Track Monitoring Data Systems for Evaluation of Earthworks Instability

Ian Payne – Senior Asset Engineer (Geotechnics)
Jonathan Garelick – Asset Engineer (Geotechnics)
Jason Lund - On Track Machine Engineer

26th October 2017

Presentation is part of a more detailed paper skeleton

Title *– Track Monitoring Data Systems for Evaluation of Earthworks Instability*

1. Introduction
Purpose of the paper
Why important
What included and what not included
Digital age limits track walkouts but still need to visit sites r

2. Data Capture
Track recording train
Routeview
LADS Output
Omnicom
JBA Earthworks reports/Inclinometer data
BGS Database
Slope monitoring instrumentation
Google/BING Mapping
RINM Cross sections
OLE height/stagger

3. Track Behaviour
What does good track look like
Maintenance intervention types
Ballast properties and behaviour
Embankment fill properties and behaviour (Ash Fill/Clay fill etc)
Track zone of influence

4. Twist Faults/Cant deficiencies
(a) Track Related issues
- wet beds
-cyclic top on one rail

(b) Earthworks related issues
- Tree Desiccation cyclic top on one rail
- Slope instability
- Burrowing

5. Alignment Faults
(a) Track Related issues
- wet beds

(b) Earthworks related issues
- Slope instability

6. Maintenance Interventions/Trend analysis
(a) Track Related issues
- wet beds

(b) Earthworks related issues
- Slope instability
- Desiccation (trend analysis)

7. Dip Angle
(a) Track Related issues
- Jointed track on poor foundation

(b) Earthworks related issues
- Slope instability
- Bridge run-on/off

8. Rolling SD (Rolling eights/static eighths)
(a) Track Related issues
- Ballast attrition

(b) Earthworks related issues
- Slope instability

9. Ground Probing Radar
(a) Track Related issues
- Contaminated ballast

(b) Earthworks related issues
- Slope instability
- Pockets of water

10. Future Innovations
Satellite monitoring
Vibration Detection Units
Argo

11. Conclusions/Summary
Lessons learnt
Further work

Need to differentiate between Earthworks Failures and other Track Failures (cyclic top, poor ballast, switches and crossings, track joints etc)

ISSUES DISCUSSED IN PRESENTATION

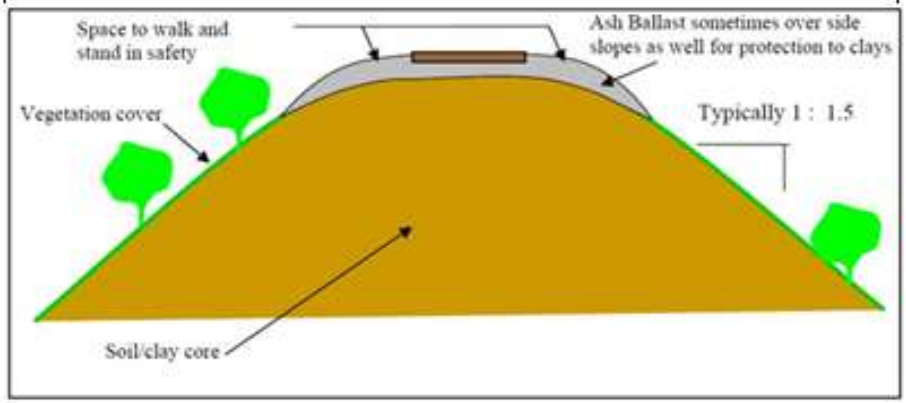
Introductions
Anglia Earthworks
Track Recording Data (LADS)

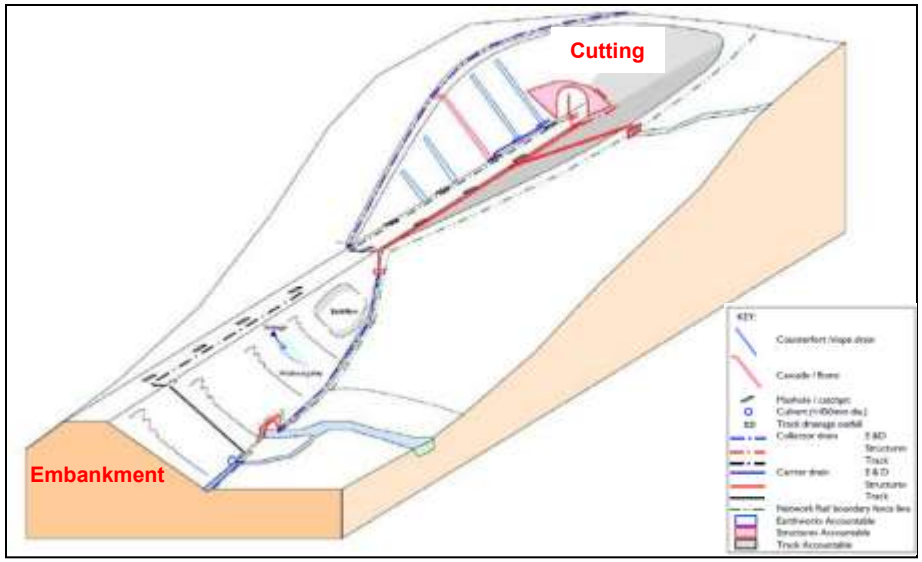
Earthworks and Drainage Issues
Deep seated slope instability
Desiccation
Structures Run-on/off
Wet Beds

Other Track Issues
Maintenance effectiveness
Poor ballast condition

Some Background Information Geology/Embankments/Rainfall/Drainage

Large post construction collapse settlement following rainfall infiltration.
Readily available locomotive ash and track ballast reinstated embankments.





Range of Typical Anglia Earthworks Failures

Deep seated London Clay embankment instability
Chelmsford 2009

London Clay cutting slope failures
Walthamstow Central 2009

Perched Water table instability
(Tills over Clays) Brantham Hall 2014

Glacial Till/Crag Washouts
Wymondham 2017

Ash degradation /instability
Nags Head Lane 2016

Storm Surge track and embankment washouts
Haddiscoe 2014

Chalk Slope instability
Coalpit Cutting 2013

Peat Wastage /Subsidence
Thrandeston Bog 2008

Badger burrowing subsidence
Fordham 2016

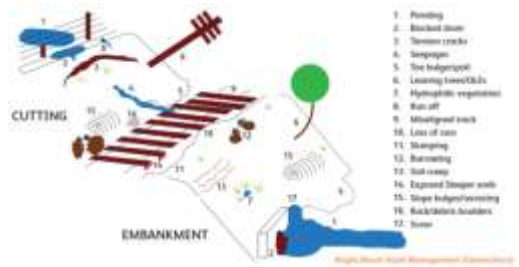
Rabbit burrowing subsidence
Pesthouse Lane 2015

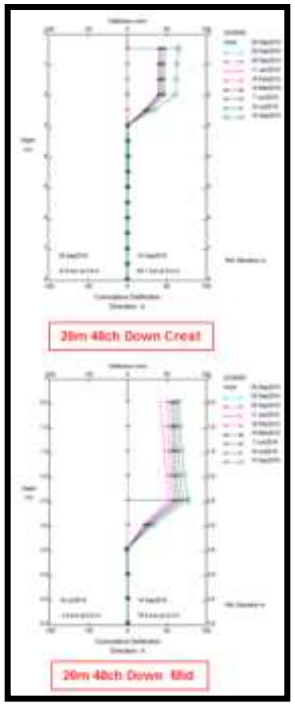
Clay Desiccation Track instability
Great Bentley 2009

Ash Fires
Jacques Hall 1985

West Horndon to Dunton - FSS2 19m 35ch to 20m 55ch

Typical of issues on many embankments in Anglia





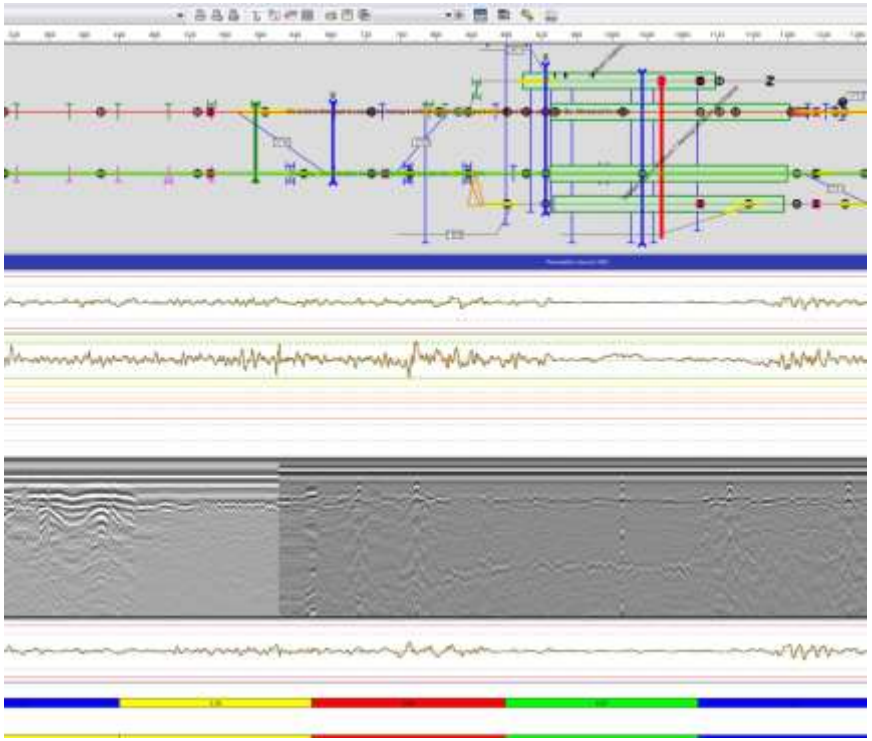
- Slope Slip Surface Instability
- Soil Creep
- Vermin Burrowing
- Tree Root Desiccation
- Ash Degradation
- Thick Ballast
- Structures Run-on/Run-off
- Poor Toe Drainage
- Locally Prolific Hydrophilic Horsetail
- Wet Beds
- Inadequate Cess Walkways
- Historic Patchwork of Treatments

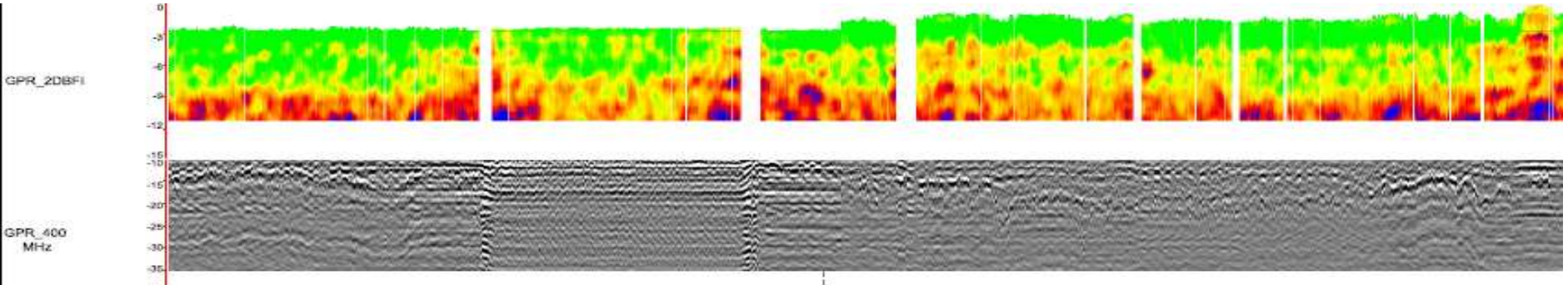
What Is LADS

Linear Asset Decision Support (LADS) is a decision support tool designed to improve how you carry out Track, Earthworks and OLE maintenance inclusive of renewals . It is an integrated dashboard view of track asset information and is a key enabler in better understanding:-

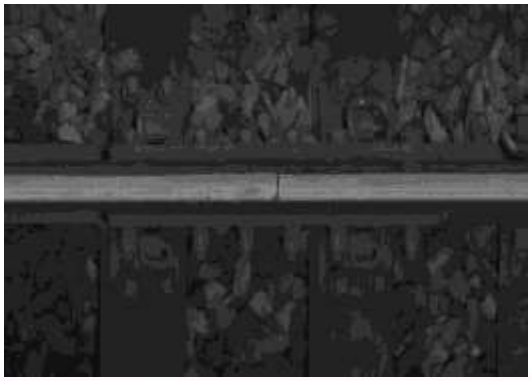
- Rates of asset degradation
- Different track fault types
- Determining the effectiveness of renewals and maintenance interventions,
- Predicting work volumes and output
- Targeted systems intervention

It allow greater validation of the proposed interventions and is part of a wider Asset Management toolkit



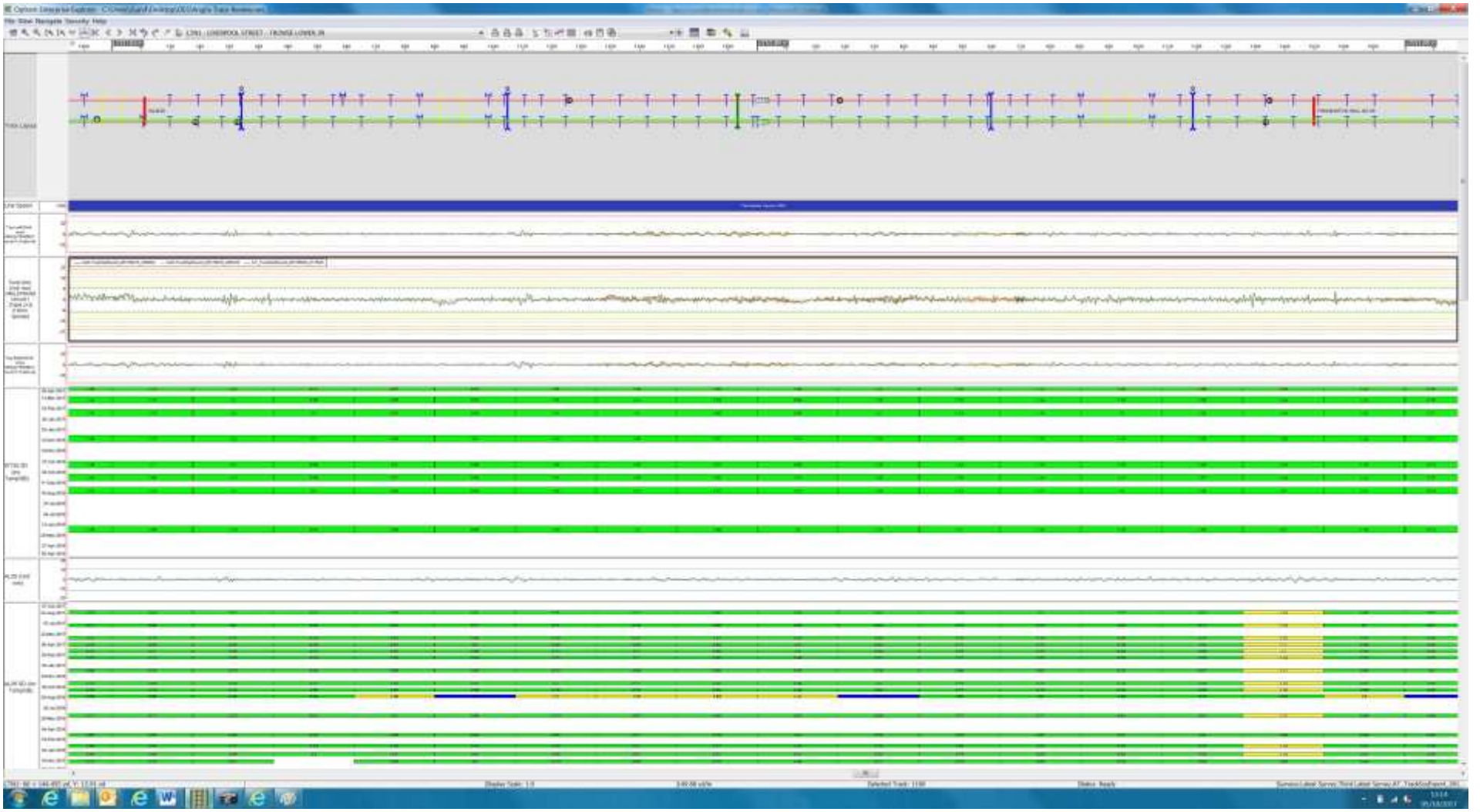


Data Presented by LADS



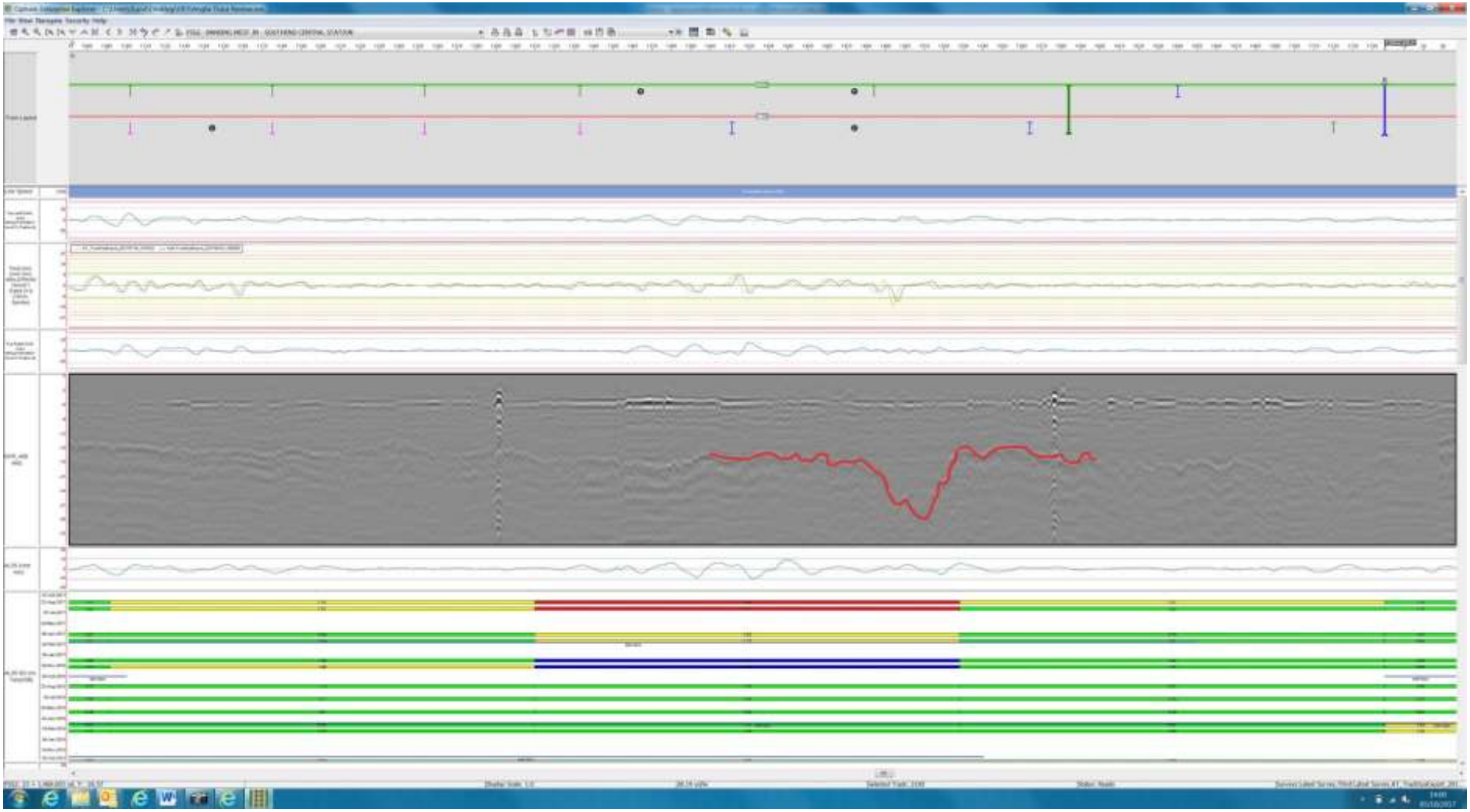
Data Source	Asset Information	Refresh*	History/Retention
ACTRAFF:	Traffic (EMGTPA)	Periodically	12 months history
CARRS	Structures	One Off	Current record
Ellipse	S&C, Level Crossings, On track Assets, Drainage, Workbank	Weekly Monthly Daily	Current record
GEOGIS	Track Asset Register	Weekly	Current record
Radargrams & Ballast Fouling Index	Ground Penetrating Radar (GPR)	Monthly	Current record
JBA	Earthworks	One Off	Current record
RDMS	Rail Defects, Rail Breaks, Rail Suspects, Rail RCF	Daily	Current record (3 yrs history)
GMS	Network Model	Monthly	Current record
TICLED	Tight Clearances	One Off	Current record
CDMS/TGR:	Track Geometry	Daily	3 yrs history
TRS:	Renewals	Weekly	Current record (3 yrs history)

What Good LADS Track Data Looks Like

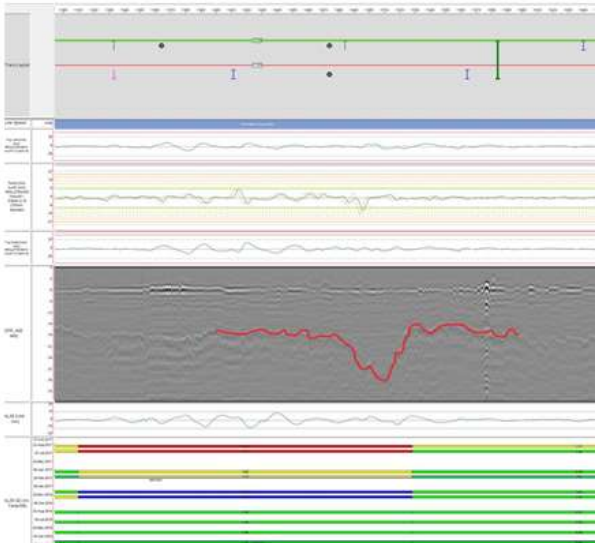


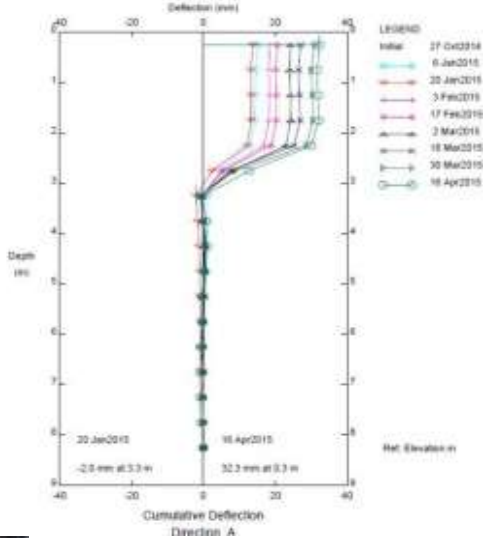
What Bad LADS Track Data Looks Like

Ashdon Way Basildon – LADS data with Deeper 400Hz GPR

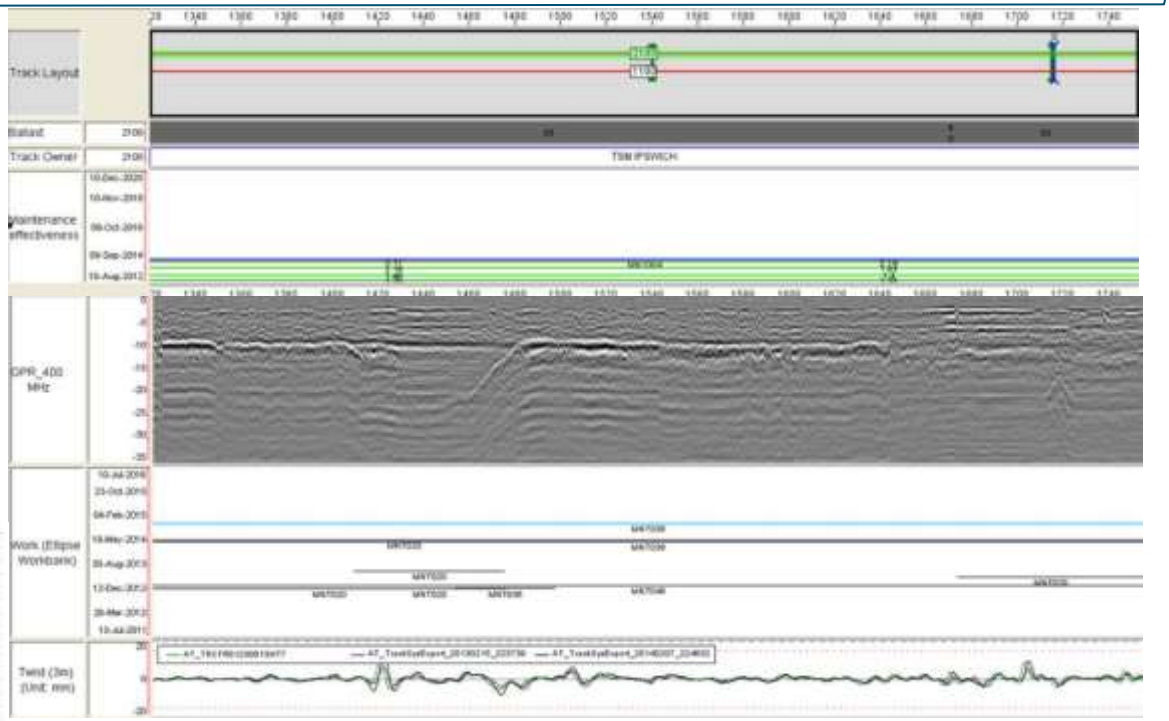


Ashdon Way Basildon – Deep Seated Progressive Embankment Failure (FSS2 23m 60ch to 24m 10ch)

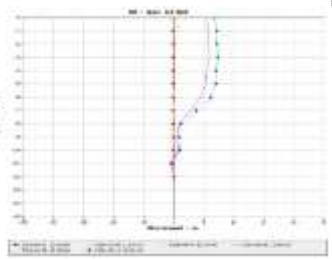


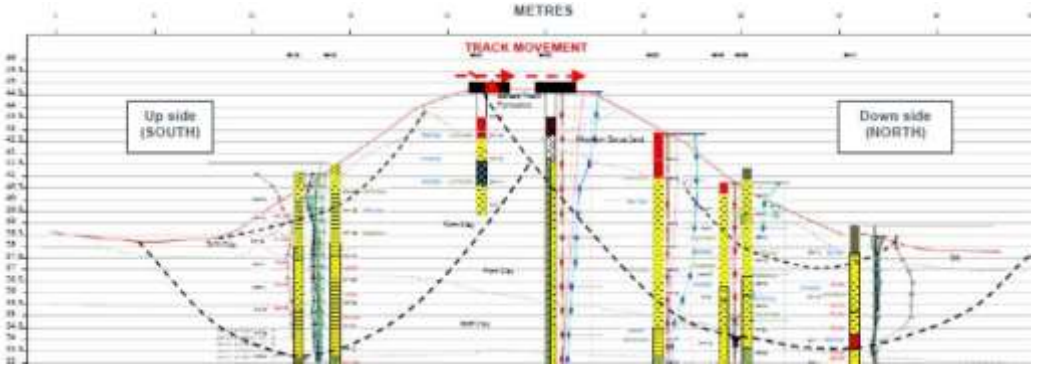


Tostock Embankment – Deep Seated Progressive Failure (CCH 34m 65ch)



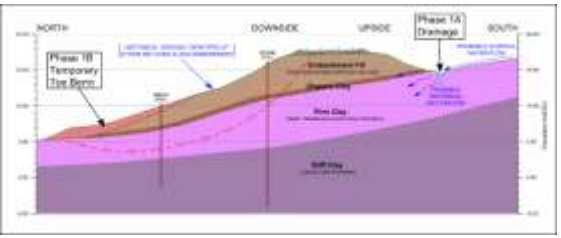
-Early identification of problem area extents
-Both GPR and twist faults show similar extents
-Identified progressive deterioration
-Targeting site investigation and embankment monitoring locations

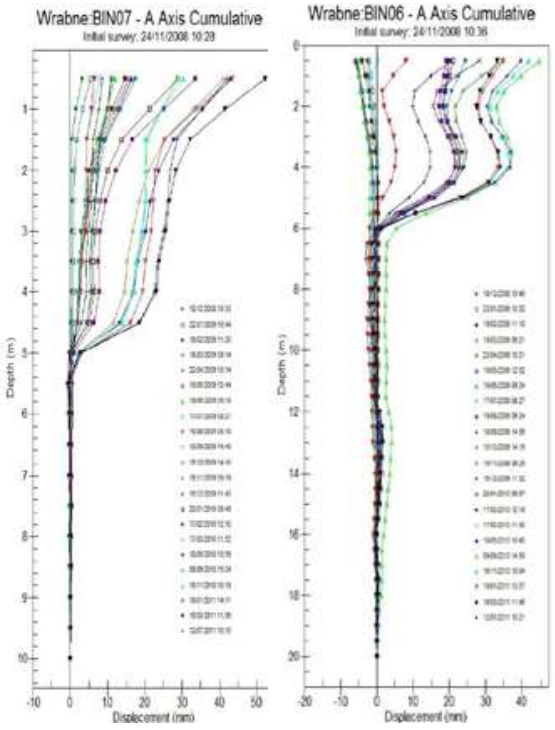




Wrabness Embankment – Deep Seated Progressive Failure

(MAH 65m 60ch to 70ch)

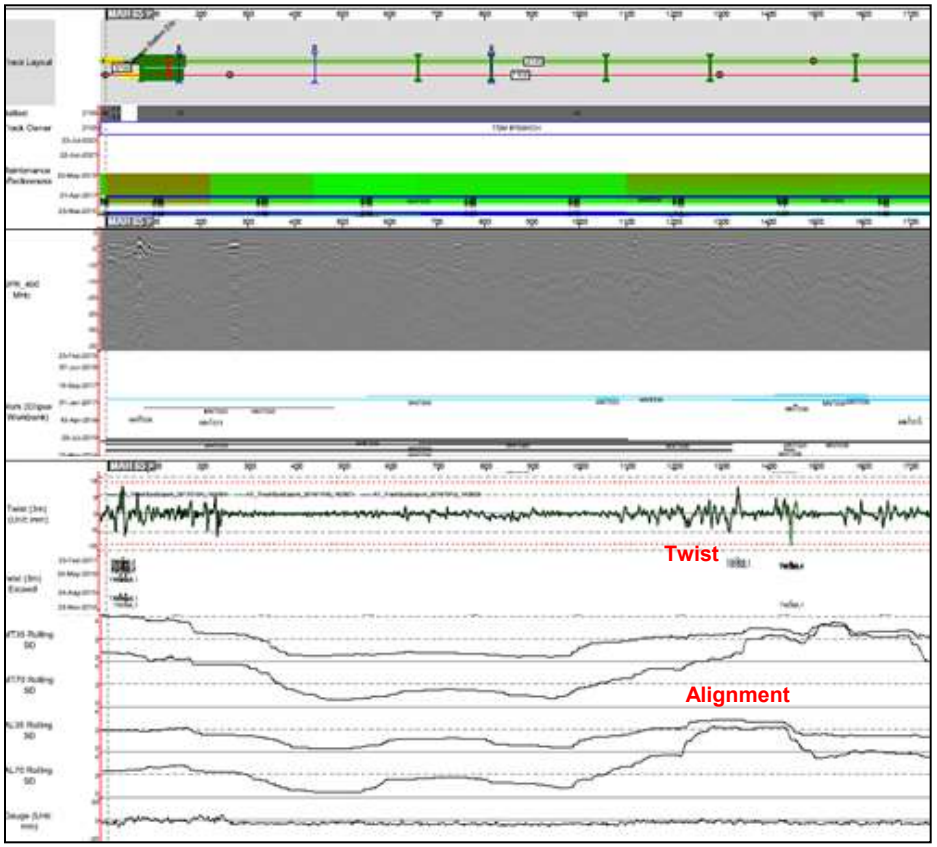




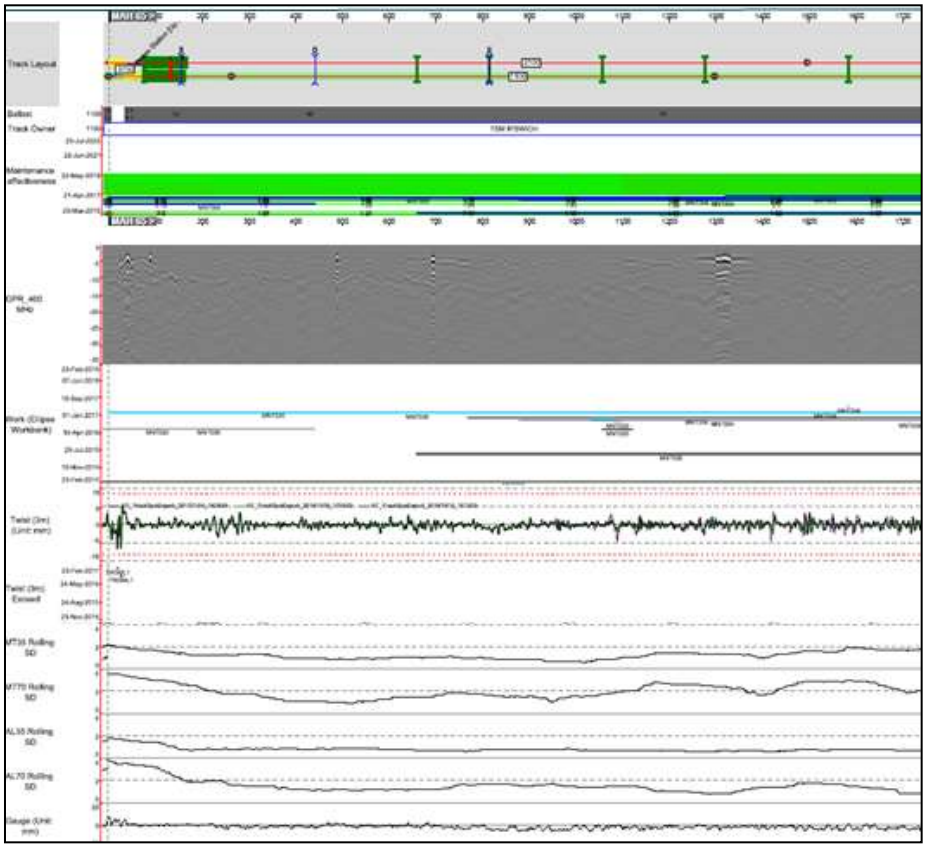
Sleeper Ends Exposed - Twist Fault

Long Dip in track – Alignment Fault

Wrabness LADS track data 65M TO 66M – Up and Down Comparison



DOWN Side



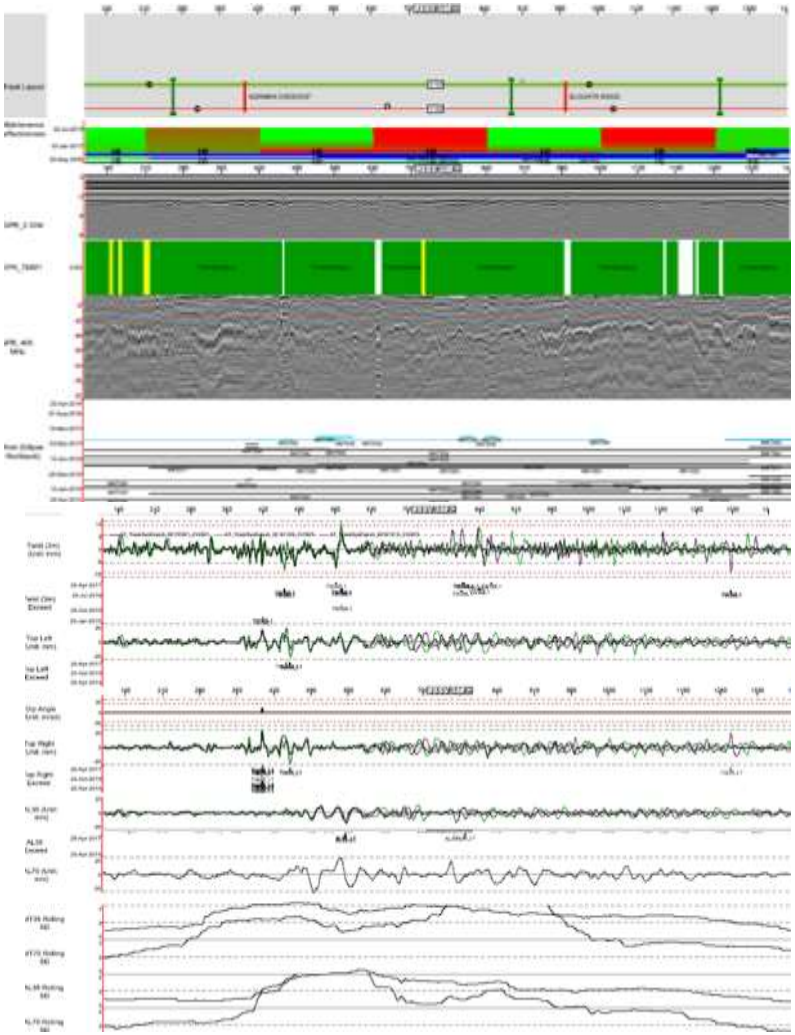
UP Side

Blountswood Road SSV 34m 05ch to 65ch

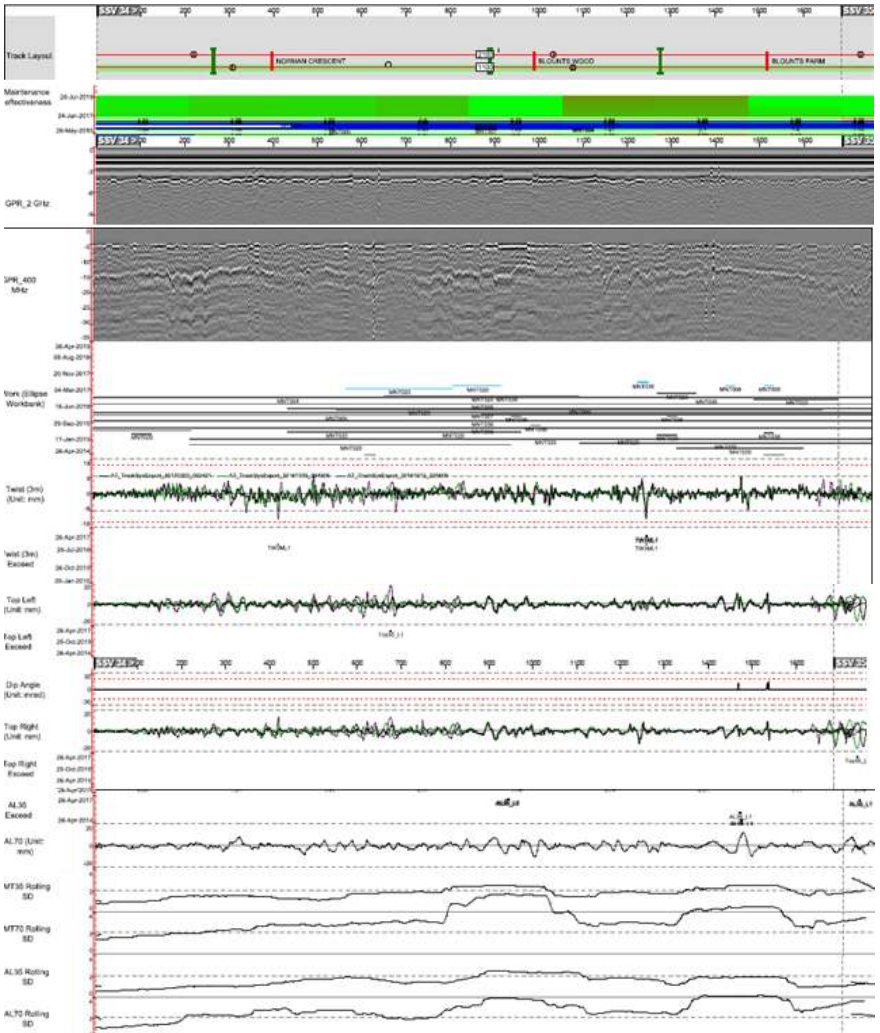
Slope Slip Surface Instability
Soil Creep
Vermin Burrowing
Ash Degradation
Poor Toe Drainage
Leaning OLE Mast
Thick Ballast
Locally Prolific Hydrophilic Horsetail
Leaning trees
Inadequate Cess Walkways
Historic Patchwork of Treatments

Blountswood Road SSV 34m 05ch to 65ch Up and Down LADS Comparison

Down

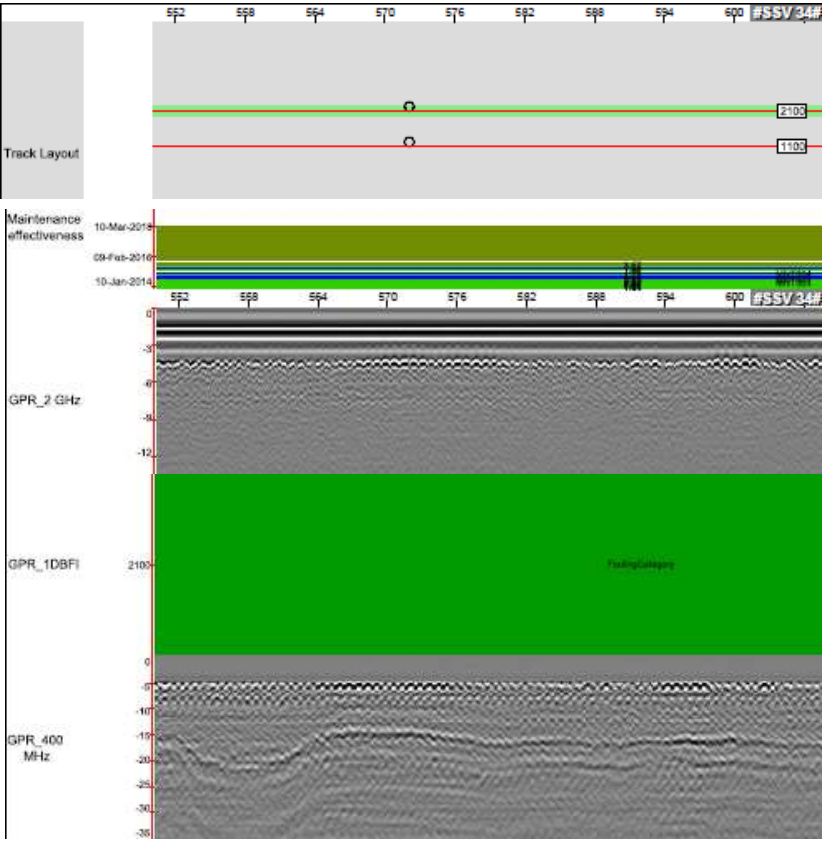


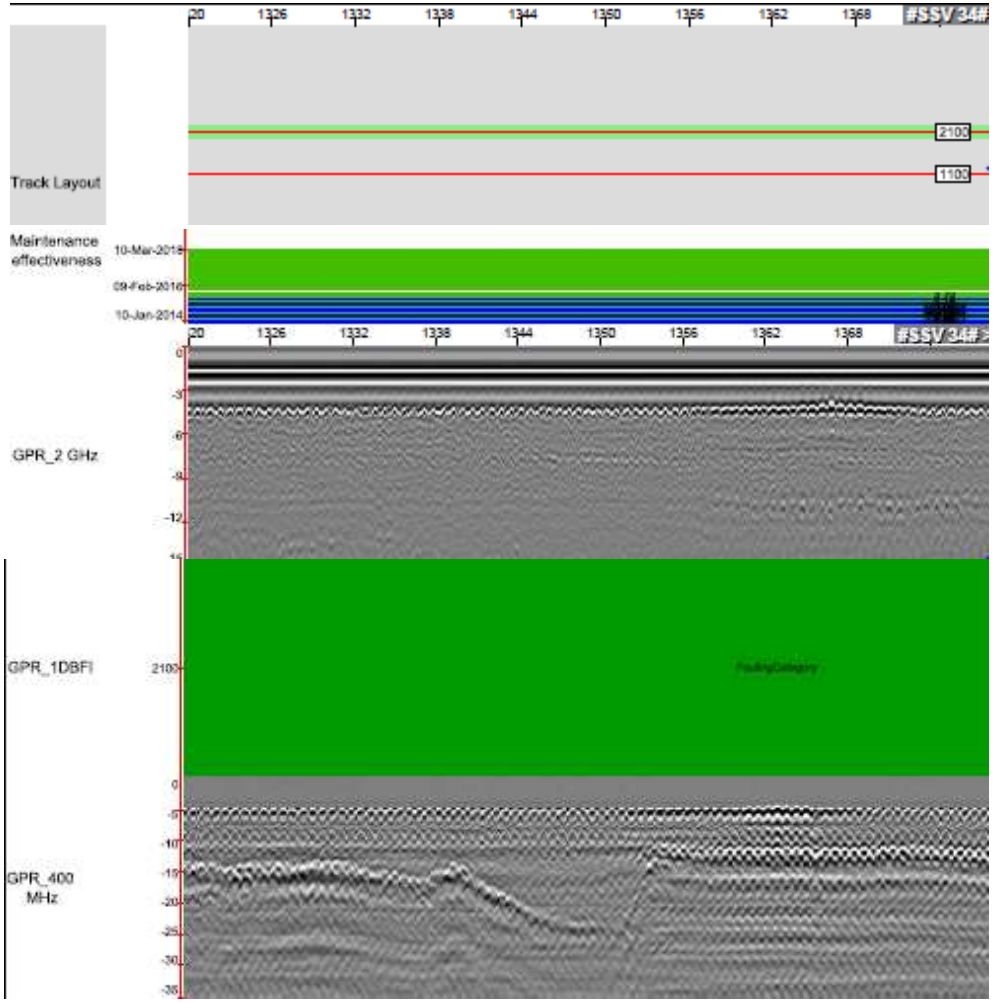
Up



Blountswood Road SSV 34m 05ch to 65ch Down LADS data

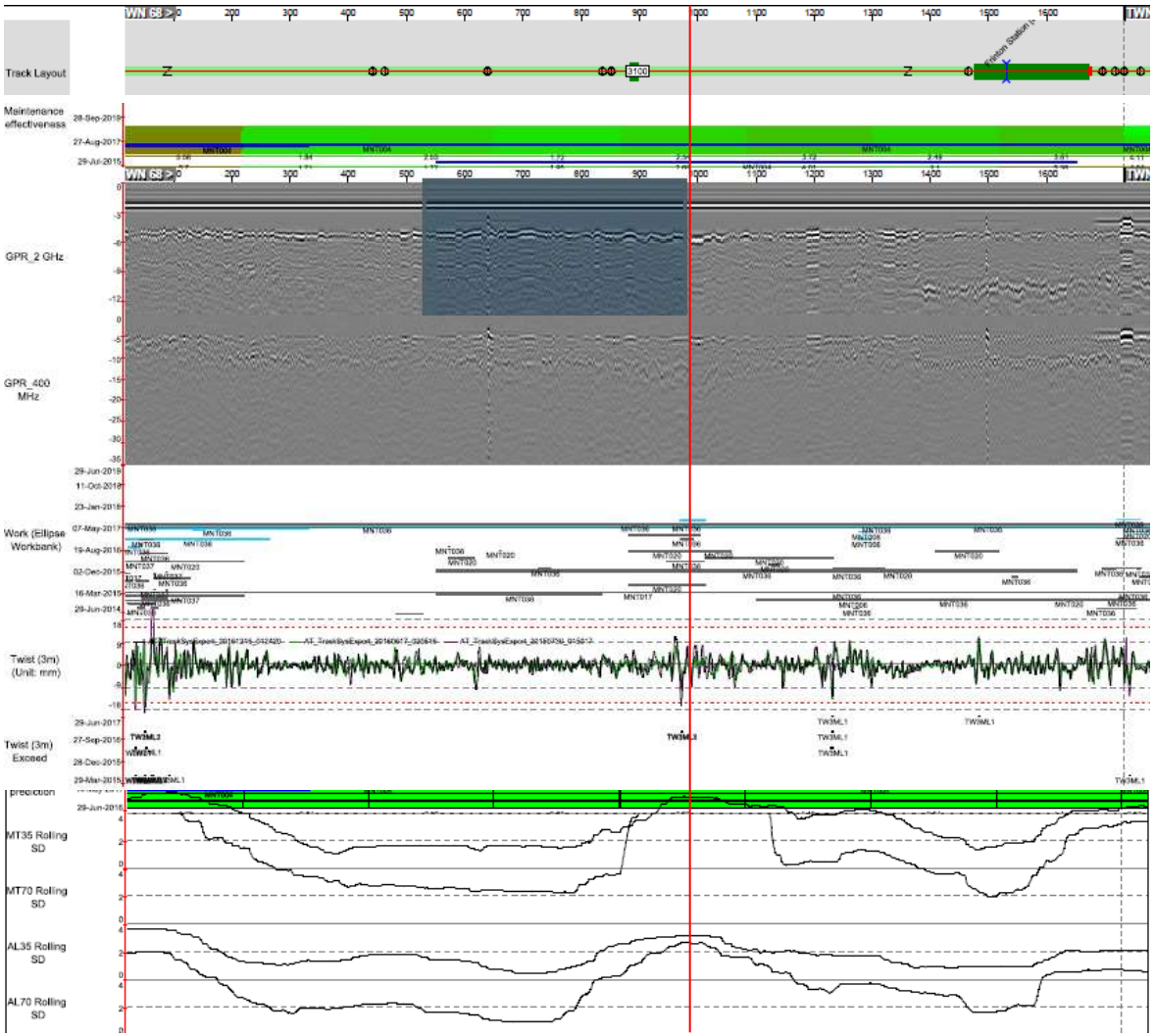
GPR features at 25ch and 61ch





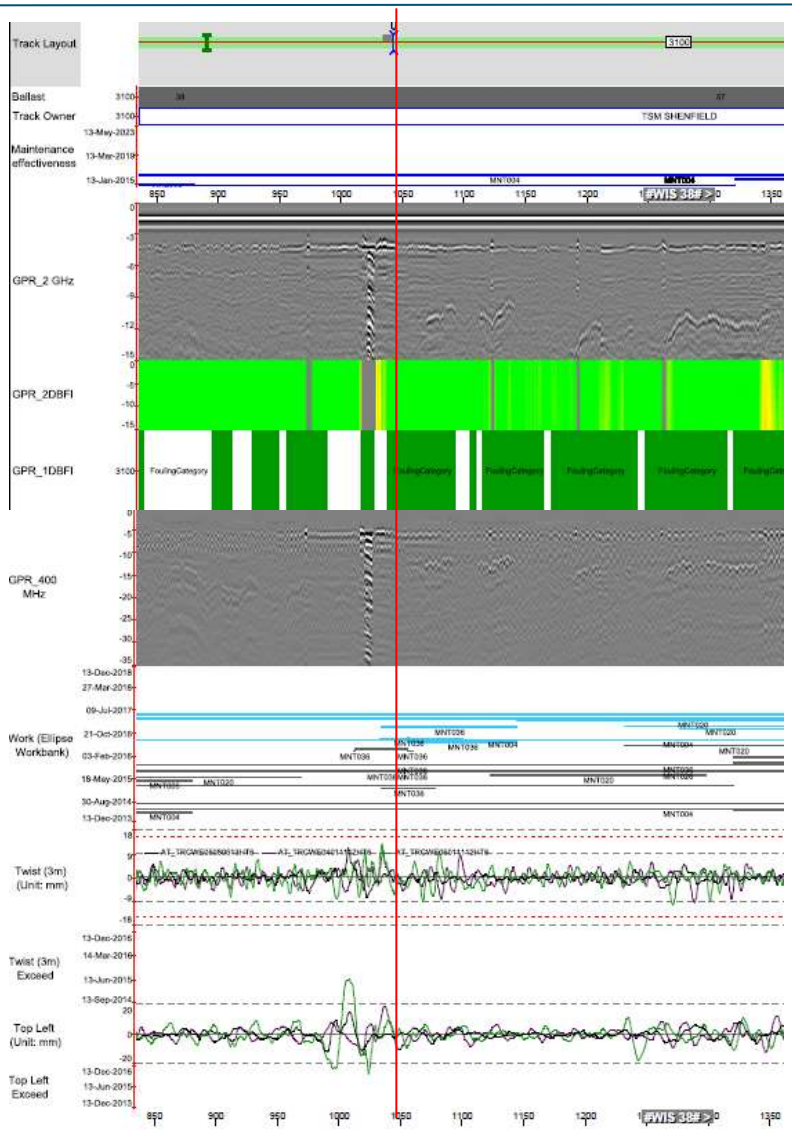
SSV 34ml 25.25ch to 34ml 25.75ch Down embankment shoulder drops and walkway restrained, but 3.5m cess, track good although recently tamped.
Cess walkway in poor condition between 34ml 59.5ch and 34ml 65.75ch Down, track good but recently tamped. From 34ml 60.25ch to 34ml 63.5ch cess and walkway drops with increased ballast thickness, there is also Horsetail in walkway.
There is a gabion toe berm between 34ml 60.75ch and 34ml 61.75ch

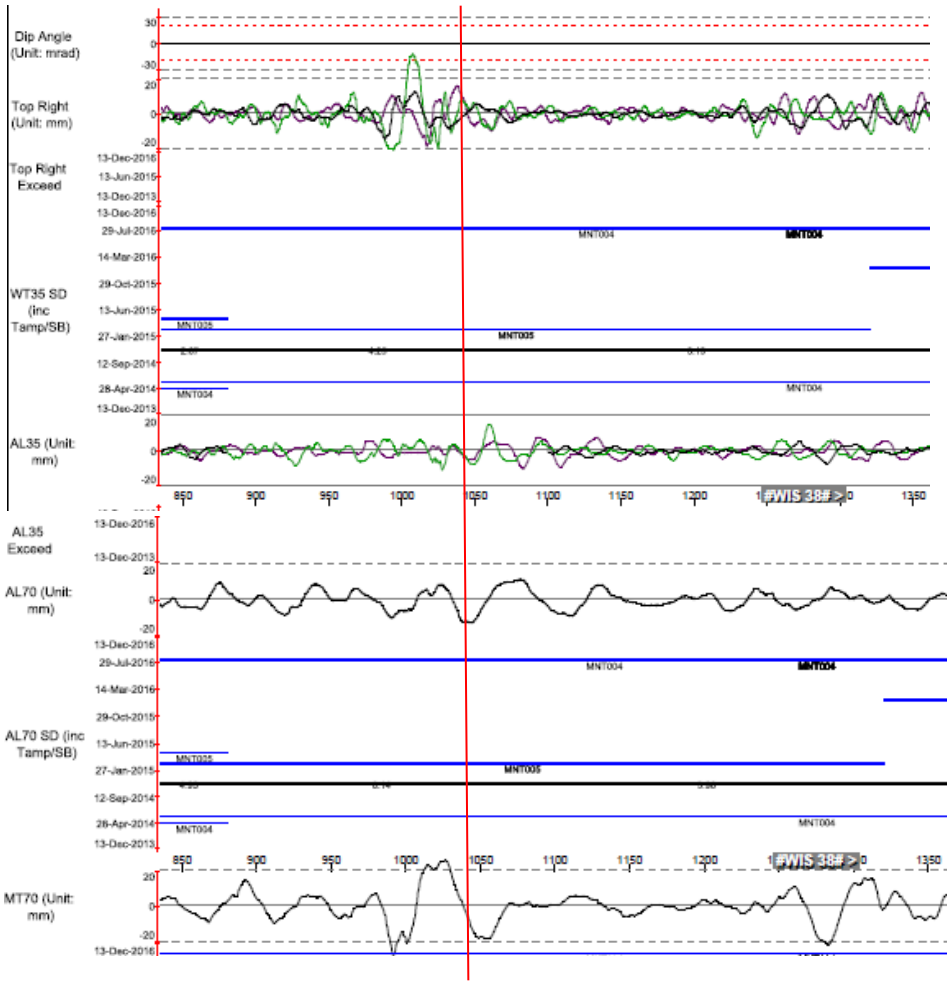
TWN 68m to 69m - LADS Up and Down (Single track) Problem 68m 45ch



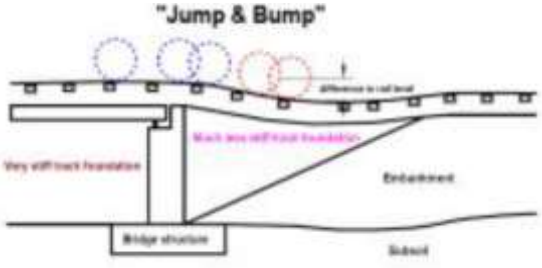
Ulemans Farm WIS 38 miles 1100yds - Embankment instability

Ulemans Farm WIS 38 miles 1015yds to 1120yds - Embankment instability

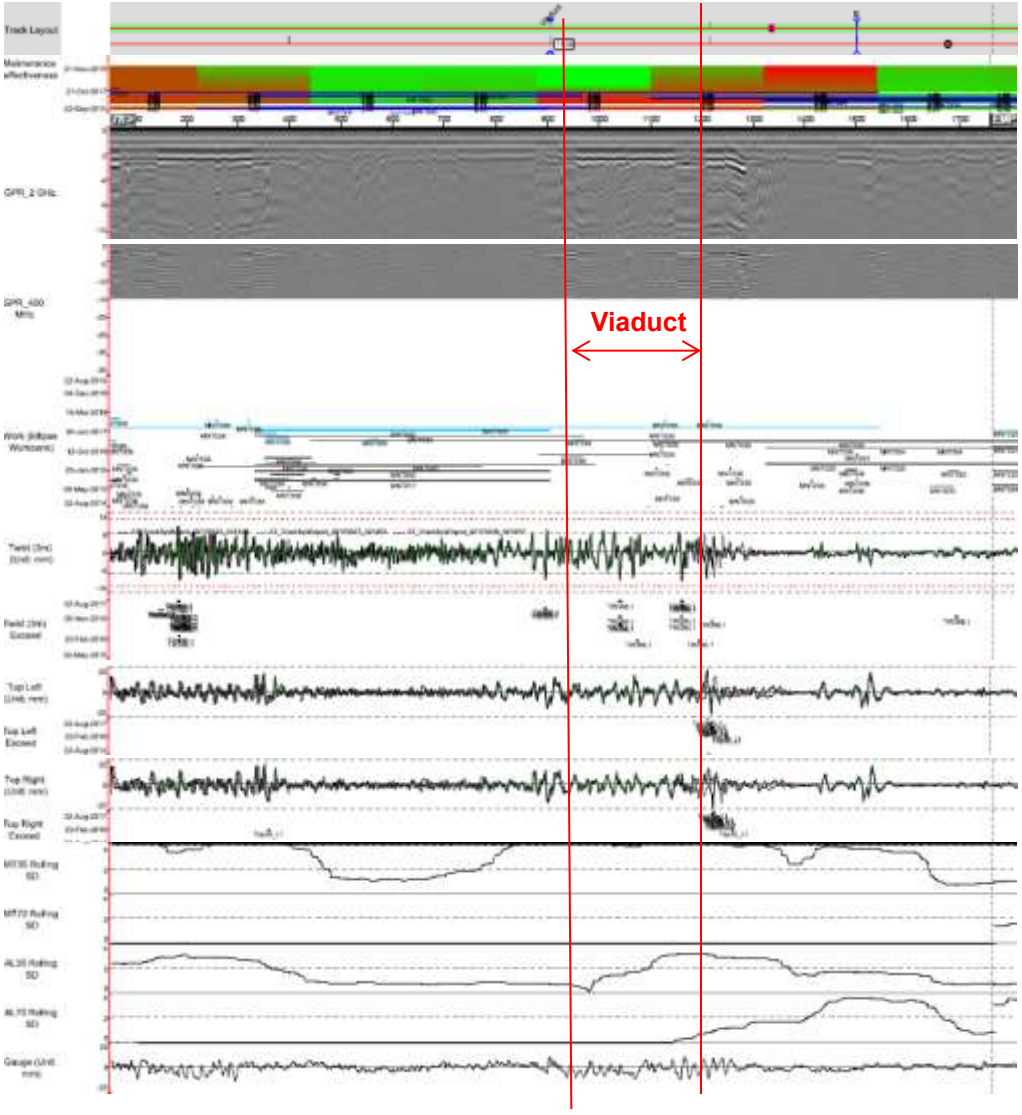


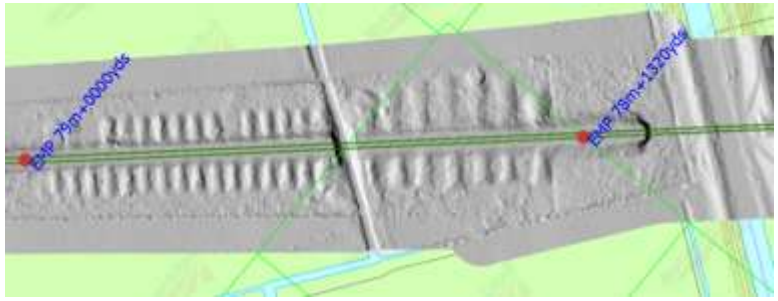


Typical Anglia Embankment/Structure Run-on/Run-off Differential Settlements



Manea Viaduct Approach Embankments
EMP 78m (east) to 79m (west) - LADS Down





Local Twist Faults on Peat Fens due to Trees

(ETN 72m 0880yds to 72m 1650yds Up)

Plate 6a 72m 1020yds Up to 0940yds

Plate 6b 72m 0940yds Up

Plate 6c 72m 0908yds Slack and Slew

Plate 6d Willow tree

Plate 6e Routeview of Willow tree

Plate 6f 72m 0880yds Slack and Slew

Plate 5c 72m 1150yds Up from 1100yds

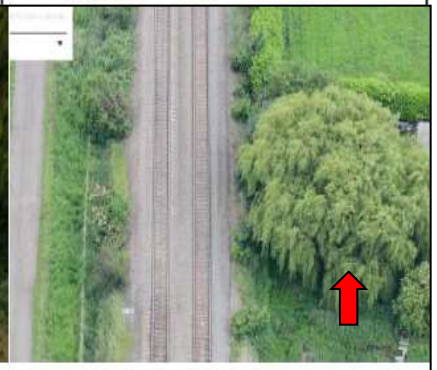
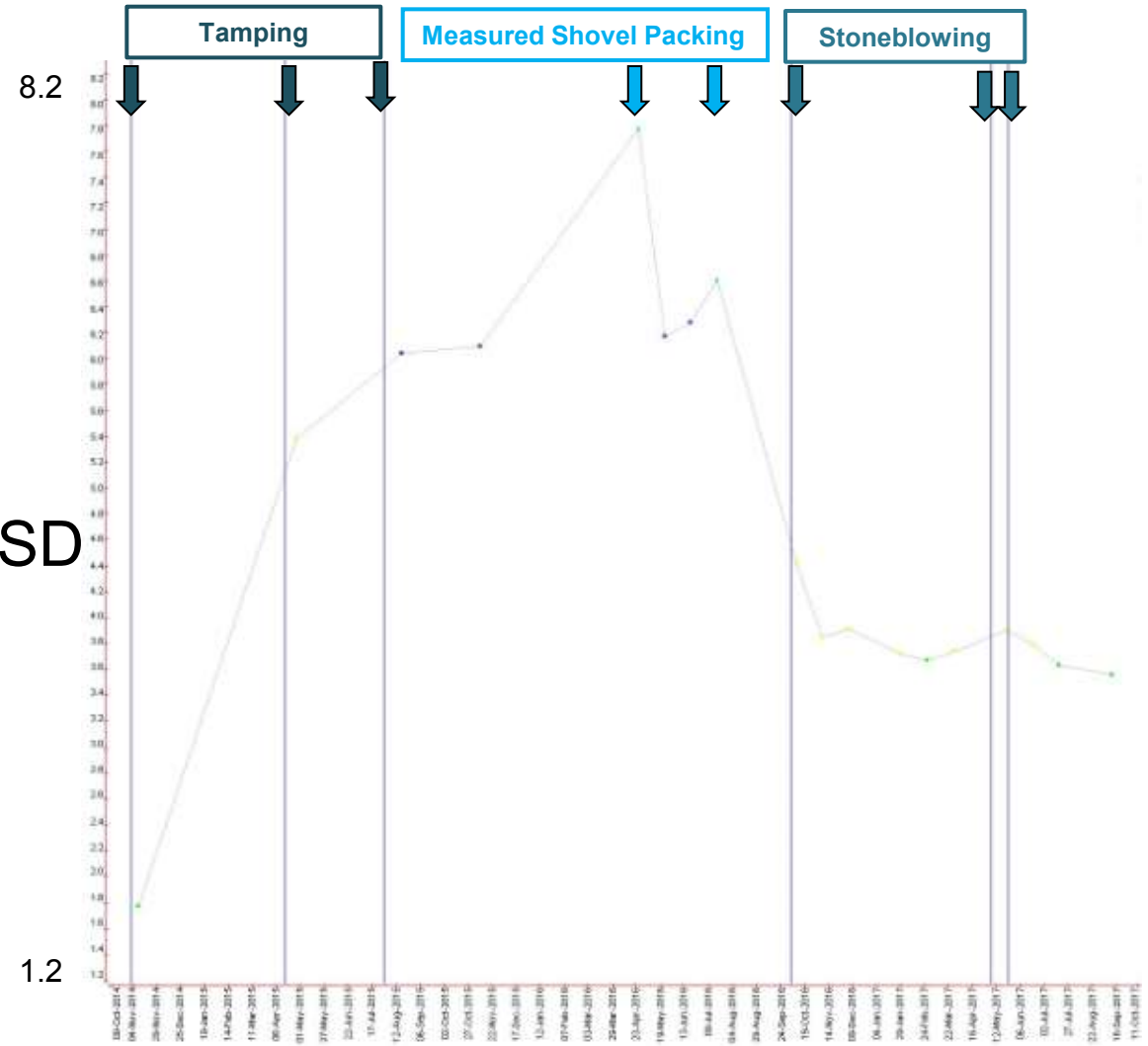


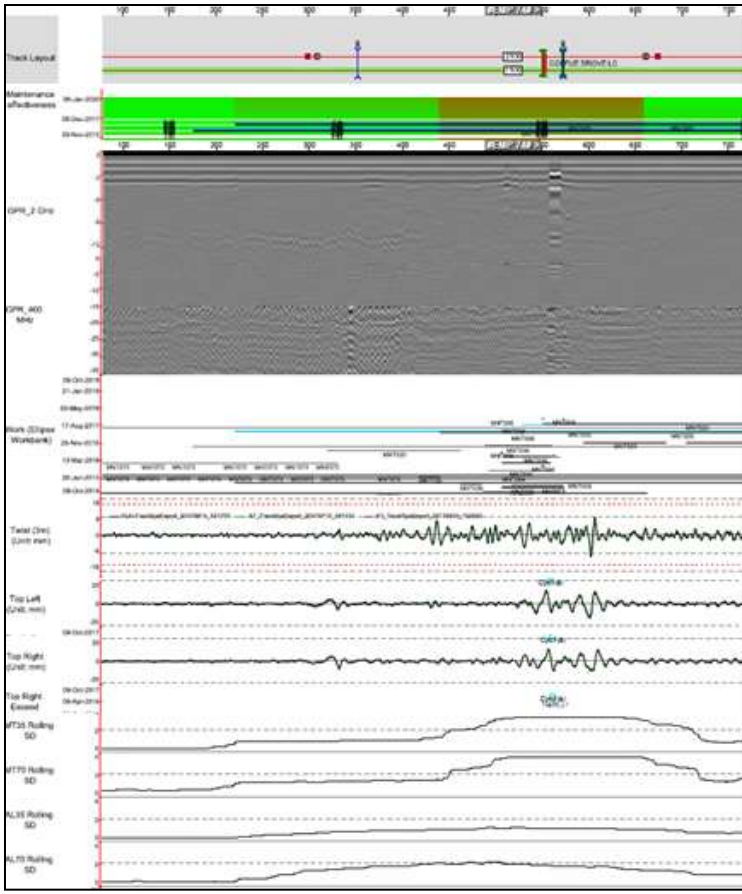
Plate 5d 72m 1150yds Up Willow

LADS Summaries ETN 72m 0800yds to 72m 1650yds Up

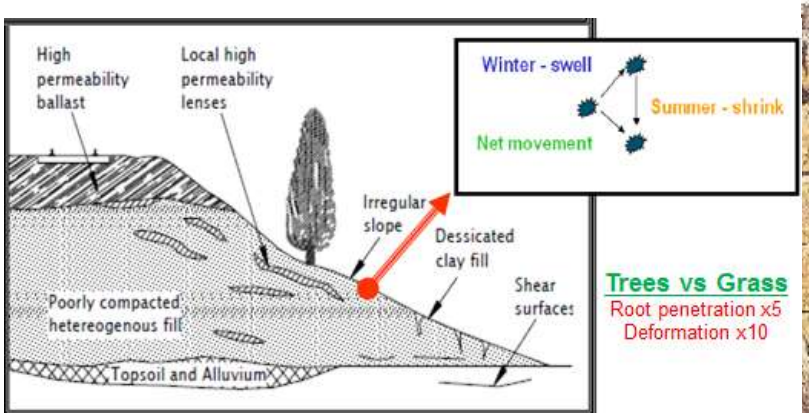
Maintenance effectiveness on Fens (EMP 74m 0550yds Up)

Stoneblowing more effective than Tamping





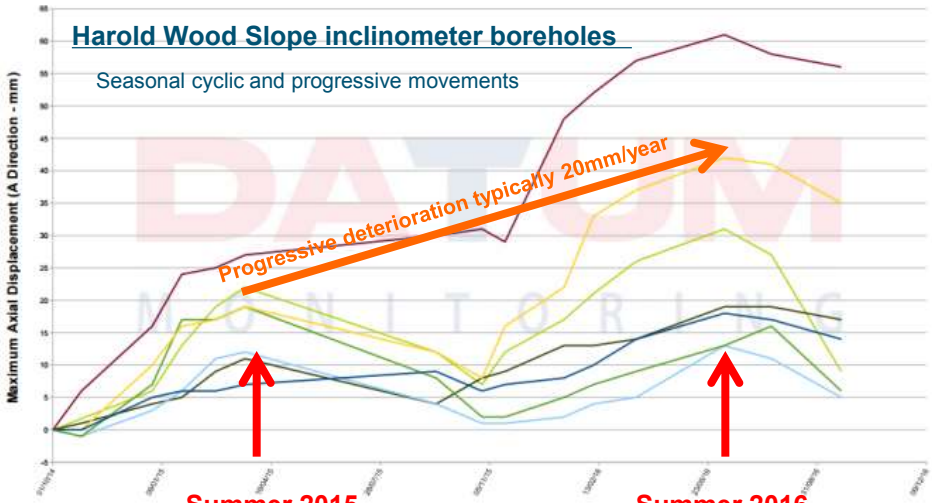
Clay Embankment Desiccation



BRE 412 "Desiccation in Clay Soils" - Desiccation in clay soils can result in shrinkage of the soil and subsidence of the ground; this may lead to damage to buildings. As the soil re-hydrates, it can swell, resulting in ground heave; this may also cause damage to buildings

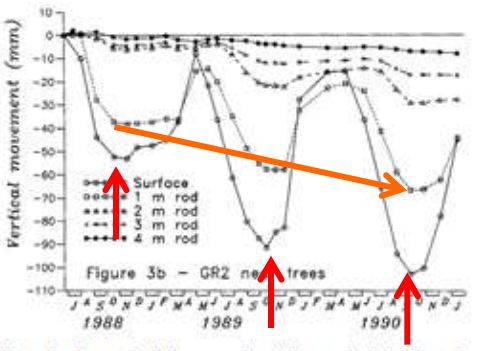
Harold Wood Slope inclinometer boreholes

Seasonal cyclic and progressive movements

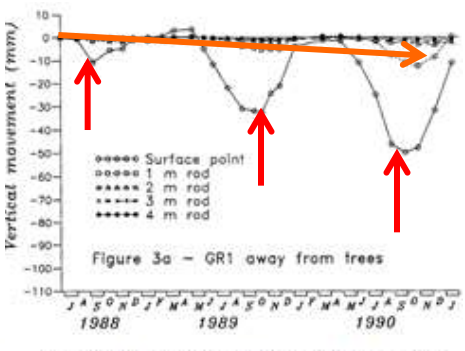


Chatteden London Clay BRE Settlement rods

Seasonal cyclic and progressive movements showing effects of trees and grass

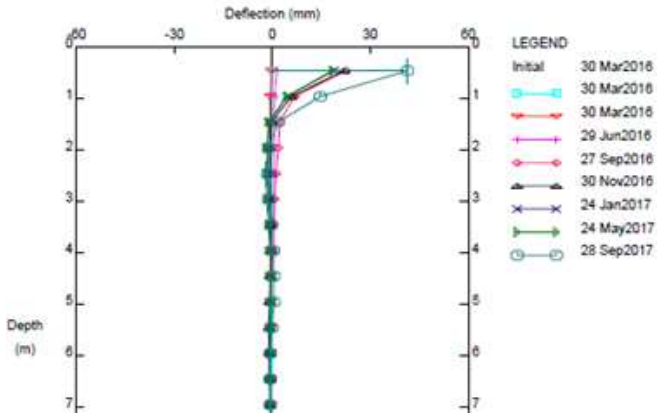


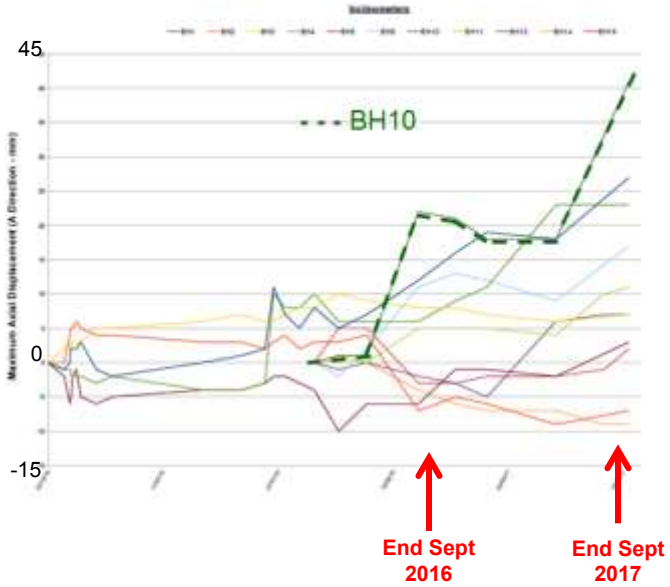
Nearby tree shrinkage potential on shrinkable clay



Grass shrinkage potential on shrinkable clay

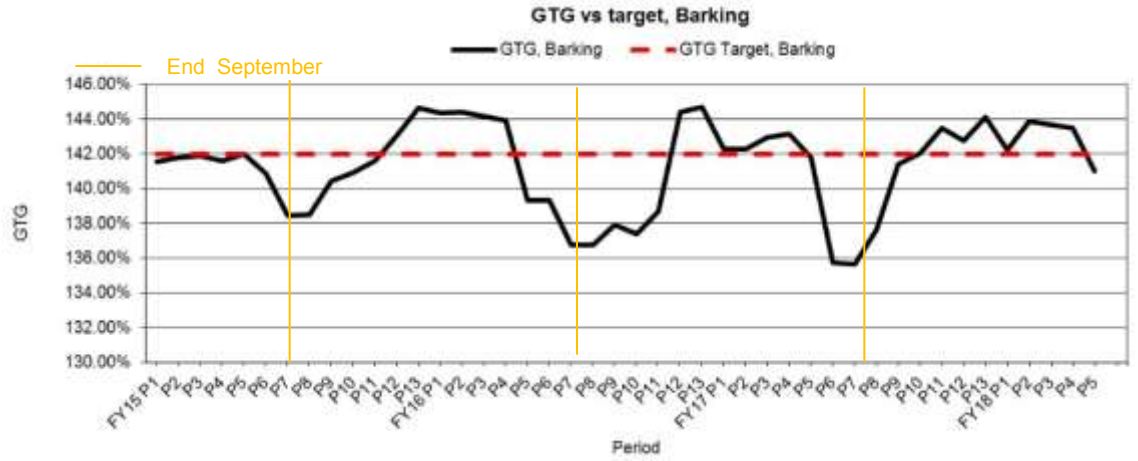
Wrabness Desiccation Rough Ride 65milesM 1317yds Down 28.09.17

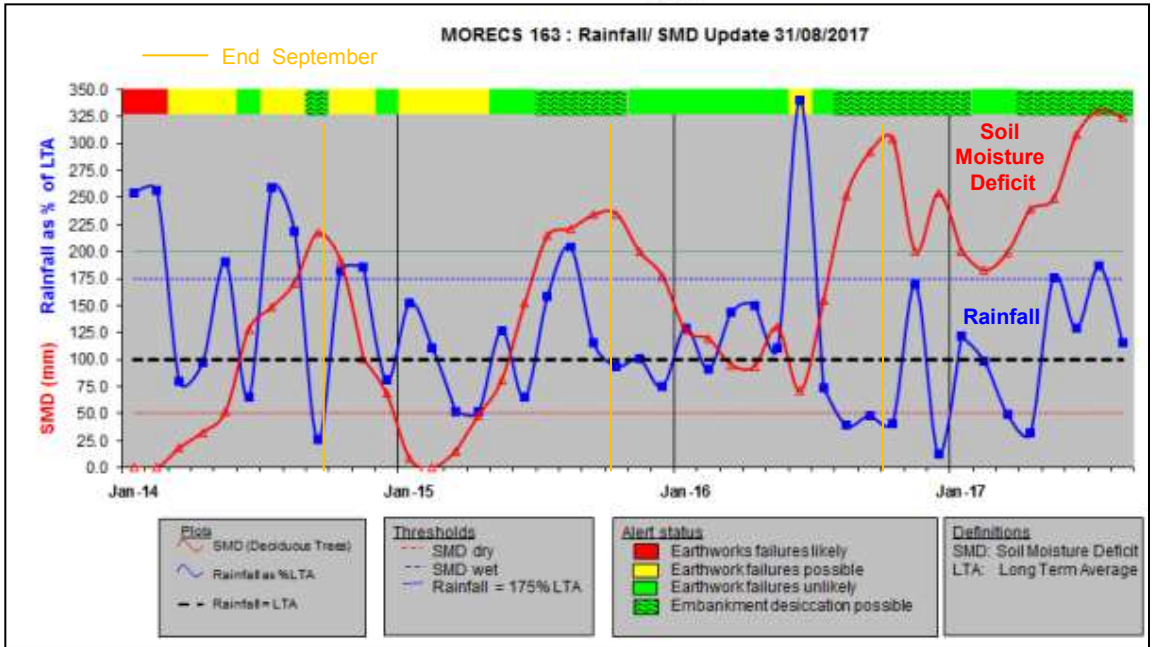




Desiccation related track deterioration

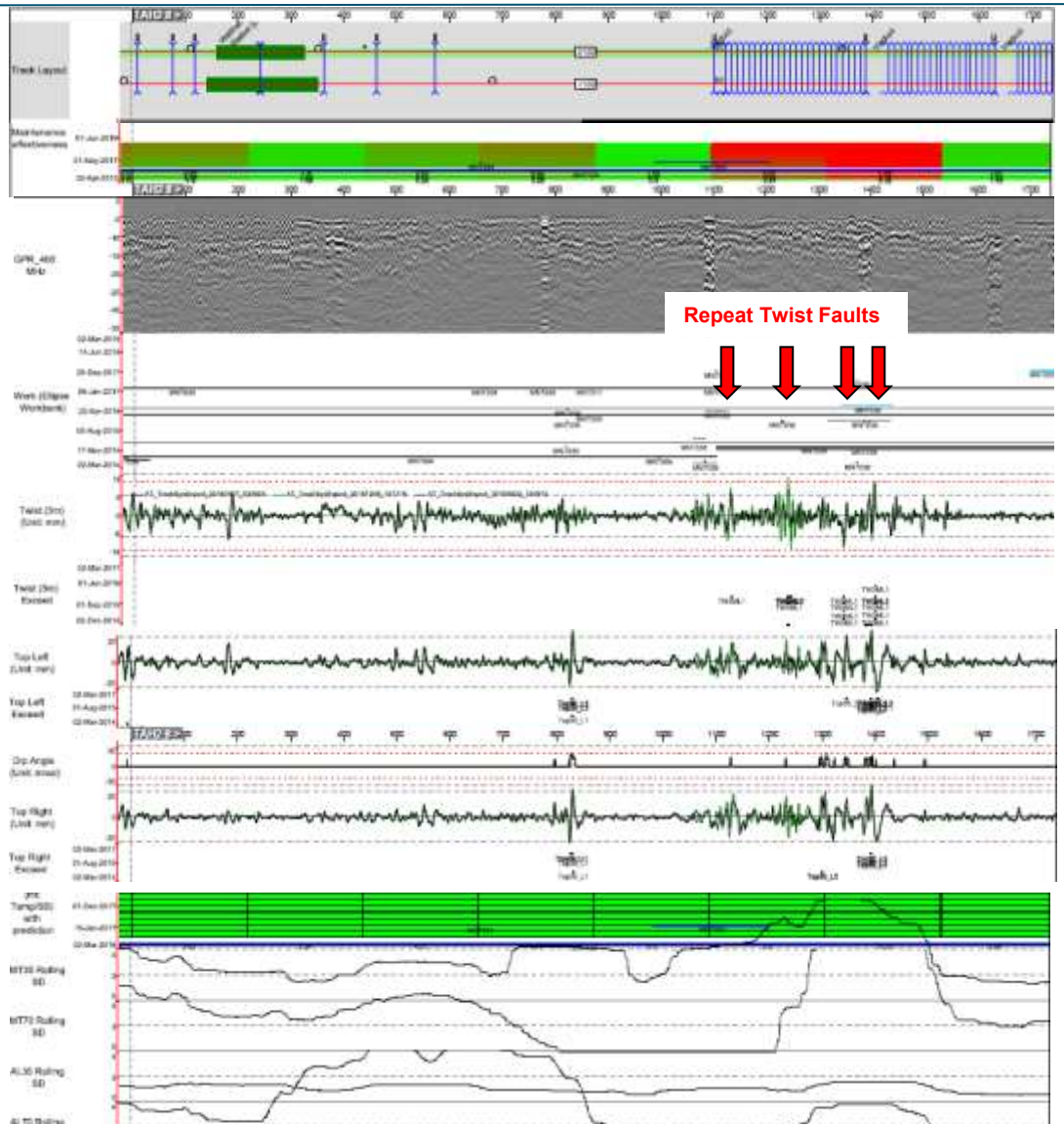
Good Track Geometry on London Clay Soils FSS2 and TLL





TAH2 8m 1270yds to 1340yds Down Wet Beds

TAH2 8m 1270yds to 1340yds Down Wet Beds



Conclusions

1. Track monitoring data is a useful tool in the assessment of certain types of earthworks failure
2. Anglia Route are looking to undertake a wider Route review of such track monitoring data
3. Track monitoring data is a complimentary tool to supplement other existing earthworks assessment tools
4. Sharing case history data will hopefully assist in the more widespread use of such track monitoring data
5. Production of a more detailed user manual would further assist in the understanding of LADS
6. Network Rail are embarking centrally on a more detailed review of the benefits of using track monitoring data

The End

Track Monitoring Data Systems for Evaluation of Earthworks Instability

Ian Payne – Senior Asset Engineer (Geotechnics)
Jonathan Garelick – Asset Engineer (Geotechnics)
Jason Lund - On Track Machine Engineer

26th October 2017