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Level 3

Examination of Earthworks

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User information

This Network Rail specification contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *No variations, could stop the railway*

- Red indicates requirements to be complied with and achieved.
- Red requirements are presented in a red box and expressed as a direct instruction.
- Accountability for the efficacy of red requirements lies with the Professional Head/owner.
- Red requirements are monitored for compliance.
- Corrective actions are to be enforced if variations are discovered through functional checks (such as engineering verification visits, audit or operations self-assurance).

Amber requirements – *Controlled variations, approved risk analysis and mitigation*

- Amber indicates requirements to be complied with unless variation has been approved in advance.
- Amber requirements are presented with an amber sidebar and expressed as a direct instruction.
- Accountability for the efficacy of amber requirements lies with the Professional Head/owner, or their nominated delegated authority.
- Amber requirements are monitored for compliance.
- Variations may be permitted. Variations are approved by the process owner or through existing delegated authority arrangements.
- Corrective actions are to be enforced if non-approved variations are discovered through functional checks (such as engineering verification visits, audit or operations self-assurance).

Green – Guidance

- Green indicates guidance. This is presented with a dotted green sidebar and with the word 'should' (usually in notes) or expressed as a recommendation.
- Guidance is based on good practice and represents supporting information to help achieve red and amber requirements.
- Guidance is not mandatory and is not monitored for compliance.
- Alternative solutions may be used. Alternative solutions do not need to be formally approved.
- Decisions made by a competent person to use alternative solutions should be backed up by appropriate evidence or documentation.

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1 Introduction

1.1 Purpose

The purpose of this Standard is to define the requirements for:

1. Undertaking, recording and reporting the findings of Examinations on Earthworks,
2. Identifying those actions from the findings of an Examination that need to be implemented so that there is no unacceptable risk to the safe operation or performance of railway infrastructure.

This Standard defines requirements that expand upon, or are supplementary to, those given in [NR/L1/CIV/032](#): *The Management of Structures*.

1.2 Scope

This Standard covers all Earthworks within the Network Rail boundary, and where it is appropriate to do so, slopes outside the boundary that may affect Network Rail infrastructure.

This Standard applies to the following:

1. Network Rail owned or managed¹ Earthworks equal to or greater than 3 metres high - this includes Earthworks lying above a Retaining Wall where the Earthwork component is greater than or equal to 3 metres.
2. Network Rail owned or managed¹ Earthworks (irrespective of their height) whose failure could pose an unacceptable risk to the safe operation or performance of railway infrastructure, for example, those Earthworks which have a history of instability, or are at risk of flooding or water action.
3. Outside Party Slopes (irrespective of their height) whose failure could pose an unacceptable risk to the safe operation or performance of railway infrastructure (section 4.1 only applies). If application of this Standard is not appropriate to such slopes then a suitable bespoke system should be adopted to manage the risk.
4. Earthworks (irrespective of their height) that lie above the portal of a railway tunnel.
5. Approach Embankments to an overline Bridge that are equal to or greater than 3 metres high, except those owned by a Highway Authority, Roads Authority or other competent authority.
6. Nailed or reinforced soil structures whose face angle is less than or equal to 70 degrees to the horizontal.
7. Any Embankment that also acts as a Coastal, Estuarine or River Defence, irrespective of its height.

The requirements of this Standard need not be applied to Earthworks that do not meet any of the above criteria.

This Standard does not apply to:

1. Examinations specifically undertaken to assess ground movements resulting from, for example, mineral extraction, landfill operations, or a subterranean fire.

¹ Totally or Shared

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2. The examination of vegetation - other than the factors affecting slope stability: the requirements for inspecting vegetation are defined in [NR/L2/TRK/5201](#): *Management of lineside vegetation*.
3. The examination of Earthworks drainage - other than the factors affecting slope stability: the requirements for inspecting drainage are defined in [NR/L3/CIV/005](#): *Railway Drainage Systems Manual*.
4. The examination of nailed or reinforced soil structures steeper than 70 degrees, Retaining Walls and gabion walls - other than the factors that may indicate instability of the slope (see 8.2 and 9.2). The examination of such structures is defined in [NR/L3/CIV/006](#): *Handbook for the Examination of Structures*
5. The examination of Coastal, Estuarine or River Defence works that are not also Embankments. The examination of such works is defined in [NR/L3/CIV/006](#): *Handbook for the Examination of Structures*.

This Standard does not cover:

1. Health and safety requirements applicable to operational safety and emergency evacuation procedures.
2. The commercial and all the organisational responsibilities for delivering the requirements of the Standard.
3. A list of parameters to be collected in an examination is given in NR/L3/CIV/065/F020, F021, F022, F023 and F024.
4. The Evaluation of an Earthwork: this is covered by [NR/L2/CIV/086](#): *Management of Earthworks* and [NR/GN/CIV/203](#): *Evaluation and Assessment of Earthworks*.

1.3 References

The following referenced documents are indispensable for the application of this specification. For dated references, only the edition cited applies. For undated references, the latest edition of the reference (including any amendments) applies.

[NR/ARM/M6DF](#): *Definitions for the Reporting of M6 Earthworks Failures*

[NR/GN/CIV/203](#): *Evaluation and Assessment of Earthworks*

[NR/GN/CIV/209](#): *Definition of Risk Evaluation Matrix (REM)*

[NR/L1/CIV/032](#): *The Management of Structures*

[NR/L2/CIV/086](#): *Management of Earthworks*

[NR/L2/TRK/5201](#): *Management of lineside vegetation*

[NR/L3/CIV/005](#): *Railway Drainage Systems Manual*

[NR/L3/CIV/006](#): *Handbook for the Examination of Structures*

[NR/SP/CTM/017](#): *Competence and Training in Civil Engineering*

2 Roles and responsibilities

Earthworks management roles:

- **Route Asset Manager (RAM)**: The person responsible for all Earthworks (and possibly other assets) within the route.

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- **Earthworks Manager (EM):** The person reporting to the Route Asset Manager responsible for managing Earthworks.
- **Earthworks Examining Engineer (EEE):** The person responsible for managing the Examination process.
- **Earthworks Examiner (EE):** The person responsible for carrying out an Examination of an Earthwork.

The Route Asset Manager (RAM) is responsible for appointing an *Earthworks Manager* for each Earthwork that lies within their respective route (see 4.2).

For the Earthworks allocated to them by the *Route Asset Manager*, the *Earthworks Manager* is responsible for:

1. Specifying the timing², type, purpose and scope of Examinations so that timely and appropriate action, such as remedial works, can be implemented to maintain the safety and performance of those Earthworks (see sections 4.2, 6, 7, 11, 12 and 13).
2. Providing relevant information prior to an Examination (see 4.2).
3. Approving the appointment of an Earthworks Examining Engineer(s) and directly appointing, as necessary, Earthworks Examiner(s) (see 4.2).
4. When either a Cyclical Examination has been delayed beyond the permitted interval or an Examination is incomplete (a) the review and approval of a risk assessment, and (b) the identification of any necessary mitigation and arranging for the implementation of that mitigation (see 6.2 and 12.4).
5. Specifying and/or agreeing with the Earthworks Examining Engineer the format of Special Examination reports (see 12.1 and 12.3).
6. The maintenance of adequate records; including details of the next planned Cyclical Examination (see 6.1), risk assessments (see 6.2), Examination reports (see 12.6) and Earthworks with a higher likelihood of failure (see 12.6).
7. Where an Urgent Defect Report is received, identifying and arranging for actions necessary to maintain the safe operation and performance of railway infrastructure (see 13)

For the Earthworks allocated to them by the *Earthworks Manager*, the *Earthworks Examining Engineer* is responsible for:

1. The appointment of Earthworks Examiners (see 4.2).
2. The submission to the Earthworks Manager of an Examination plan (see 6.1)
3. The submission to the Earthworks Manager of a risk assessment where either an Examination is delayed beyond the permitted interval (see 6.2) or an Examination is incomplete (see 12.4).
4. Agreeing with the Earthworks Manager the format of Special Examination reports (see 12.1 and 12.3).
5. The checking, approval and submission of Examination reports (see 12.5).

² All currently known Earthworks that fall within the scope of this Standard (see 1.2) shall be examined by 1st April 2015. All Never inspected 5 chains shall be inspected by 1st April 2017 in order for the Network Rail Earthworks Examinations Database to achieve A2 data quality status. All newly found Earthworks shall receive a Full Examination in accordance with this Standard in the next Earthworks Examination season after their discovery.

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6. The submission of reports of re-examinations, and identifying and implementing actions necessary to maintain or improve the consistency of Examinations (see 12.5).
7. The submission of Urgent Defect Reports (see 13)

An *Earthworks Examiner* is responsible for:

1. Making suitable preparations prior to undertaking an Examination (see 5).
2. Carrying out Examinations in accordance with this Standard (see 8 to 11).
3. Preparing, signing and submitting a report for each Examination to the Earthworks Examining Engineer or Earthworks Manager (see 12).
4. Immediately notifying the Earthworks Examining Engineer and/or the Earthworks Manager of defects which give rise to a concern about safety (see 13)
5. Submitting to the Earthworks Manager via the Earthworks Examining Engineer an Urgent Defect Report where defects which give rise to a concern about safety have been found and/or where urgent action has been taken or is required to maintain safety (see 13).

Those appointing persons to positions with responsibility or delegated duties to deliver one or more of the requirements of this Standard are responsible for checking that appointees are competent and that appointees understand their responsibilities. Appointments, responsibilities and duties are to be documented.

Those appointed to positions having the responsibility or delegated duty to deliver one or more of the requirements of this Standard are required to:

1. Have the competency, skill, knowledge and experience necessary to undertake their duties commensurate with the form, type and complexity of the Earthworks being managed.
2. Be aware of their responsibilities.
3. Understand why and be able to judge when urgent action is required to maintain safety.

Earthworks Managers are required to be competent to carry out their responsibilities in accordance with the relevant unit of Network Rail Standard [NR/SP/CTM/017: Competence and training in Civil Engineering](#).

Earthworks Examiners and *Earthworks Examining Engineers* are required to be competent to carry out their responsibilities and have the experience and qualifications given in Table 1. The *Earthworks Manager* may accept lesser qualifications and/or post graduate experience for the roles based on a CV review and/or formal interview.

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Experience/ Qualification Requirements	Earthworks Examining Engineer (EEE)	Earthworks Examiner (EE)
Earthworks Examination within the railway environment	>5 Years	> 3 Years
Experience of Network Rails Earthworks Examination Software	>2 Years	> 1 Year
Academic qualifications & post graduate experience	MSc + 3 Years or BSc + 5 Years or HND + 10 Years	MSc + 1 Year or BSc + 3 Years or HND + 7 Years
Professional qualifications	Chartered Engineer or Geologist	Not applicable

Table 1 Experience and qualification requirements

All *Earthworks Examiners* are required to be trained and certified in the assessment of SCHI and SEHI and the use of the Network Rail Earthworks Examination Software either by the *Earthworks Examining Engineer* or by an external provider approved by Network Rail. All *Earthworks Examiners* carrying out Examinations of rock slopes are required additionally to be trained and certified in the assessment of RSHI by an organisation approved by Network Rail. The SCHI, SEHI, RSHI and Network Rail Earthworks Examination Software certification lasts for a period of up to 5 years. However, if an *Earthworks Examiner* has greater than a 2 year absence from Cyclical Examinations, or in the opinion of the *Earthworks Manager* has an unacceptable number of rejected Examinations in an Examination season, the *Earthworks Examiner* will require recertification before recommencing Examinations.

3 Definitions³

Bridge

A structure of one or more spans greater than or equal to 1.8 metres, whose prime purpose is usually to carry traffic or services over an obstruction or gap.

Coastal, Estuarine and River Defence

For the purposes of this Standard an engineered Embankment type structure that protects railway infrastructure against erosion or flooding by tidal or non-tidal waters. It includes protection works, which protect land against erosion and encroachment by such waters but which perform no flood defence role; and defences, which protect against flooding or attack by such waters. For examination purposes such defences shall be treated as an Embankment.

Culvert

A structure with a span or diameter greater than 0.45 metres but less than 1.8 metres whose primary purpose is usually to permit water or services to pass under or adjacent to a railway, road or other Network Rail infrastructure.

³ Definitions flagged with an asterisk are not used in the body of this Standard but are required for completeness to understand subsidiary and related documentation.

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Earthwork

An Earthwork is a Cutting, Embankment, or Natural Slope segment up to 5 chains long lying within the Network Rail boundary that is equal to or greater than 3 metres high, or if less than 3m high whose failure could pose an unacceptable risk to the safe operation or performance of railway infrastructure. The term excludes the track formation, blanketing and ballast etc. and also geosynthetics that form an integral part of the track supporting system. An Earthwork comprises either the Up or Down side of the railway, with the two sides being separated by an imaginary line along the centre of the track(s).

Cutting

An excavation that allows railway lines to pass at an acceptable level and gradient through the surrounding ground. Categorised as:

- **Soil Cutting:** A Cutting composed entirely or predominantly of soil, very weak or weak rock and may include supporting structures such as retaining or gabion walls.
- **Rock Cutting:** A Cutting composed entirely or predominantly of moderately weak or stronger rock, and may include local support, such as dentition, bolting, and netting. In situ rock slopes exposed below track level in areas of sidelong ground are also included.
- **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.

Embankment

A construction that allows railway lines to pass at an acceptable level and gradient over low-lying ground or ground that is susceptible to flooding composed entirely of soil or rock fill.

Natural Slope

Sloping ground that has been formed by natural processes. For the purposes of examination a Natural Slope sloping towards the track is considered as a Cutting, and a Natural Slope sloping away from the track is considered as an Embankment.

Approach Embankment

An Embankment oblique to the railway on the approaches to a bridge over the railway or a level crossing.

Approach Cutting*

A Cutting oblique to the railway on the approaches to a bridge under the railway

Tunnel portal*

The opening structure to a tunnel providing entry/exit. Any Earthwork existing over the tunnel portal is recorded against the Up Earthwork inspection 5 chain at the tunnel portal, as follows:

- **Soil Cutting above tunnel portal:** A Soil Cutting existing over a tunnel portal structure, oblique to the railway.
- **Rock Cutting above tunnel portal:** A Rock Cutting existing over a tunnel portal structure, oblique to the railway.

No earthwork

5 chain lengths of route on one side of the railway positively verified as not containing an Earthwork as defined above, lying within the Network Rail boundary. Categorised as follows:

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- **At grade:** Level ground not requiring any substantial Earthwork to allow railway lines to pass at an acceptable level. Any Embankments or Cuttings present are less than 3 metres in height.
- **Tunnel:** 5 chain lengths of route entirely enclosed within a tunnel structure.
- **Viaduct:** 5 chain lengths of route elevated above ground level on an extended bridge structure.

Earthworks defect

A feature of an Earthwork that reduces, or has the potential to reduce, the safety and/or performance of the Earthwork, or to increase its vulnerability to triggering events that may reduce its safety and/or performance.

Earthworks failure*

Earthwork slope in a state of collapse, for example; rock fall, soil slip, slide or flow in an Embankment, Cutting or Natural Slope. The full definition of an Earthworks failure is given in [NR/ARM/M6DF](#): *Definitions for the Reporting of M6 Earthworks Failures*.

Earthwork height

The height of a Cutting, at a particular section, is the difference between the level of its crest and the lowest level of the ground at its toe (such as the level of the cess or the bottom of an open ditch). The height of an Embankment, at a particular section, is the difference between the level of the top of a sleeper and lowest level of the ground at its toe (including the bottom of an open ditch if present).

Earthwork segmentation

For the purposes of management, Earthworks are divided into 5 chain (approximately 100m) segments. The terminology adopted is illustrated in Figure 1.

- **Earthwork asset:** A segment of Earthwork (Soil Cutting, Rock Cutting or Embankment) up to 5 chains in length on one side of the railway.
- **Earthwork inspection 5 chain:** A 5 chain length of the network on one side of the railway that may contain one or more Earthwork assets of similar or different Earthwork type. Defines the lateral extent of the Examination of all Earthwork assets within it.
- **Whole earthwork:** The full (unsegmented) length of an Earthwork of a given construction type (Soil Cutting, Rock Cutting or Embankment) on one side of the railway composed of one or more adjacent Earthwork assets.

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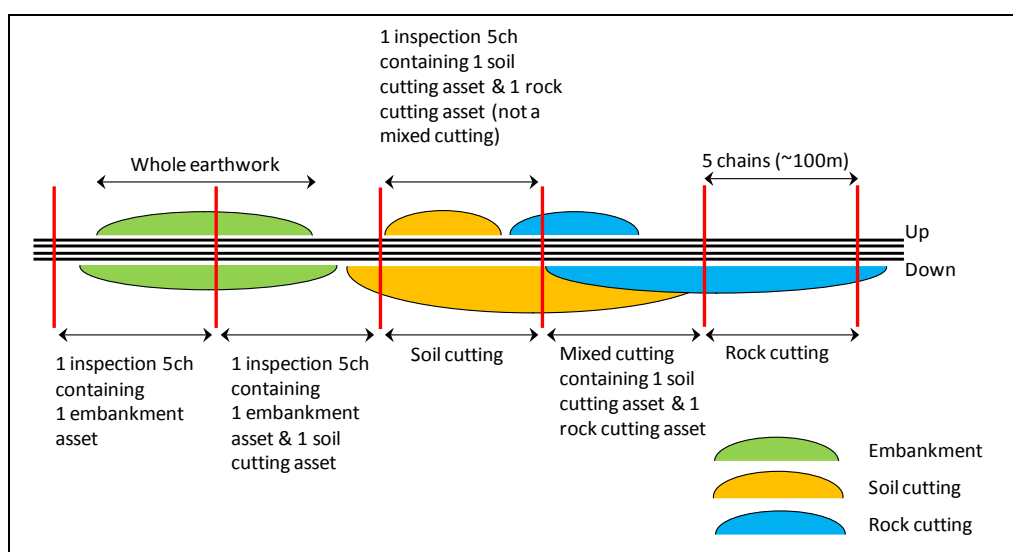


Figure 1 Segmentation of Earthworks

Earthwork inspection 5 chain status*

Each Earthwork inspection 5 chain of the network on the Up and Down sides will have a status that indicates whether an Earthworks inspection has been carried out or not at any time in the past. The terminology is illustrated in Figure 2

- **Never inspected⁴:** A 5 chain section of the network that has never been inspected for Earthworks and it is not currently known whether there are any Earthwork assets present or not.
- **Inspection finished:** A 5 chain section of the network that has been inspected and one or more Earthwork assets have been recorded into the Network Rail Earthworks Examination Database. All of the Earthwork assets in the 5 chain section currently have an Earthwork asset status of Full Examination.
- **Inspection unfinished:** A 5 chain section of the network that has been inspected and one or more Earthwork assets have been recorded into the Network Rail Earthworks Examination Database. One or more of the Earthwork assets in the 5 chain section currently have an Earthwork asset status of Not examined, Unscored Examination or Incomplete Examination.
- **No earthwork:** A 5 chain section of the network that has been inspected and no Earthwork assets that fall within the scope of this Standard (see 1.2) have been found.

Earthwork asset status*

Each Earthwork asset entered into the Network Rail Earthworks Examination Database will have a status that indicates the level of detail of Examination data held. The terminology adopted is illustrated in Figure 2.

- **Full Examination:** The Earthwork asset has had at least one Full Examination in accordance with this Standard and all the parameters necessary to calculate a Hazard

⁴ All Never inspected 5 chains shall be inspected by 1st April 2017 in order for the Network Rail Earthworks Examinations Database to achieve A2 data quality status. All newly found Earthworks shall receive a Full Examination in accordance with this Standard in the next Earthworks Examination season after their discovery.