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Transport Infrastructure Ireland

# TII Publications



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## Managing Geotechnical Risk

DN-ERW-03083  
October 2019

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## Contents

<b>1. Introduction .....</b>	<b>1</b>
<b>2. Management of Geotechnical Risk.....</b>	<b>6</b>
<b>3. Geotechnical Classification .....</b>	<b>10</b>
<b>4. Geotechnical Reports – General Requirements .....</b>	<b>11</b>
<b>5. Initial Review of Project.....</b>	<b>13</b>
<b>6. Preliminary Assessment.....</b>	<b>14</b>
<b>7. Geotechnical Design.....</b>	<b>15</b>
<b>8. Geotechnical Feedback .....</b>	<b>17</b>
<b>9. References.....</b>	<b>18</b>
<b>Appendix A: .....</b>	<b>19</b>
Format of Geotechnical Risk Register .....	19
<b>Appendix B: .....</b>	<b>22</b>
Format of Statement of Intent .....	22
<b>Appendix C: .....</b>	<b>24</b>
Format of Preliminary Sources Study Report .....	24
<b>Appendix D: .....</b>	<b>28</b>
Format of Ground Investigation Report.....	28
<b>Appendix E:.....</b>	<b>32</b>
Format of Geotechnical Design Report.....	32

**Appendix F:**..... **39**  
Format of Geotechnical Feedback Report ..... 39

## Contents Table

<b>1. Introduction</b>	<b>1</b>
1.1 Scope	1
1.2 Definitions and abbreviations	1
1.3 Implementation	4
1.4 Liaison between the Road Authority, Designer, and TII	4
1.5 Independent Checking	4
1.6 Third Party Developments	4
1.7 Geotechnical Certificate	5
<b>2. Management of Geotechnical Risk</b>	<b>6</b>
<b>3. Geotechnical Classification</b>	<b>10</b>
<b>4. Geotechnical Reports – General Requirements</b>	<b>11</b>
<b>5. Initial Review of Project</b>	<b>13</b>
5.1 Statement of Intent	13
<b>6. Preliminary Assessment</b>	<b>14</b>
6.1 Preliminary Sources Study Report	14
<b>7. Geotechnical Design</b>	<b>15</b>
7.1 Ground Investigation Report	15
7.2 Geotechnical Design Report	15
7.3 Geotechnical Certificate	16
7.4 Additional ground investigation during main works contract	16
7.5 Requirements for strengthened earthworks	16
<b>8. Geotechnical Feedback</b>	<b>17</b>
8.1 Geotechnical Feedback Report	17
8.2 Geotechnical Certificate	17
<b>9. References</b>	<b>18</b>
<b>Appendix A:</b>	<b>19</b>
Format of Geotechnical Risk Register	19
<b>Appendix B:</b>	<b>22</b>
Format of Statement of Intent	22
<b>Appendix C:</b>	<b>24</b>
Format of Preliminary Sources Study Report	24
<b>Appendix D:</b>	<b>28</b>

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Format of Ground Investigation Report.....	28
<b>Appendix E:</b> .....	<b>32</b>
Format of Geotechnical Design Report.....	32
<b>Appendix F:</b> .....	<b>39</b>
Format of Geotechnical Feedback Report.....	39

# 1. Introduction

## 1.1 Scope

This road Standard provides a framework to record the process for the management of geotechnical risks involved in a National Road Project. The purpose of the Standard is to ensure that the geotechnical risks associated with a project are identified at an early stage and managed through the project life cycle. The process requires the submission of one or more Geotechnical Documents as appropriate to the relevant Road Authority (RA) during the development of a National Road Project.

This Standard establishes the Designer's Geotechnical Advisor (DGA) who is responsible for liaison with the RA. A key aspect of effectively managing geotechnical risk is the establishment of liaison between these parties at an early stage of the project.

This Standard has been developed to provide consistency of approach for geotechnical design and certification for all National Road Projects.

This Standard is not intended to provide guidance on the nature or extent of ground investigations or at which stage of a project these should take place. The Designer should ensure that adequate ground investigations are undertaken at each Project Phase as appropriate.

## 1.2 Definitions and abbreviations

The following definitions are applicable to this Standard:

**Decision Register:** Project Decision Register as defined in PE-PMG-02041 *Project Management Guidelines*.

**Designer:** The Organisation employed to carry out the actual design work required for a project.

**Designer's Geotechnical Advisor (DGA):** A chartered geotechnical engineer with experience appropriate to the project being undertaken, and a minimum of ten years post-chartered experience who is employed by the Designer as Lead Professional, to oversee and act as focal point for the planning, procurement, interpretation, and implementation of the geotechnical aspects of a project.

**Designer's Site Representative (DSR):** The representative of the Designer based on site, on projects where detailed design is carried out by the Contractor appointed to execute the Works.

**Earthworks:** Work involving excavating or raising of ground.

**Geotechnical Activities:** For the purposes of this Standard, Geotechnical Activities includes without limitation, the design, construction, and maintenance of:

- a) Earthworks.
- b) Strengthened Earthworks.
- c) Ground investigations, both intrusive and non-intrusive.
- d) Earth retaining structures.
- e) Structural foundations and excavations.
- f) Ground treatment.

**Geotechnical Asset:** A principal element of the national road network, including the foundations to the road pavement and structures, together with the surrounding land, through which the route is formed, (including but not limited to cuttings embankments, pavement subgrade and a diverse range of natural geological strata and man-made materials).

**Geotechnical Design Report (GDR):** The report setting out assumptions, data, methods of calculation and results of the verification of safety and serviceability as required by IS EN 1997-1.

**Geotechnical Document (GD):** A document prepared to fulfil the requirements of this Standard.

**Geotechnical Engineering:** The application of sciences of soil and rock mechanics and engineering geology, in building, civil engineering construction, and the protection of the environment.

**Geotechnical Risk:** The risk to the project or the Road Authority's asset created by the site ground conditions, construction, and operational activities.

**Geotechnical Risk Register:** Tool for documenting geotechnical risks and actions to mitigate such risks

**Geotechnical Works:** The carrying out of Geotechnical Activities including associated aspects such as the assessment of contamination risks.

**Ground Investigation Report (GIR):** The report presenting all available geotechnical information and an evaluation of that information as required by IS EN 1997-2.

**Hazard:** Something which has the potential to have an adverse or undesirable impact.

**Independent Checking Consultant (ICC):** A Geotechnical Consultant employed to carry out an independent check of aspects of the geotechnical design. The ICC and Designer shall be from separate organisations with the ICC having no involvement in that stage of the project design. The ICC shall be subject to the agreement of the Road Authority.

**Managing Agent (MA):** The organisation responsible for the day to day management and maintenance of the road network.

**Project Execution Plan:** Project Execution Plan as defined in PE-PMG-02041 *Project Management Guidelines*.

**Project Phases:** Project Phases 0 to 7 as defined in PE-PMG-02041 *Project Management Guidelines*.

**Risk Classification:** A measure of the likelihood of a hazard occurring and the resulting possible consequence.

**Road Authority (RA):** For the purpose of this Standard, Road Authority shall be as defined under the Roads Act, or an alternative entity appointed by the Road Authority.

**Road Authority Site Representative (RASR):** The representative of the Road Authority based on site.

**SEAF:** Strengthened Earthwork Appraisal Form (included in Appendix E).

**Strengthened Earthworks:** Placed or in situ soil or other material, the stability of which has been improved by and including without limitation, inclusions in the form of tensile reinforcement acting through interface friction, bearing or other means, e.g. reinforced soil, soil nailing, or by external support such as gabions or crib walls or other proprietary methods.



**Structures Section:** The entity responsible for agreeing the Technical Acceptance and subsequently accepting the relevant certificates for the design of structures covered by DN-STR-03001 *Technical Acceptance of Road Structures on Motorways and Other National Roads*, as defined in DN-STR-03001.

**Third Party:** Any person, organisation, or other legal entity that is not employed directly or indirectly by the Road Authority.

### 1.3 Implementation

The procedures outlined in this Standard shall be followed during the process of planning and reporting of ground investigations and during the planning, design, and construction of Geotechnical Activities for National Road Projects in Ireland. The purpose of the procedure is to ensure that the geotechnical risks to such projects are identified, reported, and managed.

The procedures are applicable to:

- a) Projects promoted by TII, where TII is responsible for procurement of both the design and construction.
- b) Projects funded by TII, where the design and construction procurement is the responsibility of a Third Party.

The procedures detailed in this Standard are required on all projects which involve Geotechnical Activities as defined in Section 1.2. The process is also required where geotechnical information is required as part of assessment, design, and/or remedial works for structures covered by DN-STR-03001 *Technical Acceptance of Road Structures on Motorways and Other National Roads*, whether carried out as part of another project, or as projects in their own right. The requirements of this Standard shall not apply to pavement schemes undertaken in accordance with AM-PAV-06049 *Pavement Asset Repair and Renewal - Scheme Approval Procedures*, unless this is specifically included in the project scope.

This Standard requires all Strengthened Earthworks to be individually appraised, using the Strengthened Earthwork Appraisal Form (SEAF), which is in line with the Approval in Principle process that is required for road structures as described in DN-STR-03001.

At their discretion, the RA may require application of all or parts of this Standard on other projects (or parts of projects) not covered by the above.

### 1.4 Liaison between the Road Authority, Designer, and TII

For each project, the Designer is required to appoint a DGA as the focal point for all geotechnical aspects of that project. The RA will nominate a named individual that the DGA will be required to liaise with on the geotechnical aspects of the project. The RA shall inform TII when the documents required under this Standard have been received. The RA shall provide copies of the documents to TII when required by TII.

### 1.5 Independent Checking

An Independent Check of the geotechnical design of a project shall be required for all works covered by this Standard. This check will be carried out by a Geotechnical Consultant known as the Independent Checking Consultant (ICC). The RA may agree, at their discretion, to the removal of this requirement. The ICC shall include a chartered geotechnical engineer with a minimum of ten years' experience relevant to the project being undertaken.

### 1.6 Third Party Developments

The RA may from time to time require third party developments involving proposed works adjacent to, under or over a national road to follow all or parts of this Standard to ensure an efficient process.

## **1.7 Geotechnical Certificate**

At Phase 5 or 6 (depending on procurement type) as defined in PE-PMG-02041, a Geotechnical Design Certificate signed by the Designer, and unless agreed otherwise by the RA, a Geotechnical Check Certificate signed by the ICC, shall accompany geotechnical submissions to the RA.

On receipt of the Geotechnical Design/Check Certificate(s) and the accompanying submission, the RA or its representative will respond within a time limit laid down in the relevant contract documentation.

The professional responsibility for geotechnical design shall rest with the Designer. Acceptance of certificates or documents by the RA in the course of the procedure detailed in this Standard shall not modify or reduce the responsibility of the Designer.

Geotechnical certificates shall be individually numbered, including a project reference, unique certificate reference, and certificate revision number.

## 2. Management of Geotechnical Risk

To be effective in terms of reducing risk and identifying opportunities, geotechnical risk management should commence as soon as possible following project identification. The establishment of the Geotechnical Risk Register is an essential part of these procedures and shall be developed and refined as the project progresses.

Geotechnical risk management should not be carried out in isolation but shall be considered as an integral part of the whole of the project process from initial planning through to construction and completion. The processes set out in this Standard will require interaction between all members of the project team.

To ensure that the geotechnical risks are identified and correctly managed, this Standard requires the project team to follow a logical sequence of reporting and review of the geotechnical design process. This Standard sets out the procedure to be followed during the process of planning and reporting Geotechnical Activities for projects under the jurisdiction of the relevant RA.

Geotechnical Documents are prepared at several stages over the life of the project. These stages are arranged to be an integral part of the overall project progression to ensure the procurement of the geotechnical information necessary to undertake an accurate assessment of project risks.

The Statement of Intent (SOI), Preliminary Sources Study Report (PSSR), the Ground Investigation Report (GIR), the Geotechnical Design Report (GDR) and the Geotechnical Feedback Report (GFR) comprise the main requirements for this Standard.

The Geotechnical Risk Register is an important part of each of these documents and shall be updated throughout the life of the Project as it progresses through the Project Phases as defined in PE-PMG-02041.

The Geotechnical Risk Register shall document the identification of reasonably foreseeable geotechnical hazards, the risks or consequences should those hazards be encountered, and actions (taken or planned) to further investigate and understand the risk and to account for them in the design.

The suggested format to be followed in preparation of the Geotechnical Risk Register is given in Appendix A.

Where amendments to the documents as set out in this Standard are deemed appropriate, this shall be clearly documented and justified in the Project Execution Plan and is conditional on the agreement of the RA.

The Geotechnical Documents required under this Standard shall be produced at the relevant Project Phases outlined in Tables 2.1(a) and 2.1(b).

**Table 2.1(a): Project Phases and corresponding Geotechnical Document Requirements – Detailed Design carried out by the Employer prior to the appointment of a Contractor to execute the Works.**

<b>Project Phase</b>	
Geotechnical Documents (GD)	Certification
<b>Phase 0 Scope and Pre- Appraisal</b>	
<i>No GD required under this Standard</i>	
<b>Phase 1 Concept and Feasibility</b>	
<i>No GD required under this Standard</i>	
<b>Phase 2 Option Selection</b>	
Statement of Intent (incl. Preliminary Geotechnical Risk Register)	
Preliminary Sources Study Report (incl. Geotechnical Risk Register)	
<b>Phase 3 Design and Environmental Evaluation</b>	
Phase 3 Ground Investigation Report (incl. Geotechnical Risk Register)	
Phase 3 Geotechnical Design Report (incl. Geotechnical Risk Register)	
<b>Phase 4 Statutory Process</b>	
<i>No GD required under this Standard</i>	
<b>Phase 5 Enabling and Procurement</b>	
Detailed Design Ground Investigation Report (incl. Geotechnical Risk Register)	Design Certificate and unless agreed otherwise Check Certificate
Detailed Design Geotechnical Design Report (incl. Geotechnical Risk Register)	

Phase 6 Construction and Implementation	
Geotechnical Feedback Report	Design Certificate
Phase 7 Closeout and Review	
<i>No GD required under this Standard</i>	

**Table 2.1(b): Project Phases and corresponding Geotechnical Document Requirements - Preliminary Design carried out by the Employer and Detailed Design carried out by the Contractor appointed to execute the Works.**

TII Project Phase	
Geotechnical Documents (GD)	Certification

Phase 0 Scope and Pre- Appraisal	
<i>No GD required under this Standard</i>	
Phase 1 Concept and Feasibility	
<i>No GD required under this Standard</i>	
Phase 2 Option Selection	
Statement of Intent (incl. Preliminary Geotechnical Risk Register)	
Preliminary Sources Study Report (incl. Geotechnical Risk Register)	
Phase 3 Design and Environmental Evaluation	
Phase 3 Ground Investigation Report (incl. Geotechnical Risk Register)	
Phase 3 Geotechnical Design Report (incl. Geotechnical Risk Register)	

<b>Phase 4 Statutory Process</b>	
<i>No GD required under this Standard</i>	
<b>Phase 5 Enabling and Procurement</b>	
<i>No GD required under this Standard</i>	
<b>Phase 6 Construction and Implementation</b>	
Detailed Design Ground Investigation Report (incl. Geotechnical Risk Register)	Design Certificate and unless agreed otherwise Check Certificate
Detailed Design Geotechnical Design Report (incl. Geotechnical Risk Register)	
Geotechnical Feedback Report	Design Certificate
<b>Phase 7 Closeout and Review</b>	
<i>No GD required under this Standard</i>	

### 3. Geotechnical Classification

Depending on the complexity of the proposed geotechnical works and the geotechnical risk implications, the project shall be assigned a Geotechnical Classification based on the geotechnical categories defined in IS EN 1997-1.

The Geotechnical Classification for a project is assigned by the DGA and is subject to acceptance by the RA, irrespective of procurement method or design/construction responsibility, as part of Phase 2 Option Selection. Subject to the agreement of the RA a different Geotechnical Category may be assigned to separate parts of a project.

The majority of geotechnical activities associated with National Road Projects are anticipated to fall into Geotechnical Category 2.

The Geotechnical Classification shall be determined on the basis of the geotechnical works and risk implications. The structural checking category under DN-STR-03001 and the geotechnical category under EN1997 are independent definitions. The geotechnical categories do not necessarily correspond to the categories adopted for technical acceptance of structures to DN-STR-03001. A Category 3 structure in accordance with DN-STR-03001 may not correspond to a Geotechnical Category 3 as per this Standard. For example, a complex structure may have conventional foundations, or a conventional structure may be located in an area where abnormal geotechnical risks are present. Determination of the Geotechnical Classification in such situations should include discussions with the structural designer and the Structures Section.

For Geotechnical Category 1 projects it may be agreed between the DGA and the RA that production of the Geotechnical Reports set out in this Standard are not required. The DGA shall provide written justification for this decision. Agreement can only be given in advance of the design work being completed. Where the Geotechnical Reports are not produced, geotechnical risk shall be considered and recorded in the general project risk register.

For projects where, at the outset, it is clear that geotechnical activities are absent, the project Decision Register is annotated to that effect and no further action need be taken unless the project brief is amended. The Geotechnical Classification is reviewed if there is a change to the project brief. Subsequent Certification procedures will depend on that revised Geotechnical Classification, type of project or the procurement method to be used.



## 4. Geotechnical Reports – General Requirements

A fundamental requirement of the Geotechnical Risk Management procedure is the production of thorough and rigorously prepared reports. The reports must demonstrate how the geotechnical risks on a project are to be managed during the design and construction of a project. This includes how risks and the management of risk is communicated to the site team during construction. An overview of the requirement of the reports is given in this section with further detail in Sections 5.0 to 8.0 of this Standard.

The five Geotechnical Documents required to be prepared under this Standard are as follows:

- Statement of Intent (SOI).
- Preliminary Sources Study Report (PSSR).
- Ground Investigation Report (GIR).
- Geotechnical Design Report (GDR).
- Geotechnical Feedback Report (GFR).

All reports required by this Standard shall be prepared by the Designer for submission to the RA. For some forms of procurement, the reports will be submitted directly by the Designer to the RA (for example Employer designed schemes). For some forms of procurement, the reports will be submitted to the RA by a contractor organisation, (for example Contractor designed schemes and Public Private Partnership schemes). This Standard has been written such that it is applicable in principle to all current and likely future forms of procurement.

All reports shall include a Quality Assurance (QA) sign off sheet clearly documenting the people responsible for preparation, checking and approval of the document. Alternative terminology may be used to suit an individual Designer's QA procedures.

The aim of these reports is to set out, in a logical manner, the Designer's processes for identifying and overcoming or managing the geotechnical risks on a project. The GDR is a key document, which clarifies how the geotechnical design was undertaken and shall form part of the records for the project.

Preparation of a Geotechnical Risk Register is a fundamental part of the process for managing geotechnical risk. The risk register shall document consideration of reasonably foreseeable geotechnical risks, any actions, planned or taken, to investigate or quantify the presence or extent of risks and any decisions taken in the design arising from uncertainty associated with risks.

The geotechnical reports produced as part of the Geotechnical Risk Management process shall be living documents, in that they shall be updated and amended as appropriate as the design progresses, as information becomes available, as geotechnical risks are identified and resolved, and as information becomes available through construction.

Where the method of procurement or the Designer for a project changes during the life of the project e.g. at a later Project Phase, geotechnical information produced for the project shall be transferred. The outgoing Designer shall complete the geotechnical reporting to the stage required at handover. Any reports shall be provided to the incoming Designer as part of information accompanying, but not necessarily forming part of, the contract documentation for the procurement of the project. The RA provides no warranty as to the suitability, completeness, or accuracy of reports or information. Provision of these reports shall not in any way modify or reduce the responsibilities of the incoming Designer.

The content of the various reports will depend on the geotechnical complexity of the project. However, the report section numbering indicated in Appendices C, D, E, F, and G shall be followed irrespective of project size, with sections not being used or not relevant being noted as such in the contents page of each report. For projects within Geotechnical Category 1, it is acceptable to produce a shortened form of report to the same format that addresses the areas where geotechnical risk needs to be managed.

All Geotechnical Documents produced under the auspices of the Geotechnical Risk Management procedure are intended to be open documents and available to all parties during the progress of a project throughout its design, tender and construction stages.

## **5. Initial Review of Project**

At Phase 2 the project shall be reviewed in order to determine its Geotechnical Category and establish the Geotechnical Risk Management requirements. The DGA shall complete a Statement of Intent (SOI) for submission to the RA.

The complexity of the project shall be identified together with the geotechnical activities that may be involved to determine the Geotechnical Category. These shall be assessed together with the risks posed by and to the project. The Geotechnical Categories are as defined in Section 3 based on the requirements of IS EN 1997-1.

### **5.1 Statement of Intent**

Following initial review, determination of geotechnical classification and appointment of the Designer, the Designer shall prepare a SOI. The SOI shall identify known or suspected geotechnical risks and state the scope, purpose, estimated programme and cost of the initial geotechnical assessments. The SOI also includes the preliminary Geotechnical Risk Register. The suggested format to be followed in preparation of the SOI is given in Appendix B. The Preliminary Geotechnical Risk Register shall be included as an appendix to the SOI. The suggested format to be followed in preparation of the Preliminary Risk Register is given in Appendix A. It is intended to be a brief document and where appropriate may take the form of a letter. The SOI shall be appended to the Option Selection Report unless otherwise agreed between the DGA and the RA.

The SOI may provide details for a single route option or for more than one route option as required. Where the SOI provides details for more than one route option its contents may be used in the development of the emerging preferred route option. Any requirement for the SOI to provide details on more than one route option shall be agreed between the DGA and the RA.

For projects which clearly indicate that no geotechnical activities will be involved, there is no need for them to be assessed further and the project file shall be annotated accordingly.

## 6. Preliminary Assessment

The Designer shall complete a Preliminary Sources Study Report (PSSR) at Phase 2 for submission to the RA. This shall comprise of a Desk Study to document the geotechnical and other investigation implications for the feasibility of all project options. The suggested format for the report is provided in Appendix C.

### 6.1 Preliminary Sources Study Report

The PSSR is required for all projects which involve works covered by this Standard and includes a record of a site reconnaissance. The PSSR shall be appended to the Option Selection Report unless otherwise agreed between the DGA and the RA. The DGA shall consider whether it is appropriate to develop the PSSR in a staged approach in order to align with the development of the Option Selection Process as per PE-PMG-02042.

The PSSR shall include the geotechnical risks, implications and feasibility of all scheme options considered. The Geotechnical Risk Register shall be updated using information gathered in the production of the PSSR. The Geotechnical Risk Register shall establish the approach required to manage those risks identified and shall provide the geotechnical input into the assessment of project risks.

The PSSR shall address the geological, geotechnical, geomorphological, hydrogeological, and geo-environmental aspects of the project site as well as the historical development of the area. Contamination risks shall be investigated and reported within the PSSR.

The PSSR shall provide a preliminary engineering assessment of the project area and shall inform of likely hazards to construction. It shall identify risks and consequences to the project of the information gathered and inform an update to the Geotechnical Risk Register so as to establish the means to manage those risks.

The PSSR shall provide details for the area around the emerging preferred route option. The PSSR may provide details for more than one route option where these have been considered, as agreed between the Designer and the RA.

Annex A of the PSSR shall develop the objectives and methodology for investigation of ground conditions, and any phasing of such works that are deemed necessary by the DGA, which should cover both geotechnical and geo-environmental requirements.

On the basis of the information gathered for the PSSR and the identification of significant geotechnical issues, the vulnerability of a project to these issues and to any associated hazards shall be assessed by the DGA. The preliminary Geotechnical Risk Register produced as part of the SOI shall be updated to reflect the further site-specific information gathered at this stage. Updating of the risk register is an integral part of the risk management system and shall be repeated as more data becomes available through the project life cycle to completion.

The PSSR shall confirm or amend the project's Geotechnical Classification. If the brief for the project is revised, then the original SOI shall be reviewed and revised as necessary.

## **7. Geotechnical Design**

The Designer shall complete a Phase 3 Ground Investigation Report (GIR) and Phase 3 Geotechnical Design Report (GDR) for submission to the RA. These reports shall be revised and updated at TII PMG Phase 5 or 6 (depending on procurement method) to reflect the detailed design of the geotechnical activities. The Detailed Design GIR and Detailed Design GDR prepared at Phase 5 or 6 (depending on procurement method) shall be submitted to the RA with a Geotechnical Design Certificate and unless agreed otherwise a Geotechnical Check Certificate.

The GIR produced at Phase 3 shall be developed to a sufficient level of detail to inform the production of the Phase 3 GDR.

The Phase 3 GDR is the Designer's report on their interpretation of all investigations and the design of the geotechnical elements of the project to a sufficient level of detail to allow land take requirements and earthworks requirements to be established. The report shall detail how the risks identified in the Geotechnical Risk Register have been managed.

The Detailed Design GIR (produced at Phase 5 or 6) shall be developed to a sufficient level of detail to inform the production of the Detailed Design GDR (produced at Phase 5 or 6). It is to be expected that the Detailed Design GIR will contain a greater level of detail than the Phase 3 GIR.

The Detailed Design GDR (produced at Phase 5 or 6) is the Designer's detailed report on their interpretation of all investigations and the detailed design of the geotechnical elements of the project. The report shall detail how the risks identified in the Geotechnical Risk Register have been managed.

### **7.1 Ground Investigation Report**

The required content of the GIR shall be as detailed in IS EN 1997-2. When produced for projects covered by this Standard, the GIR shall also include plots of measured and, where used, derived parameters, a geotechnical evaluation of the information stating the assumptions made in the interpretation of the test results, and the known limitations of the results.

On completion of the ground investigation, the Designer shall prepare a GIR incorporating all the factual records and test results produced by the specialist Ground Investigation contractor (preferably produced as a separate volume). Confirmation or amplification of problems identified in the PSSR shall be included in this report.

The anticipated contents for the GIR are provided in Appendix D. The headings given in Appendix D shall be used in the GIR, but further headings may be added by the Designer if required.

Where applicable, recommendations and justification for further ground investigation works at subsequent phases shall be included in the GIR.

The Geotechnical Risk Register shall be updated based on the further information gathered in the production of the GIR.

### **7.2 Geotechnical Design Report**

The required content of the GDR shall be as detailed in IS EN 1997-1. When produced for projects covered by this Standard the GDR shall also document and justify the methodology used in the selection of characteristic values of geotechnical parameters.

The anticipated contents for the GDR are given in Appendix E. The headings given in Appendix E shall be used in the GDR, but further headings may be added by the Designer if required.

### **7.3 Geotechnical Certificate**

A Geotechnical Design Certificate and unless agreed otherwise a Geotechnical Check Certificate shall accompany all submissions of the GIR and GDR produced at Phase 5 or 6. If amendments which affect the geotechnical design are made during design development, then the GIR and GDR shall be updated by way of a revision to reflect those changes. This revision shall be submitted under cover of a new Geotechnical Certificate(s).

The GIR (or part thereof) shall be submitted to the RA in advance of any part of the GDR (or corresponding part thereof). Where the RA requires acceptance of the GIR in advance of submission of any part of the GDR this requirement should be laid out in the relevant contract documents. No works covered by the GDR shall be commenced by the Contractor before the relevant Certification for that part of the Works has been completed.

The GDR may be submitted in whole, or parts, to suit the design and construction programme as agreed with the RA. For large schemes, it is anticipated that the GDR may be split into a number of parts (covering individual earthworks areas, or individual structures) to allow it to be produced and certified in alignment with the construction programme. For a smaller straightforward scheme, it is envisaged that all elements may be addressed in a single GDR.

Certification is required under this Standard for the geotechnical matters of sub-structure design for structures covered by DN-STR-03001. If strengthened earthworks are envisaged or required, then additionally Section 4.0 of the Geotechnical Design Report shall be completed together with a Strengthened Earthwork Appraisal Form (SEAF) (see Appendix E).

### **7.4 Additional ground investigation during main works contract**

Where additional ground investigations are carried out during the course of a main works contract or where the design is amended from that contained in the certified GDR, the GIR and GDR shall be updated. The revised documents shall include the additional work and any amendment to the design and shall be submitted under cover of a new Geotechnical Certificate(s).

### **7.5 Requirements for strengthened earthworks**

Where the use of Strengthened Earthworks is proposed on a project, irrespective of procurement method, the Designer shall, prior to the submission of any GDR to the RA, complete and submit to the RA a SEAF based on the model form set out in Appendix E.

Where required by the Contract documents, an outline SEAF shall be submitted and approved prior to the return of any Main Works tender documentation. A full SEAF will be required to be prepared by the Designer and resubmitted once contracts have been awarded and design work undertaken.

The completed SEAFs shall be attached as an Annex to the GDR.

## **8. Geotechnical Feedback**

The Geotechnical Feedback Report (GFR) shall be produced at Phase 6 at the completion of the construction phase for submission to the RA. The format and requirements for the feedback report are presented in Appendix F.

The RA shall submit an electronic copy of the GFR to TII when it is received.

### **8.1 Geotechnical Feedback Report**

The GFR shall be completed by the Employer's Representative (for projects where detailed design is carried out by the Employer prior to the appointment of a Contractor to execute the Works) or the Designer's Site Representative (for projects where detailed design is carried out by the Contractor appointed to execute the Works), unless otherwise agreed by the RA, and shall be submitted to the RA within 6 months of Project Completion.

The GFR is required for all projects, irrespective of the method of procurement. It should be prepared as an ongoing task during the contract construction period.

The report shall utilise construction data to provide a record of the location and nature of materials encountered and utilised. Particular geotechnical problems not envisaged in the design and their solutions shall be recorded. The GFR shall record design changes implemented on site where they relate to geotechnical activities.

The report shall highlight any area of the specification or standards used that should be reviewed in the light of problems encountered on site. Where necessary, it shall also highlight any requirements for ongoing monitoring or maintenance requirements. The GFR shall include as built drawings.

The format of the GFR is given in Appendix F. A reduced scope of reporting for Category 1 projects may be appropriate. This shall be agreed with the Road RA prior to submission of the report.

The GFR shall be produced as an independent document, but once accepted should be incorporated within the Health and Safety File produced for the scheme.

### **8.2 Geotechnical Certificate**

A Geotechnical Design Certificate shall accompany all submissions of the GFR.

## **9. References**

DN-STR-03001 Technical Acceptance of Road Structures on Motorways and Other National Roads

PE-PMG-02041 Project Management Guidelines

AM-PAV-06049 Pavement Asset Repair and Renewal - Scheme Approval Procedures

IS EN 1997-1 Eurocode 7: Geotechnical Design – Part 1: General Rules

IS EN 1997-2 Eurocode 7: Geotechnical Design – Part 2: Ground Investigation and Testing



## **Appendix A:**

Format of Geotechnical Risk  
Register

Date (+ initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	Further Action	By	Status Active / Closed

The Designer is responsible for preparing the Geotechnical Risk register. Only those risks deriving directly from geotechnical works appear in the Geotechnical Risk Register. In preparing the Geotechnical Risk Register the following can be considered:

- The likelihood of a hazard being encountered can be given a numerical rating and this along with a numerical rating for the severity of the consequent risk can be used to give each risk a Classification. The application of mitigation measures should be designed to reduce the likelihood and / or the severity of a risk. This can be used to show the reduction in the Risk Classification after application of mitigation measures.
- The application of a numerical based risk classification should be considered on each project and should be developed to suit the Designers purposes.

The following is a non-exhaustive list of hazards that may be encountered on a road project;

- Presence of soft ground. Uncertainty regarding the thickness or extent of soft ground present. Uncertainty regarding the characteristic parameters to be used in developing the design of the geotechnical asset. Presence of different ground conditions to those assumed in the design, (data gathered through a site walk over, PSSR and any investigation work informs what a reasonable variation from the assumed conditions may be).

The following is a non-exhaustive list of Risks that may be encountered on a road project;

If present soft ground may have insufficient strength to support the proposed works. If the behaviour of ground supporting part of the works is different from that assumed in the design this could lead to collapse or unacceptable settlements. Different conditions to those assumed in the design may result in development of designs which do not meet the project requirements or Standard requirements

The following is a non-exhaustive list of Mitigations that may be encountered on a road project ;

- Calculations using characteristic parameters may be supplemented by calculations using worst credible parameters to assess impact of the occurrence of a risk, additional ground investigation may be undertaken to further inform the understanding of the hazard. Consideration of what a reasonable variation from the assumed conditions may be, and the consequence to the design if that reasonable variation occurs\*

\* This Mitigation could result in a different design being adopted to that initially anticipated. This will lead to the contents of the risk register being refreshed for the different design. Hazards which do not apply to the new design are indicated as such and are not deleted from the Risk Register.

## **Appendix B:**

### Format of Statement of Intent

## **1. Scheme**

Name and details of Scheme, key plan.

## **2. Objectives**

## **3. Existing Information**

Summary of existing information that has been identified to date.

## **4. Geotechnical Risk**

Preliminary summary of key geotechnical risks that are envisaged.

## **5. Proposed Studies and Investigations**

Outline of proposed studies and investigations that are to be undertaken to achieve geotechnical certification.

## **6. Specialist Consultation**

Details of any consultations required with reasons.

## **7. Programme and Cost**

Estimated programme and cost of work involved in preparation of the Preliminary Sources Study and Ground Investigation Report and any physical work required to support that report. (Not required in all cases).

## **Appendix C:**

Format of Preliminary Sources  
Study Report

## **1. Introduction**

Title Sheet, clearly indicating the name of the scheme, together with the title, details of the authorship and the version number of the report. The version number and date of the report is clearly placed as a footer to every page of the report.

Reference to Statement of Intent. Limits of study area and content and note of any previous geotechnical studies in the area.

## **2. Sources of Information & Desk Study**

Details of the results of all enquiries made and of all sources used for geotechnical, historical and other general information relevant to the area. Nil or negative responses should also be reported.

## **3. Field Studies**

Description of any field activities undertaken for this report - walkovers, geomorphological/geological mapping, probing, pitting and testing work, drainage/hydrological studies, geophysical or photographic surveys etc.

## **4. Site Description**

The topography, geology, hydrology, hydrogeology, geomorphology, man-made features, and historical development of the area should be investigated together with the geo-environmental and possible contamination issues. Most conveniently presented as a series of plans and overlays.

## **5. Ground Conditions**

Description of soils anticipated, with engineering properties known and predicted; significance of geological formations, ground water conditions etc.

## **6. Preliminary Engineering Assessment**

For each soil type and/or location preliminary consideration of the design implications including: General - location, classification, earthworks acceptability criteria, groundwater, likely difficulties and problems, areas/ features to avoid.

Cuttings – side slopes (short and long term), potential acceptability of material, merits of special drainage or ground treatment, swelling problems.

Embankments – side slopes, characteristics and restrictions on use of particular soils, plant use options, drainage requirements, foundation treatment.

Subgrade (where required) – likely CBR values for cutting areas and for potential fill materials in embankments, capping layers and availability of material, drainage requirements.

Structure foundations – Alternative types of foundation likely to be applicable, estimates of bearing pressures and settlements, groundwater, problem areas/strata, potential construction difficulties etc.

Contaminated land/Soil Chemistry – possibility of harmful elements present in soil or groundwater and implications of these. Scope for the reuse of marginal/recycled material within the works.

Any existing geotechnical problems i.e. Slope failures, solution features, mine workings slopes with marginal factors of safety, very soft/highly compressible soils.

Effects of man-made obstacles/site history.

## **7. Comparison of Project Options and Risks**

List all geotechnical, geo-environmental, historical and other factors discovered which are likely to influence the project for example routes, alignment and buildability.

An updated Geotechnical Risk Register; in which the risks of the primary hazards are assessed, the consequences of these risks to the project determined, and details of how the risks are to be managed given.

The Geotechnical Category is provided along with reasons why the category is appropriate. Where more than one route is under consideration a Geotechnical Category is given for each route.

A statement of the preferred routes/options (on geotechnical grounds) should be given if appropriate.

## **8. Drawings and Photographs**

Site Plan (usually 1:10,000) with study limits and scheme options. Plans/overlays to show topography, historical development, existing trial holes, geology, geomorphology, hydrogeology, hazards including contaminated ground and man-made features etc as appropriate. Geological longitudinal sections with cross-sections where appropriate.

Photographs both ground and air obtained for the study should be reproduced and referenced to the site plan.



## **Annex A to Preliminary Sources Study**

### **1. Objectives and format of any investigation**

(For example): To provide information to confirm and amplify the geotechnical and geomorphological findings of the Preliminary Sources Study, as reported separately and to obtain detailed knowledge of the soils encountered and their likely behaviour and acceptability. To ascertain ground water conditions and locations of underground workings, if any. Limits of work envisaged.

### **2. Special Problems to be Investigated**

Location of structures. Sub-soil conditions below and around areas of high embankment or other works. Aquifers and likely water-bearing strata affecting the works. Rock stability problems. Effects on adjacent properties etc. Any man-made features to be encountered. Contaminated ground.

### **3. Proposed Investigation**

Fieldwork - details of exploratory work proposed for specific areas with reasons for choice of investigatory method.

Laboratory work - details of proposals with reasons for choice of test and relevance to design. Summarised as tables. Requirement for Factual Data to be supplied in digital form to AGS Format.

### **4. Site & Working Restrictions**

Traffic management, difficult access, Statutory Undertaker's plant, Irish Rail restrictions, flora and fauna, designated sites.

### **5. Specialist Consultation**

Details and reason if proposed.

### **6. Programme, Cost and Contract Arrangements**

Anticipated start dates, contract periods, restrictions on programme, cost estimates (VAT excluded) for factual and interpretative work. Arrangements for contract work and supervision of contract.

### **7. Reporting**

Responsibility for reporting (with reasons), format and topics to be covered.

## **Appendix D:**

Format of Ground Investigation  
Report

**Note:** This report shall meet the requirements for the Ground Investigation Report as set out in IS EN 1997-2. The anticipated contents for the GIR is given in this Appendix.

## **Title Sheet and Contents**

Clearly indicating the name of the scheme together with the title, details of the authorship and the version number of the report. The version number and date of the report shall be clearly placed on every page of the report.

Contents of all volumes listed in the front of each volume with the contents of the particular volume highlighted. No Company specific disclaimers are to be attached to the report.

### **1. Executive Summary**

### **2. Introduction**

- 2.1 Scope and objective of the report
- 2.2 Description of project (including site description)
- 2.3 Geotechnical Category of project
- 2.4 Other relevant information

### **3. Existing Information**

This section is a review carried out by the Designer of all existing, geotechnically relevant information available on the project. The review highlights the implications to the project of that information. The PSSR is a basis for this section, but the information contained in the PSSR should be updated as necessary when such information is of a time-limited nature (this does not require the PSSR to be updated). Photographs obtained are reproduced and clearly referenced.

- 3.1 Topographical maps  
(old and recent)
- 3.2 Geological maps and memoirs
- 3.3 Aerial photographs  
(old and recent)
- 3.4 Records of mines and mineral deposits  
(including an updated Mineral Valuer's Report)
- 3.5 Land use and soil survey information
- 3.6 Archaeological and historical investigations
- 3.7 Existing ground investigations  
(including the relevant investigations carried out for the Road Authority and the results of those investigations)
- 3.8 Consultation with Statutory Bodies and Agencies.
- 3.9 Flood Records

- 3.10 Contaminated land
- 3.11 Other relevant information  
(may include hydrology and hydrogeology, natural cavities, landslides, erosion and deposition, seismic etc.)

## 4. Field and Laboratory Studies

This section is a description of the investigations carried out by the Designer as part of the design process.

- 4.1 Walkover survey
- 4.2 Geomorphological/geological mapping
- 4.3 Ground Investigations.  
(Description of the investigations carried out by the designer, including an outline of the aims and reasoning behind the requirement for the investigation)
- 4.3.1 Description of fieldwork
- 4.3.2 Factual Report  
(Factual account of all field and laboratory investigations. This can be bound separately if required)
- 4.3.3 Summary of results of in situ tests
- 4.4 Drainage studies
- 4.5 Geophysical surveys
- 4.6 Pile tests
- 4.7 Other field work
- 4.8 Summary of Results of Laboratory investigation
- 4.8.1 Description of tests
- 4.8.2 Summary of test results  
(The Ground Investigation information shall also be provided in digital form as set out in the Association of Geotechnical Specialists publication 'Electronic Transfer of Geotechnical Data from Ground Investigations').
- 4.9 Evaluation of geotechnical information  
(Assessment of the quality of the field or laboratory information and comment on any limitations which apply to the use of some or all of the data).

## 5.0 Ground Summary and Material Properties

This section describes the Designer's summary interpretation of the results of the investigations carried out in sections 3 and 4 above. The Ground Summary is a summary of the interpretation on the topography, geology, hydrology, hydrogeology, geomorphology, man-made features and historical development of the project and may be supplemented by a series of plans and overlays. A general ground model to be used for design is presented for the site. The ground summary shall include profile(s) showing the differentiation of the various formations and detailed descriptions of all formations including their physical properties and their deformation and strength characteristics. This section includes a review of the measured and derived values of geotechnical properties.

## **6.0 Geotechnical Risk Register**

This section contains an update of the Geotechnical Risk Register established for the project. The register highlights the risks and consequence of those risks together with the measures taken to mitigate those risks. It is essential that there is cross referencing in the report to ensure that the mitigation measures are taken forward in the design outlined in the Geotechnical Design Report.

## **7.0 References**

## **Appendix E:**

Format of Geotechnical Design  
Report

**Note:** This report shall meet the requirements for the Geotechnical Design Report as set out in IS EN 1997-1. The anticipated contents for the GDR are given in this Appendix.

The report includes details of the interpretation of design data and justification for the design and includes a layout drawing of that part of the works. Characteristic parameters and groundwater conditions for use in design calculations are presented and justified. The report includes the ground model to be used for design at each relevant section, area or structure.

Future maintenance requirements shall be considered and documented in the GDR.

The report is subdivided into sections on cuttings, embankments, structures and strengthened earthworks and is further subdivided for each unique earthwork or structure. Details for drainage design relevant to subgrade design and capping is be included. For larger schemes, the designer is encouraged to submit this section of the report in parts to suit the design and construction programme for the works. A discussion of potential contamination and proposed remediation requirements (if required) is be included.

IS EN 1997-1 requires this report to include a plan of supervision and monitoring, as appropriate. Items, which require checking during construction or, which require maintenance after construction are clearly identified. This is reported in Section 12 of this report.

## **Title Sheet and Contents**

Clearly indicates the name of the scheme together with the title, details of the authorship and the version number of the report. The version number and date of the report is clearly placed on every page of the report.

Contents of all volumes listed in the front of each volume with the contents of the particular volume highlighted. No Company specific disclaimers are to be attached to the report.

### **1.0 Introduction**

1.1 Scope and objective of the report

### **2.0 Earthworks**

2.1 Cutting stability

Full details of the methods of analysis, characteristic parameters, drainage, slope angles, CBR and other considerations. Summary of design including location, side slopes, maximum and typical depths, relevant site investigation, assumed soil strata and ground water conditions, earthworks, drainage requirements and pavement design. This may be either tabulated or submitted as a series of summary forms.

2.2 Embankment stability

Full details of the methods of analysis, characteristic parameters, drainage, slope angles, CBR and other considerations. Summary of design including location, side slopes, maximum and typical depths, relevant site investigation, assumed soil strata and ground water conditions, predicted settlements, earthworks, drainage requirements and pavement design. This may be either tabulated or submitted as a series of summary forms.

## 2.3 Re-use of Materials

Discussion of potential for re-use of excavated material and appropriate earthworks acceptability criteria.

## 3.0 Structures

Details of Structure type

Full details of the method of analysis and characteristic parameters assumed in the geotechnical design of structures including design of foundations and retaining elements. Summary of design including allowable bearing pressures, pile capacity, earth pressures, movement and differential settlement and protection against chemical attack to be provided for each structure. This information may be either tabulated or submitted as a series of summary forms.

## 4.0 Strengthened Earthworks

Details of Strengthened Earthworks.

Full details of the method of analysis and material parameters assumed in the design with reference to the appropriate SEAF. Summary of design to be provided at each location. This information may be either tabulated or submitted as a series of summary forms.

## 5.0 Drainage

Details of how the drainage design will address the groundwater conditions and how groundwater risks are to be managed.

## 6.0 Pavement Design, Subgrade & Capping

Method of analysis, soil parameters, ground water assumptions.

## 7.0 Assessment of Potential Contamination

7.1 Summary of the extent of the contamination testing that has been undertaken.

Description of the liaison that has been undertaken with the statutory authorities and the scope of risk assessments carried out to comply with regulatory authorities' requirements. This section is to include a summary of the current status with regards to regulatory approval and where appropriate records acceptance of these risk assessments by the statutory body.

7.2 Summary of the findings and conclusions of the risk assessments including the site remediation requirements that have been agreed with regulatory authorities.

This section includes any restrictions placed on the chemical content of materials to be used in the Works i.e. what it is acceptable to leave on the site and what needs to be removed from site. This can be presented in terms of limits for U1 in accordance with Series 600 of the Specification.

7.3 Details of contaminated materials to be removed from site.

## 8.0 Ground Treatment

Details of ground treatment (including void stabilisation, excavate and replace etc.)



## **9.0 Geotechnical Risk Register**

This section contains an update of the Geotechnical Risk Register specific to the elements covered by each GDR. The register highlights the risks and consequence of those risks together with the measures taken to mitigate those risks.

## **10.0 Specification Appendices**

Details of parameters and amendments for the specification appendices completed in Annex 1.

## **11.0 Instrumentation and Monitoring**

- 11.1 Full details of purpose, installation requirements, restrictions and frequency of readings and trigger levels for measured parameters
- 11.2 Instrumentation and monitoring action plan setting out actions to be taken, and by whom, should trigger levels be approached or exceeded
- 11.2 Use of Observational Methods/Controls. Predicted and critical readings and restrictions on work
- 11.3 Pile testing requirements

## **12 Maintenance Requirements**

Details of maintenance requirements which result from the chosen design during the operation of the road.

## **13 References**

ANNEX 1

Completed Specification Table 1/5 and Series 500, 600, and 1600 appendices including Tables 6/1, 6/2 and 6/3.

ANNEX 2

Completed SEAFs

## **Annex 2 to Geotechnical Design Report: strengthened earthwork Appraisal Form (“SEAF”)**

*Note: Typical contents of SEAF are outlined below. Format and content of SEAF to be confirmed and included in contract documentation.*

(Notes appended to explain the anticipated content of sections)

1. Scheme details
  - 1.1 Name of Scheme
  - 1.2 Type of Road
  - 1.3 Permitted Traffic Speed
  - 1.4 Nature of scheme/scheme element  
(e.g. new construction, widening of existing road, earthworks maintenance)
2. Strengthened earthwork type, purpose and location
  - 2.1 Generic Type of Strengthened Earthwork  
(e.g. strengthened soil slope, gabions, strengthened soil, soil nailing, crib wall)
  - 2.2 Purpose of Strengthened Earthwork  
(i.e. to allow road widening, for earthworks failure reinstatement, for new construction in area of restricted land take etc)
  - 2.3 Intended Location(s) for Use  
(a schedule of proposed lengths of strengthened earthworks and locations)
3. Outline of Existing Ground and Groundwater Conditions  
(This section to refer to the relevant sections of the Geotechnical Design Report when available)
  - 3.1 Ground Investigation Data  
(list report references and comment on extent of data)
  - 3.2 Existing Ground Conditions  
(brief summary of natural soil sequence, presence of Made Ground etc)
  - 3.3 Existing Groundwater Conditions  
(note on groundwater levels)
  - 3.4 Soil and Groundwater Chemistry  
(note on sulfate/chloride/pH conditions and/or ground contamination and microbiological action)
  - 3.5 Existing Geotechnical Problems and Risks  
(any factors of geotechnical significance related to the existing ground conditions, e.g. slope failures, solution features, mineworkings, slopes with marginal factors of safety, very soft/highly compressible soils etc)

4. Proposed Strengthened Earthwork
  - 4.1 Description of Strengthened Earthwork  
(range of and average height of proposed strengthened earthwork in its final form, ie slope face angle, facing/landscaping details including where appropriate topsoil and planting details)
  - 4.2 Foundation Preparation, including any Measures to deal with Geotechnical Problems  
(foundation proposals for the strengthened earthwork, including any special measures or associated works to take account of any problems outlined in 3.5 above)
  - 4.3 Materials to be used in Construction  
(outline description of geosynthetics, soil nails, gabion baskets, imported fill materials etc., including Design Certificates and evidence of CE marking under the Construction Products Directive where appropriate)
  - 4.4 Drainage Measures  
(particular drainage control measures to be incorporated)
  - 4.5 Arrangements for Road Furniture and Buried Services and Landscaping  
(relevant details)
  - 4.6 Inspection and Maintenance  
(particular inspection and maintenance requirements [including where appropriate the maintenance of vegetated slope faces], over and above routine observations)
  - 4.7 Interface with Structures  
(brief details of interface construction measures with bridges, abutments, retaining walls, buried structures, other Strengthened Earthworks etc)
5. Design Methods
  - 5.1 Internal Stability  
(the referenced design method/approach for determining stability of the strengthened earthwork itself)
  - 5.2 External/Global Stability  
(the referenced design method/approach for determining stability of any associated overall slopes which include the strengthened earthwork)
6. Design/Assessment Criteria
  - 6.1 List of Relevant Documents
  - 6.2 Limit State Design Criteria  
(factors of safety on limit state stability conditions to be applied in the design, on both stability of the strengthened earthwork itself and on overall stability of associated slopes)
  - 6.3 Serviceability Design Criteria  
(any total/differential settlement or other movement criteria adopted by the designer, including any imposed by Employer's Requirements)
  - 6.4 Design Parameters for Soils and Materials  
(schedule of relevant main design parameters for the soils and other materials to be used in construction)

- 6.5 Design Groundwater Conditions  
(statement of worst case, or range of piezometric conditions and/or  $r_u$  values to be used in design)
- 6.6 Live Loadings  
(confirmation of worst case live loadings to be assumed in design)
- 6.7 Description/Diagram of Idealised Soil Structure Model to be used in Analysis  
(provide a section of the strengthened earthwork to illustrate the design method and associated main design assumptions)
- 6.8 Precautions against Chemical Attack to Materials  
(measures to accommodate ground conditions set out in 3.4)
- 6.9 Proposed Departures from Design Standards  
(departures from documents listed in 6.1)
- 7. Checking  
(Designer to indicate the independent checking procedures to be employed)
- 8. Drawings and Documents
- 8.1 List of drawings and documents accompanying submission

Appendix A:

Soils Information (A list of the relevant trial hole logs and test results from the soils reports listed in para 3.1 and from any additional site investigation, extract from Geotechnical Report including the relevant parts of section 8 of the Geotechnical Report)

Appendix B

Relevant Correspondence, Documents and Certificates from Consultation with Relevant Authorities.

Appendix C

Drawings and documents.

## **Appendix F:**

### Format of Geotechnical Feedback Report

The anticipated format of the GFR are given in this Appendix.

## **Title sheet**

The name of the scheme together with the title (e.g. Geotechnical Feedback Report) and version and date of the report. The version number and date of the report is placed as a footer to every page of the report. For smaller schemes it may be appropriate to adopt a reduced scope for the Feedback Report. This should be discussed with the Road Authority prior to submission of the report.

## **Contents**

Contents of all volumes listed in the front of each volume with the contents of the particular volume highlighted.

### **1.0 Introduction**

- 1.1 Scope and object of the report
- 1.2 Limits of the area covered by the report
- 1.3 Bibliography of scheme specific geotechnical reports
- 1.4 Other relevant information

### **2.0 Earthworks**

- 2.1 General description of the earthworks
- 2.2 Problems not envisaged in the Geotechnical Design Report and their solutions.
- 2.3 Weather conditions
- 2.4 Application of acceptability criteria
- 2.5 Comparison of predicted and actual quantities of acceptable and unacceptable material.
- 2.6 Topsoil and planting
- 2.7 Details of any validation reports prepared to demonstrate compliance with the site remediation strategy and the requirements of the regulatory bodies

### **3.0 Cuttings**

- 3.1 For each cutting, location of materials excavated and their subsequent destination in the Works (with dates)\* – see Note 1
- 3.2 Details of problems encountered
- 3.3 Instability problems and unusual ground conditions
- 3.4 Ground water conditions and problems and drainage measures to overcome them
- 3.5 Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

## **4.0 Embankments**

- 4.1 For each embankment, source and location of all material placed (with dates)\*- See Note 1
- 4.2 Details of problems encountered
- 4.3 Instability problems and unusual ground conditions
- 4.4 Foundation treatment, including drainage measures and treatment of soft areas
- 4.5 Settlement of foundation and fill material

## **5.0 Subgrade/Capping/Pavement**

- 5.1 Method of subgrade preparation, details of capping materials used and details of any problems encountered
- 5.2 Method of placing each pavement layer and details of any problems

## **6.0 Drainage**

- 6.1 Methods of installing permanent drainage and details of any problems encountered

## **7.0 Imported materials**

- 7.1 Types of imported materials and their use
- 7.2 Source of imported materials and their location in the Works (with dates)\* - see Note 1
- 7.3 Acceptability and performance

## **8.0 Strengthened Earthworks**

- 8.1. Description of Strengthened Earthworks types and locations
- 8.2. Fill materials used
- 8.3 Record of soils and groundwater conditions encountered and drainage measures required
- 8.4 Inspection and maintenance requirements
- 8.5 Details of any in situ testing
- 8.6 Details of any problems encountered

## **9.0 Structure foundations**

- 9.1 Record of soil and ground water conditions encountered
- 9.2 Temporary works required and their effectiveness
- 9.3 Details of any problems encountered
- 9.4 Pile logs summary, pile test results and other relevant information
- 9.5 Settlement records with dates of each major stage including backfill of abutments and approach fills
- 9.6 Details of as built foundations

## **10.0 Testing**

- 10.1 Summary of site laboratory testing
- 10.2 Separate section on each type of test giving a summary of all results together with comments on them

(If a material report is prepared by the testing organisation then this should be used as the basis for this section with the actual report attached as an appendix to the Feedback Report)

## **11.0 Instrumentation**

- 11.1 Location and details of instruments
- 11.2 Purpose and performance
- 11.3 Readings (with dates) and predicted values
- 11.4 Details and effects of resulting action
- 11.5 Comment on need to continue monitoring

## **12.0 Summary of Problems Experienced and Design Changes**

- 12.1 Summary of problems and details of design changes to overcome them
- 12.2 Comments on how problems might be avoided in the future, including suggested revisions required to the SHW

## **13.0 Residual Health and Safety Risks**

Details of any residual Health and Safety risks on the project which would need to be considered if future work is carried out by the maintaining authority e.g. residual contamination, potential ground gas. Make reference to the Health and Safety File where appropriate.

**NOTE 1** Items marked \* (and others where possible) may be conveniently presented on longitudinal profiles and accompanying plans compiled as construction proceeds. Alternatively, electronic presentation of data may be appropriate.

**NOTE 2** Photographs should be included in the report to illustrate particular points.







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