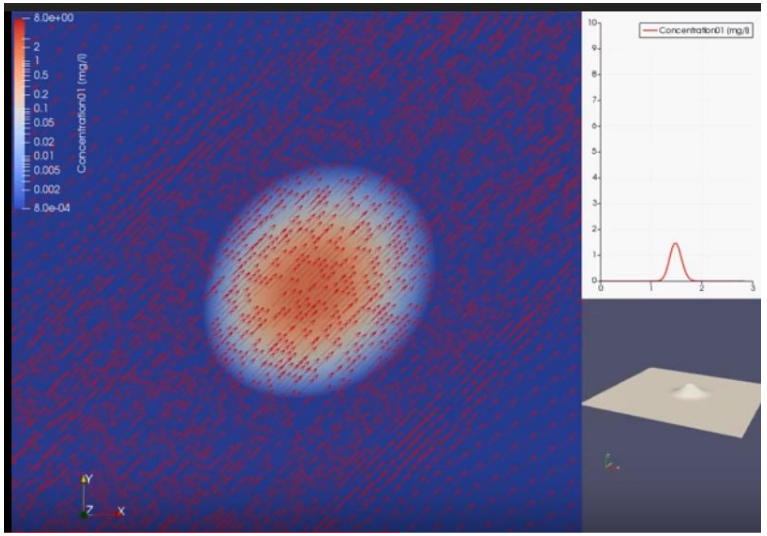
Modelling the Transport of Contaminants in Urban Flood Flows



25th Jan – University of Sheffield

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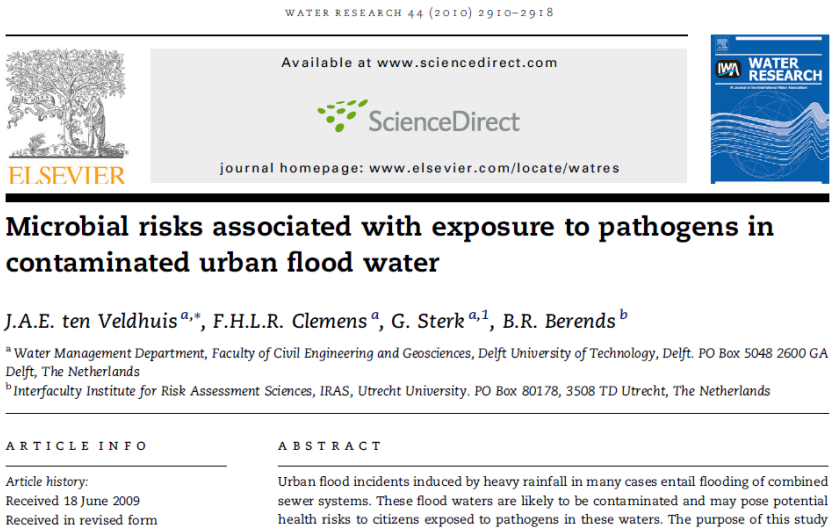
Health Risks of Urban Floods



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Microbial risks associated with exposure to pathogens in contaminated urban flood water

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ABSTRACT

Urban flood incidents induced by heavy rainfall in many cases entail flooding of combined sewer systems. These flood waters are likely to be contaminated and may pose potential health risks to citizens exposed to pathogens in these waters. The purpose of this study

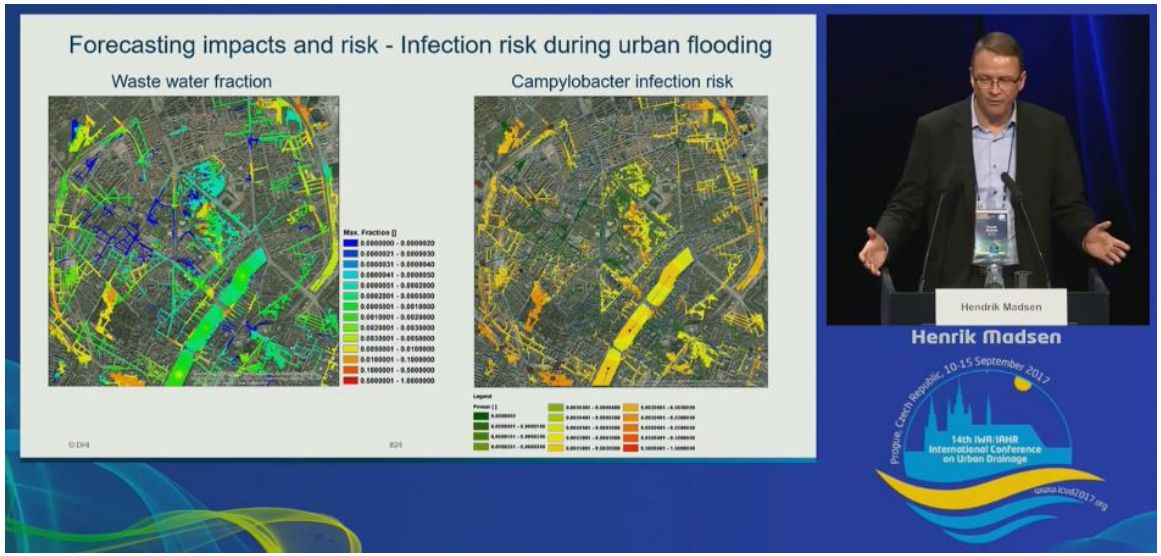
Water Research, 2010

The Sun, 200?

- Urban floods (especially those in areas with combined sewers) contain high levels of pathogens and other harmful bacteria
- Direct and indirect contamination risk, risk to vulnerable sites

- Is it possible to develop modelling capability to include this?

International Conference on Urban Drainage 2017, Prague



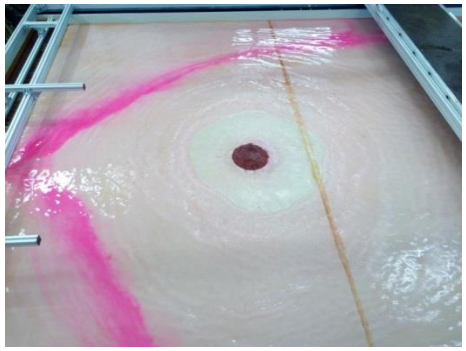
- Presentation at ICUD 2017 from Head of Innovation at DHI
- Contaminant transport model added to flood model
- Calibration/Verification data?

Considerations for a (accurate) urban flood infection risk model

- Initial distribution in the catchment (temperature/time of year…..)
- Transport mechanisms (sediments/solutes)
- Urban runoff
- Reaction / degradation in the sewer
- Sewer hydraulics and transport (sediments/solutes)
- Transport through gully/manhole
- Exchange to surface (complex hydraulics)
- Survival/growth in urban floodwater
- Transport in urban floodwater (sediment/solute)
- Effects of turbulence on bacteria
- Fate and lifespan on the surface (environmental factors)
- …….

Solute Transport Model for Urban Flood Flows

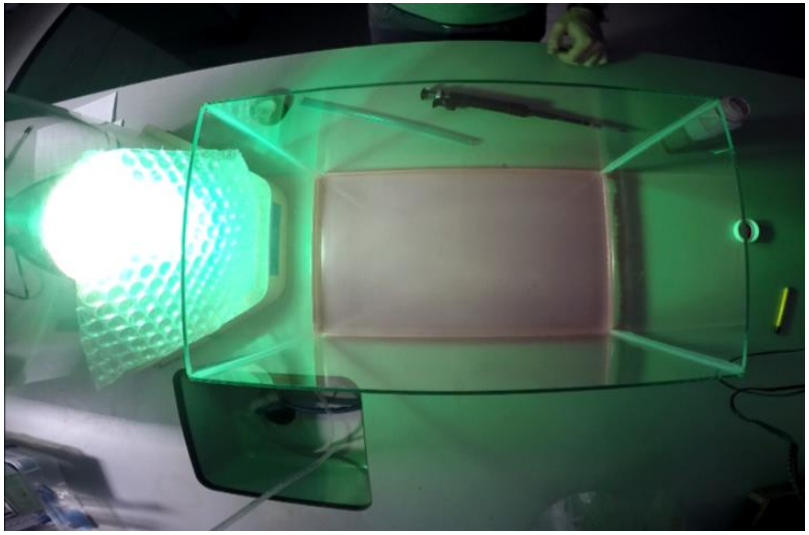
- Develop the facility to track the concentration of a soluble tracer as it moves from sewer to surface
  - Concentration of tracer can be derived from measured light intensity under illumination

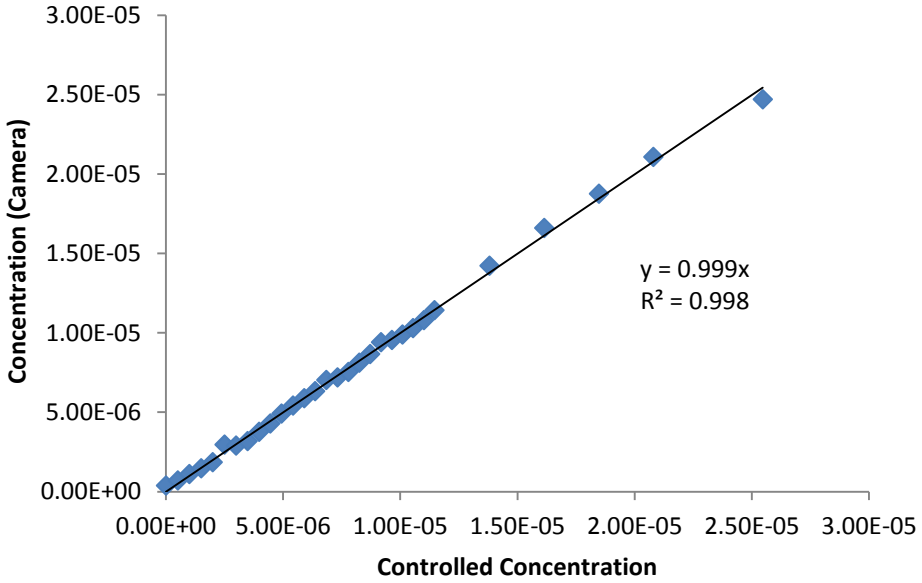


- Test a simple transport only model in shallow urban flood flow
  - No chemical/biological reactions
  - Mixing and transport processes on the surface only
  - Range of hydraulic and urban surface setups

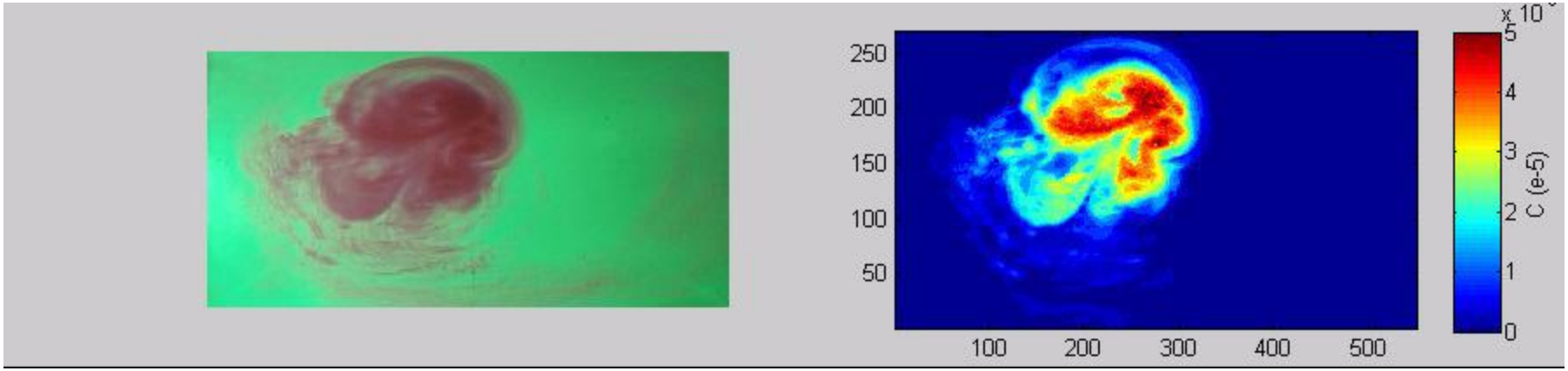
Concentration Measurements

- Technique to measure depth averaged concentrations of a tracer over the floodplain
  - Green light to fluoresce dye
  - Non uniform illumination – Calibration required for each pixel





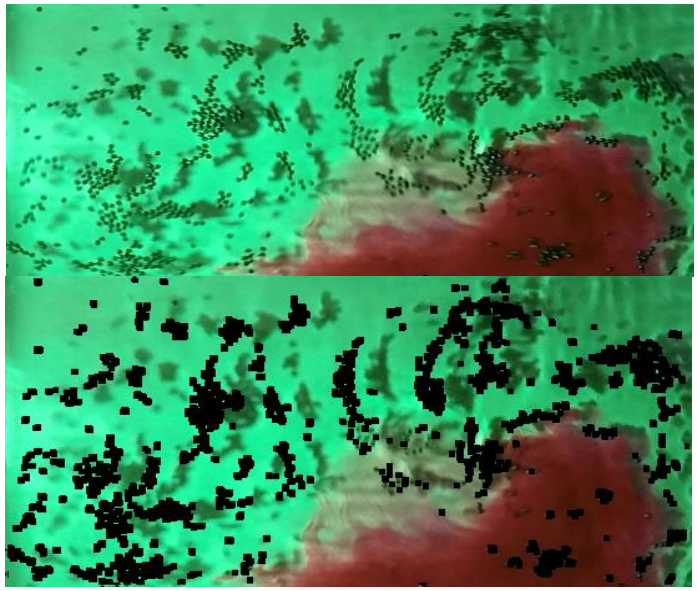
Dynamic Examples

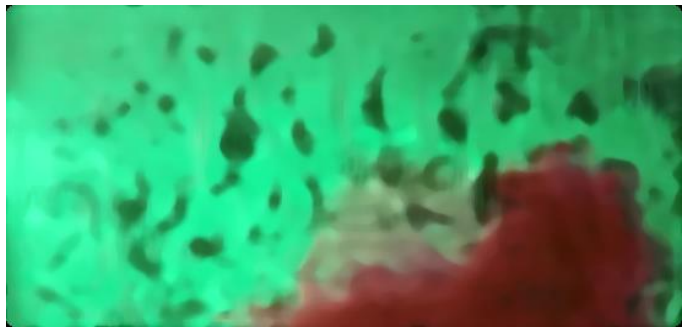


- Feasible technique for concentration measurement if uniform lighting maintained

Velocity + Concentration

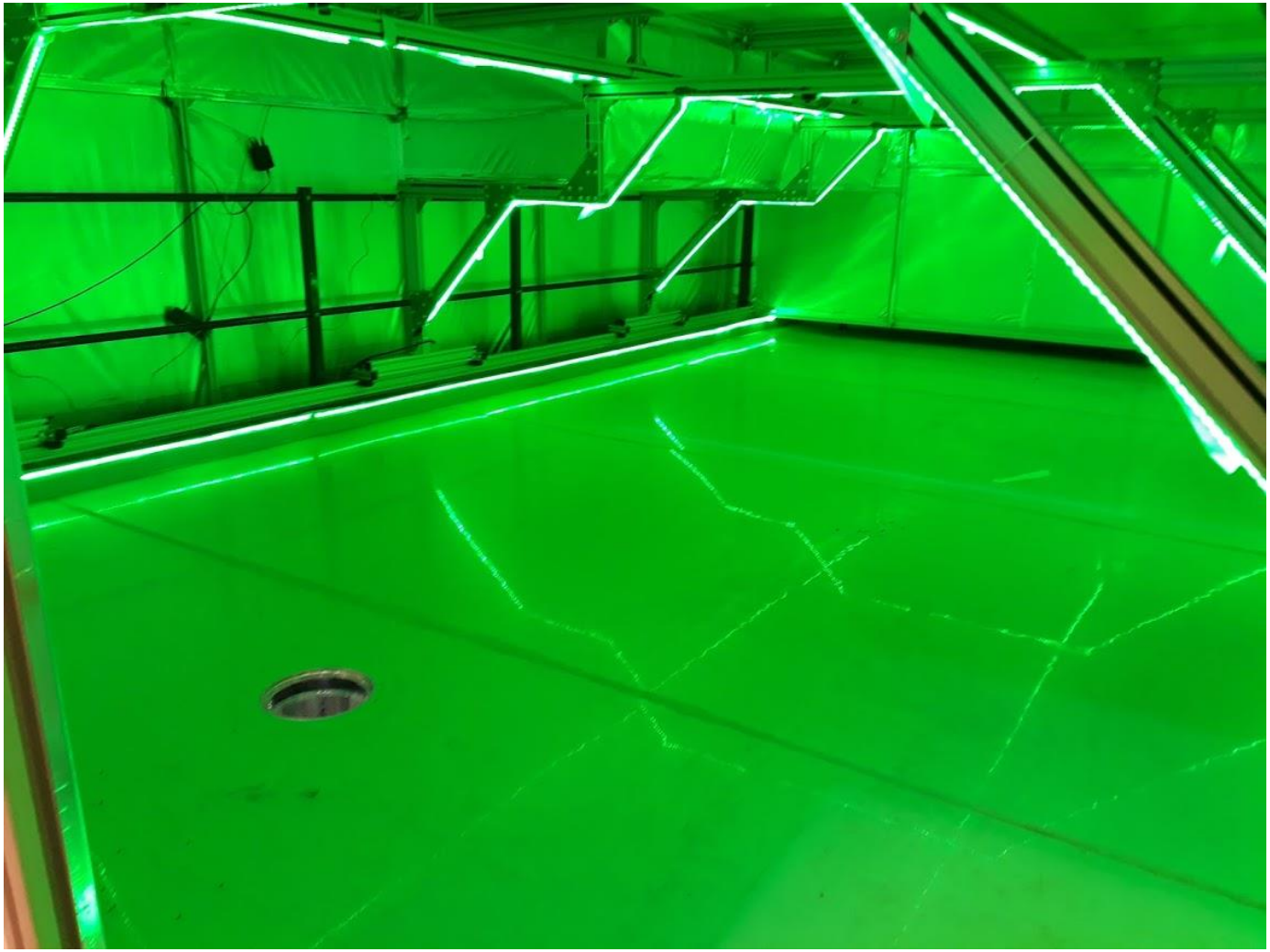
- Feasible to conduct PIV and Conc. together





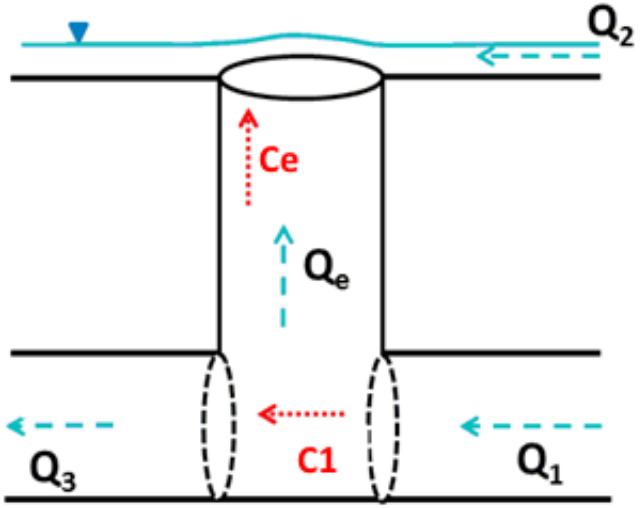
- Initial Image
- Ratio of component colours used to identify particles in image
- Particles have been removed from image BUT shadow are harder to remove
  - a more diffuse light source helps

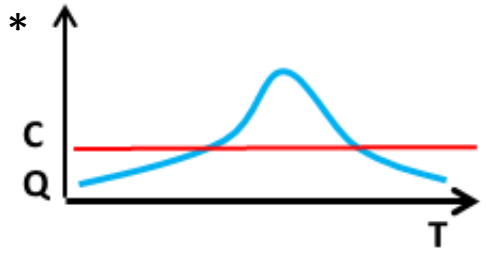
The illuminated facility



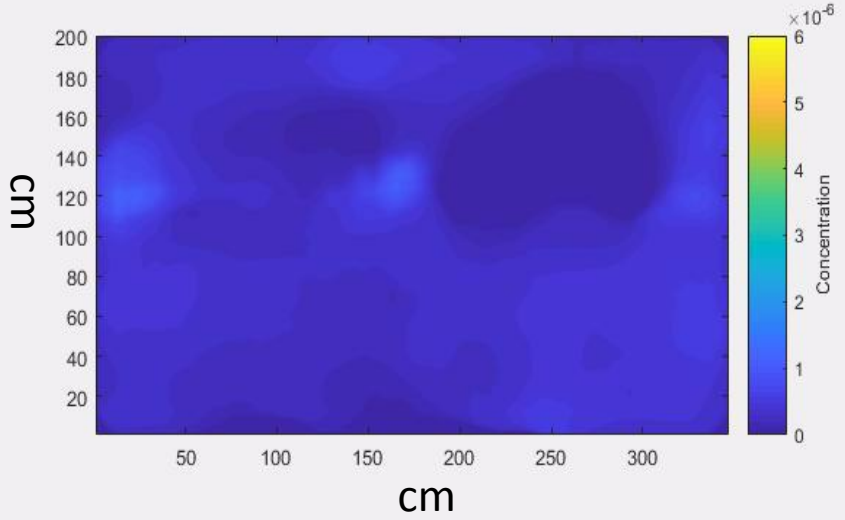
The Source (Sewer)

- Options…..
  - Steady Surcharge rate, Steady Concentration
  - Steady Surcharge Rate, Unsteady Concentration
  - Unsteady Surcharge rate, Steady concentration*
  - Unsteady Surcharge rate, Unsteady concentration



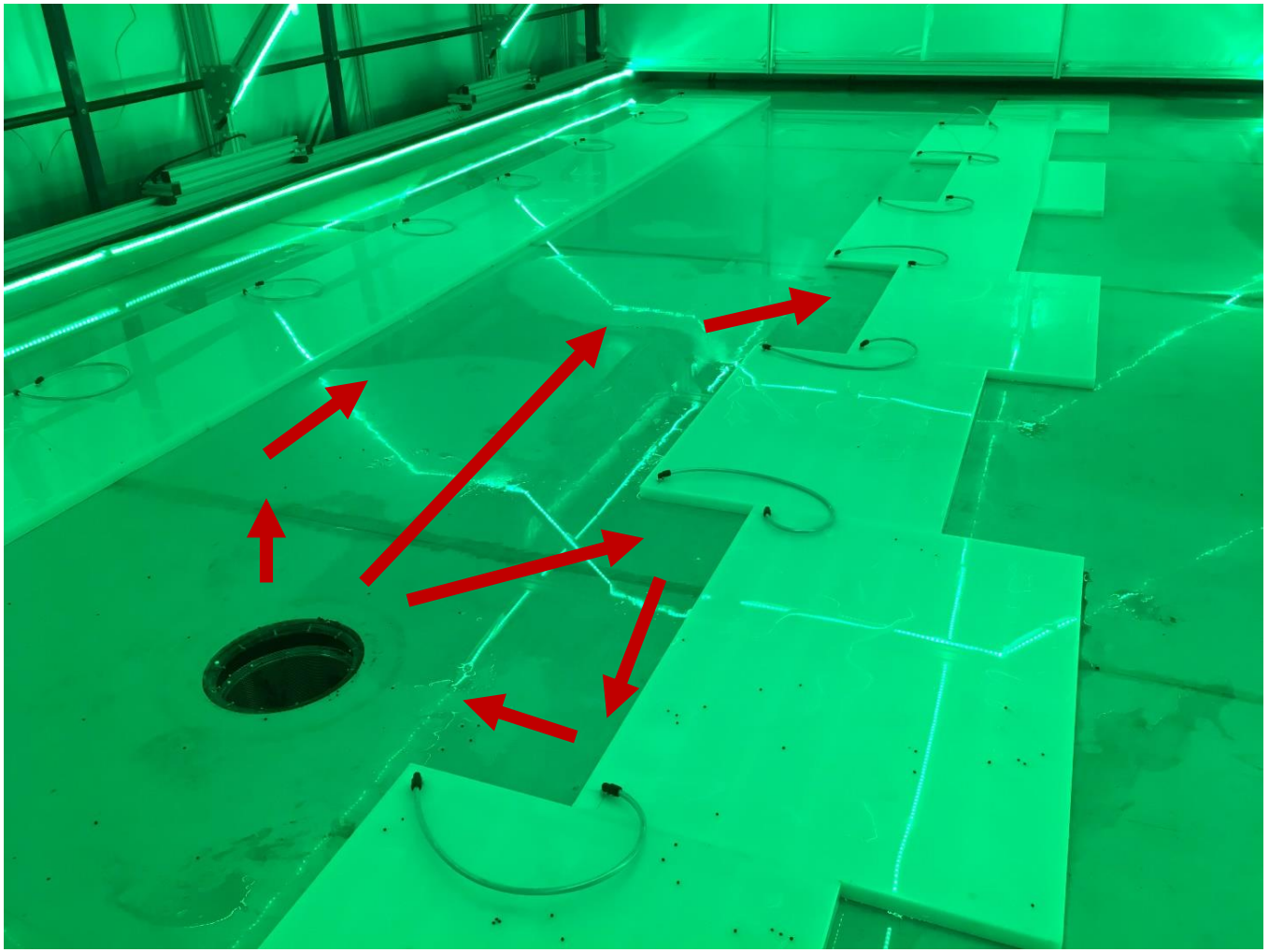


Measurements on the Facility



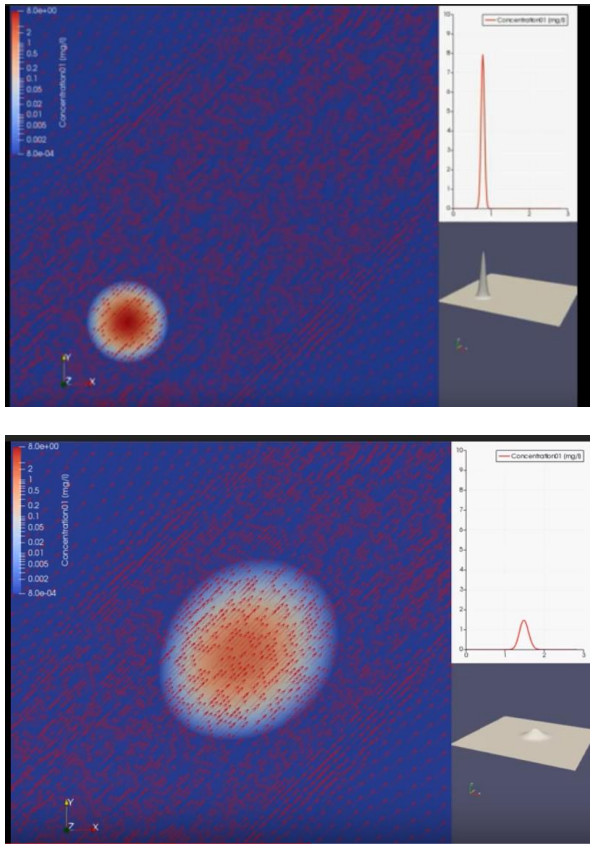
Unit discharge = 0.7l/sm, Surcharge 3l/s,

Transport and Mixing Processes



Modelling Pollutant Transport

- Developed a model based on the 2D ADE
  - Surface flow, not manhole
  - Couple with hydraulic model
- Next step is to calibrate against data from facility
  - Velocity data (from hydraulic model)



Conclusions

- Increasing awareness of the health impacts of urban flooding
- Some health impact models are now under development
- This work has developed a facility to examine solute transport in shallow flows
- Future work to calibrate the ADE model
- Followed by……