Whisk Assessment: PFAS stock watering screening levels to protect people consuming home-produced chicken eggs

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Presentation Outline

Exposure to eggs from backyard chickens

Screening level derivation approach

Transfer factors

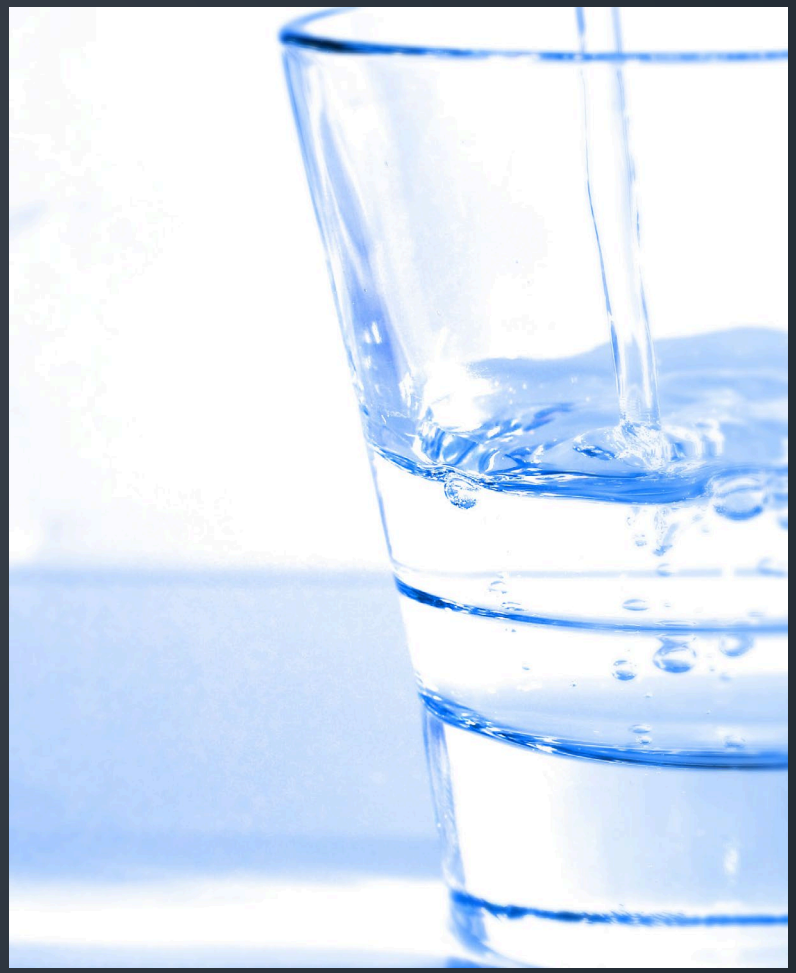
Results

Eggs from backyard chickens: a plausible exposure pathway

- In urban catchments, groundwater may be abstracted for a range of uses.
- Stock watering is a potential use commonly requiring assessment.
- Many stock watering uses are unlikely in urban catchments, or even prohibited, e.g. council restrictions on the keeping of certain stock animal types.
- People do, however, keep backyard chickens in urban areas, and the watering of these chickens with abstracted groundwater may be a plausible use requiring assessment.

Just use drinking water screening levels?

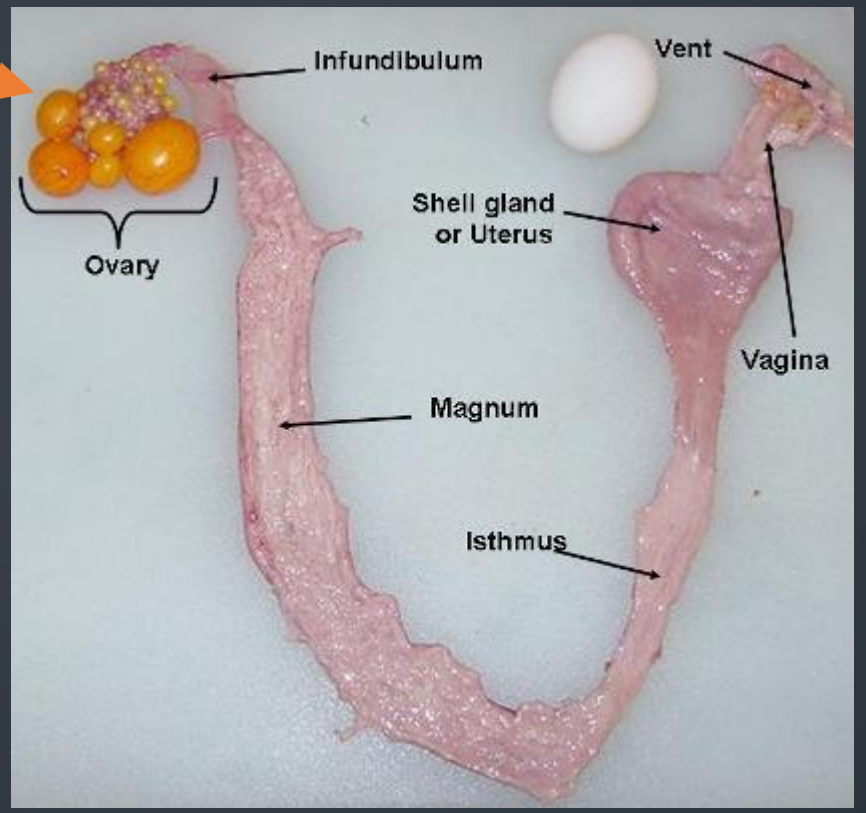
- In line with ANZECC & ARMCANZ (2000) drinking water criteria are often adopted as default screening levels for stock watering
  - Screening levels offering protection to human health will also offer a protection to animal health
  - Stock watering specific levels may be useful as the drinking water standards are conservative and may overestimate the area where the use is precluded
- For contaminants which bioaccumulate, drinking water criteria do not necessarily offer protection to consumers of animal products
- Specifically for PFAS, a pathway of human consumption of chicken eggs may be of particular concern given the potential for PFAS to bind to protein, and the evidence egg formation is a key excretion pathway for PFAS in chickens



How does an egg form?

Yolks form within the ovary

- **Yolk is 17% protein and 35% fat, and this is where almost all of the PFAS (>99%) in an egg is accumulated**
- At birth, the chicken is born with all of the ova (yolks) it will ever produce
- On average, one matures every day, with several at different stages of development at any time
- Maturation takes 4-6 days, during which 2 g of yolk is accumulated per day
- PFAS will accumulate in the yolk over this period, with the concentration in the yolk depending on the overall body burden of PFAS in the chicken over this time period



After ovulation

- Fertilisation (if it occurs) happens within an hour of ovulation (release of the yolk from the ovary)
- Membranes and albumen (egg white) are then accumulated as the egg passes through the infundibulum and magnum (this takes ~6 hours)
- The shell is deposited in the uterus before the egg is laid (this takes ~19 hours)

Screening level derivation approach

- The USEPA presents a methodology for estimating concentrations in chicken eggs
  - Estimate contaminant intake from the measured concentrations in their diet (grain, water, and incidental soil ingestion)
  - Apply a transfer factor (TF) representing the proportion of intake which passes into the egg
  - The approach assumes that at steady-state, a fixed percentage of PFAS excretion is via egg laying (i.e. if fewer eggs are laid, the concentration in each egg will be proportionally higher to compensate)
- We have back-calculated screening levels in water which will not result in egg concentrations exceeding the acceptable level (defined as the FSANZ, 2017 trigger values for poultry eggs)
  - Trigger values are defined as the maximum concentration in individual foods such that even at high consumption levels, consumers of these foods would not have dietary exposures exceeding the relevant health based guidance value
  - Approach assumes exposure via water only

- The equation (simplified for water intake only) is as follows:

$$SSL = \frac{TV \cdot LR \cdot EW}{TF \cdot Q_w}$$

SSL	stock watering screening level (µg/L)
TV	FSANZ trigger value (µg/kg)
LR	laying rate (eggs/day)
EW	average weight of edible portion of egg (kg/egg)
TF	transfer factor into eggs (expressed as percentage of total intake)
Qw	Quantity of water drunk by the chicken (L/day)

Transfer factors: Scolexia Study

- A key factor in the derivation is estimation of the transfer factor (TF), which represents the proportion of intake which passes into the egg.
- A lab-based observational exposure study completed by Scolexia (Scolexia, 2017) was undertaken with the purpose of defining egg transfer factors for laying hens watered with PFAS impacted water

5 groups of 22-25 chickens (n=119), drinking water with target concentrations of PFOS, PFHxS, PFOA and PFHxA				
Control (T1)	0.3 µg/L (T2)	3 µg/L (T3)	30 µg/L (T4)	300 µg/L (T5)

Each group shared a drinking water supply

Estimated intakes are averages for the groups

Usually 6 eggs analysed from each group every 2 days

Transfer factors estimated based on the average concentration for each group during steady state period

Transfer factors: Scolexia Study

Review of the Scolexia study identified a number of uncertainties (discussed further on the next slide)

The data manipulation methods adopted in the study resulted in significant data censorship for some of the treatment groups, overestimating the transfer rates for some PFAS compounds

For some treatment groups, analysis of the data indicates that steady-state conditions were not reached

Senversa has developed refined transfer factors which excluded treatment groups where steady-state was not reached, or where a high percentage of non-detected values compromised the ability to develop a representative transfer factor

Transfer factors: Scolexia Study

In Group T2 (0.3 µg/L) 144 eggs were collected and analysed during the “steady state” period.

Eggs where PFAS was not detected above the detection limit were excluded from the estimation of transfer factors

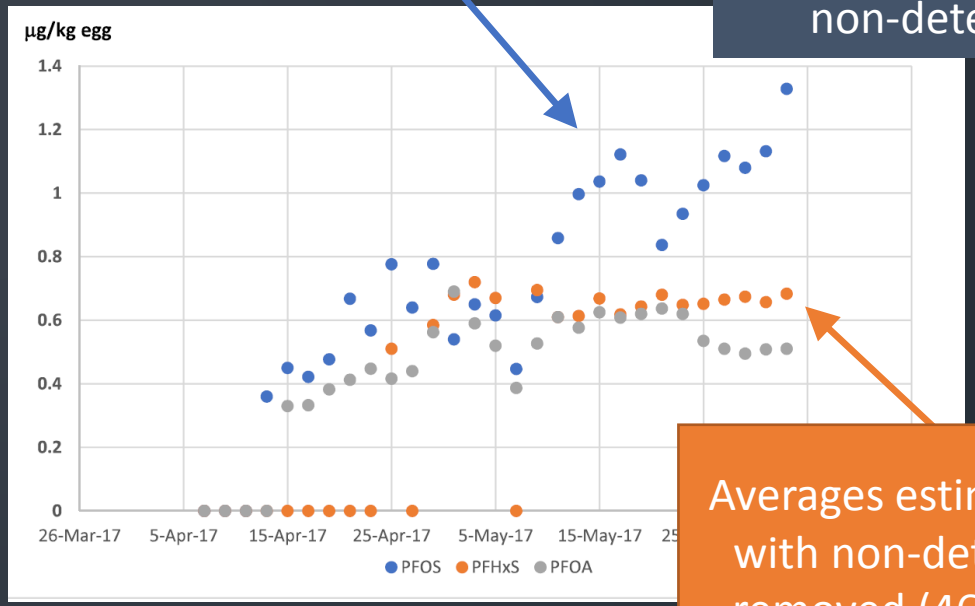
This resulted in significant censorship of the data for this group

PFOS: 116/144 (19%)	PFOA: 22/144 (15%)	PFHxS: 66/144 (46%)

Removal of non-detect data will result in an overestimate of the transfer rate

PFOS: does this data show steady-state was reached?

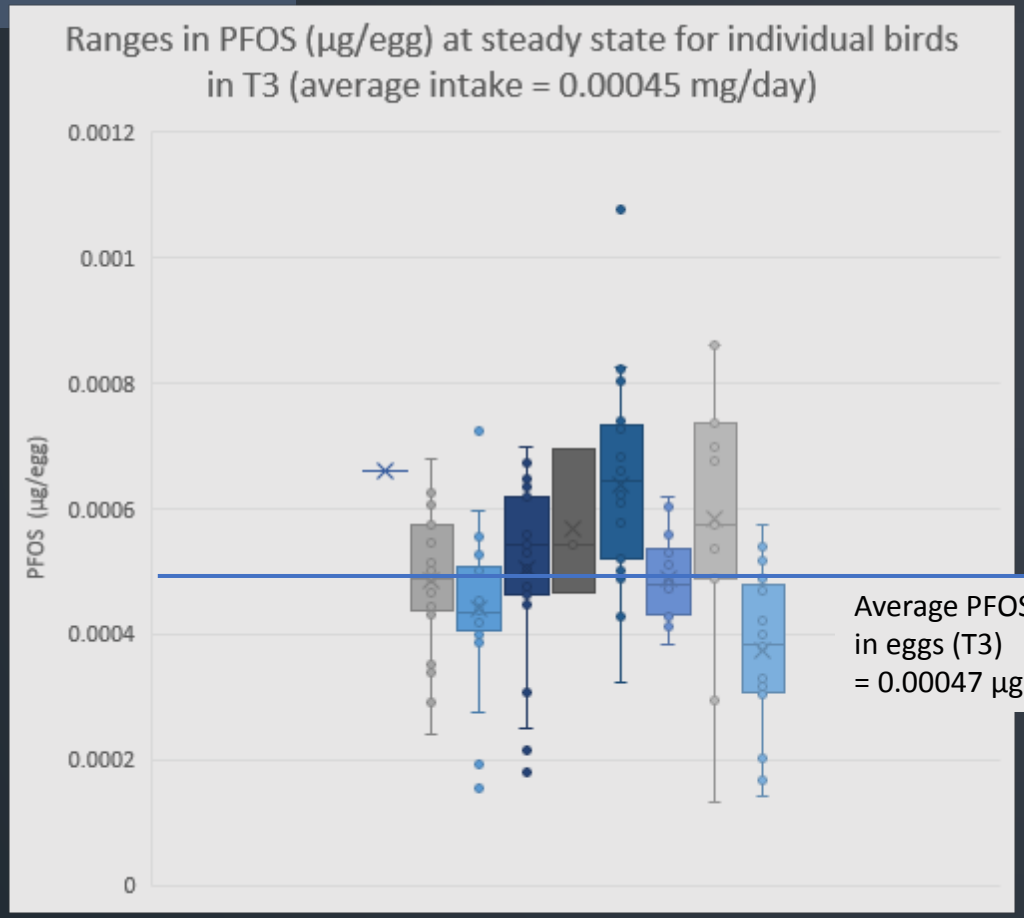
This graph shows the **average** concentration on each date (excluding non-detects)



Averages estimated with non-detects removed (46% of data for PFHxS)

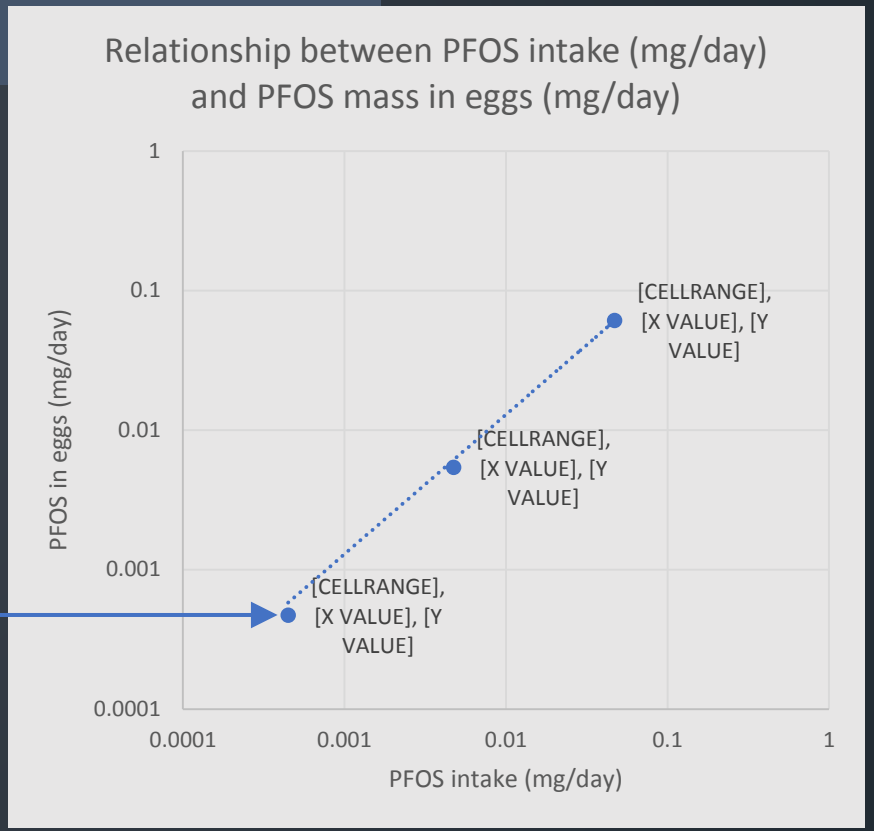
Transfer factors: Scolexia Study

How variable is PFAS transfer into eggs within a treatment group (T3)?



Average PFOS mass in eggs (T3) = 0.00047 µg/day

The very good fit demonstrates consistent **average** transfer % across widely spaced dose groups



Screening level development

- Senversa developed screening levels based on refined transfer factors
  - These transfer factors excluded treatment group T2 where steady-state was not reached, or where a high percentage of non-detected values compromised the ability to develop a representative transfer factor
- It was necessary to estimate the following parameters:
- Q_w: The drinking water intake rate by hens (0.4 L/day)
- LR: The laying rate (0.7 eggs/day)
- EW: The mass of an egg (0.044 kg/egg)

$$SSL = \frac{TV \cdot LR \cdot EW}{TF \cdot Q_w}$$

This may be conservative, as many hens lay every day

Yes: it is estimated that 100% of PFOS intake passes into the egg

CoPC	Refined transfer factor	Screening level (µg/L)
PFOS	1	0.85
PFHxS	0.63	1.3
PFOA	0.44	15

No health effects seen in chickens even at much higher concentrations (>100 µg/L PFOS) so these levels are also considered protective of chicken health

Screening levels compared with ambient concentrations

- The screening levels are compared to ambient groundwater concentrations measured in Victoria below:

CoPC	Screening level (µg/L)	Range in Victorian Groundwater (µg/L)
PFOS	**0.85**	<0.02 – 1.3
PFHxS	1.3	<0.02 – 0.086
PFOA	15	<0.02 – 0.06

Screening levels assume exposure via water only

- unimpacted feed/soil
- water not used for irrigation

Data from EPA Victoria 2017 environmental assessment programme

Questions?

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