



Inquiry Report by Ralph Spernagel, Construction Director

Enforcement Notice Appeal at Sneddon Law Wind Farm

05 April 2018

1166504 - 1 - A3

Document history

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Issue	Date	Revision Details
A1	5 April 2018	First draft
A2	5 April 2018	Issued to Client
A3	5 April 2018	Final Issue

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ISO 9001:2008 UK
ISO 14001:2004 UK



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1. Background

1. The Natural Power Consultants Limited (Natural Power) is an international multi-disciplinary technical consultancy working in the energy and infrastructure sector, headquartered in southwest Scotland. The business has multiple technical specialisms including a geotechnical engineering consultancy and contracting business and a dedicated hydrology department.
2. Natural Power are an independent consultancy and work with a wide variety of clients across the aforementioned sectors, including local authorities, central government, private developers, contractors, utilities and funding organisations. Our relationship with CWL is formed on a client/consultant commercial basis, with no equity or joint ownership interest in any projects.
3. Natural Power has extensive expertise in providing geotechnical engineering and hydrogeological services, including groundwater prospecting, design and installation of private borehole water, geohydraulic testing and commissioning of supplies in the Scotland and across the UK. Our team of highly experienced drillers (British Drilling Association accredited) and chartered geotechnical engineers have over 20 years of experience in this sector, and have installed multiple wells of a similar nature to those installed on the Sneddon Law project.
4. A recent example of our experience in this regard is the provision of **9 new Type B private water supplies to replace spring fed private water supplies for properties in close proximity to the new South West Scotland (SWS) Interconnector scheme being built on behalf of Scottish Power Transmission Plc.** This project consists of a series of new overhead lines (pylons and poles), substations and associated infrastructure, including stone access tracks, crane pads and reinforced concrete foundations **similar in nature to wind farm infrastructure.** The SWS Interconnector scheme is a significant infrastructure project which runs through Ayrshire and Dumfries & Galloway.
5. The water supplies provided by Natural Power on the SWS scheme were required in order to manage the risk of potential contamination resultant from the construction of the overhead line infrastructure (tracks, crane pads and foundations) at a number of residential properties of varying sizes, demands and configurations. Boreholes were drilled by Natural Power's own plant and equipment to a depth of between 70 and 180 metres utilising very similar techniques and methods as to those employed for the replacement water supplies on Sneddon Law. All commissioned supplies have been registered with the relevant local authorities and SEPA.
6. In addition to the large infrastructure project water supply campaigns undertaken, we have also undertaken numerous borehole water supply installations supplies for private householders, leisure facilities (Type A and Type B under The Private Water Supplies (Scotland) Regulations 2006), construction projects and agriculture/aquaculture operations including dairy farms, mixed use livestock farms and fisheries.
7. Natural Power acted as consultants to the Hare Hill and Afton wind farms, both located in East Ayrshire, providing hydrological and project management services. Both schemes have similar private water supply conditions to the Sneddon Law wind farm (CWP133 & CWP134).
8. In the Hare Hill wind farm private water supply discharge documentation, East Ayrshire Council have approved the discharge of the relevant condition based on no fixed mitigation strategy in the event a

private water supply was disrupted by construction works (CWP134). The relevant planning submission details the provision of an IBC and/or bottled water of unspecified volumes, followed up with a discussion between the ECoW, SEPA and East Ayrshire Council regarding an undefined mitigation to be installed as a long term replacement. Notwithstanding the requirements as set out by the previous reporter in conditions 1.1 and 1.2, the level of detail required by East Ayrshire Council in respect of the required Hare Hill proposed mitigation strategies is notably less than the detail provided by CWL regarding infrastructure which has already been installed under conditions 1.1 and 1.2 of PPA-190-2054.

9. In the Afton windfarm private water supply contingency plan, East Ayrshire Council have approved the discharge of the relevant condition (which is identical to the unamended condition 36 of the Sneddon Law windfarm consent) based on subjective commentary around the capability of Business Stream, as statutory undertaker, to deliver the required mitigation strategy (CWP133). There are a great deal of uncertainties regarding delivery of interim mitigations, and no detail whatsoever regarding long term mitigation. Notwithstanding the requirements as set out by the previous reporter in conditions 1.1 and 1.2, the level of detail required by East Ayrshire Council in respect of the required Afton proposed mitigation strategies is notably less than the detail provided by CWL regarding infrastructure which has already been installed under conditions 1.1 and 1.2 of PPA-190-2054.

2. Natural Power Involvement on Sneddon Law

10. In August 2016, CWL appointed Natural Power to review the Construction Environmental Management Plan (CEMP) and Borrow Pit scheme of work prepared by CWL in connection with the planning appeal on discharge of certain suspensive planning conditions relating to the Sneddon Law project.
11. In October/November 2016, Natural Power attended planning appeal hearings relating to a number of planning conditions connected with the Sneddon Law project. Toby Gilbert, Head of Geotechnical and Allan Rutherford, Senior Geotechnical Engineer from Natural Power attended the planning hearings.
12. In connection with the appeal for Condition 36, in January 2017, Natural Power provided a technical report for CWL regarding private water supplies (Ref: Water Supply Well Assessment, 1134767 – 1 – C, dated 31 January 2017).
13. Natural Power thereafter undertook the geotechnical site investigations for the Sneddon Law project. Personnel, plant and equipment were mobilised to the Sneddon Law site to commence site investigation works in July 2017, ceasing upon issue of the enforcement notice (EN/17/0216/UA) on 9 August 2017 and demobilising thereafter. During the site operations, a report was submitted by an unknown person to EAC complaining of a fuel spillage at the compound being used on the Sneddon Law site for the site investigation works. EAC and SEPA investigated the complaint and discovered that this was an unfounded complaint and no environmental event or spillage had occurred (CWP56).
14. In parallel, Natural Power also provided a report (Ref: Private Water Supply Installation Summary Report, 1166186, dated 26 June 2017) on the quality and quantity of three replacement water supplies installed by Raeburn Drilling and Geotechnical Limited (Raeburn) at the locations identified in condition 1.1(a)-(c) of the Planning Appeal (Ref: PPA-190-2054).
15. Following issue of the enforcement notice, Natural Power provided a technical response to the Envireau Water note (Re: Response to Dr P Ham Technical Note, 12115UKC dated 10 August 2017. This response includes our response to the arguments presented by Dr Ham in his technical note used to support

issuance of the enforcement notice. It also details the reasons why, in our opinion, CWL had satisfied the pertinent elements of 1.1(a)-(c) as of the date of their original submission.

16. Without prejudice to the contention that CWL had already complied with the relevant conditions 1.1(a)-(c) as at the date of service of the enforcement notice, Natural Power were asked to undertake and comment on the quantity and quality of these in the context of planning condition 1.1 in an attempt to resolve the enforcement notice before it took effect. Natural Power were instructed to undertake constant rate pump testing, along with the associated recovery test, in August 2017 on the three replacement supplies. A report (Ref: Water Supply Pump Tests Summary, 1146186 – 1 – B, dated 1 September 2017) and letter (Ref: Sneddon Law Wind Farm – Borehole Water Supplies, 1151688-1-A1, dated 4 September 2017) were provided to CWL in connection with this.

3. Replacement Water Supply Reports

17. Natural Power undertook four reports on the replacement water supplies for the Sneddon Law wind farm, namely:
- a. Water Supply Well Assessment, 1134767 – 1 – C, dated 31 January 2017 (CWP11);
 - b. Private Water Supply Installation Summary Report, 1166186, dated 26 June 2017 (EAC2);
 - c. Response to Dr P Ham Technical Note dated 31/07/2017, 12115UKC, dated 10 August 2017 (CWP37); and
 - d. Water Supply Pump Tests Summary, 1146186 – 1 – B, with accompanying letter (Ref: 1151688 – 1 - A1) (CWP15).
18. All four reports relate to the provision of replacement water supplies in connection with condition 1.1, namely:
- a. Blackshill (also known as Cowan’s Law);
 - b. Alton Muirhouse Farm & Alton Lodge (referred to as Alton Muirhouse); and
 - c. Muirburn and Tayburn (also known as Craigends).

3.1. Blackshill Replacement Supply - Quantity

19. Consideration of the Blackshill replacement supply is included within our January 2017 report. The existing supply was noted as a ‘spring supply’. The objective was to examine possible borehole locations, constraints and likely yields compared to demand. A final objective was to set out likely timescales for the borehole well development.
20. The report was a desk-based assessment utilising a number of published and commonly used data sources, including British Geological Society (BGS) geology and hydrogeology mapping and historical water well and borehole records. The assessment also utilised the MacArthur Green (MG) consolidated water risk assessment (Sneddon Law Technical Report on Private Water Supplies: Consolidated Water Risk Assessment) (CWP12) which was prepared in connection with the discharge of planning conditions process in November 2016. Natural Power note that MacArthur Green are a specialist environmental consultancy with a specific expertise in hydrology and water resource management.

21. For the purposes of understanding land and access constraints, mapping from CWL was also provided, setting out the land under their control and the proposed wind farm layout.
22. Indicative demand requirements were noted within our report based on the various properties served by the existing Blackshill Spring based on initial consultations with the various users undertaken by CWL. These estimates were highly conservative and, per the requirements of condition 1.1, when further detailed consultation with the users was undertaken by CWL, cross-referenced to DEFRA established ranges of livestock water consumption, the baseline consumption figures were calculated as being reduced to a lower level.
23. The baseline demand figure for the Blackshill replacement supply was calculated by CWL as 6.97m³/day.
24. Following review of the BGS records (which included other water well data from sources within the area) and MG report by Allan Rutherford, Senior Geotechnical Engineer and Toby Gilbert, Head of Geotechnical at Natural Power, it was established that the likely yields from supplies from the Limestone Coal Formation were classified as moderate, with yields unlikely to exceed 10 litres/second (36m³/hr). Accordingly, it was considered likely that a borehole water supply would meet or exceed the assessments of demand for the replacement supply at Blackshill based on the consultation with the users by CWL.
25. Following the review of the target resource rock formation for the well, recommendations were made as to the location and characteristics for the Blackshill replacement supply with specific notes highlighting that filtration was likely to be required for elevated levels of natural mineralisation in the raw water (principally iron and manganese) and that sampling of the new supplies should be undertaken during installation to determine the filter system requirements. This recommendation was based on good industry practice, Natural Power's own experience of installing private water supply boreholes and from review of nearby borehole water sample records.
26. Subsequently, Raeburn installed a water well borehole between 28 April 2017 and 3 May 2017. Raeburn are a highly experienced drilling and geotechnical contractor, with over 30 years of installing private water supplies throughout Scotland and the wider UK.
27. The Raeburn works included the drilling of the borehole, logging of the various geological strata encountered, assessing the water yield encountered, installing the borehole lining and pump system and the pipework connections. Water quality testing was also undertaken at this time.
28. In our report dated 26 June 2017, Natural Power reviewed the information provided by Raeburn, including the borehole records prepared from the drillers logs which provide information on the geological strata encountered, where water strikes were recorded and information regarding the flow experienced and resting level of water in the borehole. At Blackshill, the Raeburn information records a water strike at 30m below ground level, and records an approximate yield of 1.2m³/hr. Yield estimates in the field are a commonplace and industry standard method of approximating flow rates from boreholes and regularly used to inform decision points during installations. Natural Power relied on the expertise and experience of the Raeburn drilling team and considered that the daily rate estimated from this flow rate demonstrated that a supply of sufficient quantity had been achieved insofar that there was a sufficient margin of oversupply to outweigh the approximate nature of flow measurements whilst drilling.
29. Based upon the demand figures at Blackshill (6.97m³/day) compared against the Raeburn estimated yield (28.8 m³/day) of the replacement supply, Natural Power considered that the replacement water supply was such that it would not prejudice the quantity of water supplied to the Blackshill users from the existing

- supply, drawing groundwater from a much deeper source than the spring supply. This was stated within our report of 26 June 2017 in Section 2.7.
30. Pump testing was subsequently undertaken by Natural Power on the Blackshill supply between 17 August 2017 and 1 September 2017. The purpose of the test was to satisfy the additional requirements set out by East Ayrshire Council in the enforcement notice.
 31. We assessed the yield from the replacement supply at Blackshill in the context of condition 1.1(a). The test processes and results were presented in our report "Water Supply Pump Tests Summary" (Ref: 1146186 – 1 – B) dated 4 September 2017.
 32. The pump testing comprised a series of step tests (stages of pumping at different increasing flow rates) followed by a longer duration constant rate test and a period of recovery monitoring after pumping was terminated. The rate of discharge was measured via a stopwatch to establish the time taken to fill a known volume (25l). The known volume method is a common and practical solution for measuring the flow rate at flows less than 0.6l/sec.
 33. The step test flow rates were based on the likely demand since it was evident that the well would yield more than the demand. The range of step test flow rates was selected to span low to high demand. In doing this we simulated a period of estimated peak demand and to establish at what flow rate the well would be unable to respond. The range of flows was selected based on the driller's log, the required flow and our on-site observations to select the upper flow rates. The lower bound rate of 0.9m³/hr simulated flow was slightly above the estimated demand. The upper bound rate of 1.66m³/hr was to simulate over extraction and find the limit of supply. These rates indicate that the provision of a header tank/reservoir arrangement in addition to the available resource within the well would be unnecessary. It is our experience that these type of arrangements are avoided where possible unless there are concerns over the capacity of the well to supply the demand.
 34. The pump testing results presented within the report demonstrated that the aggregate and peak demand of the various properties which were covered under the requirements of condition 1.1(a) at Blackshill was achieved.
 35. It is noted that EAC commissioned a further series of short duration tests under the supervision of Envireau (Ref: P:\IF Sneddon Law Appeal (1947)\17.EW Field Work\TN.docx) on 14 & 15 November 2017 to assess confidence in the borehole yields.
 36. The results from the EAC commissioned testing resulted in a higher available yield estimate for the Blackshill replacement borehole when compared to the NPC pump test results.
 37. The Envireau report utilised a variety of short duration flow-rates tests within the study to establish estimated peak flow-rates. Natural Power did not report on this specifically in our September report as a 24 hour pump test and recovery period to assess the yield from the supplies addresses this point and is considered to be the standard industry test. This is in line with what EAC have set out in their enforcement notice and statement of case as being sufficient to evidence that the supplies could consistently deliver the required volumes (Chapter 11, item (vi)). Short term high flow rates were investigated during the Natural Power pump tests as detailed above.
 38. Peak user demands have been assessed both anecdotally by CWL in consultation with the end users and by measured flow rates undertaken by a local plumbing contractor. The ability of the new well to offer

short term high flow rates as noted above was established at Blackshill/Cowan's Law as between 0.9-1.66m³/hr.

39. The consultation with the users provided by CWL indicates that the boreholes are sufficient for peak flows. We are in agreement with the Envireau yield figures from their November 2017 report that the Blackshill well yields sufficient quantities when compared with the demand figures as calculated.
40. The 24hr pump testing undertaken by Natural Power meets the requirements of the user demand figures as calculated, and confirms the position set out in our report of June 2017 that the quantity element of condition 1.1(a) has been demonstrated for the Blackshill/Cowan's Law replacement supply.

3.2. Blackshill Replacement Supply - Quality

41. Within our January 2017 report, it was highlighted that natural levels of mineral and bacterial content were likely to be encountered within the raw water from the replacement boreholes, which would require filtration, as is standard on installations of this type when used for human consumption. It is noted that the installation and maintenance of filtration at point of use is a CWL requirement under the consolidated water risk assessment. Sampling was recommended during the replacement supply installation to assess the levels and size appropriate filtration systems.

42. The water sampled from the Blackshill borehole by Raeburn on 5 May 2017, and tested at a UKAS accredited laboratory (Glasgow Scientific Services), indicated no evidence of bacteriological PCV's exceeding the relevant limits for a Type A or Type B supply (as defined under The Private Water Supplies (Scotland) Regulations 2006). **Levels of iron and manganese were detected in excess of the PCV's for a Type A supply. However, Blackshill is a Type B supply and there is no iron (Fe) or manganese (Mn) value set as a PCV within the Type B supply categorisation,** and accordingly, Natural Power considered that at the time of preparing our report in June 2017, the data provided indicated that the replacement supply would not prejudice the quality of existing supplies and that the quality element of Clause 1.1(a) had been fulfilled with a further comment noting that filtration would also be provided for the supply to reduce the levels of Fe and Mn.

NB. Type B results



43. Further sampling was undertaken on 25 August 2017 by AA Enviro, the approved independent water quality consultant with longstanding experience in providing water quality services, with the results included within our letter dated 4 September 2017. This showed that the results from the post-filter installation sampling of the replacement supply at Blackshill were in line with the required chemical and bacteriological PCV limits for a Type B supply, re-confirming the position made in our report of our June 2017 that the quality of the replacement supplies meet the requirements of condition 1.1(a).

3.3. Alton Muirhouse Replacement Supply - Quantity

44. Consideration of the Alton Muirhouse replacement supply (including Alton Muirhouse Farm and Alton Lodge) is included within our January 2017 report. . The objective was to examine possible borehole locations, constraints, and likely yields compared to demand. A final objective was to set out likely timescales for the well development from receipt of client instruction.
45. The report was a desk-based assessment utilising a number of published and commonly used data sources, including British Geological Society (BGS) geology and hydrogeology mapping and historical water well and borehole records. The assessment also utilised the MacArthur Green (MG) consolidated water risk assessment (Sneddon Law Technical Report on Private Water Supplies: Consolidated Water

- Risk Assessment) which was prepared in connection with the discharge of planning conditions process in November 2016.
46. For the purposes of understanding land and access constraints, mapping from CWL was also provided, setting out the land under their control and the proposed wind farm layout.
 47. Indicative demand requirements were noted within our report for the Alton Muirhouse replacement supply based on initial consultations with the users undertaken by CWL. These estimates were highly conservative and, per the requirements of condition 1.1, when further detailed consultation with the users was undertaken by CWL and cross-referenced to DEFRA established ranges of livestock water consumption, the baseline consumption figures were calculated as being reduced to a lower level.
 48. The baseline demand figure for the Alton Muirhouse replacement supply was calculated by CWL as 7.15m³/day.
 49. Following review of the BGS records (which included other water well data from sources within the area) and MG report by Natural Power it was established that the likely yields from supplies from the Darvel Lava Member Formation were classified as low, with yields unlikely to exceed 2 litres/second (7.2m³/hr). Accordingly, it was likely that a borehole water supply would meet or exceed the conservative assessments of demand for the replacement supply at Alton Muirhouse based on the consultation with the users by CWL.
 50. Following the review of the target resource rock formation for the well, recommendations were made as to the location and characteristics for the Alton Muirhouse replacement supply with specific notes highlighting that filtration was likely to be required for elevated levels of iron and manganese and that sampling of the new supplies should be undertaken during installation to determine the filter system requirements. This recommendation was based on good industry practice, Natural Power's own experience of installing private water supply boreholes and from review of nearby borehole water sample records.
 51. Subsequently, Raeburn installed a water well borehole at Alton Muirhouse between 28 April 2017 and 8 May 2017.
 52. The Raeburn works included the drilling of the borehole, logging of the various geological strata encountered, assessing the water yield encountered, installing the borehole lining, pump system and the pipework connections. Water quality testing was also undertaken at this time.
 53. In our report dated 26 June 2017, Natural Power reviewed the information provided by Raeburn, including the borehole records prepared from the drillers logs which provide information on the geological strata encountered, where water strikes and resting levels were recorded and information regarding the flow experienced. The Raeburn information records a water strike at 4.5m and 18m below ground level, and record an approximate yield of 0.45m³/hr. Yield estimates in the field are a commonplace and industry standard method of approximating flow rates from boreholes. Natural Power relied on the expertise and experience of the Raeburn drilling team and considered that the daily rate estimated from this flow rate demonstrated that a supply of sufficient quantity had been achieved insofar as there was a sufficient margin of oversupply to outweigh the approximate nature of flow measurements whilst drilling.
 54. Based upon the demand figures at Alton Muirhouse (7.15m³/day) compared against the Raeburn estimated yield (10.8m³/day) of the replacement supply, it was apparent to Natural Power that the replacement water supply was such that it would not prejudice the quantity of water supplied to the Alton

- Muirhouse users from the existing supply. This was stated within our report of 26 June 2017 in Section 3.7.
55. Pump testing was subsequently undertaken by Natural Power on the Alton Muirhouse supply between 17 August 2017 and 1 September 2017. The purpose of the test was to satisfy the additional requirements set out by East Ayrshire Council in the enforcement notice.
 56. We assessed the yield from the replacement supply at Alton Muirhouse in the context of condition 1.1(b). The test processes and results were presented in our report "Water Supply Pump Tests Summary" (Ref: 1146186 – 1 – B) dated 4 September 2017.
 57. The pump testing comprised a series of step tests (stages of pumping at different increasing flow rates) followed by a longer duration constant rate test and a period of recovery monitoring after pumping was terminated. The rate of discharge was measured via a stopwatch to establish the time taken to fill a known volume (25l). The test results indicated a yield of 14.4m³/day.
 58. The step test flow rates were based on the likely demand since it was evident that the well would yield more than the demand. The range of step test flow rates was selected to span low to high demand. In doing this we simulated a period of estimated peak demand and to establish at what flow rate the well would be unable to respond. The range of flows was selected based on the driller's log, the required flow and our on-site observations to select the upper flow rates. The lower bound rate of 0.4 m³/hr simulated flow slightly below the estimated demand. The upper bound rate of 1.0m³/hr was to simulate over extraction and find the limit of supply. These rates indicate that the provision of additional header tank/reservoir arrangements in addition to the available resource within the well would be unnecessary. It is our experience that these type of arrangements are avoided unless there are concerns over the capacity of the well to supply the demand.
 59. The pump testing results presented within the report demonstrated that the aggregate and peak demand of the two properties which were covered under the requirements of condition 1.1(b) were met and exceeded by the replacement supply at Alton Muirhouse.
 60. It is noted that EAC commissioned a further series of short duration tests under the supervision of Envireau (Ref: P:\IF Sneddon Law Appeal (1947)\17.EW Field Work\TN.docx) on 14 & 15 November 2017 to assess confidence in the borehole yields.
 61. The results from the EAC commissioned testing resulted in a slightly lower available yield estimate (12.2m³/day) for the Alton Muirhouse replacement borehole when compared to the NPC pump test results, but was still higher than the demand.
 62. The Envireau report has utilised a variety of short duration flow-rates within the study to establish estimated peak flow-rates. NPC did not report on this specifically in our September report as a 24 hour pump test and recovery period to assess the yield from the supplies addresses this point and is considered to be the standard industry test. This is in line with what EAC have set out in their enforcement notice and statement of case as being sufficient to evidence that the supplies could consistently deliver the required volumes (Chapter 11, item (vi)). Short term high flow rates were investigated during the Natural Power pump tests, as set out above.
 63. Peak user demands have been assessed both anecdotally by CWL in consultation with the end users and by measured flow rates undertaken by a local plumbing contractor. In the case of Alton Muirhouse the replacement supply (0.6m³/hr by NPC, 0.5m³/hr by Envireau) is capable of a flow which is greater than the

old supply (0.48 m³/hr). The user noted that peak demand would be filling the stock watering troughs at the start of each day and Natural Power understand from CWL consultations with the landowners that there are already storage tanks within the farm buildings which are connected to the borehole supply, providing further comfort on the capacity of the supply in times of peak demand.

64. The ability of the new wells to offer short term high flow rates in consideration of peak demand was investigated during the Natural Power step tests (Alton Muirhouse step test range 0.4-1.0m³/hr).
65. The consultation with the users provided by CWL indicates that the boreholes are sufficient for peak flows. We are in agreement with the Envireau yield figures from their November 2017 report that the Alton Muirhouse well yields sufficient quantities when compared with the demand figures as calculated.
66. The 24hr pump testing undertaken by Natural Power meets the requirements of the user demand figures as calculated, and confirms the position set out in our report of June 2017 that the quantity element of condition 1.1(b) has been demonstrated at the Alton Muirhouse replacement supply.

3.4. Alton Muirhouse Replacement Supply - Quality

67. Within our January 2017 report, it was highlighted that natural levels of mineral and bacterial content was likely to be encountered within the raw water, which would require filtration, as is standard on installations of this type when used for human consumption. It is noted that the installation and maintenance of filtration at point of use is a CWL requirement under the consolidated water risk assessment. Sampling was recommended during the replacement supply installation to assess the levels and size appropriate filtration systems.
68. The water sampled from the borehole by Raeburn on 1 June 2017, and tested at a UKAS accredited laboratory (Glasgow Scientific Services), indicated coliform presence exceeding the PCV limit for a Type A or Type B supply, prior to installation of filtration to treat the water prior to consumption. It was also noted that the existing supplies at Alton Muirhouse and Alton Lodge taken in spring 2017 indicated a pre-existing level of coliform presence in the existing supplies. Levels of manganese were detected in excess of the **PCV's for a Type A supply.** However, there is no manganese value set as a PCV within the Type B supply categorisation. Accordingly, Natural Power considered that at the time of preparing our report in June 2017, the data provided indicated that the replacement supply would not prejudice the quality of existing supplies and that the quality element of Clause 1.1(b) would be fulfilled when the filtration was installed for the supply, per the requirements of the consolidated water risk assessment.
69. Further sampling was undertaken by AA Enviro on 25 August 2017 with the results included within our letter dated 4 September 2017. This showed that all results from the post-filter installation sampling of the replacement supply at Alton Muirhouse were in line with the required chemical and bacteriological PCV limits for a Type B supply, re-confirming the position made in our report of our June report that the quality of the replacement supplies meet the requirements of condition 1.1(b).

3.5. Craigends Replacement Supply – Quantity

70. Consideration of the Craigends (covering Tayburn and Muirburn) replacement supply is included within our January report. The objective was to examine possible borehole locations, constraints, and likely yields compared to demand. A final objective was to set out likely timescales for the well development from receipt of client instruction.

71. The report was a desk-based assessment utilising a number of published and commonly used data sources, including British Geological Society (BGS) geology and hydrogeology mapping and historical water well and borehole records. The assessment also utilised the MacArthur Green (MG) consolidated water risk assessment (Sneddon Law Technical Report on Private Water Supplies: Consolidated Water Risk Assessment) which was prepared in connection with the discharge of planning conditions process in November 2016.
72. For the purposes of understanding land and access constraints, mapping from CWL was also provided, setting out the land under their control and the proposed wind farm layout.
73. Indicative demand requirements were noted within our report for the Craighends based on initial consultations with the users undertaken by CWL. These estimates were highly conservative and, per the requirements of condition 1.1, when further detailed consultation with the users was undertaken by CWL the baseline consumption figures were revised downwards. The baseline demand figure for the Craighends replacement supply was calculated by CWL as 1.20m³/day.
74. Following review of the BGS records (which included other water well data from sources within the area) and MG report by Natural Power, it was established that the likely yields from supplies from the Flow Moss Lava Formation were classified as low, with yields unlikely to exceed 2 litres/second (7.2m³/hr). However, only 2 residential properties were expected to be served by the new borehole and accordingly, it was likely that a borehole water supply would meet or exceed the conservative assessments of demand for the replacement supply at Craighends based on the consultation with the users by CWL.
75. Following the review of the target resource rock formation for the well, recommendations were made as to the location and characteristics for the Craighends replacement supply with specific notes highlighting that filtration was likely to be required for elevated levels of iron and manganese and that sampling of the new supplies should be undertaken during installation to determine the filter system requirements. This recommendation was based on good industry practice, Natural Power's own experience of installing private water supply boreholes and from review of nearby borehole water sample records.
76. It is noted in the statement of case (Item 3) from Mr Berlow Jackson that the new borehole at Craighends is not shown to be from a source shown to be at low or negligible risk of contamination. Expert advice from the project hydrogeologist (Geodivining International) (CWP74) indicated that the new source was from a different and more productive structural target (geological strata) than the existing supplies, and not located on the fault line indicated on BGS maps extending NW-SE through the proposed wind farm and running to the north of the existing Tayburn borehole. The replacement supply location is positioned approximately 300m north west of the fault-line. Whilst this is in closer proximity to the wind farm infrastructure (circa 170m), the reasons for a major risk being flagged in the MG report was the potential connectivity from the wind farm infrastructure in weathered bedrock strata and the aforementioned fault and the wind farm site. It is also noted in the MG report that the wind farm infrastructure crosses the fault in only one location, where floating, not excavated tracks are proposed, meaning that excavations into the fault area will not be undertaken, as the floating method of track construction does not involve excavation. Where there is no excavation proposed new pathways for surface water infiltration will not be created. MG specifically note in their report that their assessments of risk may be an overly cautious approach.
77. In addition to this, the geological records from the Sneddon Law site **investigation information undertaken prior to the issue of the stop notice shows that although weathered rock was encountered in places,** there

is no indication of a significant faulting zone within the borehole logs, with the rock fracturing recorded typical of the basalt rock type over the rest of the site.

78. Subsequently, Raeburn installed a water well borehole at Craigends between 10 May and 11 May 2017 to an overall depth of 61m.
79. The Raeburn works included the drilling of the borehole, logging of the various geological strata encountered, assessing the water yield encountered, installing the borehole lining and pump system, filter installation and the pipework connections. Water quality testing was also undertaken at this time.
80. Based upon the strata recorded in the replacement borehole at Craigends, weathered rock was not encountered, and the productive zone in the dolerite bedrock is protected by permanent surface casing and the annulus sealed from that level back to ground level to avoid sources of potential contamination above the water gathering section of the borehole. Accordingly, Natural Power considered that the risk of a pollution pathway between weathered rock and the replacement water supply borehole at Craigends is low. This was the principal area of concern from the MG water risk assessment report regarding the supplies in the locality.
81. As noted above, based upon the geological records available to Natural Power, it was considered that the replacement supply at Craigends (Muirburn & Tayburn) was derived from a source at low risk of contamination and disruption. This also accords with the EAC position on the replacement supplies noted (Chapter 15, item (iv)) being considered to be at a low or negligible risk of contamination.
82. In our report dated 26 June 2017, Natural Power reviewed the information provided by Raeburn, including the borehole records prepared from the drillers logs which provide information on the strata encountered, where water strikes were recorded and information regarding the flow experienced. The Raeburn information records a water level at 16m below ground level, and records an approximate yield of 1.9m³/hr. Yield estimates in the field are a commonplace and industry standard method of approximating flow rates from boreholes and regularly used to inform decision points during installations. Natural Power relied on the expertise and experience of the Raeburn drilling team and considered that the daily rate estimated from this flow rate demonstrated that a supply of sufficient quantity had been achieved insofar as there was a sufficient margin of oversupply to outweigh the approximate nature of flow measurements whilst drilling.
83. Based upon the demand figures at Craigends (Muirburn and Tayburn) (1.2m³/day) compared against the Raeburn estimated yield (45.6m³/day) of the replacement supply, it was clear to Natural Power that the replacement water supply was such that it would not prejudice the quantity of water supplied to the Craigends users from the existing supply. This was stated within our report of 26 June 2017 in Section 4.7.
84. Pump testing was subsequently undertaken by Natural Power on the Craigends supply between 17 August 2017 and 1 September 2017. The purpose of the test was to satisfy the additional requirements set out by East Ayrshire Council in the enforcement notice.
85. We assessed the yield from the replacement supply at Craigends in the context of condition 1.1(c). The test processes and results were presented in our report "Water Supply Pump Tests Summary" (Ref: 1146186 – 1 – B) dated 4 September 2017.

86. The pump testing comprised a series of step tests (stages of pumping at different increasing flow rates) followed by a longer duration constant rate test and a period of recovery monitoring after termination of pumping. The rate of discharge was measured via a stopwatch to establish the time taken to fill a known volume (25l). The test results indicated a yield of 21.6m³/day. It is noted that there were a number of interruptions during the pump testing and abstractions made from the borehole before the test, introducing a degree of conservatism in the yield figures established by Natural Power.
87. The step test flow rates were based on the likely demand since it was evident that the well would yield more than the demand. The range of step test flow rates was selected to span low to high demand. In doing this we simulated a period of estimated peak demand to establish at what flow rate the well would be unable to respond. The range of flows was selected based on the driller's log, the required flow and our on-site observations to select the upper flow rates. The lower bound rate of 0.58 m³/hr simulated flow below the estimated demand. The upper bound rate of 1.5m³ / hr was to simulate over extraction and find the limit of supply. These rates indicate that the provision of additional header tank/reservoir arrangements in addition to the available resource within the well would be unnecessary. It is our experience that these type of arrangements are avoided unless there are concerns over the capacity of the well to supply the demand.
88. The pump testing results presented within the report demonstrated that the aggregate and peak demand of the two properties which were covered under the requirements of condition 1.1(c) were met and exceeded by the replacement supply at Craigends.
89. It is noted that EAC commissioned a further series of short duration tests under the supervision of Envireau (Ref: P:\IF Sneddon Law Appeal (1947)\17.EW Field Work\TN.docx) on 14 & 15 November 2017 to assess confidence in the borehole yields.
90. The results from the EAC commissioned testing resulted in a significantly higher available yield estimate (43m³/day) for the Craigends replacement borehole when compared to the Natural Power pump test results.
91. The Envireau report has utilised a variety of short duration flow-rates within the study to establish estimated peak flow-rates. Natural Power did not report on this specifically in our September report as a 24 hour pump test and recovery period to assess the yield from the supplies addresses this point and is considered to be the standard industry test. This is in line with what EAC have set out in their enforcement notice and statement of case as being sufficient to evidence that the supplies could consistently deliver the required volumes (Chapter 11, item (vi)). Short term high flow rates were investigated during the Natural Power pump tests as detailed above.
92. Peak user demand was not measured at the Craigends properties beforehand. However, considering the differential between the relatively low demand figures and the significantly higher available yield from the borehole, it was considered unlikely that peak demand flows would exceed the available flow rate from the Craigends borehole, as the hourly flow rate measured is higher than the calculated peak demand for both properties.
93. The ability of the new well to offer short term high flow rates in consideration of peak demand was investigated during the NPC step tests (Craigends step test range - 0.58-1.5m³/hr).
94. The consultation with the users provided by CWL indicates that the boreholes are sufficient for peak flows. We are in agreement with the Envireau yield figures from their November 2017 report that the Craigends replacement supply yields sufficient quantities when compared with the demand figures as calculated.

95. The 24hr pump testing undertaken by Natural Power meets the requirements of the user demand figures as calculated, and confirms the position set out in our report of June 2017 that the quantity element of condition 1.1(c) has been demonstrated at the Craighends replacement supply.

3.6. Craighends Replacement Supply - Quality

96. Within our January 2017 report, it was highlighted that natural levels of mineral and bacterial content was likely to be encountered within the raw water, which would require filtration, as is standard on installations of this type when used for human consumption. It is noted that the installation and maintenance of filtration at point of use is a CWL requirement under the consolidated water risk assessment. Sampling was recommended during the replacement supply installation to assess the levels and size appropriate filtration systems.
97. The water sampled from the borehole by Raeburn on 19 May 2017 and tested at a UKAS accredited laboratory (Glasgow Scientific Services) indicated a number of chemical and bacteriological quality parameters exceeding the PCV limit, as predicted. These samples were taken prior to the installation of filtration which was to be installed by CWL in accordance with the consolidated water risk assessment and which is industry standard for treatment of raw water from private water supplies (Type B). Accordingly, Natural Power considered that at the time of preparing our report in June 2017, the data provided indicated that the replacement supply would not prejudice the quality of existing supplies and that the quality element of Clause 1.1(c) had been fulfilled with a further comment noting that filtration would also be provided for the supply.
98. Further sampling was undertaken by AA Enviro on 25 August 2017 with the results included within our letter dated 4 September 2017 showing that all results from the post-filter installation sampling of the replacement supply at Craighends were in line with the required chemical and bacteriological PCV limits for a Type B supply, re-confirming the position made in our report of our June 2017 report that the quality of the replacement supplies are meet the requirements of condition 1.1(c).

4. Summary

99. Natural Power **were provided with records** relating to the installation and testing of the replacement water supplies at Blackshill, Alton Muirhouse and Craighends prior to issuance of the stop notice by EAC. Based upon the information provided our experienced geotechnical engineering team assessed the results and, a report was prepared for CWL in June 2017, stating that the supplies met the criteria of condition 1.1 with respect to the quality and quantity aspects and that the supplies were from a source at low or negligible risk of contamination.
100. A subsequent round of pump testing and quality sampling was undertaken in August 2017, with a summarising report and letter issued in September 2017 confirming the conclusions of the Natural Power report in June 2017.

Appendix A Water Supply Well Assessment, 1134767 – 1 – C, dated 31 January 2017;

Appendix B Private Water Supply Installation Summary Report, 1166186, dated 26 June 2017

Appendix C Response to Dr P Ham Technical Note dated 31/07/2017, 12115UKC, dated 10 August 2017

Appendix D Water Supply Pump Tests Summary, 1146186 – 1 – B, with accompanying letter (Ref: 1151688 – 1 - A1).

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