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Monitoring Groundwater Temperatures in a Shallow Urban Aquifer Before, During and After Installation of a Ground Source Heat System in Cardiff, U.K.

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Exploitation of shallow urban aquifers, warmed by the Urban Heat Island Effect, is a relatively new concept in the U.K. An extensive groundwater temperature baseline monitoring network has been established for a shallow superficial aquifer in the city of Cardiff, U.K., to characterise groundwater temperatures and monitor the impacts of the first open-loop ground source heat pump (GSHP) installed in the city.

In Spring 2014, temperature profiling was carried out at 1m depth intervals at 168 groundwater monitoring boreholes across Cardiff, establishing baseline groundwater temperatures within the shallow (<20m) superficial aquifer during the groundwater's forecast coldest time of year. Data was contoured to form the first U.K. 2D city heat map.

During the warmest time of year, Autumn 2014, a subset of boreholes were re-profiled to ascertain seasonal temperature variation, defining the Zone of Seasonal Fluctuation. Re-profiling was again carried out at these boreholes in Autumn 2015 to confirm these temperatures as normal for that time of year. By comparing Spring and Autumn profiles, the average depth to the base of the Zone of Seasonal Fluctuation was found to be 9.5mbgl.

Two >100m boreholes showed the urban warming effect may extend to 80mbgl, before temperatures follow the predicted geothermal gradient. We term this the Zone of Anthropogenic Influence.

After initial baseline temperatures were established, a site was selected for the installation of a shallow GSHP. Before installation work began, a monitoring network was set up to establish a temperature baseline for future GSHPs and identify any impacts on the thermal resource caused by removing $\sim$2°C from the abstracted groundwater prior to reinjection into the aquifer. This comprised of 97 temperature loggers in 60 boreholes, including the abstraction and recharge boreholes and boreholes up and down gradient of the site.

Some of these boreholes have multiple loggers at different depths, including the near-surface, but the majority of loggers were placed within the boreholes' slotted sections, below the base of the Zone of Seasonal Fluctuation. In addition, six boreholes, including those used for the GSHP, have been telemetered, providing real-time temperature data.

The aim of the monitoring network was to establish a baseline for groundwater temperatures in the shallow aquifer and to monitor local changes in temperatures close to the GSHP system. This study aimed to provide understanding of how GSHPs interact with the groundwater in order to confirm the sustainability of groundwater temperatures as a long-term thermal resource and provide planners with knowledge needed to develop sustainable wide-scale GSHP systems/networks. We present temperature data taken before and after installation.