



NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2016 Second Quarter Report

1 S. Wilmington Street
Raleigh, NC 27601



Last Updated:
August 1, 2016

CONSULTANT CERTIFICATION OF COMPLETION

July 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; Q2, 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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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 Second Quarter Assessment of the Triangle Expressway.

The overall 2016 second quarter maintenance rating of the Triangle Expressway is 94.7, which is above the NCTA target rating of 90. As shown in **Table 1**, four of the five elements assessed achieved a rating greater than the target rating of 85.

Table 1: MRP Element Results for the 2016 Second Quarter Assessment		
Element	MRP Rating	Target Rating
Road Surface	100.0	85.0
Unpaved Shoulders and Ditches	100.0	85.0
Drainage	91.0	85.0
Roadside	83.4	85.0
Traffic Control Devices	96.1	85.0
Overall MRP Performance Rating	94.7	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 93.8.

Table 2: MRP Rolling Element Results					
Element	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	ROLLING Rating
Road Surface	99	98	98	100	99
Unpaved Shoulders and Ditches	100	98	98	100	99
Drainage	94	84	93	91	90
Roadside	86	91	92	83	88
Traffic Control Devices	89	92	93	96	93
Overall MRP Performance Rating	93.1	92.8	94.9	94.7	93.8

In addition, the report provides findings of the Green Level Historic District signs inspection. This quarter, two of the four signs were vandalized and appeared to be cut off at the post. However, the remaining Green Level Historic District signs are in good physical condition and all landscape areas around the signs are being 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.

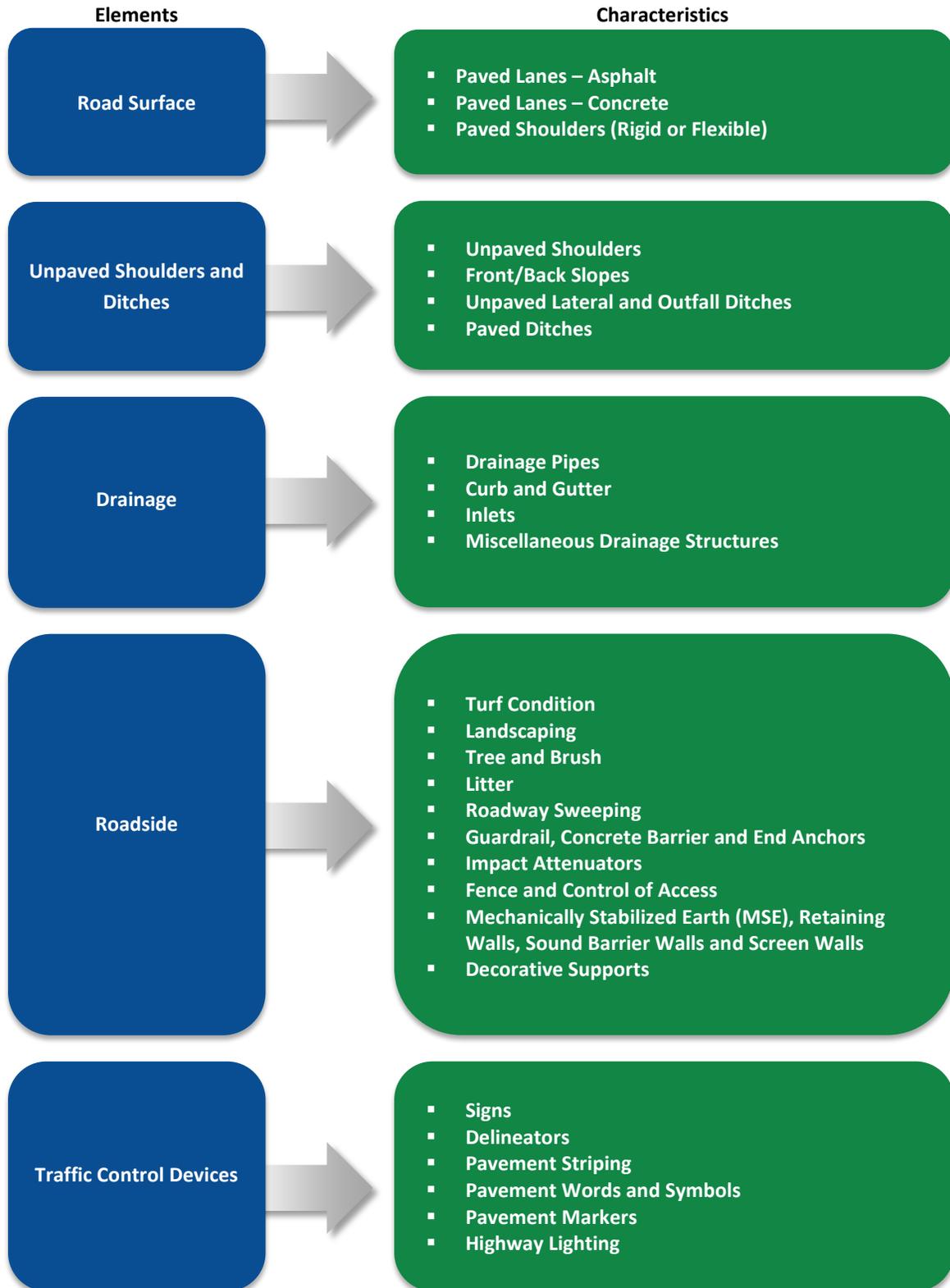
The NCTA performance standards, threshold criteria and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

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:

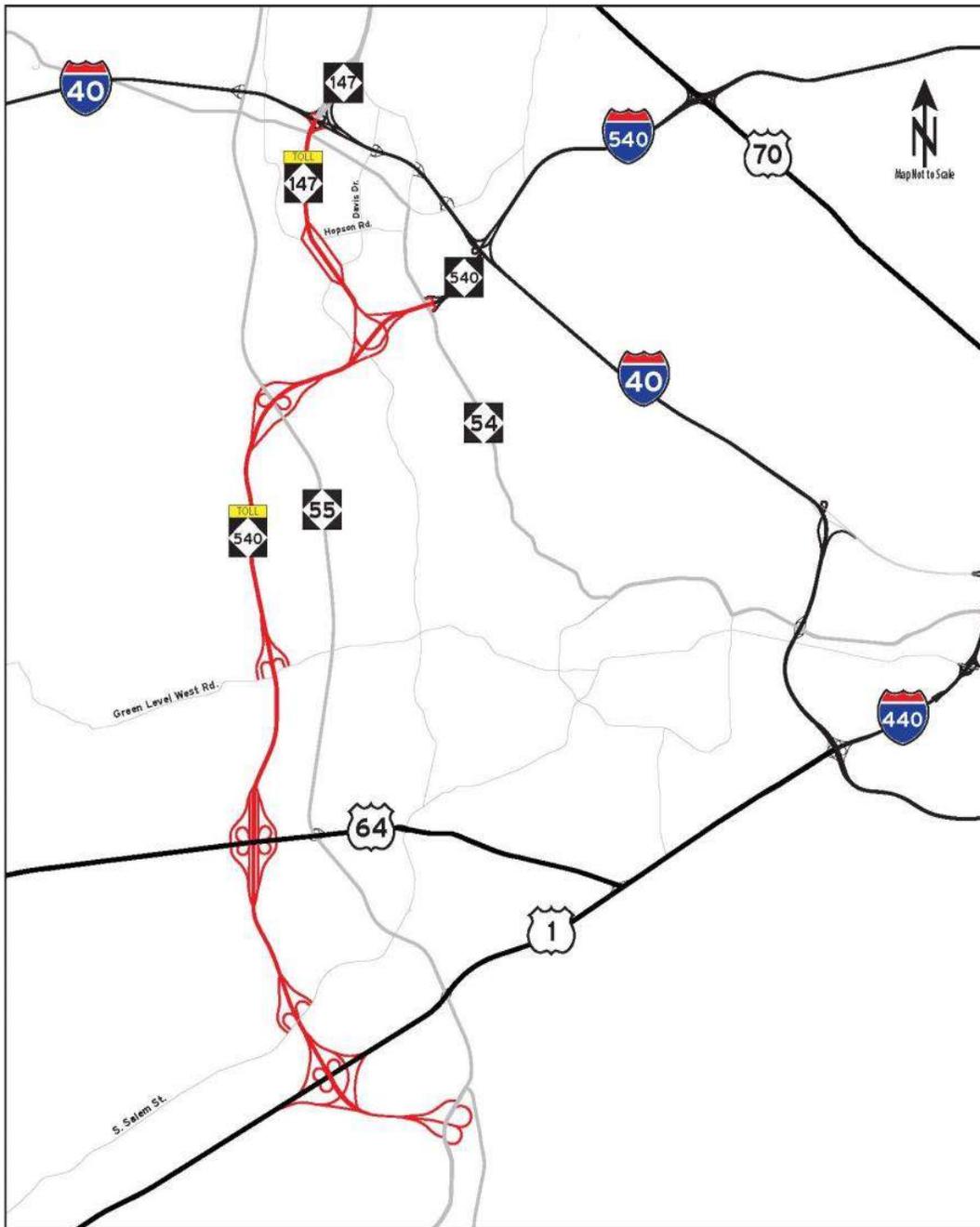
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

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 second quarter all assets located on NC-540 south of US-1 and north of NC-55 Bypass were temporarily removed from the inventory due to the Access 540 Construction Project. **Table 3** presents the number of assets that are eligible for inspection throughout the duration of the construction project.

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 ASSESSMENT

6.1 Quarterly Results

The overall 2016 second quarter maintenance rating of the Triangle Expressway is 94.7, exceeding NCTA’s target overall rating of 90. Most elements assessed achieved ratings above the target rating of 85, with the exception of Roadside (83.4). Miscellaneous Drainage (63) and Turf Condition (44) are the characteristics that scored below the target rating of 80. It is important to note that these results are only representative of the second 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, provides a 95% confidence level in statistical sampling. The second quarter MRP performance ratings for elements and characteristics are presented in **Table 4** and **Table 5**, respectively.

Table 4: MRP Element Results for Q2 2016	
Element	Q2 2016 MRP Rating
Road Surface	100.0
Unpaved Shoulders and Ditches	100.0
Drainage	91.0
Roadside	83.4
Traffic Control Devices	96.1
Overall MRP Performance Rating	94.7

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Table 5: MRP Characteristic Results for Q2 2016						
Road Surface	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q2 Rating
Paved Lanes Asphalt	21	21	9	189	189	100
Paved Lanes Concrete	19	19	9	171	171	100
Paved Shoulder	40	40	5	200	200	100
Element Total				560	560	100.0
Unpaved Shoulders And Ditches	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q2 Rating
Unpaved Shoulder	40	40	9	360	360	100
Front/Back Slopes	40	40	6	240	240	100
Lateral and Outfall Ditches, Unpaved	40	40	6	240	240	100
Ditches, Paved	1	1	5	5	5	100
Element Total				845	845	100.0
Drainage	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q2 Rating
Drainage Pipes	29	32	7	203	224	91
Curb and Gutter	23	24	6	138	144	96
Inlets	34	34	7	238	238	100
Misc. Drainage Structure	15	24	4	60	96	63
Element Total				639	702	91.0
Roadside	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q2 Rating
Turf Condition	32	73	7	224	511	44
Landscaping	25	26	4	100	104	96
Trees and Brush	25	25	4	100	100	100
Litter	40	40	4	160	160	100
Roadway Sweeping	40	40	5	200	200	100
Guardrail, Concrete Barrier and End	25	28	9	225	252	89
Impact Attenuators	9	9	9	81	81	100
Fence, Control Access	29	29	7	203	203	100
Retaining Walls and Sound Barrier Walls	17	18	5	85	90	94
Decorative Supports	21	22	5	105	110	95
Graffiti and Stain Removal	40	40	4	160	160	100
Element Total				1643	1971	83.4
Traffic Control Devices	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q2 Rating
Signs	28	31	7	196	217	90
Delineators	29	32	3	87	96	91
Pavement Striping/Marking	40	40	8	320	320	100
Words and Symbols	28	28	7	196	196	100
Pavement Markers	40	40	9	360	360	100
Highway Lighting	29	33	6	174	198	88
Element Total				1333	1387	96.1

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

6.2 Analysis and Recommendations

Elements

Roadside is the only element of the five that fell below NCTA's target threshold criteria of 85. The second quarter rating for Roadside (83.4) is 8.8 points lower than the first quarter rating (92.1). This element's low rating for the second quarter is mostly attributed to a significantly low rating of Turf Condition (44). Recommendations to improve this rating are provided in the following section. In addition, it is recommended that the maintenance provider continue to monitor closely other characteristics within the Roadside element group that met the maintenance rating expectations, but obtained lower ratings for this reporting period:

- Landscaping (96), 4 points lower than the first quarter rating (100)
- Guardrail/Concrete Barrier/End Anchors (89), 11 points lower than the first quarter rating (100)
- Decorative Supports (95), 5 points lower than first quarter rating (100)

Characteristics

This quarter all but two characteristics, Miscellaneous Drainage Structure and Turf Condition, satisfied the NCTA target threshold criteria of 80. It should be noted that this is the second consecutive quarter in which Pavement Markers reach the maximum rating (100). This significant improvement is mostly due to the pavement marker replacement work that took place during March. Also, this quarter's Retaining/Sound/Screen Walls score (94) improved as a result of warranty work performed during the spring along the sound wall joints.

Additional warranty work was performed this quarter on paved surfaces and paved shoulder joints. Although no significant impact was observed on this quarter's paved surface and paved shoulder scores, the work improved safety conditions along the corridor and helped mitigate continued degradation of asset condition.

Miscellaneous Drainage Structure (63) and Turf Condition (44) are the two characteristics that failed to meet the NCTA target threshold criteria. 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 (63 rating – 9 of the 26 assets failed). All nine failures occurred because of obstruction. 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* reference 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.

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.

Maintenance and 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 (44 rating – 41 of the 73 assets failed). Out of the 73 turf areas inspected, 7 failed because of height and 34 failed because of bare ground. Two of the failing turf areas are presented in *Figure 4*.

Figure 4: Turf Failures



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

Maintenance Program Standards:

- 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 manufacturer's recommendations in August.

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- 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.

This summer NCDOT Division 5 Landscape Unit is planning to lead a reseeding effort throughout the Expressway with centipede grass using a drill seeding method. Additionally, the landscape unit has completed a round of fertilization throughout the facility. 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.

7.0 ROLLING MRP RATING

The current rolling maintenance rating of the Triangle Expressway is 93.8, 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 70, 58 and 75, respectively.

The cumulative rolling results are presented in **Tables 6 and 7**. These results are a collection of the four latest quarterly inspections.

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Table 6: MRP Rolling Characteristic Results					
Road Surface	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Rolling Rating
Paved Lanes Asphalt	100	98	100	100	99
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulders	95	93	95	100	96
Element Total	99.3	97.9	98.3	100.0	98.6
Unpaved Shoulders And Ditches	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Rolling Rating
Unpaved Shoulders	100	95	98	100	98
Front/Back Slopes	100	100	95	100	99
Lateral and Outfall Ditches, Unpaved	100	100	100	100	100
Paved Ditches	100	100	100	100	100
Element Total	100.0	97.8	97.7	100.0	98.9
Drainage	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Rolling Rating
Drainage Pipes	91	85	97	91	91
Curb and Gutter	92	84	100	96	93
Inlets	100	94	97	100	98
Misc. Drainage Structures	88	63	66	63	70
Element Total	93.5	83.8	92.6	91.0	90.2
Roadside	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Rolling Rating
Turf Condition	47	66	73	44	58
Landscaping	100	97	100	96	98
Trees and Brush	100	100	100	100	100
Litter	100	100	100	100	100
Roadway Sweeping	98	100	100	100	100
Guardrails and Concrete Barriers	97	100	100	89	97
Impact Attenuators	89	100	100	100	97
Fence and Control Access	100	90	93	100	96
Retaining, Sound and Screen Walls	79	95	89	94	89
Decorative Supports	100	88	100	95	96
Graffiti and Stain Removal	100	100	100	100	100
Element Total	86.3	90.5	92.1	83.4	88.2
Traffic Control Devices	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Rolling Rating
Signs	100	88	91	90	92
Delineators	76	88	89	91	84
Pavement Striping/Marking	97	100	100	100	99
Words and Symbols	93	100	100	100	98
Pavement Markers	86	90	100	100	93
Highway Lighting	67	67	69	88	75
Element Total	89.0	92.2	93.5	96.1	92.6

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Table 7: MRP Rolling Element Results					
Element	Q3 2015 Rating	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Rolling Rating
Road Surface	99	98	98	100	99
Unpaved Shoulders and Ditches	100	98	98	100	99
Drainage	94	84	93	91	90
Roadside	86	91	92	83	88
Traffic Control Devices	89	92	93	96	93
Overall MRP Performance Rating	93.1	92.8	94.9	94.7	93.8

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, two of the four signs were found to be in good condition, with the landscaped areas being well maintained. *Figure 5* shows these signs.

Figure 5: Green Level West Historic District Signs, in Good Standing



However, during the inspection it was noticed that two of the four signs were vandalized and appeared to be cut off at the post. *Figure 6* shows the posts where these signs used to be mounted on. These posts are located at Green Level Church Road, near the Green Level Baptist Church (left) and near the intersection of Green Level Church Road and Green Level West Road (right). NCTA is in the process of replacing these signs.

Figure 6: Green Level West Historic District Signs, Vandalized



9.0 CONCLUSION

This report presents the 2016 second 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 second quarter 2016 overall rating is **94.7** and the cumulative rolling rating is **93.8**. The quarterly and cumulative rolling ratings for this quarter are currently above the target rating of 90.

All element ratings are above the target rating for the cumulative rolling assessment; however, only four of the five elements met the target rating for the quarterly assessment. Roadside experienced a decline in rating due to lower scores for Turf Condition, Landscaping, Guardrail/Concrete Barrier/End Anchors, and Decorative Supports. Most characteristic's quarterly ratings exceeded the target rating of 80 with the exception of Miscellaneous Drainage Structure (63) and Turf Condition (44). Pavement Markers (100) and Retaining/Sound/Screen Walls (94) ratings experienced a significant improvement from previous quarters. Additionally, based on the cumulative rolling assessment ratings, Miscellaneous Drainage Structure (70), Turf Condition (58) and Highway Lighting (75) fell below the threshold.

In order to improve the quarterly and rolling 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.

In addition, 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 that NCDOT Division 5 Landscape Unit continue to proceed with the reseeding and fertilization effort planned for 2016.

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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.

Two of the four Green Level Historic District signs were vandalized. NCTA is currently working towards replacing these two signs. However, the other Green Level Historic District signs are in good condition and all landscaped areas surrounding the signs are being well maintained; preserving sign visibility and aesthetic appearance.

Appendix A

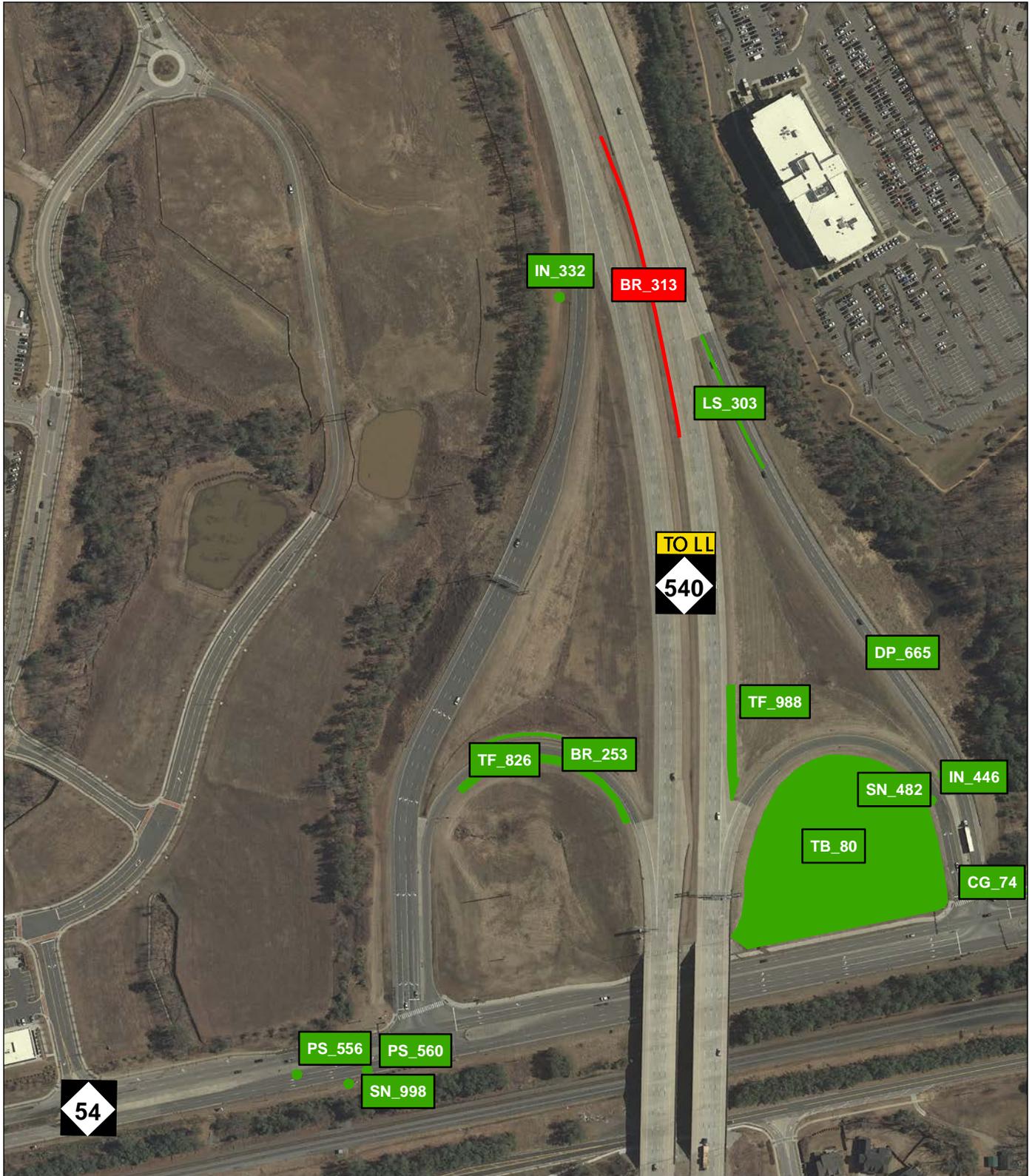
Triangle Expressway 2016 Second Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2016 Second 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:

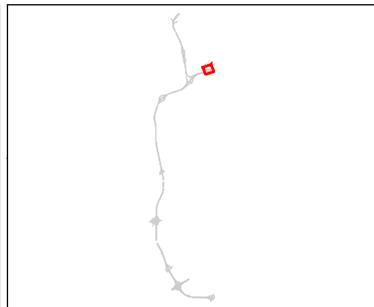
- Guardrail, Concrete Barrier and End Anchors – BR
- Curb and Gutter – CG
- Decorative Supports – DS
- Drainage Pipes – DP
- Misc. Drainage Structures – MDP
- Fence and Control of Access – FN
- Graffiti - GF
- Highway Lighting – HL
- Impact Attenuators – IA
- Inlets – IN
- Landscaping – PB
- Linear Samples – 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 Second Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

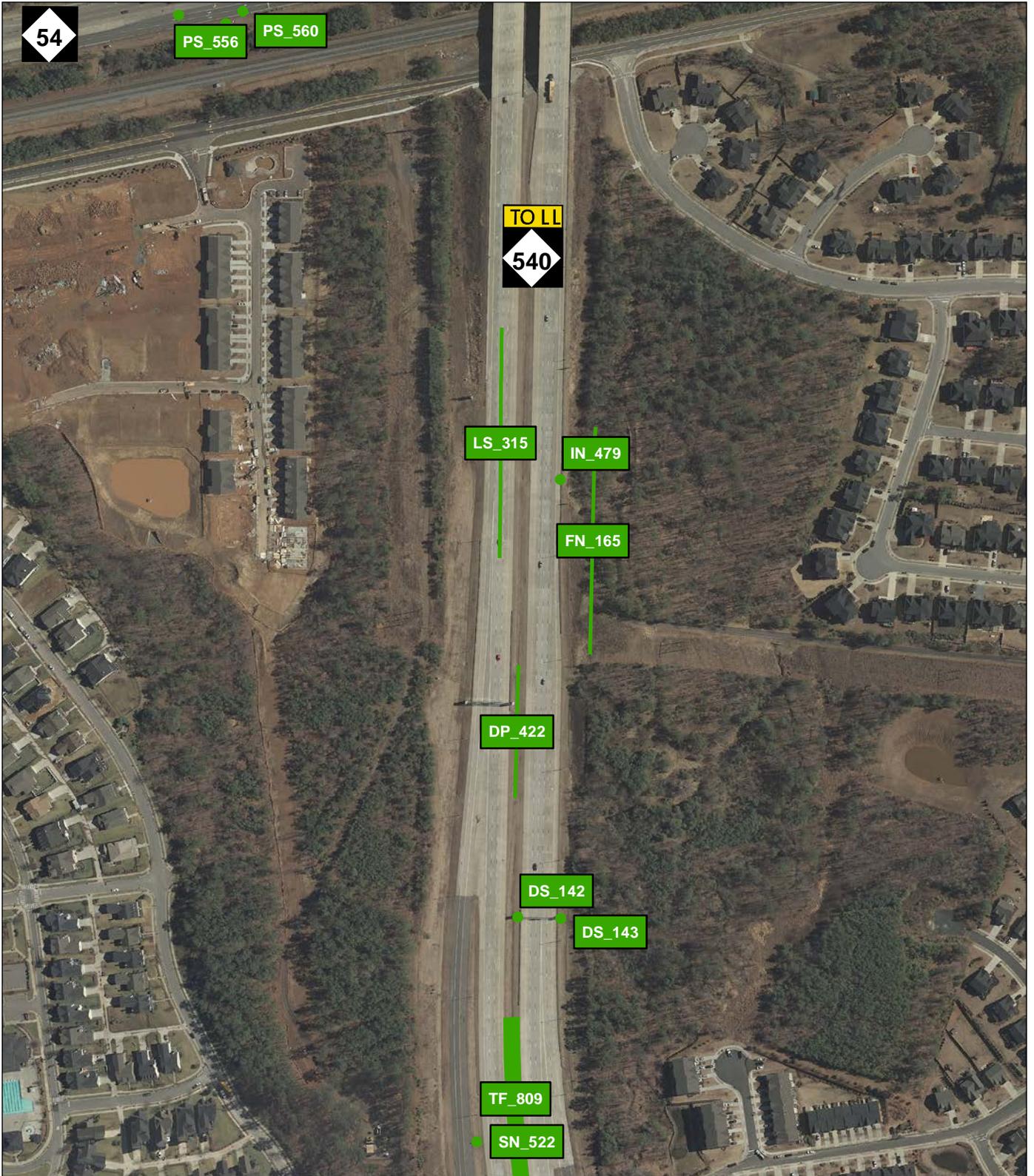


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

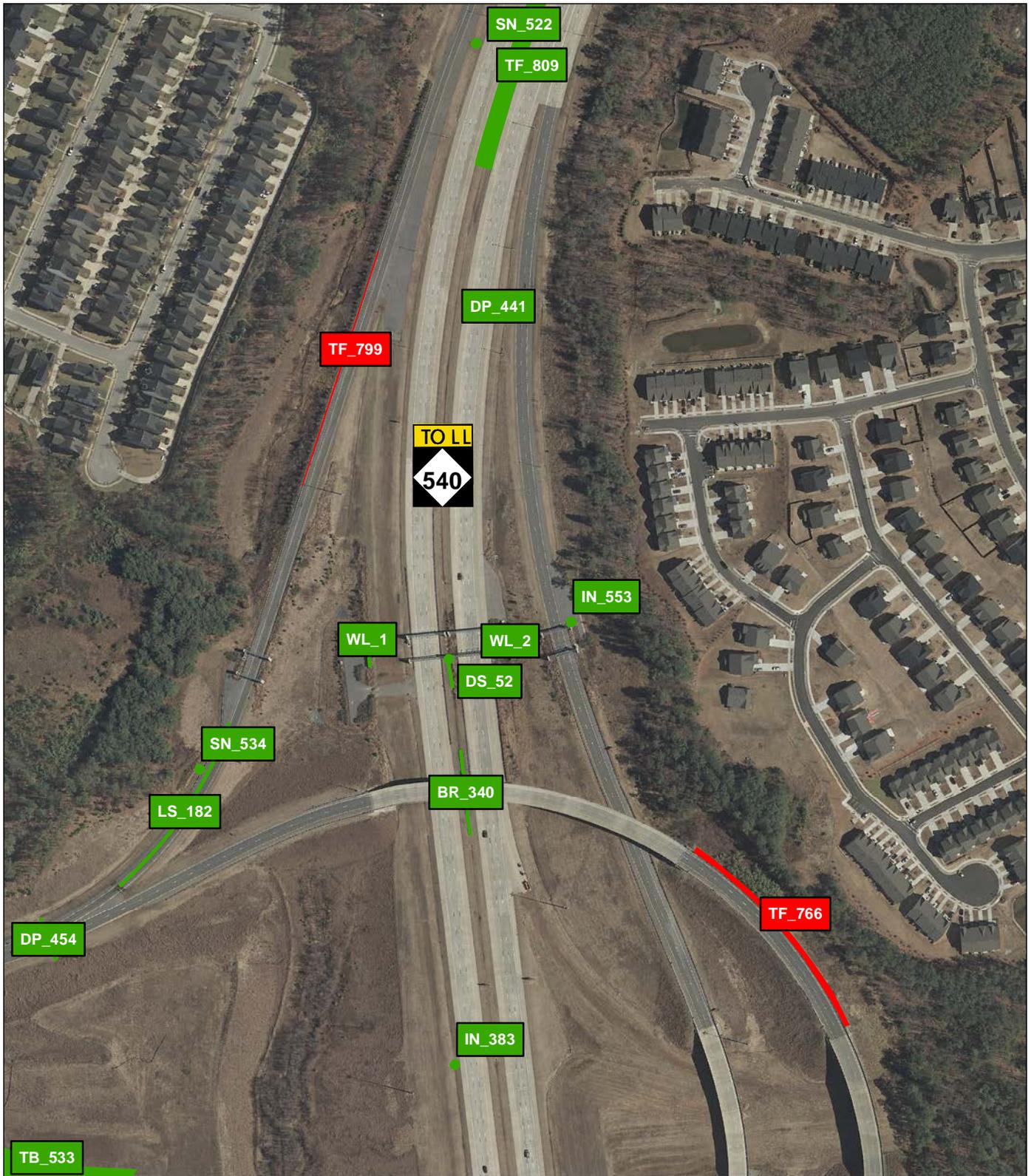


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

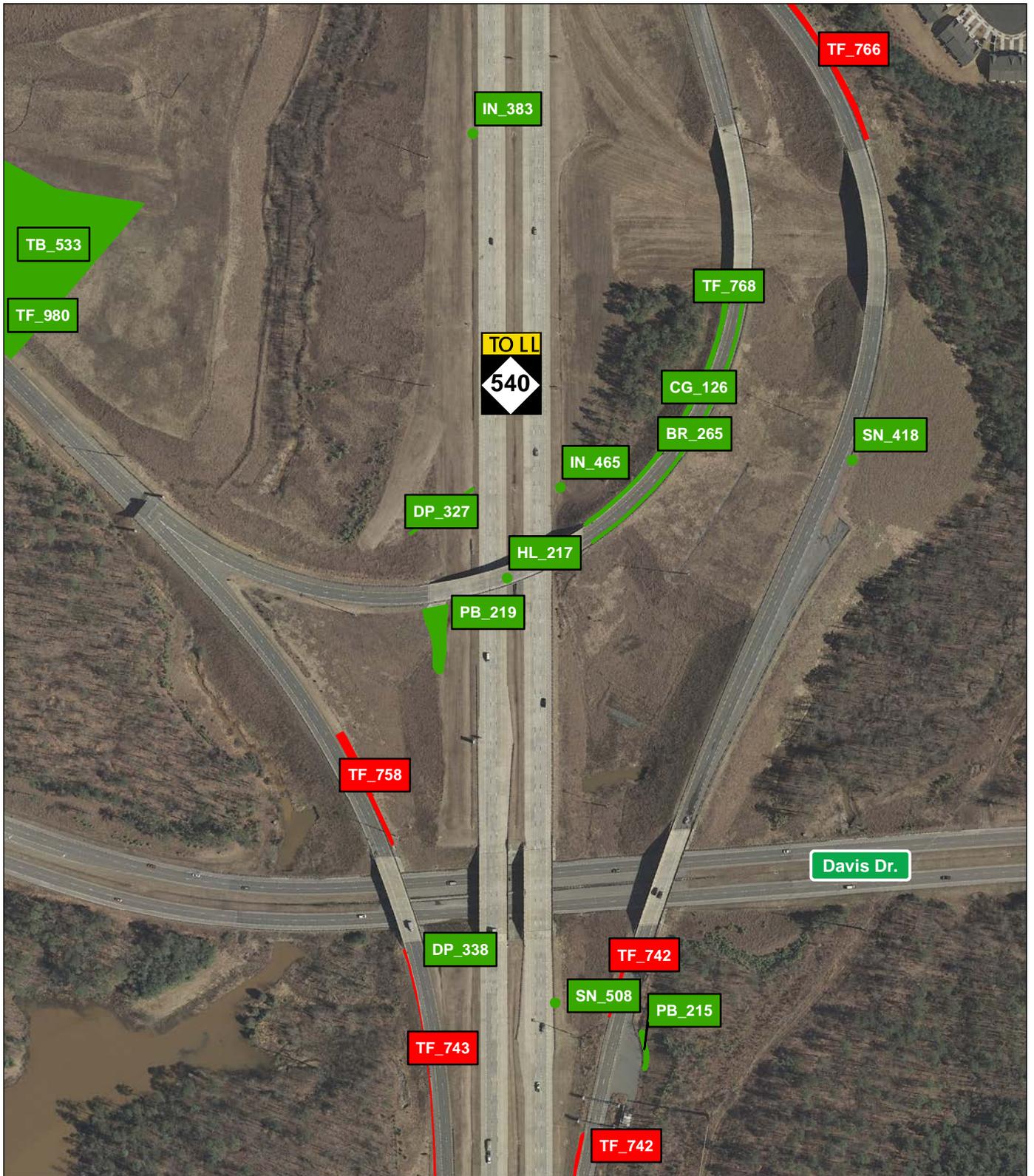


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

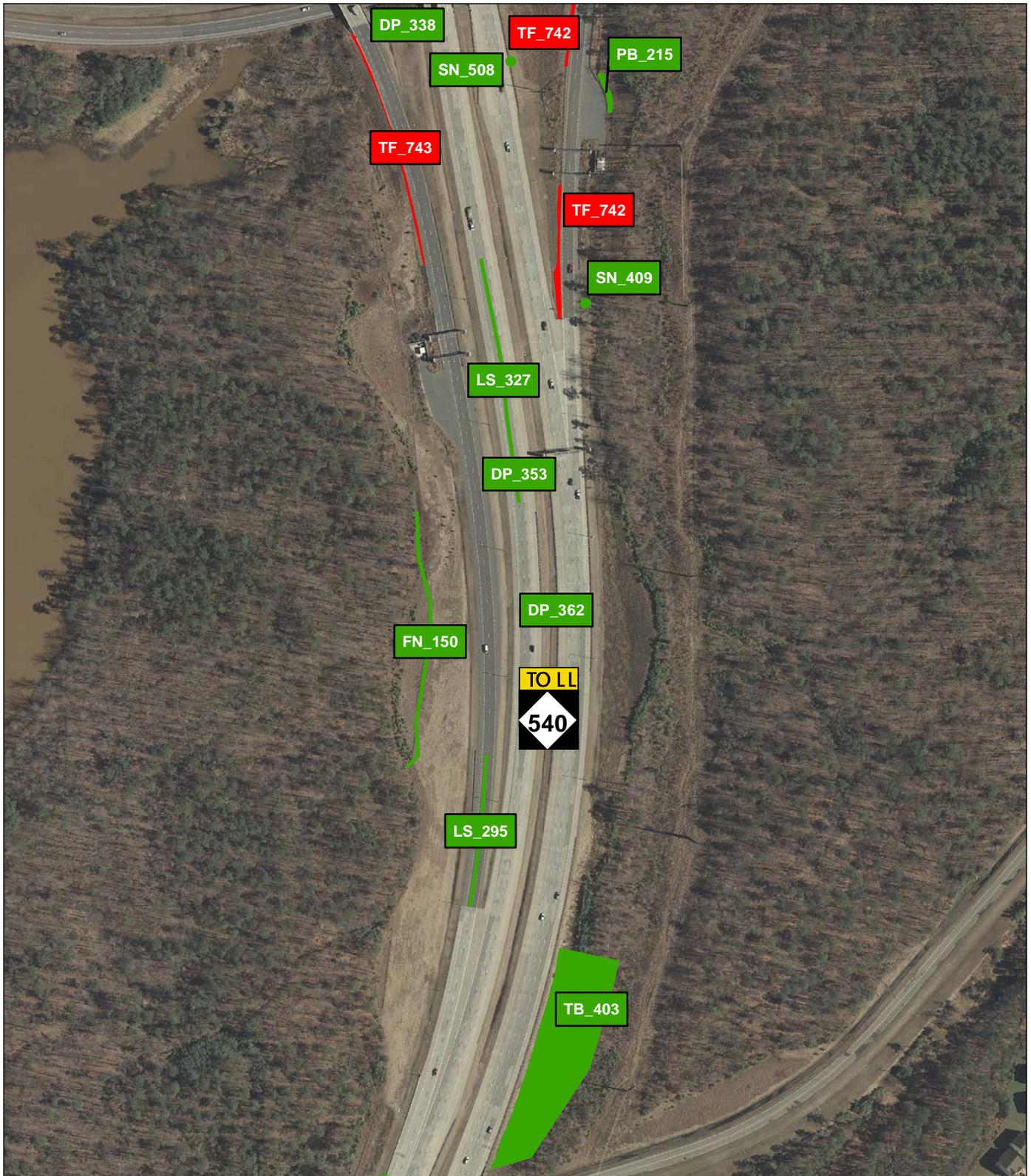


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

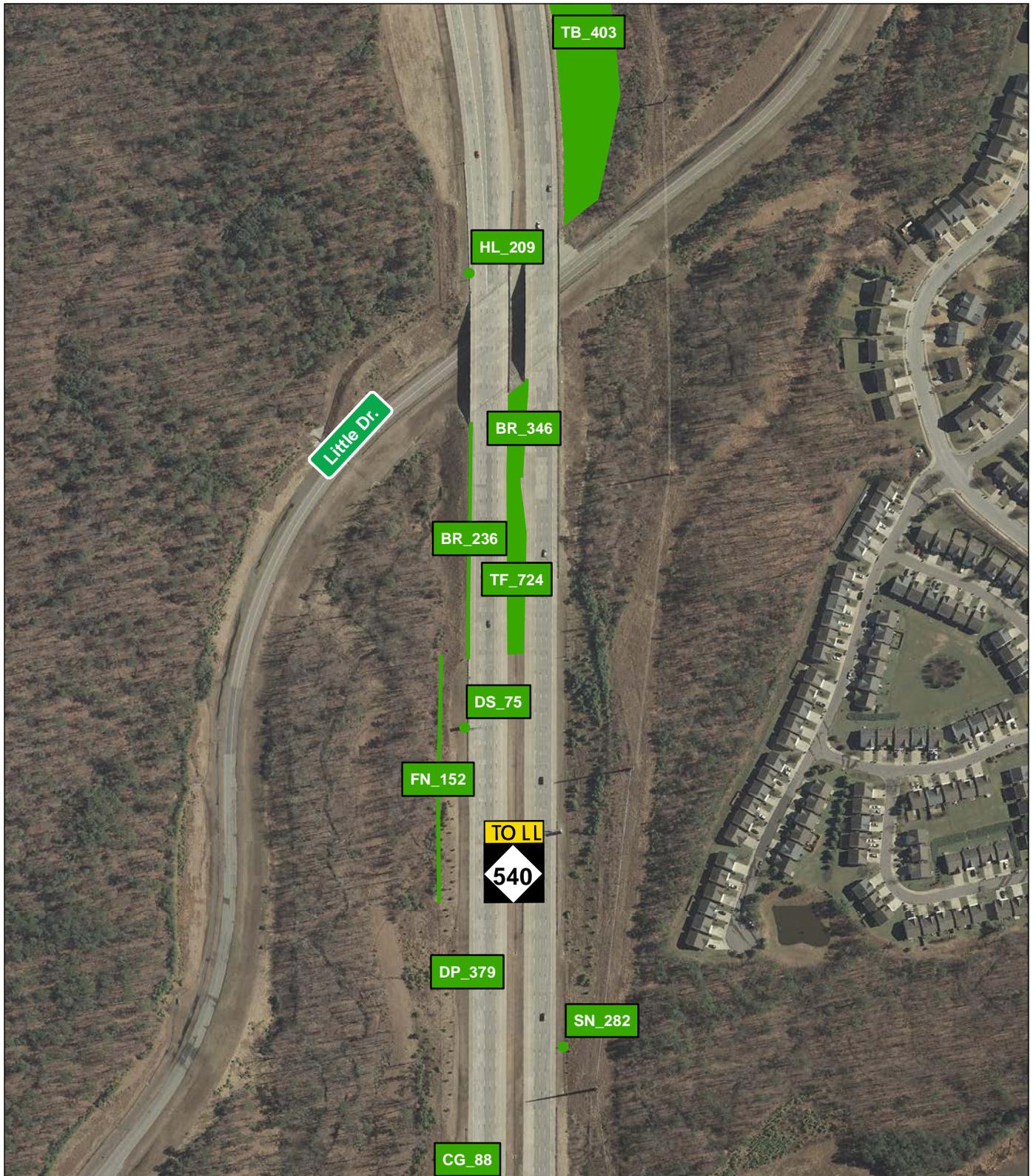


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

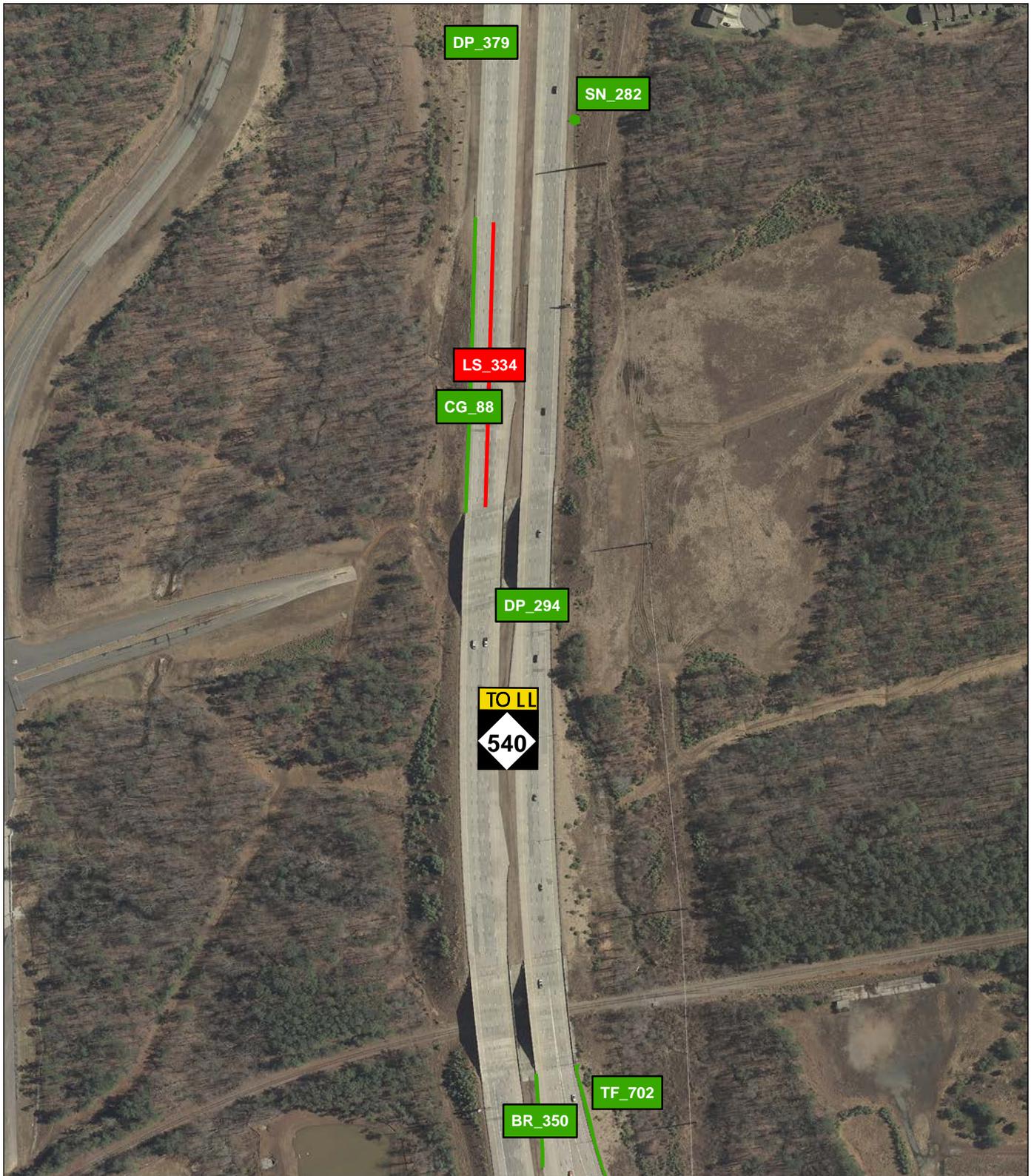


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset

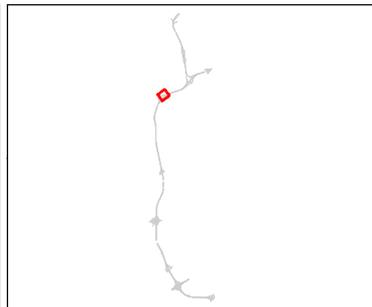


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

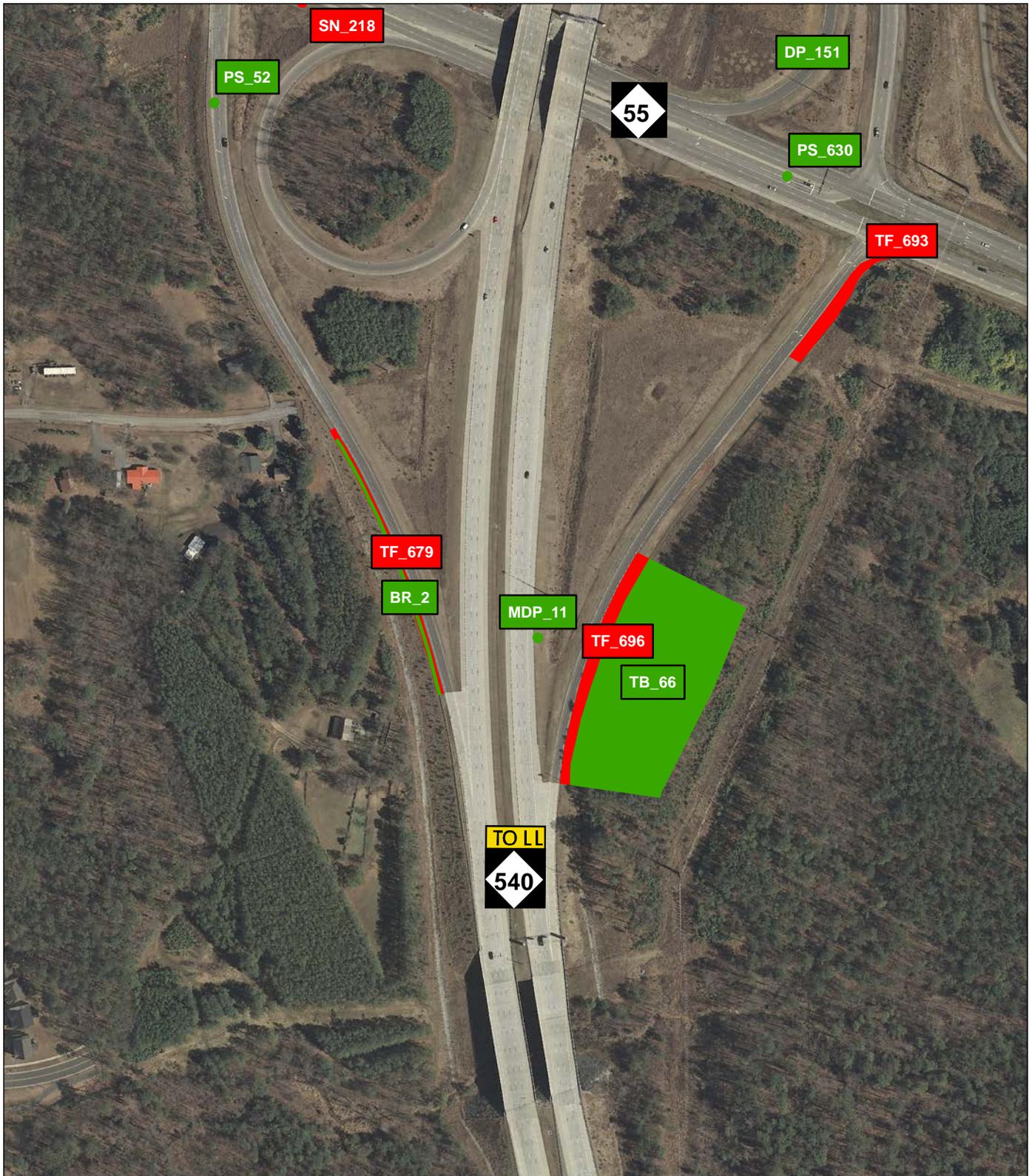


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

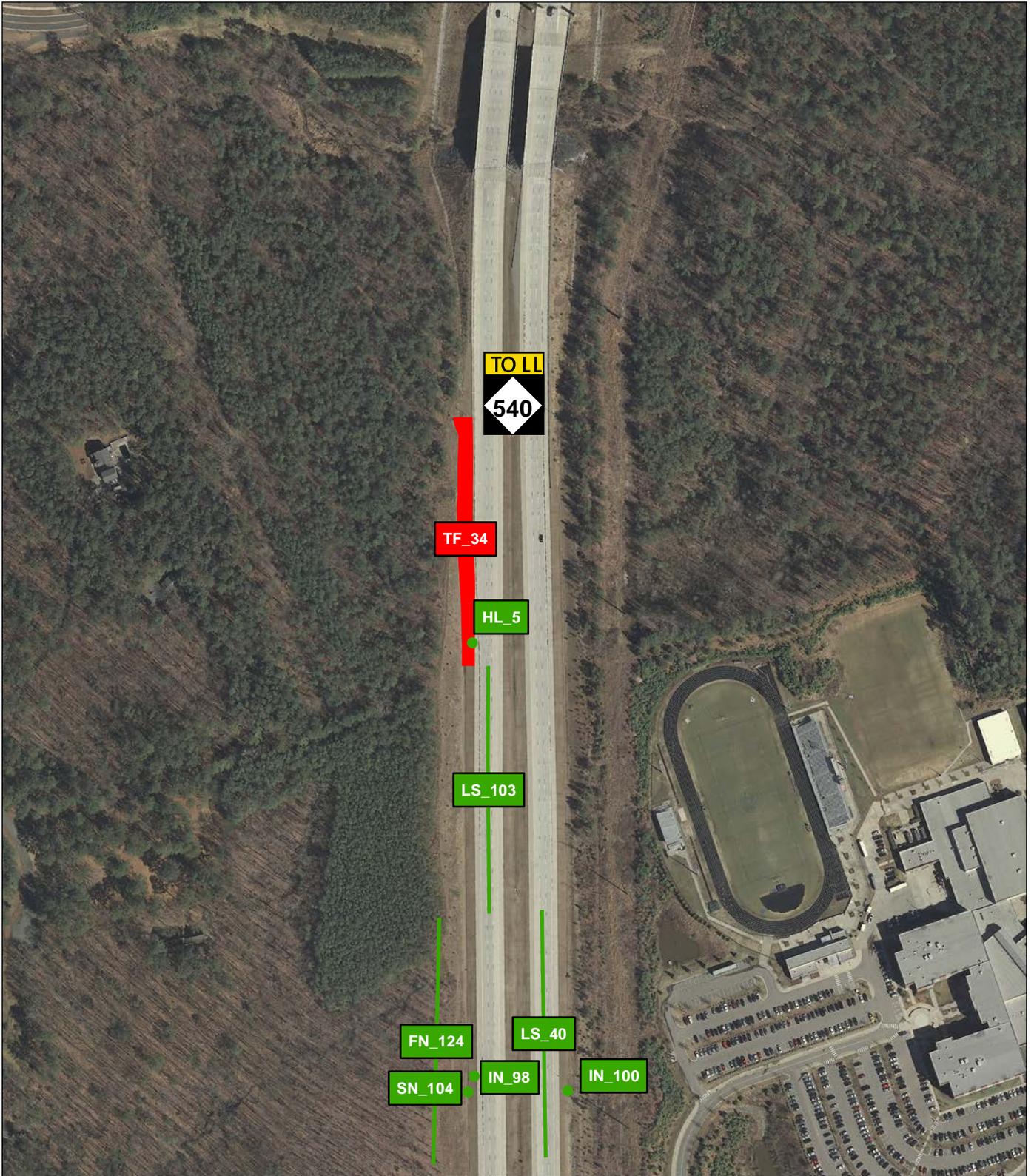


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-  Passing Asset
-  Failing Asset

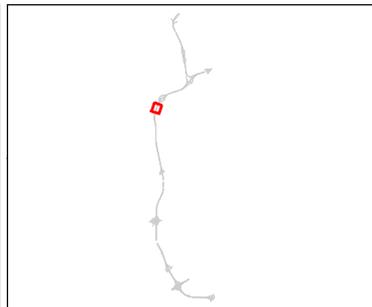


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

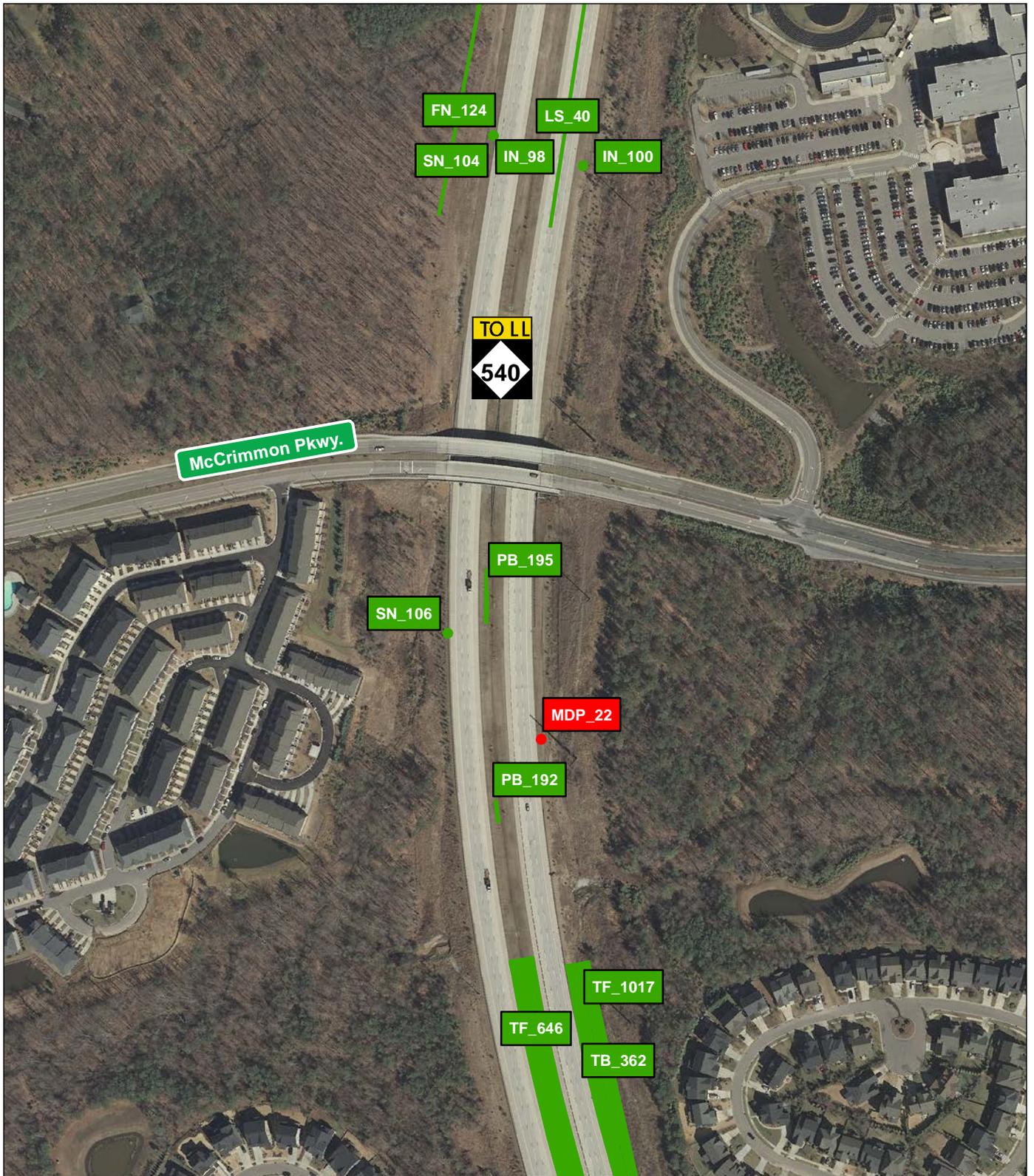


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

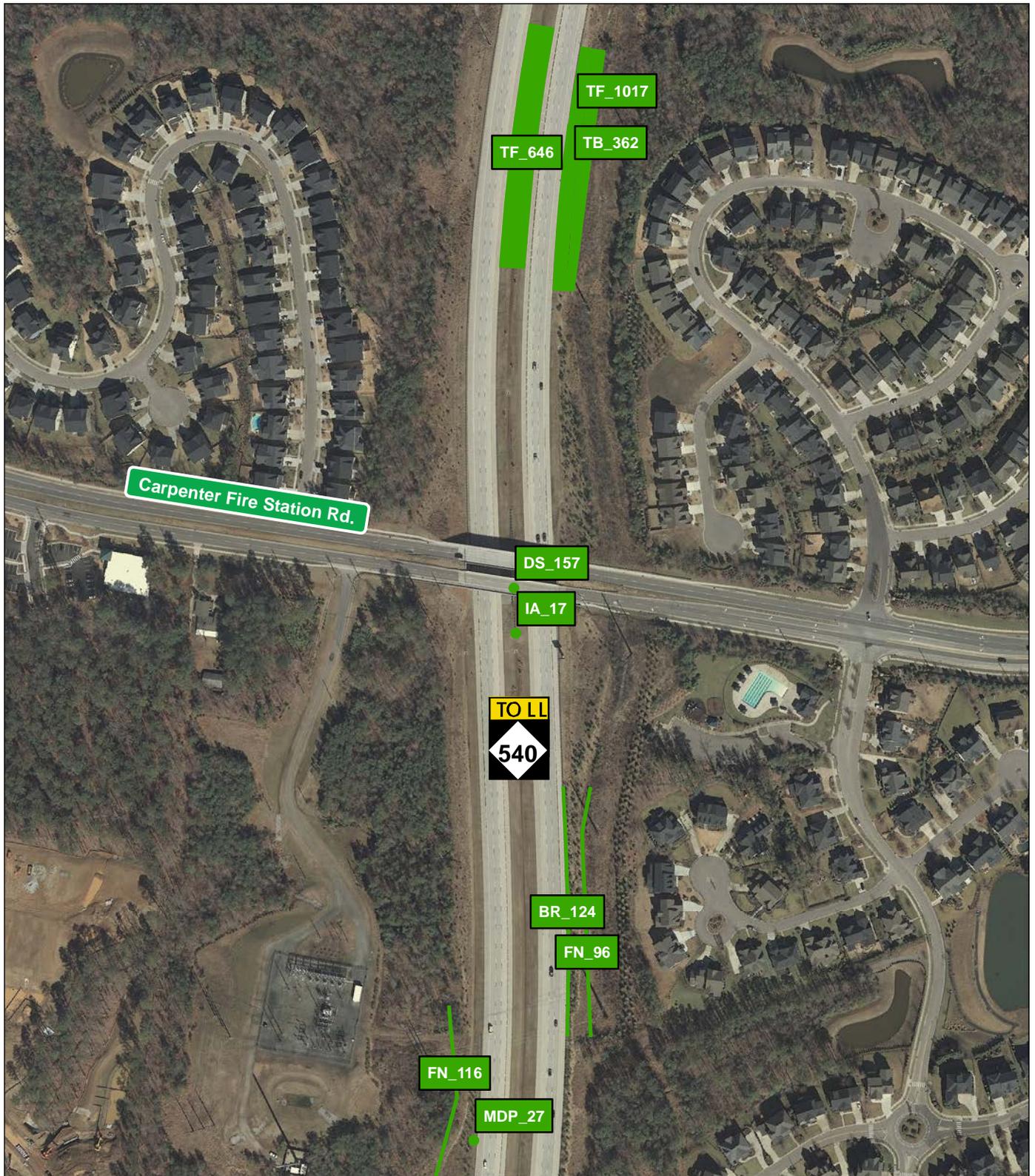


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

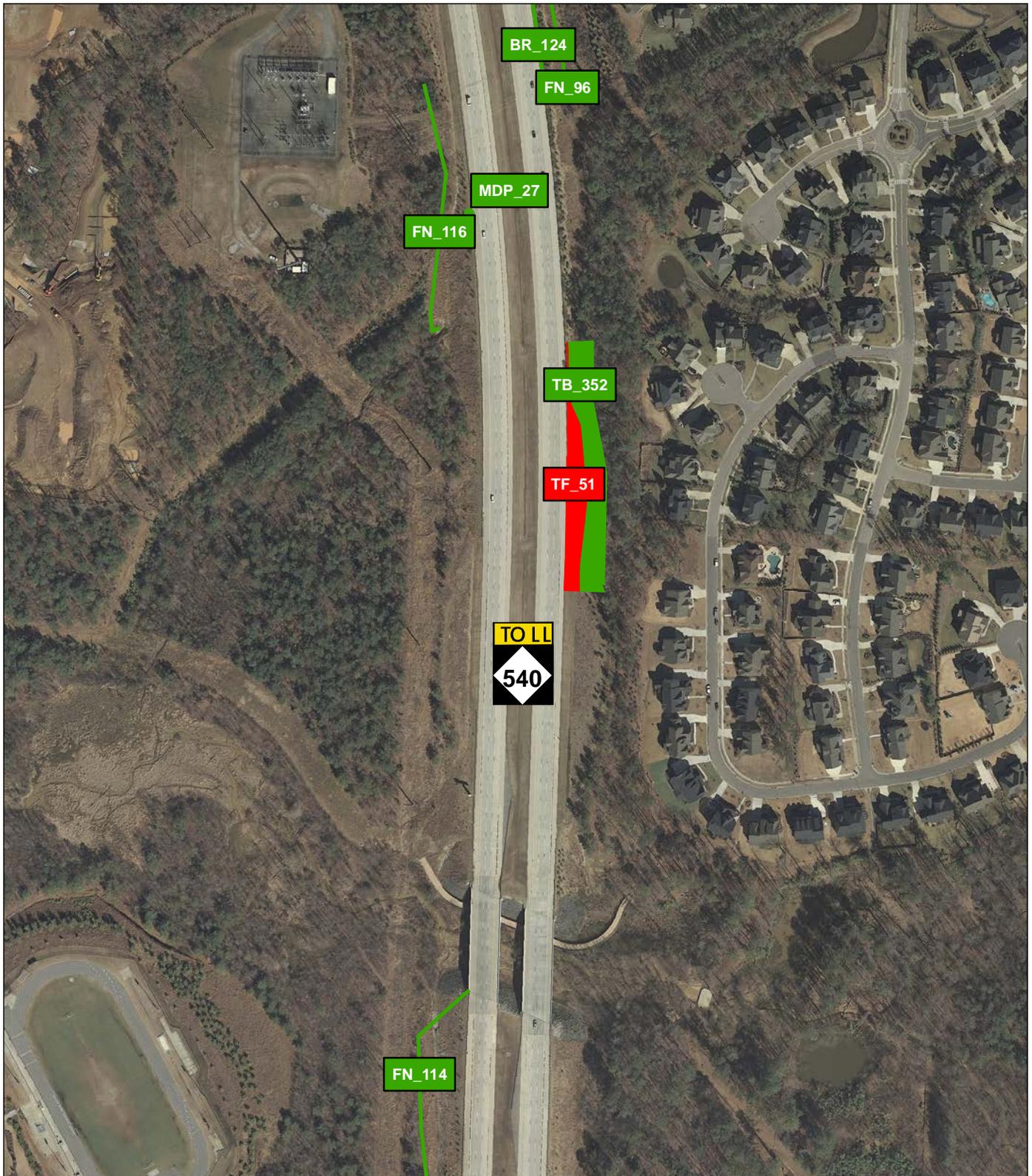


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

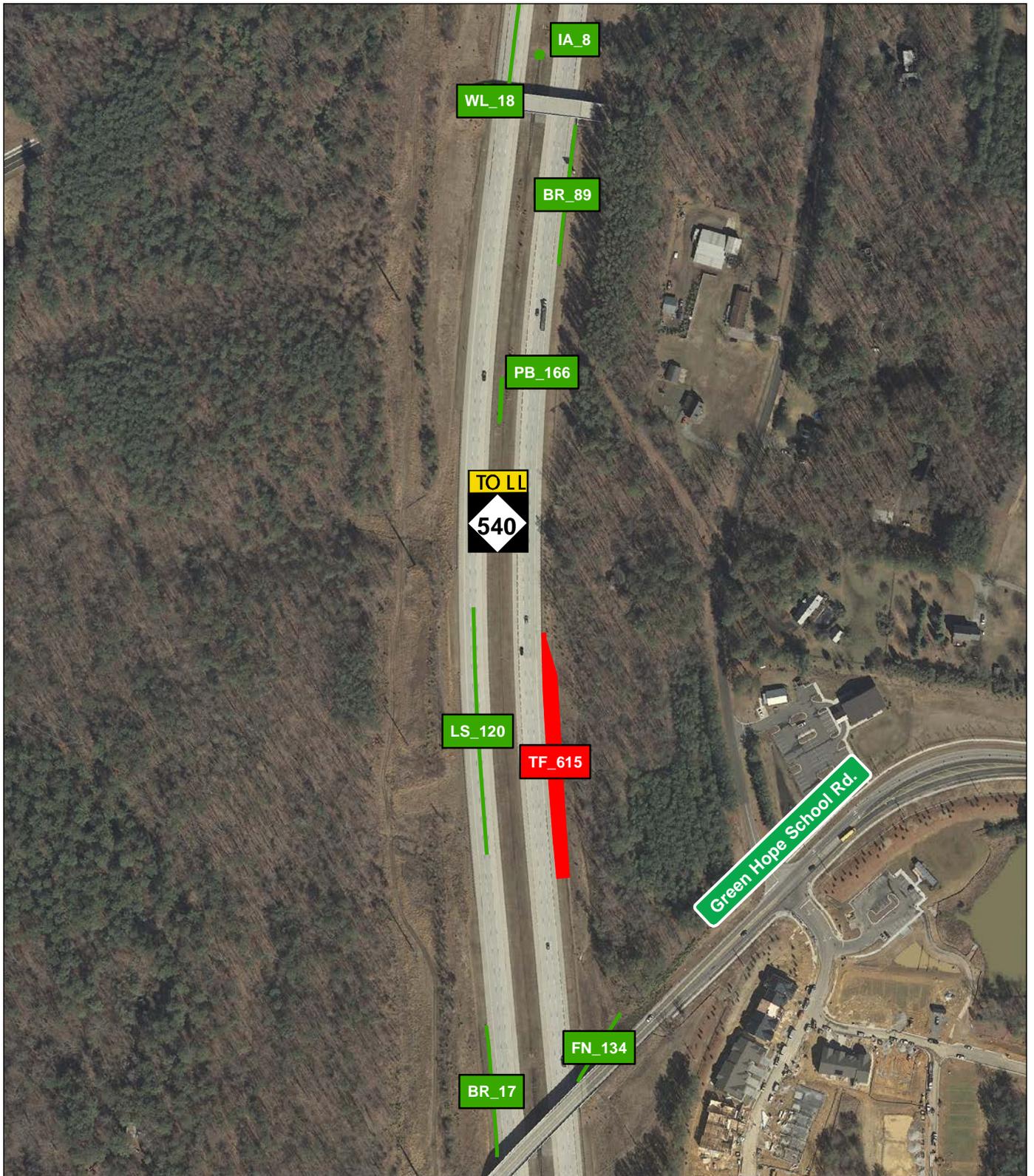


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

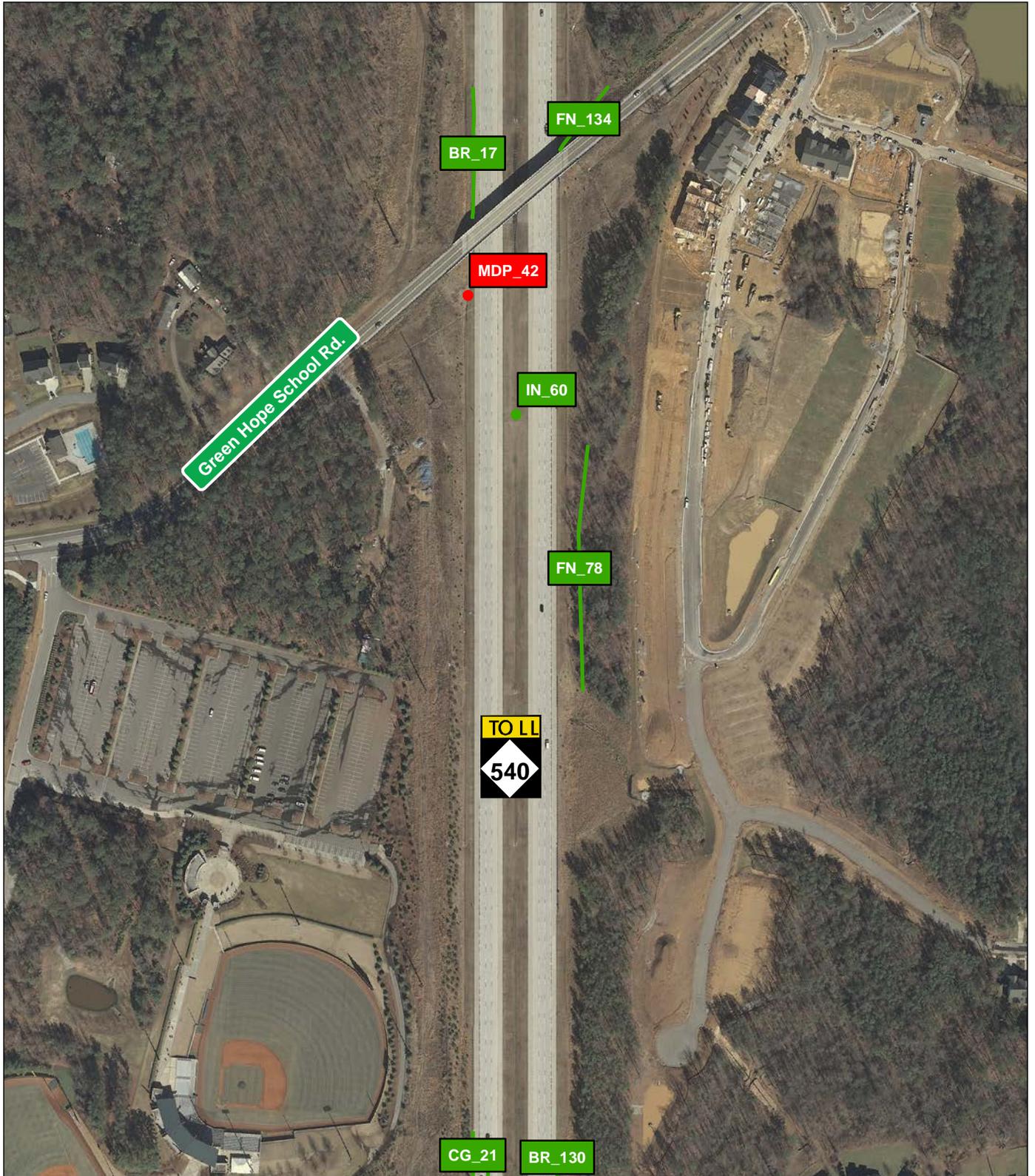


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

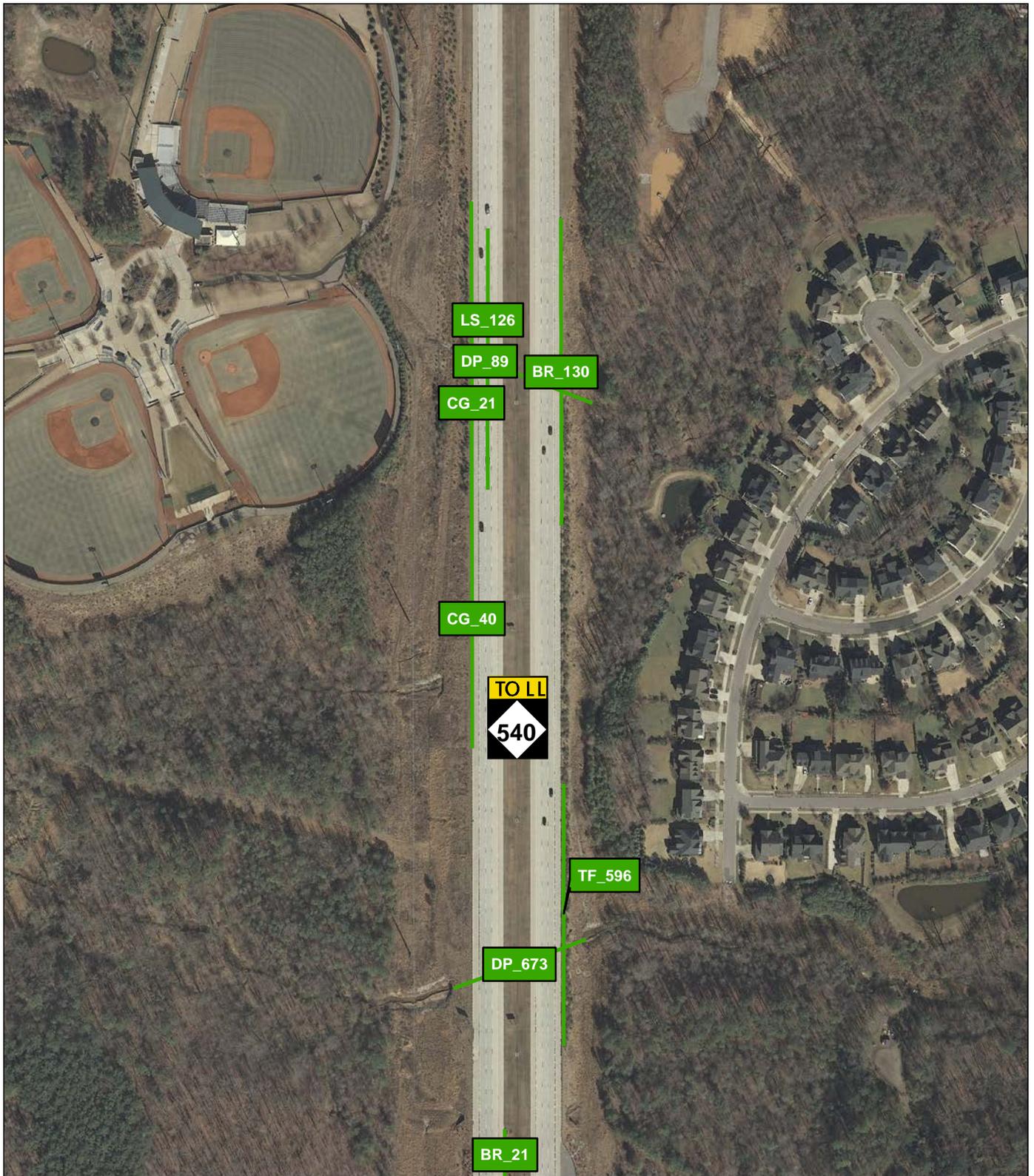


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

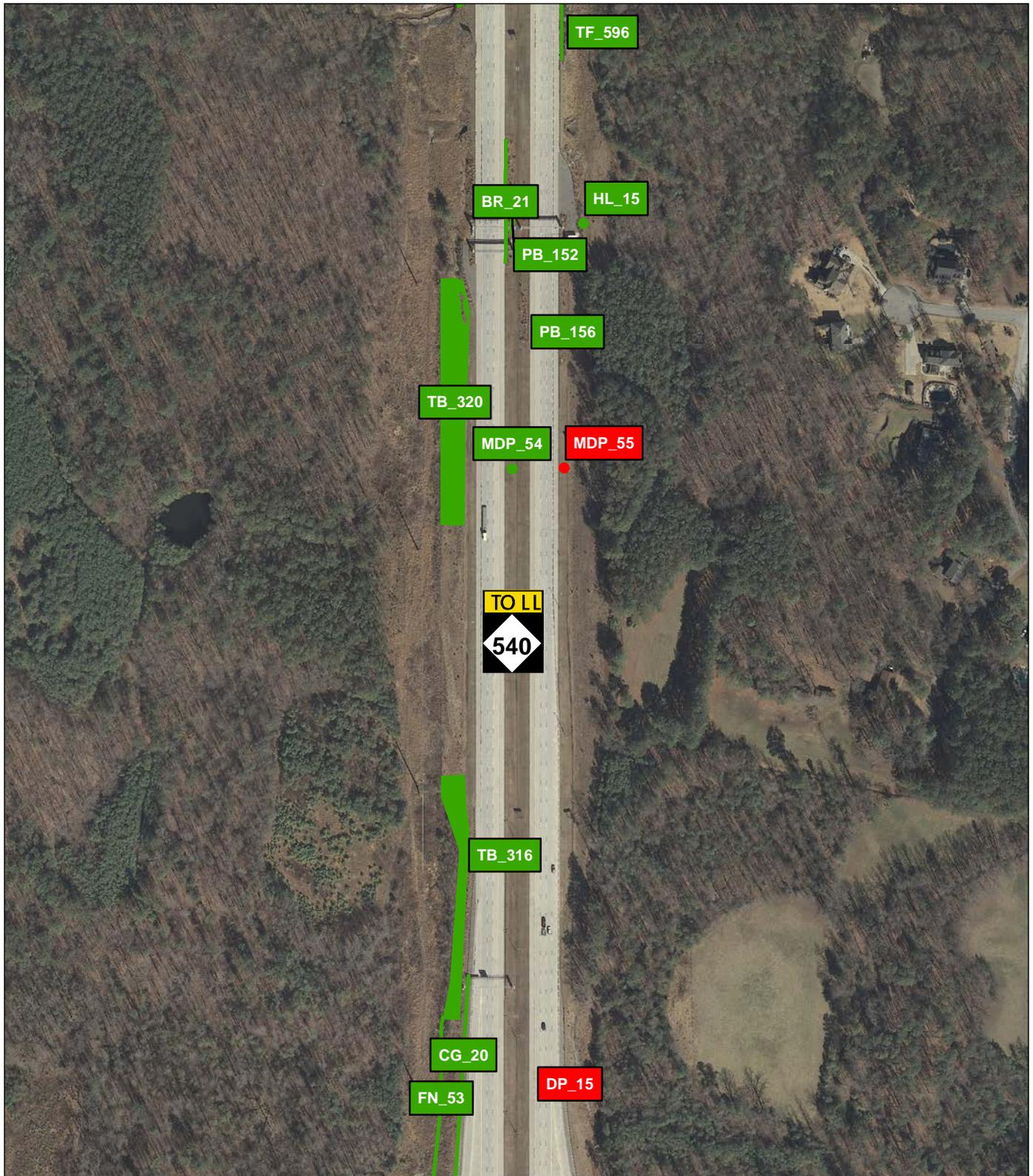


Legend

-  Passing Asset
-  Failing Asset

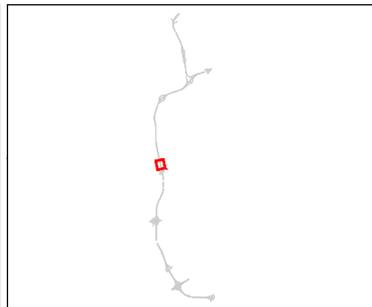


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

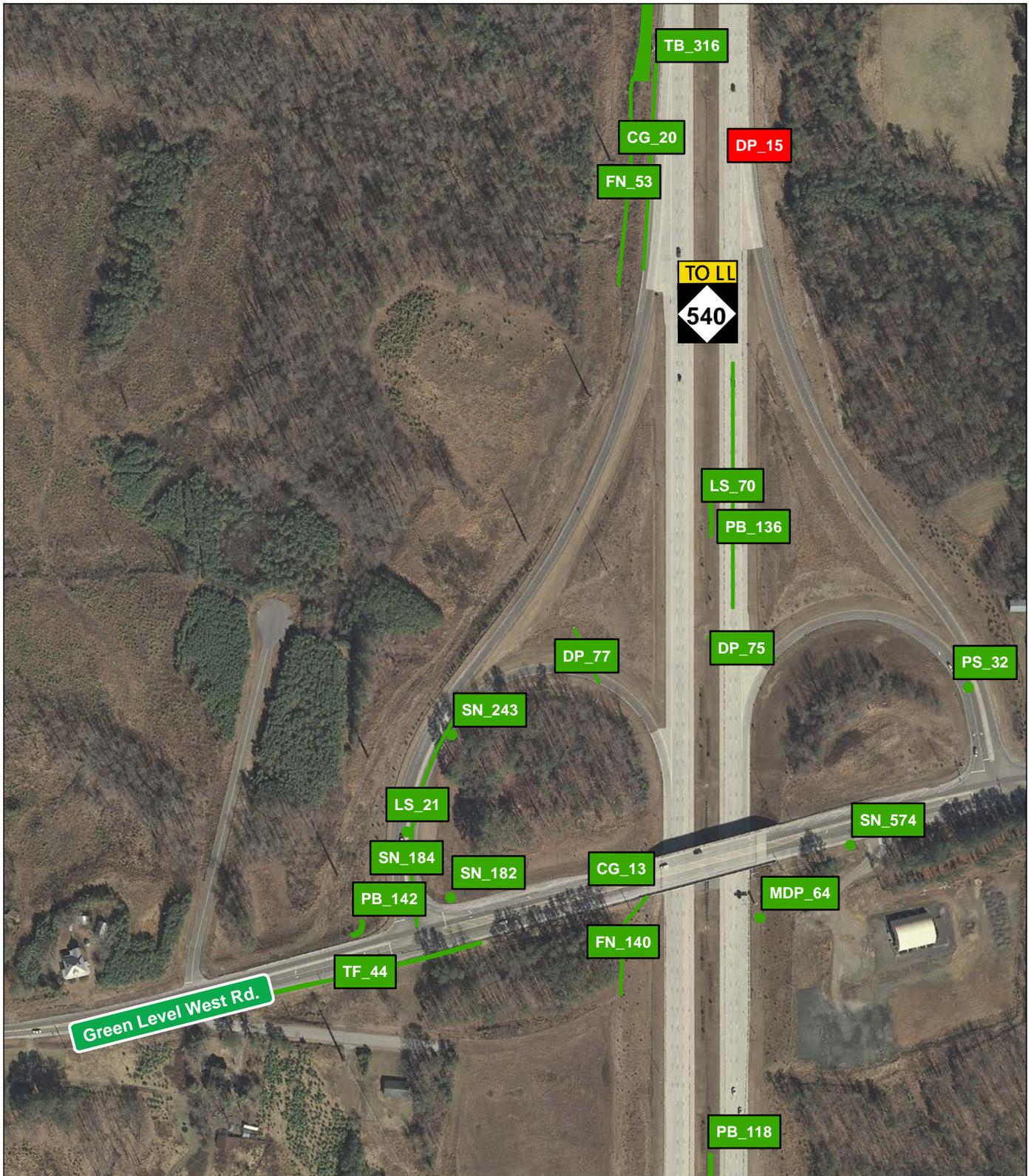


Legend

-  Passing Asset
-  Failing Asset

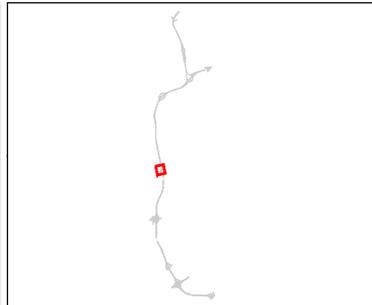


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

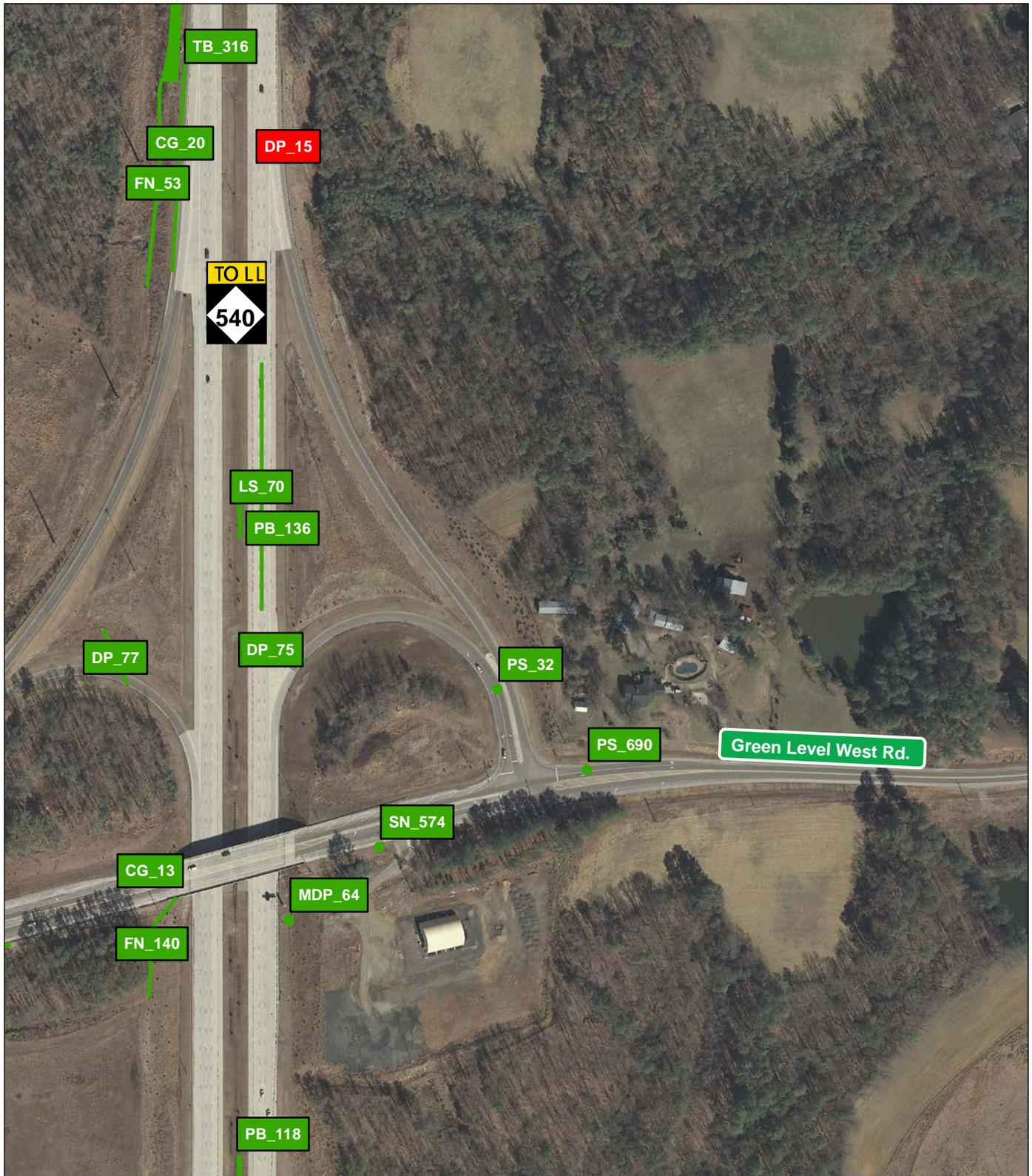


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

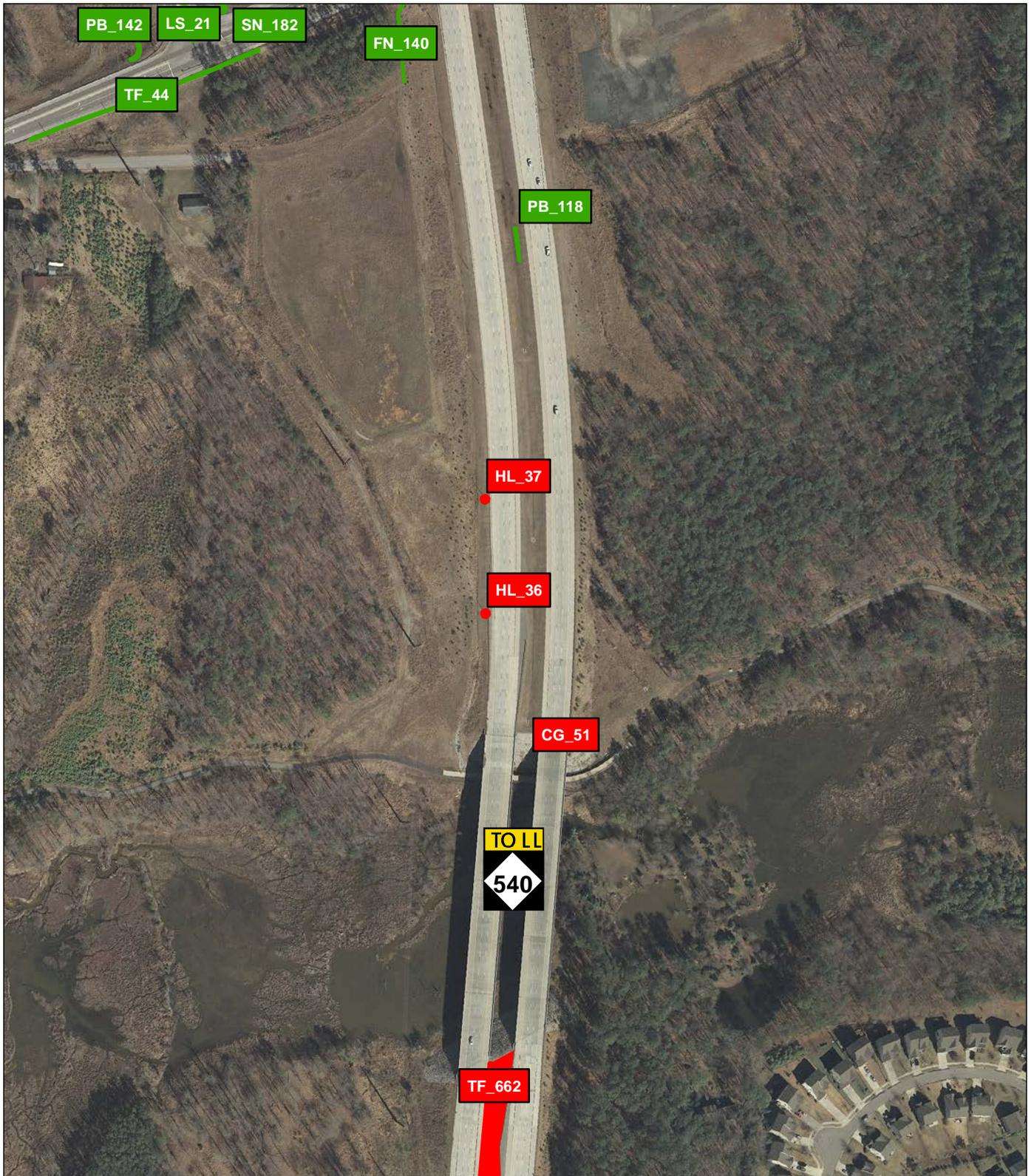


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

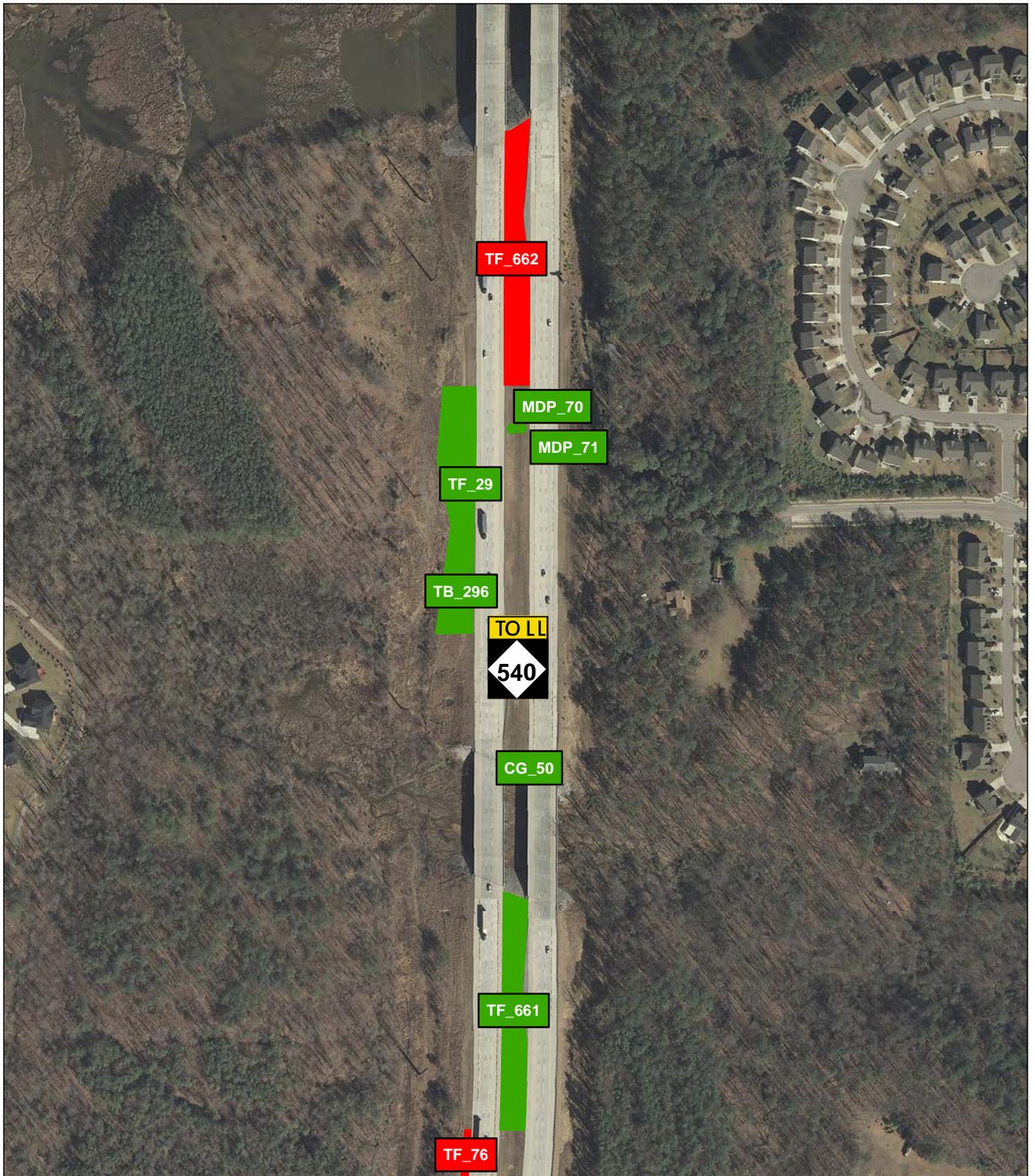


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

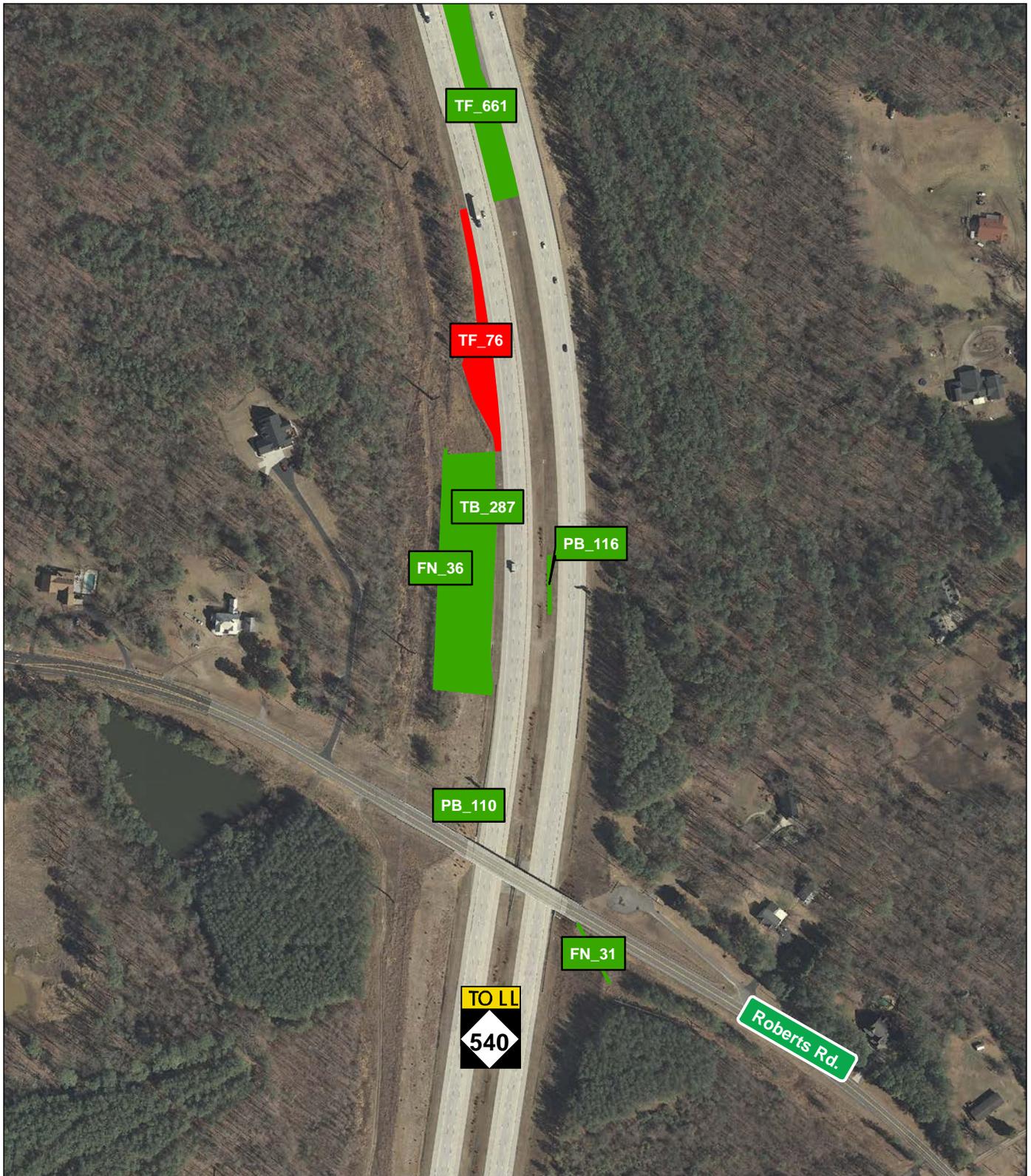


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

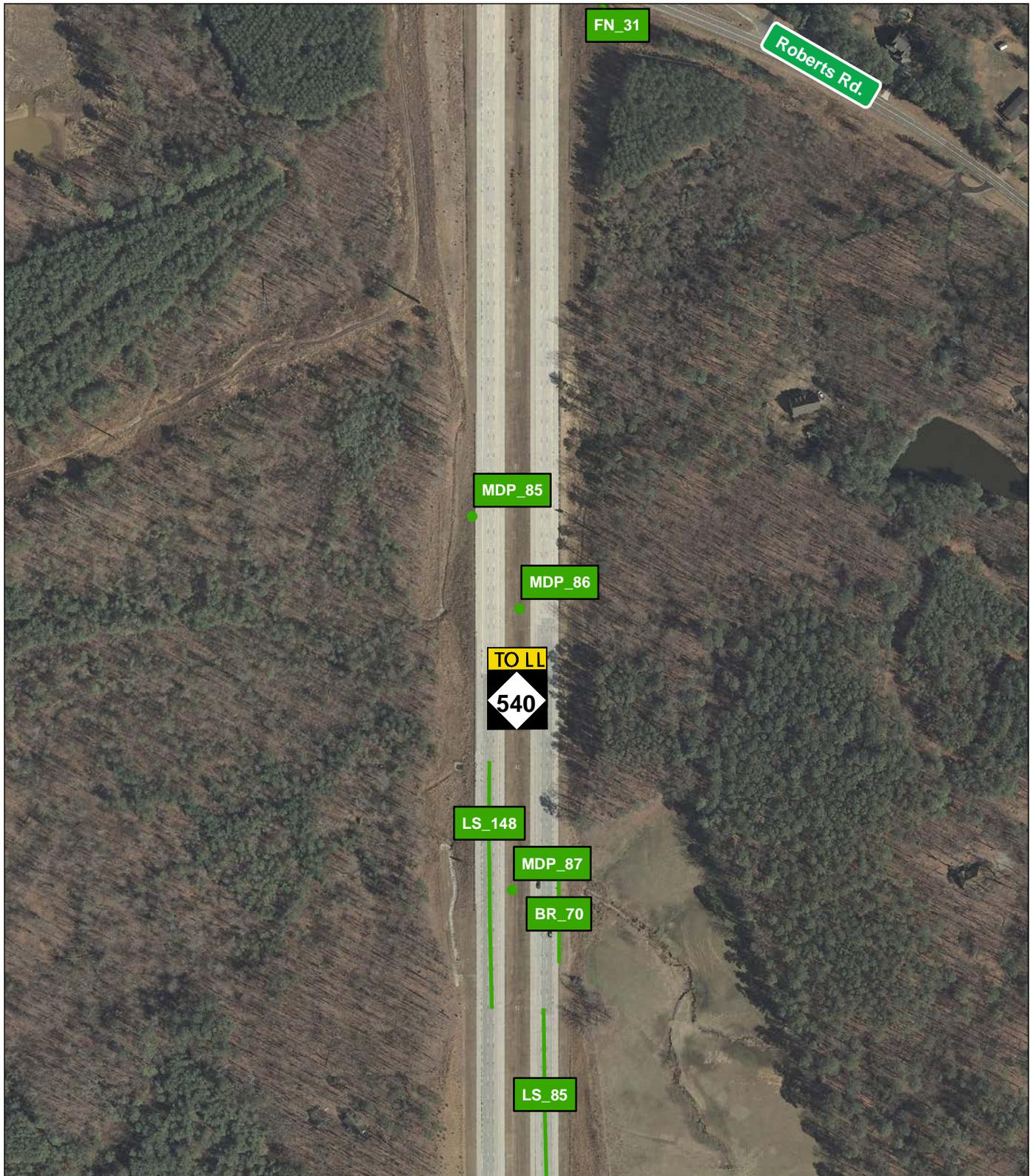


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

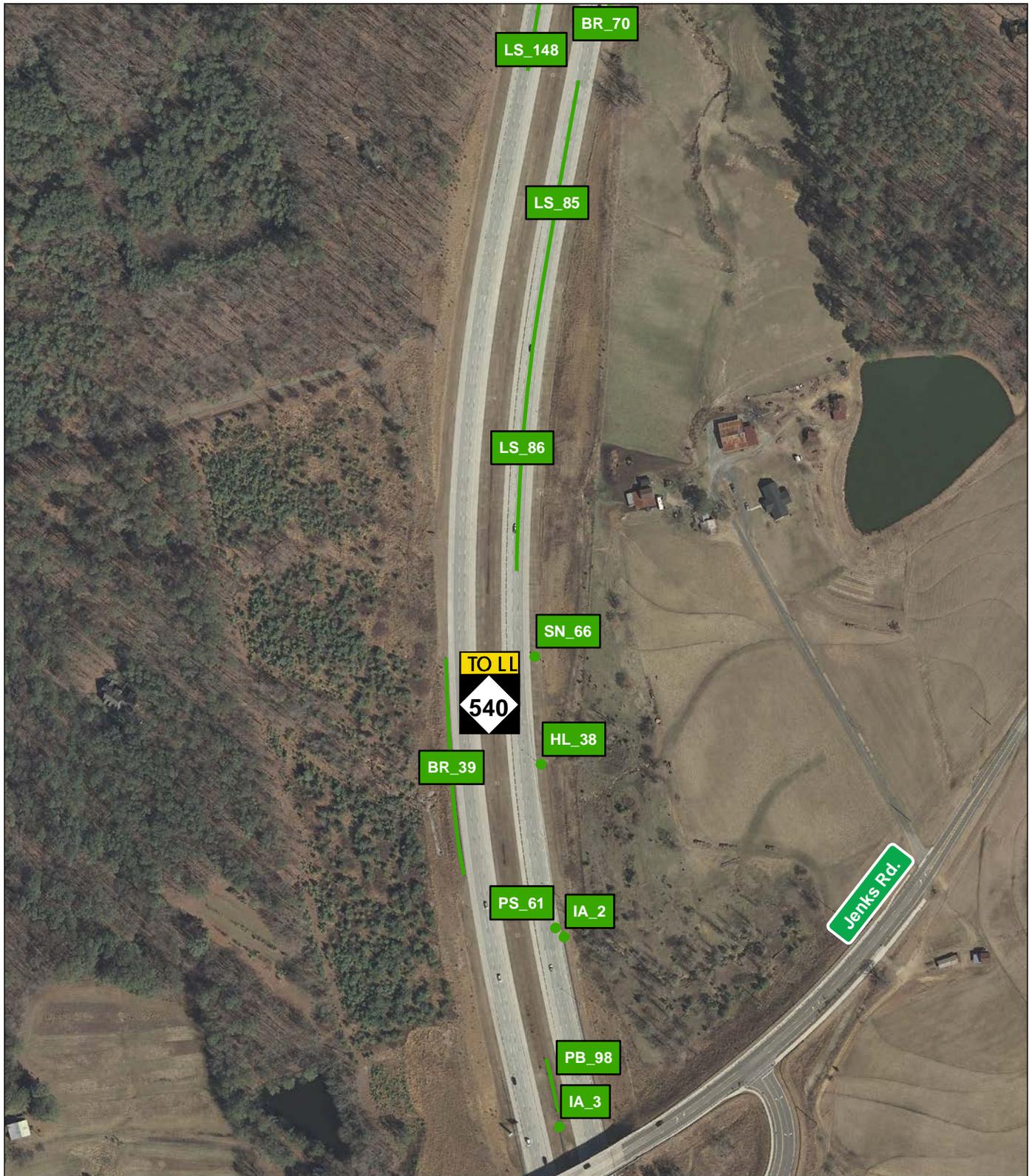


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

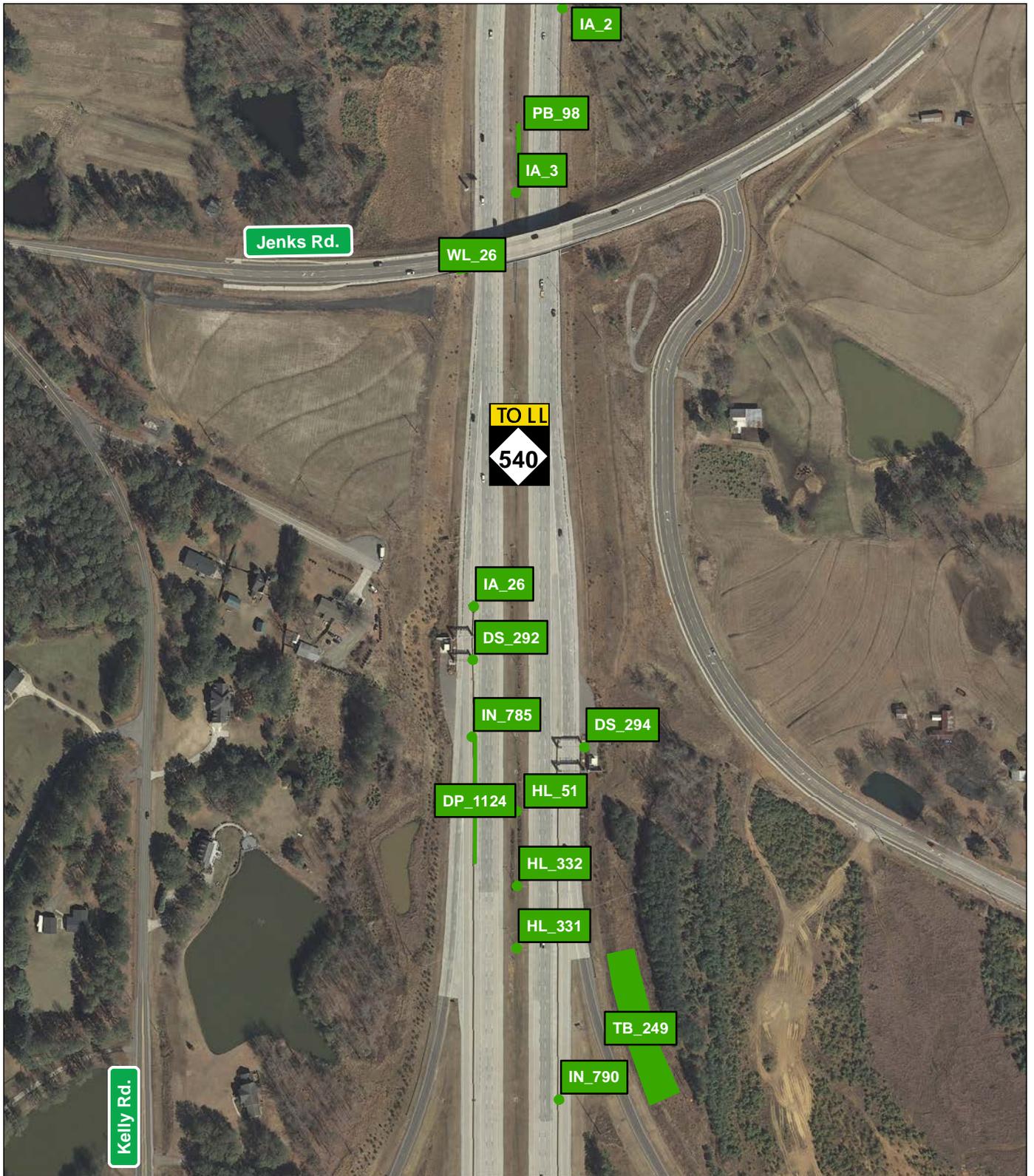


Legend

-  Passing Asset
-  Failing Asset

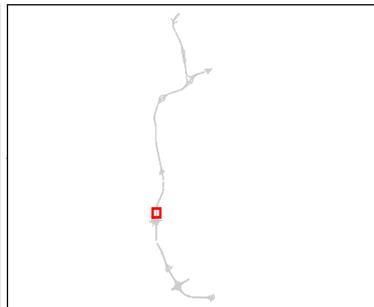


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

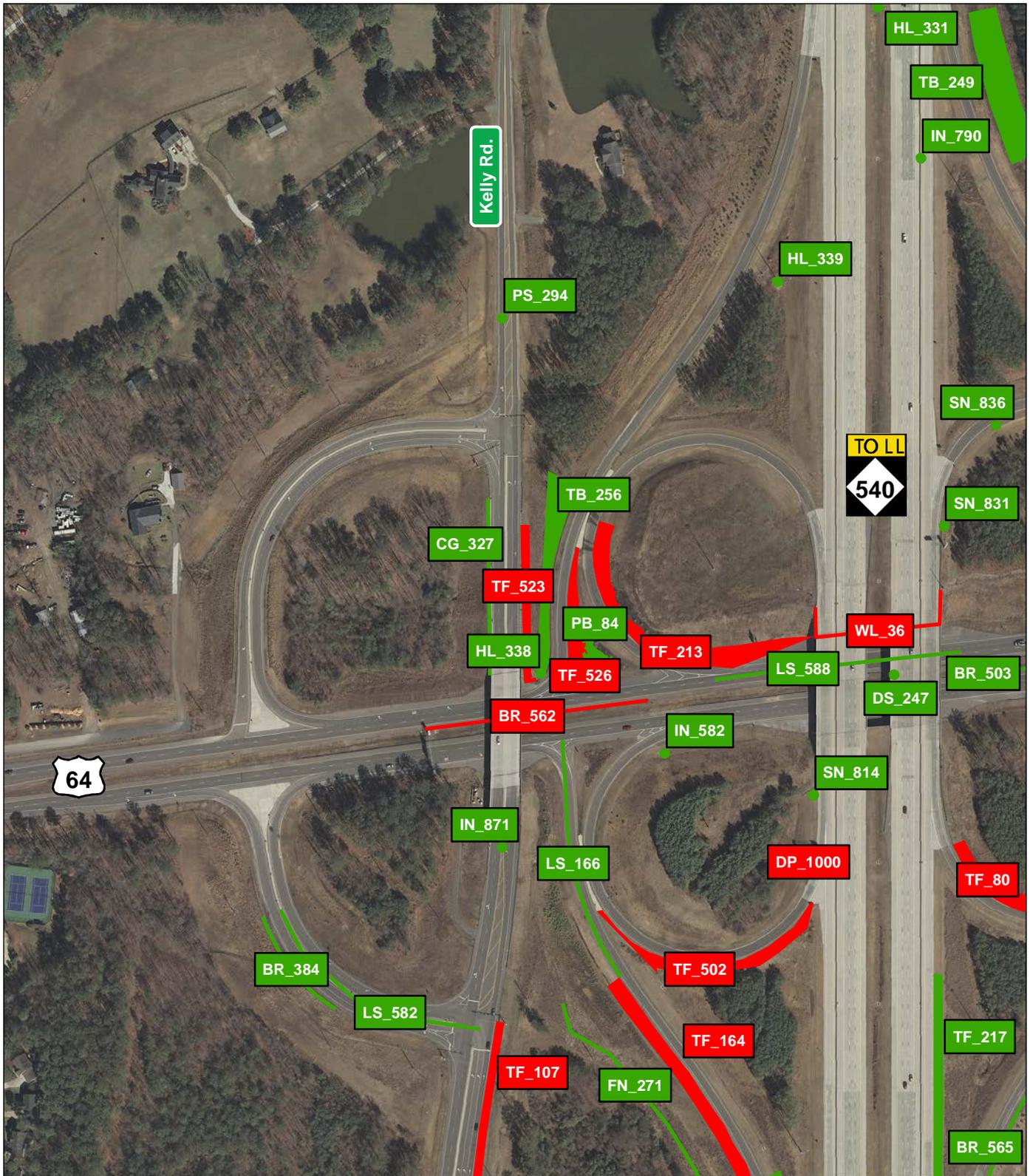


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

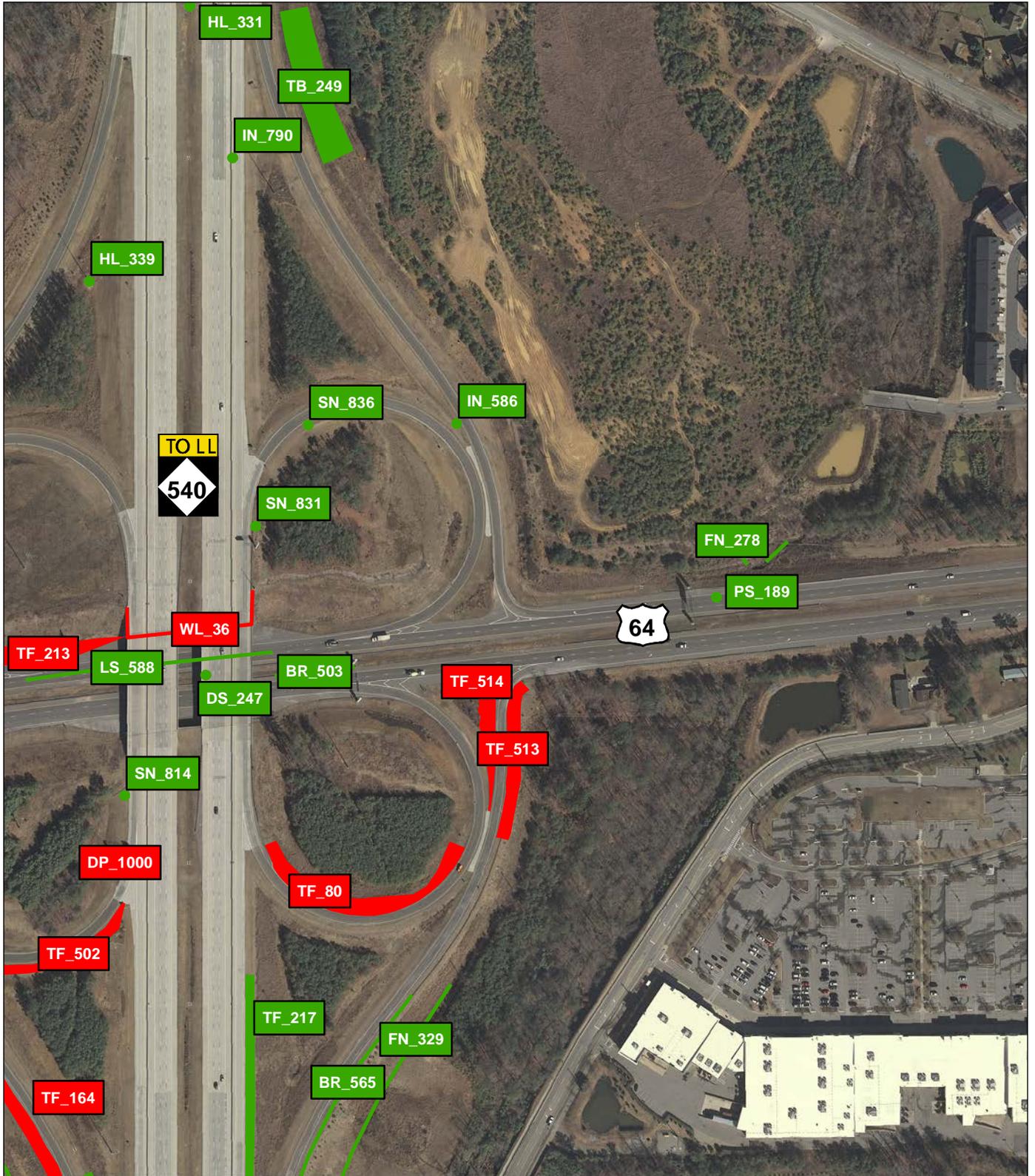


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

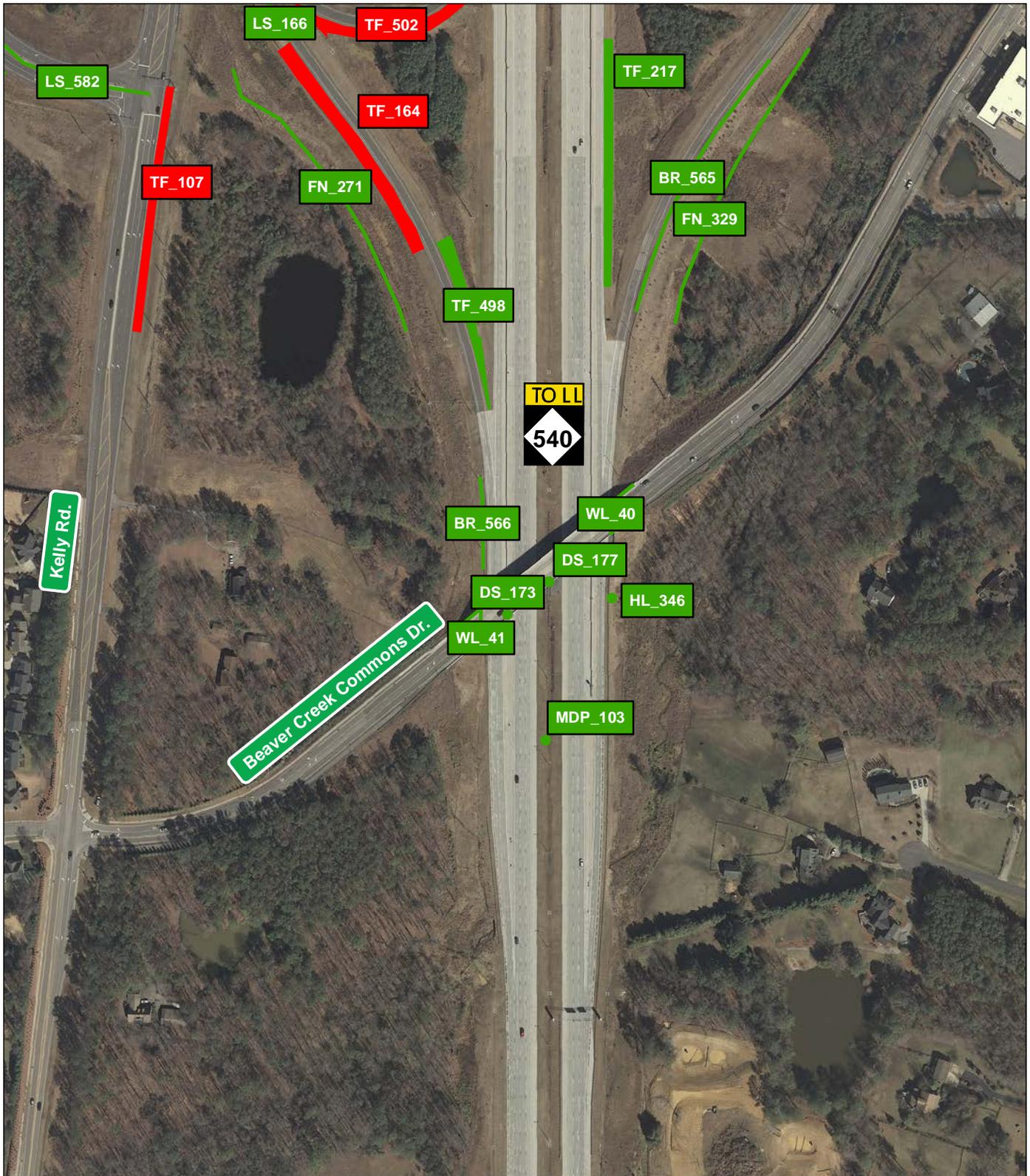


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

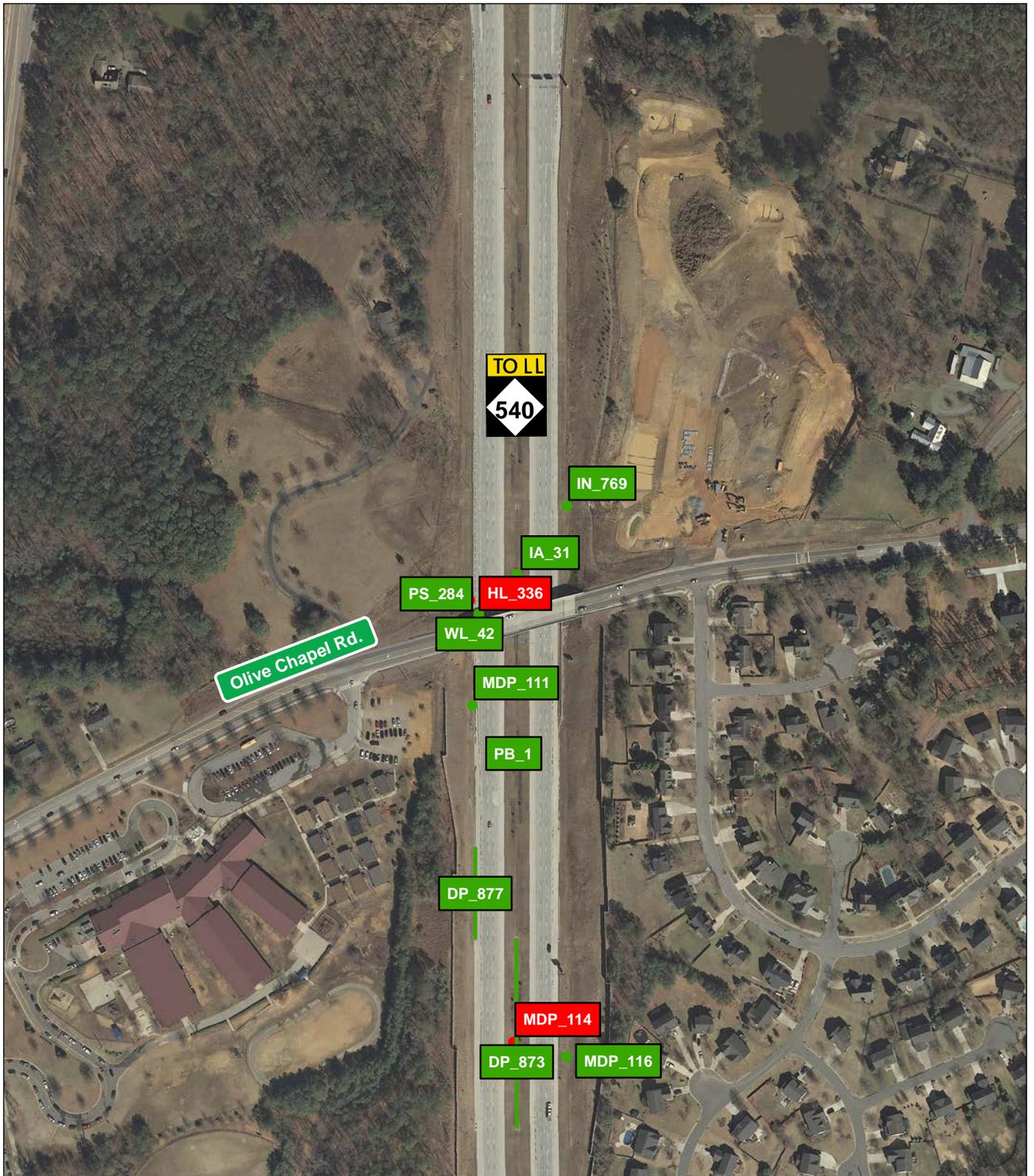


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

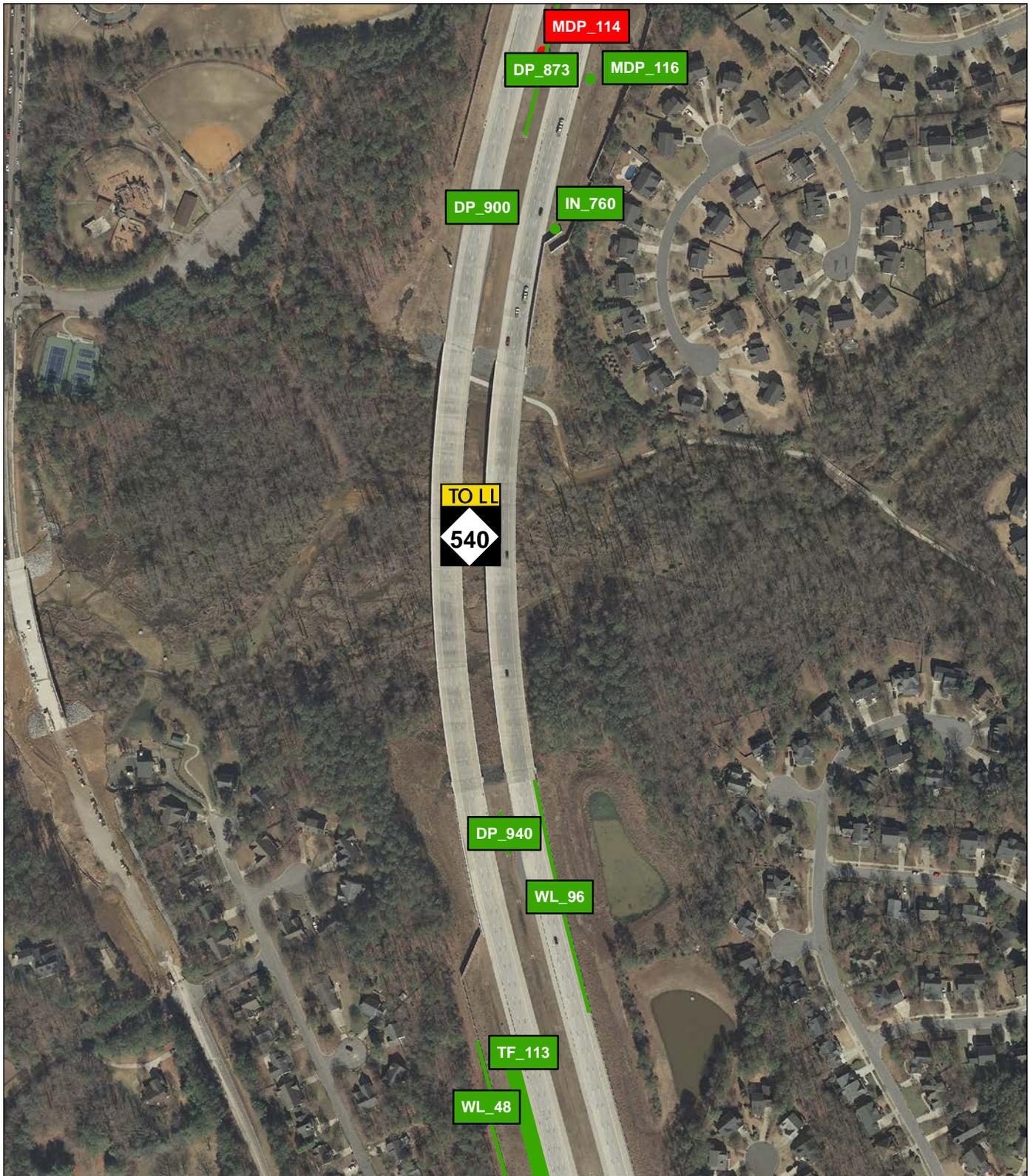


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

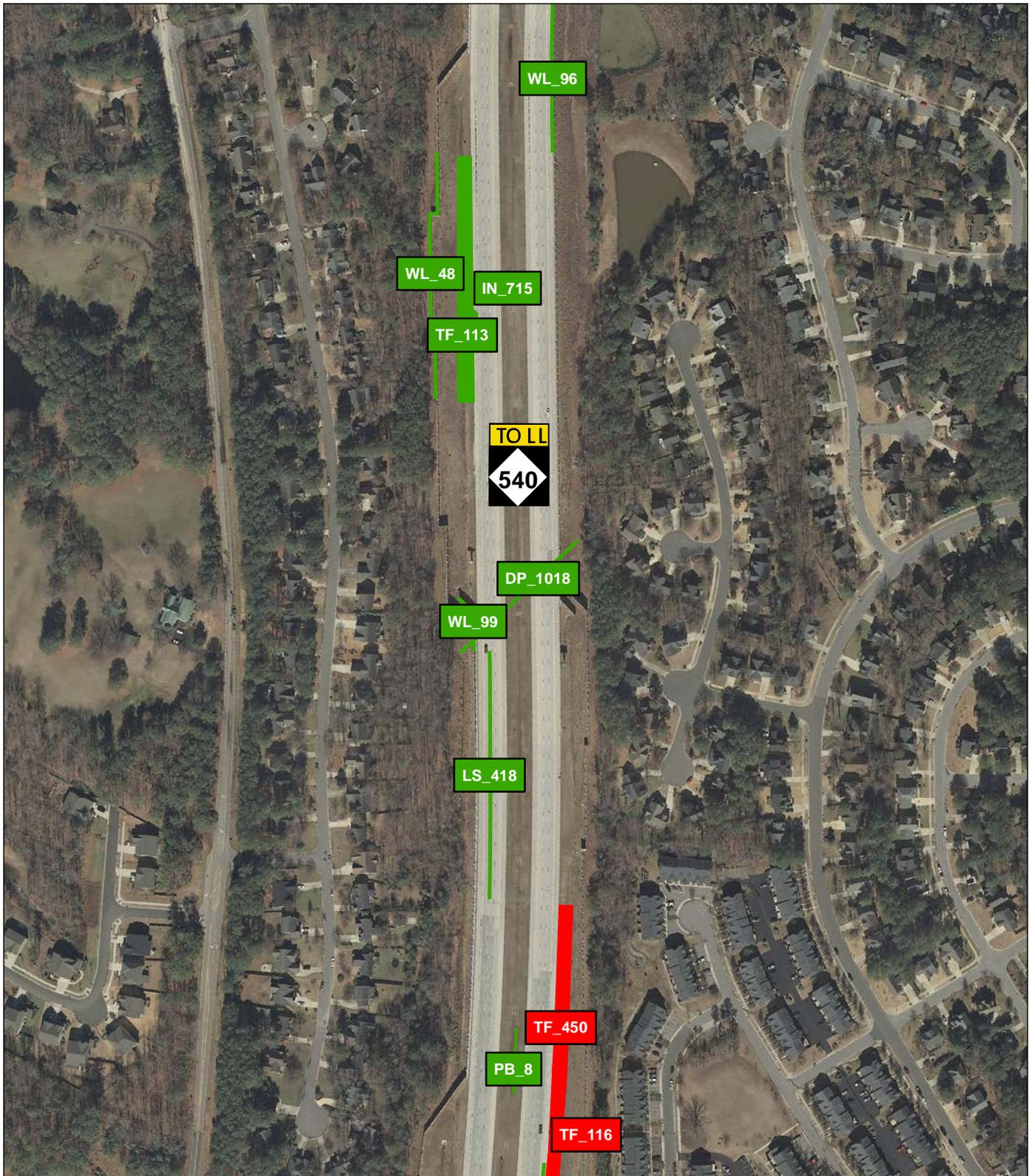


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

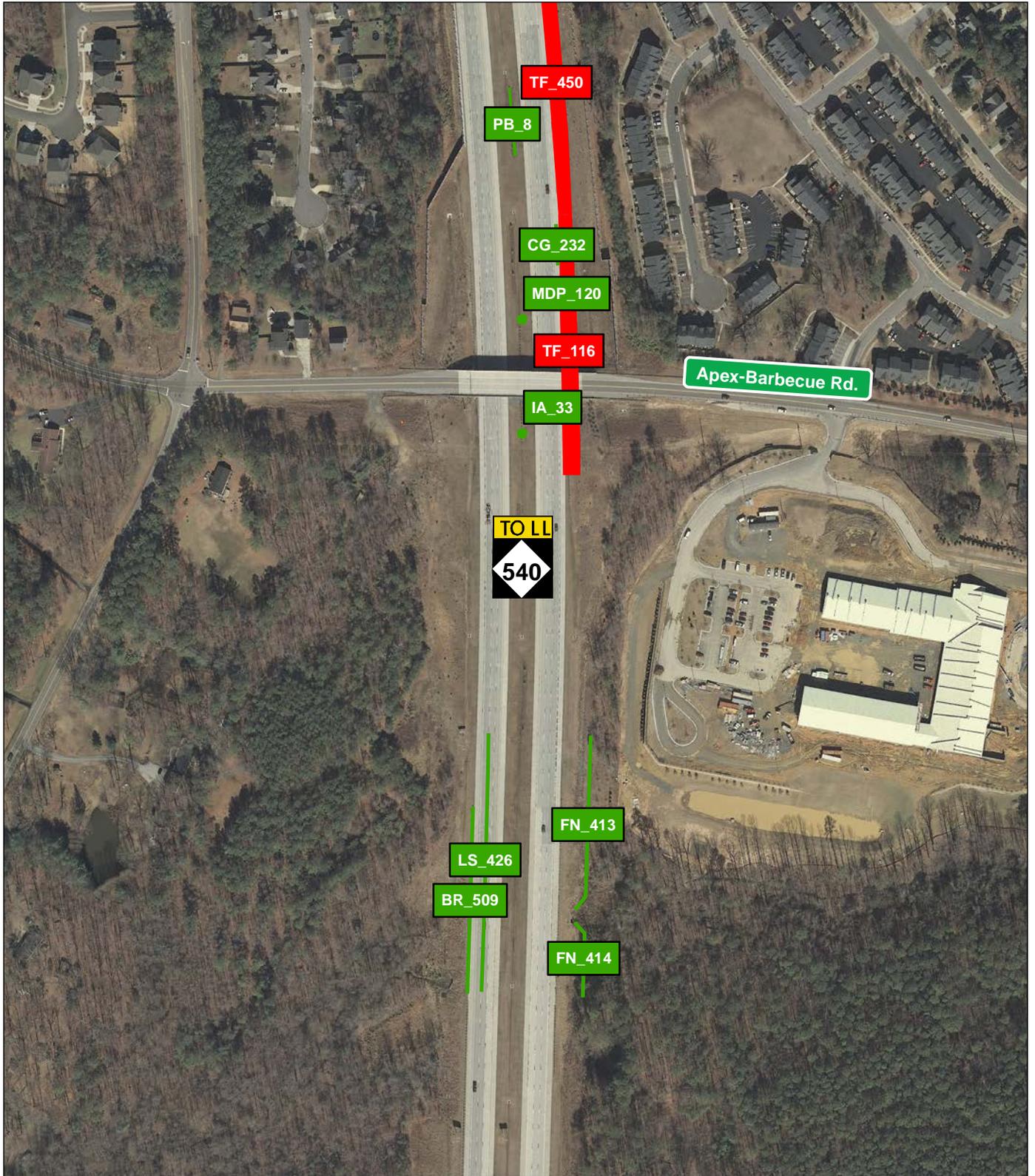


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

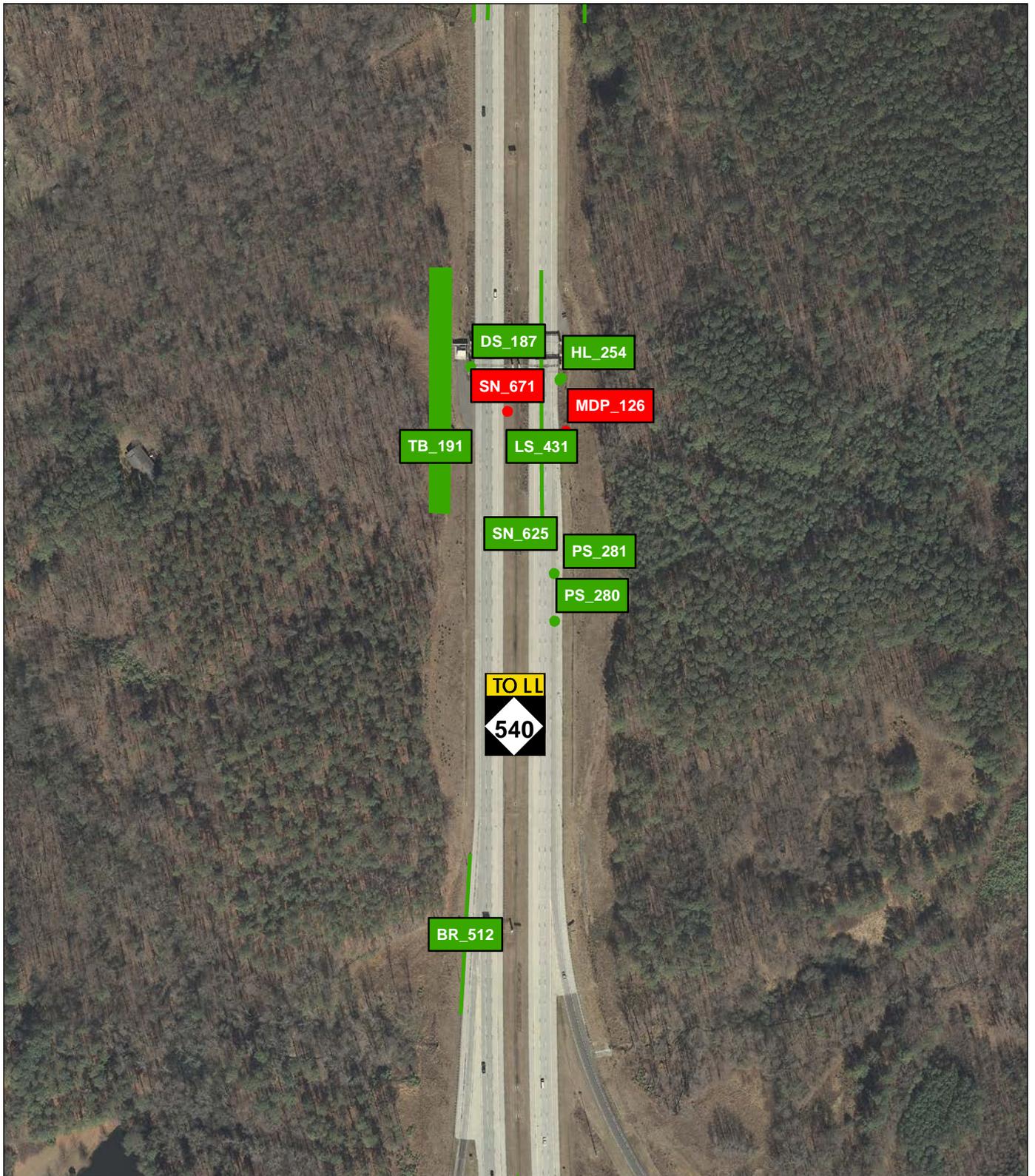


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

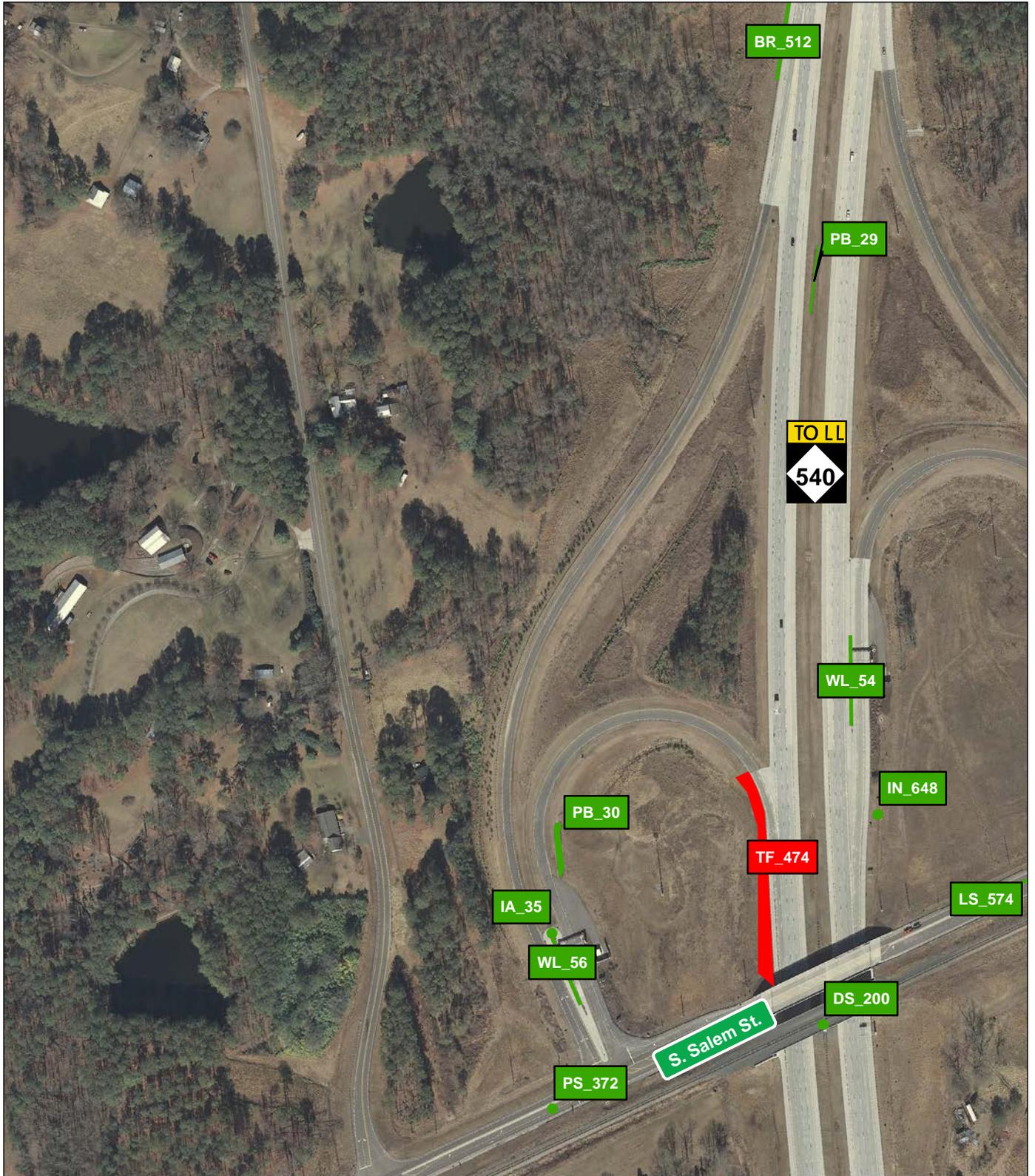


Legend

-  Passing Asset
-  Failing Asset

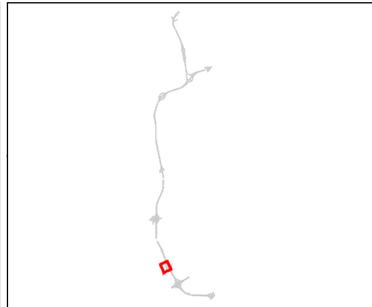


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

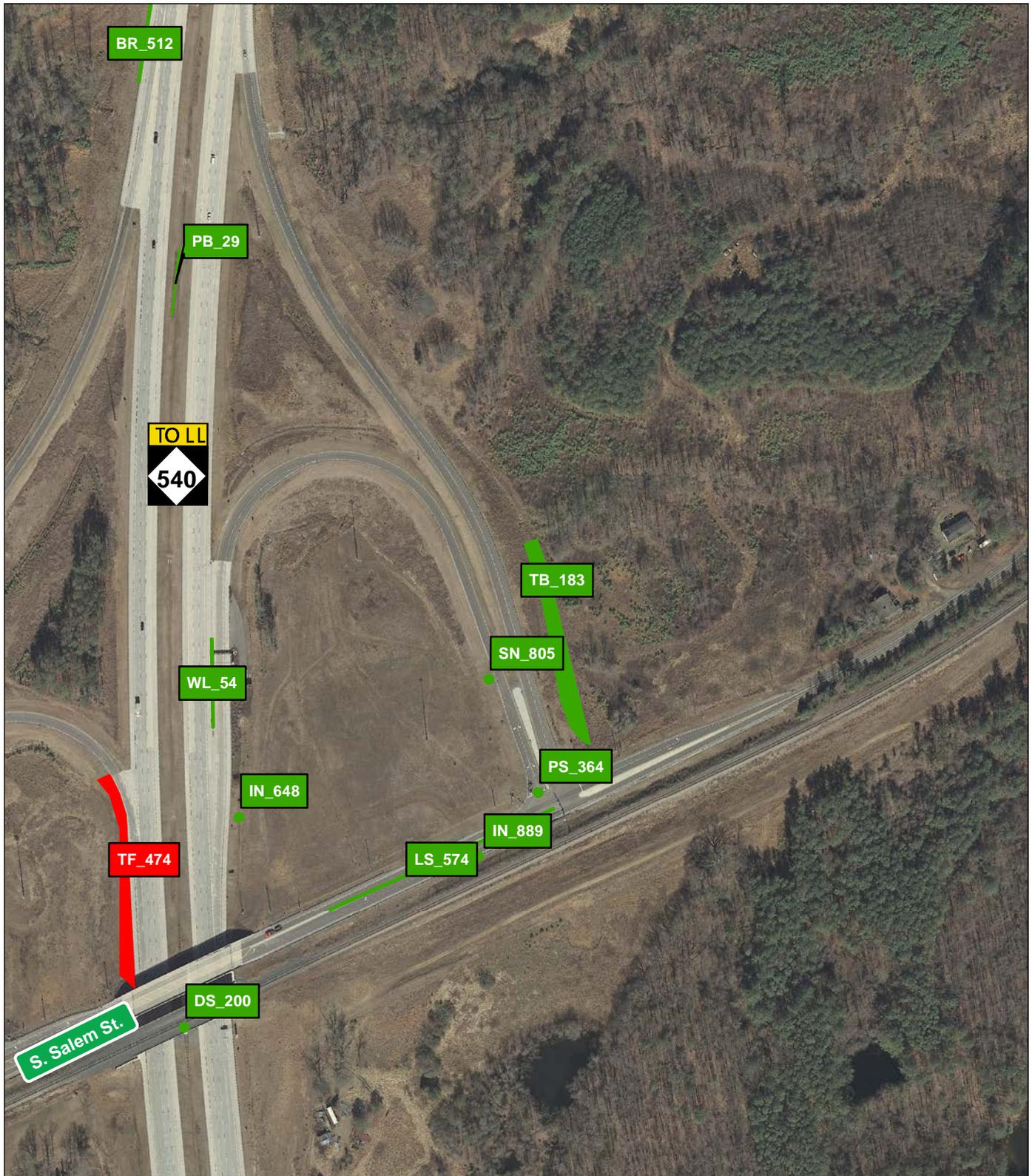


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

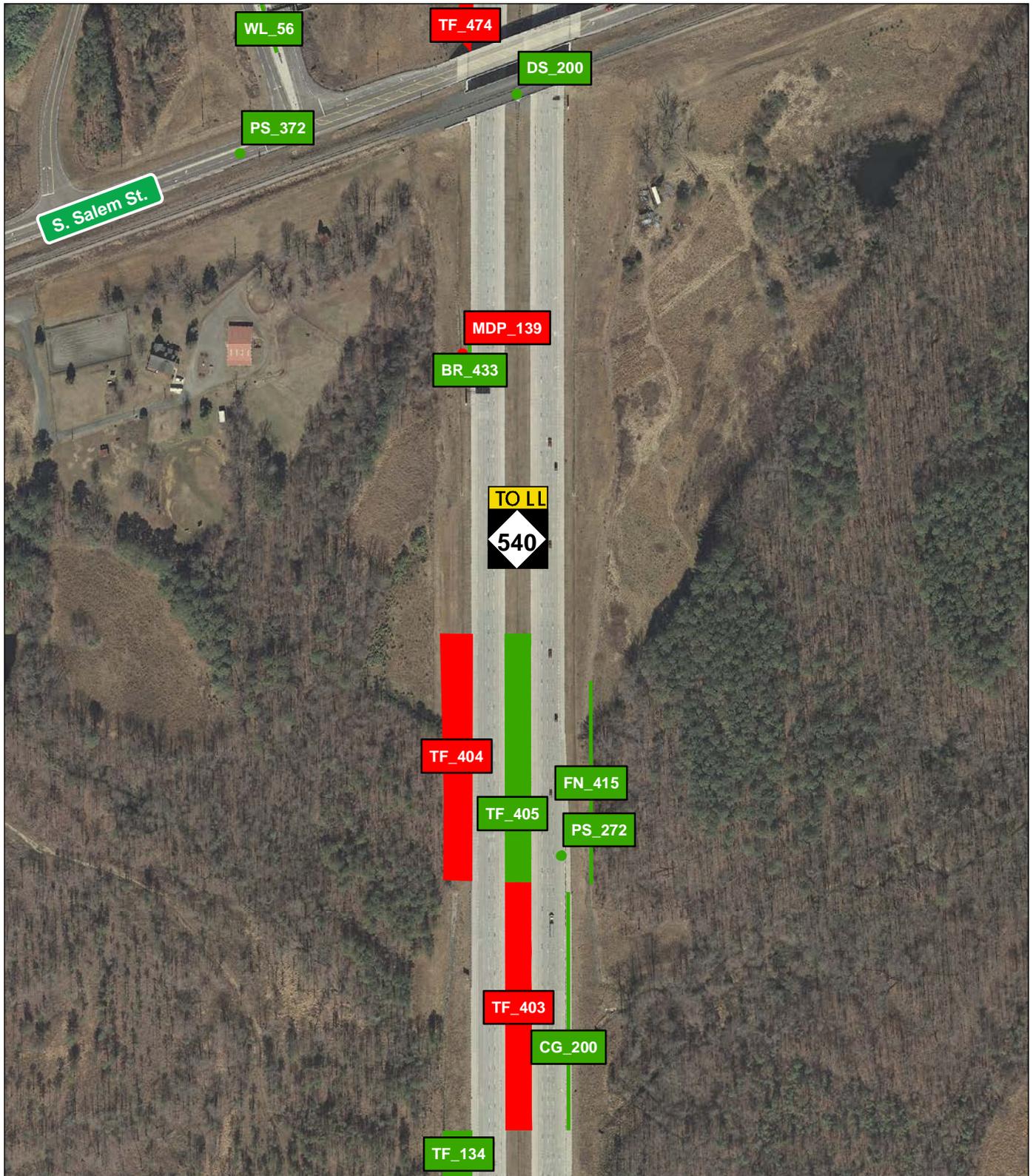


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

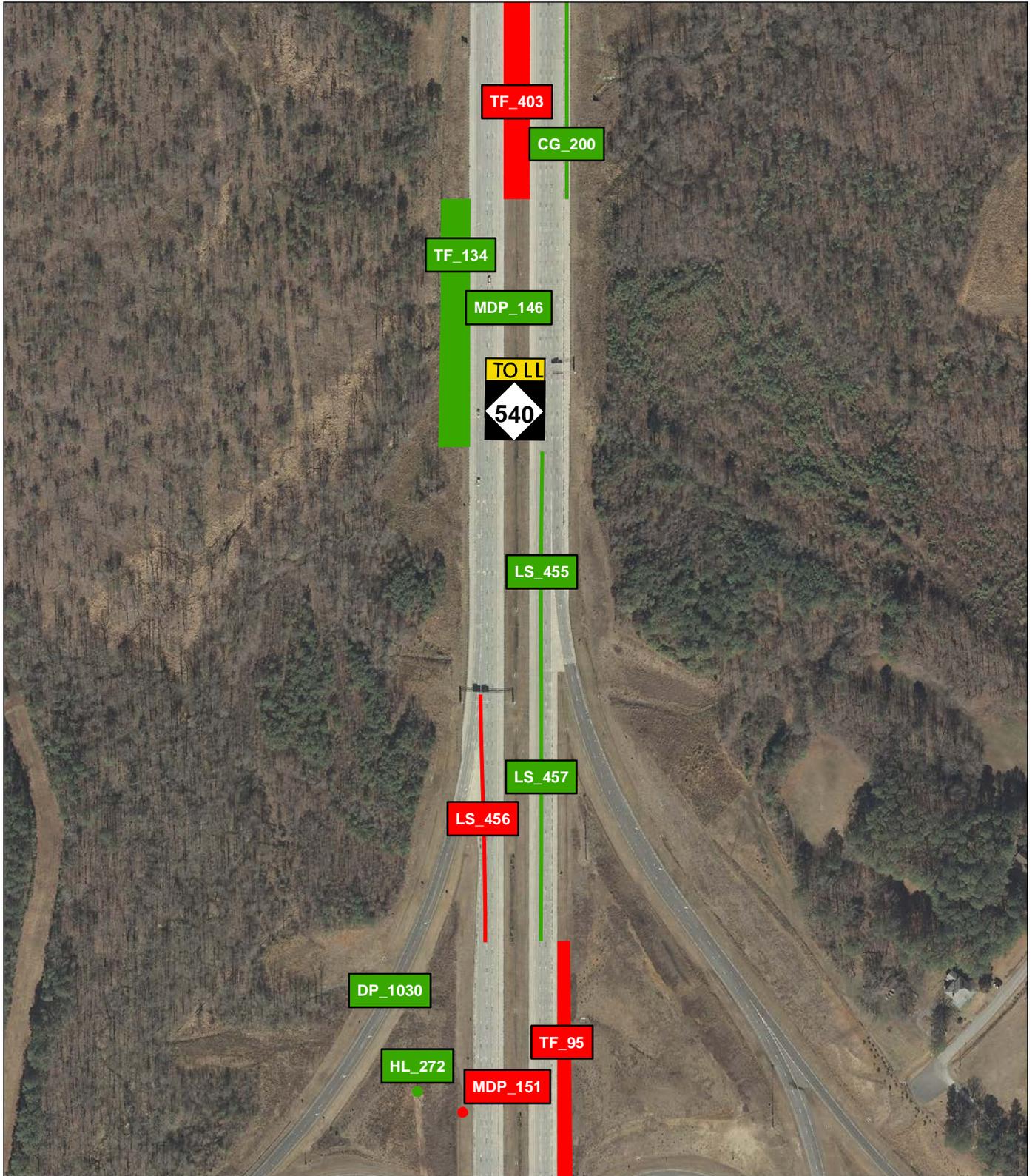


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

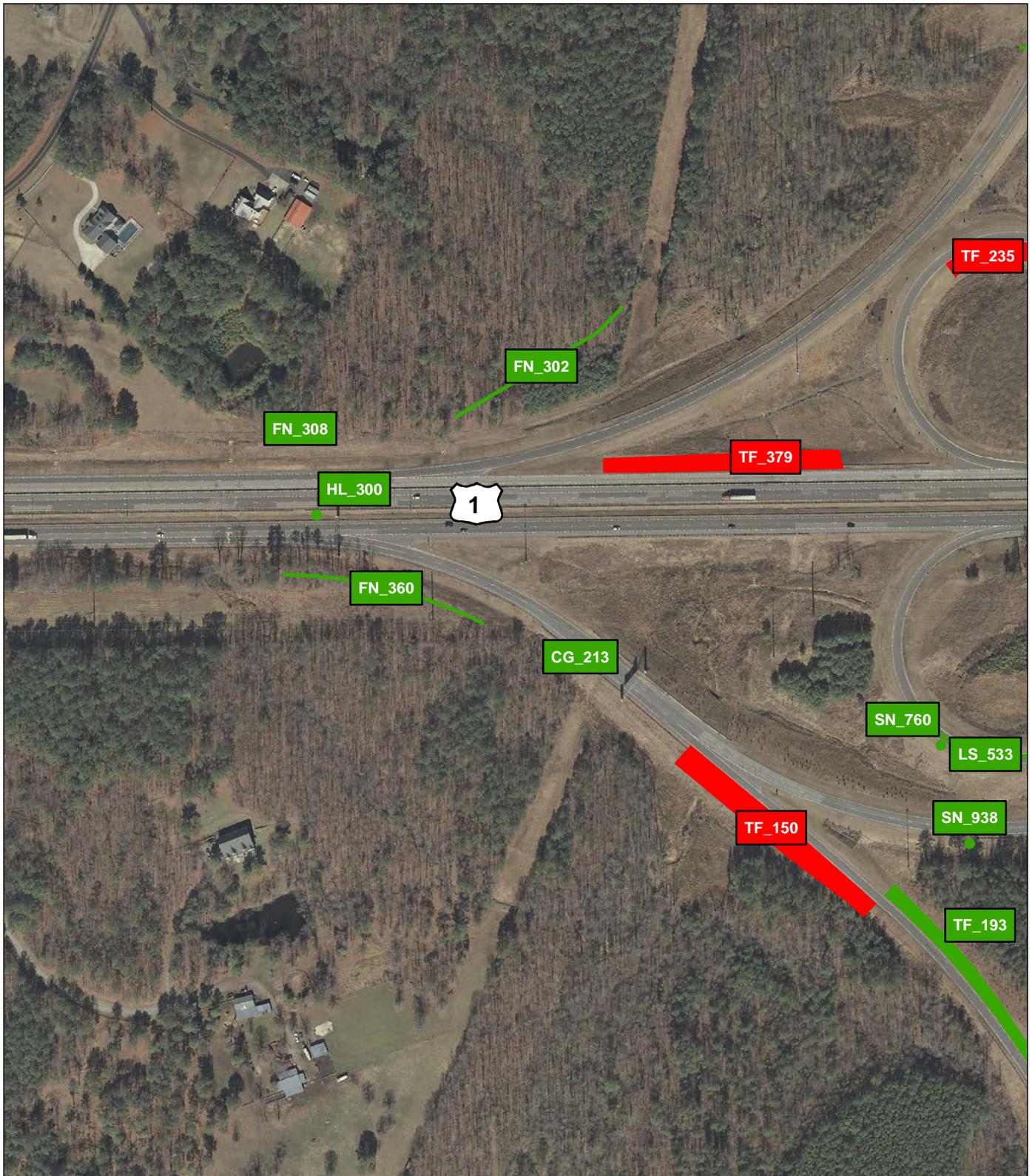


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

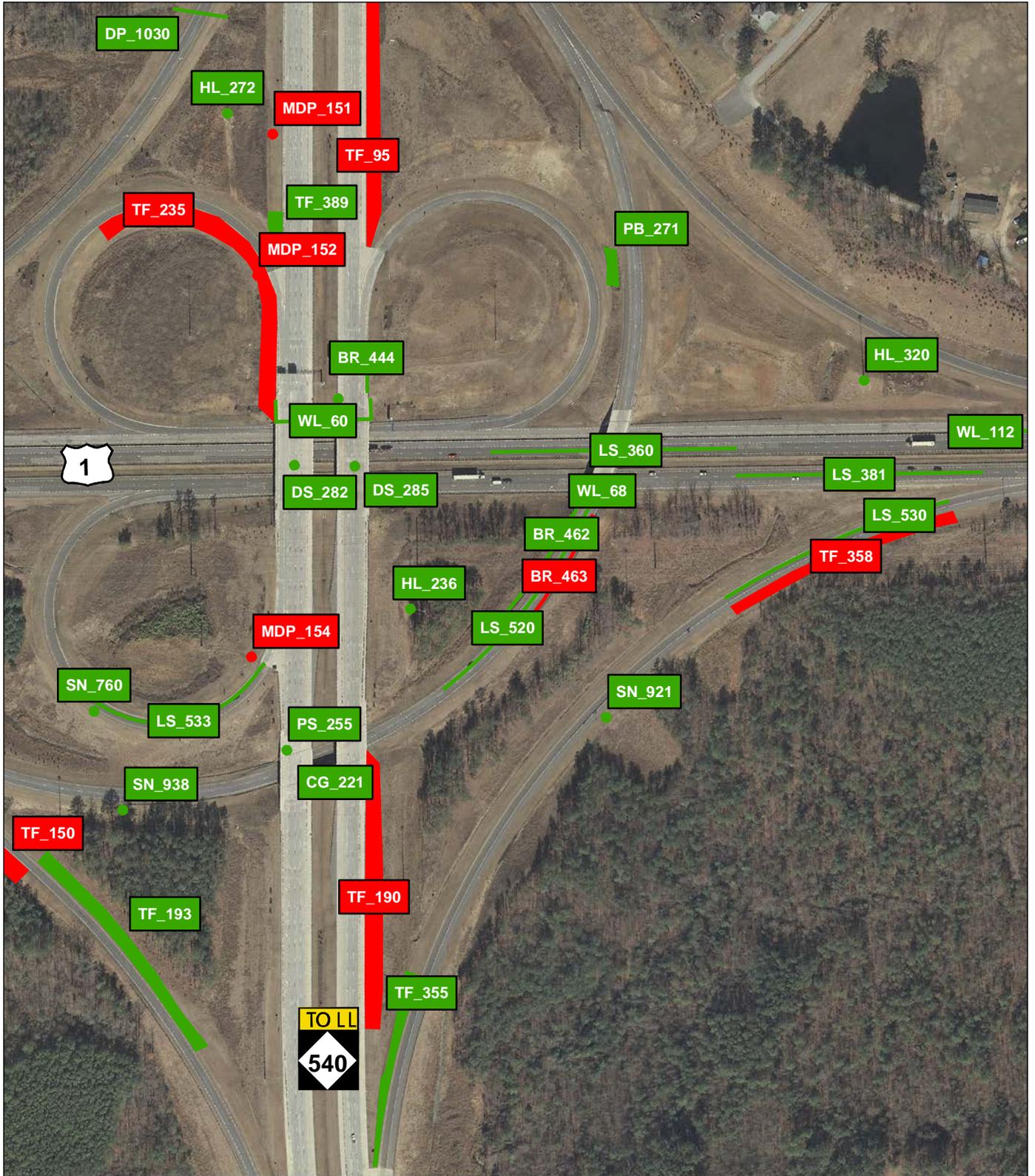


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

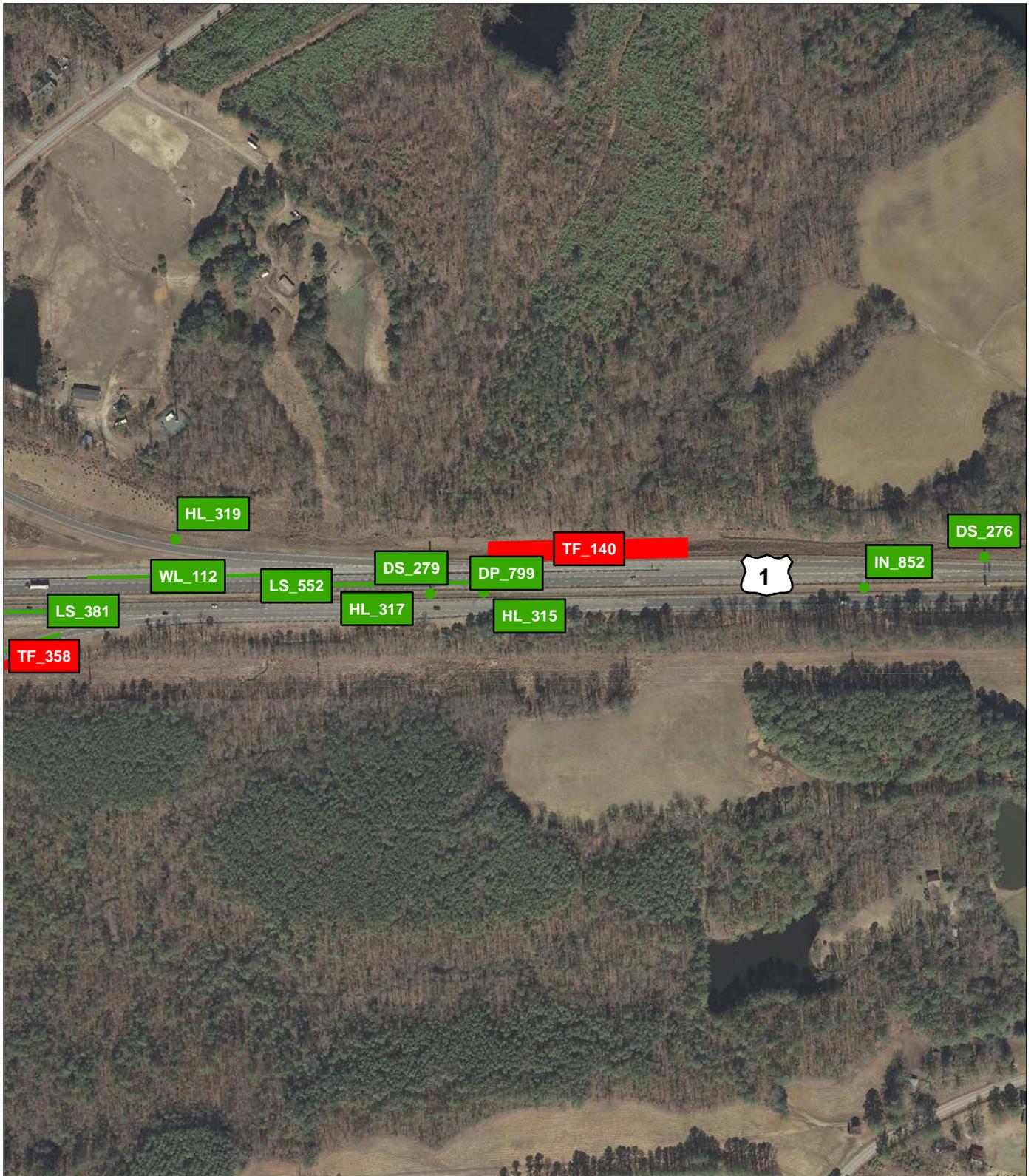


Legend

- Passing Asset
- Failing Asset

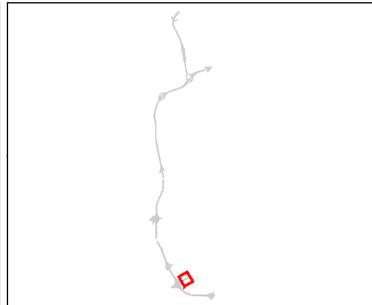


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset

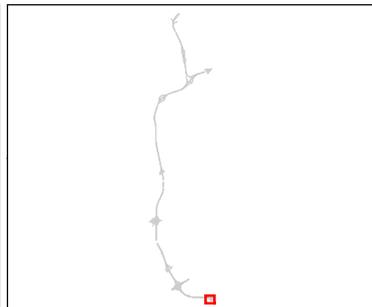


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

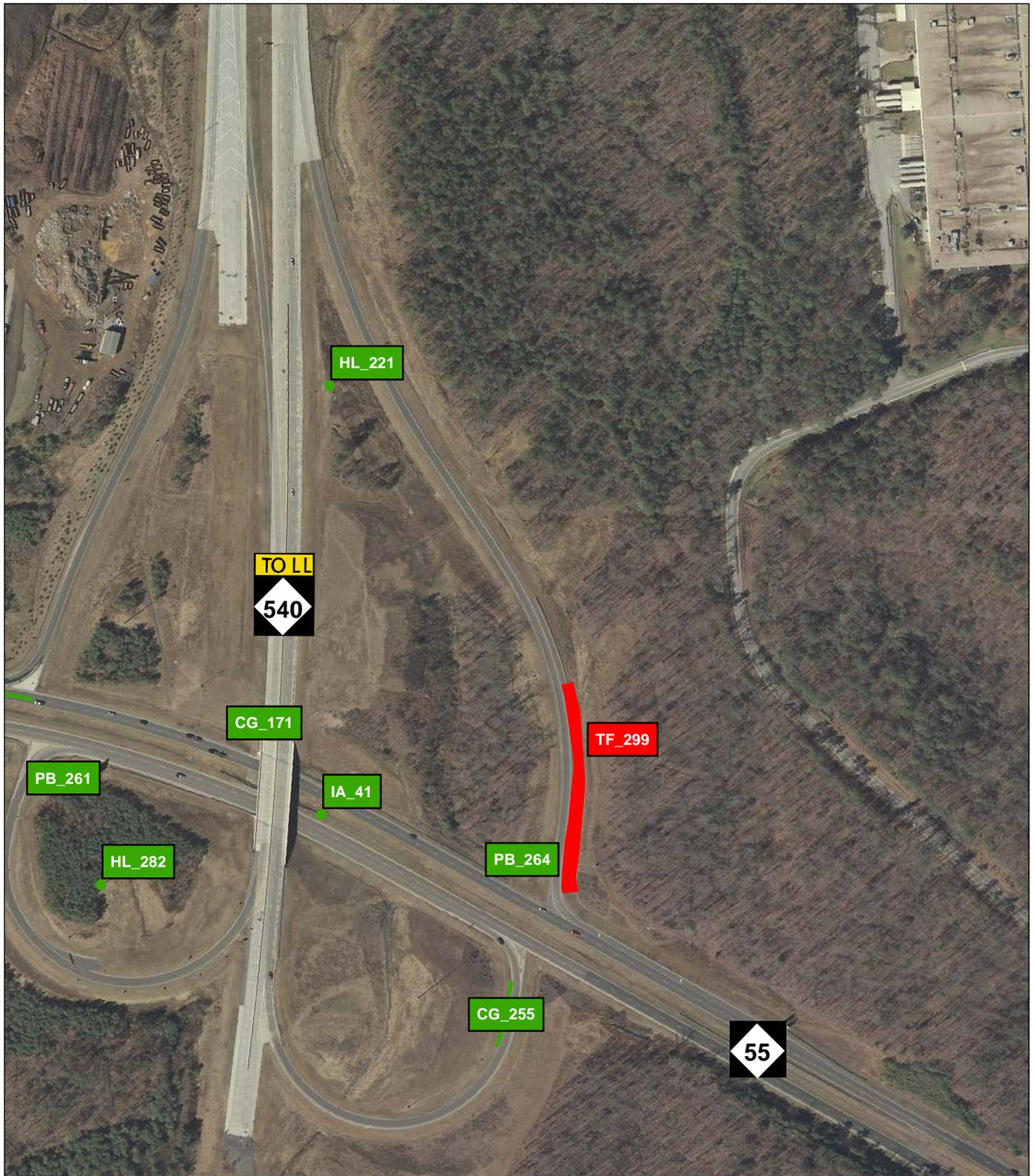


Legend

-  Passing Asset
-  Failing Asset

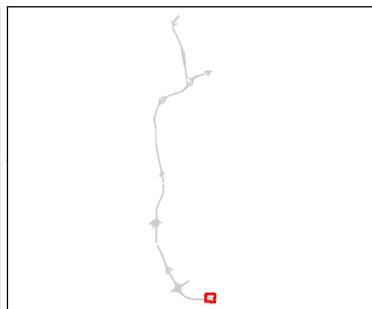


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

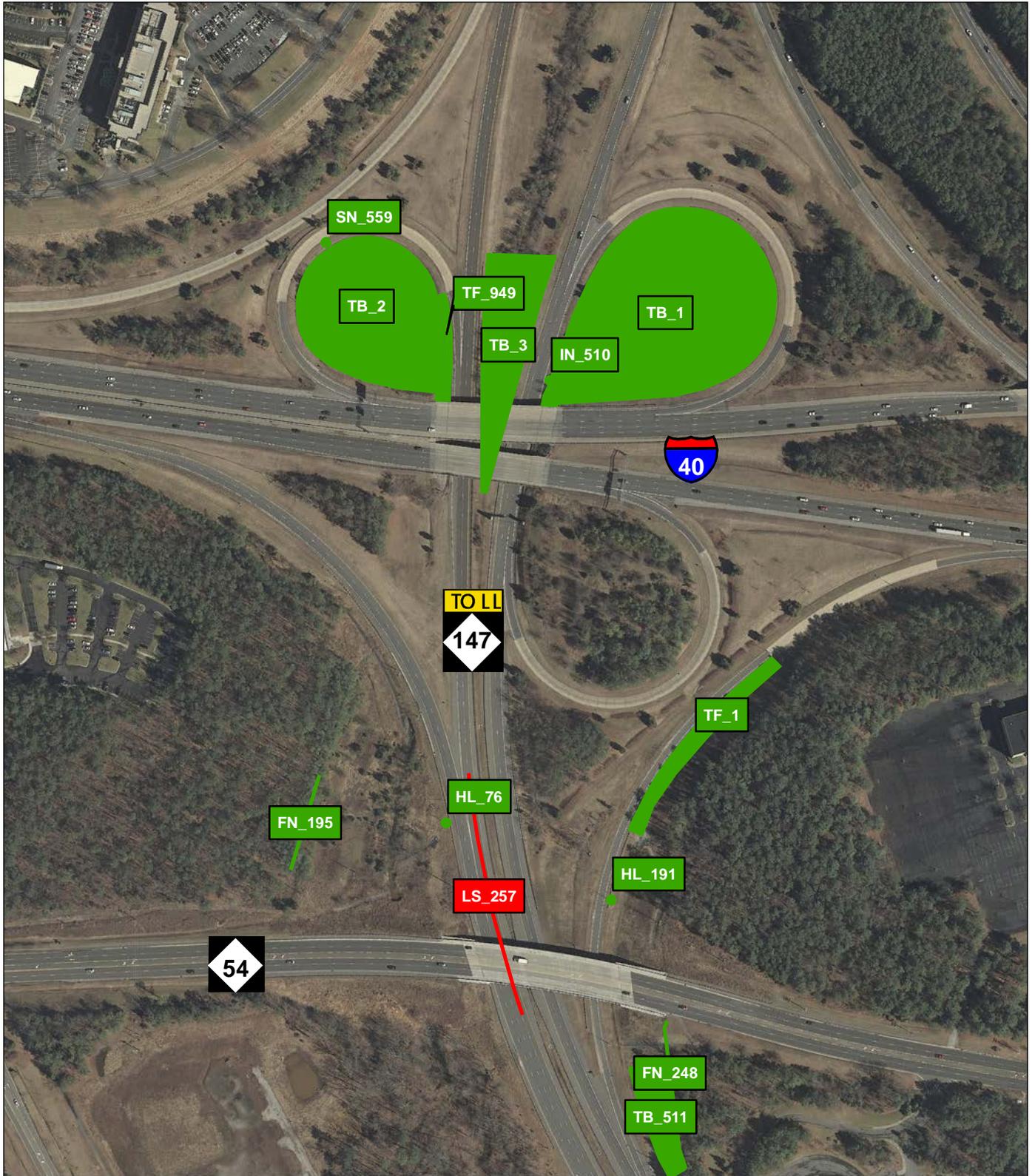


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

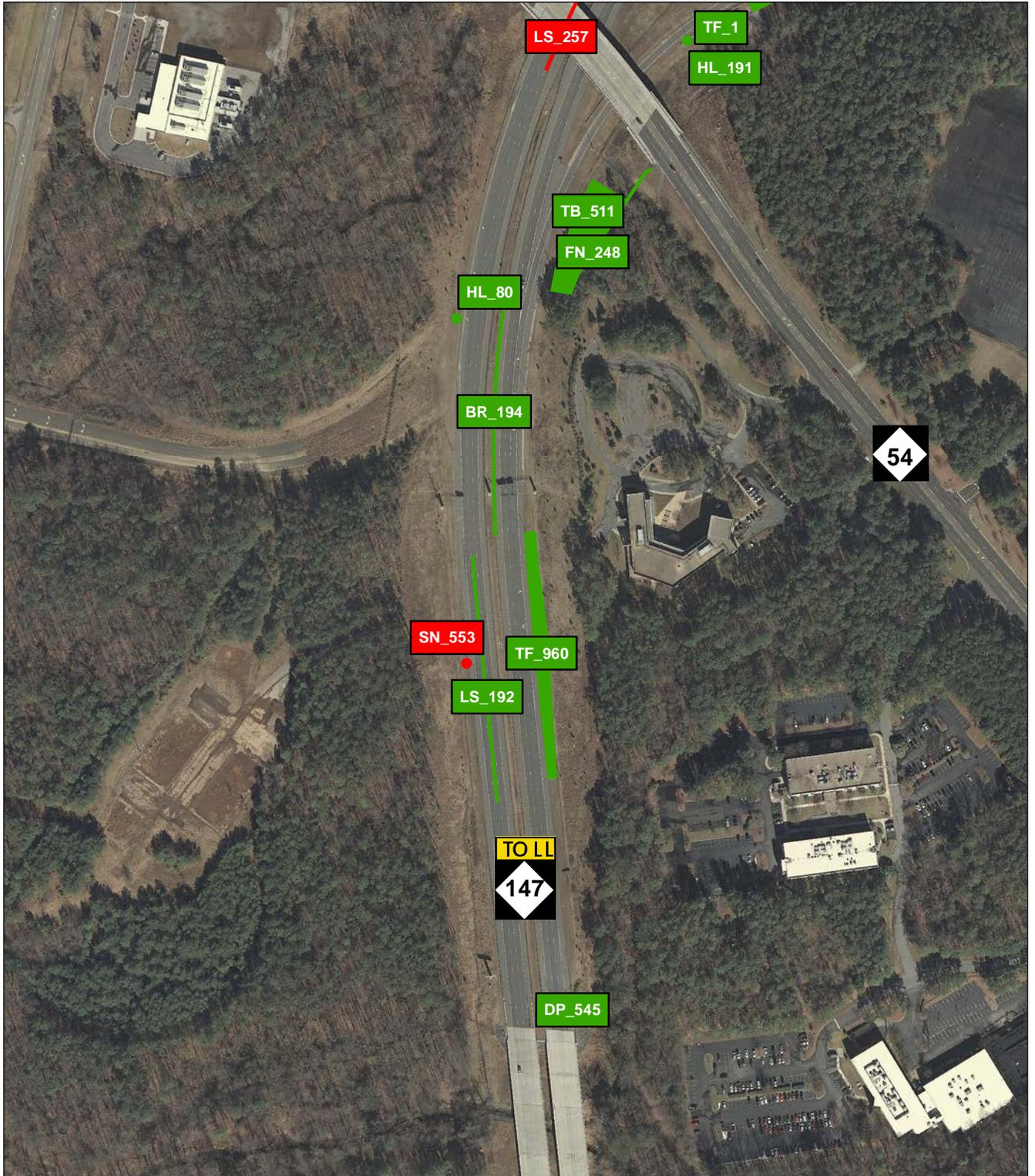


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

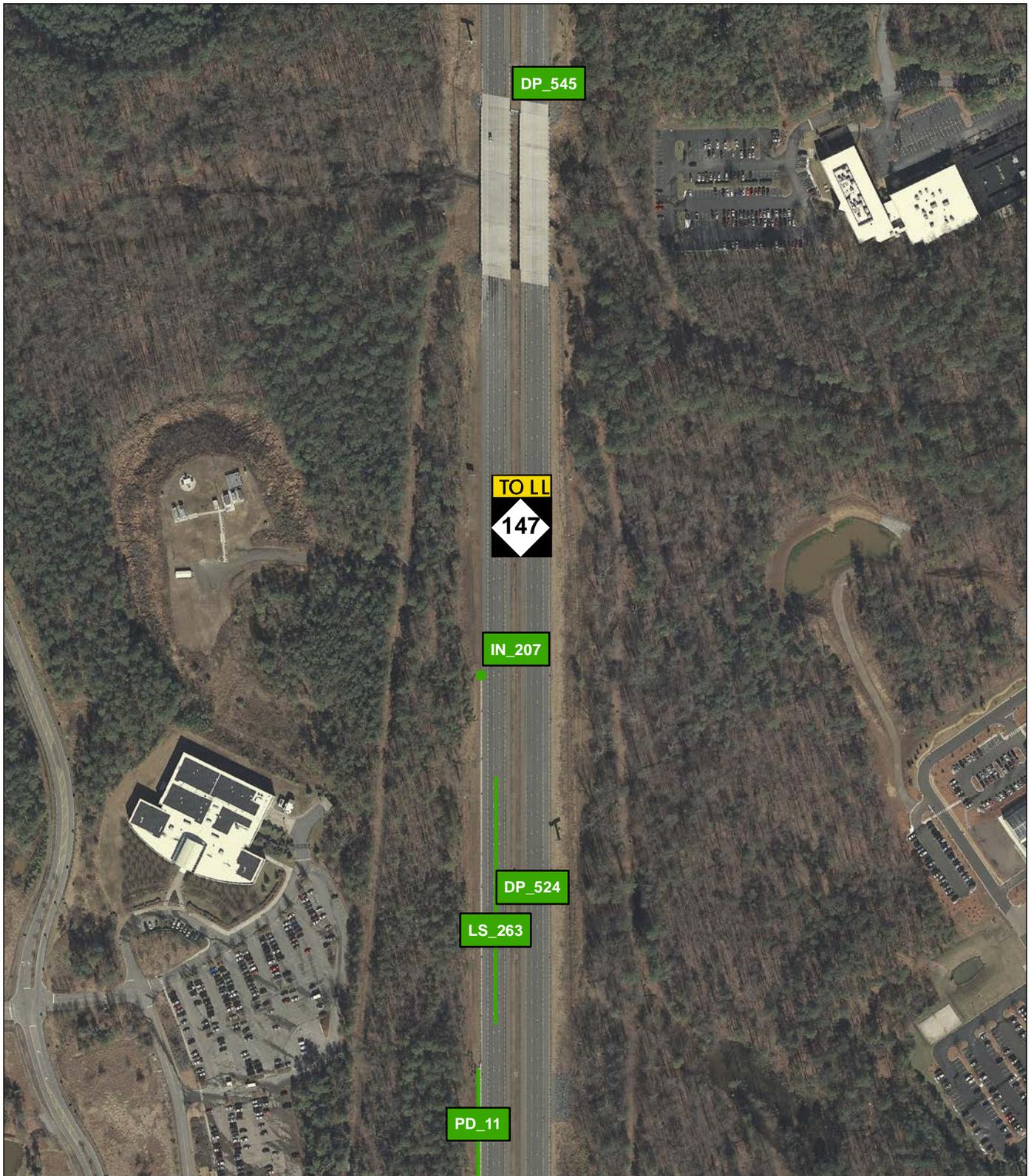


Legend

- Passing Asset
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Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

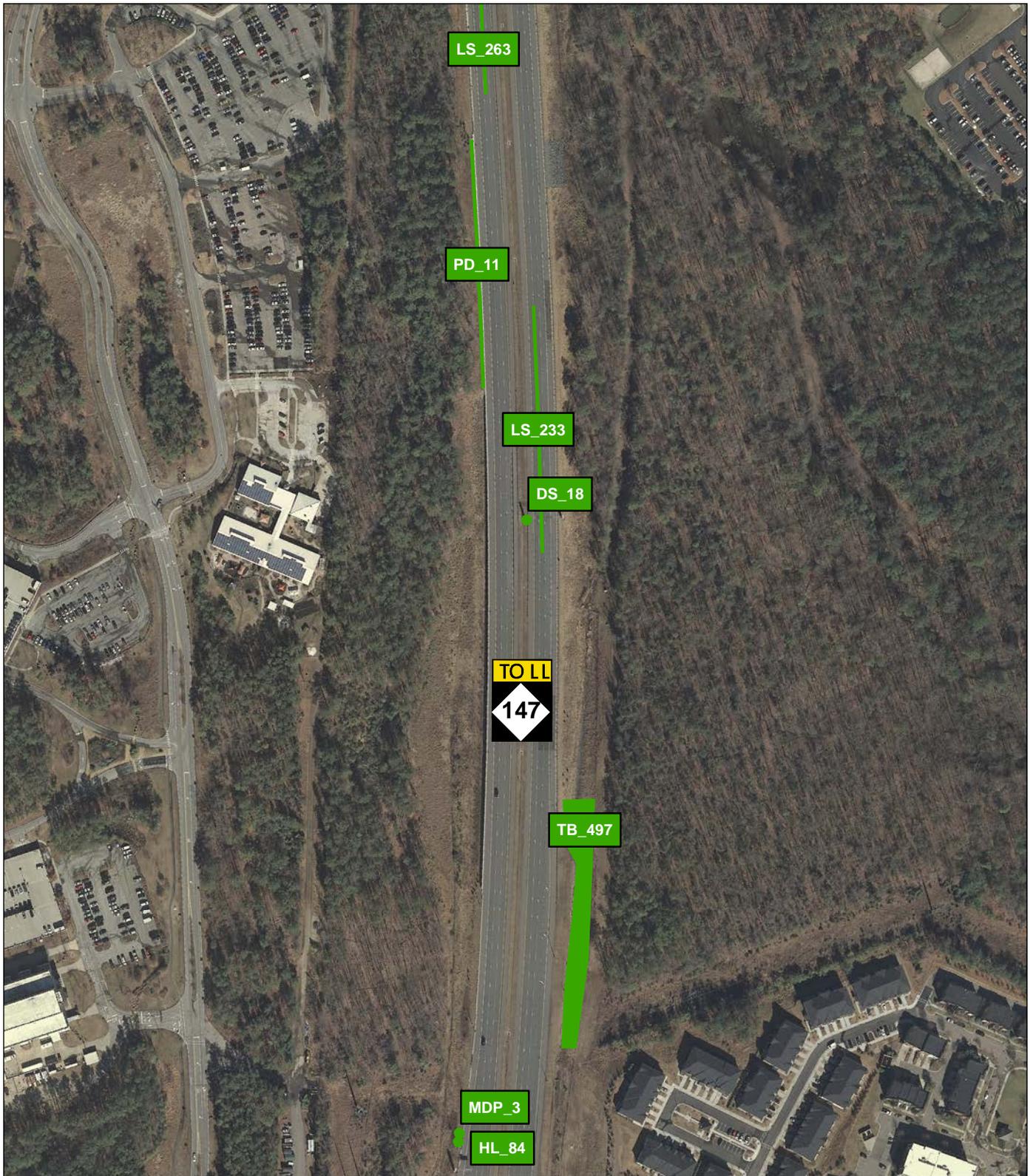


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

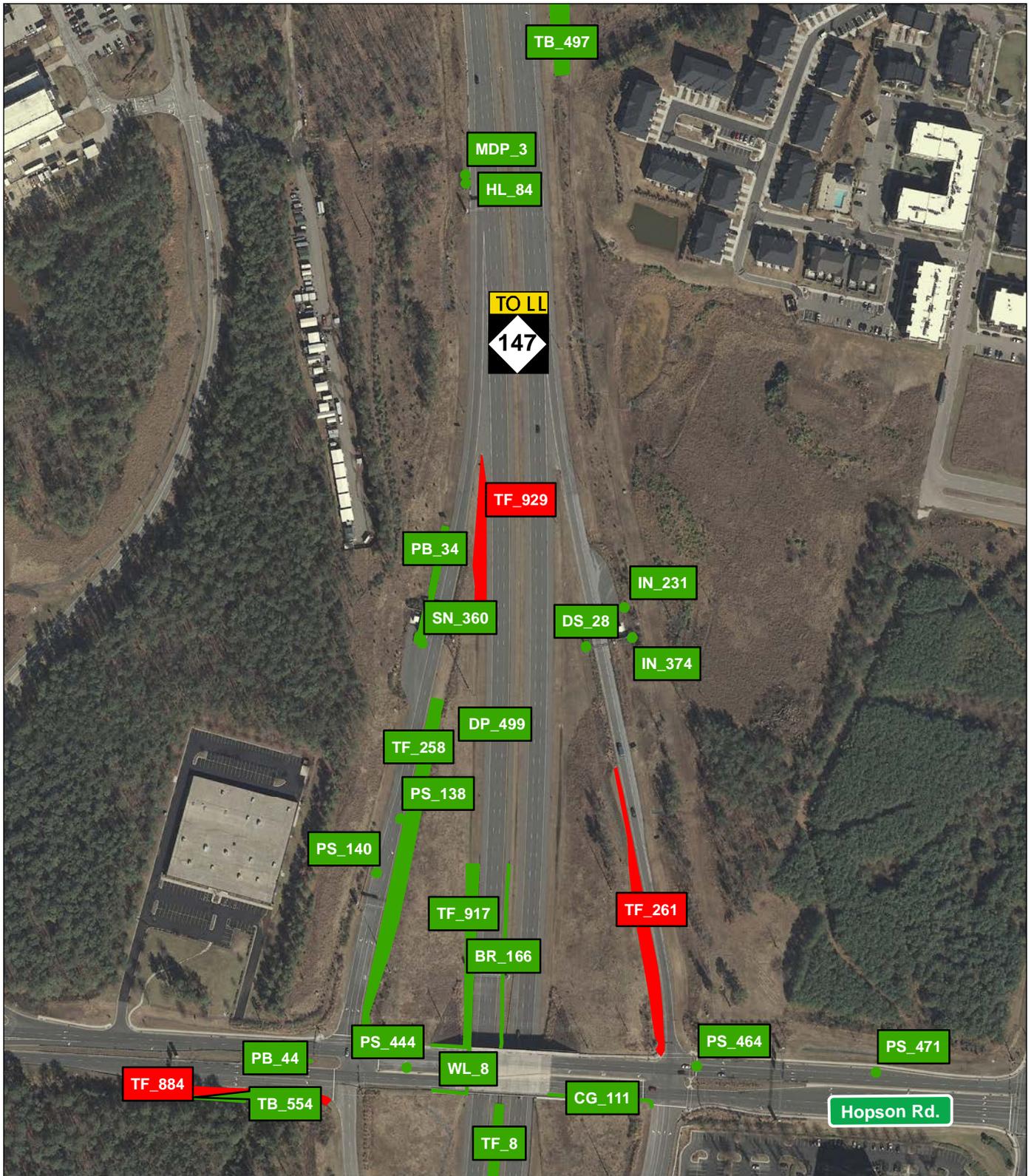


Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

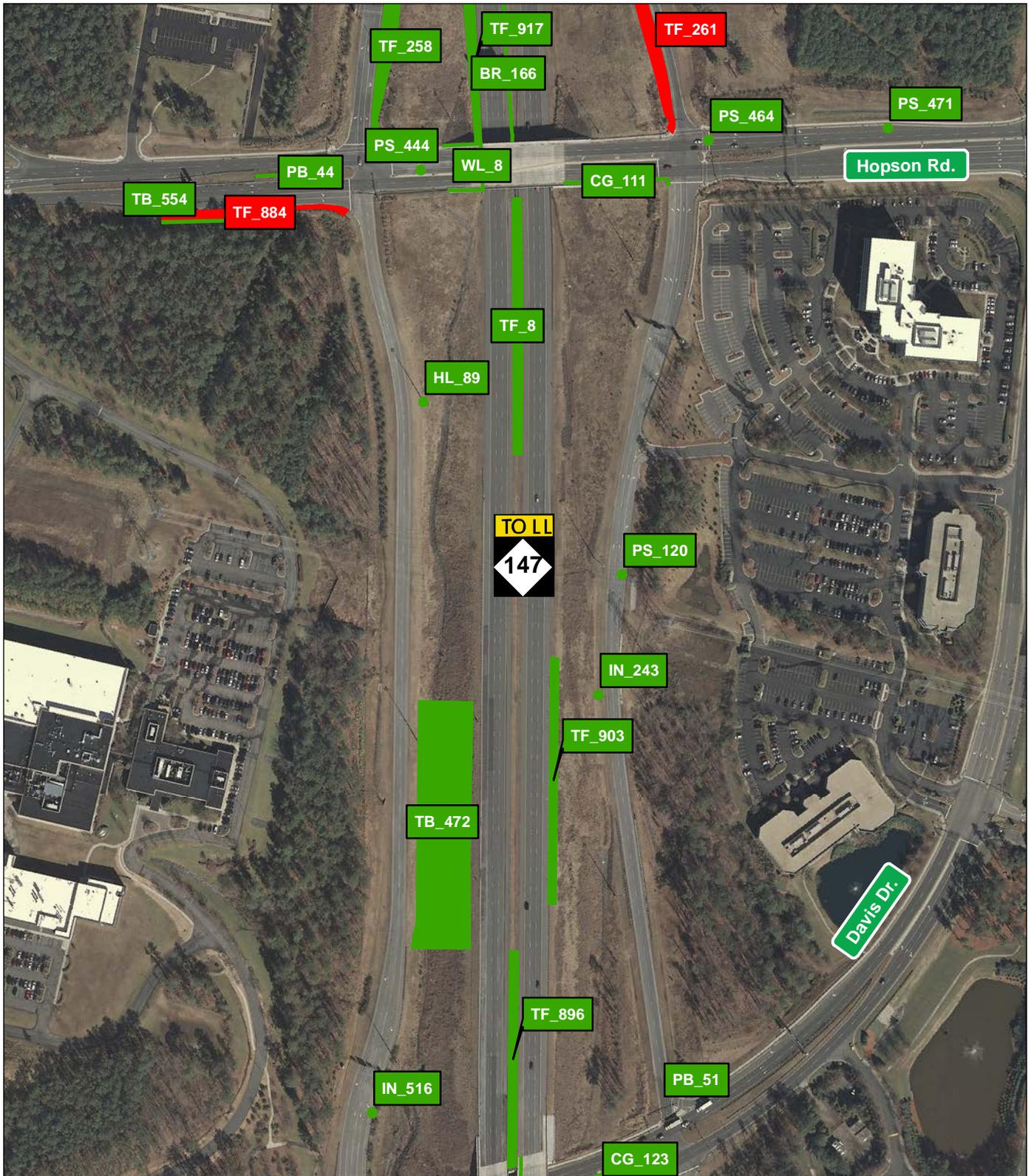


Legend

- Passing Asset
- Failing Asset

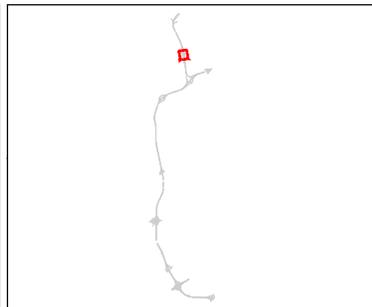


Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

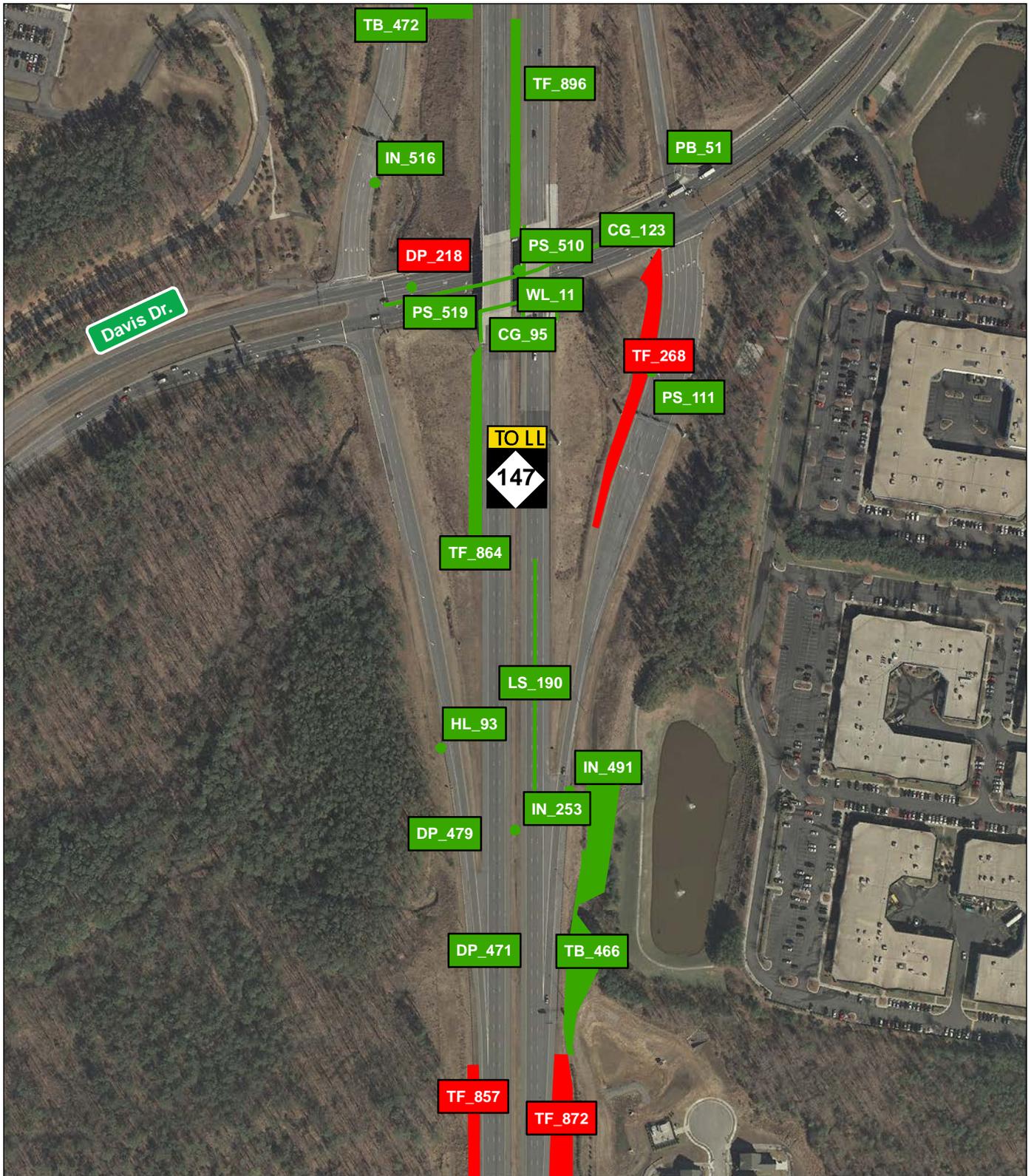


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations

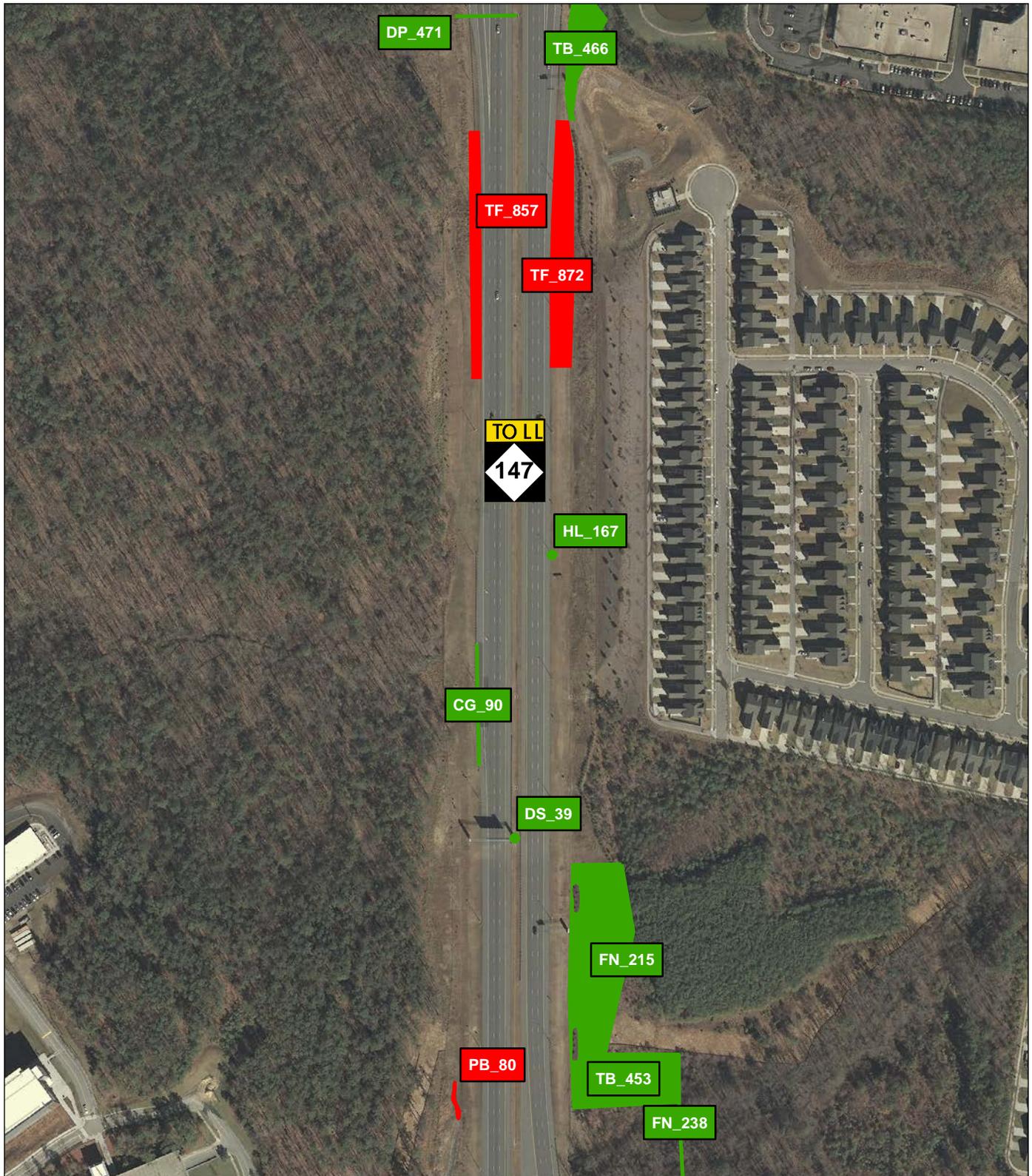


Legend

- Passing Asset
- Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations



Legend

-  Passing Asset
-  Failing Asset



Appendix A: Triangle Expressway 2016 Second Quarter Asset Assessment Locations



Legend

- Passing Asset
- Failing Asset



Appendix B

Triangle Expressway 2016 Second Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2016 Second 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)	13
Inlets (IN).....	14
Landscaping (PB)	15
Paved Lanes – Asphalt (LS).....	16
Paved Lanes – Concrete (LS)	17
Paved Shoulders (LS).....	18
Unpaved Shoulders (LS)	19
Front/Back Slopes (LS)	20
Unpaved Lateral and Outfall Ditches (LS)	21
Litter (LS)	22
Roadway Sweeping (LS)	23
Pavement Striping (LS).....	24
Pavement Markers (LS).....	25
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).....	42

The Inventory ID and GIS Reference Page number correspond to the map packets provided 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
1	Cable Guardrail	BR_313	Functional Damage		A2
2	Guardrail	BR_463	Functional Damage		A43
3	Guardrail	BR_562	Missing Parts		A30

Curb and Gutter (CG)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Valley	CG_51	Material Accumulation		A24

Decorative Supports (DS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Overhead Sign Support	DS_266	Paint Scaling		A45

Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Drain	DP_15	Erosion		A21, A22, A23
2	Drain	DP_218	Pipe Damage		A53
3	Cross Pipe	DP_1000	Pipe Damage		A30, A31

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_22	Obstruction		A14
2	Shoulder Drain	MDP_42	Obstruction and Grate Damage		A19
3	Shoulder Drain	MDP_55	Obstruction		A21
4	Shoulder Drain	MDP_114	Obstruction		A33, A34

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Shoulder Drain	MDP_126	Obstruction		A37
6	Shoulder Drain	MDP_139	Obstruction		A40
7	Shoulder Drain	MDP_151	Obstruction and Grate Damage		A41, A43
8	Shoulder Drain	MDP_152	Obstruction		A43

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Shoulder Drain	MDP_154	Obstruction		A43

Fence and Control of Access (FN)

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

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	HL_36	Single Roadway	Functional Damage	Not Available for Nighttime Failure.	A24
2	HL_37	Single Roadway	Functional Damage	Not Available for Nighttime Failure.	A24
3	HL_163	Single Roadway	Functional Damage	Not Available for Nighttime Failure.	A55
4	HL_336	Single Roadway	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
This asset did not produce any failures.					

Landscaping (PB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Plant Bed	PB_80	Health		A54, A55

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
This asset did not produce any failures.					

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
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_257	Missing Markers		A47, A48
2	Concrete	LS_334	Missing Markers		A9
3	Concrete	LS_456	Nighttime Reflectivity	Not Available for Nighttime Failure.	A41

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	Merge	SN_218	Height Requirement		A10, A12
2	Mile Post	SN_553	Leaning		A48
3	One Way	SN_671	Height Requirement		A37

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_34	Bareground		A13
2	Turf	TF_51	Bareground		A16
3	Turf	TF_76	Bareground		A25, A26
4	Turf	TF_80	Bareground		A30, A31

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_95	Bareground		A41, A43
6	Turf	TF_107	Bareground		A30, A32
7	Turf	TF_116	Bareground		A35, A36
8	Turf	TF_140	Bareground		A44

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Turf	TF_150	Bareground		A42, A43
10	Turf	TF_164	Bareground		A30, A31, A32
11	Turf	TF_190	Bareground		A43
12	Turf	TF_213	Bareground		A30, A31

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Turf	TF_235	Bareground		A42, A43
14	Turf	TF_261	Bareground		A51, A52
15	Turf	TF_268	Bareground		A53
16	Turf	TF_299	Bareground		A46

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
17	Turf	TF_358	Bareground		A43, A44
18	Turf	TF_379	Bareground		A42
19	Turf	TF_403	Bareground		A40, A41
20	Turf	TF_404	Bareground		A40

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
21	Turf	TF_450	Bareground		A35, A36
22	Turf	TF_474	Bareground		A38, A39, A40
23	Turf	TF_502	Bareground		A30, A31, A32
24	Turf	TF_513	Bareground		A31

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
25	Turf	TF_514	Bareground		A31
26	Turf	TF_523	Height and Bareground		A30
27	Turf	TF_526	Bareground		A30
28	Turf	TF_615	Bareground		A18

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
29	Turf	TF_662	Bareground		A24, A25
30	Turf	TF_679	Bareground		A12
31	Turf	TF_693	Bareground		A11, A12
32	Turf	TF_696	Bareground		A12

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
33	Turf	TF_742	Height		A6, A7
34	Turf	TF_743	Height		A6, A7
35	Turf	TF_758	Height		A6
36	Turf	TF_766	Height		A5, A6

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
37	Turf	TF_799	Height		A5
38	Turf	TF_857	Bareground		A53, A54
39	Turf	TF_872	Bareground		A53, A54
40	Turf	TF_884	Height		A51, A52

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
41	Turf	TF_929	Bareground		A51

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

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	MSE/ Retaining Wall	WL_36	Paint Scaling		A30, A31