Office of Rail Regulation and Network Rail

Part A Reporter Mandate AO/049: Review of updated Earthworks Asset Policy for CP5 years 3-5

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Ove Arup and Partners Ltd.
13 Fitzroy Street,
London W1T 4BQ
United Kingdom
www.arup.com

ARUP

Contents

Glossary

BCAM	Buildings and Civils Asset Management
CAM	Civils Adjustment Mechanism
CCT	Common Consequence Tool
CP4	Control Period 4 – April 2009 – March 2014
CP5	Control Period 5 - April 2014 – March 2019
CSAMS	Civil Strategic Asset Management Solution
DP15	Delivery Plan update 2015 (due 31st March 2015)
EHC	Earthworks Hazard Category
EACB	Earthworks Asset Criticality Band
FDP	NR's Final Delivery Plan for CP5
FWI	Fatalities and Weighted Injuries
MAA	Moving Annual Average
NERRP	National Earthworks Risk Reduction Programme
NR	Network Rail
ORR	Office of Rail Regulation
PAnTS	Powerpack Analysis Tool Set
PowerPack	Tier 3 tool to support Policy implementation and assurance
RSHI	Rock Slope Hazard Index
RSSB	Railway Safety and Standards Board
SBP	Strategic Business Plan
SCAnNeR	Strategic Cost Analysis for Network Rail (Tier 1/2 Model for Earthworks and Drainage assets)
SRM	Safety Risk Model
SSHI	Soil Slope Hazard Index
WLCC	Whole Life Cycle Cost

1 Executive Summary

1.1.1 Arup have been appointed by the Office of Rail Regulation (ORR) and Network Rail (NR) as Part A Independent Reporter to provide assurance as to the quality, accuracy and reliability of NR's data that is used to report performance to ORR, the Department for Transport (DfT) and the wider industry.

1.1.2 In their Strategic Business Plan (Jan. 2013) NR adopted a new Earthworks Asset Policy for CP5 (dated December 2012). At that time NR noted that their CP5 policy was new and largely untried in practice. To reflect this the Final Determination set out a Civils Adjustment Mechanism (CAM) to allow a more complete workbank for years 3,4 and 5 of CP5 to be submitted by NR at the end of year 1 (31st March 2015).

1.1.3 As part of their continuous improvement activity, NR have prepared an updated CP5 Earthworks Asset Policy (dated August 2014). This revised Policy is currently being used by the Routes as a basis for planning and developing their workbank for years 3,4 and 5 of CP5.

1.1.4 At present NR are still developing their CAM submission and this report summarises our findings from a review of the updated CP5 Earthworks Asset Policy. Our findings have been discussed with NR and ORR following submission of our Draft report.

Key Changes

1.1.5 Key changes in the updated Asset Policy relate to available asset inventory & condition data, and the formation of the 'safety risk matrix' which is used with condition and consequence data to select soil slopes for intervention.

1.1.6 Since the previous Asset Policy NR have undertaken a significant number of specific activities to improve the quality of their inventory & condition data.

1.1.7 NR have also undertaken a detailed review of their historic failure data for soil slopes looking at the linkage between condition data collected in their examinations and actual failures. This has led to NR proposing a revised condition index (EHC - Earthworks Hazard Category) that replaces the previous Soil Slope Hazard Index used in policy derivation.

1.1.8 In their CP5 Asset Policy NR adopted an explicit 'risk-based approach' which was a significant step forward. In the revised policy NR have further developed that approach linking to wider work being undertaken by NR's Safety and Sustainability Team on a 'Common Consequence Tool'. NR have implemented this common consequence tool for earthworks through an update to their 'safety risk matrix' adopting a revised consequence scale (Earthworks Asset Criticality Band – EACB).

General Comments

1.1.9 The Asset Policy is underpinned by asset inventory, condition & failure data. It is very positive that NR are continuing to develop their earthworks asset knowledge and are taking measures to improve data quality. It is suggested that these activities should be more clearly defined in a time-bound improvement plan with clear data quality targets similar to those set out for Track in NR's March 2014 Final Delivery Plan.

1.1.10 In terms of the updated 'safety risk matrix' there is evidence that for historic failure data (prior to CP5) the new EHC (x-axis of matrix) provides an improved

relationship between soil slope condition and failure probability. However, whilst the new consequence scale EACB (y-axis) does not seem unreasonable, there is limited evidence to demonstrate the difference it makes over the previous scale at present.

1.1.11 At the time of writing, there is still limited feedback as to the effectiveness of the CP5 asset policy – NR are collating material on the volumes of work activity undertaken, policy implementation and failure data for the first year of CP5.

1.1.12 In addition, a number of concerns raised in our previous review of the CP5 Asset Policy (Dec 2012) still remain as set out below.

Policy Robustness[1]

1.1.13 On the basis that the Earthworks Asset Policy has a clear linkage to asset outputs (e.g. Condition Index), is based on reasonable inventory and condition information and has an explicit risk based intervention approach, we still consider it reasonably likely that the Asset Policy will be robust and capable of delivering a reduction in asset risk in the short-term. There is however not yet any significant feedback to draw on.

1.1.14 The focus of the Asset Policy is rightly primarily on the selection of sites based on safety risk. However, we note that NR under their licence has performance obligations to also meet. At present there is no guidance to Routes on selection of sites driven by performance. This might also consider network resilience – for example the importance of a line that is a 'diversion route'.

Policy Sustainability[2] and Whole System Cost

1.1.15 We continue to support the Policy principle of targeting more 'lighter' pro-active intervention activities (such as drainage) to reduce safety risk. However we still consider it uncertain as to whether the Earthworks Asset Policy will deliver the required outputs both in the short and long-term at lowest possible whole system cost over the lifetime of the assets. Our concerns relate to the reduction in the volume of more 'traditional' 'heavier' 'renewal' interventions.

1.1.16 At present NR have yet to provide their Tier 1 / Tier 2 Whole Life Cycle Cost (WLCC) / SCAnNeR analyses to demonstrate policy optimisation and so we are unable to comment on the impact of the revised policy on whole system cost.

Policy Implementation

1.1.17 NR are continuing to use their PowerPack Tool to support Earthworks Policy implementation at a Route Level. This seems to be a very effective mechanism for providing a clear basis for central review of workbanks and policy alignment.

1.1.18 The documents that we have seen so far suggest that policy alignment currently varies significantly between Routes. The source of policy mis-alignment may originate from many sources but it does reinforce that significant Route level judgement will be needed to select the appropriate workbank. This is potentially of concern as our discussions with the Routes in 2013 indicated that there was a varied level of understanding of asset management principles in the Routes and that the local application of Asset Policies was at different stages of maturity.

[1] Robustness: whether assets will deliver the required outputs; and
[2] Sustainability: whether asset policies continue to deliver the outputs over the longer term

1.1.19 We still have concerns related to the constraint of reducing risk and condition at a Route Level but maintaining overall 'average' risk and condition, in that this seems to suggest that the earthworks condition at some Routes may deteriorate and the risk at some Routes could increase. We are still unclear as to whether this approach complies with NR's Statutory Obligations under ALARP principles[3]. This should be addressed by NR in their CAM submission.

1.1.20 The new Earthworks Hazard Category potentially provides improved guidance on targeting 'the right slopes' for intervention. However, as yet there is little objective feedback that the maintenance and refurbishment interventions can be practically implemented and that they will be effective in reducing safety risk. This still poses a risk to delivery of performance improvement and the achievement of cost & efficiency targets in CP5.

Review and Continuous Improvement

1.1.21 We still have concern that there is little evidence of a structured continuous improvement approach to monitor the effectiveness of the CP5 Earthworks Policy. Specifically the Asset Policy update seems to have been undertaken before there was formal feedback and learning from the Dec 2012 policy. It is suggested that NR implement a more formally controlled continuous improvement process.

Conclusion

1.1.22 The CP5 Earthworks Asset Policy (Dec 12) introduced a new largely untried approach to the management of earthworks assets involving targeting an increased number of maintenance and refurbishment interventions and a reduced number of major renewal activities. The new policy (Aug 14) does not change this but potentially provides an improved way of selecting the 'right' earthworks for intervention using the new EHC index and the consequence scale. It is very positive that NR have extended the risk based principles to move towards a common 'cross-asset' consequence scale.

1.1.23 The CP5 Asset Policy has only been in use since April 2014 and so at present there is little evidence that the policy is able to be implemented by the Routes and is effective in reducing safety risk.

1.1.24 In summary our view is that the updated Policy is likely to be an improvement on the December 2012 policy, but there is not yet sufficient evidence from the first year of CP5 to demonstrate this with any certainty.

1.1.25 It is recommended that NR explicitly reviews the emerging effectiveness of the Asset Policy by considering a number of real examples with each Route to confirm that the Policy does, as they expect, identify key sites and appropriate interventions that will reduce safety risk. **[2015EWP-01]**

1.1.26 We recommend that NR provides explicit guidance to Routes on selection of sites driven by performance. This would complement the current safety related guidance. **[2015EWP-02]**

1.1.27 We also recommend that to improve confidence in the updated 'safety risk matrix', NR should undertake a more detailed calibration exercise to ensure alignment

[3] NR have a duty under the Health & Safety at Work etc. Act (1974) to manage safety risks to a level as low as reasonably practicable (ALARP). Our interpretation of this is that safety improvements should be implemented unless the costs are grossly disproportionate to the safety benefits.

between failure data, assessment methods, policy recommendations and actual example slopes. This would include both rock and soil slopes. **[2015EWP-03]**

Acknowledgement

1.1.28 The Independent Reporter Team would like to thank both NR and ORR staff for their assistance with this review activity, for openly explaining progress and their thinking as well as providing documents / plans.

2 Introduction

2.1 General

2.1.1 Arup have been appointed by the Office of Rail Regulation (ORR) and Network Rail (NR) as CP4 Part A Independent Reporter to provide assurance as to the quality, accuracy and reliability of NR's data that is used to report performance to ORR, the Department for Transport (DfT) and the wider industry.

2.1.2 At present, Network Rail are in the process of developing their civils workbanks for Years 3 to 5 of CP5. These will be submitted to ORR in March 2015 for their agreement under the Civils Adjustment Mechanism (CAM) [Doc.19].

2.1.3 As part of their continuous improvement activity, NR have prepared an updated CP5 Earthworks Asset Policy (dated August 2014) [Doc. 4] which will be used by the Routes as a basis for planning and developing their 'bottom-up' workbanks.

2.1.4 This report summarises our findings from a progressive assurance review of the updated CP5 Earthworks Asset Policy.

2.1.5 The review has been undertaken by Arup in response to Independent Reporter Mandate AO/049. A full copy of the Mandate is included in Appendix A.

2.1.6 The findings detailed herein represent our current understanding based on our work to date. The findings have been reviewed with NR and ORR following submission of our Draft report.

2.1.7 Key reference documents provided for our review are listed in Appendix C2 and referenced in square brackets [Doc xx].

2.2 Previous Reports and Comments

2.2.1 As part of the ORR review of NR's Strategic Business Plan in 2013, Arup undertook a detailed review of the CP5 Earthworks Asset Policy dated December 2012 and the Whole Life Cycle Cost (WLCC) Models that NR had developed to inform their Policy. Three key reports produced under Mandate AO/030 are relevant:

- Arup 2013 PR13 Maintenance & Renewals Review – Summary Report AO/030/01 Issue 1 May 2013.[Ref. 2]
- Arup 2013a PR13 Maintenance & Renewals Review – Policy and WLCC Model Review' Ref AO/030/02 Issue 1 May 2013. [Ref 3.]
- Arup 2013b PR13 Maintenance & Renewals Review – Earthworks Tier 1 Model Review' Ref AO/030/03C Issue 1 May 2013.[Ref. 4]

2.2.2 In our review we have referred back to these reports as appropriate and we have included a summary of our key findings in Appendix B.

2.3 Report Structure

2.3.1 This Report is structured as follows:

- Section 3 sets out the purpose, scope and our approach to this review;
- Section 4 sets out our understanding of the overall NR Asset Management approach as applied to Earthworks and provides a factual context for our review;
- Section 5 presents our findings / comments from our review;
- Section 6 sets out our conclusions
- Section 7 lists key references.
- A copy of the Mandate is included in Appendix A.
- Comments from our review of the previous CP5 Earthworks Asset Policy are summarised in Appendix B.
- A list of interviewees / documentation provided for this Mandate is included in Appendix C.
- A copy of the 'Question Log' used in tripartite meetings with ORR and NR to explore specific aspects is included as Appendix D.

Observations, Comments and Recommendations

2.3.2 Within the report key observations, comments and recommendations are highlighted by the use of green boxes like this.

2.4 Management of Potential Conflict of Interest

2.4.1 In accordance with our framework contract as an Independent Reporter, for each individual Mandate we review potential for conflict of interest with NR and ORR before we are appointed to undertake the work.

2.4.2 Our conflict of interest review for this Mandate identified that a separate team in Arup was / had been involved in developing some of the material that has been used by NR in their Asset Policy. This was highlighted to NR and ORR. It was agreed with both NR and ORR that this review would be undertaken by a separate and independent team in Arup.

2.5 Acknowledgement

2.5.1 The Independent Reporter Team would like to thank both NR and ORR staff for their assistance with this review activity, for openly explaining progress and their thinking as well as providing documents / plans.

3 Purpose, Scope and Review Approach

3.1 Purpose and Scope

3.1.1 At present NR are developing their Civils Adjustment Mechanism (CAM) submission which is due to be issued in March 2015. The CAM submission will be considered in detail by ORR at that time.

3.1.2 This review is part of progressive assurance of CAM being undertaken by ORR ahead of formal issue of the CAM submission. Specifically the Mandate is to review the updated Earthworks Asset Policy - dated August 2014 [Doc. 4] and comment on the key changes that NR have made since the Earthworks Asset Policy (dated December 2012) [Doc. 1] that was used to develop the CP5 Strategic Business Plan [Doc. 33] and CP5 Final Delivery Plan [Doc. 22].

3.1.3 A reporting date of February 2015 for our Draft Report was agreed to suit availability of information from NR.

3.1.4 To reflect the fact that NR are still preparing their CAM submission it was agreed that Arup would address aspects in the Mandate in stages. At the time of writing it has not been possible to review the following specific aspects of the Mandate:

- Tier 3 'PowerPack' Tool (and the PAnTS Powerpack Analysis Tool Set) – these have not been provided by NR so we have been unable to review whether changes to the Asset Policy have been accurately modelled;
- Whole Life Cycle Cost (WLCC) / SCAnNeR analyses – these are presently being updated by NR and have not been provided.

3.1.5 It has also been agreed that review of the Mining Policy is not required.

3.1.6 In undertaking this Policy review we have been provided with some information on the Common Consequence Tool (CCT). We have not been provided with the CCT itself and have only considered the information provided in the general context of the 'safety risk matrix' – specifically we have not reviewed the CCT work.

3.1.7 In progressing our review we have considered:

- Compliance with the Network Licence, particularly Section 1 relating to Network Management; and
- ORR tests of robustness, sustainability and minimum whole lifecycle, whole system cost and further criteria for assessing asset policy as shared with NR.

3.2 Approach

3.2.1 Our approach has been a desk-top based review of policy documentation supplemented by written answers provided by NR to specific questions raised in the Question Logs and meetings. A list of meetings is included as Appendix C1, together with a copy of the final Question Log in Appendix D. We have not had the opportunity to make any site visits or meet with the Route teams.

3.2.2 We have based our review on the key documents provided by NR (and ORR) as listed in Appendix C2.

4 Context

4.1 Introduction

4.1.1 The aim of this section is to summarise our understanding as to how the NR Asset Policies fit into the overall Asset Management System and how they are related to models, outputs and the volumes quoted in the CP5 Delivery Plan. It provides a factual context for the subsequent sections that review and comment on the Asset Policy.

4.2 Asset Management System

4.2.1 NR's overall asset management system is described in their Asset Management Policy [Doc. 20] and Asset Management Strategy [Doc. 21]. These are dated March 2014 and October 2014 respectively.

4.2.2 NR's asset management framework is shown in Figure 4-1 below. This defines the cycle of NR's asset management decisions and activities in a Plan-Do-Review sequence.

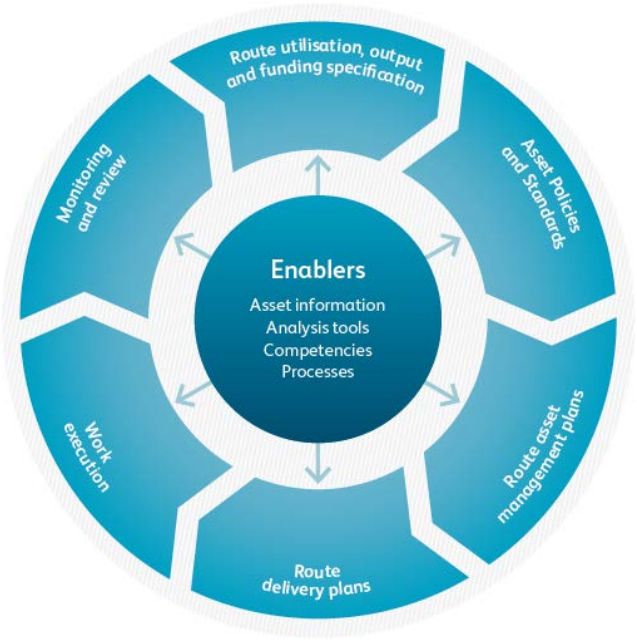


Figure 4-1: Network Rail Asset Management Framework [Doc. 21]

4.3 Asset Policies

4.3.1 Asset Policies are a key part of NR's asset management framework and NR [Doc. 21] explains the purpose of Asset Policies as :

> *"Asset Policies Specify how to select the major inspection, maintenance and renewal interventions for each asset discipline to deliver the required outputs at lowest whole lifecycle cost (WLCC) …"*
>
> *"…rules to ensure objectives are delivered consistently…"*

This is shown schematically in Figure 4-2 below.

4.3.2 The NR Asset Policies are informed by 'Tier 2' Whole Life Cycle Cost (WLCC) models and in turn then inform the Route Plans and the Delivery Plans.

Earthworks 'SCAnNeR' WLCC Model

4.3.3 The December 2012 CP5 Earthworks Asset Policy [Doc 1] was derived from analyses using a 'Tier 1/ Tier 2' WLCC Model known as 'SCAnNeR'. This model informed NR's selection of optimum maintenance and renewal interventions that represent lowest whole lifecycle cost. The model was also used to inform the volumes of interventions proposed for CP5. Further detail is included in our previous reports [Arup, 2013a,b].

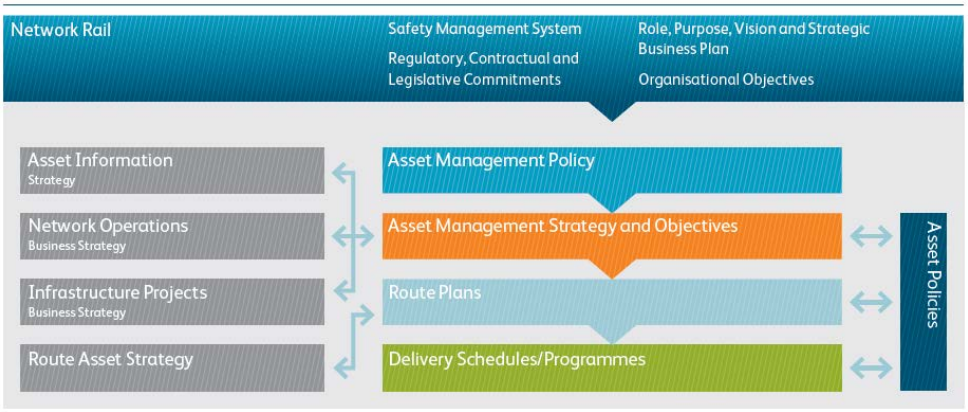


Figure 4-2: Network Rail Asset Management System Documents [Doc. 21]

Earthworks 'PowerPack' Tools

4.3.4 NR have embedded their CP5 Earthworks Asset Policy principles and their inventory & condition data into a 'Tier 3' spreadsheet tool known as 'Powerpack'. Powerpack is a workbank planning tool that aligns intervention activity to assets. Planned future works can then be analysed against policy application. The tool has been provided to the Routes to help them develop their workbanks for CP5.

4.3.5 NR have also developed a PAnTS tool (Powerpack Analysis Tool Set) to enable workbank output modelling.

4.4 Asset Output Measures

4.4.1 In January 2013, NR's CP5 Strategic Business Plan [Doc. 33] set out a series of asset output measures relating to:

- 'robustness'
- 'sustainability'
- 'renewal volumes'

At that time the robustness measure was still under development, and an 'earthworks risk index' was proposed as the sustainability measure. The Network-wide renewal volumes for earthworks are summarised in Figure 4-3 below.

Renewal Volumes	2014/15	2015/16	2016/17	2017/18	2018/19	CP5
Earthworks (5 chain-length)	3,554	3,549	3,547	3,552	3,554	17,757
Source: NR Strategic Business Plan for CP5 – page 41						

Figure 4-3: SBP Network-wide earthworks renewal volumes [Doc. 33 page 41]

4.4.2 For their CP5 Final Delivery Plan [Doc. 22] NR have developed their SBP asset output measures into a set of Regulated Outputs[4] and Indicators[5] that they plan to be delivered in CP5. For the Earthworks asset these comprise the following indicators:

- 'asset condition reliability'
- 'asset condition sustainability'
- 'renewal volumes'

The Network-wide specific values are summarised below in Figures 4-4, 4-5 and 4-6 respectively.

Asset Condition Reliability		2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Earthworks	Earthwork failures	109	105	101	98	94	90
Source: NR Delivery Plan for CP5 – Table 24							

Figure 4-4: FDP Network-wide Asset Condition Reliability [Doc. 022 Table 24]

Asset Condition Sustainability		2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Earthworks	Earthworks - Condition Banding	1.75	1.75	1.75	1.75	1.75	1.74
Source: NR Delivery Plan for CP5 – Table 25							

Figure 4-5: FDP Network-wide Asset Condition Sustainability [Doc. 022 Table 25]

[4] Regulated outputs: - Outputs that, if Network Rail fails to deliver, ORR would consider whether this amounts to a licence breach and hence may take enforcement action.

[5] Indicators:- Used for specific monitoring purposes to indicate trends which may raise concern about Network Rail's likely future compliance with a regulated output.

Renewal Volumes		2014/15	2015/16	2016/17	2017/18	2018/19	CP5
Earthworks	5-chain	3,178	3,108	3,052	3,548	3,193	16,077
Source: NR Delivery Plan for CP5 - Table 32							

Figure 4-6: FDP Network-wide civils renewal volumes [Doc. 022 Table 32]

4.4.3 We understand from NR that the reduction in renewal volumes (about 9.5% reduction) between the SBP (Figure 4-3) and the Final Delivery Plan (Figure 4-6) relates to the fact that the SBP volumes were determined by top down modelling whereas the FDP volumes came from detailed bottom-up workbanks produced by the Routes.

4.5 Civils Adjustment Mechanism (CAM)

4.5.1 In their Strategic Business Plan [Doc.33] NR noted that whilst they believed that all their asset policies would deliver the required outputs in CP5, their view was that their policies for civils assets (structures, earthworks, drainage) were new and (while supported by models) were largely untried in practice. NR suggested an approach of:

> '*delivering increased activity levels while continuing to review whether the revised asset policies are recovering the backlog and reducing the level of risk relating to civils assets.'*
>
> NR Strategic Business Plan page 41 [Ref 033]

4.5.2 ORR were unable to conclude on CP5 civils expenditure in their 2013 Periodic Review because of the level of uncertainty in Network Rail's SBP submission. In recognition of this the ORR Determination set out a Civils Adjustment Mechanism (CAM).

The CAM requires NR to submit an updated civils asset management plan to demonstrate that it has in place a bottom-up workbank for years 3, 4 and 5 of CP5 (2016/17 to 2018/19), created by applying its asset policies to the civils asset portfolio, in accordance with condition 1.19 of its Network Licence. NR's plan is required to justify the proposed expenditure.

4.5.3 At present NR are still developing their CAM submission. This is due to be issued to ORR by 31st March 2015.

5 Review and Comment on Policy

5.1 General

5.1.1 As part of their continuous improvement activity, NR have prepared an updated CP5 Earthworks Asset Policy (dated August 2014) [Doc. 4].

5.1.2 This updated Asset Policy replaces the previous Asset Policy (Dec 2012) [Doc. 1] and is being currently used by the Routes as a basis for planning and developing their 'bottom-up' CAM workbanks for years 3, 4 and 5 of CP5.

5.1.3 NR have also further developed their 'Tier 3' 'PowerPack' spreadsheet tool to support the Routes in developing their workbanks. As noted earlier, a review of the policy implementation in the 'PowerPack' tool has not been possible at present.

Key Changes

5.1.4 The December 2012 Asset Policy was based on the following key inputs:

- Inventory and Condition data;
- Analysis of failure data;
- Adoption of a 'risk based' approach with assumed relationships between asset condition and consequence;
- Intervention effectiveness and cost assumptions;
- 'Top down' modelling to identify 'optimum' intervention strategies (SCAnNeR Modelling).

5.1.5 The update to the Policy relates to the first three of these aspects for soil cuttings and embankments. The interventions are unchanged and the 'top down' SCAnNeR modelling has not yet been re-run by NR to demonstrate policy optimisation. In addition NR have extended the risk based principles to move towards a common 'cross-asset' consequence scale.

5.1.6 The key changes are discussed below with our comments and observations. Feedback on the CP5 policy implementation to date is also discussed.

5.2 Inventory and Condition Data

5.2.1 Based on information available at the time, in March 2013 our understanding of the earthworks inventory data was that:

- the earthworks inventory comprised 175,123 asset 5 chain lengths (see Figure 5-1;

Asset Type	Asset 5 chain lengths	Examination 5 chain lengths
Embankments	97,815	159,407
Soil Cuttings	68,085	
Rock Cuttings	9,223	
Total:	**175,123**	

Figure 5-1 Inventory Data (as at 15/02/12) – [Ref 3 - Arup 2013a]

- only about 1% of the national database of assets remained to be examined;
- there was some variability in asset data between Routes, but we assessed that at a National Level there was low uncertainty associated with the overall NR earthworks inventory

5.2.2 In terms of condition data, our view in March 2013 was that:

- the condition profile (SSHI/RSHI) for the earthworks asset was as presented in Figure 5-2:

	Asset Five Chain Lengths				
	Serviceable	Marginal	Poor	Top Poor	Total
Embankment	54959 (56.2%)	36800 (37.6%)	5295 (5.4%)	761 (0.8%)	97815 (100%)
Soil Cutting	39222 (57.6%)	25981 (38.2%)	2033 (3.0%)	849 (1.2%)	68085 (100%)
Rock Cutting	4388 (47.6%)	3788 (41.1%)	762 (8.3%)	285 (3.1%)	9223 (100%)
Total	98569	66569	8090	1895	175123

Figure 5-2 Condition Data (as at 15/02/12) – [Ref 3 - Arup 2013a]

- the majority of NR earthworks five chain lengths had had at least one examination and so there was a reasonably low uncertainty associated with earthworks condition data.
- there was some variability in asset data between Routes and that the last examination, in some instances, may have been up to 10 years ago.

5.2.3 The updated Asset Policy indicates that the earthworks inventory is now known to comprise at least 184,551 asset 5 chain lengths (see Figure 5-3) – this is approximately 5% greater than in Feb 2012 (Figure 5-1). NR have developed their definition of ‘inspection 5 chains’ and so the total number of ‘earthworks inspection 5 chains’ has changed from 159,407 to 332,774.

Asset Type	Earthwork assets	Earthwork inspection 5 chains
Embankments	99,329	332,774
Soil Cuttings	70,149	
Rock Cuttings	15,073	
Total:	**184,551**	

Figure 5-3 Inventory Data (as at 02/05/14) – [Doc. 4]

5.2.4 Of the 184,551 assets, 172,249 asset 5 chain lengths are listed [Doc 4 Table 2-3] as having full examinations – i.e. 93%.

5.2.5 NR are continuing to improve their understanding of the asset inventory and condition, specifically they have recently made improvements to earthworks inspection terminology with introduction of categories such as ‘never inspected’, ‘inspection unfinished’, ‘incomplete examination’ etc. to reflect the fact that some of the inspection and examination records were incomplete.

5.2.6 The updated information suggests that at October 2014, there are actually 62,224 5-chain lengths that have never been inspected for earthworks and where it is not currently known whether there are any earthworks assets present or not – See Figure 5-4. This represents approximately 19% of the total asset length.

5.2.7 Of the potential 19%, NR believe that once Route level data improvement has been undertaken that the never inspected earthwork inspection 5-chains assets may fall to about 7%.

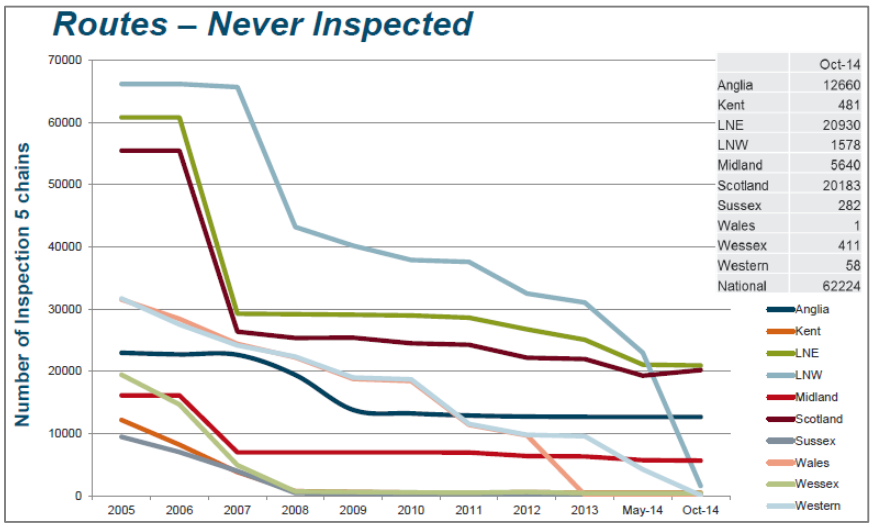


Figure 5-4 Never Inspected Earthworks (Inspection 5-chains) [Doc 34]

5.2.8 Figure 5-5 shows the variations in asset count by asset type and route. The exact source of these changes is unclear – i.e. whether due to a further inspection seasons between 2012 and 2014 or data cleansing / improvement activity but it is positive that NR are still actively developing their asset knowledge.

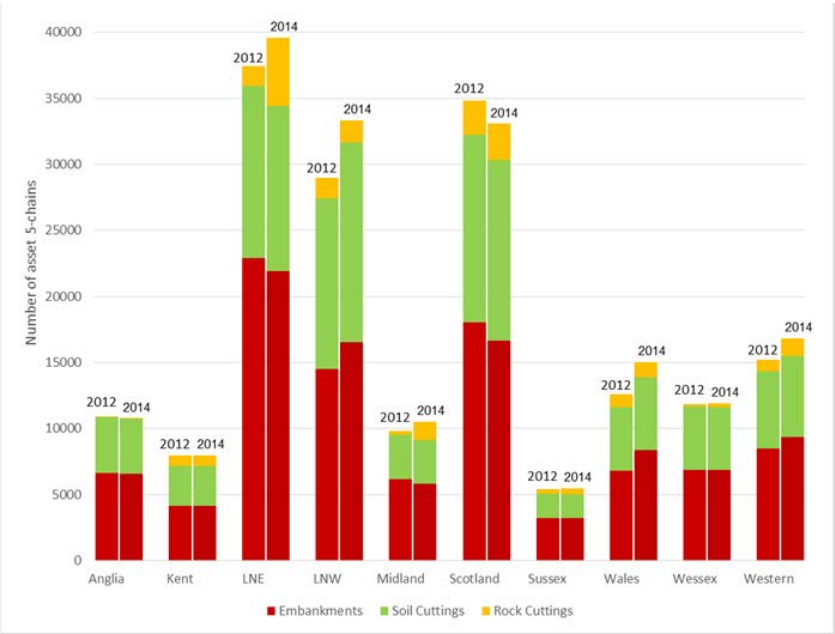


Figure 5-5: Variation in earthworks asset inventory by route and earthwork type between 15/02/12 data set and 02/05/14 data set.

Data Quality

5.2.9 NR have produced a detailed Data Quality Report [Doc. 12] dated January 2014, which provides a consolidated view on asset data quality. The document summarises the results of several exercises that have resulted in reviews of earthwork asset data quality including:

- ORBIS: Asset Data Improvement Programme (ADIP) analysis, Nov 2011
- Data processing report for CeCost model, Oct 2012
- Issues noted during CP5 policy development
- Issues noted during development of the adverse weather risk prioritisation, 2013
- Data clean-up activities with Route teams (during 2013) CP5 earthworks team/JBA Consulting (JBA) data quality assessment 2013.

5.2.10 The document also provides a collated summary of the data quality issues list identified by CP5 earthworks team and JBA based on analysis undertaken on 26 June 2013.

5.2.11 Issues are prioritised and quantified. These comprise 8 ‘red’ concerns that may lead to significant uncertainty and 12 ‘amber’ concerns. The ‘red’ concerns are reproduced below.

RAG	Summary of issues
Red	1. Duplicate assets (same real asset, two or more IDs at asset level) 2. Inconsistency between asset types listed at exam level and actual assets in database 3. Not all Rail 5 chains (BIDs) attributed with required data for asset criticality calculations 4. Base data for asset criticality calculation out of date, particularly for track quality data? Route classification? 5. There are sections of the network where potential assets have been identified by LiDAR, that have yet to become complete asset records (grey assets) 6. There is not complete coverage of the NR network with 'earthworks' data. Yet ground related hazards can impact on sections at grade as well 7. Mixed slopes; currently not possible for NR to definitively state how many mixed rock/soil slopes they have. 8. Drainage data link/overlap with asset data (whether earthwork there or not)

Figure 5-6: Summary of Data Quality Issues (as analysed at 26/06/13) [Doc.12]

5.2.12 It is very positive that the report defines actions to resolve these issues and sets out acceptance criteria. The Data Quality Report [Doc. 12] also recommends that steps should be taken to prevent these (and other) data quality issues from reoccurring. The steps identified are:

Data validity

- Validation checks in field tool
- Checks built into data upload
- Annual re-analysis of the data quality checks and correction

Data accuracy

- Consider a 100% re-survey requirement
- Use available data sets to check and verify examination data
- Use linked datasets (rather than data cuts)

Standards

- Remove incomplete or incompatible data
- Consider impact of changes in examination standard to existing data
- Re-configure dataset to be 'asset centric' (rather than examination time-based)

Competence and training

- Review competence
- Provide training

5.2.13 We note that a specific asset data quality trajectory for the Track asset is included in NR's FDP (dated 31 March 2014). We have not been provided with the current asset data quality score for Earthworks or a trajectory for improvement but note that the FDP states that asset data quality for earthworks will be reported in the 2015 Delivery Plan update. Mention of this is not included in the Data Quality Report (dated January 2014).

5.2.14 We understand that as part of their CSAMS[6] work, NR have an ongoing workstream to improve data quality of the earthworks asset dataset and that a data quality update should be available shortly.

5.2.15 The Data Quality Report (Jan 2014) makes a number of useful recommendations on how to improve data quality considering process, data and technology. This is very positive.

5.2.16 It is very positive that NR are actively improving the quality of their earthworks inventory and condition data, however we have not seen any evidence of a time-bound improvement plan or the linkage to the asset data quality trajectory mentioned in the FDP. It is suggested that such an improvement plan should be prepared by NR (and actions implemented if not already underway) with clear data quality targets similar to those set out for Track in NR's March 2014 Final Delivery Plan.

[6] Civil Strategic Asset Management Solution

5.3 Analysis of Failure Data

5.3.1 Since December 2012, NR have spent considerable effort in reviewing the earthwork examination data (for soil slopes) to investigate and improve on the relationship between condition and failure. This has involved detailed statistical analysis to try to better represent the likelihood of failure by weighting particular key condition features [Doc. 5, 13]. This is very positive.

5.3.2 A revised condition index (Earthworks Hazard Category - EHC) has been developed which replaces the existing Soil Slope Hazard Index (SSHI) algorithm. EHC has five categories (A, B, C, D &E) which replaces the four SSHI bands.

5.3.3 NR have not revised the Rock Slope Hazard Index (RSHI) algorithm.

5.3.4 A comparison of failure probabilities is shown in Figure 5-7 and Figure 5-8 below.

		Annual probability of failure				
	Existing bands	Serviceable	Marginal		Poor	Top Poor
	New categories	A	B	C	D	E
Embankments	SSHI 4 bands	0.02%	0.03%		0.12%	0.22%
	New Hazard Index 5 categories	0.01%	0.02%	0.05%	0.15%	0.66%
Soil Cuttings	SSHI 4 bands	0.04%	0.07%		0.19%	0.82%
	New Hazard Index 5 categories	0.02%	0.05%	0.16%	0.48%	1.21%
Rock Cuttings	RSHI 4 bands	0.12%	0.22%		0.39%	0.33%
	RSHI 5 categories	0.12%	0.19%	0.25%	0.39%	0.36%

Figure 5-7 Annual Failure Probabilities (SSHI/RSHI compared) [Doc. 5]

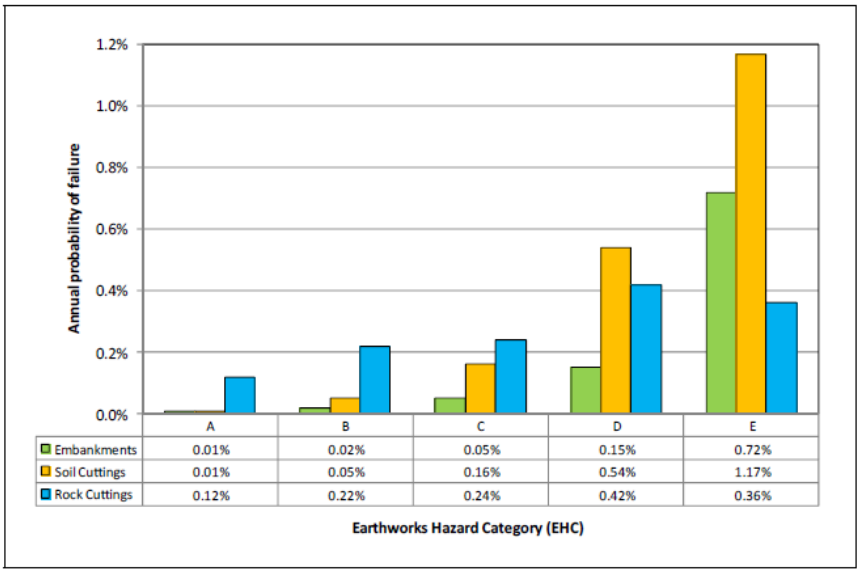


Figure 5-8 Annual Earthwork Failure Probabilities [Doc. 4]

5.3.5 NR have also taken steps to improve the quality and consistency of failure recording and reporting through their updates to the NR Asset Reporting Manual and specifically the M6 'Earthworks Failure' measure. This is very positive.

5.4 Risk Based Approach

5.4.1 The key improvement in the December 2012 CP5 Earthworks Asset Policy was the adoption of a 'safety risk matrix' to guide selection of sites for intervention.

5.4.2 At that time the 'x-axis' likelihood score was represented by Earthworks Hazard Index (EHI) and the 'y-axis' consequence by 'Modified EPM'. This gave the 3x4 matrix shown in Figure 5-9 below.

5.4.3 The 'safety risk matrix' has now been updated to use Earthworks Hazard Category – EHC (x-axis) and a 5 band 'consequence scale' Earthworks Asset Criticality Band – EACB (y-axis) to give the 5x5 matrix shown in Figure 5-10 below.

The following sections set out our comments on NR's updated risk based approach.

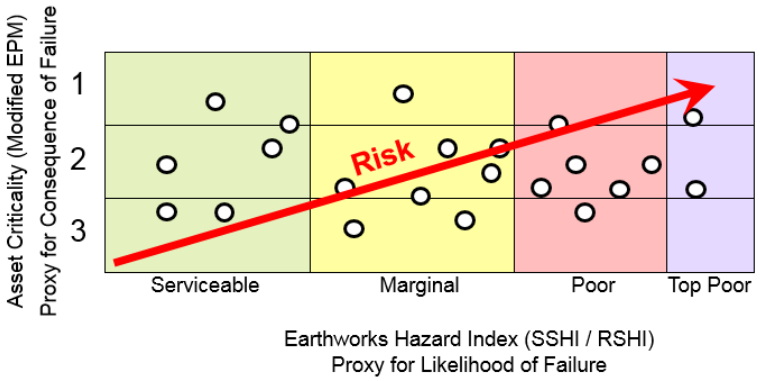


Figure 5-9 Earthworks Risk Matrix (CP5 Policy December 2012 [Doc 1])

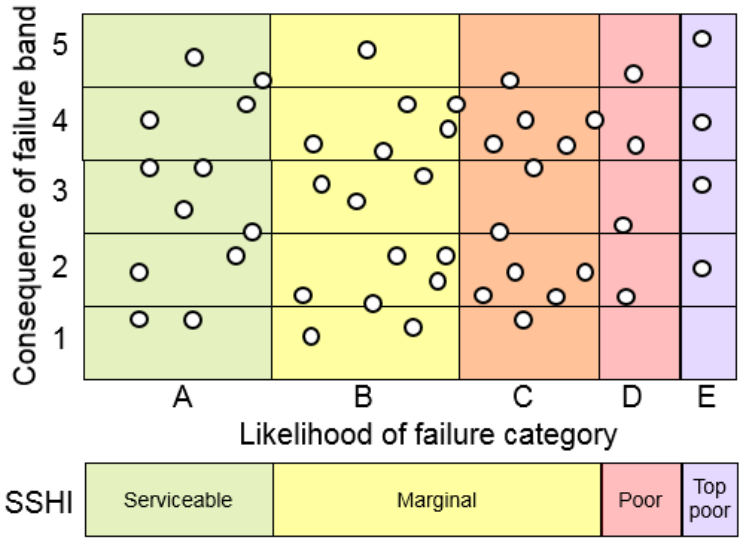


Figure 5-10 Updated Earthworks Risk Matrix (CP5 Policy August 2014 [Doc 4]

Common Consequence Tool

5.4.4 NR Safety & Sustainability Team have developed a Common Risk Scoring Matrix for Safety ('Safety Risk Matrix') that can compare various asset / functional / operational risks on a consistent basis. The aim is to be able to evaluate and compare different safety investments [Doc 16.].

5.4.5 At present we understand that NR have completed Phase 2 of their development which includes a 'common consequence tool' (CCT) to provide a consistent means of modelling consequences of derailment for any location. Specifically the CCT assesses consequence in terms of Fatalities and Weighted Injuries (FWI) which can be used across the entire safety risk space and permit cost asset comparison.

5.4.6 Although not directly part of this review, we consider that the development of the 'common consequence tool' (CCT) to support cross-asset safety investment trade-off decisions is a very significant step forward. The potential benefit was indicated in our review of Civil Structures in 2011 [Ref 1] and SBP Review [Ref 2], where we identified that cross-asset trade-offs were an area for future development.

5.4.7 A diagrammatic representation of the CCT and the linkage to the RSSB Safety Risk Model is shown in Figure 5-11 below.

5.4.8 We note that the NR Earthworks Team have adopted a 'bow –tie' risk analysis approach – see Figure 5-12 below. We consider that this reflects 'best practice' – and is consistent with British Standard BS EN 31010[7].

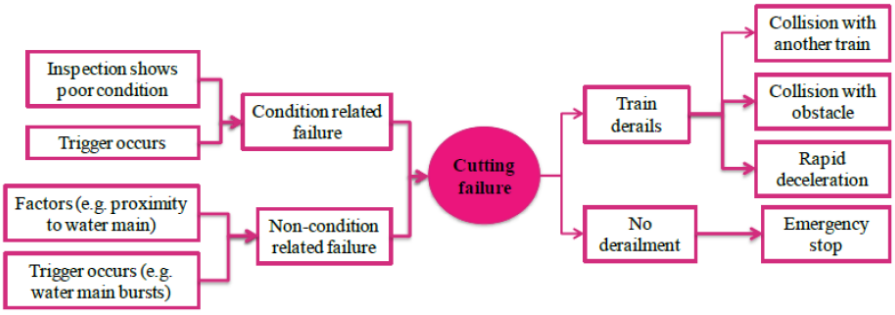


Figure 5-12 Bow tie diagram showing safety risk model for cuttings [Doc 15]

5.4.9 As noted above, we consider the development of a common consequence approach to supporting the prioritisation of safety investments to be a very positive step forward. However, in terms of further development, this approach should be extended to consider wider railway performance to provide balanced guidance to Routes on workbank development. At present we have not seen any such central guidance (qualitative or quantitative). This is discussed further below.

[7] BS EN 31010:2010 Risk management - Risk assessment techniques

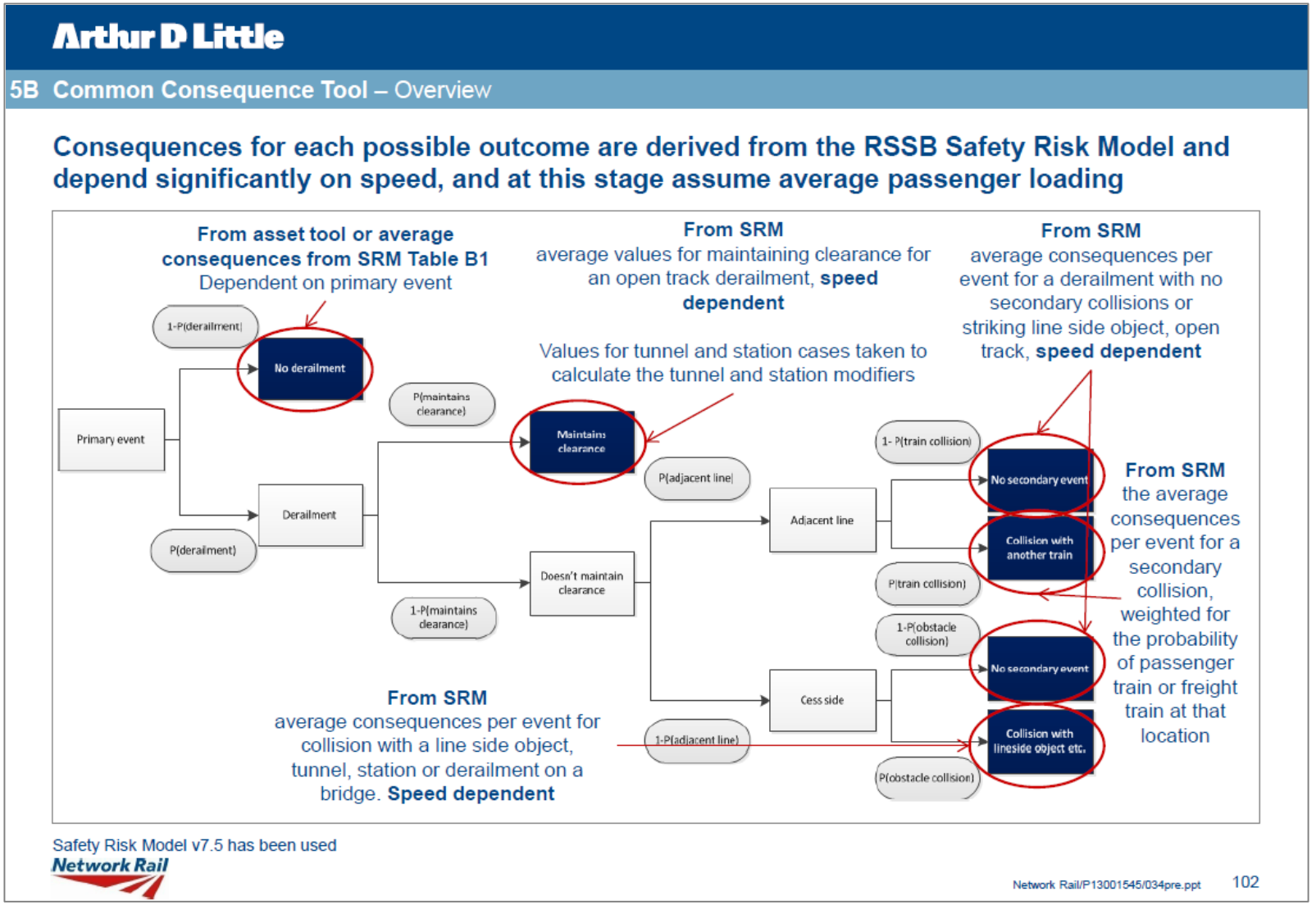


Figure 5-11 AD Little Common Consequence Tool – Overview [Doc 16]

Likelihood of Failure (x-axis)

5.4.10 NR have defined a new hazard index for soil cuttings and embankments utilising parameters in the existing 065 earthworks examination inspection database but weighting them in a different way to more closely fit the CIV/028 failure database. Our understanding of this is outlined below.

5.4.11 The 065 examination database has been re-assessed by NR to determine a Hazard Index which is a numerical score that better represents the statistical likelihood that an earthwork may fail resulting in a possible safety incident. The previous Soil Slope Hazard Index (SSHI) data has been re-worked and linked to CIV028 failure data to weight the parameters to effect an improved index linking asset condition to failure events [Doc 5].

5.4.12 The range of possible Hazard Index scores has been segmented into five categories – A to E – which are termed Earthwork Hazard Categories (EHCs). Category A being the statistically least likely to fail and category E - the most likely to fail – see Figure 5-10.

5.4.13 This data analysis is a very positive step and considerable work has been undertaken by NR to make the best use of available data in this regard.

5.4.14 It is noted, however, that the analysis was constrained by a limited quantity of linked clean asset and failure information to permit correlation; only 197 soil cutting and 105 embankment failure records were able to be used – approximately a quarter of the total available / recorded safety-related asset failures. The correlation methods used by NR have combined statistical assessment and the application of engineering judgement to arrive at an improved index that is indicated by NR to improve alignment between earthwork asset condition and potential for failure.

5.4.15 It is also recognised that correlation between pre-failure condition and failure is potentially hampered by the interval between the examination date / record and the failure event. Information provided by NR – Figure 5-13 – indicates that only 50% of the failures had a condition record made in the 1.5 years preceding its failure. The application of engineering judgement in the correlation approach will have accommodated some of the inevitable variances but this will have introduced some level of additional uncertainty.

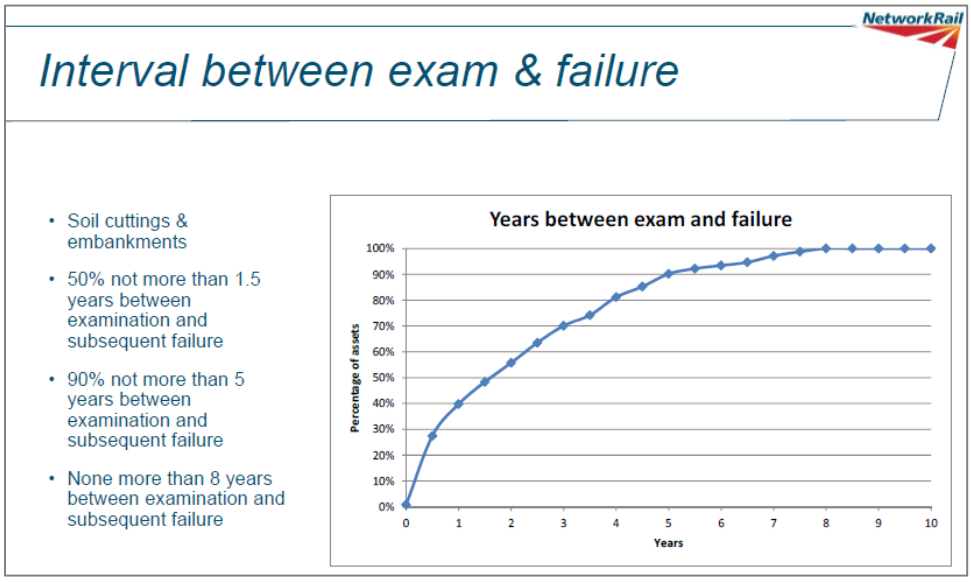


Figure 5-13 Number of Years between Condition Score and Failure [Doc 30]

5.4.16 As indicated by NR's Earthworks Safety Risk Bow-Tie Diagram (Figure 5-14) - the assessment method combines condition and non-condition related failures. However we note that despite analysis work (for example NR review of adverse weather [Doc 47]) at present NR are generally unable to separate out adverse weather related failure events. It is suggested that this is an area for further development.

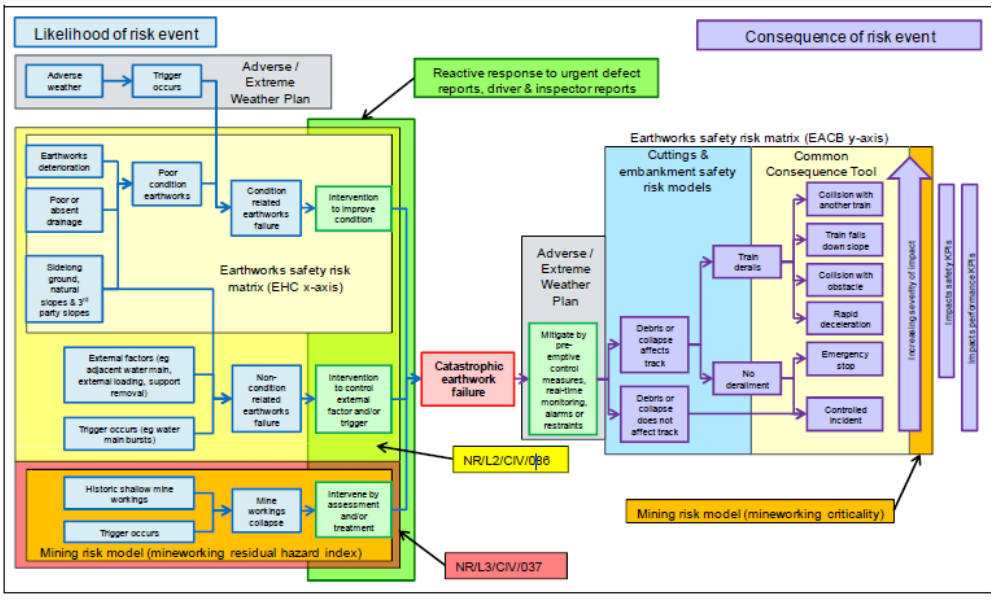


Figure 5-14 Earthworks Safety Risk Bow-Tie Diagram [Figure 7-2, Doc 4]

5.4.17
5.4.18 It is positive that NR have recognised the importance of weather-related triggers and their potential linkage to the failure of better condition earthwork assets. Specifically we note that NR have undertaken studies associated with their management of earthworks in extreme weather events [Doc 47]. This is very positive, however we are unclear how this is being considered in future developments.

5.4.19 NR have implemented changes in the earthwork examination standards NR/L3/CIV/065 and performance reporting NR/ARM/M33PR as a result of their analysis work. This includes changes to earthwork classification to align with the EHC and revision of inspection frequencies and, we understand, data capture requirements. For example, the planned inspection interval for 'marginal' / B+C category soil cuttings has been reduced from 5 to 3 years. There have also been changes made to the reporting of earthwork failures – NR/ARM/M6PR. This implementation of improvements arising from the data review is very positive.

5.4.20 Rock cuttings have not been re-evaluated in the same detail, however, an interim re-categorisation of RSHI data to a similar 5-point scale has been applied [Doc 5].

5.4.21 In the Dec 2012 Asset Policy the categorisation of rock cuttings appeared to be inconsistent in that the predicted estimated annual probability of failure is higher for category D than E – ref [Doc 1]. This concern remains with the updated Asset Policy – see Figure 5-15 below.

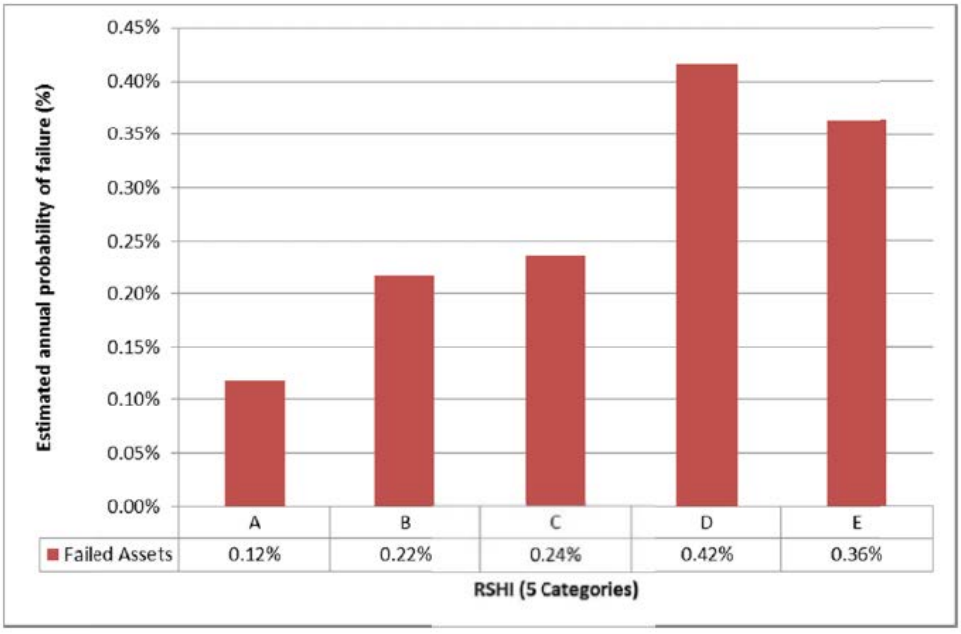


Figure 5-15 – Estimated annual probability of failure for rock cuttings by Earthworks Hazard Category (EHC) [Doc 5].

5.4.22 Anomalies with RSHI still exist – for example RSHI category E Rock Cuttings have a lower failure probability (0.36%) than RSHI category D Rock Cuttings (0.39%). It is understood that NR intend to review rock cutting data in due course – however no timing for this improvement work has been advised by NR. It is suggested that this is included in a time-bound improvement plan.

5.4.23 NR have provided three specific examples [Doc 49] that the re-categorisation of earthwork assets using the revised EHC approach has improved the selection process. This seems a very limited sample.

5.4.24 To assist in our review in Table 5-1 we have calculated the likely number of asset failures for each earthwork type derived from the estimated failure likelihoods presented by NR [Doc 5]. This indicates that the failures of 51 soil cuttings, 27 embankments and 23 rock cuttings could be predicted per annum.

Total earthwork assets (Table A)

EHC	A	B	C	D	E	Total	Source
Soil Cuttings	29,877	19,121	13,039	2,464	251	64,752	Table 2-3 Doc 4
Embankments	44,010	27,728	16,168	4,902	209	93,017	
Rock Cuttings	9,640	2,790	1,572	308	170	14,480	
	83,527	49,639	30,779	7,674	630	172,249	

Estimated Annual Probability of Failure (Table B)

EHC	A	B	C	D	E		Source
Soil Cuttings	0.02%	0.05%	0.16%	0.48%	1.21%		Figure 9-5 Doc 5
Embankments	0.01%	0.02%	0.05%	0.15%	0.66%		Figure 9-11 Doc 5
Rock Cuttings	0.12%	0.22%	0.24%	0.42%	0.36%		Figure 9-18 Doc 5

Estimated Annual Failures (Table AxB)

Estimated annual failures	A	B	C	D	E	Total
Soil Cuttings	6	10	21	12	3	51
Embankments	4	6	8	7	1	27
Rock Cuttings	12	6	4	1	1	23
	22	21	33	20	5	101

Table 5-1 Estimation of likely Annual Failures [ref Docs 4 and 5]

Note: The calculation uses the quantum of assets by type and EHC presented in the Aug 14 policy [Table 2-3, Doc 4] and the estimated annual failure probabilities provided in both the Hazard Index derivation [Doc 5] and summarised in the Aug 14 policy [Doc 4].

5.4.25 NR have also provided information on recorded failures of earthwork assets as part of the EHC method validation. The data for failures in the period to Feb 2013 is summarised on Table 5-2. The numbers of failure seen in the partial year's data is broadly consistent with the estimated annual failures. It is suggested that NR monitors the trajectory of failures.

Actual Failures – to Feb 2014

EHC	A	B	C	D	E	Total	Source
Soil Cuttings	3	12	14	9	2	40	Figure 10-1 Doc 5
Embankments	2	3	6	5	1	17	Figure 10-2 Doc 5
Rock Cuttings	-	-	-	-	-	-	No data provided
						57	

Table 5-2 Recorded Asset Failures [from Doc 5]

5.4.26 NR have explained how the re-categorisation of EHC was carried out such that "parity" was retained between the quantities of earthworks assets in each hazard category under the old metric and under the new metric at the point of changeover. The impact of this approach has been discussed with NR and at present we still remain unclear as to the implications.

Consequence of Failure (y-axis)

5.4.27 The Dec 2012 Asset Policy adopted a semi-quantitative criteria known as the 'Modified Earthworks Priority Model' ('Modified EPM') which relied heavily on engineering judgement rather than an explicit assessment of potential severity of consequence [Doc. 15].

5.4.28 In developing their Aug 14 Policy update, NR have applied the principles of the 'Common Consequence Tool' and used this to derive a single value of Fatalities and Weighted Injuries (FWI)/event for each earthwork. The relationship with the CCT is shown diagrammatically below in Figure 5-16.

5.4.29 NR have split the FWI data into a 5 point criticality scale [Doc. 11]. We note that NR considered several ways of splitting the consequence data, and that NR eschewed their recommended approach of drawing boundaries based on criticality values and instead adopted an approach to maintain consistency with the previous Modified EPM scale to maintain a 'smooth transition'. NR have not explained the implications of this approach and we are concerned that this may lead to the adoption of a classification that does not accurately reflect consequence.

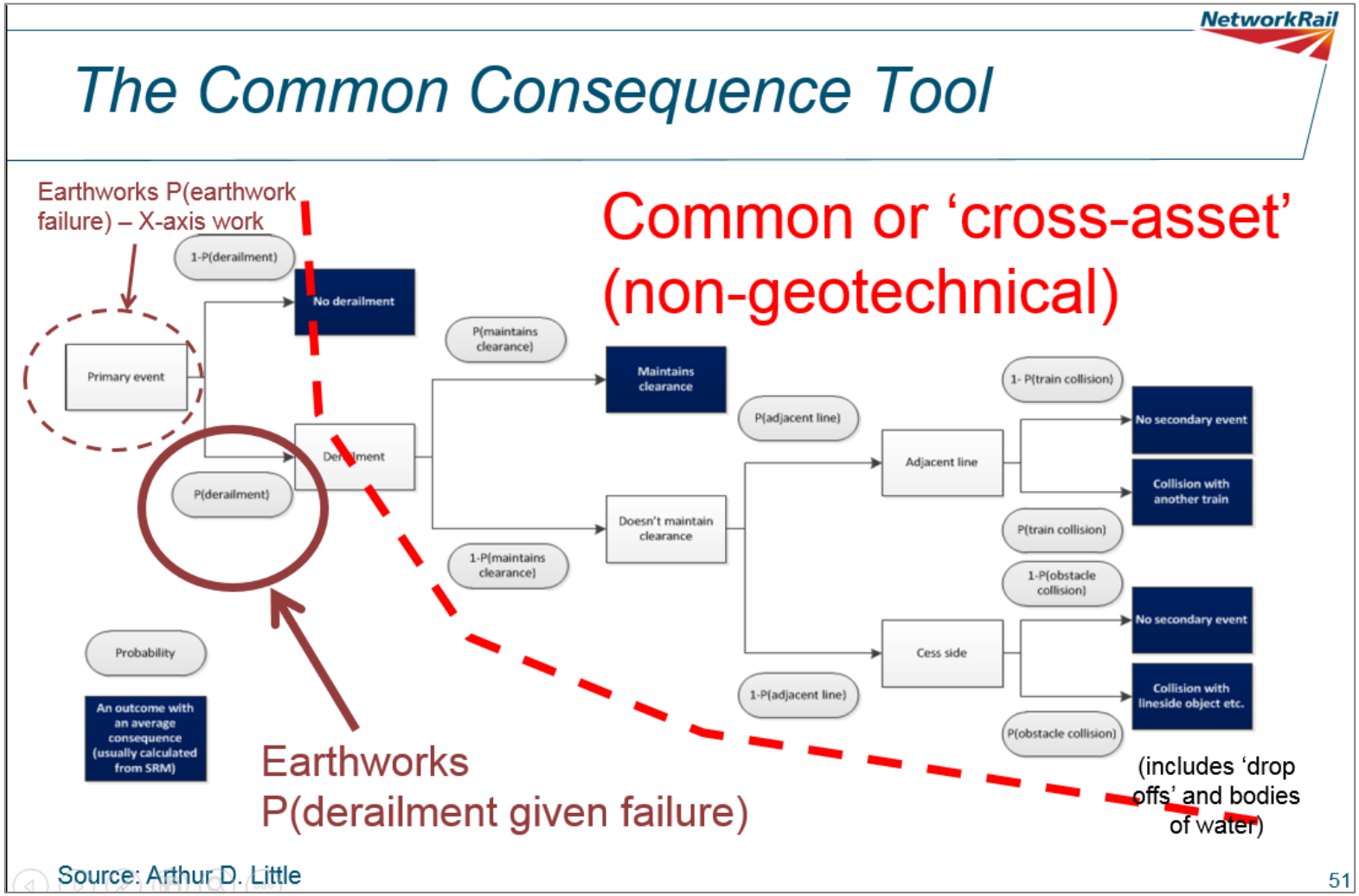


Figure 5-16 Interface with Common Consequence Tool [Doc 32]

Overall Risk Evaluation

5.4.30 As noted above, we consider it very positive that NR has developed an updated condition index (EHC - Earthworks Hazard Category), an updated consequence index (EACB- Earthworks Asset Criticality Band) and is adopting a common consequence tool approach for earthworks.

5.4.31 NR have provided material to indicate that they have kept the total national number of assets the same in each condition category and that asset volumes may change at a Route level. We understand that NR have calculated these changes in asset volumes at Route level, however, at present these have not been provided to us.

5.4.32 Accordingly, we are unclear as to the exact implications of imposing requirements to maintain consistency between the previous axes and the revised scales. Specifically, we are uncertain as to the practical change that comes from introducing the updated Aug 2014 'safety matrix'.

5.4.33 We are also unclear as to the extent that the risk levels of specific earthworks may have changed simply due to the 'parity' requirement rather than the actual 're-classification'. It is suggested that NR undertakes a review to satisfy itself that the new matrix gives an improved criteria for selection of earthworks safety interventions.

5.4.34 Going forward it would be useful if a clear improvement plan was developed and presented to allow future continuous improvement to be understood.

5.4.35 It is recommended that to improve confidence in the updated 'safety risk matrix' NR should undertake a more detailed calibration exercise to ensure alignment between failure data, assessment methods, policy recommendations and actual example slopes. This would include both rock and soil slopes.

5.5 Policy Implementation

5.5.1 In 2013 we reviewed the December 2012 Earthworks Asset Policy in detail. This is presented in our previous reports [Ref 2,3 4] and a summary of the key points is included in Appendix B.

5.5.2 In their Strategic Business Plan (Jan. 2013) NR noted that their CP5 policy was new and largely untried in practice.

5.5.3 At present there is still very limited feedback as to the effectiveness of the CP5 asset policy – the policy was only due to be implemented in April 2014 and NR are still collating material on the volumes of work activity undertaken, policy implementation and failure data for this first year of CP5.

5.5.4 This lack of feedback is unfortunate as it means that a number of our previous uncertainties related to the December 2012 Asset Policy still remain in relation to the:

- ability of the CP5 policy to reduce asset risk in the short-term;
- long term sustainability associated with reduction in the volume of more 'traditional' 'heavier' 'renewal' interventions
- degree to which the Routes will be able to practically apply the asset policy and target 'the right slopes' for maintenance and refurbishment activities.

5.5.5 It is suggested that NR reviews CP5 policy implementation by the Routes and the degree to which it is reducing earthworks risk.

5.5.6 NR have provided CP5 condition score forecasts in their FDP together with predicted CP4 exit values [Doc. 022]. These are summarised below in Figure 5-17.

Final Delivery Plan earthworks condition scores

Route / National	Earthworks condition score						
	CP4 exit (SBP)	CP4 Exit (DDP)	CP5				
			2014/15	2015/16	2016/17	2017/18	2018/19
Anglia	1.68	1.68	1.69	1.70	1.72	1.73	1.74
Kent	1.87	1.78	1.79	1.79	1.80	1.80	1.81
LNE	1.68	1.70	1.71	1.71	1.71	1.72	1.72
LNW	1.79	1.85	1.85	1.84	1.83	1.82	1.81
Midlands	1.60	1.69	1.69	1.69	1.69	1.68	1.68
Scotland	**1.55**	**1.55**	**1.55**	**1.55**	**1.54**	**1.54**	**1.54**
Sussex	1.81	1.74	1.74	1.74	1.74	1.74	1.74
Wales	2.00	2.02	2.01	2.00	1.99	1.98	1.97
Wessex	1.71	1.69	1.69	1.70	1.71	1.72	1.73
Western	2.07	1.99	1.96	1.93	1.92	1.91	1.90
England & Wales	**1.79**	**1.80**	**1.80**	**1.80**	**1.79**	**1.79**	**1.79**
England, Scotland & Wales	**1.74**	**1.75**	**1.75**	**1.75**	**1.75**	**1.75**	**1.74**

Figure 5-17: Earthworks Asset Condition Sustainability Indicator Forecasts at March 2014 [Doc. 018 / 022]

5.5.7 At present, NR are in the process of re-running their analyses to provide an updated set of earthworks condition forecasts for CP5 that will take the CP4 exit position into account. However, in the meanwhile we have been advised by ORR that the actual CP4 exit position (SBP and DDP) is different from that shown in Fig 5-17.

5.5.8 As noted previously we still have concern that maintaining a national average condition implies that the earthworks condition at some Routes may deteriorate during CP5 (for example Anglia). We are unclear as to the implication this will have on risk at a Route level. We are also unclear whether the proposed policy / intervention mix will comply with Statutory Obligations under ALARP principles . It is suggested that NR address this point when they re-run their modelling of the new Policy.

5.5.9 Notwithstanding the fact that the CAM submission is still under development and discussions are ongoing with the Routes it appears that there is currently a significant difference in the level of 'policy alignment' across the Routes [Ref 035] - see Figure 5-20 below.

5.5.10 Specifically, in Kent, Route feedback suggests that at 16th December 2014 [Doc 43]:

- Only 39% of the total CP5 workbank aligned to Policy (344/891 schemes).
- Only 38% of the years 3-5 workbank had been aligned to Policy (188/498 schemes)

See Figures 5-18 & 5-19 below.

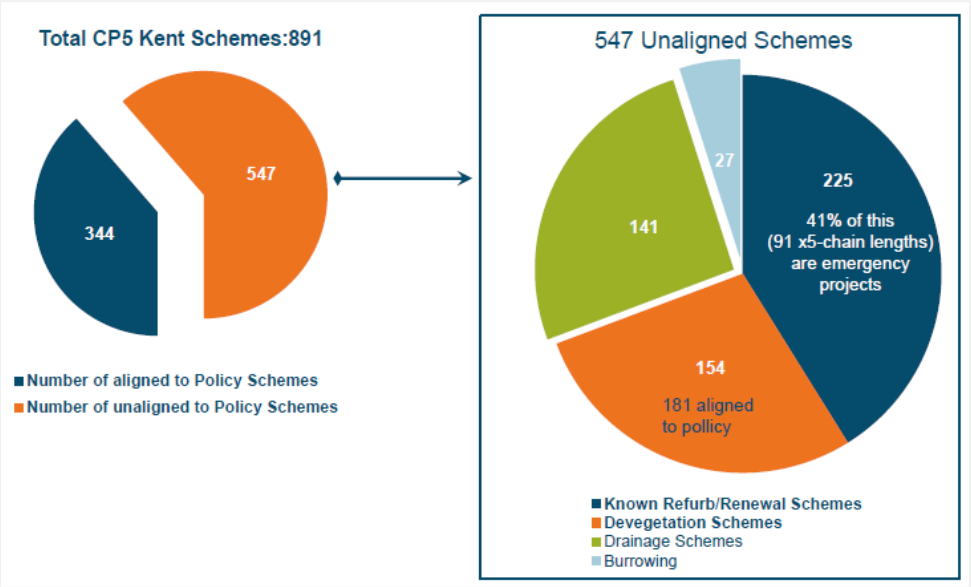


Figure 5-18 Alignment of CP5 Workbank to Policy [Doc 43]

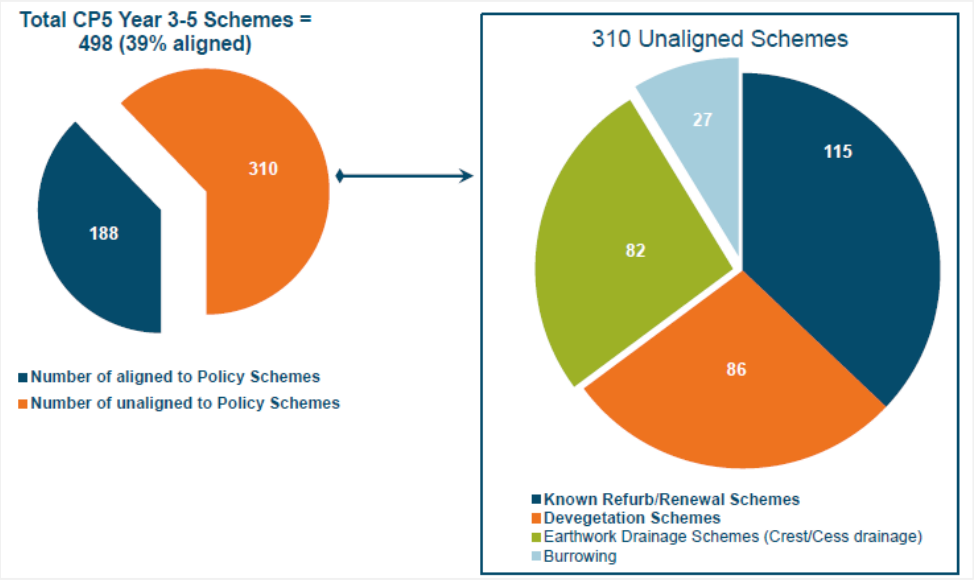
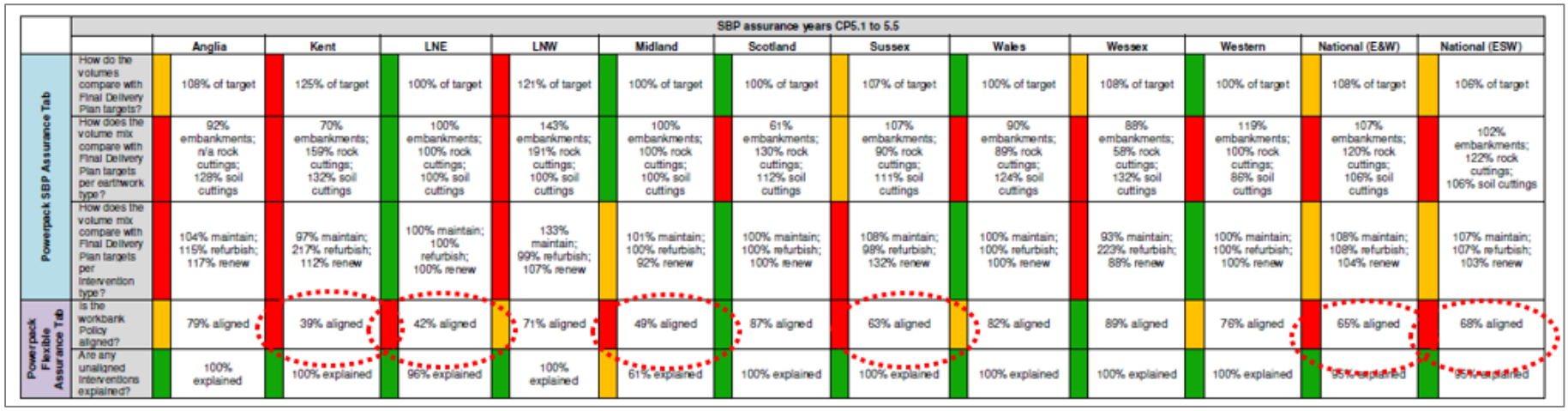


Figure 5-19 Alignment of CP5 Year 3-5 Workbank to Policy [Doc 38]

5.5.11 We note that the Earthworks Asset Policy is to provide guidance to the Routes, and that it is for the Routes to decide where and how to intervene based on local knowledge and experience, however the low level of policy alignment is potentially of concern as it does rely on the maturity of the Route team and / or central review and assurance.

5.5.12 Our BCAM Embedment Review undertaken in Autumn 2013 [Ref 5] indicated a significant variation in asset management maturity between Routes. Whilst this is now some 18 months ago, this does raise the concern that Route level choices may introduce significant inconsistency into the management of the earthworks asset.



		SBP assurance years CP5.1 to 5.5											
		Anglia	Kent	LNE	LNW	Midland	Scotland	Sussex	Wales	Wessex	Western	National (E&W)	National (ESW)
Powerpack SBP Assurance Tab	How do the volumes compare with Final Delivery Plan targets?	108% of target	125% of target	100% of target	121% of target	100% of target	100% of target	107% of target	100% of target	108% of target	100% of target	108% of target	106% of target
	How does the volume mix compare with Final Delivery Plan targets per earthwork type?	92% embankments; n/a rock cuttings; 128% soil cuttings	70% embankments; 159% rock cuttings; 132% soil cuttings	100% embankments; 100% rock cuttings; 100% soil cuttings	143% embankments; 191% rock cuttings; 100% soil cuttings	100% embankments; 100% rock cuttings; 100% soil cuttings	61% embankments; 130% rock cuttings; 112% soil cuttings	107% embankments; 90% rock cuttings; 111% soil cuttings	90% embankments; 89% rock cuttings; 124% soil cuttings	88% embankments; 58% rock cuttings; 132% soil cuttings	119% embankments; 100% rock cuttings; 86% soil cuttings	107% embankments; 120% rock cuttings; 106% soil cuttings	102% embankments; 122% rock cuttings; 106% soil cuttings
	How does the volume mix compare with Final Delivery Plan targets per intervention type?	104% maintain; 115% refurbish; 117% renew	97% maintain; 217% refurbish; 112% renew	100% maintain; 100% refurbish; 100% renew	133% maintain; 99% refurbish; 107% renew	101% maintain; 100% refurbish; 92% renew	100% maintain; 100% refurbish; 100% renew	108% maintain; 98% refurbish; 132% renew	100% maintain; 100% refurbish; 100% renew	93% maintain; 223% refurbish; 88% renew	100% maintain; 100% refurbish; 100% renew	108% maintain; 108% refurbish; 104% renew	107% maintain; 107% refurbish; 103% renew
Powerpack Flexible Assurance Tab	Is the workbank Policy aligned?	79% aligned	39% aligned	42% aligned	71% aligned	49% aligned	87% aligned	63% aligned	82% aligned	89% aligned	76% aligned	65% aligned	68% aligned
	Are any unaligned interventions explained?	100% explained	100% explained	96% explained	100% explained	61% explained	100% explained	100% explained	100% explained	100% explained	100% explained	95% explained	95% explained

Figure 5-20: Route and National RAG Status for SBP Policy (Dec 2014) [Doc. 35]

6 Summary and Conclusions

6.1 General

6.1.1 The Asset Policy is underpinned by inventory, condition and failure data. It is very positive that NR are continuing to develop their earthworks asset knowledge and are taking measures to improve data quality.

6.1.2 Generally, at present there is still very limited feedback as to the effectiveness of the CP5 asset policy – for example NR are still collating material on the volumes of work activity undertaken, policy implementation and failure data for the first year of CP5.

6.1.3 In addition, a number of concerns raised in our previous review of the CP5 Asset Policy (Dec 2012) still remain as set out below.

6.2 Inventory and Condition Data

6.2.1 The Data Quality Report (Jan 2014) makes a number of useful recommendations on how to improve data quality considering process, data and technology. This is very positive.

6.2.2 It is also very positive that NR are actively improving the quality of their earthworks inventory and condition data, however we have not seen any evidence of a time-bound improvement plan or the linkage to the asset data quality trajectory mentioned in the FDP. It is suggested that such an improvement plan should be prepared by NR (and actions implemented if not already underway) with clear data quality targets similar to those set out for Track in NR's March 2014 Final Delivery Plan.

6.3 Analysis of Failure Data

6.3.1 Since December 2012, NR have spent considerable effort in reviewing the earthwork examination data (for soil slopes) to investigate and improve on the relationship between condition and failure. This has involved detailed statistical analysis to try to better represent the likelihood of failure by weighting particular key condition features [Doc. 5, 13]. This is very positive.

6.3.2 NR have also taken steps to improve the quality and consistency of failure recording and reporting through their updates to the NR Asset Reporting Manual and specifically the M6 'Earthworks Failure' measure. This is also very positive.

6.4 Risk-based Approach

6.4.1 Although not directly part of this review, we consider that the development of the 'common consequence tool' (CCT) to support cross-asset safety investment trade-off decisions is a very significant step forward. The potential benefit was indicated in our review of Civil Structures in 2011 [Ref 1] and SBP Review [Ref 2], where we identified that cross-asset trade-offs were an area for future development.

6.4.2 As noted above, we consider the development of a common consequence approach to supporting the prioritisation of safety investments to be a very positive step forward. However, in terms of further development, this approach should be

extended to consider wider railway performance to provide balanced guidance to Routes on workbank development. At present we have not seen any such central guidance (qualitative or quantitative). This is discussed further below.

6.4.3 It is positive that NR have recognised the importance of weather-related triggers and their potential linkage to the failure of better condition earthwork assets. Specifically we note that NR have undertaken studies associated with their management of earthworks in extreme weather events [Doc 47]. This is very positive, however at present NR are generally unable to separate out adverse weather related failure events. We are unclear how improvement in this area is being considered in NR's future plans.

6.4.4 Anomalies with RSHI still exist – for example RSHI category E Rock Cuttings have a lower failure probability (0.36%) than RSHI category D Rock Cuttings (0.39%). It is understood that NR intend to review rock cutting data in due course – however no timing for this improvement work has been advised by NR. It is suggested that this is included in a time-bound improvement plan.

6.4.5 NR have explained how the re-categorisation of EHC was carried out such that "parity" was retained between the quantities of earthworks assets in each hazard category under the old metric and under the new metric at the point of changeover. The impact of this approach has been discussed with NR and at present we still remain unclear as to the implications.

6.4.6 NR have split the FWI data into a 5 point criticality scale [Doc. 11]. We note that NR considered several ways of splitting the consequence data, and that NR eschewed their recommended approach of drawing boundaries based on criticality values and instead adopted an approach to maintain consistency with the previous Modified EPM scale to maintain a 'smooth transition'. NR have not explained the implications this approach and we are concerned that this may lead to the adoption of a classification that does not accurately reflect consequence.

6.4.7 We are also unclear as to the extent that the risk levels of specific earthworks may have changed simply due to the 'parity' requirement rather than the actual 're-classification' itself. It is suggested that NR undertakes a review to satisfy itself that the new matrix gives an improved criteria for selection of earthworks safety interventions.

6.5 Policy Robustness[10]

6.5.1 On the basis that the Earthworks Asset Policy has a clear linkage to asset outputs (e.g. Condition Index), is based on reasonable inventory and condition information and has an explicit risk based intervention approach, we still consider it reasonably likely that the Asset Policy will be robust and capable of delivering a reduction in asset risk in the short-term. There is however not yet any significant feedback to draw on.

6.5.2 The focus of the Asset Policy is rightly primarily on the selection of sites based on safety risk. However, we note that NR under their licence has performance obligations to also meet. At present there is no guidance to Routes as to on selection of sites driven by performance. This might also consider network resilience – for example the importance of a line that is a 'diversion route'.

[10] Robustness: whether assets will deliver the required outputs; and

6.6 Policy Sustainability[11] and Whole System Cost

6.6.1 We continue to support the Policy principle of targeting more 'lighter' pro-active intervention activities (such as drainage) to reduce safety risk. However we still consider it uncertain as to whether the Earthworks Asset Policy will deliver the required outputs both in the short and long-term at lowest possible whole system cost over the lifetime of the assets. Our concerns relate to the reduction in the volume of more 'traditional' 'heavier' 'renew' interventions.

6.6.2 At present NR have yet to re-run their Tier 1 / Tier 2 Whole Life Cycle Cost (WLCC) / SCAnNeR analyses to demonstrate policy optimisation and so we are unable to comment on the impact of the revised policy on whole system cost.

6.7 Policy Implementation

6.7.1 NR are continuing to use their PowerPack Tool to support Earthworks Policy implementation at a Route Level. This seems to be a very effective way of providing a clear basis for central review of workbanks and policy alignment.

6.7.2 The documents that we have seen so far suggest that policy alignment currently varies significantly between Routes. The source of policy mis-alignment may originate from many sources but it does reinforce that significant Route level judgement will be needed to select the appropriate workbank.

6.7.3 Our BCAM Embedment Review undertaken in Autumn 2013 [Ref 5] indicated a significant variation in asset management maturity between Routes. Whilst this is now some 18 months ago, this does raise the concern that Route level choices may introduce significant inconsistency into the management of the earthworks asset

6.7.4 It is suggested that NR reviews CP5 policy implementation by the Routes and the degree to which it is reducing earthworks risk.

6.7.5 The new Earthworks Hazard Category potentially provides improved guidance on targeting ‘the right slopes’ for intervention. However, as yet there is little objective feedback that the maintenance and refurbishment interventions can be practically implemented and that they will be effective in reducing safety risk. This still poses a risk to delivery of performance improvement and the achievement of cost & efficiency targets in CP5.

6.7.6 As noted in our SBP review in 2013 [Ref 2.] we still have concern that maintaining a national average condition implies that the earthworks condition at some Routes may deteriorate during CP5 (for example Anglia). We are unclear as to the implication this will have on risk at a Route level. We are also unclear whether the proposed policy / intervention mix will comply with Statutory Obligations under ALARP principles[12]. This should be addressed by NR in their CAM submission.

[11] Sustainability: whether asset policies continue to deliver the outputs over the longer term

[12] NR have a duty under the Health & Safety at Work etc. Act (1974) to manage safety risks to a level as low as reasonably practicable (ALARP). Our interpretation of this is that safety improvements should be implemented unless the costs are grossly disproportionate to the safety benefits.

6.8 Review and Continuous Improvement

6.8.1 Generally we still have concern that there is little evidence of a structured continuous improvement approach to monitor the effectiveness of the CP5 Earthworks Policy. Specifically the Asset Policy update seems to have been undertaken before there was formal feedback and learning from the Dec 2012 policy. It is suggested that NR implement a more formally controlled continuous improvement process.

6.9 Conclusion

6.9.1 The CP5 Earthworks Asset Policy (Dec 12) introduced a new largely untried approach to the management of earthworks assets involving targeting an increased number of maintenance and refurbishment interventions and a reduced number of major renewal activities. The new policy (Aug 14) does not change this but potentially provides an improved way of selecting the 'right' earthworks for intervention using the new EHC index and the consequence scale. It is very positive that NR have extended the risk based principles to move towards a common 'cross-asset' consequence scale.

6.9.2 The CP5 Asset Policy has only been in use since April 2014 and so at present there is little evidence that the policy is able to be implemented by the Routes and is effective in reducing safety risk.

6.9.3 In summary our view is that the updated Policy is likely to be an improvement on the December 2012 policy, but there is not yet sufficient evidence from the first year of CP5 to demonstrate this with any certainty.

6.10 Recommendations

6.10.1 The following recommendations are made in relation to this review.

No.	Recommendation	Benefits	Evidence of implementation	Owner	Target date for completion
2015 EWP-01	Policy Effectiveness It is recommended that NR explicitly reviews the emerging effectiveness of the Asset Policy by considering a number of real examples with each Route to confirm that the Policy does, as they expect, identify key sites and appropriate interventions that will reduce safety risk.	Feedback and learning on CP5 Asset Policy	Feedback Review	NR Prof. Head for Earthworks	End of October 2015 (post annual return)

No.	Recommendation	Benefits	Evidence of implementation	Owner	Target date for completion
2015 EWP-02	Performance based Interventions We recommend that NR provides explicit guidance to Routes on selection of sites driven by performance. This would complement the current safety related guidance.	Improved consistency of CP5 Workbanks	Guidance Note to Routes	NR Prof. Head for Earthworks	End of March 2016
2015 EWP-03	Calibration We recommend that to improve confidence in the updated 'safety risk matrix' NR should undertake a more detailed calibration exercise to ensure alignment between failure data, assessment methods, policy recommendations and actual example slopes. This would include both rock and soil slopes.	Improved confidence in risk based approach to site selection	Feedback Note on Calibration	NR Prof. Head for Earthworks	End of March 2016

7 References

1) Arup 2011 'Office of Rail Regulation and Network Rail Part A Reporter Mandate AO/007: Review Asset Policy, Stewardship and Management of Structures – Final Report – Review and Benchmarking' Job Number 209830-07 Revision 1 March 2011.

2) Arup 2013 'Office of Rail Regulation and Network Rail Part A Reporter Mandate AO/030: PR13 Maintenance & Renewals Review – Summary Report' Job Number 223767-13 Ref AO/030/01 Issue 1 May 2013.

3) Arup 2013a 'Office of Rail Regulation and Network Rail Part A Reporter Mandate AO/030: PR13 Maintenance & Renewals Review – Policy and WLCC Model Review' Job Number 223767-13 Ref AO/030/02 Issue 1 May 2013.

4) Arup 2013b 'Office of Rail Regulation and Network Rail Part A Reporter Mandate AO/030: PR13 Maintenance & Renewals Review – Earthworks Tier 1 Model Review' Job Number 223767-13 Ref AO/030/03C Issue 1 May 2013.

5) Arup 2014 'Office of Rail Regulation and Network Rail Part A Reporter Mandate AO/045: BCAM Embedment Review' Job Number 223767-25 Issue 1 Jan 2014.

Appendix A

Independent Reporter Part A - Mandate AO/049

Mandate for Independent Reporter Part A

Audit Title:	Civils Cost Adjustment Mechanism (March 2015 submission) : review of updated earthworks asset policy developed and issued to Routes for planning and developing compliant workbanks for Years 3 to 5 of CP5.
Mandate Ref:	AO/049
Document version:	Draft A
Date:	01/10/2014
Draft prepared by:	James P. McGregor
Remit prepared by:	
Network Rail reviewer:	

Authorisation to proceed

ORR		
Network Rail		

Background

Network Rail's SBP submission (and hence ORR's Draft and Final Determinations) was based on asset policies which reflected Network Rail's best view of robust, sustainable and efficient policy at that time. The asset policy documents and supporting evidence were reviewed by the ORR, supported by the independent reporters. Subsequently, Network Rail updated its Earthworks Asset Policy and embedded its principles in the spreadsheet-based system (known as PowerPack) issued to the Routes to help them develop their workbanks for Years 3, 4 and 5 of CP5. These workbanks in turn form the basis for Network Rail's Civils Cost Adjustment Mechanism (CAM) submission which is due to be presented to ORR by 31 March 2015.

The updated Earthworks Asset Policy contains a number of significant developments from the previous version. In particular, it replaces the previous earthworks "condition" classes (Top Poor, Poor, Marginal and Serviceable) with a new 5-band classification system; and for soil embankments and soil cuttings it replaces the previous failure likelihood metric (Soil Slope Hazard Index) with a new Hazard Index which Network Rail believes is better able to predict the propensity for failure as it exhibits a stronger correlation with its records of previous failed earthworks.

Network Rail must submit evidence to ORR to demonstrate that it is making sufficient progress in developing a robust CAM submission. This is termed progressive assurance. Network Rail will submit its revised Earthworks Asset Policy and supporting evidence for review as part of this progressive assurance.

Purpose

The work covered by this mandate is intended to assist ORR in assessing whether the changed Earthworks Asset Policy on which the CAM submission is based will enable Network Rail to manage its earthworks assets in a robust, sustainable, safe and efficient manner.

Scope

Under this mandate the reporter will assess:

- The updated Earthworks Asset Policy;
- The evidence supplied by Network Rail relating to the basis for the changes to its Earthworks Asset Policy;
- Any other evidence provided by Network Rail under progressive assurance relating to the updated Earthworks Asset Policy or its application in the development of the PowerPack.

In doing so it will consider whether and if so to what extent changes to the policy impact upon:

- Compliance with the Network Licence, particularly section 1 relating to Network Management; and
- Our tests of robustness, sustainability and minimum whole lifecycle, whole system cost and further criteria for assessing asset policy as shared with Network Rail.

Network Rail has also updated its Structures Asset Policy but its consideration is not included in this Mandate, which is currently limited to the Earthworks Asset Policy alone. Should significant changes be made to the Mining Asset Policy and / or the Drainage Asset Policy, further Mandates may be issued for their review.

Network Rail submitted its updated Earthworks Asset Policy to ORR on 26 August 2014. The reporter will provide a progressive assurance report and feedback to ORR and Network Rail by 5 December 2014.

Asset policy documents

The review will build on the findings of the reporter mandate AO/030: PR13 Maintenance & Renewals Review - Policy and WLCC Model Review. Changes to the Policy will be assessed against the impact (whether positive or negative) they may have on the criteria of robustness, sustainability and lowest whole life, whole system cost and the further indicators of good asset stewardship which were assessed under mandate AO/030 and which are detailed again in Appendix 1.

PowerPack

The reporter will consider whether the changes to the Policy have been accurately modelled in the PowerPack tool. The review of computational accuracy of the PowerPack is not included within this mandate.

Methodology

As part of this workstream the reporter will undertake the following activities:

1. Attend all relevant progressive assurance, policy presentation and policy challenge meetings;
2. Undertake a review of the changes to the asset policy and policy justification documents;
3. Undertake a review of any other relevant supporting documents and information;
4. Prepare and submit draft and final reports, setting out the main observations and conclusions arising from the review process;

The reporter will produce a detailed methodology in presenting its proposals.

As far as possible, it is intended that the reporters shall co-ordinate their activities with the analysis being carried out by the ORR in order to avoid duplication of work.

The Reporters shall also avoid duplicating activity already undertaken or in progress under any other Mandates.

Deliverables

1. Minutes of meetings and a summary of the reporters' views of the challenge workshops.
2. Progressive assurance review of the updated Earthworks Asset Policy and its justification – presentation of findings to ORR and Network Rail by 14 November 2014.
3. Draft Report - 21 November 2014.
4. Final Report – 5 December 2014.

Timescales

The key milestones for the work are as follows:

- Network Rail provided ORR with its updated Earthworks Asset Policy on 26 August 2014.
- Close out meeting and presentation of findings to ORR and Network Rail on 14 November 2014.
- Reporter to provide draft report by 21 November 2014.
- Reporter to provide final report by 5 December 2014.

Independent Reporter proposal

The Reporter shall prepare a proposal for review and approval by the ORR and Network Rail on the basis of this mandate. The approved proposal will form part of the mandate and shall be attached to this document.

It is anticipated that the work under this mandate should take approximately 10 man days. The reporter should take cognisance of this in preparation of the proposal. The proposal will detail methodology, tasks, programme, deliverables, resources and costs.

Given the importance of this review, the Reporter shall provide qualified personnel with direct experience in the respective disciplines to be approved by the ORR and Network Rail. The contractor is asked to submit details of the previous experience and qualifications of such personnel as part of their proposal. For consistency and to minimise the learning curve / extent of re-work required, the Reporter should, where possible, use staff who were involved in progressive assurance of the SBP Earthworks Asset Policy.

Appendix 1 – Policy review

The review will consider asset policies against three high level criteria:

1. **Robustness: Is it reasonable to believe that the policy can deliver the required outputs, for England & Wales and Scotland?** In testing the robustness of the policy the reporter should consider whether the policy and plans have been demonstrated to be capable of delivering the outputs required for CP5 (2014-2019). This includes consideration of outputs, KPIs and condition measures as disaggregated by operating route.
2. **Sustainability: If demand on the network were to remain steady, would application of the asset policy continue to deliver the outputs specified indefinitely?** A sustainable asset policy is one which delivers (at least) the agreed outputs for the final year of the control period in the long term (to at least end of CP11) if demand on the system remains within the capacity limits of the current network and any enhancement schemes already committed to by industry. The demonstration of compliance with this test is likely to involve forecasting and modelling as part of the submission. This test is to ensure that, in managing within CP4 funding, Network Rail is making genuine efficiencies and is not deferring essential work at the cost of inefficiently higher expenditure in later control periods.
3. **Lowest whole life, whole system cost: Has asset policy been demonstrated to deliver the required outputs both in the short and long-term at lowest possible whole system cost over the lifetime of the assets?** In demonstrating minimum whole life cost Network Rail must demonstrate that both scope and unit cost efficiencies have been fully considered.

In assessing against these high level criteria the reporter will also consider the 'Indicators of Good Asset Stewardship' as set out below. They will assess whether comprehensive and convincing rationales have been provided demonstrating good asset stewardship in compliance with Network Rail's licence obligations.

The reporter will assess against the following key tests (i.e. not an exhaustive list) as a sub-set of the overall asset management capability, that are generally associated with good asset stewardship and that are likely to give rise to compliance with the Licence obligations relating to asset management policies and plans.

1. **Performance Requirements / Outputs** – have these been defined at system and individual asset group level taking into account strategic objectives? How are these influenced by demand? What level of risk can be tolerated for each performance requirement? What level of system resilience etc.?
2. **Line of sight** – is there a clear relationship from business objectives (performance, demand, capacity etc.), policy/strategy down to specific outputs defined in the route asset management plans and route delivery plans.
3. **Asset Knowledge** – is there adequate accuracy and completeness of asset inventory data, capability, capability, including structure and critical component / element details, age, condition, maintenance history, failure modes, service life etc.
4. **Asset Behaviour and Criticality** – is there an adequate understanding of asset behaviour, criticality, critical components, and failure modes
5. **Asset Degradation** – is there an adequate understanding of deterioration rates of critical components and materials?
6. **Renewal and Maintenance interventions** - Has a suitable range of intervention options been considered taking into account any enhancement requirements due to interoperability, asset system interfaces etc.? Do these interventions simply reflect current / historic practice or have materials and techniques used by others (e.g. identified from benchmarking activity) and other future developments / techniques been considered?
7. **Asset Cost Data** – is there adequate maintenance and renewal cost data for the identified maintenance and renewal interventions to enable suitably accurate lifecycle cost estimation? Are suitable unit rates available for calculating the works and other costs (e.g. access, possession costs, mobilisation etc.)?

8. **Lifecycle Option Preparation** – have a suitable range of alternative lifecycle management options been considered for the critical asset types and components, based on adequate asset knowledge an understanding of asset behaviour, maintenance and renewal options? How has resilience been considered? Have any Scotland specific issues been identified and considered? How have sub-options been rationalised and optimised?
9. **Lifecycle Option Selection and Strategies** – have clear alternative lifecycle strategies been considered? Typical strategies may be:
    - "Do Minimum" Strategy – the minimum required to sustain safety across the analysis period, e.g. infrequent/irregular but major interventions to satisfy/meet the minimum safety and performance targets.
    - Preventative Strategy – regular and frequent minor interventions to maintain the condition of the asset by slowing down the rate of deterioration.
    - Targeted Strategies – with interventions aimed towards:
        - Minimising Whole Life Costs while satisfying safety/performance targets;
        - Minimising network disruption; satisfying the disruption targets;
        - Delivering a required condition score;
        - Etc.

    Where asset policies deviate from lowest whole lifecycle, whole system cost, has the inefficiency caused by funding constraints been quantified to understand the long-term cost and risk implications?
10. **Preferred Lifecycle Option** - How are the preferred lifecycle options for different asset types reflected in the asset policies and plans?
11. **Sensitivity testing** – Has sensitivity testing been carried out to understand levels of uncertainty within confidence limits, both for underlying asset information and in the decision support tools used in the development of asset policy?
12. **Overall Planning Process** – is it clear how 'top-down' decisions will be used in practice to influence local asset maintenance and renewal choices? How are 'bottom-up' unconstrained asset needs evaluated against 'top-down' asset policies and a planned workbank produced (e.g. how a workbank at an SRS level is derived)?
13. **Systems Approach** – has the policy adopted a systems engineering approach which considers cross-asset groups and cross-industry requirements? Has interaction between asset types/ overall system been considered? (e.g. if head hardened rails are specified has the impact on wheels been considered).
14. **Risk and Review** – is it clear how asset risks will be managed and reviewed? Is there definition of tolerable risks and is this applied in practice? What level of resilience is required, has a RAMS (reliability, availability, maintainability and safety) approach been adopted?
15. **Deliverability** – is it clear how the proposed asset management approach will be delivered? – is it feasible that the policy can be delivered given known constraints e.g. technology, supply chain, training, experience etc. (e.g. Maintenance – does the policy adequately consider the maintenance implications in terms of numbers of staff, skills, training, and equipment?) Are roles and responsibilities defined?
16. **Continuous Improvement** – research and development, feedback and efficiency improvements.

Appendix B

Review of CP5 Earthworks Policy (Dec 2012)

B1 CP5 Earthworks Policy (Dec 2012)

B1.1.1 The following section summarises the key points raised in our review of the CP5 Earthworks Policy in 2013 [Ref 2, 3 and 4].

General

B1.1.2 The CP5 Final Delivery Plan (dated 31 March 2014) for earthworks was based on the CP5 Earthworks Policy dated December 2012 [Doc 001].

B1.1.3 When we undertook our previous Earthworks review in March 2013 (Arup 2013, a and b) and Mandate AO/45 in Autumn 2013 we reviewed the December 2012 CP5 Earthworks Policy and concluded that:

B1.1.4 NR had made significant progress with developing their Asset Policies since CP4 adopting a standard format and a specific Asset Policy for Earthworks.

Risk Based Approach

B1.1.5 It was very positive that the Earthworks Asset Policy had adopted a 'risk based approach' to the identification of sites for remedial work and that interventions should be primarily driven by 'safety' issues rather than say 'track performance'.

B1.1.6 We were however unclear how NR had equated safety risk between the 'principal' asset types such as Buildings vs. Earthworks vs. Structures. This gave rise to a significant uncertainty that assets might be funded to achieve different levels of safety risk. This concern also linked back to an earlier review of Civil Structures Asset Management (Arup 2011).

Policy Derivation

B1.1.7 NR had used their SCAnNeR model as a strategy evaluation tool to determine an optimum policy by varying intervention strategy combinations considering the output of the asset population as a whole. They had then derived ‘top-down’ costs and volumes for the SBP for the preferred intervention strategy. We had a number of concerns about some of the values used in the modelling.

Policy Robustness[13]

B1.1.8 On the basis that the Earthworks Asset Policy had a clear linkage to asset outputs (e.g. Risk Index), was based on reasonable inventory and condition information and had an explicit risk based intervention approach, we considered it reasonably likely that the Asset Policy would be robust and capable of delivering a reduction in asset risk in the short-term.

[13] Robustness: whether assets will deliver the required outputs; and

Policy Sustainability[14] and Whole System Cost

B1.1.9 We supported the Policy principle of targeting more 'lighter' pro-active intervention activities (such as drainage) to reduce safety risk. However we considered it uncertain as to whether the Earthworks Asset Policy would deliver the required outputs both in the short and long-term at lowest possible whole system cost over the lifetime of the assets. Our concern related to the reduction in the volume of more 'traditional' 'heavier' 'renew' interventions.

Policy Application

B1.1.10 NR had explicitly disaggregated their national Earthworks SCAnNeR outputs to a Route level and provided the Route teams with a 'PowerPack' tool to help them develop their CP5 constrained workbanks and achieve alignment with policy.

B1.1.11 Discussions with Routes in Autumn 2013 indicated The use of the PowerPack Tool seemed to have been very effective – providing a clear basis for detailed discussion as to priorities and that this had generally led to the emphasis on interventions in Rock and Soil cuttings which pose the higher safety risk.

B1.1.12 Discussions with the Routes did however indicate that there was a varied level of understanding of asset management principles in the Routes and that the application of Asset Policies was at different stages of maturity.

B1.1.13 The use of the PowerPack Tool to support Earthworks Policy implementation at a Route Level seems to have been very effective – providing a clear basis for detailed discussion as to priorities.

B1.1.14 We had concerns related to the constraint of reducing risk and condition at a Route Level but maintaining overall 'average' risk and condition, in that this seemed to suggest that the earthworks condition at some Routes could deteriorate and the risk at some Routes (such as Scotland) could increase. We were we are unclear as to whether the proposed policy / intervention mix would comply with Statutory Obligations under ALARP principles[15].

B1.1.15 We also had concerns relating to the degree to which the Routes would be able to effectively apply the 'top down' modelling in practice and target 'the right slopes' for the proposed maintenance and refurbishment activities. We considered that this would potentially impact on both the performance improvement that could be achieved, and the cost of achieving that improvement.

Review and Continuous Improvement

B1.1.16 We noted that the Earthworks Policy implied a new way of working at Route level with the focus on 'lighter' pro-active intervention

[14] Sustainability: whether asset policies continue to deliver the outputs over the longer term

[15] NR have a duty under the Health & Safety at Work etc. Act (1974) to manage safety risks to a level as low as reasonably practicable (ALARP). Our interpretation of this is that safety improvements should be implemented unless the costs are grossly disproportionate to the safety benefits.

activities. We had a concern that we had seen little evidence of a structured continuous improvement approach to monitor the effectiveness of such a ‘new approach’.

Appendix C

Meetings and Documents Provided

C1 Meetings Held

Date / Location	Topic	Present
25th Nov 2014/ ORR London	Tripartite meeting to discuss Question Log wrt Asset Policy	James McGregor, Mervyn Carter, Chris Davies, Jonathan Haskins, Tony Wilcock, Simon Abbott, Katherine Bird, Tim Spink, Mark Rudrum, Peter Whittlestone.
5th Dec 2014 / MMD Croydon	Supplementary meeting to discuss Questions EP018, EP019, EP020 wrt Hazard Index Report	Simon Abbott, Mike Edwards, Tim Spink, Adam Noakes, Scott Loudon, Mark Rudrum. Peter Whittlestone
20th Jan 2015 / Arup London	Tripartite meeting to discuss updated Question Log wrt Asset Policy and NR responses.	James McGregor, Mervyn Carter, Tony Wilcock, Simon Abbott, Mike Edwards, Juliet Mian, Tim Spink, Mark Rudrum, Peter Whittlestone.
24th Feb 2015 / ORR London	Tripartite meeting to discuss Draft A report	James McGregor, Mervyn Carter, Mark Morris, Julian Sindall, Jonathan Haskins, Piers Treacher, Simon Abbott, Tim Spink, Mark Rudrum, Peter Whittlestone.

C2 Documents Provided

The key documents provided as a basis for our review are listed on the following sheets.

Document Register v3
Project Name: Mandate AO/049 Earthworks Policy Review
Project No: 223767-27

Arup Ref	Filename	FullPath	Document Title	Document Date	Document Type
0001	001 SBPT3015_Earthworks_Asset_Policy.pdf		*CP5 Earthworks Asset Policy*	01/12/2012	Adobe Acrobat Document
0002	002 NR_L3_CIV_065.pdf		*Examination of Earthworks*	05/09/2014	Adobe Acrobat Document
0003	003 NR_L2_CIV_086.pdf		*Management of Earthworks*	05/09/2014	Adobe Acrobat Document
0004	004 Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED.pdf		*CP5 Earthworks Asset Policy*	01/08/2014	Adobe Acrobat Document
0005	005 NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF		*Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure*	31/03/2014	Adobe Acrobat Document
0006	006 NR_ARM_M06DF-08 Definitions for the Reporting of Earthworks Failures_2014-05-16MEedit.pdf		*Definitions for the Reporting of M6 Earthworks Failures*	16/05/2014	Adobe Acrobat Document
0007	007 NR_ARM_M06PR-06 Procedures for the Reporting of Earthworks Failures_2014-09-12ME.pdf		*Proeedures for the Reporting of M6 Earthworks Failures*	12/09/2014	Adobe Acrobat Document
0008	008 NR_ARM_M33DF-03 Definitions for the Reporting of Earthworks Condition Banding_2014-05-16MEedit.pdf		*Definitions for the Reporting of M33 Earthworks Condition Banding*	16/05/2014	Adobe Acrobat Document
0009	009 NR_ARM_M33PR-03 Proeedures for the Reporting of Earthworks Condition Banding_2014-09-12ME.pdf		*Procedures for the Reporting of M33 Earthworks Condition Banding*	12/09/2014	Adobe Acrobat Document
0010	010 Powerpack version 5 User Manual rev 09 AS ISSUED 2014_08_13.psf		*Powerpack version 5*	13/08/2014	Adobe Acrobat Document
0011	011 CCT Implementation Phase 1_Issue1.pdf		*Asset Criticality - Y-axis: Phase 1 Implementation of Common Consequence Tool - Earthworks*	01/08/2014	Adobe Acrobat Document
0012	012 Earthworks data quality report_rev02d_2014-01-30 FINAL.pdf		*Network Rail Earthworks Data Quality Report*	30/01/2014	Adobe Acrobat Document
0013	013 NR_New_HI_Addendum_Report_Rev01I_2014-11-06 DRAFT EXTRACT of change matrices.pdf		*Assessment of changes from SSHI to new HI definition*		Adobe Acrobat Document
0014	014 Safety Risk Adendum_v1.pdf		*Earthworks CP5 Roadmap: Understanding Safety Risk - Development of Cutting and Embankment Safety Risk Models*	07/04/2014	Adobe Acrobat Document
0015	015 2014-02-10 NR-Arup - Earthworks CP5 Roadmap_Review of Asset Criticality (Safety).pdf		*Earthworks CP5 Roadmap: Review of Asset Criticality (Safety)*	10/02/2014	Adobe Acrobat Document
0016	016 2013-11 ArthurDlittle [Phase 2] - Establishing a Common Risk Scoring Matrix for Safety across Network Rail.pdf (SECURED)		*Establishing a Common Risk Scoring Matrix for Safety across Network Rail*	01/11/2013	Adobe Acrobat Document
0017	017 2014-03-20 orr-nr Prof Head Geotechnical periodic assurance meeting_MEv1.doc		*Minutes of Meeting*		Microsoft Word 97-2003 Document
0018	018 2014-03-20 Update on NRIP_2011_12 and 2012_13 actions_rev09.ppt		*ORR-NR Geotechnical Quarterly Meeting*	20/03/2014	Microsoft PowerPoint 97-2003 Presentation
0019	019 civils-adjustment-mechanism-notice-march-2014.pdf		*Notice for Network Rail's civils asset management plan 2016/17-2018/19*	20/03/2014	Adobe Acrobat Document
0020	020 Asset Management Policy(2).pdf		*Asset Management Policy*	20/03/2014	Adobe Acrobat Document
0021	021 Asset Management Strategy.pdf		*Asset Management Strategy*	01/10/2014	Adobe Acrobat Document
0022	022 Network Rail_s Delivery Plan for CP5.pdf		*Network Rail's Delivery Plan for Contril Period 5*	31/03/2014	Adobe Acrobat Document
0023	023 - NRIP1112 NRIP1213 Earthworks.msg		*NRIP11/12 & NRIP12/13 Earthworks - Message (HTML)*	09/04/2014	Outlook Message Format - Unicode
0024	024 Earthwks meeting 1-07-2104 notes v3.doc		*Earthworks Quarterly Meeting 1/07/14 - NOTES OF MEETING*	01/07/2014	Microsoft Word 97-2003 Document
0025	025 RE ORRNR Earthworks Liaison meeting 1 July 2014 - draft notes + comments.msg		*RE: ORR/NR Earthworks Liaison meeting 1 July 2014 - draft notes + comments*	14/08/2014	Outlook Message Format - Unicode
0026	026 2014-07-01 ORR-NR Prof Head Geotechnical quarterly assurance meeting_M.doc		*ORR-NR Prof Head [Geotechnical] quarterly liaison meeting*	01/07/2014	Microsoft Word 97-2003 Document
0027	027 ORR Update_01_07_14_TW010714_v2.ppt		*ORR Quarterly Liaison Meeting Erathworks*	01/07/2014	Microsoft PowerPoint 97-2003 Presentation

Document Register **v3**
Project Name: Mandate AO/049 Earthworks Policy Review
Project No: 223767-27

Arup Ref	Filename	FullPath	Document Title	Document Date	Document Type
0028	028 2014-07-31 NR response to NRIP 2013_14 National Report.pdf		*NR response to NRIP 2014/14 National Report: high-level plan*		Adobe Acrobat Document
0029	029 ORRNR Quarterly Liaison Meeting - 1st July 2014 - Minutes of Meeting and NRIP 201314 NR Programme of Actions.msg		*ORR/NR Quarterly Liaison Meeting - 1st July 2014 - Minutes of Meeting and NRIP 2013/14 NR Programme of Actions*	31/07/2014	Outlook Message Format - Unicode
0030	030 Arup meeting EHC derivation rev 03e 2014_12_05 AS ISSUED/pdf		*Derivation of EHC*	05/12/2014	Adobe Acrobat Document
0031	031 2014-03-20 ORR-NR Prof Head Geotechnical periodic assurance meeting_MEv1.doc - **DUPLICATE - Same as 0017**		*ORR-NR Prof Head [Geotechnical periodic assurance meeting]*	20/03/2014	Microsoft Word 97-2003 Document
0032	032 2014-03-20 Update on NRIP_2011_12 and 2012_13 actions_rev09.ppt		*ORR-NR Geotechnical Quarterly Meeting*	20/03/2014	Microsoft PowerPoint 97-2003 Presentation
0033	033 Strategic business plan for England and Wales for CP5 - 2014-19.pdf		*Strategic Business Plan for England & Wales*	*01/01/2014*	Adobe Acrobat Document
0034	034 Never Inspected Earthworks.pdf		*Earthworks Inspection History*	01/10/2014	Adobe Acrobat Document
0035	035 Earthworks_CAM_SBP_Policy_Assurance_rev_01d_2014_12_03 AS ISSUED.pdf		*CAM Earthworks Assurance SBP Policy Assurance*	03/12/2014	Adobe Acrobat Document
0036	036 Embankments safety risk model ISSUE20140203.pdf		*Earthworks CP5 Roadmap: Understanding Safety Risk - Embankment Risk Model*	03/02/2014	Adobe Acrobat Document
0037	037 Performance Risk Review_v1 0_Issue.pdf		*CP5 Roadmap: Understanding Performance Risk - Feasibility Study and Preliminary Performance Risk Model*	07/02/2014	Adobe Acrobat Document
0038	038 Year 3-5 Pie Chart un-alignment.pdf		*Total CP5 Year 3-5 Schemes*	14/01/2015	Adobe Acrobat Document
0039	039 Desk Evaluation SBJ 44 1430UP.pdf		*Desk Evaluation SBJ 44.1430 (u)*	13/01/2015	Adobe Acrobat Document
0040	040 Geotech Remit.xls TTH GS2-8 Telham Embankment V1.0.pdf		*Project Manager's Remit/Project Requirement Specification (PRS)*	14/01/2015	Adobe Acrobat Document
0041	041 Geotech Remit Allington Rock Cutting 41 0000-41 0220 V2.pdf		*Project Manager's Remit/Project Requirement Specification (PRS)*	14/01/2015	Adobe Acrobat Document
0042	042 Geotech Remit Borough Green V2.pdf		*Project Manager's Remit/Project Requirement Specification (PRS)*	14/01/2015	Adobe Acrobat Document
0043	043 Civils Adjustment Mechanism (CAM) Kent presentation 16122014.pdf		*Civils Adjustment Mechanism (CAM)*	16/12/2014	Adobe Acrobat Document
0044	044 RF6 ORR Report Final.doc		*Renewals & Maintenance Volume Quarter 2 Assurance Review*		Microsoft Word 97-2003 Document
0045	045 Poor Top Poor to EHC DE_changes per Route_As Issued.pdf		*Earthwork Asset Percentages*		Adobe Acrobat Document
0046	046 Copy of Breakdown of Geotech volumes.xlsx		*Final Delivery Plan Volumes 5 Chain Lengths*		Microsoft Excel 97-2003 Workbook
0047	047 20140806 Adverse_Weather_2_Rainfall_issue.pdf		*Earthworks CP5 Roadmap: Adverse Weather 2 (Rainfall)*	29/07/2014	Adobe Acrobat Document
0048	048 Geotechnics - P8 V2.pdf		*Geotechnics - Period 8*	27/01/2015	Adobe Acrobat Document
0049	049 EHC examples of change.pdf		*Serviceable Soil Cutting*	27/01/2015	Adobe Acrobat Document
0050	050 CAM evidence - Kent (Geotech)		*CAM evidence - Kent (Geotech)*	20/01/2015	Outlook Message Format - Unicode
0051	051 FW: Second update to actions following 20th Jan meeting		*FW: Second update to actions following 20th Jan meeting*	27/01/2015	Outlook Message Format - Unicode

Appendix D

Question Log

D1 Question Log

Specific discussion points were raised with NR using a Question Log. These points were then explored through correspondence and face to face meetings. A copy of the final Question Log is appended.

A status has been assigned to each question as to whether or not it is considered to be 'closed out'.

REVIEW OF EARTHWORKS ASSET POLICY - QUESTIONS LOG			Prepared by:	Jim McGregor		Date:	08/09/2014		v19 - 3 March 2015 (post tri-partite mtg and ORR comments provided 3/03/15)
Policy version:	CP5 Earthworks Asset Policy Issue 3 (22 August 2014)		Checked by:			Date:			
Supplemental document:	***Provided at start of Mandate:*** 1. Generation, Analysis and Application of New Hazard Index for likelihood of Earthwork Failure (31 March 2014) 2. CP5 Earthworks Asset Policy Issue 3 (22 August 2014) ***Provided: 26/11/14*** 3. NR ARM M06PR-06 Procedures for the Reporting of Earthwork Failures 4. NR ARM M06DF-08 Definitions for the Reporting of Earthwork Failures 5. NR ARM M33PR-03 Procedures for the Reporting of Earthworks Condition Banding 6. NR ARM M33DF-03 Definition for the Reporting of Earthworks Condition Banding 7. Safety Risk Addendum v1 8. Earthworks Data Quality Report rev02d 9. CCT Implementation Phase 1 10. NR New HI Addendum Report Rev01 11. Powerpack version 5 User Manual rev09						***Provided: 02/12/14*** 12. Arthur D. Little, "Establishing a Common Risk Scoring Matrix for Safety across Network Rail, Phase 2 Report", Nov 2013 13. Network Rail, "Earthworks CP5 Roadmap: Review of Asset Criticality (Safety)", Feb 2014 ***Provided: 03/12/14*** 14. Earthworks CAM SBP Policy Assurance - 3rd December 2014. ***Provided: 17/12/14*** 15. CP5 Roadmap: Understanding Safety Risk - Embankment safety risk model. Issue 1. 16. CP5 Roadmap: Understanding Performance Risk.. Issue 1. ***Provided: 18/12/14 (Arup only - previously provided to ORR)*** 17. Earthworks Inspection History (October 2014) - Powerpoint Presentation.		

Comment No.	Document title	Text ref. if applicable (page no. + para no; table no.; etc.)	Topic	Question / Issue	Date of question (DD/MM/YYYY)	Originator of question / comment	Importance H/M/L	NR response date (DD/MM/YYYY)	Originator of response	NR response	ORR / ARUP view - question closed?	Comment
Earthworks/001	Earthworks Asset Policy	Page 21, last para of 1.4.2		States "A validation exercise ***has been carried out*** to identify earthworks previously omitted ..." but NR/L3/CIV/065 Issue 4 (as confirmed on page 22) indicates all "never inspected" 5ch lengths are to be inspected by 1 April 2017. Please clarify this apparent contradiction and, in light of this, please comment on the robustness of the "validation exercise".	06/10/2014	ORR Jim McGregor	H		Simon Abbott	There is no contradiction. The validation exercise identified the issues, which included the Never inspected 5ch lengths. And as a result of this validation exercise a programme of works has been instigated to achieve the objective of all such sites being inspected by 1st April 2017.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/002	Earthworks Asset Policy	Page 21 / 22		Please provide a copy of the Network Rail (January 2014) Data Quality Report.	06/10/2014	ORR Jim McGregor	M		Tim Spink	The report will be provided under separate cover. Update: Provided 26/11/14.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/003	Earthworks Asset Policy	Page 22		If not stated in the Data Quality Report, please confirm (by Route) (a) the number of "never inspected" 5 chain lengths (b) the number of paper records which have still to be entered into the database (c) the number of null records without locational information and (d) the number of missing ELRs.	06/10/2014	ORR Jim McGregor	H		Simon Abbott	(a)As of 21/10/14, "Never Inspected" 5ch sections of the network that exist within the Earthwork Examination Database: Anglia 12660, Kent 481, LNE 20930, LNW 1578, Midland 5640, Scotland 20183, Sussex 282, Wales 1, Wessex 411, Western 58, National 62224 (19%). (b) N/A - we are managing and reported via the Earthwork Database. (c) - all 5ch's within the Earthworks Database have geo-referenced locational information. There are currently 62224 that have that status of "Never Inspected" that require inspection to identify or otherwise the presence of any earthworks. (d) - to be advised **UPDATED FEB 13:** b) All paper records have been captured into the JBA examinations database at examination score level. Those with incomplete examination attributes are scheduled for re-examination in the 2014/15 fieldwork season. c) All records held in the JBA examinations database have locational information. d) All running line ELRs are held within the JBA examinations database.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/004	Earthworks Asset Policy	Page 22, para 1.4.5		Please comment on the implications (if any) of using one data cut (on 15/02/2012) for the policy modelling and a different data cut (on 02/05/2014) for the policy's asset statistics and workbank development. In particular, please comment on whether the conclusions of the modelling exercise would have been significantly different - and if so, in what respect(s) - if the modelling had been re-done using the 02/05/2014 data cut.	06/10/2014	ORR Jim McGregor	H		Tim Spink	Modelling previously undertaken was to develop Policy. Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. The modelling will be re-run as part of the CAM development, and any differences identified from the SBP modelling will be advised as part of the CAM submission.	**No**	**Keep open until results of modelling or timescale for this is provided.**

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Earthworks/005	Earthworks Asset Policy	Page 26, para 2.3		Please clarify how "mixed ground" slopes are dealt with in this section.	06/10/2014	ORR Jim McGregor	M		Simon Abbott	p14 Section 1.2.1 clarifies the approach to cuttings where components of soil and rock exist the components are examined anr recorded separately; "Mixed Cutting: A cutting composed of both soil and rock, either one component overlying the other, or interbedded. For management purposes the soil and rock components are examined and recorded separately." p22 of previous policy version details assets in similar charts. **UPDATE JAN 15:** Inspection 5ch's consist of the actual 5ch on the ground. An inspection 5ch may contain more than one earthwork asset. For example - where there is the presence of an embankment and cutting within a 5ch section or where there is a soil cutting above a rock cutting within the 5ch section. Therefore for management purposes each element counts as an earthwork asset. We have Inspection 5ch's which represent the total length of the network and then Earthwork assets that represent the total number of exams.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/006	Earthworks Asset Policy	Page 27, para 2.4		When will the results of the RSSB "Embankment Vulnerability to Traffic Damage" project be available?	06/10/2014	ORR Jim McGregor	L		Eifion Evans	Update: The Final report can be obtained from the link below (you may need to register for an account to download): http://www.rssb.co.uk/pages/research-catalogue/t679.aspx	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/007	Earthworks Asset Policy	Pages 29 & 30, Figs 2-3 & 2-4 and Table 2-3		Please review Figs 2-3 and 2-4 in light of the data in Table 2-3 e.g. Fig 2.3 appears to show that LNE, Scotand & Wales do not have any category E assets whereas Table 2-3 shows Scotland having one of the largest populations of category E assets.	06/10/2014	ORR Jim McGregor	L		Simon Abbott	Western has the biggest percentage of EHC grade E assets totalling 1.1% of its route. This is shown is Fig 2.4. LNW & Scotland have the second and third highest total of assets in 'E' and these equate to 0.4% of the Routes total asset portfolio. The small percentage and numbers of actual assets is slightly lost in the scale of the charts - hence the reason for the production of the data in Table 2-3.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/008	Earthworks Asset Policy	Page 30, Table 2-3		The percentage of category E assets seems particularly low for some Routes, especially LNE and Midland. Please comment.	06/10/2014	ORR Jim McGregor	M		Simon Abbott	At the time of the May 2014 data cut there were 12,302 earthworks in the database for which it was not possible to determine the EHC. These sites are therefore currently graded as Unscored and will be re-examined in the 2014/15 season to obtain the EHC score. Only once this re-examination is carried out will we have the full EHC profile for each route. Section 1.4.3 on p21 defines: Unscored examination: The earthwork asset has been examined at sometime but the Network Rail Earthworks Examination Database does not contain all of the parameters necessary to calculate a Hazard Index score and therefore an Earthwork Hazard Category can not be determined. The earthwork asset may have been examined to an earlier Standard or the full details of an examination carried out to the current 065 Standard have not been recorded in the database. **UPDATE JAN 15:** The constraint of assets within each condition grade was nationally and therefore parity has been retained at a national level and not at a Route level. Discussed in meeting of 20 January. NR would like to consider this closed.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/009	Earthworks Asset Policy	Page 30, Table 2-3		To allow "sense-checking" of the figures, please provide (by Route) the percentage of earthworks assets which were previously classed as Poor or Top Poor compared to those now in category D and E. Please also comment on any significant differences.	06/10/2014	ORR Jim McGregor	H		Tim Spink	Will be provided under separate cover. **UPDATE JAN 15:** Provided on 23rd Jan by email to ARUP and ORR.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/010	Earthworks Asset Policy	Page 31, para 2.6.1		Why has the failure data only been updated to P7 2012/13 (as this omits the large number of failures in the winter of 2012/13 and 2013/14)?	06/10/2014	ORR Jim McGregor	H		Simon Abbott	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. The failure statistics were not updated.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/011	Earthworks Asset Policy	Page 32, para 2.6.2 & Table 2-4		It would be helpful if this section included number of incidents where trains collided with failed earthworks but did not derail. Is this data available?	06/10/2014	ORR Jim McGregor	H		Simon Abbott	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. This section has therefore not been updated. The ORR's comments are noted and will be considered in the development of the CP6 earthworks Policy.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/012	Earthworks Asset Policy	Page 34, para 2.6.3 and Page 36, para 2.6.6		While delay minutes may provide an indirect measure of incident severity & recovery speed, there is no strong evidence that "the total number of Schedule 8 delay minutes accumulated …. is a good indication of the management of the asset". Nor is there strong evidence in this section that "expenditure on the earthworks and earthworks drainage asset has addressed a large proportion of the significant defects which required day-to-day maintenance management" - if the data had been extended to cover the winters of 2012/13 and 2013/14, I suspect the evidence would, in fact, show the contrary.	06/10/2014	ORR Jim McGregor	M		Simon Abbott	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. This section has therefore not been updated. The ORR's comments are noted and will be considered in the development of the CP6 earthworks Policy.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/013	Earthworks Asset Policy	Page 36, Fig 2-12		I have generally ignored Mining aspects in reviewing the earthworks policy as I understand the Mining policy is due to be updated, but please confirm whether the earthworks policy will be updated where relevant in light of the revised mining policy e.g. will the "actual" end CP4 figure be used instead of the projected end CP4 figure in Fig 2-12?	06/10/2014	ORR Jim McGregor	L		Tony Wilcock	To be advised **UPDATE FEB 13**: Draft mining policy is currently under internal review.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/014	Earthworks Asset Policy	Page 39, para 3.1		Please provide a copy of "Earthworks CP5 Roadmap : Understanding Safety Risk - Development of Cutting and Embankment Safety Risk Models" (April 2014).	06/10/2014	ORR Jim McGregor	H		Juliet Mian	The report will be provided under separate cover Update: provided on 26/11/14. See document reference 7 above.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/015	Earthworks Asset Policy	Page 39, para 3.1		Please provide a copy of "Asset Criticality - Y-axis : Phase 1 Implementation of Common Consequence Tool - Earthworks" (August 2014). Please also comment on what action has been taken or is being taken in response to ORR's comments when this subject was presented to ORR in Kemble Street on 25/09/2014.	06/10/2014	ORR Jim McGregor	H		Juliet Mian	The report will be provided under separate cover. Work is ongoing to address the issues raised. Update: provided on 26/11/14. See document reference 9 above.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/016	Earthworks Asset Policy	Page 39, para 3.1		CCT should more properly be called "Derailment Common Consequence Tool". Please also confirm how the policy addresses non-derailment consequences.	06/10/2014	ORR Jim McGregor	H		Juliet Mian / Tim Spink	Overall CCT, as an integral component of EACB, is considered to be a positive step forward in our understanding of consequence compared to the previous EPM. EACB is fully quantitative, whereas EPM was qualitative. Also, we consider that in comparison to other asset groups who use SRS as a consequence measure, EACB represents a considerable advance. In the case of earthworks, as shown in the SRM, and supported in work preceding the CCT (NERRP and Adverse Weather), the significant safety impact of a failure is derailment. The non-derailment consequences of an earthwork failure are included in a single node of the CCT event tree, which is considered appropriate. For other assets and operations, the CCT is not yet rolled out and would be reviewed and sense checked in the same way. The intention is for the tool to model all safety consequences in a common framework. **UPDATE JAN 15:** discussed and explained at meeting on 20th Jan with ARUP and ORR. NR would like to consider this closed.	No	**Response indicates non-derailment consequences are included in CCT - further information on how this is included would be helpful.** **March 2015 update : At 20/1/2015 meeting NR agreed to provide a summary of what's included / not included in CCT. Item remains open as this still not received. NR agreed again to provide this at 24/2/2015 meeting.**

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Earthworks/017	Earthworks Asset Policy	Page 41, Table 3-2		The percentage of EACB category 5 assets seems particularly low for some Routes, especially Kent, Wales, Wessex and (to a lesser extent) Scotland. Please comment.	06/10/2014	ORR Jim McGregor	M		Juliet Mian	The boundaries for EACBs have been drawn so that the national distribution of assets is consistent with the former EPM approach, with the division between EACB5 and EACB4 to give an adequate national differentiation. This was a necessary step in managing the change in relation to the CP5 workbank (see comment 020). It was not appropriate to do this at a Route level as it was not desirable to have differing meanings to any given 'EACB' across the routes. The CCT evaluation is not biased by route, and so the national distribution of assets across the EACBs is in line with the hazards present. This has resulted in some routes having fewer assets in EACB5 than others, but based on the relative hazardousness, this appears to be the correct outcome. **UPDATE JAN 15:** discussed and explained at meeting on 20th Jan with ARUP and ORR. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/018	Earthworks Asset Policy	Page 53, para 5.3.2		Please provide a copy of "Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure. Addendum Report".	06/10/2014	ORR Jim McGregor	H		Tim Spink	This report will be provided as soon as it has been reviewed by NR and published. **Update:** due for publication in the New Year.	**No**	
Earthworks/019	Earthworks Asset Policy	Page 57, Fig 5-17		Please confirm whether failure probabilities quoted are absolute or have been normalised by population size for each earthwork type. As this seems to contradict failure data, please comment particularly on the graph's indication that rock cuttings in EHC bands D & E are considerably less likely to fail than soil cuttings and embankments in similar condition - ORR suspects from previous discussions this is due to the how (erroneously, in ORR's view) the EHC boundary conditions for each earthwork type were chosen.	06/10/2014	ORR Jim McGregor	H		Tim Spink	The failure probabilities are expressed as percentages (as is normal). When these percentages are multiplied by the number of assets in each EHC category the statistically assessed number of earthwork failures will be obtained. New metrics have been derived for soil cuttings and embankments (SCHI and SEHI) which have successfully optimised the failure probabilities for these two asset types, giving a failure probability range from category A to E of about 100. There has been no similar development of RSHI for rock cuttings at this time, and it retains its previous failure probability range of only 3. This fully explains the differences in the failure probabilities seen in Fig 5-17. **UPDATE JAN 15:** NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/020	Earthworks Asset Policy	Page 59, para 6.1		Retaining parity by keeping the same quantum on the old and new x and y-axes is only one possible way of calibrating the model, and as criticism of the old y-axis (modified EPM) is understood to be one of the reasons for changing, this might cast doubt on the appropriateness of this approach. What steps have been taken to verify the calibration? In particular, have previous slopes which failed been plotted on the new graph to establish whether they would have been in the top right (high risk) sector? If not, why not?	09/10/2014	ORR Jim McGregor	H		Simon Abbott / Tim Spink	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. In order to retain the Policy, to utilise the Policy intervention matrices and to retain the Policy KPIs we must retain parity on both the likelihood and consequence axes of the risk matrix. The enhancement work that we have carried out on the likelihood and consequence axes definitions has been carried out whilst workbank development for CP5 has been going on, and therefore it has been essential to maintain a consistent approach to avoid derailing this process. If we had not maintained parity then it would not have been possible for either NR or the ORR to gauge the level of improvement that has been achieved, and it would not have been possible to assess CP5 delivery against the forecast KPIs committed in the Final Delivery Plan. **UPDATE FEB 06:** Discussed on the 20th Jan with ORR and ARUP. The likelihood of failure is reflected in the EHC metric, and the distribution of the historic failures is recorded in the failure probability statistics presented in chapter 9 of the March 2014 Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure report. The EACB axis has no impact on where historic failures plot on the risk matrix, it indicates the level of consequence based on where the failures occurred. ie failures will never cluster top right in the matrix. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/021	Earthworks Asset Policy	Page 62, Fig 6-1		Why is the risk matrix symmetrical rather than assymetrical to include C/5 (i.e. relatively high likelihood of catastrophic consequence) as Red? (See also item Earthworks/023 below.)	09/10/2014	ORR Jim McGregor	H		Simon Abbott / Tim Spink	This matrix demonstrates the theory of increasing risk when combining EHC and EACB into a matrix. This is not a Policy chart to drive Intervention Activity, this is represented by Figs 6-4, 6-5, 6-6. **UPDATE JAN 15:** NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/022	Earthworks Asset Policy	Page 60, Fig 6-2		According to this Figure (read in conjunction with Fig 6-1), there are only 506 (370 + 64 = 72) high risk slopes. This figure seems excessively low when compared with (a) the current annual failure rate (b) the degradation rates in Fig 5-19 which indicates 1.76% or ~3250 slopes will degrade to poor / top poor / failed each control period and (c) the number of slopes identified as at risk during adverse weather. This suggests to me that the model has not been correctly calibrated. The numbers would, however, have more credibility if the risk matrix was assymetric and included C5 (1610 slopes).	09/10/2014	ORR Jim McGregor	H		Simon Abbott / Tim Spink	With reference to question 021, the risk matrix is symmetric, but the intervention matrix is assymetric. The model has been fully calibrated using all of the CIV028 failure data available to us. **UPDATE JAN 15:** As per response to Q21 this matrix demonstrates the theory of increasing risk when combining EHC and EACB into a matrix. This is not a Policy chart to drive Intervention Activity, this is represented by Figs 6-4, 6-5, 6-6. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/023	Earthworks Asset Policy	Page 62 & 63, Figs 6-4, 6-5 and 6-6		These figures overlay an assymetrical intervention matrix on a symmetrical risk matrix. The nature of the assymetry indicates that Network Rail's approach is still biased towards Condition (rather than either Consequence or Risk) as the driving factor. For example, in Fig 6-4, an embankment in Poor condition but whose failure will have very low consequence (D/1) will be refurbished but an embankment in Marginal condition but with the highest potential consequence (C/5) will not be refurbished. Please comment.	09/10/2014	ORR Jim McGregor	H		Simon Abbott	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. With reference to question 020, parity has been retained so that the intervention matrices can be retained. **UPDATE JAN 15:** the boundaries of intervention activity along x and y axis have not changed, nor has parity of the national asset distribution profile. We have not changed policy and have not modified these boundaries that existed in the previous policy. We recognise that potential improvements can be explored throughout the CP as we begin to embed the applicaiton of this policy. However, we are not at this stage changing the policy matrices. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/024	Earthworks Asset Policy	Page 64, Table 6-2		Why does the "refurbish" entry for embankments include "substantial tree removal" but the refurbish entry for soil cuttings does not? (Please refer to the research carried out for Network Rail on the impact of vegetation and trees on cuttings, especially in light of climate change.)	09/10/2014	ORR Jim McGregor	M		Simon Abbott	These are 'typical' earthwork intervention types and mapped across from Previous Policy version. Substantial tree removal on embankments, in particular cohesive embakments in over-consolidated clay, helps to manage the impact of desiccation. Therefore there can be significant benefit to managing trees on embankments in the right way. Trees on Soil Cuttings are more of an issue from a safety perspective - should they fall and foul the line, and also cause adhesion issues in areas of high leaf fall. Substantial tree removal on soil cuttings gives little benefit to the Soil Cutting - some benefit is gained in facilitating exams. the main benefit in Soil Cuttings would be removal of vegetation along the crest which would be a requirement and enabler under the option of Crest Drainage refurbishment.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/025	Earthworks Asset Policy	Page 76, Fig 7-2		This graphic suggests "Debris or collapse does not affect track" is a "controlled incident". In the context of train derailment, this may be valid but this ignores the potential for other significant safety consequences (e.g. bridges or other structures being undermined and possibly collapsing, debris falling onto roads or other 3rd party land, etc.).	09/10/2014	ORR Jim McGregor	M		Simon Abbott	Fig 7-2 illustrates the enormous strides that have been made to provide an integrated modelling approach and associated standards that apply on both sides of the safety risk bow tie diagram. Policy and guidance to the routes allows them to address special case situations that may be outwith the detailed standards and models.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/026	Earthworks Asset Policy	Page 77, Fig7-3		Many elements of the "likelihood of risk event" box apply equally (if not more so) to safety risk as to performance risk.bow-tie	20/10/2014	ORR Jim McGregor	L		Simon Abbott	This is present in the Previous Policy - see p71 of Previous Policy.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/027	Earthworks Asset Policy	Pages 79 - 81, para 7.5		This section on Tolerability of Risk contains various assertions (e.g. "There are no earthworks in the unacceptable risk category") for which Network Rail does not offer any evidential basis. ORR notes Network Rail's view on these matters but does not necessarily accept them.	20/10/2014	ORR Jim McGregor	M		Simon Abbott	The content of section 7.5 of the Policy document was arrived at after lengthy discussions between NR and the ORR and their Reporter in 2012. We have not changed the agreed statements that were arrived at then, we have simply updated the section to bring in the advances made since then.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/028	Earthworks Asset Policy	Page 81, Fig 7-5		On what basis does Network Rail believe that soil cuttings with Hazard Category A and EACB 4 and 5 are tolerable but Embankments and rock cuttings with the same Hazard Category and EACB are broadly acceptable?	20/10/2014	ORR Jim McGregor	M		Simon Abbott	This is an updated diagram to reflect EHC and EACB in the new 5x5 matrix. The definitions of locations on the matrices are mapped across from the 4x3 matrix. **UPDATE JAN 15:** the boundaries of intervention activity along x and y axis have not changed, nor has parity of the national asset distribution profile. We have not changed policy and have not modified these boundaries that existed in the previous policy. We recognise that potential improvements can be explored throughout the CP as we begin to embed the applicaiton of this policy. However, we are not at this stage changing the policy matrices. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/029	Earthworks Asset Policy	Page 81, para 7.5, 3rd bullet		"Risk" includes "likelihood" ***and*** "consequence" and asset criticality is a proxy for consequence, so the statement that "higher levels of risk can be accepted in areas of lower asset criticality" is terminologically incorrect. Furthermore, the legal obligation is to manage risk to "as low as reasonably practicable" (alarp) and this statement infers that differential levels of risk can be set purely on judgements of asset criticality, which is incorrect. It would therefore be more correct to state that "Higher likelihood of failure can be accepted in areas of lower asset criticality" as this statement would not contradict the obligation to manage risk to alarp.	20/10/2014	ORR Jim McGregor	M		Simon Abbott	This bullet point exists on the Previous Policy on p75.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/030	Earthworks Asset Policy	Pages 81 - 85, paras 7.6 & 7.7, Figs 7-6, 7-7 & 7-8		According to para 7.7, an optimum policy requires "..... A search for the best combination of intervention matrices and intervention mixes that meet the required outcomes", and the italicised note to paras 7.6 & 7.7 asserts that the only impact of the move to the new 5 point EHC & EACB is to change the absolute values of parameters. However, a 5 x 5 approach has potentially many more intervention matrix options than the previous approach (see, for example, Fig 7-7). On what basis, therefore, does Network Rail conclude that (a) the previously optimum Policy selection remains valid and (b) the Policy will deliver the same Enhance / Sustain / Degrade outcome without having re-run the model to determine the potential impact of the wider range of intervention matrices available with the 5 x 5 approach?	20/10/2014	ORR Jim McGregor	H		Tim Spink	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. With reference to question 020, parity has been retained so that the intervention matrices can be retained. The modelling will be re-run as part of the CAM development, and any differences identified from the SBP modelling will be advised as part of the CAM submission. **UPDATE JAN 15:** NR beleive the current optimum Policy selection remains valid as the basic policy has not changed. The toolkit of an improved examination score (aligned better to failure data) and an improved understanding of infrastructure features (consequence factors) allow for better decision making at route level. We are not changing policy and parity / distribution has been retained. Until modelling of workbanks is complete we will not be able to see what the application of policy delivers.	**No**	**Need to explore further - response does not really address specific questions i.e. "On what basis, therefore, does Network Rail conclude that (a) the previously optimum Policy selection remains valid and (b) the Policy will deliver the same Enhance / Sustain / Degrade outcome without having re-run the model to determine the potential impact of the wider range of intervention matrices available with the 5 x 5 approach?"** **March 2015 update : NR's update still fails to address key issue - "believing" that the optimum policy remains valid is not the same as demonstrating evidentially that this is the case. However, ORR notes NR's statement that "until modelling of workbanks is complete we will not be able to see what the application of policy delivers" and therefore proposes to keep open until results of modelling is provided.**

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Earthworks/031	Earthworks Asset Policy	Pages 97 & 99, para 8.3		This states that the Tier 1 CeCost models for embankments and soil cuttings "follow the SSHI algorithm closely"; that they "calculate the overall condition each time step by using the SSHI algorithm rules"; and that "Interventions can be programmed to uplift the various characteristics depending on ... the SSHI algorithm rules". Please comment on the robustness of the CeCost output in light of the conclusions of the work to develop the new EHC algorithm i.e. that the SSHI algorithm was not well correlated to failure likelihood.	20/10/2014	ORR Jim McGregor	M		Tim Spink	Section 8 of the Policy relates to the modelling that was done in 2012 as part of the SBP Policy development. The main tool used to optimise and quantify the SBP submission was earthworks SCAnNeR, not CeCost. CeCost was used to validate the earthworks SCAnNeR model. The immediate plans are to modify earthworks SCAnNeR so that it will work with the new 5x5 risk matrix and this will be used for CAM modelling. CeCost would need a substantial rebuild if it is to be used for any further modelling. **UPDATE FEB 06:** It has been decided not to progress the further development of the CeCost earthworks model. CAM modelling will be completed using the earthworks SCAnNeR model that has now been modified to work with the new 5x5 risk and intervention matrices.	**No**	**Keep open until results of modelling is provided.** **March 2015 update : As NR now no longer progressing development of CeCost earthworks model but instead intend using earthworks SCAnNeR model, propose keeping open until results of SCAnNeR modelling is provided.**
Earthworks/032	Earthworks Asset Policy	Page 104, para 8.11		Please provide envisaged timescales for the three future developments listed in this para.	20/10/2014	ORR Jim McGregor	L		Simon Abbott / Tim Spink	For earthworks SCAnNeR the modelling of phasing has been added, and it is currently being modified to handle the 5x5 risk matrix. The other limitations will be handled for the CAM modelling by the same means adopted at SBP. Integration of the UCWB and Powerpack capability into the CSAMS asset management system in the manner suggested in Figure 8-7 - circa 2016 Development of a Tier 3 tactical/operational DST to assist the routes in refining their workbank plans - circa 2019	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/033	Earthworks Asset Policy	Page 112, para 9.2, 6th bullet		SBP Option 1 included contingency provision based on a bottom up estimate by the Routes of the volume of work required in CP5 on "unknown grey assets". Please comment for each Route on how the quantum of "unknown grey assets" included in the provision compares with the quantum of "blue line" entries.	20/10/2014	ORR Jim McGregor	M		Simon Abbott	This text has hardly changed from Previous Policy version. As per current standard and definitions blue line entries are now known as "Never Inspected" and these totals are shown in response to Q-003. **UPDATE JAN 15:** Grey assets are where an earthwork is known to exist but has not yet had an examination and are now called "Not examined". Blue lines are what we now call "Never Inspected". The adopted SBP Option 2 contained no allowance for grey assets (see Fig 9-4 in the Policy document), ie the SBP submission contained no contingency allowances.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/034	Earthworks Asset Policy	Page 121, para 10.1, 1st bullet and 10.2.1 1st sub-bullet		This states that a key policy objective is to maintain the overall condition profile in CP5 and beyond at the CP5 entry level. ORR notes, however, that the actual CP5 entry level was worse (and significantly worse in the case of Scotland Route) than anticipated at SBP. How is this being addressed?	20/10/2014	ORR Jim McGregor	M		Tim Spink	This will be addressed in the CAM submission once modelling of actual workbanks is undertaken against the current actual portfolio condition.	**No**	**Keep open until CAM submission received and reviewed to confirm that this it addresses this item.**
Earthworks/035	Earthworks Asset Policy	Page 127, para 10.4.1, "second question" 1st bullet		A previous NRIP report challenged the conclusions on landslip risk due to climate change & quoted additional studies and despite this statement in the policy there now seems to be consensus in Network Rail that climate change is likely to have an impact on landslips. For example, recently published WRCC Adaptation Plans generally list "earthslips" as high or medium priority based on up to 17 - 25% predicted increase in February mean daily precipitation. If NR does not expect landslips to increase due to climate change, ORR would not expect earthworks to feature in the WRCCA plans. Please therefore confirm whether or not NR believes climate change is likely to have an impact on earthworks failures.	20/10/2014	ORR Jim McGregor	H		Simon Abbott	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. Further work will be undertaken to improve policy in areas of climate change in development of the CP6 earthworks Policy. WRCCA plans to be included in the CAM submission will include Geotechnical assets and focus on weather resilience and climate change. Investing in additional volume will add resilience into the network. This will provide a more reliable and safe geotechnical portfolio from the effects of weather. **UPDATE JAN 15:** Increased rainfall events and duration of storms are likely to see the geotechnical asset base tested to a greater extent. Given the historical legacy of the construction (pre understanding of soil mechanics) this testing may result in a greater extent of earthwork issues , either serviceability and / or safety related. However, this remains an area of ongoing research that will feed into the CP6 Policy. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/036	Earthworks Asset Policy	Page 136, para 10.7		As deliverability is stated to depend on changes in working practices and staffing levels, please comment on what progress has been made in implementing the changed working practices and improved staffing levels in each route.	20/10/2014	ORR Jim McGregor	M		Simon Abbott	Growth has occurred following project Darwin and devolution. **UPDATE JAN 15.** Period report from LNW provided to show a route tuning into the new application of Policy. In regards to staffing levels. High level estimate of RAM teams in Geo& Drainage were around c30-40 c2006. This has increased to around c65-75 in 2015. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/037	Earthworks Asset Policy	Page 137, para 10.9		The robustness measure was defined by ORR as "Number of earthworks failures to be reported at route level every period" but the poloicy states Network Rail's definition is the "annual average number of earthworks failures measured over 5 years". To calculate the 5-year average the period figures must be known but for the avoidance of doubt please confirm that the number of failures each period will also be reported.	20/10/2014	ORR Jim McGregor	M		Simon Abbott / Tony Wilcock	The level of reporting will be advised. Update: still to be advised.	**No**	
Earthworks/038	Earthworks Asset Policy	Page 138, Fig 10-1		This shows the weighting applied to slopes in Earthworks Hazard Category B and C as being the same, presumably since these were previously combined as "Marginal" condition. However, it is self-evident that C will have a higher likelihood of failure (and hence should have higher weighting) than B - if this was not the case, there would be no benefit in splitting marginal into B & C and no basis on which to do so. Please comment therefore on (a) the robustness of the M33 metric in the light of this observation and (b) any plans to determine separate weightings for B and C slopes.	20/10/2014	ORR Jim McGregor	M		Simon Abbott/ Tim Spink	With reference to question 020 parity has been retained with the previous weightings so that the KPIs committed in the Final Delivery Plan (based on Serviceable, Marginal, Poor and Top Poor) can be monitored throughout CP5 using the new 5 point EHC. We envisage that the weightings will be reviewed with potentially a new KPI metric being defined for monitoring performance in CP6. **UPDATE FEB 06:** As noted in the ORR and ARUP meeting of 20th January, a period of stability is required, with the current metrics being utilised for the remainder of CP5. The metrics will be reviewed as part of the CP6 Policy development. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/039	Generation, Analysis and Application etc	Page 8, paras 2.2 & 2.3		Given the very small sample size after elimination of CIV/028 data sets without prior exams and incomplete exam records, how can NR be assured that the "used" sample is of sufficient size to be statistically representative?	27/10/2014	ORR Jim McGregor	H		Tim Spink	Please refer to Network Rail, March 2014. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure section 10 in which a validation exercise using the most recent failure data confirmed the conclusions of the main analysis.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/040	Generation, Analysis and Application etc	Page 8, para 2.2		Did the analysis include ***all*** CIV/028 failures or only those scored >20? If only those scored >20, what is the likely impact on the robustness of the analysis of omission of those with lower scores?	27/10/2014	ORR Jim McGregor	M		Tim Spink	All CIV028 failures used that could be located and which had a prior examination.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/041	Generation, Analysis and Application etc	Page 8, para 2.2		Where a single event included multiple failures, was each failure individually analysed?	27/10/2014	ORR Jim McGregor	M		Tim Spink	Every failure that could be related to a specific earthwork was used.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/042	Generation, Analysis and Application etc	Page 13, para 5.1		What other methodologies for identifying the most significant factors were considered and why was the "Difference" and "Factor" methodology chosen?	27/10/2014	ORR Jim McGregor	M		Tim Spink	Various statistical methods of mutlivariant analysis were considered (specifically multiple regression and neural network analysis), however it was decided that these methods were too "black box", and that it was desirable to have a completely transparent method, the inner workings of which could be fully understood, picked apart and sensitivity tested. It was necessary that the method would stand up to rigorous scrutiny by the Earthworks Panel of Experts (and the ORR).	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/043	Generation, Analysis and Application etc	Page 13, para 5.1 and Tables 5-1 & 5-2		This states that "group boundaries were determined in order to generate a roughly normal distribution of parameters per band". Please explain this further as this appears to suggest the analysis forced a roughly normal distribution within Group 1, a roughly normal distribution within Group 2, etc. (See also item Earthworks/044.)	27/10/2014	ORR Jim McGregor	M		Tim Spink	This would be better worded "The group boundaries were determined in order to generate a roughly normal distribution of parameters across the bands."	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/044	Generation, Analysis and Application etc	Page 14, Table 5-3		No explanation is offered as to how the boundary conditions in Table 5-3 were established, but I note that selection of these boundary conditions results in a small number of negative cells (7); a larger number of neutral cells (11); and an even larger number of positive cells (17). Although centred around Factor C, this does not appear to give a normal distribution as there is likely to be a much larger positive tail. Please comment further on how and why the boundary conditions in Table 5-3 were selected and why NR believes these boundary conditions are justified.	27/10/2014	ORR Jim McGregor	H		Tim Spink	Absolute weightings are arbitrary - relative differences are important. Skew inevitably arises from the fact that the 065 parameters records are primarily associated with instability rather than stability - thus there are naturally more opportunities for negative weightings than positive ones. This is also good engineering sense - it is potentially harder to demonstrate that a slope is in EHC A than in EHC E because the burden of evidence is stacked against "stabilising" parameters. **UPDATE FEB 06:** This was discussed in the meeting with ARUP on 5 December, and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/045	Generation, Analysis and Application etc	Pages 14 & 15, para 5.2; and Page 16, para 6.2.1		Para 5.2 states that "initial assignments of weightings ... were based purely on engineering assessment", but does not state by whom or on what basis. Para 6.2.1 describes this as "a sensible first attempt at a weightings distribution". Why was this approach (i.e. assignment of weightings on the basis of engineering assessment) adopted when there are stitistical methods which could have been used to assess individual parameter weightings?	27/10/2014	ORR Jim McGregor	H		Tim Spink	See answer to question 042. This approach allowed the sensitivity analysis described in section 6, to fully understand the impact of different weightings and weighting distributions. This sensitivity analysis would not have been possible with a statistical black box method.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/046	Generation, Analysis and Application etc	Page 15, para 5.4		If the new HI is believed to be a better metric for failure likelihood than SSHI (which NR's analysis now shows had a relatively poor record of predicting failure), why has NR assumed that the SSHI split provides a robust basis for allocating the number of slopes in each new Hazard Index category? In particular, as SSHI appears to have been a poor predictor of "serviceable" slope failures, does this not suggest that the higher likelihood category / categories should have more slopes than were suggested by the SSHI method?	27/10/2014	ORR Jim McGregor	H		Tim Spink	See answer to question 020. Without maintaining parity between the old and new systems there would have been a complete disconnect in the earthworks Policy, Policy application and KPIs. **UPDATE FEB 06:** This was discussed in the meeting with ARUP on 5 December, and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/047	Generation, Analysis and Application etc	Page 15, para 5.4		As past failures suggest that cutting slopes have a higher failure rate than embankments and (normalised by no. of each type of slope) rock cuttings have a higher failure rate than soil cuttings, it would be expected that the higher likelihood category / categories are skewed accordingly but the analysis described here does not suggest that such considerations were taken into account in allocating the number of slopes to each category.	27/10/2014	ORR Jim McGregor	H		Tim Spink	Our method has been a) Fix the boundaries to retain parity. These boundaries are different for each asset type b) Determine the probability of failure for each category defined. The EHC categories have different failure probabilities for each of the three asset types. Under the AD Little cross asset risk matrix that aims to bring all such risk matrices together, this is perfectly acceptable. It is not appropriate to force the same risk categories on each asset type. **UPDATE FEB 06:** This was discussed in the meeting with ARUP on 5 December, and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/048	Generation, Analysis and Application etc	Page 15, para 5.4		One means of at least partially validating the calibration of the adopted model would be to re-assess each failed slope against the new likelihood criteria to sense check the boundary conditions (e.g. if a significant number of failed slopes do not lie in the higher likelihood categories it is likely that the boundary conditions need to be re-defined to include them). Has NR carried out such a validation exercise? If not, why not and is it now the intention to do so, and if so, by when?	27/10/2014	ORR Jim McGregor	H		Tim Spink	Our whole analysis is based on: a) Maximising the probability of failure to the higher EHCs (compared with what SSHI achieved) b) Minimising the probability of failure of the lower EHCs (compared with what SSHI achieved) c) And hence maximising the spread of probability between the lowest and highest EHC (compared with what SSHI achieved) d) Improving the shape of the probability distribution across the EHCs (compared with what SSHI achieved) e) Improving the distribution of the number of failed assets across the EHCs (compared with what SSHI achieved) f) Improving the distribution of the number of assets across the EHCs (compared with what SSHI achieved) All of this has been achieved by calibrating against the CIV028 dataset. **UPDATE FEB 06:** Refer to updated answer to question 020.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/049	Generation, Analysis and Application etc	Page 16, para 6.1 and Page 18, para 6.2.11		The initial weightings (as noted in Earthworks/045 above) were based "purely on engineering assessment"; and these weightings were then adjusted "by the application of engineering judgement" for runs 15 - 21. Run 21 was then taken forward as the new methodology for soil cuttings. It therefore appears that the final weightings are based solely on engineering judgement rather than on a robust statistical analysis of the failure correlation of each parameter. This significantly undermines the confidence in the robustness of the new soil cutting index, particularly since the report itself admits (in para 6.2.8) that "several engineering based runs (15/16/17) were not having the desired effects".	27/10/2014	ORR Jim McGregor	H		Tim Spink	We disagree with the ORR statements. Refer to the answer of question 042 for why this approach was adopted. Formal multivariant analysis was initailly considered but not used. Logistic regression or a neural network model would have been candidates for this. The decision was that a hybrid approach of expert judgement and numerical analysis, under a totally transparent framework, was preferable to complex, impenetrable statistical methods which, to work correctly, would require significant training datasets. "Robustness" in the true sense cannot be ensured by relying on statistical analysis alone - the comments in the report concerning trial runs 15/16/17 demonstrate this, since it was these runs that employed minimal engineering judgement, resulting in a less satisfactory model overall. **UPDATE FEB 06:** The derivation of the weightings was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/050	Generation, Analysis and Application etc	Page 19, Table 6-1 and Pages 20 & 21, para 6.4		From review of the table, it appears that if the various runs were ranked in terms of pseudo-probability of failure (i.e. accuracy in predicting slopes at risk of failure), the chosen run (run 21) would probably be somewhere in the middle of the table. This is confirmed in the final sentence of para 6.4 i.e. "The final run, Run 21, was chosen as a middle ground between Run 1 and 16". When compared with the SSHI run, it does not appear to give a dramatic predictability improvement. ORR also notes that "Run 1 generally proved the best option ... but could not be taken forward as a final option due to the presence of scores within the matrix that did not fit with engineering judgement". All of this suggests that the new index is not optimal and that the improvement on the previous index may be significantly less than the policy appears to suggest. A better outcome might therefore have been obtained by using a more robust statistical correlation analysis to determine the parameter weightings rather than engineering judgement and (what appears to be relatively arbitrary) numerical values (i.e. try 40, try 70, try 100, etc).	27/10/2014	ORR Jim McGregor	H		Tim Spink	We disagree with the ORR statements. Refer to the answer of question 048 on the objectives of the analysis. Run 21 was the optimal run when assessed against all of these objectives, and demonstrated considerable improvement over SSHI. **UPDATE FEB 06:** The derivation of the weightings was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/051	Generation, Analysis and Application etc	Page 22, para 7		See comment Earthworks/049 above, which is also applicable to the new embankments hazard index.	27/10/2014	ORR Jim McGregor	H		Tim Spink	See replies above. **UPDATE FEB 06:** The derivation of the weightings was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/052	Generation, Analysis and Application etc	Page 22, para 7.1.3		This states that all positive track movement indicators were allocated the maximum weighting. There does not appear to have been a run which tested intermediate values for track movement (Run 2 allocated a weighting of 0). With so few test runs, why does NR believe that all track movement indicators should have the maximum weighting?	27/10/2014	ORR Jim McGregor	M		Tim Spink	There were insufficient records in the database to generate a statistical weighting. This demonstrates the importance of the approach adopted that an engineering override could be applied (rather than a purely statistical approach which would give a nonsensical answer). For embankments, if the track defects become visible to the naked eye then there is something seriously wrong, and this should be reflected in the weightings. **UPDATE FEB 06:** The derivation of the weightings was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/053	Generation, Analysis and Application etc	Page 22, para 7.1.3		This correctly notes that track movement indicators are significant only where they are due to embankment failure. However, it does not state what steps were taken to identify and exclude track movement indicators which are not genuinely indicative of embankment failure, nor is it clear that there is a robust process for excluding such data when the new index is in regular use (the Gismo Pocket Guide merely states on Page 30 that examiners should "record track movement which ***looks like*** it is associated with the embankment"). It is therefore possible that the index is potentially skewed by inclusion of factors which in fact only reflect poor track maintenance and that these factors have / will be given the maximum weighting (see also comment Earthworks/052 above).	27/10/2014	ORR Jim McGregor	H		Tim Spink	EHC has not changed the requirements of examinations for the Examiner to record observations on site. The examiners data must be taken at face value. If this flags a serious degradation of the earthwork, then an NR pair of eyes will review it as part of an Evaluation, and correct any errors present. UPDATE FEB 06: The derivation of the weightings was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/054	Generation, Analysis and Application etc	Page 25, para 8.1.3		Please comment on the level of unreliability or uncertainty associated or introduced by the smoothed bootstrap scaling method adopted and comment on whether this methodology is likely to introduce any bias and, if so, what kind of bias.	28/10/2014	ORR Jim McGregor	M		Tim Spink	Bootstrapping is applied to improve reliability and reduce bias in the raw data by scaling up the useable data to match the total volume (including the unusable records). This process is described in detail in Section 8.1.3. Smoothing is controlled by iteratively adjusting the variance of the random perturbation applied to each resampled data point until best fit with the non-bootstrapped frequency density is achieved, as shown in the example graph in Fig 9-2. This produces the most representative density function possible, upon which probability estimates are based. **UPDATE FEB 06:** The bootstrapping process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/055	Generation, Analysis and Application etc	Page 26, paras 8.1.5 & 8.1.6		The failure probability varies significantly by earthwork type (cuttings fail more frequently than embankments and rock cuttings fail more frequently thansoil cuttings) but it is not clear whether or how the method adopted for calculating failure probability took account of these significant differences (it appears from the narrative that only condition banding was taken into account) or even whether failed rock slopes were included in this analysis. Please clarify how (if at all) the greater propensity of some asset types to fail was taken into account in assessing failure probabilities.	28/10/2014	ORR Jim McGregor	H		Tim Spink	Our method is summarised in our answers to questions 047 and 048. It takes full account of the failure probability variation between soil cuttings and embankments (rock cuttings have not been analysed). **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/056	Generation, Analysis and Application etc	Page 28, Table 9-1		Please explain why the score ranges shown in Table 9-1 were chosen.	28/10/2014	ORR Jim McGregor	H		Tim Spink	These score boundaries achieve the objective of keeping the number of assets the same in each category between the old metric and the new metric, in order to achieve parity for all the reasons stated in our answer to question 020. **UPDATE FEB 06:** Parity was discussed in the meeting with ORR and ARUP on 20 January. NR would like to consider this closed.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/057	Generation, Analysis and Application etc	Page 30, 1st bullet		Please explain the basis for splitting Marginal in the ratio 3:2 rather than some other ratio.	28/10/2014	ORR Jim McGregor	M		Tim Spink	This split gave the best optimisation of the objectives stated in our answer to question 048. Numerous splits were assessed - it was completely fortuitous that the optimum split point came out to be the same for both soil cuttings and embankments. **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/058	Generation, Analysis and Application etc	Page 31, 1st bullet; Page 32, Fig 9-4; and Page 33, Fig 9-5		This states (and Fig 9-4 shows) that the peak in the number of assets failing is in Category C, however the earthworks policy focuses only on assets in categories D & E. ORR's concern about Marginal slopes was that those near the SSHI boundary were in risk terms not really distinguishable from Poor slopes. Figs 9-4 and 9-5 appear to confirm this - one possible interpretation of the graphs is that in fact the boundary has been incorrectly defined and many of the Category C slopes should really be included in Category D. Alternatively, the policy should target slopes in categories C, D & E, rather than just those in D & E. Please comment.	29/10/2014	ORR Jim McGregor	H		Tim Spink	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. **UPDATE FEB 06:** Discussed in the ORR and ARUP meeting of 20 January, in which NR stated that a period of stability was required before the intervention matrices are adjusted again - this will be part of CP6 Policy development. In the meantime the workbank prioritisation procedures developed for CAM and the revised 065 examination procedures will be applied to manage these identified risks ie reduced examination intervals, consideration of adverse weather sites, consideration of water concentration features, consideration of evaluation recommendations, consideration of condition history, consideration of EHC and EACB, consideration of route asset knowledge.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/059	Generation, Analysis and Application etc	Page 34, Table 9-2		Please explain why the score ranges shown in Table 9-2 were chosen.	29/10/2014	ORR Jim McGregor	H		Tim Spink	See answer to question 056 **UPDATE FEB 06:** Parity was discussed in the meeting with ORR and ARUP on 20 January. NR would like to consider this closed.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/060	Generation, Analysis and Application etc	Page 36, 1st bullet; and Pages 43 (last bullet) & 44 (Fig 9-18)		Please explain the basis for splitting Marginal in the ratio 3:2 rather than some other ratio. In particular, I note that the comment on page 43 (last bullet) says there is only a slight increase in failure probability from Category B to C (as the graph in Fig 9-18 also shows), and this would appear to suggest that a different split should have been adopted (i.e. one which shows a greater increase in failure probability from B to C). Please therefore also comment on whether different splits were tried; and how the evidence in Fig 9-18 on possible improved splits was addressed.	29/10/2014	ORR Jim McGregor	H		Tim Spink	See answer to question 057. There was no analysis to redefine the weightings in RSHI. Marginal was split to create the 5 EHC categories. In the absence of any other means of determining the split point the 3:2 ratio achieved in both soil cuttings and embankments was adopted. **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/061	Generation, Analysis and Application etc	Page 36, 2nd last bullet; Page 37, Fig 9-10; and Page 38, Fig 9-11		This states (and Fig 9-10 shows) that the peak in the number of assets failing is in Category C, however the earthworks policy focuses only on assets in categories D & E. ORR's concern about Marginal slopes was that those near the SSHI boundary were in risk terms not really distinguishable from Poor slopes. Figs 9-10 and 9-11 appear to confirm this - one possible interpretation of the graphs is that in fact the boundary has been incorrectly defined and many of the Category C slopes should really be included in Category D. Alternatively, the policy should target slopes in categories C, D & E, rather than just those in D & E. Please comment.	29/10/2014	ORR Jim McGregor	H		Tim Spink	See answer to question 058 **UPDATE FEB 06:** See updated answer to 058.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/062	Generation, Analysis and Application etc	Page 39, para 9.3		NR has concluded that SSHI is not a good predictor of failure likelihood, so it is likely that RSHI will also be a poor predictor. Why therefore was no attempt made to revise the RSHI algorithm?	29/10/2014	ORR Jim McGregor	M		Tim Spink	It is currently planned to attempt a similar analysis of RSHI in due course.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/063	Generation, Analysis and Application etc	Page 39, para 9.3		Please explain the basis for splitting Marginal in the ratio 3:2 rather than some other ratio - this para appears to suggest the only reason for doing so was because this was the same division was adopted for soil cuttings and embankments. (Please also see comment Earthworks/060 above which questions the validity of this split for embankments.)	29/10/2014	ORR Jim McGregor	H		Tim Spink	See answer to question 060. **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/064	Generation, Analysis and Application etc	Page 39, Table 9-3		Please explain why the score ranges shown in Table 9-3 were chosen.	29/10/2014	ORR Jim McGregor	M		Tim Spink	Only the boundary between B and C has been added (see answer to question 060), all the other boundaries are unchanged. **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	Yes	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**

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Earthworks/065	Generation, Analysis and Application etc	Page 45, para 10.1		While the results may be favourable compared to SSHI, the conclusion that this test "Is very encouraging" may not be entirely valid since (a) although improved, there is still a significant number of Serviceable / Category A failures (3 out of 41, or 7.3%) and (b) the number of Marginal / Category B & C failures is still dominant (as Fig 10-1 shows). Even better results might therefore be obtained from a different index and / or boundary conditions. Please comment.	29/10/2014	ORR Jim McGregor	M		Tim Spink	We have clearly demonstrated in our report that SCHI is a significant improvement over SSHI (against all of the parameters given in our answer to question 048), and we are encouraged by this validation test provided by an independent set of data. **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/066	Generation, Analysis and Application etc	Page 46, para 10.2		While the results may be favourable compared to SSHI, the conclusion that this test "Is very encouraging" may not be entirely valid since (a) although improved, there is still a significant number of Serviceable / Category A failures (2 out of 17, or 11.8%) and (b) the number of Marginal / Category B & C failures is still dominant (as Fig 10-1 shows). Even better results might therefore be obtained from a different index and / or boundary conditions. Please comment.	29/10/2014	ORR Jim McGregor	M		Tim Spink	See answer to question 065. **UPDATE FEB 06:** The analysis process was discussed in the meeting with ARUP on 5 December and we believe it will be covered in their independent report.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/067	Generation, Analysis and Application etc	Page 49, 4th sub-bullet for soil cuttings and embankments		Has the NR Panel of Geotechnical Experts reviewed the Case 1 exceptions for both soil cuttings and embankments? If so, what was the outcome of this review?	29/10/2014	ORR Jim McGregor	L		Tim Spink	Everything in our report was presented to the Earthworks Panel of Experts on several occasions. This work was presented to the Earthworks Panel of Experts who required further investigation. This further work will be reported in Network Rail, in press. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure, Addendum Report, once it has been reviewed by NR and published.	**No**	**Keep open until Addendum Report received.**
Earthworks/068	Generation, Analysis and Application etc	Page 49, last sub-bullet for soil cuttings and embankments		Has there been discussion of whether Case 2 is realistic with the NR Panel of Geotechnical Experts? If so, what was the outcome of this discussion?	29/10/2014	ORR Jim McGregor	L		Tim Spink	Everything in our report was presented to the Earthworks Panel of Experts on several occasions. This work was presented to the Earthworks Panel of Experts who required further investigation. This further work will be reported in Network Rail, in press. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure, Addendum Report, once it has been reviewed by NR and published.	**No**	**Keep open until Addendum Report received.**
Earthworks/069	Generation, Analysis and Application etc	Page 49, final paragraph		Has the outcome of the intervention assessment been reviewed with the NR Panel of Geotechnical Experts? If so, what conclusion was reached regarding whether there should be any changes to the 065 exam process and / or the new hazard index?	29/10/2014	ORR Jim McGregor	L		Tim Spink	Everything in our report was presented to the Earthworks Panel of Experts on several occasions. This work was presented to the Earthworks Panel of Experts who required further investigation. This further work will be reported in Network Rail, in press. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure, Addendum Report, once it has been reviewed by NR and published.	**No**	**Keep open until Addendum Report received.**

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Earthworks/070	Generation, Analysis and Application etc	Page 60, Table 12-1		This table shows that the failure rate for Category C embankments and soil cuttings is almost twice the failure rate of Marginal slopes. Category C rock cuttings also have a higher failure rate than Marginal rock cuttings although the difference is not as pronounced (this is to be expected since the RSHI algorithm has not been altered - the only change has been to split Marginal into Category B & C). Since slopes in Category C are now "proven" to have a higher failure rate than Marginal slopes, it obviously begs the question - what additional risk control measures has NR implemented to address this known increased risk, particularly for soil cuttings and embankments? ORR is unaware of the policy proposing any additional risk control measures to address this now recognised higher risk associated with Category C slopes - the only additional measure identified is in NR/L3/CIV/065 Issue 4, which reduces the exam interval for Marginal Soil cuttings but not for Marginal embankments. Please comment.	29/10/2014	ORR Jim McGregor	H		Tim Spink	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The intervention matrices are unchanged. **UPDATE FEB 06:** Discussed in the ORR and ARUP meeting of 20 January, in which NR stated that a period of stability was required before the intervention matrices are adjusted again - this will be part of CP6 Policy development. In the meantime the workbank prioritisation procedures developed for CAM and the revised 065 examination procedures will be applied to manage these identified risks ie reduced examination intervals, consideration of adverse weather sites, consideration of water concentration features, consideration of evaluation recommendations, consideration of condition history, consideration of EHC and EACB, consideration of route asset knowledge.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/071	Earthworks Asset Policy	Page 60, Fig 6.2		Are the colours correct?	29/10/2014	ORR S.Maitra	L		Simon Abbott	There is no relationship between the colours used to represent levels of risk in Fig 6-1 and the colours used to represent number of assets in Fig 6-2. The colours in Fig 6-2 are as intended.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/072	Earthworks Asset Policy	Page 71, 72 tables 6.5 and 6.6		Unit cost shown are per asset, the Delivery plan gives volume in 5ch lengths. Is there a unit cost/ 5ch length or average asset length calculated somewhere so that a correlation can be made?	29/10/2014	ORR S.Maitra	M		Simon Abbott	The Delivery Plan volumes are per asset (the terminology used may be somewhat inconsistent with the clearer definitions introduced in the 2014 Policy update, after the Delivery Plan was published). Therefore there is direct correspondence with the unit costs and the volumes.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/073	Earthworks Asset Policy	Page 109-110 Fig 9.1-9.3		SBP Options1 and 2 -From these tables the risk index looks virtually static for CP5-CP11. Earlier comments in the Policy document make reference to failure trends going down, so the overall interpretation could be that the investment made in earthworks is giving no return on improving the risk levels delivered. Also as traffic levels are predicted to rise in future the overall risk level will rise, if all other factor remain static. How does the calculated risk index explain this apparent contradiction? A similar comment can be made about SBP option 3 – no apparent return on the investment in terms of risk output delivered.	29/10/2014	ORR S.Maitra	M		Tim Spink	SBP Option 2 has been adopted following approval by the ORR. This SBP Option aimed to sustain the condition index and risk index through to CP11 but with a slight improvement in risk level in CP5 and a slight degradation in condition in CP5 which is recovered by CP10. If the ORR now desires to either improve the condition or achieve an ongoing reduction in the risk level from the earthworks asset, then additional investment will be required over and above the levels modelled at SBP. NR will be pleased to consider such a change in forward investment levels in developing the CP6 earthworks Policy. **UPDATE FEB 06:** The predicted earthworks condition index for the remainder of CP5 will be provided as part of the CAM submission.	**No**	**For the record, ORR did not (and does not) "approve" NR decisions, and NR is responsible for developing & implementing suitable arrangements for managing its assets in compliance with its statutory duties. The Final Determination (which applies only to CP5), and NR's acceptance of it, is intended to provide NR with funding necessary to deliver commitments it made, including delivery of its CP5 asset policies, which NR's response confirms includes an improvement in risk level in CP5. ORR has previously highlighted worsenment in CP5 entry position from that indicated at SBP and still awaits NR's updated CP5 trajectory.** **March 2015 update : Keep open until CAM submission received and reviewed to confirm that this it addresses this item.**
Earthworks/074	Earthworks Asset Policy	Page 109-110 Fig 9.1-9.3 + p121		The NR Delivery plan shows around 16000 nr: 5 ch length will be remediated. As a percentage this around 5 % of the assets. (around 330,000 5ch lengths stated in policy, Table1.1). Both SBP Option 1 – baseline and SBP Option 2 – preferred , the bar charts (the middle one) shows 12% and 10% of asset will be remediated. There is also a discrepancy on in the "SBP options 3 SoFA" chart which shows about 6.5 % of earthworks assets will have remediation work. Which is correct? Some numbers of remediated sites in relevant units, would be useful to allow correlation between policy outputs and delivery plans.	29/10/2014	ORR S.Maitra	M		Tim Spink	SBP Option 2 has been adopted following approval by the ORR and Fig 9-2 shows about 10% total volume of interventions in CP5 based on the SBP top-down modelling of the earthworks asset as it stood at that time. The FDP shows 16,000 total interventions on 184,551 earthwork assets determined by bottom-up workbank development. This equates to 8.7%. The modelling will be re-run as part of the CAM development, and any differences identified from the SBP modelling will be advised as part of the CAM submission. **UPDATE FEB 06:** The predicted earthworks condition index for the remainder of CP5 will be provided as part of the CAM submission.	**No**	**Keep open until results of modelling is provided. ORR also rejects reference to ORR's "approval" (see Earthworks/073 above).** **March 2015 update : Keep open until CAM submission received and reviewed to confirm that this it addresses this item.**

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Earthworks/075	Earthworks Asset Policy	Page 109-111		A related point to the one above – 16000nr: 5ch lengths for remediation (delivery plan figure) equates to about 5% of the assets. This means an average of 300 sites /route/year for remediation, which seems very high. (note in the policy document this figure varies from 7-12 % depending on option chosen, which is higher still). Some numbers on asset remediation sites stated in the policy to allow correlation with outputs and policy would be helpful. As a separate issue do these numbers present a delivery risk? Is there a consequential increase in safety risk?		ORR S.Maitra	M		Simon Abbott	As per the Final Delivery Plan the focus is predominately on Maintenance and Refurbishment activities which are more light touch. Routes are not undertaking heavy Renewal at 300 sites per year. The detailed breakdown of intended works can be provided after the CAM submission.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
Earthworks/076	Earthworks Asset Policy	P119, 125		adverse weather/asset resilience – various references in the policy mention the importance of managing risk from these factors. It would be useful to know in due course what percentage of the total earthworks spend is targeted towards this aspect of the policy specifically e.g. the extent of instrumentation or remote monitoring utilised to help manage the risk, data collection and management initiatives etc.	29/10/2014	ORR S.Maitra	M		Tim Spink	It is currently intended that the CAM submission will separately identify works to achieve the SBP Policy committments, from additional works that may be needed to improve asset resilence.	**Yes**	**See 03/03/2015 email from J McGregor to NR's Simon Abbott (acting geotech professional head)**
EP001	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Earthworks Asset Criticality Band (EACB)	Please can you explain how the EACB bands of 1,2,3,4 or 5 have been related to the soil cutting risk model, rock cutting risk model or embankment risk model and consequence of derailment (from the CCT).	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Tim Spink	Please refer to reports "Earthworks CP5 Roadmap : Understanding Safety Risk - Development of Cutting and Embankment Safety Risk Models" (April 2014) and "Asset Criticality - Y-axis : Phase 1 Implementation of Common Consequence Tool - Earthworks" (August 2014). "	**Closed**	
EP002	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Improvement	How would NR demonstrate that the next classification system gives a 'better' segmentation of the earthworks asset than previously ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Tim Spink	NR has moved from a qualitative Condition Rating to a quantitative Hazard Index that directly relates to likelihood of failure. Please refer to report for full details: Network Rail, March 2014. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure.	**Closed**	
EP003	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Practical Impact	What does the new policy mean in practice ? for example what sites would now be identified for intervention that previously would not have been and vice-versa ? Please can you provide some real Route examples.	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Tim Spink	Will be provided under separate cover.	**Closed**	3 examples provided by NR
EP004	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED	Figure 10.1	Outputs	Condition Score – please can you explain - Current value (and derivation) - Full definition (Document M33DF ??) - what is the 'baseline' for CP5 start - what are the CP5 target values - what improvement has been achieved since the start of CP5 Please can you explain / provide the Route level values as well as National / Network level ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott	Please refer to NR/ARM/M33DF: Definitions for the Reporting of Earthworks Condition Banding (Network Rail, May 2014) for the full definition. The CP5 baseline values were stated in the Final Delivery Plan, a formal change will be advised through the DP14 update and CAM process. The CP5 target values were stated in the Final Delivery Plan, any changes from these will be advised through the DP14 update and CAM process after discussion and endorsement by NR Exec.	**Closed**	
EP005	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED and NR Delivery Plan dated 31 March 2014		Outputs	The NR Delivery Plan has a series of figures for Earthworks Condition Banding (e.g. Table 25 et seq) – how are these affected by the change in Asset Policy ? How does the new M33 relate to the 'condition banding' in the Delivery Plan ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Tim Spink	The new M33 is the Condition Banding stated in the Final Delivery Plan. The core objectives of the Policy (see section 10.1 on p121) have not changed. Parity has been retained between the old and the new systems and hence the national target volumes of interventions are retained.	**Closed**	
EP006	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED	Figure 5-17 page 57	Rock Cuttings	For rock cuttings Cat E does not seem to have a higher failure probability than Cat D. Similarly the probabilities of failure seem to be very similar for Cat B and Cat C. This seems to imply that the earthworks safety risk matrix using EHC may not be an appropriate way to prioritise rock cutting interventions. Please can you comment ? 	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Tim Spink	With reference to the answer to question 019. New metrics have been derived for soil cuttings and embankments (SCHI and SEHI) which have successfully optimised the failure probabilities for these two asset types, giving a failure probability range from category A to E of about 100. There has been no similar development of RSHI for rock cuttings at this time, and it retains its previous failure probability range of only 3. This fully explains the differences in the failure probabilities seen in Fig 5-17.	**Closed**	

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EP007	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Site Selection	At PR13 stage in 2012 / 2013 a key concern was that the SSHI was not adequately identifying the 'right' sites to remediate – primarily because the over-riding factor was rainfall. Please can you explain / demonstrate the improvement due to the revised Asset Policy ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Tim Spink	Please refer to Network Rail, March 2014. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure. The new metrics have been entirely calibrated against the CIV028 failure record, and hence they are inherently related to rainfall triggered failures.	**Closed**	Answer noted
EP008	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Average Condition	We noted that one key implication of applying a constraint of maintaining overall 'average' condition leads to Routes with 'poor' start condition earthworks improving and Routes with 'better' start condition earthworks being allowed to deteriorate. We had concerns that this constraint seemed to suggest that the condition of earthworks in Scotland (which have the second highest number of failures) will overall deteriorate in CP5 – CP11. Please can you explain how this is addressed in the revised Policy ? We were also unclear that allowing this deterioration complied with Statutory Obligations under ALARP principles. Please can you comment ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott/ Tim Spink	This will be addressed in the CAM submission when the modelling will be re-run as part of the CAM development.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP009	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Progress in first 2 years of CP5	What evidence is there that the risk level has been reduced by the CP5 Asset Policy ? (Dec 2012 version)	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott/ Tim Spink	The condition and risk profile of the earthworks asset will be first revealed on completion of the current earthworks examinations season.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing development**
EP010	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED			What evidence is there that the CP5 Asset Policy has been / is being implemented in practice ? (Dec 2012 version)	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott	The Assurance carried out as part of CAM development and emerging period reports has satisfied NR that the Policy is being appropriately implemented. UPDATE: This report - referenced as 14 in above list - was sent to ORR on the 2/12/14. It was later provided to ARUP on the 18/12/14.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP011	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED			How has feedback on practical implementation been taken into account in the update ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott	Policy update has not been a complete rewrite but an update of key sections around 5x5 matrix, EHC and EACB. The core objectives of the Policy (see section 10.1 on p121) have not changed. However, the tool provided to the routes for workbank development (Powerpack) has been rebuilt for CAM development taking into account route feedback.	**Closed**	
EP012	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED			What sample sites been considered to look at the actual effect of the revised policy ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott	Initial site visits have been undertaken as part of the Corporate Engineering Verification process.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP013	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED			Have the targets proposed for the first years of CP5 been achieved at a Network and Route level ? • Asset Condition Reliability – Number of Earthworks Failures (Delivery Plan Table 24 et seq) • Asset Condition Sustainability – Earthworks Condition Banding (Delivery Plan Tables 25 et seq) • Renewals Volumes (Delivery Plan Tables 32 et seq) How has the risk level changed ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott	In progress.	**Pending**	**Noted that this is to be considered by NR in due course as part of future developments**

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EP014	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Tier 1/2 Modelling	We note that the Dec 2012 Asset Policy was based on extensive modelling. How do the Policy changes (e.g. EHC and EACB) affect that SBP Modelling and the original basis for the proposed intervention policy ? (Tier 1 / 2 Earthworks SCAnNeR etc.) How has this output been updated ?	10-Nov-14	Indep Reporter Team DMR	H	24/11/2014	Simon Abbott	The modelling will be re-run as part of the CAM development, and any differences identified from the SBP modelling will be advised as part of the CAM submission.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP015	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	1.1		Could NR confirm the level of analysis carried out on rock slopes.	13-Nov-14	Indep Reporter Team APW	M	24/11/2014	Tim Spink	Please refer to Network Rail, March 2014. Generation, Analysis and Application of New Hazard Index for Likelihood of Earthwork Failure. There has been no analysis or optimisation of RSHI at the present time, only a splitting of Marginal into two bands to achieve the 5 point EHC scale.	**Closed**	
EP016	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	2.2/2.3		The reduction of data to allow analysis is described. It is indicated that data on broadly 18% of soil cutting failures and 12% of the soil embankment failures was used due to missing inspection information. What is the impact of this reduced data sample on the analysis presented ?	13-Nov-14	Indep Reporter Team APW	M	24/11/2014	Tim Spink	See reply to question 054. Statistical methods were adopted to make best use of the available data.	**Closed**	
EP017	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	2.2/2.3		Can more information be provided on the source of missing data? Is this an historic problem ?	13-Nov-14	Indep Reporter Team APW	M	24/11/2014	Tim Spink	The earlier records have the highest proportion of missing data.	**Closed**	
EP018	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	5.1		Could NR provide some examples of the parameter categorisation to confirm our understanding of the process described. How might the reduced failed data sample have affected this process?	13-Nov-14	Indep Reporter Team APW	L	24/11/2014	Tim Spink	Further clarification of the question required.	**Closed**	NR provided further information at meeting on 5 Dec 14. Examples of the calculation used to assess parameter correlation were provided and clarified the method. Limited data set constrains the analysis
EP019	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	8.1		Can NR provide the basis for the approach described using smoothed bootstrapping to 'repopulate data gaps'. Also on what basis is noise assumed to normally distributed and how does this noise reflect on the scoring (weightings) described earlier.	13-Nov-14	Indep Reporter Team APW	L	24/11/2014	Tim Spink	See answer to question 054.	**Closed**	NR provided further information at meeting on 5 Dec 14. NR described the 'kernel density estimation' (KDE) approach adopted to bootstrap the dataset. Approach has enabled an interpretation of the dataset to be made and taken forward to an improved SSHI
EP020	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	9.1		Would NR demonstrate the determination of failure probabilities to check our understanding For example Fig 9.4 indicates that 0.4% of all cuttings and 7.2% of failed cuttings are within HI category E, and Fig 9.5 / Table 12.1 show the annual failure probability of 1.12%. Using these figures directly suggests a higher annual failure probably based on the totals of assets indicated in Section 2.	13-Nov-14	Indep Reporter Team APW	L	24/11/2014	Tim Spink	The failure probabilities were derived by the method stated in Section 8 of the report, including the use of the bootstrapping process, and cannot be simply derived from numbers given on the plots in the report which are also the result (not the input) to the bootstrapping process. However, the key factors missing from the calculations that we suspect that you have carried out are: a) the time interval of the CIV028 observations, this must be used to normalise the outputs to achieve the annual failure probabilities b) the bootstrapped failed and nonfailed asset population distributions	**Closed**	NR provided further information at meeting on 5 Dec 14. NR described how the CIV28 failure records were reviewed and aligned to the asset data. This matching process reduced the number of failed assets used in the analysis to that indicated in the report. The failure probability estimations presented aligns to the revised CV028 records.
EP021	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	10		Figures 10.1 and 10.2 suggest that more failures occur in new HI category C. Why?	13-Nov-14	Indep Reporter Team APW	M	24/11/2014	Tim Spink	The shape of the failure distribution in the validation test is the same as in the main analysis. Compare Fig 10.1 and 10.2 with 9.4 and 9.10 which gives us confidence that the results are generally applicable.	**Closed**	
EP022	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	12		What is the impact on expected costs of managing the asset given the changes in categorisation?	13-Nov-14	Indep Reporter Team APW	H	24/11/2014	Simon Abbott / Tim Spink	Any changes in costs due to the re-categorisation are likely to be small due to the process adopted of retaining parity between the old and new systems.	**Closed**	

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EP023	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF	12	1f	Please can you explain this statement and its relevance	13-Nov-14	Indep Reporter Team APW	M ?	24/11/2014	Tim Spink	Refer to answer to question 020.	**Closed**	
EP024	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF		Statistical Ap	Could NR provide information on the alternative methods that were considered to correlate earthwork failures with asset information other than the one selected?	12-Dec-14	Indep Reporter Team APW	L	06/01/2015	Tim Spink	As stated in the meeting of 5 December 2014, we considered using multiple regression or neural network analysis, but these were rejected in favour of the adopted approach as they were considered to be too "black box" and would not stand up to challenge from the Panel of Experts	**Closed**	Noted
EP025	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF		Statistical Ap	Which additional data would be necessary to improve the HI approach? Are there factors not represented in the SSHI information that may be important to determination of failure likelihood?	12-Dec-14	Indep Reporter Team APW	M	06/01/2015	Tim Spink	All factors included in SSHI were included in the analysis for SEHI and SCHI. The fundamental approach was to use all existing parameters so that the new metric could be back propagated through the historical data.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing policy development**
EP026	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF		Statistical Ap	The analysis appears to focus on precursor indicators. How have the records of the failure events (if they exist ?) been used in the assessment ? Are there additional factors that should be included in asset grading (SSHI) to accommodate these factors ?	12-Dec-14	Indep Reporter Team APW	M	06/01/2015	Tim Spink	As stated in the meeting of 5 December 2014 all of the records of failure that could be both located and had a pre-failure examination with EHC parameters were used to calibrate the new metrics. See also answer to question EP025, the metric was required to be backward compatible, so that it could be applied to the historic data.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing development**
EP027	Strategic Business Plan (page 41) compared with Delivery Plan Table 32		Outputs	We note that the volumes for earthworks renewals in the Delivery Plan dated 31 March 2014 (16,077 5 chain lengths) appear to be lower than the volumes stated in the Strategic Business Plan (17,757 5 chain lengths). Please can you confirm the logic for this and provide evidence that the outputs will still be achieved with this reduced volume of renewals ?	12-Dec-14	Indep Reporter Team DMR	H	06/01/2015	Tim Spink	SBP volumes were determined by top down modelling. FDP volumes were determined from detailed bottom-up workbanks. The workbanks are currently being updated for the CAM submission. Prior to this submission the predicted outputs will be determined by modelling.	**Closed**	Noted
EP028	NR New Hazard Index Addendum Report		Additional R	When will this Addendum report be available to review ?	12-Dec-14	Indep Reporter Team	M	06/01/2015	Simon Abbott	Currently anticipated to be February 2015.	**Pending**	**Report awaited**
EP029	Safety Risk Adendum_v1 Report	Foot note page 6	Additional R	Can we have a copy of the report: Earthworks CP5 roadmap: understanding safety risk - embankment risk model (Feb 13)?	12-Dec-14	Indep reporter team	H	06/01/2015	Simon Abbott	Provided by email on the 17/12/14 - see referenced document 15 from list at top.	**Closed**	Document provided
EP030	2014-02-10 NR-Arup - Earthworks CP5 Roadmap_ Review of Asset Criticality (Safety)	Page 4 (Section 1.1)	Additional R	Can we have a copy of the report: Earthworks CP5 Roadmap – Performance Risk Feasibility Study and Preliminary Performance Risk Model, February 2014?	12-Dec-14	Indep reporter team	H	06/01/2015	Simon Abbott	Provided by email on the 17/12/14 - see referenced document 16 from list at top.	**Closed**	Document provided
EP031			Additional R	We have found it challenging to understand how all the various reports and initiatives fit together. Are there any other reports that are relevant, or perhaps executive summary that provides overview of the significant body of work undertaken by NR	12-Dec-14	Indep reporter team	H	06/01/2015	Simon Abbott	Ultimately the Policy document is the single document, backed up by the Standards.	**Closed**	NR to consider for future reviews how an overview of the changes can be communicated to the Reporter
EP032	Delivery Plan	Table 32	Outputs	What renewal volumes have been delivered so far in CP5 for earthworks ? How do these compare with the planned civils renewal volumes in the first year of the Control Period ? (April 2014 – March 2015) - i.e. are NR on target to deliver the planned volumes in 2014/15 ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott	Quarterly reporting of cost and volumes are provided to the Regulator. The ORR will see the RF9 submission. This will detail a level of granularity that that has previously been agreed	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing development**
EP033	Delivery Plan	Table 32	Outputs	What is the split of the planned national renewals between the Policy intervention categories of: Maintain, Refurbish and Renew ? (by year in whole of CP5)	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott / Tim Spink	The workbanks are currently being revised for the CAM submission, the requested detail could be provided once the CAM submission has been issued. The assurance report (referenced document 14 at top of page) details the Intervention breakdown of each Earthwork Type for each Route as it currently stands - this may not represent the final submission.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing development**

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EP034	Delivery Plan	Table 32	Outputs	What is the split of the actual national renewals between the Policy intervention categories of: Maintain, Refurbish and Renew ? for 2013/14 and to date in 2014/15 ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott	Quarterly reporting of cost and volumes are provided to the Regulator. The ORR will see the RF9 submission. This will detail a level of granularity that that has previously been agreed. The answer to EP0033 is also applicable here - but noting that the assurance report is in progress.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing development**
EP035	Delivery Plan	Table 24	Outputs	The Delivery Plan includes a reliability indicator for earthworks in terms of 'earthworks failures'. Please can you confirm that the target values in Table 24 of the Delivery Plan are still current ? Can you also provide numbers of earthworks failures for 2013/14 and to date in 2014/15 ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott / Tim Spink	The reliability indicator for earthworks will be reassessed as part of the CAM submission. Earthwork failures in 13/14 were 127. Failures to 19 December 2014 in 14/15 are 23. It should be noted that the reliability indicator is a measure and not a target.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP036	Delivery Plan	Table 25	Outputs	The Delivery Plan includes a sustainability indicator for earthworks in terms of 'condition banding'. Please can you confirm that the target values in Table 24 of the Delivery Plan are still current ? Can you also provide condition banding figures for 2013/14 and to date in 2014/15 ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Tim Spink	The condition band indicator for earthworks will be reassessed as part of the CAM submission.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP037	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED	Figure 6-2	Outputs	Figure 6-2 provides a useful summary of the number of earthworks assets in each category of the safety risk matrix currently. Can NR please provide a similar matrix for the planned outcome at end CP5 ? Can NR please provide similar matrices for the previous classification system (2 May 2014 data and end CP5) ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Tim Spink	The predicted condition banding at the end of CP5 will be assessed through modelling as part of the CAM submission.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing CAM development**
EP038	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Policy Implementation	Ref EP010 - At the meeting on 25th November, NR undertook to provide their NR interim assurance report by COB 3/12/14 - we believe that this is still awaited at 12 Dec 2014	12-Dec-14	Indep reporter team	H	06/01/2015	Simon Abbott	This report was issued to the ORR on the 3/12/14 (reference document 14 above). This was forwarded to Arup on the 18/12/14.	**Closed**	Document provided
EP039	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Feedback on Policy Application	Further to Qn EP011 we take the answer as being that feedback on practical implementation has not yet been collected, evaluated and used to update the Asset Policy. Please can you confirm our understanding / or provide details of the feedback ? Please can you confirm when this feedback will be available and reviewed by NR ?	12-Dec-14	Indep reporter team	H	06/01/2015	Simon Abbott / Tim Spink	Assurance visits have been carried out and the outcome from these will feed into the development of CP6 Policy. The driver for updating the policy document is to include the new 5x5 matrix, introducing EACB and EHC. The update has not changed the overall objectives of the policy or applicable interventions that are available. Answer to EP034 is also applicable here.	**Closed**	NR to consider the implications in future developments
EP040	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Practical Impact	Further to Qn EP003 *'What does the new policy mean in practice ? for example what sites would now be identified for intervention that previously would not have been and vice-versa ? Please can you provide some real Route examples. '* - please can you confirm when this information will be made available ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott	Will be provided under separate cover in due course.	**Closed**	Refer to EP003
EP041	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Practical Impact	The 'y-axis' report has some useful 'spot checks' (Asset Criticality – Y-axis: Phase 1 Implementation of Common Consequence Tool – Earthworks - pages 39-42) - have similar check been undertaken on the new Risk Matrix to check reasonableness of changes to some specific sites ?	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott	Will be provided under separate cover in due course.	**Closed**	Examples provided by NR
EP042	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF		Rock Slopes	We note that the analysis has not included Rock Slopes. What are the plans and timescales for undertaking similar for rock slopes?	12-Dec-14	Indep reporter team		06/01/2015	Simon Abbott	A review of RSHI will initially be considered as part of the scope for CP6 Policy development. This intial review is likely to take place in 2015.	**Closed**	NR to consider in future developments

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EP043	Powerpack version 5 User Manual rev 09 AS ISSUED 2014_08_13		Policy Applic	We note that the focus of the Policy update has been around safety risk which is very positive. However, NR also has an obligation to meet various train performance regulated outputs and this will mean that some performance related interventions may be required by the Routes. Please can you explain how this is to be managed ?	12-Dec-14	Indep reporter team	H	06/01/2015	Simon Abbott / Tim Spink	Performance issues relating to Geotechnical assets are typicaly pre-cursors to safety events. An embankment with frequent rough rides, assocaited with the embankment, are typically associated with a gradually failing slope. This would be identified from a ground investigation and monitoring. Even if unaligned to the Policy intervention matrix the policy allows for flexibility outside of normal renewal areas. The intervention matrices in the Policy are provided as a tool to the routes, but they are always permitted to address any issues that may not be Policy aligned if justification can be provided.	**Closed**	NR to consider the implications in future developments
EP044	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF and Asset Criticality – Y-axis: Phase 1 Implementation of Common Consequence Tool – Earthworks		Parity	Further to Qn EP005 - please could you explain whether parity of target volumes been retained between Routes or simply at a National Level ?	12-Dec-14	Indep Reporter Team	M	06/01/2015	Tim Spink	Parity means - we have kept the total national number of assets the same in each category. Asset volumes may change at route level.	**Closed**	
EP045	NR_New_Hazard_Index_Report_rev03c_2014-03-31 AS ISSUED.PDF and Asset Criticality – Y-axis: Phase 1 Implementation of Common Consequence Tool – Earthworks		Parity	From discussions we understand that the 'parity' assumption has been adopted as an 'interim' measure. Please can NR explain how they intend to develop / review this going forward and the anticipated programme for such review ?	12-Dec-14	Indep Reporter Team DMR	M	06/01/2015	Simon Abbott / Tim Spink	This is not a correct statement. The parity approach is integral to the change over between the old and the new metrics. In time natural shift in the portfolio will occur as more inspections are undertaken.	**Closed**	
EP046	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Parity	If parity has been maintained at national level how are the volumes at route and/or earthwork type affected ?	12-Dec-14	Indep Reporter Team DMR	M	06/01/2015	Tim Spink	The earthworks Policy and commitment to sustain condition is a National Policy and commitment. Volumes change route by route.	**Closed**	
EP047	Earthworks_Policy_2014_Update_Rev_09t_2014-08-22 AS ISSUED		Parity	How does the omission of rock slopes affect the parity of the work banks?	12-Dec-14		M	06/01/2015	Tim Spink	There is no change in the way rock slopes are managed.	**Closed**	NR to consider the implications in future developments
EP048	Data Quality Report (Earthworks data quality report_rev02d_2014-01-30 FINAL)		Data Quality Improvement	Please would you confirm this constitutes your data improvement plan ? What progress is being made with the issues and resolutions listed in the report? Have any other Data Quality reviews been undertaken ? (we note that the DQ report provides limited information on overall “data quality” focussing on a collated list of consistency issues.)	12-Dec-14	Indep Reporter Team	H	06/01/2015	Simon Abbott	This report provides a snapshot of the data quality at the time it was produced. The NR Exec have currently put CSAMS on hold until Jan/Feb. The Asset Data Improvement Programme (ADIP) will look to address these issues during data migration. When CSAMS is up and running live data quality reports will be available for key attributes of asset data.	**Pending**	**Report awaited**

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EP049	Data Quality Report (Earthworks data quality report_rev02d_2014-01-30 FINAL)		Data Quality	The DQ Report identifies a number of issues (for example s - Issue 21 34% coverage missing?) - How is this likely to impact on the selected policy approach ? How will this be considered going forward ?	12-Dec-14	Indep Reporter Team	M	06/01/2015	Simon Abbott	In October a presentation was previously provided to ORR following a meeting in Kemble St. This was sent to Arup on the 18/12/14. Following updated 065 standard some key changes to terminology were introduced. Never Inspected was introduced to show the extent of network where no record exists within JBA of whether an earthwork is present or not. In October this was 19% - but this includes a number of 'never inspected' sites in some Routes that have converted 030 records to 065 records. Anglia are an example where the Route has been walked but electronic records do not justify a complete asset inventory.	**Pending**	**Noted that this is to be considered by NR in due course as part of ongoing development**
EP050	2013-11 ArthurDLittle [Phase 2] - Establishing a Common Risk Scoring Matrix for Safety across Network Rail		Common Consequence Tool	To what extent has the ADL report and tool been reviewed and approved by NR Safety Team and/or external reviewers ? (2014-02-10 NR-Arup - Earthworks CP5 Roadmap_ Review of Asset Criticality (Safety), Section 4.2.1 indicates that the model is being fully tested by NR) - please can you provide evidence of this review ?	12-Dec-14	Indep reporter team	H	06/01/2015	Juliet Mian / Simon Abbott	NR S&SD team have an ongoing commission (to be completed early 2015) reviewing the CCT. It is important to note that in the earthworks policy, EACB (which contains an element of CCT) has been used as a prioritisation measure, i.e. the absolute values of FWI calculated are not used directly, only to rank earthworks , therefore the testing of the logic and the spot checks of sites presented in the CCT Implementation report are evidence of review.	**Closed**	Noted
EP051	CCT Implementation Phase 1_Issue1		CCT Implementation	We note that this is the first asset application of the CCT. To what extent have the CCT authors (AD Little) been involved in implementation / review of the application of their tool ?	12-Dec-14	Indep reporter team	H	06/01/2015	Juliet Mian	The steering group for the current CCT review (see answer above) comprises representatives from ADLittle and the RSSB as well as NR stakeholders. ADLittle are aware of the implementation but do not have asset domain knowledge or experience of data sources which are the key components of the implementation,	**Closed**	Noted
EP052	CCT Implementation Phase 1_Issue1	Slide 48+49	CCT Implementation	It is very positive that next steps and recommendations are identified. How important are these and if so when are they to be addressed? Is there an update to the CCT to incorporate the points raised?	12-Dec-14	Indep reporter team	M	06/01/2015	Juliet Mian	See reply to question EP050. A review and update is in progress, covering: stakeholders, technical aspects, IT solutions and data.	**Closed**	Noted
EP053	CCT Implementation Phase 1_Issue2	Section 5	CCT Implementation	We note that the y-axis has been constrained to maintain parity to the delivery plan. This is similar to the approach used to establish the x-axis. When is this to be updated to follow the recommendations of the report?	12-Dec-14	Indep reporter team	M	06/01/2015	Simon Abbott	Future development is recommended before the Common Consequence Tool is rolled-out as a fully-functioning cross-asset tool. As previously mentioned in EP051 response the NR S&SD team have an ongoing commission (to be completed early 2015) reviewing the CCT. A period of stability to allow embedment for both EABC and EHC are considered essential.	**Closed**	NR to consider in future developments
EP054	Safety Risk Addendum_v1	Foot note page 6	Data	Can NR confirm that the adjustments made to the CIV028 data referred to in the 5 Dec meeting are reflected in the determination of p(derailment / failure) assessment?	12-Dec-14	Indep reporter team	M	06/01/2015	Juliet Mian	p(derail|fail) was based on derailment and failure statistics up to 16 February 2014. Updated stats will affect the calibration of p(derail|fail) to get a quantified probability for each category, but will not impact on the expert panel input to rank earthworks, and will not therefore impact on the bands used in the Policy matrix. We will undertake a comparison using the latest cleaned up data, in due course.	**Closed**	Noted