NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2017 Fourth Quarter and Annual Report

1 S. Wilmington Street
Raleigh, NC 27601

Last Updated:
February 09, 2018

CONSULTANT CERTIFICATION OF COMPLETION

January 26, 2018

Dennis Jernigan, P.E.
Director of Highway Operations, NCTA
1 South Wilmington Street
Raleigh, NC 27601

NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q4, FY 2017 Rating

This is to certify that I, Ken M. McEntire, PE am an authorized official representative of the company The Kercher Group, Inc., 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,

The Kercher Group, Inc.

Ken M. McEntire, PE
Principal

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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 2017 Fourth Quarter Assessment of the Triangle Expressway.

The overall 2017 fourth quarter maintenance rating of the Triangle Expressway was 91.1, meeting 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 2017 Fourth Quarter Assessment

Element	MRP Rating	Target Rating
Road Surface	98.9	85.0
Unpaved Shoulders and Ditches	97.9	85.0
Drainage	87.6	85.0
Roadside	92.5	85.0
Traffic Control Devices	82.4	85.0
Overall MRP Performance Rating	**91.1**	**90.0**

This report also provides a summary and analysis of the 2017 Annual Assessment of the Triangle Expressway, which takes into account the results of all four quarterly inspections conducted in 2017 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 2017 annual maintenance rating of the Triangle Expressway was 91.8, 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 2017 Annual Assessment

Element	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Q4 2017 Rating	Annual Rating
Road Surface	97.8	100.0	98.1	98.9	98.6
Unpaved Shoulders and Ditches	95.6	95.5	100.0	97.9	97.5
Drainage	86.7	92.3	83.2	87.6	87.4
Roadside	90.3	87.4	90.4	92.5	90.3
Traffic Control Devices	91.4	88.5	85.2	82.4	86.8
Overall MRP Performance Rating	**92.7**	**92.7**	**90.9**	**91.1**	**91.8**

In addition, the report provides findings of the Green Level Historic District signs inspection. This quarter, due to a Town of Cary development project near the area, three of the four signs were available for inspection. All three signs inspected were found to be in good physical condition, and the landscaped areas around the signs were well maintained.

2.0 INTRODUCTION

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

Using outcome-based performance measures and the service level scale (0 through 100), the inspection results are rated against established thresholds criteria. The program analysis is accomplished using 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.

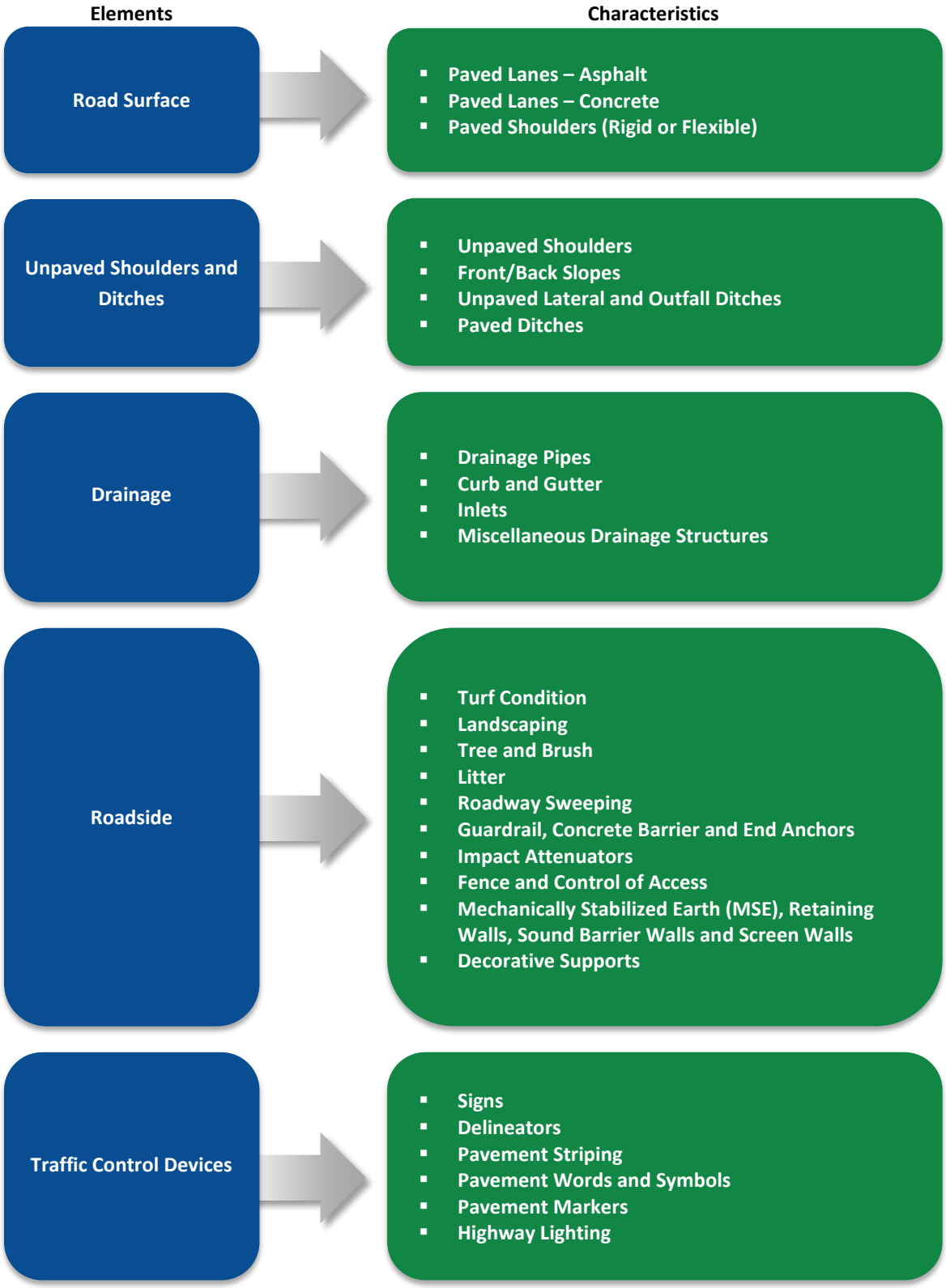
The NCTA performance standards, threshold criteria and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

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



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 using 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, an 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:

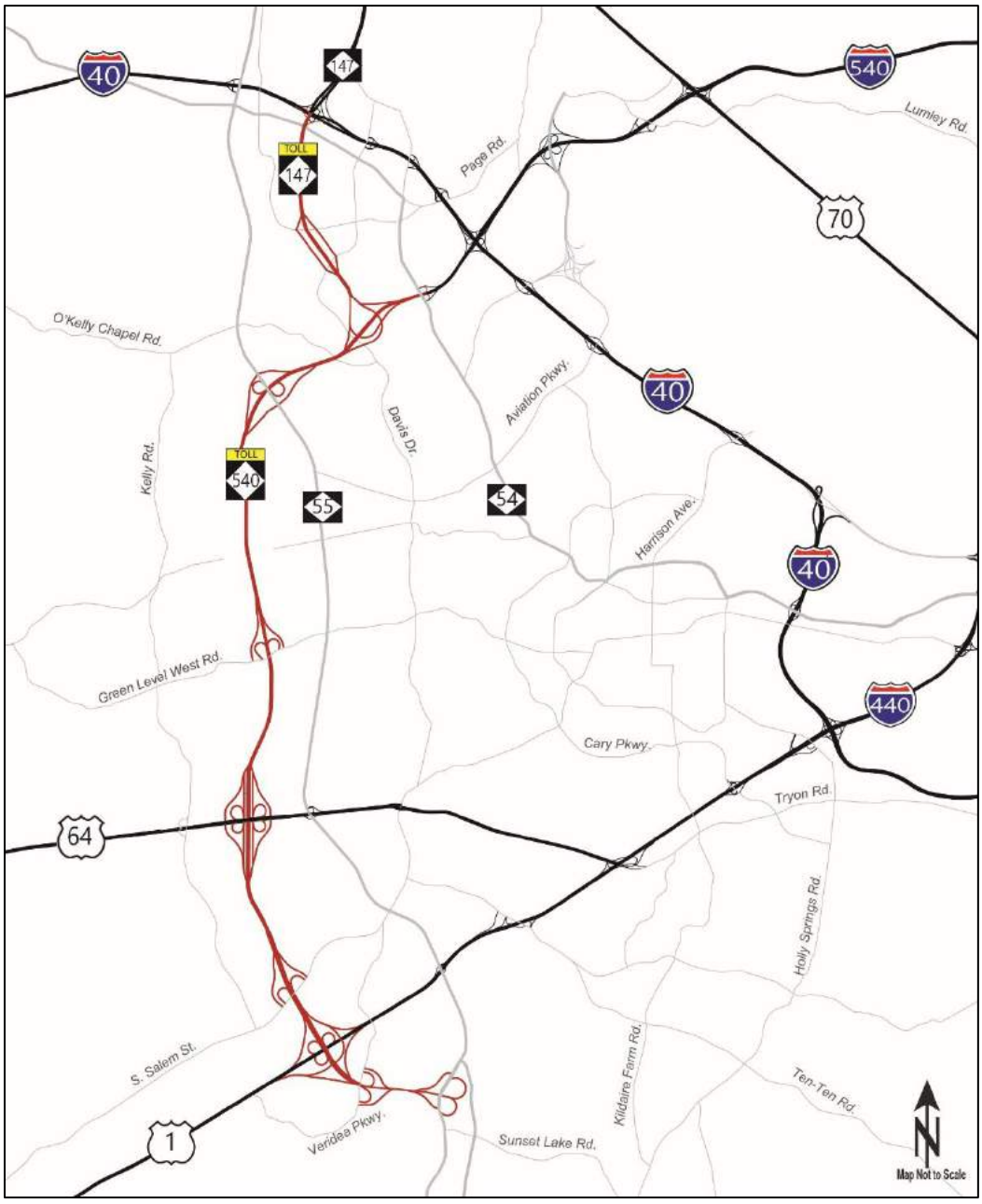
Road Surface =	**25%**
Unpaved Shoulders =	**13%**
Drainage =	**15%**
Roadside =	**17%**
Traffic Control Devices =	**30%**
Total	**100%**

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 Toll NC-147 in Durham to the NC-55 Bypass near Holly Springs (***Figure 2***). It includes a one-mile segment on Toll NC-540 extending north from the Toll NC-540 / Toll NC-147 interchange to the NC-54 interchange. The Triangle Expressway consists of eleven interchanges and twenty 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 this quarter, no assets were removed or added to the inventory. However, with the completion of the Access 540 Project NCTA plans to add to the inventory all new assets located in the Veridea Parkway interchange by March 2018.

6.0 MRP FOURTH QUARTER ASSESSMENT

6.1 Quarterly Results

The overall 2017 fourth quarter maintenance rating of the Triangle Expressway was 91.1, meeting NCTA's target overall rating of 90. Most elements assessed achieved ratings above the target rating of 85, with the exception of Traffic Control Devices (82.4). Curb and gutter (79), Miscellaneous Drainage (74), Retaining Walls and Sound Walls (73), Pavement Striping/Marking (68), and Highway Lighting (68) 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 at the end of each calendar year, provides a 95% confidence level in statistical sampling. The fourth quarter MRP performance ratings for elements and characteristics are presented in ***Table 3*** and ***Table 4***, respectively.

Table 3: MRP Element Results for Q4 2017

Element	Q4 2017 MRP Rating
Road Surface	98.9
Unpaved Shoulders and Ditches	97.9
Drainage	87.6
Roadside	92.5
Traffic Control Devices	82.4
Overall MRP Performance Rating	**91.1**

Table 4: MRP Characteristic Results for Q4 2017						
Road Surface	**Sample Passed**	**Sample Total**	**Weighted Values**	**Actual Pts**	**Available Pts**	**Q4 Rating**
Paved Lanes Asphalt	13	13	9	117	117	100
Paved Lanes Concrete	21	21	9	189	189	100
Paved Shoulder	33	34	5	165	170	97
Element Total				**471**	**476**	**98.9**
Unpaved Shoulders and Ditches	**Sample Passed**	**Sample Total**	**Weighted Values**	**Actual Pts**	**Available Pts**	**Q4 Rating**
Unpaved Shoulder	33	34	9	297	306	97
Front/Back Slopes	34	34	6	204	204	100
Lateral and Outfall Ditches, Unpaved	33	34	6	198	204	97
Ditches, Paved	1	1	5	5	5	100
Element Total				**704**	**719**	**97.9**
Drainage	**Sample Passed**	**Sample Total**	**Weighted Values**	**Actual Pts**	**Available Pts**	**Q4 Rating**
Drainage Pipes	32	34	7	224	238	94
Curb and Gutter	19	24	6	114	144	79
Inlets	32	34	7	224	238	94
Misc. Drainage Structure	26	35	4	104	140	74
Element Total				**666**	**760**	**87.6**
Roadside	**Sample Passed**	**Sample Total**	**Weighted Values**	**Actual Pts**	**Available Pts**	**Q4 Rating**
Turf Condition	67	80	7	469	560	84
Landscaping	22	25	4	88	100	88
Trees and Brush	31	31	4	124	124	100
Litter	34	34	4	136	136	100
Roadway Sweeping	33	34	5	165	170	97
Guardrail, Concrete Barrier and End Anchors	31	31	9	279	279	100
Impact Attenuators	9	9	9	81	81	100
Fence, Control Access	26	29	7	182	203	90
Retaining Walls and Sound Barrier Walls	11	15	5	55	75	73
Decorative Supports	25	25	5	125	125	100
Graffiti and Stain Removal	34	34	4	136	136	100
Element Total				**1840**	**1989**	**92.5**
Traffic Control Devices	**Sample Passed**	**Sample Total**	**Weighted Values**	**Actual Pts**	**Available Pts**	**Q4 Rating**
Signs	32	36	7	224	252	89
Delineators	20	25	3	60	75	80
Pavement Striping/Marking	23	34	8	184	272	68
Words and Symbols	27	30	7	189	210	90
Pavement Markers	33	34	9	297	306	97
Highway Lighting	28	41	6	168	246	68
Element Total				**1122**	**1361**	**82.4**

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 did not achieve their target ratings.

6.2 Analysis and Recommendations

Elements

During the fourth quarter, most elements exceeded NCTA's threshold criteria of 85 except for Traffic Control Devices (82.4). Road Surface (98.9) and Unpaved Shoulder/Ditches (97.9) continued to obtain ratings higher than 95, while Roadside (92.5) and Drainage (87.6) obtained ratings just above 90 and 85, respectively.

Drainage (87.6) was the elements that experienced the most significant increase in rating compared to the previous quarter. The rating obtained for this element was 4.4 points higher than the rating obtained during the third quarter of 2017. This increase in rating is attributed to a higher rating obtained for Inlet (94).

In contrast, Traffic Control Devices (82.4) was the element that experienced the most significant decrease in rating compared to the previous quarter. The rating obtained for this element was 2.8 points lower than the rating obtained during the third quarter of 2017. This decrease in rating is attributed to low ratings attained for Pavement Striping/Marking (68) and Highway Lighting (68).

Recommendations to improve specific critical characteristic ratings are provided in the following sections.

Characteristics

This quarter all but five characteristics, Curb and Gutter (79), Miscellaneous Drainage Structure (74), Retaining Walls and Sound Barrier Walls (73), Pavement Striping/Marking (68), and Highway Lighting (68) met the NCTA target threshold criteria of 80. A description of the characteristics' conditions and future work planning recommendations are provided below. Pictures of all characteristic failures are included in ***Appendix B***.

Curb and Gutter (79 rating – 5 of the 24 assets did not pass): Out of the 5 curb and gutter segments that did not pass inspection, 4 were obstructed and 1 had material accumulation. Two of the curb and gutter segments that did not pass inspection are presented in ***Figure 3***.

Figure 3: Curb and Gutter Inspection Results Sample

To improve curb and gutter performance throughout the facility, it is recommended that the maintenance provider inspect, sweep, and repair curb and gutter segments pursuant to the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below. During inspections, it is also recommended that the maintenance provider remove any debris accumulation upon routine observations.

Maintenance Program:

1) Curb and gutter debris shall be removed upon observation. Routine sweeping of all curb and gutter sections are required once per month.
2) Curb and gutter shall be visually inspected for cracks and damage every 4 months.
3) Evidence of damage shall be scheduled for repair within the annual work program.

Maintenance and Evaluation Standards:

Curb and gutters do not meet the maintenance standards when any of the following criteria is observed:

1) Settlement greater than 2 inches
2) Misalignment greater than 2 inches
3) Structural damage is present. Any cracking that is 0.75 inches or greater will be considered damaged.
4) Obstructions 2 inches or greater in depth for at least 2 feet of gutter length.

Miscellaneous Drainage (74 rating – 9 of the 35 assets did not pass): Out of the 9 miscellaneous drainage structures that did not pass inspection, 5 were obstructed and 4 had damage at the outlet. Two of the miscellaneous drainage structures (shoulder underdrains) that did not pass inspection are presented in ***Figure 4***.

Figure 4: Miscellaneous Drainage Inspection Results Sample

In accordance with *NCTA Roadway and Facility Maintenance Standards V4,* referenced below, the maintenance provider shall plan annual cleaning of these drainage features to remove any debris or overgrown vegetation. It is also recommended that the maintenance provider continue to follow the routine patrol schedule and repair any erosion or soil buildup problems along the ditch line near the outlets. Edge drains are a critical component of extending the life cycle of pavements as they provide a means for water to drain away from the subgrade and base.

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**.**

Some of the obstruction failures are a result of inadequate gradient flow away from the edge drain outlets. To avoid affecting the natural flow of water near the drainage features and potential pavement failures, 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.

Retaining Walls and Sound Barrier Walls (73 rating – 4 of the 15 assets did not pass)**:** Out of the 4 retaining wall and sound barrier wall structures that did not pass inspection, 3 had paint scaling and 1 unwanted vegetation growth. Two of the wall segments that did not pass inspection are presented in ***Figure 5***.

Figure 5: Retaining and Sound Barrier Walls Inspection Results Sample

In accordance with *NCTA Roadway and Facility Maintenance Standards V4*, referenced below, it is recommended that the maintenance provider plan for and schedule paint repairs within the annual work program and that unwanted vegetation is removed upon observation.

Retaining Walls and Sound Barrier Walls Maintenance Program Standards:

1) Walls shall be inspected during daily patrols.
2) Unwanted vegetation and graffiti (see graffiti standard) shall be scheduled for removal.
3) Minor wall or column damage shall be scheduled for repair within the annual work program.
4) Staining damage shall be scheduled for repair within the annual work program.
5) Any structural damage that poses a safety risk shall be scheduled immediately upon observation. Mitigate any safety hazard upon observation.

Standards Maintenance and Evaluation Standards:
MSE/retaining walls, sound barrier walls, and screen walls do not meet the maintenance standards when any of the following criteria is observed:

1) More than 10% of exposed surface is covered with unwanted vegetation.
2) Any single spall 1 inch deep or greater or cumulative spalls in excess of 1 inch deep over 5 SF.
3) More than 25% of weep holes within the sample section are not functioning properly.
4) Unsealed cracks or joints greater than 0.25 inches in width.
5) Stained areas exhibit cumulative scaling in excess of 1 SF.

Pavement Striping/Marking (68 rating – 11 of the 34 assets did not pass)**:** Out of the 11 pavement striping/marking segments that did not pass inspection, 9 segments had missing sections or did not meet the required line width, and 2 segments did not reflect during the night. Two of the pavement striping and marking segments that did not pass inspection are presented in ***Figure 6***.

Figure 6: Pavement Striping/Marking Inspection Results Sample

To maintain a well-defined lane delineation throughout the Triangle Expressway, it is recommended that the maintenance provider consider scheduling pavement striping/marking replacement cycles in accordance with the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Maintenance Program:

1) Pavement striping is observed daily and inspected every 4 months for compliance to the standard.
2) Worn or missing markings are evaluated for compliance annually, and generally are scheduled on a 3-5 year replacement cycle depending on the material.

Maintenance and Evaluation Standards:
Pavement Striping/Marking does not meet the maintenance standards when any of the following criteria is observed:

1) More than 10% of the length of any line is less than 5.4 inches wide.
2) More than 10% of each line is not visible at a distance of 160 feet during nighttime observation.
3) More than 10% of the length of any line is missing.
4) More than 10% of the length of any line is covered by soil, grass, or debris.

Pavement striping/markings were installed along portions of Triangle Expressway over 5 years ago. Understanding that the lifespan of epoxy paint is 3 to 5 years, NCTA has made preparations in its capital budget and work schedule for the replacement of pavement striping/markings. A pavement striping replacement contract for Toll NC-540 is scheduled to be awarded in spring of 2018, and work is expected to be completed by the end of 2018.

Highway Lighting (68 rating – 13 of the 41 did not pass): Out of the 13 highway lights that did not pass inspection, 6 had functional damage, 5 had damaged parts, and 2 had missing parts. Two of the highway lights that did not pass inspection are presented in ***Figure 7***.

Figure 7: Highway Lighting Inspection Results Sample

To increase this asset's rating, it is recommended that all non-functioning or damaged highway lights noted during the inspection be repaired and/or replaced in accordance with the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Highway Lighting Maintenance Program Standards:

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

Highway Lighting 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.
3) More than 10% of the poles are damaged or missing.
4) Rodent screen protection is not in place.

7.0 MRP ANNUAL 2017 ASSESSMENT

7.1 Annual Results

The 2017 annual maintenance rating of the Triangle Expressway was 91.8, exceeding NCTA's target overall rating of 90. All element ratings exceeded the target rating of 85. Also, all but four characteristics' ratings met or exceeded the target rating of 80. Ratings for Paved Ditches, Miscellaneous Drainage Structure, Turf Condition, and Highway Lighting were 75, 68, 75, and 70, respectively.

The 2017 results are presented in ***Tables 5 and 6***. These results are a collection of the four quarterly inspections conducted throughout the year.

Table 5: MRP Element Results for 2017

Element	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Q4 2017 Rating	Annual Rating
Road Surface	97.8	100.0	98.1	98.9	98.6
Unpaved Shoulders and Ditches	95.6	95.5	100.0	97.9	97.5
Drainage	86.7	92.3	83.2	87.6	87.4
Roadside	90.3	87.4	90.4	92.5	90.3
Traffic Control Devices	91.4	88.5	85.2	82.4	86.8
Overall MRP Performance Rating	**92.7**	**92.7**	**90.9**	**91.1**	**91.8**

Table 6: MRP Rolling Element Results					
Road Surface	**Q1 2017 Rating**	**Q2 2017 Rating**	**Q3 2017 Rating**	**Q4 2017 Rating**	**Annual Rating**
Paved Lanes Asphalt	100	100	100	100	100
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulder	94	100	95	97	96
Element Total	**97.8**	**100.0**	**98.1**	**98.9**	**98.6**
Unpaved Shoulders and Ditches	**Q1 2017 Rating**	**Q2 2017 Rating**	**Q3 2017 Rating**	**Q4 2017 Rating**	**Annual Rating**
Unpaved Shoulder	94	92	100	97	96
Front/Back Slopes	94	100	100	100	98
Lateral and Outfall Ditches, Unpaved	100	100	100	97	99
Ditches, Paved	100	0	100	100	75
Element Total	**95.6**	**95.5**	**100.0**	**97.9**	**97.5**
Drainage	**Q1 2017 Rating**	**Q2 2017 Rating**	**Q3 2017 Rating**	**Q4 2017 Rating**	**Annual Rating**
Drainage Pipes	91	100	97	94	96
Curb and Gutter	92	88	88	79	86
Inlets	97	97	74	94	90
Misc. Drainage Structure	55	72	71	74	68
Element Total	**86.7**	**92.3**	**83.2**	**87.6**	**87.4**
Roadside	**Q1 2017 Rating**	**Q2 2017 Rating**	**Q3 2017 Rating**	**Q4 2017 Rating**	**Annual Rating**
Turf Condition	75	54	80	84	75
Landscaping	96	100	88	88	93
Trees and Brush	100	100	100	100	100
Litter	97	100	97	100	98
Roadway Sweeping	100	100	100	97	99
Guardrail, Concrete Barrier and End Anchors	97	97	94	100	97
Impact Attenuators	100	100	100	100	100
Fence, Control Access	79	93	87	90	87
Retaining Walls and Sound Barrier Walls	100	100	75	73	87
Decorative Supports	100	92	96	100	97
Graffiti and Stain Removal	100	96	100	100	99
Element Total	**90.3**	**87.4**	**90.4**	**92.5**	**90.3**
Traffic Control Devices	**Q1 2017 Rating**	**Q2 2017 Rating**	**Q3 2017 Rating**	**Q4 2017 Rating**	**Annual Rating**
Signs	89	92	86	89	89
Delineators	96	100	94	80	92
Pavement Striping/Marking	97	88	87	68	84
Words and Symbols	100	97	93	90	95
Pavement Markers	97	88	95	97	95
Highway Lighting	73	78	60	68	70
Element Total	**91.4**	**88.5**	**85.2**	**82.4**	**86.8**

7.2 Analysis and Recommendations

Based on the combined results of all four quarterly inspections conducted in 2017, all elements exceeded NCTA's threshold criteria of 85. In addition, all but four of the characteristics did not meet the target threshold criteria of 80. These characteristics are Paved Ditches (75), Miscellaneous Drainage Structure (68), Turf Condition (75), and Highway Lighting (70). Miscellaneous Drainage, Turf Condition, and Highway Lighting were three or these four characteristics that obtained consistently low ratings throughout the year, while the rating for Paved Ditches dropped during the second quarter inspections. It is noted that Turf Condition obtained third and fourth quarter ratings just above the threshold criteria.

In order to continue to increase the rating obtained for miscellaneous drainage structures and highway lights, 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 and paved ditches, 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.
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 25% of the undesirable vegetation is present within the mowing limits of the area.
2) Noxious weeds present.
3) More than 50 cumulative SF of bare ground is present in the turf evaluation area.

Paved Ditches

Maintenance Program:

1) Ditch lines shall be inspected by routine patrols. Evidence of undermining or erosion/siltation shall be scheduled for repair within the annual work program.
2) Finished work shall conform to the lines and grades of the typical section in the area where the work is being performed.
3) Grade site(s) to meet adjacent contours and provide flow for surface drainage.

Maintenance and Evaluation Standards:
Ditches Paved do not meet the maintenance standards when any of the following criteria is observed:

1) Accumulation of material greater than 25% of the depth of the ditch.
2) Undermining or erosion is present at either end or along the parallel edges that threatens the structural integrity.
3) Settlement or misalignment greater than 2 inches.
4) More than 10% of the surface area has cracking exceeding 0.5 inches in width.

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 project. 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, an assessment team visits 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 at the intersection of Green Level Church Road and Green Level West Road was excluded from the inspection inventory due to its removal during the completion of a Town of Cary development project near the intersection. The three signs included in the inspection inventory were found to be in good condition, with the landscaped areas being well maintained. ***Figure 8*** shows two of these signs.

Figure 8: Green Level West Historic District Signs, Landscape Areas

9.0 CONCLUSION

This report presents the 2017 fourth quarter and 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 2017 overall rating was **91.1** and the annual rating was **91.8**, both ratings met the target rating of 90.

All element ratings were above the target ratings for the annual assessment. However, only four of the five elements met the target rating for the quarterly assessment. During the fourth quarter, Traffic Control Devices (82.4) obtained a rating lower than the required elements rating of 85. This rating is attributed to low ratings obtained for Pavement Striping/Marking (68) and Highway Lighting (68). Out of the four elements that met the required rating, Traffic Control Devices (82.4) also experienced a decrease in rating compared to the previous quarter, while Drainage (87.6) experienced an increase in rating compared to the previous quarter. The Traffic Control Devices rating decreased by 2.8 points, and the Drainage rating increased by 4.4 points.

During the fourth quarter assessment, all but five characteristics met or exceeded the target rating of 80. These five characteristics are: Curb and Gutter (79), Miscellaneous Drainage (74), Retaining Walls and Sound Barrier Walls (73), Pavement Striping/Marking (68), and Highway Lighting (68). Similarly, during the annual assessment four characteristics did not meet the target rating of 80. These characteristics are: Paved Ditches (75), Miscellaneous Drainage (68), Turf Condition (75), and Highway Lighting (70).

To improve the ratings, it is recommended that the maintenance provider conduct routine patrols of curb and gutters and shoulder underdrains, in addition to periodically removing any debris or overgrown vegetation that may impede the flow of water. It is also recommended that outlet elevations be checked against the outflow ditch elevations to ensure positive drainage and prevent drain outlets from backing up with water. Applicable grading of the ditch line may be necessary to provide positive flow.

Also, it is recommended that the maintenance provider repair and/or replace all defects in highway lights, and that unwanted vegetation is removed from walls and decorative supports. Additionally, wall paint scaling issues should be scheduled for repair within the annual work plan to alleviate further deterioration and maintain the facility's intended aesthetics. Pavement striping/marking replacement cycles should be scheduled and completed as planned in the capital budget, and the bare areas seeding/fertilization program efforts should also continue during the spring and summer seasons to promote new turf growth.

This quarter, only three of the four Green Level Historic District sign locations were inspected due to the removal of one of the signs as part a Town of Cary development project near Green Level West Road. The three signs inspected were found to be in good standing condition. Additionally, the landscaped areas surrounding the signs were found to be well maintained.

Appendix A

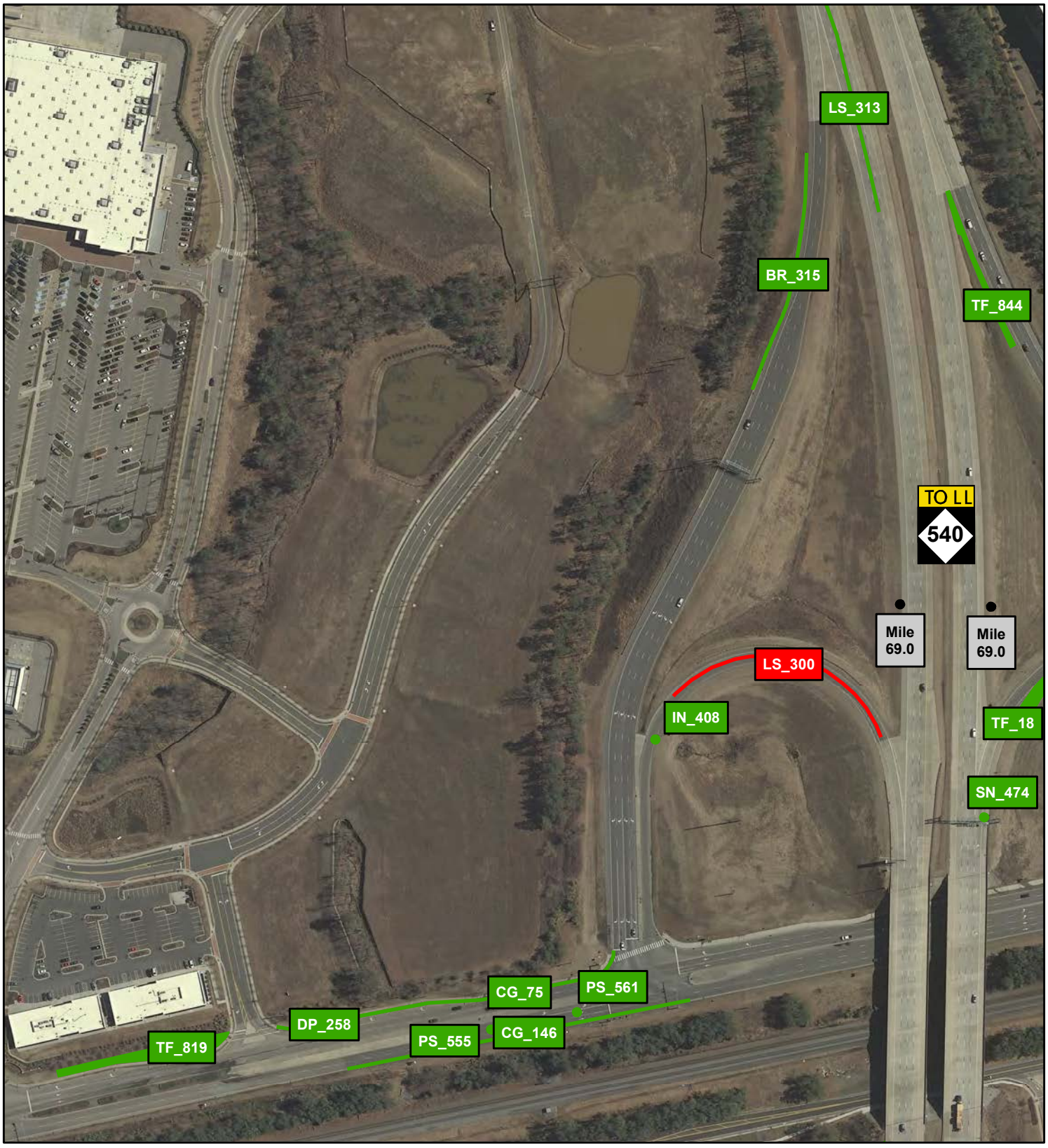
Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2017 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 Attenutators – 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 2017 Fourth Quarter Asset Assessment Locations



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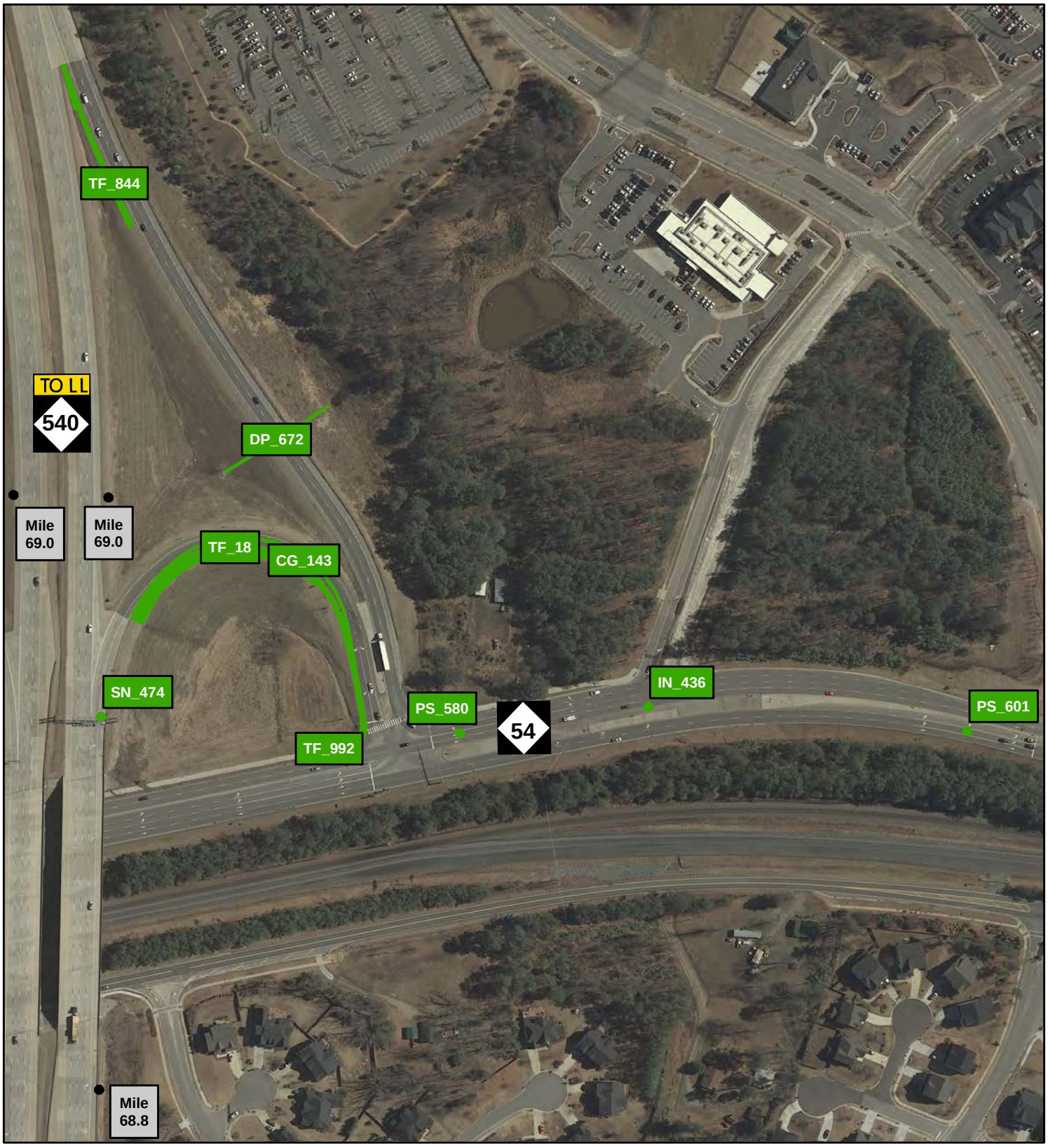
NORTH CAROLINA Turnpike Authority

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations



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NORTH CAROLINA Turnpike Authority

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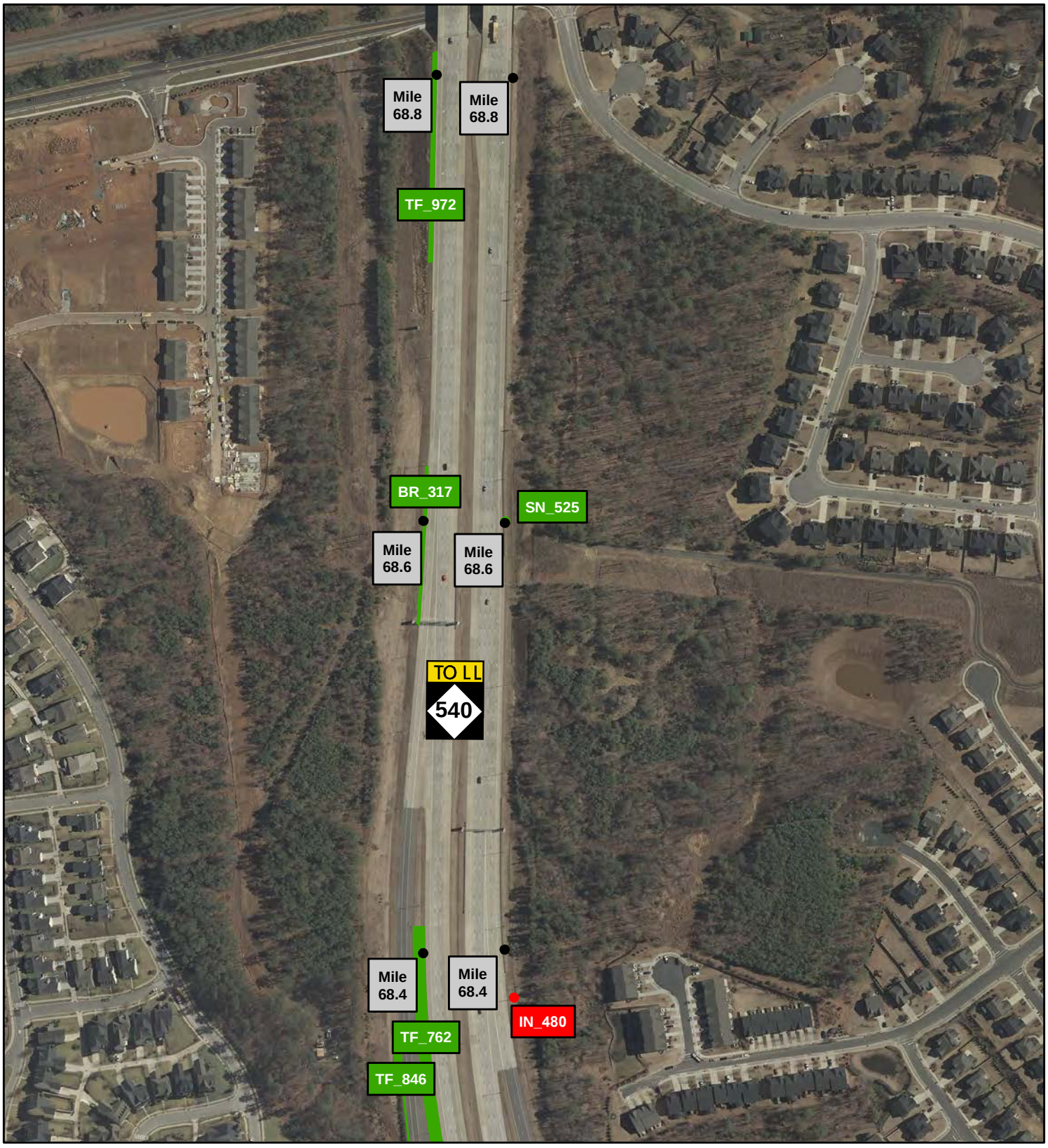
Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations



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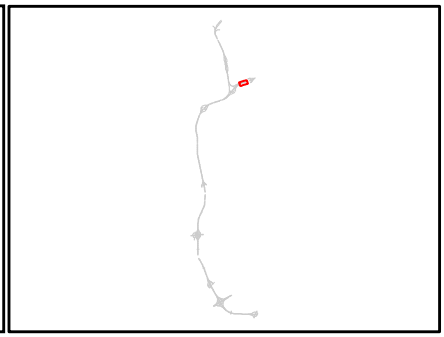

NORTH CAROLINA Turnpike Authority

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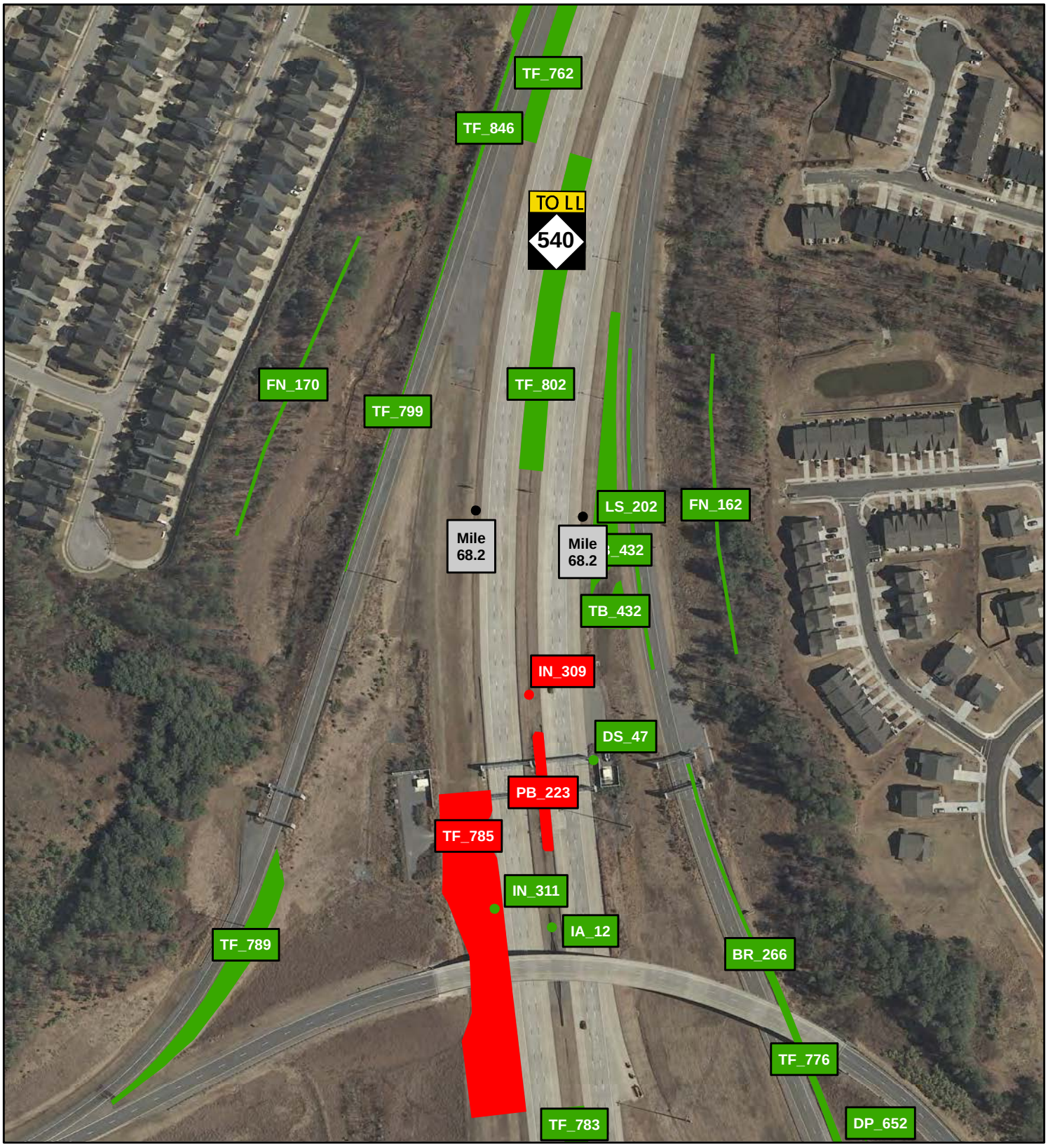

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NORTH CAROLINA Turnpike Authority

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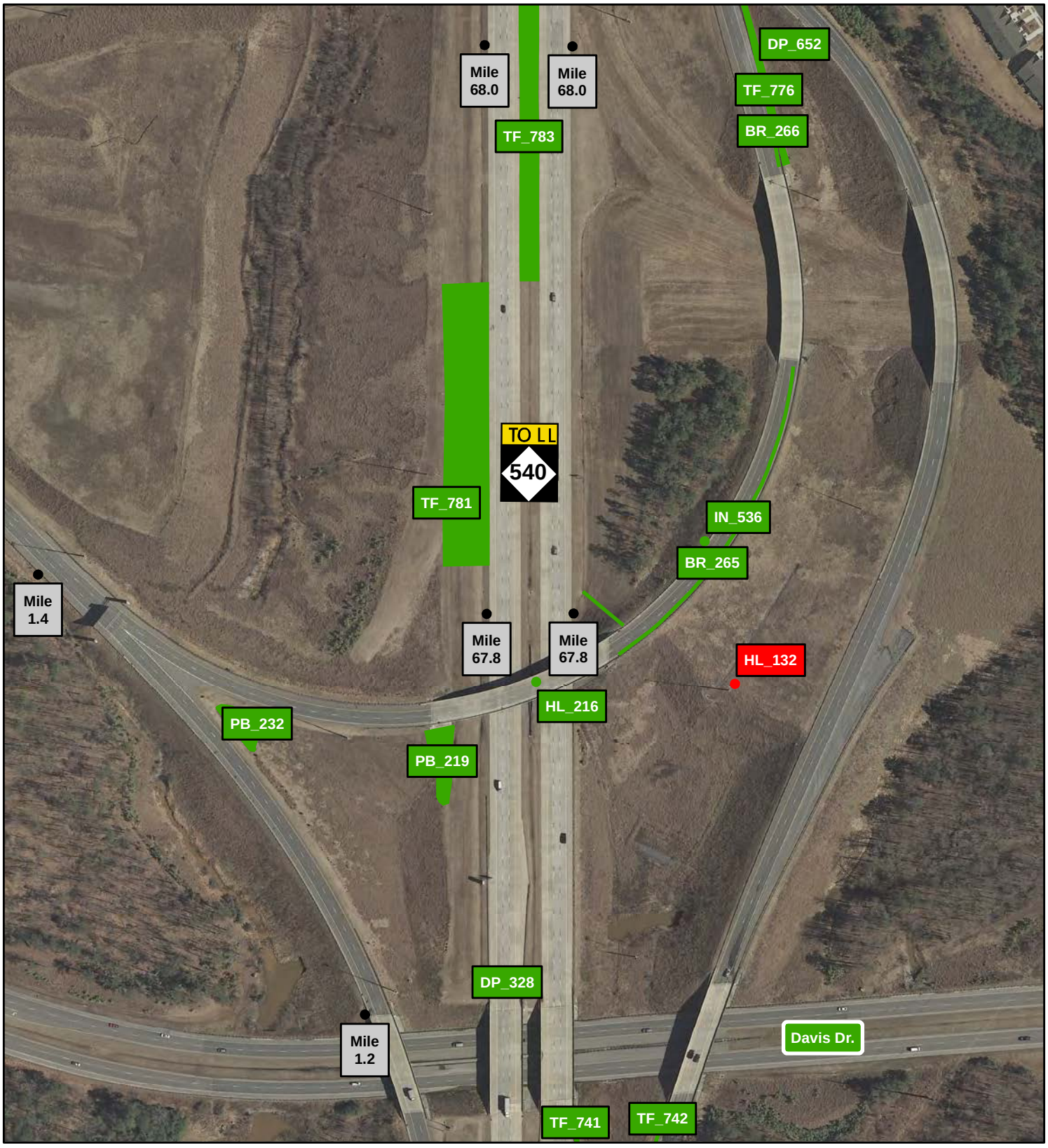

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NORTH CAROLINA Turnpike Authority

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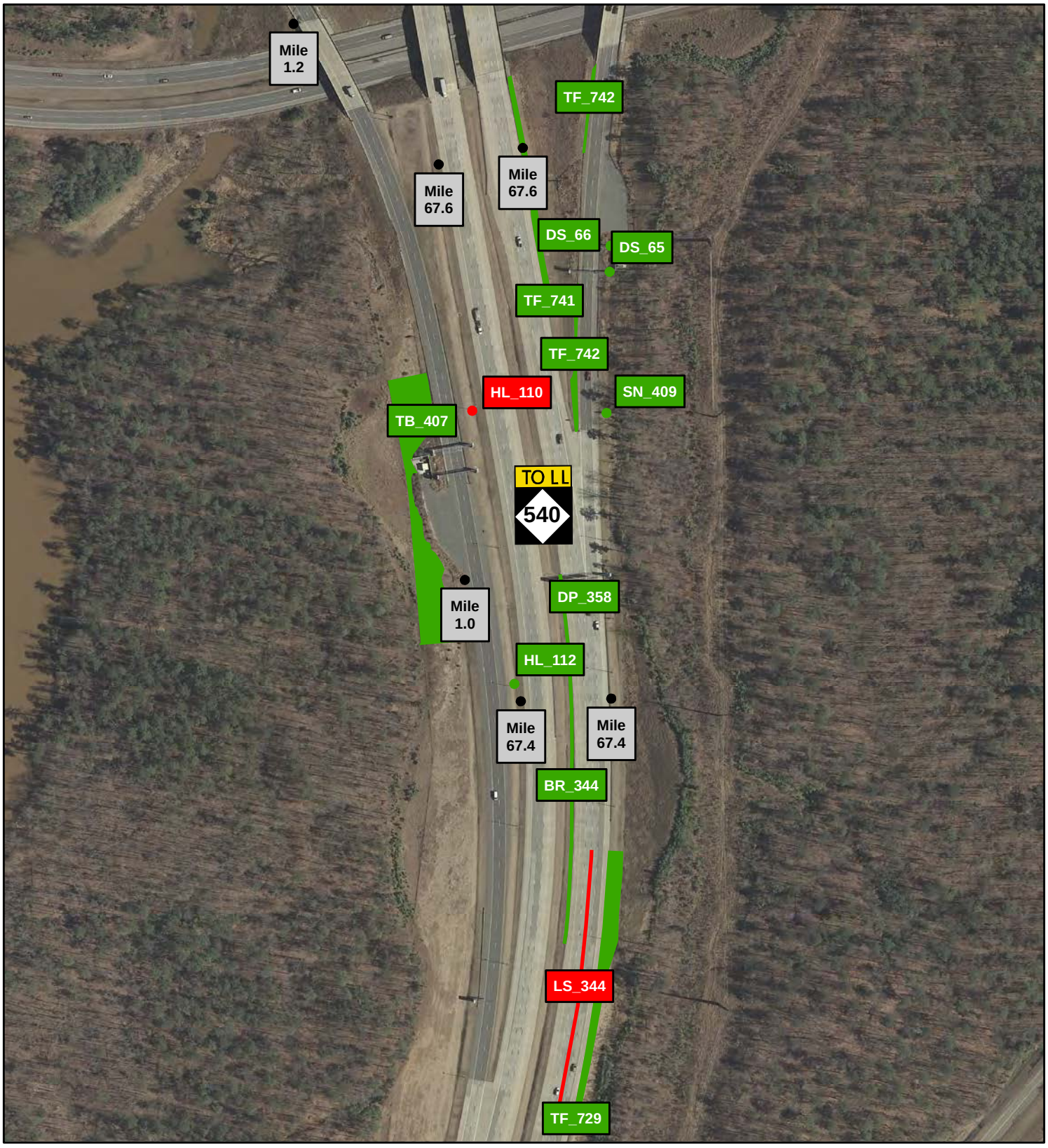

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NORTH CAROLINA Turnpike Authority

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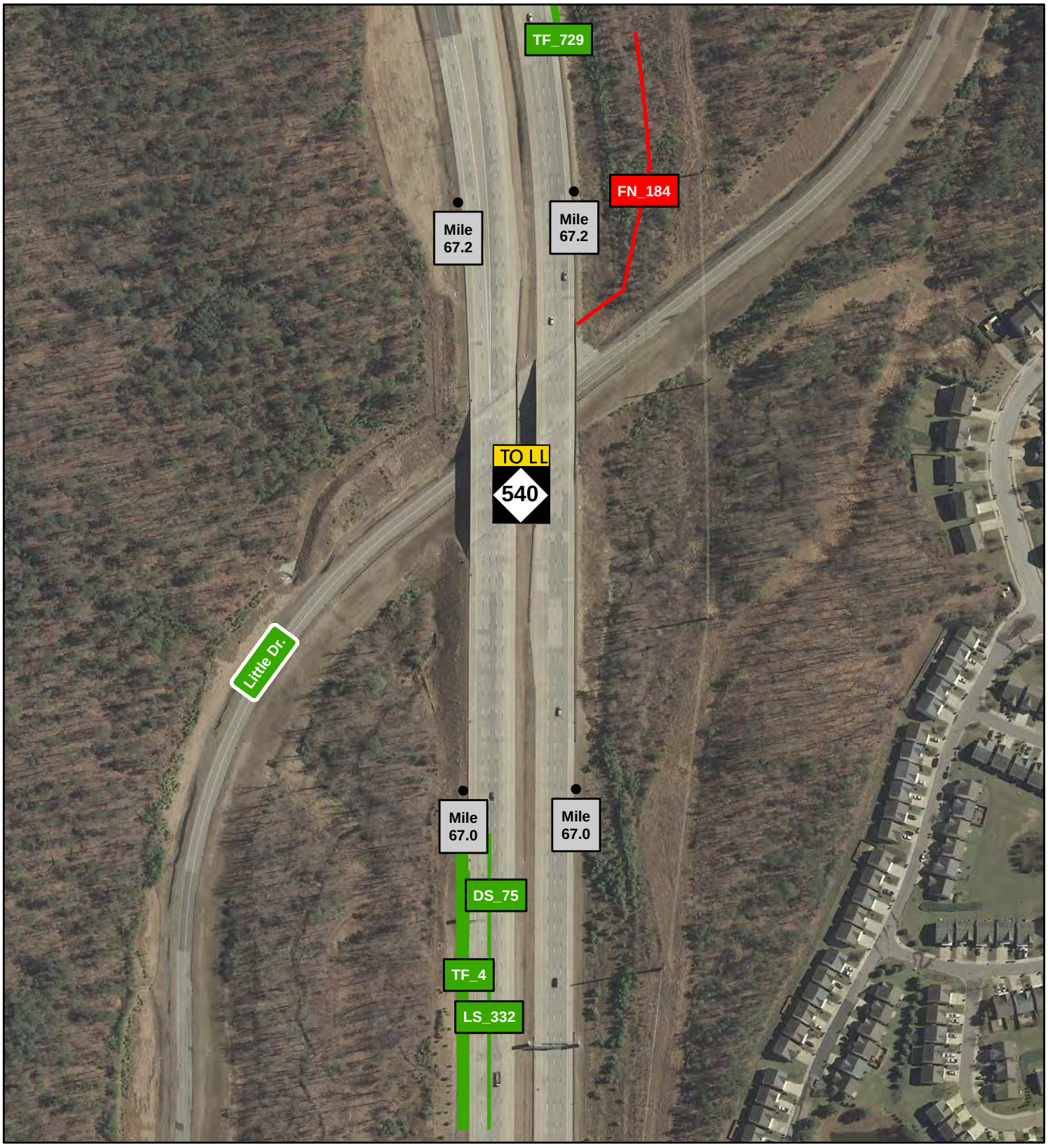

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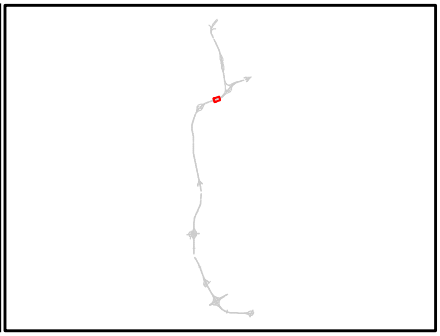

NORTH CAROLINA Turnpike Authority

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations

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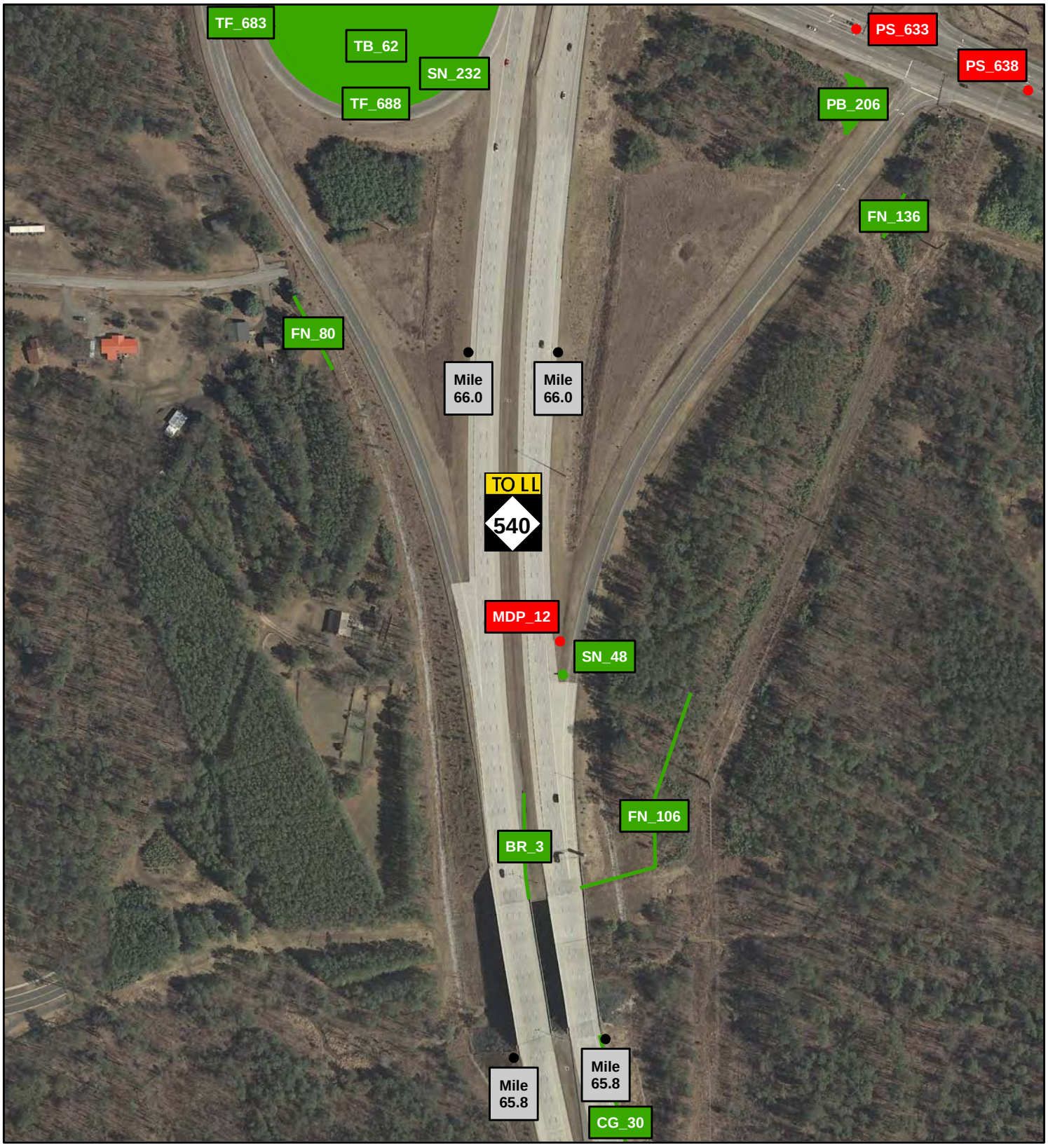

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Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations

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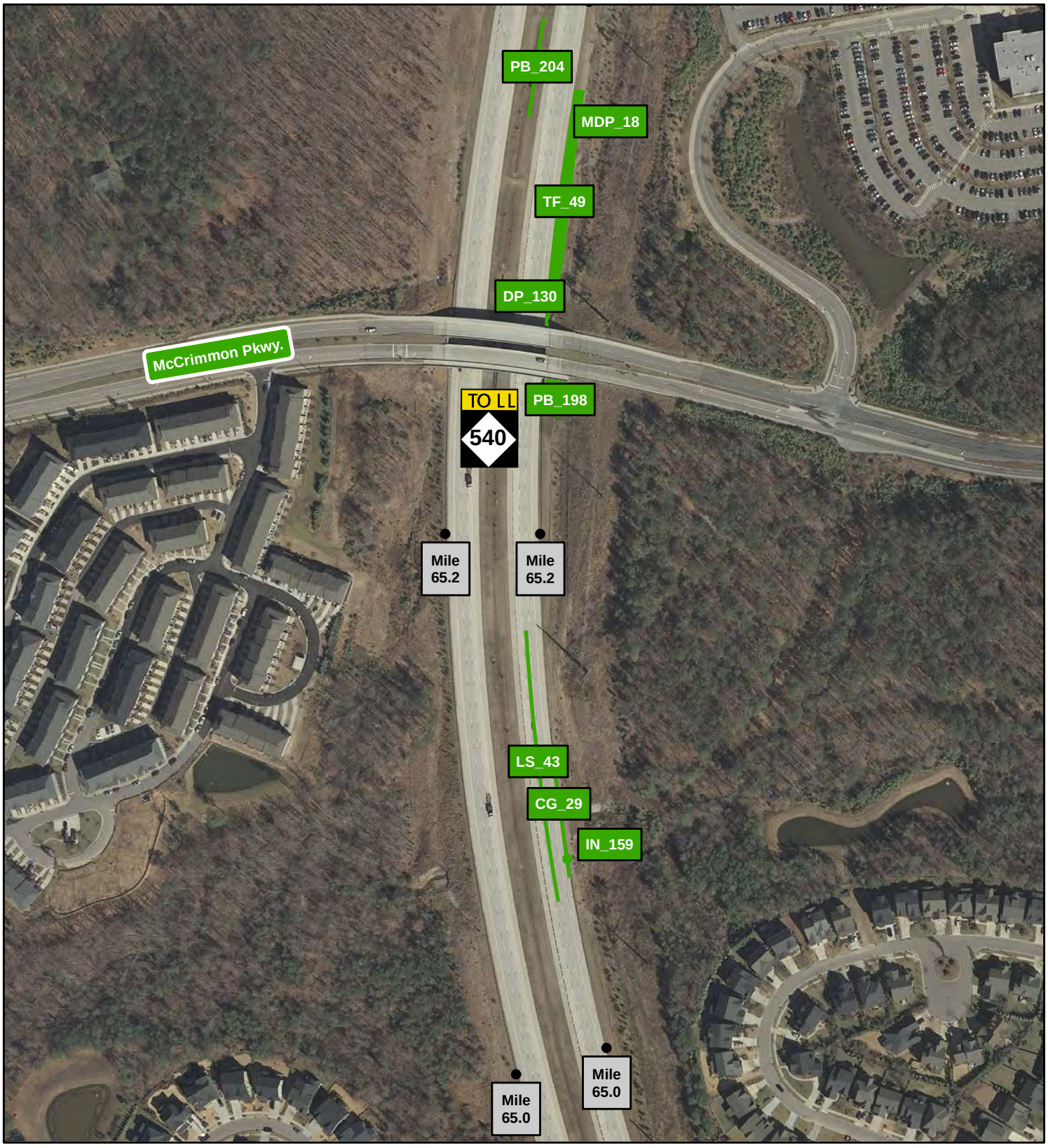

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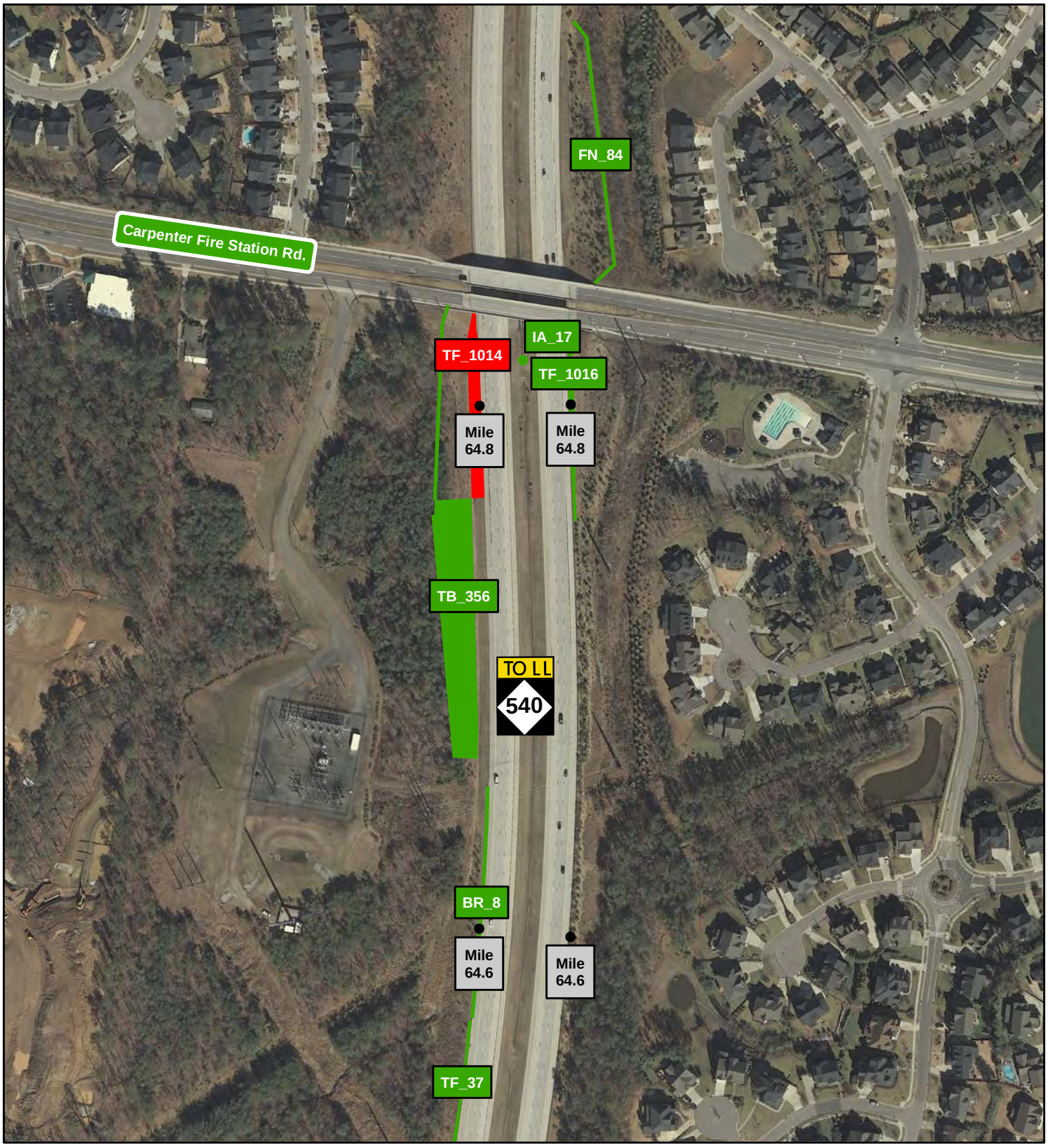

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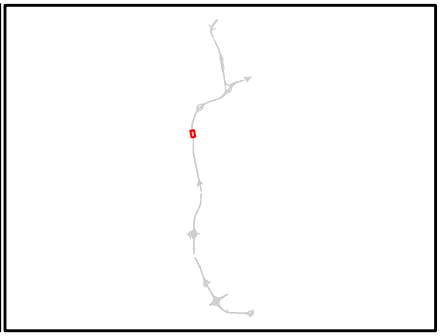

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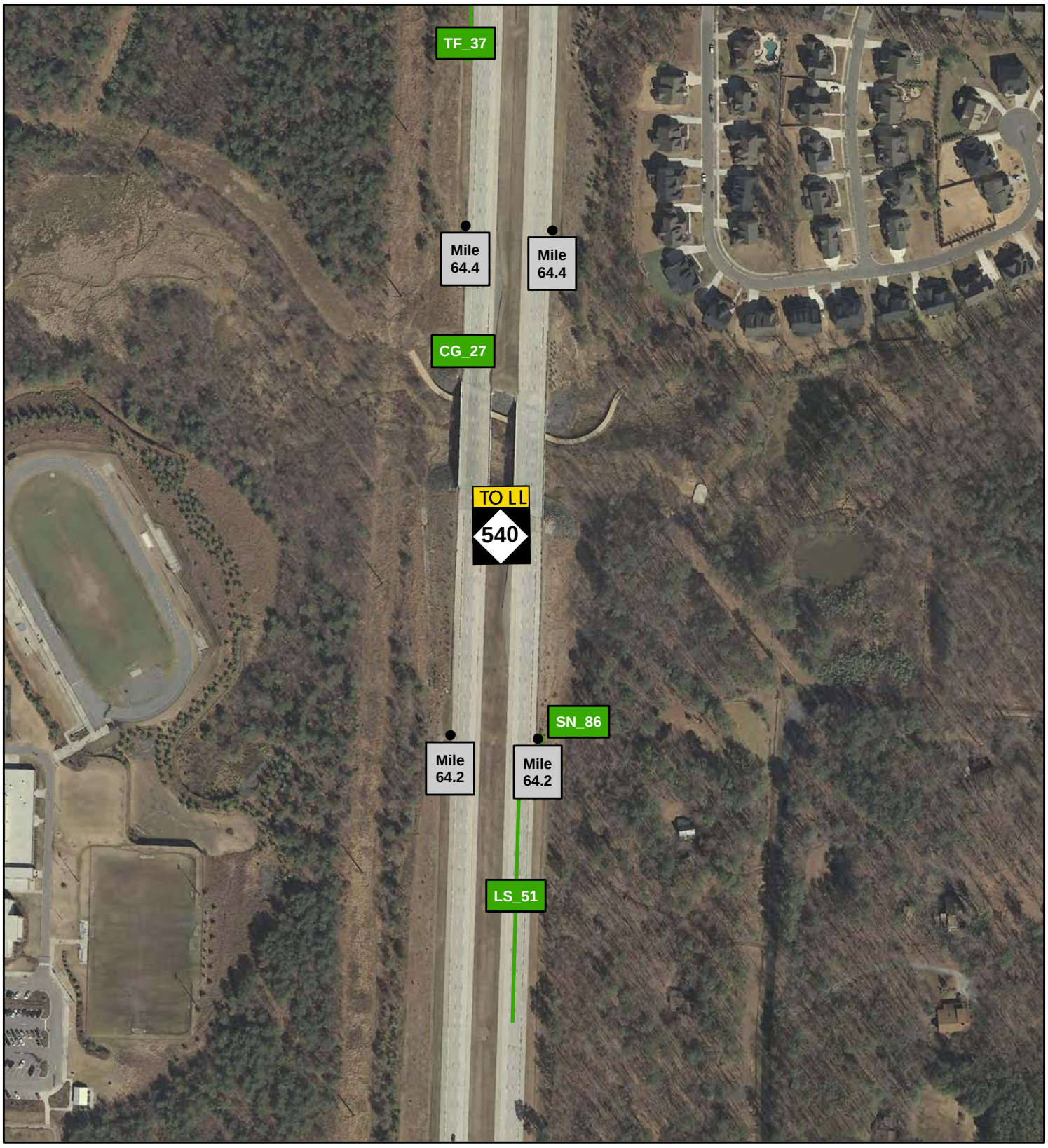

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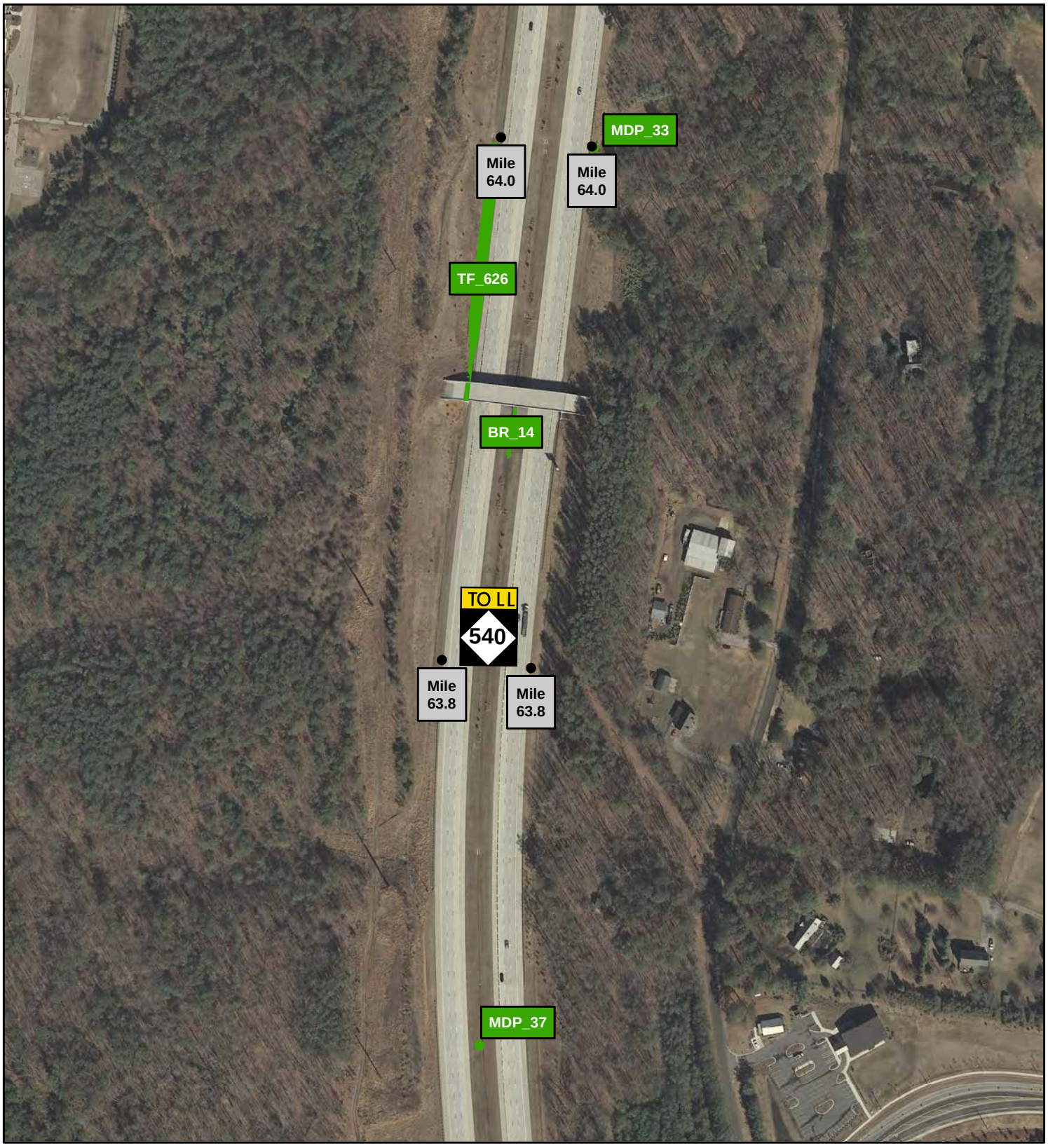

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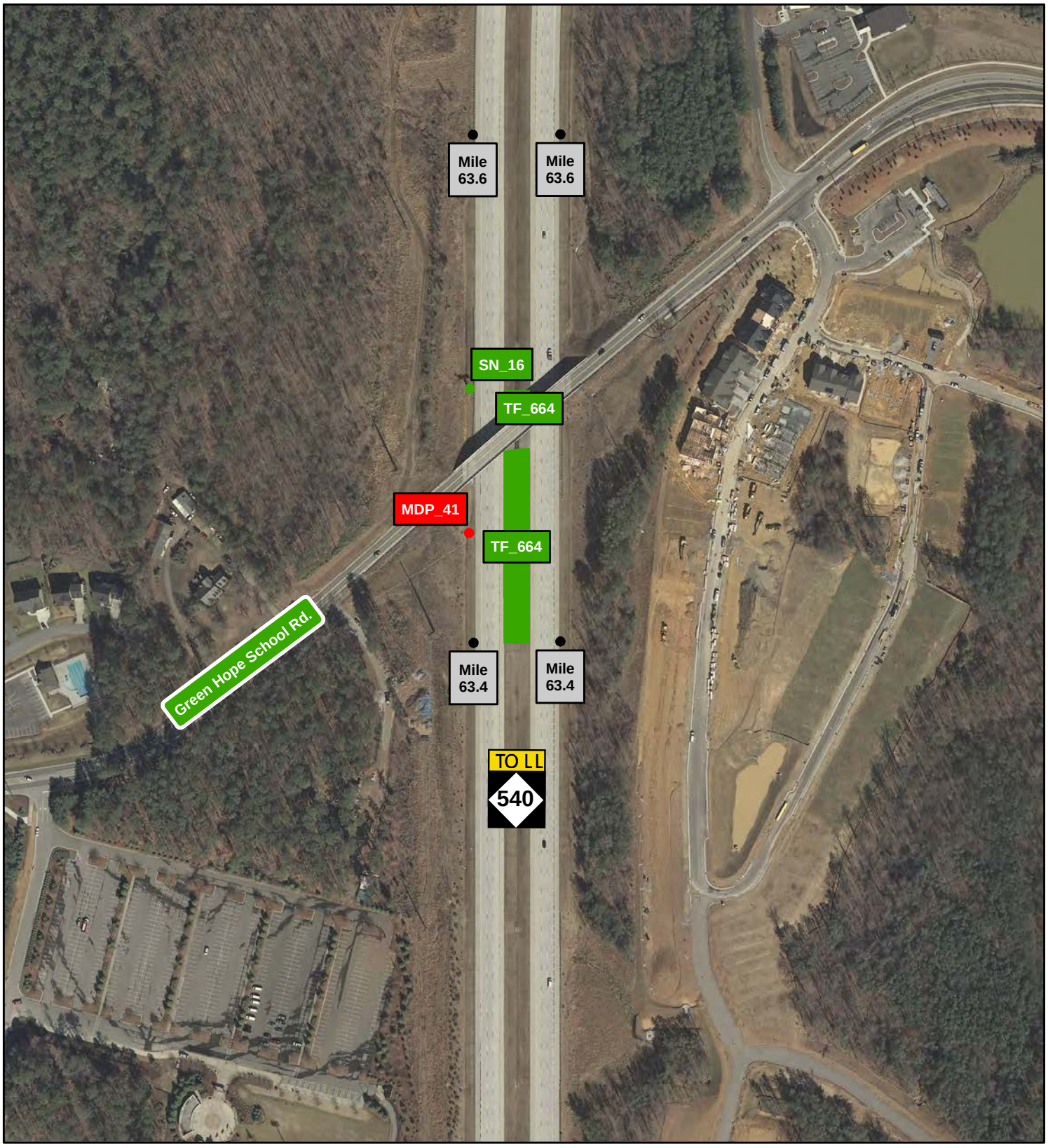

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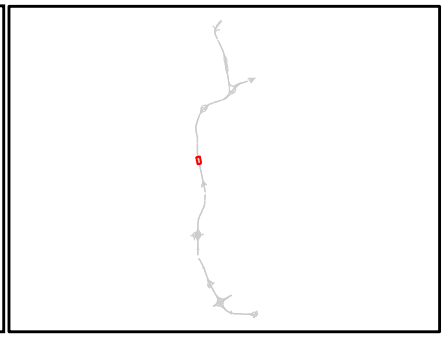

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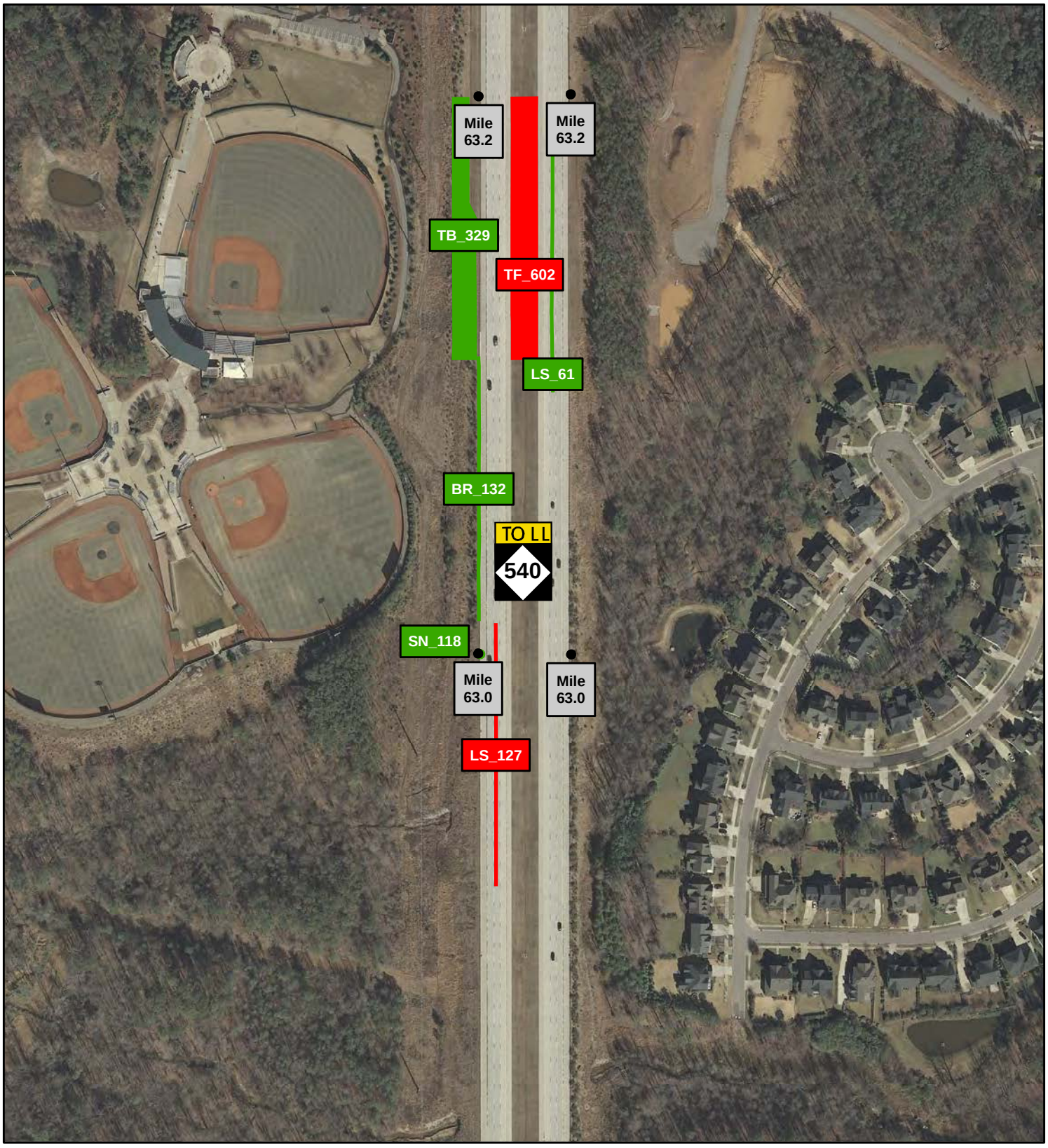

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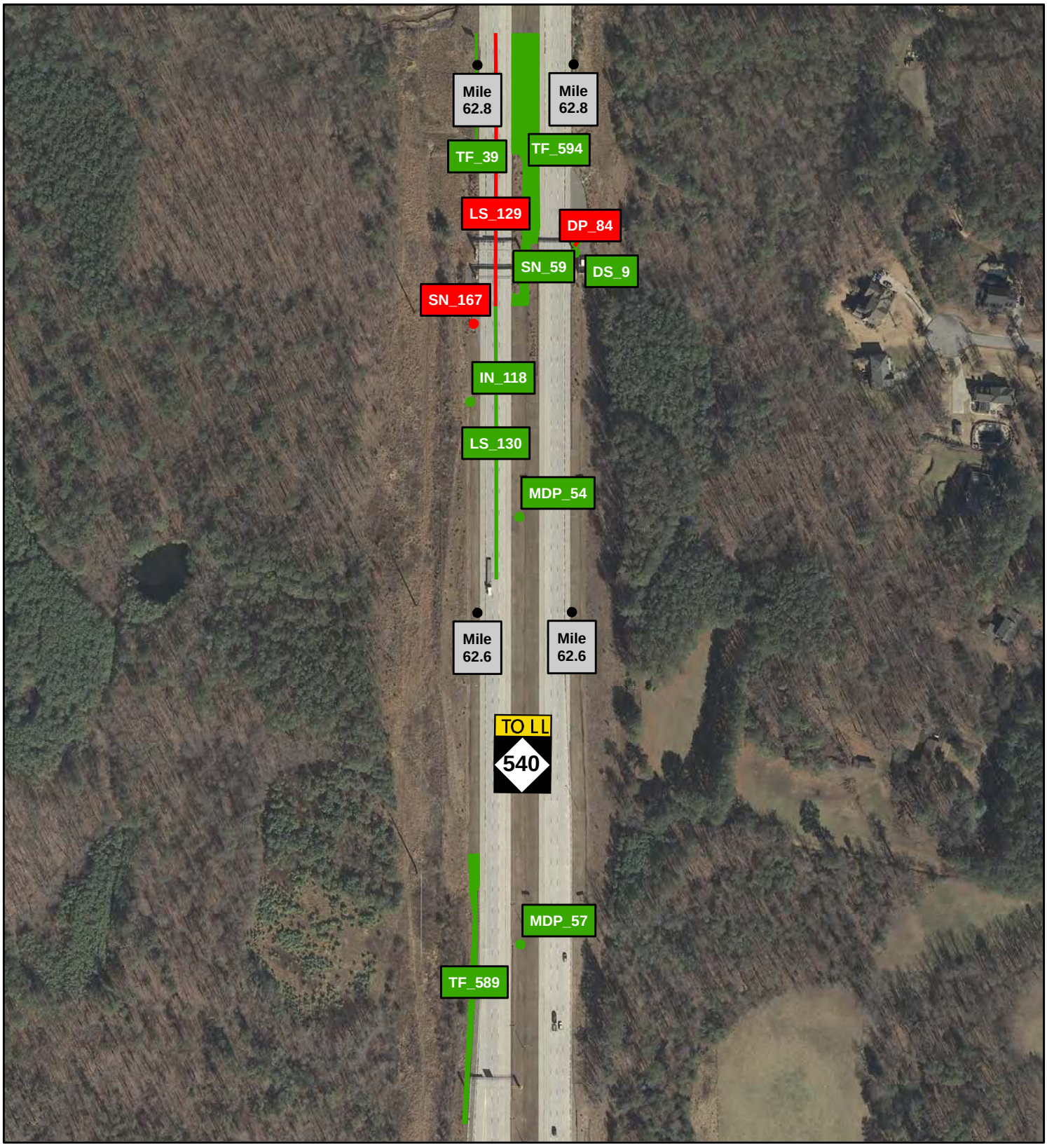

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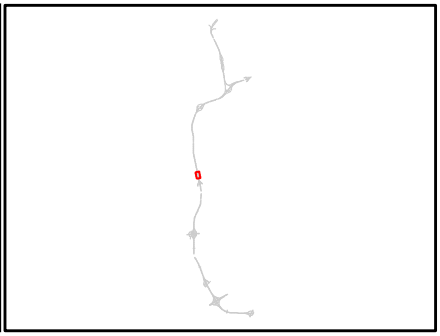

NORTH CAROLINA Turnpike Authority

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations

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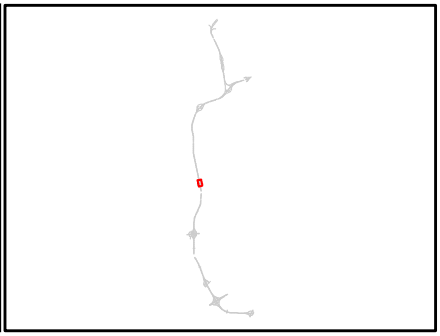

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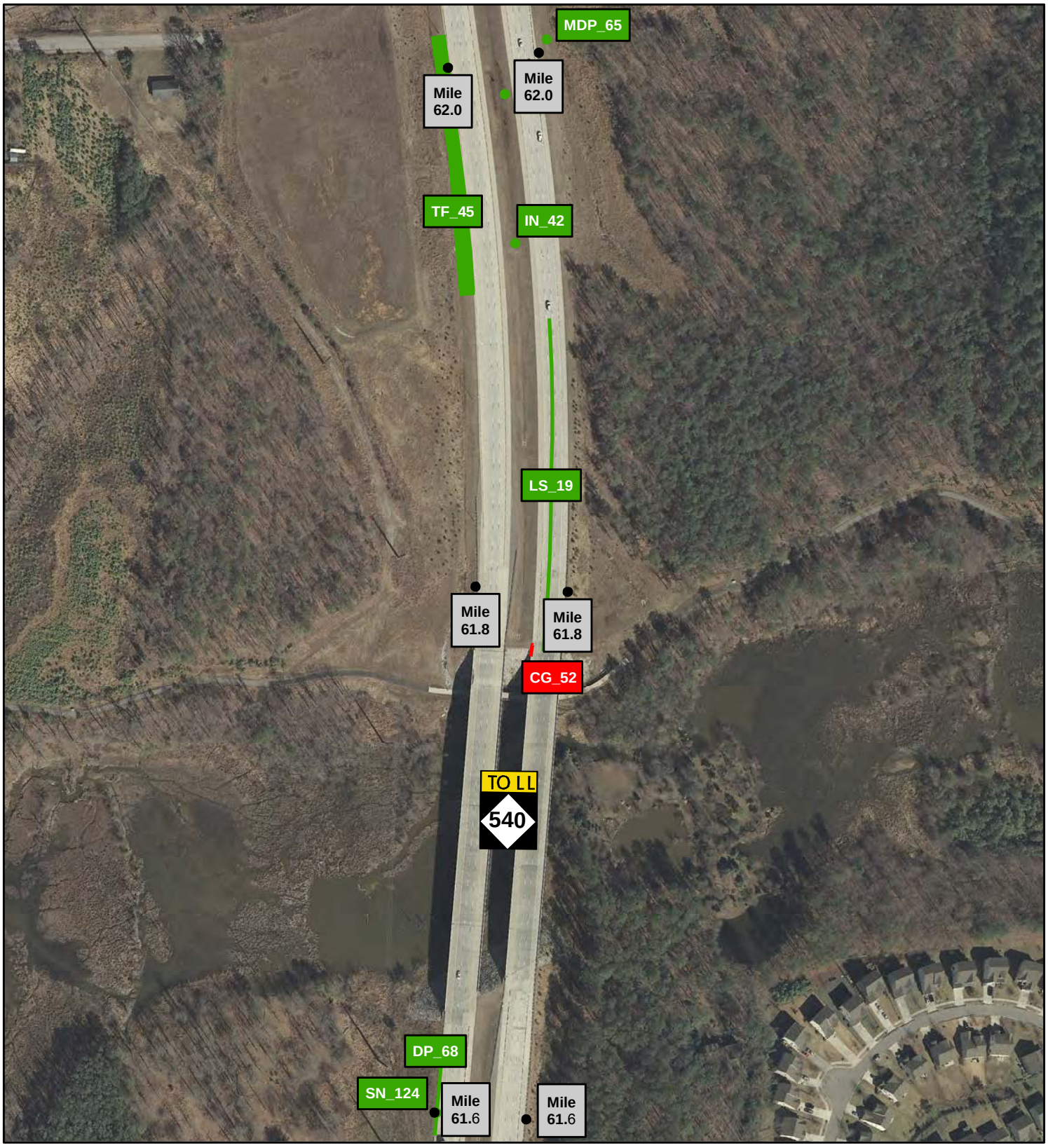

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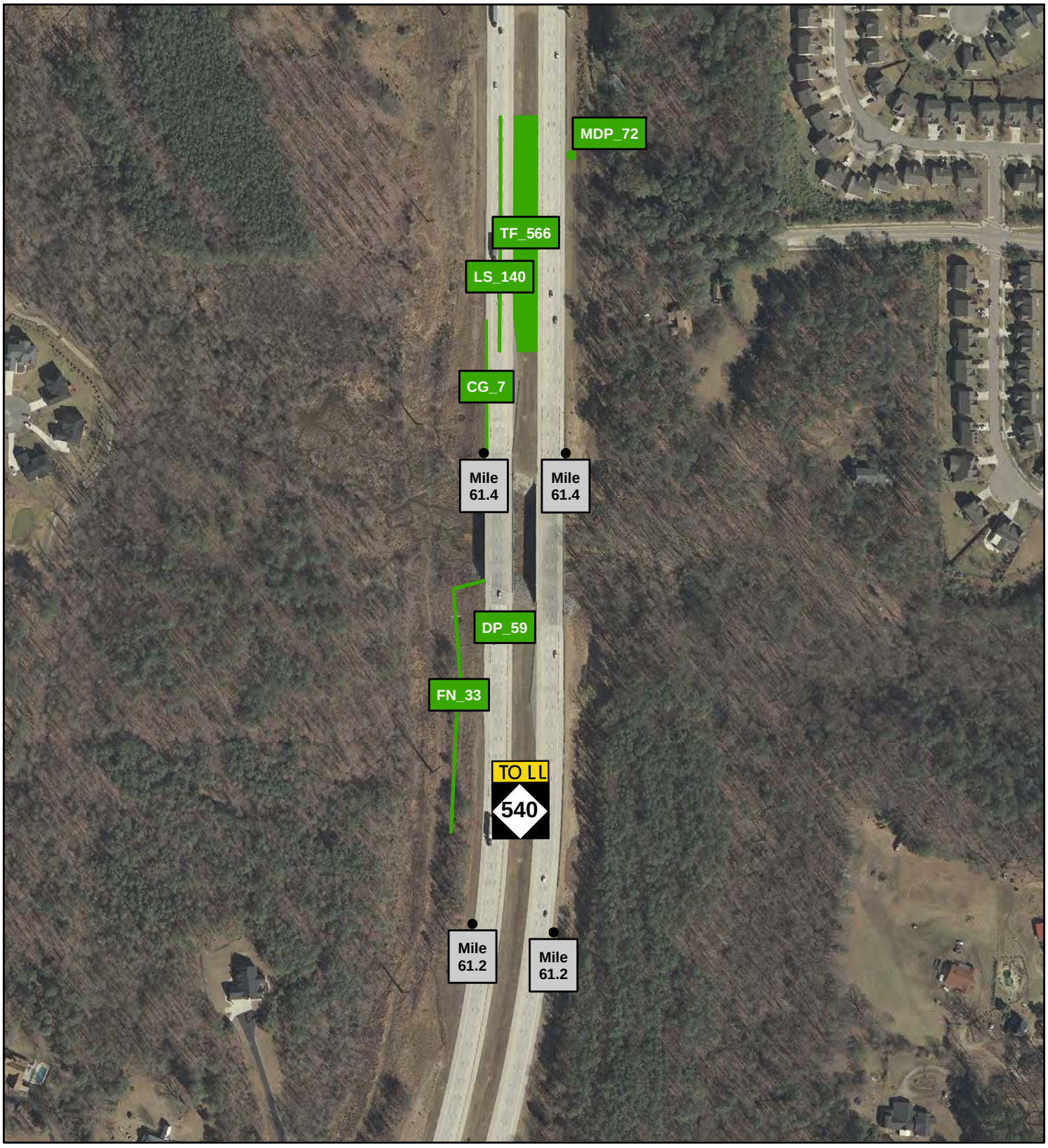

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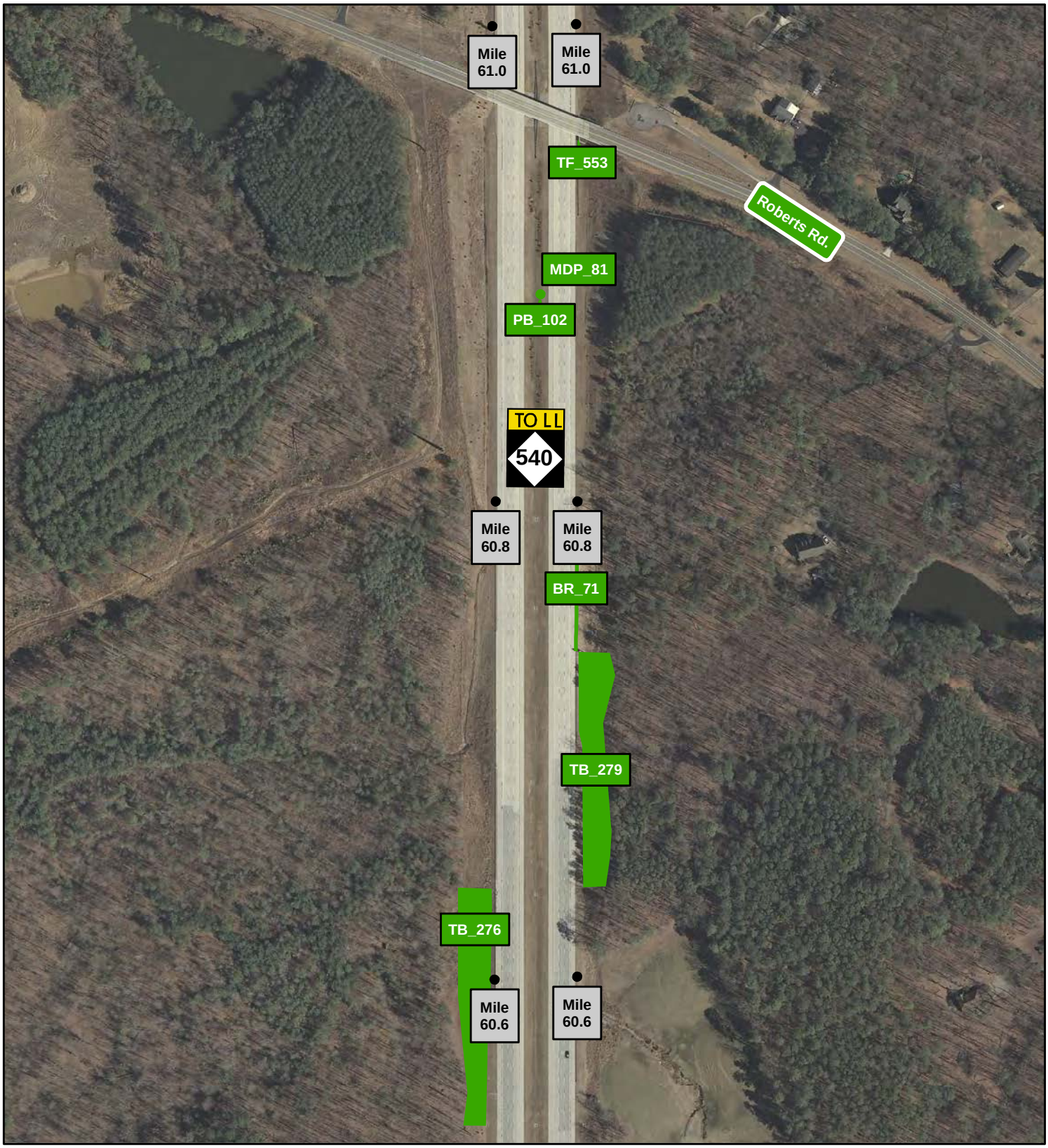

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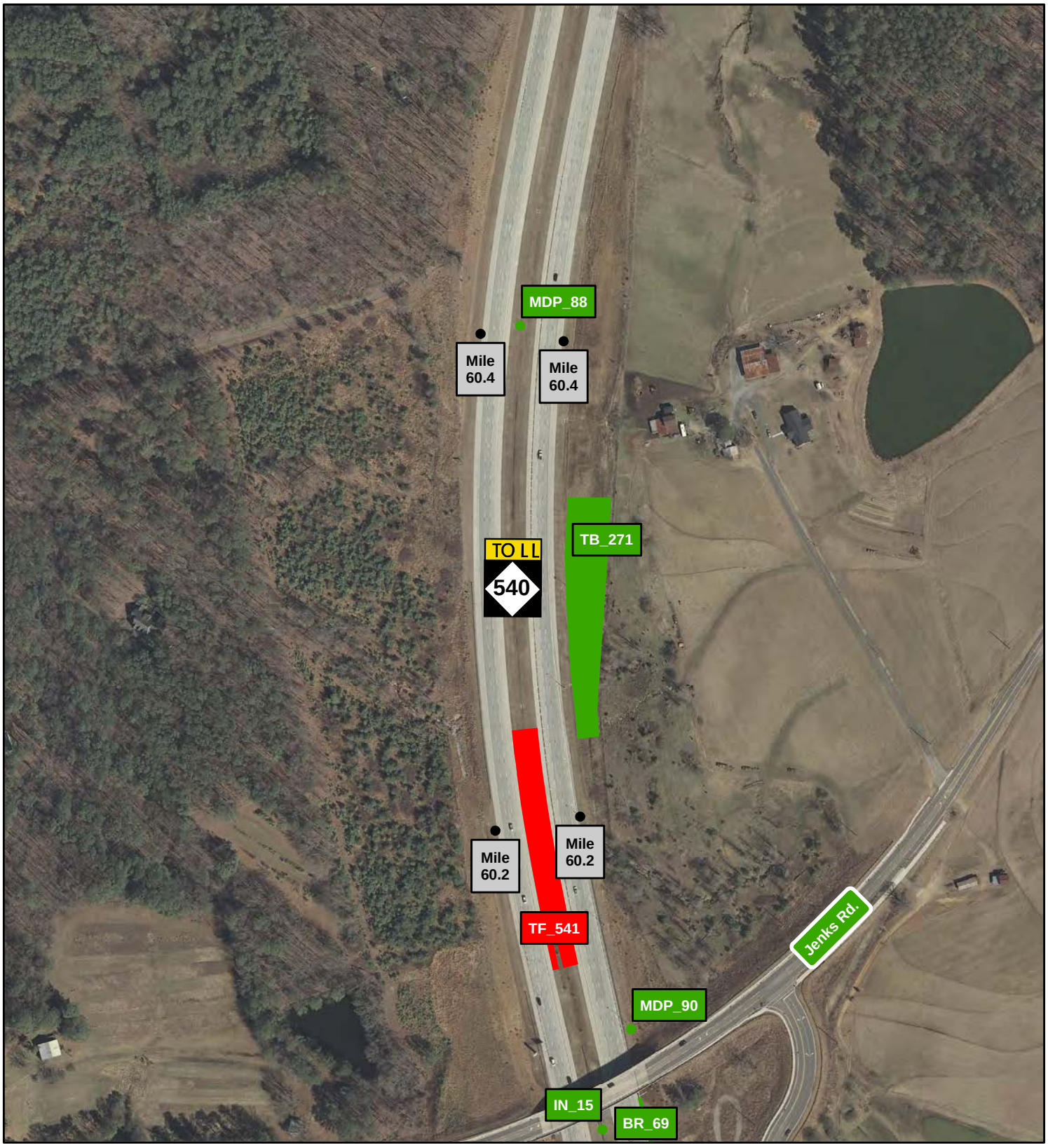

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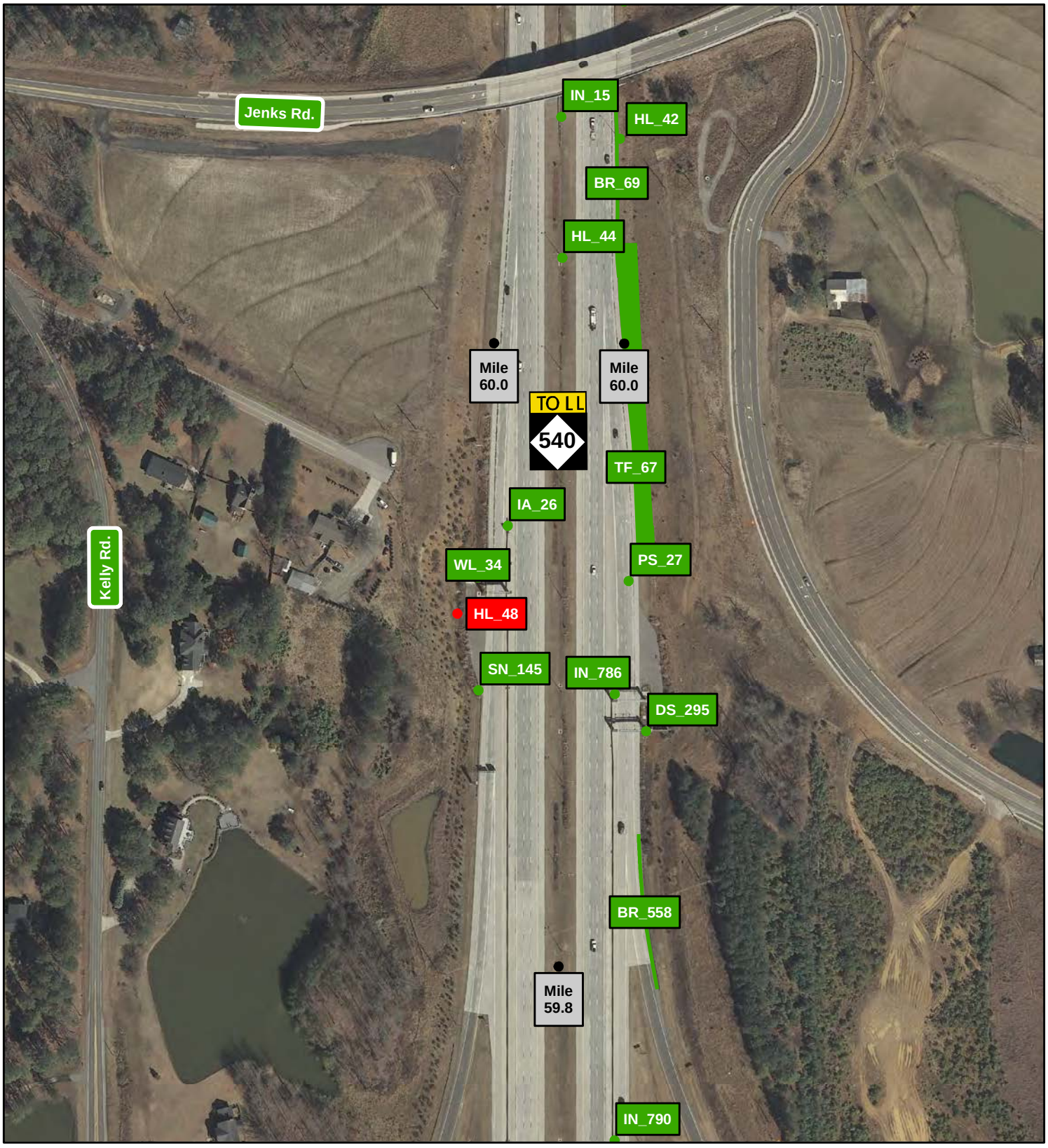

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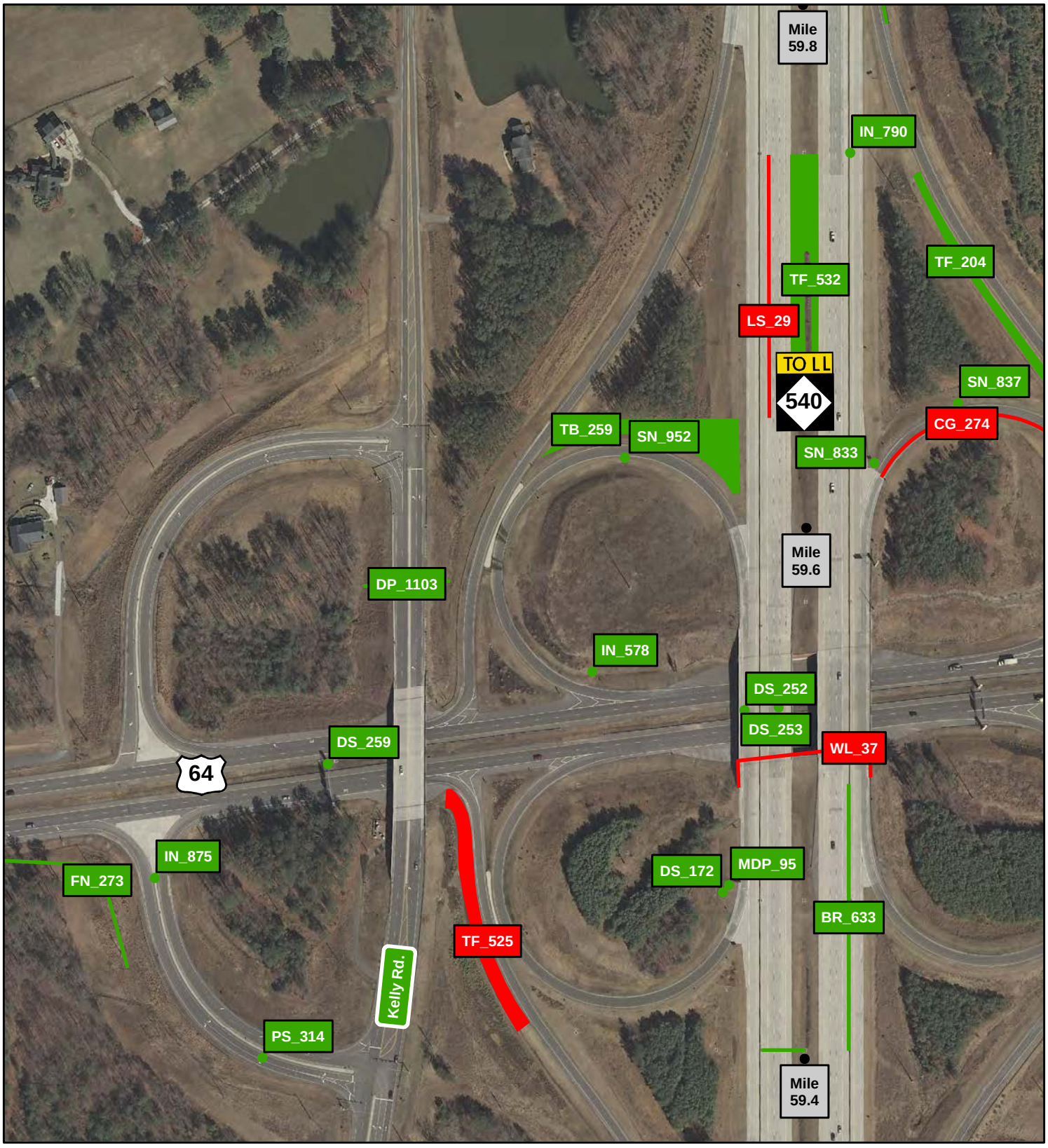

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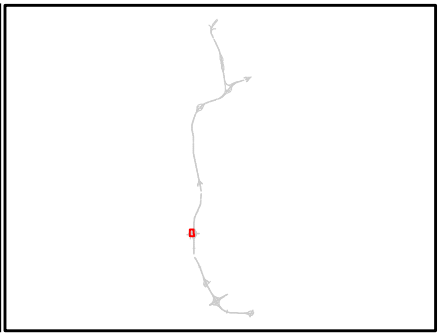

NORTH CAROLINA Turnpike Authority

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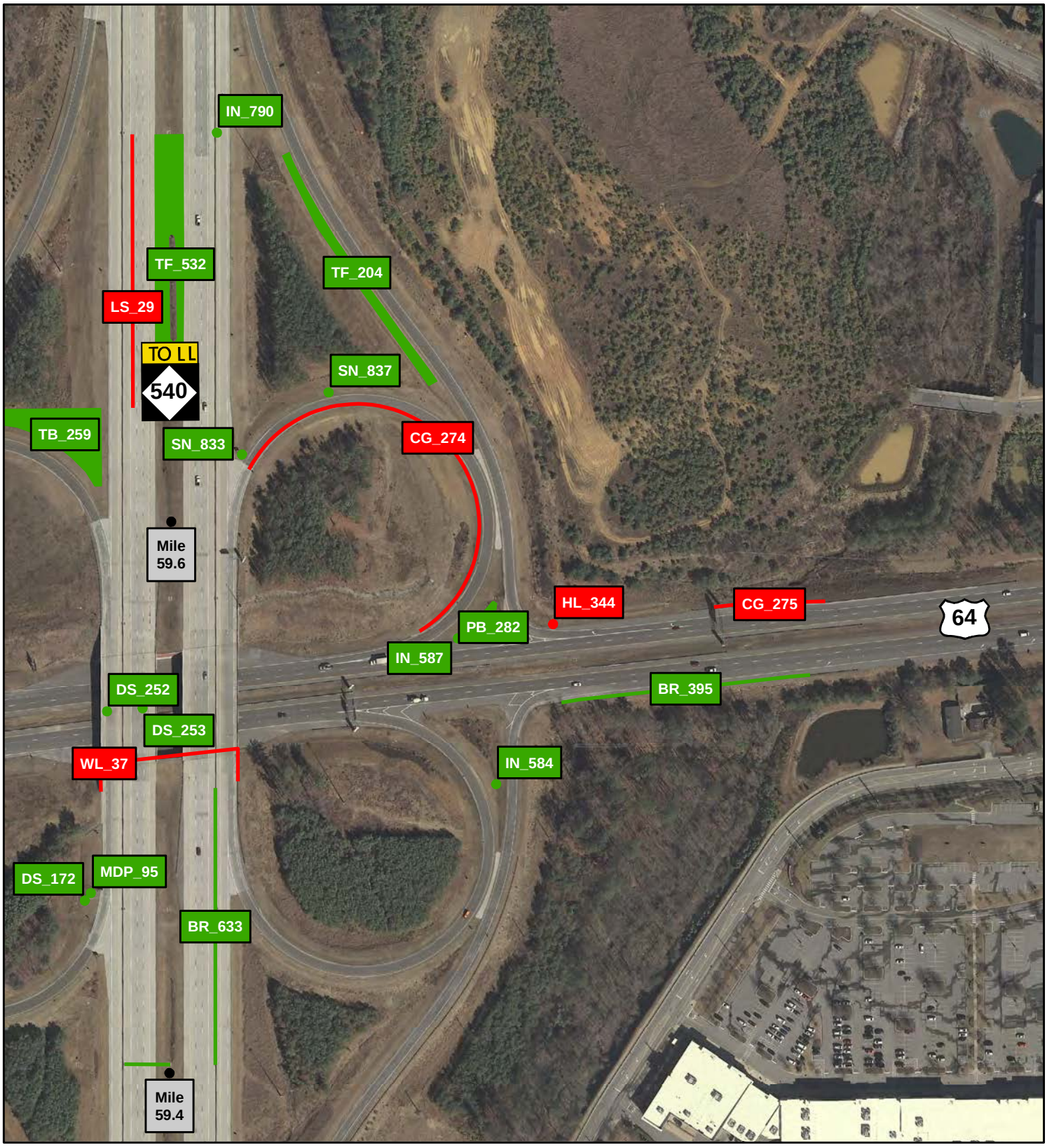

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NORTH CAROLINA Turnpike Authority

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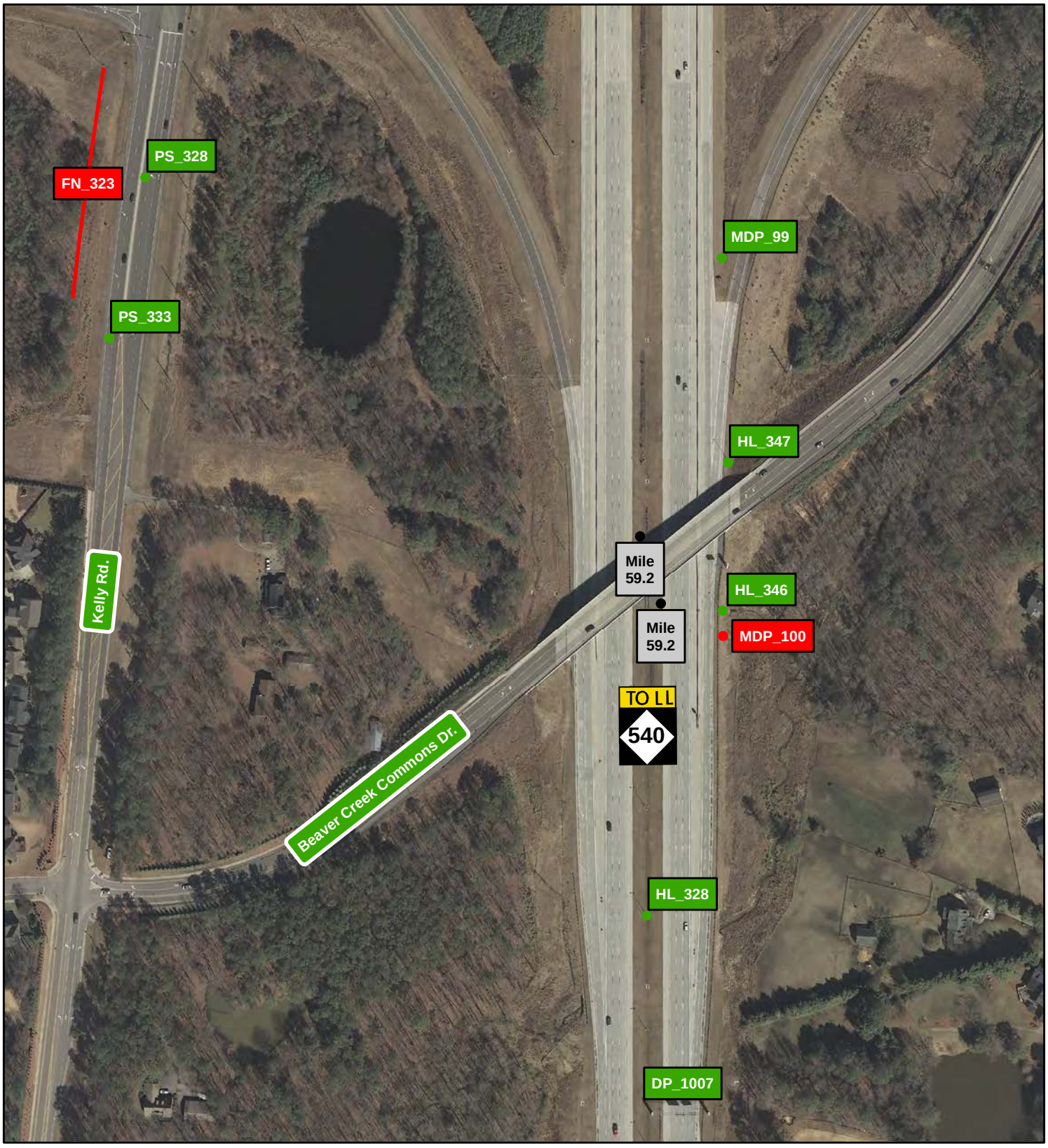

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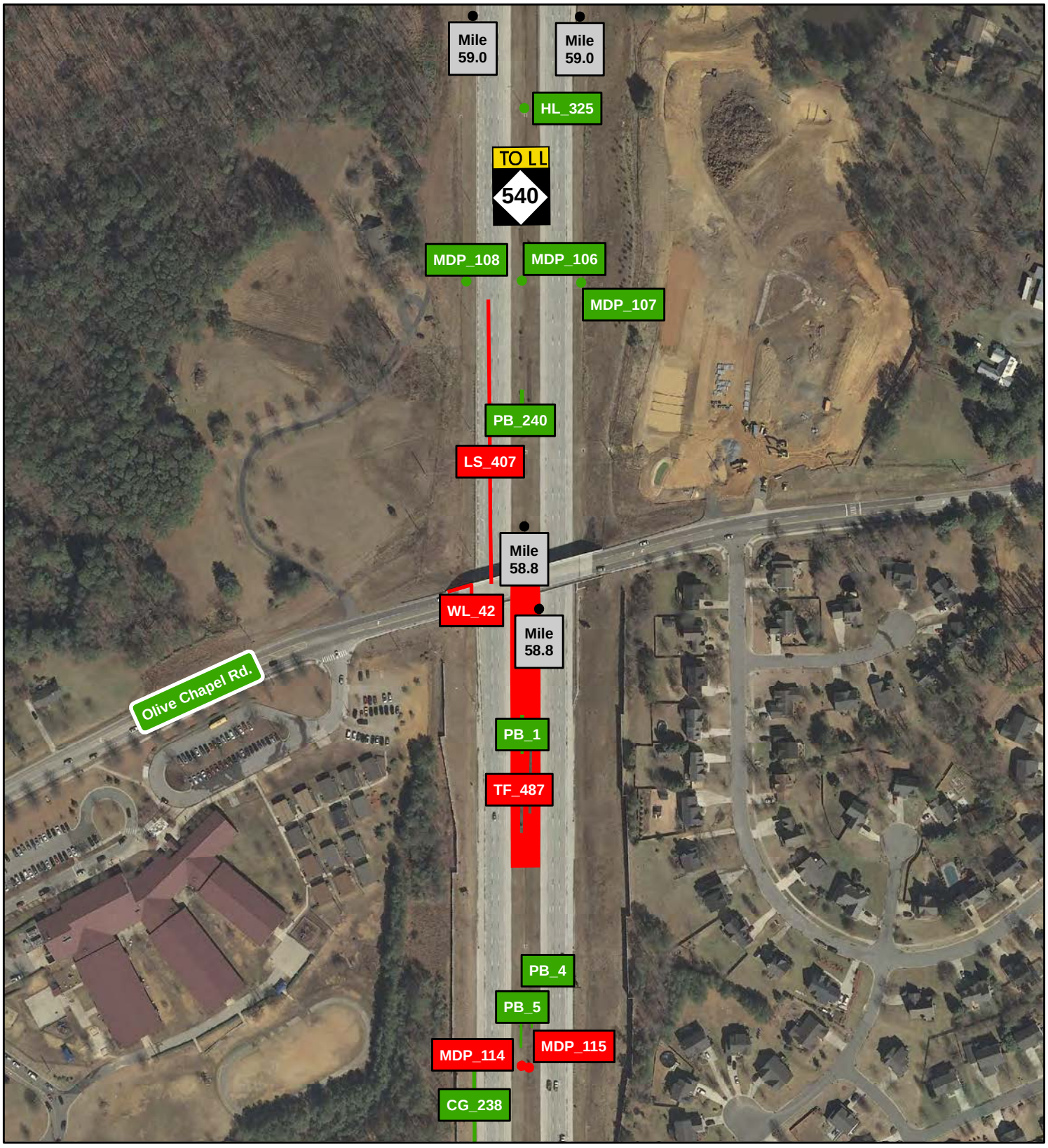
NORTH CAROLINA Turnpike Authority

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations



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NORTH CAROLINA Turnpike Authority

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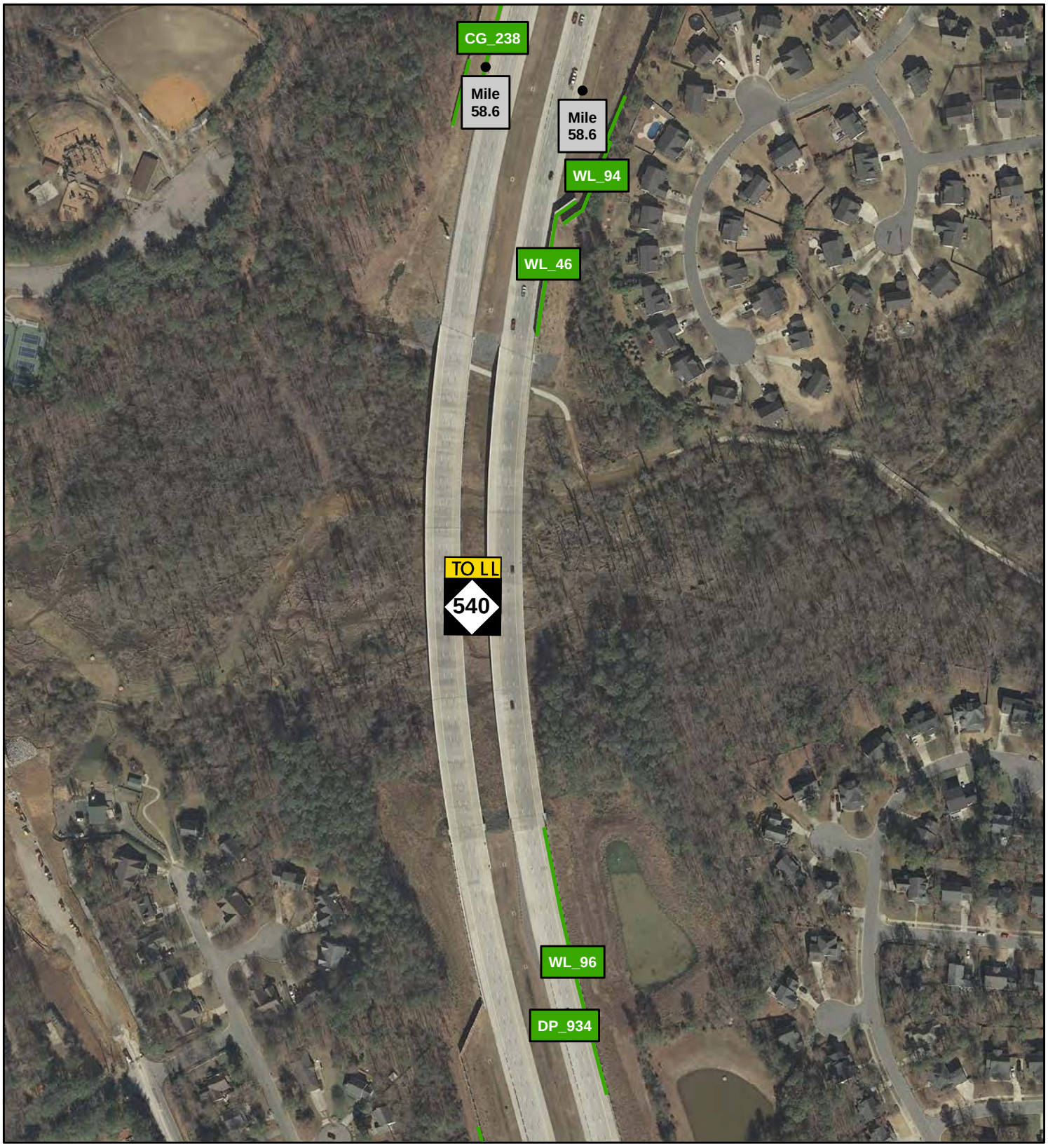

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NORTH CAROLINA Turnpike Authority

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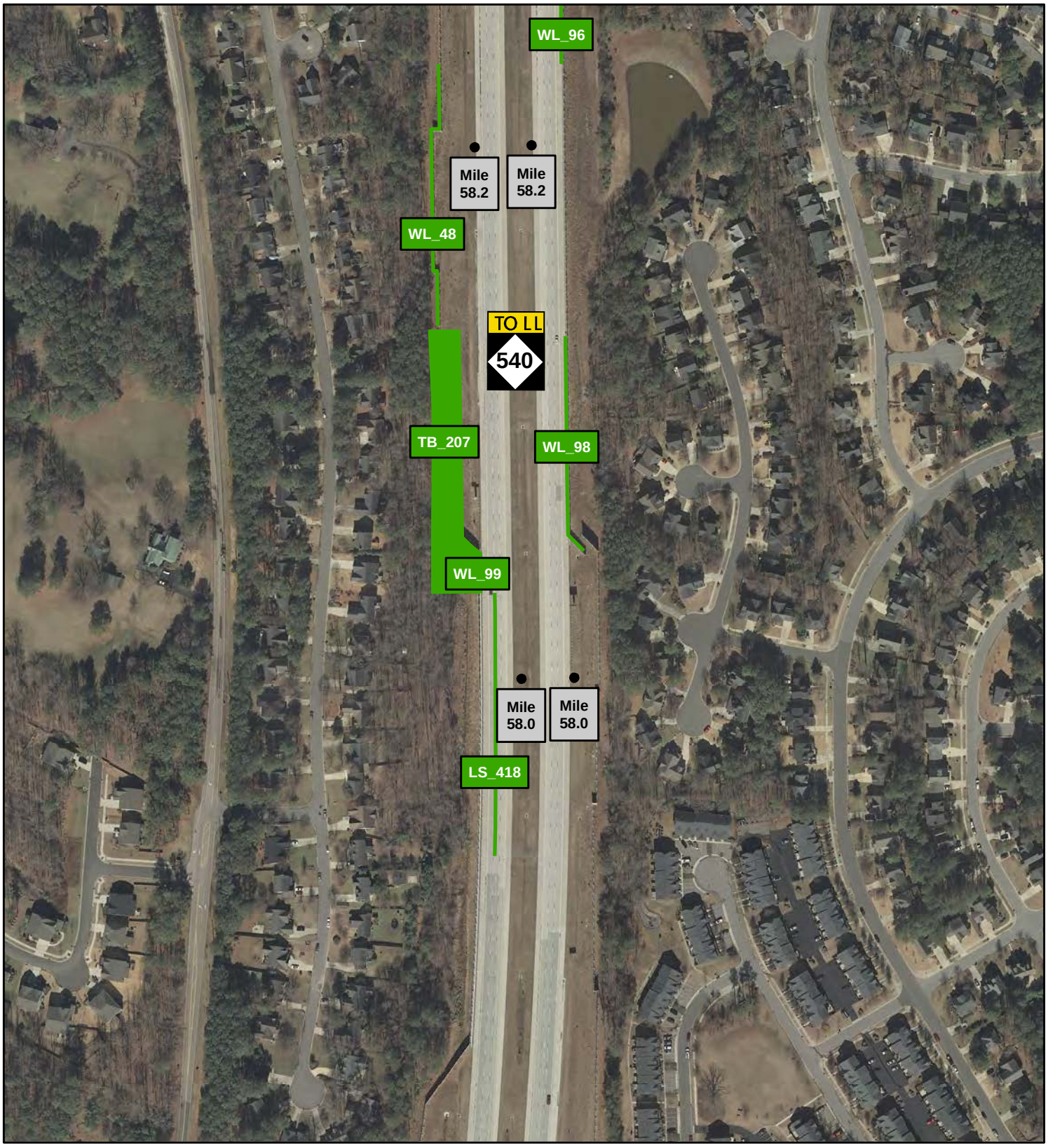

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NORTH CAROLINA Turnpike Authority

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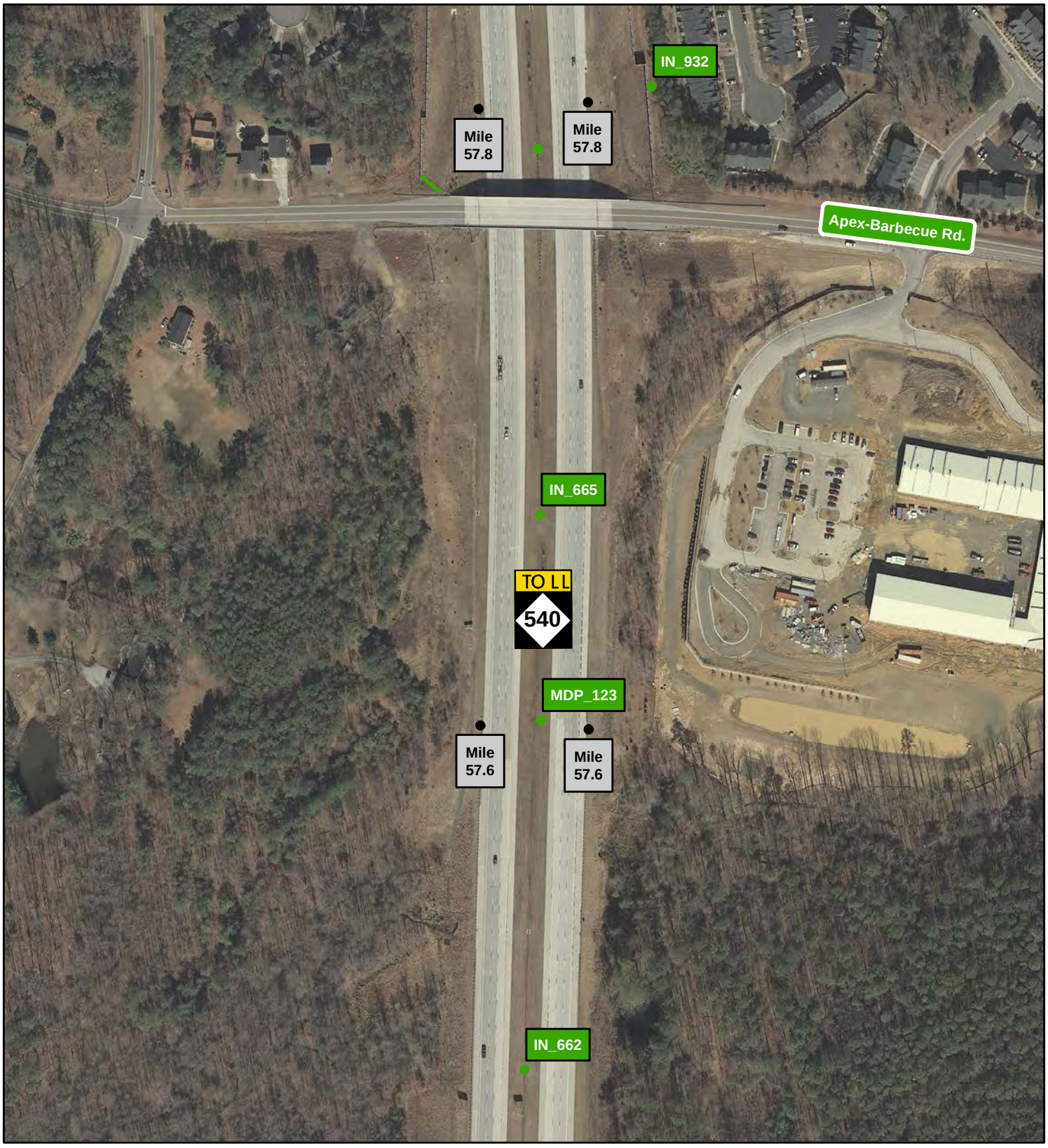

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NORTH CAROLINA Turnpike Authority

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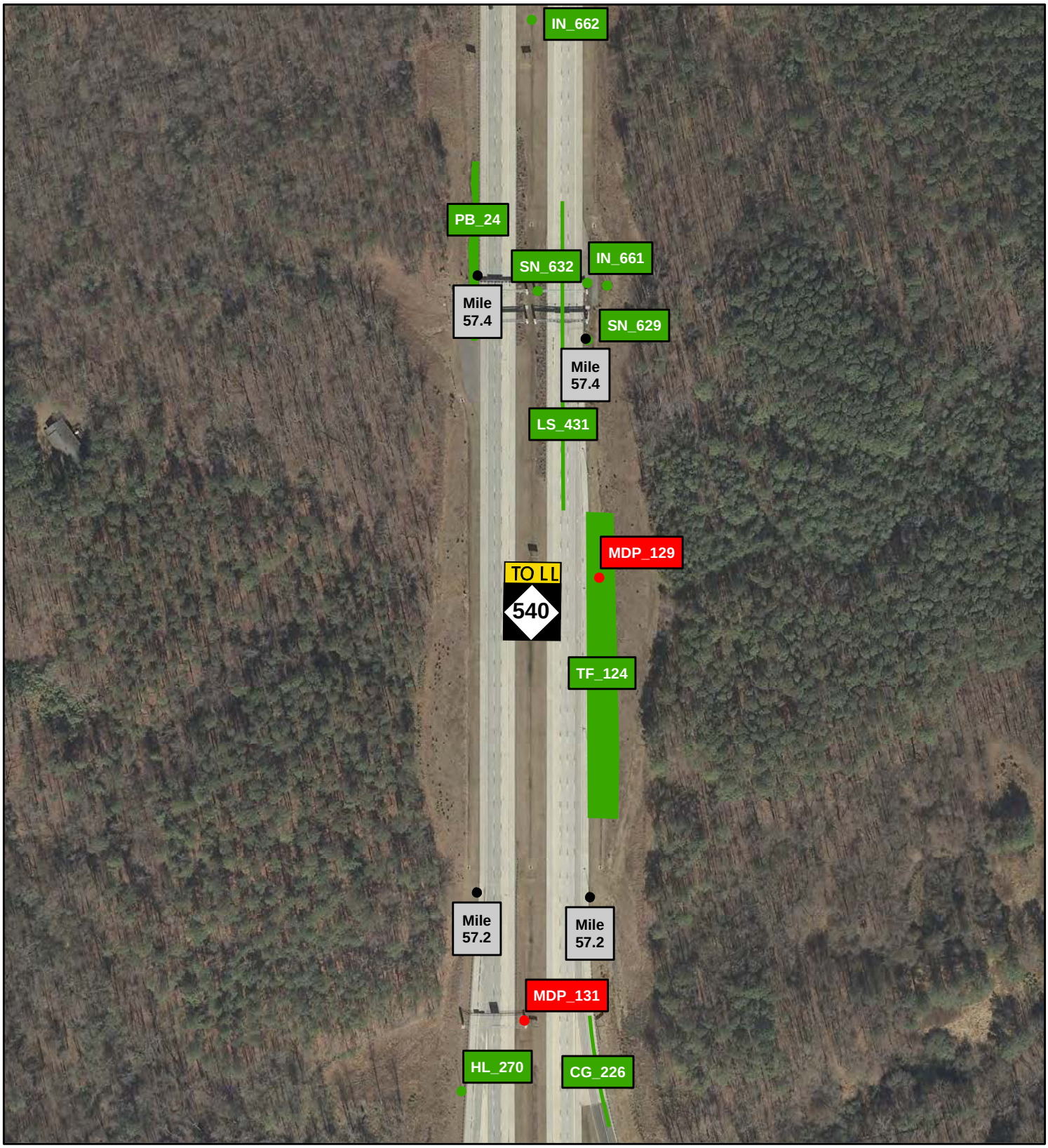

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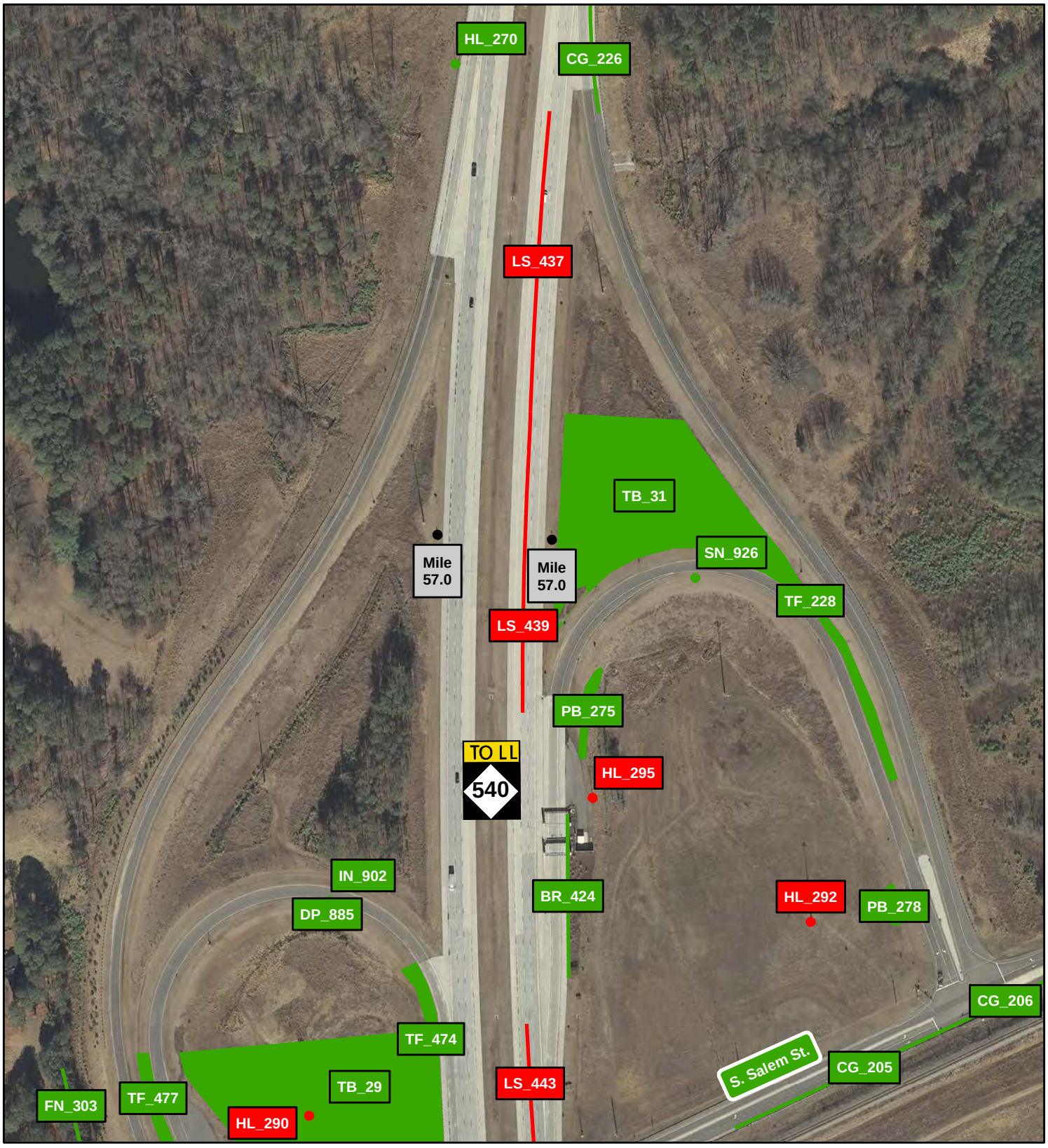

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NORTH CAROLINA Turnpike Authority

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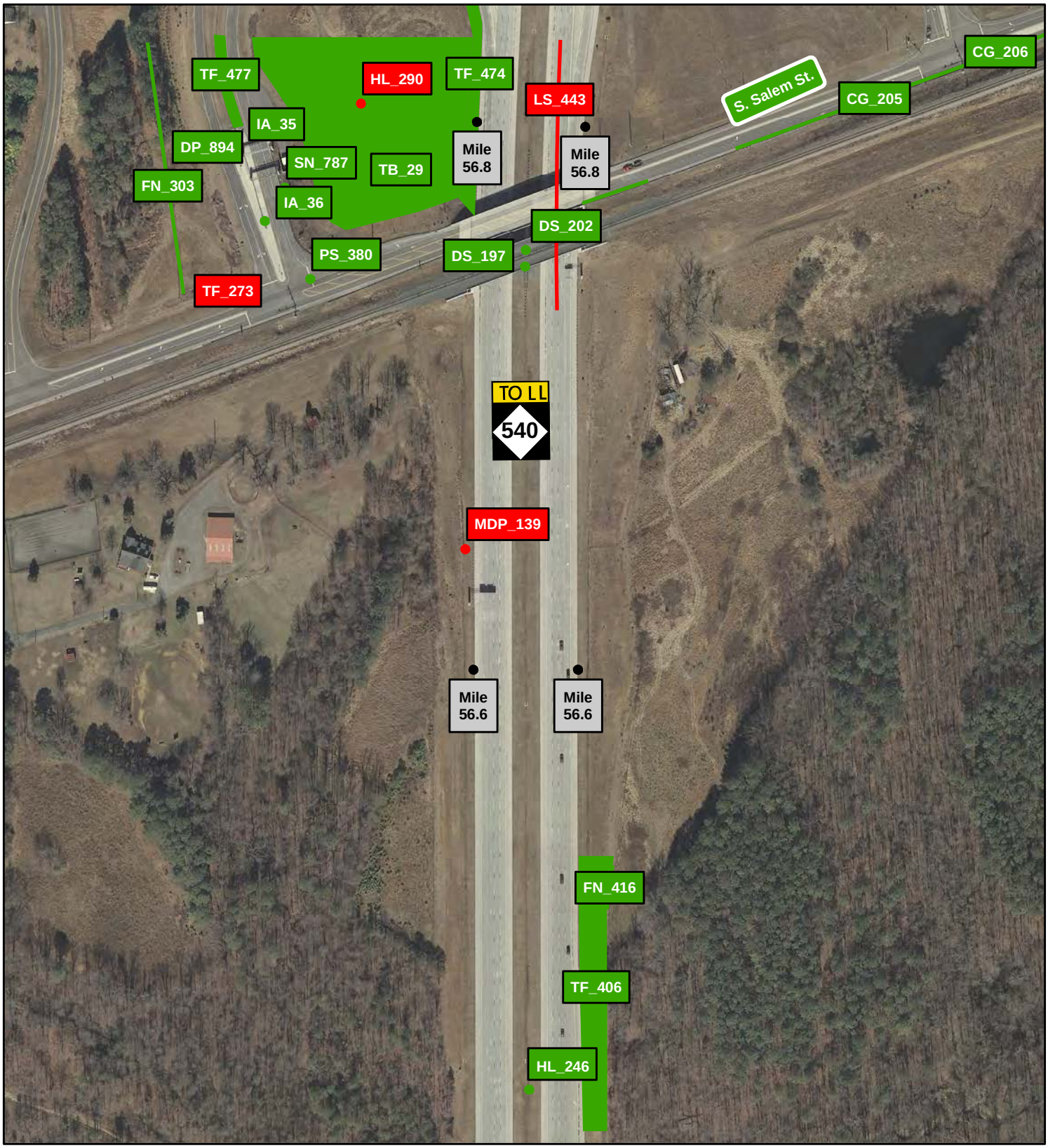

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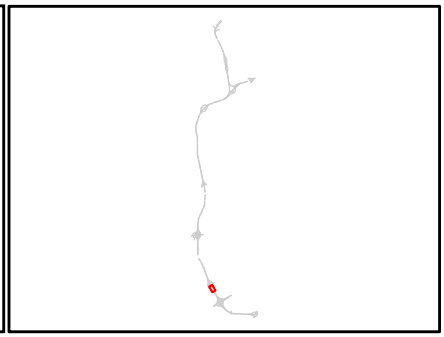

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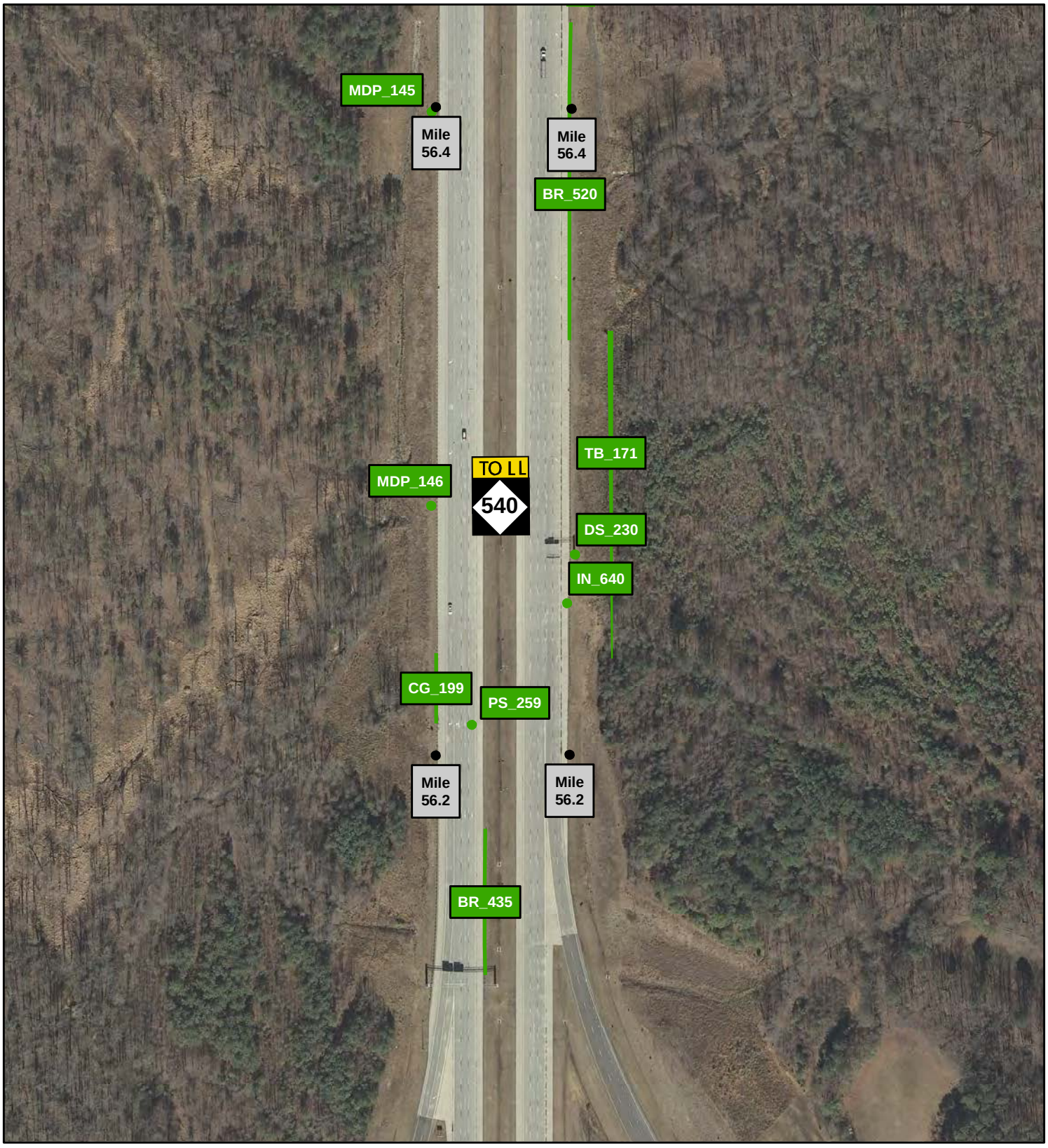
Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations



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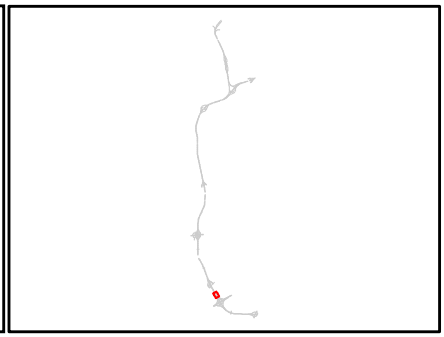

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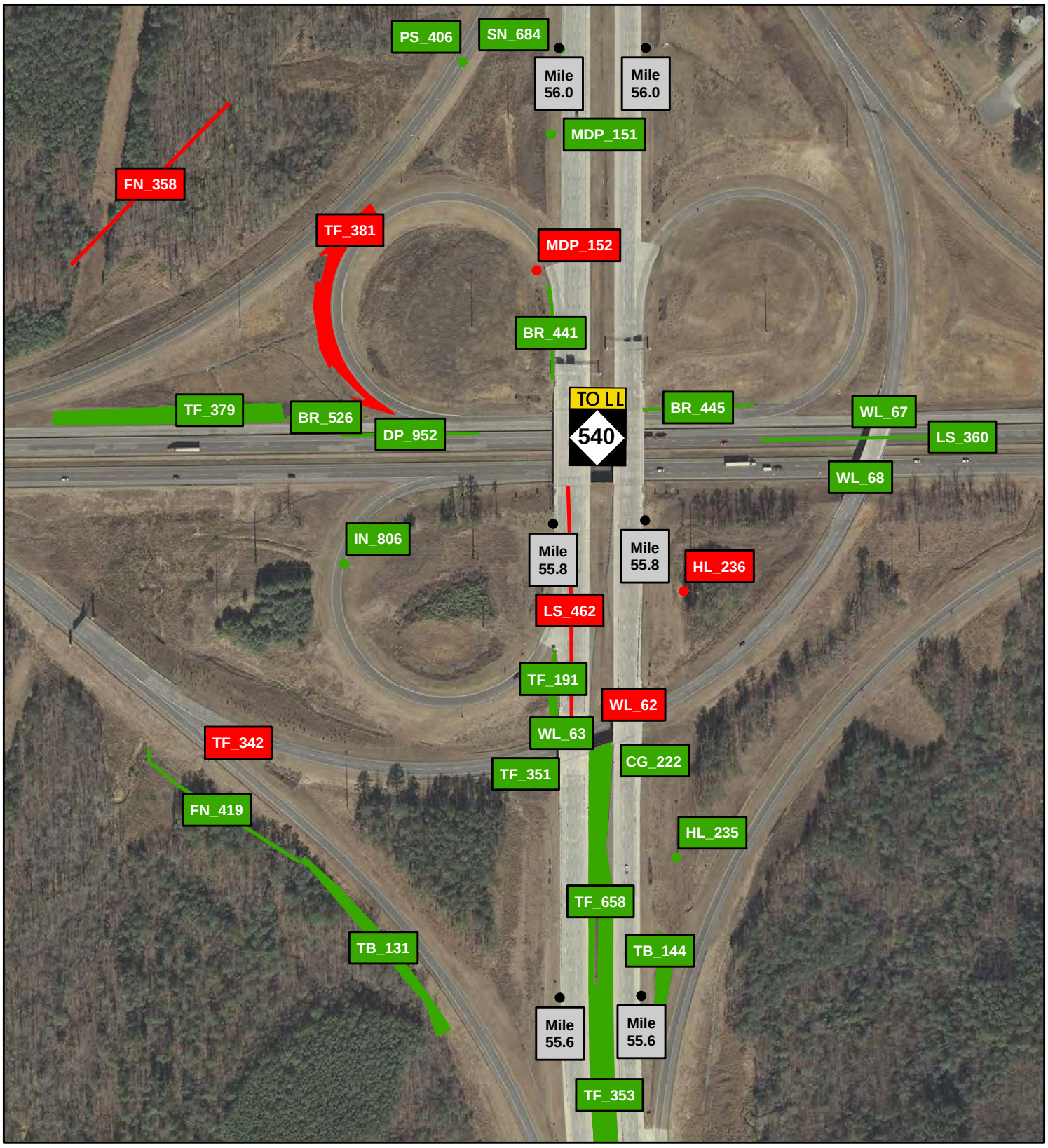

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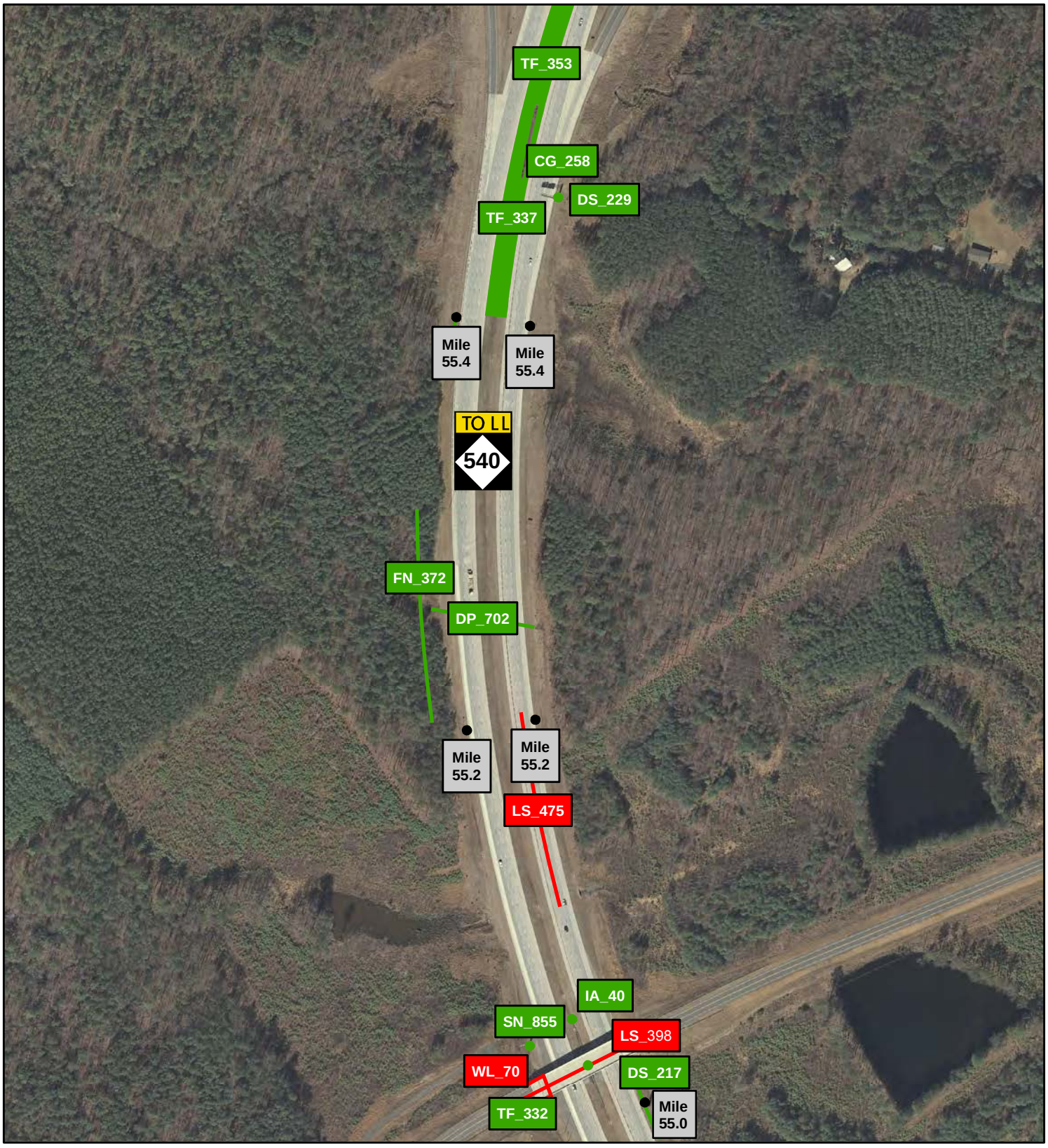

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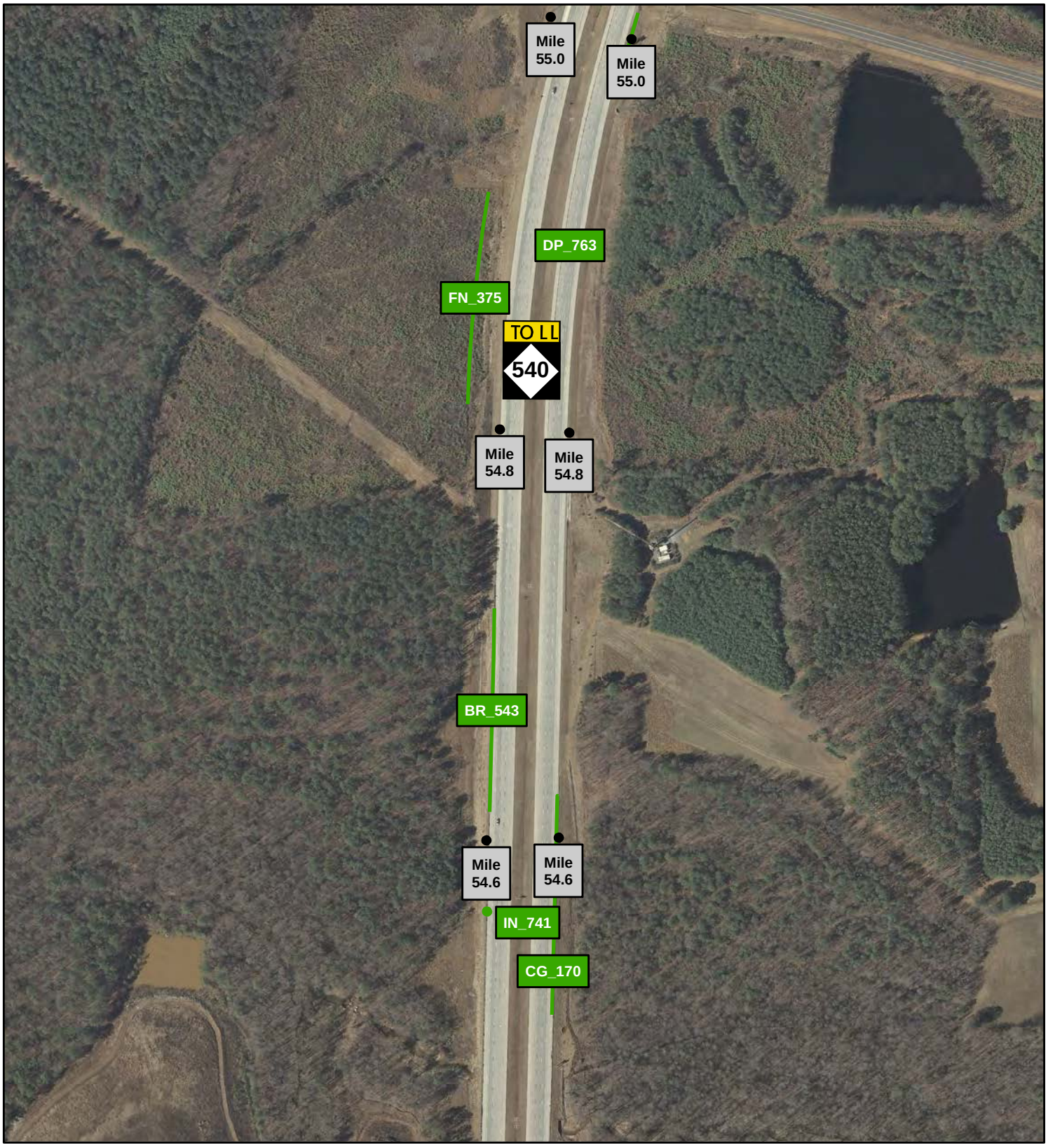

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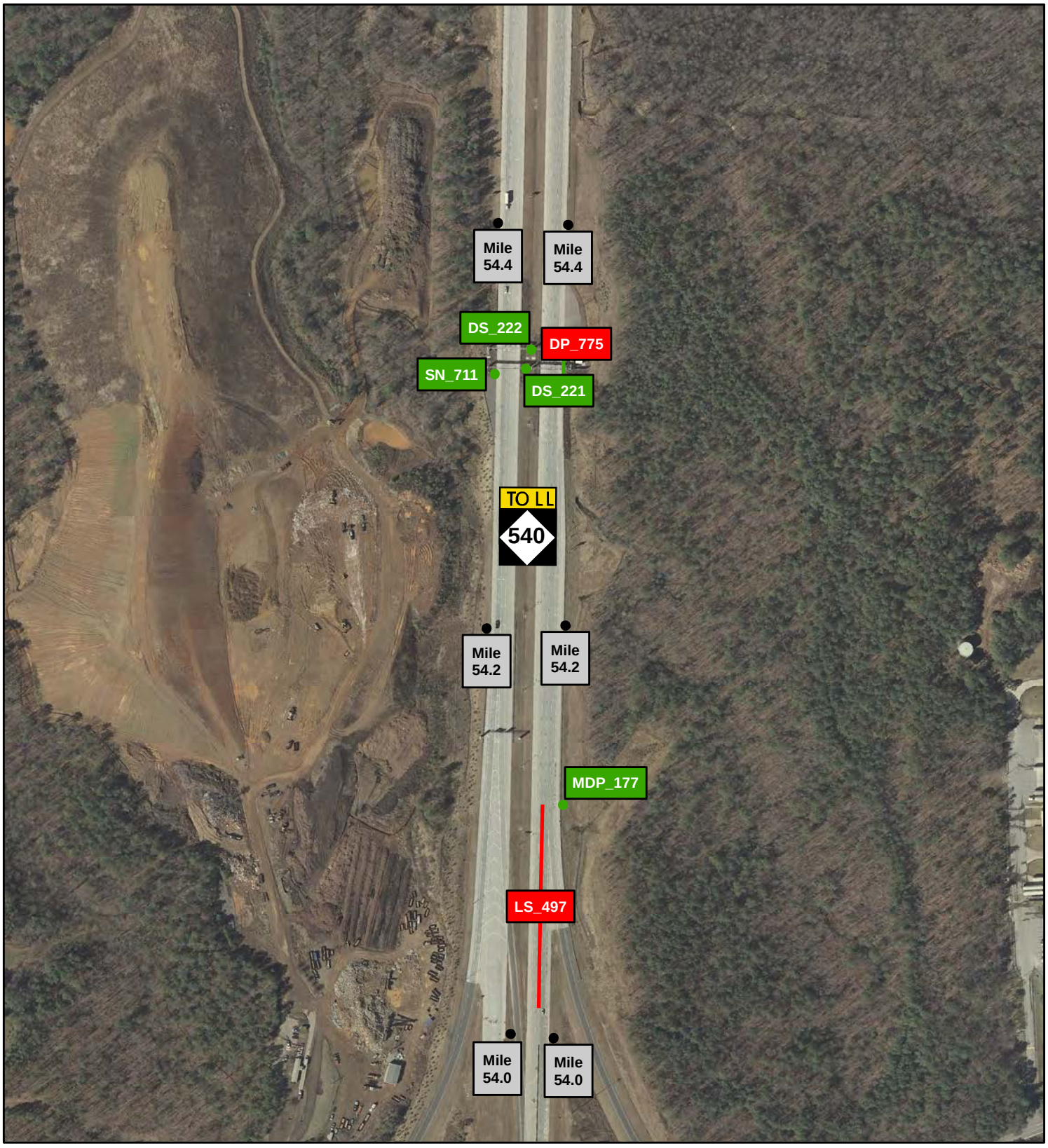
NORTH CAROLINA Turnpike Authority

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations



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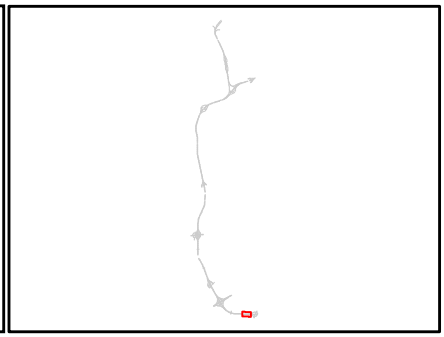
Failing Asset

Passing Asset



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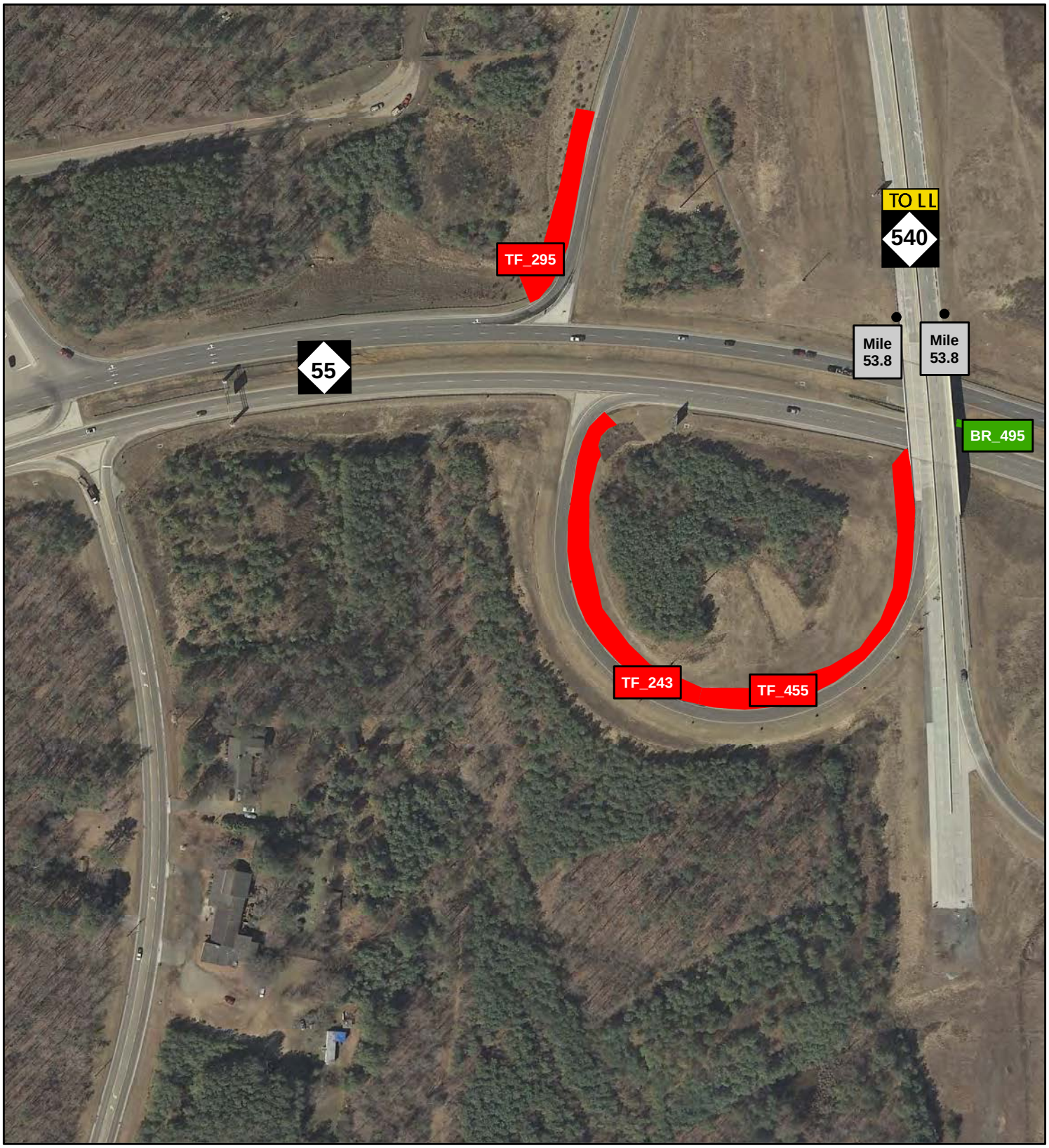

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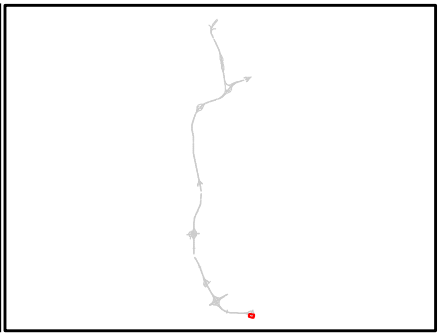

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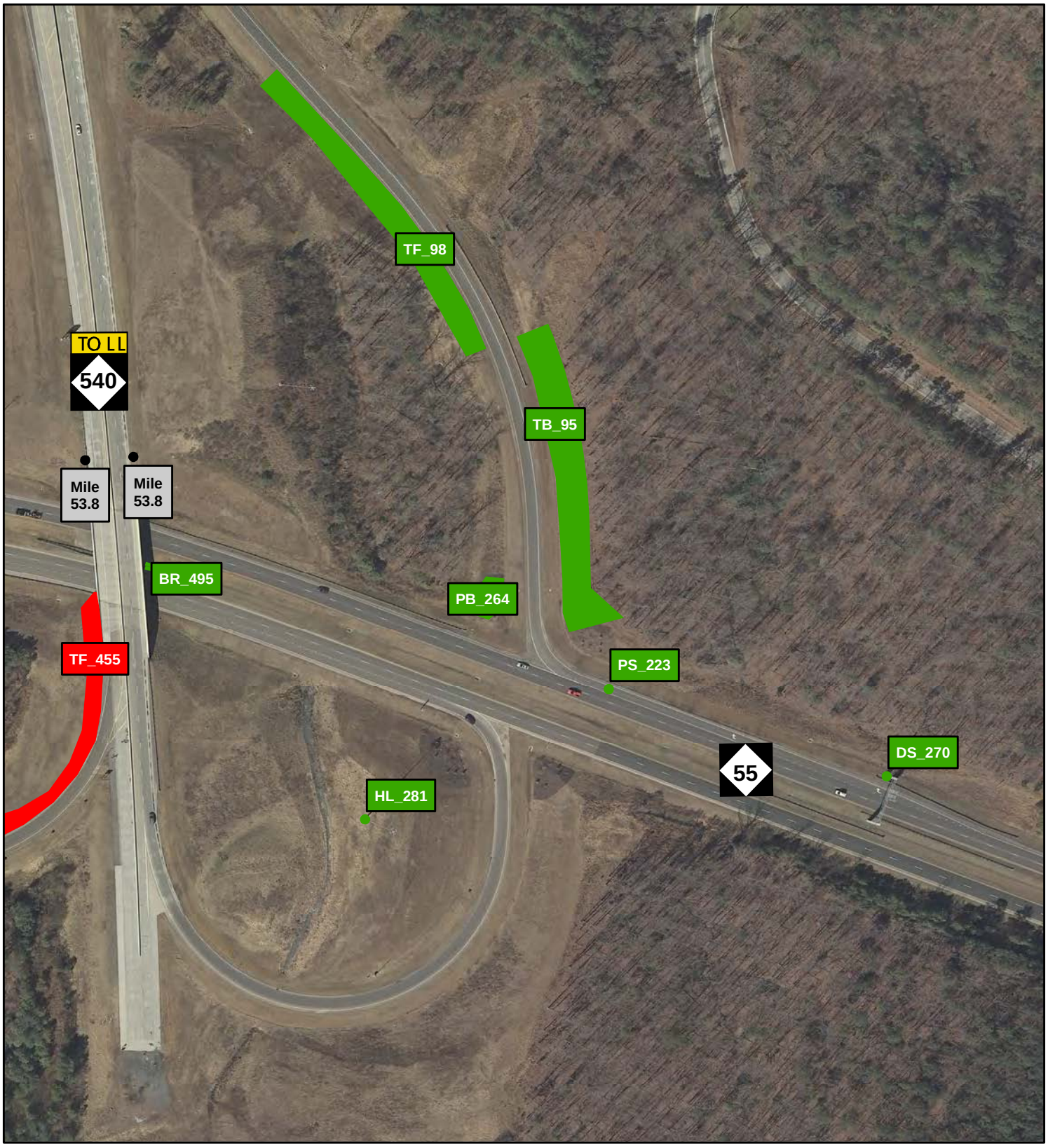

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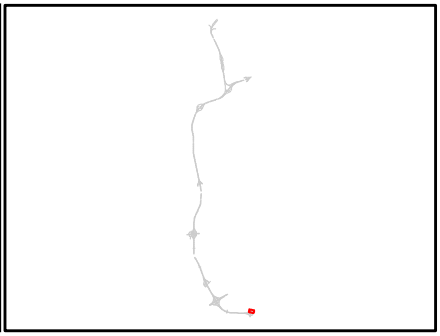

NORTH CAROLINA Turnpike Authority

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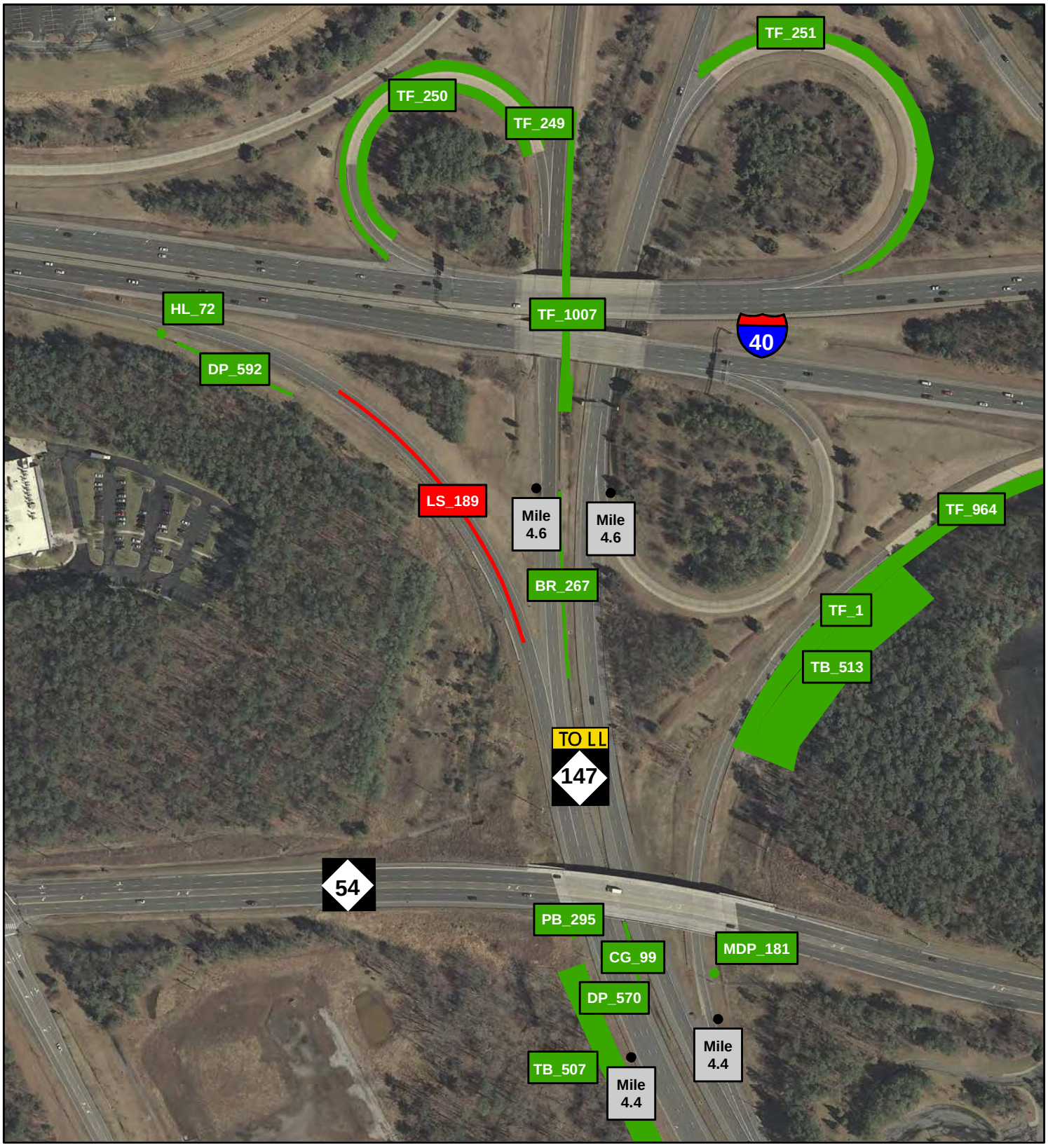

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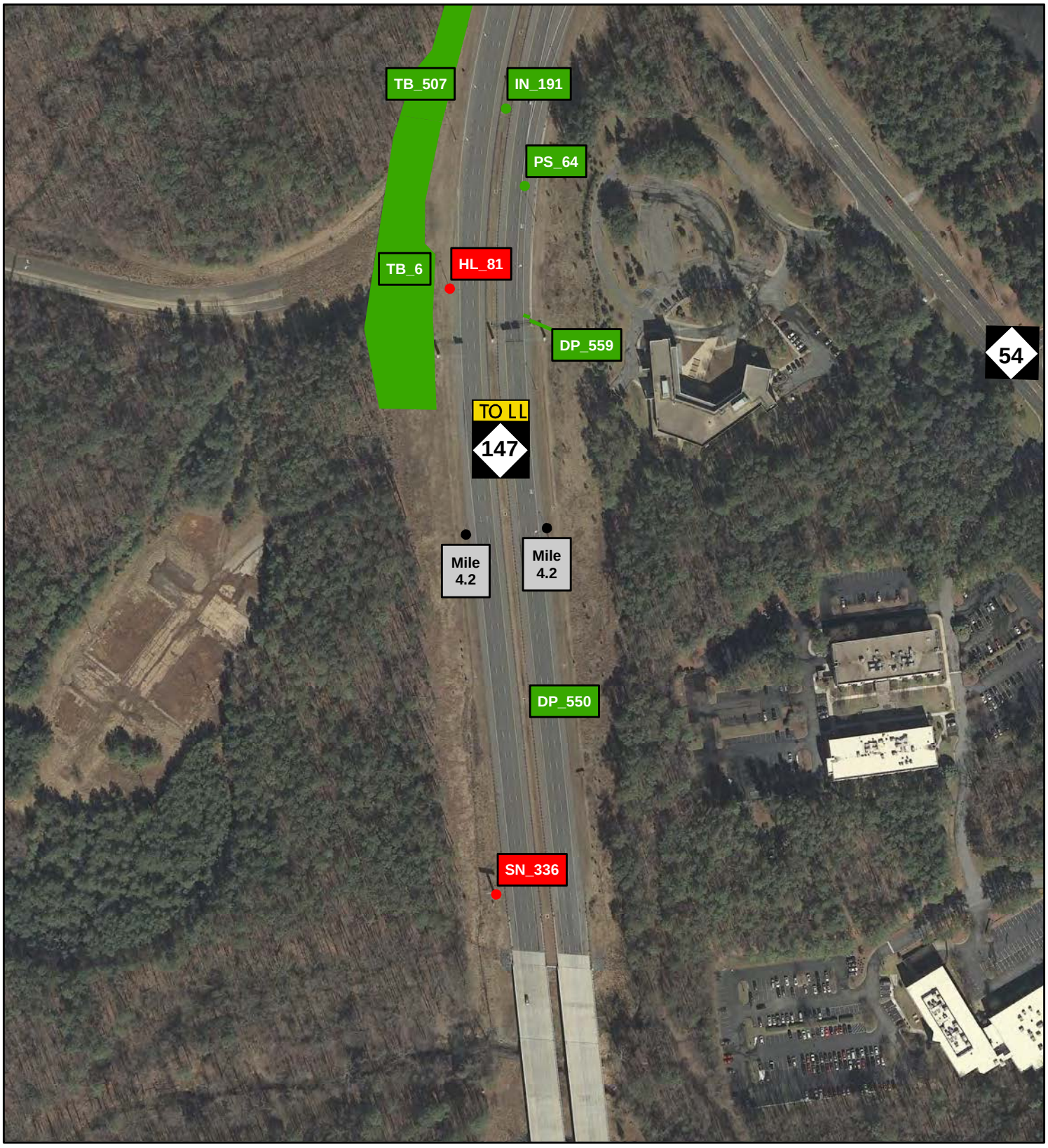

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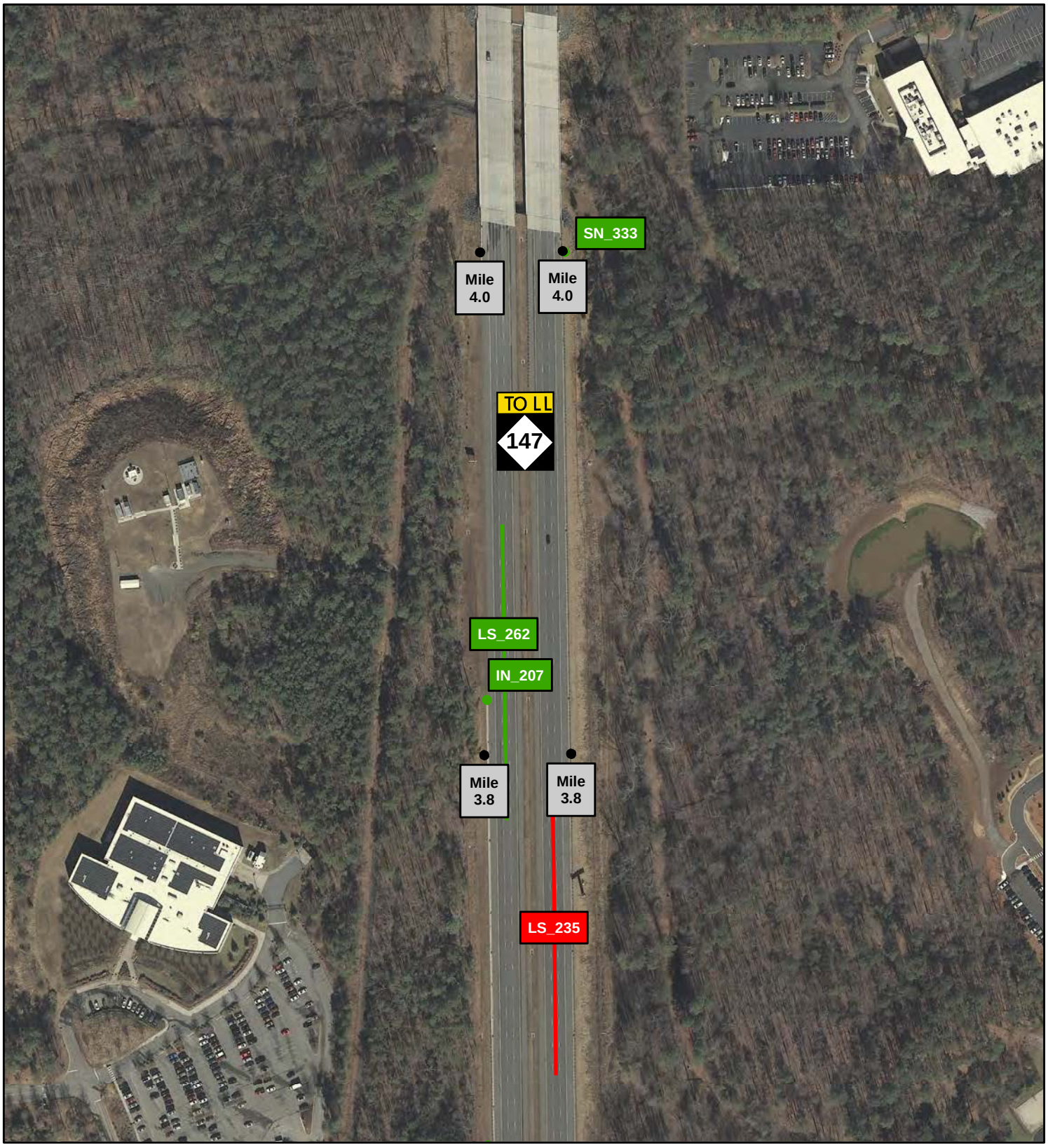

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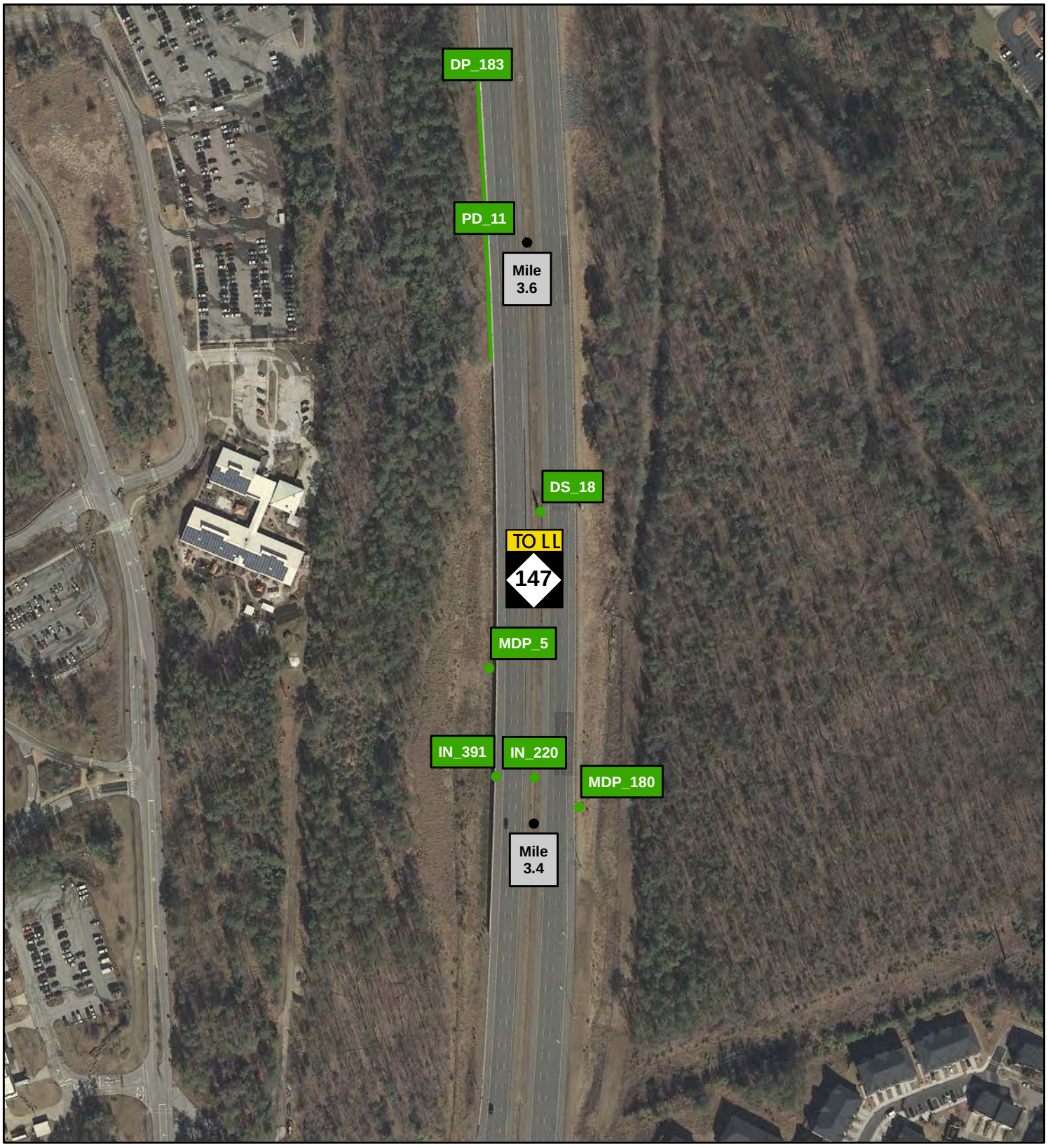

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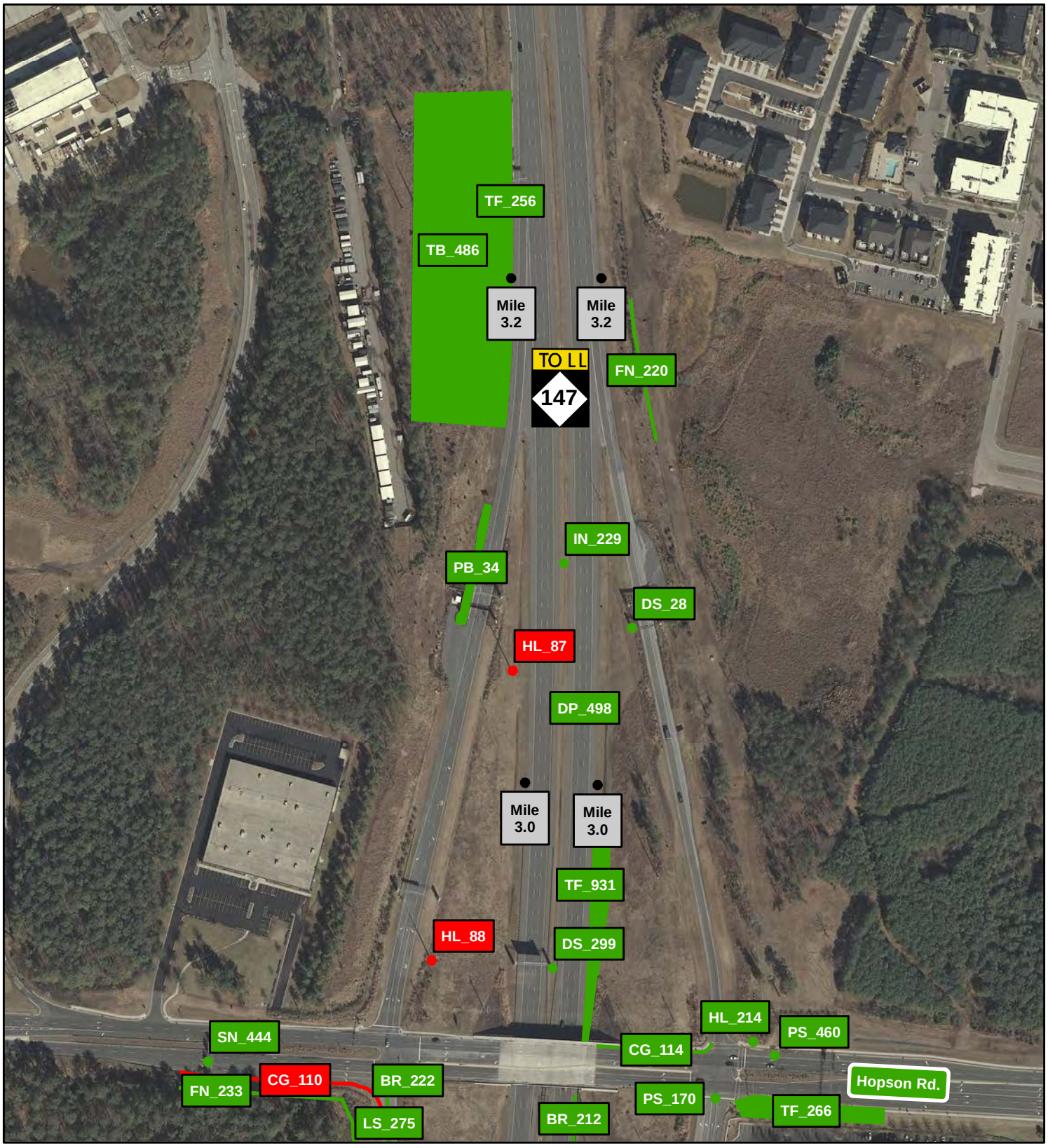

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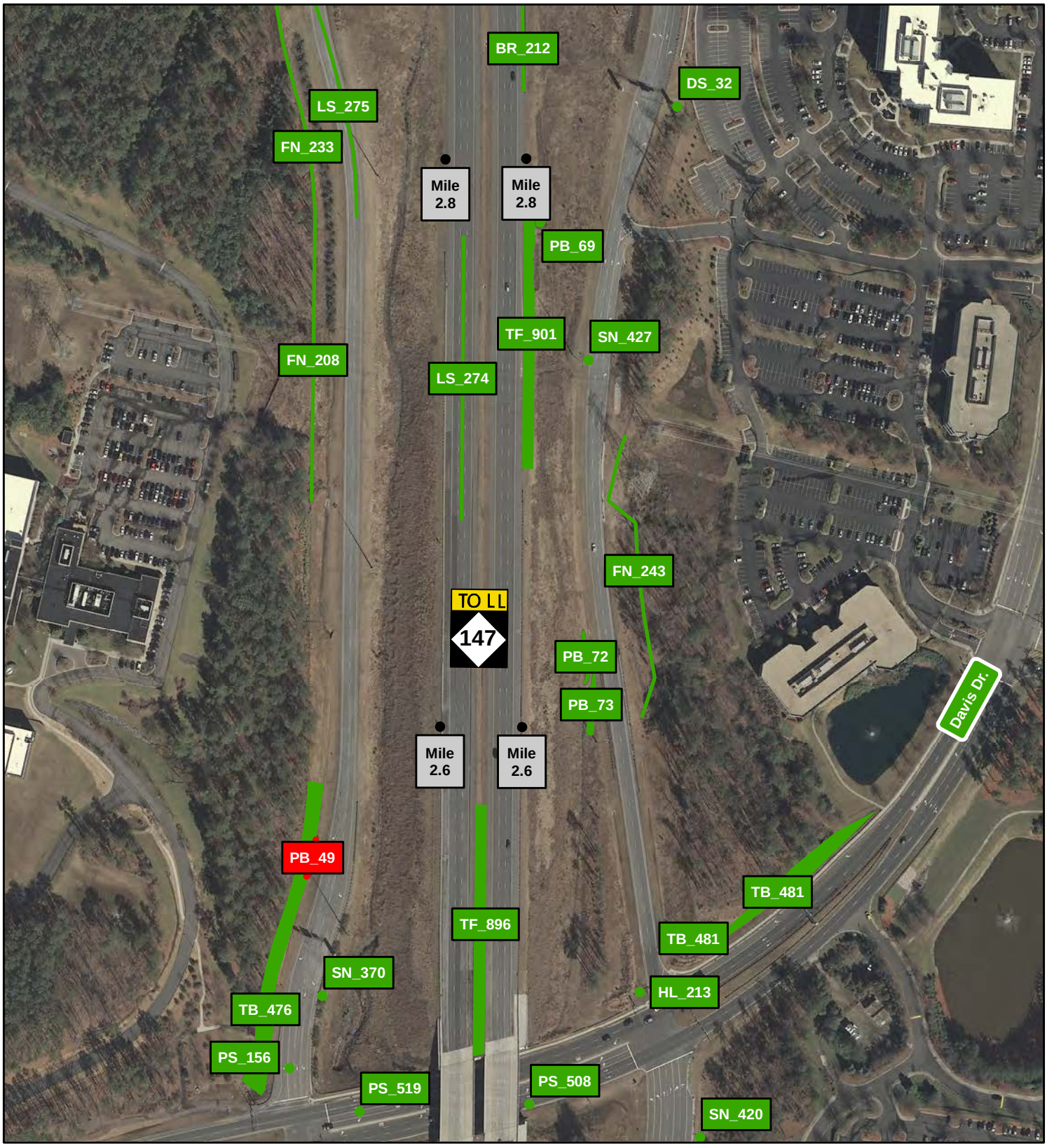

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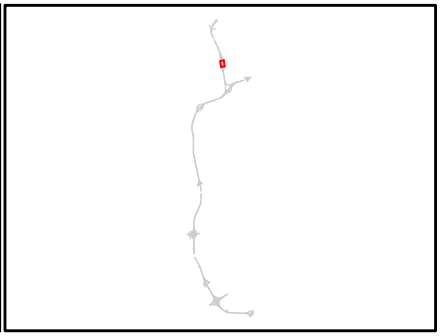

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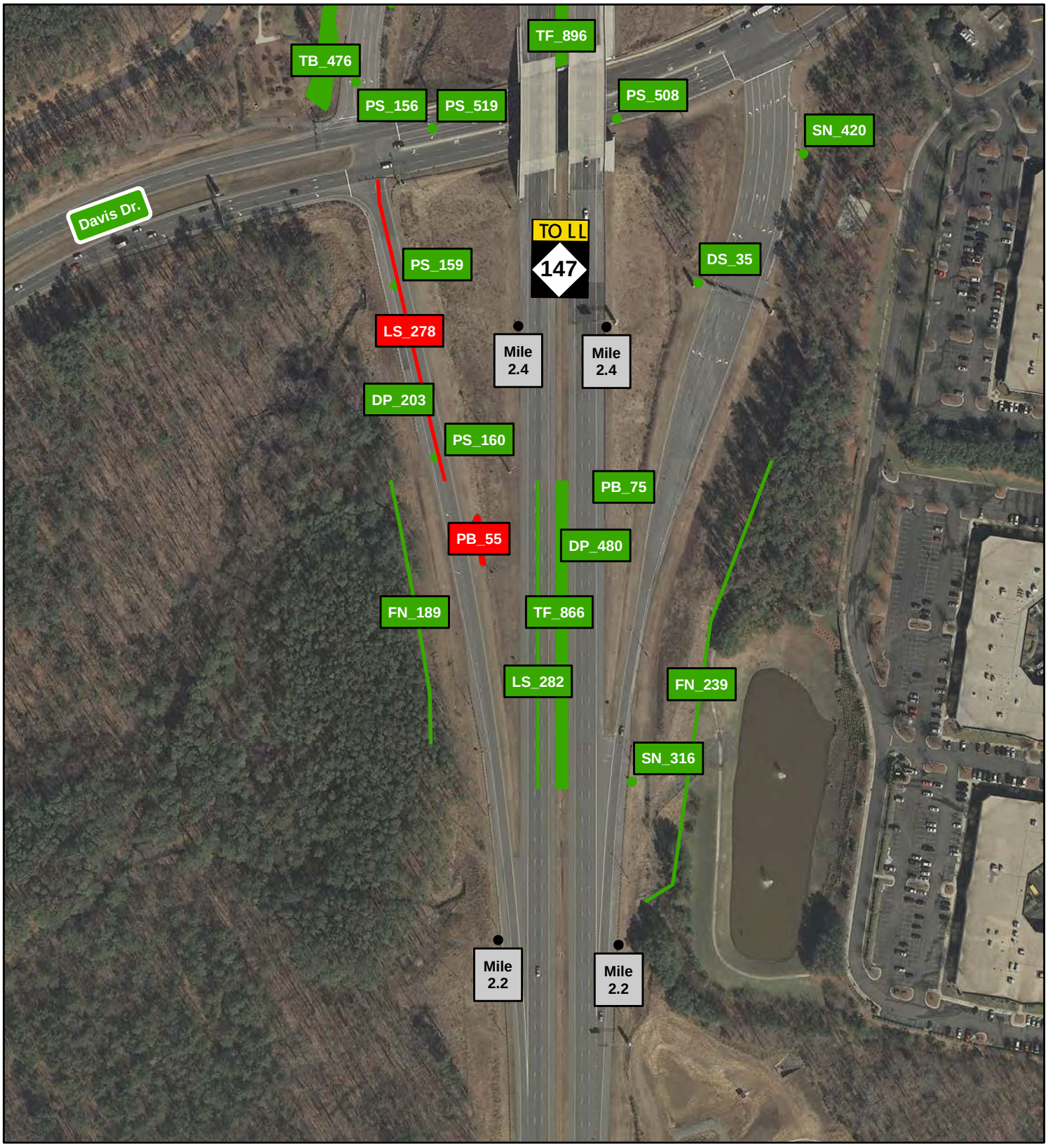

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Failing Asset

Passing Asset

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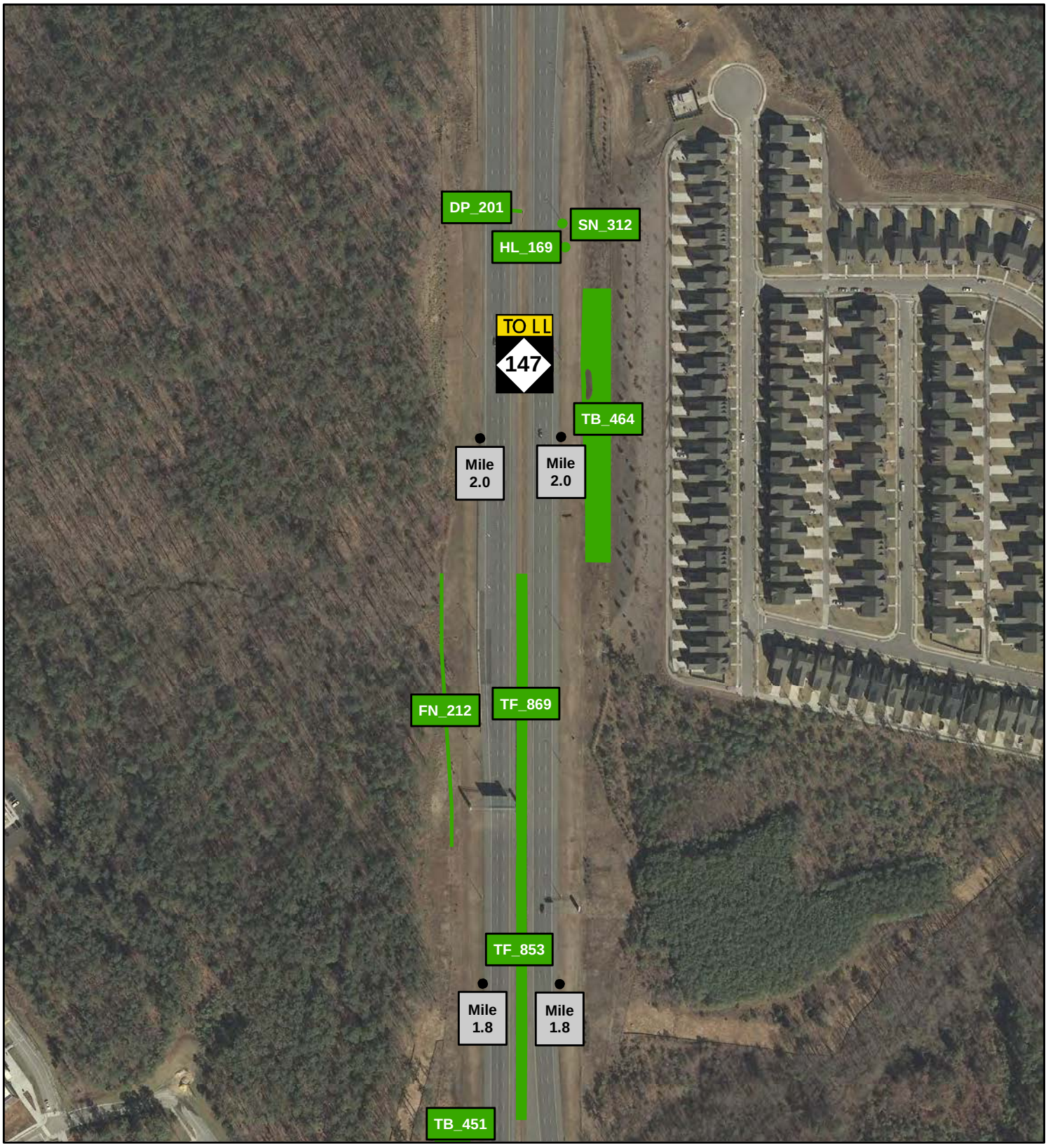
A50

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations



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Failing Asset

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NORTH CAROLINA Turnpike Authority

Appendix A: Triangle Expressway 2017 Fourth Quarter Asset Assessment Locations

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Turnpike Authority

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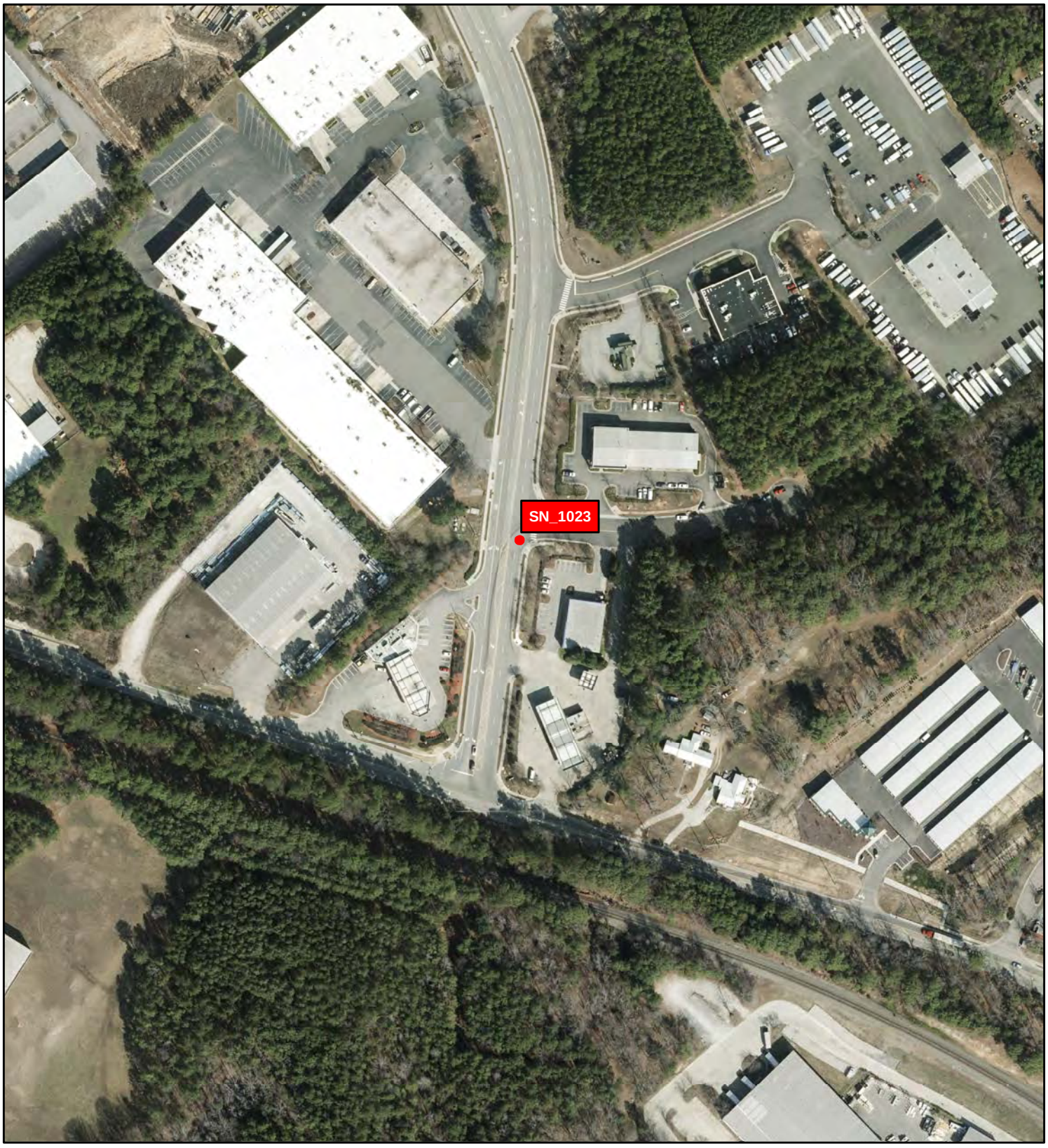

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Failing Asset

Passing Asset

NORTH CAROLINA Turnpike Authority

A53

Appendix B

Triangle Expressway 2017 Fourth Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2017 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:

The Inventory ID and GIS Reference Page number correspond to the maps provided in Appendix A, to allow for the quick location of particular asset failures. Photos of failures are 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
1	Valley	CG_52	Material Accumulation		A21
2	Valley	CG_64	Obstruction/Material Accumulation		A10
3	Concrete	CG_110	Obstruction		A48
4	Concrete	CG_274	Obstruction		A26, A27

Curb and Gutter (CG)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Valley	CG_275	Obstruction		A27

Decorative Supports (DS)

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

Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Drain	DP_84	Obstruction		A19
2	Drain	DP_775	Obstruction		A41

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Inlets and Basins	MDP_12	Grate Damage		A11
2	Inlets and Basins	MDP_41	Obstruction		A17
3	Inlets and Basins	MDP_100	Grate Damage		A28
4	Inlets and Basins	MDP_114	Obstruction		A29

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Inlets and Basins	MDP_115	Obstruction		A29
6	Inlets and Basins	MDP_129	Grate Damage		A33
7	Inlets and Basins	MDP_131	Grate Damage		A33
8	Inlets and Basins	MDP_139	Obstruction		A35

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Inlets and Basins	MDP_152	Obstruction		A37

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_184	Hole Height		A8
2	Woven	FN_323	Fence Height		A28
3	Woven	FN_358	Open Gate		A37

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_28	Functional Damage	Not Available for Nighttime Failure	A20
2	Double Roadway	HL_48	Functional Damage	Not Available for Nighttime Failure	A25
3	Single Roadway	HL_81	Functional Damage, Part Damage		A45
4	High Mast	HL_87	Part Damage		A48
5	High Mast	HL_88	Part Damage		A48
6	Double Roadway	HL_110	Functional Damage	Not Available for Nighttime Failure	A7
7	Single Roadway	HL_122	Functional Damage	Not Available for Nighttime Failure	A9

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
8	High Mast	HL_132	Part Damage		A6
9	High Mast	HL_236	Part Damage		A37
10	High Mast	HL_290	Missing Part		A34, A35
11	High Mast	HL_292	Missing Part		A34
12	Single Roadway	HL_295	Functional Damage	Not Available for Nighttime Failure	A34

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Double Roadway	HL_344	Part Damage		A27

Impact Attenuators (IA)

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

Inlets (IN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Inlets	IN_309	Surface Damage		A5
2	Inlets	IN_480	Surface Damage		A4

Landscaping (PB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Plant Bed	PB_49	Health		A49
2	Plant Bed	PB_55	Health		A50
3	Plant Bed	PB_223	Health		A5

Paved Lanes – Asphalt (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_235	Pavement Cracking		A46

Paved Lanes – Concrete (LS)

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

Paved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_278	Joint Separation		A50

Unpaved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Ramp	LS_5	Shoulder Drop		A10

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
1	Ramp	LS_300	Ditch Erosion		A2

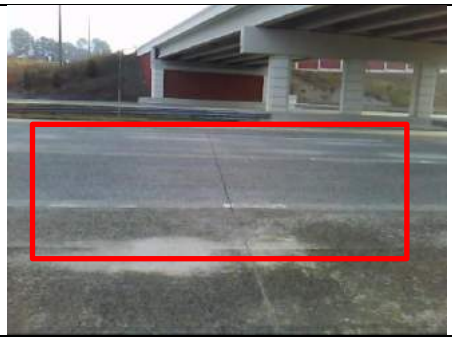
Litter (LS)

#	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
1	Ramp	LS_189	Roadway Sweeping		A44

Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_29	Line Missing, Line Width		A26, A27
2	Asphalt	LS_189	Line Missing, Line Width		A44
3	Asphalt	LS_300	Line Missing, Line Width		A2
4	Concrete	LS_344	Nighttime Visibility	Not Available for Nighttime Failure	A7
5	Concrete	LS_407	Line Missing, Line Width		A29

Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
6	Concrete	LS_437	Line Missing, Line Width		A34
7	Concrete	LS_439	Line Width		A34
8	Concrete	LS_443	Line Missing, Line Width		A34, A35
9	Concrete	LS_462	Line Missing, Line Width		A37
10	Concrete	LS_475	Nighttime Visibility	Not Available for Nighttime Failure	A39

Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
11	Concrete	LS_497	Nighttime Visibility, Line Missing, Line Width		A41

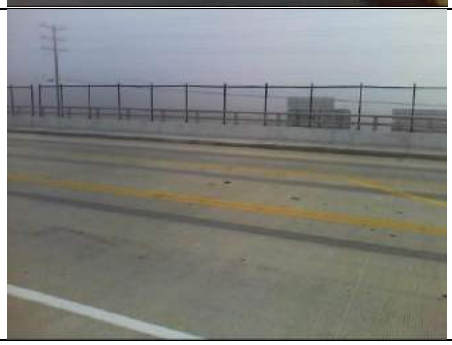
Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_475	Missing Markers		A39

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_127	Missing Markers		A18
2	Concrete	LS_129	Missing Markers, Nighttime Reflection		A19
3	Asphalt	LS_189	Missing Markers		A44
4	Concrete	LS_344	Missing Markers		A7

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Asphalt	LS_398	Missing Markers		A39
6	Concrete	LS_475	Missing Markers		A39

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
1	Merge Left	PS_50	Nighttime Reflectivity	Not Available for Nighttime Failure	A12
2	Stop Bar	PS_633	Nighttime Reflectivity	Not Available for Nighttime Failure	A10, A11
3	Thru Arrow	PS_638	Nighttime Reflectivity, Daytime Assessment		A10, A11

Signs (SN)

#	Sign Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Authorized Vehicles	SN_167	Nighttime Reflectivity	Not Available for Nighttime Failure	A19
2	Merge	SN_218	Height Requirement		A10
3	Message Board	SN_336	Nighttime Reflectivity	Not Available for Nighttime Failure	A45
4	Other	SN_1023	Leaning		A53

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_243	Bare Ground		A42
2	Turf	TF_273	Bare Ground		A35
3	Turf	TF_295	Bare Ground		A42
4	Turf	TF_342	Bare Ground		A37

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_381	Bare Ground		A37
6	Turf	TF_455	Bare Ground		A42, A43
7	Turf	TF_487	Bare Ground		A29
8	Turf	TF_525	Bare Ground		A26

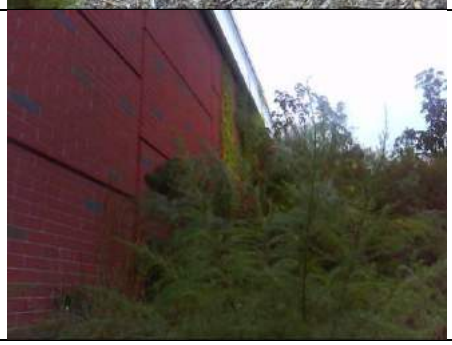
Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Turf	TF_541	Bare Ground		A24
10	Turf	TF_602	Bare Ground		A18
11	Turf	TF_704	Undesirable Vegetation		A10
12	Turf	TF_785	Bare Ground		A5

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Turf	TF_1014	Bare Ground		A14

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

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	MSE Wall	WL_70	Paint Scaling		A39
2	MSE Wall	WL_37	Paint Scaling		A26, A27
3	MSE Wall	WL_42	Paint Scaling		A29
4	MSE Wall	WL_62	Vegetation		A37