SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Non-Destructive Data Collection for Airport Infrastructure

September 16, 2010

Darel Mesher, PhD, P.Eng

EBA ENGINEERING
A Tetra Tech Company

Contents

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Technologies

- Inertial Profiling
- Ground Penetrating Radar
- Terrestrial LiDAR
- 3D Digital Imagery
- Pavement Strength
- Friction Testing

Applications

EBA ENGINEERING
A Tetra Tech Company

Contents

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Technologies

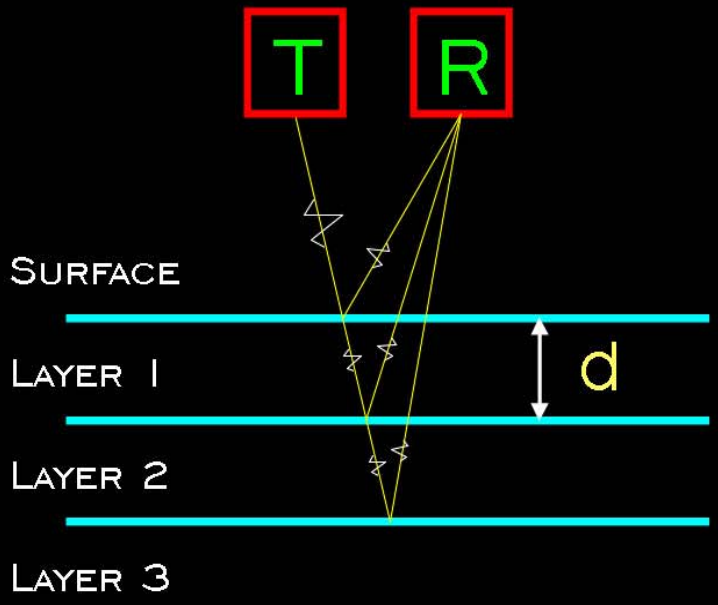
- Inertial Profiling
- Ground Penetrating Radar
- Terrestrial LiDAR
- 3D Digital Imagery
- Pavement Strength
- Friction Testing

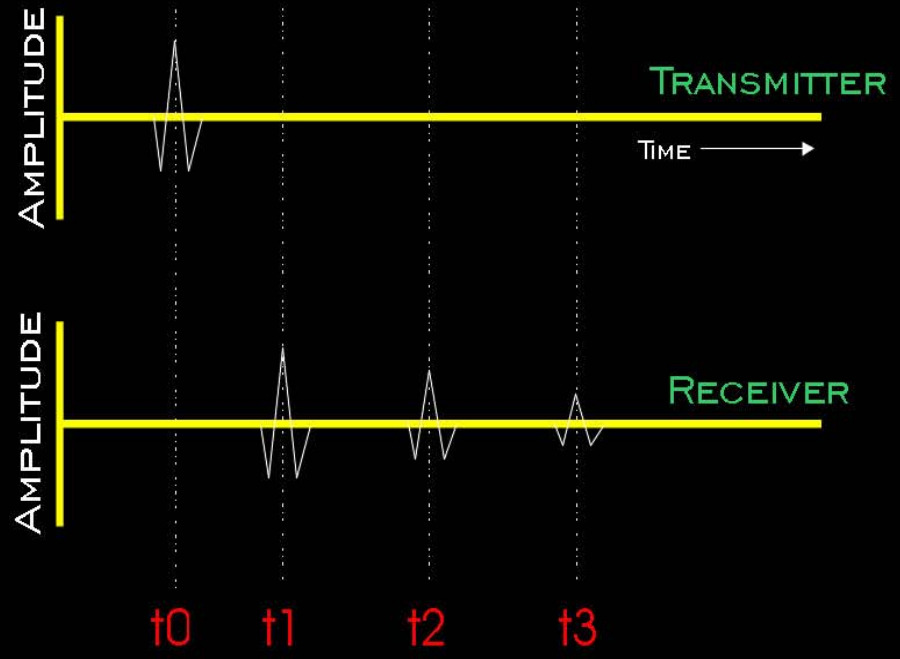
Applications

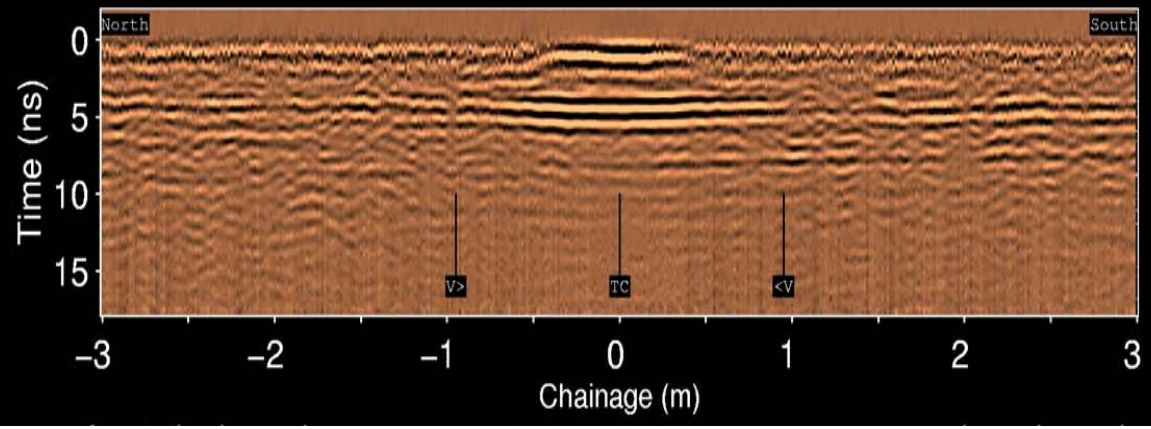
EBA ENGINEERING
A Tetra Tech Company

Radar Theory

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES







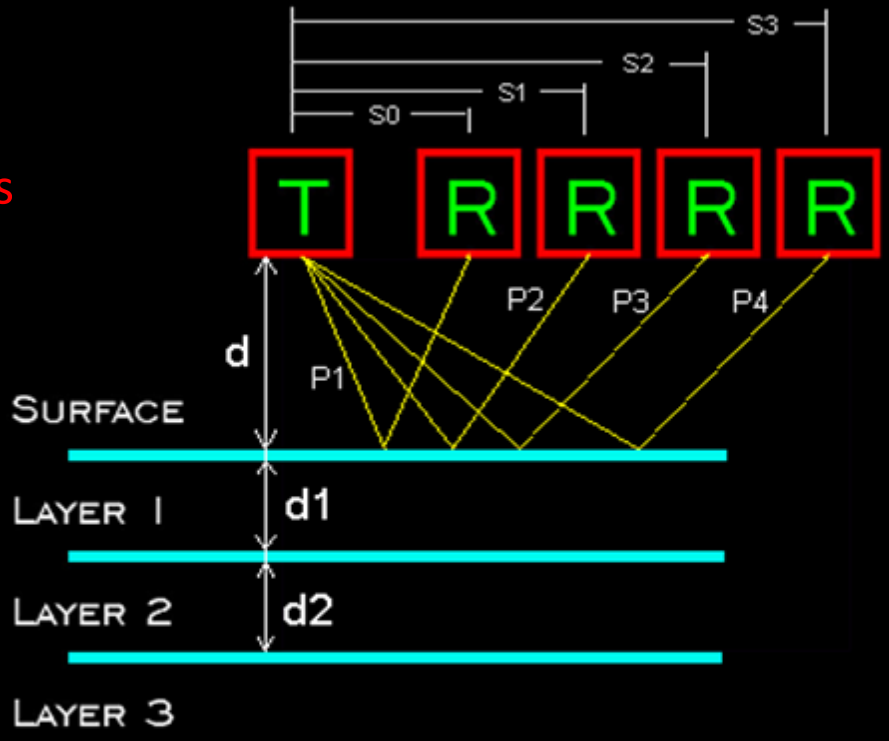
GRAPHICAL RADAR DATA WINDOW

Radar Array

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

If we use a Multiple Receiver Array configuration we able able to:

- Calculate Layer Depth
- Calculate Layer Electrical Properties



Result:

- Measure Layer Thickness Accurately
  (without the need for destructive cores for calibration)
- Detect variations in in-situ material properties continuously

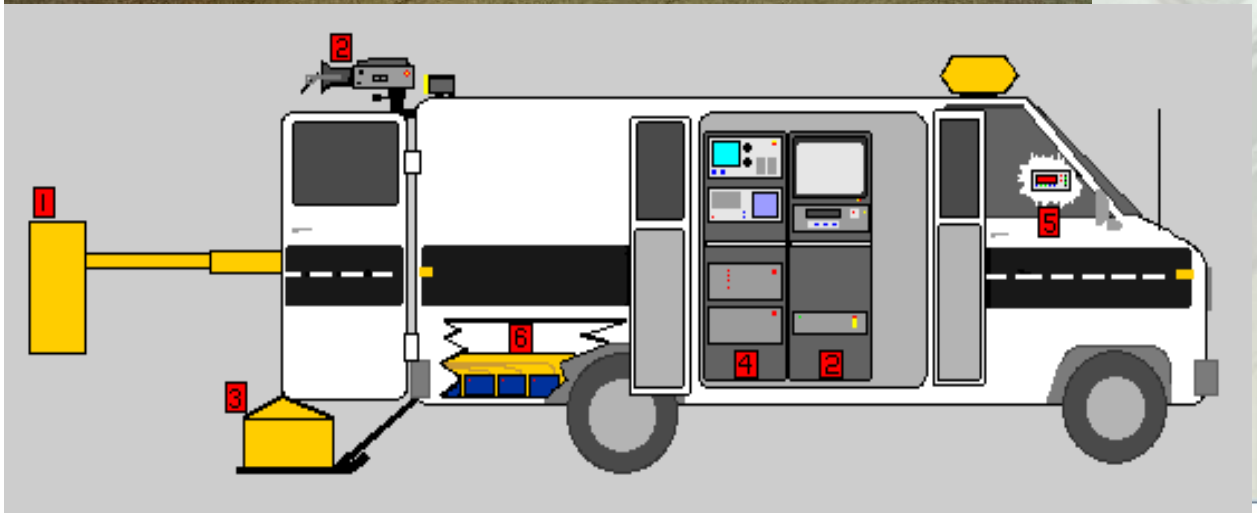
The Road Radar™ System

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Specifications

- Max Penetration Depth: 2m
- Min Layer Thickness: 50mm

- Accuracy (uncalibrated): +/- 5%
- Maximum Survey Speed: 100kph



EBA ENGINEERING
A Tetra Tech Company

Structural Verification and Forensic Analysis

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Project: Runway

Taxiway

Length: Runway: 3.8km x 4 lines

Taxiway: 65m x 44 lines

Task: As-built Structure Verification

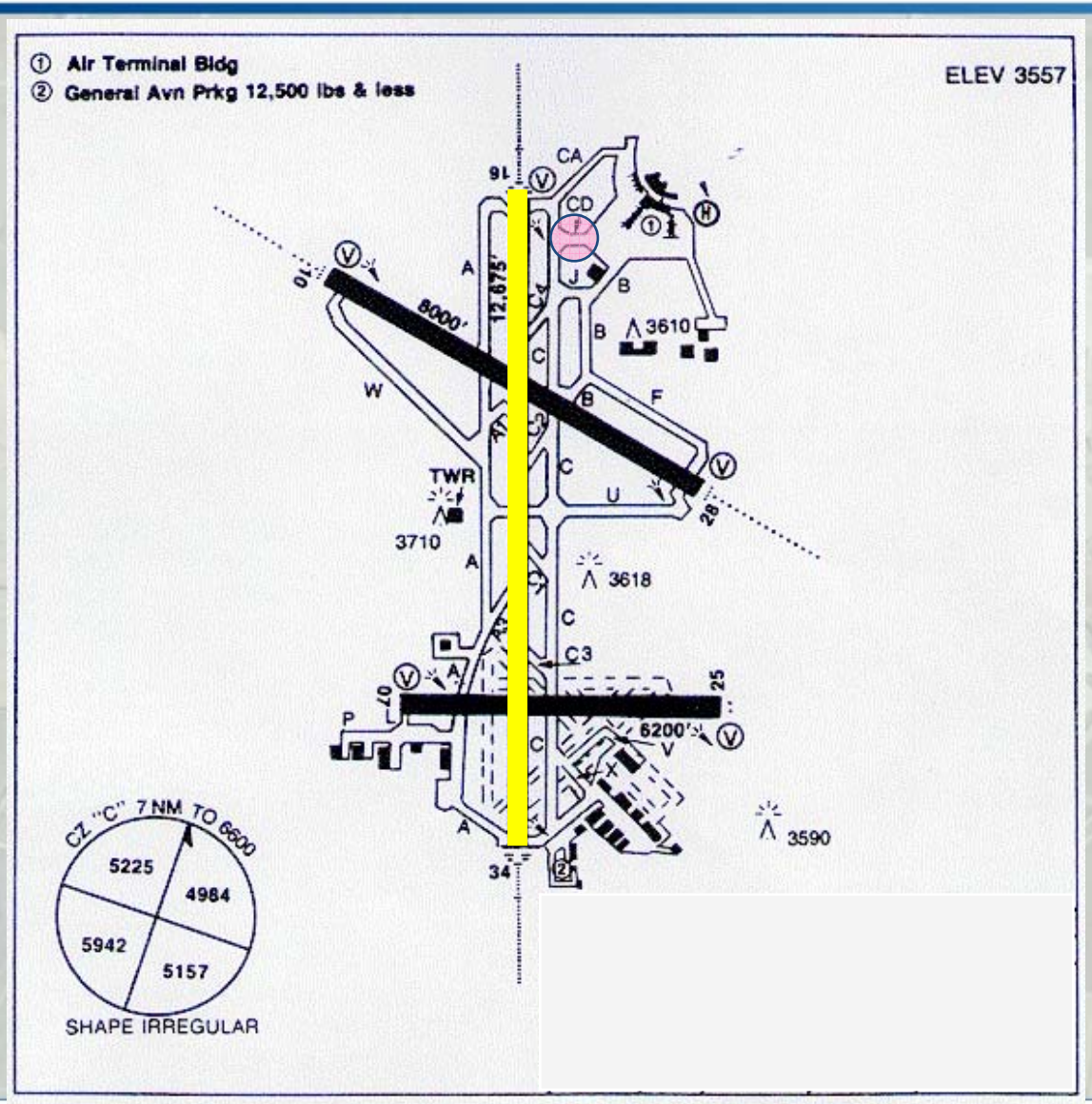
Forensic Analysis

- ACP Deterioration
- Crack Analysis
- PCC Material Property Variations
- Voids

EBA ENGINEERING
A Tetra Tech Company

Structural Verification/Analysis

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



Runway

- 4 Lines
- 3,875m Long
- 0.20m Spacing
- 19,735 Samples/line

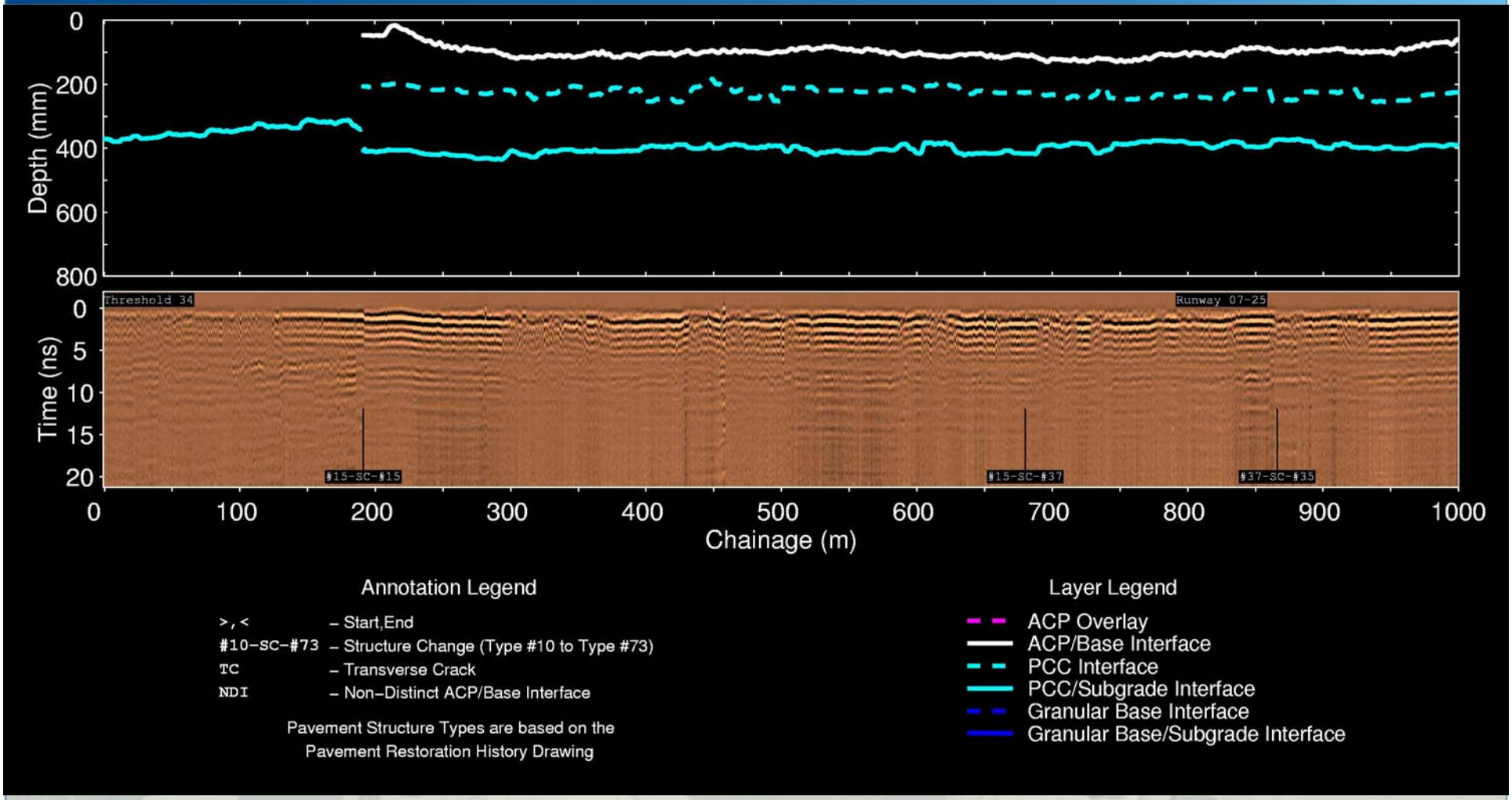
Taxiway

- 44 Lines
- 65m Long
- 0.015m Spacing
- 4,333 Samples/line

EBA ENGINEERING
A Tetra Tech Company

As-Built Structure

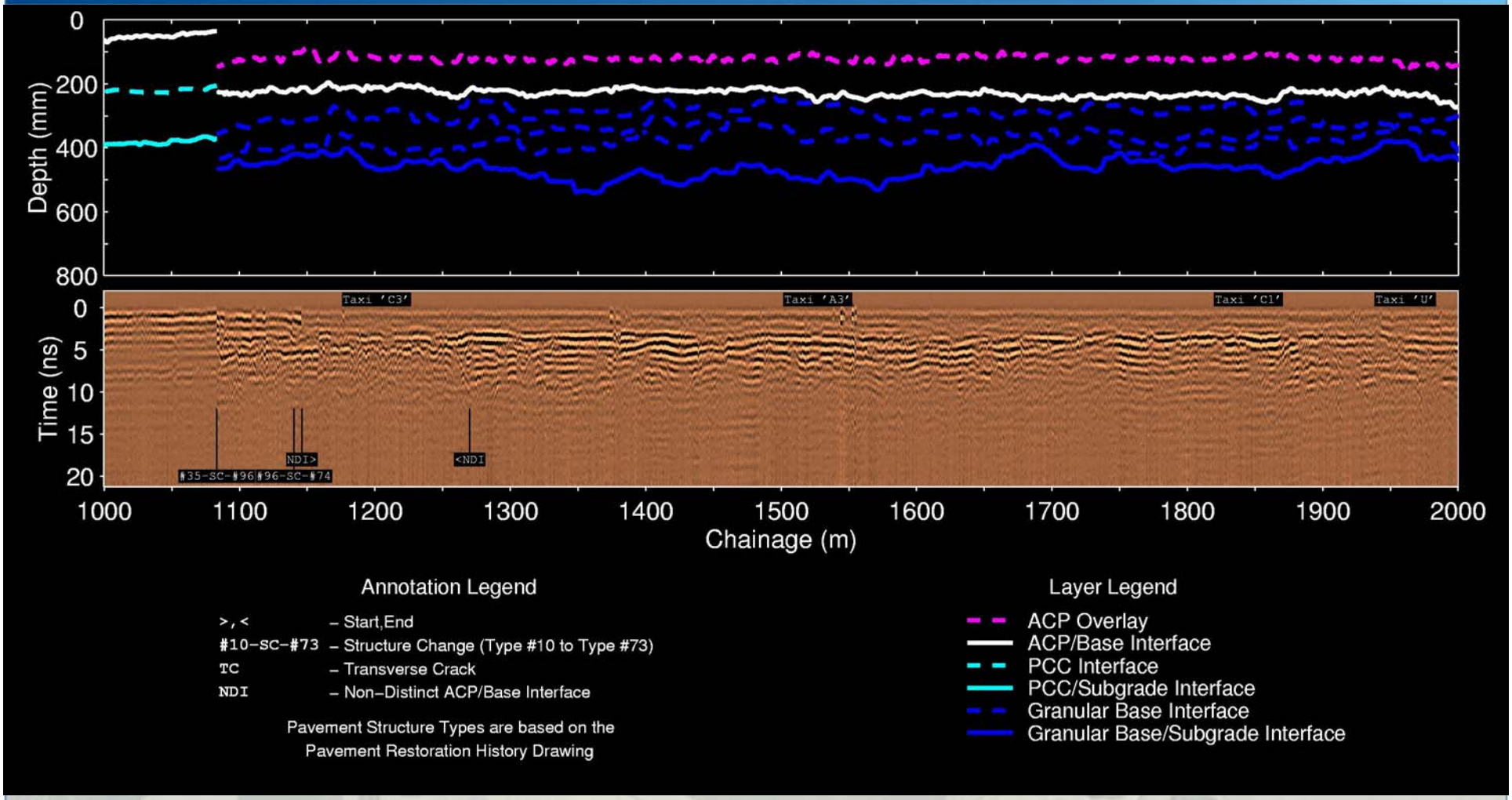
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



EBA ENGINEERING
A Tetra Tech Company

As-Built Structure

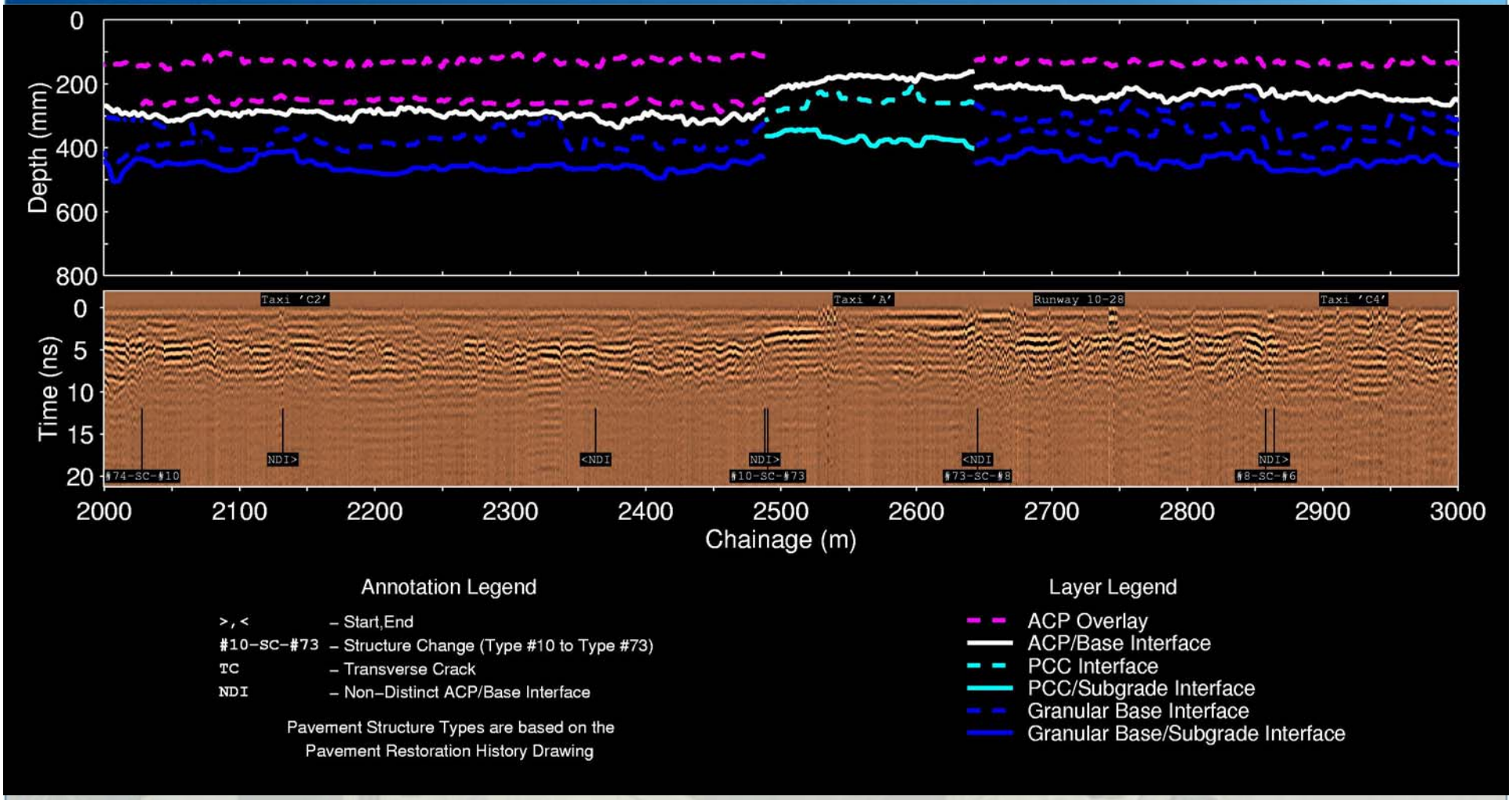
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



EBA ENGINEERING
A Tetra Tech Company

As-Built Structure

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



Annotation Legend

>, <	– Start,End
#10–SC–#73	– Structure Change (Type #10 to Type #73)
TC	– Transverse Crack
NDI	– Non–Distinct ACP/Base Interface

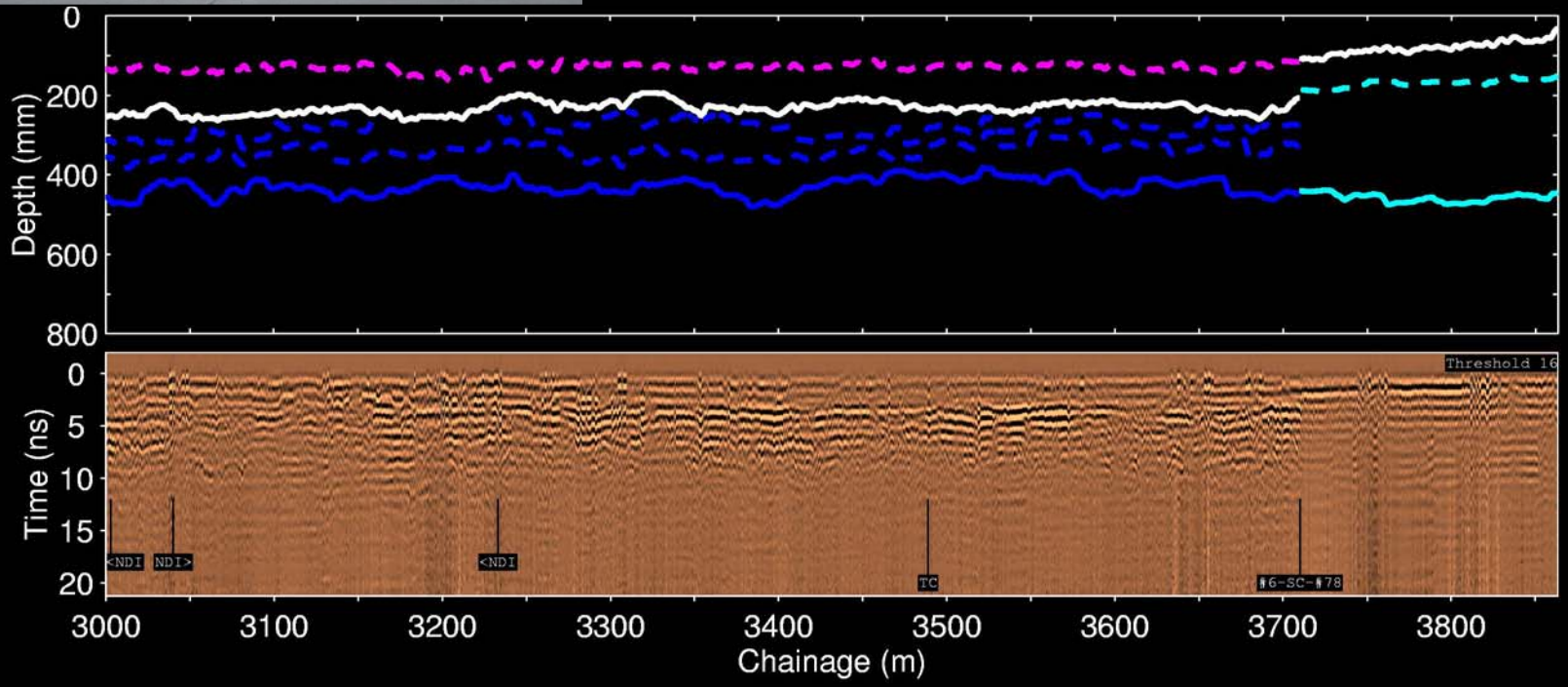
Pavement Structure Types are based on the Pavement Restoration History Drawing

Layer Legend

- ACP Overlay
- ACP/Base Interface
- PCC Interface
- PCC/Subgrade Interface
- Granular Base Interface
- Granular Base/Subgrade Interface

EBA ENGINEERING
A Tetra Tech Company

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



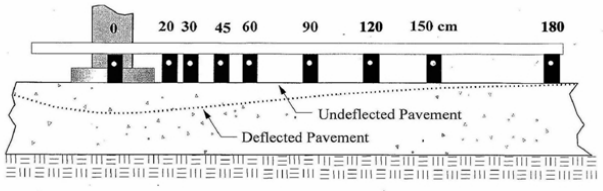
Annotation Legend

>, <	– Start,End
#10–SC–#73	– Structure Change (Type #10 to Type #73)
TC	– Transverse Crack
NDI	– Non–Distinct ACP/Base Interface

Pavement Structure Types are based on the
ory Drawing

Layer Legend

- ACP Overlay
- ACP/Base Interface
- PCC Interface
- PCC/Subgrade Interface
- Granular Base Interface
- Granular Base/Subgrade Interface



EBA ENGINEERING
A Tetra Tech Company

Runway Core

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

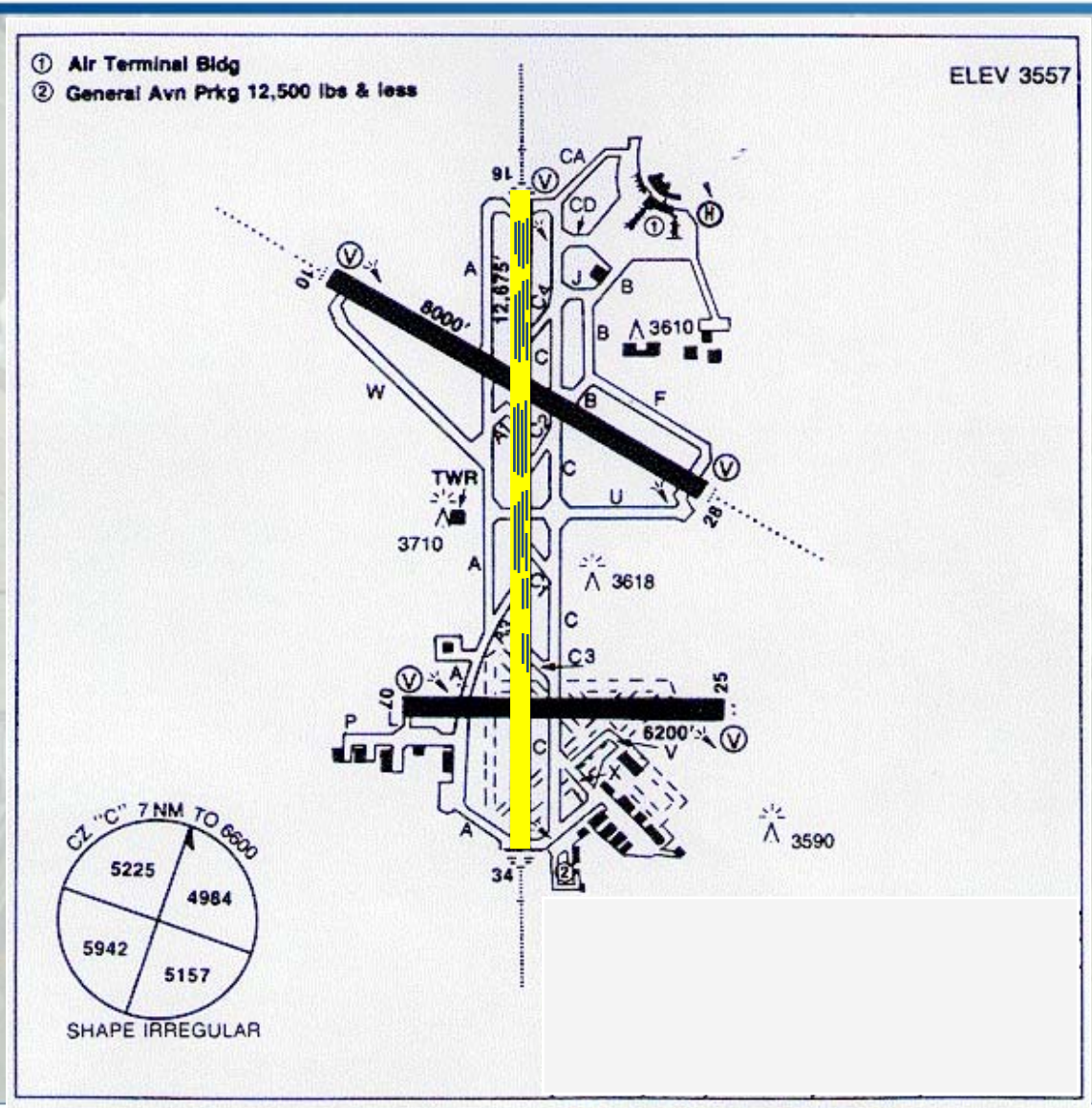
Multiple ACP Layers

Stripped Original ACP

EBA ENGINEERING
A Tetra Tech Company

ACP/BASE Anomaly

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



EBA ENGINEERING
A Tetra Tech Company

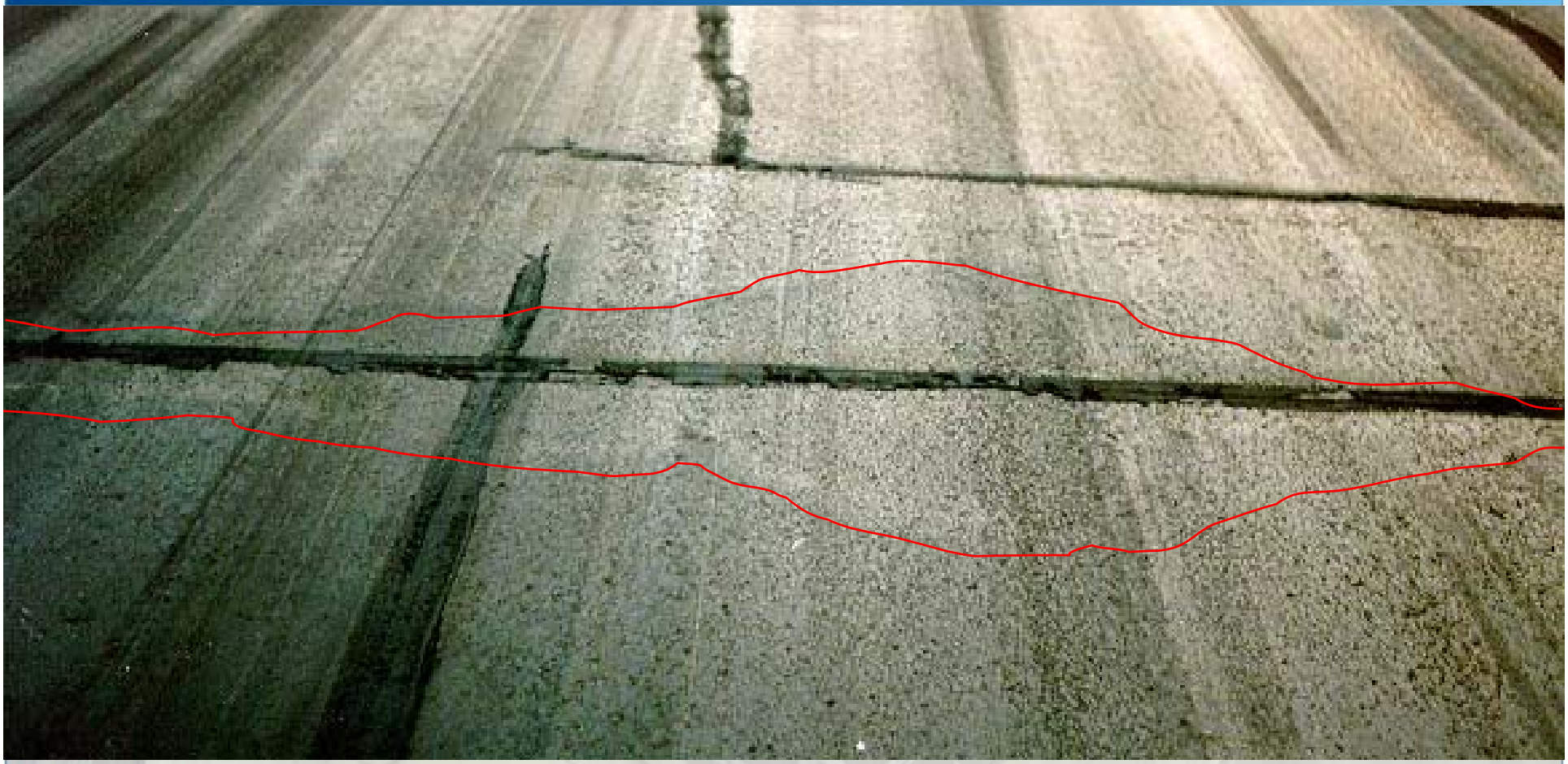
Crack Analysis

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

EBA ENGINEERING
A Tetra Tech Company

Crack Analysis

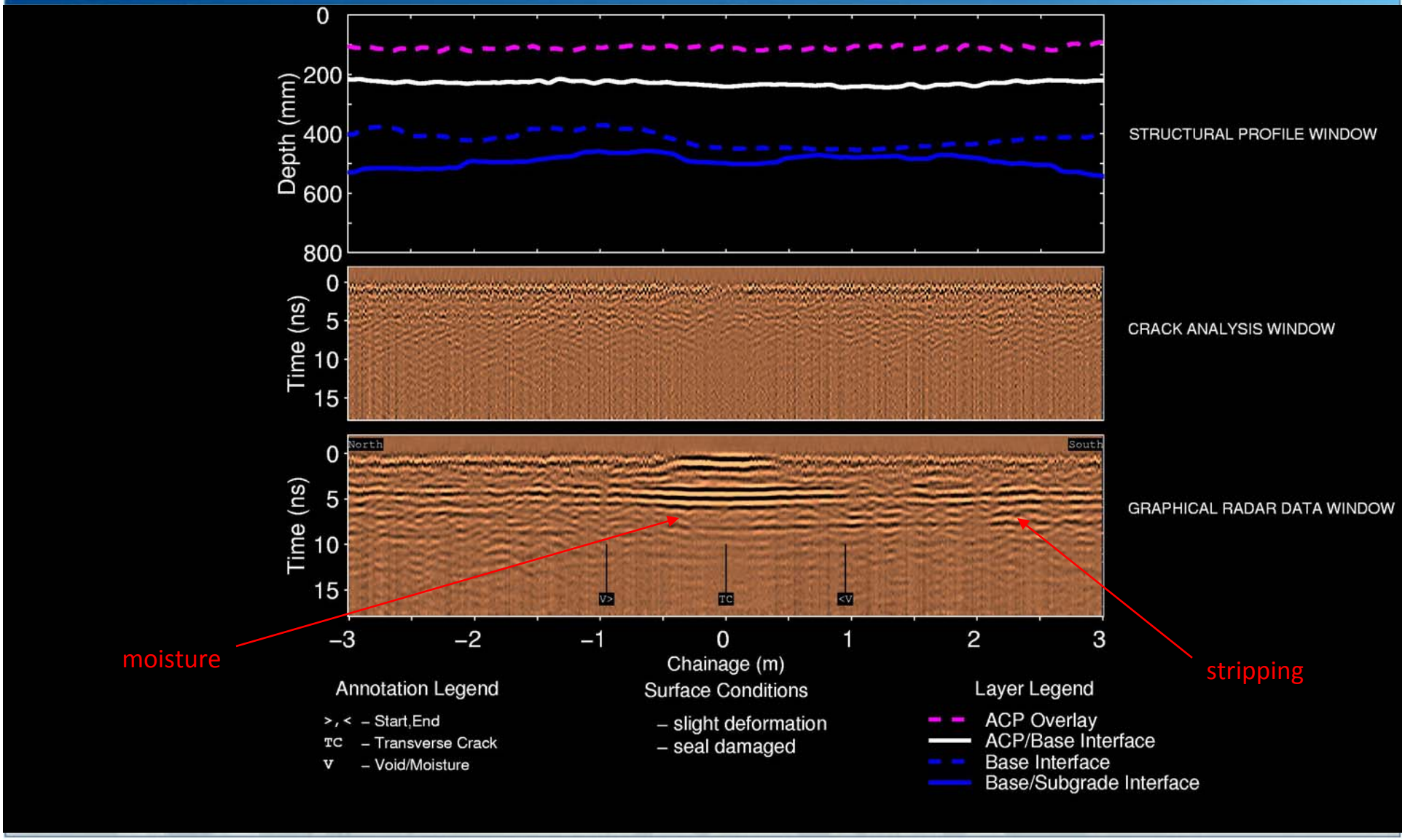
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



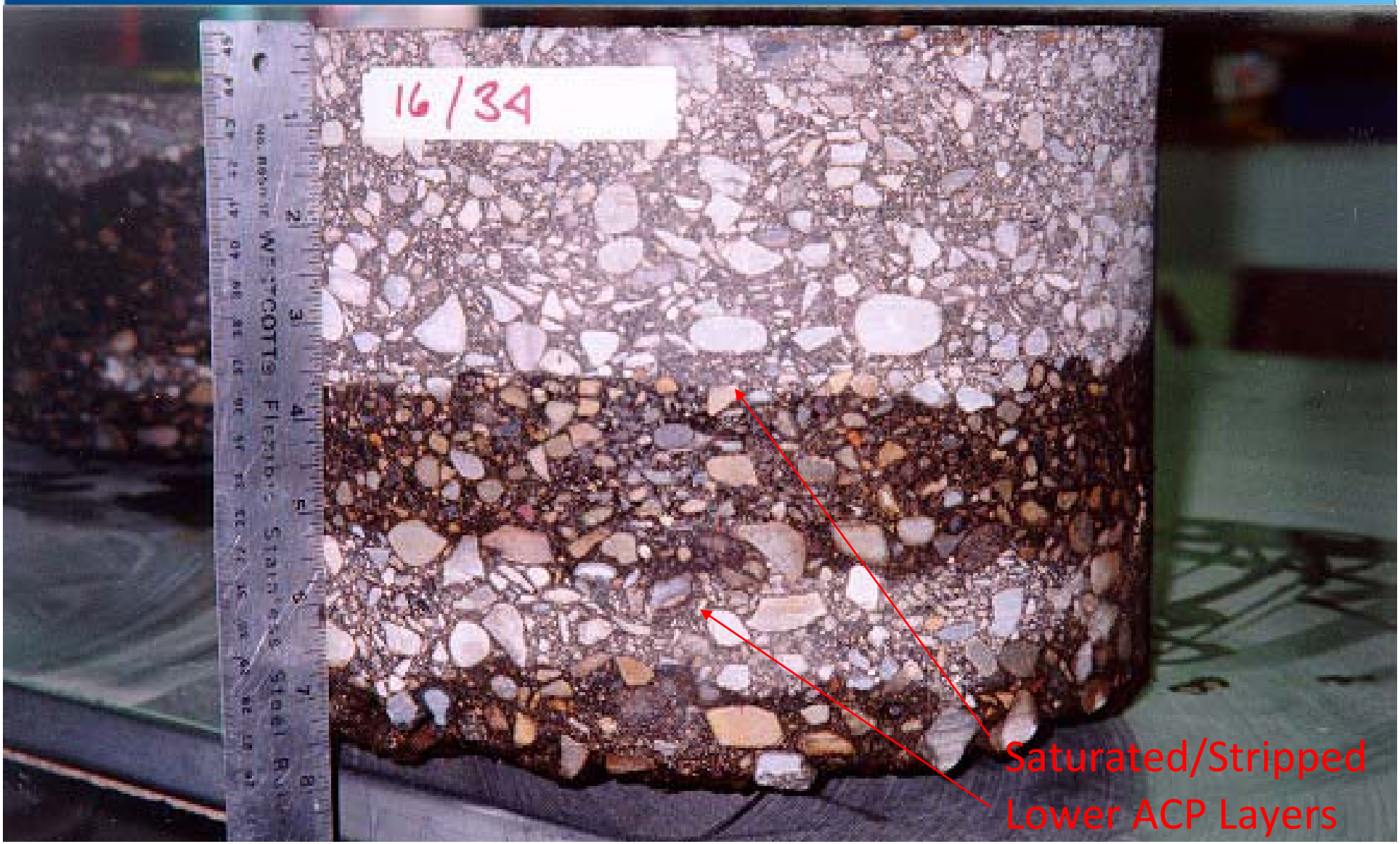
EBA ENGINEERING
A Tetra Tech Company

Radar Analysis

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

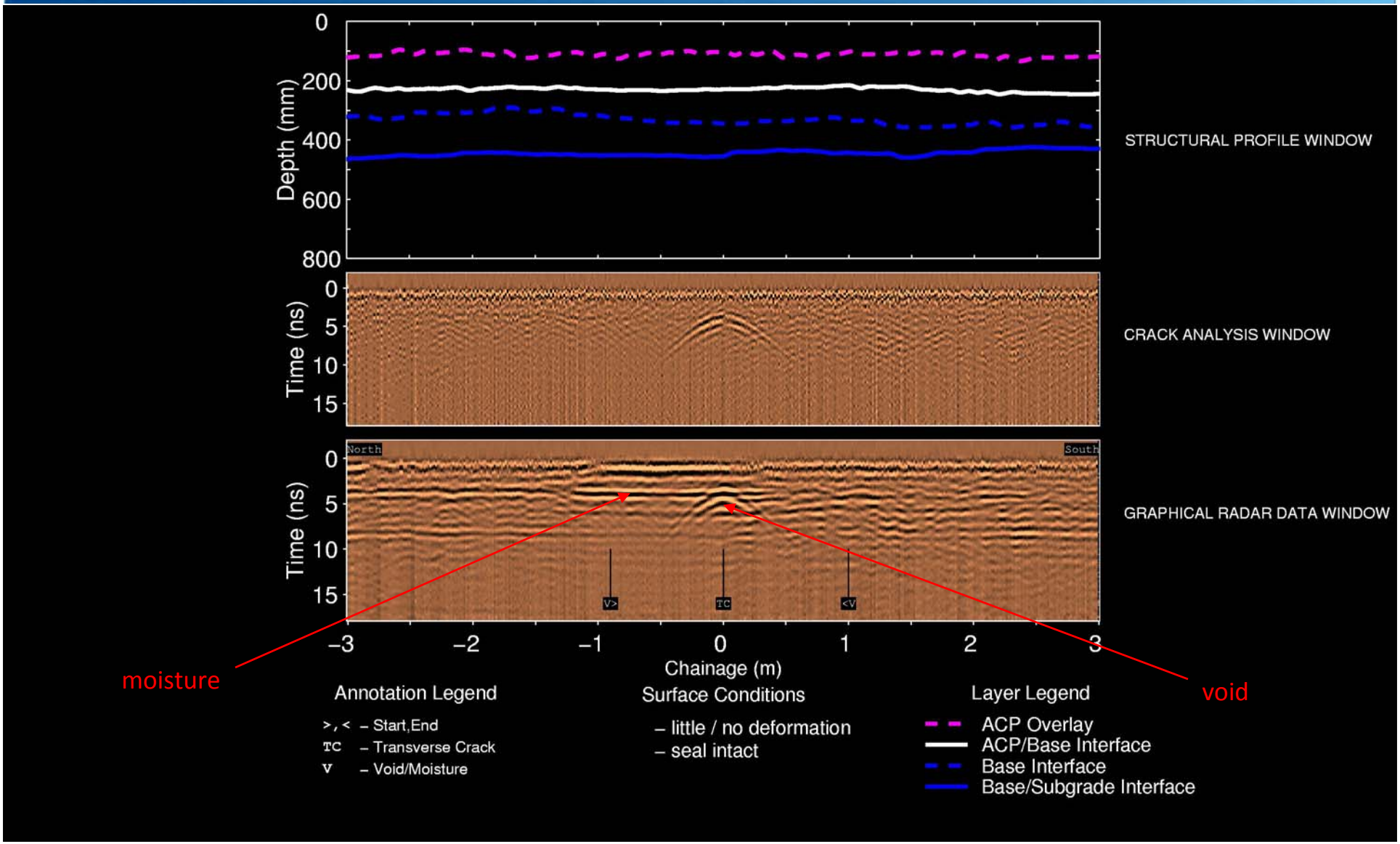


Core Near Transverse Crack

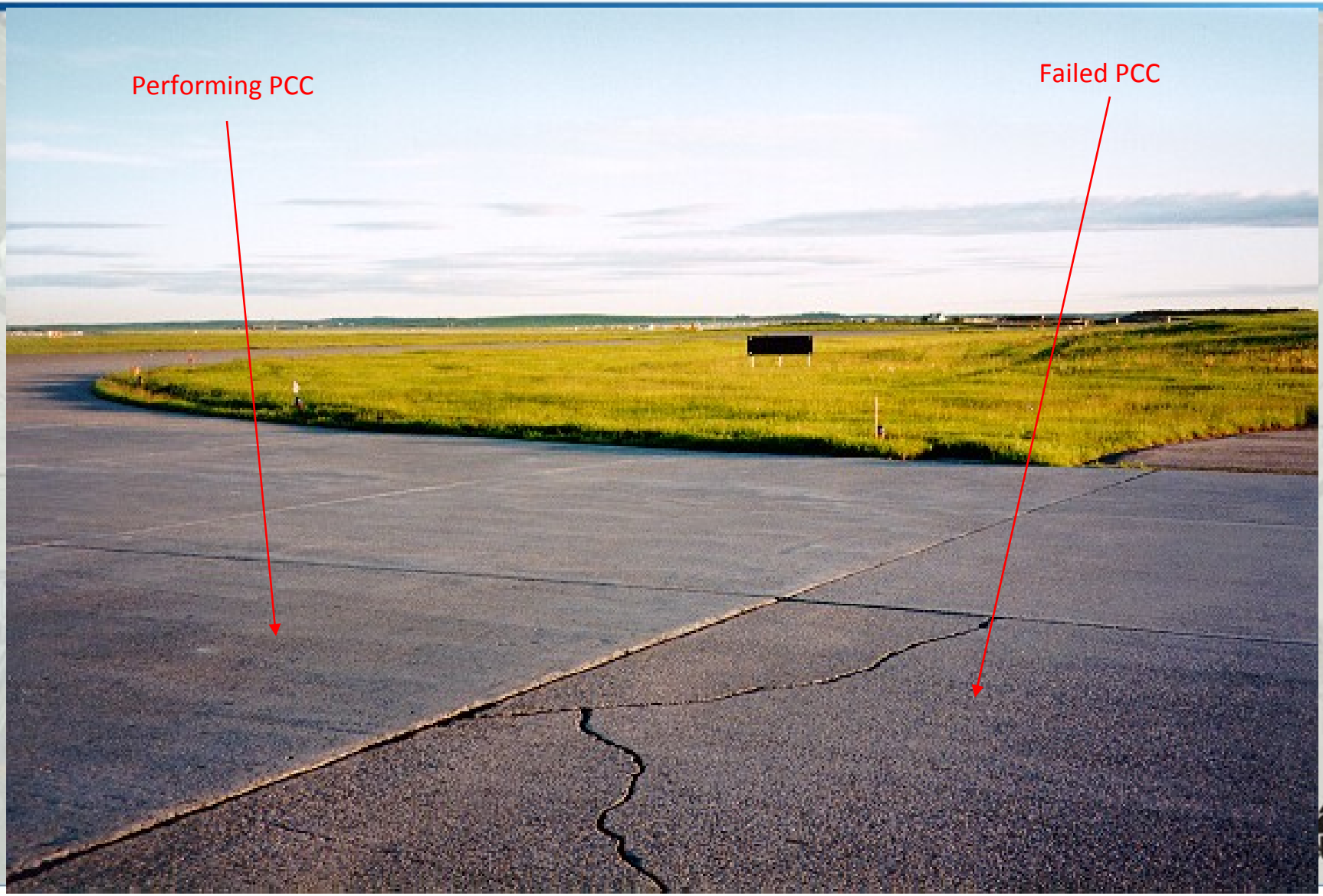


Radar Analysis

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

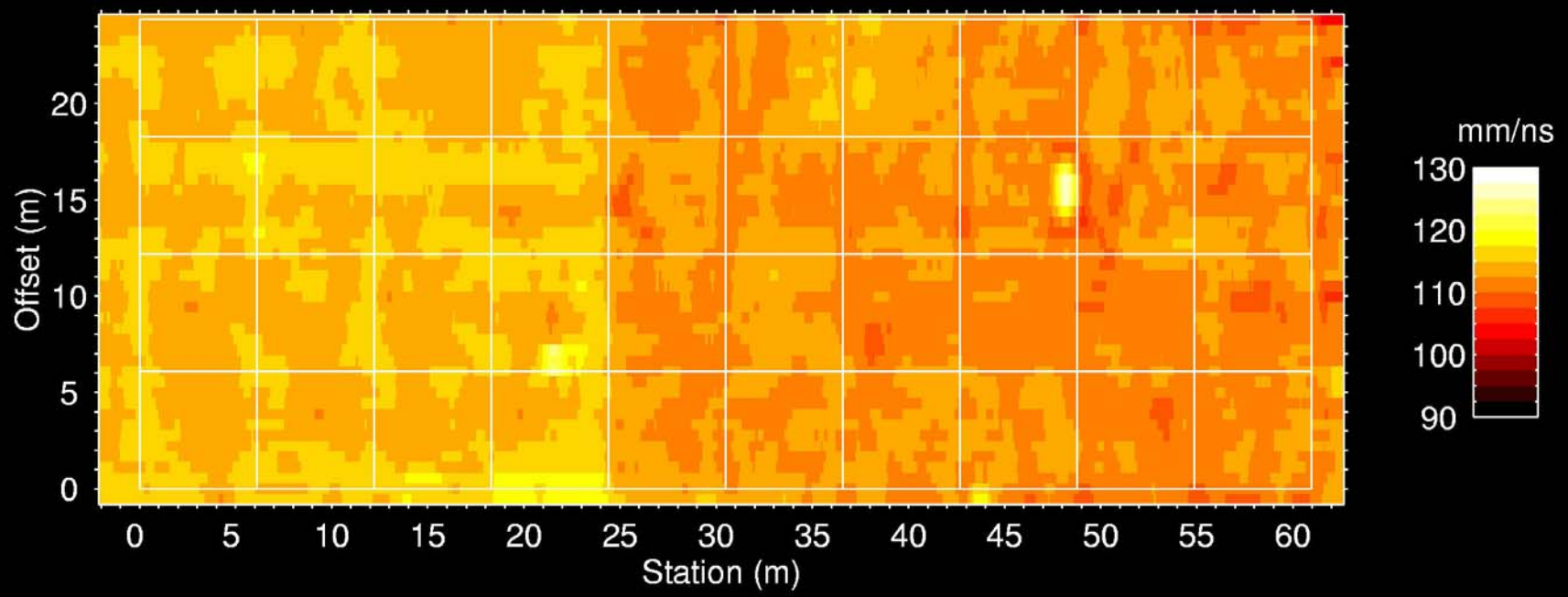


Taxiway



PCC Material Properties

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



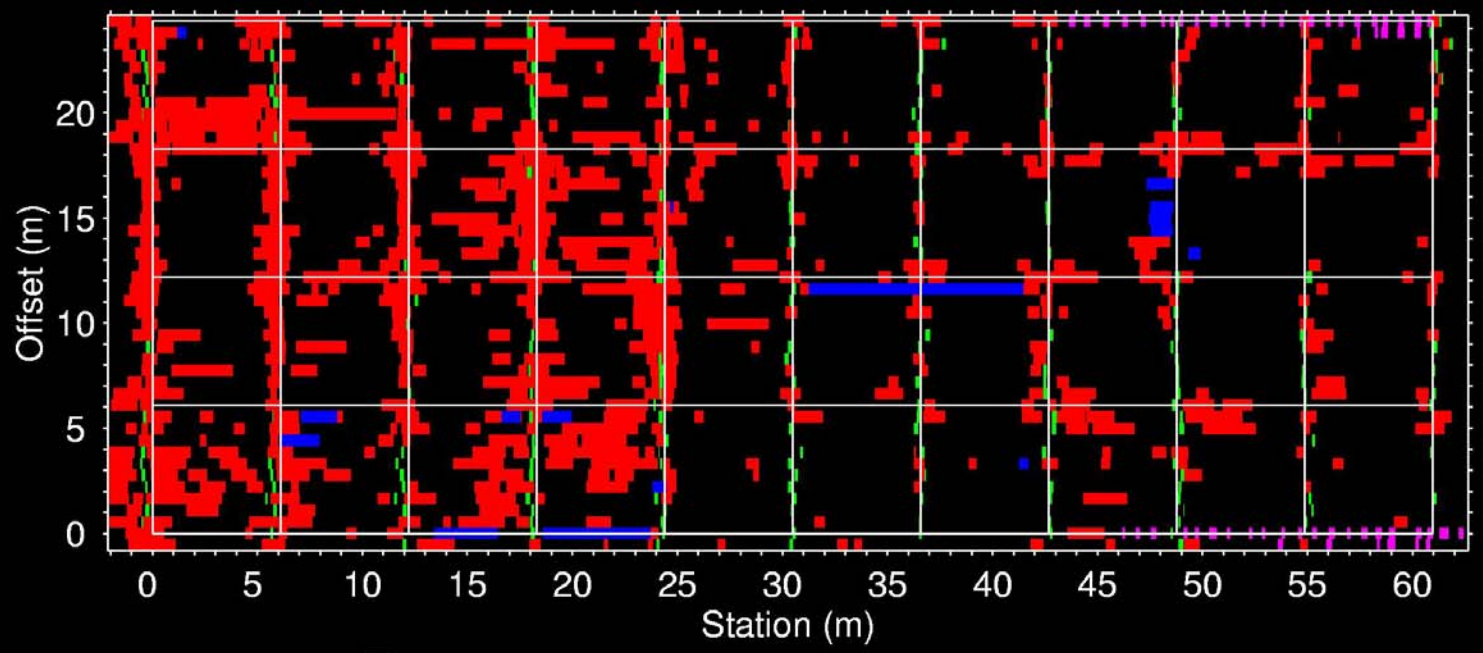
EBA ENGINEERING
A Tetra Tech Company

Void Analysis

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

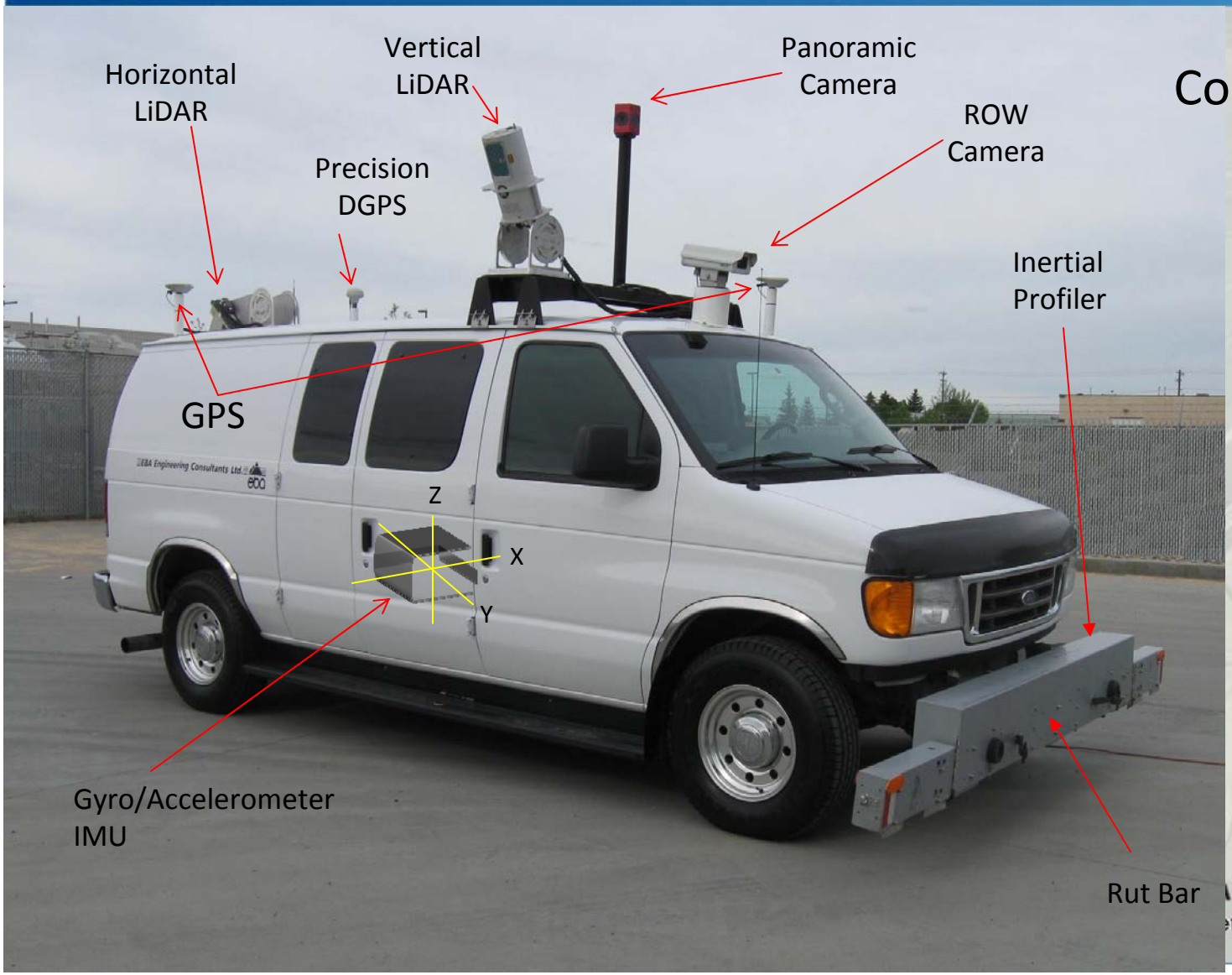
Subsurface Anomalies

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



Data Collection Vehicle

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



Collected Data:

- Longitudinal Profile
- Transverse Profile
- Geometrics
- ROW Images
- Panoramic Images
- Surface LiDAR
- 3D LiDAR
- Surface Distress
- Spatial Reference Synchronization

ENGINEERING
Tetra Tech Company
eba

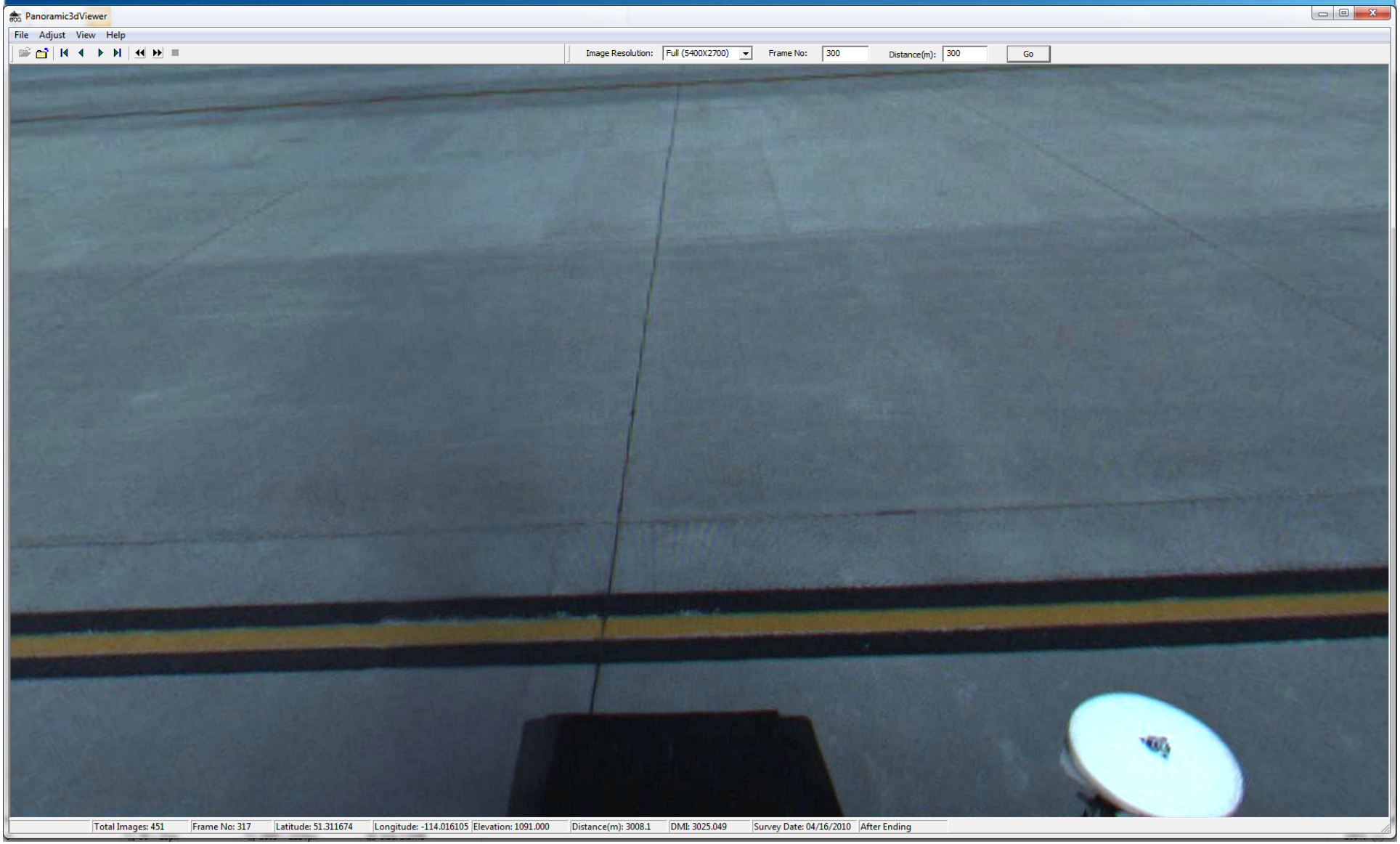
Panoramic Videolog

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Appurtenances

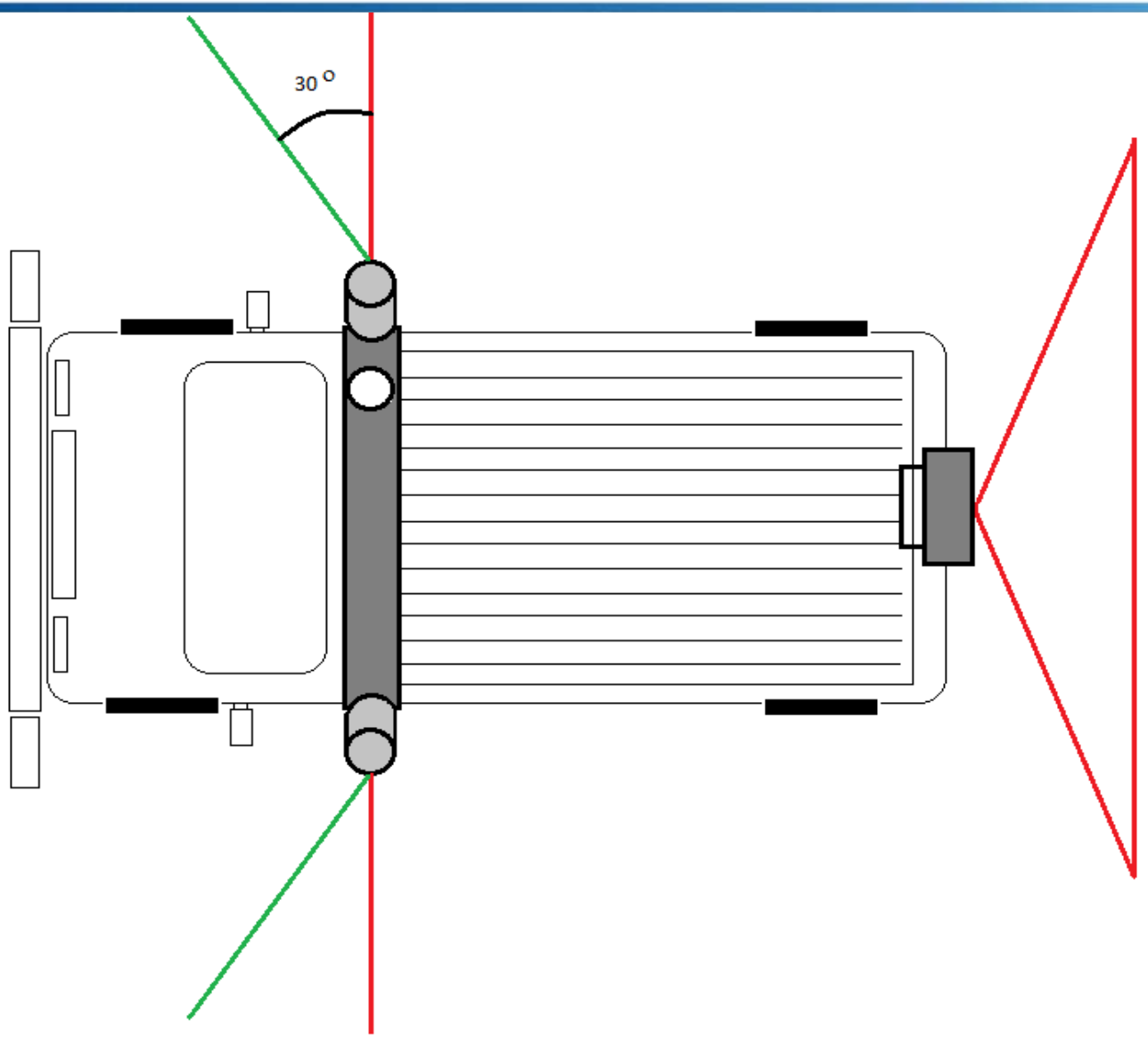
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Pavement Videolog Record



Kinematic Terrestrial LiDAR

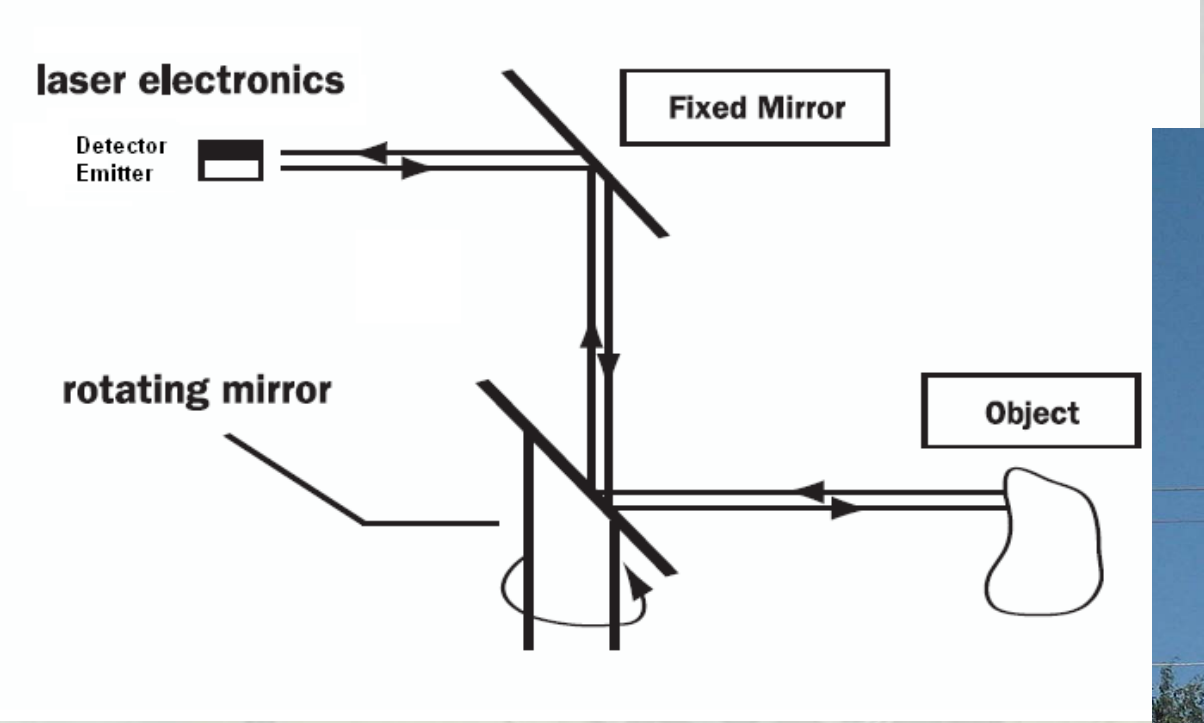
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES



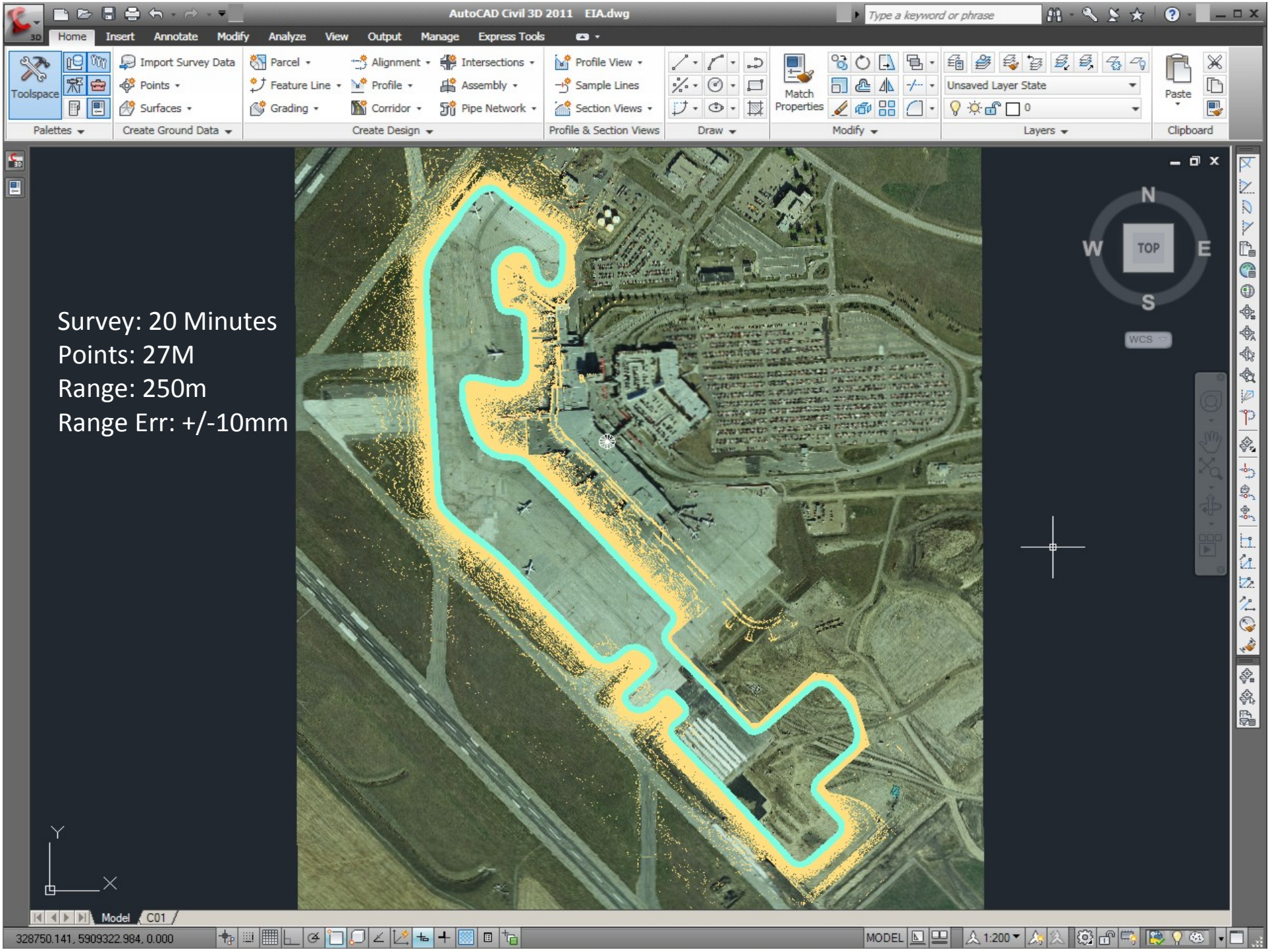
Kinematic Terrestrial LiDAR

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

Bistatic Rotating Mirror LiDAR Sensor Schematic (Horizontal Configuration)

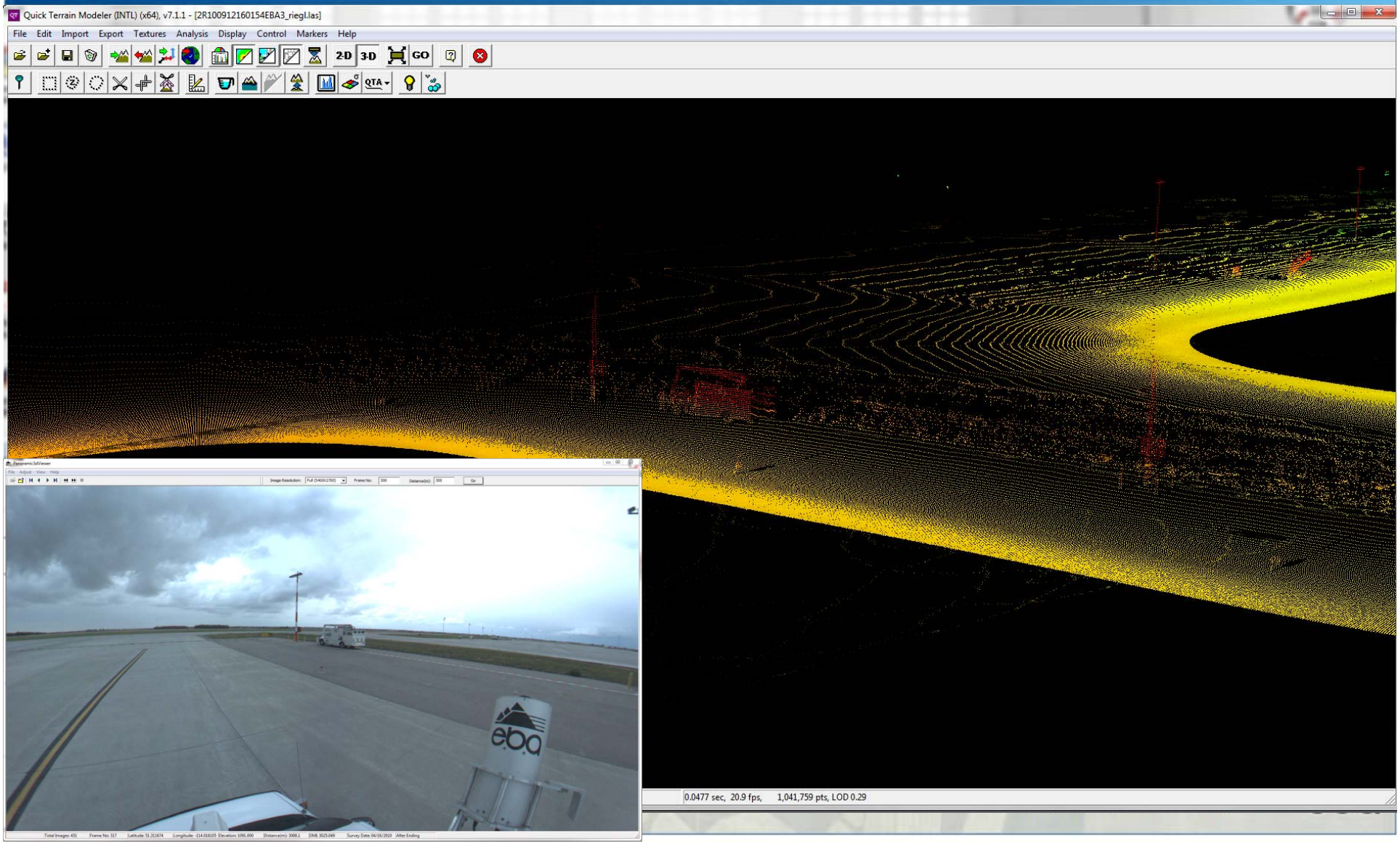


LIght Detection And Ranging

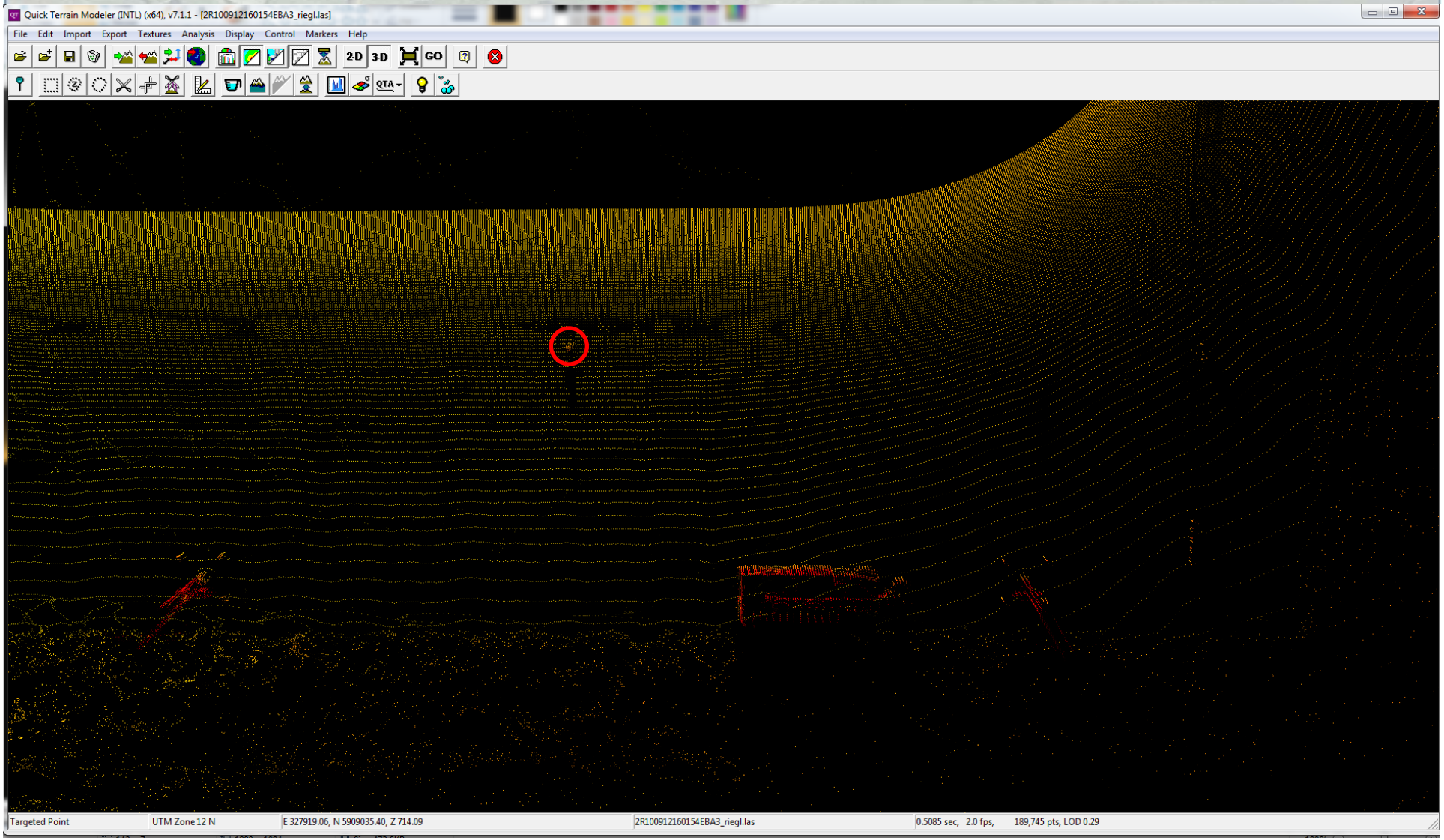

AutoCAD Civil 3D 2011 EIA.dwg
Type a keyword or phrase
Home
Insert
Annotate
Modify
Analyze
View
Output
Manage
Express Tools
Toolspace
Import Survey Data
Points
Surfaces
Parcel
Feature Line
Grading
Alignment
Profile
Corridor
Intersections
Assembly
Pipe Network
Profile View
Sample Lines
Section Views
Match Properties
Unsaved Layer State
Paste
Palettes
Create Ground Data
Create Design
Profile & Section Views
Draw
Modify
Layers
Clipboard
Survey: 20 Minutes
Points: 27M
Range: 250m
Range Err: +/-10mm
N
W
TOP
E
S
WCS
Model
C01
328750.141, 5909322.984, 0.000
MODEL
1:200

Referenced Point Cloud

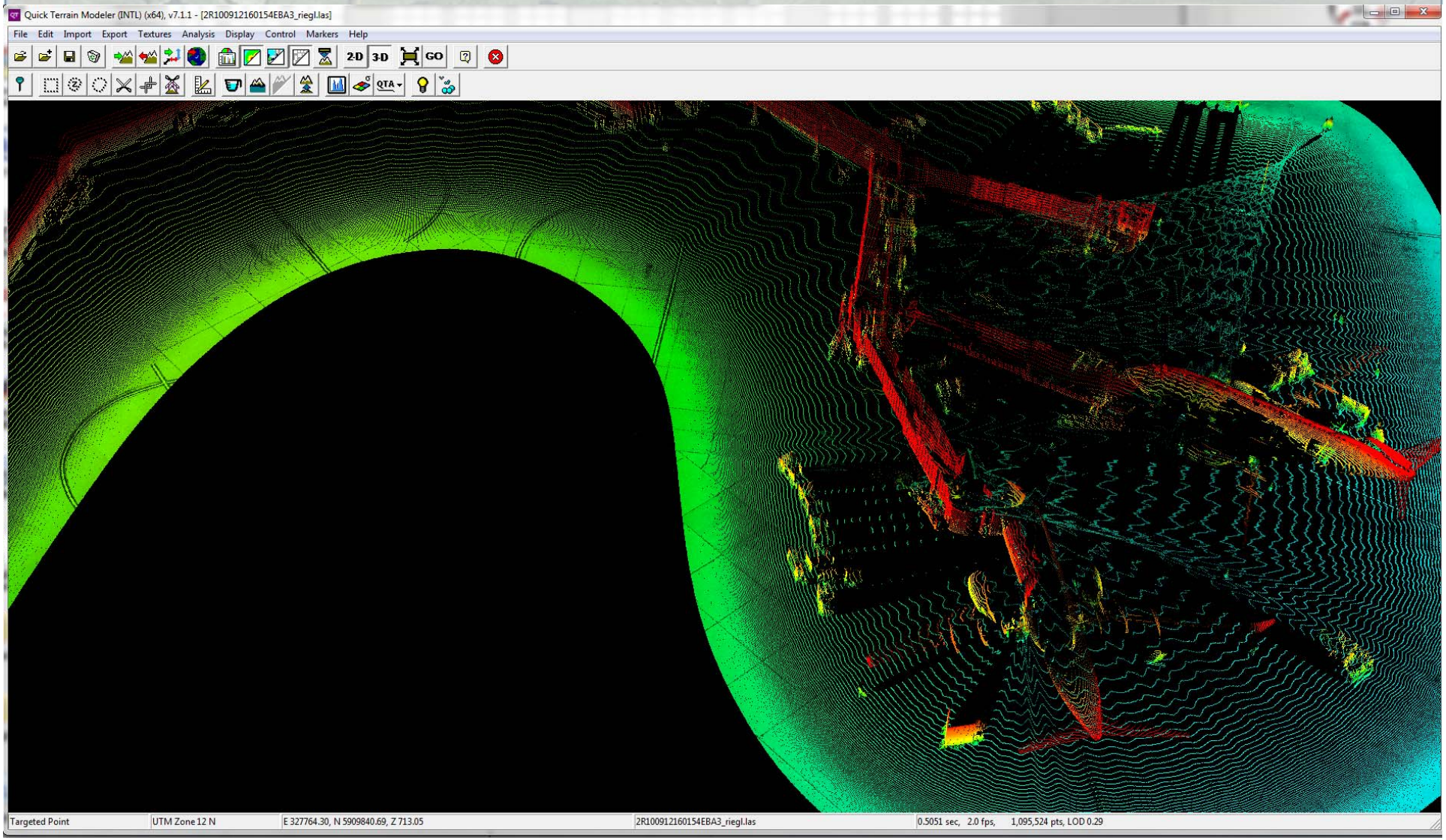
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

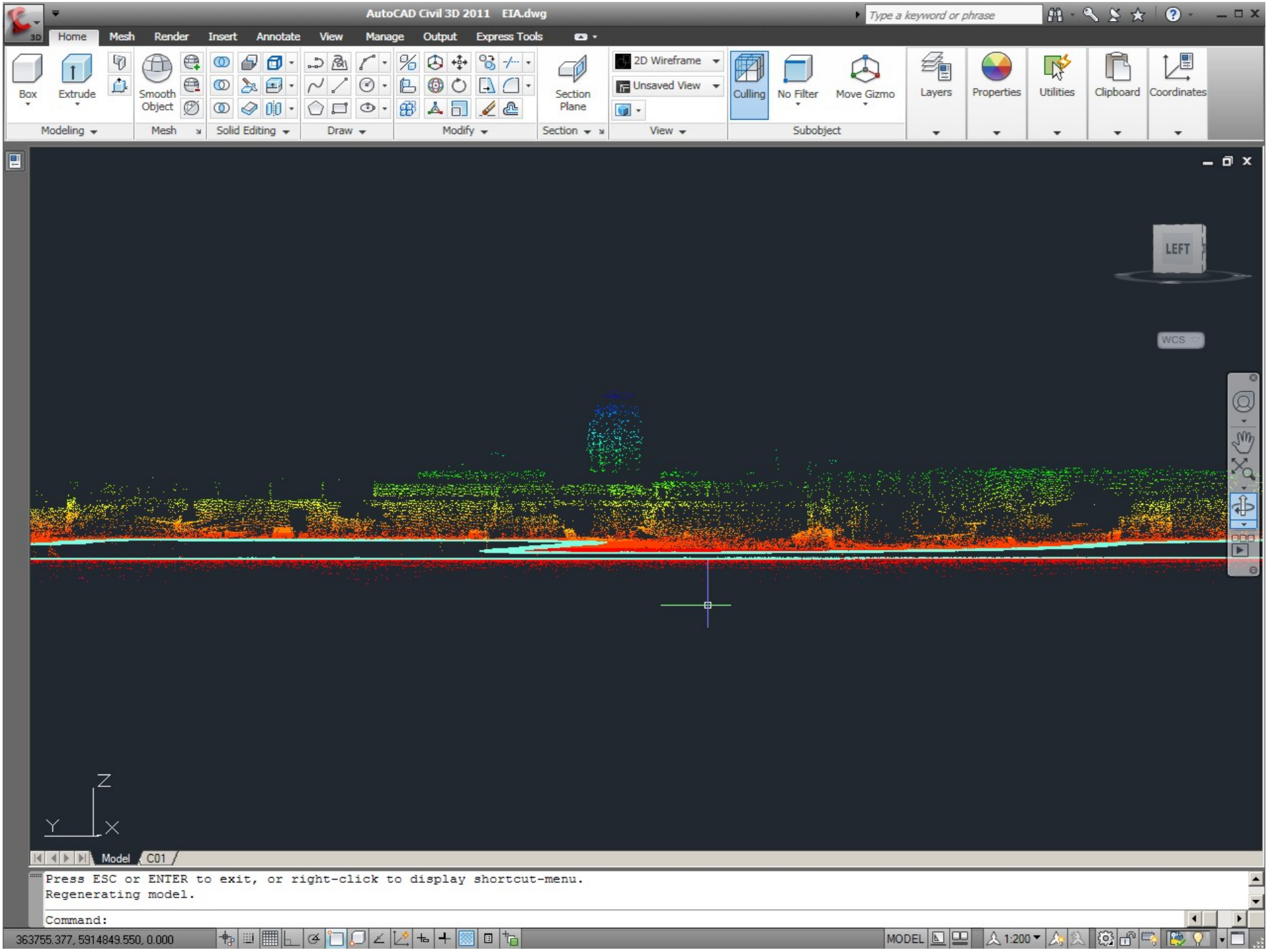


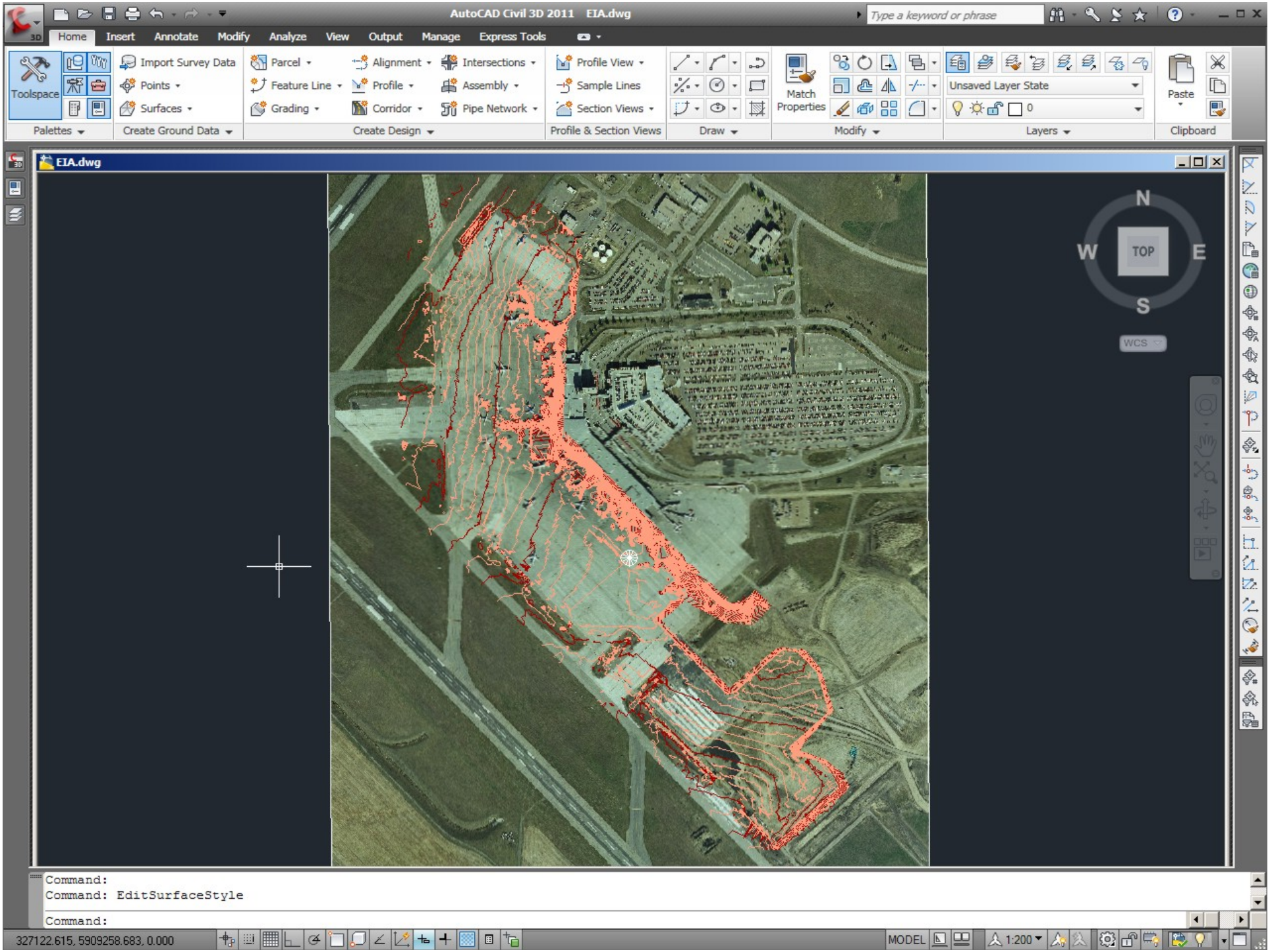
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

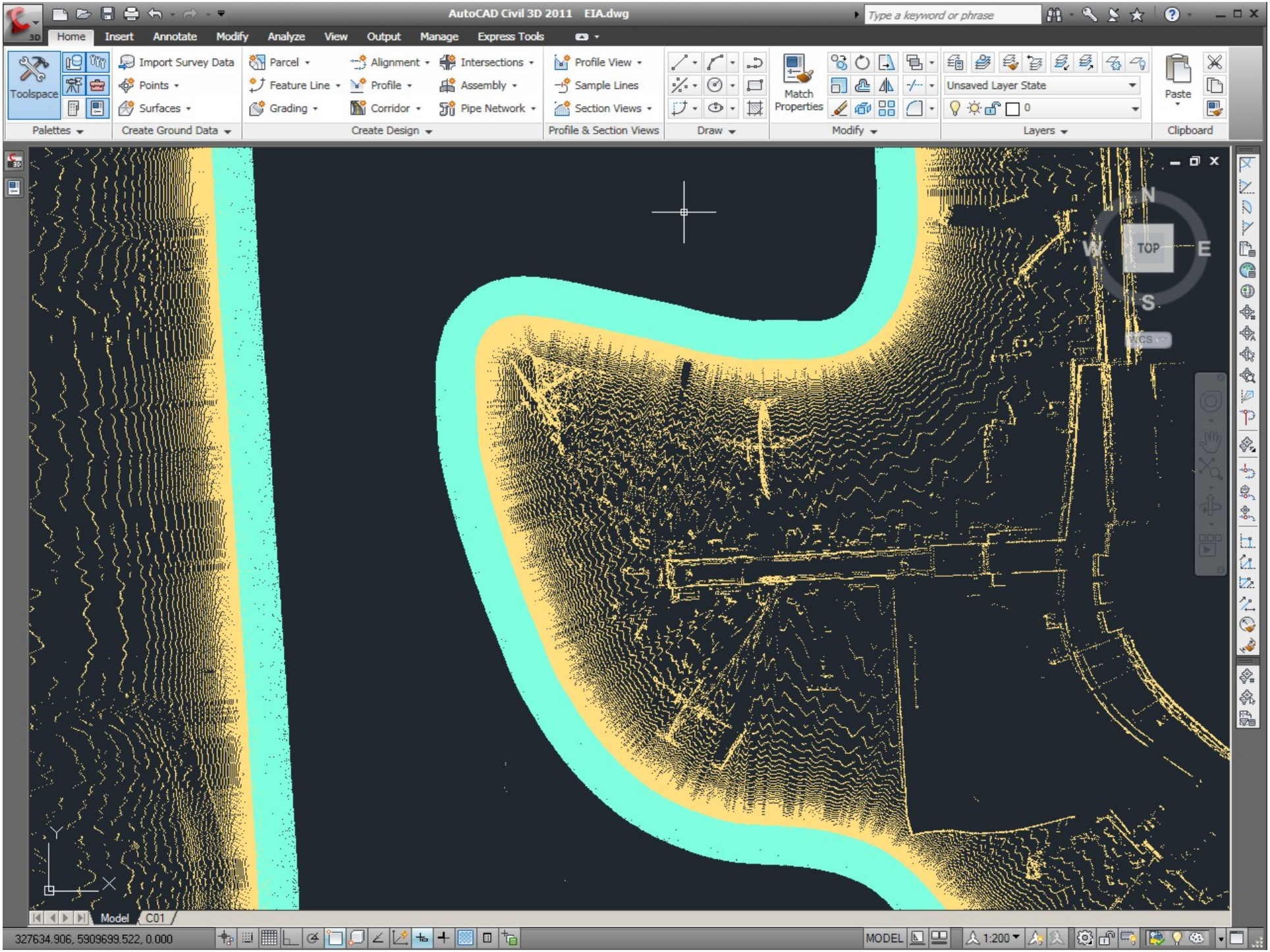


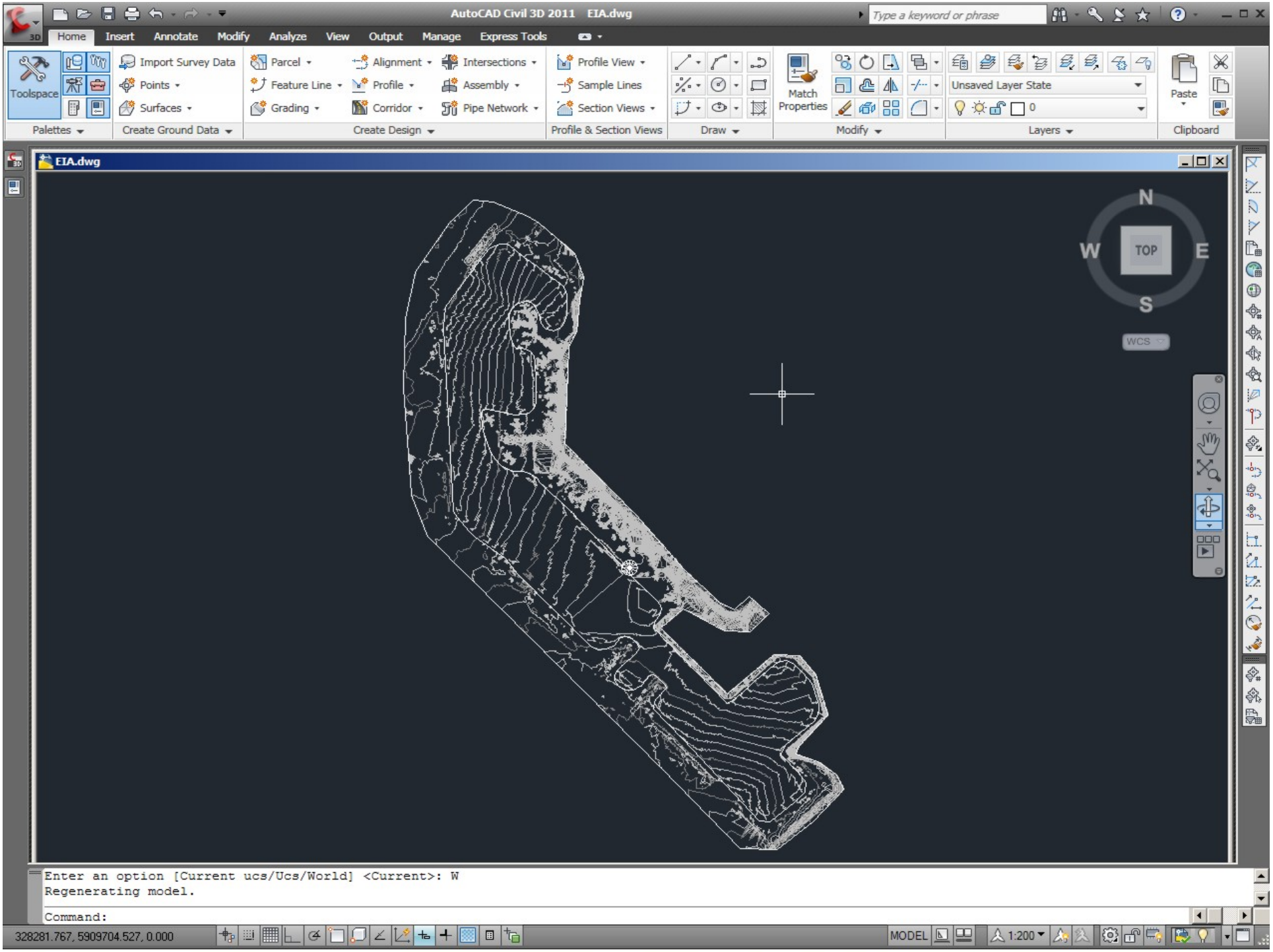
SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

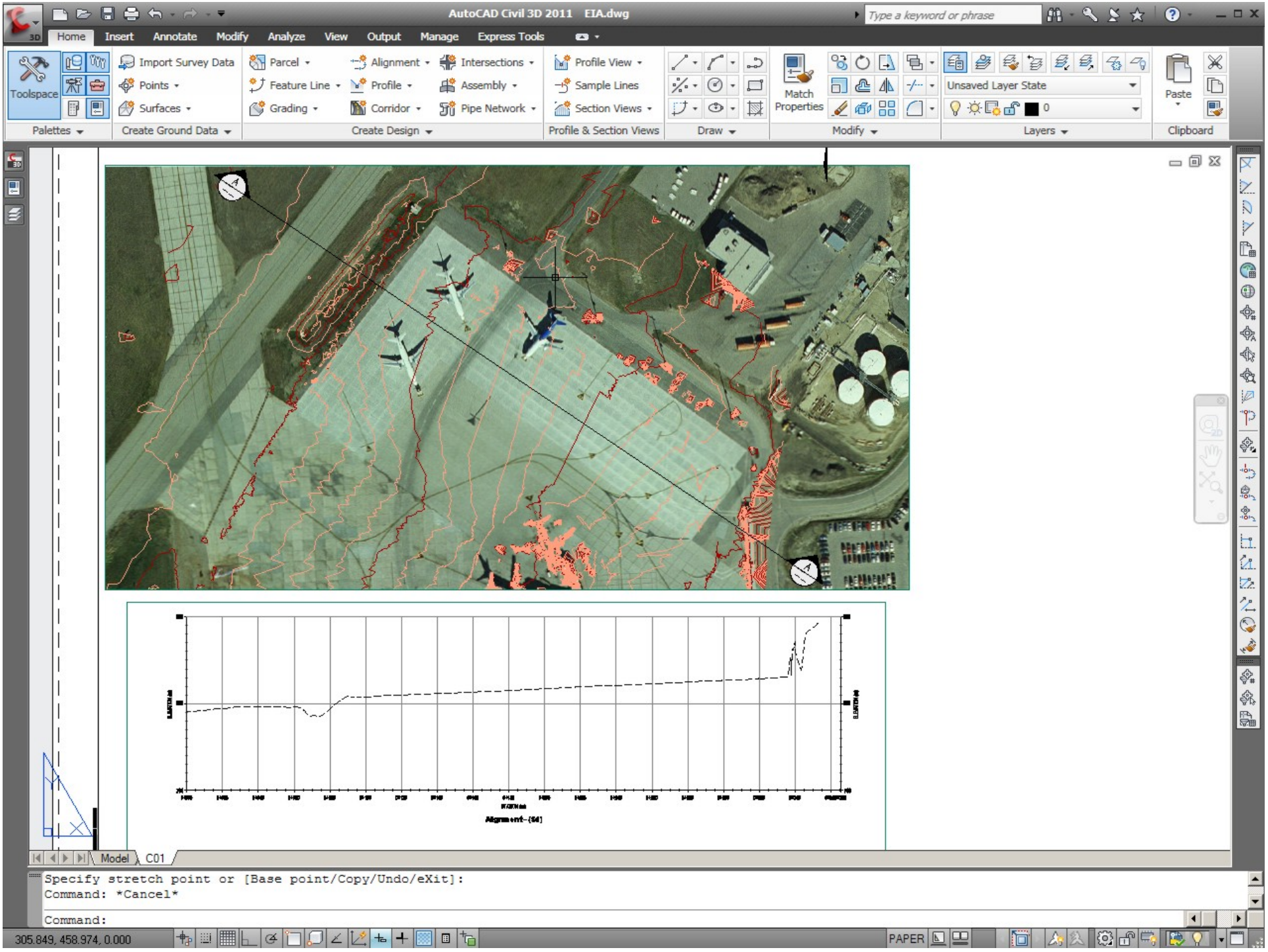



AutoCAD Civil 3D 2011 EIA.dwg
Type a keyword or phrase
Home
Mesh
Render
Insert
Annotate
View
Manage
Output
Express Tools
Box
Extrude
Smooth Object
Modeling
Mesh
Solid Editing
Draw
Modify
Section Plane
Section
2D Wireframe
Unsaved View
View
Culling
No Filter
Move Gizmo
Subobject
Layers
Properties
Utilities
Clipboard
Coordinates
LEFT
WCS
Z
Y
X
Model
C01
Press ESC or ENTER to exit, or right-click to display shortcut-menu.
Regenerating model.
Command:
363755.377, 5914849.550, 0.000
MODEL
1:200


AutoCAD Civil 3D 2011 EIA.dwg
Type a keyword or phrase
Home
Insert
Annotate
Modify
Analyze
View
Output
Manage
Express Tools
Toolspace
Import Survey Data
Points
Surfaces
Parcel
Feature Line
Grading
Alignment
Profile
Corridor
Intersections
Assembly
Pipe Network
Profile View
Sample Lines
Section Views
Match Properties
Unsaved Layer State
Paste
Palettes
Create Ground Data
Create Design
Profile & Section Views
Draw
Modify
Layers
Clipboard
EIA.dwg
N
W
TOP
E
S
WCS
Command:
Command: EditSurfaceStyle
Command:
327122.615, 5909258.683, 0.000
MODEL
1:200


AutoCAD Civil 3D 2011 EIA.dwg
Type a keyword or phrase
Home
Insert
Annotate
Modify
Analyze
View
Output
Manage
Express Tools
Toolspace
Import Survey Data
Points
Surfaces
Parcel
Feature Line
Grading
Alignment
Profile
Corridor
Intersections
Assembly
Pipe Network
Profile View
Sample Lines
Section Views
Match Properties
Unsaved Layer State
Paste
Palettes
Create Ground Data
Create Design
Profile & Section Views
Draw
Modify
Layers
Clipboard
N
W
TOP
E
S
WCS
Model
C01
327634.906, 5909699.522, 0.000
MODEL
1:200


AutoCAD Civil 3D 2011 EIA.dwg
Type a keyword or phrase
Home
Insert
Annotate
Modify
Analyze
View
Output
Manage
Express Tools
Toolspace
Import Survey Data
Points
Surfaces
Parcel
Feature Line
Grading
Alignment
Profile
Corridor
Intersections
Assembly
Pipe Network
Profile View
Sample Lines
Section Views
Match Properties
Unsaved Layer State
Paste
Palettes
Create Ground Data
Create Design
Profile & Section Views
Draw
Modify
Layers
Clipboard
EIA.dwg
N
W
TOP
E
S
WCS
Enter an option [Current ucs/Ucs/World] <Current>: W
Regenerating model.
Command:
328281.767, 5909704.527, 0.000
MODEL
1:200


AutoCAD Civil 3D 2011 EIA.dwg
Type a keyword or phrase
Home
Insert
Annotate
Modify
Analyze
View
Output
Manage
Express Tools
Toolspace
Import Survey Data
Points
Surfaces
Parcel
Feature Line
Grading
Alignment
Profile
Corridor
Intersections
Assembly
Pipe Network
Profile View
Sample Lines
Section Views
Match Properties
Unsaved Layer State
Paste
Palettes
Create Ground Data
Create Design
Profile & Section Views
Draw
Modify
Layers
Clipboard
Model
C01
Specify stretch point or [Base point/Copy/Undo/eXit]:
Command: *Cancel*
Command:
305.849, 458.974, 0.000
PAPER

SWIFT
SUMMER WINTER
INTEGRATED FIELD TECHNOLOGIES

EBA ENGINEERING
A Tetra Tech Company