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# Demonstration of Infrared Pavement Heater



Dwayne Harris

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# EXECUTIVE SUMMARY

Indiana Department of Transportation (INDOT) maintenance currently employs several patching methodologies; however, prior to this study, INDOT had little experience with using infrared pavement heaters as a maintenance tool. The purpose of this research was to introduce pavement heating technologies and provide INDOT maintenance personnel with experience using these technologies.

This demonstration project provided INDOT maintenance personnel with practical experience using infrared pavement-heating technology to address a wide range of asphalt pavement distresses. Districts employed the infrared heater to mitigate rutting, longitudinal and block cracking, potholes, shoving, localized depressions, transverse cracking, and corner distress associated with reflective cracking on composite pavements.

Overall, the infrared patches installed during the study performed acceptably. Most patches were constructed by heating the existing pavement surface, reworking the softened material, adding small quantities of new HMA, and compacting the area. Although the absence of rejuvenator may reduce long-term performance, this limitation was largely offset by the fact that many patches were intended to last one year or less.

In summary, infrared pavement patching can be an effective maintenance tool when applied to appropriate locations, especially where moderate distress and low-volume traffic conditions are present. However, its increased cost and sensitivity to underlying pavement conditions must be carefully considered when determining whether the method is suitable for a specific maintenance scenario.

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# 1. INTRODUCTION

As asphalt pavement progresses through its life cycle, pavement distress develops and leads to deterioration. Patching is one of the tools used to mitigate pavement distress. Indiana Department of Transportation (INDOT) maintenance currently employs several patching methodologies; however, prior to this study, INDOT had little experience with using infrared pavement heaters as a maintenance tool. The purpose of this research was to introduce pavement heating technologies (see Figure 1 through Figure 3) and provide INDOT maintenance personnel with experience using these technologies.

Before releasing the equipment for field experimentation at the individual maintenance units, a meeting was held with INDOT maintenance personnel to determine the types of patching scenarios that should be included in the study. Guidance from INDOT leadership suggested that the experimental patches should address the following:

- Fatigued pavement including in just the right wheel path
  - Cracking, including alligator cracking
  - Rutting
- Slumps in pavement
- Pavement shoving
- Shallow pothole repair

Training on the infrared pavement heater was provided shortly after the equipment was delivered to Laporte District for field experimentation. Training sessions were conducted by personnel from the equipment manufacturers (Heat Design).

The deliverables for this project include:

1. Training videos on operation of the infrared pavement heater.
2. A database of specialized data collected from infrared heater-constructed patches
3. A final report summarizing the project results

## 1.1 Scope

The following topics are discussed to present INDOT's initial experience with utilizing an infrared pavement for mitigating pavement distress:

- Background of infrared pavement heaters
- Infrared Patching Case Studies
  - Pavement condition prior to patching
  - Analysis of nondestructive data collected throughout the life of each patch
- Summary of maintenance unit feedback
  - Pros
  - Cons
  - Suggestions for improvement
- Recommendations and conclusions.

## 1.2 Background

INDOT maintenance units are currently utilizing several patching methods including traditional patching (see Figure 4), throw and roll (see Figure 5), spray injection, and mastic patching.

Selecting the appropriate patching method requires balancing multiple variables such as cost, expected patch life, hot-mix asphalt (HMA) availability, turnaround time, available personnel, and equipment availability.

Traditional patching depends on an HMA source plant whereas throw and roll is used when repairs with a short turnaround time are required.

Throw-and-roll patches generally have lower cost and shorter expected service life than traditional patches.

Infrared pavement heaters offer several advantages relative to the methods currently used by INDOT including:

- Improved bonding between patch and surrounding pavement (Byzyka et al., 2018)
- Ability to provide semipermanent/permanent patching during winter (Nazzal et al., 2014)
- Long-lasting patch performance (Leininger, 2015)
- Durable crack repair (Uzarowski et al., 2011)
- Use of hot in-place recycling (HIR) reducing material costs (Carruth & Mejías-Santiago, 2015; Leininger, 2015).

The research findings of the following three studies provide guidance for using infrared pavement heaters in patching operations.

### *1.2.1 Nazzal et al. (2014)*

Objective: Evaluate the performance and cost-effectiveness of infrared patching compared to throw-and roll and spry injection.

Findings:

- Infrared patches required an average of 16 min, more than four times longer than throw-and-roll patches.
- Infrared patches received significantly better performance ratings than the other methods.
- Raveling was the primary distress noted on the infrared patches.
- Infrared patches outperformed patches from the other two systems.
- Throw and roll was less expensive for short term repairs when user costs were excluded.

### *1.2.2 Wang and Chen (2024)*

Objective: Evaluate tools, technologies, and materials for improving pothole repairs in New Jersey.

Findings:

- Preheating the excavated pothole prior to repair improves the interface bonding between the existing pavements and the hot filling material.
- Infrared radiation efficiently heats pothole surfaces.
- Infrared heaters support HIR, reducing material costs.
- Preheating significantly improved patch performance.
- The breakeven lifespan for the increased cost for using the infrared heater in patching was greater than 55 weeks for all life cycle analysis cases.

### *1.2.3 Leininger (2015)*

Findings:

- Infrared patching supports durable, year-round repairs that outperform other methods.

- Patch density strongly influences patch quality.
- The dosage of the rejuvenator had a minimal if not negligible effect on the density of the patch.
- Rejuvenator application correlated with the tensile strength of the patch.
- Proper compaction, rejuvenator application, and heating techniques were essential for successful infrared patches.

## 2. DISCUSSION

This demonstration project allowed INDOT personnel to gain hands-on experience with a new patching method. The individual units selected patch locations, determined rejuvenator and material use, and established quality control measures for each patch. A flowchart of the infrared patching process is provided in Figure 6.

Quality control is a critical factor influencing patch performance. Because infrared patching as used in this study is a hot in-place recycling process, the pre-existing pavement condition greatly affects patch performance—especially when minimal rejuvenator or new HMA is added. The training test patch at INDOT Research and Development demonstrates this effect: the patch was heated, worked, and compacted without adding rejuvenator or HMA; the path shows poor performance and all the cracking in surrounding pavement reflected through the patch after 1.5 years (see Figure 7). Conversely, patches where rejuvenator additional HMA are included perform better (e.g., the Westfield test patches; see Figure 8 through Figure 10). However, when the rejuvenator and HMA were applied to severely distressed pavement, the resulting patch showed raveling or distress recurrence within one year (see Figure 8).

The demonstration project proceeded in the following steps:

1. The infrared pavement heater was rotated among units in the Laporte, Seymour, and Greenfield Districts for use on various patching projects.
2. The maintenance units reported patch location and provided feedback regarding the utilization of the infrared pavement heater.
3. Patch locations were mapped using a real-time kinematic (RTK) GPS rover.
4. Specialized pavement condition data was collected at multiple intervals post-construction.
5. Images from INDOT's Pavement Condition System were compiled.
6. PathWeb was used to retrieve pre- and post-patching data from Pathway Services.
7. Patches were evaluated using these datasets.

Communication lapses resulted in incomplete datasets for some locations. Some patches were overlaid before data could be collected, and some patches were never reported. Patching scenarios analyzed in this report include high-priority conditions: rutting, slumps, shoving, and shallow potholes.

### 2.1 Case Studies

Maintenance units in the Laporte, Seymour, and Greenfield Districts employed the infrared heater to address a broad spectrum of pavement distresses. These included right-wheel-path rutting, longitudinal and block cracking, potholes, pavement shoving, localized depressions, transverse cracking, left-wheel-path deterioration, and corner distress associated with reflective cracking in composite pavements.

The case studies in this report draw on pavement-condition data collected using two primary sources: Pathway Services (via PathWEB) and INDOT's Pavement Condition System. Available datasets include right-of-way (ROW) images, elevation profiles, laser-intensity images, and three-dimensional (3D) light-intensity images. Each case study presents data from before and after patching; several sites include multiple post-patch evaluations. In many instances, however, patches were paved over before later data-collection cycles, limiting long-term analysis.

Although this report summarizes selected patches, the full patch database—provided as a separate deliverable—contains all recorded results. Case study data were drawn from the following locations and datasets:

#### *2.1.1 Laporte District*

- State Road (SR) 16: 26 Patches
  - Distress
    - 25 Patches Cracking and Rutting Right Wheel Path
    - 1 Patch Over Culvert
  - Datasets
    - INDOT
      - August 2023; All Patches
      - February 2024; All Patches
      - October 2024; All Patches
      - April 2025; All Patches
      - June 2025; All Patches
    - Pathway Services Pathweb
      - July 2022; All Patches
      - September 2023; All Patches
      - October 2024; All Patches
- SR 329 North: 1 patch
  - Distress
    - Longitudinal Cracking and Potholing in Right Wheel Path
  - Datasets
    - INDOT
      - August 2023
      - February 2024
      - October 2024
    - Pathway Services Pathweb
      - August 2022
      - September 2023
      - October 2024
- Old SR 25 South: 7 patches
  - Distress
    - Pavement Shoving
  - Datasets
    - INDOT
      - August 2023, Before Patching
      - February 2024 After Patching
- SR 25 South Driving: 1 Patch
  - Distress
    - Severe Deterioration
  - Datasets
    - INDOT
      - August 2023
      - February 2024
      - October 2024
      - April 2025

    - Pathway Services Pathweb
        - August 2022
        - September 2023
        - October 2024
- US 35:10 Patches
  - Distress
    - 1 patch edge distress including potholing
    - Remaining patches Block Cracking, longitudinal cracking
  - Datasets
    - INDOT
        - February 2024: 7 Patches
        - October 2024: 1 Patch
        - April 2025: 1 Patch
    - Pathway Services Pathweb
        - July 2022
        - August 2023

### *2.1.2 Seymour District*

- SR 3 South: 10 patches
  - Distress
    - Developing Potholes
    - Longitudinal cracking
    - Deterioration of old patch
  - Datasets
    - INDOT
        - October 2024: All patches
        - April 2024: All Patches
    - Pathway Services Pathweb
        - November 2023
        - November 2024

### *2.1.3 Greenfield District*

- SR 38 ramp onto US 31 South: 1 patch
  - Distress
    - Depression and Transverse Cacking
- Datasets
  - INDOT
    - November 2025
  - Pathway Services Pathweb
    - October 2023
- US 31 Northbound: 11 patches
  - Distress
    - Corner Deterioration of Reflected Transverse Cracks
  - Datasets
    - Pathway Services
        - August 2023
        - October 2024

### *2.1.4 SR 16 Right Wheel Path Rutting/Fatigue Cracking Case Study*

The Laporte District used the infrared pavement heater to construct a series of 24 patches along SR 16 between SR 55 and Interstate 65 (I-65). Twenty of the patches were in the westbound lane and four were in the eastbound lane (see Figure 11 through Figure 16). Only minimal rejuvenator or additional HMA was required. Traffic volumes along this segment range from 1,290 to 1,526 annual average daily traffic (AADT; INDOT, 2025). Patch WP3 is presented as a representative example.

Pathway Services data were used to evaluate the pavement before patching. Images from 2022 (pre-patch) reveal rutting and low-severity longitudinal cracking in the right wheel path (see Figure 17 through Figure 19). Elevation and laser-intensity data confirmed a depression in the right wheel path prior to patching (see Figure 18 and Figure 19). Post-patch images (2023) show the patch after construction (see Figure 20 and Figure 21).

Data were collected with INDOT's Pavement Condition Systems and inertial profiler to evaluate the performance of the patch. The initial data collection was done in August of 2023. Additional runs were made in February 2024, October 2024, April 2025, and June 2025. An image taken when the patch was surveyed is included (see Figure 22). ROW, elevation (normal) and 3D light intensity images were collected with the INDOT's Pavement Condition System supplemented by ROW images collected by INDOT's inertial profile (see Figure 23 through Figure 26). There was little change in the 3D normal images (elevation) and 3D light intensity images collected with the Pavement condition van for the time period between August 2023 and June 2025 (see Figure 25 and Figure 26). This would indicate that the infrared patch performed well. All the remaining patches in the right wheel path for SR 16 performed similarly well. Note that this section of road is low volume. Information on the remaining patches is included in the database provided as one of deliverables for this project.

### *2.1.5 SR 329 Right-Wheel-Path High Severity Longitudinal/ Fatigue Cracking and Potholing Distress Case Study*

The Laporte District installed an infrared patch on SR 329 (see Figure 27 and Figure 28). to mitigate severe longitudinal cracking and potholes observed in the 2022 Pathway Services imagery (see Figure 29 through Figure 33). Distress is clearly visible across ROW, elevation, and intensity data (see Figure 29 through Figure 33). Images collected by Pathway Services after the patch are included for comparison (see Figure 34 through Figure 37). Little to no rejuvenator or additional HMA material was added during the patching process. The AADT for this section of pavement is 3,235 (INDOT, 2025).

Data were collected with INDOT's Pavement Condition System to evaluate the performance of the patch. Initial data collection was done in August 2023. Additional runs were made in February 2024 and October 2024. Images provided by the unit when the patch constructed show that a plate compactor was utilized during the construction of the patch (see Figure 38 and Figure 39). ROW images, elevation images (normal images), and 3D light intensity images collected with each dataset (see Figure 40 through Figure 42). Analysis of these datasets showed negligible changes in the elevation and 3D light intensity datasets, indicating good short-term patch performance. The patch was paved over prior to the data collection run made April 2025.

### *2.1.6 US 35 Travel Lane/Shoulder Edge Distress with Potholing*

The Laporte District utilized the infrared pavement heater for several patches on US 35 (see Figure 42, Figure 43).

For patch NP1, the ROW images collected by Pathway Services in 2022 show severe longitudinal distress at the joint between the travel lane and shoulder with low severity potholes developing prior to patching utilizing the infrared pavement heater (see Figure 44 and Figure 45). The elevation and intensity images collected with the Pathway Services are not wide enough to show the longitudinal joint between the travel lane and the shoulder. Little to no rejuvenator or additional HMA material was added during the patching process. The AADT for this section of pavement is 7,936 (INDOT, 2025).

Data were collected with INDOT's Pavement Condition System to evaluate the performance of the patch. This initial data collection was done in February 2024. Additional runs were made October 2024 and April 2025. ROW images were collected February 2024, October 2024, and April 2025 (see Figure 46). There was little change in the 3D normal images (elevation), and 3D light intensity images collected with the Pavement condition van for the time periods between February 2024 and April 2025 (see Figure 47 and Figure 48). This would indicate that the infrared patch is performing well.

### *2.1.7 US 35 Fatigue Cracking in Right-Wheel Path of the Origional Travel Path*

The Laporte District utilized the infrared pavement heater for several patches on US 35 (see Figure 42, Figure 49). For patch groups NP2 and SP3 the distress occurs in the right-wheel path of the original travel path of the road. The change in the travel path evident in the ROW images collected by Pathway Services in 2012 and 2013 (see Figure 50). For patch group NP2, the elevation and intensity images collected by Pathway Services in 2022 (pre-patch) show moderate block cracking distress and low severity potholes developing in the right wheel path of the old travel lane prior to patching (see Figure 51 through Figure 54). Elevation and intensity images collected by Pathway Services in August of 2023 are also included (see Figure 55 through Figure 60).

In addition to the data collected by Pathway Services, data were collected with INDOT's Pavement Condition System to evaluate the performance of the patch. This initial data collection was done in February 2024. The patched area was paved over prior to the data collection run made in October 2024. ROW images collected with INDOT's Pavement Condition system are included in Figure 61.

For several of the patches in NP2 group, there are noticeable changes in the elevation (normal) images collected using the INDOT Pavement condition collected in February 2024 (see Figure 62 through Figure 64), and the elevation images collected in August 2023 by Pathway Services (see Figure 55 through Figure 57). This indicates the patches were starting to break down. There was evidence of material loss and additional patching done after the installation of the infrared patches (see Figure 62 through Figure 64).

For patch group SP3, the elevation and intensity images collected by Pathway Services in 2022 show moderate longitudinal fatigue cracking distress and low severity potholes developing in the right wheel path of the old travel path prior to patching (see Figure 65 through Figure 68). Elevation and intensity images collected by Pathway Services in August of 2023 are also included (see Figure 69 through Figure 72).

In addition to the data collected by Pathway Services, data was collected with INDOT's Pavement condition system to evaluate the performance of the patch. This initial data collection was done in February of 2024. The patched area was paved over prior to the data collection run made in October 2024. ROW images collected with INDOT's Pavement Condition system are included in Figure 73.

For several of the patches in SP3 group, there are noticeable changes in the elevation (normal) images collected using the INDOT Pavement condition collected in February 2024 (see Figure 74 through Figure 77) and the image elevation images collected in August 2023 by Pathway Services (see Figure 69 and Figure 70). This indicates the patches were starting to break down. There was evidence of material loss and additional patching done after the installation of the infrared patches (see Figure 74 through Figure 77).

There was little to no rejuvenator or additional HMA material added during the patching process. The AADT for this section of pavement is 7,936 (INDOT, 2025).

### *2.1.8 Old SR 25 Pavement Shoving Case Study*

The Laporte District utilized the pavement heater to address pavement shoving on Old SR 25 (see Figure 77 and Figure 78). Pre-patch (August 2023) ROW and elevation images from INDOT's inertial profiler showed clear deformation from pavement shoving (see Figure 79, and Figure 82 through Figure 86).

Seven patches were constructed using the infrared pavement heater. Data from February 2023 captured patch condition before the area was paved over before October 2024 (see Figure 80 through Figure 86). No rejuvenator or significant HMA was added. AADT is 3,606.

No Pathway data was available.

## 2.2 SR 38 Ramp onto US 31 Southbound Depression/Bump High Severity Transverse Cracking

The Greenfield District installed an infrared patch at the SR 38 ramp to southbound US 31 (see Figure 87 and Figure 88). Pre-patch 2023 Pathway Services data showed a depression and a transverse crack (see Figure 89 through Figure 92). The depression is most visible in the ROW image (see Figure 89). Rejuvenator and additional HMA were used.

Data collected using INDOT's testing equipment from October 2025 showed that the patch remained in good condition across ROW, elevation, and intensity images (see Figure 93 through Figure 95). AADT is 5,333.

### *2.2.1 SR 3 Case Study*

The Seymour District utilized the infrared pavement heater for ten patches on SR 3 through the town of Charlestown, Indiana (see Figure 96 to Figure 98), six are summarized here.

ROW images collected by Pathway Services prior to patching, November 2023, at location P8 were not detailed enough to show distress (see Figure 99). There is a small depression/pothole developing in the elevation and intensity images collected by Pathway Services prior to patching, November 2023 (see Figure 100 and Figure 101 ). The patch is visible in the images collected by Pathway Services in November 2024 (see Figure 100 and Figure 101).

Data were collected with INDOT's inertial profiler and Pavement Condition System in October 2024 and April 2025. The ROW images, elevation (normal) images, and 3D light intensity images collected with the Pavement Condition System shows cracking and the other changes in the patch in the images collected in April 2025 versus those collected in October 2024 (see Figure 102 and Figure 103). These changes include additional patch material visible in the ROW images (inside red boxes; see Figure 102). Once identified as the source the additional patch materials are visible in the elevation (normal) and 3D light intensity images (inside red boxes; see Figure 103). The AADT for this section of pavement is 16,902 (INDOT, 2025).

ROW images collected by Pathway Services prior to patching, November 2023, at location P5, P6, and P7 showed existing distress and an old patch near the location of P6 (see Figure 104). There is a pothole developing and an existing patch in the intensity images collected by Pathway Services prior to patching, November 2023 at the location of P6 (see Figure 105 and Figure 106). The patch is visible in the images collected by Pathway Services in November of 2024 (see Figure 107 and Figure 108). There is some left-wheel-path rutting and cracking present in the intensity images collected by Pathway Services prior to patching, November 2023 at the locations of P5 and P7 (see Figure 105 and Figure 106). There is a pothole developing in the location of P5 (see Figure 105 and Figure 106). The patches are visible in the images collected by Pathway Services in November of 2024 (see Figure 107 and Figure 108).

Data were collected with INDOT's inertial profiler and Pavement Condition System in October 2024 and April 2025. The ROW images, elevation (normal) images, and 3D light intensity images collected with the Pavement Condition System show significant cracking in P7 collected in April 2025 versus those collected in October of 2024 (see Figure 110). There has been additional patch material added to patches P5 and P6 after the installation of the infrared patches (Figure 111). The AADT for this section of pavement is 16,902 (INDOT, 2025).

ROW images, elevation images and intensity collected by Pathway Services prior to patching, November 2023, at location P1 show the condition of the pavement (see Figure 112 through Figure 114). The elevation image collected shows evidence of left-wheel-path rutting at the location of the patch (see Figure 113). Images collected by Pathway Services after patching in November 2024 are also included (see Figure 115 and Figure 116)

Data were collected with INDOT's inertial profiler and Pavement Condition System in October 2024 and April 2025. The ROW images, elevation (normal) images, and 3D light intensity images collected with the Pavement Condition System show additional patching after the installation of the infrared patch (red boxes) in data collected April 2025 (see Figure 117 and Figure 118). There is very little change in the images collected in the infrared patches in the passing lane PP1 (see Figure 97, Figure 118, and Figure 119). The AADT for driving lane for this section of pavement is 11,676 (INDOT, 2025).

### *2.2.2 SR 25 Case Study: Severe Fatigue Cracking and Patch Deterioration*

An infrared patch was installed on SR 25 near a bridge (see Figure 120 and Figure 121). Pre-patch images from 2022 showed severe block cracking and potholing (see Figure 122 through Figure 124). Minimal HMA was added during patching.

Pathway and INDOT Pavement Condition System images from 2023–2025 revealed significant deterioration, including material loss and spreading cracking (see Figure 125 through Figure 132). This performance reflects the severity of underlying pavement distress. AADT is 11,139.

### *2.2.3 SR 16 Pipe Patch Case Study*

The Laporte District utilized the infrared pavement heater to construct patch over a culvert/pipe on SR 16 (see Figure 11 and Figure 133) showing block cracking and a depression (2022 Pathway images; see Figure 134 through Figure 136). Little to no rejuvenator or additional HMA was utilized during patching.

INDOT data collected from 2023 to 2025 showed minimal changes in ROW, elevation, and intensity images, indicating good patch performance (see Figure 137 and Figure 138). AADT is 1,236.

### *2.2.4 I-65 Case Study*

The Laporte District utilized the infrared pavement heater to install four patches on a segment of I-65 in January 2024 (see Figure 139 and Figure 140). This section of pavement was not performing well and was overlayed prior to the data collection run in October 2024. The pavement breakdown is obvious in ROW images collected in October 2024 verses those collected in August 2023 in an area just north of the patches (see Figure 141) There was little to no rejuvenator or additional HMA material added when patching with the infrared pavement heater. The 2024 AADT for this section of road is 45,196 (INDOT, 2025).

Images collected with INDOT's inertial profiler and Pavement Condition Systems in August 2023 prior to patching show longitudinal and transverse cracking as well as an existing patch in the pavement at site of patches NP1 and NP2 (see Figure 140, Figure 142, Figure 144). An image of the patch collected while patching is included (see Figure 143).

ROW, elevation, and 3D light intensity images collected with INDOT's inertial profiler in February 2024 show additional patching closely adjacent to NP1 and NP2 the month after patching (see Figure 142 and Figure 144). There is little change in the portion of the patch visible in data collected in October 2024 verses February 2024 (see Figure 142 and Figure 145).

Images collected with INDOT's inertial profiler and Pavement Condition Systems in August 2023 prior to patching show longitudinal and transverse cracking and a pothole developing in the pavement at site of NP3 (see Figure 140, Figure 142 and Figure 147). An image of the patch collected while patching is included (see Figure 146).

ROW, elevation, and 3D light intensity images collected with INDOT's inertial profiler in February 2024 show additional patching encroaching on NP3 the month after patching (see Figure 142 and Figure 147).

Images collected with INDOT's inertial profiler and Pavement Condition Systems in August 2023 prior to patching show longitudinal cracking and a depression in the pavement at site of NP4 (see Figure 140, Figure 148, and Figure 150). An image of the patch collected while patching is included (see Figure 149).

ROW, elevation, and 3D light intensity images collected with INDOT's inertial profiler in February 2024 show little change NP4 the month after patching (see Figure 148 and Figure 150). There is little change in the portion of the patch visible in data collected in October 2024 verses February 2024 (see Figure 148 and Figure 151).

#### *2.2.5 US 31 Reflection Joint Corner Distress*

The Greenfield District utilized the infrared pavement heater to install several patches in the travel lane of US 31 northbound between the 236th Street interchange and the intersection with 246th Street (see Figure 152). The size of patches indicates the small one panel infrared pavement heater was utilized for most of the patches (see Figure 153 through Figure 163). Rejuvenator and additional HMA were added to these patches. The AADT for this section of road is 31,505.

The patches in this section of road were discovered though the analysis of data collected by Pathway Services. The patches in this section of road were paved over when the site was visited with INDOT's specialized testing equipment. The data collected by Pathway Services prior to patching show reflective cracks with deterioration in the shoulder corner (see Figure 153 through Figure 166).

#### *2.2.6 Case Study Conclusions*

Overall, infrared patch performance varied by site. Patches placed over low-volume roads and moderate-severity distress (e.g., SR 16, SR 38) performed well for the expected 1-year life. Sites with severe structural distress (e.g., SR 25, US 35 NP2/SP3) exhibited deterioration despite patching.

Performance depended heavily on:

- Underlying pavement condition,
- Use of rejuvenator, and
- Addition of supplemental HMA.

Many patches involved only reheating, reworking, and minimal added mix. Under those conditions, and given the expected limited service life, the infrared patches generally performed acceptably.

### 2.3 Maintenance Unit Feedback

#### *2.3.1 Laporte District Feedback*

Laporte District maintenance personnel provided both observations and a list of pros (advantages) and cons (disadvantages) regarding the use of infrared pavement heater. The observations follow:

- The infrared heater would be easier to move if it had handles on all sides.
- It would be safer and more efficient if the infrared unit came equipped with electric igniters or other internal ignition system.
- Improving the process and access for filling the propane tanks would improve efficiency.
- Traffic affects the speed/time taken for the infrared pavement heater to heat the pavement to a workable temperature (Air movement and other environmental effects from traffic).
- It would be nice to have access to spare propane tanks when operating the equipment.
- Cold mix on the road takes longer to heat and break up than virgin pavement.
- It would be better to treat a larger area at once (utilize infrared equipment with a large footprint).
- The propane tanks freeze/frost over in cold weather limiting the applicability in cold weather.

The pros (advantages) follow:

- Using the infrared pavement heater allows smoothing out the rough areas when patching.
- The infrared heater is simple to use.

The cons (disadvantages) follow:

- Getting the pavement up to temperature is time consuming.
- The area heated by the unit provided is small (small footprint).
- Leaving the unit in one place too long can catch the roadway on fire.
- It takes a long time at least 2 hr to heat the asphalt in the hot box if the mix is left in the box for an extended time.

#### *2.3.2 Seymour District Feedback*

Seymour District maintenance personnel provided a pro and a con from their experience with the infrared pavement heater.

The pro (advantage):

- Really good on interstate.

The con (disadvantage):

- The infrared pavement heater does not work well on chip-sealed roads.

#### *2.3.3 Greenfield District*

Greenfield District personnel provided the following observation regarding utilizing the infrared pavement heater.

- Overall, the equipment works pretty well.
- Reheating the material can catch the pavement on fire.
- On windy days, the pavement catches fire quicker.

- Rejuvenator should be used on all infrared patches.
- When patching the big hunks should be removed from the heated material prior to spraying with rejuvenator and compacting.
- The use of millings is acceptable.
- The small one burner infrared heater is versatile (unit utilized for several patches).
- Most infrared patches in this study are designed for a 6-month to 1-year service life.
- It would be nice to have a skirt that would keep out more of the wind better.
- If equipment with a bigger footprint is utilized, good patching would require the addition of a piece of equipment to grind the material; otherwise, the crew could not easily keep up the infrared heater.

Types of repairs that would benefit the use of an infrared heater:

- Bump removal
- Filling potholes
- Spider web cracking

## 3. CONCLUSIONS AND RECOMMENDATIONS

This demonstration project provided INDOT maintenance personnel with practical experience using infrared pavement-heating technology to address a wide range of asphalt pavement distresses. Districts employed the infrared heater to mitigate rutting, longitudinal and block cracking, potholes, shoving, localized depressions, transverse cracking, and corner distress associated with reflective cracking on composite pavements.

Overall, the infrared patches installed during the study performed acceptably. Most patches were constructed by heating the existing pavement surface, reworking the softened material, adding small quantities of new HMA, and compacting the area. Although the absence of rejuvenator may reduce long-term performance, this limitation was largely offset by the fact that many patches were intended to last one year or less. Several locations, such as the SR 16 sites, showed minimal change between August 2023 and June 2025. Other locations exhibited deterioration such as cracking, material loss, or the need for additional patching which is consistent with the severity of underlying pavement conditions. Patch longevity was strongly influenced by the condition of the host pavement, as well as whether rejuvenator or supplemental HMA was added during repair.

Infrared patching demands significantly more time and labor than traditional throw-and-go patching, resulting in higher costs. Previous research (Nazzal et al., 2014) indicates that infrared patching can require more than four times the time of conventional methods, limiting its practicality for certain maintenance situations. These considerations are reflected in the proposed infrared patching decision tree (see Figure 167). The increased investment is particularly relevant when dealing with patches expected to have short service lives. Wang and Chen (2024) found that the breakeven patch lifespan needed to justify the higher cost of infrared patching exceeded 55 weeks across all life-cycle cost analyses, reinforcing the need to consider expected patch life before selecting this method.

Quality control is also essential to patch performance. The infrared patching process is highly sensitive to initial pavement condition—the principle of "garbage in, garbage out" applies—and to workmanship during construction. A quality-control flowchart based on the work of Leininger (2015) is included as Figure 168 to support the development of INDOT's infrared patching quality-control program.

In summary, infrared pavement patching can be an effective maintenance tool when applied to appropriate locations, especially where moderate distress and low-volume traffic conditions are present. However, its increased cost and sensitivity to underlying pavement conditions must be carefully considered when determining whether the method is suitable for a specific maintenance scenario.

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## Introduction, Background, and Discussion Figures



**Figure 1** INDOT Infrared Pavement Heater (Heat Design).

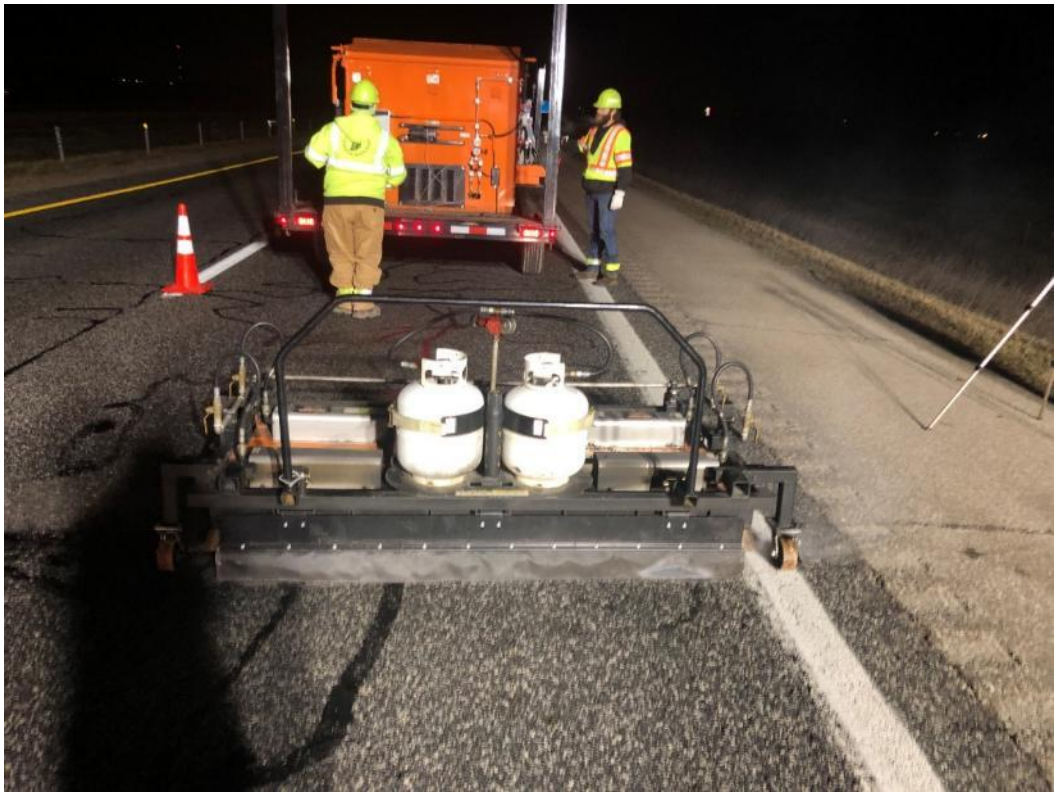


**Figure 2** INDOT Infrared Pavement Heater (Heat Design).



**Figure 3** INDOT Infrared Pavement Heater (Heat Design).

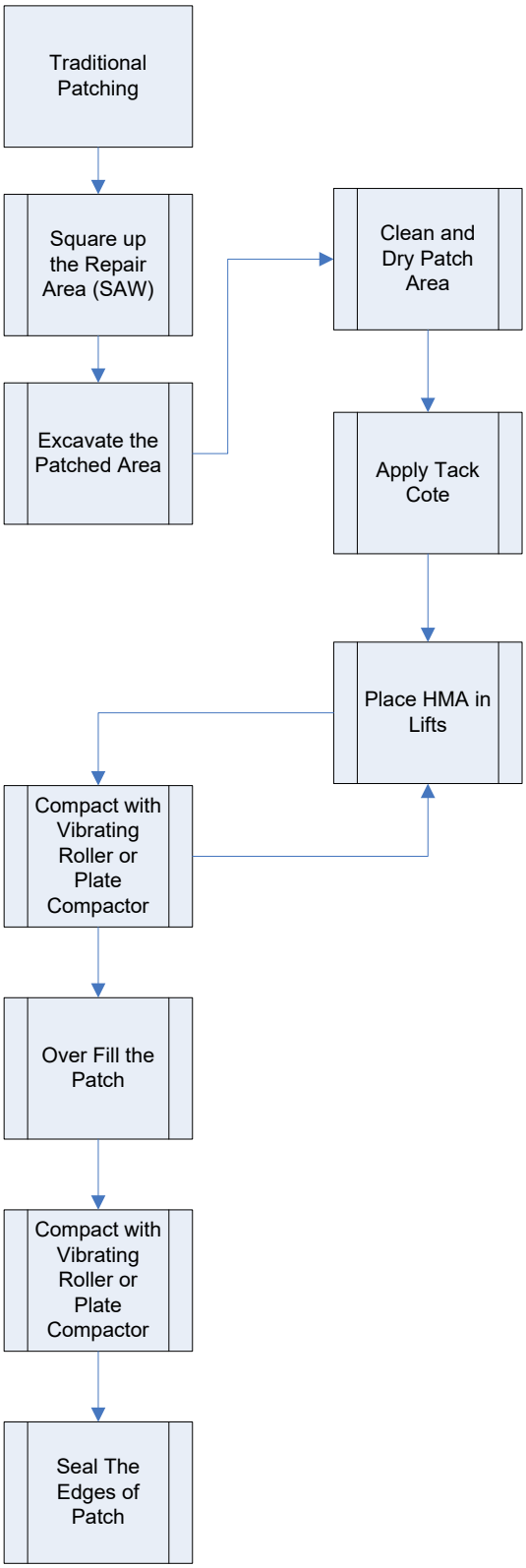



**Figure 4** Traditional Patching Flowchart.

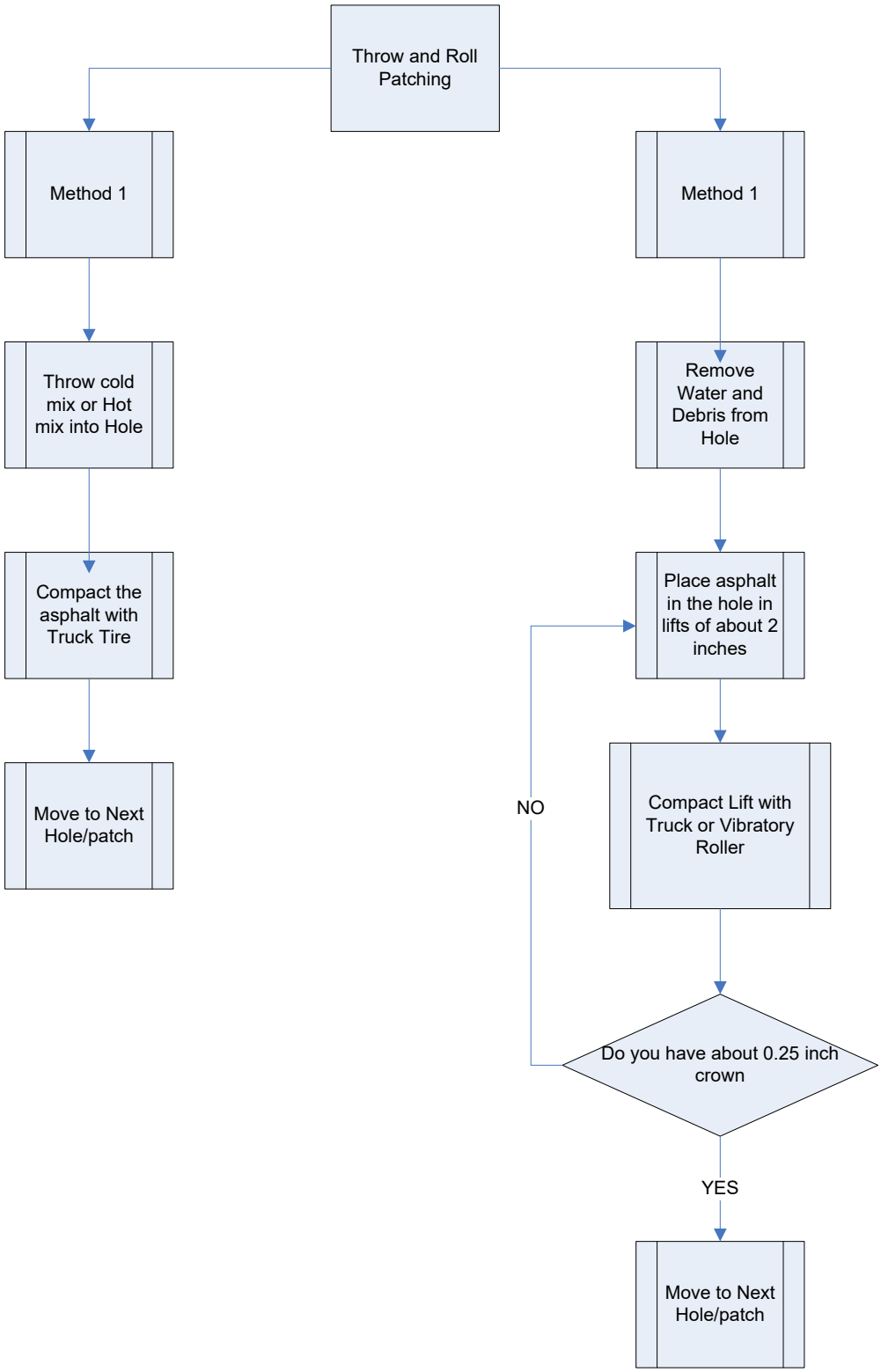



**Figure 5** Throw and Roll Patch Methodology Flowchart.

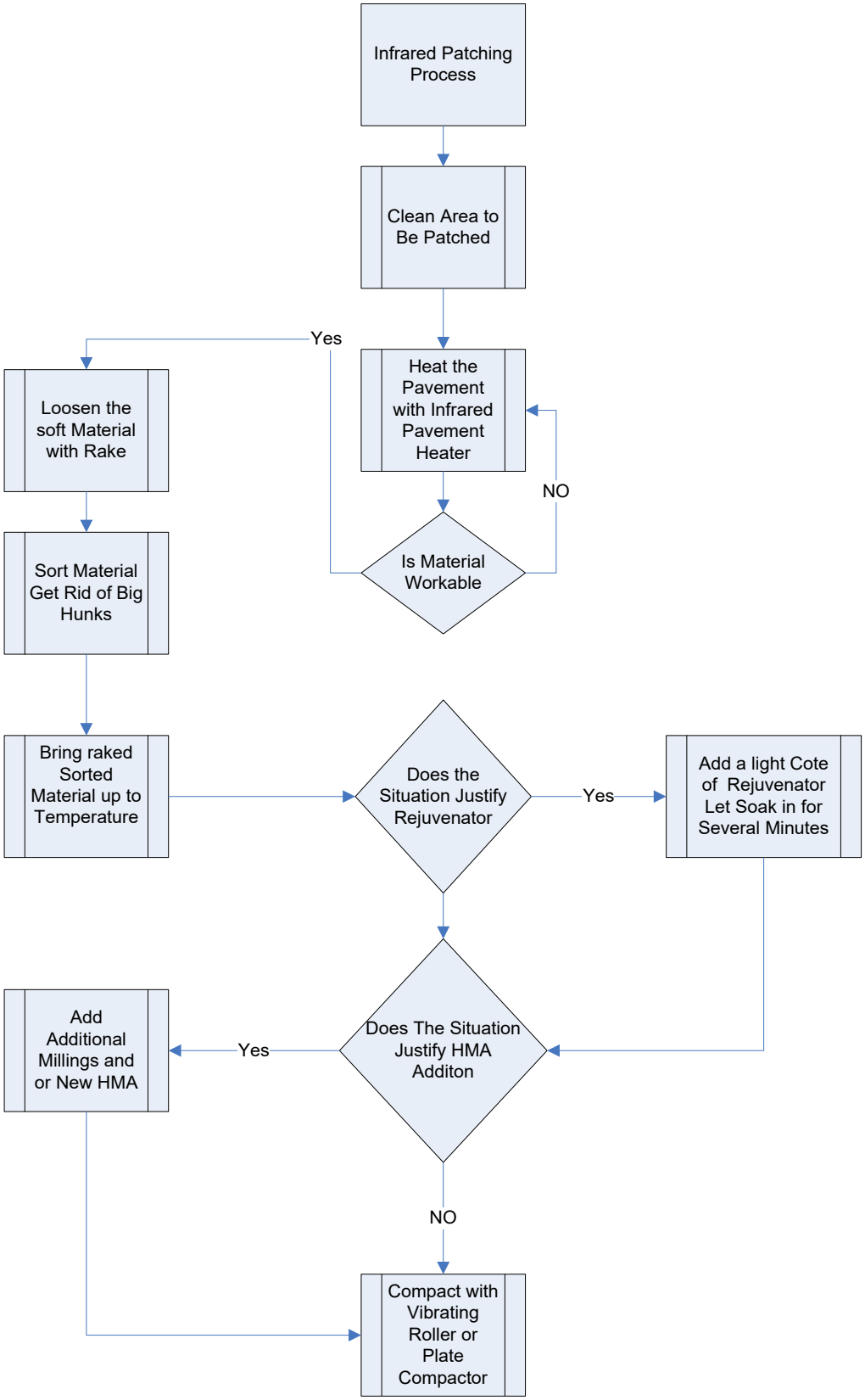



**Figure 6** Flowchart of Infrared Patching Process.



**Figure 7** Infrared Patch Utilized for Training at INDOT Research in Development December 2023, Patch Installed July 2022, No Rejuvenator or HMA Material Added During Patching.



**Figure 8** Westfield Unit Test Patch 1, 1 Year After Patch. Note: Initial Pavement Condition Poor, Raveling Present in Patch.

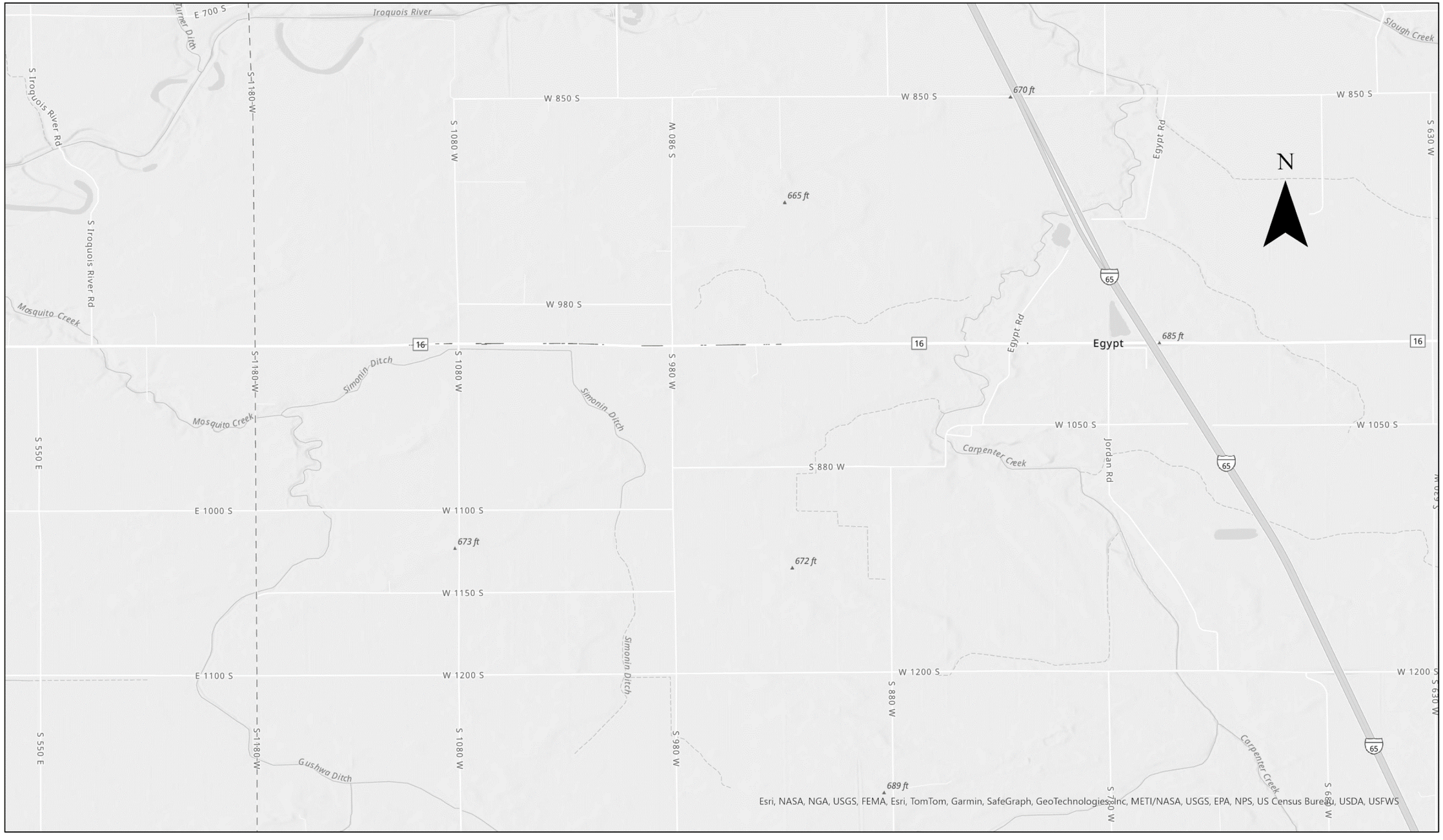


**Figure 9** Westfield Unit Test Patch 2, 1 Year After Patch. Note: Block Cracking in the Pavement, Limited Distress in the Patch.



**Figure 10** Westfield Unit Test Patch 3, 1 Year After Patch. Note: Little Distress in Initial Condition of Pavement, Very Little Distress in the Patch.

**SR 16 Right Wheel Path Rutting/Fatigue Cracking Case Study Figures**



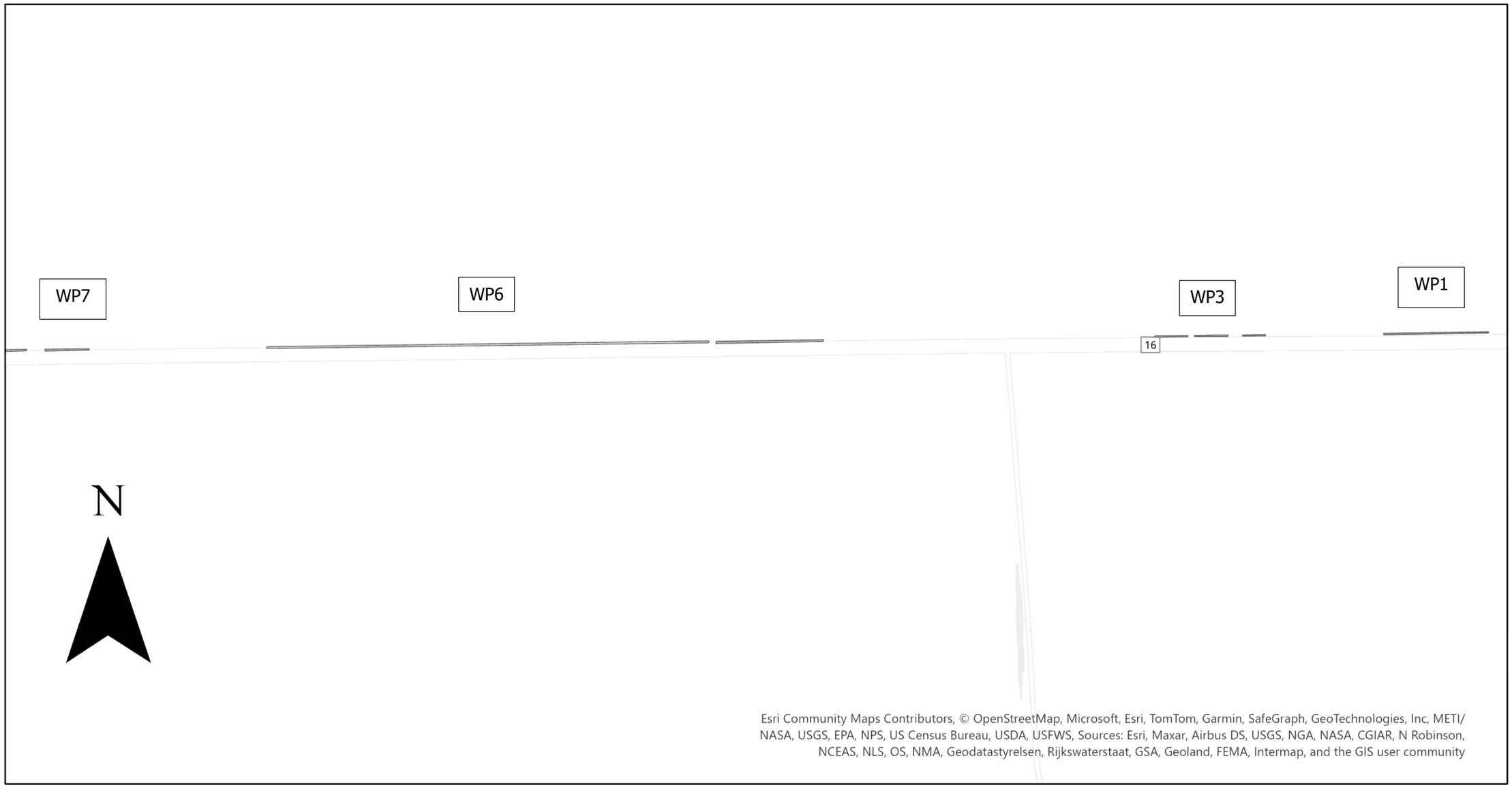



**Figure 11** SR 16 Infrared Test Section.

**Figure 12** SR 16 Westbound Patch Locations.

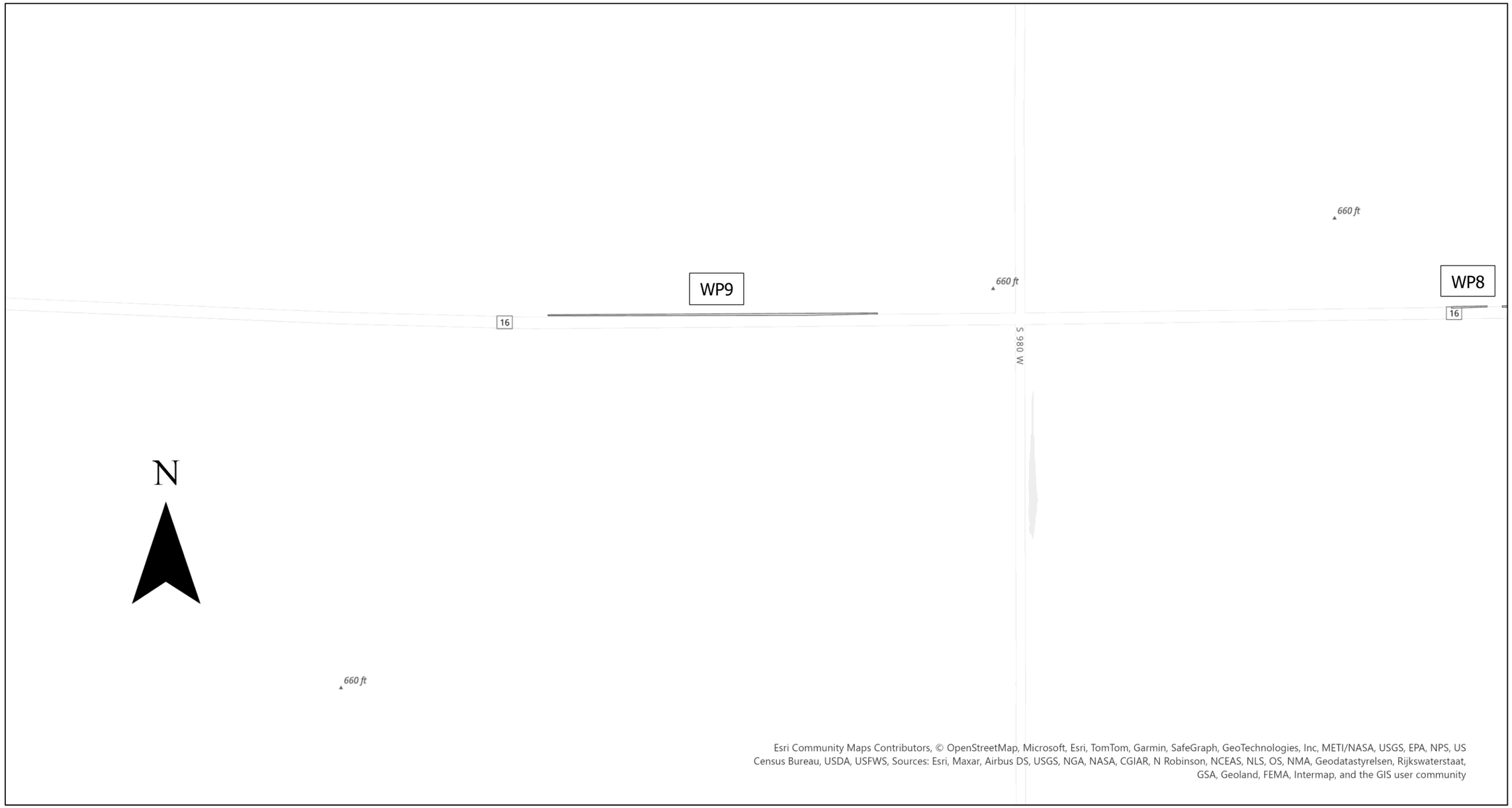



**Figure 13** SR 16 Location Westbound Patches 8 and 9.

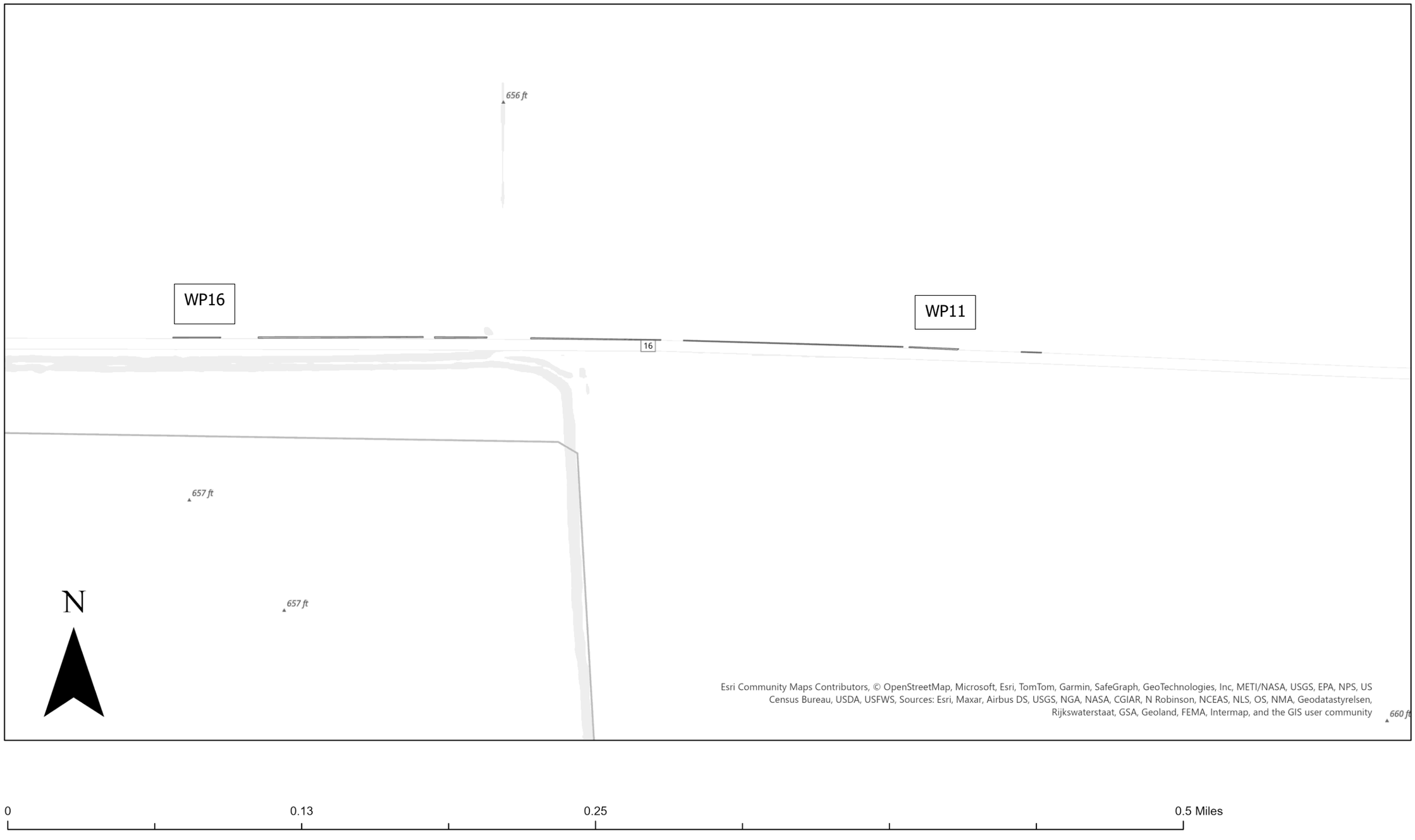



**Figure 14** Location of SR 16 Westbound Patches 10 Through 16.

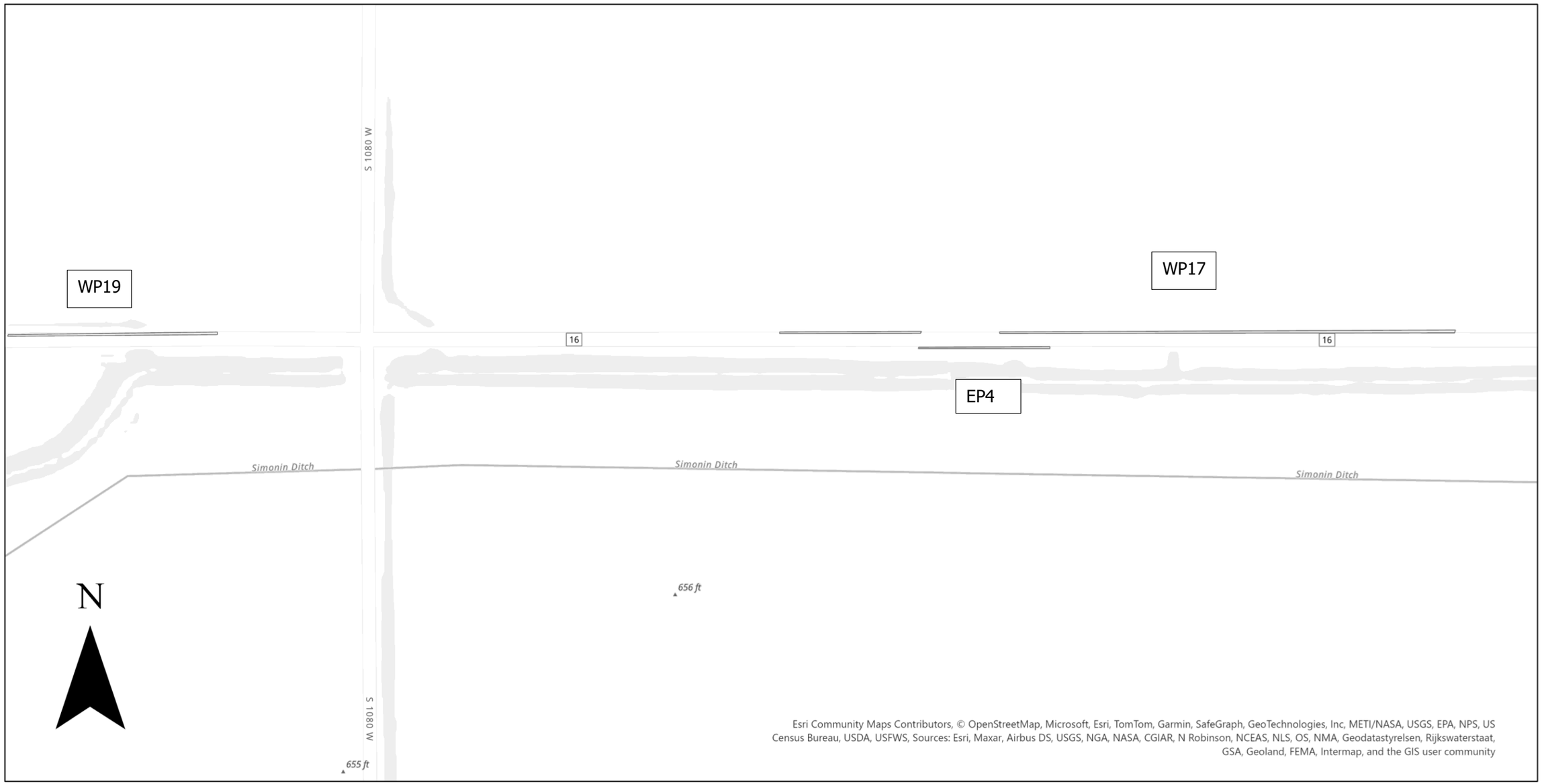



**Figure 15** Location of SR 16 Westbound Patches 17 Through 18 and Eastbound Patch 4.

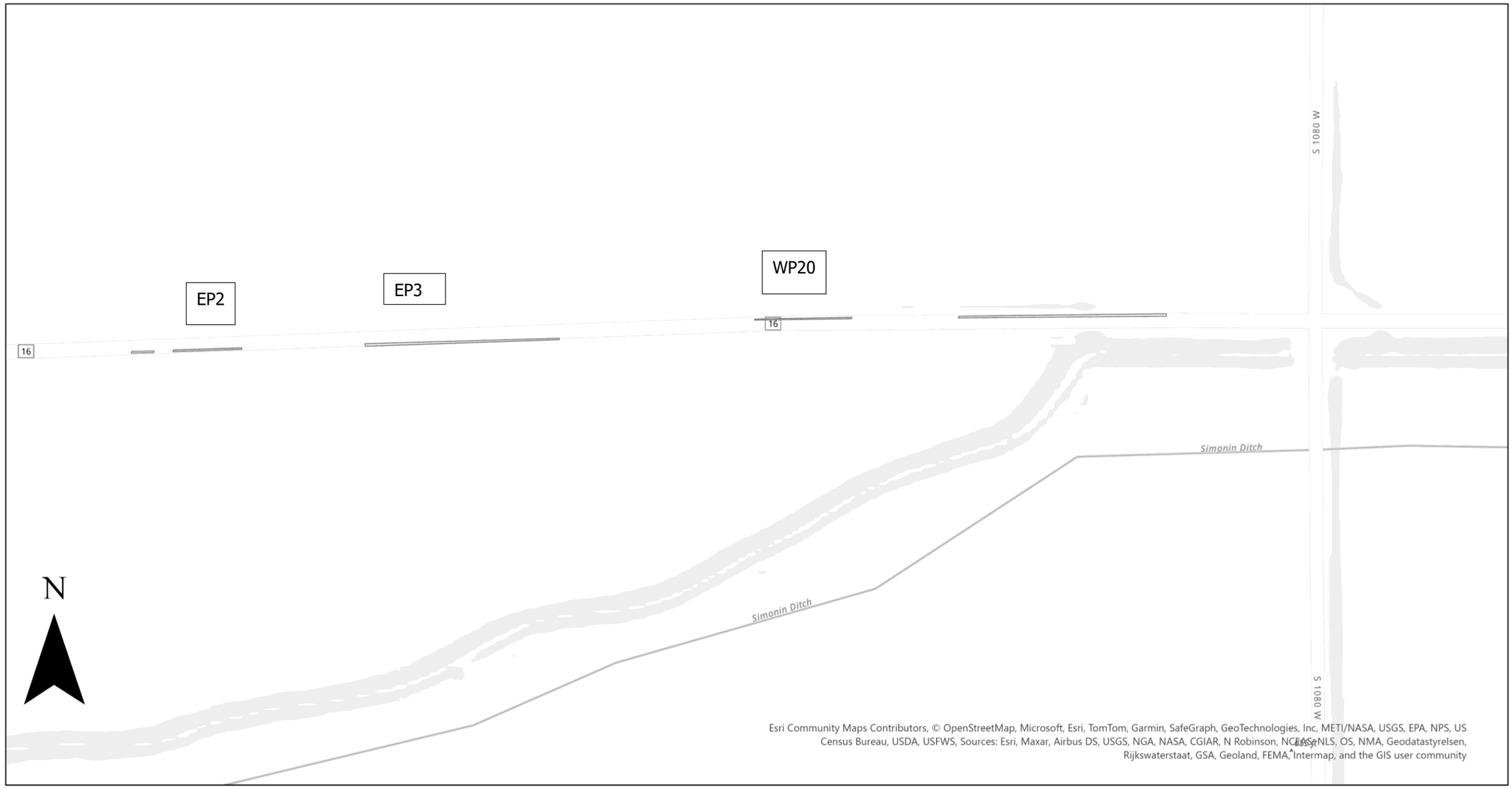



**Figure 16** Location of SR 16 Westbound Patches 18 and 19 and Eastbound Patches 1 Through 3.

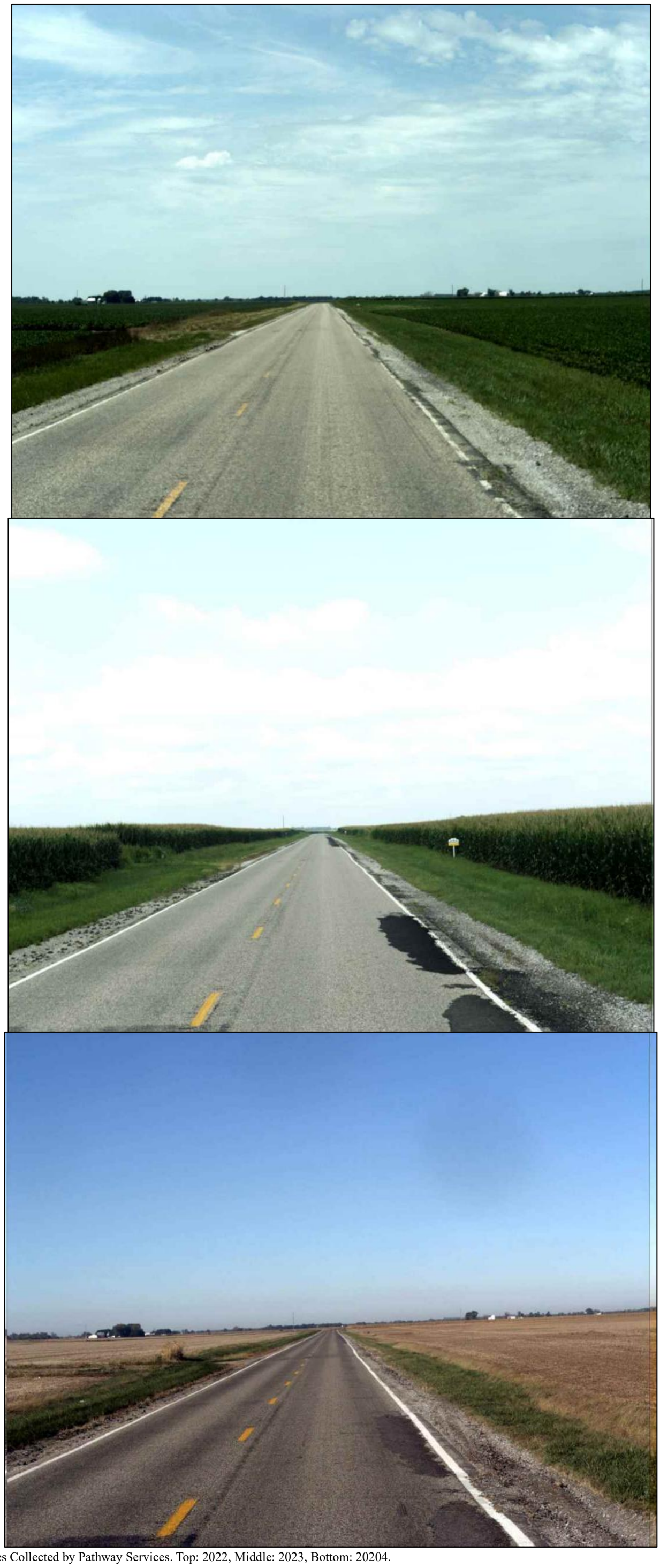


**Figure 17** SR 16 WP3 ROW Images Collected by Pathway Services. Top: 2022, Middle: 2023, Bottom: 20204.

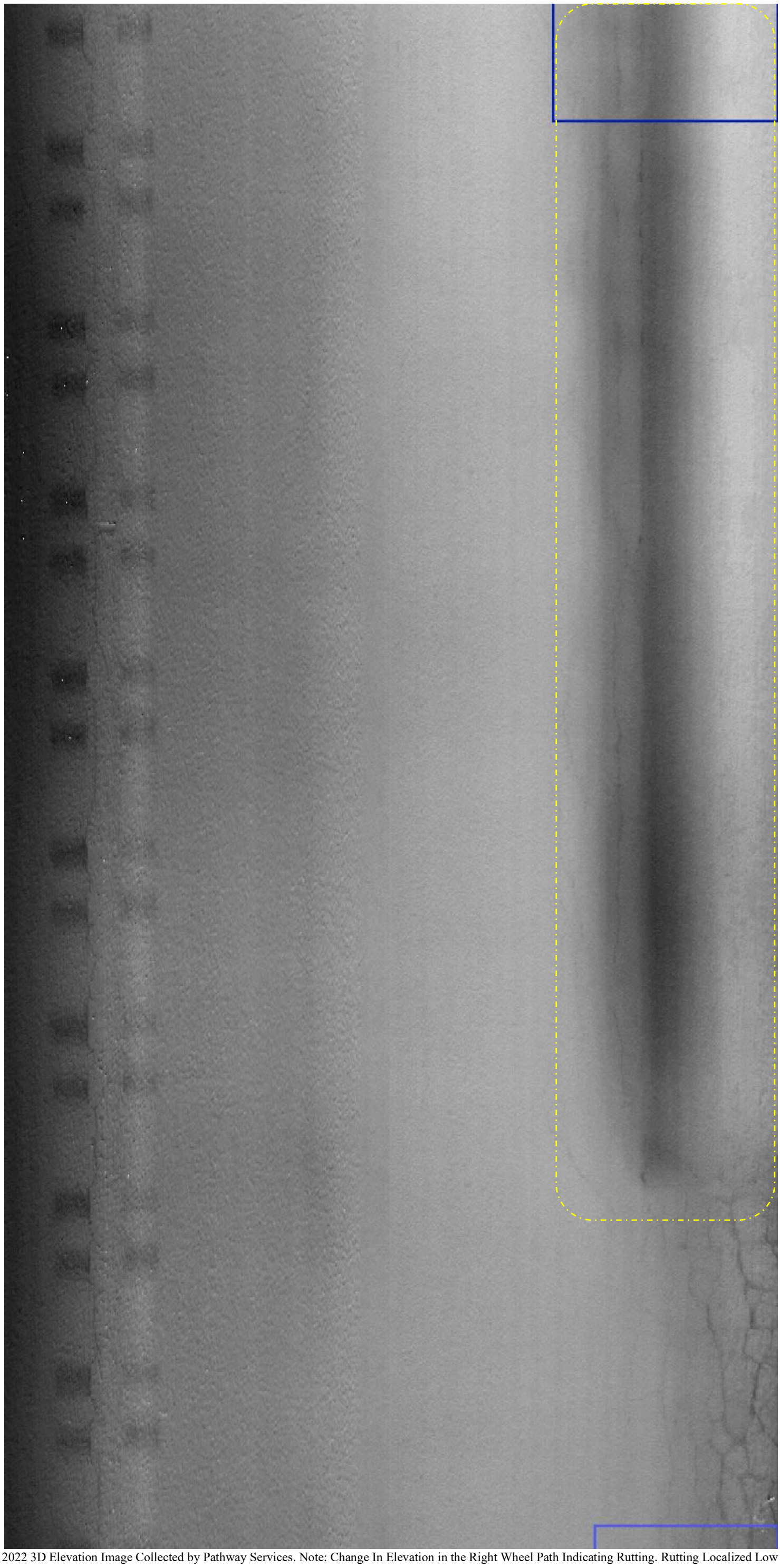


**Figure 18** SR 16 WP3 2022 3D Elevation Image Collected by Pathway Services. Note: Change In Elevation in the Right Wheel Path Indicating Rutting. Rutting Localized Low in Elevation (Dark Colors).

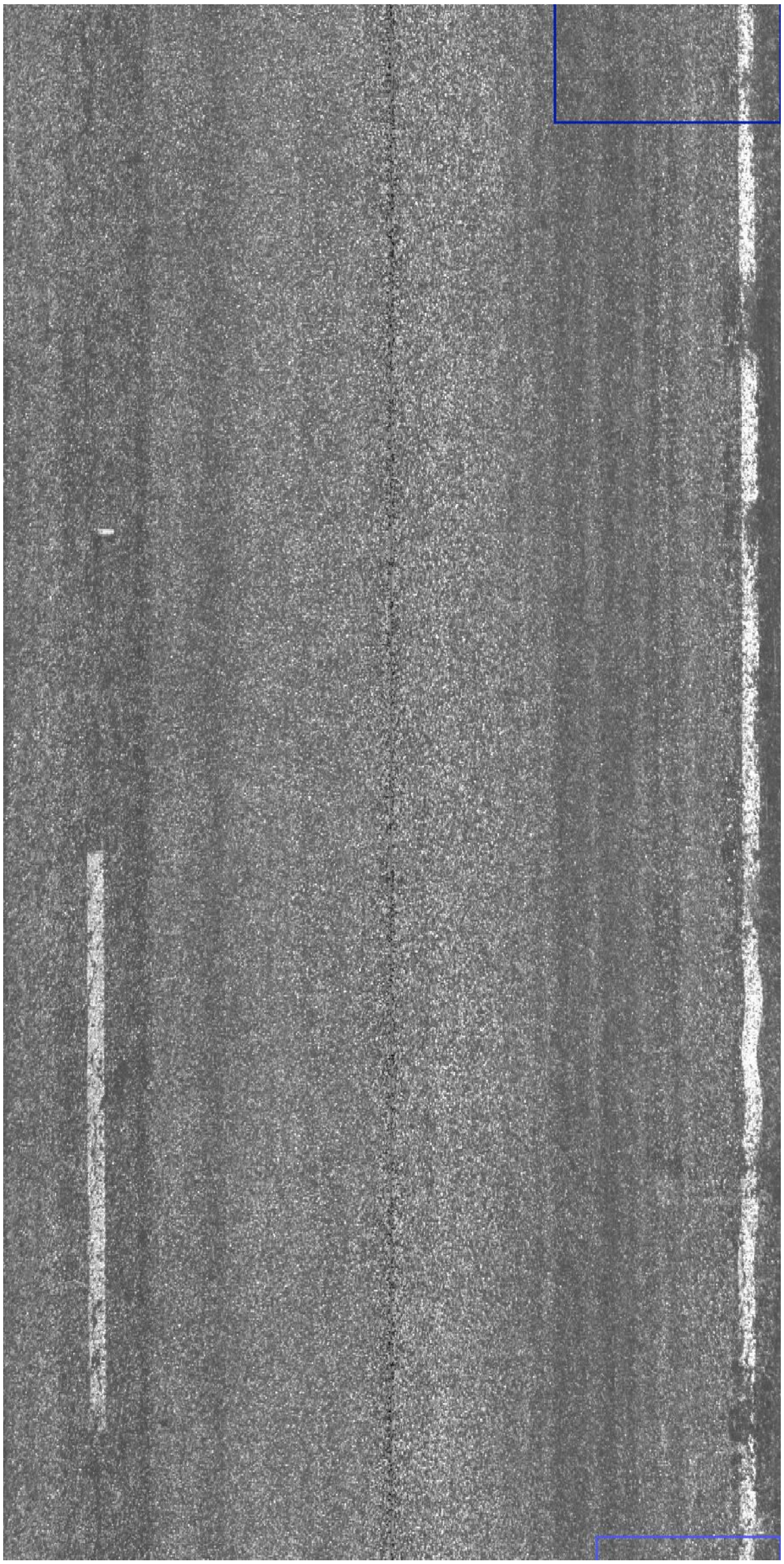


**Figure 19** SR 16 WP2 2022 Intensity Image Collected by Pathway Services Note: Changes in Intensity in the Right Wheel Path Indicating Changes in the Pavement Surface.

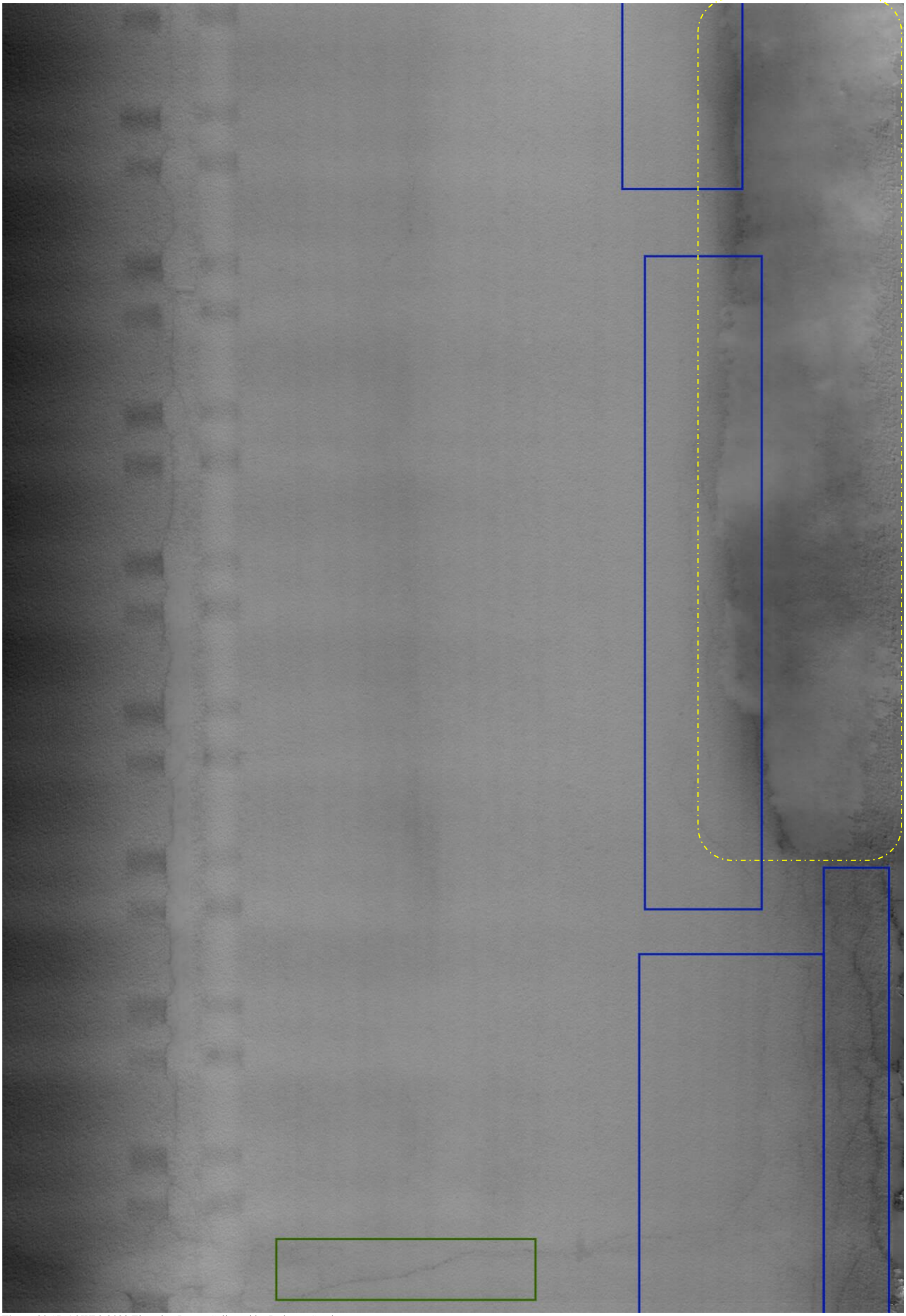


**Figure 20** SR 16 WP3 2023 Elevation Image Collected by Pathway Services.

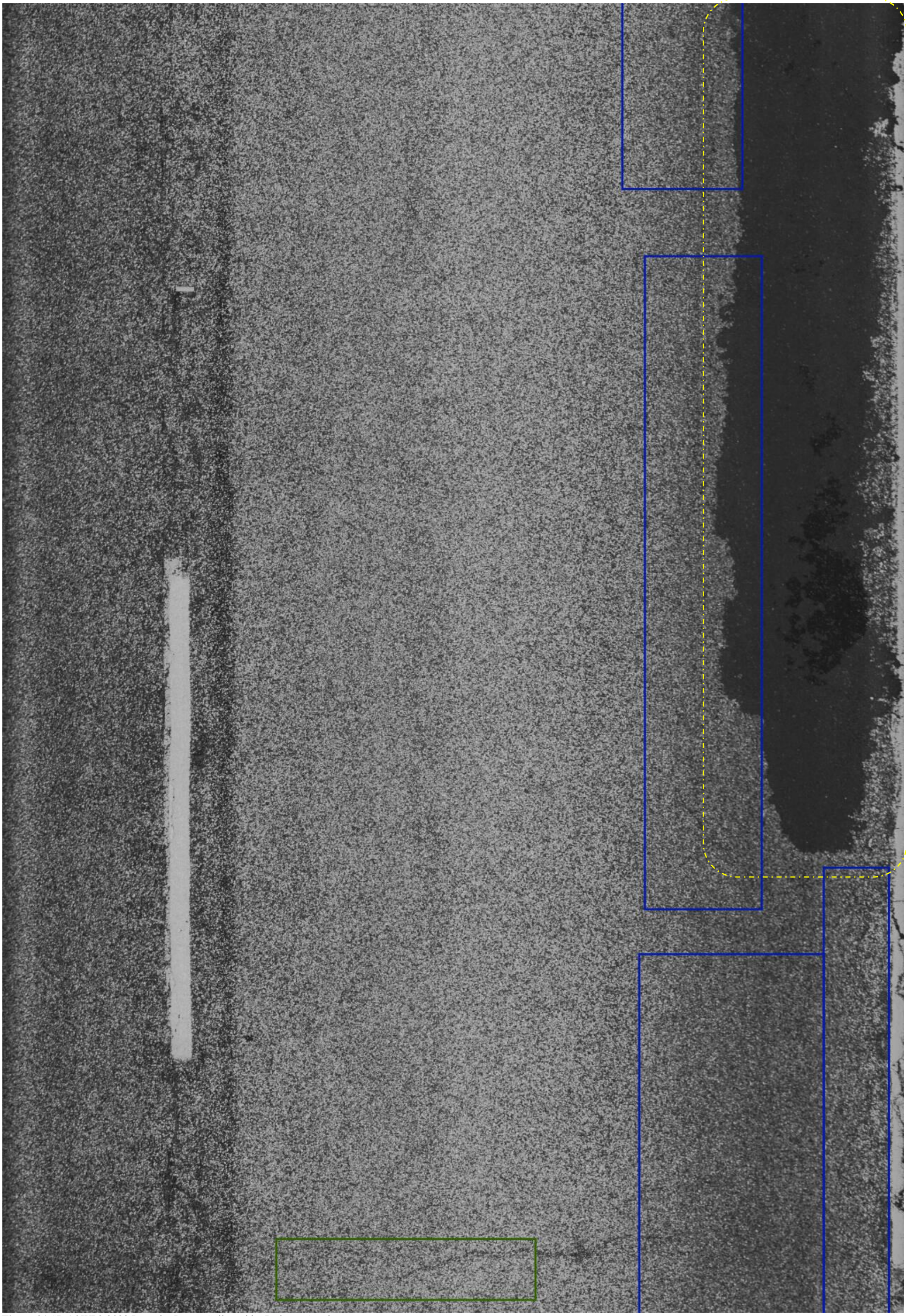


**Figure 21** SR 16 WP3 2023 Intensity Image Collected by Pathway Services.



**Figure 22** SR 16 WP3 Image Taken December 2023.













**Figure 23** SR 16 WP3 Images Collected With Inertial Profiler Data. Note: Dates Are on Images.



SR16WP3:1 of 4: ROW Images: Top Left=August 2023, Top Right=February 2024, Bottom Left=October 2024, Bottom Right=April 2025



**Figure 24** SR 16 WP3 ROW Images Collected With Pavement Condition Van.

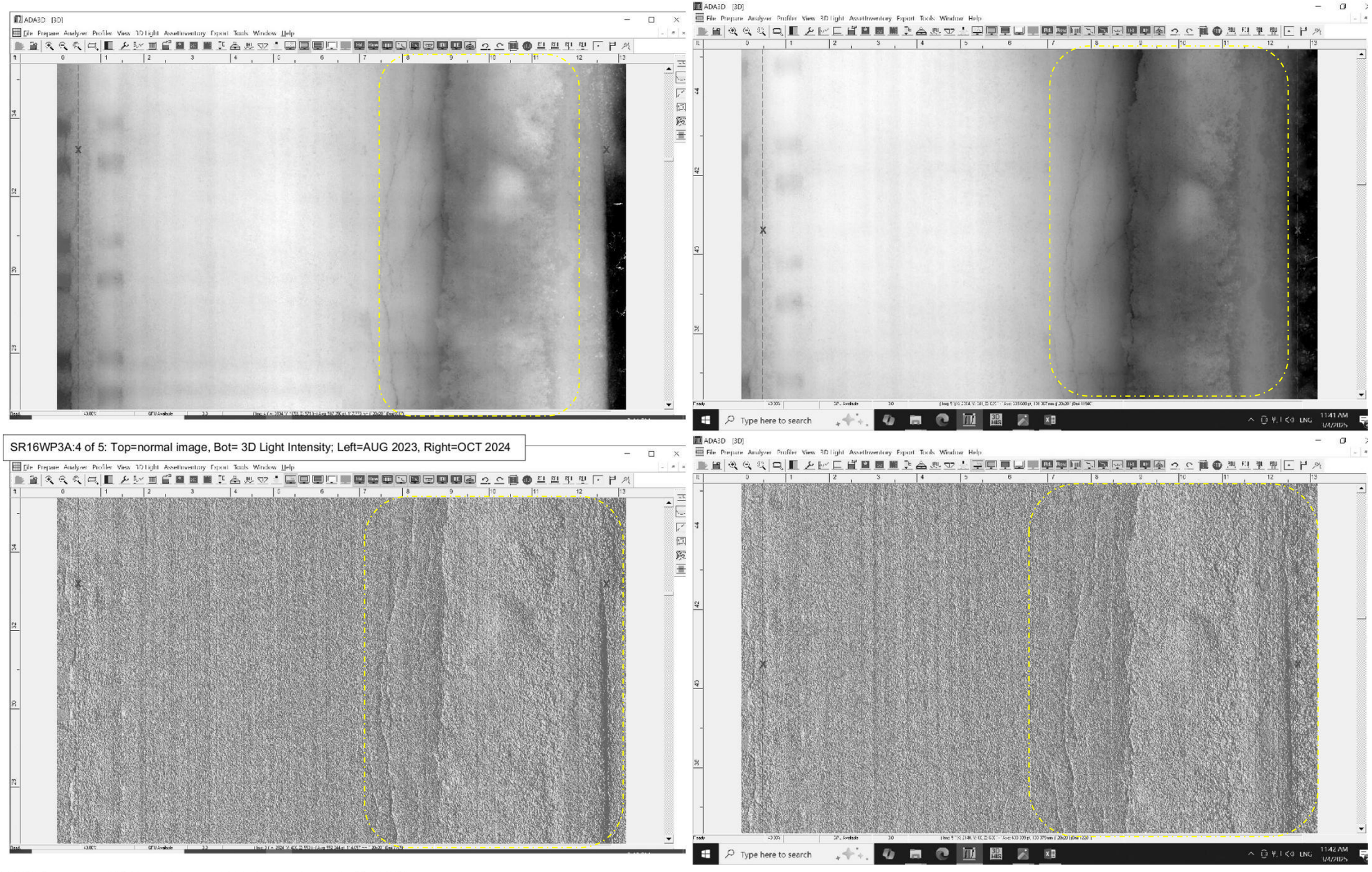



**Figure 25** SR 16 WP3 Comparison of 3D Normal Images and Light Intensity Images for SR 16 WP3.

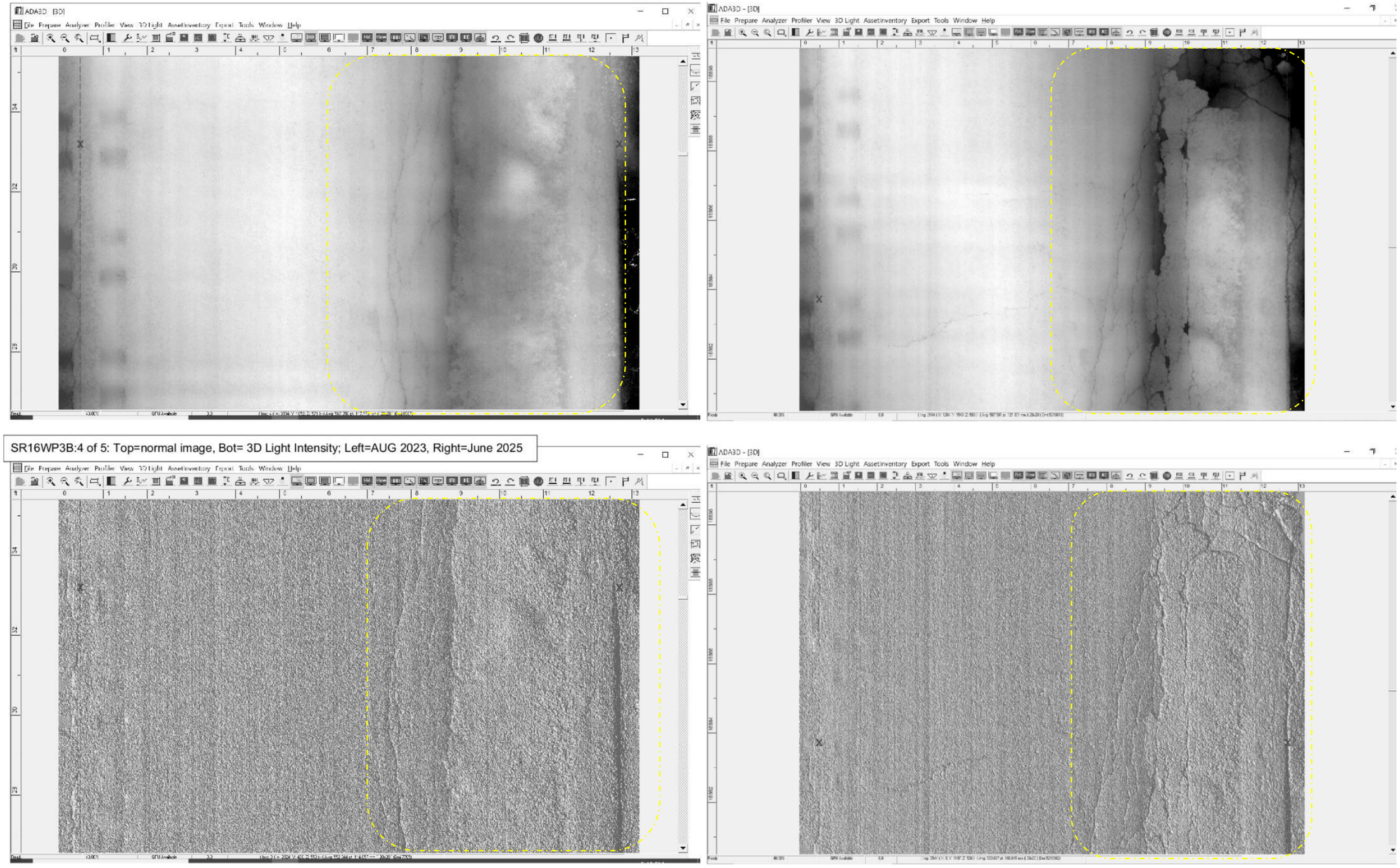



**Figure 26** SR 16 WP3 Comparison of 3D Normal Images and Light Intensity Images for SR 16 WP3.

**SR 329 Right Wheel Path High Severity Longitudinal/Fatigue Cracking and Potholing Distress Case Study Figures**

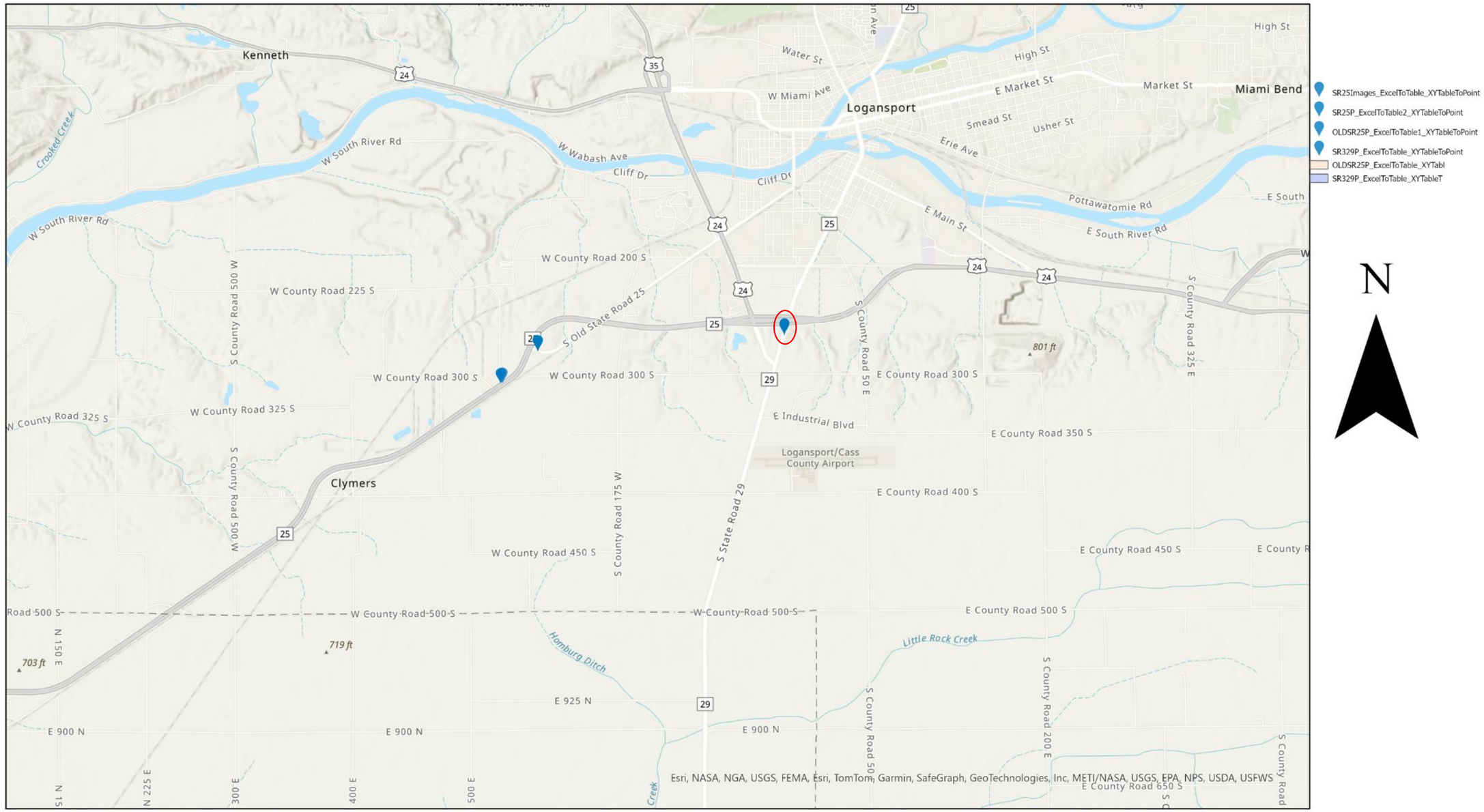



**Figure 27** Location of SR 329 Patch.

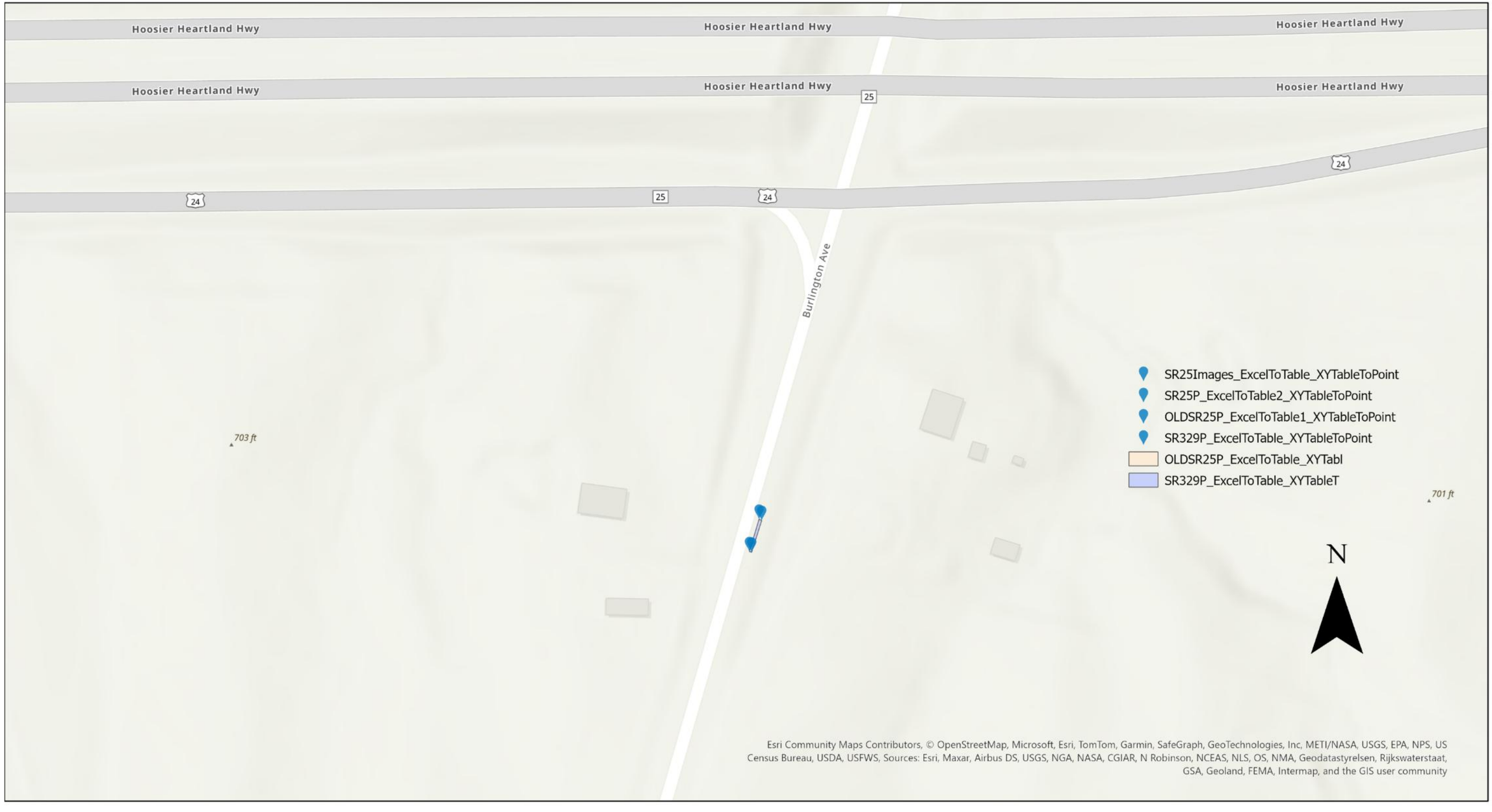



**Figure 28** Location of SR 329 Patch ZOOMED.






**Figure 29** SR 329 Patch ROW Images Collected by Pathway Services 2022 Showing Right Wheel Path Distress.

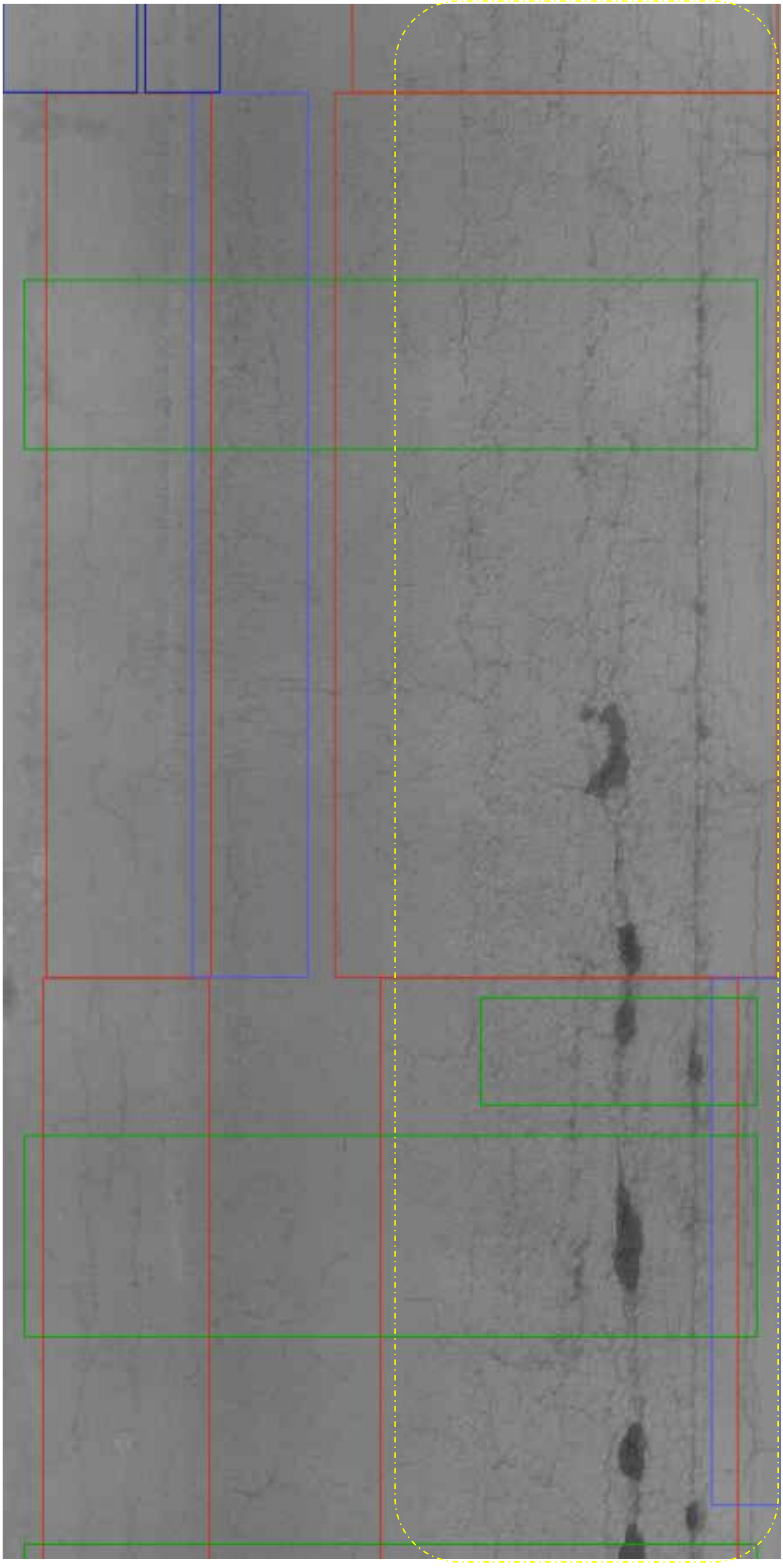


**Figure 30** SR 329 Patch Elevation Image Collected by Pathway Services 2022 Segment 1.

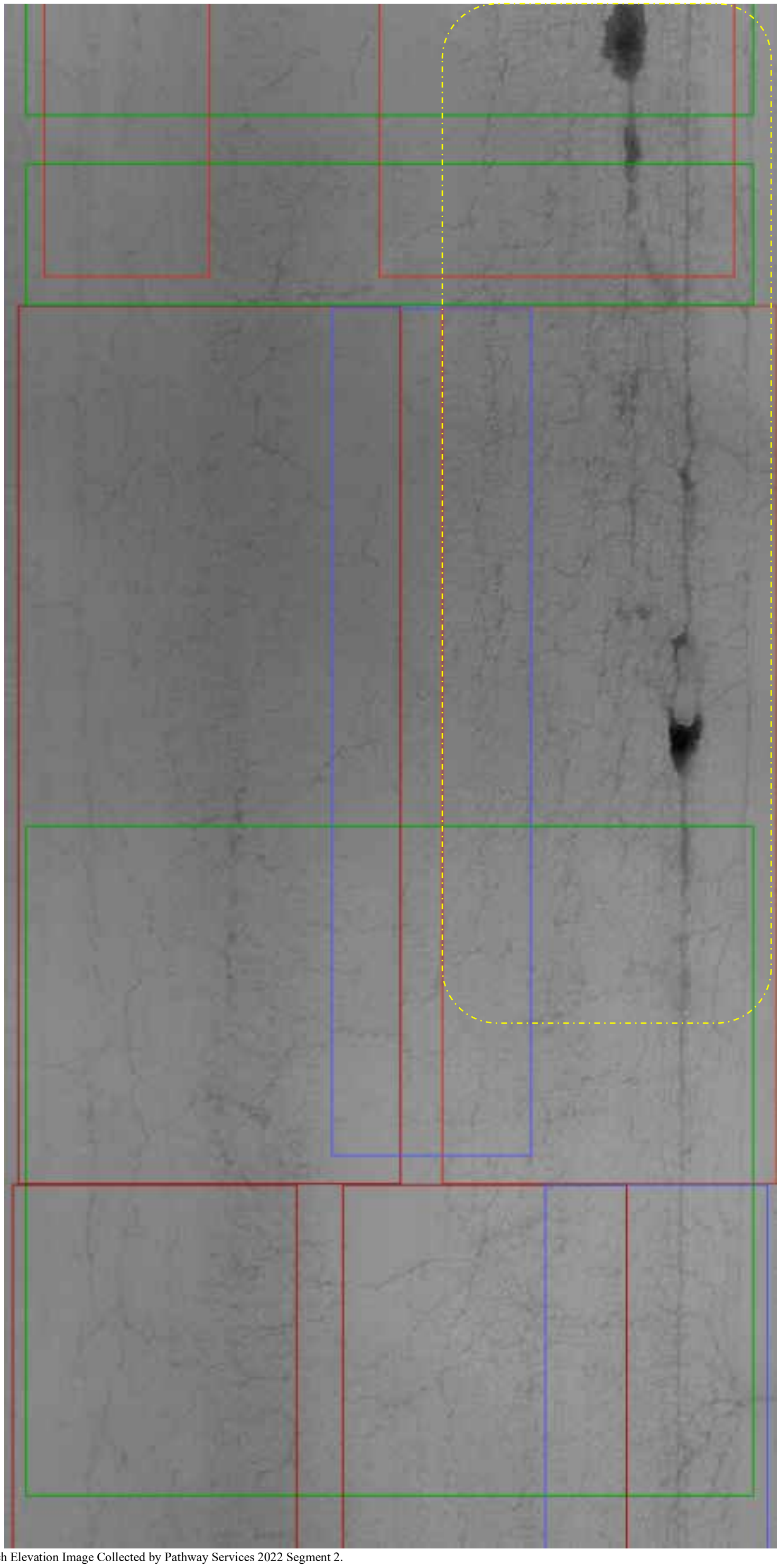


**Figure 31** SR 329 Patch Elevation Image Collected by Pathway Services 2022 Segment 2.

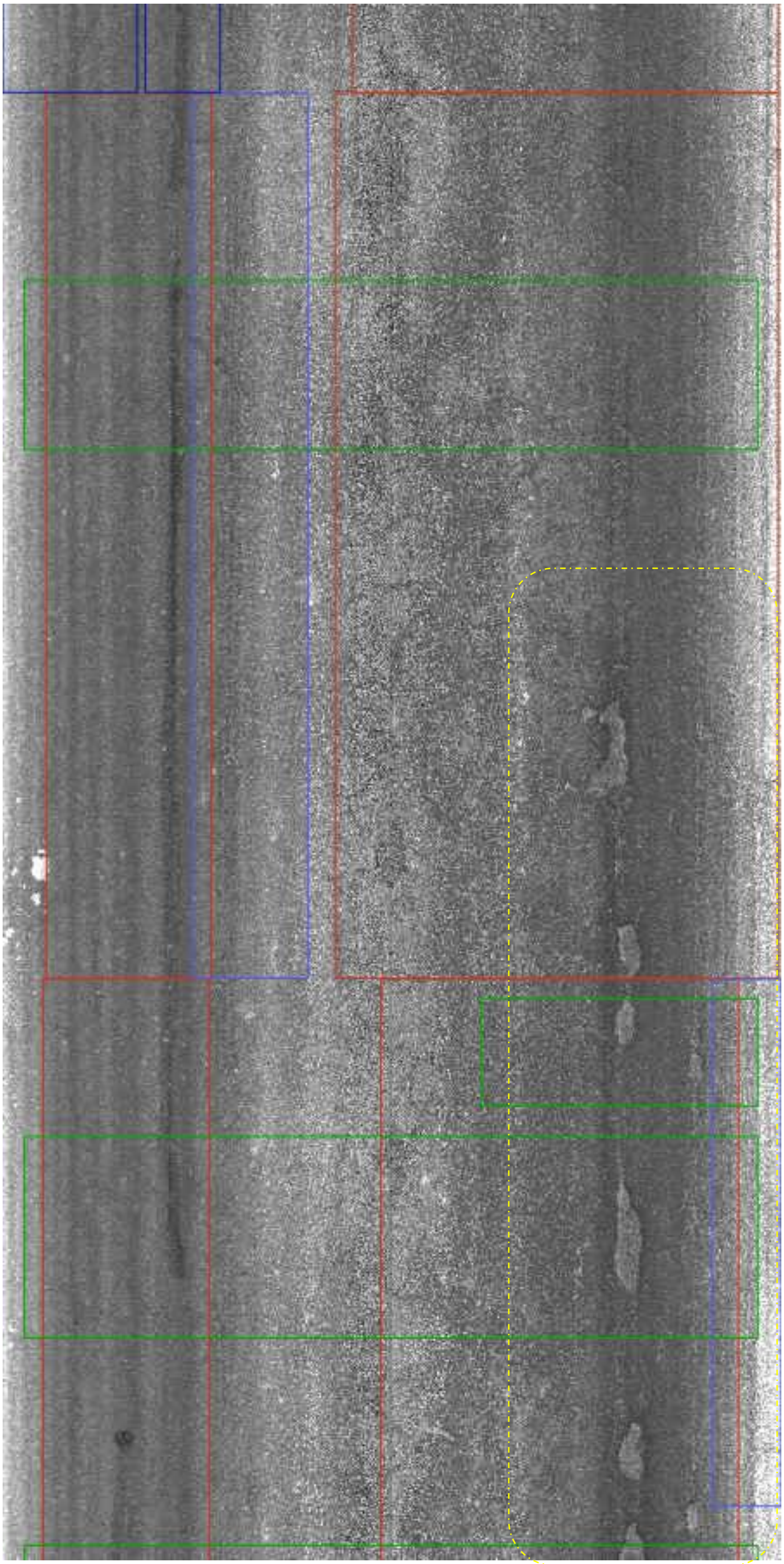


**Figure 32** SR 329 Patch Intensity Image Collected by Pathway Services 2022 Segment 1.

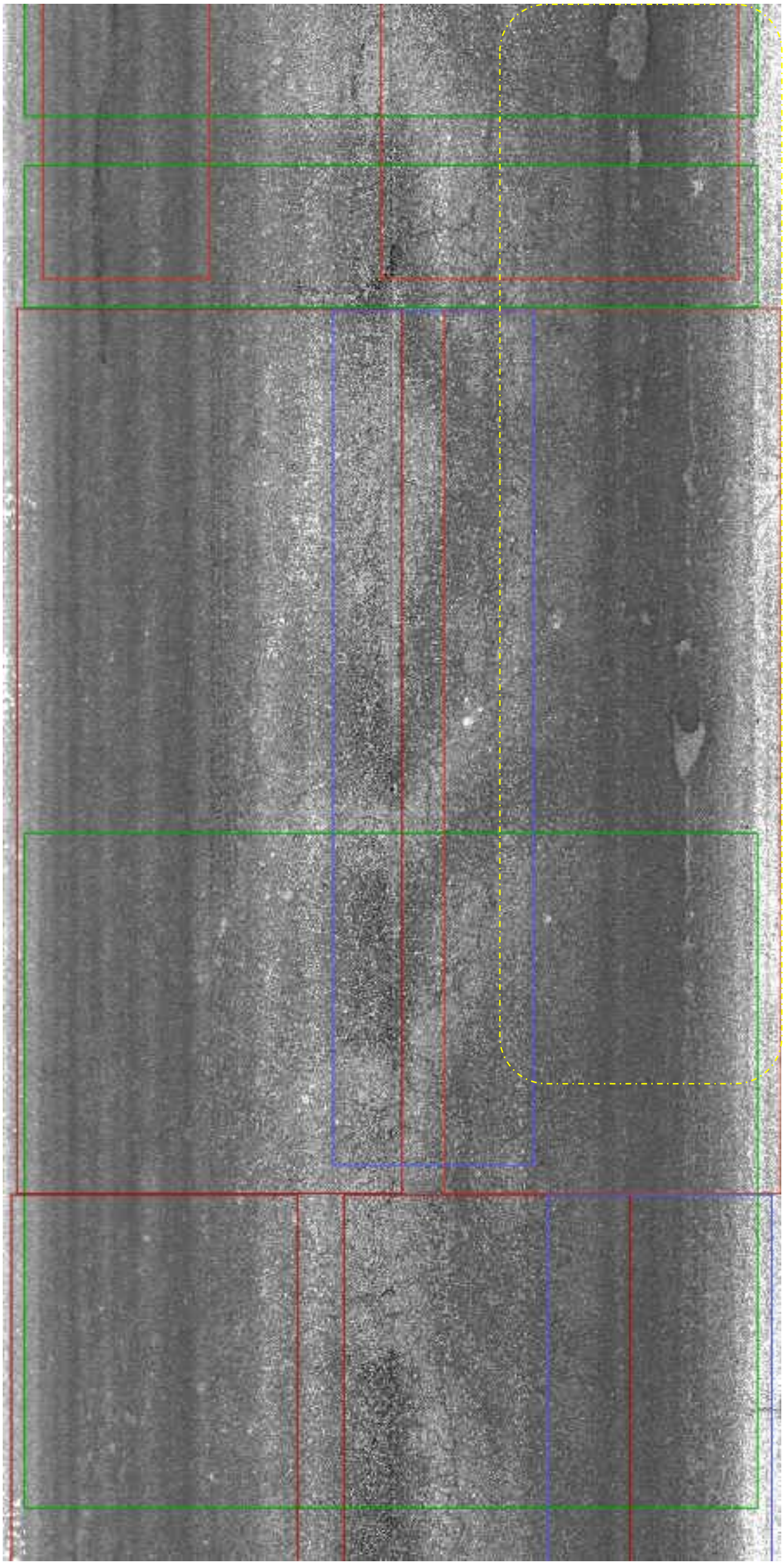


**Figure 33** SR 329 Patch Intensity Image Collected by Pathway Services 2022 Segment 2.

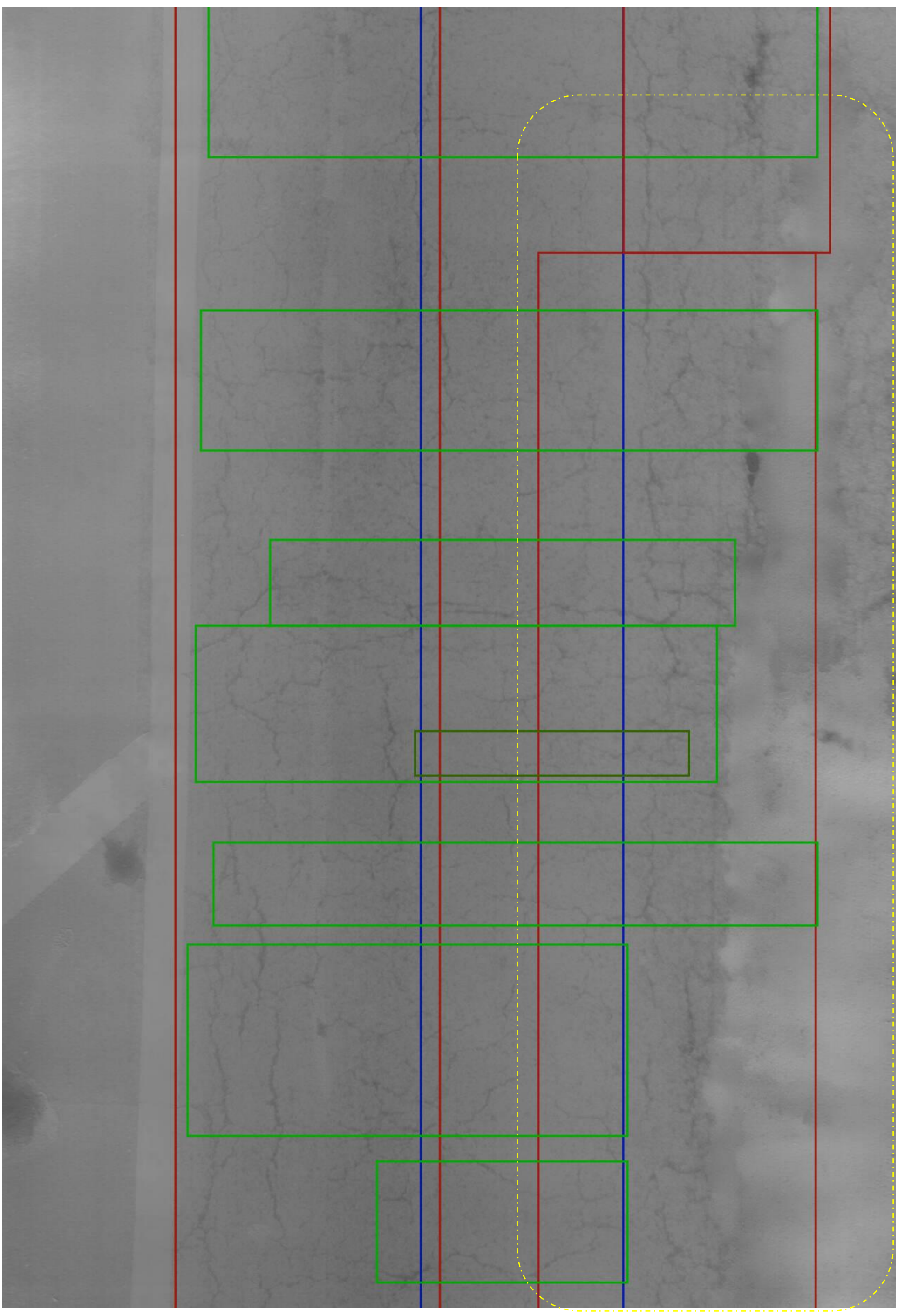


**Figure 34** SR 329 Patch Elevation Image Collected by Pathway Services 2023 Segment 1.

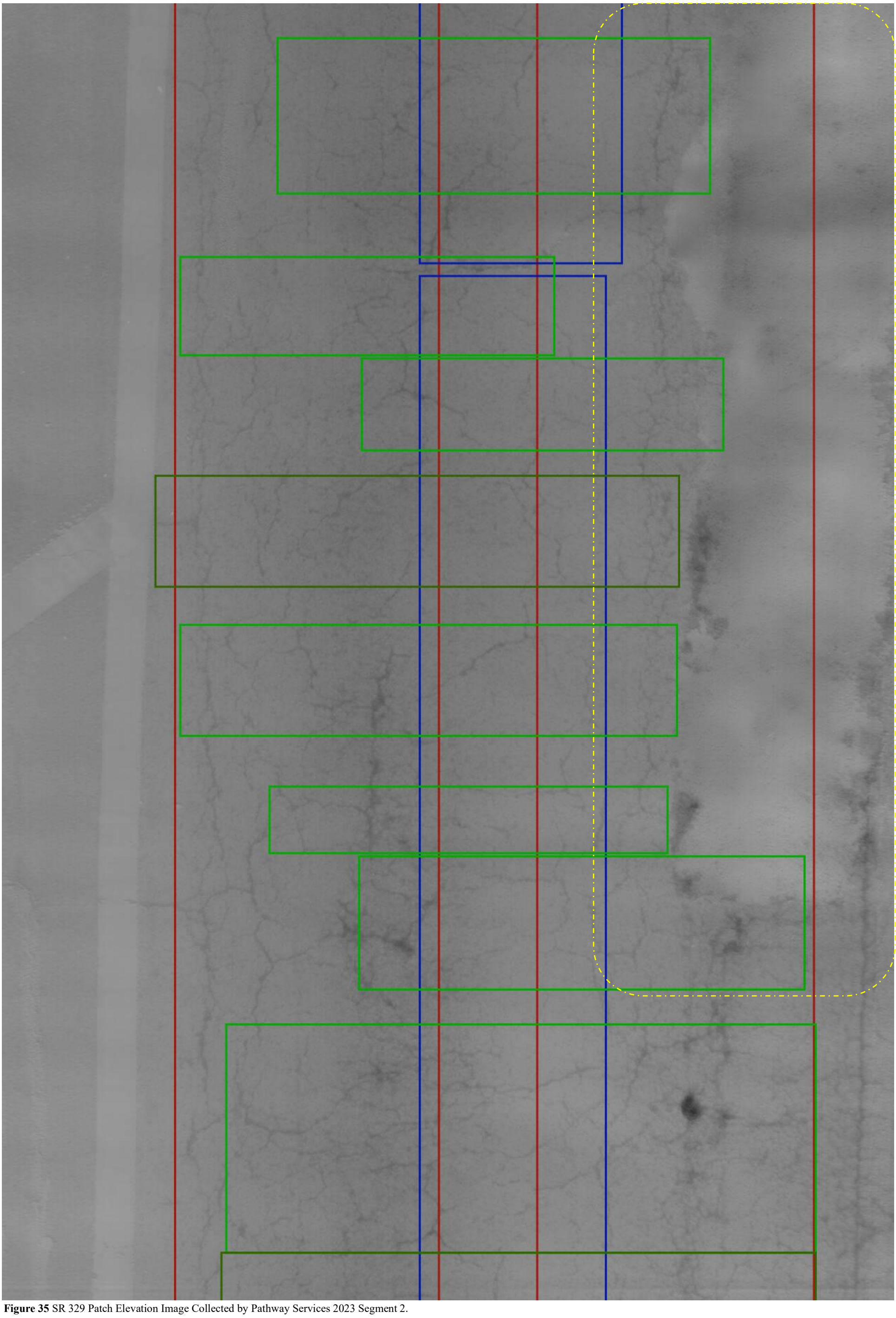


**Figure 35** SR 329 Patch Elevation Image Collected by Pathway Services 2023 Segment 2.

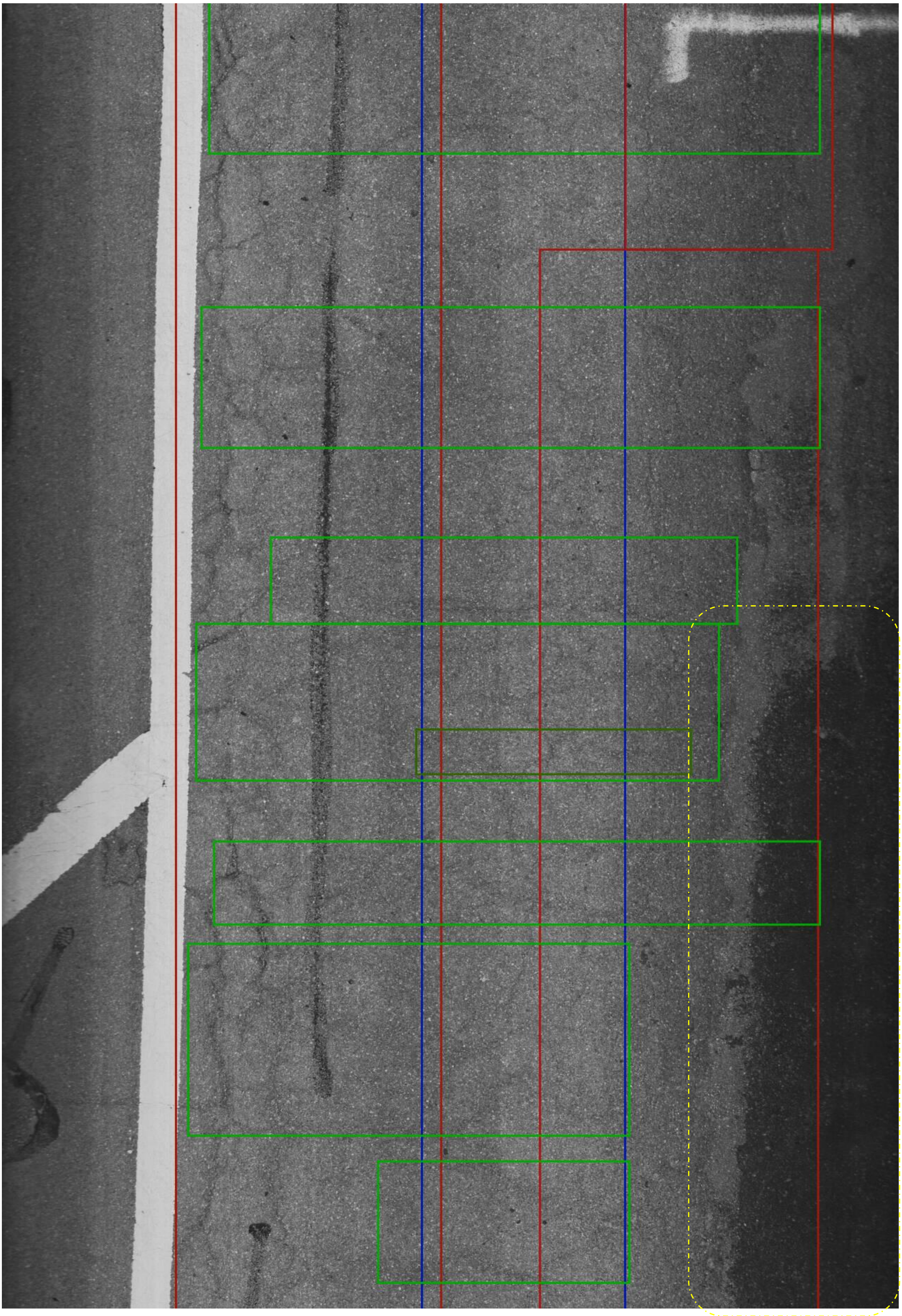


**Figure 36** SR 329 Patch Intensity Image Collected by Pathway Services 2023 Segment 1.

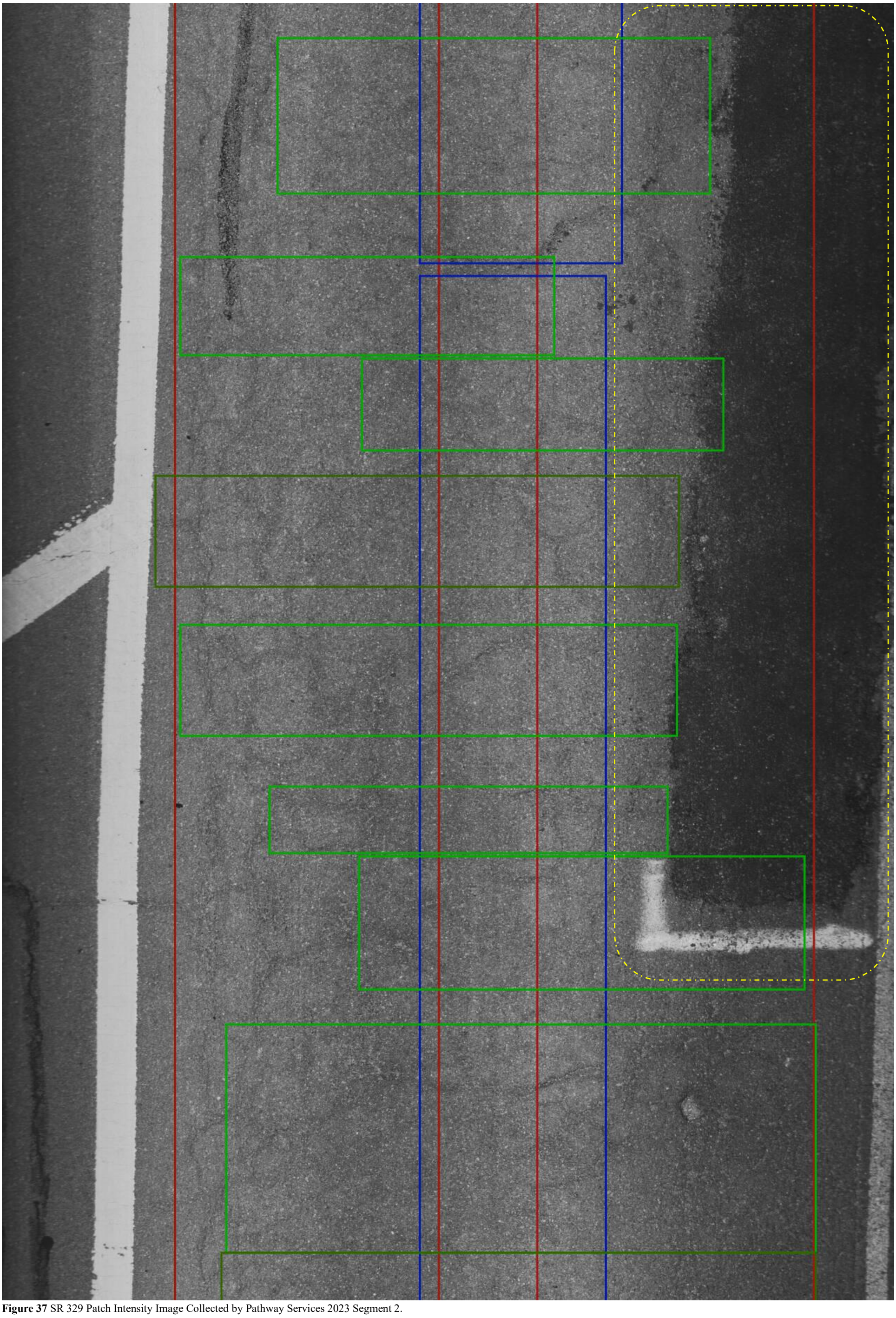


**Figure 37** SR 329 Patch Intensity Image Collected by Pathway Services 2023 Segment 2.




**Figure 38** SR 329 Patch Image Taken December 2023.





**Figure 39** SR 329 Images Taken During Patching Process.




SR329:2 of 4: ROW Images: Top Left=August 2023, Top Right=March 2024, Bottom Right=October 2024

**Figure 40** SR 329 Patch ROW Images Collected With Pavement Condition System.

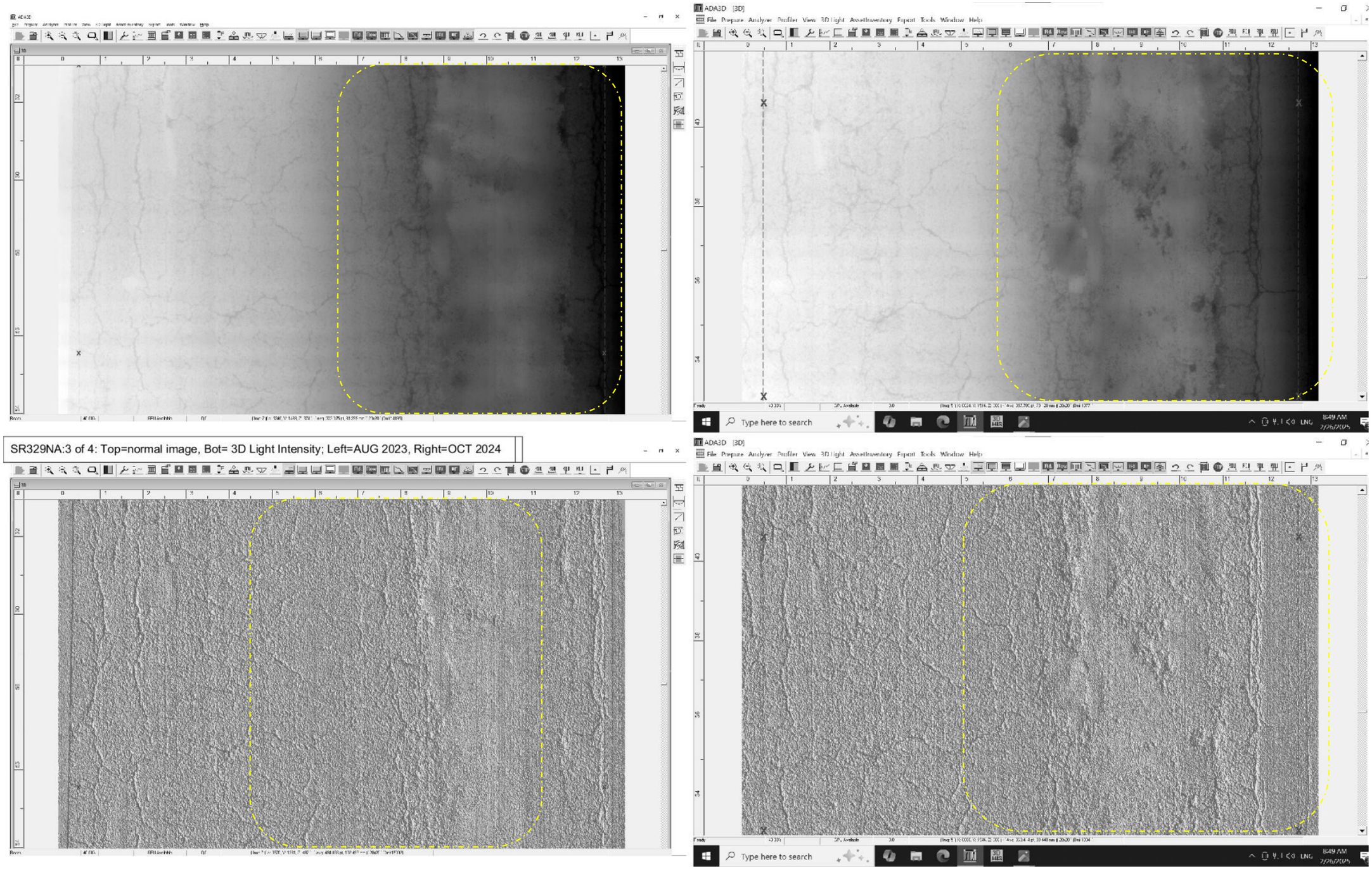



**Figure 41** SR 329 Patch Comparison of 3D Normal Images and Light Intensity Images.

**US 35 Travel Lane/Shoulder Edge Distress with Potholeing Figures**

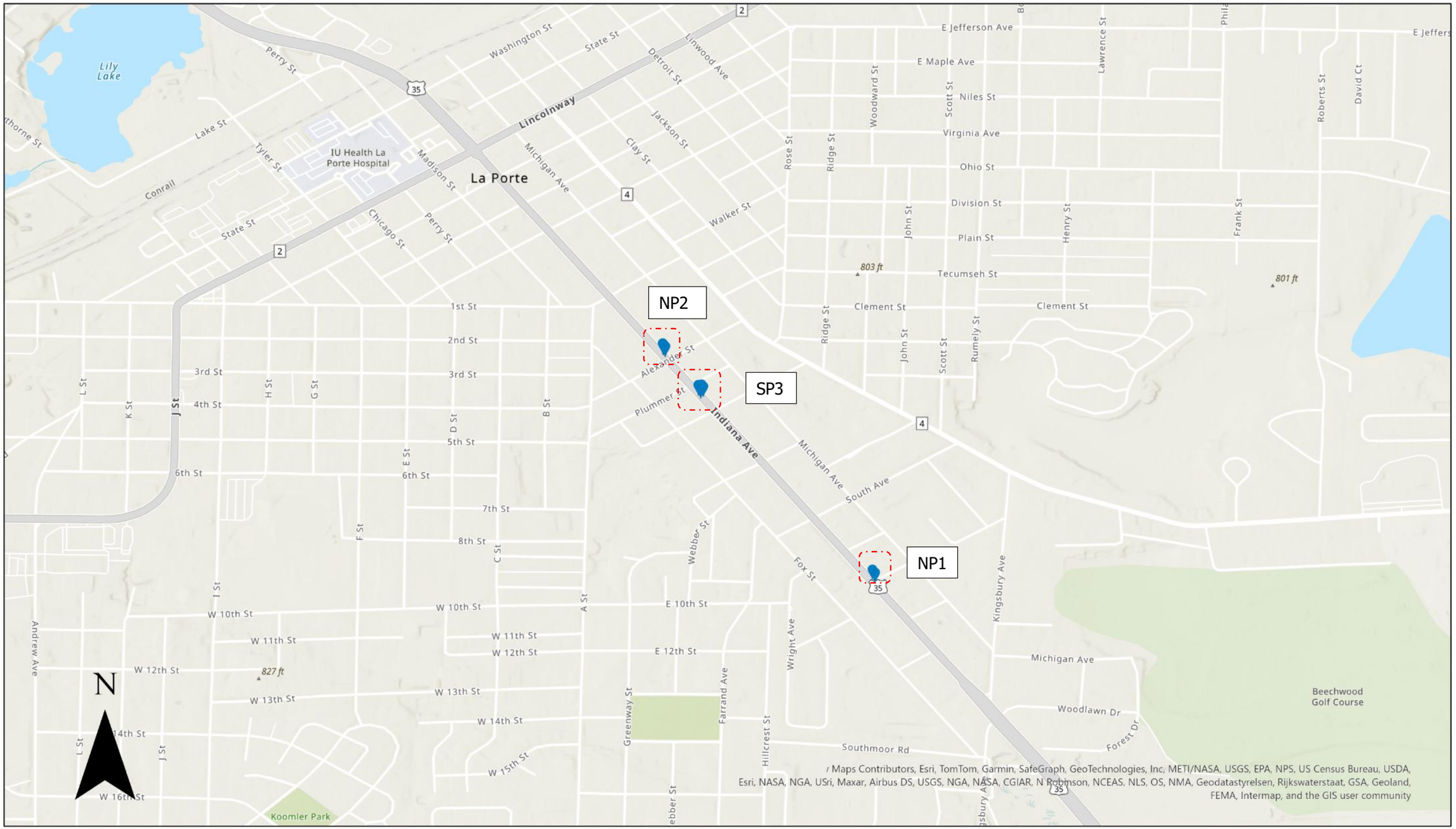



**Figure 42** US 35 Patch Locations.

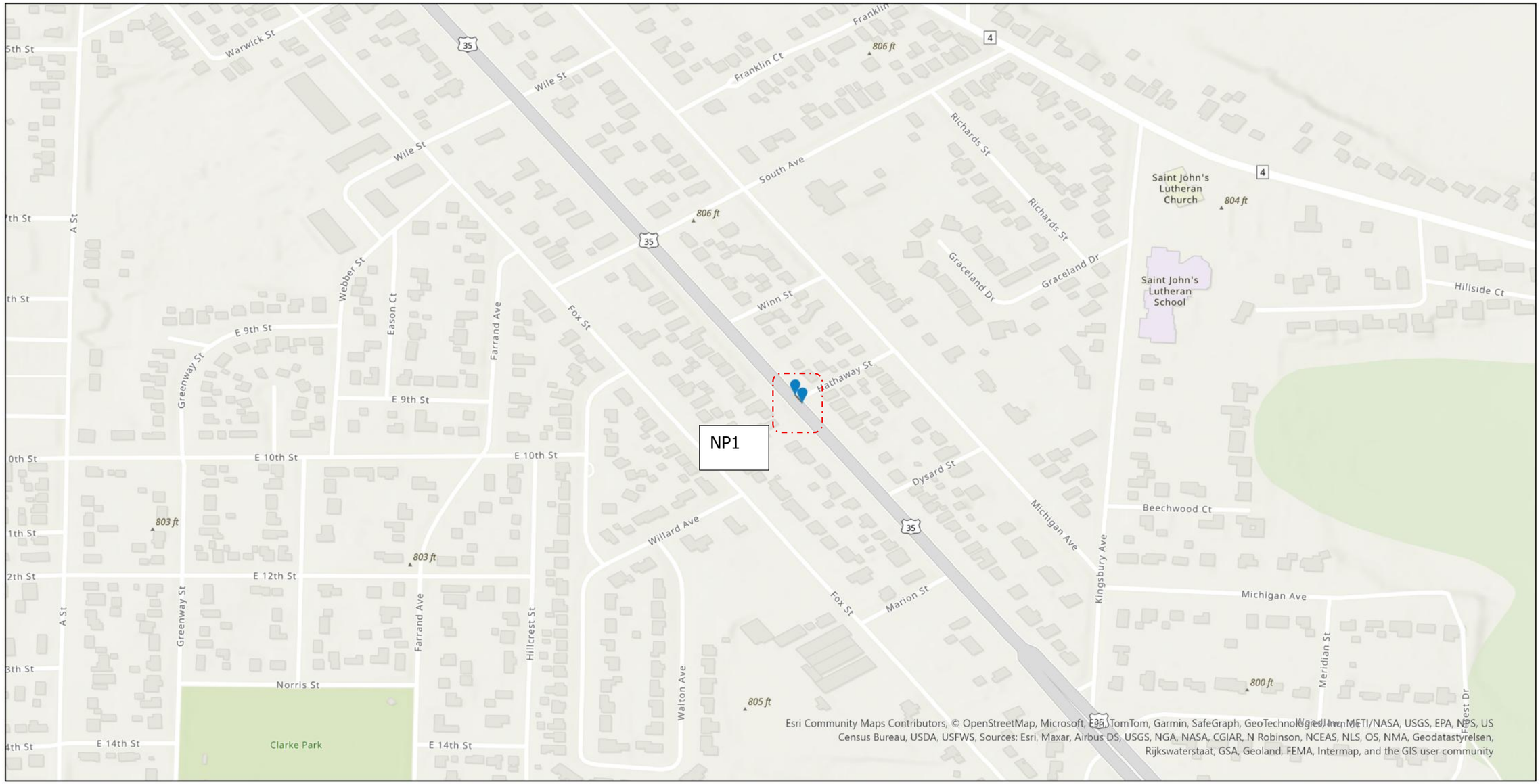



**Figure 43** US 35 NP1 Patch Location Zoomed.




**Figure 44** US 35 NP1 ROW Image Collected By Pathway Services In 2022. Note: Distress on the Longitudinal Joint Between Travel Lane and Shoulder Segment 1.



**Figure 45** US 35 NP1 ROW Image Collected By Pathway Services In 2022. Note: Distress on the Longitudinal Joint Between Travel Lane and Shoulder Segment 2.



US35NP1:2 of 4: ROW Images: Top Left=Feburary 2024, Top Right=October 2024, Bottom Right=April 2025

**Figure 46** US 35 NP1 ROW Images Collected With Pavement Condition System.

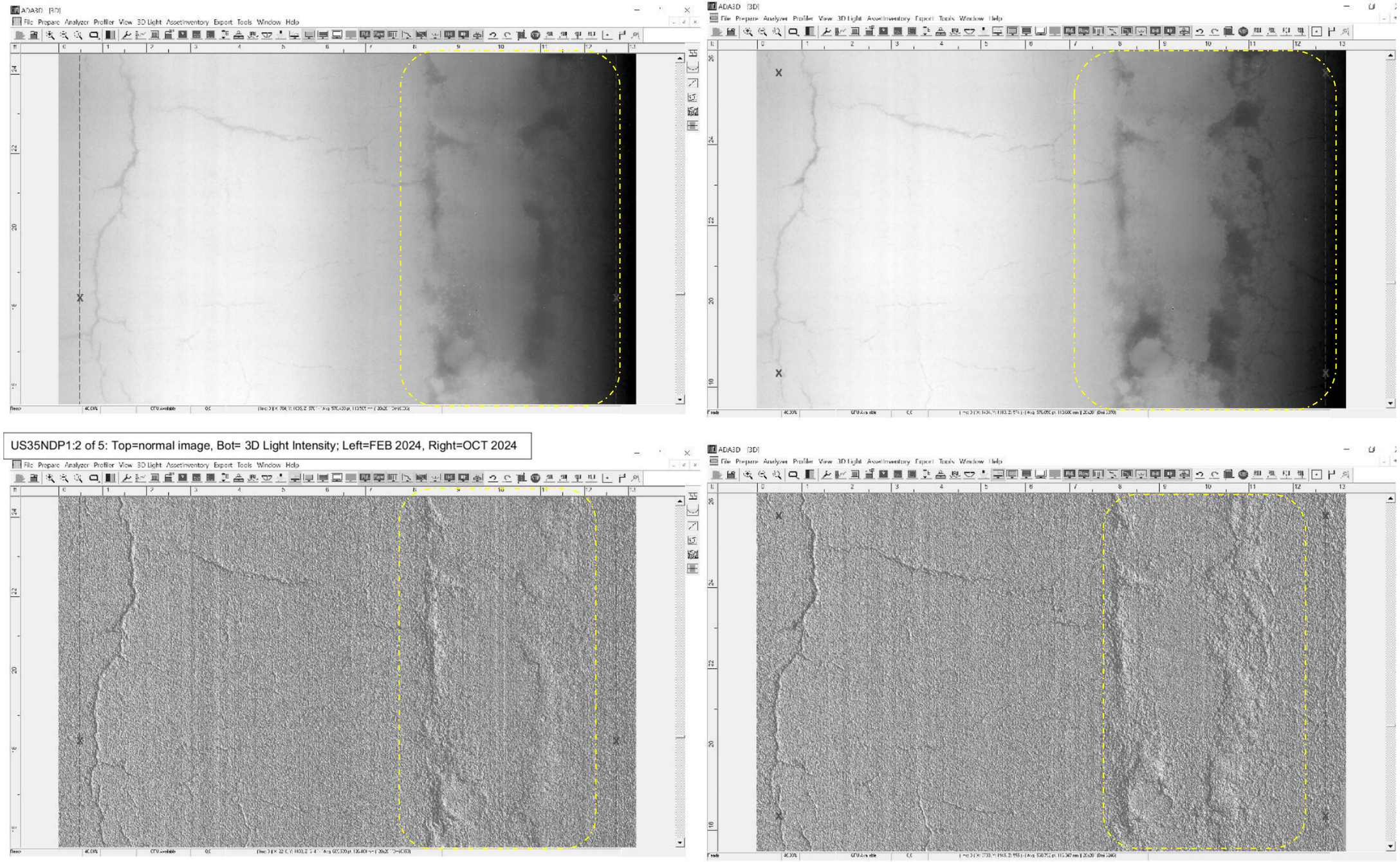



**Figure 47** US 35 NP1 Comparison of 3D Normal Images and Light Intensity Images February 2024 and October 2024.

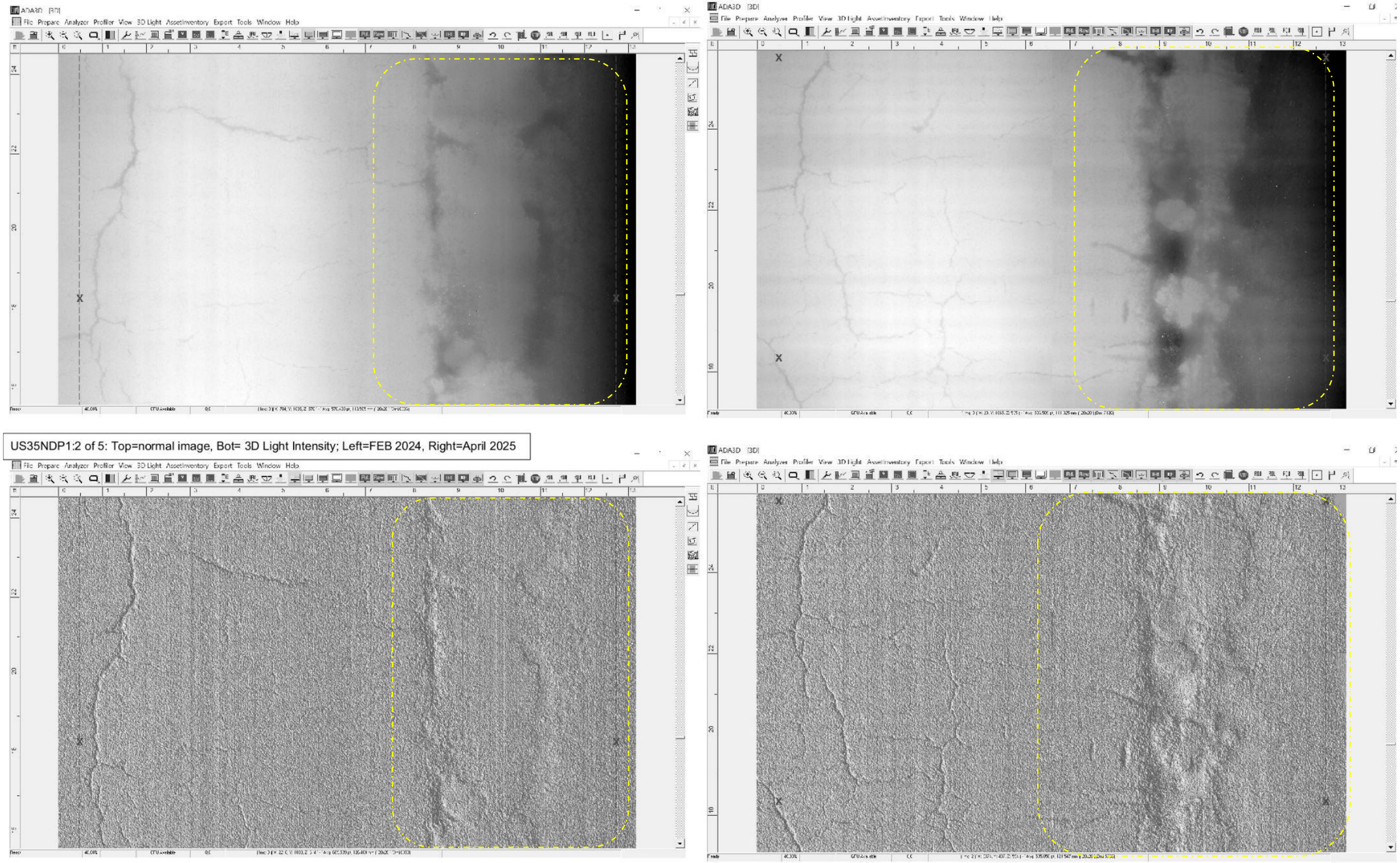



**Figure 48** US 35 NP1 Comparison of 3D Normal Images and Light Intensity Images for February 2024 and April 2025.

**US 35 Fatigue Cracking in Right Wheel Path of the Original Travel Path Figures**

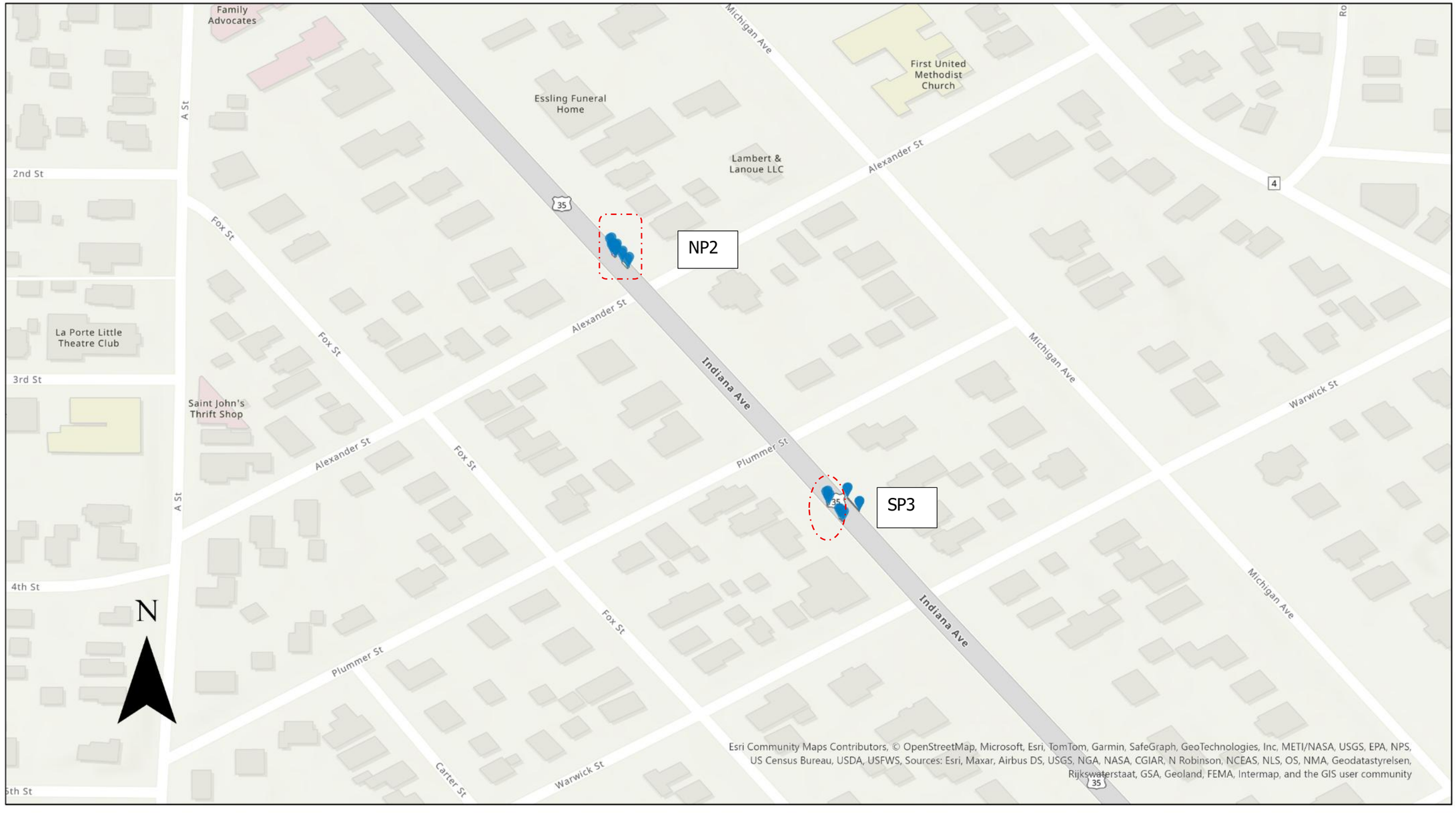



**Figure 49** US 35 NP1 and SP3 Patch Locations.




**Figure 50** US 35 ROW Images Collected by Pathway Services Showing Change in Travel Path Between 2012 (Top) and 2013 (Bottom).

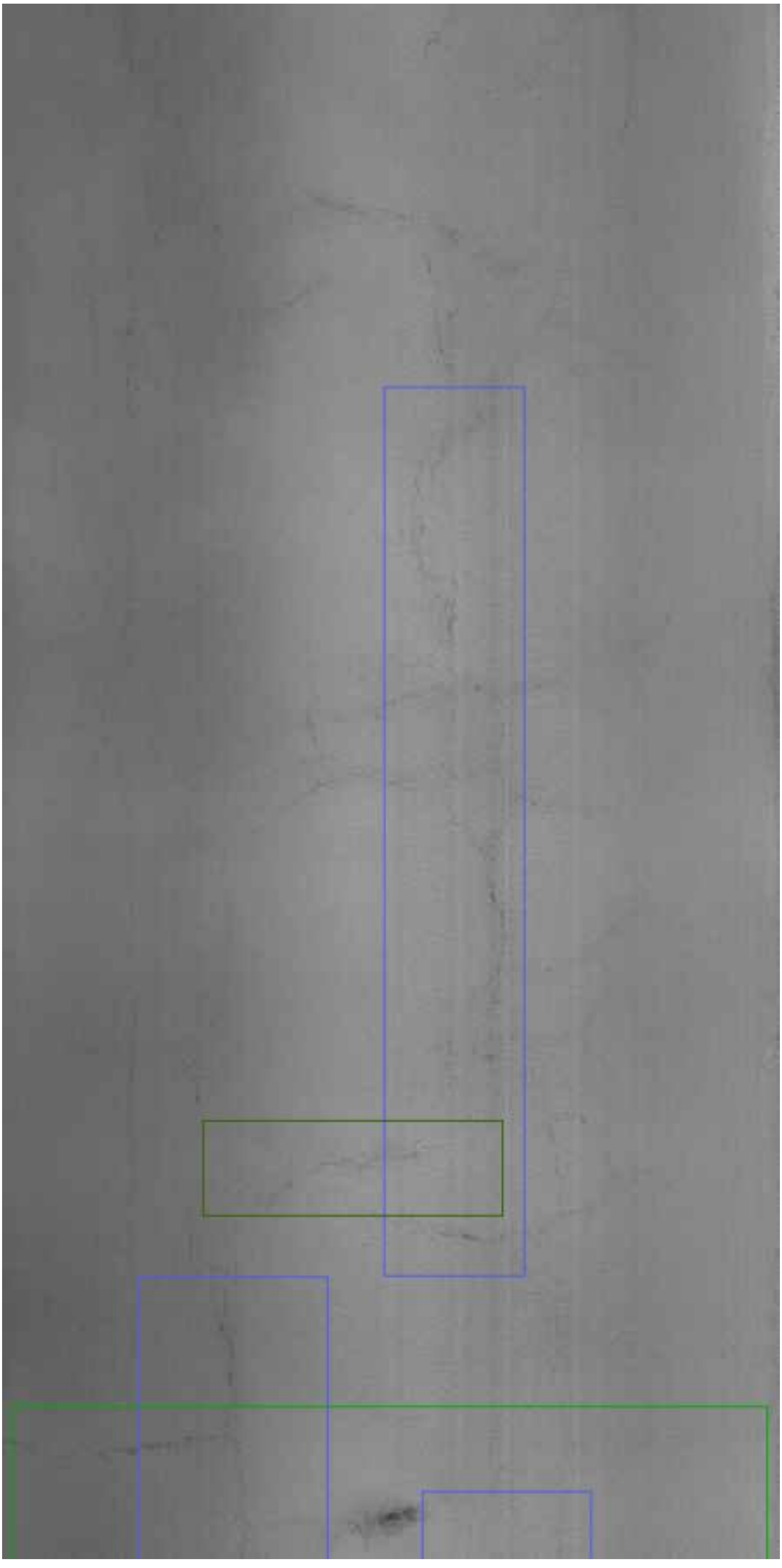


**Figure 51** US 35 NP2 Elevation Image Collected by Pathway Services 2022 Segment 1.

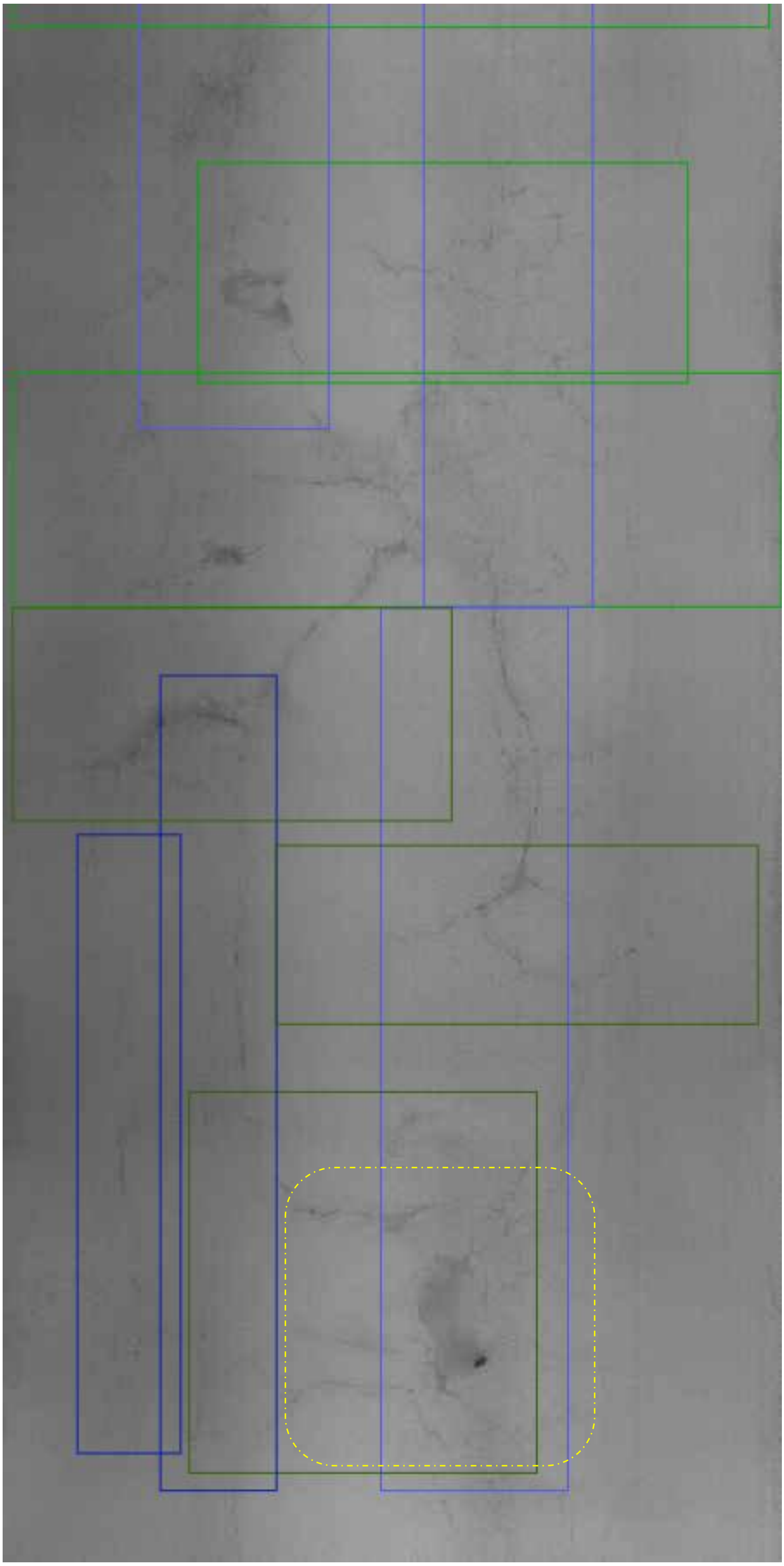


**Figure 52** US 35 NP2 Elevation Image Collected by Pathway Services 2022 Segment 2.

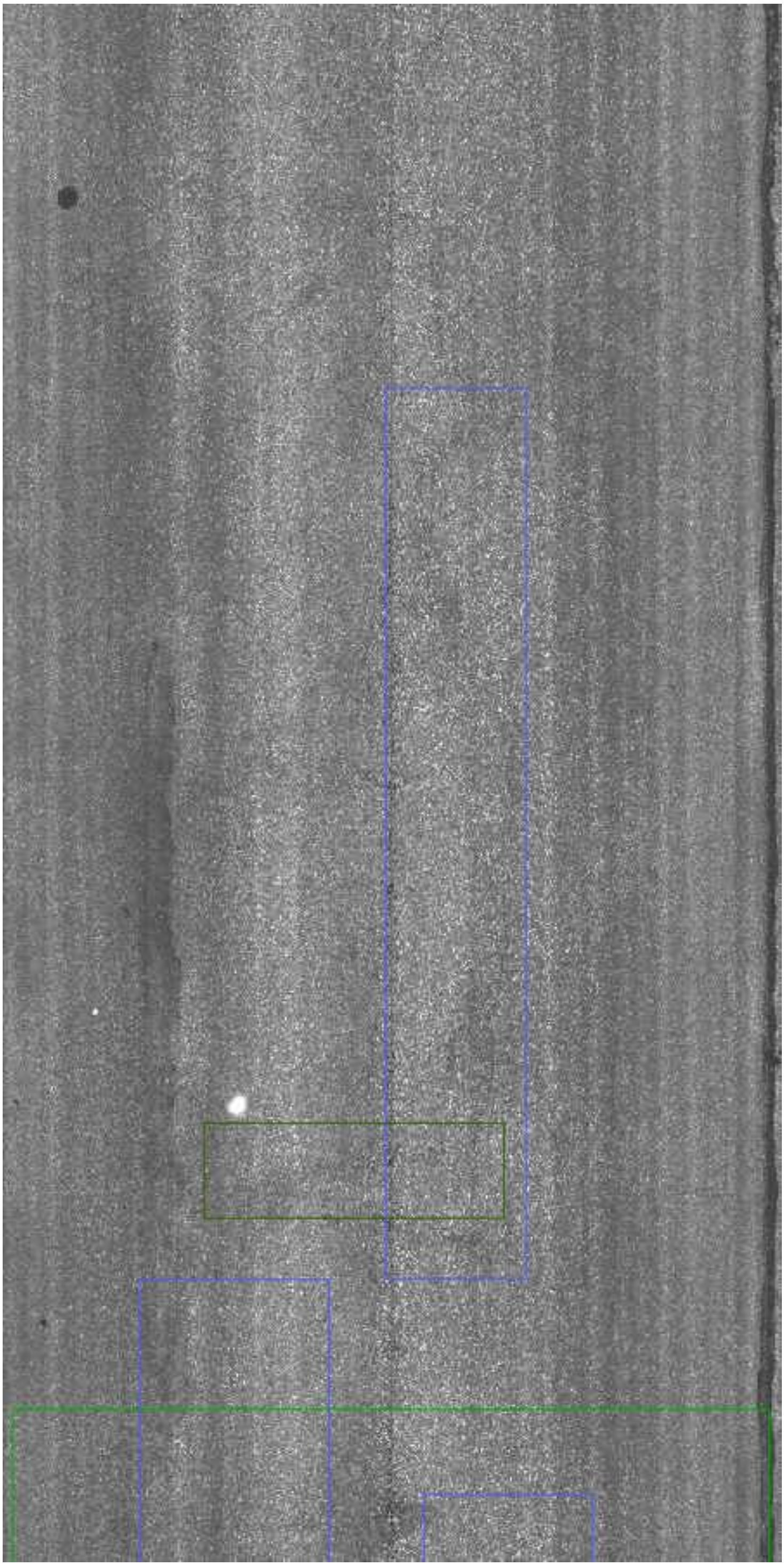


**Figure 53** US 35 NP2 Intensity Image Collected by Pathway Services 2022 Segment 1.

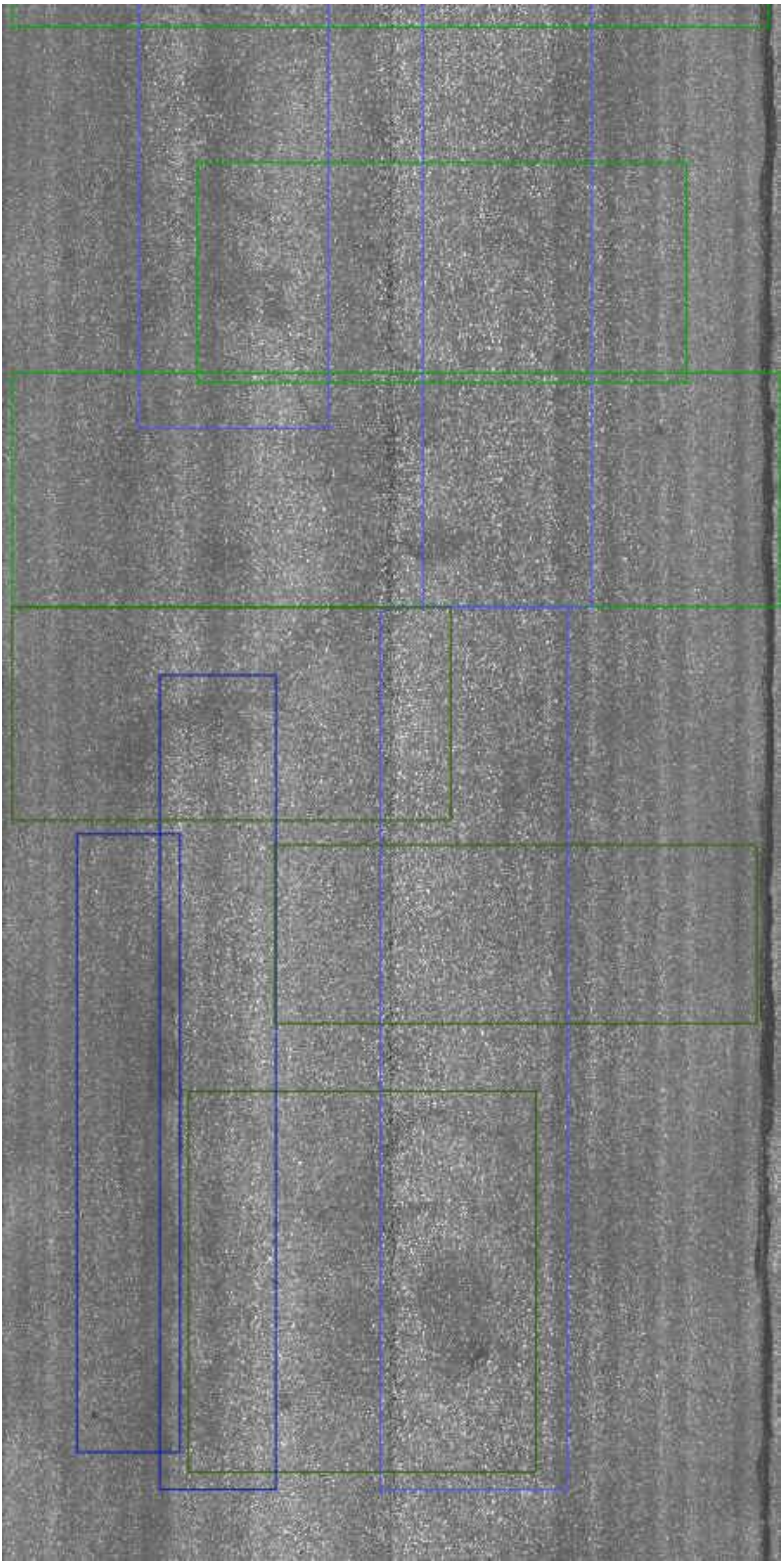


**Figure 54** US 35 NP2 Intensity Image Collected by Pathway Services 2022 Segment 2.

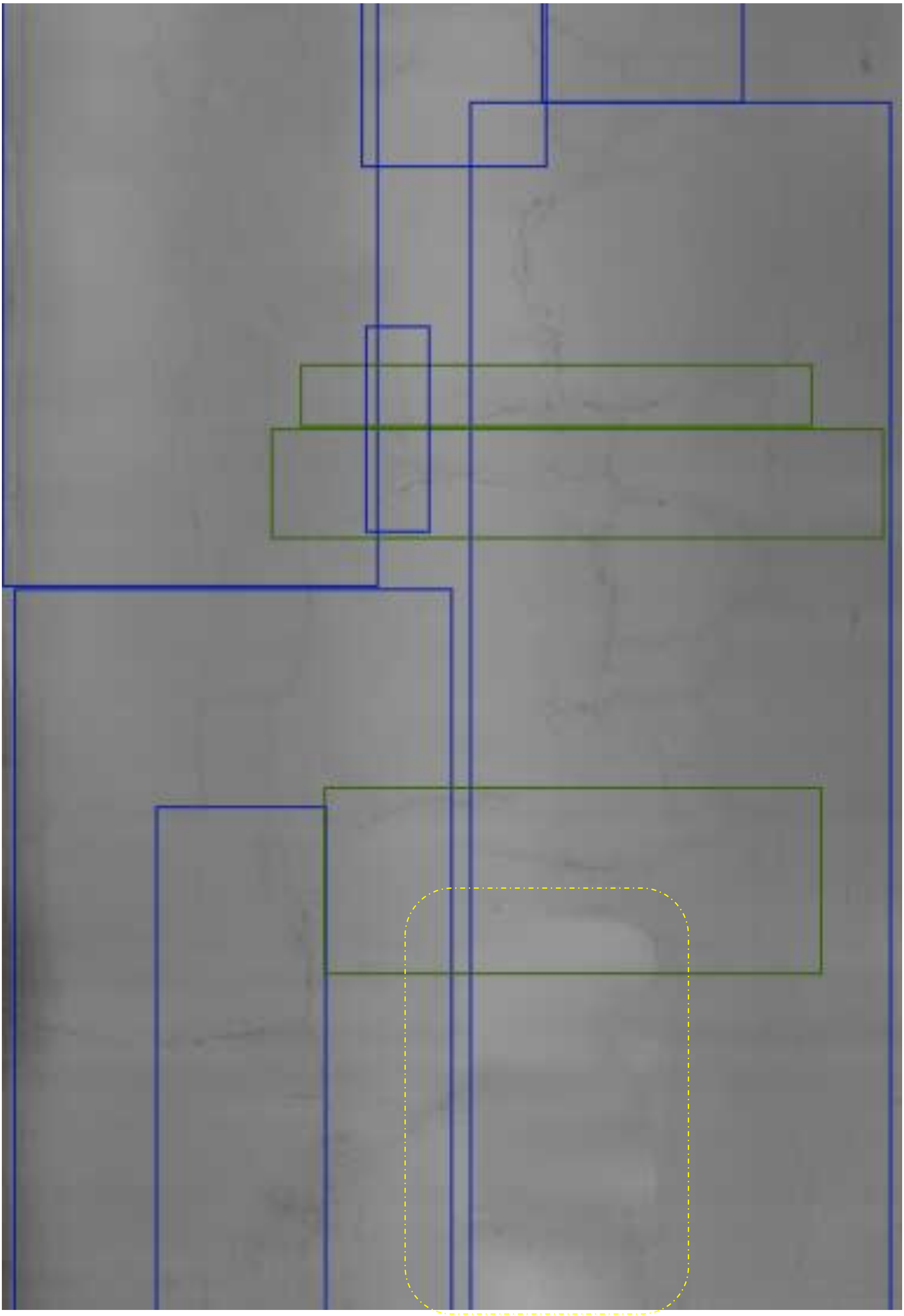


**Figure 55** US 35 NP2 Elevation Image Collected by Pathway Services August 2023 Segment 1.

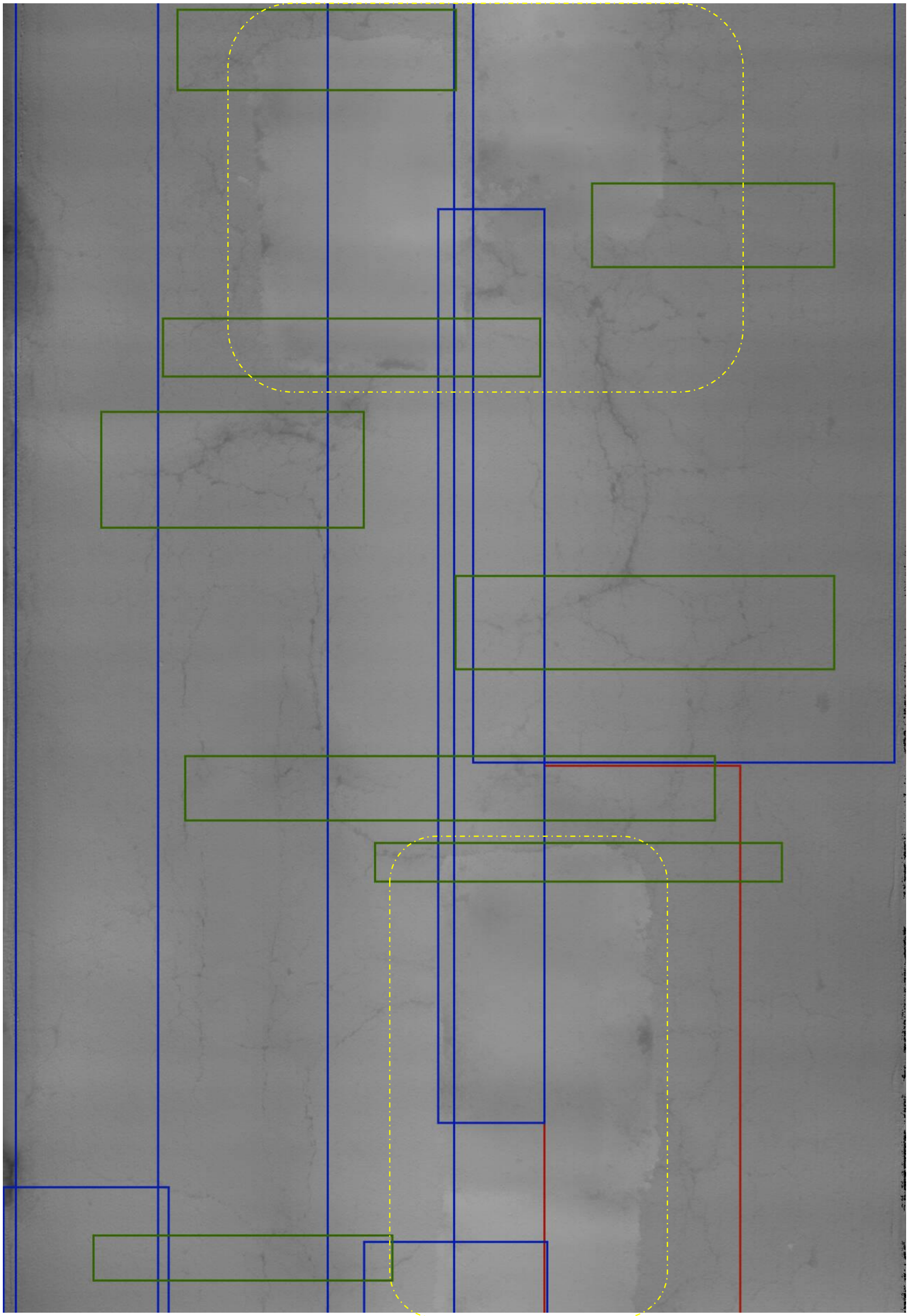


**Figure 56** US 35 NP2 Elevation Image Collected by Pathway Services August 2023 Segment 2.

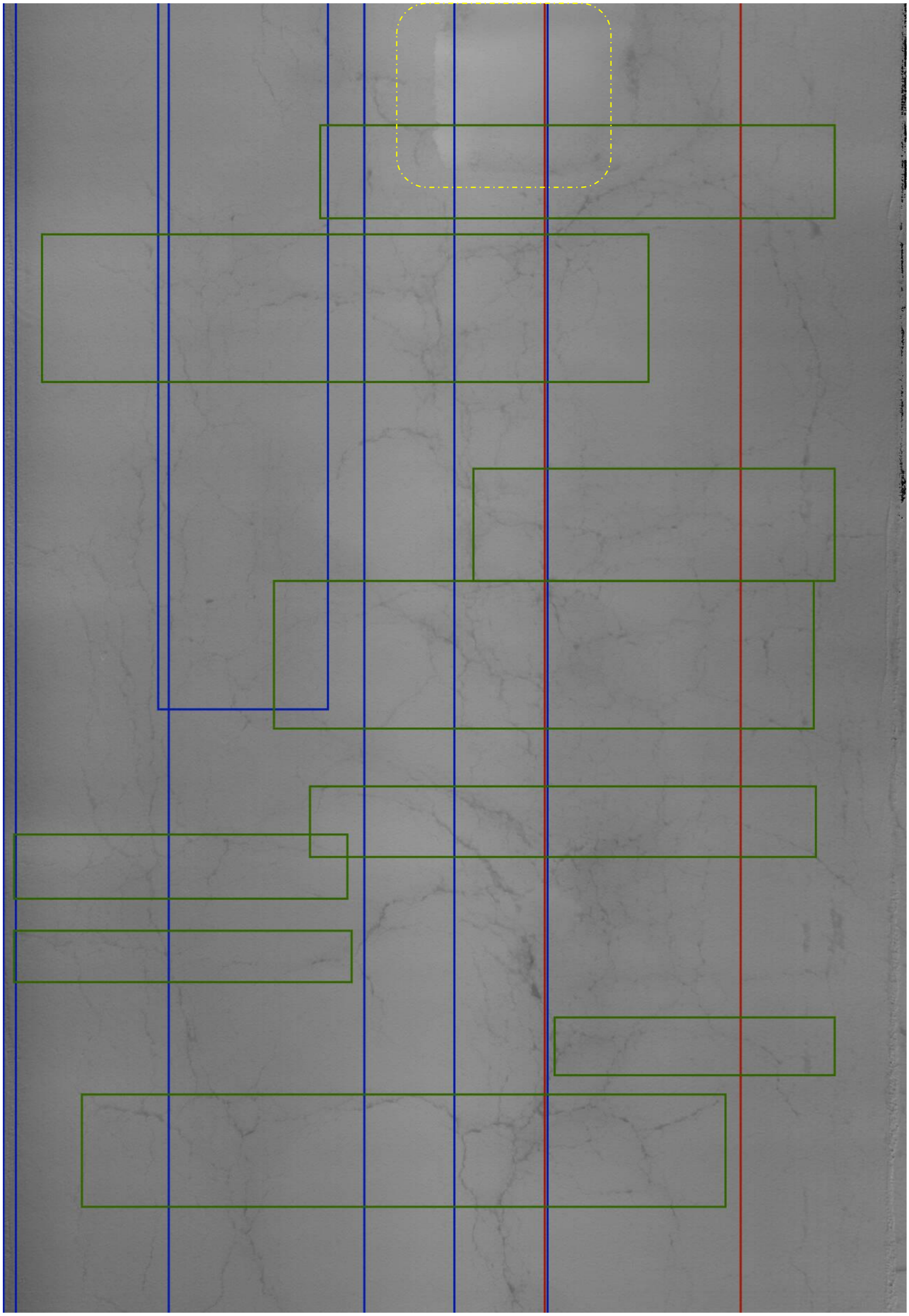


**Figure 57** US 35 NP2 Elevation Image Collected by Pathway Services August 2023 Segment 3.

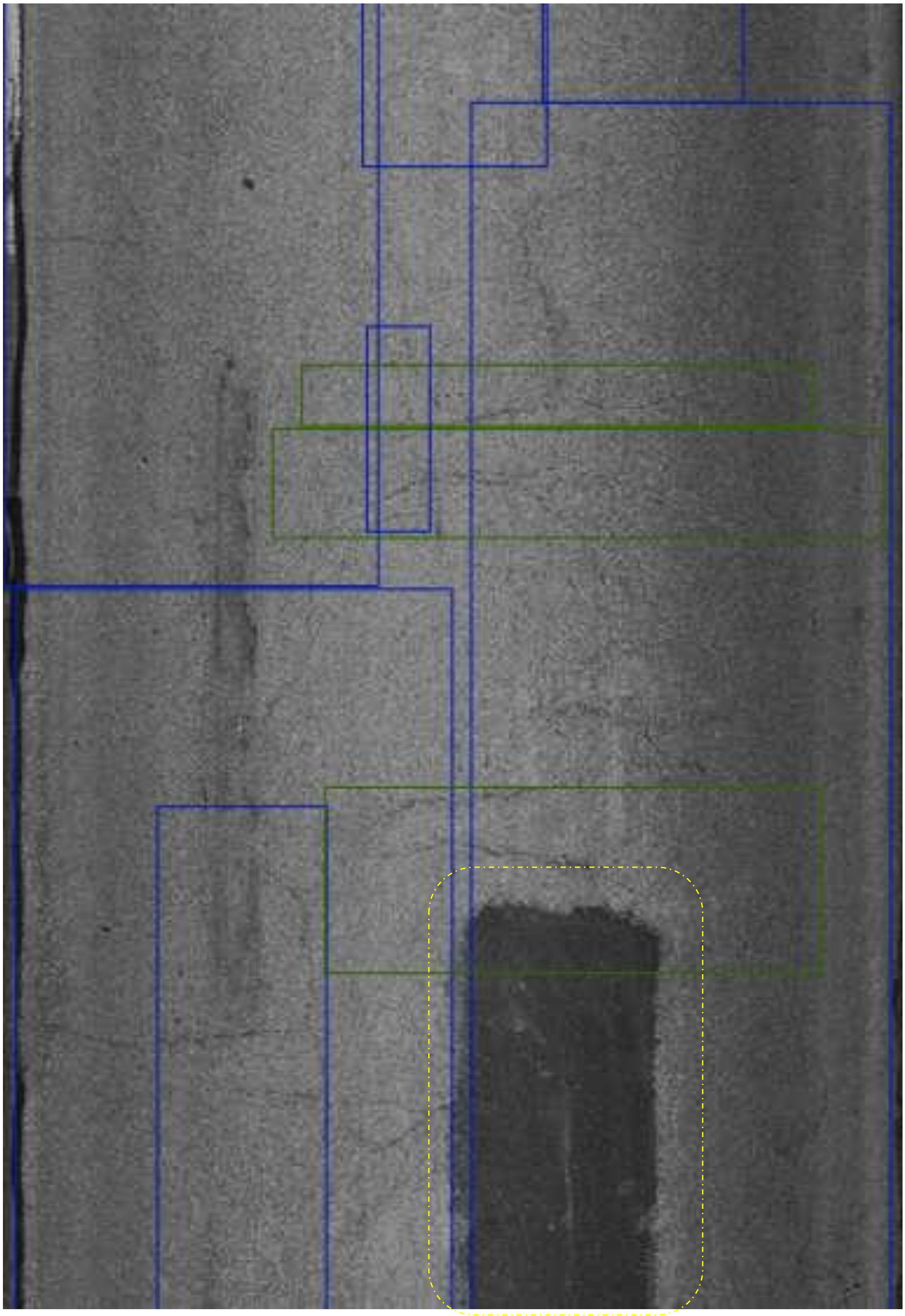


**Figure 58** US 35 NP2 Intensity Image Collected by Pathway Services August 2023 Segment 1.

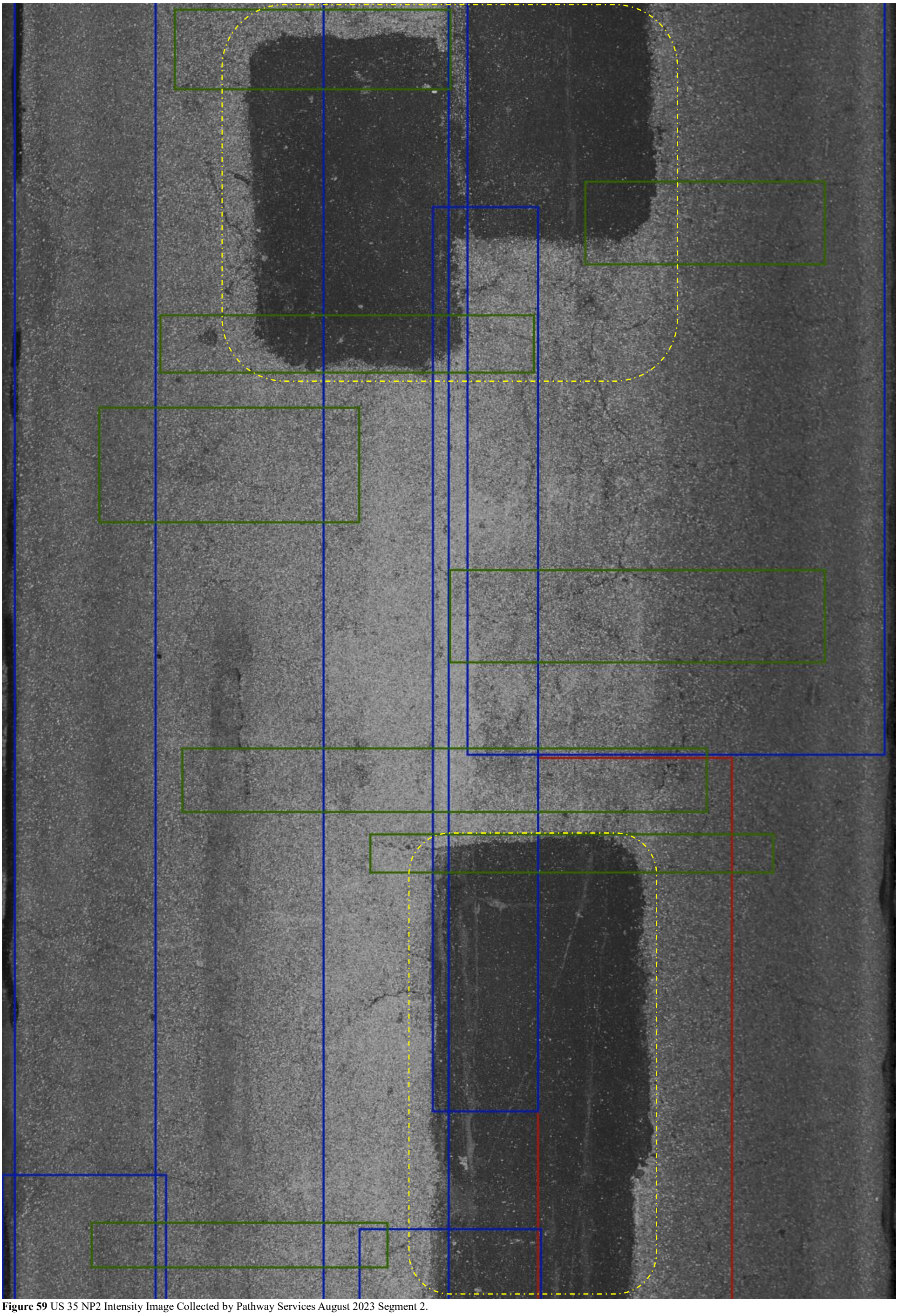


**Figure 59** US 35 NP2 Intensity Image Collected by Pathway Services August 2023 Segment 2.

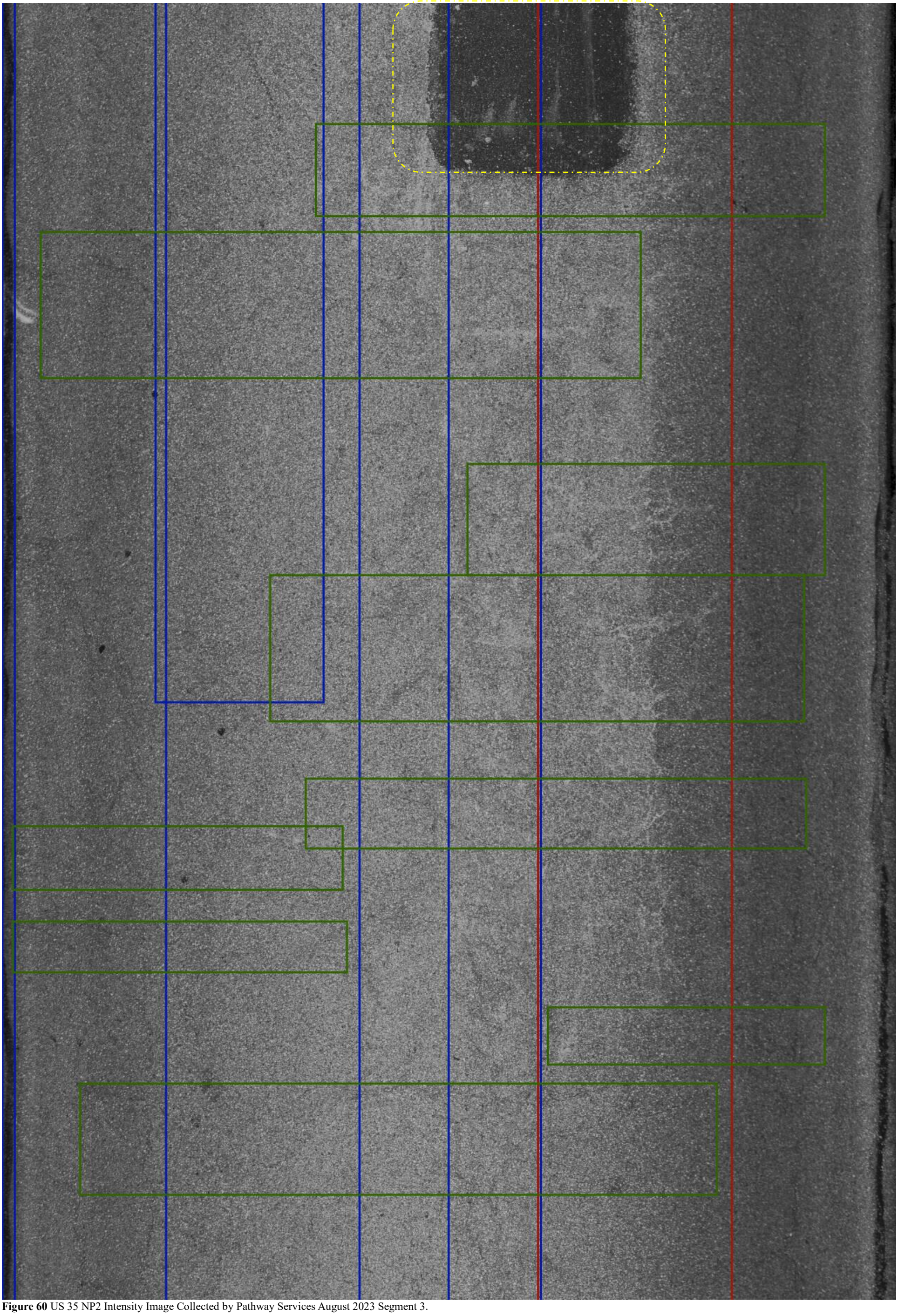


**Figure 60** US 35 NP2 Intensity Image Collected by Pathway Services August 2023 Segment 3.




**Figure 61** US 35 NP2 ROW Images Collected With Pavement Condition System February 2024.

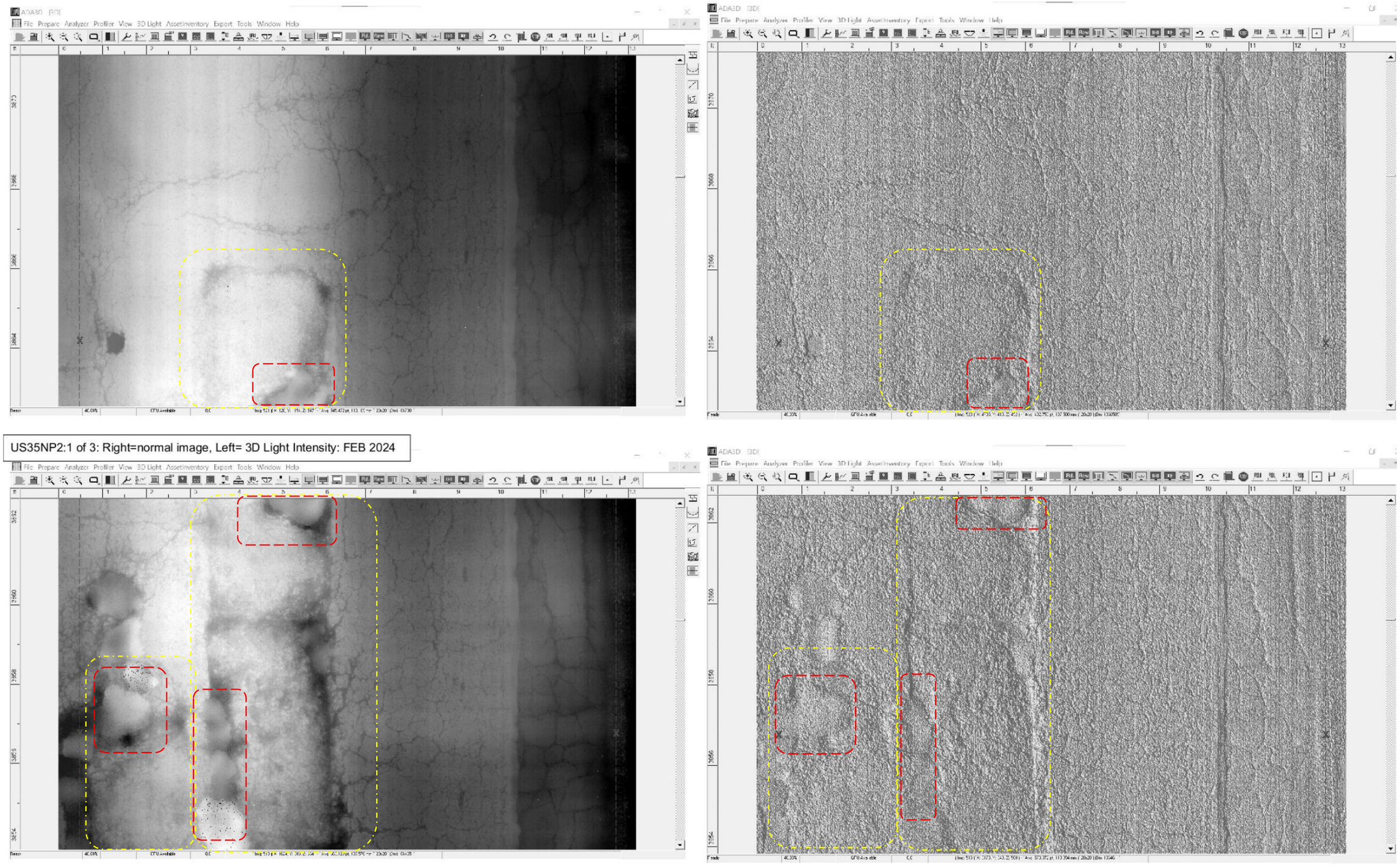



**Figure 62** US 35 NP2 Elevation and 3D Light Intensity Images Collected With INDOT's Pavement Condition System Segment 1, February 2024.

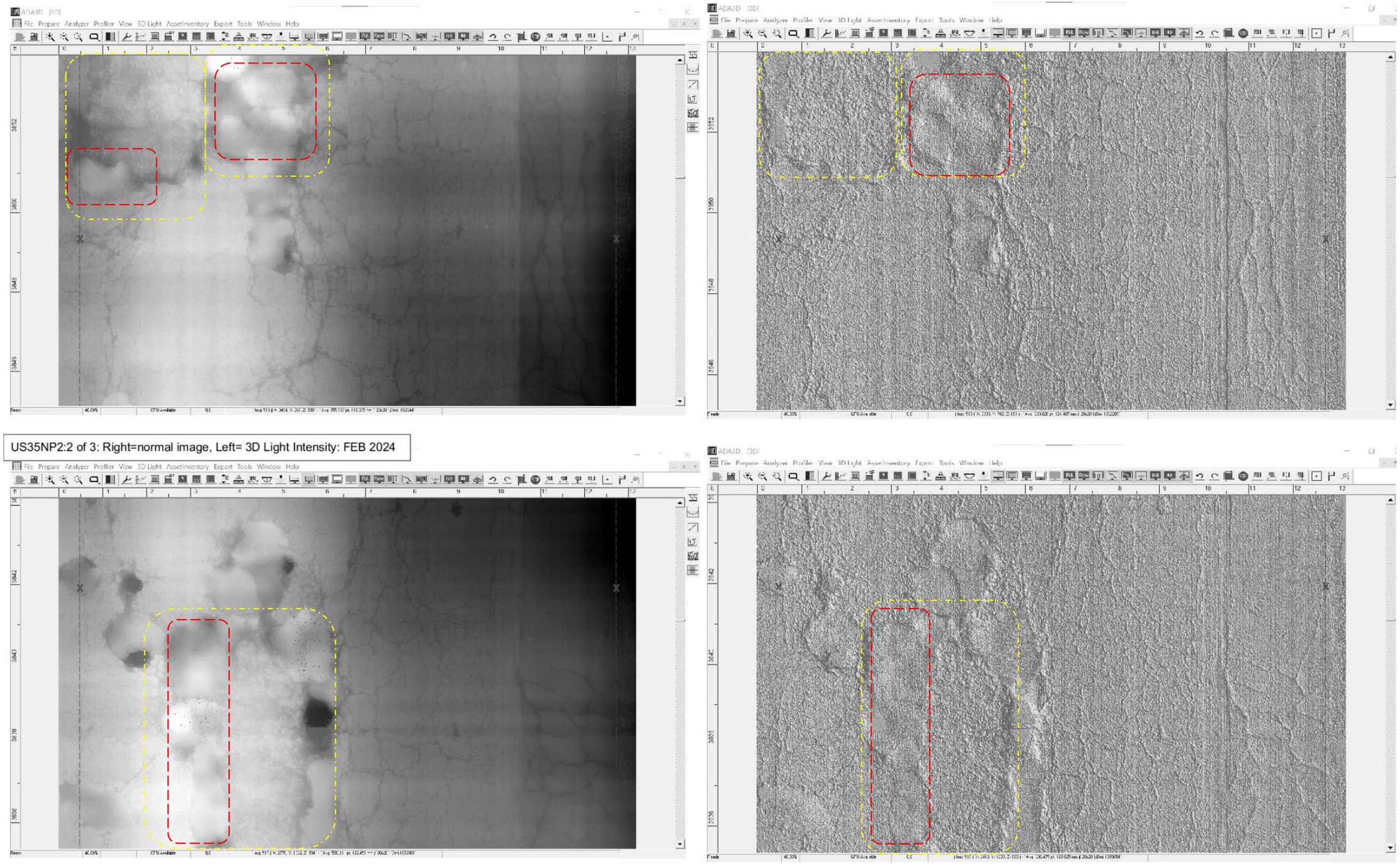
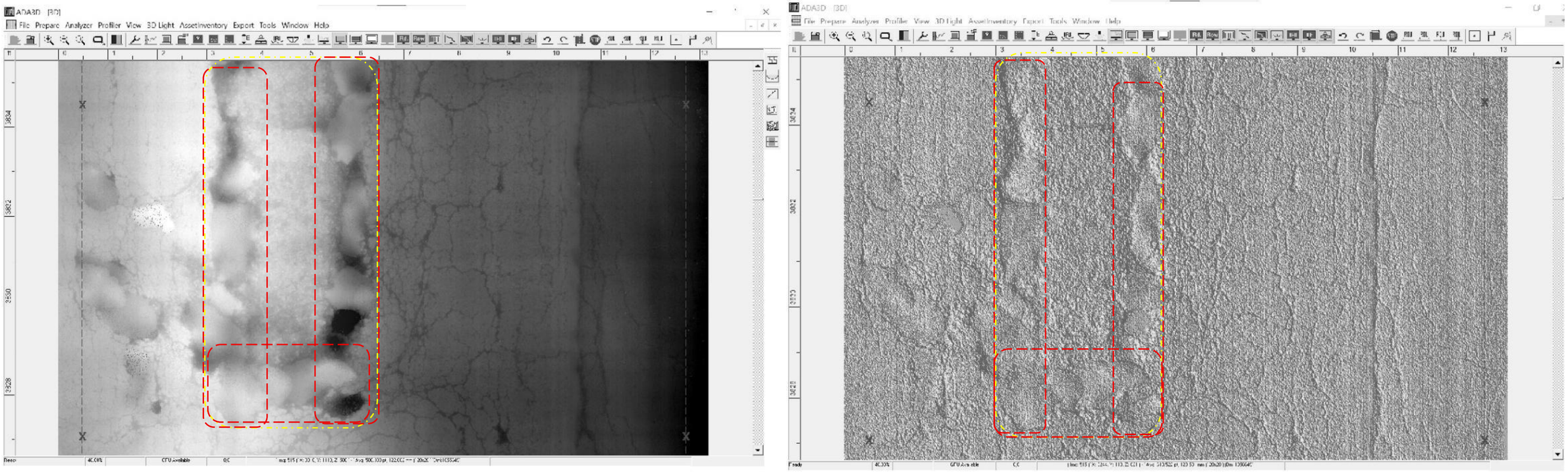



**Figure 63** US 35 NP2 Elevation and 3D Light Intensity Images Collected With INDOT's Pavement Condition System Segment 2, February 2024.




US35NP2:3 of 3: Right=normal image, Left= 3D Light Intensity: FEB 2024

**Figure 64** US 35 NP2 Elevation and 3D Light Intensity Images Collected With INDOT's Pavement Condition System Segment 3, February 2024.

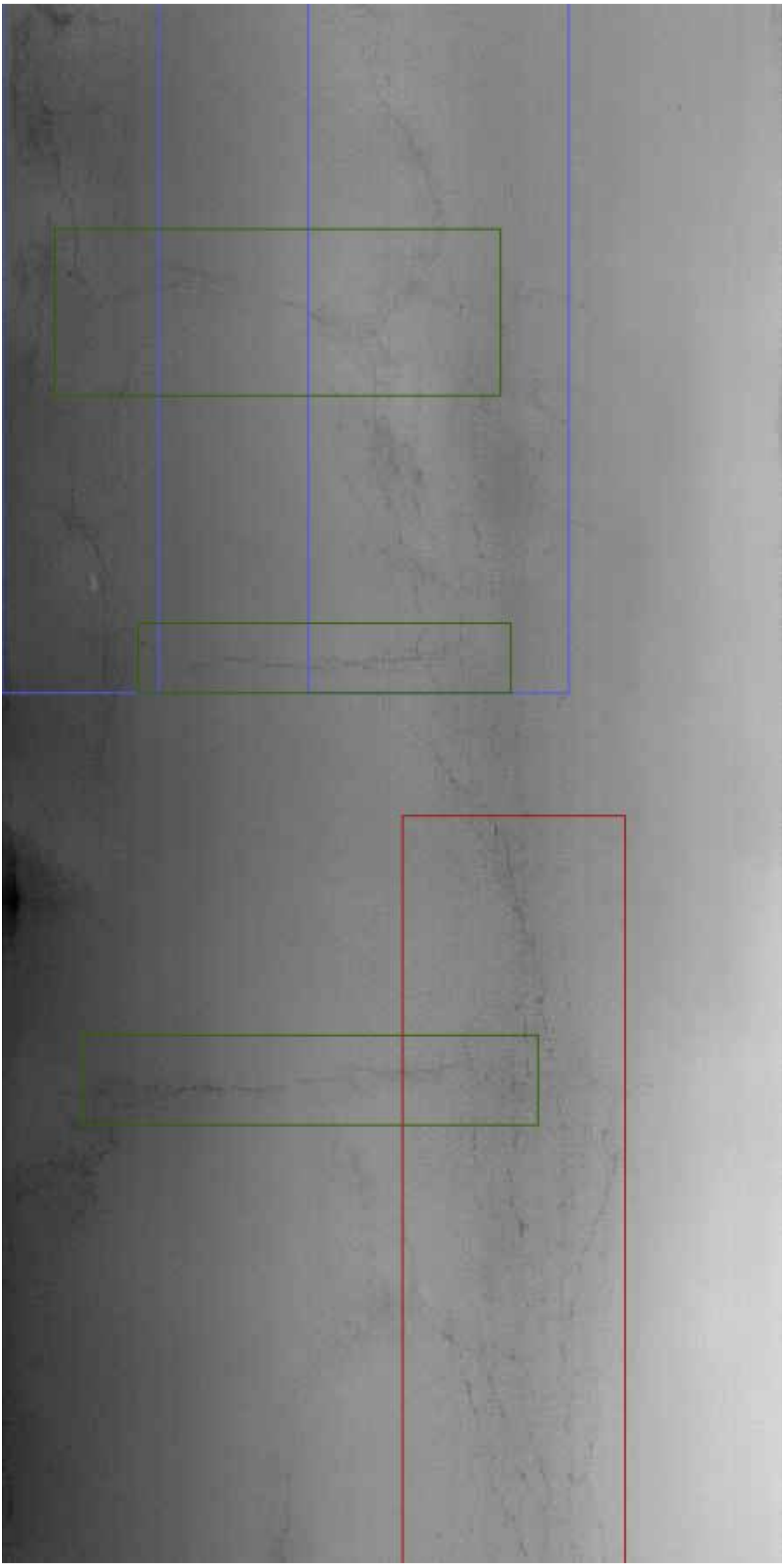


**Figure 65** US 35 SP3 Elevation Image Collected by Pathway Services 2022 Segment 1.

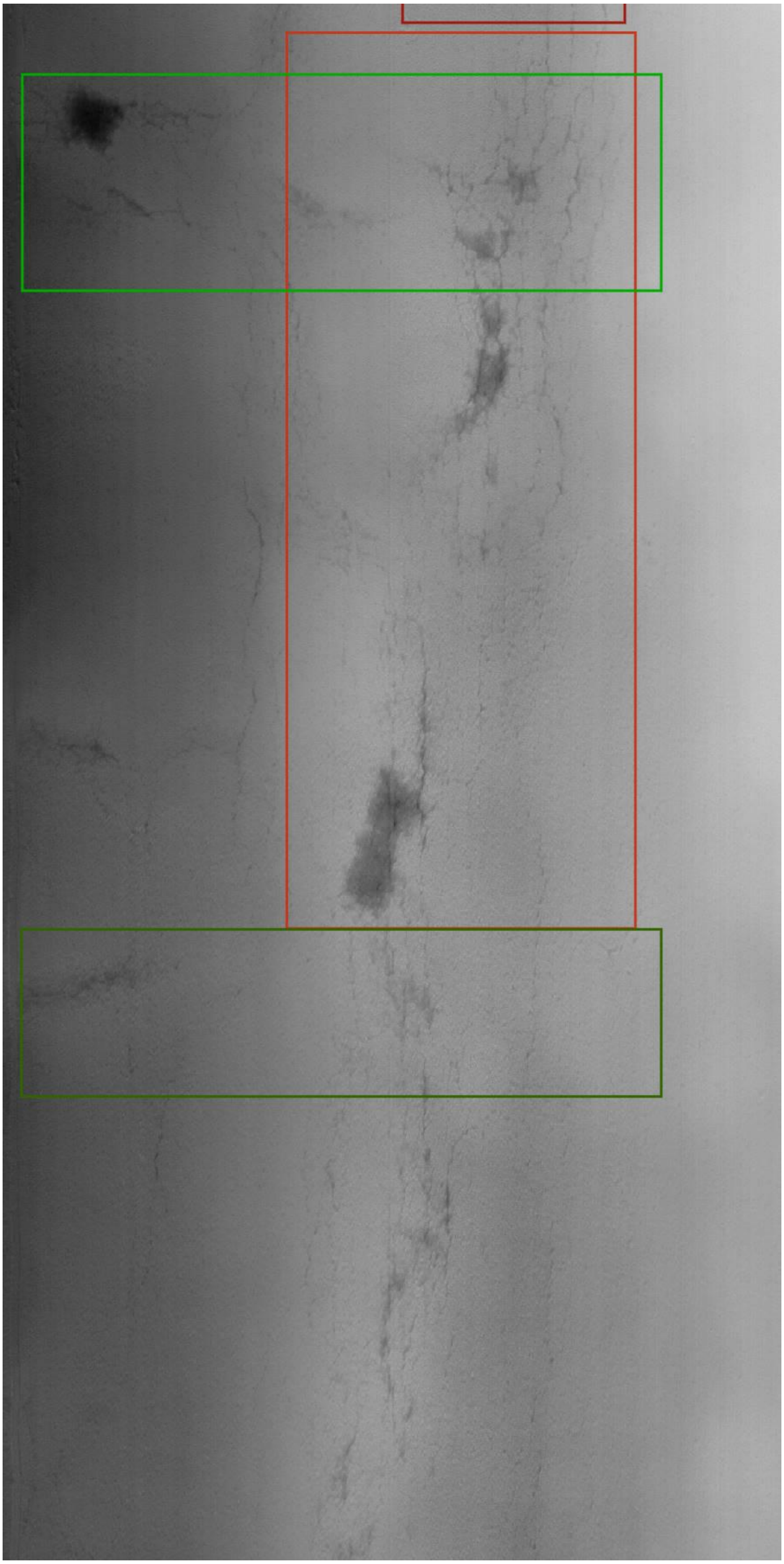


**Figure 66** US 35 SP3 Elevation Image Collected by Pathway Services 2022 Segment 2.

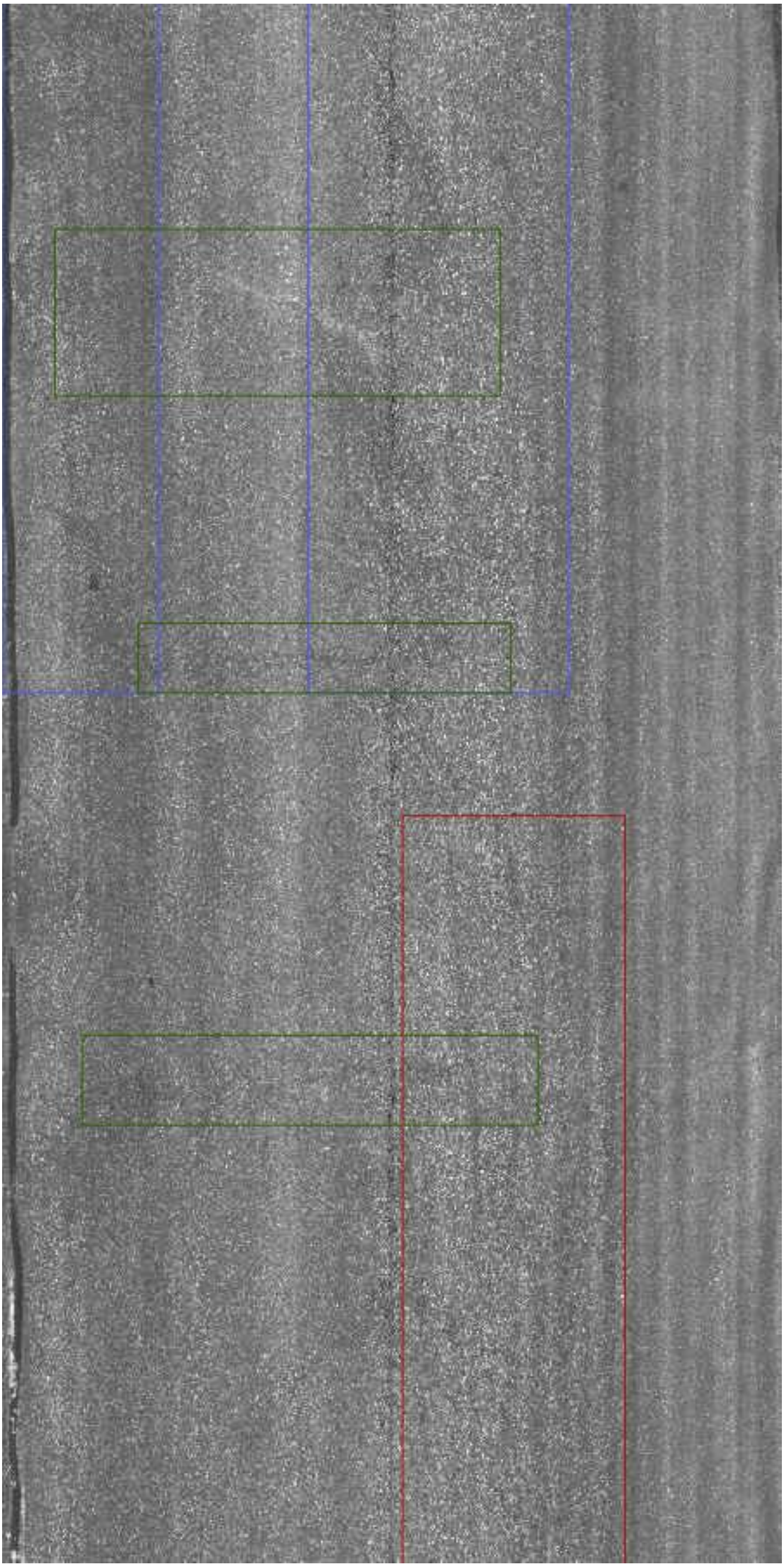


**Figure 67** US 35 SP3 Intensity Image Collected by Pathway Services 2022 Segment 1.

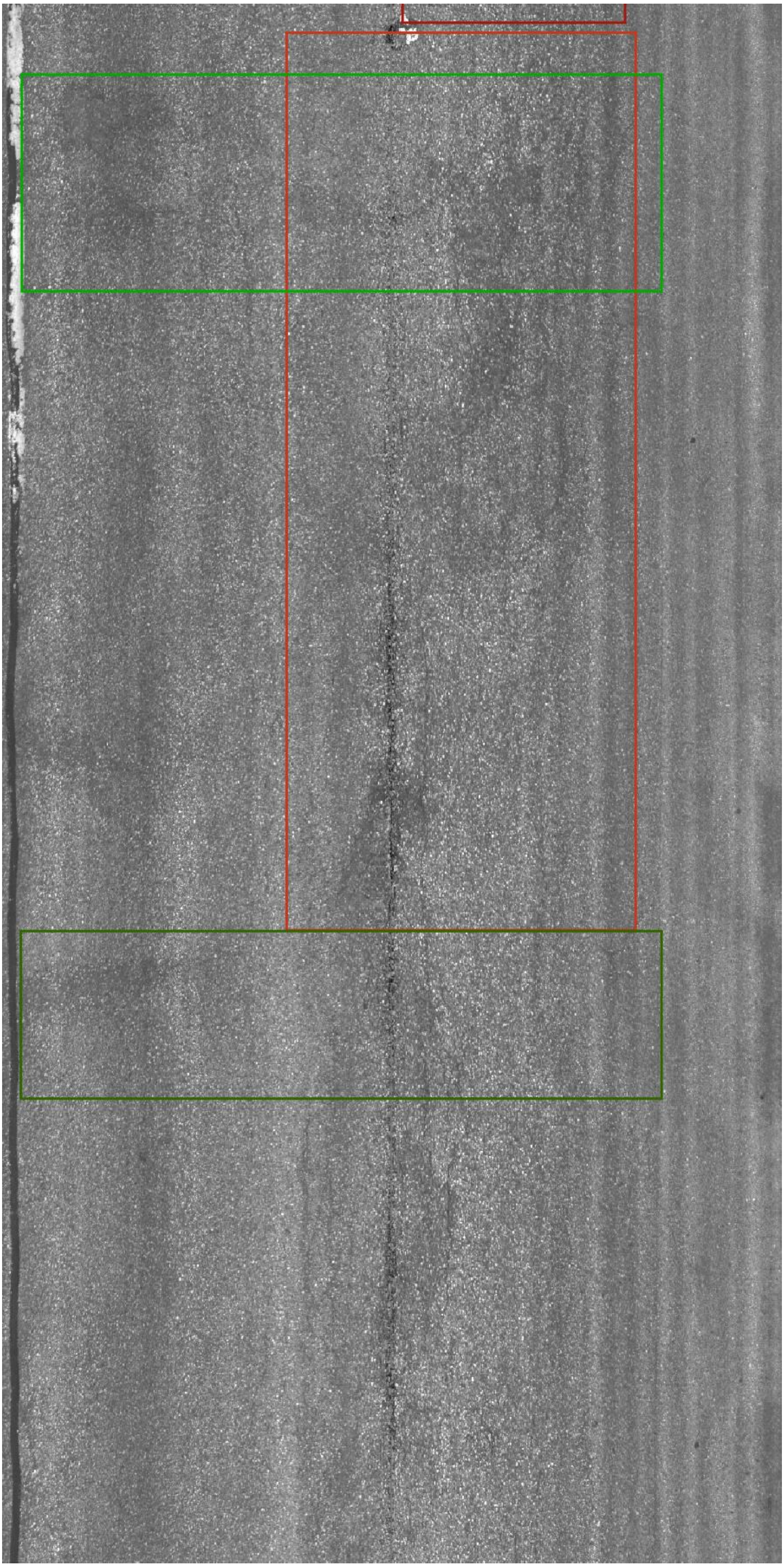


**Figure 68** US 35 SP3 Intensity Image Collected by Pathway Services 2022 Segment 2.

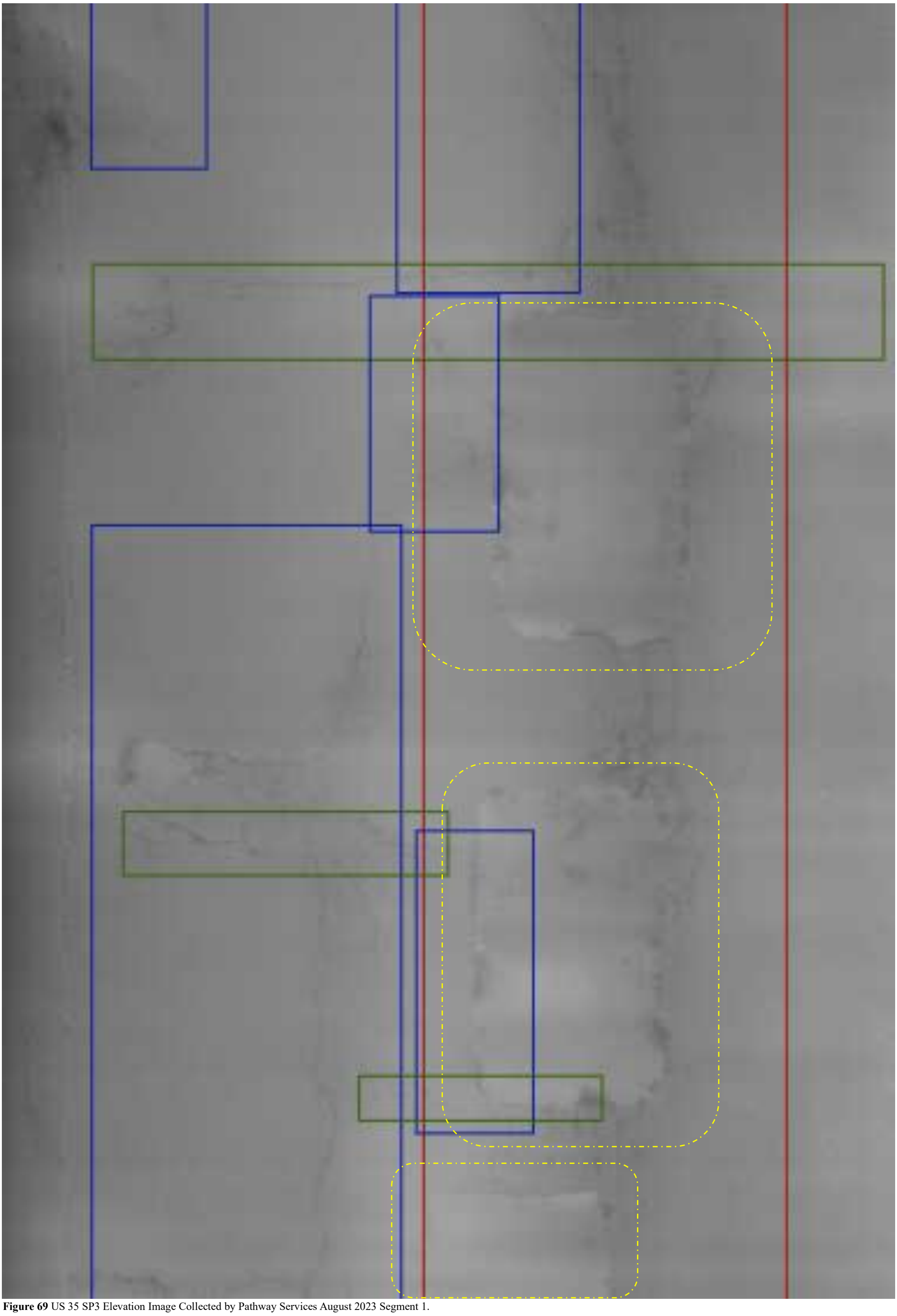


**Figure 69** US 35 SP3 Elevation Image Collected by Pathway Services August 2023 Segment 1.



**Figure 70** US 35 SP3 Elevation Image Collected by Pathway Services August 2023 Segment 2.

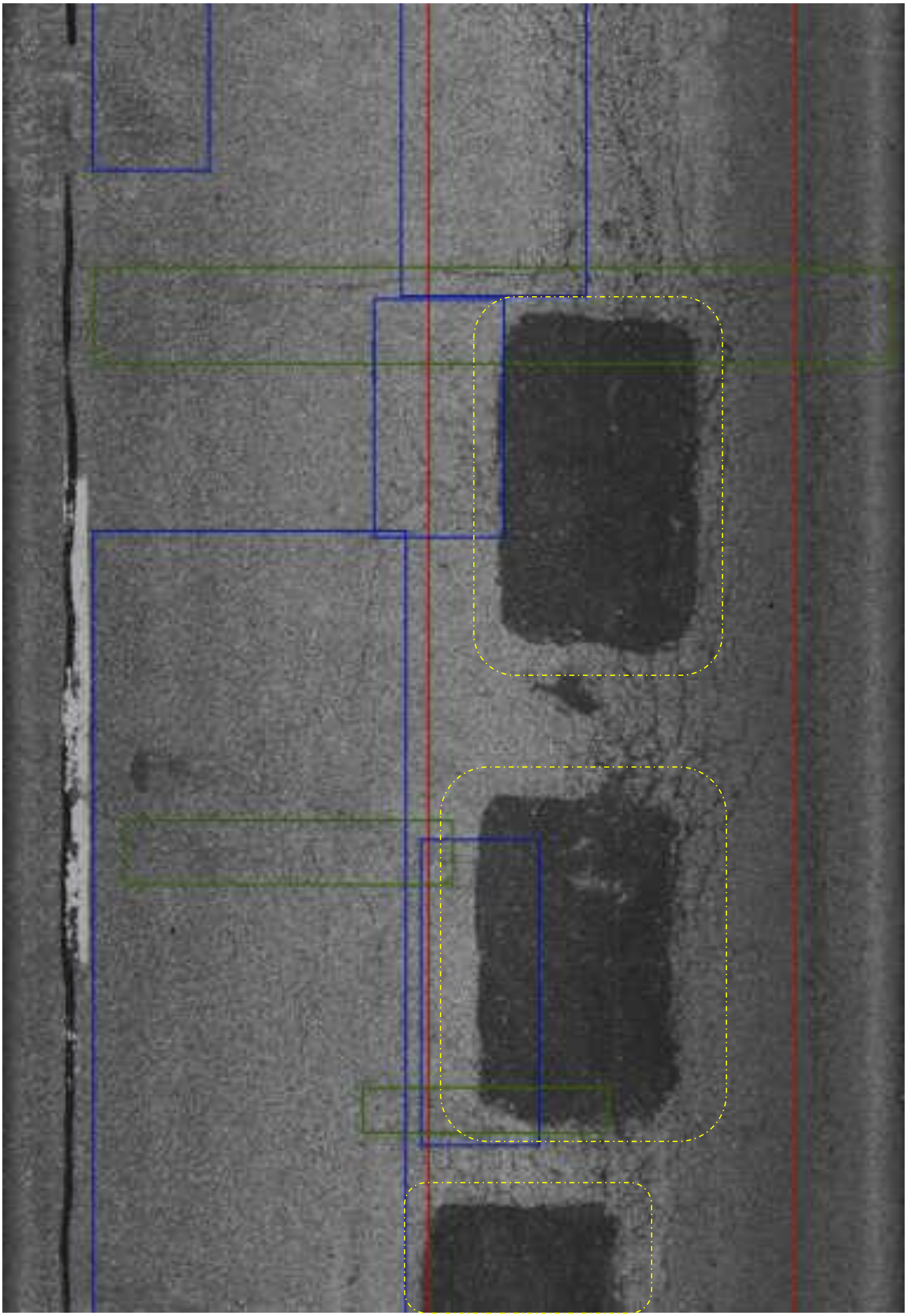


**Figure 71** US 35 SP3 Intensity Image Collected by Pathway Services August 2023 Segment 1.

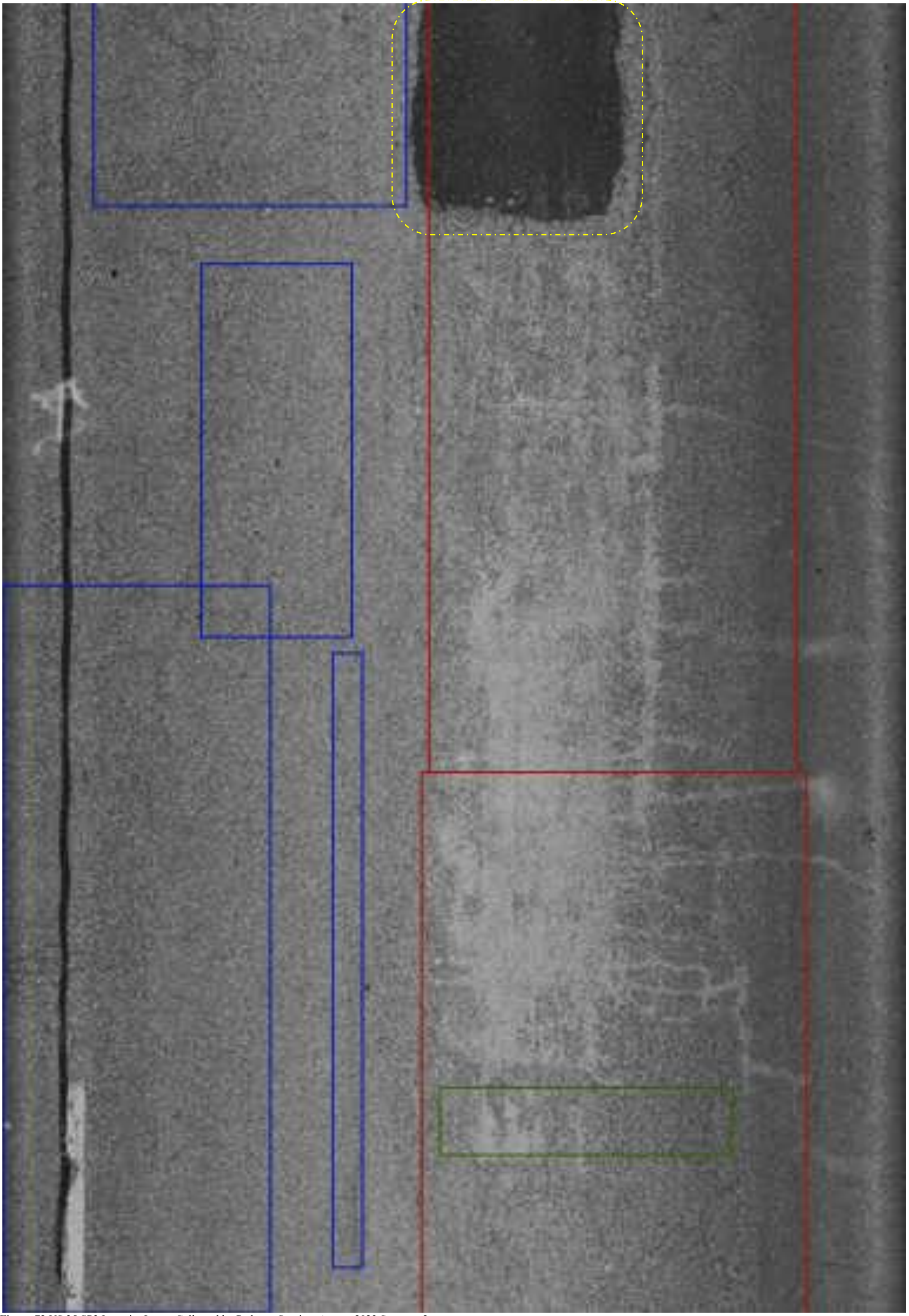


**Figure 72** US 35 SP3 Intensity Image Collected by Pathway Services August 2023 Segment 2.



US35SP3ROW: ROW Images February 2024: Top Left=Segment1, Top Right=Segment2, Bottom Right=Segment3

**Figure 73** US 35 SP3 ROW Images Collected With INDOT's Pavement Condition System February 2024.

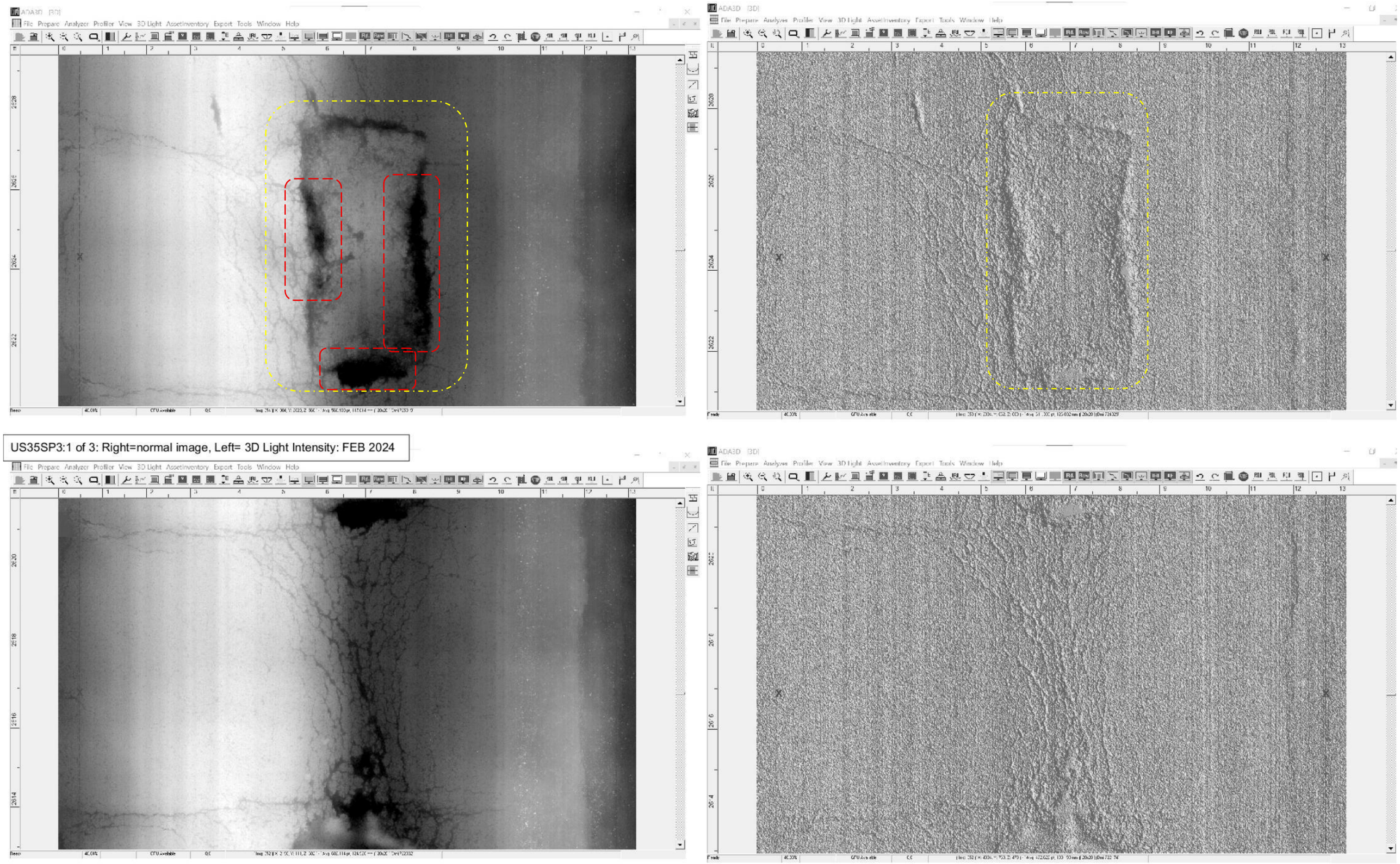



**Figure 74** US 35 SP3 Elevation (Normal) and 3D Light Intensity Images Collected With INDOT's Pavement System Segment 1, February 2024.

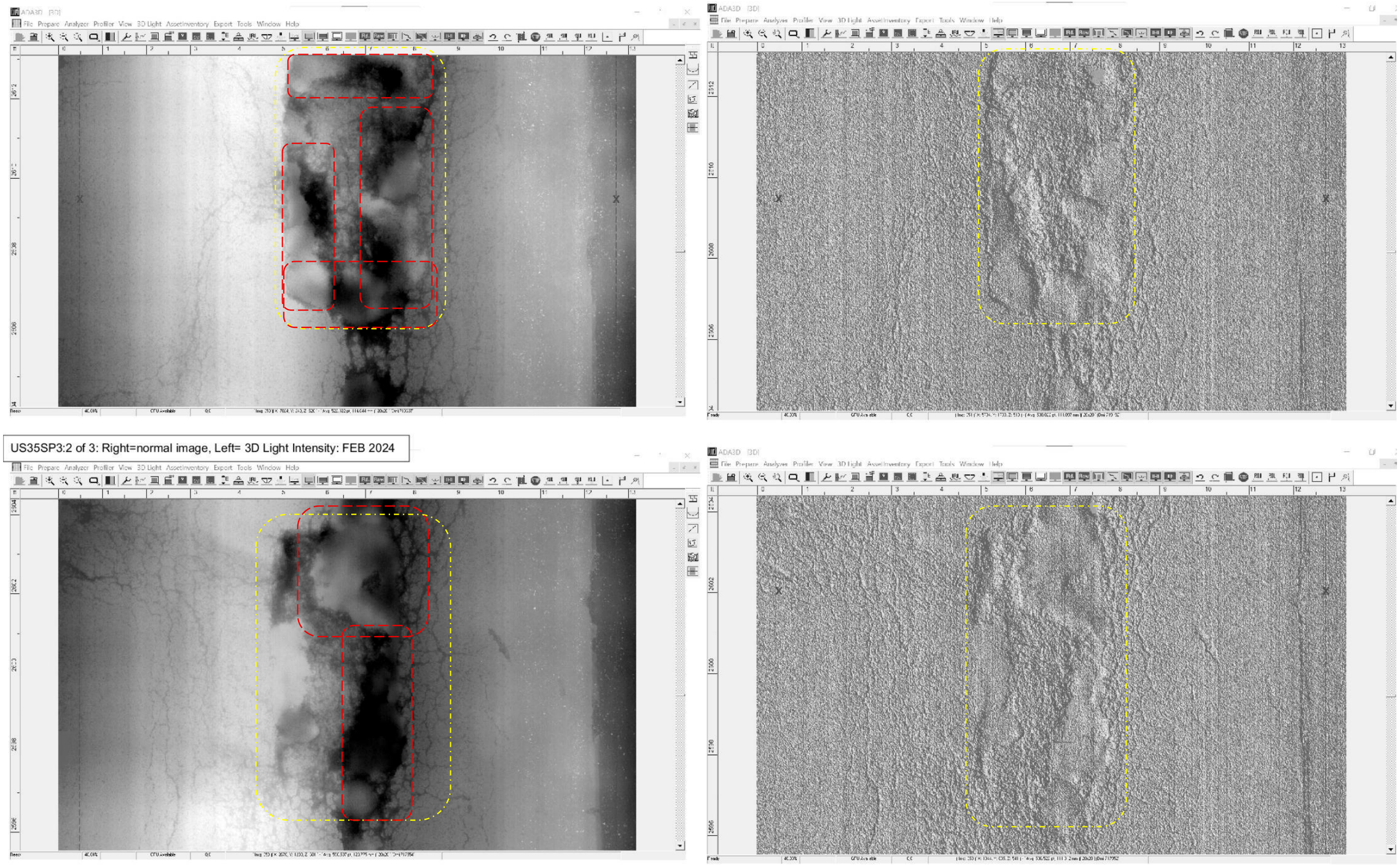



**Figure 75** US 35 SP3 Elevation (Normal) and 3D Light Intensity Images Collected With INDOT's Pavement System Segment 2, February 2024.

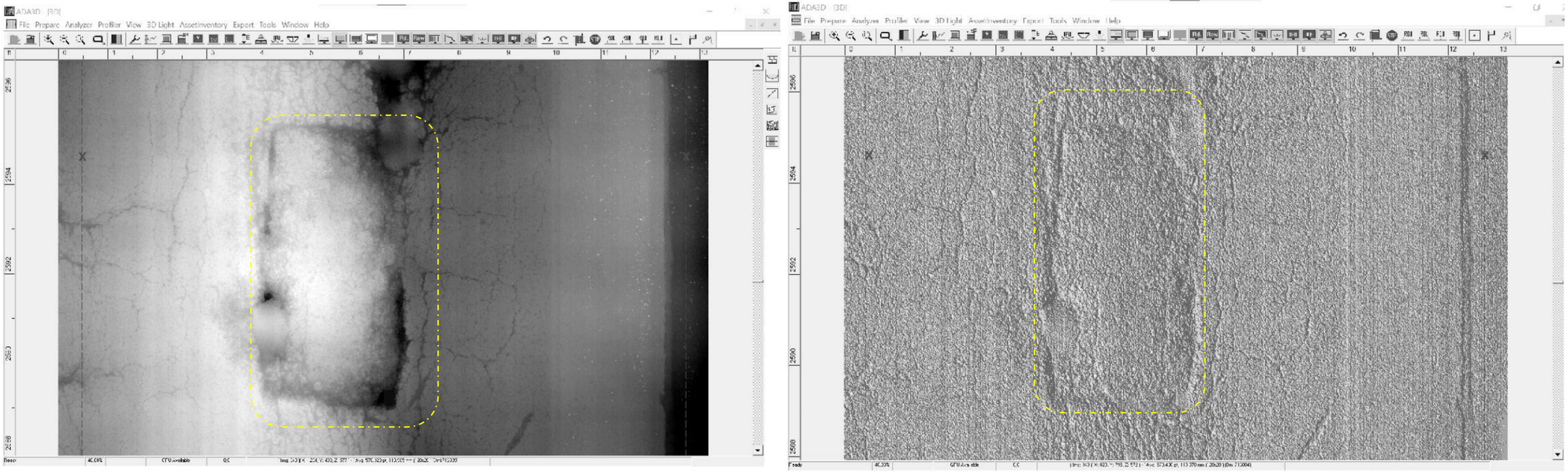



**Figure 76** US 35 SP3 Elevation (Normal) and 3D Light Intensity Images Collected With INDOT's Pavement System Segment 1, February 2024.

**Old SR 25 Pavement Shoving Case Study FIgures**

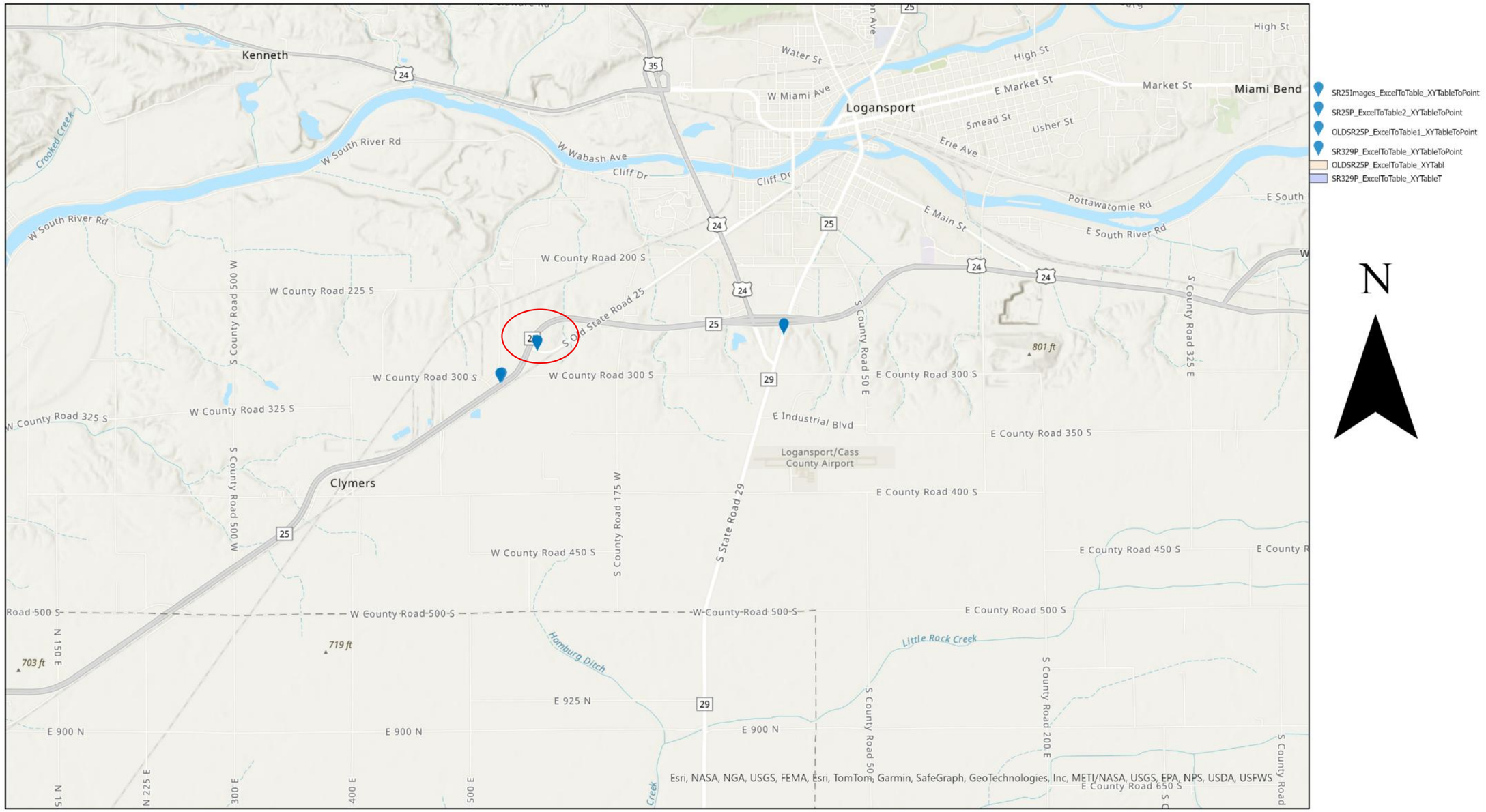



**Figure 77** Location of Patches Around Logansport, Indiana. The Location of the Old SR 25 Patch Is in the Red Ellipse.

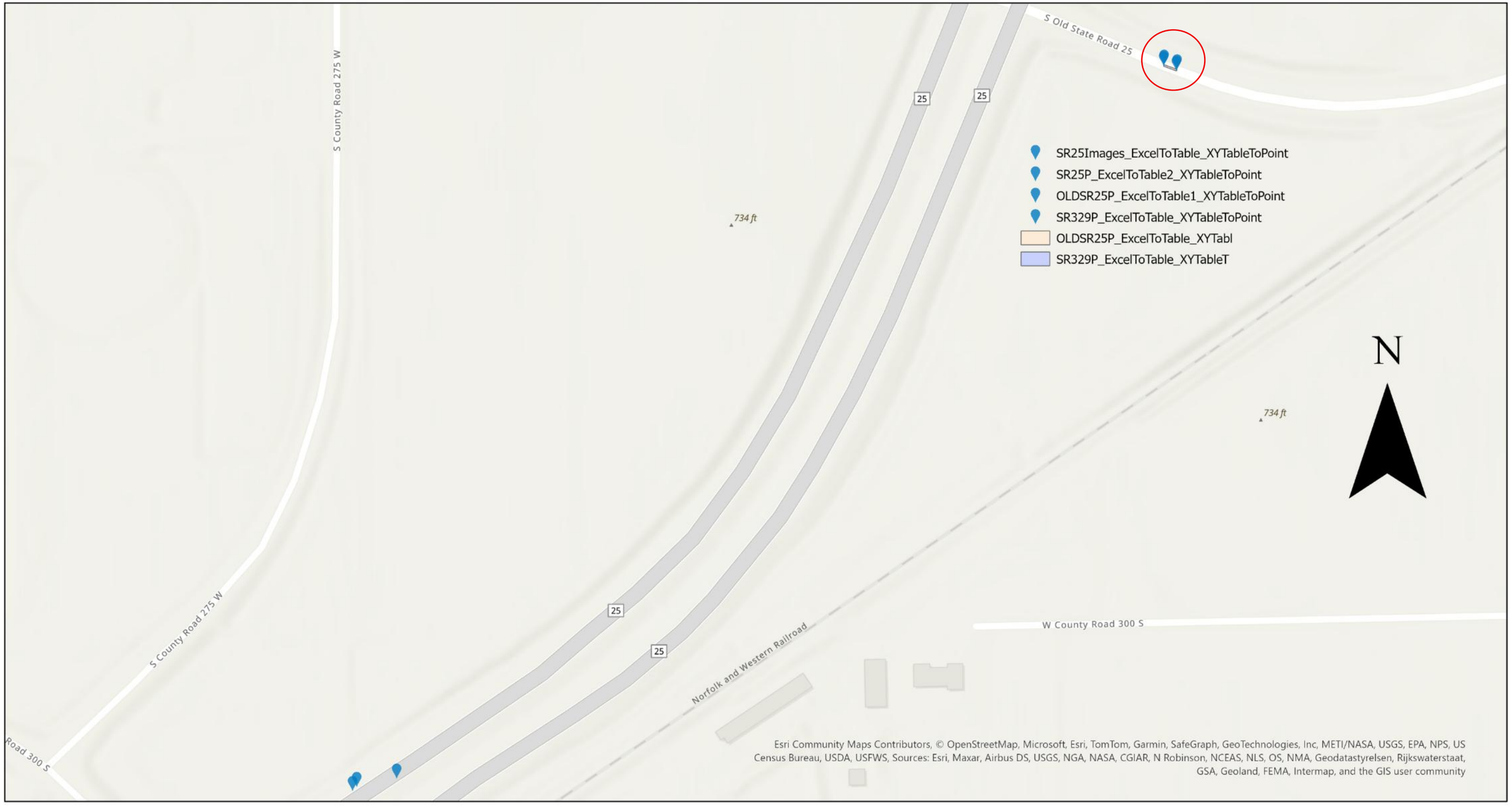



**Figure 78** Location of the Patches on Old SR 25 and SR 25. The Location of the Patch on Old SR 25 Is in the Red Ellipse.



**Figure 79** Old SR 25 Patched Area Prior To Patching Showing Shoving Collected With Pavement Condition System.




**Figure 80** OLD SR 25 Row Images Collected With Specialized Testing System. Top Left: Pavement Condition System August 2023; Top Right Pavement Condition March 2024; Bottom Left: Inertial Profiler August 2023; Bottom Right: Inertial Profiler February 2024.




**Figure 81** Image of Old SR 25 Patch December 2023.

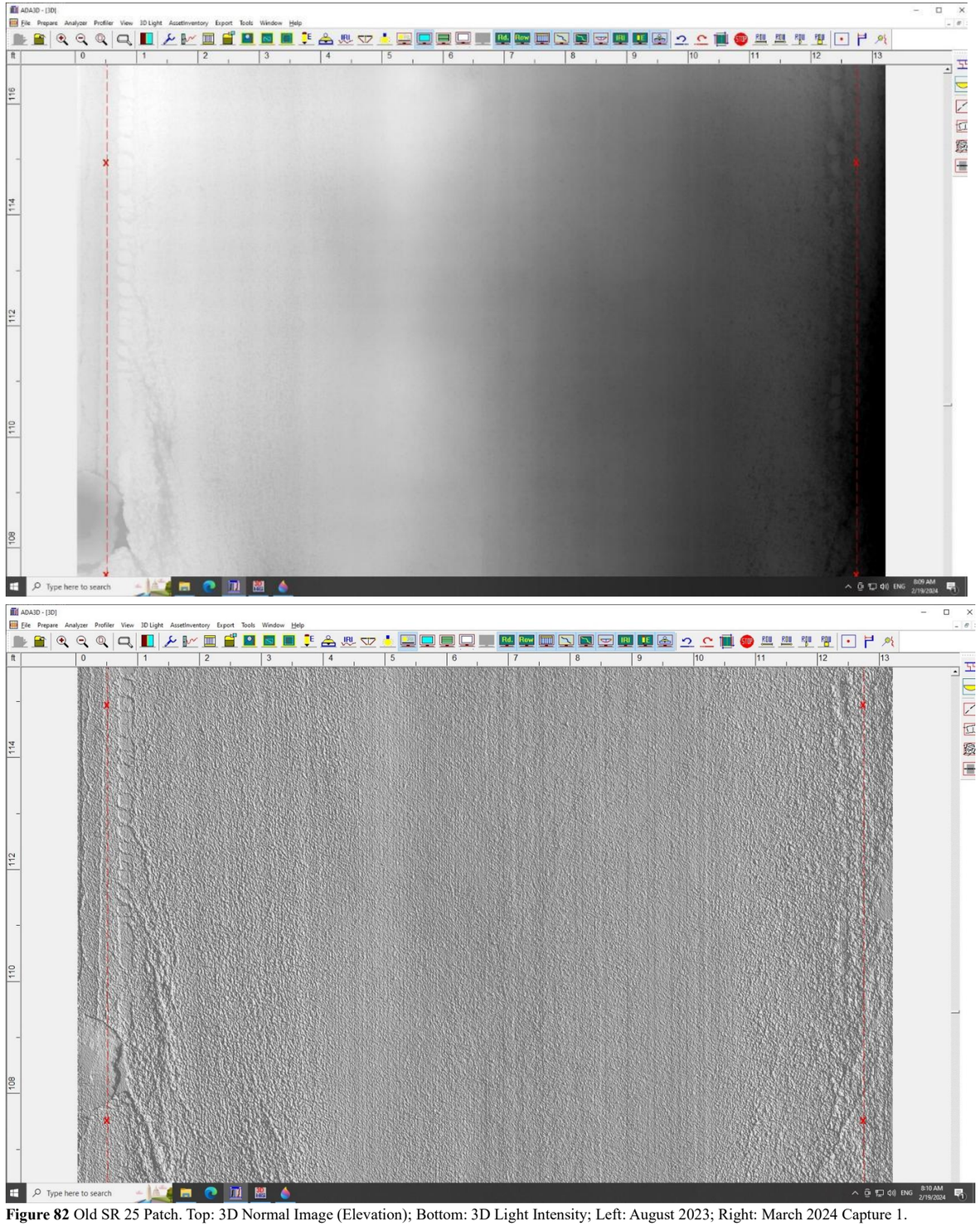


**Figure 82** Old SR 25 Patch. Top: 3D Normal Image (Elevation); Bottom: 3D Light Intensity; Left: August 2023; Right: March 2024 Capture 1.

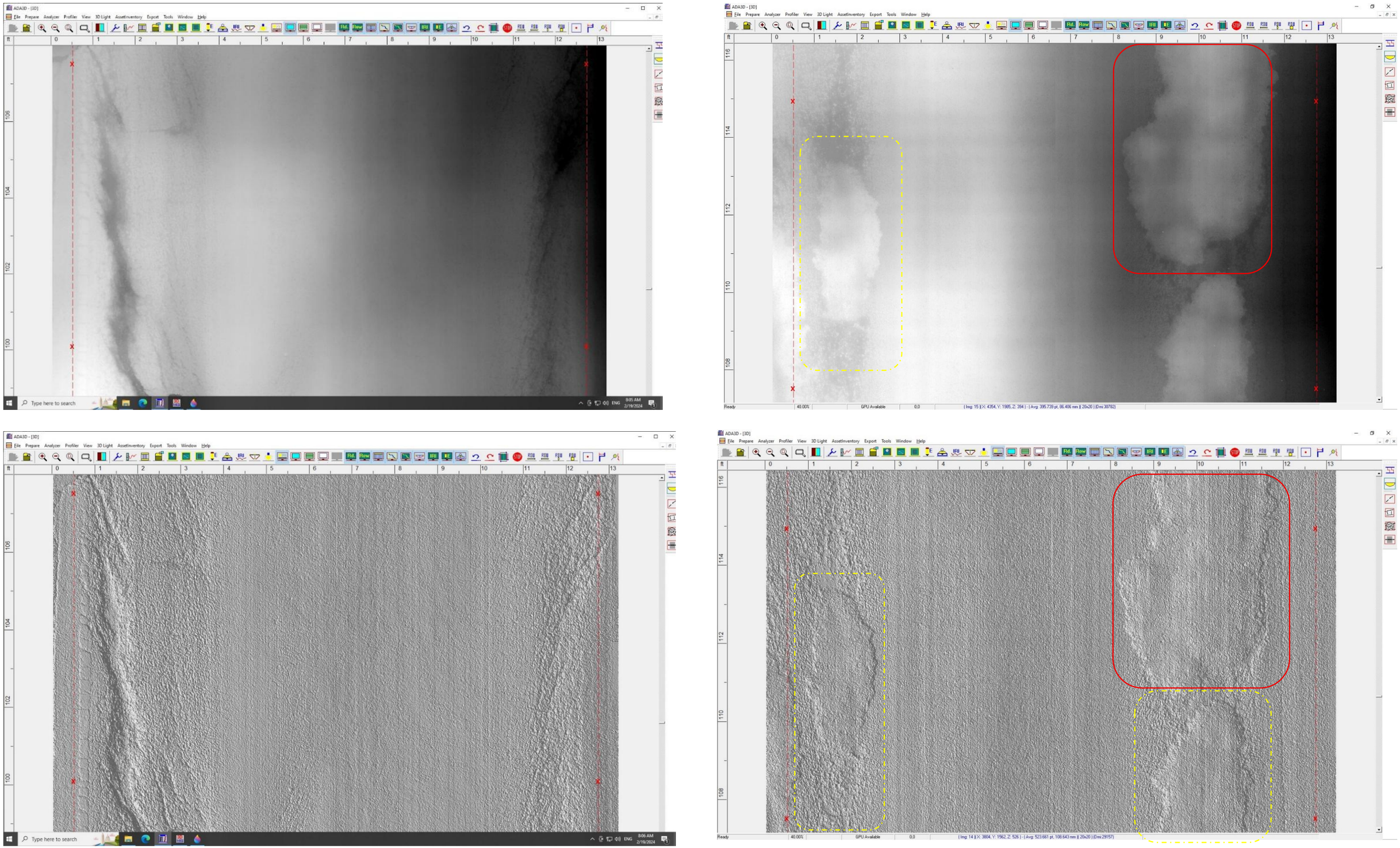


**Figure 83** Old SR 25 Patch. Top: 3D Normal Image (Elevation); Bottom: 3D Light Intensity; Left: August 2023; Right: March 2024 Capture 2.

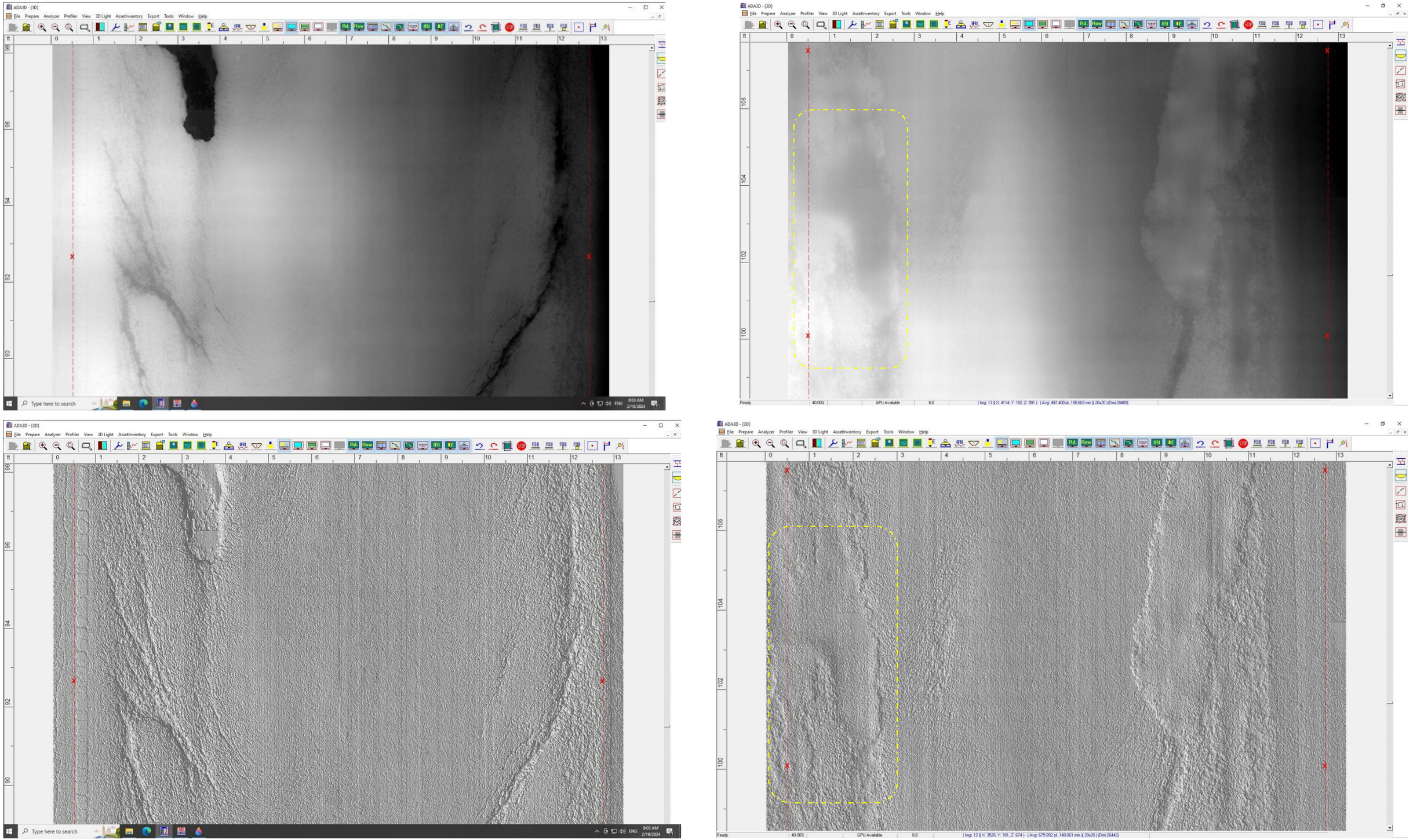


**Figure 84** Old SR 25 Patch. Top: 3D Normal Image (Elevation); Bottom: 3D Light Intensity; Left: August 2023; Right: March 2024 Capture 3.

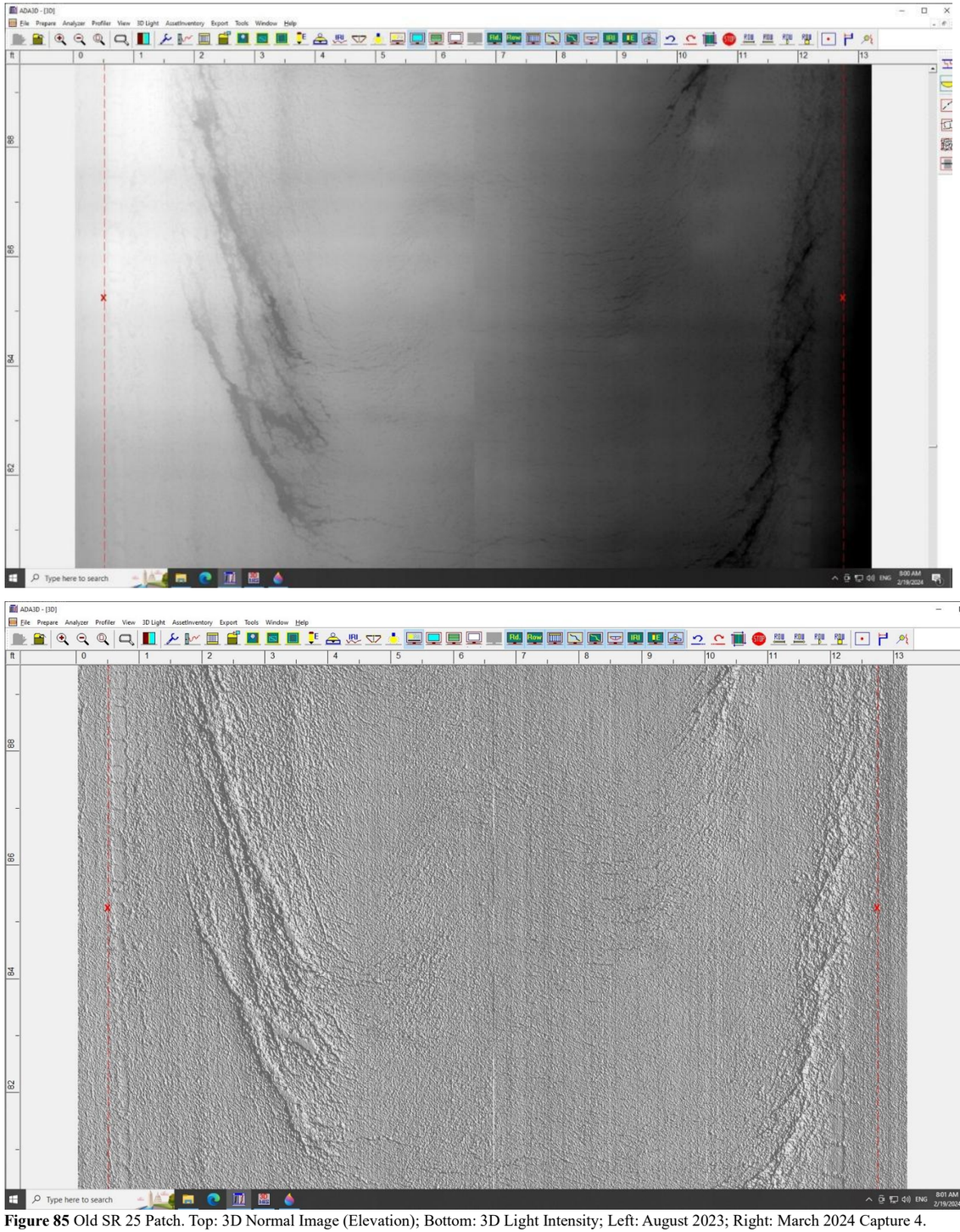
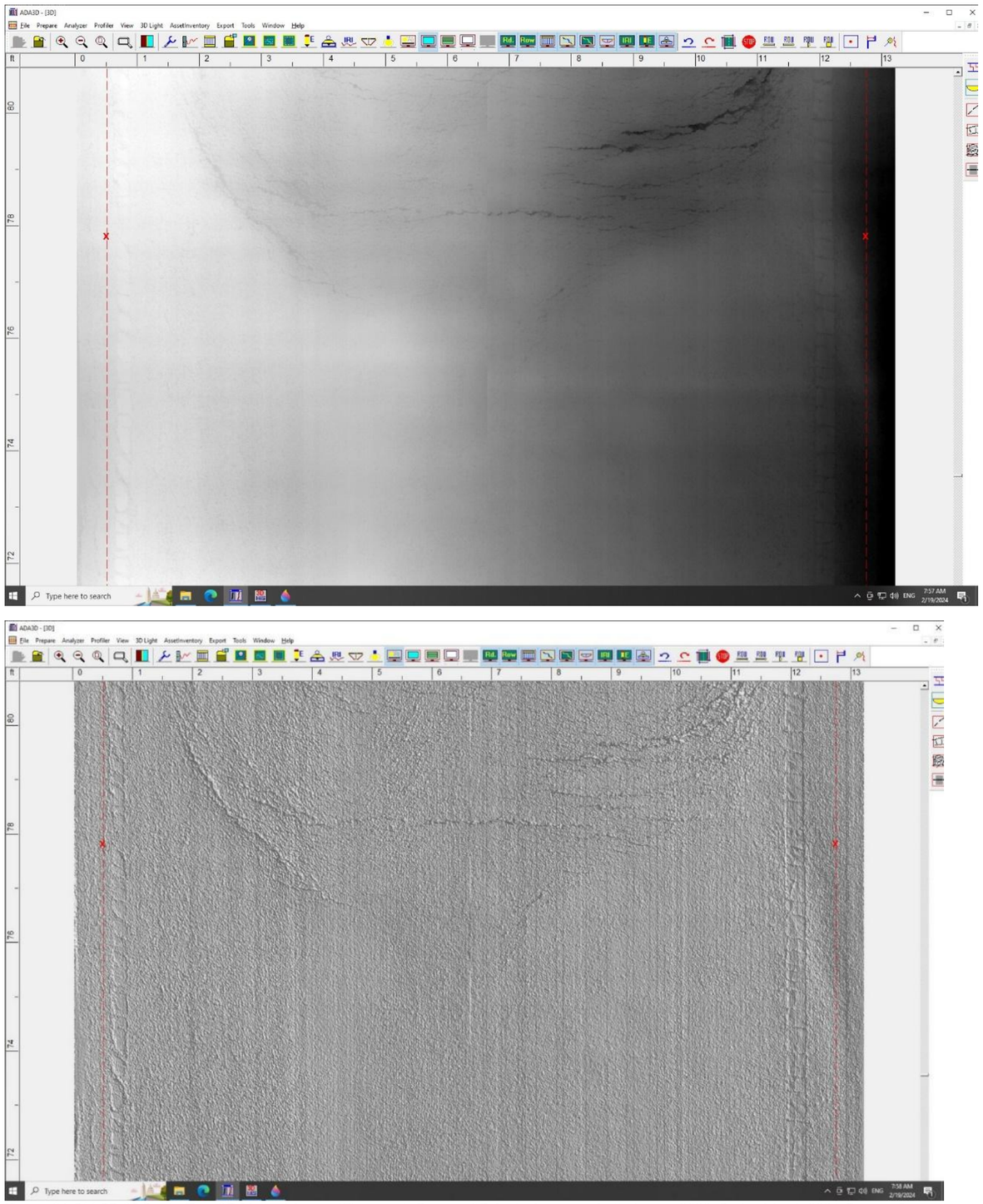


**Figure 85** Old SR 25 Patch. Top: 3D Normal Image (Elevation); Bottom: 3D Light Intensity; Left: August 2023; Right: March 2024 Capture 4.



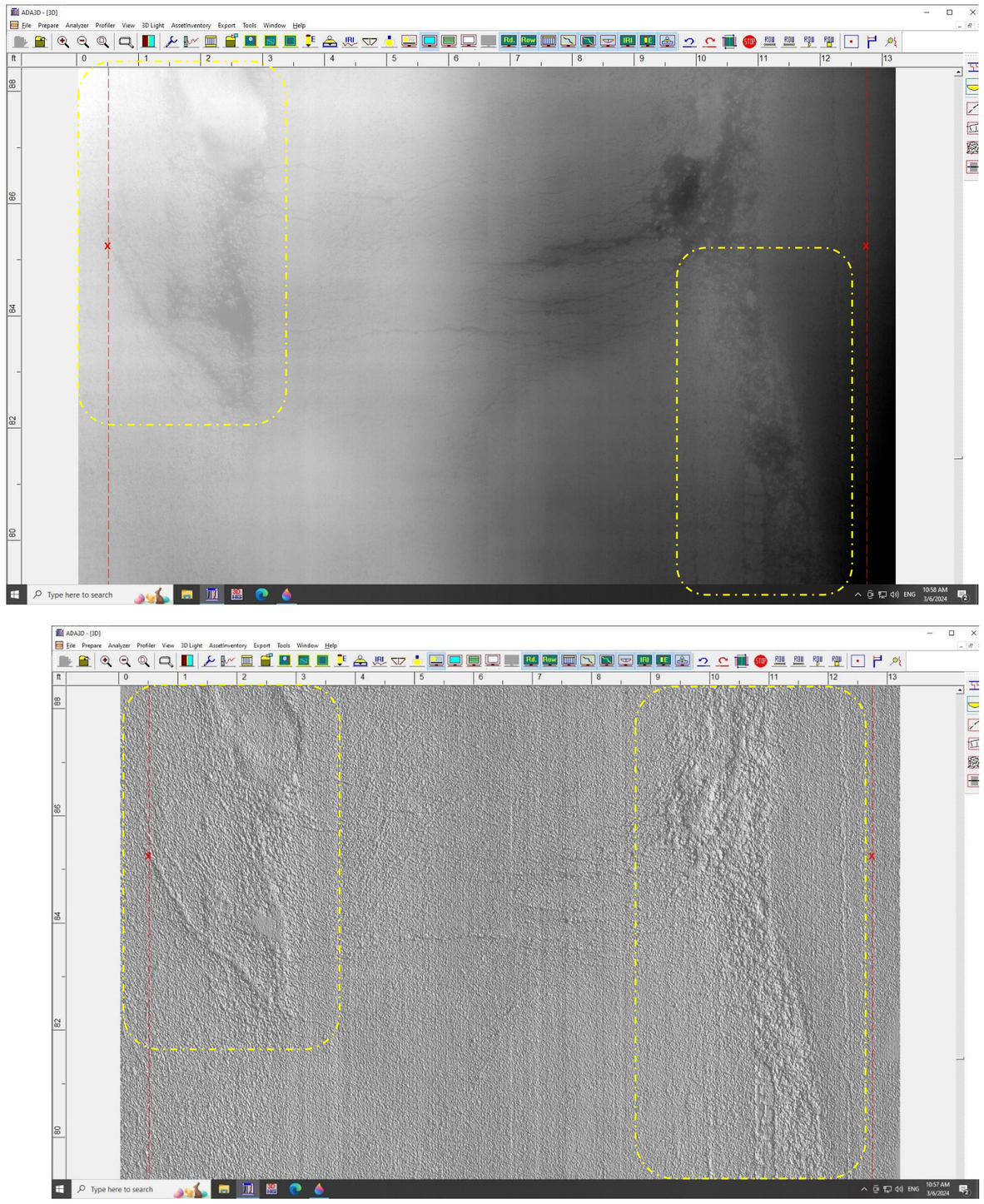




**Figure 86** Old SR 25 Patch. Top: 3D Normal Image (Elevation); Bottom: 3D Light Intensity; Left: August 2023; Right: March 2024 Capture 5.

**SR 38 Ramp onto US 31 Southbound Depression/Bump High Severity Transverse Cracking Figures**

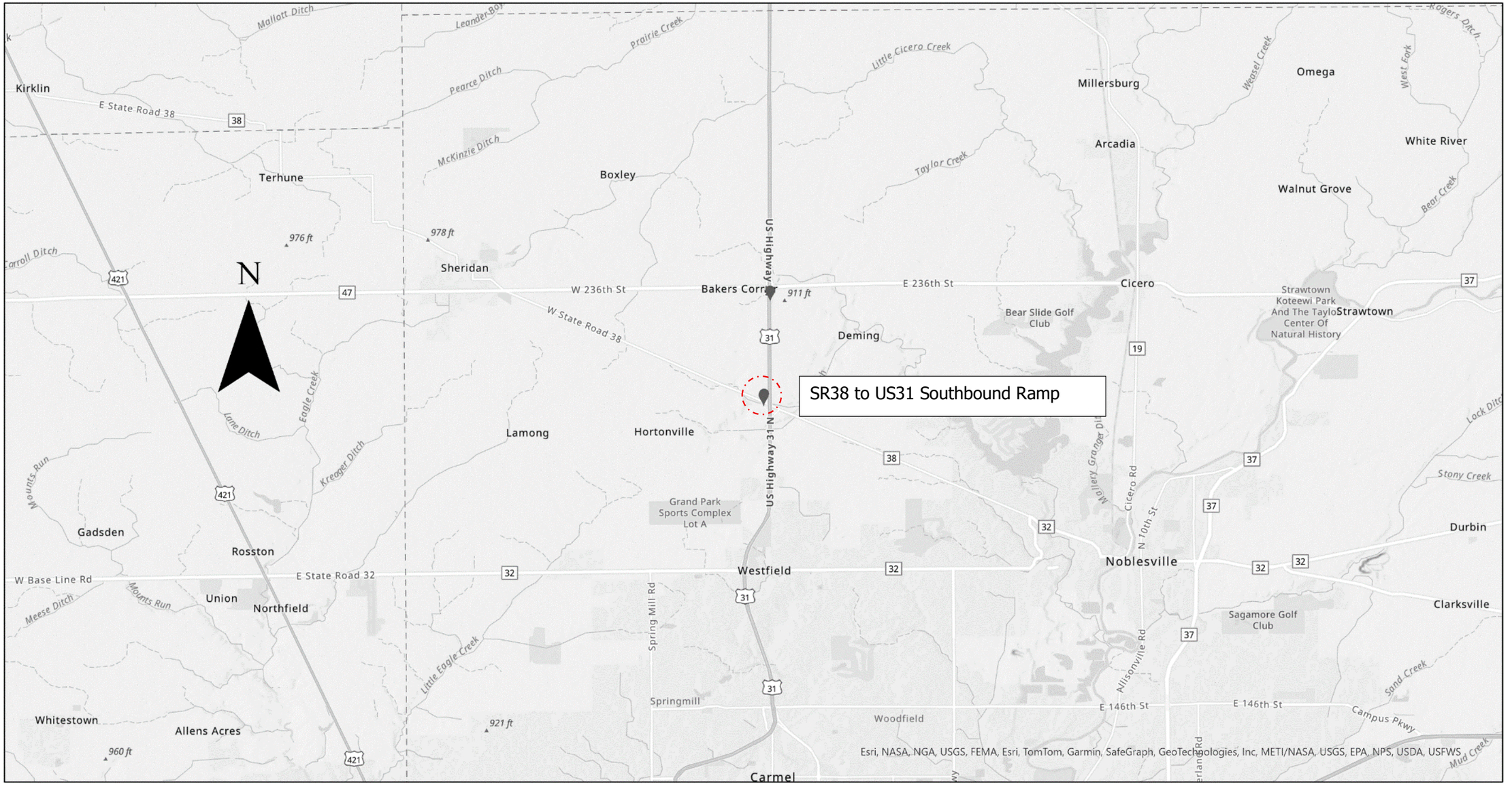



**Figure 87** SR 38 To US 31 Southbound Ramp Patch Location.




**Figure 88** SR 38 Ramp Onto US 31 Soutbond Patch Location.



**Figure 89** SR 38 Ramp Onto US 31 Southbound. SR 38RP1 ROW Image Collected by Pathway Services October 2023 Showing Depression and Transverse Cracking.

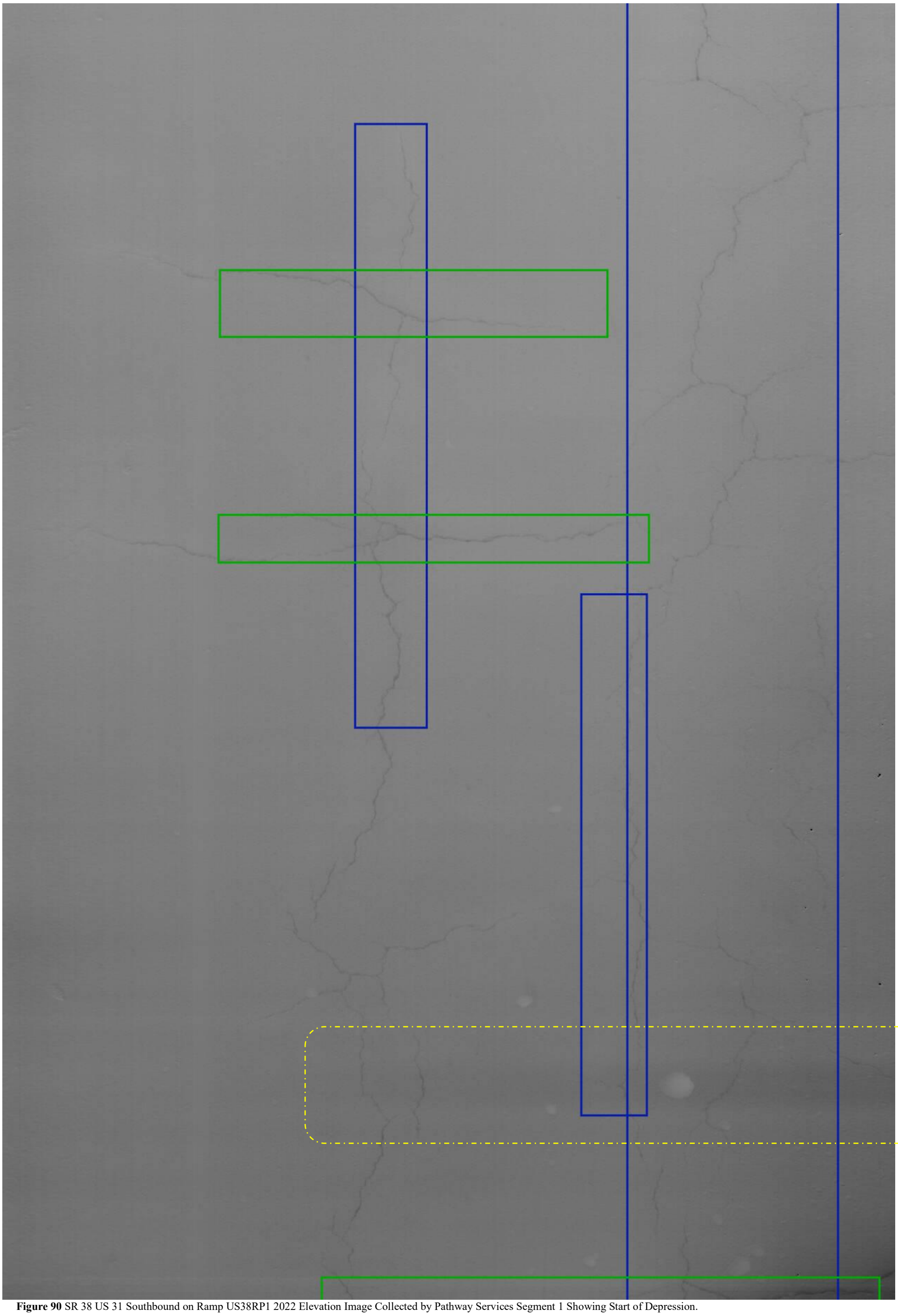


**Figure 90** SR 38 US 31 Southbound on Ramp US38RP1 2022 Elevation Image Collected by Pathway Services Segment 1 Showing Start of Depression.

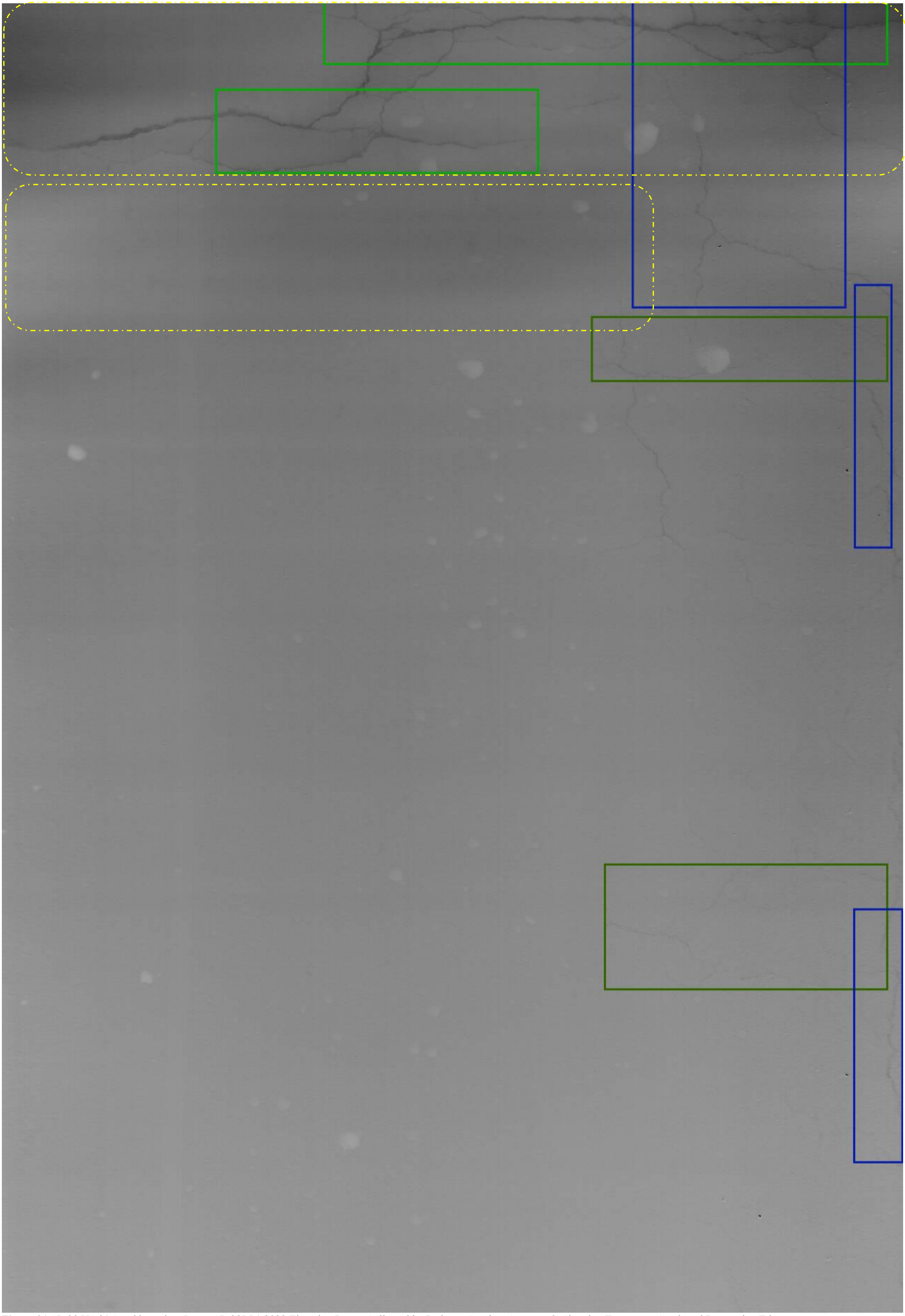


**Figure 91** SR 38 US 31 Southbound on Ramp SR 38RP1 2022 Elevation Image Collected by Pathway Services Segment 2, Showing Transverse Crack and Depression Edge.

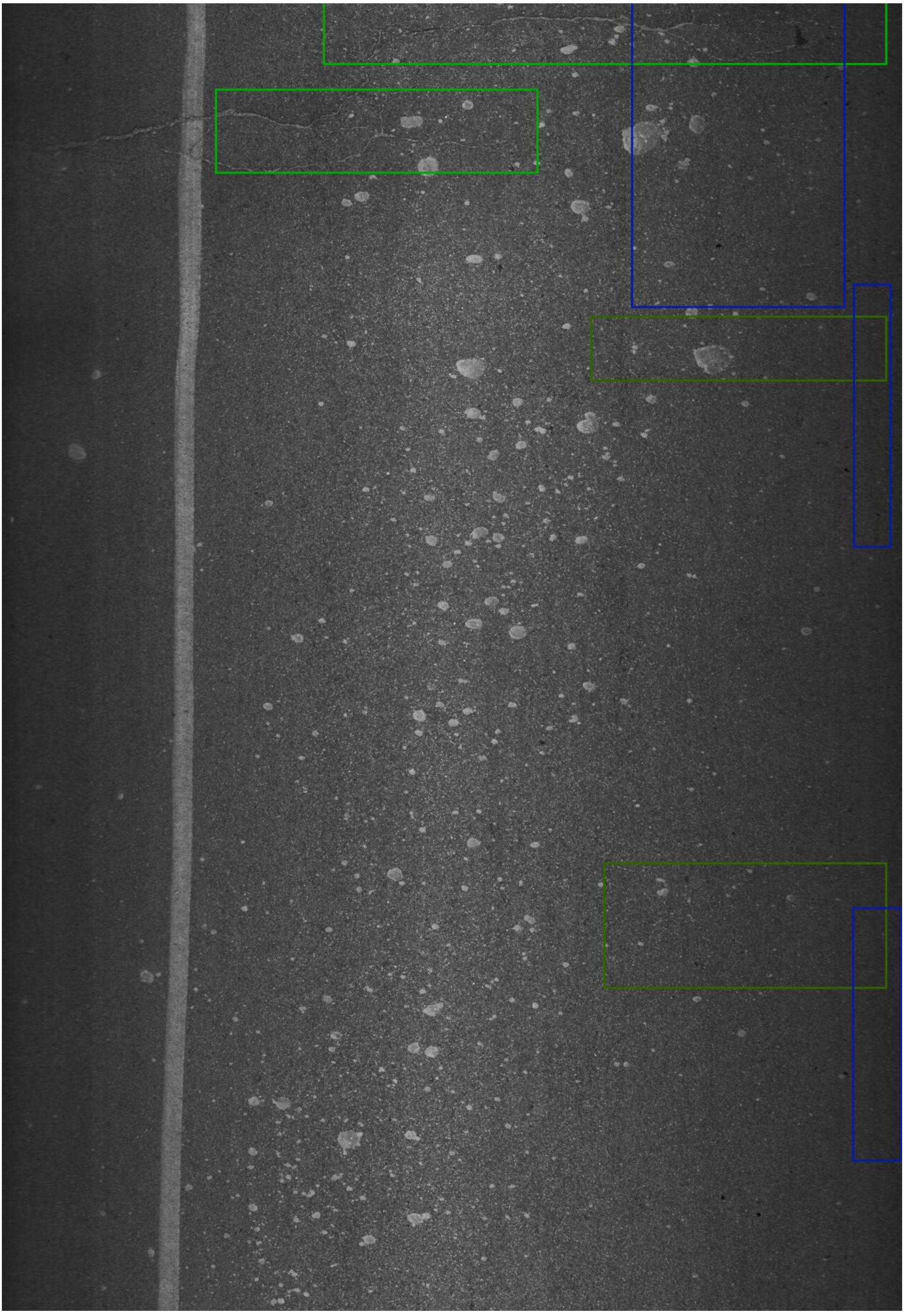


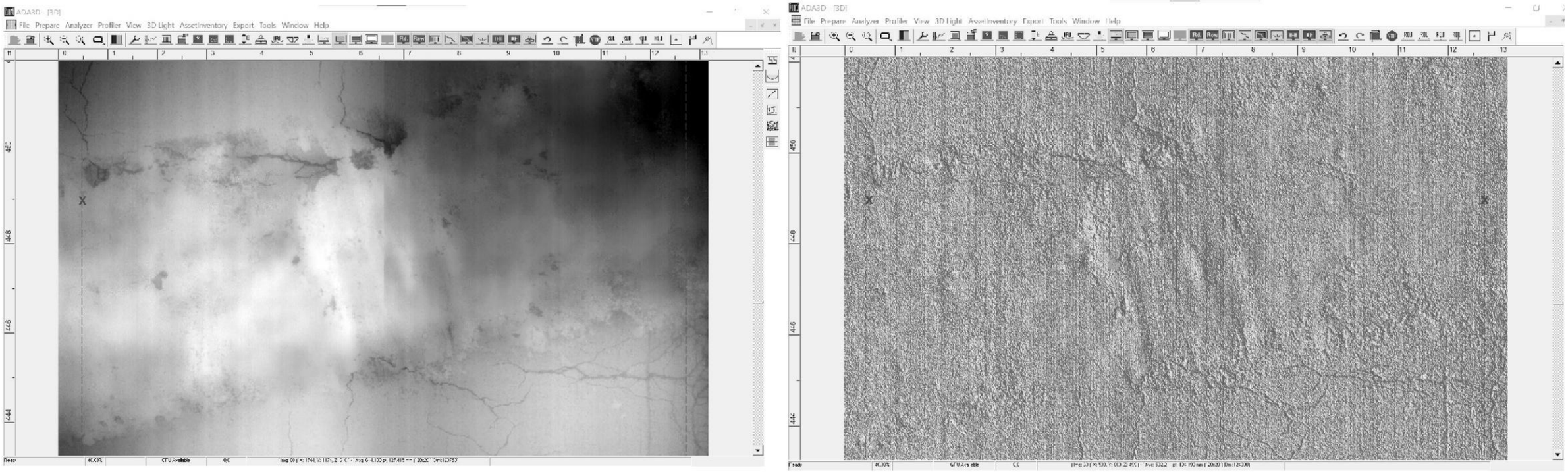
**Figure 92** SR 38 US 31 Southbound on Ramp SR 38RP1 2022 Intensity Image Collected by Pathway Services Segment 2.




**Figure 93** SR 38 US 31 Southbound SR 38RP1 ROW Image Collected With Inertial Profiler Collected November 2025.



**Figure 94** SR 38 US 31 Southbound SR 38RP2 ROW Image Collected With Pavement Condition System Collected November 2025.




SR38toUS31SRamp:1 of 1: Right=normal image, Left= 3D Light Intensity: NOV 2025

**Figure 95** SR 38 US 31 Southbound SR 38RP1 Elevation (Normal) and 3D Light Intensity Image Collected With Pavement Condition System Collected November 2025.

**SR 3 Case Study Figures**

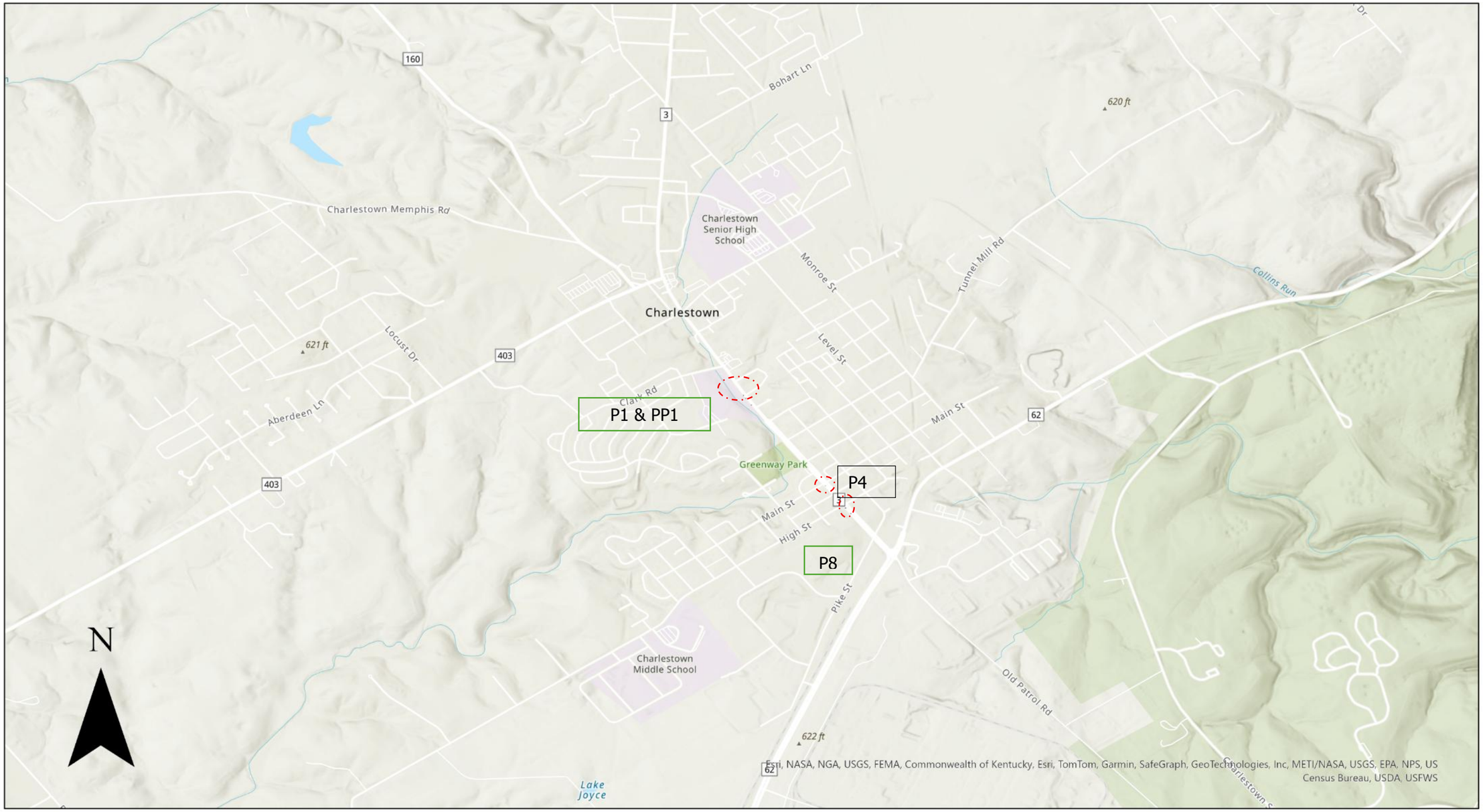



**Figure 96** Location of Patchs on SR 3.




**Figure 97** Location of Patchs on SR 3.




**Figure 98** Location of SR 3 Patch 8.




**Figure 99** SR 3 Patch 8 ROW Images Collected By Pathway Services. Top: Noveber 2023; Bottom: November 2024.

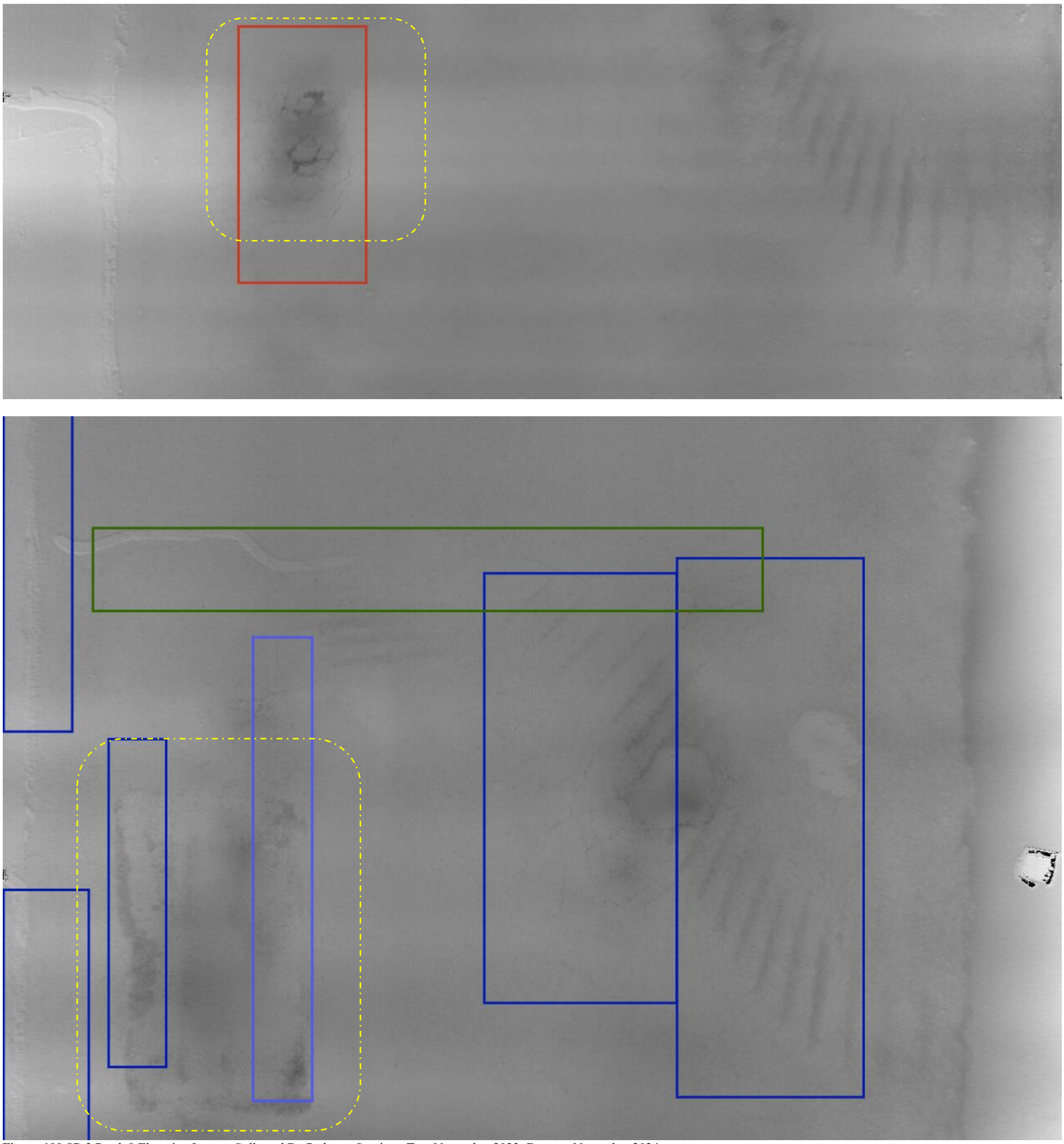


**Figure 100** SR 3 Patch 8 Elevation Images Collected By Pathway Services. Top: November 2023; Bottom: November 2024.

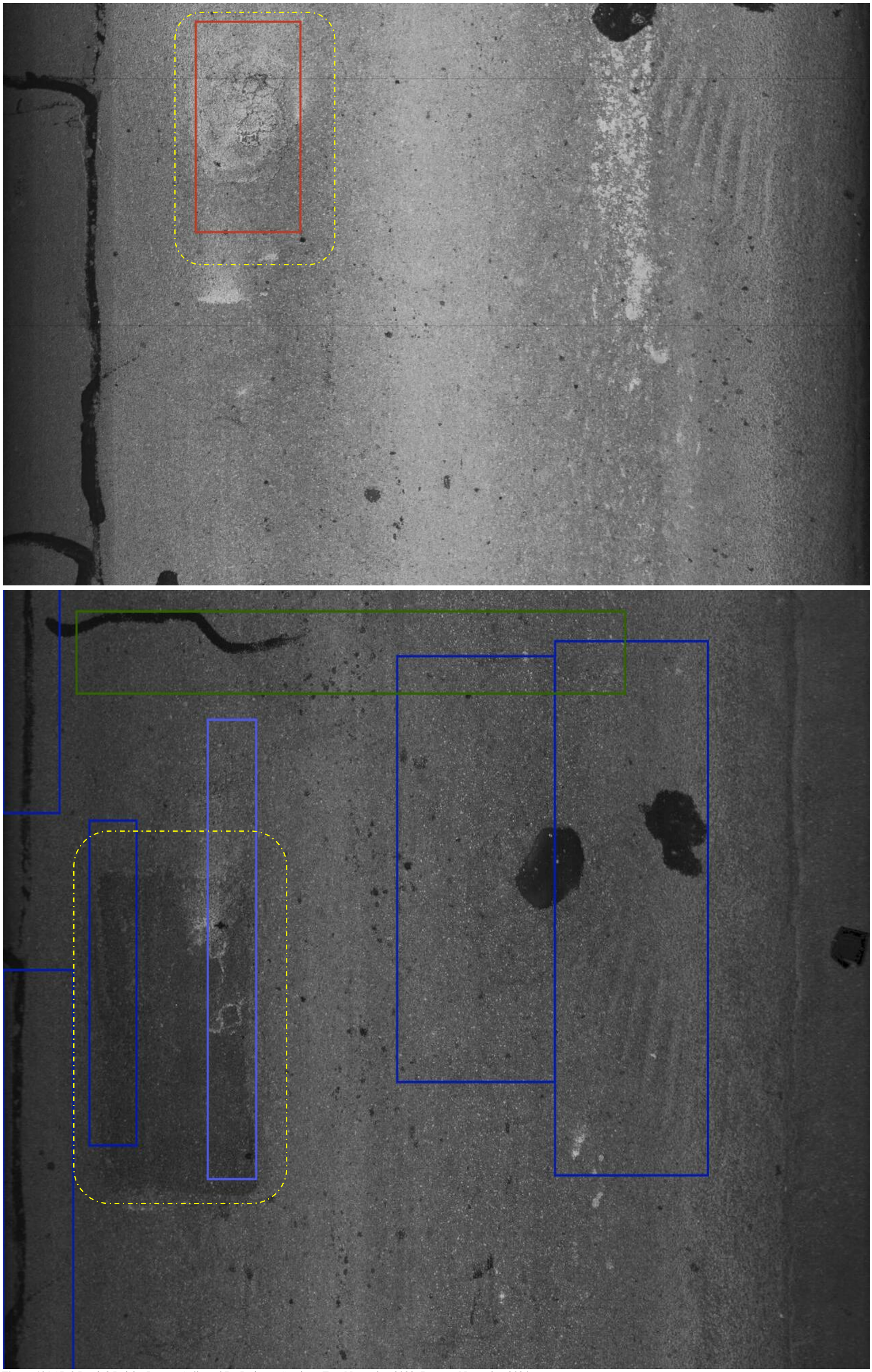


**Figure 101** SR 3 Patch 8 Intisity Images Collected By Pathway Services. Top: November 2023; Bottom: November 2024.



| SR3SDP8:1 of 1: ROW Images: Top Left=October 2024, Top Right=April 2025 | 25 |
|---|---|

**Figure 102** SR 3 Patch 8 ROW Images Collected by INDOT's Pavement Condition System. Left: October 2024; Right: April 2025.

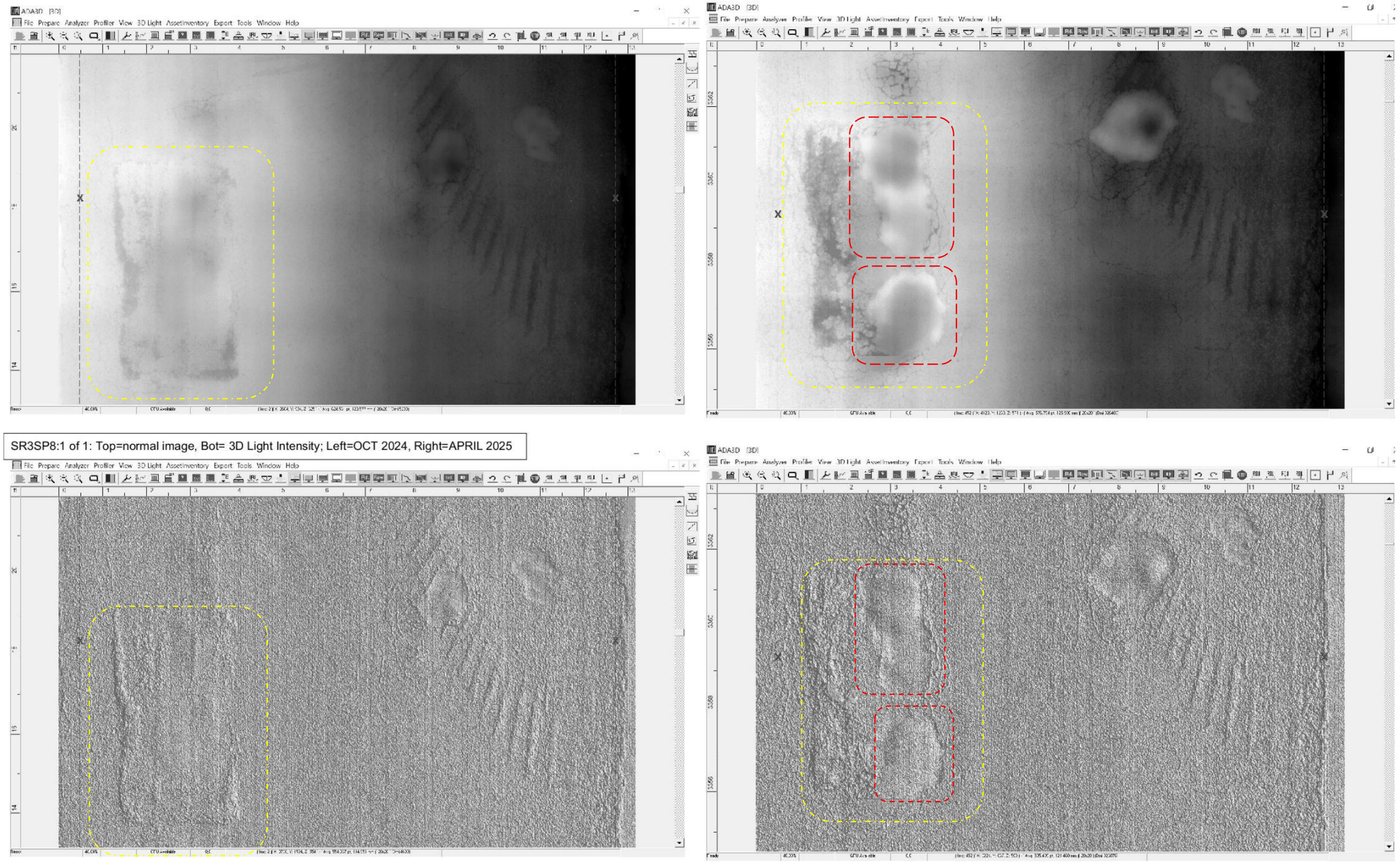



**Figure 103** SR 3 Patch 8 Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: October 2024; Right: April 2025.




**Figure 104** SR 3 Patchs P5, P6, and P7 ROW Images Collected By Pathway Services. Top: November 2023; Bottom: November 2024.

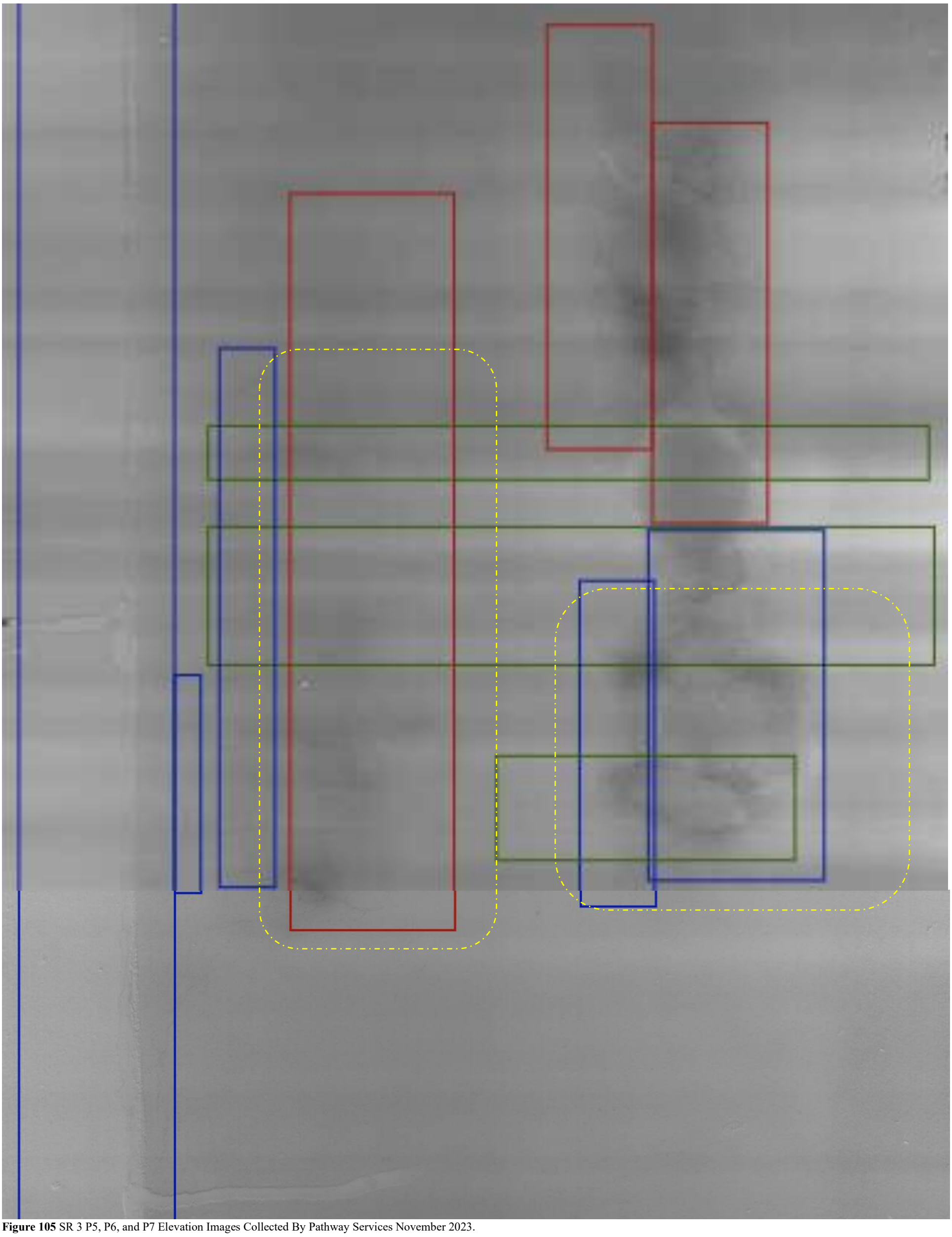


**Figure 105** SR 3 P5, P6, and P7 Elevation Images Collected By Pathway Services November 2023.

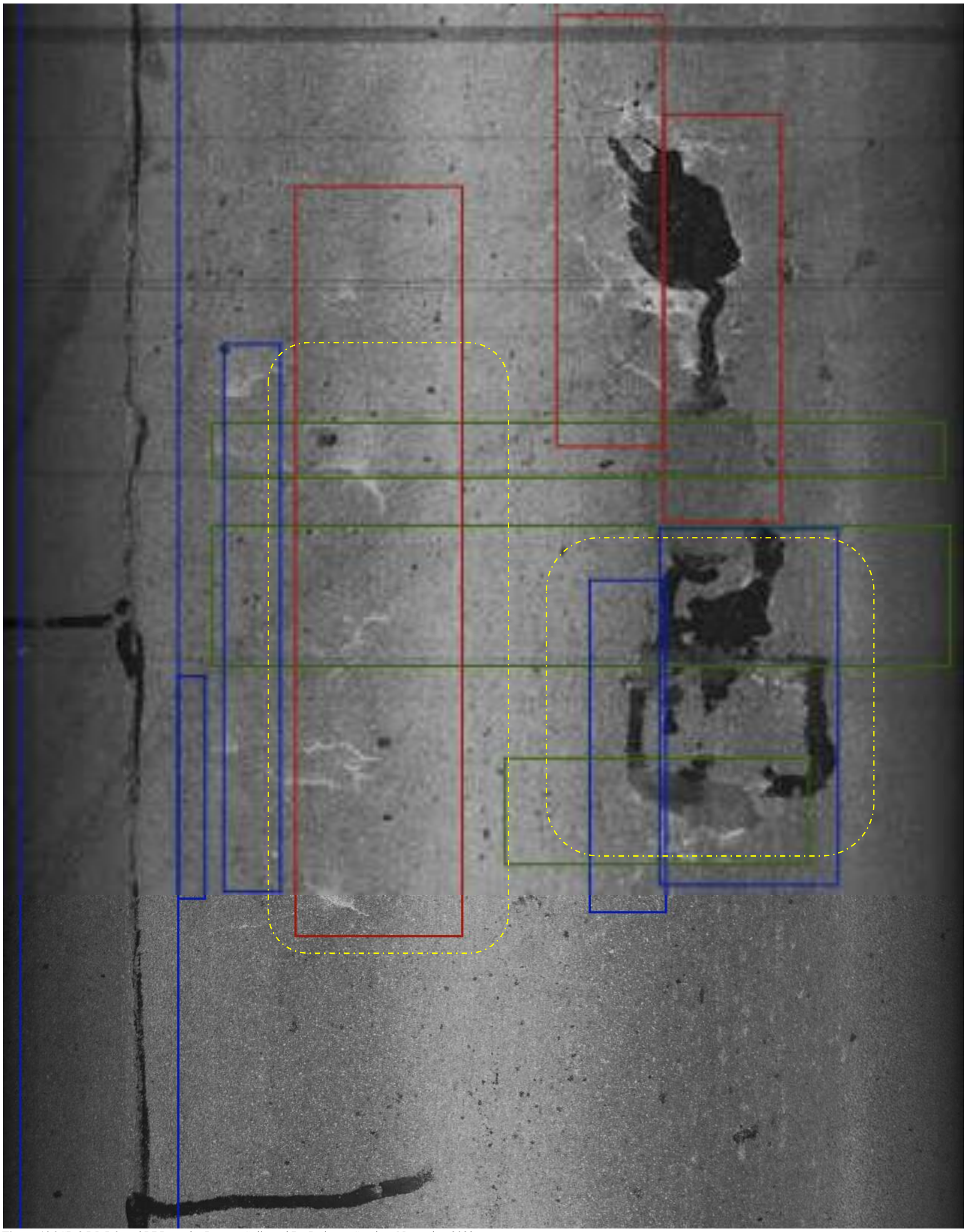


**Figure 106** SR 3 P5, P6, and P7 Intensity Images Collected By Pathway Services November 2023.

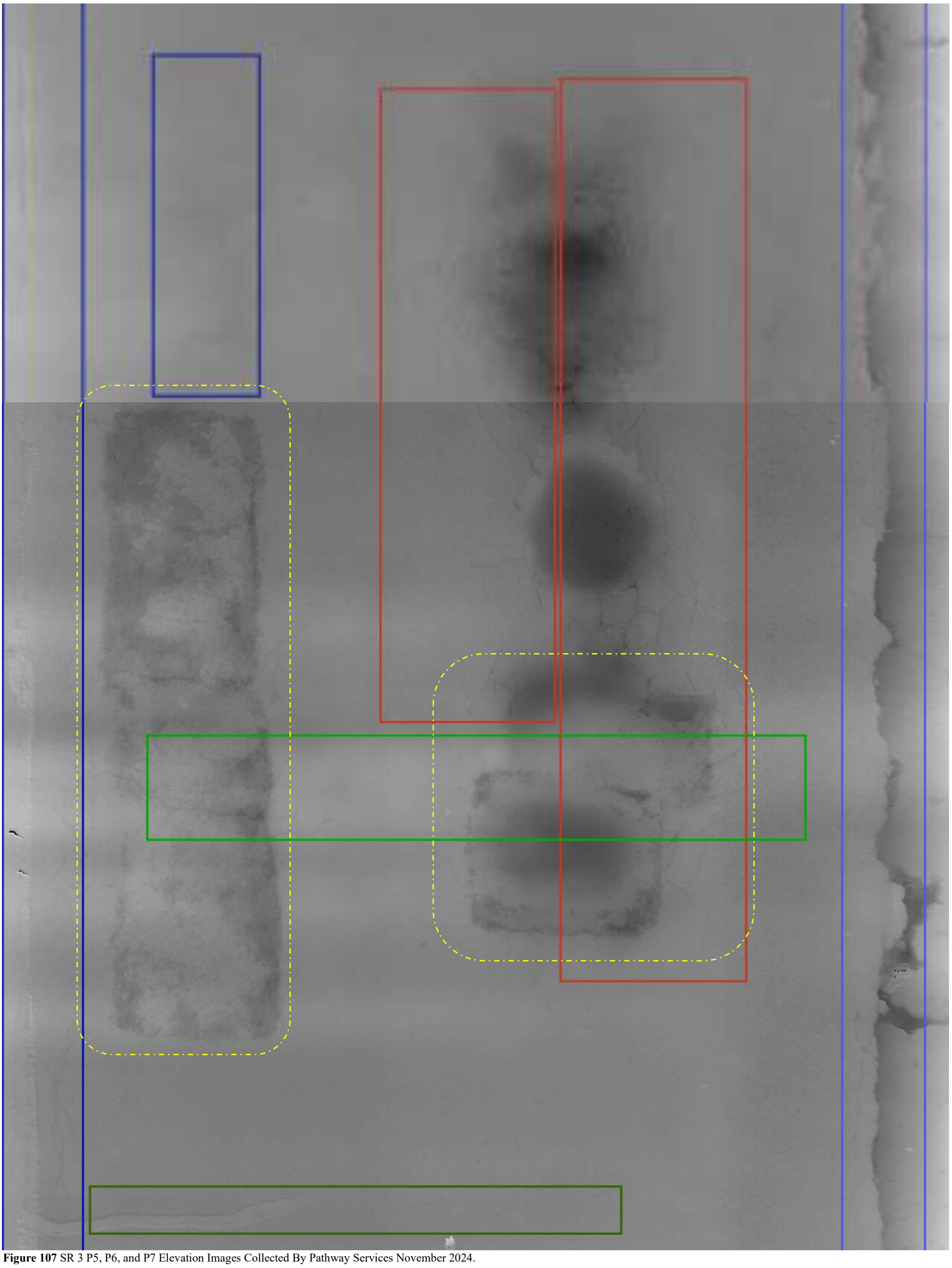


**Figure 107** SR 3 P5, P6, and P7 Elevation Images Collected By Pathway Services November 2024.

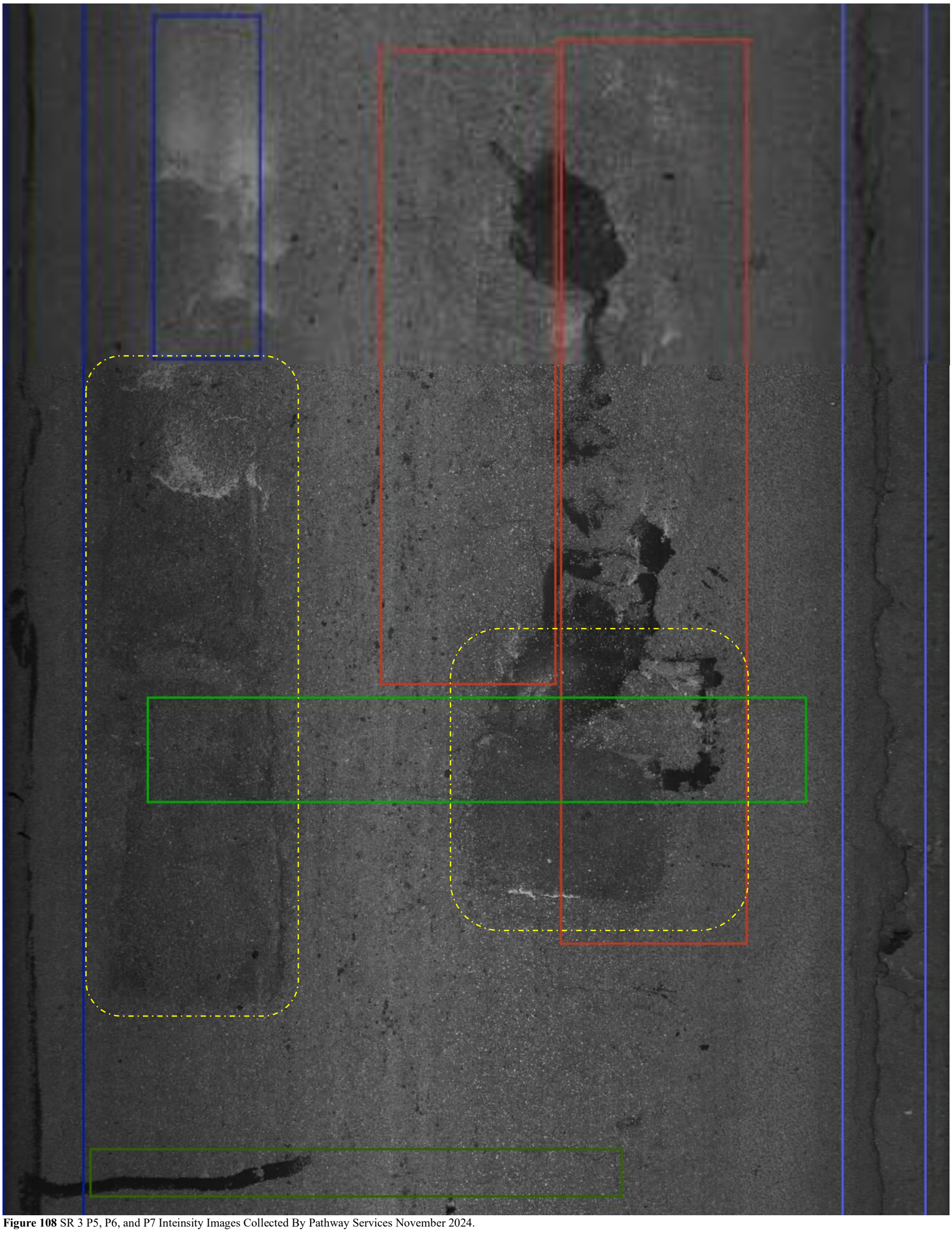


**Figure 108** SR 3 P5, P6, and P7 Inteinsity Images Collected By Pathway Services November 2024.




SR3SDP5x6x7:1 of 1: ROW Images: Top Left=October 2024, Top Right=April 2025

**Figure 109** SR 3 Patches 5, 6, and 7 ROW Images Collected by INDOT's Pavement Condition System. Left: October 2024; Right: April 2025.

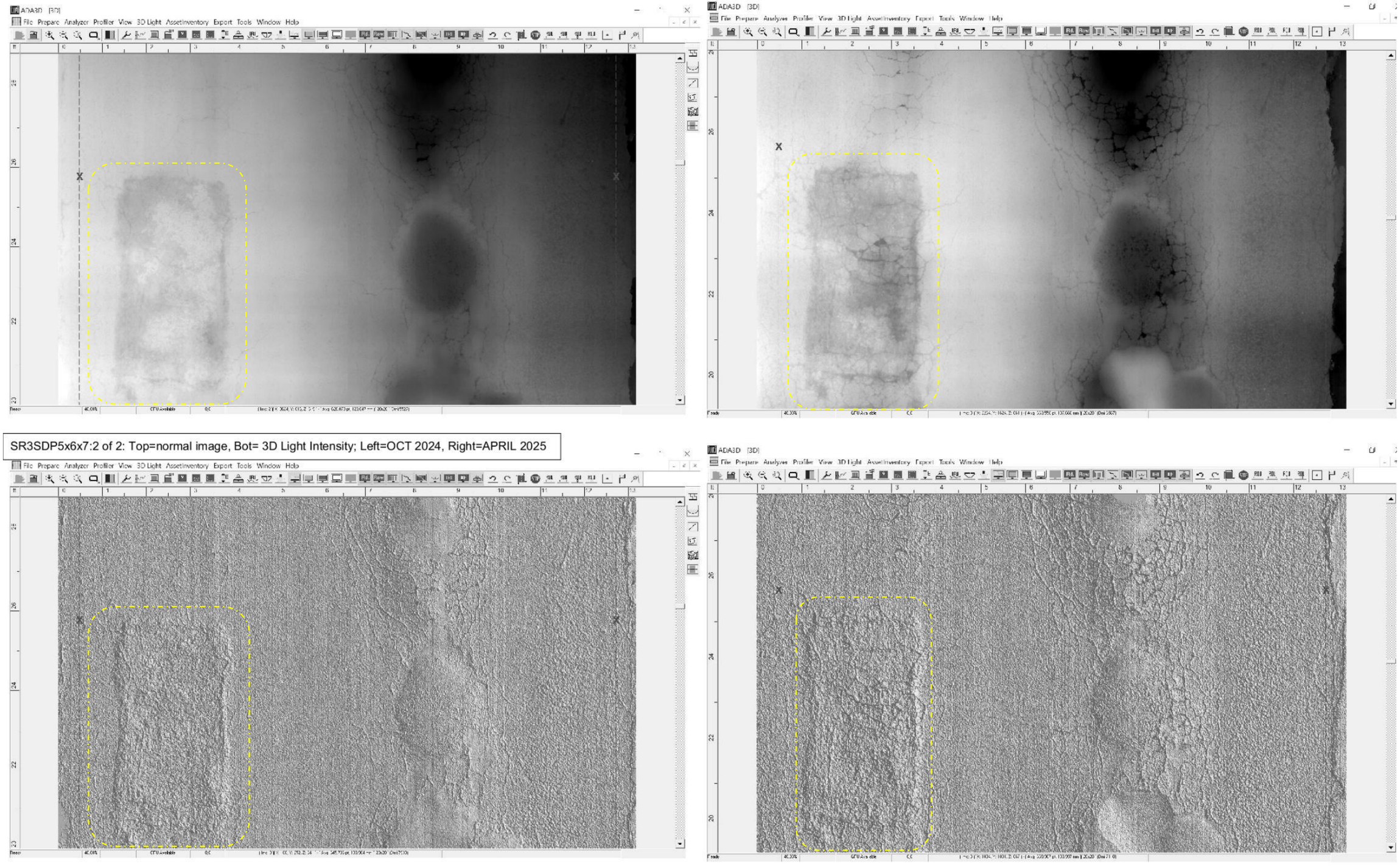



**Figure 110** SR 3 Patches 5, 6, and 7 Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: October 2024; Right: April 2025 Segment 1.

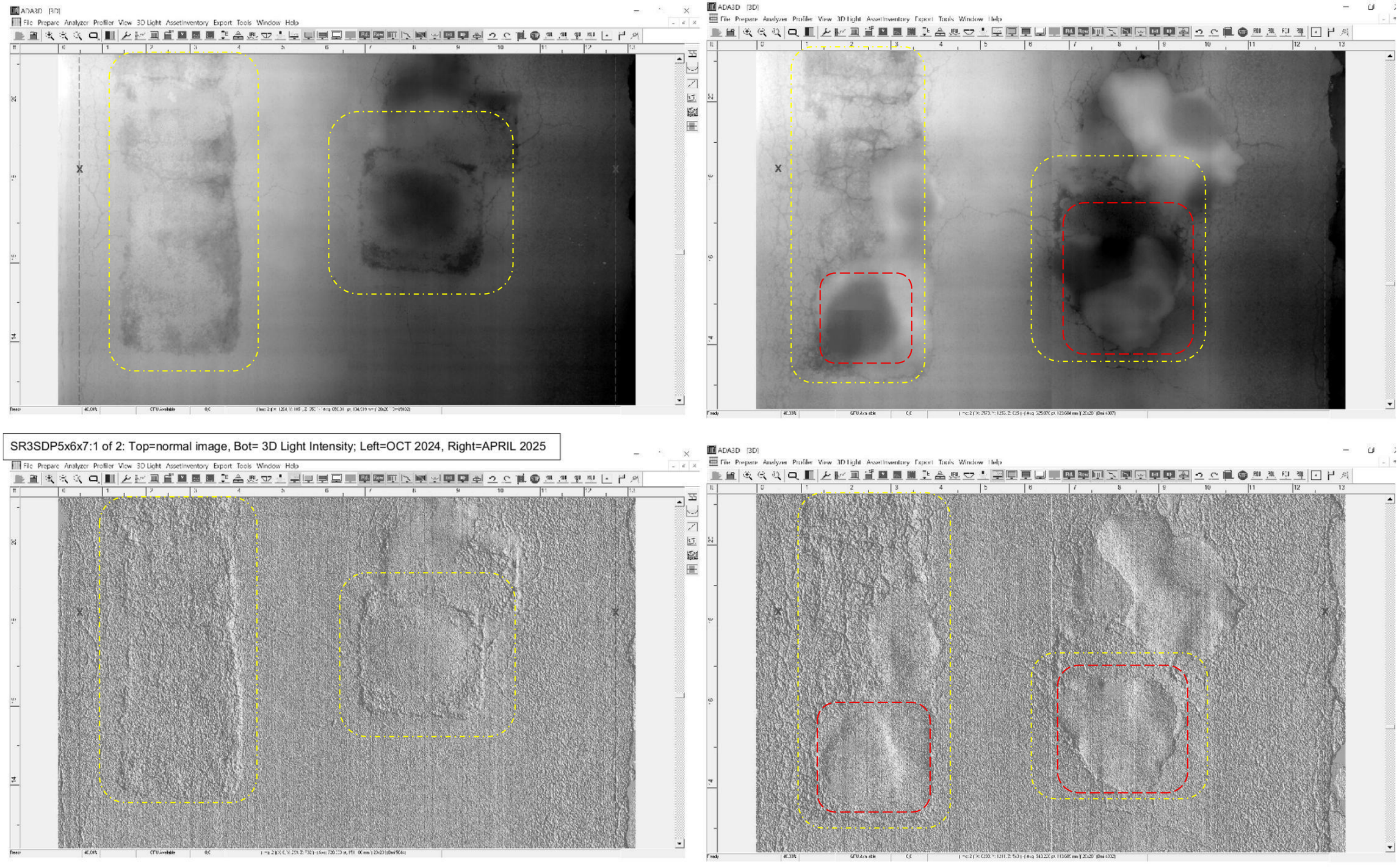



**Figure 111** SR 3 Patches 5, 6, and 7 Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: October 2024; Right: April 2025 Segment 2.




**Figure 112** SR 3 P1 and PP1 ROW Images Collected By Pathway Services. Top: November 2023; Bottom: November 2024.

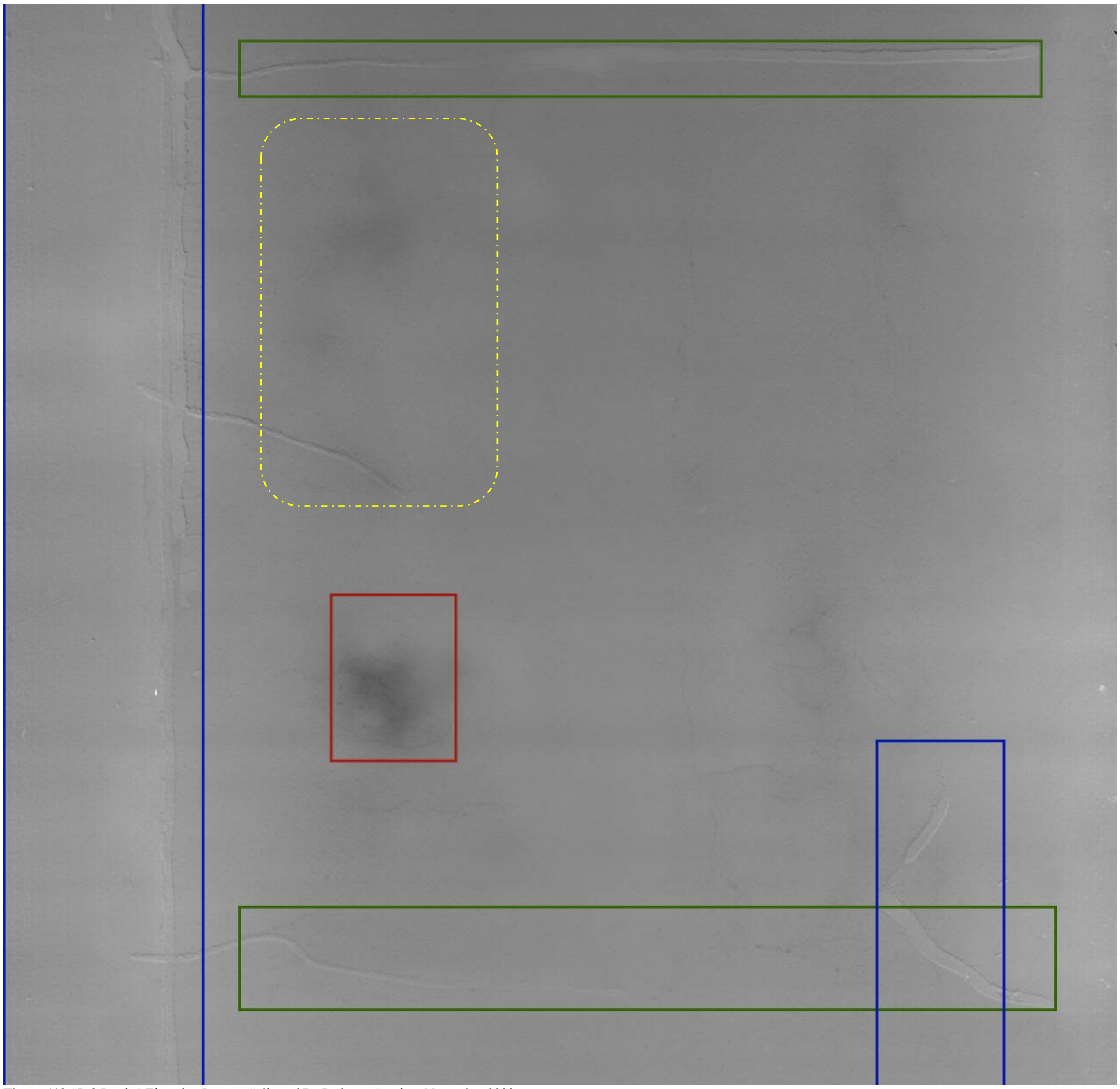


**Figure 113** SR 3 Patch 1 Elevation Images Collected By Pathway Services November 2023.

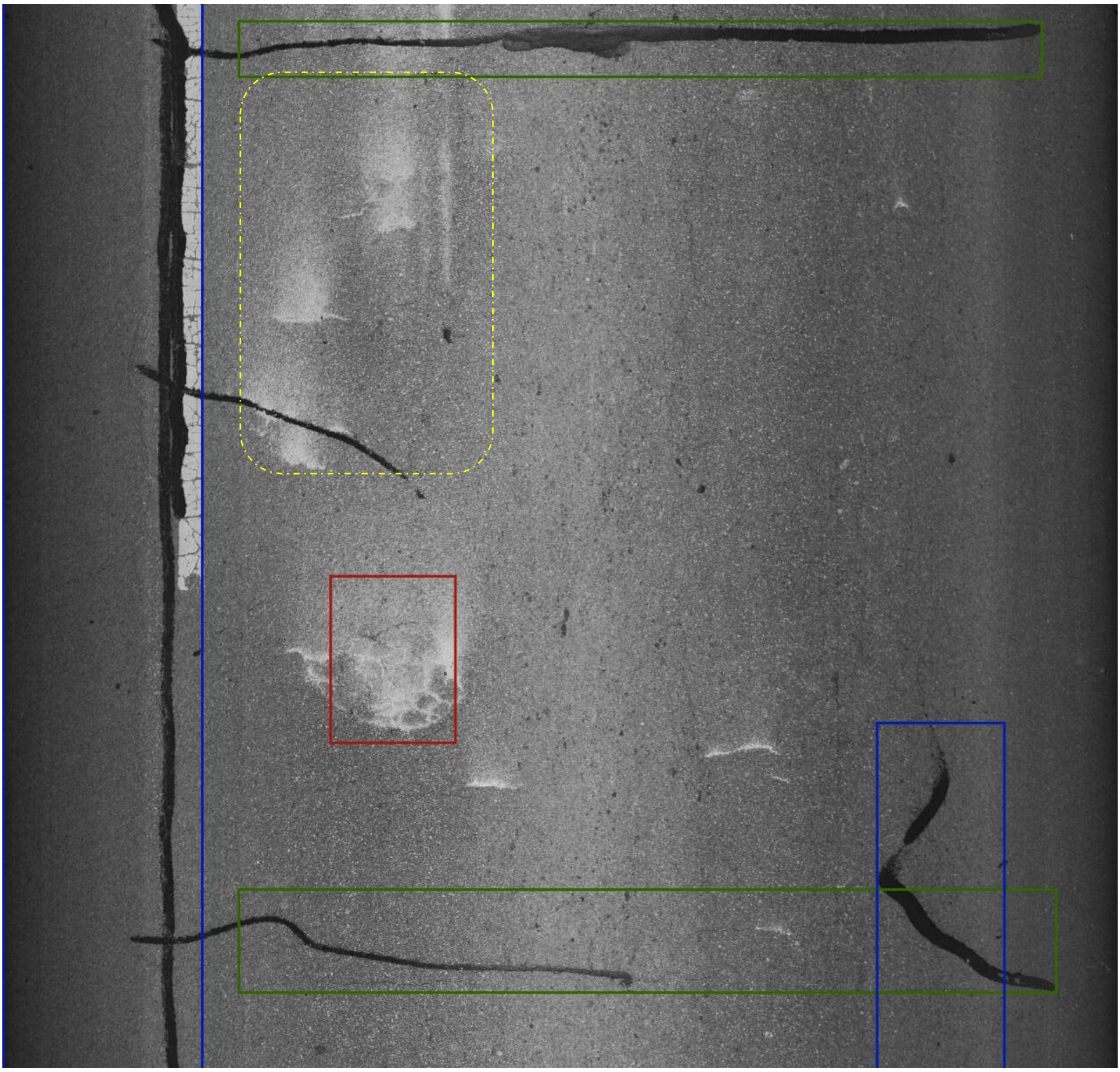


**Figure 114** SR 3 Patch 1 Intensity Images Collected By Pathway Services November 2023.

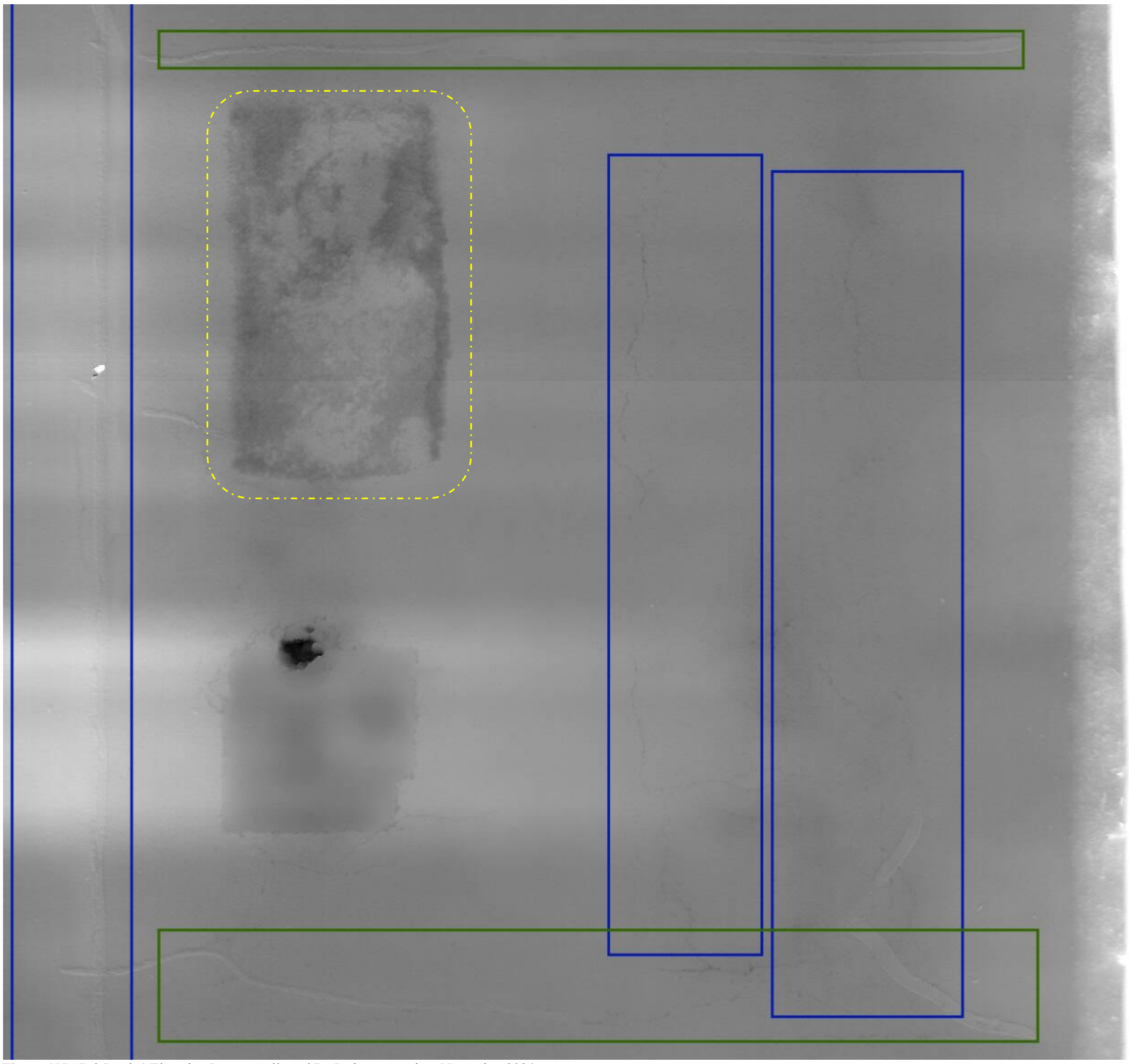


**Figure 115** SR 3 Patch 1 Elevation Images Collected By Pathway Services November 2024.

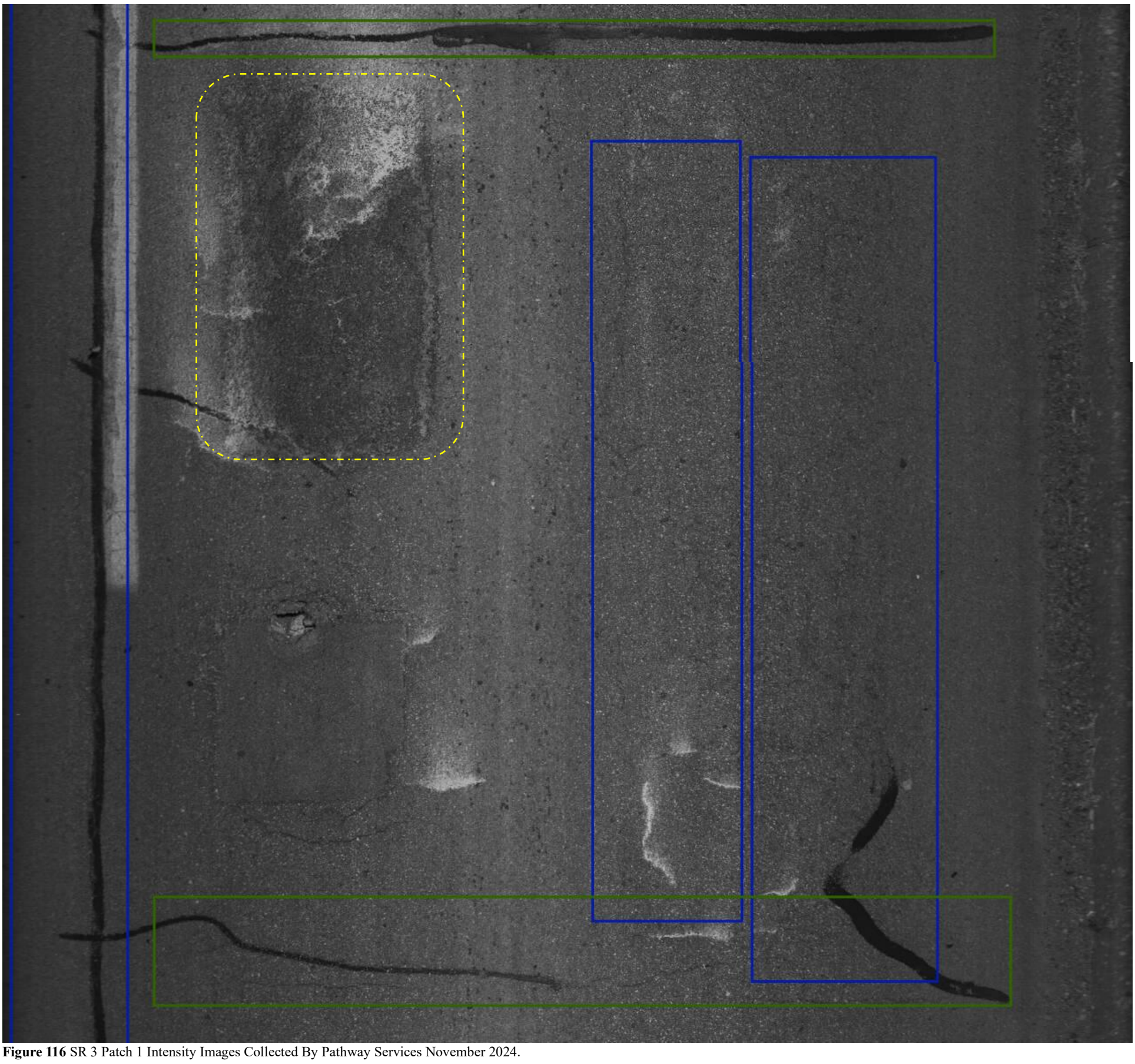


**Figure 116** SR 3 Patch 1 Intensity Images Collected By Pathway Services November 2024.




SR3SDP1:1 of 1: ROW Images: Top Left=October 2024, Top Right=April 2025

**Figure 117** SR 3 Patch 1 ROW Images Collected by INDOT's Pavement Condition System. Left: October 2024; Right: April 2025, Path 1 and Passing Patch 1 Are in the Yellow Boxes.

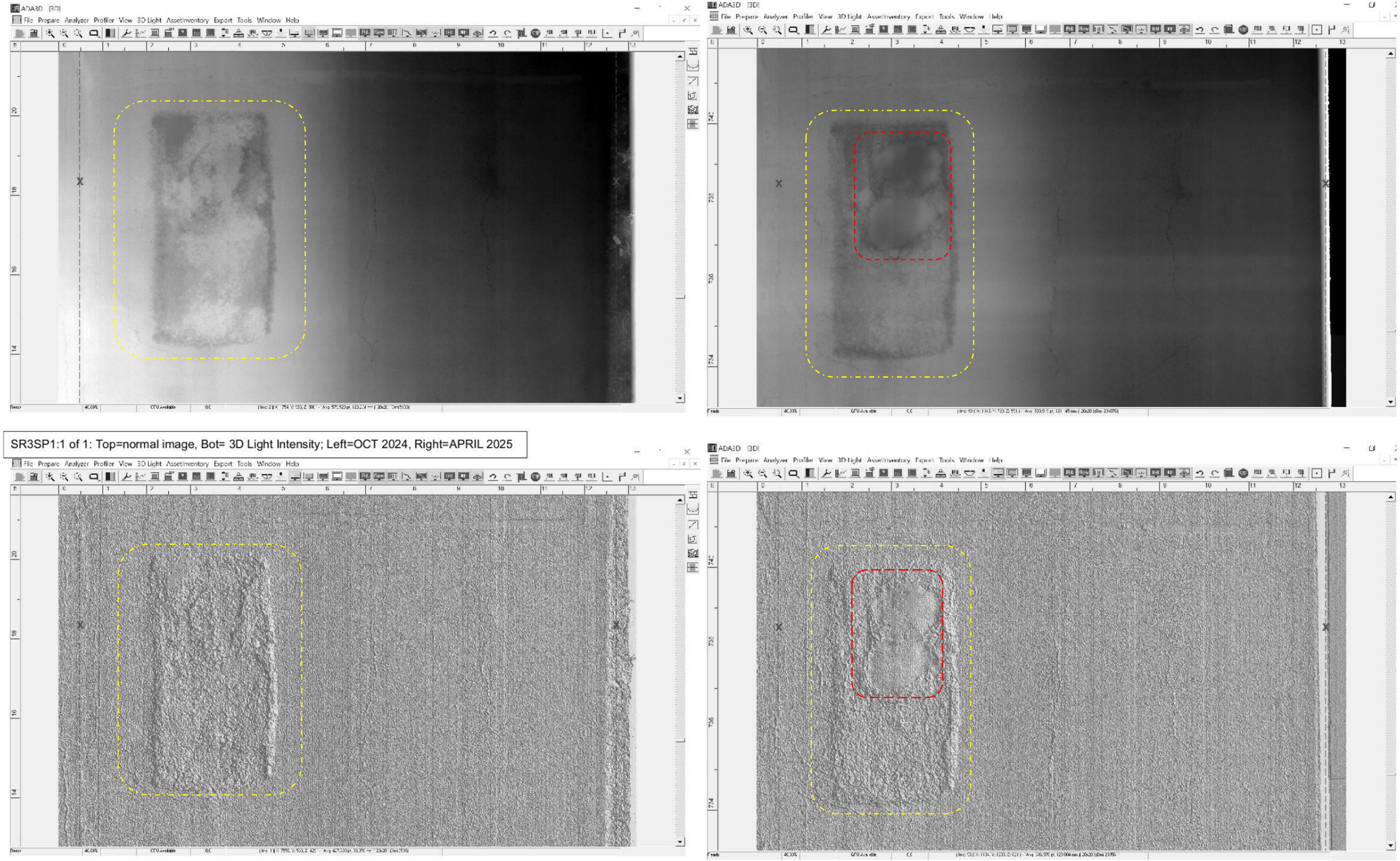



**Figure 118** SR 3 Patch 1 Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: October 2024; Right: April 2025.

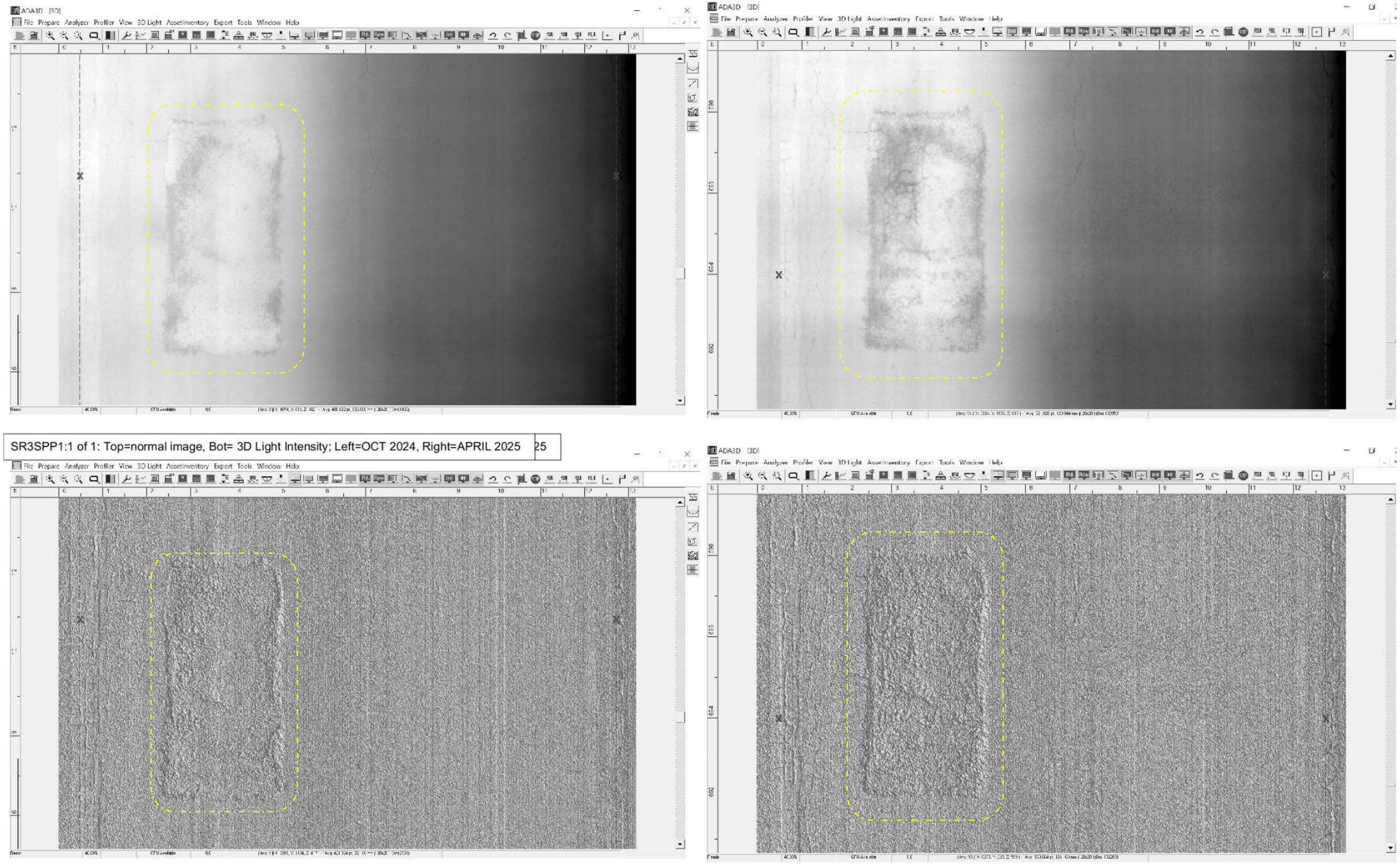



**Figure 119** SR 3 Passing Patch 1 Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: October 2024; Right: April 2025.

**SR 25 Case Study: Severe Fatigue Cracking and Patch Deterioration Figures**

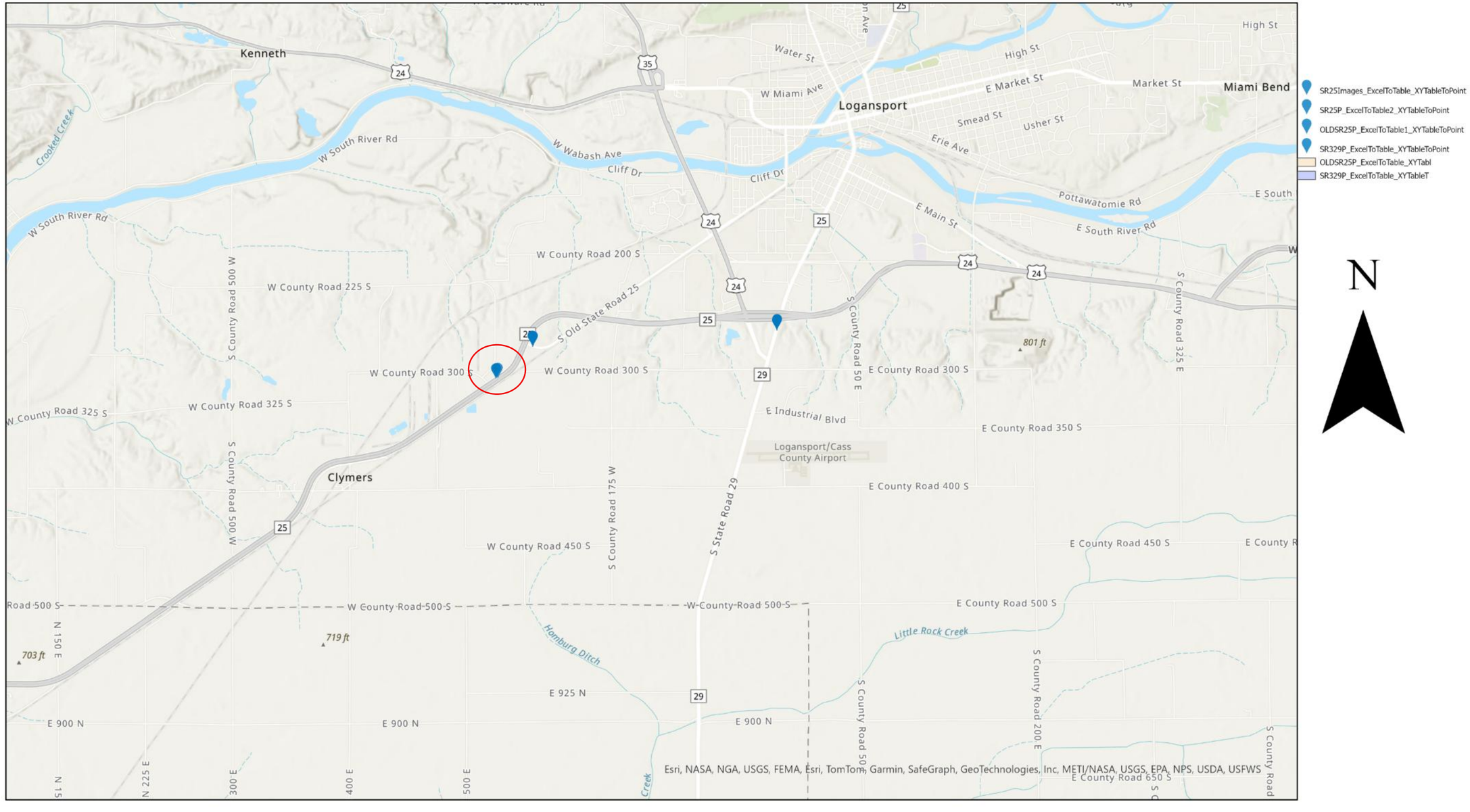



**Figure 120** SR 25 Patch Location.

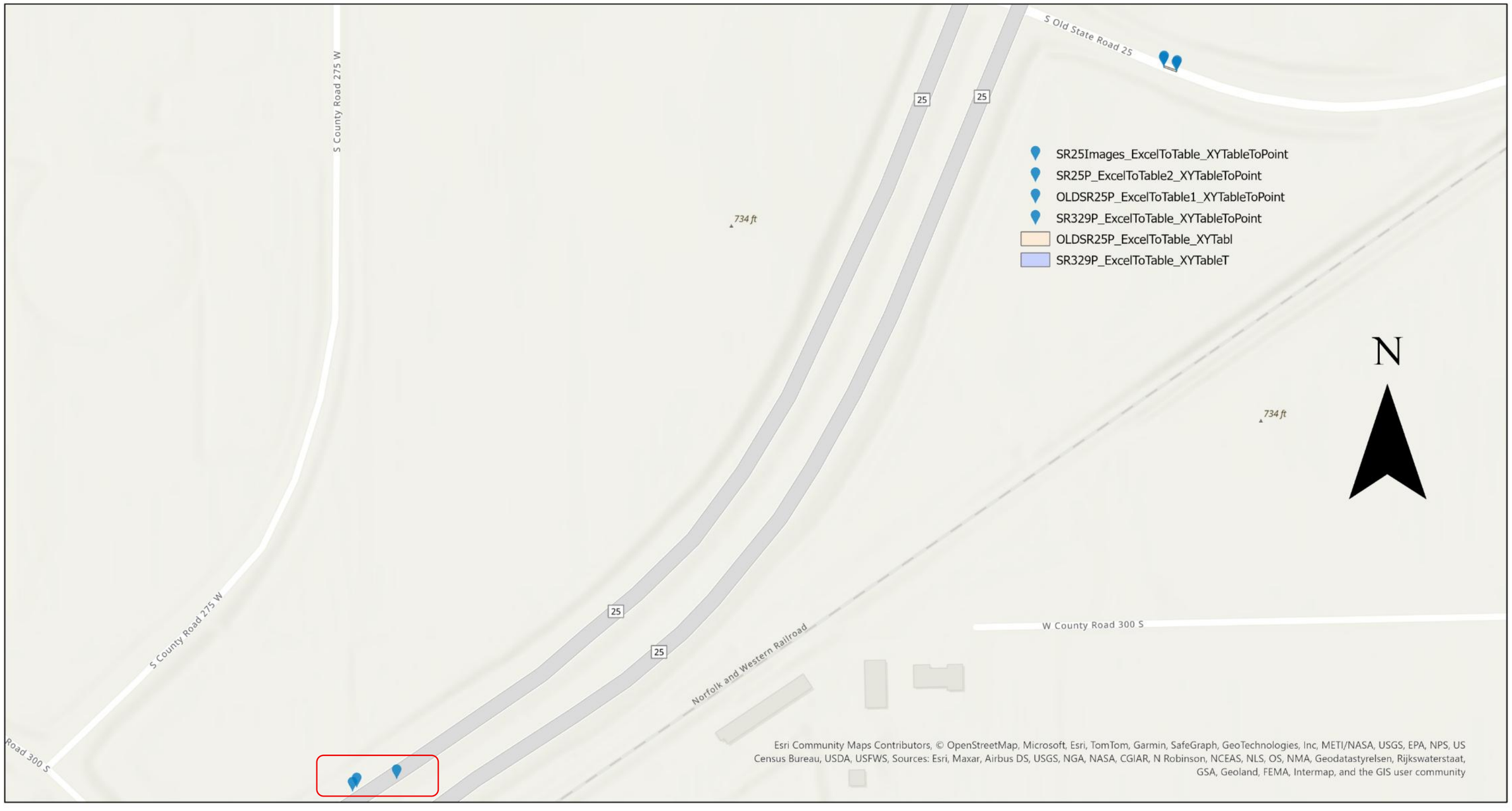



**Figure 121** SR 25 Patch Location Zoomed.



**Figure 122** SR 25 Patch ROW Images Collected by Pathway Services. Top: August 2022; Bottom: September 2023.

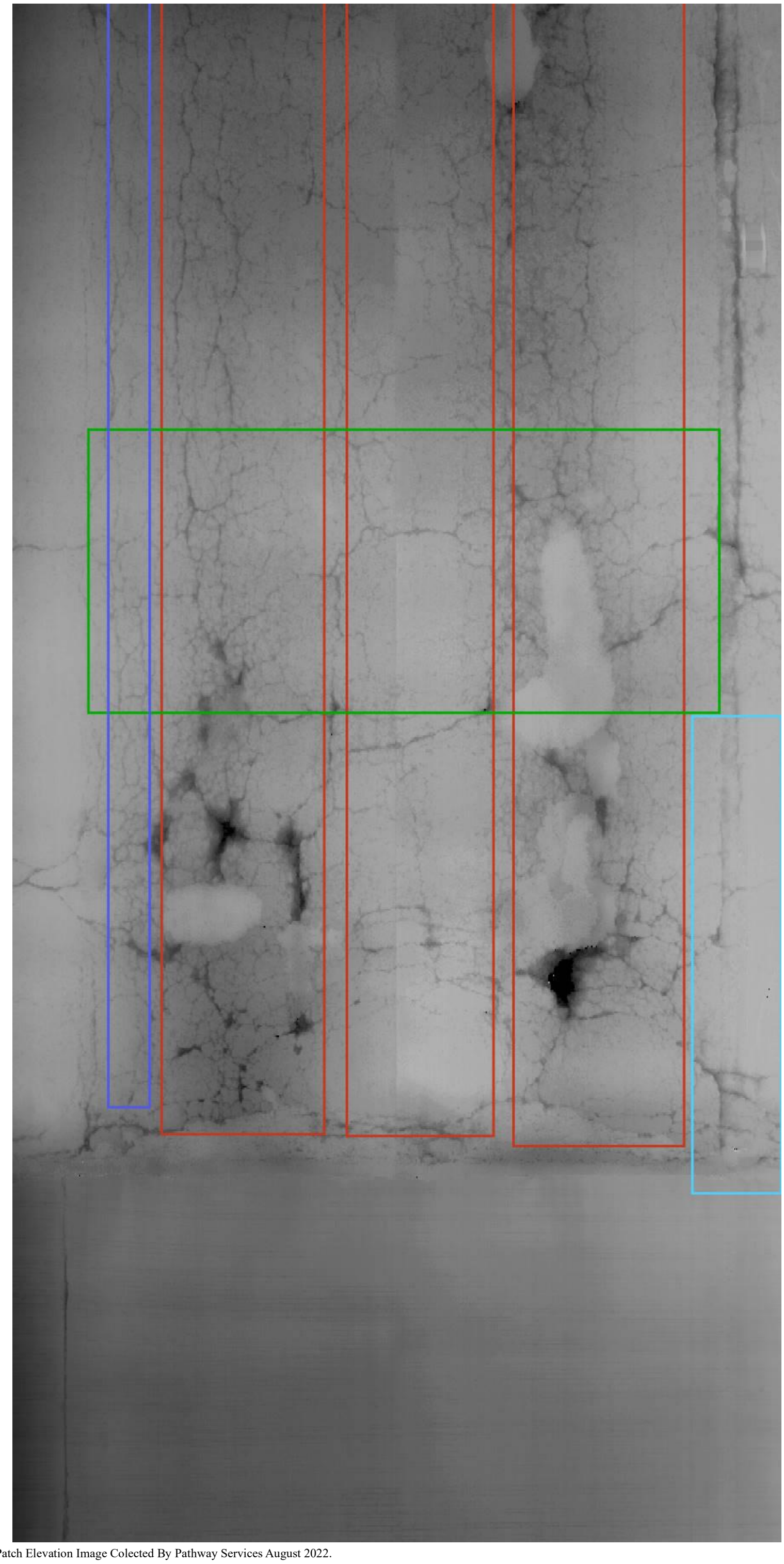


**Figure 123** SR 25 Patch Elevation Image Colected By Pathway Services August 2022.

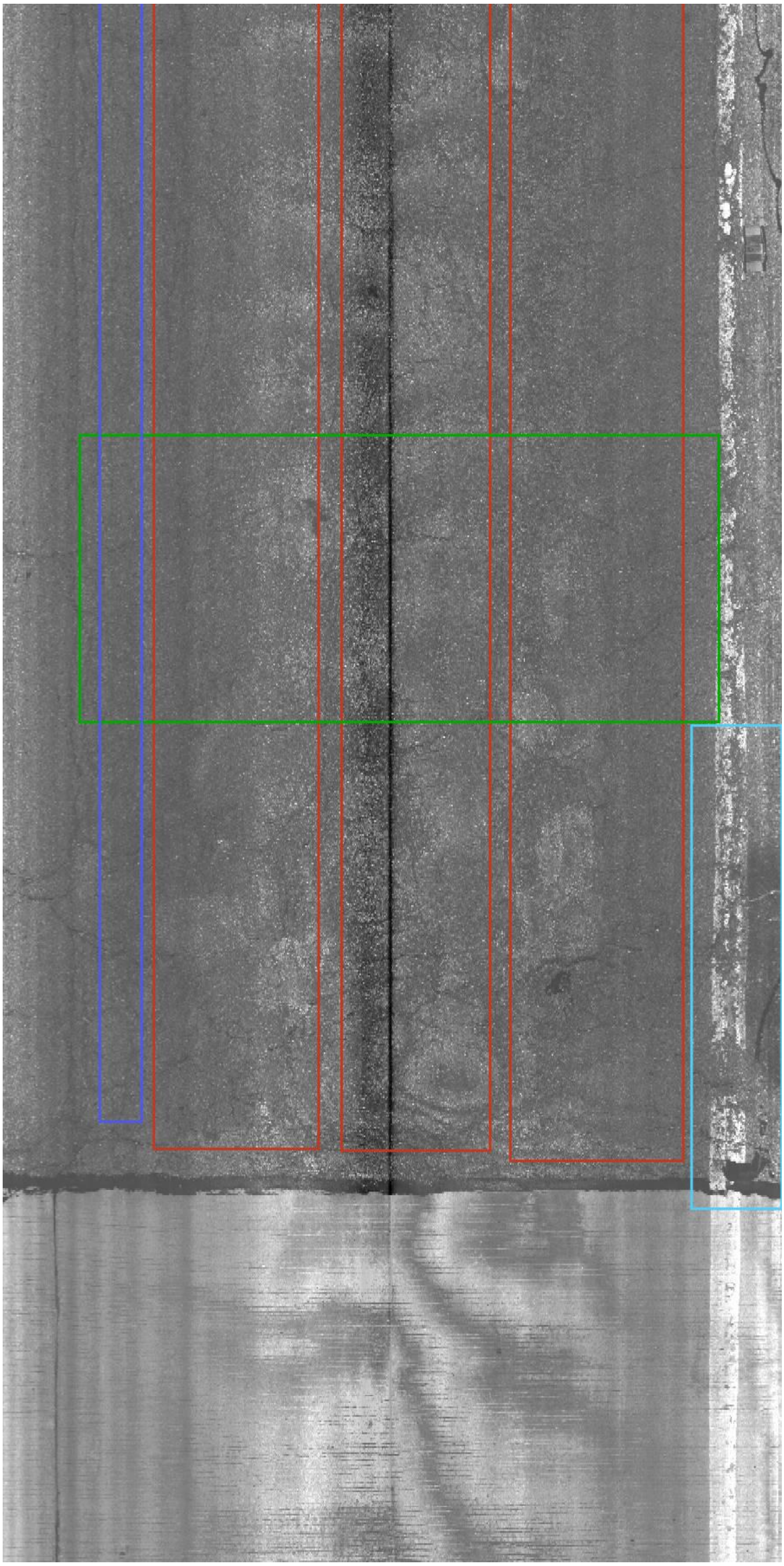


**Figure 124** SR 25 Patch Intensity Image Collected By Pathway Services August 2022.

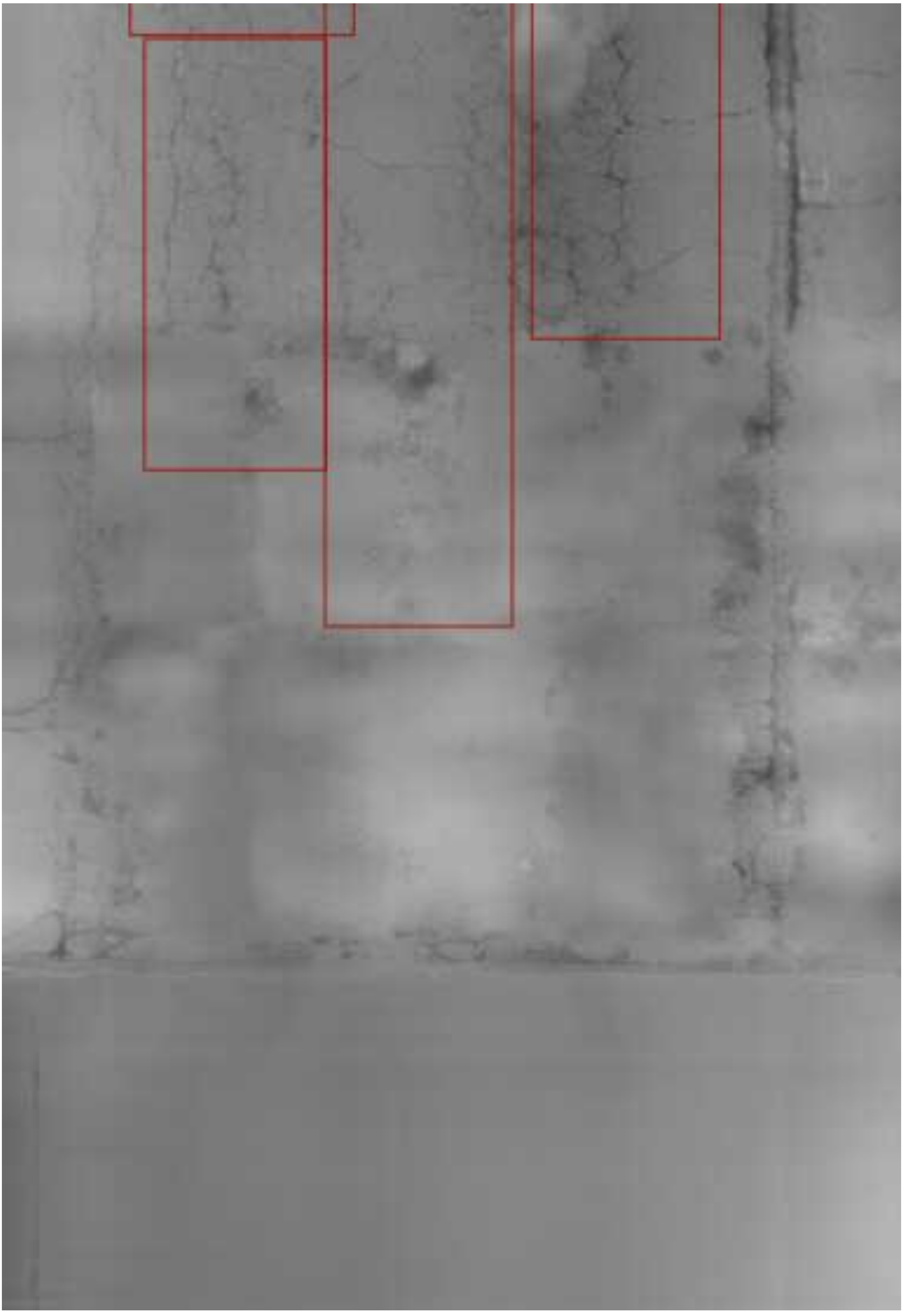


**Figure 125** SR 25 Patch Elevation Image Collected By Pathway Services September 2023.

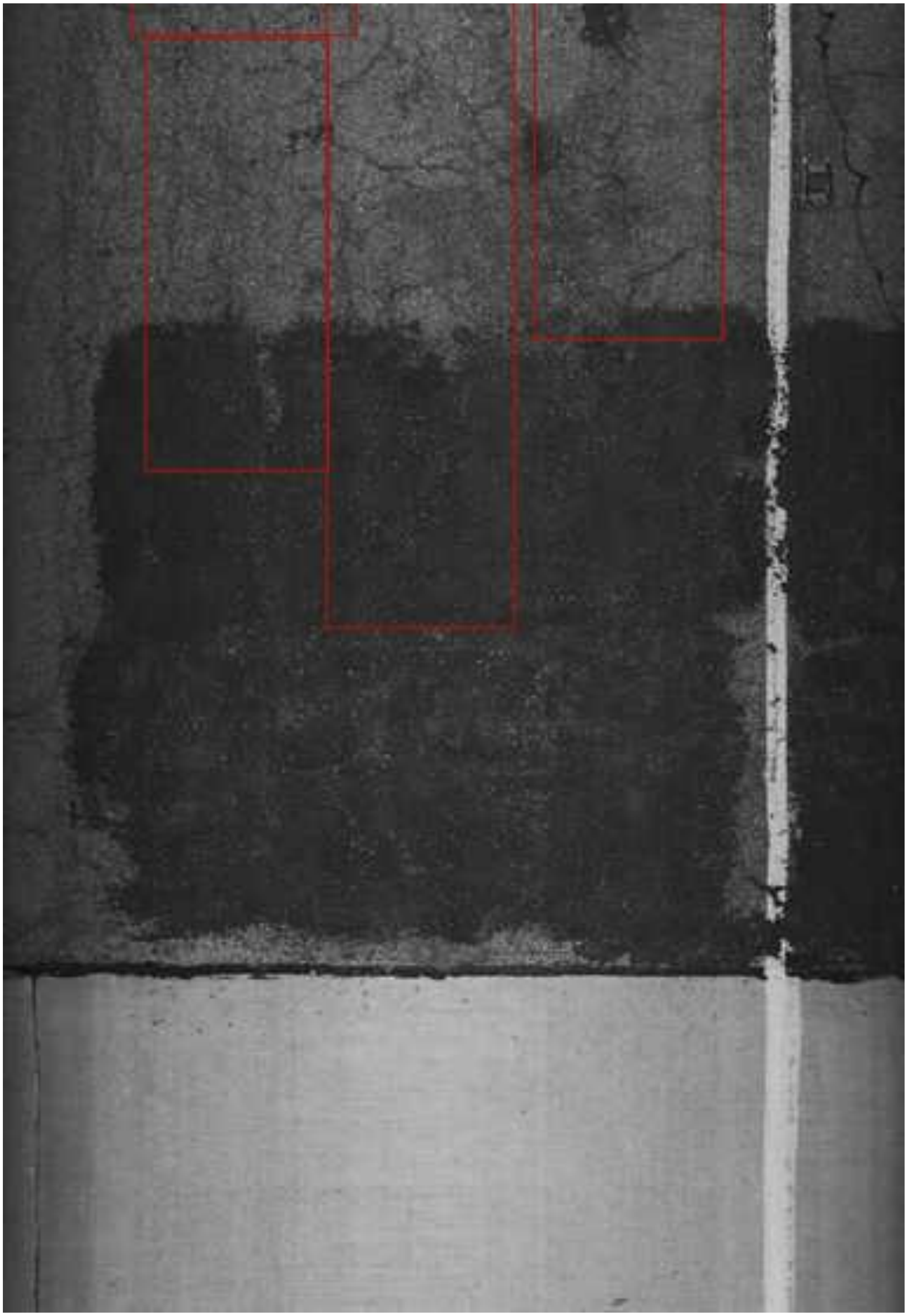


**Figure 126** SR 25 Patch Intensity Image Collected By Pathway Services September 2023.

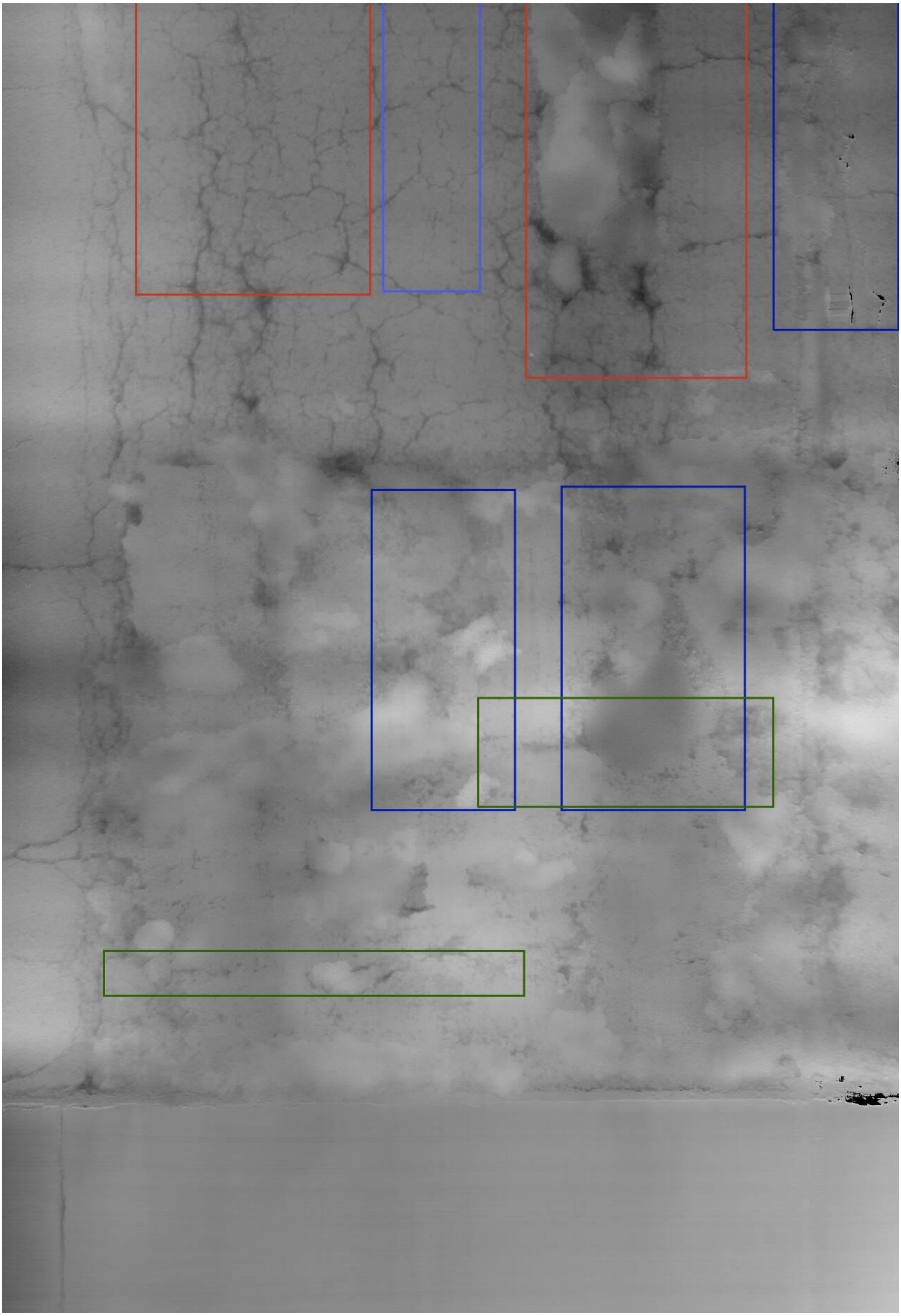


**Figure 127** SR 25 Patch Elevation Image Collected By Pathway Services October 2024.



**Figure 128** SR 25 Patch Elevation Image Collected By Pathway Services October 2024.



**Figure 129** SR 25 Patch Images Collected When Patch Was Done.




**Figure 130** SR 25 Patch ROW Images Collected by INDOT's Pavement Condition System.

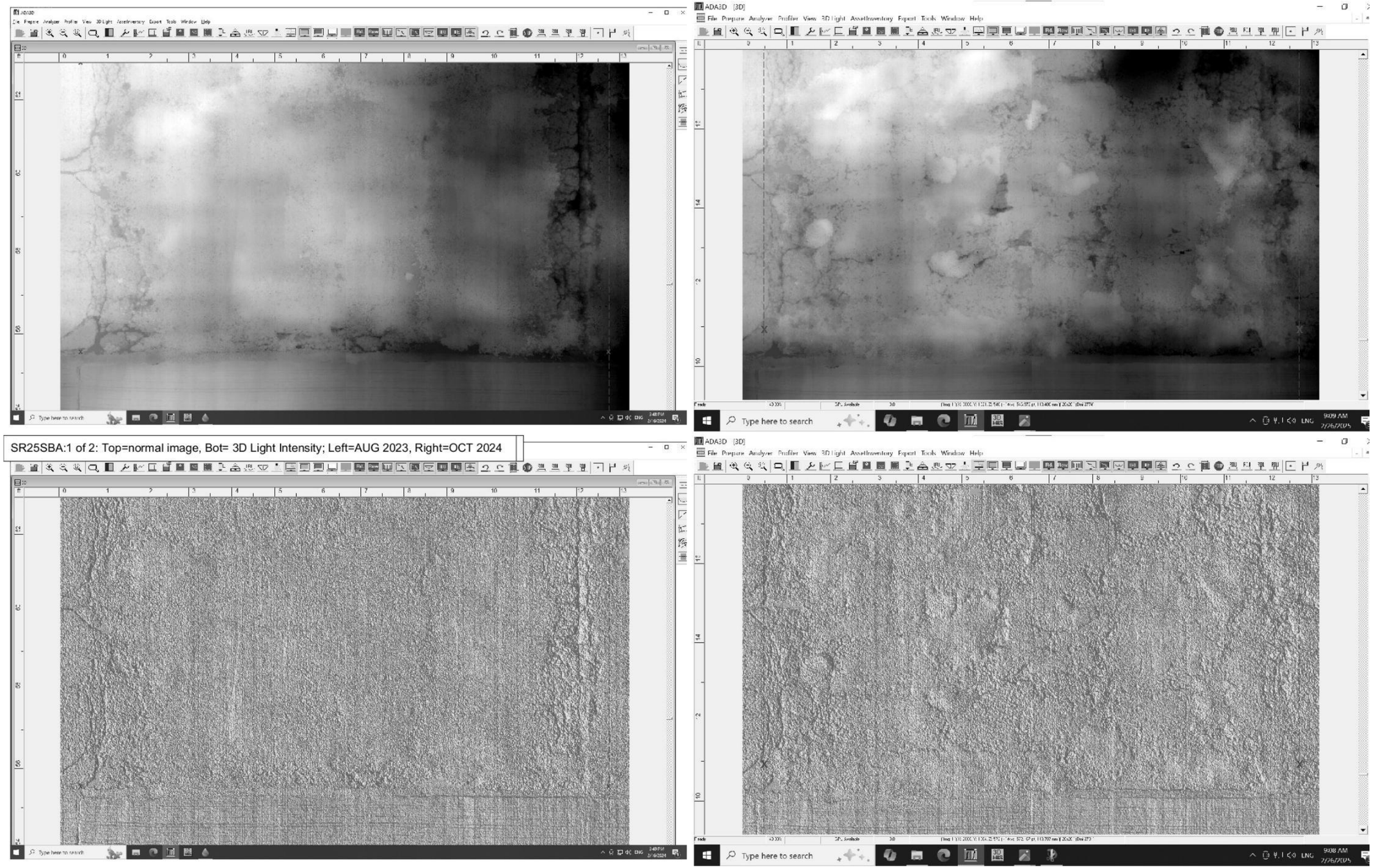



**Figure 131** SR 25 Patch Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: August 2023; Right: October 2024.

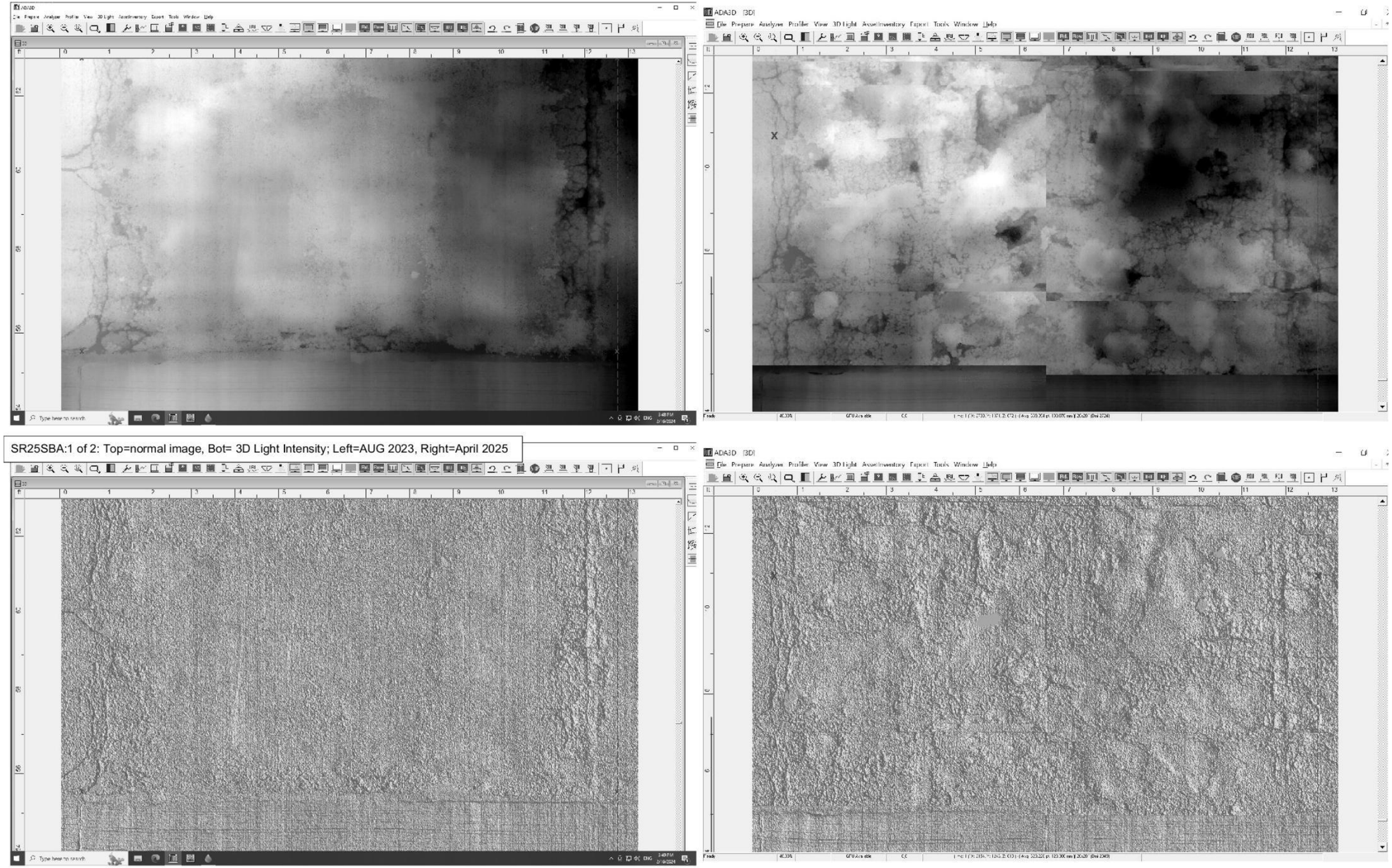



**Figure 132** SR 25 Patch Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: August 2023; Right: April 2025.

**SR 16 Pipe Patch Case Study Figures**




**Figure 133** SR 16 Pipe Patch Location.



**Figure 134** SR 16 Pipe Patch ROW Images Collected By Pathway Servies. Left: Eastbound; Right: Westbound; Top: July 2022; Bottom: August 2023.

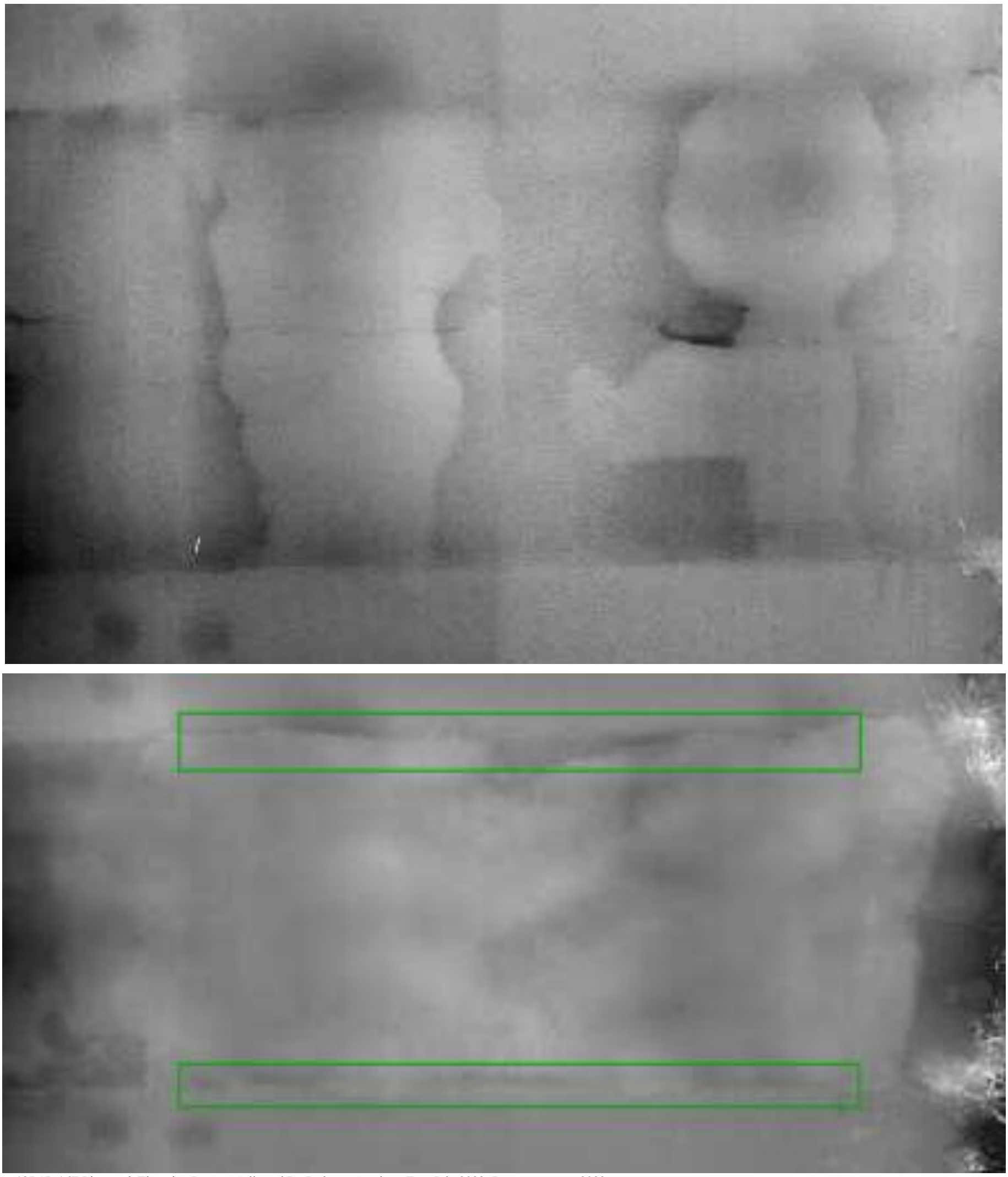


**Figure 135** SR 16E Pipepatch Elevation Images Collected By Pathway Services. Top: July 2022; Bottom: August 2023.

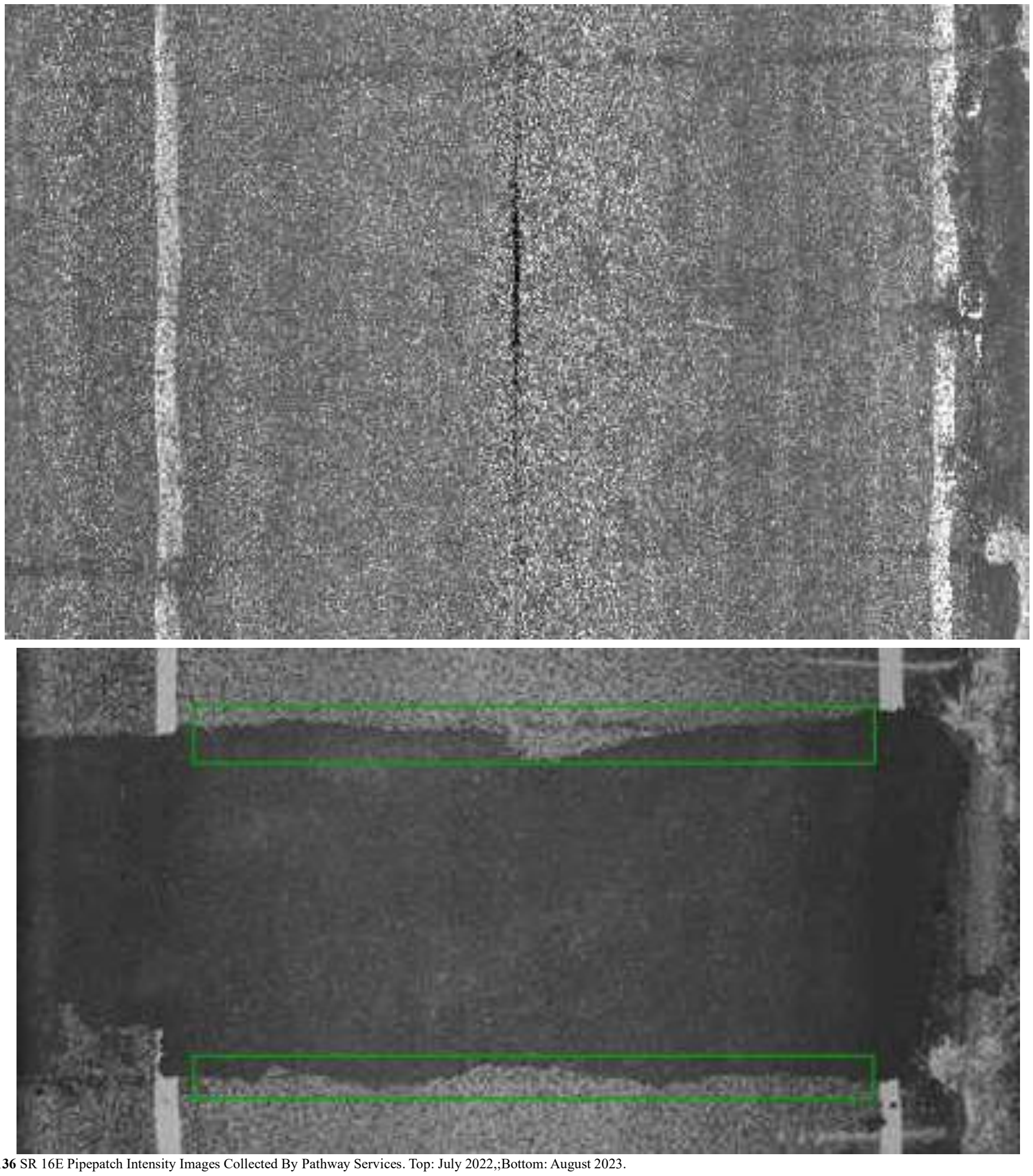


**Figure 136** SR 16E Pipepatch Intensity Images Collected By Pathway Services. Top: July 2022,;Bottom: August 2023.




**Figure 137** SR 16E ROW Images Collected by INDOT's Pavement Condition System.

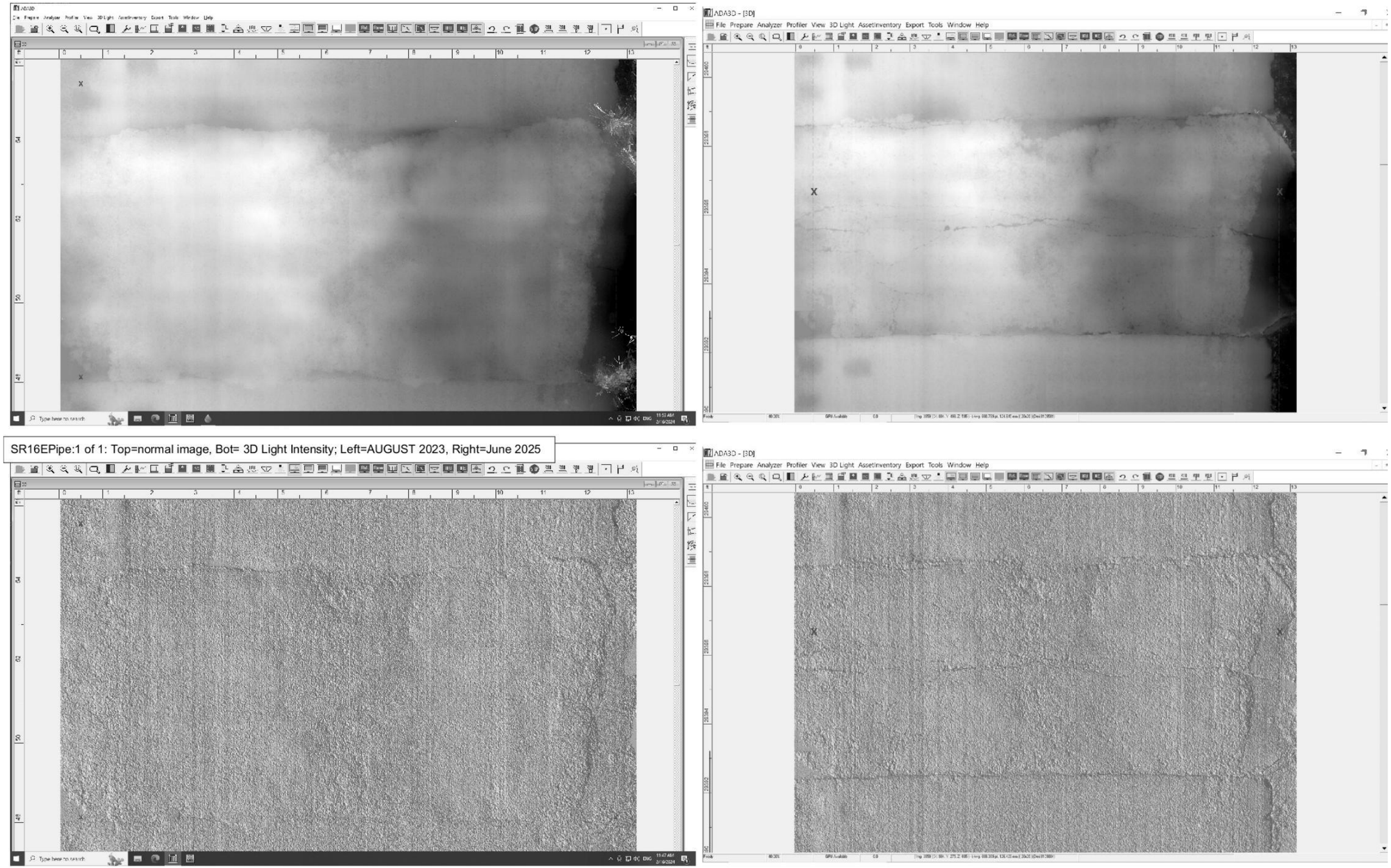



**Figure 138** SR 16E Pipe Patch Pavement Condition System Image Comparison. Top: Elevation (Normal Image); Bottom: 3D Light Intensity; Left: August 2023; Right: June 2025.

**I-65 Case Study Figures**

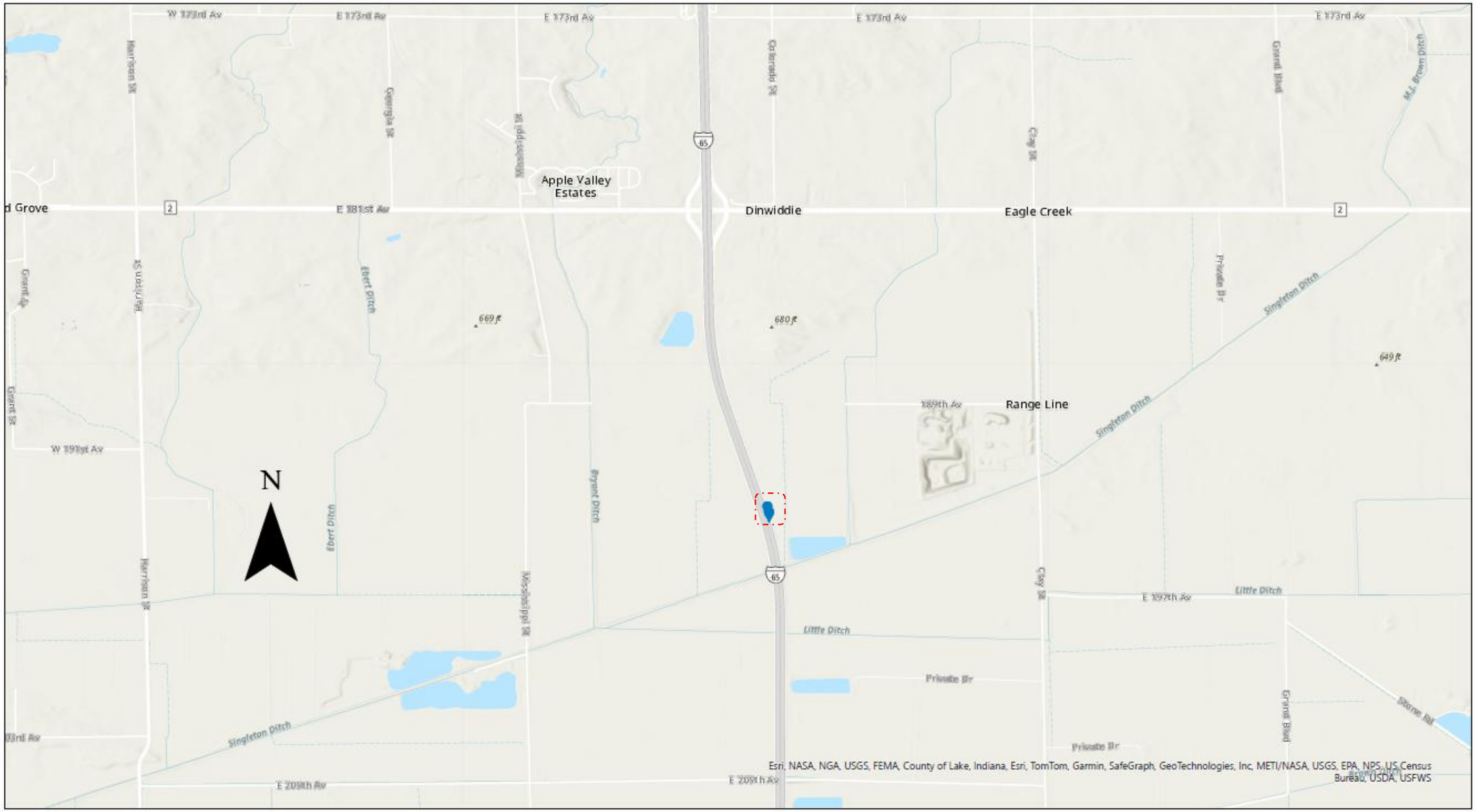



**Figure 139** I-65 Patch Locations.

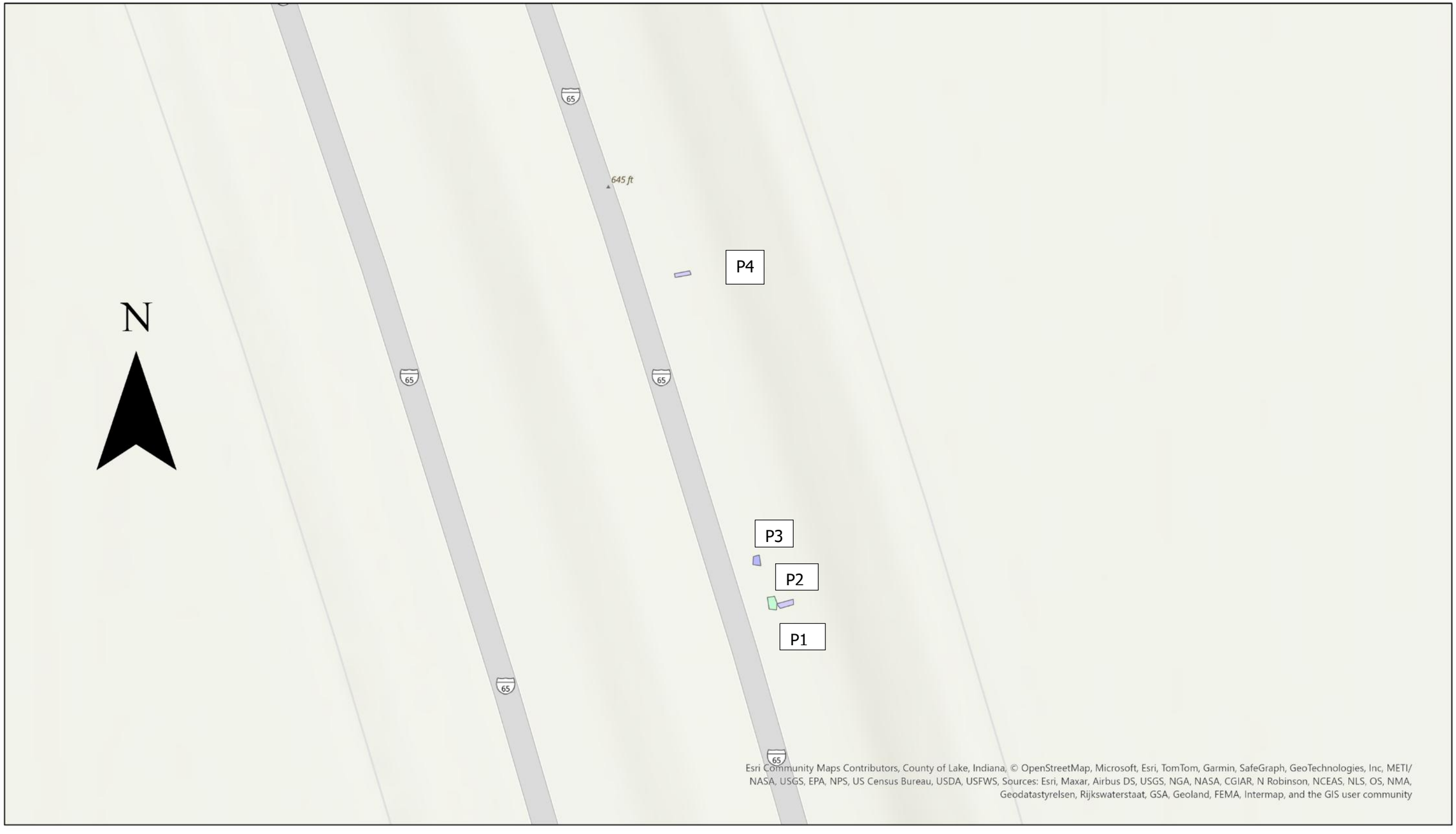



**Figure 140** I-65 Patch Location Zoomed.

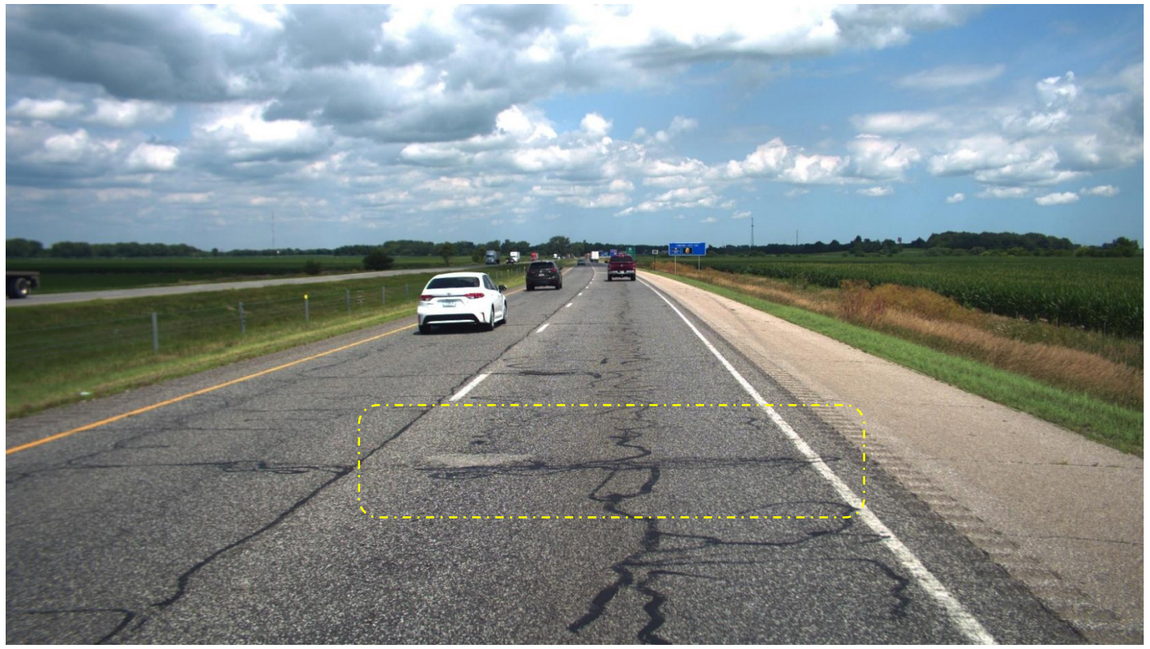





I65Example:1 of 1: ROW Images: Top Left=July 2023, Top Right=February 2024, Bottom Right=October 2024



**Figure 141** I-65 Pavement Performance Example North of Patches ROW Images Collected With INDOT's Inertial Profiler and Pavement Condition System.





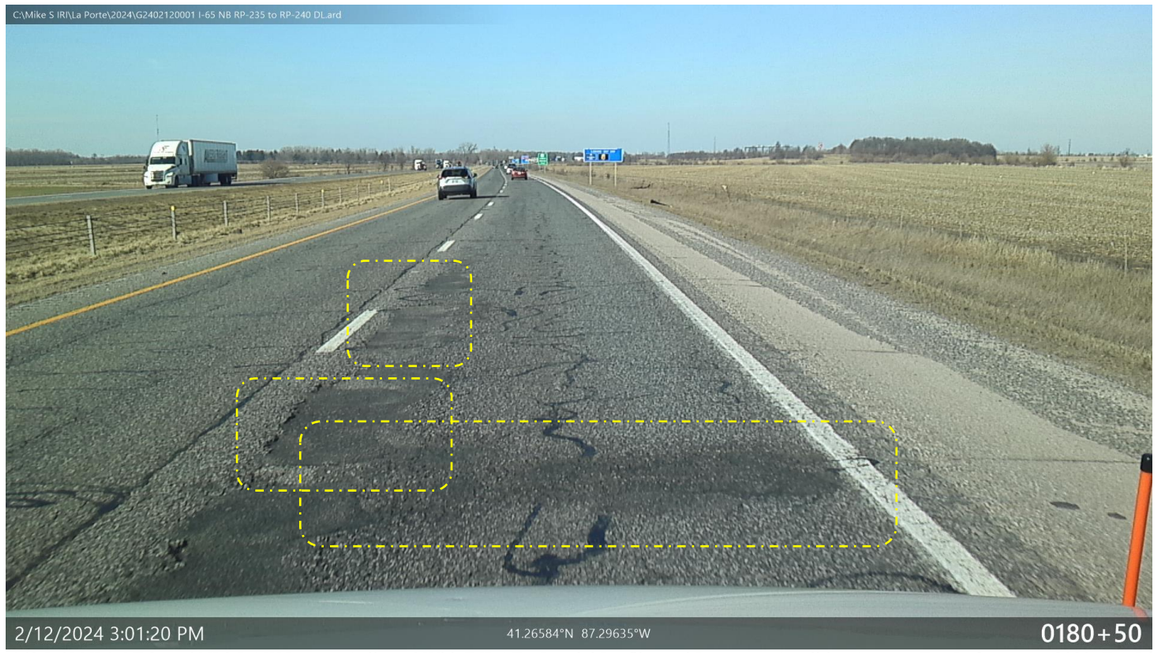





**Figure 142** I-65 NP1, NP2, and NP3 ROW Images Collected With INDOT's Inertial Profiler and Pavement Condition System. Top Left: August 2023; Top Right and Bottom Left: February 2024; Bottom Right: October 2024.



**Figure 143** I-65 NP1 and NP2 Images Collected During Patching Process January 2024.

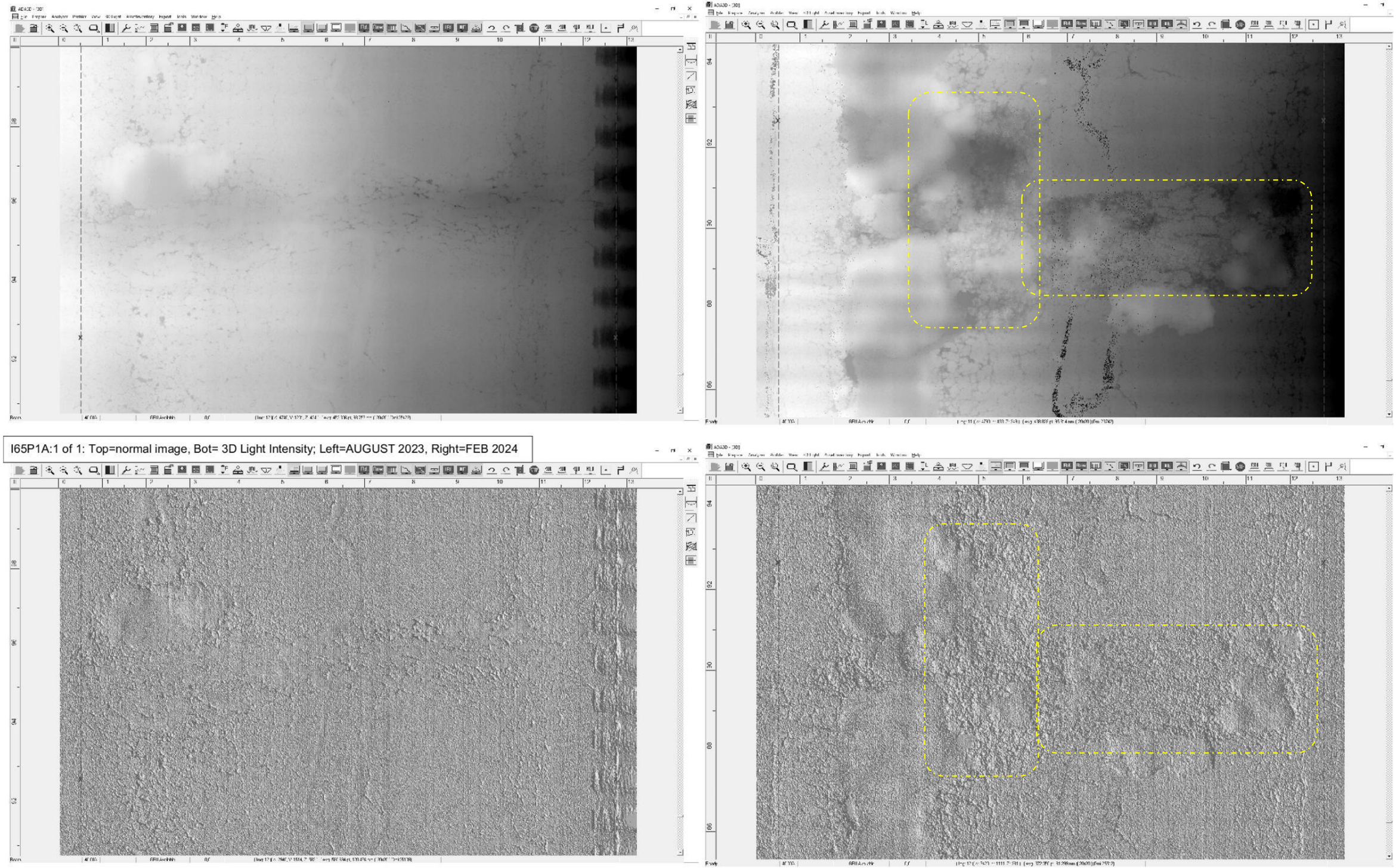



**Figure 144** I-65 NP1 and NP2 INDOT Pavement Condition System Normal (Elevation) and Intesity Image Comparison. Left: Before Patch August 2023; Right: February 2024.

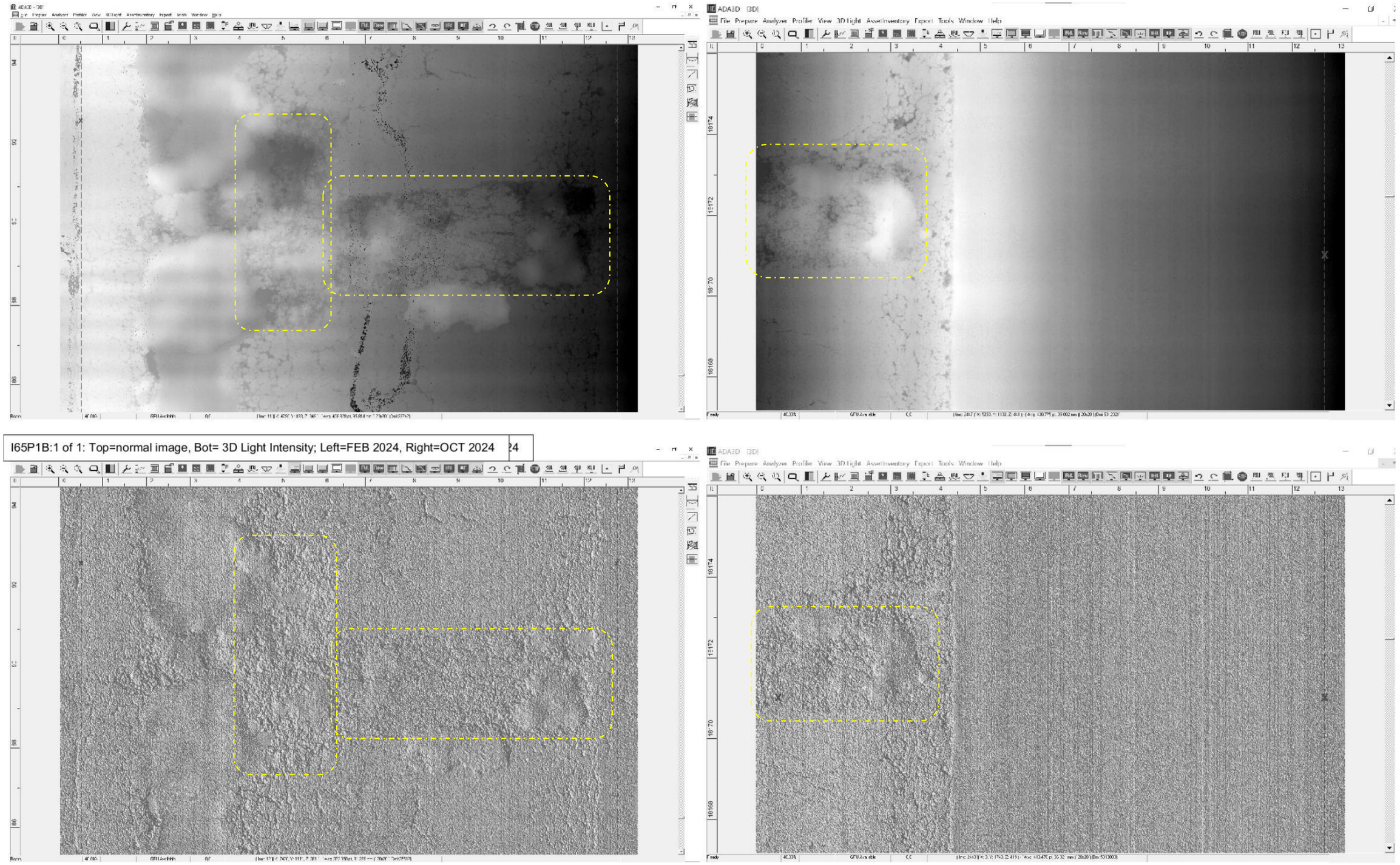



**Figure 145** I-65 NP1 and NP2 INDOT Pavement Condition System Normal (Elevation) and Intesity Image Comparison. Left: February 2024; Right:  October 2024.



**Figure 146** I-65 NP3image Taken With Patching January 2024.

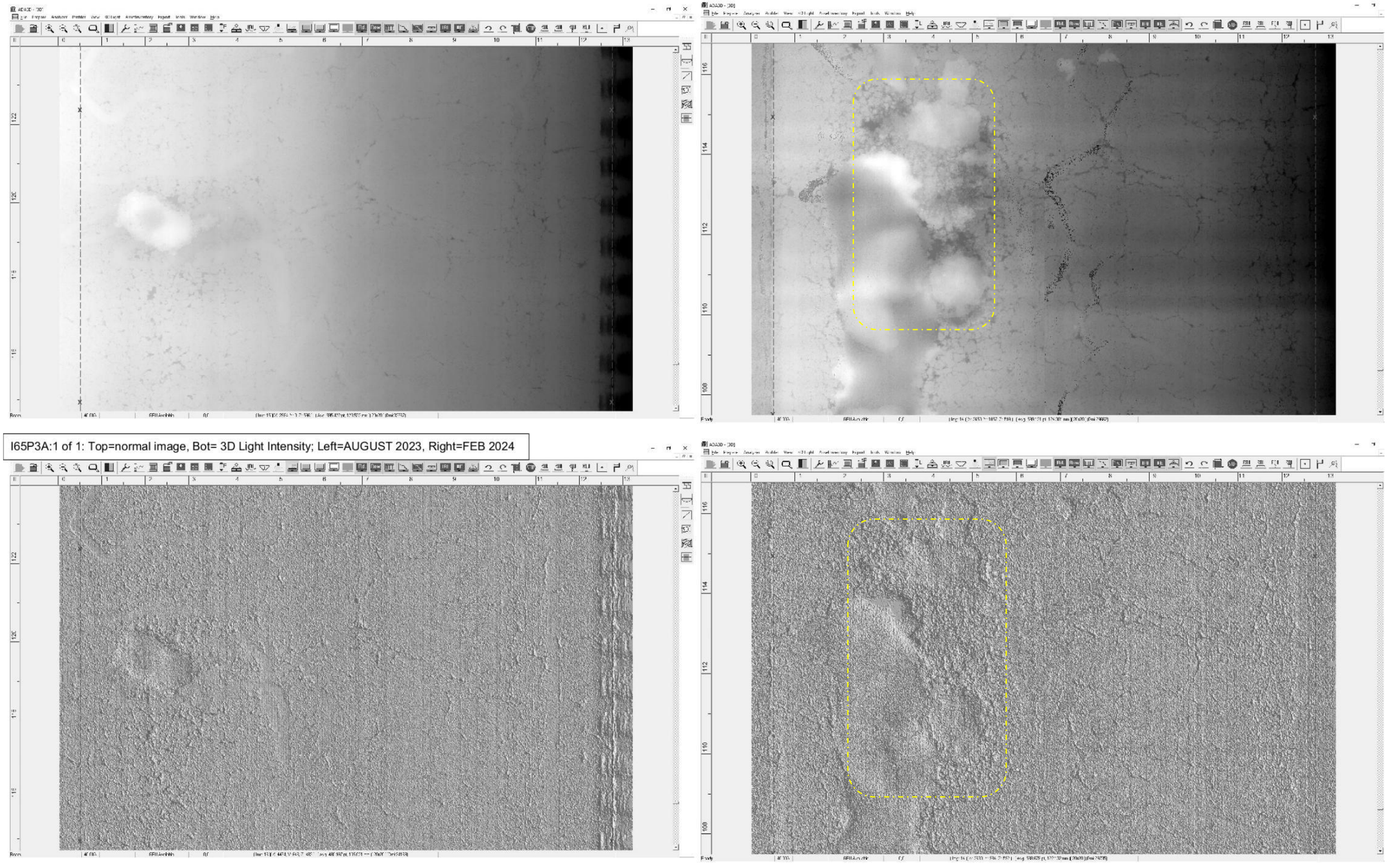



**Figure 147** I-65 NP3 INDOT Pavement Condition System Normal (Elevation) and Intesity Image Comparison. Left: Before Patch August 2023; Right: February 2024.




**Figure 148** I-65 NP4 ROW Images. Top Left: Before Patch August 2023; Top Right and Bottom Right: February 2024; Bottom Left: October 2024.



**Figure 149** I-65 NP4 Image Collected With Patching January 2024.

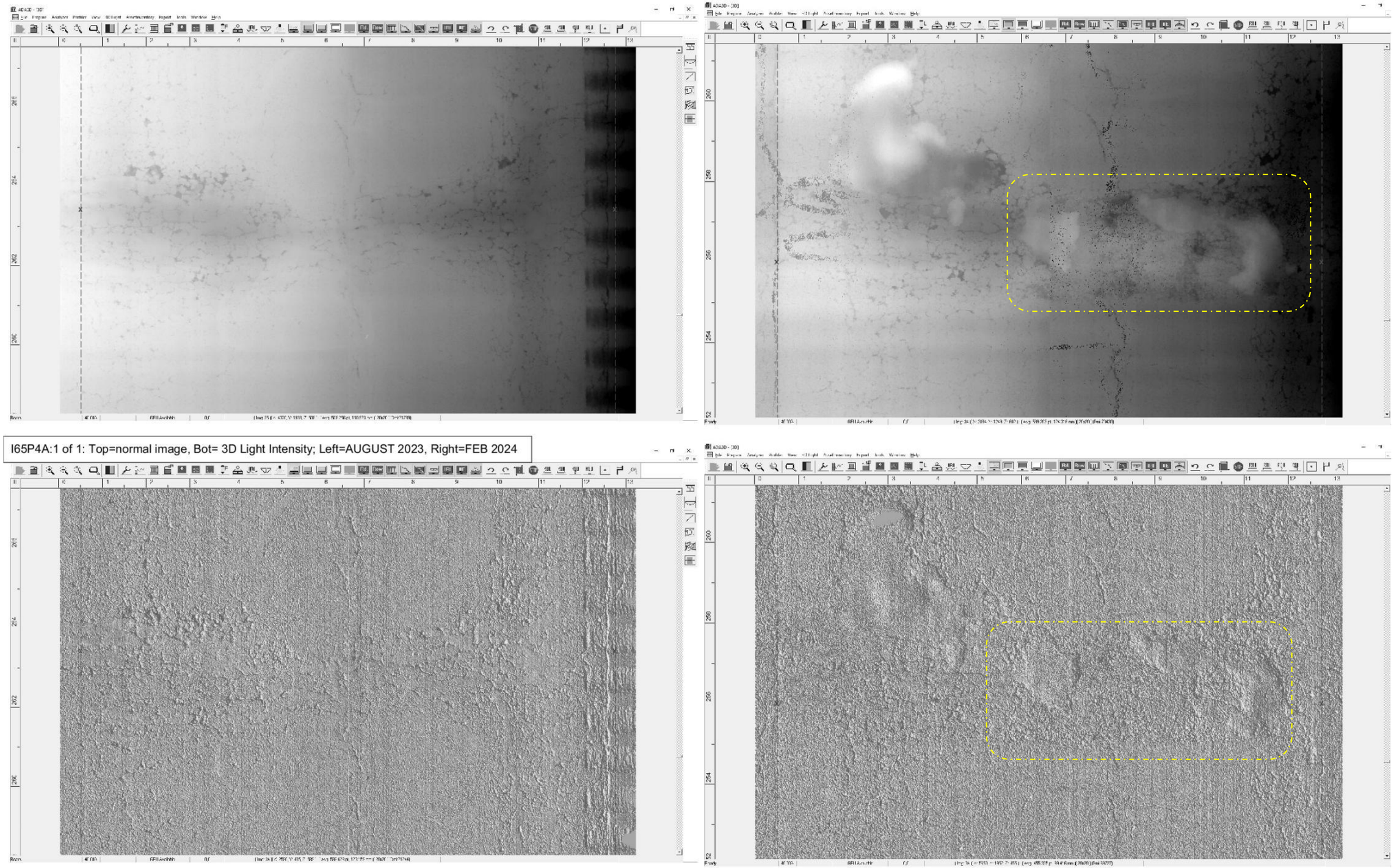



**Figure 150** I-65 NP4 INDOT Pavement Condition System Normal (Elevation) and Intesity Image Comparison. Left: Before Patch August 2023; Right: February 2024.

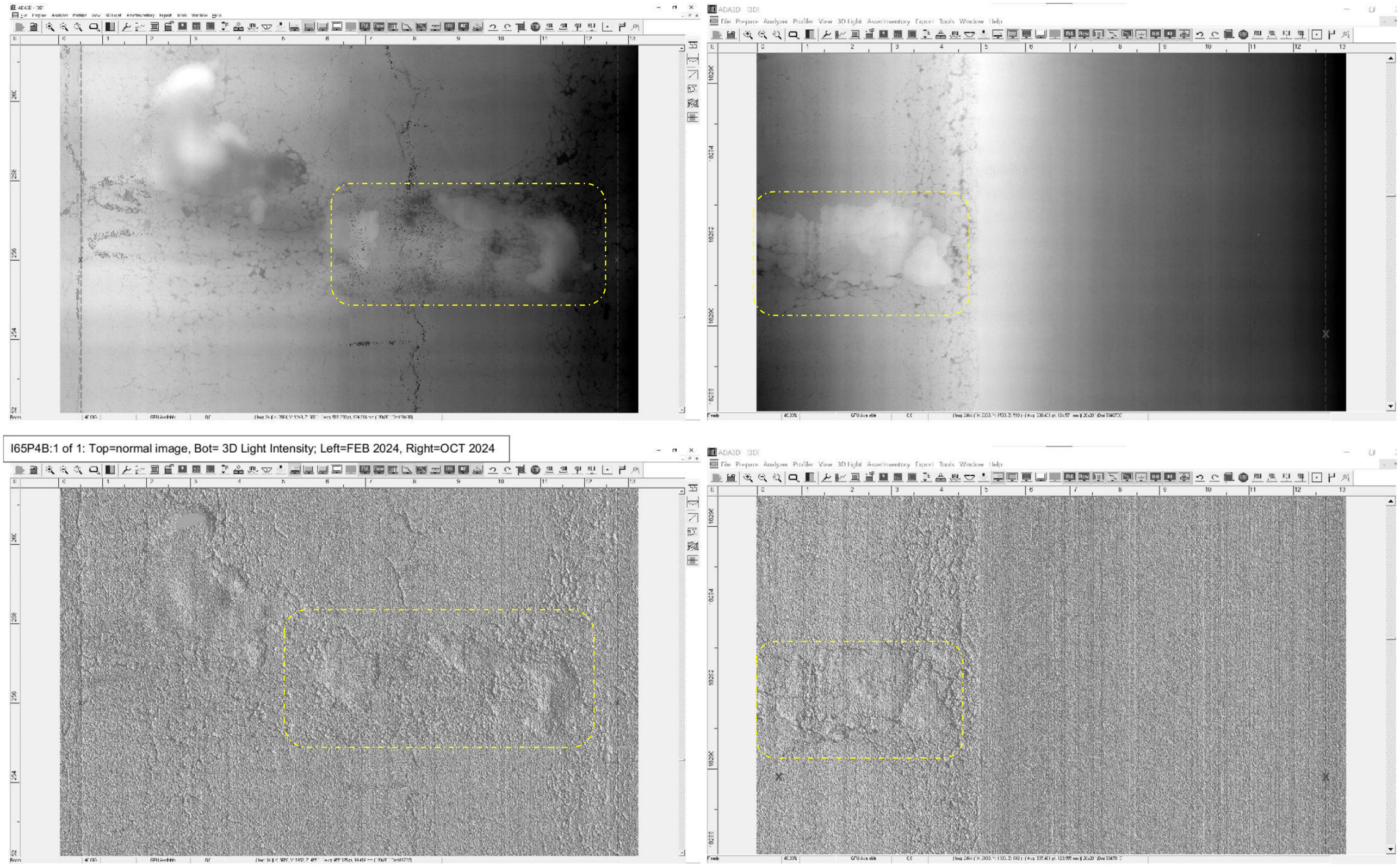



**Figure 151** I-65 NP4 INDOT Pavement Condition System Normal (Elevation) and Intesity Image Comparison. Left: Before Patch February 2024; Right: October 2024.

## US 31 Reflection Joint Corner Distress Figures

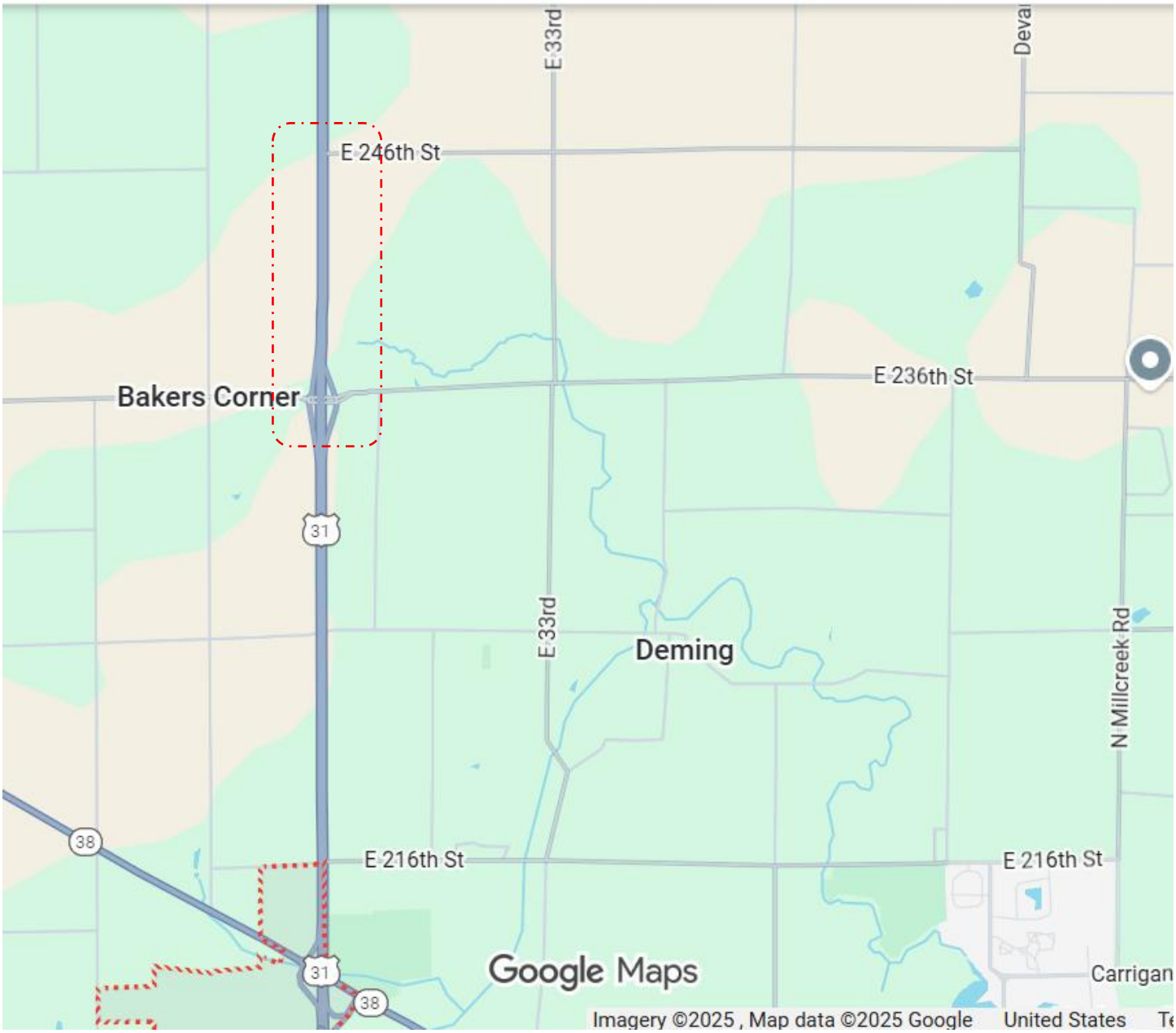



**Figure 152** Location of US 31 Patches.




**Figure 153** US 31 P1 Pathway Services ROW Images; Small Infrared Unit Corner of Reflective Crack Top: August 2023, Bottom October 2024.

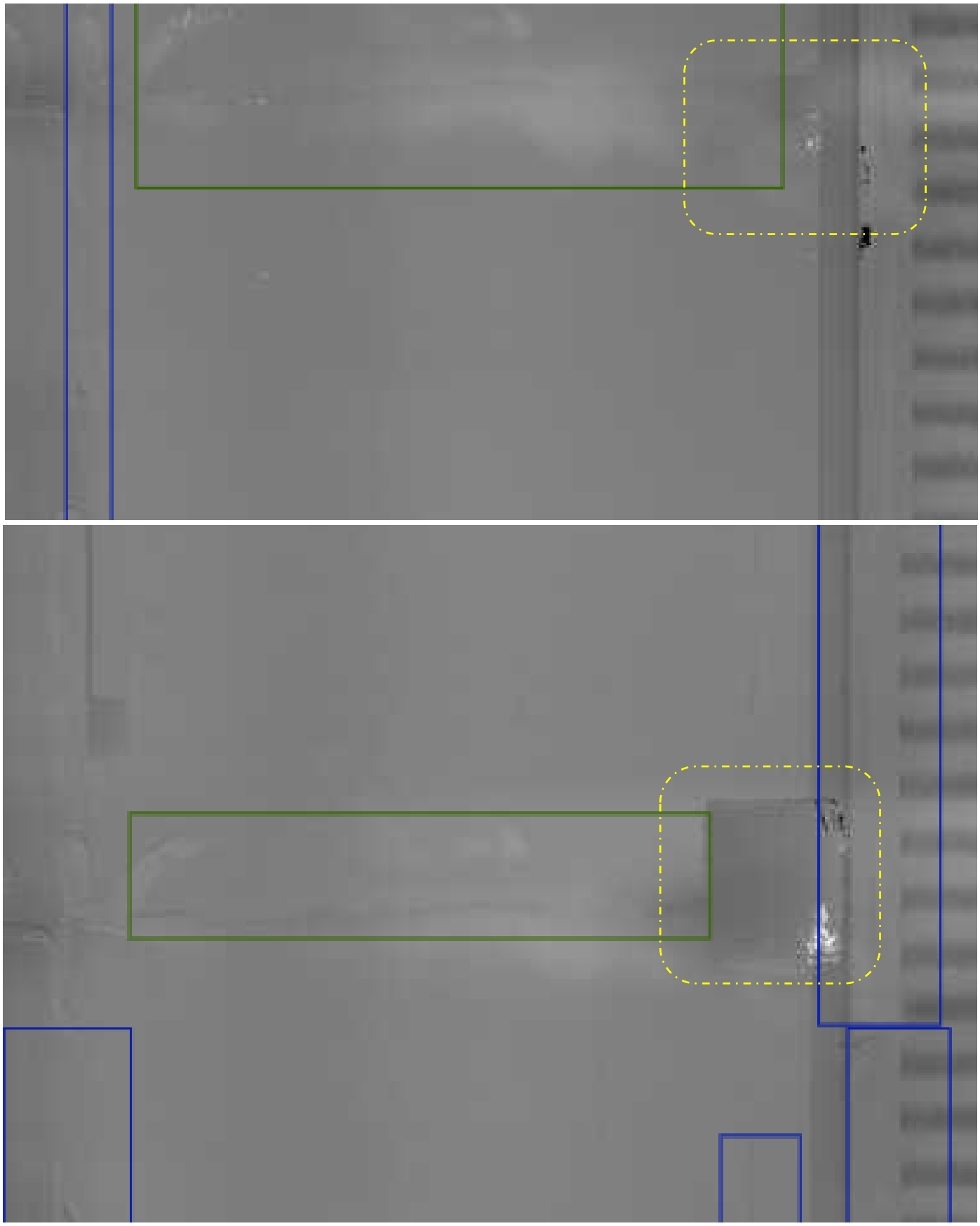


**Figure 154** US 31 P1 Pathway Services Elevation Images; Small Infrared Unit Corner of Reflective Crack Top: August 2023; Bottom: October 2024.

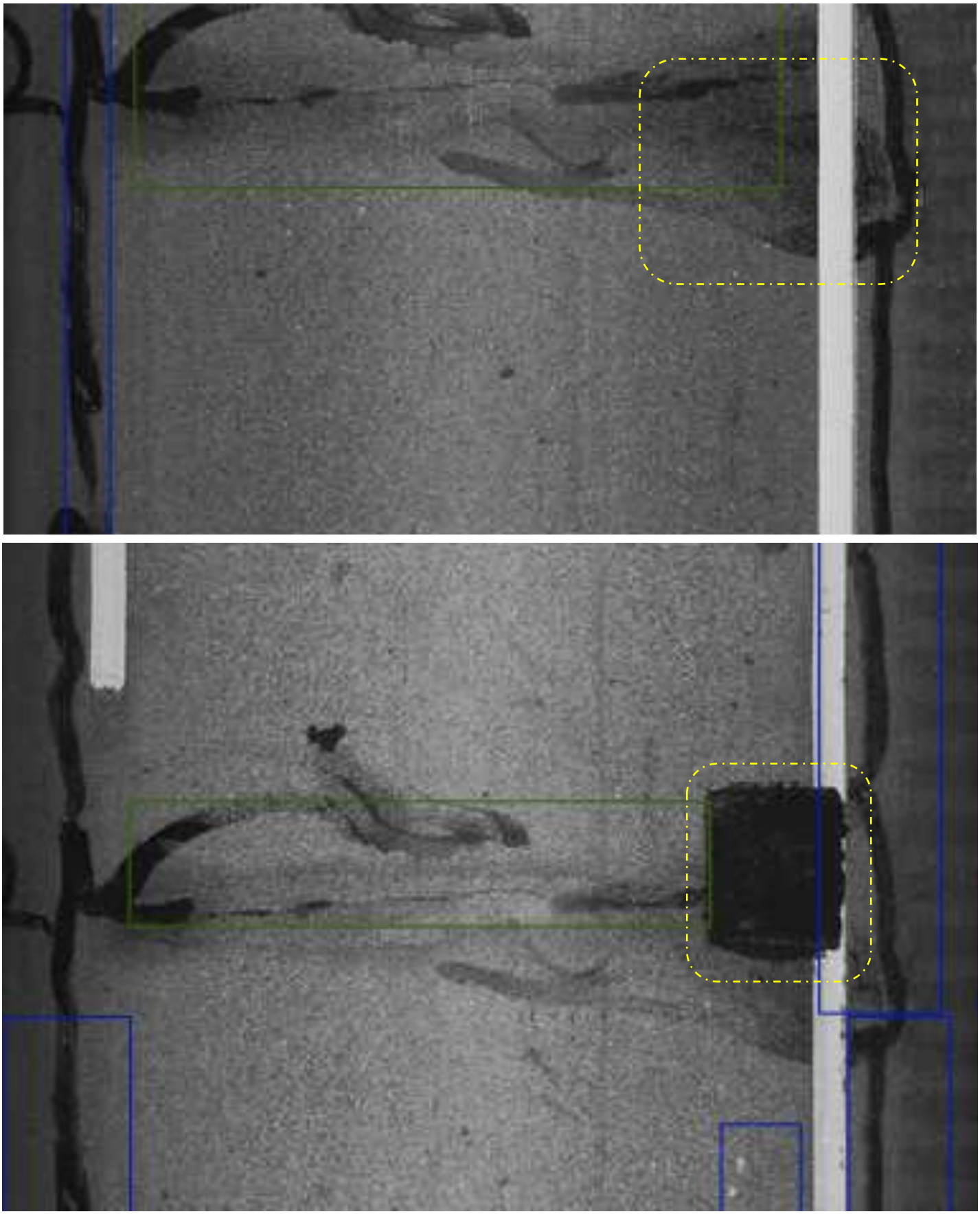


**Figure 155** US 31 P1 Pathway Services Intnsity Images; Small Infrared Unit Corner of Reflective Crack. Top (A): August 2023, Bottom (B): October 2024.




**Figure 156** US 31 Patches P2 and P3 Pathway Services ROW Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023; Bottom October 2024.

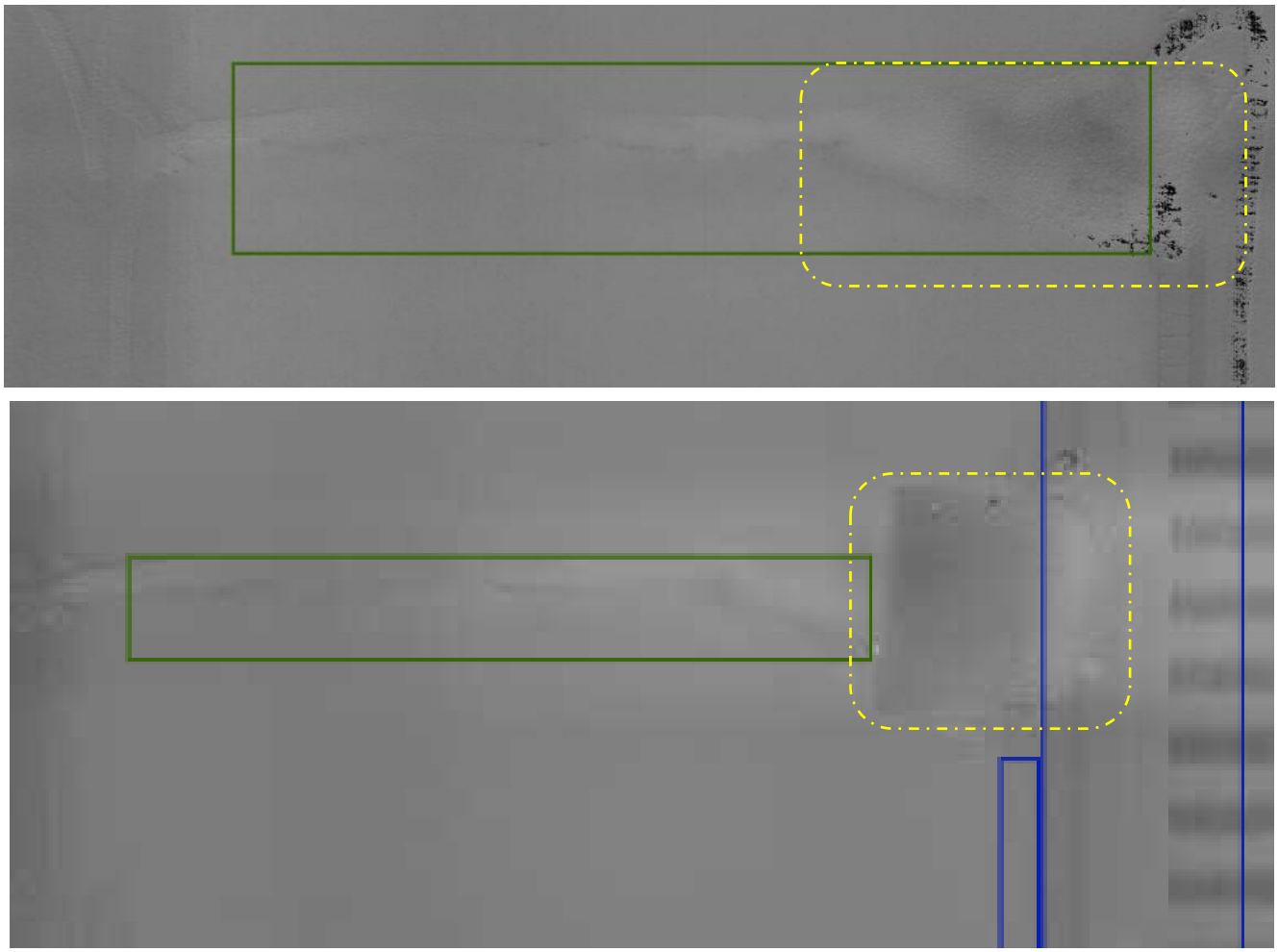


**Figure 157** US 31 P2 Pathway Services Elevation Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023; Bottom: October 2024.

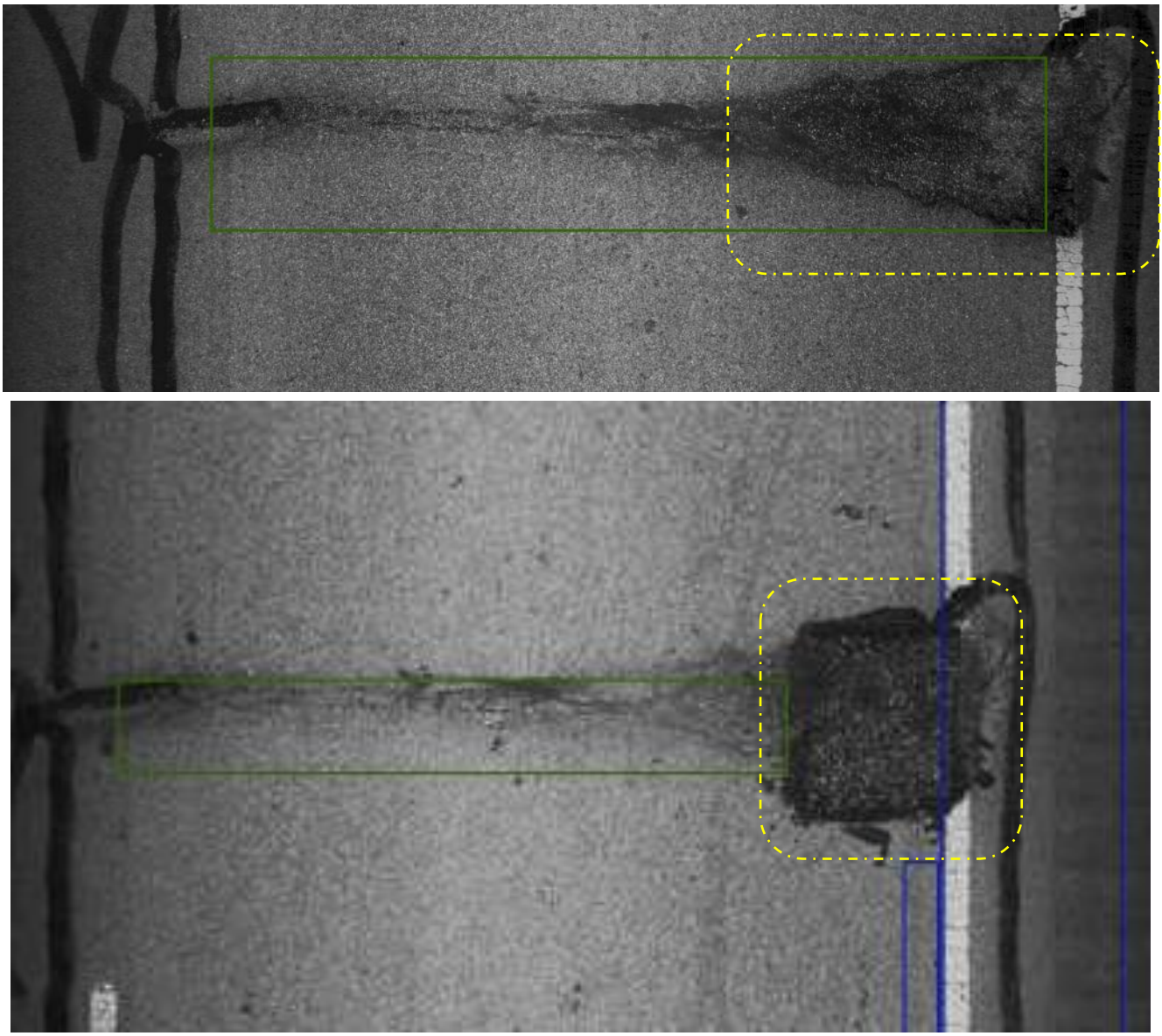


**Figure 158** US 31 P2 Pathway Services Intensity Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023; Bottom:  October 2024.

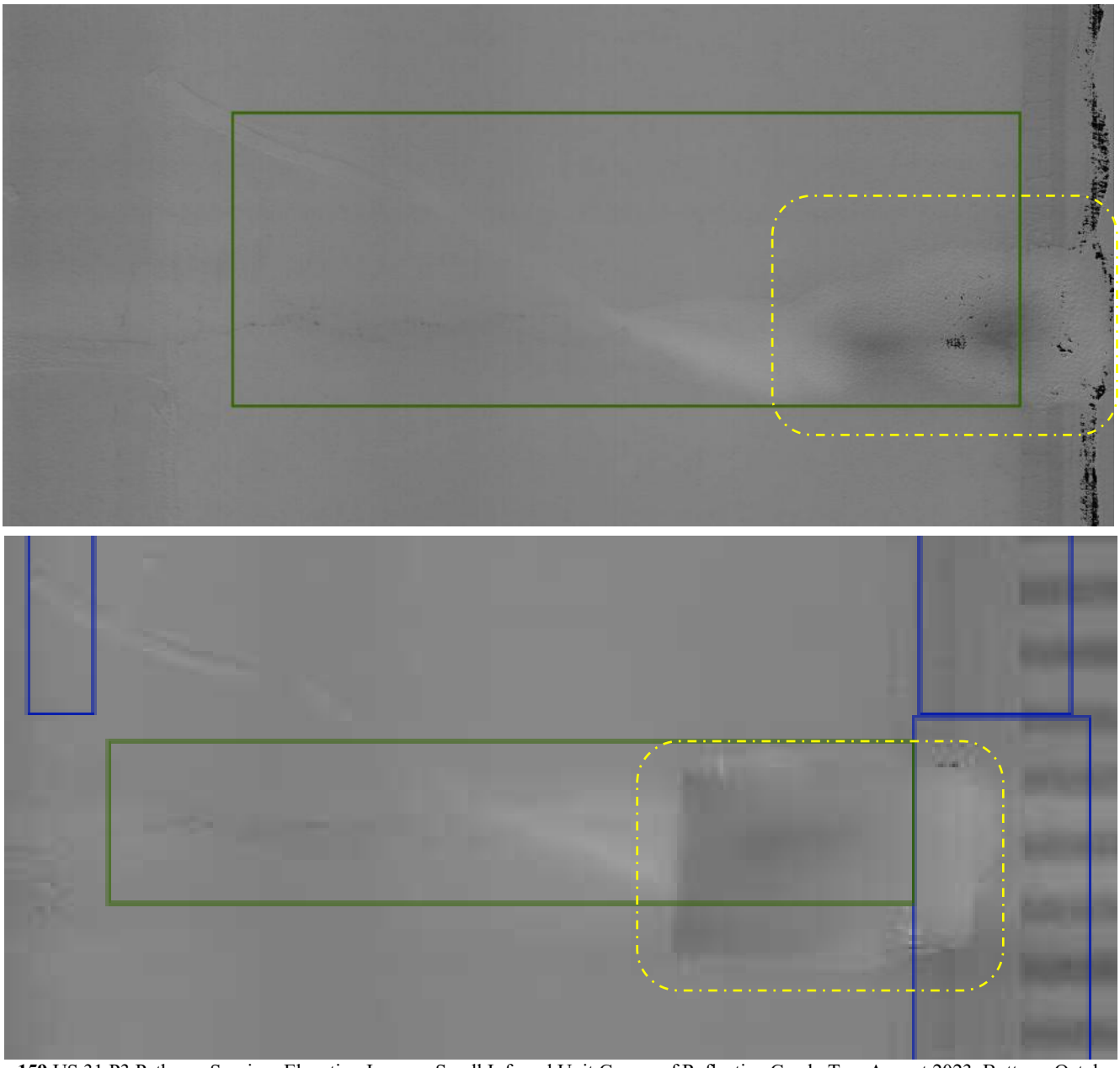


**Figure 159** US 31 P3 Pathway Services Elevation Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023, Bottom: October 2024.

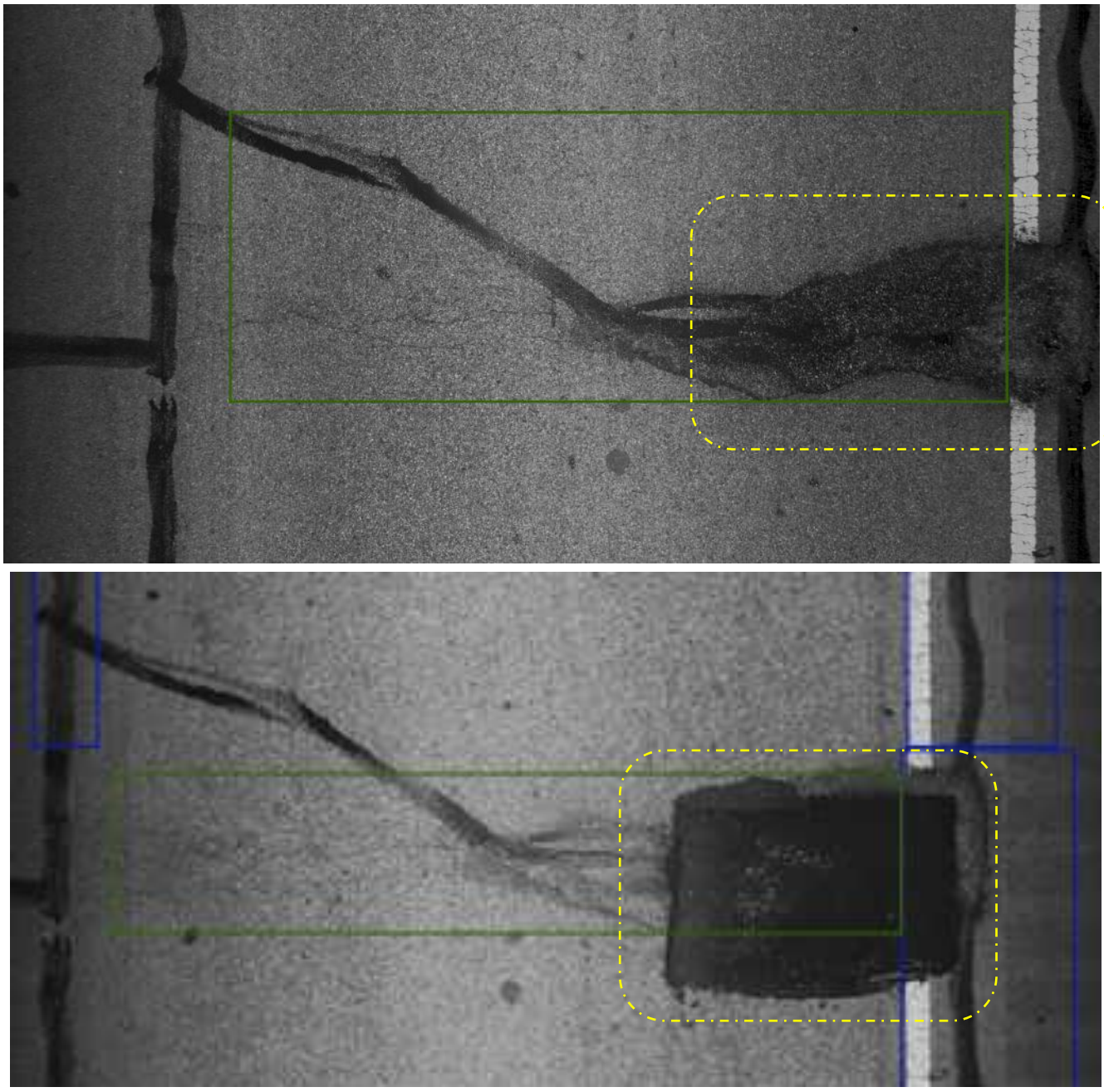


**Figure 160** US 31 P3 Pathway Services Intensity Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023, Bottom: October 2024.



**Figure 161** US 31 P4 Pathway Services ROW Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023; Bottom: October 2024.

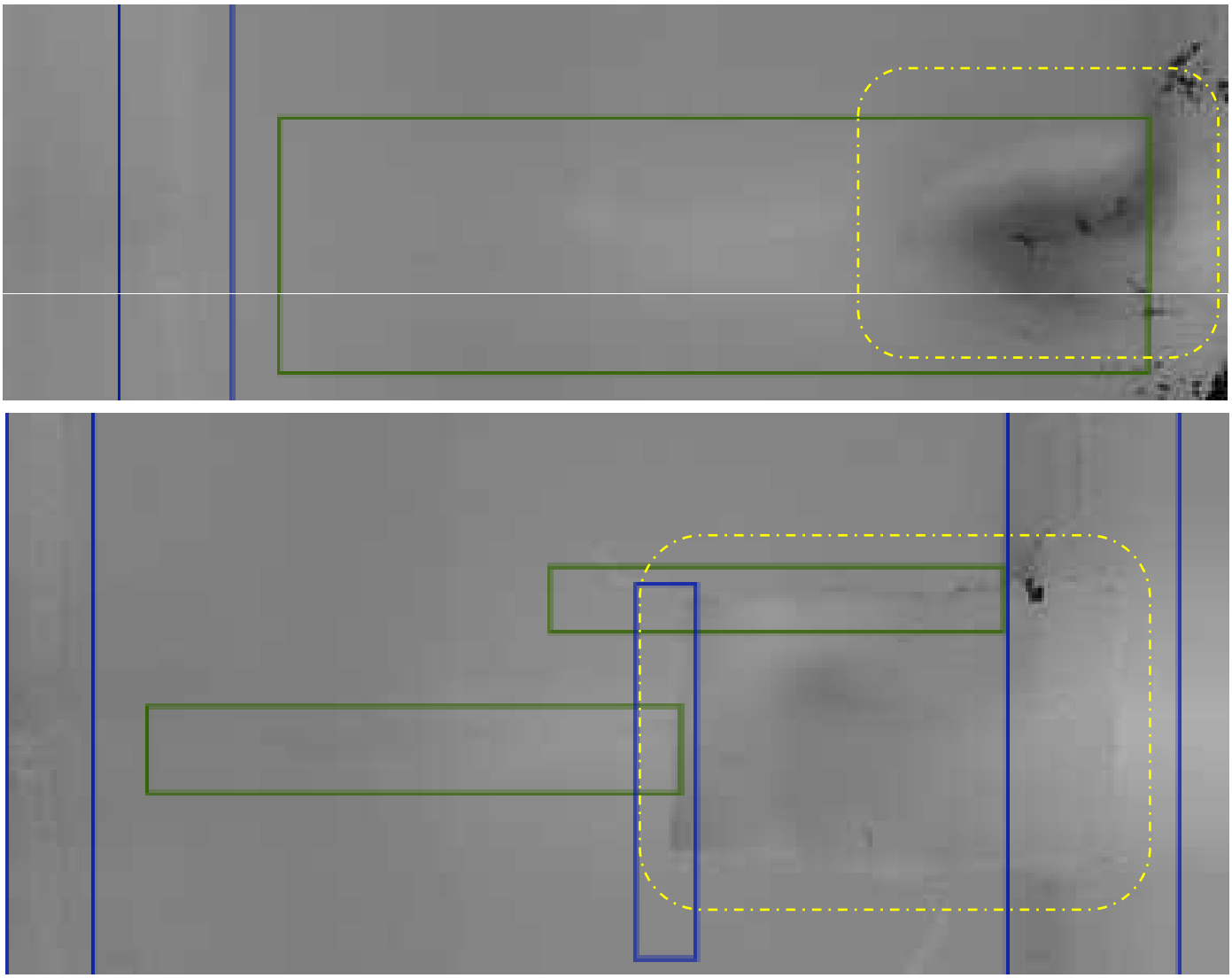


**Figure 162** US 31 P4 Pathway Services Elevation Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023; Bottom: October 2024.

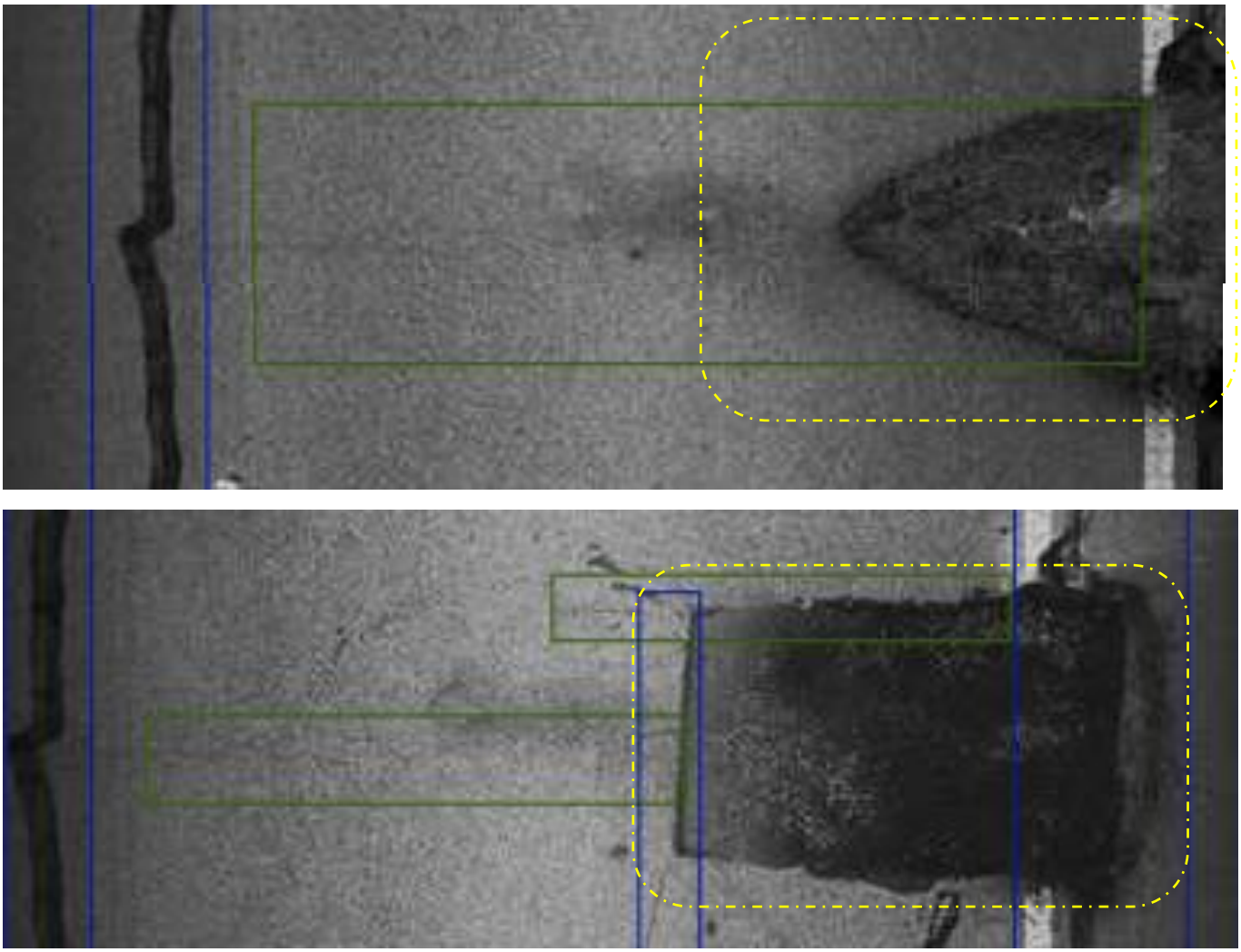


**Figure 163** US 31 P4 Pathway Services Intensity Images; Small Infrared Unit Corner of Reflective Crack. Top: August 2023; Bottom: October 2024.



**Figure 164** US 31 P5 Pathway Services ROW Images; Corner of Reflective Crack. Top: August 2023; Bottom: October 2024.

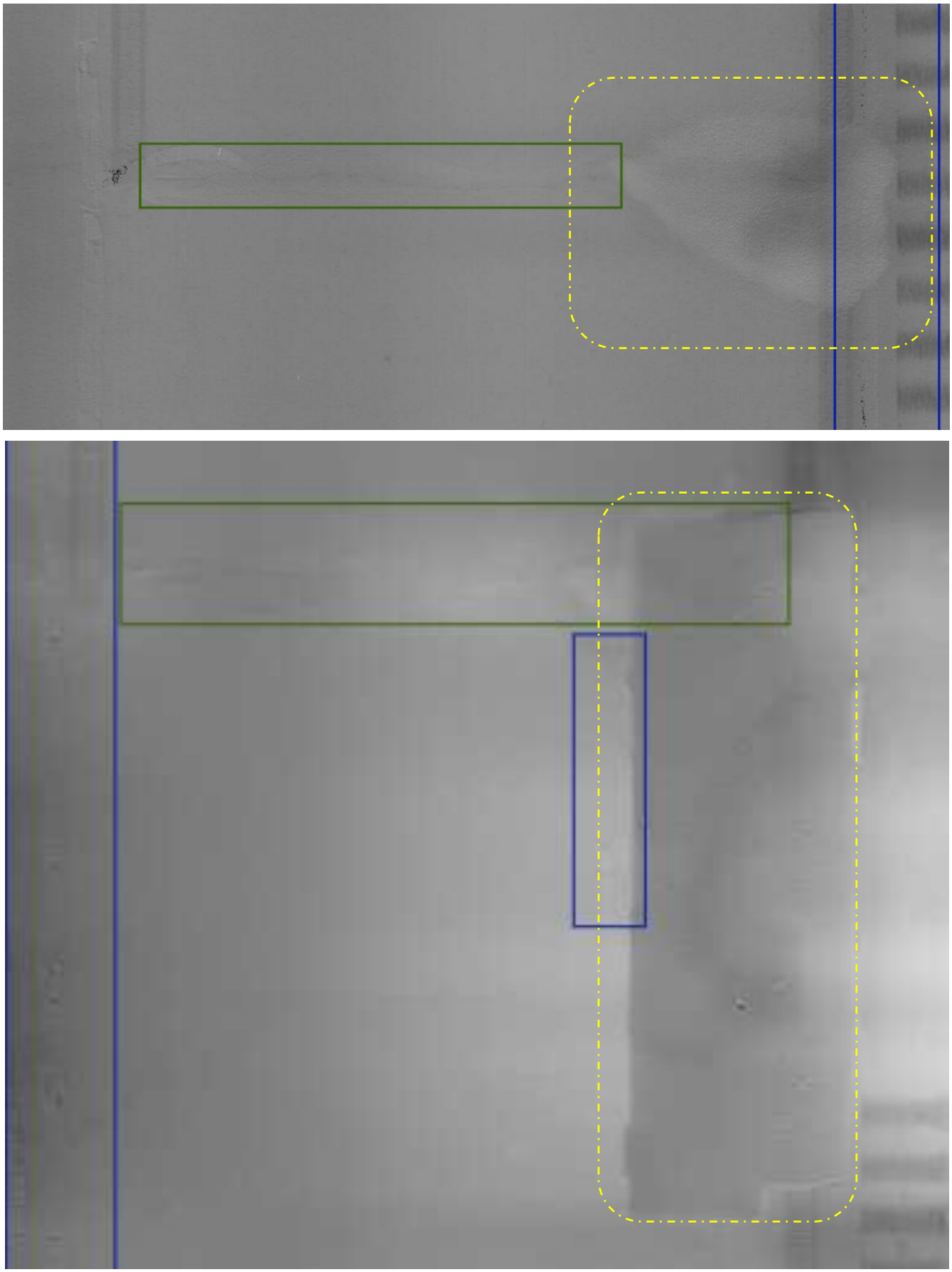


**Figure 165** US 31 P5 Pathway Services Elevation Images; Corner of Reflective Crack. Top: August 2023; Bottom: October 2024.

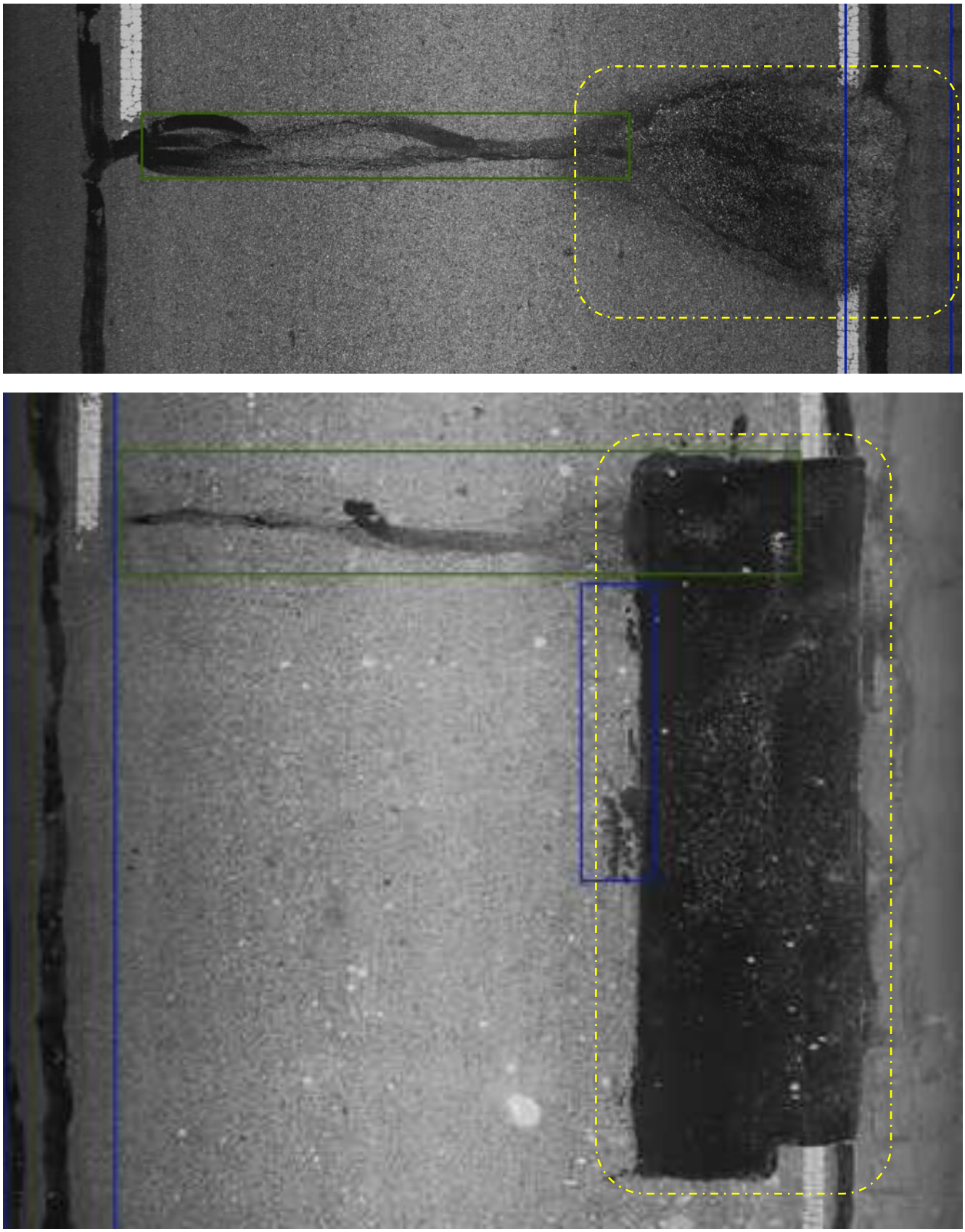


**Figure 166** US 31 P5 Pathway Services Intensity Images; Corner of Reflective Crack. Top: August 2023, Bottom:  October 2024.

## Conclusion Figures

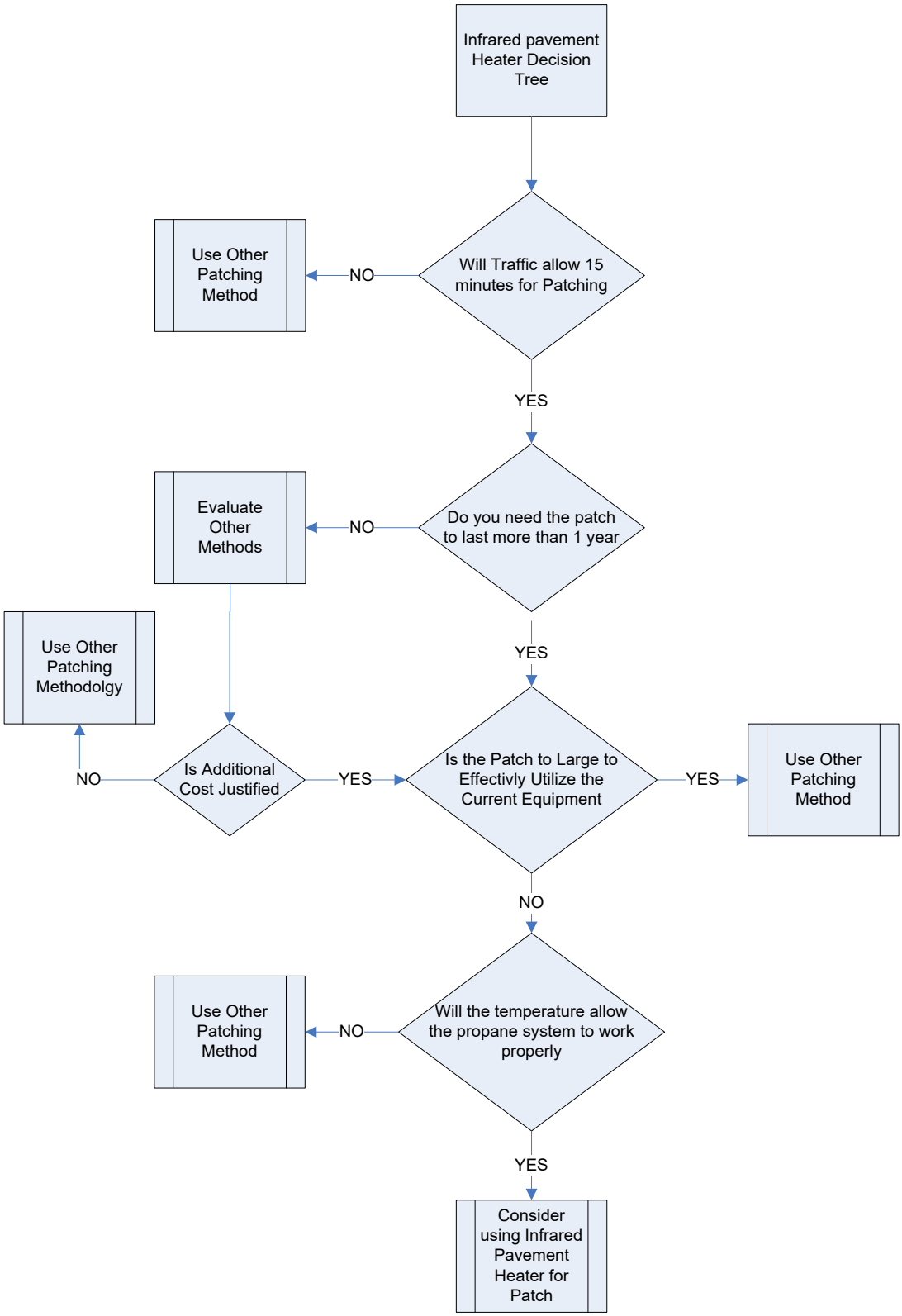



**Figure 167** Proposed Decision Tree for Infrared Patching.

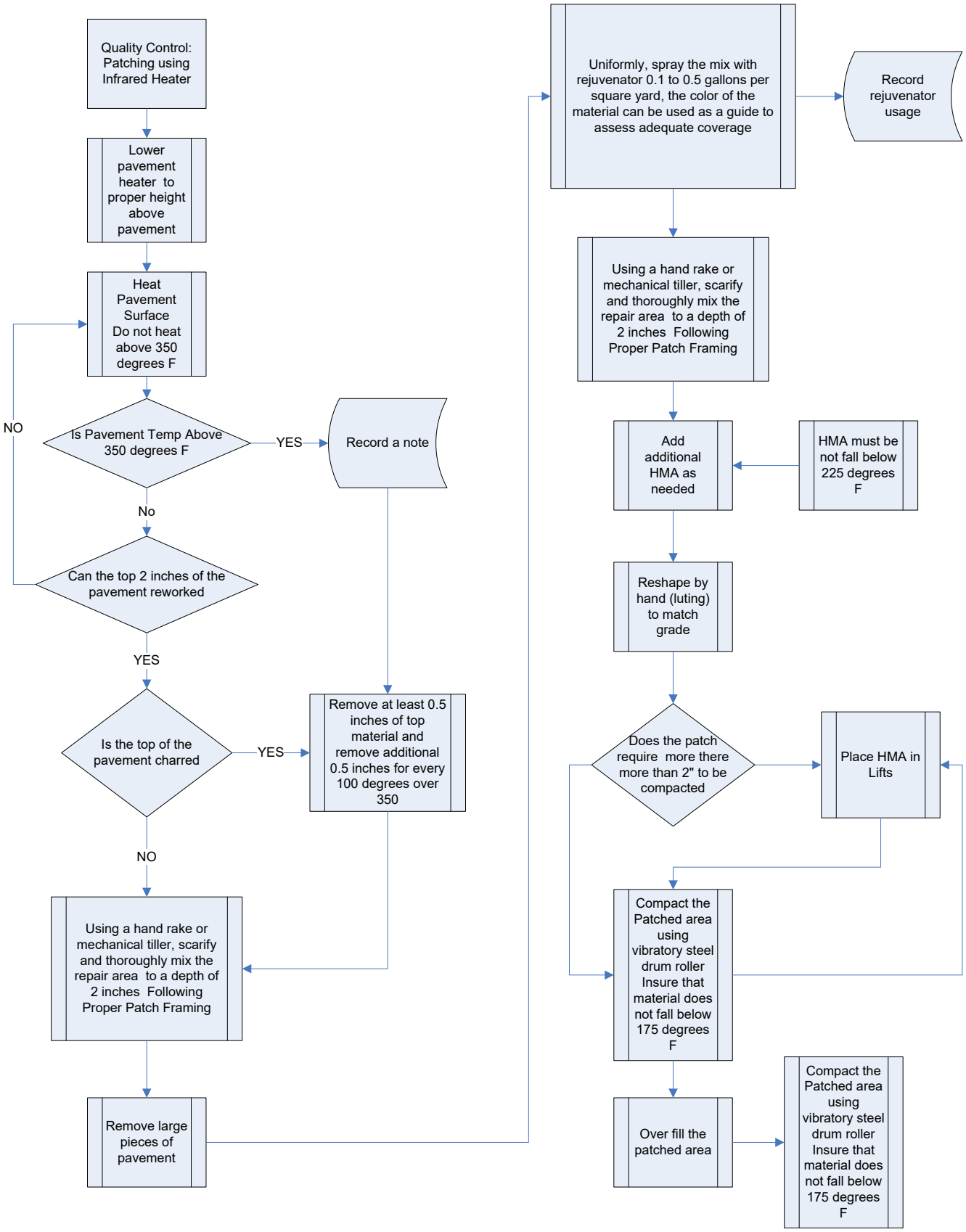



**Figure 168** Flowchart With Suggested Construction Quality Control for Patching With Infrared Pavement Heater.

## About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at docs.lib.purdue.edu/jtrp/.

Further information about JTRP and its current research program is available at engineering.purdue.edu/JTRP.

## About This Report

An open access version of this publication is available online. See the URL in the citation below.

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