On-site Wastewater Management Training Course

Failing Systems; Tracers and Source Tracking

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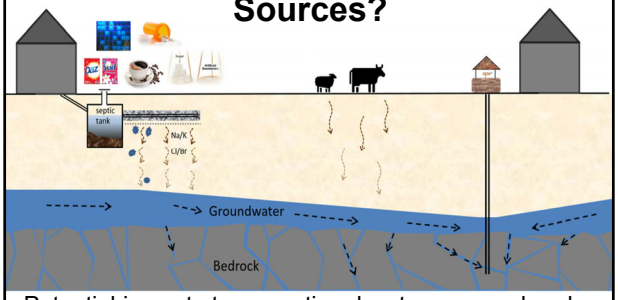
Why Track Domestic Effluent Sources?



Potential impacts to recreational waters, ground and surface water quality, aquaculture and public health if systems fail and water contaminated

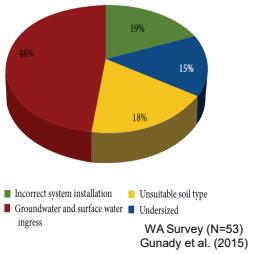
System Performance

- Research over the last 30 years suggests that many on-site wastewater systems perform poorly and may fail periodically

- Failure is when the system does not achieve the performance expected (based on its specifications) and an unacceptable level of contaminants is released via groundwater or surface pathways to receiving waters

Failing Systems

- System failures may be due to:
  - poor installation
  - hydraulic under-design
  - unsuitable soils
  - groundwater contact
  - surface water ingress
  - age



WA Survey (N=53)
Gunady et al. (2015)

- If large numbers fail at the same time, why are there not more public health impacts?
- Evidence for major off-site impacts is harder and more expensive to obtain at the catchment scale

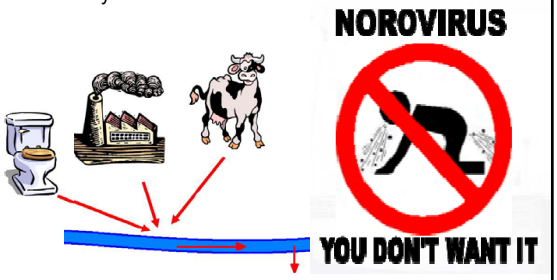
Water Quality Indicators

- Many physico/chemical parameters are not definitive of faecal contamination
- Microorganisms used as indicators are water transmissible pathogens such as *coliform bacteria*
- FIB (faecal indicator bacteria) typically used include faecal coliforms, *Escherichia coli, Enterococcus* spp.

Most FIB cannot be used to directly determine source of contamination or distinguish between humans and animals

Whose FC is it? Does it Matter?

Important to know whose faecal bacteria is in our surface and groundwaters and the contribution from domestic wastewater systems

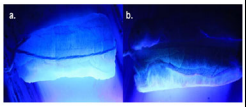


Possible Tracers

- Use compounds which are often unique and only present in domestic wastewaters
- May be either bi-products of human metabolism or those added such as those in food, detergent chemicals and human pharmaceuticals
- Examples include personal care product compounds, such as in toothpaste, artificial sweeteners, endocrine disrupting compounds, caffeine and faecal sterols

Optical Brighteners
(Fluorescent Whitening Compounds)

- Optical brighteners present in washing powders fluoresce
- Added to adsorb to fabrics and brighten clothing by fluorescing when exposed to ultraviolet light
- Absorb radiation in 360nm wavelength range and re-emit it as blue fluorescent light at approximately 430nm
- Typical industry guide for formulating laundry products would give a recommended dose of approx. 0.2% (w/w)
- Non-toxic



Possible Interpretation of FC/FWC Results

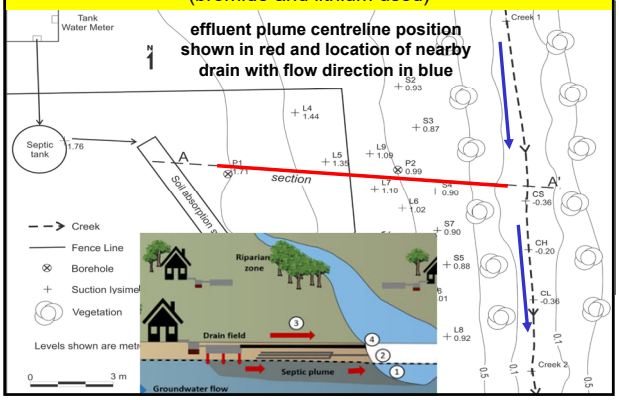
Faecal bacteria numbers	FWC concentration	Likely cause
High	High	Failing on-site septic systems or leaking sewer pipe
High	Low	Waste from human or animal or other warm-blooded animals
Low	High	Grey water in storm water system
Low	Low	No evidence of faecal contamination

Likely cause of faecal contamination when certain numbers of faecal bacteria and levels of FWCs are observed

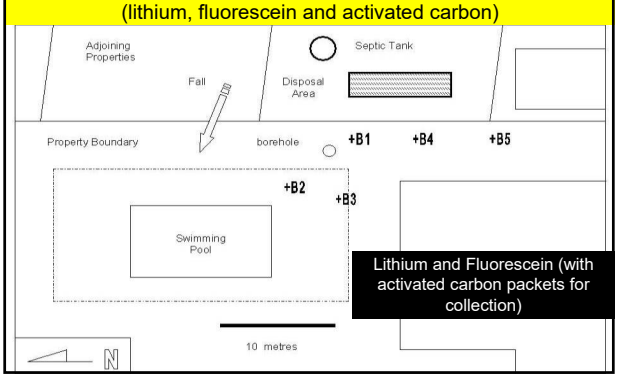
Added Tracers

- Conservative inorganic compounds can be added e.g. potassium bromide, lithium chloride
- Fluorescent dyes can be added e.g. sodium fluorescein, pyranine, eosin, rhodamine B and WT
- Dyes are of low toxicity, water soluble, easy to detect, readily available and low cost
- Can use visual inspection or instrumental methods such as UV light, fluorimeter or spectrophotometer for determination
- Activated carbon packets for fluorescein can be used for collection

Example of Added Chemical Tracer
(bromide and lithium used)



Example of Added Chemical & Fluorescing Tracer
(lithium, fluorescein and activated carbon)



Lithium and Fluorescein (with activated carbon packets for collection)

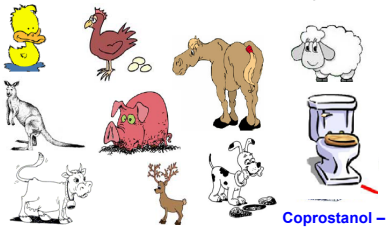
Faecal Source Tracking (FST)

A set of methods used to determine the host (different animals or human) that contributes faecal pollution to a variety of water bodies. Determining the origin of faecal contamination through the use of biological and chemical analytical methods.

Faecal Sterols

Used to differentiate between human and animal sources of faecal contamination in waters and sediments. Bacterial conversion of sterol compounds in fatty acids in digestive tract of mammals results in cholesterol breakdown to coprostanol in humans.

Biohydrogenation of Cholesterol by Gut Bacteria



24-Ethylcoprostanol – Abundant in Herbivore Faeces

Cholesterol – Abundant in Dogs and Birds Faeces

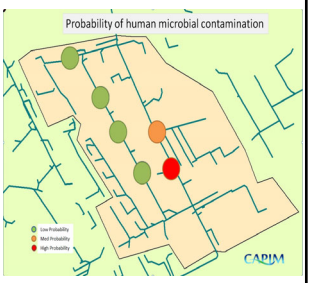
Coprostanol – Abundant in Human Faeces

Catchment Scale Source Tracking

Wastewater Systems Implicated in Contamination of Oysters – NSW Coast

Combined Chemical and Bacterial Methods

- Ammonia passive samplers to identify high-risk sub-catchments
- DNA testing (via Quantitative PCR) to test for human faecal pollution
- Conventional (grab) samples for *E.Coli*
- Ammonia test kits used as quick indicators of human microbial contamination



Review

- Is there a need to determine if wastewater systems are failing and may be impacting water quality and public health?
- Is flow likely to be surface or subsurface?
- Is there a need to monitor and obtain quantitative evidence of failure?
- Choice of tracer will depend upon whether the application proposed is at the individual lot or catchment scale
- Need to consider cost and likely outcomes which will depend on tracer properties, its behaviour and scale of application

Remember: the greener grass on the other side of the fence is not always better…..it may be due to a septic tank issue!