Modelling Group
WATER NEW ZEALAND

Modelling Symposium

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TUFLOW FV CONSTRUCTED WETLAND MODELLING

Presented by
Dr Brad Scarfe

18 March 2025

Coming up today....

1. The global business case of wetlands
2. Little (Big) Wahi Estuary, Cutwater Road Project – the place and the people
3. What TUFLOW FV can do
4. What we did and wetland design
5. What we found: Results
6. Turning the sod
7. Reflections and Q&A

Acknowledgements – Our core team

Chartered Professional Engineer – Carey Senior

Civil design partners – Michael Arthur, Angus Machenzie-Simpson and Leo Ivanov

Modelling technical support – Michael Barry and Colin Roberts

Council - Claire McCorkindale, Pim De Monchy, Braden Rowson

The “global” business case for wetlands

Wetlands deliver a range of ecosystem services

support important **flora and fauna**

are **culturally** significant

are places to visit , **people love them**!

protect against **floods** and tsunamis

only 5-10% of pre-European wetlands remain in Aotearoa

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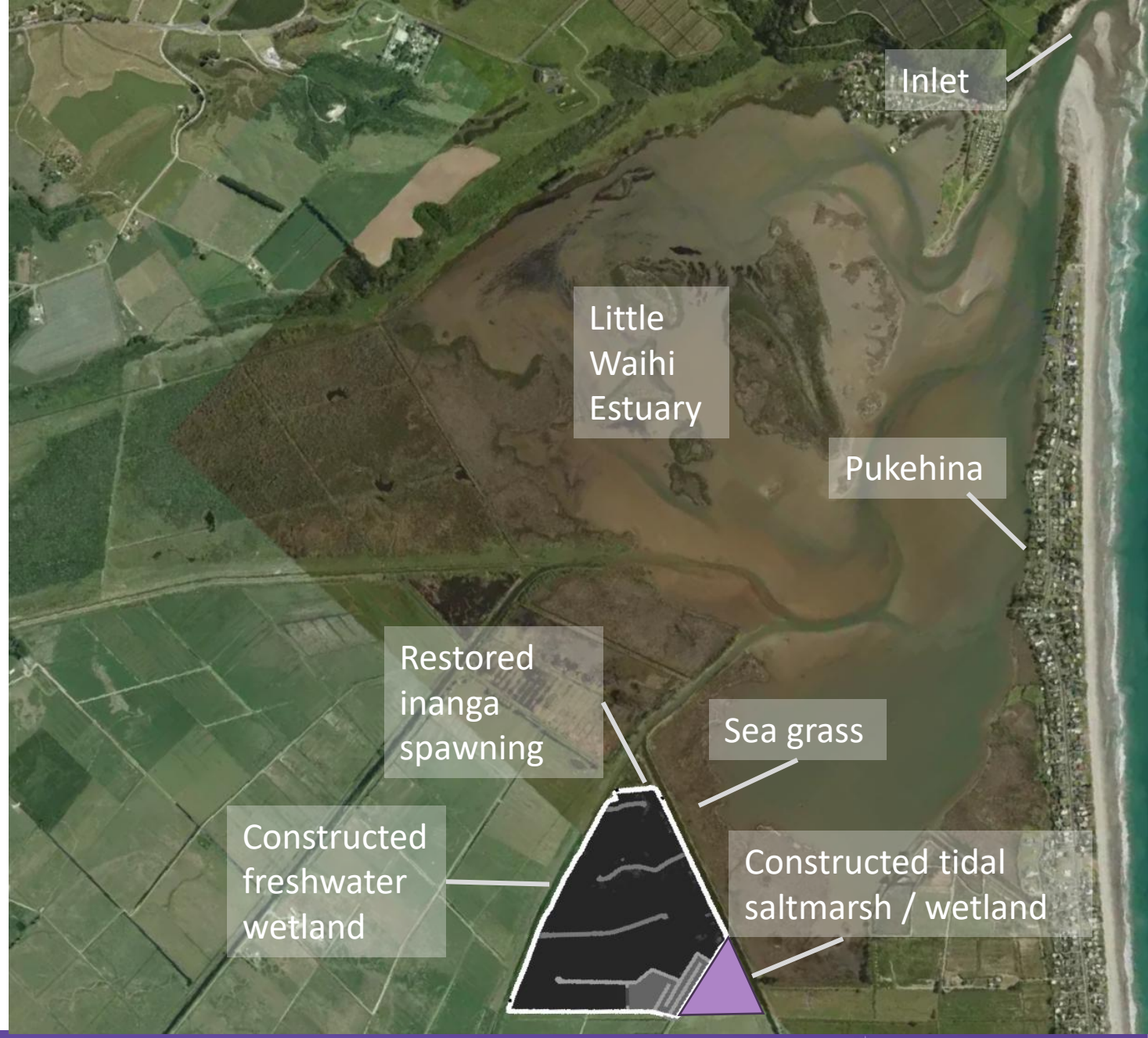
THE PLACE

Little Wahi Estuary

- **Location** – Bay of Plenty
- **Geography** – Coastal flats, drained for agriculture
- **Ecology and water quality** – one of the top 5 degraded estuaries in NZ
- **Land uses** – multiple agricultures uses, dairy around wetland

Little Wahi Estuary

- Restored inanga spawning area
- Managed drainage scheme including pump stations and drains for dairy farms
- New 27 ha freshwater wetland *under construction*
- New 3 ha tidal saltwater *under construction*

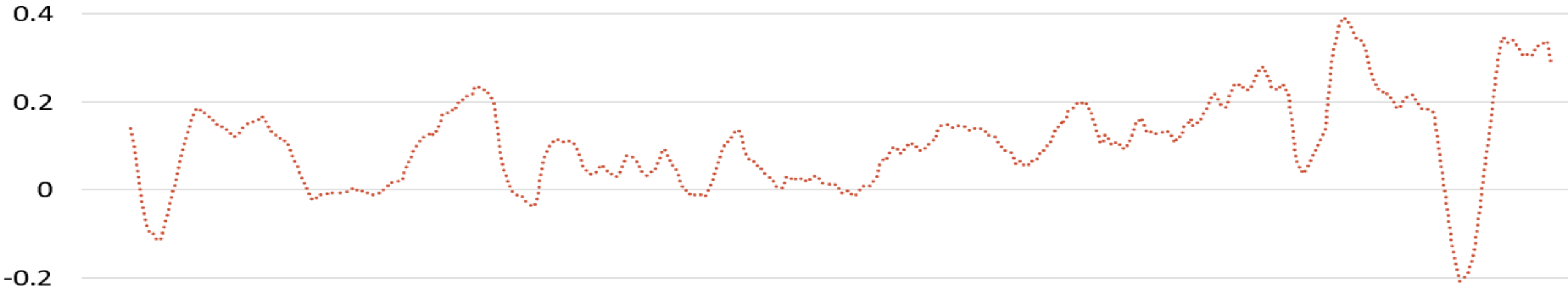


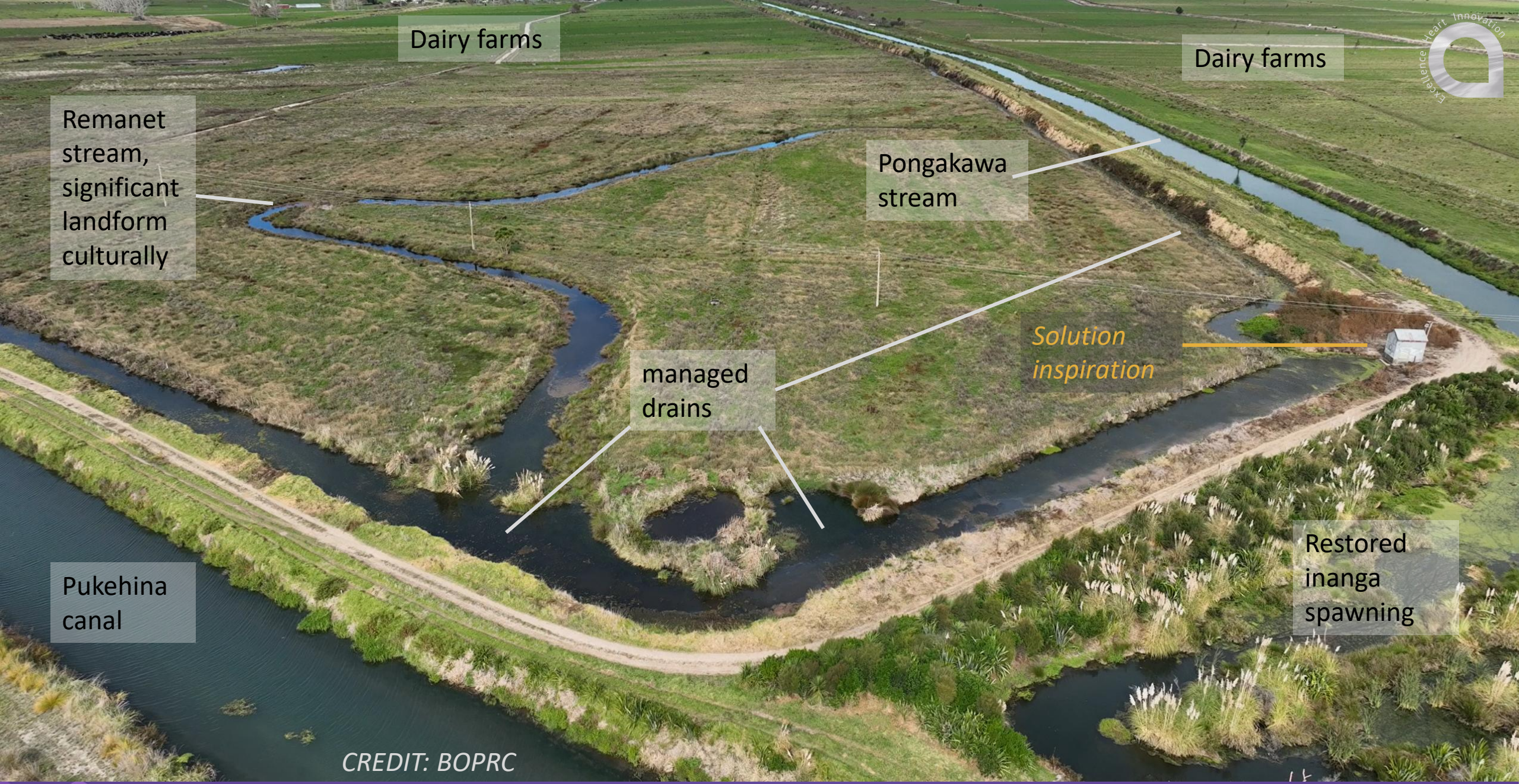
Hydraulic challenge

Typically water goes downhill through wetland

……. or head created from upstream flows

It’s flat




Dairy farms
Dairy farms
Remanet stream, significant landform culturally
Pongakawa stream
Solution inspiration
managed drains
Pukehina canal
Restored inanga spawning
CREDIT: BOPRC


Remnant stream
Farm drain

Excellence Heart Innovation

THE PEOPLE

Mana whenua – led by Te Wahapū o Waihī

BOPRC

Landowners

Waihī District Drainage Society

Ministry for the Environment (via Freshwater Improvement Fund)

Many supporting consultants and specialists

The modelling bit – what was done

- Concept modelling to provide hydraulic feasibility to understand flushing rates and hydraulic feasibility
- Incorporation of long term (3 year) climate to understand impacts of temperature, rain, wind, evaporation etc
- Identification of design dry and wet events
- Iterations of design details relating features, risks and hydraulics such as:
    - sediment pond design
    - high / low velocity area
    - ponds configurations
    - inflow and outflow hydraulics
    - 3D tracer, temperature and velocity behaviour
    - wetland volumes
    - groundwater loss
    - impacts of tides on inflows / outflow

TUFLOW FV

What the software can do:

- 3D hydraulics, sediment, morphology, water quality, particle tracking simulation
- Can include climatic conditions
- Many things, many tools – need to choose your weapon
- (TUFLOW CATCH - for another day)

The parts we used:

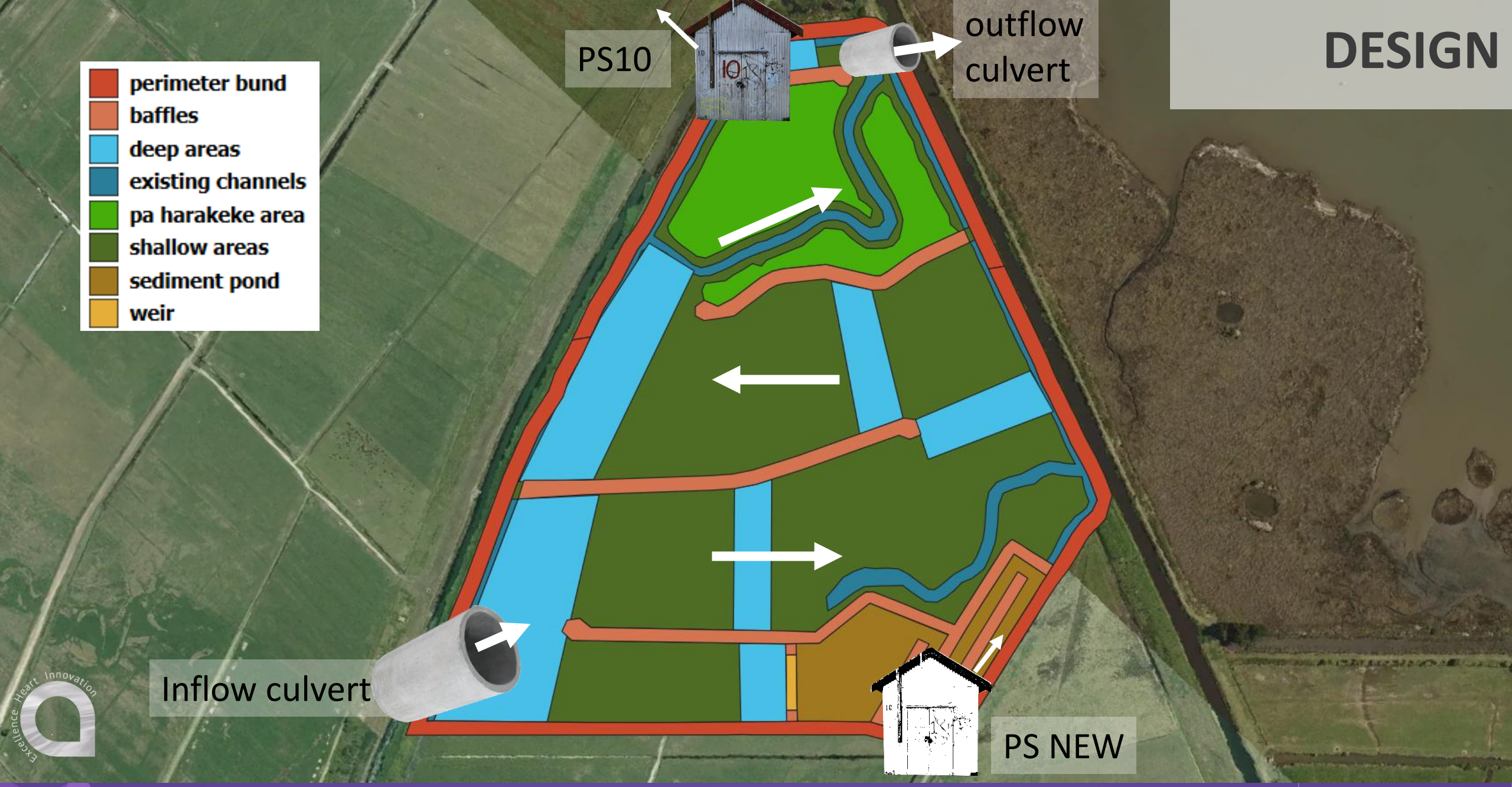
- 3D circulation hydraulics
- Climate and weather forecast/reforecast model outputs as boundaries via **Get Atmos**
- Tracer tracking to understand wetland flushing
- Data science techniques for data rich outputs (tfv.readthedocs.io and Jupyter Notebooks)

DESIGN

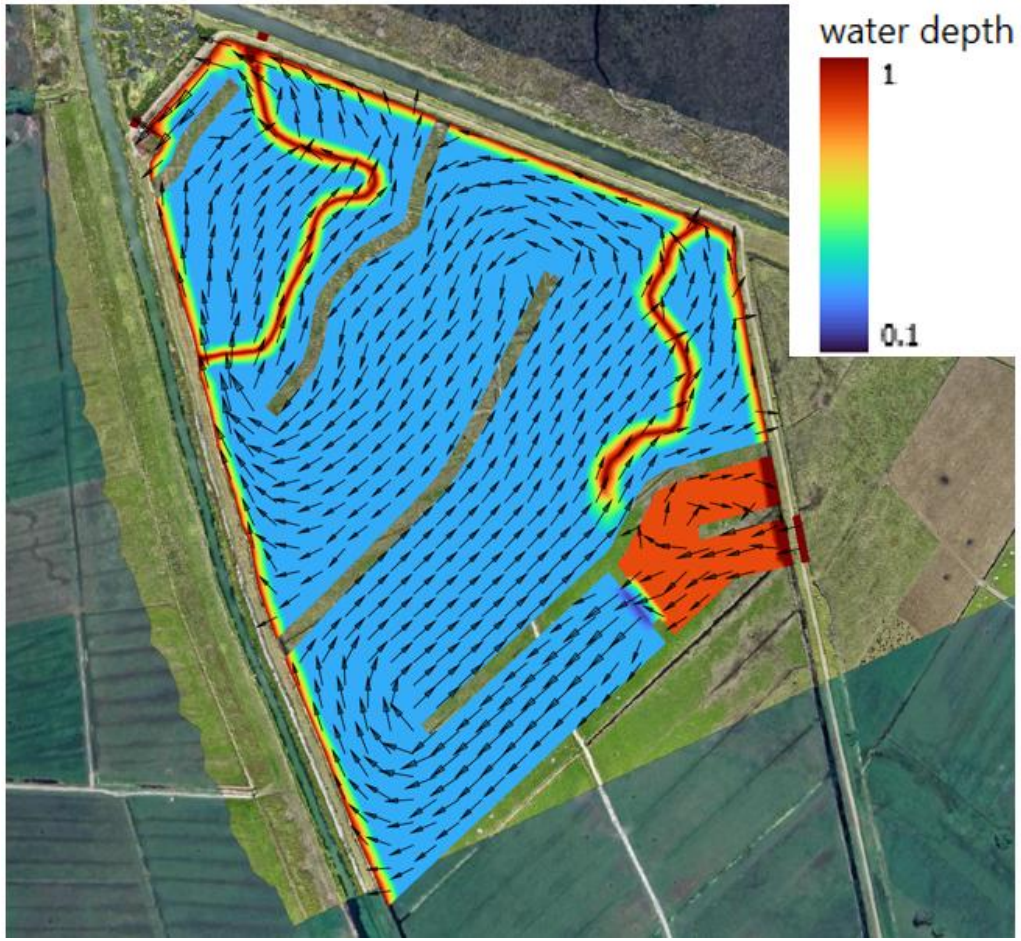

perimeter bund
baffles
deep areas
existing channels
pa harakeke area
shallow areas
sediment pond
weir

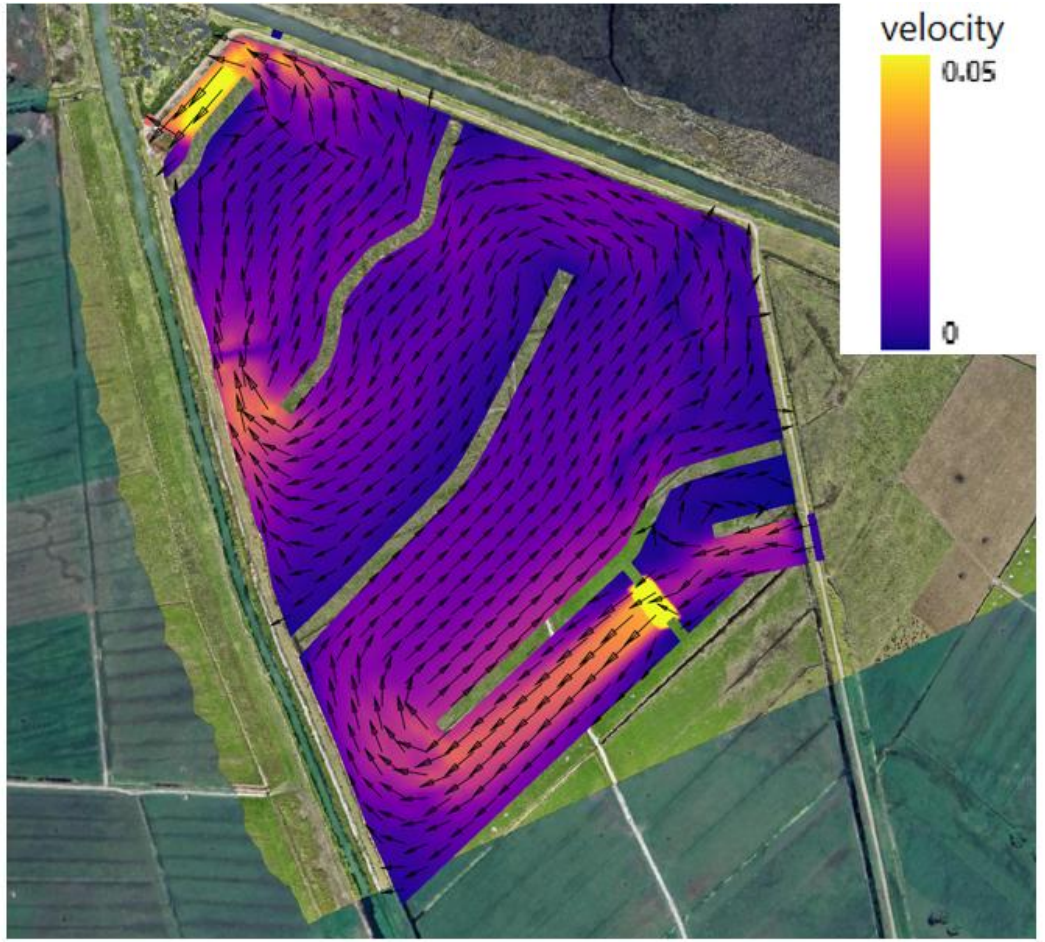

Solution
inspiration
10
10

DESIGN

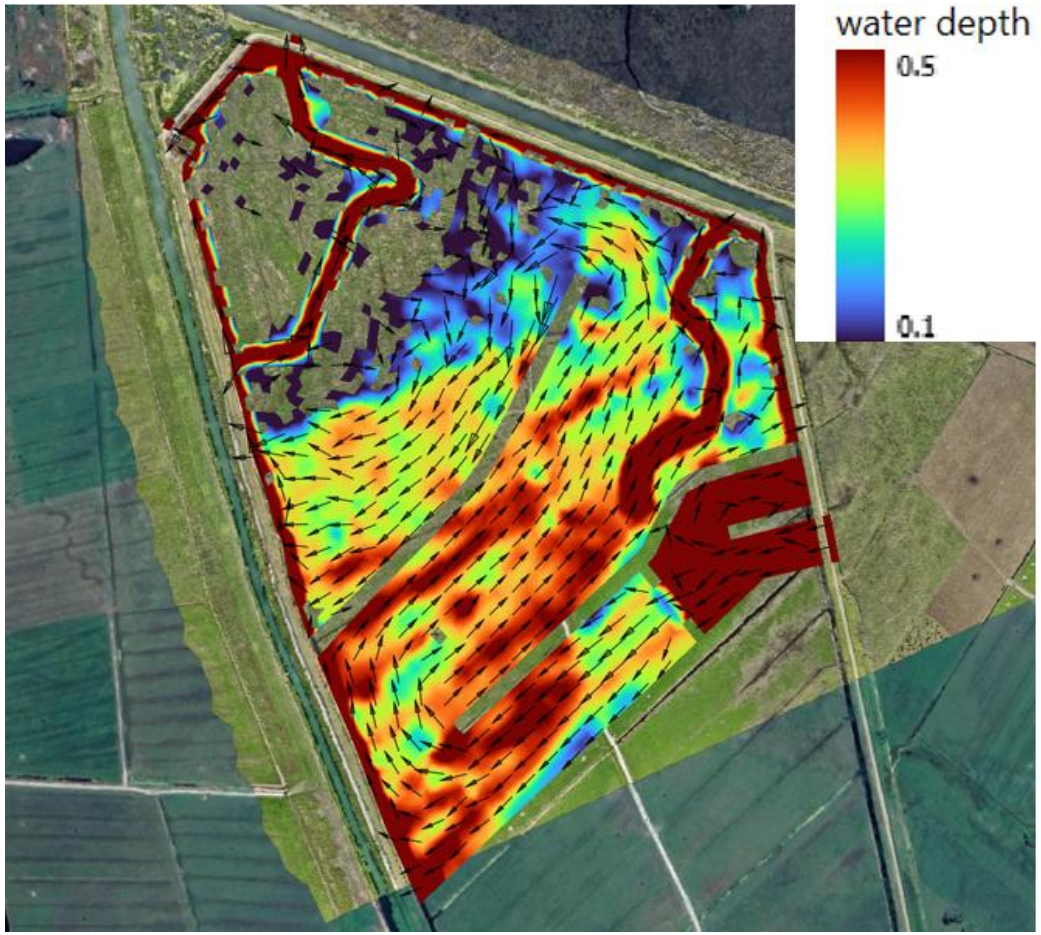

perimeter bund
baffles
deep areas
existing channels
pa harakeke area
shallow areas
sediment pond
weir
PS10
outflow culvert
Inflow culvert
PS NEW

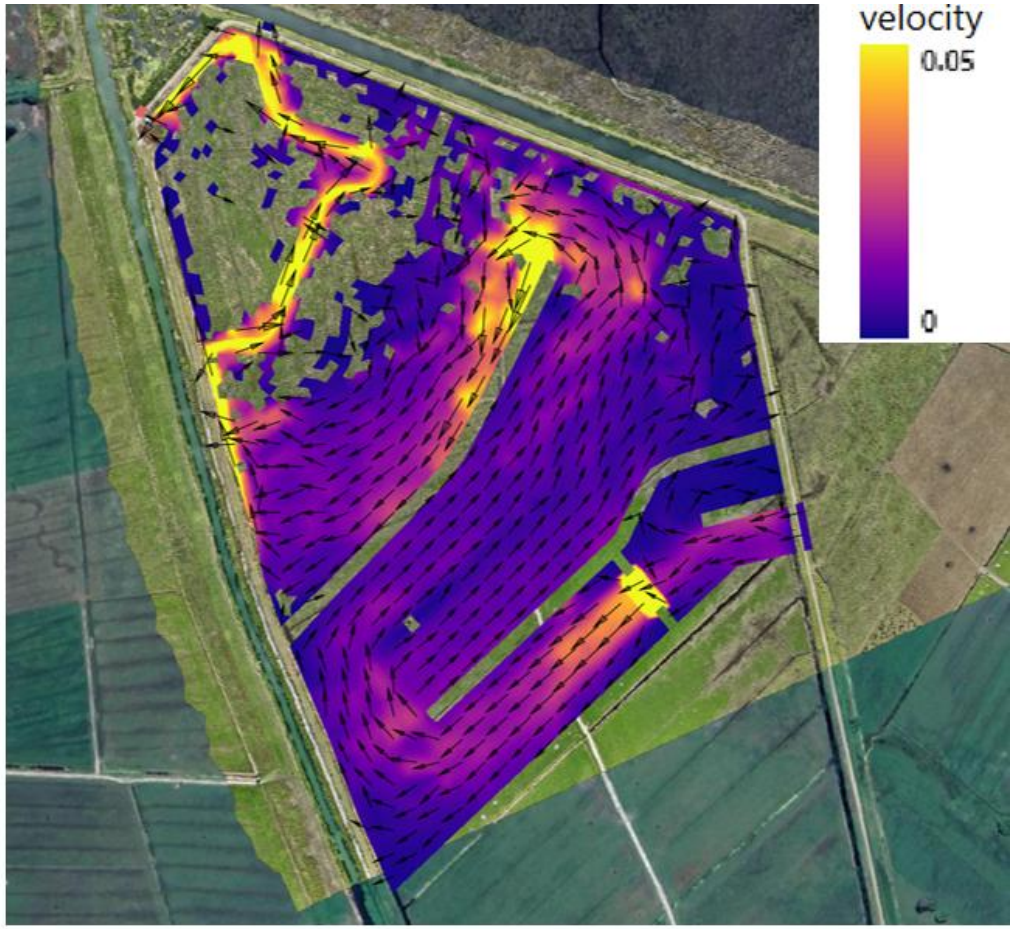
Base case – simple flat wetland surface



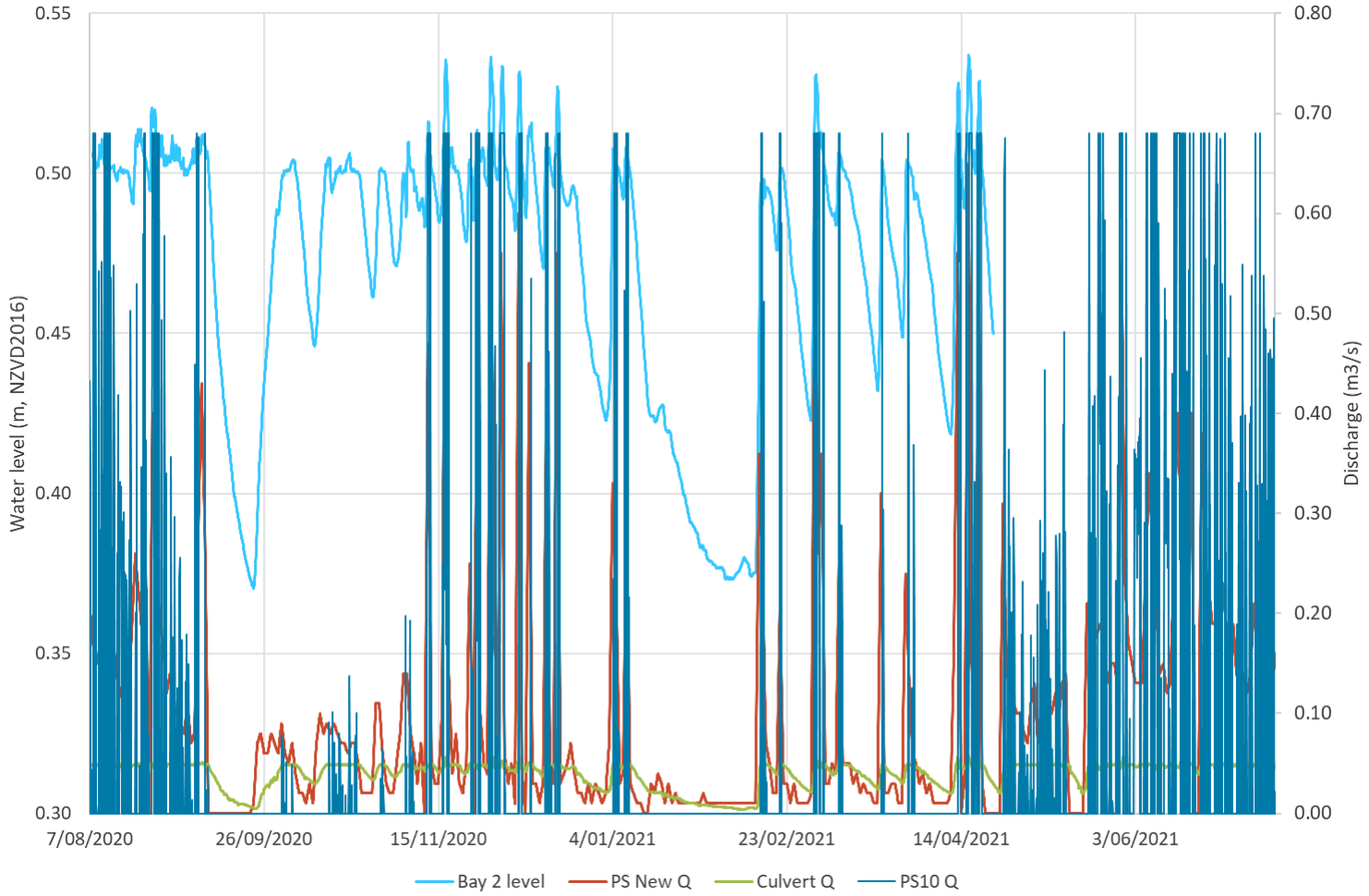


Early hydraulic challenges – using DEM





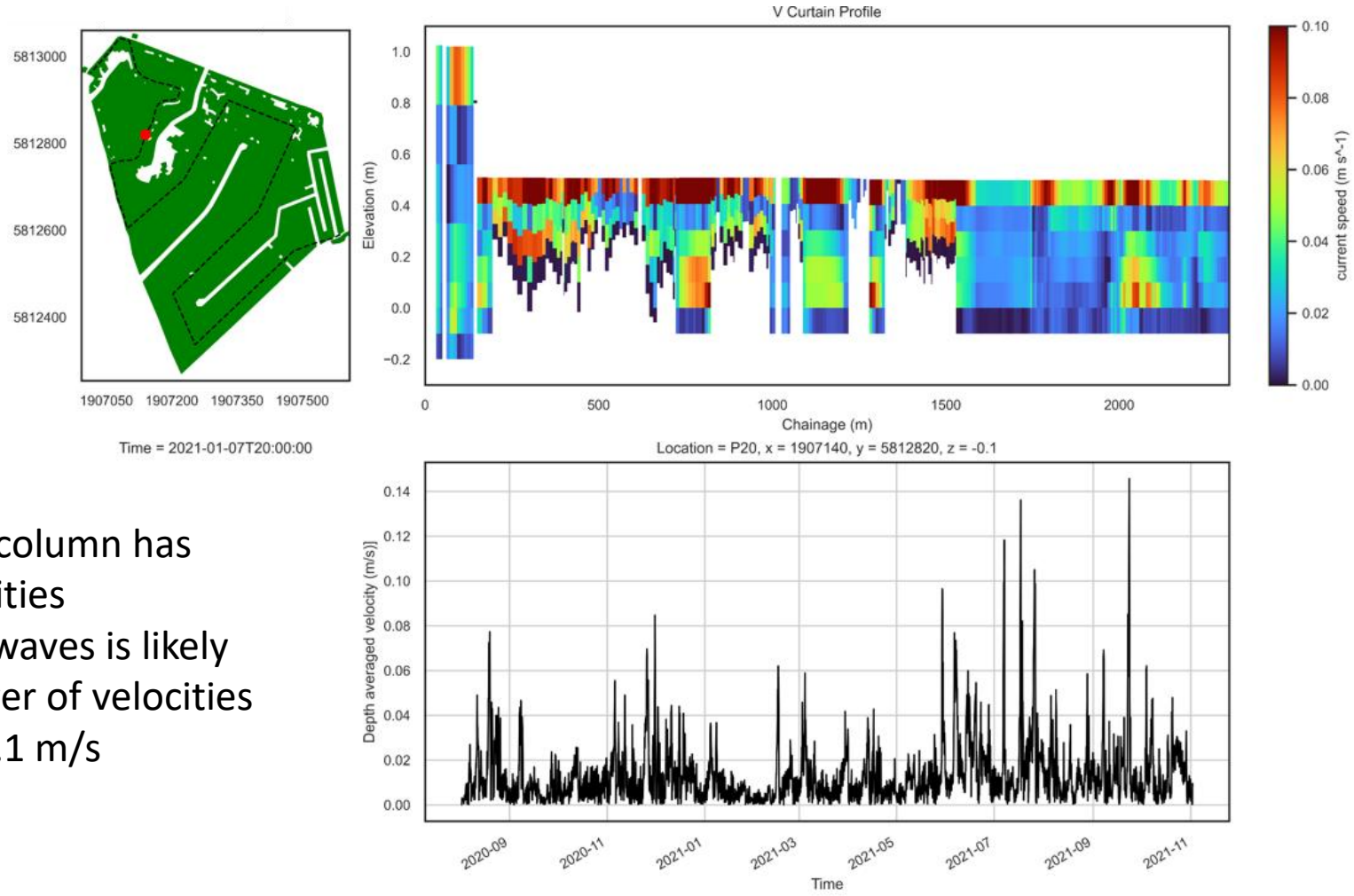
Messy graph example



Challenge is:

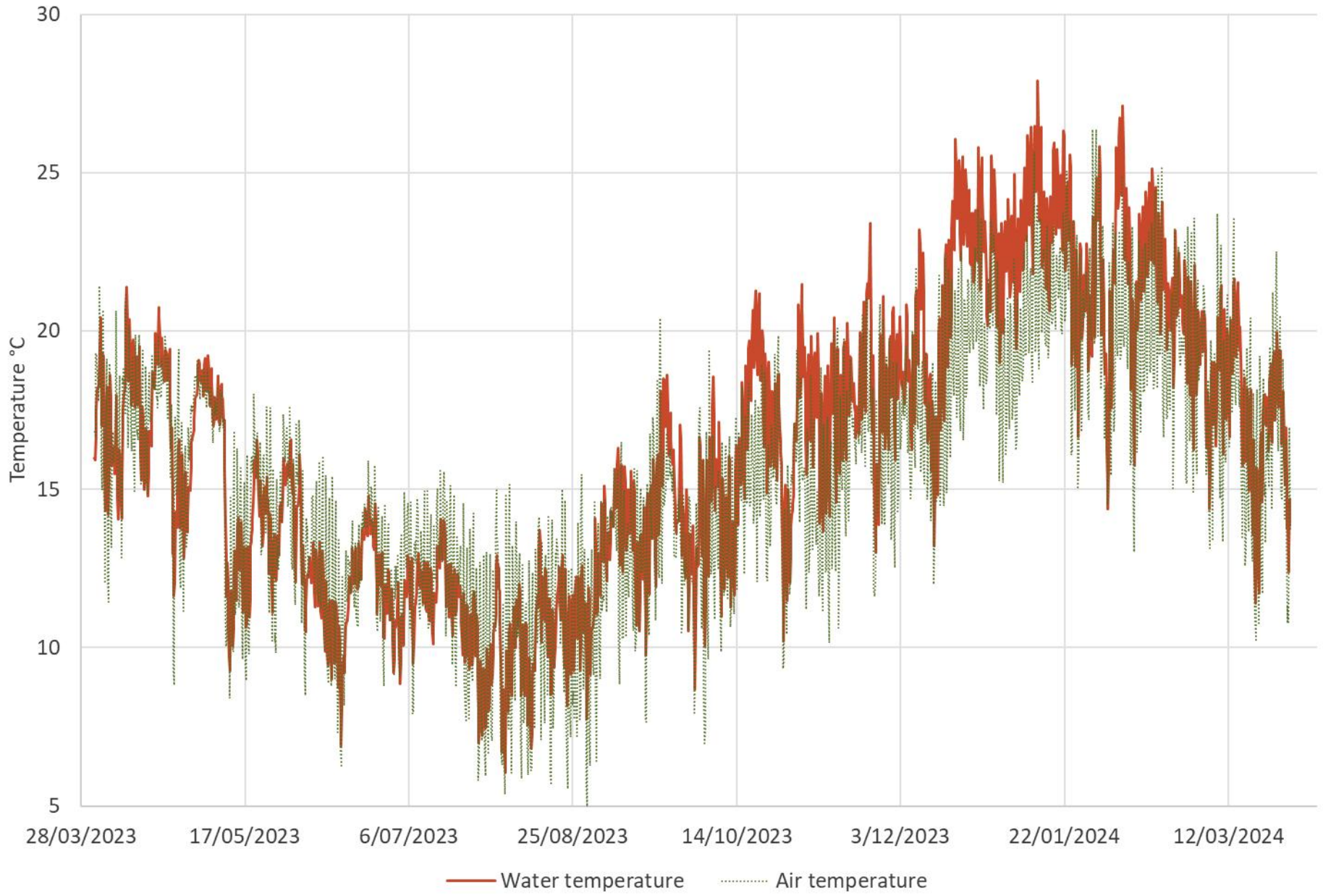
- the amount of data
- how to look at it
- what to do it with it

Velocity through the water column

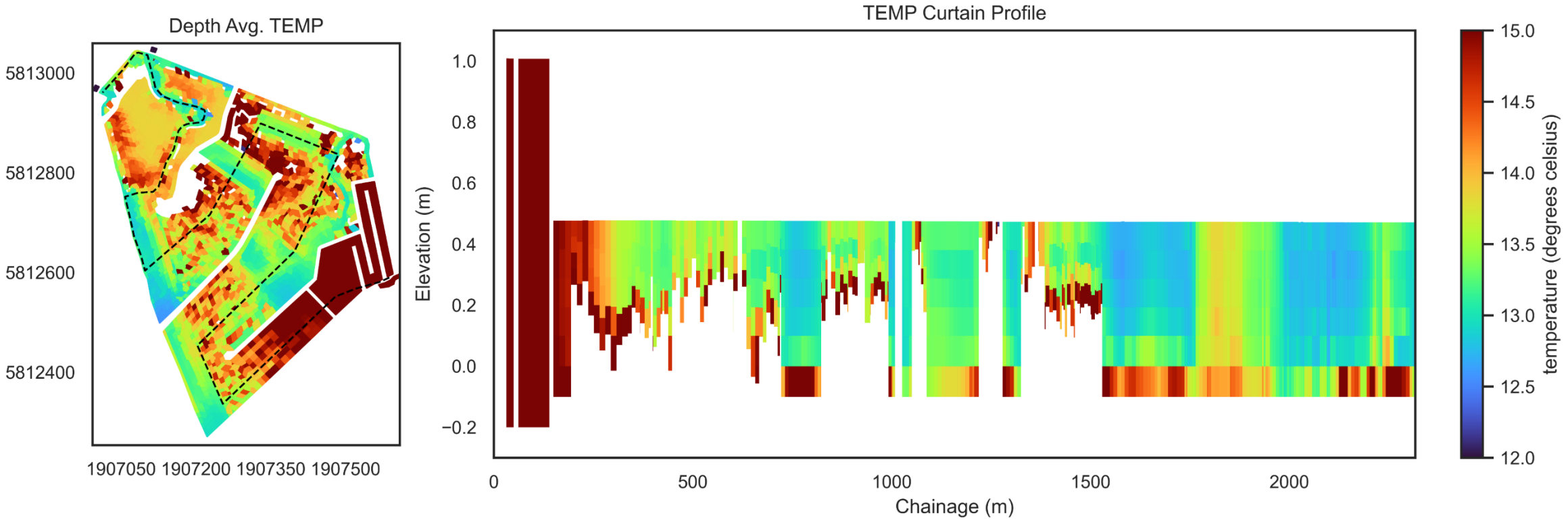


- Top of water column has highest velocities
- Wind driven waves is likely to be the driver of velocities above 0.05-0.1 m/s

Air vs water temperature

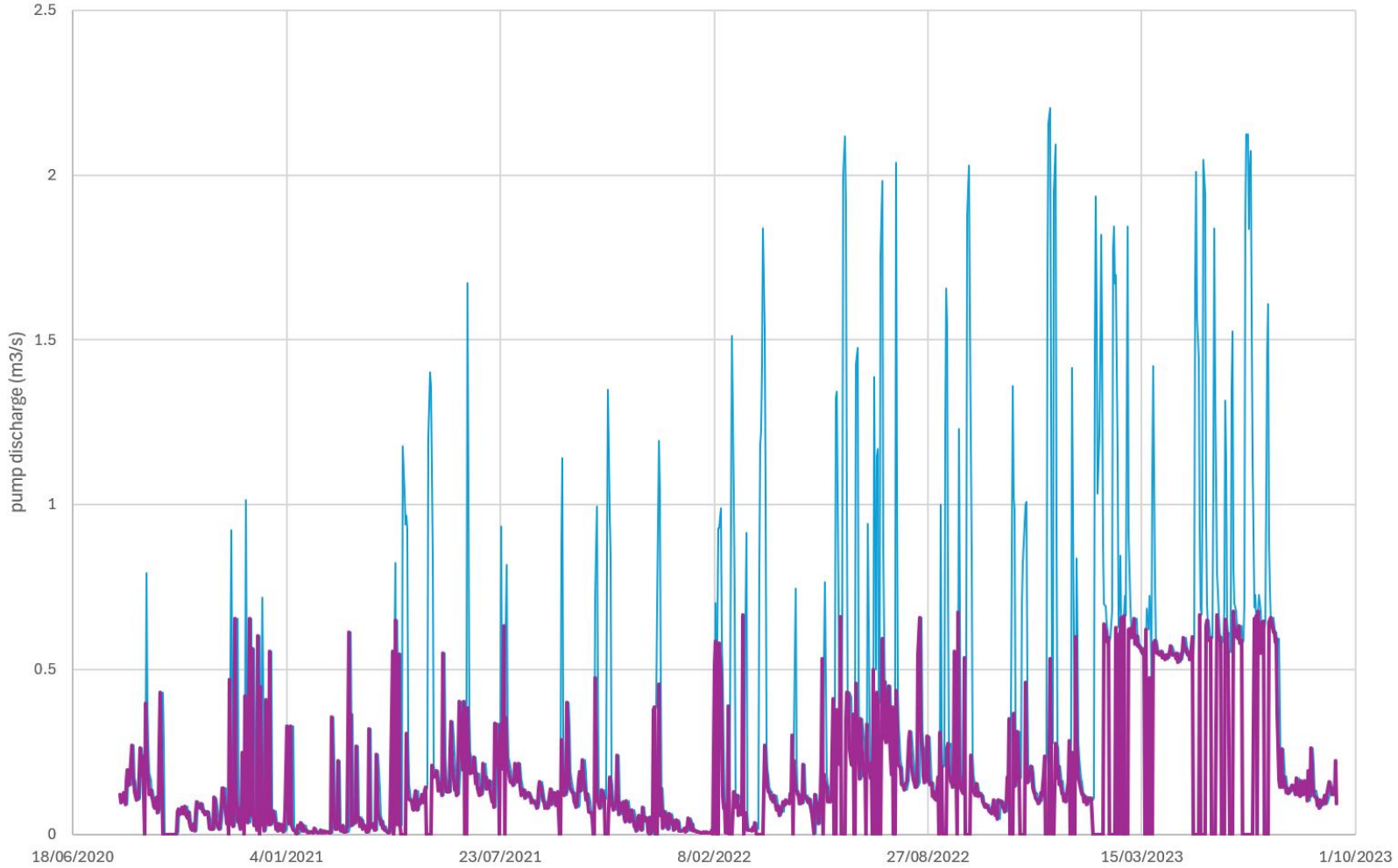


Temperature through water column



- The wetland processes are 3D dimensional
- Land and air temperatures stratify temperature through the water column
- Water temperature boundary condition entering sediment pond is set to air temperature

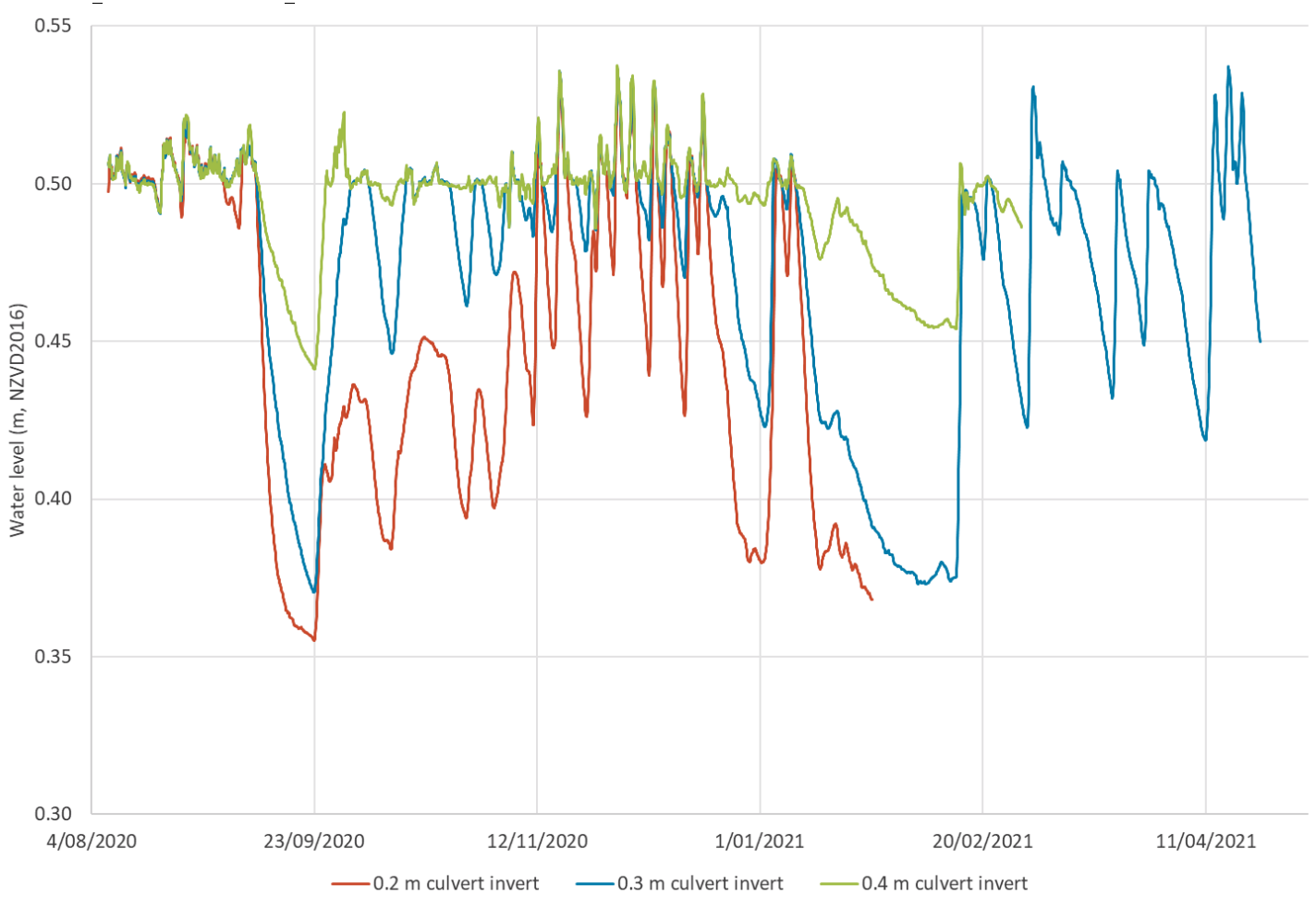
Wetland inflow boundary



Blue is total pumping

Purple is pump record truncated at 0.68 m3/s and used as an upstream boundary condition for the new pump station

Outflow culvert invert impact on water

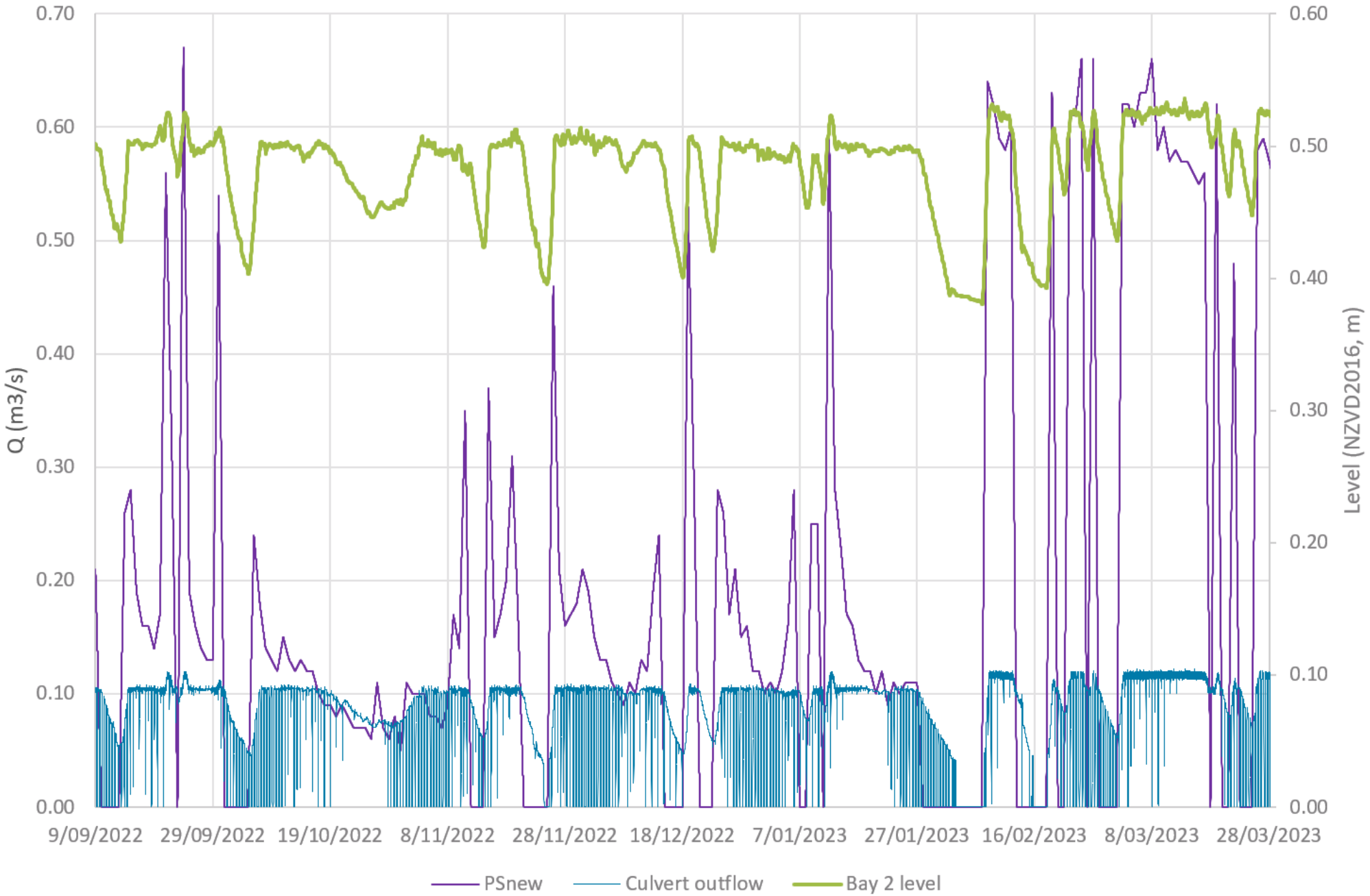


Outflow culvert invert impacts water level

This implied that there is a constraint on water supply and:

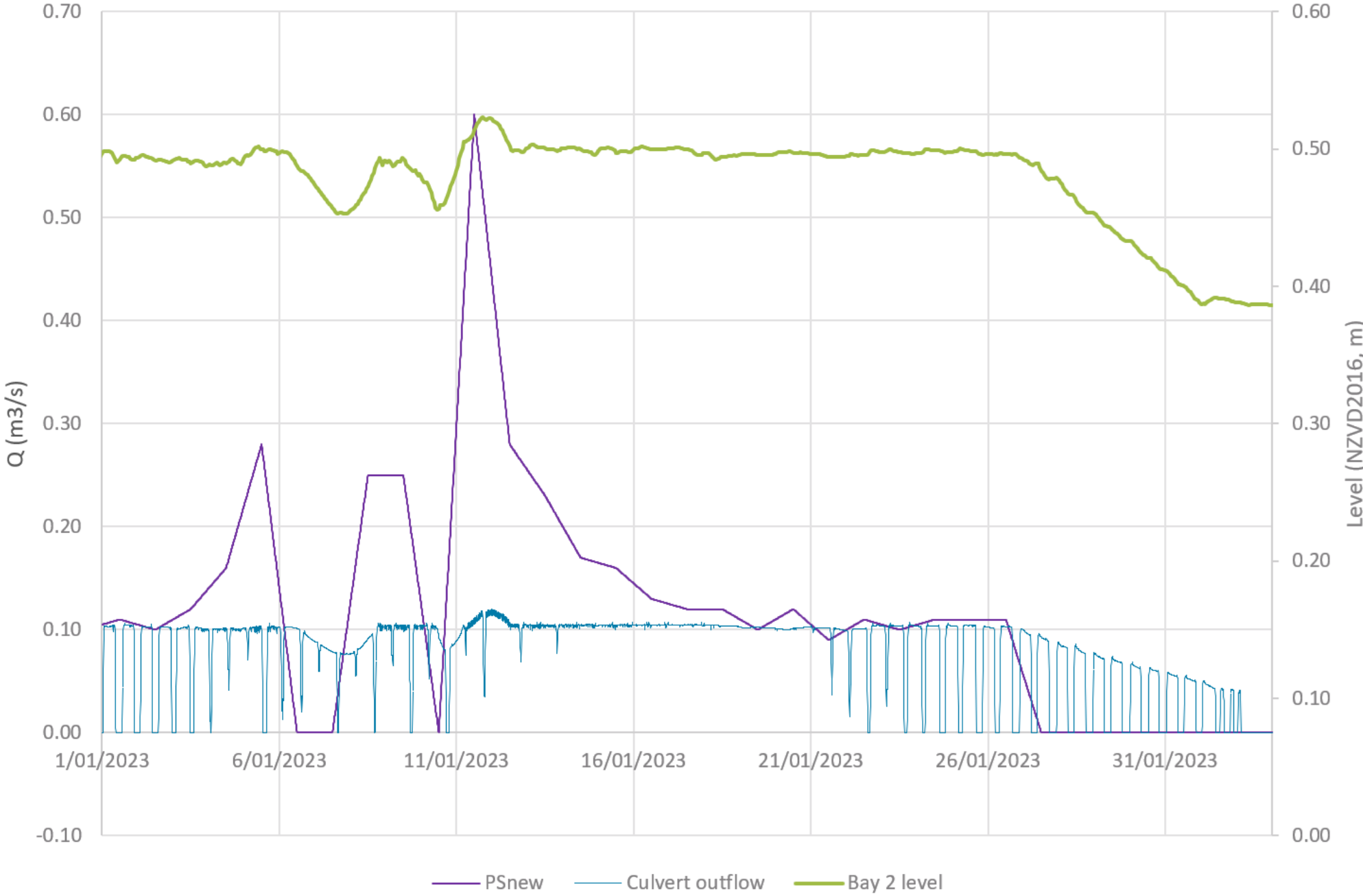
- culvert level needs to be raised *and/or*
- be able to be manually closed *and/or*
- accept periods at lower level

Understanding relative behaviour of structures

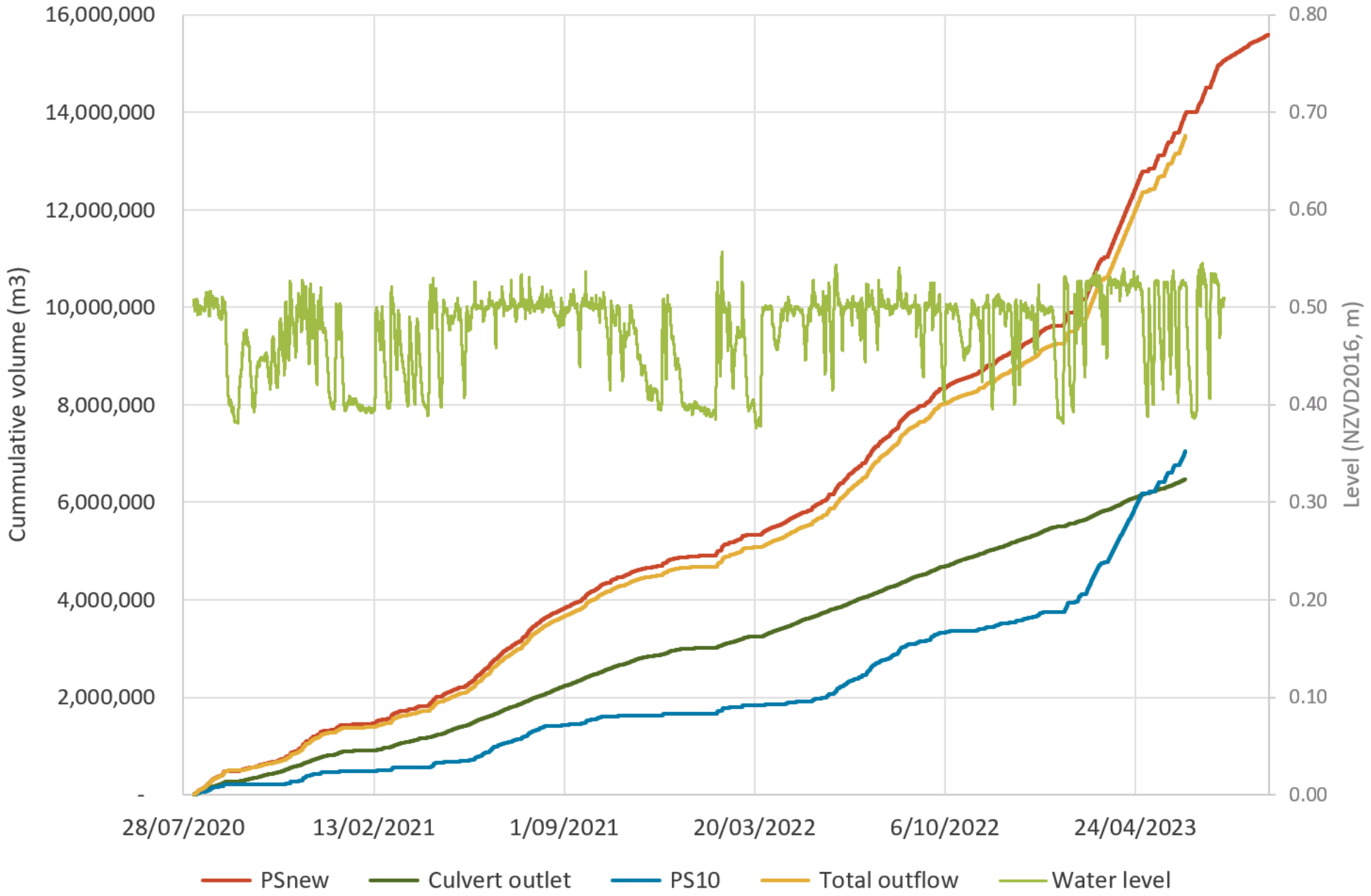


Understanding relative behaviour of structures

- one month

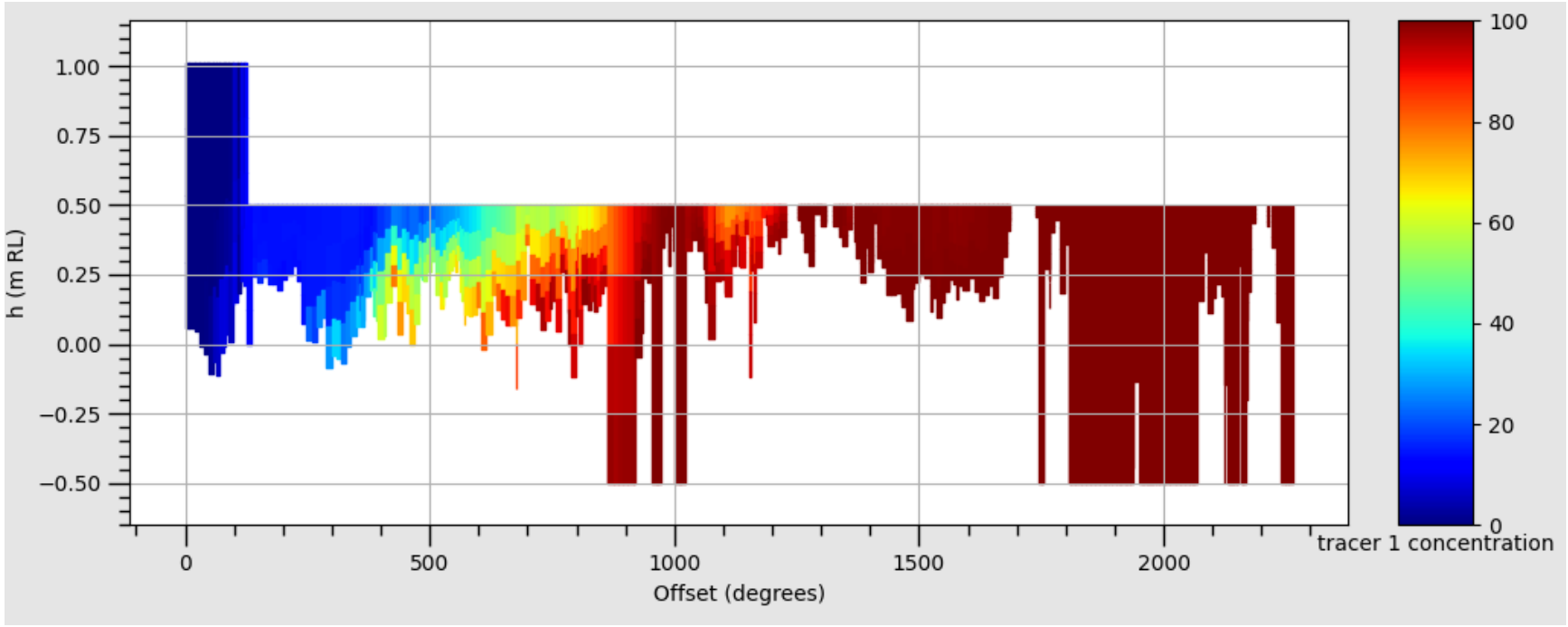


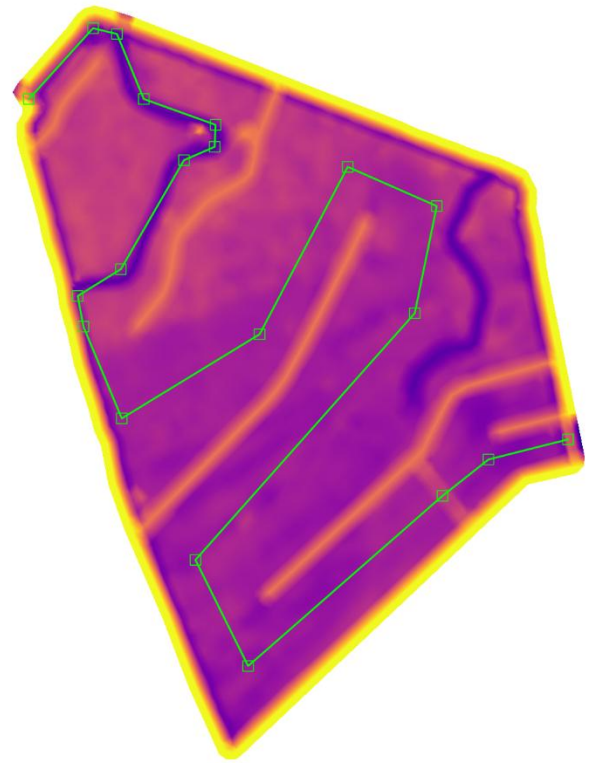
Volume over time



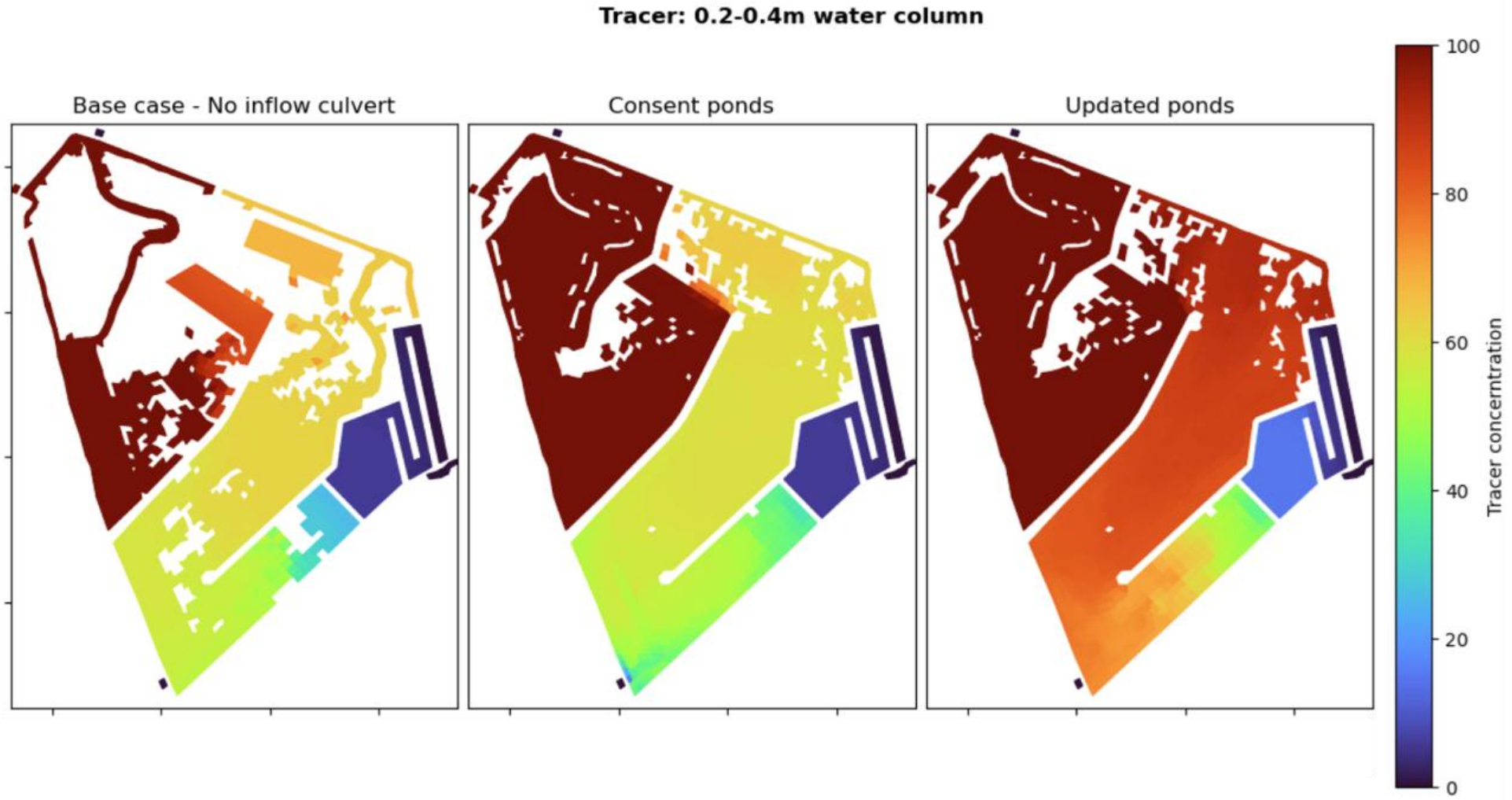
Testing impacts of water lost to groundwater

Tracer showing 3D flushing

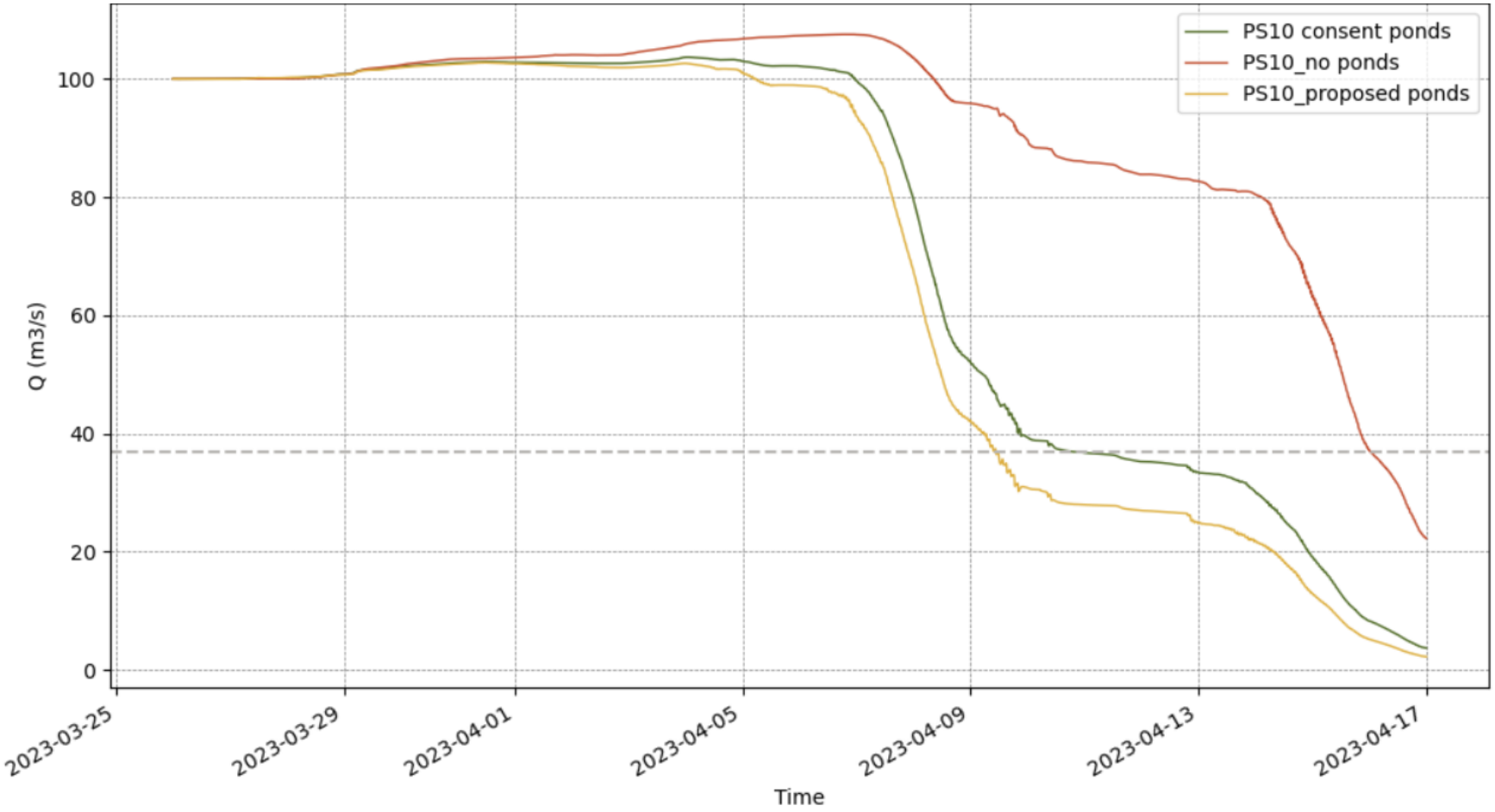




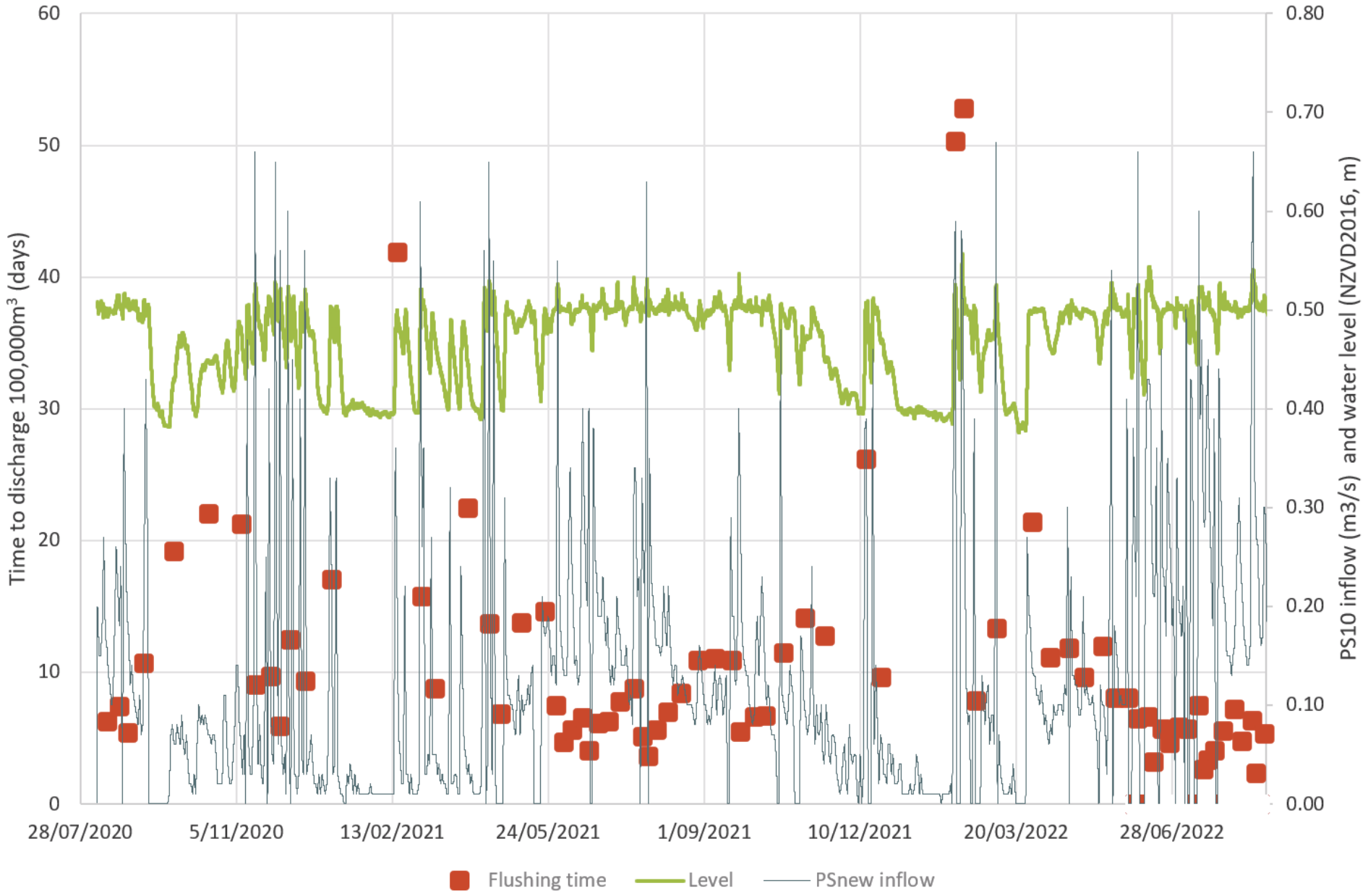
Tracer concentration



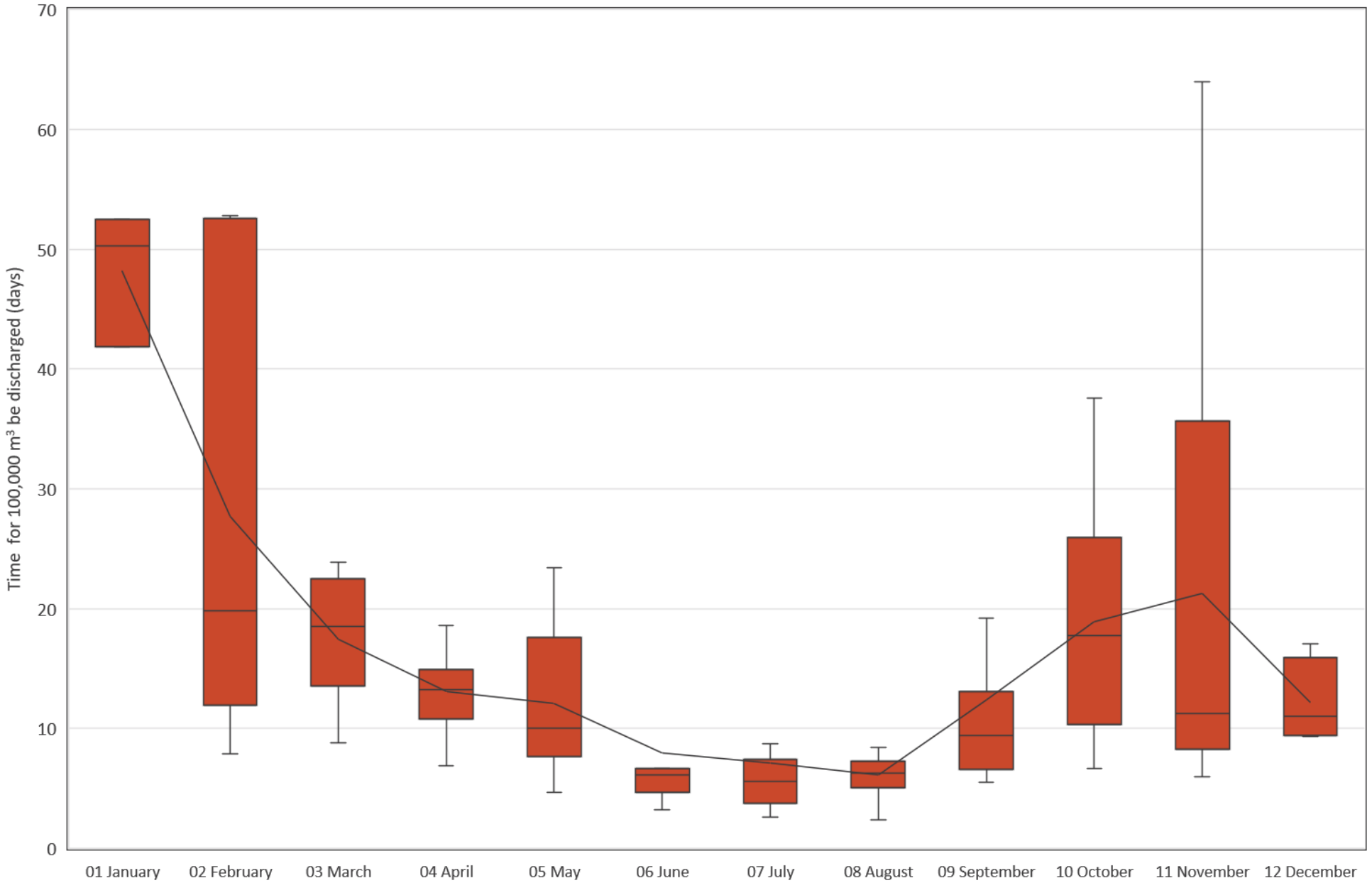
Tracer decay



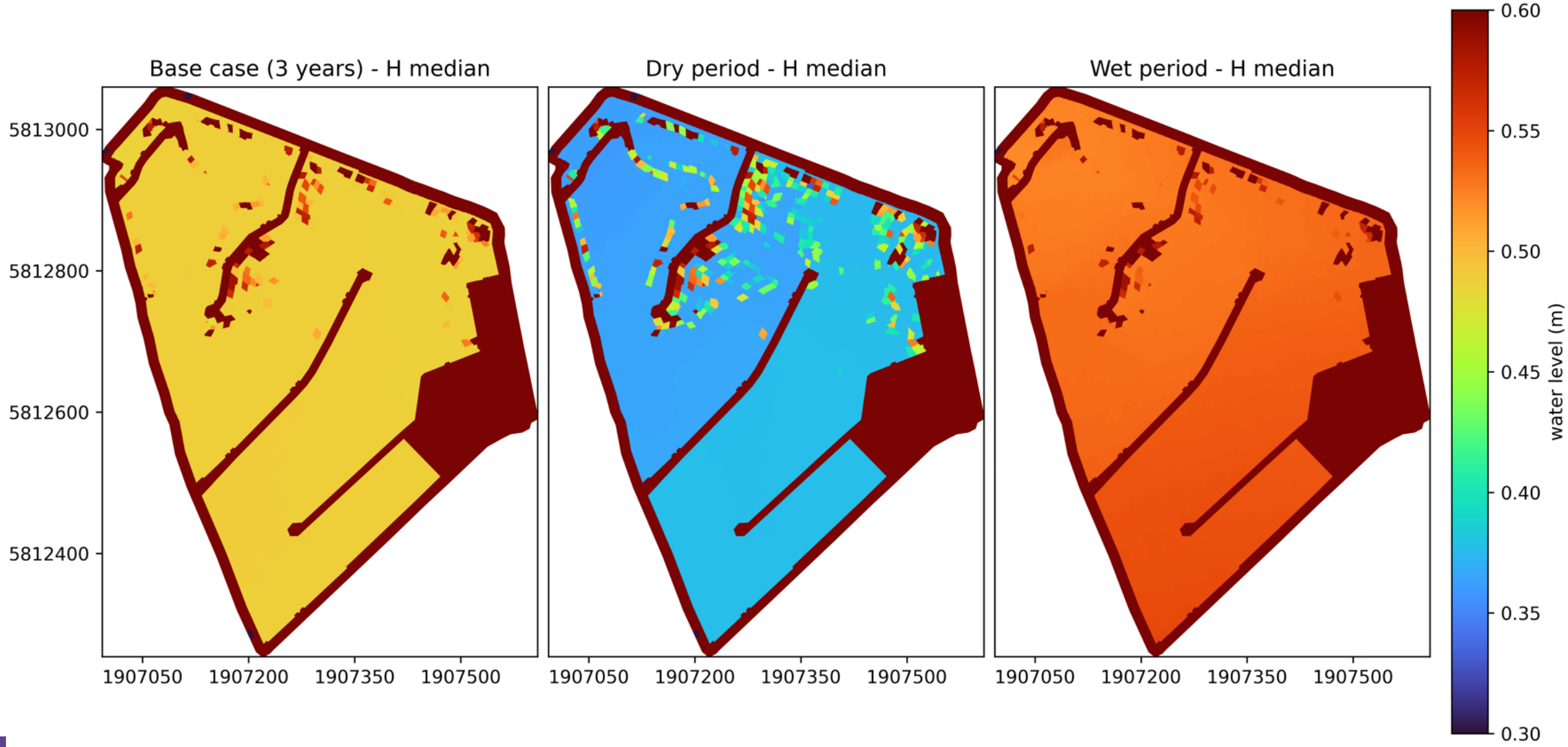
Flushing time



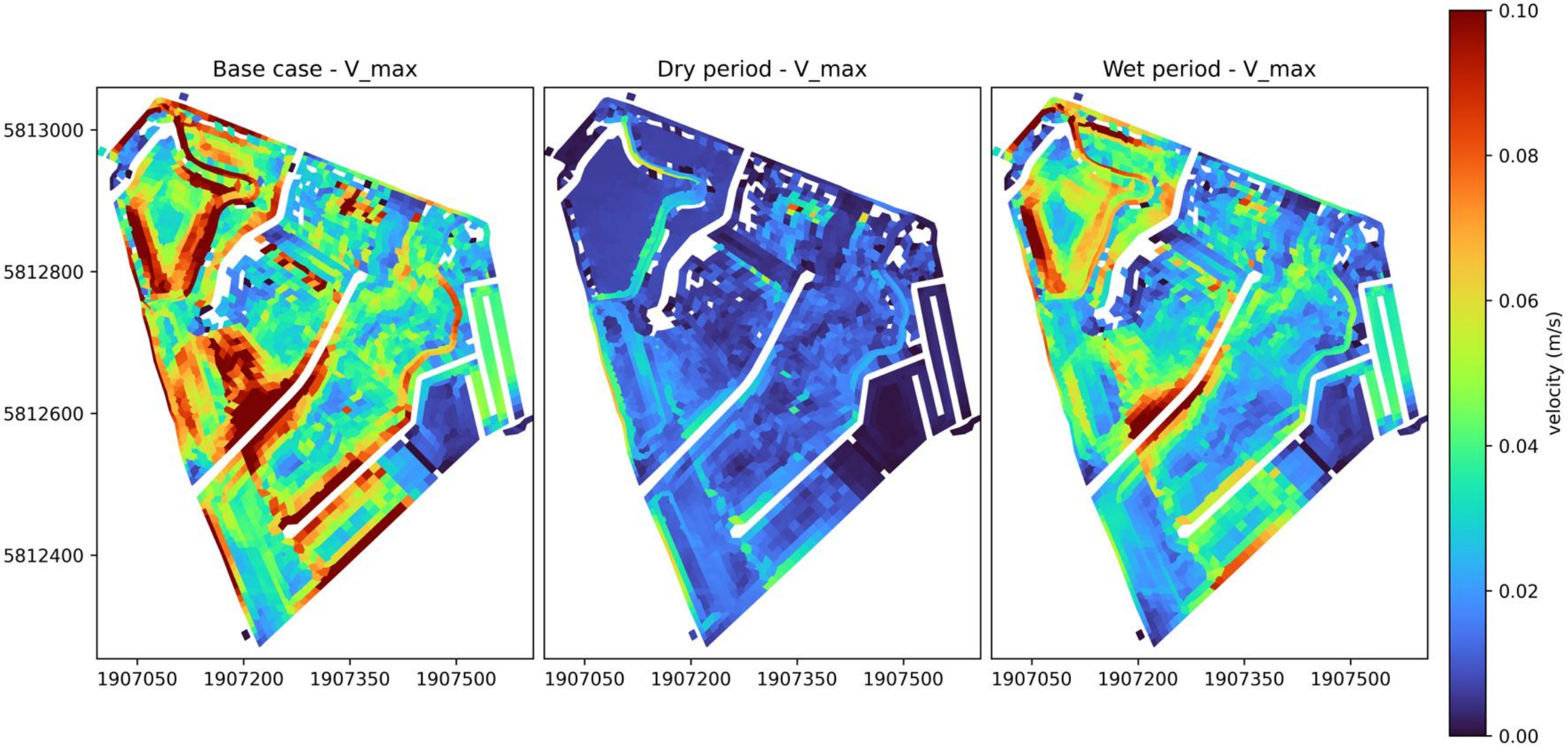
Flushing time by month



Median water levels



Max velocities



Example design findings

- LiDAR DEM 10% faster flushing than flat DEM, likely due to existing channels
- Primary driver of flushing rate is inlet pump volumes
- Outflow culvert generally does not change flushing but does reduce the PS10 load
- Roughness has minor impacts but worth including in model
- Climate has a significant impact on levels, which impacts inflow and outflow volumes
- Distance baffle to bund to be 75-100 m
- High velocities around area of higher topography need consideration in earthworks design, and are often wind driven
- Wetland guidelines helpful start and check, and 3D modelling great for the details and sensitivity testing

Under construction

BOPRC LinkedIn post

- Sunrise hui and karakia on 26 November 2024
- Project partners Toi Moana Bay of Plenty Regional Council and iwi collective Te Wahapū o Waihī broke ground
- The wetland is estimated to treat 5 million m^3 of contaminated catchment water annually and provides substantial habit for flora and fauna

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QUESTIONS