RAIB

Rail Accident Investigation Branch

Rail Accident Report

Network Rail's Management of Existing Earthworks

Department for Transport

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This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Network Rail's Management of Existing Earthworks

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Introduction

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

3 Access was freely given by Network Rail and Rail Safety and Standards Board (RSSB) to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain the following glossaries:

- acronyms and abbreviations are explained in Appendix A; and
- technical terms (shown in *italics* the first time they appear in the report) are explained in Appendix B.

Summary of the report

5 Previous RAIB investigations into three accidents where *earthworks* failures were significant causal factors raised a broader question regarding the current state of the earthworks on the national rail network.

6 This investigation was carried out to address this broader question and not, as is more common practice for the RAIB, in response to a specific incident. The format is therefore that of a technical review of the current status and practice within Network Rail.

7 This investigation:

a) considered whether the risks were being adequately identified and managed;

b) identified whether there was any evidence of an undesirable trend in the incidences of major earthworks failures;

c) considered the accuracy and effectiveness of Network Rail's *technical assessments*, and

d) compared Network Rails' systems with other infrastructure owner's earthworks management systems.

8 The investigation reviews the development of earthwork related Group Standards and Network Rail company standards, and considers failure data statistics, to the end of the 2007/8 year.

9 The investigation considered evidence and information from a wide range of sources. Incident and failure data was obtained from Network Rail; interviews were conducted with senior managers in Network Rail and sample interviews were carried out with staff in permanent way maintenance who are instrumental in *Safety of the Line* activities.

10 The RAIB engaged a specialist consultant to assess the technical processes used by Network Rail and also to consider how those processes and practices compare with other infrastructure sectors.

Conclusions

11 The number of data points available for analysis of failure trends is small. An increase in the number of earthworks-related failures can be observed over recent years. However, this is too small to be statistically significant and may be the result of ongoing improvements in reporting within Network Rail.

12 There has been no fatality attributed, either directly or indirectly, to an earthworks failure since 1995.

13 The degree of implementation of the latest Network Rail standards varies across the *territories*. This is related to the extent to which the previous issues of the Network Rail standards were being operated.

14 Recent earthworks statistics indicate a greater prevalence of failures in cuttings than embankments. There is witness evidence that this may be influenced by the greater focus given to embankment defects and maintenance by local track maintenance teams as a result of embankments' direct influence on the track support.

15 The approach to earthworks management taken by Network Rail is comparable or better than other industries with similar earthworks.

16 The practical understanding of climate change and its effect on railway infrastructure is currently limited. There are no actions at present to change procedures for the management of earthworks as a result.

17 There is inconsistency in the application of earthworks management systems across Network Rail. The systems' effectiveness at any one location appears to be highly dependent upon local practice.

18 Staff who hold Safety of the Line responsibilities use their local knowledge and experience to mitigate the risk to the operational railway. Whilst there is some information provided to track inspection staff during initial training about observing and identifying earthworks problems, there is no defined reporting procedure for earthworks issues detected during track inspection.

Recommendations

19 Recommendations can be found in paragraph 192. They relate to the following areas:

- work by Network Rail to understand the sensitivity, accuracy and effectiveness of the inspection process and assessment *algorithm* in mitigating the risk from earthworks failure;
- improving the consistency of application of good practice seen during this investigation;
- provision of guidance to staff in regard to the railways' neighbours;
- alignment of procedures which define the actions to be taken in adverse weather; and
- communications between civil engineering, maintenance and operations**.**

Earthworks investigation

20 The RAIB has previously investigated incidents at Oubeck in November 2005 (RAIB report 19/2006) and Moy in November 2005 (RAIB report 22/2006). The investigation into the derailment at Kemble on 15 January 2007 (RAIB report 07/2008)[1] found features in common with these earlier incidents, relating to earthworks.

21 All three incidents were initiated by earth slope failures and resulted in passenger train derailments. Each was an unexpected cutting failure and involved:

- a recent period of localised extreme weather;
- deficiencies in the performance of the local drainage systems at the site; and
- surface water standing on, or flowing from, adjacent non-railway land.

22 As a result the RAIB decided to investigate the overall Network Rail process for the management of its earthworks.

23 The scope of this investigation addresses the following questions:

a) Does the available evidence indicate an increasing number of safety related incidents occurring as a result of earthworks failures?

b) Are the earthworks management systems used by Network Rail appropriately identifying the safety risk?

c) Do the technical procedures used by Network Rail adequately categorise the safety risk from earthworks to allow appropriate mitigation?

d) How do the processes and systems used by Network Rail compare with those used by the owners of other, similar infrastructure?

e) Is there any evidence of climate change affecting the behaviour of earthworks and if so how is Network Rail addressing this?

f) Does the Safety of the Line management system recognise and adequately deal with issues from earthworks?

g) Are processes within the earthworks management and Safety of the Line taking appropriate cogniscence of issues outside the Network Rail boundary?

h) How is the risk from earthworks failure managed in the event of extreme weather? Is the earthworks management input to extreme weather management plans appropriate?

24 The management of Safety of the Line is fundamental to the safe operation of the network. This responsibility is placed predominantly on permanent way staff and discharged through their inspection and maintenance duties. This investigation considered whether earthworks risks are being considered within this process, in such a way as to understand and control the effect of a failure on the infrastructure. Relationships between Safety of the Line staff and other specialist engineering teams were also considered.

25 Earthworks issues which the RAIB had identified during the Kemble investigation were further examined within this investigation.

26 The purpose of the RAIB investigation was to understand the Network Rail arrangements for the management of the earthworks on its infrastructure and recommend improvements as necessary to improve railway safety.

[1] RAIB reports are available at www.raib.gov.uk

Sources of evidence

27 Evidence for the investigation was obtained from:

- relevant Network Rail standards;
- interviews with key local and HQ Network Rail civil engineering staff;
- information gathered as part of previous RAIB investigations into earthworks related incidents;
- interviews with a sample of Network Rail Safety of the Line staff, maintenance managers and engineers;
- an independent technical review of the earthworks management process and in particular the current standards NR/SP/CIV/086 and NR/SP/CIV/065;
- data and event records obtained from Network Rail;
- climate change project status reports from the Rail Safety and Standards Board (RSSB); and
- a review of the earthworks content of track inspection training courses and discussions with training staff relating to this.

Earthworks Performance

Background and Standards

British Rail Earthworks Management

28 Prior to rail privatisation, British Rail did not have a national strategy for the management of earthworks. A small, centralised technical resource was available to support local *permanent way* managers, by providing specialist support such as testing, analysis, interpretation and design capability. The local permanent way organisation was responsible for the safety of the operational railway infrastructure and part of this was the inspection and minor maintenance of track *formation*, drainage and earthworks.

29 Local permanent way teams were larger than in recent years and were required to maintain a broad range of infrastructure, including fencing, drainage and vegetation and to carry out vermin control.

30 The local permanent way teams routinely monitored identified problems with earthworks, carried out remedial works as far as they were capable and used specialist resources in a reactive manner when problems arose.

31 When geotechnical requirements extended beyond the control, resources or understanding of the local team a request for specialist assistance would be made, initially through the *Regional Civil Engineer's* organisation.

Railtrack / Network Rail Earthworks Management

32 After rail privatisation, Railtrack carried out its infrastructure maintenance, primarily using external contractors through *infrastructure maintenance contracts*. These contracts focussed on predictable day-to-day activities associated with track and signalling. In an attempt to make the maintenance contracts as efficient as possible, many specialist activities, such as structures inspections and related reactive works were placed outside their scope.

33 At that time the overarching management requirements for earthworks were specified in a *Railway Group Standard* GC/RT 5151 "Safe Asset Management – Embankments and Cuttings", which was first issued in 1996. This Group Standard set out the generic principles for categorising, recording, examining and *evaluating* earthworks. The details and criteria to be applied were to be determined by the *infrastructure controller*.

34 The management of earthworks was a direct responsibility of the Railtrack *Zone* organisations, with consultants being engaged by the Zone technically specialised work.

35 The responsibility for earthworks *stewardship* varied from zone to zone; generally being allocated to the track engineer or structures engineer. Budgetary provisions remained similar to BR's and focussed on remedial works to address emerging problems.

36 During the period post privatisation a number of earthworks failures occurred which it was considered may have been preventable had an earthworks inspection and assessment regime been in operation.

37 Railtrack recognised this, and employed consultants to develop a method of examination and evaluation of earthworks. This resulted in the issue of the company procedure RT/CE/P/030 "Management of embankments and cuttings" in 1997. This procedure defined *relevant earthworks* as those greater than 3 m in height, and those below this height which were known sites of instability. The procedure required these earthworks and their associated drainage to be physically examined and then assessed for condition in accordance with the prescribed marking scheme. The output from this was also used to determine the requirement for any further evaluation of the earthworks.

38 This procedure was intended to provide a means of readily comparable results. However, implementation of the company procedure was varied and inconsistent.

39 Railtrack North West was the first to appoint a Regional Earthworks Engineer in 2000. This was partly as a consequence of an incident at a site that had previously been inspected, but not acted upon. This particular appointment carried responsibility for asset stewardship within that Region[2]. Other Regions followed with the appointment of earthworks engineers, but not all positions carried stewardship responsibility; some were in house specialist advisors.

40 Issue 2 of RT/CE/P/030 was produced in 2002 and additionally covered the "Management of Embankments, Cuttings & Natural Slopes". This procedure introduced the concept of a classification system for each earthwork element as 'poor', 'marginal', or 'serviceable'. Later these terms were defined during the development of Network Rail[3] standard RT/CE/S/065 (paragraph 41) RT/CE/S/030 prescribed *examination frequencies* of 1, 5 and 10 years respectively, with maximum permitted increases to *inspection intervals* of 4, 6 and 12 months respectively.

41 The process was further refined, and in June 2005 RT/CE/P/030 issue 2 was withdrawn and the technical elements included in RT/CE/S/065 (now designated NR/SP/CIV/065) "Examination of Earthworks". A key feature of the new standard was the inclusion of the *Slope Stability Hazard Index*.

42 The Slope Stability Hazard Index is a value generated from the methodology in RT/CE/S/065 that is used to assess earthwork failure risk. The process uses an algorithm to generate a value indicating relative risk based upon possible failure modes. Defined data, such as slope angles, drainage, vegetation, are collected, by measurement or observation, during the inspection of an earthwork and these are used as inputs to the algorithm. The output is a numerical value which is used to categorise the earthwork as 'poor', 'marginal', or 'serviceable' by comparison with predefined bands.

43 The *Soil Slope Consequence Index* is a mechanism to provide a further level of risk differentiation between slopes assessed as being in otherwise similar condition. It uses parameters associated with the operating railway to assess the risk to trains.

44 The overall Soil Slope Risk Factor is the multiple of Slope Stability Hazard Index and Soil Slope Consequence Index.

45 A graphic representation of the relationship and development of the standards is provided in Figure 1.

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[2] Zones became Regions under Railtrack and Territories under Network Rail.

[3] Network Rail took over ownership of the railway infrastructure from Railtrack in 2002.

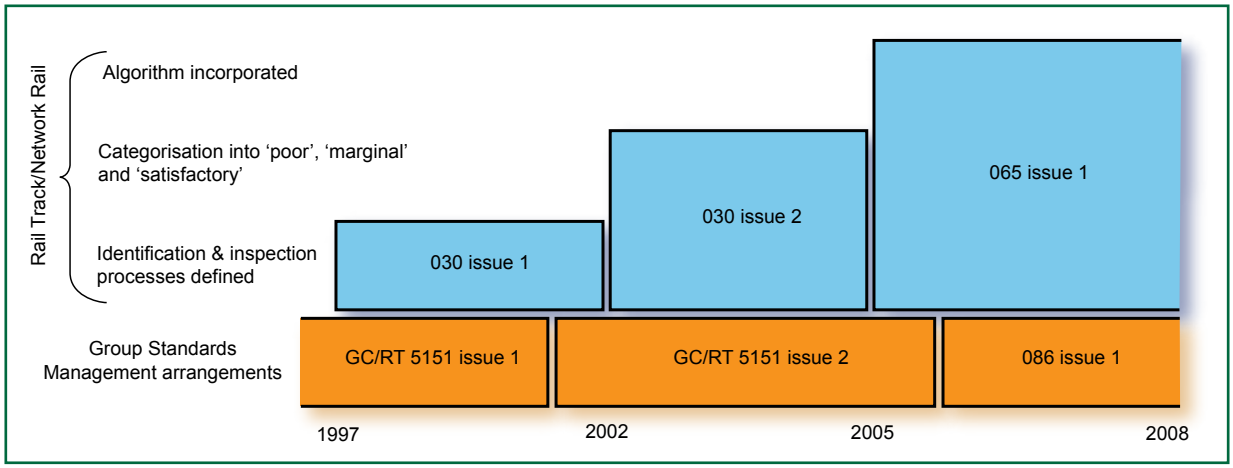

Figure 1: Chronology of Earthworks Standards

46 As more comprehensive records became available, and the extent and cost of physical works became visible, the Regions, now known as Territories, appointed their own in-house management teams and engaged *term-contractors* for earthworks inspection and *framework contractors* for physical remedial works. These teams are now led by Territory Earthworks and Drainage Engineers, and include specialists in the fields of both drainage and earthworks renewals.

47 RT/CE/S/086 "Management of Existing Earthworks" (Figure 1) was first issued in June 2005 with a compliance date of 1 April 2008. This standard specified the arrangements within Network Rail for the management of earthworks and replaced the management requirements of RT/CE/P/030 issue 2 and the Group Standard GC/RT 5151 issue 2 which were withdrawn. RT/CE/S/086 had an *implementation* date of June 2005 and a *compliance* date of April 2008.

Kemble earthworks failure

48 The RAIB report (paragraph 20) comprehensively describes the incident which occurred on 15 January 2007 at Kemble, where a First Great Western class 158 diesel multiple unit was derailed following a cutting slope failure and subsequent wall collapse.

49 Recommendations were made in the investigation report to address issues other than those associated with earthworks.

Key features of the failure

50 At the Network Rail boundary, there were the remnants of a crest drain. The history of this crest drain was not known by Network Rail and there are no records of it.

51 The adjoining land, from the crest to a road running almost parallel to and approximately 70 m east of the railway, was waterlogged, with standing water or wet mud over most of the width. The adjoining land does not belong to Network Rail.

52 Examination records for this section of the cutting show that it was examined on three occasions; 6 June 2001, 20 November 2002, and 6 January 2004.

Conclusions

53 After the 2004 inspection the slope at Kemble had been reclassified from "poor" to "marginal" as a result of clearing vegetation from the area above the wall. This moved the cutting from a yearly inspection frequency to a five-yearly inspection frequency with the next inspection due in 2009. If the cutting had remained classified as "poor" it would have received at least two more annual inspections in the years leading to the date of the failure.

54 The adjacent land was severely waterlogged and this almost certainly contributed to the slope failure. The nature of the clay material and the steepness of the cutting slope made it susceptible to a *slip failure.* No record of this standing water was made during any of the inspections. Therefore it is not possible to determine whether the water was present at the time of any of the inspections**.**

55 The crest drain had not been maintained for many years. It can reasonably be assumed that the drain was originally installed following recognition of the risk from a high water table at the cutting crest. The fact that the drain was not functioning would have increased the risk created from a high water level at, or behind, the crest.

Trends in Earthworks Failures

56 The data in the following table was provided by Network Rail. National data in this format started to be collected during 2003/4. Information prior to 2003 is considered to be less accurate and consistent, because of the varied regional systems for collection of relevant data in use at that time.

57 The data available for 2003/4 (the first year) is not as complete as that for later years and detailed analysis by Territory and failure type for this year is unreliable.

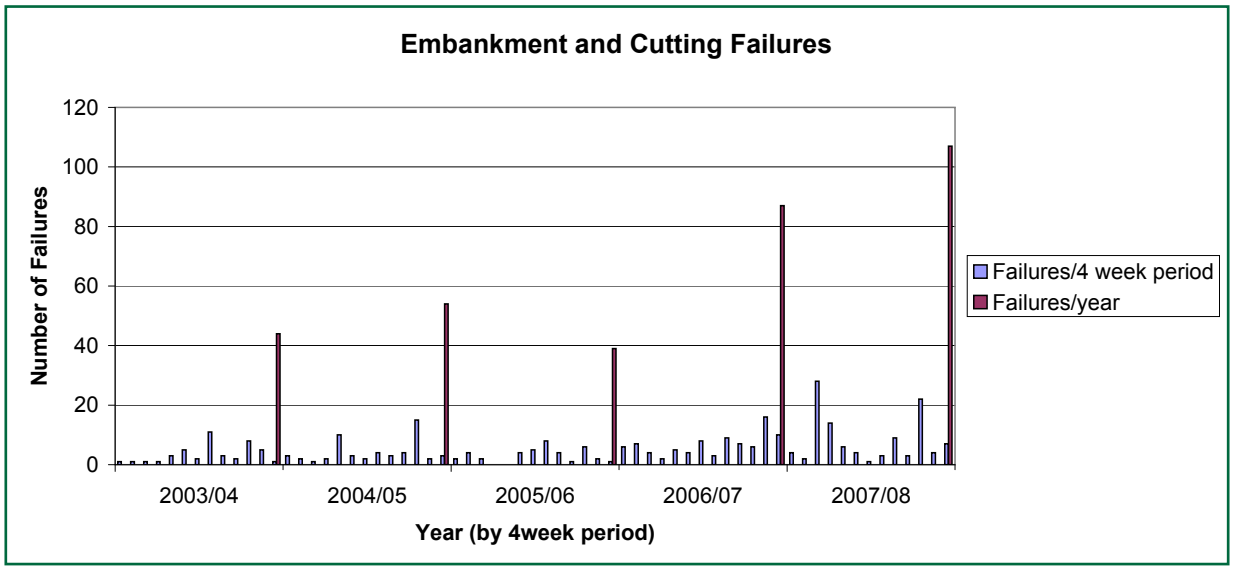

Figure 2: 2003 to 2008 Network Rail recorded earthworks failures

58 In the period covered by this data, train derailments attributed to earthwork failure were:

- 1 in 2003/4 – rock fall;
- 1 in 2004/5 – embankment slip;
- 2 in 2005/6 – 1 cutting slip and 1 cutting *washout*;
- 3 in 2006/7 – 1 cutting washout and 2 cutting slips; and
- 0 in 2007/8.

59 The last fatality related to an earthwork failure was in 1995, when a derailment occurred on the Settle and Carlisle line and a member of the *traincrew* died in a subsequent collision with another train. Her Majesty's Railway Inspectorate (HMRI), at that time part of the Health & Safety Executive, published a report into the accident in October 1997, which recorded the actions taken, none of which were related to infrastructure or earthworks, and made no further recommendations. It has proved difficult to establish the previous attributable fatality, but it was a considerable time ago, and may have been before 1940.

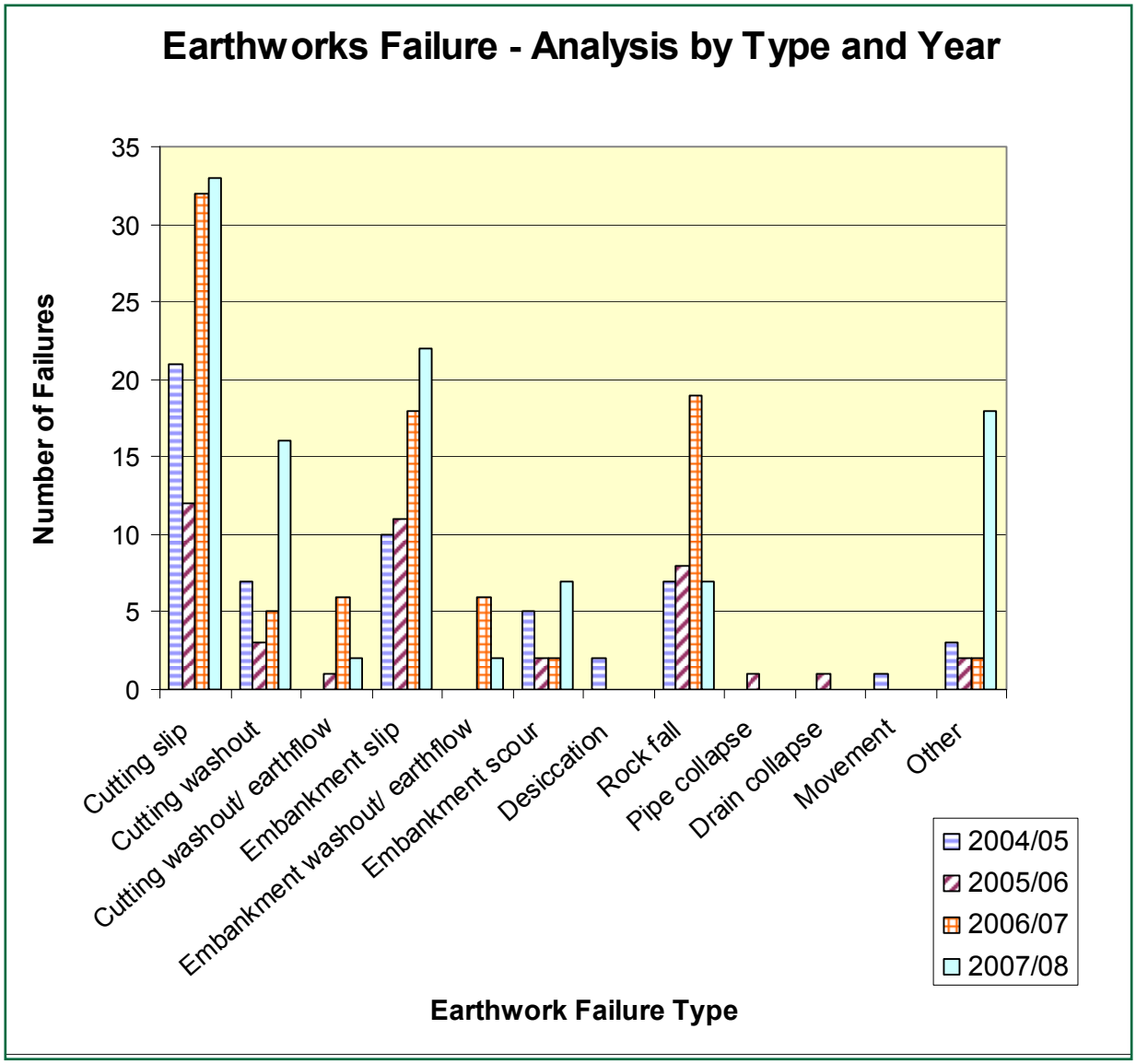

Figure 3: Network Rail recorded earthworks failures by type 2004 to 2008

60 Figure 3 indicates that the most prevalent earthworks failure mode in recent years was cutting slip followed by embankment slip.

61 Network Rail's Western Territory provided detailed earthworks data as part of the investigation into the failure at Kemble.

62 Starting in 2003, and using the process defined in RT/CE/P/030, Western Territory identified a total of 1175 miles of earthworks using mapping information (paragraph 37). These earthworks comprise 52 % embankments and 48 % cuttings. Following examination using the process specified in RT/CE/P/030, approximately 4 % of the total earthworks miles were classified as 'poor', 52.5 % as 'marginal' and the remaining 43.5 % were classified as 'serviceable'.

63 Network Rail Western Territory experienced 12 slip failures other than Kemble between November 2006 and January 2007. Of these ten were in cuttings and two on embankments.

64 In 2007/8 the Network Rail spend on earthworks was approximately £80 million. Approximately 3.5 % was spent on inspection, evaluation and assessment processes. Of the rest, 8.8 % was used for emergency and *reactive works*, but the majority, approximately 87.7 %, was used for planned proactive preventative measures.

65 The annual average Railtrack/Network Rail total spend on earthworks for the period from 2004/5 to 2008/9 is £83 million. The equivalent annual average spend for the period from 1999/2000 to 2003/4 was £53 million.

66 In 2004/5 £17 million was spent on emergency and reactive works. In 2007/8 this had reduced to £7 million.

Conclusions

67 Earthworks failure data has only been collated in its current form since 2003, and witness evidence suggests that during that period the quality of reporting has improved. Whilst the limited data available indicates a slight increasing trend in the rate of reported earthworks failures and also in the trend of consequential derailments, the extent of the data does not permit meaningful analysis.

68 Cutting and embankment slips are the predominant earthwork failure type (paragraph 60). The evidence indicates that catastrophic failures have occurred more frequently in cuttings than on embankments. Some earthworks staff have expressed reservations about the accuracy of the relative weightings in the algorithm for cuttings and embankments due to this imbalance in failures in otherwise similarly categorised earthworks.

69 Earthworks failures to date have resulted in small numbers of derailments over a period of 13 years, although one resulted in a staff fatality (paragraph 59).

70 There has been a substantial increase in Network Rail's annual expenditure in regard to earthworks, over the limited time period where reliable data is available. There is an indication within this same period that the requirement for emergency and reactive works has reduced.

Review of the Technical Process

71 The RAIB commissioned an independent technical review by a professional railway geotechnical engineer to assess the methodology and algorithm used in the current standards, NR/SP/CIV/086 and particularly NR/SP/CIV/065.

72 Where information was available to them the reviewers also considered the status of the implementation of the examination process within Network Rail.

73 In this review the following key questions were addressed:

- Is the process defined in the Network Rail company standards, to identify and record those earthworks to be included in the *earthworks asset register,* clear and workable?
- Is the requirement for the competency levels of staff, who carry out inspections, evaluations and assessments clearly defined, relevant and properly implemented?
- Does the Slope Stability Hazard Index algorithm consider all relevant data in a reasonable technical manner and is the data used in an appropriate way to predict the risk of failure?
- Does the algorithm include appropriate and adequate consideration of the consequences of earthwork failure?
- How does the technical approach taken by Network Rail compare with that of other asset owners with similar earthwork construction?
- Have there been any detrimental aspects within the development process from RT/CE/P/030 to RT/CE/S/065?
- Is there any recognition of issues which relate to adverse weather conditions in the current standards, either in their internal data handling or in the output of information to assist with operational risk management?

Network Rail Standards RT/CE/P/030, RT/CE/S/065 and RT/CE/S/086

74 When RT/CE/P/030 was introduced in 1997 it specified an implementation date of August 1997 with a date of December 1997 for completion of the list of sites. No final compliance date was specified.

75 The revised procedure, issue 2 (2002), specified a completion date of April 2014 for the examination cycle.

76 In 1997 the organisation structure and resource availability was significantly different across the Railtrack Zones. The rate of implementation varied considerably. When RT/CE/S/065 was issued in 2005 the implementation date was given as April 2005, and due to the ten-year examination cycle for slopes classified as serviceable, the deadline for compliance was given as April 2015.

77 Some Network Rail Territories stated that by 2005 they had made good progress with their earthworks inspection programme using the process given in RT/CE/P/030 issue 2. They took a decision to continue with this to complete a full cycle of inspections. Other Territories that had carried out few or no inspections using RT/CE/P/030 issue 2 started their inspection programme using RT/CE/S/065. The two standards produce incompatible data.

78 Examples were found of some Territories broadly operating to RT/CE/P/030 issue 1 and some to RT/CE/S/065. Due to the topography and access issues, Scotland Territory was operating an inspection system in some parts of their territory based upon *Stereo Oblique Aerial Photography*. This is a useful technique which has a number of potential benefits, but used alone it is not compliant with either standard. The issues connected with the use of this methodology were discussed in the RAIB report into the derailment at Moy (paragraph 20).

79 NR/SP/CIV/086 contains a requirement for those embankments which may be subject to scour or flooding to be assessed, and for this assessment to be reviewed every three years. Those embankments which are considered to be susceptible to damage should be further assessed to determine whether an action plan is required during flooding.

80 NR/SP/CIV/086 does not state who is responsible for developing or implementing this adverse weather plan. As the standard owner is the Head of Civil Engineering, it is reasonable to assume that implementation lies with the Territory Civil Engineer who would delegate it to the Territory Earthworks and Drainage Engineer.

81 Territory Earthworks and Drainage Engineers interviewed during this investigation had no adverse weather plans, nor were such action plans seen elsewhere during this investigation. The scale of (re)action necessary in the event of a flood event was considered to be beyond the Territory Earthworks and Drainage Engineers resources.

82 RT/LS/S/021 "Weather – Managing the Operational Risks" issue 2 (2004) is a Network Rail operational standard. It includes reference to scour, flooding and heavy rainfall and the specific risk of *landslides, slope failures* and washouts. It makes reference to Engineering being a participant in the Extreme Weather Action Team, but does not identify any particular responsibilities for Engineering.

83 There are no cross references between the action plan referenced in NR/SP/CIV/086 and the operational actions within RT/LS/S/021.

84 The RAIB, having reviewed the independent technical report, agrees with the conclusion that the process, defined in NR/SP/CIV/086, for determining and recording relevant earthworks is clear and pragmatic and considers that the earthworks asset register created using this process should be comprehensive and accurate.

Conclusions

Roles

85 NR/SP/CIV/065 references a number of roles and responsibilities; Earthworks Manager, Earthworks Examining Engineer and Earthworks Examiner. It references RT/CE/S/046: "Standards of Competence for the Examination of earthworks" to be issued in 2005. This standard has never been issued. However, competency requirements for these three roles are included in NR/SP/CTM/017: "Competence and Training in Civil engineering" issued in June 2006.

86 No role is defined for a person carrying out an evaluation in accordance with the requirements of NR/SP/CIV/086, nor is there a specified competency.

Algorithm

87 The Slope Stability Hazard Index algorithm has been developed over a period of time and several iterations and is considered to be technically sound. However, it does not form an integral part of NR/SP/CIV/086, but sits outside of the Network Rail standard, to allow adjustment and update, if required, without requiring a formal reissue of the standard.

88 It is not clear how Slope Stability Consequence Index has been implemented across the territories.

89 Evidence was obtained which suggested that some Territories had modified the algorithm to reflect problems with vermin and animal burrowing.

90 During the RAIB's investigation into the incident at Moy (paragraph 20) minor errors were discovered within the algorithm and these were highlighted to Network Rail HQ.

91 As there is no formal document control procedure attached to the algorithm, there may be issues over the currency of the versions in use.

Other sectors' management of earthworks

92 A comparison was made with a number of organisations in other sectors who operate with and manage similar earthwork assets: The Highways Agency; The Environment Agency; British Waterways and London Underground.

93 There are some variations in approach, particularly relating to the frequency and detail of examinations, the competency level of those carrying out examinations and also the evaluation process. These variations appear to reflect the different operational environments and safety requirements. The principles and methodologies used by Network Rail are as technically advanced as that used by any other of these organisations, allowing a numerical risk factor to be calculated and are probably the most appropriate in the railway operations environment.

Standards and Inspection

94 No detrimental aspects were identified in the transitions from the earlier versions of RT/CE/P/030 to NR/SP/CIV/086 and RT/CE/S/065.

95 In the previous earthwork failure investigations carried out by the RAIB, standing water, water inflows and drainage issues were key features. The effect of these deficiencies may not be fully identified within the inspection and assessment process. Observation of remote features is not a prescriptive requirement and it is possible that water or drainage issues are not present or visible to the examiner at the time of the inspection, because of seasonal or short-term weather variations.

96 Implementation of the standards RT/CE/P/030 and RT/CE/S/065 varies significantly across the Network Rail Territories (paragraphs 77 and 78). Therefore obtaining a view of the current position with respect to proportion of identified sites inspected and resultant categorisation is difficult. Network Rail HQ has stated that compliance with RT/CE/S/065 will be achieved nationally by 2015 as required by the standard.

97 It is understood that the inspection frequencies in RT/CE/S/065 were based upon engineering judgement and opinion, and not from any formal risk modelling. In many risk mitigation solutions there would be an expectation of closer steps at the higher risk end of the spectrum widening at the lower risk end. The one, five and ten year frequencies do not accord with this.

98 The responsibilities for developing and implementing response plans for adverse weather events are not clearly identified within RT/CE/S/065. NR/L3/TRK/1010 was issued in October 2007. This is a Network Rail maintenance organisation procedure which defines the management process and actions to be taken as a result of extreme weather. There is no alignment between civil engineering and operations standards for adverse weather management.

Territory Earthworks and Drainage Engineers Resources

99 The Territory Earthworks and Drainage Engineers have small in-house teams of around six earthworks and drainage specialists per territory to manage the inspection programmes, collate earthworks records, conduct technical evaluations, develop remits for remedial scheme designs and manage the remedial and emergency works programmes.

100 Additionally each Territory has a term contractor to carry out the planned inspections, and a remedial works design framework contractor.

101 Over recent years some of the Territory Earthworks and Drainage Engineers' teams have operated below establishment. The technical roles within these teams are quite specialised and are in demand in several sectors outside of the rail industry, and recruitment can therefore be protracted. Witness evidence also suggests that Network Rail has been controlling its staffing levels by restricting recruitment. There is recent evidence that recruitment for some of these posts has commenced. Some Territories have used agency resources to attempt to mitigate this situation

102 Territory earthworks teams, which have been operating with substantially complete headcounts, have made progress over a number of years in building detailed forward works programmes in addition to managing day-to-day activities and emergencies.

103 Where teams have been forced to operate with vacancies, witness evidence suggests that there is a reduced level of forward planning as immediate concerns occupy the entire team.

104 Network Rail has conducted a basic evaluation to determine the optimum balance of resources between in-house staff and term contractors for earthworks inspection work.

105 Network Rail found no case for increasing in-house staff and reducing contracted work.

Conclusions

106 The earthworks teams report that inspection programmes were being achieved and forward work plans considered, where Territory Earthworks and Drainage Engineers in-house resources are at or approaching establishment. This indicates that the numbers of staff within the teams are adequate for the workload. A small shortfall in resources as observed in some teams appears to have rapidly led to under-delivery and "fire-fighting".

Safety of the Line

Track maintenance staff

107 Routine inspection of the line to ensure that it remains safe for trains to run is carried out by track maintenance staff within the Network Rail maintenance organisation.

108 Safety of the Line responsibility rests at its lowest level with the local Section Supervisor or Track Section Manager. The supervisor inspects his section of route to a prescribed frequency and identifies items requiring attention, the remedial action to be taken and the timescales.

109 Track inspectors (or patrollers) walk the sections on behalf of the supervisor more frequently and ensure that no new problems have arisen which may affect the Safety of the Line and that no existing defects have deteriorated more rapidly than envisaged and require urgent attention.

110 Network Rail standard NR/SP/TRK/001 "Inspection and Maintenance of Permanent Way" includes the requirements for visual inspections. Section 8 of the standard stipulates the frequency of inspection and section 9 details the principles and method for "Visual track inspection" and "Features to be observed".

111 Section 9.3 of the standard, "Features to be observed", contains comprehensive listings of items to be included in general and specific areas of the track environment. The section includes primary items to be viewed during all inspections, but also includes a secondary element headed "To the extent that it is reasonable to do so in the course of track inspections, the following items shall also be identified and reported:".

112 Within this section are sub headed sections for "Lineside, and lineside security", "Bridges and other structures", and "Cuttings and embankment slopes". Each subheading contains prompts for features, which might include defects affecting the long-term stability and safety of the rail infrastructure.

113 The section for Cuttings and embankment slopes lists the "Features to be observed" as:

- signs of loose, displaced or fallen material (particularly after severe frost, heavy rainfall or thaw);
- signs of cracking (particularly in clay slopes during very dry weather); and
- signs of movement where large trees are present that may fall onto the track.

114 Section 9.8 of the standard describes the general process for reporting of inspections. Later sections and appendices define specific action to be taken if the Safety of the Line is compromised by discrete track geometry faults, for example twists or misalignments, or by integrity defects such as broken rails or cracked crossings. There is no reference in the document to reporting of other types of problem.

115 Existing *certificated* track inspection staff are subject to the Network Rail "*assessment in the line*" process to confirm their ongoing competency. This locally supervised, computer driven, system seeks to ensure that staff retain knowledge and understanding of the required activities.

116 Staff being given inspection duties are initially instructed at a Network Rail training centre using an approved training syllabus. The syllabi for track inspection and supervisor's inspection both contain short sections on issues relating to earthworks and also some reference to earthworks in sections relating to extreme weather actions.

Track inspection teams

117 The RAIB interviewed a small number of staff in different grades and territories within the Network Rail maintenance organisation. The objective was to obtain a representative view of their understanding of the inspection responsibilities relating to earthworks and related issues, for example with regard to drainage and vegetation, and what inspection practice is applied. The interviews also sought to find what reporting process is being used in the event of an earthworks problem being discovered.

118 Those maintenance staff interviewed clearly demonstrated an understanding of the risk to the operational railway from an earthworks failure and that this was an integral element of Safety of the Line. Observation of cuttings and embankments were seen as a key part of maintaining a safe permanent way. Protecting operational traffic following the discovery of a significant earthwork problem was the priority action. Those interviewed expressed a high level of confidence in their management of Safety of the Line where earthworks were concerned.

119 However, the primary initiator for reporting or further action was the effect on the track geometry. This gives a greater focus to the stability of embankments, which provide support to the track structure. Indicative signs of poor track geometry would possibly lead to further inspection of the earthwork and instigation of a course of remedial action.

120 Cuttings in general have much less relevance to track support and observation was limited to the potential for failure close to the line generating an obstruction or movement that would allow trees or other debris to fall towards the line. Track inspectors and supervisors rarely looked over the crest or walked to the top of cuttings.

121 Observation of adjacent land and property was also limited to cases where trees were seen to lean, fences were insecure or water inflows were observed from neighbours' land onto the railway track itself.

122 One Network Rail Area Track Engineer, recognising that earthworks present a risk that is not clearly defined, had developed and presented a technical briefing, with regard to the observation of earthworks, in a planned session to the whole of the area management, technical and supervisory organisation.

123 There was a consensus amongst the track inspectors interviewed that, other than taking the appropriate Rule Book specified action in conjunction with the *signaller* to protect the line should an extremely serious defects be discovered, all fault and problem reporting was to their immediate supervisor. In several previous instances inspectors had taken action by blocking the line to ensure safety or imposing a cautionary speed restriction through the signaller, and then referred the problem to their supervisor for further consideration.

124 The supervisors interviewed had reported earthworks problems through a number of channels; mainly to their Track Maintenance Engineer.

125 The communication conduits were generally informal and relied on individual contacts. The process was ad hoc and no loop existed to provide any feedback to the reporter regarding receipt of the information or proposed course of action.

126 One supervisor had determined that the probable course of remedial action for a particular earthworks problem was beyond his resource and technical capability and likely to need input and assistance from the earthworks team. In the absence of a defined reporting procedure he therefore formally logged the earthworks problem as a fault with *Infrastructure Fault Control* and identified the Territory Earthworks and Drainage Engineer as the person responsible for remedial action and closure of the fault.

Conclusions

127 Based upon a sample of interviews (paragraphs 117 and 118) local track maintenance supervisors are clear that the Safety of the Line is their responsibility and that this includes observing lineside earthworks as far as is practicable.

128 Track inspectors state they will take appropriate action should, in their opinion, the line become unfit for continued operation at line speed, including circumstances where this is related to earthworks failure. Evidence from Network Rail's log and operational records support this.

129 This action may include blocking the line or imposition of an emergency speed restriction in liaison with the signaller. They will follow this with a report to their maintenance supervisor.

130 In NR/SP/TRK/001 there is a requirement to observe a number of peripheral off-track features "To the extent that it is reasonable to do so…". "Reasonable" is not qualified and therefore inspections may not reliably identify defects.

131 NR/SP/TRK/001 lists off-track features that create risk, and new track inspectors and supervisors are also given information during their initial training sessions.

132 Neither the standard or the training provides any specific guidance, or instruction, on the reporting procedure should any defects be identified. In practice the reports are generally made through the line management chain to the Track Maintenance Engineer.

133 NR/L3/TRK/1010 was issued in October 2007. This is a maintenance organisation procedure which defines the management process and actions to be taken as a result of extreme weather. This procedure uses a predefined register of at risk earthworks as the basis for maintenance staff to carry out inspections during periods of extreme weather. The reporting process is clearly defined, but does not cover the reporting of defects discovered during routine track inspections.

134 Witness and other evidence indicates that Track Maintenance Engineers do report problems to the Territory Earthworks and Drainage Engineer's organisation, although there is no formal procedure for this. Communication links do exist between these teams (see paragraphs 139 to 146).

135 Concern regarding the absence of a defined formal identification and reporting process led one ATE, referred to in paragraph 122, to provide local guidance through his area technical briefing. One supervisor felt it was necessary to formally record the presence of a fault, which he considered needed action by the Territory Earthworks and Drainage Engineer organisation, by recourse to the fault management system.

136 These two specific actions are confirmation that there is a lack of clarity and defined process with respect to identifying and reporting earthworks issues within the maintenance function of Network Rail.

137 The maintenance teams consider that they are able to mitigate the risk to safety of the line from earthwork failures. However, they openly acknowledge that they focus on track structure and track support during inspections and would only look over the horizons of cuttings if they observe a potential problem. Embankments are considered to be the highest risk because of their track support role.

138 Consideration of features and events outside the boundary is also of low priority and is usually focussed on fencing and trees. Water flowing onto railway property is considered to be an issue because of its potentially damaging effect on the permanent way and not because of its effects on earthworks.

Maintenance organisation relationship with earthworks teams

139 The relationship between the maintenance organisation and the Territory Earthworks and Drainage Engineer teams was investigated through the interviews conducted (paragraph 117).

140 Two types of information were considered to be relevant:

- that relating to problem sites, where issues were discovered during programmed or exceptional earthworks inspections and where this information might assist both track maintenance and Territory Earthworks and Drainage Engineer organisations if the maintainers were made aware, and
- that relating to remedial works activities, both in regard to planned works programmes and current active worksites.

141 Significant variations were discovered in the quantity and quality of the information provided and the working relationship between maintenance organisation and Territory Earthworks and Drainage Engineer.

142 There is evidence that in some locations the Territory Earthworks and Drainage Engineer has provided information regarding problem earthworks sites to the local maintainer, but usually only where specific actions were identified against the maintainer, or where site-monitoring feedback was requested from them. Even where sites may have been categorised by the Territory Earthworks and Drainage Engineer as poor and therefore identified as potentially high risk, there was no basic information provided from the Territory Earthworks and Drainage Engineer to the maintainer.

143 No locations were found where the Territory Earthworks and Drainage Engineer routinely provided information on remedial works to the maintainer. Examples were discovered where physical site works had commenced without the knowledge of the local maintenance team.

144 The maintenance team are often the first point of contact for Network Rail's neighbours. In some cases questions or complaints from neighbours were the first information received by maintenance managers that earthworks remediation works were taking place.

145 Examples existed where proposed remedial programmes had been provided to maintainers. However these were not always actioned on the planned dates.

146 Whilst this is the general view, one of the maintenance engineers reported a good response from the Territory Earthworks and Drainage Engineer where he had reported earthworks problems. Site visits had been made within a few days of the report.

Conclusions

147 The communications between Territory Earthworks and Drainage Engineer and maintainers is not standard or prescribed. A wide variation was seen within the small sample of communication links observed. The range varied from responsive one-to-one contact to no meaningful contact at all.

148 No Network Rail procedure was found to ensure that this communication occurs regularly or consistently. Where communication links were good, the content of information was generally limited to that deemed necessary for immediate needs. Little information was provided by any Territory Earthworks and Drainage Engineer's in regard to planned work.

149 The shortage of appropriate and relevant earthworks information passing to the maintenance team from the Territory Earthworks and Drainage Engineer's team reduces their ability to ensure a safe railway. The lack of a defined procedure and communication link from maintenance to the Territory Earthworks and Drainage Engineer restricts the flow of potentially useful supplementary information for earthworks analysis.

Other resources that might influence Safety of the Line

150 Other Network Rail staff and contractors also have a presence around the network. Their potential to assist with identification of earthworks problems is limited for a number of reasons:

- Off-track teams managing fencing and vegetation are not a locally managed resource, they visit infrequently and unpredictably to attend to a specific infrastructure item. They have no technical training in earthworks or track inspection.
- Structure examiners operate, other than in emergency response, to a predominantly annual programme of visits and have no specific earthworks training. They would normally only identify earthworks issues if they were in the proximity of a structure and may have an adverse effect on its performance. There are anecdotal examples of structures examination staff reporting minor earthworks problems through their management teams to the Territory Earthworks and Drainage Engineer organisation.
- Earthworks inspections currently take place on a one, five or ten yearly frequency as determined by the condition rating of "poor", "marginal" or "satisfactory" (paragraph 40).

Conclusions

151 Specific inspections of earthworks are carried out to a varying frequency, dependent upon the assessed risk category following the previous inspection. The earthworks inspection staff who perform these inspections are competent (paragraph 86) and operate to a prescribed process, as they have clearly defined parameters to observe or measure.

152 However, the seasonal timing and environmental circumstances at the time of the inspection allow the examiner only a "snapshot" opportunity to see and capture relevant information. This will reduce the effectiveness of the inspection in identifying all issues which might be relevant.

153 The relatively long intervals between earthworks inspections also indicates that there is likely to be very limited value in regard to the management of ongoing Safety of the Line risks.

154 Other "visiting" resources, for example off-track teams or structures examiners, not only have an infrequent and possibly unplanned pattern of inspections, but also have no training or experience in understanding the behaviour of earthworks. These resources are currently unlikely to add much value to Safety of the Line risk mitigation.

Issues outside the Network Rail boundary

155 Local maintenance staff interviewed (paragraph 117) were unclear as to the legal rights of Network Rail in respect of taking action against neighbours whose property or management processes, for example trees, drainage or fencing, posed a risk to the safe operation of the railway. They were also not aware of any sources of advice or information within Network Rail. These are the staff who manage the immediate risk.

156 To expedite solutions to local neighbour problems, such as overhanging or leaning trees, or drainage deficiencies, work is often done using local Network Rail teams by cooperation and negotiation with neighbours, even though in some instances the liability may rest solely with the neighbour.

Conclusions

157 The risks to Network Rail's infrastructure and operation from neighbours' property are often addressed by use of local knowledge and by the actions of the local maintenance teams. There is no clear policy or procedure for maintenance staff to follow should problems be discovered.

158 The RAIB made a recommendation in the report into the derailment at Moy (paragraph 20) with regard to the inclusion of Network Rail as a statutory consultee within the planning application process for works adjacent to the railway. This recommendation is currently being progressed by The Scottish Government for Scotland and the Department of Communities and Local Government for England and Wales. Both parties are considering the representation of Network Rail as part of a larger review of statutory consultees with their planning processes.

Extreme Weather management

159 The Network Rail maintenance organisation provides a response and monitoring service, for example in the event of hot weather or flooding.

160 Network Rail's Territory Civil Engineers should develop a register of earthworks at risk as part of their Extreme Weather Plan in accordance with NR/L3/TRK/1010, issued in October 2007. This EWP is forwarded to the relevant Area Track Engineer for review in conjunction with the local Track Maintenance Engineer and supervisors.

161 Infrastructure Fault Control will inform the appropriate contacts as specified in the Extreme Weather Plan to initiate the appropriate inspection response. One of these contact points is listed as Route Operations Control.

162 No evidence was seen to confirm the effectiveness of this procedure.

163 Network Rail's operational response planning process for adverse weather conditions includes inputs from engineering and maintenance (paragraph 82).

164 One of the Territory Earthworks and Drainage Engineers interviewed stated that neither they nor any of their staff had been involved in discussions regarding the management of railway operations during periods of extreme weather, despite concerns regarding specific sections of earthworks within his territory. He stated that he was not aware of the Extreme Weather Action Team arrangements.

165 Due to the unique features and regular experience of severe weather, including tidal effects, a discrete management plan exists for the sea wall at Dawlish.

166 Network Rail Civil Engineering and Operations are conducting work to develop route strategic response plans in response to weather warnings. These plans will include information on the highest risk earthwork within a railway route combined with weather warning triggers to initiate an operational response for the whole route. Similar route strategy arrangements exist for the management of structures. There was little knowledge of this development within the Territory Earthworks and Drainage Engineer organisations sampled, and no knowledge with the maintenance teams interviewed.

Conclusions

167 The Territory Earthworks and Drainage Engineer teams are not structured or resourced to take proactive protective action at discrete earthworks in the event of adverse weather.

168 In certain locations around the network, local arrangements have previously been developed for response to at risk earthworks. The RAIB report on the derailment at Moy includes details of the arrangements then in place in Scotland.

169 In October 2007 Network Rail issued maintenance procedure NR/L3/TRK/1010 which defines a mechanism to utilise maintenance staff to inspect and monitor at risk earthworks, as well as structures and other locations.

170 The RAIB considers that the work started by Network Rail to consider a route-based response to extreme weather conditions should result in a more effective method of managing the risk to the operational railway from potential earthworks failures than consideration and action for individual earthworks.

171 The actions of local maintenance teams during periods of extreme weather also appears to have been broadly effective in respect of earthworks risks, although the criteria for examination and locations had generally been determined by the local knowledge of maintenance supervisors.

172 Specific response arrangements for individual high risk sites, similar to that in place for the sea wall at Dawlish, also appears to have merit as the weather conditions are often localised and require a more focussed response.

173 There is no formal linkage between the engineering and maintenance response using NR/L3/TRK/1010 as a basis and the EWAT process managed by Operations within RT/LS/S/021 (paragraph 82).

Climate Change

174 Network Rail have been collating earthworks failure data in its current form since 2003 (paragraph 56). There is currently insufficient quantity and duration of data to allow meaningful correlation with national or regional climate patterns. Network Rail have appointed a climate change manager to act as the focal point in collecting information, liaising with other organisations, including the various research projects and establishing the parameters for future modelling work.

175 Network Rail has contributed to a number of research projects which aim to understand climate behaviour, the direction that this might take in the future and the effect on the network infrastructure.

176 RSSB have also sponsored studies into climate change and its effect on the management of infrastructure and safety implications for the railway industry. T096: Safety implications of weather, climate and climate change and T371: Implications of weather extremes and climate change on railway infrastructure, both considered the changing risks to infrastructure and a review of work done to date. The projects considered the direction that future research should take to provide management information on which to base decisions.

177 As a result of the findings in T371, RSSB, Network Rail and the Environment Agency have completed a further specific project study, T643 "Assessing the impact of climate change on transport infrastructure", to investigate the impact of climate change on the railway defence assets at Dawlish.

178 Network Rail's stated intention is to obtain a comprehensive understanding of the asset and its current performance (paragraph 96), before attempting to model potential long-term climate effects.

Conclusions

179 The comparative review with other sectors demonstrates that Network Rail is in a similar position to them with respect to the understanding of issues relating to long-term climate change effects on its infrastructure. If Network Rail did have a more detailed and accurate understanding of future climate change effects, it could not be accurately modelled onto the incomplete infrastructure data currently available.

180 Completing the current inspection programme of earthwork assets in a consistent and structured manner to provide a robust database of earthwork conditions will enable risk management and climate change effect modelling to be carried out with more confidence and accuracy.

181 The RSSB studies have focussed on the future requirements and options for management and modelling of infrastructure, and work has yet to be completed to determine the actual effects.

Overall Findings

182 Network Rail has significantly increased the financial spend on earthworks in comparison with BR (paragraph 64 and 65). However, no statistical improvement in earthworks failure trends is yet visible (paragraph 11).

183 The limited data available suggests that there may be an increasing trend in the number of earthworks failures reported. However the number of serious operational incidents and in particular fatalities as a consequence of earthworks failure remains very low. As standards have evolved the related reporting regimes have also improved and it is probable that a large proportion of the increase in reported failures results from improved reporting (paragraph 67).

184 Network Rail's identification and examination regime has been developed through stages and the current principles and processes compare with those of other sector earthworks asset owners (paragraph 92).

185 There appears to be inconsistent application of the current standard NR/CIV/S/065 and some evidence to suggest inconsistency with the algorithm version control and implementation status (paragraph 91).

186 The effect of external influences and seasonal variations may not be fully identified within the current earthworks examination regime (paragraph 95).

187 Network Rail's in-house and contracted resource levels appear to operate satisfactorily when maintained to planned levels, but evidence suggests that "critical mass" is soon lost when vacancies occur (paragraph 106).

188 Operational safety managed through Safety of the Line responsibilities relies primarily on local geographical knowledge and observation by track inspection staff. The scope of their off-track observations is not comprehensively defined, although some guidance on common defects is given during the initial inspection training course (paragraph 112 to 116).

189 Reporting procedures and communications in general between maintenance and inspection staff and earthworks management teams are not defined and rely on local practices (paragraph 147).

190 Corrective actions taken by local maintenance teams, mainly in response to track support issues on embankment, may be mitigating or preventing some catastrophic earthworks failures. This could lead to the conclusion that the Slope Stability Hazard Index algorithm is inaccurately predicting the risk of failure from either embankments or cuttings (paragraph 68 and 137).

191 Whilst there is a Network Rail operational procedure, RT/LS/S/021, which defines the response to extreme weather conditions, there is little awareness of this within the maintenance or engineering teams. The maintenance response is defined in NR/L3/TRK/1010 which uses as an input the earthworks at risk register. Prior to this the local response was determined in most cases by local experience and knowledge, although both local and specific examples were found of response procedures. The Territory Earthworks and Drainage Engineer's teams have no response resources.

Recommendations

192 The following safety recommendations are made[1]:

1 Network Rail should conduct a study into the potential contribution to the assessment and understanding of earthworks risk from the following factors, and amend their processes as appropriate to include any improvements identified:

a) the use of inspection intervals of one, five and ten years (paragraph 97);

b) local maintenance staff not reporting all precursor earthworks related defects – these may have rectification measures applied locally without further reporting (paragraph 190);

c) lack of a process for maintenance staff to report earthworks defects to the Territory Earthworks and Drainage Engineer organisation to enable appropriate action to be taken (paragraph 189);

d) track inspection staff not routinely looking over cutting horizons (paragraph 137);

e) a high focus by track inspection staff on track support areas and particularly embankments to the detriment of other earthworks elements (paragraph 138);

f) track maintenance staff not having the capability, knowledge or time available to routinely inspect off-track issues – for example water in neighbouring land (paragraph 138);

g) the potential for earthworks examiners to not observe all relevant factors and indicators, because of the infrequent and seasonal visits (paragraph 95);

h) the relative weighting attached to the risks from cuttings and embankments in the Slope Stability Hazard Index algorithm – and particularly in view of b), d), e) above (paragraph 68);

i) the risk weighting attached to the operational consequence of an earthworks failure (paragraph 88); and

j) the value of information sources used in other inspections and whether this could be utilised in the reduction of risk from an earthworks failure (paragraph 154).

Continued

[1] Duty holders, identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.
Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to ORR to enable them to carry out their duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to the RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 167 to 171) can be found on RAIB's web site at www.RAIB.gov.uk.

2 Network Rail should review the best practice found in the following areas during this investigation and include within their procedures so that it is universally applied:

- maintenance of Territory Earthworks and Drainage Engineers resource levels (paragraph 106);
- track maintenance staff briefings (paragraph 122);
- the reporting arrangements for earthworks problems (paragraph 126); and
- communication systems between maintenance staff and territory earthworks teams (paragraph 146).

3 Network Rail should provide clear policy, information and guidance to staff, particularly those in the maintenance organisation, with regard to neighbours and problems related to the management of infrastructure risk (paragraph 157).

4 Network Rail should align the actions in regard to adverse weather which currently appear in NR/CIV/S/086, NR/L3/TRK/1010 and RT/LS/S/021 to provide a clearer and more cohesive response and ensure that this is communicated throughout the relevant parts of the organisation (paragraph 164).

5 Network Rail should develop and implement a communications procedure between Territory Earthworks and Drainage teams and local maintenance staff to provide relevant information and allow more effective management of the earthworks risk and Safety of the Line (paragraph 149).

6 Network Rail should clarify the requirements for maintenance inspectors to observe earthworks and develop an appropriate reporting process. This information should be included in NR/SP/TRK/001 (paragraphs 111 to 114).

Appendices

Appendix A - Glossary of abbreviations and acronyms

HMRI	Her Majesty's Railway Inspectorate
RSSB	Railway Safety and Standards Board

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis' British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com

Algorithm	A logical step-by-step procedure for solving a mathematical problem in a finite number of steps, often involving repetition of the same basic operation.
Assessment in the line	Part of the competence management system covering Network Rail's employees involving an assessment of competence carried out under the supervision of an employee's line management
Certificated	Holding an official document that gives proof and details of training and/or competency.
Compliance	The date by which all aspects of a standard must be achieved.
Earthworks	All natural earth slopes and earth-related constructions such as Cuttings and Embankments.*
Earthworks asset register	The set of records which schedule all of the railway earthworks within a defined geographical area.
Evaluating	An appraisal of all relevant information and circumstances relating to an Earthwork including its condition, use and location to establish whether action is required to ensure that the level of safety and serviceability of an Earthwork remain acceptable.*
Examination frequency	The number of times that an inspection takes place during a period of time.
Formation	The prepared surface of the ground, on which any filter or structural materials, the Ballast and the Track is laid. Other specialists refer to this is the Sub-formation. Also Roadbed, Track Bed. See also Formation Treatment.*
Framework contractors	An organisation contracted to perform specified tasks on demand, normally to predefined terms.
Her Majesty's Railway Inspectorate	A body with ultimate responsibility for ensuring that: • new works are designed and implemented correctly • the operation of Railways of all types is carried out safely • accidents are thoroughly investigated It was previously a specialist division within the Health and Safety Executive (HSE). On 1 April 2006, responsibility for health and safety policy and enforcement on the railways transferred from HSE to the Office of Rail Regulation (ORR). This transfer affects the regulation of the operation of Railways and other guided transport systems, including Heritage Railways, metros and Light Rail systems. However, HSE retains responsibility for Guided Buses and trolley vehicle systems.
Implementation	The date from which the requirements of a standard are to be applied.

Infrastructure controller	The organisation responsible for the control and operation of a Railway, or part of a Railway, including the Track, Structures, plant and control equipment. Network Rail (NR) is the current Infrastructure Controller for the Lines formerly operated by British Railways (BR), i.e. most of the Standard Gauge Lines in Great Britain. See National Railway Network (NRN).*
Infrastructure Fault Control	An organisation within Network Rail (NR) that controls the real-time reporting and rectifying of faults on the Infrastructure.*
Infrastructure maintenance contract	A contract let and managed by Railtrack to provide routine infrastructure maintenance services, mainly in connection with permanent way, signalling and traction power supplies.
Inspection intervals	The time interval between successive inspections.
Landslide	A movement of a large mass of earth and rock down a mountainside, cliff, Cutting Slope or Embankment. See Bank Slip. See also Slip, Slip Circle, Slip Plane*
Permanent way	a) The Track, complete with ancillary installations such as Rails, Sleepers, Ballast, Formation and Track Drains, as well as Lineside Fencing and Lineside Signs b) Formerly used to differentiate between the permanent Track under construction, and the Temporary Way that was used to aid the construction and removed later A collective term used to describe those persons engaged in the upkeep of the Track on the Railway.*
Railway Group Standard	A document mandating the technical or operating standards required of a particular system, process or procedure to ensure that it interfaces correctly with other systems, process and procedures. Network Rail (NR) produces Network Rail Company Standards (NRCS) that detail how the requirements of the Railway Group Standards are to be achieved on its system.
Railway Safety and Standards Board	A body established on 1 April 2003 as a result of recommendations from the second part of the Cullen Report into the Ladbroke Grove Accident, which absorbed Railway Safety Limited. The new company's objective is to co-ordinate the Railway Industry's work in achieving continuous improvement in the health and safety performance of the National Railway Network (NRN), and thus facilitate a reduction of risk to employees and Passengers. RSSB is responsible for the Railway Group Standards (RGS). See also Rail Accident Investigation Branch (RAIB).*
Reactive works	Work performed as a result of a failure or incident.*

Regional Civil Engineer	The Civil Engineering (Bridges, Track) functions of British Railways (BR) were divided into Regions, each of which was responsible for the Maintenance and Renewal of Bridges and Track within its control whilst also reporting to the Director of Civil Engineering (DoCE) at British Railways Headquarters (BRHQ). Each Region was further divided into Areas, or Area Civil Engineers (ACE).*
Relevant earthworks	Earthworks which meet the definition in RT/CE/P/030 and are to be included in the inspection and evaluation regime.
Safety of the Line	The condition of freedom from danger to the operators, Passengers and Traffic of a Railway. Safety of the Line is one of the most important aspects of the Railway culture and many courageous acts have been carried out to protect it.*
Signaller	The term for a person engaged in operating a Signal Box or the operational supervision of a Signalling System.*
Slip failure	A Bank Slip, landslip, rock fall or other unintentional downward movement of material in a Cutting or Embankment, generally leading to a need for emergency action.*
Slope failure	A Bank Slip, landslip, rock fall or other unintentional downward movement of material in a Cutting or Embankment, generally leading to a need for emergency action.*
Slope Stability Hazard Index	The Network Rail (NR) standardised method for assessing the condition of Earthworks with respect to their potential instability. It determines the risk of failure against five potential failure modes, namely Rotational Failure, translational failure, Earth Flow, Washout, and animal burrowing.*
Soil Slope Consequence Index	The Network Rail (NR) standardised method for assessing the consequences of an Earthworks failure with respect to the operational railway.
Stereo Oblique Aerial Photography	A technique of using aerial photography to provide data for earthworks assessment.
Stewardship	The management of an asset by designating lead responsibility.
Technical assessment	The process of determining the condition of an asset by applying criteria to relevant data.
Term contractors	An organisation contracted to perform specified tasks over a period of time.
Territories	The new Network Rail (NR) regional organisation, loosely equivalent in coverage to their precedents, the Regions.*
Traincrew	Collective term for the driver, Driver's Assistant, Guard and Train Manager of a Train.*
Washout	A failure condition in which a Bridge, the Formation or occasionally the whole Railway is removed by a flood.*

Zone	The regional divisions of the former Railtrack, being: • Anglia Zone (AZ, EAZ) (latterly merged with London North East Zone to form Eastern Region) • East Coast Zone • Great Western Zone (GWZ) • London North East Zone (LNEZ) • North West Zone (NWZ) • Scotland Zone (SCZ) • Southern Zone (SZ) See Network Rail (NR), Region, Territory.*

Appendix C - Key standards

GC/RT 5151	Safe Asset Management - Embankments and Cuttings
NR/SP/CIV/065	Examination of Earthworks
NR/SP/CIV/086	Management of Existing Earthworks
NR/SP/CTM/017	Competence and Training in Civil Engineering
NR/SP/TRK/001	Inspection and Maintenance of Permanent way
RT/CE/P/030	Management of embankments and Cuttings
RT/CE/S/046	Standards of Competence for Examination of Earthworks
RT/LS/S/021	Weather – Managing Operational Risk

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