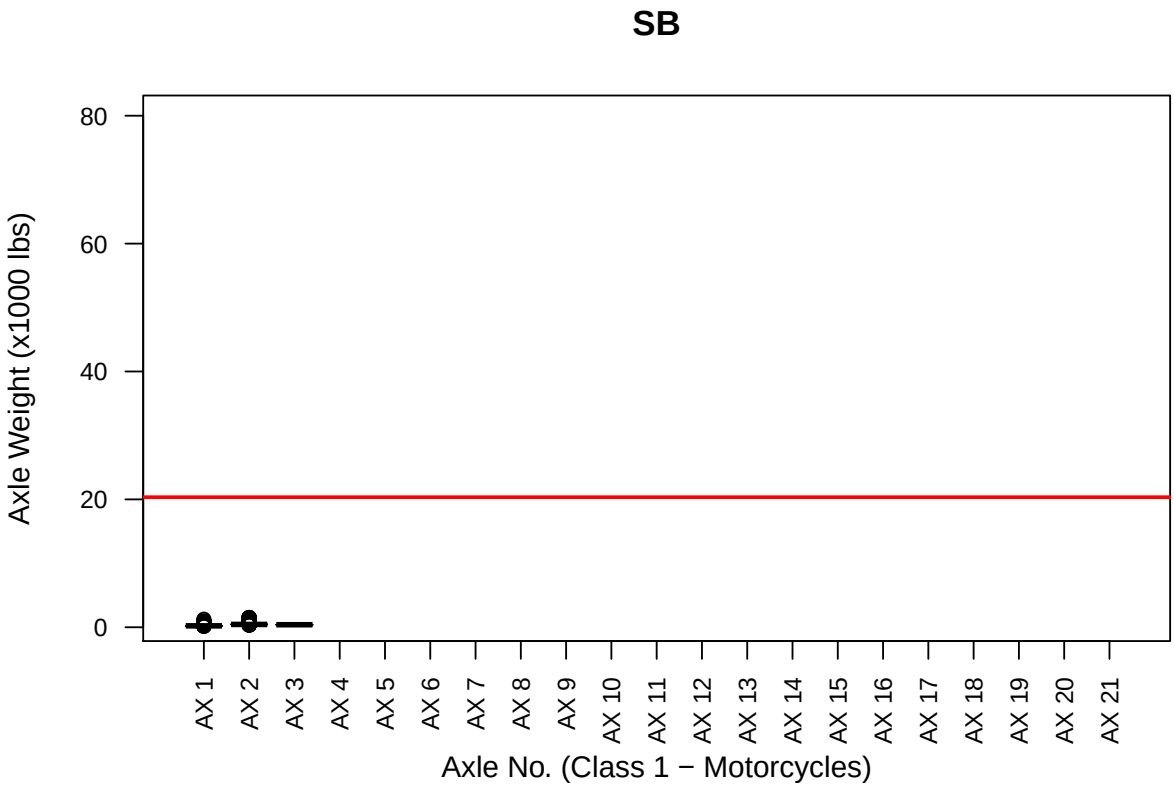
	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
Jan	3	5	1	0	0	2	3	16	1	NA	NA	NA	NA	NA	NA
Feb	1	6	1	0	0	0	2	15	3	NA	NA	NA	NA	NA	NA
Mar	1	6	2	1	0	0	0	10	11	NA	NA	NA	NA	NA	NA
Apr	5	2	2	9	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
May	9	0	0	7	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Jun	1	2	2	1	3	1	8	11	1	NA	NA	NA	NA	NA	NA
Jul	2	3	1	4	0	1	9	11	NA	NA	NA	NA	NA	NA	NA
Aug	1	6	2	0	0	0	0	14	8	NA	NA	NA	NA	NA	NA
Sep	7	3	0	9	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oct	7	1	0	0	0	0	8	14	1	NA	NA	NA	NA	NA	NA
Nov	8	3	0	6	13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dec	1	5	5	3	5	12	NA	NA	NA	NA	NA	NA	NA	NA	NA

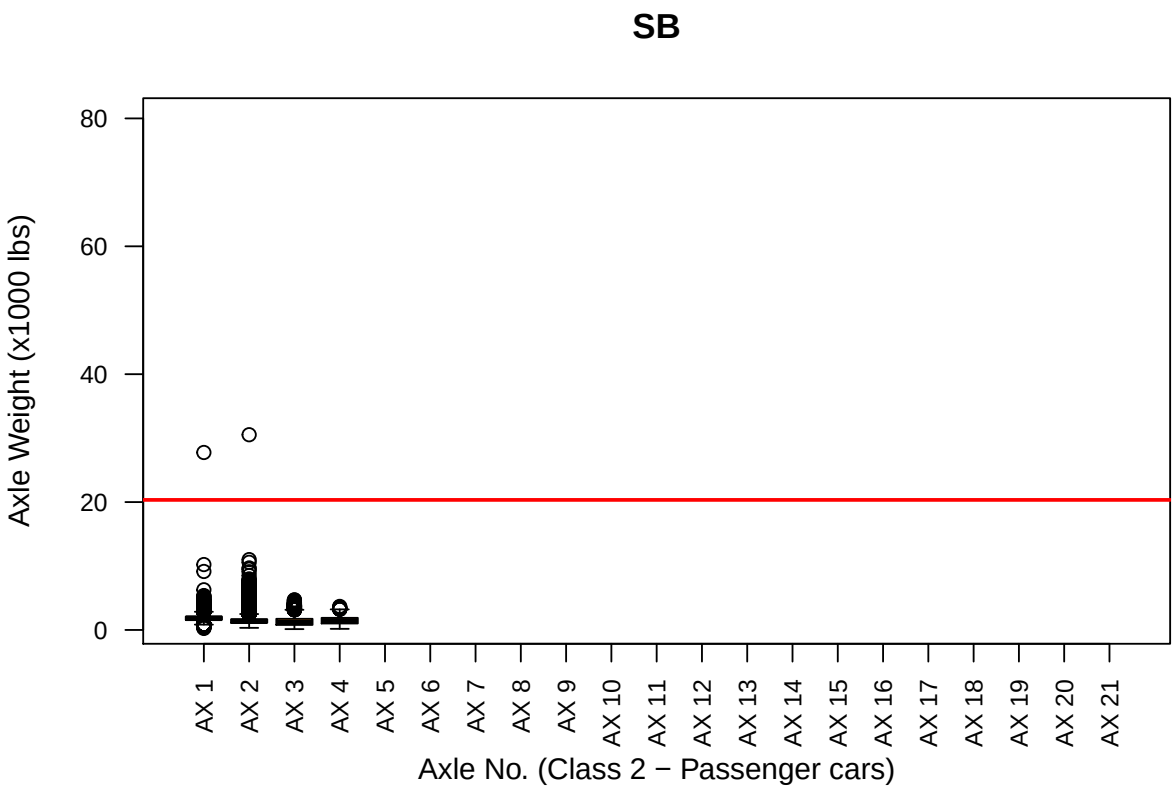
A-4.7.7 Graphical Summary - Axle Weight and Spacing Distributions by Class

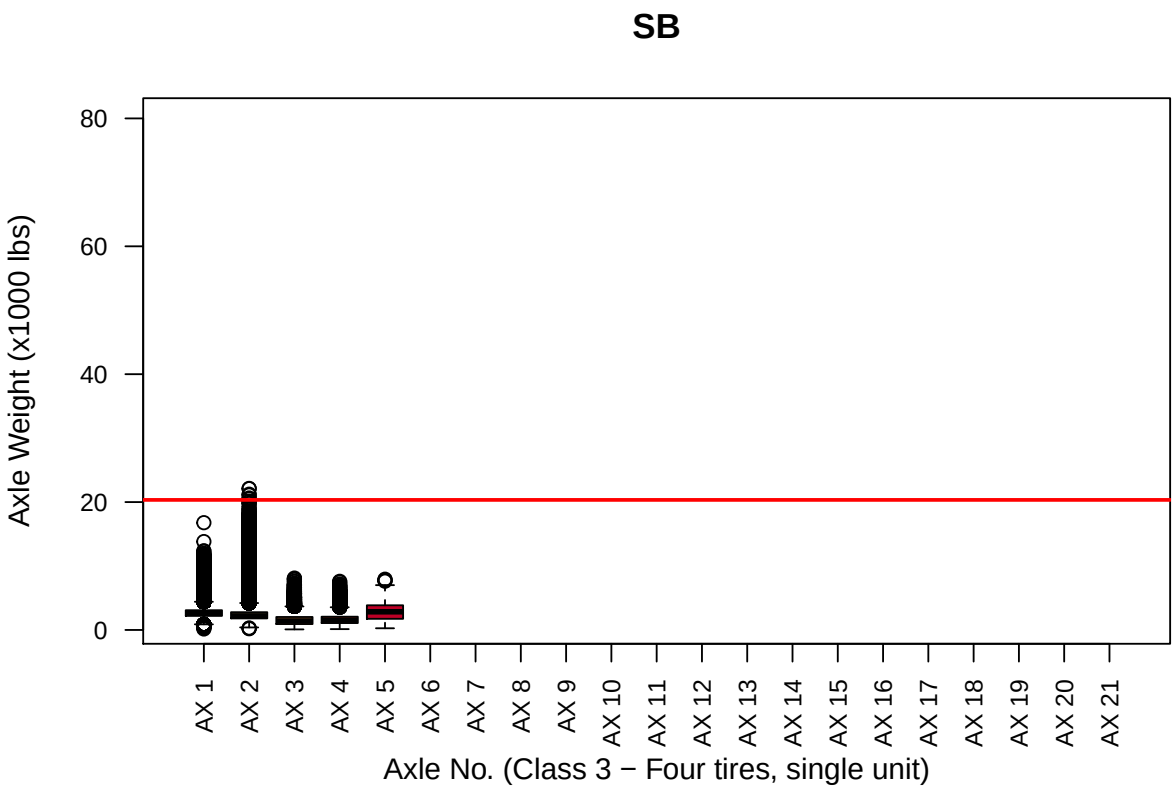
A-4.7.7(a) Direction 1 - Axle count and weight by class

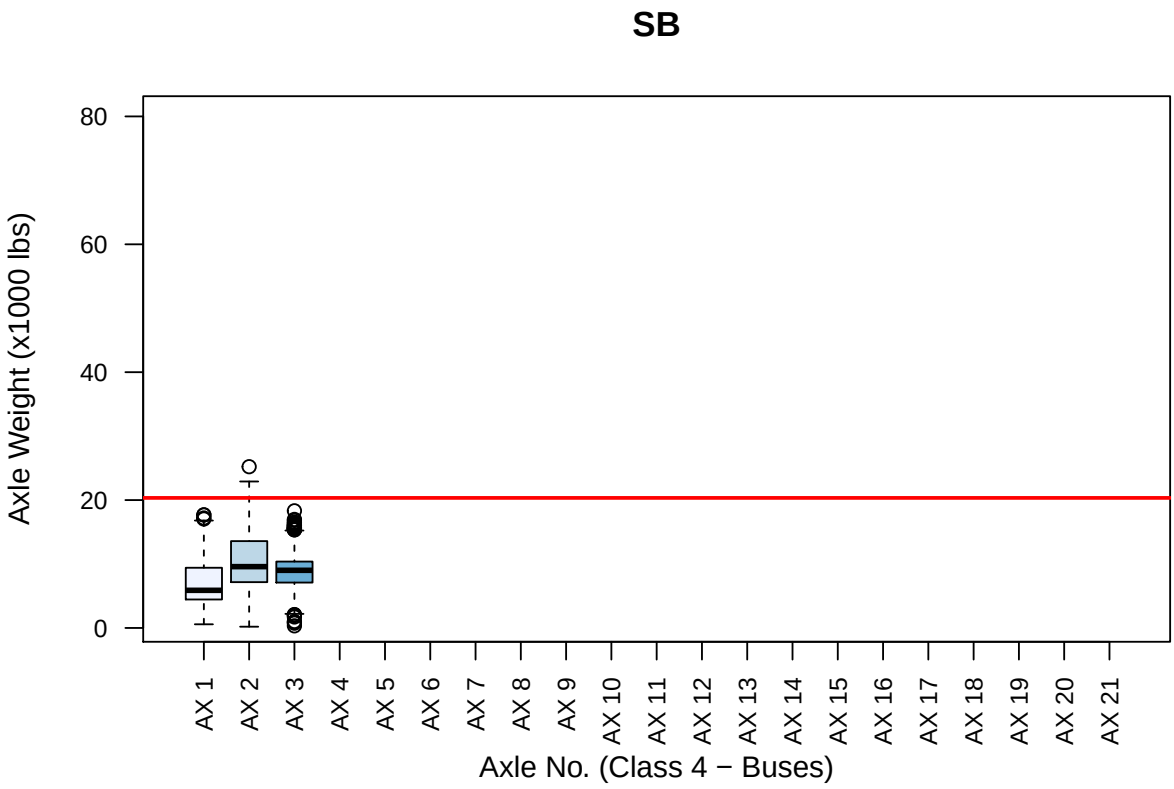
```
## null device
##           1
```

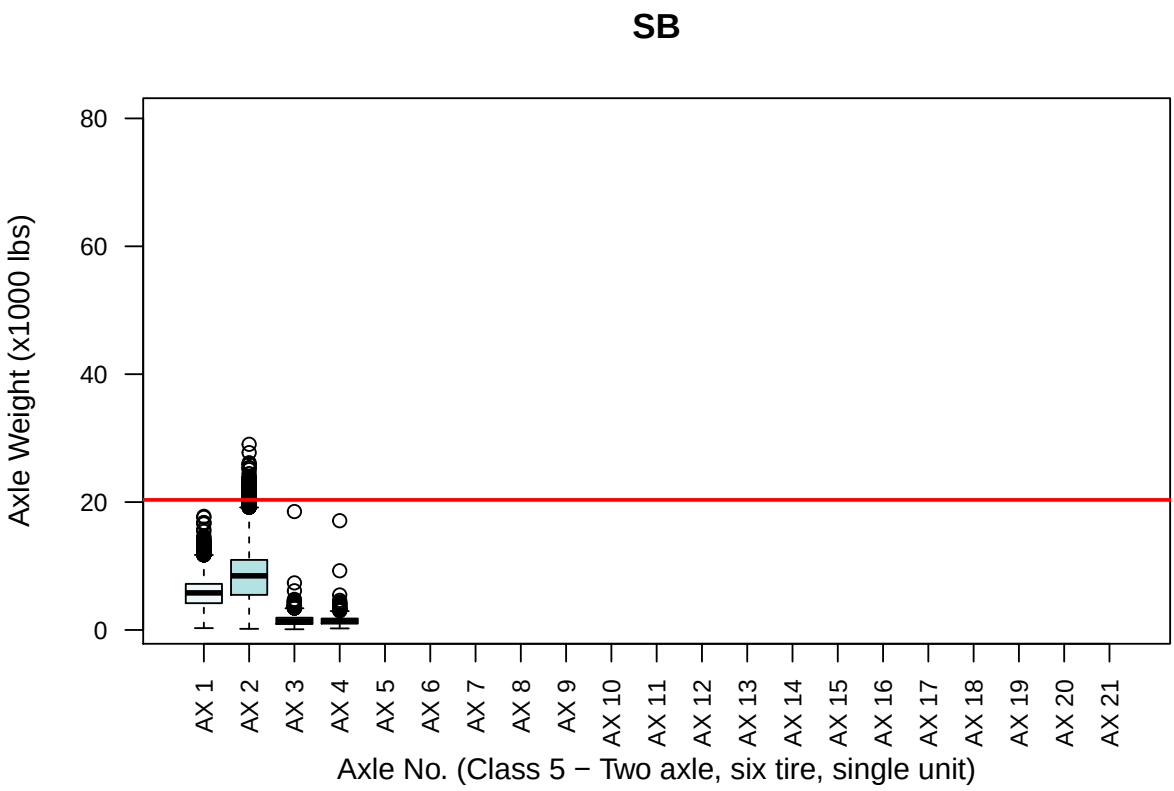
```
##
##  Box plots
```

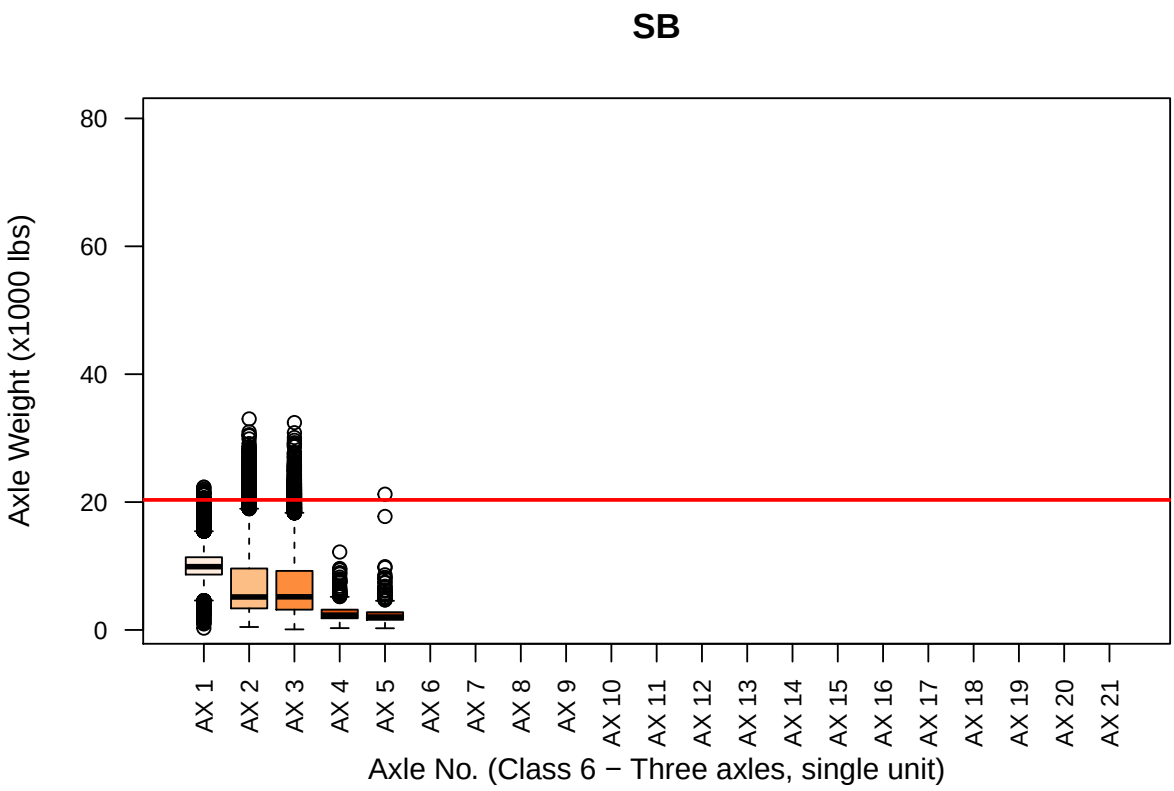

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 1 − Motorcycles)

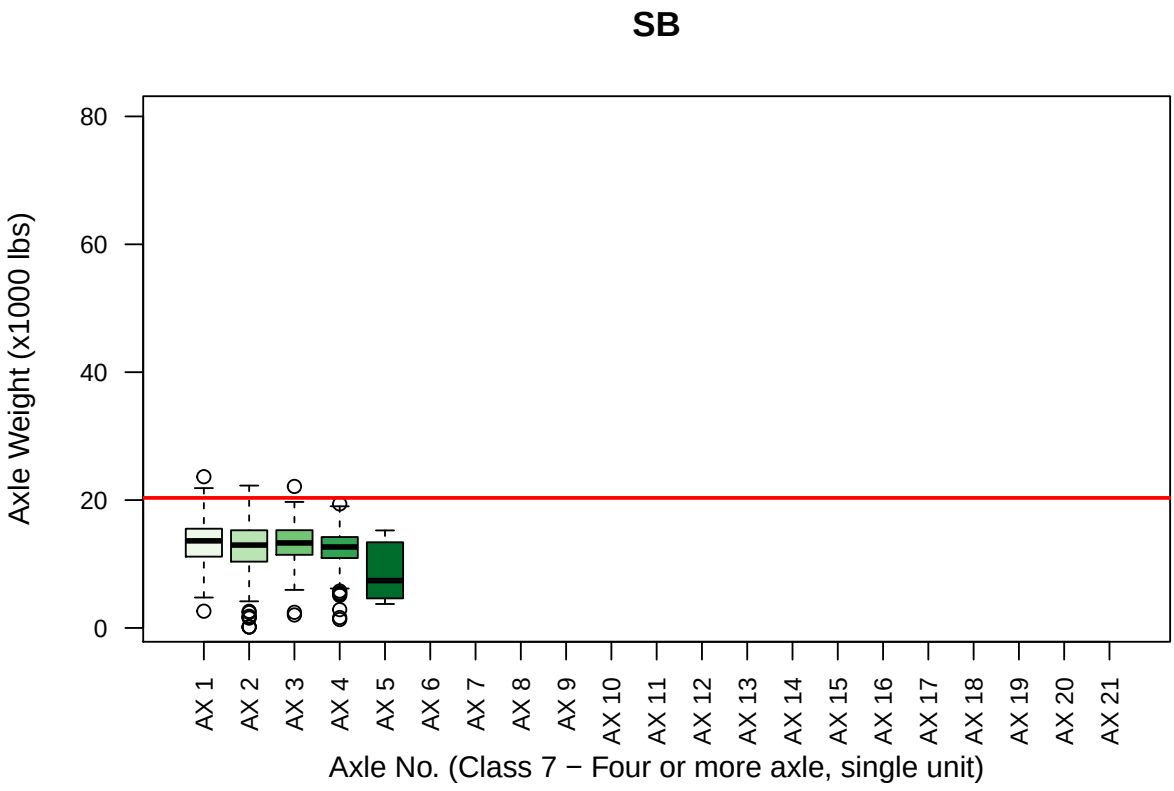

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 2 − Passenger cars)

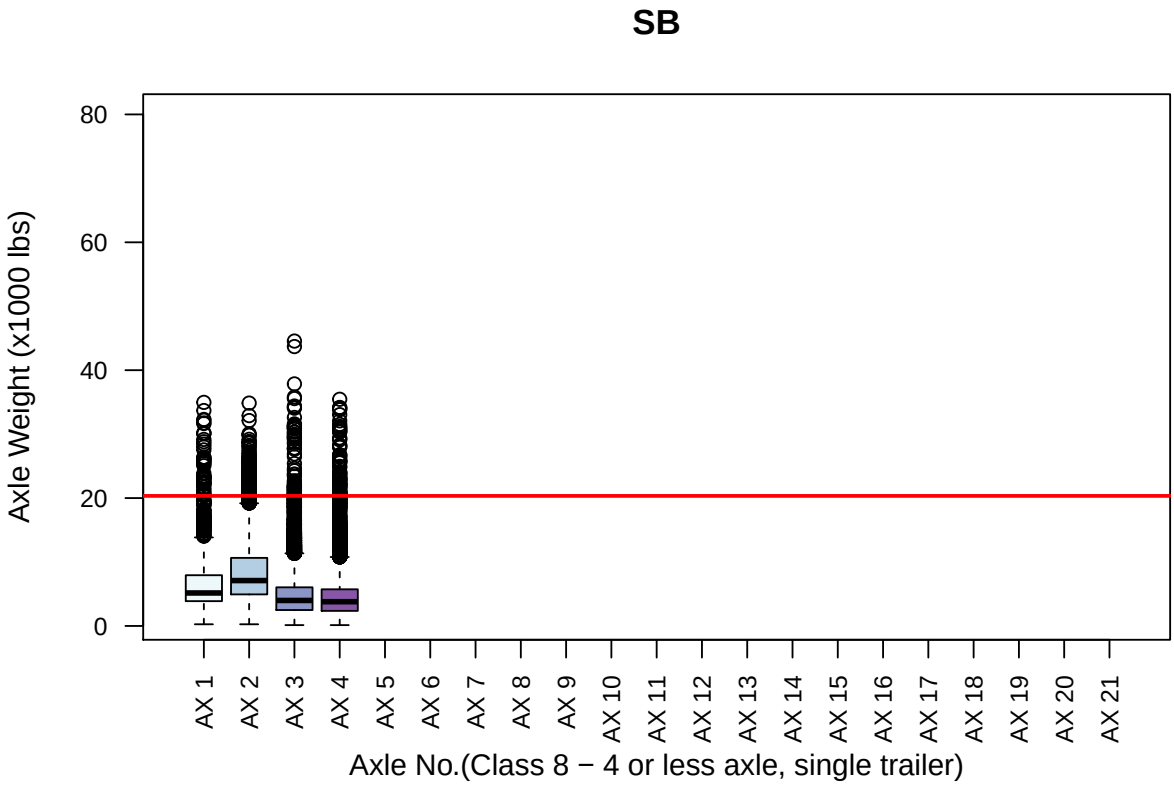

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 3 − Four tires, single unit)

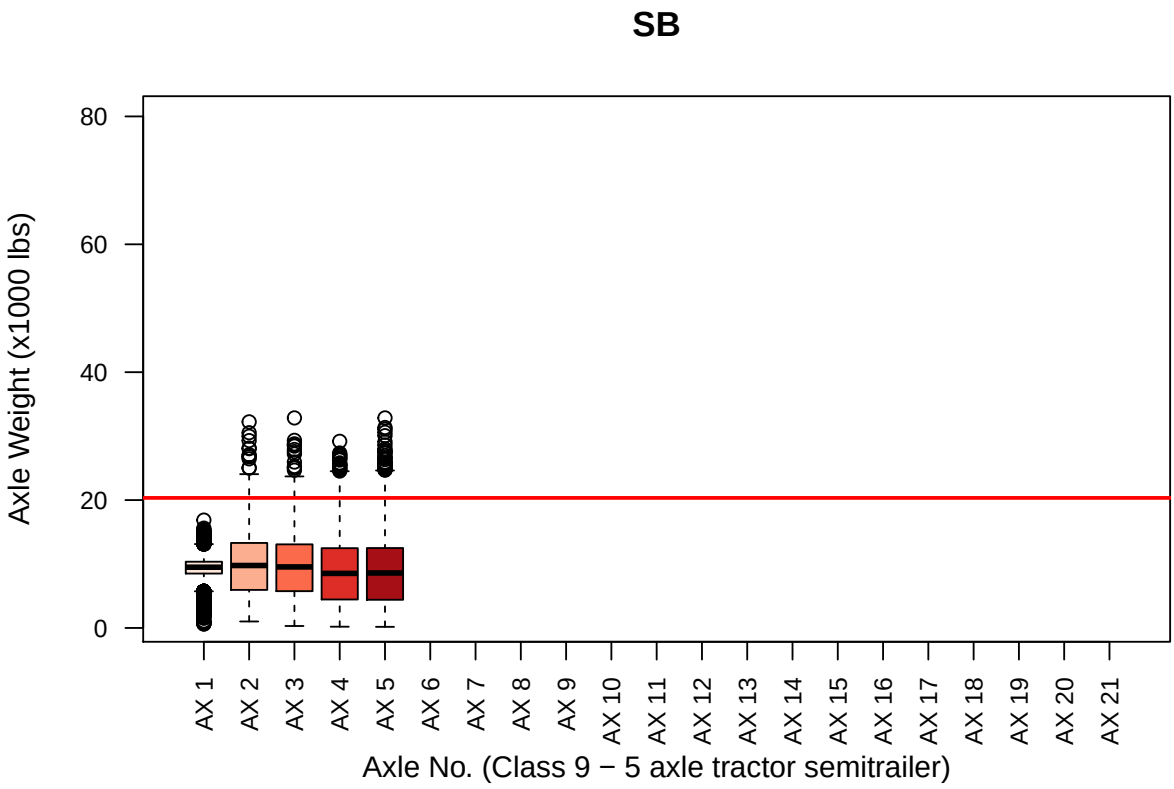

SB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 4 − Buses)

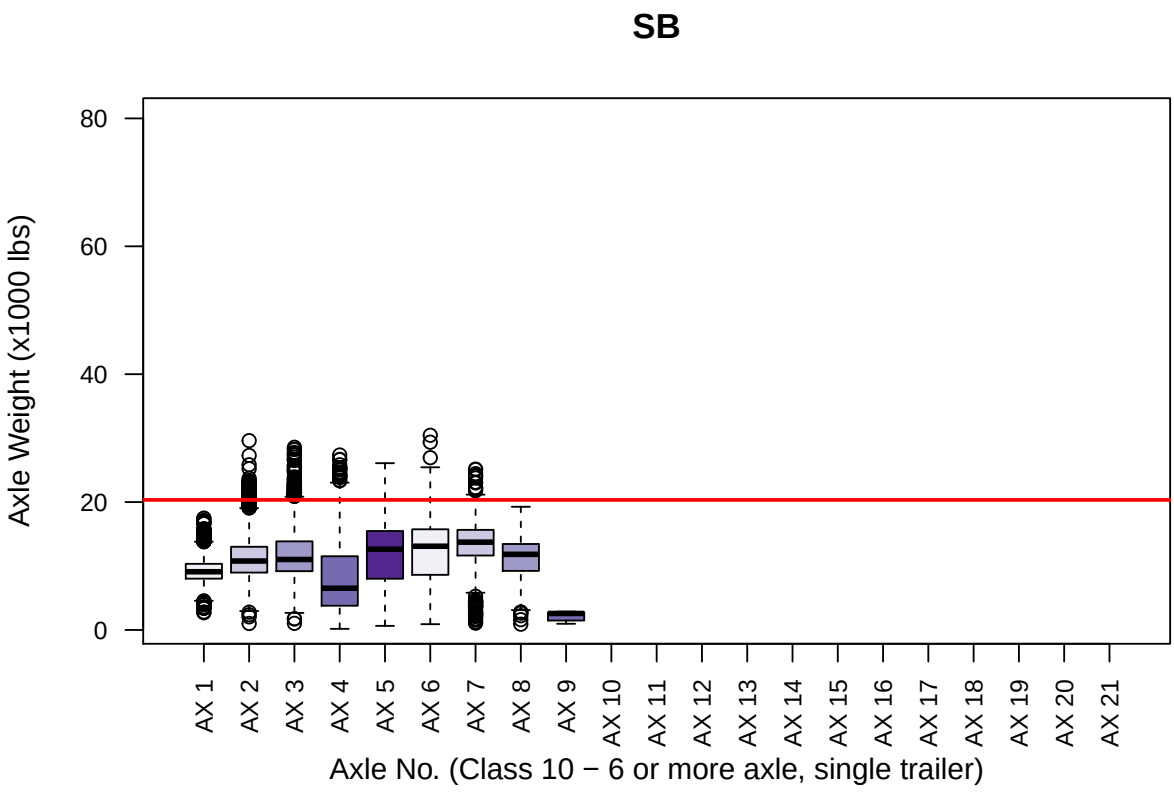

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 5 − Two axle, six tire, single unit)

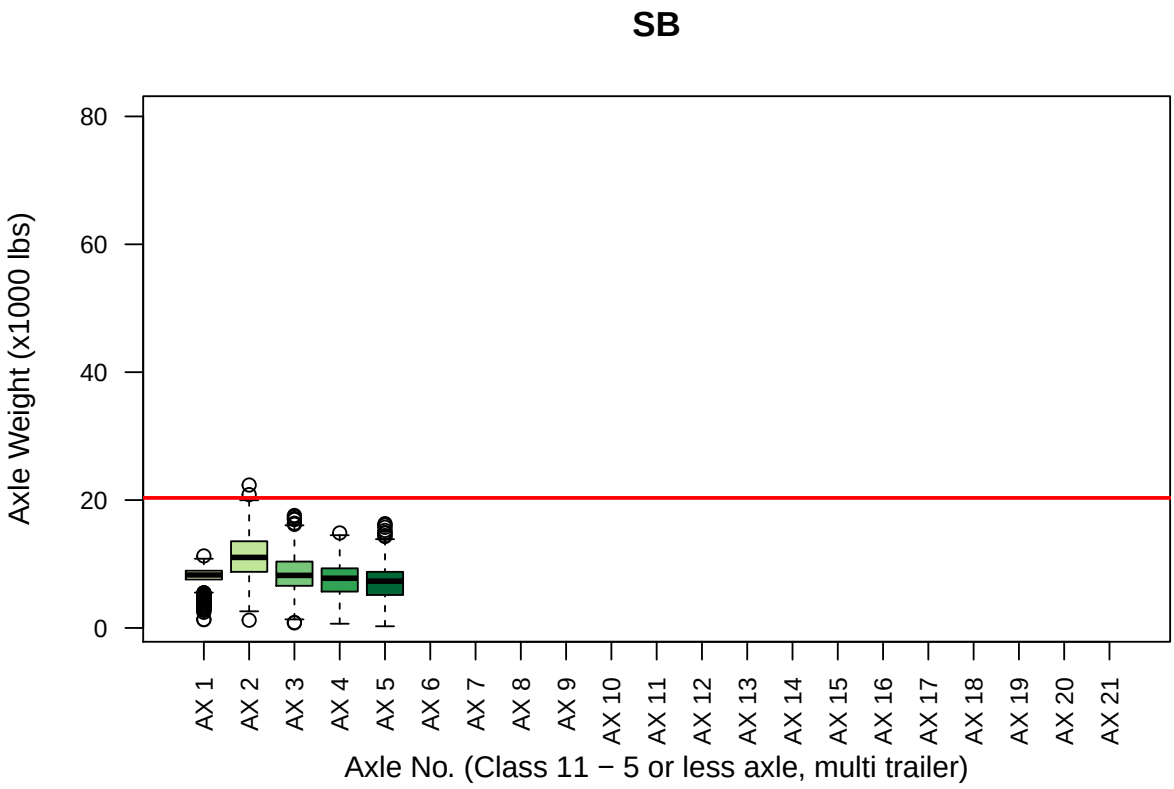

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 6 − Three axles, single unit)

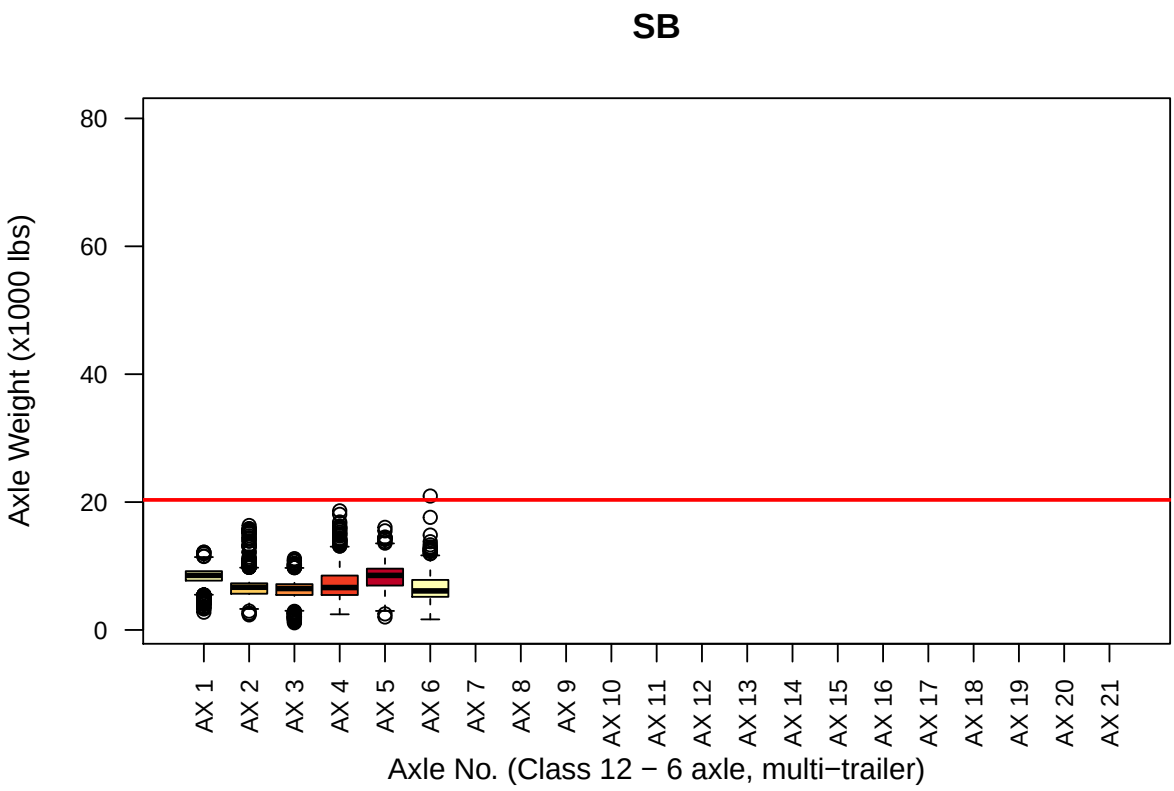

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 7 − Four or more axle, single unit)

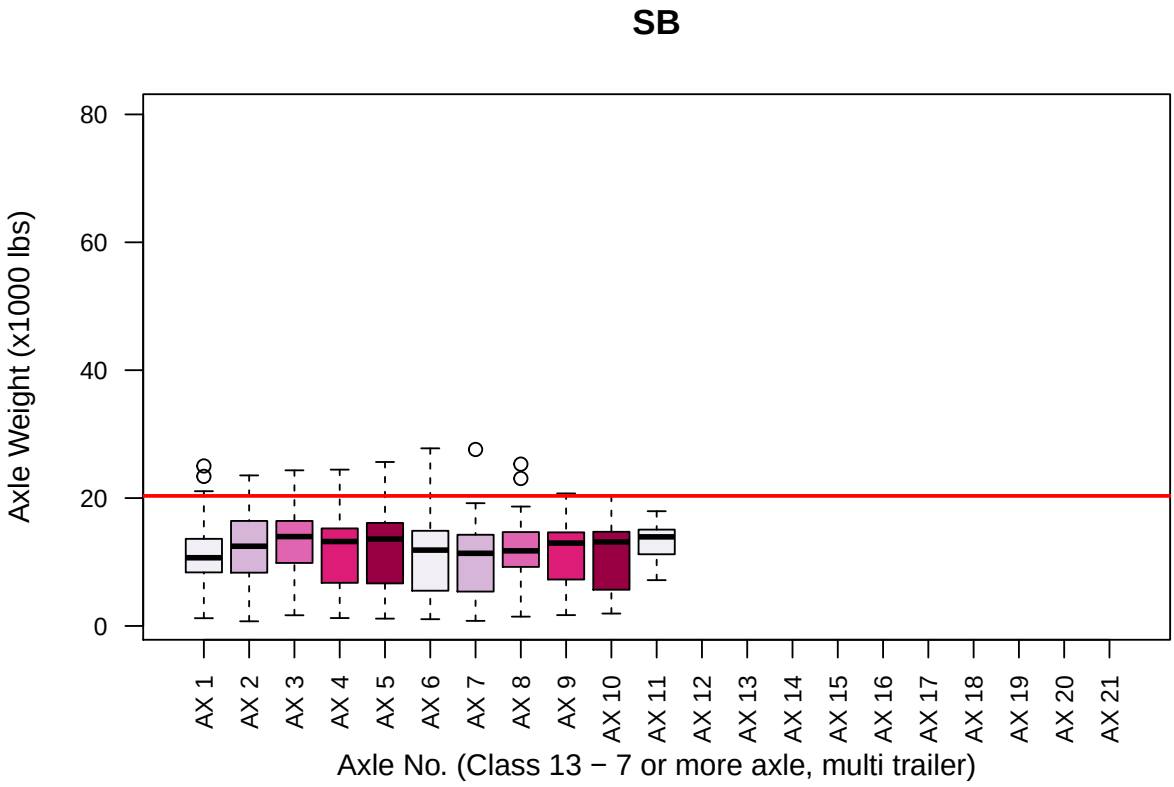

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No.(Class 8 − 4 or less axle, single trailer)

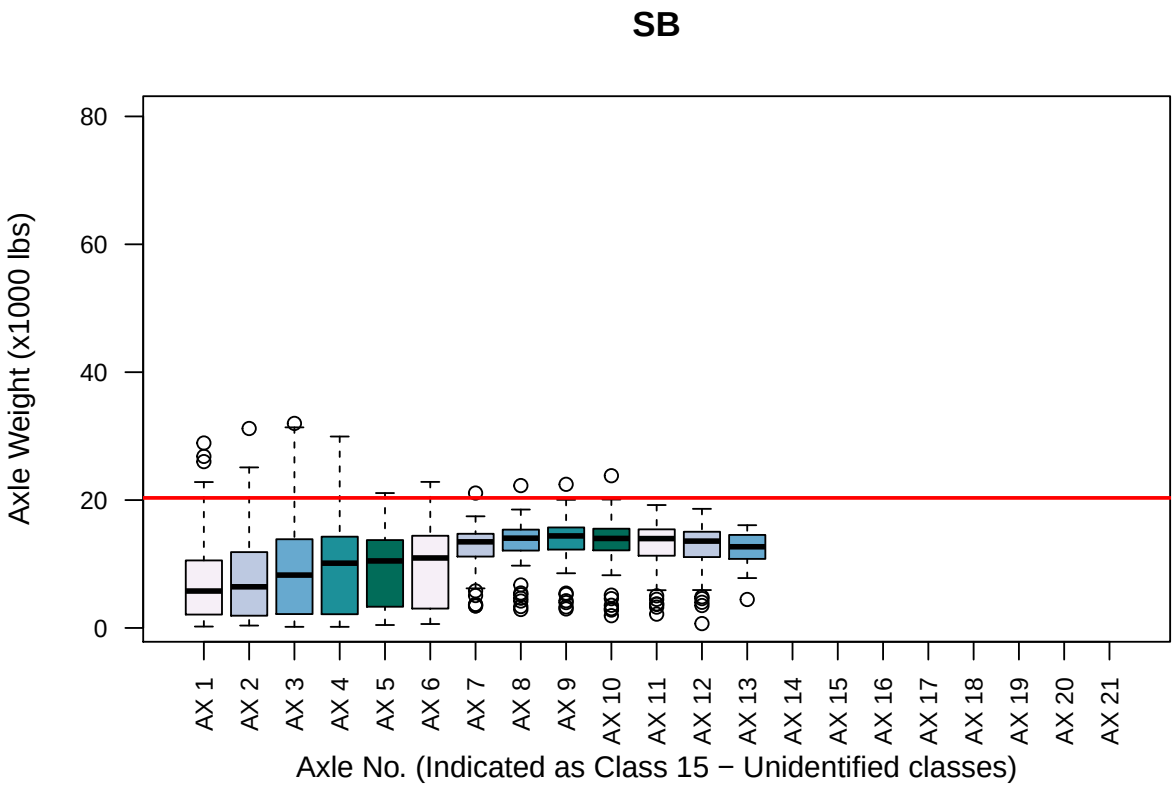

SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 9 − 5 axle tractor semitrailer)

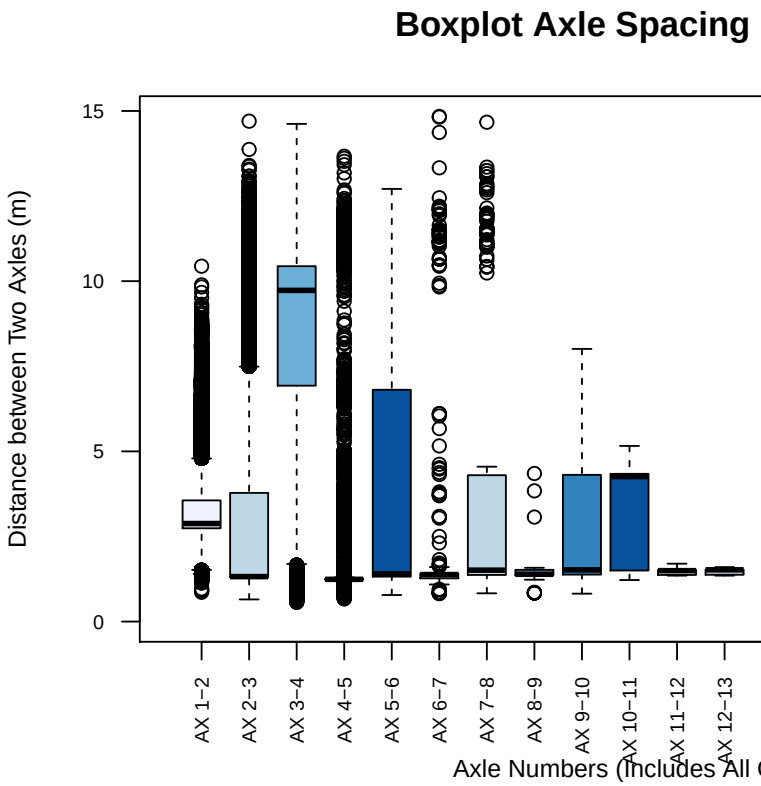

SB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 10 − 6 or more axle, single trailer)


SB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 11 − 5 or less axle, multi trailer)

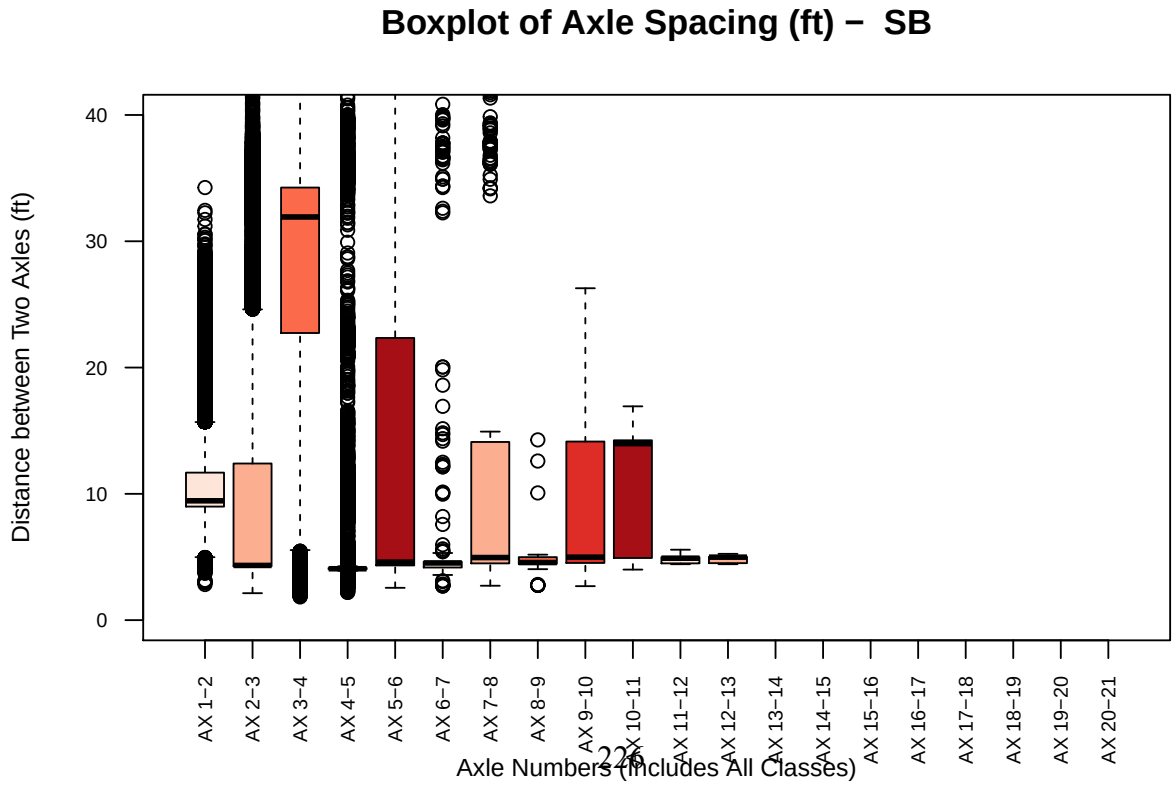

SB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 12 − 6 axle, multi−trailer)

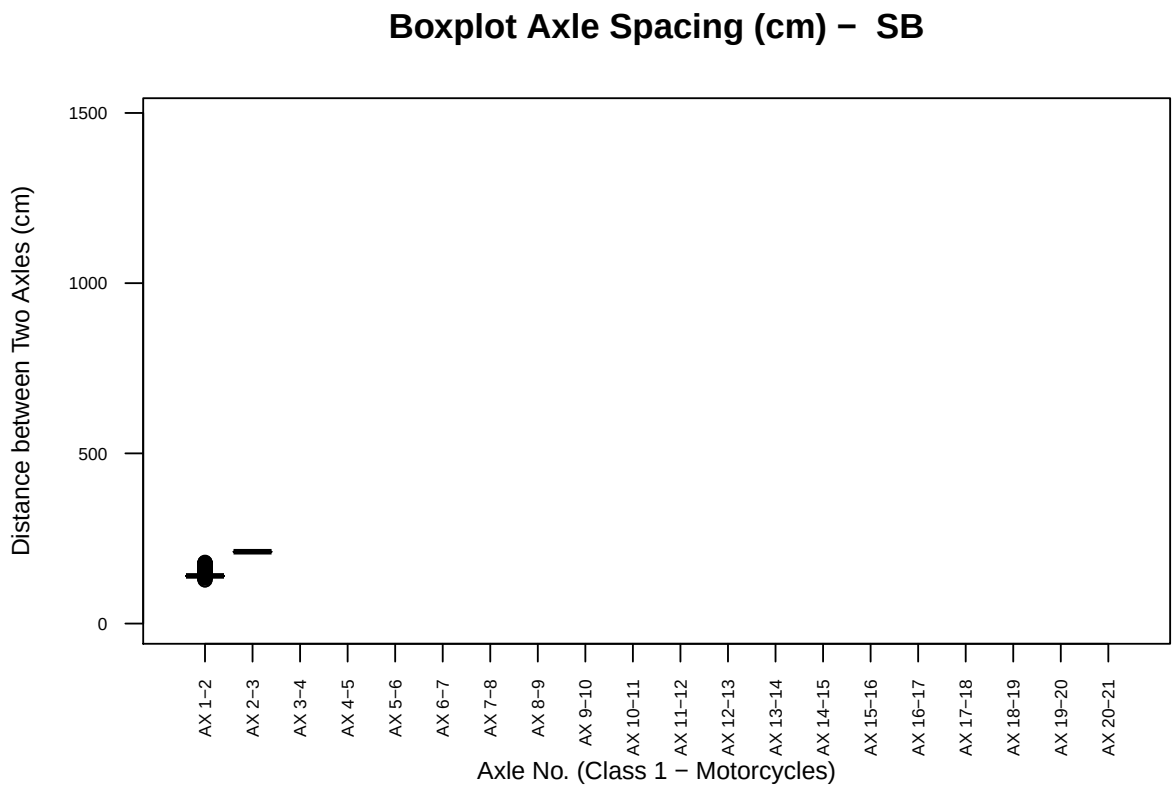

SB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 13 − 7 or more axle, multi trailer)

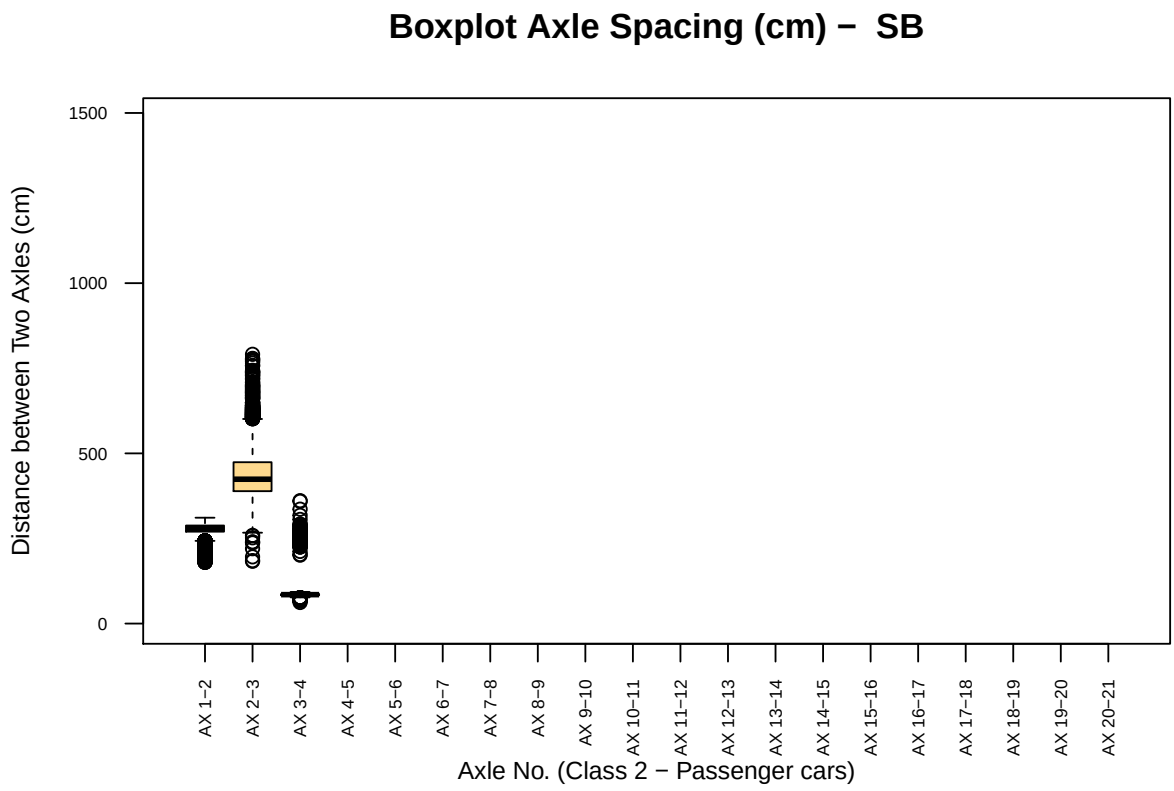

SB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Indicated as Class 15 − Unidentified classes)

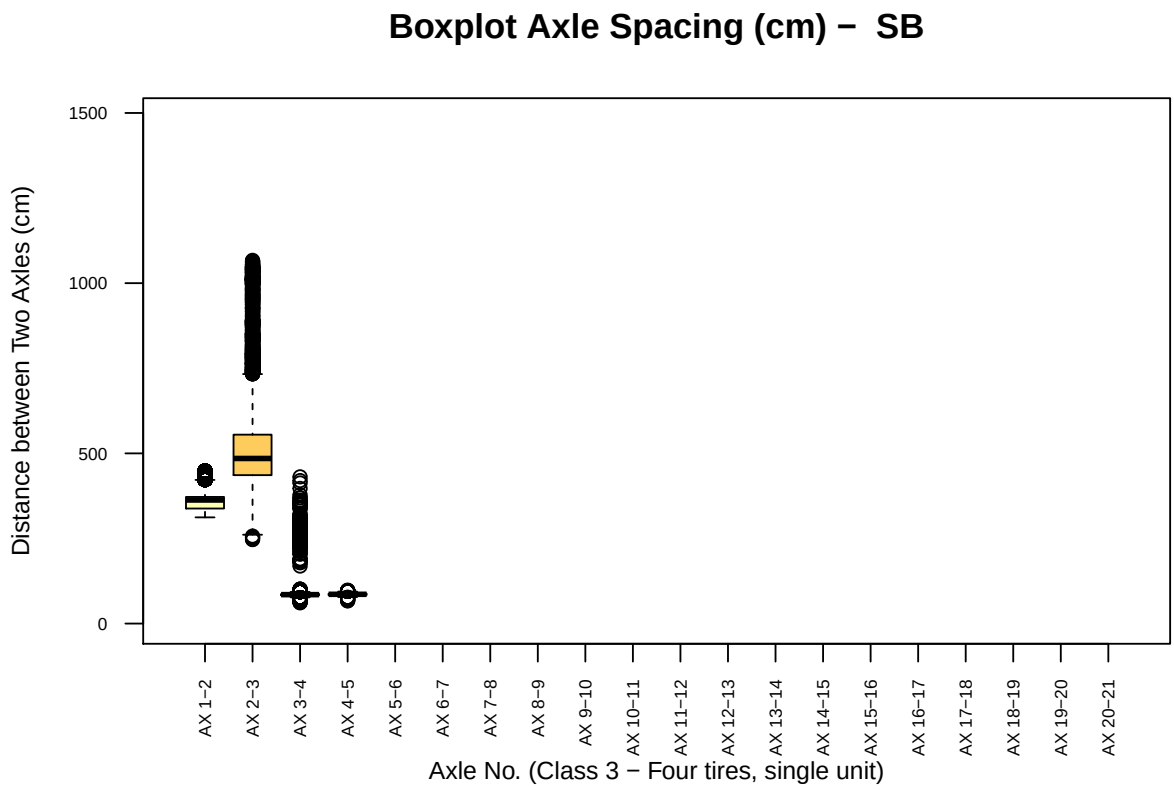


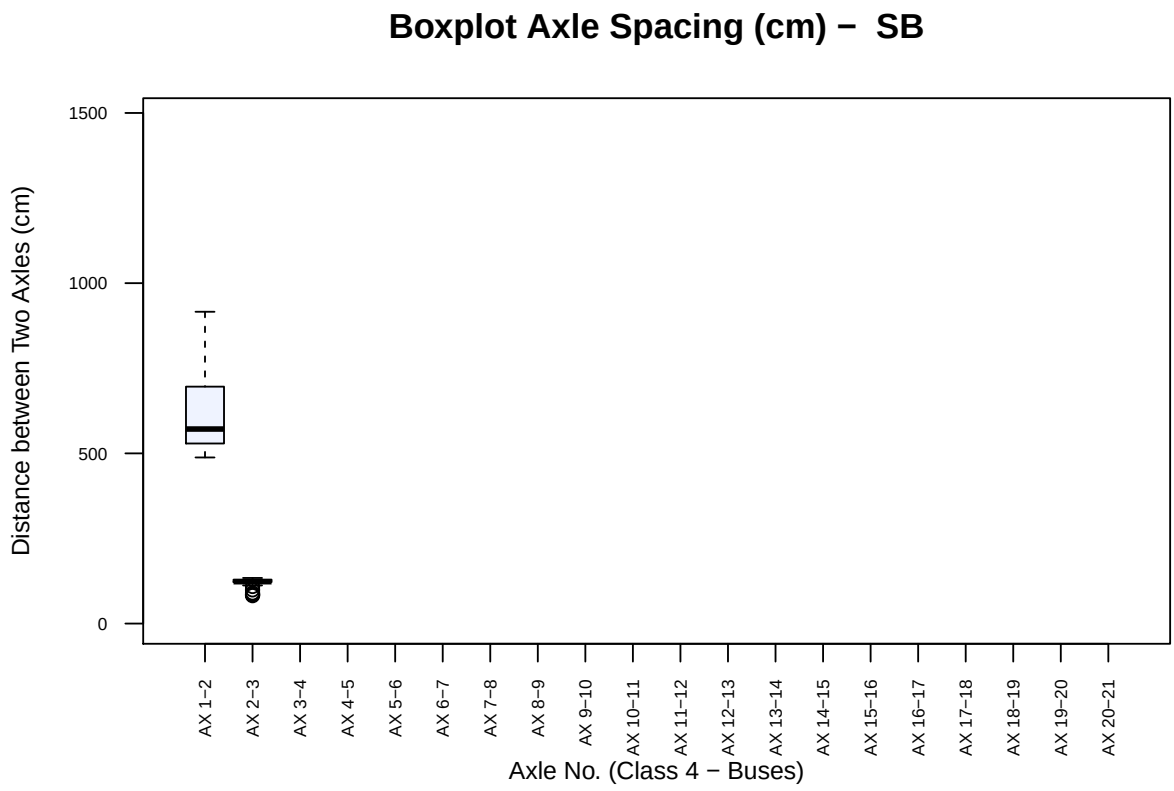
A-4.7.7(b) Direction 1 - Axle spacing by class

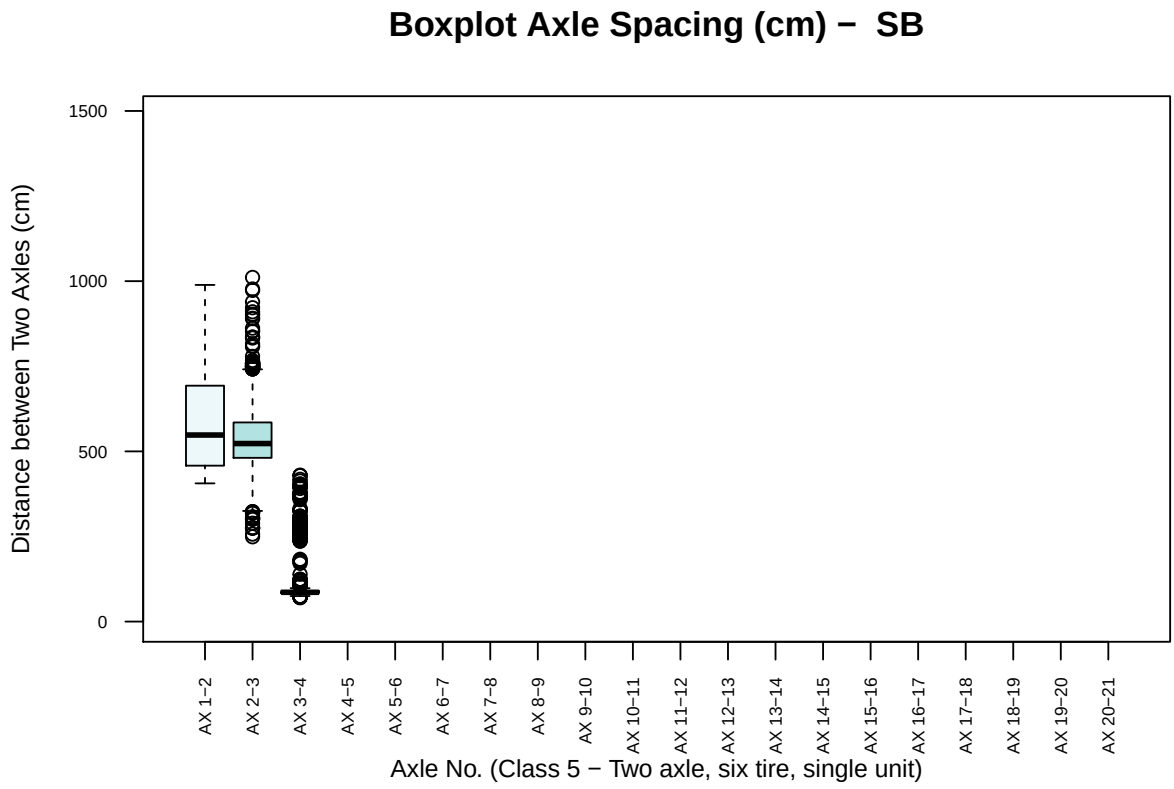


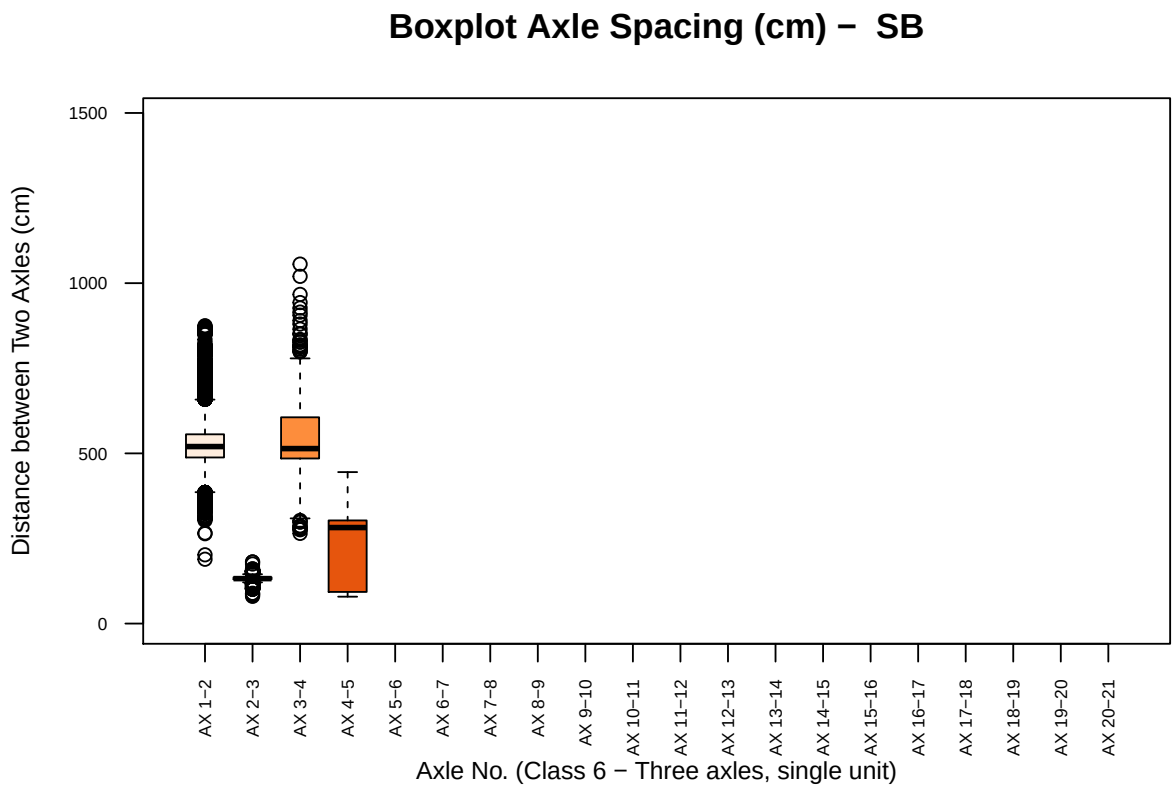

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 1 − Motorcycles)

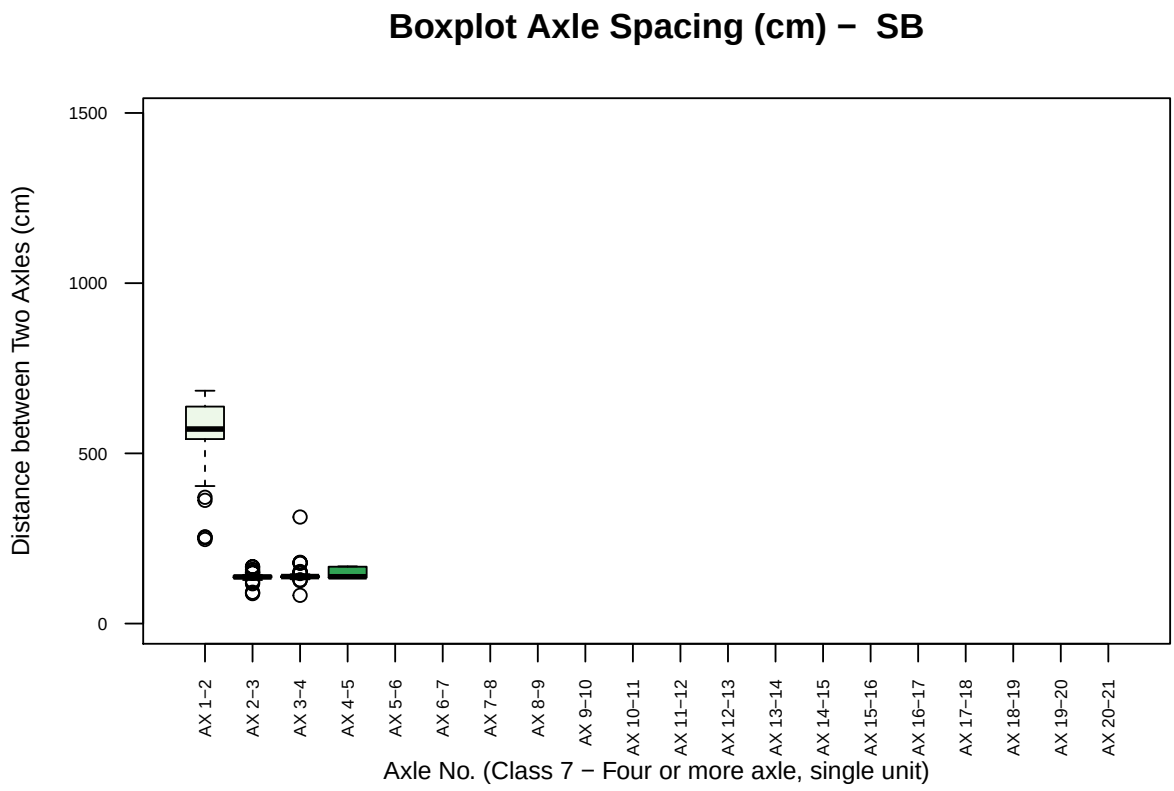

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 2 − Passenger cars)

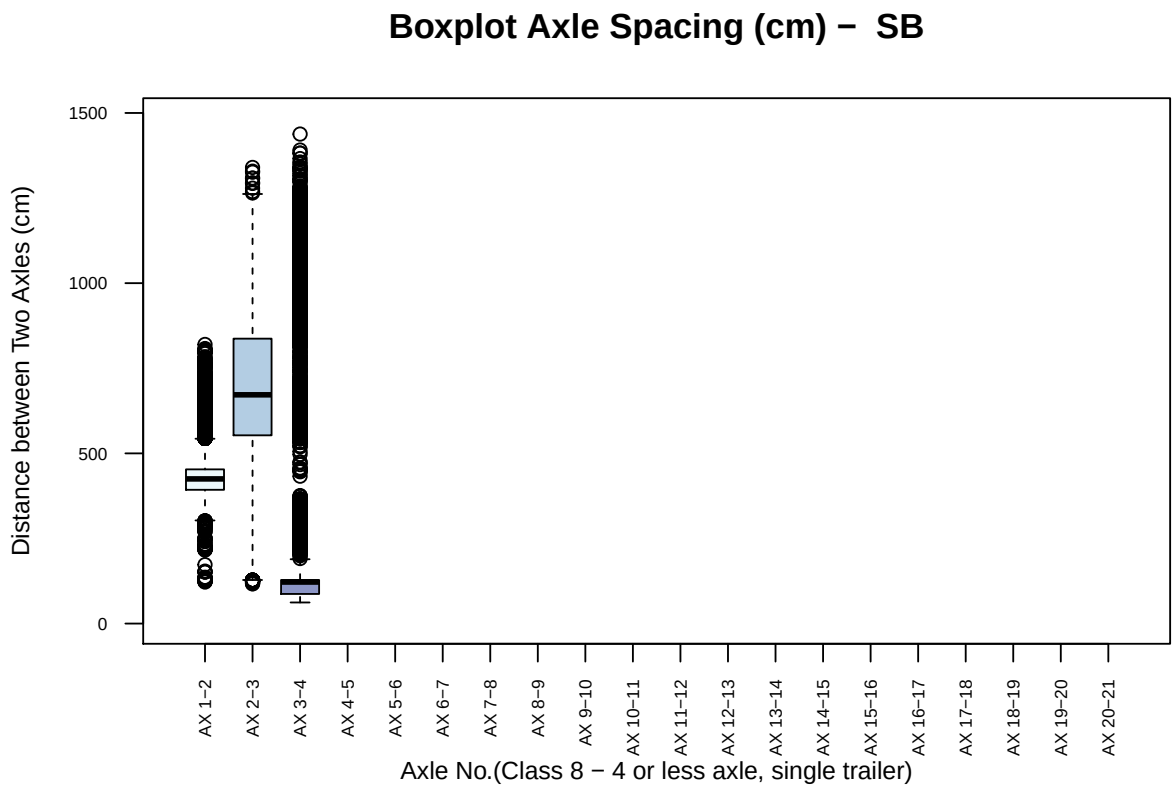

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 3 − Four tires, single unit)

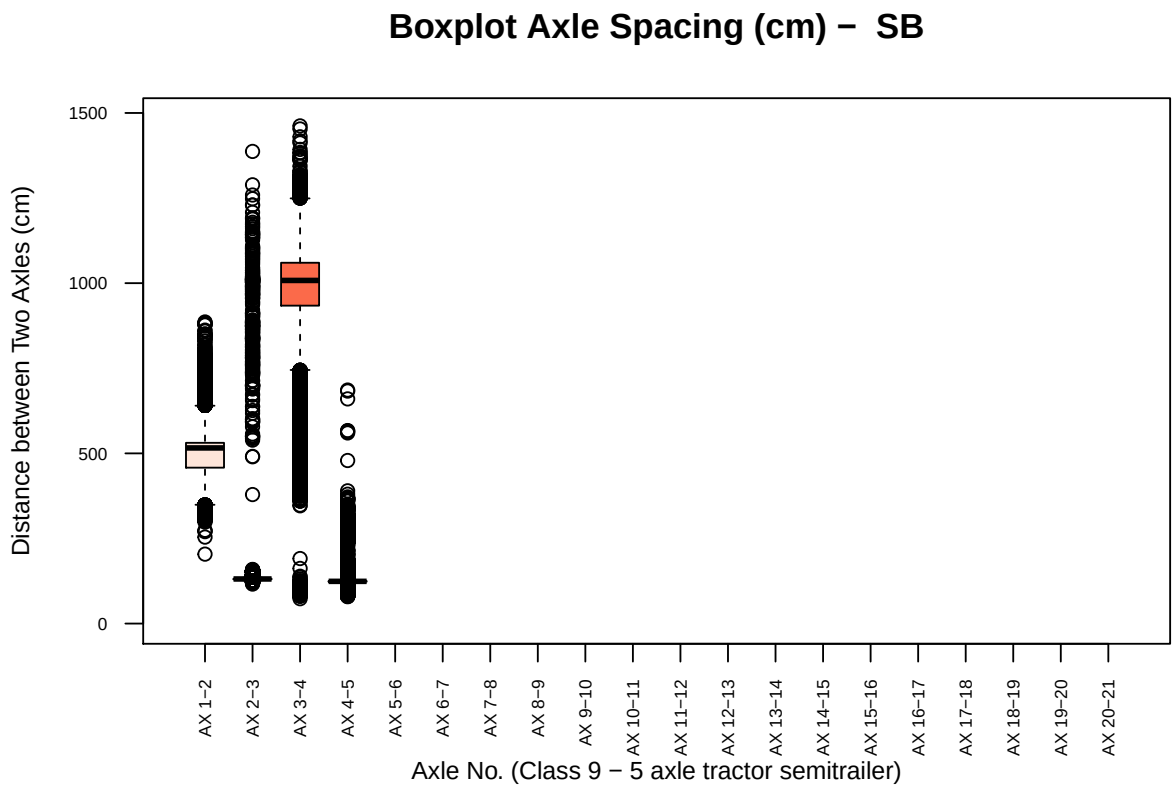

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 4 − Buses)

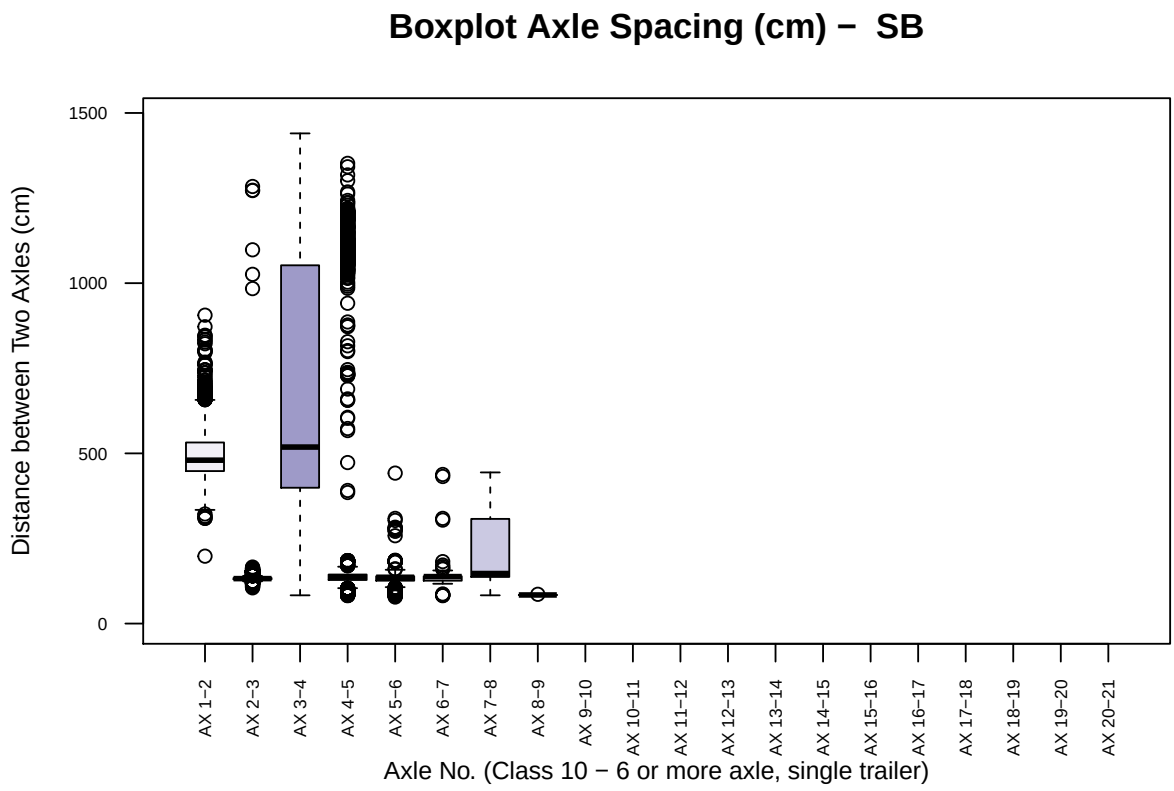

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 5 − Two axle, six tire, single unit)

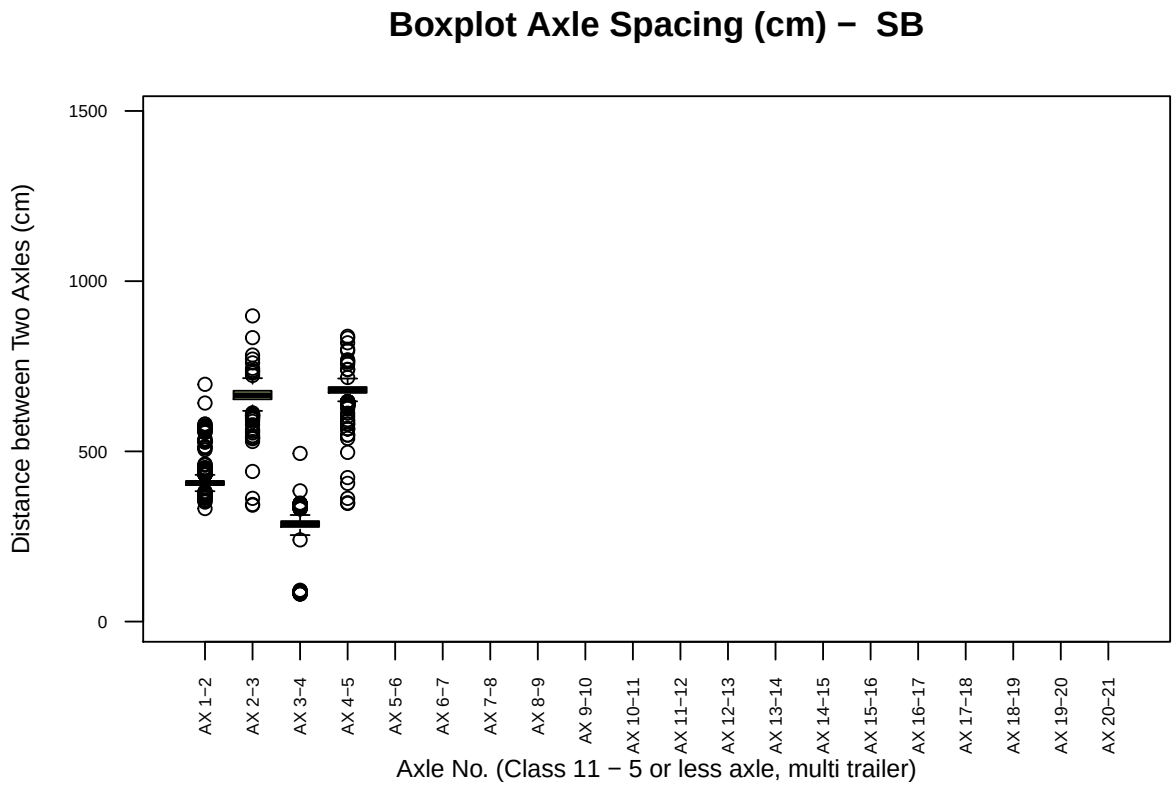

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 6 − Three axles, single unit)

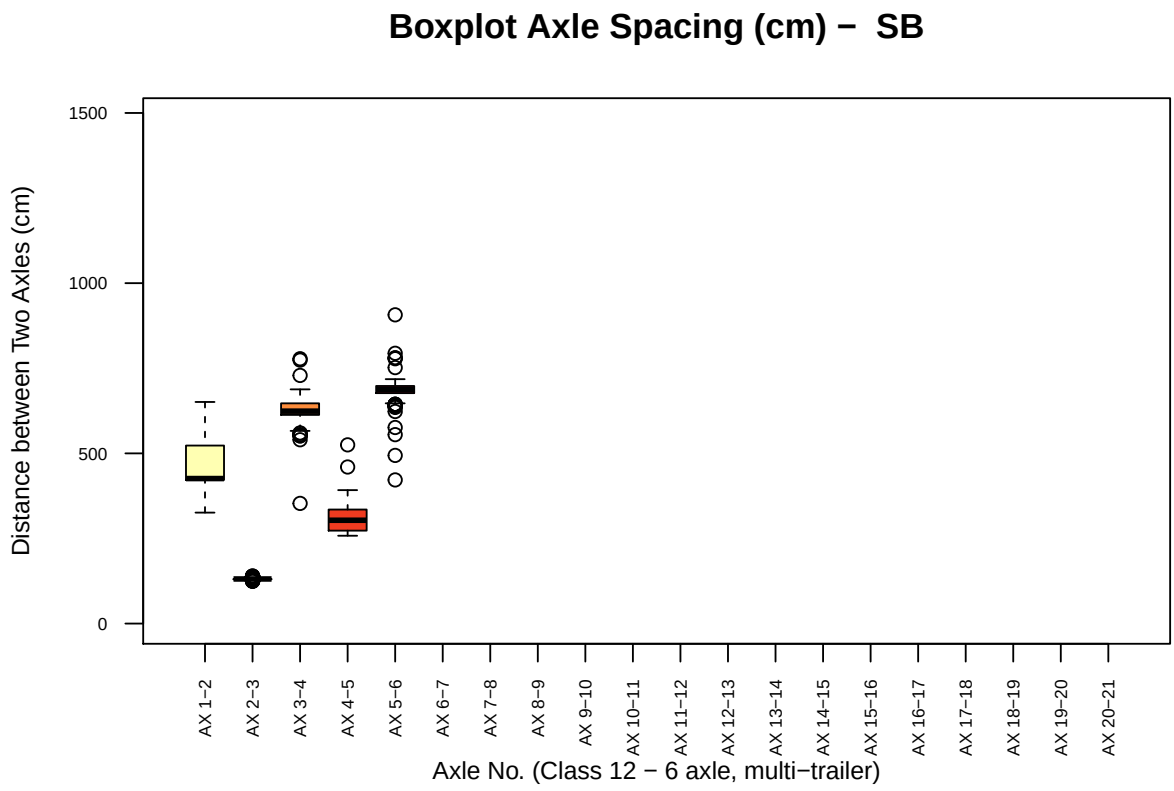

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 7 − Four or more axle, single unit)

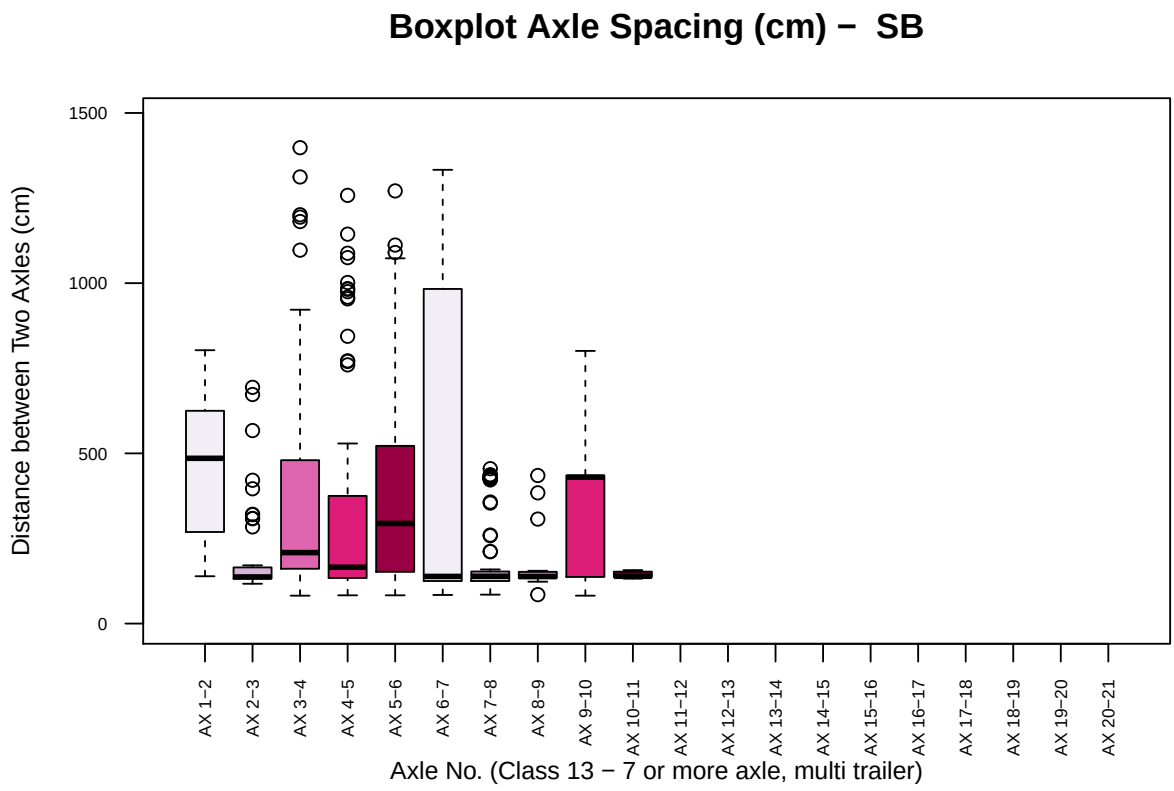

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No.(Class 8 − 4 or less axle, single trailer)

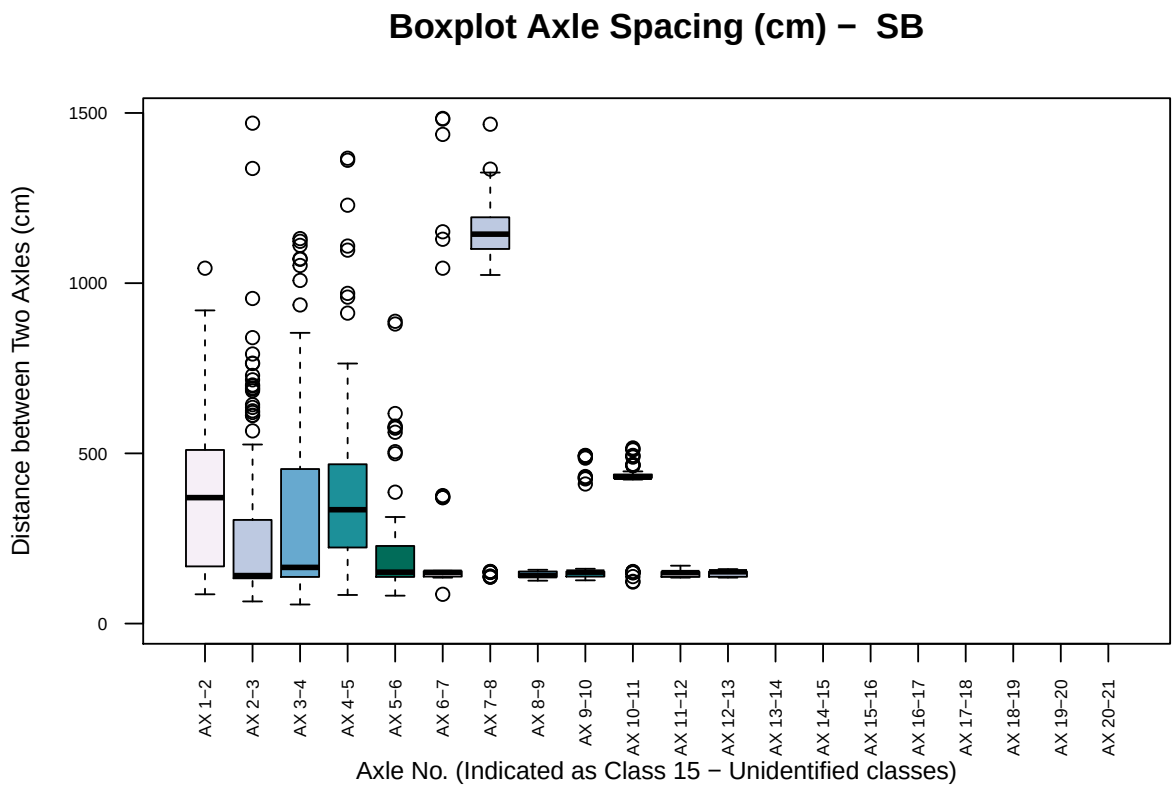

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 9 − 5 axle tractor semitrailer)


Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 10 − 6 or more axle, single trailer)


Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 11 − 5 or less axle, multi trailer)


Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 12 − 6 axle, multi−trailer)

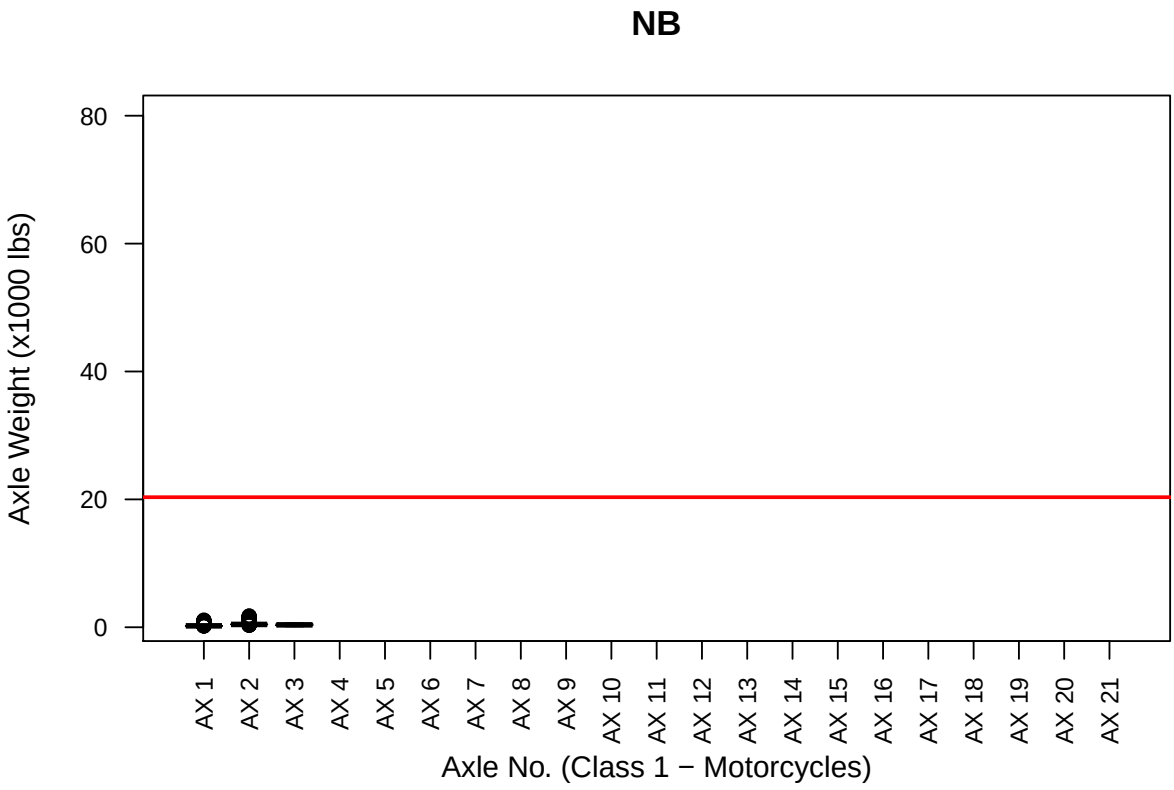

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 13 − 7 or more axle, multi trailer)

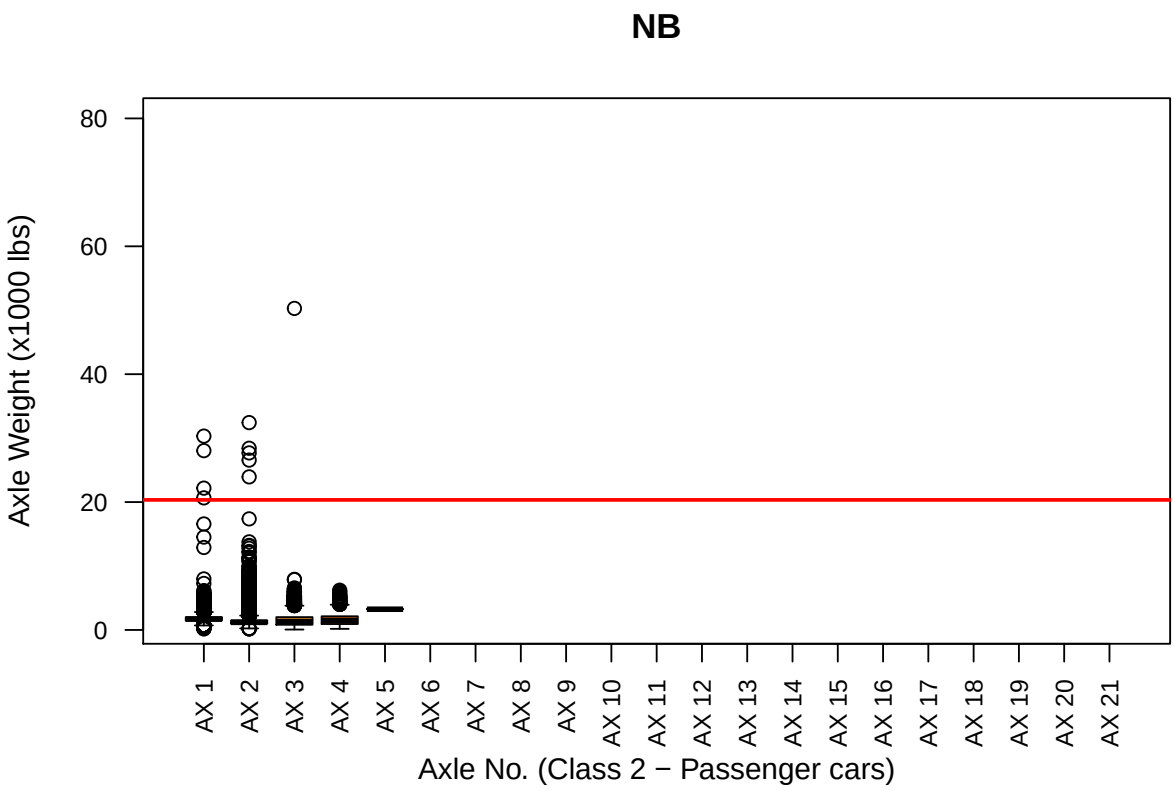

Boxplot Axle Spacing (cm) − SB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Indicated as Class 15 − Unidentified classes)

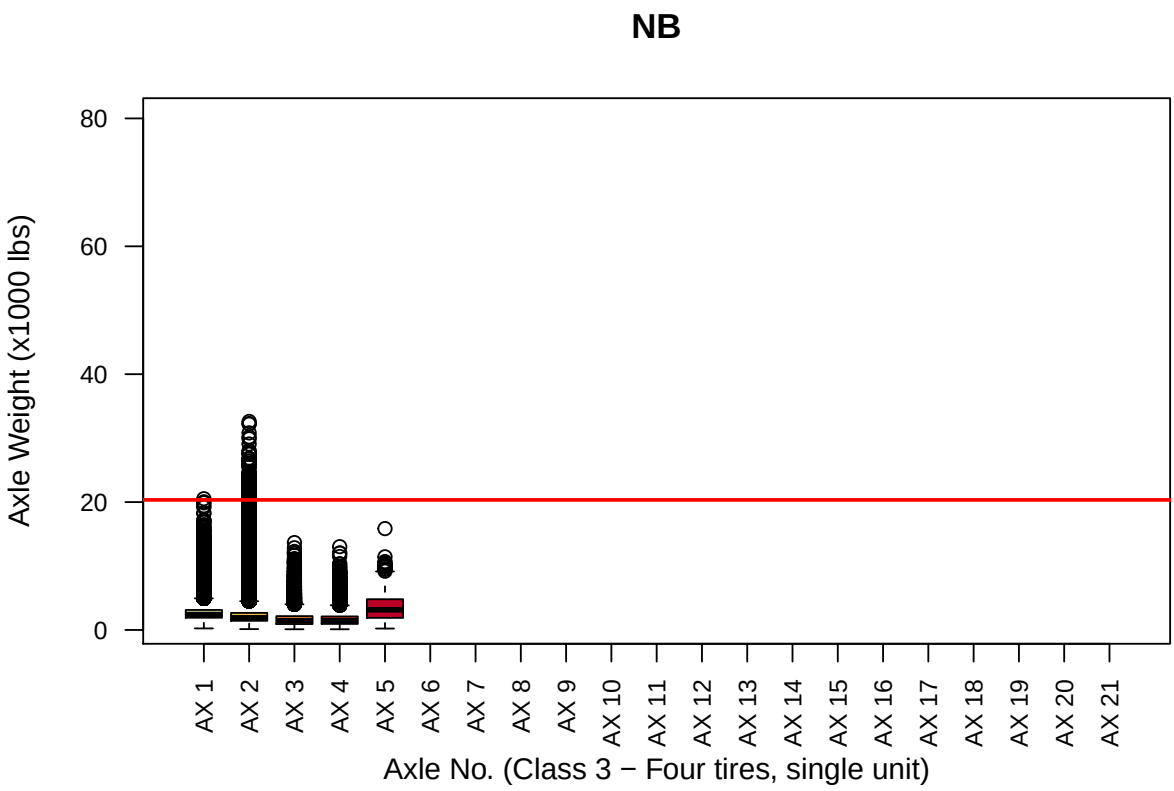
A-4.7.7(c) Direction 2 - Axle count and weight by class

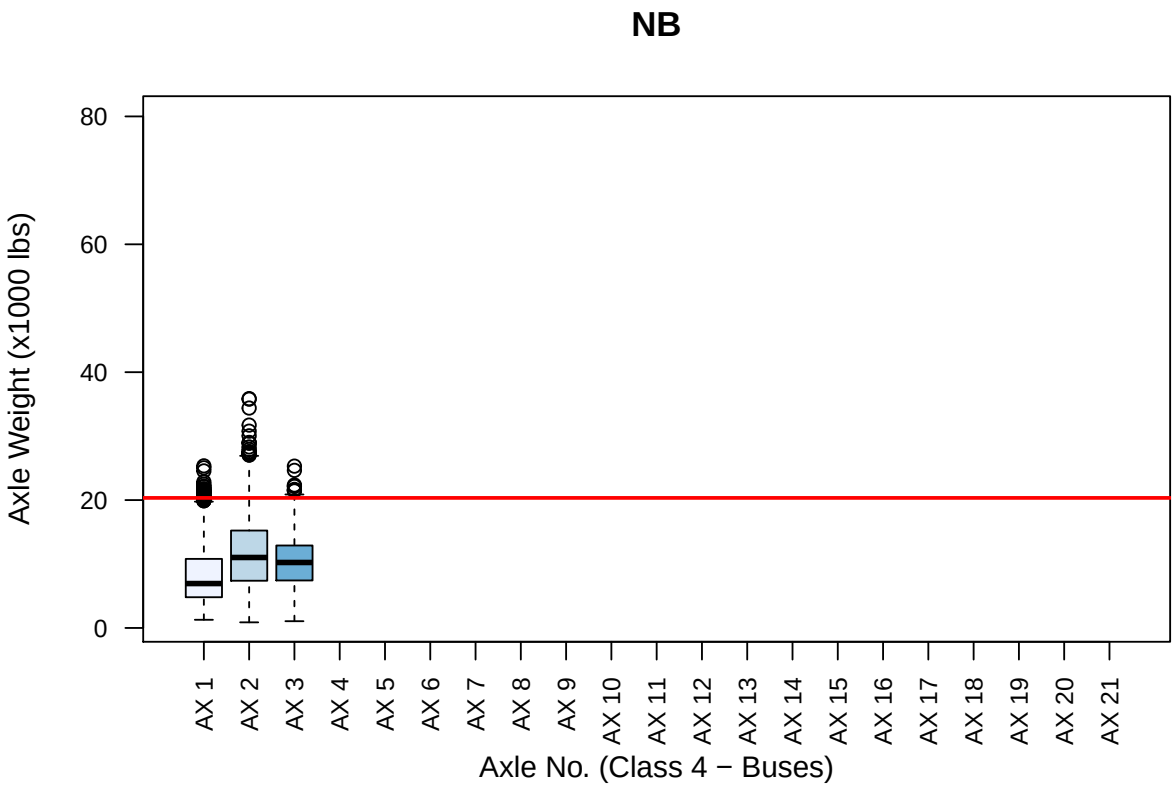
```
## null device
##           1
```

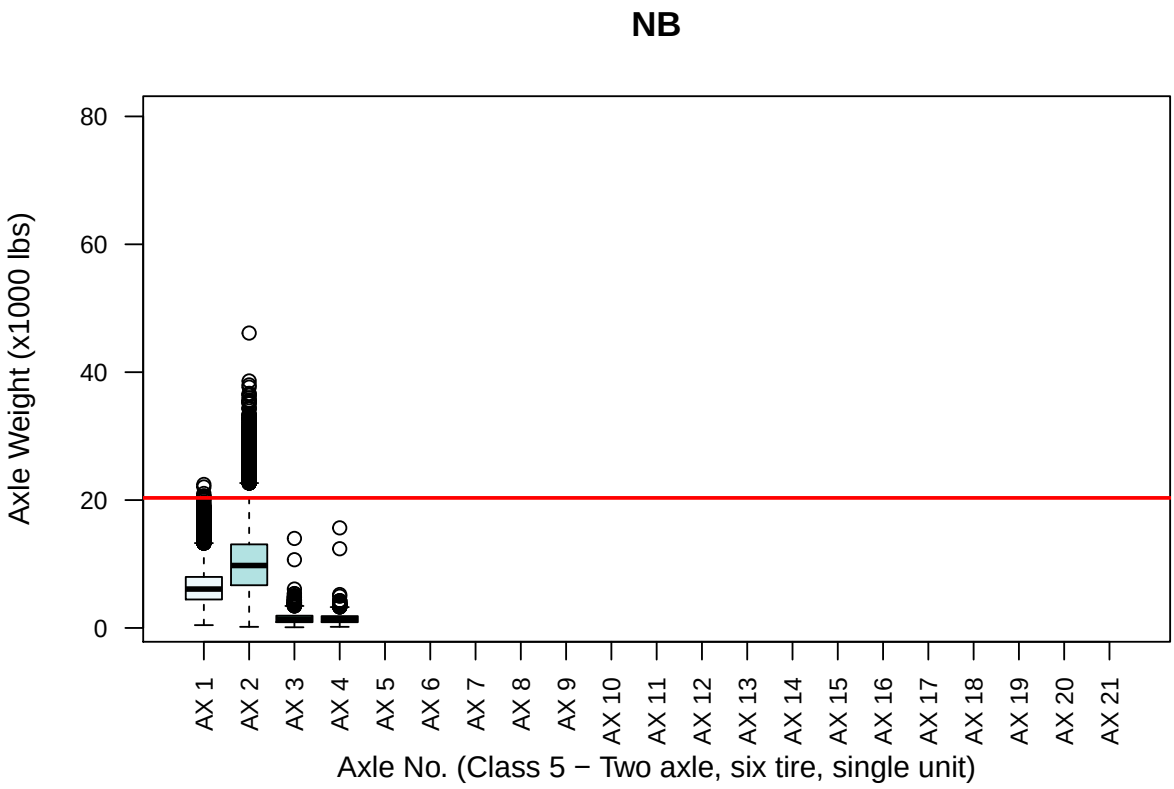
```
##
##  Box plots
```

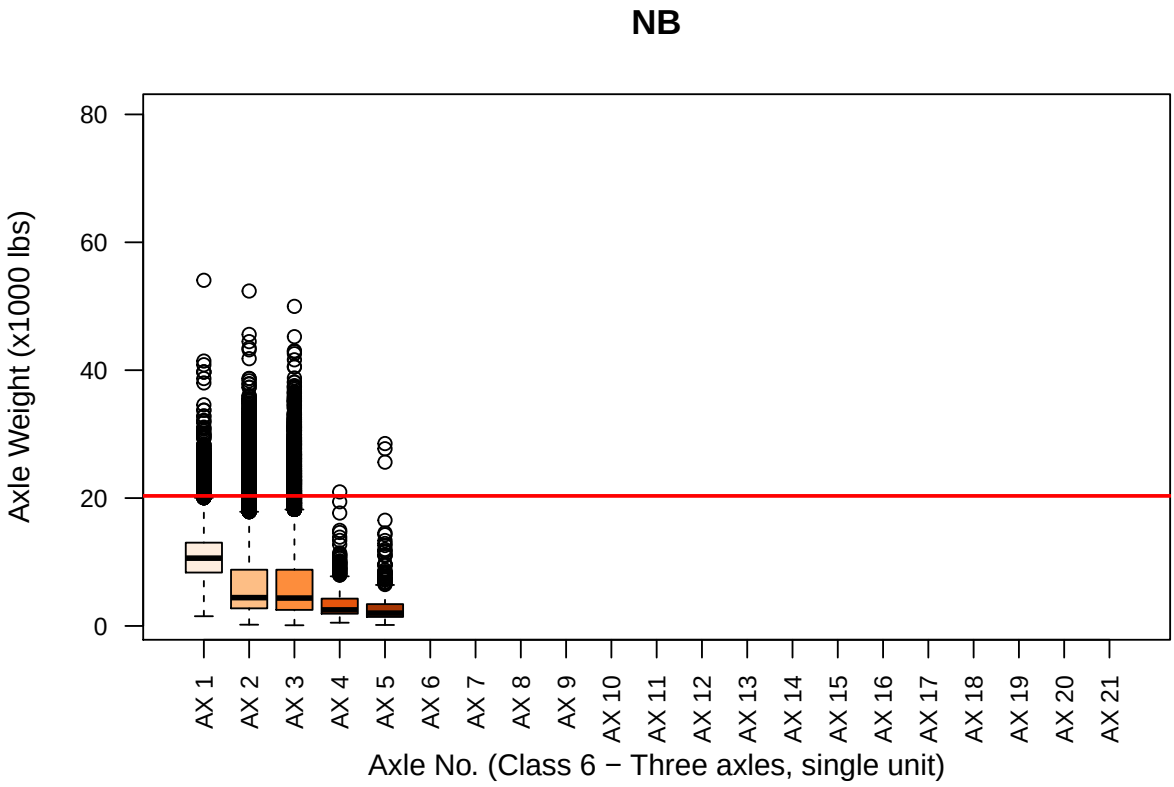

NB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 1 − Motorcycles)

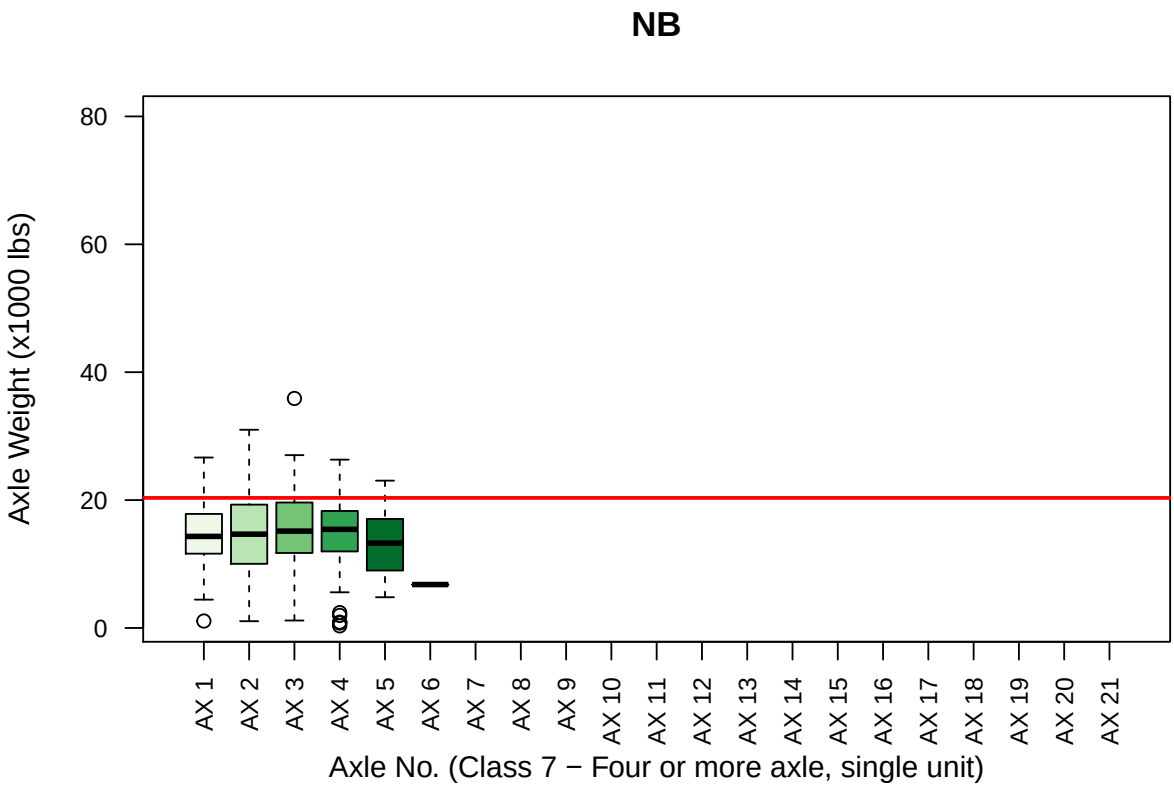

NB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 2 − Passenger cars)

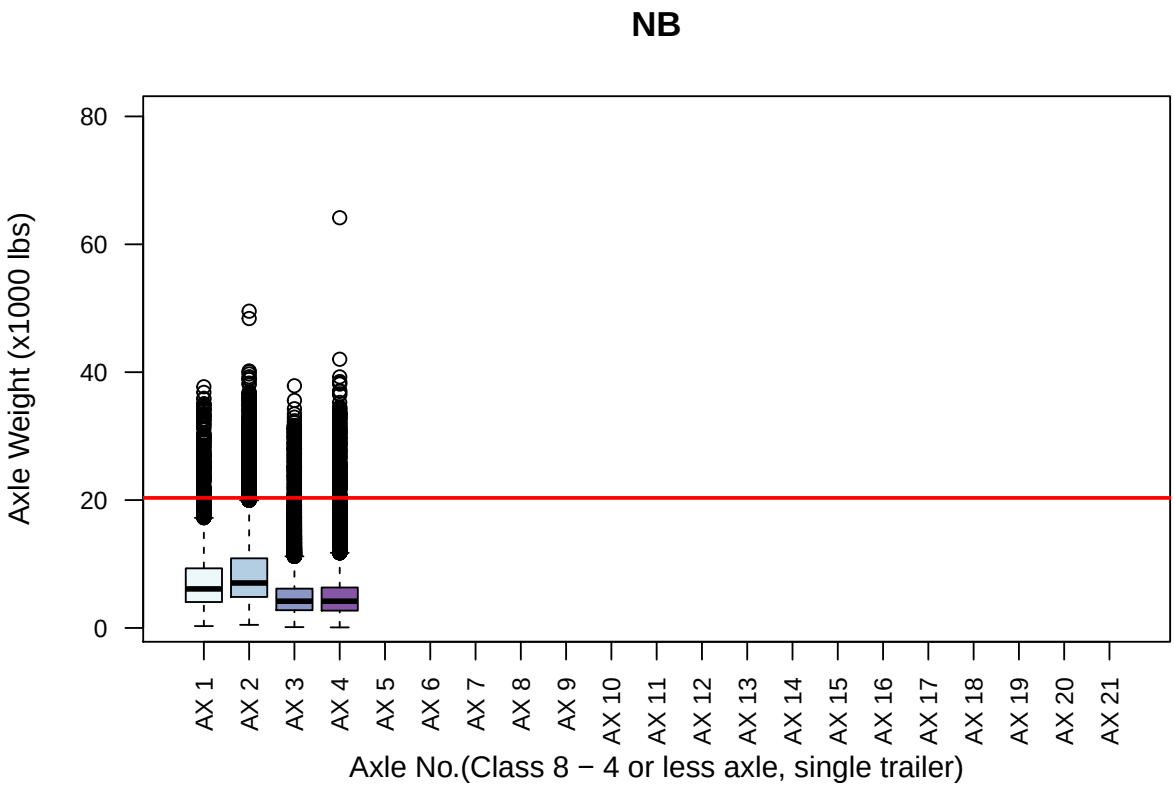

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 3 − Four tires, single unit)

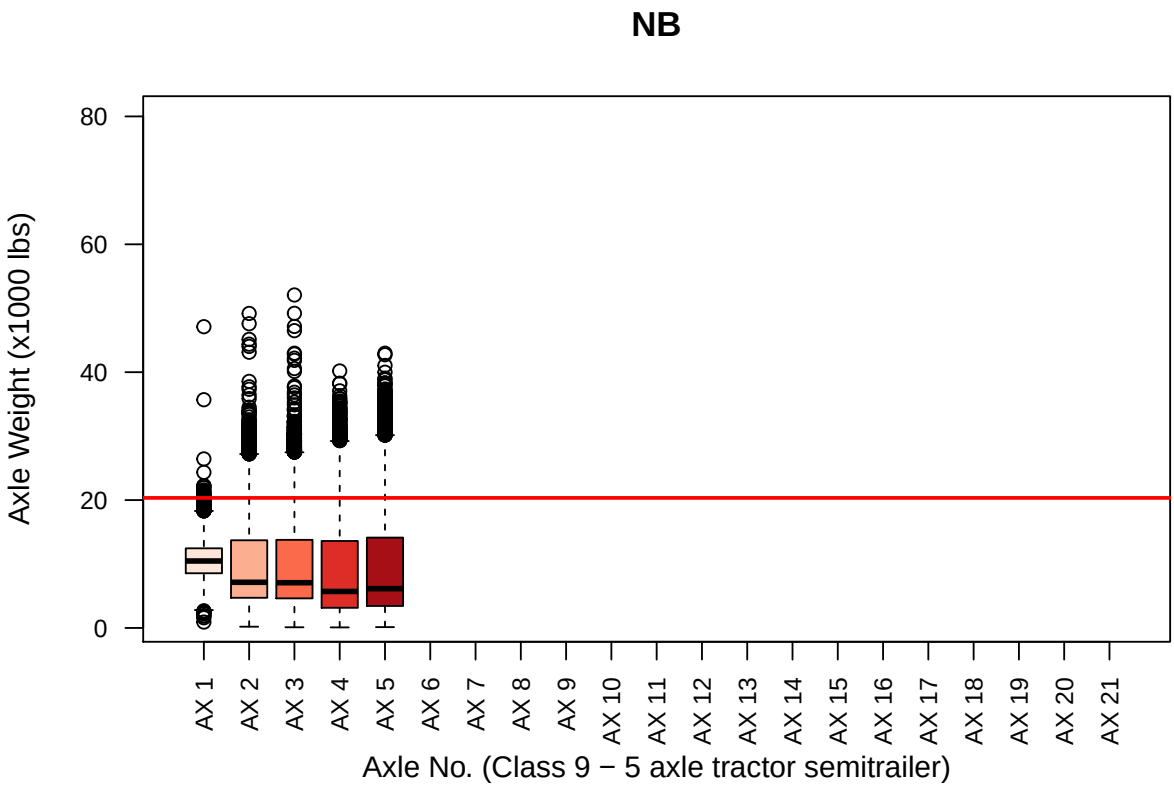

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 4 − Buses)

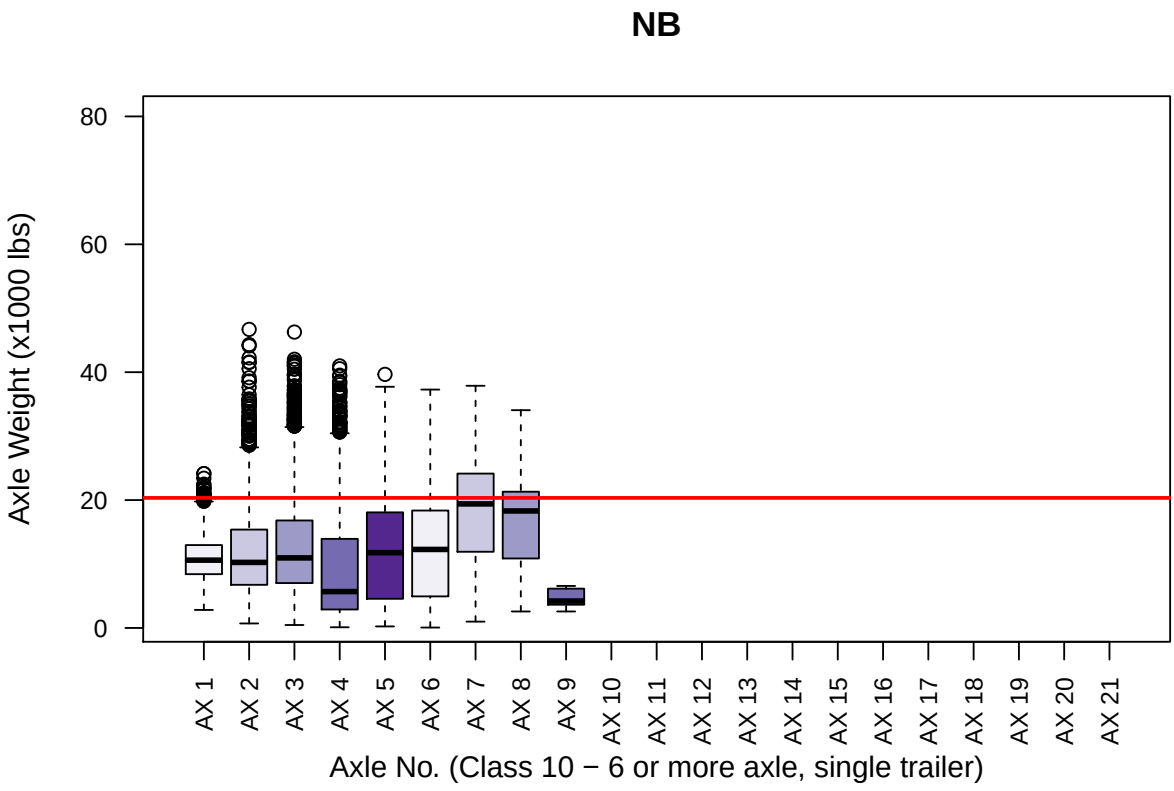

NB
Axle Weight (x1000 lbs)
80
60
40
20
0
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 5 − Two axle, six tire, single unit)

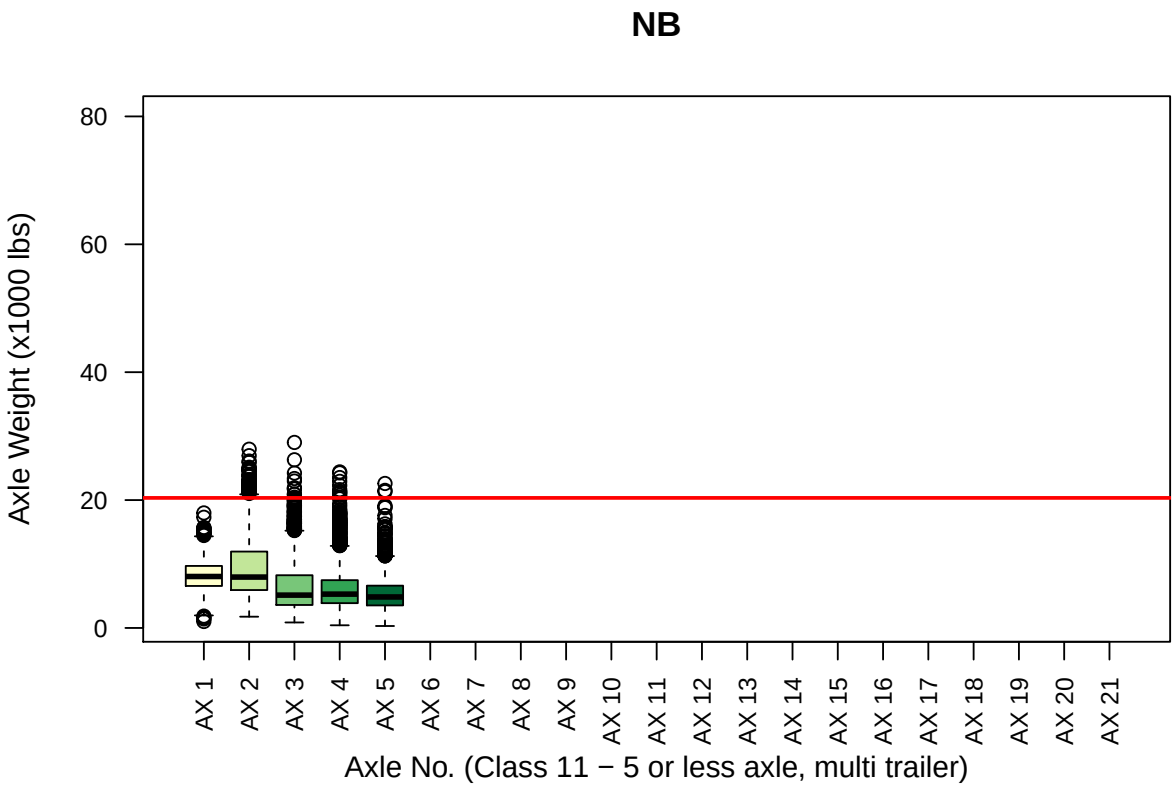

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 6 − Three axles, single unit)

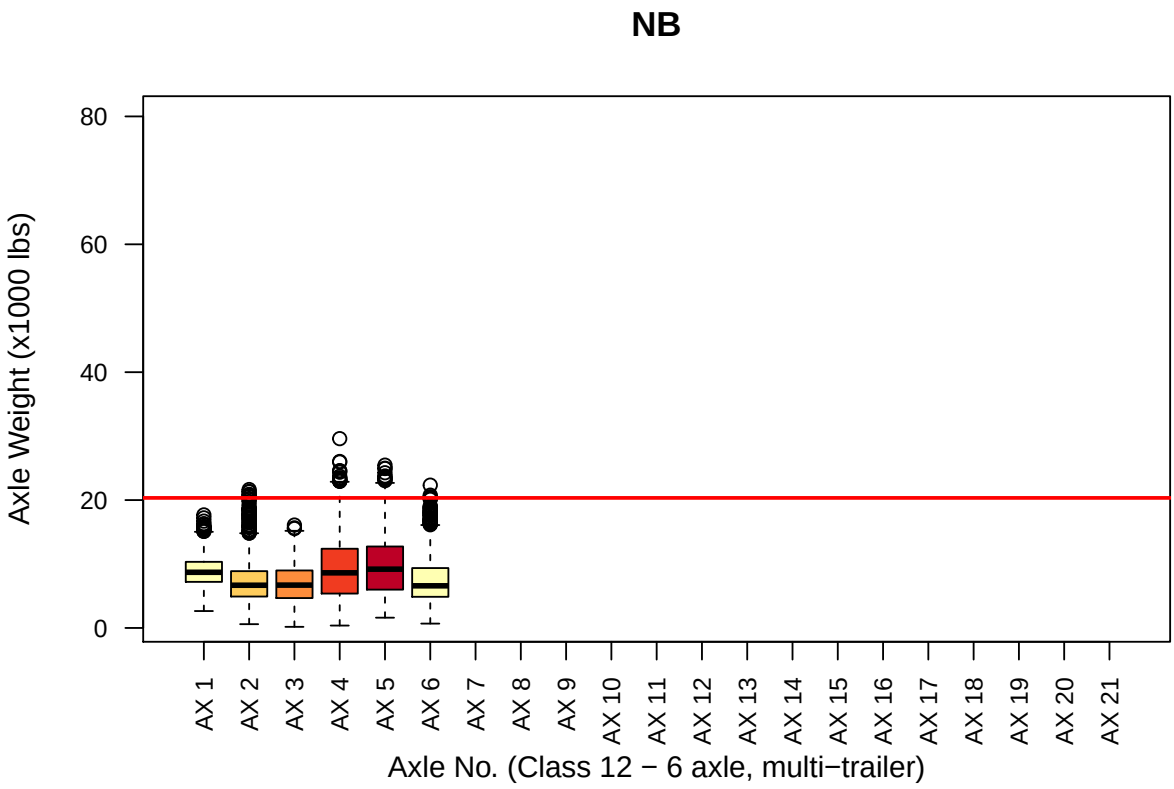

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 7 − Four or more axle, single unit)

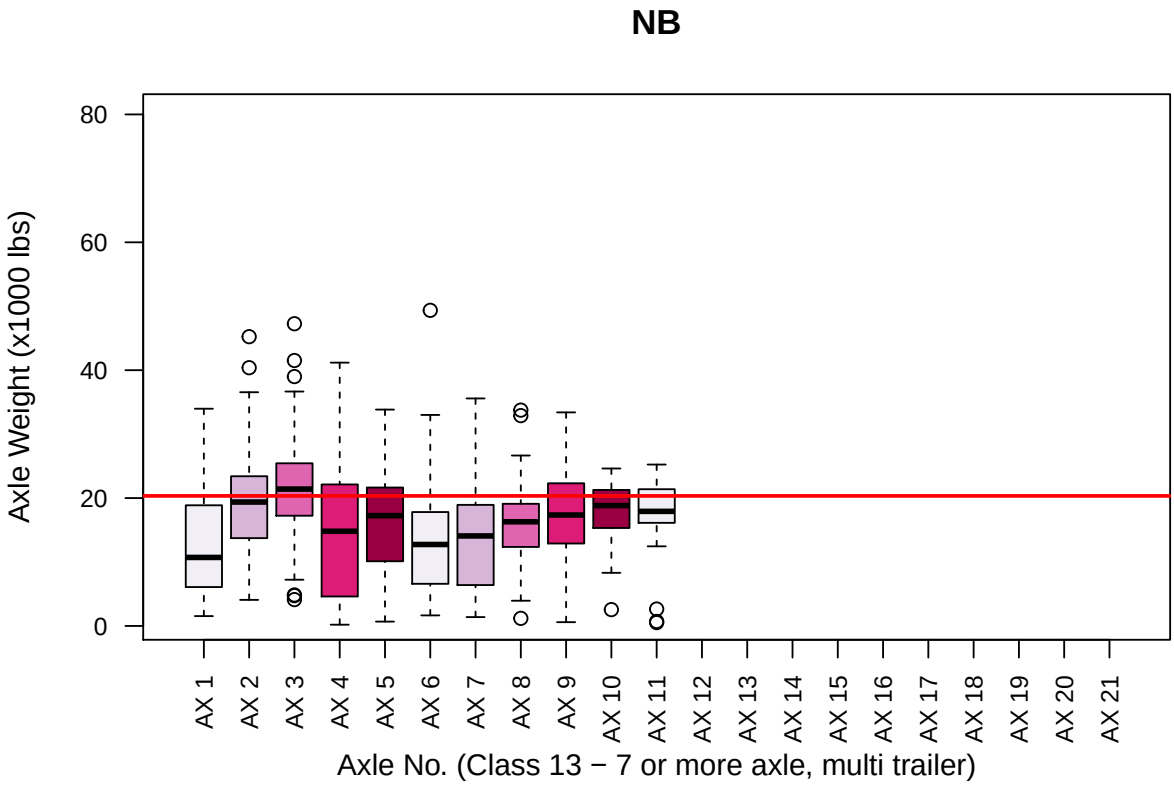

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No.(Class 8 − 4 or less axle, single trailer)

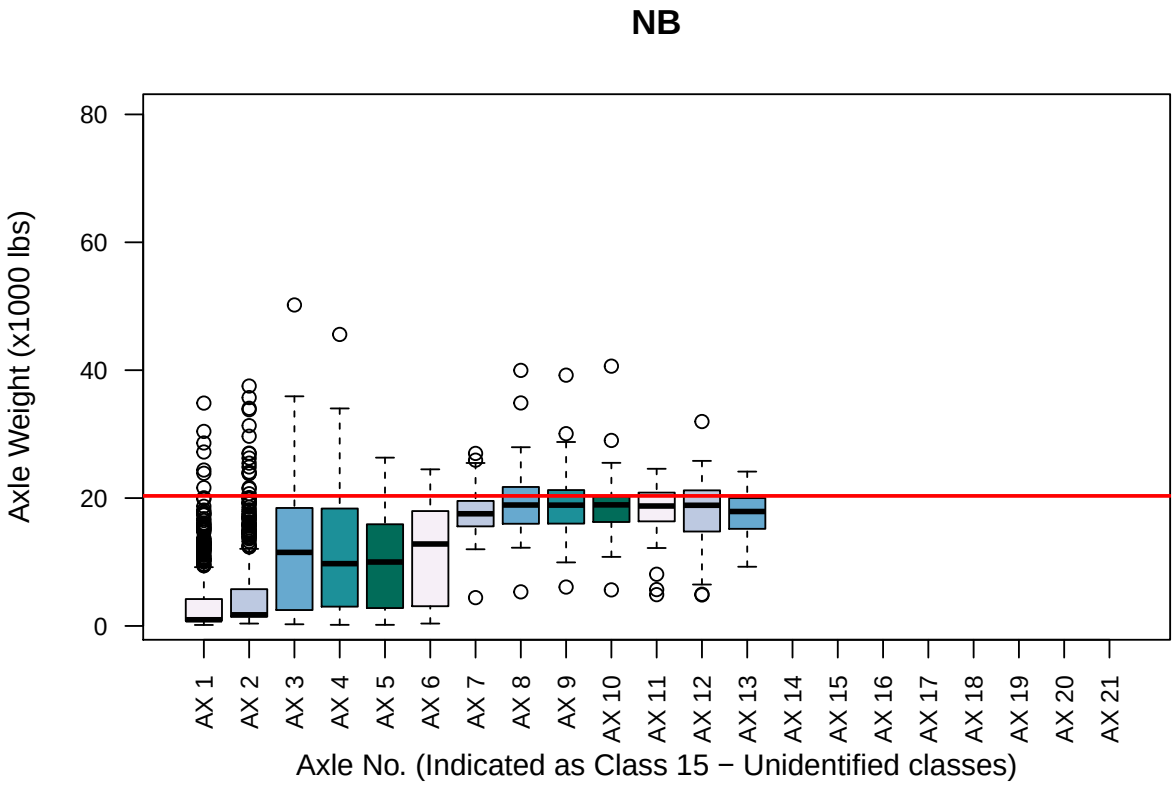

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 9 − 5 axle tractor semitrailer)

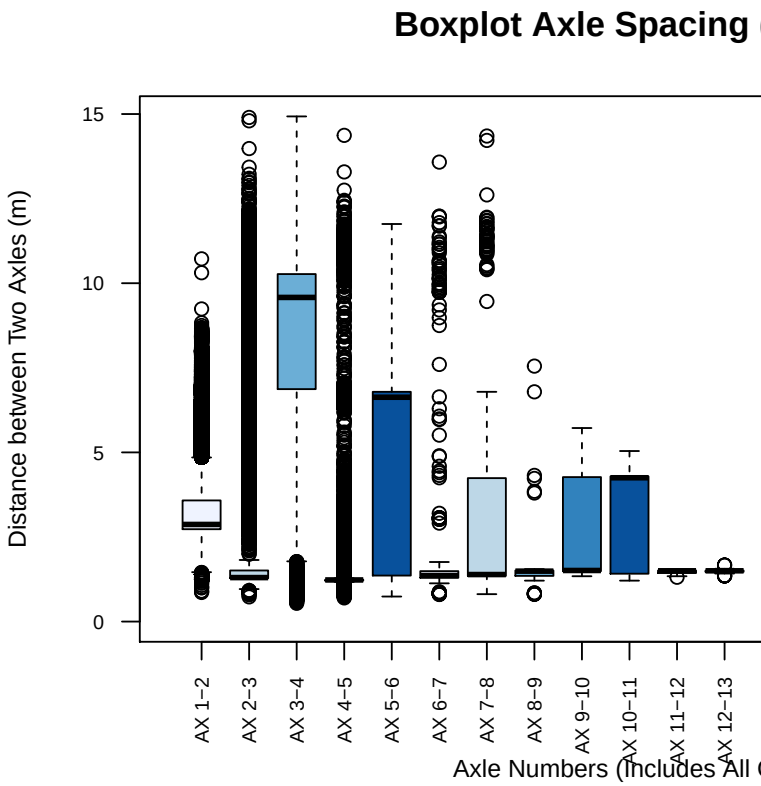

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 10 − 6 or more axle, single trailer)


NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 11 − 5 or less axle, multi trailer)

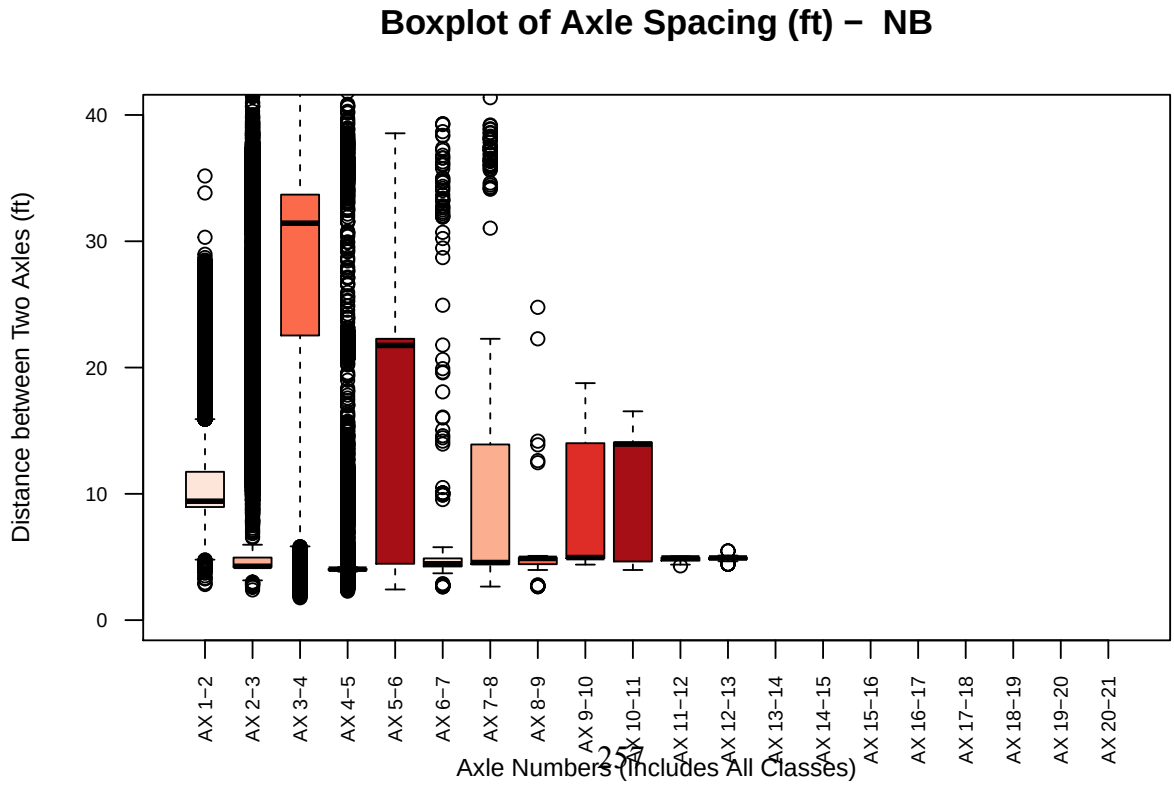

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 12 − 6 axle, multi−trailer)

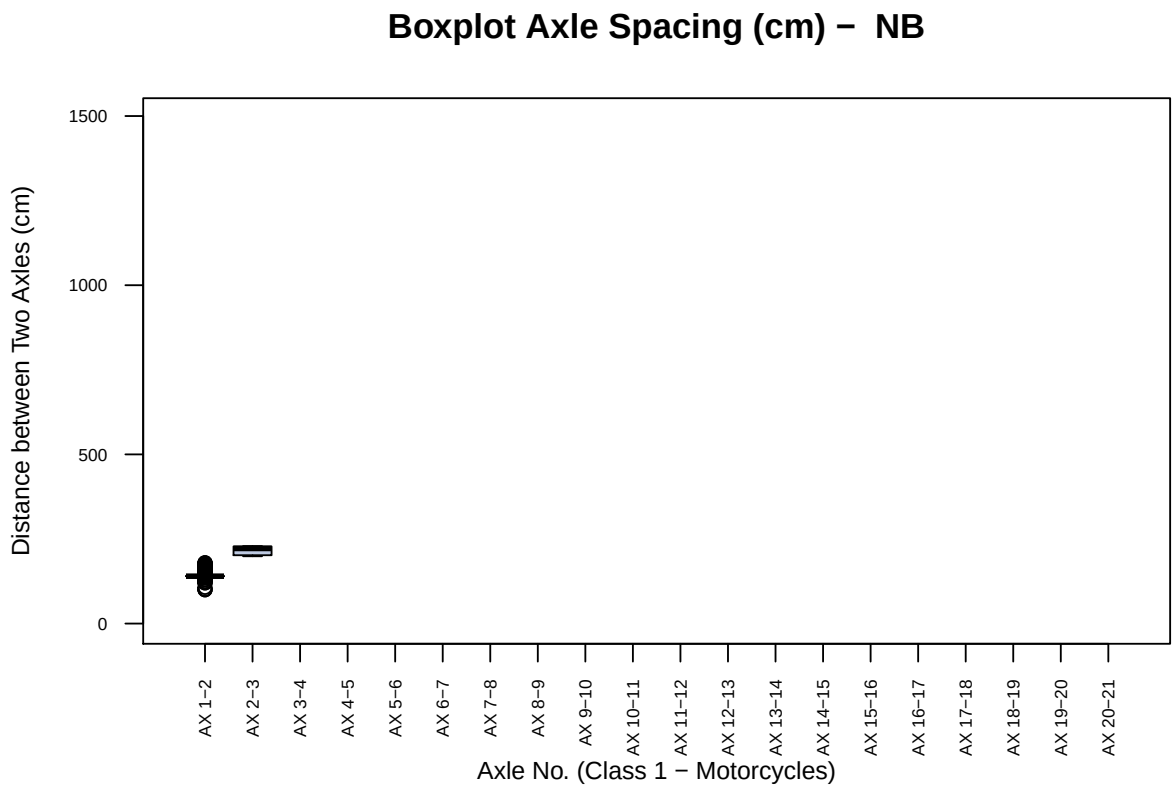

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Class 13 − 7 or more axle, multi trailer)

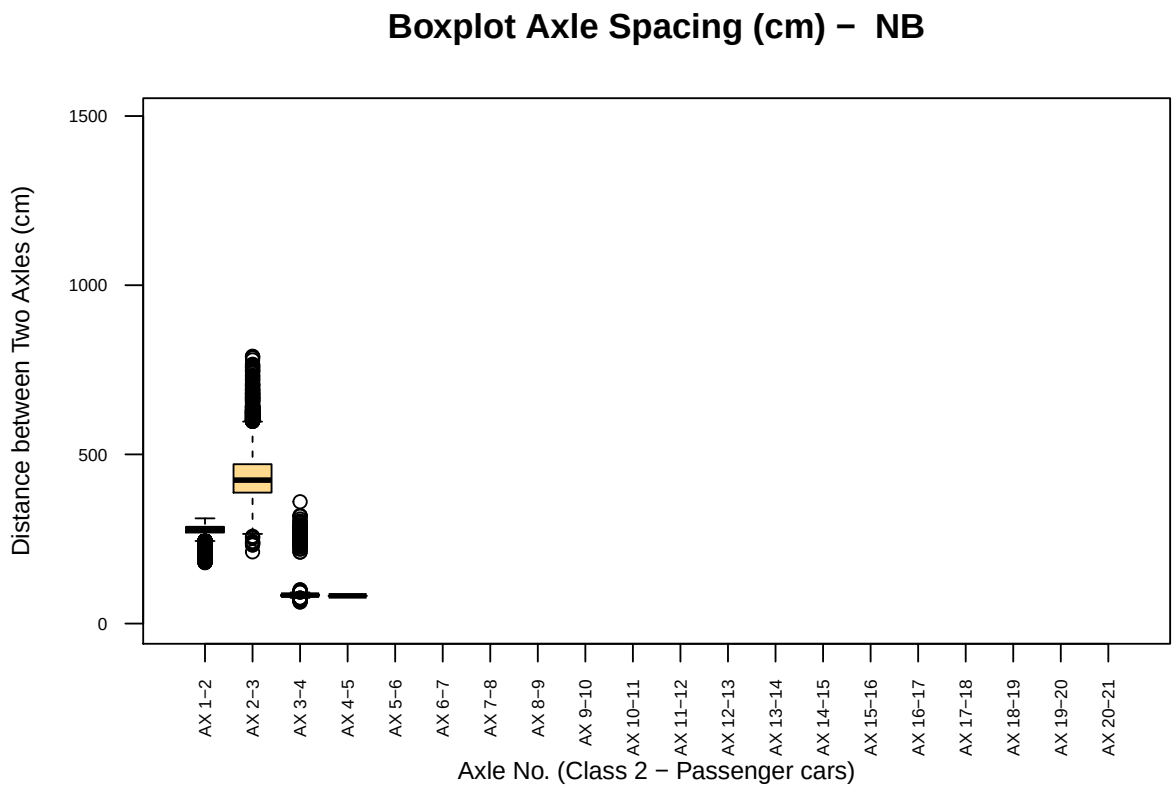

NB
Axle Weight (x1000 lbs)
0
20
40
60
80
AX 1
AX 2
AX 3
AX 4
AX 5
AX 6
AX 7
AX 8
AX 9
AX 10
AX 11
AX 12
AX 13
AX 14
AX 15
AX 16
AX 17
AX 18
AX 19
AX 20
AX 21
Axle No. (Indicated as Class 15 − Unidentified classes)

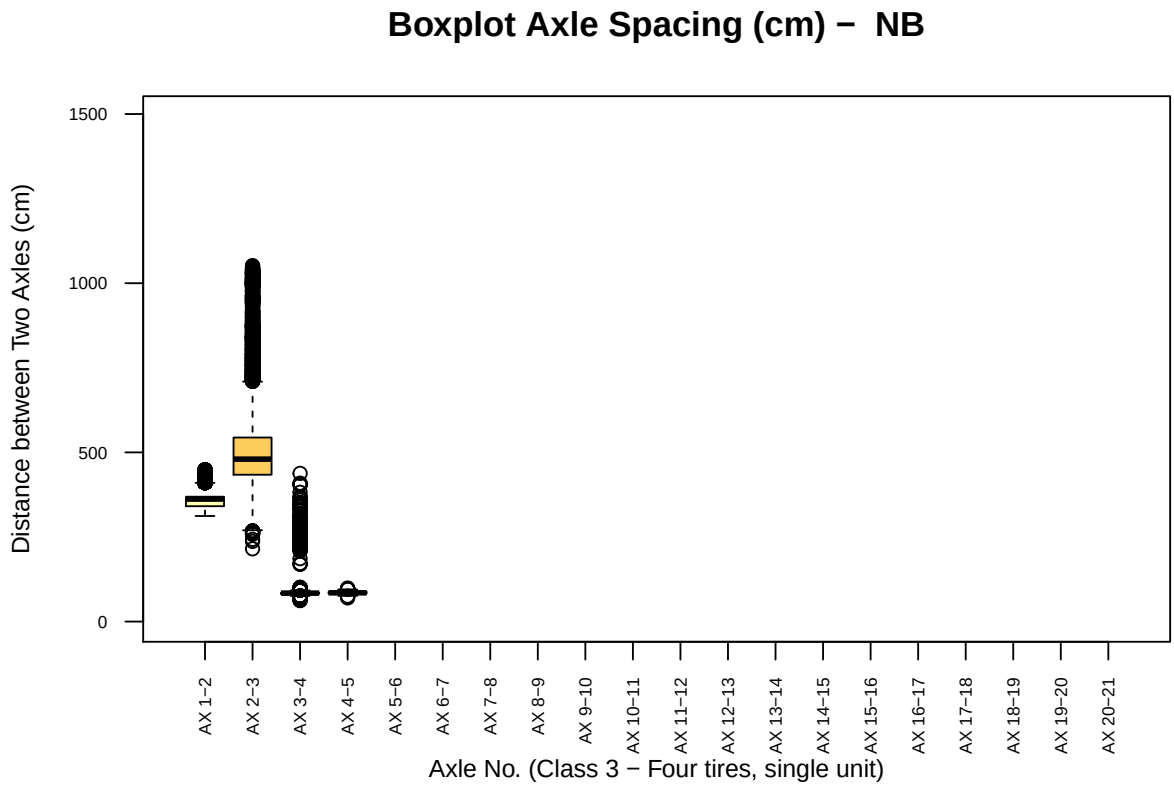


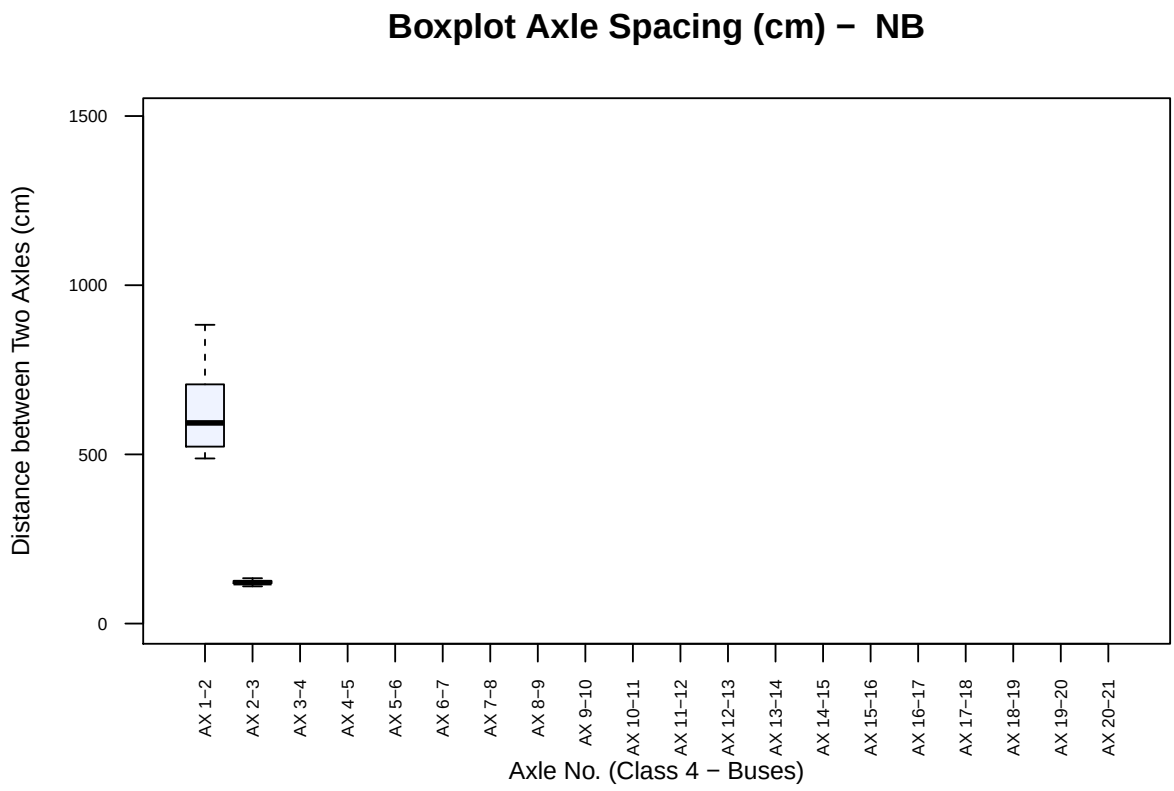
A-4.7.7(d) Direction 2 - Axle spacing by class

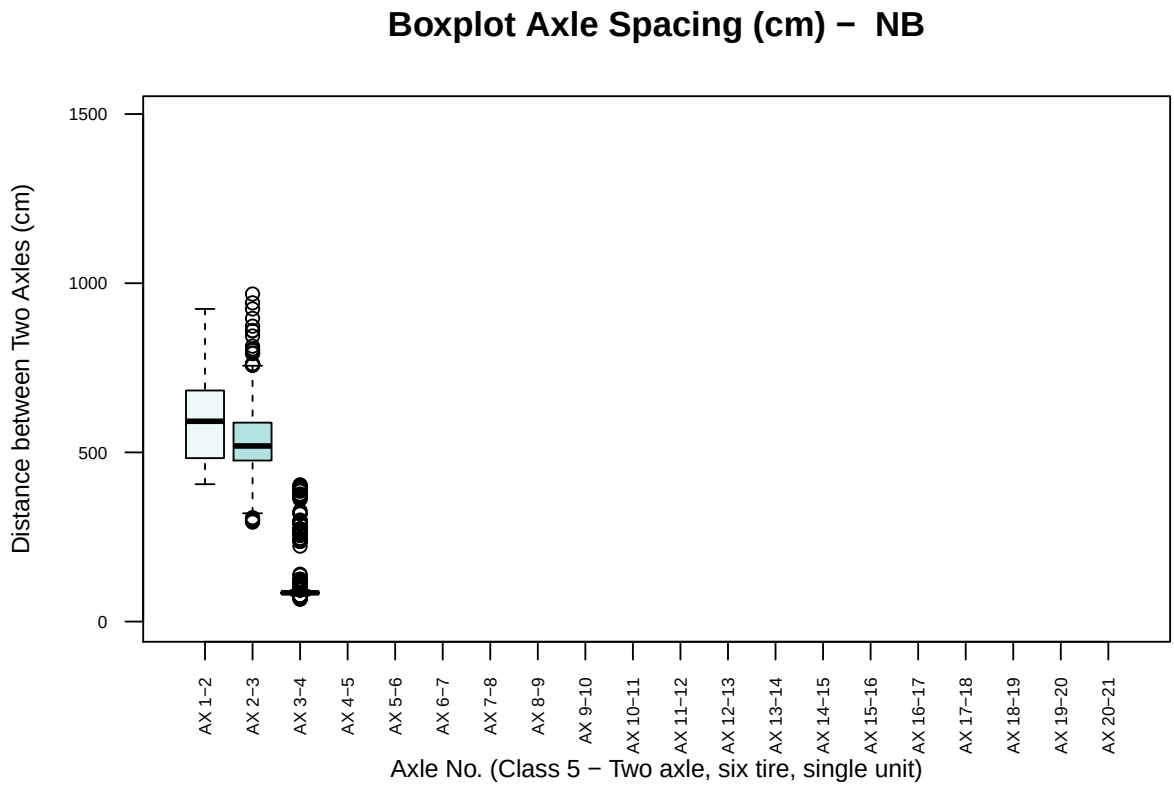


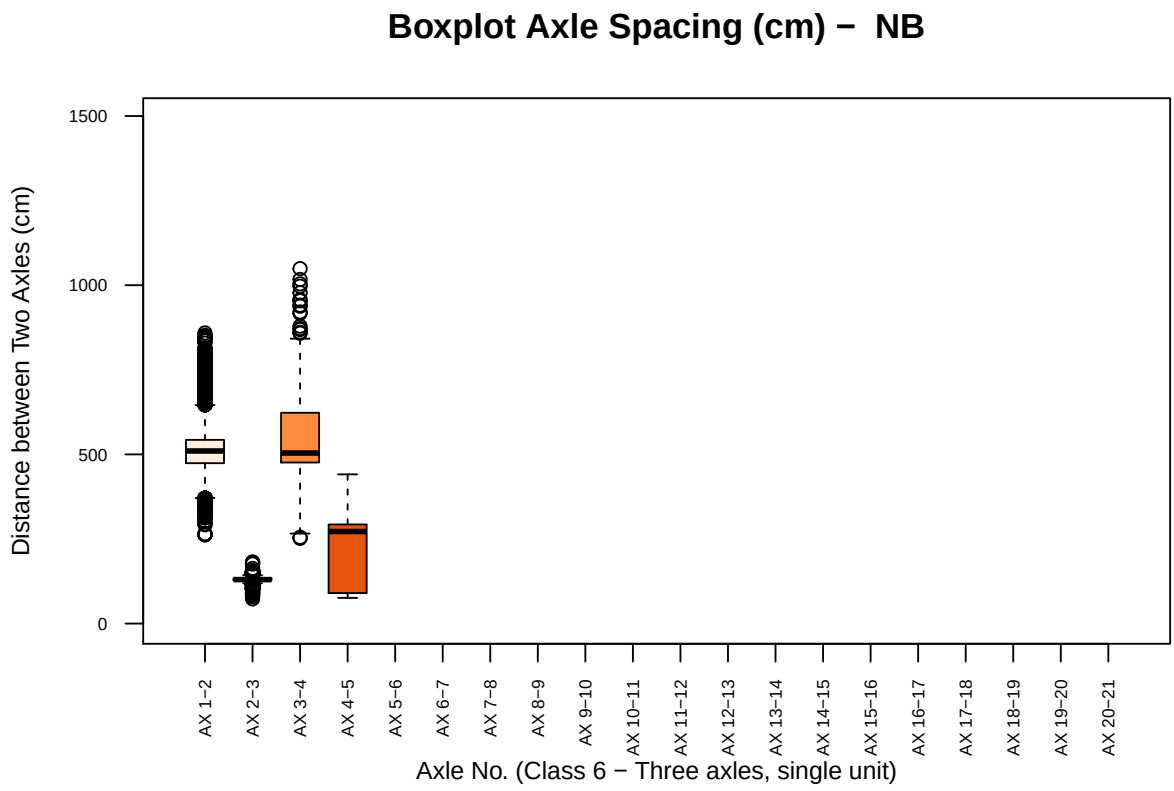

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 1 − Motorcycles)

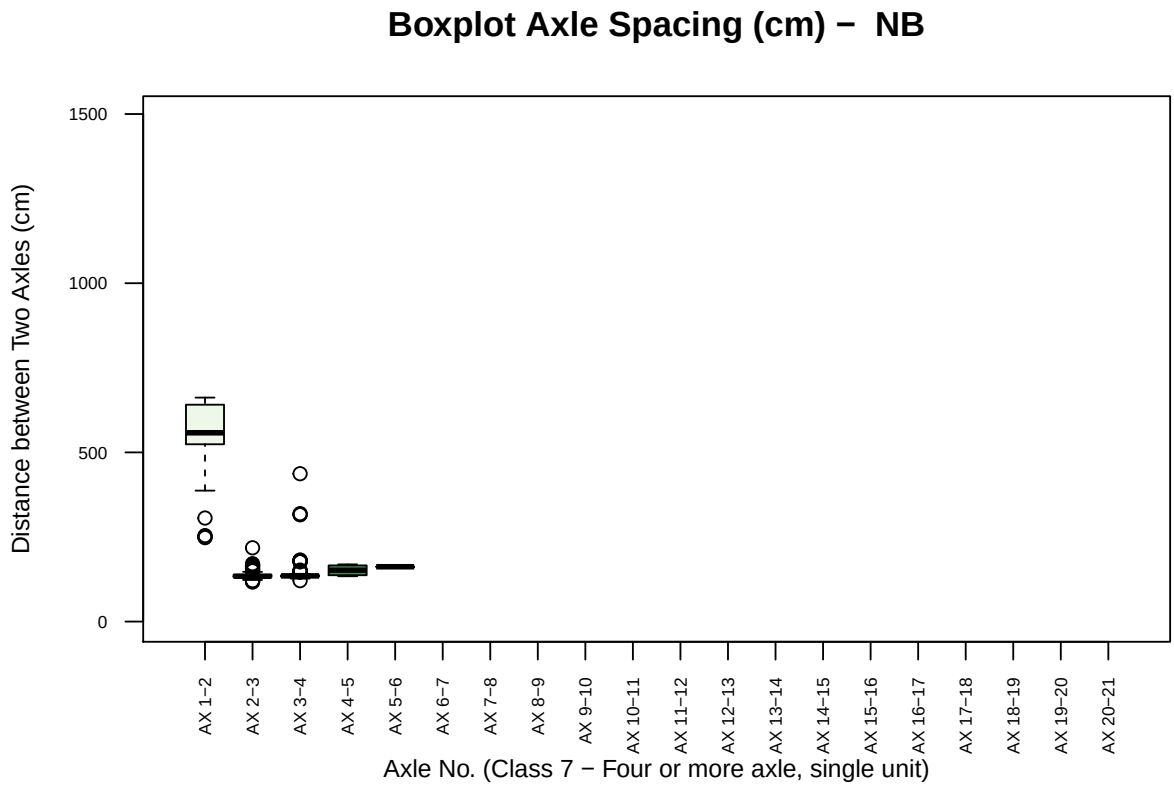

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 2 − Passenger cars)

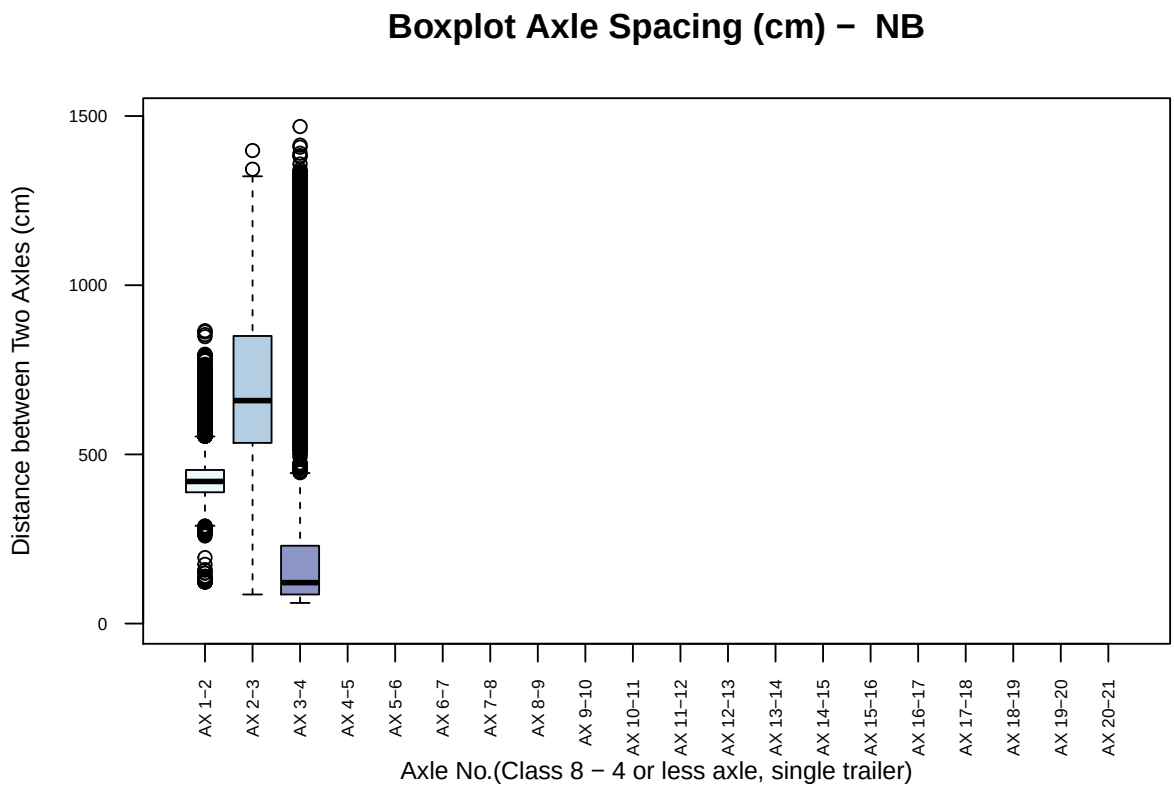

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 3 − Four tires, single unit)

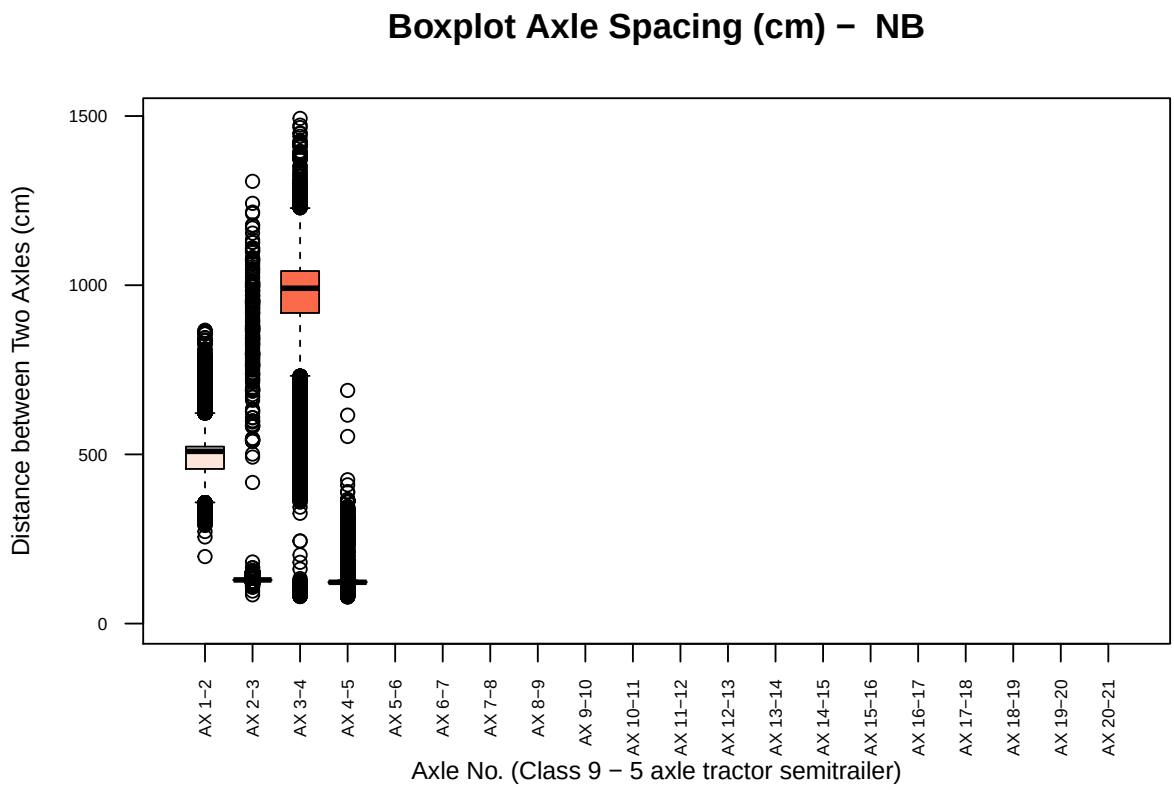

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 4 − Buses)

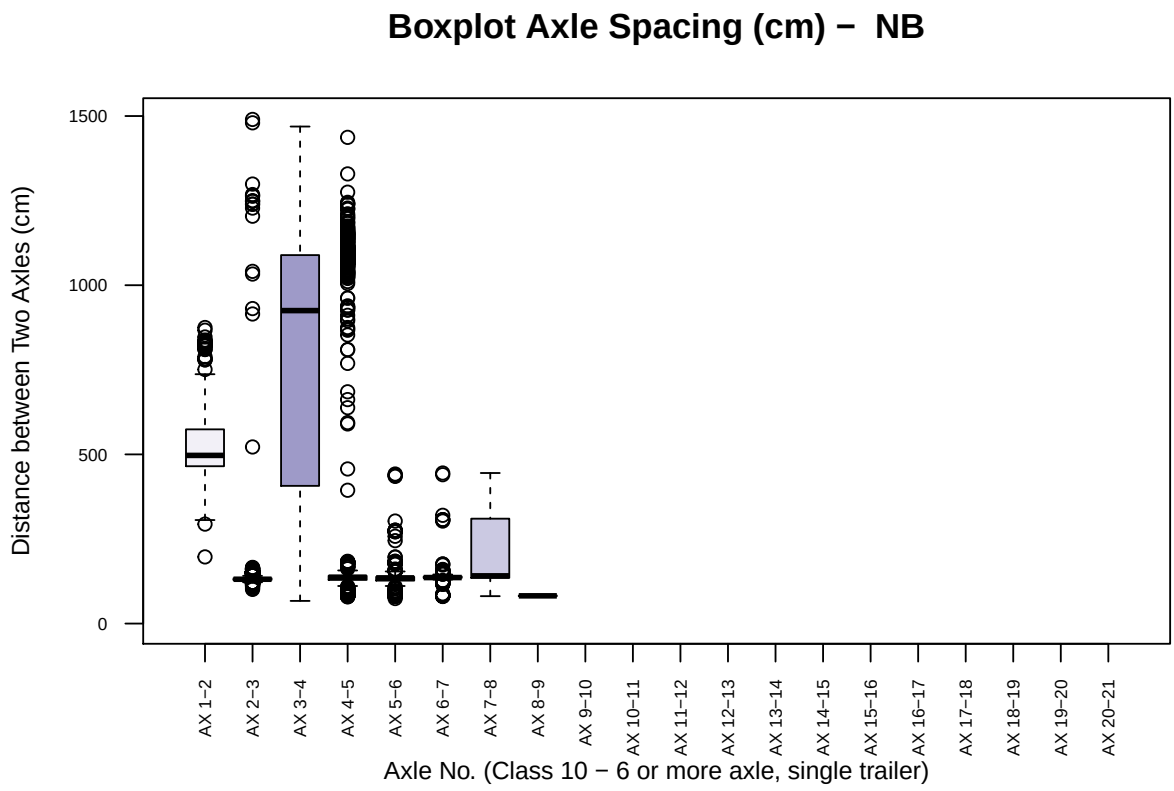

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 5 − Two axle, six tire, single unit)

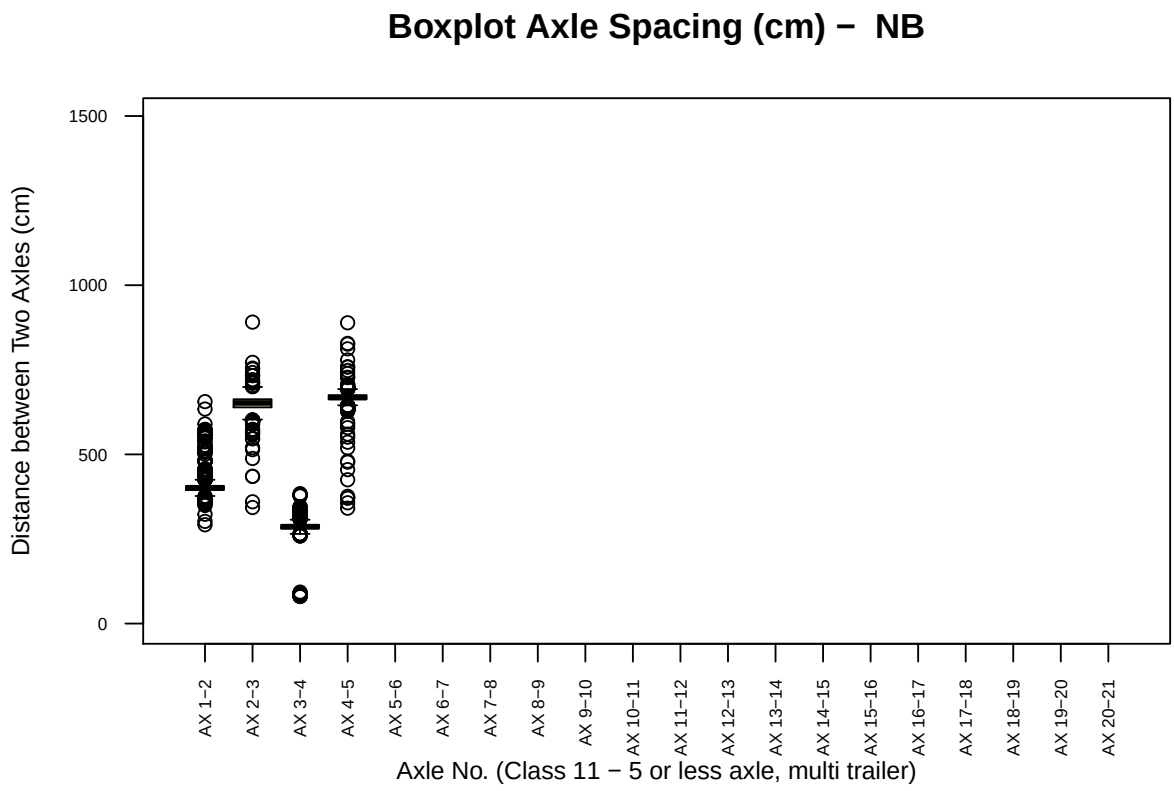

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 6 − Three axles, single unit)

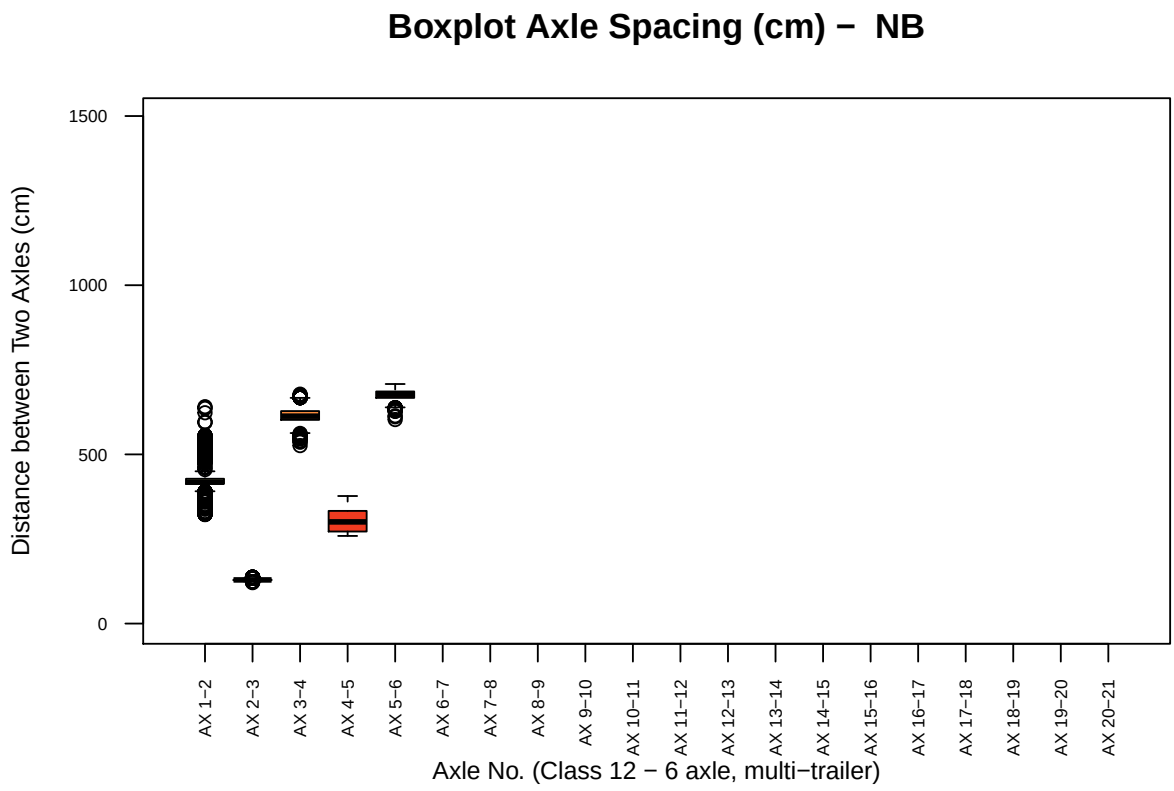

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 7 − Four or more axle, single unit)

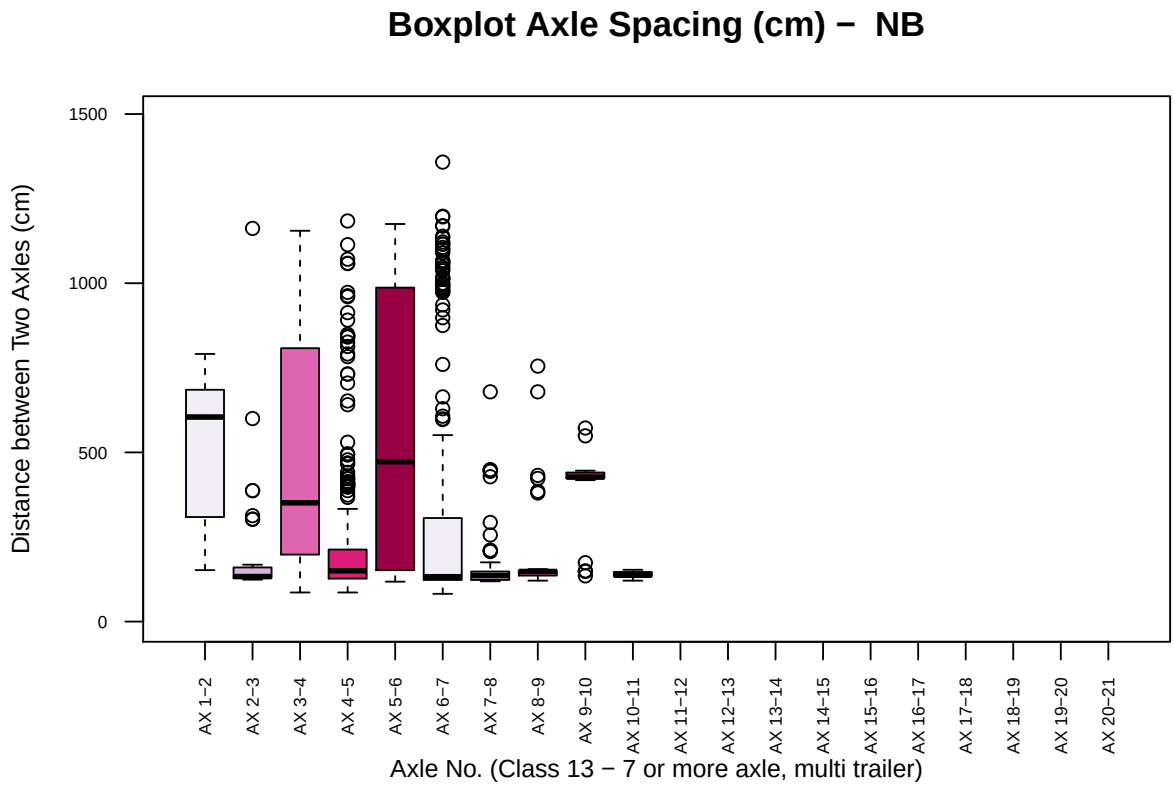

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No.(Class 8 − 4 or less axle, single trailer)

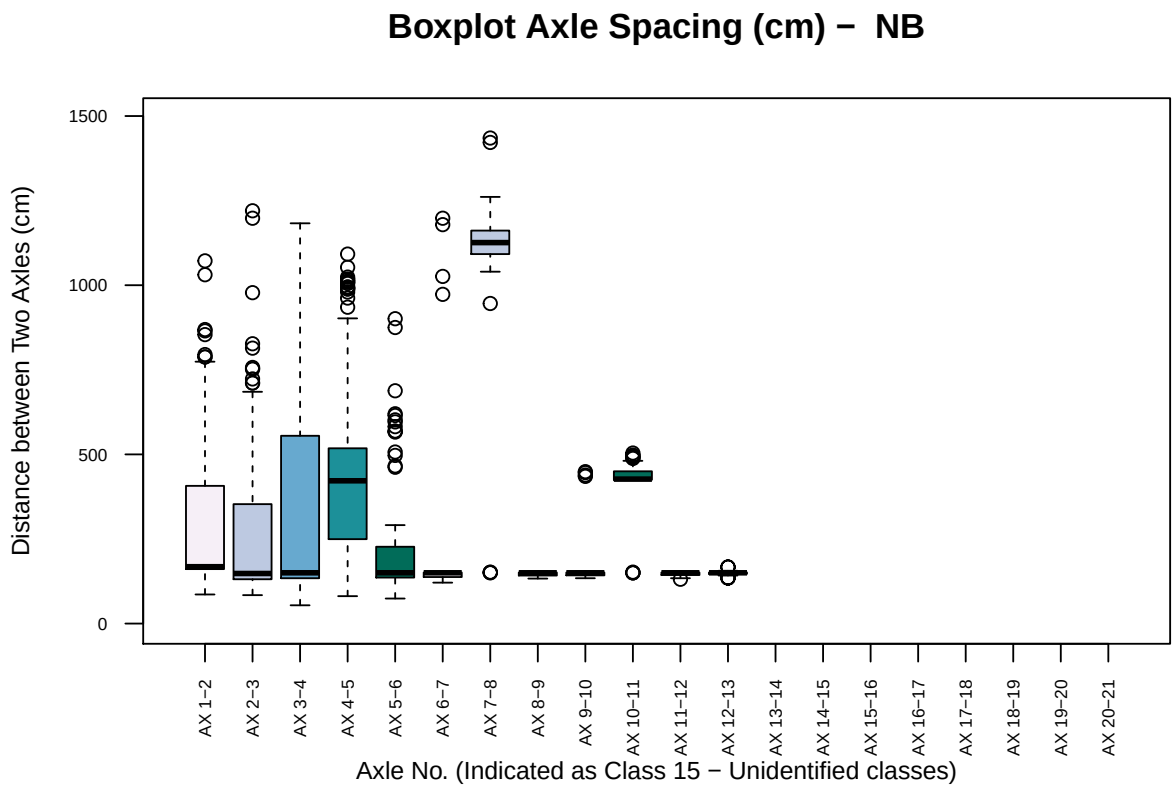

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 9 − 5 axle tractor semitrailer)


Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 10 − 6 or more axle, single trailer)


Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 11 − 5 or less axle, multi trailer)


Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 12 − 6 axle, multi−trailer)

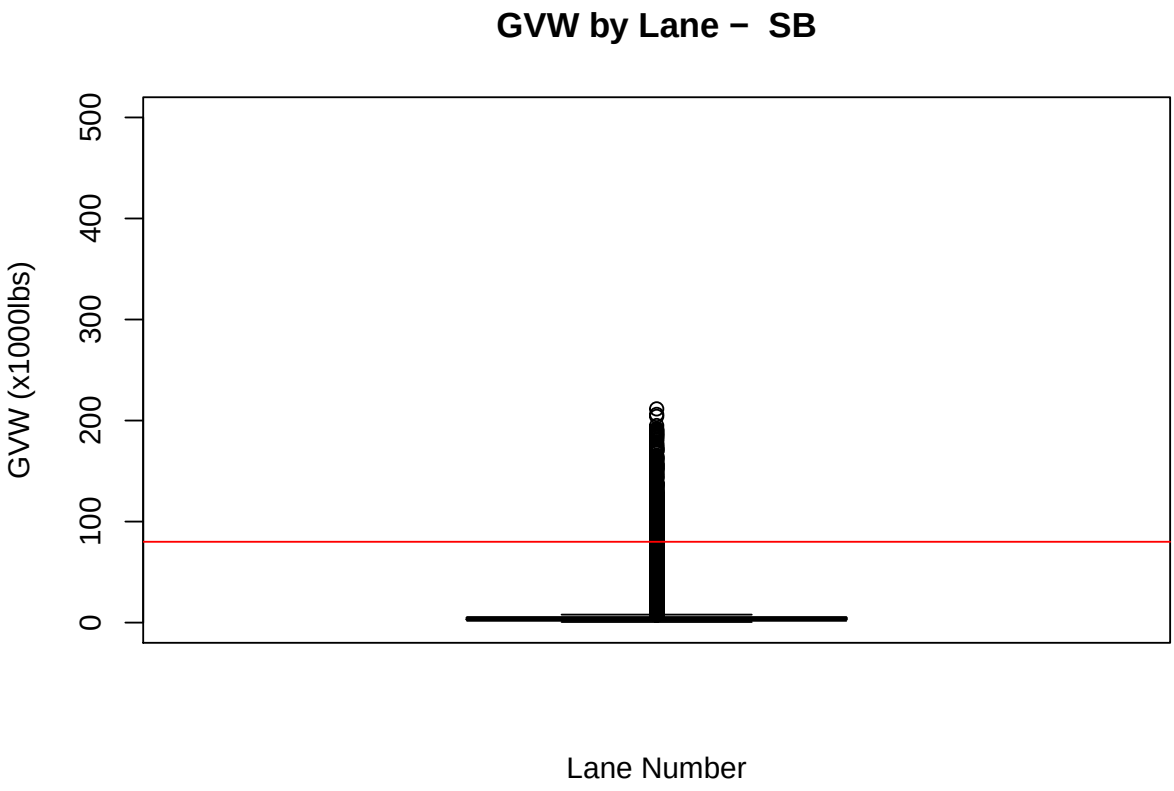

Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Class 13 − 7 or more axle, multi trailer)


Boxplot Axle Spacing (cm) − NB
Distance between Two Axles (cm)
1500
1000
500
0
AX 1−2
AX 2−3
AX 3−4
AX 4−5
AX 5−6
AX 6−7
AX 7−8
AX 8−9
AX 9−10
AX 10−11
AX 11−12
AX 12−13
AX 13−14
AX 14−15
AX 15−16
AX 16−17
AX 17−18
AX 18−19
AX 19−20
AX 20−21
Axle No. (Indicated as Class 15 − Unidentified classes)

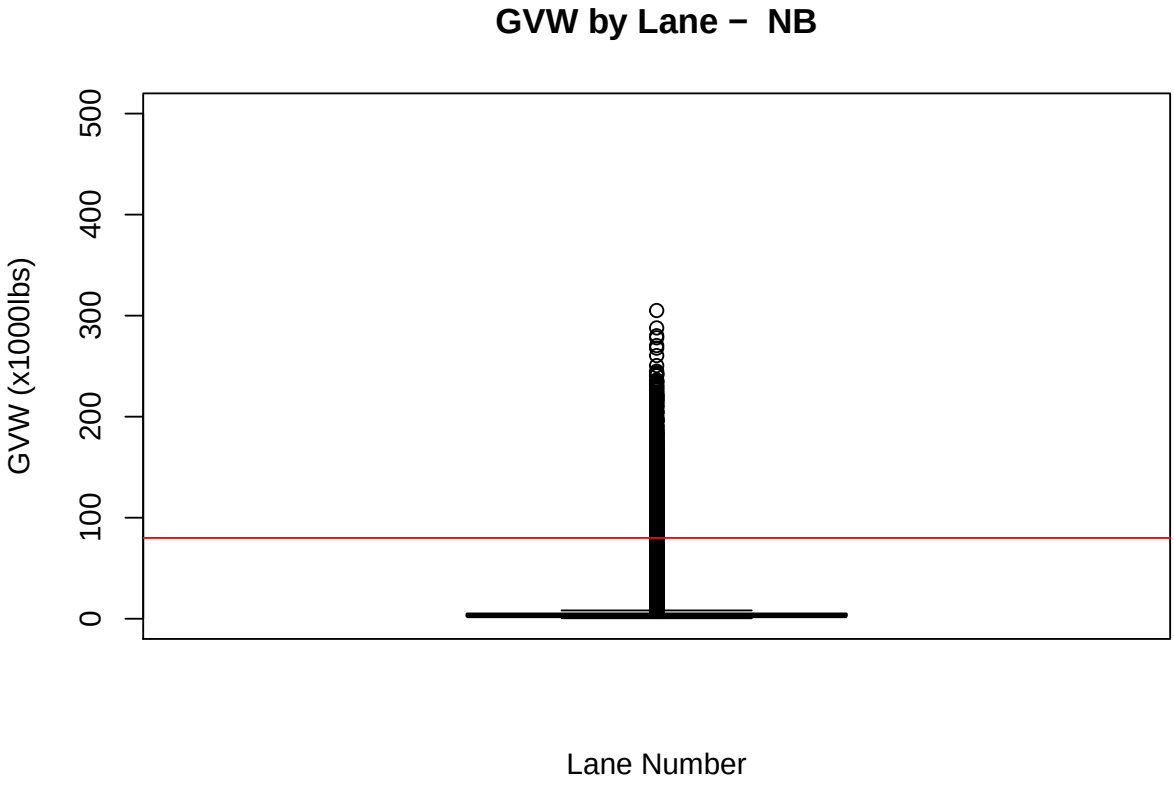
A-4.7.8 Graphical Summary - Gross Vehicle Weight and Length

A-4.7.8(a) GVW by Lane

```
## Boxplot - Direction 1
```

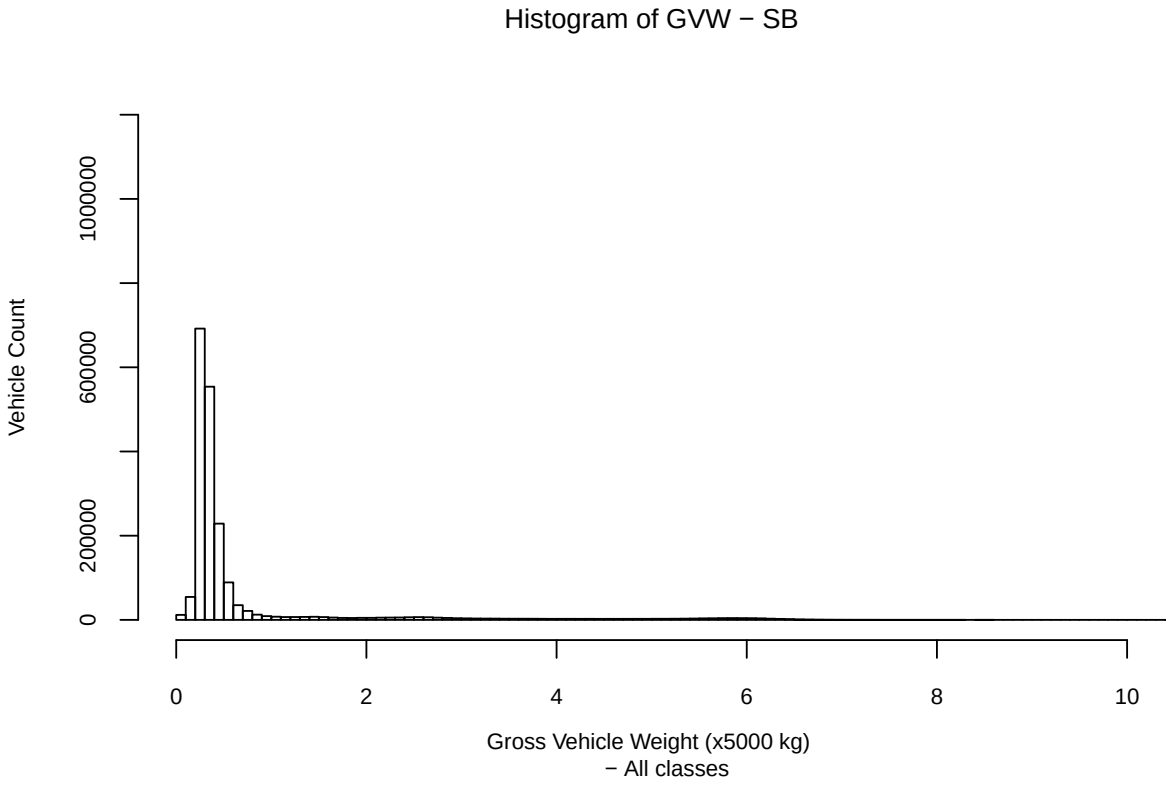


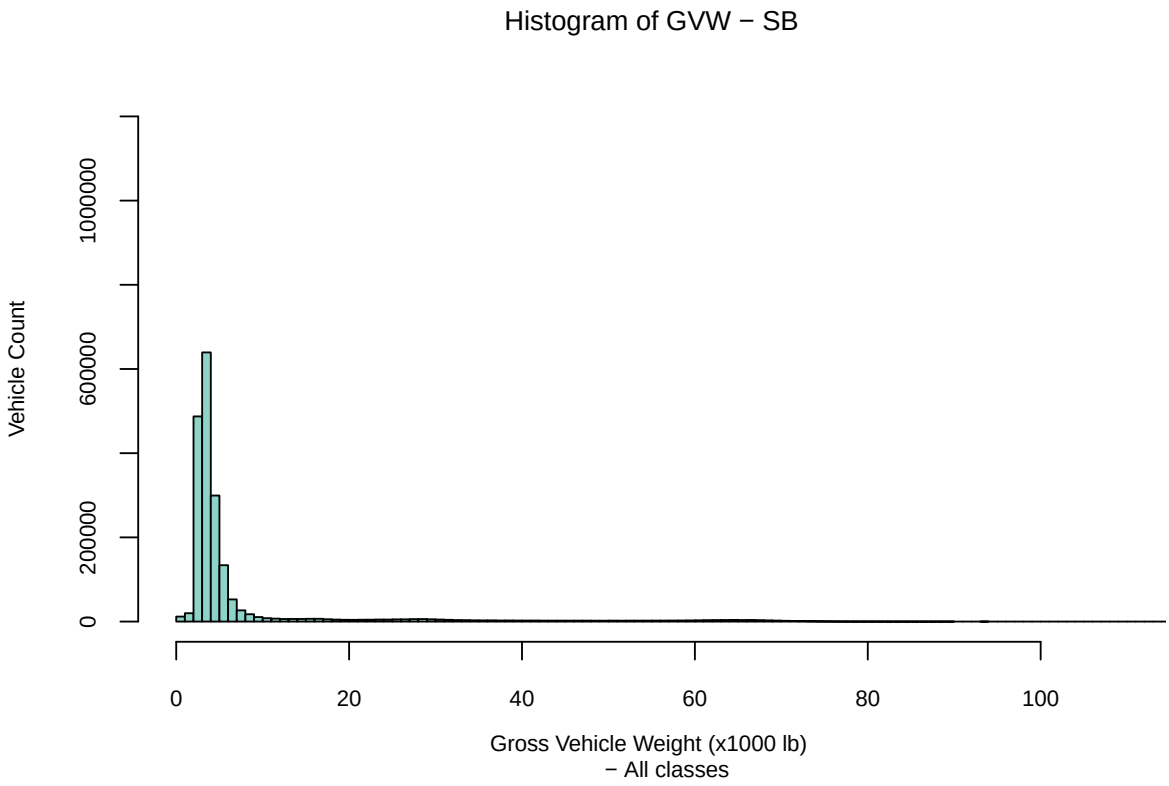
```
## Boxplot - Direction 2
```

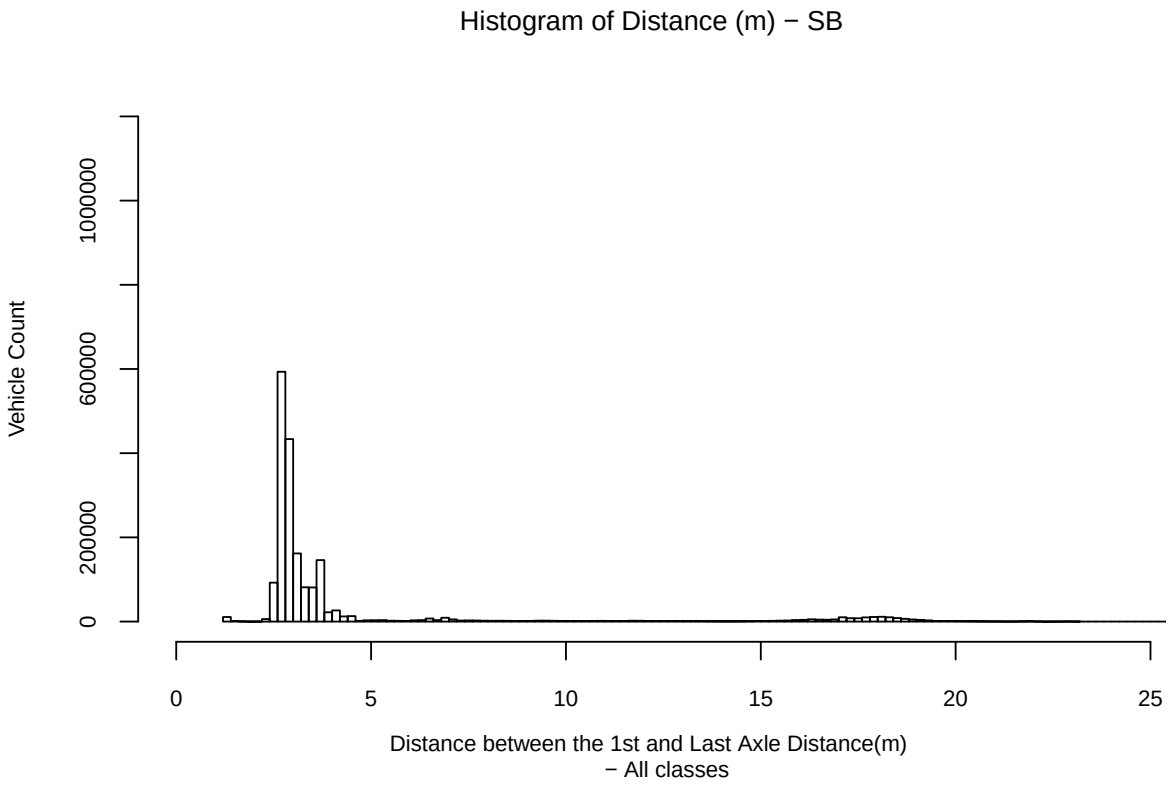


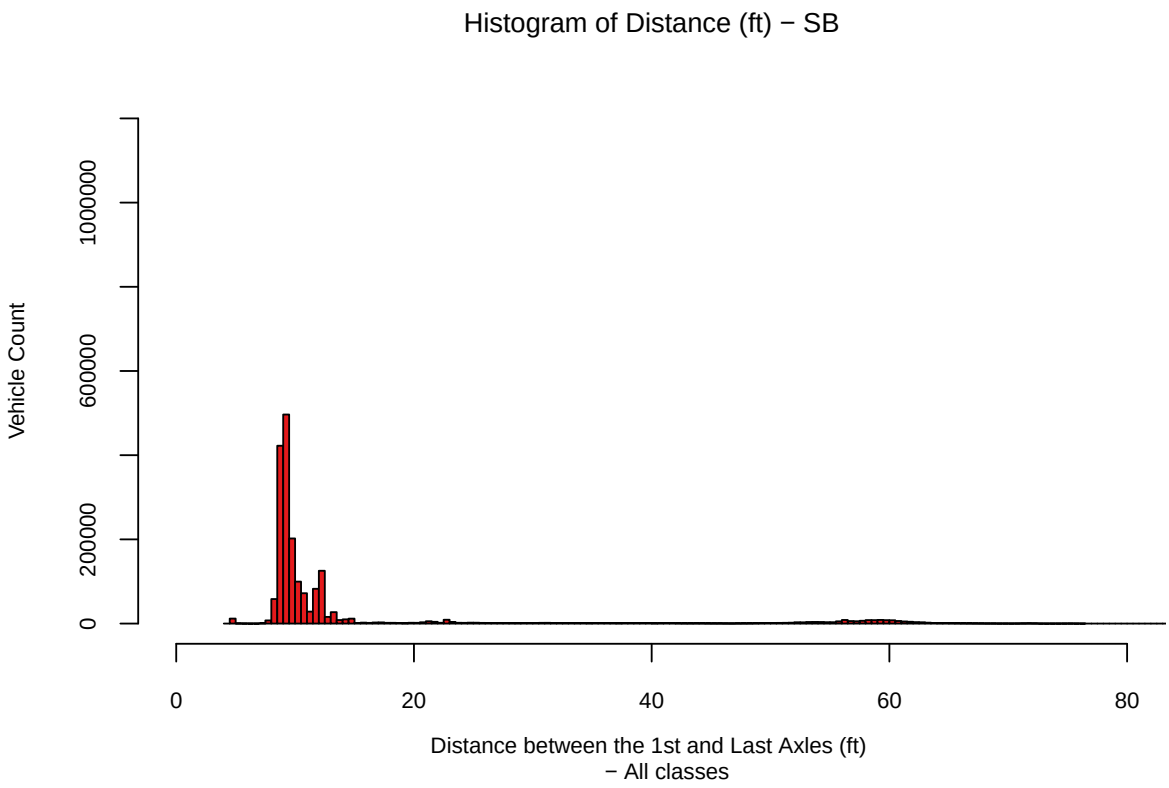
A-4.7.8(b) Direction 1 - GVW and length

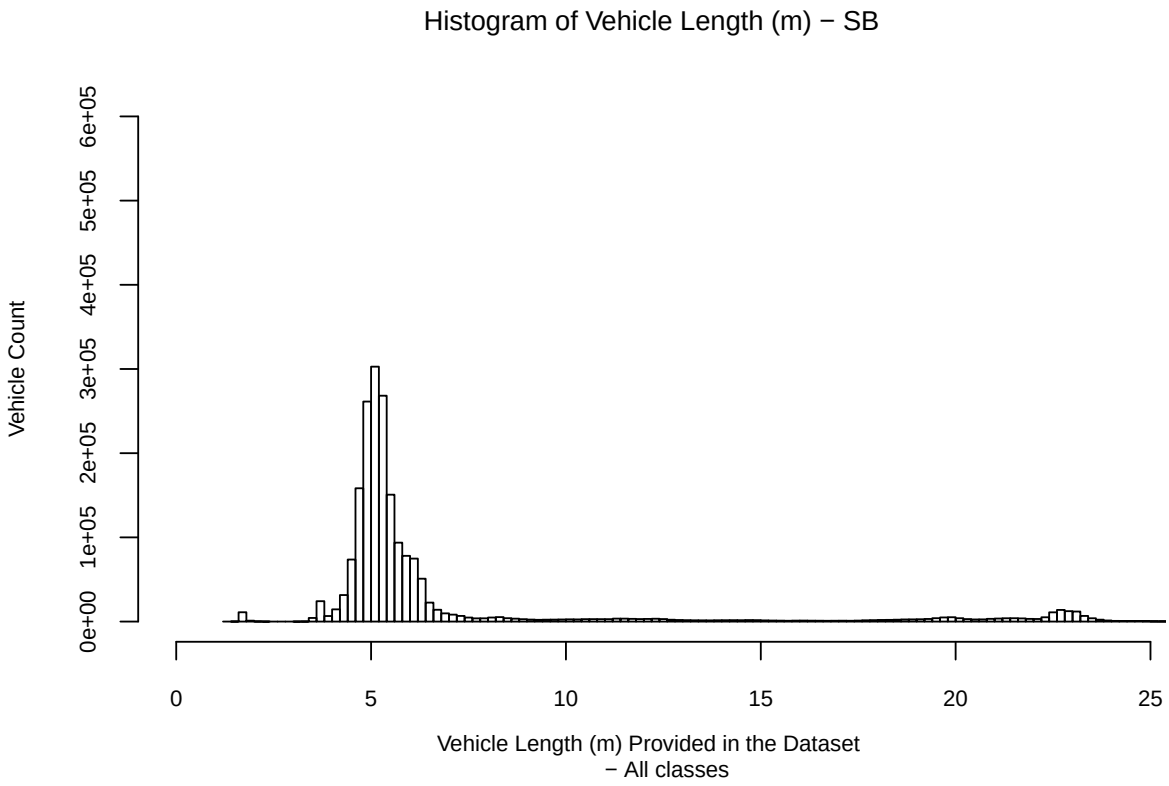
```
##
##  Box plots
```

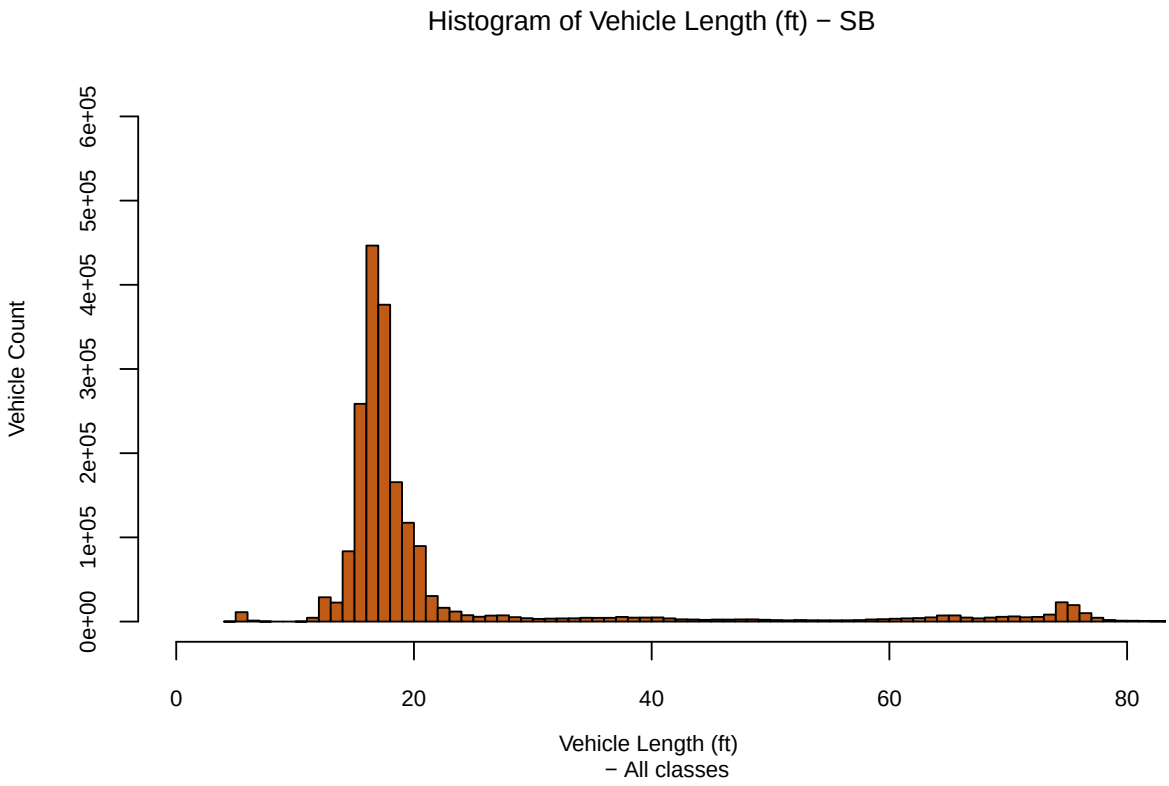



Histogram of GVW − SB
Vehicle Count
0
200000
600000
1000000
0
20
40
60
80
100
Gross Vehicle Weight (x1000 lb)
− All classes


Histogram of Distance (m) − SB
Vehicle Count
0
200000
600000
1000000
0
5
10
15
20
25
Distance between the 1st and Last Axle Distance(m)
− All classes

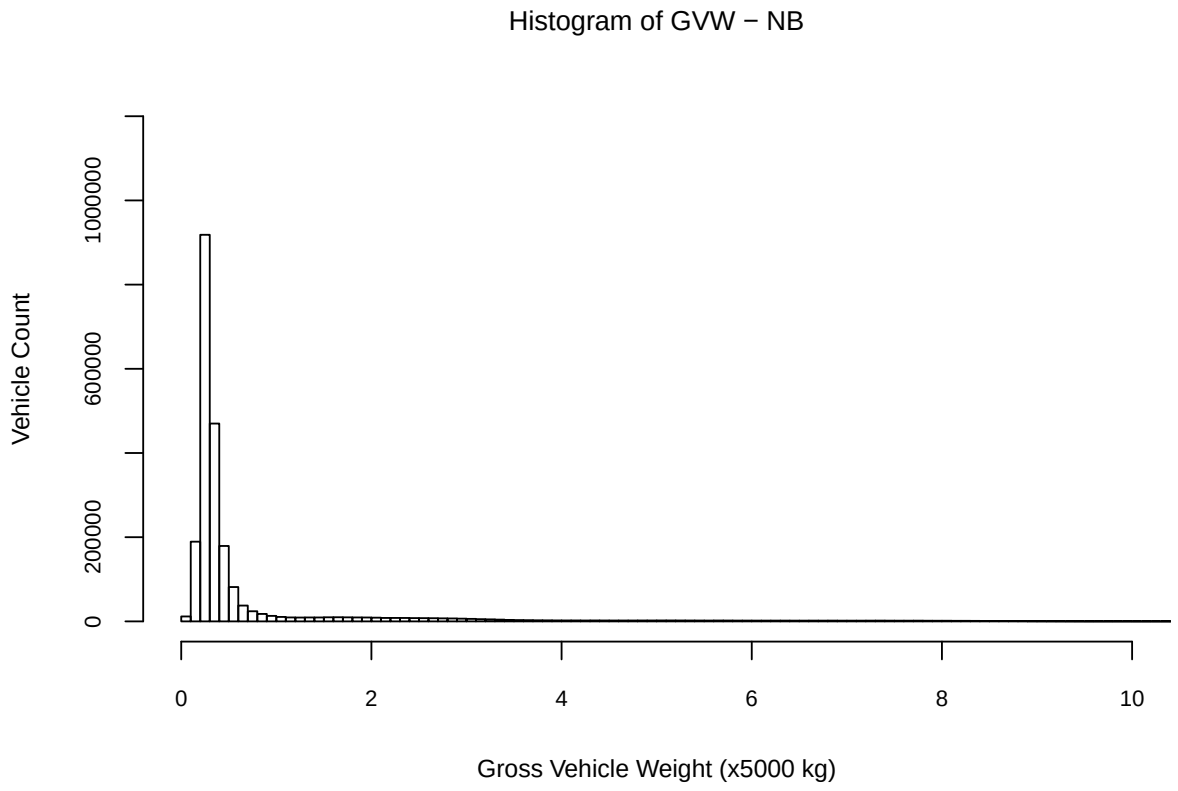

Histogram of Distance (ft) − SB
Vehicle Count
0
200000
600000
1000000
0
20
40
60
80
Distance between the 1st and Last Axles (ft)
− All classes

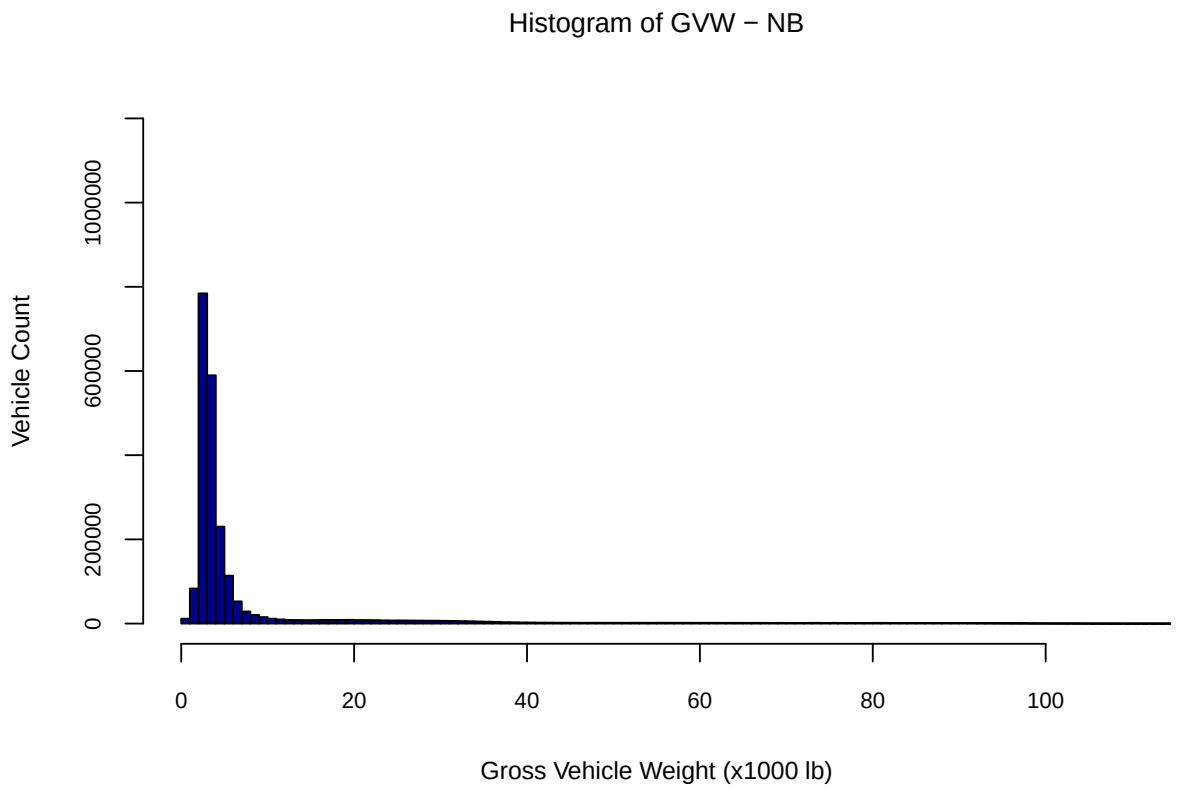

Histogram of Vehicle Length (m) − SB
Vehicle Count
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
0
5
10
15
20
25
Vehicle Length (m) Provided in the Dataset
− All classes

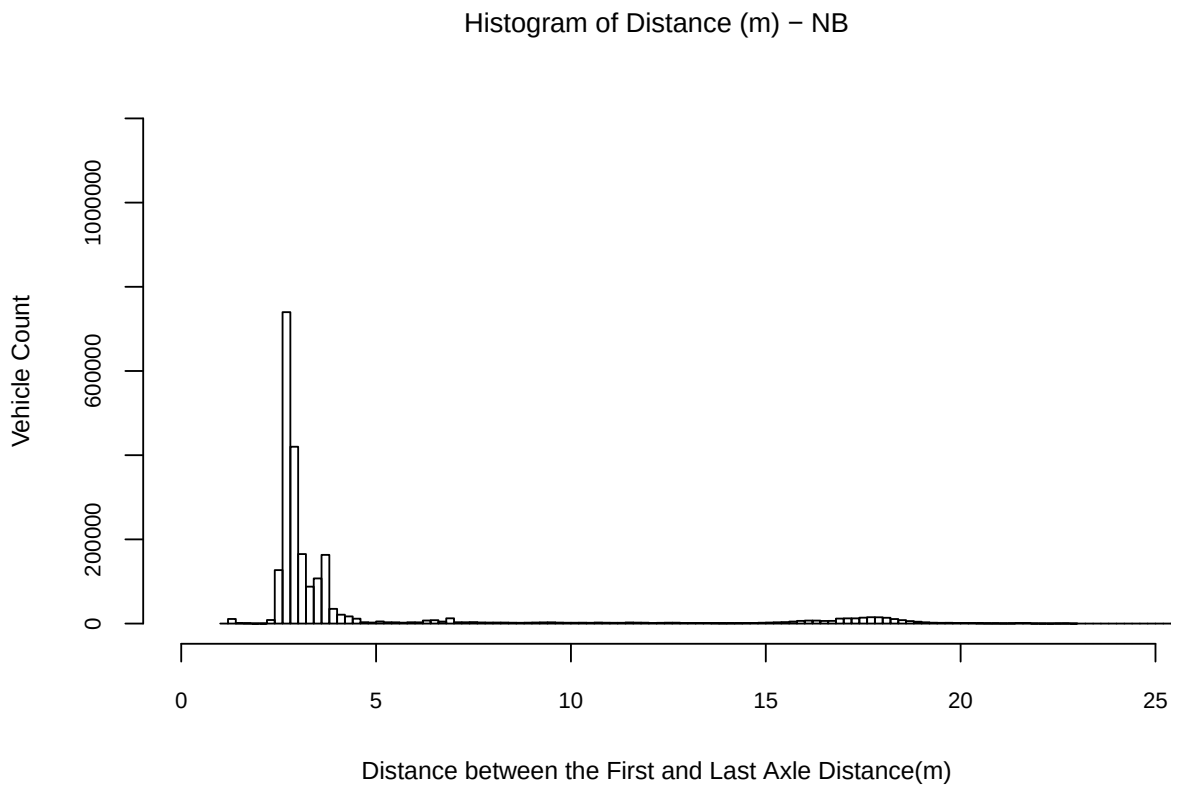

Histogram of Vehicle Length (ft) − SB
Vehicle Count
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
0
20
40
60
80
Vehicle Length (ft)
− All classes

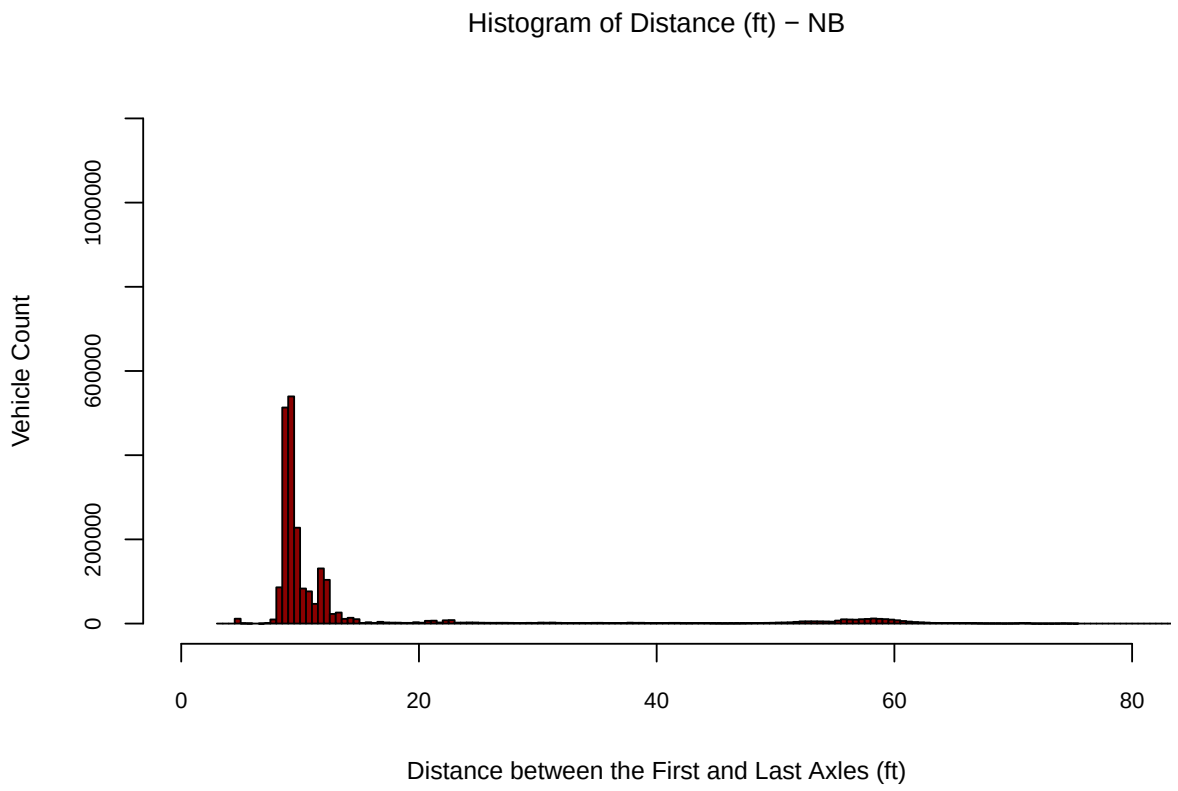
A-4.7.8(c) Direction 2 - GVW and length

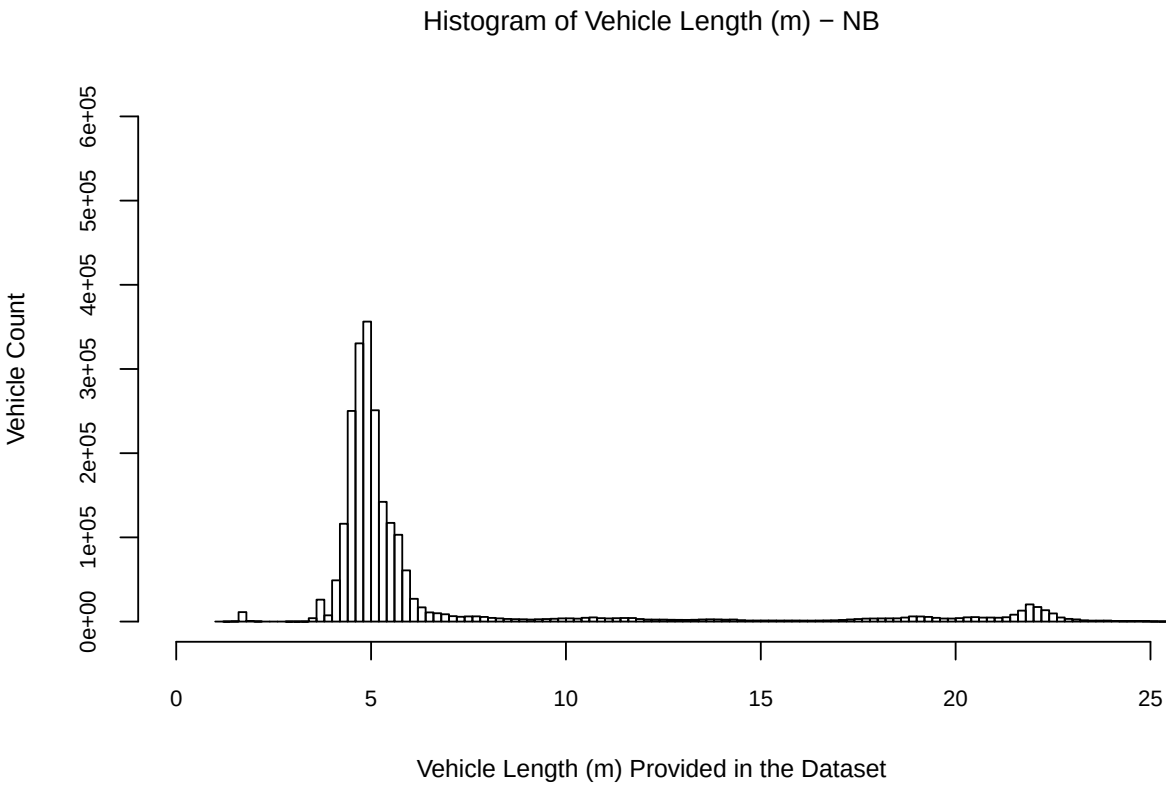
```
## Histograms
```

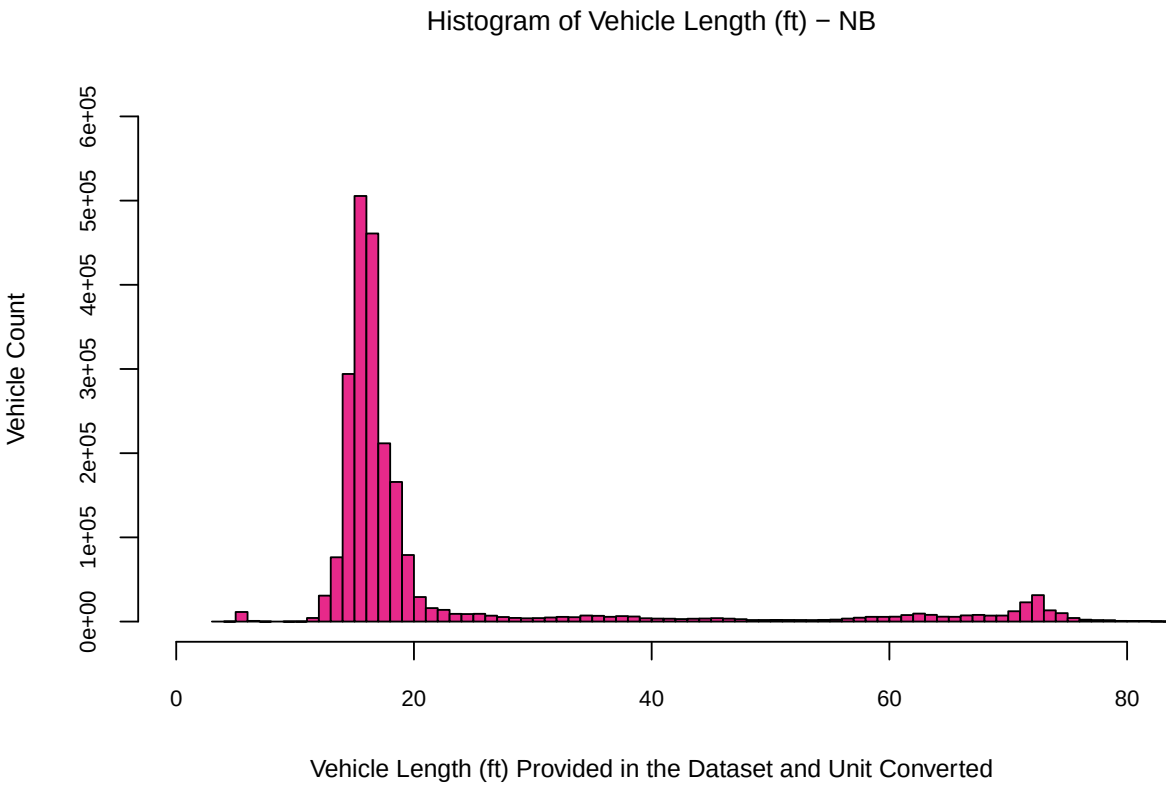


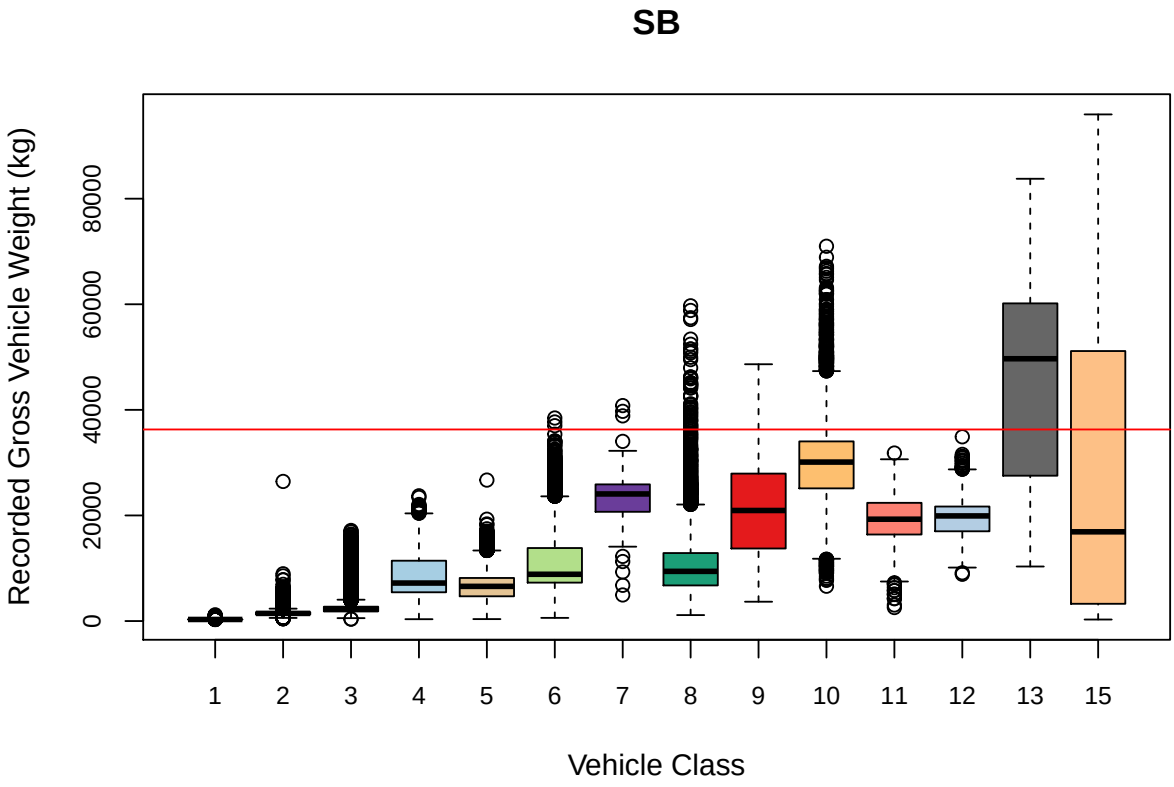

Histogram of GVW − NB
Vehicle Count
0
200000
600000
1000000
0
20
40
60
80
100
Gross Vehicle Weight (x1000 lb)

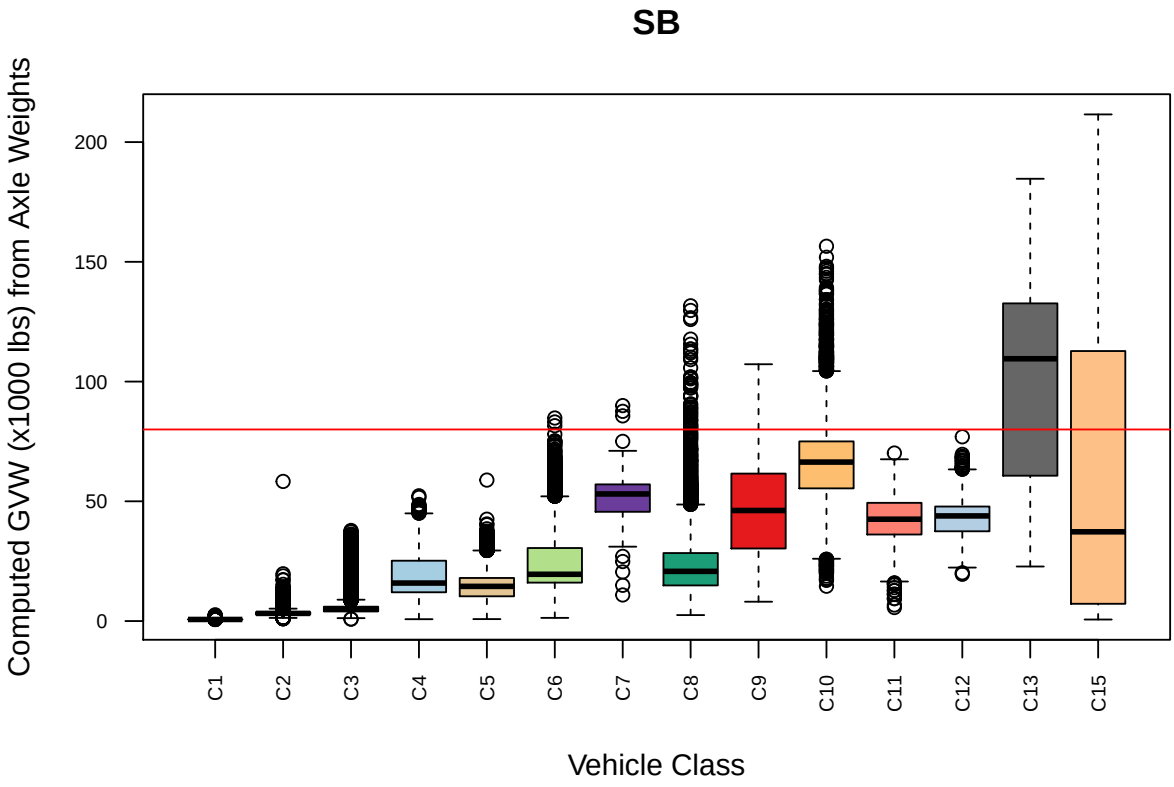

Histogram of Distance (m) − NB
Vehicle Count
0
200000
600000
1000000
0
5
10
15
20
25
Distance between the First and Last Axle Distance(m)

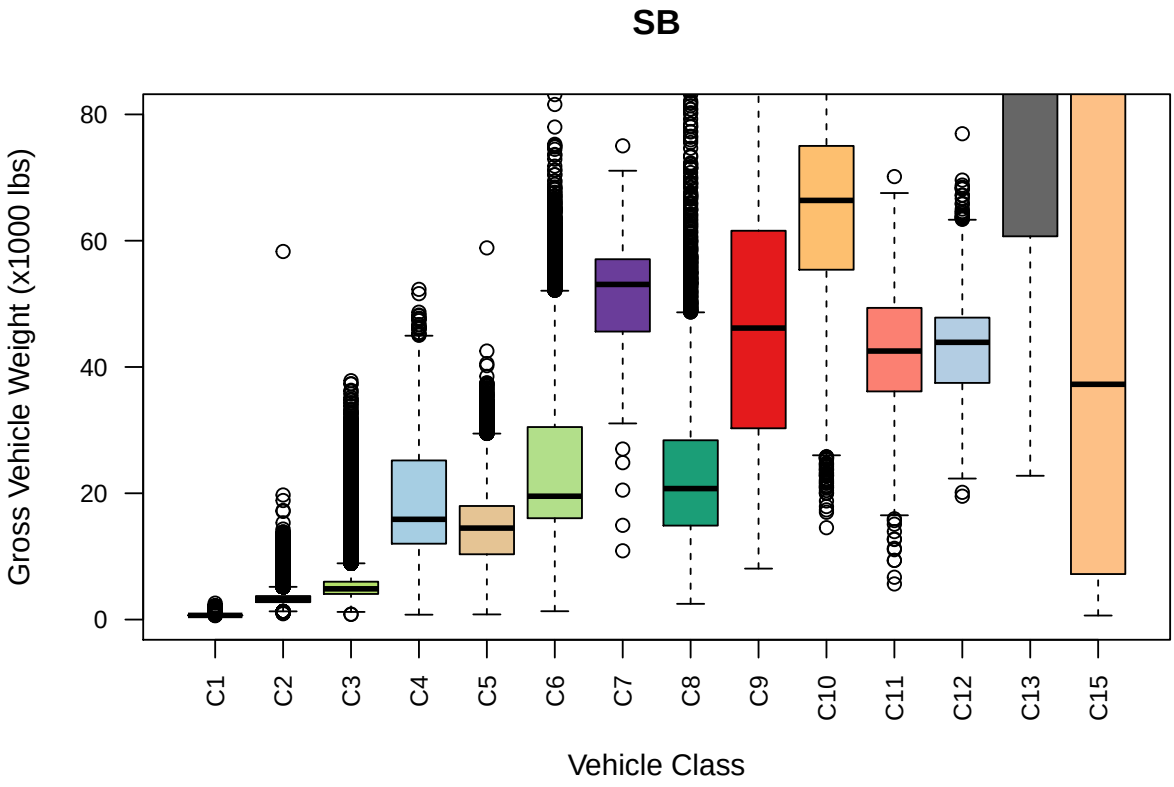

Histogram of Distance (ft) − NB
Vehicle Count
0
200000
600000
1000000
0
20
40
60
80
Distance between the First and Last Axles (ft)

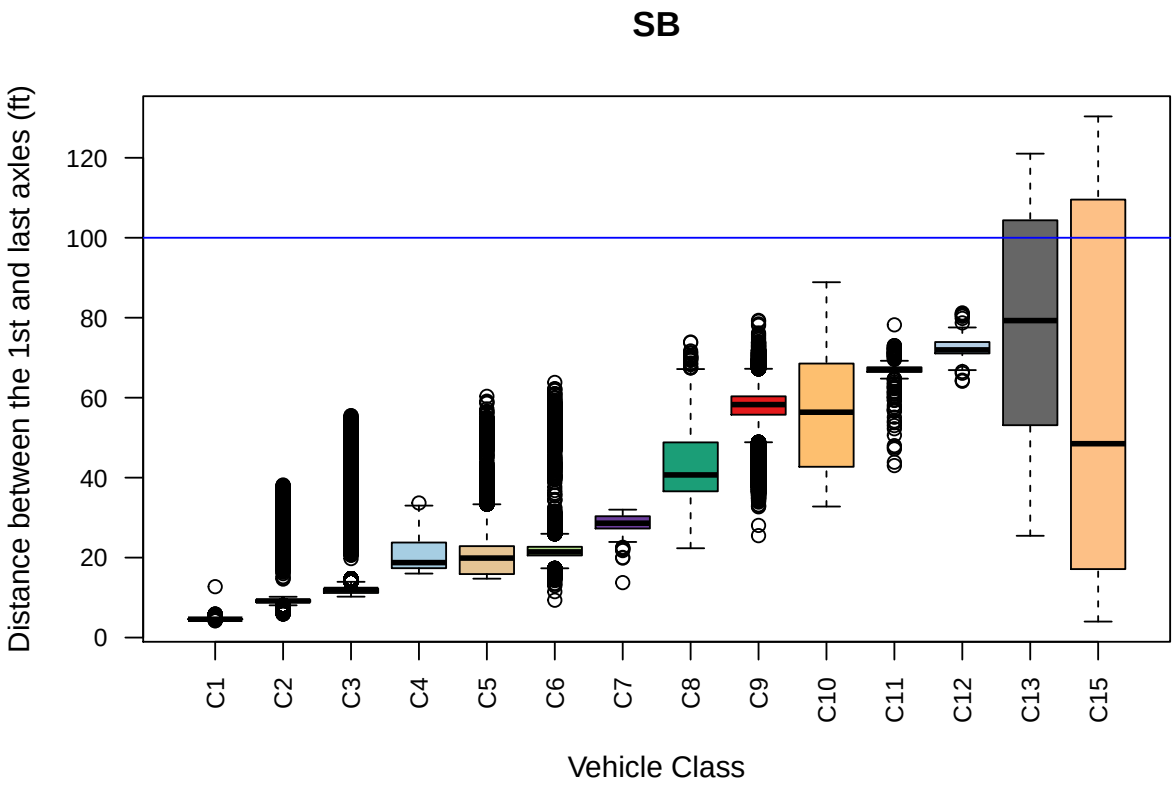

Histogram of Vehicle Length (m) − NB
Vehicle Count
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
0
5
10
15
20
25
Vehicle Length (m) Provided in the Dataset

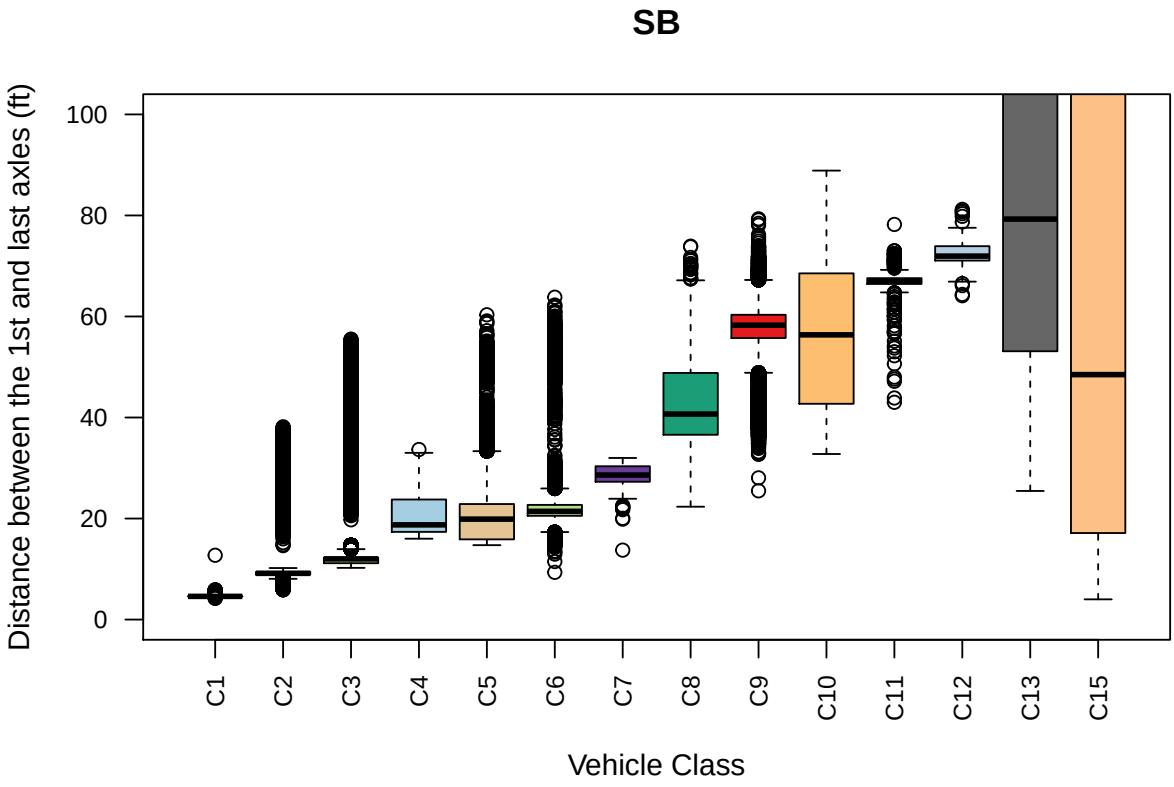

Histogram of Vehicle Length (ft) − NB
Vehicle Count
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
0
20
40
60
80
Vehicle Length (ft) Provided in the Dataset and Unit Converted


SB
Recorded Gross Vehicle Weight (kg)
0
20000
40000
60000
80000
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class


SB
Computed GVW (x1000 lbs) from Axle Weights
200
150
100
50
0
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C15
Vehicle Class


SB
Gross Vehicle Weight (x1000 lbs)
0
20
40
60
80
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C15
Vehicle Class


SB
Distance between the 1st and last axles (ft)
0
20
40
60
80
100
120
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C15
Vehicle Class


SB
Distance between the 1st and last axles (ft)
0
20
40
60
80
100
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C15
Vehicle Class

A-4.7.9 Numercial Summary - % Vehicle Counts with GVW and Length Exceeding a Threshold.

A-4.7.9(a) Direction 1 - % Vehicle counts with GVW and length exceeding a threshold

```
## SB - Number of Class 9 (or 5-axle)
##      vehicles with the 9th axle load: 0 vehicles
##


## SB - Proportion of Vehicles with GVW > 80,000 lbs: 0.07 %

## SB - Number of Vehicles with GVW > 80,000 lbs: 1256
##


## SB - Proportion of Vehicles with Length > 100 ft: 0.01 %

## SB - Number of Vehicles with Length > 100 ft: 146
##


## SB Class 1 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.6     0.7     0.7     0.7     0.7     2.6

## SB Class 2 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.9     2.8     3.2     3.3     3.7    58.3

## SB Class 3 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8     4.1     4.9     5.3     6.0    37.8

## SB Class 4 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8    12.0    15.9    19.4    25.2    52.3

## SB Class 5 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8    10.3    14.5    14.7    18.0    58.9
```

```
## SB Class 6 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     1.3    16.0    19.5    24.7    30.5    84.8

## SB Class 7 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    10.9    45.8    53.1    51.4    57.1    90.0

## SB Class 8 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     2.5    14.9    20.7    22.4    28.4   131.6

## SB Class 9 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     8.1    30.3    46.2    46.1    61.6   107.2

## SB Class 10 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    14.6    55.4    66.4    66.7    75.0   156.5

## SB Class 11 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     5.6    36.1    42.5    42.6    49.4    70.2

## SB Class 12 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    19.5    37.5    43.9    43.3    47.8    76.9

## SB Class 13 - Summary of GVW (lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    22.8    60.9   109.5   100.8   132.5   184.7

## SB Class 1 - Summary of Distance (ft)
##     bewteen First and Last Axles:
```
292

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     4.2     4.6     4.6     4.7     4.6    12.7

## SB Class 2 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     5.9     8.9     9.2     9.2     9.4    38.2

## SB Class 3 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    10.2    11.2    12.0    12.8    12.3    55.5

## SB Class 4 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    16.0    17.4    18.8    21.2    23.8    33.7

## SB Class 5 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    14.7    15.9    19.9    20.4    22.9    60.3

## SB Class 6 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.4    20.5    21.4    22.3    22.7    63.8

## SB Class 7 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    13.7    27.3    28.6    28.1    30.3    32.0

## SB Class 8 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    22.3    36.6    40.7    42.5    48.8    73.9
```

```
## SB Class 9 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    25.5    55.7    58.3    57.7    60.3    79.3

## SB Class 10 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    32.8    42.7    56.4    56.0    68.5    88.9

## SB Class 11 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    43.0    66.4    67.0    66.8    67.6    78.2

## SB Class 12 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    64.1    71.1    71.9    72.1    73.9    81.2

## SB Class 13 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    25.5    53.1    79.3    79.3   104.2   121.0
```

A-4.7.9(b) Direction 2 - % Vehicle counts with GVW and length exceeding a threshold

```
## NB - Proportion of Vehicles with GVW > 80,000 lbs: 1.13 %

## NB - Number of Vehicles with GVW > 80,000 lbs: 25359
##

## NB - Proportion of Vehicles with Length > 100 ft: 0.01 %

## NB - Number of Vehicles with Length > 100 ft: 171

## NB Class 1 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.7     0.7     0.7     0.7     0.7     2.5

## NB Class 2 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.5     2.5     2.9     3.1     3.5    60.5

## NB Class 3 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.5     3.4     4.5     5.1     6.0    64.9

## NB Class 4 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     3.3    13.0    18.4    22.7    30.6    68.5

## NB Class 5 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     2.1    11.6    16.1    17.0    20.9    65.8

## NB Class 6 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     3.3    14.9    20.0    24.6    29.2   147.0

## NB Class 7 - Summary of GVW (x1000 lbs):
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.5    47.1    59.7    60.6    73.1   135.1

## NB Class 8 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     2.5    15.9    22.0    24.6    30.2   138.0

## NB Class 9 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     7.2    26.4    37.4    46.3    65.6   164.1

## NB Class 10 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.5    40.1    65.0    71.6    90.9   221.5

## NB Class 11 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     5.5    25.1    32.6    35.5    43.2    90.8

## NB Class 12 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    13.3    35.8    46.9    48.9    61.1   104.4

## NB Class 13 - Summary of GVW (x1000 lbs):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    39.1    86.2   129.1   127.6   160.8   250.6

## NB Class 1 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     3.3     4.6     4.6     4.6     4.6    13.0

## NB Class 2 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     5.9     8.8     9.1     9.2     9.4    41.5
```

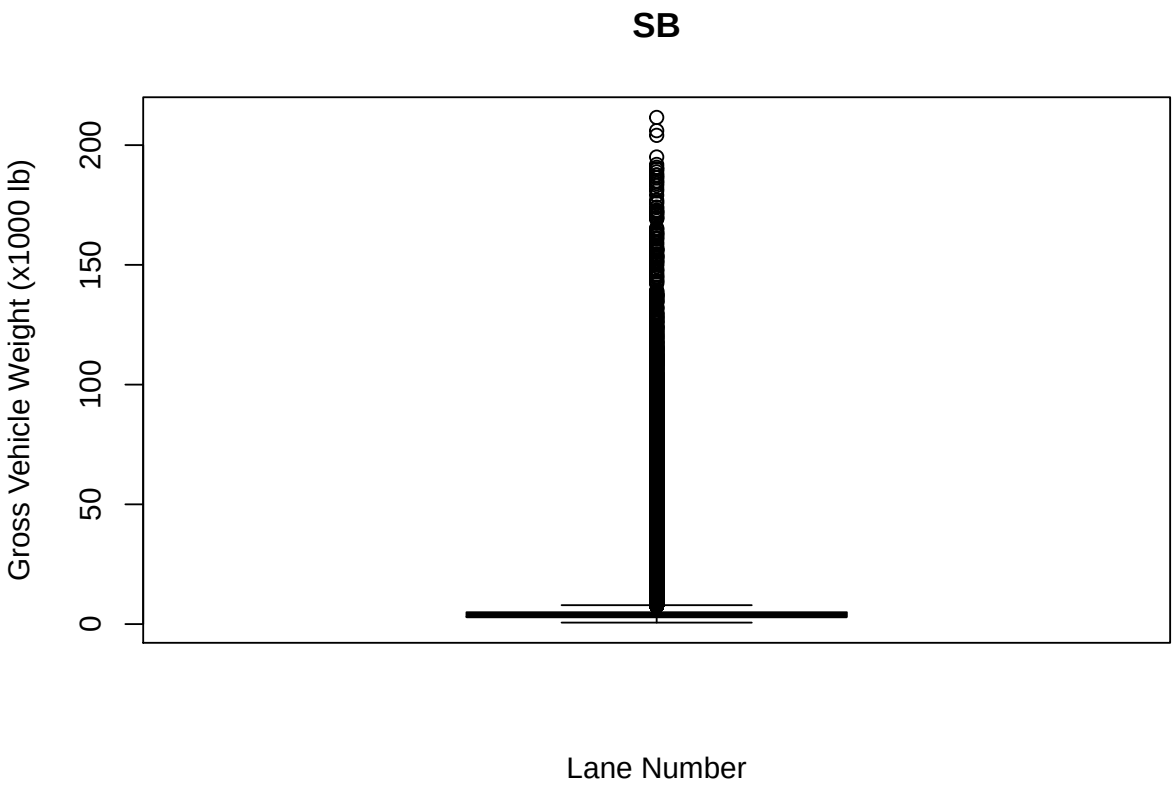
```
## NB Class 3 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    10.2    11.3    11.9    12.8    12.2    54.8

## NB Class 4 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    16.0    17.2    19.5    21.6    25.7    33.3

## NB Class 5 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    14.7    16.7    21.0    20.5    22.5    61.5

## NB Class 6 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    11.1    19.8    21.0    21.7    22.2    63.4

## NB Class 7 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    20.8    26.8    28.0    27.6    29.9    35.0

## NB Class 8 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    21.9    35.8    40.3    42.2    49.3    76.4

## NB Class 9 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    25.8    54.7    57.4    56.6    59.4    86.2

## NB Class 10 - Summary of Distance (ft)
##     bewteen First and Last Axles:
```

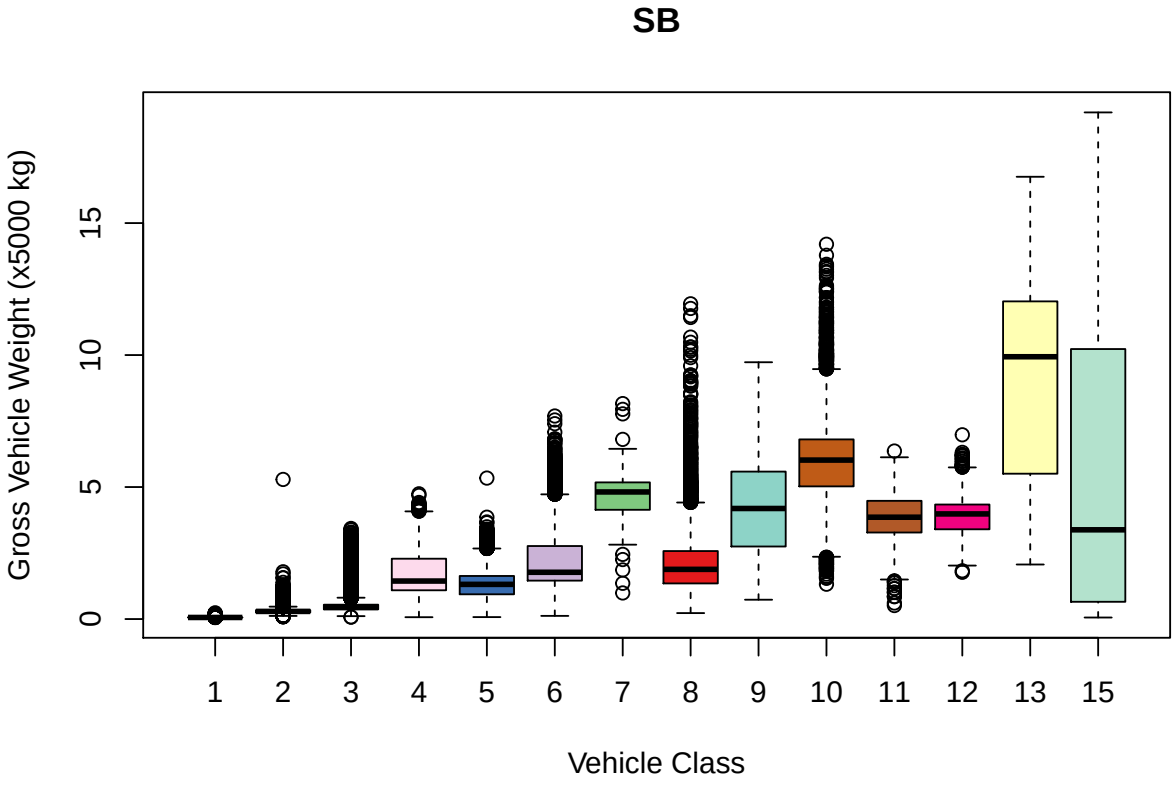
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    30.7    48.7    63.1    59.5    68.3    87.8

## NB Class 11 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    40.6    65.4    66.0    66.0    66.5    77.4

## NB Class 12 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    65.4    69.6    70.8    70.9    71.6    76.7

## NB Class 13 - Summary of Distance (ft)
##     bewteen First and Last Axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    38.1    56.2    91.8    83.7    99.3   122.1
```

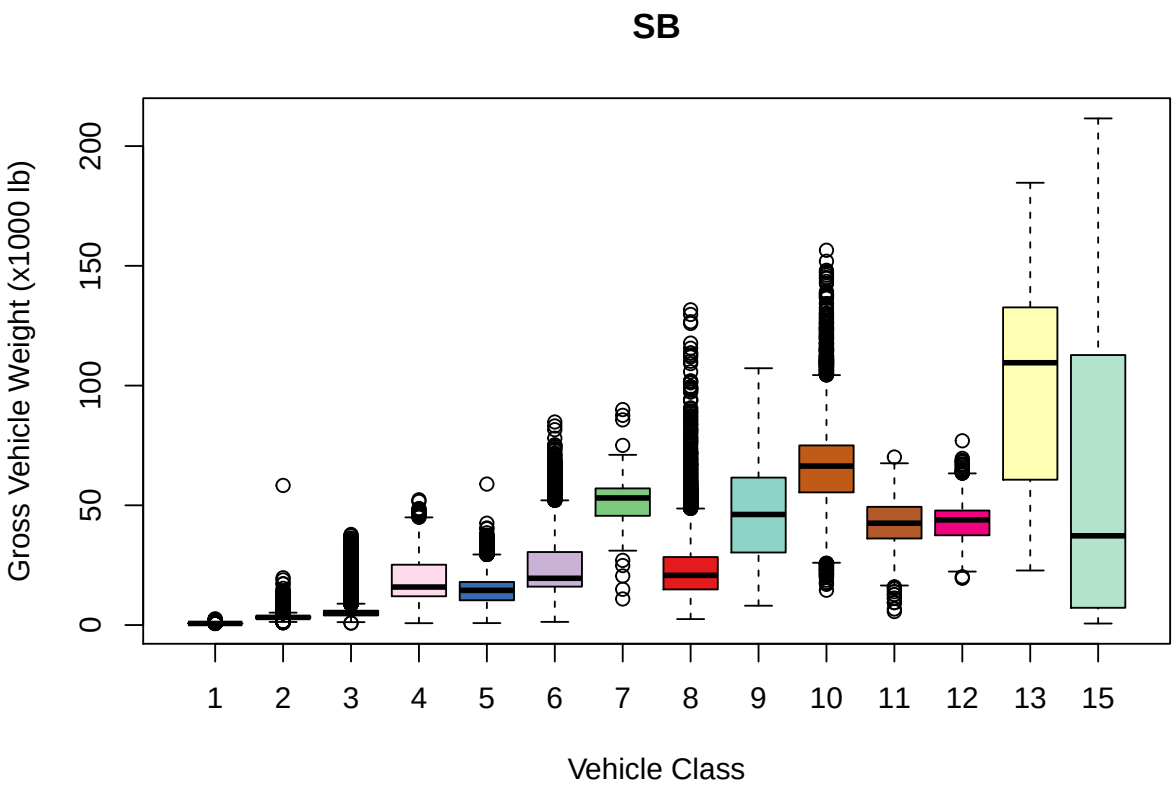
A-4.7.10 Graphical and Numerical Summary of GVW Distribution for Each Class

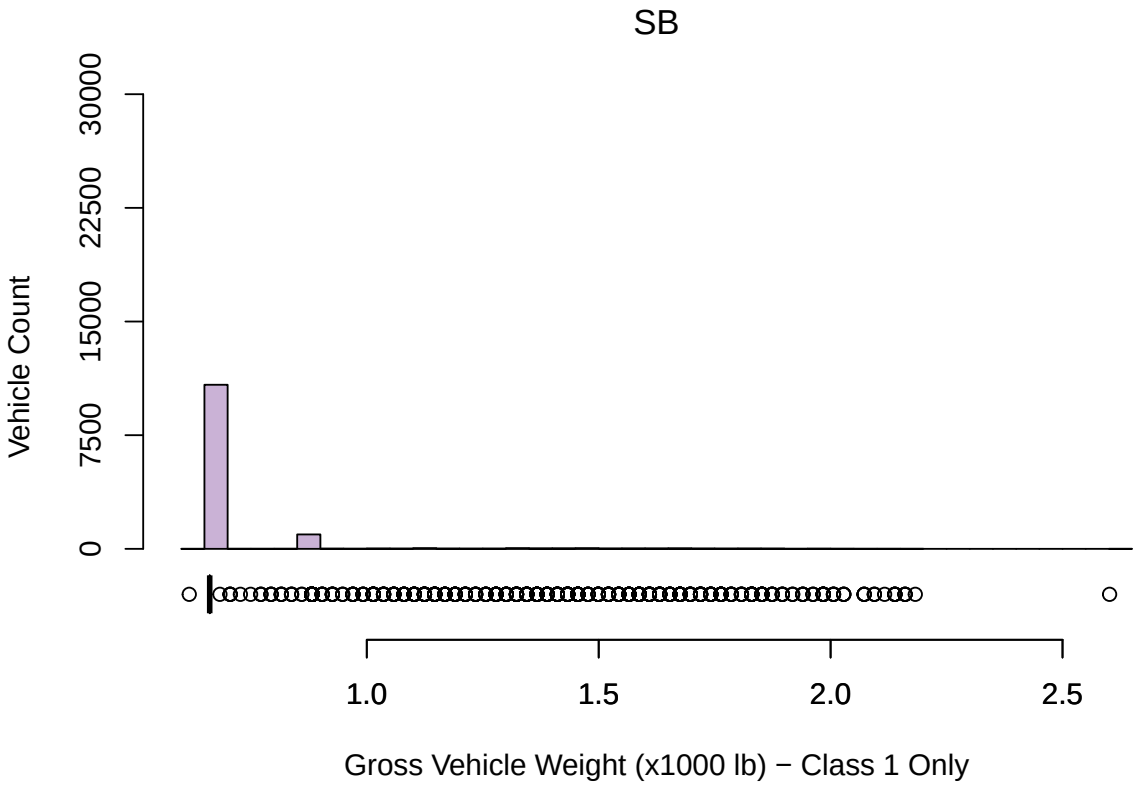
A-4.7.10(a) Direction 1 - GVW Distribution for Each Class

```
## Boxplots and Histograms with a boxplot
```

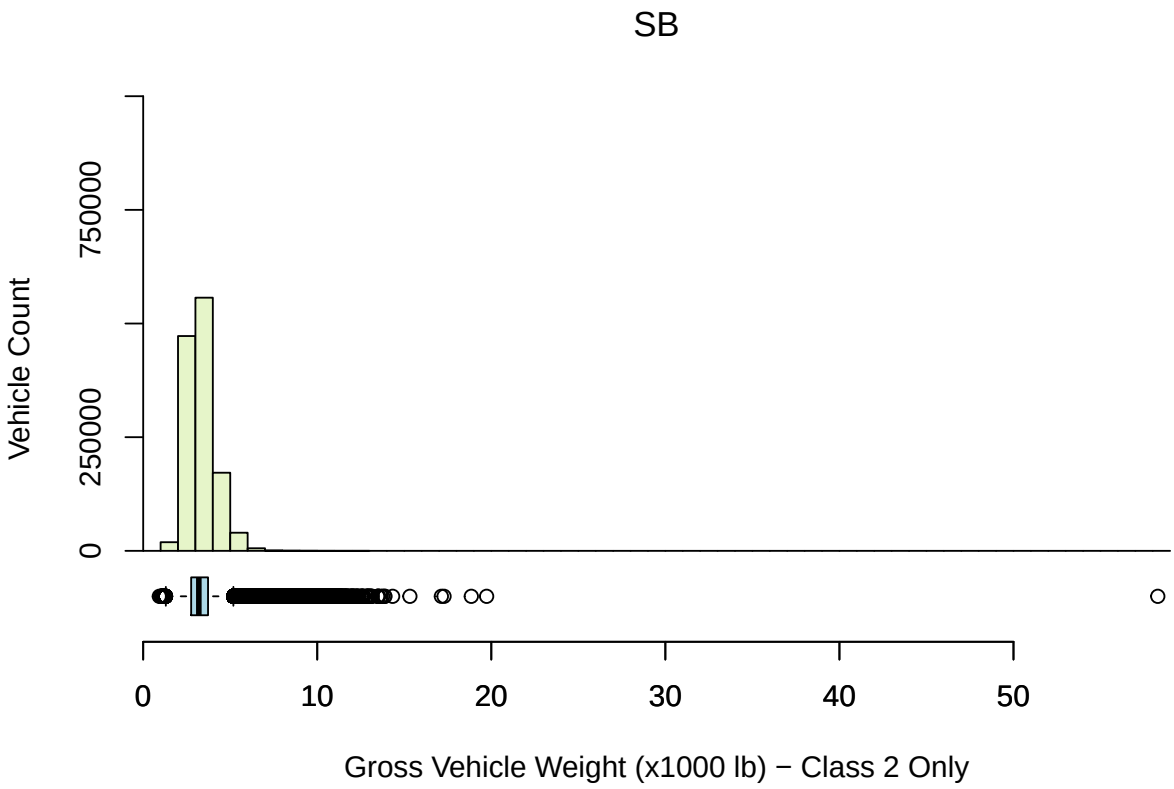



SB
Gross Vehicle Weight (x5000 kg)
0
5
10
15
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class

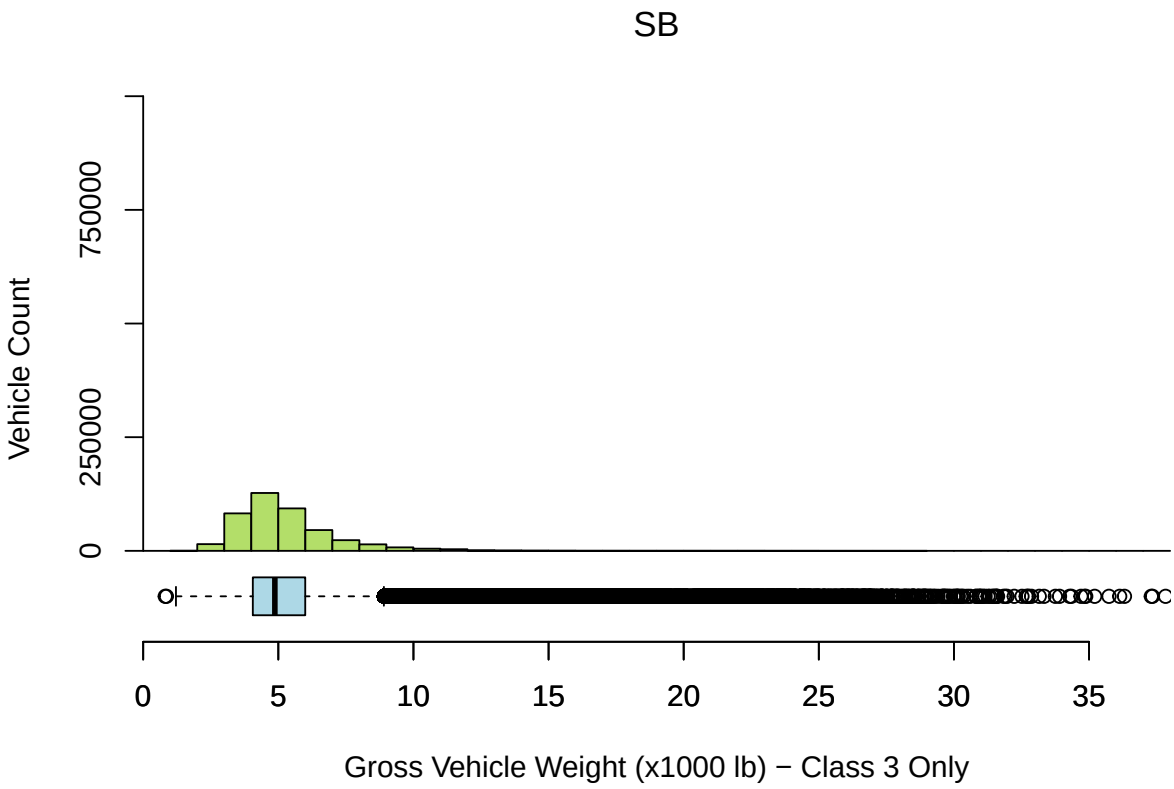

SB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class



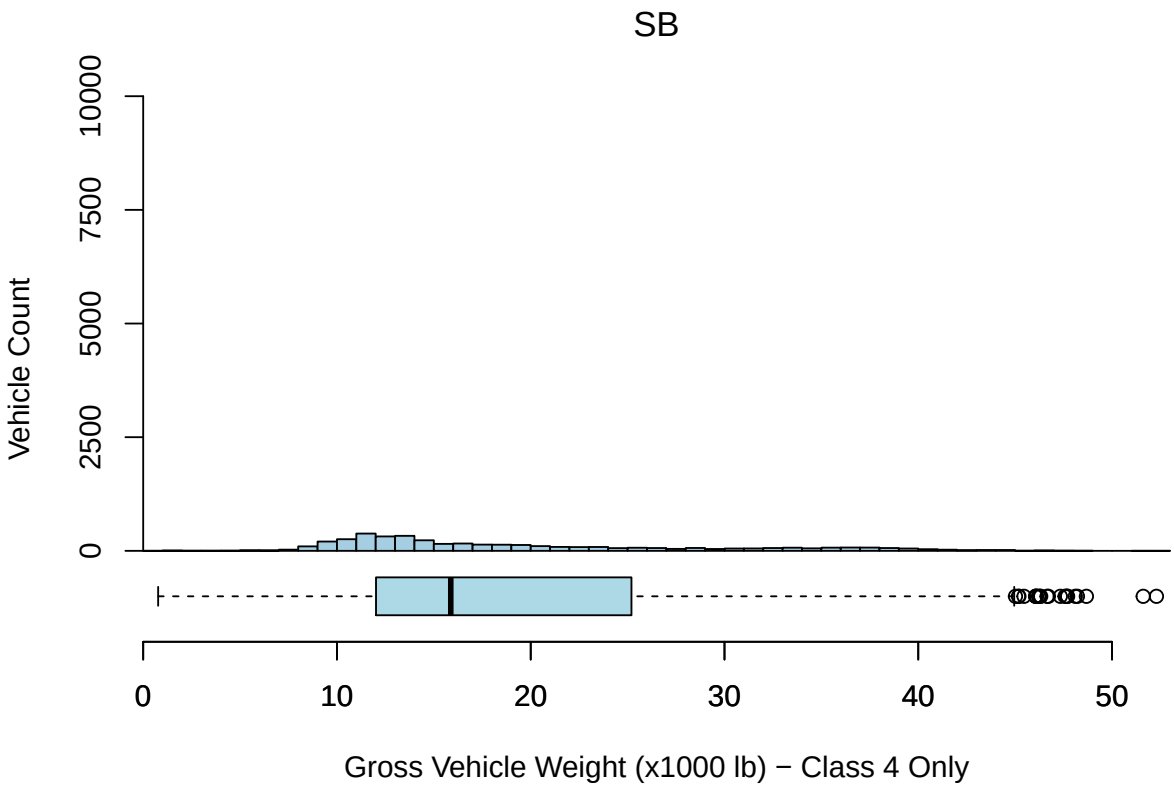

```
## SB Class 1 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.6     0.7     0.7     0.7     0.7     2.6

##    Standard deviation: 0.2
```



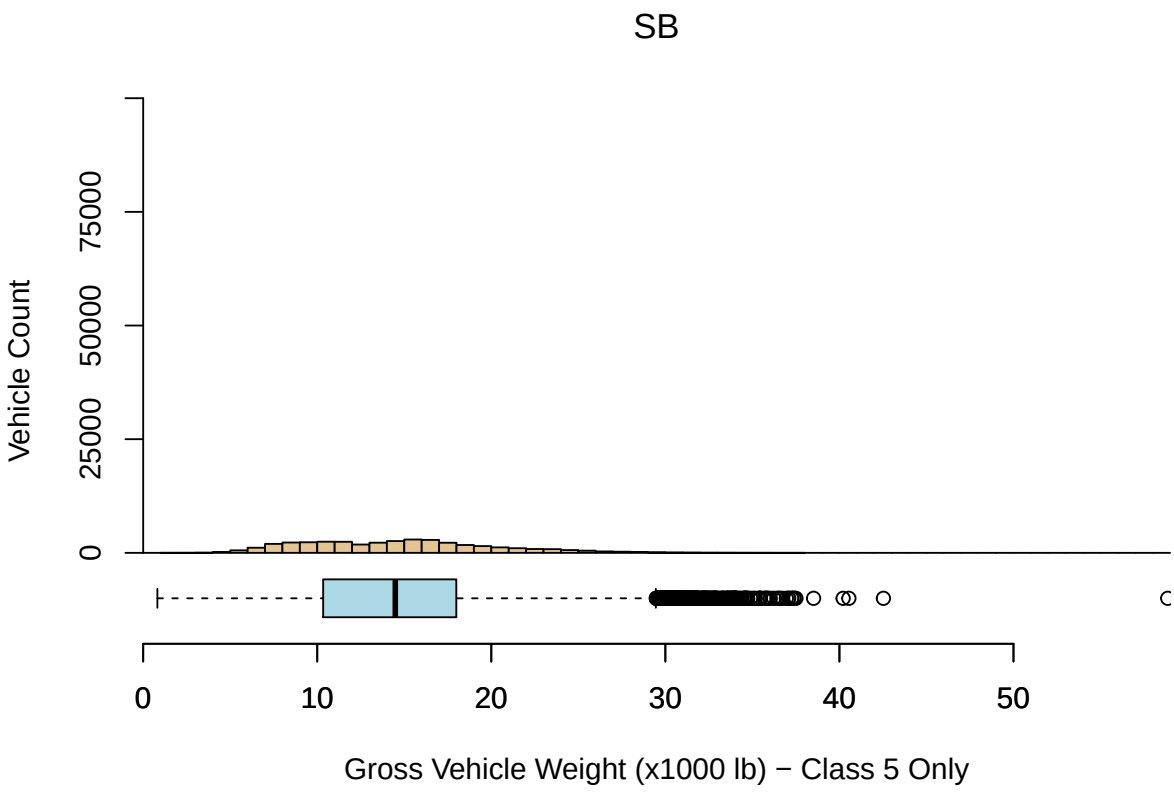

```
## SB Class 2 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.9     2.8     3.2     3.3     3.7    58.3

##    Standard deviation: 0.8
```



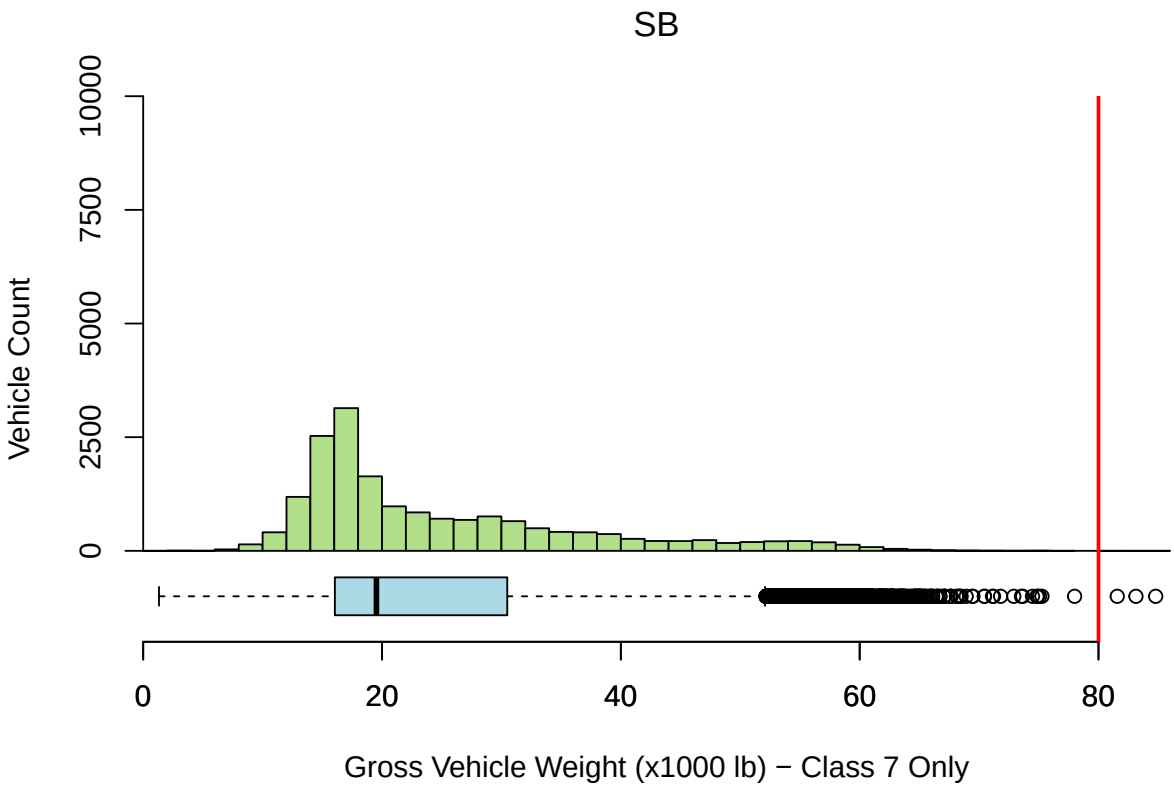

```
## SB Class 3 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8     4.1     4.9     5.3     6.0    37.8

##    Standard deviation: 2.1
```



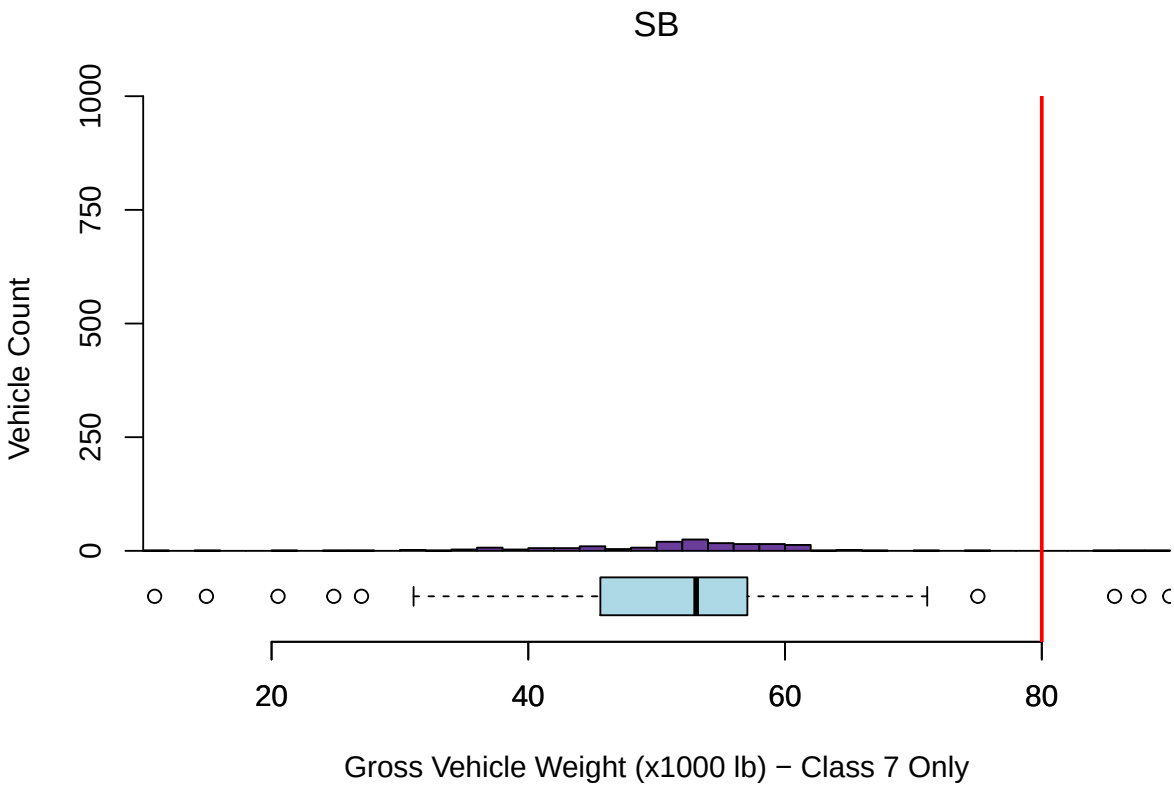

```
## SB Class 4 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8    12.0    15.9    19.4    25.2    52.3

##    Standard deviation: 9.7
```



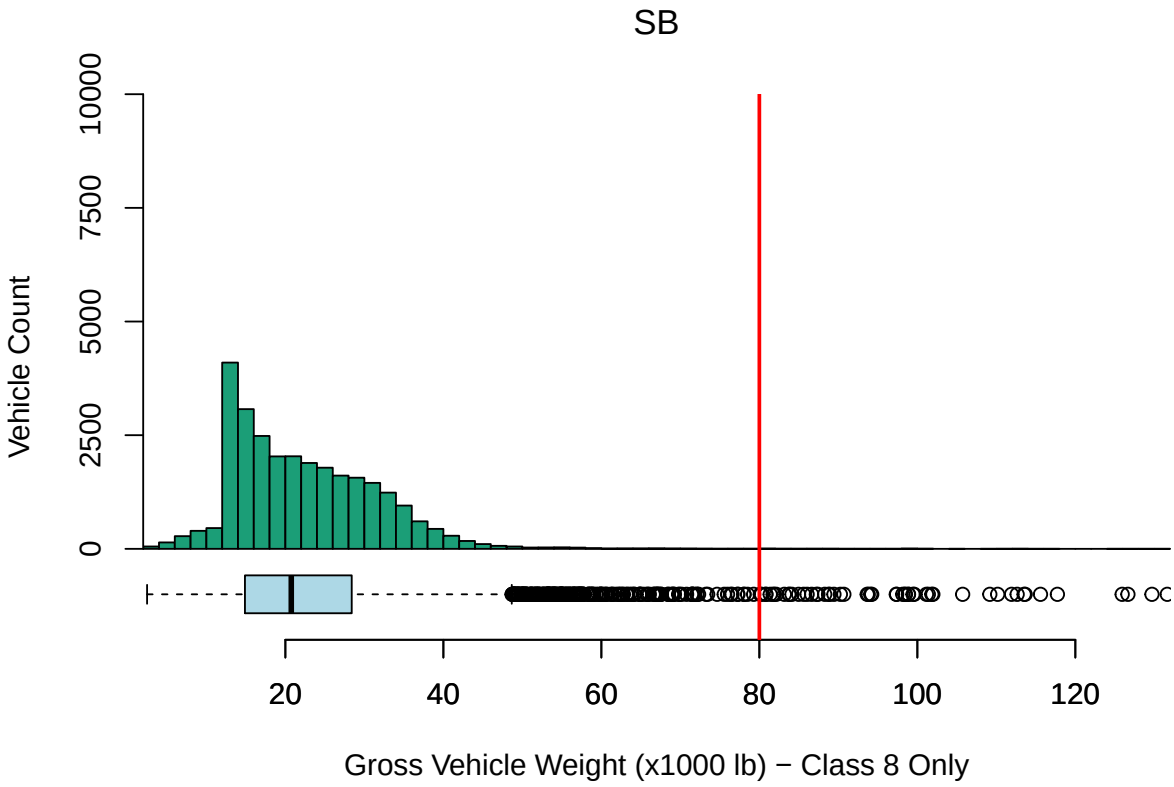

```
## SB Class 5 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8    10.3    14.5    14.7    18.0    58.9

##    Standard deviation: 5.5
```



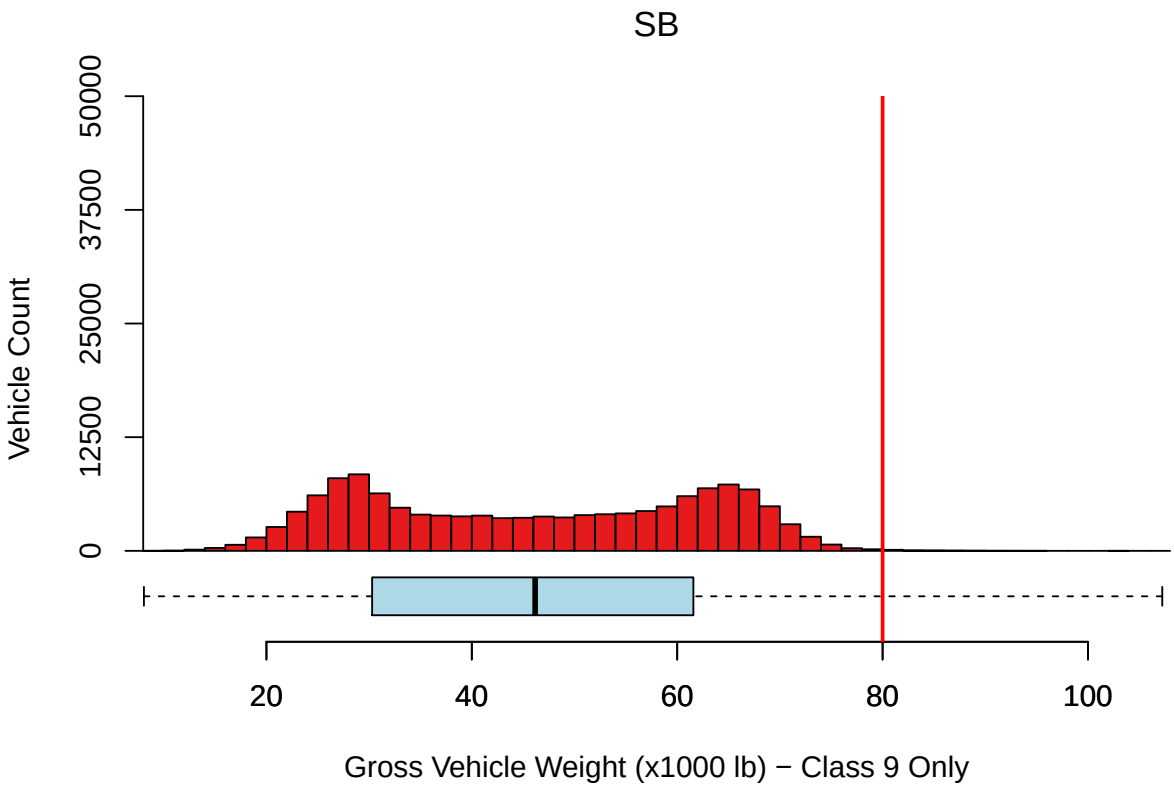

```
## SB Class 6 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     1.3    16.0    19.5    24.7    30.5    84.8

##    Standard deviation: 12.2
```



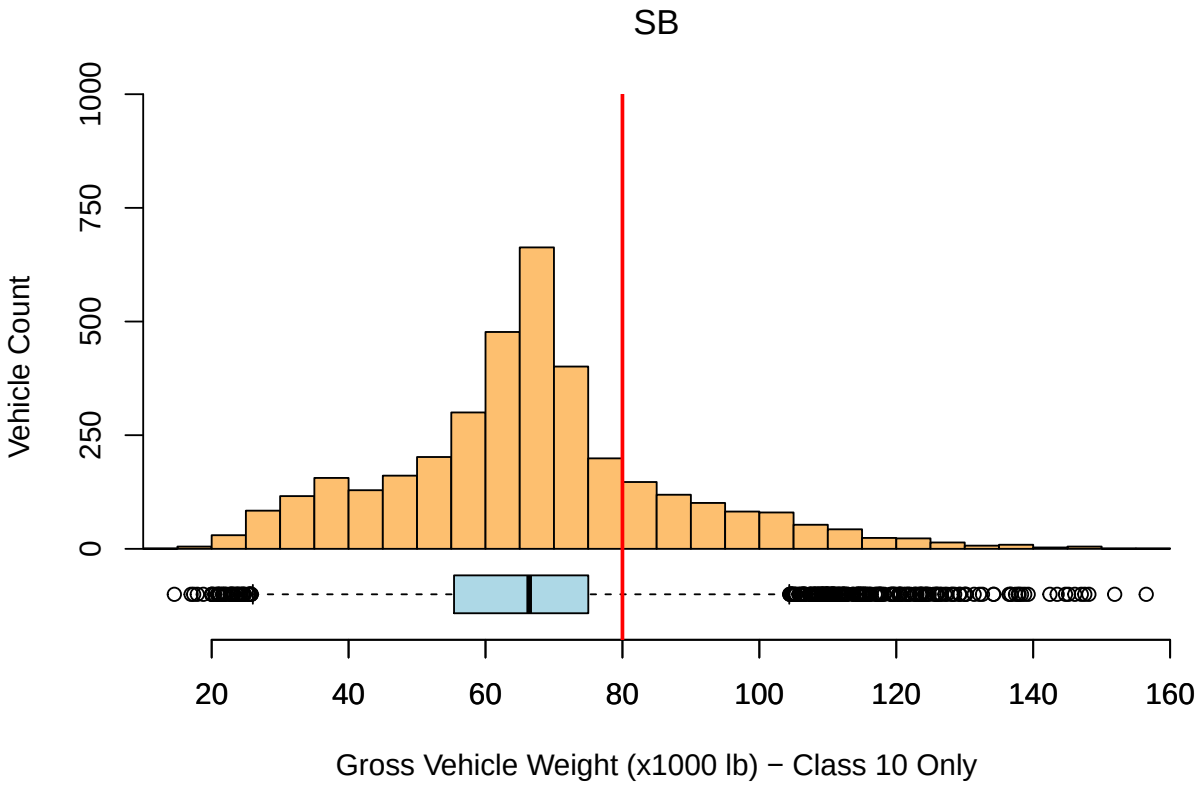

```
## SB Class 7 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    10.9    45.8    53.1    51.4    57.1    90.0

##    Standard deviation: 10.7
```



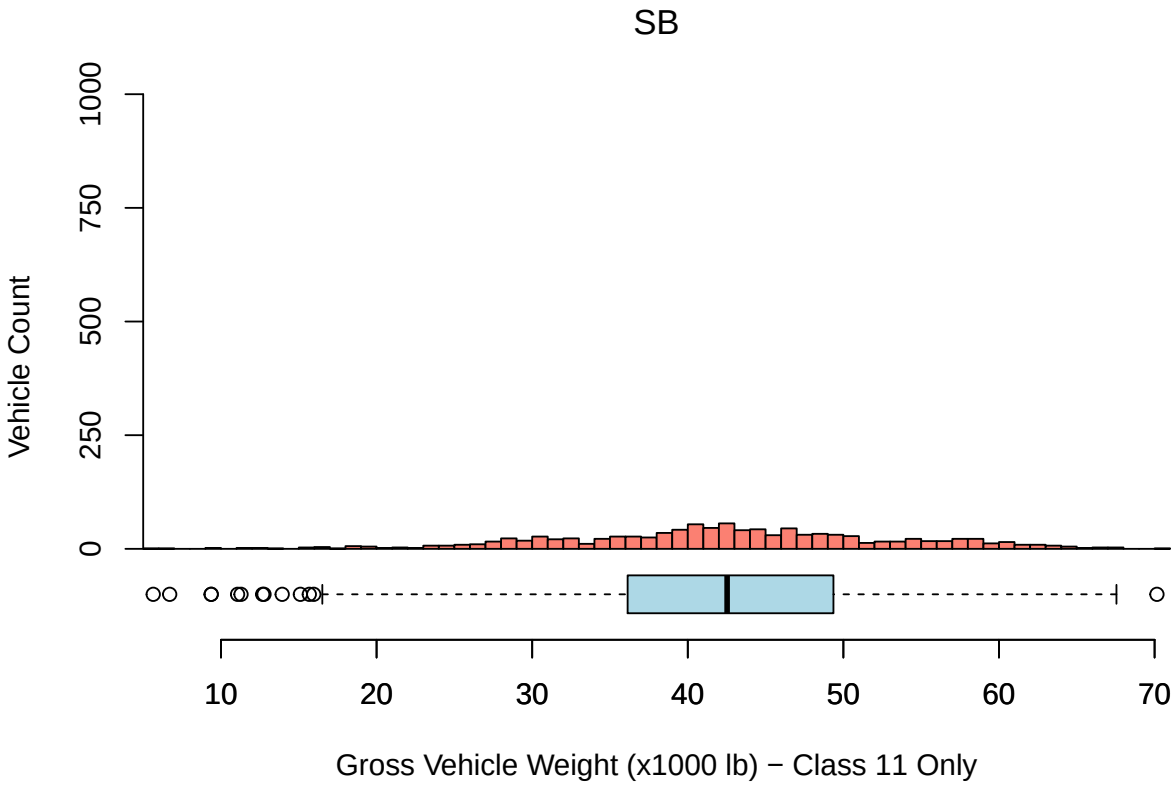

```
## SB Class 8 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     2.5    14.9    20.7    22.4    28.4   131.6

##    Standard deviation: 9.6
```



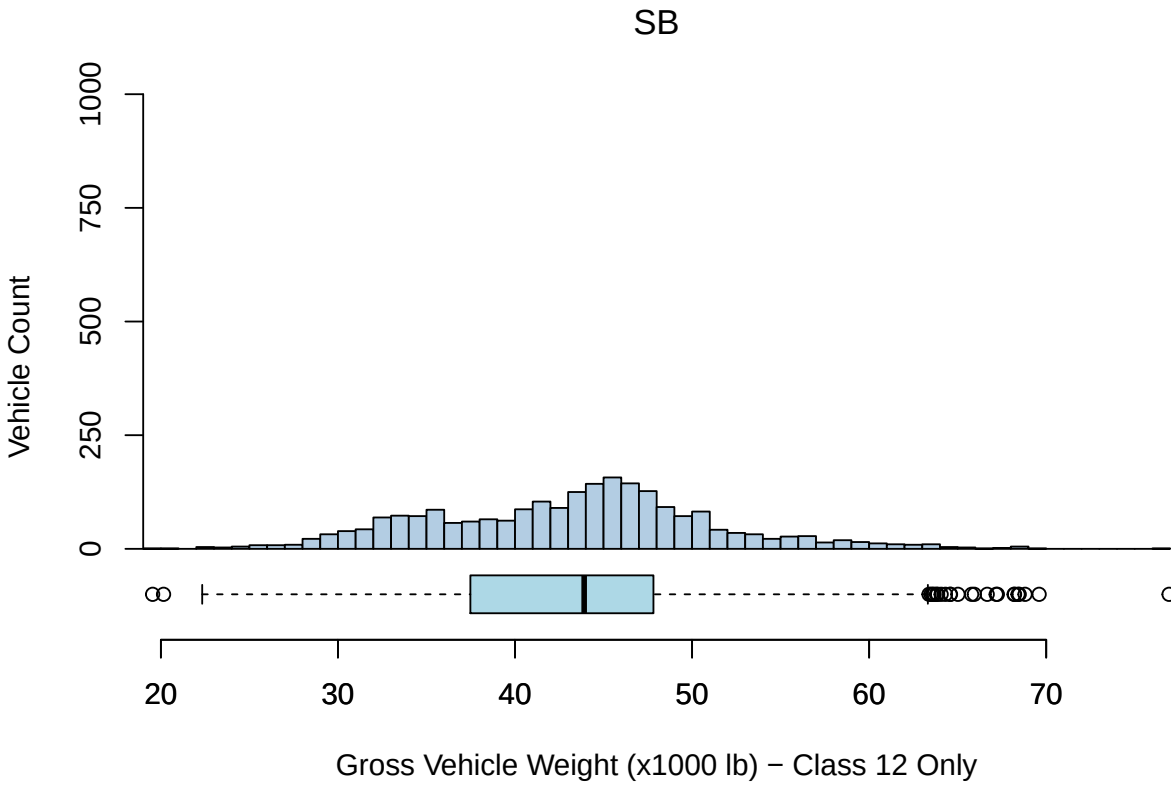

```
## SB Class 9 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     8.1    30.3    46.2    46.1    61.6   107.2

##    Standard deviation: 16.3
```



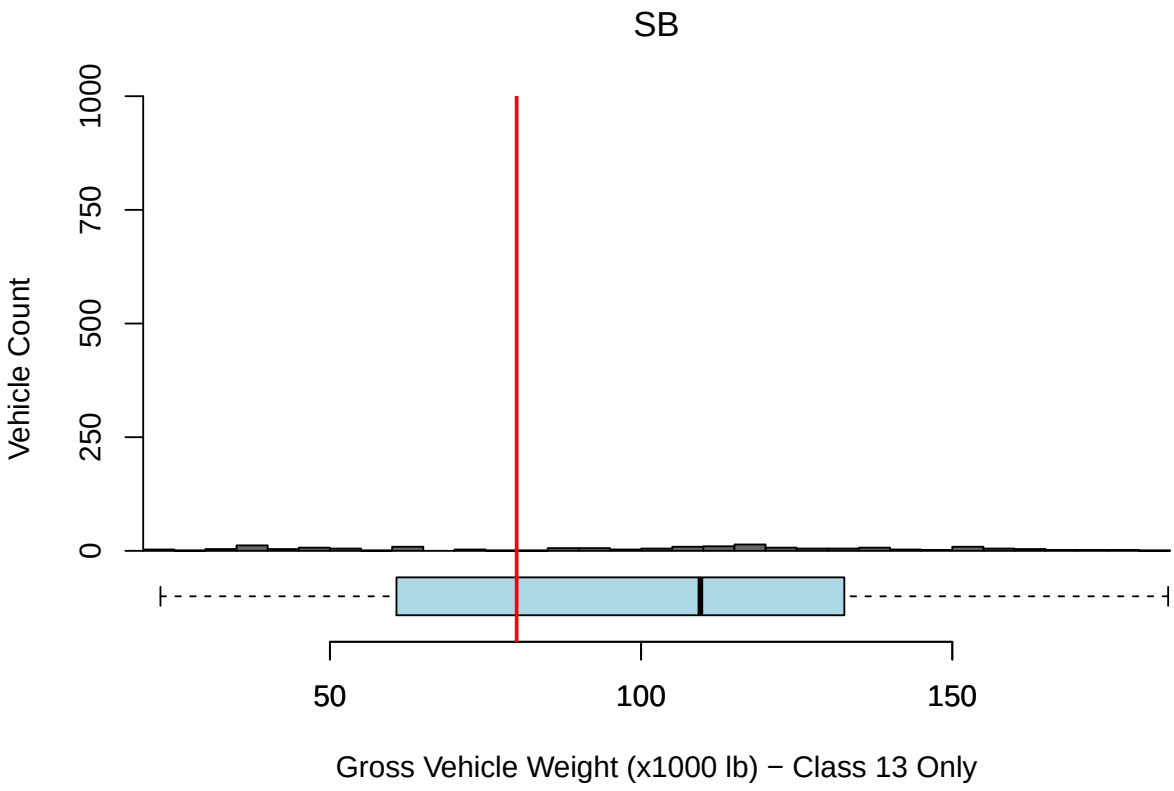

```
## SB Class 10 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    14.6    55.4    66.4    66.7    75.0   156.5

##    Standard deviation: 20.7
```



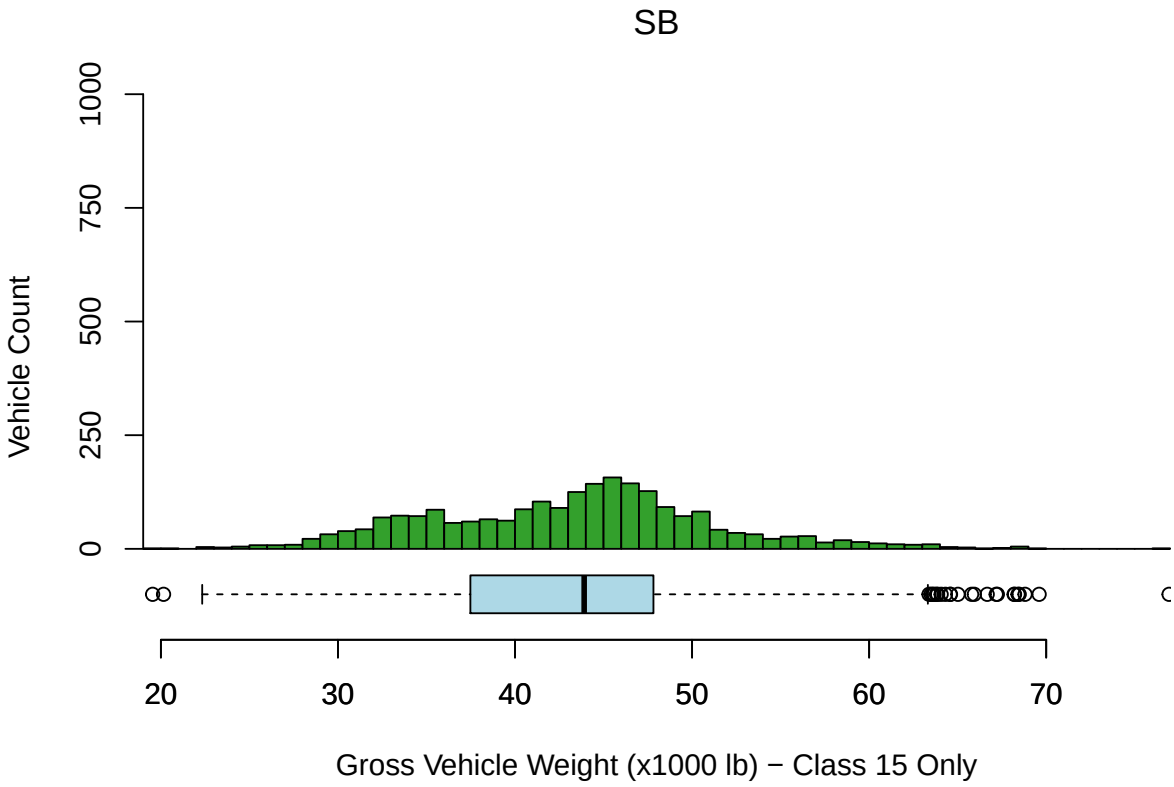

```
## SB Class 11 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     5.6    36.1    42.5    42.6    49.4    70.2

##    Standard deviation: 10.7
```




```
## SB Class 12 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    19.5    37.5    43.9    43.3    47.8    76.9

##    Standard deviation: 7.9
```



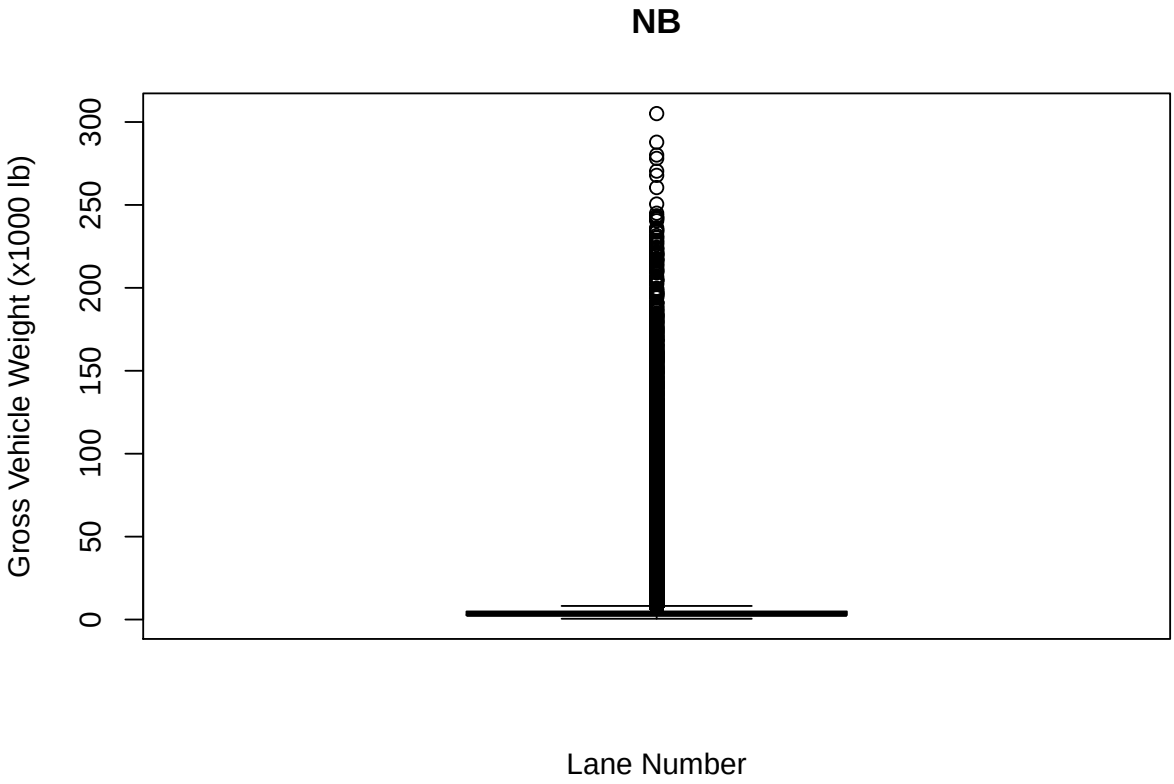

```
## SB Class 13 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    22.8    60.9   109.5   100.8   132.5   184.7

##    Standard deviation: 42.5
```

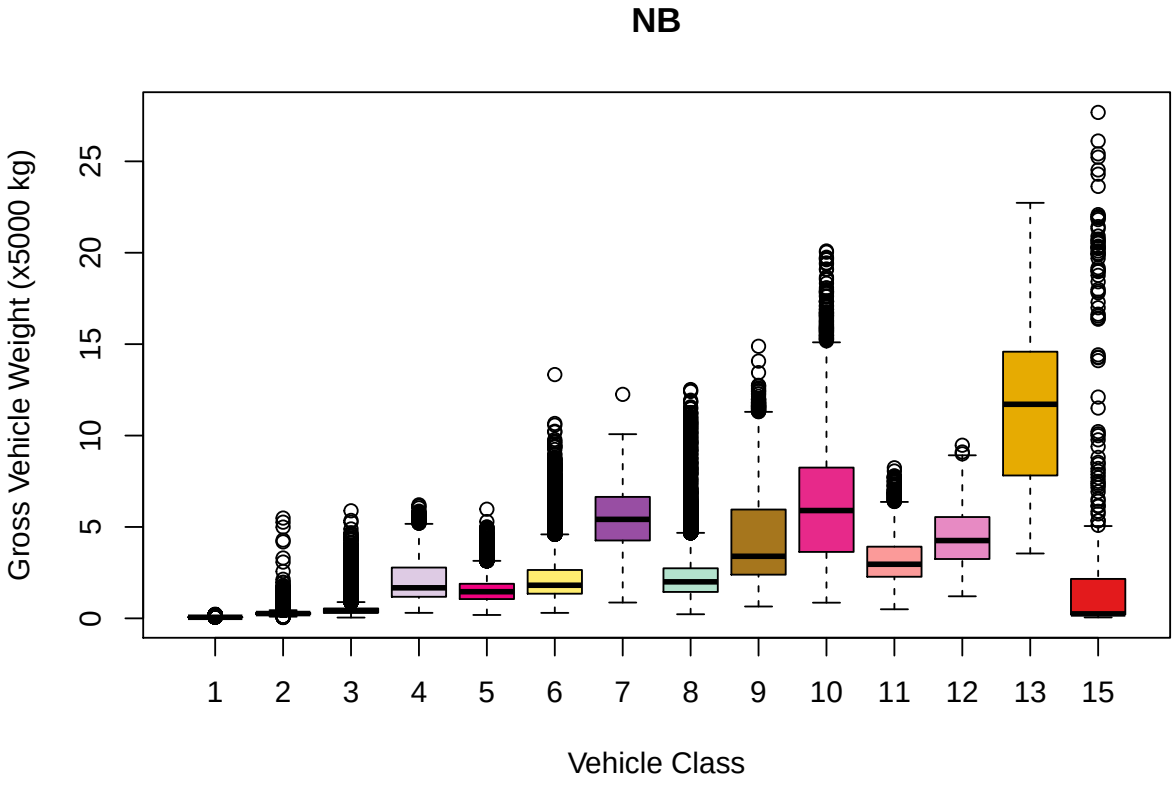


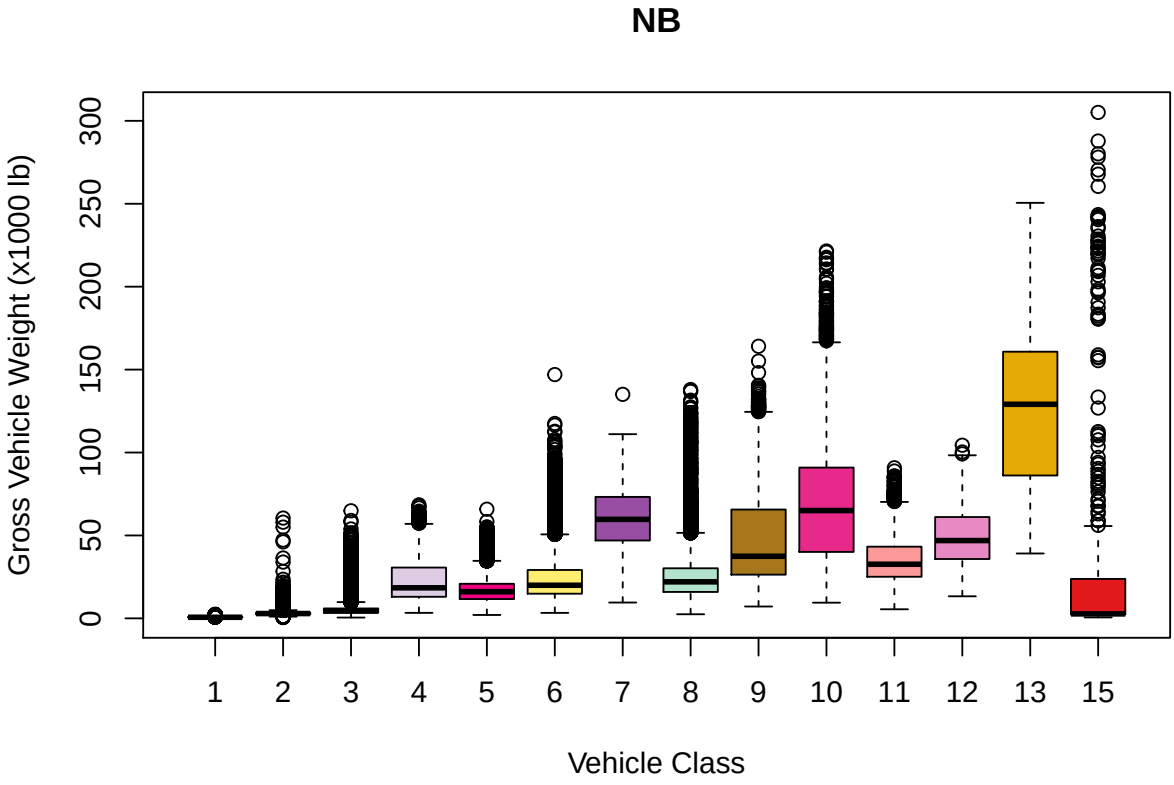

```
## SB Class 15 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.6     7.2    37.3    62.7   112.7   211.6

##    Standard deviation: 66
```

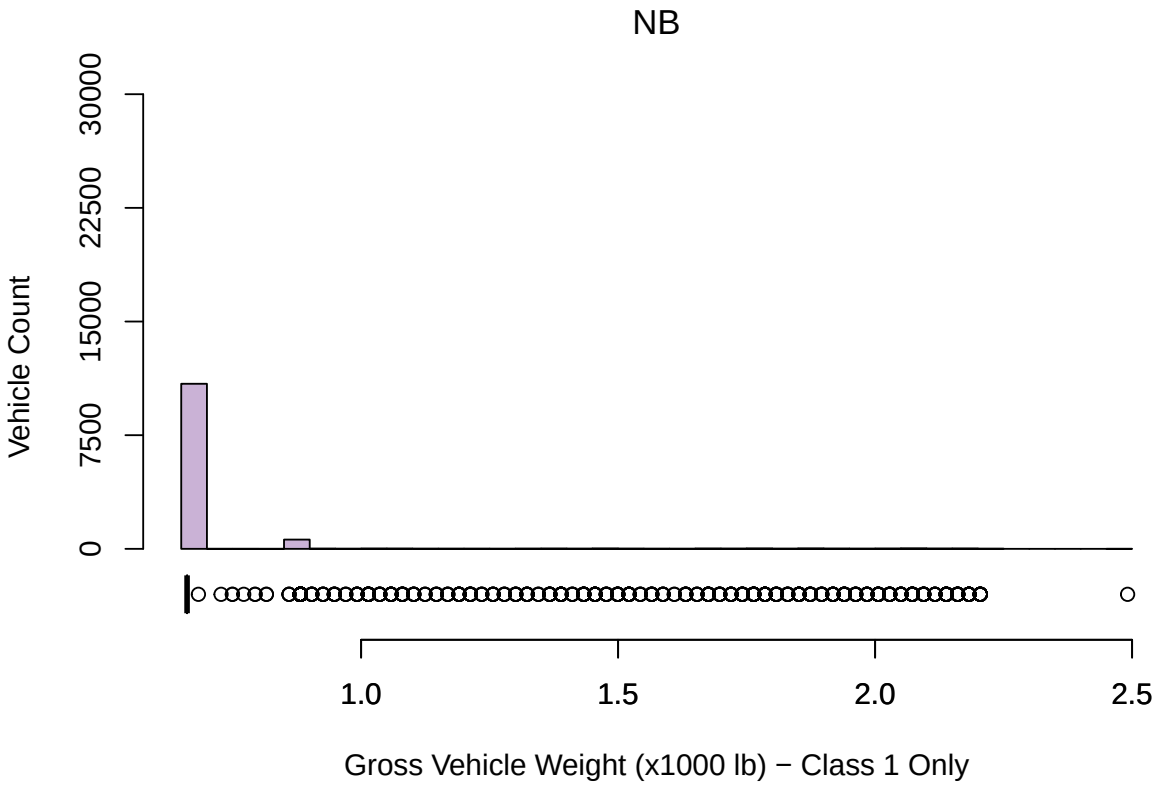
A-4.7.10(b) Direction 2 - GVW Distribution for Each Class

```
## Boxplots and Histograms with a boxplot
```

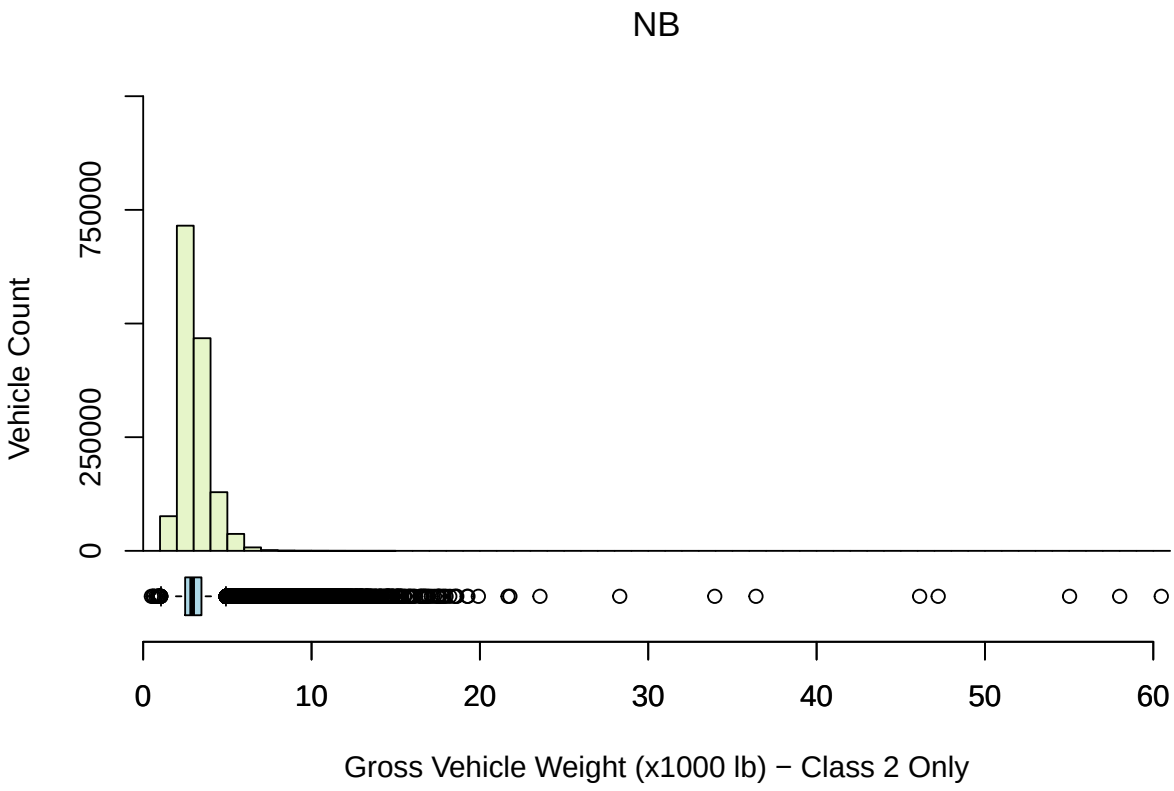



NB
Gross Vehicle Weight (x5000 kg)
0
5
10
15
20
25
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class

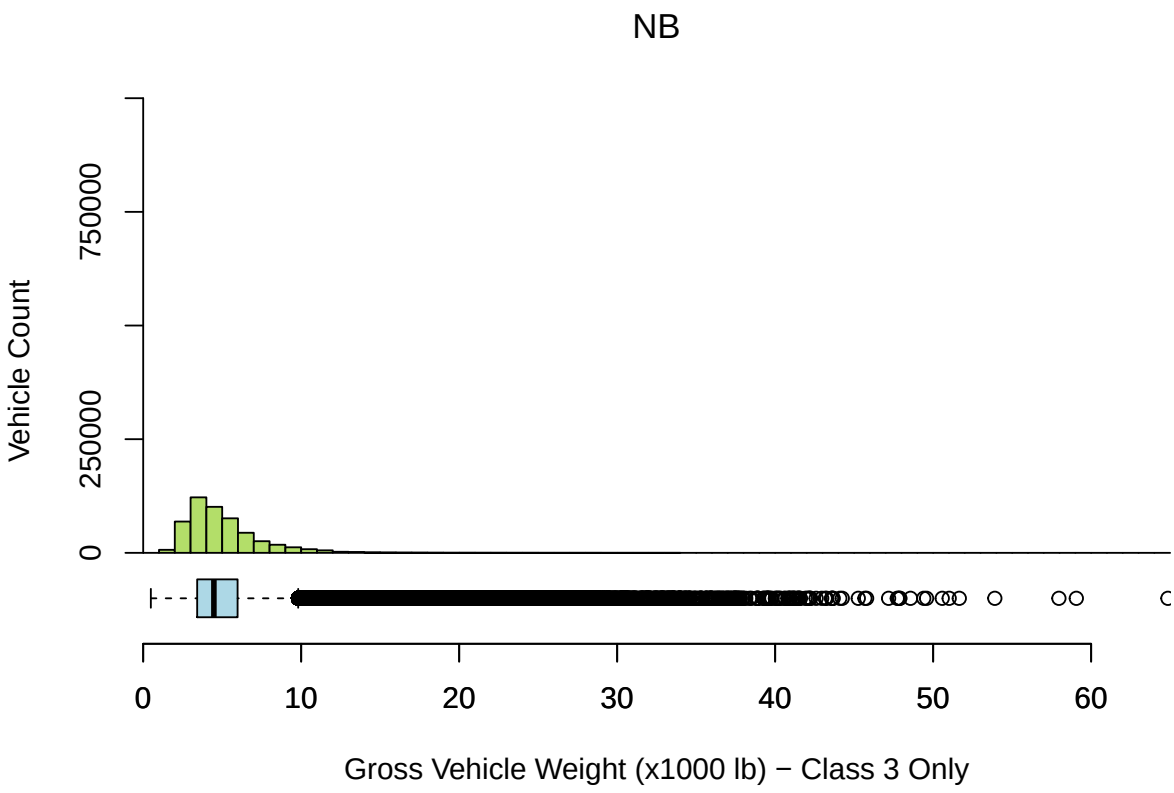

NB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
250
300
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class



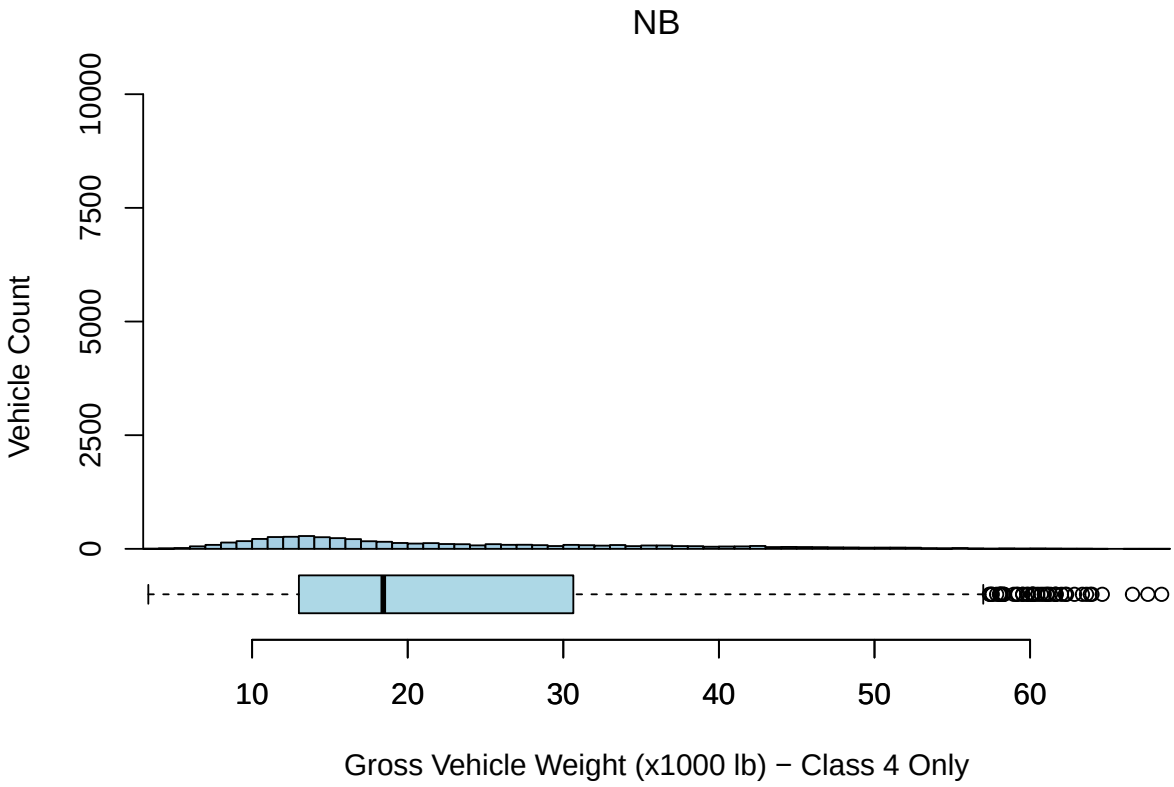

```
## NB Class 1 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.7     0.7     0.7     0.7     0.7     2.5

##    Standard deviation: 0.2
```



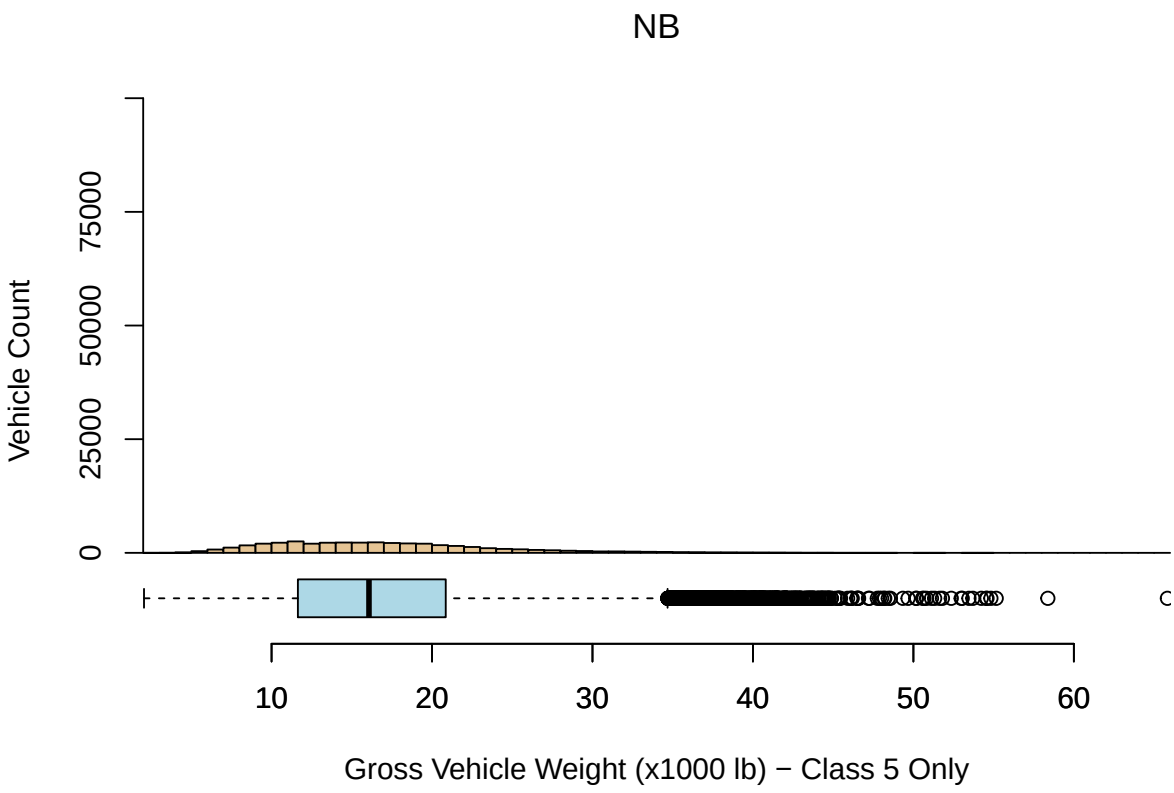

```
## NB Class 2 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.5     2.5     2.9     3.1     3.5    60.5

##    Standard deviation: 0.9
```



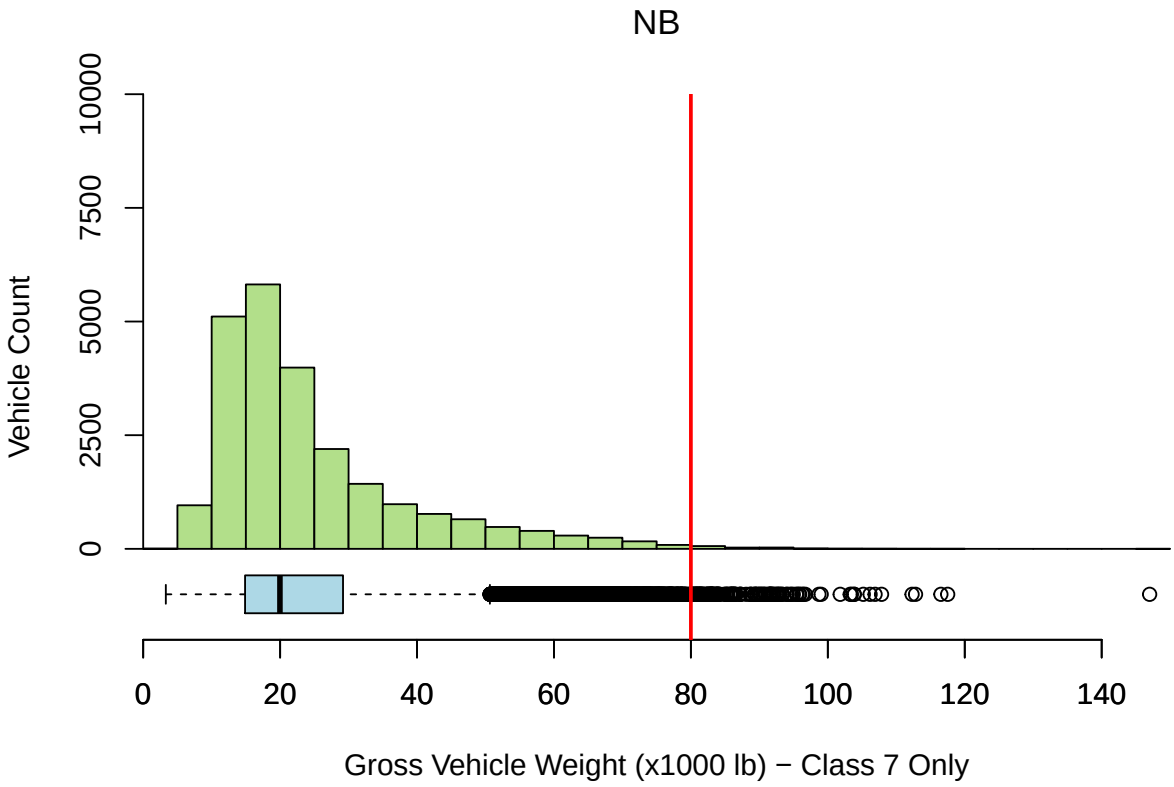

```
## NB Class 3 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.5     3.4     4.5     5.1     6.0    64.9

##    Standard deviation: 2.7
```



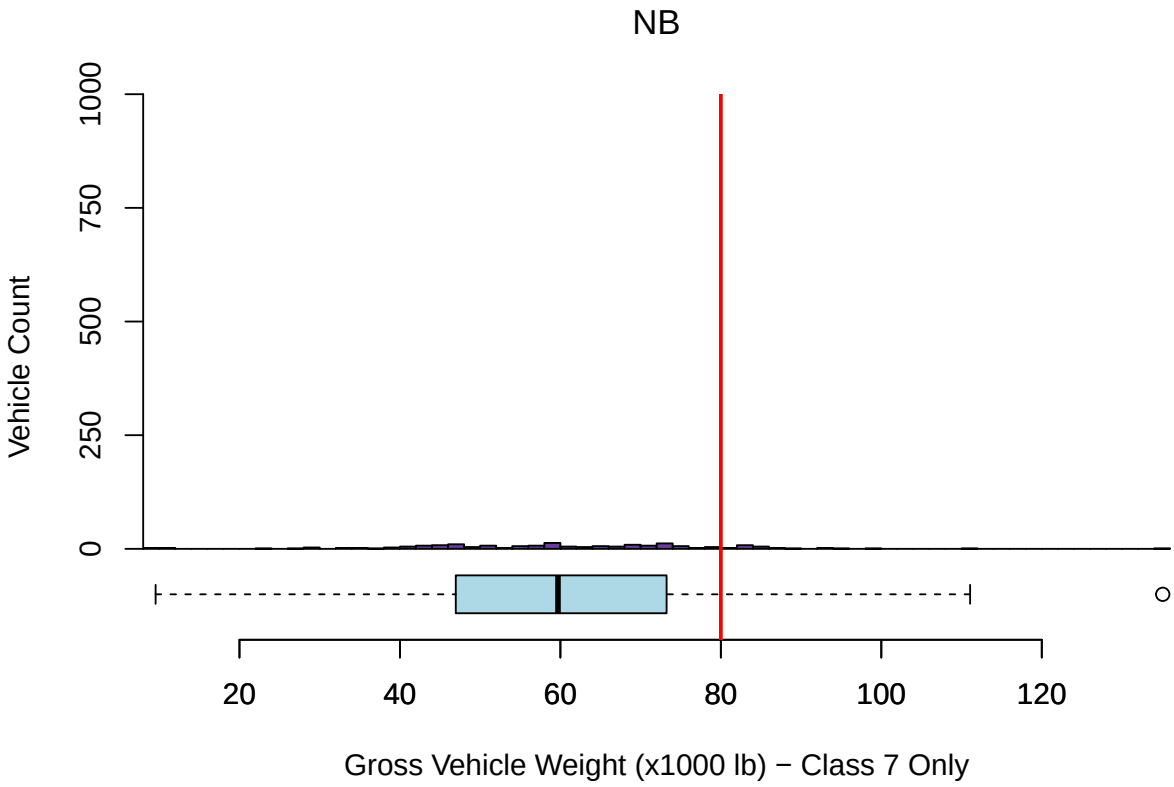

```
## NB Class 4 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     3.3    13.0    18.4    22.7    30.6    68.5

##    Standard deviation: 12.5
```



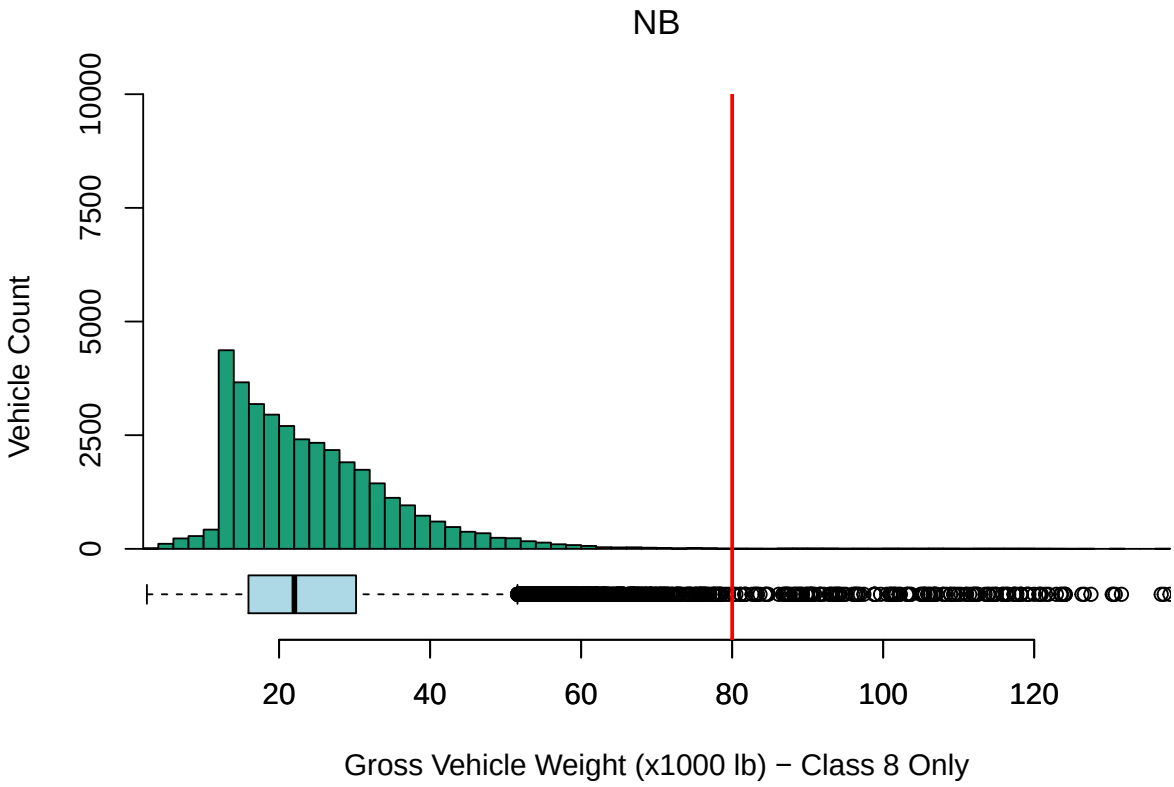

```
## NB Class 5 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     2.1    11.6    16.1    17.0    20.9    65.8

##    Standard deviation: 7
```



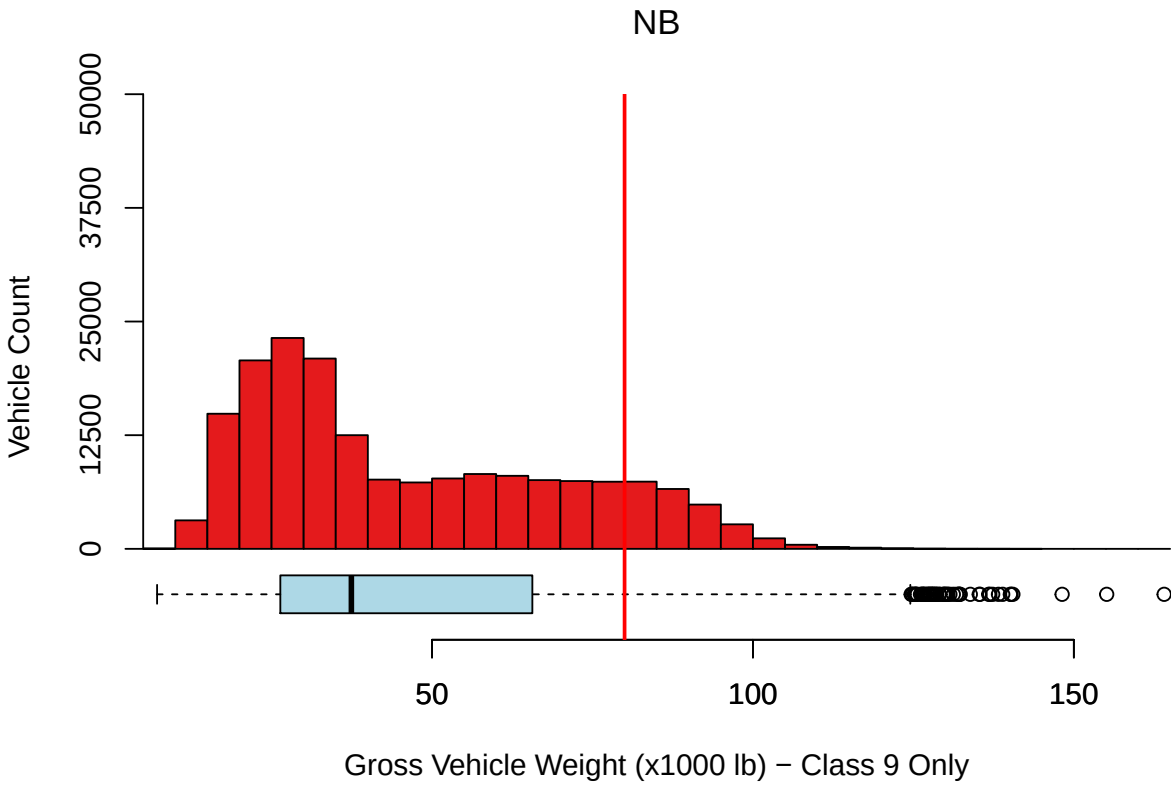

```
## NB Class 6 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     3.3    14.9    20.0    24.6    29.2   147.0

##    Standard deviation: 14.6
```



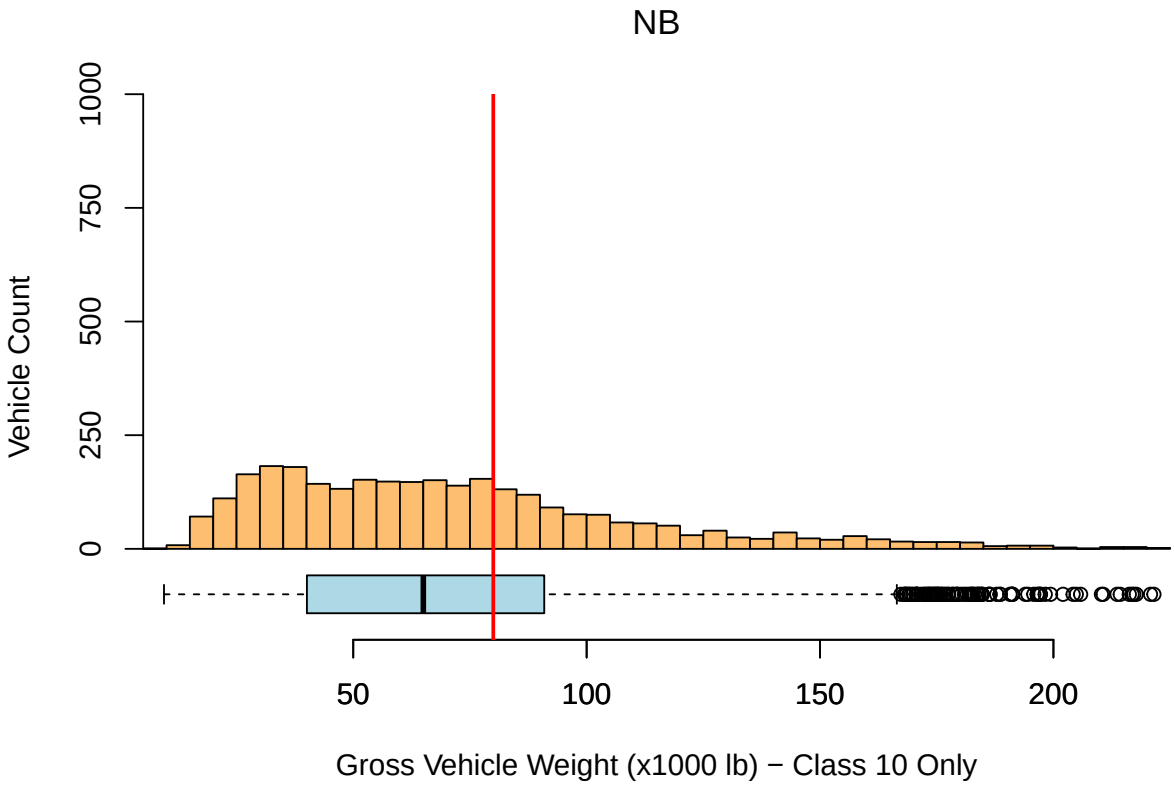

```
## NB Class 7 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.5    47.1    59.7    60.6    73.1   135.1

##    Standard deviation: 18.7
```



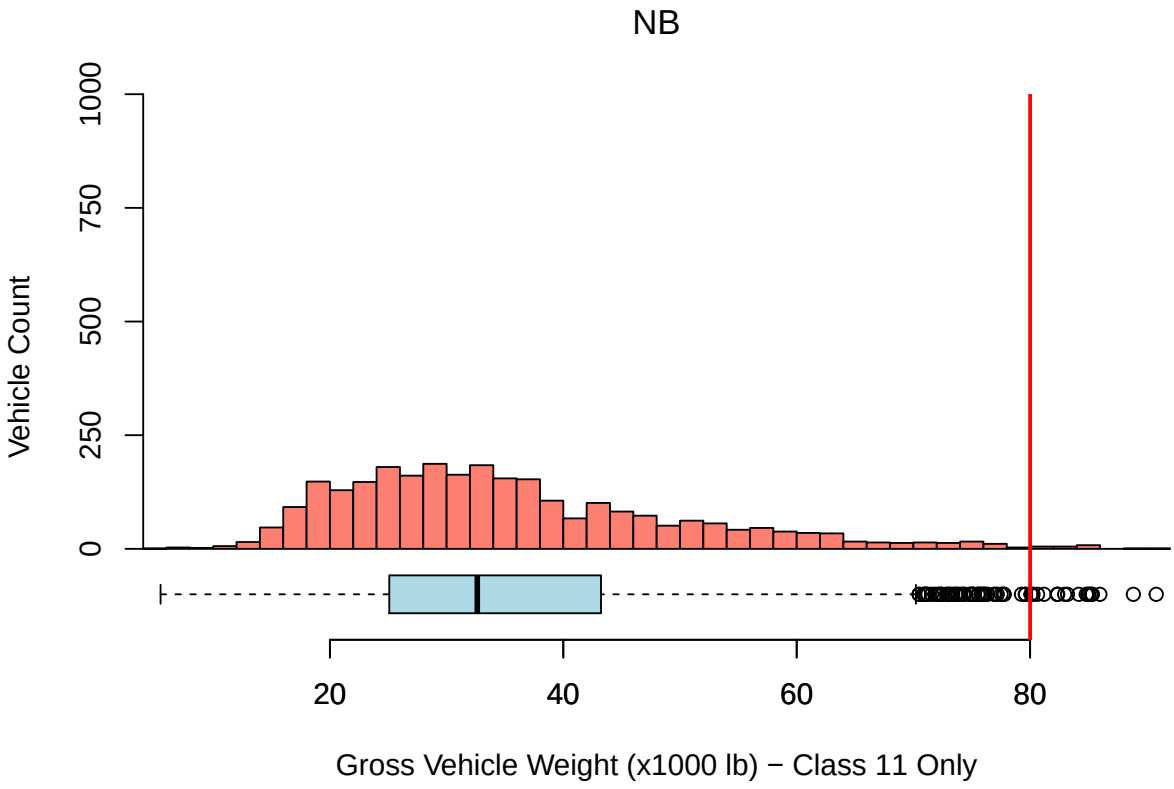

```
## NB Class 8 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     2.5    15.9    22.0    24.6    30.2   138.0

##    Standard deviation: 11.9
```



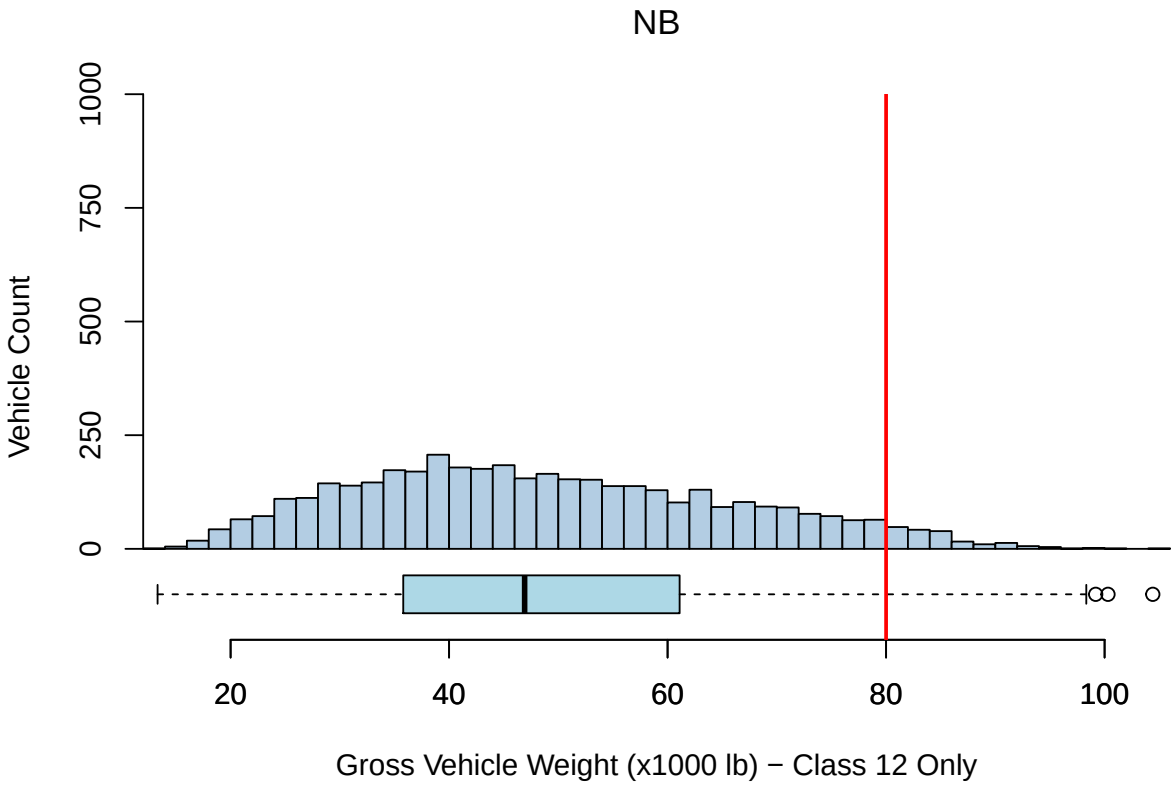

```
## NB Class 9 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     7.2    26.4    37.4    46.3    65.6   164.1

##    Standard deviation: 24.2
```



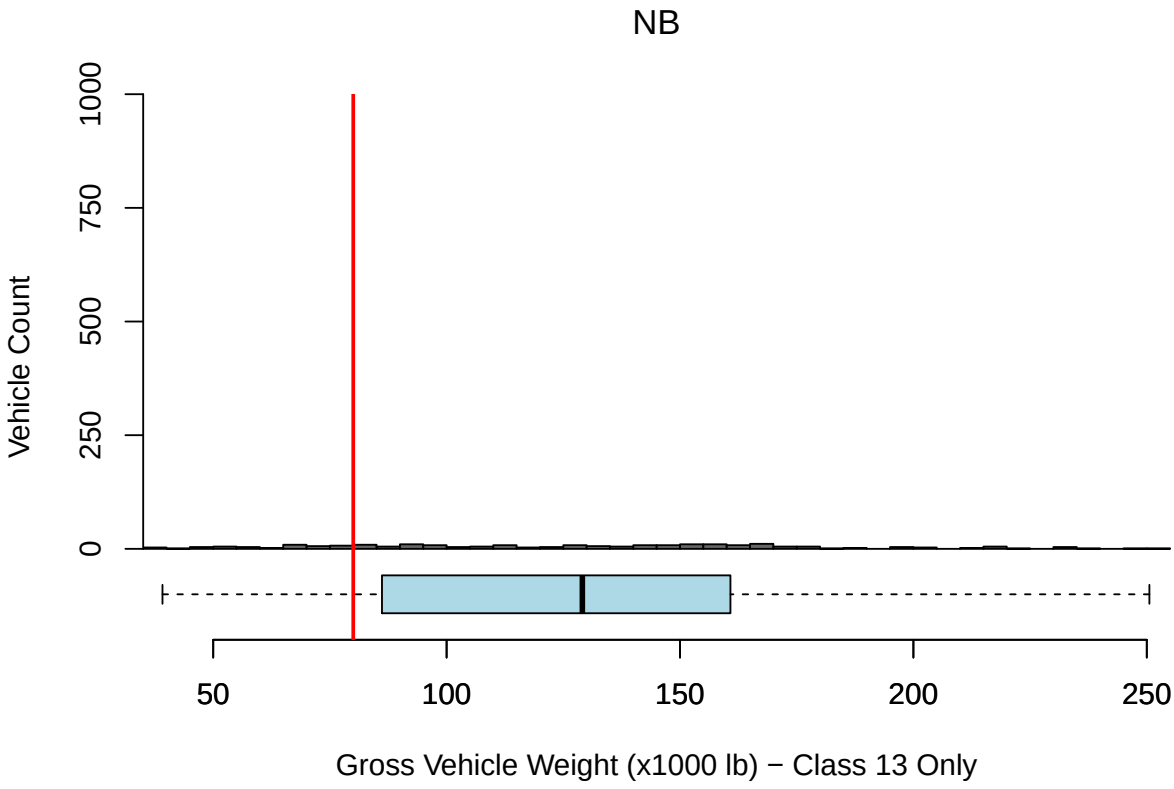

```
## NB Class 10 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.5    40.1    65.0    71.6    90.9   221.5

##    Standard deviation: 39.6
```



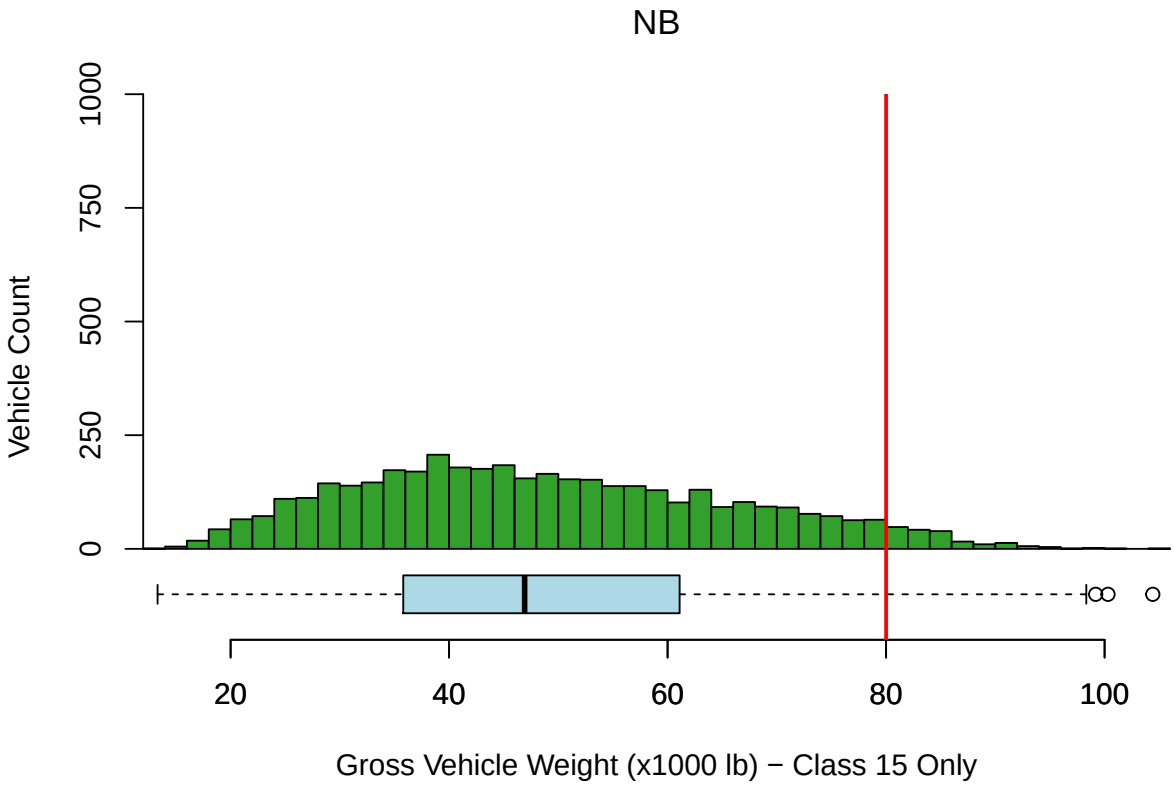

```
## NB Class 11 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     5.5    25.1    32.6    35.5    43.2    90.8

##    Standard deviation: 14.3
```




```
## NB Class 12 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    13.3    35.8    46.9    48.9    61.1   104.4

##    Standard deviation: 17
```




```
## NB Class 13 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    39.1    86.2   129.1   127.6   160.8   250.6

##    Standard deviation: 49.5
```

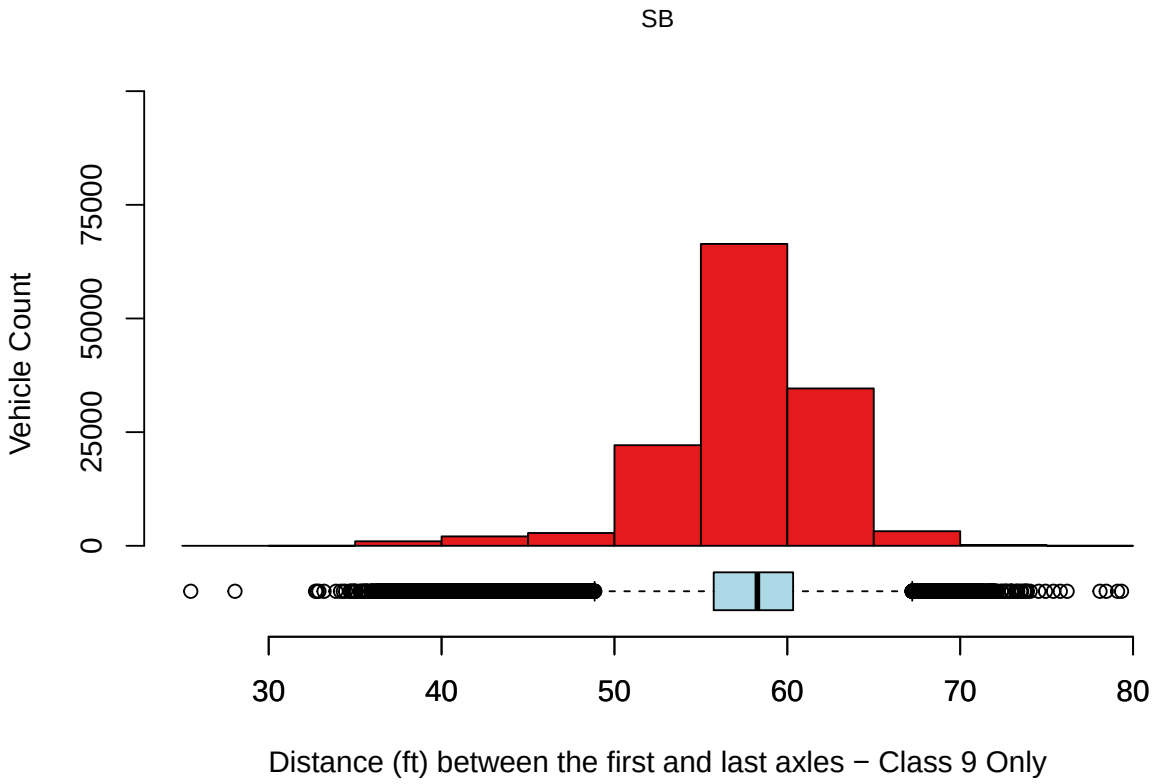


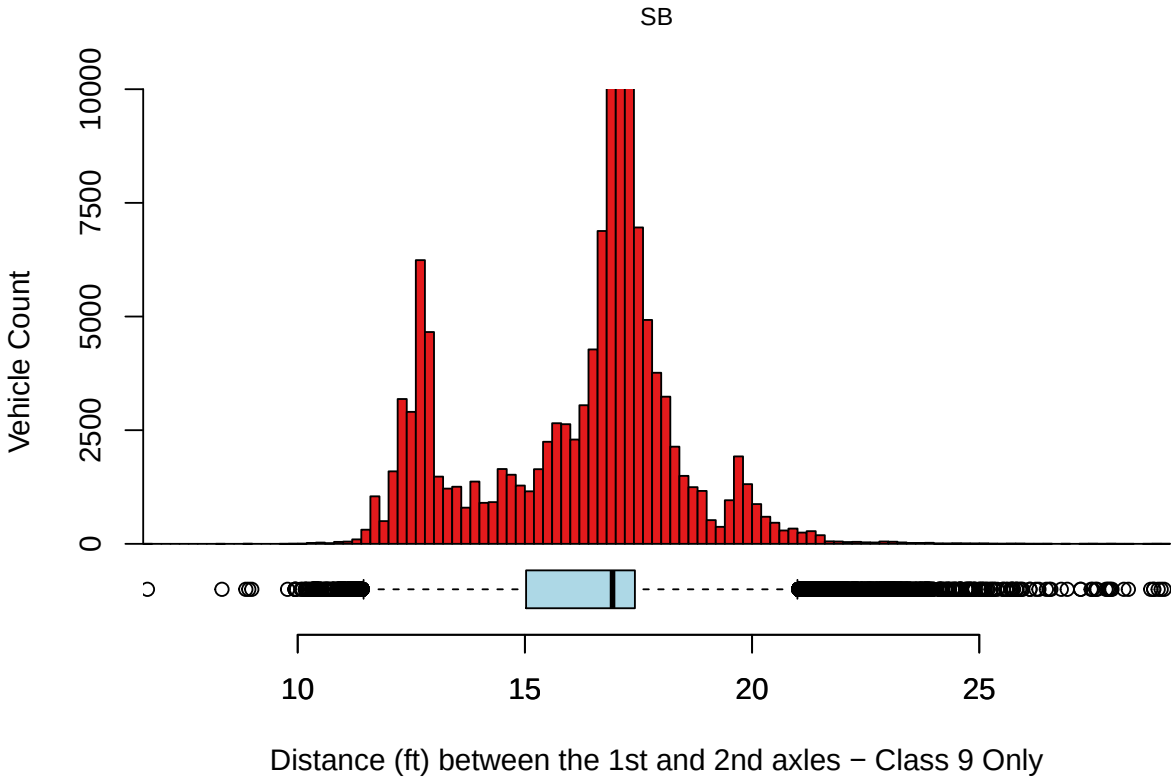

```
## NB Class 15 GVW (x1000 lb):

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.6     2.3     2.7    37.9    23.8   305.1

##    Standard deviation: 72.1
```

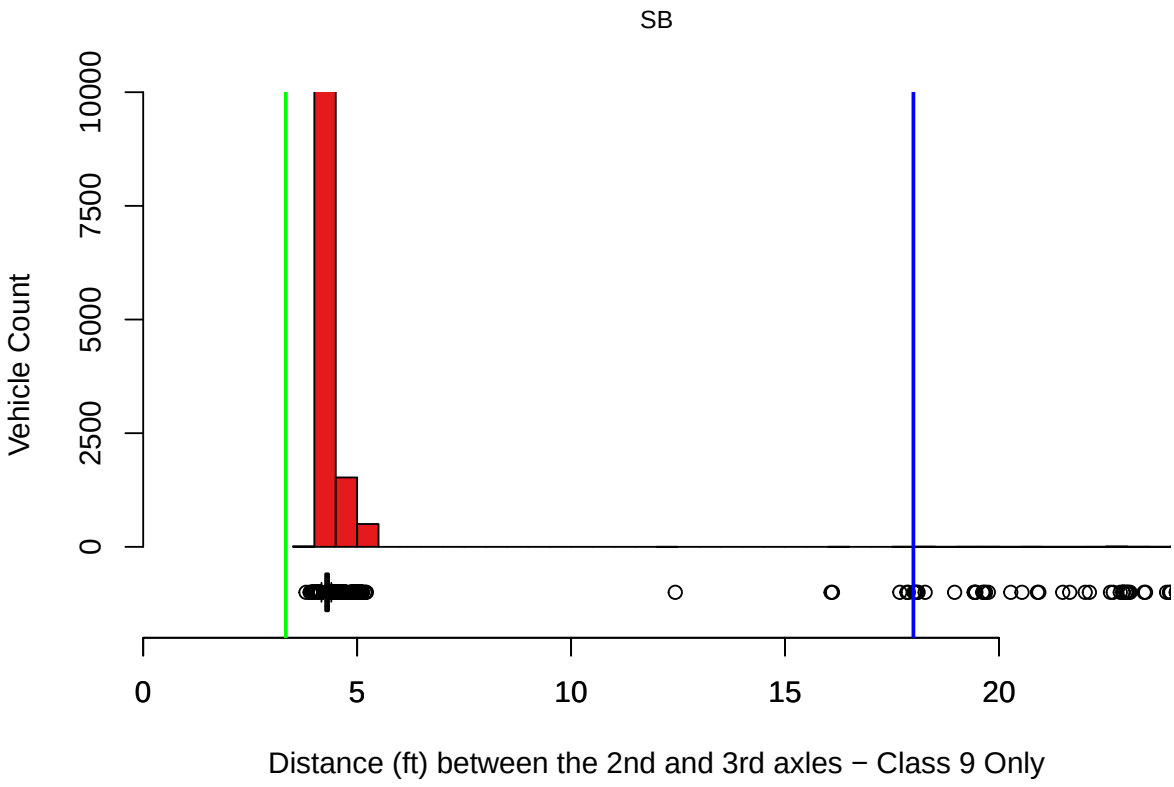
A-4.7.11 Graphical Summary of Axle Spacings for Class 9

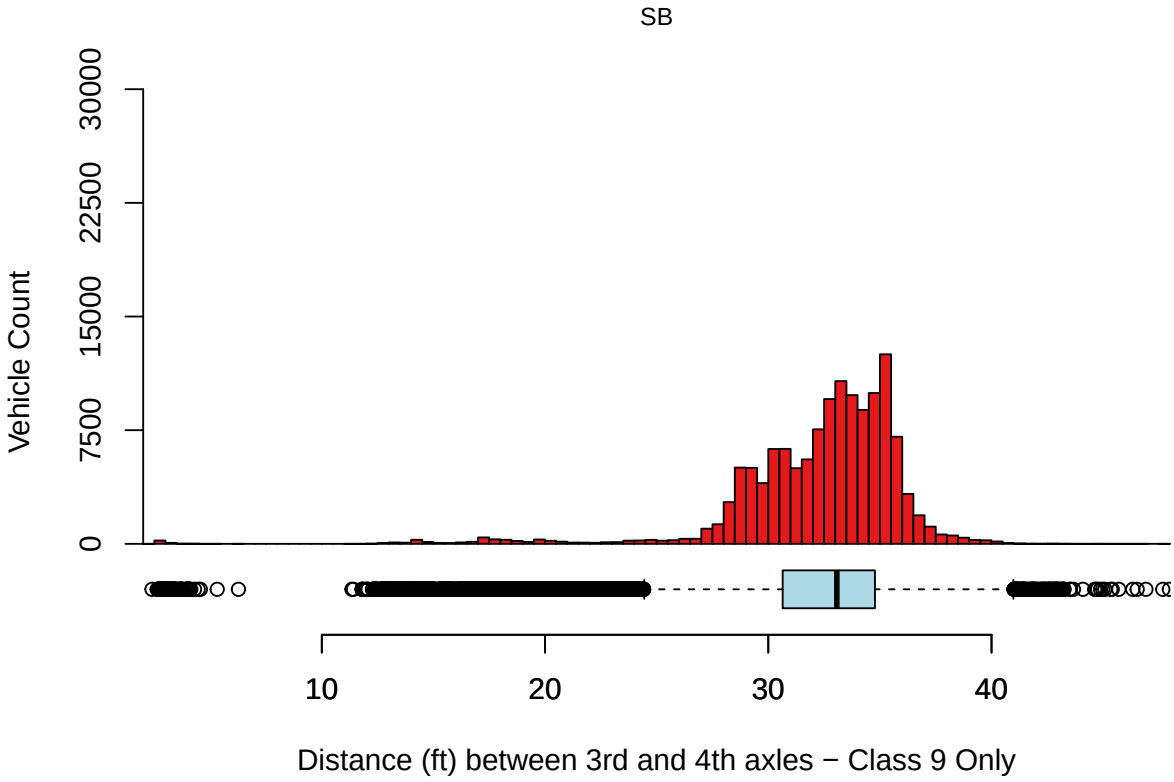
A-4.7.11(a) Direction 1 - Axle spacings for Class 9

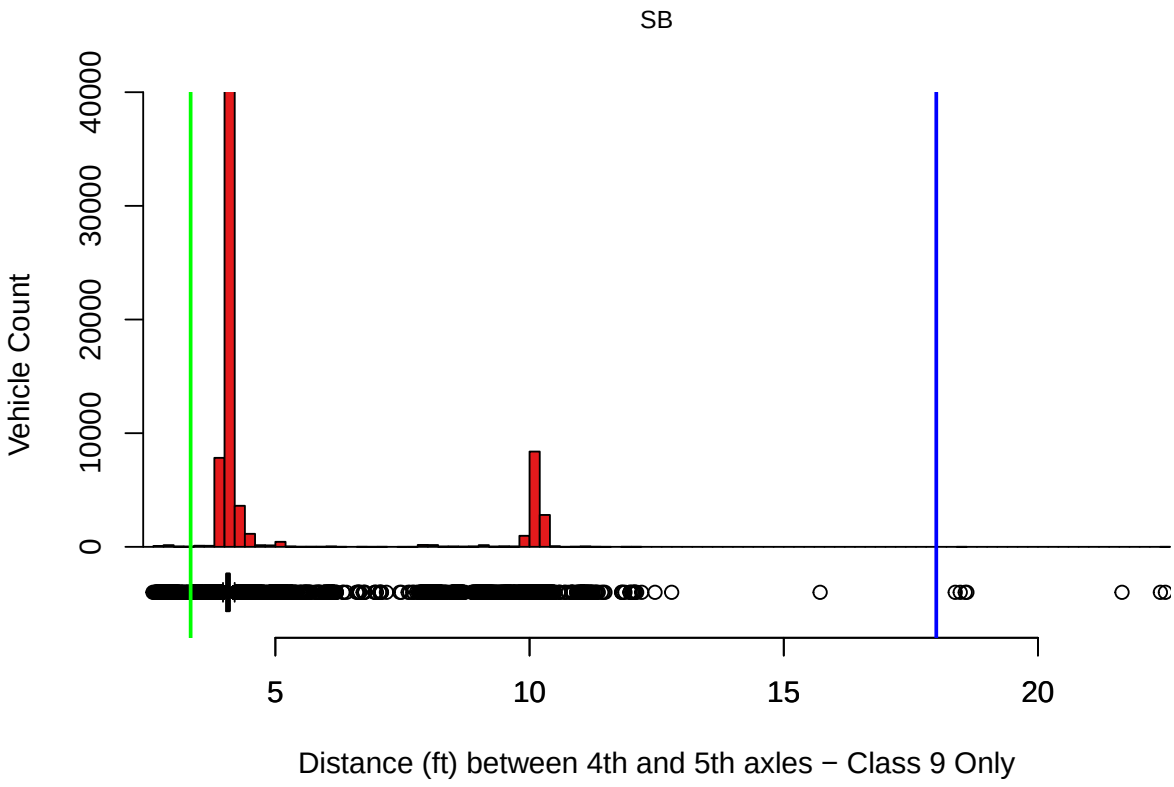
```
## Histograms with a boxplot

## SB - (Class 9) Summary of distance (ft) between the first and last axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   25.49   55.74   58.27   57.65   60.33   79.33

## Standard deviation of distance (ft) between the 1st and last axle: 4.43
```




SB
Vehicle Count
0
2500
5000
7500
10000
10
15
20
25
Distance (ft) between the 1st and 2nd axles − Class 9 Only


SB
Vehicle Count
0
2500
5000
7500
10000
0
5
10
15
20
Distance (ft) between the 2nd and 3rd axles − Class 9 Only

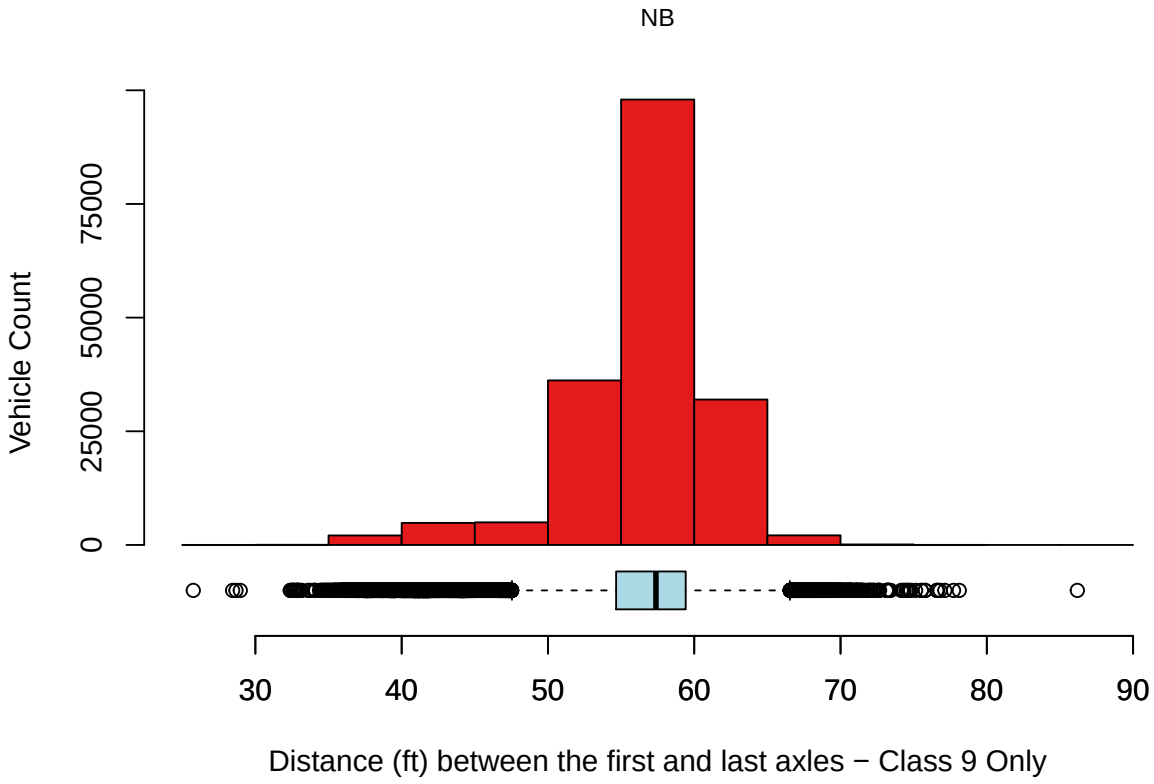

SB
Vehicle Count
0
7500
15000
22500
30000
10
20
30
40
Distance (ft) between 3rd and 4th axles − Class 9 Only

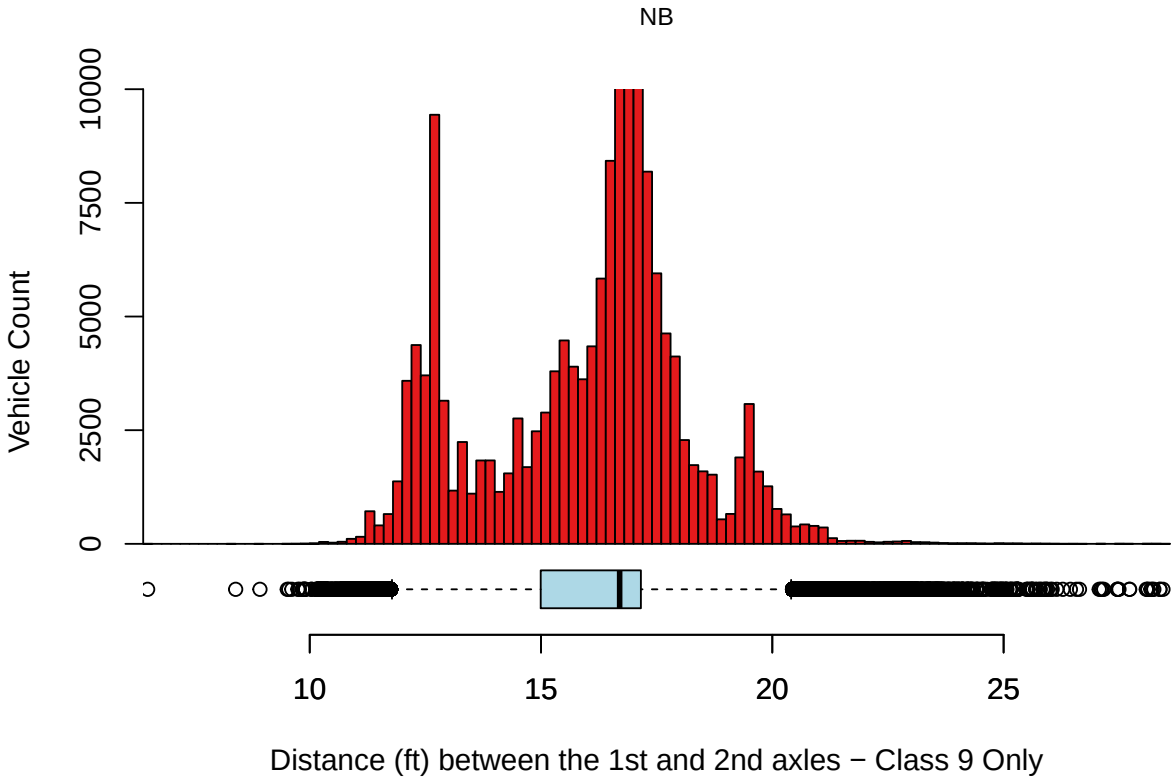


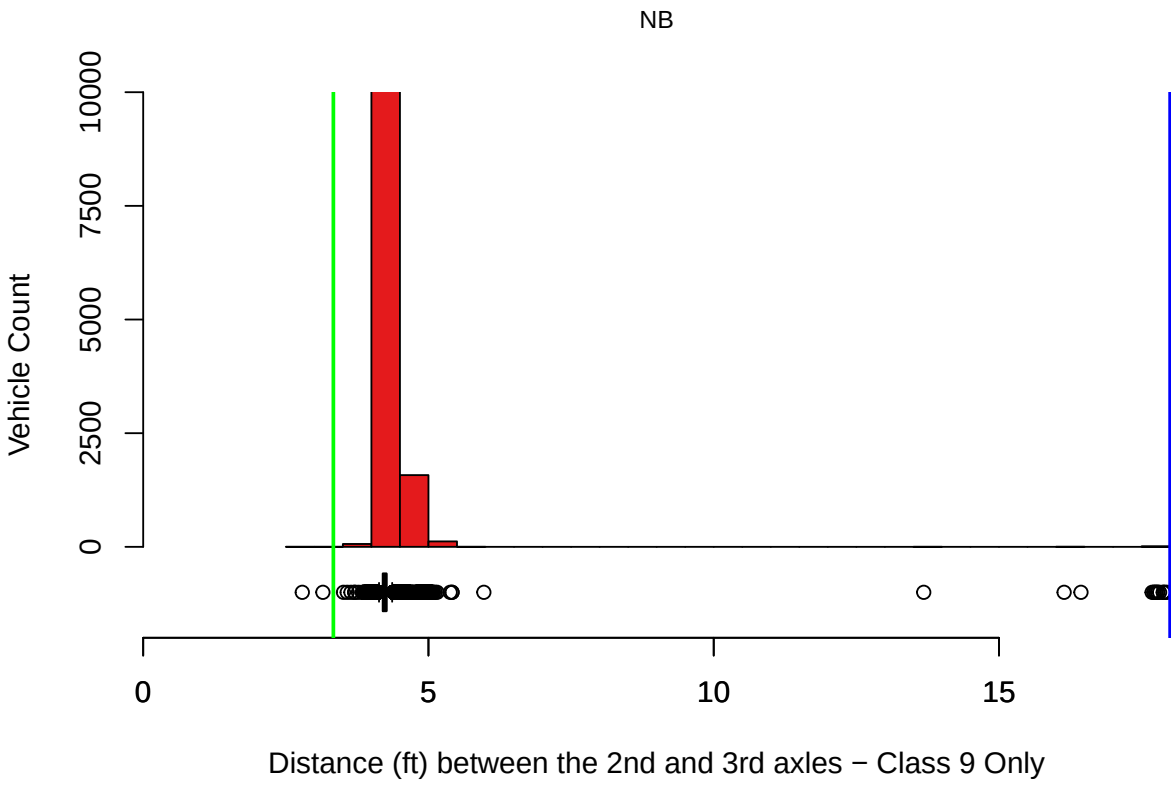

```
##
##  SB  - (Class 9) No spacing (between 5th and 6th) data exist.
```

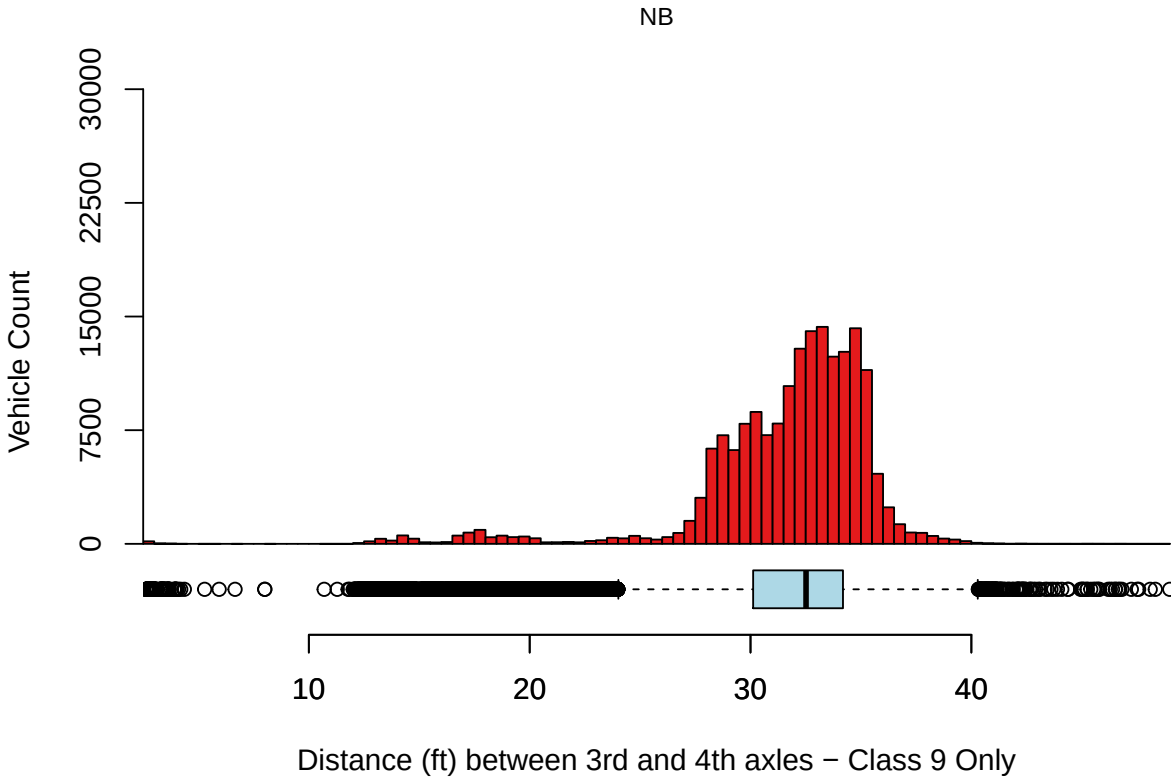
A-4.7.11(b) Direction 2 - Axle spacings for Class 9

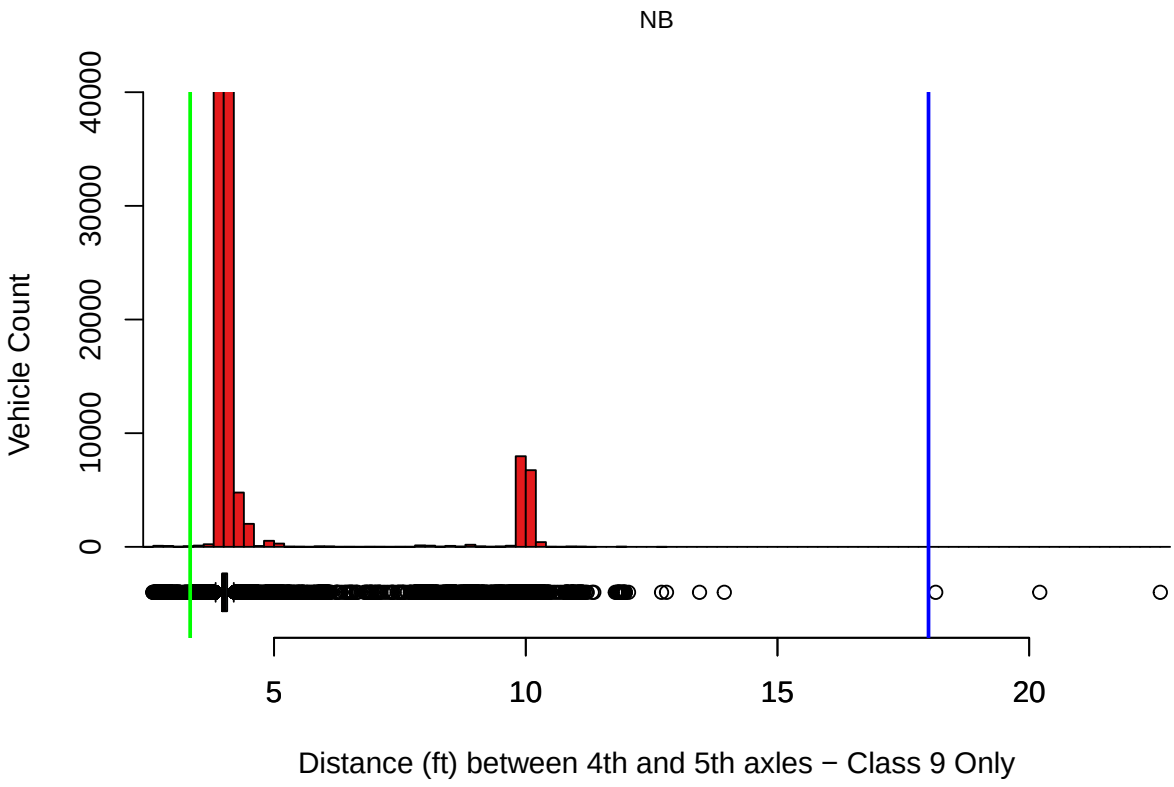
```
## Histograms with a boxplot

## NB - (Class 9) Summary of distance (ft) between the first and last axles:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   25.75   54.66   57.38   56.60   59.42   86.19

## Standard deviation of distance (ft) between the 1st and last axle: 4.7
```




NB
Vehicle Count
0
2500
5000
7500
10000
10
15
20
25
Distance (ft) between the 1st and 2nd axles − Class 9 Only


NB
Vehicle Count
0
2500
5000
7500
10000
0
5
10
15
Distance (ft) between the 2nd and 3rd axles − Class 9 Only


NB
Vehicle Count
0
7500
15000
22500
30000
10
20
30
40
Distance (ft) between 3rd and 4th axles − Class 9 Only

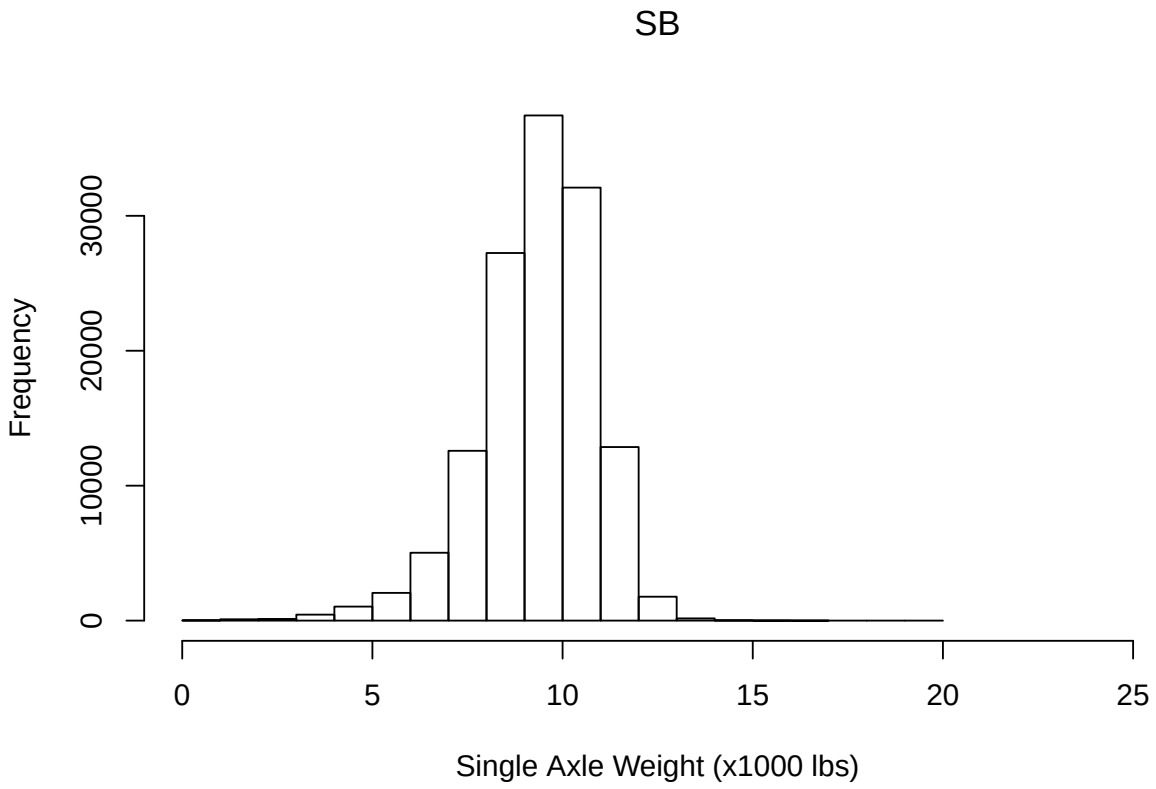


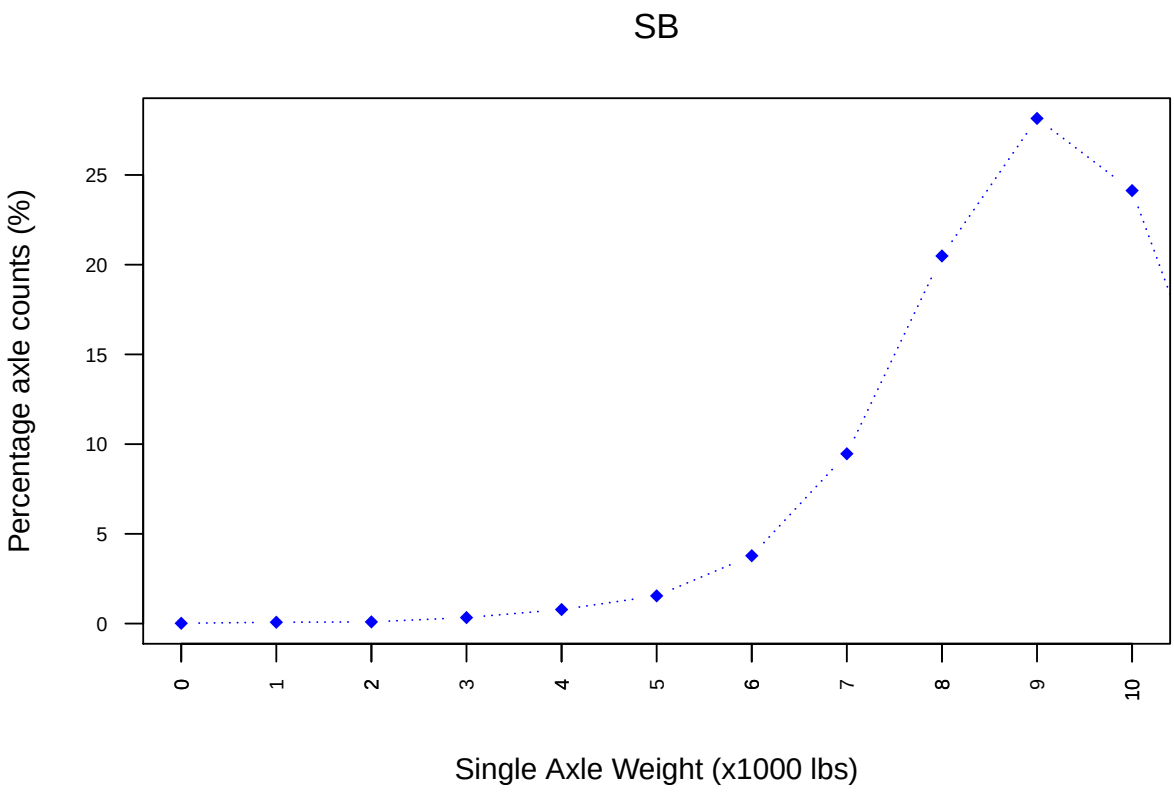

```
##
##  NB  - (Class 9) No spacing (between 5th and 6th) data exist.
```

A-4.7.12 Graphical Summary of (Annual) Single Axle Load Spectra for Class 9 Vehicles

A-4.7.12(a) Direction 1 - Single Axle Load Spectrum for Class 9

```
## Load Spectra
```

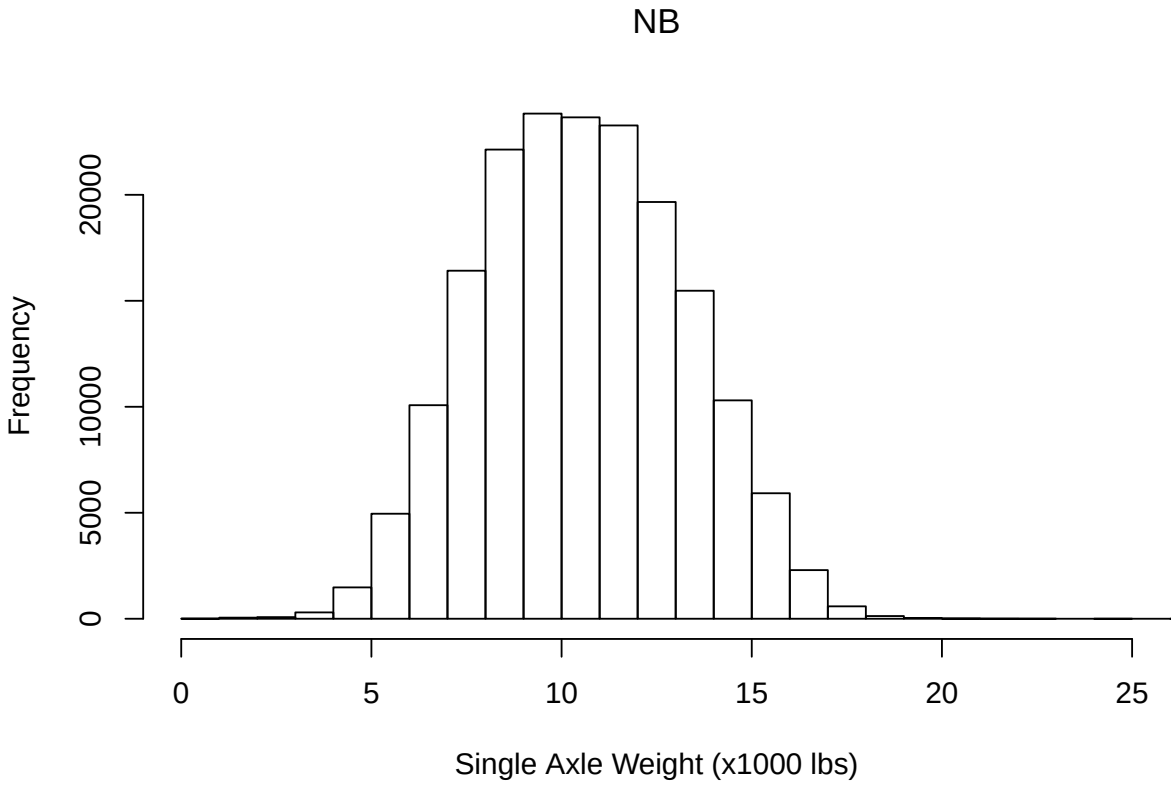


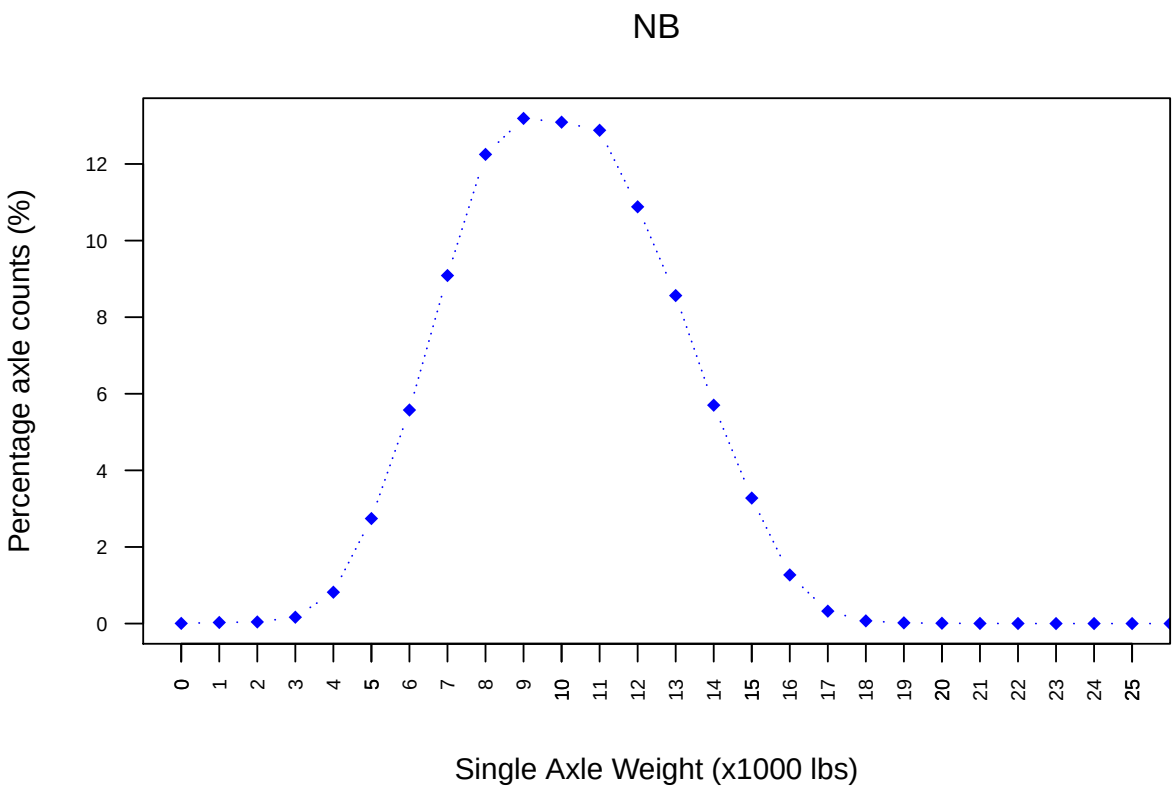



```
## SB - (Class 9) Proportion of single axle weight > 20,000 lbs: 0 %
```

A-4.7.12(b) Direction 2 - Single Axle Load Spectrum for Class 9

```
## Load Spectra
```



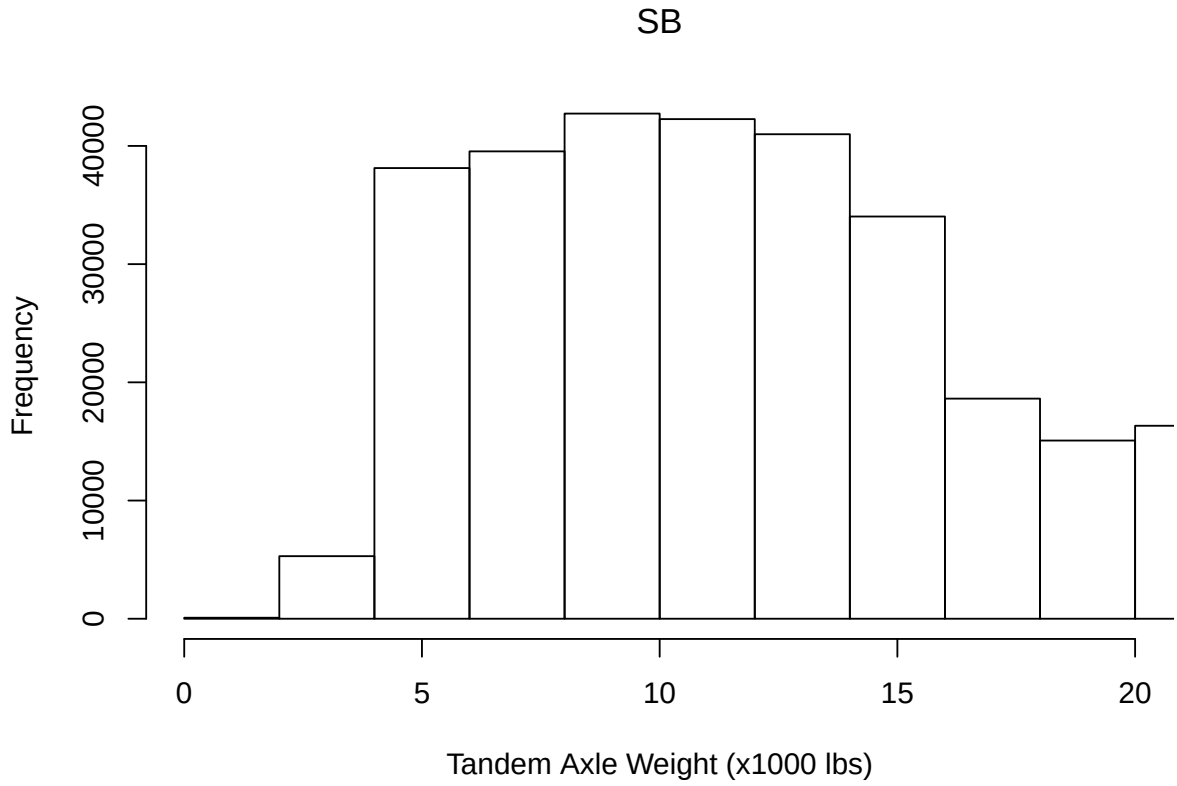


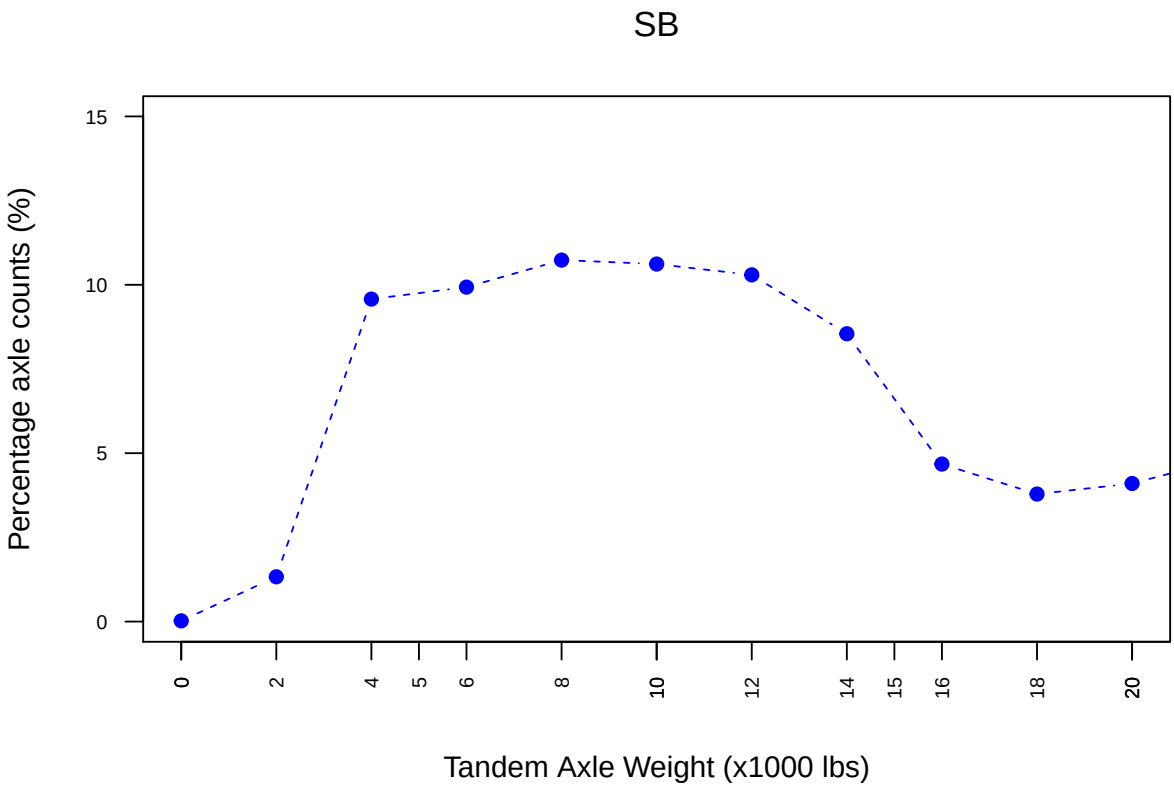

```
## NB - (Class 9) Proportion of single axle weight > 20,000 lbs: 0.02 %
```

A-4.7.13 Graphical Summary of (Annual) Tandem Axle Load Spectra for Class 9 Vehicles

A-4.7.13(a) Direction 1 - Tandem Axle Load Spectra for Class 9

```
## Histograms
```

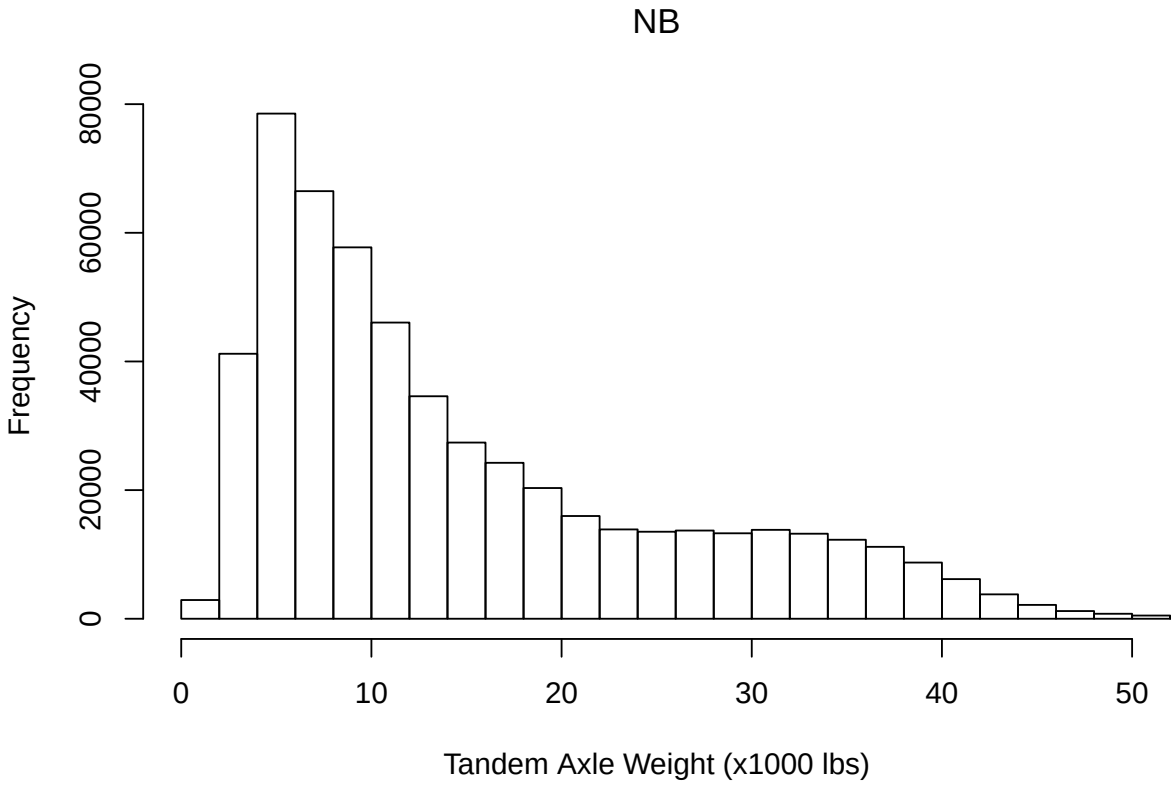


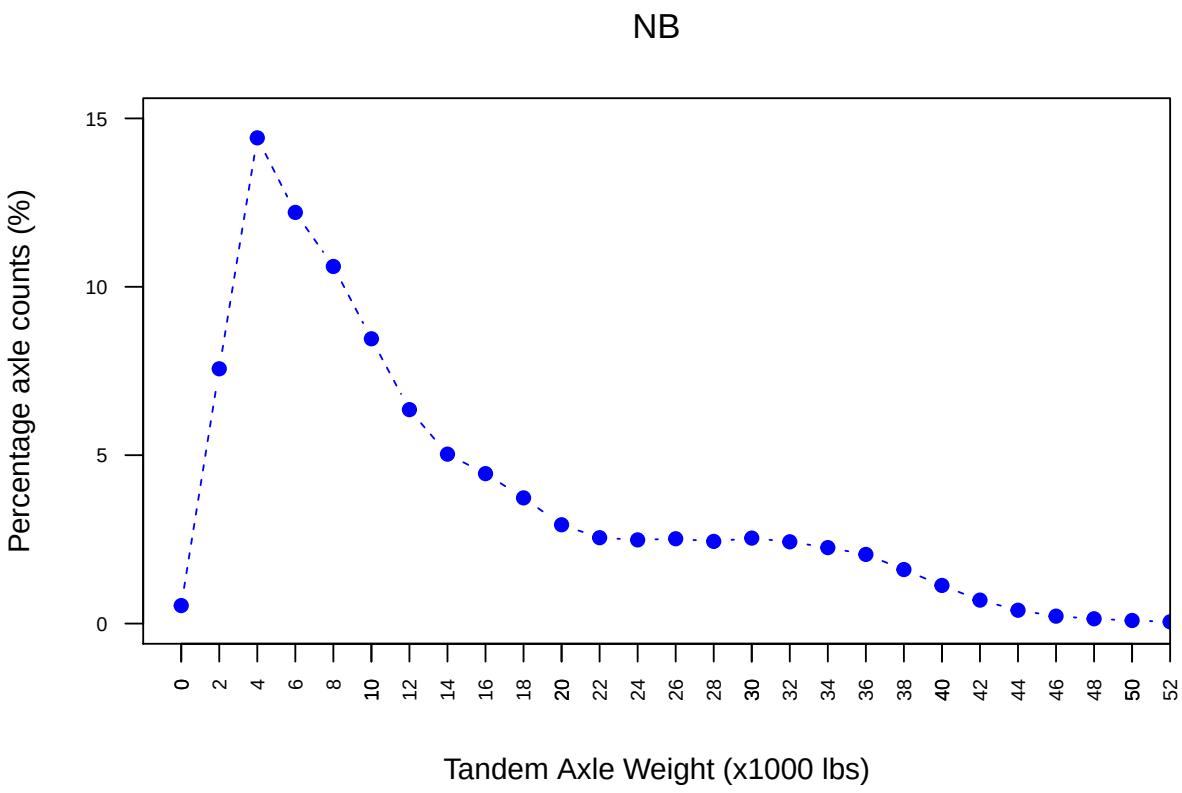



```
## SB - (Class 9) Proportion of
##            tandem axle weight > 34,000 lbs: 0.9 %
```

A-4.7.13(b) Direction 2 - Tandem Axle Load Spectra for Class 9

```
## Histograms
```






```
## NB - (Class 9) Proportion of
##            tandem axle weight > 34,000 lbs: 8.75 %
```

A-4.7.14 Numerical Summary - Proportions of Axle Spacing Qualifying Single Axle (Class 9 Only)

A-4.7.14(a) Direction 1 - Single Axle Load Spectrum for Class 9

```
## SB - (Class 9) Proportion of 2nd spacing qualifying single axle: 0 %

## SB - (Class 9) Proportion of 2nd spacing qualifying tandem axle: 135.98 %

## SB - (Class 9) Proportion of 2nd spacing >216 inches 0.16 %
##

## SB - (Class 9) Proportion of 3rd spacing qualifying single axle: 0.14 %

## SB - (Class 9) Proportion of 3rd spacing qualifying tandem axle: 3.2 %

## SB - (Class 9) Proportion of 3rd spacing >216 inches 132.8 %
##

## SB - (Class 9) Proportion of 4th spacing qualifying single axle: 0.15 %

## SB - (Class 9) Proportion of 4th spacing qualifying tandem axle: 135.99 %

## SB - (Class 9) Proportion of 4th spacing >216 inches: 0 %
```

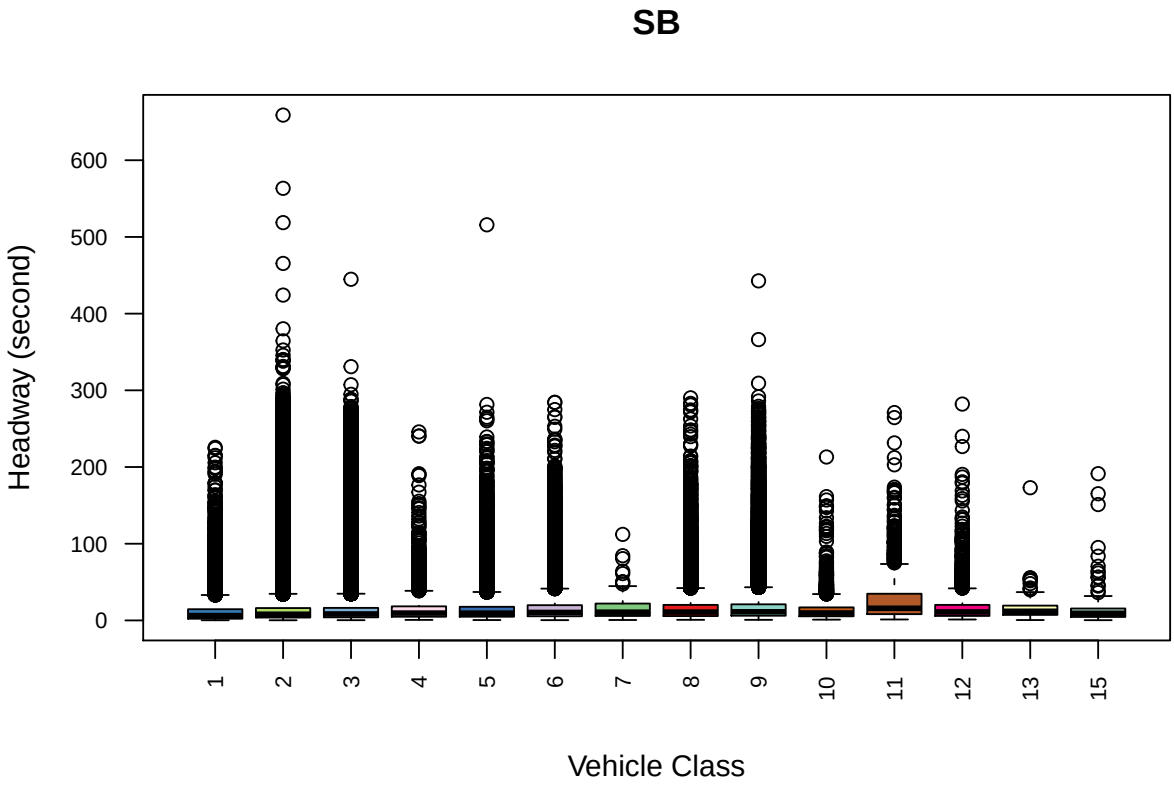
A-4.7.14(b) Direction 2 - Single Axle Load Spectrum for Class 9

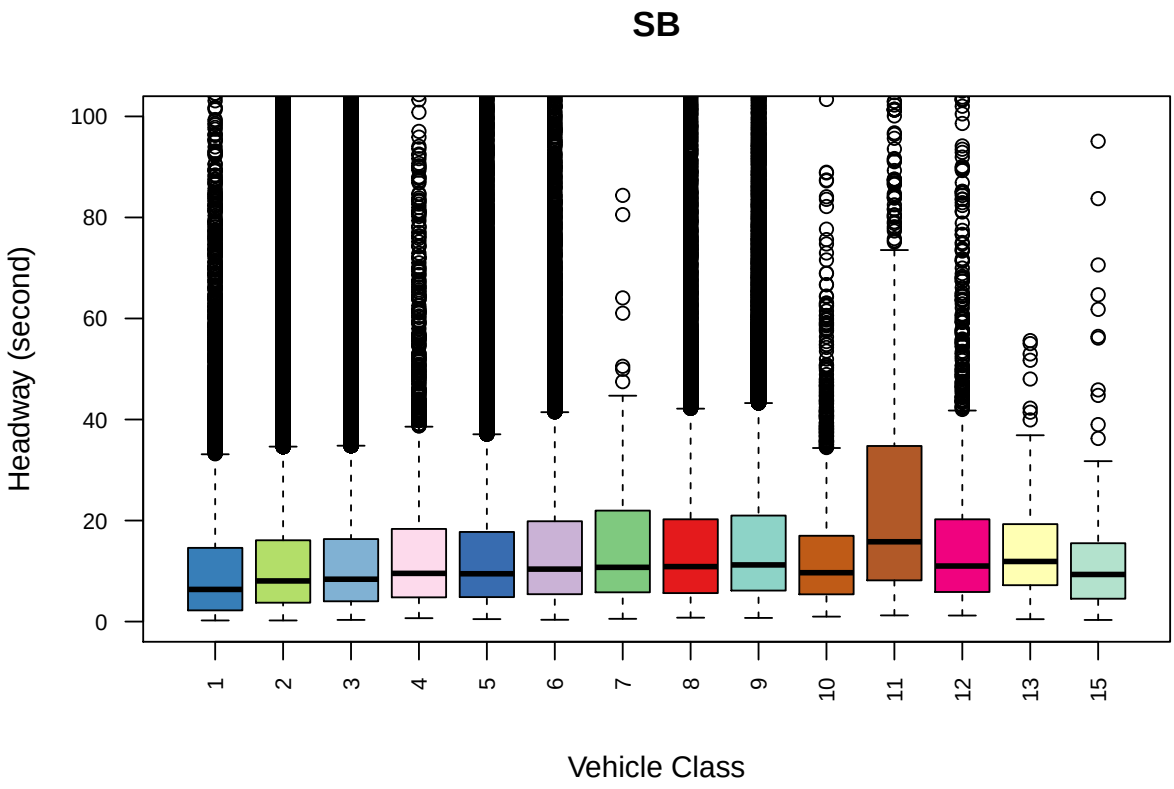
```
##
## 1. Distance between the 2nd and 3rd axles (or 2nd spacing)

## NB - (Class 9) Proportion of 2nd spacing qualifying single axle: 0 %

## NB - (Class 9) Proportion of 2nd spacing qualifying tandem axle: 99.88 %

## NB - (Class 9) Proportion of 2nd spacing >216 inches 0.12 %

##
## 2. Distance between the 3rd and 4th axles (or 3rd spacing)

## NB - (Class 9) Proportion of 3rd spacing qualifying single axle: 0.1 %

## NB - (Class 9) Proportion of 3rd spacing qualifying tandem axle: 2.35 %

## NB - (Class 9) Proportion of 3rd spacing >216 inches 97.55 %

##
## 3. Distance between the 4th and 5th axles (or 4th spacing)

## NB - (Class 9) Proportion of 4th spacing qualifying single axle: 0.11 %

## NB - (Class 9) Proportion of 4th spacing qualifying tandem axle: 99.89 %

## NB - (Class 9) Proportion of 4th spacing >216 inches: 0 %
```

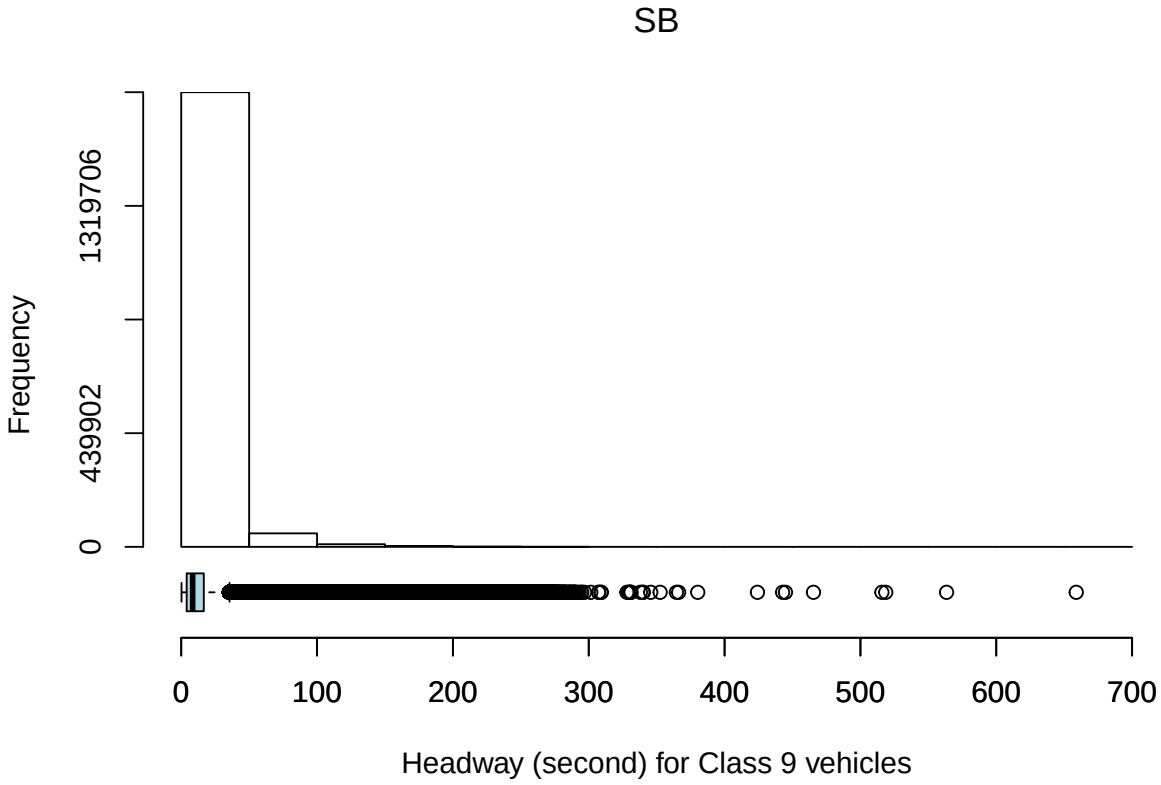
A-4.7.15 Graphical Summary of Headway (or Gap) between Vehicles for Class 9

A-4.7.15(a) Direction 1 - Headway (s) by Class

```
## Boxplot and Histogram
```



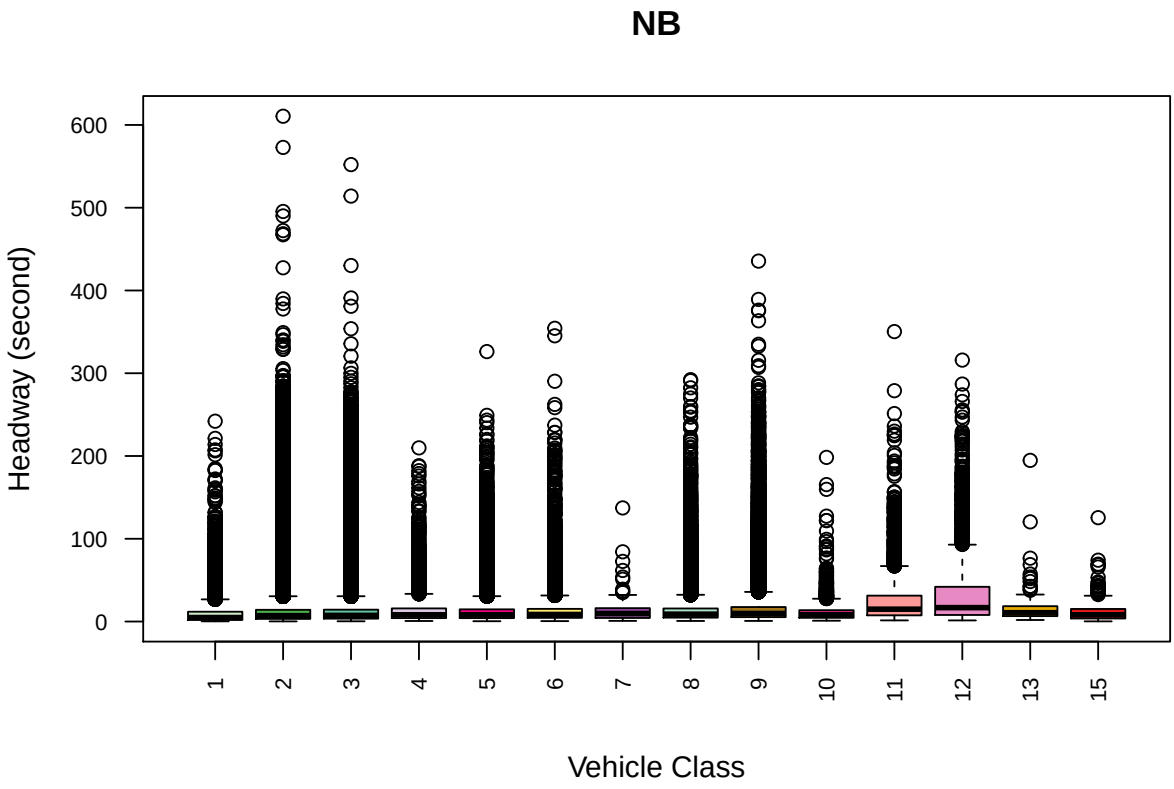

SB
Headway (second)
0
20
40
60
80
100
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class

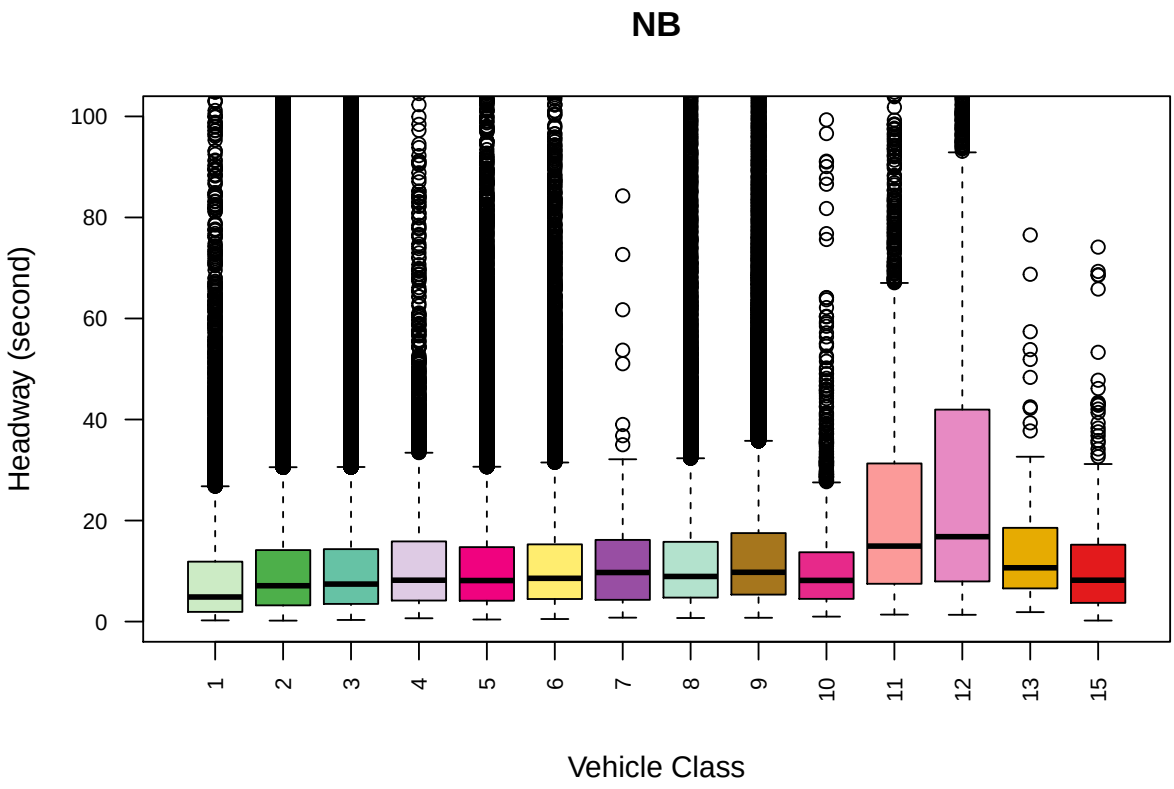


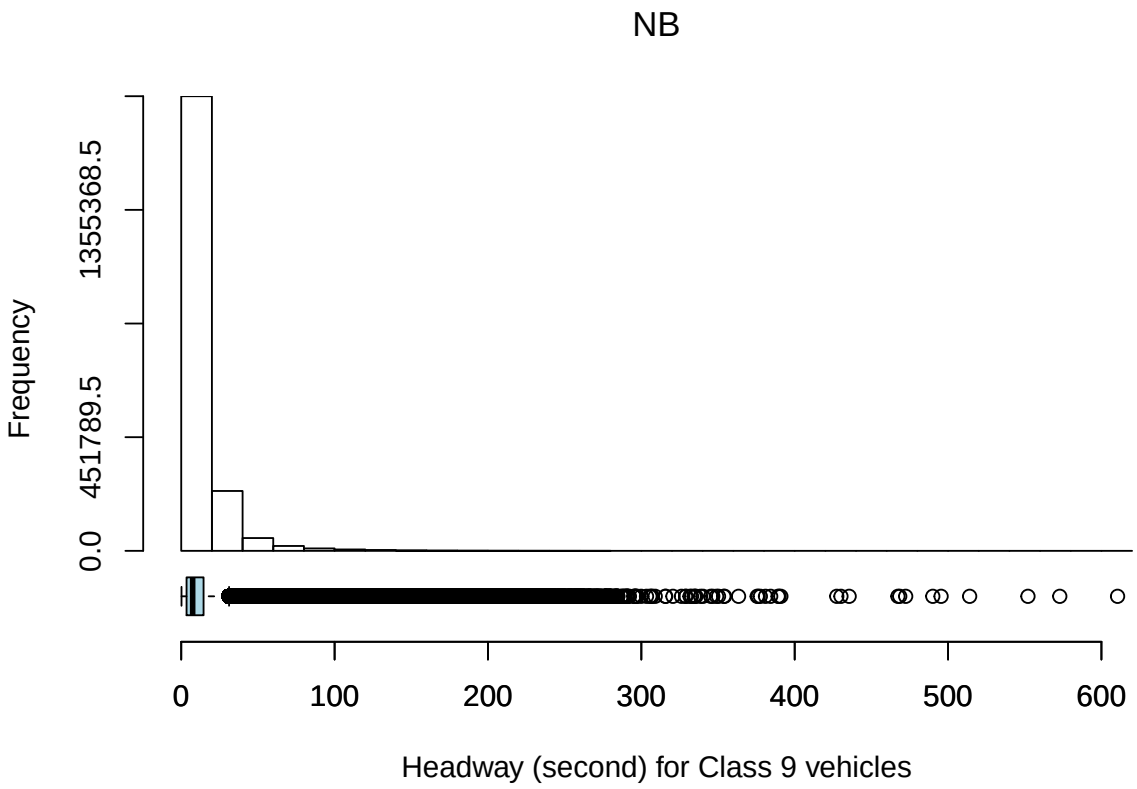

```
##
## % Vehicle Counts with zero or missing 'Headway'(second) data for Class 9 Only:
##  7.5 %

##
## Vehicle Counts with zero or missing 'Headway'(second) data for Class 9 Only:
##  9895
```

A-4.7.15(b) Direction 2 - Headway (s) by Class

```
## Boxplot and Histogram
```




NB
Headway (second)
0
20
40
60
80
100
1
2
3
4
5
6
7
8
9
10
11
12
13
15
Vehicle Class

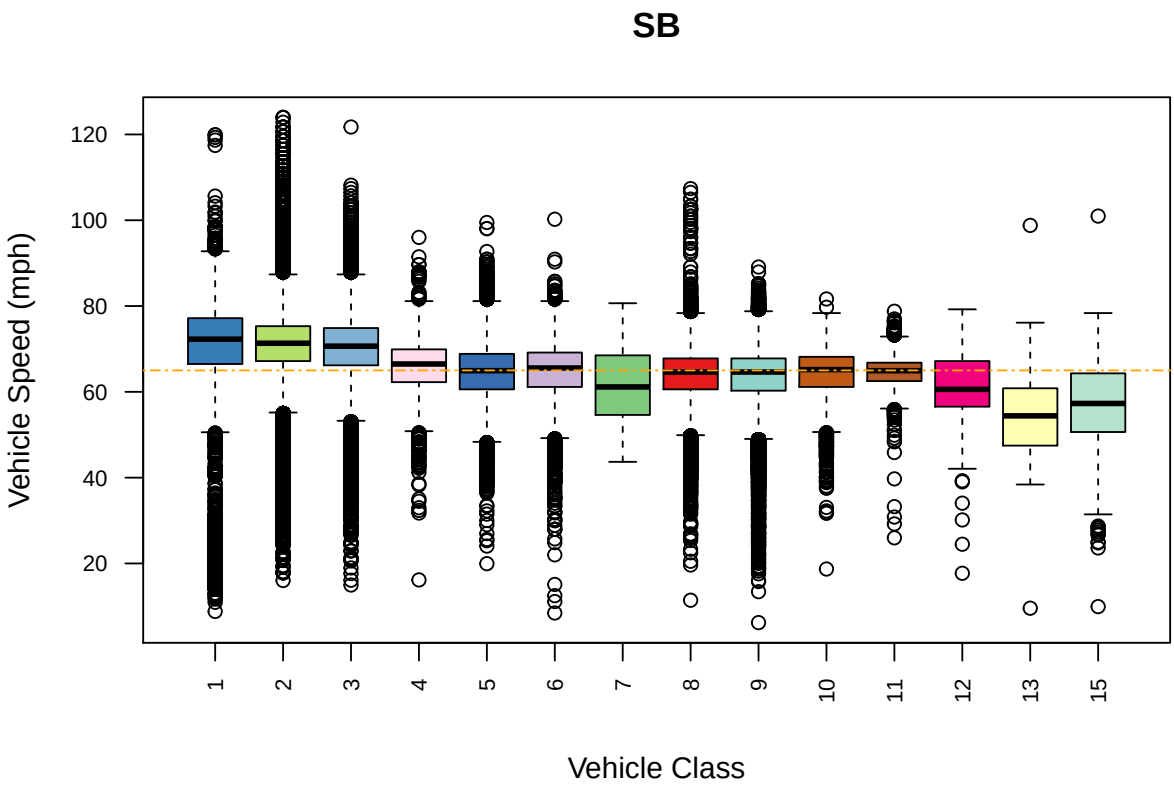


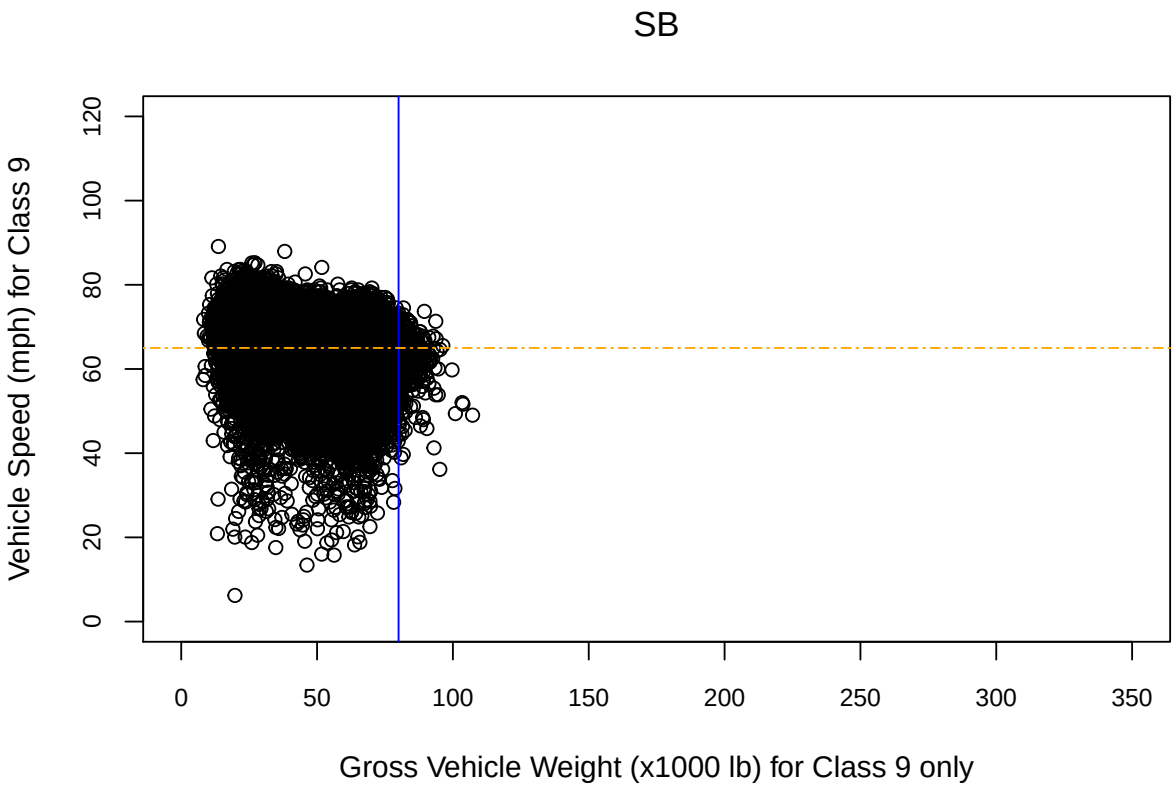

```
##
## % Vehicle Counts with zero or missing 'Headway'(second) data for Class 9 Only:
##  6.1 %

##
## Vehicle Counts with zero or missing 'Headway'(second) data for Class 9 Only:
##  10991
```

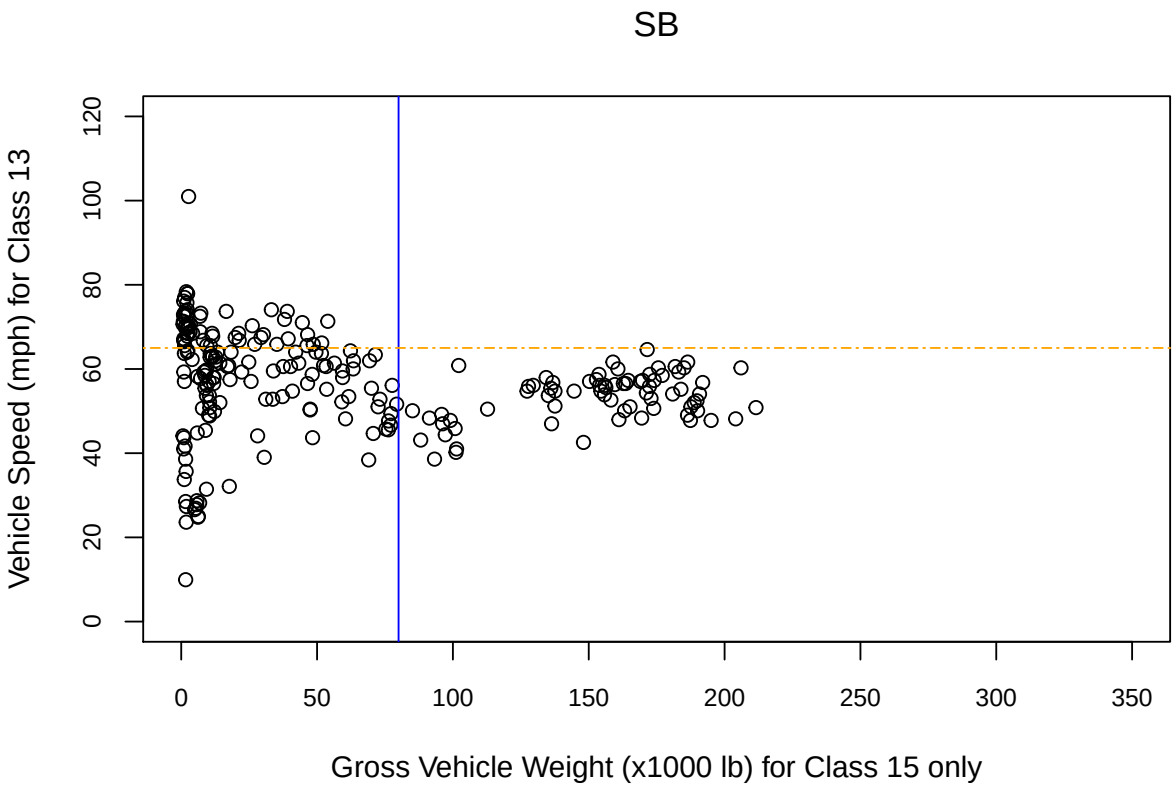
A-4.7.16 Graphical Summary of Speed (mph) and Weight Variation by Month

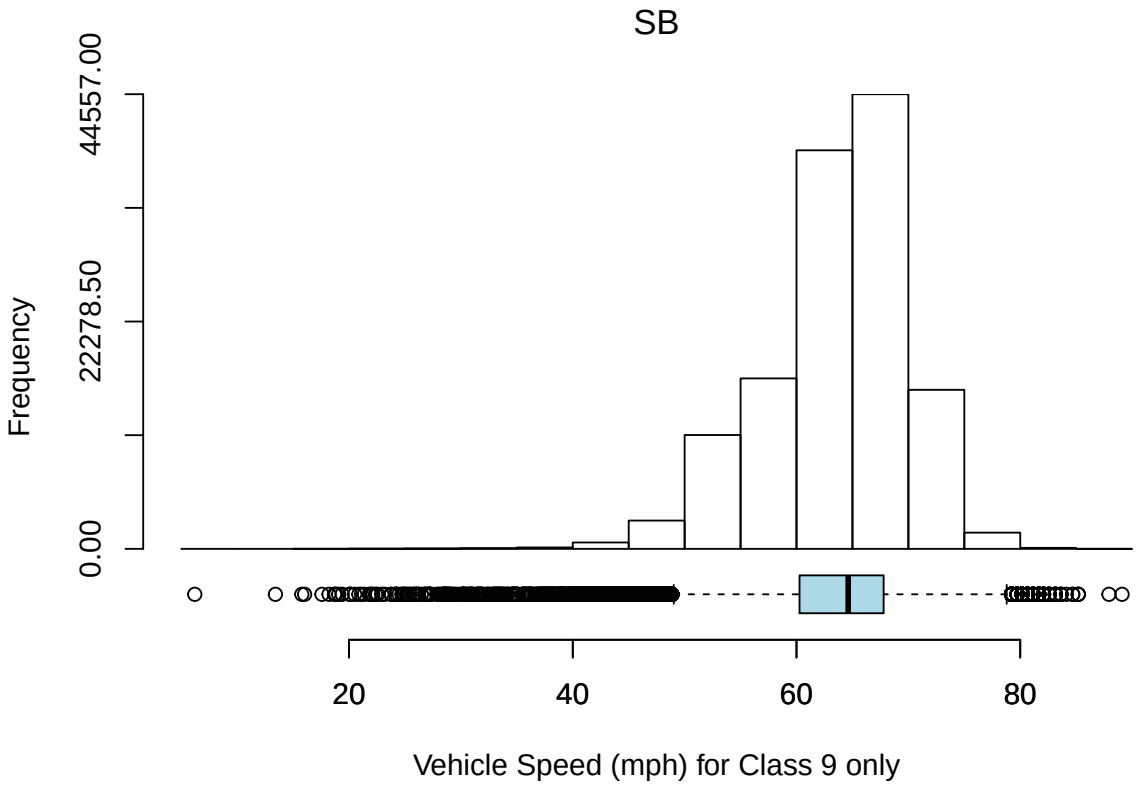
A-4.7.16(a) Direction 1 - Speed (mph) by Class

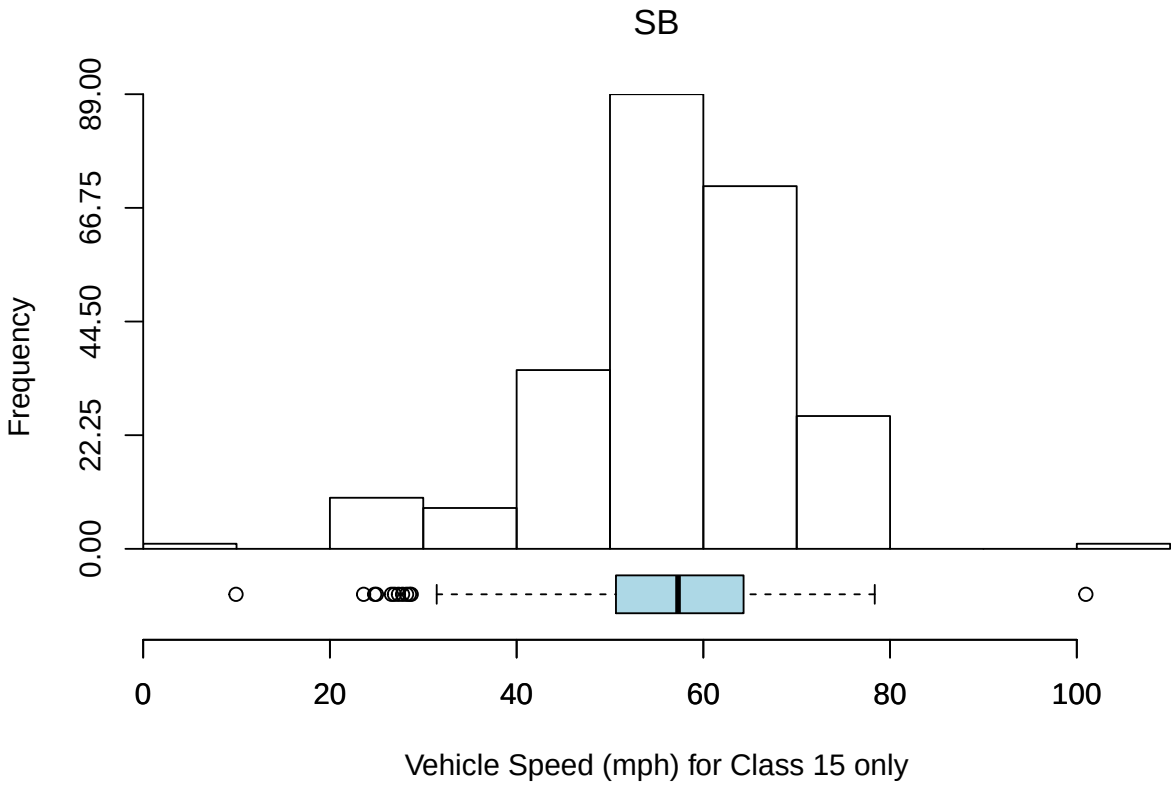
```
## Boxplot and scatter plots
```




SB
Vehicle Speed (mph) for Class 9
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
Gross Vehicle Weight (x1000 lb) for Class 9 only

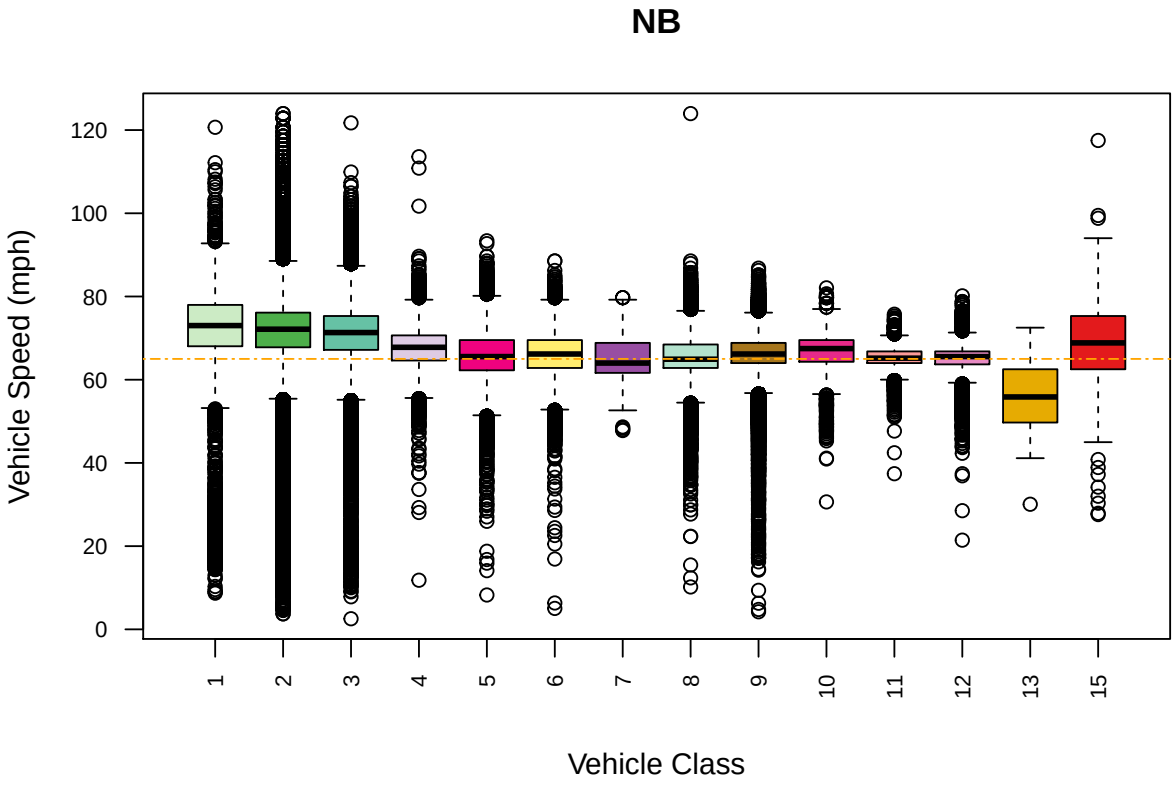

SB
Vehicle Speed (mph) for Class 13
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
Gross Vehicle Weight (x1000 lb) for Class 15 only

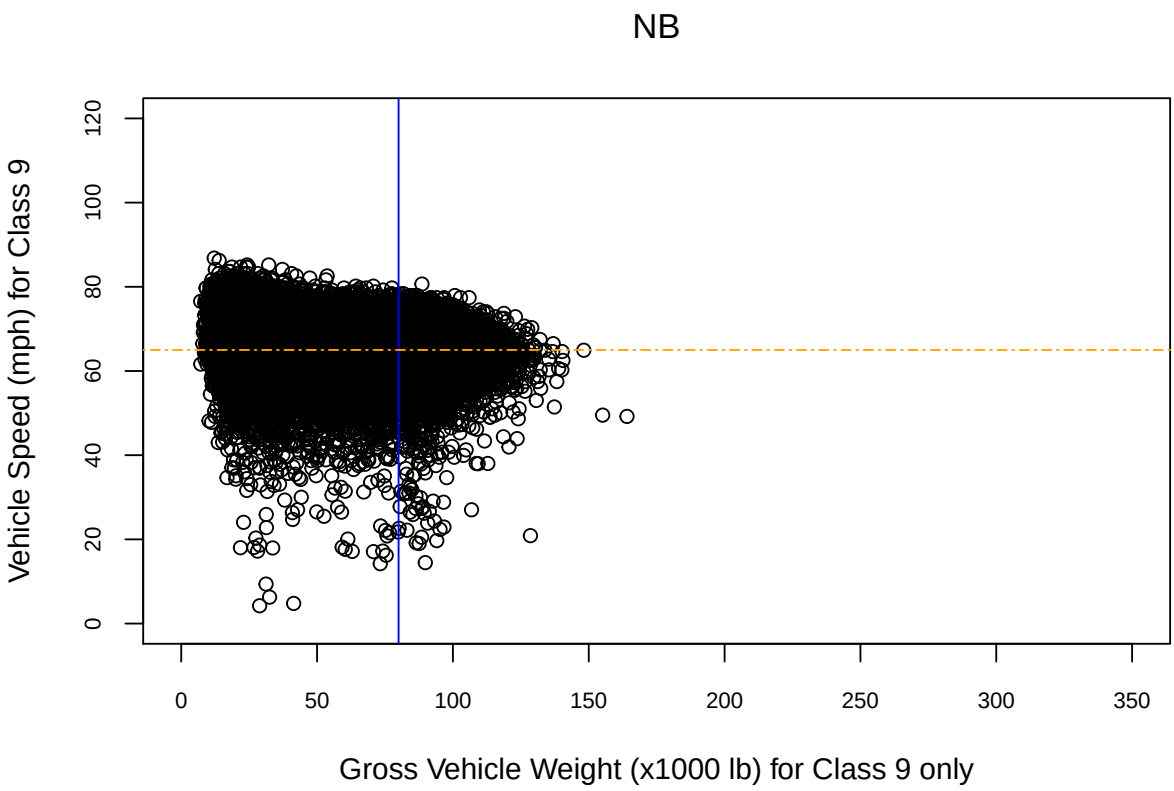

SB
Frequency
0.00
22278.50
44557.00
20
40
60
80
Vehicle Speed (mph) for Class 9 only

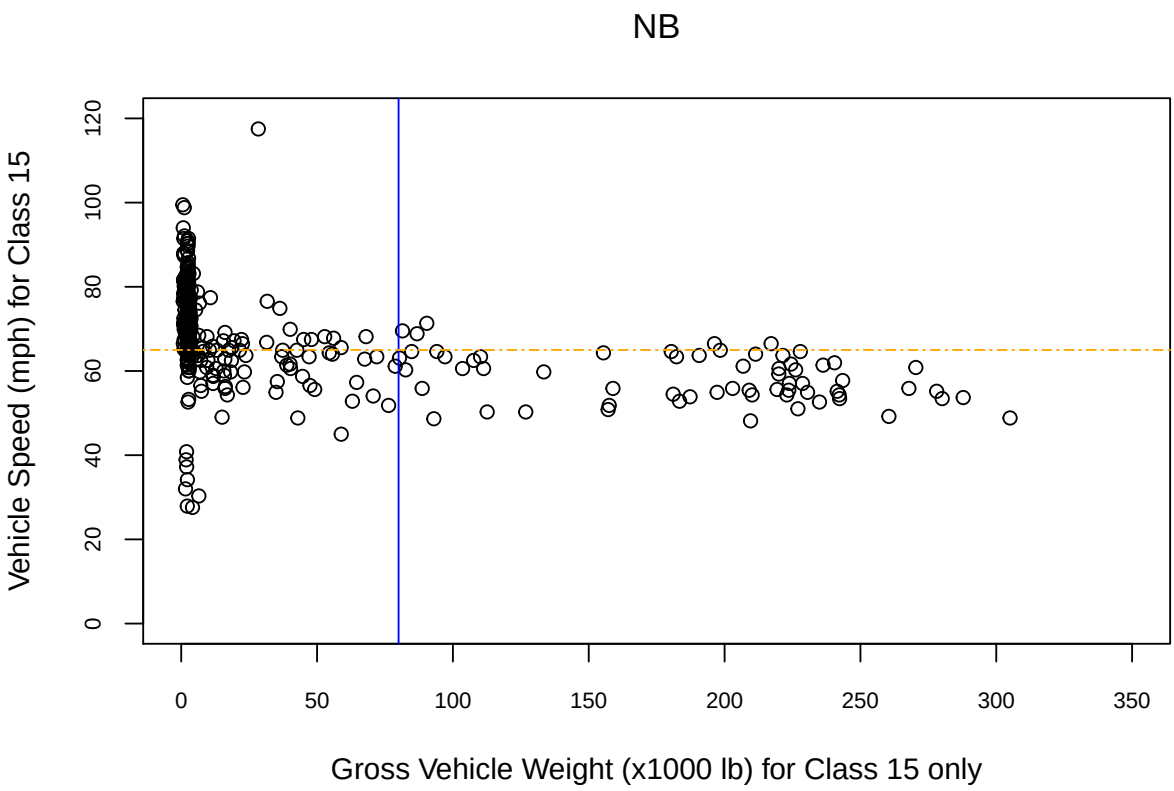

SB
Frequency
0.00
22.25
44.50
66.75
89.00
0
20
40
60
80
100
Vehicle Speed (mph) for Class 15 only

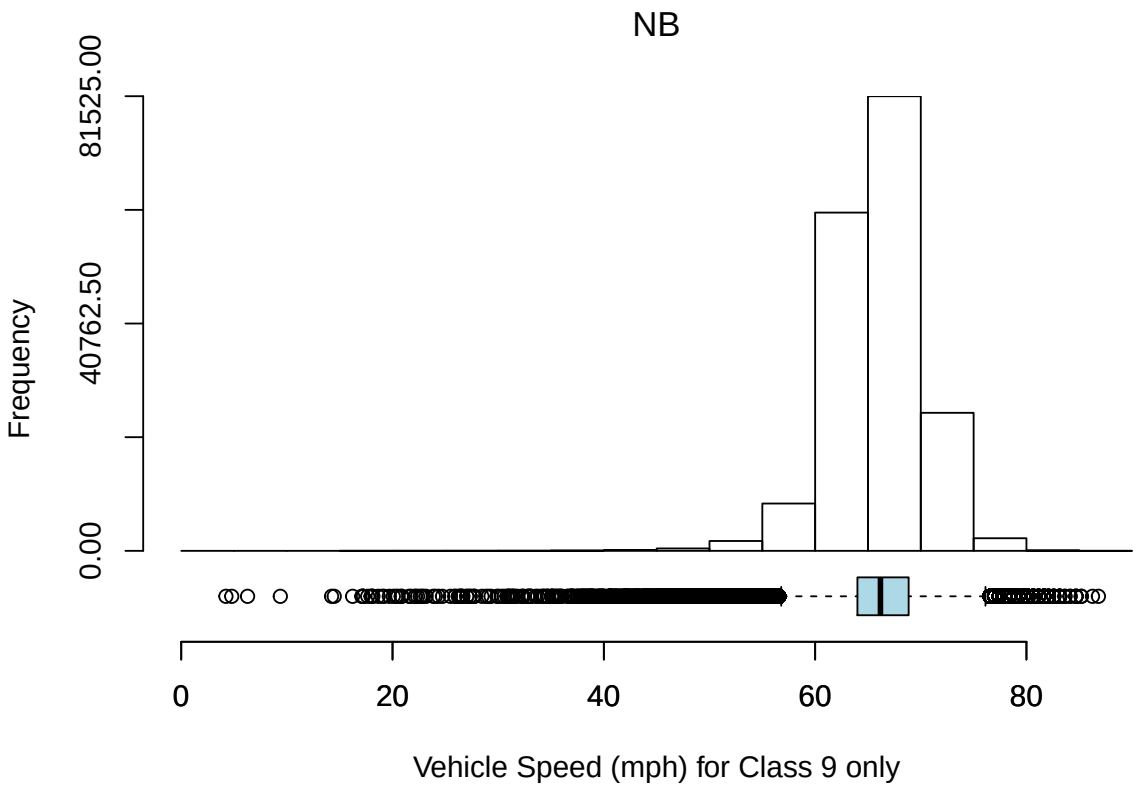
A-4.7.16(b) Direction 2 - Speed (mph) by Class

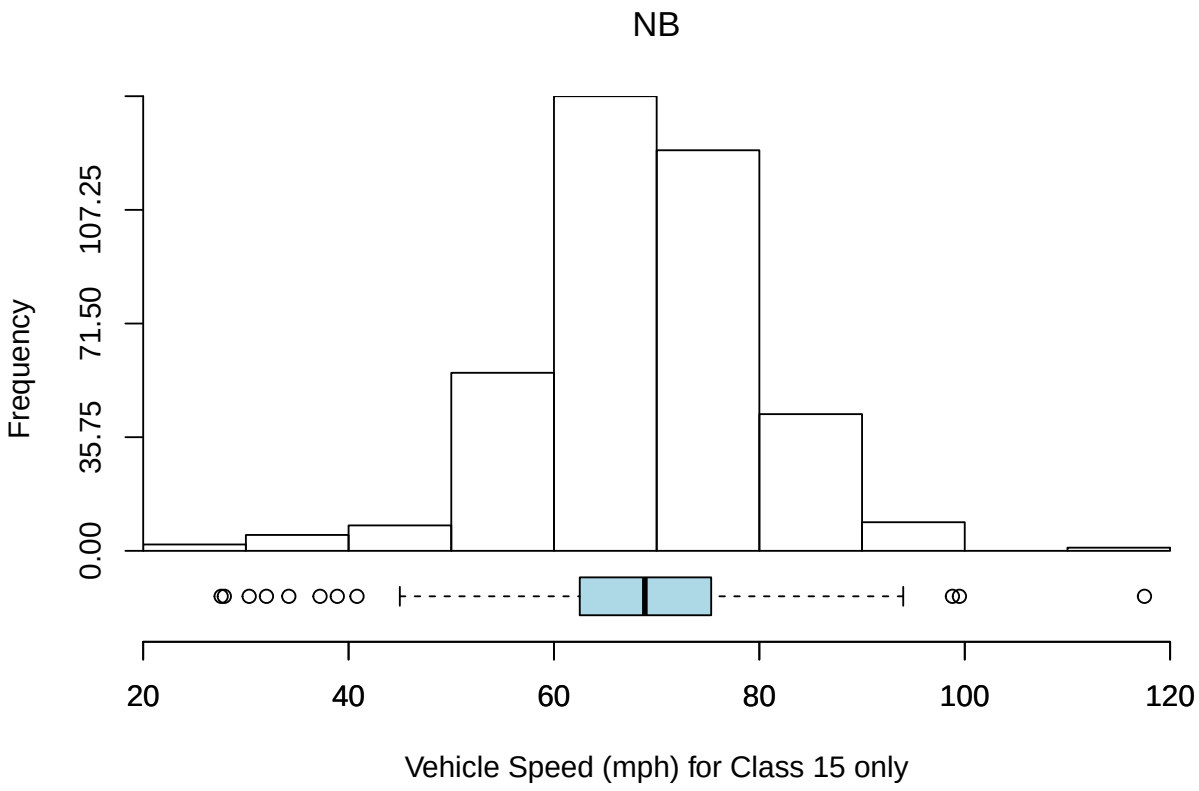
```
## Boxplot and scatter plots
```




NB
Vehicle Speed (mph) for Class 9
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
Gross Vehicle Weight (x1000 lb) for Class 9 only

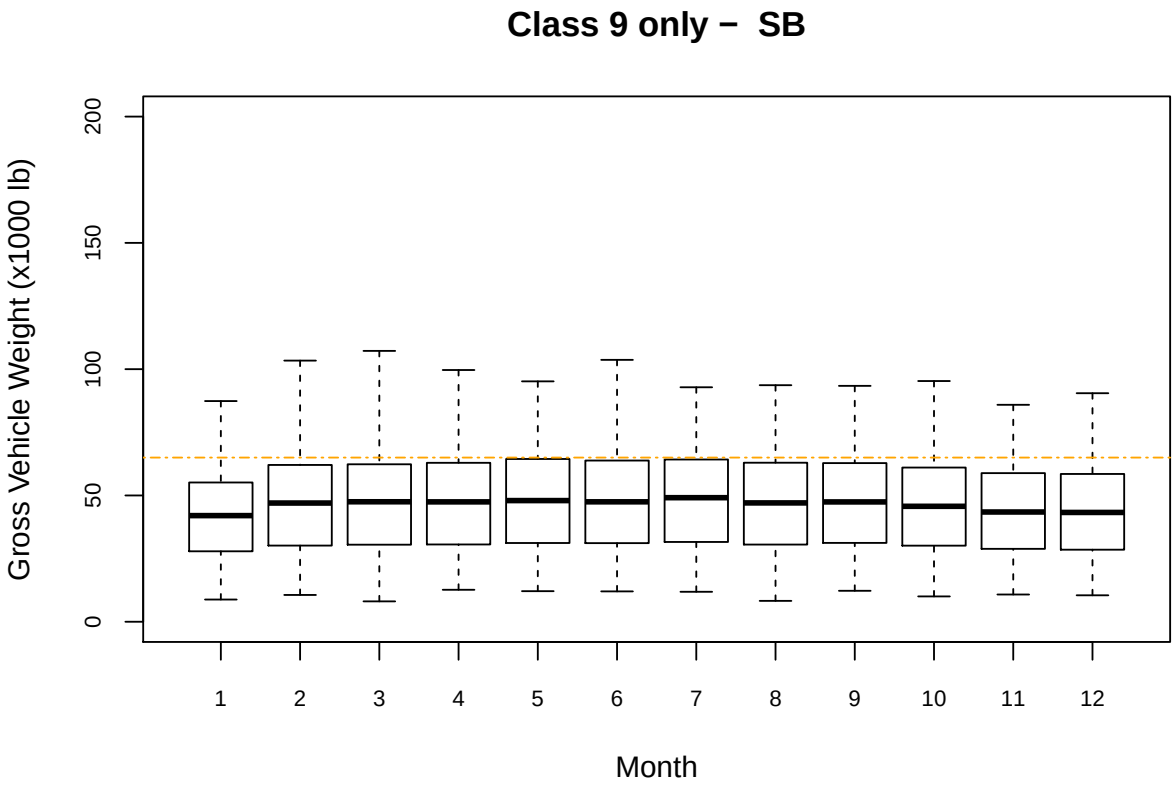

NB
Vehicle Speed (mph) for Class 15
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
Gross Vehicle Weight (x1000 lb) for Class 15 only

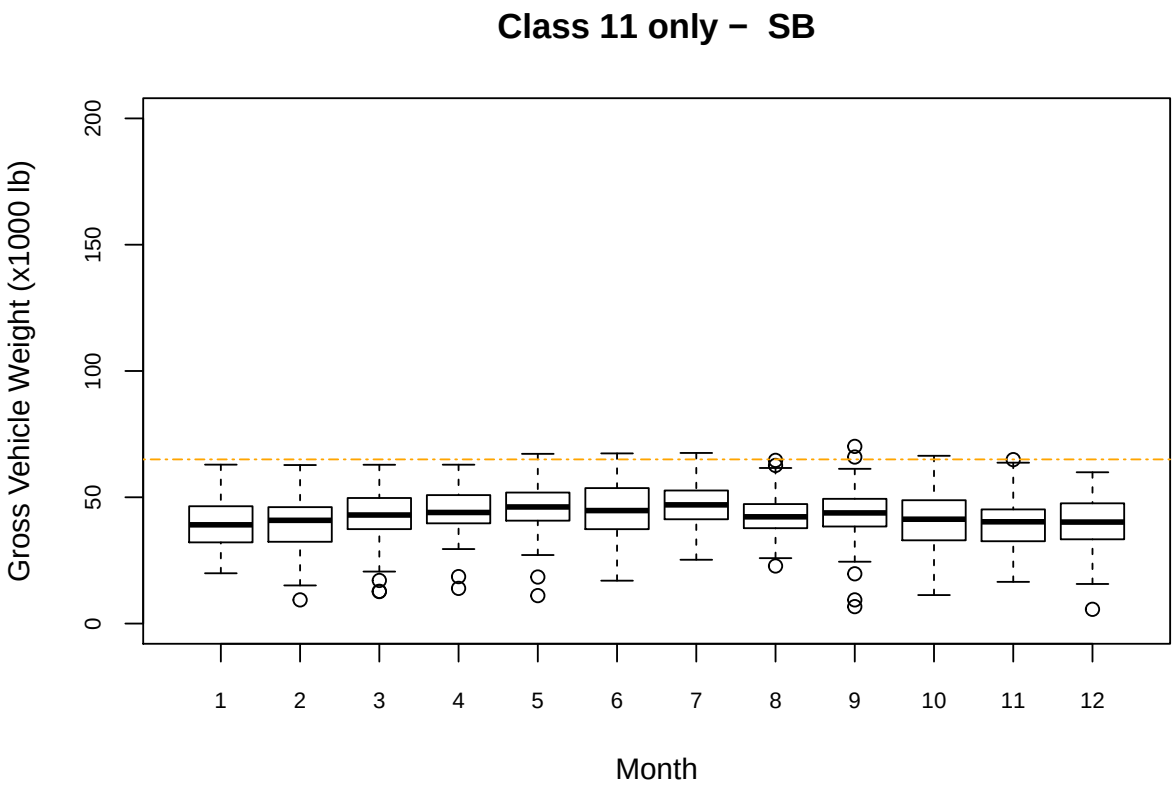

NB
Frequency
0.00
40762.50
81525.00
0
20
40
60
80
Vehicle Speed (mph) for Class 9 only

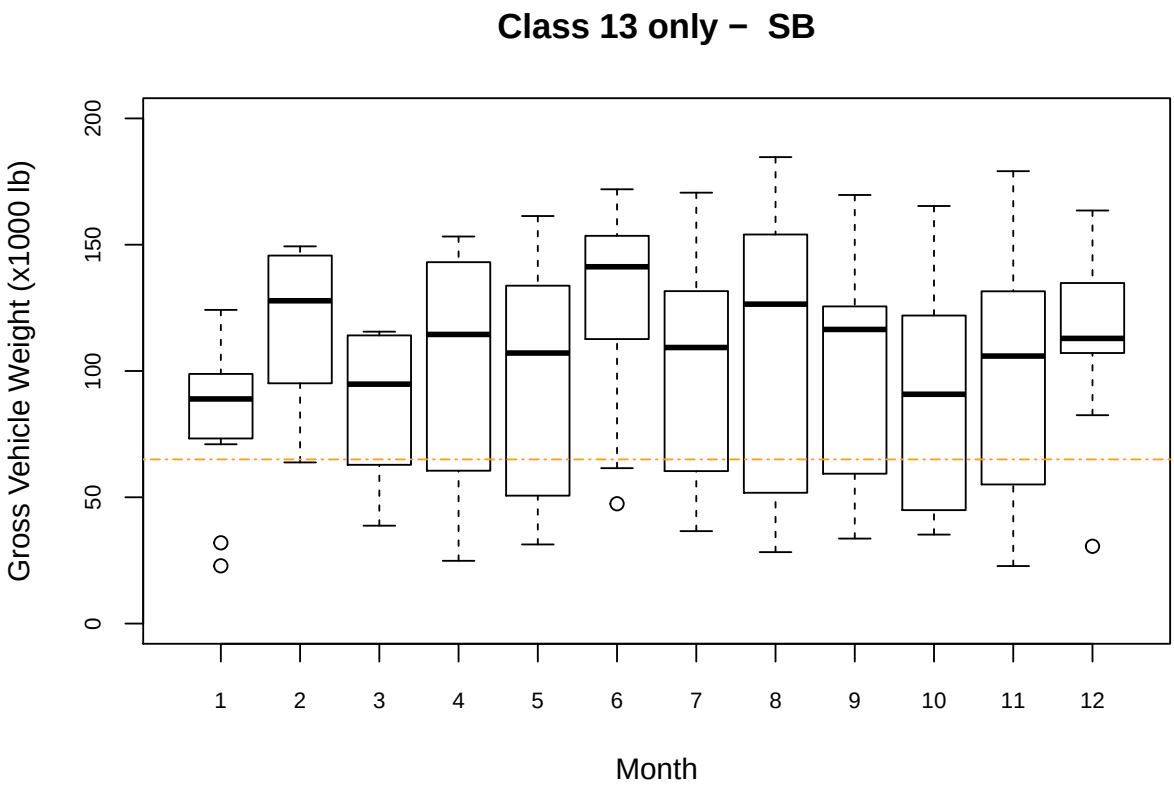

NB
Frequency
0.00
35.75
71.50
107.25
20
40
60
80
100
120
Vehicle Speed (mph) for Class 15 only

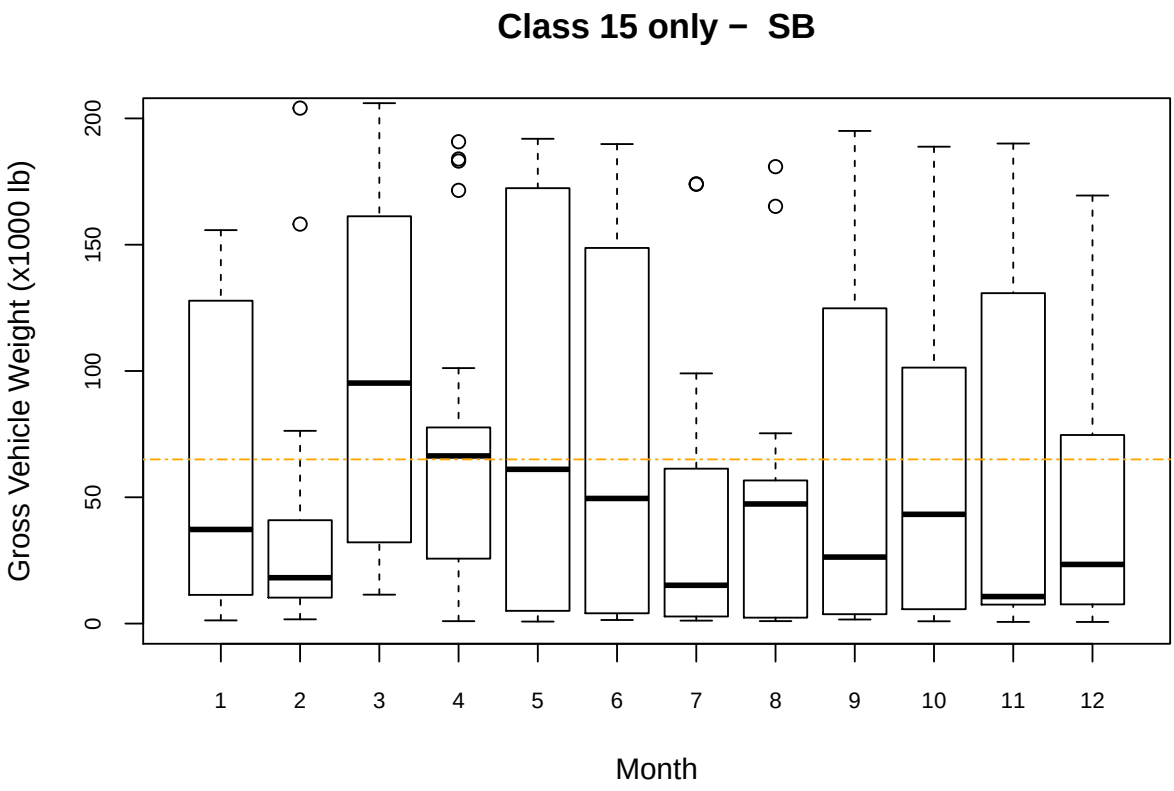
A-4.7.16(c) Direction 1 - Weight Variation by Month

```
## Boxplot plots
```



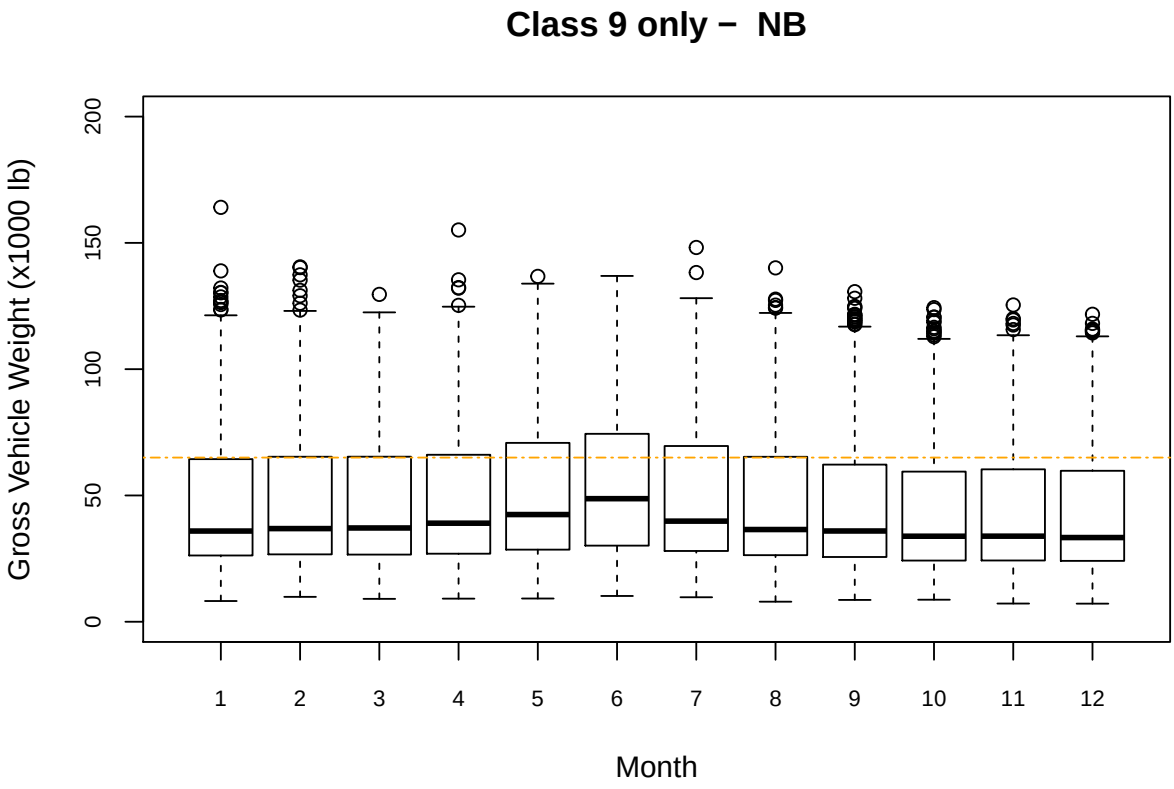

Class 11 only − SB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
Month

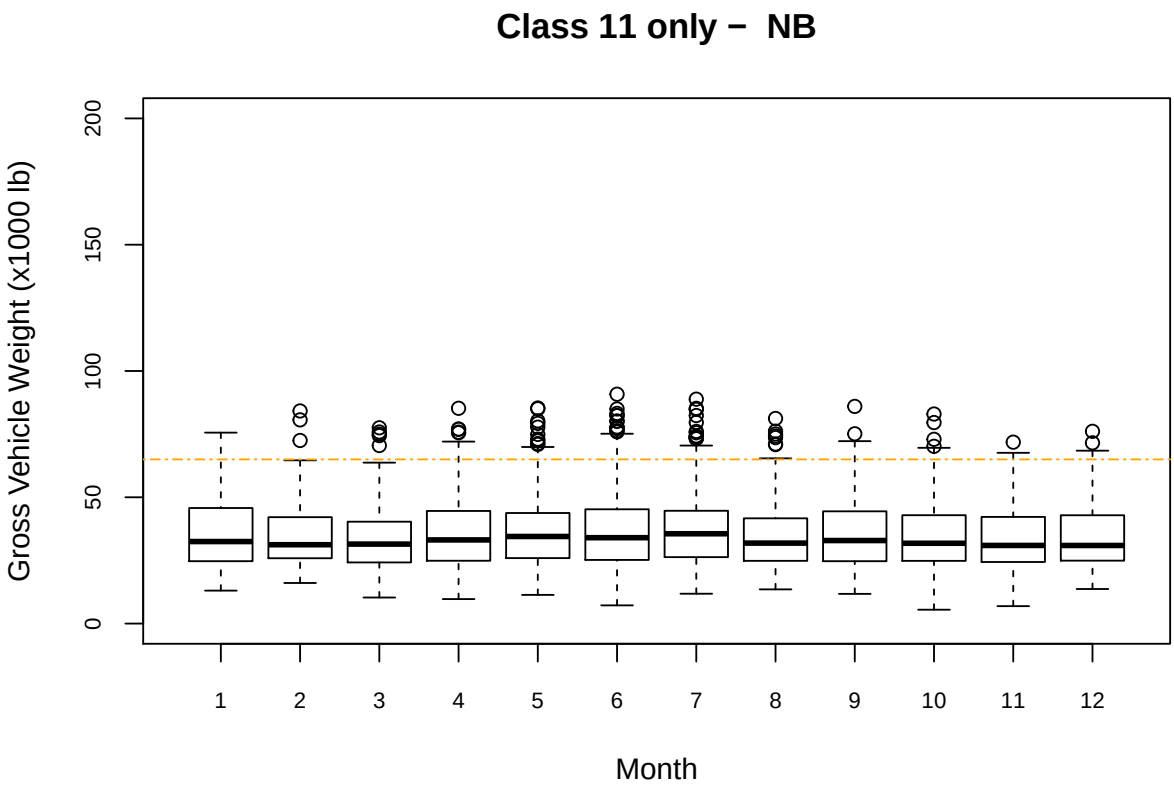

Class 13 only − SB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
Month

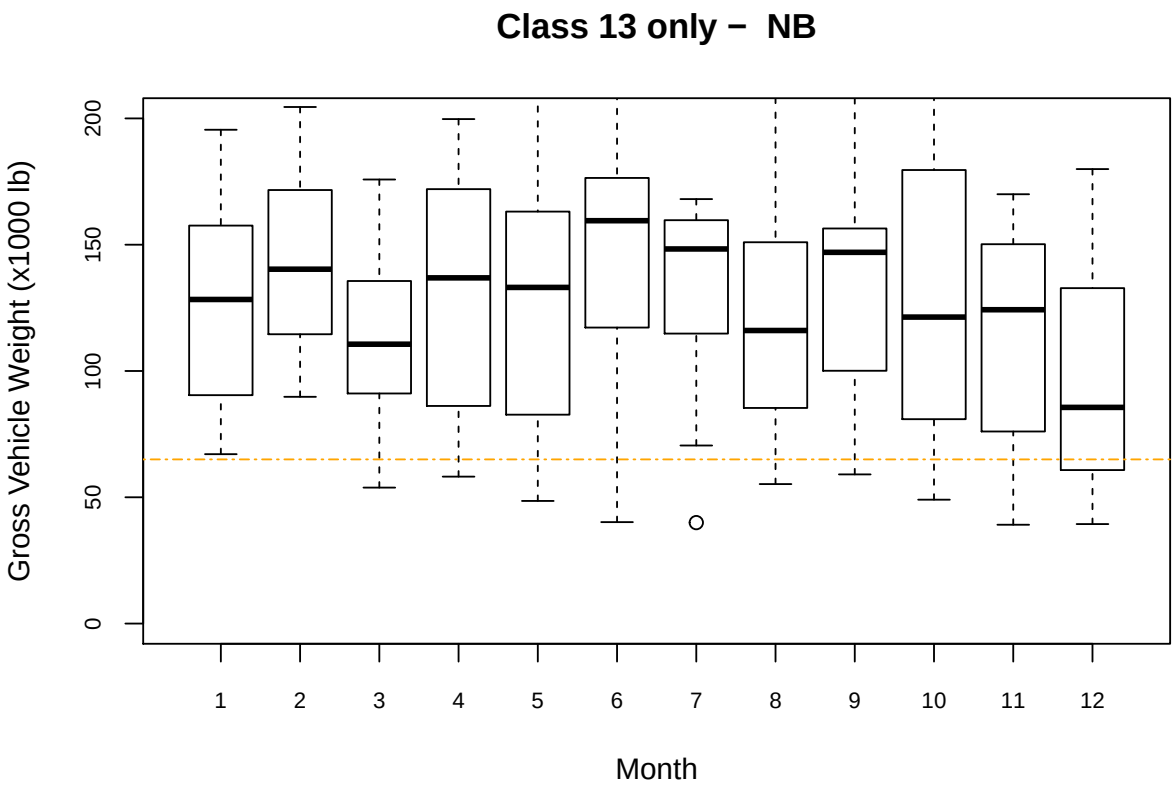

Class 15 only − SB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
Month

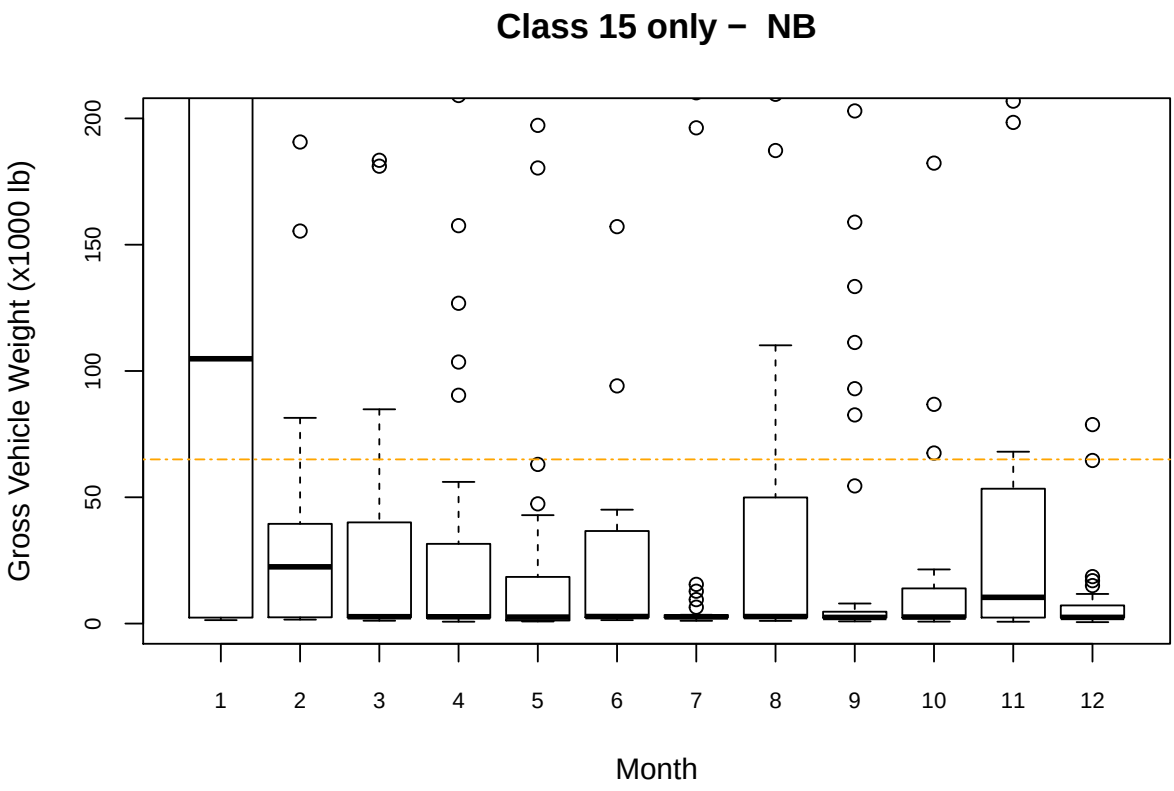
A-4.7.16(d) Direction 2 - Weight Variation by Month

```
## Boxplot plots
```




Class 11 only − NB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
Month


Class 13 only − NB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
Month


Class 15 only − NB
Gross Vehicle Weight (x1000 lb)
0
50
100
150
200
1
2
3
4
5
6
7
8
9
10
11
12
Month

A-4.7.17 Numerical Summary of the WIM Data

A-4.7.17(a) Without Modification

```
##      Node               Cosit                 Time
##  Length:4169343     Length:4169343     Min.   :2019-01-01 00:00:24
##  Class :character   Class :character   1st Qu.:2019-04-04 18:52:44
##  Mode  :character   Mode  :character   Median :2019-07-05 08:18:43
##                                        Mean   :2019-07-04 15:18:13
##                                        3rd Qu.:2019-10-04 09:27:08
##                                        Max.   :2019-12-31 23:59:59
##
##  Vehicle Number          Lane        Lane Name          Straddle Lane
##  Min.   :1630337   Min.   :1.000   Length:4169343     Mode:logical
##  1st Qu.:2292475   1st Qu.:1.000   Class :character   NA's:4169343
##  Median :2813645   Median :1.000   Mode  :character
##  Mean   :2830010   Mean   :1.463
##  3rd Qu.:3334819   3rd Qu.:2.000
##  Max.   :4152815   Max.   :2.000
##
##  Straddle Lane Name Reverse         Class Scheme Class Scheme Name
##  Mode:logical       Mode:logical   Min.   :14    Length:4169343
##  NA's:4169343       NA's:4169343   1st Qu.:14    Class :character
##                                    Median :14    Mode  :character
##                                    Mean   :14
##                                    3rd Qu.:14
##                                    Max.   :14
##
##      Class          Class Name          Length (m)      Headway (s)
##  Min.   : 1.000   Length:4169343     Min.   : 1.070   Min.   :  0.18
##  1st Qu.: 2.000   Class :character   1st Qu.: 4.770   1st Qu.:  3.70
##  Median : 2.000   Mode  :character   Median : 5.130   Median :  7.89
##  Mean   : 2.969                      Mean   : 6.754   Mean   : 12.92
##  3rd Qu.: 3.000                      3rd Qu.: 5.760   3rd Qu.: 15.47
##  Max.   :15.000                      Max.   :64.550   Max.   :658.87
##                                      NA's   :819      NA's   :204149
##     Gap (s)         Speed (mph)      Weight (kg)     Temperature (C)
##  Min.   :  0.00   Min.   :  2.55   Min.   :   220   Mode:logical
##  1st Qu.:  3.43   1st Qu.: 66.18   1st Qu.:  1260   NA's:4169343
##  Median :  7.62   Median : 70.65   Median :  1570
##  Mean   : 12.65   Mean   : 70.59   Mean   :  3566
##  3rd Qu.: 15.20   3rd Qu.: 74.87   3rd Qu.:  2230
##  Max.   :658.65   Max.   :123.96   Max.   :138380
##  NA's   :206953
##  Duration (ms)   Validity Code      Chassis Code    Class Index
##  Min.   :    2   Min.   : 4        Min.   :  3.0   Min.   :  0.000
##  1st Qu.:  217   1st Qu.:64        1st Qu.: 87.0   1st Qu.:  1.000
##  Median :  233   Median :64        Median :119.0   Median :  1.000
```

```
##  Mean   :  296   Mean   :64        Mean   :122.5   Mean   :  4.366
##  3rd Qu.:  265   3rd Qu.:64        3rd Qu.:162.0   3rd Qu.:  2.000
##  Max.   :12126   Max.   :64        Max.   :255.0   Max.   :120.000
##  NA's   :4       NA's   :4037930   NA's   :813
##  Loop Time (ms)   Chassis Profile      Num Axles      Axle Weights (kg)
##  Min.   :  72.0   Length:4169343     Min.   : 2.000   Length:4169343
##  1st Qu.: 201.0   Class :character   1st Qu.: 2.000   Class :character
##  Median : 220.0   Mode  :character   Median : 2.000   Mode  :character
##  Mean   : 280.6                      Mean   : 2.304
##  3rd Qu.: 252.0                      3rd Qu.: 2.000
##  Max.   :9879.0                      Max.   :13.000
##  NA's   :822
##  Axle Spacings (m)
##  Length:4169343
##  Class :character
##  Mode  :character
##
##
##
##
```

A-4.7.17(b) Direction 1 Data after Removing data with missing vehicle class and traffic directions

```
## Direction 1:

##      Node              Cosit                Time
##  Length:1928857     Length:1928857     Min.   :2019-01-01 00:00:24
##  Class :character   Class :character   1st Qu.:2019-04-04 17:15:55
##  Mode  :character   Mode  :character   Median :2019-07-07 07:04:50
##                                        Mean   :2019-07-05 14:17:36
##                                        3rd Qu.:2019-10-06 17:23:25
##                                        Max.   :2019-12-31 23:59:59
##
##  Vehicle.Number         Lane    Lane.Name         Straddle.Lane
##  Min.   :1630337   Min.   :2   Length:1928857     Mode:logical
##  1st Qu.:2112553   1st Qu.:2   Class :character   NA's:1928857
##  Median :2594773   Median :2   Mode  :character
##  Mean   :2594769   Mean   :2
##  3rd Qu.:3076987   3rd Qu.:2
##  Max.   :3559201   Max.   :2
##
##  Straddle.Lane.Name Reverse         Class.Scheme Class.Scheme.Name
##  Mode:logical       Mode:logical   Min.   :14    Length:1928857
##  NA's:1928857       NA's:1928857   1st Qu.:14    Class :character
##                                    Median :14    Mode  :character
##                                    Mean   :14
##                                    3rd Qu.:14
##                                    Max.   :14
##
##      Class         Class.Name          Length..m.      Headway..s.
##  Min.   : 1.000   Length:1928857     Min.   : 1.290   Min.   :  0.22
##  1st Qu.: 2.000   Class :character   1st Qu.: 4.930   1st Qu.:  3.99
##  Median : 2.000   Mode  :character   Median : 5.250   Median :  8.42
##  Mean   : 2.912                      Mean   : 6.807   Mean   : 13.79
##  3rd Qu.: 3.000                      3rd Qu.: 5.920   3rd Qu.: 16.60
##  Max.   :15.000                      Max.   :58.510   Max.   :658.87
##                                      NA's   :365      NA's   :102502
##     Gap..s.         Speed..mph.      Weight..kg.    Temperature..C.
##  Min.   :  0.00   Min.   :  6.21   Min.   :  280   Mode:logical
##  1st Qu.:  3.72   1st Qu.: 65.86   1st Qu.: 1340   NA's:1928857
##  Median :  8.14   Median : 70.28   Median : 1640
##  Mean   : 13.51   Mean   : 70.15   Mean   : 3452
##  3rd Qu.: 16.32   3rd Qu.: 74.87   3rd Qu.: 2240
##  Max.   :658.65   Max.   :123.96   Max.   :95960
##  NA's   :103804
##  Duration..ms.     Validity.Code      Chassis.Code    Class.Index
##  Min.   :    4.0   Min.   : 4       Min.   :  3.0   Min.   :  0.000
##  1st Qu.:  221.0   1st Qu.:64       1st Qu.: 86.0   1st Qu.:  1.000
```

```
##  Median :  241.0   Median :64        Median :118.0   Median :  1.000
##  Mean   :  301.1   Mean   :64        Mean   :121.2   Mean   :  4.135
##  3rd Qu.:  272.0   3rd Qu.:64        3rd Qu.:160.0   3rd Qu.:  2.000
##  Max.   :11557.0   Max.   :64        Max.   :255.0   Max.   :120.000
##  NA's   :2         NA's   :1864266   NA's   :362
##  Loop.Time..ms.    Chassis.Profile     Num.Axles      Axle.Weights..kg.
##  Min.   :  72.0    Length:1928857    Min.   : 2.000   Length:1928857
##  1st Qu.: 208.0    Class :character  1st Qu.: 2.000   Class :character
##  Median : 228.0    Mode  :character  Median : 2.000   Mode  :character
##  Mean   : 285.6                      Mean   : 2.281
##  3rd Qu.: 256.0                      3rd Qu.: 2.000
##  Max.   :9250.0                      Max.   :13.000
##  NA's   :365
##  Axle.Spacings..m.        w1              w2              w3
##  Length:1928857     Min.   :   60   Min.   :   70   Min.   :   40
##  Class :character   1st Qu.:  770   1st Qu.:  560   1st Qu.: 1710
##  Mode  :character   Median :  920   Median :  730   Median : 3000
##                     Mean   : 1271   Mean   : 1172   Mean   : 3446
##                     3rd Qu.: 1180   3rd Qu.: 1040   3rd Qu.: 5300
##                     Max.   :15860   Max.   :15810   Max.   :20210
##                                                     NA's   :1712041
##        w4              w5              w6              w7
##  Min.   :   60   Min.   :   80   Min.   :  280   Min.   :  360
##  1st Qu.: 1660   1st Qu.: 2010   1st Qu.: 2640   1st Qu.: 5025
##  Median : 2970   Median : 3890   Median : 4130   Median : 6080
##  Mean   : 3436   Mean   : 3954   Mean   : 4556   Mean   : 5788
##  3rd Qu.: 5270   3rd Qu.: 5670   3rd Qu.: 6450   3rd Qu.: 7020
##  Max.   :16080   Max.   :14900   Max.   :13810   Max.   :12520
##  NA's   :1752815 NA's   :1787756 NA's   :1922701 NA's   :1927994
##        w8              w9              w10             w11
##  Min.   :  410   Min.   :  440   Min.   :  870   Min.   : 980
##  1st Qu.: 4495   1st Qu.: 4720   1st Qu.: 4960   1st Qu.:5118
##  Median : 5590   Median : 6180   Median : 6210   Median :6330
##  Mean   : 5309   Mean   : 5438   Mean   : 5603   Mean   :5914
##  3rd Qu.: 6582   3rd Qu.: 6855   3rd Qu.: 6980   3rd Qu.:6948
##  Max.   :11480   Max.   :10190   Max.   :10800   Max.   :8720
##  NA's   :1928561 NA's   :1928722 NA's   :1928736 NA's   :1928751
##       w12             w13             w14             w15
##  Min.   : 310    Min.   :2020    Min.   : NA     Min.   : NA
##  1st Qu.:5145    1st Qu.:4910    1st Qu.: NA     1st Qu.: NA
##  Median :6160    Median :5760    Median : NA     Median : NA
##  Mean   :5784    Mean   :5605    Mean   :NaN     Mean   :NaN
##  3rd Qu.:6822    3rd Qu.:6590    3rd Qu.: NA     3rd Qu.: NA
##  Max.   :8450    Max.   :7290    Max.   : NA     Max.   : NA
##  NA's   :1928793 NA's   :1928829 NA's   :1928857 NA's   :1928857
##       w16             w17             w18             w19
##  Min.   : NA     Min.   : NA     Min.   : NA     Min.   : NA
##  1st Qu.: NA     1st Qu.: NA     1st Qu.: NA     1st Qu.: NA
```

```
##  Median : NA       Median : NA       Median : NA       Median : NA
##  Mean   :NaN       Mean   :NaN       Mean   :NaN       Mean   :NaN
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA
##  Max.   : NA       Max.   : NA       Max.   : NA       Max.   : NA
##  NA's   :1928857   NA's   :1928857   NA's   :1928857   NA's   :1928857
##       w20               w21               Total.w            s1
##  Min.   : NA       Min.   : NA       Min.   :  280   Min.   : 0.860
##  1st Qu.: NA       1st Qu.: NA       1st Qu.: 1340   1st Qu.: 2.740
##  Median : NA       Median : NA       Median : 1640   Median : 2.880
##  Mean   :NaN       Mean   :NaN       Mean   : 3452   Mean   : 3.232
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: 2240   3rd Qu.: 3.560
##  Max.   : NA       Max.   : NA       Max.   :95960   Max.   :10.440
##  NA's   :1928857   NA's   :1928857
##        s2                s3                s4                s5
##  Min.   : 0.6      Min.   : 0.6      Min.   : 0.7      Min.   : 0.8
##  1st Qu.: 1.3      1st Qu.: 6.9      1st Qu.: 1.2      1st Qu.: 1.3
##  Median : 1.3      Median : 9.7      Median : 1.2      Median : 1.4
##  Mean   : 2.6      Mean   : 8.0      Mean   : 1.5      Mean   : 3.4
##  3rd Qu.: 3.8      3rd Qu.:10.4      3rd Qu.: 1.3      3rd Qu.: 6.8
##  Max.   :14.7      Max.   :14.6      Max.   :13.7      Max.   :12.7
##  NA's   :1712041   NA's   :1752815   NA's   :1787756   NA's   :1922701
##        s6                s7                s8                s9
##  Min.   : 0.8      Min.   : 0.8      Min.   :0.8       Min.   :0.8
##  1st Qu.: 1.3      1st Qu.: 1.4      1st Qu.:1.4       1st Qu.:1.4
##  Median : 1.4      Median : 1.5      Median :1.4       Median :1.5
##  Mean   : 2.0      Mean   : 3.8      Mean   :1.4       Mean   :2.6
##  3rd Qu.: 1.4      3rd Qu.: 4.3      3rd Qu.:1.5       3rd Qu.:4.3
##  Max.   :14.8      Max.   :14.7      Max.   :4.3       Max.   :8.0
##  NA's   :1927994   NA's   :1928561   NA's   :1928722   NA's   :1928736
##       s10               s11               s12               s13
##  Min.   :1.2       Min.   :1.4       Min.   :1.4       Min.   : NA
##  1st Qu.:1.5       1st Qu.:1.4       1st Qu.:1.4       1st Qu.: NA
##  Median :4.3       Median :1.5       Median :1.5       Median : NA
##  Mean   :3.0       Mean   :1.5       Mean   :1.5       Mean   :NaN
##  3rd Qu.:4.3       3rd Qu.:1.5       3rd Qu.:1.5       3rd Qu.: NA
##  Max.   :5.2       Max.   :1.7       Max.   :1.6       Max.   : NA
##  NA's   :1928751   NA's   :1928793   NA's   :1928829   NA's   :1928857
##       s14               s15               s16               s17
##  Min.   : NA       Min.   : NA       Min.   : NA       Min.   : NA
##  1st Qu.: NA       1st Qu.: NA       1st Qu.: NA       1st Qu.: NA
##  Median : NA       Median : NA       Median : NA       Median : NA
##  Mean   :NaN       Mean   :NaN       Mean   :NaN       Mean   :NaN
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA
##  Max.   : NA       Max.   : NA       Max.   : NA       Max.   : NA
##  NA's   :1928857   NA's   :1928857   NA's   :1928857   NA's   :1928857
##       s18               s19               s20            Total.s
##  Min.   : NA       Min.   : NA       Min.   : NA       Min.   : 1.220
##  1st Qu.: NA       1st Qu.: NA       1st Qu.: NA       1st Qu.: 2.740
```

```
##  Median : NA       Median : NA       Median : NA       Median : 2.880
##  Mean   :NaN       Mean   :NaN       Mean   :NaN       Mean   : 4.376
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: 3.580
##  Max.   : NA       Max.   : NA       Max.   : NA       Max.   :39.730
##  NA's   :1928857   NA's   :1928857   NA's   :1928857
##       date                          year          month             day
##  Min.   :2019-01-01 00:00:24   Min.   :2019   Min.   : 1.000   Min.   : 1.00
##  1st Qu.:2019-04-04 17:15:55   1st Qu.:2019   1st Qu.: 4.000   1st Qu.: 8.00
##  Median :2019-07-07 07:04:50   Median :2019   Median : 7.000   Median :16.00
##  Mean   :2019-07-05 14:17:36   Mean   :2019   Mean   : 6.625   Mean   :15.71
##  3rd Qu.:2019-10-06 17:23:25   3rd Qu.:2019   3rd Qu.:10.000   3rd Qu.:23.00
##  Max.   :2019-12-31 23:59:59   Max.   :2019   Max.   :12.000   Max.   :31.00
##
##       hour          minute          second           v1
##  Min.   : 0.0   Min.   : 0.00   Min.   : 0.00   Length:1928857
##  1st Qu.:10.0   1st Qu.:15.00   1st Qu.:14.00   Class :character
##  Median :14.0   Median :29.00   Median :30.00   Mode  :character
##  Mean   :13.7   Mean   :29.38   Mean   :29.51
##  3rd Qu.:17.0   3rd Qu.:44.00   3rd Qu.:45.00
##  Max.   :23.0   Max.   :59.00   Max.   :59.00
##
##       v2                Dir                diff.w
##  Length:1928857     Length:1928857     Min.   :0
##  Class :character   Class :character   1st Qu.:0
##  Mode  :character   Mode  :character   Median :0
##                                        Mean   :0
##                                        3rd Qu.:0
##                                        Max.   :0
##
```

A-4.7.17(c) Direction 2 Data after Removing data with missing vehicle class and traffic directions

```
## Direction 2:

##      Node              Cosit                Time
##  Length:2240486     Length:2240486     Min.   :2019-01-01 00:02:24
##  Class :character   Class :character   1st Qu.:2019-04-04 22:54:54
##  Mode  :character   Mode  :character   Median :2019-07-03 12:34:20
##                                        Mean   :2019-07-03 19:30:41
##                                        3rd Qu.:2019-10-02 09:06:40
##                                        Max.   :2019-12-31 23:59:48
##
##  Vehicle.Number         Lane    Lane.Name         Straddle.Lane
##  Min.   :1912264   Min.   :1   Length:2240486     Mode:logical
##  1st Qu.:2472397   1st Qu.:1   Class :character   NA's:2240486
##  Median :3032530   Median :1   Mode  :character
##  Mean   :3032531   Mean   :1
##  3rd Qu.:3592651   3rd Qu.:1
##  Max.   :4152815   Max.   :1
##
##  Straddle.Lane.Name Reverse         Class.Scheme Class.Scheme.Name
##  Mode:logical       Mode:logical   Min.   :14    Length:2240486
##  NA's:2240486       NA's:2240486   1st Qu.:14    Class :character
##                                    Median :14    Mode  :character
##                                    Mean   :14
##                                    3rd Qu.:14
##                                    Max.   :14
##
##      Class          Class.Name          Length..m.      Headway..s.
##  Min.   : 1.000   Length:2240486     Min.   : 1.070   Min.   :  0.18
##  1st Qu.: 2.000   Class :character   1st Qu.: 4.670   1st Qu.:  3.47
##  Median : 2.000   Mode  :character   Median : 4.990   Median :  7.46
##  Mean   : 3.019                      Mean   : 6.708   Mean   : 12.17
##  3rd Qu.: 3.000                      3rd Qu.: 5.640   3rd Qu.: 14.56
##  Max.   :15.000                      Max.   :64.550   Max.   :610.53
##                                      NA's   :454      NA's   :101647
##     Gap..s.         Speed..mph.      Weight..kg.     Temperature..C.
##  Min.   :  0.00   Min.   :  2.55   Min.   :   220   Mode:logical
##  1st Qu.:  3.21   1st Qu.: 66.80   1st Qu.:  1200   NA's:2240486
##  Median :  7.19   Median : 71.02   Median :  1510
##  Mean   : 11.91   Mean   : 70.97   Mean   :  3665
##  3rd Qu.: 14.30   3rd Qu.: 75.31   3rd Qu.:  2210
##  Max.   :610.26   Max.   :123.96   Max.   :138380
##  NA's   :103149
##  Duration..ms.     Validity.Code      Chassis.Code    Class.Index
##  Min.   :    2.0   Min.   : 4       Min.   :  8.0   Min.   :  0.000
##  1st Qu.:  213.0   1st Qu.:64       1st Qu.: 89.0   1st Qu.:  1.000
```

```
##  Median :  229.0   Median :64        Median :120.0   Median :  1.000
##  Mean   :  291.5   Mean   :64        Mean   :123.6   Mean   :  4.566
##  3rd Qu.:  261.0   3rd Qu.:64        3rd Qu.:164.0   3rd Qu.:  2.000
##  Max.   :12126.0   Max.   :64        Max.   :255.0   Max.   :120.000
##  NA's   :2         NA's   :2173664   NA's   :451
##  Loop.Time..ms.    Chassis.Profile     Num.Axles      Axle.Weights..kg.
##  Min.   :  72.0    Length:2240486    Min.   : 2.000   Length:2240486
##  1st Qu.: 196.0    Class :character  1st Qu.: 2.000   Class :character
##  Median : 216.0    Mode  :character  Median : 2.000   Mode  :character
##  Mean   : 276.2                      Mean   : 2.324
##  3rd Qu.: 244.0                      3rd Qu.: 2.000
##  Max.   :9879.0                      Max.   :13.000
##  NA's   :457
##  Axle.Spacings..m.        w1              w2              w3
##  Length:2240486     Min.   :   70   Min.   :   60   Min.   :   30
##  Class :character   1st Qu.:  700   1st Qu.:  490   1st Qu.: 1450
##  Mode  :character   Median :  870   Median :  640   Median : 2490
##                     Mean   : 1343   Mean   : 1162   Mean   : 3398
##                     3rd Qu.: 1190   3rd Qu.:  980   3rd Qu.: 5060
##                     Max.   :24520   Max.   :23760   Max.   :23620
##                                                     NA's   :1951656
##        w4              w5              w6              w7
##  Min.   :   40     Min.   :   60     Min.   :   30     Min.   :  450
##  1st Qu.: 1260     1st Qu.: 1570     1st Qu.: 2220     1st Qu.: 4655
##  Median : 2210     Median : 2810     Median : 3460     Median : 7850
##  Mean   : 3419     Mean   : 3999     Mean   : 4301     Mean   : 7474
##  3rd Qu.: 5380     3rd Qu.: 6360     3rd Qu.: 5738     3rd Qu.:10080
##  Max.   :29100     Max.   :19490     Max.   :22390     Max.   :17180
##  NA's   :2003816   NA's   :2048597   NA's   :2233264   NA's   :2239846
##        w8              w9              w10             w11
##  Min.   :  540     Min.   :  270     Min.   : 1160     Min.   :  240
##  1st Qu.: 5882     1st Qu.: 5850     1st Qu.: 7110     1st Qu.: 7385
##  Median : 8045     Median : 7910     Median : 8565     Median : 8360
##  Mean   : 7577     Mean   : 7730     Mean   : 8344     Mean   : 8009
##  3rd Qu.: 9382     3rd Qu.: 9710     3rd Qu.: 9425     3rd Qu.: 9505
##  Max.   :18130     Max.   :17790     Max.   :18430     Max.   :11450
##  NA's   :2240228   NA's   :2240389   NA's   :2240408   NA's   :2240411
##       w12             w13             w14             w15
##  Min.   : 2200     Min.   : 4200     Min.   : NA       Min.   : NA
##  1st Qu.: 6700     1st Qu.: 6890     1st Qu.: NA       1st Qu.: NA
##  Median : 8560     Median : 8120     Median : NA       Median : NA
##  Mean   : 8097     Mean   : 7825     Mean   :NaN       Mean   :NaN
##  3rd Qu.: 9620     3rd Qu.: 9070     3rd Qu.: NA       3rd Qu.: NA
##  Max.   :14500     Max.   :10950     Max.   : NA       Max.   : NA
##  NA's   :2240439   NA's   :2240459   NA's   :2240486   NA's   :2240486
##       w16             w17             w18             w19
##  Min.   : NA       Min.   : NA       Min.   : NA       Min.   : NA
##  1st Qu.: NA       1st Qu.: NA       1st Qu.: NA       1st Qu.: NA
```

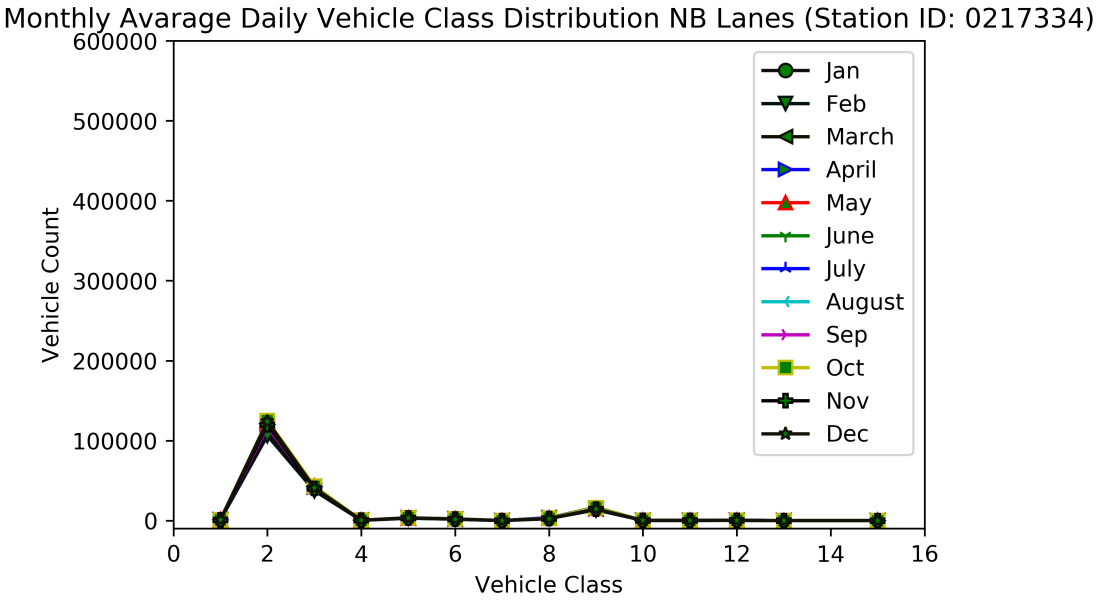
```
##  Median : NA       Median : NA       Median : NA       Median : NA
##  Mean   :NaN       Mean   :NaN       Mean   :NaN       Mean   :NaN
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA
##  Max.   : NA       Max.   : NA       Max.   : NA       Max.   : NA
##  NA's   :2240486   NA's   :2240486   NA's   :2240486   NA's   :2240486
##       w20               w21               Total.w            s1
##  Min.   : NA       Min.   : NA       Min.   :   220   Min.   : 0.860
##  1st Qu.: NA       1st Qu.: NA       1st Qu.:  1200   1st Qu.: 2.730
##  Median : NA       Median : NA       Median :  1510   Median : 2.870
##  Mean   :NaN       Mean   :NaN       Mean   :  3665   Mean   : 3.246
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.:  2210   3rd Qu.: 3.580
##  Max.   : NA       Max.   : NA       Max.   :138380   Max.   :10.720
##  NA's   :2240486   NA's   :2240486
##        s2                s3                s4                s5
##  Min.   : 0.7      Min.   : 0.5      Min.   : 0.7      Min.   : 0.7
##  1st Qu.: 1.3      1st Qu.: 6.9      1st Qu.: 1.2      1st Qu.: 1.4
##  Median : 1.3      Median : 9.6      Median : 1.2      Median : 6.6
##  Mean   : 2.5      Mean   : 8.0      Mean   : 1.5      Mean   : 4.5
##  3rd Qu.: 1.5      3rd Qu.:10.3      3rd Qu.: 1.2      3rd Qu.: 6.8
##  Max.   :14.9      Max.   :14.9      Max.   :14.4      Max.   :11.8
##  NA's   :1951656   NA's   :2003816   NA's   :2048597   NA's   :2233264
##        s6                s7                s8                s9
##  Min.   : 0.8      Min.   : 0.8      Min.   :0.8       Min.   :1.3
##  1st Qu.: 1.3      1st Qu.: 1.4      1st Qu.:1.4       1st Qu.:1.5
##  Median : 1.4      Median : 1.4      Median :1.5       Median :1.5
##  Mean   : 2.1      Mean   : 3.4      Mean   :1.6       Mean   :2.6
##  3rd Qu.: 1.5      3rd Qu.: 4.2      3rd Qu.:1.5       3rd Qu.:4.3
##  Max.   :13.6      Max.   :14.3      Max.   :7.5       Max.   :5.7
##  NA's   :2239846   NA's   :2240228   NA's   :2240389   NA's   :2240408
##       s10               s11               s12               s13
##  Min.   :1.2       Min.   :1.3       Min.   :1.4       Min.   : NA
##  1st Qu.:1.4       1st Qu.:1.4       1st Qu.:1.5       1st Qu.: NA
##  Median :4.2       Median :1.5       Median :1.5       Median : NA
##  Mean   :3.1       Mean   :1.5       Mean   :1.5       Mean   :NaN
##  3rd Qu.:4.3       3rd Qu.:1.5       3rd Qu.:1.5       3rd Qu.: NA
##  Max.   :5.0       Max.   :1.5       Max.   :1.7       Max.   : NA
##  NA's   :2240411   NA's   :2240439   NA's   :2240459   NA's   :2240486
##       s14               s15               s16               s17
##  Min.   : NA       Min.   : NA       Min.   : NA       Min.   : NA
##  1st Qu.: NA       1st Qu.: NA       1st Qu.: NA       1st Qu.: NA
##  Median : NA       Median : NA       Median : NA       Median : NA
##  Mean   :NaN       Mean   :NaN       Mean   :NaN       Mean   :NaN
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA
##  Max.   : NA       Max.   : NA       Max.   : NA       Max.   : NA
##  NA's   :2240486   NA's   :2240486   NA's   :2240486   NA's   :2240486
##       s18               s19               s20            Total.s
##  Min.   : NA       Min.   : NA       Min.   : NA       Min.   : 1.000
##  1st Qu.: NA       1st Qu.: NA       1st Qu.: NA       1st Qu.: 2.730
```

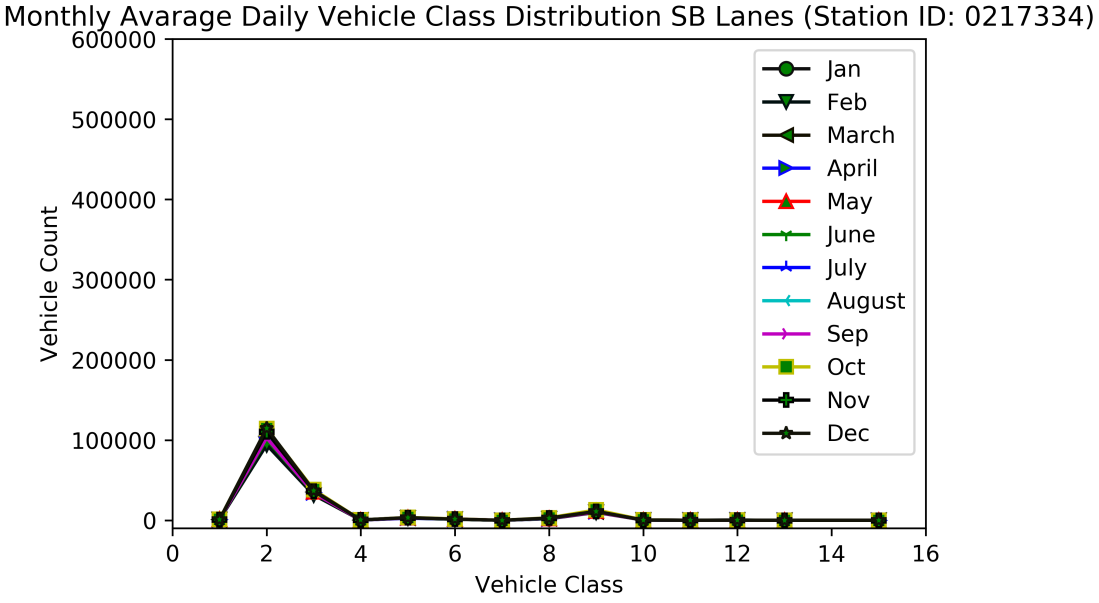
```
##  Median : NA       Median : NA       Median : NA       Median : 2.870
##  Mean   :NaN       Mean   :NaN       Mean   :NaN       Mean   : 4.552
##  3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: NA       3rd Qu.: 3.630
##  Max.   : NA       Max.   : NA       Max.   : NA       Max.   :39.990
##  NA's   :2240486   NA's   :2240486   NA's   :2240486
##       date                          year          month             day
##  Min.   :2019-01-01 00:02:24   Min.   :2019   Min.   : 1.000   Min.   : 1.00
##  1st Qu.:2019-04-04 22:54:54   1st Qu.:2019   1st Qu.: 4.000   1st Qu.: 8.00
##  Median :2019-07-03 12:34:20   Median :2019   Median : 7.000   Median :16.00
##  Mean   :2019-07-03 19:30:41   Mean   :2019   Mean   : 6.568   Mean   :15.73
##  3rd Qu.:2019-10-02 09:06:40   3rd Qu.:2019   3rd Qu.:10.000   3rd Qu.:23.00
##  Max.   :2019-12-31 23:59:48   Max.   :2019   Max.   :12.000   Max.   :31.00
##
##       hour           minute         second           v1
##  Min.   : 0.00   Min.   : 0.0   Min.   : 0.00   Length:2240486
##  1st Qu.: 8.00   1st Qu.:15.0   1st Qu.:15.00   Class :character
##  Median :12.00   Median :30.0   Median :30.00   Mode  :character
##  Mean   :12.48   Mean   :29.7   Mean   :29.52
##  3rd Qu.:16.00   3rd Qu.:44.0   3rd Qu.:45.00
##  Max.   :23.00   Max.   :59.0   Max.   :59.00
##
##       v2                Dir
##  Length:2240486     Length:2240486
##  Class :character   Class :character
##  Mode  :character   Mode  :character
##
##
##
##
```

A-4.7.18 Summary Developed Using Python to Cross-Check the Findings in R.

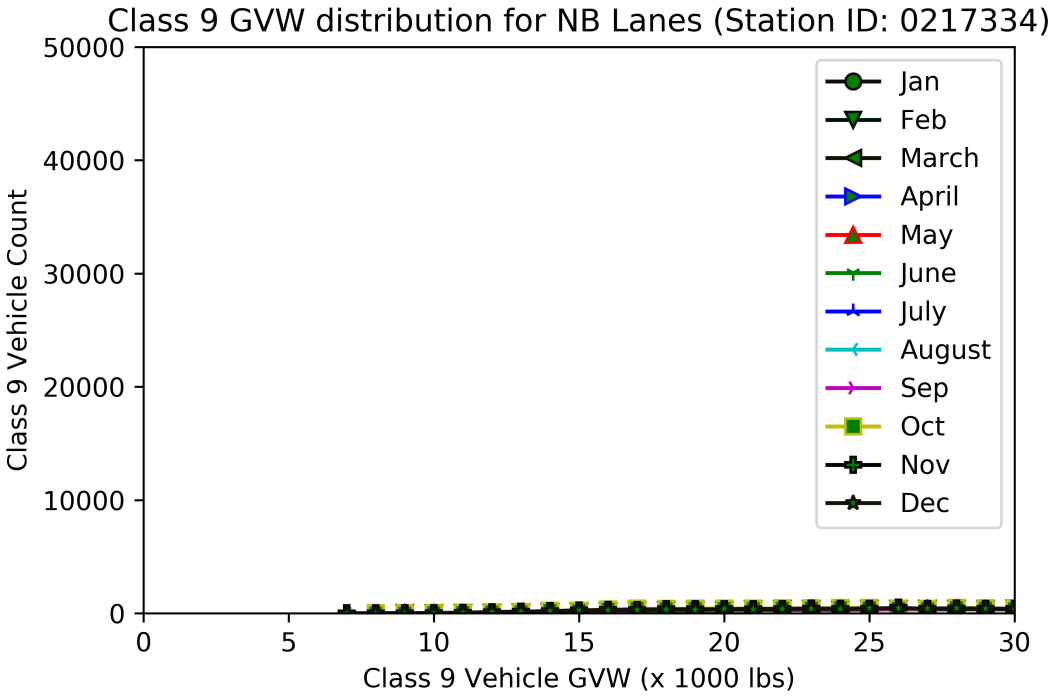
A-4.7.18(a) Graphical Summary

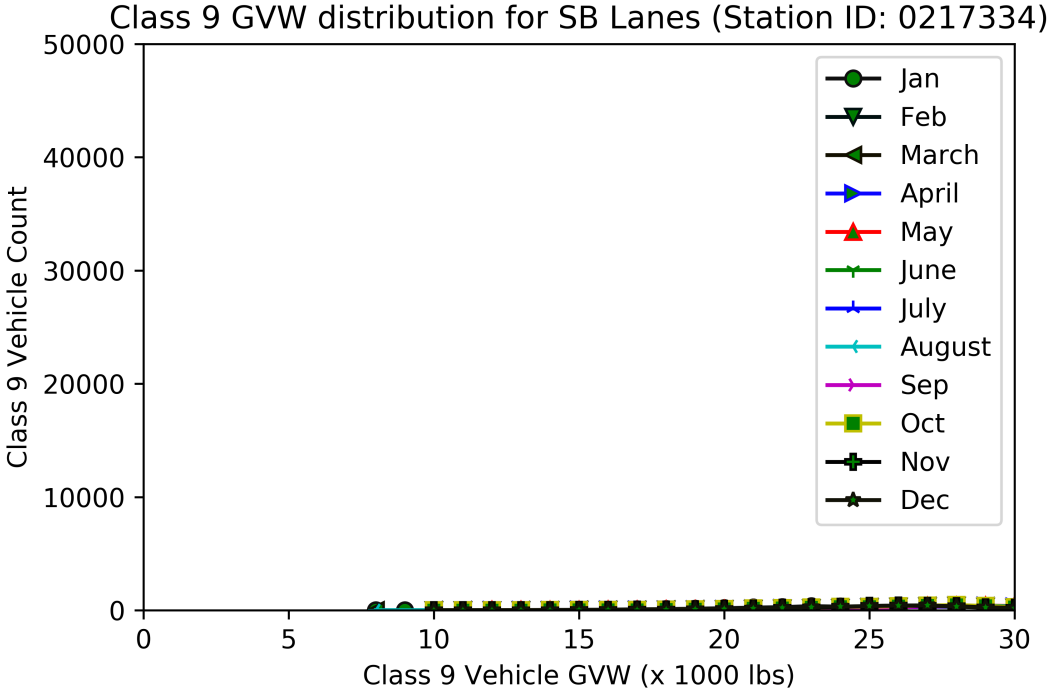
```
## Monthly vehicle counts by class:
```



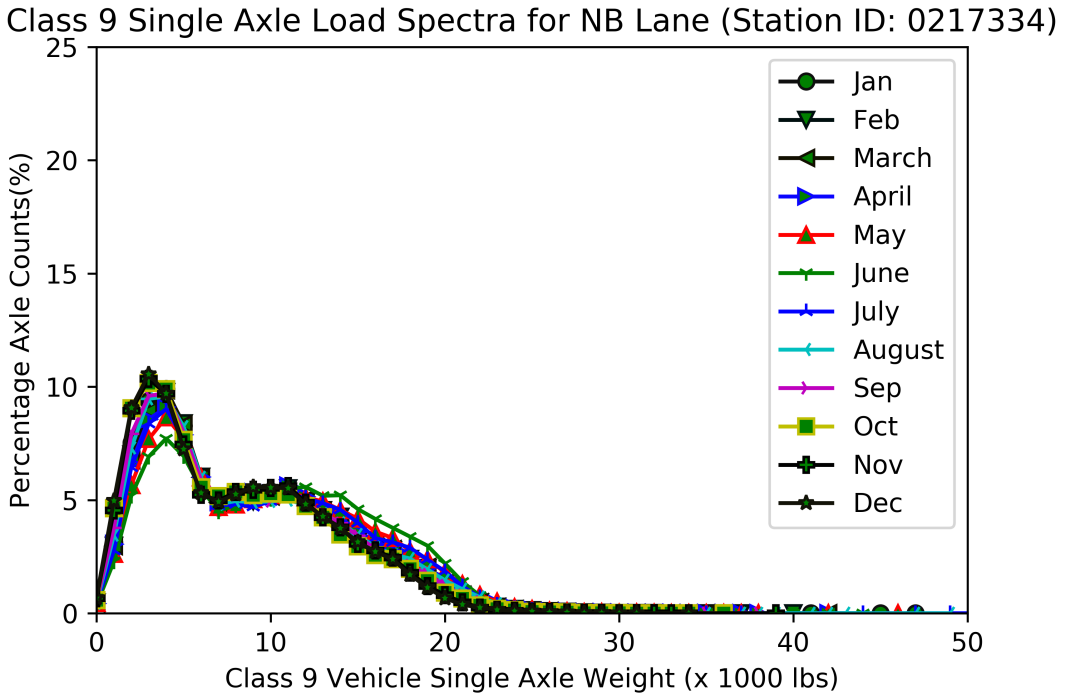


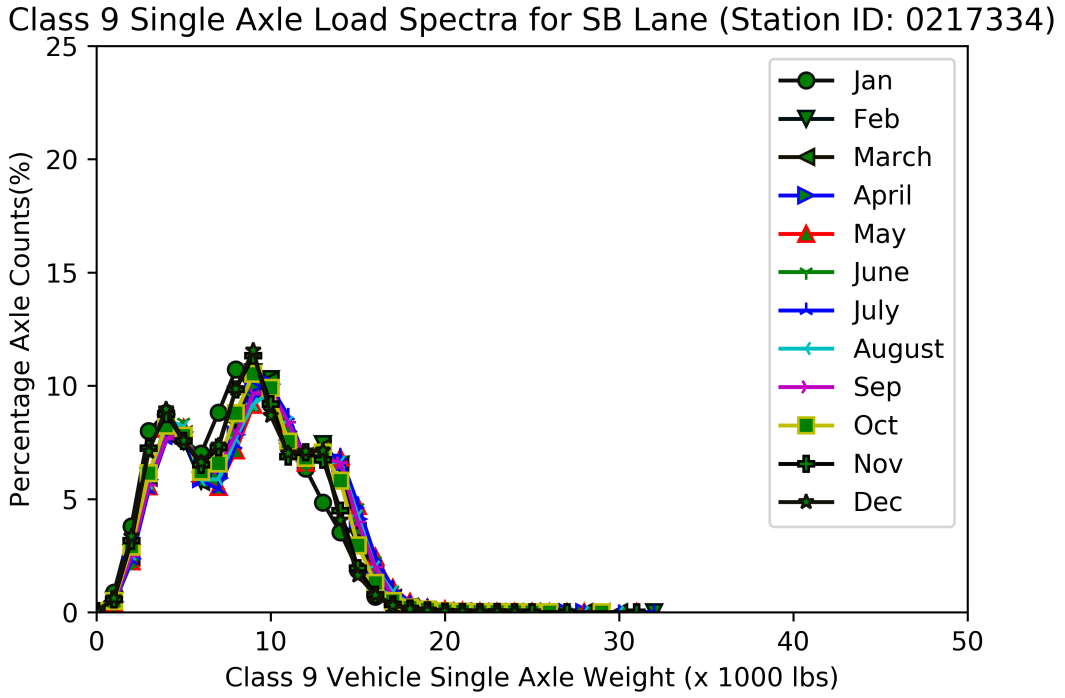

```
## Class 9 GVW distribution:
```


Class 9 GVW distribution for NB Lanes (Station ID: 0217334)
Class 9 Vehicle Count
Class 9 Vehicle GVW (x 1000 lbs)
Jan
Feb
March
April
May
June
July
August
Sep
Oct
Nov
Dec
0
10000
20000
30000
40000
50000
0
5
10
15
20
25
30

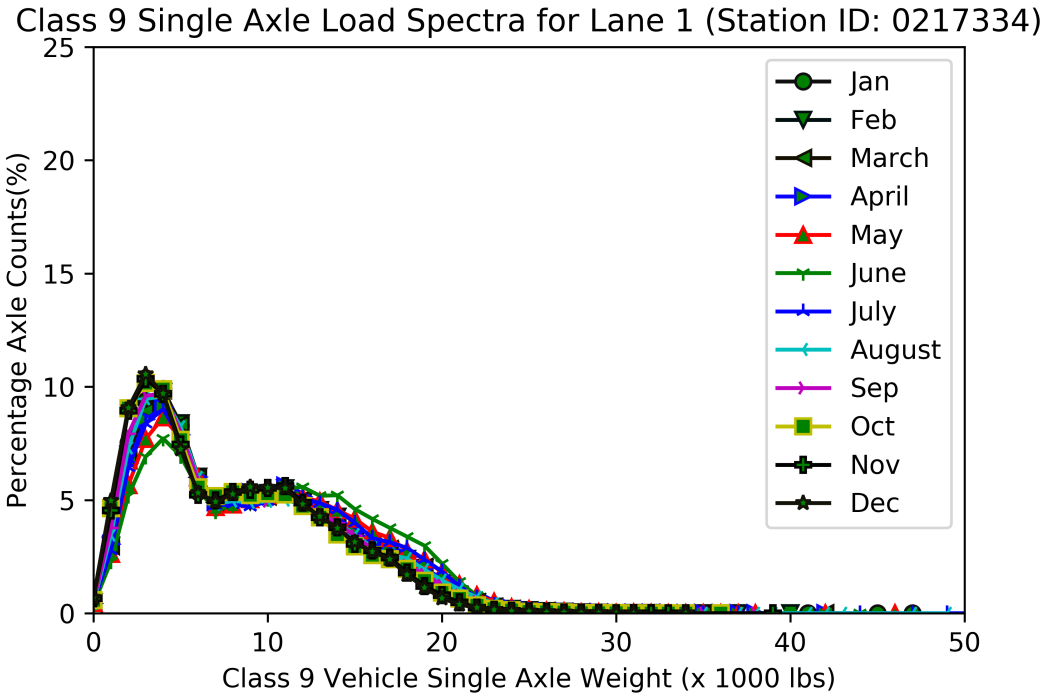

Class 9 GVW distribution for SB Lanes (Station ID: 0217334)
Class 9 Vehicle Count
Class 9 Vehicle GVW (x 1000 lbs)
Jan
Feb
March
April
May
June
July
August
Sep
Oct
Nov
Dec
0
10000
20000
30000
40000
50000
0
5
10
15
20
25
30

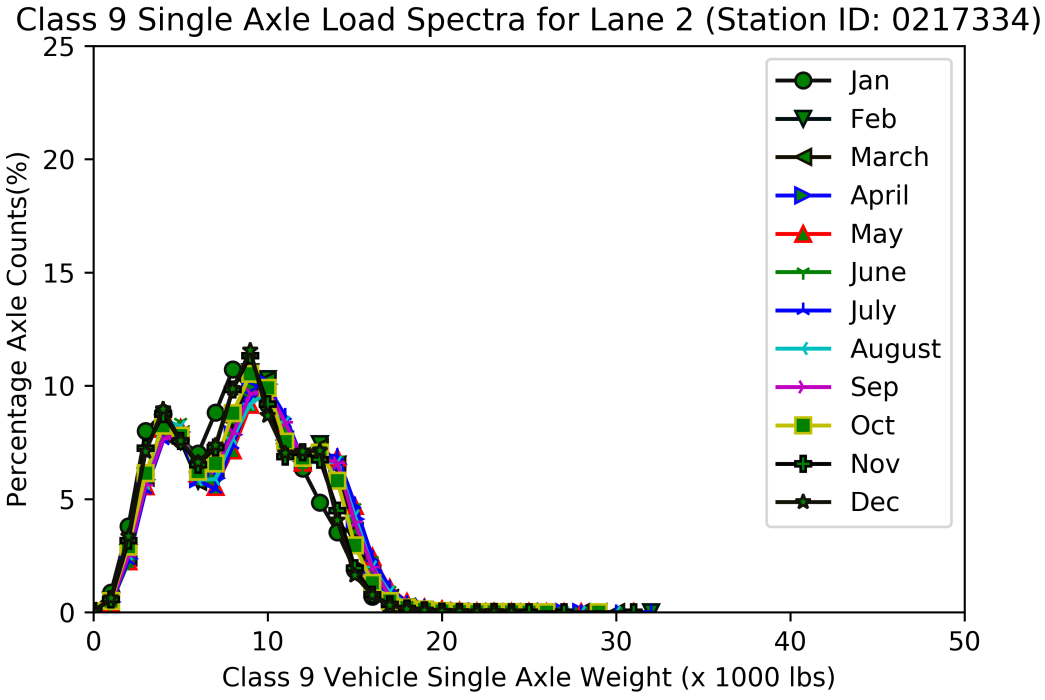
Class 9 Single axle load spectra by month:





Class 9 Single axle load spectra by lane:





```
## Lane 3 data do not exist.

## Lane 4 data do not exist.
```

```
## Lane 5 data do not exist.

## Lane 6 data do not exist.
```

A-4.7.18(b) Numerical Summary

```
## Summary of Selected Data Columns:
```

Site: 0217334

First Data Line: 2019-01-01 00:00:18.989000

Last Data Line: 2019-12-31 23:59:54.594000

Total Lines of data: 16,381,839

Lane#|Vehicle counts:

1 2592487

2 3582618

3 1919769

4 2536822

5 3698419

6 2051724

Name: Lane, dtype: int64

Lane No+Names Available:

1=Channel 1 1

1=Ln 1 NB Slow 2592486

2=Ln 2 NB Center 3582618

3=Ln 3 NB Fast 1919769

4=Channel 4 56

4=Ln 1 SB Slow 2536766

5=Channel 5 76

5=Ln 2 SB Center 3698343

6=Channel 6 49

6=Ln 3 SB Fast 2051675

Name: LaneNumName, dtype: int64

Classes Available:

2 8671168

9 3319874

3 2862336

8 529486

4 279599

5 195873

11 164235

12 119222

6 85137

1 75874

15 61606

10 15621

7 928

13 880

Name: Class, dtype: int64

Missing Headway count: 617,315

Missing Speed count: 1,050,551 [6.412900285492978 %]

Zero (Vehicle Total) Weight count: 5,752,615 [35.1158072057722 %]

Missing Num Axle count: 0 [0.0 %]

Missing Gap count: 644,520 [3.934356820378958 %]

Missing Axle Weight count: 1,053,653 [6.431835888510442 %]

Missing Axle Spacings count: 1,053,653 [6.431835888510442 %]

Tot: 75,874 Class: 1 -> found: 0ax: 3534, 2ax: 72013, 3ax: 327

Tot: 8,671,168 Class: 2 -> found: 0ax: 396952, 2ax: 8205406, 3ax: 53188, 4ax: 15604, 5ax: 18

Tot: 2,862,336 Class: 3 -> found: 0ax: 131765, 2ax: 2546924, 3ax: 77369, 4ax: 79865, 5ax: 26413

Tot: 279,599 Class: 4 -> found: 0ax: 234517, 2ax: 23742, 3ax: 21340

Tot: 195,873 Class: 5 -> found: 2ax: 162220, 3ax: 8747, 4ax: 24906

Tot: 85,137 Class: 6 -> found: 3ax: 74279, 5ax: 10858

Tot: 928 Class: 7 -> found: 4ax: 878, 5ax: 27, 6ax: 23

Tot: 529,486 Class: 8 -> found: 0ax: 124695, 3ax: 55378, 4ax: 349413

Tot: 3,319,874 Class: 9 -> found: 0ax: 130755, 5ax: 3189119

Tot: 15,621 Class: 10 -> found: 6ax: 12696, 7ax: 1907, 8ax: 885, 9ax: 133

Tot: 164,235 Class: 11 -> found: 5ax: 164235

Tot: 119,222 Class: 12 -> found: 6ax: 119222

Tot: 880 Class: 13 -> found: 10ax: 77, 11ax: 122, 7ax: 392, 8ax: 200, 9ax: 89

Tot: 61,606 Class: 15 -> found: 0ax: 31435, 10ax: 43, 11ax: 21, 12ax: 86, 13ax: 70, 14ax: 4, 16ax: 3, 17ax: 2, 2ax: 24317, 21ax: 1, 3ax: 1500, 4ax: 1450, 5ax: 1937, 6ax: 631, 7ax: 54, 8ax: 24, 9ax: 28

Errors found: Empty DataFrame

Columns: [Vehicle Number, Weight (kg), Gross_Weight, Class, matching]

Appendix C. Summary of WIM Quality Control Analysis Results

Given the sheer amount of data, it is not practical for Georgia Department of Transportation's (GDOT) Office of Transportation Data (OTD) to review every line of the R and Python summaries and deduce practical conclusions. Thus, this section offers a summary of findings. Table C.1 through Table C.18 show the major findings with practical implications for quality control (QC) at sites with data available for 2019 through 2021. Table C.19 through Table C.21 show the major findings with practical implications for QC at sites with data available only for 2021.

Table C.1. Summary of 2019–2021 QC Results for Site 051-0368.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	21,805,840	19,156,231	8,681,542	Site is inactive now (as of May 2022). Confirmed on GDOT's TADA website.
No. of usable* entries	21,796,954	19,156,110	8,678,412	
No. of unusable entries (% of the raw data)	8,886 (<0.1%)	5,121 (<0.1%)	3,130 (<0.1%)	(2019–2021) Less than 0.1% unusable data.
# of zero/invalid weight **	165	121	43	
# of unidentified class (% of the usable data)	8,000 (<0.1%)	5,000 (<0.1%)	3,087 (<0.1%)	
# of class 9 vehicles (% of the usable data)	720,000 (3.3%)	775,000 (4.0%)	335,000 (3.9%)	
# of missing classification	44	0	0	(2020–2021) No missing classification.
# of missing axle spacing	850	120	43	
No. of entries >80 mph (% of the usable data)	819,614 (3.8%)	946,373 (4.9%)	260,453 (3.0%)	
No. of missing speed	0	0	0	
# of gross weight >80,000 lbs (% usable data - SB/EB)	74,387 (0.3%)	108,555 (0.6%)	41,283 (0.5%)	
# of gross weight >80,000 lbs (% usable data - NB/WB)	57,588 (0.3%)	26,040 (0.1%)	8,582 (0.1%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	67,422 (0.3%)	38,610 (0.2%)	19,372 (0.2%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	125,247 (0.6%)	80,837 (0.4%)	57,030 (0.7%)	
# of missing headway	422,426	425,192	182,986	
# of missing temperature (% usable data)	21,805,840 (100.0%)	19,156,231 (100.0%)	8,681,542 (100.0%)	
No. of days recorded	365	366	159	(2021) No data between July and December.
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	159 (100.0%)	
Unique hours recorded	8,760	8,784	3,807	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	3,807 (100.0%)	
Unique seconds recorded	14,623,467	13,265,802	5,980,843	
No. of seconds in the usable data (%)	14,622,947 (~100.0%)	13,265,730 (~100.0%)	5,980,818 (~100.0%)	

* The parameters used to determine "usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.2. Summary of 2019–2021 QC Results for Site 127-0312.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	14,148,722	6,833,986	7,874,504	(2019) Lanes 5, 7, 8 did not record vehicle classification data, and this data has been excluded from the analysis. (2020–2021) Lanes 3, 4, 5, 7, 8 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	12,305,255	6,820,652	7,844,401	
No. of unusable entries (% of the raw data)	1,843,467 (13.0%)	13,334 (0.2%)	30,103 (0.4%)	(2019) High % of unusable entries in raw data. (2020–2021) Less than 1% unusable data.
# of zero/invalid weight **	1,826,276	7	11,380	(2019) Lanes 5, 7, 8 did not record vehicle classification data, and this data has been excluded from the analysis. High number of zero weight entries recorded in remaining lanes.
# of unidentified class (% of the usable data)	17,191 (0.1%)	13,327 (0.2%)	18,723 (0.2%)	
# of class 9 vehicles (% of the usable data)	2,157,000 (17.5%)	1,680,000 (24.6%)	1,612,000 (20.5%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	19	8	352	
No. of entries >80 mph (% of the usable data)	1,489,345 (12.1%)	815,989 (12.0%)	695,779 (8.9%)	(2019–2020) More than 10% entries >80 mph in usable data.
No. of missing speed	0	0	8	
# of gross weight >80,000 lbs (% SB/EB usable data)	52,910 (0.4%)	331,285 (4.9%)	142,596 (1.8%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	51,847 (0.4%)	33,086 (0.5%)	21,636 (0.3%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	4,704 (<0.1%)	4,418 (<0.1%)	584 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	603 (<0.1%)	2,280 (<0.1%)	4,233 (<0.1%)	
# of missing headway	808,014	768,568	814,382	(2020–2021) More than 10% missing headway in usable data.
# of missing temperature (% usable data)	368,285 (1.7%)	11,738,285 (68.1%)	20,690,545 (93.4%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	14,014,921	12,069,778	14,325,509	
No. of seconds in the usable data (%)	9,646,260 (68.8%)	6,218,099 (51.5%)	7,062,064 (49.3%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.3. Summary of 2019–2021 QC Results for Site 185-0227.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	10,631,696	9,722,763	11,122,443	(2019–2021) Lanes 5 & 6 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	10,611,985	9,687,234	5,237,487	
No. of unusable entries (% of the raw data)	19,711 (0.2%)	35,529 (0.4%)	5,884,956 (52.9%)	(2019–2020) Less than 1% unusable data. (2021) High % of unusable entries in raw data.
# of zero/invalid weight **	2,347	22,370	5,875,846	(2021) Lanes 5 & 6 did not record vehicle classification data, and this data has been excluded from the analysis. High number of zero weight entries recorded in remaining lanes.
# of unidentified class (% of the usable data)	17,182 (0.2%)	13,159 (0.1%)	9,110 (0.2%)	
# of class 9 vehicles (% of the usable data)	2,842,000 (26.8%)	2,837,000 (29.3%)	2,254,000 (43.0%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	1,053,653	362,694	46,676	
No. of entries >80 mph (% of the usable data)	1,929,408 (18.2%)	1,851,107 (19.1%)	559,309 (10.7%)	(2019–2021) More than 10% entries >80 mph in usable data.
No. of missing speed	1,050,551	317,408	638	(2019) 9.9% missing speed in usable data. (2020) 3.3% missing speed in usable data.
# of gross weight >80,000 lbs (% SB/EB usable data)	19,926 (0.2%)	16,191 (0.2%)	13,135 (0.3%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	10,805 (0.1%)	14,709 (0.2%)	7,514 (0.1%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	467 (<0.1%)	254 (<0.1%)	255 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	824 (<0.1%)	915 (<0.1%)	3,016 (<0.1%)	
# of missing headway	617,315	606,771	625,173	(2021) More than 10% missing headway in usable data.
# of missing temperature (% usable data)	16,381,839 (100.0%)	14,675,189 (100.0%)	17,796,931 (100.0%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	11,832,212	10,905,493	12,636,016	
No. of seconds in the usable data (%)	8,661,690 (73.2%)	8,045,087 (73.8%)	4,820,388 (38.1%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.4. Summary of 2019–2021 QC Results for Site 021-7334.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	4,169,343	3,803,114	4,329,838	Note that the road contains 6 lanes; however, only 2 lanes (center in each direction) are instrumented & record data.
No. of usable* entries	4,168,709	3,796,029	4,328,041	
No. of unusable entries (% of the raw data)	634 (<0.1%)	7,085 (0.2%)	1,797 (<0.1%)	(2019–2021) Less than 0.1% unusable data.
# of zero/invalid weight **	0	171	6	
# of unidentified class (% of the usable data)	634 (<0.1%)	6,914 (0.2%)	1,791 (<0.1%)	
# of class 9 vehicles (% of the usable data)	313,000 (7.5%)	316,000 (8.3%)	341,000 (7.9%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	0	171	6	
No. of entries >80 mph (% of the usable data)	316,499 (7.6%)	315,062 (8.3%)	343,432 (7.9%)	
No. of missing speed	0	0	0	
# of gross weight >80,000 lbs (% SB/EB usable data)	1,256 (<0.1%)	1,607 (<0.1%)	16,489 (0.4%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	25,359 (0.6%)	15,035 (0.4%)	12,251 (0.3%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	146 (<0.1%)	913 (<0.1%)	98 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	171 (<0.1%)	238 (<0.1%)	318 (<0.1%)	
# of missing headway	204,149	210,150	208,148	
# of missing temperature (% usable data)	4,169,343 (100.0%)	3,803,114 (100.0%)	4,329,838 (100.0%)	
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	3,967,976	3,635,443	4,110,246	
No. of seconds in the usable data (%)	3,967,976 (100.0%)	3,635,290 (~100.0%)	4,110,241 (~100.0%)	

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.5. Summary of 2019–2021 QC Results for Site 285-0243.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	7,767,076	4,411,848	5,130,792	(2020–2021) Lanes 2 & 4 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	4,119,351	4,392,731	5,130,325	
No. of unusable entries (% of the raw data)	3,647,725 (47.0%)	19,117 (0.4%)	467 (<0.1%)	(2019) High % of unusable entries in raw data. (2020–2021) Less than 1% unusable data.
# of zero/invalid weight **	3,645,492	601	0	(2019) Analysis seems to show all lanes recorded vehicle classification data. High number of zero weight entries recorded.
# of unidentified class (% of the usable data)	2,189 (0.1%)	18,516 (0.4%)	467 (<0.1%)	
# of class 9 vehicles (% of the usable data)	375,000 (9.1%)	473,000 (10.8%)	508,000 (9.9%)	
# of missing classification	23	0	0	(2020–2021) No missing classification.
# of missing axle spacing	90,234	3,027	5,182	
No. of entries >80 mph (% of the usable data)	760,938 (18.5%)	678,765 (15.5%)	692,792 (13.5%)	(2019–2021) More than 10% entries >80 mph in usable data.
No. of missing speed	63,346	537	492	(2019) 1.5% missing speed in usable data.
# of gross weight >80,000 lbs (% SB/EB usable data)	11,555 (0.3%)	21,318 (0.5%)	13,188 (0.3%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	37,803 (0.9%)	42,897 (1.0%)	21,190 (0.4%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	43 (<0.1%)	686 (<0.1%)	62 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	64 (<0.1%)	55 (<0.1%)	67 (<0.1%)	
# of missing headway	379,956	410,222	413,960	
# of missing temperature (% usable data)	7,761,090 (99.9%)	15,551 (0.2%)	4,366 (0.1%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	348	366	365	(2020) 366 unique days, not 365 days.
No. of days in the usable data (%)	278 (79.9%)	366 (100.0%)	365 (100.0%)	(2019) No data in January & February. Less than 90% recorded days in usable data.
Unique hours recorded	8,308	8,784	8,760	
No. of hours in the usable data (%)	6,653 (80.1%)	8,784 (100.0%)	8,760 (100.0%)	(2019) Less than 90% recorded hours in usable data.
Unique seconds recorded	6,508,871	5,893,420	6,920,152	
No. of seconds in the usable data (%)	3,875,304 (59.5%)	4,194,895 (71.2%)	4,840,001 (69.9%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.6. Summary of 2019–2021 QC Results for Site 051-0387.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	14,493,725	13,941,265	15,153,728	(2019) Lane 6 did not record vehicle classification data, and this data has been excluded from the analysis. (2020–2021) Lanes 3 & 6 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	12,184,788	13,937,201	14,636,632	
No. of unusable entries (% of the raw data)	2,308,937 (15.9%)	4,064 (<0.1%)	517,096 (3.4%)	(2019) High % of unusable entries in raw data. (2020) Less than 0.1% unusable data.
# of zero/invalid weight **	2,301,012	2	508,699	(2019) Lane 6 did not record vehicle classification data, and this data has been excluded from the analysis. High number of zero weight entries recorded in remaining lanes.
# of unidentified class (% of the usable data)	7,925 (0.1%)	4,062 (0.0%)	8,397 (0.1%)	
# of class 9 vehicles (% of the usable data)	2,034,000 (16.7%)	2,548,000 (18.3%)	2,455,000 (16.8%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	62,980	66,655	601,285	
No. of entries >80 mph (% of the usable data)	1,021,759 (8.4%)	1,571,825 (11.3%)	1,797,546 (12.3%)	(2020–2021) More than 10% entries >80 mph in usable data.
No. of missing speed	72	116	508,890	(2021) 3.5% missing speed in usable data.
# of gross weight >80,000 lbs (% SB/EB usable data)	123,032 (1.0%)	86,979 (0.6%)	247,219 (1.7%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	199,691 (1.6%)	74,426 (0.5%)	15,013 (0.1%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	472 (<0.1%)	511 (<0.1%)	457 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	502 (<0.1%)	515 (<0.1%)	553 (<0.1%)	
# of missing headway	470,889	633,472	634,923	
# of missing temperature (% usable data)	307 (<0.1%)	21 (<0.1%)	0 (<0.1%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	275	366	365	(2019) No data in January–March.
No. of days in the usable data (%)	275 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	6,600	8,784	8,760	
No. of hours in the usable data (%)	6,600 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	10,760,116	12,992,913	14,347,268	
No. of seconds in the usable data (%)	9,330,591 (86.7%)	11,068,875 (85.2%)	11,570,826 (80.6%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.7. Summary of 2019–2021 QC Results for Site 175-0247.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	8,849,695	4,978,938	5,038,430	(2020–2021) Lanes 2 & 4 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	3,987,794	4,975,734	4,898,088	
No. of unusable entries (% of the raw data)	4,861,901 (54.9%)	3,204 (0.1%)	140,342 (2.8%)	(2019) High % of unusable entries in raw data. (2020) Less than 0.1% unusable data.
# of zero/invalid weight **	4,856,154	0	137,761	(2019) Analysis seems to show all lanes recorded vehicle classification data. High number of zero weight entries recorded.
# of unidentified class (% of the usable data)	4,833 (0.1%)	3,204 (0.1%)	2,581 (0.1%)	
# of class 9 vehicles (% of the usable data)	1,008,000 (25.3%)	1,607,000 (32.3%)	1,713,000 (35.0%)	
# of missing classification	30	0	0	(2020–2021) No missing classification.
# of missing axle spacing	16,871	1,801	195,542	
No. of entries >80 mph (% of the usable data)	498,202 (12.5%)	685,903 (13.8%)	692,472 (14.1%)	(2019–2021) More than 10% entries > 80 mph in usable data.
No. of missing speed	103	68	137,862	(2021) 2.8% missing speed in usable data.
# of gross weight >80,000 lbs (% SB/EB usable data)	48,563 (1.2%)	65,247 (1.3%)	136,358 (2.8%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	89,787 (2.3%)	18,727 (0.4%)	16,337 (0.3%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	242 (<0.1%)	372 (<0.1%)	357 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	203 (<0.1%)	306 (<0.1%)	293 (<0.1%)	
# of missing headway	386,855	415,026	415,983	
# of missing temperature (% usable data)	8,849,695 (100.0%)	2,007 (<0.1%)	0 (<0.1%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	355	366	365	
No. of days in the usable data (%)	267 (75.2%)	366 (100.0%)	364 (99.7%)	(2019) No data in January & February. Less than 90% recorded days in usable data.
Unique hours recorded	8,511	8,784	8,760	
No. of hours in the usable data (%)	6,376 (74.9%)	8,784 (100.0%)	8,655 (98.8%)	(2019) Less than 90% recorded hours in usable data.
Unique seconds recorded	7,280,325	6,847,224	7,367,124	
No. of seconds in the usable data (%)	3,758,585 (51.6%)	4,713,446 (68.8%)	4,648,986 (63.1%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.8. Summary of 2019–2021 QC Results for Site 245-0218.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	17,028,477	2,483,268	No data available.	Site is inactive now (as of May 2022). Confirmed on GDOT's TADA website. (2019) Lane 2 did not record vehicle classification data, and this data has been excluded from the analysis. (2020) Lanes 2, 3, 6 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	15,821,173	2,481,296		
No. of unusable entries (% of the raw data)	1,207,304 (7.1%)	1,972 (0.1%)		(2019) High % of unusable entries in raw data. (2020) Less than 0.1% unusable data.
# of zero/invalid weight **	1,173,808	0		(2019) Lane 2 did not record vehicle classification data, and this data has been excluded from the analysis. High number of zero weight entries recorded in remaining lanes.
# of unidentified class (% of the usable data)	33,476 (0.2%)	1,972 (0.1%)		
# of class 9 vehicles (% of the usable data)	1,438,000 (9.1%)	258,000 (10.4%)		
# of missing classification	0	0		(2019–2020) No missing classification.
# of missing axle spacing	39	2		
No. of entries >80 mph (% of the usable data)	386,233 (2.4%)	32,941 (1.3%)		
No. of missing speed	0	0		
# of gross weight >80,000 lbs (% SB/EB usable data)	50,961 (0.3%)	5,743 (0.2%)		
# of gross weight >80,000 lbs (% NB/WB usable data)	312,739 (2.0%)	7,459 (0.3%)		
No. of vehicle length >100 ft (% usable data–SB/EB)	11,089 (<0.1%)	185 (<0.1%)		
No. of vehicle length >100 ft (% usable data–NB/WB)	1,031 (<0.1%)	103 (<0.1%)		
# of missing headway	561,918	109,217		
# of missing temperature (% usable data)	10,267,800 (47.0%)	1,839,743 (46.7%)		% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	365	71		(2020) No data for April–December.
No. of days in the usable data (%)	365 (100.0%)	71 (100.0%)		
Unique hours recorded	8,760	1,689		
No. of hours in the usable data (%)	8,760 (100.0%)	1,689 (100.0%)		
Unique seconds recorded	14,500,971	2,672,190		
No. of seconds in the usable data (%)	11,997,718 (82.7%)	2,025,724 (75.8%)		(2019–2020) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.9. Summary of 2019–2021 QC Results for Site 083-0214.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	24,626,710	22,199,331	24,456,405	
No. of usable* entries	23,934,783	21,774,584	22,166,947	
No. of unusable entries (% of the raw data)	691,927 (2.8%)	424,747 (1.9%)	2,289,458 (9.4%)	(2021) High % of unusable entries in raw data.
# of zero/invalid weight **	632,576	315,878	2,161,389	(2019–2021) Analysis seems to show all lanes recorded vehicle classification data. High number of zero weight entries recorded.
# of unidentified class (% of the usable data)	56,670 (0.2%)	108,869 (0.5%)	128,069 (0.6%)	
# of class 9 vehicles (% of the usable data)	4,615,000 (19.3%)	4,681,000 (21.5%)	4,428,000 (20.0%)	
# of missing classification	1,266	0	0	(2019) High number of entries missing classification. (2020–2021) No missing classification.
# of missing axle spacing	590,801	315,878	2,161,381	
No. of entries >80 mph (% of the usable data)	368,259 (1.5%)	388,587 (1.8%)	289,482 (1.3%)	
No. of missing speed	531,514	199,578	1,466,326	
# of gross weight >80,000 lbs (% SB/EB usable data)	713,218 (3.0%)	716,827 (3.3%)	536,046 (2.4%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	889,219 (3.7%)	559,164 (2.6%)	305,729 (1.4%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	7,332 (<0.1%)	7,240 (<0.1%)	5,804 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	2,184 (<0.1%)	2,088 (<0.1%)	2,835 (<0.1%)	
# of missing headway	419,413	436,792	429,191	
# of missing temperature (% usable data)	63,031 (0.3%)	105,031 (0.5%)	28,403 (0.1%)	
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	357 (97.8%)	(2021) 8 days missing in usable data.
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,560 (97.7%)	
Unique seconds recorded	16,433,009	15,254,376	16,454,615	
No. of seconds in the usable data (%)	16,168,493 (98.4%)	15,125,887 (99.2%)	15,378,990 (93.5%)	

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.10. Summary of 2019–2021 QC Results for Site 083-0194.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	5,660,903	5,189,386	6,007,701	
No. of usable* entries	5,646,739	5,153,956	5,874,351	
No. of unusable entries (% of the raw data)	14,164 (0.3%)	35,430 (0.7%)	133,350 (2.2%)	(2019–2020) Less than 1% unusable data.
# of zero/invalid weight **	7,526	19,724	112,696	
# of unidentified class (% of the usable data)	6,314 (0.1%)	15,706 (0.3%)	20,654 (0.4%)	
# of class 9 vehicles (% of the usable data)	1,350,000 (23.9%)	1,279,000 (24.8%)	1,374,000 (23.4%)	
# of missing classification	120	0	0	(2020–2021) No missing classification.
# of missing axle spacing	7,531	19,723	112,696	
No. of entries >80 mph (% of the usable data)	689,988 (12.2%)	712,767 (13.8%)	903,772 (15.4%)	(2019–2021) More than 10% entries >80 mph in usable data.
No. of missing speed	655	83	2,743	
# of gross weight >80,000 lbs (% SB/EB usable data)	151,724 (2.7%)	45,155 (0.9%)	28,112 (0.5%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	213,267 (3.8%)	51,524 (1.0%)	104,327 (1.8%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	385 (<0.1%)	381 (<0.1%)	402 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	483 (<0.1%)	448 (<0.1%)	492 (<0.1%)	
# of missing headway	374,974	399,673	403,602	
# of missing temperature (% usable data)	115,640 (2.0%)	35,373 (0.7%)	23,222 (0.4%)	
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	5,048,272	4,657,181	5,318,337	
No. of seconds in the usable data (%)	5,043,172 (99.9%)	4,643,187 (99.7%)	5,222,628 (98.2%)	

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.11. Summary of 2019–2021 QC Results for Site 021-0378.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	22,967,201	6,514,785	25,286,253	
No. of usable* entries	22,775,386	6,504,616	18,538,130	
No. of unusable entries (% of the raw data)	191,815 (0.8%)	10,169 (0.2%)	6,748,123 (26.7%)	(2019–2020) Less than 1% unusable data. (2021) High % of unusable entries in raw data.
# of zero/invalid weight **	678	910	6,699,218	(2021) Analysis seems to show all lanes recorded vehicle classification data. High number of zero weight entries recorded.
# of unidentified class (% of the usable data)	190,285 (0.8%)	9,259 (0.1%)	48,905 (0.3%)	
# of class 9 vehicles (% of the usable data)	3,096,000 (13.6%)	1,059,000 (16.3%)	3,117,000 (16.8%)	
# of missing classification	44	0	0	(2020–2021) No missing classification.
# of missing axle spacing	953	910	168,095	
No. of entries >80 mph (% of the usable data)	6,438,449 (28.3%)	2,059,287 (31.7%)	2,915,017 (15.7%)	(2019–2021) More than 10% entries > 80 mph in usable data.
No. of missing speed	0	9	876	
# of gross weight >80,000 lbs (% SB/EB usable data)	12,201 (0.1%)	15,845 (0.2%)	322,903 (1.7%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	174,502 (0.8%)	55,424 (0.9%)	163,930 (0.9%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	1,992 (<0.1%)	445 (<0.1%)	3,229 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	6,890 (<0.1%)	436 (<0.1%)	1,646 (<0.1%)	
# of missing headway	639,850	209,822	640,018	
# of missing temperature (% usable data)	23,367 (0.1%)	108,477 (1.7%)	25,258,778 (99.9%)	
No. of days recorded	365	123	365	(2020) No data for May–November.
No. of days in the usable data (%)	365 (100.0%)	123 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	2,927	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	2,927 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	15,064,188	4,435,352	15,957,134	
No. of seconds in the usable data (%)	15,063,379 (~100.0%)	4,435,045 (~100.0%)	13,667,367 (85.7%)	(2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.12. Summary of 2019–2021 QC Results for Site 087-0103.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	2,096,543	1,878,539	2,091,927	
No. of usable* entries	2,086,803	1,873,469	2,086,460	
No. of unusable entries (% of the raw data)	9,740 (0.5%)	5,070 (0.3%)	5,467 (0.3%)	(2019–2021) Less than 1% unusable data.
# of zero/invalid weight **	0	0	0	(2019–2021) No zero/invalid weight entries.
# of unidentified class (% of the usable data)	9,483 (0.5%)	5,070 (0.3%)	5,467 (0.3%)	
# of class 9 vehicles (% of the usable data)	240,000 (11.5%)	227,000 (12.1%)	241,000 (11.6%)	
# of missing classification	1	0	0	(2020–2021) No missing classification.
# of missing axle spacing	0	0	0	
No. of entries >80 mph (% of the usable data)	92,813 (4.4%)	78,779 (4.2%)	86,897 (4.2%)	
No. of missing speed	0	0	0	
# of gross weight >80,000 lbs (% SB/EB usable data)	14,289 (0.7%)	3,861 (0.2%)	20,448 (1.0%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	10,566 (0.5%)	11,639 (0.6%)	15,317 (0.7%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	293 (<0.1%)	71 (<0.1%)	39 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	14 (<0.1%)	16 (<0.1%)	41 (<0.1%)	
# of missing headway	350,273	357,798	363,860	(2019–2021) More than 10% missing headway in usable data.
# of missing temperature (% usable data)	86,927 (4.1%)	54,441 (2.9%)	11,851 (0.6%)	
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	2,004,821	1,802,186	1,999,072	
No. of seconds in the usable data (%)	2,004,574 (~100.0%)	1,802,186 (100.0%)	1,999,072 (100.0%)	

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.13. Summary of 2019–2021 QC Results for Site 051-0700.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	3,568,780	3,306,456	4,578,701	
No. of usable* entries	3,568,605	3,293,891	4,569,515	
No. of unusable entries (% of the raw data)	175 (<0.1%)	12,565 (0.4%)	9,186 (0.2%)	(2019) Less than 0.1% unusable data. (2020–2021) Less than 1% unusable data.
# of zero/invalid weight **	0	0	0	(2019–2021) No zero/invalid weight entries.
# of unidentified class (% of the usable data)	81 (<0.1%)	12,565 (0.4%)	9,186 (0.2%)	
# of class 9 vehicles (% of the usable data)	1,123,000 (31.5%)	1,133,000 (34.4%)	1,464,000 (32.0%)	
# of missing classification	1	0	0	(2020–2021) No missing classification.
# of missing axle spacing	76	0	0	
No. of entries >80 mph (% of the usable data)	39,540 (1.1%)	29,677 (0.9%)	43,276 (0.9%)	
No. of missing speed	0	0	0	
# of gross weight >80,000 lbs (% SB/EB usable data)	38,736 (1.1%)	34,925 (1.1%)	57,197 (1.3%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	87,640 (2.5%)	72,004 (2.2%)	51,640 (1.1%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	138 (<0.1%)	138 (<0.1%)	177 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	105 (<0.1%)	155 (<0.1%)	212 (<0.1%)	
# of missing headway	347,081	341,777	373,069	(2020) More than 10% missing headway in usable data.
# of missing temperature (% usable data)	10,581 (0.3%)	536,876 (16.2%)	4,578,701 (100.0%)	
No. of days recorded	365	358	365	(2020) 8 days missing in recorded data.
No. of days in the usable data (%)	365 (100.0%)	358 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,572	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,572 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	3,187,772	2,982,907	4,029,315	
No. of seconds in the usable data (%)	3,187,687 (~100.0%)	2,982,907 (100.0%)	4,029,315 (100.0%)	

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.14. Summary of 2019–2021 QC Results for Site 051-0264.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	4,114,301	3,940,914	4,610,739	(2019–2021) Lanes 2 & 4 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	4,107,400	3,934,914	4,598,093	
No. of unusable entries (% of the raw data)	6,901 (0.2%)	6,000 (0.2%)	12,646 (0.3%)	(2019–2021) Less than 1% unusable data.
# of zero/invalid weight **	0	0	0	(2019–2021) No zero/invalid weight entries.
# of unidentified class (% of the usable data)	5,581 (0.1%)	6,000 (0.2%)	12,646 (0.3%)	
# of class 9 vehicles (% of the usable data)	304,000 (7.4%)	289,000 (7.3%)	365,000 (7.9%)	
# of missing classification	7	0	0	(2020–2021) No missing classification.
# of missing axle spacing	22,878	19,710	27,997	
No. of entries >80 mph (% of the usable data)	742 (<0.1%)	1,139 (<0.1%)	4,678 (0.1%)	
No. of missing speed	20	50	41	
# of gross weight >80,000 lbs (% SB/EB usable data)	39,784 (0.1%)	41,613 (1.1%)	40,588 (0.9%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	41,000 (1.0%)	40,970 (1.0%)	42,233 (0.9%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	456 (<0.1%)	337 (<0.1%)	396 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	404 (<0.1%)	3,451 (<0.1%)	676 (<0.1%)	
# of missing headway	394,517	407,494	411,974	(2020) More than 10% missing headway in usable data.
# of missing temperature (% usable data)	7,799,692 (100.0%)	7,476,475 (100.0%)	9,013,605 (100.0%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,743 (99.8%)	
Unique seconds recorded	6,416,015	6,199,139	7,250,591	
No. of seconds in the usable data (%)	3,901,053 (60.8%)	3,745,174 (60.4%)	4,348,165 (60.0%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.15. Summary of 2019–2021 QC Results for Site 245-0214.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	7,886,101	9,296,834	8,779,229	(2019–2020) Lanes 1, 4, 5, 8 did not record vehicle classification data, and this data has been excluded from the analysis. (2021) Lanes 4 & 8 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	7,879,574	9,246,075	8,774,751	
No. of unusable entries (% of the raw data)	6,527 (0.1%)	50,759 (0.5%)	4,478 (0.1%)	(2019–2021) Less than 1% unusable data.
# of zero/invalid weight **	0	42	0	(2019 & 2021) No zero/invalid weight entries.
# of unidentified class (% of the usable data)	6,527 (0.1%)	50,717 (0.5%)	4,478 (0.1%)	
# of class 9 vehicles (% of the usable data)	786,000 (10.0%)	996,000 (10.8%)	720,000 (8.2%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	0	42	0	
No. of entries >80 mph (% of the usable data)	539,623 (6.8%)	768,964 (8.3%)	719,101 (8.2%)	
No. of missing speed	0	0	0	
# of gross weight >80,000 lbs (% SB/EB usable data)	10,003 (0.1%)	266,682 (2.9%)	66,744 (0.8%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	82,010 (1.0%)	138,212 (1.5%)	39,318 (0.4%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	272 (<0.1%)	2,614 (<0.1%)	402 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	243 (<0.1%)	2,014 (<0.1%)	234 (<0.1%)	
# of missing headway	373,093	429,307	274,003	
# of missing temperature (% usable data)	124,066 (0.9%)	1,952,355 (12.0%)	0 (0.0%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	177	240	123	(2019) No data in July–December (2020) No data in September–December (2021) No data in January–July
No. of days in the usable data (%)	177 (100.0%)	240 (100.0%)	123 (100.0%)	
Unique hours recorded	4,243	5,750	2,941	
No. of hours in the usable data (%)	4,243 (100.0%)	5,750 (100.0%)	2,941 (100.0%)	
Unique seconds recorded	8,214,301	10,177,841	5,776,356	
No. of seconds in the usable data (%)	5,947,046 (72.4%)	7,214,554 (70.9%)	5,550,566 (96.1%)	(2019–2020) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.16. Summary of 2019–2021 QC Results for Site 047-0114.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	35,533,801	31,558,572	34,527,082	
No. of usable* entries	35,518,679	31,543,556	34,503,560	
No. of unusable entries (% of the raw data)	15,122 (<0.1%)	15,016 (<0.1%)	23,522 (0.1%)	(2019–2021) Less than 0.1% unusable data.
# of zero/invalid weight **	1	3	1	
# of unidentified class (% of the usable data)	14,501 (<0.1%)	15,013 (<0.1%)	23,521 (0.1%)	
# of class 9 vehicles (% of the usable data)	4,937,000 (13.9%)	5,011,000 (15.9%)	5,323,000 (15.4%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	220	3	0	
No. of entries >80 mph (% of the usable data)	1,851,017 (5.2%)	1,514,256 (4.8%)	2,018,502 (5.9%)	
No. of missing speed	0	0	0	(2019–2021) No missing speed.
# of gross weight >80,000 lbs (% SB/EB usable data)	24,658 (0.1%)	22,133 (0.1%)	107,901 (0.3%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	88,936 (0.3%)	23,599 (0.1%)	59,548 (0.2%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	7,823 (<0.1%)	5,807 (<0.1%)	4,424 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	11,269 (<0.1%)	9,675 (<0.1%)	6,040 (<0.1%)	
# of missing headway	620,973	645,054	644,912	
# of missing temperature (% usable data)	114,143 (0.3%)	159,063 (0.5%)	96,384 (0.3%)	
No. of days recorded	365	366	365	
No. of days in the usable data (%)	365 (100.0%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	8,760	8,784	8,760	
No. of hours in the usable data (%)	8,760 (100.0%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	19,789,613	18,483,363	19,598,225	
No. of seconds in the usable data (%)	19,789,386 (~100.0%)	18,483,362 (~100.0%)	19,598,225 (100.0%)	

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.17. Summary of 2019–2021 QC Results for Site 143-0216.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	12,541,053	No data available.	5,603,402	(2021) Lanes 2 & 4 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	10,292,187		5,598,018	
No. of unusable entries (% of the raw data)	2,248,866 (17.9%)		5,384 (0.1%)	(2019) High % of unusable entries in raw data. (2021) Less than 1% unusable data.
# of zero/invalid weight **	2,215,271		0	(2019) Analysis seems to show all lanes recorded vehicle classification data. High number of zero weight entries recorded. (2021) No zero/invalid weight entries.
# of unidentified class (% of the usable data)	32,770 (0.3%)		5,384 (0.1%)	
# of class 9 vehicles (% of the usable data)	2,397,000 (23.3%)		2,027,000 (36.2%)	
# of missing classification	6		0	(2021) No missing classification.
# of missing axle spacing	6,138,701		1	
No. of entries >80 mph (% of the usable data)	1,763,551 (17.1%)		403,272 (7.2%)	(2019) More than 10% entries >80 mph in usable data.
No. of missing speed	794,752		0	(2019) 7.7% missing speed in usable data.
# of gross weight >80,000 lbs (% SB/EB usable data)	108,069 (1.1%)		205,168 (3.7%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	66,875 (0.6%)		74,400 (1.3%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	1,639 (<0.1%)		292 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	553 (<0.1%)		219 (<0.1%)	
# of missing headway	397,260		322,369	
# of missing temperature (% usable data)	12,541,053 (100.0%)		10,920,399 (100.0%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	363		276	(2019) 2 days missing in recorded data. (2021) No data in January–February.
No. of days in the usable data (%)	342 (94.2%)		276 (100.0%)	(2019) 21 days missing in usable data.
Unique hours recorded	8,700		6,616	
No. of hours in the usable data (%)	8,207 (94.3%)		6,616 (100.0%)	
Unique seconds recorded	9,828,829		8,368,016	
No. of seconds in the usable data (%)	8,342,667 (84.9%)		5,214,848 (62.3%)	(2019 & 2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.18. Summary of 2019–2021 QC Results for Site 217-0218.

QC Measures \ Year	2019	2020	2021	Comment
Total number of entries in the Raw Data	8,111,957	9,525,539	10,432,739	(2019–2021) Lanes 2 & 4 did not record vehicle classification data, and this data has been excluded from the analysis.
No. of usable* entries	8,063,069	9,523,961	10,430,415	
No. of unusable entries (% of the raw data)	48,888 (0.6%)	1,578 (<0.1%)	2,324 (<0.1%)	(2019) Less than 1% unusable data. (2020–2021) Less than 0.1% unusable data.
# of zero/invalid weight **	44,014	0	0	(2020–2021) No zero/invalid weight entries.
# of unidentified class (% of the usable data)	4,874 (0.1%)	1,578 (<0.1%)	2,324 (<0.1%)	
# of class 9 vehicles (% of the usable data)	1,253,000 (15.5%)	1,684,000 (17.7%)	1,819,000 (17.4%)	
# of missing classification	0	0	0	(2019–2021) No missing classification.
# of missing axle spacing	176,023	170,404	190,259	
No. of entries >80 mph (% of the usable data)	436,884 (5.4%)	769,142 (8.1%)	983,032 (9.4%)	
No. of missing speed	102	82	86	
# of gross weight >80,000 lbs (% SB/EB usable data)	60,210 (0.7%)	35,889 (0.4%)	66,953 (0.6%)	
# of gross weight >80,000 lbs (% NB/WB usable data)	76,414 (0.9%)	39,253 (0.4%)	66,438 (0.6%)	
No. of vehicle length >100 ft (% usable data–SB/EB)	860 (<0.1%)	463 (<0.1%)	529 (<0.1%)	
No. of vehicle length >100 ft (% usable data–NB/WB)	445 (<0.1%)	476 (<0.1%)	690 (<0.1%)	
# of missing headway	317,273	427,793	426,100	
# of missing temperature (% usable data)	0 (<0.1%)	40,781 (0.2%)	16,853 (0.1%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of days recorded	275	366	365	(2019) No data in January–March.
No. of days in the usable data (%)	274 (99.6%)	366 (100.0%)	365 (100.0%)	
Unique hours recorded	6,600	8,784	8,760	
No. of hours in the usable data (%)	6,562 (99.4%)	8,784 (100.0%)	8,760 (100.0%)	
Unique seconds recorded	10,458,362	12,405,531	13,650,186	
No. of seconds in the usable data (%)	7,146,554 (68.3%)	8,546,621 (68.9%)	9,273,106 (67.9%)	(2019–2021) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See subchapter "Analysis of Entries with Zero Weight" in chapter 4.

Table C.19. Summary of 2021 QC Results for Sites 003-0132, 015-0276, 039-0218, 051-0109.

QC Measures \ Year	003-0132	015-0276	039-0218	051-0109	Comment
Total Number of Entries in the Raw Data	1,286,270	20,224,476	19,001,879	13,504,301	(003-0132) Lanes 2 & 4 did not record vehicle classification data and this data has been excluded from the analysis. (015-0276 & 039-0218) Lanes 3 & 6 did not record vehicle classification data and this data has been excluded from the analysis.
No. of Usable* Entries	1,281,910	20,220,234	18,959,459	13,436,304	
No. of Unusable Entries (% of the Raw Data)	4,360 (0.3%)	4,242 (<0.1%)	42,420 (0.2%)	67,997 (0.5%)	(015-0276) Less than 0.1% unusable data.
# of Zero/Invalid Weight **	0	0	6,296	49,607	(003-0132 & 015-0276) No zero/invalid weight entries.
# of Unidentified Class (% of the Usable Data)	4,360 (0.3%)	4,242 (<0.1%)	36,124 (0.2%)	18,390 (0.1%)	
# of Class 9 Vehicles (% of the Usable Data)	220,000 (17.2%)	5,784,000 (28.6%)	3,542,000 (18.7%)	612,000 (4.6%)	
# of Missing Classification	0	0	0	0	(All sites) No missing classification.
# of Missing Axle Spacing	906	0	6,587	49,607	
No. of Entries >80 mph (% of the Usable Data)	4,745 (0.4%)	1,596,054 (7.9%)	1,144,002 (6.0%)	4,489 (<0.1%)	
No. of Missing Speed	2	0	6,623	49,971	(051-0109) 0.4% missing speed in usable data.
# of Gross Weight >80,000 lbs (% SB/EB Usable Data)	39,061 (3.0%)	277,999 (1.4%)	206,086 (1.1%)	42,081 (0.3%)	
# of Gross Weight >80,000 lb (% NB/WB Usable Data)	17,655 (1.4%)	195,168 (1.0%)	50,600 (0.3%)	43,427 (0.3%)	
No. of Vehicle Length >100 ft (% Usable Data–SB/EB)	371 (<0.1%)	1,263 (<0.1%)	724 (<0.1%)	7,281 (<0.1%)	
No. of Vehicle Length >100 ft (% Usable Data–NB/WB)	313 (<0.1%)	848 (<0.1%)	444 (<0.1%)	315 (<0.1%)	
# of Missing Headway	339,264	646,951	642,325	420,864	(003-0132) More than 10% missing headway in usable data.
# of Missing Temperature (% Usable Data)	333,235 (19.0%)	30,021,228 (100.0%)	0 (<0.1%)	296,063 (2.2%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of Days Recorded	365	365	365	365	
No. of Days in the Usable Data (%)	365 (100.0%)	365 (100.0%)	365 (100.0%)	365 (100.0%)	
Unique Hours Recorded	8,760	8,760	8,760	8,760	
No. of Hours in the Usable Data (%)	8,760 (100.0%)	8,760 (100.0%)	8,760 (100.0%)	8,760 (100.0%)	
Unique Seconds Recorded	1,682,205	18,100,091	16,407,815	10,211,683	
No. of Seconds in the Usable Data (%)	1,266,450 (75.3%)	15,000,305 (82.9%)	14,065,151 (85.7%)	10,187,794 (99.8%)	(003-0132, 015-0276, 039-0218) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.

** See the subchapter titled, "Analysis of Entries with Zero Weight" in Chapter 4.

Table C.20. Summary of 2021 QC Results for Sites 051-1113, 081-0347, 087-0125, 103-0159.

QC Measures \ Year	051-1113	081-0347	087-0125	103-0159	Comment
Total Number of Entries in the Raw Data	872,345	2,050,635	3,532,290	2,063,584	(081-0347 & 087-0125) Lanes 2 & 4 did not record vehicle classification data and this data has been excluded from the analysis.
No. of Usable* Entries	868,978	2,046,949	3,531,259	2,039,051	
No. of Unusable Entries (% of the Raw Data)	3,367 (0.4%)	3,686 (0.2%)	1,031 (<0.1%)	24,533 (1.2%)	(051-1113 & 081-0347) Less than 1% unusable data. (087-0125) Less than 0.1% unusable data.
# of Zero/Invalid Weight **	0	3,445	0	22,203	(051-1113 & 087-0125) No zero/invalid weight entries.
# of Unidentified Class (% of the Usable Data)	3,367 (0.4%)	241 (<0.1%)	1,031 (<0.1%)	2,330 (0.1%)	
# of Class 9 Vehicles (% of the Usable Data)	319,000 (36.7%)	376,000 (18.4%)	362,000 (10.3%)	356,000 (17.5%)	
# of Missing Classification	0	0	0	0	(All sites) No missing classification.
# of Missing Axle Spacing	0	13,862	46,617	7,395	
No. of Entries >80 mph (% of the Usable Data)	450 (0.1%)	23,634 (1.2%)	4,336 (0.1%)	1,221 (0.1%)	
No. of Missing Speed	0	9,682	1	7,443	(081-0347) 0.5% missing speed in usable data. (103-0159) 0.4% missing speed in usable data.
# of Gross Weight >80,000 lbs (% SB/EB Usable Data)	15,148 (1.7%)	32,241 (1.6%)	33,586 (1.0%)	53,017 (2.6%)	
# of Gross Weight >80,000 lb (% NB/WB Usable Data)	21,192 (2.4%)	4,462 (0.2%)	21,550 (0.6%)	30,067 (1.5%)	
No. of Vehicle Length >100 ft (% Usable Data–SB/EB)	21 (<0.1%)	27 (<0.1%)	164 (<0.1%)	34 (<0.1%)	
No. of Vehicle Length >100 ft (% Usable Data–NB/WB)	53 (<0.1%)	64 (<0.1%)	128 (<0.1%)	13 (<0.1%)	
# of Missing Headway	151,712	385,648	361,440	101,853	(051-1113, 081-0347 & 087-0125) More than 10% missing headway in usable data.
# of Missing Temperature (% Usable Data)	872,345 (100.0%)	0 (<0.1%)	17,364 (0.4%)	2,480 (0.1%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of Days Recorded	365	365	365	183	(103-0159) No data in January – May.
No. of Days in the Usable Data (%)	365 (100.0%)	365 (100.0%)	365 (100.0%)	182 (99.5%)	(103-0159) 1 day missing in usable data.
Unique Hours Recorded	8,707	8,760	8,760	4,355	
No. of Hours in the Usable Data (%)	8,707 (100.0%)	8,760 (100.0%)	8,760 (100.0%)	4,330 (99.4%)	
Unique Seconds Recorded	860,295	2,952,206	4,122,816	1,966,219	
No. of Seconds in the Usable Data (%)	860,295 (100.0%)	2,000,078 (67.7%)	3,389,210 (82.2%)	1,946,076 (99.0%)	(081-0347 & 087-0125) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.
** See the subchapter titled, "Analysis of Entries with Zero Weight" in Chapter 4.

Table C.21. Summary of 2021 QC Results for Sites 115-0052, 145-0243, 161-0189, 235-0138.

QC Measures \ Year	115-0052	145-0243	161-0189	235-0138	Comment
Total Number of Entries in the Raw Data	1,250,501	7,629,361	1,869,905	1,122,859	(161-0189) Lanes 2 & 4 did not record vehicle classification data and this data has been excluded from the analysis.
No. of Usable* Entries	1,184,083	7,156,578	1,864,825	1,113,106	
No. of Unusable Entries (% of the Raw Data)	66,418 (5.3%)	472,783 (6.2%)	5,080 (0.3%)	9,753 (0.9%)	(161-0189 & 235-0138) Less than 1% unusable data.
# of Zero/Invalid Weight **	65,115	463,077	1,939	7,301	
# of Unidentified Class (% of the Usable Data)	1,303 (0.1%)	9,706 (0.1%)	3,141 (0.2%)	2,452 (0.2%)	
# of Class 9 Vehicles (% of the Usable Data)	132,000 (11.1%)	992,000 (13.9%)	241,000 (12.9%)	108,000 (9.7%)	
# of Missing Classification	0	0	0	0	(All sites) No missing classification.
# of Missing Axle Spacing	7,068	75,657	2,230	7,301	
No. of Entries >80 mph (% of the Usable Data)	3,560 (0.3%)	1,758,072 (24.6%)	1,548 (0.1%)	280 (<0.1%)	(145-0243) More than 10% entries >80mph in usable data.
No. of Missing Speed	7,124	155	1,958	7,307	(115-0052, 161-0189 & 235-0138) More than 0.1% missing speed in usable data.
# of Gross Weight >80,000 lbs (% SB/EB Usable Data)	21,281 (1.8%)	67,138 (0.9%)	42,967 (2.3%)	16,074 (1.4%)	
# of Gross Weight >80,000 lb (% NB/WB Usable Data)	8,509 (0.7%)	70,566 (1.0%)	12,027 (0.6%)	21,517 (1.9%)	
No. of Vehicle Length >100 ft (% Usable Data–SB/EB)	9 (<0.1%)	771 (<0.1%)	43 (<0.1%)	4 (<0.1%)	
No. of Vehicle Length >100 ft (% Usable Data–NB/WB)	7 (<0.1%)	195 (<0.1%)	59 (<0.1%)	4 (<0.1%)	
# of Missing Headway	97,353	213,104	375,181	97,776	(161-0189) More than 10% missing headway in usable data.
# of Missing Temperature (% Usable Data)	1,248,882 (99.9%)	0 (<0.1%)	20,545 (0.7%)	36,167 (3.2%)	% includes entries from lanes that did not record vehicle classification data in raw data.
No. of Days Recorded	183	184	365	185	(115-0052) No data in January – June. (145-0243 & 235-0138) No data in January – May.
No. of Days in the Usable Data (%)	176 (96.2%)	184 (100.0%)	365 (100.0%)	185 (100.0%)	(115-0052) 7 days missing in usable data.
Unique Hours Recorded	4,383	4,393	8,760	4,391	
No. of Hours in the Usable Data (%)	4,214 (96.1%)	4,393 (100.0%)	8,759 (100.0%)	4,391 (100.0%)	
Unique Seconds Recorded	1,209,660	5,753,682	2,716,070	1,091,595	
No. of Seconds in the Usable Data (%)	1,147,761 (94.9%)	5,519,550 (95.9%)	1,827,700 (67.3%)	1,085,029 (99.4%)	(161-0189) Less than 90% recorded seconds in usable data.

* The parameters used to determine the "Usable" entries are provided in INTRODUCTION.

** See the subchapter titled, "Analysis of Entries with Zero Weight" in Chapter 4.

Appendix D. Detailed Findings in Sample Bridge Analysis of Operating Rating Reductions in Low Reliability Index Bridges

(1) Bridge # 051-0054-0 Summary

Bridge Information

Table 1. Bridge # 051-0054-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000005100540
N/A	Reliability Index (WIM Site A*)	1.528
N/A	Reliability Index (WIM Site B*)	0.895
N/A	Reliability Index (WIM Site C*)	1.352
N/A	Reliability Index (WIM Site D*)	1.342
N/A	Reliability Index (WIM Site E*)	0.638
N/A	Age	68
5B	Route Prefix	3 – State Highway
5D	Route Number	25
3	County Code	51 – Chatham
6A	Features Intersected	SAVANNAH RIVER
7	Facility Carried by Structure	HOULIHAN BRIDGE
9	Location	1 MI NE PORT WENTWORTH
16	Latitude	32°09'55.43"N (32.1654)
17	Longitude	81°09'16.30"W (-81.1545)
27	Year Built	1922
28A	No. of Traffic Lanes on the Structure	2
28B	No. of Traffic Lanes under the Structure	0
29	Average Daily Traffic (ADT)	3570
30	Year of ADT	2012
41	Structure Open, Posted, or Closed to Traffic?	P – Posted for load
43A	Structure Type – Material and/or Design	4 – Steel continuous
43B	Structure Type – Design and/or Construction	17 – Movable (Swing)
49	Structure Length	446.5m (1464.9ft)
92A	Fracture Critical Details	Y12 –inspection required every 12 months
92B	Underwater Inspection	Y60 – inspection required every 60 months
92C	Other Special Inspection	Y00 – inspection required
101	Parallel Structure Designation	N
102	Direction of Traffic	2-way traffic
106	Year Reconstructed	1954
109	Average Daily Truck Traffic (% of ADT)	35%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Specialized Team 2 3/3/22. High tide.

Figure 1. Image. 2022 Views of Bridge # 051-0054-0 [2].

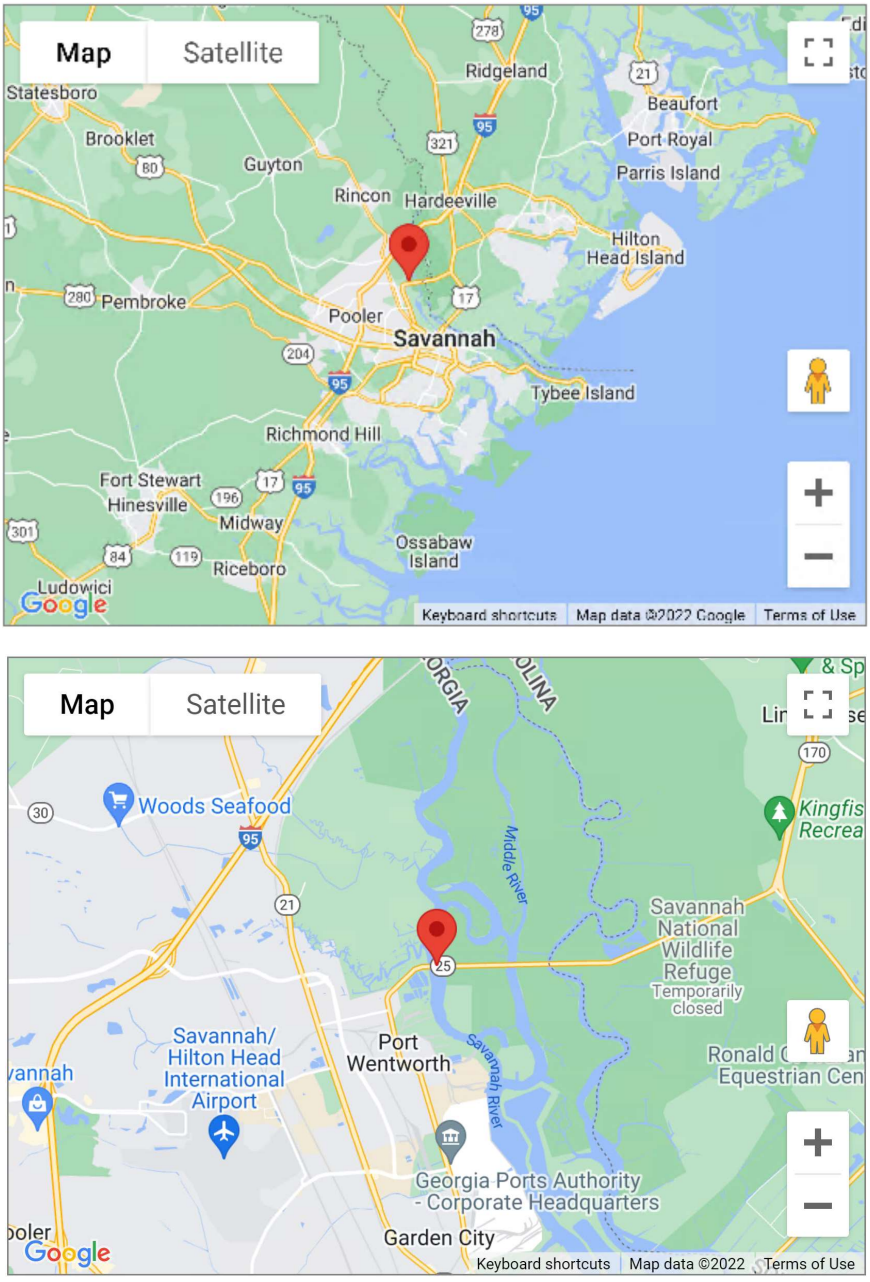


Figure 2. Image. Bridge # 051-0054-0 Location [3].

NBI Data Analysis

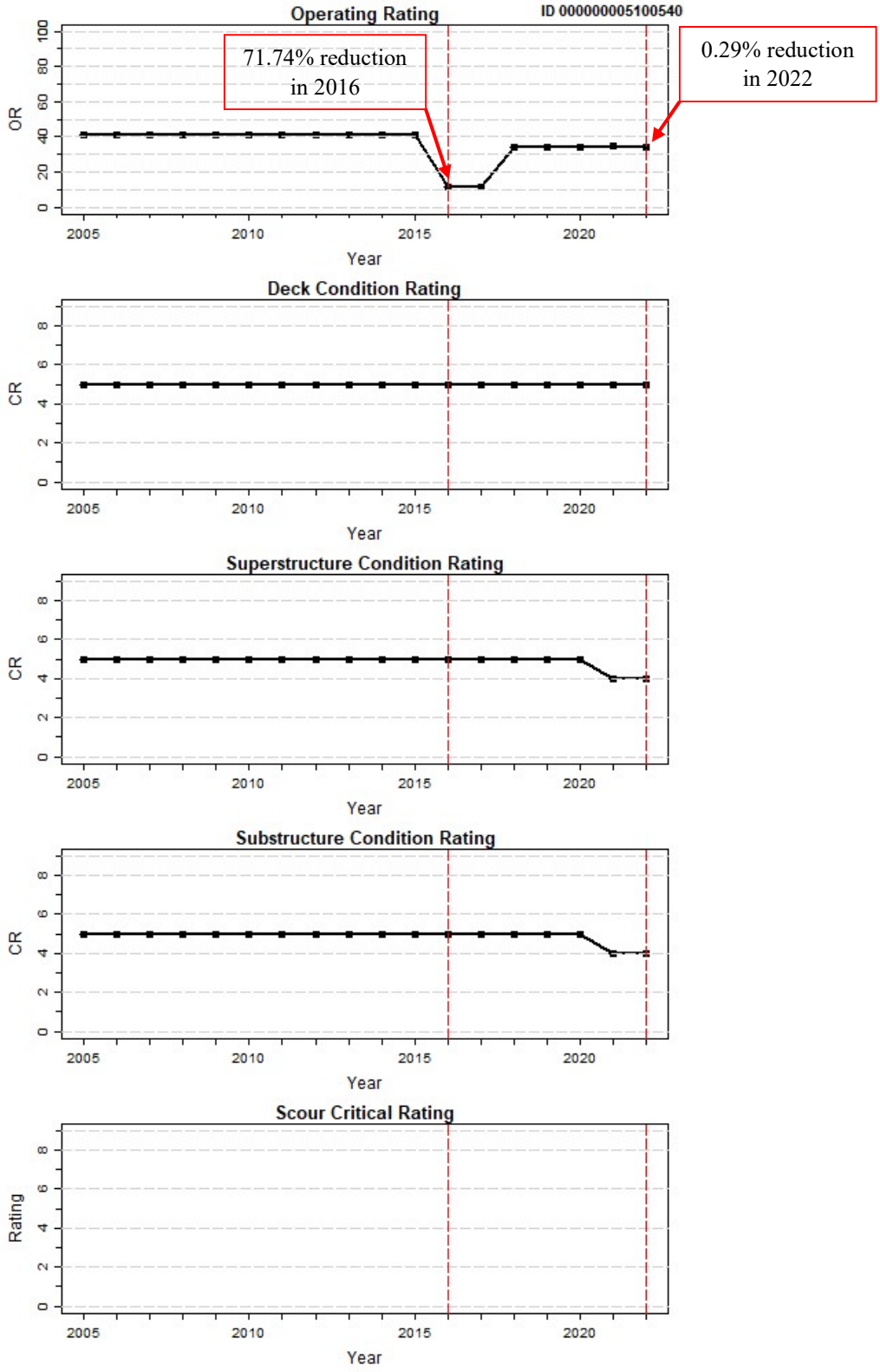


Figure 3. Graphs. NBI Operating & Condition Ratings for Structure # 051-0054-0 [1].

Table 2. NBI Data for Structure # 051-0054-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	2	41.4		5	5	5	U
2006	2	41.4	0.00	5	5	5	U
2007	2	41.4	0.00	5	5	5	U
2008	2	41.4	0.00	5	5	5	U
2009	2	41.4	0.00	5	5	5	U
2010	2	41.4	0.00	5	5	5	U
2011	2	41.4	0.00	5	5	5	U
2012	2	41.4	0.00	5	5	5	U
2013	2	41.4	0.00	5	5	5	U
2014	2	41.4	0.00	5	5	5	U
2015	2	41.4	0.00	5	5	5	U
2016	2	11.7	-71.74	5	5	5	U
2017	2	11.7	0.00	5	5	5	U
2018	2	34.2	192.31	5	5	5	U
2019	2	34.2	0.00	5	5	5	U
2020	2	34.2	0.00	5	5	5	U
2021	2	34.5	0.88	5	4	4	U
2022	2	34.4	-0.29	5	4	4	U

*Note: The code “U” for the scour critical item means the bridge has an "unknown" foundation that has not been evaluated for scour. Since risk cannot be determined, it is flag for monitoring during flood events and, if appropriate, closure.

NBI Element Data Analysis

Note that in the following figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 051-0054-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
    - EN16 - RC Top Flange
    - EN28 - Steel Open Grid Deck
    - EN29 - Steel-Concrete Filled Grid Deck
- Superstructure:
    - EN110 - RC Girder/Beam
    - EN113 - Steel Stringer
    - EN120 - Steel Truss
    - EN152 - Steel Floor Beam
    - EN162 - Steel Gusset Plate
- Substructure:
    - EN204 - PSC Column
    - EN205 - RC Column
    - EN210 - RC Pier Wall
    - EN215 - RC Abutment
    - EN220 - RC Pile Cap/Footing
    - EN227 - RC Pile
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN316 - Bearing Other

- Bridge Rails:
    - EN330 - Steel Bridge Rail
    - EN331 - RC Bridge Rail
- Wearing Surfaces & Protective Coatings:
    - EN510 - Wearing Surface (EPN16 RC Top Flange)
    - EN515 - Steel Protective Coating (EPN113 Steel Stringer)
    - EN515 - Steel Protective Coating (EPN120 Steel Truss)
    - EN515 - Steel Protective Coating (EPN152 Steel Floor Beam)
    - EN515 - Steel Protective Coating (EPN162 Steel Gusset Plate)
    - EN515 - Steel Protective Coating (EPN316 Bearing Other)
    - EN521 - Concrete Protective Coating (EPN227 RC Pile)

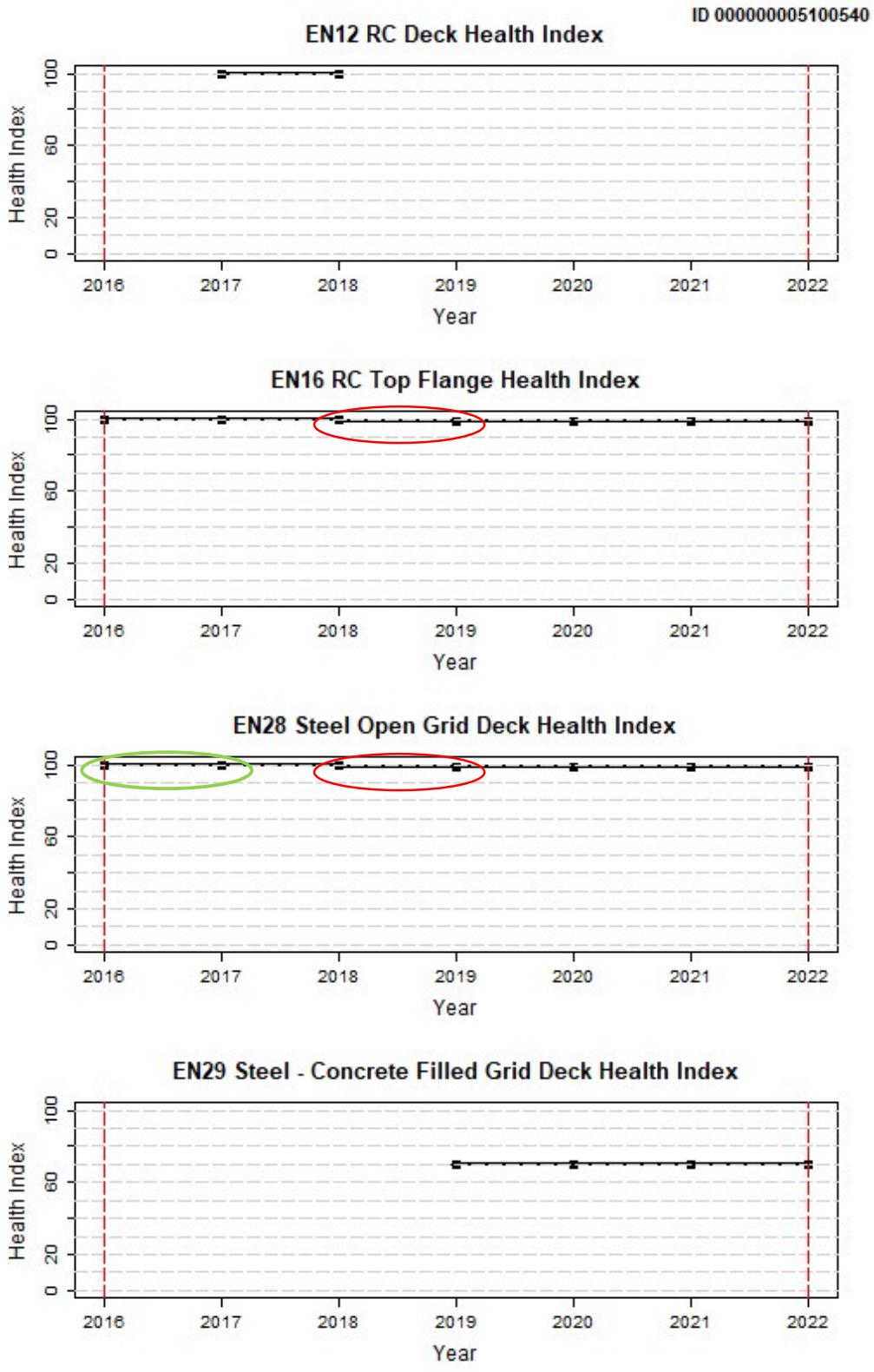


Figure 4. Graphs. Deck/Slab Element Health Indices for Structure # 051-0054-0 [4].

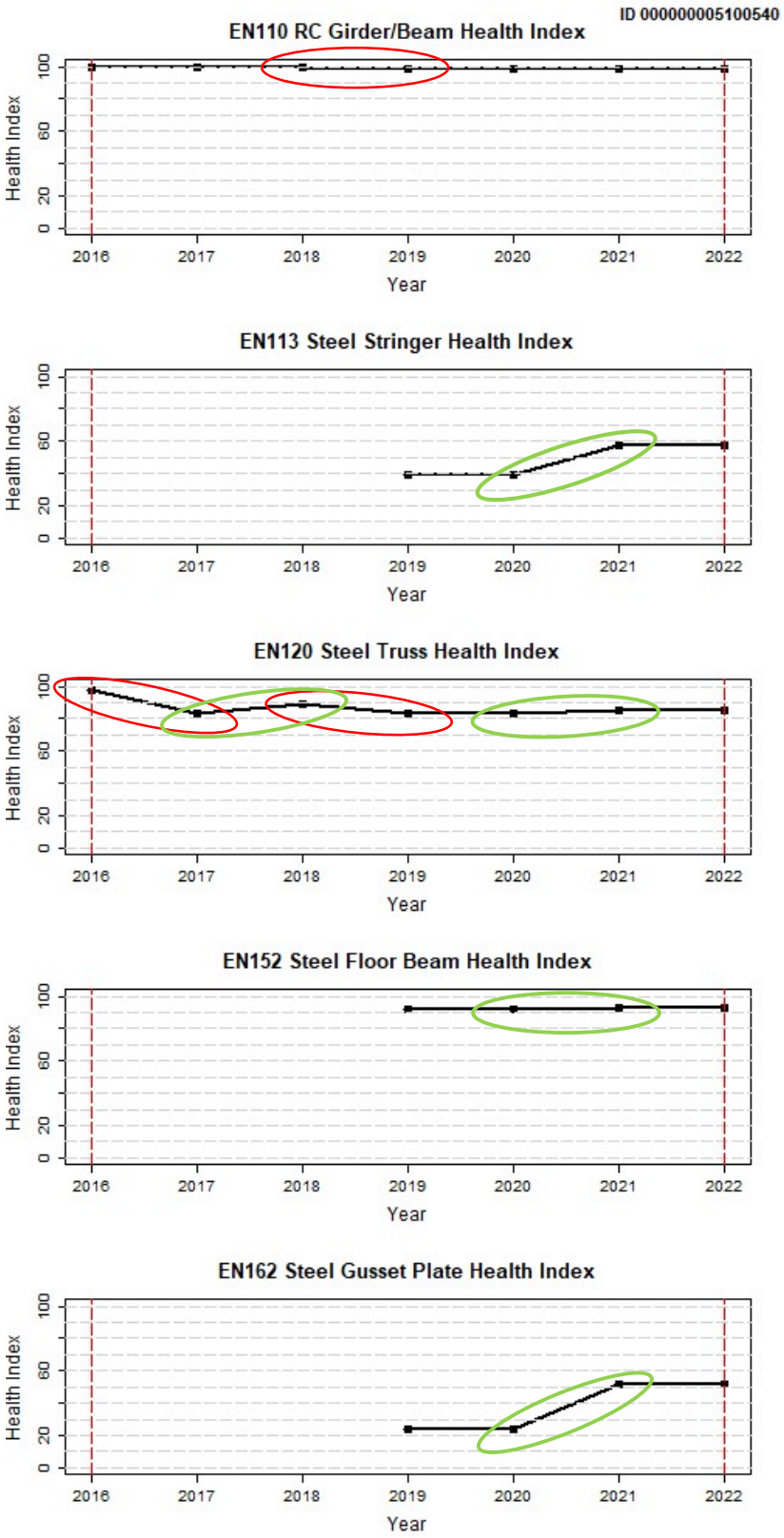


Figure 5. Graphs. Superstructure Element Health Indices for Structure # 051-0054-0 [4].

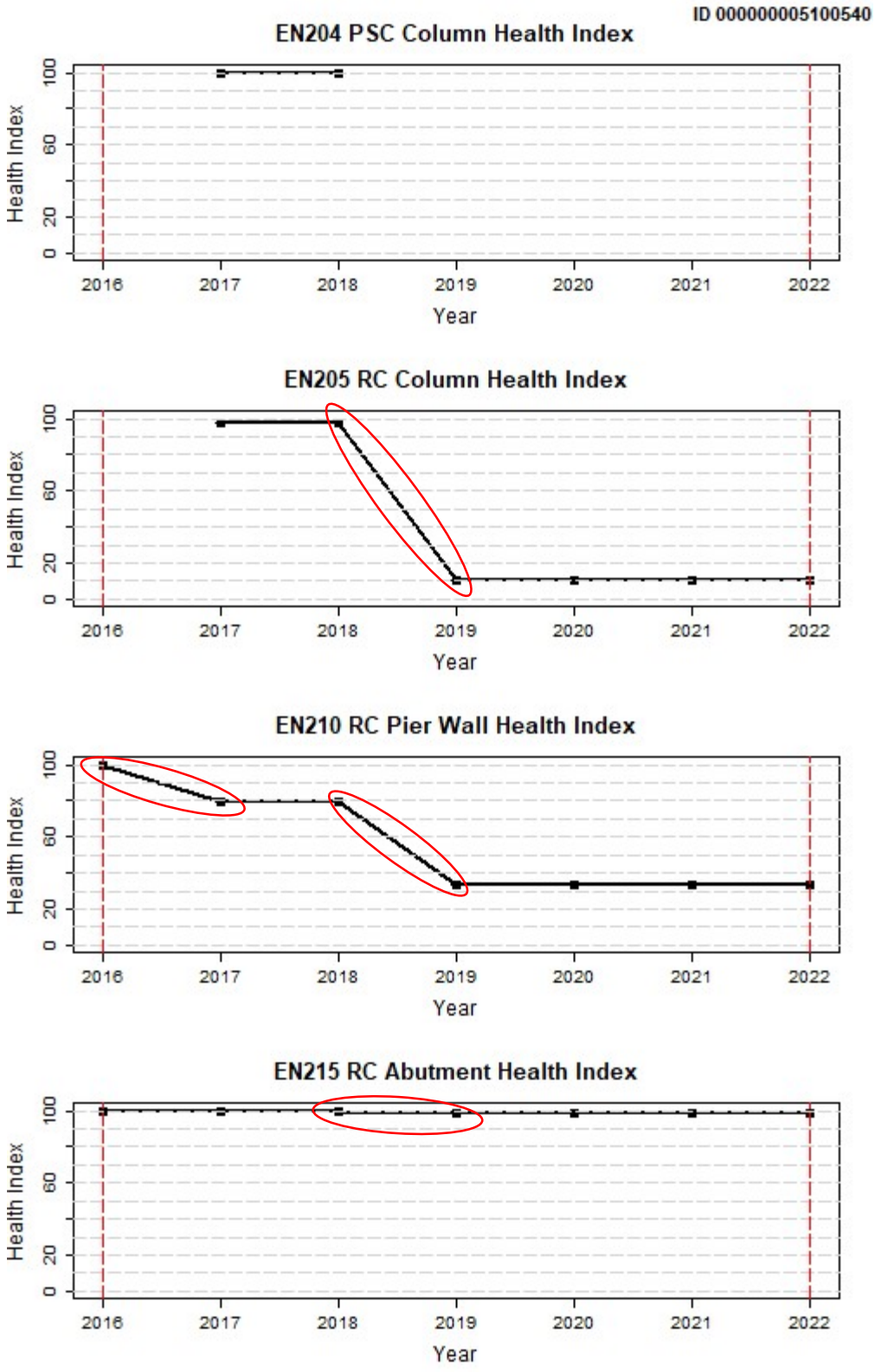


Figure 6. Graphs. Substructure Part 1 Element Health Indices for Structure # 051-0054-0 [4].

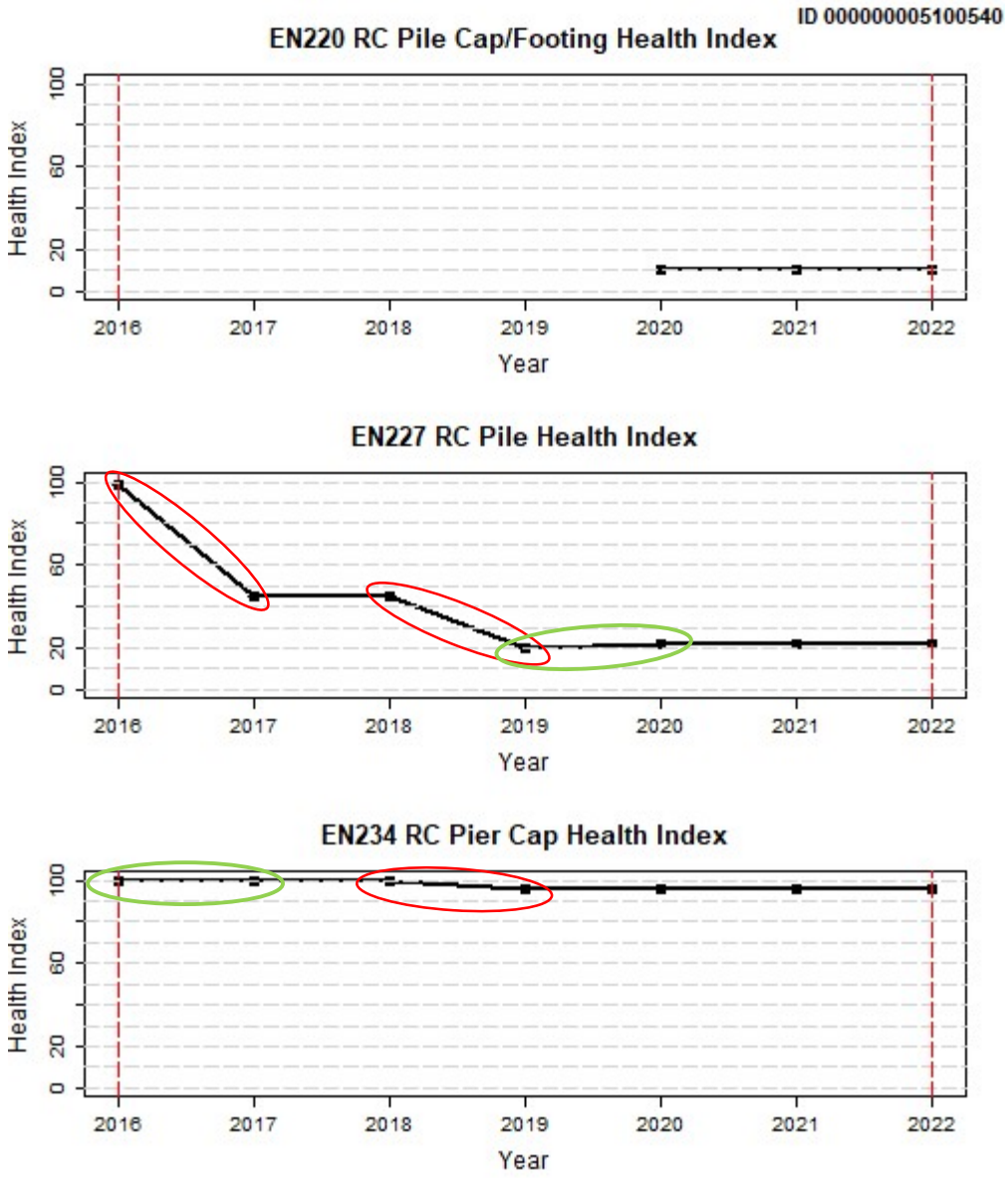


Figure 7. Graphs. Substructure Part 2 Element Health Indices for Structure # 051-0054-0 [4].

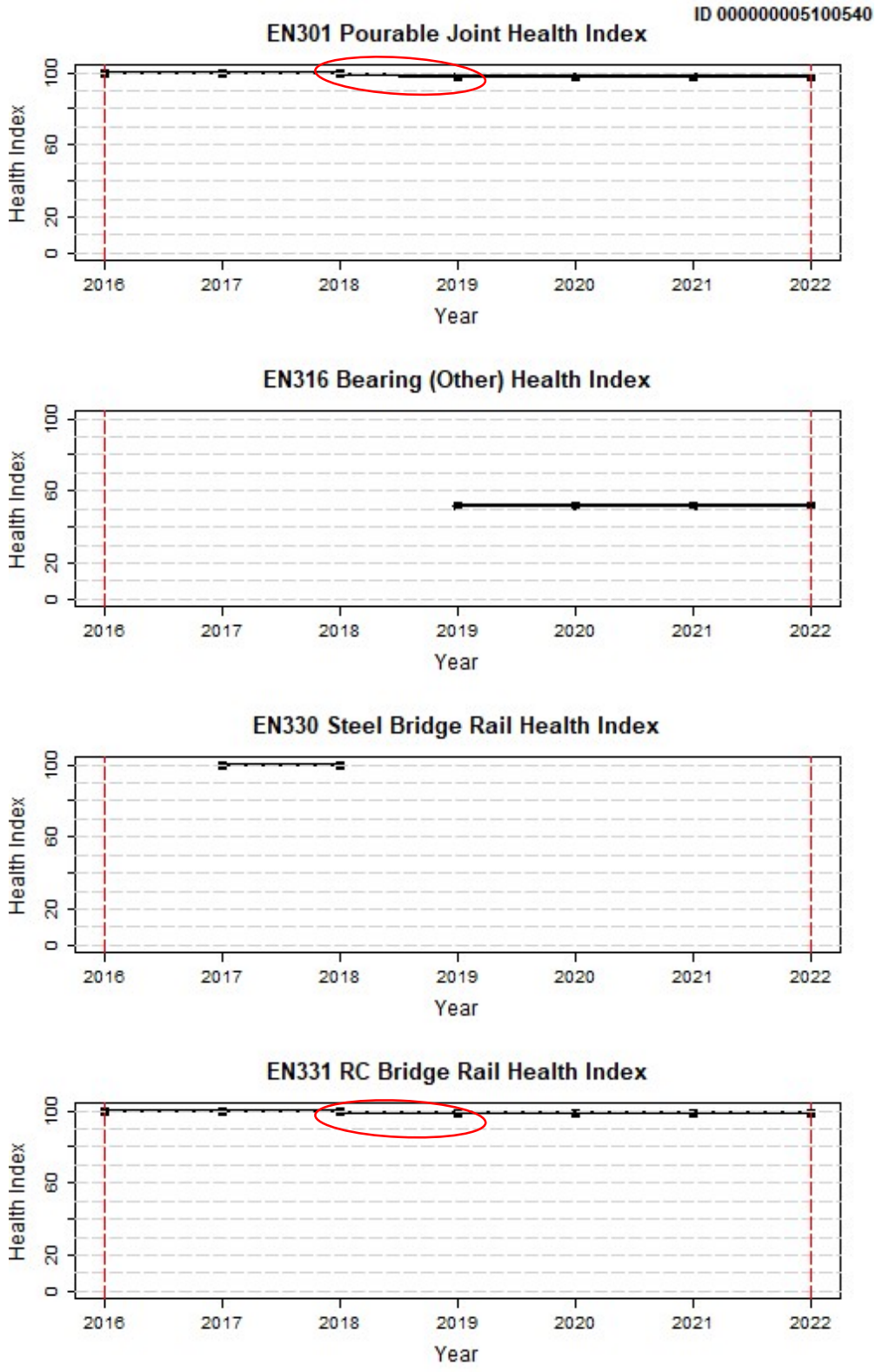


Figure 8. Graphs. Joint, Bearing, and Bridge Rail Element Health Indices for Structure # 051-0054-0 [4].

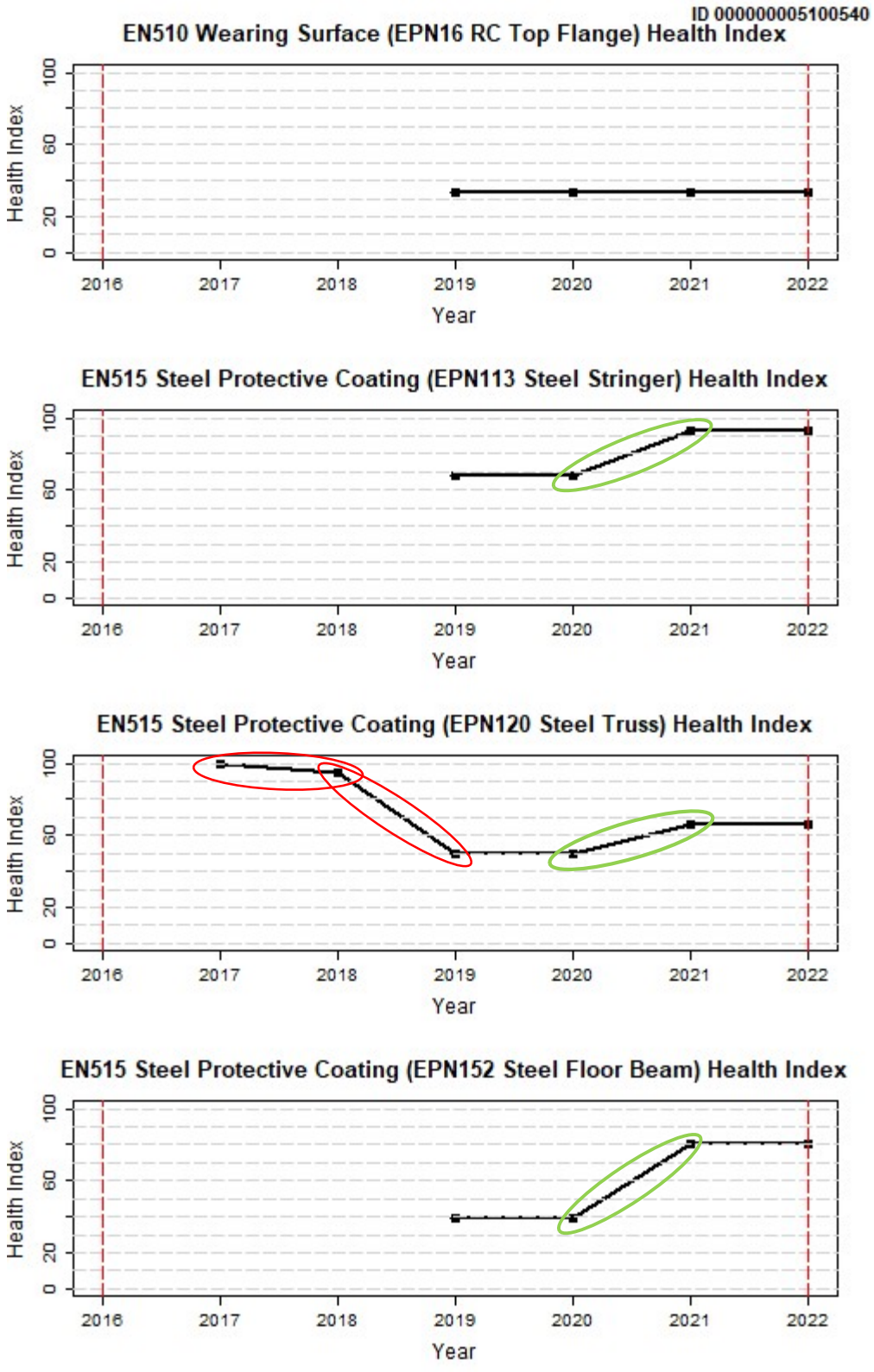


Figure 9. Graphs. Wearing Surface & Protective Coating Part 1 Element Health Indices for Structure # 051-0054-0 [4].

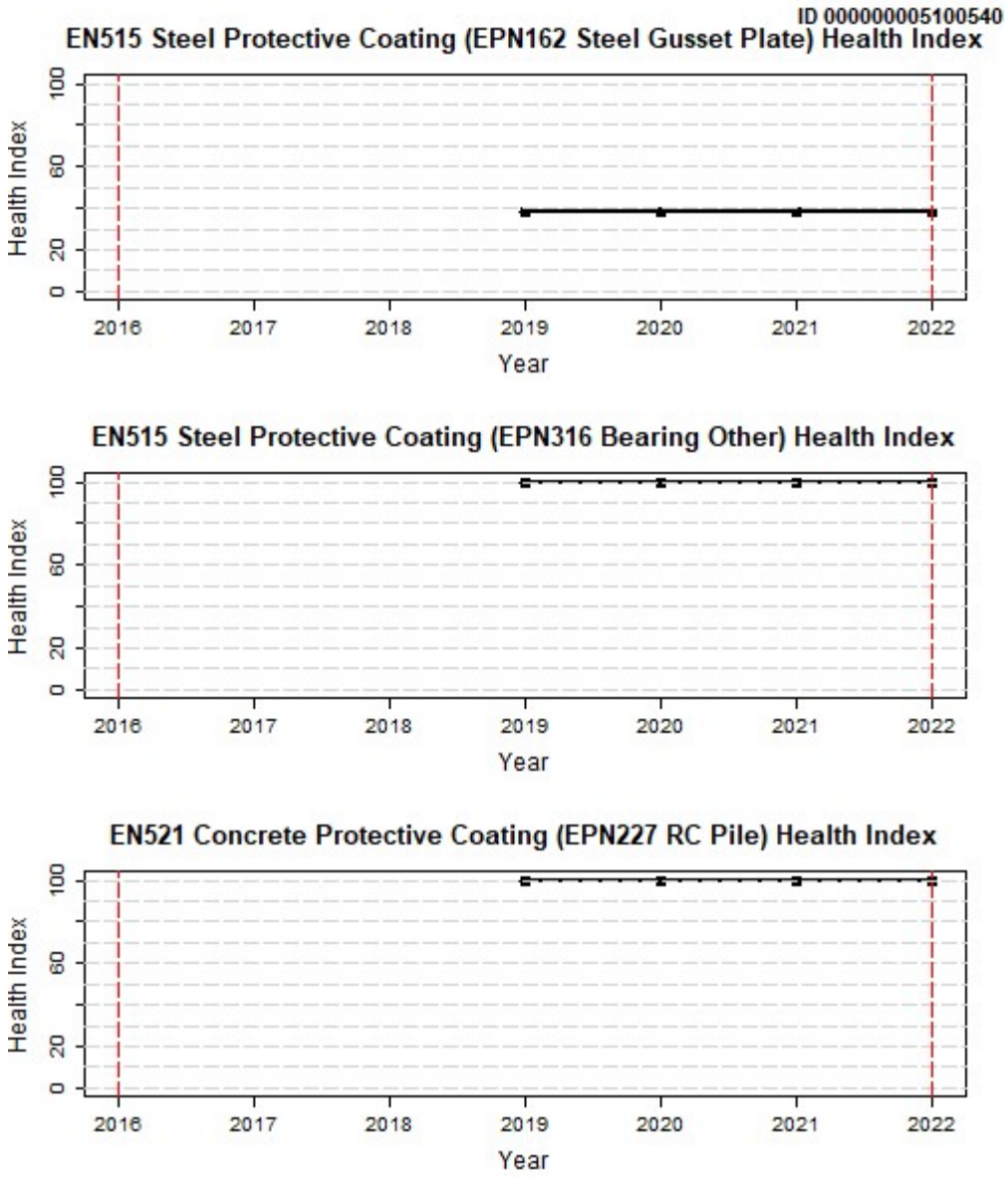


Figure 10. Graphs. Protective Coating Part 2 Element Health Indices for Structure # 051-0054-0 [4].

Supplemental Tables

Table 3. Deck NBI Bridge Element Data for Structure # 051-0054-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2017	100.000		100.000	0.000	0.000	0.000	41020	SF
2018	100.000	0.000	100.000	0.000	0.000	0.000	41020	SF
EN16 – RC Top Flange								
2016	100.000		100.000	0.000	0.000	0.000	41160	SF
2017	100.000	0.000	100.000	0.000	0.000	0.000	41160	SF
2018	100.000	0.000	100.000	0.000	0.000	0.000	41160	SF
2019	99.024	-0.976	98.831	0.253	0.916	0.000	41160	SF
2020	99.024	0.000	98.831	0.253	0.916	0.000	41160	SF
2021	99.024	0.000	98.831	0.253	0.916	0.000	41160	SF
2022	99.024	0.000	98.831	0.253	0.916	0.000	41160	SF
EN28 – Steel Open Grid Deck								
2016	99.330		99.256	0.000	0.744	0.000	8064	SF
2017	99.890	0.563	99.878	0.000	0.122	0.000	49084	SF
2018	99.890	0.000	99.878	0.000	0.122	0.000	49084	SF
2019	98.342	-1.550	98.158	0.000	1.842	0.000	7056	SF
2020	98.342	0.000	98.158	0.000	1.842	0.000	7056	SF
2021	98.342	0.000	98.158	0.000	1.842	0.000	7056	SF
2022	98.342	0.000	98.158	0.000	1.842	0.000	7056	SF
EN29 – Steel Concrete Filled Grid Deck								
2019	70.000		50.000	50.000	0.000	0.000	784	SF
2020	70.000	0.000	50.000	50.000	0.000	0.000	784	SF
2021	70.000	0.000	50.000	50.000	0.000	0.000	784	SF
2022	70.000	0.000	50.000	50.000	0.000	0.000	784	SF

Table 4. Superstructure NBI Bridge Element Data for Structure # 051-0054-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN110 – RC Girder/Beam								
2016	100.000		100.000	0.000	0.000	0.000	7206	LF
2017	100.000	0.000	100.000	0.000	0.000	0.000	7206	LF
2018	100.000	0.000	100.000	0.000	0.000	0.000	7206	LF
2019	98.294	-1.706	97.769	1.007	1.224	0.000	7350	LF
2020	98.294	0.000	97.769	1.007	1.224	0.000	7350	LF
2021	98.294	0.000	97.769	1.007	1.224	0.000	7350	LF
2022	98.294	0.000	97.769	1.007	1.224	0.000	7350	LF
EN113 – Steel Stringer								
2019	39.145		0.000	97.150	2.850	0.000	2140	LF
2020	39.145	0.000	0.000	97.150	2.850	0.000	2140	LF
2021	57.271	46.305	29.720	68.411	1.869	0.000	2140	LF
2022	57.271	0.000	29.720	68.411	1.869	0.000	2140	LF
EN120 – Steel Truss								
2016	97.656		97.396	0.000	2.604	0.000	1920	LF
2017	83.194	-14.809	78.241	9.259	12.500	0.000	2160	LF
2018	89.528	7.613	84.861	10.509	4.630	0.000	2160	LF
2019	83.457	-6.781	75.720	17.695	6.584	0.000	972	LF
2020	83.457	0.000	75.720	17.695	6.584	0.000	972	LF
2021	85.154	2.034	78.292	15.638	6.070	0.000	972	LF
2022	85.154	0.000	78.292	15.638	6.070	0.000	972	LF
EN152 – Steel Floor Beam								
2019	91.811		89.082	5.459	5.459	0.000	403	LF
2020	91.811	0.000	89.082	5.459	5.459	0.000	403	LF
2021	93.151	1.459	90.571	5.459	3.970	0.000	403	LF
2022	93.151	0.000	90.571	5.459	3.970	0.000	403	LF
EN162 – Steel Gusset Plate								
2019	24.250		0.000	47.500	52.500	0.000	40	EA
2020	24.250	0.000	0.000	47.500	52.500	0.000	40	EA
2021	52.000	114.433	37.500	27.500	35.000	0.000	40	EA
2022	52.000	0.000	37.500	27.500	35.000	0.000	40	EA

Table 5. Substructure NBI Bridge Element Data for Structure # 051-0054-0 [4].

Year	Health	HI % Change	CS1%	CS2%	CS3%	CS4%	Total	Units
EN204 – PSC Column								
2017	100.000		100.000	0.000	0.000	0.000	100	EA
2018	100.000	0.000	100.000	0.000	0.000	0.000	100	EA
EN205 – RC Column								
2017	97.647		97.386	0.000	2.614	0.000	153	EA
2018	97.647	0.000	97.386	0.000	2.614	0.000	153	EA
2019	10.000	-89.759	0.000	0.000	100.000	0.000	4	EA
2020	10.000	0.000	0.000	0.000	100.000	0.000	4	EA
2021	10.000	0.000	0.000	0.000	100.000	0.000	4	EA
2022	10.000	0.000	0.000	0.000	100.000	0.000	4	EA
EN210 – RC Pier Wall								
2016	100.000		100.000	0.000	0.000	0.000	102	LF
2017	79.545	-20.455	77.273	0.000	22.727	0.000	88	LF
2018	79.545	0.000	77.273	0.000	22.727	0.000	88	LF
2019	33.182	-58.286	0.000	77.273	22.727	0.000	88	LF
2020	33.182	0.000	0.000	77.273	22.727	0.000	88	LF
2021	33.182	0.000	0.000	77.273	22.727	0.000	88	LF
2022	33.182	0.000	0.000	77.273	22.727	0.000	88	LF
EN215 – RC Abutment								
2016	100.000		100.000	0.000	0.000	0.000	68	LF
2017	100.000	0.000	100.000	0.000	0.000	0.000	68	LF
2018	100.000	0.000	100.000	0.000	0.000	0.000	68	LF
2019	98.676	-1.324	98.529	0.000	1.471	0.000	68	LF
2020	98.676	0.000	98.529	0.000	1.471	0.000	68	LF
2021	98.676	0.000	98.529	0.000	1.471	0.000	68	LF
2022	98.676	0.000	98.529	0.000	1.471	0.000	68	LF
EN220 – RC Pile Cap/Footing								
2020	10.000		0.000	0.000	100.000	0.000	18	LF
2021	10.000	0.000	0.000	0.000	100.000	0.000	18	LF
2022	10.000	0.000	0.000	0.000	100.000	0.000	18	LF
EN227 – RC Pile								
2016	99.156		99.063	0.000	0.938	0.000	320	EA
2017	44.864	-54.754	38.776	0.000	60.884	0.340	294	EA
2018	44.864	0.000	38.776	0.000	60.884	0.340	294	EA
2019	19.664	-56.169	0.000	32.215	67.785	0.000	298	EA
2020	21.477	9.215	2.013	32.215	65.772	0.000	298	EA
2021	21.477	0.000	2.013	32.215	65.772	0.000	298	EA
2022	21.477	0.000	2.013	32.215	65.772	0.000	298	EA
EN234 – RC Pier Cap								
2016	99.945		99.938	0.000	0.062	0.000	1626	LF
2017	99.973	0.028	99.970	0.000	0.030	0.000	3342	LF
2018	99.973	0.000	99.970	0.000	0.030	0.000	3342	LF
2019	96.128	-3.846	95.198	1.501	3.301	0.000	1666	LF
2020	96.128	0.000	95.198	1.501	3.301	0.000	1666	LF
2021	96.128	0.000	95.198	1.501	3.301	0.000	1666	LF
2022	96.128	0.000	95.198	1.501	3.301	0.000	1666	LF

Table 6. Joint & Bearing NBI Bridge Element Data for Structure # 051-0054-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 – Pourable Joint								
2016	100.000		100.000	0.000	0.000	0.000	1394	LF
2017	100.000	0.000	100.000	0.000	0.000	0.000	1394	LF
2018	100.000	0.000	100.000	0.000	0.000	0.000	1394	LF
2019	98.163	-1.837	97.959	0.000	2.041	0.000	1372	LF
2020	98.163	0.000	97.959	0.000	2.041	0.000	1372	LF
2021	98.163	0.000	97.959	0.000	2.041	0.000	1372	LF
2022	98.163	0.000	97.959	0.000	2.041	0.000	1372	LF
EN316 – Bearing (Other)								
2019	52.000		20.000	80.000	0.000	0.000	5	EA
2020	52.000	0.000	20.000	80.000	0.000	0.000	5	EA
2021	52.000	0.000	20.000	80.000	0.000	0.000	5	EA
2022	52.000	0.000	20.000	80.000	0.000	0.000	5	EA
EN330 – Steel Bridge Rail								
2017	100.000		100.000	0.000	0.000	0.000	480	LF
2018	100.000	0.000	100.000	0.000	0.000	0.000	480	LF
EN331 – RC Bridge Rail								
2016	100.000		100.000	0.000	0.000	0.000	2880	LF
2017	100.000	0.000	100.000	0.000	0.000	0.000	2880	LF
2018	100.000	0.000	100.000	0.000	0.000	0.000	2880	LF
2019	98.753	-1.247	98.534	0.239	1.227	0.000	2934	LF
2020	98.753	0.000	98.534	0.239	1.227	0.000	2934	LF
2021	98.753	0.000	98.534	0.239	1.227	0.000	2934	LF
2022	98.753	0.000	98.534	0.239	1.227	0.000	2934	LF

Table 7. Wearing Surface & Protective Coating NBI Bridge Element Data for Structure # 051-0054-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN510 Wearing Surface (EPN16 RC Top Flange)								
2019	33.496		26.107	0.000	73.893	0.000	31850	SF
2020	33.496	0.000	26.107	0.000	73.893	0.000	31850	SF
2021	33.496	0.000	26.107	0.000	73.893	0.000	31850	SF
2022	33.496	0.000	26.107	0.000	73.893	0.000	31850	SF
EN515 Steel Protective Coating (EPN113 Steel Stringer)								
2019	68.109		50.000	43.696	6.304	0.000	17924	SF
2020	68.109	0.000	50.000	43.696	6.304	0.000	17924	SF
2021	93.054	36.626	88.423	11.577	0.000	0.000	17924	SF
2022	93.054	0.000	88.423	11.577	0.000	0.000	17924	SF
EN515 Steel Protective Coating (EPN120 Steel Truss)								
2016	94.792		91.319	8.681	0.000	0.000	11520	SF
2017	100.000	5.495	100.000	0.000	0.000	0.000	11520	SF
2018	94.479	-5.521	90.799	9.201	0.000	0.000	11520	SF
2019	50.052	-47.023	21.354	69.444	9.201	0.000	11520	SF
2020	50.052	0.000	21.354	69.444	9.201	0.000	11520	SF
2021	65.677	31.217	47.396	43.403	9.201	0.000	11520	SF
2022	65.677	0.000	47.396	43.403	9.201	0.000	11520	SF
EN515 Steel Protective Coating (EPN152 Steel Floor Beam)								
2019	39.583		0.397	97.419	2.184	0.000	2015	SF
2020	39.583	0.000	0.397	97.419	2.184	0.000	2015	SF
2021	80.437	103.210	68.238	30.074	1.687	0.000	2015	SF
2022	80.437	0.000	68.238	30.074	1.687	0.000	2015	SF
EN515 Steel Protective Coating (EPN162 Steel Gusset Plate)								
2019	38.250		0.000	94.167	5.833	0.000	360	SF
2020	38.250	0.000	0.000	94.167	5.833	0.000	360	SF
2021	38.250	0.000	0.000	94.167	5.833	0.000	360	SF
2022	38.250	0.000	0.000	94.167	5.833	0.000	360	SF
EN515 Steel Protective Coating (EPN316 Bearing Other)								
2019	100.000		100.000	0.000	0.000	0.000	16	SF
2020	100.000	0.000	100.000	0.000	0.000	0.000	16	SF
2021	100.000	0.000	100.000	0.000	0.000	0.000	16	SF
2022	100.000	0.000	100.000	0.000	0.000	0.000	16	SF
EN521 Concrete Protective Coating (EPN227 RC Pile)								
2019	100.000		100.000	0.000	0.000	0.000	360	SF
2020	100.000	0.000	100.000	0.000	0.000	0.000	360	SF
2021	100.000	0.000	100.000	0.000	0.000	0.000	360	SF
2022	100.000	0.000	100.000	0.000	0.000	0.000	360	SF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

TURN SPAN CONCRETE BUSTING UP.

SAME AS LAST PHOTO SHOWING TURN SPAN.

BENT 12 CONCRETE AND XJS MATERIAL INLAY.

Figure 11. Images. Typical Damage in Deck for Structure # 051-0054-0.

Photo 28 - Section loss in the bottom flange of Stringer 10-10 between Floor Beams 10-1 and 10-2

Photo 27 - Typical corrosion and section loss in the bottom flange of Stringers 1 an 10 on both sides of the pivot pier (Pier 10)

Photo 29 - Typical crack in stringers (Stringer 10-4 at Floor Beam 10-4 shown)

Figure 12. Images. Steel Deterioration for Structure # 051-0054-0.

SUPER SHOT.

Posted signs

Figure 13. Images. Photos of Structure # 051-0054-0.

Bent 9 column 1 and 2 back face, deteriorated concrete.

Bent 10, Timber forms

Bent 9 column 2, Timber forms

Figure 14. Images. Typical Deterioration for Structure # 051-0054-0.

Representation of spalls with steel exposed.

Photo 13 - Typical spalls in the intermediate diaphragms

Photo 12 - Spall with exposed painted rebar in Beam 23-2

Photo 9 - Typical spalls in the original deck underside

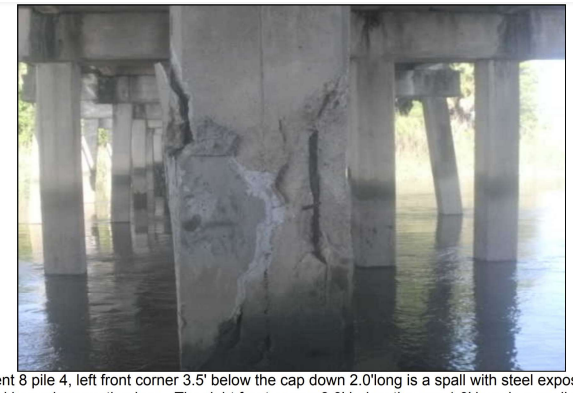
Photo 8 - Typical spalls in the original deck overhangs

Spall/delamination in the lower west edge of Bent 14 cap

Figure 15. Images. Typical Spall and Exposed Rebar for Structure # 051-0054-0.

Bent 8 pile 3, Left front corner

Bent 14 pile 5 right back corner 1/2" crack with rust stains.



Bent 8 pile 4, left front corner 3.5' below the cap down 2.0'long is a spall with steel exposed. Steel has minor section loss. The right front corner 3.0' below the cap 1.0' long is a spall which is being held in place by an epoxy patch at the bottom of the spall. There is steel exposed with up to minor section loss.

Representation of cracks.

Photo 11 - Beam 6-5 cracked and delaminated at mid-span

Typical crack at construction joint in cap.

Figure 16. Images. Typical Concrete Cracking for Structure # 051-0054-0.

Findings

- NBI Data concerns:
  - 71.74% reduction in operating rating between 2015 and 2016
    - No changes in condition ratings for deck, superstructure, substructure, and scour
  - 0.29% reduction in operating rating between 2021 and 2022
    - Superstructure and substructure condition ratings decreased from 5 to 4 in 2021
- NBI Element Data concerns:

    - Superstructure:
        - Steel Truss: 14.81% health index reduction in 2017
        - Steel Truss: 6.78% health index reduction in 2019
    - Substructure:
        - RC Column: 89.76% health index reduction in 2019
        - RC Pier Wall: 20.46% health index reduction in 2017
        - RC Pier Wall: 58.29% health index reduction in 2019
        - RC Pile: 54.75% health index reduction in 2017
        - RC Pile: 56.17% health index reduction in 2019
- Inspection Report concerns:
    - Reports available in 2004, 2006, 2008, 2010, 2012, 2014 – 2022
    - Repairs made to steel truss in 2017, 2019 & 2020
    - Repairs made to certain piles in 2019 (epoxy filled fiber glass jacket)
    - Deck (2004-2022):
        - Asphalt overlays have map cracks, transverse cracks, and potholes in multiple areas
        - Steel grating has cracked welds in multiple areas
        - Steel concrete filled grating has map cracks, spall with exposed corroded rebar, and corrosion of underside of steel grating
        - Deck underside has spall with exposed rebar throughout, delamination, and transverse cracks in multiple areas
        - Joints have adhesion failure or missing sealant throughout; joint header has spalls/delamination and cracking
        - Bridge railing has spalls with exposed rebar, cracks, corrosion staining
    - Superstructure (2004-2022):
        - Reinforced concrete beams have longitudinal cracking, spalls/delamination with exposed rebar
        - Steel truss and its connections have corrosion, paint loss, and section loss; multiple members have collision damage from multiple collisions over the years
    - Substructure (2004-2022):

- Piles have scale damage, spall with exposed rebar, delamination, vertical cracking; some piles no longer reach their caps
- Columns have scale damage with voids
- Pier walls have moderate to heavy abrasion
- Some abutments have spall with exposed rebar
- Caps have horizontal cracking, spalls with exposed rebar
- Footings have severe deterioration

(2) Bridge # 063-0105-0 Summary

Bridge Information

Table 8. Bridge # 063-0105-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000006301050
N/A	Reliability Index (WIM Site A*)	0.904616187
N/A	Reliability Index (WIM Site B*)	1.473044853
N/A	Reliability Index (WIM Site C*)	1.047268281
N/A	Reliability Index (WIM Site D*)	0.932663788
N/A	Reliability Index (WIM Site E*)	1.036940961
N/A	Reliability Index (WIM Site F*)	1.339015251
N/A	Reliability Index (WIM Site G*)	0.958563923
N/A	Age	37
5B	Route Prefix	1 – Interstate
5D	Route Number	285
3	County Code	63 – Clayton
6A	Features Intersected	I-285 RAMP TO I-75 SBL
7	Facility Carried by Structure	I-285
9	Location	0.05 MI SE OF ATL AIRPORT
16	Latitude	33°37'59.11"N (33.6331)
17	Longitude	84°24'10.31"W (-84.4029)
27	Year Built	1985
28A	No. of Traffic Lanes on the Structure	6
28B	No. of Traffic Lanes under the Structure	1
29	Average Daily Traffic (ADT)	78270
30	Year of ADT	2012
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restriction
43A	Structure Type – Material and/or Design	5 – Prestressed Concrete
43B	Structure Type – Design and/or Construction	2 – Stringer/Multi-beam or Girder
49	Structure Length	60.4 m (198.2 ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	N
102	Direction of Traffic	2-way traffic
106	Year Reconstructed	NA
109	Average Daily Truck Traffic (% of ADT)	1%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 17. Image. 2021 Views of Bridge # 063-0105-0 [2].

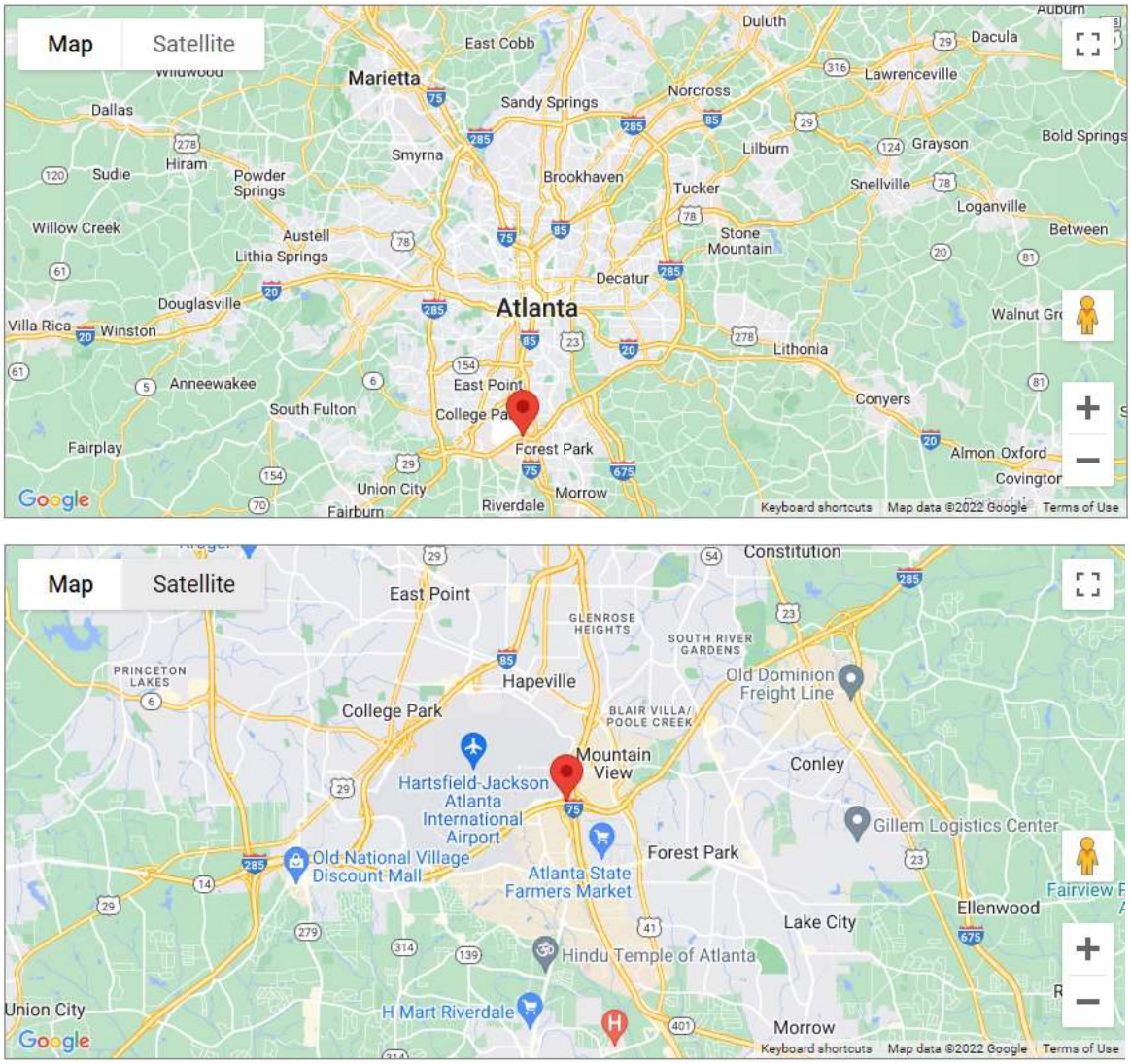


Figure 18. Image. Bridge # 063-0105-0 Location [3].

NBI Data Analysis

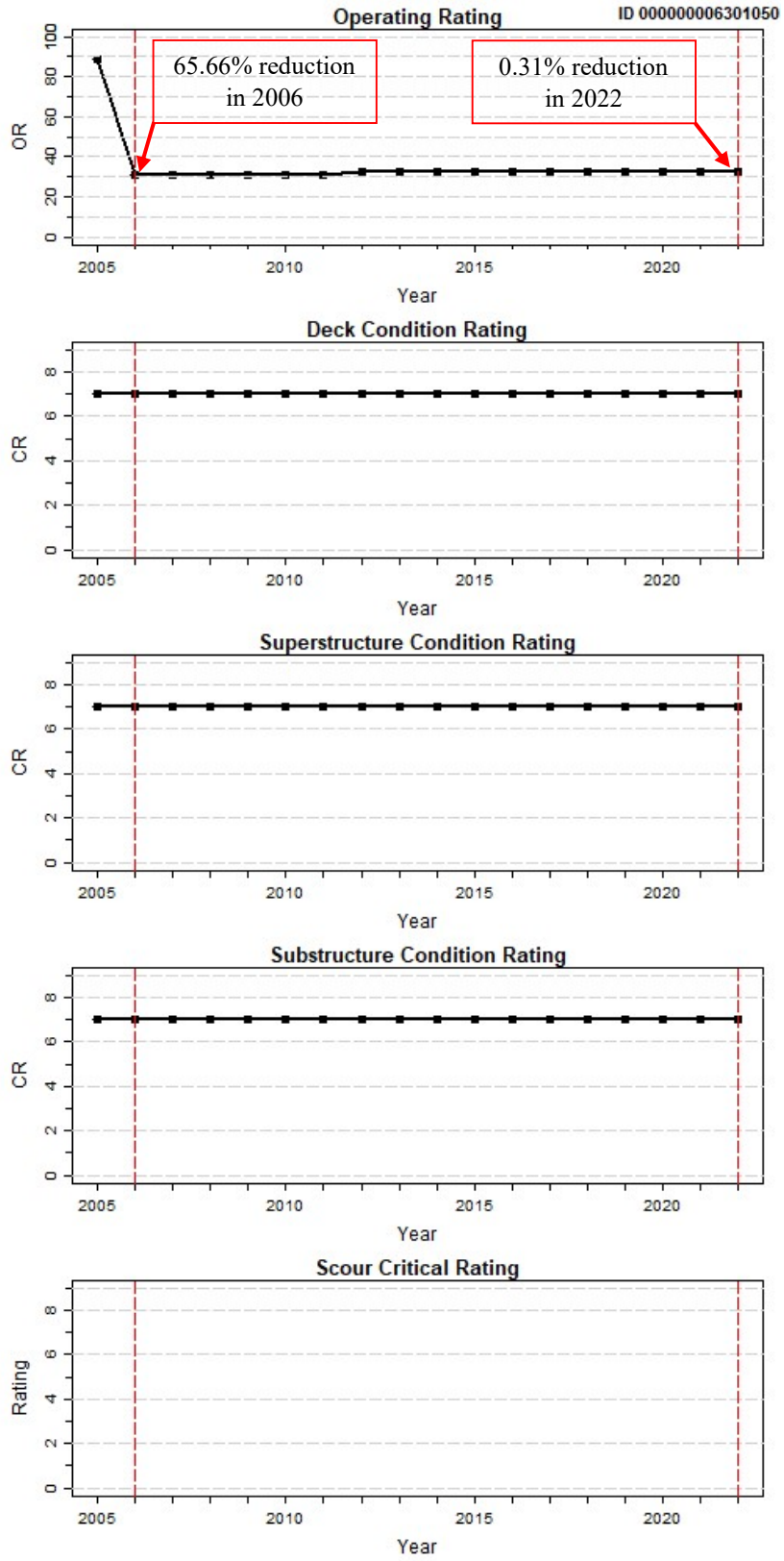


Figure 19. Graphs. NBI Operating & Condition Ratings for Structure # 063-0105-0 [1].

Table 9. NBI Data for Structure # 063-0105-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	89.1		7	7	7	N
2006	1	30.6	-65.66	7	7	7	N
2007	1	30.6	0.00	7	7	7	N
2008	1	30.6	0.00	7	7	7	N
2009	1	30.6	0.00	7	7	7	N
2010	1	30.6	0.00	7	7	7	N
2011	1	30.6	0.00	7	7	7	N
2012	1	32.4	5.88	7	7	7	N
2013	1	32.4	0.00	7	7	7	N
2014	1	32.4	0.00	7	7	7	N
2015	1	32.4	0.00	7	7	7	N
2016	1	32.4	0.00	7	7	7	N
2017	1	32.4	0.00	7	7	7	N
2018	1	32.4	0.00	7	7	7	N
2019	1	32.4	0.00	7	7	7	N
2020	1	32.4	0.00	7	7	7	N
2021	1	32.7	0.93	7	7	7	N
2022	1	32.6	-0.31	7	7	7	N

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 063-0105-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
- Superstructure:
    - EN109 - PSC Girder/Beam
- Substructure:
    - EN205 - RC Column
    - EN215 - RC Abutment
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail

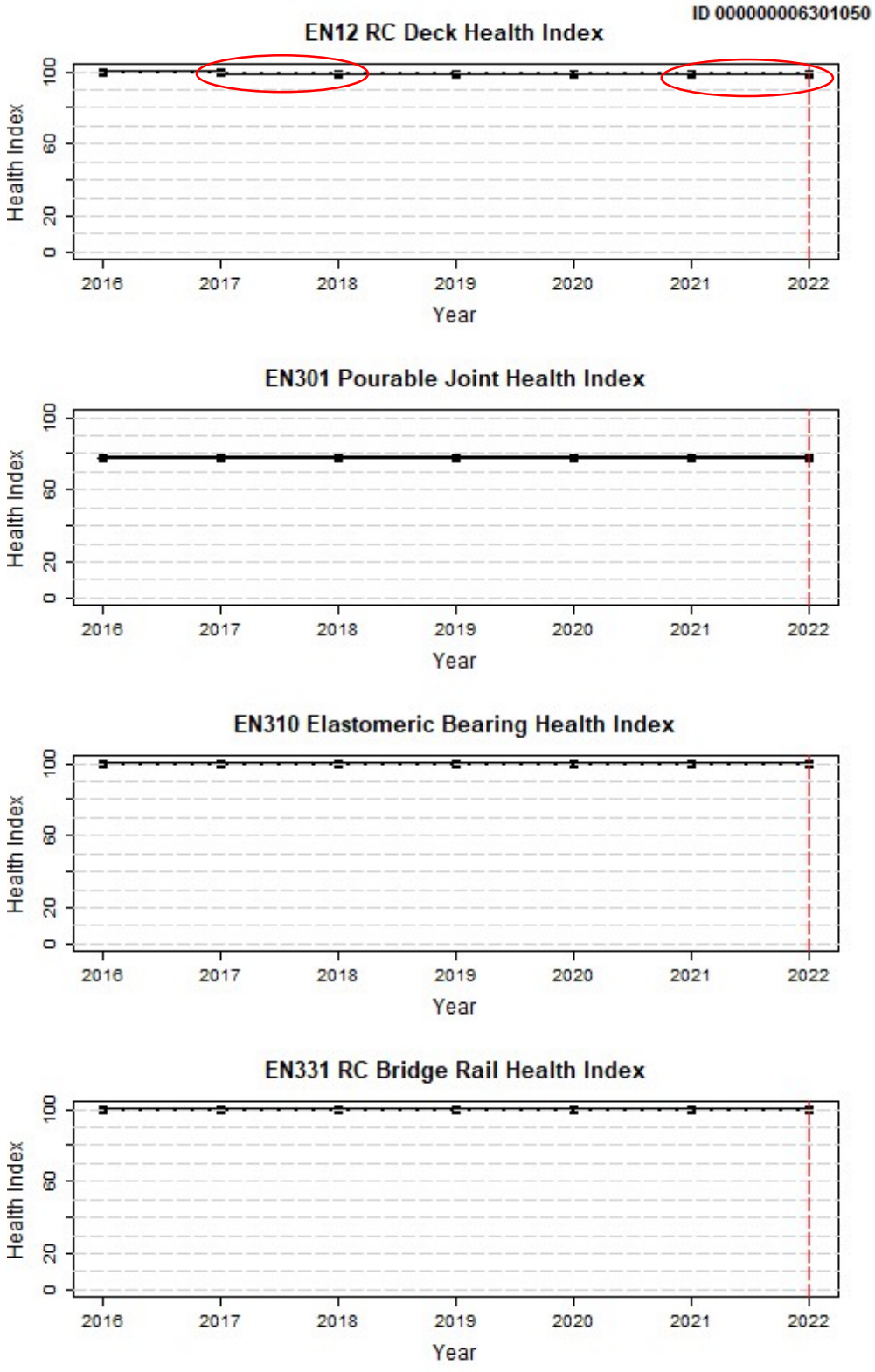


Figure 20. Graphs. Deck/Slab, Joints, Bearings, and Rail Element Health Indices for Structure # 063-0105-0 [4].

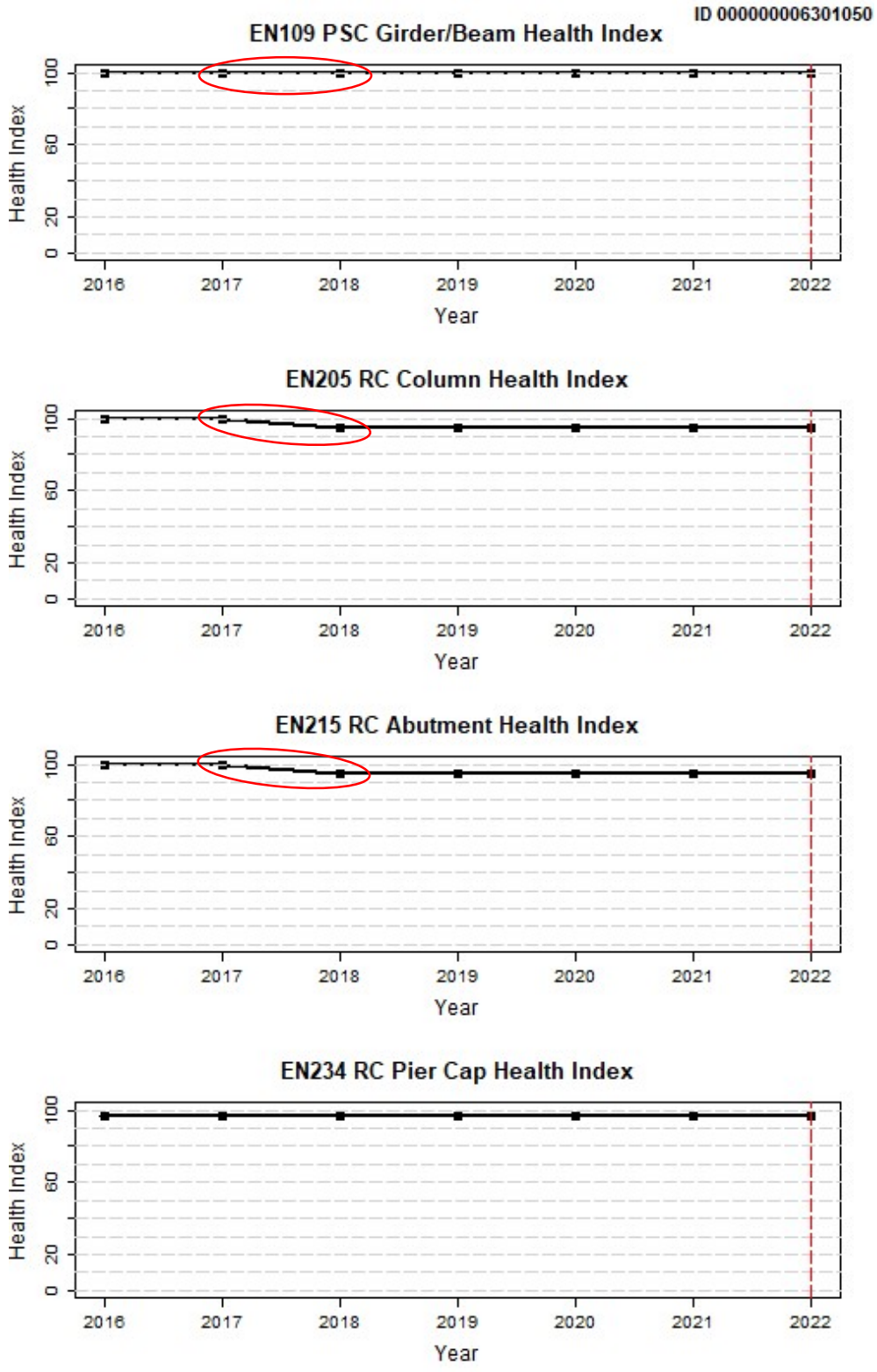


Figure 21. Graphs. Superstructure & Substructure Element Health Indices for Structure # 063-0105-0 [4].

Supplemental Tables

Table 10. Deck, Joint, Bearing, & Rail NBI Bridge Element Data for Structure # 063-0105-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2016	99.98		99.96	0.04	0.00	0.00	25958	SF
2017	99.98	0.00	99.96	0.04	0.00	0.00	25958	SF
2018	99.17	-0.81	98.81	0.81	0.39	0.00	25958	SF
2019	99.17	0.00	98.81	0.81	0.39	0.00	25958	SF
2020	99.17	0.00	98.81	0.81	0.39	0.00	25958	SF
2021	99.17	0.00	98.81	0.81	0.39	0.00	25958	SF
2022	98.99	-0.17	98.61	0.81	0.58	0.00	25958	SF
EN301 – Pourable Joint								
2016	77.50		75.00	0.00	25.00	0.00	500	LF
2017	77.50	0.00	75.00	0.00	25.00	0.00	500	LF
2018	77.50	0.00	75.00	0.00	25.00	0.00	500	LF
2019	77.50	0.00	75.00	0.00	25.00	0.00	500	LF
2020	77.50	0.00	75.00	0.00	25.00	0.00	500	LF
2021	77.50	0.00	75.00	0.00	25.00	0.00	500	LF
2022	77.50	0.00	75.00	0.00	25.00	0.00	500	LF
EN310 – Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	108	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	108	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	108	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	108	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	108	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	108	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	108	EA
EN331 – RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	396	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	396	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	396	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	396	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	396	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	396	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	396	LF

Table 11. Superstructure & Substructure NBI Bridge Element Data for Structure # 063-0105-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN109 – PSC Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	3564	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	3564	LF
2018	99.97	-0.03	99.97	0.00	0.03	0.00	3564	LF
2019	99.97	0.00	99.97	0.00	0.03	0.00	3564	LF
2020	99.97	0.00	99.97	0.00	0.03	0.00	3564	LF
2021	99.97	0.00	99.97	0.00	0.03	0.00	3564	LF
2022	99.97	0.00	99.97	0.00	0.03	0.00	3564	LF
EN205 – RC Column								
2016	100.00		100.00	0.00	0.00	0.00	12	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	12	EA
2018	95.00	-5.00	91.67	8.33	0.00	0.00	12	EA
2019	95.00	0.00	91.67	8.33	0.00	0.00	12	EA
2020	95.00	0.00	91.67	8.33	0.00	0.00	12	EA
2021	95.00	0.00	91.67	8.33	0.00	0.00	12	EA
2022	95.00	0.00	91.67	8.33	0.00	0.00	12	EA
EN215 – RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	342	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	342	LF
2018	94.74	-5.26	91.23	8.77	0.00	0.00	342	LF
2019	94.74	0.00	91.23	8.77	0.00	0.00	342	LF
2020	94.74	0.00	91.23	8.77	0.00	0.00	342	LF
2021	94.74	0.00	91.23	8.77	0.00	0.00	342	LF
2022	94.74	0.00	91.23	8.77	0.00	0.00	342	LF
EN234 – RC Pier Cap								
2016	96.36		93.94	6.06	0.00	0.00	330	LF
2017	96.36	0.00	93.94	6.06	0.00	0.00	330	LF
2018	96.36	0.00	93.94	6.06	0.00	0.00	330	LF
2019	96.36	0.00	93.94	6.06	0.00	0.00	330	LF
2020	96.36	0.00	93.94	6.06	0.00	0.00	330	LF
2021	96.36	0.00	93.94	6.06	0.00	0.00	330	LF
2022	96.36	0.00	93.94	6.06	0.00	0.00	330	LF

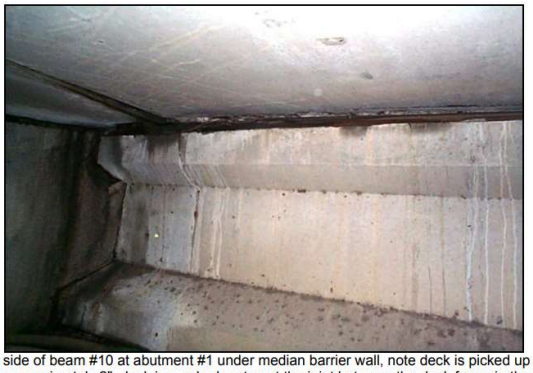
Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Under bent 3

Underneath, looking at Bent 3. 2021

Figure 22. Images. View Over Time Under Structure # 063-0105-0.



Right side of beam #10 at abutment #1 under median barrier wall, note deck is picked up over beam approximately 2", deck is cracked on top at the joint between the deck forms in the right side of the photo. No change 2013.

Bent #3 forward side left of column #4. 2' L Typical for crack at bent #2 forward side Left of column #4. 18" L

Void under cap at abutment #1 Void is 6' under x 4'D x 10'L

Column 6 at bent 3, corner spall

Column 6 at bent 3, corner spall

Figure 23. Images. Typical Concrete Deterioration Over Time for Structure # 063-0105-0.

Abutment #1 erosion:
Abutment #1 slope paving, near centerline has an erosion hole (25.0' long x 8.0' wide x up to 5.0' deep) paving has crackied and fell into void; erosion extends under the abutment cap causing a 12.0' x 12.0' void under cap and approach slab. Needs to be repaired.

Span 1 slope erosion

Abutment 1, concrete slope and void repaired with concrete. 2021

Figure 24. Images. Abutment #1 Over Time for Structure # 063-0105-0.

Findings

- NBI Data concerns:
    - 65.66% reduction in operating rating between 2005 and 2006
    - 0.31% reduction in operating rating between 2021 and 2022
        - No changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Substructure:
        - RC Column: 5.00% health index reduction in 2018
        - RC Abutment: 5.26% health index reduction in 2018
- Inspection Report concerns:
    - Reports available in 2005, 2007, 2009, 2011, 2013, 2015, 2016, 2017, 2019, & 2021
    - Repairs made to abutment #1 in 2019
    - Deck (2005-2021):
        - Concrete spall with exposed rebar and cracking
        - Abutment #1 deck joint failure
    - Superstructure (2005-2021):
        - Concrete spall with exposed rebar
    - Substructure (2005-2021):
        - Concrete spall, cracking, and voids
        - Abutment #1 has void which grew larger from 2009 until repair in 2019

(3) Bridge # 051-0101-0 Summary

Bridge Information

Table 12. Bridge # 051-0101-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000005101010
N/A	Reliability Index (WIM Site A*)	1.909208018
N/A	Reliability Index (WIM Site B*)	1.32832007
N/A	Age	56
5B	Route Prefix	1 – Interstate
5D	Route Number	16
3	County Code	51 – Chatham
6A	Features Intersected	M-4052- CS 1506 W BROAD
7	Facility Carried by Structure	I-16 (EBL)
9	Location	IN CITY LIMITS SAVANNAH
16	Latitude	32°04'21.79"N (32.0727)
17	Longitude	81°06'00.28"W (-81.1001)
27	Year Built	1966
28A	No. of Traffic Lanes on the Structure	2
28B	No. of Traffic Lanes under the Structure	7
29	Average Daily Traffic (ADT)	20130
30	Year of ADT	2011
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restriction
43A	Structure Type – Material and/or Design	3 – Steel
43B	Structure Type – Design and/or Construction	2 – Stringer/Multi-beam or Girder
49	Structure Length	127.1m (417.0ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	N
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	NA
109	Average Daily Truck Traffic (% of ADT)	4%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 25. Image. 2022 Views of Bridge # 051-0101-0 [2].

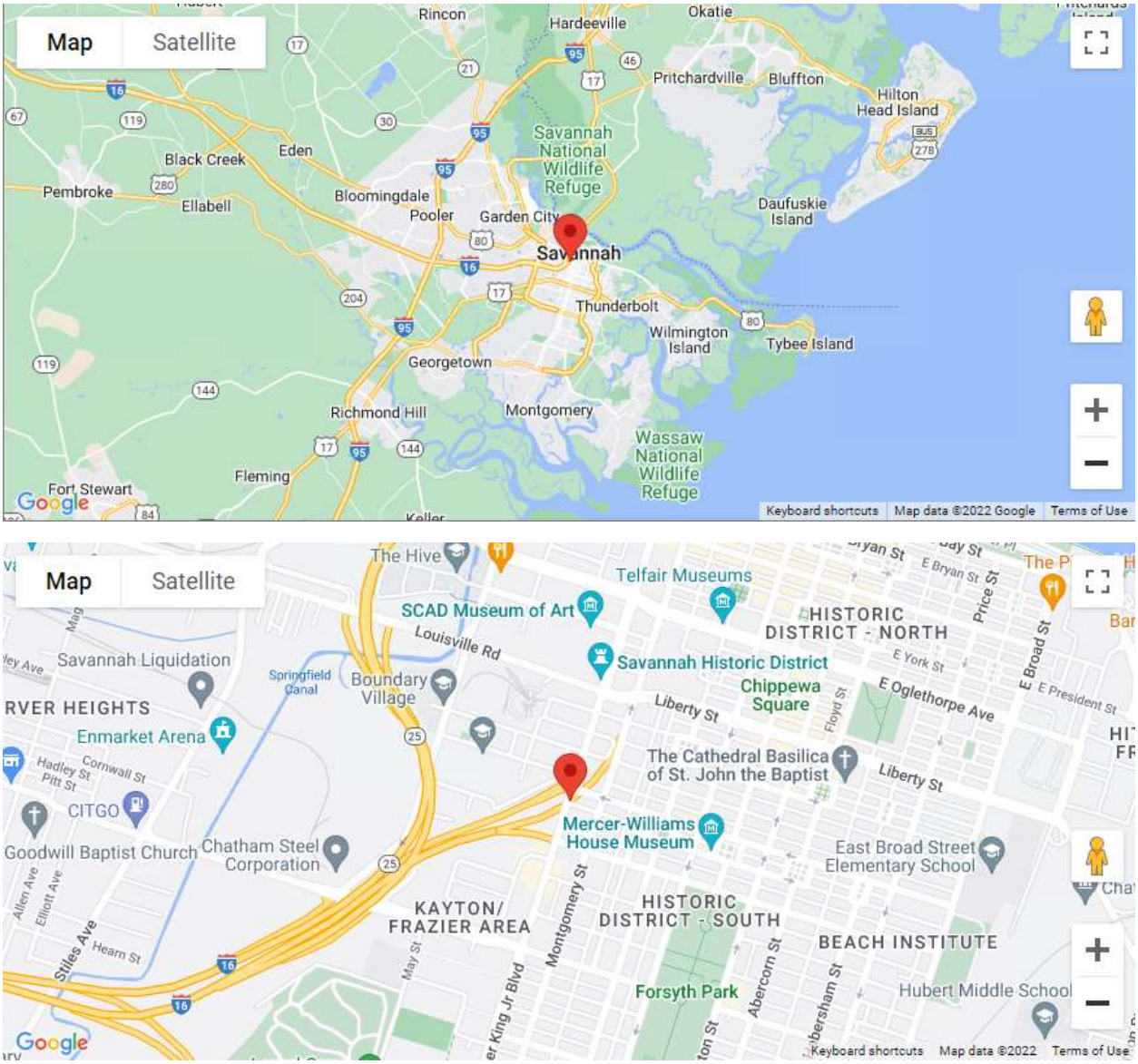


Figure 26. Image. Bridge # 051-0101-0 Location [3].

NBI Data Analysis

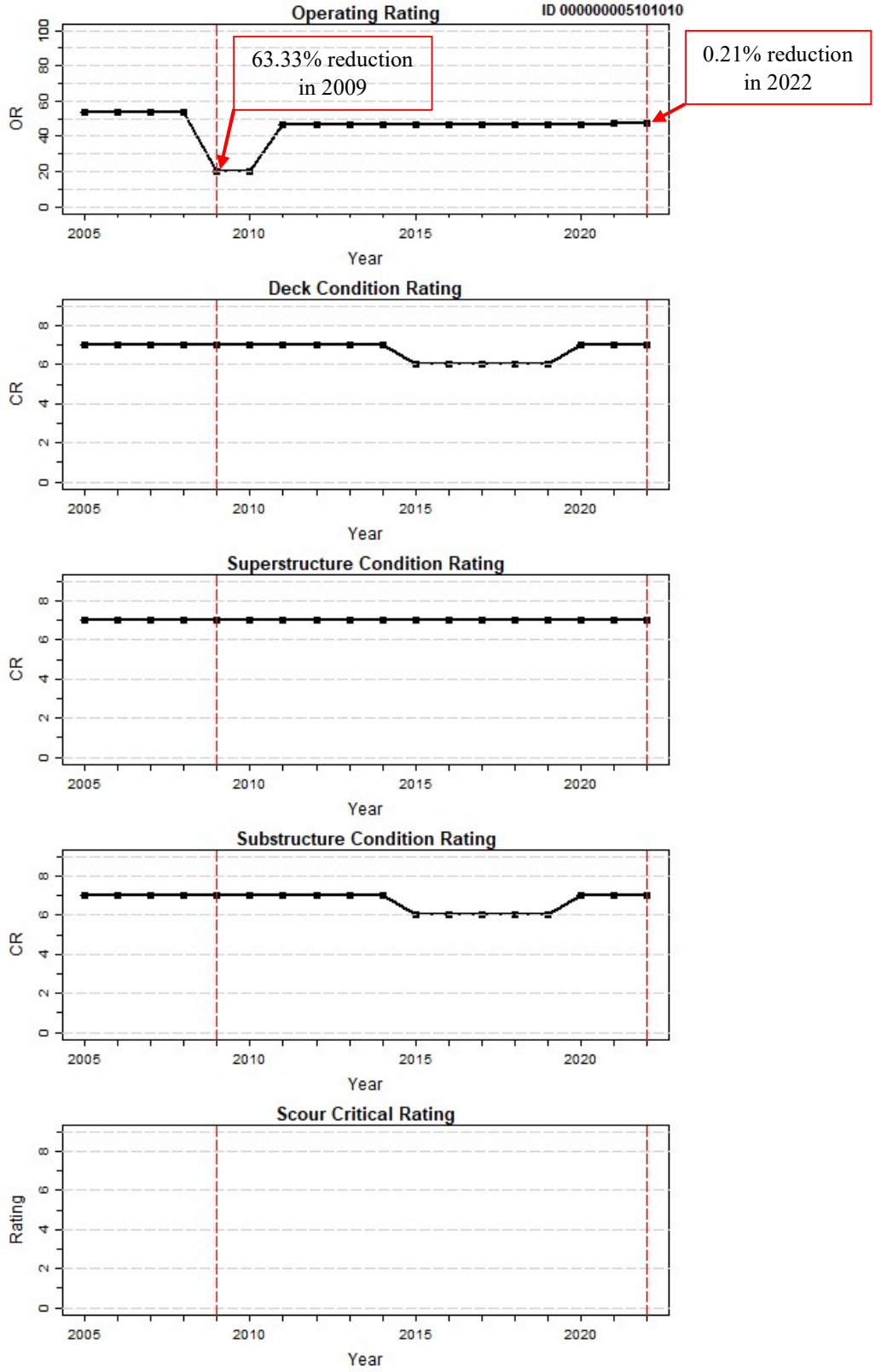


Figure 27. Graphs. NBI Operating & Condition Ratings for Structure # 051-0101-0 [1].

Table 13. NBI Data for Structure # 051-0101-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	54.0		7	7	7	N
2006	1	54.0	0.00	7	7	7	N
2007	1	54.0	0.00	7	7	7	N
2008	1	54.0	0.00	7	7	7	N
2009	1	19.8	-63.33	7	7	7	N
2010	1	19.8	0.00	7	7	7	N
2011	1	46.8	136.36	7	7	7	N
2012	1	46.8	0.00	7	7	7	N
2013	1	46.8	0.00	7	7	7	N
2014	1	46.8	0.00	7	7	7	N
2015	1	46.8	0.00	6	7	6	N
2016	1	46.8	0.00	6	7	6	N
2017	1	46.8	0.00	6	7	6	N
2018	1	46.8	0.00	6	7	6	N
2019	1	46.8	0.00	6	7	6	N
2020	1	46.8	0.00	7	7	7	N
2021	1	47.2	0.85	7	7	7	N
2022	1	47.1	-0.21	7	7	7	N

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 051-0101-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
- Superstructure:
    - EN107 - Steel Girder/Beam
- Substructure:
    - EN205 - RC Column
    - EN215 - RC Abutment
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN311 - Movable Bearing
    - EN313 - Fixed Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail
- Wearing Surfaces & Protective Coatings:
    - EN515 - Steel Protective Coating (EPN unknown)
    - EN515 - Steel Protective Coating (EPN107 - Steel Girder/Beam)
    - EN515 - Steel Protective Coating (EPN311 - Movable Bearing)
    - EN515 - Steel Protective Coating (EPN313 - Fixed Bearing)

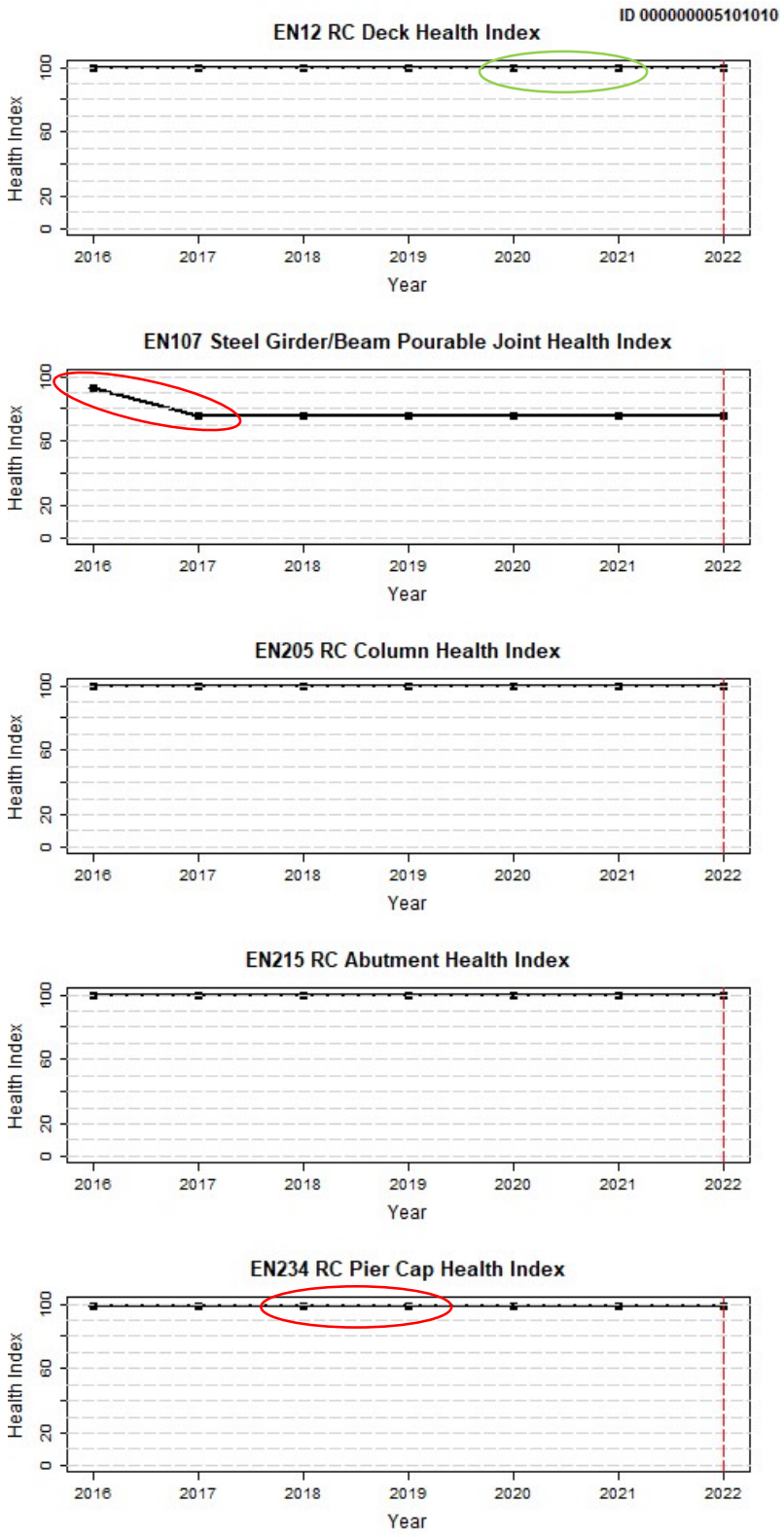


Figure 28. Graphs. Deck, Superstructure, & Substructure Element Health Indices for Structure # 051-0101-0 [4].

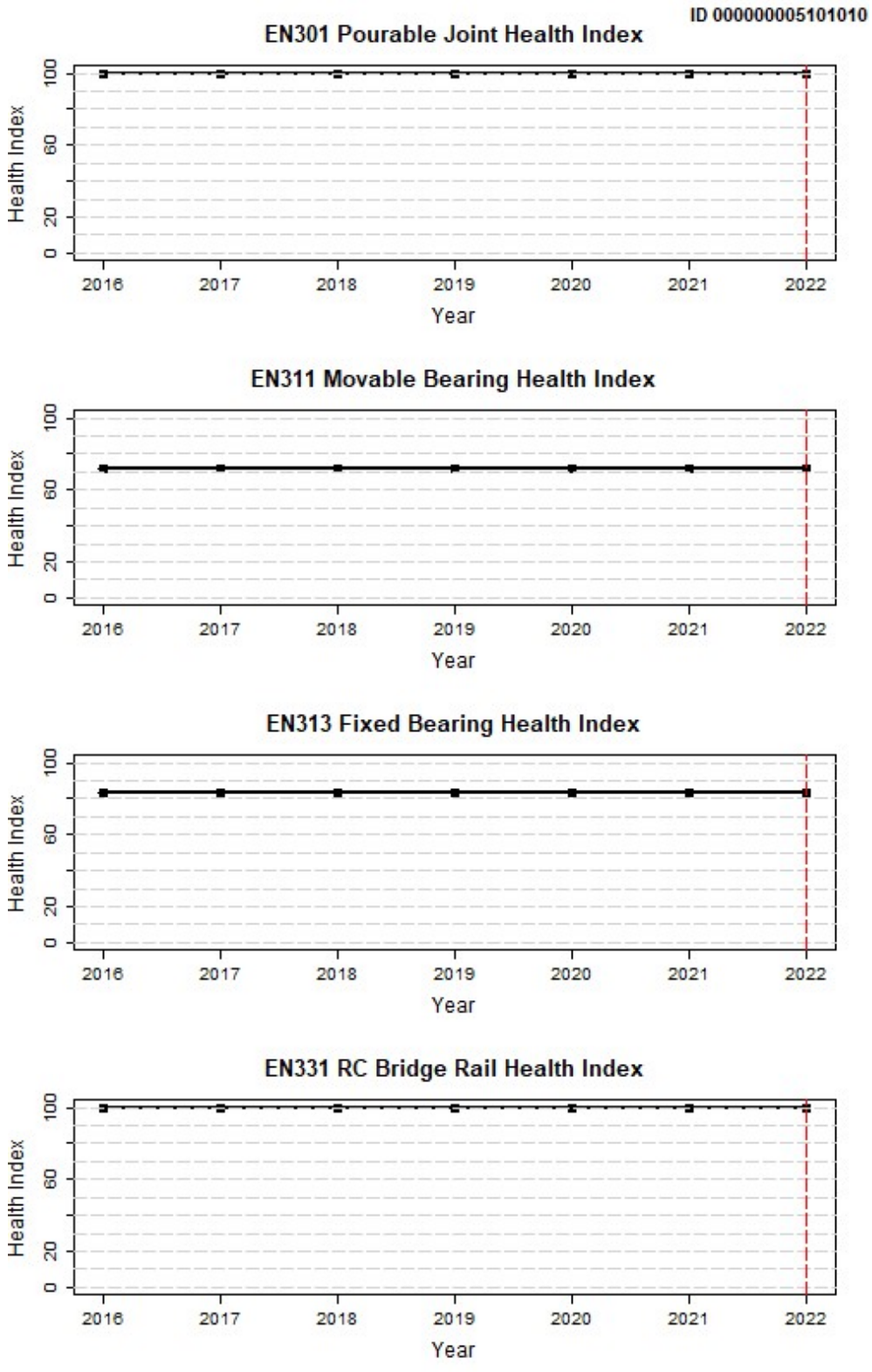


Figure 29. Graphs. Joints, Bearings, and Rail Element Health Indices for Structure # 051-0101-0 [4].

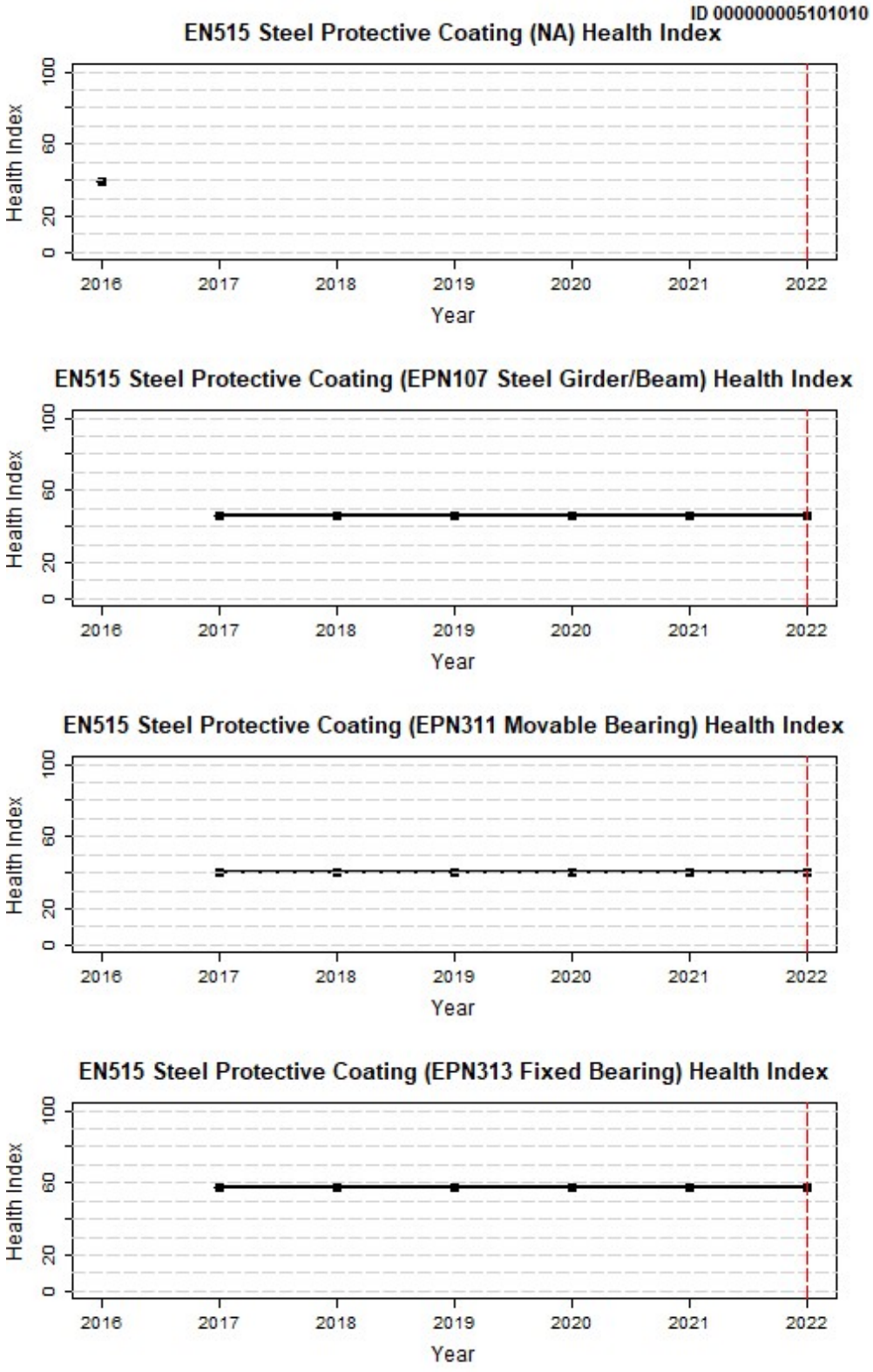


Figure 30. Graphs. Protective Coating Element Health Indices for Structure # 051-0101-0 [4].

Supplemental Tables

Table 14. Deck, Superstructure, & Substructure NBI Bridge Element Data for Structure # 051-0101-0 [4].

Year	Health	HI % Change	CS1%	CS2%	CS3%	CS4%	Total	Units
EN12 – RC Deck								
2016	99.99		99.99	0.00	0.01	0.00	14166	SF
2017	99.99	0.00	99.99	0.00	0.01	0.00	14166	SF
2018	99.99	0.00	99.99	0.00	0.01	0.00	14166	SF
2019	99.99	0.00	99.99	0.00	0.01	0.00	14166	SF
2020	99.99	0.00	99.99	0.00	0.01	0.00	14166	SF
2021	100.00	0.01	100.00	0.00	0.00	0.00	14166	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	14166	SF
EN107 – Steel Girder/Beam								
2016	93.18		88.63	11.37	0.00	0.00	1935	LF
2017	76.03	-18.40	60.05	39.95	0.00	0.00	1935	LF
2018	76.03	0.00	60.05	39.95	0.00	0.00	1935	LF
2019	76.03	0.00	60.05	39.95	0.00	0.00	1935	LF
2020	76.03	0.00	60.05	39.95	0.00	0.00	1935	LF
2021	76.03	0.00	60.05	39.95	0.00	0.00	1935	LF
2022	76.03	0.00	60.05	39.95	0.00	0.00	1935	LF
EN205 – RC Column								
2016	100.00		100.00	0.00	0.00	0.00	10	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	10	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	10	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	10	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	10	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	10	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	10	EA
EN215 – RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	68	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	68	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	68	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	68	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	68	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	68	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	68	LF
EN234 – RC Pier Cap								
2016	98.94		98.82	0.00	1.18	0.00	170	LF
2017	98.94	0.00	98.82	0.00	1.18	0.00	170	LF
2018	98.94	0.00	98.82	0.00	1.18	0.00	170	LF
2019	98.41	-0.54	98.24	0.00	1.76	0.00	170	LF
2020	98.41	0.00	98.24	0.00	1.76	0.00	170	LF
2021	98.41	0.00	98.24	0.00	1.76	0.00	170	LF
2022	98.41	0.00	98.24	0.00	1.76	0.00	170	LF

Table 15. Joints, Bearings, and Rail NBI Bridge Element Data for Structure # 051-0101-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 - Pourable Joint								
2016	100.00		100.00	0.00	0.00	0.00	186	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	186	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	186	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	186	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	186	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	186	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	186	LF
EN311 - Movable Bearing								
2016	72.22		66.67	7.41	25.93	0.00	27	EA
2017	72.22	0.00	66.67	7.41	25.93	0.00	27	EA
2018	72.22	0.00	66.67	7.41	25.93	0.00	27	EA
2019	72.22	0.00	66.67	7.41	25.93	0.00	27	EA
2020	72.22	0.00	66.67	7.41	25.93	0.00	27	EA
2021	72.22	0.00	66.67	7.41	25.93	0.00	27	EA
2022	72.22	0.00	66.67	7.41	25.93	0.00	27	EA
EN313 - Fixed Bearing								
2016	83.33		81.48	0.00	18.52	0.00	27	EA
2017	83.33	0.00	81.48	0.00	18.52	0.00	27	EA
2018	83.33	0.00	81.48	0.00	18.52	0.00	27	EA
2019	83.33	0.00	81.48	0.00	18.52	0.00	27	EA
2020	83.33	0.00	81.48	0.00	18.52	0.00	27	EA
2021	83.33	0.00	81.48	0.00	18.52	0.00	27	EA
2022	83.33	0.00	81.48	0.00	18.52	0.00	27	EA
EN331 - RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	835	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	835	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	835	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	835	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	835	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	835	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	835	LF

Table 16. Protective Coating NBI Bridge Element Data for Structure # 051-0101-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN515 - Steel Protective Coating (EPN unknown)								
2016	39.44		32.71	0.00	67.29	0.00	11610	SF
EN515 - Steel Protective Coating (EPN107 - Steel Girder/Beam)								
2017	45.87		35.16	14.08	50.75	0.00	14202	SF
2018	45.87	0.00	35.16	14.08	50.75	0.00	14202	SF
2019	45.87	0.00	35.16	14.08	50.75	0.00	14202	SF
2020	45.87	0.00	35.16	14.08	50.75	0.00	14202	SF
2021	45.87	0.00	35.16	14.08	50.75	0.00	14202	SF
2022	45.87	0.00	35.16	14.08	50.75	0.00	14202	SF
EN515 - Steel Protective Coating (EPN311 - Movable Bearing)								
2017	40.00		33.33	0.00	66.67	0.00	30	SF
2018	40.00	0.00	33.33	0.00	66.67	0.00	30	SF
2019	40.00	0.00	33.33	0.00	66.67	0.00	30	SF
2020	40.00	0.00	33.33	0.00	66.67	0.00	30	SF
2021	40.00	0.00	33.33	0.00	66.67	0.00	30	SF
2022	40.00	0.00	33.33	0.00	66.67	0.00	30	SF
EN515 - Steel Protective Coating (EPN313 - Fixed Bearing)								
2017	57.00		50.00	6.67	43.33	0.00	30	SF
2018	57.00	0.00	50.00	6.67	43.33	0.00	30	SF
2019	57.00	0.00	50.00	6.67	43.33	0.00	30	SF
2020	57.00	0.00	50.00	6.67	43.33	0.00	30	SF
2021	57.00	0.00	50.00	6.67	43.33	0.00	30	SF
2022	57.00	0.00	50.00	6.67	43.33	0.00	30	SF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Figure 31. Images. Steel Superstructure Over Time for Structure # 051-0101-0.

Figure 32. Images. Concrete Deterioration Over Time for Structure # 051-0101-0.

Findings

- NBI Data concerns:
    - 63.33% reduction in operating rating between 2008 and 2009
    - 0.21% reduction in operating rating between 2021 and 2022
        - No significant changes in condition ratings for deck, superstructure, substructure, and scour
        - Deck and substructure condition ratings decreased from 7 to 6 in 2015, however increased back to 7 in 2020
- NBI Element Data concerns:
    - Superstructure:
        - Steel girder/beam: 18.40% health index reduction in 2017
- Inspection Report concerns:
    - Reports available in 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2019, 2020, & 2022
    - Reports are not very detailed in written descriptions or photo documentation
    - Looks like steel girders/beams were painted between 2020 & 2022
    - Deck (2004-2022):
        - Concrete has scaling, cracks, and exposed rebar
    - Superstructure (2004-2020):
        - Steel has cracks, rust, and needs to be painted
    - Substructure (2004-2022):
        - Concrete abutment caps and have cracking and exposed rebar

(4) Bridge # 021-0076-0 Summary

Bridge Information

Table 17. Bridge # 021-0076-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000002100760
N/A	Reliability Index (WIM Site A*)	1.536169853
N/A	Reliability Index (WIM Site B*)	1.9279266
N/A	Age	27
5B	Route Prefix	1 – Interstate
5D	Route Number	75
3	County Code	21 – Bibb
6A	Features Intersected	TOBESOFKEE CREEK O/F
7	Facility Carried by Structure	I-75 SBL
9	Location	2.2 MI S OF MACON CTY LMT
16	Latitude	32°45'57.63"N (32.7660)
17	Longitude	83°42'07.95"W (-83.7022)
27	Year Built	1970
28A	No. of Traffic Lanes on the Structure	3
28B	No. of Traffic Lanes under the Structure	0
29	Average Daily Traffic (ADT)	32610
30	Year of ADT	2011
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restriction
43A	Structure Type – Material and/or Design	1 – Concrete
43B	Structure Type – Design and/or Construction	4 – Tee beam
49	Structure Length	61m (200ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	L – The left structure of parallel bridges. This structure carries traffic in the opposite direction.
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	1995
109	Average Daily Truck Traffic (% of ADT)	9%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 33. Image. 2022 Views of Bridge # 021-0076-0 [2].

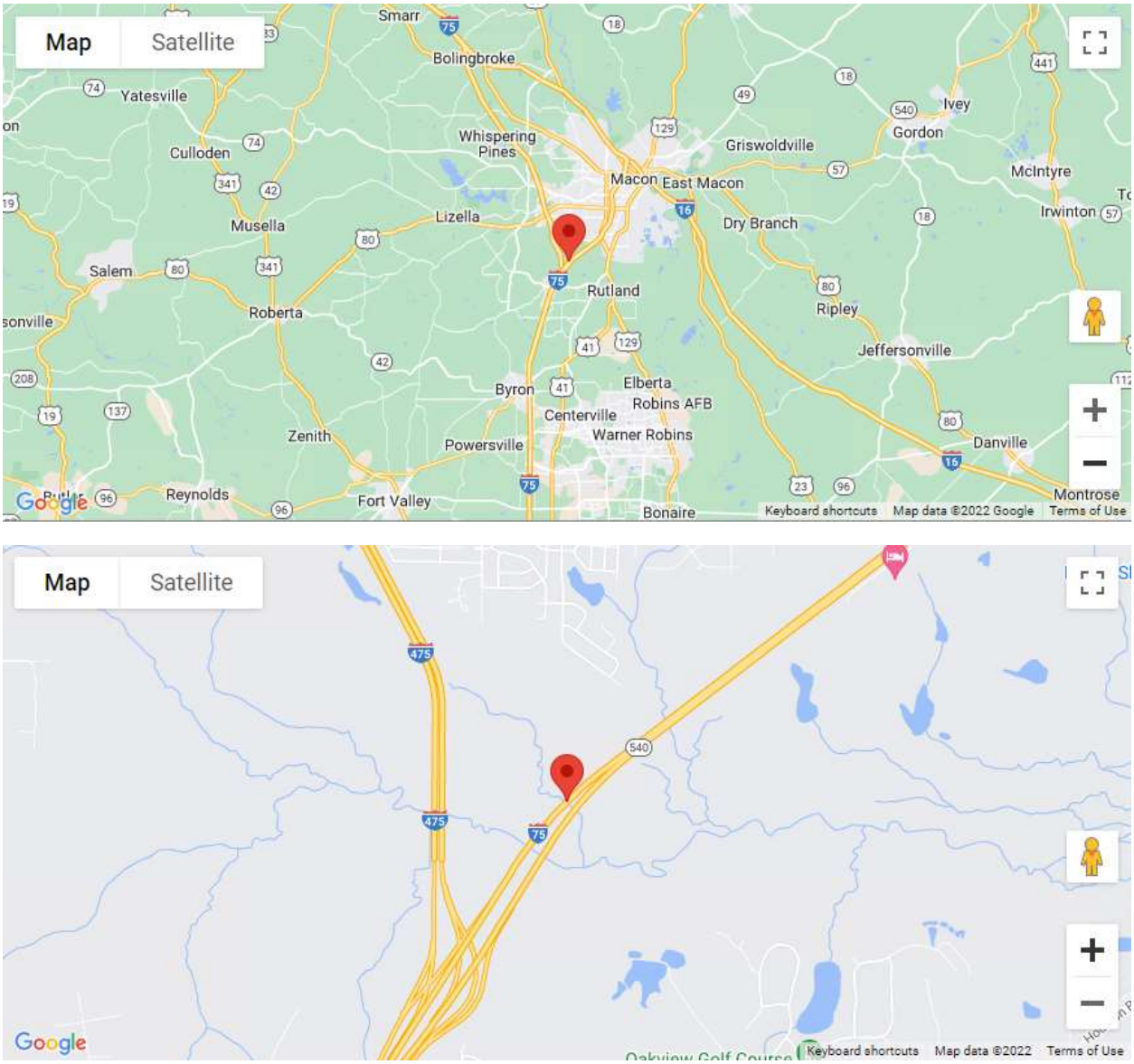


Figure 34. Image. Bridge # 021-0076-0 Location [3].

NBI Data Analysis

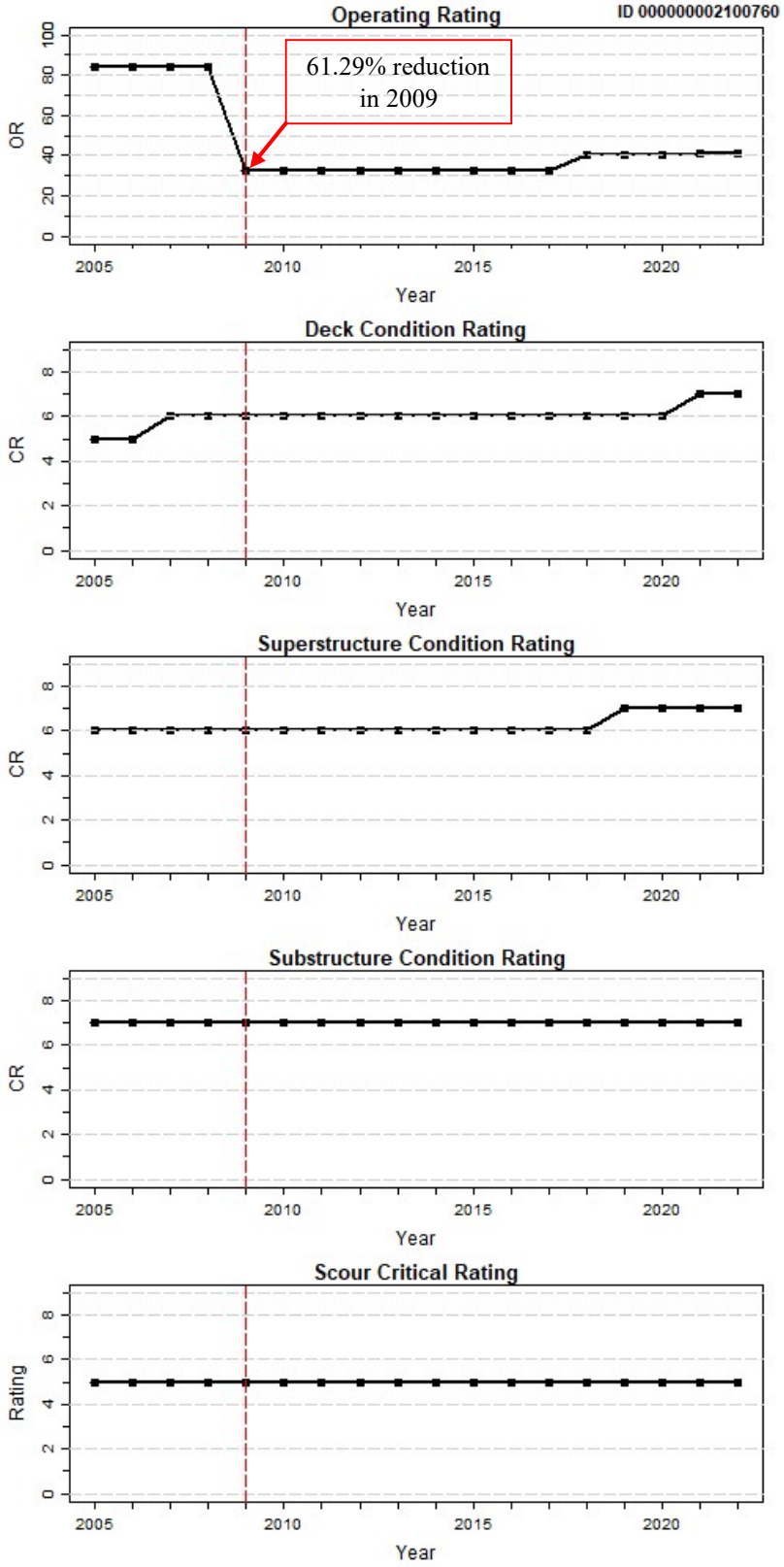


Figure 35. Graphs. NBI Operating & Condition Ratings for Structure # 021-0076-0 [1].

Table 18. NBI Data for Structure # 021-0076-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	83.7		5	6	7	5
2006	1	83.7	0.00	5	6	7	5
2007	1	83.7	0.00	6	6	7	5
2008	1	83.7	0.00	6	6	7	5
2009	1	32.4	-61.29	6	6	7	5
2010	1	32.4	0.00	6	6	7	5
2011	1	32.4	0.00	6	6	7	5
2012	1	32.4	0.00	6	6	7	5
2013	1	32.4	0.00	6	6	7	5
2014	1	32.4	0.00	6	6	7	5
2015	1	32.4	0.00	6	6	7	5
2016	1	32.4	0.00	6	6	7	5
2017	1	32.4	0.00	6	6	7	5
2018	1	40.5	25.00	6	6	7	5
2019	1	40.5	0.00	6	7	7	5
2020	1	40.5	0.00	6	7	7	5
2021	1	40.8	0.74	7	7	7	5
2022	1	40.8	0.00	7	7	7	5

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 021-0076-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
    - EN16 - RC Top Flange
- Superstructure:
    - EN109 - PSC Girder/Beam
    - EN110 - RC Girder/Beam
- Substructure:
    - EN204 - PSC Column
    - EN215 - RC Abutment
    - EN226 - PSC Pile
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN330 - Steel Bridge Rail
    - EN331 - RC Bridge Rail
    - EN333 - Other Bridge Rail

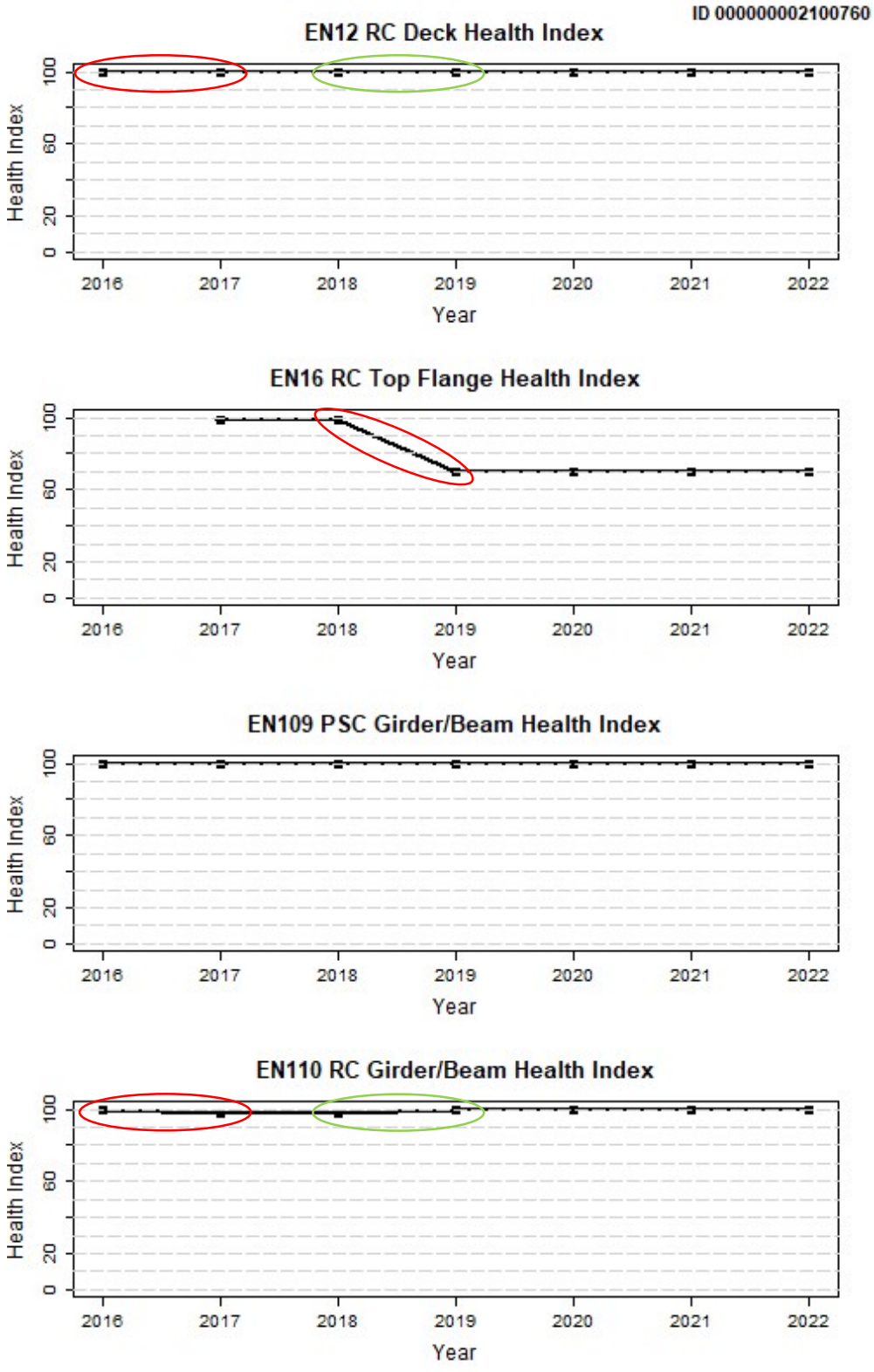


Figure 36. Graphs. Deck/Slab and Superstructure Element Health Indices for Structure # 021-0076-0 [4].

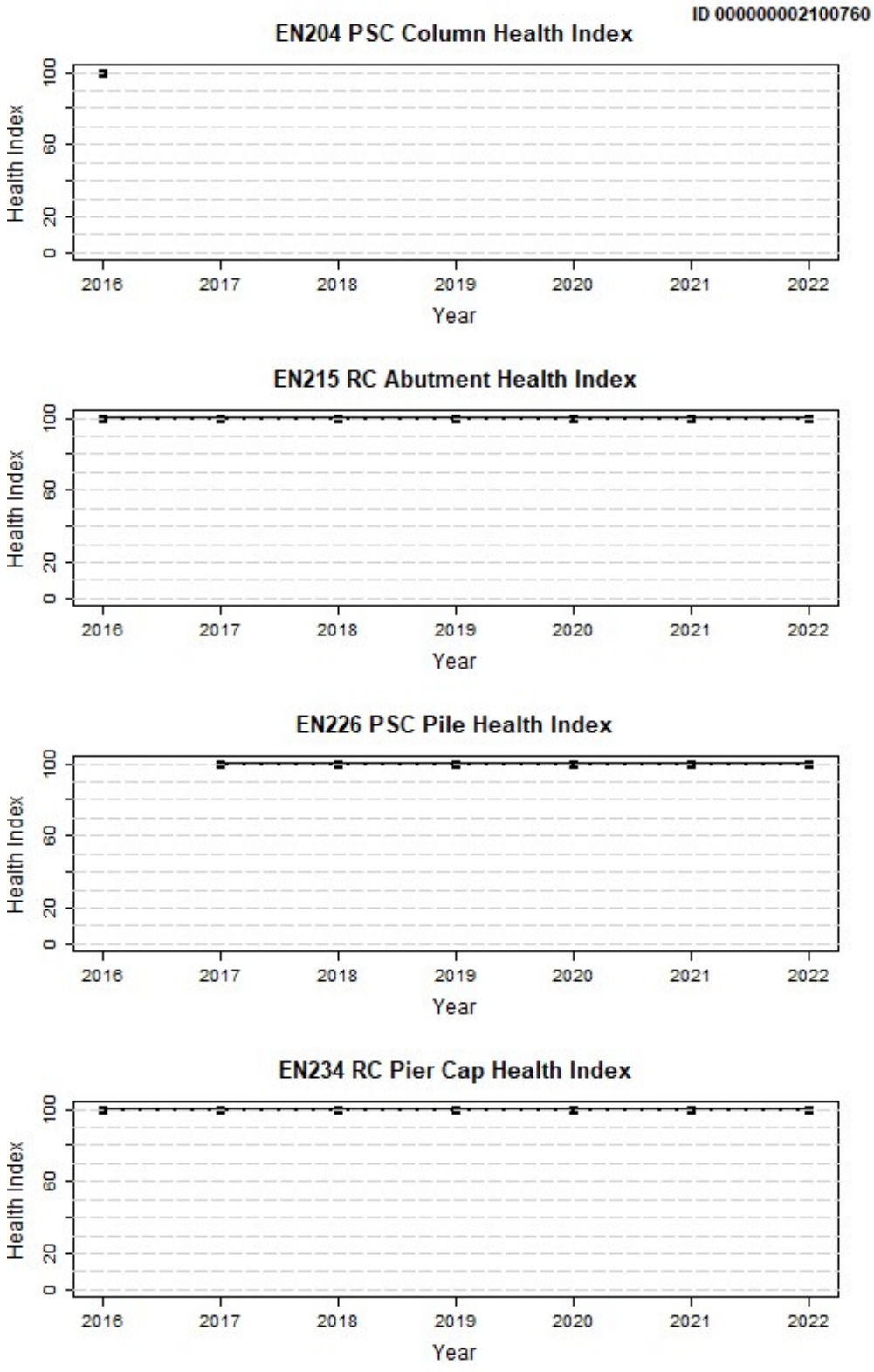


Figure 37. Graphs. Substructure Element Health Indices for Structure # 021-0076-0 [4].

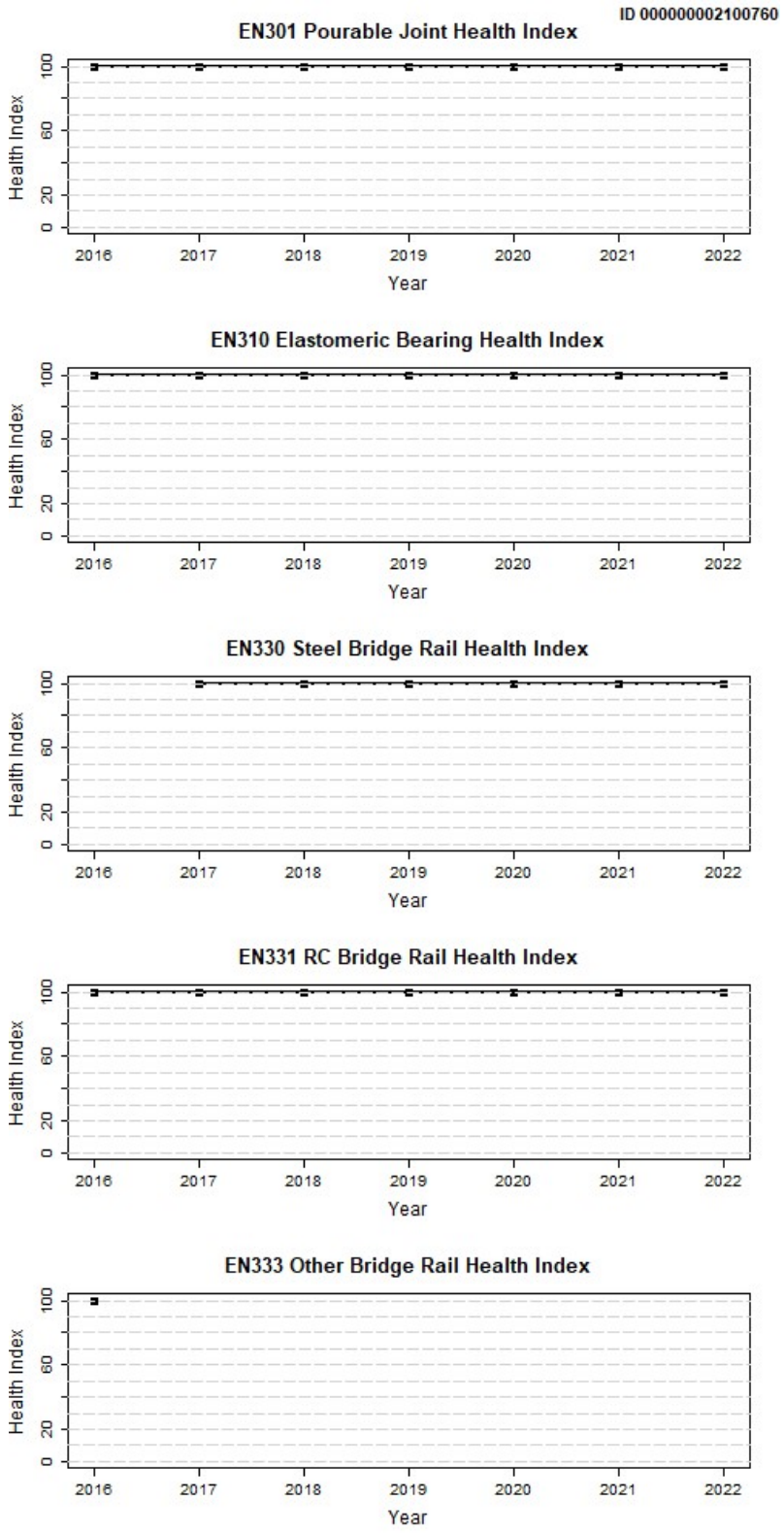


Figure 38. Graphs. Joints, Bearings, and Rail Element Health Indices for Structure # 021-0076-0 [4].

Supplemental Tables

Table 19. Deck & Superstructure NBI Bridge Element Data for Structure # 021-0076-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2016	99.90		99.83	0.17	0.00	0.00	12000	SF
2017	99.70	-0.20	99.50	0.50	0.00	0.00	4000	SF
2018	99.70	0.00	99.50	0.50	0.00	0.00	4000	SF
2019	100.00	0.30	100.00	0.00	0.00	0.00	4000	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	4000	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	4000	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	4000	SF
EN16 – RC Top Flange								
2017	98.61		97.69	2.31	0.00	0.00	8000	SF
2018	98.61	0.00	97.69	2.31	0.00	0.00	8000	SF
2019	70.00	-29.02	50.00	50.00	0.00	0.00	8000	SF
2020	70.00	0.00	50.00	50.00	0.00	0.00	8000	SF
2021	70.00	0.00	50.00	50.00	0.00	0.00	8000	SF
2022	70.00	0.00	50.00	50.00	0.00	0.00	8000	SF
EN109 – PSC Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	600	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
EN110 – RC Girder/Beam								
2016	99.90		99.83	0.17	0.00	0.00	1200	LF
2017	97.60	-2.30	96.00	4.00	0.00	0.00	1200	LF
2018	97.60	0.00	96.00	4.00	0.00	0.00	1200	LF
2019	99.70	2.15	99.50	0.50	0.00	0.00	1200	LF
2020	99.70	0.00	99.50	0.50	0.00	0.00	1200	LF
2021	99.70	0.00	99.50	0.50	0.00	0.00	1200	LF
2022	99.70	0.00	99.50	0.50	0.00	0.00	1200	LF

Table 20. Substructure NBI Bridge Element Data for Structure # 021-0076-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN204 – PSC Column								
2016	100.00		100.00	0.00	0.00	0.00	36	EA
EN215 – RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	124	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	124	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	124	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	124	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	124	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	124	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	124	LF
EN226 – PSC Pile								
2017	100.00		100.00	0.00	0.00	0.00	36	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	36	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	36	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	36	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	36	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	36	EA
EN234 – RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	248	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	248	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	248	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	248	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	248	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	248	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	248	LF

Table 21. Joints, Bearings, & Railings NBI Bridge Element Data for Structure # 021-0076-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 – Pourable Joint								
2016	100.00		100.00	0.00	0.00	0.00	302	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	302	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	302	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	302	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	302	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	302	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	302	LF
EN310 – Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	90	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	90	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	90	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	90	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	90	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	90	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	90	EA
EN330 – Steel Bridge Rail								
2017	100.00		100.00	0.00	0.00	0.00	200	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
EN331 – RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	200	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
EN333 – Other Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	200	LF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Figure 39. Images. Views Over Time for Structure # 021-0076-0.

Deck cracking.

Both approach slabs have moderate cracking

Figure 40. Images. Deck Cracking Over Time for Structure # 021-0076-0.

Findings

- NBI Data concerns:
    - 61.29% reduction in operating rating between 2008 and 2009
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Deck:
        - RC Top Flange: 29.02% health index reduction in 2019
- Inspection Report concerns:
    - Reports available in 2004, 2006, 2008, 2010, 2014, 2016, 2018, 2020, & 2022
    - Reports are not very detailed in written descriptions or photo documentation
    - Deck:
        - Deck has various types of cracking, delamination since 2004
        - Approach slabs have cracking since 2004; began spalling in 2010
    - Superstructure:
        - T-beams have deflection cracking since 2004
        - Beams began spalling in 2020
    - Substructure:
        - Abutment has shear cracking since 2004
        - Caps have exposed rebar and erosion since 2004; settlement began at abutment 1 in 2012
        - Piles have cracking, abrasion, and spall since 2004

(5) Bridge # 089-0285-0 Summary

Bridge Information

Table 22. Bridge # 089-0285-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000008902850
N/A	Reliability Index (WIM Site A*)	0.533897173
N/A	Reliability Index (WIM Site B*)	1.057508429
N/A	Reliability Index (WIM Site C*)	0.586628326
N/A	Reliability Index (WIM Site D*)	0.484310596
N/A	Reliability Index (WIM Site E*)	0.607866688
N/A	Reliability Index (WIM Site F*)	0.910830727
N/A	Reliability Index (WIM Site G*)	0.522724006
N/A	Age	38
5B	Route Prefix	1 – Interstate
5D	Route Number	285
3	County Code	89 – DeKalb
6A	Features Intersected	SR 42 RAMP TO I-285 EB
7	Facility Carried by Structure	I-285R TO I-675 SB
9	Location	7 MI S OF DECATUR
16	Latitude	33°40'10.34"N (33.6695)
17	Longitude	84°20'05.35"W (-84.3348)
27	Year Built	1984
28A	No. of Traffic Lanes on the Structure	1
28B	No. of Traffic Lanes under the Structure	1
29	Average Daily Traffic (ADT)	11630
30	Year of ADT	2011
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restrictions
43A	Structure Type – Material and/or Design	5 – Prestressed Concrete
43B	Structure Type – Design and/or Construction	2 – Stringer/Multi-beam or girder
49	Structure Length	78.6m (257.9ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	N
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	NA
109	Average Daily Truck Traffic (% of ADT)	1%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 41. Image. View of Bridge # 089-0285-0 [2].

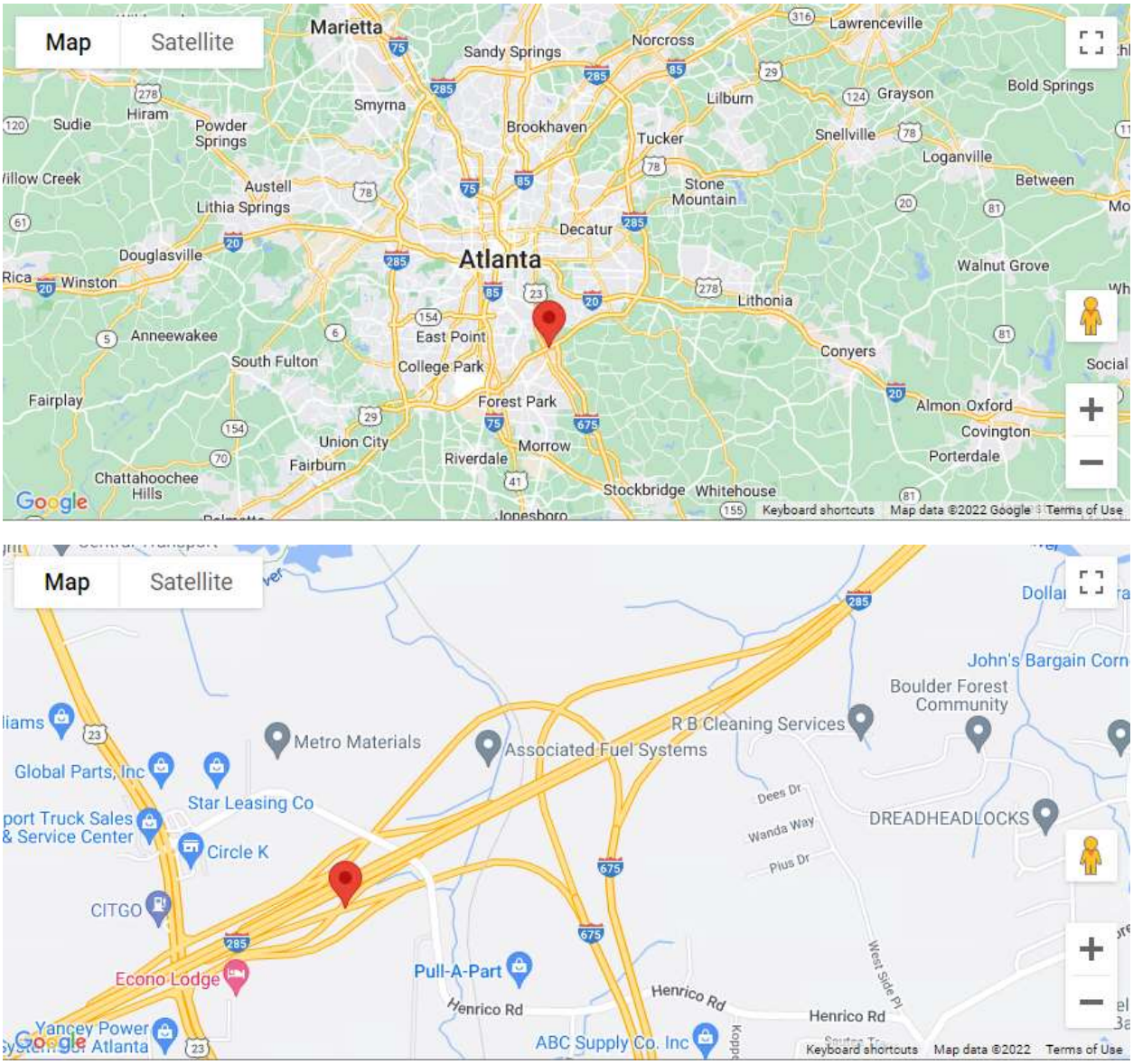


Figure 42. Image. Bridge # 089-0285-0 Location [3].

NBI Data Analysis

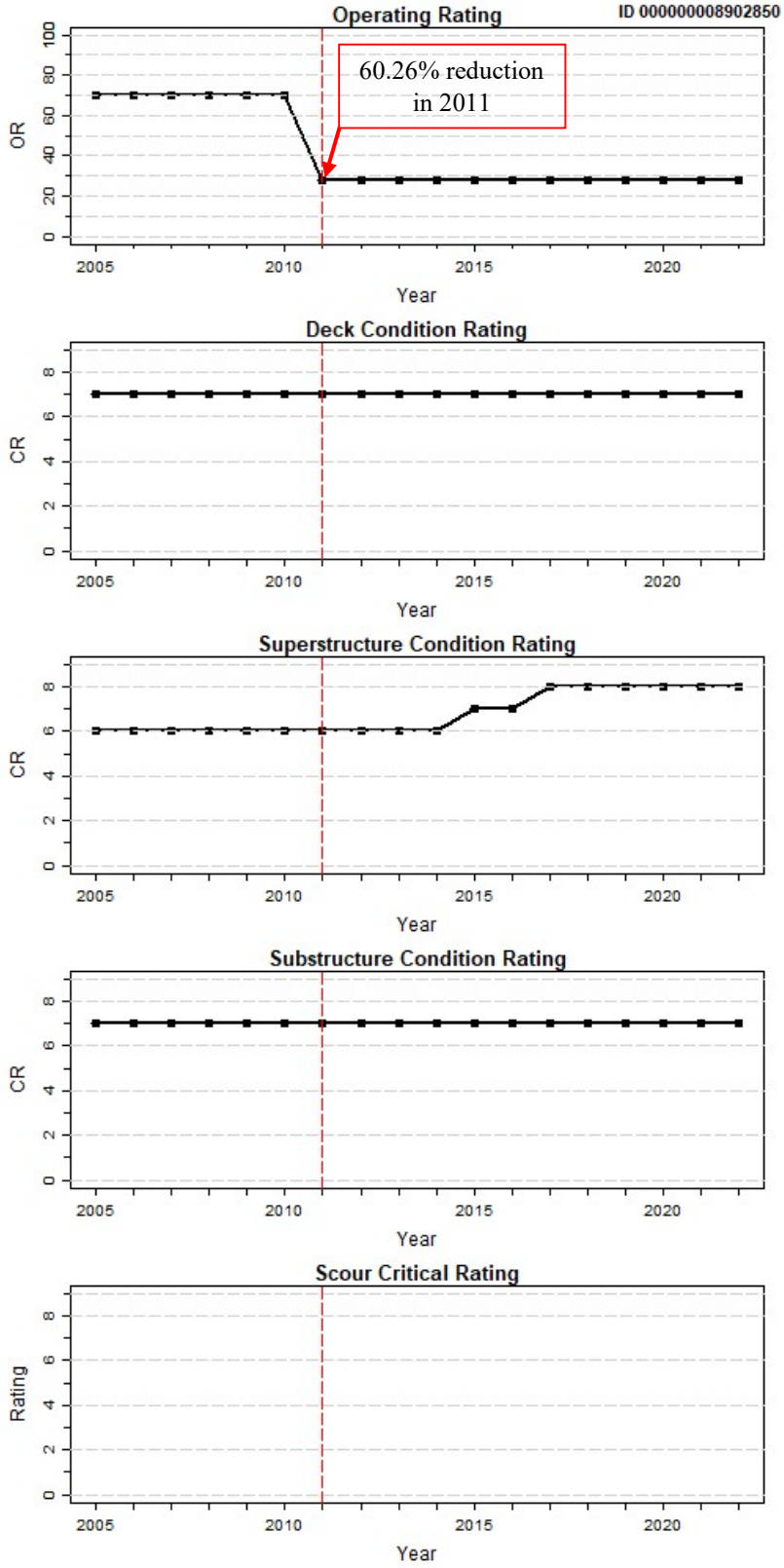


Figure 43. Graphs. NBI Operating & Condition Ratings for Structure # 089-0285-0 [1]

Table 23. NBI Data for Structure # 089-0285-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	70.2		7	6	7	N
2006	1	70.2	0.00	7	6	7	N
2007	1	70.2	0.00	7	6	7	N
2008	1	70.2	0.00	7	6	7	N
2009	1	70.2	0.00	7	6	7	N
2010	1	70.2	0.00	7	6	7	N
2011	1	27.9	-60.26	7	6	7	N
2012	1	27.9	0.00	7	6	7	N
2013	1	27.9	0.00	7	6	7	N
2014	1	27.9	0.00	7	6	7	N
2015	1	27.9	0.00	7	7	7	N
2016	1	27.9	0.00	7	7	7	N
2017	1	27.9	0.00	7	8	7	N
2018	1	27.9	0.00	7	8	7	N
2019	1	27.9	0.00	7	8	7	N
2020	1	27.9	0.00	7	8	7	N
2021	1	28.1	0.72	7	8	7	N
2022	1	28.1	0.00	7	8	7	N

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 089-0285-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
- Superstructure:
    - EN109 - PSC Girder/Beam
- Substructure:
    - EN205 - RC Column
    - EN215 - RC Abutment
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN302 - Compression Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail

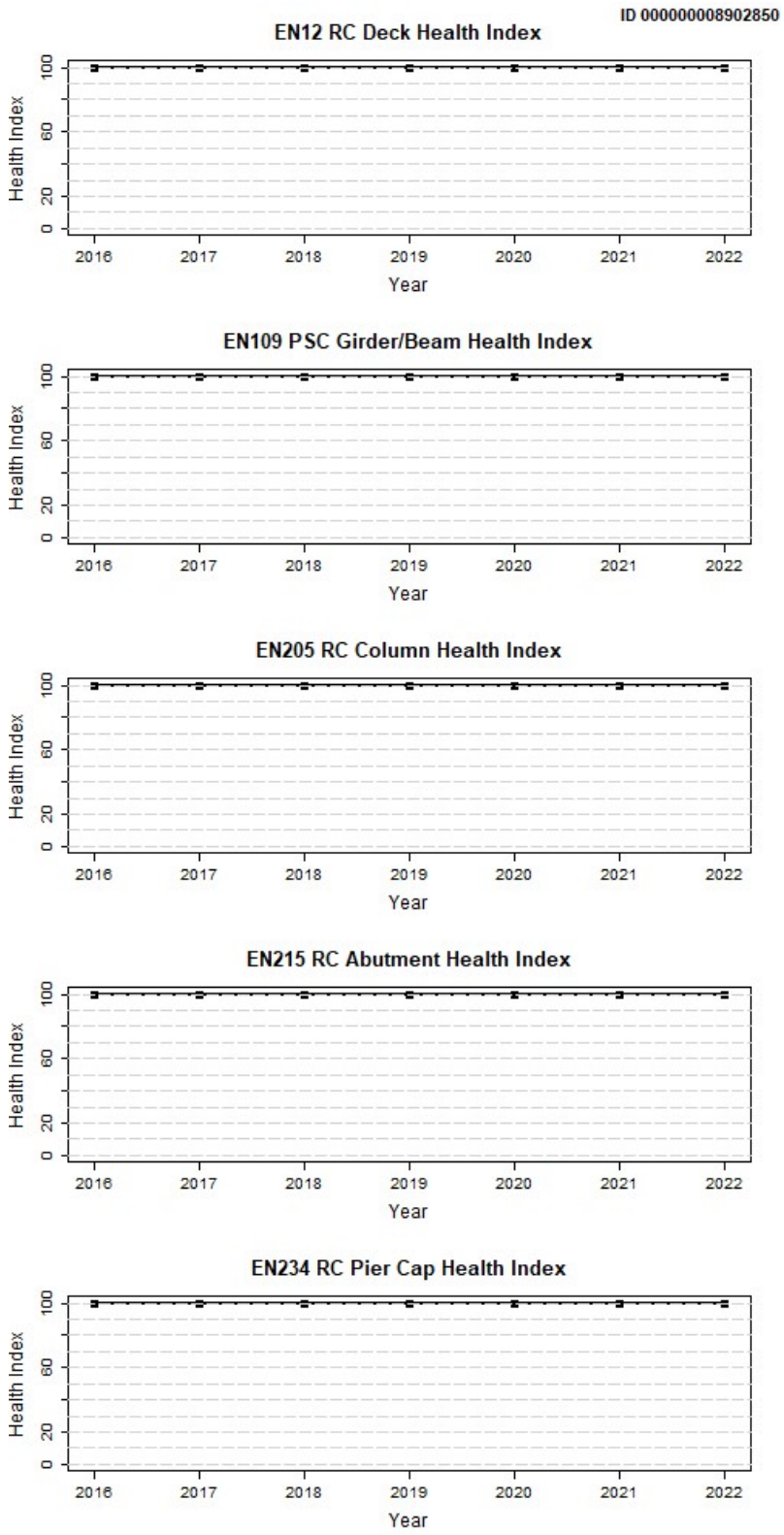


Figure 44. Graphs. Deck/Slab, Joints, Bearings, and Rail Element Health Indices for Structure # 089-0285-0[4].

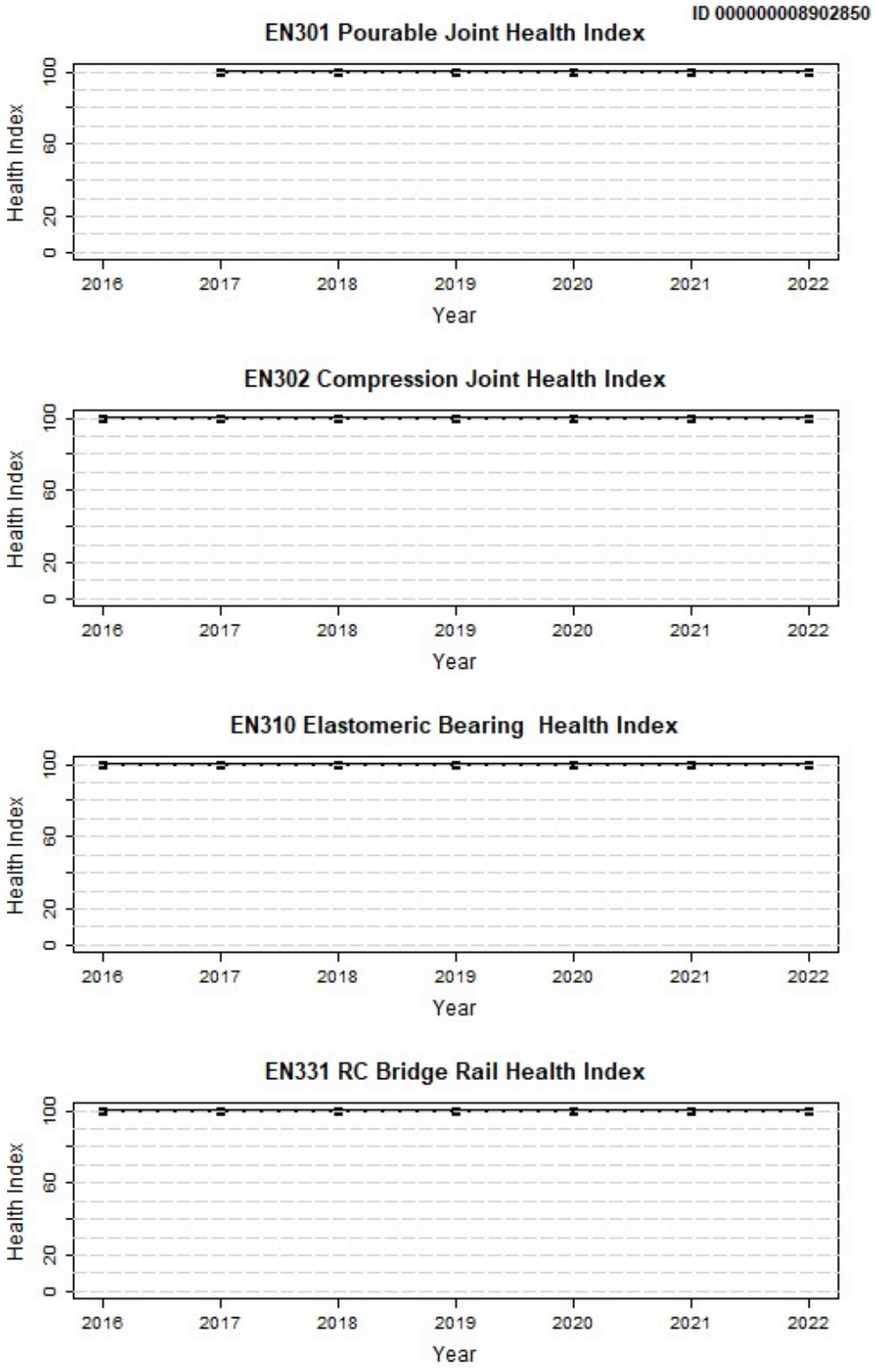


Figure 45. Graphs. Superstructure & Substructure Element Health Indices for Structure # 089-0285-0[4].

Supplemental Tables

Table 24. Deck, Superstructure, & Substructure NBI Bridge Element Data for Structure # 089-0285-0[4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2016	100.00		100.00	0.00	0.00	0.00	3420	SF
2017	100.00	0.00	100.00	0.00	0.00	0.00	3420	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	3420	SF
2019	100.00	0.00	100.00	0.00	0.00	0.00	3420	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	3420	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	3420	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	3420	SF
EN109 – PSC Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	456	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	456	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	456	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	456	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	456	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	456	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	456	LF
EN205 – RC Column								
2016	100.00		100.00	0.00	0.00	0.00	4	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	4	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	4	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	4	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	4	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	4	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	4	EA
EN215 – RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	90	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
EN234 – RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	90	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	45	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	45	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	45	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	45	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	45	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	45	LF

Table 25. Joints, Bearings, & Railing NBI Bridge Element Data for Structure # 089-0285-0[4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 – Pourable Joint								
2017	100.00		100.00	0.00	0.00	0.00	261	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	261	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	261	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	261	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	261	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	261	LF
EN302 – Compression Joint								
2016	100.00		100.00	0.00	0.00	0.00	135	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	135	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	135	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	135	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	135	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	135	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	135	LF
EN310 – Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	24	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	24	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	24	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	24	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	24	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	24	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	24	EA
EN331 – RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	152	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	152	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	152	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	152	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	152	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	152	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	152	LF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Right shoulder of X-Ref roadway at bent 2

Erosion at shoulder behind guardrail at bent 2 causing roadway to crack

Span 2 at bent 2

Figure 46. Images. Erosion of Road Under Bridge Over Time for Structure # 089-0285-0.

Construction detail.

Looking CB.

Span 1

Span1/Bent2

Taken from left rear

Figure 47. Images. Views Over Time of Structure # 089-0285-0.

Findings

- NBI Data concerns:
    - 60.26% reduction in operating rating between 2010 and 2011
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - All elements have a 100 health index for 2016 to 2022 – this does not seem realistic
- Inspection Report concerns:
    - Reports available in 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, & 2022
    - Reports are not very detailed in written descriptions or photo documentation
    - Repairs made to prior to 2006:
        - Beam ends repaired using epoxy injection type sealer
        - Cracks in cap at abutment #3 sealed
    - Deck:
        - Deck has cracking since 2006
        - Approach slabs have cracking since 2006; approach slab at abutment #3 has erosion with penetration beginning in 2010 – requires backfill repair
    - Superstructure (time):
        - Beams have spalls and cracking since 2006
    - Substructure (time):
        - Abutments have cracking since 2006
        - Caps have cracking since 2006
        - Erosion at shoulder behind guardrail at bent 2 causing roadway under bridge to crack beginning in 2018

(6) Bridge # 107-0072-0 Summary

Bridge Information

Table 26. Bridge # 107-0072-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000010700720
N/A	Reliability Index (WIM Site A*)	0.882112489
N/A	Reliability Index (WIM Site B*)	1.010033562
N/A	Reliability Index (WIM Site C*)	1.074385179
N/A	Reliability Index (WIM Site D*)	0.507893683
N/A	Reliability Index (WIM Site E*)	0.974888573
N/A	Reliability Index (WIM Site F*)	0.974463046
N/A	Reliability Index (WIM Site G*)	0.382776174
N/A	Age	45
5B	Route Prefix	1 – Interstate
5D	Route Number	16
3	County Code	107 – Emanuel
6A	Features Intersected	JACKS CREEK
7	Facility Carried by Structure	I-16 WBL
9	Location	4.2 MI S OF STILLMORE
16	Latitude 33°40'10.34"N	32°23'04.74"N (32.3847)
17	Longitude	82°14'32.88"W (-82.2425)
27	Year Built	1977
28A	No. of Traffic Lanes on the Structure	2
28B	No. of Traffic Lanes under the Structure	0
29	Average Daily Traffic (ADT)	17280
30	Year of ADT	2012
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restrictions
43A	Structure Type – Material and/or Design	5 – Prestressed concrete
43B	Structure Type – Design and/or Construction	2 – Stringer/Multi-beam or girder
49	Structure Length	81.4m (267ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	L – The left structure of parallel bridges. This structure carries traffic in the opposite direction.
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	NA
109	Average Daily Truck Traffic (% of ADT)	1%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 48. Image. View of Bridge # 107-0072-0 [2].

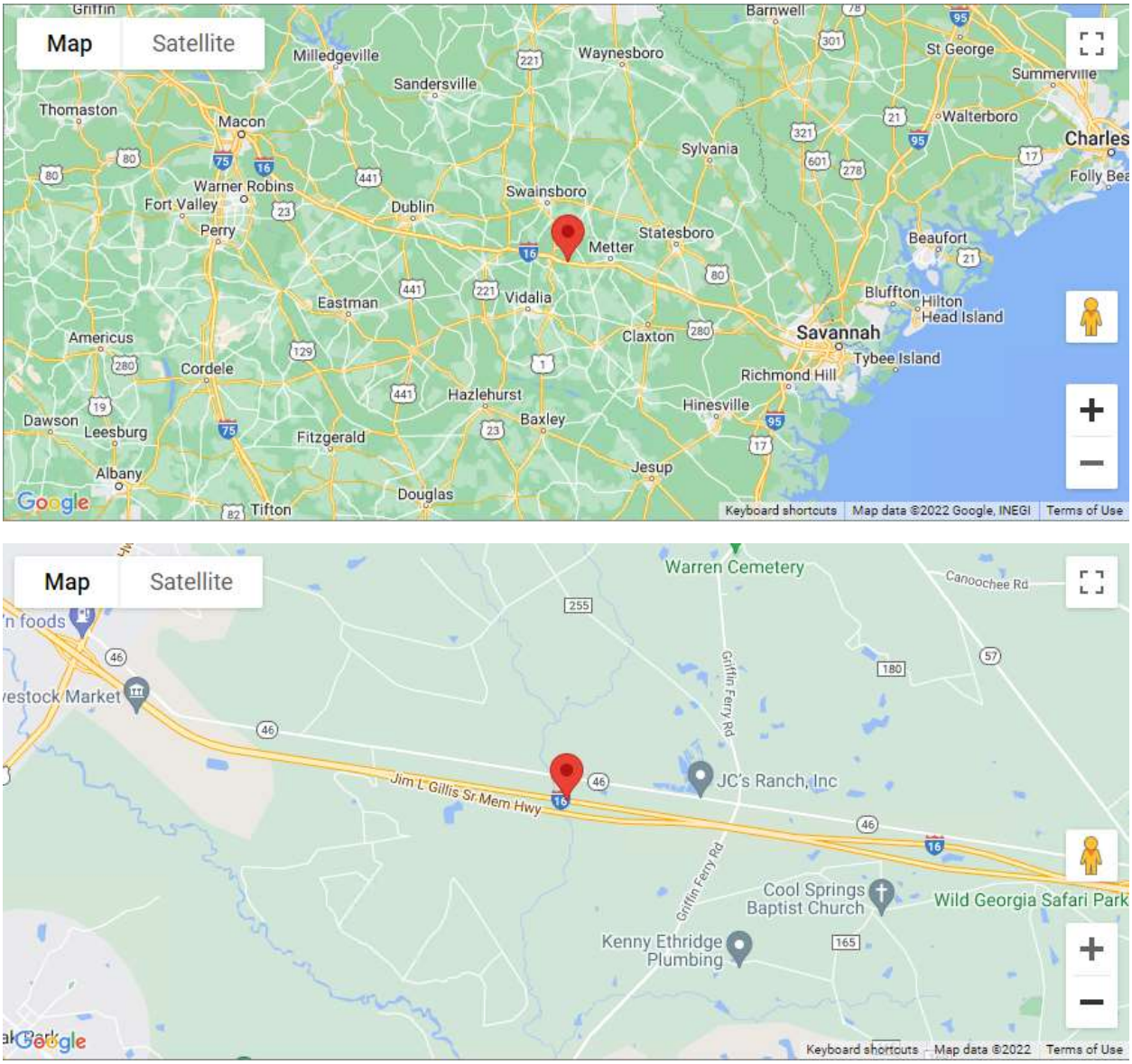


Figure 49. Image. Bridge # 107-0072-0 Location [3].

NBI Data Analysis

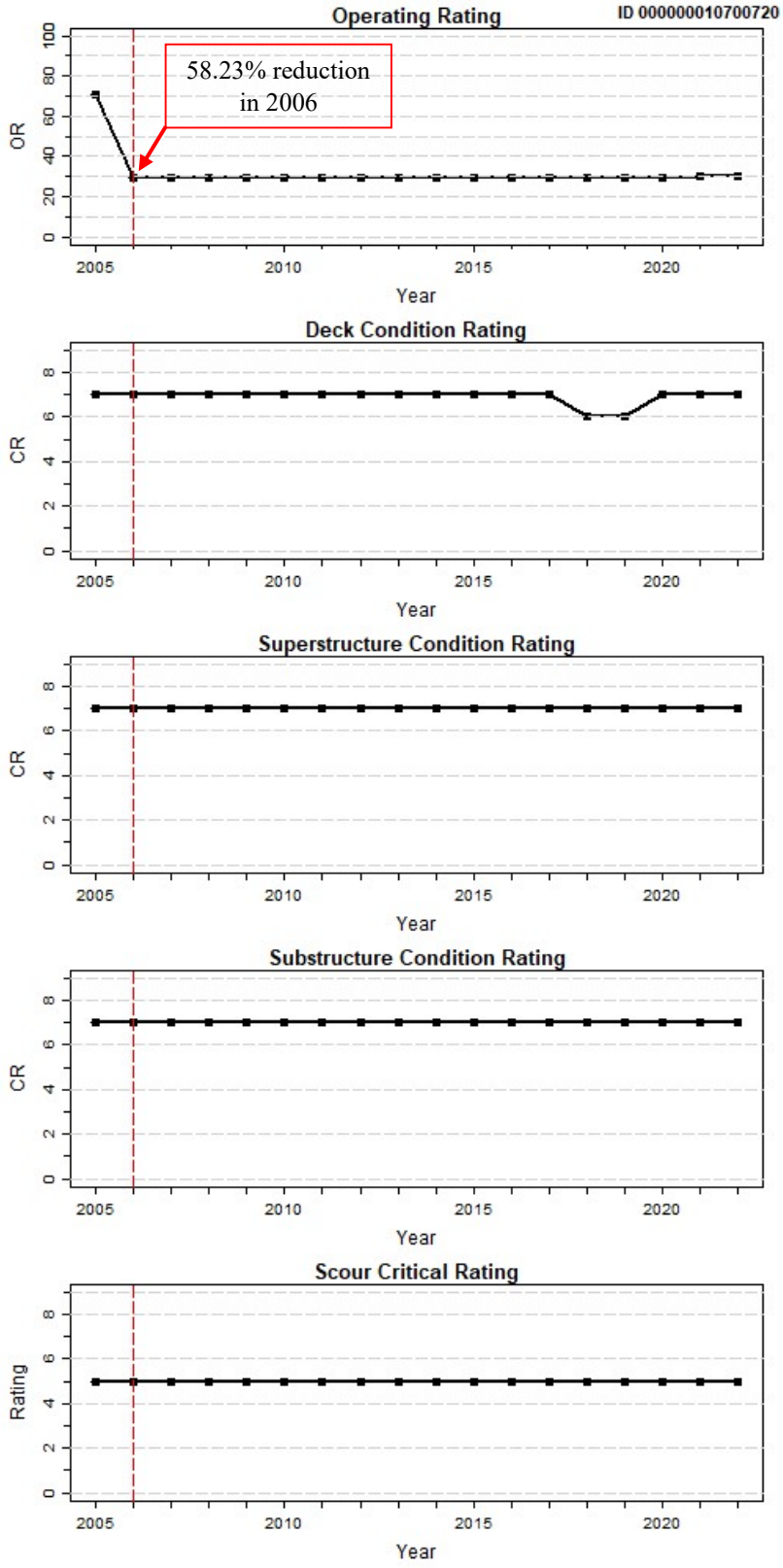


Figure 50. Graphs. NBI Operating & Condition Ratings for Structure # 107-0072-0 [1].

Table 27. NBI Data for Structure # 107-0072-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Superstructure	Substructure	Scour Critical
2005	1	71.1		7	7	7	5
2006	1	29.7	-58.23	7	7	7	5
2007	1	29.7	0.00	7	7	7	5
2008	1	29.7	0.00	7	7	7	5
2009	1	29.7	0.00	7	7	7	5
2010	1	29.7	0.00	7	7	7	5
2011	1	29.7	0.00	7	7	7	5
2012	1	29.7	0.00	7	7	7	5
2013	1	29.7	0.00	7	7	7	5
2014	1	29.7	0.00	7	7	7	5
2015	1	29.7	0.00	7	7	7	5
2016	1	29.7	0.00	7	7	7	5
2017	1	29.7	0.00	7	7	7	5
2018	1	29.7	0.00	6	7	7	5
2019	1	29.7	0.00	6	7	7	5
2020	1	29.7	0.00	7	7	7	5
2021	1	29.9	0.67	7	7	7	5
2022	1	29.9	0.00	7	7	7	5

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 107-0072-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
- Superstructure:
    - EN109 - PSC Girder/Beam
- Substructure:
    - EN215 - RC Abutment
    - EN226 - PSC Pile
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail

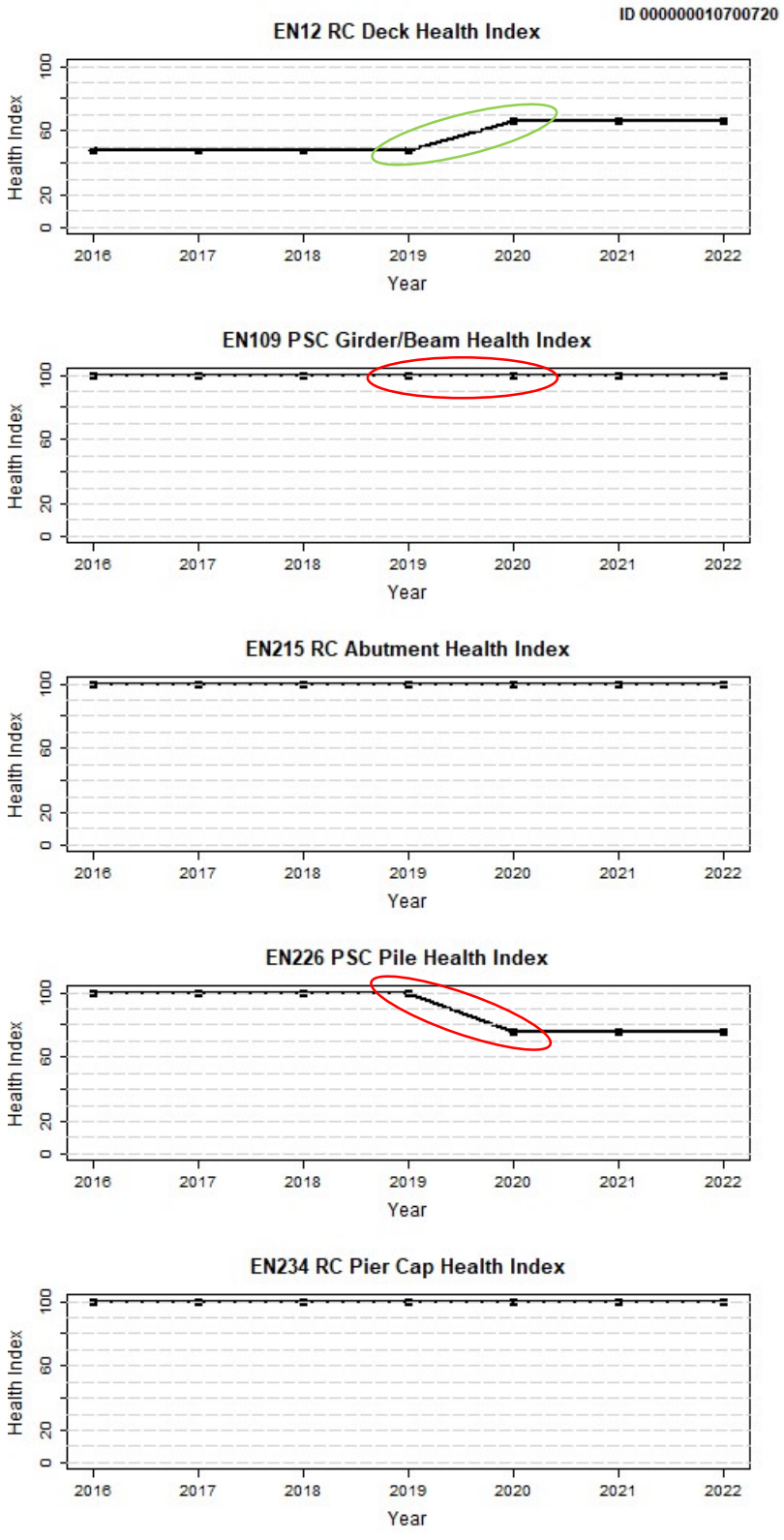


Figure 51. Graphs. Deck, Superstructure, & Substructure Element Health Indices for Structure # 107-0072-0 [4].

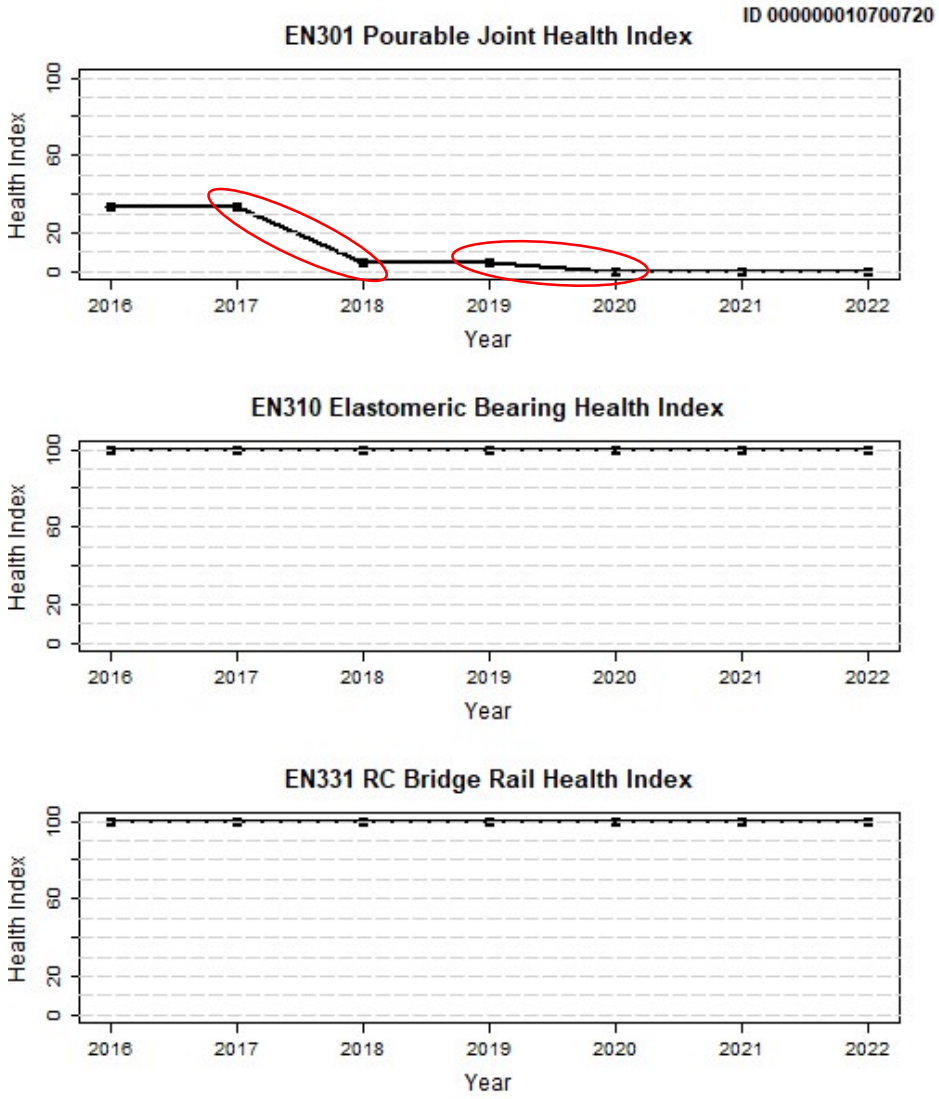


Figure 52. Graphs. Joints, Bearings, & Railing Element Health Indices for Structure # 107-0072-0 [4].

Supplemental Tables

Table 28. Deck, Superstructure, & Substructure NBI Bridge Element Data for Structure # 107-0072-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2016	47.74		12.90	87.10	0.00	0.00	11481	SF
2017	47.74	0.00	12.90	87.10	0.00	0.00	11481	SF
2018	47.74	0.00	12.90	87.10	0.00	0.00	11481	SF
2019	47.74	0.00	12.90	87.10	0.00	0.00	11481	SF
2020	66.46	39.21	44.10	55.90	0.00	0.00	11481	SF
2021	66.46	0.00	44.10	55.90	0.00	0.00	11481	SF
2022	66.46	0.00	44.10	55.90	0.00	0.00	11481	SF
EN109 – PSC Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	1602	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	1602	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	1602	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	1602	LF
2020	99.85	-0.15	99.75	0.25	0.00	0.00	1602	LF
2021	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
2022	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
EN215 – RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	90	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
EN226 – PSC Pile								
2016	100.00		100.00	0.00	0.00	0.00	60	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2020	76.00	-24.00	60.00	40.00	0.00	0.00	60	EA
2021	76.00	0.00	60.00	40.00	0.00	0.00	60	EA
2022	76.00	0.00	60.00	40.00	0.00	0.00	60	EA
EN234 – RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	215	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	215	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	215	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	215	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	215	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	215	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	215	LF

Table 29. Joint, Bearing, & Rail NBI Bridge Element Data for Structure # 107-0072-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 – Pourable Joint								
2016	33.33		0.00	83.33	0.00	16.67	240	LF
2017	33.33	0.00	0.00	83.33	0.00	16.67	240	LF
2018	5.00	-85.00	0.00	0.00	50.00	50.00	240	LF
2019	5.00	0.00	0.00	0.00	50.00	50.00	240	LF
2020	0.00	-100.00	0.00	0.00	0.00	100.00	240	LF
2021	0.00	0.00	0.00	0.00	0.00	100.00	240	LF
2022	0.00	0.00	0.00	0.00	0.00	100.00	240	LF
EN310 – Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	60	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
EN331 – RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	534	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	534	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	534	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	534	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	534	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	534	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	534	LF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Figure 53. Images. Issues Documented in 2013 for Structure # 107-0072-0.

Span 2 Bent 3

Upstream side.

Typical scaling in the bottom of piles.

Heavy scaling in the rear approach slab.

Figure 54. Images. Issues Documented in 2019 for Structure # 107-0072-0.

Findings

- NBI Data concerns:
    - 58.23% reduction in operating rating between 2005 and 2006
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Substructure:
        - PSC Pile: 24.0% health index reduction in 2020
    - Joints:
        - Pourable Joint: 85.0% health index reduction in 2018
        - Pourable Joint: 100.0% health index reduction in 2020
- Inspection Report concerns:
    - Reports available in 2005, 2007, 2009, 2011, 2013, 2015, 2017, & 2019
    - Reports are not very detailed in photo documentation
    - Guardrail repaired in 2007
    - Deck:
        - Deck has shrinkage cracks throughout since 2005; scaling since 2017
        - Joints have adhesion failure, sealant missing & leakage since 2005; cracking with efflorescence since 2019
        - Approach slabs have cracking since 2005; potholes since 2009
        - Guardrail damaged in 2005
    - Superstructure:
        - Beams have spalling since 2005; spalling with exposed rebar since 2019
        - Leveling nuts attached to beams don't allow beams to set fully on bearing pads since 2009
    - Substructure:
        - Caps have cracking, spall with exposed rebar, and voids since 2005
        - Piles have spall since 2005; spall with exposed rebar since 2009; scaling in bottom of piles since 2019
        - Abutments have spalling, cracking, and abutment 6 cap has void due to slope erosion since 2009

(7) Bridge # 021-0074-0 Summary

Bridge Information

Table 30. Bridge # 021-0074-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000002100740
N/A	Reliability Index (WIM Site A*)	1.118604926
N/A	Reliability Index (WIM Site B*)	1.410210964
N/A	Age	27
5B	Route Prefix	1 – Interstate
5D	Route Number	75
3	County Code	21 – Bibb
6A	Features Intersected	TOBESOFKEE CREEK
7	Facility Carried by Structure	I-75 (SBL)
9	Location	2.2 MI S OF MACON
16	Latitude	32°45'48.67"N (32.7635)
17	Longitude	83°42'17.17"W (-83.7048)
27	Year Built	1970
28A	No. of Traffic Lanes on the Structure	3
28B	No. of Traffic Lanes under the Structure	0
29	Average Daily Traffic (ADT)	31460
30	Year of ADT	2011
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restrictions
43A	Structure Type – Material and/or Design	1 – Concrete
43B	Structure Type – Design and/or Construction	4 – Tee beam
49	Structure Length	61m (200ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	Y60 – inspection required every 60 months
92C	Other Special Inspection	Y24 – inspection required every 24 months
101	Parallel Structure Designation	L – The left structure of parallel bridges. This structure carries traffic in the opposite direction.
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	1995
109	Average Daily Truck Traffic (% of ADT)	8%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 55. Image. 2022 Views of Bridge # 021-0074-0 [2].

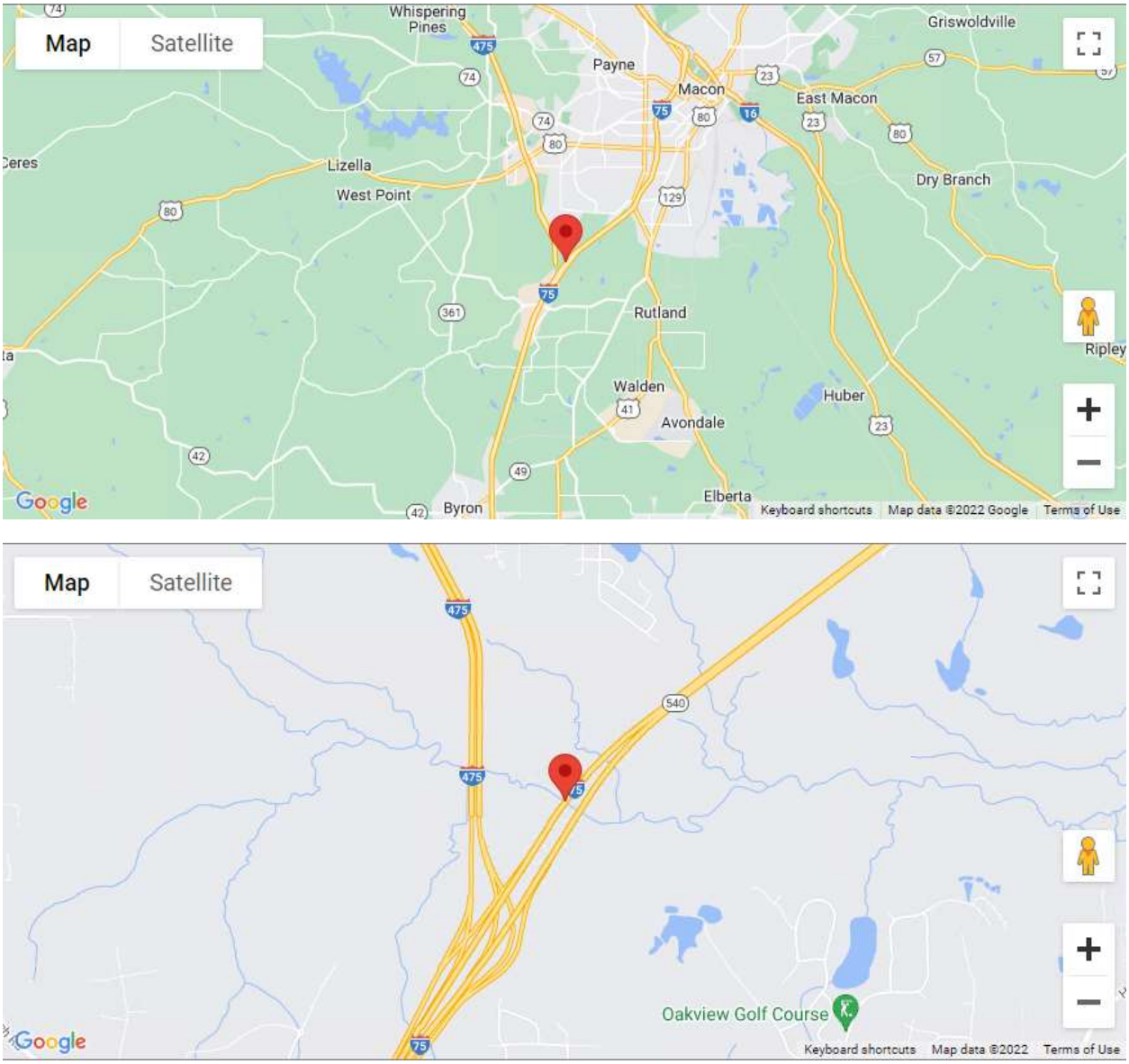


Figure 56. Image. Bridge # 021-0074-0 Location [3].

NBI Data Analysis

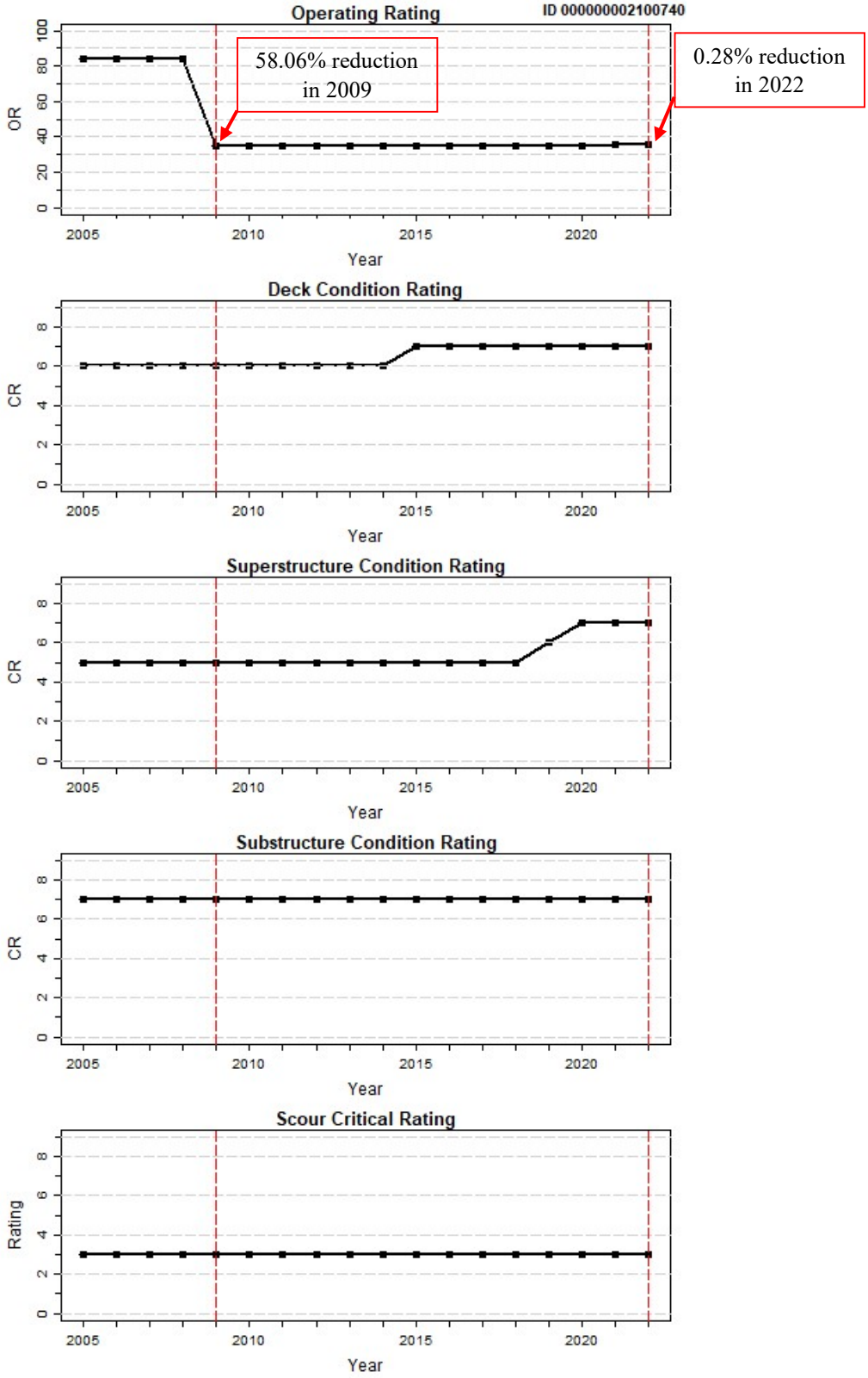


Figure 57. Graphs. NBI Operating & Condition Ratings for Structure # 021-0074-0 [1].

Table 31. NBI Data for Structure # 021-0074-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	83.7		6	5	7	3
2006	1	83.7	0.00	6	5	7	3
2007	1	83.7	0.00	6	5	7	3
2008	1	83.7	0.00	6	5	7	3
2009	1	35.1	-58.06	6	5	7	3
2010	1	35.1	0.00	6	5	7	3
2011	1	35.1	0.00	6	5	7	3
2012	1	35.1	0.00	6	5	7	3
2013	1	35.1	0.00	6	5	7	3
2014	1	35.1	0.00	6	5	7	3
2015	1	35.1	0.00	7	5	7	3
2016	1	35.1	0.00	7	5	7	3
2017	1	35.1	0.00	7	5	7	3
2018	1	35.1	0.00	7	5	7	3
2019	1	35.1	0.00	7	6	7	3
2020	1	35.1	0.00	7	7	7	3
2021	1	35.4	0.85	7	7	7	3
2022	1	35.3	-0.28	7	7	7	3

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 021-0074-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
    - EN16 - RC Top Flange
- Superstructure:
    - EN109 - PSC Girder/Beam
    - EN110 - RC Girder/Beam
- Substructure:
    - EN204 - PSC Column
    - EN215 - RC Abutment
    - EN226 - PSC Pile
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail

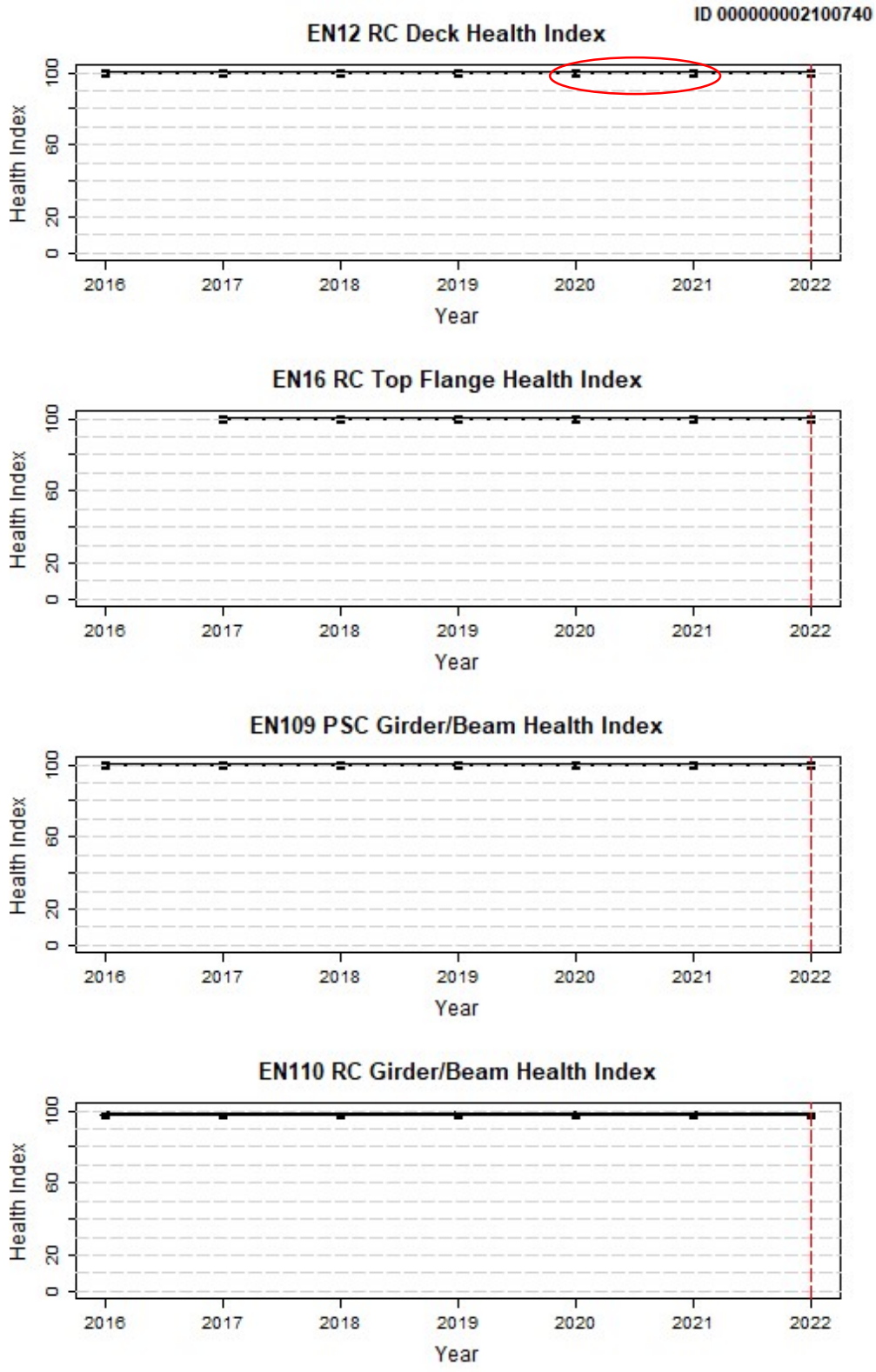


Figure 58. Graphs. Deck/Slab & Superstructure Element Health Indices for Structure # 021-0074-0 [4].

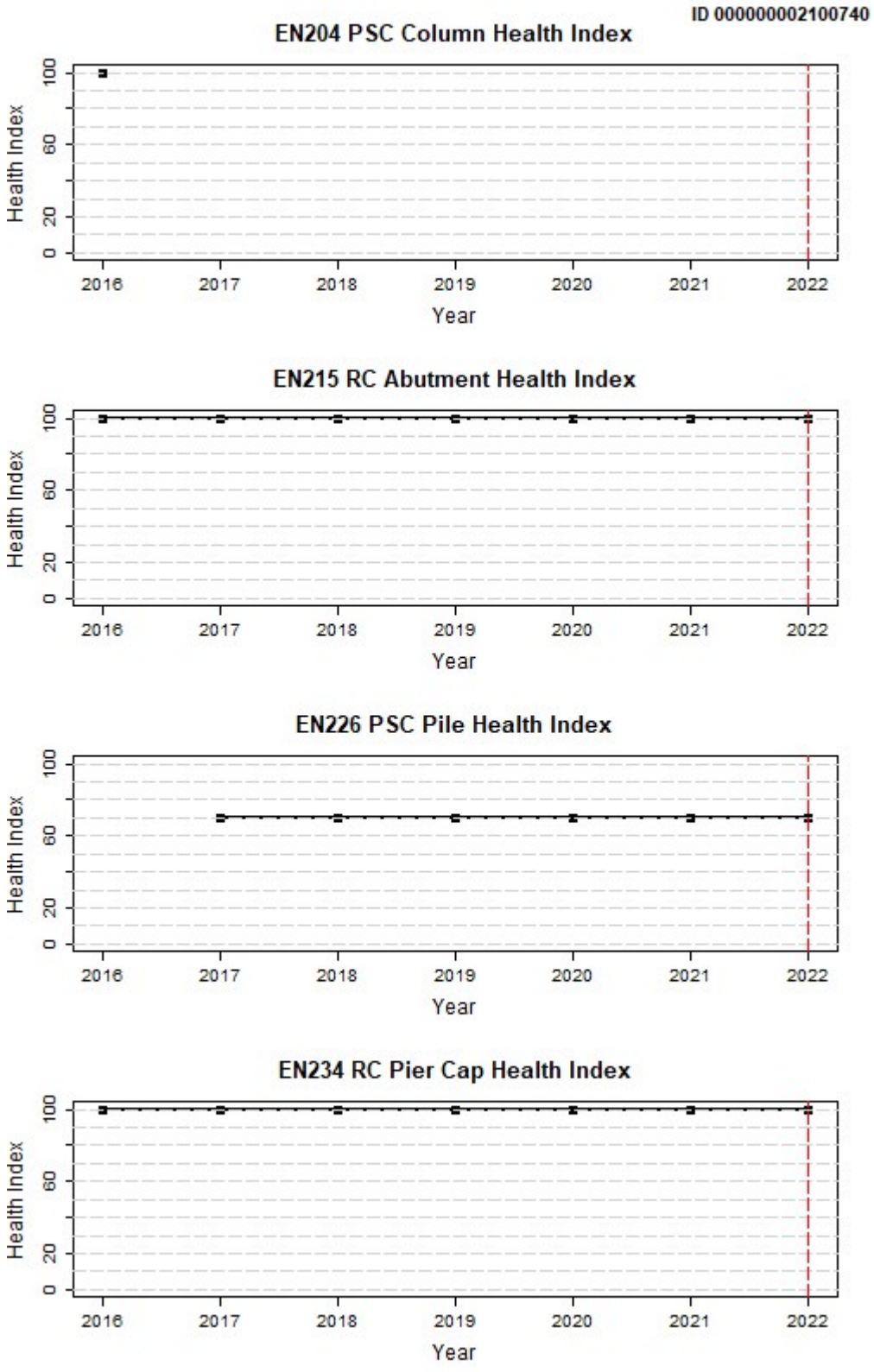


Figure 59. Graphs. Substructure Element Health Indices for Structure # 021-0074-0 [4].

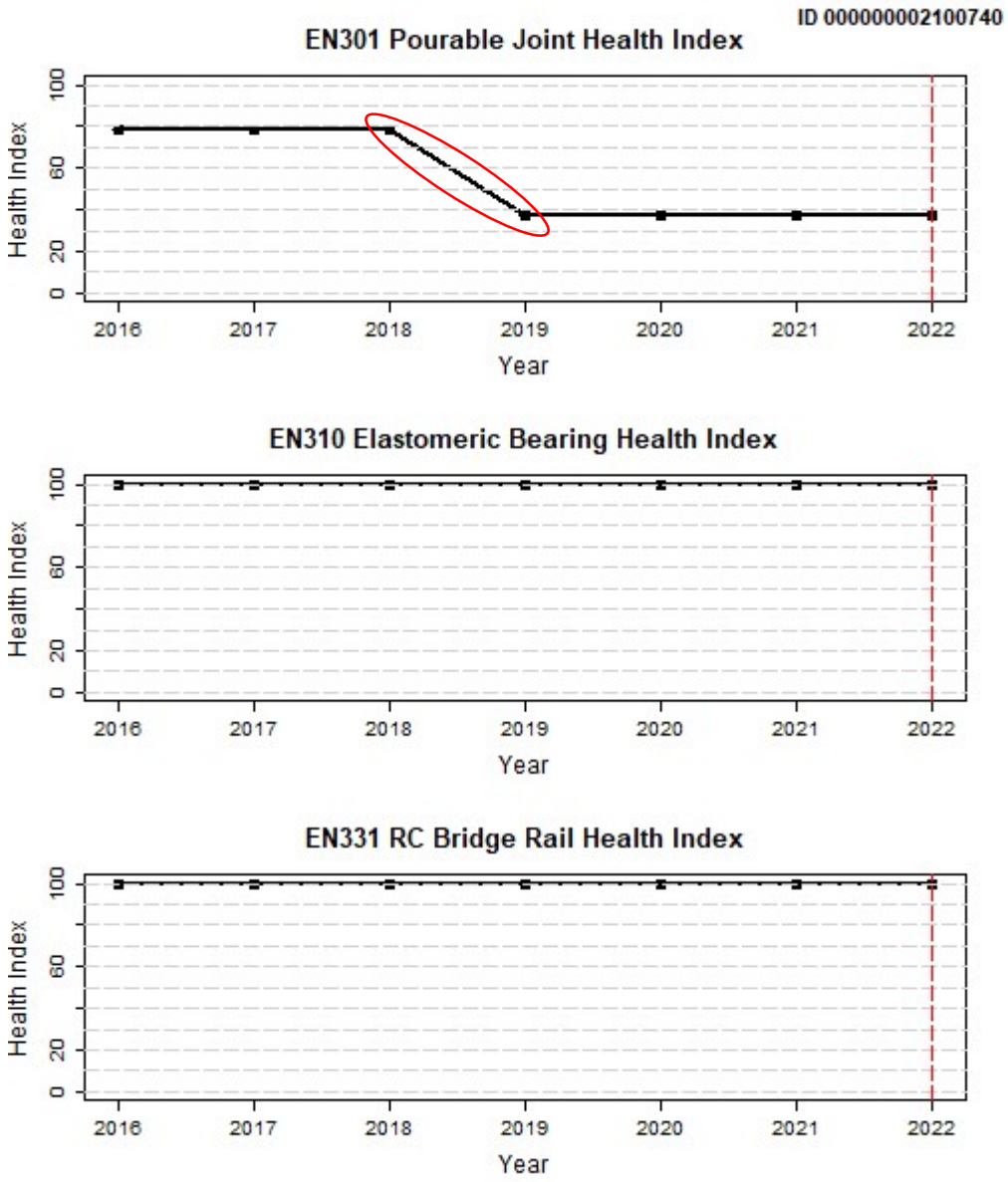


Figure 60. Graphs. Joints, Bearings, & Rail Element Health Indices for Structure # 021-0074-0 [4].

Supplemental Tables

Table 32. Deck & Superstructure NBI Bridge Element Data for Structure # 021-0074-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2016	100.00		100.00	0.00	0.00	0.00	12520	SF
2017	100.00	0.00	100.00	0.00	0.00	0.00	4695	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	4695	SF
2019	100.00	0.00	100.00	0.00	0.00	0.00	4695	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	4695	SF
2021	99.96	-0.04	99.96	0.00	0.04	0.00	4695	SF
2022	99.96	0.00	99.96	0.00	0.04	0.00	4695	SF
EN16 – RC Top Flange								
2017	100.00		100.00	0.00	0.00	0.00	7824	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	7824	SF
2019	100.00	0.00	100.00	0.00	0.00	0.00	7824	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	7824	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	7824	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	7824	SF
EN109 - PSC Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	600	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
EN110 - RC Girder/Beam								
2016	98.15		96.92	3.08	0.00	0.00	1200	LF
2017	98.15	0.00	96.92	3.08	0.00	0.00	1200	LF
2018	98.15	0.00	96.92	3.08	0.00	0.00	1200	LF
2019	98.15	0.00	96.92	3.08	0.00	0.00	1200	LF
2020	98.15	0.00	96.92	3.08	0.00	0.00	1200	LF
2021	98.15	0.00	96.92	3.08	0.00	0.00	1200	LF
2022	98.15	0.00	96.92	3.08	0.00	0.00	1200	LF

Table 33. Substructure NBI Bridge Element Data for Structure # 021-0074-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN204 - PSC Column								
2016	100.00		100.00	0.00	0.00	0.00	36	EA
EN215 - RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	130	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
EN226 - PSC Pile								
2017	70.00		50.00	50.00	0.00	0.00	36	EA
2018	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2019	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2020	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2021	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2022	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
EN234 - RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	252	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	252	LF

Table 34. Joints, Bearings, & Rail NBI Bridge Element Data for Structure # 021-0074-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 - Pourable Joint								
2016	78.80		74.67	5.33	20.00	0.00	300	LF
2017	78.80	0.00	74.67	5.33	20.00	0.00	300	LF
2018	78.80	0.00	74.67	5.33	20.00	0.00	300	LF
2019	37.00	-53.05	0.00	90.00	10.00	0.00	300	LF
2020	37.00	0.00	0.00	90.00	10.00	0.00	300	LF
2021	37.00	0.00	0.00	90.00	10.00	0.00	300	LF
2022	37.00	0.00	0.00	90.00	10.00	0.00	300	LF
EN310 - Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	30	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
EN331 - RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	400	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	400	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	400	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	400	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	400	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	400	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	400	LF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Photo 03 - Typical cracks in original beams over the abutments

Photo 04 - Typical adhesion loss to expansion joint sealant

Photo 05 - Spall in east lane of south approach slab at approach roadway end

Photo 06 - Spall in east lane of north approach slab at approach roadway end

Photo 07 - Cracks in north approach slab

Figure 61. Images. Issues Documented in 2012 for Structure # 021-0074-0.

typical

Required sideview (upstream)

2 sq. ft. spall at abutment 1

All deck joints are leaking.

Both approach slabs have moderate transverse cracking

Figure 62. Images. Typical Issues Over Time for Structure # 021-0074-0.

Findings

- NBI Data concerns:
    - 58.06% reduction in operating rating between 2008 and 2009
    - 0.28% reduction in operating rating between 2021 and 2022
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Substructure:
        - PSC Pile: low health index (70.0) 2017-2022
    - Joints:
        - Pourable joint: 53.05% health index reduction in 2019
- Inspection Report concerns:
    - Reports available in 2004, 2006, 2008, 2010, 2012, 2014, & 2015-2022
    - Repairs:
        - Joint sealant replaced and headers repaired in 2008
    - Deck:
        - Deck since cracking, scaling since 2004
        - Joints have spall, cracking and are leaking since 2004 (repaired 2008)
            - Adhesion loss and deteriorated sealant present in 2010
            - Joint at abutment 1 has spall with exposed rebar since 2020
        - Handrails cracking with efflorescence since 2004
        - Approach slabs have cracking (longitudinal, shrinkage, transverse) since 2004; diagonal cracking, spall with some exposed rebar since 2010
            - North approach slab settlement causing impact on bent 5 since 2004
    - Superstructure:
        - Beams have cracking (shear, horizontal, diagonal, deflection) and spall since 2004
        - Cracking in bearing areas of beams since 2004
    - Substructure:
        - Caps have cracking, erosion, efflorescence, exposed rebar since 2004

- Piles have cracking and scale/abrasion at water line since 2004; spalling in 2012
- Abutments have cracking, erosion and beginnings of delamination in 2010

(8) Bridge # 107-0071-0 Summary

Bridge Information

Table 35. Bridge # 107-0071-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000010700710
N/A	Reliability Index (WIM Site A*)	0.882112489
N/A	Reliability Index (WIM Site B*)	1.010033562
N/A	Reliability Index (WIM Site C*)	1.074385179
N/A	Reliability Index (WIM Site D*)	0.507893683
N/A	Reliability Index (WIM Site E*)	0.974888573
N/A	Reliability Index (WIM Site F*)	0.974463046
N/A	Reliability Index (WIM Site G*)	0.382776174
N/A	Age	45
5B	Route Prefix	1 – Interstate
5D	Route Number	16
3	County Code	107 – Emanual
6A	Features Intersected	JACKS CREEK
7	Facility Carried by Structure	I-16 EBL
9	Location	4.2 MI S OF STILLMORE
16	Latitude	32°22'59.52"N (32.3832)
17	Longitude	82°14'32.39"W (-82.2423)
27	Year Built	1977
28A	No. of Traffic Lanes on the Structure	2
28B	No. of Traffic Lanes under the Structure	0
29	Average Daily Traffic (ADT)	17280
30	Year of ADT	2012
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restriction
43A	Structure Type – Material and/or Design	5 – Prestressed Concrete
43B	Structure Type – Design and/or Construction	2 – Stringer/Multi-beam or girder
49	Structure Length	81.4m (267ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	R – The right structure of parallel bridges carrying the roadway in the direction of the inventory.
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	NA
109	Average Daily Truck Traffic (% of ADT)	1%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

East: Direction of inventory. 10/2/2017

Upstream side. 10/2/2017

Figure 63. Image. View of Bridge # 107-0071-0 [2].

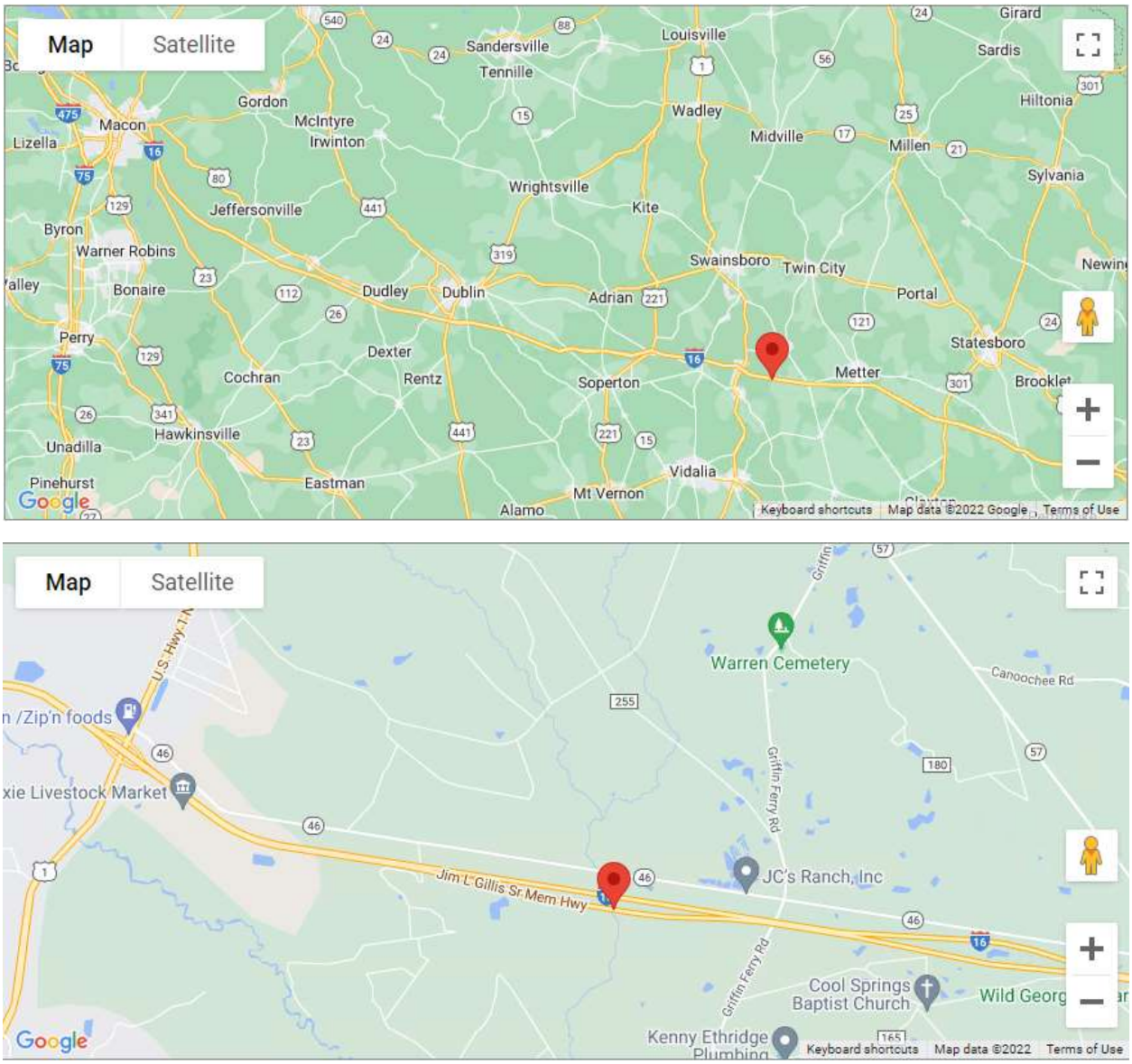


Figure 64. Image. Bridge # 107-0071-0 Location [3].

NBI Data Analysis

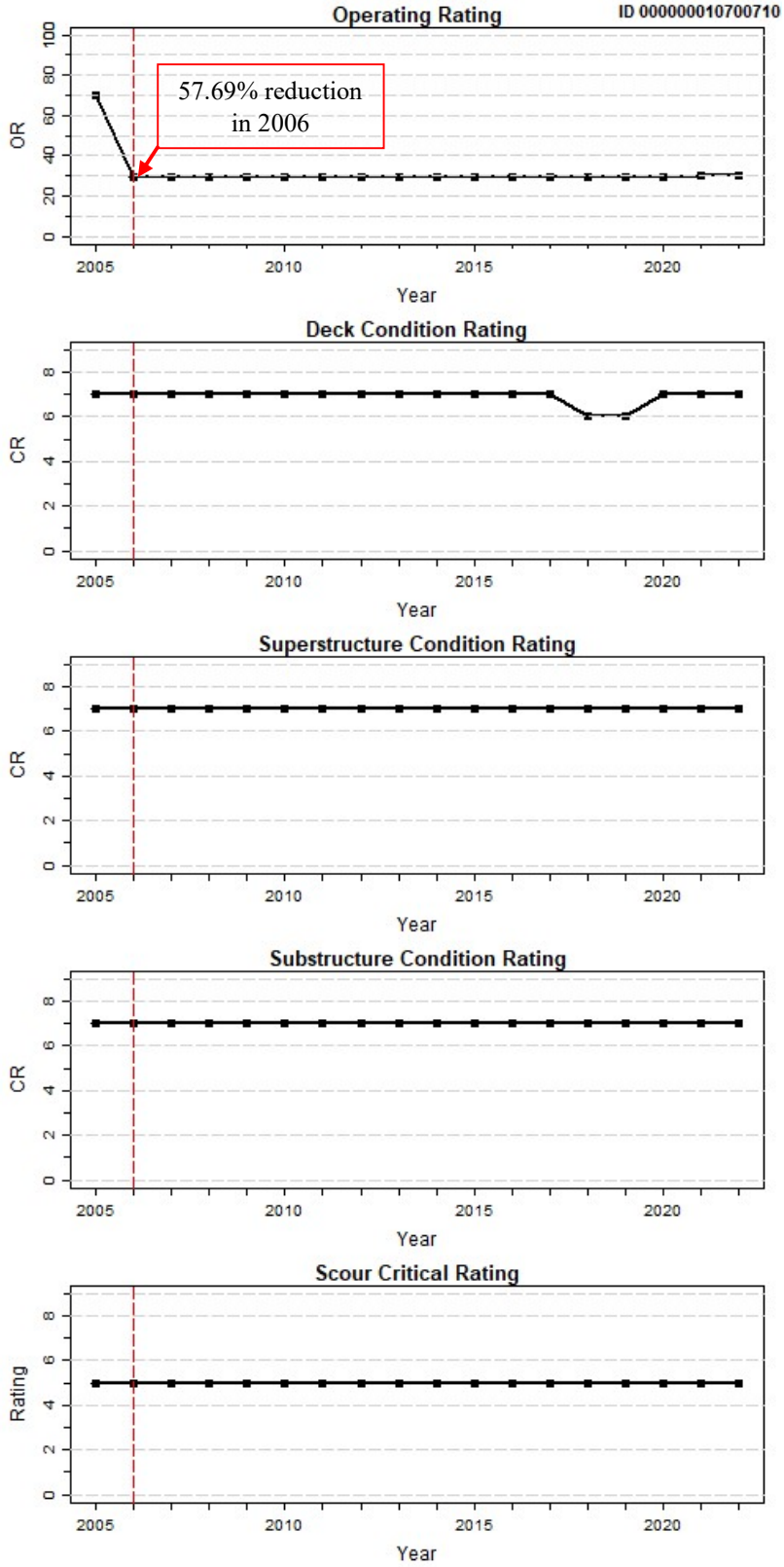


Figure 65. Graphs. NBI Operating & Condition Ratings for Structure # 107-0071-0 [1].

Table 36. NBI Data for Structure # 107-0071-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	70.2		7	7	7	5
2006	1	29.7	-57.69	7	7	7	5
2007	1	29.7	0.00	7	7	7	5
2008	1	29.7	0.00	7	7	7	5
2009	1	29.7	0.00	7	7	7	5
2010	1	29.7	0.00	7	7	7	5
2011	1	29.7	0.00	7	7	7	5
2012	1	29.7	0.00	7	7	7	5
2013	1	29.7	0.00	7	7	7	5
2014	1	29.7	0.00	7	7	7	5
2015	1	29.7	0.00	7	7	7	5
2016	1	29.7	0.00	7	7	7	5
2017	1	29.7	0.00	7	7	7	5
2018	1	29.7	0.00	6	7	7	5
2019	1	29.7	0.00	6	7	7	5
2020	1	29.7	0.00	7	7	7	5
2021	1	29.9	0.67	7	7	7	5
2022	1	29.9	0.00	7	7	7	5

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 107-0071-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
- Superstructure:
    - EN109 - PSC Girder/Beam
- Substructure:
    - EN215 - RC Abutment
    - EN226 - PSC Pile
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail

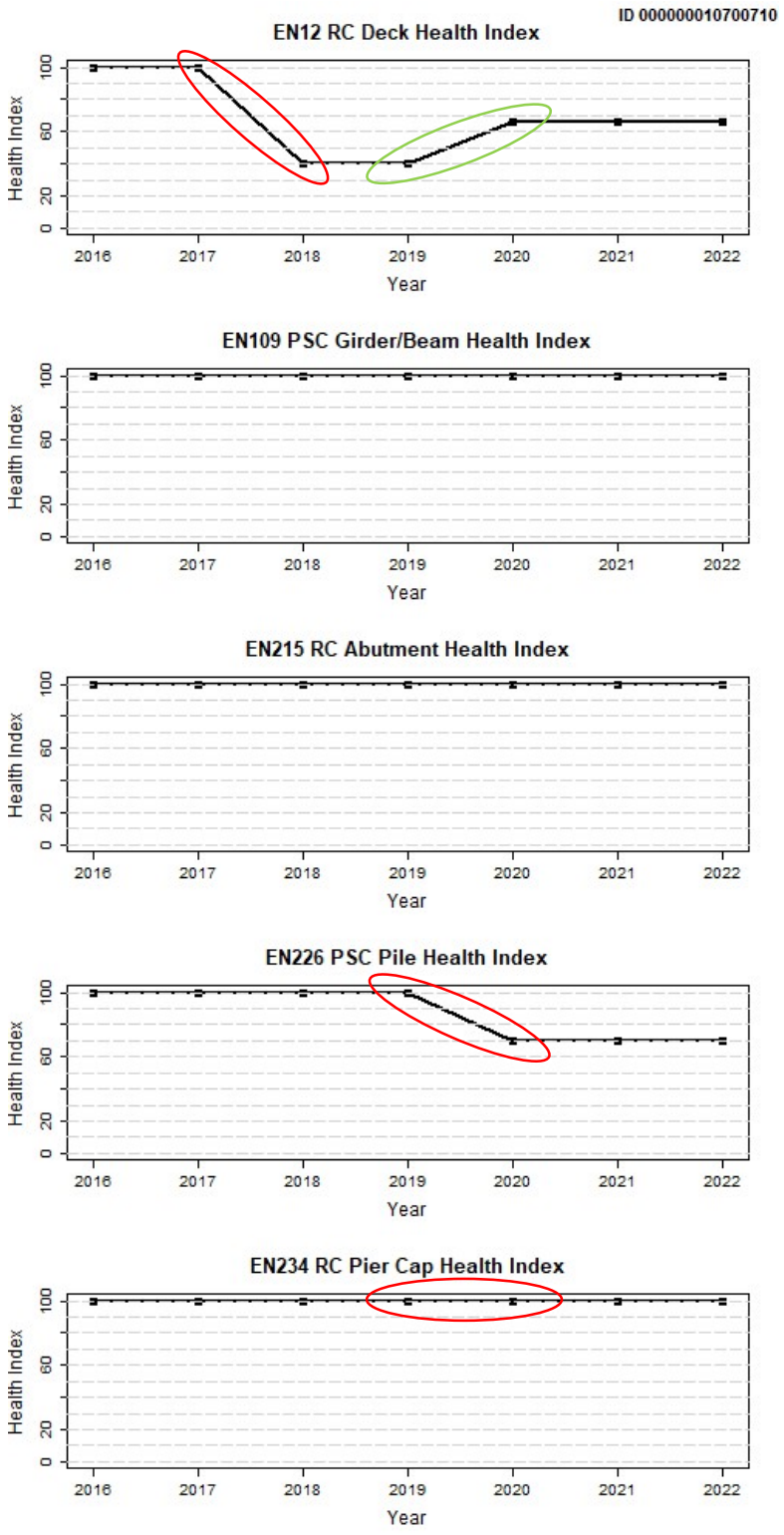


Figure 66. Graphs. Deck, Superstructure & Substructure Element Health Indices for Structure # 107-0071-0 [4].

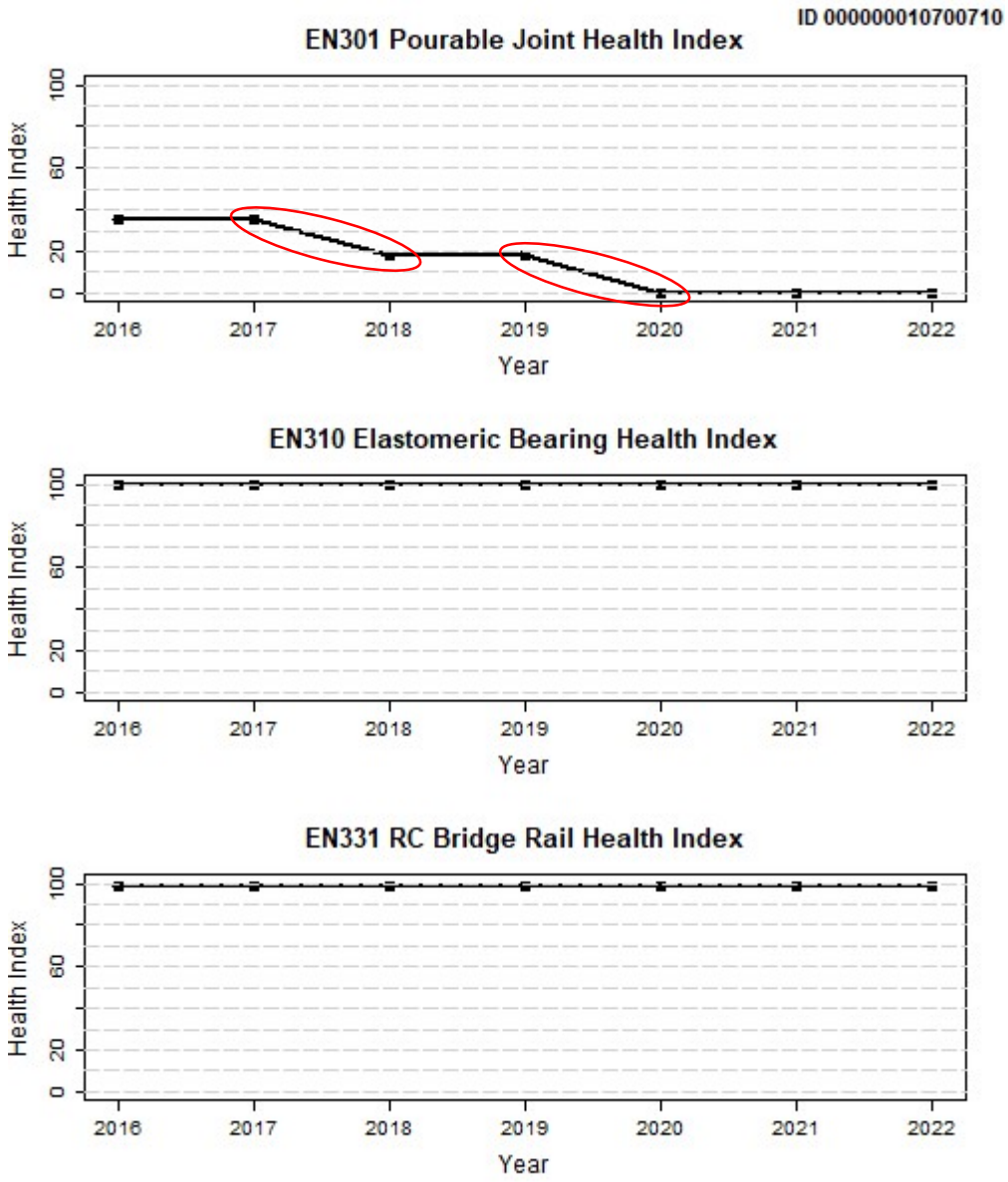


Figure 67. Graphs. Joints, Bearings, and Rail Element Health Indices for Structure # 107-0071-0 [4].

Supplemental Tables

Table 37. Deck, Superstructure, & Substructure NBI Bridge Element Data for Structure # 107-0071-0 [4].

Year	Health	HI % Change	CS1%	CS2%	CS3%	CS4%	Total	Units
EN12 – RC Deck								
2016	100.00		100.00	0.00	0.00	0.00	11481	SF
2017	100.00	0.00	100.00	0.00	0.00	0.00	11481	SF
2018	40.00	-60.00	0.00	100.00	0.00	0.00	11481	SF
2019	40.00	0.00	0.00	100.00	0.00	0.00	11481	SF
2020	66.51	66.28	44.19	55.81	0.00	0.00	11481	SF
2021	66.51	0.00	44.19	55.81	0.00	0.00	11481	SF
2022	66.51	0.00	44.19	55.81	0.00	0.00	11481	SF
EN109 – PSC Girder/Beam								
2016	99.85		99.75	0.25	0.00	0.00	1602	LF
2017	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
2018	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
2019	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
2020	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
2021	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
2022	99.85	0.00	99.75	0.25	0.00	0.00	1602	LF
EN215 – RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	90	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	90	LF
EN226 – PSC Pile								
2016	100.00		100.00	0.00	0.00	0.00	48	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	48	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	48	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	48	EA
2020	70.00	-30.00	50.00	50.00	0.00	0.00	48	EA
2021	70.00	0.00	50.00	50.00	0.00	0.00	48	EA
2022	70.00	0.00	50.00	50.00	0.00	0.00	48	EA
EN234 – RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	172	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	172	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	172	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	172	LF
2020	99.30	-0.70	98.84	1.16	0.00	0.00	172	LF
2021	99.30	0.00	98.84	1.16	0.00	0.00	172	LF
2022	99.30	0.00	98.84	1.16	0.00	0.00	172	LF

Table 38. Joint, Bearing, & Rail NBI Bridge Element Data for Structure # 107-0071-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 – Pourable Joint								
2016	35.00		16.67	33.33	50.00	0.00	240	LF
2017	35.00	0.00	16.67	33.33	50.00	0.00	240	LF
2018	18.33	-47.62	16.67	0.00	16.67	66.67	240	LF
2019	18.33	0.00	16.67	0.00	16.67	66.67	240	LF
2020	0.00	-100.00	0.00	0.00	0.00	100.00	240	LF
2021	0.00	0.00	0.00	0.00	0.00	100.00	240	LF
2022	0.00	0.00	0.00	0.00	0.00	100.00	240	LF
EN310 – Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	60	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	60	EA
EN331 – RC Bridge Rail								
2016	99.10		98.50	1.50	0.00	0.00	534	LF
2017	99.10	0.00	98.50	1.50	0.00	0.00	534	LF
2018	99.10	0.00	98.50	1.50	0.00	0.00	534	LF
2019	99.10	0.00	98.50	1.50	0.00	0.00	534	LF
2020	99.10	0.00	98.50	1.50	0.00	0.00	534	LF
2021	99.10	0.00	98.50	1.50	0.00	0.00	534	LF
2022	99.10	0.00	98.50	1.50	0.00	0.00	534	LF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Spall with exposed rebar in top face of Bent 5 cap at north end.

Spalls with exposed steel in bottom face of Span 3 forward Beam 1 at Bent 4.

Typical leveling nuts and bowed bearing sole plates

Typical vertical crack in barriers/end posts (southeast corner shown)

Figure 68. Images. Issues Documented in 2015 for Structure # 107-0071-0.

Span 2 and Tower Bent 3

Upstream side.

Spall with exposed rebar in top face of Bent 5 cap at north end.

Typical scaling in the bottom of the piles.

Figure 69. Images. Views & Issues Documented in 2019 for Structure # 107-0071-0.

Findings

- NBI Data concerns:
    - 57.69% reduction in operating rating between 2005 and 2006
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Deck:
        - RC Deck: 60.0% health index reduction in 2018
    - Substructure:
        - PSC Pile: 30.0% health index reduction in 2020
    - Joints:
        - Pourable Joint: 47.62% health index reduction in 2018
        - Pourable Joint: 100.0% health index reduction in 2020
- Inspection Report concerns:
    - Reports available in 2005, 2007, 2009, 2011, 2013, 2015, 2017, & 2019
    - 2021 report unable to download
    - Repairs:
        - Minor void under cap at abutment 6 was repaired prior to 2005
    - Deck:
        - Deck has shrinkage cracks since 2005; scaling since 2015
        - All joints have leakage since 2005; adhesion failure and missing sealant since 2009
        - Approach slabs have cracking since 2005
        - Guardrail damage since 2005; cracking due to lack of expansion joint since 2009
    - Superstructure:
        - Beams have spalling since 2005; spall with exposed rebar since 2009
        - Leveling nuts are not allowing beams to set fully onto elastomeric bearings and are causing the plates to become bowed (2009)
    - Substructure:
        - Piles have spalling since 2005; scaling on bottom of piles since 2019

- Caps have spalling since 2005; spalling with exposed rebar since 2009

(9) Bridge # 021-0073-0 Summary

Bridge Information

Table 39. Bridge # 021-0073-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000002100730
N/A	Reliability Index (WIM Site A*)	1.329069119
N/A	Reliability Index (WIM Site B*)	1.672415085
N/A	Age	27
5B	Route Prefix	1 – Interstate
5D	Route Number	75
3	County Code	21 – Bibb
6A	Features Intersected	TOBESOFKEE CREEK
7	Facility Carried by Structure	I-75 (NBL)
9	Location	3 MI S OF MACON
16	Latitude	32°45'46.26"N (32.7629)
17	Longitude	83°42'13.68"W (-83.7038)
27	Year Built	1970
28A	No. of Traffic Lanes on the Structure	3
28B	No. of Traffic Lanes under the Structure	0
29	Average Daily Traffic (ADT)	31460
30	Year of ADT	2011
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restriction
43A	Structure Type – Material and/or Design	1 – Concrete
43B	Structure Type – Design and/or Construction	4 – Tee beam
49	Structure Length	61m (200ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	Y60 – inspection required every 60 months
92C	Other Special Inspection	Y24 – inspection required every 24 months
101	Parallel Structure Designation	R – The right structure of parallel bridges carrying the roadway in the direction of the inventory.
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	1995
109	Average Daily Truck Traffic (% of ADT)	8%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 70. Image. 2022 Views of Bridge # 021-0073-0 [2].

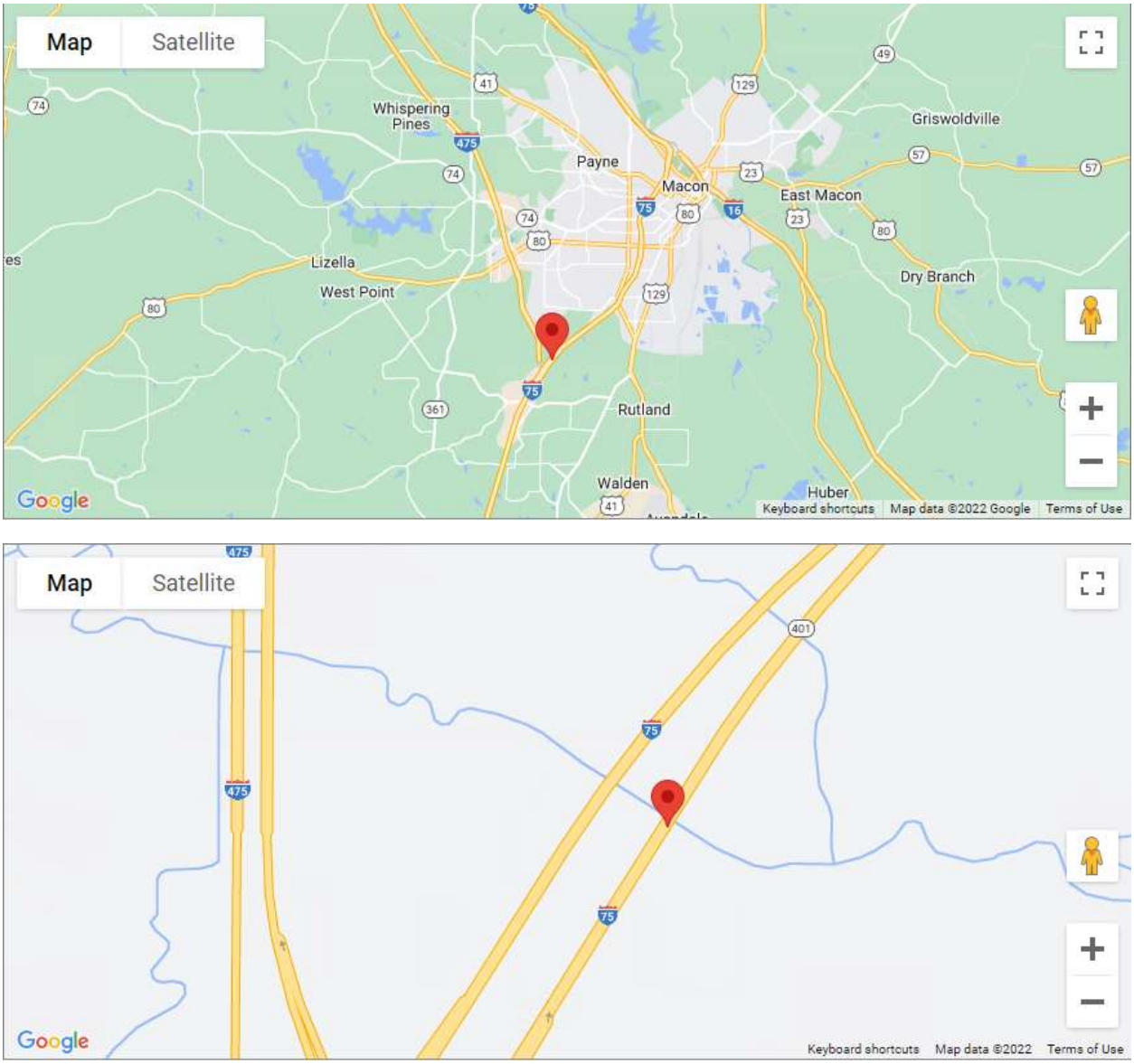


Figure 71. Image. Bridge # 021-0073-0 Location [3].

NBI Data Analysis

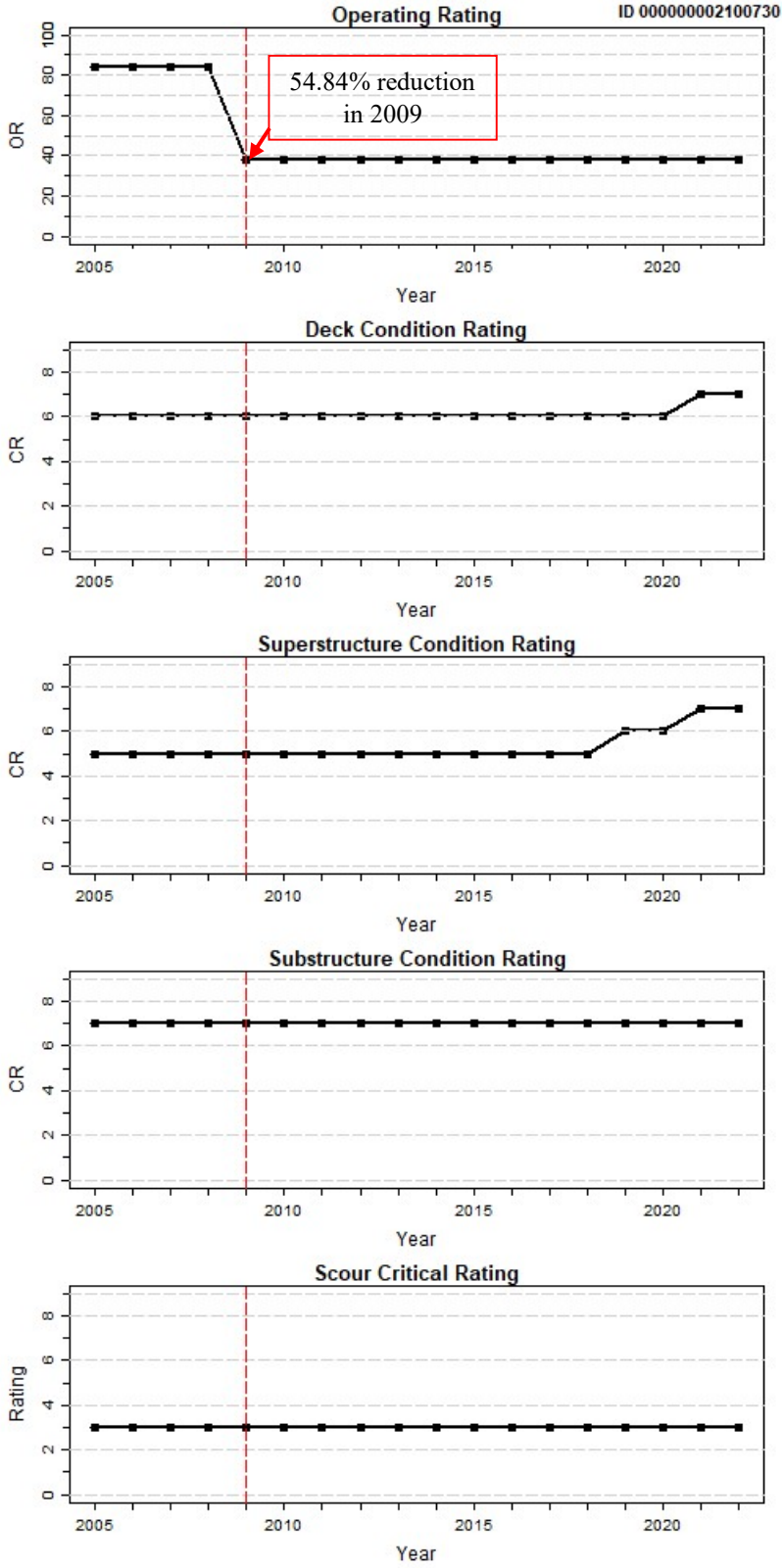


Figure 72. Graphs. NBI Operating & Condition Ratings for Structure # 021-0073-0 [1].

Table 40. NBI Data for Structure # 021-0073-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Super structure	Sub structure	Scour Critical
2005	1	83.7		6	5	7	3
2006	1	83.7	0.00	6	5	7	3
2007	1	83.7	0.00	6	5	7	3
2008	1	83.7	0.00	6	5	7	3
2009	1	37.8	-54.84	6	5	7	3
2010	1	37.8	0.00	6	5	7	3
2011	1	37.8	0.00	6	5	7	3
2012	1	37.8	0.00	6	5	7	3
2013	1	37.8	0.00	6	5	7	3
2014	1	37.8	0.00	6	5	7	3
2015	1	37.8	0.00	6	5	7	3
2016	1	37.8	0.00	6	5	7	3
2017	1	37.8	0.00	6	5	7	3
2018	1	37.8	0.00	6	5	7	3
2019	1	37.8	0.00	6	6	7	3
2020	1	37.8	0.00	6	6	7	3
2021	1	38.1	0.79	7	7	7	3
2022	1	38.1	0.00	7	7	7	3

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 021-0073-0 from 2016-2022:

- Deck/Slab:
    - EN12 - RC Deck
    - EN16 - RC Top Flange
- Superstructure:
    - EN109 - PSC Girder/Beam
    - EN110 - RC Girder/Beam
- Substructure:
    - EN204 - PSC Column
    - EN215 - RC Abutment
    - EN226 - PSC Pile
    - EN234 - RC Pier Cap
- Joints & Bearings:
    - EN301 - Pourable Joint
    - EN310 - Elastomeric Bearing
- Bridge Rails:
    - EN331 - RC Bridge Rail
    - EN333 - Other Bridge Rail

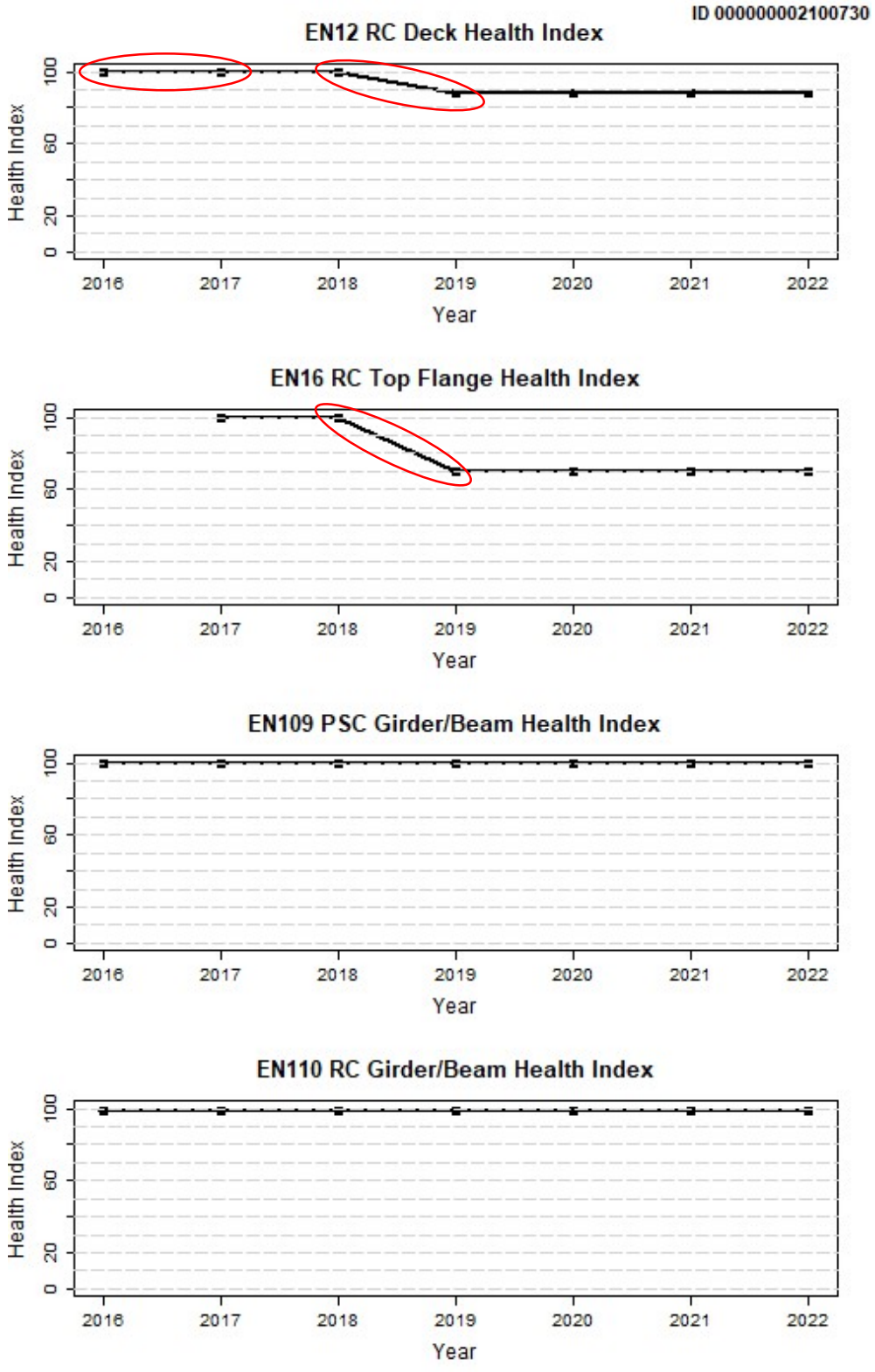


Figure 73. Graphs. Deck/Slab & Superstructure Element Health Indices for Structure # 021-0073-0 [4].

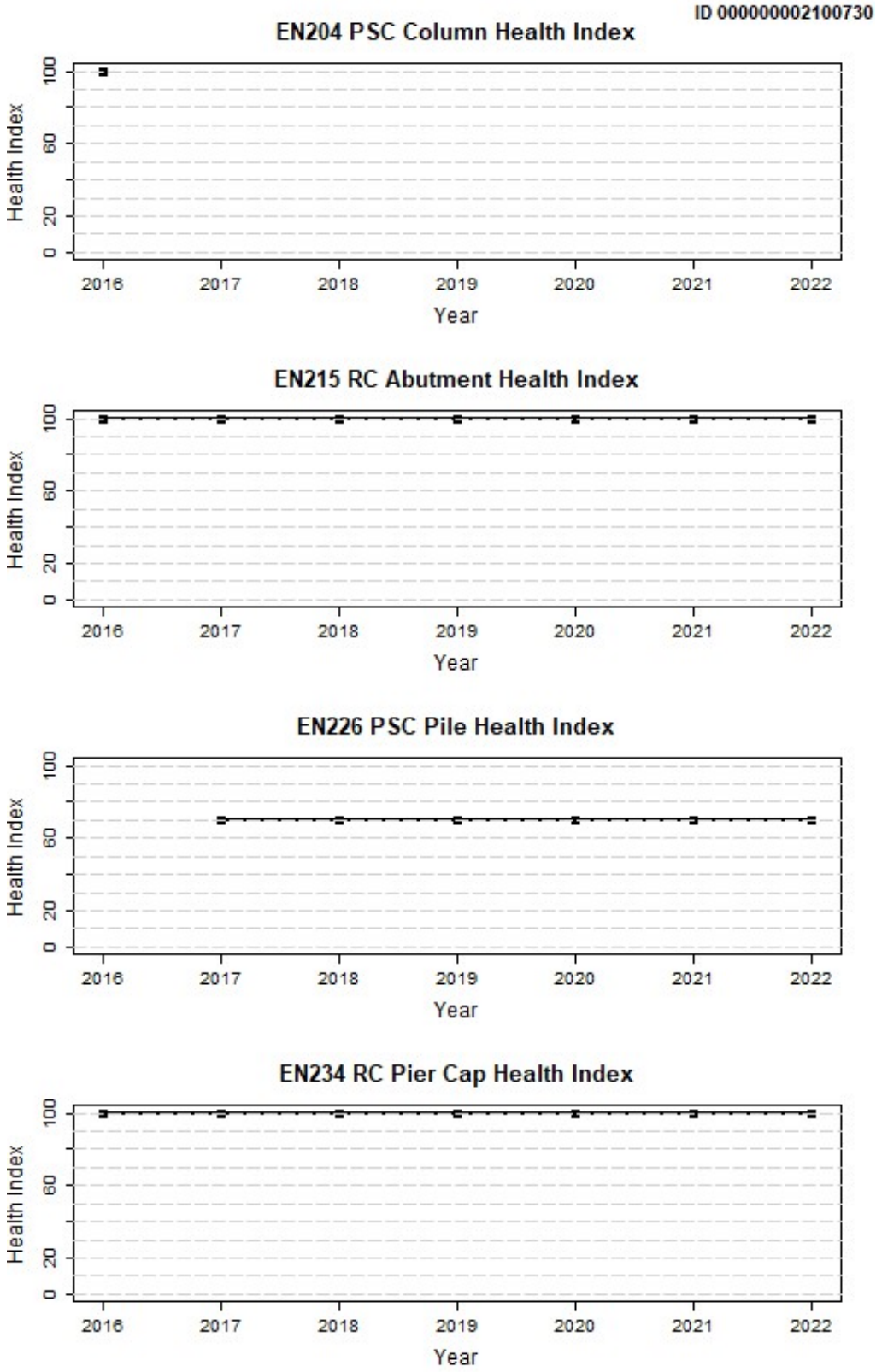


Figure 74. Graphs. Substructure Element Health Indices for Structure # 021-0073-0 [4].

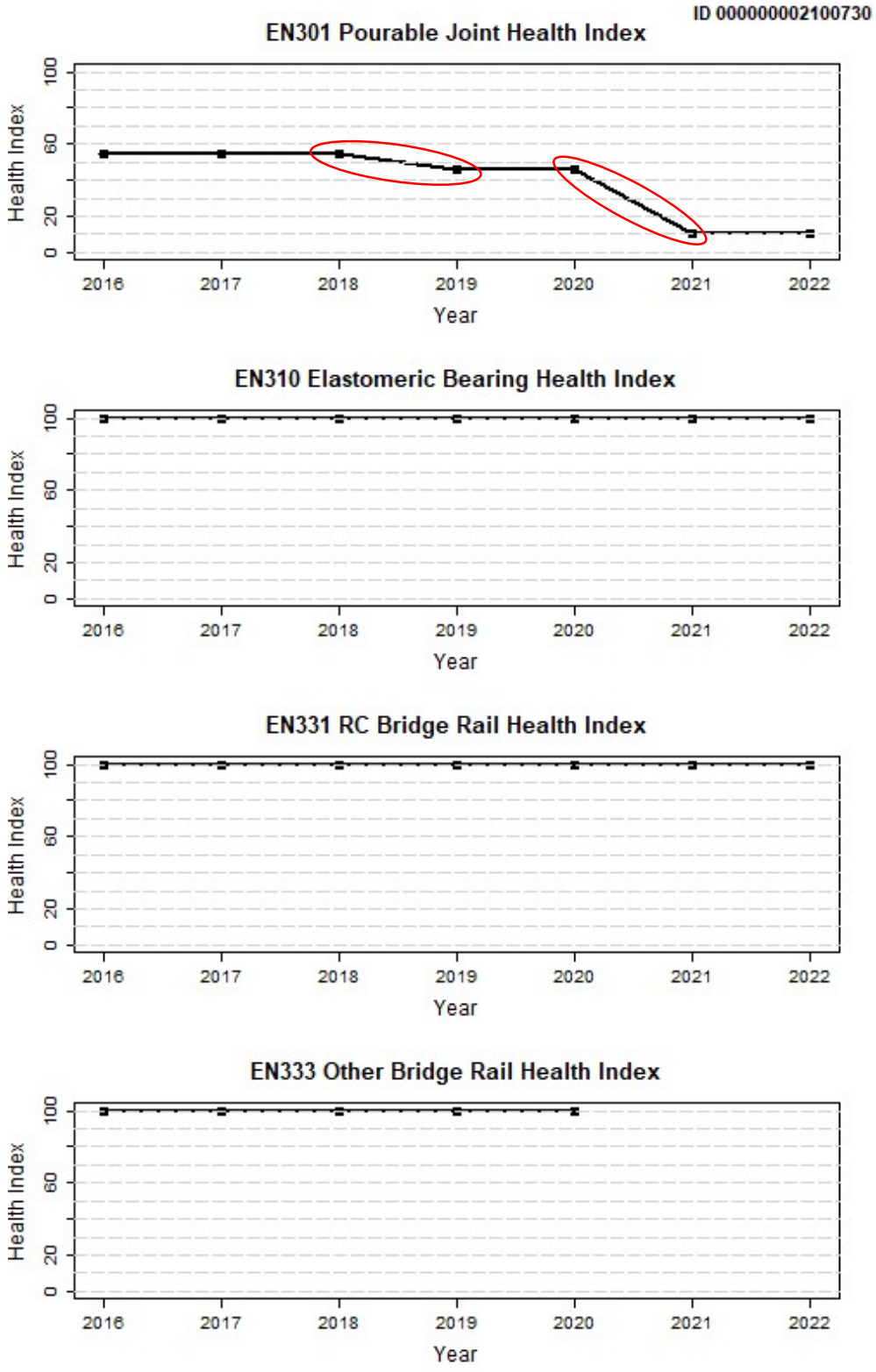


Figure 75. Graphs. Joints, Bearings, & Rail Element Health Indices for Structure # 021-0073-0 [4].

Supplemental Tables

Table 41. Deck, Joint, Bearing, & Rail NBI Bridge Element Data for Structure # 021-0073-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN12 – RC Deck								
2016	99.90		99.84	0.16	0.00	0.00	12520	SF
2017	99.74	-0.16	99.57	0.43	0.00	0.00	4695	SF
2018	99.74	0.00	99.57	0.43	0.00	0.00	4695	SF
2019	87.74	-12.03	79.57	20.43	0.00	0.00	4695	SF
2020	87.74	0.00	79.57	20.43	0.00	0.00	4695	SF
2021	87.74	0.00	79.57	20.43	0.00	0.00	4695	SF
2022	87.74	0.00	79.57	20.43	0.00	0.00	4695	SF
EN16 - RC Top Flange								
2017	100.00		100.00	0.00	0.00	0.00	7825	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	7825	SF
2019	70.02	-29.98	50.03	49.97	0.00	0.00	7825	SF
2020	70.02	0.00	50.03	49.97	0.00	0.00	7825	SF
2021	70.02	0.00	50.03	49.97	0.00	0.00	7825	SF
2022	70.02	0.00	50.03	49.97	0.00	0.00	7825	SF
EN109 - PSC Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	600	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	600	LF
EN110 - RC Girder/Beam								
2016	98.90		98.17	1.83	0.00	0.00	1200	LF
2017	98.90	0.00	98.17	1.83	0.00	0.00	1200	LF
2018	98.90	0.00	98.17	1.83	0.00	0.00	1200	LF
2019	98.90	0.00	98.17	1.83	0.00	0.00	1200	LF
2020	98.90	0.00	98.17	1.83	0.00	0.00	1200	LF
2021	98.90	0.00	98.17	1.83	0.00	0.00	1200	LF
2022	98.90	0.00	98.17	1.83	0.00	0.00	1200	LF

Table 42. Superstructure & Substructure NBI Bridge Element Data for Structure # 021-0073-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN204 - PSC Column								
2016	100.00		100.00	0.00	0.00	0.00	36	EA
EN215 - RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	130	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	130	LF
EN226 - PSC Pile								
2017	70.00		50.00	50.00	0.00	0.00	36	EA
2018	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2019	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2020	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2021	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
2022	70.00	0.00	50.00	50.00	0.00	0.00	36	EA
EN234 - RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	252	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	252	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	252	LF

Table 43. Superstructure & Substructure NBI Bridge Element Data for Structure # 021-0073-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 - Pourable Joint								
2016	55.00		50.00	0.00	50.00	0.00	300	LF
2017	55.00	0.00	50.00	0.00	50.00	0.00	300	LF
2018	55.00	0.00	50.00	0.00	50.00	0.00	300	LF
2019	46.00	-16.36	40.00	0.00	60.00	0.00	300	LF
2020	46.00	0.00	40.00	0.00	60.00	0.00	300	LF
2021	10.00	-78.26	0.00	0.00	100.00	0.00	300	LF
2022	10.00	0.00	0.00	0.00	100.00	0.00	300	LF
EN310 - Elastomeric Bearing								
2016	100.00		100.00	0.00	0.00	0.00	30	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	30	EA
EN331 - RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	200	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
EN333 - Other Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	200	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	200	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	200	LF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

Photo 03 - Erosion along Abutment 6

Photo 04 - Abutment 1 slope repairs

Photo 05 - Location of shear crack in Beam 5-7 west face at Abutment 6

erosion hole at south approach slab behind abutment 1 3'W x 2.5'L x 3'D

Photo 07 - Typical missing/deteriorated sealant in expansion joint

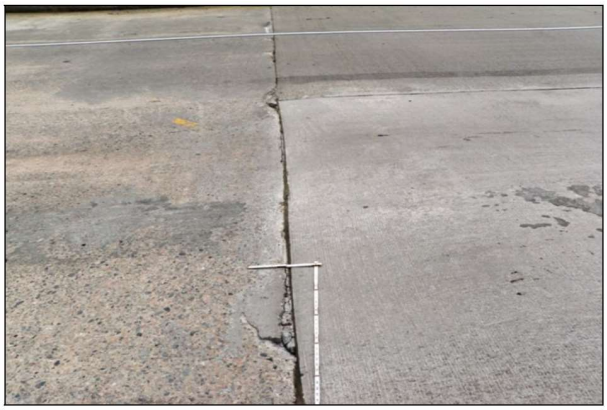


Photo 08 - Spalls at south end of south approach slab

Figure 76. Images. Issues Documented in 2012 for Structure # 021-0073-0.

Figure 77. Images. Issues Documented in 2022 for Structure # 021-0073-0.

Findings

- NBI Data concerns:
    - 54.84% reduction in operating rating between 2008 and 2009
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Deck:
        - RC Deck: 12.03% health index reduction in 2019
        - RC Top Flange: 29.98% health index reduction in 2019
    - Substructure:
        - PSC Pile: low health index (70.0) 2017 – 2022
    - Joints:
        - Pourable Joint: 16.36% health index reduction in 2019
        - Pourable Joint: 78.26% health index reduction in 2021
- Inspection Report concerns:
    - Reports available in 2004, 2006, 2008, 2010, 2012, & 2014-2022
    - Repairs made
    - Deck:
        - Deck has cracking (shrinkage, transvers), scaling, spalling since 2004; longitudinal cracking and cut outs (no exposed rebar) since 2010
        - Diagonal cracking at abutments since 2004
        - Approach slabs have cracking (longitudinal, transverse, shrinkage) since 2004; erosion holes at abutments since 2008; spall and delamination (no exposed rebar since 2010
        - Joints have spalling since 2008; missing/deteriorated sealant since 2010; all deck joints are leaking since 2018
    - Superstructure:
        - T-Beams have cracking (deflection/flexure) since 2004
        - Beams have cracking (shear), spall since 2004
    - Substructure:

- Piles have cracking, scaling/abrasion below waterline since 2004; trivial scour present in 2017
- Caps have cracking since 2004
- Abutments have erosion and holes since 2004; settlement since 2012; cracking with efflorescence since 2018

(10) Bridge # 051-0114-0 Summary

Bridge Information

Table 44. Bridge # 051-0114-0 NBI Data to Note [1].

NBI Item	Item Name	Item Data
8	Structure Number	000000005101140
N/A	Reliability Index (WIM Site A*)	0.737824685
N/A	Reliability Index (WIM Site B*)	0.982950475
N/A	Reliability Index (WIM Site C*)	1.701232643
N/A	Reliability Index (WIM Site D*)	1.044102941
N/A	Reliability Index (WIM Site E*)	1.496933024
N/A	Reliability Index (WIM Site F*)	1.483186076
N/A	Reliability Index (WIM Site G*)	0.737824685
N/A	Age	27
5B	Route Prefix	1 – Interstate
5D	Route Number	95
3	County Code	51 – Chatham
6A	Features Intersected	SR 26 (US 80)
7	Facility Carried by Structure	I-95 (SBL)
9	Location	10.5 MI NW OF SAVANNAH
16	Latitude	32°06'45.07"N (32.1125)
17	Longitude	81°14'17.41"W (-81.2381)
27	Year Built	1976
28A	No. of Traffic Lanes on the Structure	3
28B	No. of Traffic Lanes under the Structure	6
29	Average Daily Traffic (ADT)	71150
30	Year of ADT	2011
41	Structure Open, Posted, or Closed to Traffic?	A – Open, no restriction
43A	Structure Type – Material and/or Design	4 – Steel continuous
43B	Structure Type – Design and/or Construction	2 – Stringer/Multi-beam or girder
49	Structure Length	72.2m (237ft)
92A	Fracture Critical Details	N
92B	Underwater Inspection	N
92C	Other Special Inspection	N
101	Parallel Structure Designation	L -The left structure of parallel
102	Direction of Traffic	1-way traffic
106	Year Reconstructed	1995
109	Average Daily Truck Traffic (% of ADT)	1%

*Note: Each calculated reliability index for the bridge was found using live load data from all WIM sites associated with the bridge's route. Multiple WIM sites are often associated with one given bridge. Refer to Ananta Sinha's dissertation "Data-Informed Cognitive Approaches to the Evaluation of Weigh-In-Motion Based Live Loads for Bridge Reliability" for details.

Figure 78. Image. 2022 Views of Bridge # 051-0114-0 [2].

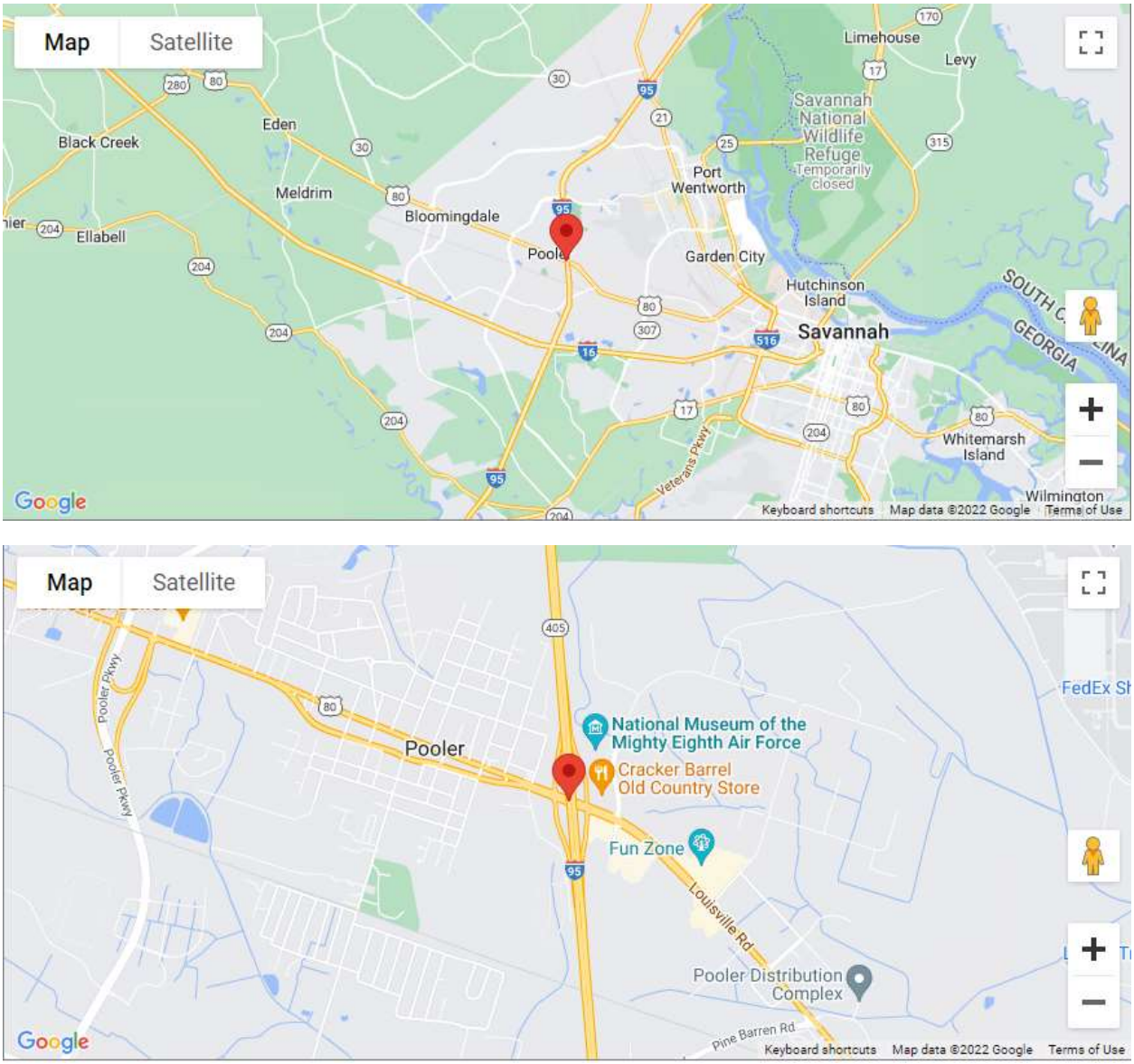


Figure 79. Image. Bridge # 051-0114-0 Location [3].

NBI Data Analysis

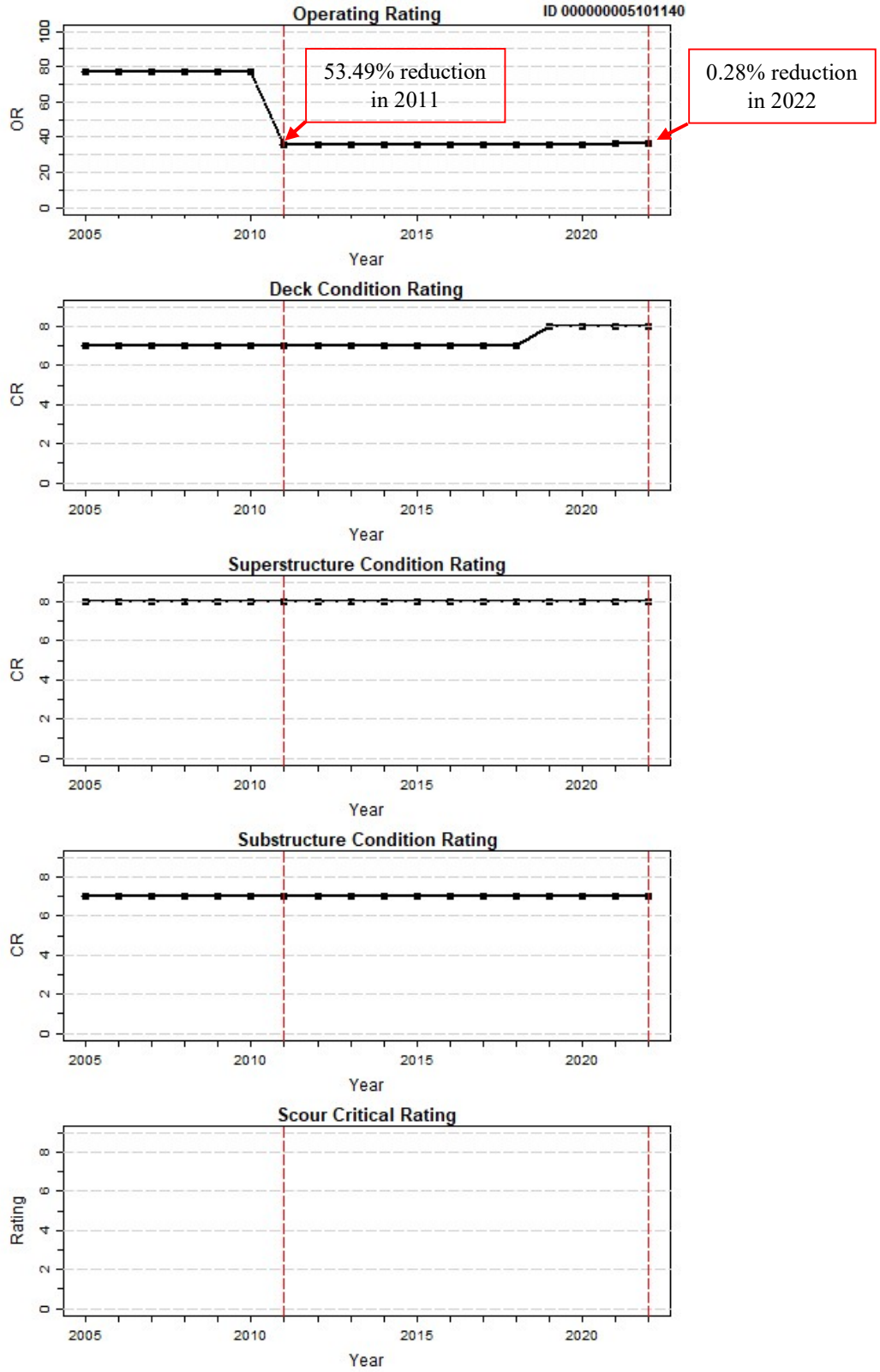


Figure 80. Graphs. NBI Operating & Condition Ratings for Structure # 051-0114-0 [1].

Table 45. NBI Data for Structure # 051-0114-0 [1].

Year	Operating Rating Method	Operating Rating (OR)	OR % Change Year-to-Year	Condition Ratings			
				Deck	Superstructure	Substructure	Scour Critical
2005	1	77.4		7	8	7	N
2006	1	77.4	0.00	7	8	7	N
2007	1	77.4	0.00	7	8	7	N
2008	1	77.4	0.00	7	8	7	N
2009	1	77.4	0.00	7	8	7	N
2010	1	77.4	0.00	7	8	7	N
2011	1	36	-53.49	7	8	7	N
2012	1	36	0.00	7	8	7	N
2013	1	36	0.00	7	8	7	N
2014	1	36	0.00	7	8	7	N
2015	1	36	0.00	7	8	7	N
2016	1	36	0.00	7	8	7	N
2017	1	36	0.00	7	8	7	N
2018	1	36	0.00	7	8	7	N
2019	1	36	0.00	8	8	7	N
2020	1	36	0.00	8	8	7	N
2021	1	36.3	0.83	8	8	7	N
2022	1	36.2	-0.28	8	8	7	N

NBI Element Data Analysis

Note that in the figures, red circles indicate a reduction in element health index while green circles indicate an increase in element health index. Likewise, a red highlight in the tables indicates a reduction in element health index or element total quantity while a green highlight indicates an increase in element health index or element total quantity.

The following elements are recorded in bridge # 051-0114-0 from 2016-2022:

- Deck/Slab:
  - EN12 - RC Deck
- Superstructure:
  - EN107 - Steel Girder/Beam
- Substructure:
  - EN205 - RC Column
  - EN215 - RC Abutment
  - EN234 - RC Pier Cap
- Joints & Bearings:
  - EN301 - Pourable Joint
  - EN311 - Movable Bearing
  - EN313 - Fixed Bearing
- Bridge Rails:
  - EN331 - RC Bridge Rail
- Wearing Surfaces & Protective Coatings:
  - EN510 - Wearing Surface (EPN12 RC Deck)
  - EN515 - Steel Protective Coating (EPN107 Steel Girder/Beam)
  - EN515 - Steel Protective Coating (EPN311 Movable Bearing)
  - EN515 - Steel Protective Coating (EPN313 Fixed Bearing)
  - EN521 - Concrete Protective Coating (EPN12 RC Deck)

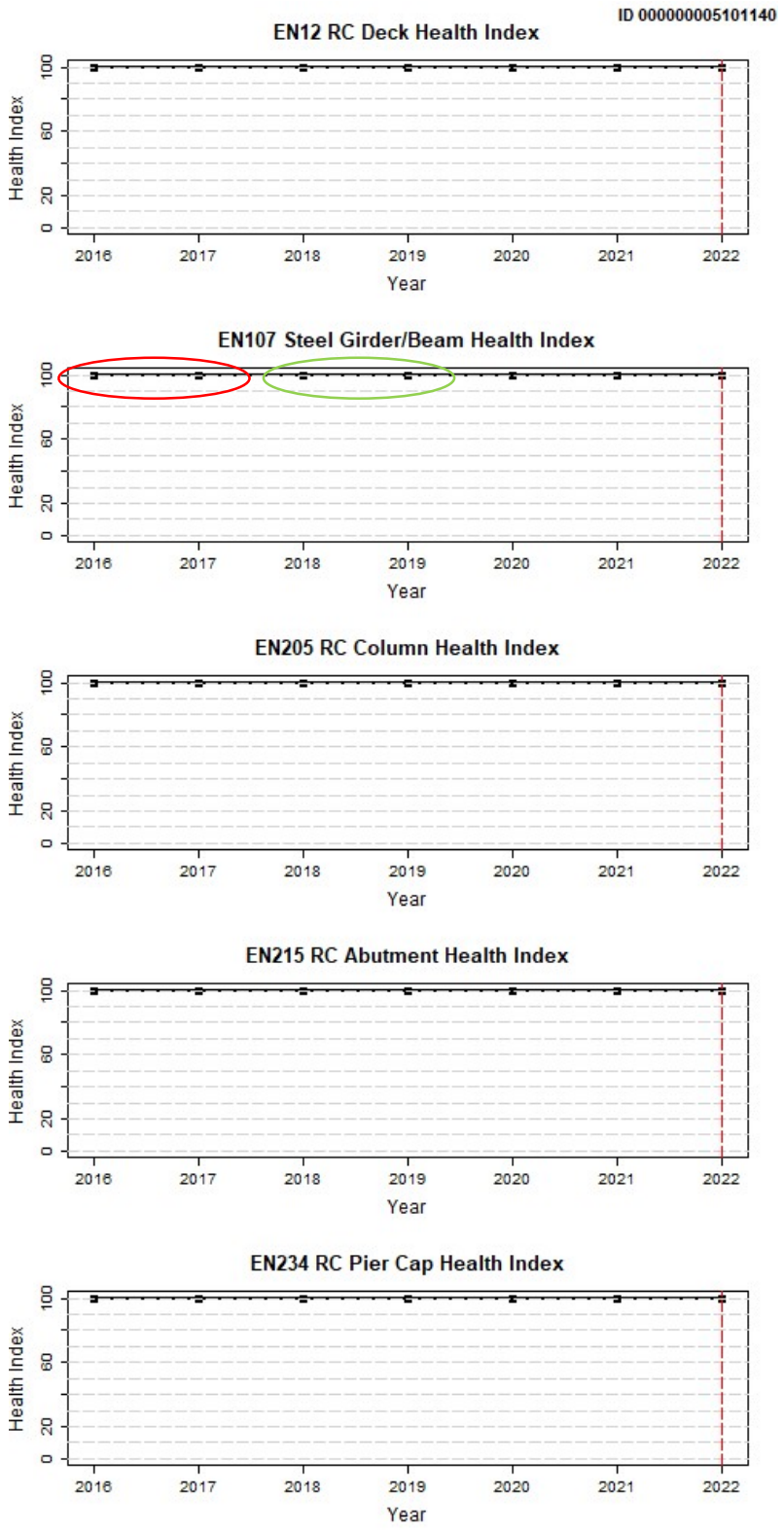


Figure 81. Graphs. Deck, Superstructure, & Substructure Element Health Indices for Structure # 051-0114-0 [4].

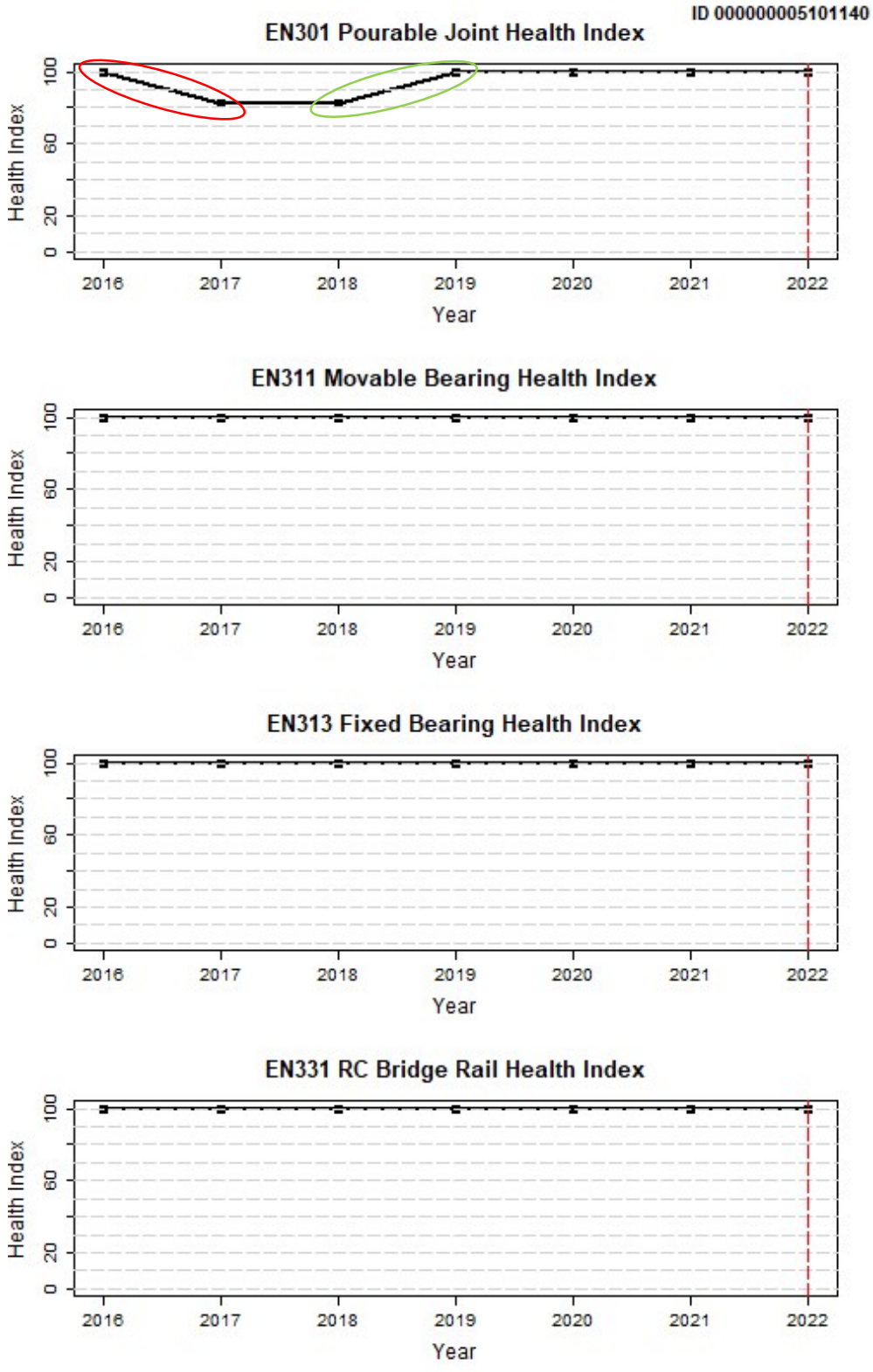


Figure 82. Graphs. Joints, Bearings, and Rail Element Health Indices for Structure # 051-0114-0 [4].

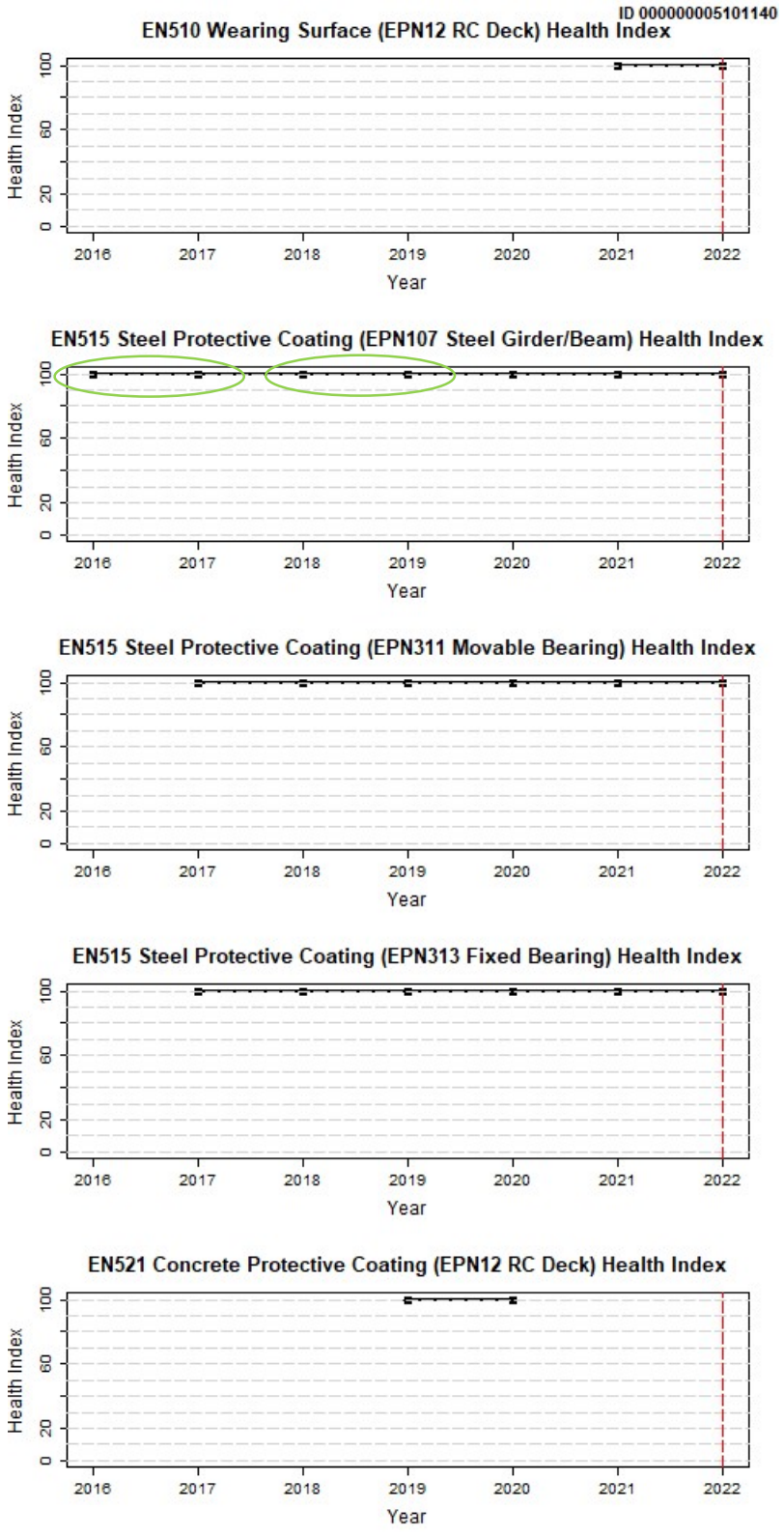


Figure 83. Graphs. Wearing Surface & Protective Coatings Element Health Indices for Structure # 051-0114-0 [4].

Supplemental Tables

Table 46. Deck, Superstructure, & Substructure NBI Bridge Element Data for Structure # 051-0114-0 [4].

Year	Health	HI % Change	CS1%	CS2%	CS3%	CS4%	Total	Units
EN12 – RC Deck								
2016	100.00		100.00	0.00	0.00	0.00	18842	SF
2017	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
2019	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
EN107 - Steel Girder/Beam								
2016	100.00		100.00	0.00	0.00	0.00	2546	LF
2017	99.98	-0.02	99.96	0.04	0.00	0.00	2546	LF
2018	99.98	0.00	99.96	0.04	0.00	0.00	2546	LF
2019	100.00	0.02	100.00	0.00	0.00	0.00	2546	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	2546	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	2546	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	2546	LF
EN205 - RC Column								
2016	100.00		100.00	0.00	0.00	0.00	15	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	15	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	15	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	15	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	15	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	15	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	15	EA
EN215 - RC Abutment								
2016	100.00		100.00	0.00	0.00	0.00	160	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	160	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	160	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	160	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	160	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	160	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	160	LF
EN234 - RC Pier Cap								
2016	100.00		100.00	0.00	0.00	0.00	240	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	240	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	240	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	240	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	240	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	240	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	240	LF

Table 47. Joint, Bearing, & Rail NBI Bridge Element Data for Structure # 051-0114-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN301 - Pourable Joint								
2016	100.00		100.00	0.00	0.00	0.00	390	LF
2017	82.00	-18.00	80.00	0.00	20.00	0.00	390	LF
2018	82.00	0.00	80.00	0.00	20.00	0.00	390	LF
2019	100.00	21.95	100.00	0.00	0.00	0.00	390	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	390	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	390	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	390	LF
EN311 - Movable Bearing								
2016	100.00		100.00	0.00	0.00	0.00	66	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	66	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	66	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	66	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	66	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	66	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	66	EA
EN313 - Fixed Bearing								
2016	100.00		100.00	0.00	0.00	0.00	22	EA
2017	100.00	0.00	100.00	0.00	0.00	0.00	22	EA
2018	100.00	0.00	100.00	0.00	0.00	0.00	22	EA
2019	100.00	0.00	100.00	0.00	0.00	0.00	22	EA
2020	100.00	0.00	100.00	0.00	0.00	0.00	22	EA
2021	100.00	0.00	100.00	0.00	0.00	0.00	22	EA
2022	100.00	0.00	100.00	0.00	0.00	0.00	22	EA
EN331 - RC Bridge Rail								
2016	100.00		100.00	0.00	0.00	0.00	476	LF
2017	100.00	0.00	100.00	0.00	0.00	0.00	476	LF
2018	100.00	0.00	100.00	0.00	0.00	0.00	476	LF
2019	100.00	0.00	100.00	0.00	0.00	0.00	476	LF
2020	100.00	0.00	100.00	0.00	0.00	0.00	476	LF
2021	100.00	0.00	100.00	0.00	0.00	0.00	476	LF
2022	100.00	0.00	100.00	0.00	0.00	0.00	476	LF

Table 48. Wearing Surface & Protective Coatings NBI Bridge Element Data for Structure # 051-0114-0 [4].

Year	Health Index (HI)	HI % Change Year-to-Year	CS1%	CS2%	CS3%	CS4%	Total Quantity	Units
EN510 - Wearing Surface (EPN12 RC Deck)								
2021	100.00		100.00	0.00	0.00	0.00	18842	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF
EN515 - Steel Protective Coating (EPN107 Steel Girder/Beam)								
2016	99.41		99.35	0.00	0.65	0.00	15276	SF
2017	99.82	0.41	99.80	0.00	0.20	0.00	15276	SF
2018	99.82	0.00	99.80	0.00	0.20	0.00	15276	SF
2019	100.00	0.18	100.00	0.00	0.00	0.00	15276	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	15276	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	15276	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	15276	SF
EN515 - Steel Protective Coating (EPN311 Movable Bearing)								
2017	100.00		100.00	0.00	0.00	0.00	66	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	66	SF
2019	100.00	0.00	100.00	0.00	0.00	0.00	66	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	66	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	66	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	66	SF
EN515 - Steel Protective Coating (EPN313 Fixed Bearing)								
2017	100.00		100.00	0.00	0.00	0.00	22	SF
2018	100.00	0.00	100.00	0.00	0.00	0.00	22	SF
2019	100.00	0.00	100.00	0.00	0.00	0.00	22	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	22	SF
2021	100.00	0.00	100.00	0.00	0.00	0.00	22	SF
2022	100.00	0.00	100.00	0.00	0.00	0.00	22	SF
EN521 - Concrete Protective Coating (EPN12 RC Deck)								
2019	100.00		100.00	0.00	0.00	0.00	18842	SF
2020	100.00	0.00	100.00	0.00	0.00	0.00	18842	SF

Inspection Report Analysis

The following section summarizes information detailed in inspection reports recorded by the Georgia Department of Transportation (GDOT) [2]. It should be noted that information collected in inspection reports is reflected in the following year's NBI data. For example, data collected and recorded in a 2015 inspection report would be reflected in 2016 NBI data.

LOOKING NORTH DIRECTION OF INVENTORY.

LOOKING NORTH DIRECTION OF INVENTORY. Right side.

LOOKING NORTH DIRECTION OF INVENTORY. LOOKING AT BENT 3 CAP OF ORIGINAL SECTION.

Figure 84. Images. Typical Views in 2012 for Structure # 051-0114-0.

Figure 85. Images. Typical Views in 2022 for Structure # 051-0114-0.

Findings

- NBI Data concerns:
    - 53.49% reduction in operating rating between 2010 and 2011
    - 0..28% reduction in operating rating between 2021 and 2022
        - No impactful changes in condition ratings for deck, superstructure, substructure, and scour between 2005 and 2022
- NBI Element Data concerns:
    - Almost all health indexes are 100.0
    - Joints:
        - Pourable Joint: 18.0% health index reduction in 2017
- Inspection Report concerns:
    - Reports available in 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, & 2022
    - Repairs:
        - Bridge was under contract and completed in June 2002
        - Spalls in substructure patched between 2016 & 2018
    - Deck:
        - Deck has cracking since 2004
        - Rear abutment joint leaking since 2016
        - Approach slab overlay peeling in 2022
    - Superstructure:
        - Flanges have paint flaking since 2008
    - Substructure:
        - Abutment caps have cracks and spall since 2004
        - Columns have cracks since 2016

References

1. *National Bridge Inventory ASCII Data - Georgia*. 2005-2022, U.S. Department of Transportation Federal Highway Administration.
2. *InspectX Version 1.7.9*. 2020, Georgia Department of Transportation.
3. Maps, G. 2022, Google.
4. *National Bridge Inventory Element Data - Georgia*. 2016-2022, U.S. Department of Transportation Federal Highway Administration.