Institution: University of Birmingham

Unit of Assessment: UoA 14 – Civil and Construction Engineering

a. Context

The research activities of the School impacts on several sectors – Industry, Safety / Regulation, Codification, Media and the public, and Higher Education Institutes, and are based around two themes - Railway Engineering and Sustainability and Resilience. These are fed by four research groups; Fluid Mechanics, Environmental Engineering, Transport Engineering and Structural Engineering. The railway work is carried out through the multi-disciplinary Birmingham Centre for Railway Research and Education (BCRRE).

b. Approach to impact

The School's vision is the delivery of innovative interdisciplinary research to address the vital issues associated with urban environments in the 21st and 22nd centuries, with a range of impacts across a variety of sectors as follows.

Industry Impact

a) *Industry partnerships*. BCRRE has one of only four formal partnership agreements with Network Rail, specifically in the field of Data Integration and Management. Current work in the School on the effect of climate on the railways is influencing the development of the Network Rail weather mitigation and climate change adaptation strategies.

b) Industry funded research. Projects of direct relevance to industry include studies of tunnel aerodynamics and train slipstreams for Network Rail (Baker); investigations of high capacity scheduling of Thameslink trains (Schmid); development of novel slabtrack forms for Crossrail (Schmid); wind measurements in the Olympic Stadium (Quinn); incorporating climate change effects into road maintenance scheme appraisals (Burrow); development of a standard (for Atkins) for collapsible soils (Jefferson); projects to increase biogas generation and reduce energy usage in the water industry (Carliel-Marquet, Bridgeman), projects on structural wind engineering for the Finnish steel industry (Baniotopoulos).

c) *International industrial links*. BCRRE is a member of a Framework consortium for research with the USA Federal Railroad Authority, and has strong international educational and research links with organizations in China. Staff are also partners on EU projects with major international rail industrial organisations eg Bombardier, Siemens, Alstom and Hitachi.

d) *Product and software development*. Research has resulted in commercial products – eg the wheat lodging model now used routinely by ADAS to advise farmers on crop choice; and the HDM-4 software, used by the World Bank in the assessment of road building programmes, which is marketed by the spin-out company, HDMGlobal.

e) *Active collaboration in major projects*. Research into Sustainable Urban Environments (SUE) (Rogers), resulted in a process known as "The Urban Futures Method", which identifies the vulnerabilities of any given sustainability solution or decision. This methodology has been incorporated into the Lancaster Luneside East development and has been influential in the planning of the Digbeth redevelopment in Birmingham.

Safety and regulatory impact

a) Within the railway sector significant work has been carried out for RSSB and Network Rail in a number of areas – eg the safety of people subjected to the slipstreams of trains (Baker); finite element analysis of switches and crossings (Hemida). Evidence has been presented to the government sponsored McNulty Commission on the future of railways (Schmid).

b) Staff have acted as expert witnesses in court cases involving the blowing over of vehicles in high winds (Quinn) and the effect of high buildings on pedestrians and vehicles (Baker).

c) The School has representation on a number of international working groups and committees, for example the UNECD group on Transport and Climate Change (Baker).

d) Staff have carried out the basic design work for the Mapping the Underworld Centre of Excellence for training and accreditation of utility surveyors (£2m funded by JK Guest Ltd.).

Codification impact

a) Staff are working with industry and the BSI to develop a set of standards for geophysical detection of buried utilities using geophysical techniques, based on the Mapping the Underworld project (Metje). Results from RSSB work on the aerodynamic loads on trackside structures are being utilised in the development of a National Annex for a Eurocode (Baker).

b) Structural Engineering staff have assisted in the updating of international design guidelines for shear strengthening of existing concrete structures (Baniotopoulos). Baker is also a member of the committee revising the ISO wind loading code and a CEN working group on the revision of climatic codes of practice.

Media and General public impact

a) *Television and radio*. Staff within the School have presented their research in media appearances. A Radio 4 programme (*Mapping Britain's Underworld*) showcasing the findings of MTU to an audience of 600,000, was broadcast in 2012. Our water quality assessment work (Bridgeman) has been featured heavily in the media, including a showcase on national television to an audience of >3M; Carliell-Marquet was featured in a Naked Scientist broadcast on "Wattage from waste and watching our water". A Westmister MTU workshop in 2011, with representatives from local and national government and regulatory authorities, illustrated MTU's potential to transform streetworks (Rogers/Metje).

b) *Public Engagement activities*. On a number of research council grants, funds have been obtained for work within local primary and secondary school eg current research on wind engineering engages with students from local secondary and primary schools (Sterling).

HE Impact

a) *UK university partnerships*. Multi-disciplinary, multi-university EPSRC consortia led by Birmingham include Urban Futures (with Exeter, Lancaster, BCU), Liveable Cities (with UCL, Lancaster and Southampton), MTU (Sheffield, Bath, Leeds and Southampton), and FUTURENET (Loughborough, Nottingham, with BGS, HR and TRL).

b) *Overseas university partnerships*. BCRRE has strong collaborations with a number of overseas universities – Chalmers in Gothenburg, Central South University in Changsha (PRC), Shanghai Jiao Tong University (PRC) in particular, whilst our work on fluid mechanics and water quality has been carried out in collaboration with UNESCO-IHE, the Universities of New South Wales and South Australia, and TERI University in India, and the Urban Futures research on policy influence was advanced with University of Milan Bicocca

Knowledge transfer activities

a) The SUE methodology has been widely distributed through the distribution of a succinct document "Designing Resilient Cities; a guide to good practice", to the SUE practising partner network. A Knowledge Transfer Secondment with CH2MHill created material for CPD training and university modules, drawing from the SUE programme (Rogers).

b) Two further KTS secondments to embed research into the behavior, role and bioavailability of metals in anaerobic sludge digesters with Severn Trent Water (Carliell)

b) BCRRE is very active in knowledge transfer, through its MSc provision mainly aimed at those working in the rail industry and training courses for organizations such as LUL, TfL and HMRI and through publications such as the "Wheel rail interface best practice handbook". The Environmental Engineering group regularly delivers CPD training – e.g. a course for Land Surveyors in Malaysia on MTU research and the Transportation group has run the successful Senior Roads Executive programme for the last nine years which has recently seen 55 delegates every year mainly from overseas.

c. Strategy and plans

Within the School there are three strands to our impact strategy – to actively ensure that recently completed research achieves its full impact, to put into place and operate systems for embedding impact activities into current and future research projects and to undertake a small number of high impact initiatives. To help achieve this, the School has a dedicated Business Development Manager. Additional support is provided by the College's Research and Knowledge Transfer Committee. The University provides overarching strategy and leadership for impact through its Research and Business Engagement Committees, both of which work in association with the University's central Research and Innovation Services and Business Engagement Directorate structure. The University's technology transfer company (Alta Innovations Ltd) provides expertise and resources to help academics protect their ideas, identify routes to commercialization, including IP licensing and spin-out. It also manages consultancy services and supports a range of entrepreneurial activities, which the majority of staff within Civil Engineering use for industrial consultancy work.

Impact of completed research.

There are a number of completed projects where the impact of the research is ongoing - these

include much of the work carried out as part of the SUE programme, where there is evidence that the Urban Futures Methodology is significantly influencing thinking in the development of sustainable infrastructure designs, and continued encouragement is needed to ensure that its potential is fully utilised. Similarly the FUTURENET methodology for modelling the effect of weather and climate on transport systems has much potential and needs to be embedded in practice. Future developments will be taken forward through a range of activities including the use of newsletter and technical briefings to a wide range of specialist and non-specialist audiences through professional journal and trade magazine articles; through dissemination seminars and press releases presentations at relevant trade exhibitions), industrial liaison through Research Council Networks and conference organisation, and press releases and radio interviews where appropriate. Alta Innovations will be used to take forward any exploitation opportunities that occur.

Embedding impact into current and future projects

a) Grant application review. All grant applications are internally reviewed by senior School staff to ensure that all possible impact activities opportunities embraced and fully embedded. These include newsletters, technical briefings, dissemination seminars, press releases etc..

b) Industrial Steering Committees and partnerships. We work with potential beneficiaries throughout projects, to ensure that dissemination is targeted at all potential audiences and in an appropriate manner (the work associated with the MTU and the creation of the Mapping the Underworld centre by JK Guest Ltd is an excellent example of the success of this approach). Consequently, we ensure that, where appropriate, our research projects are led by a Steering Committee, drawn from a wide range of practitioner partners to enhance industrial, safety, policy, regulatory and codification impact.

c) Community groups and public engagement activities. Where appropriate the School utilises web based community groups, including online tools for impact generation where we advertise and disseminate the results of the research and include notice boards, blogs and e-bulletin newsletters. (See http://www.mappingtheunderworld.ac.uk/blog/?cat=3 and http://www.mappingtheunderworld.ac.uk/forum/). To consider the wider environment of our research, project open days have been held for which the target audience varies from school children to UG students, PG students, and industrialists (e.g., Kings Norton School have participated in a design and build competition based on Sterling's research). The School also offers media training to all researchers.

d) Fellowships and exploitation. The School supports impact generation and KT activities, by encouraging staff to pursue industrial collaboration fellowships and commercial exploitation of research (e.g. RAEng Industrial Secondment Fellowship, EPSRC KTS).

e) Staff Workload. To further encourage impact activities, the School intends to embed such activities into our staff workload model to reflect its importance to the School.

High Impact Initiatives

The School will carefully evaluate possibilities for initiatives that have high impact and develop these as appropriate. For example Civil Engineering BCRRE staff are actively pursuing initiatives in China to set up a UOB sponsored Railway Research Institute for Chinese rail industry issues (including climate and weather resilience) and to deliver an industry based MSc in Railway Risk Analysis, sponsored by the Lloyds' Register trust.

d. Relationship to case studies

The School has submitted three Case studies - Impact of research of vehicle aerodynamics (Fluid Mechanics Group); Mapping the Underworld (Environmental Engineering Research Group); Development of HDM-4 for road economic appraisal (Transport Research Group). These address industrial, safety and regulatory and codification impacts.