

Chapter 2: Consideration of Alternatives

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2 Consideration of Alternatives

2.1 Introduction

- 2.1.1 The Proposed Development has evolved through an iterative design process which has been influenced by engineering feasibility design works, economic considerations, environmental survey data and from responses received through the consultation process (see Chapter 4: EIA Approach, Scoping and Consultation). This Chapter provides an overview of the site selection and design evolution process for The Proposed Development.
- 2.1.2 A Design Statement has been prepared for The Proposed Development which sets out the principles and design objectives that were aspired to during the design process. The Design Statement is included in Appendix 3.1.
- 2.1.3 It should be noted that the consideration of alternative solutions to transport spoil excavated from the underground works off site is covered specifically within Chapter 7: Spoil Management.

2.2 Site Selection

- 2.2.1 One of the main challenges associated with pumped storage hydro is in the identification of a site comprising suitable topography and water availability¹. There are very few sites within the UK which could be considered to have potential for the development of a technically, economically and environmentally feasible pumped storage facility of this size.
- 2.2.2 To this end, SSE commissioned a study, completed in July 2006, which examined seven potential pumped storage sites in Scotland in terms of capital cost and engineering feasibility. The objectives of the study were to identify technically viable sites, derive budget estimates for each of the sites and establish any high level planning and environmental constraints associated with the development of a pumped storage scheme in each location.
- 2.2.3 The Coire Glas site ranked highly in this preliminary assessment and following initial landowner discussions, SSE Renewables decided to progress the project through the EIA and planning process. Consent was granted for a 600 MW scheme (The Consented Development) in December 2013. It is now proposed to increase the capacity of The Consented Development to up to 1500 MW to maximise the potential of the site.

2.3 Design Process

- 2.3.1 Following identification of the Coire Glas site as a potential pumped storage site, SSE Renewables commissioned MWH in 2011 to carry out a technical feasibility study and outline design of a 600 MW pumped storage scheme in this location which was progressed through the planning process and gained Section 36 consent in December 2013.
- 2.3.2 Due to the increase in generating capacity of The Proposed Development (up to 1500MW), compared to The Consented Development (600 MW), certain modifications are required to

¹ Scottish Renewables (2016), The Benefits of Pumped Storage Hydro to the UK.

the consented design. MWH (now Stantec UK) has therefore provided engineering design advice in relation to the increase in generating capacity. These changes are outlined in Chapter 1: Introduction and Background, and particular elements described in more detail in Chapter 3: Description of Development.

- 2.3.3 Stantec UK worked closely with ASH to ensure all engineering studies of The Proposed Development were progressed in parallel with the EIA, and that the project was informed by environmental considerations where possible. Experience and knowledge gained by the EIA team in working with other large scale hydroelectric projects in the Highlands of Scotland has also been integral to this process.
- 2.3.4 The Proposed Development configuration presented in this EIA Report is considered to be the optimal technical design based on feasibility studies to date whilst minimising any environmental impacts where practicable.
- 2.3.5 There is always the option of simply not developing a project. However, given current national government policy supporting the development of renewable sources of energy (see Chapter 5: Planning Policy), the Applicant believes that pumped storage hydro will play an important role in the UK's future energy and generation portfolio.

2.4 Design Evolution

- 2.4.1 Given the complexity of this project, there are many elements of The Proposed Development that are necessarily technically and economically driven in order to achieve a viable project. These include the size and location of the dam, the location of the surge shaft and ventilation shaft, the tunnelling and underground cavern power station, and the general location of the lower control works. However, within these technical and economic parameters, there remain design and environmental considerations, opportunities and constraints to be factored in during the iterative design and EIA process.
- 2.4.2 The following sections explain how the various above ground elements of The Proposed Development have evolved through the iterative EIA and design process. Construction and operational access is covered in Section 2.5.

Dam and Upper Reservoir

- 2.4.3 The location and height of the dam is technically driven, determined in part by the amount of water required to be stored within the upper reservoir to provide a scheme with the capacity to offer up to 30GWh of energy storage potential. Reappraisal of the reservoir basin in light of the 1500 MW scheme has prompted a slight modification to the dam axis for The Proposed Development, which has moved downstream by approximately 50 m, to ensure the full 30GWh reservoir storage volume is realised. The crest level of the dam would remain the same as The Consented Development.
- 2.4.4 In selecting the most appropriate type of dam, a number of factors were considered including technical factors (such as topography, foundation conditions and construction materials), local factors (such as climate, environment and availability of expertise) and economic factors (such as buildability, capital cost and maintenance cost).

- 2.4.5 Various types of dams were considered for the upper reservoir, but it was determined that a concrete faced rock fill dam (CFRD) would be the most appropriate type of dam for this location. Further details on the selection of dam type are provided in Appendix 2.1.

Surge Shaft and Ventilation Shaft

- 2.4.6 The location for the surge and ventilation shafts to “daylight” is technically driven, the optimum location being on the saddle of Sean Mheall. Design of the above ground elements of the shafts has been given consideration within the Design Statement (Appendix 3.1), whilst alternative track alignments to access the shafts are discussed in Section 2.5.

Lower Control Works

- 2.4.7 The lower control works, comprising two screened inlet / outlet structures and stop logs, would channel water in and out of Loch Lochy and would be located on the north-western shoreline of Loch Lochy (see Figure 3.1: Scheme Overview).
- 2.4.8 The general positioning of the lower control works is similar to that of The Consented Development, but as the structures would extend over an increased footprint compared to The Consented Development to accommodate the higher pumping and generating flows, a decision was required as to whether this would extend to the north east or the south west. There was a general consensus amongst the project team that avoiding where practicable the Glas Dhoire promontory to the south west due to the screening benefit it would provide in views from the south of Loch Lochy, and the recreational, ecological and cultural heritage value (albeit local) it has, was preferable. The structures have therefore been extended to the north east.
- 2.4.9 Other design considerations incorporated into The Proposed Development at the lower control works are documented within The Design Statement (see Appendix 3.1).

Administration Building

- 2.4.10 An administration building would be located at the portal to the main access tunnel, with day to day operation and maintenance of The Proposed Development being performed from this building.
- 2.4.11 In order to explore options for the conceptual design of the administration building, SSE Renewables commissioned Page and Park Architects who have experience of designing buildings in sensitive locations throughout Scotland. The indicative design layout has fed into the development of a preliminary design and mitigation proposal for the loch shore area (see Figure 3.2). It is considered that the development of a clear design strategy for this area, and inclusion of a well designed building, would allow potential impacts to be minimised and opportunities for the building to become a positive addition to the loch shore. The preferred design (see Appendix 3.1: Design Statement), has been developed in close consultation with SSE Renewables and ASH.

Emergency Access Tunnel

- 2.4.12 The location of the emergency access tunnel for The Consented Development was located on the upper forestry track through South Laggan Forest. However, the increase in capacity

of the scheme would result in the underground cavern power station being slightly closer to the shoreline at Loch Lochy in comparison to The Consented Development. This would have the effect of creating a steep gradient from the emergency access tunnel (in its consented position) to the underground cavern power station. As such, the location of the emergency access tunnel portal had to be revisited. Options for relocating the portal included off the lower forestry track at the lower reservoir works, or mid-way between the upper and lower tracks. To reduce visual impact and minimise forestry felling, it was agreed amongst the project team that a portal off the lower forestry track was preferable. However, final siting of the portal would be subject to detailed design.

2.5 Access

2.5.1 Construction and operational access would be required for accessing the upper reservoir works and lower reservoir works. The preference for establishing access is to first utilise the existing public road and forestry tracks where practicable, some of which may require upgrading. There would also be a requirement for the creation of new tracks. This section describes the alternative access options for each element of the works.

Access to Dam and Upper Reservoir

2.5.2 Access to the upper reservoir works would be taken off the A87 at White Bridge (Invergarry).

2.5.3 Whilst the proposed access for The Consented Development utilises the existing forestry track from White Bridge to the edge of the forestry plantation to the south of Meall nan Ruadhag (upgraded as required) (Option A below), it was suggested by Forestry Commission Scotland (FCS) during scoping consultations that a review of access options through the forestry should be undertaken.

2.5.4 As such, three options were reviewed (including utilising the existing forestry track). Options A, B and C are shown on Figure 2.1: Access Track Alignment Options, and a summary of the potential constraints and opportunities of using each option is discussed in the following paragraphs. It is worth noting that all options would utilise the existing bridge crossing at White Bridge.

2.5.5 Option A follows the existing forestry tracks (to be upgraded) through the plantation from White Bridge. The first section of the track to approximate grid reference NH 264 005 is of good standard and width, being frequently used by forestry vehicles. From this point to the edge of the forestry plantation (approximate grid reference NN 265 987), the track is much narrower and not currently suitable for standard vehicles. Upgrading of this track would be required to ensure a consistent running width of circa 8m width. This would result in some tree felling to accommodate these upgrade requirements. A review of ecological constraints has identified that the upgrade requirements could impact on an area of Caledonian Forest (birch and scattered Scot's Pine), whilst signs of pine marten and bat roost potential were also noted. These constraints are applicable to all options considered through this forest. Peat depth is known to be shallow along the length of this track. The upper section of track runs close to Allt na Cailliche in places, but any upgrade requirements would likely be made to the west (i.e. away from the watercourse). Again, this would be applicable to all options considered through the forest. There is an existing FCS owned property located adjacent to the forest haul road. The public car park at White Bridge and associated trails and footpaths would largely be unaffected directly by the

works, although traffic and recreational management measures would need to be implemented to ensure safe separation with construction traffic.

- 2.5.6 Option B offers an alternative to approximately 1.3 km of Option A, from approximate grid reference NH 283 012 to NH 275 005. This option would involve the realignment of approximately 1 km of existing minor track and the construction of approximately 0.5 km of new track, located to the west of the existing forestry haul road, prior to re-joining the existing main haul road. This option would require felling through a new swathe of coniferous plantation forestry, although habitat, protected species and peat constraints suggest minimal effect to these receptors. Recreational constraints are similar to that of Option A, although there is potentially more interaction with users of the path network as one of the noted footpaths overlaps with a section of this track as it tees off from the main forest haul road.
- 2.5.7 Option C would involve the creation of a new section of track from approximate grid reference NH 283 013 to NH 265 005. This new section of track would require considerable forest felling and the potential for additional borrow pits for stone to build the new track. The new route would be approximately 2.5 km in length to the north and west of the existing forestry haul road. The existing property at Glenluie would be located within approximately 500 m of the track. A review of habitat, protected species and peat constraints suggest minimal effect to these receptors. Recreational constraints are similar to that of Option A, although there is potentially more interaction with users of the path network as one of the noted footpaths overlaps with a section of this track.
- 2.5.8 Considering these three options, it was agreed amongst the project team that there would be a clear preference in environmental and economic terms to using the existing forestry haul road (Option A) as this would result in less felling and creation of new track infrastructure. Whilst the interaction of recreational users at White Bridge would need to be managed during the construction phase, there is no clear benefit to recreation from the other options put forward in comparison to Option A (preferred).
- 2.5.9 From the edge of the plantation to the upper reservoir and dam site, a new permanent track would be required. The indicative track alignment shown on Figure 2.1: Access Track Alignment Options, has been developed through consideration of environmental constraints, and has sought to avoid areas of deeper peat, sensitive habitats and areas of Ground Water Dependent Terrestrial Ecosystems (GWDTE) where possible.

Surge Shaft and Ventilation Shaft

- 2.5.10 A surge shaft is required in order to respond to the fluctuations in pressure within the tunnels due to increased flow rates (compared to The Consented Development). To enable access for construction and ongoing maintenance of the surge shaft and ventilation shaft, a new access track from the upper reservoir area would be required. Three indicative options were reviewed. Options D, E and F are shown on Figure 2.1: Access Track Alignment Options, and a summary of the potential constraints and opportunities of using each option is discussed in the following paragraphs.
- 2.5.11 At scoping stage, access to the surge and ventilation shafts was proposed to be via a crossing of the Allt a' Choire Ghlais watercourse and a number of its tributaries, following a tributary up to the shaft location. This is shown as Option D in Figure 2.1. Concerns were raised by SEPA with regard to the indicative alignment of this option due to the potential

large number of watercourse crossings that would be required. On this basis SEPA considered that the indicative alignment of the track was not acceptable. Further review of this track by the project team through the EIA process also concluded that the number of water course crossings would, by necessity, be considerable. Small areas of blanket bog and wet heath would also likely be impacted by this track. In addition, the track could potentially impact upon a sensitive ornithological receptor.

- 2.5.12 An alternative alignment (Option E) was identified, linking the track directly with the dam via the north east flank of Sean Mheall. Whilst this option is the shortest of the three options considered, and would avoid crossing the Allt a' Choire Ghlais watercourse, it would continue to cross a number of other smaller burns. Given the steepness in topography, the track would require careful engineering. A small area of blanket bog would likely be impacted by this track alignment. Potential ornithological constraints were a key factor in the evaluation of this option.
- 2.5.13 Option F, flanking the north-west slope of Meall nan Dearcag hill and crossing Allt a'Choire Ghlais watercourse (further to the east in comparison with Option D), was the third option considered. Whilst this option would traverse land of reasonably steep gradient and in proximity to craggy outcrops, requiring careful engineering, it would avoid the need to cross and impact on several watercourses. A small area of blanket bog would likely be impacted by this track alignment. The alignment is also routed further from sensitive ornithological receptors.
- 2.5.14 On balance, it was determined by the project team, and in consultation with The Highland Council, Scottish Natural Heritage (SNH) and SEPA, that Option F is preferred on the basis that it would have less impact on ornithological and water environment constraints.

Lower Reservoir Works

- 2.5.15 Access to the lower reservoir works would be taken off the A82 at North Laggan, continuing along the minor road through North Laggan (known locally as Kilfinnan Road) (to be upgraded) and along existing forestry tracks (to be upgraded). During development of The Consented Development consideration was given to creating an alternative access route, avoiding the requirement to upgrade the existing minor road. Options considered included new alignments above (to the north west of) or below (towards the Caledonian Canal) Kilfinnan Road. These were discounted due to the steepness of the topography to the west of the existing road and the requirement for extensive ground stabilisation works as well as space limitations in land to the east of Kilfinnan Road.
- 2.5.16 Consideration was also given to providing access to the lower reservoir works from the south via the B8005 and utilising existing forestry tracks. This route was determined to be less favourable because of restrictions on the minor roads linking both the A82 at Spean Bridge and A830 at Banavie to the forestry entrance at Clunes. Both of these alternative routes would have required significantly greater works than the proposed access at North Laggan.

2.6 Transportation of Spoil from Lower Reservoir to the Dam

- 2.6.1 The consideration of alternative solutions to transport spoil excavated from the underground works off site is covered separately (see Chapter 7: Spoil Management). This

section considers the alternatives available for using excavated spoil in construction of the dam.

- 2.6.2 The ability to use excavated spoil material in the construction of the dam depends on both the construction programme/sequencing of dam construction and the suitability of the spoil. This is discussed further in Chapter 7: Spoil Management.
- 2.6.3 Excavation of most of the underground works would commence at the lower reservoir works on the shore of Loch Lochy, with the majority of excavated spoil being removed via the tunnel portals near the shore at Loch Lochy. It has been calculated that approximately 0.6 million tonnes of construction aggregate would be needed for concreting operations both in the underground works and at the Lower Control Works. It is anticipated that of the total excavated spoil, it is estimated that 20% would be removed from the tunnel portal at the upper reservoir and will be used in dam and track construction. Once the material re-used at the dam and the processed spoil used for construction aggregate has been accounted for, it is anticipated that the quantity of spoil generated by The Proposed Development will result in approximately 3.9 million tonnes of surplus material at the lower reservoir works which will require on-site re-use or onward transportation for re-use off site. This estimate is based on the proposed 1500 MW scheme (i.e. the 'worst case scenario' in terms of the generation of excavated materials).

Transportation Options

- 2.6.4 The following options to transport spoil from the lower reservoir works to the upper reservoir have been considered:
- **Transport via Public Road Network:** This option would involve spoil being transported by HGV along Kilfinnan Road and onto the public trunk roads (A82 and A87), before accessing the proposed main haul road to the upper reservoir works at White Bridge. This haul route would cover an ascent of at least 500 m over a route of up to 24 km (one way). This is a significant distance, with the potential for effects on the local community (disruption, amenity, traffic, air quality and noise). The carbon impact of this option could also be considerable;
 - **Temporary Haul Road:** The construction of a dedicated temporary haul road to connect the lower reservoir works with the upper reservoir works has been reviewed. Given the topography and gradients in this area options are limited, but an indicative alignment for a temporary track has been identified. This would involve the construction of a track to the east of the emergency access tunnel portal at the lower reservoir works, initially heading through Laggan Forest before sweeping to the east of the lower slopes of Meall nan Dearcag and joining the proposed track between the surge shaft and dam (see Figure 3.1: Scheme Overview). Alignment options for this track considered habitat and peat depth constraints, but given the steepness of topography to the north and west (Meall nan Dearcag) and Kilfinnan Burn to the east, options were restricted. As such, the alignment does pass through an area of GWDTE, albeit the habitat here is degraded and commonplace within the local area and it is considered that potential impacts could be minimised by appropriate mitigation. An alternative route south west via Cam Bhealach then heading in a horseshoe to the north-east (see Figure 2.1: Access Track Alignment Options) was also considered, but discounted as this option would cover an ascent of

at least 600 m over a route of up to 15 km (one way), through a Wild Land Area and with potential ornithological and recreational constraints; and

- **Conveyor and Cableway:** The potential use of an overland conveyor system would require a conveyor route, alongside which a new access track would need to be constructed for maintenance and operational purposes. Whilst this method could potentially cope with the capacity of spoil expected, to ensure the conveyor is not excessively wide, the won spoil would need to be processed (crushed and graded) prior to discharging to a conveyor for transport. Given the gradient, the most feasible route for access (and therefore a conveyor route) would be the route of the temporary haul road (see above). However, the combination of a conveyor and temporary access along this route could lead to an increased construction corridor and may result in potential effects on the environment (e.g. visual, noise). An underground conveyor system was also considered (through the main access tunnel to the surge shaft or another specially constructed adit or shaft) but it is not anticipated at this stage that such a solution would be viable without programming and cost implications. It could also lead to increased spoil volumes through the creation of an additional adit or shaft, and may present potential health and safety risks that would require due consideration.

2.6.5 On balance, it was determined by the project team that of the options considered, the construction of a new dedicated track to the east of the lower slopes of Meall nan Dearcag to the upper reservoir works was the overall preferred option.