Optimising Autosampler Use for Enhanced Event-Based Monitoring and Decision-Making

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We acknowledge the Traditional Custodians of the land and water on which we work and recognise the continuing cultural and spiritual connections that Aboriginal and Torres Strait Islander People have to Country. We pay our respects to Elders past and present.

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Water Quality Monitoring

Monitoring approaches

Grab sampling: Snapshot of the status

Autosampler sampling: Event-based monitoring

Passive sampling: Time-average conc

Sensor: Real-time and high-resolution data

Autosampler use

Autosamplers are used to provide event-based data for water quality monitoring

- Autosamplers are **automated devices** used to collect water samples at set **intervals** or based on **specific events** – still need to collect water samples back for analysis
- Benefits: **improve sampling efficiency**, **reduce manual labor** and provide **high-resolution data over time**
- **Pollutograph** and **hydrograph** used for inflow events to determine the pollutant loads in the catchment
- Measurement:
  - **Physical** and **chemical** concentration of contaminants
  - **Biological** concentration of contaminants

Autosampler operation challenges

Data quality constraints

- **Remote sites** with access difficulty
- **Delayed sample collection** affects data integrity
- **Sample preservation** due to inconsistent refrigeration and power supply

Project lifecycle and long-term planning

- Asset installation for specific **short-term projects**
- **Lack of consistent framework** for autosampler operation decision-making
- **Limited long-term resourcing** and maintenance responsibilities

Sampling programming

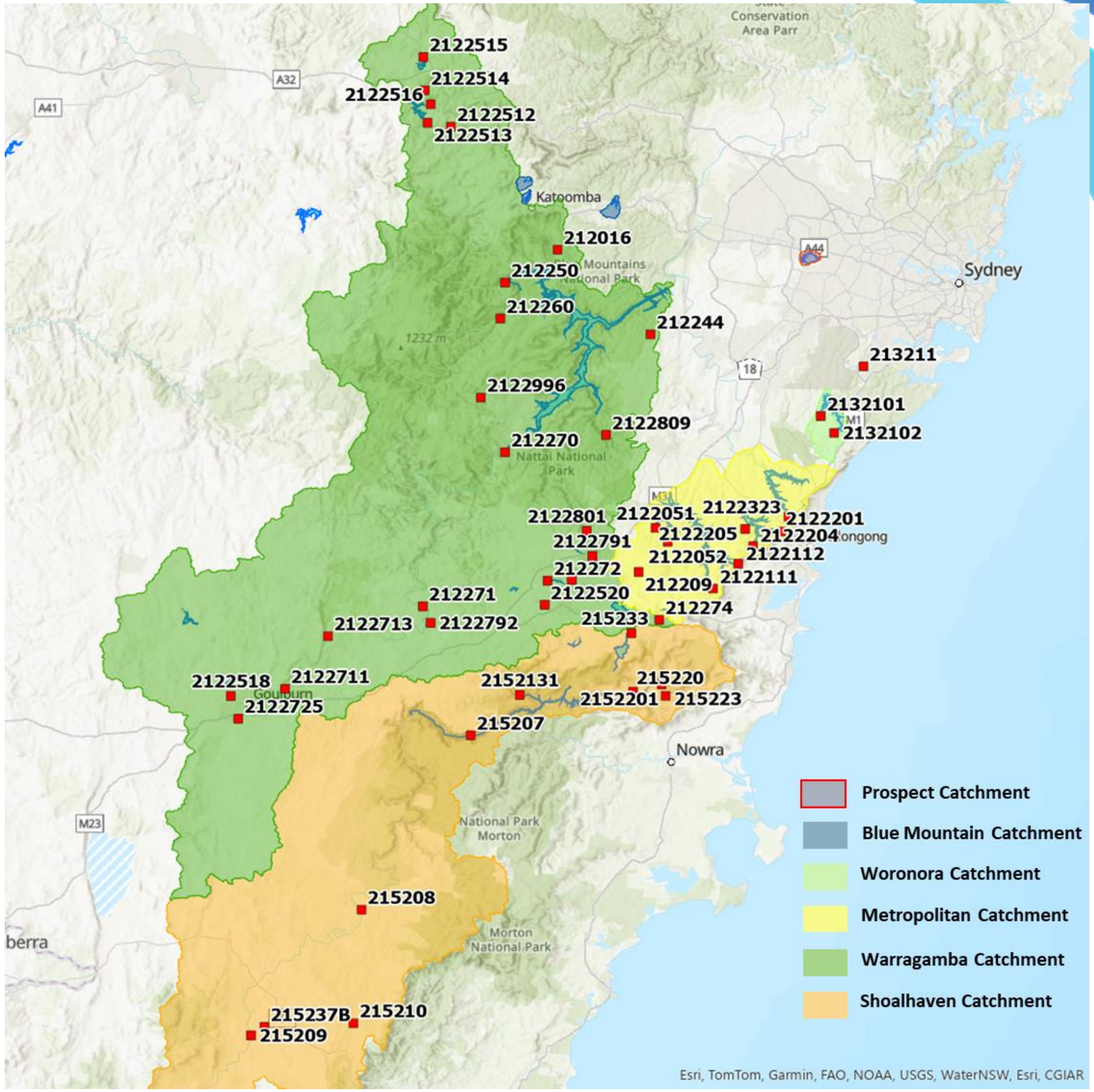
- **Pre-programmed sampling** may misalign with hydrographs – miss peaks of events
- **Outdated trigger thresholds** no longer match current hydrological condition

Data management

- WQ and flow data **alignment**
- **Pollutograph construction** limited by inconsistent sampling
- **Lack of data** for integrated analysis and pollutant load estimation

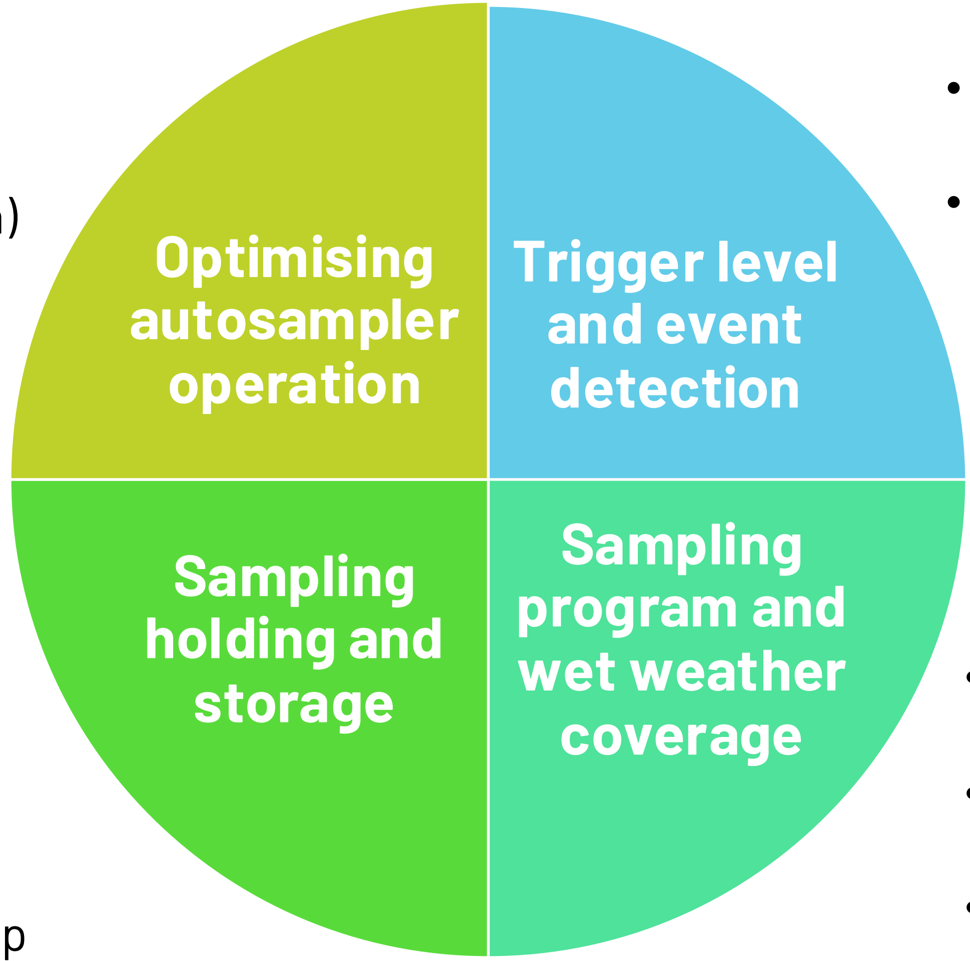
Autosampler deployment in WaterNSW

- **46 sites** across WaterNSW catchment
- Catchments:
  - Warragamba Catchment
  - Metropolitan Catchment
  - Woronora Catchment
  - Shoalhaven Catchment
- Monitored analytes:
  - Total organic carbon
  - Suspended solids
  - Nutrients (total nitrogen and phosphorus)
  - Metals (total aluminum, iron and manganese)
  - Microbial indicators (*Cryptosporidium* and *Giardia*)



Findings from literature

- Limited bottles
- Smart, modular units
- Prioritise high-value samples (e.g., first flush)
- Tailor setup



- Old fixed triggers often miss events
- Dual triggers (flow + level change)
- Balance trigger sensitivity

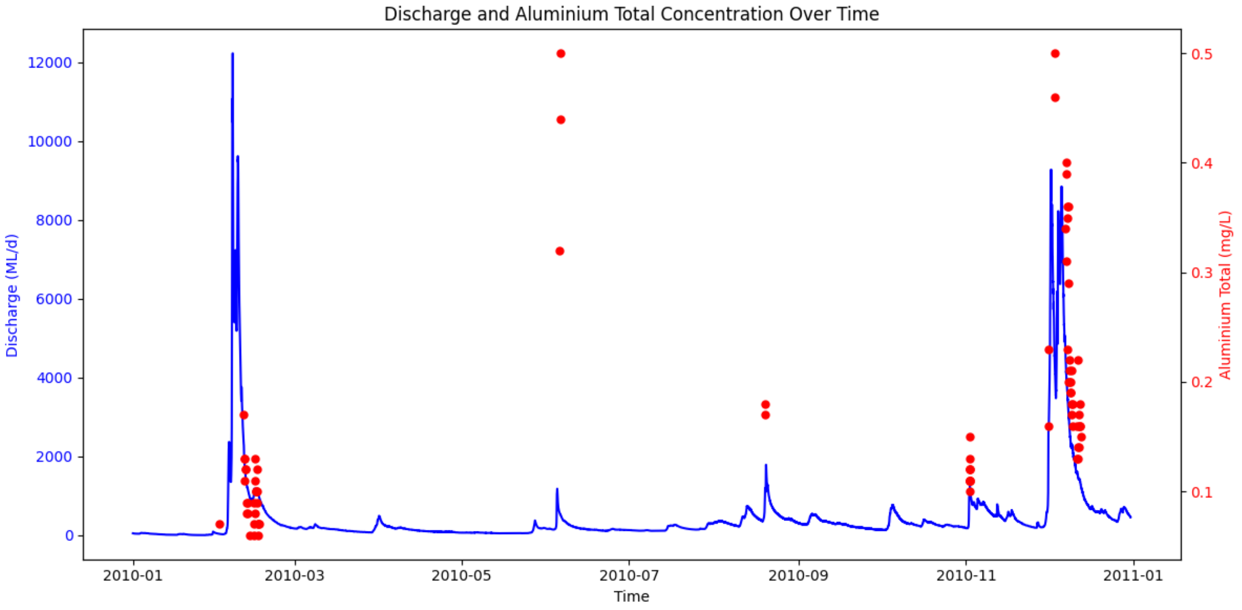
- Refrigeration and quick retrieval
- Nutrient and microbial data not for >24 hr
- Remote sites - need passive or sensor backup

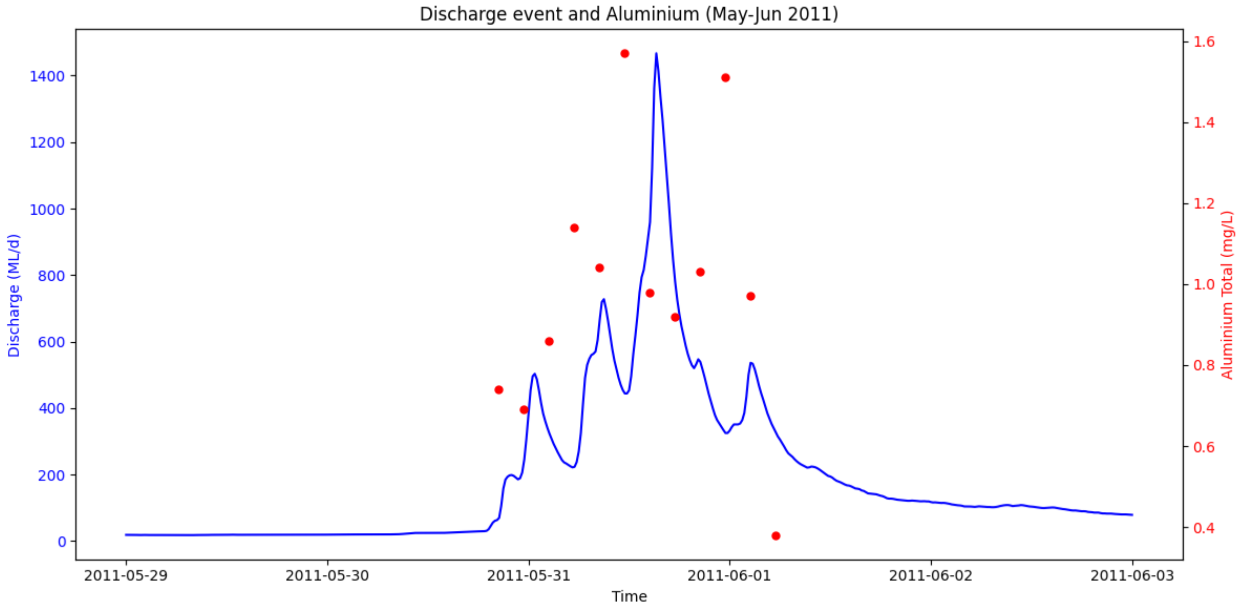
- Focus sampling on the rising limb
- Use adaptive or flexible schedules
- No single setup suits all

Case study – alignment with hydrograph

- Strong capacity to capture major high-flow events throughout the year
- Occasional lag in response compared to real-time flow changes

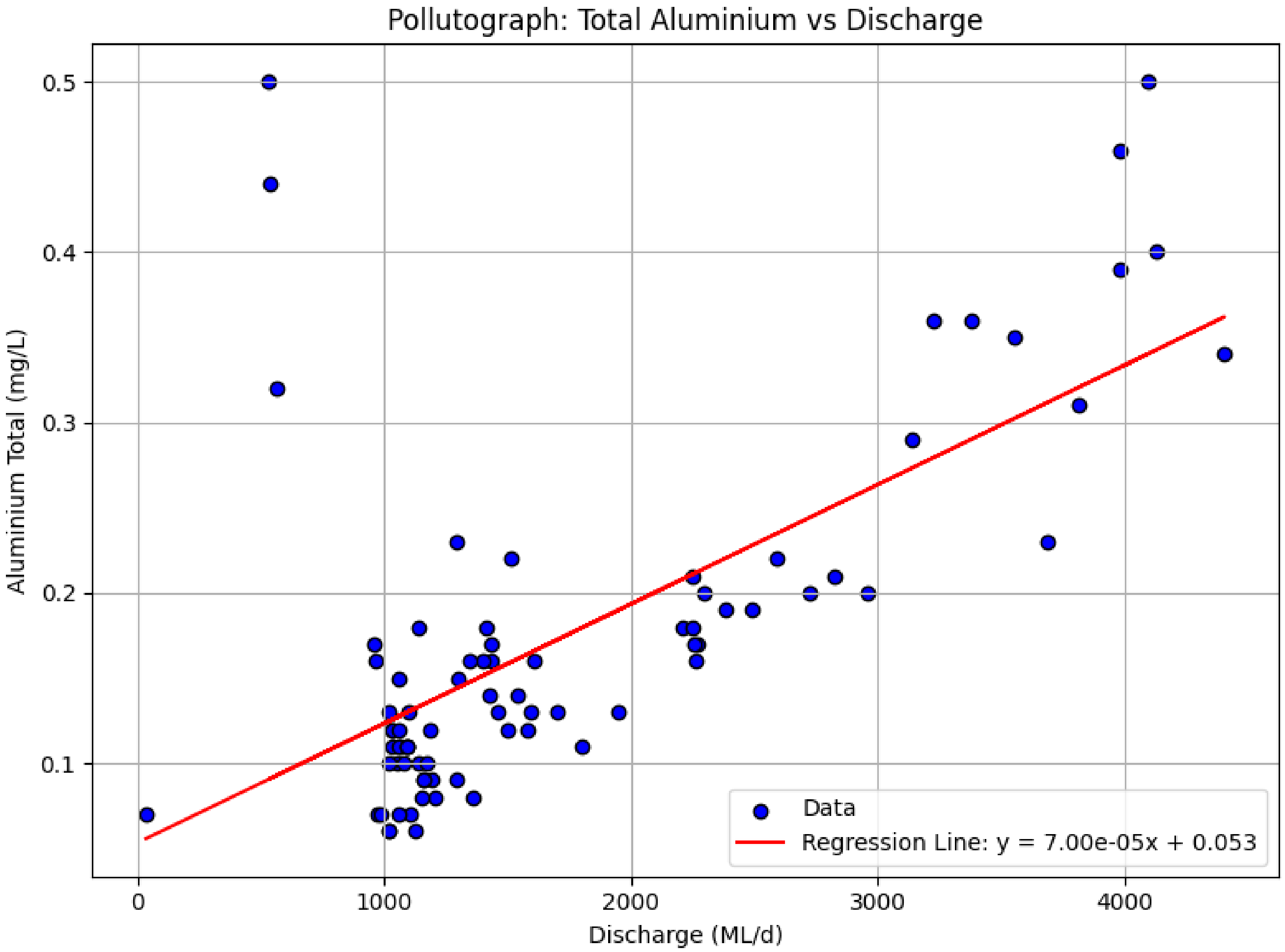
- Capable of capturing entire high-flow events
- Effectiveness depends on event duration and timing
- Shows good alignment with hydrograph behaviour





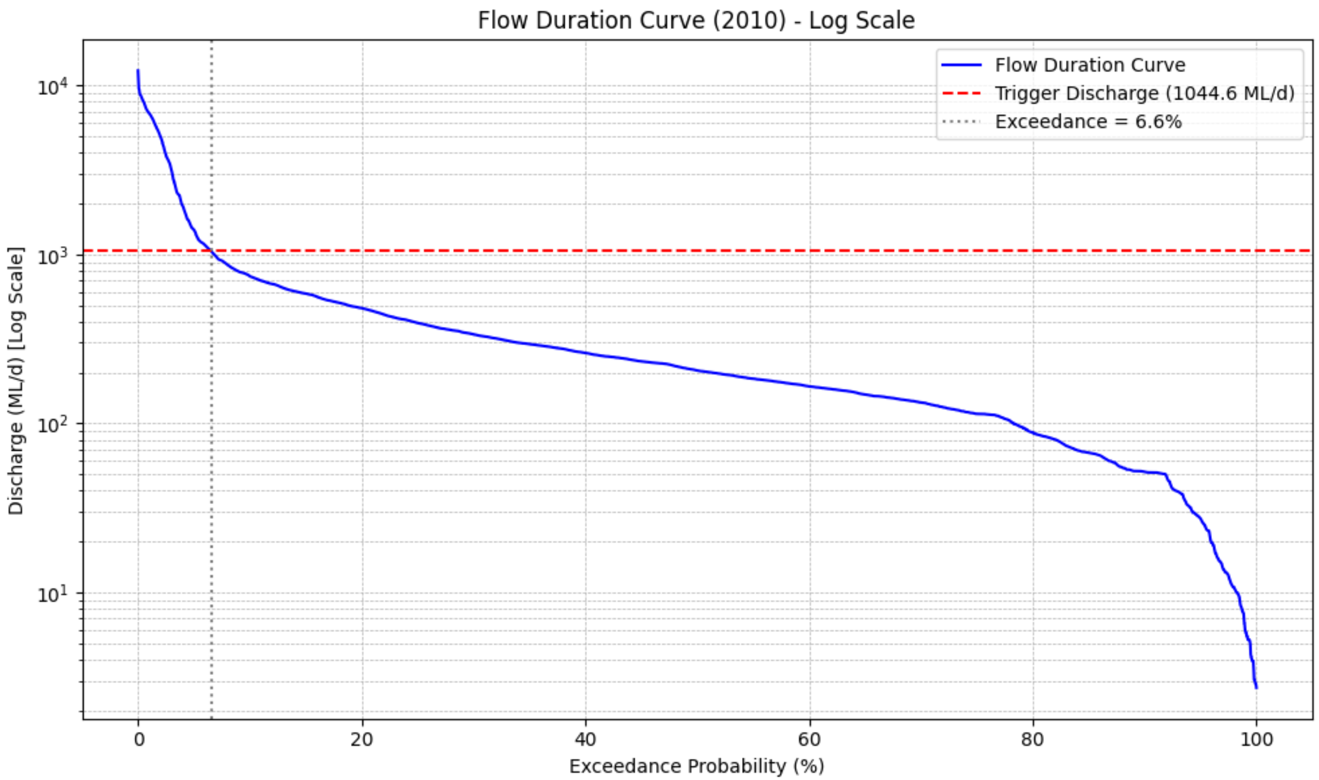
Case study – pollutograph for assessment

- **Autosamplers enable pollutographs** showing pollutant–flow relationships during storm events
- **Higher aluminium concentrations** occur at **higher discharge rates** – consistent with the first flush effect
- **Moderate positive correlation** between discharge and aluminium ($r \approx 0.65$)
- **Event-based data** provide insights for pollutant load modelling not achievable through grab sampling



Case study – flow duration curve

- Captures **rare**, **high-flow events** that transport most pollutants
- Enables **safe**, **event-based monitoring** beyond grab sampling limits
- **Trial load estimation** showed data gaps reduce accuracy
- **Machine learning methods** show promise for filling gaps and improving load estimates
- Better **autosampler performance** will strengthen model reliability and confidence



Stakeholder thinking

Data needs and priorities

- Event-based pollutant load data
- High-priority catchments
- Integrated datasets

Sampling and monitoring

- Calibration of trigger levels and QA/QC
- Capturing full storm profiles
- Extend sampling duration

Data application and value

- Critical for pollutant load estimation, catchment health assessment and modelling support
- Multi-tool analysis with sensor and passive sampler data

Future opportunities

- Technology integration
- Collaboration across teams and with external stakeholders

Technology implications

Current advances

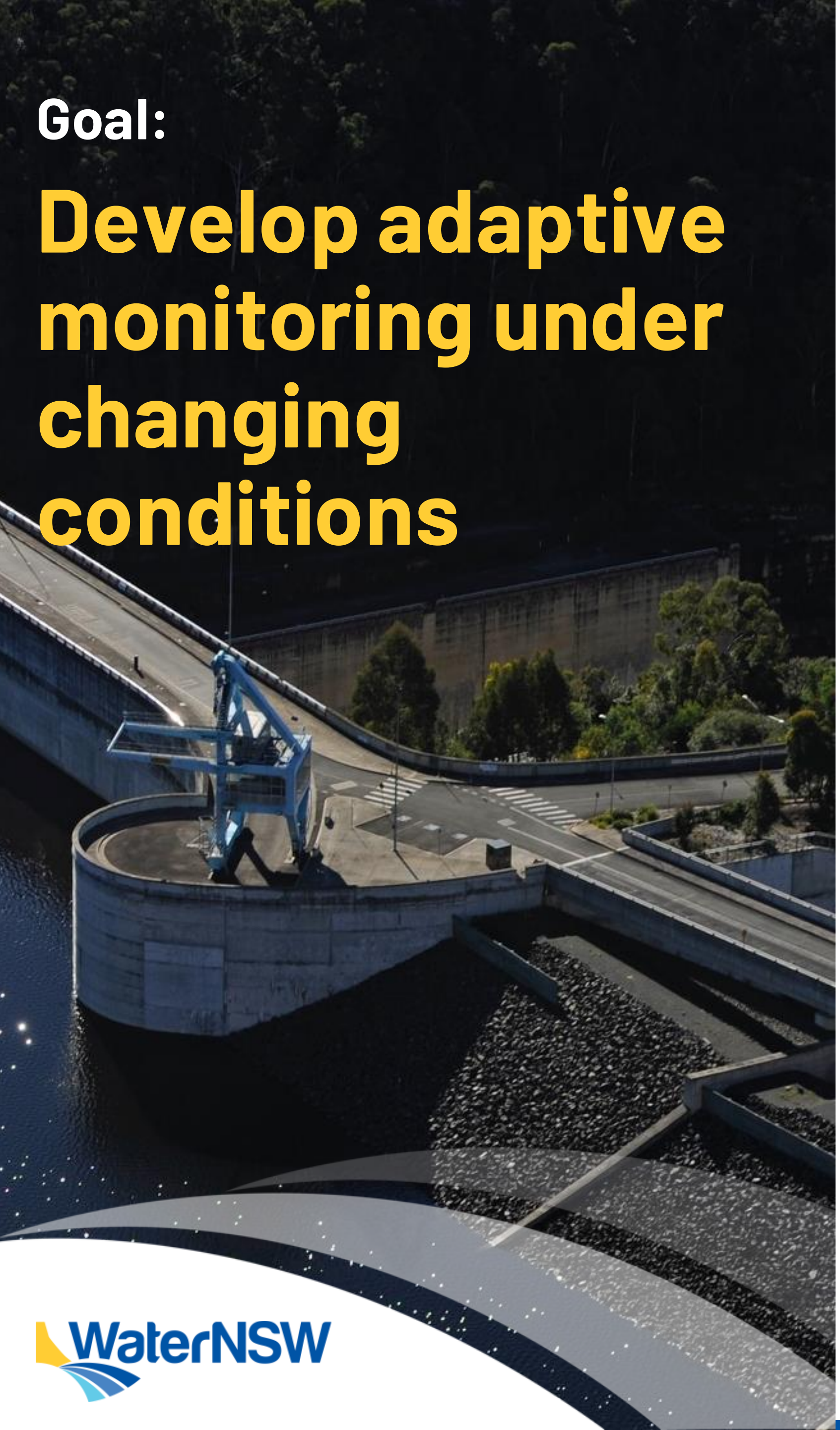
- Modern autosamplers now include **telemetry**, **cloud dashboards**, and **smart triggering**
- **Remote diagnostics** and **cooling systems** help optimise field visits.
- **Manual bottle retrieval** is still required for lab analysis.

In-situ sensing: role & limits

- Provides **real-time, continuous** data (e.g., turbidity, pH, DO, nitrate)
- **No sensors** yet for **key analytes** (metals, nutrients, pathogens)
- **Surrogate measures** (e.g., turbidity) are **site-specific** and not always reliable
- **Sensor drift**, **fouling**, and **power issues** limit long-term deployment

Future directions

- **Use sensors as smart triggers** to capture peak events efficiently.
- **Prioritise key analytes** and develop robust surrogates to reduce lab dependency.
- Adopt a **hybrid monitoring strategy** combining autosamplers, sensors, and passive samplers.



Goal:

Develop adaptive monitoring under changing conditions

Key recommendations:

- Adopt a **hybrid monitoring framework** combining autosamplers, sensors, and passive samplers
- **Prioritise deployment sites** using risk-based spatial analysis (e.g., MCAS-S)
- Refine trigger logic with **sensor-assisted activation** for better event capture
- Strengthen **governance and resourcing** for safe access, maintenance, and calibration
- Integrate **flow and water-quality data** with consistent **QA/QC** protocols
- Explore **new technologies** such as machine learning and portable automated systems

Thank you!

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