

## **Predicting motorway de-icing salt impacts to surface water and groundwater: field assessment and model tool development**

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The application of de-icing salts to road networks is widespread in colder climates. Many countries have witnessed increased applications in recent decades for a variety of reasons ranging from increased liability concerns to more severe weather conditions potentially related to climate change. Salt application rates on the UK's motorway – trunk-road network are typically higher than those used in Europe. Much of the applied salt is ultimately anticipated to end up in the water environment leading to derogation of water resources and environments. Runoff from many of the UK's road networks directly pipe discharges to surface waters, some of which may leak to groundwater. Alternatively, direct runoff infiltration to ground and in turn groundwater may occur. The aim of this PhD is to better predict and reduce motorway de-icing salt impacts to surface water and groundwater environments. This will be accomplished through: (i) field assessment, including monitoring technology development, based upon intensive spatial and temporal monitoring of motorway – stream – groundwater interaction sites in the UK Midlands established by the University of Birmingham in collaboration with the Environment Agency and consultants acting for the Highways Agency; (ii) the development of models that predict motorway runoff and de-icing salt fate and the loading to the water environment compartments as well as adjacent land and vehicle uptake. The developed models will be validated against the collected and recent winter historic data and then used to (iii) predict water resource, environmental and ecosystem service impacts as well as guide what potential measured may be adopted to ameliorate or reduce impacts. The PhD would suit numerate students with scientific, environmental or engineering backgrounds keen to develop environmental field assessment and (numerical) modelling skills. It is proposed that the project will work alongside the Environment Agency, the Highways Agency and their consultants extending the University's existing relationships.

The proposed PhD research would build on several MSc and MSci projects conducted in recent years including the severe winters of 2009-10 and 2012-13 that have assessed the impact of the M5 – M42 junction impact to a receiving surface water, the Battlefield Brook that leaks to the underlying Triassic sandstone aquifer used for public water supply. These studies have been supervised by Dr Rivett at the University of Birmingham and were instigated with seed funding from the Environment Agency. Our continuous logged records of electrical conductivity (EC) correlate with spot chloride data and may be used to estimate a reliable temporal record of stream water chloride quality. Our preliminary developed models of motorway runoff that incorporate daily motorway salt application data (from The Highways Agency) reasonably reproduce the observed salt impacts to the receiving surface water that may exceed EQS (Environmental Quality Standards), often considerably. Much more could be achieved through a PhD study that would involve more intensive monitoring of the system including the development of novel technologies (continuous in-situ EC and temperature measurement) to look at salt fluxes including the exchange of salt between surface water and groundwater. The developed models could be made much more process robust by more explicit representation of salt fate and run off from the motorway and better interface of such model to catchment – groundwater models. The PhD will look to develop not only sophisticated models, but also more simple models that are more generically transferable and may be used as scoping tools by practitioners, i.e., the agencies and their consultants. The developed model tools will be used to examine impacts and their sensitivities as well as potential remedial measures. The research has other spin-off benefits. Although focused on water impacts, the research will provide the Highways Agency with a supporting measure to the difficult-to-quantify residual salts remaining on motorway surfaces, important to the decision making on further salt applications. It also underpins evaluation of concerns of salt migration through SUDS (sustainable urban drainage systems).

Applicants should apply via

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