



NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2016 Fourth Quarter and Annual Report

1 S. Wilmington Street
Raleigh, NC 27601



Last Updated:
January 27, 2017

CONSULTANT CERTIFICATION OF COMPLETION

January 25, 2017

Dennis Jernigan, P.E.
NCTA Project Controls Engineer
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Raleigh, NC 27601

NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q4, 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

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Table of Contents

List of Figures ii

List of Tables ii

1.0 Executive Summary..... 1

2.0 Introduction 2

3.0 MRP Procedure 2

4.0 Triangle Expressway Description 5

5.0 Triangle Expressway Asset Inventory Update..... 6

6.0 MRP Fourth Quarter Assessment 7

 6.1 Quarterly Results 7

 6.2 Analysis and Recommendations 9

7.0 MRP Annual 2016 Assessment..... 12

 7.1 Annual Results..... 12

 7.2 Analysis and Recommendations 14

8.0 Green Level Historic District Signs 16

 8.1 Analysis and Recommendations 16

9.0 Conclusion..... 16

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

List of Figures

Figure 1: Maintenance Elements and Characteristics 3
Figure 2: Triangle Expressway Map 5
Figure 3: Miscellaneous Drainage Failures 10
Figure 4: Pavement Marker Failures 11
Figure 5: Green Level West Historic District Signs, Landscape Areas 16

List of Tables

Table 1: MRP Element Results for the 2016 Fourth Quarter Assessment 1
Table 2: MRP Element Results for the 2016 Annual Assessment 1
Table 3: Asset Inventory 6
Table 4: MRP Element Results for Q4 2016 7
Table 5: MRP Characteristic Results for Q4 2016 8
Table 6: MRP Characteristic Results for 2016 13
Table 7: MRP Element Results for 2016 14

Appendices

- A. Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations
- B. Triangle Expressway 2016 Fourth Quarter Table Results of Assets Failing MRP

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

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 Fourth Quarter Assessment of the Triangle Expressway.

The overall 2016 fourth quarter maintenance rating of the Triangle Expressway is 93.9, 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 Fourth Quarter Assessment		
Element	MRP Rating	Target Rating
Road Surface	97.7	85.0
Unpaved Shoulders and Ditches	100.0	85.0
Drainage	93.8	85.0
Roadside	93.7	85.0
Traffic Control Devices	88.3	85.0
Overall MRP Performance Rating	93.9	90.0

This report also provides a summary and analysis of the 2016 Annual Assessment of the Triangle Expressway, which takes into account the results of all four quarterly inspections conducted in 2016 during the months February, May, August, and November. The summation of these results produces the annual rating which is considered to be a statistically valid representation of the assets' conditions with a 95% confidence level in statistical sampling.

The overall 2016 annual maintenance rating of the Triangle Expressway is 94.2, which is above the NCTA target rating of 90. As shown in **Table 2**, all annual element ratings were also above the target rating of 85.

Table 2: MRP Element Results for the 2016 Annual Assessment					
Element	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	2016 Annual Rating
Road Surface	98	100	99	98	99
Unpaved Shoulders and Ditches	98	100	100	100	99
Drainage	93	91	88	94	91
Roadside	92	83	90	94	90
Traffic Control Devices	93	96	90	88	92
Overall MRP Performance Rating	94.9	94.7	93.4	93.9	94.2

In addition, the report provides findings of the Green Level Historic District signs inspection. Due to construction work, this quarter only three of the four sign locations were inspected. These three sign locations were only inspected for landscape appearance, because of missing signs due to vandalism. All landscaped areas at the sign locations were found to be 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.

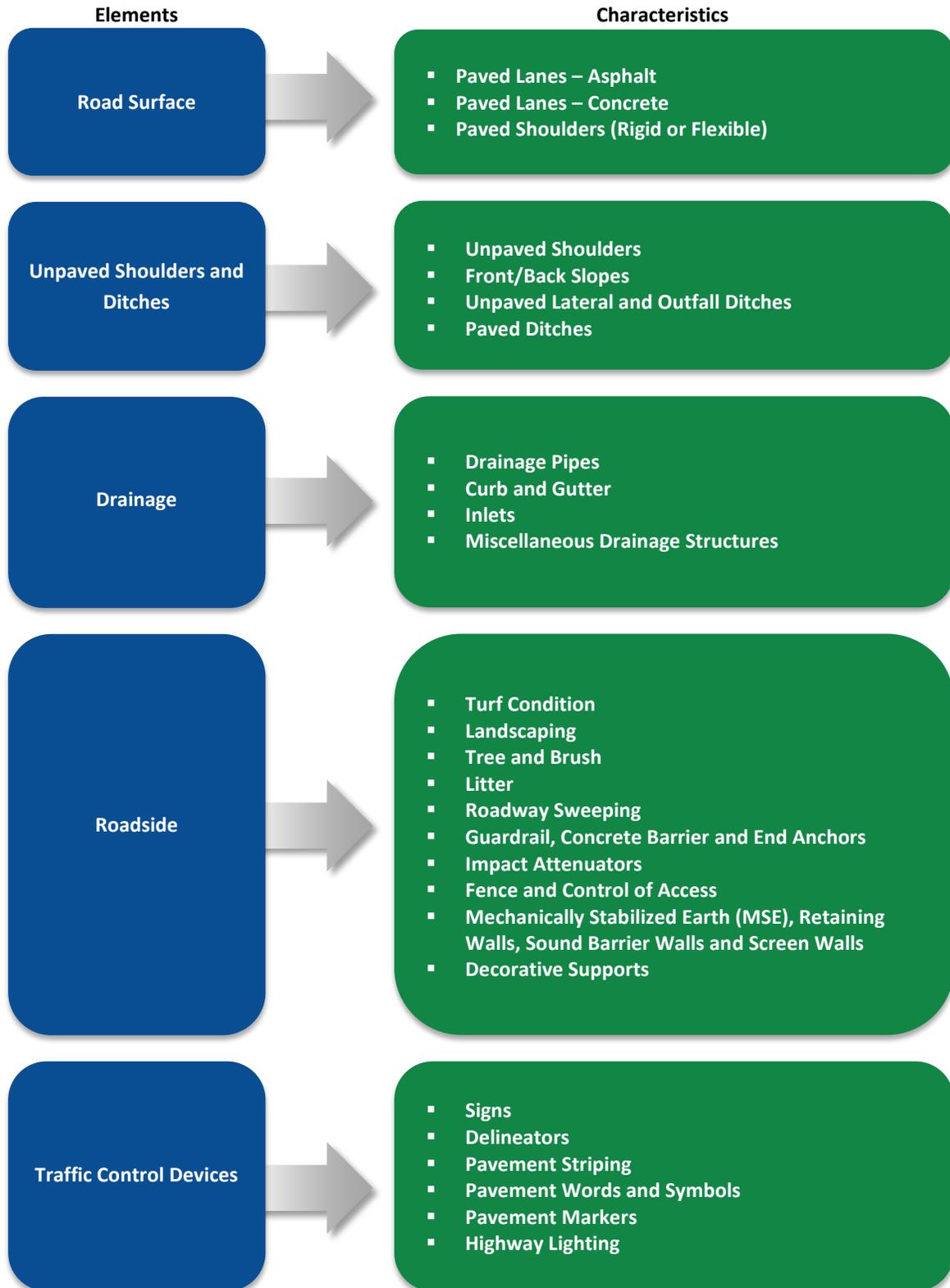
The NCTA performance standards, threshold criteria and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

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



Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

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:

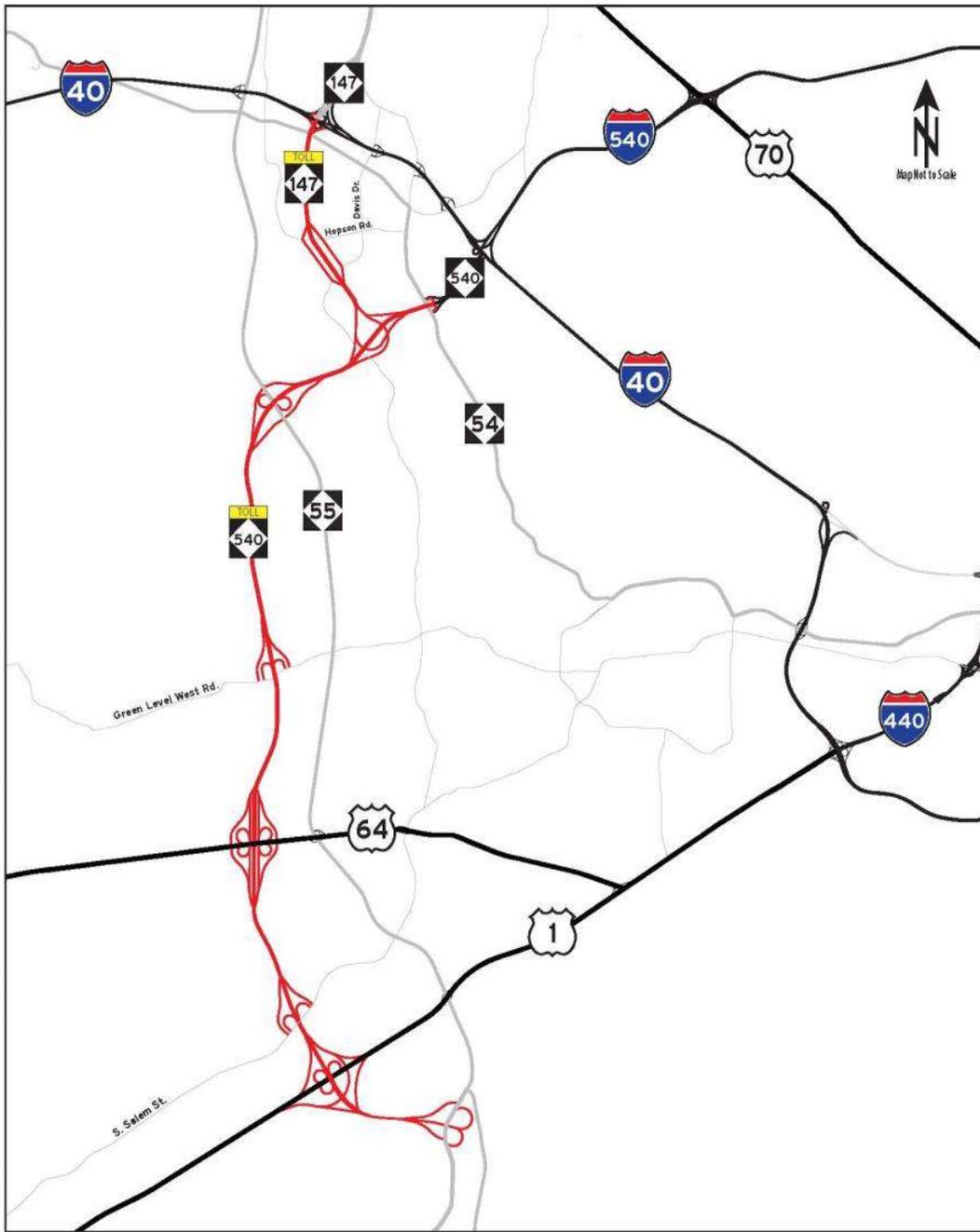
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

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.

As mentioned in the second quarter report, all assets located on NC-540 south of US-1 and north of NC-55 Bypass have been temporarily removed from the inventory due to the Access 540 Construction Project. During the fourth quarter, these assets continued to be excluded from the inventory. **Table 3** presents the number of assets that are currently eligible for inspection.

Table 3: Asset Inventory		
Assets	Total Inventory	2016 Eligible Inventory
Barriers	552	503
Curb and Gutter	235	218
Decorative Supports	243	223
Drainage	1136	1049
Misc. Drainage	181	164
Fences	432	379
Highway Lighting	316	296
Impact Attenuators	39	36
Inlets	968	901
Linear Segments	585	530
Plant Beds	292	286
Paved Ditches	2	1
Pavement Symbols	525	496
Signs	968	879
Tree and Brush	566	509
Turf	1010	923
Walls	113	107

6.0 MRP FOURTH QUARTER ASSESSMENT

6.1 Quarterly Results

The overall 2016 fourth quarter maintenance rating of the Triangle Expressway is 93.9, exceeding NCTA's target overall rating of 90. All elements assessed achieved ratings above the target rating of 85. Miscellaneous Drainage (78) and Pavement Markers (79) are the characteristics that scored below the target rating of 80. It is important to note that these results are only representative of the fourth 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 in **Section 7**, provides a 95% confidence level in statistical sampling. The fourth quarter MRP performance ratings for elements and characteristics are presented in **Table 4** and **Table 5**, respectively.

Table 4: MRP Element Results for Q4 2016	
Element	Q4 2016 MRP Rating
Road Surface	97.7
Unpaved Shoulders and Ditches	100.0
Drainage	93.8
Roadside	93.7
Traffic Control Devices	88.3
Overall MRP Performance Rating	93.9

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

Table 5: MRP Characteristic Results for Q4 2016						
Road Surface	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Paved Lanes Asphalt	20	21	9	180	189	95
Paved Lanes Concrete	22	22	9	198	198	100
Paved Shoulder	42	43	5	210	215	98
Element Total				588	602	97.7
Unpaved Shoulders And Ditches	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Unpaved Shoulder	43	43	9	387	387	100
Front/Back Slopes	43	43	6	258	258	100
Lateral and Outfall Ditches, Unpaved	43	43	6	258	258	100
Ditches, Paved	1	1	5	5	5	100
Element Total				908	908	100.0
Drainage	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Drainage Pipes	35	35	7	245	245	100
Curb and Gutter	23	23	6	138	138	100
Inlets	30	33	7	210	231	91
Misc. Drainage Structure	21	27	4	84	108	78
Element Total				677	722	93.8
Roadside	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Turf Condition	62	75	7	434	525	83
Landscaping	26	26	4	104	104	100
Trees and Brush	34	34	4	136	136	100
Litter	43	43	4	172	172	100
Roadway Sweeping	43	43	5	215	215	100
Guardrail, Concrete Barrier and End Anchors	30	30	9	270	270	100
Impact Attenuators	5	5	9	45	45	100
Fence, Control Access	22	25	7	154	175	88
Retaining Walls and Sound Barrier Walls	17	20	5	85	100	85
Decorative Supports	24	24	5	120	120	100
Graffiti and Stain Removal	40	40	4	160	160	100
Element Total				1895	2022	93.7
Traffic Control Devices	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Signs	31	34	7	217	238	91
Delineators	30	31	3	90	93	97
Pavement Striping/Marking	39	43	8	312	344	91
Words and Symbols	32	32	7	224	224	100
Pavement Markers	34	43	9	306	387	79
Highway Lighting	26	32	6	156	192	81
Element Total				1305	1478	88.3

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

6.2 Analysis and Recommendations

Elements

During the fourth quarter, all elements exceeded NCTA's threshold criteria of 85. This quarter's rating for Roadside (94) is 4 points higher than previous quarter. This continued increase in the Roadside rating is related to improvements observed in Turf Conditions (83) which obtained a rating 20 points higher than the previous quarter. It should be noted that while the ratings for Retaining/Sound Walls (85) and Control Access Fences (88) characteristics, both part of the Roadside element, are within the acceptable threshold, the ratings are lower than the previous quarter by 15 and 8 points, respectively.

This quarter, the rating for Drainage (88) also increased by 6 points from the previous quarter. This increase is mostly due to higher ratings obtained for Inlets (91) and Miscellaneous Drainage Structure (78), which increased by 3 and 14 points, respectively. However, even with a significant rating increase in this quarter, Miscellaneous Drainage Structure is still below NCTA's threshold criteria of 80.

In addition, this quarter Traffic Control Devices (88), now 2 points lower than the previous quarter, continued to decrease. This element's decrease in rating is mostly due to lower ratings obtained for Pavement Striping/Marking (91) and Pavement Markers (79). The ratings for these characteristics decreased by 7 and 16 points, respectively. It should also be noted, that compared to the previous quarter, the rating obtained for Highway Lighting (81) and Signs (91) increased by 15 and 6 points, respectively.

Recommendations to improve the most critical characteristic ratings and therefore continue to meet or exceed NCTA's threshold criteria are provided in the following sections.

Characteristics

This quarter all but two characteristics, Miscellaneous Drainage Structure (78) and Pavement Markers (79), met the NCTA target threshold criteria of 80. A description of the characteristics' conditions and future work planning recommendations are provided below. Pictures of the failures are included in **Appendix B**.

Miscellaneous Drainage (78 rating – 6 of the 27 assets failed). Out of the 27 miscellaneous drainage structures inspected, 6 failed because of obstruction. Two of the failing miscellaneous drainage structures are presented in **Figure 3**.

Figure 3: Miscellaneous Drainage Failures



Most 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 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

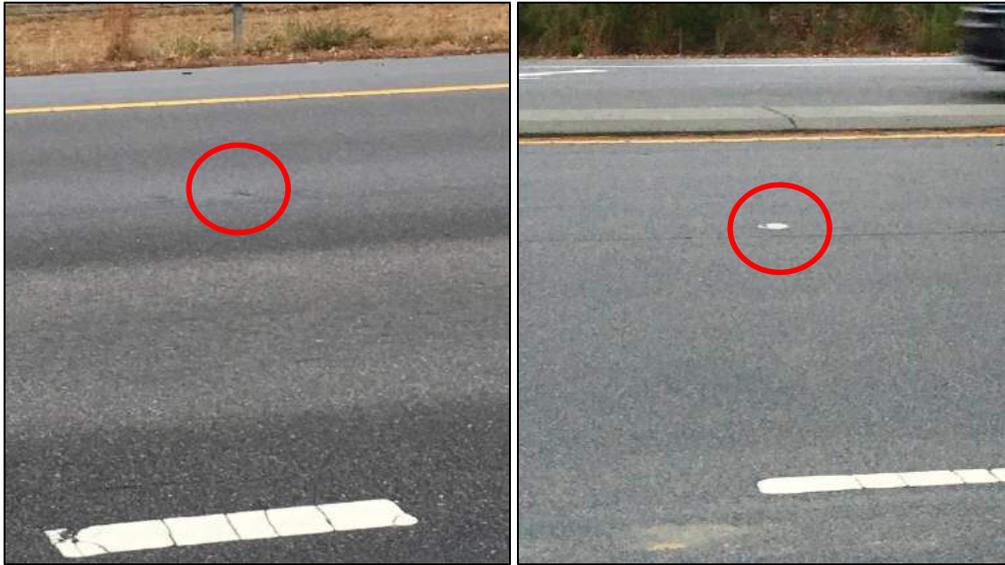
Miscellaneous Drainage Evaluation Standards:

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

Pavement Markers (79 rating – 9 of the 43 assets failed). All 9 pavement marker failures are due to missing markers and insufficient reflectivity during the nighttime inspections. Two examples of the pavement markers failures are represented in *Figure 4*.

Figure 4: Pavement Marker Failures



In order to maintain a well define lane delineation, especially during inclement weather, throughout the Triangle Expressway, it is recommended that the maintenance provider consider replacing all missing or non-functional markers in accordance with the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Maintenance Program:

- 1) Pavement markers are observed daily and especially after snow plowing for damage and further evaluated every 4 months for compliance to the standard.
- 2) Missing markers shall be scheduled for replacement annually, and generally are scheduled on a 3 year lens replacement cycle depending inspection results.

Maintenance and Evaluation Standards:

Pavement markers do not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 30% of the required raised pavement markers are missing.
- 2) More than 30% of the required markers are not visible at a distance of 528 feet during nighttime observation.
- 3) More than 2 continuous markers along a centerline or lane are absent.

7.0 MRP ANNUAL 2016 ASSESSMENT

7.1 Annual Results

The overall 2016 maintenance rating of the Triangle Expressway is 94.2, 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 are 68, 66 and 76, respectively.

The 2016 results are presented in **Tables 6 and 7**. These results are a collection of the four quarterly inspections conducted throughout the year.

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

Table 6: MRP Characteristic Results for 2016					
Road Surface	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Annual Rating
Paved Lanes Asphalt	100	100	100	95	99
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulder	95	100	98	98	98
Element Total	98.3	100.0	99.1	97.7	98.8
Unpaved Shoulders And Ditches	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Annual Rating
Unpaved Shoulder	98	100	100	100	99
Front/Back Slopes	95	100	100	100	99
Lateral and Outfall Ditches, Unpaved	100	100	100	100	100
Ditches, Paved	100	100	100	100	100
Element Total	97.7	100.0	100.0	100.0	99.4
Drainage	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Annual Rating
Drainage Pipes	97	91	97	100	96
Curb and Gutter	100	96	92	100	97
Inlets	97	100	88	91	94
Misc. Drainage Structure	66	63	64	78	68
Element Total	92.6	91.0	87.9	93.8	91.3
Roadside	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Annual Rating
Turf Condition	73	44	63	83	66
Landscaping	100	96	100	100	99
Trees and Brush	100	100	100	100	100
Litter	100	100	100	100	100
Roadway Sweeping	100	100	100	100	100
Guardrail, Concrete Barrier and End Anchors	100	89	100	100	98
Impact Attenuators	100	100	100	100	100
Fence, Control Access	93	100	96	88	95
Retaining Walls and Sound Barrier Walls	89	94	100	85	92
Decorative Supports	100	95	96	100	98
Graffiti and Stain Removal	100	100	100	100	100
Element Total	92.1	83.4	90.0	93.7	89.9
Traffic Control Devices	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Annual Rating
Signs	91	90	85	91	89
Delineators	89	91	93	97	93
Pavement Striping/Marking	100	100	98	91	97
Words and Symbols	100	100	100	100	100
Pavement Markers	100	100	95	79	93
Highway Lighting	69	88	66	81	76
Element Total	93.5	96.1	90.5	88.3	92.0

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

Table 7: MRP Element Results for 2016					
Element	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Annual Rating
Road Surface	98	100	99	98	99
Unpaved Shoulders and Ditches	98	100	100	100	99
Drainage	93	91	88	94	91
Roadside	92	83	90	94	90
Traffic Control Devices	93	96	90	88	92
Overall MRP Performance Rating	94.9	94.7	93.4	93.9	94.2

7.2 Analysis and Recommendations

Based on the combined results of all four quarterly inspections conducted in 2016, all elements exceeded NCTA's threshold criteria of 85. In addition, all but three of the characteristics failed to meet the target threshold criteria of 80. These characteristics are Miscellaneous Drainage Structure (68), Turf Condition (66), and Highway Lighting (76). All three characteristics have consistently obtained low ratings throughout the year, but it should be noted that during the fourth quarter their ratings increased significantly. While Turf Condition and Highway Lighting obtained fourth quarter ratings above the threshold criteria, Miscellaneous Drainage Structure failed to meet the threshold criteria by 2 points.

In order to continue to increase the rating obtained for Miscellaneous Drainage and meet NCTA's threshold criteria, it is recommended that the maintenance provider follow the maintenance recommendations provided in **Section 6**. Additionally, in order to continue to meet NCTA's threshold criteria for Turf Condition and Highway Lighting, it is recommended for the maintenance provider to continue to follow the maintenance program and standards presented in the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Turf Condition

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 feet 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.

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

- 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

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.

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 and ensure they are in good standing. During this quarter, the sign located near the intersection of Green Level Church Road and Green Level West Road was excluded from the inspection inventory due to inaccessibility to the sign because of construction work in the area. The three signs included in the inspection inventory were only inspected for landscape appearance because two of the three signs were vandalized and the other sign was temporarily removed to be used as a sample to replace the vandalized signs. All landscaped areas at the location of the signs were found to be well maintained (**Figure 5**). NCTA is in the process of replacing all signs.

Figure 5: Green Level West Historic District Signs, Landscape Areas



9.0 CONCLUSION

This report presents the 2016 fourth quarter and 2016 annual rating assessment of the Triangle Expressway. The NCTA's target ratings are 90 overall, 85 for elements and 80 for characteristics. The fourth quarter 2016 overall rating is 93.9 and the 2016 annual rating is 94.2, both of these ratings are above the target rating of 90.

All fourth quarter and 2016 annual element ratings are above the target rating of 85. However, during the fourth quarter assessment all but two characteristics met or exceeded the target rating of 80. Those two characteristics are Miscellaneous Drainage Structure (78) and Pavement Markers (79). Similarly, based on

Maintenance Rating Program for the Triangle Expressway

2016 Fourth Quarter and Annual Report

the combined results from all four quarterly inspections conducted in 2016, all but three characteristics met or exceeded the target rating of 80. Those three characteristics are Miscellaneous Drainage Structure (68), Turf Condition (66) and Highway Lighting (76).

In order to improve the quarterly and annual ratings, it is recommended that at least once per year the maintenance provider plan to remove any debris or overgrown vegetation that may impair outflow from the shoulder drain outlets. It is also recommended that all erosion soil buildup problems identified along the ditch line near and adjacent to the outlets be repaired. Additionally, 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 in order to provide positive flow.

It is also recommended that the maintenance provider replace all missing or non-functional pavement markers in an annual basis. In addition, it is recommended that all non-functioning or damaged highway lights be repaired and/or replaced. Also, it is recommended that mowing heights continue to be closely monitored during each mowing cycle and that the NCDOT Division 5 Landscape Unit continues to fertilize bare areas to promote new growth.

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.

This quarter, only three of the four Green Level Historic District sign locations were inspected due to construction work. The three sign locations were only inspected for landscape appearance because of missing signs due to vandalism. All landscaped areas at the sign location were found to be well maintained. NCTA is currently working towards replacing all Green Level West signs that were vandalized.

Appendix A

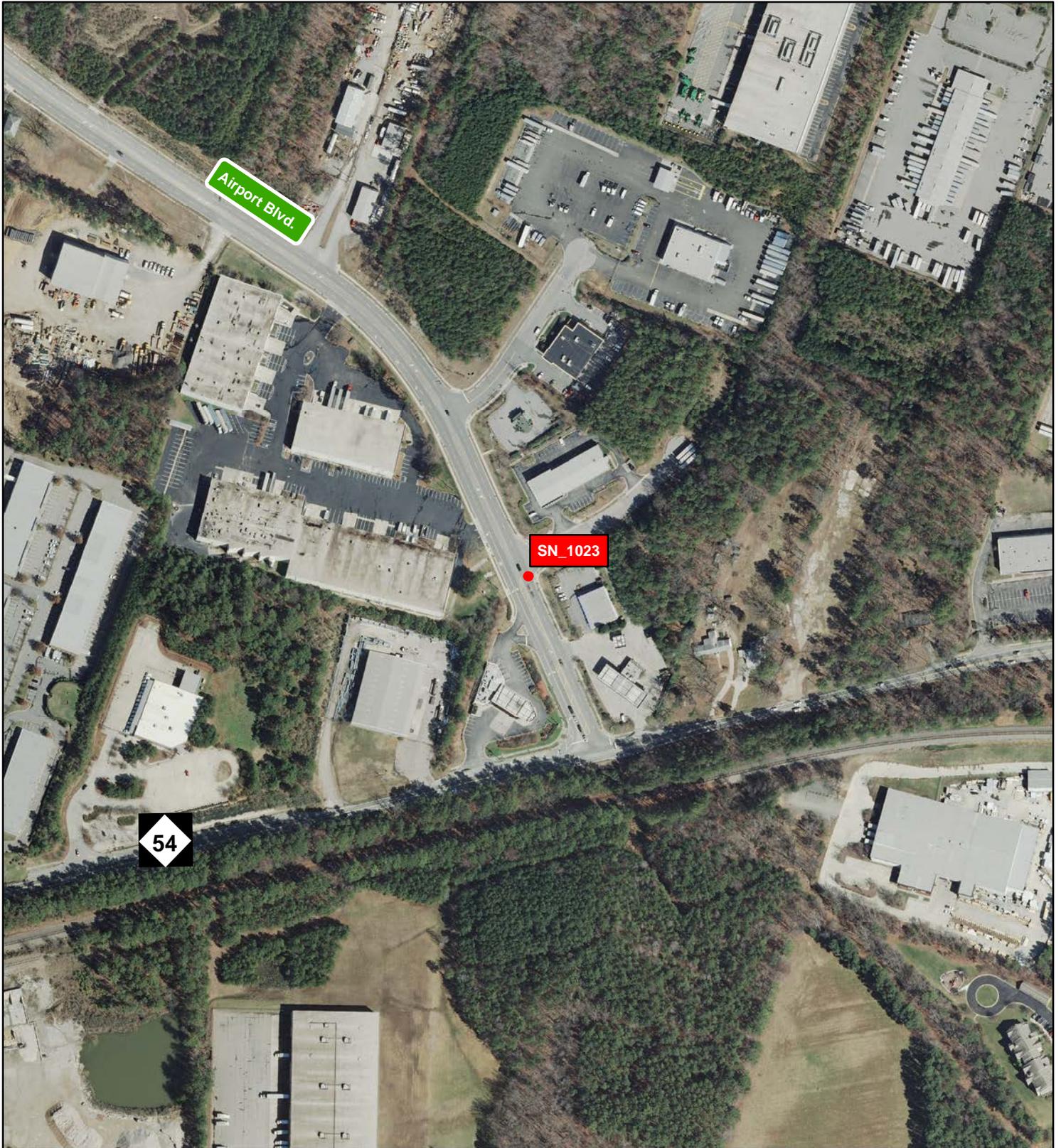
Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

Provided below are a series of maps outlining the assets that were a part of this quarter's sample and their corresponding result. 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 Fourth Quarter Asset Assessment Locations

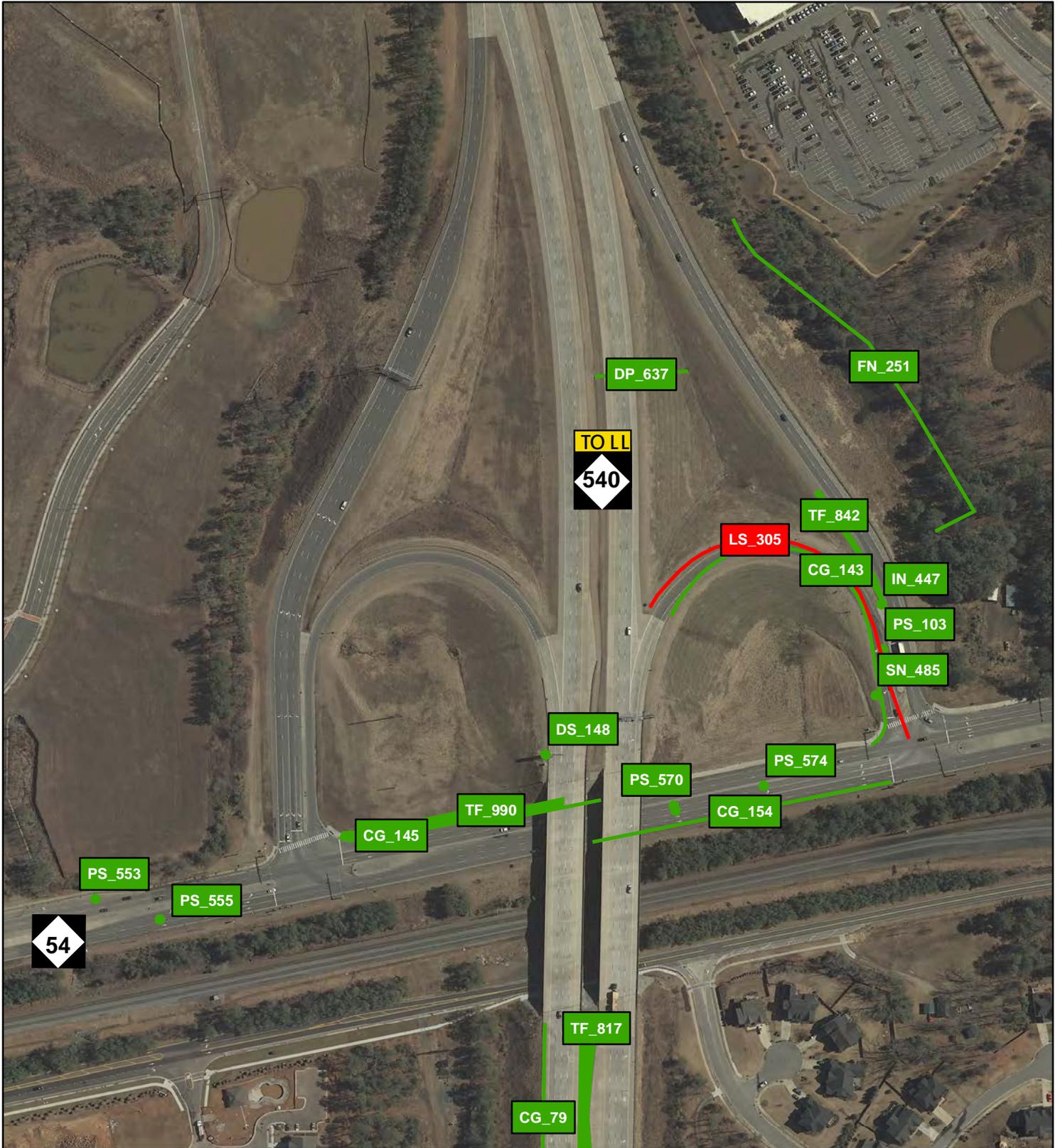


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

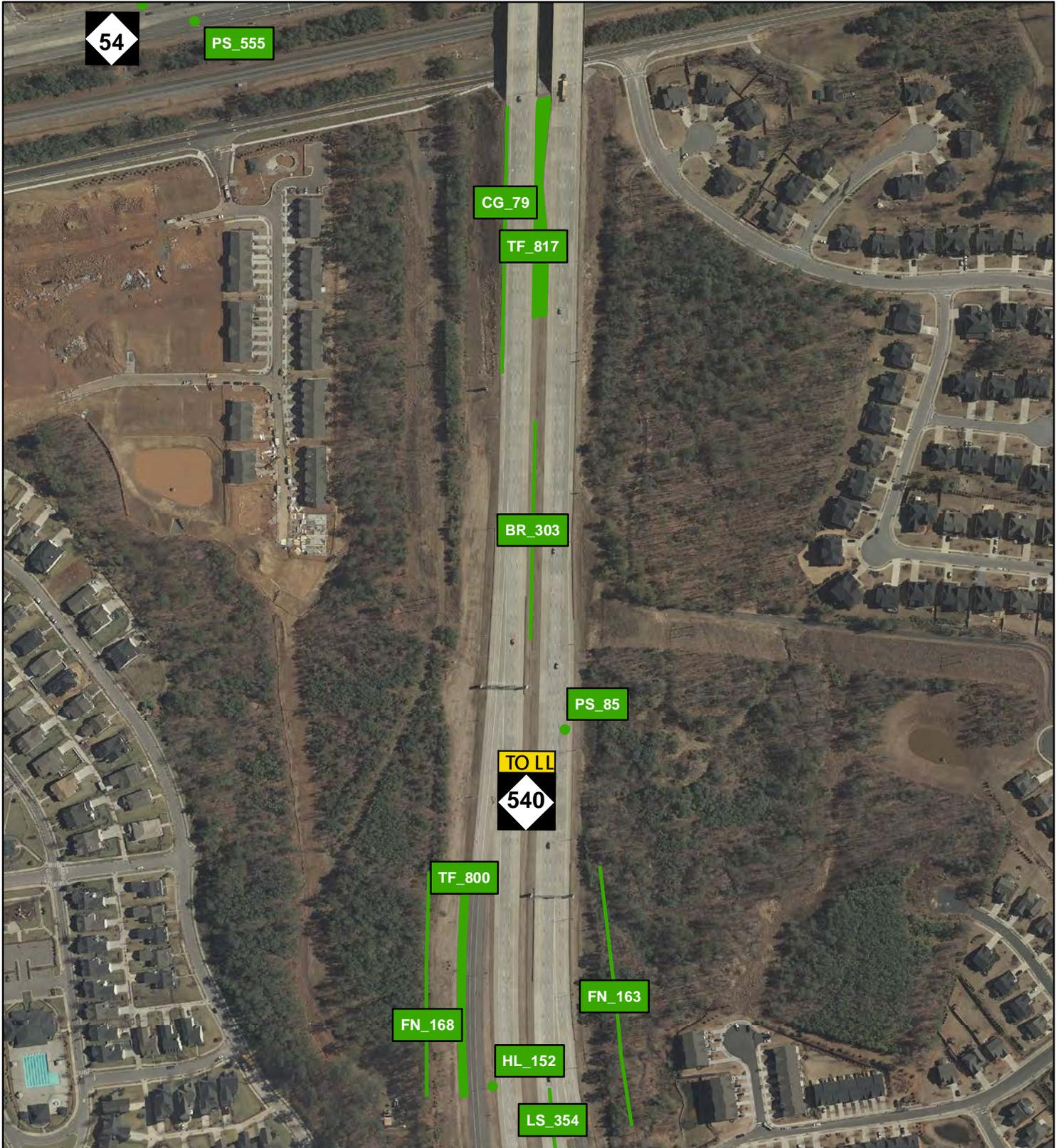


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

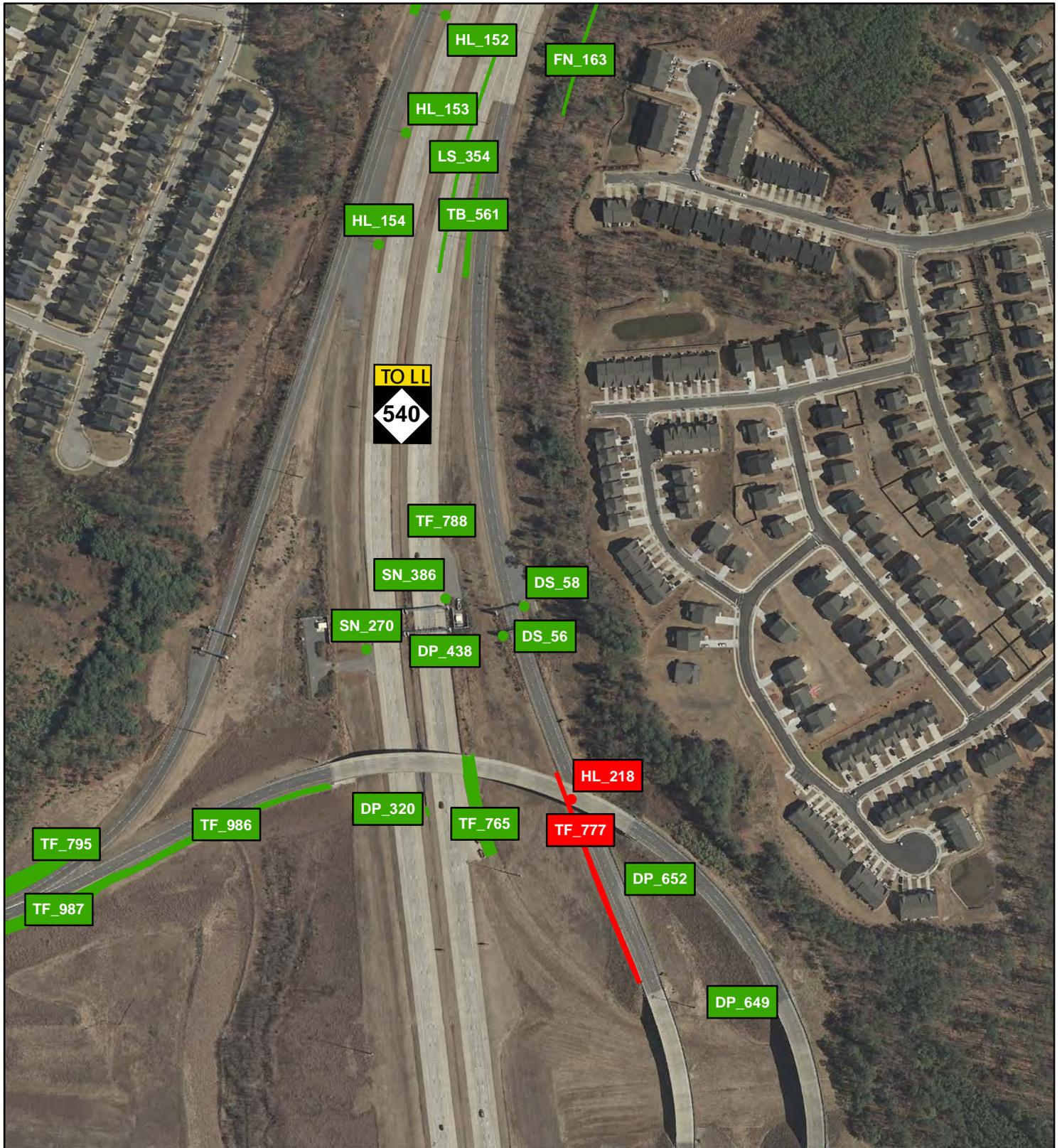


Legend

-  Failing Asset
-  Passing Asset

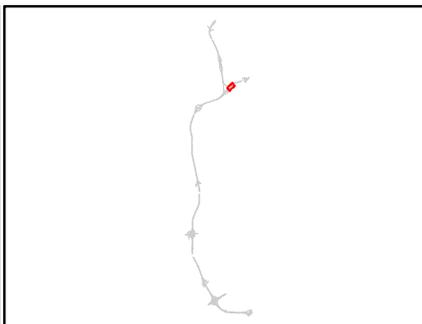


Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

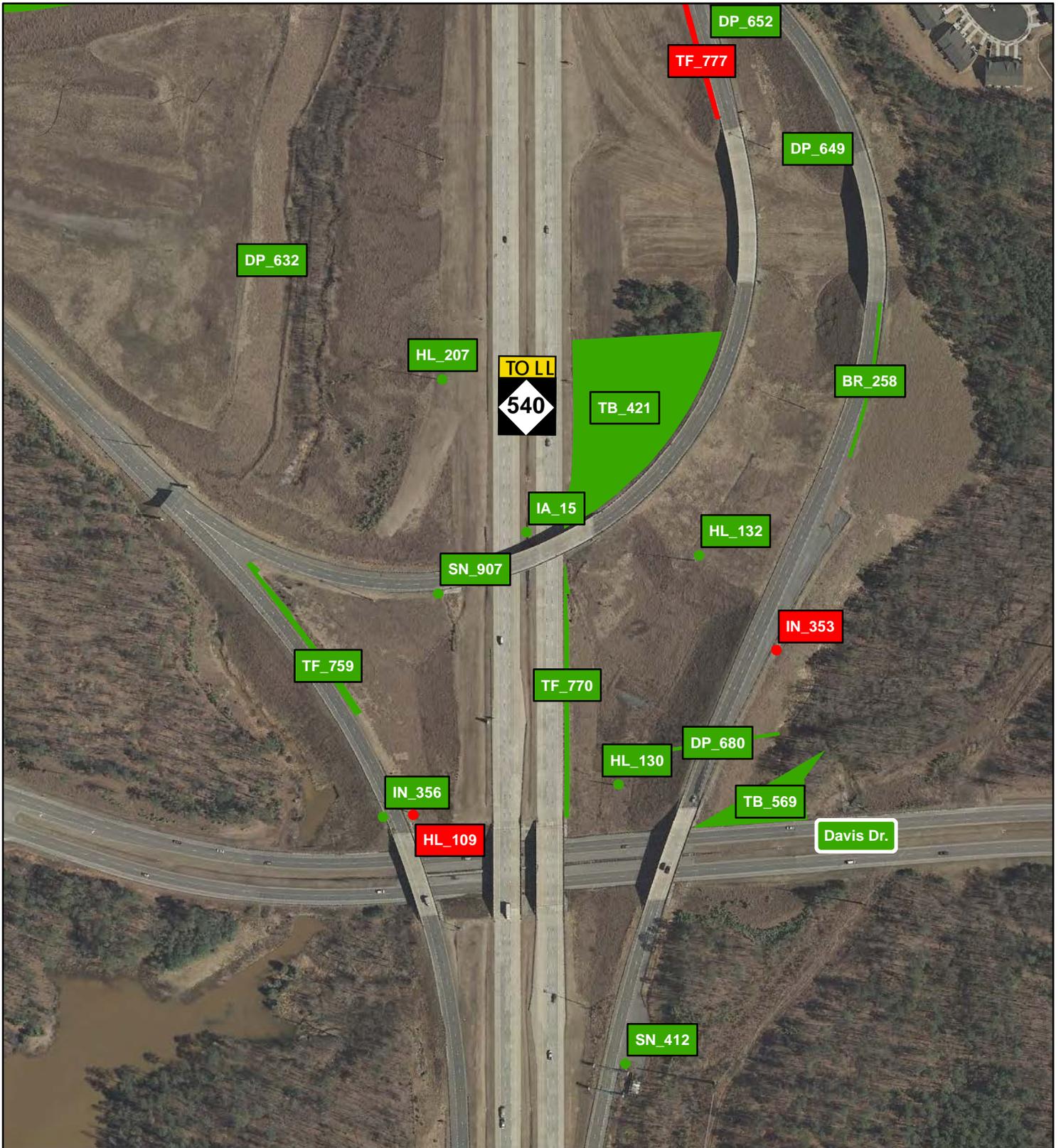


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

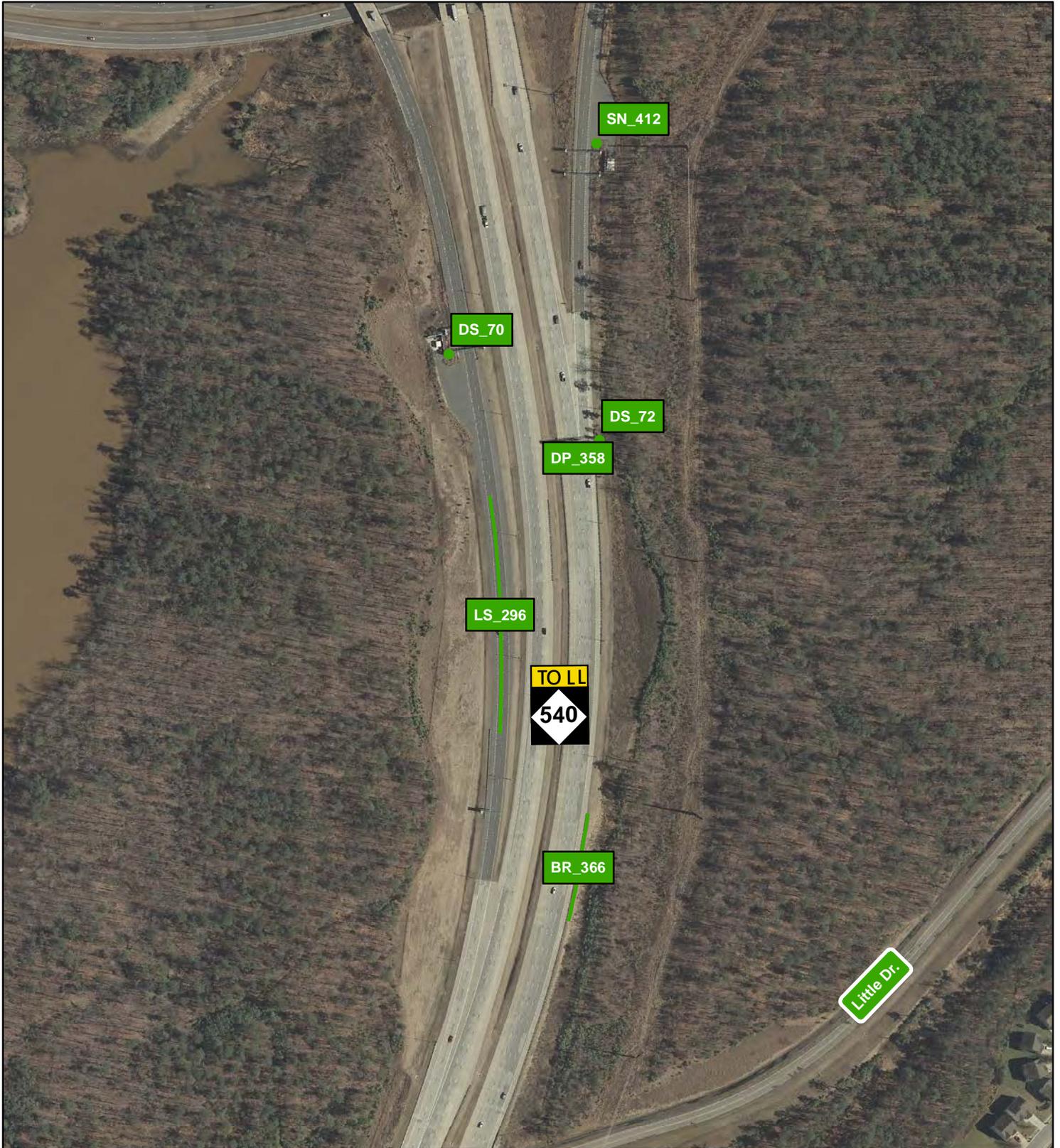


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

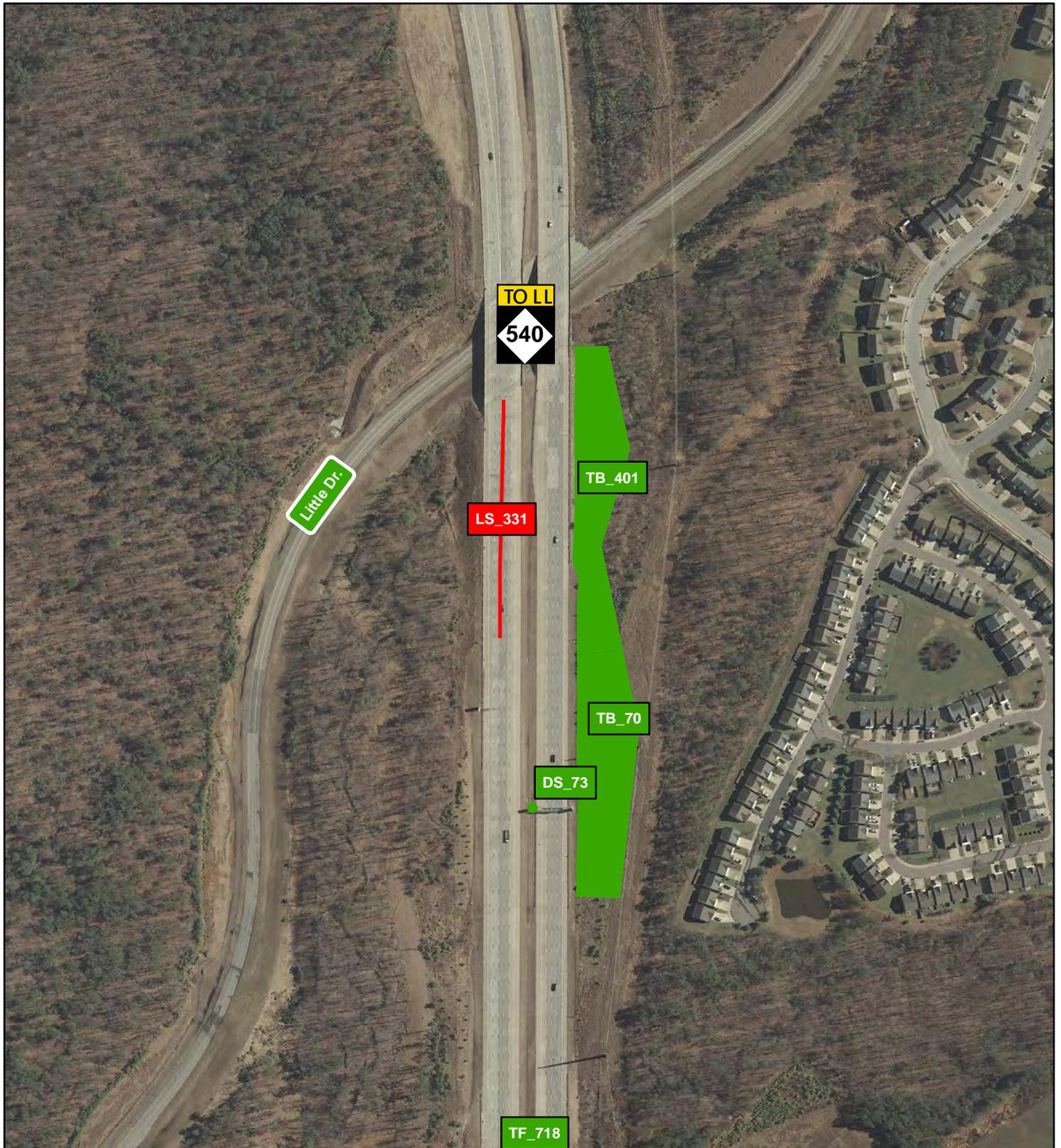


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

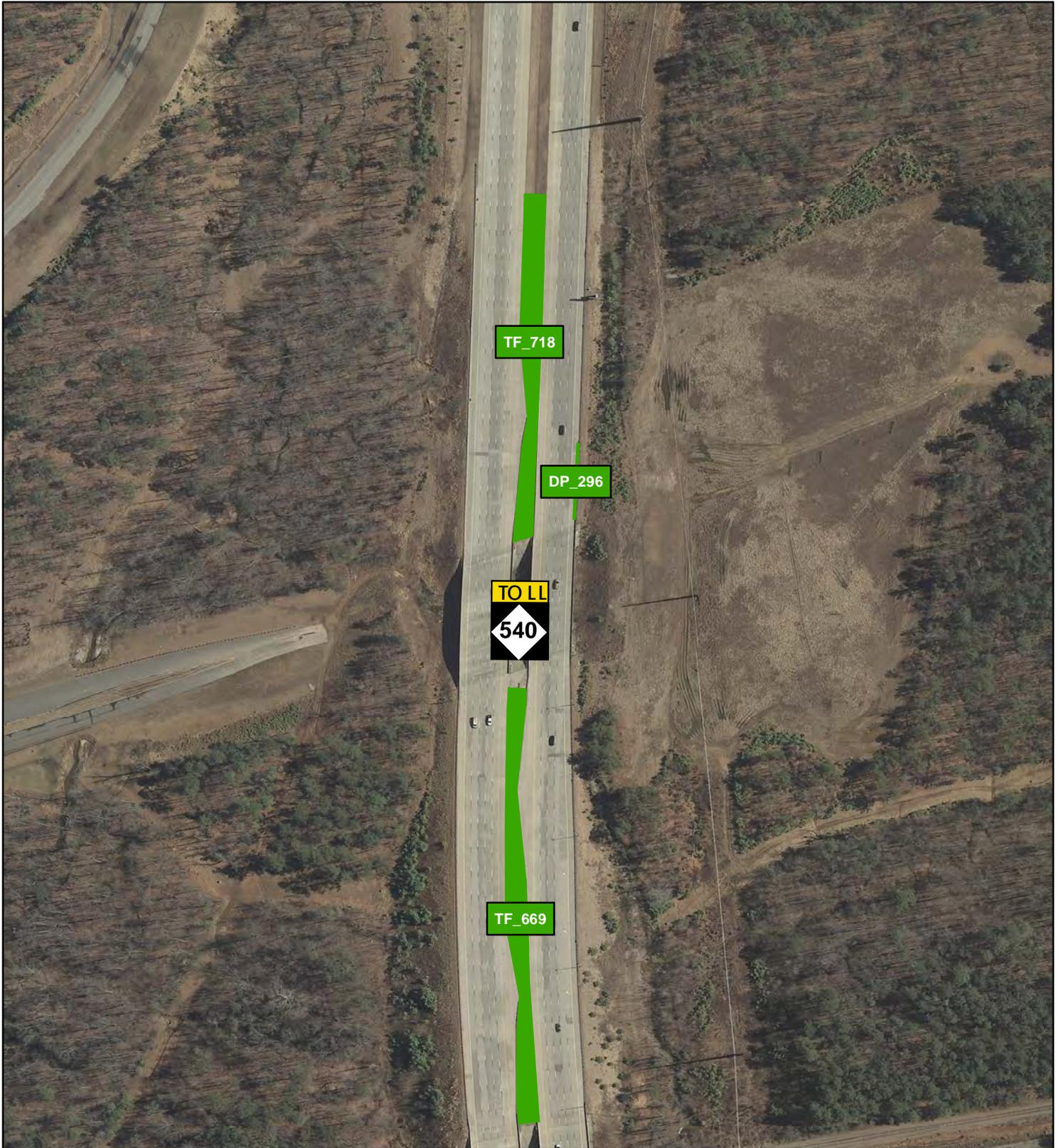


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

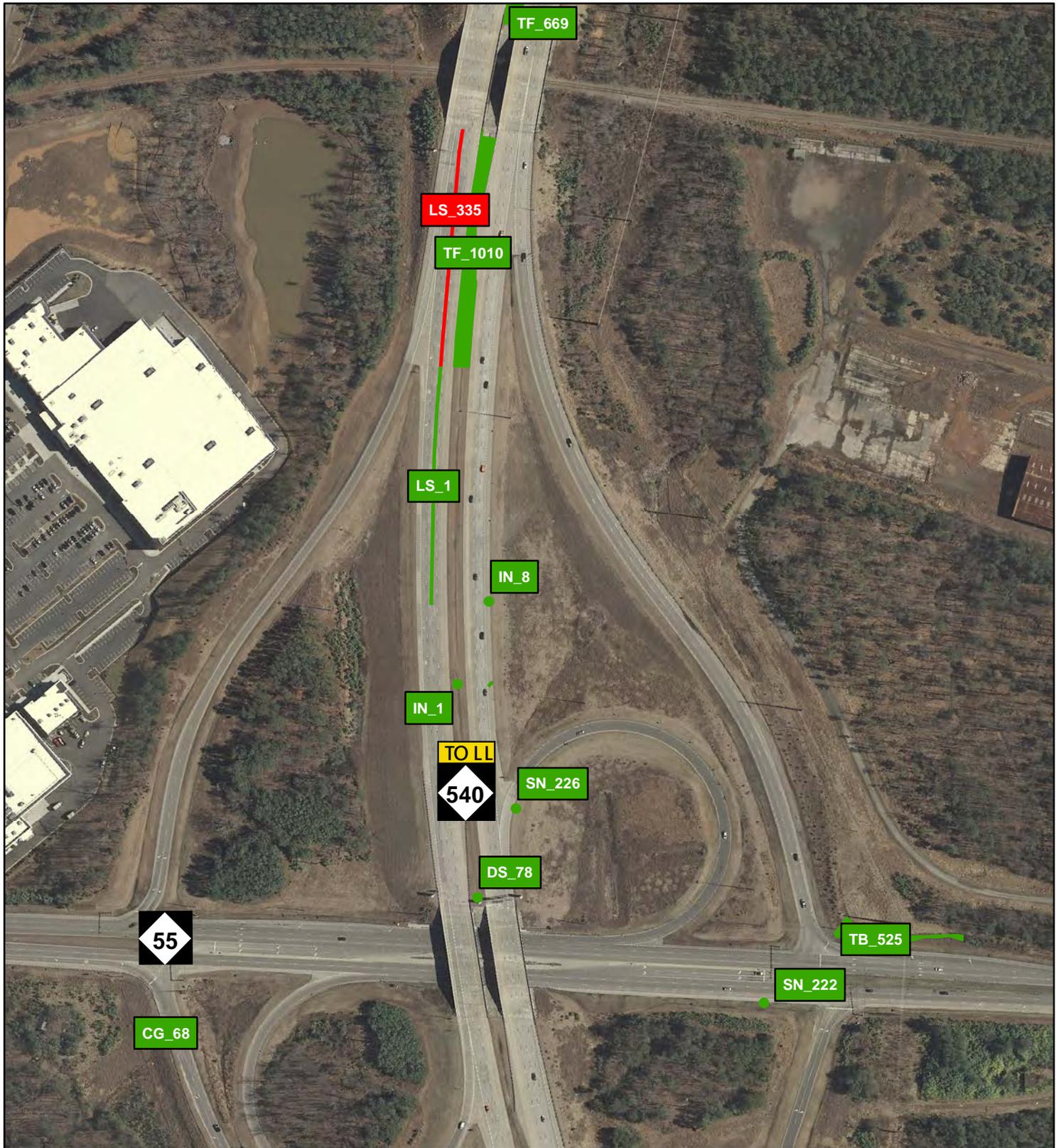


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

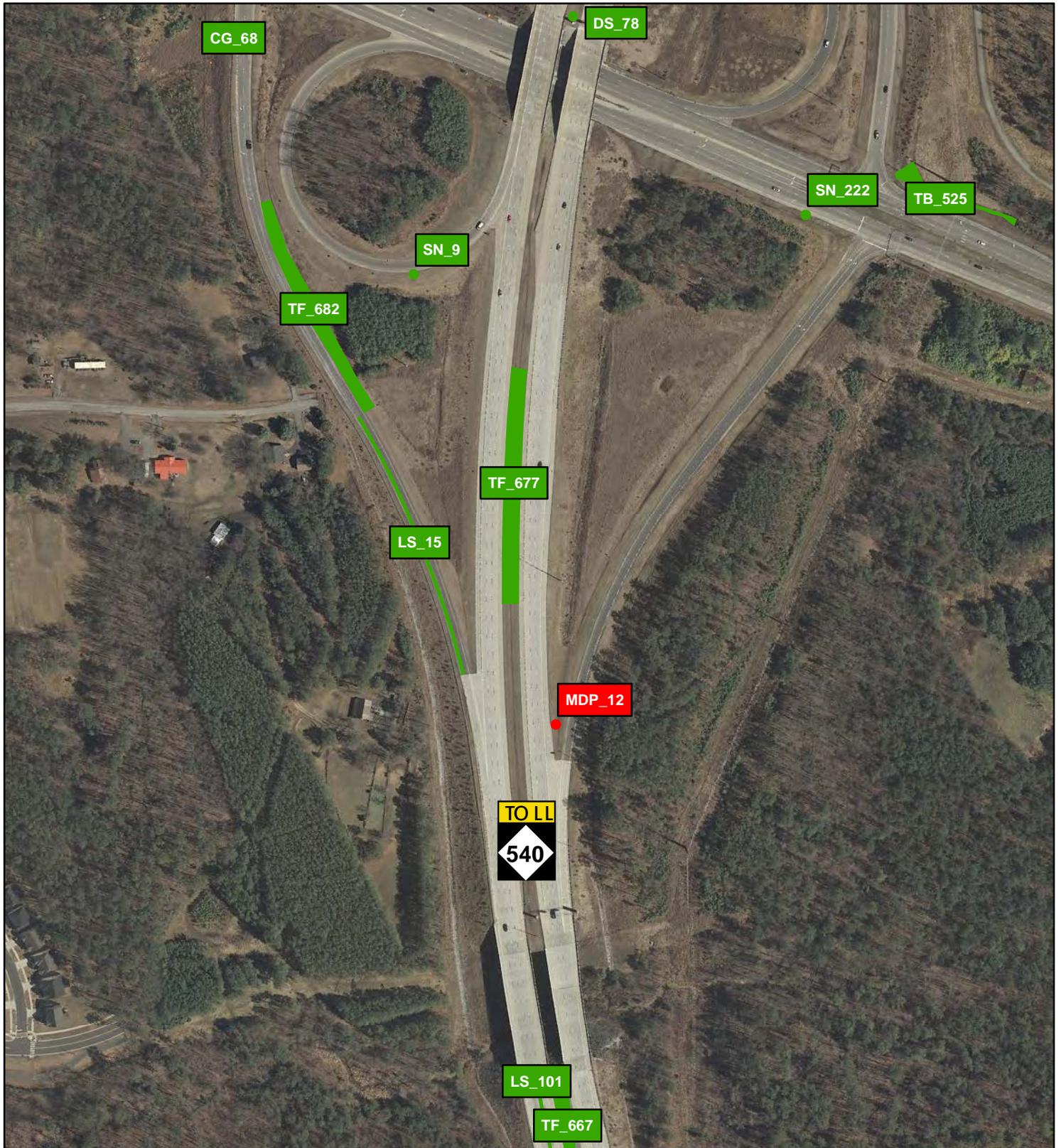


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

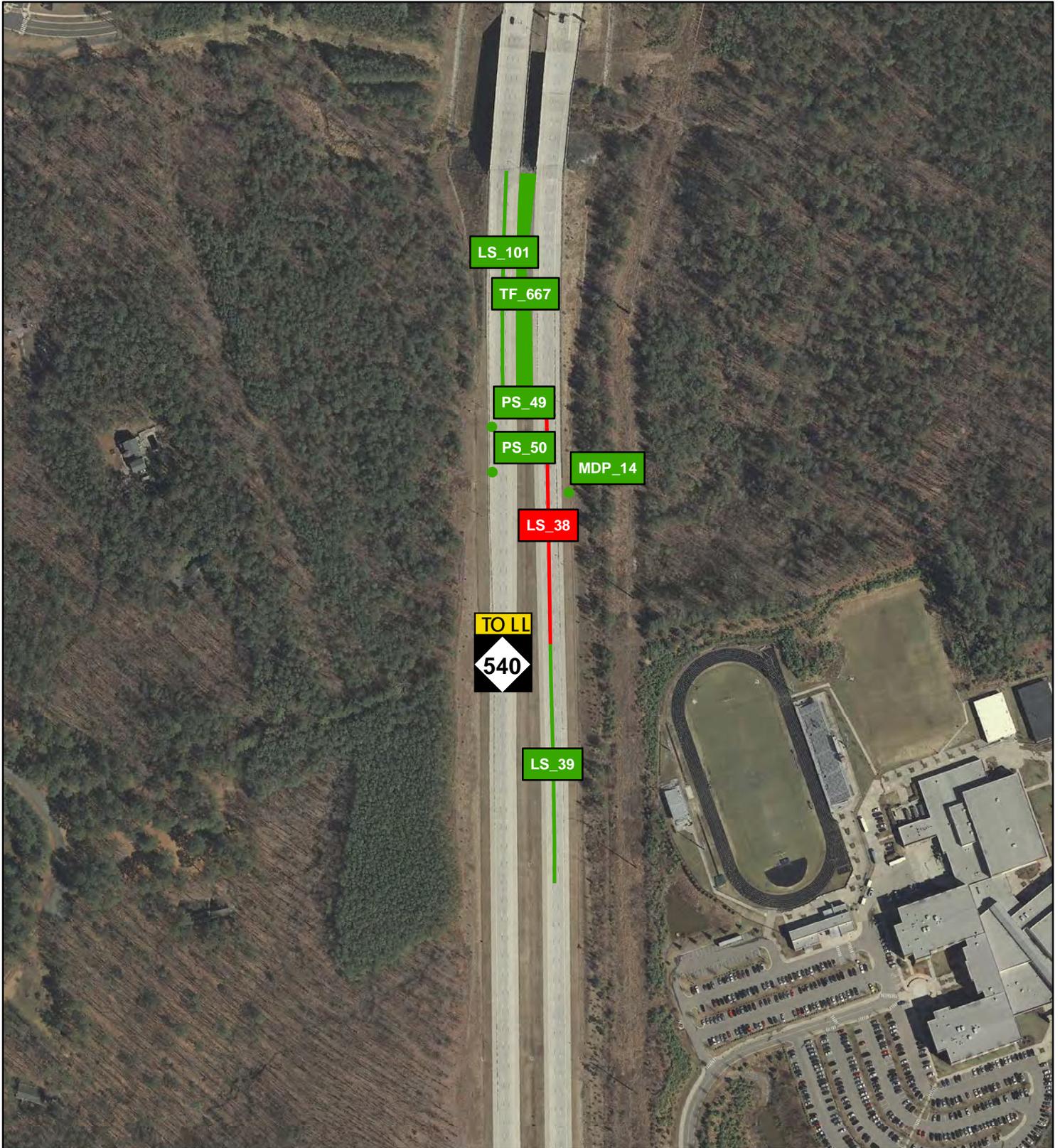


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

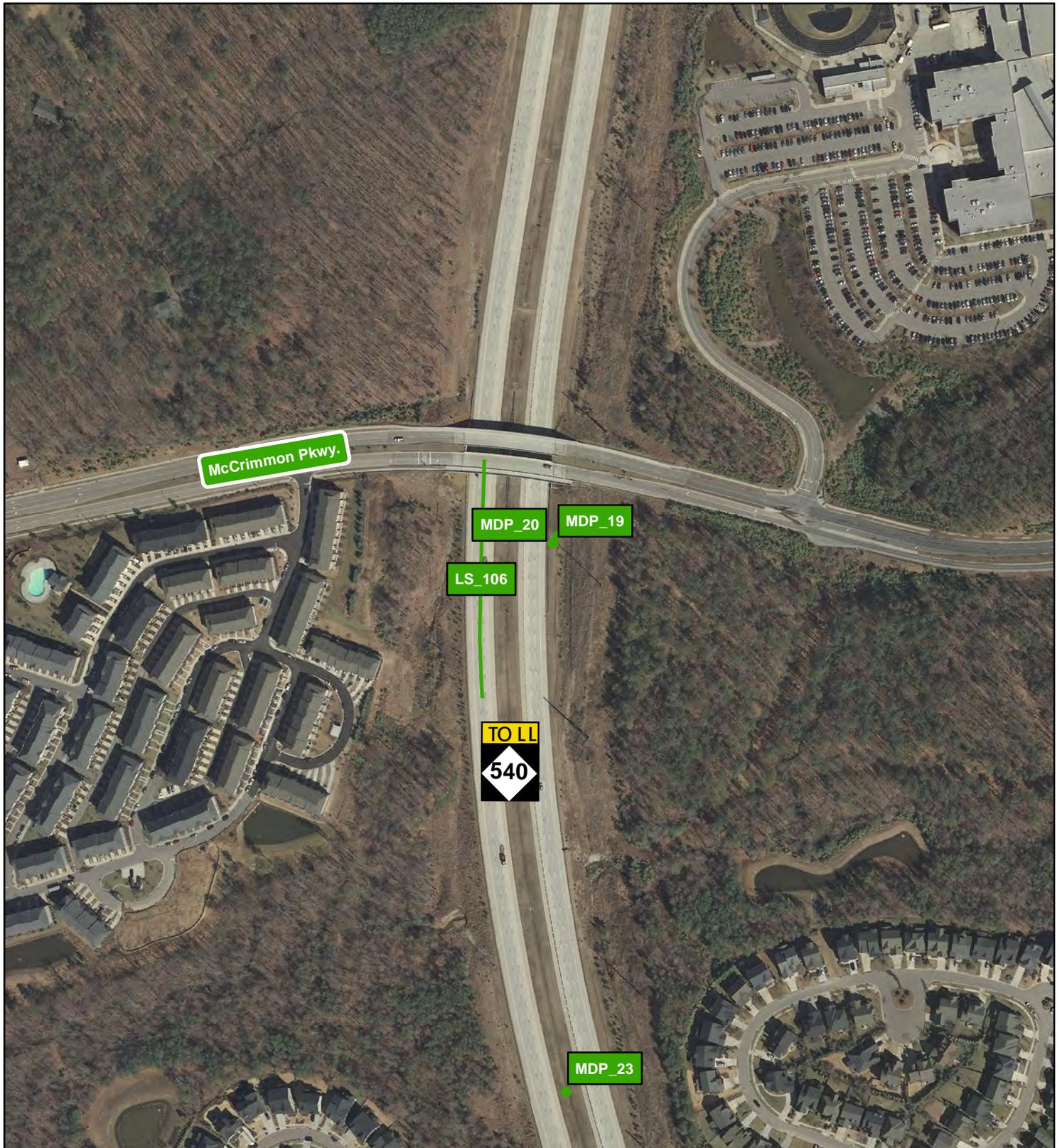


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

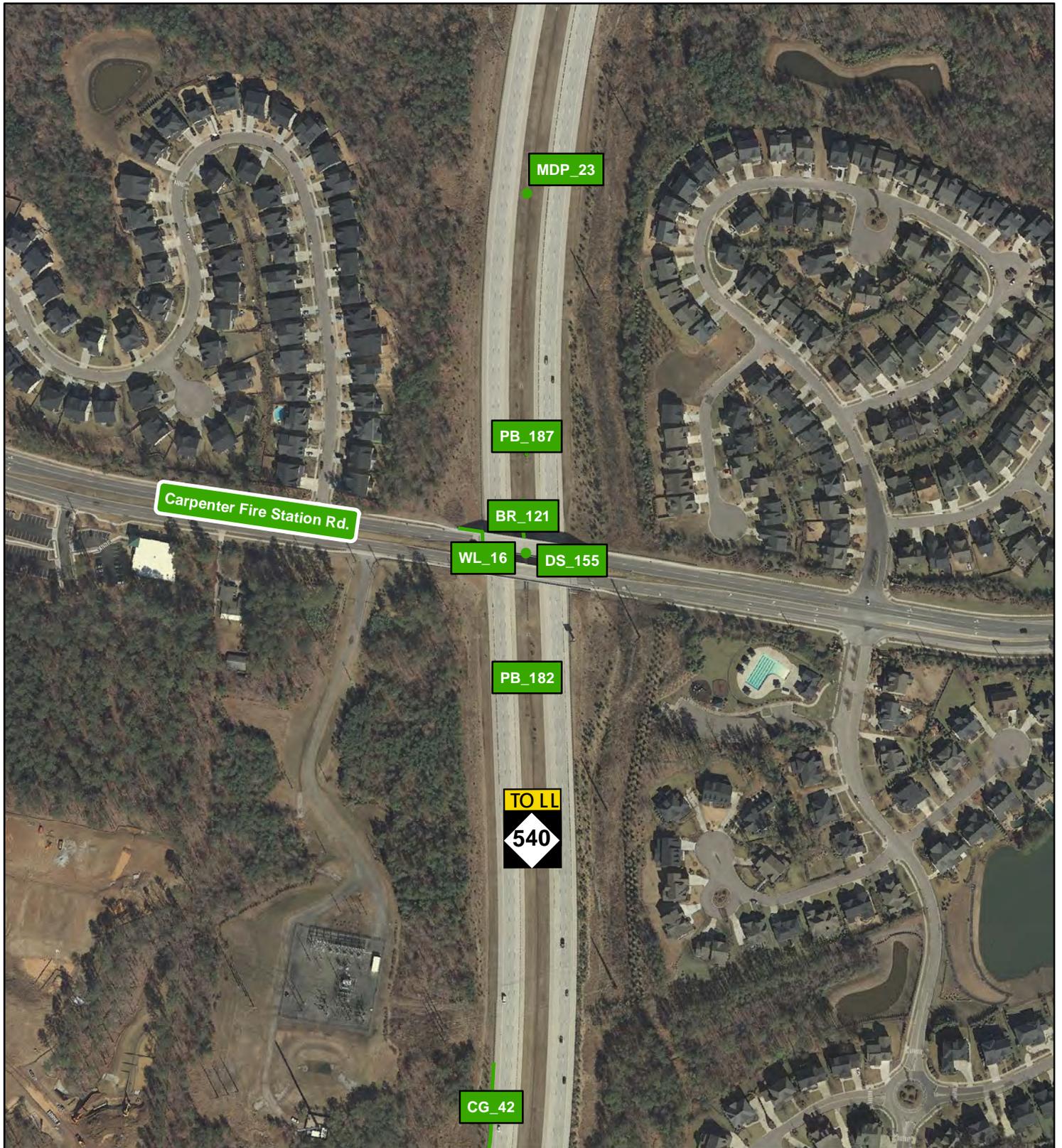


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

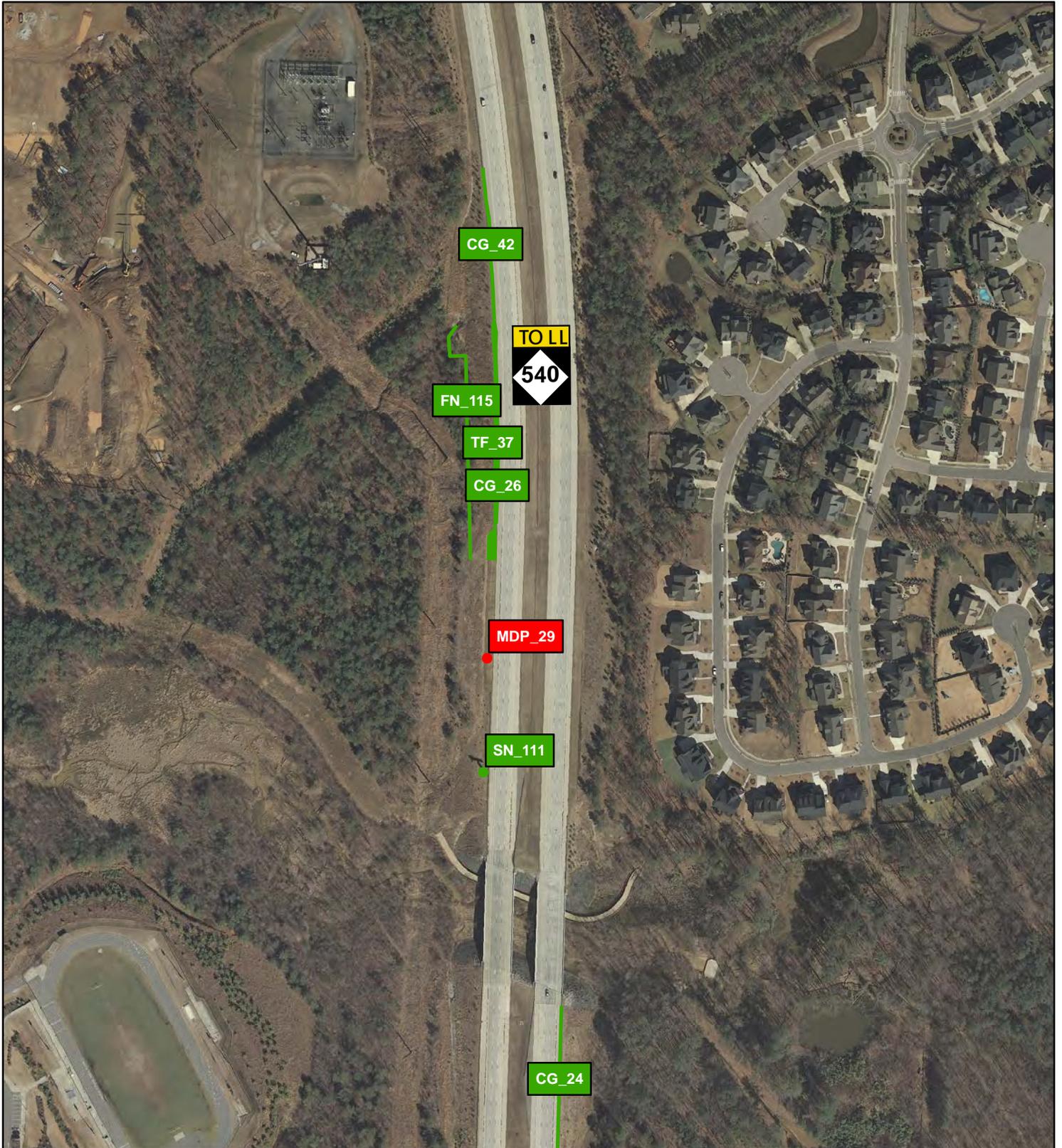


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

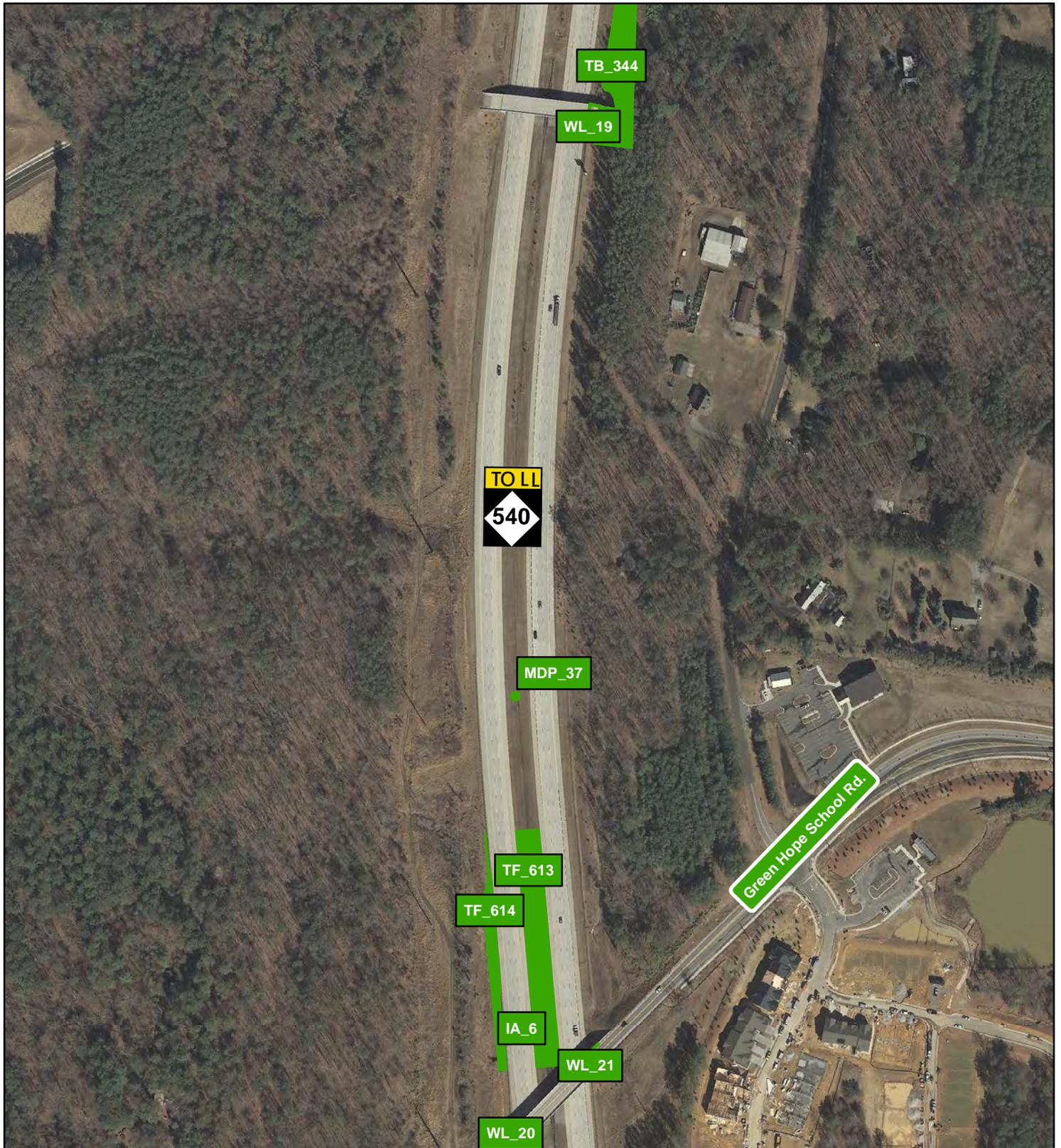


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

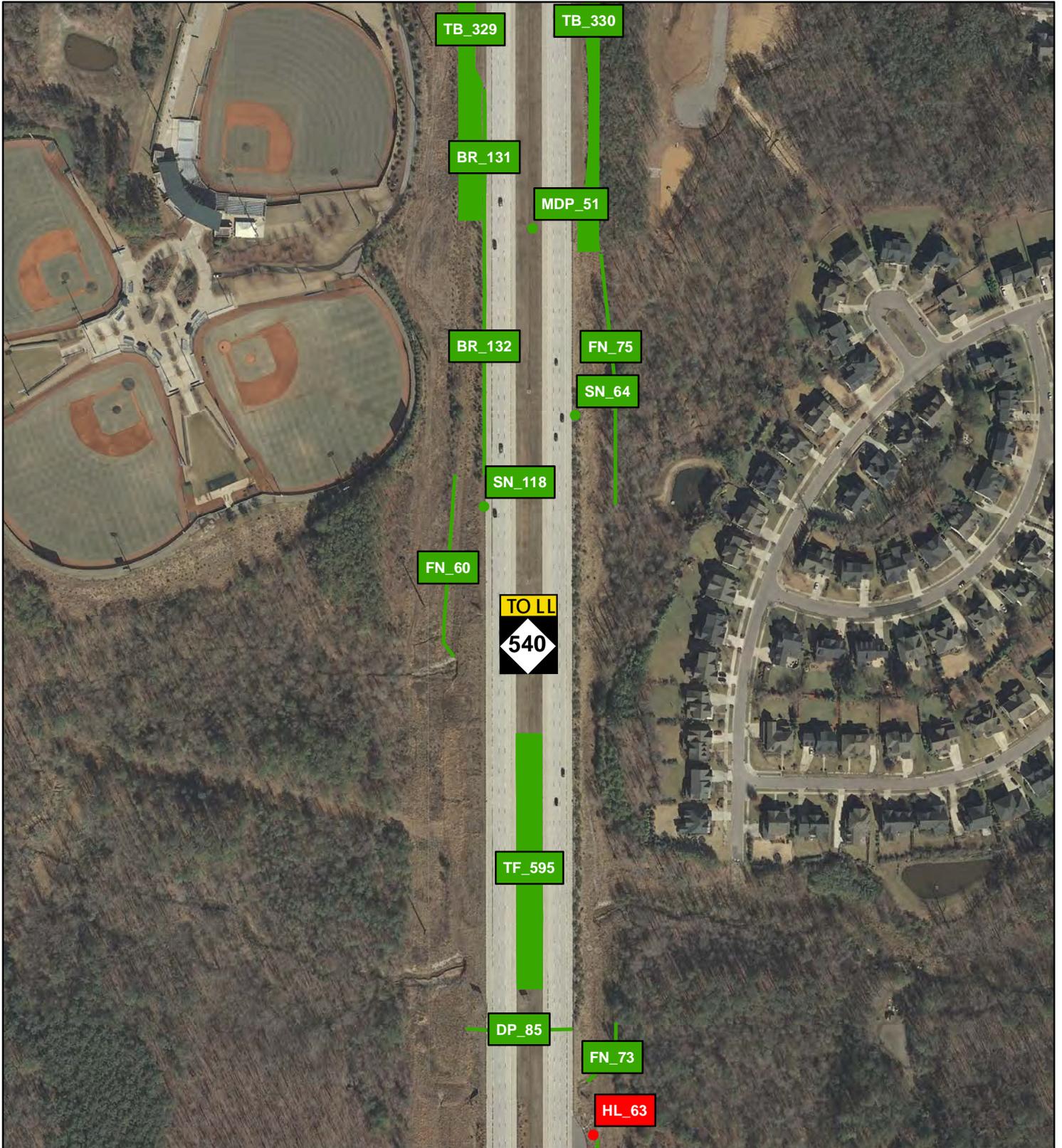


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

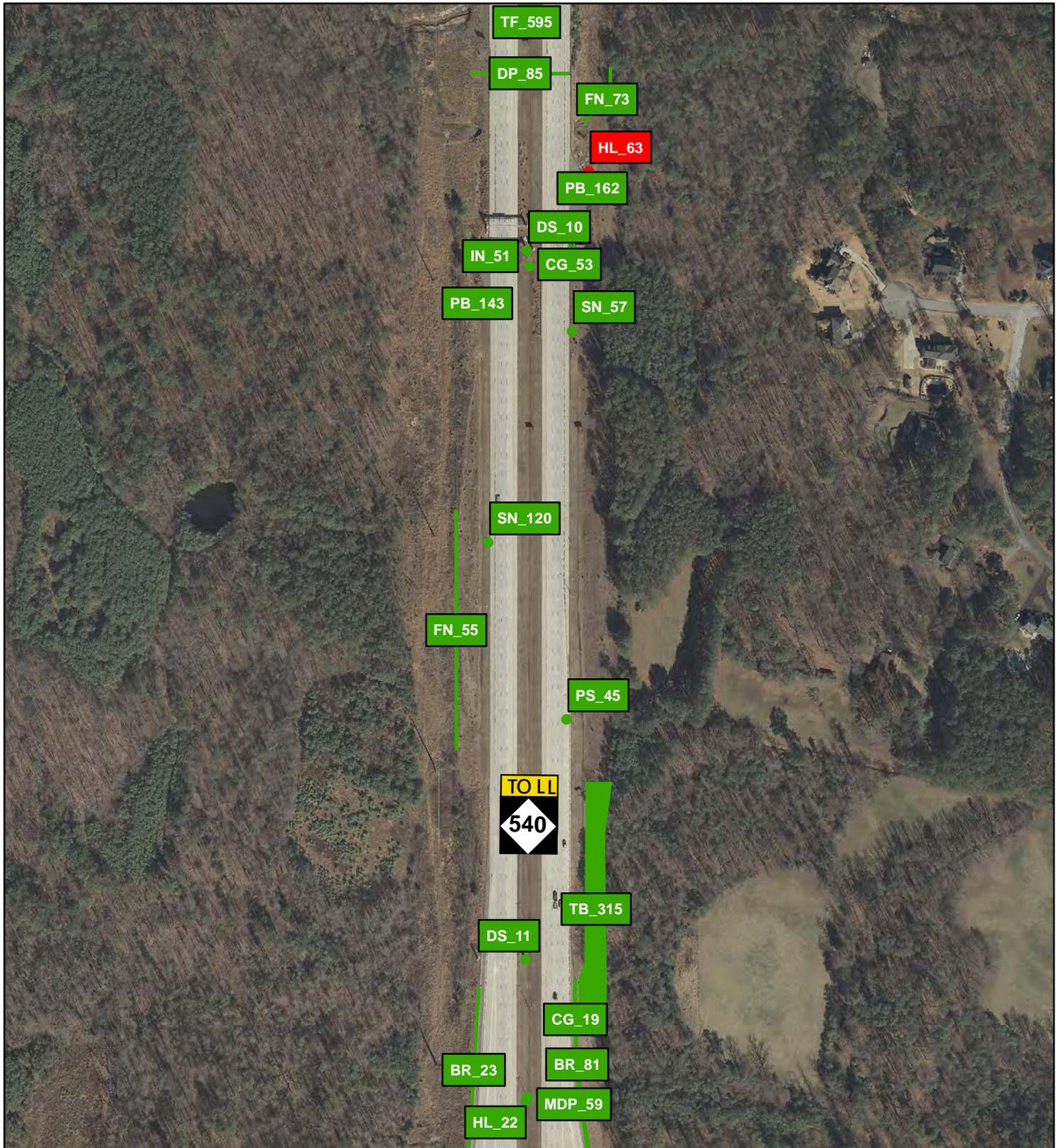


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

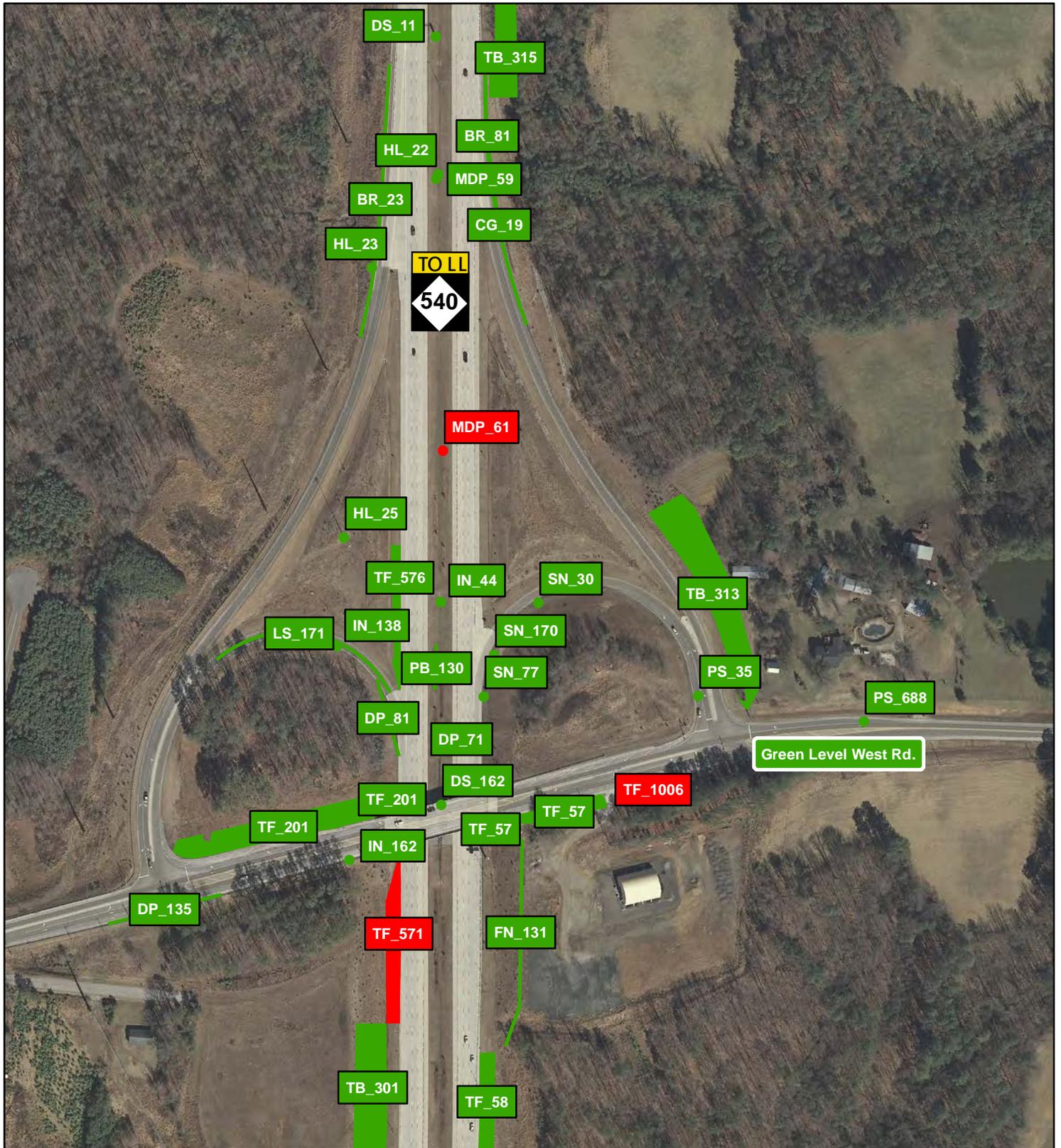


Legend

-  Failing Asset
-  Passing Asset

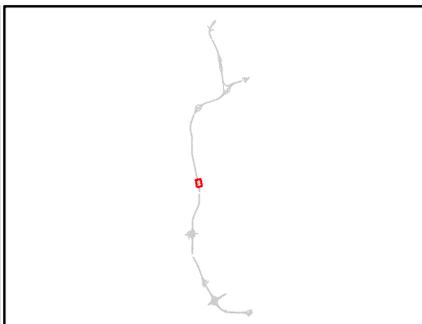


Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

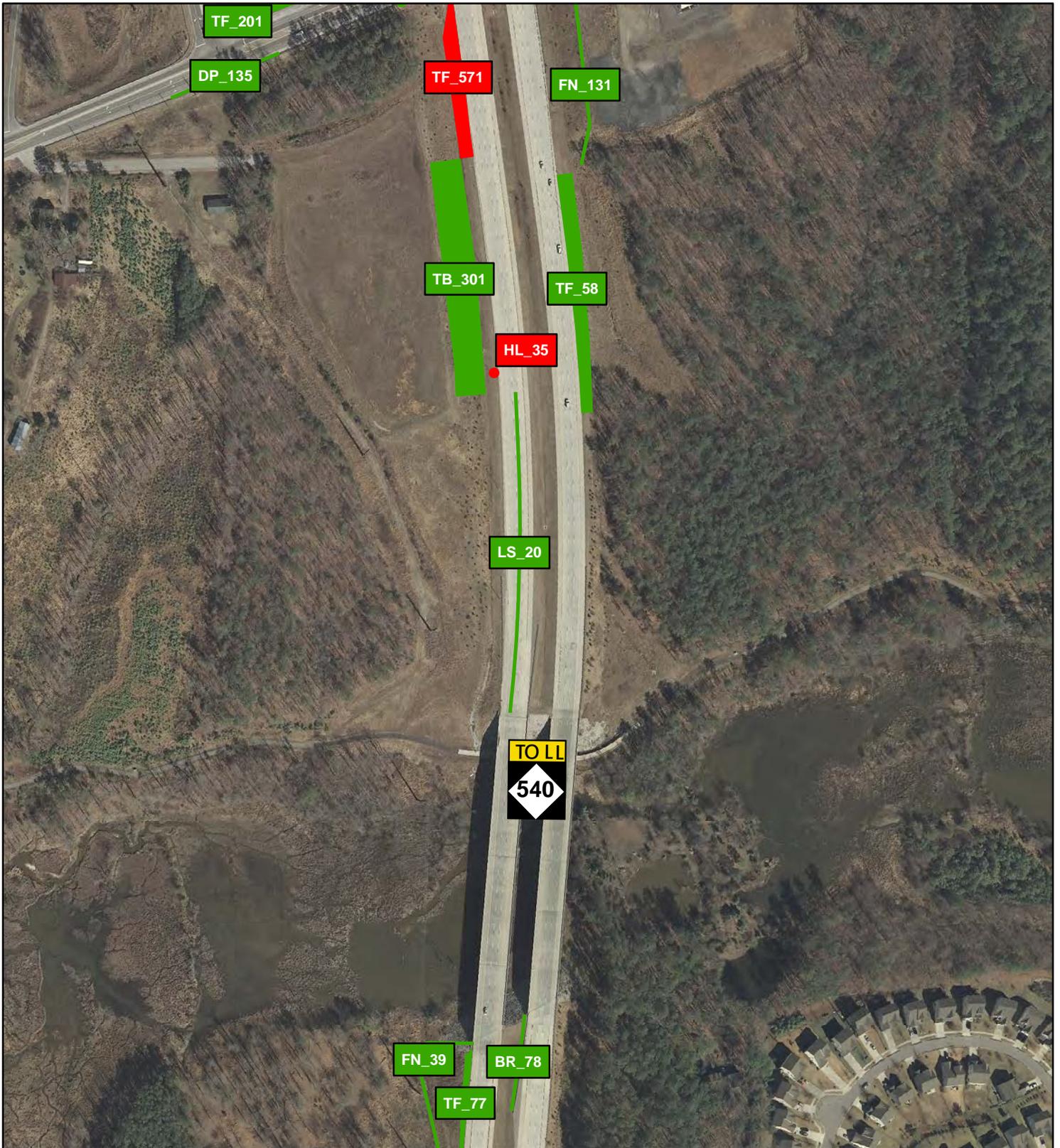


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

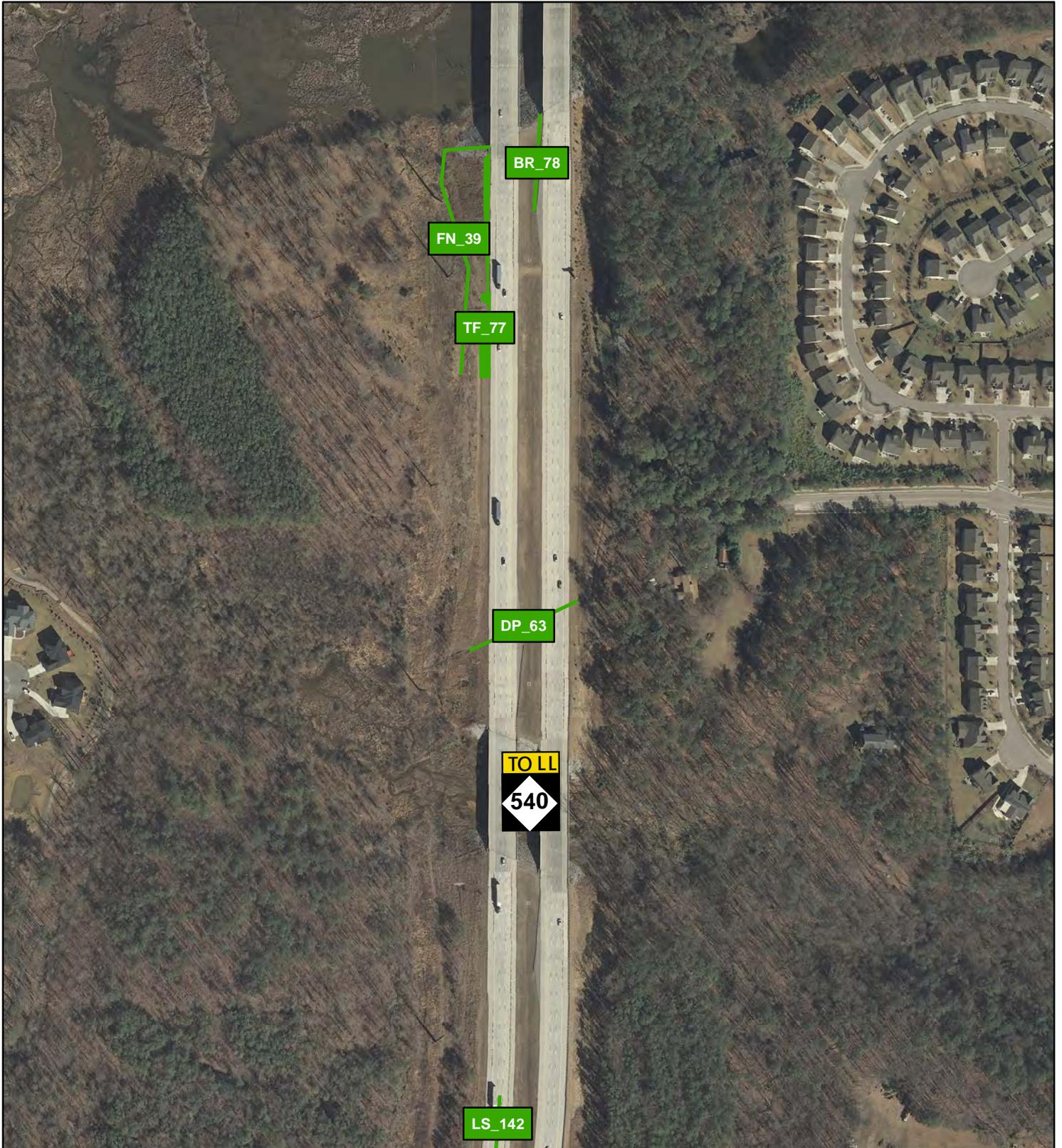


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

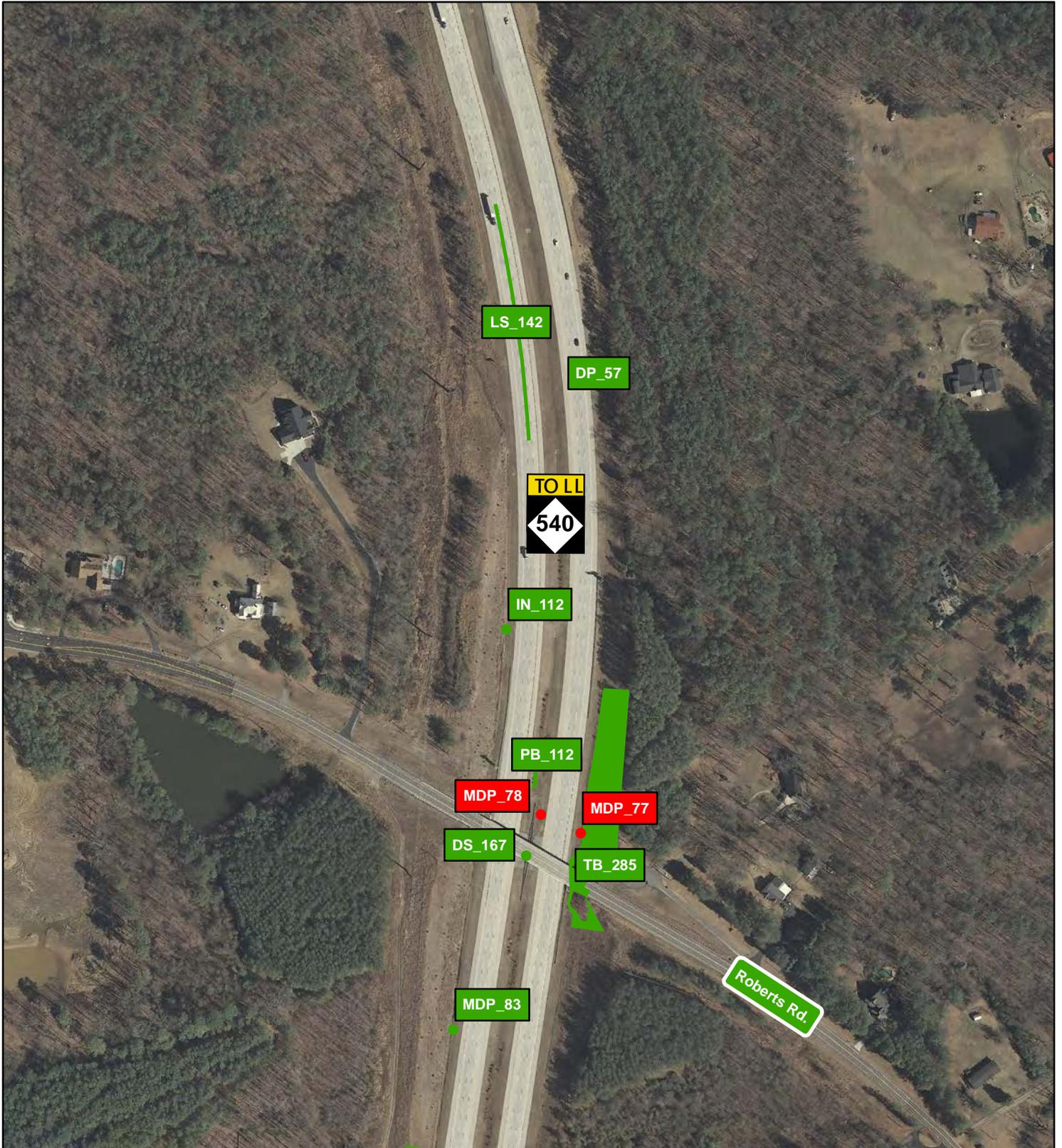


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

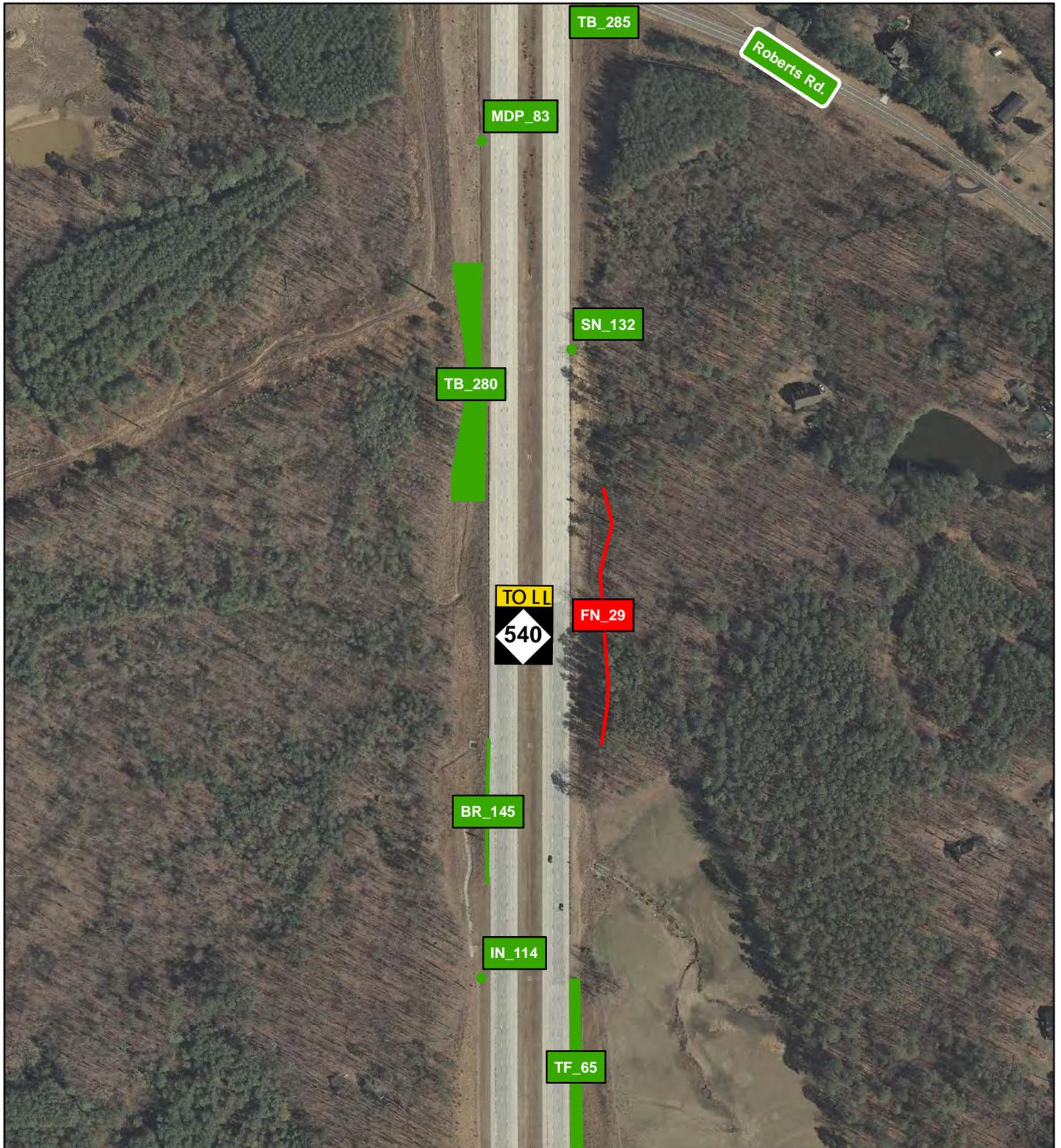


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

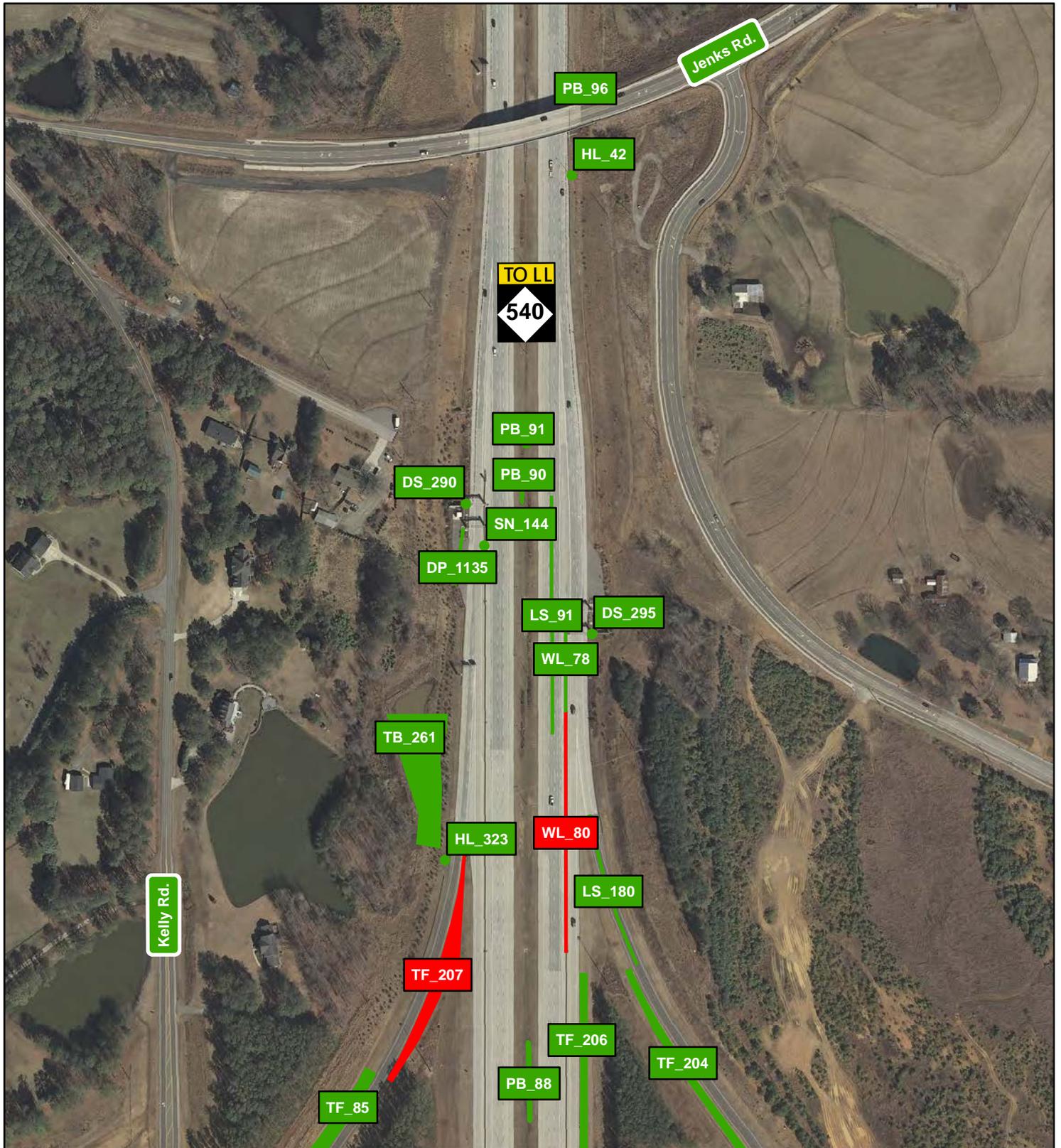


Legend

-  Failing Asset
-  Passing Asset

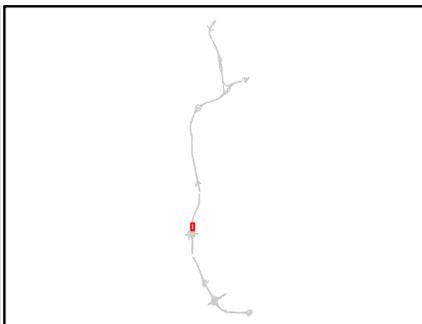


Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

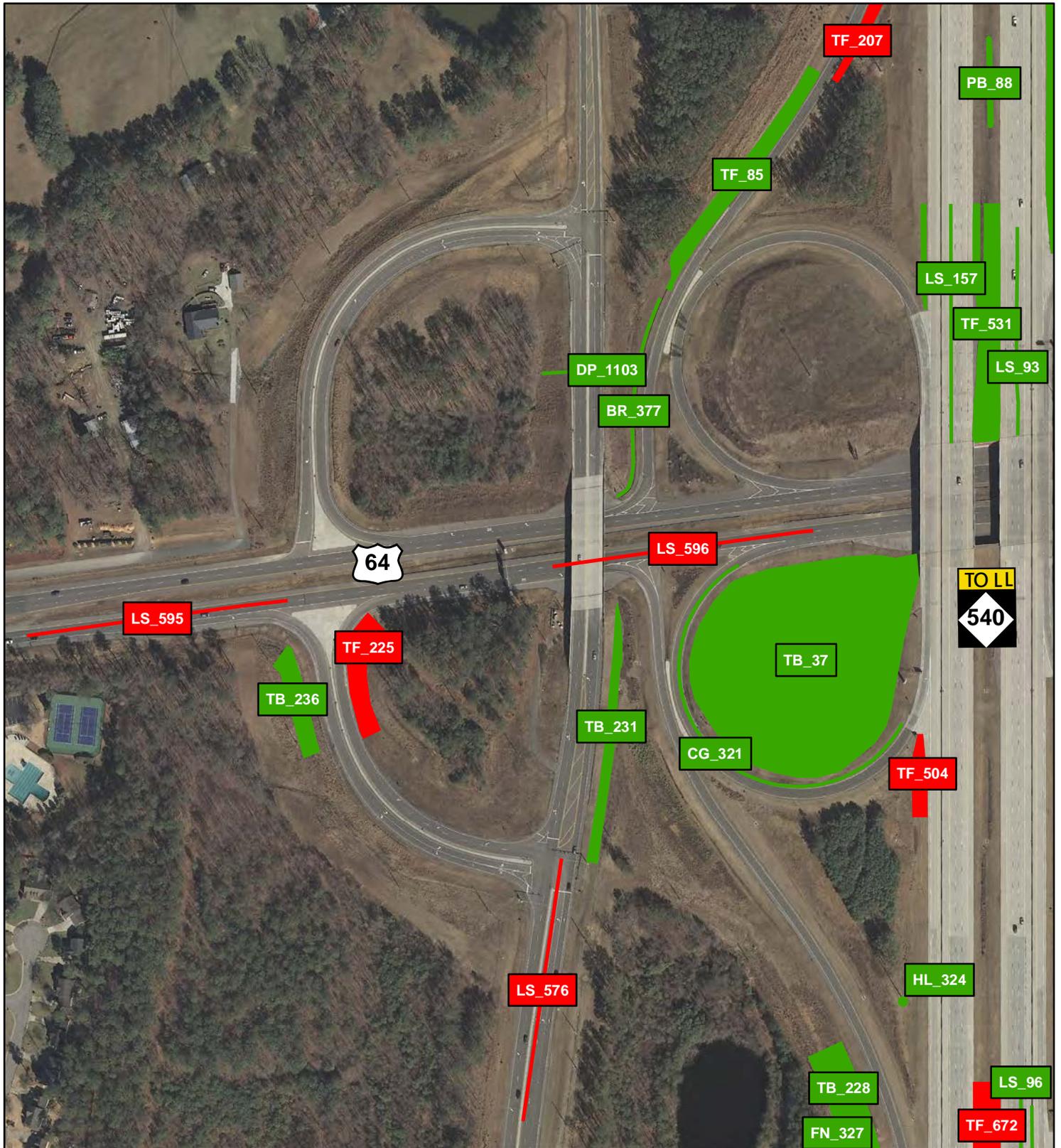


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

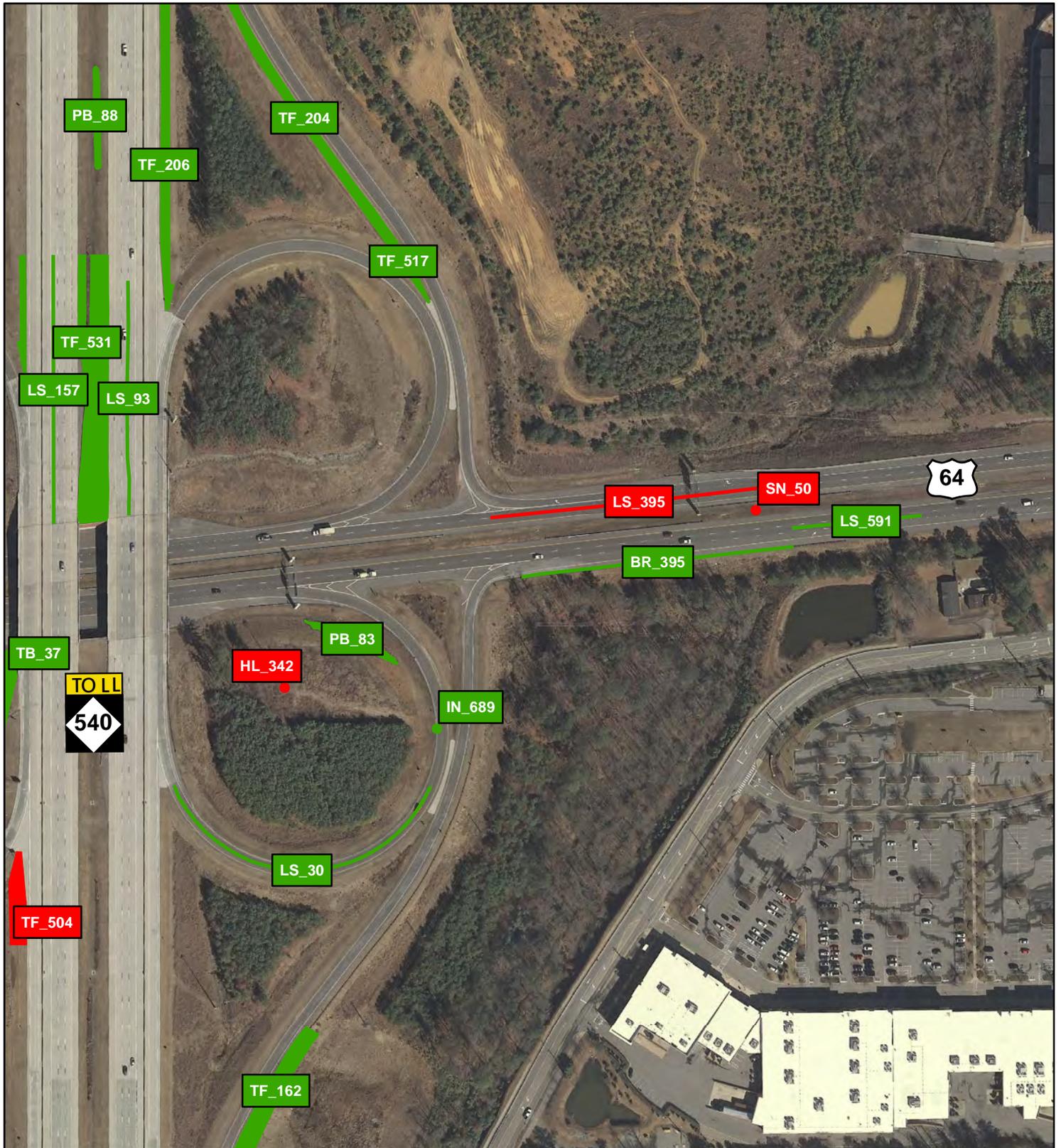


Legend

- Failing Asset
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Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

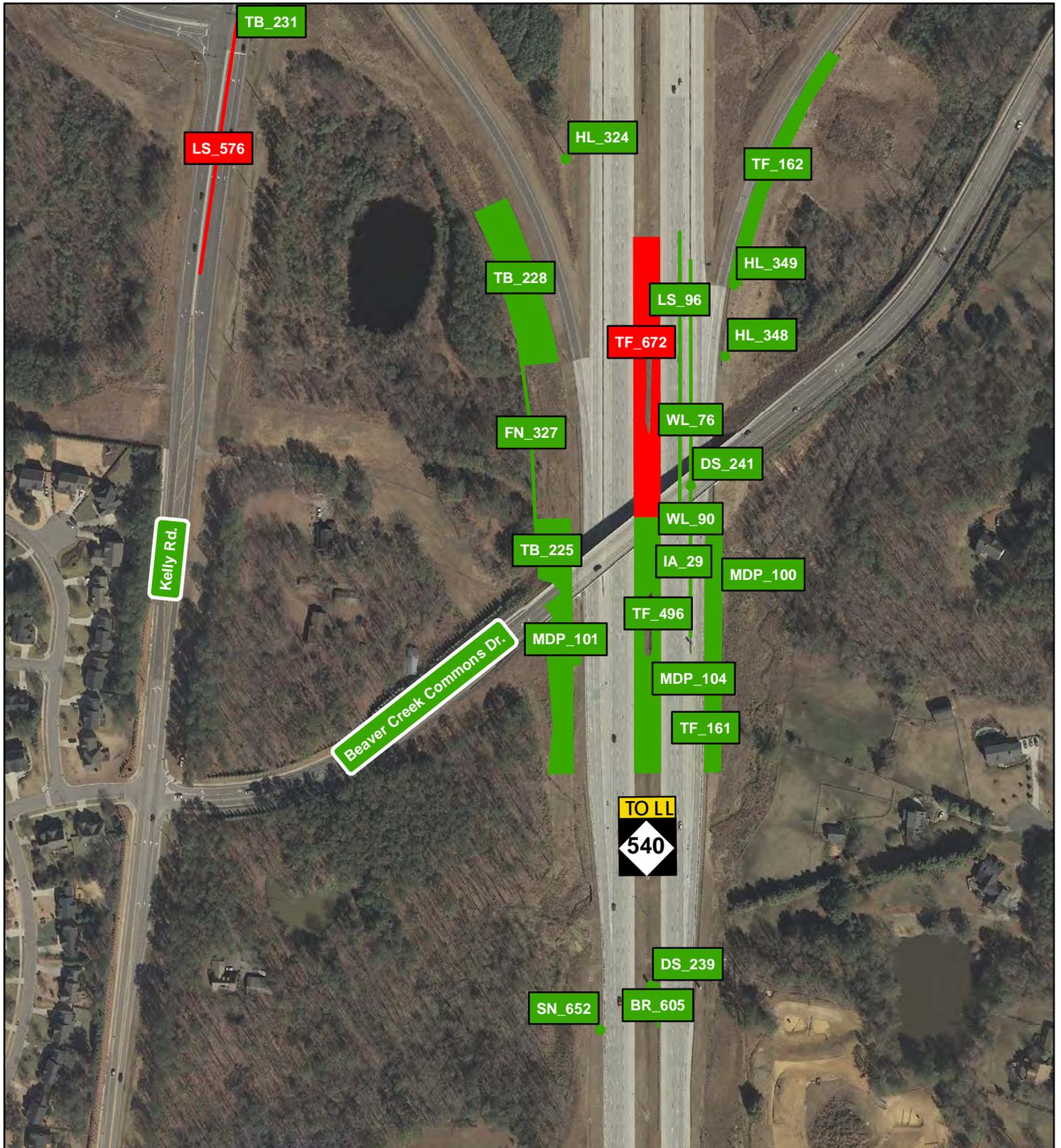


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

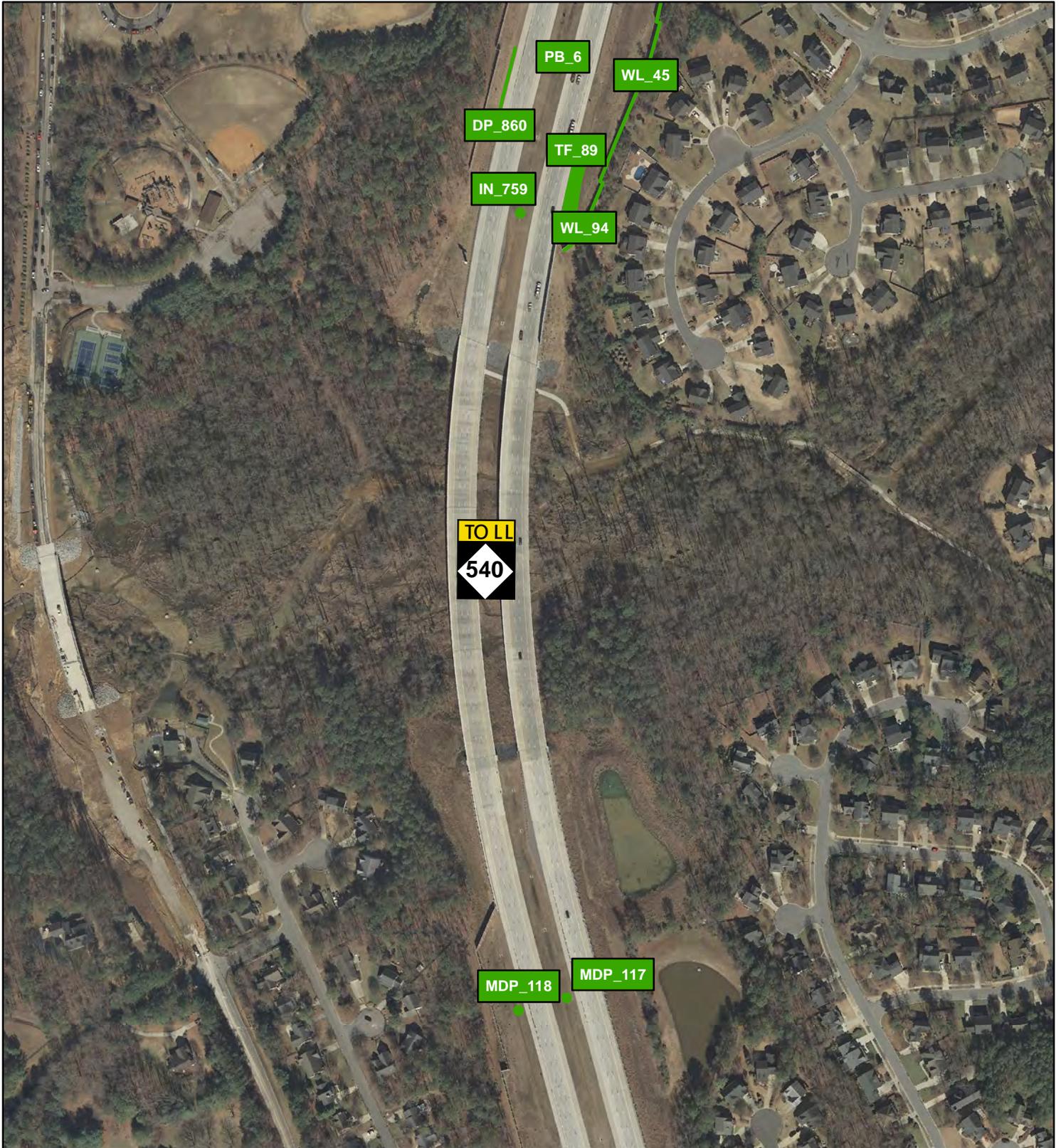


Legend

- Failing Asset
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Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

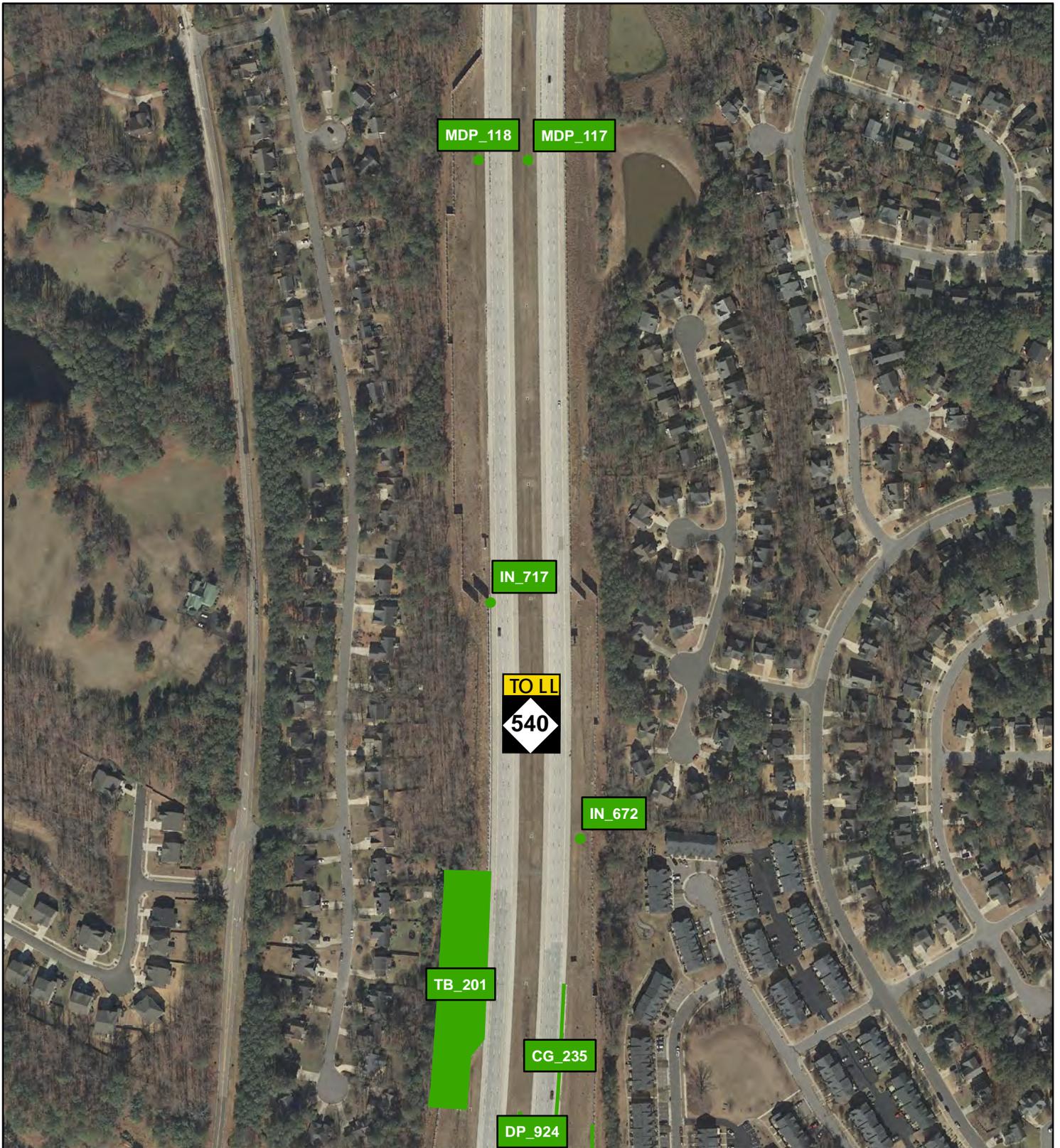


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

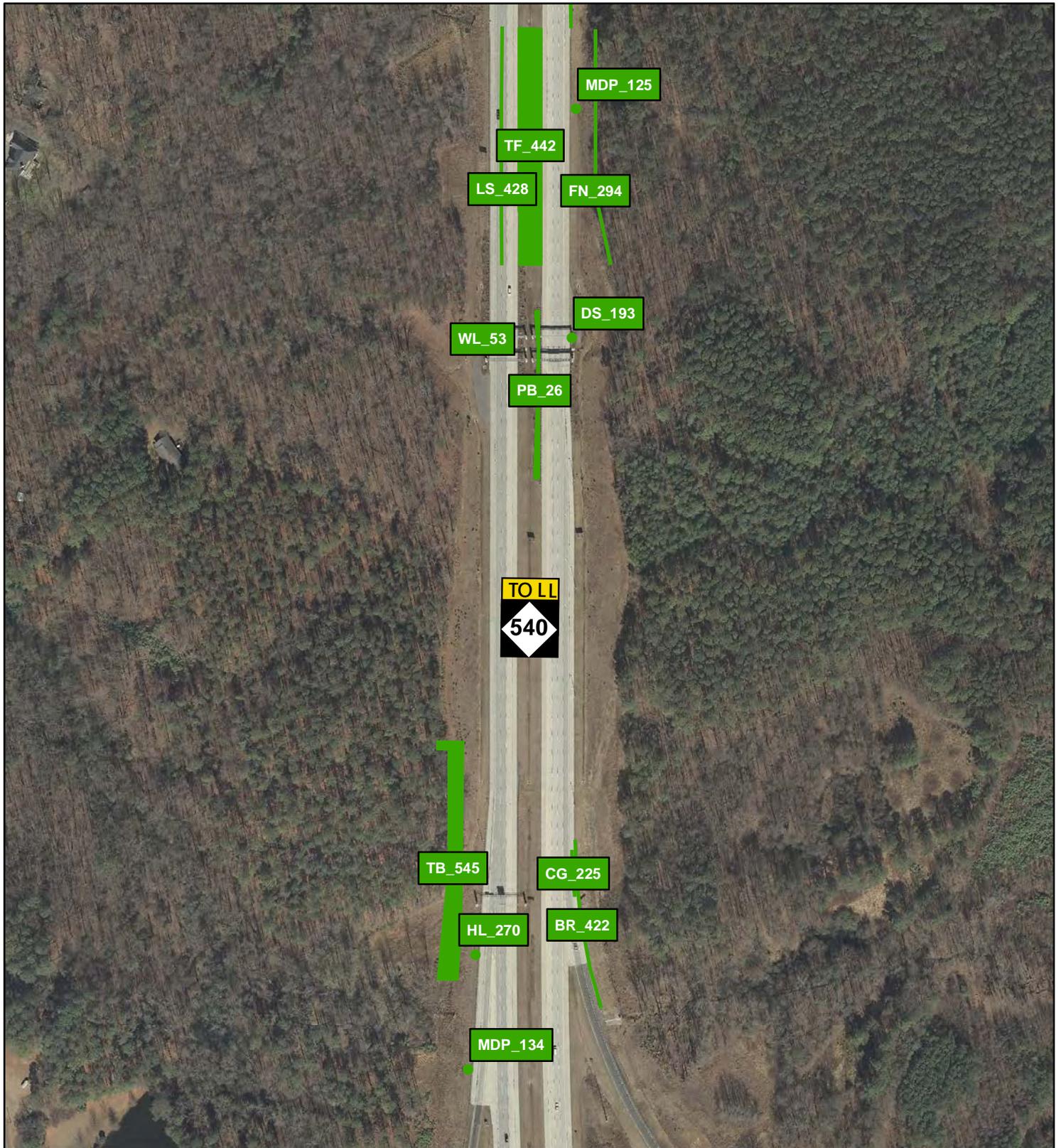


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

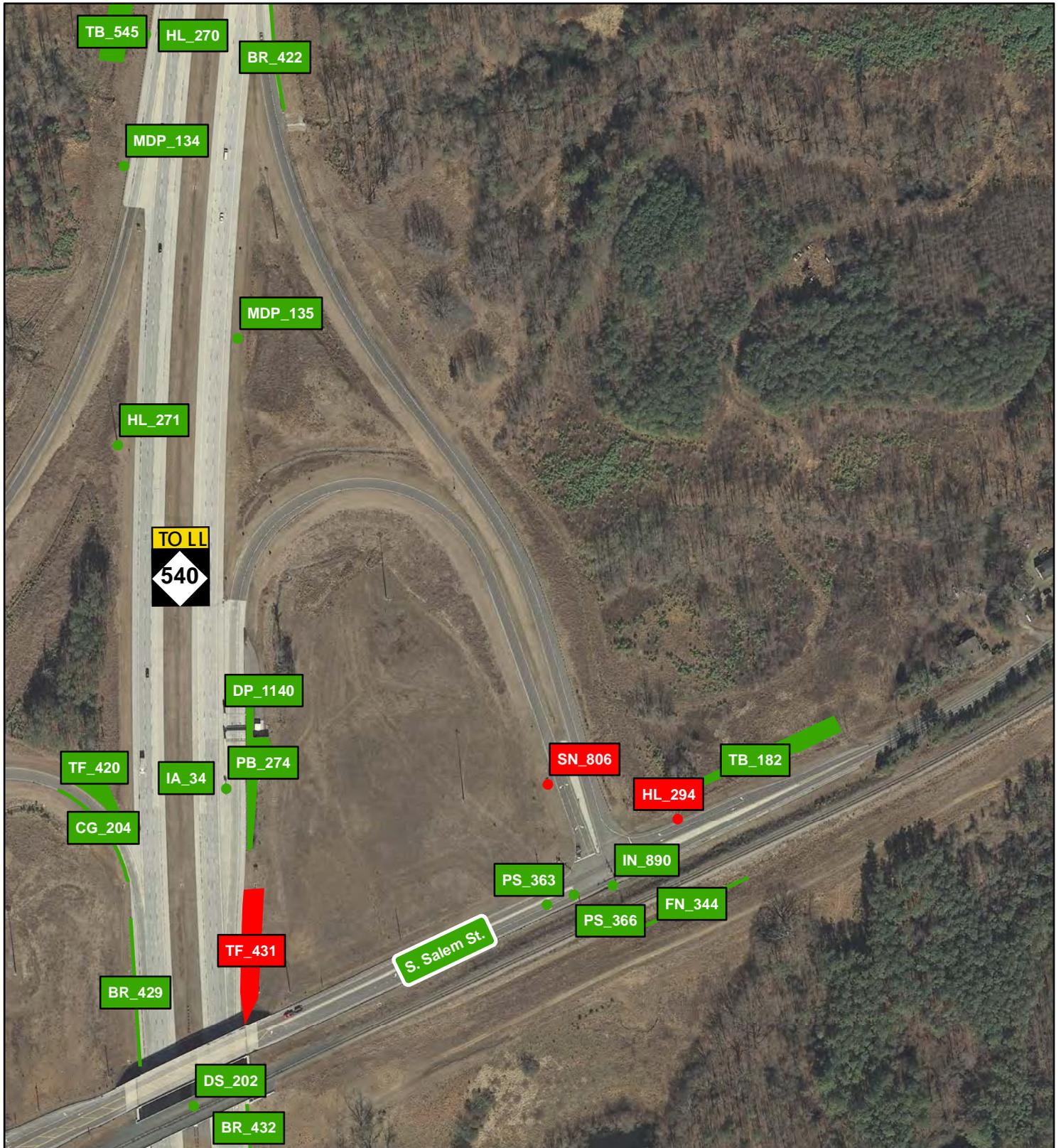


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

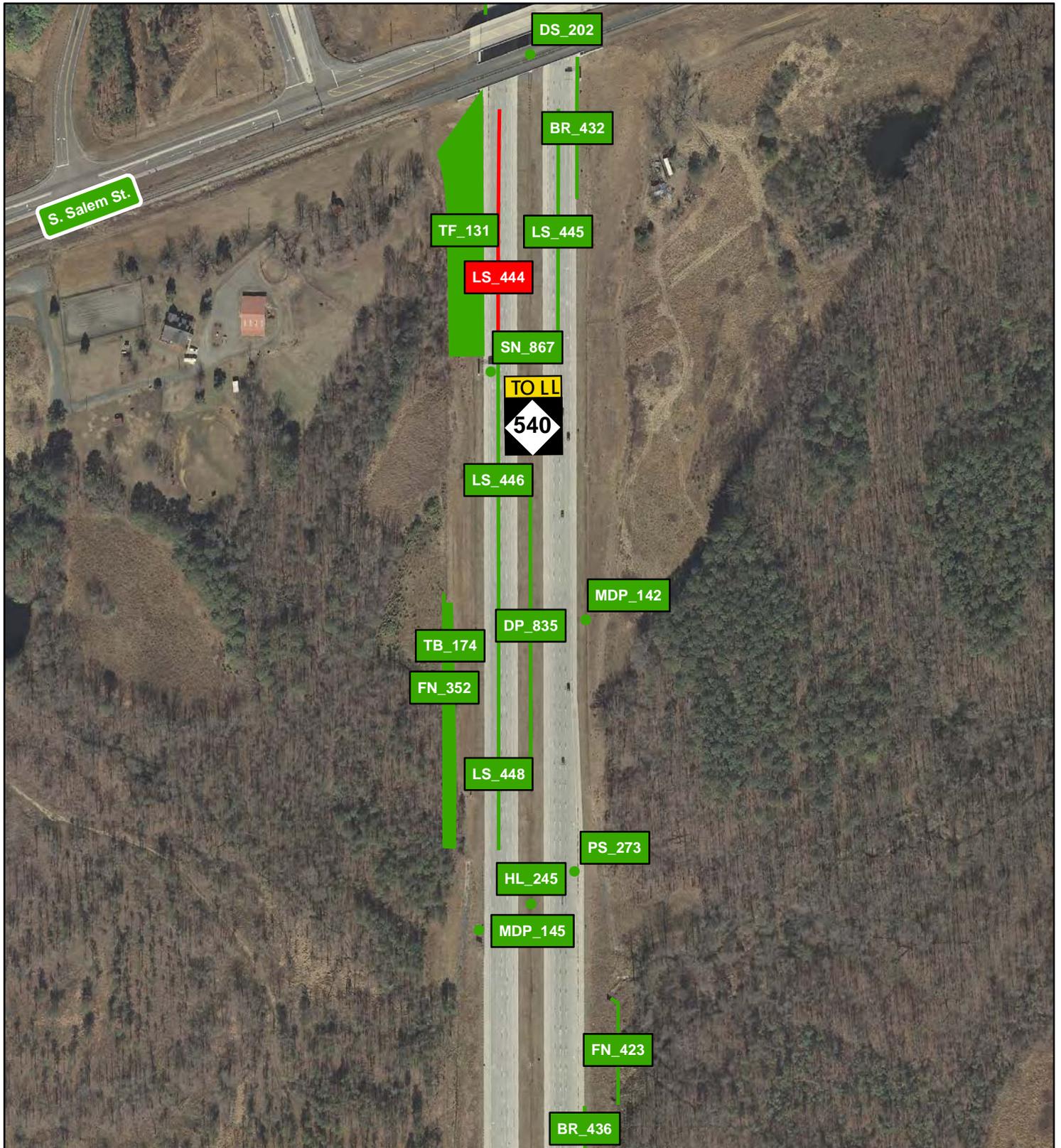


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

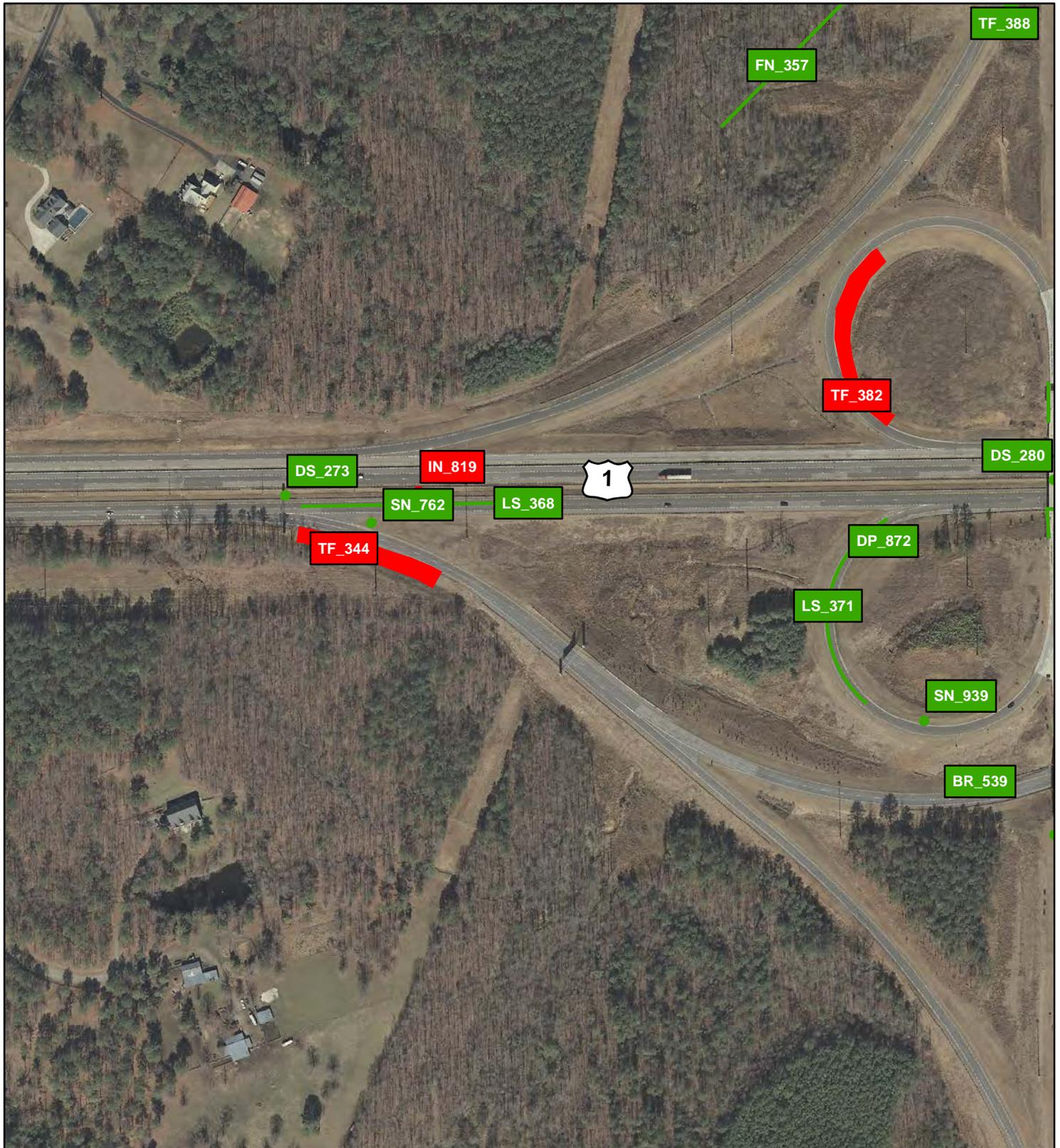


Legend

- Failing Asset
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Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

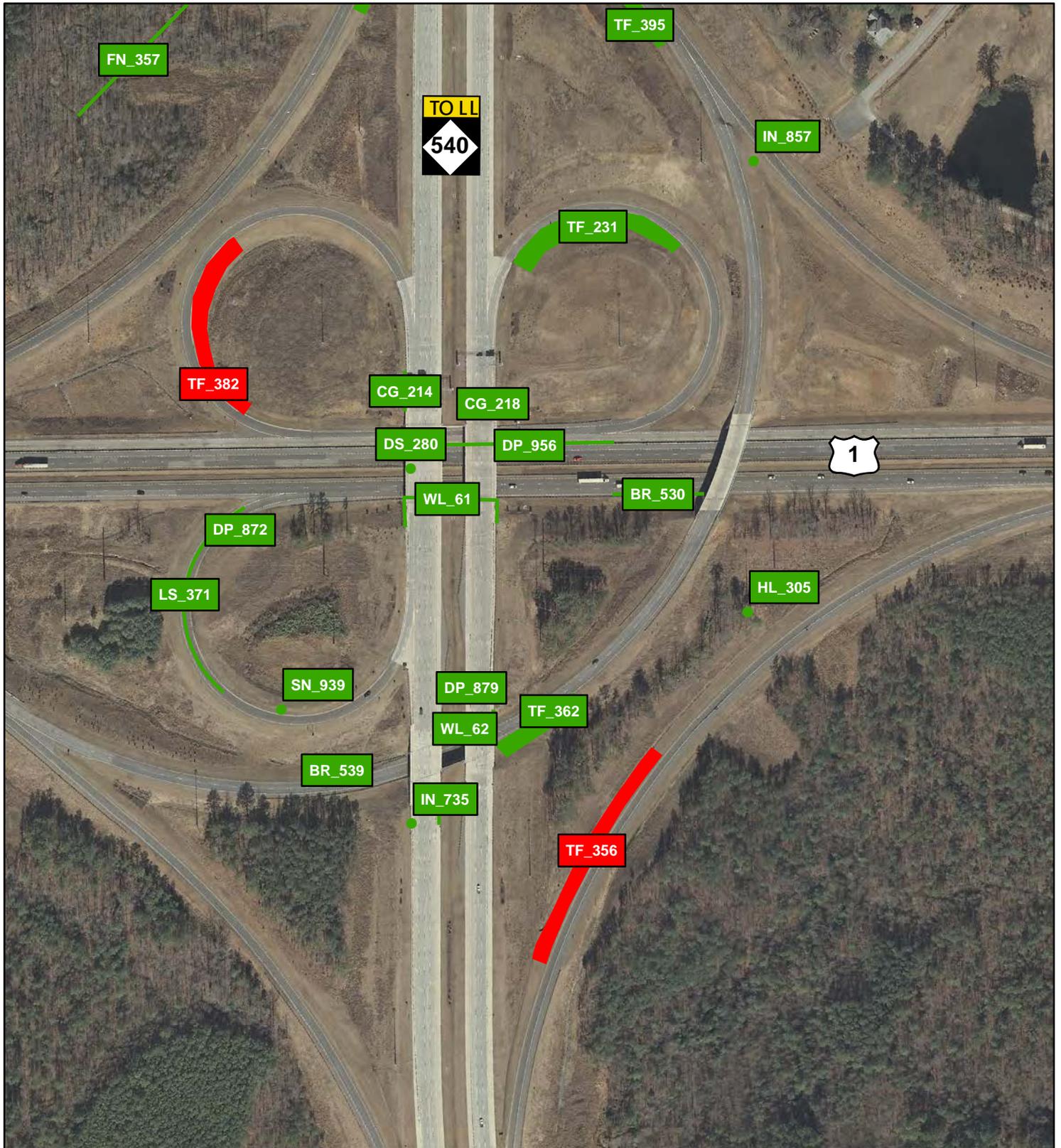


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

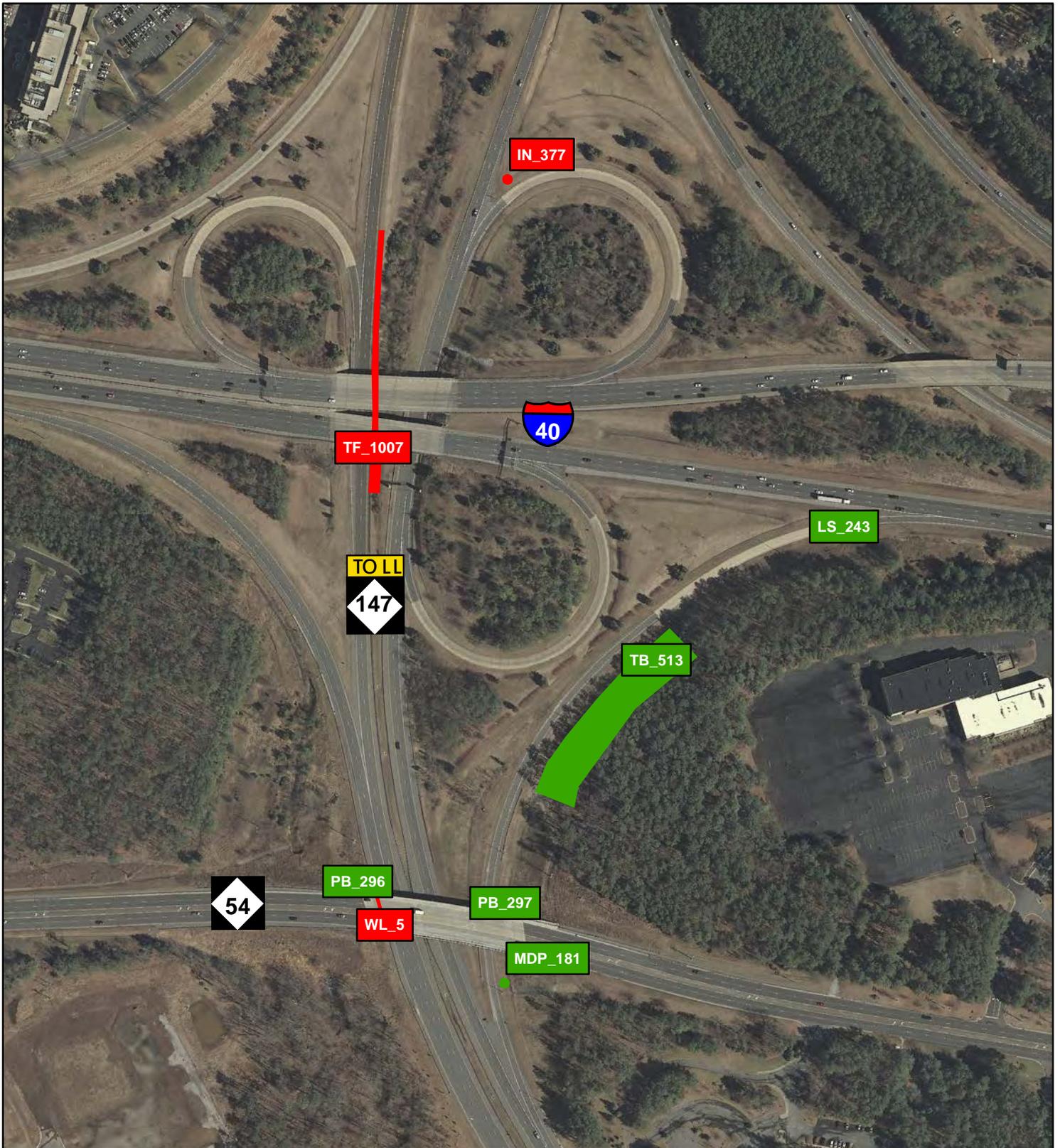


Legend

-  Failing Asset
-  Passing Asset

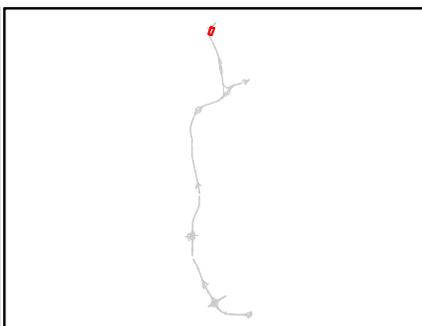


Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

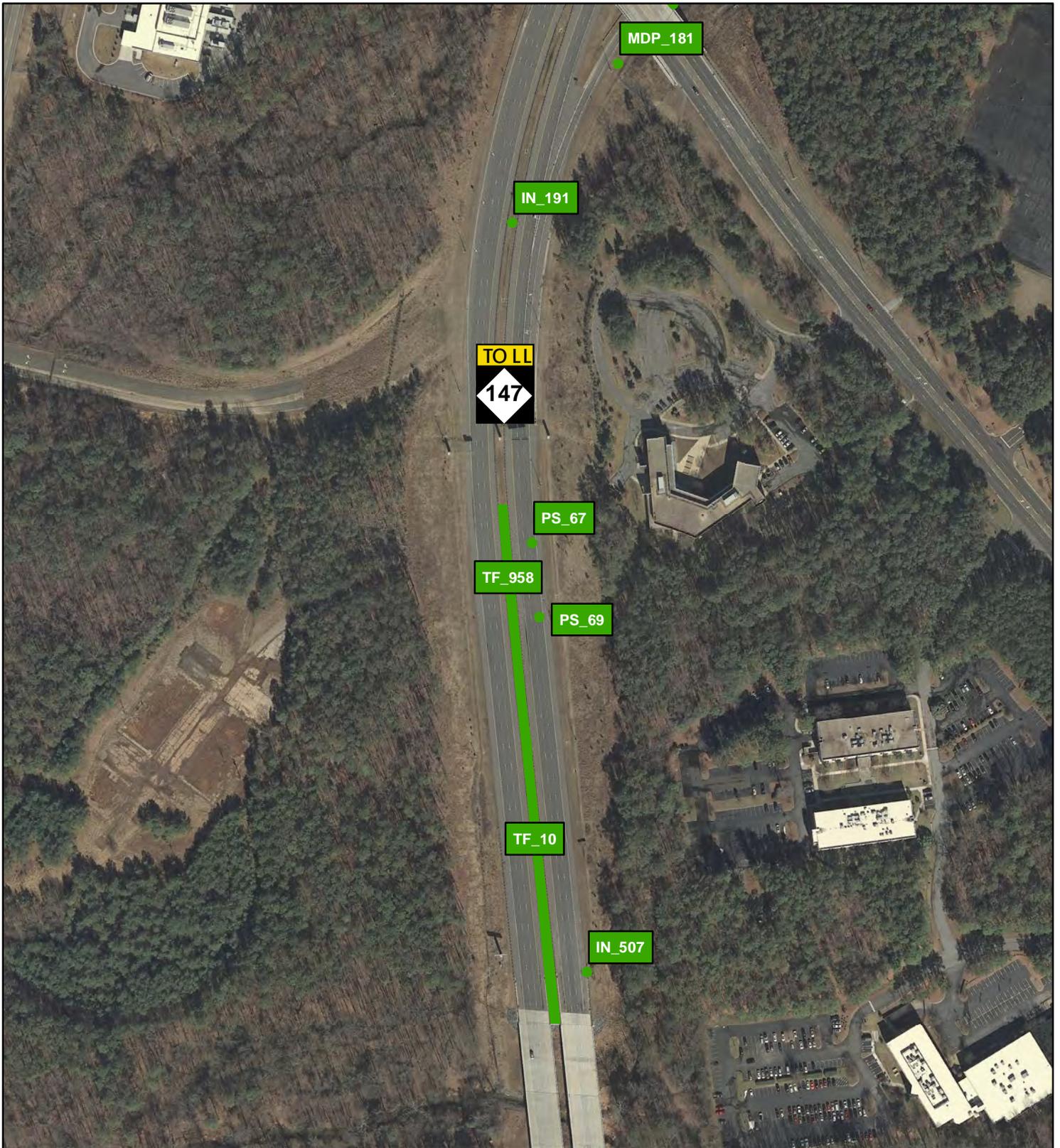


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

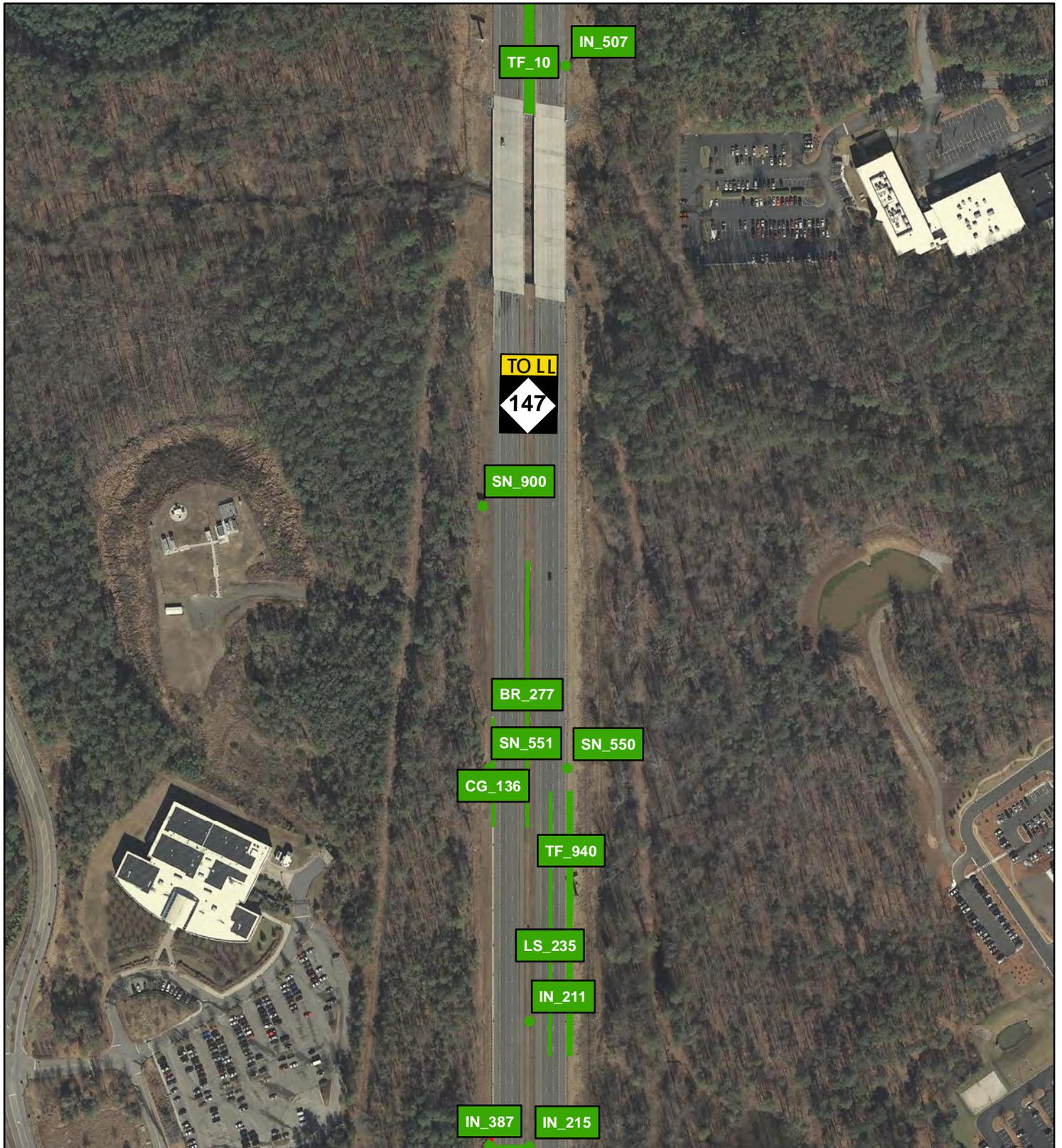


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

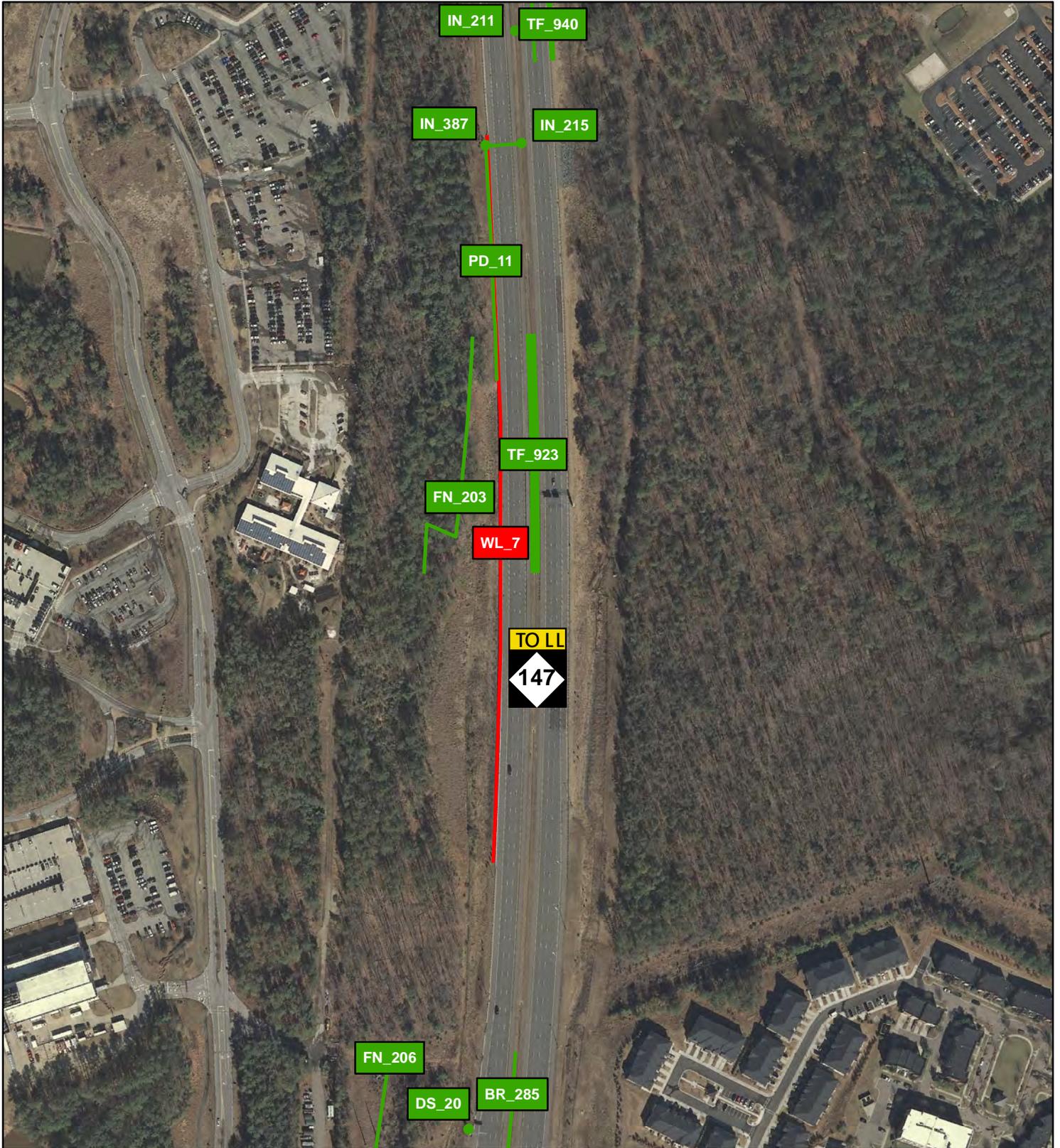


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

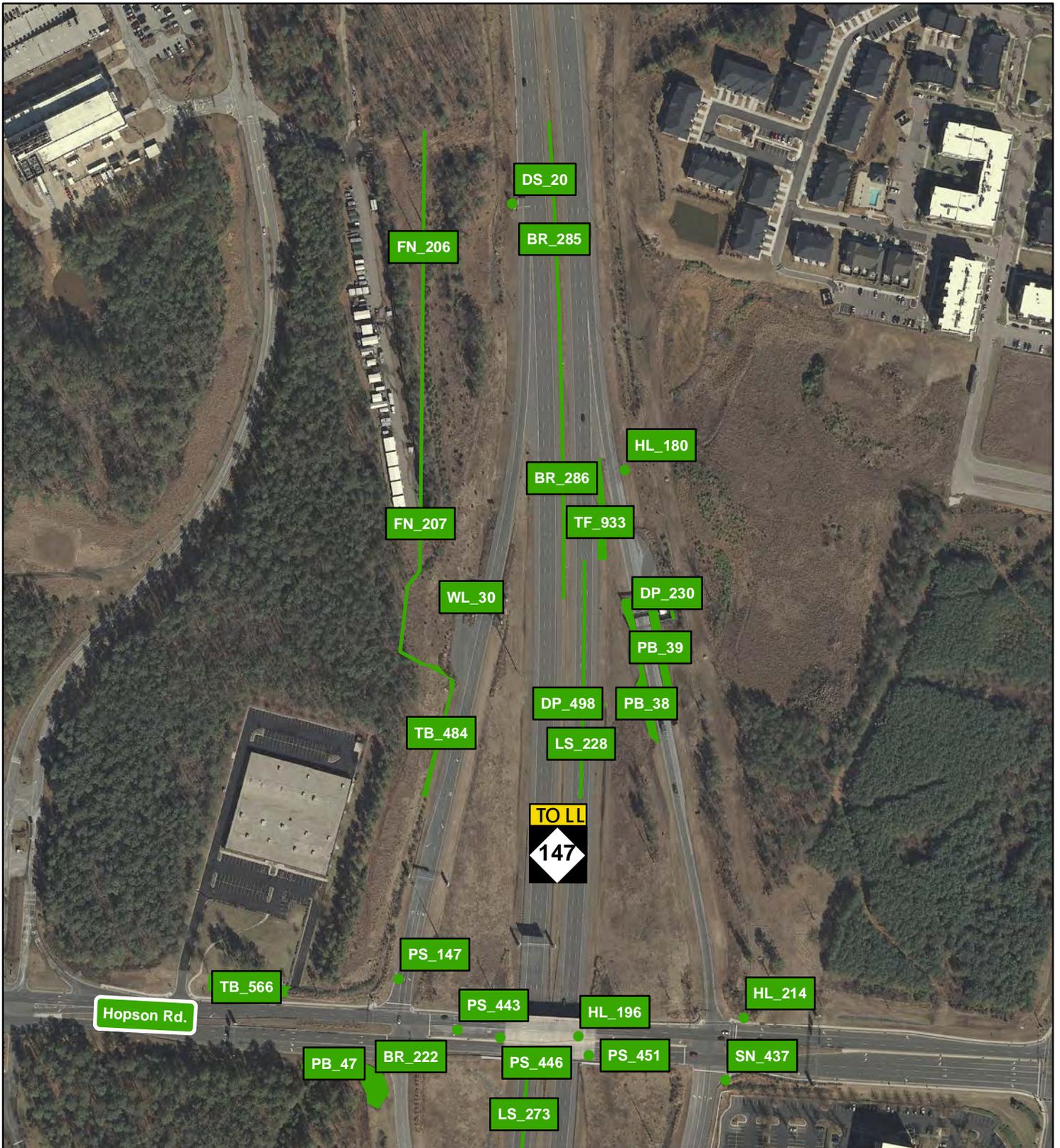


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

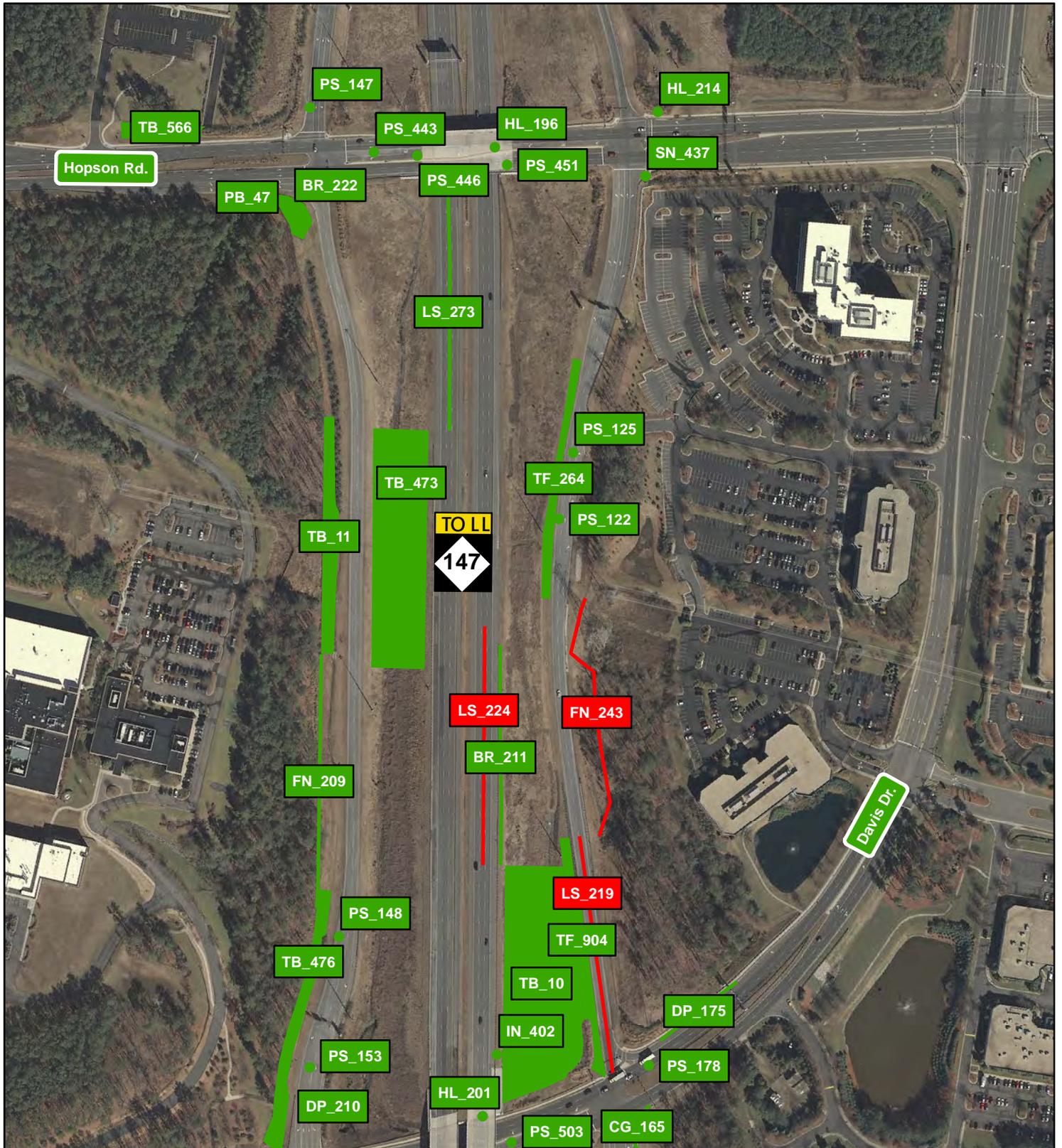


Legend

- Failing Asset
- Passing Asset

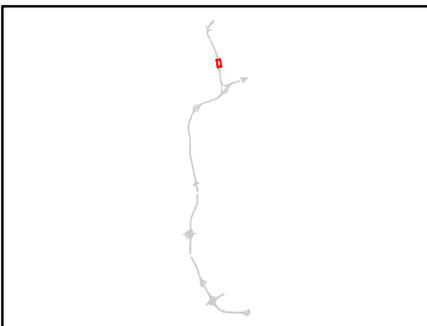


Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

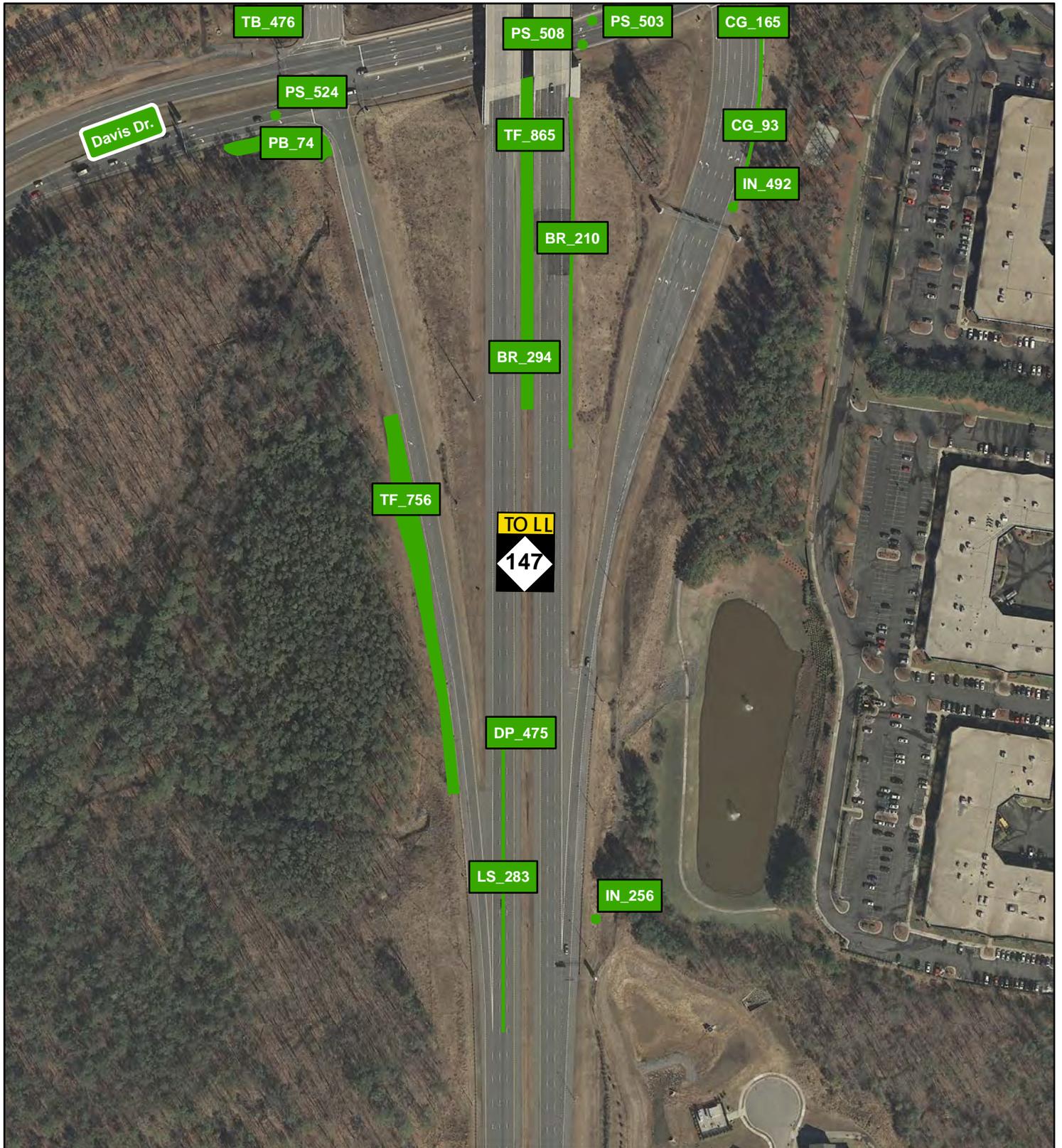


Legend

- Failing Asset
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Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

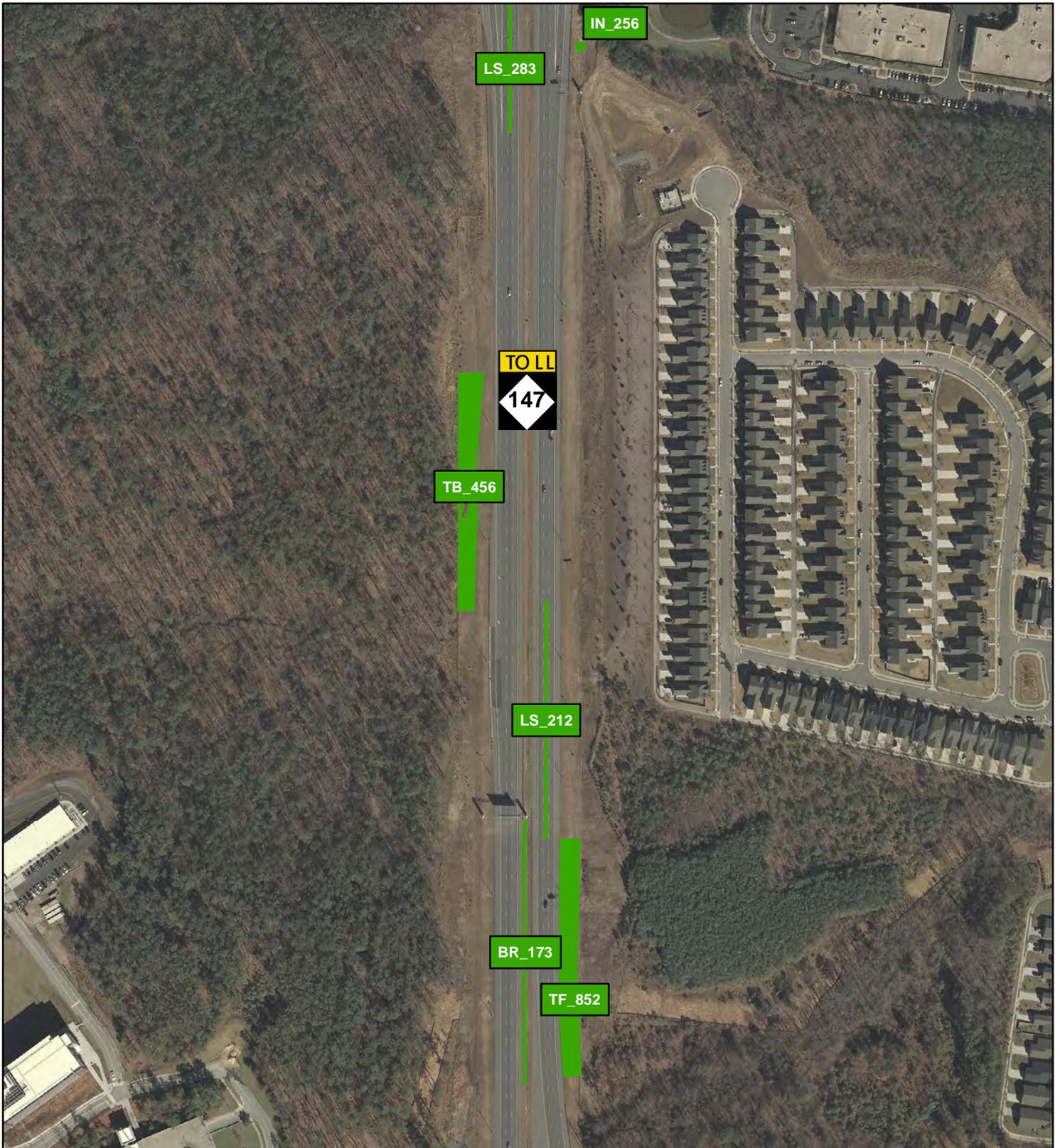


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations

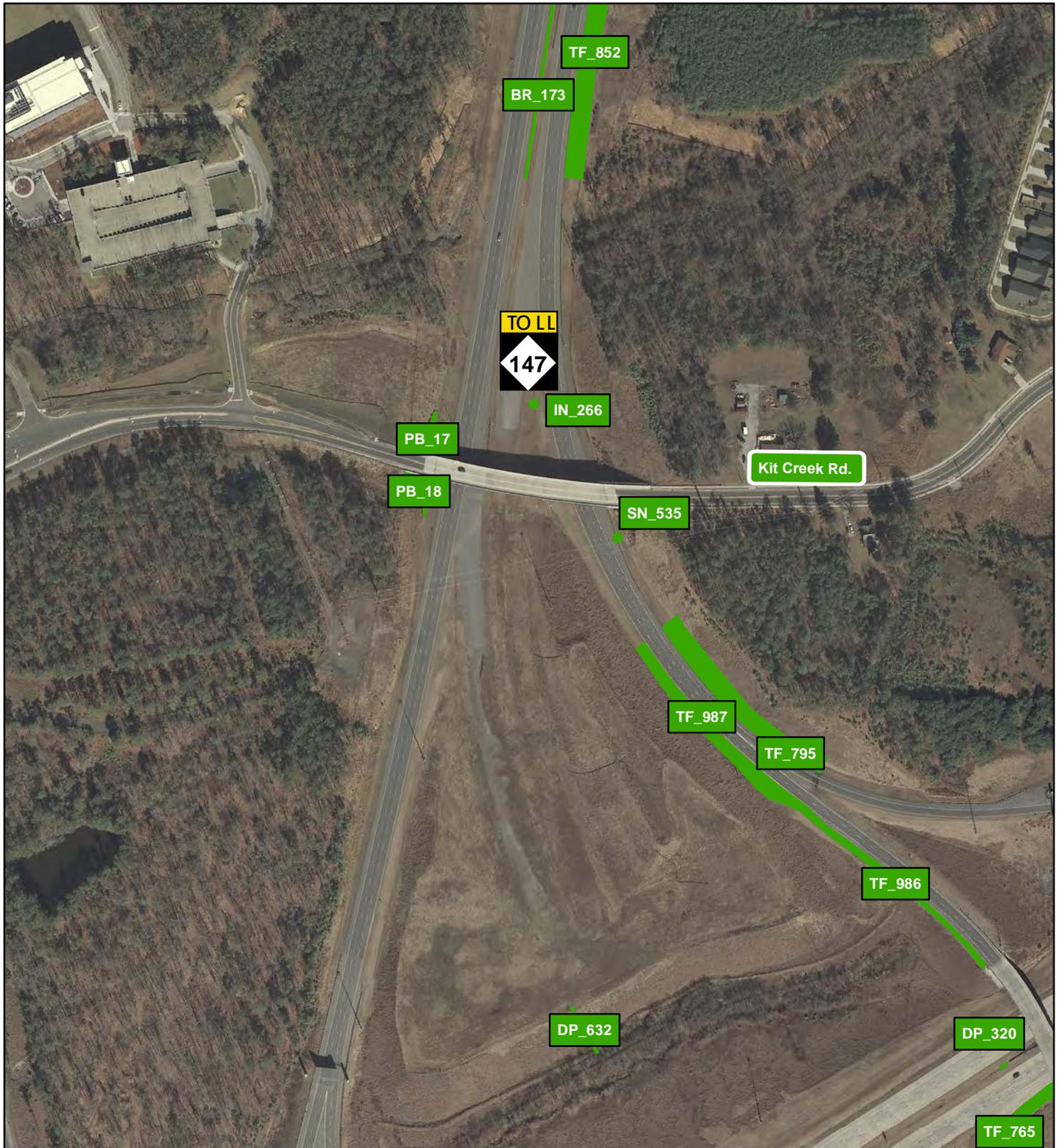


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Fourth Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix B

Triangle Expressway 2016 Fourth Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2016 Fourth 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 Structures (MDP)..... 7
Fence and Control of Access (FN) 9
Graffiti (GR) 10
Highway Lighting (HL) 11
Impact Attenuators (IA) 12
Inlets (IN)..... 13
Landscaping (PB) 14
Paved Lanes – Asphalt (LS)..... 15
Paved Lanes – Concrete (LS) 16
Paved Shoulders (LS)..... 17
Unpaved Shoulders (LS) 18
Front/Back Slopes (LS) 19
Unpaved Lateral and Outfall Ditches (LS) 20
Litter (LS) 21
Roadway Sweeping (LS) 22
Pavement Striping (LS)..... 23
Pavement Markers (LS)..... 24
Delineators (LS) 26
Paved Ditches (PD)..... 27
Pavement Words and Symbols (PS)..... 28
Signs (SN) 29
Tree and Brush (TB)..... 30
Turf Condition (TF) 31
MSE/Retaining Walls, Sound Barrier Walls and Screen Walls (WL)..... 35

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
This asset did not produce any failures.					

Misc. Drainage Structures (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_12	Obstruction	 A photograph showing a shoulder drain opening in a grassy area. The drain is partially blocked by a large clump of tall, green grass growing over it.	A11
2	Shoulder Drain	MDP_29	Obstruction	 A photograph of a shoulder drain opening. The drain is almost completely obscured by a dense, tangled mass of dry, brownish grass and weeds.	A15
3	Shoulder Drain	MDP_41	Obstruction	 A photograph showing a shoulder drain opening. The drain is heavily obstructed by a thick layer of dry, brown grass and weeds. A person's boot is visible in the foreground, stepping on the vegetation.	A18
4	Shoulder Drain	MDP_61	Obstruction	 A photograph of a shoulder drain opening. The drain is blocked by a dense growth of dry, brown grass. A person's leg and foot in a light-colored shoe are visible in the foreground, standing near the drain.	A21

Misc. Drainage Structures (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Shoulder Drain	MDP_77	Obstruction		A24
6	Shoulder Drain	MDP_78	Obstruction		A24

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_29	Fence Height		A25
2	Chain Link	FN_243	Fence Height		A47
3	Woven	FN_367	Fence Height		A41

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_35	Functional Damage	Not Available for Nighttime Failure	A22
2	Single Roadway	HL_63	Functional Damage	Not Available for Nighttime Failure	A19, A20
3	High Mast	HL_109	Missing Parts		A6
4	Underpass Lighting	HL_218	Functional Damage	Not Available for Nighttime Failure	A5
5	Single Roadway	HL_294	Functional Damage	Not Available for Nighttime Failure	A36
6	High Mast	HL_342	Part Damage		A29

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	Inlet	IN_353	Obstruction		A6
2	Inlet	IN_377	Obstruction		A42
3	Inlet	IN_819	Surface Damage		A39

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
1	Asphalt	LS_224	Unsealed Cracks		A47
2	Asphalt	LS_305	Payment Flushing		A3

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	Asphalt	LS_224	Paved Shoulder Joint Separation		A47

Unpaved Shoulders (LS)

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

Front/Back Slopes (LS)

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

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
1	Asphalt	LS_305	Nighttime Line Visibility	Not Available for Nighttime Failure	A3
2	Concrete	LS_331	Nighttime Line Visibility	Not Available for Nighttime Failure	A8
3	Concrete	LS_444	Missing Line		A37
4	Asphalt	LS_596	Nighttime Line Visibility	Not Available for Nighttime Failure	A28

Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_219	Marker Reflectivity	Not Available for Nighttime Failure	A47
2	Asphalt	LS_224	Marker Reflectivity	Not Available for Nighttime Failure	A47
3	Asphalt	LS_305	Marker Reflectivity, Missing Markers		A3
4	Concrete	LS_335	Marker Reflectivity	Not Available for Nighttime Failure	A10
5	Asphalt	LS_395	Marker Reflectivity, Missing Markers, Continuous Markers		A29
6	Concrete	LS_444	Marker Reflectivity	Not Available for Nighttime Failure	A37
7	Asphalt	LS_576	Marker Reflectivity, Missing Markers, Continuous Markers		A28, A30

Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
8	Asphalt	LS_595	Missing Markers, Continuous Markers		A28
9	Asphalt	LS_596	Marker Reflectivity	Not Available for Nighttime Failure	A28

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_38	Missing Markers, Nighttime Reflectivity		A12

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	Wrong Way	SN_50	Leaning		A29
2	Mileage to City	SN_806	Height Requirement		A36
3	Other	SN_1023	Leaning		A2

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_207	Bareground		A27, A28
2	Turf	TF_225	Bareground		A28
3	Turf	TF_344	Bareground		A39
4	Turf	TF_356	Height		A40

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_382	Bareground		A39, A40
6	Turf	TF_398	Bareground		A38
7	Turf	TF_431	Bareground		A36
8	Turf	TF_504	Bareground		A28, A29

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Turf	TF_571	Bareground		A21, A22
10	Turf	TF_672	Bareground		A28, A30
11	Turf	TF_777	Height		A5, A6
12	Turf	TF_1006	Height		A21

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Turf	TF_1007	Bareground		A42

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

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Bridge Wall	WL_5	Joints and Cracks		A42
2	Sound Wall	WL_7	Joints and Cracks		A45
3	Wall	WL_80	Paint Scaling		A27