

## Sustainable cooling of the London Underground network

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### Scientific Background

Subsurface rail networks across the globe are becoming increasingly overheated because of climate change. More prolonged and extreme summers, combined with a rapidly increasing urban population, has led to devastating impacts on both public health and rail engineering. Surprisingly, little attention has been paid to mitigating this situation, even in major cities like London, whose Underground network currently only uses temporary fans to shift warm air around in summer. At the same time, any proposed cooling scheme should be fully environmentally sustainable and must not contribute towards climate change, so should not contain refrigerants. In this way, this project will elucidate a proof-of-concept scheme that harnesses water from buried rivers and the Chalk aquifer to cool Tube stations via a process of heat exchange (using ground-source heat pumps – GSHPs).

### Research Methodology

First, the student will identify feasible locations for the operation of such a proof-of-concept scheme from a hydrological point of view, by mapping subterranean rivers and groundwater levels across central London. Then, the effects of abstracting and re-injecting heated water on the subsurface will be investigated using a variety of numerical modelling tools. An economic cost-benefit analysis will also be undertaken. Field mapping at several proxy Chalk outcrops across southeast England will elucidate fracture patterns, which will allow the numerical modelling to be calibrated. Following the development of self-build water level sensors and GSHPs, the student will conduct field tests, together with a scale model that cools a theoretical subsurface railway station using groundwater and/or subterranean river water that flows through a GSHP.

### Training

The student will be trained and gain skills in the computer laboratory (in using GIS and numerically modelling water flow), field, and workshop (developing self-made environmental sensors and GSHPs).

### Person specification

The student will ideally be numerate, with a Physical Science or Engineering degree, and will be willing to conduct field and modelling experiments. Experience in electronics (e.g. soldering) is beneficial but not essential.

### References

- 1 Paul J.D., 2016. High-resolution geological maps of central London, UK: Comparisons with the London Underground. *Geoscience Frontiers*, 7(2), 273–286
- 2 Upton K.A., Jackson C.R., Butler A.P., et al., 2020. An integrated modelling approach for assessing the effect of multiscale complexity on groundwater source yields. *Journal of Hydrology*, 588
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# Competition-funded NERC PhD project



- 3 Paul J.D., W. Buytaert, N. Sah, 2020. A technical evaluation of lidar-based measurement of river water levels. Water Resources Research, 56(4), e2019WR026810

## Key Information

- This project has been shortlisted for funding by the ARIES NERC DTP and will start on 1st October 2024. The closing date for applications is 23:59 on 10th January 2024.
- Successful candidates who meet UKRI's eligibility criteria will be awarded a NERC studentship, which covers fees, stipend (£18,622 p.a. for 2023/24) and research funding. International applicants are eligible for fully-funded ARIES studentships including fees. Please note however that ARIES funding does not cover additional costs associated with relocation to, and living in, the UK. We expect to award between 4 and 6 studentships to international candidates in 2024.
- ARIES students benefit from bespoke graduate training and ARIES provides £2,500 to every student for access to external training, travel and conferences, on top of all Research Costs associated with the project. Excellent applicants from quantitative disciplines with limited experience in environmental sciences may be considered for an additional 3-month stipend to take advanced-level courses.
- ARIES is committed to equality, diversity, widening participation and inclusion in all areas of its operation. We encourage enquiries and applications from all sections of the community regardless of gender, ethnicity, disability, age, sexual orientation and transgender status. Academic qualifications are considered alongside non-academic experience, and our recruitment process considers potential with the same weighting as past experience.
- All ARIES studentships may be undertaken on a part-time or full-time basis, visa requirements notwithstanding.
- For further information, please contact the supervisor. To apply for this Studentship follow the instructions at the bottom of the page or click the 'apply now' link.
- ARIES is required by our funders to collect Equality and Diversity Information from all of our applicants. The information you provide will be used solely for monitoring and statistical purposes; it will remain confidential, and will be stored on the UEA sharepoint server. Data will not be shared with those involved in making decisions on the award of Studentships, and will have no influence on the success of your application. It will only be shared outside of this group in an anonymised and aggregated form. You will be asked to complete the form by the University to which you apply.
- ARIES funding is subject to UKRI terms and conditions. Postgraduate Researchers are expected to live within reasonable distance of their host organisation for the duration of their studentship. See <https://www.ukri.org/publications/terms-and-conditions-for-training-funding/> for more information