Executive Summary

Background & Project Description	Belfast City Council (BCC) are developing a new build flagship tourism and visitor experience centre (Belfast Stories) in central Belfast. To align with Belfast City Council's (BCC's) Net-Zero Carbon Roadmap for Belfast and their Resilience Strategy published in December 2020, BCC commissioned a study to look at the potential for using geothermal technology to meet the buildings heating and cooling requirements. An assessment of the site with respect to its potential to use ground source shallow geothermal technology has been completed. No detailed design for the development was available at the time of this study preparation, however a concept layout for the site and development was available from which an initial building model was developed. This enabled Tetra Tech to complete an initial assessment of the buildings heating and cooling requirements. The work also permitted an initial comparison of heating and cooling technologies for the site.
Site Setting	The site is located at the junction of Royal Avenue and North Street in central Belfast, Northern Ireland. The site has been partially cleared of previous buildings. The former Bank of Ireland building remains and its entrance fronts onto Royal Avenue. It is expected that the former bank building will be retained and integrated into the Belfast Stories development. Other more modern buildings are also present along this side, some of which may also be retained.
Geological/Hydrogeological /Thermogeological Setting	The site sits within the Lagan Valley, it is underlain by 10-25m of unconsolidated superficial deposits, below which lies the Sherwood Sandstone aquifer (bedrock), The bedrock is expected to reach thicknesses of several hundred metres below the site. The Sherwood Sandstone is a significant aquifer resource which has the potential to sustain large abstractions. The aquifer has a long history of use supporting many different industries, including public water supply, large private water supplies (Belfast Hospitals, QUB) and more recently geothermal. Available information for the Sherwood Sandstone bedrock indicates it has favourable thermal properties, and has good heat transfer capability compared to many other bedrock types in Northern Ireland.
Technology Options Assessment	The site setting is such that a range of established ground source heating and cooling options are potentially viable. These options include open loop – which involves physically pumping groundwater from the underlying aquifer and subsequently discharging groundwater back into the ground. A closed loop solution is considered potentially viable. This involves the connection of heat pumps to the ground via pipework installed in boreholes and/or piles. Each option has implications for the building design. Further site investigation and or modelling would be required once the buildings heating and cooling requirements are better understood (i.e. once a design has been developed). This will then all BCC to confirm the viability of each option or establish the maximum contribution that each technology could make to the buildings overall heating and cooling requirements. The investigations and modelling will also allow BCC to refine the carbon savings and CAPEX/OPEX costs presented in this initial feasibility assessment. The outcome of the financial and carbon analysis completed as part of this study shows that, in principle, ground source heat pumps are a viable option for the site. A geothermal solution has the potential to provide significant carbon reductions and boasts competitive operational costs when compared to alternative technologies on the market today.
Conclusions	Geothermal is a viable option for the site. A closed loop geothermal solution is preferred for the site relative to an open loop system. Ground investigation work and modelling will be required. The data gathered from this work can be used to inform a geothermal design for Belfast Stories once the building heating and cooling demands have been derived. **CO2** Based on the data available and the assumptions made during the preparation of this feasibility assessment, a closed loop geothermal system comes out on top as a low carbon solution when compared to other heating and cooling solutions (30 year emission estimate: Gas 1241 tC02, Biomass/gas 711 tC02, Geothermal 284 tC02 and Air Source 346 tCO2). For geothermal this equates to a C02 saving compared to Gas of 957 tC02 over 30 years. This option would align with BCC's Resilience Strategy and Net Zero Carbon Road map.

	However, on the grounds of CAPEX and OPEX costs over a 30-year period, a closed loop geothermal system is more expensive. **CAPEX** For CAPEX the derived geothermal estimate cost of £1.45M compares to Gas – £0.21M, Biomass/gas – £0.34M and Air Source £0.47M. **OPEX** For OPEX the geothermal estimate cost of £1.6M compares to Gas – £1.38M, Biomass/gas – £1.46M and Air Source £2.16M. Based on the estimates made, the geothermal solution is therefore c.£13,300 per annum (on average) more costly over a 30 year period compared to the next lowest CO2 emission technology of Air Source (air to water).