Contents

WELCOME 1
Key Contacts 2
Introduction 3
  Centres for Doctoral Training 3
  A programme offering innovative PhD awards 4
  The WIRe CDT 4
Project identification and sponsorship 6
The WIRe experience 8
  Transferable Skills Programme 10
  Doctoral Level Research 10
  Progress Reviews 10
  Engagement with the project sponsor 11
  Cohort building 11
  Research training support 11
  Developing a professional network 12
  Public Outreach 12
  Responsible Research and Innovation 12
  Equality Diversity and Inclusivity 13
  Our commitment to continual improvement 13
  Support and assistance 13
Welcome

I would like to take this opportunity to welcome you to the Centre for Doctoral Training (CDT) in Water Infrastructure and Resilience (WIRe). Our hope is that the programme’s aspirational and unique training environment will provide you with the opportunities to achieve your ambitions.

WIRe is supported by the Engineering and Physical Science Research Council (EPSRC) and a host of industrial and end-user partners. It is the first CDT of its kind with the ambition to transform how we manage the interactions between water and our critical infrastructure through ‘resilience thinking’.

Three UK major academic centres of excellence in water science and engineering form the CDT: Cranfield University, University of Sheffield and Newcastle University. Each is recognised both for their internationally leading research and their track record for training highly qualified scientists and engineers to support the UK economy.

Currently, ‘resilience thinking’ is not embedded into the training of researchers who will lead future innovation in complex infrastructure systems; a skills gap which inhibits society’s ability to respond to current and emerging challenges associated with our important infrastructure. As such, the WIRe programme’s ambitions have been specifically aligned with national requirements for sustainable water management, sectoral requirements to address the expectations of government, regulators, and the public, and employer specific demands for a new generation of technically knowledgeable leaders. We aim to nurture researchers with the multi-disciplinary, disruptive thinking to enhance the resilience of new and existing water infrastructure.

Whether you are a potential WIRe student, a research project sponsor, or a potential collaborator, this handbook provides you with the information needed to get involved in delivering on this ambition.

Professor Peter Jarvis
WIRe CDT Director
WIRe Centre for Doctoral Training

Key Contacts

Peter Jarvis
WIRe CDT Director
Cranfield University
p.jarvis@cranfield.ac.uk

Chris Kilsby
WIRe CDT Manager
Newcastle University
chris.kilsby@ncl.ac.uk

James Shucksmith
WIRe CDT Manager
University of Sheffield
j.shucksmith@sheffield.ac.uk

Luca Alibardi
WIRe CDT Centre Manager
Cranfield University
l.alibardi@cranfield.ac.uk

Tania Rice
WIRe CDT Programme Facilitator
Cranfield University
t.c.rice@cranfield.ac.uk

Justine Easten
WIRe CDT Programme Facilitator
Newcastle University
justine.easten@newcastle.ac.uk

Lindsay Hopcroft
WIRe CDT Programme Facilitator
University of Sheffield
l.hopcroft@sheffield.ac.uk
1. Introduction

This Handbook provides a source of general information for all stakeholders in the Centre for Doctoral Training (CDT) in Water Infrastructures and Resilience (WIRe): PhD students, their supervisors, their sponsors and potential future supporters and end users. The WIRe CDT is a collaborative programme between three universities and this handbook should be read in conjunction with the appropriate PhD regulations in force at the university hosting the project.

The information contained in this document is believed to be accurate at the time of publishing. As the programme is under continual development the management team reserve the right to alter or amend it as necessary.

Centres for Doctoral Training

The Engineering and Physical Sciences Research Council (EPSRC) announced the funding of 75 new Centres for Doctoral Training (CDTs) in early 2019 with an investment of £446 million in skills development across the UK and a further contribution of £386 million in cash or in-kind support from industry and end-user partners.

At the launch of the CDTs, Science and Innovation Minister Chris Skidmore said:

“As we explore new research to boost our economy with an increase of over £7 billion invested in R&D over five years to 2021/22 – the highest increase for over 40 years – we will need skilled people to turn ideas into inventions that can have a positive impact on our daily lives.”

“The Centres for Doctoral Training at universities across the country will offer the next generation of PhD students the ability to get ahead of the curve. In addition, this has resulted in nearly £400 million being leveraged from industry partners. This is our modern Industrial Strategy in action, ensuring all corners of the UK thrive with the skills they need for the jobs of tomorrow.”

“As Science Minister, I’m delighted we’re making this massive investment in postgraduate students as part of our increased investment in R&D.”

The WIRe CDT is one of only two CDTs that is focused entirely on water and its interaction with infrastructure, highlighting the strength of the proposal and the importance of the topic area for the UK economy. As a CDT, WIRe operates with strong support from industrial and end-user project sponsors and enables interested graduates to study for a PhD award. The research projects tackled by the Centre’s students deliver the fundamental scientific understanding needed to drive innovation and novel solutions for the resilience of our water systems.
A programme offering innovative PhD awards

The WIRe CDT provides post-graduate research opportunities leading to the award of a PhD. The PhD research projects run through the WIRe CDT have the following characteristics:

- PhD research students register for an enhanced four year programme.
- PhD students can be university based or hosted by a sponsoring organisation. However, all students are expected to undertake extended placements with their sponsor(s) as well as an international placement.
- All PhD students are offered a programme of technical and transferable skills training sessions that will suit students looking for a career in academia or industry.
- All students are expected to undertake and pass the assessed training programme as part of the WIRe CDT.

The PhD awarded by the WIRe CDT is a four-year research degree on industrially relevant research challenges, funded by industry and end-user organisations. WIRe PhD students experience the same intellectual challenges to that of a typical PhD but are supported by a programme of competence development combined with personal and professional development courses preparing them to become future leaders in engineering and science. The programme aims to:

- Develop confident, collaborative and connected individuals with excellent communication skills who are able to lead multi-disciplinary teams and deliver end user impact.
- Shape experts with knowledge in one or more specialist fields able to deploy methods and techniques that balance social, environmental, economic, and engineering considerations.
- Produce innovative solutions to contemporary water resilience infrastructure challenges with the potential to export the results and skills outside of the UK.
- Demonstrate thought leadership in infrastructure resilience through world leading publications in high quality journals, publications and emerging media.

The WIRe CDT

Globally, one in four cities is facing water stress, and the projected demand for water in 2050 is set to increase by 55%. Water infrastructure is fundamental to our society and economy in providing benefit from water as a vital resource and in managing risks from water hazards, such as wastewater, floods, droughts, and environmental pollution. The need for resilient water systems has never been greater and more recognised in the context of our industrial infrastructure networks and facilities for water supply, wastewater treatment and urban drainage. Similarly, safeguarding critical infrastructure in key sectors such as transport, energy and waste from the impacts of water has never been more important. Combined, resilience in these systems is vitally important for public health and safety. Industry, regulators and government all recognise the huge skills gap. Therefore, there is an imperative need for highly skilled graduates who can transcend disciplines and deliver innovative solutions to contemporary water infrastructure challenges.
Placing an inspirational student experience at the centre of our delivery model, the WIRe CDT will nurture a new generation of research leaders to provide the multi-disciplinary, disruptive thinking to enhance the resilience of new and existing water infrastructure. The WIRe CDT will contribute to improve the resilience of water infrastructure which conveys and treats water and wastewater as well as the impacts of water on other infrastructure systems which provide vital public services in urban environments.

A unique feature of the CDT is its access to world leading water infrastructure testing facilities and environments through our partnership with the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC). UKCRIC provides:

- Leadership and support for the development and growth of a coordinated and coherent, world class, UK-based national infrastructure research community
- Collaboration and engagement with government, city and commercial policy makers, investors, citizens and academia - a joint venture that drives innovation and value creation in the exploitation of services provided by national infrastructure
- Central coordination to drive knowledge transfer, UKCRIC supports a step-change in the nation's approach to infrastructure investment
- Significant initial support from government, industry and universities enabling national research capability > £125M (March 2017): in total, more than £216.6M invested by EPSRC and partner organisations

Together with our internationally renowned research consortium (Cranfield University, the University of Sheffield and Newcastle University), the WIRe CDT will produce scientists and engineers to deliver the innovative and disruptive thinking for a resilient water infrastructure future.

The CDT is delivered in cohorts, with a highly relevant end user-led training programme with integration within, and between, cohorts to provide a common learning and skills development environment. Enhanced training will be spread across the consortium, using integrated delivery and bespoke teaching, providing students with a set of unique experiences and skills. Strong support from industry and professional associations, as well as collaboration with national and global professional networks, ensure that our PhD students have every opportunity to make a significant contribution to delivering resilient and sustainable water services for a growing population.
2. **Project identification and sponsorship**

The WIRe CDT places a strong emphasis in delivering end-user relevant research. As such, the research themes which PhD students address need to reflect existing and anticipated sector challenges. This ensures that we are able to attract both direct financial and in-kind support for the research and training components of the programme. In consultation with our CDT partners, Figure 1 shows a summary of some of the challenges and themes that we expect to be addressed by research in the CDT.

**Figure 1.** Challenges and opportunities to enhance resilience in water infrastructures and research themes that WIRe CDT aims to develop.

Companies and organisations interested in developing and sponsoring research via WIRe are welcome to contact academics at the three universities at any time (see page 2 for contact details). Consortia funded projects are encouraged to extend the range of end-users involved, with one lead company responsible for providing student supervision. Proposals are expected to fit within the scope of the CDT as well as meeting the needs of the industrial sponsor.

Sponsors and academics collaboratively define a project specification with detailed research targets and budget commitment. The deadline for proposal submission is generally November for the cohort starting in October the next year. The research proposals are considered by the management board of the CDT and a decision on which projects to be funded through the WIRe programme is normally made by January each year. Student recruitment takes place between January and September with students registering for the WIRe programme at the university where the primary academic supervisor is based.
Project sponsors benefit from:

- Significant leverage on research investment.
- High quality research directly relevant to your organisation.
- Strong collaboration with leading academics and institutions.
- Access to world class research facilities.
- Opportunities to coordinate research efforts across the sector.
- Involvement in PhD student recruitment.
- Opportunity to guide PhD student training.
- Free participation in WIRe activities such as the Summer Challenge weeks and annual conference.
- Added value through interaction with a network of PhD students, sponsors and research facilities.
- A high profile national programme.

WIRe projects receive financial support from EPSRC with the industrial sponsors matching the funding requirement for the full cost of the PhD project. This leverage opportunity is available every year but limited to a certain number of bursaries. Fully funded projects where the sponsor covers the full cost of the student’s fees and stipend as well as the incidental costs of the research are welcome.

Please contact the WIRe Programme Manager for further details of how industrial sponsorship of WIRe PhD students works.
3. **The WIRe experience**

PhD students are recruited onto the WIRe programme by the university hosting the project they apply for. They are registered for a degree at the host university and are subject to the regulations (academic and other) of the host university. For example, annual progression requirements, and thesis and viva assessment processes. However, some elements of the standard host university training may be replaced by those in the WIRe CDT programme. Students should confirm these details with their supervisors/local WIRe manager and must read the student handbook of their host university. The WIRe programme consists of three important components;

(i) acquisition of advanced technical skills through attendance at accredited masters level (MSc) training courses
(ii) tuition in the competencies and abilities expected of scientist and senior engineers through a Transferable Skills Programme (TSP) component, and
(iii) doctoral level research project(s).

Specific components and approximate delivery timings are shown in Figure 2.

![Figure 2. Overview of the WIRe programme and student experience](image)

WIRe PhD students spend the first semester (the Induction Semester) of their four-year programme (October-December) attending the following taught modules at Cranfield University:

- Water & Wastewater Treatment Principles
- Water Resilience
- Water in Cities

A more detailed plan of the Induction Semester is shown in Figure 3. This first semester provides the fundamental knowledge needed to consider resilience in a holistic sense
and form a common language to communicate with colleagues. Lectures and seminars are delivered by staff from the collaborating universities as well as by industry experts. Assessments for the taught elements of the induction semester are completed by December. For each cohort, the PhD student with the highest average score across all the induction semester modules will be awarded the “Best Performing Student” prize.

Following the induction semester, PhD students begin work on their research projects. Additional technical skills training is obtained through attendance on Masters level technical modules over subsequent years of the programme. Additional technical skills training will reflect student backgrounds, employer research needs and career development goals. PhD students, in consultation with their supervisors, will assess their technical skills requirements and plan their attendance at these additional modules from MSc courses in their hosting university.

Attendance on the Induction Semester and completion of associated assessments are both compulsory elements of the PhD programme. PhD students will normally be expected to pass all of the assessments associated with the technical skills modules.

<table>
<thead>
<tr>
<th>Date</th>
<th>Module/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-11th October</td>
<td>Induction Module</td>
</tr>
<tr>
<td>14-18th October</td>
<td>Module 1: Water and Wastewater Treatment Principles</td>
</tr>
<tr>
<td>21-25th October</td>
<td>Complete Assignment</td>
</tr>
<tr>
<td>28 Oct - 1 Nov</td>
<td>Module 2: Water Resilience</td>
</tr>
<tr>
<td>4-8th November</td>
<td>Complete Assignment</td>
</tr>
<tr>
<td>11-15th November</td>
<td>Pre-reading &amp; Meeting with Sponsors</td>
</tr>
<tr>
<td>18-22nd November</td>
<td>Module 3: Water in Cities</td>
</tr>
<tr>
<td>25-29th November</td>
<td>Transferable skills: Cranfield</td>
</tr>
<tr>
<td></td>
<td>Being an effective researcher</td>
</tr>
<tr>
<td>2-6th December</td>
<td>Ideas to Innovation</td>
</tr>
</tbody>
</table>

Figure 3. Induction semester timetable.
Transferable Skills Programme (TSP)
The TSP element of the WIRe programme is designed to provide WIRe PhD students with the skills and competencies they need to progress their careers. The first TSP programme is held at Cranfield during the induction semester, while the TSP components at Sheffield and Newcastle take place between January and May in each subsequent year. The following TSP modules will be undertaken:

- **Being an Effective Researcher (Cranfield University).** This training will ensure that all PhD students understand the principles of research, ethical and social responsibility of researchers, and will enable them to carry forward Responsible Research and Innovation principles throughout the duration of their project.

- **Communication and Leadership (University of Sheffield).** All students will be trained to develop their communication skills so that they are confident and effective in articulating their discovery science and research impact to a full spectrum of audiences, from the CEO of a business to members of the public. Each student will be supported in developing a bespoke, tailored communication strategy that aligns to their strengths and future career aspirations.

- **Business Skills Challenge (Wetsus, Netherlands).** Students will undertake the European Business Challenge organised by Wetsus, the European centre of excellence for sustainable water technology based in Leeuwarden, The Netherlands. Students will learn how to build innovative technologies and services into a successful international business and will inspire them to deliver impacts from their research and promote multidisciplinary collaboration on global water infrastructure challenges.

- **The Thesis and Beyond (Newcastle University).** This module will encompass thesis planning and will support the PhD students preparing for the viva examination. PhD students will also receive career guidance to best match up career aspirations with appropriate opportunities.

Doctoral Level Research
WIRe students conduct a programme of research which contributes significant original knowledge, or the application of existing knowledge, to new situations to be reported on in a thesis. Examination involves an oral examination (the Viva Voce defence). The supervisory team for PhD students include at least one academic from the host university and an industrial supervisor from the project sponsor. Research activities are planned, reviewed, and audited at regular review meetings and a personalised professional development log is used to enable students and supervisors to keep track of progress.

Progress Reviews
The WIRe programme encourages students and supervisory teams to undertake regular, structured performance and progress reviews. These encompass research project delivery, development of advanced technical and transferable skills, and academic progress towards achievement of a PhD award. Review meetings may have targeted agendas (i.e. be solely concerned with one aspect of progress) and may have variable membership dependent on the purpose of the review.

Progress reviews and reporting will meet the requirements of the student’s home university, as each university has its own slightly different academic progress review system. However, the WIRe programme monitors and benchmarks student progress.
across and between all cohorts through a special meeting of the Programme Management Board (PMB) held during the Summer Challenge.

**Engagement with the project sponsor**

Project sponsors under the WIRe programme receive from the PhD student and the supervisory team regular updates on the direction of the studies and on progress of the research activity and results.

Project sponsor meetings are organised by the PhD student with the support of the supervisory team at least every six months. Sponsors have the possibility to give advice on the impact of the outcomes of the study, steer the direction of the research activities and share internally the early benefit of the project to speed up implementation and roll out of new processes or procedures.

Project sponsors are welcome to extend the invitation of these meetings to colleagues from other departments with interests in the project to help the PhD student in understanding the wide impact of the research for the sponsor’s organisation and the wider water sector.

**Cohort building**

A series of annual events attended by all WIRe students provides opportunities for cohort and inter-cohort identity building and networking.

(i) The initial induction semester for each cohort based at Cranfield University.
(ii) The annual Summer Challenge which takes place in June/July.
(iii) Conferences and seminars developed by the WIRe programme. This includes the National Resilience Debate, a national one day event bringing together professionals from various sectors to discuss the contemporary issues of resilience. Additionally, this includes the Global Series Seminars, where academics and industry leaders share and address innovative thinking and projects with the WIRe students.

The Summer Challenge is an opportunity for all WIRe stakeholders to review the previous year’s activities and provide advice and support for the following year. During this week, PhD students will benefit from additional transferrable skills sessions, guest lectures from leading industrialists and scientists (from both water sector and other utility/engineering backgrounds) as well as from technicians and operators from across the industry, design and problem solving challenges, individual and inter-cohort competitions and site visits. End-User Advisory Panel, Steering, and Management Board meetings will also be held during this week as appropriate.

**Research training support**

All WIRe PhD students receive support from the programme with allocated funding to cover costs of specific personal training developments, travel and subsistence to attend events, visits and training fees. Students are encouraged to discuss with their supervisory teams a plan for the use of this fund over the four years of the project. All individual project budgets are managed through the student’s host university.
Developing a professional network
As future leaders in science and engineering, the development of a supportive and career enhancing professional network should be a central ambition for those studying through the WIRe programme. Where appropriate, WIRe students are provided with an opportunity to undertake a short study visit to an internationally leading research centre as part of their second or third year calendar.

Students are strongly encouraged to submit conference papers and author peer reviewed journal papers. Financial support to attend national and international conferences is available. Where appropriate, supervisory teams will organise opportunities for students to co-supervise placement student projects during their third or fourth year as part of their professional development programme.

To facilitate student engagement with professional associations, the WIRe programme funds student membership of the International Water Association and a relevant professional institution for each student for four and two years respectively. In addition, all WIRe students are automatically registered with the International Water Association’s ‘Young Professionals’ programme.

Public Outreach
All students will be trained to develop their communication skills. In achieving this, every student will be trained to utilise a wide spectrum of communication pathways (papers, academic and business presentations, videos, networking, social media, interviews and business pitches). Students will understand how to tailor content and style to maximise uptake of the message to the target audience and achieve the desired outcomes. Ultimately, each student will be supported in developing a bespoke, tailored communication strategy that aligns to their strengths and future career aspirations.

Responsible Research and Innovation (RRI) in WIRe
Urban water systems satisfy a basic societal need and are unique amongst infrastructure systems in the universality of their impact. In this context, the need for RRI training for WIRe students is crucial. Students will learn about the principles of RRI and how the way in which they conduct their research can have wide ranging and unintended consequences. PhD students will be required to examine the ethical dimensions of their research during project design, such as respect for personal privacy, sustainability, and the polluter pays principle. These considerations will also form part of the assessment undertaken during the annual cross-cohort Summer Challenge which will involve a wide range of stakeholders (academics, utilities, regulators, business, and policy makers), demonstrating the need to work collaboratively during the research and innovation process. It is the aim of WIRe that its graduates will gain the knowledge and confidence to promote institutional change in RRI by stakeholders and institutions in their future careers. The CDT management will act transparently and in-line with the RRI principles. All users of the CDT resources
will be required to act ethically. The CDT will strive to ensure fair access to funding to support PhD projects, networking activities, access to knowledge and data, and fair distribution of any academic and commercial reward from the resulting innovations.

Equality Diversity and Inclusivity (EDI)
The WIRe CDT will operate a number of best practice policies designed to promote greater equality, diversity and inclusivity within the engineering and academic sectors. Specific EDI activities will cover: recruitment processes, training activities, maternity, paternity and adoption policy, work life balance and outreach activities. Membership of the WIRe delivery team includes both women and men who work part time. Further information on the WIRe CDT EDI strategy is available on request.

Our commitment to continual improvement
The WIRe programme seeks to provide a vision for end-user led post-graduate training, innovations in training delivery and distributed cohort development, and an actionable programme to deliver the next generation research leaders to provide the multi-disciplinary, disruptive thinking to enhance the resilience of new and existing water infrastructure for the UK. This aspiration can only be achieved if we assiduously identify and implement progressive and transformative improvements to the programme.

Students are expected to monitor the progress and impact of their research and record outputs and outcomes from their work. All students must log their progress, as per UK Research and Innovation (UKRI) regulations, through the Researchfish portal.

We follow EPSRC Best Practice on operating post-graduate research programmes and regularly talk to our various stakeholder groups to monitor programme performance. Potential improvements to the programme are formulated and discussed at meetings of the PMB. To ensure that students contribute to programme delivery and management, each annual cohort will nominate two representatives to sit on a student council. The council will meet twice per year, with outputs, recommendations and suggestions reported to the PMB through a student representative, responsible for coordinating student inputs. Our End-User Advisory Panel provides an important practical perspective on our activities and our International Review Panel ensures that our performance is benchmarked against leading comparable schemes globally.

Support and assistance
PhD students registered within the WIRe programme receive the same extensive level of support and assistance as any other research student at their host university. WIRe PhD students are welcome to discuss or seek advice from their supervisory team, local WIRe representative or the CDT Programme Director about the support the host university can offer in cases of difficulty or adverse circumstances. This includes, but is not limited to, student personal and health issues, and concerns about their supervision or project progress. Each hosting university will follow local regulations for the management of various circumstances (e.g. parental/caring or sickness leave), details of these arrangements can be obtained from the WIRe managers on request.