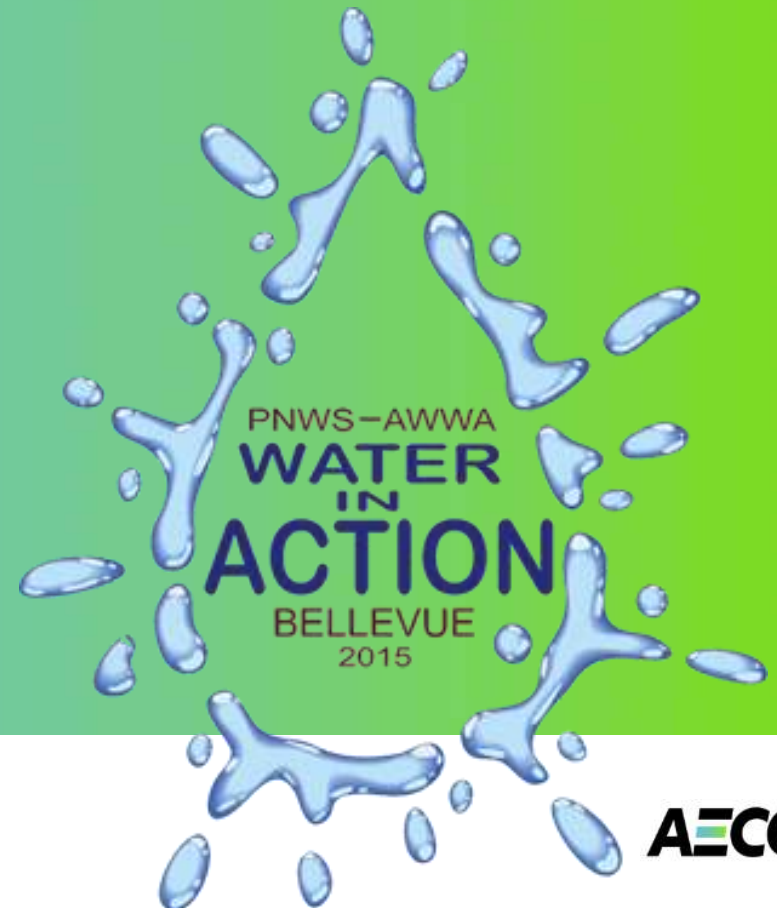


Guideline Development for Managing Microbial Water Quality in Healthcare Facility Potable Water Distribution Systems

Alex Mofidi PE

AECOM Director

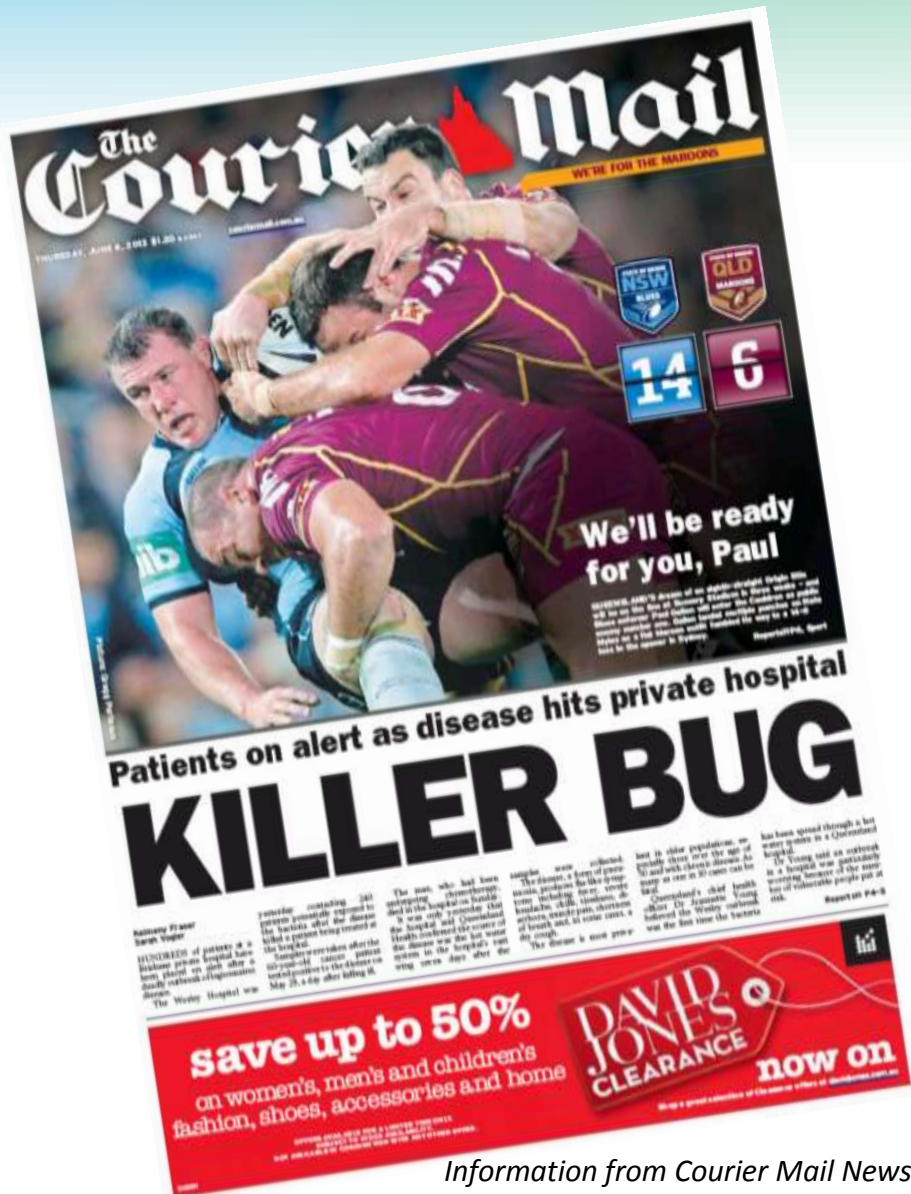


Discussion



- ❑ State / Water System Background
 - » What happened?
 - » Where did it happen?
 - » Background (water quality system planning)
- ❑ Healthcare Guideline Development
 - » Event and information gathering
 - » Hazard condition assessment process
 - » Issuance of public health Guideline
- ❑ Guideline Implementation and Case Study
- ❑ Summary

Event: June 2013



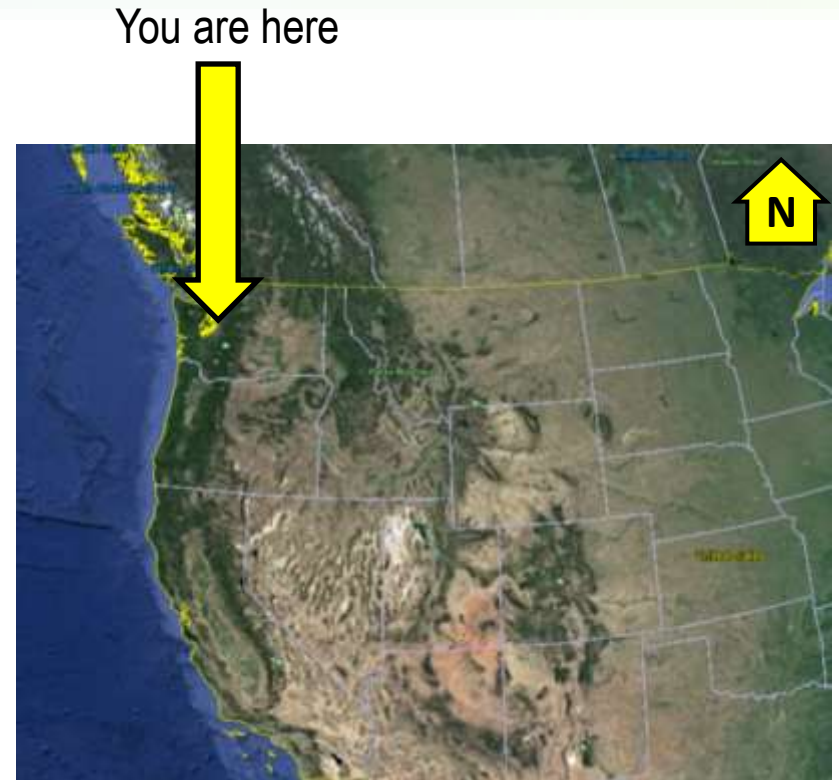
Information from Courier Mail Newspaper

- Brisbane QLD Hospital
- Legionellosis Outbreak, June 2013
 - » Route: Shower steam inhalation
 - » Shut down
 - » Remediation
 - » Re-open after 'all-clear'
- State Healthcare Guideline

Background: Location, Location....

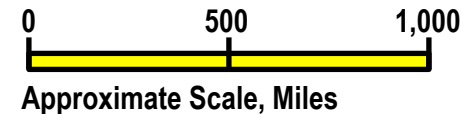


□ Queensland, AUS



» 1.85 million km² (715,000 mi²)

» 4 million people

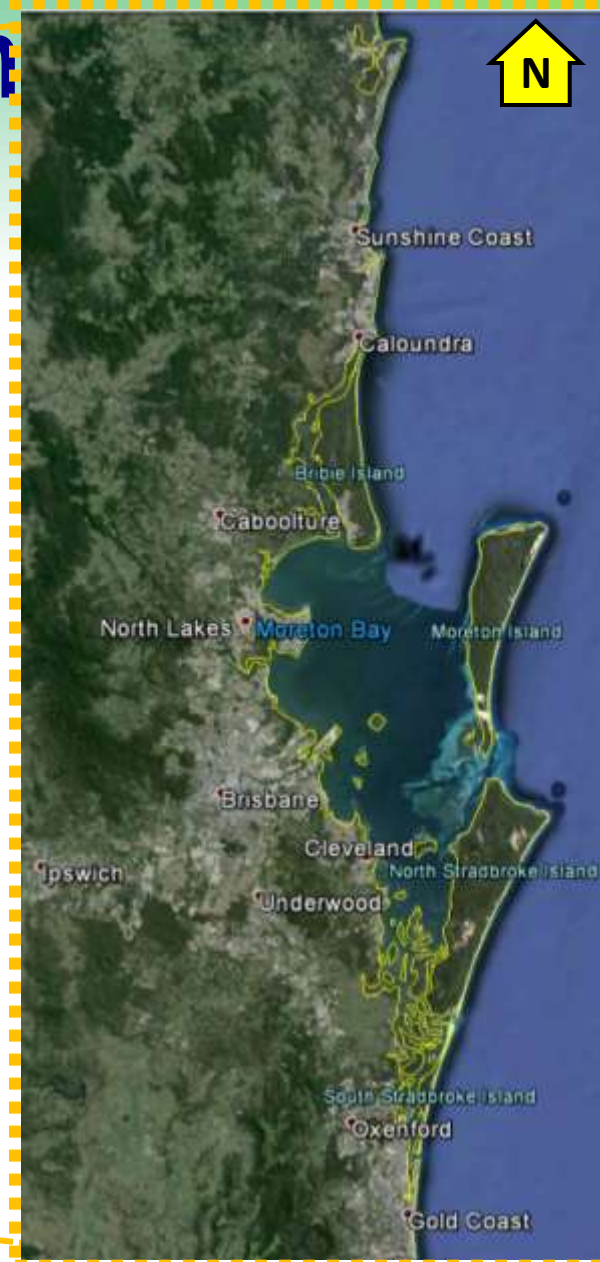


Background: Location

□ Queensland, AUS



□ South East QLD
» 3 million people



~200 Km
(125 mi)

~80 Km (50 mi)



Background: Location, Location....



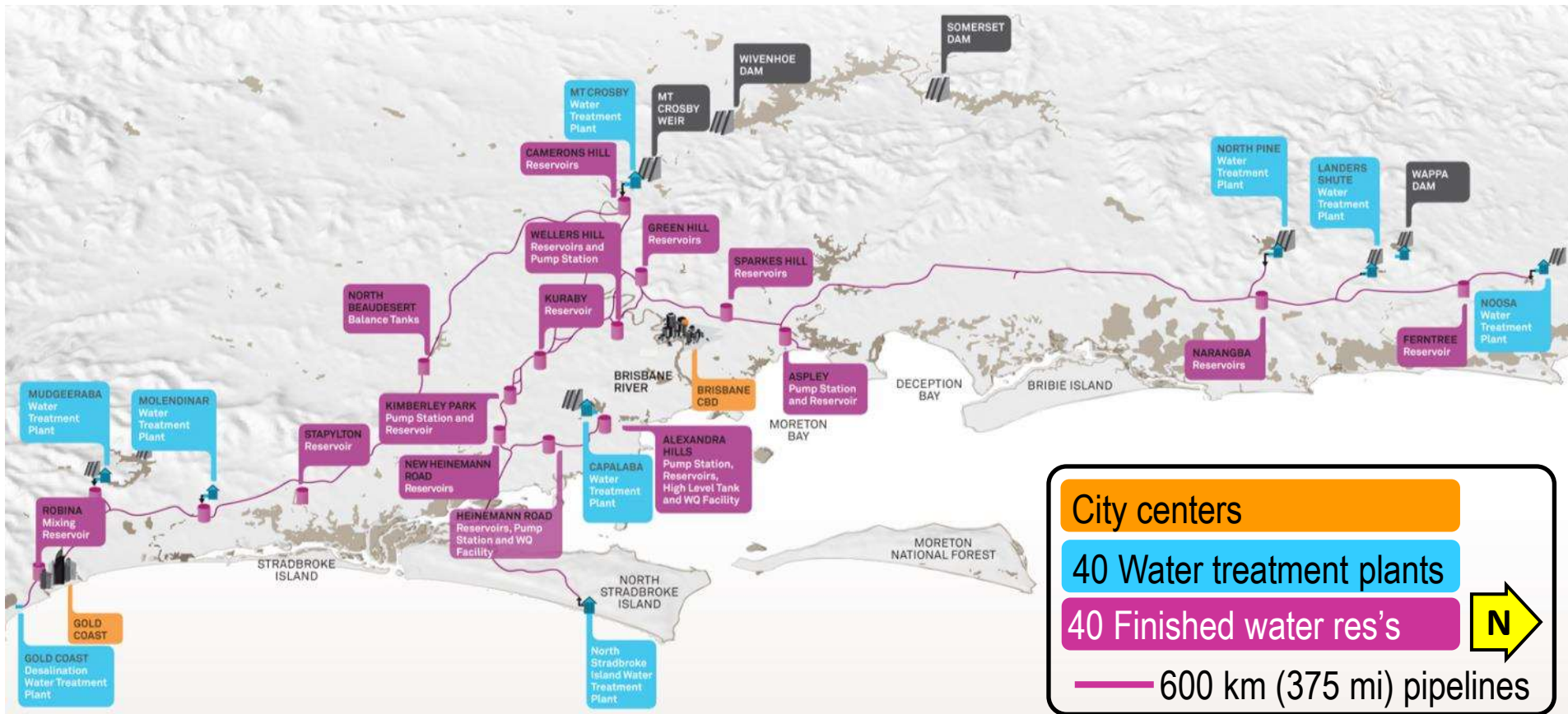
□ South East Queensland



Background: Location, Location....



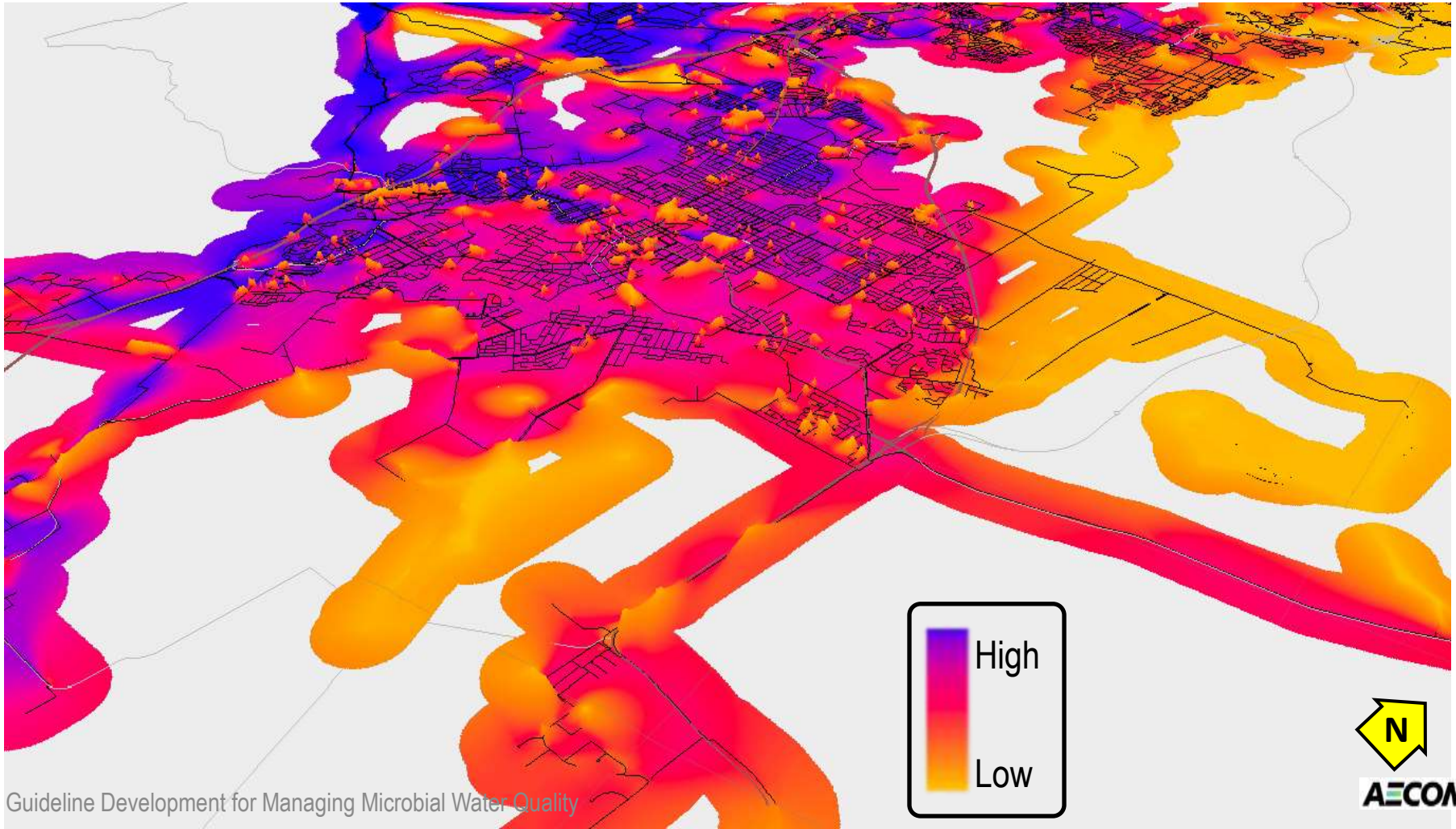
□ South East Queensland Water Grid



Water Quality Setting: Condition



□ Disinfectant Residual



Water Quality Setting: Improvements

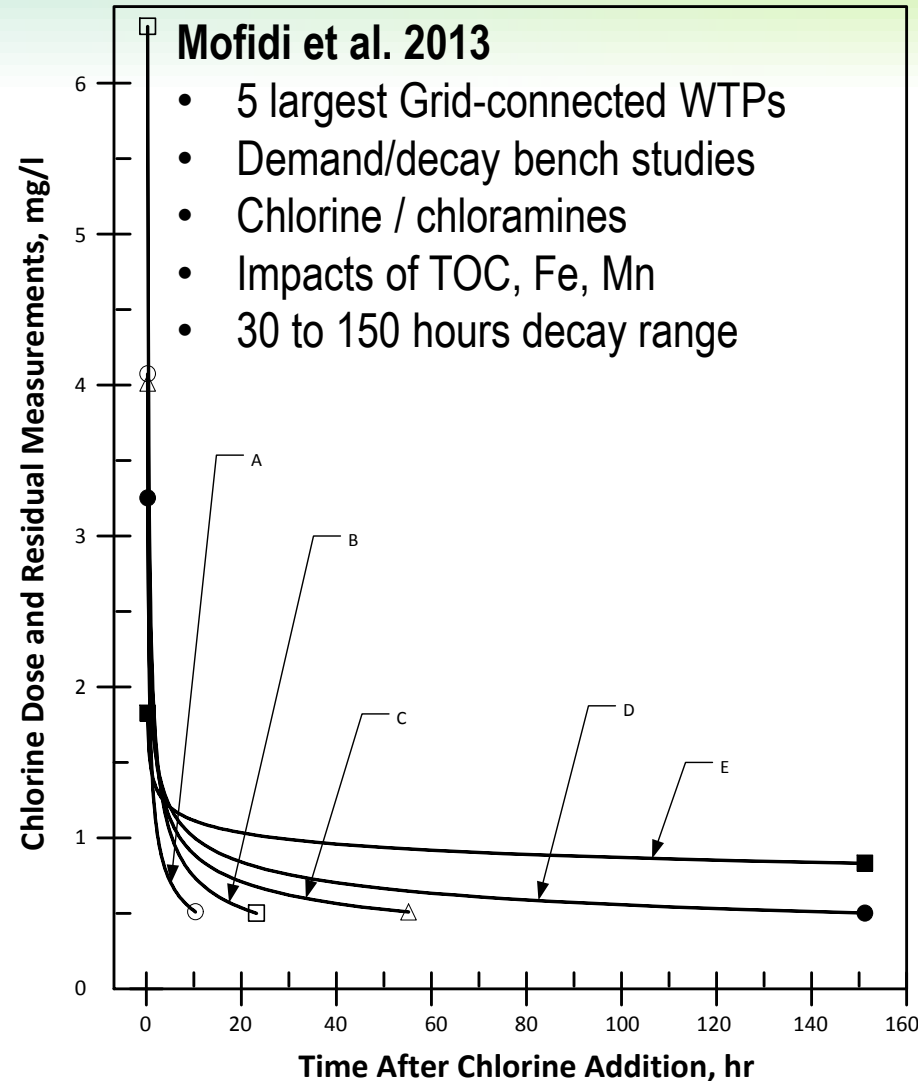


□ SEQ Water Supply

- » Multiple inputs
- » Complex mix of chlorine and chloramines

□ Quality Planning

- » 2012: Treatment



Water Quality Setting: Improvements



□ SEQ Water Supply

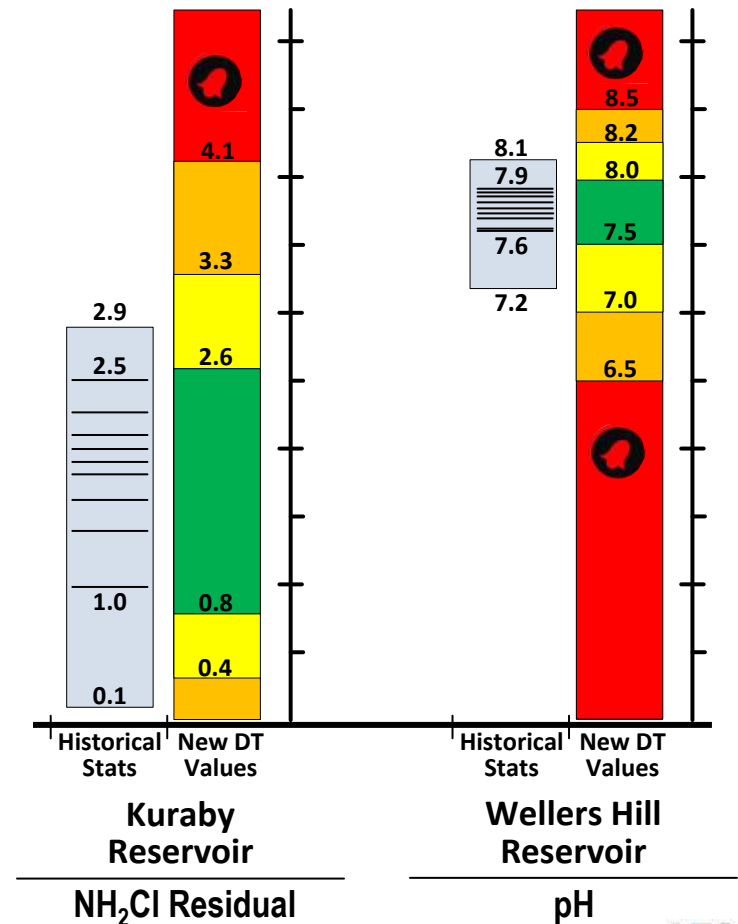
- » Multiple inputs
- » Complex mix of chlorine and chloramines

□ Quality Planning

- » 2012: Treatment
- » 2013: Distribution

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- Bulk delivery pipelines & reservoirs
- Breakpoint chlorination facilities
- Cl₂, NH₂Cl, pH, flow, age, SUVA



Water Quality Setting: Improvements



□ SEQ Water Supply

- » Multiple inputs
- » Complex mix of chlorine and chloramines

□ Quality Planning

- » 2012: Treatment
- » 2013: Distribution
- » 2013: Storage

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- Bulk delivery pipelines & reservoirs
- Breakpoint chlorination facilities
- Cl₂, NH₂Cl, pH, flow, age, SUVA
- Nitrification algorithms



Organics Level and Reactivity (Organics)

Bulk Delivery System Health (System Health)

Disinfectant (Free Chlorine) Residual Sustainability (Cl₂ Stability)

Nitrification Potential (Nitrification)

$$\text{Nitrification} \int_{\text{High Risk}}^{\text{Low Risk}} \{R, NH_3, NO_2, Age, NO_3D, T, M, HPC, AOB, NOB\}$$

Legionella Outbreak



The Courier Mail
THURSDAY, June 4, 2012 \$1.50

WE'RE FOR THE MARoons

NSW SLUGS **OLD MARoons**

14 6

We'll be ready for you, Paul

Patients on alert as disease hits private hospital
KILLER BUG

save up to 50%
on women's, men's and children's fashion, shoes, accessories and home

DAVID JONES CLEARANCE
now on

The Wesley Hospital

TIMELINE

- **MAY 27:** 60-year-old patient at Wesley Hospital falls ill
- **MAY 28:** Patient tests positive for legionnaires disease
- **MAY 29:** Water samples taken from the hospital for testing
- **JUNE 2:** Patient dies.
- **YESTERDAY:** Water sample results returned, showing legionnaires

The WESLEY HOSPITAL
MAIN ENTRANCE →
EMERGENCY CENTRE →

Information from Courier Mail Newspaper

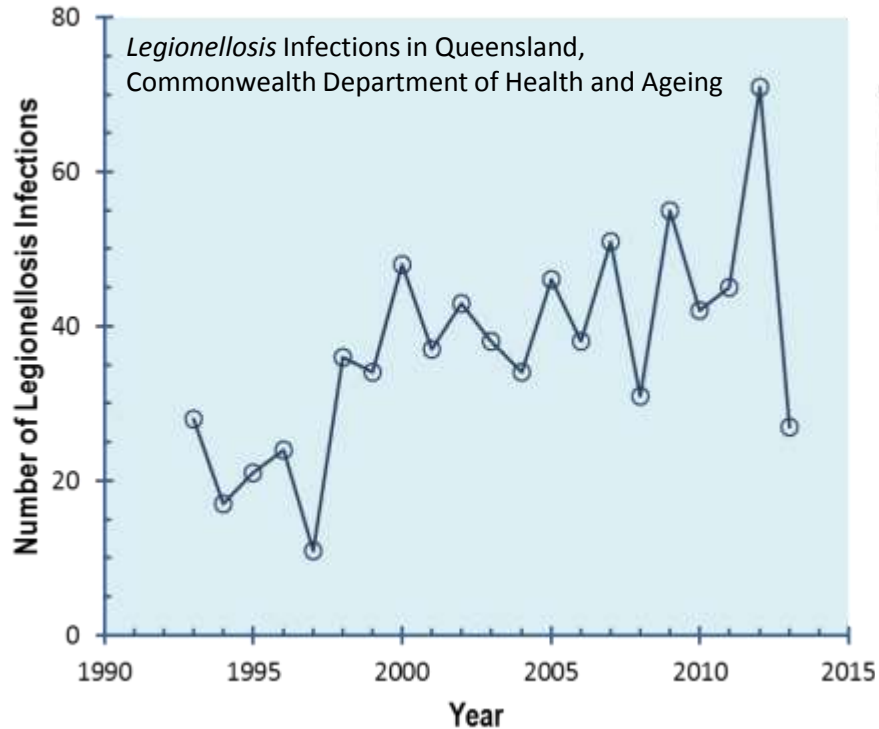
Legionella Outbreak



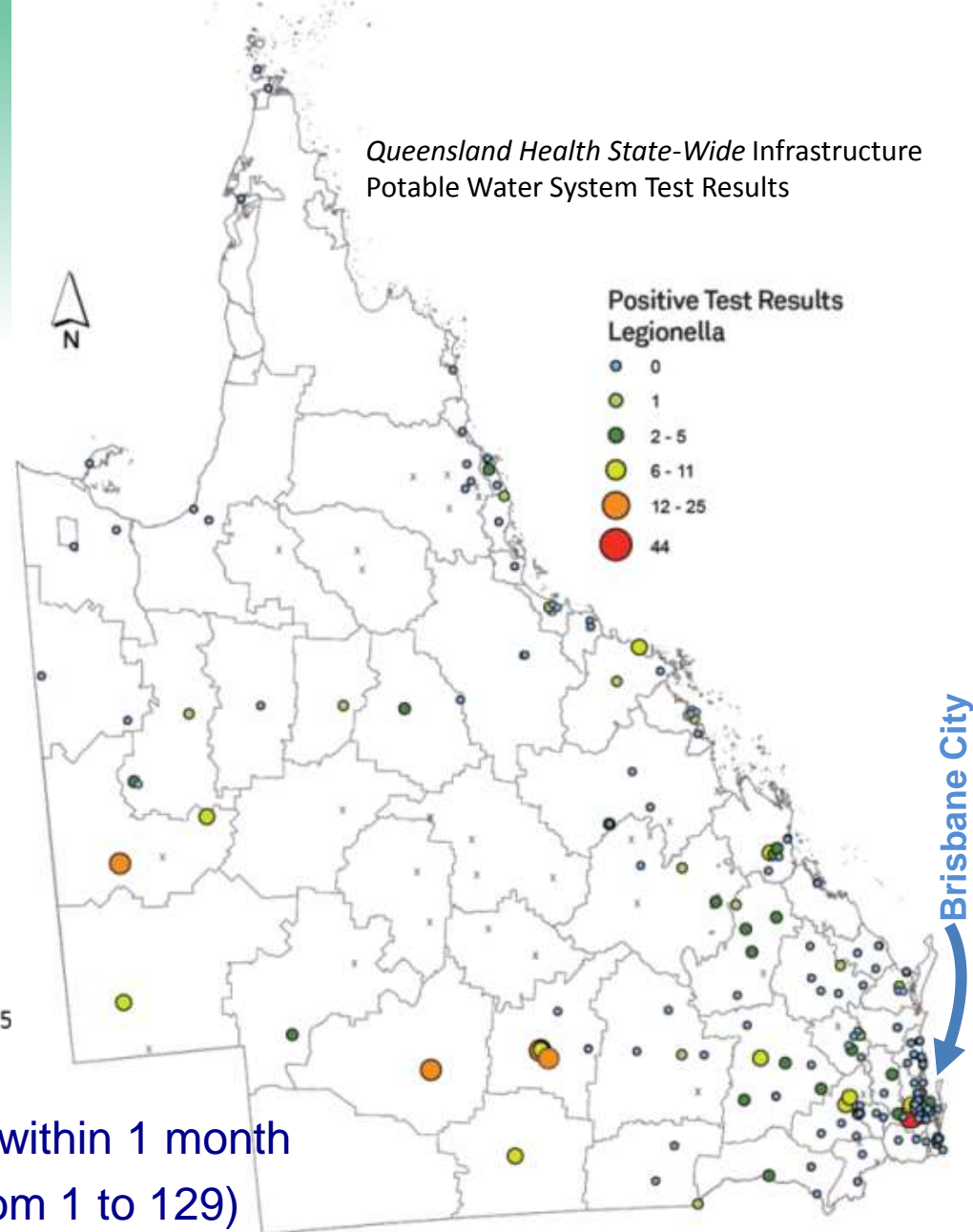
- \$Millions Lost
 - » Patient re-routing
 - » Facility closure
 - » Potable water pipelines cleaning / flushing
- Role (Holiday Weekend)
 - » Identify pipework
 - » Pipework re-designs
 - » 24 hr/day flushing, treatment, sampling
 - » Interpret results / achieve all clear for each wing



Hospital Sampling



- ❑ 226 healthcare facilities sampled within 1 month
- ❑ Average of 14 samples/facility (from 1 to 129)



Mofidi et al. 2014

Hospital Sampling



Hosp.	Cold Temp. (°C)	<i>L.pneumophila</i> (CFU/mL)	L.other (CFU/mL)	HPC (CFU/mL)
A	--	4100	3500	360
B	22.8	<	6000	30000
C	23	<	5100	14900
D	22.1	<	1000	21500
E	22.8	<	200	150
F	21.6	2100	<	550
G	28.4	<	1000	4500
H	36.2	<	12000	<
I	34.5	3200	<	<
J	--	<	1200	--
K	22.2	<	1500	6500
L	20.5	<	2100	2000
M	24.1	<	3100	>100000
N	21.9	<	2100	<
O	20.8	<	1000	330
P	20.8	<	6600	25000
Q	23.1	2400	<	2000

Hosp.	Cold Temp. (°C)	<i>L.pneumophila</i> (CFU/mL)	L.other (CFU/mL)	HPC (CFU/mL)
R	18.9	7900	2300	--
S	--	600	17500	13000
T	--	4100	800	320000
U	--	<	14800	50000
V	--	<	1200	140000
W	--	23600	<	540
X	24	20	2800	--
Y	--	1700	<	--
Z	--	6100	<	--
AA	--	1800	<	--
BB	--	12000	<	--
CC	--	3400	<	--
DD	21.5	<	2300	<
EE	--	<	2000	89000
FF	19.6	<	5100	890
GG	--	3400	<	--
HH	--	1600	<	--

Legend Hospital names withdrawn to protect confidentiality of Queensland Health data
 < = Below detection limit Temp = Temperature
 -- = No result reported HPC = Heterotrophic plate count bacteria
 L.other = Non-pneumophila *Legionella*

- ❑ Maximum heterotrophic plate count (HPC) bacteria >9x10⁶ CFU/mL
- ❑ Maximum *Legionella* count 23,600 CFU/mL

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State Guideline Developed



□ Needed a Mixed Approach

» Industrial Hygiene  Static / One Direction

» Water System Operations  Dynamic / Multi-Direction

□ Starting Approach: Hazard Analysis and Critical Control Point (HACCP) Process

» Food-industry based

» Active quality management and control

» Reporting, Staff Education

□ Water System Management Techniques

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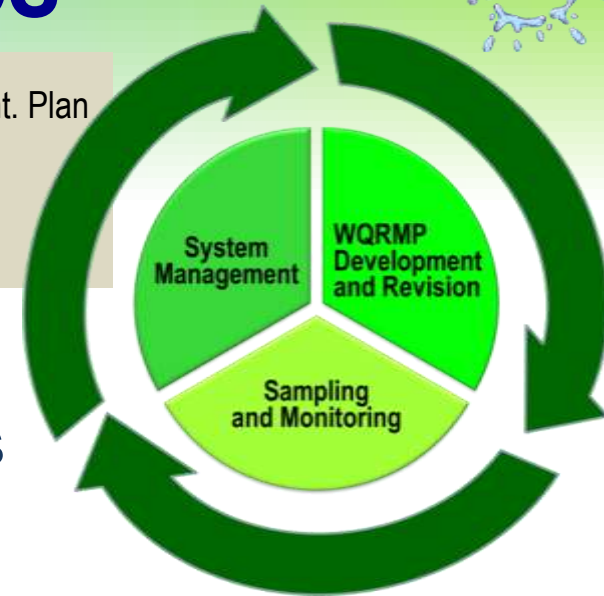
AECOM

Risk Management Principles



WQRMP
Water Quality Risk Mgmt. Plan
QCPs
Quality Control Points
CCPs
Critical Control Points

- ❑ Develop WQRMP
- ❑ Set/ID QCPs and CCPs
 - » Flushing, sampling, passive controls
 - » Treatment and direct controls
- ❑ Perform Continuous System Audits
 - » Clinical risk levels (ICU, cardiac care, long-term care)
 - » Locational risk levels (water usage, problem areas)
 - » Event response (assign risk ratings, respond, resample)
- ❑ Communicate Results and Repeat
 - » Administrators and staff
 - » Patients



Risk Management Guidance



□ Develop & Plan

- » Team building
- » System analysis
- » Risk identification
- » Risk management
- » Gap analysis
- » Action planning
- » **Communications**

□ Quality Control

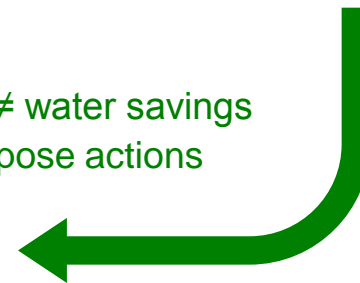
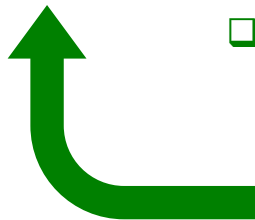
- » Systems management
- » Physical parameters
- » Chemical parameters
- » Microbial parameters
- » Facility locations
- » **Communications**

□ Respond & Manage

- » Manage data
- » Compare recommendations
- » Low-level responses
- » Medium-level responses
- » Critical-level responses
- » **Communications**

□ Managing Risk

- » Microbial quality management ≠ water savings
- » Flexible, reasonable, fit-for-purpose actions
- » Sampling, re-sampling
- » **Staff & patient education**
- » Facility adjustments



State Guideline Implemented



- A 'Call To Arms' for Healthcare Facilities
- All Implementing WQRMPs
- Educate / Monitor
 - » Microbial water quality
 - » Disinfectant residual
 - » Passive/active treatment
 - Flushing
 - Physical/chemical Treatment (?)
- Key = Communication



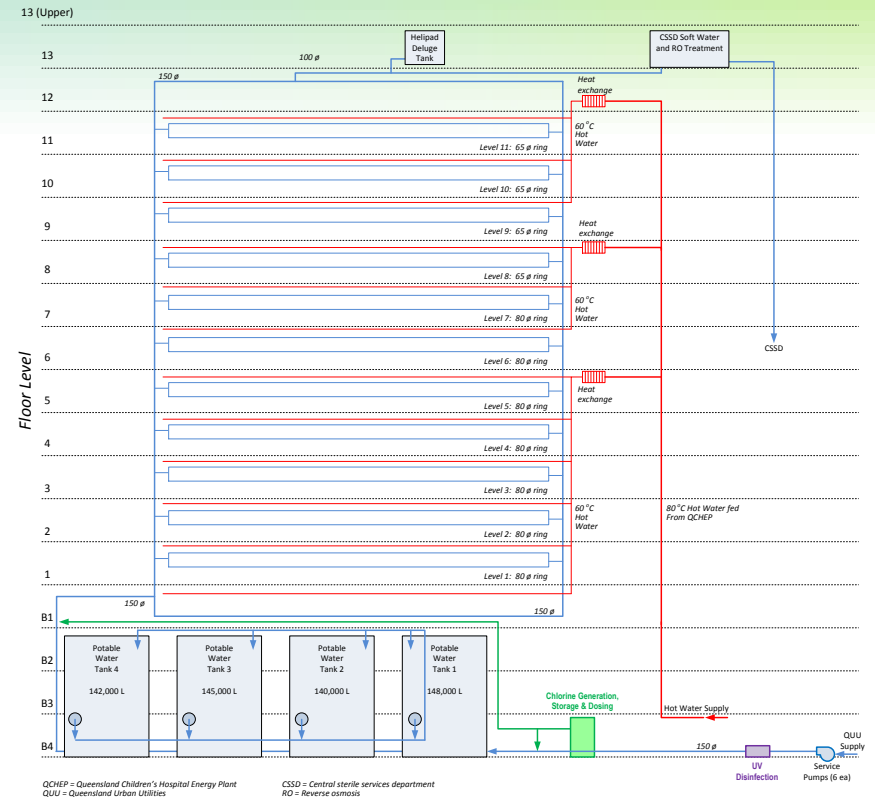
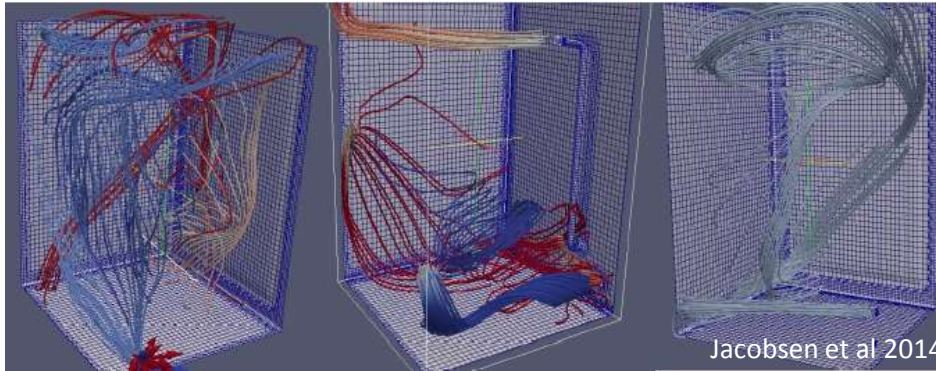
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Case-Study: Lady Cilento Children's Hospital



- \$1.5B; 860,000 ft²; 12 clinical levels w/ R&D
 - » Design, Construction Management, Startup
 - » Water system treatment and conveyance
 - » Water quality monitoring guidance & planning

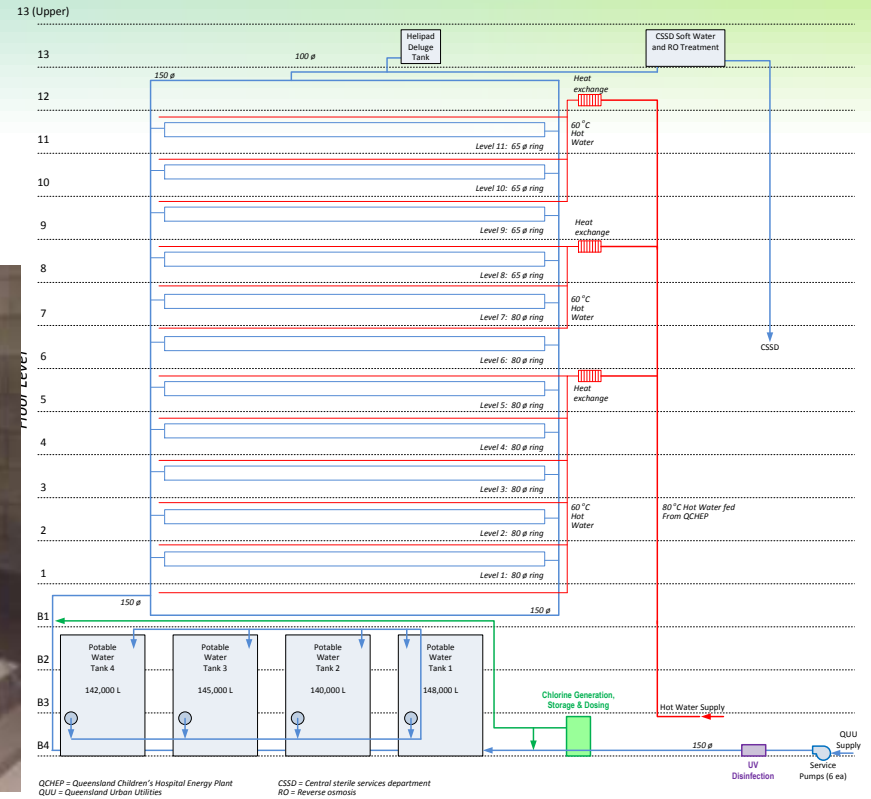
Case Study: Lady Cilento Children's Hospital



Physical & Treatment System Design

» Optimized hydraulics and recirculation systems

Case Study: Lady Cilento Children's Hospital



Physical & Treatment System Design

- » Optimized hydraulics and recirculation systems
- » UV Disinfection and OSEC Chlorination

Case Study: Lady Cilento Children's Hospital

The collage features several key elements:

- Top Left:** A floor plan of the hospital showing various departments and their locations.
- Top Right:** A photograph of a hand being washed with soap and water, with the text 'Keeping hospital water clean' overlaid.
- Middle Left:** A diagram titled 'Managing Legionella' showing a hand being washed, with text explaining the hospital's water management plan.
- Middle Right:** A photograph of a water tap being flushed, with text explaining the importance of flushing taps.
- Bottom Left:** A floor plan of the hospital showing the location of the water treatment system.
- Bottom Right:** A photograph of a water tap being flushed, with text explaining the importance of flushing taps.

- ❑ Physical & Treatment System Design
- ❑ Technical Work Supported by Communications
 - » Staff involved
 - » Patient Comm's

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Summary



- ❑ Lack of Illness ≠ Risk Level
- ❑ Practical Risk Management Developed
- ❑ Modified HACCP-Based Approach
 - » Principles and skills from water and food industries
 - » Microbial and chemical system management
 - » Communications, communications, communications
 - » Revise plan and repeat
- ❑ Meanwhile, In Queensland....
 - » Guideline-based WQRMPs are being implemented
 - » QLD Health investigating water quality correlations to presence of *Legionella*, *Naegleria*, others...

Guideline Development for Managing Microbial Water Quality in Healthcare Facility Potable Water Distribution Systems

Thank You!

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