

# Examples of SSP concepts applied in low rainfall climate sewage

California



Australia



# Learning Point 1

## Microbial health-based targets

- California (aligned to USEPA)
  - $10^{-4}$  **infections** per person-year
    - One infection
    - Per year
    - Per ten thousand exposed people
- Australia (aligned to WHO)
  - $10^{-6}$  **disability-adjusted life years** per person-year
    - One disability-adjusted life year lost
    - Per year
    - Per million exposed people

### DALY

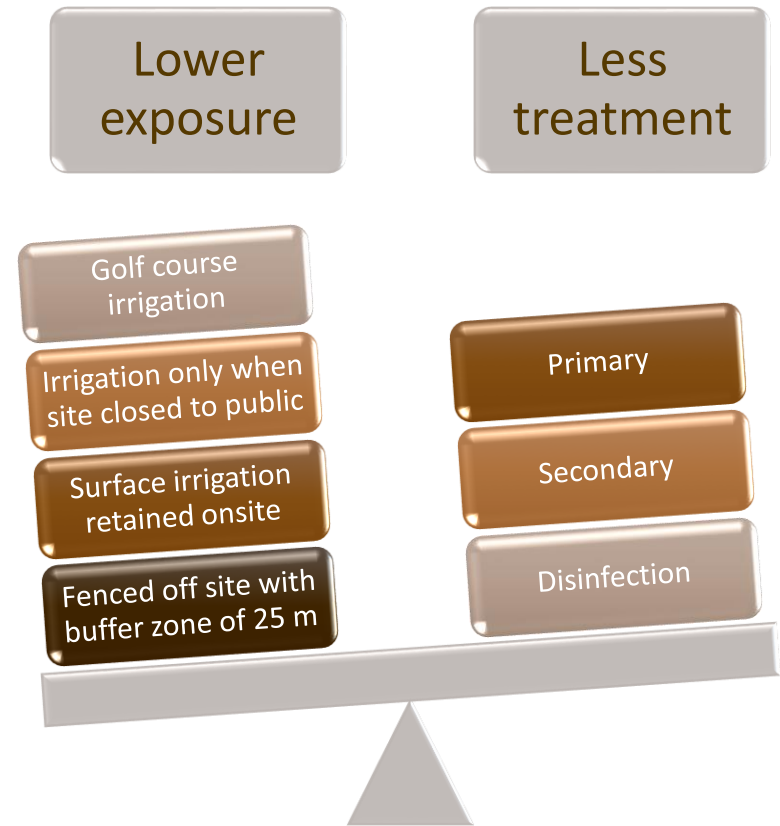
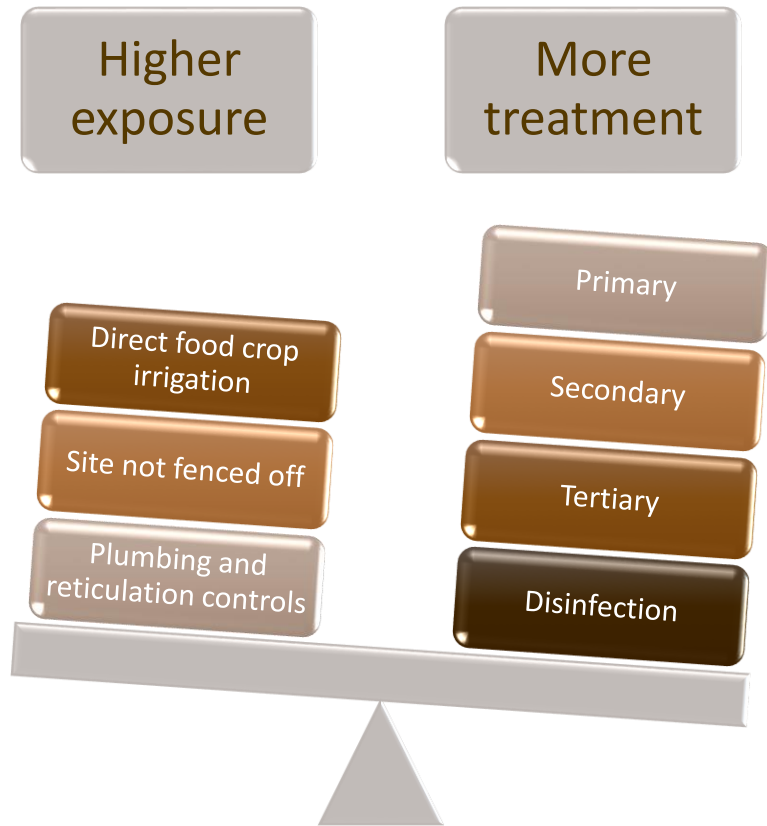
Disability Adjusted Life Year is a measure of overall disease burden, expressed as the cumulative number of years lost due to ill-health, disability or early death

$$= \text{YLD} + \text{YLL}$$

Years Lived with Disability + Years of Life Lost



# Learning point 2: Matching treatment to exposure for optimal benefit:cost



# Typical Control measures

- California (2018) and Australia (2006)
  - Source control
    - Categories of waste
    - Acceptance criteria]
  - Treatment
    - Secondary
    - [Filtration]
    - [Disinfection]
  - Use restrictions
    - Exposure
    - Signage
    - Livestock type
    - Crop type
    - Purple pipes
    - Plumbing controls



# Operational monitoring

- California (2018) and Australia (2006)
  - Online continuous treatment process monitoring
    - Flow rates
    - Dosing systems
    - Turbidity
    - Chlorine
  - Periodic user monitoring
    - Water meters
    - Site inspections



# Process performance targets for unrestricted irrigation water

- California (2018)
  - Technology: Secondary followed by filtration (coagulation with media or membranes)
  - Operational monitoring targets:
    - Filtration
      - Media: 2 (max 10) NTU
      - Membrane: 0.2 (max 0.5) NTU
    - Disinfection
      - $\geq 450$  chlorine mg•min/L with  $\geq 90$  min contact time
      - [or 5- $\log_{10}$  validated reduction of viruses (coliphage or poliovirus)]
  - Verification targets: Total coliforms median  $< 2.2$  (max  $< 240$ ) per 100 mL
- Australia (2006)
  - Technology: Secondary followed by filtration (coagulation with media or membranes) and disinfection validated to:
    - 5- $\log_{10}$  reduction of viruses
    - 3.5- $\log_{10}$  reduction of protozoa
    - 4.0- $\log_{10}$  reduction of bacteria
    - 4- $\log_{10}$  reduction of helminth ova
  - Verification targets: *E. coli* median  $< 1$  per 100 mL

# Process performance targets for restricted irrigation water

- California (2018)

- Technology: Secondary followed by disinfection
- Exposure restrictions
  - No public access during irrigation
  - Drift and spray controls
  - No contact with edible parts of crops
- Verification targets:
  - Total coliforms median < 23 (max < 240) per 100 mL



- Australia (2006)

- Technology: Secondary followed by disinfection
- Exposure restrictions
  - No public access during irrigation
  - Drift and spray controls
  - No contact with edible parts of crops
- Verification targets:
  - *E. coli* median < 100 per 100 mL

# Additional considerations

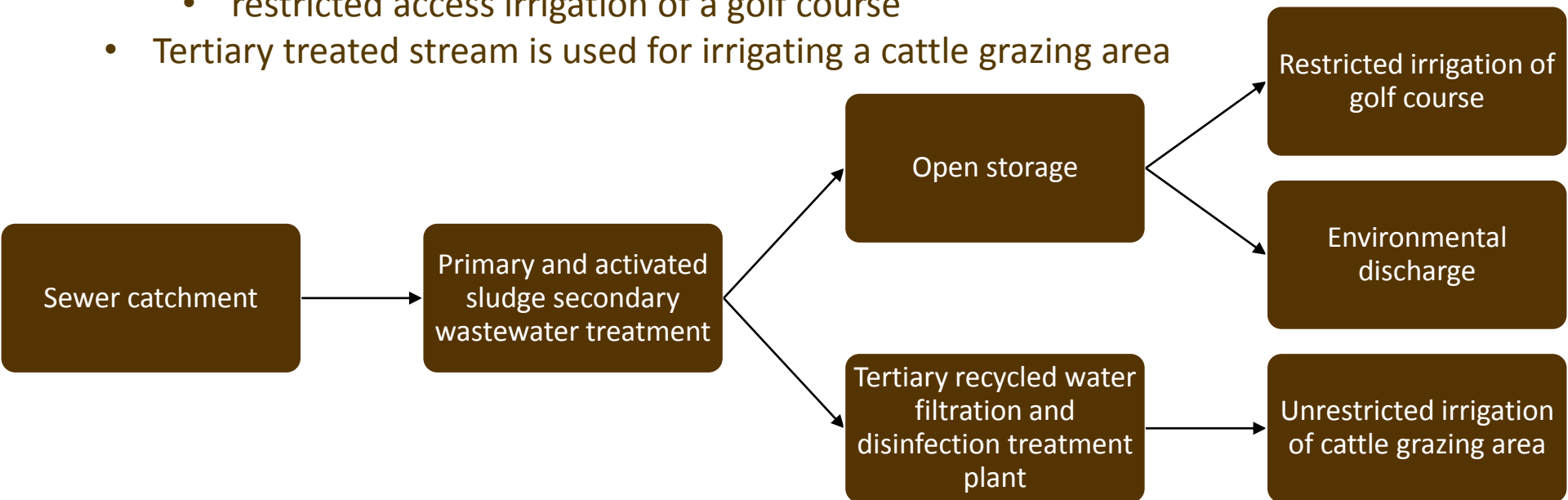
- Common additional hazards of significance
  - Salinisation of soils
  - Nitrates and impacts on drinking water
  - Boron impacting some crops
  - Chlorine residual impacting aquatic life
- Common additional hazardous events of significance
  - Plumbing cross-connections and drinking from taps
  - Leakage from reticulation and irrigation
  - Over-irrigation leading to runoff and forming vector habitat
  - Cyanobacteria in open recycled water storages
- Emerging concerns
  - Persistent organic pollutants such as PFAS



# Interactive Workshop

## System Description and flow diagram

- Conventional urban sewerage system
- Treatment divided into two streams:
  - Secondary treated stream goes via two flow pathways
    - environmental discharge
    - restricted access irrigation of a golf course
  - Tertiary treated stream is used for irrigating a cattle grazing area



- Questions:
  - What other information is needed to assess risk?
  - What information is needed to ensure monitoring is adequate?



# Interactive Workshop

## Risk Assessment



Step	Hazardous event	Hazard	Control measures	Likelihood	Severity	Risk	Improvement actions
Sewer catchment	Illegal inputs contaminate reuse water	PFAS	Acceptance criteria on sewer connections	2	4	8 (M)	Undertake quarterly testing
Sewer catchment	Zoonotic disease transferred to cattle	Helminths	Tertiary <b>filtration</b>	?	?	?	?
Open storage	Proliferation of cyanobacteria	Cyanotoxins	<b>None</b>	?	?	?	?
Golf course	Timers fail and irrigation occurs during playing hours	Pathogens	Mains power time clock with <b>no battery backup</b>	?	?	?	?
Etc...							

# Interactive Workshop

## Process Control and Operational Monitoring



Step	Control measure	Target criteria	Operational monitoring	Corrective actions	Improvement actions
f	Acceptance criteria on sewer connections	Compliance with agreement	Regular inspection of high-risk customer connections	Issue compliance order to enforce compliance	Install online analysers at high-risk connections such as metal processing facility
Secondary wastewater treatment	Activated sludge process with biological nutrient removal	Ammonia < 3 mg/L	<b>Weekly grab</b> samples	Do not supply recycled water to tertiary plant	?
Tertiary filtration treatment	Coagulation and media filtration	Turbidity < 2 NTU	Online monitoring	<b>Advisory to</b> farmer that process has failed	?
Golf course	Irrigation restricted by timers	Only irrigate during periods where nobody is playing	<b>Annual</b> check on timer settings	Restore correct timer settings	?
Etc...					

# Interactive Workshop

## Verification Monitoring



Step	Parameter	Specifications	Frequency	Statistic	Corrective action
Treated water to restricted golf course irrigation area	<i>E. coli</i>	< 1,000 MPN or CFU per 100 mL	Weekly	Rolling annual median with no more than two exceedance in series	Divert all flow to environmental discharge until compliance is restored for two sequential samples
Treated water to unrestricted cattle grazing area	<i>E. coli</i>	< ? MPN or CFU per 100 mL	Weekly	Rolling annual median with no more than two exceedance in series	?
Treated water to unrestricted cattle grazing area	Helminth ova	< 1 helminth egg L	?	?	?
Etc...					

# Supporting programs

- Formal agreements
  - with connected high-risk sewer dischargers
  - ?
- Procedures
  - for operational monitoring treatment systems
  - ?
- Auditing
  - golf course and farm site to check against agreements
  - ?