Submitted: 11 June 2024

Published online in 'accepted manuscript' format: 30 October 2024

Manuscript title: Civil engineering employers engagement in work-integrated learning

Authors: Mike Murray

Affiliations: Department of Civil & Environmental Engineering, University of Strathclyde, Glasgow

Corresponding author: Mike Murray, Department of Civil & Environmental Engineering, University of Strathclyde, Glasgow

E-mail: m.d.murray@strath.ac.uk

Abstract

In this paper I provide two case studies of enhancing undergraduate students' learning through Work-Integrated Learning (WIL). Both interventions involve university-industry partnerships with local and regional civil engineering employers. Industry Mentoring (2010-2024) is a curricular activity with an authentic assessment. Third-year students mentees (N=1130) were mentored by 298 practising civil engineers, representing 80 employers. Civil Engineering 4 Real (CE4R, 2012-2024) is a co-curricular hybrid programme of problem / project-based evening workshops (N=133), attended by 594 students with circa 2867 student attendances, supported by 218 engineers, representing 76 employers. Industry Mentoring and CE4R support students to network with employers, enhance their employability skills, and shape their professional identity. Through their pro bono assistance, employers have established a talent pipeline, recruiting students for summer placements and graduate jobs. For employers, their engagement provides evidence of enacting their Corporate Social Responsibility (CSR) through providing a social value contribution to a local university.

Keywords: employers, students, education & training, social impact

Introduction

Ferguson and Chrimes (2011: p.49) note that 'the question of how an engineer should best be educated and trained has, throughout its life, been the greatest issue the [Institution of Civil Engineers] has had to address'. Since the first university courses in civil engineering appeared in the UK during the late 19th century, the industry narrative has emphasized scientific knowledge over practical training. This led to universities recruiting academics with a PhD and a research-focused portfolio, rather than civil engineers with industrial experience. Subsequently, there have been calls to ensure that graduate civil engineers can synthesize their theoretical (knowing that) and practical (knowing how) experience to create professional knowledge (Forster *et al*, 2023). The 'knowing how' part can be conveyed to students by employers and their engineers engaged in university-industry partnerships.

The aim of this paper is to provide employers and academics with two examples (Industry Mentoring & CE4R) of Work-Integrated learning (WIL) that have provided win-win outcomes for all stakeholders (university, students, employers, graduates). Both initiatives are replicable in any engineering discipline and this paper and associated citations provide a benchmark resource for those readers who wish to embark on their own university-industry partnership.

In Section 2 I examine the role of practising engineers in the education of civil engineering students. WIL is introduced in Section 3 and in Section 4 I examine how employers can use their educational outreach to create social value. In Section 5 I explain how students can undertake Initial Professional Development (IPD) during their university studies. Section 6 provides an account of the Industry Mentoring initiative and includes a case study of a contractors (RJ McLeod) involvement. Section 7 introduces CE*4*R and a case study provide by a consultant engineer (Avove). Following this I consider how the Covid Pandemic 2020-2022 impacted on both initiatives (Section 8). Section 9 details how Alumni can help universities to secure buy-in from employers to support the initiatives. In Section 10 I discuss the outcomes of the initiatives. I conclude the paper in Section 11 with a look forward to the skills and knowledge required by civil engineers towards 2030.

1. Engineering Education and Training

The respected engineering academic John Heywood (2016: p. 36) noted that 'if it is intended that the curriculum should prepare engineering students for work, it is necessary to understand what qualified engineers do at work'. Typically, this involves engineers from industry delivering guest lectures and mentoring students as a means to 'improving the skills and work-readiness of engineering graduates' (Valentine, Marinelli and Male, 2021: p.1). Indeed, Buckley, Trevelyan and Winberg (2022: p.1) noted that 'practising engineers are particularly needed as collaborators to ensure that engineering programmes stay current in the face of rapid technological change'. Moreover, there have been calls for university-industry partnerships to involve students in the early years of the undergraduate engineering curriculum (Shah and Gillen, 2023) and for intergenerational dialogue between young people and experienced professionals (RAE,2024).

The Joint Board of Moderators (JBM, 2023) who are responsible for overseeing the accreditation of civil engineering courses in the UK, require Higher Education Institutions (HEI's) to involve practising engineers in their programmes. Moreover, the Institution of Civil Engineers (ICE) Code of Conduct (2022) makes an explicit reference for their members to collaborate with academia and young people. In the UK, Industry-academic engagement can be formalised through the appointment of a Royal Academy of Engineering (RAE, 2023) Visiting Professor. The aim of the scheme reflects the role of adjunct professors who can bring 'their wealth of practical experience and expertise [to offer] students' resources for career preparation' (Bae, Polmear & Simmons, 2022: p.9)

2. Work-Integrated learning (WIL)

WIL involves student engagement in authentic work-focused experiences, structured through a tripartite relationship-HEI's, students, and employers. Furthermore, graduate employability is an increasingly strategic focus for HEI's and provides a useful driver for linking student, alumni, and employer engagement activities (Jisc, 2013). WIL initiatives allow employers to pre-screen future staff through hosting a student in their organisation (Fleming, Ferns and Zegwaard, 2023)

and provide students with a 'trial run' with an employer (Drewery, Pretti, and Church, 2020). Zegwaard *et al* (2023) found that WIL can include students being situated in an organization (i.e., work placement, internships) or involve students on campus undertaking tasks that are relevant to extremal stakeholders (i.e., employers). They recognise that HEI's have developed varied local practice that reflects elements of WIL (see Table 1).

At Strathclyde we encourage our students to seek out summer placements / year out opportunities with civil engineering employers (Tennant *et al*.,2018) albeit this experience is optional, not curricular. Further optional 'co-curricular' activities include ConstructEd (2024) Scotland (formerly Constructionarium Scotland) a five-day experiential activity where students construct small scale versions of structures. Visits to live construction projects (Murray and Tennant, 2016) are also undertaken by students but again these are optional. Of note, the department has a stand alone Graduate Apprenticeship Civil Engineering BEng (Hons) work-based learning programme designed in partnership with engineering employers (University of Strathclyde, 2024).

This paper examines two WIL initiatives, one curricular (Industry Mentoring) and the other co-curricular (CE*4*R) that have provided students with new explicit disciplinary knowledge and has provided an opportunity for engineers to convey to students the importance of non-technical skills in the workplace. This is significant given that research with employers revealed that soft skills 'emerged as significantly more important in the workplace than many of the technical skills which dominate the curricula of undergraduate [civil engineering] courses' (ICE, 2018: p. 28).

3. Creating Social Value through Educational Outreach

Contractors working on university campus projects should enact their Corporate Social Responsibility (CSR) policy through the provision of site engagement opportunities for students (JBM,2023). Fleming, Ferns and Zegwaard (2023) found that organisations that are motivated to support student learning can secure kudos through their exemplary CSR practice. At Strathclyde, there will be a circa £1 billion investment in the campus by 2025. To date all of the main

contractors have added social value through their educational outreach (see Balfour Beatty, 2023) and contributions to CE*4*R and Industry Mentoring (see Project Scotland, 2017). In addition, the contractors have provided opportunities for student visits and summer placements. The main contractors are typically registered with the Considerate Constructors Scheme (CCS, 2024). Educational outreach can enable contractors to improve the image of the construction industry (the overarching goal of the CCS) through presenting positive role models and practice to students. Indeed, employers who have participated in CE*4*R (see Alan White Design, 2019; Avove, 2024) and Industry Mentoring (see Story, 2022) have used their social media outlets to disseminate their educational outreach activities and communicate elements of their corporate culture, values, and brand.

4. Initial Professional Development (IPD) During University Studies.

The debate on 'knowing that' and 'knowing how' and the role of education as opposed to the training of civil engineers has gone on for over 150 years (Clarke, 2012). Several academic engineers (Chrisp and Fordyce, 1993; Clarke, 2007; Thompson and Surgeoner,2014) have proposed closer links between what civil engineering students learn, and profession practice. Today, this is reflected in JBM accreditation guidance for HEI's whereby students are required 'to appreciate the need for continuing professional development' (JBM, 2023: p. 4). To help familiarise students with the graduate training process whilst at university the ICE (2023a) developed a simplified version of their IPD documents for student use. To assist students to start tracking and documenting what they do and learn in addition to the requirements of their academic course. Amongst the benefits stated, the ICE note that students can use the student version of Attribute Achievement Form (AAF) to demonstrate to employers their commitment to professional development. At Strathclyde our students are encouraged to use the document to record their co-curricular (not assessed) activities (i.e., Industry placement, CE*4*R, Site Visits, ConstructEd,2024) and extra-curricular activities (i.e., non-industry work, volunteering). The

JBM (2023) recognize that these ‘extra mural activities’ contribute to students’ professional development:

> It should also be remembered that many qualities upon which employers place considerable importance are developed by involvement with activities external to the department, so these should be encouraged (p. 35).

5. Industry Mentoring

Industry Mentoring was developed in 2010 to ensure that on completion of third-year studies, all of our students would have secured exposure to real civil engineering practice, to bridge the gap between theory and real-world engineering. There is an undersupply of year-out and summer placements for civil engineering students in the West of Scotland (Tennant *et al*.,2018) and the mentoring of students by practising engineers can help mitigate the impact of this deficit. Our third-year cohort is typically one-hundred students so individual mentoring is not a viable option. Before the students complete their second-year studies they are required to form a group with peers (groups of 4-5) and to decide on their preference for a mentor employed by a contractor, consultant, or client. Students without prior industry experience can find this challenging and they are directed to career guidance such as Target Jobs (2023). Correspondingly, students with prior industrial exposure (i.e., summer placement, site visits, CE*4*R attendance, family member a civil engineer) will often request a specific employer.

Each group appoints a peer contact to undertake communications with their mentor(s) and arrangements are made for each group to visit their mentors place of work (see Figure 4) on four occasions between October-December and January-March, circa 2hrs per visit (Murray *et al*.,2015). Exposure to these ‘real’ workplace environments can assist students to develop an

identity as an engineer and to witness the repertoires of engineering practice (Johri and Olds, 2011). Mills (2011) recommends that civil engineering students should be presented with multiple practitioner identities so to expose them to various career opportunities. The Industry Mentoring has been particularly successful where consultant employers have used multiple mentors from different departments (i.e., transport, water, structures, geotechnics) with the mentees visiting a different part of the carousel on each visit. One of the key benefits that contractors can offer to their mentees is providing access to live construction sites (Murray and Tennant, 2016) and introducing their mentees to different roles (temporary works, health and safety, environmental, planning, quantity surveying) within their organisations. Occasionally both consultants and client mentors have provided site visits for their mentees. For some students, a site visit can be a catalyst for decisions about their graduate career:

> *Our mentor was from [Contractor] and from the first day I set foot on a [Contractor] site I knew that contracting was the job for me. Since then, I have stayed in contact with [Mentor], and as of Friday I have signed the contract for my first job and graduate position as a Civil Engineer with [Contractor]. It cannot go unsaid that the opportunity in third year created a bright and hopeful opportunity to expand my list of contacts, which, coupled with work experience and some snazzy CV content, inevitably landed me the job with [Contractor]* (Unsolicited student email, 2021).

As of March 2024, the Industry Mentoring initiative has involved:

- 1130 3rd year civil & environmental engineering student mentees
- 294 groups comprising between 4-5 mentees
- 299 Industry mentors
- 80 Employers (44 consultants; 26 contractors; 10 clients)

6.1 Assessment

The Industry Mentoring is curricular, part of a third-year 10-credit module (CL305 Construction Project Management). The assessment for this module is based on 'Assessment for Learning' (Sambell, McDowell, and Montgomery, 2013) principles and designed to 'enhance students' employability and pre-professional self-identity' (Dalrymple *et al*.,2021: p. 76). The module assessment (100% coursework) involves a group book reading (Murray, 2018) activity using the *ICE Civil Engineering Procedure* (ICE, 2020); a group Rich Picture based on learning secured from the book reading; individual reflective reports and reflective vlogs; PowerPoint presentations to mentors; and a Curriculum Vitae (CV) & Cover letter submission to mentors. Typically, the reflective mentoring assessment has constituted a 30-40% weighting and the mentors play an important role in making this assessment authentic:

> In the view of the authors, one of the most important roles that an industrial mentor can play is to help motivate students towards learning what is useful and what might make them a better engineer rather than just focusing on grades, which unfortunately in the university setting, is the preoccupation of many students. (Broadbent and McCann 2016a: p.23).

Whilst too many of our students are grade focused (and they may have legitimate reasons vis-à-vis gaining access to 5th year MEng studies) the reflective mentoring assessment has sought to develop a professional practitioner identity through a link to the ICE Attributes (2023a). However, engaging civil engineering students in reflective practice is challenging given that 'it is often considered of secondary importance to results in bounded mathematical examinations' (Francis and Norton, 2024 :p.70).From 2023 the assessment requires the students to demonstrate a cognizance with the ICE (2022) Code of Professional Conduct; ICE (2023b) Advice on ethical Conduct; Construction Design & Management Regulations (HSE,2015); and Climate Emergency (Ibell and Russell, 2022; ICE, 2023c; JBM, 2023).

6.2 Employer View of Industry Mentoring

The employers do not know the composition of their group of mentees until they arrive for the first meeting. They are not able to 'cherry pick' students with a strong academic performance, and prior industry practice, with an intention of finding a future 'star' employee. The analogy of the mentee group being a 'lucky bag' that may or may not contain future talent, is perhaps more appropriate. Nonetheless, the key benefit for employers who take part in the mentoring is an opportunity to establish a talent pipeline. Secondly, to provide an opportunity for their graduate engineers to enhance their own IPD through mentoring, and thirdly, to demonstrate their organisations working practices, organisational culture and corporate values to their mentees:

> *A number of our Graduate Engineers mentor University of Strathclyde undergraduates. The purpose is to give the undergraduates an idea of what they are coming into in the Civil Engineering industry, how it works and how our Graduate Engineers have found the experience in their first few years in industry. A by product is that our Graduate Engineers pick up CPD credits in working towards becoming Chartered and hopefully full members of the Institution of Civil Engineers or linked professional bodies. A further strand to the Graduate Mentoring scheme and the benefits we see, is that it is an intrinsic link to our annual recruitment process*. (Contracts Director, Balfour Beatty, 2022)

> *The graduate mentoring programme is excellent and is highly beneficial to both the students, our graduates in the business and AECOM as a whole* (Regional Director North, Scotland & Ireland, AECOM, 2022)

> *I have been involved in interviews to offer a summer placement position at [Consultant]. The students that stood out are the students that have been part of the mentoring groups*

run by Strathclyde. It really makes them stand out in interviews, and this has certainly caught our attention (Unsolicited email from senior engineer, 2022).

6.3 Industrial Mentoring Case Study: RJ McLeod (Contractors) Ltd

During the 2023-24 academic session a group of students were mentored by engineers from RJ McLeod, a privately owned civil engineering and building contractor. The company has a seventy-year legacy operating in Scotland, including the Western and Northern Isles, and has circa 400 employees, including Alumni of Strathclyde. The company has expertise in marine engineering and flood prevention schemes including sea defence works, breakwaters, causeways, harbours, and jetty construction. As part of the mentoring experience the students visited a current project being undertaken by the contractor.

6.3.1 Project Site Visit: Largs Seawall Replacement

The student mentoring experience was coordinated by a Contracts Manager (CM) in the company. The CM is an ideal university-employer intermediary in contracting companies given that it requires an engineer to have an eye on ‘coal face’ site practice, as well as strategic policy issues (i.e., Corporate Social Responsibility & Social Value). The CM liaised with a company Site Agent who hosted a student to visit a live project, an upgrade of Largs seawall, along the Firth of Clyde, for North Ayrshire Council (Figure 1). The project included associated drainage and infill material behind the new structure (138no. precast concrete wave wall units ,1.95m - 3.7m high) and widening of the current promenade, scour protection, new guardrails and resurfacing of the existing promenade is also included in the works.

At Largs, temporary works were required to allow for the demolition of existing access steps, ramp and reprofiling of structure, and thereupon the construction of precast concrete seawall.

This involved tidal working during winter and mitigating the weather impacts (storms/tidal swells/high winds etc.) as well as significant environmental controls including noise and vibration. Sheet piles formed part of the permanent works solution, providing protection against the lifetime tidal effects below the concrete wave wall. These sheet piles were installed from the existing promenade using a piling rig with extended boom. To provide the required works area for the installation of the precast wave wall, 240m of interlocking concrete Lego blocks were used overall, with 40-50m long caisson sections at a time keeping the workforce safe as the construction progressed (Figures 2 & 3).

6.3.2 The Mentees Visit

Ahead of the site visit, the mentors met with the students to:

- Discuss the background to the company, and civil engineering as a profession.
- Review the pre-start questionnaires sent out to the students to determine their aspirations for the mentoring scheme.
- Identify which ICE attributes could be developed during this scheme.
- Provide some information on the whole-life structure of a traditional civil engineering project from a contractor's perspective (tender, construction, post-construction, handover, maintenance)
- Highlight the regulatory compliance bodies for safety, environmental, and quality under which civil projects must comply in Scotland (Health & Safety Executive, Scottish Environmental Protection Agency, British Standard Institution etc.)
- Discuss the approach to programming and coordinating of small and large-scale projects.
- Provide an overview to the Conditions of Contract generally used within the industry and outline commercial parameters of good project management.

During the visit on site the students were given a presentation on:

- The scope of the project, and introduction to the project stakeholders.

- The various activities to be undertaken on the project.
- Project constraints regarding tidal working, vibration and noise limits, environmental health
- Issues which are inherent in the project (seasonal working, inclement weather, tidal swells, public engagement)
- The various options assessed regarding the temporary works solutions and on-site test cases which were carried out prior to progressing with the interlocking blocks.
- Programming of the works, and the regular updates required to ensure the project stakeholders are kept abreast of progress.
- Penalties which can be implemented for missed key dates or completion dates.

The students were then accompanied on a site walk to a safe viewing platform to view the works being undertaken, before being de-briefed and transported off site. Feedback from one of the students is indicative of the specialist knowledge that can be gained from visiting a sea defence project:

> *The trip was very informative and provided much insight into engineering jobs that involve the tide and salt water. I personally found how working hours on sight were based on the position and timing of the tide each day quite fascinating. The trip also highlighted the importance of planning a project and the adaptability engineers must pursue, especially when working on projects with many uncontrollable variables. Overall, the visit was extremely beneficial in terms of representing the role of a contractor.*

7.0 Civil Engineering 4 Real (CE4R)

CE*4*R is a co-curricular (Monday evening 5-7pm) initiative that encourages students to use their prior knowledge from curricular and co-curricular learning, to problematize authentic engineering case studies (Murray, Hendry and McQuade, 2020) and ‘to work on complex problems and make mistakes in a safe environment’ (Francis and Norton, 2024: p.70). CE4R workshops are hybrid project-problem based learning activities that provide students with an

opportunity to ‘work with complex/ill-defined problems’ (JBM, 2023: p.17) using real project documents, ‘something that universities really struggle with’ (Broadbent and McCann, 2016a: p.19).

CE*4*R addresses Donald Schon’s (1987) call for students to work in the ‘swampy lowland’ (societal problems, that are fuzzy and defy only technical solutions) rather than on the ‘high ground’ where he argued that technical rationality and positivist pedagogy were dominant in engineering schools. Unfortunately, several decades on, the pedagogy of ‘old model engineering’ remains:

> Tightly bounded technical problems should always be considered in their wider real-world context, and precise mathematical solutions should not be conflated with the idea that complex problems have simple right or wrong solutions. (Francis and Norton, 2024: p.71).

Schon encourages the use of ‘practicum’, to introduce students into the world of practice through learning by doing, under the guidance of a practitioner, and supported by fellow students:

> [Students] learn by undertaking projects that simulate and simplify practice; or they take on real-world projects under close supervision (Schon, 1987: p.37).

Student attendance at CE4R is voluntary, the workshop details (title, synopsis, employer, name of engineers, links to ICE Attributes) are advertised, and students register prior to each workshop. Students are then allocated to a group of 4-5 peers with a maximum of seven groups to ensure that each group will benefit from discourse with the guest engineers as they move around the tables. Group composition typically involves students from all five cohorts of our

undergraduate programmes (BEng (Hons)- MEng Civil Engineering & BEng (Hons)- MEng Civil & Environmental Engineering) to ensure each group has a mix of knowledge and experience. The workshops comply with a call (Broadbent and McCann, 2016b) to improve engineering education vis-à-vis (1) Vertical integration – find opportunities for older students to be role models for younger students (2) Bring in experts from industry (3) Build trust to support peer-to-peer learning. As on March 2024 CE4R has involved:

- 133 x 2hr workshops (Monday 5-7PM).
- 594 undergraduate students attended one or more workshops (years1-5).
- 2867 student attendances. X 2hr workshop = 5734 hrs. of student IPD whilst at university.
- 76 industrial partners (30 contractors / 38 consultants / 8 clients).
- 218 industry workshop presenters (Including Alumni).

Each workshop follows a similar structure- (1) guest engineer(s) introduce their employer's business and their roles, then present the case study problem(s)- 20mins. Typically, the case study involves a recent or current project (see Figure 6) and may be anonymized. Local, regional, and high-profile projects are attractive to students and on occasions the CE*4*R is coordinated in parallel with a student visit to the case study construction site. (2) student groups work on the problem(s) and the guest engineers circulate around the groups and answer queries and talk about

their work-55mins ;(3) student groups present their proposal(s) to the room- 15mins; (4) engineers evaluate students proposals, provide verbal feedback-10min; (5) engineers provide their solution(s) or proposals-15mins; (6) photograph with students and guest engineer(s)-5mins. Students receive CPD certificates that are endorsed with the employer's logo and the guest engineers' signature(s). Typically, the certificates are used by students during the recruitment process to provide evidence of IPD during their studies:

> *From CE4Rs alone, I have well over 60 hours' worth of CPD. I have received praise from people in the industry who have said it's amazing that I have so many hours recorded and understand the importance of this as a student. To see this on my CV and applications as a student really helped to make me stand out* (Unsolicited email from graduating student, 2021).

Since 2012 the CE*4*R workshops have covered the full spectrum of civil engineering practice. Over time it was found that it has been necessary to craft the workshop titles to avoid alienating students who have developed preconceived notions of engineering practice based on their academic studies (i.e., *I don't like hydraulics because I find it difficult!*). As Male and King (2014: p. 5) have noted, where engineering students have learned theoretical knowledge without context or relevance, they 'are likely to have misperceptions about engineering practice and develop professional identities that are inconsistent with practice'.

One of the key employability skills that students experience at CE*4*R is team working, a norm for civil engineers (ICE, 2018). The vertical integration of senior, middle, and junior year students, collaborating in a non-competitive, non-credit bearing task, makes for a friendly climate. Moreover, students with prior industry experience, and, or advanced theoretical knowledge have demonstrated their collegiate behaviour through 'scaffolding' (i.e. explaining through discourse and sketches) the learning of their peers. Scaffolding (Vygotsky, 1978) by

student peers and the guest engineers enhances student learning beyond that of what could be achieved by working independently:

> *Working with not only industry experts but also fellow peers further along in their studies, I gained a lot of valuable knowledge and insight into Civil Engineering, both as a career and as a university course. Meeting those working in the field shows you the possibilities that are out there and really drives you to aspire to higher achievements throughout your course* (CE*4*R student feedback 2021).

7.1 CE4R Case Study: Avove

Title: Designing a Robust Solution for a Wastewater Infrastructure Project.

Engineers: Principal Engineering manager and two Assistant Engineers (All Alumni).

Workshop Synopsis: Our client is required to decommission an existing Sewage Treatment Works, as it will fail future Environmental Agency consents. The scope of works is to construct a new Sewage Pumping Station (SPS) to transfer existing flows via. a new rising main to an upgraded existing Sewage Treatment Works (STW). Each group will design the new rising main pipe route considering the key site constraints, buildability & H&S concerns, whilst also considering the overall cost and programme

ICE Attributes Related to Workshop Content

- **Core-**Understanding and Practical Application of Engineering; Health, Safety and Welfare
- **Secondary**- Management and Leadership; Commercial Ability; Sustainable Development; Interpersonal Skills and Knowledge; Professional Commitment

Student Attendance

- 31 students attended the workshop. Seven year one, two year two, eight year three, one year-four, one MSc Civil Engineering, and twelve MSc Advanced Construction Technologies & Building Information Modelling students.

7.1.1 Project Background

Norton Juxta Sewage Treatment Works (STW) is an existing Severn Trent Water site which contains an inlet pumping station, SAF unit, chemical dosing units, tertiary reed bed. Treated effluent and stormwater overflows are discharged to a nearby tributary of River Mease. A commitment is in place between Severn Trent Water and the Environmental Agency to shut down the site as it is forecasted that future water quality consents will not be met. The proposed solution is to decommission the existing works and construct a new pumping station to transfer flows via. a new rising main pipeline to a nearby treatment works (Snarestone STW). Avove has been appointed as Principal Designer and Principal Contractor on the project. Construction works is to commence in 2024.

Project Brief

Students were provided the following handouts to complete their task:

- Plan drawings (See Figure 5) which include the key site constraints that are to be considered.
- Project brief which includes material costs and construction durations.

Project Work pack.

Groups were required to use the handover information provided to produce a robust design solution for the new rising main pipework between the new Norton Juxta pumping station and Snarestone STW.

The project output will be a pipeline route marked onto the drawings provided. Groups will also produce a build up for the cost and construction programme based on their design.

Project Targets
Cost: £1,200,000
Programme: 32 weeks

7.1.2 Selected Student Feedback

Post-workshop student feedback demonstrates that attendance at CE*4*R can increase students' motivation to learn- *I found it incredibly fun and engaging. This experience has made me want to attend every other CE4R in the future.* Furthermore, the Alumni acted as role models to students- *This CE4R session was extremely informative and interactive! It was great to see them here as former Alumni, which is quite inspiring.* For one student the importance of acquiring useful new knowledge is clear-*This was the first CE4R I've taken part in that included cost and time budgeting. I found this very enlightening as I haven't really explored that side of construction yet. I will definitely use what I learned in future projects keeping costs and deadlines in mind.*

7.1.3 Avove Engineer Reflections

> *The three Avove Engineers that took part in this CE4R event are all former students at Strathclyde University. They all think the CE4R events allow a practical insight into an actual working environment to try and put into practice the theory being learnt. Our aim was to make the brief easy enough to understand but, with various elements to consider, make it interesting and challenging. All the teams were very engaged with the workshop and asked questions if they were unsure of anything. It was good to see the groups made up of different abilities as this then gives the attendees additional communication and team building skills. It was also beneficial for the engineers giving the presentation as they can use this towards signing off attributes as part of the ICE traiing schemes they are on and it contributes towards their own CPD* (Principal Engineer Manager, Avove).

8.0 Cross-Case Comparison

Both the Industry Mentoring & CE4R provide students with opportunities to engage in WIL. However, there is one fundamental difference in the delivery model. Industry Mentoring is curricular and offers educational economies of scale. All third-year students (other than a small number of students each year who engage in international study abroad for both semesters) benefit from exposure to engineers and industry practice. Changing CE4R from a co-curricular (voluntary attendance) to a curricular presents significant challenge in relation to aligning programme timetables to allow senior, middle and junior undergraduate students to collaborate. Furthermore, given that the total enrolment on our undergraduate programmes (excluding the Graduate Apprentice programme) exceeds four-hundred students, the offering could only be as an optional elective, not compulsory. Table 1 provides additional comparisons of both initiatives with reference to WIL.

9.0 Securing Industry Buy-In

The author has undertaken boundary spanning role as a ‘broker’, (Posner, 2009: p.16) connecting students to a network of engineering employers. LinkedIn has proven to be excellent for tracking and building educational outreach relationships with Alumni. The mentee to mentor transition can be strengthened by considering students as ‘Alum from Day One’ (Gallo, 2021: p.31) and this is consistent with the JBM (2023) who believe that freshers commence their careers as professional engineers on their first day at university. Indeed, Weerts and Ronca (2008: p. 289) note that ‘institutions that focus on teaching and learning are essentially "growing their own volunteers" by exposing them to high quality academic experiences’.

As demonstrated in this paper, university-industry engagement can provide win-win outcomes for all stakeholders. For the graduates their participation provides evidence of their own IPD towards IEng /CEng qualifications. As they progress to middle and senior engineering positions, they can recommend participation to junior colleagues. Furthermore, engineers who moved between employers have introduced both Industry Mentoring and CE*4*R to a new set of prospective volunteers. In regard to the engineers who have participated in these initiatives, and are not Alumni, it has been common for them to express a desire to have had these opportunities whilst a student at their own Alma Mater.

10.0 Discussion

Through contact with practising engineers, both initiatives have provided students with opportunities to engage in networking, to shape their professional identity, and to clarify their career ambitions. CE*4*R and Industry Mentoring are aligned with the JBM (2023) accreditation requirements for HEI’s. They provide students with opportunities to:

- Take responsibility for their own learning and intellectual development.
- Apply academic knowledge to professional practice.

- Identify key personal and professional development objectives.
- Understand and demonstrate appropriate professional behaviour.
- Develop job-seeking and job-acquiring skills.
- Use the information gained to inform career goals.

10.1 Evaluating Outcomes

Previous research on the industry mentoring (Murray et al, 2015) and CE*4*R (Murray et al, 2020) has demonstrated that exposure to both initiatives has assisted students to secure employment, enhance their employability skills, and shape their identity as an engineer. In this paper, several pieces of unsolicited praise from students and engineers have corroborated the findings of this research. Moreover, each year students have provided positive testimonials (free-text question) in their responses to the UK National Student Survey (NSS)- *CE4R workshops are the best thing ever. That along with the mentor class in third year is the main reason I have my graduate job, whilst my grades and ability helped, these aspects of my course opened the door for me.*

Other metrics that capture the outcomes of both initiatives include the university careers service annual 'careers readiness' survey with fourth-year students. In September 2023 'the department [Civil and Environmental Engineering] has the highest number of students [across the eight departments in the faculty of engineering] saying they are sorted in their career' (Forbes, 2024). Both initiatives were maintained during the Covid Pandemic (2020-2022) using ZOOM / TEAMS video conferencing and it is envisaged that this had a positive influence on the student responses. Further employment data is captured in an annual UK Graduate Outcomes survey. This data is amalgamated with other data by third parties to establish university league tables. In 2024 The Guardian newspaper published a 'best UK universities for civil engineering – league table' and Strathclyde secured third place, from fifty-two universities listed. The graduate

outcome data showed that 91% of graduates from our undergraduate programmes were in employment fifteen months after graduation.

Both initiatives have been commended by internal university committee reports that evaluated learning and teaching in the department (2015 and 2021 Quinquennial Reviews) and have been recognized as best practice by JBM Accreditation panels (University of Strathclyde, 2015, 2019). Furthermore, both initiatives (Murray, Hendry & McQuade, 2019; Murray, 2022). have been disseminated as best practice by the Engineering Professors Council (EPC).

11.0 Conclusion

Employers who have participated in one or both WIL initiatives have primed their future employees with industry relevant knowledge and skills. They have opened up an employment pipeline through offering students' opportunities for summer / year out placements, and graduate jobs. As a return on their time-in-kind investment the employers secured a corporate 'sales pitch' to raise awareness of their business with students. This has been particularly beneficial for new companies, companies offering specialist services, and small-micro size employers who are largely unknown to students.

Both WIL initiatives are replicable in HEI's with any engineering discipline. For ICE members who would like to engage with their local university/ college, the ICE (2024b) academic partnerships programme can help industrialists establish links with academics. Going forward, the profession has a vital role to play in meeting the United Nations Sustainability Development Goals (ICE, 2024a) and the ongoing digital transformation of industry practice, particularly the use of Artificial Intelligence, is indicative of the challenges that face our engineering graduates. The RAE (2024: p.15) new flagship project is clear - 'Engineers 2030 must have the interests of

young people at its heart'. For civil engineering employers, this is surely a call to strengthen their links with HEI's. To ensure that teaching and learning practice reinforces the link between theory (knowing what) and practice (knowing how), to commit to virtuous and transformational practice through supporting students to undertake Work Integrated Learning.

Acknowledgements

The author would like to thank the engineers who contributed case study material (R J McLeod-Lorcan Hayes); (AVOVE- Rachel Huston, Stuart Jenkins, Jack Galbraith) and who provided wise counsel to their student mentees.

Both initiatives could not have been a success without the pro bono contributions from employers and their employees. The list below represents the who have contributed time-in-kind assistance. Several companies listed are no longer trading.

AECOM, AkII, Alan White Design, Allen Gordon, Amec, Amentum, Amey, Arcadis, Arup, Arch Henderson LLP, Atkins, Avove, Babcock, Baker Hicks, Balfour Beatty, Barnhale, BEAR Scotland, Binnies, Black & Veatch, Buro Happold, BAM Nuttall, Brookfield (Multiplex), Careys, Carillion, Castle Group Scotland Ltd, Cementation Skanska, Civic Engineers, CH2M, Costain, COWI, Create Consulting Eng Ltd, Curtins, Dougall Baillie ,Donaldson Associates, ESD JV, Fairhurst, Farrans, FLN Consulting, Forth Crossing Bridge Constructors, Forestry and Land Scotland, George Leslie, Glasgow City Council, Goodson Associates, Graham, Grontmij, Grossart Associates, Halcrow, Harley Haddow, Historic Scotland, I&H Brown, IKM Consulting Ltd, Jacobs, J & D Pierce Contracts, Jones Bros Civil Engineering UK, Kier, Kent, Lagan, Laing O'Rourke, Lend Lease, Maccafferi, Malin Abram Ltd, Malin Marine Consultants, Meinhardt (UK) Ltd, Morgan Sindall, Mott MacDonald, MGF, MHB Consultants Ltd, McLaughlin & Harvey, Morrison, Multiplex, MWH Global, Narro Associates, Network Rail, Optimus (Aberdeen) Limited, Ramage Young, Ramboll, R J McLeod, Robertson Construction Group, RBA, Richter, Ross-Shire Engineering Ltd, RPS Group, Scottish Canals, Scottish Water,

Scottish Power Renewables, Scottish & Southern Energy, Scottish Canals, Strathclyde Partnership for Transport, Skanska, Stantec, Stobart Rail & Civils, Sir Robert McAlpine, Systra Ltd, Story Contracting, Sweco, Technip, Tony Gee, The Structural Partnership, Transport Scotland, URS, Waterman, Wallace Stone, Will Rudd Davidson, Woolgar Hunter, WSP, Wills Bros, Worley, WYG, XYZ Rail & Civils, 48.3

References

Alan White design (2019) Have you got what it takes to meet our CE4R Challenge? http://alanwhitedesign.com/news/have-you-got-what-it-takes-to-meet-our-ce4r-challenge

Avove (2024) University of Strathclyde CE4R, https://www.facebook.com/photo/?fbid=370790805662816&set=a.123851193690113&locale=en_GB

Bae, H, Polmear, M and Simmons, D.R (2022) Bridging the Gap between Industry Expectations and Academic Preparation: Civil Engineering Students' Employability *Journal of Civil Engineering Education* **148(3)**:1-13, https://doi.org/10.1061/(ASCE)EI.2643-9115.0000062

Balfour Beatty (2023) University of Strathclyde Learning and Teaching facility, Glasgow, https://www.balfourbeatty.com/what-we-do/projects/university-of-strathclyde-learning-and-teaching-facility-glasgow/

Broadbent O and McCann E (2016a) Effective industrial engagement in engineering education – A good practice guide, Royal Academy of Engineering, https://www.raeng.org.uk/publications/reports/effective-industrial-engagement-in-engineering-edu

Broadbent O and McCann E (2016b) Experience-Led Learning for Engineers: A Good Practice Guide." Royal Academy of Engineering. https://www.raeng.org.uk/publications/reports/experience-led-learning-for-engineers

Buckle J Trevelyan J & Winberg C (2022) Perspectives on engineering education from the world of practice, *European Journal of Engineering Education* **47(1)**:

1-7, DOI: 10.1080/03043797.2021.2000694

Chrisp M and Fordyce (1993) Using links with industry to develop professionalism and engineering awareness in undergraduate education. *Proceedings of the Institution of*

Civil Engineering-Civil Engineering **97(2)**: 82-87, doi: 10.1680/icien.1993.23261

Clarke, B.G (2007) Introducing Students to Professional Practice in Civil Engineering, *Journal of Professional Issues in Engineering Education and Practice*, **133(2):** 107-11, https://doi.org/10.1061/

Clarke, B (2012) The 2011 James Forrest Lecture – engineering education – a historical perspective of the future, *Civil Engineering and Environmental*

Systems, **29(3)**: 191-212, DOI: 10.1080/10286608.2012.710612

Considerate Constructors Scheme (2024) The Code of Considerate Practice,

https://www.ccscheme.org.uk/resources/the-code-of-considerate-practice/

ConStructEd (2024) Creating tomorrow's engineers today, https://constructedscotland.co.uk/

Dalrymple R Macrae A Pal M and Shipman S (2021) Employability: a review of the literature 2016-2021, Advanced HE.

Drewery D Pretti T J and Church D (2020) Contributions of work-integrated learning programs to organizational talent pipelines: Insights from talent managers. *International Journal of Work-Integrated Learning* **21(3)**:275-288.

Ferguson, H and Chrimes M (2011) *The Civil Engineers: The Story of the Institution of Civil Engineers and the People Who Made it*, London: ICE Publishing.

Fleming J Ferns S J and Zegwaard K E (2023) Benefits of work-integrated learning for host organisations, In K. E. Zegwaard & T. J. Pretti (Eds.), *The Routledge international handbook of work-integrated learning*, 3rd edit, London: Routledge.pp113-130.

Forster A Pilcher N Murray M Tennant S Craig N and Galbrun L (2023) Construction and Engineering Higher Education: the role of Pracademics in Recoupling Classical Experiential Educational norms, In, Dickinson, J & Griffiths, T.L (Edits) *Professional Development for Practitioners in Academia*. Knowledge Studies in Higher Education, Vol 13, Switzerland: Springer, eBook ISBN978-3-031-33746-8, Chapter 15, pp 211-227.

Francis N and Norton E (2024) Educating civil engineers for the twenty-first century: the 'new-model engineer'. *Proceedings of the Institution of Civil Engineers – Civil Engineering* **177(2):** 63-71, https://doi.org/10.1680/jcien.23.00108

Forbes, K (2024) Email from Katrina Forbes, Head of Careers and Employability, University of Strathclyde, 26th September 2024.

Gallo M L (2021) *The Alumni Way: Building Lifelong Value from Your University Investment*, Bristol: Policy Press.

Heywood, J (2016) *The Assessment of Learning in Engineering Education: Practice and Policy.* New Jersey: Wiley-IEE Press

Health and Safety Executive (2015) The Construction (Design and Management) Regulations 2015,https://www.hse.gov.uk/construction/cdm/2015/index.htm

Ibell T and Russell N (2022) The climate is right for a fundamental change in civil engineering education. *Proceedings of the Institution of Civil Engineers – Structures and Buildings*, https://doi.org/10.1680/jstbu.21.00149

Institution of Civil Engineers (2018) ICE Professional Skills: A Report by the Skills Review Group. Retrieved from

https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Documents/News/ICE%20News/ICE-Skills-report-2018.pdf

Institution of Civil Engineers (2020) *Civil Engineering Procedure*, 8th Edit, London: ICE Publishing.

Institution of Civil Engineers (2022) Code of Professional Conduct, https://www.ice.org.uk/download-centre/code-of-conduct

Institution of Civil Engineers (2023a) Attribute achievement form for students, Version 1, Revision 1- 02 May, 2023, https://www.ice.org.uk/download-centre/attribute-achievement-form-students

Institution of Civil Engineers (2023b) ICE Advice on ethical Conduct-

https://www.ice.org.uk/download-centre/advice-on-ethical-conduct

Institution of Civil Engineers (2023c) 7 powerful things civil engineers do to fight climate change, https://www.ice.org.uk/news-insight/news-and-blogs/ice-blogs/ice-community-blog/things-civil-engineers-do-to-fight-climate-change

Institution of Civil Engineers (2024a) State of the Nation infrastructure in 2024,

https://www.ice.org.uk/media/0uldqt1j/state-of-the-nation-infrastructure-in-2024.pdf

Institution of Civil Engineers (2024b) ICE Academic Partnerships, https://www.ice.org.uk/what-is-civil-engineering/education-resources/ice-academic-partnerships

Joint Board Moderators (2023) Guidelines for Developing Degree Programmes (AHEP4): Version 1 Revision 3 – 26 July 2023, https://www.jbm.org.uk/media/hdojdcyf/guidelines-for-developing-degree-programmes_ahep4.pdf

Johri A and Olds B M (2011) Situated Engineering Learning: Bridging Engineering Education Research and the Learning Sciences, *Journal of Engineering Education*, **100(1)** : 151–185, https://doi.org/10.1002/j.2168-9830.2011.tb00007.x

Jisc (2013) Relationship management, https://www.jisc.ac.uk/full-guide/relationship-management

Male S and King R (2014) Best Practice Guidelines for Effective Industry Engagement in Australian Engineering Degrees, Australian Council of Engineering Deans Inc, https://www.engineersaustralia.org.au/sites/default/files/content-files/ACED/aced_industry_engagement_guidelines.pdf

Mills P J (2011) Civil engineering degrees: fit for the future? *Proceedings of the Institution of Civil Engineers Municipal Engineer* **164(4)**:221–228, http://dx.doi.org/10.1680/muen.2011.164.4.221

Murray M (2018) Assessment for Learning (Book, Chapter, Jigsaw), University of Strathclyde, Sharing Practice in Effective Learning and Teaching (SPELT), https://universityofstrathclyde.atlassian.net/wiki/spaces/SPELT/pages/12190218/Assessment+for+Learning+Book+Chapter+Jigsaw

Murray M and Tennant S (2016) Off-Piste Pedagogy: Construction site visits for undergraduate civil engineers, ISEE 6th International Symposium for Engineering Education, The University of Sheffield, July, 14- 15th 2016, pp 165-172. ISBN 978-0-9930611-1-0.

Murray M Ross A Blaney N and Adamson L (2015) Mentoring Undergraduate Civil Engineering Students. *Proceedings of the ICE-Management, Procurement & Law*, **168(4)**: 189–198. https://doi.org/10.1680/mpal.1400043

Murray M Hendry G and McQuade R (2020) Civil Engineering 4 Real (CE4R): Co-curricular Learning for Undergraduates. *European Journal of Engineering Education*. **45(1)**:128-150. https://doi.org/10.1080/03043797.2019.1585762

Murray M (2022) An Industry-Student Mentoring Scheme 2010-2022, Engineering Professors Council Crucible Project, 16th February, Session 1: Collaborating with industry for teaching and learning, https://strathprints.strath.ac.uk/81026/1/Murray_EPC_2022_An_Industry_Student_Mentoring_Scheme.pdf

Murray M Hendry G and McQuade R (2019) Workplace Experience: Co-curricular Learning for Undergraduates 2012-2019. In, New Approaches to Engineering Higher Education in Practice, The Institution of Engineering and Technology (IET) and Engineering Professors' Council (EPC). pp 36-39, https://www.theiet.org/media/8784/new-approaches-to-engineering-higher-education-in-practice.pdf

Shah R and Gillen A L (2023) A systematic literature review of university-industry partnerships in engineering education. *European Journal of Engineering Education*,

DOI: 10.1080/03043797.2023.2253741

Target Jobs (2023) Want a civil engineering job? Three career decisions you have to make, https://targetjobs.co.uk/careers-advice/engineering/want-civil-engineering-job-three-career-decisions-you-have-make

Tennant S Murray M. Gilmour B and Brown L (2018) Industrial work placement in Higher Education: a study of civil engineering student engagement. *Industry & Higher Education* ***32*****(2)**:108-118.

The Guardian (2024) Best UK universities for civil engineering – league table https://www.theguardian.com/education/ng-interactive/2023/sep/09/best-uk-universities-for-civil-engineering-league-table

Thompson, P & Surgeoner, D 2014, 'Bridging the gap: university to professional qualifications', *Proceedings of the ICE - Management, Procurement and Law*, **167(4)**: 189 –200. https://doi.org/10.1680/mpal.13.00034

Royal Academy of Engineering (2023) Visting Professors, https://raeng.org.uk/vp

Royal Academy of Engineering (2024) Engineering 2030 Rethinking engineering and technology skills for a world in which both people and planet can thrive-Launch paper, https://raeng.org.uk/media/zmjfjwhd/final-engineers-2030-launch-paper.pdf

University of Strathclyde (2015) JBM Report on the Accreditation Visit to the University of Strathclyde 22-23rd January 2015, University of Strathclyde Internal document.

University of Strathclyde (2019) JBM Report on the Accreditation Visit to the University of Strathclyde 21-22nd November, University of Strathclyde Internal document.

University of Strathclyde (2024) Graduate Apprenticeship Engineering: Civil Engineering BEng (Hons), https://www.strath.ac.uk/studywithus/apprenticeshipdegreesatstrathclyde/engineeringcivilengineering/

Posner P L (2009) "The Pracademic: An Agenda for Re-engaging Practitioners and Academics." *Public Budgeting & Finance* **29(1)**:12–26. doi:10.1111/j.1540-5850.2009.00921.x

Project Scotland (2017) Strathclyde students complete GRAHAM mentoring scheme,

https://projectscot.com/2017/06/strathclyde-students-complete-graham-mentoring-scheme/

Sambell K McDowell L and Montgomery C (2013) *Assessment for learning in Higher Education,* Oxon: Routledge.

Schon D (1987) *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions*, San Francisco: Jossey-Bass.

Story (2022) Strathclyde University – Mentoring Programme,
https://www.storycontracting.com/strathclyde-university-mentoring-programme/

Valentine A Marinelli M and Male S (2021) Successfully facilitating initiation of industry engagement in activities which involve students in engineering education, through social capital. *European Journal of Engineering Education*, DOI:

10.1080/03043797.2021.2010033

Vygotsky L S (1978) *Mind in Society: The development of Higher Psychological Processes.* (M. Cole, V. John-Steiner, S. Scrbner, & E. Souberman, Eds.). Harvard University Press: Cambridge MA.

Weerts D J and Ronca J M (2008). Characteristics of Alumni Donors Who Volunteer at their Alma Mater. *Research in Higher Education* **49(3)**: 274-292.

Zegwaard K E Pretti T J Rowe A D and Ferns S J (2023) Defining work-integrated learning. In K. E. Zegwaard & T. J. Pretti (Eds.), *The Routledge international handbook of work-integrated learning*, 3rd ed. London: Routledge. pp. 29-48.

Tables

Table 1: Industry Mentoring & CE4R Practice as WIL

Source: After Zegwaard *et al* ,2023, p.39

Work-Integrated Learning	**Industry Mentoring**	**CE*4*R**
Involves students, educational institution, and an external stakeholder.	Yes, symbiotic 'win-win' benefits for all stakeholders	Yes, symbiotic 'win-win' benefits for all stakeholders
Students undertake authentic work-focused tasks.	CV presentations to mentors and reflective writing report assessment emphasise professional communication	Authentic problem/ project-based task(s) during the workshop(s)
The tasks are either curricular or co-curricular but not extracurricular	Curricular, contributes to CL305 Construction Project Management. Curricular studies are not suitable as evidence of IPD	Co-curricular (not assessed)-use of ICE student Attribute Achievement Form to record IPD
Students engage in purposeful learning tasks learning through doing.	Students are mostly participant observers in the mentor's workplace.	Students work in groups on an industry related task(s)
Tasks involve students integrating theory with practice.	Students are required to determine four learning objectives for their mentoring report. Technical issues may refer to theory	Workshop content can refer to first principles (i.e. structures, geotechnics hydraulics)
Tasks require students to work in a similar way to that expected of a professional in industry.	Assessment tasks require students to produce professional standard documents	Collaborative and cooperative group working required
Tasks are relevant to the students' discipline of study and/or professional development / career interests.	CV & Cover letter task. Reflective mentoring report with content linked to the ICE Attributes.	Workshops have covered the full spectrum of civil engineering practice

Figure captions

Figure 1: Largs Seawall Replacement Source: RJ McLeod

Figure 2: Works Access Along front of Installed Units Source: RJ McLeod

Figure 3: Temporary Works Assessment - System reviewed and design supplied by Richter Source: RJ McLeod

Figure 4: University of Strathclyde 3rd-year Civil Engineering Students at Largs,2023 Source: RJ McLeod

Figure 5: Example of CE4R Student Material (Site Constraints) Source: AVOVE

Figure 6: Avove Engineer Presenting at CE4R Source: Authors Own

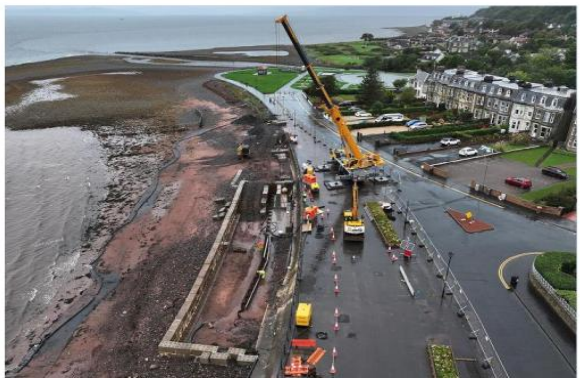

Fig. 1

Fig. 2

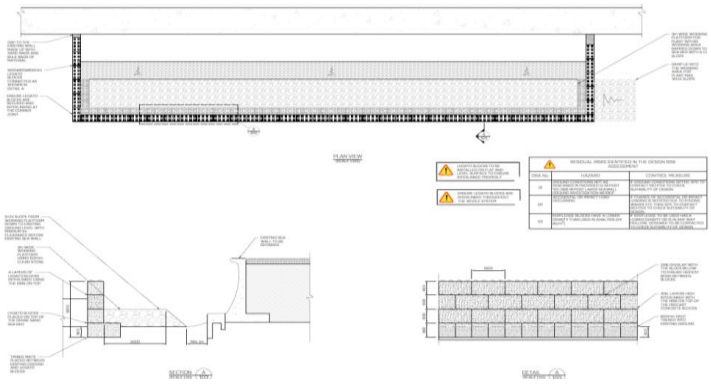

Fig. 3

Fig. 4

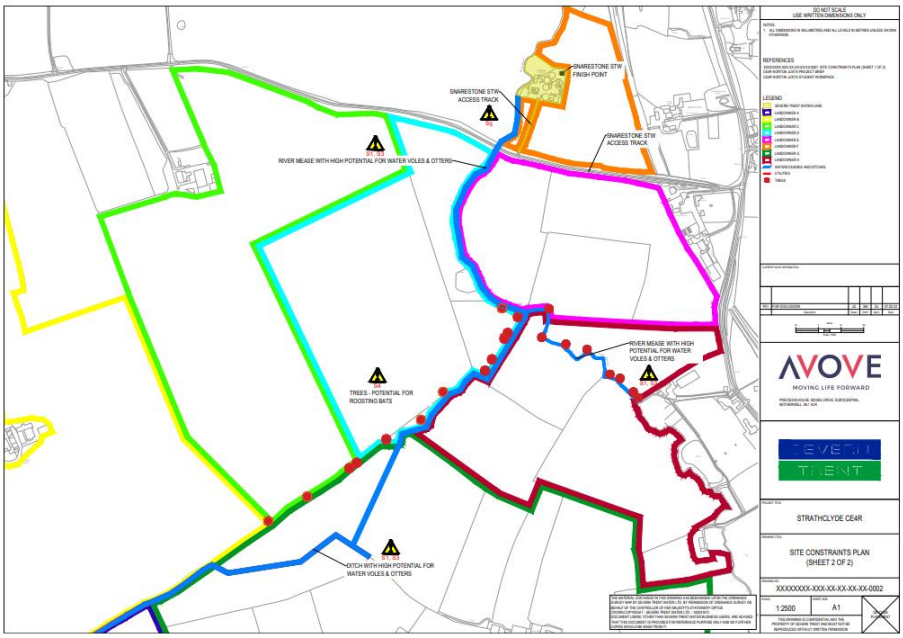
SNARESTONE STW
FINISH POINT
SNARESTONE STW
ACCESS TRACK
SNARESTONE STW
ACCESS TRACK
RIVER MEASE WITH HIGH POTENTIAL FOR WATER VOLES & OTTERS
RIVER MEASE WITH HIGH POTENTIAL FOR WATER VOLES & OTTERS
TREES - POTENTIAL FOR ROOSTING BATS
DITCH WITH HIGH POTENTIAL FOR WATER VOLES & OTTERS
AVOVE
MOVING LIFE FORWARD
STRATHCLYDE CE4R
SITE CONSTRAINTS PLAN
(SHEET 2 OF 2)
1:2500
A1

Fig.5


Norton Juxta – Final Solution
AVOVE
Be part of a winning team

Fig. 6