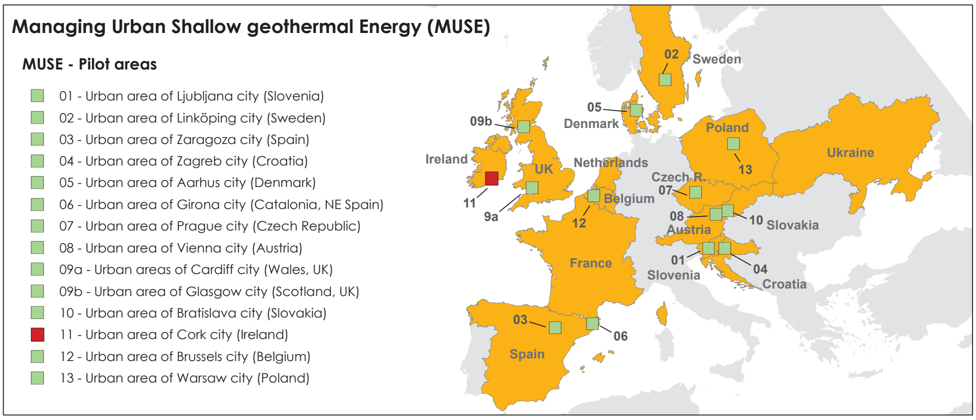
# CORK FACTSHEET

IRE/WP4/D4.1/FS11/2018

## Pilot area information




The Pilot Area encompasses central Cork City and some of its environs. Cork was chosen as it has a long history of ground source heat use, and more readily available data than other parts of Ireland. There are three hydrogeological units within the study area: a glacio-fluvial sand and gravel unit; karstified limestone underlying the river valley; and sandstone and conglomerate underlying the topographic ridges (GSI, 2004). The main target for this study is the glacio-fluvial sand and gravel unit. Groundwater in these sands and gravels are known to have temperatures between 9 and 13 °C (Connor, 1998), and groundwater temperatures of 19 – 20 °C have been recorded in the centre of the Pilot Area at a depth of 20 m in the karstified limestone unit beneath the sands and gravels (Allen and Burgess, 2010).

There is a lack of data in Ireland with regard to ground source heat exchangers, and it is difficult to find statistics on the use of shallow geothermal energy. In 2017, RES-H was 6.9 %, and 13 % of the renewable heat energy expenditure was attributed to heat pumps (mostly air source) (SEAI, 2019). The number of SGE installations in Ireland is unknown, and information on domestic installations is particularly hard to obtain (Pasquali et al., 2015).

During the MUSE project, additional data on GSHP heating and cooling installations will be collected, and databases on groundwater temperatures, hydrochemistry and water levels will be developed and populated. This information will be used to develop a better understanding of the hydrogeothermology of the study area.

| Pilot Area | Cork City |
|---|---|
| Task (MUSE) | T-4.12 |
| Country | Ireland |
| Area (km²) | 40.7 km² |
| Total number of inhabitants (date) | 125,622 (2016 total for Cork City) |
| Inhabitants per km² | 3367.9 (in Cork City) |
| Level of urbanization | 100% |
| Elevation range (m a.s.l.) | 0-115 |

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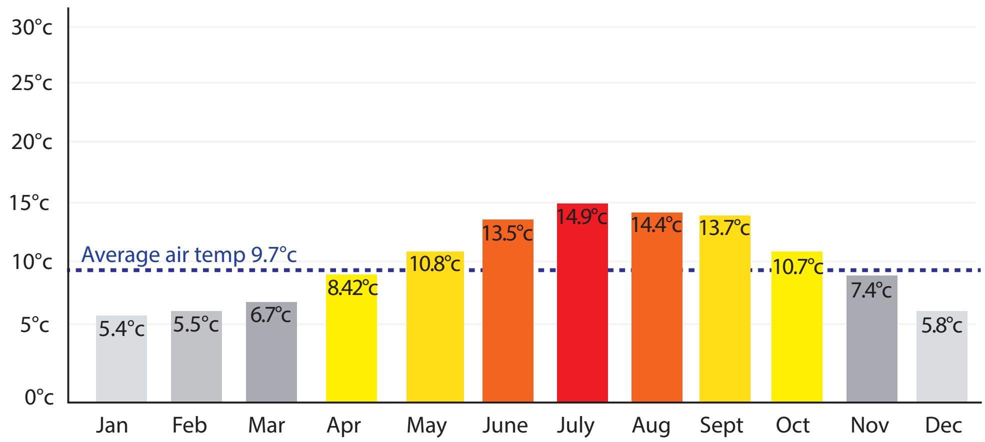
## Climatological settings

| HDD/CDD data accordingly to the local methodologies at the Pilot areas | |
|---|---|
| Heating degree days (HDD) / a/baseline reference values / period of data for calculations (note unit is hours) | 1906; (15°C) (period 2014-2018) |
| Cooling degree days (CDD) / a/b values / period of data for calculations | 0 (24 °C) (period 2014-2018) |
| Length of the heating season (days) | 220 (period 2014-2018) at (15°C) |
| Length of the cooling season (days) | 0 (24 °C) (period 2014-2018) |

Source of data: Geological Survey of Ireland

## Average monthly and annual air temperature




## Market situation

| | | |
|---|---|---|
| Number of SGE installations in pilot area | Mixture of open loop and closed loop (mainly open loop in sands and gravels, closed loop in bedrock) | 27 (currently unknown) |
| Current growth rate | | Unknown |
| Estimated share of open loop systems | | Unknown |
| Estimated share of closed loop systems | | Unknown |
| Estimated total share of shallow geothermal methods in the heating market | | Unknown |
| Other SGE technologies: Eg. Inter-seasonal heat storage schemes or energy piles | | Unknown |
| Estimated total share of RES in the heating energy market (%) (specify local or national values) | | Total market share - 6.9 % (2017) (SEAI, 2019) |

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## Economic boundary conditions

| Estimated average installation costs for shallow geothermal systems (€/kW output) [1] | |
|---|---|
| Open loop systems | 1,600 (based on figures for 10 kW domestic systems from GSI (2015) |
| Closed loop systems | V-CLS: 2000 €/kW<br>H-CLS: 1300 €/kW |
| Estimated average heating costs (€/kWh) | |
| Open loop systems | 0.16 €/kWh (Ground source heat pump) Annual maintenance cost: €250 (GSI, 2015) |
| Closed loop systems | 0.16 €/kWh (Ground source heat pump)<br>Annual maintenance cost: €150 |
| Drilling cost range per metre (€/m) for Open Loop | €35 per metre (GSI 2015) |
| Drilling cost range per metre (€/m) for Borehole Closed Loop | €25 per metre (GSI 2015) |

## Regional geological and hydrogeological characteristics

***General Setting***

Cork city occupies an elongate E-W to ENE-WSW river valleybounded by E-W ridges to the North and South of the City. The valley floor is partially occupied by the River Lee flood plain that runs through Cork City (GSI, 2004).

***Geology***

Geological ages: Devonian, Carboniferous and Quaternary at or close to the surface within the study area.
Depositional Environment: In the Devonian, terrestrial dunes and occasional rivers deposited large pebbles and cobbles, and sand beds. This was followed by a transgressive marine environment in the Carboniferous. There are no younger rocks in the pilot area so at least one episode of erosion must have occurred, followed by successive glaciations in the Quaternary.
Bedrock lithologies: Devonian Old Red Sandstone Formation consisting of sandstones and conglomerates; these are overlain by Carboniferous (Dinantian) mudstones and sandstones with bands of grey-black, slatey mudstone; followed by pure unbedded Dinantian Waulsortian Limestone Formation. These bedrock units are cross-cut by N-S faults.
Quaternary lithologies: Alluvium, glacio-fluvial sands and gravels, and glacial tills (diamicton). These units tend to be around 10 m in thick and sit above the limestone bedrock.

***Hydrogeology***

There are three types of aquifer in the study area: the Old Red Sandstone (LI – locally important fractured bedrock), karstified limestone (Rkd – regionally important karstified limestone), and the sands and gravels (Rg – regionally important sand and gravel aquifer).

***Thermogeology***

At shallow depths within the gravels beneath Cork City temperatures range between 9 and 13 °C (Connor, 1998); temperatures up to 20 °C have been observed locally in the underlying karst limestone (Allen and Burgess, 2010). The depth to the water table can vary from a few metres up to more than 10 m below ground level, depending upon topography. Seasonal variation in groundwater level is minimal next to the river, although it is tidally influenced. Under elevated ground, groundwater levels can vary by 5 – 10 m seasonally (GSI, 2004).

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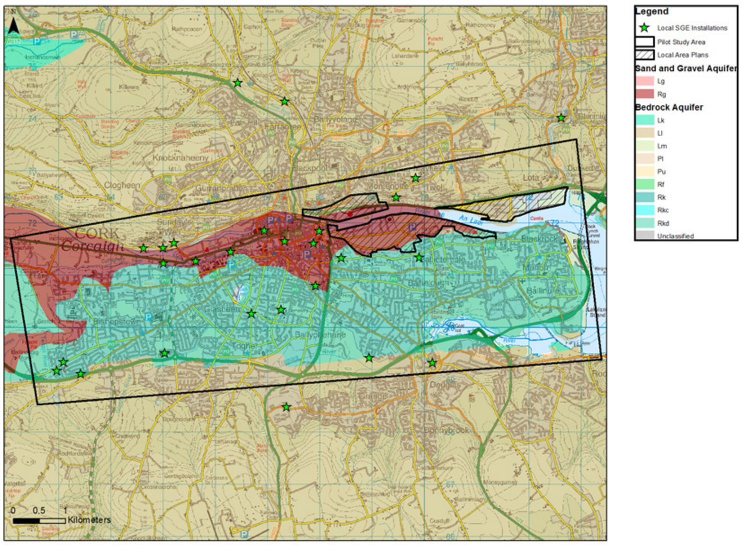


## Summary of works and timeline

| Main Objectives | |
|---|---|
| ✓ | Evaluation and characterization of geology/ hydrogeology / thermal conditions |
| ✓ | SGE assessment resources (for OCS and/or CLS) / and evaluation of UTES-BTES) |
| | Study of conflicts of use (OLS / GWL - OLS/CLS). Hazards/interferences, effects on sub-surface |
| ✓ | Strategies and actions for management and local energy plans |
| **Relation of foreseen tasks** | |
| ✓ | Data collation (TRT, DTRT, rock samples, GWL, T-profile's etc) |
| ✓ | New field works (TRT/geophysics /new samples and lab etc) |
| ✓ | Monitoring existing SGE/GWL/T etc) |
| ✓ | Mapping (in general terms) |
| ✓ | 2D/3D Modelling (in general terms) |

## Detailed summary of works at the Pilot Areas and brief timeline

***Planned activities for March 2019 – March 2020 MUSE monitoring period (may extend further)***

WP3: Review of current regulations
WP3, 4 and 5: Stakeholder questionnaires & Public engagement, Installer questionnaires

WP4: Study area – Cork City

- Collation of existing data and previous studies – geology, hydrogeology, hydrochemistry, thermogeology, GSHP installations, engineering studies.
- Baseline temperature, water level and hydrochemistry monitoring at different locations in pilot area.
- Mapping installed systems and potential conflicts of use. Assessing, where possible, current status of GSHP system (in use/abandoned/problems).

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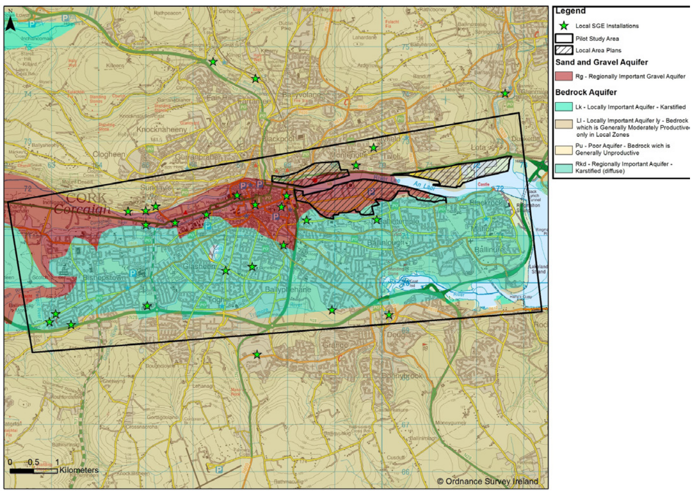
## Appendix

### 1. Map

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## 2. Regional geological and hydrogeological characteristics extended

*Bedrock*

Compression of these rocks occurred during the Variscan Orogeny forming a series of folds on E-W axes. Over time the more soluble limestone was eroded away on the anticlines, exposing the more resistant sandstone, however these limestones were preserved within the synclines of the folds. These anticlines and synclines now represent the E-W trending mountains and valleys seen today. The orogenic event caused extensive fracturing and faulting, causing the ridges and valleys to be cut by shear faults in a N-S direction and thrust faults in a E-W. A drop in sea level of ca.-130 mOD Pleistocene rivers cut down to a new base level forming the valley which Cory City sits in.

*Quaternary*

The valley created during glaciation became infilled with sand and gravels. Scourse et al (1992) suggested that the deeper sediments are of glaciofluvio outwash whereas shallower represents reworked glaciofluvial sediment caused by the rising sea level towards the end of glaciation (Hemmingway et al; 2011). Overtime the Lee River deposited alluvium in the form of estuarine clays, silts and peats with a typical thickness of 3-4 m. The upper estuary became marshland surrounded by the braided which became embanked and reclaimed by the river (Hemmingway et al; 2011).

The thickness of the sand and gravel deposits varies significantly, although they tend to be greater than 10 m. The River Lee flows along the northern side of this GWB with a 10-30 m depth to bed rock within the flood plain of this river. The undulating nature of the subsoil depth is linked to the highly karstified pure unbedded limestone beneath. Areas to the Southern and Western portions of the River Lee flood plain, subsoil thickness lessens with the underlying limestone unit becoming exposed in areas. Moving away from these outcrops in the Southern section the subsoil tends to be up to 10 m thick however areas of deeper subsoil can exist.

*Hydrogeology*

The area is composed of three aquifer bodies, these being the ORSS (LI), karstified limestone (RKd), and the sand and gravels (Rg).

The limestone has no primary intergranular permeability, groundwater exploits secondary permeability of faults and joints that have undergone karstification, the water table tends to be within 10 m from the surface. This is a regional scale aquifer defined as RKd under GSI's classification system. The limestones being overlain by sand and gravels are in hydraulic continuity with one another. The sand and gravels provide recharge to the karstified limestone and additional storage under saturated conditions.

The Alluvium is thought to be of 'moderate' permeability with the sand and gravel deposits being 'high' permeability and glacial tills considered to be 'moderate' (GSI, 2004).

## Contact

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Project number GeoE.171.006

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