



NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2016 First Quarter Report

January - March

1 S. Wilmington Street
Raleigh, NC 27601



Last Updated:
May 3, 2016

CONSULTANT CERTIFICATION OF COMPLETION

April 26, 2016

Mr. Andy Lelewski, PE
NCTA Director of Toll Road Operations
1 South Wilmington Street
Raleigh, NC 27601

NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q1, 2016 Rating

This is to certify that I, Ken M. McEntire, PE am an authorized official representative of the company Asset Management Associates, PLLC, which is a subconsultant to HNTB North Carolina, P.C. Collaboratively; we are working as the Triangle Expressway Roadway and Facility Maintenance Performance Rating Program Consultants.

I know of my own personal knowledge, and do hereby certify, that the work of the contract described above has been independently performed in accordance with, and in conformity to, the *NCTA Roadway and Facility Maintenance Performance Standards*.

Sincerely,

A handwritten signature in blue ink that reads "Ken M. McEntire". The signature is written in a cursive style with a horizontal line underlining the name.

Ken M. McEntire, PE

Asset Management Associates, PLLC
126 North Salem Street, Suite 206
Apex, NC 27502

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1.0 EXECUTIVE SUMMARY

The North Carolina Turnpike Authority (NCTA) Maintenance Rating Program (MRP) is a maintenance evaluation program for roadway features and toll facilities on the NCTA system. This report presents results from the 2016 First Quarter Assessment of the Triangle Expressway.

The overall 2016 first quarter maintenance rating of the Triangle Expressway is 94.9, which is above the NCTA target rating of 90. As shown in **Table 1**, all elements assessed achieved a rating greater than the target rating of 85.

Table 1: MRP Element Results for the 2016 First Quarter Assessment		
ELEMENT	MRP Rating	Target Rating
Road Surface	98.3	85.0
Unpaved Shoulders and Ditches	97.7	85.0
Drainage	92.6	85.0
Roadside	92.1	85.0
Traffic Control Devices	93.5	85.0
Overall MRP Performance Rating	94.9	90.0

As part of the NCTA MRP, this report provides a rolling rating of the latest four quarterly inspections of the Triangle Expressway. As presented in **Table 2**, the current rolling maintenance rating of the Triangle Expressway is 93.9.

Table 2: MRP Rolling Element Results					
ELEMENT	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Road Surface	98	99	98	98	98
Unpaved Shoulders and Ditches	97	100	98	98	98
Drainage	93	94	84	93	91
Roadside	87	86	91	92	89
Traffic Control Devices	97	89	92	93	93
Overall MRP Performance Rating	94.7	93.1	92.8	94.9	93.9

In addition, the report provides findings of the Green Level Historic District signs inspections. This quarter, all Green Level Historic District signs were found to be in good physical condition, and the landscaped areas around the signs were well maintained.

2.0 INTRODUCTION

The NCTA MRP is a comprehensive planning, measuring, and managing process that provides a means for communicating to managers, stakeholders and customers the impacts of policy and budget decisions on program service delivery.

Using outcome-based performance measures and the service level scale (0 through 100), the inspection results are rated against established thresholds criteria. The program analysis is accomplished through the use of sampling procedures that capture the level of service being provided for individual assets. The evaluation procedure is based on the establishment of threshold conditions that quantify the maximum defect allowed on assets. Over time, the results can be charted to identify work needs and subsequent necessary actions.

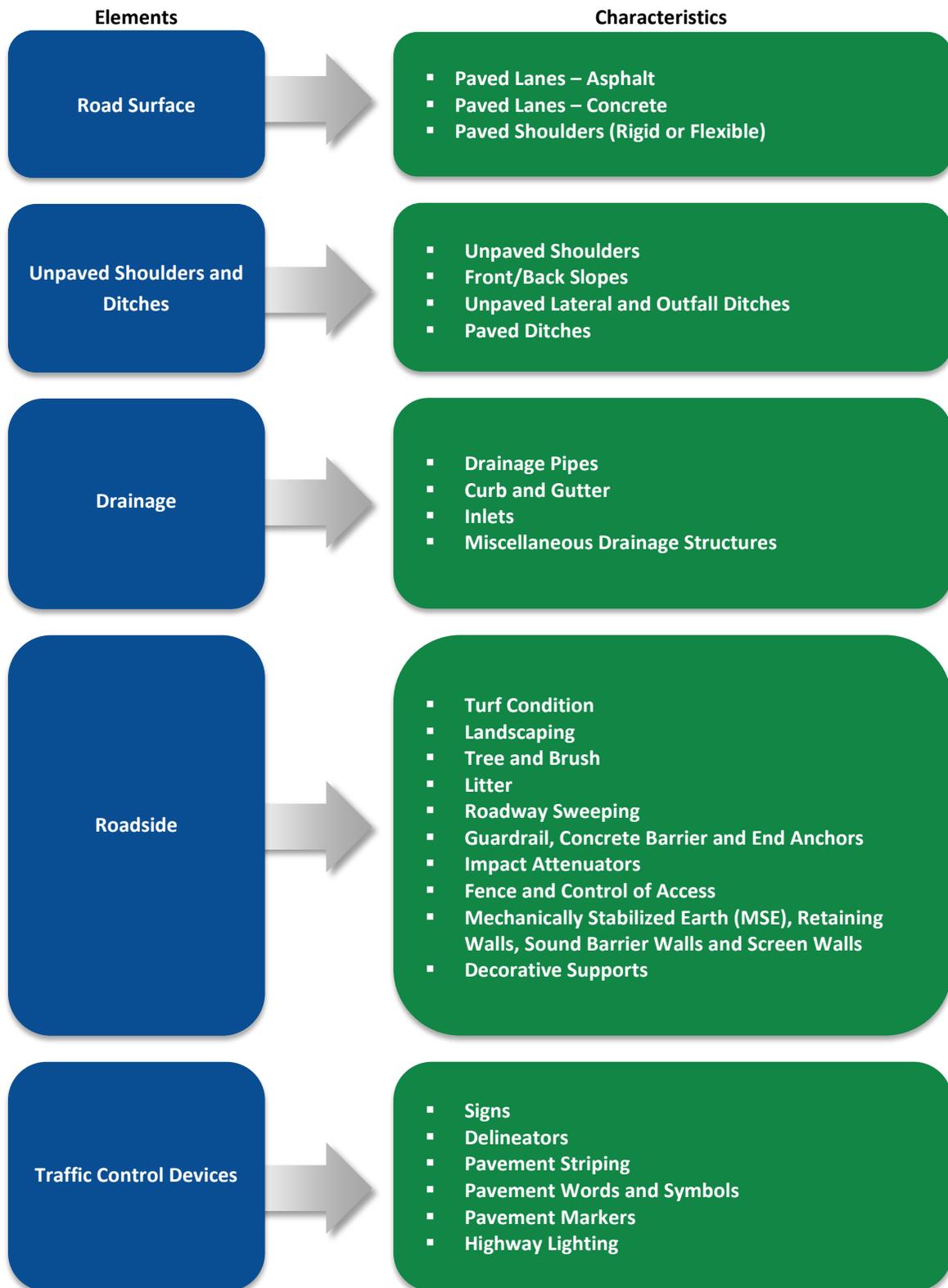
The NCTA performance standards, threshold criteria and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

Using field survey information, a maintenance matrix can be developed to show the ties between maintenance activities and the characteristics of various roadway features. The purpose of this evaluation is to provide information that can be used to schedule and prioritize routine maintenance activities and provide uniform maintenance conditions that meet established objectives.

3.0 MRP PROCEDURE

Per the *NCTA Roadway and Facility Maintenance Performance Standards V4*, roadway assets or characteristics on NCTA facilities have been grouped into elements. These elements and corresponding characteristics can be seen in **Figure 1**:

Figure 1: Maintenance Elements and Characteristics



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A weighting system has been established to identify the importance of each element and characteristic. This system consists of two weighting factors: one that accounts for the importance of individual characteristics within a given maintenance element (1-9), and one that accounts for the importance of the maintenance elements to the total rating (by % of score). This two-factor system reveals deficiencies among characteristics and elements.

The program analysis is accomplished through the use of statistically valid, random sampling procedures that capture the level of service for individual characteristics with a 95% confidence level in sampling. The sample characteristics selected are evaluated during quarterly inspections, which are performed during the months of February, May, August, and November to account for dynamic changes in assets during the various seasons. The evaluation process is completed using electronic data collection tablets and is based on established threshold conditions described in the *NCTA Roadway and Facility Maintenance Standards V4*. Those characteristics that meet or exceed the threshold are coded as PASSING; those that do not meet the threshold are coded as NOT PASSING.

When the evaluation process is completed, the number of PASSING samples and total sample are multiplied by the weighted values (1-9) to determine the actual and possible rating points for characteristics and elements. MRP ratings for elements and characteristics are then calculated as the ratio of the actual rating points to possible rating points. The MRP ratings represent the maintenance level of service currently being provided, as they define the percent of characteristics and elements that meet the maintenance condition standard. For instance, a MRP rating of 83 signifies that 83 percent of the inspected elements/characteristics met the standard.

The overall MRP rating is determined by calculating the sum of the elements ratings multiplied by the following weighted factors:

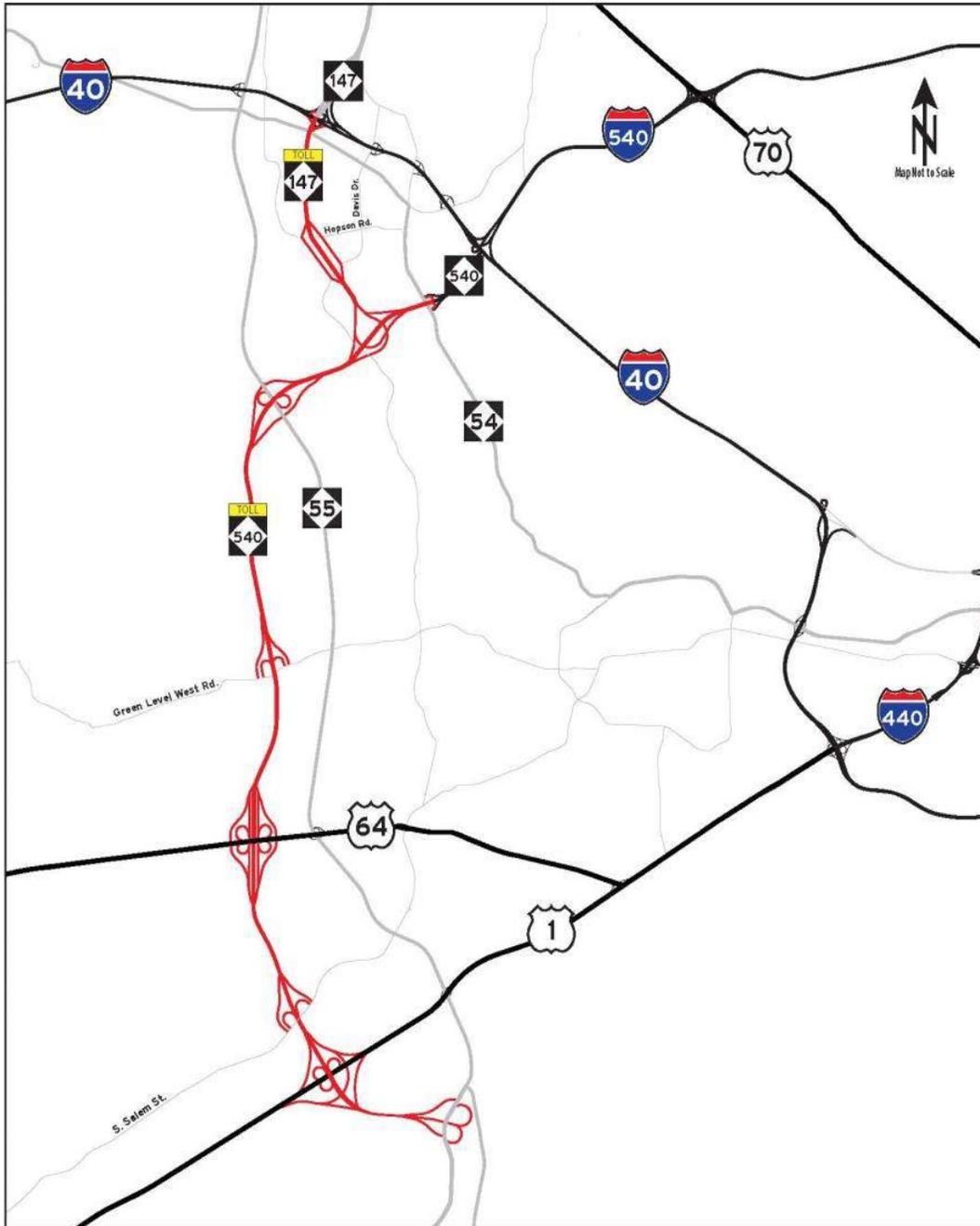
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

The NCTA's overall target rating is 90, with elements scoring 85 or higher, and characteristics 80 or higher. In addition to quarterly ratings, the cumulative rolling annual rating is calculated each quarter. This rating is obtained by adding the ratings of the latest four quarterly inspections to compensate for the likelihood of uneven sample sizes.

4.0 TRIANGLE EXPRESSWAY DESCRIPTION

The Triangle Expressway extends for approximately 18.8 miles from the interchange of I-40 and NC-147 in Durham to the NC-55 Bypass near Holly Springs (**Figure 2**). It includes a one-mile segment on NC-540 extending north from the NC-540 / NC-147 interchange to the NC-54 interchange. The Triangle Expressway consists of ten interchanges and eighteen all-electronic toll collection zones.

Figure 2: Triangle Expressway Map



5.0 TRIANGLE EXPRESSWAY ASSET INVENTORY UPDATE

Through normal day-to-day maintenance activities and the construction of special projects, roadside assets are continuously being added or modified on the roadway. NCTA coordinates closely with NCDOT Division 5 Maintenance and conducts routine field visits to maintain an accurate asset inventory and ensure the validity of the MRP.

During the first quarter no assets were removed or added to the inventory.

6.0 MRP ASSESSMENT

6.1 Quarterly Results

The overall 2016 first quarter maintenance rating of the Triangle Expressway is 94.9, and is above the overall target rating of 90. All element ratings are above the target rating of 85. Miscellaneous Drainage (66), Turf (73), and Highway Lighting (69) are the characteristics that scored below the target rating of 80. It is important to note that these results are only representative of the first quarter sample, one of the four surveys to provide an intermediate snapshot of seasonal conditions. Therefore, they are not a statistically valid representation of the assets; only the total of all four quarterly inspections, reported at the end of each calendar year, will provide a 95% confidence level in statistical sampling. The first quarter MRP performance ratings for elements and characteristics are presented in **Table 3** and **Table 4**, respectively.

Table 3: MRP Element Results for Q1 2016	
ELEMENT	Q1 2016 MRP Rating
Road Surface	98.3
Unpaved Shoulders and Ditches	97.7
Drainage	92.6
Roadside	92.1
Traffic Control Devices	93.5
Overall MRP Performance Rating	94.9

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Table 4: MRP Characteristic Results for Q1 2016						
ROAD SURFACE	SAMPLE PASSED	SAMPLE TOTAL	WEIGHTED VALUES	ACTUAL PTS	AVAILABLE PTS	Q1 RATING
Paved Lanes Asphalt	21	21	9	189	189	100
Paved Lanes Concrete	22	22	9	198	198	100
Paved Shoulder	41	43	5	205	215	95
Element Total				592	602	98.3
UNPAVED SHOULDERS AND DITCHES	SAMPLE PASSED	SAMPLE TOTAL	WEIGHTED VALUES	ACTUAL PTS	AVAILABLE PTS	Q1 RATING
Unpaved Shoulder	42	43	9	378	387	98
Front/Back Slopes	41	43	6	246	258	95
Lateral and Outfall Ditches, Unpaved	43	43	6	258	258	100
Ditches, Paved	2	2	5	10	10	100
Element Total				892	913	97.7
DRAINAGE	SAMPLE PASSED	SAMPLE TOTAL	WEIGHTED VALUES	ACTUAL PTS	AVAILABLE PTS	Q1 RATING
Drainage Pipes	32	33	7	224	231	97
Curb and Gutter	25	25	6	150	150	100
Inlets	32	33	7	224	231	97
Misc. Drainage Structure	19	29	4	76	116	66
Element Total				674	728	92.6
ROADSIDE	SAMPLE PASSED	SAMPLE TOTAL	WEIGHTED VALUES	ACTUAL PTS	AVAILABLE PTS	Q1 RATING
Turf Condition	56	77	7	392	539	73
Landscaping	26	26	4	104	104	100
Trees and Brush	31	31	4	124	124	100
Litter	43	43	4	172	172	100
Roadway Sweeping	43	43	5	215	215	100
Guardrail, Concrete Barrier and End	31	31	9	279	279	100
Impact Attenuators	9	9	9	81	81	100
Fence, Control Access	27	29	7	189	203	93
Retaining Walls and Sound Barrier Walls	17	19	5	85	95	89
Decorative Supports	25	25	5	125	125	100
Graffiti and Stain Removal	59	59	4	236	236	100
Element Total				2002	2173	92.1
TRAFFIC CONTROL DEVICES	SAMPLE PASSED	SAMPLE TOTAL	WEIGHTED VALUES	ACTUAL PTS	AVAILABLE PTS	Q1 RATING
Signs	30	33	7	210	231	91
Delineators	25	28	3	75	84	89
Pavement Striping/Marking	43	43	8	344	344	100
Words and Symbols	30	30	7	210	210	100
Pavement Markers	43	43	9	387	387	100
Highway Lighting	24	35	6	144	210	69
Element Total				1370	1466	93.5

Additionally, **Appendix A** includes maps that present the location of all assets assessed during the first quarter. **Appendix B** includes a list of the individual assets that failed the first quarter inspection.

6.2 Analysis and Recommendations

Elements

During the first quarter all elements exceeded NCTA's target threshold criteria of 85. This quarter's rating for Drainage (93) is 8.8 points higher than the previous quarter and the ratings for Roadside (92) and Traffic Control Devices (93) increased by over 1 point.

Characteristics

This quarter all characteristics satisfied the NCTA target threshold criteria of 80 with the exception of Miscellaneous Drainage Structure (66), Turf Condition (73), and Highway Lighting (69). This section describes the conditions of these characteristics and presents recommended future work planning to raise the ratings. Pictures of the failures are included in **Appendix B**.

Miscellaneous Drainage Structure (66 rating – 10 of the 29 assets failed). Out of the 10 miscellaneous drainage failures, 7 occurred because of obstruction and 3 occurred because of buildups affecting the flow of water near and adjacent to the structure. Two of the failing miscellaneous drainage structures are presented in **Figure 3**.

Figure 3: Miscellaneous Drainage Structure Failures



Some of the obstruction failures are a result of inadequate gradient flow away from the edge drain outlets. In order to avoid affecting the natural flow of water near the drainage features, it is recommended that outlet elevations be checked against the outflow ditch elevations to ensure positive drainage. Appropriate grading of the ditch line may be necessary to provide positive flow.

In accordance with *NCTA Roadway and Facility Maintenance Standards V4* referenced below, it is recommended that the maintenance provider plan annual cleaning of these drainage features to

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remove any debris or overgrown vegetation. Additionally, it is recommended that the maintenance provider schedule repairs of the erosion soil buildup problems that have been identified along the ditch line near and adjacent to the outlet.

Miscellaneous Drainage Maintenance Program Standards:

- 1) Miscellaneous Drainage Structures shall be inspected during routine patrols
- 2) Clear all outlets to edge drains annually
- 3) Schedule cleanouts and repairs during inspections

Miscellaneous Drainage Evaluation Standards:

Miscellaneous Drainage Structures do not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 50% of the structure (length and depth) is obstructed or blocked
- 2) End protection has deteriorations, erosions, washouts or buildups adversely affecting the natural flow of water

Turf Condition (73 rating – 21 of the 77 assets failed). All 21 turf areas failed because of bare ground. Two of the failing turf areas are presented in *Figure 4*.

Figure 4: Turf Failures



As per the NCDOT Division 5 Landscape Unit Plan presented in the 2015 second quarter report, selected bare ground areas (test areas) were hydro-seeded with warm season grasses during the summer of 2015. As of this report, positive results have been observed in all areas tested; grass is growing and establishing well, especially in those test areas that were fertilized near NC 55 Bypass.

Based on these results, the NCDOT Division 5 Landscape Unit is planning to lead a reseeding effort throughout the Expressway with centipede grass using a drill seeding method. This reseeding effort is expected to start by the end of May, 2016. Additionally, the landscape unit has started preparations for two rounds of fertilization throughout the facility that are scheduled to take place in May and July of 2016. It is important to recognize that results from these efforts may not be immediate as it may take several years for the centipede turf to be fully established.

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In order to prevent affecting new growth and scalping of the turf surface, it is further recommended that mowing heights continue to be closely monitored during the each mowing cycle, pursuant to the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Maintenance Program:

- 1) Roadside mowing should occur as often as necessary to conform to the evaluation standard at all times. Mowing shall be in accordance with the NCTA approved mowing patterns and must not exceed the mowing lines identified by the approved stakes. These stakes are identified with a 15 inch white top. The maintenance provider shall review and confirm clarity to the NCTA (in writing) for strict adherence to the approved mowing pattern prior to each mowing season.
- 2) Turf grass shall be cut to a height of six inches (6) with a maximum tolerance of two (2) inches plus or minus.
- 3) Maintain roadway mowing 5' behind guardrail, unless otherwise specified by landscaping stakes.
- 4) Where landscaping has been established, or around the natural enhancement areas, mowing shall conform to the established contours with smooth flowing transitions.
- 5) Roadside trimming shall occur around all traffic appurtenances including, but not limited to guardrail, sign posts, light standards and ITS devices.
- 6) Chemical applications;
 - a. Winter:
 - i. Apply limestone
 - ii. Apply fertilizer
 - b. Spring:
 - i. Apply pre and post emergent broadleaf weed control in accordance to the manufacturer's recommendations in April.
 - ii. Bare ground areas shall be scheduled for seeding in as necessary.
 - c. Fall:
 - i. Apply post-emergence herbicides to select locations in accordance to the manufactures recommendations in August.
 - ii. Bare ground areas shall be seeded in the fall as needed.

Maintenance and Evaluation Standards:

Turf does not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 2% of the vegetation exceeds a uniform height of 12 inches. Minimum height not less than 4 inches.
- 2) More than 25% of the undesirable vegetation is present within the mowing limits of the area.
- 3) Noxious weeds present.
- 4) More than 50 cumulative SF of bare ground is present in the turf evaluation area.

Highway Lighting (69 rating – 11 of the 35 assets failed). Out of the 35 highway lights inspected, 8 failed because of functional damage and 3 failed for missing or damaged parts. Two of the failing highway lights are presented in *Figure 5*.

Figure 5: Highway Lighting Failures



In order to avoid future functional damage, it is recommended that all damaged or missing parts noted be repaired and/or replaced in accordance with the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Highway Lighting Maintenance Program Standards:

- 1) Perform night patrol once a month, and identify any outages. A monthly “Lighting Outage Report” shall be submitted by the maintenance provider to the NCTA by the 30th of each month. All bulb outages must be replaced within 48 hours.
- 2) Perform cleaning of glassware at the same time as any routine maintenance function or diagnostic action is performed.
- 3) Replace any light poles damaged by traffic within 5 days or within 14 days if any foundations need pouring.

Maintenance and Evaluation Standards:

Highway and Sign Lighting do not meet the maintenance standards when any of the following criteria is observed:

- 1) Any electrical inspection plate, access panel cover, exposed electrical wire or pull box cover are not properly secured in place.
- 2) More than 10% of the total luminaries are not functioning during nighttime observation. (N)
- 3) More than 10% of the poles are damaged or missing.
- 4) Rodent screen protection is not in place.

7.0 ROLLING MRP RATING

The current rolling maintenance rating of the Triangle Expressway is 93.9, exceeding NCTA's target overall rating of 90. Additionally, all element ratings are above the target rating of 85. All but three characteristics' ratings meet or exceed the target rating of 80. Ratings for Miscellaneous Drainage Structure, Turf Condition and Highway Lighting were 78, 59 and 77, respectively.

The cumulative rolling results are presented in **Tables 5 and 6**. These results are a collection of the four latest quarterly inspections.

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Table 5: MRP Rolling Characteristic Results					
ROAD SURFACE	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Paved Lanes Asphalt	100	100	98	100	99
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulders	93	95	93	95	94
Element Total	97.6	99.3	97.9	98.3	98.2
UNPAVED SHOULDERS AND DITCHES	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Unpaved Shoulders	97	100	95	98	97
Front/Back Slopes	95	100	100	95	98
Lateral and Outfall Ditches, Unpaved	98	100	100	100	100
Paved Ditches	100	100	100	100	100
Element Total	96.6	100.0	97.8	97.7	98.1
DRAINAGE	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Drainage Pipes	88	91	85	97	90
Curb and Gutter	96	92	84	100	93
Inlets	97	100	94	97	97
Misc. Drainage Structures	94	88	63	66	78
Element Total	93.4	93.5	83.8	92.6	90.8
ROADSIDE	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Turf Condition	50	47	66	73	59
Landscaping	91	100	97	100	97
Trees and Brush	100	100	100	100	100
Litter	100	100	100	100	100
Roadway Sweeping	98	98	100	100	99
Guardrails and Concrete Barriers	97	97	100	100	98
Impact Attenuators	100	89	100	100	97
Fence and Control Access	90	100	90	93	93
Retaining, Sound and Screen Walls	95	79	95	89	89
Decorative Supports	100	100	88	100	97
Graffiti and Stain Removal	100	100	100	100	100
Element Total	86.6	86.3	90.5	92.1	88.8
TRAFFIC CONTROL DEVICES	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Signs	97	100	88	91	94
Delineators	100	76	88	89	88
Pavement Striping/Marking	97	97	100	100	98
Words and Symbols	100	93	100	100	98
Pavement Markers	95	86	90	100	92
Highway Lighting	96	67	67	69	77
Element Total	96.8	89.0	92.2	93.5	93.0

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Table 6: MRP Rolling Element Results					
ELEMENT	Q2 2015 RATING	Q3 2015 RATING	Q4 2015 RATING	Q1 2016 RATING	ROLLING RATING
Road Surface	98	99	98	98	98
Unpaved Shoulders and Ditches	97	100	98	98	98
Drainage	93	94	84	93	91
Roadside	87	86	91	92	89
Traffic Control Devices	97	89	92	93	93
Overall MRP Performance Rating	94.7	93.1	92.8	94.9	93.9

8.0 GREEN LEVEL HISTORIC DISTRICT SIGNS

The four Green Level Historic District signs and surrounding landscaped areas were installed as part of the Triangle Expressway construction projects. Currently, NCDOT is maintaining the Green Level Historic District Signs and the Town of Cary is providing maintenance to the landscaped areas surrounding these signs.

8.1 Analysis and Recommendations

As part of each quarterly inspection, assessors visit the four Green Level Historic District signs to conduct a visual inspection of each sign to ensure they are in good standing. During this quarterly inspection, all signs were found to be in good condition, with the landscaped areas being well maintained. **Figure 6** shows one of these signs.

Figure 6: Green Level West Historic District Signs



9.0 CONCLUSION

This report presents the 2016 first quarter and the current cumulative rolling assessment of the Triangle Expressway. The NCTA's target ratings are 90 overall, 85 for elements and 80 for characteristics. The first quarter 2016 overall rating is 94.9 and the cumulative rolling rating is 93.9. The quarterly and cumulative rolling ratings for this quarter are currently above the target rating of 90.

This quarter all element ratings were above the target rating for both the quarterly and rolling scores. All characteristics' quarterly ratings exceeded the target rating of 80 with the exception of Miscellaneous Drainage Structure (66), Turf Condition (73), and Highway Lighting (69). Similarly, based on the cumulative rolling assessment ratings, Miscellaneous Drainage Structure (78), Turf Condition (59) and Highway Lighting (77) fell below the threshold.

In order to improve the quarterly and rolling characteristic ratings it is recommended that the maintenance provider repair and/or replace all damaged or missing highway lighting parts. It is also recommended that mowing heights continue to be closely monitored during each mowing cycle and NCDOT Division 5 Landscape Unit proceed with the reseeding and fertilization effort planned for 2016.

In addition, it is recommended that outlet elevations be checked against the outflow ditch elevations to ensure positive drainage and prevent drain outlets from backing up with water. Applicable grading of the ditch line may be necessary to provide positive flow. It is also recommended that the maintenance provider plan to remove any debris or overgrown vegetation that may impair outflow from the shoulder drain outlets on a routine basis (once per year in accordance with the *NTCA Roadway and Facility Maintenance Standards V4*).

It is also important to note that routine attention and planning should be given to the nighttime visibility program. While the rating for Pavement Striping continues to exceed the target rating, the lifespan of epoxy paint and reflective pavement markers (RPM's) is 3 to 5 years. Pavement striping and RPM's were installed along portions of the Triangle Expressway over 3 years ago and therefore, preparations should be made in the budget and work schedule for maintenance replacement.

All Green Level Historic District signs inspected during the first quarter were found to be in good condition. Also, the landscaped areas surrounding the signs are being well maintained; preserving sign visibility and aesthetic appearance.

Appendix A

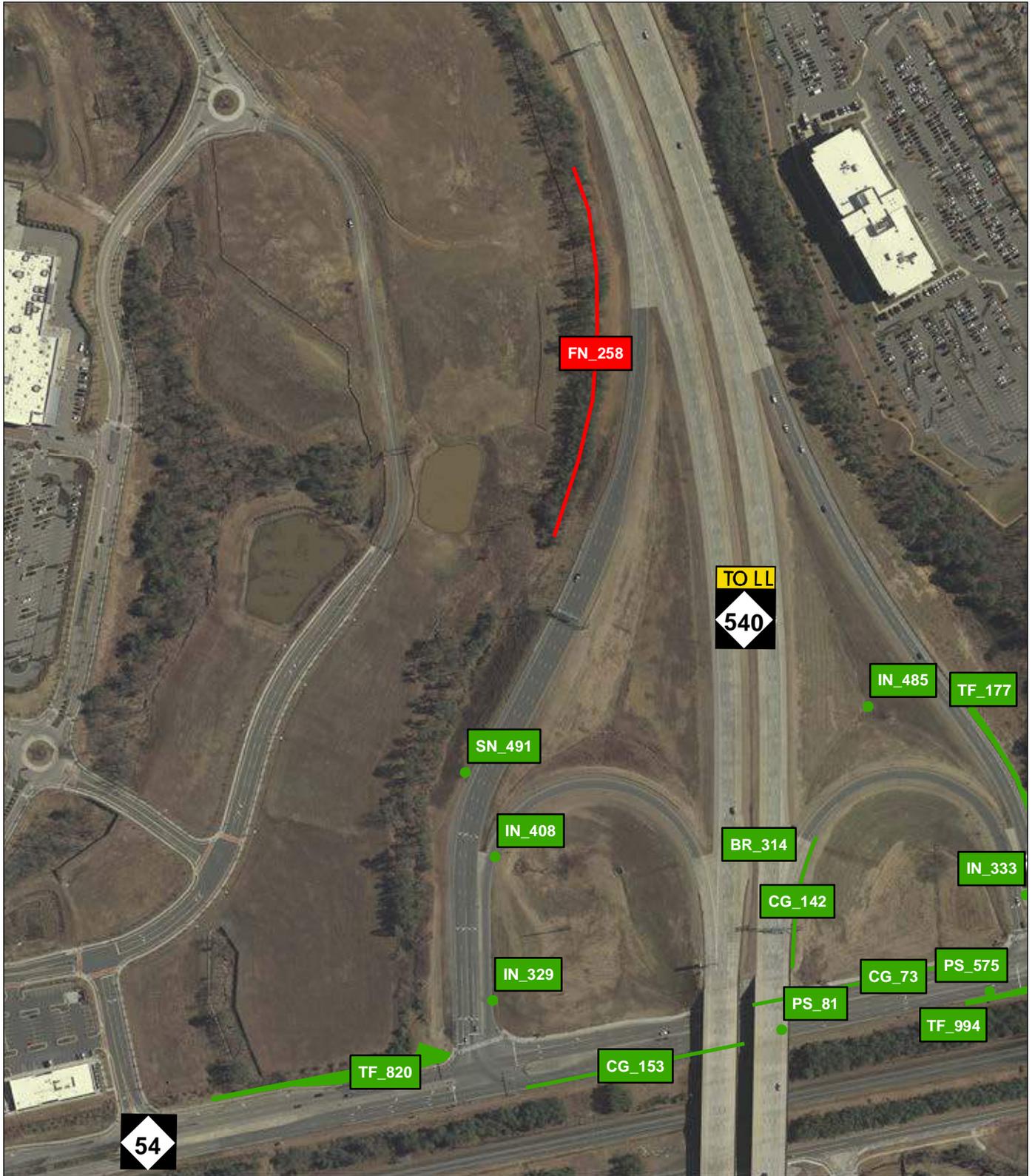
Triangle Expressway 2016 First Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

Provided below are a series of maps outlining the assets that were part of this quarter's sample and their corresponding results. Assets are defined by an Inventory ID, which is a unique identifier given to each individual asset. The components that make up the Inventory ID are an asset specific prefix along with a number, such as LS_1. All assets and their respective prefixes are listed below:

- Guardrail, Concrete Barrier and End Anchors – BR
- Curb and Gutter – CG
- Decorative Supports – DS
- Drainage Pipes – DP
- Misc. Drainage Structures – MDP
- Fence and Control of Access – FN
- Graffiti - GF
- Highway Lighting – HL
- Impact Attenuators – IA
- Inlets – IN
- Landscaping – PB
- Linear Samples – LS
 - Paved Lanes – Asphalt
 - Paved Lanes – Concrete
 - Paved Shoulders
 - Unpaved Shoulders
 - Front/Back Slopes
 - Unpaved Lateral and Outfall Ditches
 - Litter
 - Roadway Sweeping
 - Pavement Striping/Markings
 - Pavement Markers
 - Delineators
- Paved Ditches – PD
- Pavement Words and Symbols – PS
- Signs – SN
- Tree and Brush – TB
- Turf Condition – TF
- MSE/Retaining Walls, Sound Barrier Walls, and Screen Walls – WL

Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

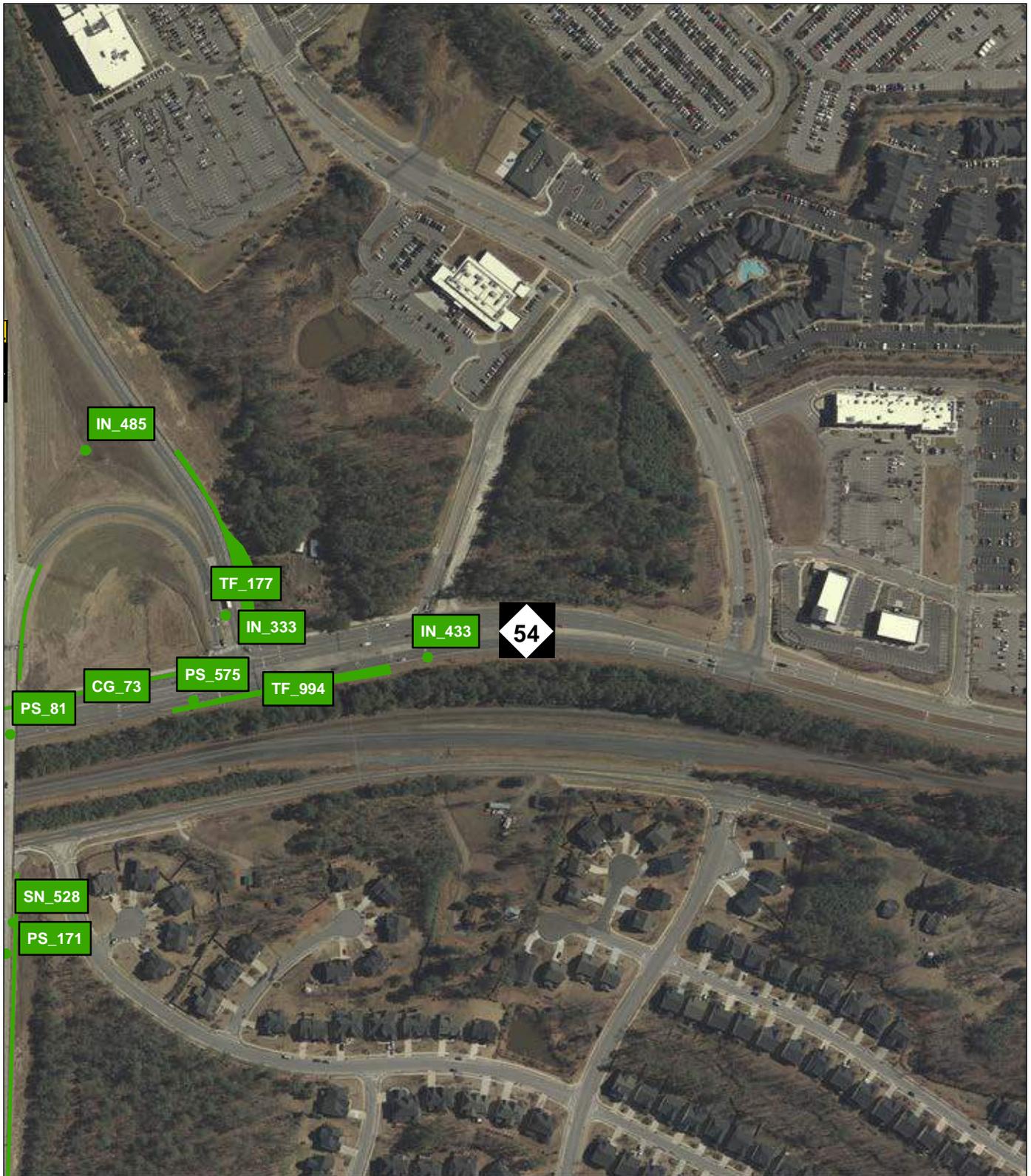


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

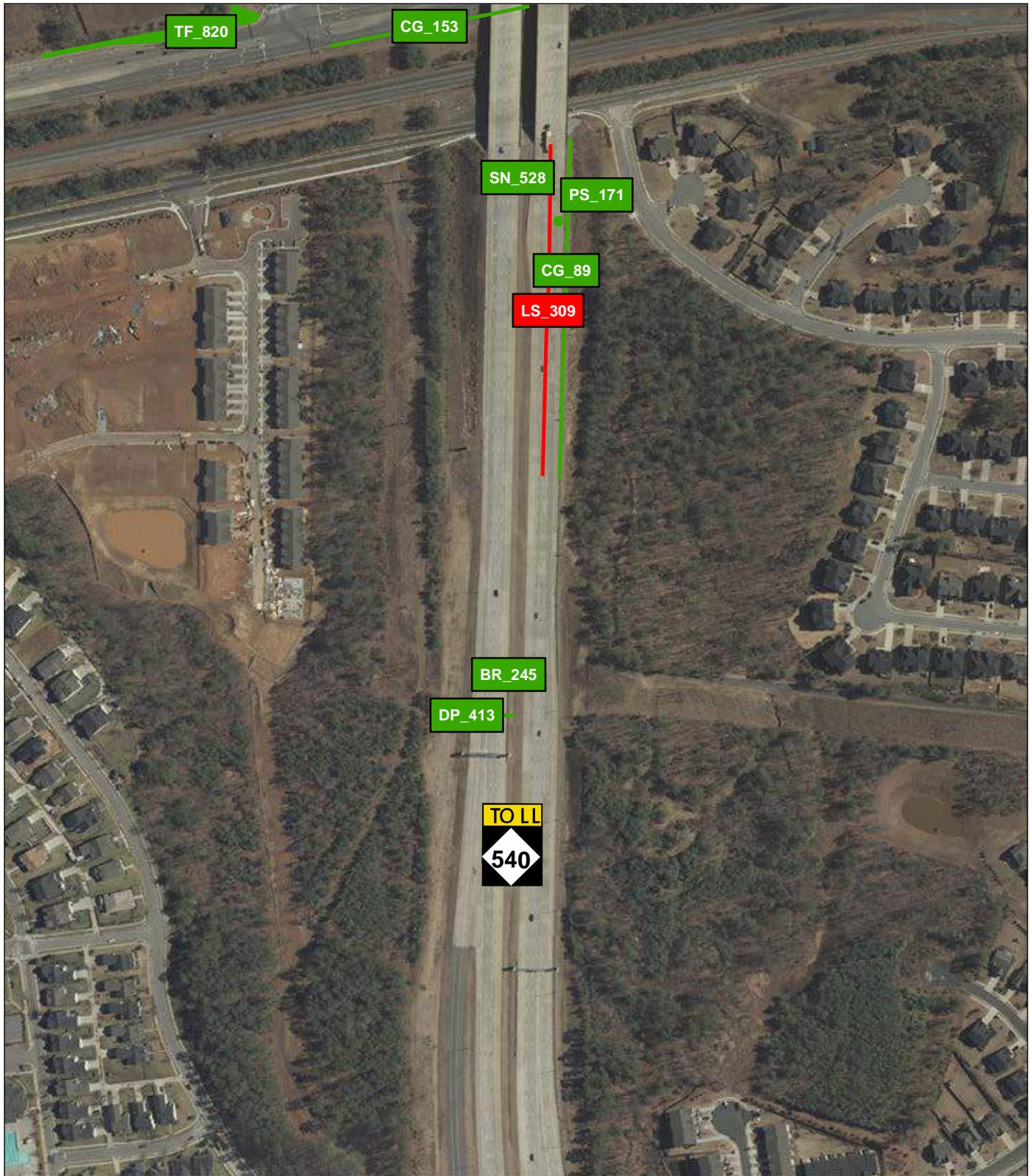


Legend

-  Passing Asset
-  Failing Asset



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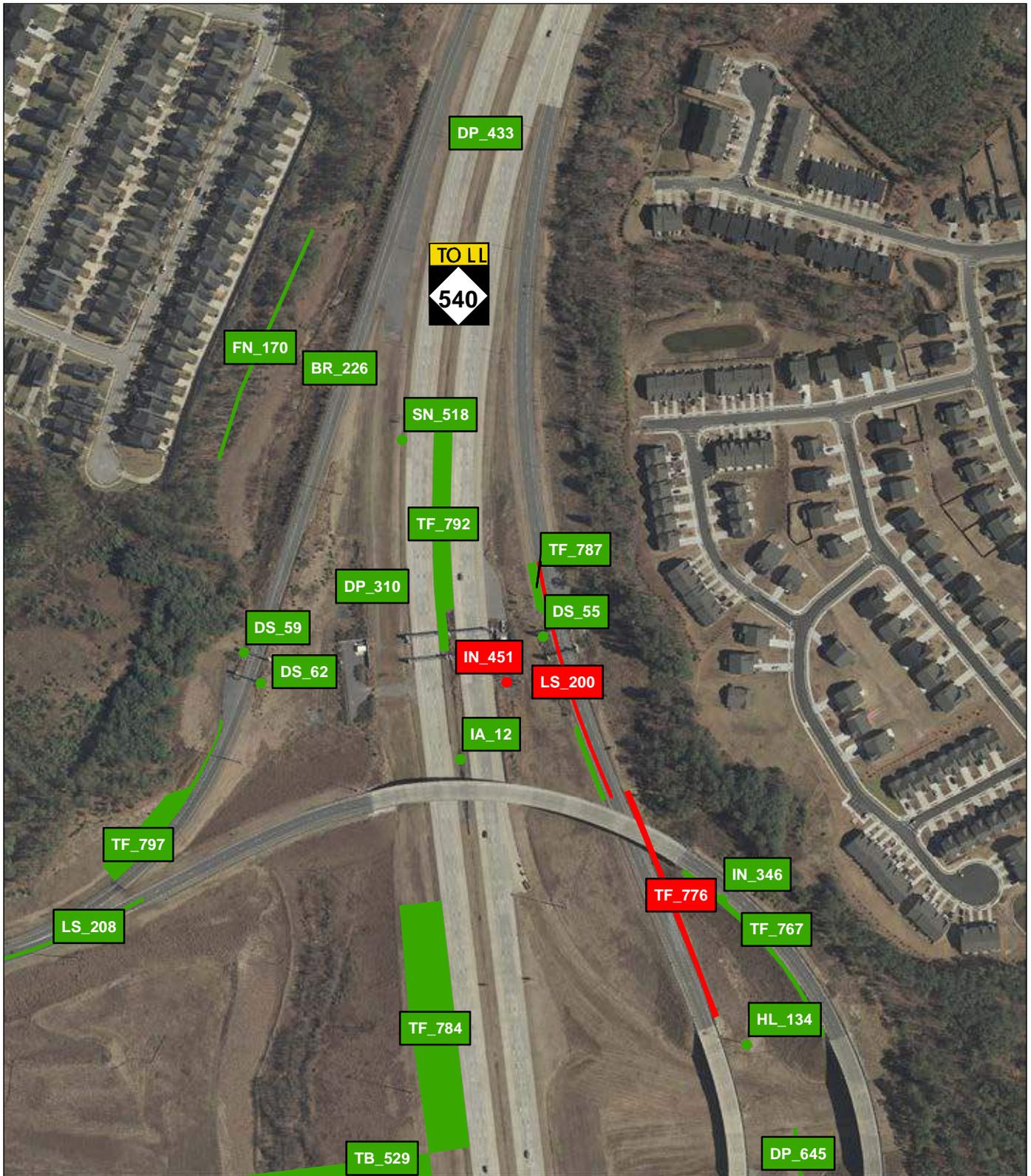


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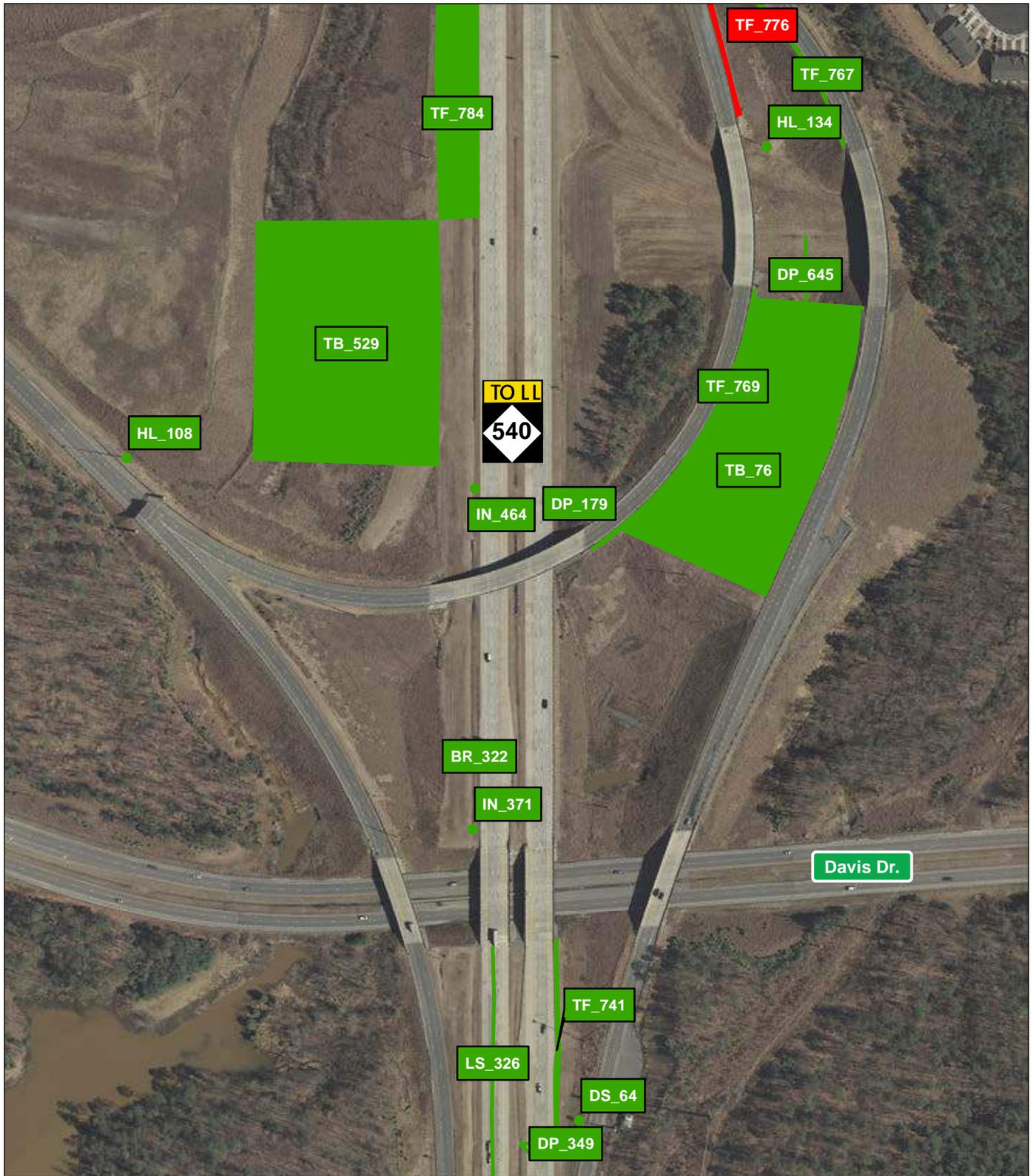


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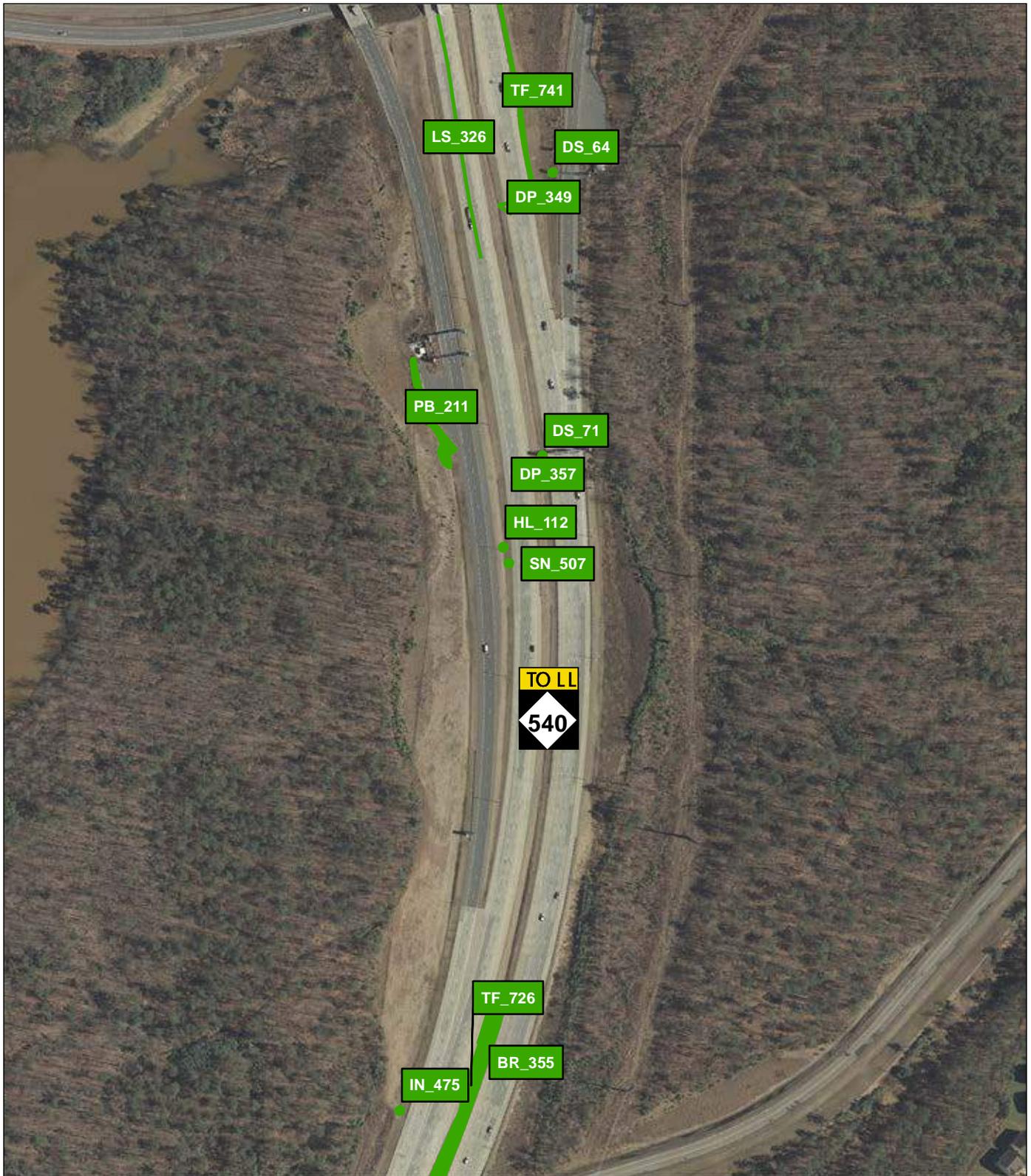


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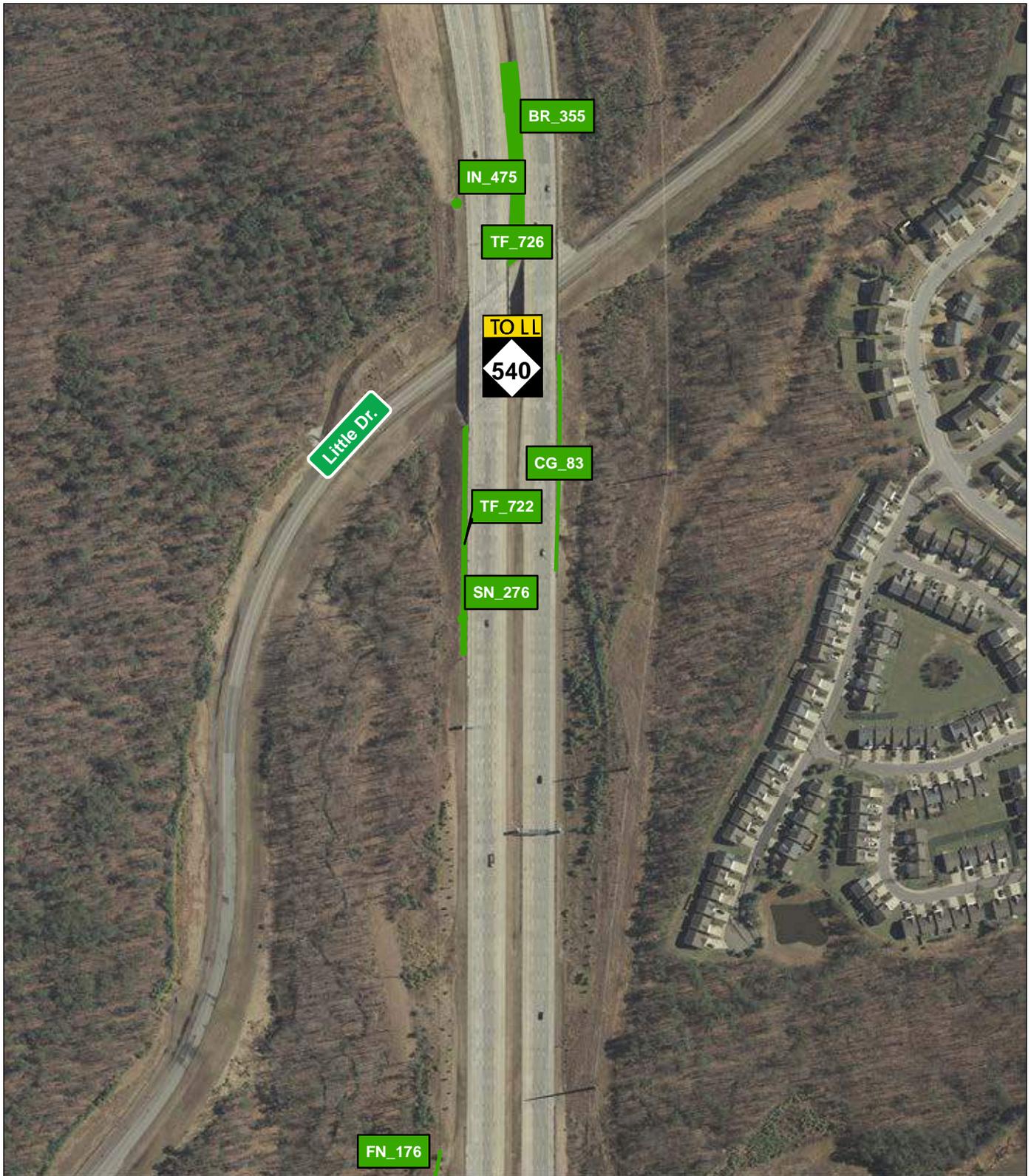


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

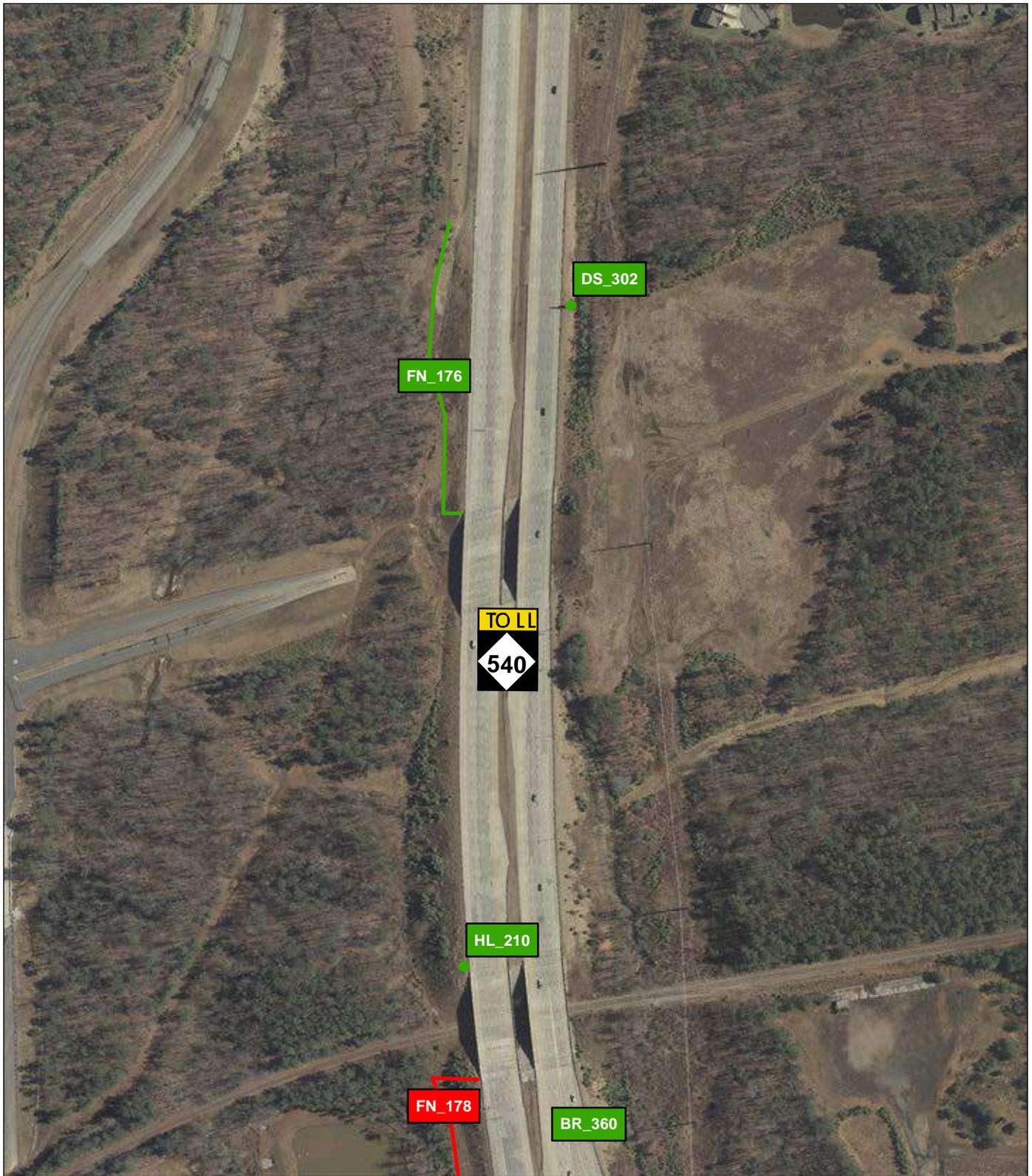


Legend

-  Passing Asset
-  Failing Asset

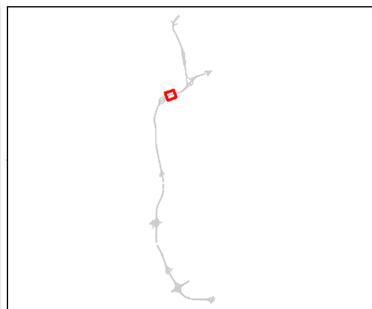


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset

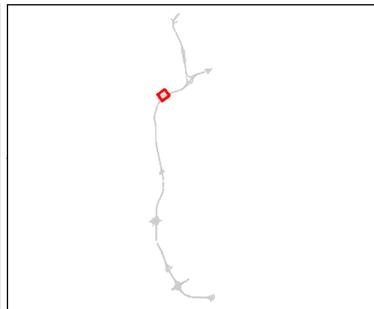


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

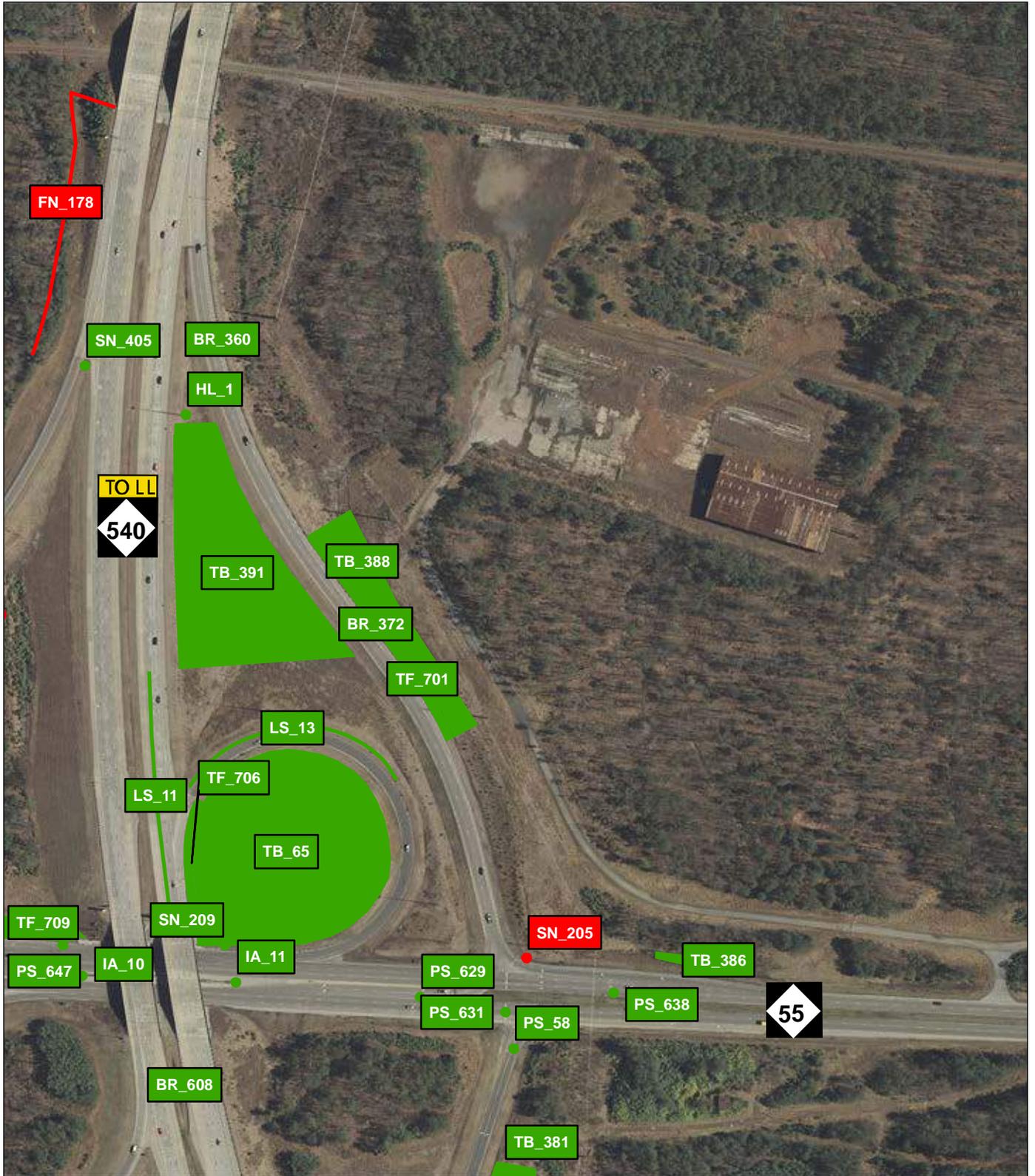


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

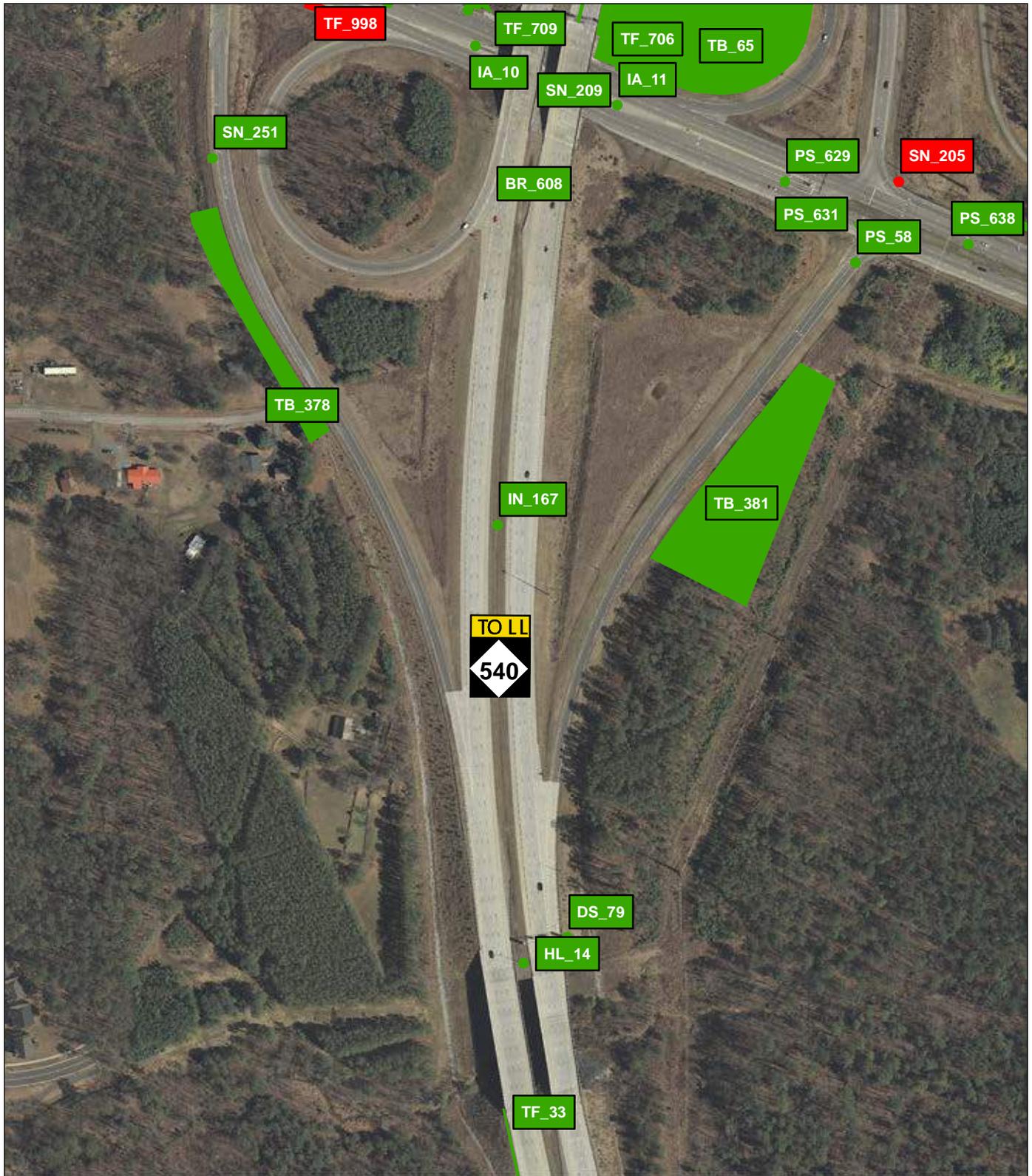


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

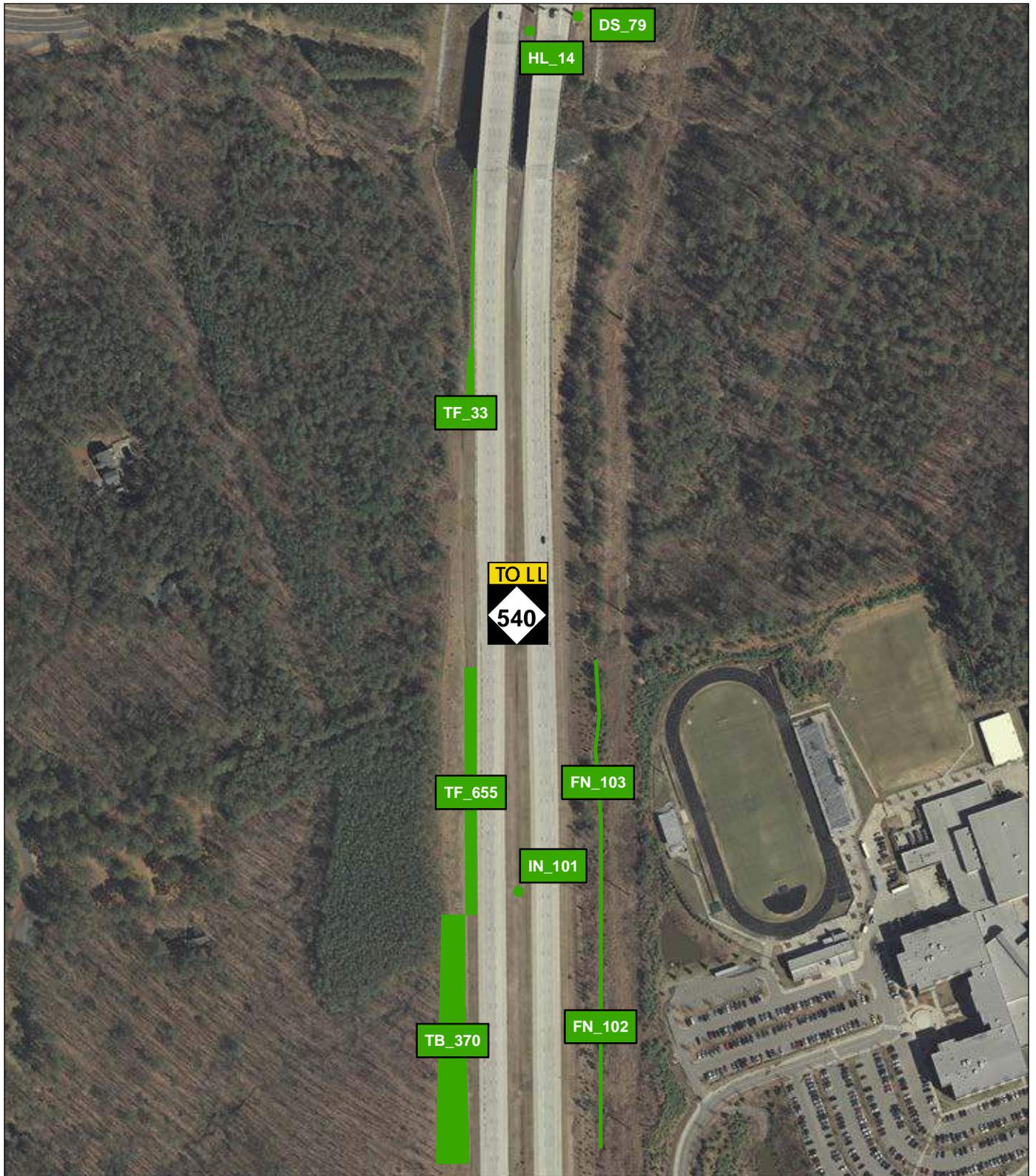


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

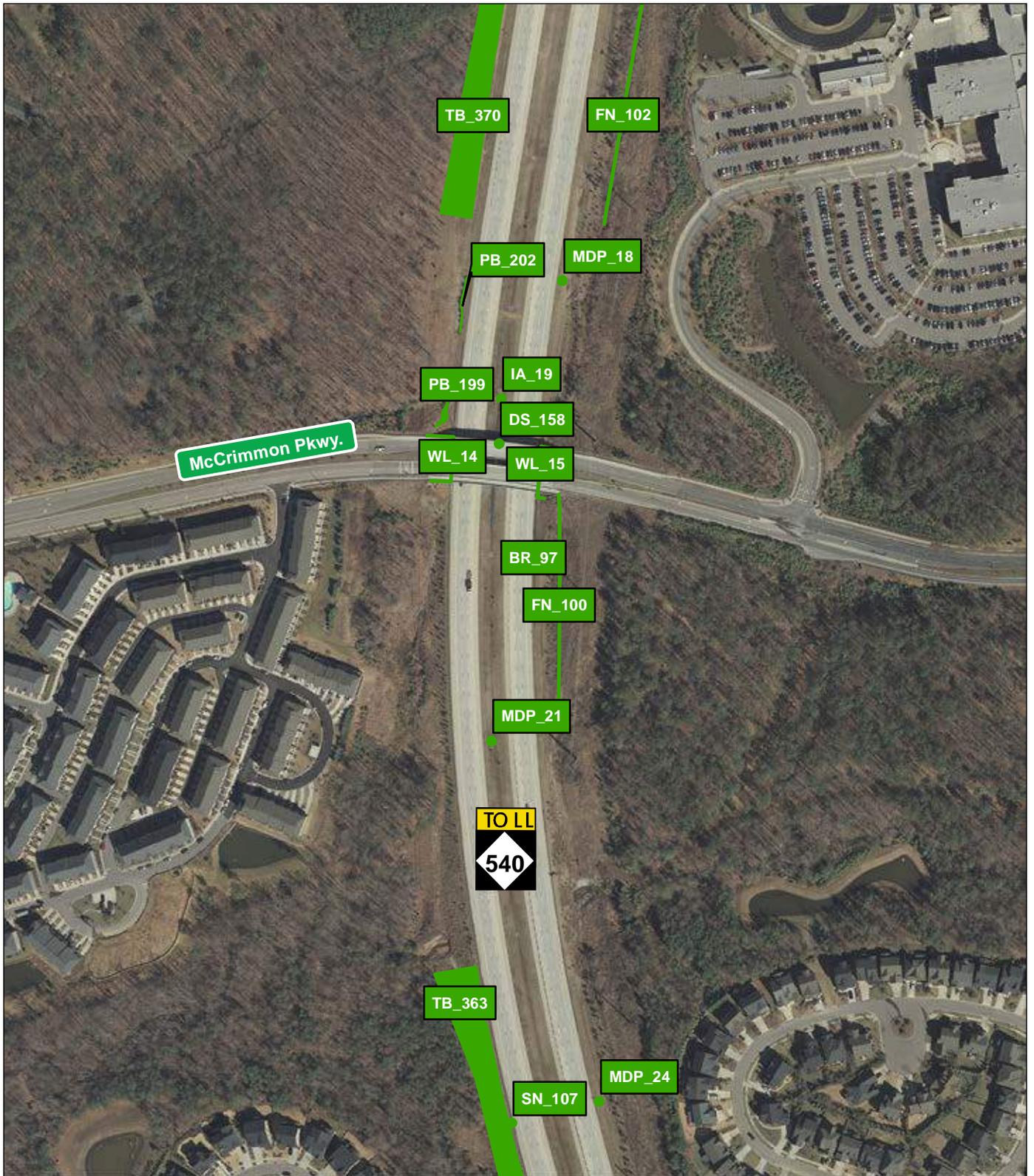


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

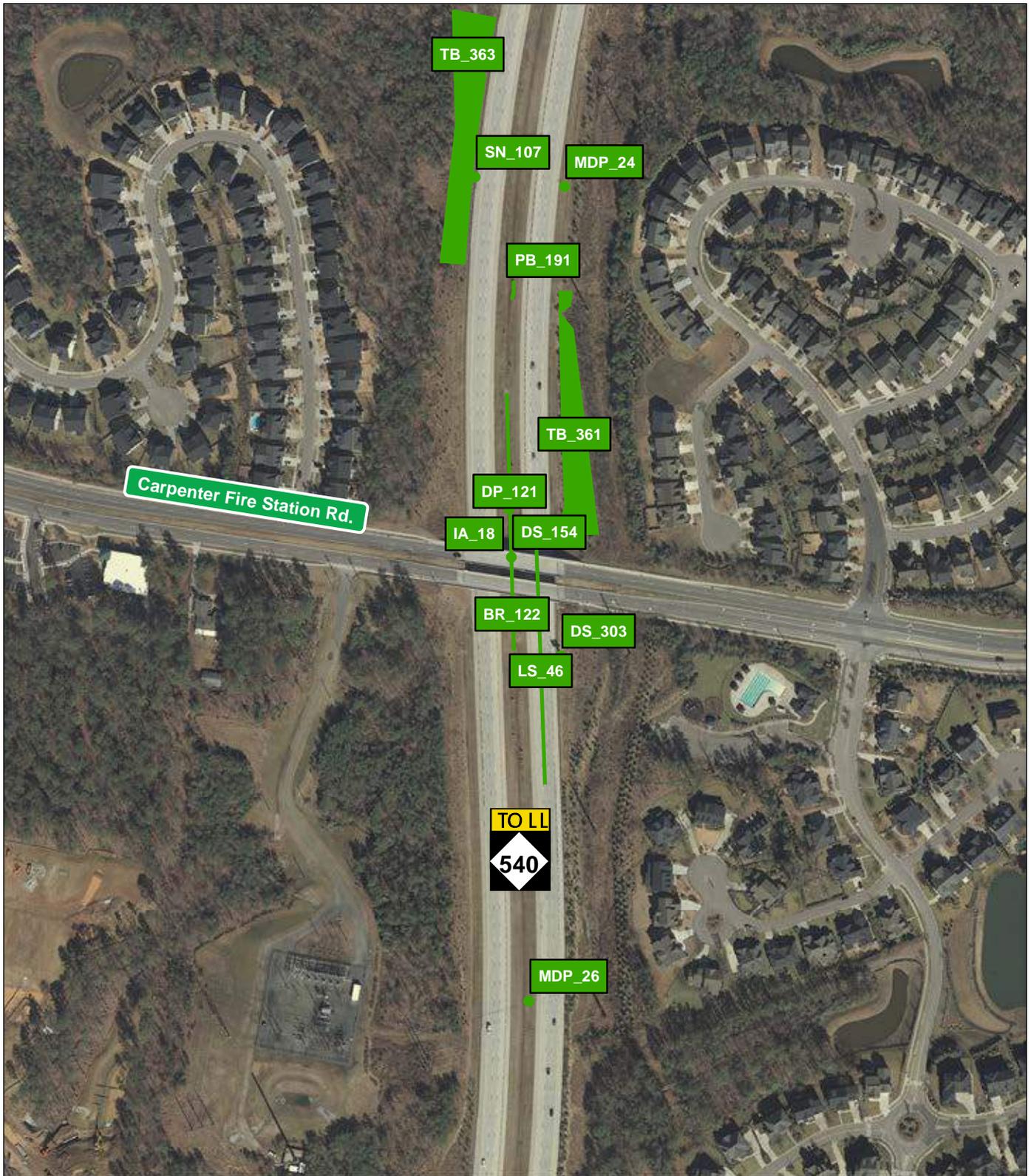


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

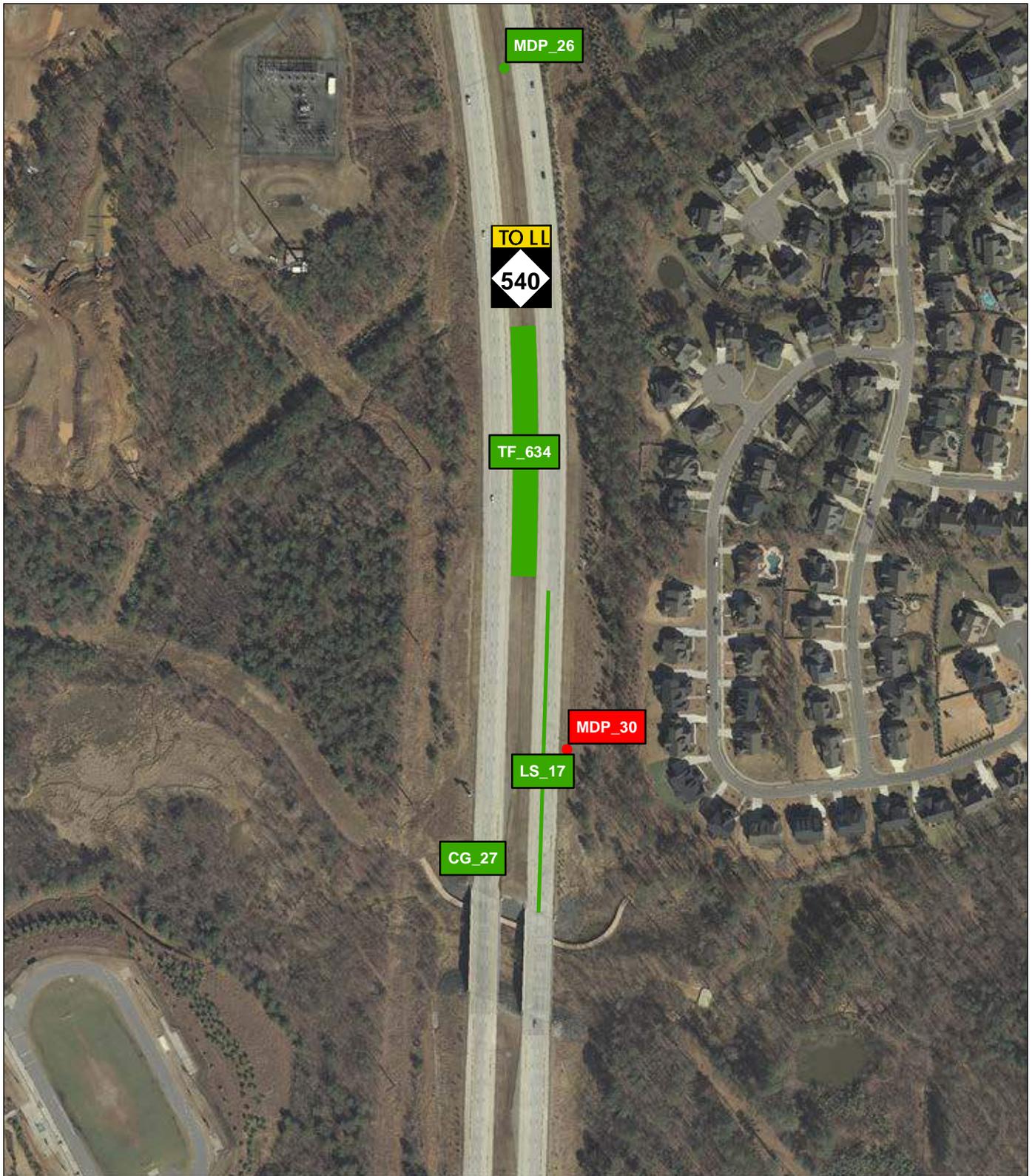


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

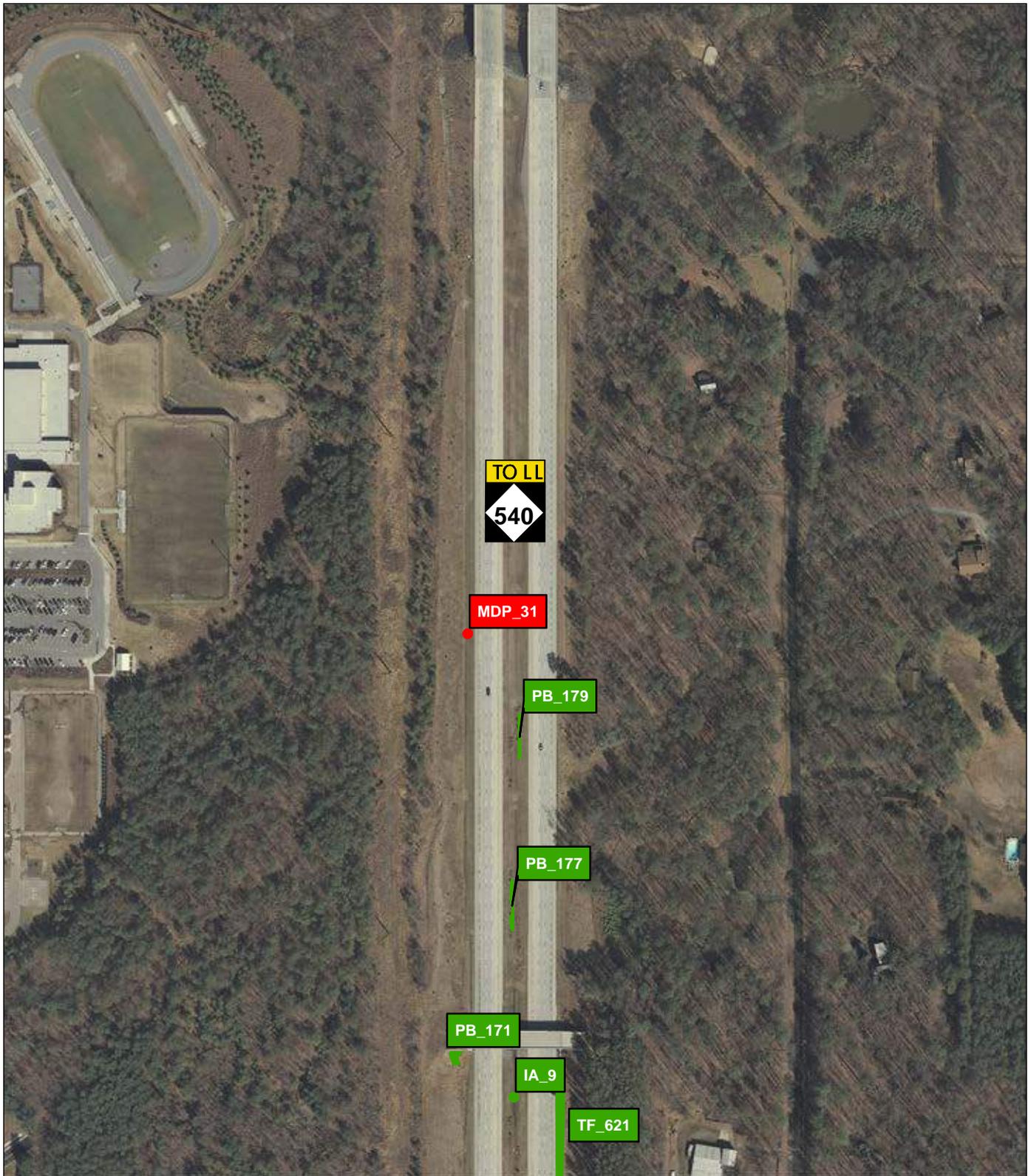


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

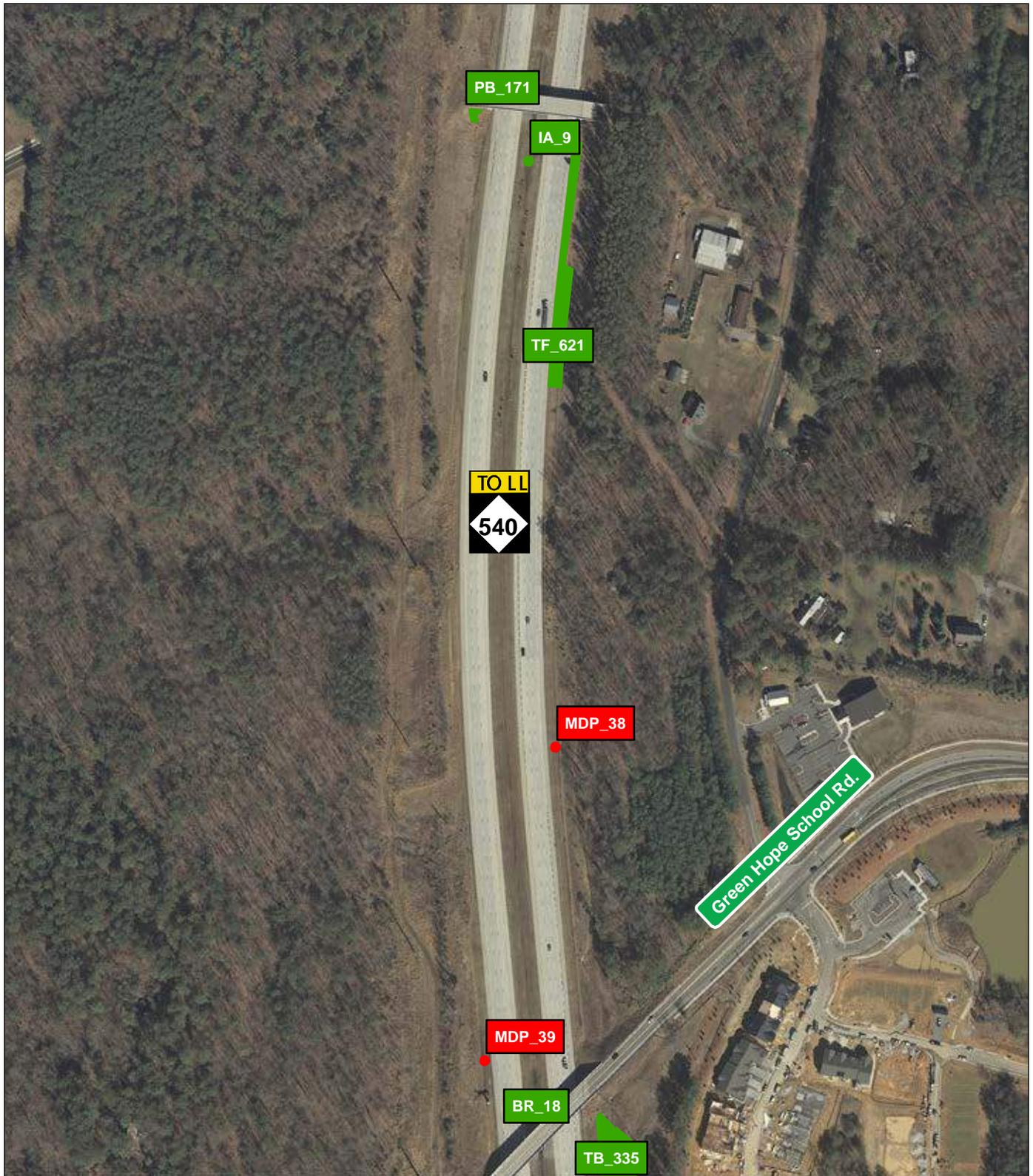


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

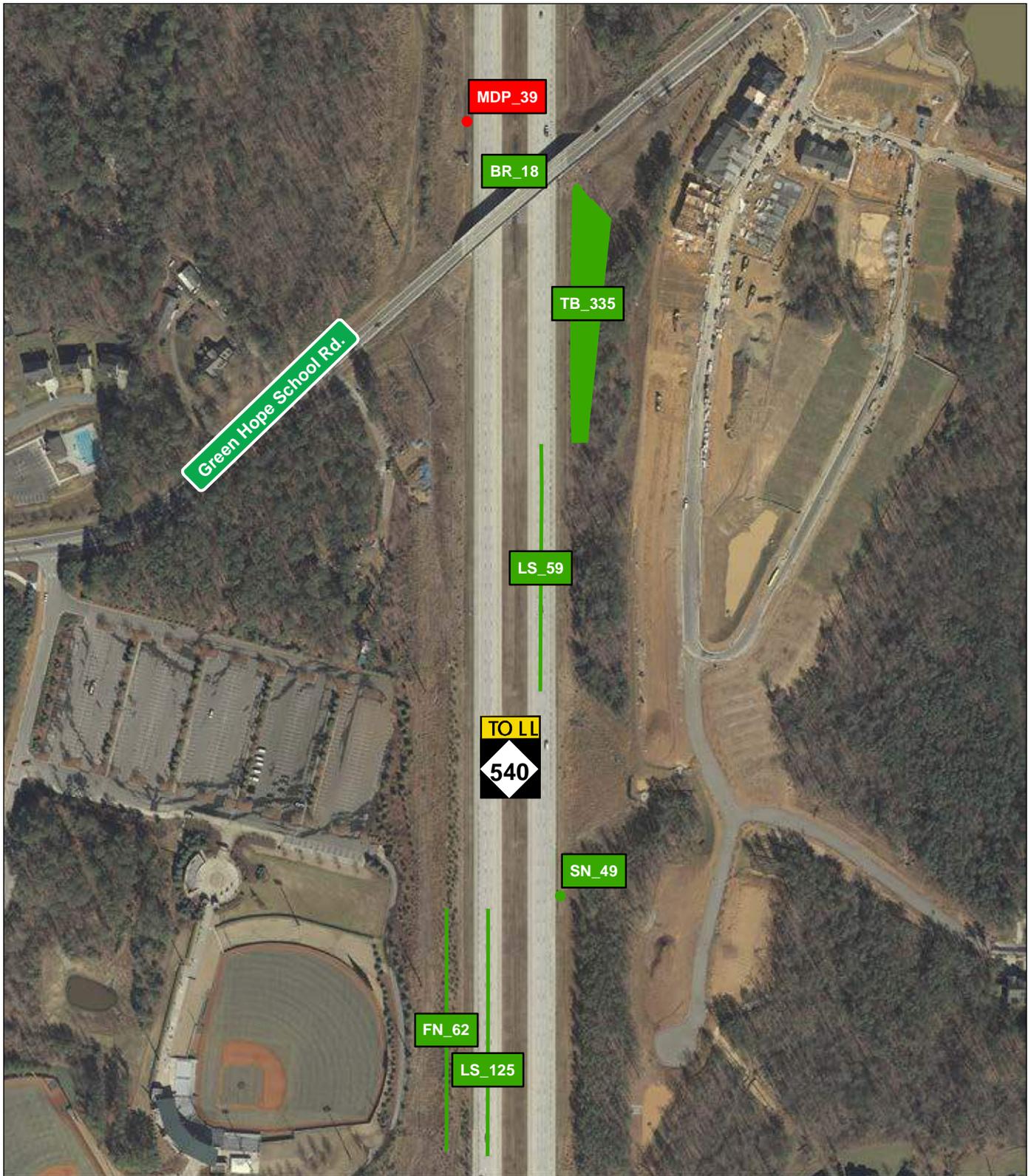


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

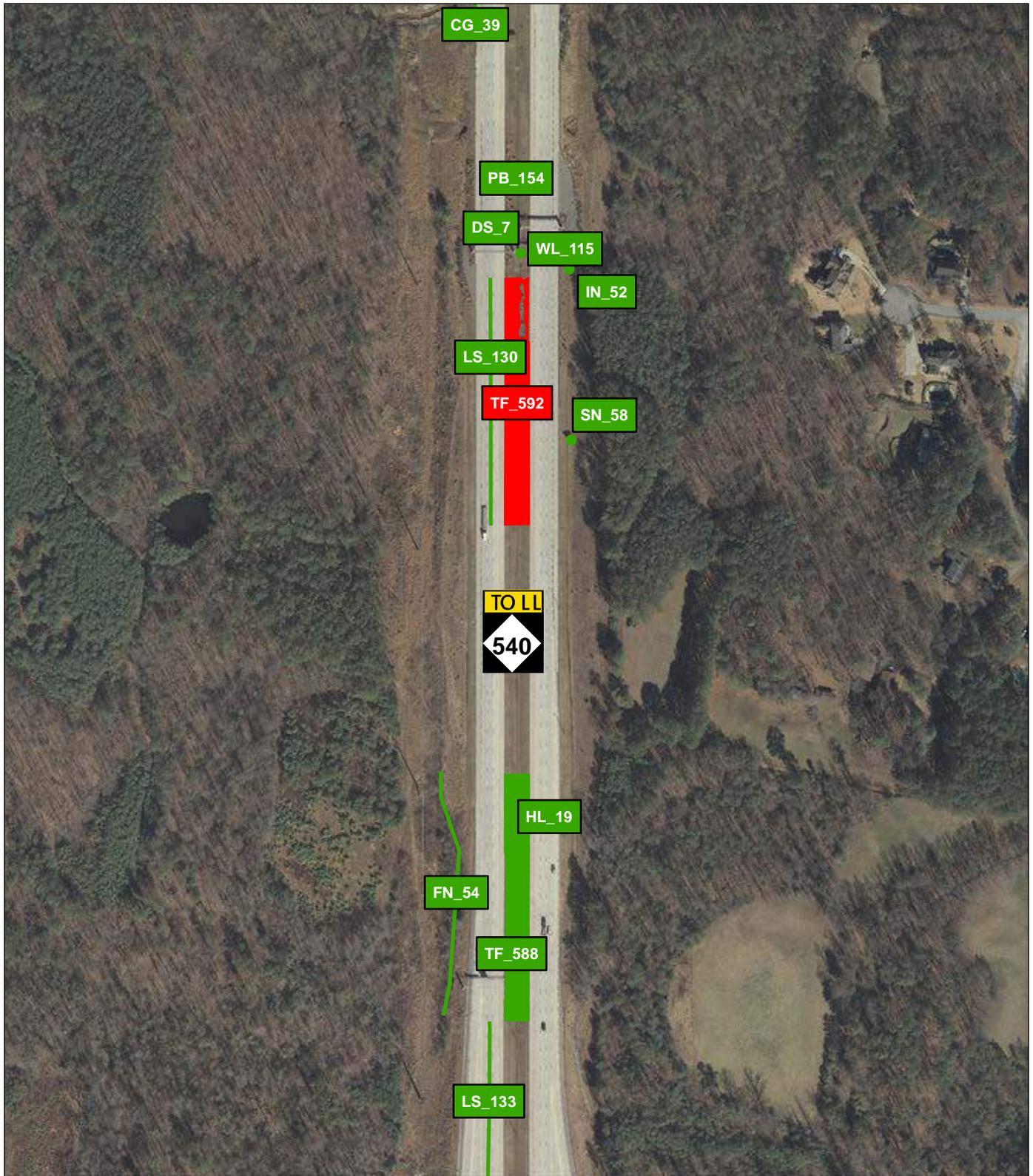


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

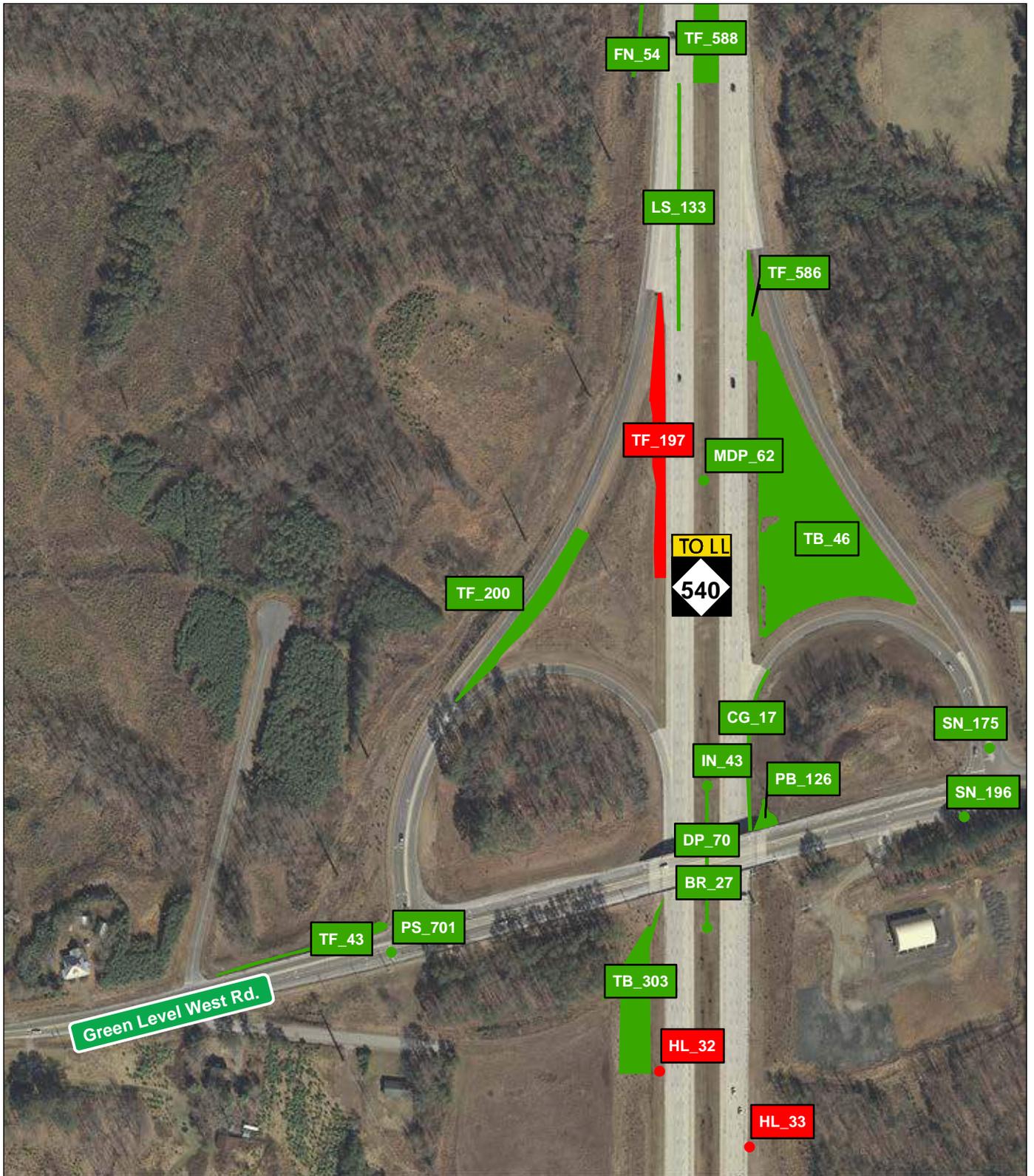


Legend

-  Passing Asset
-  Failing Asset

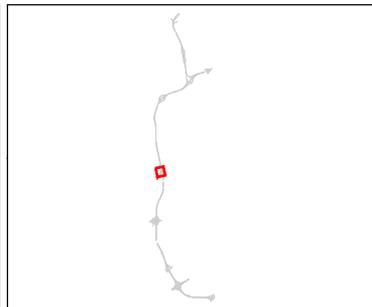


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

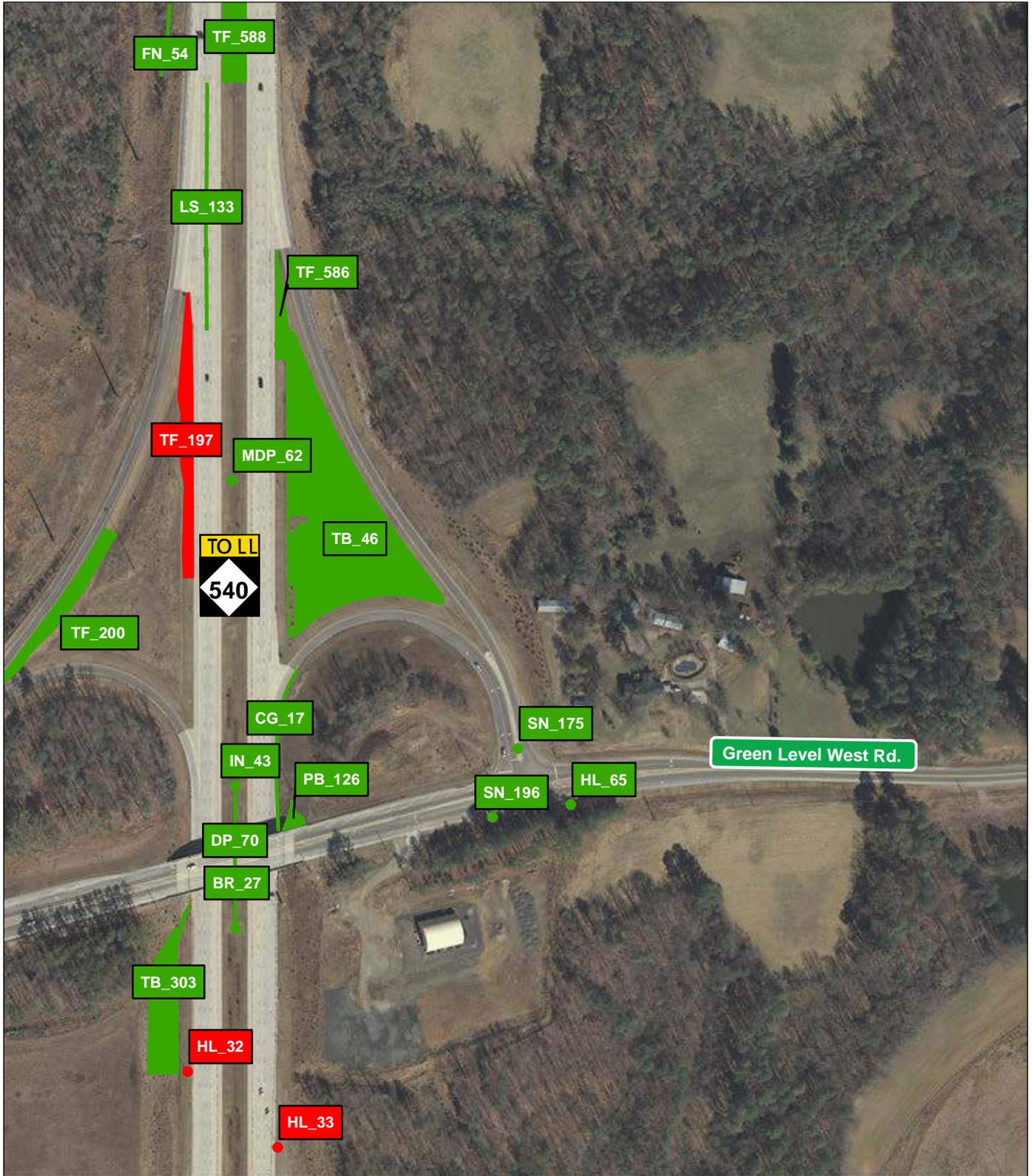


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

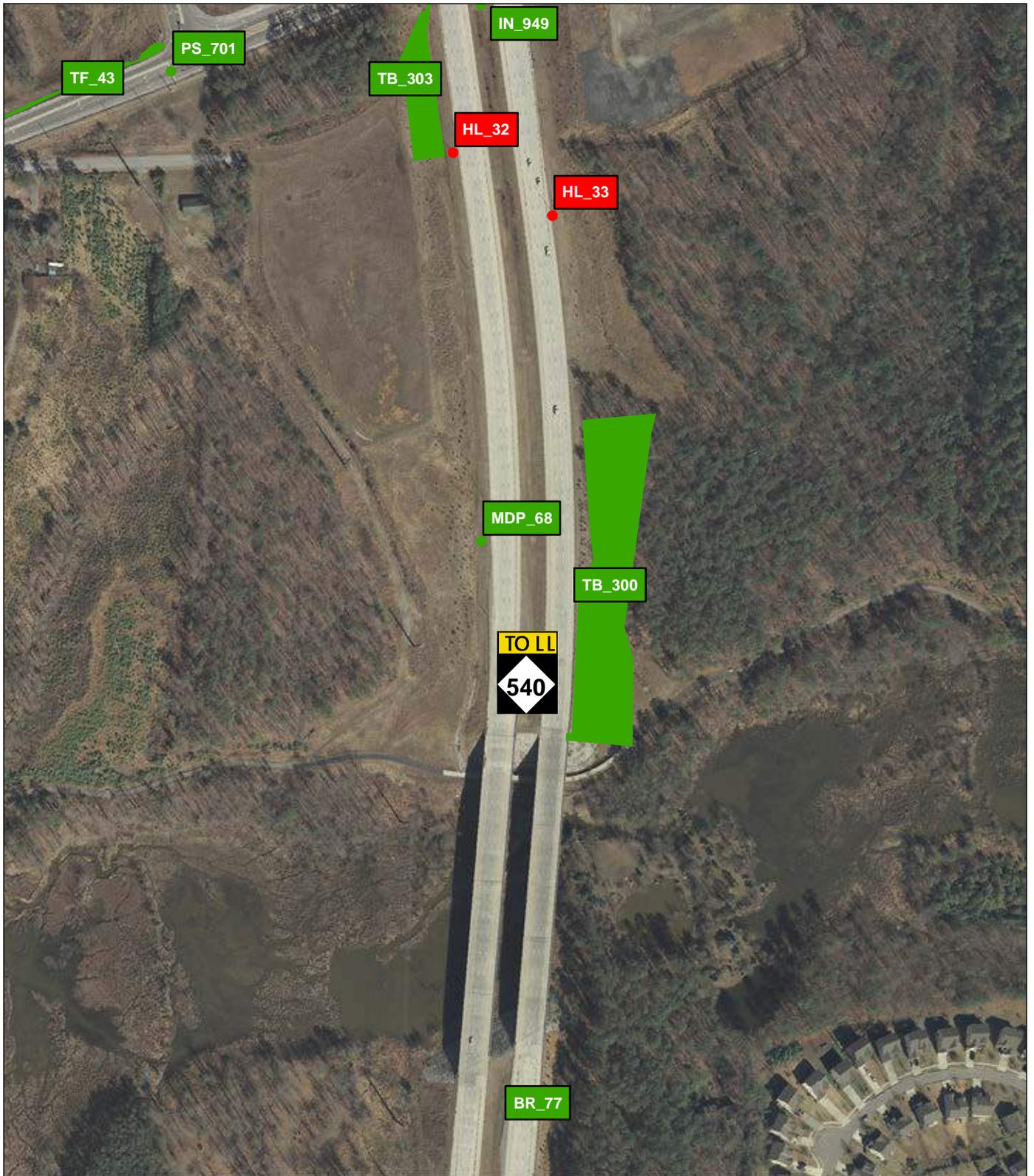


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

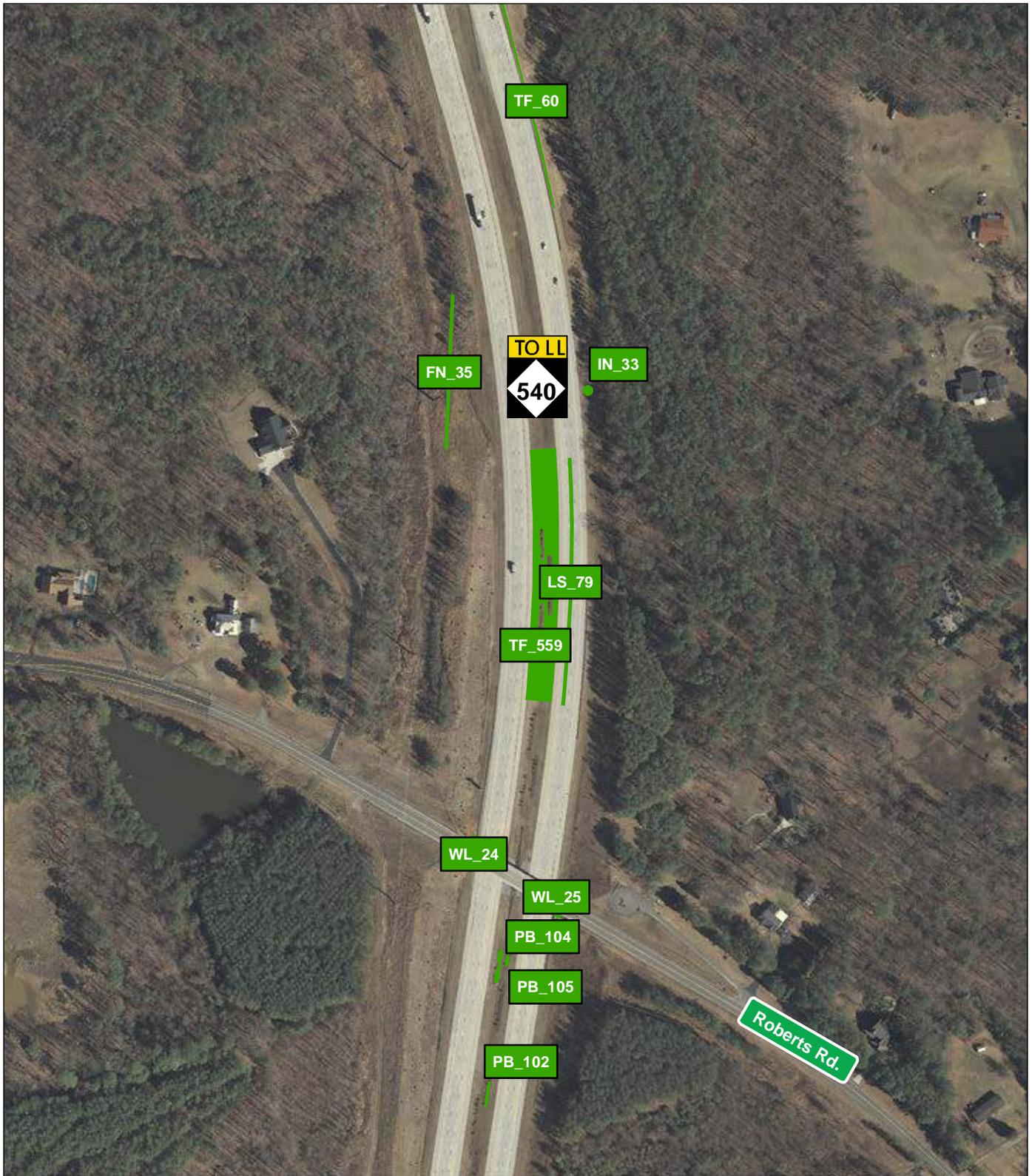


Legend

-  Passing Asset
-  Failing Asset

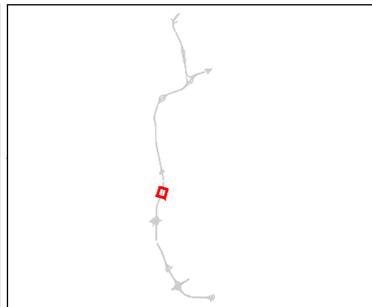


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

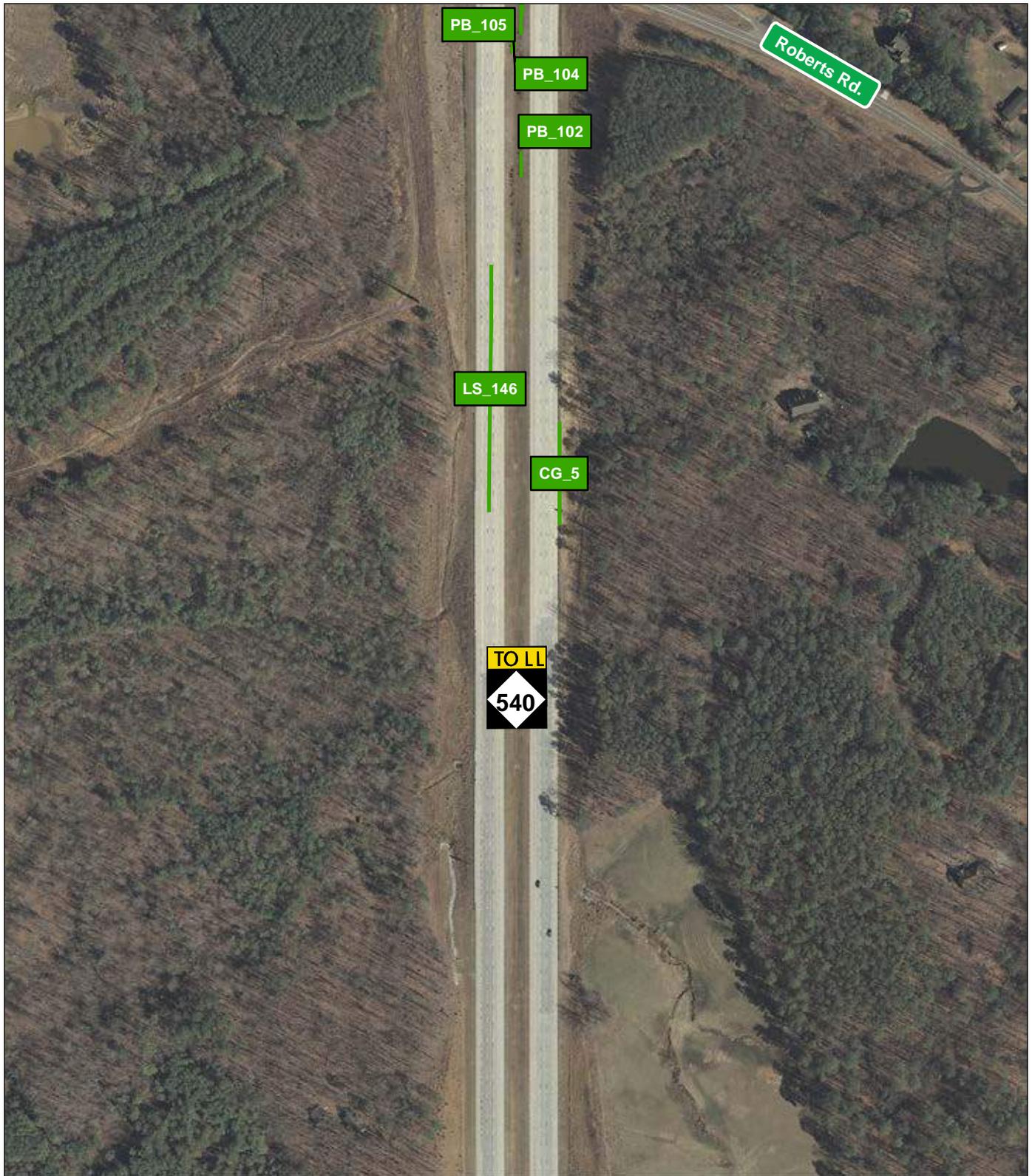


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

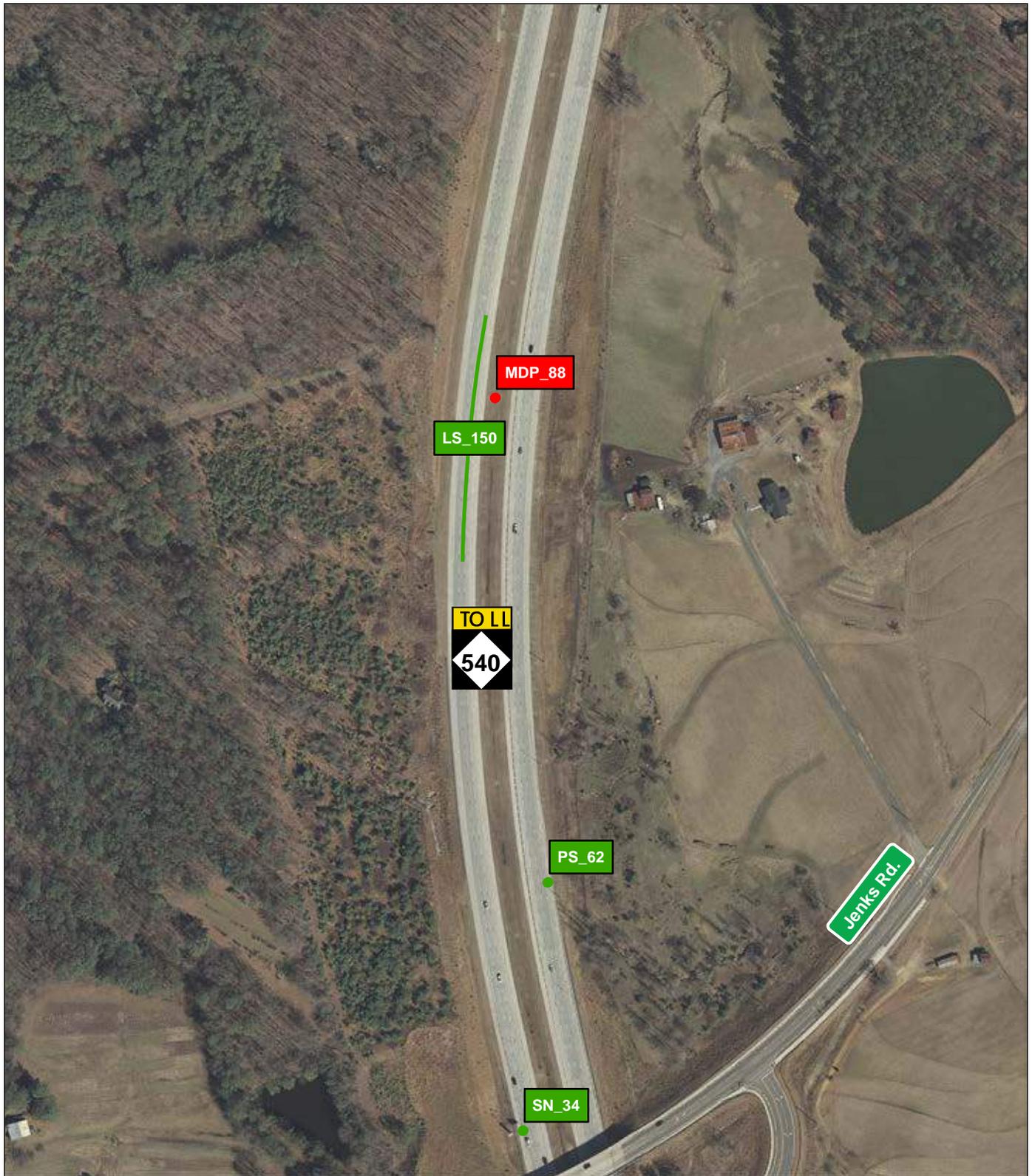


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

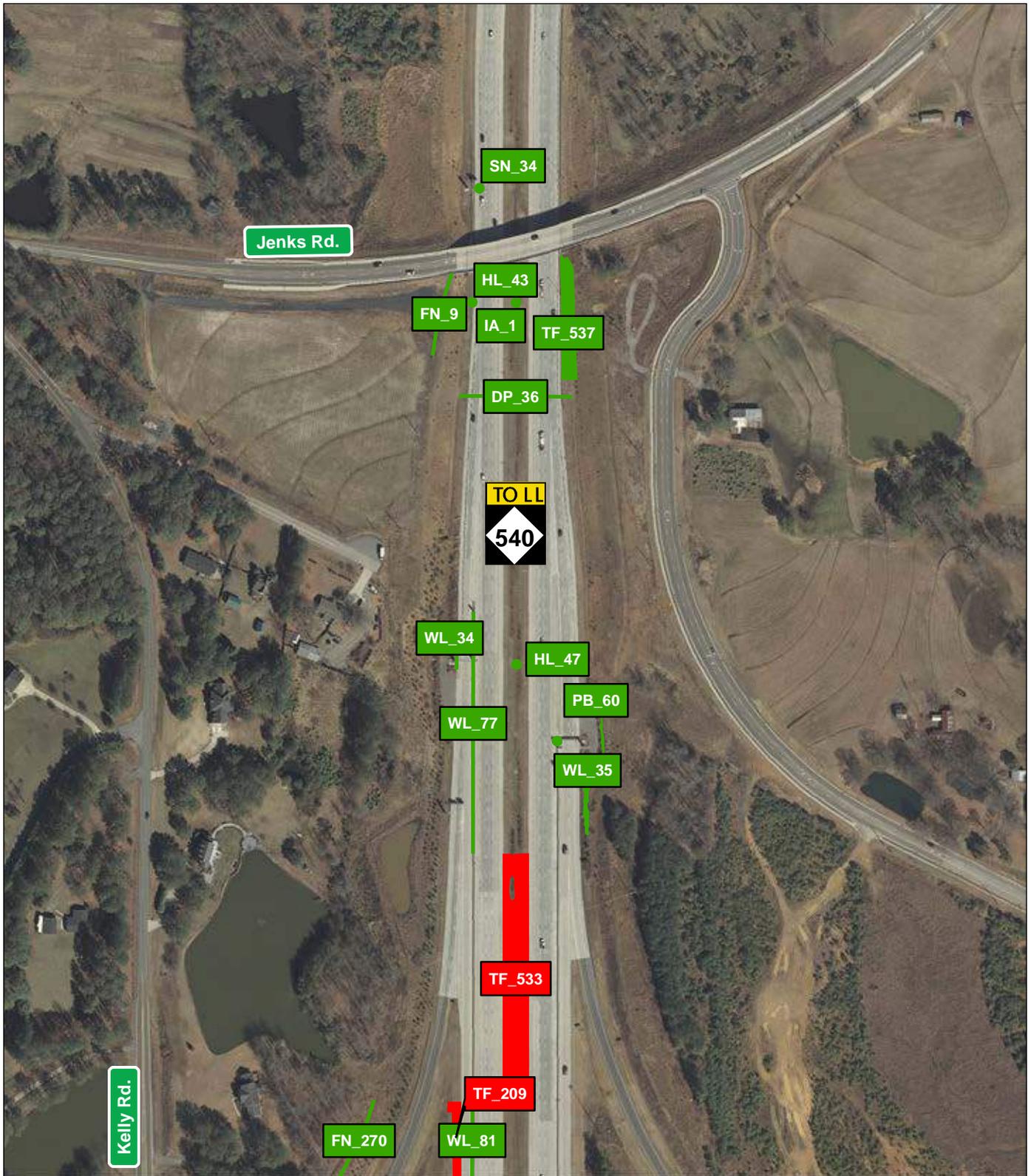


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-  Passing Asset
-  Failing Asset

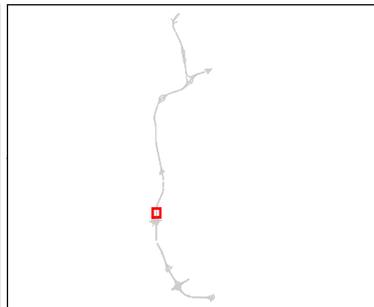


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

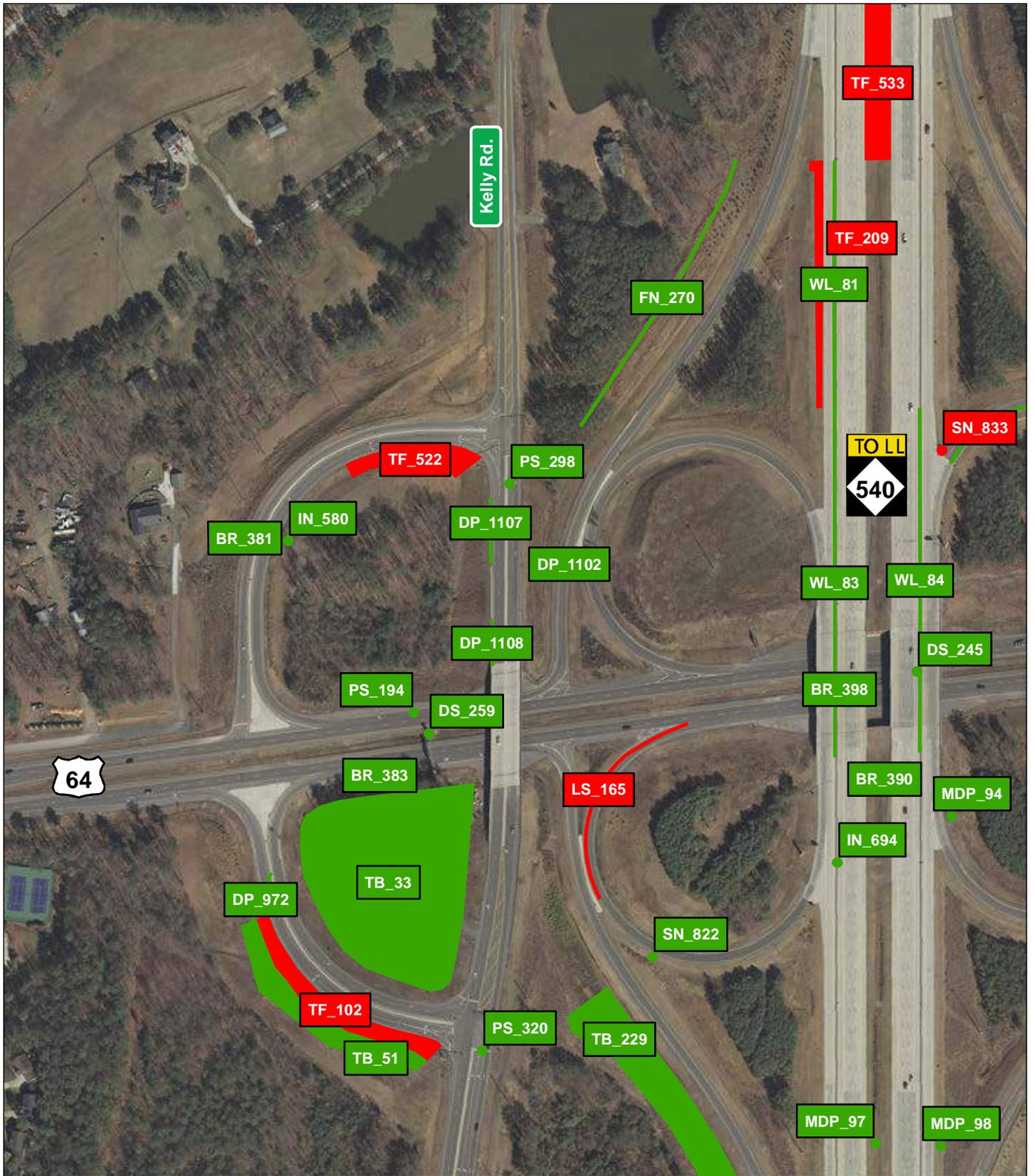


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-  Passing Asset
-  Failing Asset

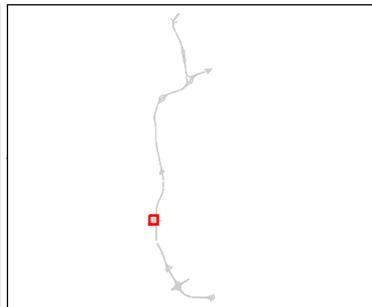


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

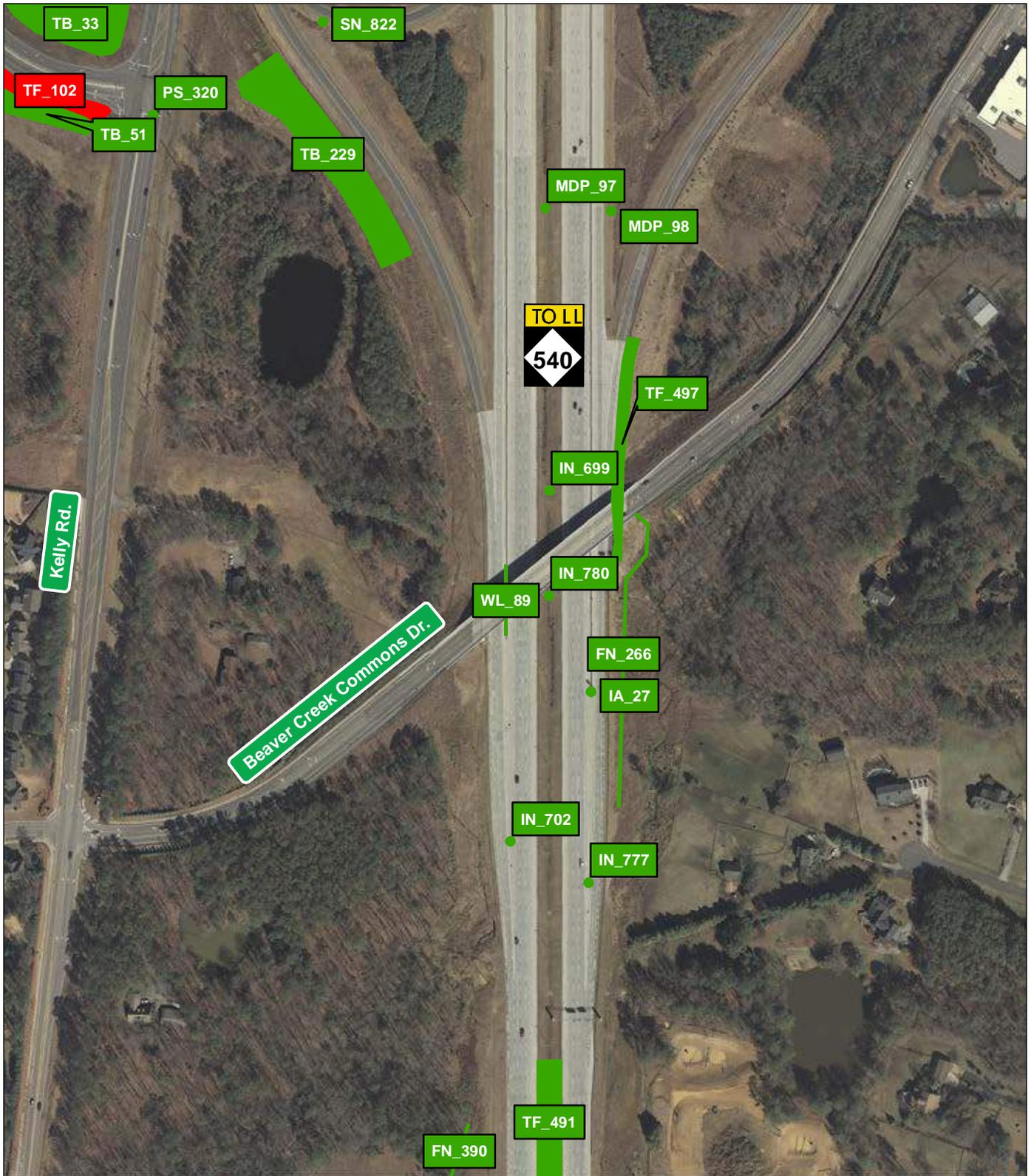


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset

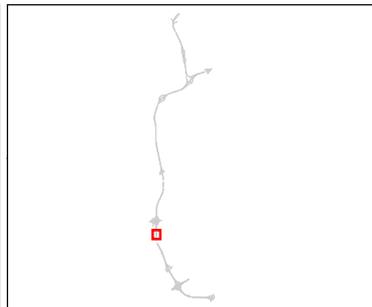


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

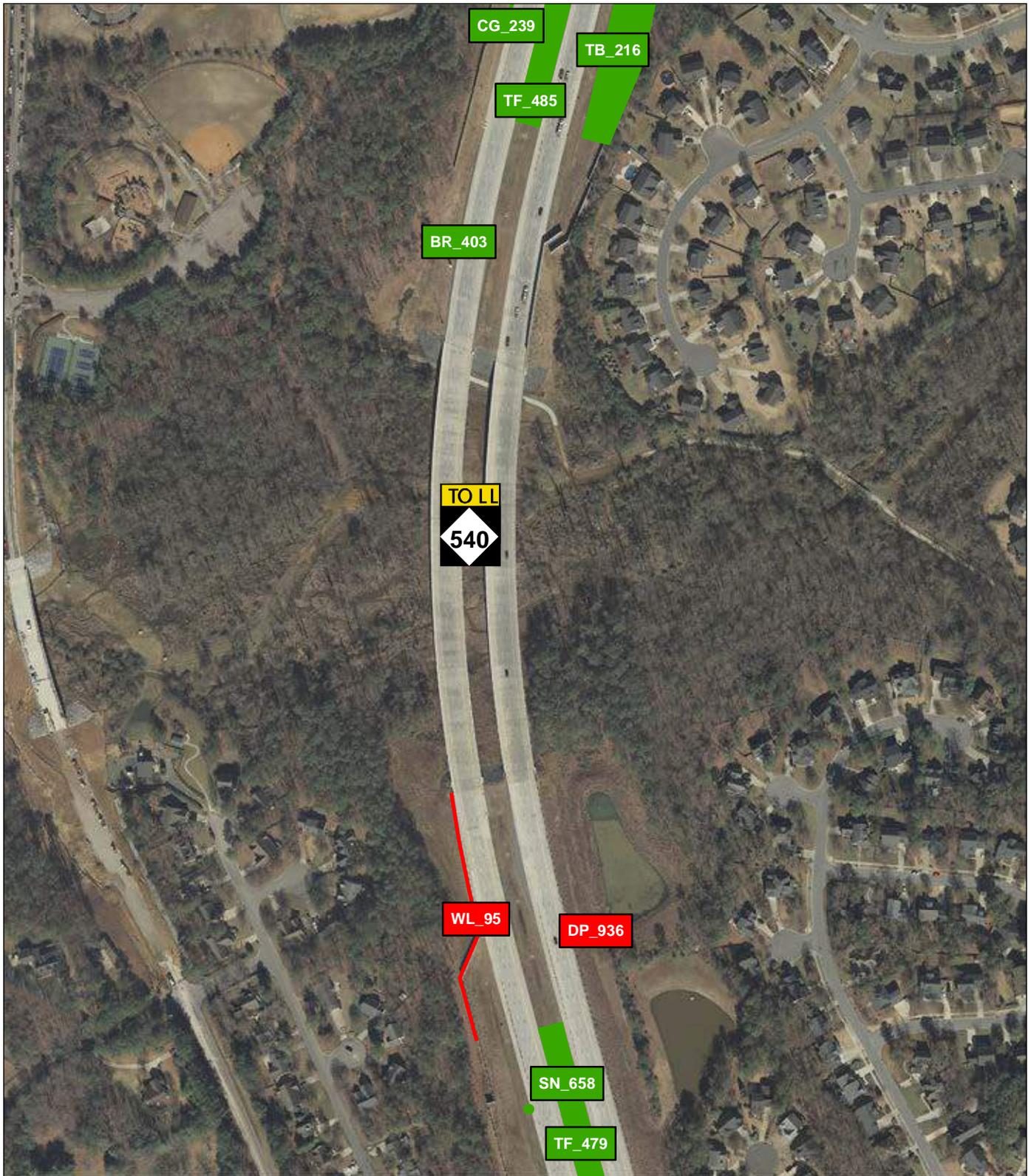


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

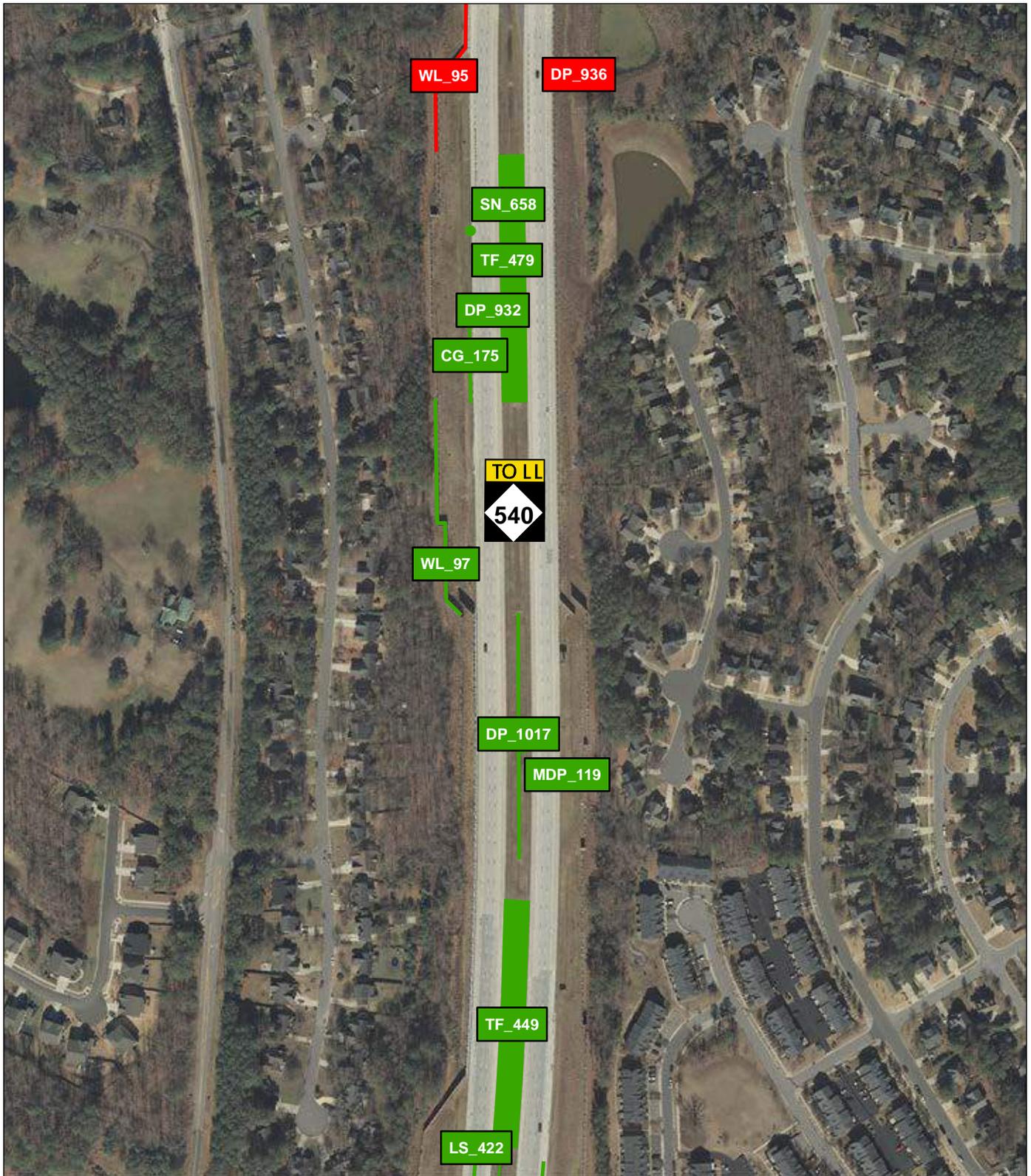


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

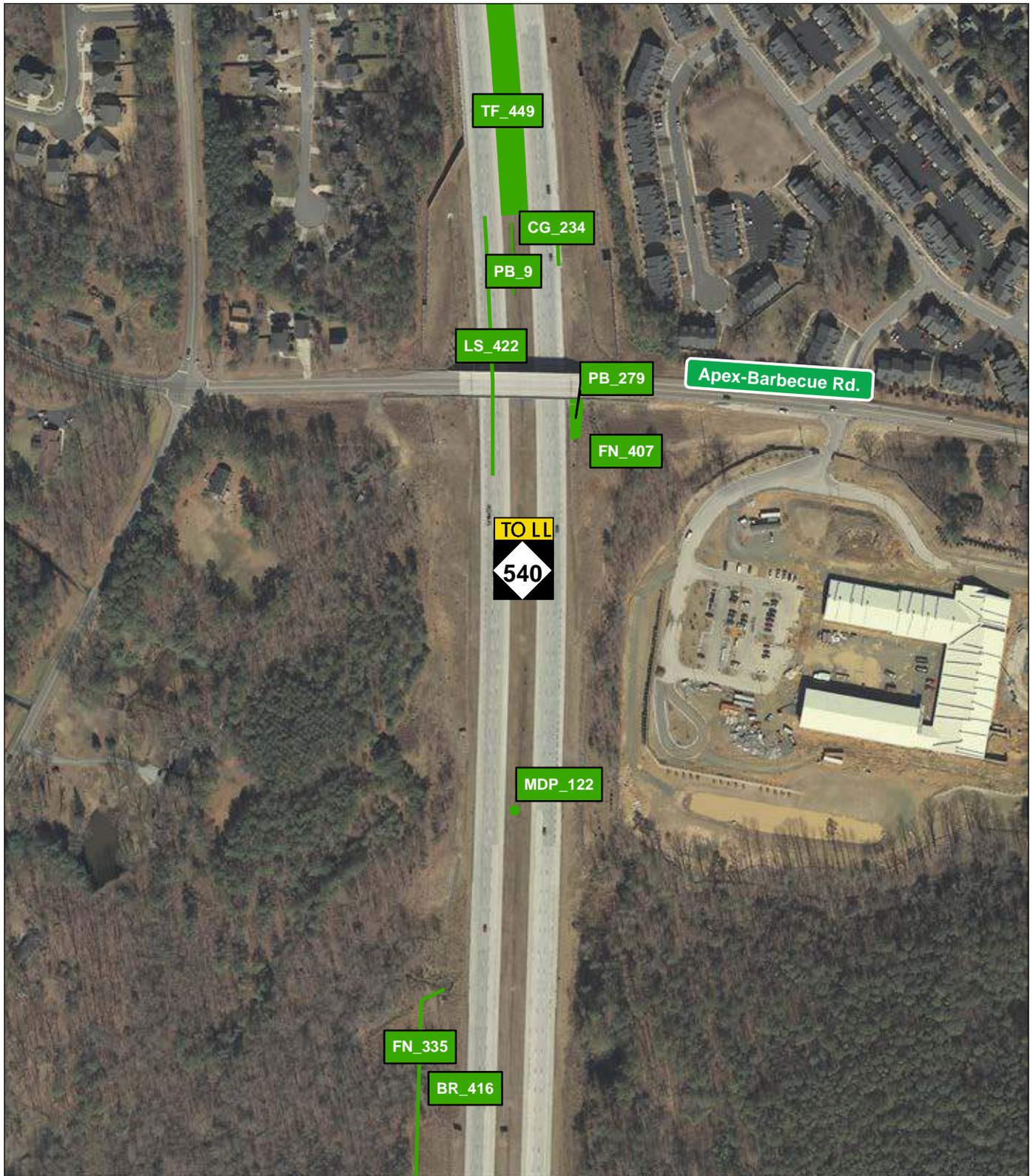


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

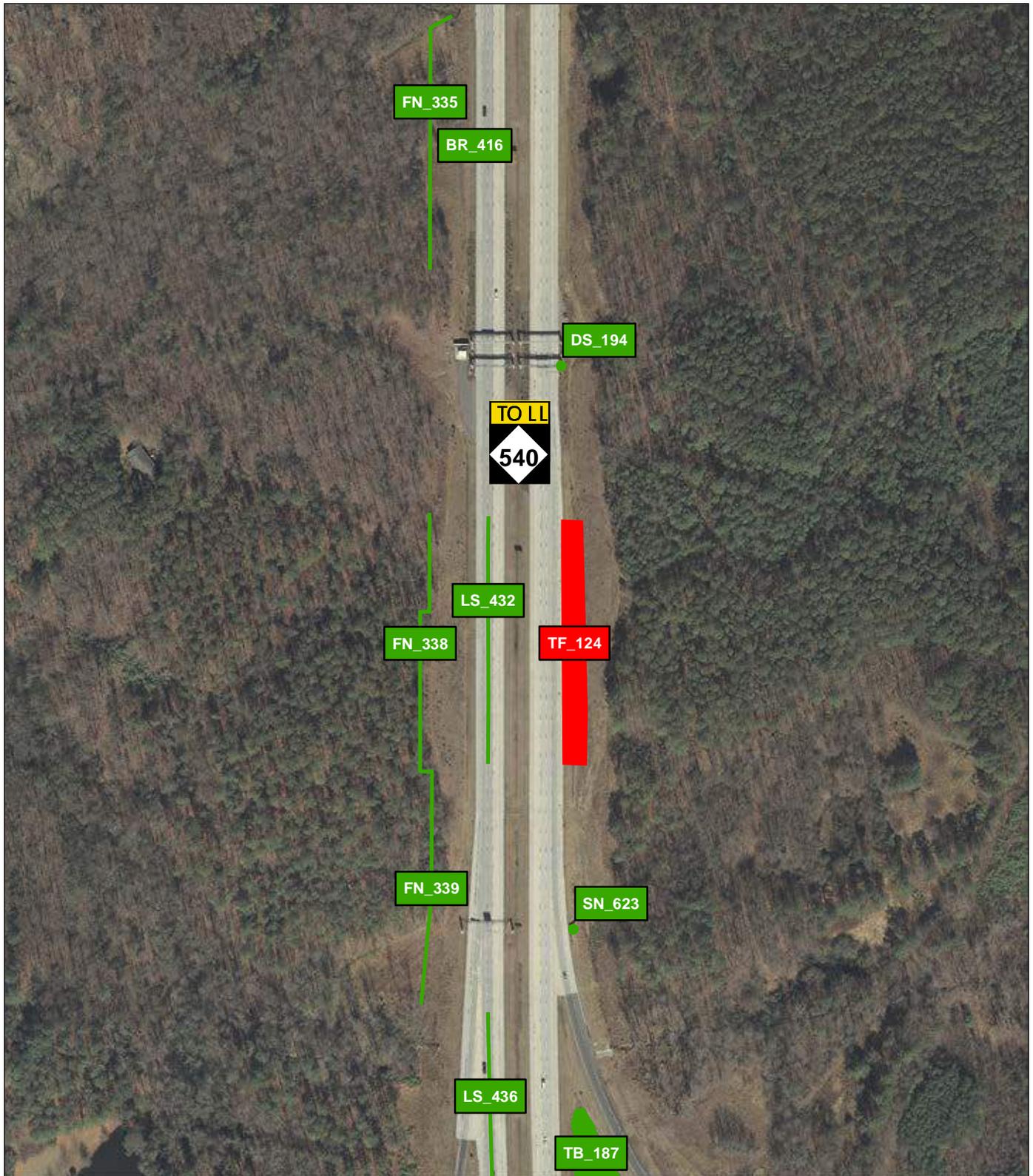


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

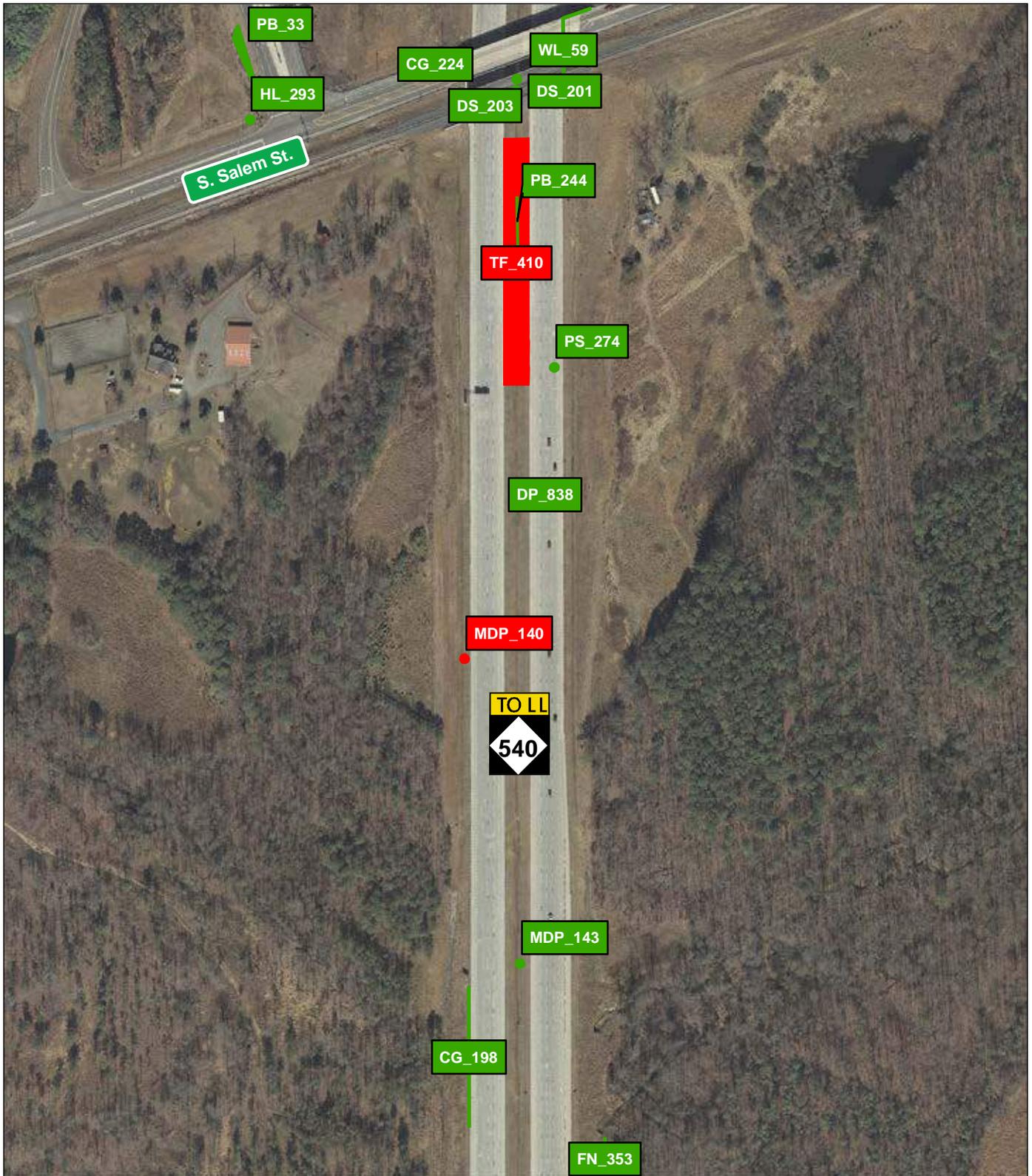


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

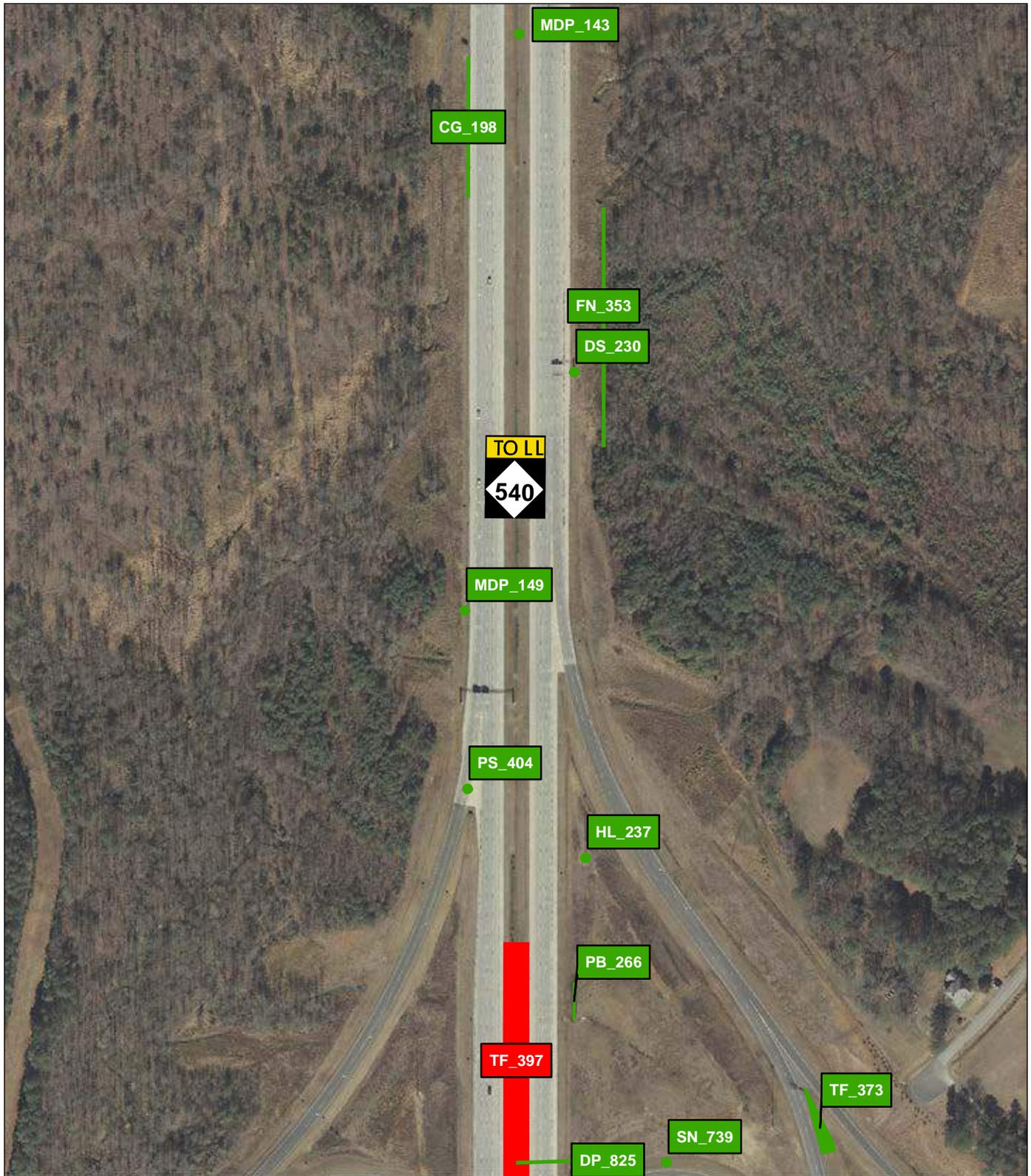


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

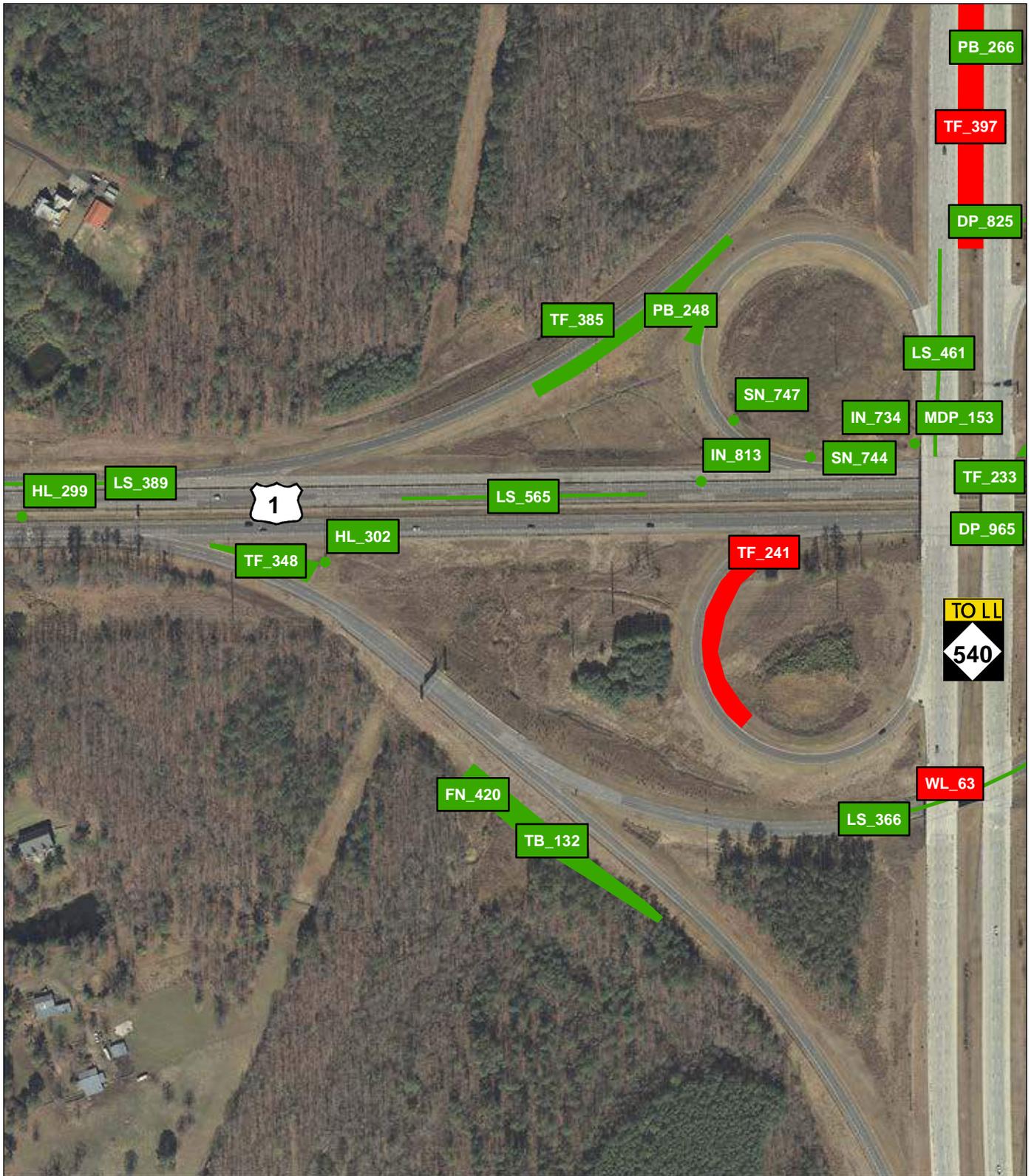


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

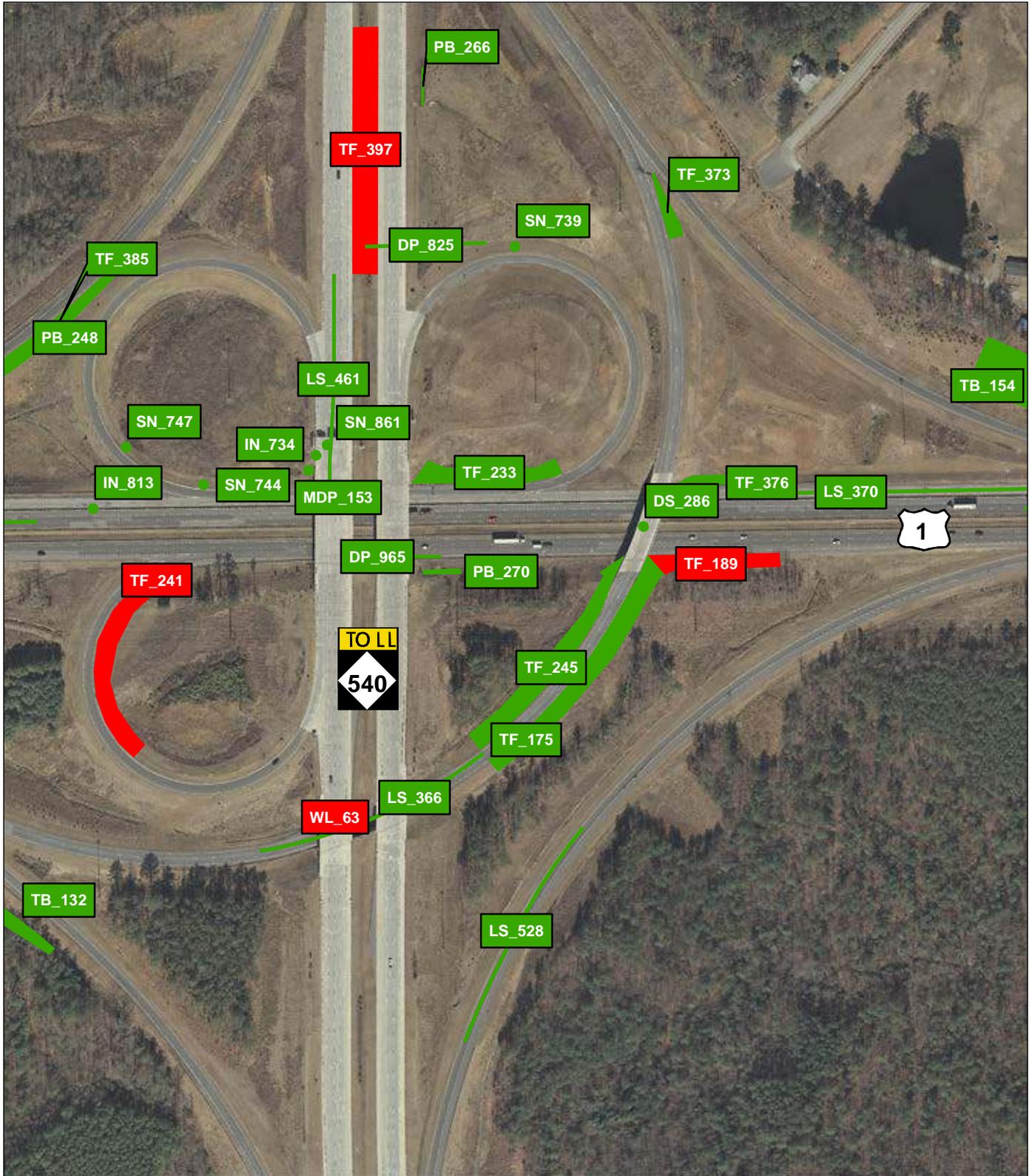


Legend

- Passing Asset
- Failing Asset

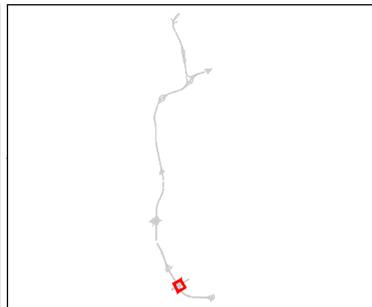


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

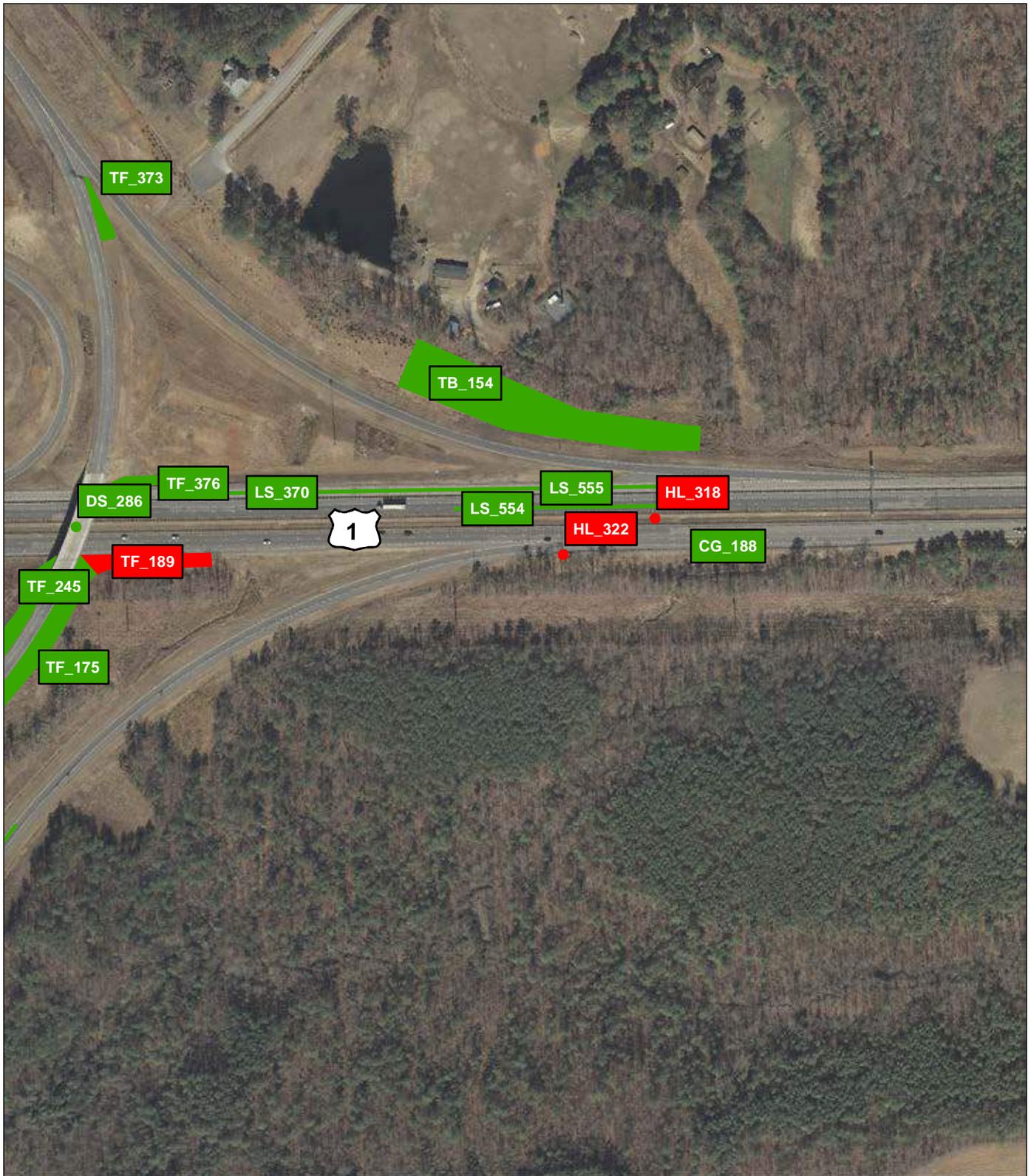


Legend

- Passing Asset
- Failing Asset

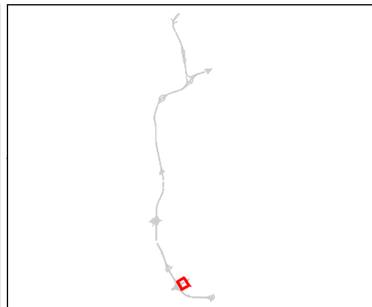


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

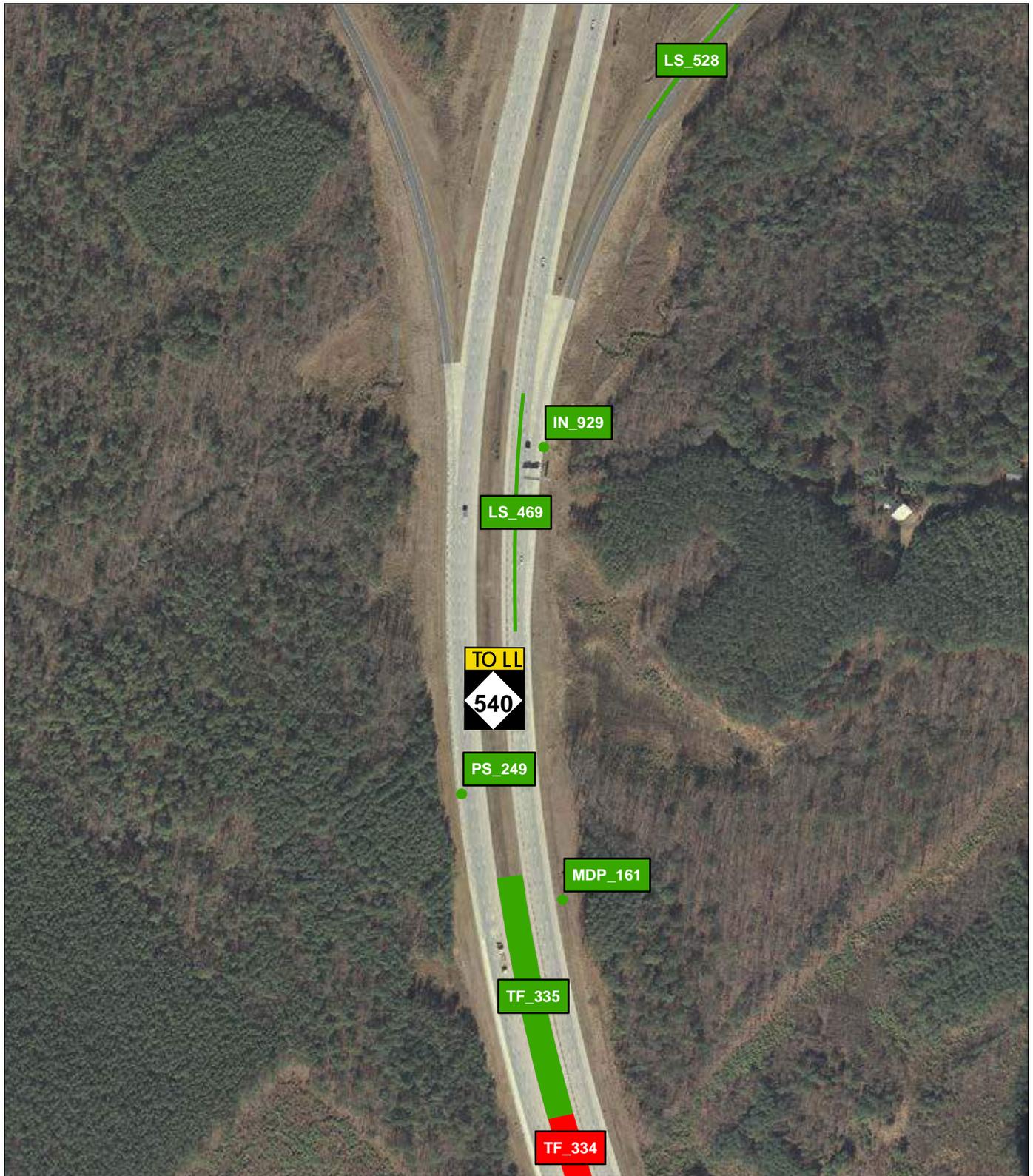


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

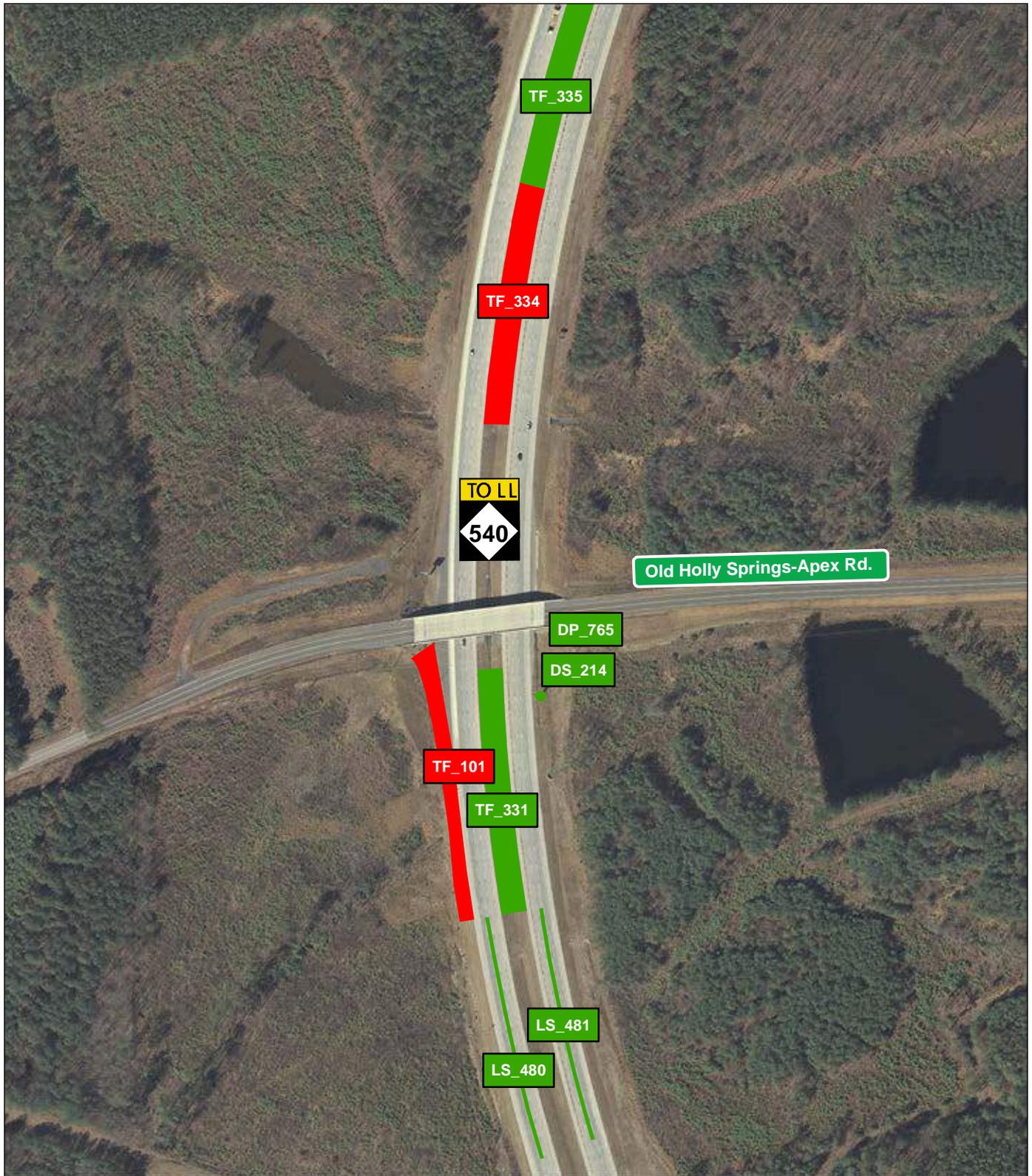


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

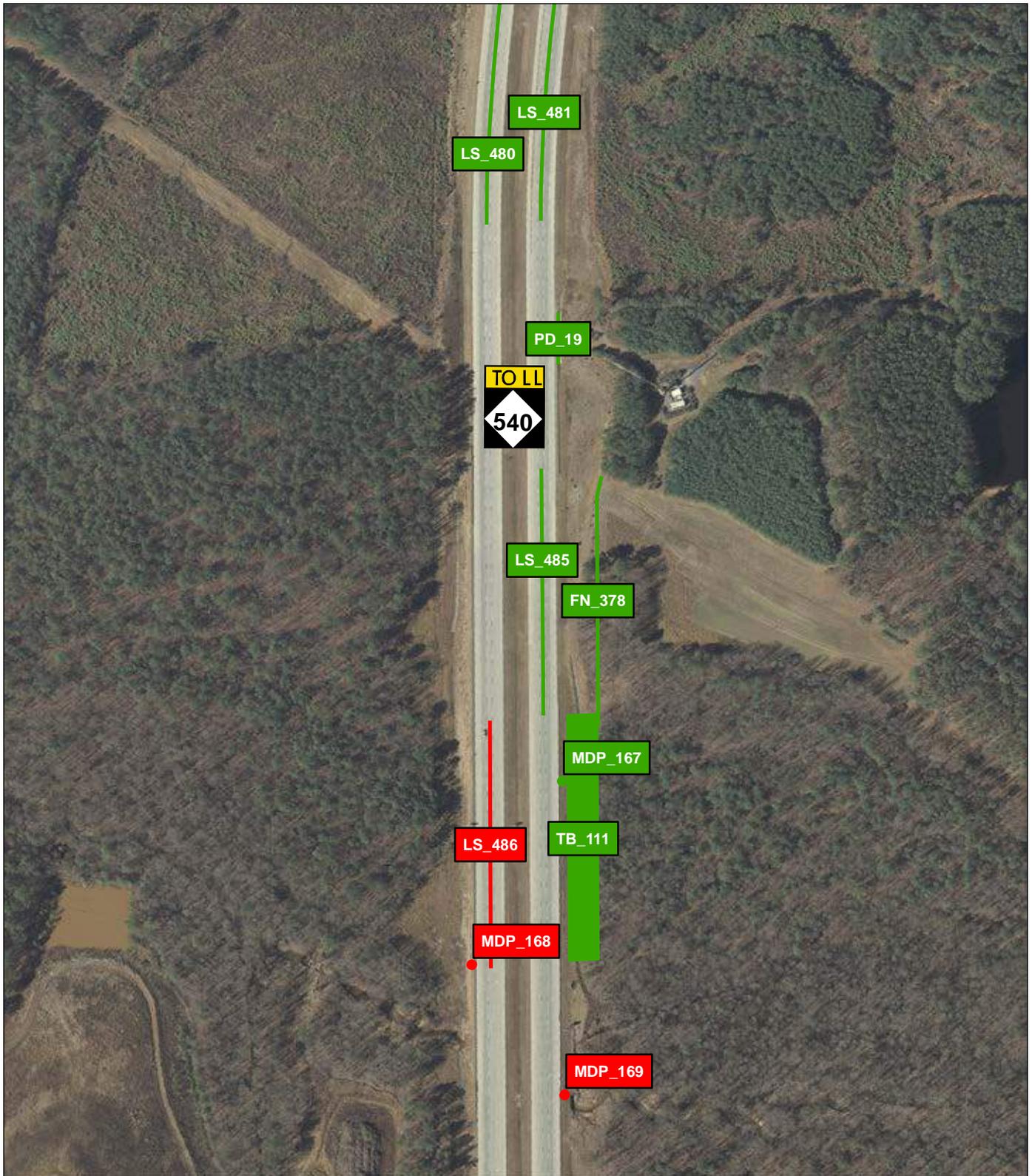


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset

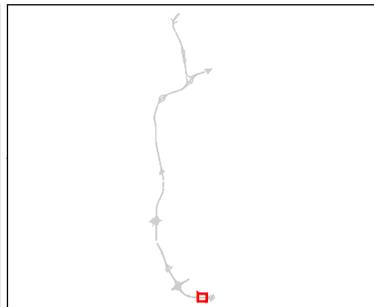


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

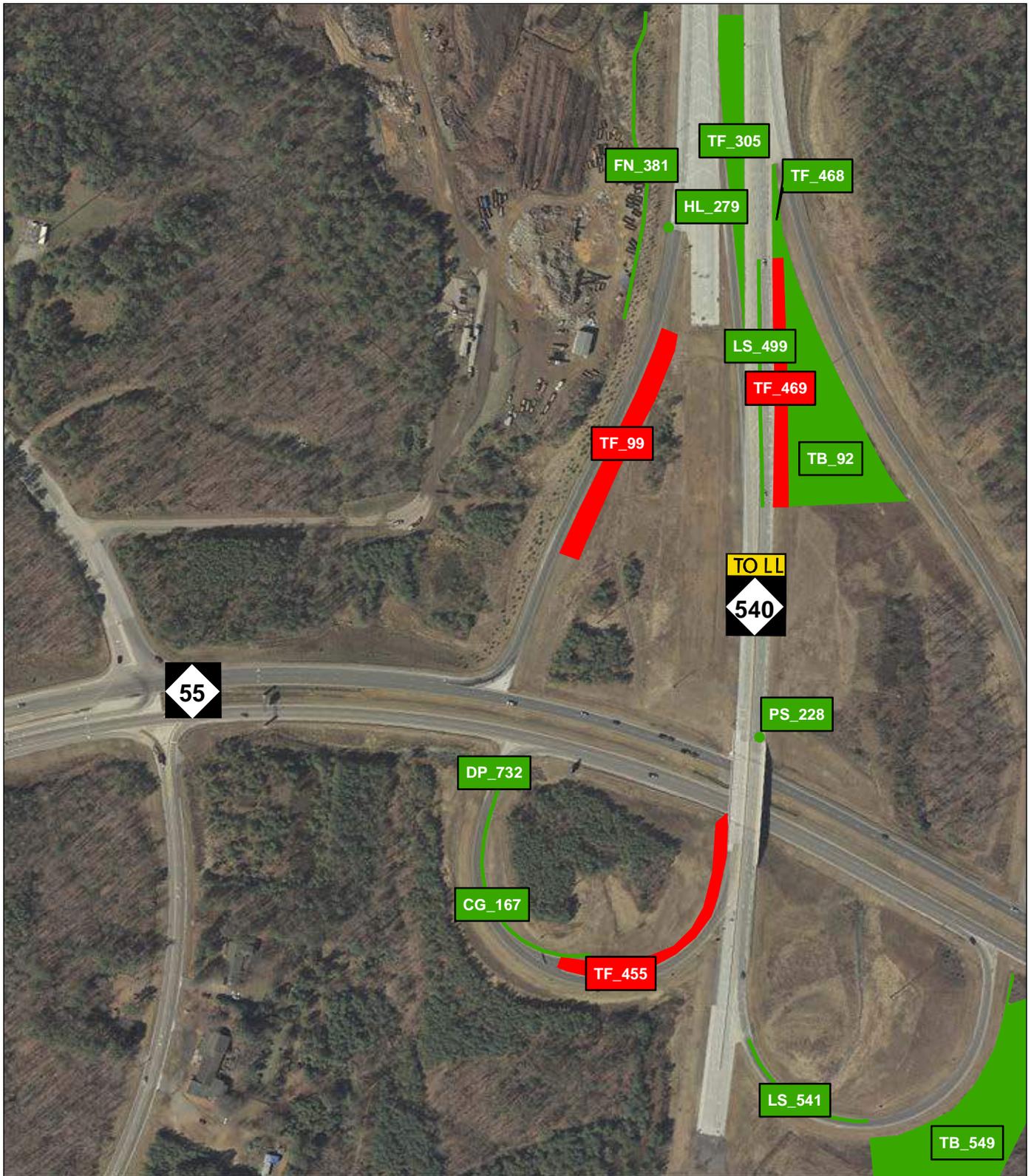


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

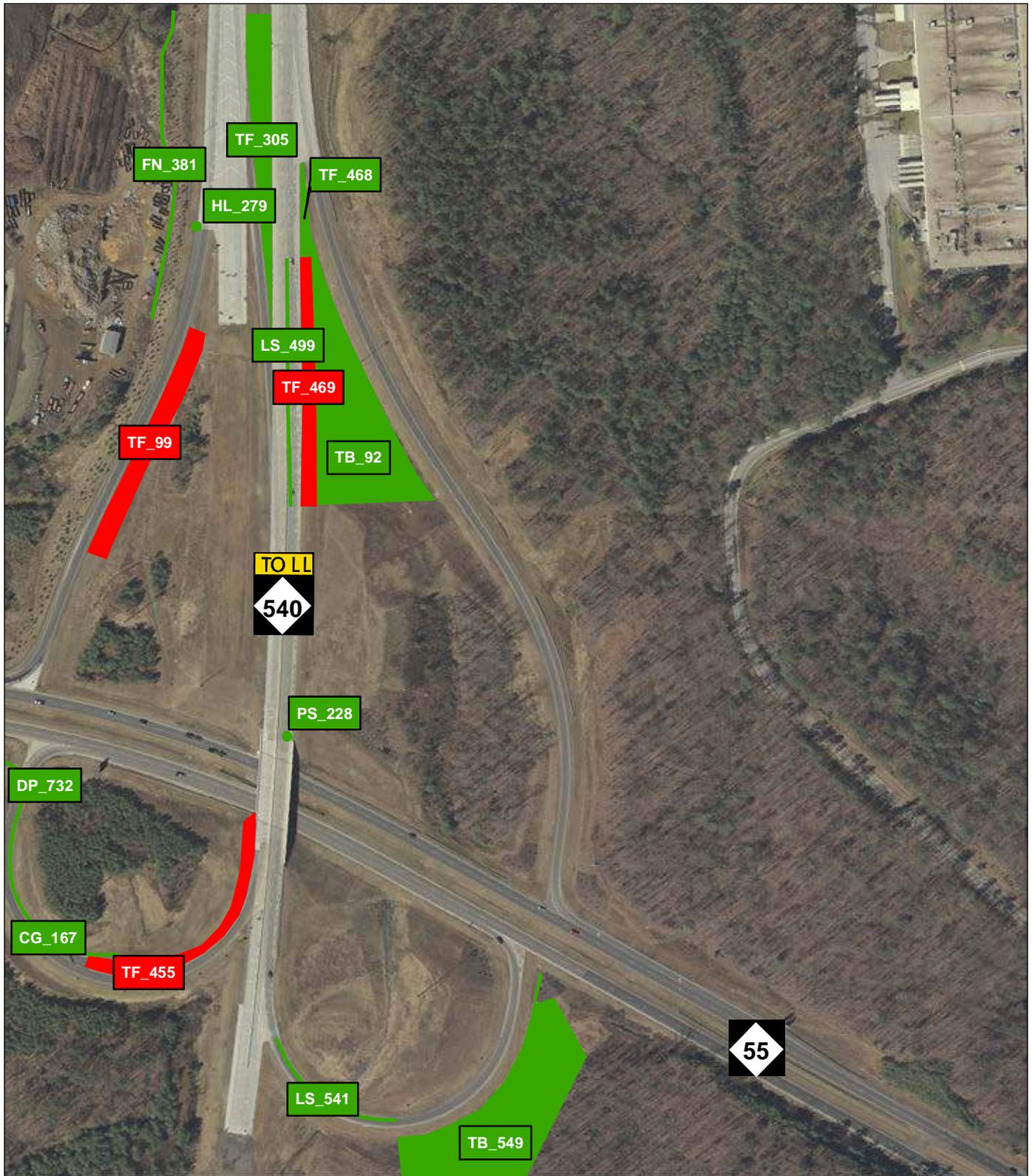


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

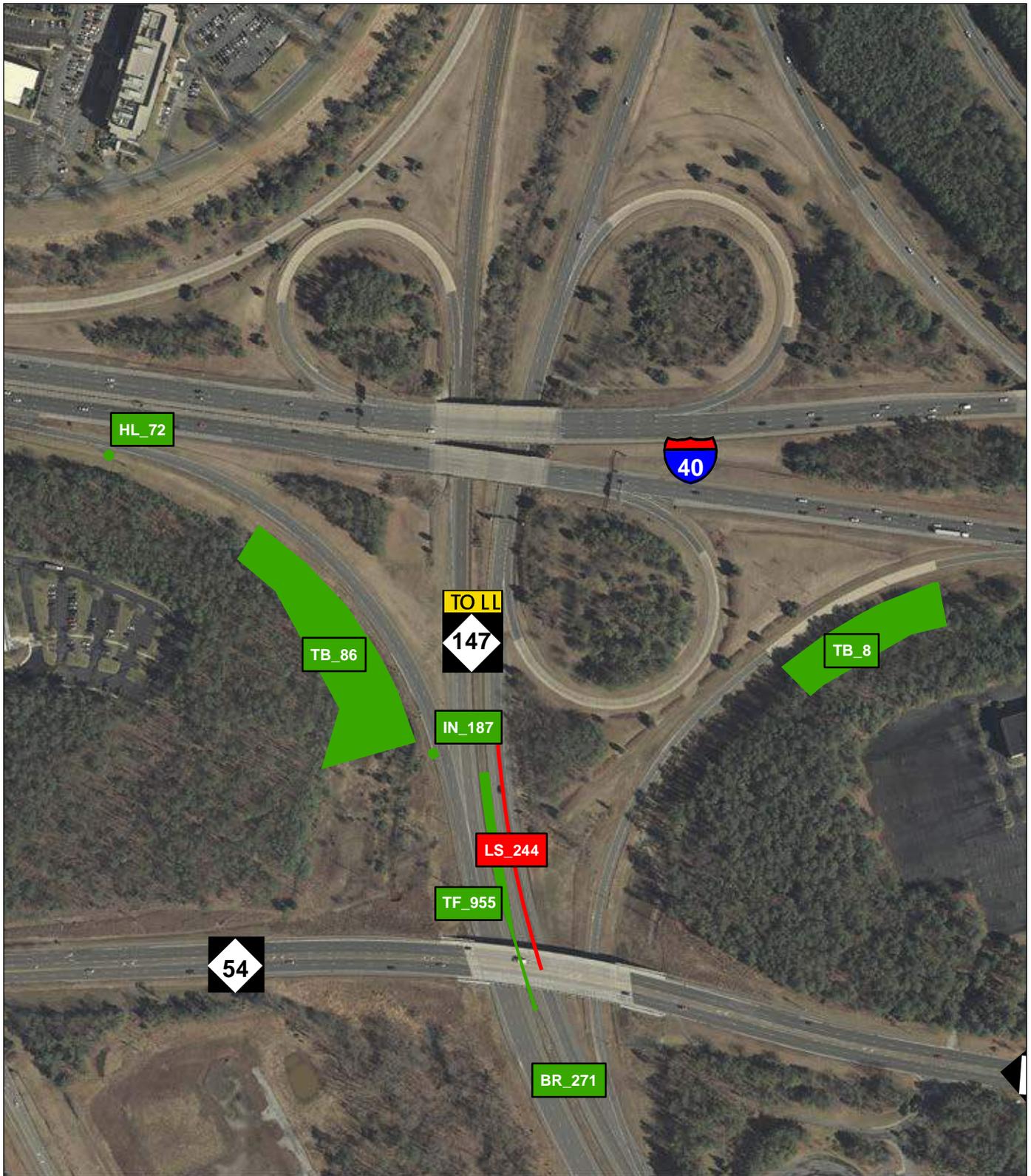


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

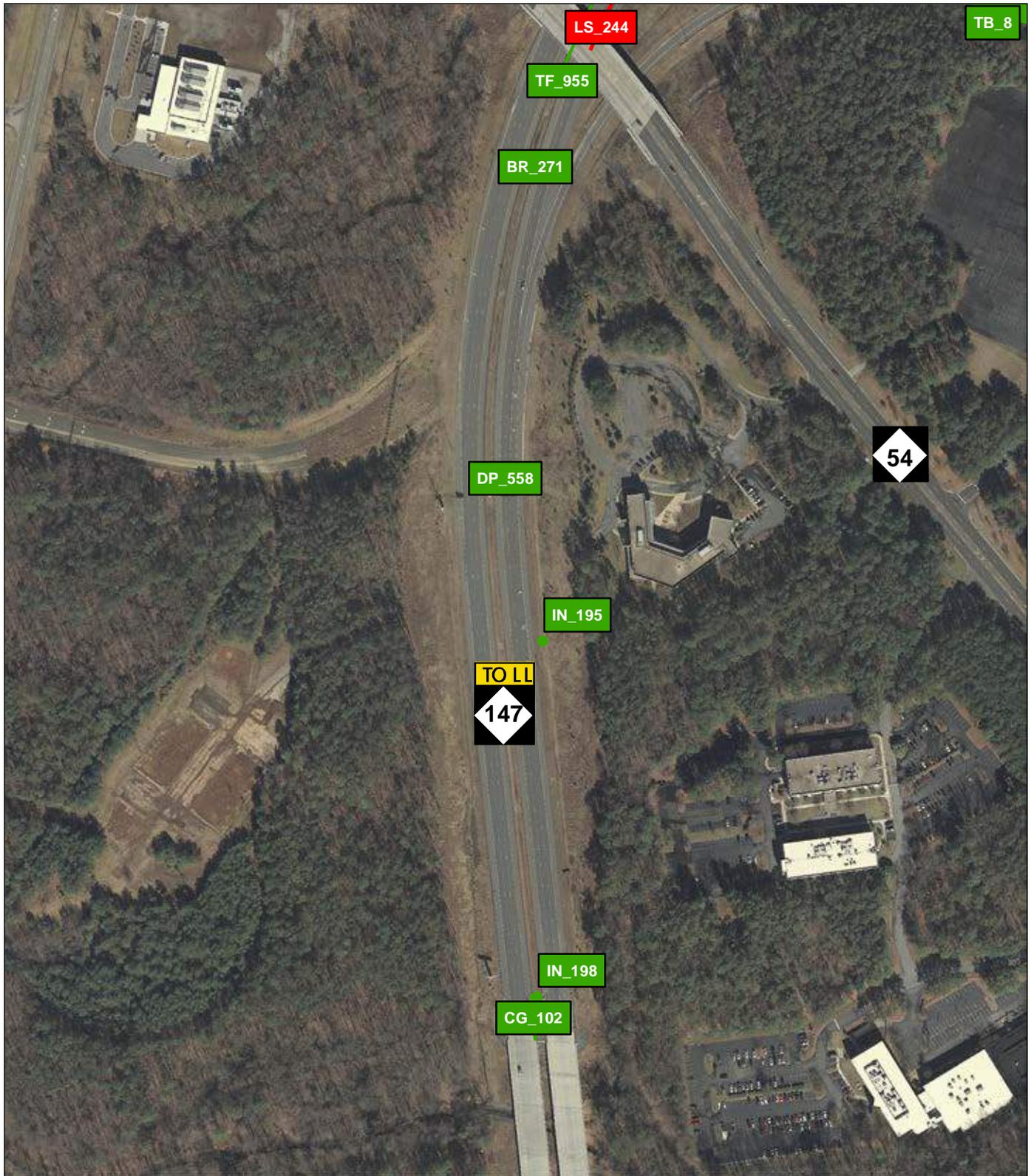


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

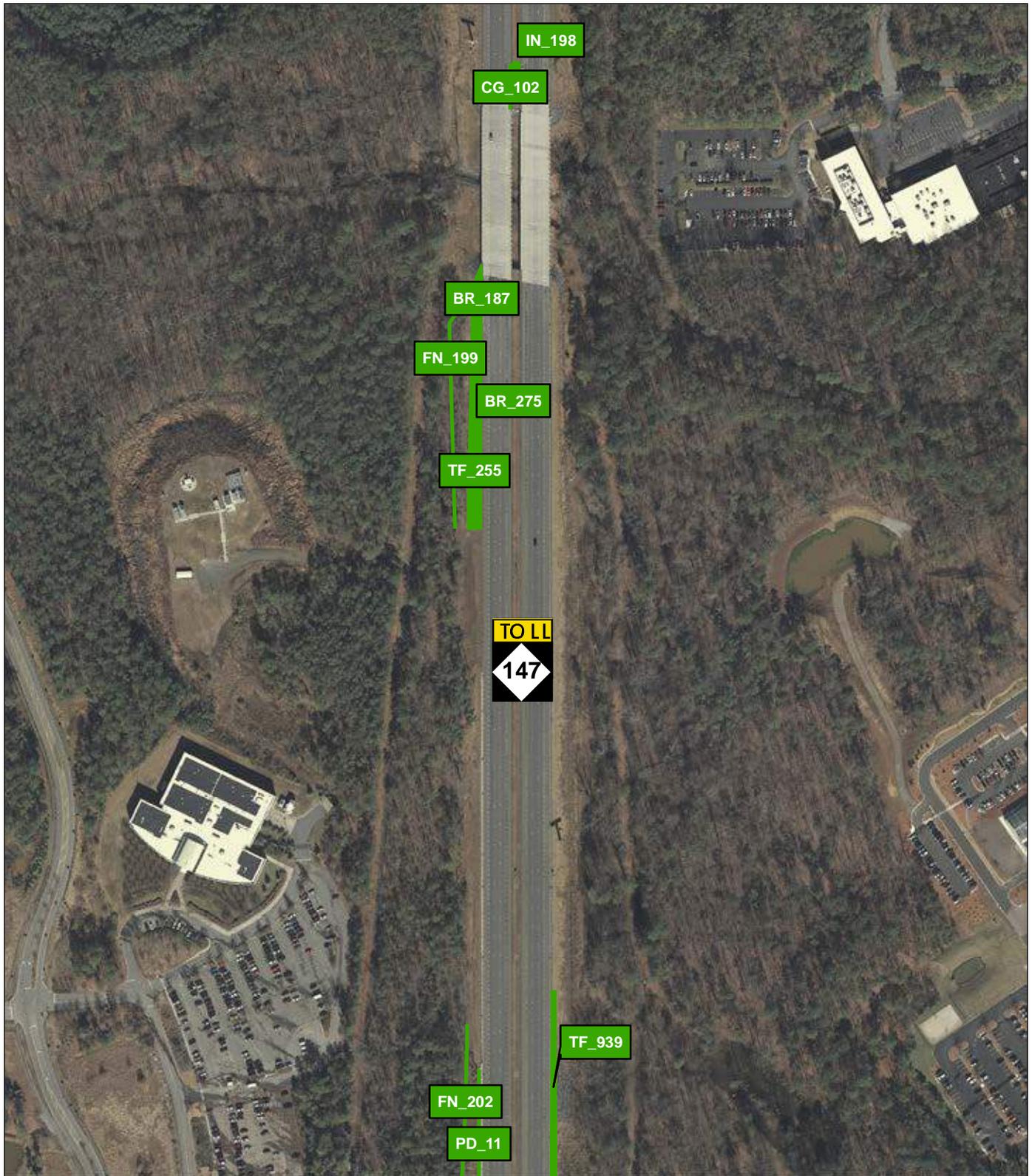


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

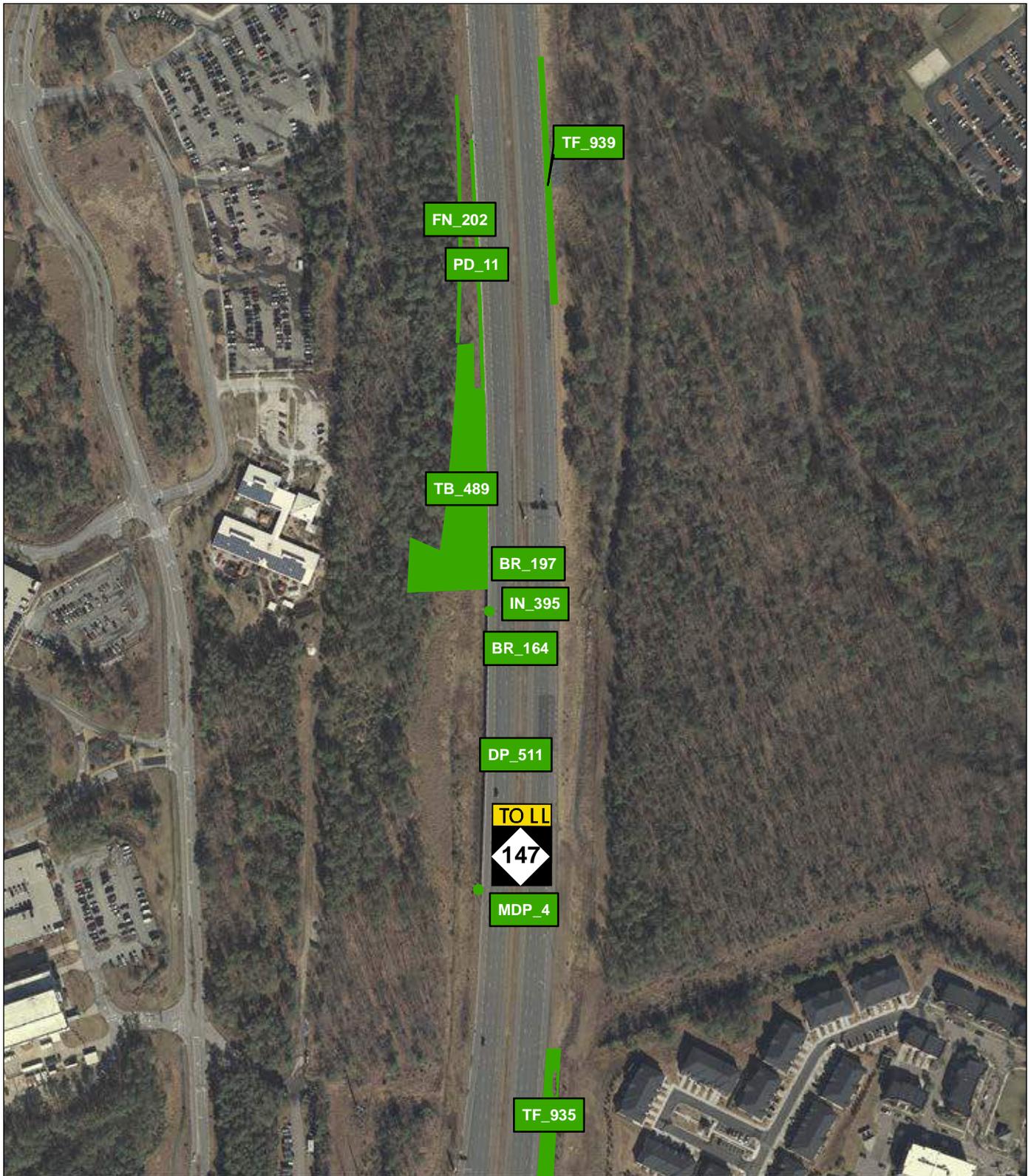


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

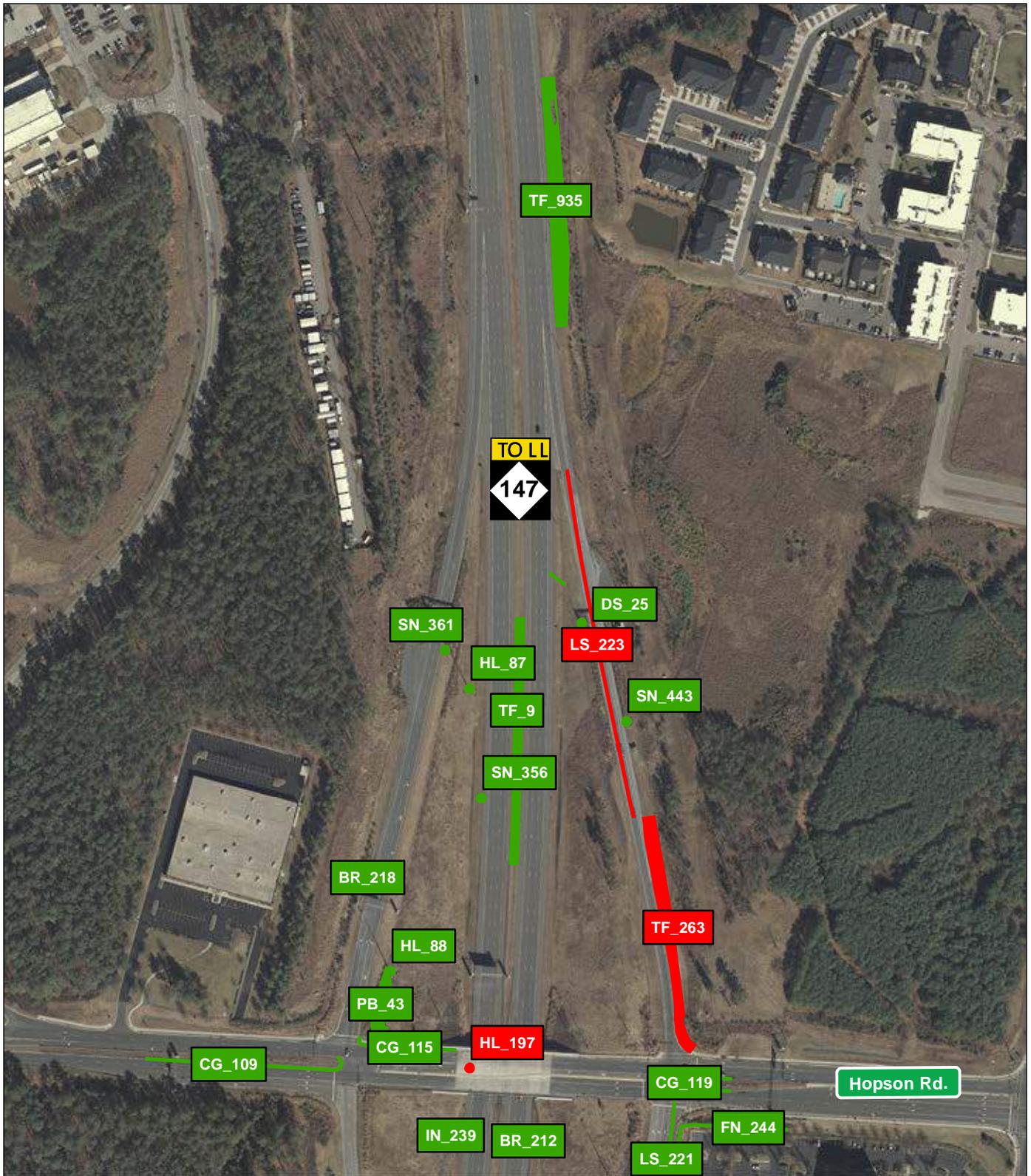


Legend

-  Passing Asset
-  Failing Asset

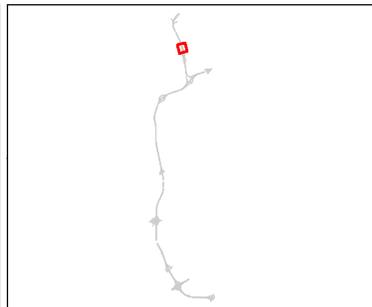


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

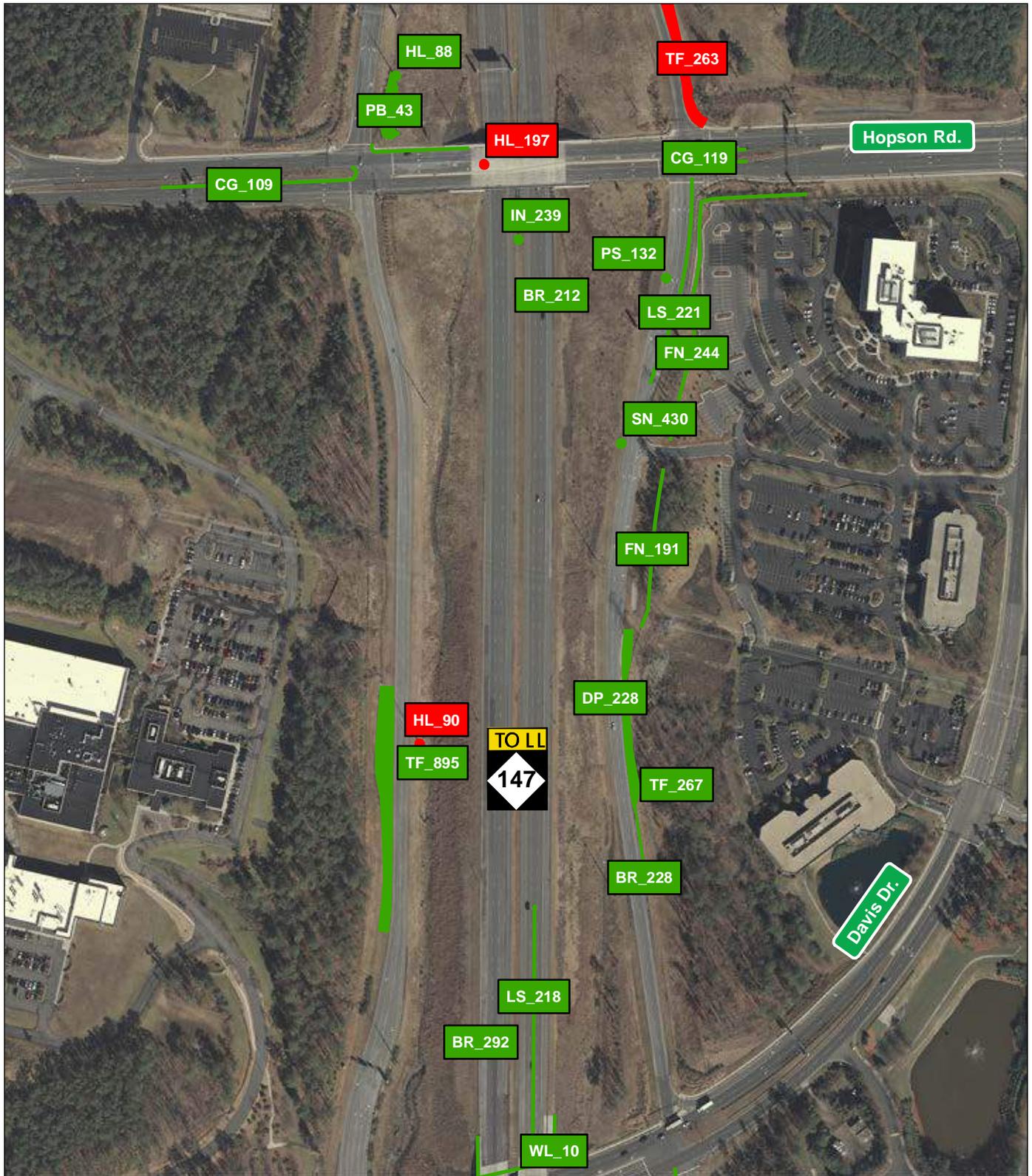


Legend

- Passing Asset
- Failing Asset

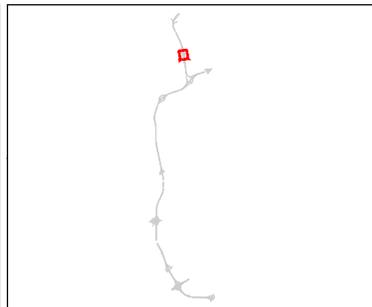


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

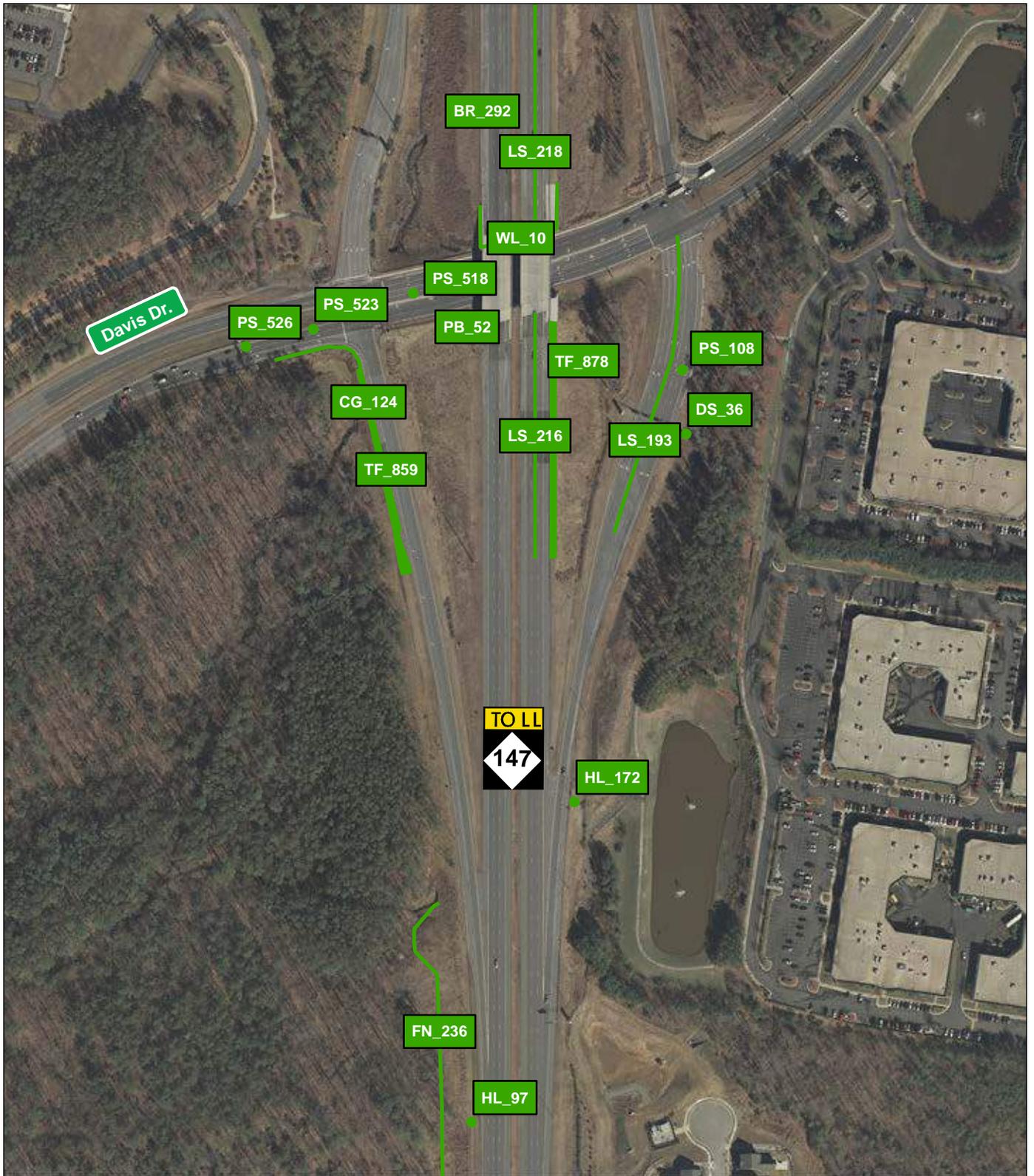


Legend

- Passing Asset
- Failing Asset

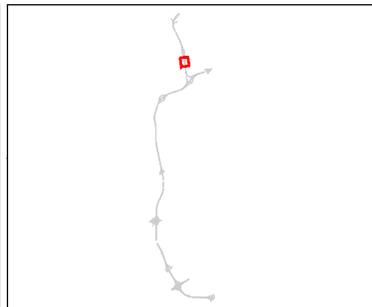


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

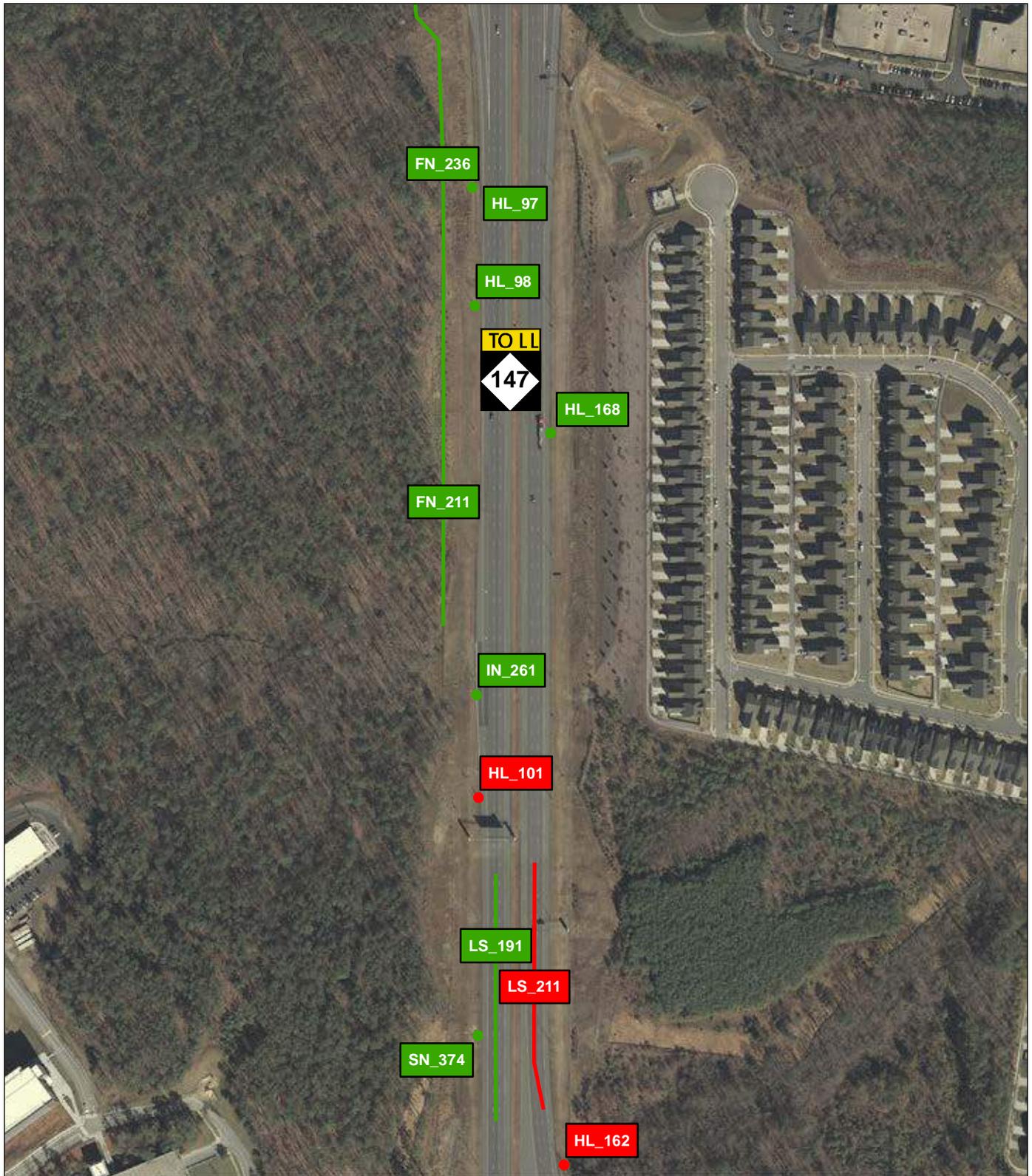


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations

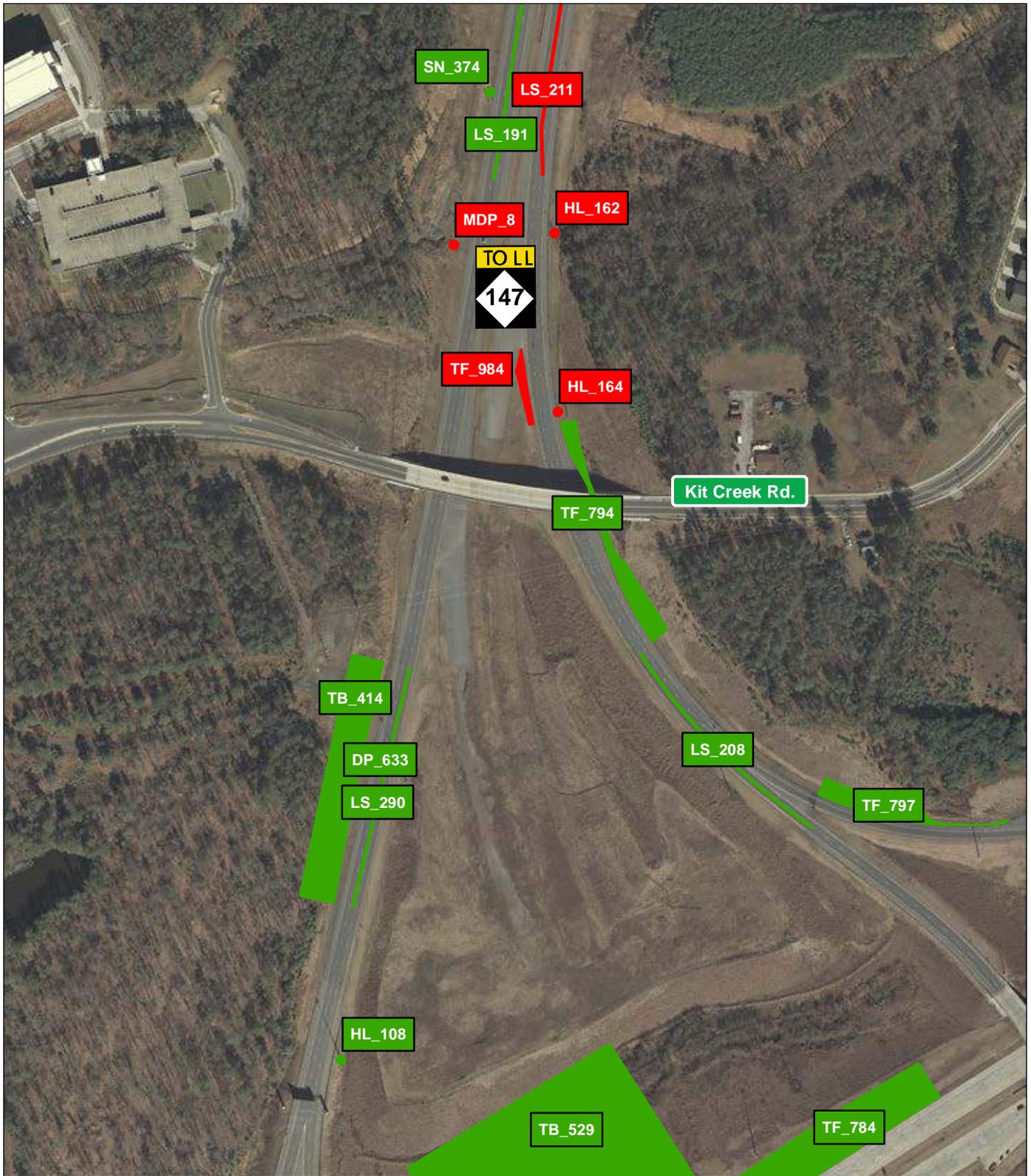


Legend

-  Passing Asset
-  Failing Asset

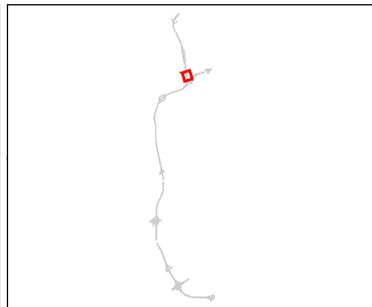


Appendix A: Triangle Expressway 2016 First Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset



Appendix B

Triangle Expressway 2016 First Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2016 First Quarter Table Results of Assets Failing MRP

Provided below are a series of tables outlining the existing failures that occurred throughout the facility. Assets are defined by an Inventory ID, which is a unique identifier given to each individual asset. The components that make up the Inventory ID are an asset specific prefix along with a number, such as LS_1. All assets and their respective prefixes are listed below:

Guardrail, Concrete Barrier and End Anchors (BR)..... 3
Curb and Gutter (CG) 4
Decorative Supports (DS)..... 5
Drainage Pipes (DP)..... 6
Misc. Drainage Structure (MDP) 7
Fence and Control of Access (FN) 10
Graffiti (GR) 11
Highway Lighting (HL) 12
Impact Attenuators (IA) 14
Inlets (IN)..... 15
Landscaping (PB) 16
Paved Lanes – Asphalt (LS)..... 17
Paved Lanes – Concrete (LS) 18
Paved Shoulders (LS)..... 19
Unpaved Shoulders (LS) 20
Front/Back Slopes (LS) 21
Unpaved Lateral and Outfall Ditches (LS) 22
Litter (LS) 23
Roadway Sweeping (LS) 24
Pavement Striping (LS)..... 25
Pavement Markers (LS)..... 26
Delineators (LS) 27
Paved Ditches (PD)..... 28
Pavement Words and Symbols (PS)..... 29
Signs (SN) 30
Tree and Brush (TB)..... 31
Turf Condition (TF) 32
MSE/Retaining Walls, Sound Barrier Walls and Screen Walls (WL)..... 38

The Inventory ID and GIS Reference Page number correspond to the provided map packets and allow for quick location of particular asset failures. Photos of failures were provided when applicable.

Guardrail, Concrete Barrier and End Anchors (BR)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Curb and Gutter (CG)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Decorative Supports (DS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Drain	DP_936	Obstruction		A34, A35

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_8	Erosion	 A photograph showing a concrete shoulder drain with significant soil erosion on either side, particularly on the right side where the concrete is exposed.	A59
2	Shoulder Drain	MDP_30	Obstruction	 A photograph of a concrete shoulder drain that is almost completely blocked by a large, dark, irregular mass of debris or vegetation.	A16
3	Shoulder Drain	MDP_31	Obstruction	 A photograph of a concrete shoulder drain with a large, dark, irregular mass of debris or vegetation blocking the opening.	A17
4	Shoulder Drain	MDP_38	Obstruction	 A photograph of a concrete shoulder drain that is almost completely blocked by a large, dark, irregular mass of debris or vegetation.	A18

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Shoulder Drain	MDP_39	Erosion	 A photograph showing a concrete shoulder drain with a significant amount of soil eroded away from its edges, leaving a deep, irregular hole in the surrounding ground.	A18, A19
6	Shoulder Drain	MDP_88	Obstruction	 A close-up photograph of a shoulder drain where a large, dark, irregular mass of debris or vegetation is completely blocking the opening of the drain.	A28
7	Shoulder Drain	MDP_112	Obstruction	 A photograph showing a shoulder drain that is almost entirely blocked by a dense, dark mass of vegetation and debris, with only a small opening visible.	A33
8	Shoulder Drain	MDP_140	Obstruction	 A photograph of a shoulder drain where a large, dark, irregular mass of debris or vegetation is completely blocking the opening of the drain. A white object is visible on the ground to the right of the drain.	A40

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Shoulder Drain	MDP_168	Obstruction		A47
10	Shoulder Drain	MDP_169	Erosion		A47, A48

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_178	Hole Height		A9, A10, A11
2	Woven	FN_258	Fence Height		A2

Graffiti (GR)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Single Roadway	HL_32	Functional Damage	Not Available for Nighttime Failure.	A22, A23, A24
2	Single Roadway	HL_33	Functional Damage	Not Available for Nighttime Failure.	A22, A23, A24
3	High Mast	HL_71	Part Damage		A10
4	High Mast	HL_90	Part Damage		A56
5	Single Roadway	HL_101	Functional Damage	Not Available for Nighttime Failure.	A58
6	Single Roadway	HL_162	Part Damage and Functional Damage		A58, A59
7	Single Roadway	HL_164	Functional Damage	Not Available for Nighttime Failure.	A59
8	Underpass Lighting	HL_197	Functional Damage	Not Available for Nighttime Failure.	A55, A56

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Double Roadway	HL_318	Functional Damage	Not Available for Nighttime Failure.	A44
10	Single Roadway	HL_322	Functional Damage	Not Available for Nighttime Failure.	A44
11	Single Roadway	HL_337	Functional Damage	Not Available for Nighttime Failure.	A33

Impact Attenuators (IA)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Inlets (IN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Inlets	IN_451	Obstruction		A5

Landscaping (PB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Paved Lanes – Asphalt (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Paved Lanes – Concrete (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Paved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_309	Paved Shoulder Joint Separation		A4
2	Concrete	LS_486	Paved Shoulder Joint Separation		A47, A48

Unpaved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_211	Shoulder Build Up		A58, A59

Front/Back Slopes (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_165	Slope Failure		A30, A31
2	Asphalt	LS_223	Slope Failure		A55

Unpaved Lateral and Outfall Ditches (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Litter (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Roadway Sweeping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_200	Missing Markers	 A photograph showing a road with a metal guardrail on the right side. The road surface is asphalt. A sign on the right side of the road lists vehicle weight limits: 2 AXLES 10 71, 3 AXLES 11 52, and 4+ AXLES 13 04. The road appears to be missing markers.	A5
2	Asphalt	LS_244	Missing Markers	 A photograph showing a road with a metal guardrail on the right side. The road surface is asphalt. The road appears to be missing markers.	A51, A52
3	Concrete	LS_309	Missing Markers	 A photograph showing a road with a metal guardrail on the right side. The road surface is concrete. The road appears to be missing markers.	A4

Paved Ditches (PD)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Pavement Words and Symbols (PS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Signs (SN)

#	Sign Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Yield	SN_205	Height Requirement		A11, A12
2	Do Not Enter	SN_807	Height Requirement		A39
3	Exit	SN_833	Height Requirement		A30, A31

Tree and Brush (TB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
This asset did not produce any failures.					

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Turf	TF_99	Bareground		A49, A50
2	Turf	TF_101	Bareground		A46
3	Turf	TF_102	Bareground		A30, A32
4	Turf	TF_124	Bareground		A37

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_189	Bareground		A43, A44
6	Turf	TF_197	Bareground		A22, A23
7	Turf	TF_209	Bareground		A29, A30, A31
8	Turf	TF_241	Bareground		A42, A43

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Turf	TF_263	Bareground		A55, A56
10	Turf	TF_275	Bareground		A39
11	Turf	TF_334	Bareground		A45, A46
12	Turf	TF_397	Bareground		A41, A42, A43

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Turf	TF_410	Bareground		A38, A39, A40
14	Turf	TF_455	Bareground		A49, A50
15	Turf	TF_469	Bareground		A49, A50
16	Turf	TF_522	Bareground		A30

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
17	Turf	TF_533	Bareground		A29, A30, A31
18	Turf	TF_592	Bareground		A21
19	Turf	TF_776	Bareground		A5, A6
20	Turf	TF_984	Bareground		A59

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
21	Turf	TF_998	Bareground		A10, A12

MSE/Retaining Walls, Sound Barrier Walls and Screen Walls (WL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Sound Wall	WL_63	Joints and Cracks		A42, A43
2	Sound Wall	WL_95	Joints and Cracks		A34, A35