

Ground Penetrating Radar (GPR)

Tool to evaluate near-surface and subsurface conditions of transportation facilities

Lindsay Hammond, PE

What is GPR?

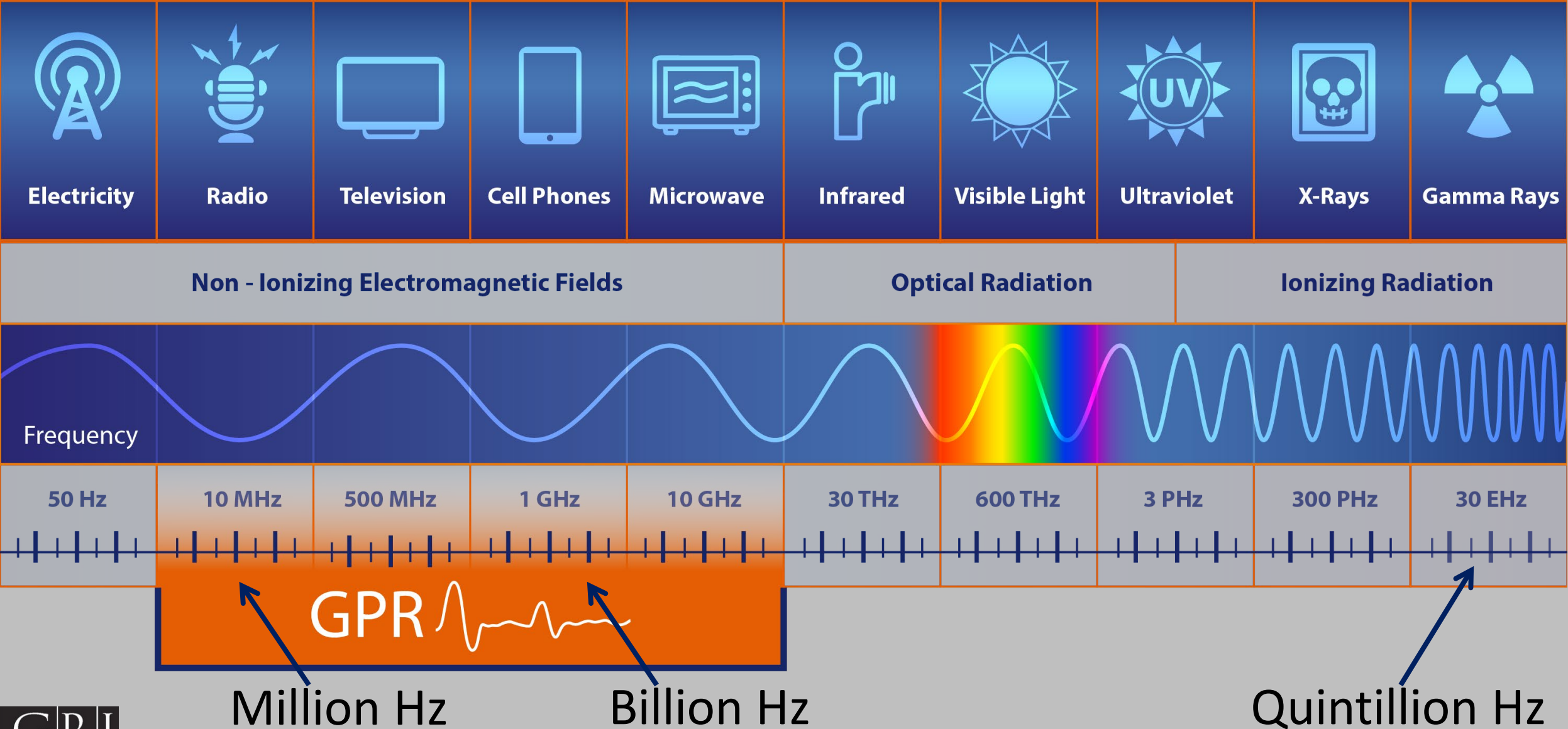
GPR =

**Ground Penetrating
RADAR**

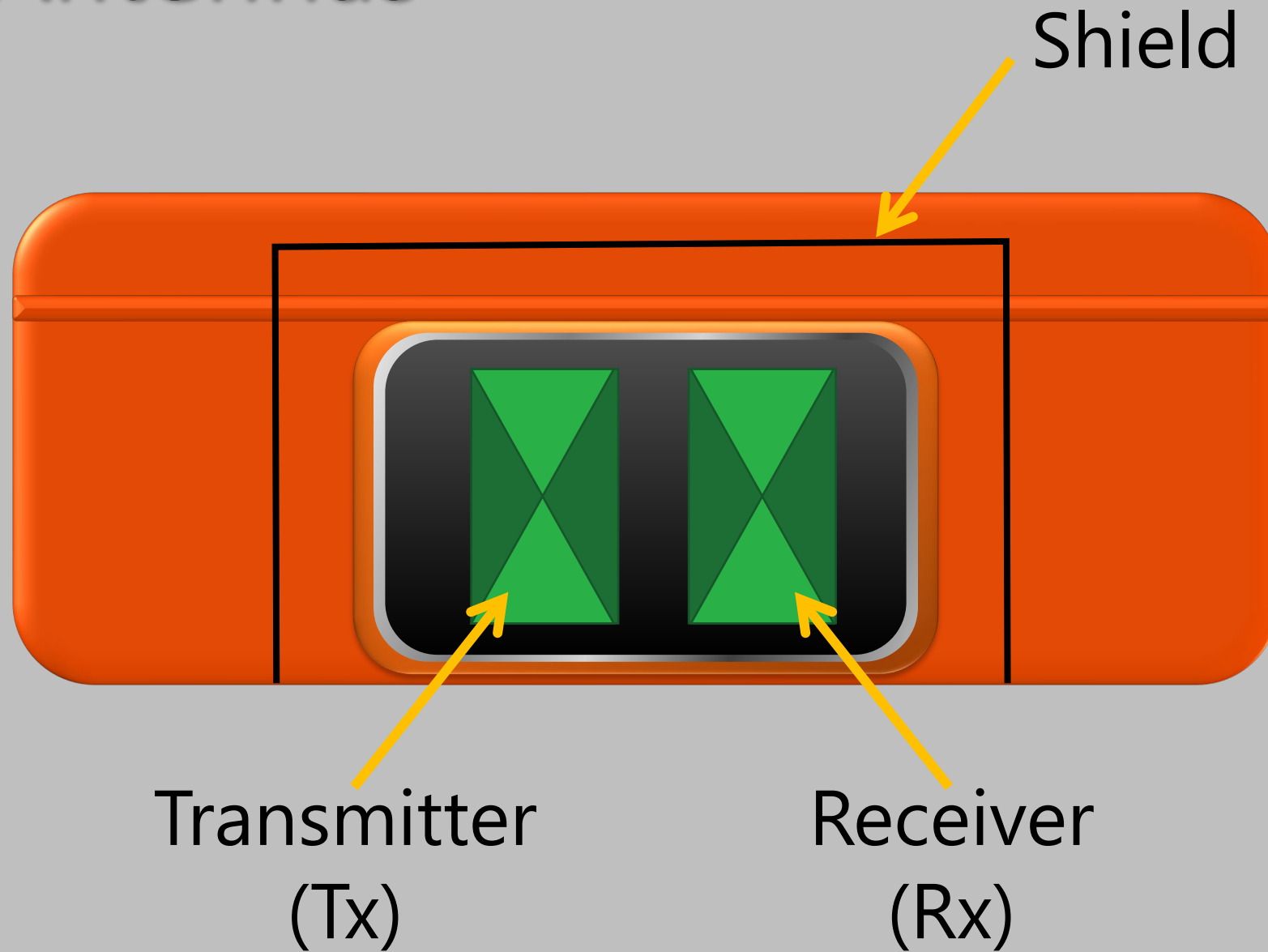
*GPR is conceptionally the
same as RADAR, such as
weather RADAR, except that
it is highly directional*



Electromagnetic Spectrum



GPR Antennas



GPR Antenna

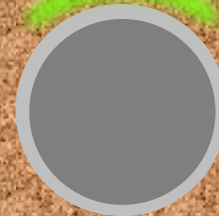


Concrete

Aggregate Base

Subgrade Soil

Cast Iron Pipe →



The Dielectric Constant

- RADAR travels at different speeds depending on what material it is traveling through.
- The *dielectric constant* is a function of the speed at which RADAR travels through a material.
 - The dielectric constant has been defined to be one (1) for air and 81 for water.



DEPTH

Penetration depth depends on:

- Frequency of the waveform
- Medium through which it travels

2 GHz

350 MHz



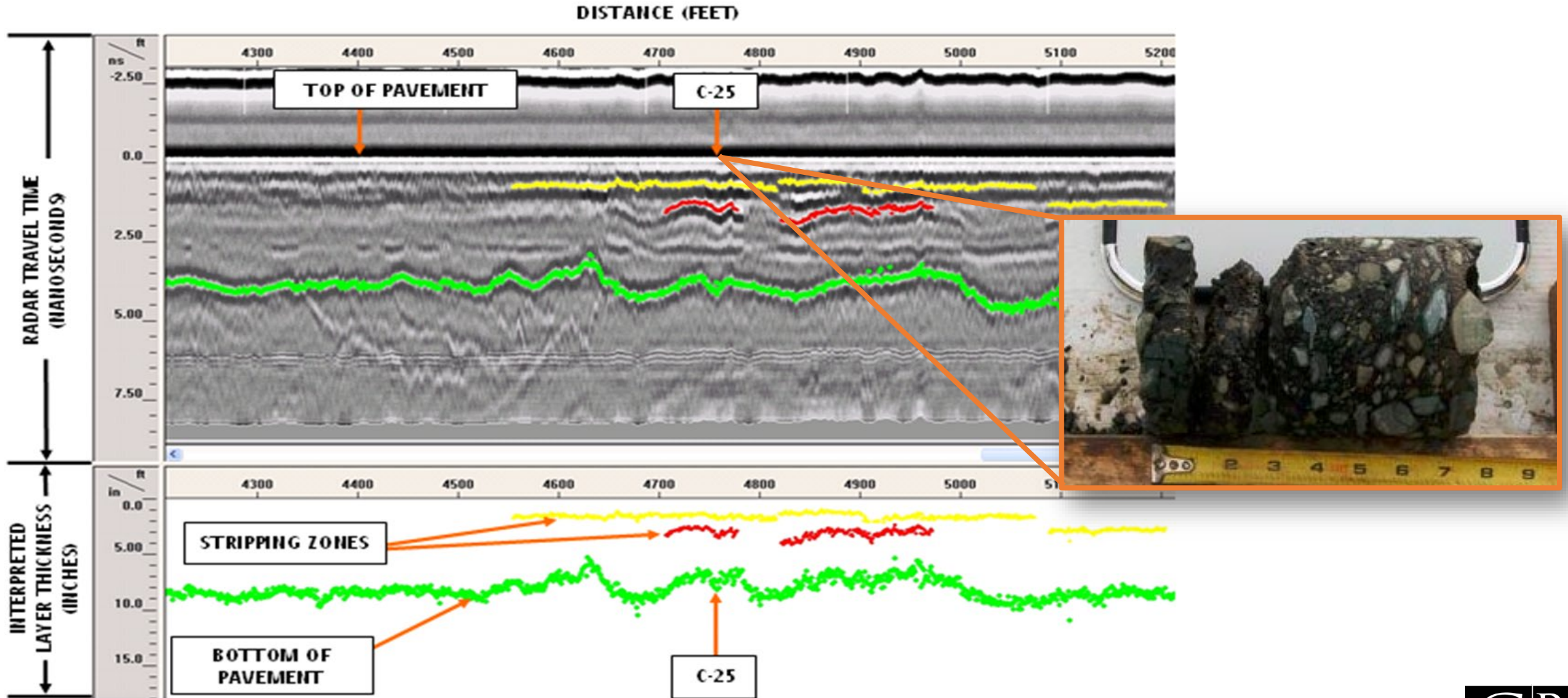


2.0 GHz → ~15-25 inches into pavement



350 MHz → ~15 to 20 feet into ground/pavement

Raw GPR Data



Projects

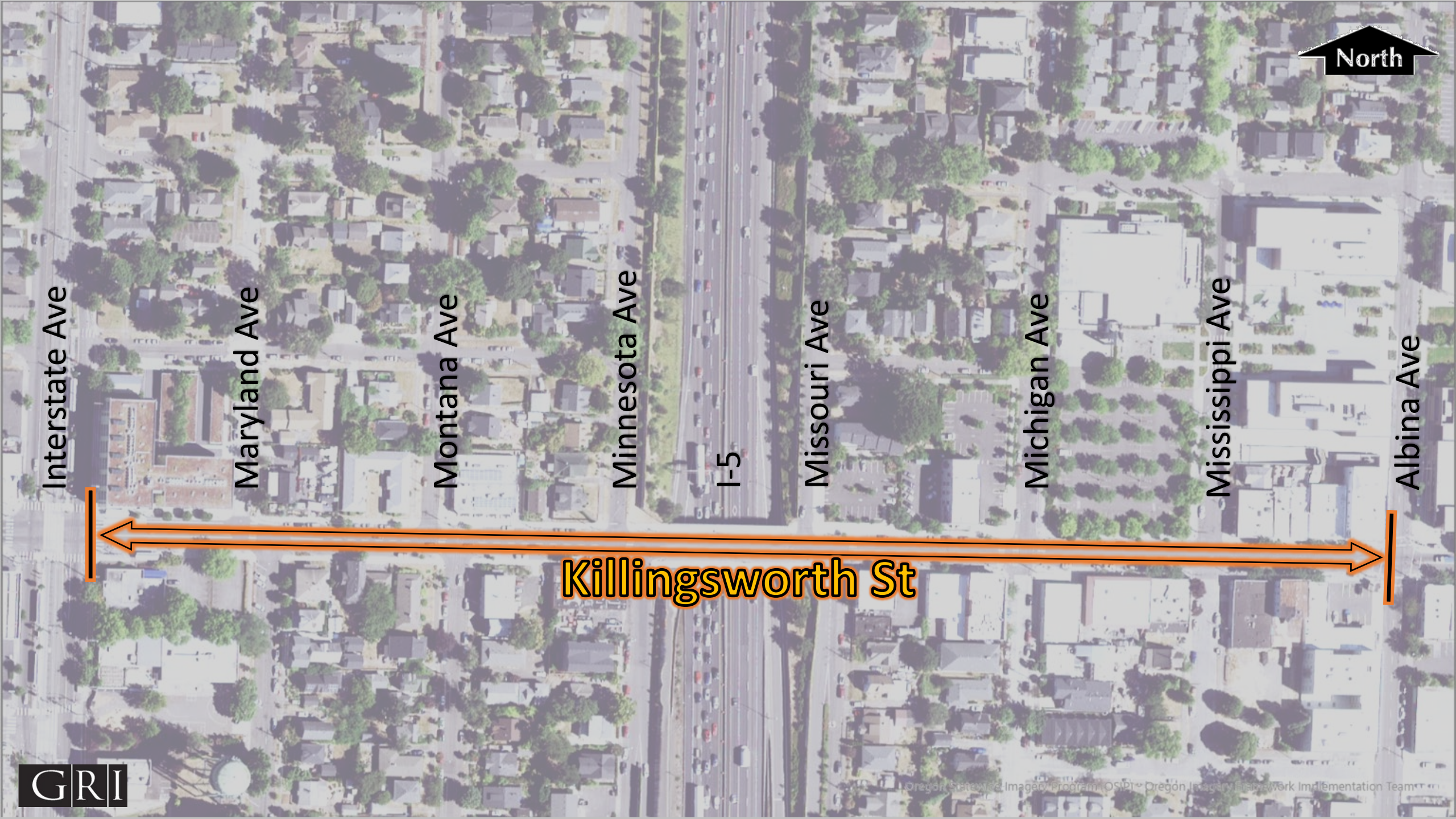
350 MHz Ground-Coupled

2 GHz Air-Launched



PROJECT 1 - KILLINGSWORTH STREET





Interstate Ave

Maryland Ave

Montana Ave

Minnesota Ave

I-5

Missouri Ave

Michigan Ave

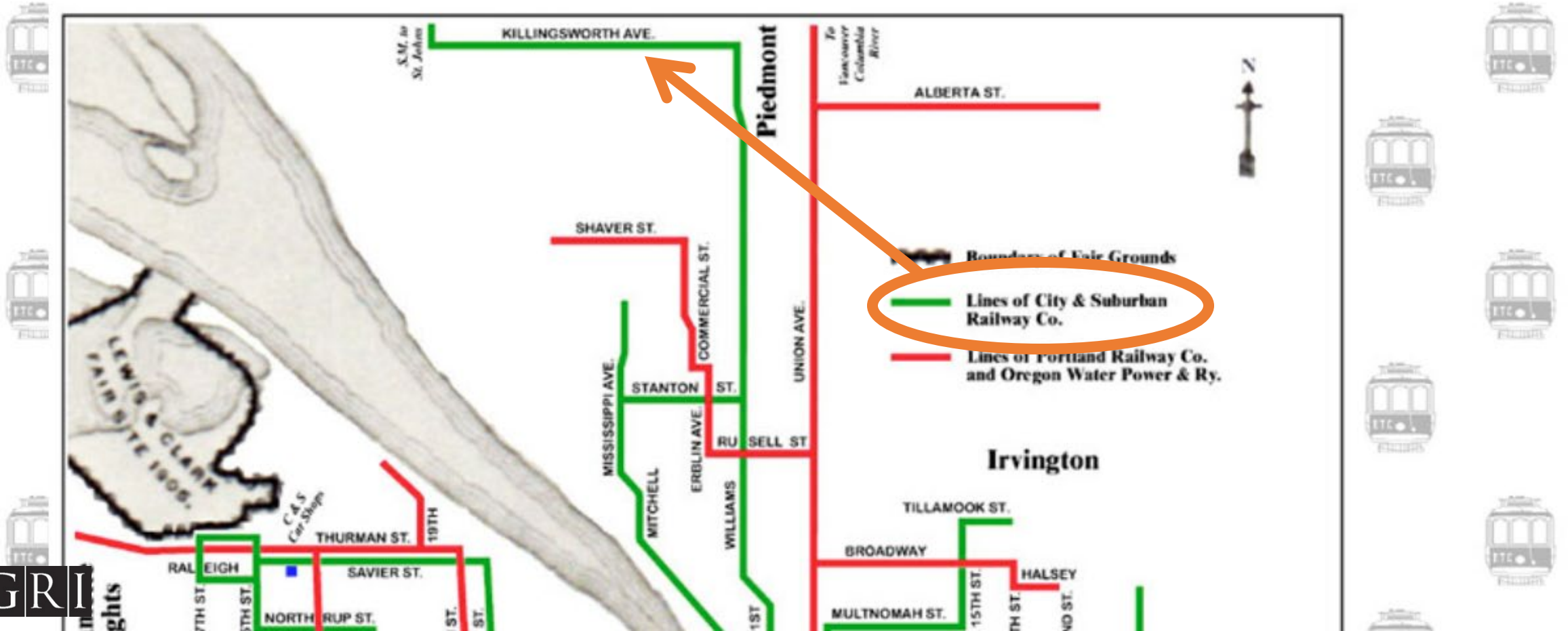
Mississippi Ave

Albina Ave

Killingsworth St

North

1904 Street Railway Map of Portland



Killingsworth St

Michigan Ave

N Killingsworth

00



Transverse GPR



Interstate Ave

Maryland Ave

Montana Ave

Minnesota Ave

I-5

Missouri Ave

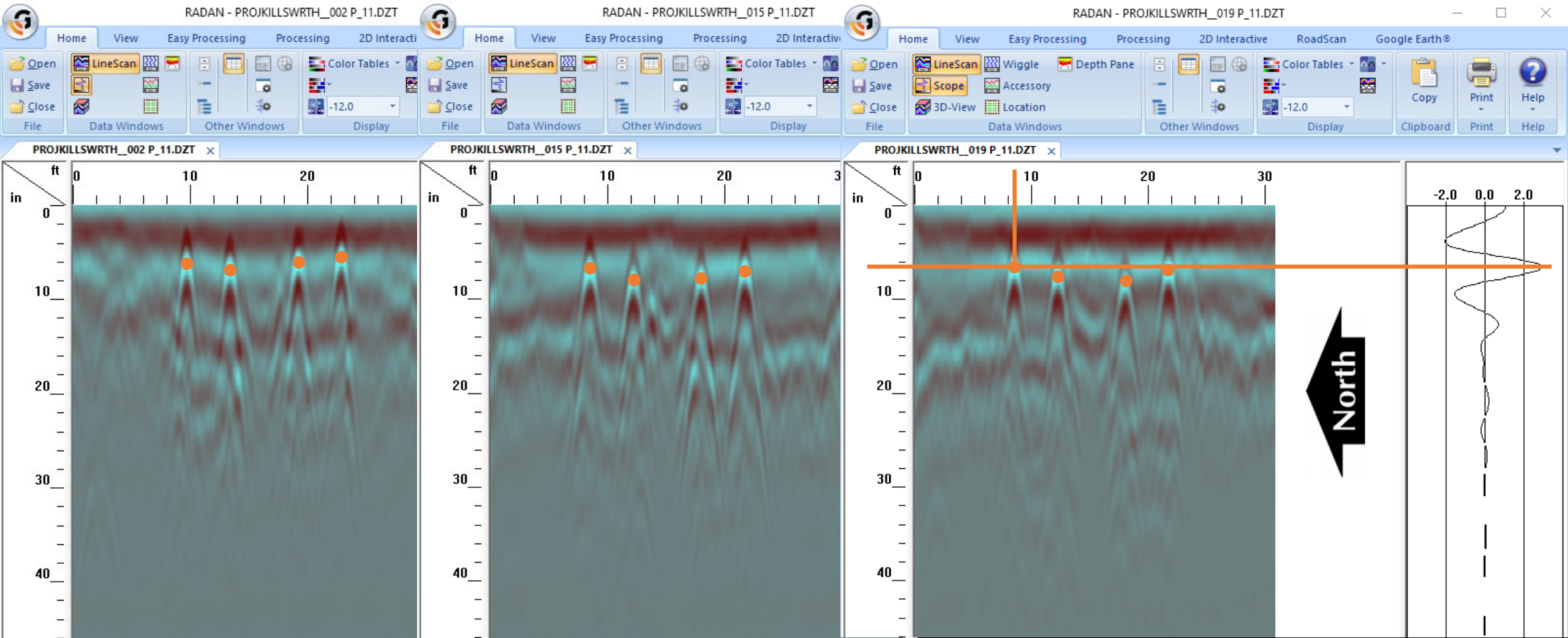
Michigan Ave

Mississippi Ave

Albina Ave

Killingsworth St

Transverse Survey

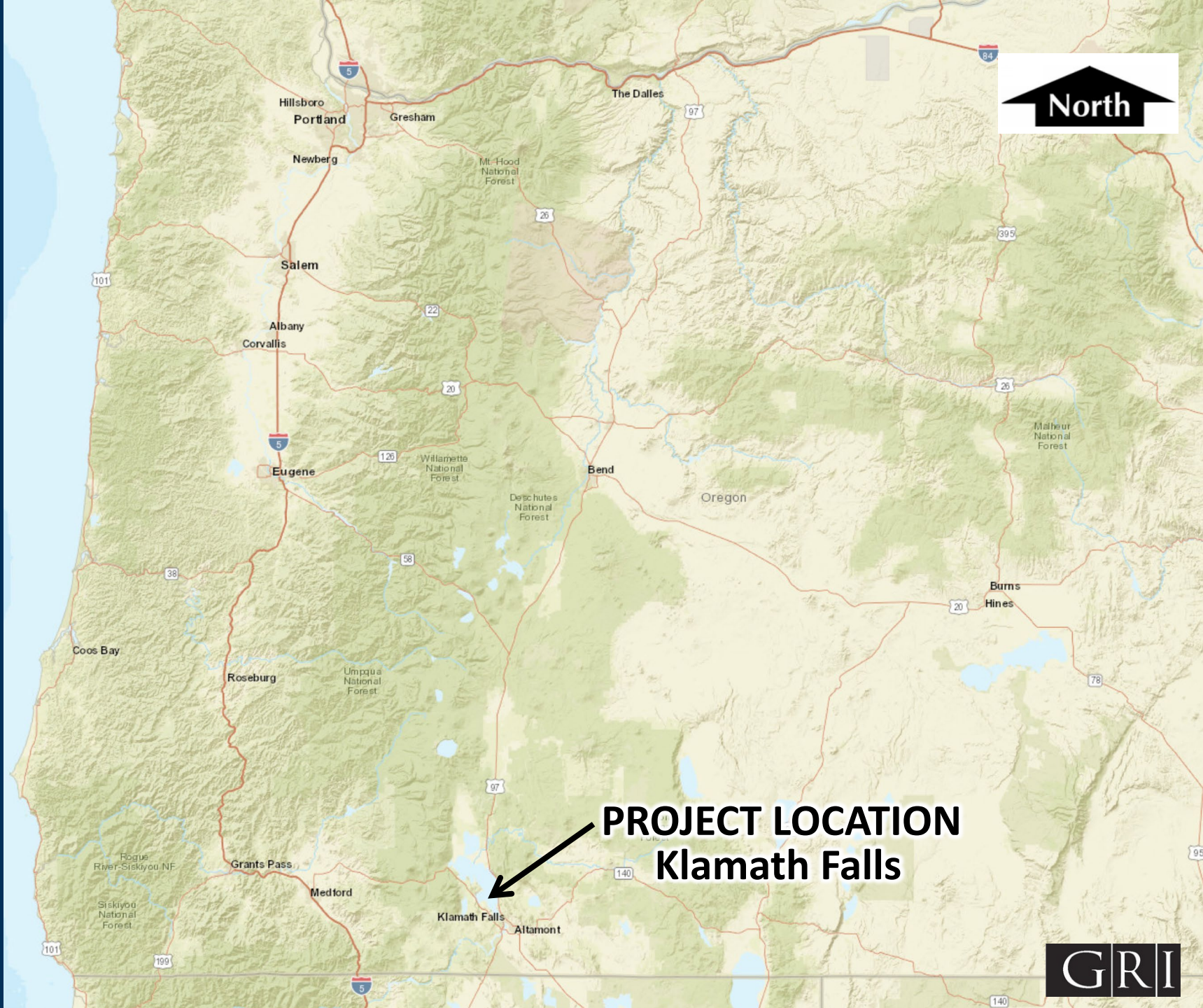


Approximate Rail Depth, inches

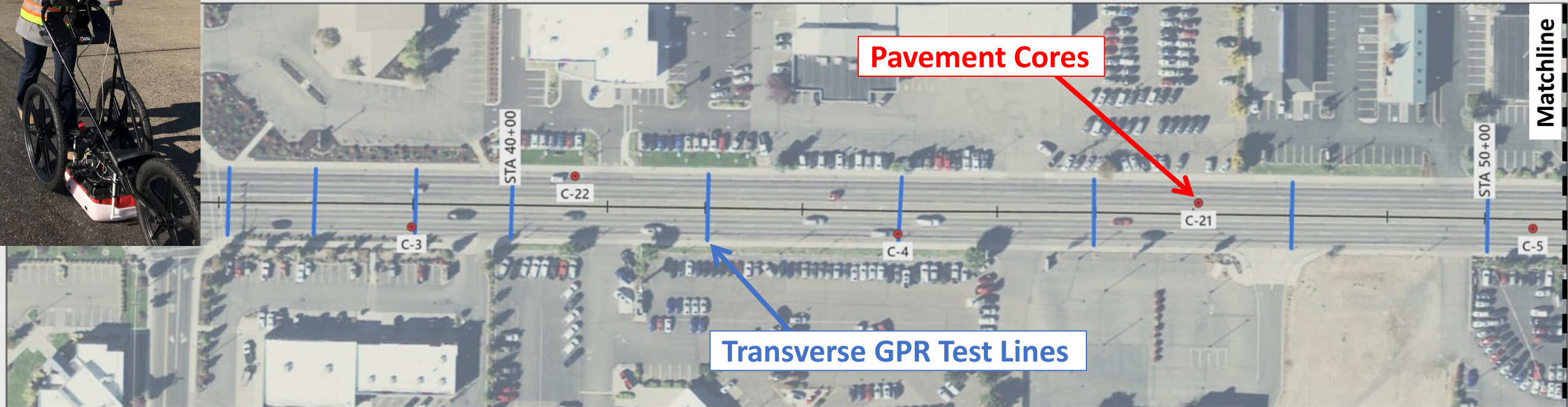


- 3.2 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- 6.0 - 6.7

PROJECT 2 - WASHBURN WAY

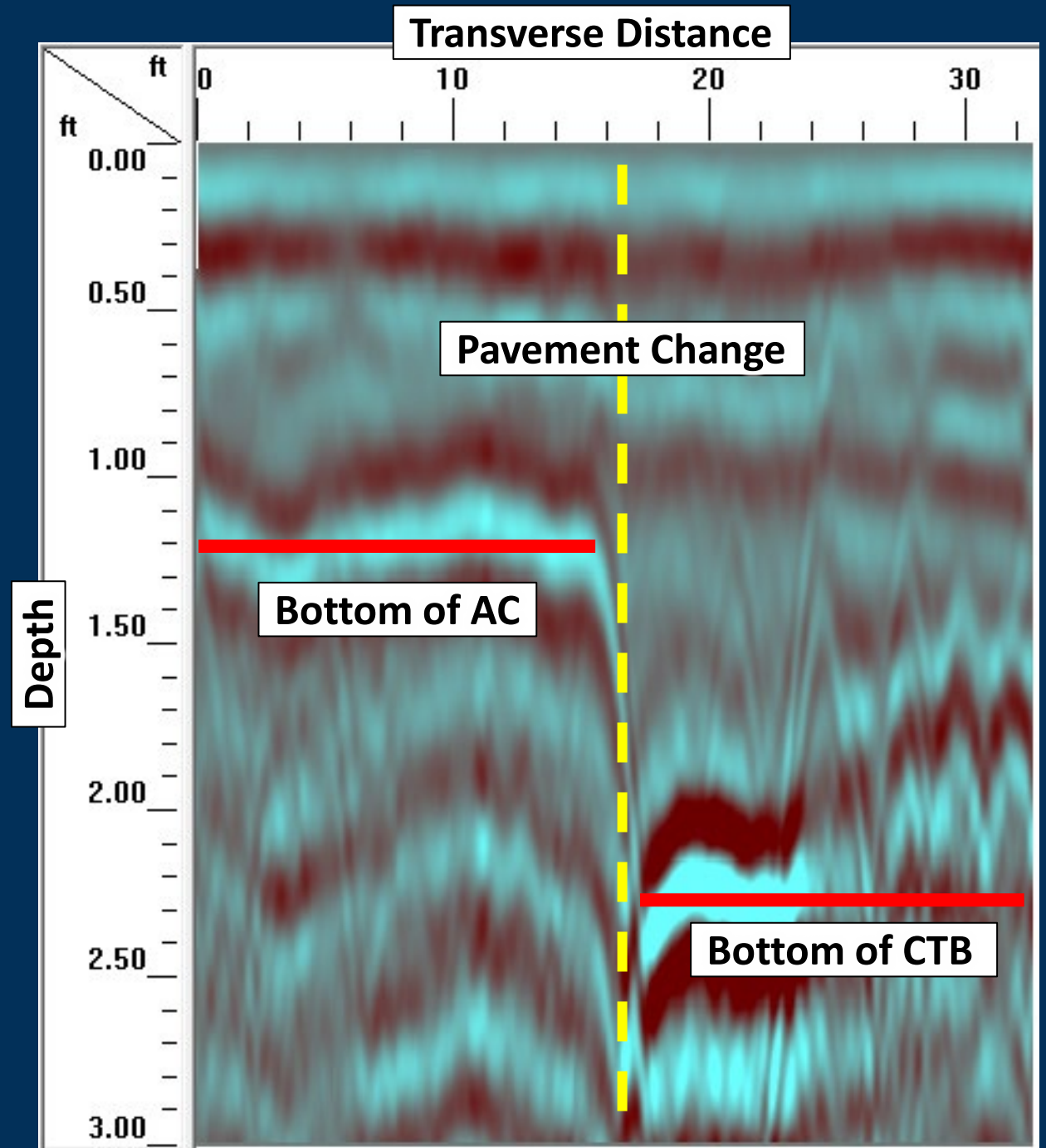


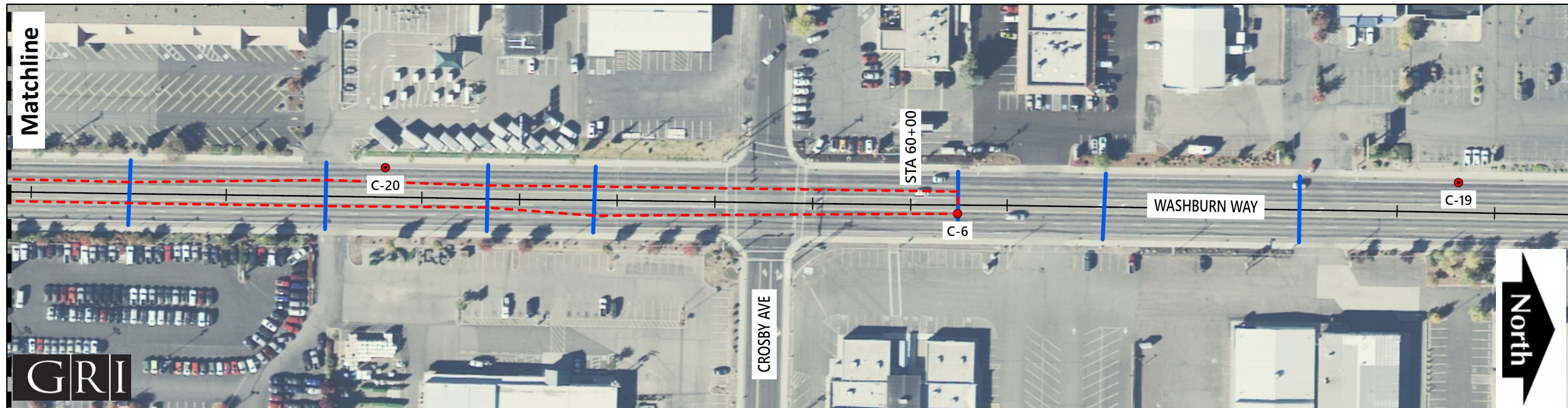
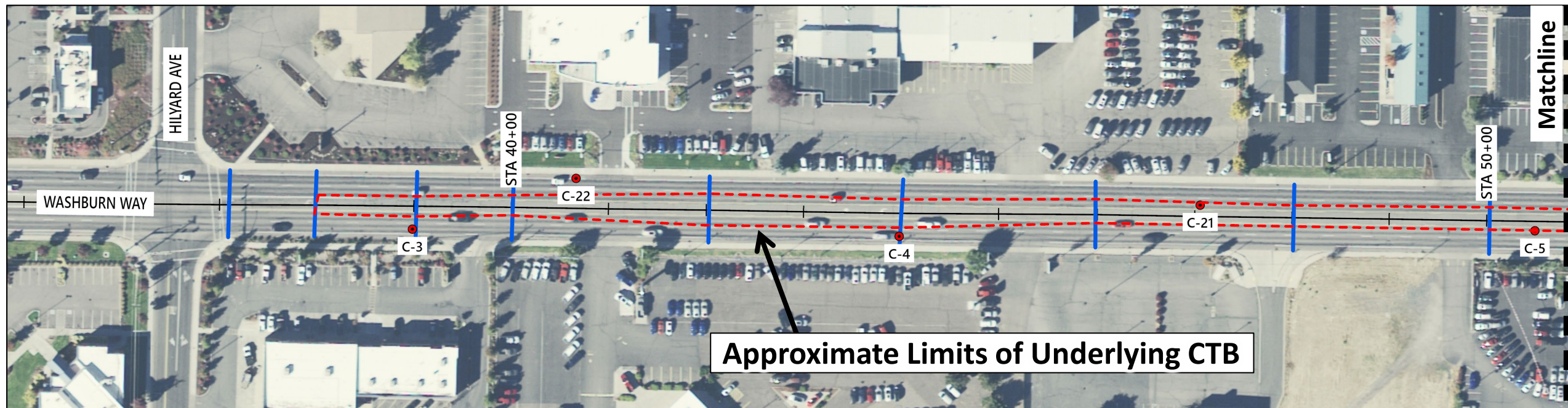
**PROJECT LOCATION
Klamath Falls**



GRI

- **Distance = 0 ft >>> Edge of Pavement**
- **Distance = 33 ft >>> Center of Roadway**
- **Pavement Change Approx. 16 ft from Edge of Pavement**





PROJECT 3 - SW GREENFIELD DRIVE





Beaverton

Portland

Tigard

Lake Oswego

SITE





**8" water main break
November 23, 2019**

















Topography



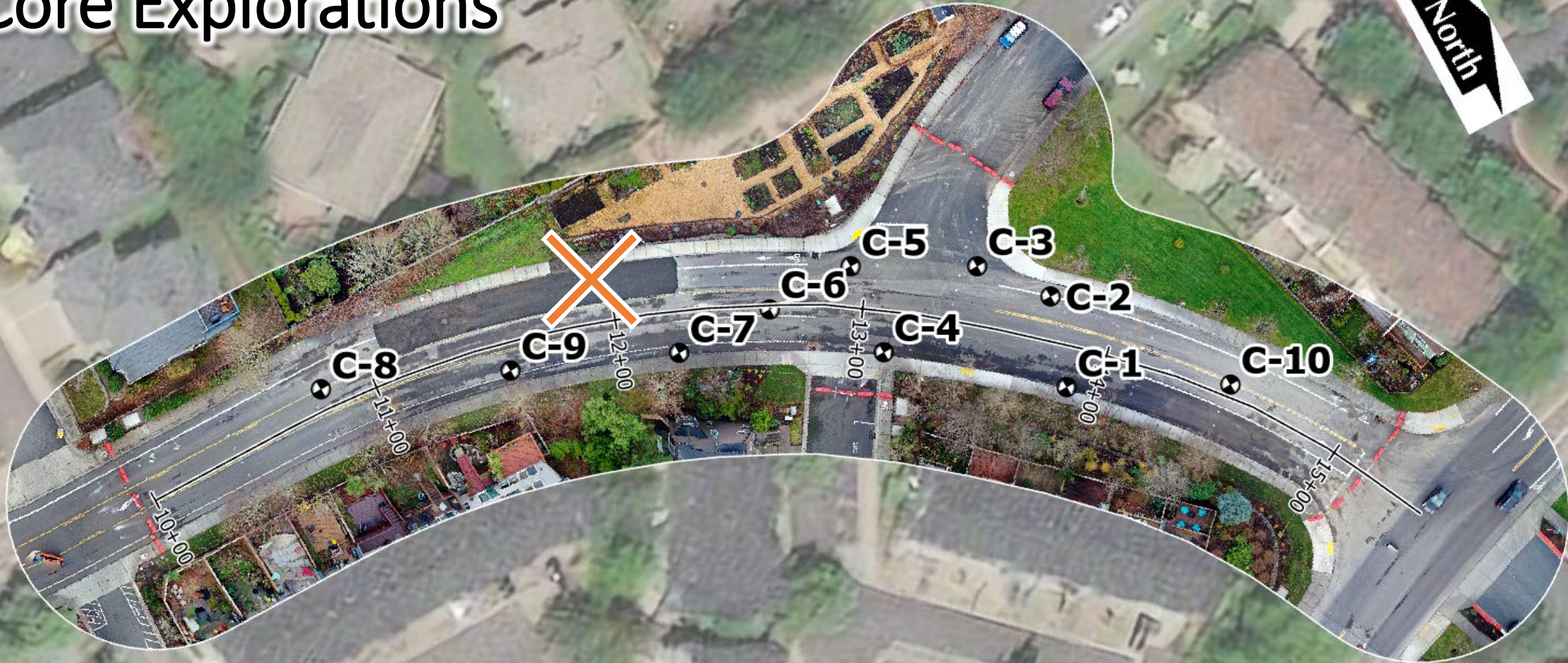
Elev. ~ 350 feet



~12% Slope

Elev. ~ 285 feet

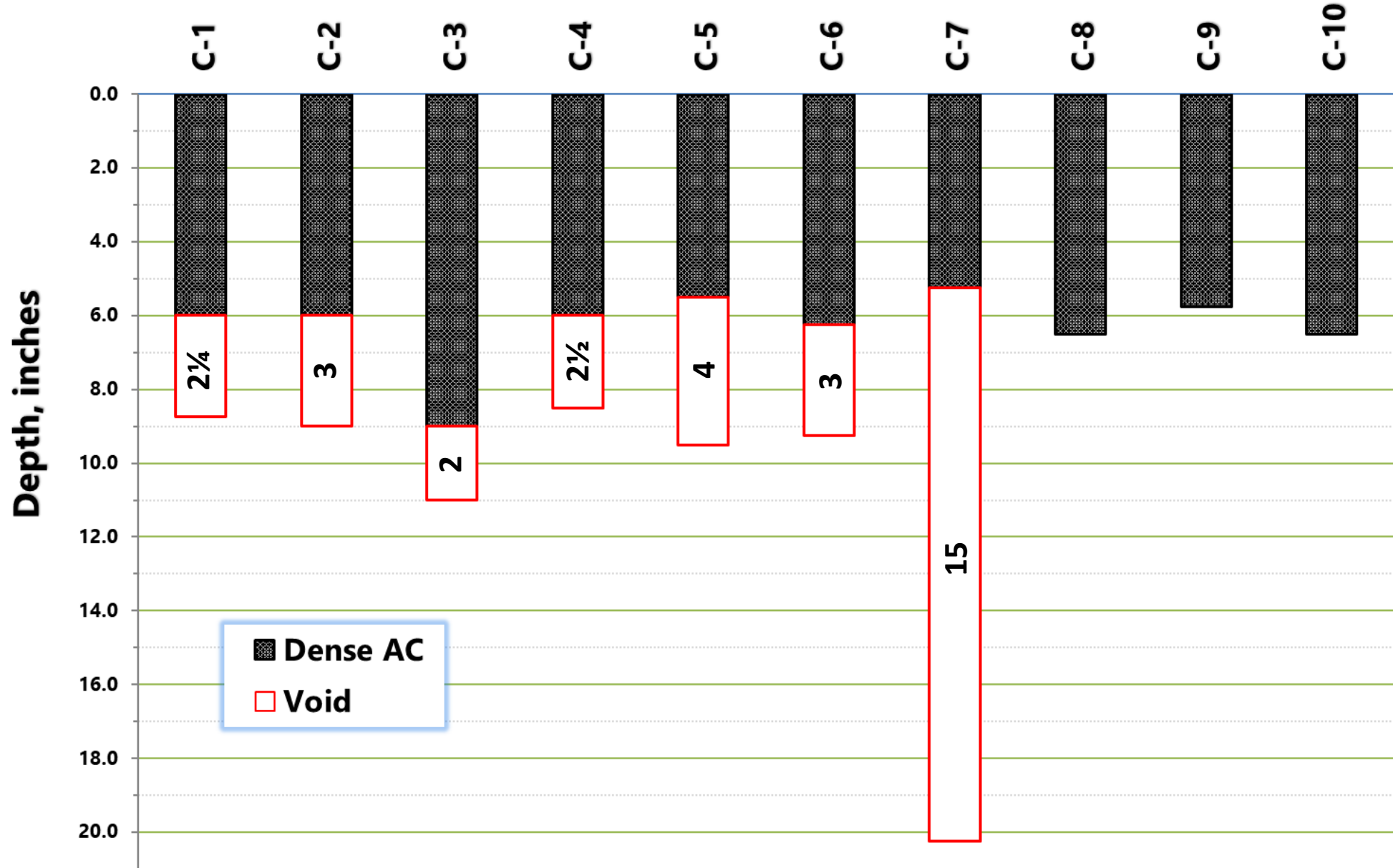
Core Explorations



Core Explorations



Core Number



GPR Survey

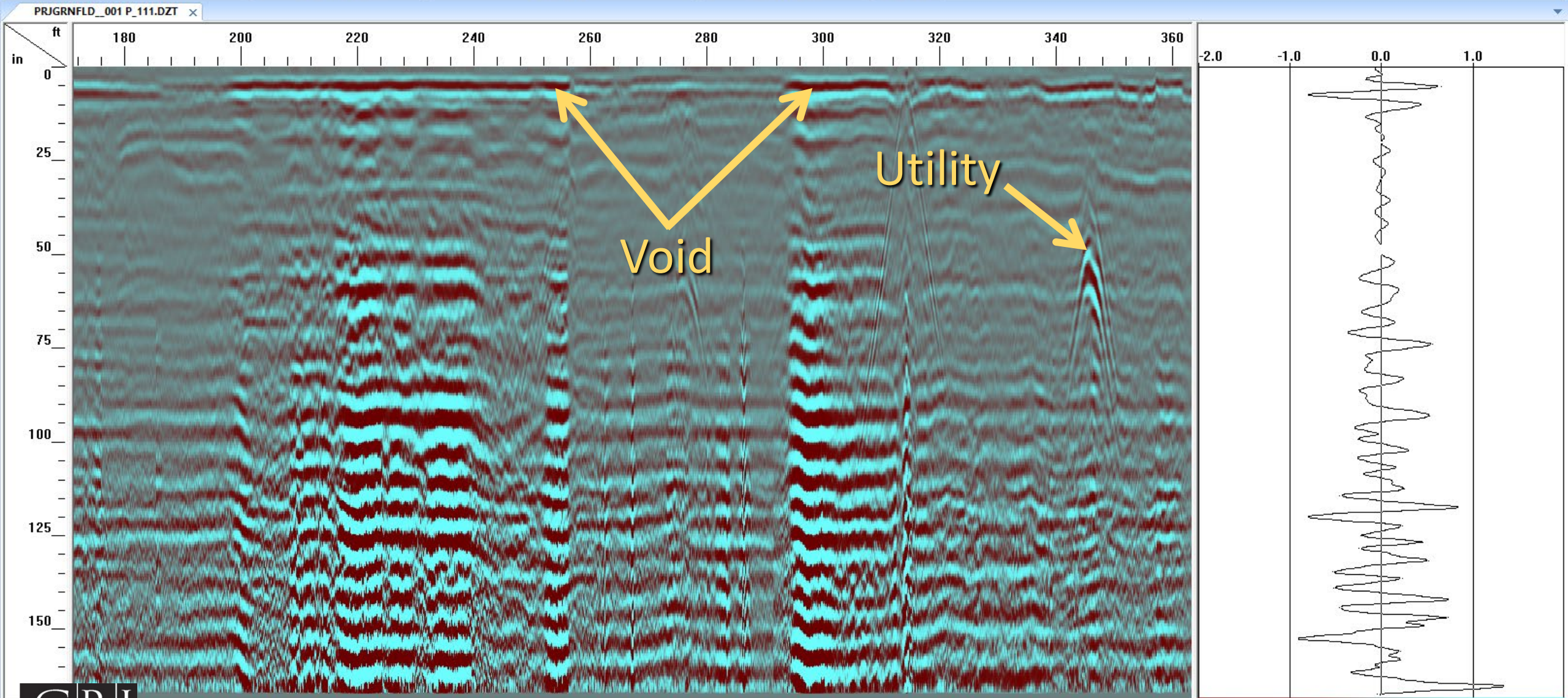




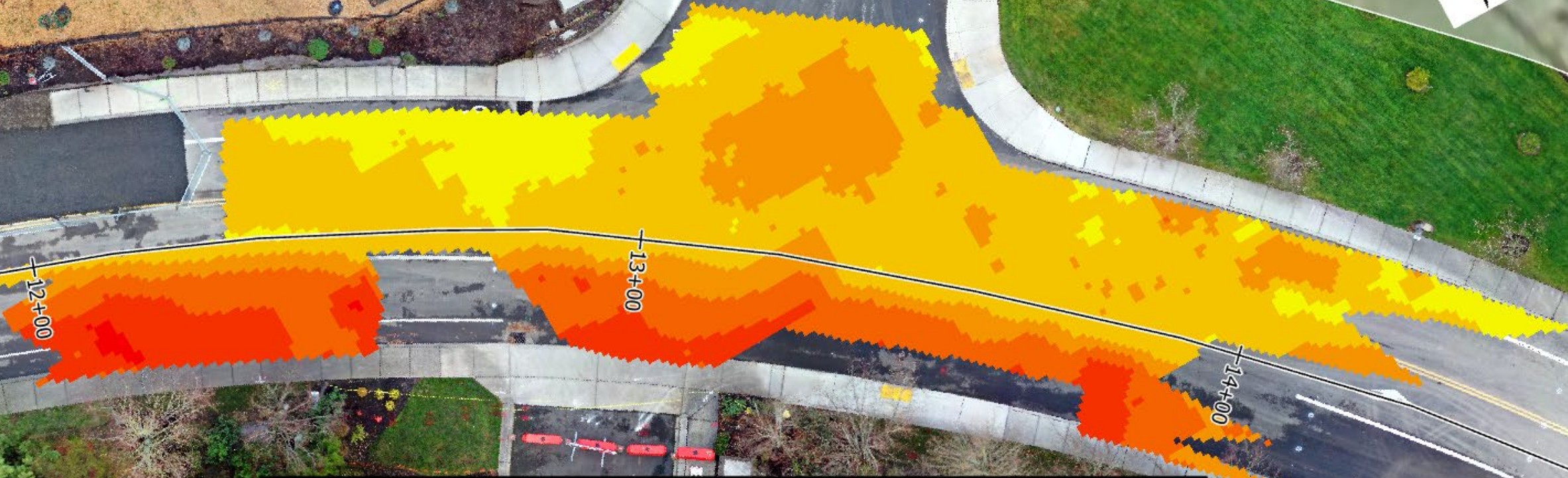
GPR Data Analysis

Home View Easy Processing Processing 2D Interactive RoadScan Google Earth®

Select Range EZ Tracker Global Options CSV File
 Round Truth Start Settings Excel
 Stop Display Gain: -6 KML File
 Other Options Export



GPR Analysis Results



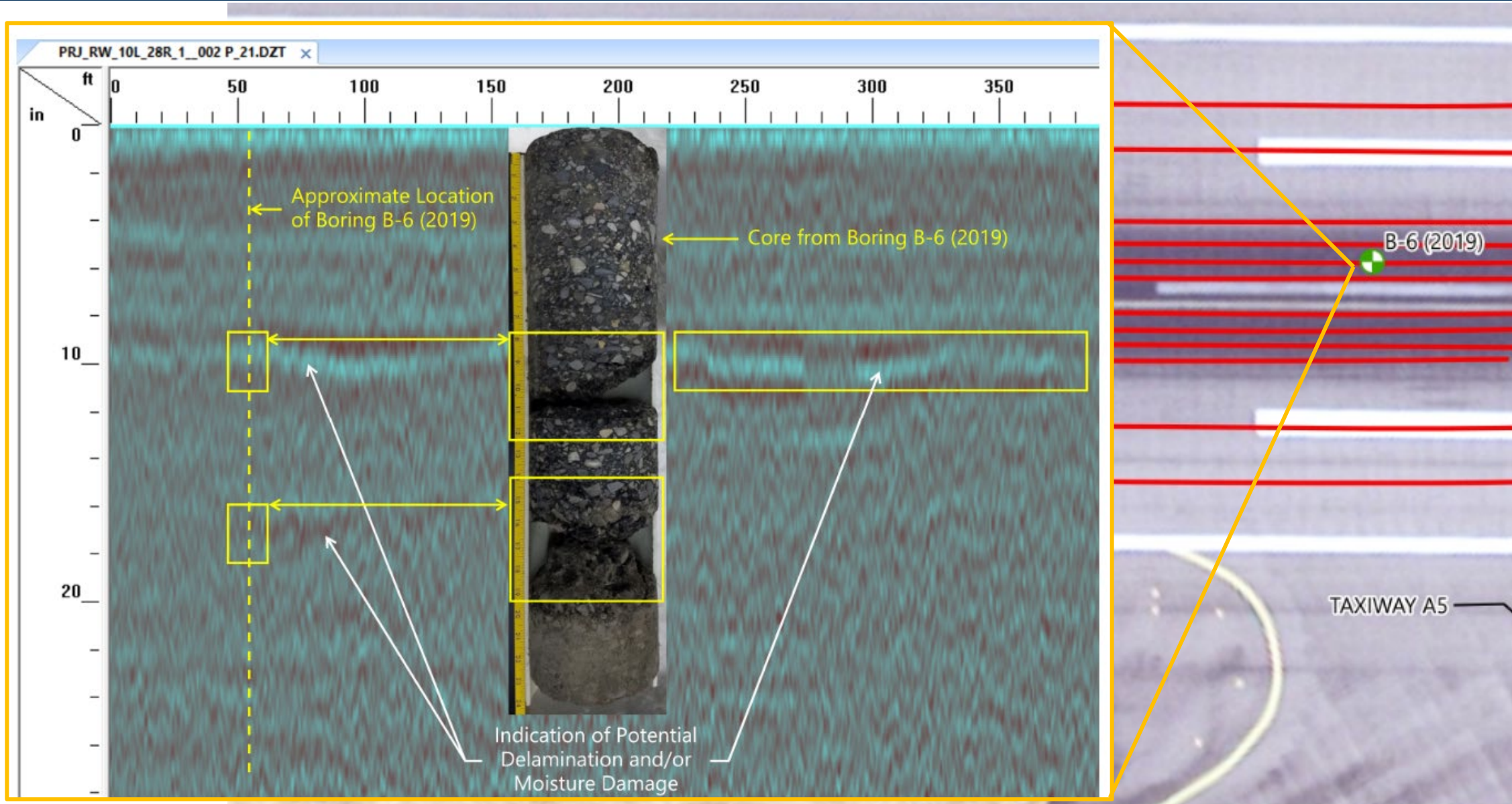
Approximated Void Depth, inches

0-3	6-9	12-15
3-6	9-12	15-17

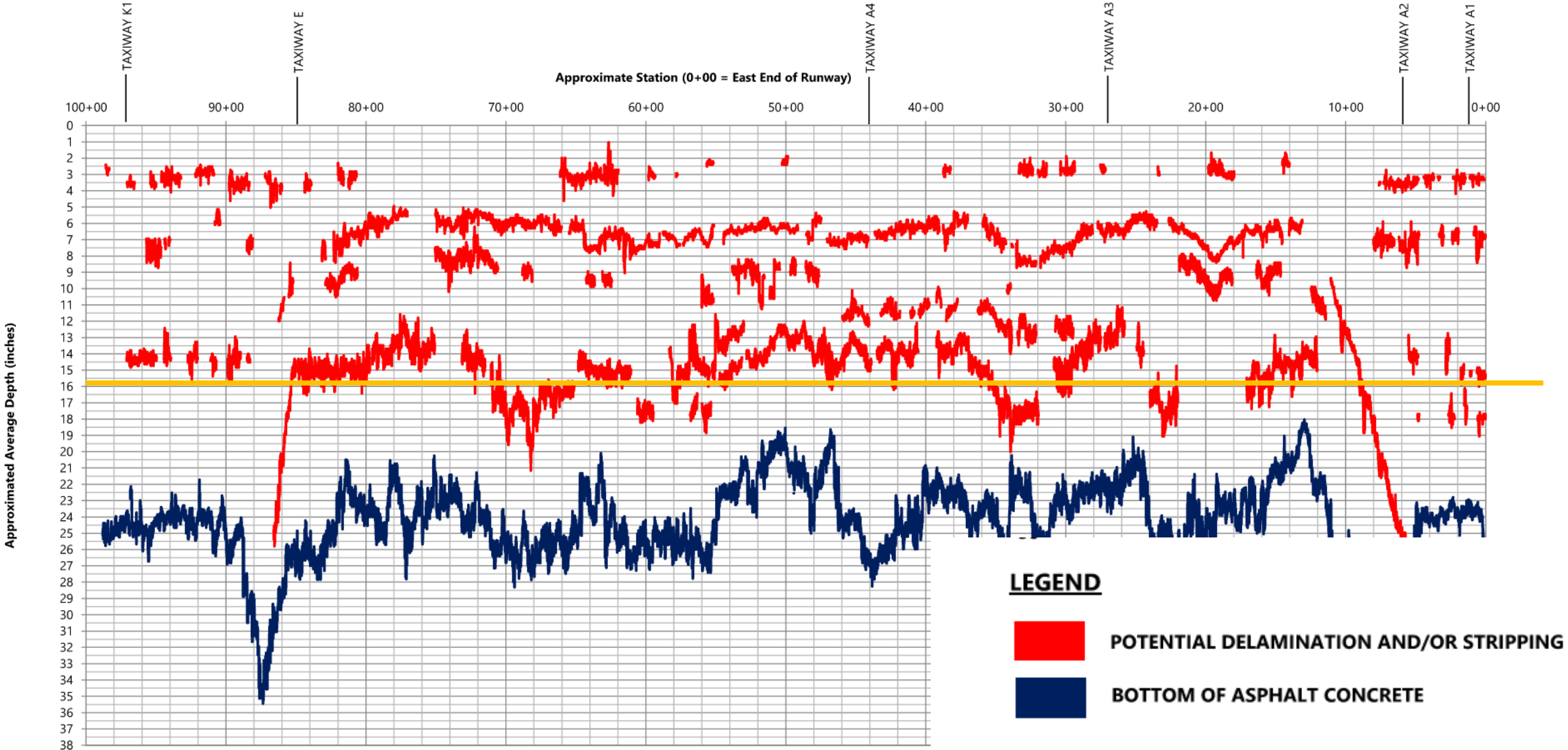
PROJECT 4 – PDX North Runway 10L/28R



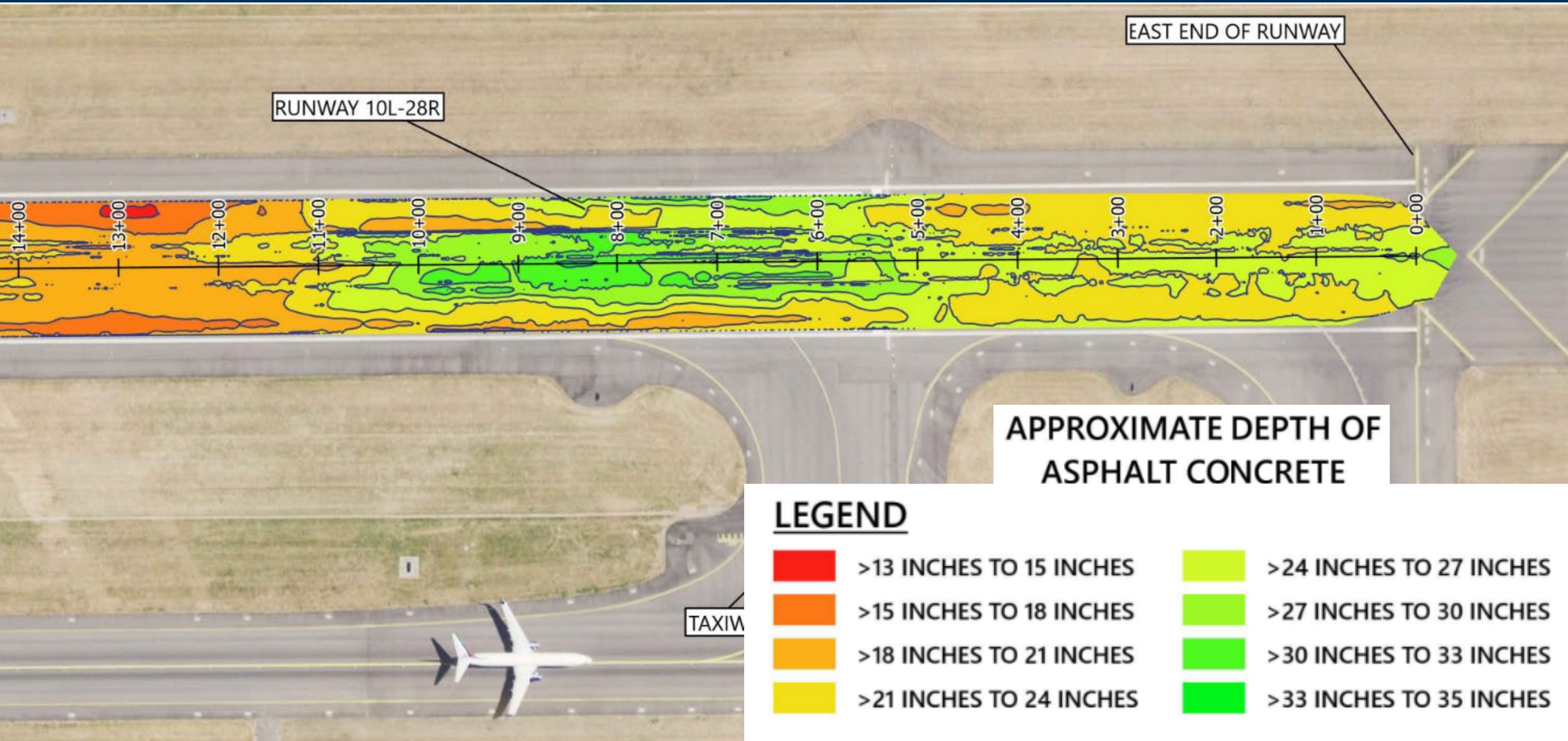
Data Collection (GPR + Borings)



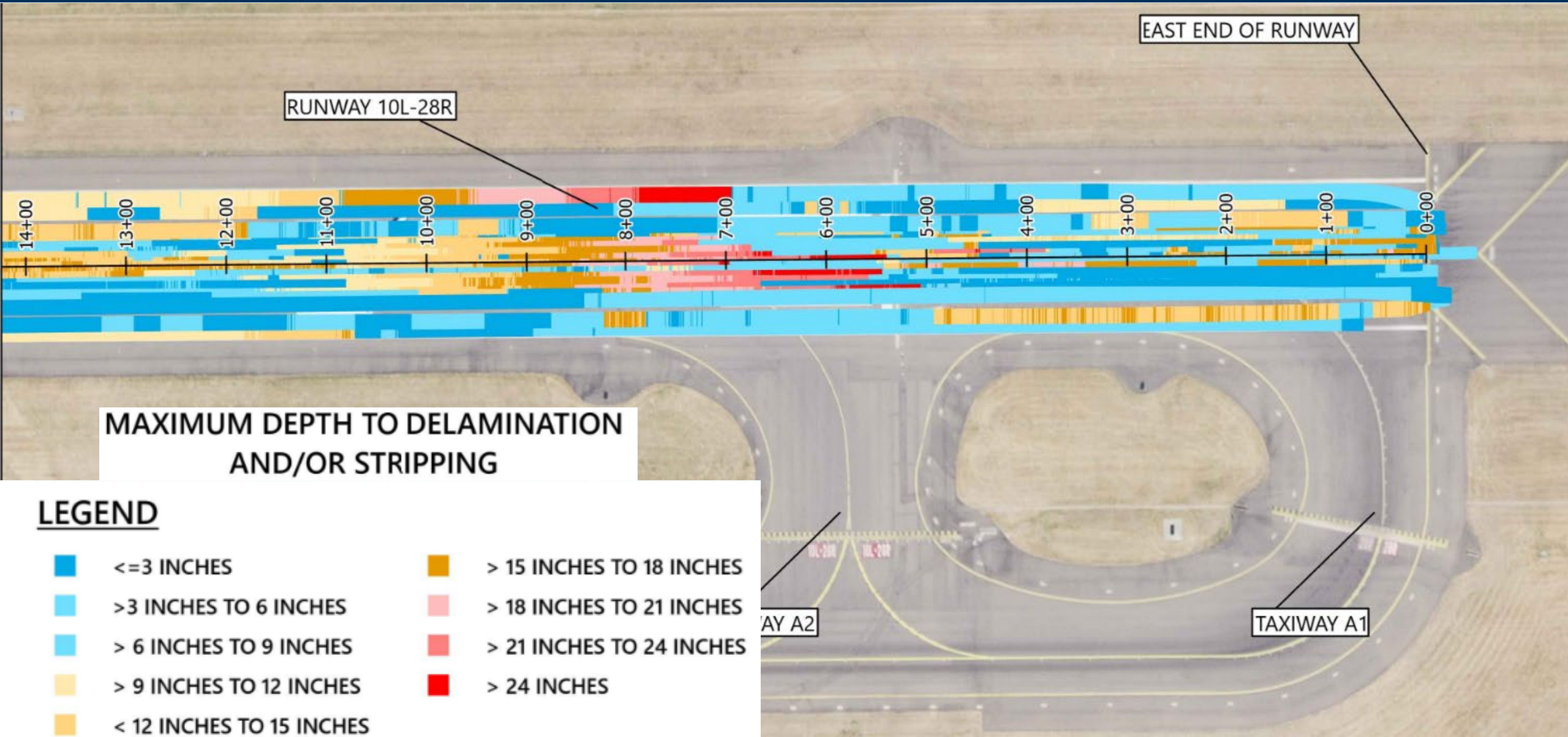
GPR Data Results – 5 Feet N Centerline



GPR Data Results



GPR Data Results



Concluding Comments

GPR IS A VERY USEFUL TOOL FOR DETECTING:

- **Pavement surfacing layer(s) thickness**
- **Delamination depth(s)**
- **Dowel bar/reinforcing steel depth**
- **Depth and location of buried features/utilities**
- **Voids below the pavement surfacing material**

QUESTIONS?



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Hazmat



Geologic
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Laboratory
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Engineering



Construction
Services



Seismic
Engineering



Alternative
Delivery

Where we are located:

