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7 Soils and Geology

7.1 Executive Summary

1. The Soils and Geology assessment also considers potential impacts of the proposed Tyrone - Cavan Interconnector on groundwater. The proposed Tyrone - Cavan Interconnector has the potential to cause minor local adverse effects on soils, geology, geomorphology and groundwater. Land take for the tower bases and the substation would entail disturbance of surface materials during construction. The relatively small scale of the tower bases and their dispersed distribution means that losses of agricultural land will be of minor significance.
2. The proposed working areas avoid potentially contaminated land and known areas of peat. Proposed mitigation measures will reduce the potential degree and extent of soil degradation and reduce the significance of any adverse effect.
3. The proposed excavation for the towers and the substation will result in surplus uncontaminated materials which will be sent to landfill. There is no evidence that the towers or the substation will impact on any areas of contaminated ground or of previous mineral working.
4. The construction of the towers has the potential to cause a temporary, short-term modification in the groundwater level and flow where dewatering is required to facilitate foundation construction. However, any potential impacts will be managed by mitigation measures implemented on the site and will be of minor significance.
5. At the substation the groundwater level is below the proposed excavation profile. Accordingly, it is concluded that the construction of the substation will have no impacts on groundwater level or flow.
6. It is considered that the operation of the proposed Tyrone - Cavan Interconnector does not pose any significant risk to geology, soils or groundwater and that no specific mitigation measures are necessary.

7. As stated in the Statement of Case, the Consolidated ES has provided an assessment of the sites of contaminated land and found that none present a risk in respect of contamination as no elements of the proposed Tyrone - Cavan Interconnector are located on areas of potential contaminated land. NIEA Land and Resource Management are satisfied with the Contaminated Land Risk Assessment reports provided for those towers located in the vicinity of potentially contaminated sites (Towers 49 and 72) and recommend approval subject to conditions.
8. Prior to construction, a Construction Environmental Management Plan (CEMP) (an outline of which is provided in Appendix 9.1 of the Consolidated ES Addendum) will be agreed with DAERA to facilitate the management of any contaminated land discovered during the construction work to prevent adverse impacts on human health, groundwater and surface water. Whilst there is no evidence that such areas exist, it is considered prudent to include a procedure within the CEMP for the management of contaminated materials unexpectedly excavated during construction. This will be within the framework of measures provided in the Outline Construction Environmental Management Plan (Appendix 9.1 of the Consolidated ES Addendum).

7.2 About the Author

9. The Geology, Soils and Groundwater assessment of the proposed project was undertaken by an AECOM hydrogeological specialist, Philip Smart. He has a BSc in Physical Geography and Geology from the University of Liverpool and an MSc in Hydrogeology from University College, London. He is a Chartered Geologist and a Fellow of the Geological Society of London.
10. Mr Smart is a Technical Director with AECOM, responsible for the hydrogeological expertise of the Company in the UK. He has 40 years' experience in hydrogeological matters with particular expertise in the investigation and exploitation of groundwater resources and groundwater management and in the assessment of groundwater contamination issues. He also has wide experience in the assessment of the impact of contaminated land on both human health and groundwater, and in geological and soils assessment for major infrastructure projects.

11. His hydrogeological experience includes projects in a wide range of hydrogeological conditions both within the UK, Ireland, and abroad, including conditions similar to those along the route of the proposed Tyrone – Cavan Interconnector. He is currently the Project Hydrogeologist advising the Contractor for the central section of the Thames Tideway Tunnels scheme in London.

7.3 Policy and Guidance Informing Assessment

12. Policy and Guidance Information is contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (page 254) and the Statement of Case that has been prepared for the proposed Tyrone – Cavan Interconnector.

7.4 Summary of Documents

13. This Technical Report summarises and incorporates by reference the content of the documents submitted in support of the planning applications for the proposed Tyrone - Cavan Interconnector in respect of geology, soils and groundwater.
14. The relevant documents are:
 - Chapter 9 of the Consolidated ES, Soils, Geology and Groundwater (pages 251-279):
 - Figure 9.1 - Summary of Bedrock Geology;
 - Figure 9.2 - Summary of Superficial Deposits;
 - Figure 9.3 - Contaminated Land and Mine Shafts & Adits;
 - Chapter 5, Proposed Development (p117-150);
 - Chapter 8, Section 8.6 (Residual Effects of Water Environment Chapter) of the Consolidated ES (page 248);
 - Appendix 9A Details of ASSI designations (Volume 3 Appendices);
 - Consolidated Environmental Statement Addendum – Volume 2 – Main Text – Chapter 5 – Cumulative Assessment; and
 - Consolidated Environmental Statement Addendum – Volume 2 – Main Text – Chapter 6 – Transboundary Assessment.

15. This Technical Report must therefore be read in conjunction with the Consolidated ES and its Addendum, and not as a standalone document. In the interest of readability these documents are not reproduced in full in this Technical Report.
16. In a general sense all EIA documentation is interrelated and, particularly with respect to the interaction of impacts, all the EIA documents are relevant. For clarity the documents the author considers to be the key documents are summarised above. The reader should form his or her own view on what documents within the Consolidated ES and its Addendum are relevant, and key, to the topic under consideration.

7.5 Further Environmental Information for the Purposes of the Inquiry

17. Since the publication of the Consolidated ES and its Addendum, the following environmental information has become available, and is presented to the inquiry for the purposes of the inquiry. Accordingly, and by virtue of Regulation 23(6) of the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015 the requirements of paragraphs (4) and (5) of the said Regulation 23 do not apply.
18. During the Oral Hearing into the section of the proposed Interconnector in Ireland (May 2016), the issue of possible ground collapses due to past underground mineral working was discussed. This issue principally related to the former Lemgare Lead Mine located immediately to the south west of the border and to the north of the proposed Interconnector. The majority of the towers in this area are in the Republic. Tower 102 is located within the proposed Tyrone – Cavan Interconnector study area and is the closest tower in Northern Ireland 2km from to the former Lemgare Mine.
19. An assessment has shown that the mineral veins associated with the former Lemgare Mine workings extend into Northern Ireland. However, workings in Northern Ireland comprise only historical trial excavations. There is no evidence for any extensive mineral workings having been carried out. It is concluded that these trial workings do not pose a constraint on the siting of the towers along this section of the proposed Tyrone - Cavan Interconnector. Further details are provided at Appendix 7A of the Consolidated ES.

7.6 Scope of Assessment

20. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (pages 251 – 252).
21. Impacts on geology, soils and groundwater were considered within a study area approximately 500m wide either side of the route of the proposed Tyrone - Cavan Interconnector between the site of the proposed substation in the north and the border with the Republic of Ireland in the south. Based on the author's professional judgement, it was considered that any effects of the proposed Tyrone - Cavan Interconnector on geology, soils and groundwater will be constrained within this distance from the route. In addition, the locations of any designated sites of geological / geomorphological / physiographical significance and sites of potentially contaminated land in the vicinity of the proposed Tyrone – Cavan Interconnector were identified.
22. The assessment was designed to identify the rock and soil types and structures and the groundwater conditions along the route of the proposed Tyrone – Cavan Interconnector, in particular to identify sensitive geological and hydrogeological locations and any areas of poorly consolidated ground that could adversely affect the stability of the towers or adjacent land.
23. The assessment of the severity of any predicted impacts was based on the sensitivity of the feature, which could be impacted, such as by:
 - Direct damage to sites of special geological/geomorphological/physiographic interest;
 - Destruction and loss of agricultural soils;
 - Importance of groundwater as a source of public or private water supply or as a feed to surface water features, wetlands and watercourses;
 - Potential impacts of excavation and handling of soils; and,
 - The scale of disturbance of contaminated materials and potential associated risks to human health and 'controlled waters' (surface waters and groundwater).
24. A qualitative approach was used in the assessment based on the significance of the attribute and through professional judgement. The significance of a predicted impact is based on a combination of the sensitivity or importance of the attribute and the predicted magnitude of any effect. The assessment considers both predicted effects on the

geological conditions and the groundwater environment and residual effects, which would remain after the implementation of any mitigation measures.

25. In order for a potential impact to be realised, three factors must be present. There must be a source or a potential effect; a receptor which can be adversely affected; and, a pathway or connection which allows the source to impact the receptor. Only when all three factors are present can an impact be realised.

7.7 Consultation Responses

26. A review of all potential environmental impacts of the proposed Tyrone – Cavan Interconnector was undertaken by the Applicant and its specialist advisers. Consultations were subsequently undertaken with stakeholders, in particular the NIEA Land and Resources Management Unit. Further details are provided in the Consolidated ES, Volume 2, Chapter 6 (Scoping and Consultation).
27. Subsequent to the publication of the Consolidated ES, no specific comments have been made in relation to geology, soils or groundwater other than a request by Armagh City, Banbridge & Craigavon Borough Council for the inclusion of conditions in respect of contaminated land, which are acceptable to the applicant.

7.8 Methodology and Surveys

28. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (pages 251 - 254).
29. The assessment considers the geology and the soil and groundwater conditions of the proposed Tyrone - Cavan Interconnector and the adjacent area, based on published and other publically available information that was collated. The data obtained has been used to prepare a detailed assessment of the existing conditions on and in the immediate vicinity of the proposed Tyrone - Cavan Interconnector. The existing conditions form the baseline against which the impact assessment was determined.
30. The Geological Survey of Northern Ireland (GSNI) was consulted with regard to the possible impact of the proposed Tyrone - Cavan Interconnector on geological features. The NIEA Land Resource Management was consulted regarding the location of

contaminated land sites in the vicinity of the proposed Tyrone - Cavan Interconnector included in the NIEA Land Use Database and to identify any comments NIEA had on the proposed Tyrone - Cavan Interconnector. The site of the proposed substation and the sites of the majority of the towers were inspected. Specific site visits were made to all areas of identified potentially contaminated land in close proximity to the proposed Tyrone - Cavan Interconnector. A qualitative contaminated land risk assessment was undertaken of those seven towers, which are located in the vicinity of potentially contaminated sites.

7.9 Assessment Overview

31. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (pages 251 - 279). The results of the assessment are contained in Section 9.4 (Potential Impacts) of the Consolidated ES (pages 270 - 275). Further information relating to the assessment methodology is presented in Section 9.2.1.2 of the Consolidated ES (pages 253-254).
32. The EIA determined that the proposed Tyrone - Cavan Interconnector has the potential to cause slight adverse effects on geology, geomorphology, hydrogeology and soils in the study area. Land take for tower base and substation construction over the length of the overhead line would entail disruption of surface materials (drift and soils) during construction, and would remove tower base locations and the substation site from other productive uses during operation.
33. The geological deposits that will be affected by the structures are of widespread occurrence, and works and operations associated with the proposed Tyrone-Cavan Interconnector will have no significant impact on their local or regional availability for study. The regional scale of the geomorphological features that will be affected by the scheme also means that tower emplacement and substation construction will have only a minor impact on these features.
34. As the Proposed Tyrone - Cavan Interconnector does not impinge on the Areas of Special Scientific Interest (ASSI) or the Earth Science Conservation Review (ESCR) sites, it is concluded that there will be no impact on the geologically designated sites.

35. The ground conditions in the vicinity of the proposed Tyrone - Cavan Interconnector are considered to be of low sensitivity as the geological deposits that will be affected by the structures are of widespread occurrence. Impacts on the existing ground conditions would be restricted to excavations necessary for the tower locations and the substation. The magnitude of the impacts at the tower locations is considered to be low. The magnitude of the impacts at the substation is considered to be high. In accordance with the assessment methodology presented in Table 9.2 of the Consolidated ES (page 254), the significance of the potential impacts on the ground conditions is considered negligible other than at the proposed substation where a moderate impact is predicted.
36. The construction of the proposed substation and the towers will generate approximately 103,797m³ of surplus material which will need to be disposed of offsite. As it is anticipated that the excavated materials will comprise natural uncontaminated soils, there will be no contamination restrictions on the ability of landfills to accept the materials.
37. Groundwater is present in the Ordovician and Silurian rocks beneath the southern section of the proposed Tyrone - Cavan Interconnector but quantities are negligible and groundwater generally is limited to fractures and to the upper weathered zone. The Carboniferous strata beneath the central 15 km section and part of the northern section of the proposed Tyrone - Cavan Interconnector are moderately permeable with limited, local importance as a groundwater resource. The Sherwood Sandstone beneath the northern section of the proposed Tyrone - Cavan Interconnector is a major aquifer of regional importance.
38. Groundwater is present in the granular units of the superficial deposits and it is likely that the groundwater generally is in hydraulic continuity with the local surface water system. The construction of the towers has the potential to cause a temporary impact on the local groundwater level and flow and to impact on water quality through dewatering. However, any potential impacts will be controlled by mitigation measures implemented on the site.
39. Based on the findings of a ground investigation undertaken at the site of the proposed substation in 2006, it is concluded that the excavations required for construction of the substation will be above the groundwater level in the underlying superficial deposits.

Accordingly, it is concluded that construction of the substation will not impact on the groundwater level or flow.

40. Following granting of planning consent, a ground investigation at each tower location will be carried out to confirm the ground and groundwater conditions. Where dewatering is required to install the tower foundations, a confirmatory survey of existing water supply sources will be undertaken within 300m of each tower. Where there is considered to be a risk of derogation of an existing water supply spring, well or borehole, an appropriate alternative supply will be provided for the period of dewatering. Any impact will be temporary and limited to the period of dewatering, which is unlikely to exceed seven days.
41. The main effect on soils of the proposed Tyrone - Cavan Interconnector is likely to be the localised loss of good quality soil within the bounds of the tower constructions. However, the relatively small scale of the tower bases, and their dispersed distribution, means that losses of agricultural land will be limited and the impact will be of negligible significance.
42. A number of sites have been identified from the NIEA Contaminated Land database within 500m of the proposed Tyrone - Cavan Interconnector as having a potential for land contamination. Construction sites will avoid these areas.
43. The sites on the NIEA database are listed in Table 9.6 (page 267) of the Consolidated ES and shown in Figure 9.3. The distance to the nearest tower has been used, as the overhead lines would have no impact on the underlying ground conditions. The only tower sites or access routes that are close to potentially contaminated sites (within around 100m) on the NIEA list are Towers 49 and 72. Towers 10, 25, 26, 29 and 31 are located within approximately 500m of potentially contaminated sites on the NIEA database.
44. It is concluded that the potentially contaminated land sites in close proximity to the route of the proposed Tyrone - Cavan Interconnector do not pose a significant risk of contamination or a constraint to the proposed Tyrone - Cavan Interconnector. None of the towers are located on areas of potential contaminated land. In summary, it is concluded that impacts related to the presence of contaminated land are negligible.

45. There is no evidence that the towers or the substation will impact on any areas of contaminated ground. Accordingly, there is no risk that the water pumped from the excavations for the towers or from the substation will contain chemical contaminants which would pose a risk to the quality of the surface water systems.
46. There is no evidence of former underground mineral workings in close proximity to the towers. Accordingly, it is concluded that such workings do not pose a constraint on the siting of towers in the southern section of the proposed Tyrone - Cavan Interconnector.
47. Tower bases are marginal to, or remote from, known peat deposits, and avoid peat areas on significant slopes, with the consequent absence of risk of potential slope failures arising from the poor cohesion of disturbed peat bodies, resulting in 'peat slides'. Such conditions do not exist along those sections of the route of the proposed Tyrone - Cavan Interconnector where works are proposed. No peat was found in boreholes or trial pits at the substation site. Whilst the towers have been located to avoid areas of peat, the ground investigations at each tower location undertaken following approval of the proposed Tyrone - Cavan Interconnector, may prove the presence of peat either at the surface or at depth. A number of foundation designs have been prepared to take account of the variable ground conditions along the route, including where peat is present. These are outlined in Chapter 5 of the Consolidated ES. These foundations have been designed to be applied to all ground conditions and can be undertaken within the defined footprint of the tower and within the planning application boundaries.
48. It should be noted that the presence of peat in a geological context is a separate issue to peat in an ecological context, e.g. bogs and wetlands. Ecological impacts are separately dealt with but there are no significant impacts as a result of the proposed Tyrone - Cavan Interconnector to wetland habitats.
49. Operational impacts on geology and groundwater will be negligible. Access to towers for maintenance purpose will be required during operation, but any additional soil compaction due to vehicle use will be of short duration and of low intensity.
50. The decommissioning of the proposed Tyrone – Cavan Interconnector is assessed in Chapter 1 of the Consolidated ES Addendum (page 5). The effects of decommissioning would be temporary and of a similar scale to or less than the construction phase, as described and assessed in the Consolidated ES. Similar mitigation measures as

described for the construction stage in the Consolidated ES should be again implemented to ensure the minimisation or elimination of any environmental impacts.

7.10 Baseline Conditions

51. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (pages 255 - 270).
52. The majority of the proposed Tyrone - Cavan Interconnector route is underlain by a variable thickness of superficial deposits, which include sand and gravel, boulder clay, alluvium and peat. Bedrock outcrops are rare due to the thick cover of superficial deposits. The superficial deposits overlie a complex bedrock geology of variable age, ranging from Ordovician to Tertiary.
53. Lower Palaeozoic greywackes (sandstones) and slates of the Acton Group underlie the southern part of the route of the proposed Tyrone - Cavan Interconnector. These deposits are widespread across the area of the southern part of the proposed Tyrone - Cavan Interconnector. Occasional dolerite and basalt dykes of Tertiary age, trending north west to south east, have been mapped within the Acton Group. Mineral development within the Acton Group indicates low grade metamorphism.
54. The central part of the route of the proposed Tyrone - Cavan Interconnector, to the west of Armagh crosses the Carboniferous Limestone of the Tyrone and Armagh Groups. Geological map Sheet 47 shows occasional faulting within the Carboniferous Limestone. However, where the rocks outcrop, such as around Benburb, a much more complex structure has been mapped with extensive faulting.
55. The Carboniferous Limestone strata are overlain unconformably by the Triassic Sherwood Sandstone Group, represented by the basal Milltown Conglomerate and the overlying Derrycreevy Sandstone Formation and the Mercia Mudstone. The Triassic rocks underlie the majority of the northern section of the route of the proposed Tyrone - Cavan Interconnector between Towers 1 and 48, apart from a section west of Moy where a faulted area of limestone of the Tyrone Group underlies approximately 3km of the proposed Tyrone - Cavan Interconnector. The Sherwood Sandstone consists principally of the Derrycreevy Sandstone, a thick sequence of red sandstone with occasional siltstone and mudstone. Table 9.3 (page 256) provides a summary of the

geology of the Study Area and Table 9.4 (pages 258-263) provides a tower by tower analysis of the geological conditions.

56. The soils and bedrock along the study area are widely variable in their hydrogeological characteristics. Ordovician greywackes and shales beneath the southern part of the overhead line route are generally of low permeability, and lack groundwater except at shallow depth. In contrast, the Sherwood Sandstone beneath the northern part of the proposed Tyrone - Cavan Interconnector (Towers 2-10, 12 and 22-48) forms a highly productive aquifer.
57. Two ASSI have been designated for their geological interest within 5km of the proposed Tyrone - Cavan Interconnector (Benburb ASSI and Benburb-Milltown ASSI). Both sites are located in the area of Benburb and are shown on Figure 9.1 of the Consolidated ES. Details of the ASSI designations for the two sites are provided within Appendix 9A of the Consolidated ES.
58. Information provided by the Geological Survey of Ireland identified former underground workings for lead at Lemgare close to the border and the route of the proposed Tyrone - Cavan Interconnector. There is evidence that the mineral veins extend into Northern Ireland. Other than two small historical trial excavations, there is no evidence of large scale mineral extractions. The mineral veins are generally more than 1km from the route of the proposed Tyrone - Cavan Interconnector. Further details are provided at Appendix 7A.

7.11 Assessment of Impacts Without Proposed Mitigation

59. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (pages 270 - 275).
60. The proposed Tyrone - Cavan Interconnector has the potential to cause minor local adverse effects on soils, geology and groundwater. Land take for the tower bases and the substation would entail disturbance of surface materials during construction. The relatively small scale of the tower bases and their dispersed distribution means that losses of agricultural land will be of minor significance.

61. The proposed working areas avoid potentially contaminated land and known areas of peat. Proposed mitigation measures will reduce the potential degree and extent of soil degradation and reduce the significance of any adverse effect.
62. There is no evidence that the towers or the substation will impact on any areas of contaminated ground. The proposed excavation for the towers and the Turleenan substation will result in uncontaminated surplus materials which will be re-used on site or sent to landfill.
63. The construction of the towers has the potential to cause a temporary, short-term, modification in the local groundwater level and flow where dewatering is required to facilitate foundation construction. However, any potential impacts will be managed by mitigation measures implemented on the site and will be of minor significance.

7.12 Proposed Mitigation

64. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (pages 275 - 277); Chapter 8, Water Environment (page 248); and Chapter 5 (page 150).
65. The impact of the proposed Tyrone - Cavan Interconnector on the local geology and landforms would be negligible and future monitoring of the potential impacts of the proposed Tyrone - Cavan Interconnector on geology and soils is considered unnecessary. Any impacts are considered likely to be minor and of a temporary nature. Measures to mitigate the impacts of the construction of the proposed Tyrone - Cavan Interconnector on geology, soils and groundwater have been considered and are discussed below. It is considered that the operation of the proposed Tyrone - Cavan Interconnector does not pose any likely significant risk to geology, soils or groundwater and that no specific mitigation measures are necessary.
66. Measures to control and mitigate impacts from the generation and runoff of suspended solids during construction are detailed in Section 8.6 (Residual Impacts of the Water Environment chapter) of the Consolidated ES (pages 248-249). Mitigation measures to address potential contamination by fuel spillages etc also are included in Chapter 8.6 of the Consolidated ES.

67. No areas of contaminated land have been identified which will be disturbed by the construction works and hence there is no known risk of chemical 'pollution' of watercourses by contaminated runoff from the construction sites.
68. In the unlikely event that contaminated land is discovered during construction, "specific proposals would be prepared, following the granting of planning permission to facilitate the management of any contaminated material" (Item 9.4, Table 21.1 of Chapter 21 of the Consolidated ES). Whilst there is no evidence that such areas exist, the requirement for this action will be included in the Contractor's CEMP, within the framework of measures in the outline CEMP (Appendix 9.1 of the Consolidated ES Addendum).
69. Potential impacts arising from soil compaction by mobile plant are considered in Chapter 8 (Water Environment) and Chapter 9 (Geology and Soils) of Volume 2 of the ES. Chapter 5 (Proposed Development) outlines measures by which soil compaction can be minimised or avoided. These measures include the use of temporary roads for mobile plant. The temporary roads will be constructed to minimise the area affected by the plant and protect the soil in the area of construction. As per item 13.3 of Table 21.1 of Chapter 21 of the Consolidated ES, vegetation will be restored prior to the end of the construction. Where soil compaction has taken place, which inhibits natural restoration, existing techniques will be used to reduce this effect and reinstate soil structure. With the reinstatement of any affected area, there will be no significant impacts.

7.13 Residual Impacts With Proposed Mitigation

70. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (page 277).
71. It is concluded that the construction of the scheme poses no significant risk to geology, soils or groundwater. Any minor impacts will be adequately controlled by standard procedures and pre-construction mitigation measures. Operational impacts will not be significant.

7.14 Cumulative Impacts

72. This is a summary of information that is contained in Chapter 5 (page 57) of the Consolidated ES Addendum. A further assessment of cumulative effects is outlined in the Joint Environmental Report for the proposed Interconnector project (i.e. the project in Northern Ireland and Ireland). This is contained in Volume 3 Appendix 2.1 of the Consolidated ES Addendum.
73. There are no other developments which interact with the proposed Tyrone - Cavan Interconnector from a soils and geology perspective. Accordingly, it is concluded that there are no cumulative geology, soils or groundwater effects.

7.15 Transboundary Impacts

74. This is a summary of the information that is contained in Chapter 6 (page 81) of the Consolidated ES Addendum. A further assessment of transboundary effects is outlined in the Joint Environmental Report for the proposed Interconnector project. This is contained in Volume 3 Appendix 2.1 of the Consolidated ES Addendum.
75. Impacts on the soils, geology and hydrogeology along the border are restricted due to the limited scale of excavations and associated works. Towers 98-102 are located in Northern Ireland adjacent to the border, with Towers 103-107 located in County Monaghan within 200m of the border. It is considered that no significant impacts will occur on the geology and groundwater conditions from the section of the proposed interconnector in County Monaghan on the receiving environment in Northern Ireland and vice versa. Accordingly, it is concluded that the proposed Tyrone - Cavan Interconnector will have no transboundary impacts in respect of soils, geology or groundwater in either country.

7.16 Response to Third Party and Statutory Consultee Submissions

76. Between 2009 and 2012, there were approximately 6,000 third party submissions made in relation to the proposed Tyrone - Cavan Interconnector. These were reviewed and taken into account in the writing of the Consolidated ES. Following the publication of that document in 2013, from May 2013 to May 2015, approximately 2,957 third party submissions were made - of these none made specific reference to geology, soils and

groundwater. In general, all submissions were considered and taken into account in the writing of the Consolidated ES Addendum.

77. Between May 2015 and November 2016, there have been approximately 594 third party submissions and none of these made specific reference to geology and soils.
78. In the letters received since May 2015, Armagh City, Banbridge & Craigavon Borough Council are the only statutory consultee that has identified any issues regarding geology, groundwater and soils. The Council has suggested that a condition should be imposed to address any risks associated with ground contamination and to require an assessment of any contaminated land unexpectedly excavated during the construction phase. The assessment provided in Chapter 9 of the Consolidated ES shows that there are no known areas of potentially contaminated land that will be disturbed by the construction of the proposed Tyrone - Cavan Interconnector. A procedure will be included in the CEMP for the management of contaminated materials unexpectedly excavated during construction, within the framework of measures in the outline CEMP (Appendix 9.1 of the Consolidated ES Addendum).

7.17 Events since the Addendum

79. Since the publication of the Consolidated ES and its Addendum, the following environmental information has become available, and is presented to the inquiry for the purposes of the inquiry. Accordingly, and by virtue of Regulation 23(6) of the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015 the requirements of paragraphs (4) and (5) of the said Regulation 23 do not apply.
80. As detailed in Appendix A of this Technical Report, in the Oral Hearing into the section of the proposed Interconnector located in Ireland (May 2016), the issue of possible ground collapses due to past underground mineral working was discussed. This issue principally related to the former Lemgare Lead Mine located immediately to the south west of the border and to the north of the proposed Interconnector. Tower 102 is the closest tower in the proposed Tyrone – Cavan Interconnector 2km from the former Lemgare Mine.
81. There is no evidence that the area immediately surrounding Tower 102 has been worked for minerals and hence it is considered that there is no reason to suspect any potential

instability of the underlying ground which could affect the tower stability. There is no evidence that the mineral has been extracted on a large scale in Northern Ireland. The available information suggests that only trial workings were undertaken at College Mine, Carryhugh and Derrynoose Lead Mine. Based on these historical trial workings, it is inferred that the mineral veins are present at least 1km east of the proposed Tyrone - Cavan Interconnector and hence it is concluded that these do not pose a constraint on the siting of the towers along this section of the proposed Tyrone - Cavan Interconnector.

82. As outlined in the Statement of Case and in Construction Technical Report (No. 4), alternative access is required to Tower 40 because of the construction of a chicken shed. Two alternative access tracks are described and assessed in the Construction Technical Report (No. 4). An assessment in terms of soils and geology for the alternative access tracks is included in that Technical Report.
83. Confirmatory aerial surveys of the entire proposed Tyrone – Cavan Interconnector (proposed substation area and 500m either side of the overhead line centreline, which includes the proposed access tracks) were undertaken in October 2016. This photography was reviewed in terms of the soils and geology baseline conditions and nothing of note was detected.

7.18 Summary and Conclusions

84. This is a summary of the information contained in the Consolidated ES, Chapter 9 – Soils, Geology and Groundwater (page 251).
85. The proposed Tyrone - Cavan Interconnector has the potential to cause minor local adverse effects on soils, geology and groundwater. Land take for the tower bases and the substation will entail disturbance of surface materials during construction. The relatively small scale of the tower bases and their dispersed distribution means that losses of agricultural land will be of minor significance.
86. The proposed working areas avoid potentially contaminated land and known areas of peat. Proposed mitigation measures will reduce the potential degree and extent of soil degradation and reduce the significance of any adverse effects.

87. The proposed excavation for the towers and the Turleenan substation will result in uncontaminated surplus materials which will be sent to landfill.
88. There is no evidence that the towers or the substation will impact on any areas of contaminated ground or of previous mineral working as no elements of the proposed Tyrone - Cavan Interconnector are located on areas of potential contaminated land. NIEA Land and Resource Management are satisfied with the Contaminated Land Risk Assessment reports provided for Towers 49 and 72 in the vicinity of potentially contaminated sites and recommend approval subject to conditions, which are acceptable to the applicant.
89. The construction of the towers has the potential to cause a temporary short-term, modification in the local groundwater level and flow where dewatering is required to facilitate foundation construction. However, any potential impacts will be managed by mitigation measures implemented on the site and will be of minor significance.
90. It is concluded that there are no significant cumulative geology and soils effects and that the proposed Tyrone - Cavan Interconnector would have no transboundary effects in respect of soils, geology and groundwater.
91. Prior to construction a CEMP, (an outline of which is at Appendix 9.1 of the Consolidated ES Addendum) will be agreed with DAERA to facilitate the management of any contaminated land unexpectedly discovered during the construction work to prevent adverse impacts on human health, groundwater and surface water. Whilst there is no evidence that such areas exist, it is considered prudent to incorporate this requirement within the CEMP.

Appendix A Assessment of the Impact of Mineral Extraction

Project:	Tyrone-Cavan Interconnector	Job No: 60120996/T10624
Subject:	Assessment of the Impact of Mineral Extraction	
Prepared by:	Philip Smart	Date: 14 September 2016
Checked by:	Fay Lagan	Date: 29 September 2016

Background

AECOM Limited is commissioned by SONI to provide technical advice in respect of the proposed construction of the Tyrone-Cavan Interconnector. This Technical Note addresses the potential impact of historical underground mineral extraction in the Republic of Ireland and the possible presence of such workings in Northern Ireland on the transmission towers located adjacent to the border. The assessment follows the Oral Hearing into the EirGrid southern section of the scheme in May 2016 when the issue of possible ground collapses due to past underground mineral working was discussed.

This issue principally relates to the former Lemgare Lead Mine located immediately to the south west of the border and partly beneath the route of the Interconnector. The majority of the towers in this area are in the Republic. Tower 102 is located within the SONI application area, but within 100m of the border. Tower 102 is the closest tower in the SONI application area to the former Lemgare Mine.

Geology

The geological conditions in the area have been interpreted from:-

- Geological Survey of Ireland *Geology of Monaghan – Carlingford* 1:100,000 Scale Map Sheet 8/9, 1997;
- Irish Geological Survey, Geological Field Sheet, unknown date (possibly 1927, updated post-1956) (Annex A1);
- County Geological Site (CGS) Report Lemgare (Annex A2);
- Historical plans of the area;
- ESCR description sheets of College Mine and Derrynoose Lead Mine (Annex B); and,
- Information from investigation boreholes drilled for the Mining Corporation of Ireland, 1956.

The area in the Republic is underlain by Silurian age strata of the Lough Avaghon Formation, consisting of massive sandstones (greywacke) with thin bands of slate and mudstone. The Lough Avaghon Formation is interpreted to be the equivalent of the Acton Group in Northern Ireland. Dolerite dykes of Tertiary age cross the area in a roughly north west to south east orientation.

Information from the Geological Survey of Ireland maps was used to identify the presence of former shafts and adits in the vicinity of the tower locations. In the area north of the border, information on former mine workings was obtained from the Geological Survey of Northern Ireland (GSNI) Shafts and Adits database. The GSNI database did not include any former mine workings in this area adjacent to the border with the Republic. However, the GSNI database includes the former Derrynoose Lead Mine (H798315) approximately 1km north east of Tower 98 and 2.5km north of the border (Site 15: Figure 9.3 of the Consolidated ES).

Derrynoose Lead Mine and the former College Mine at Carryhugh (H806335) also are both identified as ESCRs (Table 9.5 of the Consolidated ES). College Mine is described as a former trial mineral excavation for lead with a spoil heap and is located approximately 1.5km east of Tower 92 and 4.5km north of the border. Derrynoose Lead Mine is described as a *'former lead mine with spoil containing galena and sphalerite'*. In 1997, it was described as a flooded open shaft, approximately 2m wide with a spoil heap containing galena (Annex B). Both ESCR sites are located east of the proposed Tyrone - Cavan Interconnector. It appears that both are trial mineral workings which were never commercially exploited.

The extent of the former Lemgare Mine is shown on the geological field sheet (Annex A1) and the CGS report (Annex A2). This shows the presence of two principal mineral veins running parallel approximately north-north-west to south-south-east. Several former, disused adits and shafts are shown in the area associated with the two mineral veins (lodes) and to the east. The lodes are described as both 'very rich' and 'not rich'. The principal minerals present are galena (lead) together with sphalerite, barytes, pyromorphite and wulfenite. It is understood that the mineral is present as a vein breccia within a fracture approximately 4.5m wide. Information on the workings suggests that the mine only was worked for a short period during 1840 and 1841 along the western vein for a length of approximately 150m.

Subsequent trial drilling in 1956 intercepted the mineral vein in three inclined boreholes at depths of approximately 36.6m, 45.7m and 65.5-70.1m. It is inferred that the mineral veins dip to the east or south east at a steep angle of approximately 46°. The geological map also shows the presence of two basalt dykes, trending north west to south east, at least one of which cuts both mineral veins. It also is inferred from the geological map that the mineral veins appear to be associated with faulting.

Assessment

The mineral deposit at Lemgare is present within linear features running approximately north-north-west to south-south-east. As the mineral veins dip steeply to the south east and are of limited thickness, impacts on the surface are likely to be minimal unless where the mineral has been worked directly from the surface outcrop through drifts or adits. Historical maps show several shafts and adits in the vicinity of the identified mineral veins at Lemgare. The presence of shafts indicates that the mineral has not been worked from the surface but by deep mines.

Accordingly, it is considered likely that any impacts on the ground conditions will be limited to the surface expression of the mineral veins and to areas of former shafts and adits or areas of disturbed ground used for spoil/mine waste disposal.

Tower 102 is the closest tower to the border in the SONI application and is located approximately 2km north west of the northern extent of the known area of mineral workings at Lemgare Mine. There is no evidence for mineral workings in the vicinity of Tower 102. Extrapolation of the alignment of the mineral veins from the Lemgare area suggests that, if present within Northern Ireland, these would be at least 1.5km east of Tower 102. Accordingly, it is considered highly unlikely that the ground at the tower location has been disturbed by former mineral workings or presents a risk of instability/collapse posing a risk to the tower.

The information available from the published Geological Map Sheet 8/9 and on the Lemgare Mine suggests that the mineral veins are present only in the area south of the border and do not extend into Northern Ireland. There is no information on the geological maps to suggest that the mineral deposit has been worked north of the limit shown and also no information that any workings have extended into the area north of the border. However, it can be interpolated based on the alignment of the mineral veins at Lemgare and from the ESCR sites at College Mine and Derrynoose Lead Mine that the mineral deposit does extend into Northern Ireland.

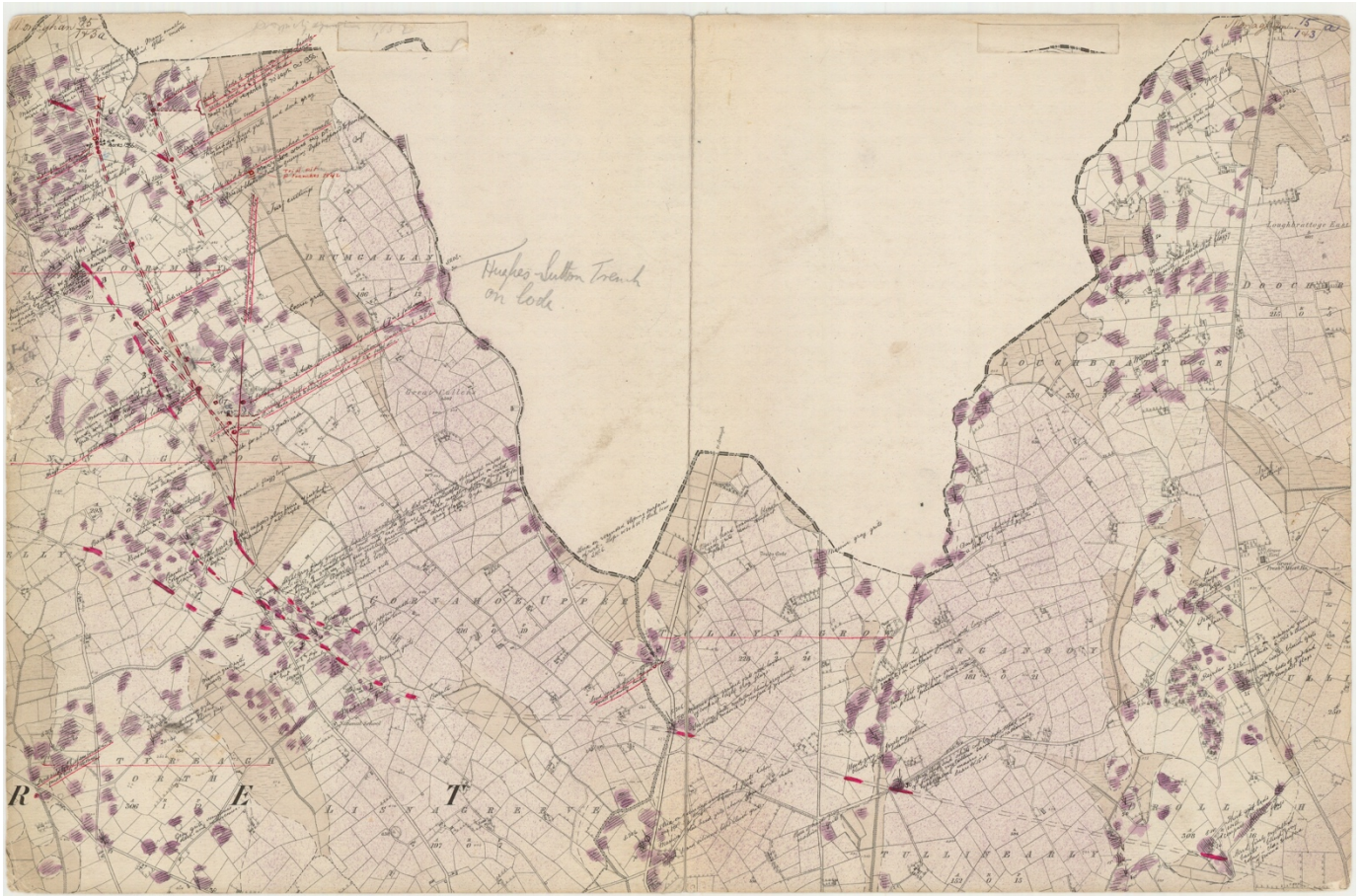
The inferred extension of the mineral veins into Northern Ireland shows that the mineral deposit is present generally more than 1km east of the proposed Tyrone - Cavan Interconnector. As the strata dip to the east/south east, it is interpreted that the mineral veins and any associated workings would be present east of the towers and east of the trial workings and hence these would not pose any risk to the proposed Tyrone - Cavan Interconnector.

Conclusions

There is no evidence that the area immediately surrounding Tower 102 has been worked for minerals and hence it is considered that there is no reason to suspect any potential instability of the underlying ground which could affect the tower stability. It is concluded that historical lead workings 2km to the south east of Tower 102, associated with Lemgare Mine do not pose a risk to Tower 102.

It is inferred that the mineral deposit extends into Northern Ireland although this is not shown on the geological plans. There is no evidence that the mineral has been extracted on a large scale in Northern Ireland and the available information suggests that only trial excavations were undertaken at College Mine, Carryhugh and Derrynoose Lead Mine. Based on these trial workings, it is inferred that the mineral veins are present at least 1km east of the proposed Tyrone - Cavan Interconnector and hence it is concluded that these do not pose a constraint on the siting of the towers along this section of the proposed Tyrone - Cavan Interconnector.

AnnexA1
Irish Geological Survey, Geological Field Sheet



Annex A2
County Geological Site Report Lemgare and Site Location Plans

MONAGHAN - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Lemgare
Other names used for site	
IGH THEME	IGH 6 Mineralogy
TOWNLAND(S)	Lemgare
NEAREST TOWN	Annayalla
SIX INCH MAP NUMBER	15
ITM CO-ORDINATES	680359E 828198N
1:50,000 O.S. SHEET NUMBER	28
GSI BEDROCK 1:100,000 SHEET NO.	8/9

Outline Site Description

This is a former mine site occupying an overgrown area at the edge of cattle pasture. Mine waste, in the form of two small boulder piles, a collapsed, filled-in shaft and covered adit portal are the only surface remains of mining.

Geological System/Age and Primary Rock Type

The bedrock consists of massive sandstones of the Silurian Lough Avaghon Formation, part of the Northern Belt of the Longford-Down inlier.

Main Geological or Geomorphological Interest

The Lemgare Pb deposit was mined briefly and apparently unproductively in 1840–41 along a single 150m-long adit that ran from north to south. Waste dumps mark the area of the adit portal and the air shaft sunk on the southern end of the adit. The mine structures are filled in or obscured and the main interest at the site is the mineral assemblage recorded in the waste dumps. This includes *wulfenite* (PbMoO_4), rare in Ireland.

The mineralization consists of galena, sphalerite and iron carbonate in irregularly oriented fractures over a width of c. 4.5m. Minerals previously recorded in the include anglesite, ankerite, barite, calcite, cerussite, chalcopryrite, native copper, dolomite, galena, goethite, pyrite, pyromorphite, quartz, siderite, sphalerite and wulfenite.

Site Importance – County Geological Site

The mine features are poorly preserved and insufficiently interesting to require any designation for the site. However, the presence of rare wulfenite means Lemgare warrants CGS status.

Management/promotion issues

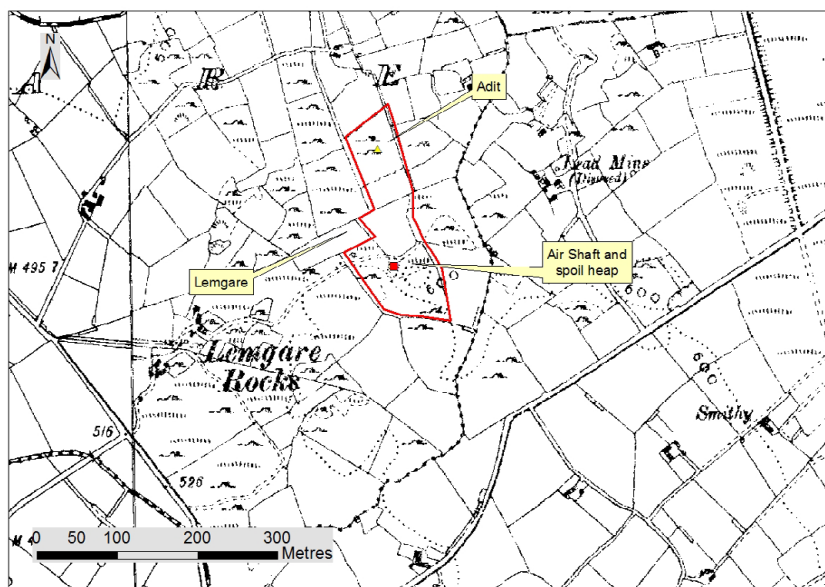
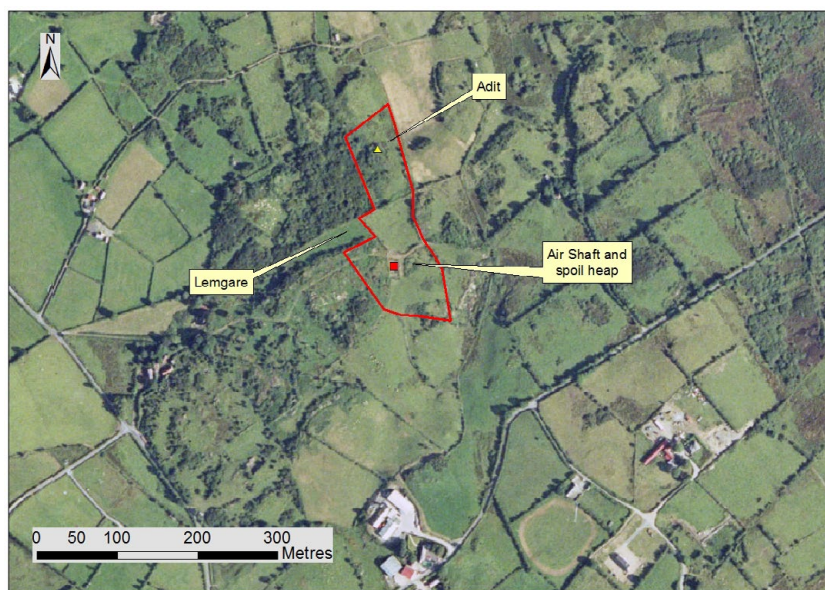
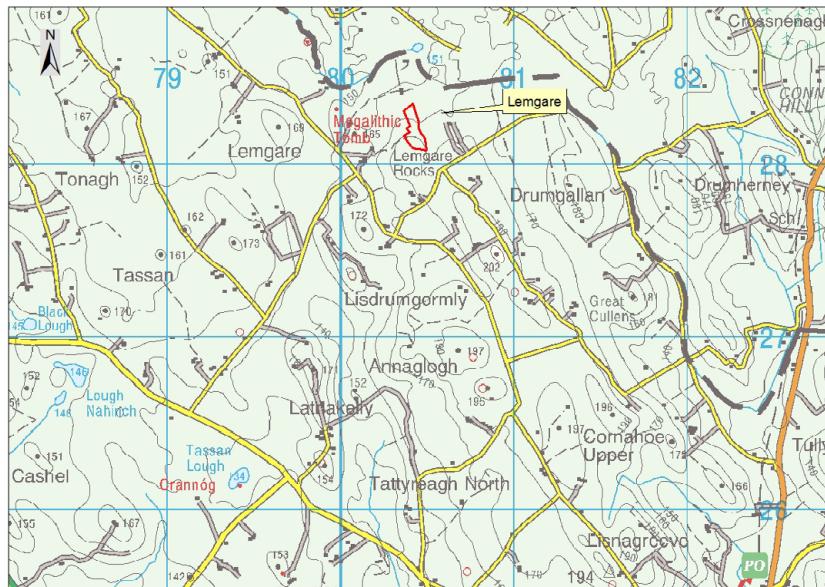
The site is part of a working farm and the fields immediately surrounding the mine dumps are used for grazing cattle. Many of the minerals recorded here can only be studied satisfactorily with specialist equipment and the site is thus likely to be of interest mainly to scientists. Therefore, it does not require further promotion.



Lemgare air shaft: view of spoil around air shaft (overgrown, on left)



Lemgare, view to north along line of adit, with air shaft spoil heap in foreground



Annex B
Details of the College Mine and Derrynoose Lead Mine ESCRs

Previous Site

Next Site



Summary



Full report

College Mine, Carryhugh

Rec. Number:	566	File Number:	
ESCC:	EM		
Locality Type:	Spoil, Trial mine and spoil	Status:	PASSI
Grid Reference:	X28063335 Centroid		
County:	Armagh	District:	
Period:	No data		
Stages:	No data		
Lithostrat:	No data		

Site Description

College Mine, Carryhugh,
Co.Armagh, May 1997.

Highlights:

Former lead mine with spoil containing galena.

Introduction:

College Mine is located on the east side of Carryhugh Glen c.120m north of the farmhouse (nearest vehicular access). It is reached by crossing a nettle- and gorse-overgrown field.

Description:



College Mine, Carryhugh,
Co.Armagh, May 1997: shaft.

The site comprises: (a) a 2m-wide, flooded, walled shaft, which has recently (1997) become exposed due to collapse of a tree, (b) a largely obscured 'partially open stope' and (c) a largely overgrown spoil heap adjoining these features and the stream.



College Mine, Carryhugh,
Co.Armagh, May 1997: overgrown
spoil heap.

Spoil material comprises brecciated shale, dolomite-veined greywacke with minor disseminated pyrite, early-stage milky quartz and late-stage vuggy calcite veins; only one small (2-3mm) galena crystal was observed (samples collected for the Ulster Museum).

Importance:

Interpretation:

Conclusions:

There is a limited quantity and poor quality of specimen material. The site is hazardous (open shaft) and difficult to access. Therefore designation is not recommended.

Notes:

No Notes

Keywords

Minerals:	Calcite, Galena, Pyrite, Quartz
Rocks:	Greywacke, Shale
FossilGroups:	No data
Fossil List:	
Products:	
Structures:	No data
Relations:	No Data
Geomorph:	
Paleoenv:	
NonGeol:	

Measurements

Length:	No data	Width:	No data	Height:	No data
Depth:	No data	Area:	No data		

Access

Approach:	Not entered
Restrictions:	Not entered
Planning:	
Management:	
Development:	
Threats:	

Uses

Uses:	Not entered
Potential:	Not entered
Educ. Level:	Not entered

References

Map(s):	None entered
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Map No:	None entered		
Rec Type	ESCR report	Recorder:	R. Nawaz and N.R. Moles
Enterer:	E M Porter		
Updates:	19 Jul 2006 / 16 Sep 2003 / 05 FEB 01 / 14 JAN 01		
Previous Site		Next Site	

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Previous Site

Next Site



Summary



Full report

Derrynoose lead mine

Rec. Number:	556	File Number:	
ESCC:	ID		
Locality Type:	Spoil	Status:	PASSI
Grid Reference:	X27963315 Approximate		
County:	Armagh	District:	
Period:	No data		
Stages:	No data		
Lithostrat:	No data		

Site Description

Derrynoose lead mine, Co.Armagh,
June 1997.

Highlights:

Former lead mine with spoil containing galena and sphalerite.

Introduction:

This site lies immediately adjacent to the main road c.0.5km WSW of Derrynoose village, and has been cleared since a visit by John Morris in 1984. Little evidence

remains of former mining activity (no shafts etc.), however samples of mineralized spoil can be found.

Description:



Derrynoose lead mine, Co. Armagh,
June 1997: disused concrete ball
court.

A grassed-over, flat-topped ridge extends c. 120m from the road (at the site of a former Hall - recently demolished, now a lay-by) to the site of a disused concrete ball court. This ridge, which is some 10-20m wide and rising 1-2m above surrounding land surface, appears to be the grassed-over spoil from the former

mine (estimated at 4,500 tonnes: Morris, 1984). A few cobbles of mineralized spoil were found on both sides of the road near the former Hall.



Derrynoose lead mine, Co. Armagh,
June 1997: mineralized spoil.

These comprise sugary-textured vein quartz containing ferroan sphalerite and galena both as disseminations and as coarsely crystalline aggregates in a sugary quartz veinrock (samples collected for the Ulster Museum). Mineralized spoil also forms the ground

surface near the ball court. No evidence of mineralized material was found at a separate western spoil heap described by Morris.

Importance:

Interpretation:

Conclusions:

The site may be worth designation on the basis that this is the only accessible occurrence of Pb-Zn-mineralized spoil in Co. Armagh.

Notes:

Recent press releases (August 2001) by Conroy Diamonds and Gold plc refer to gold mineralisation having been found by core-drilling at Derrynoose. It is not clear if the drilling location is close to the former lead mine site.

See also SLNCI Key Site 723 - Derrynoose.

Keywords

Minerals:	Galena, Sphalerite
Rocks:	No data
FossilGroups:	No data
Fossil List:	
Products:	
Structures:	hydrothermal vein
Relations:	No Data
Geomorph:	
Paleoenv:	
NonGeol:	

Measurements

Length:	120m	Width:	10-20m	Height:	1-2m
Depth:	No data	Area:	No data		

Access

Approach:	Not entered
Restrictions:	Not entered
Planning:	
Management:	This site is easily accessible, but contains very little evidence of former mining activity. Specimen material is good, but very limited in quantity unless the spoil heaps are 're-activated' by some excavation

	for this purpose. Recommendation: arrange access into field and possibly excavate part of the spoil ridge to permit collecting.		
Development:			
Threats:			
<i>Uses</i>			
Uses:	Agriculture		
Potential:	Not entered		
Educ. Level:	Not entered		
<i>References</i>			
Map(s):	None entered		
Map No:	None entered		
Rec Type	ESCR report	Recorder:	R. Nawaz and N.R. Moles
Enterer:	E M Porter		
Updates:	16 Jul 2006 / 27 Oct 2003 / 22 Sep 2003 / 16 Sep 2003 / 31 JAN 01 / 14 JAN 01		
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