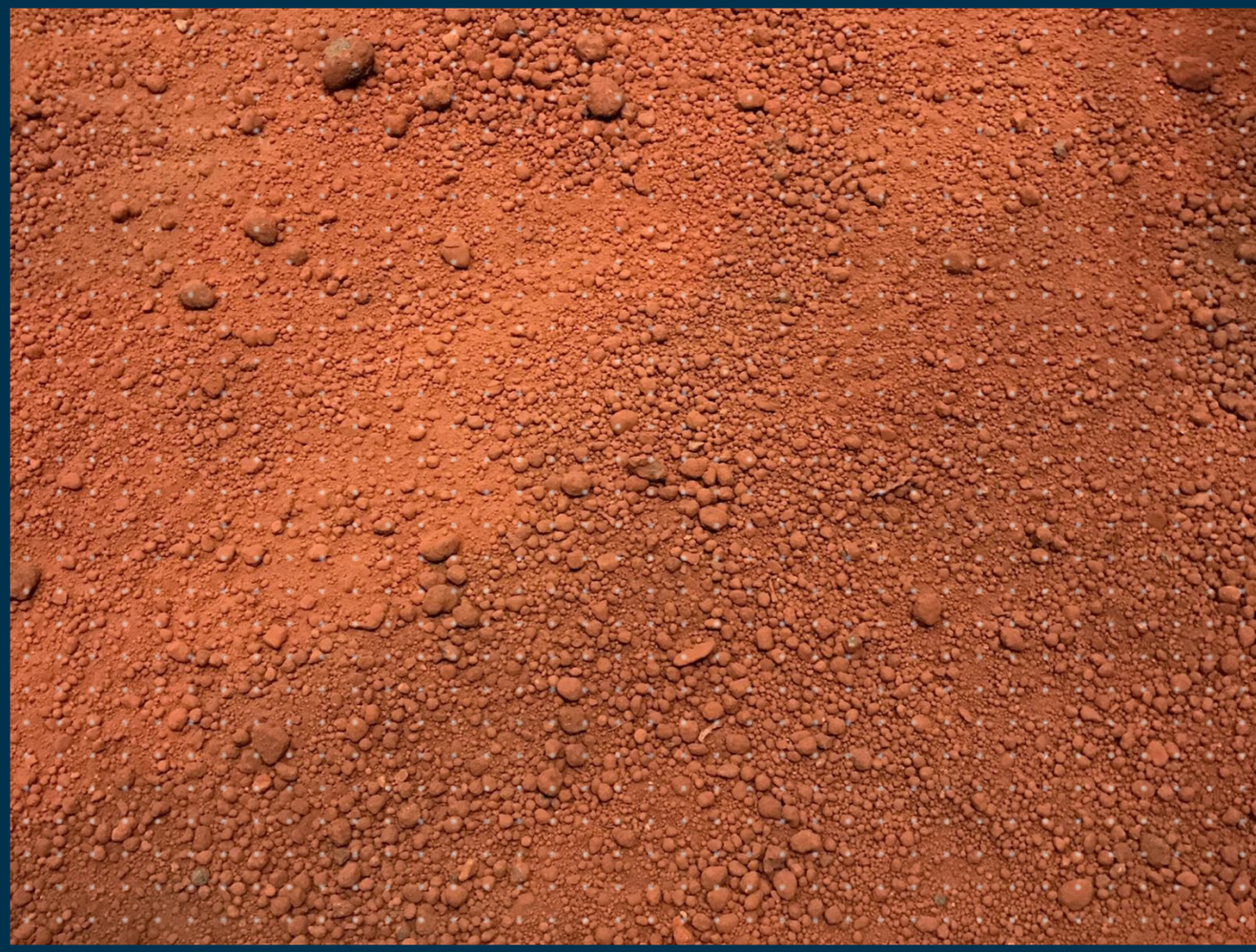
Environment Protection Authority

Audit Unit Update

Contaminated Land Advice & Audit



Jo Graham

30 October 2020

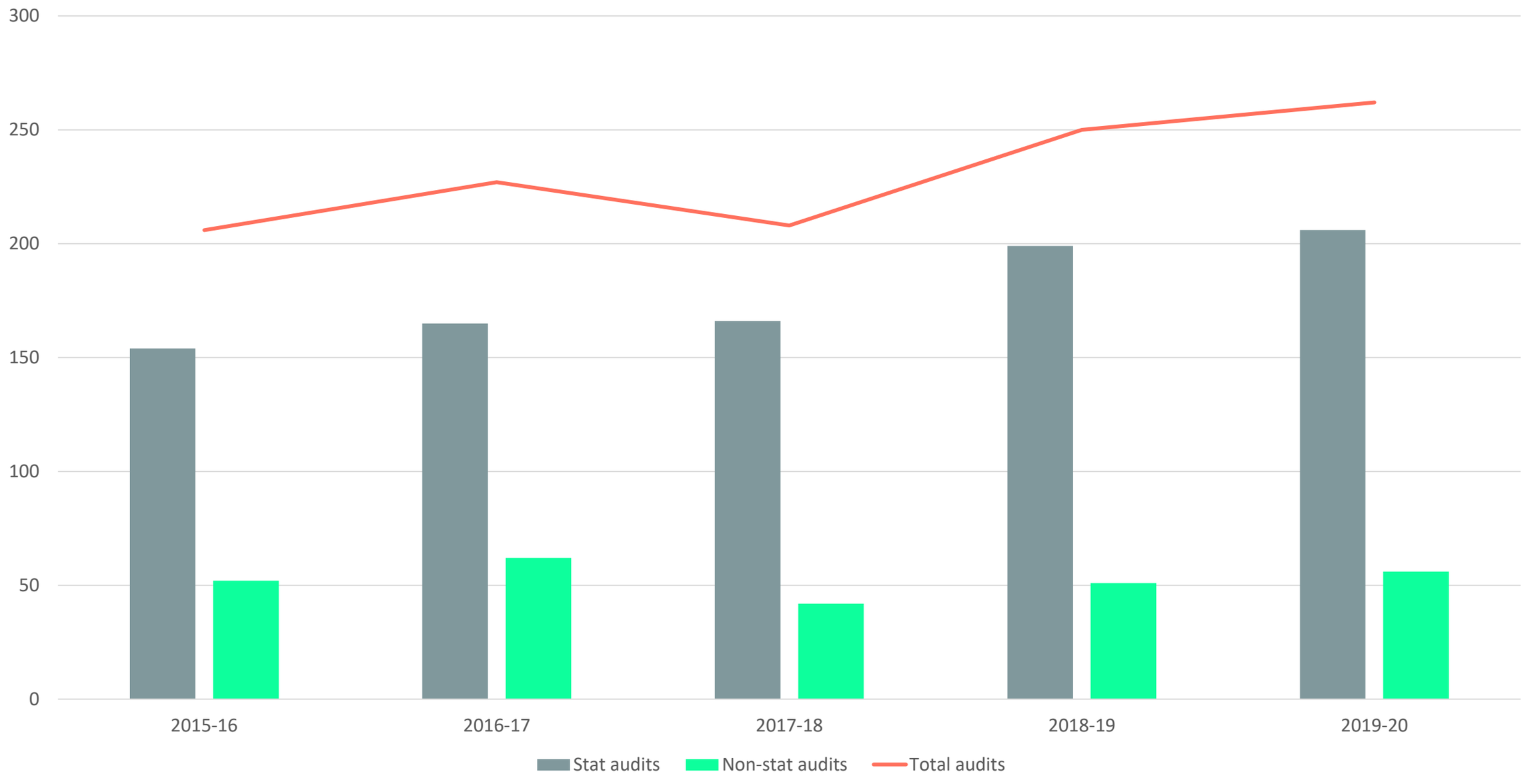
Annual Returns 2019 - 2020

- 262 audits completed (2018-19 – 250)
- 52 audits terminated (2018-19 – 62)
- 704 audits ongoing (2018-19 – 623)
- 243 stat audits commenced (2018-19 – 202)

Of the audits completed:

- 31 auditors < 5 audits (28 - 2018/19 ; 32 – 2017/18)
- 5 auditors 5-10 audits (4 – 2018-19 ; 5 – 2017/18)
- 6 auditors 10-20 audits (11 – 2018-19 ; 5 – 2017-18)
- 4 auditors >20 audits (1 - 2018-19 ; 2 – 2017/18)

Completed Audits 2016 - 2020



Admin

- SANS – statutory requirement (section 53C of CLM Act) - 7 days

- Terminations – (section 3.8.4 of the Site Auditor Guidelines)

- Emails to auditor mailbox

Feedback Survey – April 2020 Auditors' Meeting

- Clarification sought from EPA on auditor obligations if they become aware of:

  a) False and misleading information e.g. doctored lab certificates;

  Recommend bringing to attention of EPA

  b) Non-compliance with an EMP after the audit has been completed

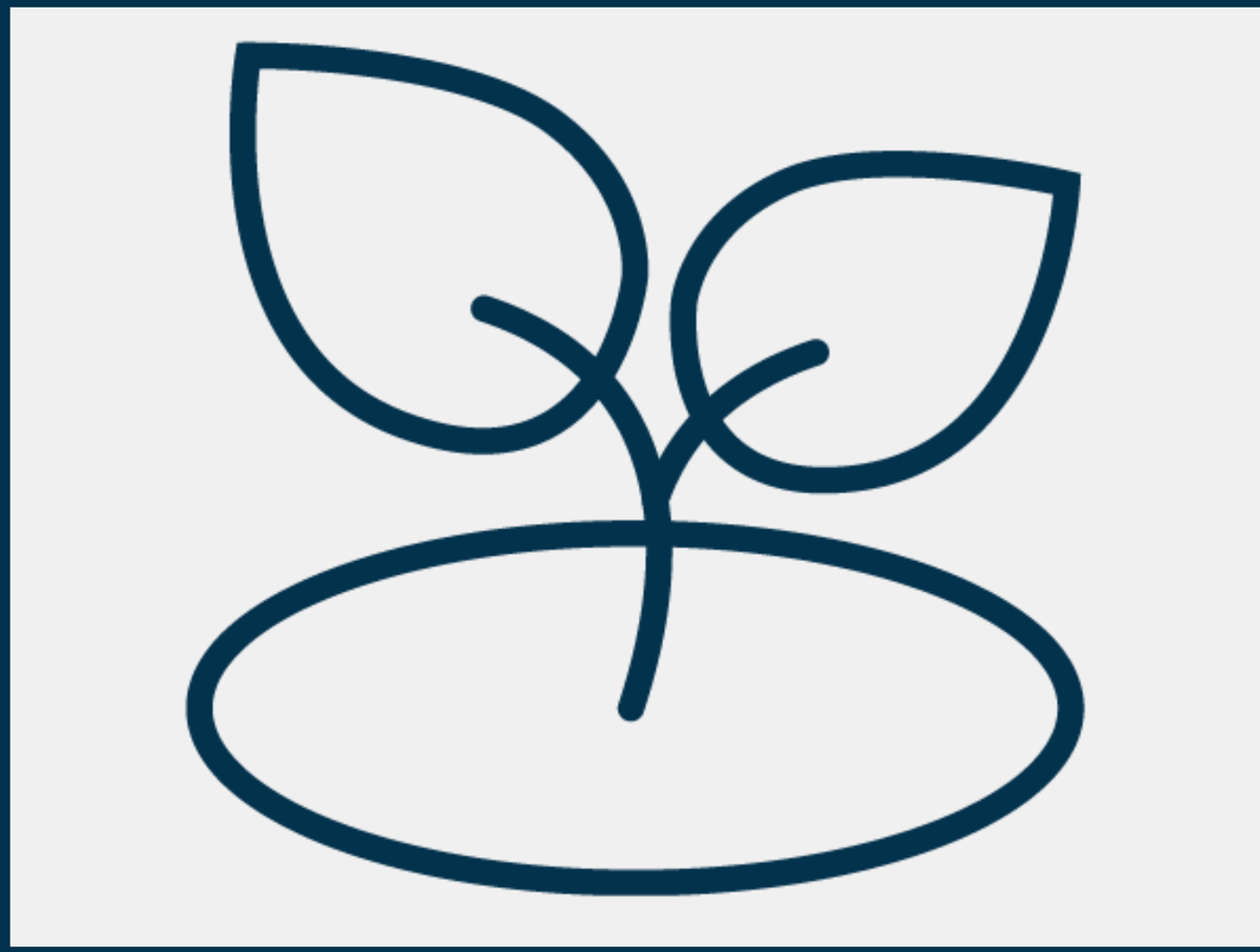
  Recommend bringing it to the attention of the enforcing authority

- Not enough time given at meetings for auditor contribution and answering auditors burning questions – particularly those not related to the discussed topics
  - EPA continuously encourages auditor contributions at the meetings
  - Queries/burning questions can be sent to the auditor mailbox at any time

Topics for Future Auditors' Meetings
Auditor presentation requests

- The challenges of being an auditor - from an auditor perspective e.g. dealing with things not in the EPA guidelines / interesting findings / practices / regional impacts and lessons learned
- Remediation/management of a PFAS contaminated site
- Containment cell placement and design (issues, solutions & best practice)
- Project file management, maintenance and retention
- Asbestos in waste materials
- Preparation and application of a s88B covenant on title related to an EMP
- Approach to applying EILs and ESLs

Questions?



Environment Protection Authority

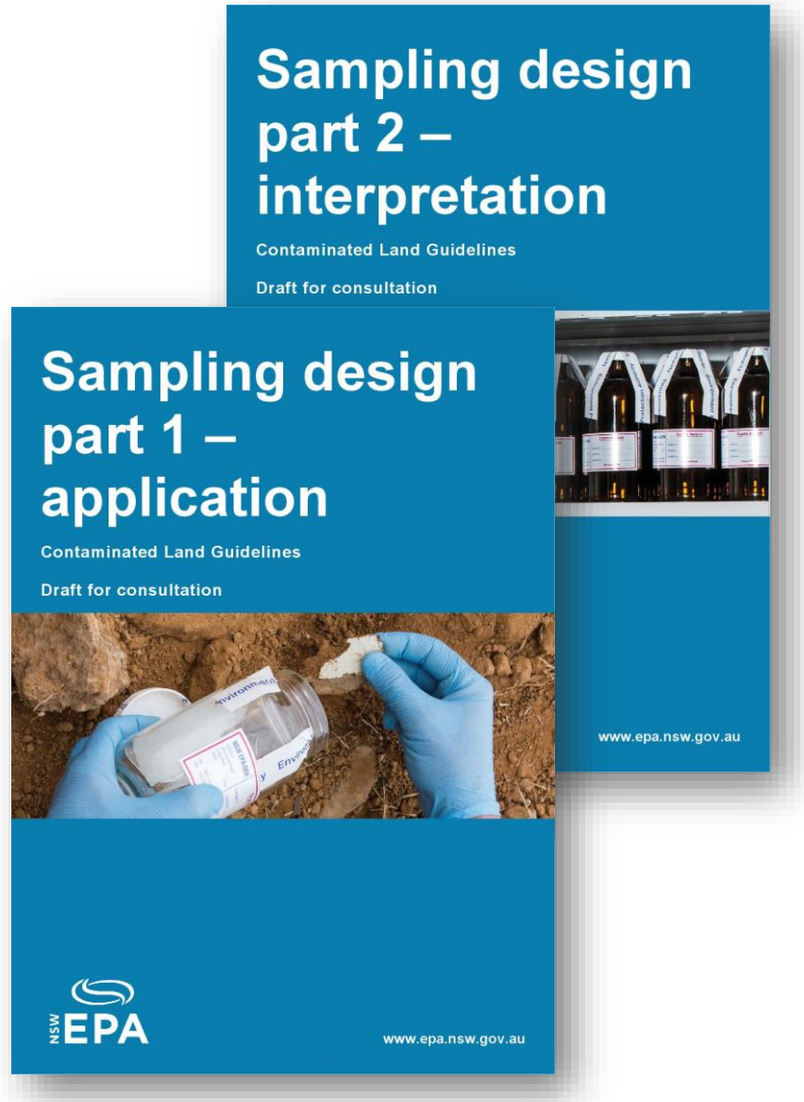
Land & Resources Policy Update

Regulatory Policy Initiatives & Advice

Magda Paszkiewicz
October 2020

Revised Sampling Design Guidelines

- The draft amended Sampling Design Guidelines (SDG) are out on public consultation until Sunday 8 November.
- They have been updated to be consistent with the NEPM and reflect current industry best practice, including modern scientific practices and sampling techniques.
- They help identify risks to human health the environment in the design of appropriate sampling and analysis plans.
- They are now in two parts: Part 1 (Application) and Part 2 (Interpretation).
- The consultation webpage is https://yoursay.epa.nsw.gov.au/sampling-design-guidelines



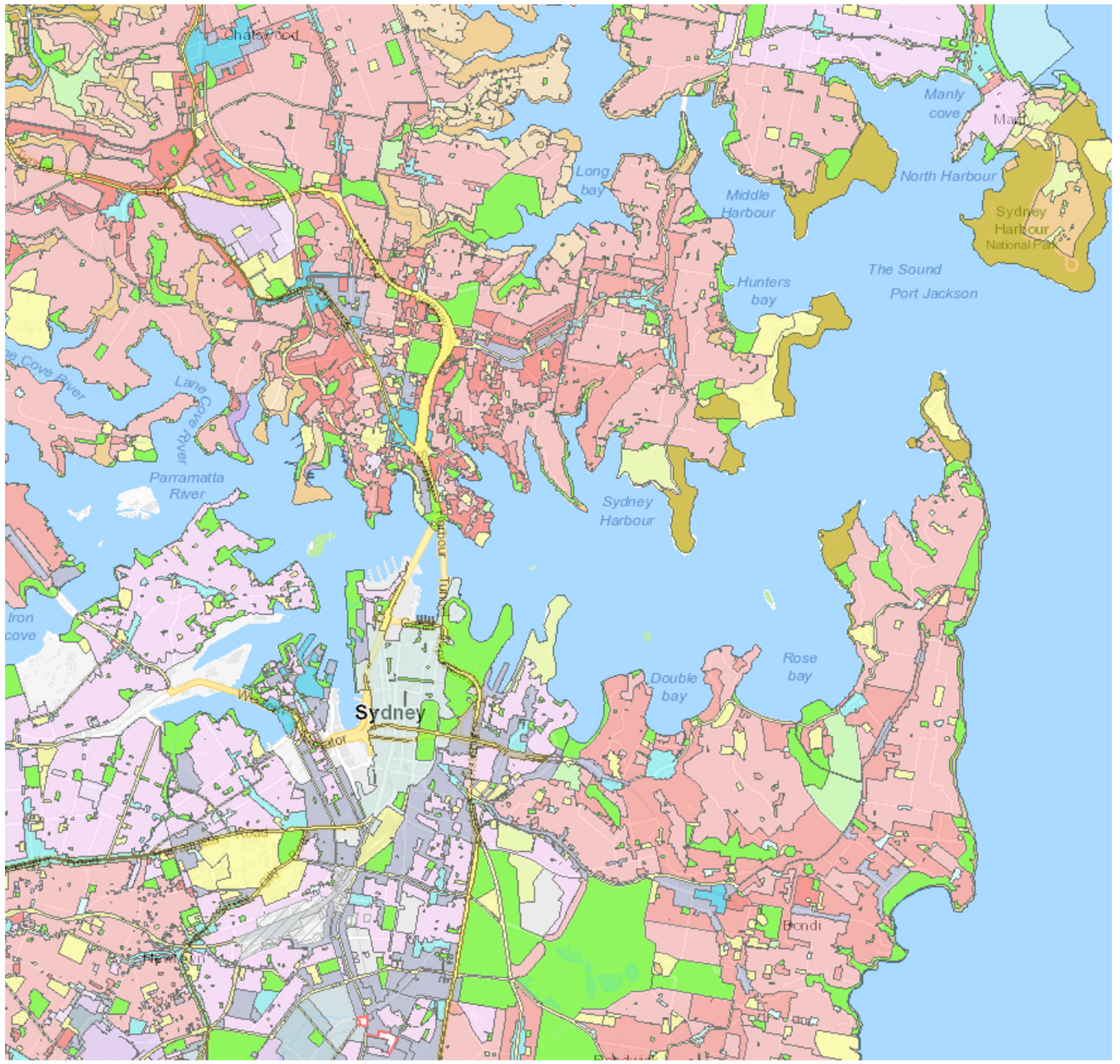
Contaminated Land Consultant Certification Policy

- The EPA is commencing a review of the effectiveness of its *Contaminated Land Consultant Certification Policy*.

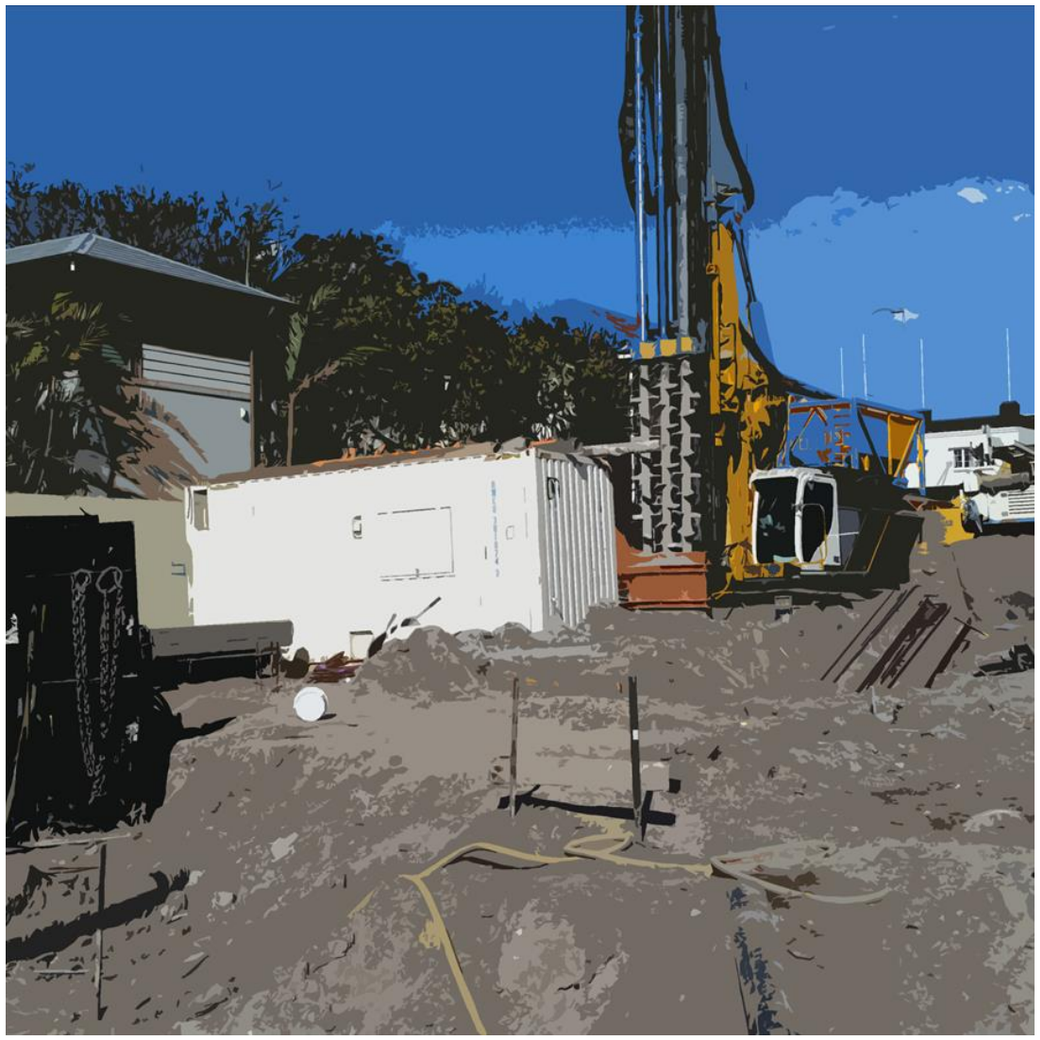
- The Policy requires that reports submitted to the EPA in compliance with the CLM Act be prepared, or reviewed and approved, by a certified contaminated land consultant.
- The review is in the project planning phase at the moment
- As part of that review, the EPA may come to you seeking your views as accredited site auditors.

Contaminated Land Planning Guidelines and SEPP

- The EPA is continuing to work with Planning on the updated Contaminated land planning guidelines.
- Planning intend to engage with the stakeholders who participated in the working groups prior to finalising the guidelines and draft instrument.



Practice Note:
Environmental Management Plans

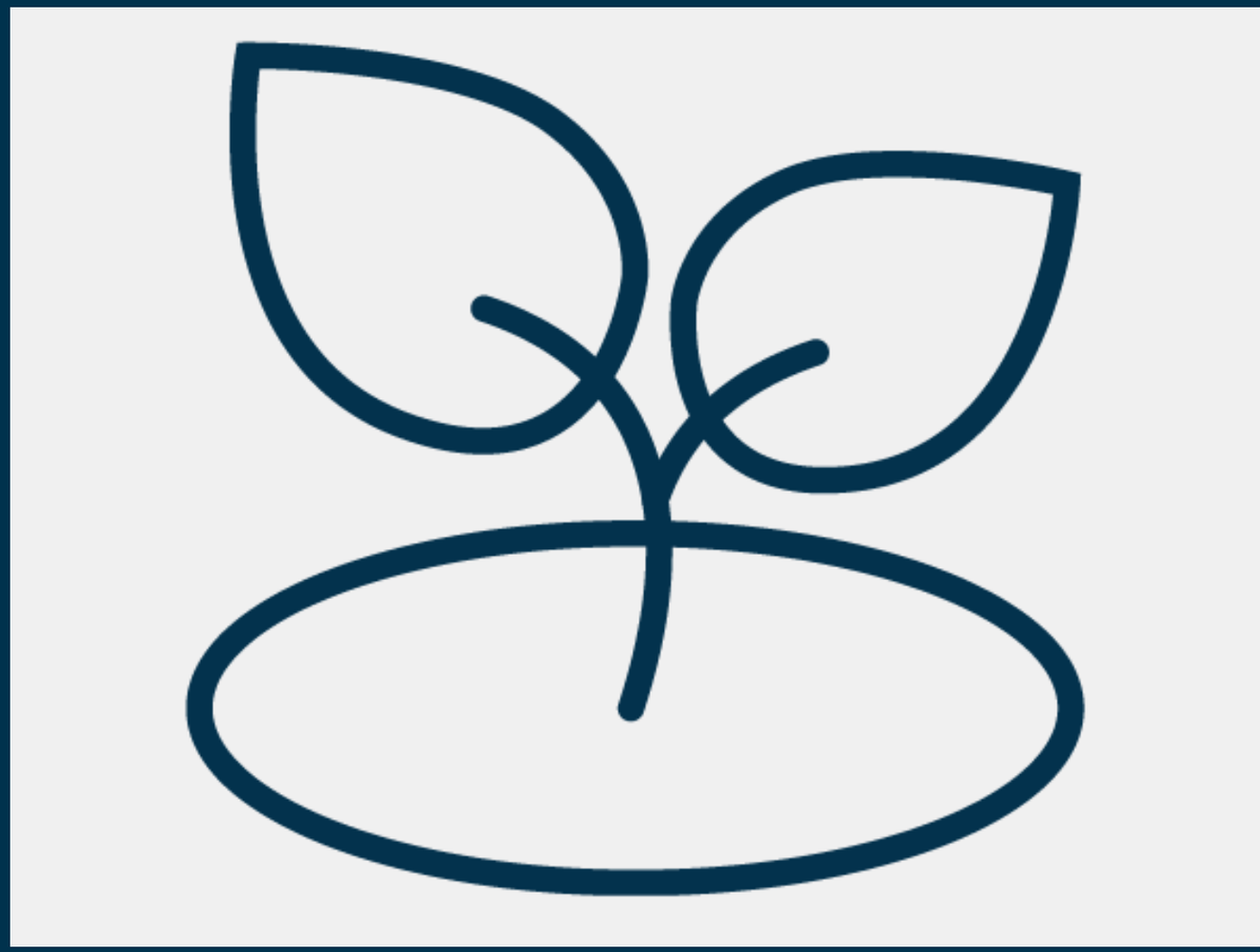


The EPA is developing a Practice Note on preparing environmental management plans (EMPs) for managing residual contamination.

This will help to guide consultants to prepare quality plans that are:

- Fit for purpose
- Include clear and transparent responsibilities and actions
- Contain information on enforcement mechanisms
- Support improved knowledge and understanding of required actions and compliance with EMPS

Thank you



ENVIRONMENT PROTECTION AUTHORITY v KATE MCMULLEN

Gave information to another person knowing that, or being reckless as to whether, the information was false or misleading in a material particular.

"From Little Things Big Things Grow " **by Paul Kelly and Kev Carmody**

Mark Rutherford
Senior Investigator
EPA Specialist Investigations

Purpose of SAS and regulatory regime

The purpose of a statutory site audit is to secure compliance with the Act to ensure contaminated land is appropriately assessed and managed with regard to the principles of ecologically sustainable development.

The purpose of a SAR is to critically review the information collected in relation to a site audit and to clearly set out the reasons for the findings contained in the relevant SAS.

(*Contaminated Land Management Act 1997)*

The Offence

NSW GOVERNMENT

Ms McMullen, on or about 8 September 2017, at Wollongong in the State of New South Wales, committed an offence against section 103(1) of the *Contaminated Land Management Act 1997* ("**the Act**") in that, in compliance or purported compliance with a requirement under the Act, she gave information to another person knowing that, or being reckless as to whether, the information was false or misleading in a material particular.

Key Particulars

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Information

Information contained in a document titled: “Site Audit Statement”, (SAS) purportedly signed by ASA, dated 14 December 2016.

Given to another person

The Defendant gave the Information to Wollongong City Council (**Council**) on 8 September 2017 by:

i. furnishing a hardcopy of the Information at Council’s reception counter Wollongong NSW; and/or

ii. emailing a downloadable link containing the Information to a Council employee at approximately 12.45pm.

That was false or misleading in a material particular

The Information was not created or signed by ASA.

In compliance, or purported compliance, with a requirement of the Act

The Defendant gave the Information to Council in compliance, or purported compliance, with s 53B(3)(b) and/or s 103(2) of the Act.

The Effect

NSW GOVERNMENT

By falsifying the SAS, the defendant misled Council to believe the Premises had been properly assessed under the Act for contamination and that it was suitable for the Development. Upon discovery of the offence, there was a genuine risk that, failing legitimate assessment by the site auditor, the site had not been remediated in accordance with the RAP.

Timeline of Events

2013, Stockland engaged Arcadis to design, project manage and provide superintendency services on its behalf to develop the Premises into residential lots at the Development.

July 2014, Arcadis commissioned JBS&G as the environmental consultant for the Development.

October 2014, ASA, as an employee of Zoic, was commissioned by Arcadis to undertake a site audit for the Premises. ASA is an accredited Site Auditor under the Act.

October 2014, A development application was lodged by Arcadis on behalf of Stockland with Council to develop the following parcels of land at the Premises.

April 2015, Ms McMullen commences as the Arcadis Project Manager of the Development.

Timeline… Con't

NSW GOVERNMENT

November 2015 Council issued development consent DA for the Development to Stockland.

Feb to July 2016, Ms. McMullen communicated with the ASA regarding the issuing of the DA.

August 2016, In accordance with section 53C of the Act, the ASA issued a Site Audit Notification (**SAN**) to the EPA, to notify the EPA that she had been commissioned by Arcadis to carry out a statutory site audit.

December 2016, Ms. McMullen had a disagreement with JBS&G over its refusal to validate material being imported to the premises. This ultimately resulted in communication with JBS&G ceasing.

March, August and September 2017, Ms. McMullen repeatedly submitted Subdivision Certificate Applications to council for the Development. Each of the applications were declined citing the absence of the site validation report (**SVR**) and SAS.

Timeline Con't

8 September 2017, Ms McMullen attends the council offices and submits a 'Lodgement of Additional Information Form' together with a purported SAS and a purported SVR to a receiving officer at the counter.

12-30 September 2017, After assessing the Subdivision Certificate Applications against the Development Consent, Council subsequently issued the subdivision certificates for the various stages of the Development. Allowing for the sale of the land by Stockland and construction to commence.

February 2018, The ASA telephoned the defendant to enquire whether a statutory site audit was still required for the Development. Ms McMullen response was non committal, but provided that the subdivision certificates had already been issued.

7 May 2018, The ASA completed an Audit Termination Letter and issued it via email to the EPA and Council.

Timeline Con't

NSW GOVERNMENT

21 May 2018, The Council Engineering Manager, telephoned the ASA in relation to the Audit Termination Letter and queried why it had been issued, given that Council had a completed SAS with their signature on it on file for the Development.

The ASA advised that they did not prepare the SAS in Council's possession.

Site Inspection

25 May 2018

NSW GOVERNMENT

Almost ready to move in…….

Aftermath, Investigation and Prosecution

NSW GOVERNMENT

The Site was immediately reassessed for contamination and suitability for development. As a result, a SAS was issued certifying site suitability.

The matter was investigated by the EPA with witness information and evidence collected from Stockland, Arcadis, Zoic, JBS&G, Wollongong Council and EPA Officers

Ms McMullen declined the opportunity to be interviewed in relation to the matter.

February 2020, the EPA commenced the prosecution of Ms McMullen in the Land and Environment Court. Ms McMullen pleaded guilty at an early court appearance.

July 2020, the Land and Environment Court sentenced Ms McMullen to a fine of $30,000 and $35,000 legal costs ($65,000).

With regard to the purpose of the Scheme and the role of the Site Auditor, consider..

(To) Provide greater certainty for planning authorities and the community through the independent review by those auditors of contaminated site assessment and remediation reports, and reports that validate the successful completion of the assessment or remediation.

Guidelines for the NSW Site Auditor Scheme (2nd edition)

Was this achieved….?

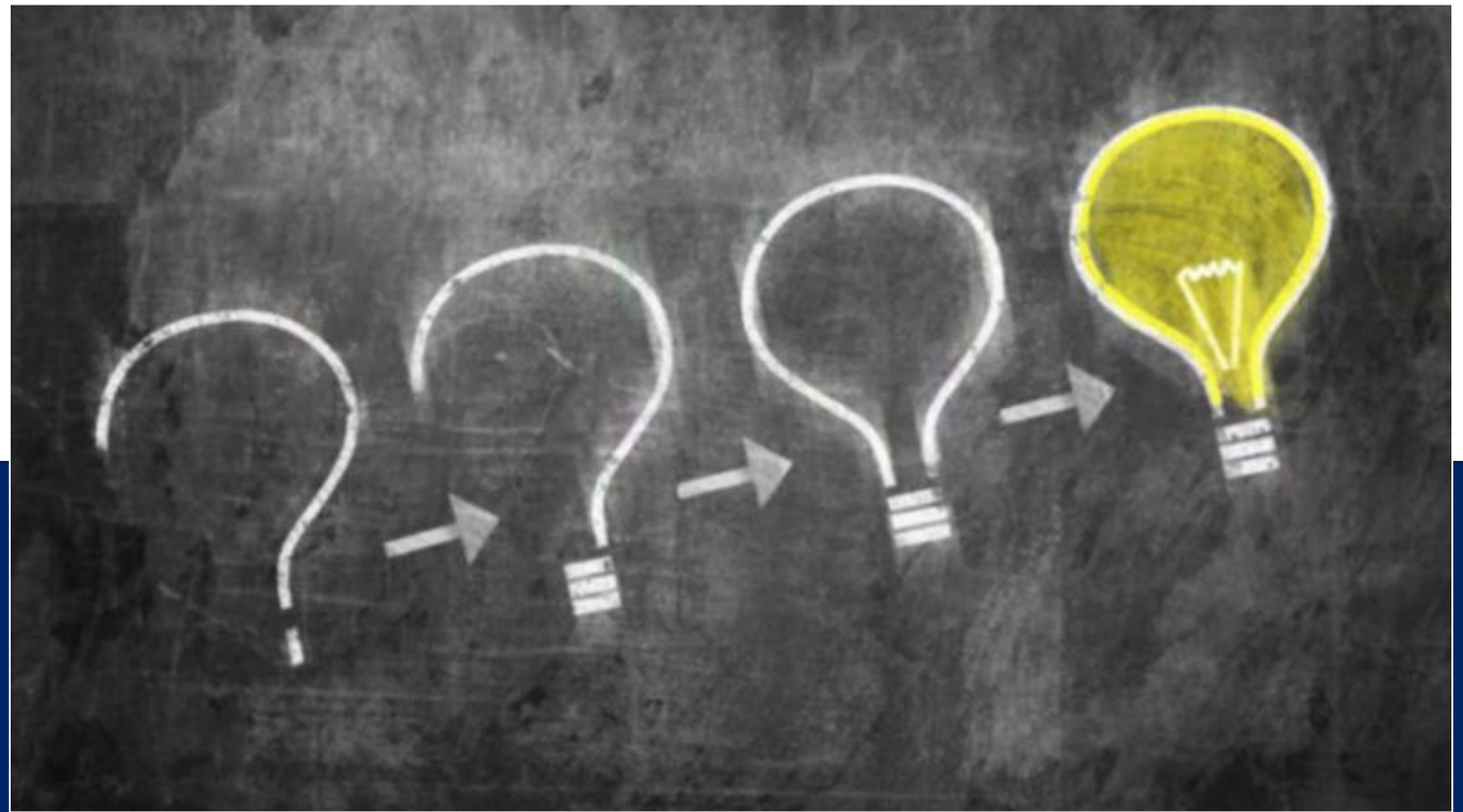
Questions….. ?

Mark Rutherford
Senior Investigator
EPA Specialist Investigations

mark.rutherford@environment.nsw.gov.au

PFAS National Environmental Management Plan (NEMP)

A brief summary



Janina Beyer

October 2020

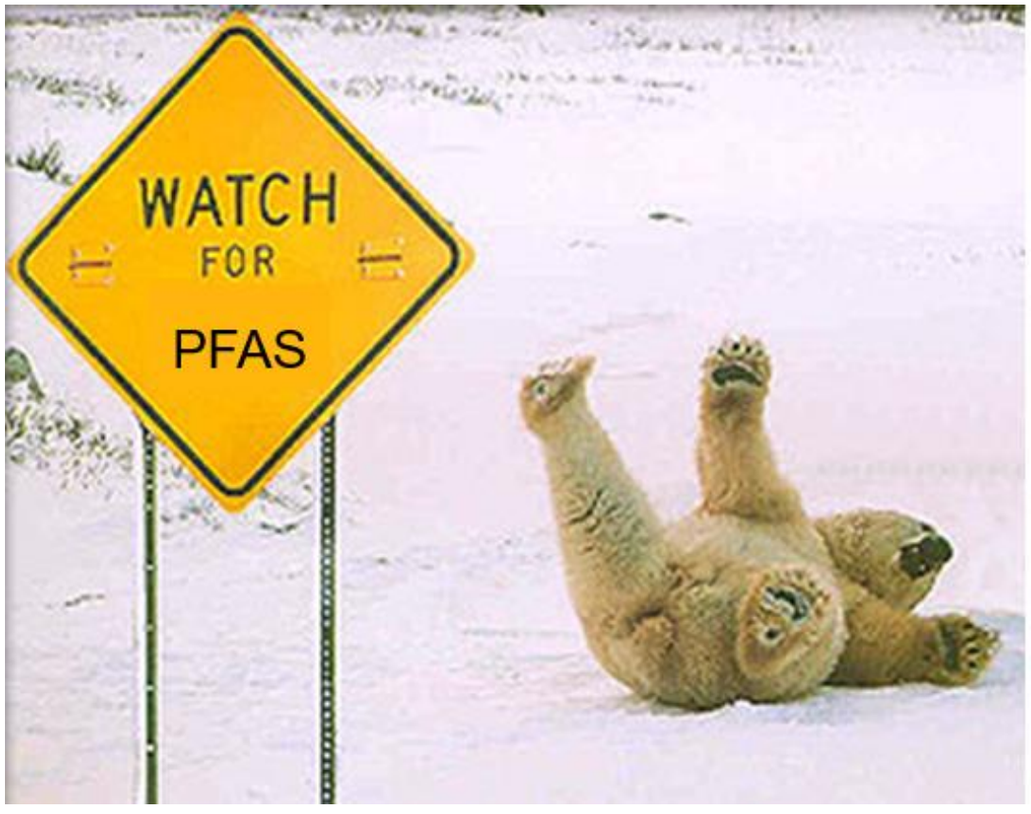
NSW DPIE - Science, Economics & Insights Division - Contaminants and Risk Team

The Journey

- ~~Background on PFAS~~
- A quick look back in time
- NEMP 1.0 & NEMP 2.0 – what has changed?

(focus on guideline values)

- Pointing to other sections in NEMP 2.0 which have additional/updated guidance



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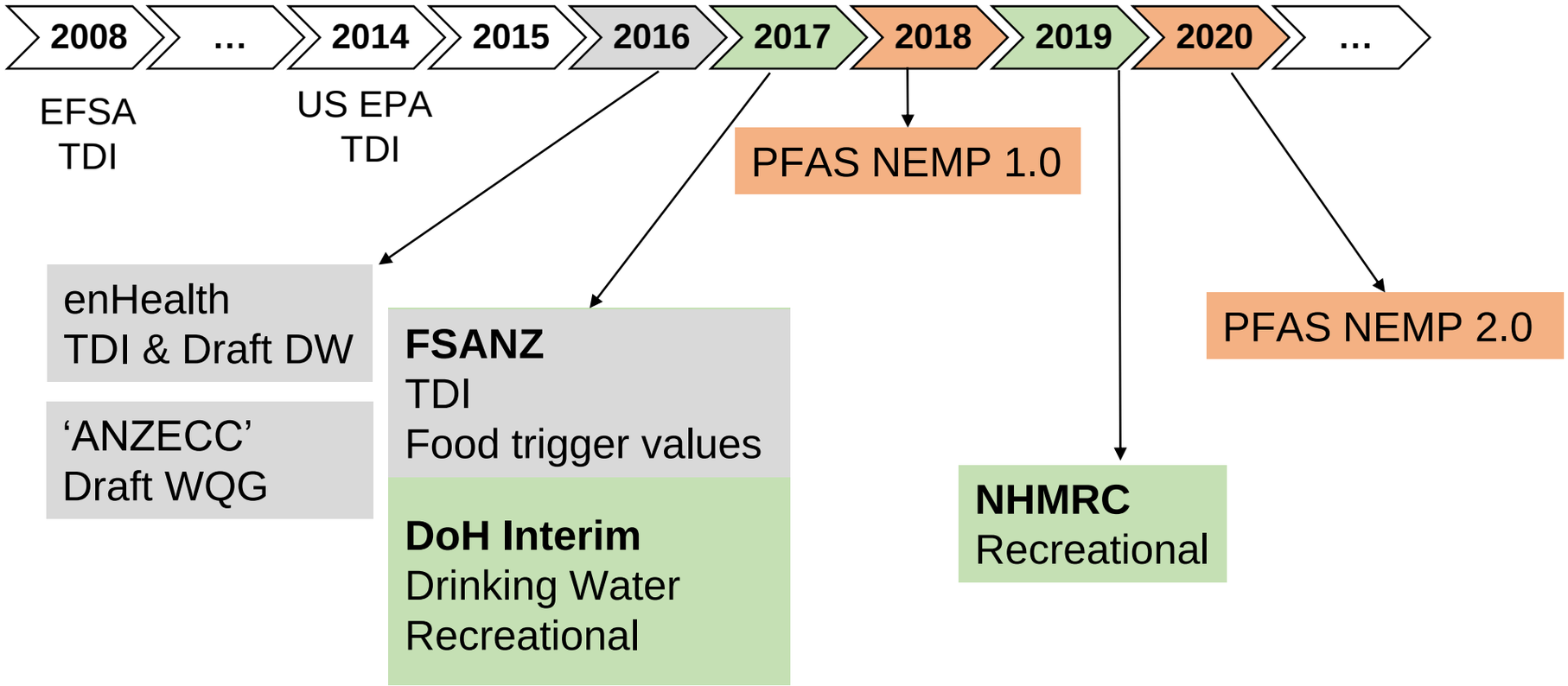
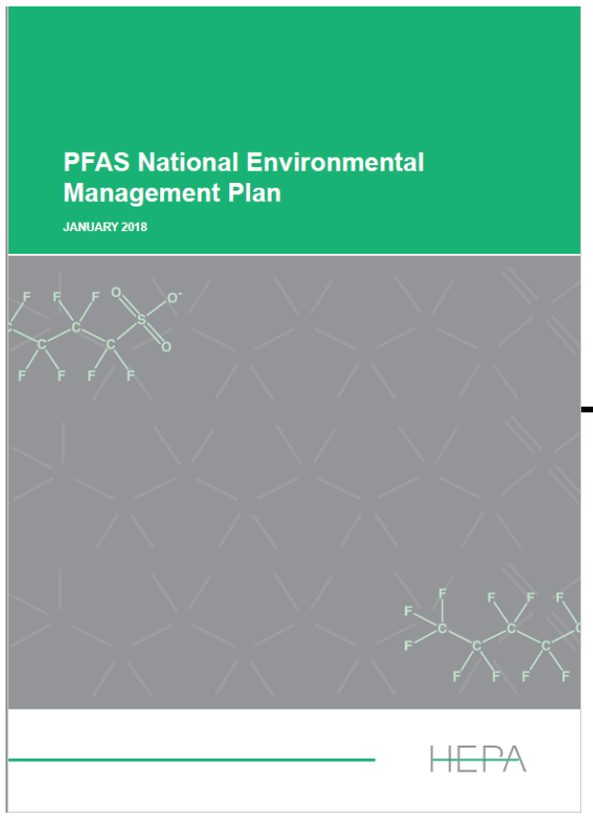
A quick look back – important when site investigation go over several years

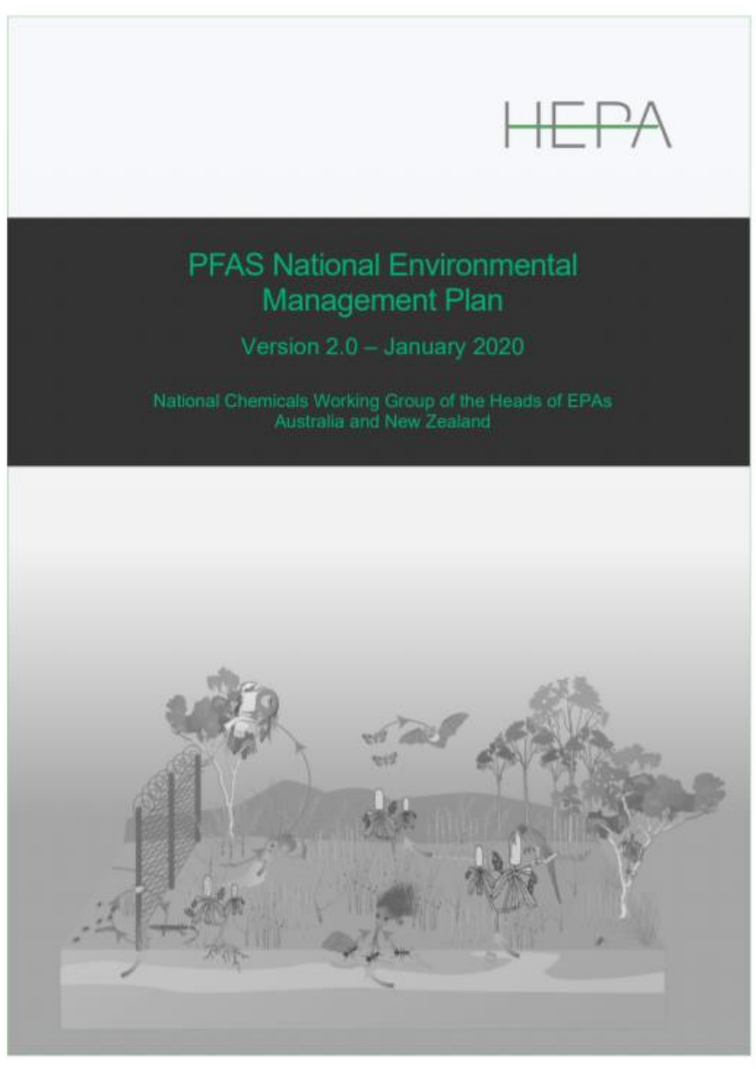


A moving feast

http://sandiharrold.com.au/ Sandi Harrold

What's changed? And what may still change?

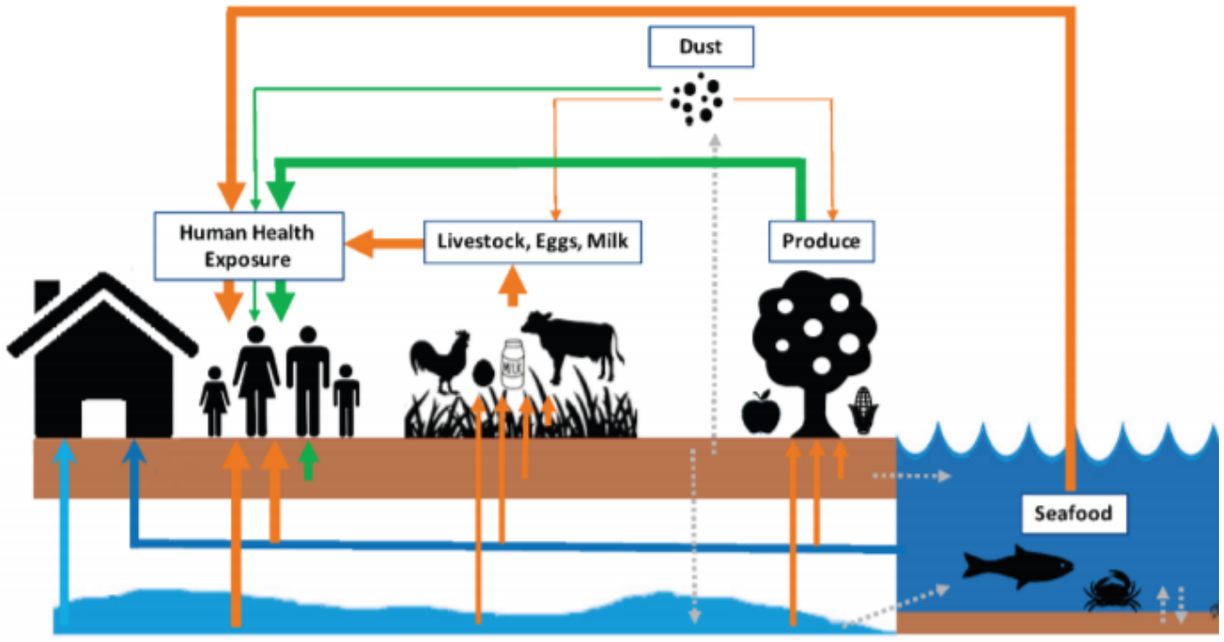


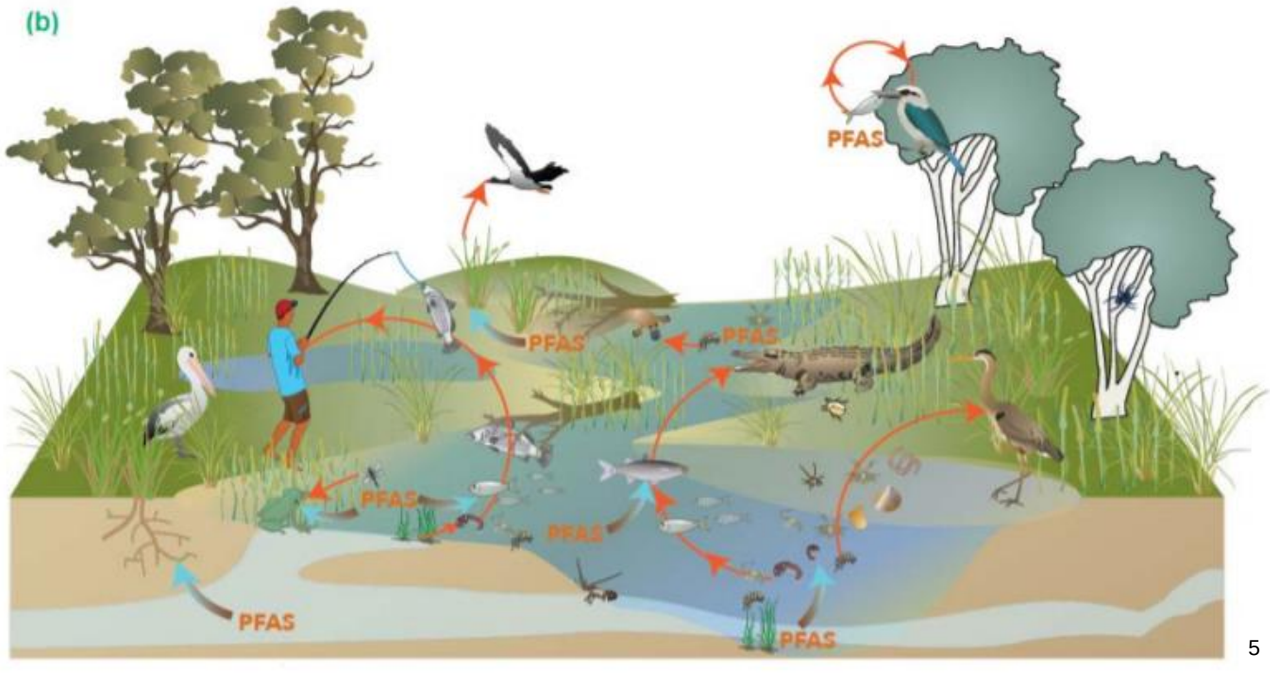


http://www.environment.gov.au/system/files/resources/2fadf1bc-b0b6-44cb-a192-78c522d5ec3f/files/pfas-nemp-2.pdf

PFAS environmental guideline values (Chapter 8 in NEMP 2.0)

Information on Conceptual Site Models (CSM) and key pathways to consider for PFAS





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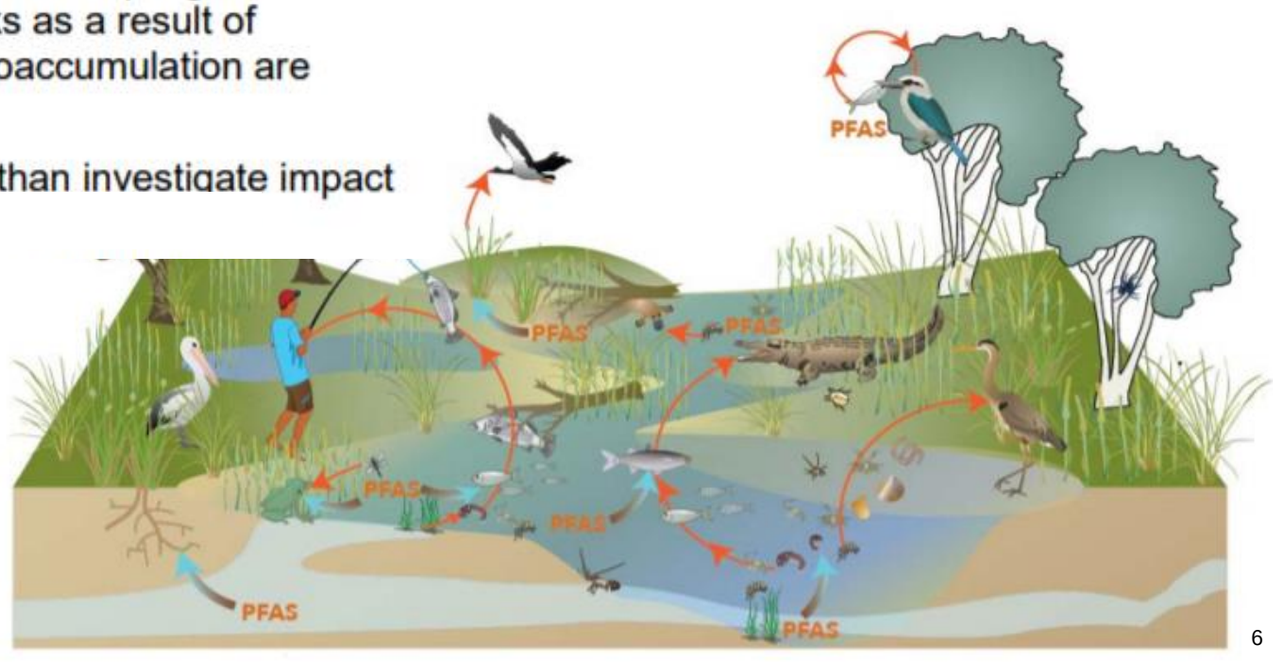
PFAS environmental guideline values (Chapter 8 & Chapter 9)

Bioaccumulation is a key component

8.4.1 Consideration of bioaccumulation

For PFAS, bioaccumulation in aquatic species cannot currently be predicted based on water concentrations. This is evident from site assessment data, where bioaccumulation in fish tissues has been measured, despite water concentrations being at the laboratory detection limits. Therefore, to consider risks as a result of bioaccumulation, direct measurement of aquatic biota is the preferred approach where exposure pathways and sensitive receptors (ecological and/or human) exist[28]. Any sampling program needs to consider if the assessment is for human health and or ecological purposes, as there may be different sampling considerations. Sampling biota will reduce uncertainty in assessing risks as a result of bioaccumulation. Additional details regarding consideration of PFAS bioaccumulation are discussed in section 9.3.2.

Where an assessment has to look forward in a predictive sense rather than investigate impact of existing contamination, multiple lines of evidence should be used.



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PFAS environmental guideline values (Chapter 8 in NEMP 2.0) HUMAN HEALTH

Recreational guideline value (updated NHMRC 2019)

Table 1. Human health guideline values developed by health regulators

Sum of PFOS and PFHxS	PFOA	Description	Comments and source
0.02 µg/kg $_{bw}$ /day	0.16 µg/kg $_{bw}$ /day	Tolerable daily intake (TDI)	FSANZ 2017
0.07 µg/L	0.56 µg/L	Drinking water quality guideline value	Australian Government Department of Health 2019
2 µg/L	10 µg/L	Recreational water quality guideline value*	NHMRC 2019

Notes: bw = body weight, µg = micrograms.

Where the guideline values refer to the sum of PFOS and PFHxS, this includes PFOS only, PFHxS only, and the sum of the two.

*NHMRC (2019) notes that people's use of recreational water is not the same, given Australia's climate and geography. Some recreational water resources may be used less frequently than the assumed guidelines (150 days/year), and (in rare cases) some may be used more frequently. In such cases more locally-appropriate event frequency based recreational guidelines can be considered in consultation with the state and regulatory health regulator.

Orange – changed since NEMP 1.0
Blue – interim/draft

PFAS environmental guideline values

(Chapter 8 in NEMP 2.0) HUMAN HEALTH

Human health investigation levels for soil – residential with garden accessible soil – HIL-A

important for HIL scenarios **– but this is NOT protective of off-site leaching**

(OEH 2019 – derived using HIL-A assumptions but note that values have not been derived under ASC NEPM)

https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Land-and-soil/human-health-soil-screening-criteria-190208.

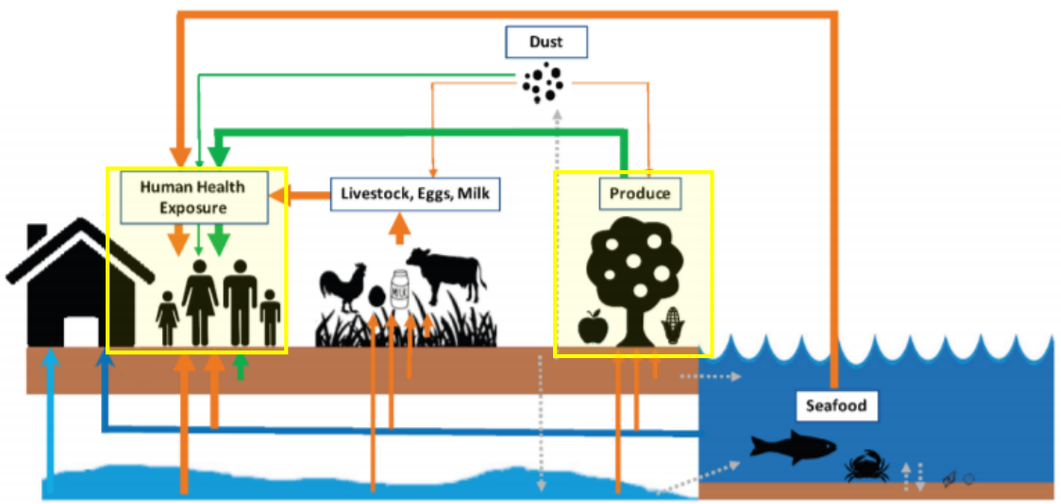

Table 2. Human health investigation levels for soil

Sum of PFOS and PFHxS	PFOA	Land use	Comments and source
0.01 mg/kg	0.1 mg/kg	Residential with garden/accessible soil (HIL A)	Assumes home-grown produce provides up to 10% of fruit and vegetable intake (does not account for consumption of any eggs from home poultry, nor of milk or meat from stock on the premises). Also includes children's day care centres, preschools and primary schools. The HILs were derived using the methodology consistent with assumptions set out in the ASC NEPM for HIL A. Note: If home-grown produce provides more than the 10% of fruit and vegetable intake assumed in the ASC NEPM generic example, a site-specific risk assessment is required. As an example, if home grown produce provides up to 50% of fruit and vegetable intake, the screening value would be 0.002 mg/kg for the sum of PFOS and PFHxS, and 0.02 mg/kg for PFOA.
2 mg/kg	20 mg/kg	Residential with minimal opportunities for soil access (HIL B)	Assumes no potential use of soil for consumption of home-grown produce. Includes dwellings with fully and permanently paved yard space such as high rise-buildings and flats. These were derived using the methodology consistent with assumptions set out in the ASC NEPM for HIL B.
1 mg/kg	10 mg/kg	Public open space (HIL C)	Relevant for public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools (except for soil used for agricultural studies) and footpaths. Excludes undeveloped public open space (such as urban bushland and reserves), which should be subject to a site-specific assessment where appropriate. These were derived using the methodology consistent with assumptions set out in the ASC NEPM for HIL C.
20 mg/kg	50 mg/kg	Industrial/ commercial (HIL D)	Assumes 8 hours is spent indoors and 1 hour spent outdoors at a site such as a shop, office, factory or industrial site. If the typical exposure for a site is predominantly outdoors with significant earthen areas, recalculation of a site-specific value is recommended. These were derived using the methodology consistent with assumptions set out in the ASC NEPM for HIL D. Note: the industrial/commercial direct exposure criterion for PFOA (including its salts and related compounds) has been set as 50 mg/kg in anticipation of the Stockholm Convention low content limit of 50 mg/kg.
Note: Where the guideline values refer to the sum of PFOS and PFHxS, this includes PFOS only, PFHxS only, and the sum of the two.			

Orange – changed since NEMP 1.0
Blue – interim/draft

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Other pathways – no guideline values – requires a risk assessment - home grown produce

One, Two, Three Fat Hens

I know something you don't

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PFAS environmental guideline values (Chapter 8 in NEMP 2.0) - ECOSYSTEMS

Ecological guideline values for soil

NEMP 1.0

Exposure scenario	PFOS mg/kg	PFOA mg/kg	Land use	Comments and source
Interim soil – ecological direct exposure	1	10	Public open space	Human health value
Interim soil – ecological indirect exposure	0.01		Residential	2017 ECCC (soil ingestion by a secondary consumer)
	0.14		Industrial/ commercial	2017 ECCC (impacts on freshwater life)

- PFAS NEMP indicates future work to review these values

NEMP 2.0

Table 3. Ecological guideline values for soil

Exposure scenario	PFOS	PFOA	Land use	Comments and source
Ecological direct exposure	1 mg/kg	10 mg/kg	All land uses	Future work may be undertaken to review available soil guideline values proposed by Australian research and industry organisations [35]. The human health screening value for public open space is used as an interim value (see Table 2).
Ecological indirect exposure	0.01 mg/kg		All land uses	The guideline value is based on dietary exposure of a secondary consumer as the most sensitive exposure pathway assessed. This value may not be protective of specific animals relevant to Australia, including predatory animals such as quolls, antechinus and reptiles. For intensively developed sites with no secondary consumers and minimal potential for indirect ecological exposure, a higher criterion of up to 0.14 mg/kg may be appropriate as outlined in the accompanying text in section 8.2.1.

Orange – changed since NEMP 1.0
Blue – interim/draft

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PFAS environmental guideline values

(Chapter 8 in NEMP 2.0) - ECOSYSTEMS

Biota guideline values

Measured in food consumed by biota
(NOT water, sediments or soil)

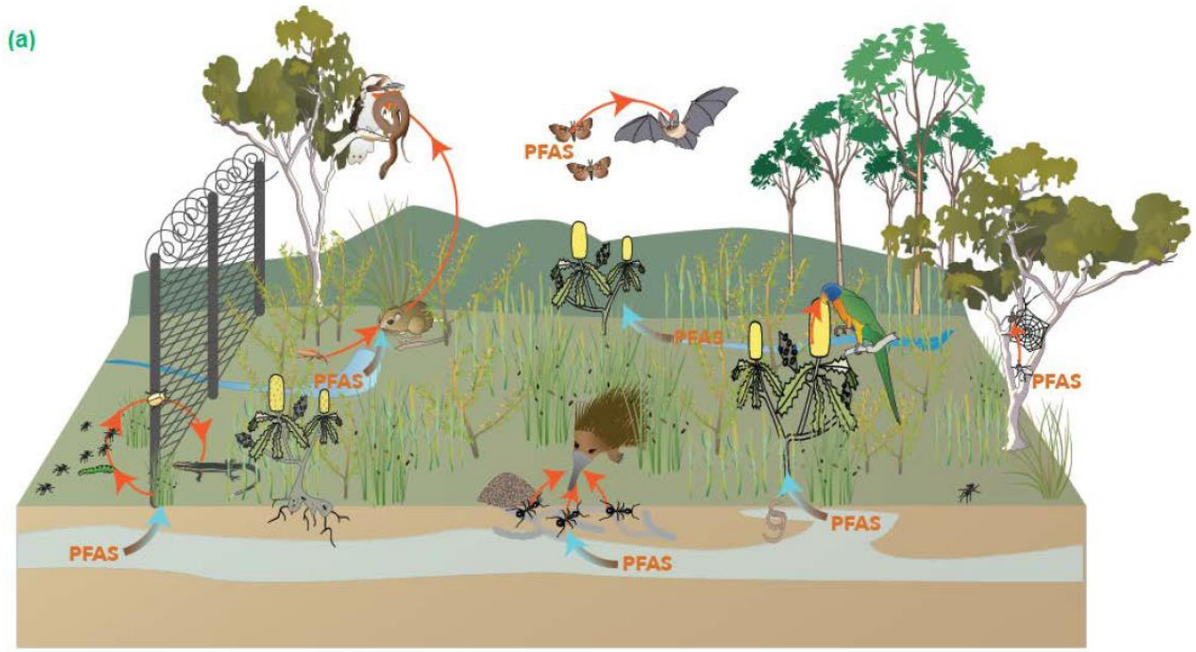

Table 4. Biota guideline values

Exposure scenario	Sum of PFOS and PFHxS	PFOA	Description	Comments and source
Ecological direct exposure for wildlife diet	4.6 µg/kg		Mammalian diet - consumption of biota as wet weight food	Canadian Federal Environment Quality Guidelines (ECCC 2018). This guideline value is to be used on sampled biota tissue for assessing risk to mammal and avian receptors based on their diet. The avian diet value may not be protective of migratory wading birds that have a high food intake due to the need to gain weight rapidly. These diet values may also not be protective of reptiles and amphibians.
	8.2 µg/kg		Avian diet - consumption of biota as wet weight food	
Ecological exposure protective of birds	0.2 µg/g		Whole bird egg as wet weight	Adapted from Canadian Federal Environment Quality Guidelines (ECCC 2018) using an additional uncertainty factor. This guideline value is to be used on sampled bird eggs to assess risk to sensitive avian ecological receptors.
Notes: Where the guideline values refer to the sum of PFOS and PFHxS, this includes PFOS only, PFHxS only, and the sum of the two. The Canadian guidelines refer to the criterion for PFOS only; in the NEMP the guideline values for ecological direct exposure for wildlife diet refer to the levels of PFOS and PFHxS in food consumed by mammals or birds. This has been adapted to allow for uncertainties and potential similar toxicities of PFHxS with PFOS. The guideline value for ecological exposure protective of birds refers to the levels of PFOS and PFHxS in bird eggs.				

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PFAS environmental guideline values

(Chapter 8 in NEMP 2.0) - ECOSYSTEMS

Draft ANZG –

Currently being reviewed – potential changing

Bioaccumulation remains an issue

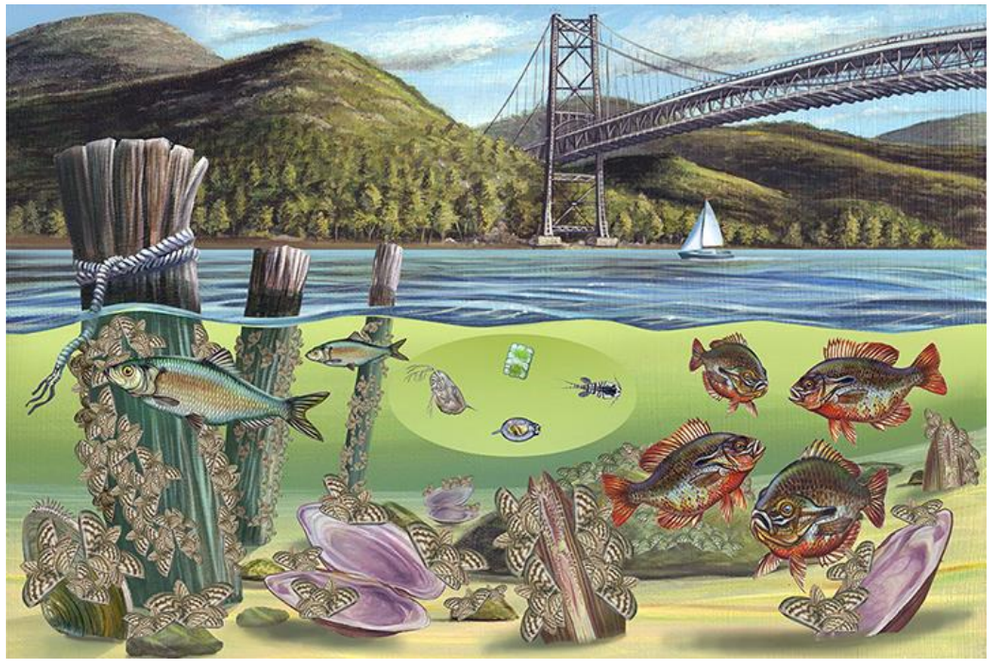


Table 5. Ecological water quality guideline values developed by water regulators

Exposure scenario	PFOS	PFOA	Exposure scenario	Comments and source
Freshwater	0.00023 µg/L	19 µg/L	99% species protection - high conservation value systems	Australian and New Zealand Guidelines for Fresh and Marine Water Quality - technical draft default guideline values for PFOS and PFOA. Note 1: The 99% species protection level for PFOS is close to the level of detection. Agencies may wish to apply a 'detect' threshold in such circumstances rather than a quantified measurement. Note 2: The draft guidelines do not account for effects which result from the biomagnification of toxicants in air-breathing animals or in animals which prey on aquatic organisms. Note 3: The WQGs advise [41] that the 99% level of protection be used for slightly to moderately disturbed systems. This approach is generally adopted for chemicals that bioaccumulate and biomagnify in wildlife. Regulators may specify or environmental legislation may prescribe the level of species protection required, rather than allowing for case-by-case assessments.
	0.13 µg/L	220 µg/L	95% species protection - slightly to moderately disturbed systems	
	2 µg/L	632 µg/L	90% species protection - highly disturbed systems	
	31 µg/L	1824 µg/L	80% species protection - highly disturbed systems	
Interim marine	0.00023 µg/L	19 µg/L	99% species protection - high conservation value systems	As above. Freshwater values are to be used on an interim basis until final marine guideline values can be set using the nationally-agreed process under the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Note 1: The WQG advise that in the case of estuaries, the most stringent of freshwater and marine criteria apply, taking account of any available salinity correction. Note 2: Marine guideline values developed by CRC CARE are under consideration through the nationally-agreed water quality guideline development process.
	0.13 µg/L	220 µg/L	95% species protection - slightly to moderately disturbed systems	
	2 µg/L	632 µg/L	90% species protection - highly disturbed systems	
	31 µg/L	1824 µg/L	80% species protection - highly disturbed systems	

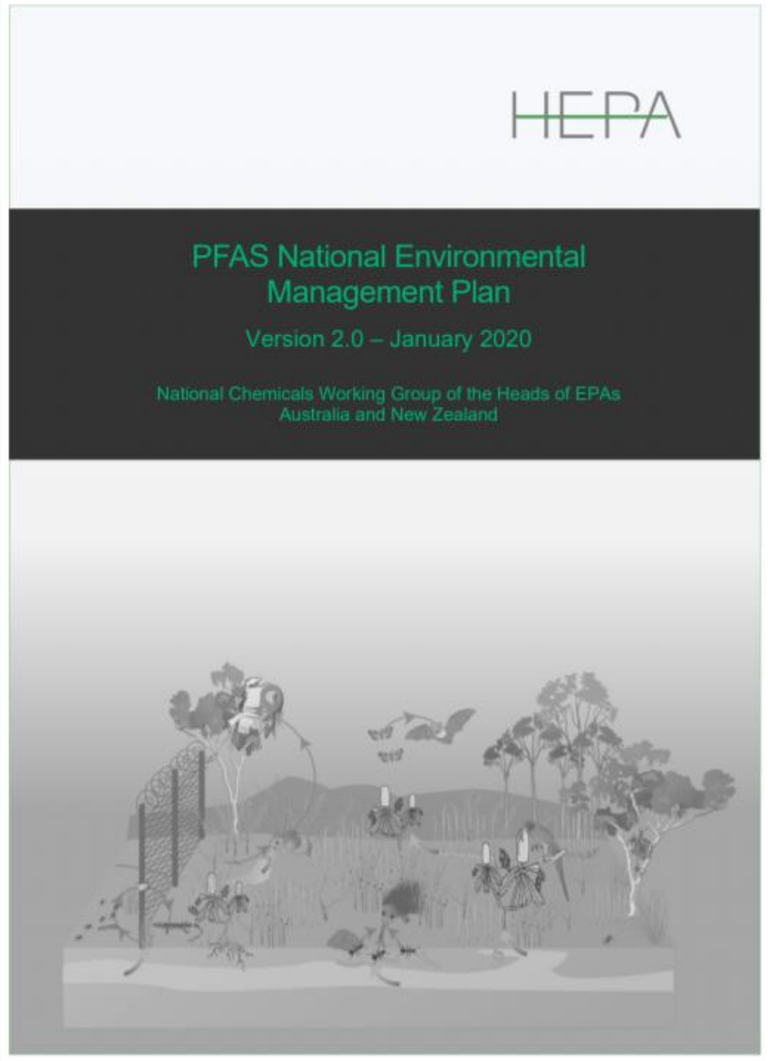
Chapters in PFAS NEMP 2 which have important updates in the text

5 PFAS monitoring

8 PFAS environmental guidelines

10 On-site stockpiling, storage and containment

12 Reuse of PFAS-contaminated materials including soils and water



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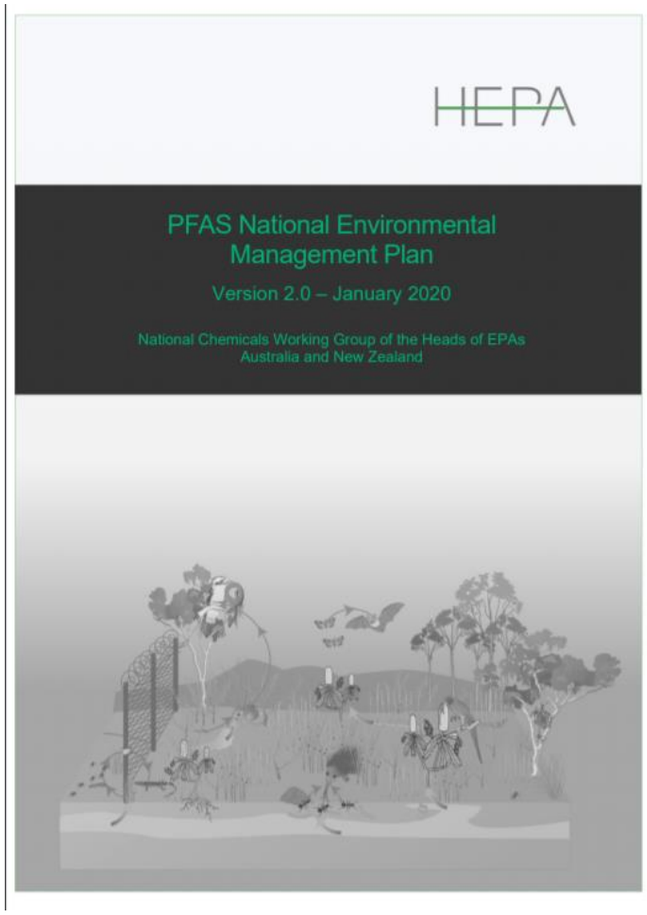
http://www.environment.gov.au/system/files/resources/2fadf1bc-b0b6-44cb-a192-78c522d5ec3f/files/pfas-nemp-2.pdf

PFAS NEMP 2 – quick focus on

13 PFAS treatment and remediation

Listed below is the preferred hierarchy of treatment and remediation options:

1. Separation, treatment and destruction. This involves on-site or off-site treatment of the PFAS-contaminated material so that it is destroyed, removed, or the associated risk is reduced to an acceptable level.
2. On-site encapsulation in constructed stockpiles or engineered storage and containment facilities, with or without chemical immobilisation. If the source site is hydrogeologically appropriate, on-site encapsulation may acceptably manage on- and off-site risks to direct and indirect beneficial uses and environmental values of soils, surface water, groundwater, and biota.
3. Off-site removal to a specific landfill cell. This may or may not include immobilisation prior to landfill disposal, noting that the conditions in the landfill may reverse or diminish the immobilisation chemistry in ways that are difficult to predict. Immobilisation prior to landfill disposal may require environmental regulatory approval. Leachate should be captured and treated to remove PFAS and the removed PFAS should be destroyed.



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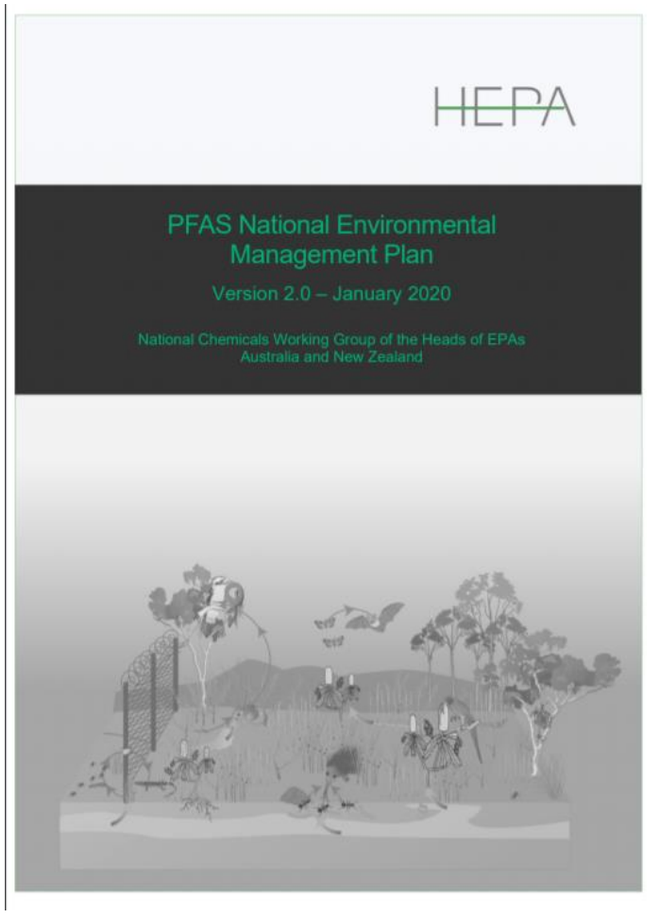
PFAS NEMP 2 – quick focus on

13 PFAS treatment and remediation

Before choosing a remediation or treatment option, the following should be considered:

- Proportionate to risks
- Sustainability of option
- Views of affected communities and jurisdictional regulators
- Availability of the best treatment or remediation technologies
- Site specific issues
- Effectiveness of technology as demonstrated by destruction efficiency or the reduction in PFAS concentration
- Treatment strategy
- Validation
- Understanding PFAS precursors



http://www.environment.gov.au/system/files/resources/2fadf1bc-b0b6-44cb-a192-78c522d5ec3f/files/pfas-nemp-2.pdf

NSW GOVERNMENT Planning, Industry & Environment

Planning, Industry & Environment

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NSW EPA – Site Auditors Meeting

Friday 30 October 2020

Draft Sampling Design Guidelines

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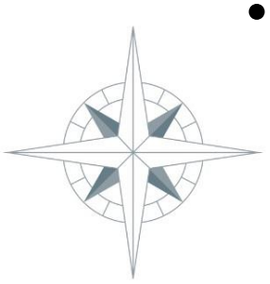
Sampling design guidelines (SDG)

What's coming?

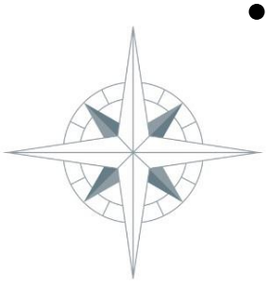
- Overview of presentation,
- Consultation process for the SDG,
- Summary of the development of the SDG,
- Overview of Part 1 Application,
- Overview of Part 2 Interpretation,
- Why the approach taken?



Sampling design guidelines

What's coming?

- Environmental data lifecycle (EDLC) – DQOs,
- Sampling design - targeted sampling example,
- Table 3 - Number of sampling locations based on grid size,
- Application of MPE method,
- What else is needed?
- Questions, comments and the like …?



Consultation process

EPA are seeking public feedback on the 2020 draft sampling design guidelines for contaminated land:

- Open for consultation until 5.00 pm Sunday 8 November,
- https://yoursay.epa.nsw.gov.au/sampling-design-guidelines,
- Once finalised and released, the new guidelines will replace the 1995 sampling design guidelines,
- Important that meaningful feedback is provided!

Consultation process

Feedback can be provided by:

- emailing a submission to CLM.consultation@epa.nsw.gov.au,
- Completing an online survey, or
- For auditors and practitioners, I would think emailing a submission, which also includes the survey questions,
- Specific section/page references would presumably be helpful.

Consultation process

Survey questions:

- Are the guidelines easy to understand given the technical nature of the content and the intended audience?
- Do the guidelines focus too much on reiterating basic statistics and should some of that content be removed?
- If so, which areas or topics should be removed or shortened?
- (or perhaps, are there areas or topics which should be expanded or included?)

Consultation process

Survey questions:

- Is it useful having the guidelines in two parts (Application and Interpretation)?
- Are there any key elements missing from the guidelines?
- Any other comments?

EPA will collate all the comments and then, depending on the nature of the comments received, determine the next steps.

Summary of the development process

How did they come about?

- Over the years there were a few EPA – auditor working groups and meetings, but never quite got off the ground …
- November 2017, Marc Salmon presented to EPA on improvement of experimental design through use of the DQOs and statistics. Abridged version of UTS CSARM Module B *Effective Site Assessment* presentation.
- December 2017 – January 2018, Easterly Point and Enviroview developed a draft table of contents for the proposed SDG.

Summary of the development process

- February – March 2018, tender for and award of *recommended revised SDG* and associated justifications report. Project team: Marc Salmon of Easterly Point, Peter Beck of GHD and David Wai formerly of EPA and author of 1995 SDG.

- March 2018 - January 2019, recommended revised SDG and justifications report submitted. Originally due in July, but breath of project resulted in variation to allow additional time.

- December 2019, work shop with EPA – auditors – consultants. Auditors: James Davis, Julie Evans and Marc Salmon Consultants: Brendan Page, Seth Molinari and Amy Valentine.

- September 2020, draft sampling design guidelines released.

Summary of the development process

- An EPA project team worked on it, with support from Sara Arthur.
- EPA consulted internally between July 2018 to July 2020 with:
  - EPA staff experienced in regulating contaminated land and the waste sector,
  - Contaminants and Risk (Science) staff, and
  - a statistician from DPIE Science Economics Insight group.

Part 1 - Application

Describes and outlines the processes in developing sampling designs and plans.

1. Introduction
2. Systematic planning
3. Environmental sampling considerations
4. Objectives of sampling programs
5. Sampling design
6. Hotspot detection
7. Number of samples required
8. Abbreviations and glossary
9. References

Part 1 - Application

Appendix A DQOs and the environmental data life-cycle process

Appendix B Data-quality objectives: worked example

Appendix C Determining sampling grids for hotspot detection

Appendix D Summary of existing guidance for sample design

Appendix E Determining the number of samples by the CRV method

Appendix F Determining the number of samples by the MPE method

Appendix G Further methods for consideration

Part 2 - Interpretation

Provides guidance on statistical analysis methods and the interpretation of sampling results.

1. Introduction
2. Comparing data results to action levels
3. Distributions, transformations and data analysis
4. Hypothesis testing
5. Confidence intervals and upper confidence limits
6. Trend analysis
7. Abbreviations and glossary
8. References

Part 2 - Interpretation

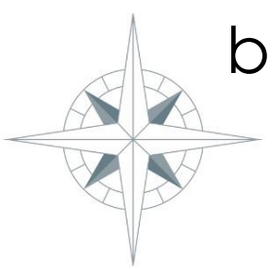
Appendix A Descriptive statistics
Appendix B Determining quartiles
Appendix C Determining measures of central tendency
Appendix D Determining measures of variability
Appendix E Assessing contaminant distribution
Appendix F One-sample t-test hypothesis testing
Appendix G Two-sample t-test hypothesis testing
Appendix H Decision errors
Appendix I 95% confidence intervals
Appendix J 95% UCL $\bar{x}$ for normal distributions
Appendix K 95% UCL $\bar{x}$ for log-normal distributions
Appendix L 95% UCL $\bar{x}$ for skewed distributions

The big picture - why the approach taken

The scope of the SDG was originally perceived as a guidance manual, where users could look up the decision required and then go to the relevant method, i.e. “down the column and across the row” style guidance.

However, the project team’s view was that practitioners needed a tool to help understand and think about their design and analysis; more a textbook than a cookbook.

For example, the *Water Quality Monitoring Guideline* describes that because water quality studies are necessarily situation specific, it is impossible to be prescriptive about the designs involved in them, beyond noting the need for several independent lines of evidence.



What's old is new again?

Also trying to give practitioners some tools to better understand their resulting data, and to get more information from it.

Not necessarily a new concept, e.g. the Queensland 1998 guidelines described that in addition to showing data on site plans and estimating population parameters, "histograms or frequency distributions should be used to illustrate the distribution results".

The SDG is also aligned with the latest guidance from the UK (2020), which describes that this "guidance addresses the problem of potentially erroneous conclusions by dropping the reliance on a single scientific test (hypothesis testing), and emphasises the importance of a comprehensive understanding of the datasets in the context of the CSM".

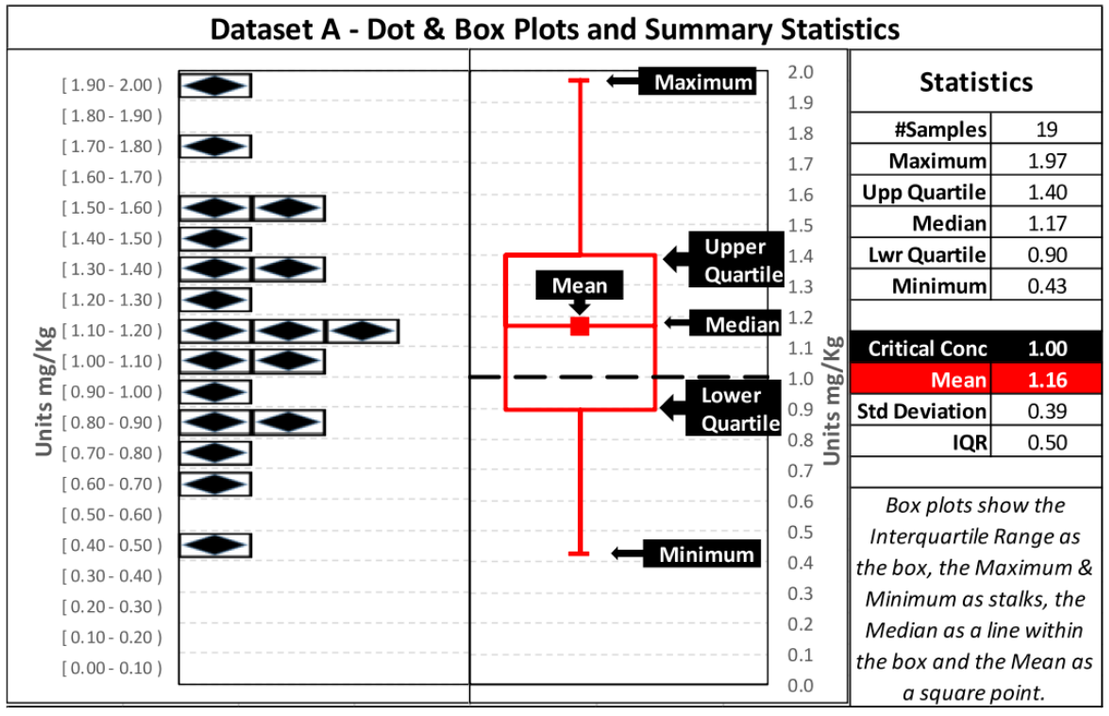


Figure 4.2. Dot & box plot and summary statistics for dataset A.

CL:AIRE (2020) *Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration*.

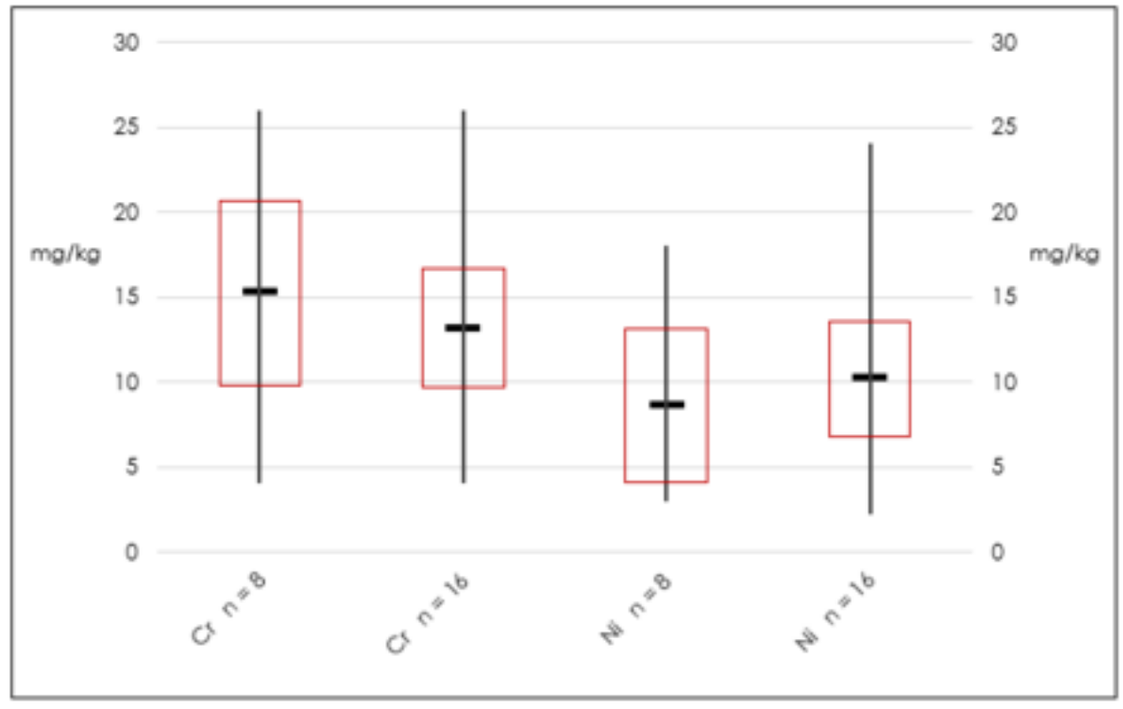


Figure 12 Summary statistics for Cr and Ni data with variable n (mg/kg) – minimum, 95% LCL, mean, 95% UCL, maximum

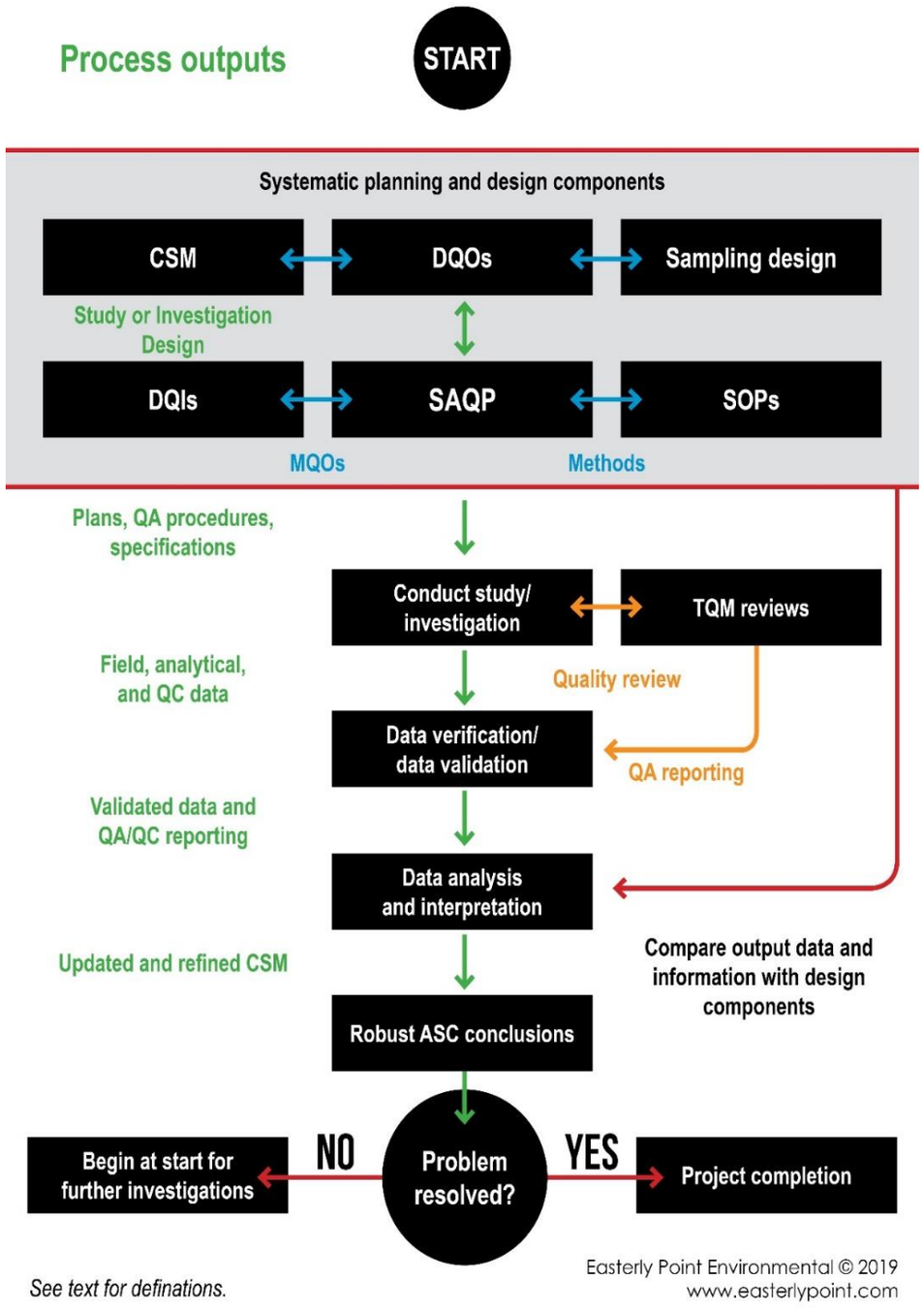
EPA (2020) *Contaminated Land Guidelines Sampling design part 2 – interpretation, Appendix I: 95% confidence intervals.*

Environmental data lifecycle (EDLC) – DQOs

1995 SDG only mentioned DQOs in *Limitations as* "Laboratory requirements do not form part of these guidelines, but Data Quality Objectives (DQO) should be established before sampling starts".

Increased emphasis on CSMs and DQOs in 2020 version, consistent with ASC NEPM and other guidance.

Introduces the USEPA's terminology of environmental data lifecycle (EDLC), to emphasise that all of these are component parts of a larger process.



The ASC NEPM describes that the DQOs process is used to define "the type, quantity and quality of data needed".

USEPA's 2015 ProUCL Technical Guide, in discussing hypotheses testing approaches, highlights that "good quality data" relates to representative data. Precision also important.

That is, the data set is sufficiently representative of the population under study; which in this context relates to field variability, with measurement variability addressed elsewhere in the EDLC process.

Omitted from judgemental sampling?

Recommended but omitted. Comments on relevance?

Judgmental sampling should not be used in isolation for site characterisation unless site histories of very high integrity exist, and detailed documentation of the history and site information is able to be provided, to support the decision.

Examples where this may be appropriate include remnant bushland, which has never been developed or sites where only extensive agriculture has occurred, although in both cases thorough inspection is required to ensure that no filling of land, dumping of wastes, or any other activities have occurred.

Omitted from judgemental sampling?

Where detailed site histories, including aerial photograph reviews, and physical features, show any past use beside strictly remnant bushland or extensive agriculture, systematic sampling is necessary in the areas of past use. This includes any building or structures, yards, dams, cattle dips, storage of fuels or chemicals, use of chemicals, filling, stockpiles, uneven or hummocky ground (indicative of past use of filling), or any other indication of use.

Perhaps more relevant in regional areas, but is a reoccurring situation, where a tight sampling grid seems excessive. Thoughts please?

Table 2 and Table 3

Table 3 Number of sampling locations based on grid size

Area size (m^2)	12 m	13 m	14 m	15 m	16 m	17 m	18 m	19 m	20 m
500	5	5	5	5	5	5	5	5	5
1,000	7	6	6	5	5	5	5	5	5
2,000	14	12	11	9	8	7	7	6	5
3,000	21	18	16	14	12	11	10	9	8
4,000	28	24	21	18	16	14	13	12	10
5,000	35	30	26	23	20	18	16	14	13
6,000	42	36	31	27	24	21	19	17	15
7,000	49	42	36	32	28	25	22	20	18
8,000	56	48	41	36	32	28	25	23	20
9,000	63	54	46						
10,000	70	60	52						
15,000	105	89	77						
20,000	139	119	103						

70 sample locations per ha?

Table 2 Systematic sampling grid size by proposed land use

Proposed land use	Grid size
Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, (no poultry), also includes children's day care centres, preschools and primary schools	12 m
Residential with minimal opportunities for soil access includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats	14 m
Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves) which should be subject to a site-specific assessment where appropriate	16 m
Commercial / industrial such as shops, offices, factories and industrial sites	18 m

Rationale to sampling density

Draft SDG based on concepts from the 2013 British Standard:

- the more sensitive the receptors or the greater the hazard, the greater the degree of confidence needed and the greater the number of sampling locations and samples; and
- typical densities of sampling grids can vary from 25 m to 50 m centres for exploratory investigations, and 10 m to 25 m centres for main investigations.

We recommended 22 – 26 sample locations per ha, based on:

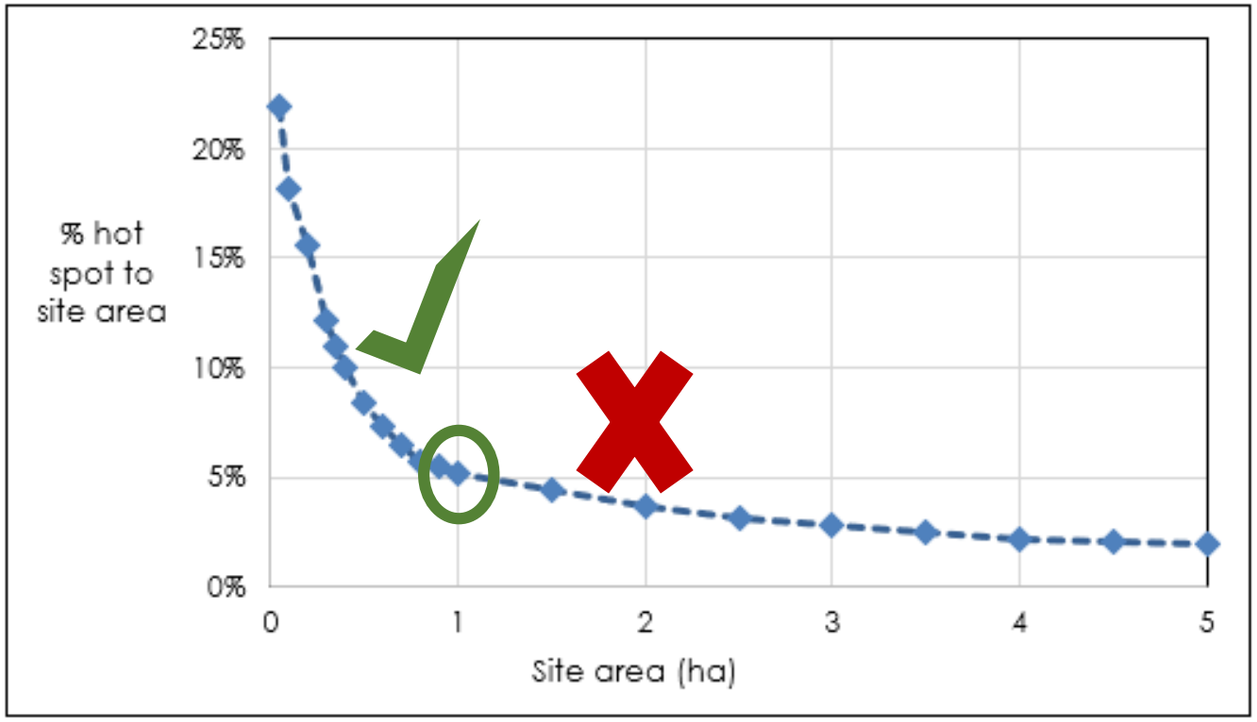
- sample design should be able to detect a "hotspot" occupying ~ 5% of the site (or decision) area; and
- one sample per lot was reasonable for buyer and not onerous for seller. Lot sizes of 400 m^2 (20 x 20 m) – 500 m^2 (~ 22.4 x 22.4 m).

Rationale to sampling density

We did not support the reduction of the sample density as the site size increased, but felt that the density for 1 ha should be replicated for the whole site, e.g. *Guidelines for Assessing Banana Plantation Sites*.

We did support the increased sample density for sites less than 1 ha.

Felt that characterisation is based on CSM and past use; not future. Variable HILs A – D account for that.



Size of hot spot that can be detected relative to site area

Number of samples by MPE

$$n = t_{95\%}{}^2 * \left(\frac{{}^{s}/_{\bar{x}}}{\frac{t_{95\%} * \left({}^{s}/_{\sqrt{n}}\right)}{\bar{x}}} \right)^2$$

t95% t value at 95% confidence level;

s sample standard deviation;

$\bar{x}$ sample arithmetic average;

MPE Margin of error (MoE)/ $\bar{x}$

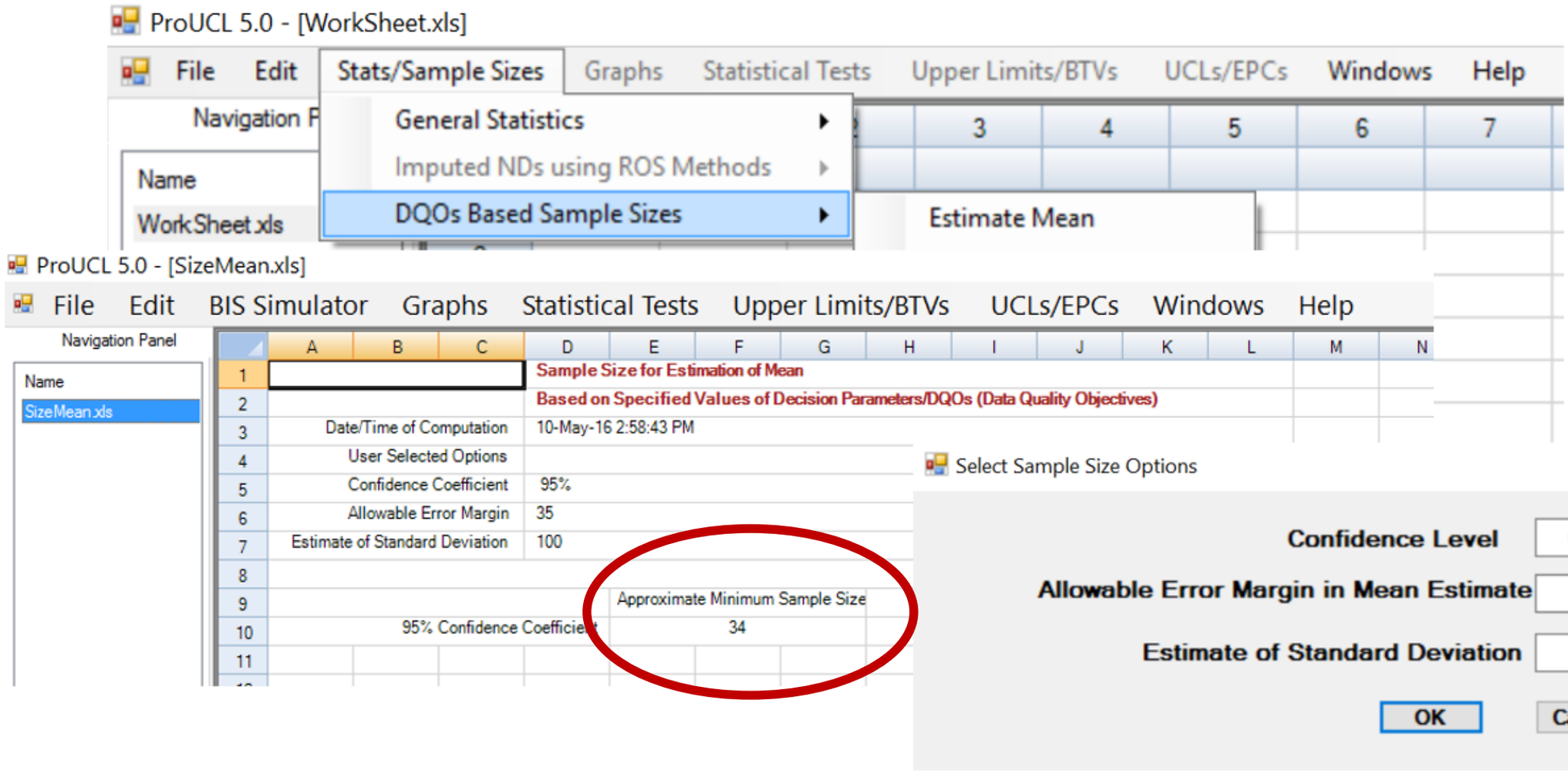
MoE $MoE = t_{95\%} \frac{s}{\sqrt{n}}$

Which reduces to n = n, so it can't be used retrospectively; i.e. it will tell you to collect the number of samples you collected!

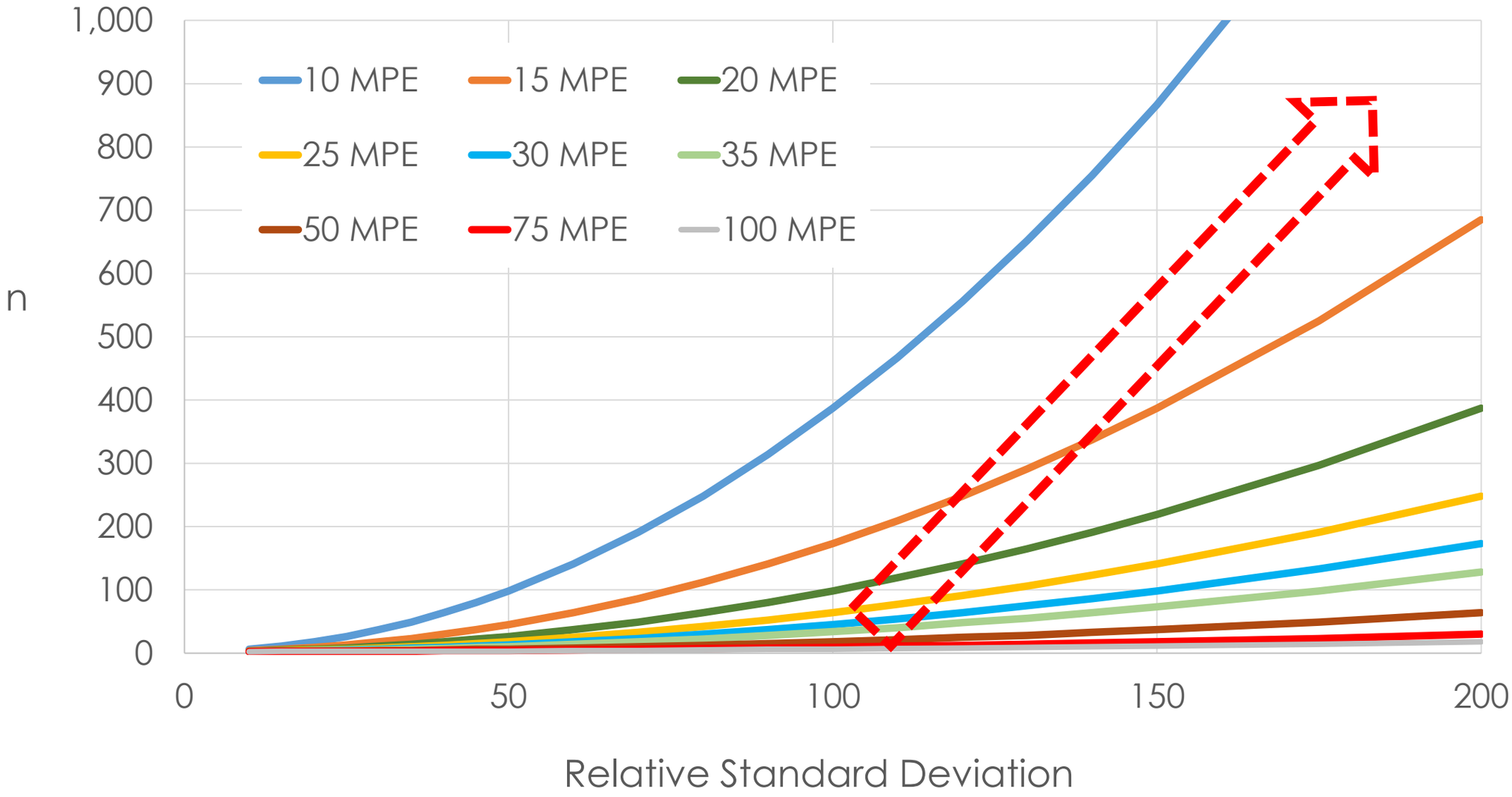
$$n = t_{95\%}{}^2 * \left(\frac{{}^{s}/_{\bar{x}}}{\frac{t_{95\%} * \left({}^{s}/_{\sqrt{n}}\right)}{\bar{x}}} \right)^2$$

Standardised form using RSD and MPE, as a % by "/$\bar{x}$"

Number of samples by MPE



Number of samples by MPE



Number of samples by MPE

	Sample Size for Estimation of Mean
	Based on Specified Values of Decision Parameters/DQOs (Data Quality Objectives)
Date/Time of Computation	29/10/2020 4:43:11 PM
User Selected Options	
Confidence Coefficient	95%
Allowable Error Margin	96.1
Estimate of Standard Deviation	115

Surface fill

	Approximate Minimum Sample Size
95% Confidence Coefficient	8

	Sample Size for Estimation of Mean
	Based on Specified Values of Decision Parameters/DQOs (D
Date/Time of Computation	29/10/2020 4:43:42 PM
User Selected Options	
Confidence Coefficient	95%
Allowable Error Margin	50
Estimate of Standard Deviation	115

Surface fill

	Approximate Minimum Sample Size
95% Confidence Coefficient	23

	Sample Size for Estimation of Mean
	Based on Specified Values of Decision Parameters/DQOs (Data Quality Objectives)
Date/Time of Computation	29/10/2020 4:44:18 PM
User Selected Options	
Confidence Coefficient	95%
Allowable Error Margin	44.2
Estimate of Standard Deviation	52.8

Depth fill

	Approximate Minimum Sample Size
95% Confidence Coefficient	8

Part 1, Appendix F

	Surafce fill	Surafce fill	Depth fill
n	**8**	**23**	**8**
RSD	**115%**	**115%**	**52.8%**
MPE	**96.1%**	**50%**	**44.2%**

n = 8, ok

n = 8, low precision

n = 23, ok

depth fill

surface fill

RSD	10 MPE	15 MPE	20 MPE	25 MPE	30 MPE	35 MPE	50 MPE	75 MPE	100 MPE
10	**6**	4	3	3	3	3	3	2	2
15	**11**	**6**	5	4	3	3	3	3	3
20	**18**	**9**	**6**	5	4	4	3	3	3
25	**26**	**13**	**8**	**6**	5	4	3	3	3
30	**37**	**18**	**11**	**8**	**6**	5	4	3	3
35	49	**23**	**14**	**10**	**8**	**6**	4	3	3
40	64	**30**	**18**	**12**	**9**	**7**	5	4	3
45	80	**37**	**22**	**15**	**11**	**9**	6	4	3
50	98	45	**26**	**18**	**13**	**10**	**6**	4	3
60	141	64	**37**	**25**	**18**	**14**	**8**	5	4
70	191	86	49	**33**	**23**	**18**	**10**	**6**	4
80	248	112	64	**42**	**30**	**22**	**12**	**7**	5
90	314	141	80	52	**37**	**28**	**15**	**8**	6
100	387	173	98	64	45	**34**	**18**	**9**	**6**
110	467	209	119	77	54	**40**	**21**	**11**	**7**
120	556	248	141	91	64	48	**25**	**12**	**8**
130	652	291	165	106	75	55	**28**	**14**	**9**
140	755	337	191	123	86	64	**33**	**16**	**10**
150	867	387	219	141	98	73	**37**	**18**	**11**

8

MPE 44.2%

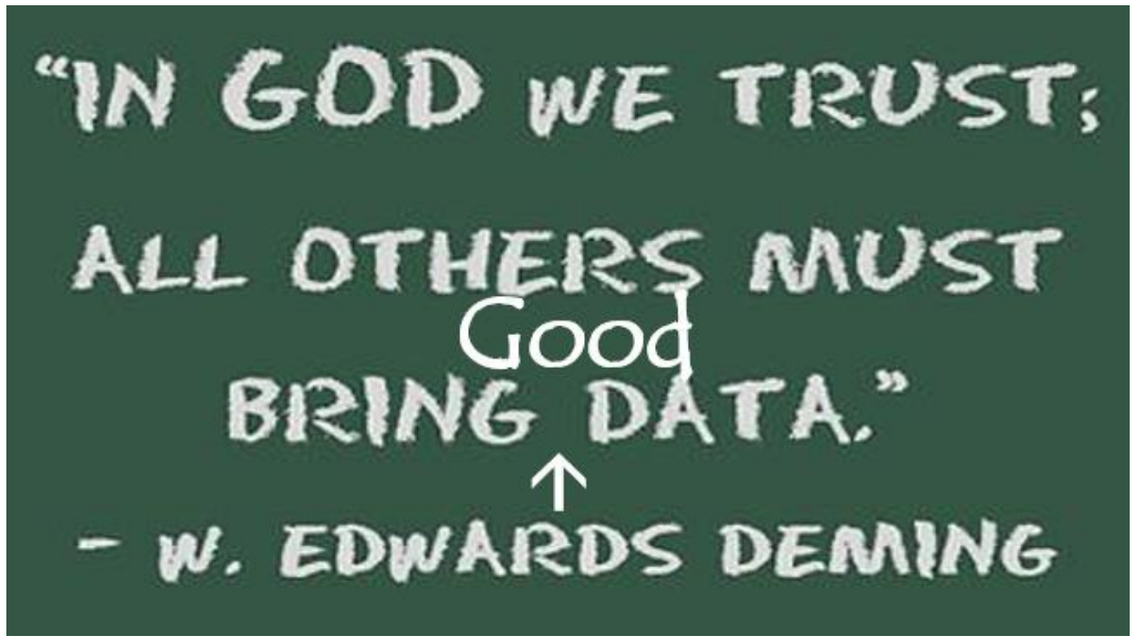
23

MPE 50%

8

MPE 96.1%

The 1995 SDG have been described as too complicated for the layperson, and too simplistic for practitioners.



The hope is that the 2020 SDG will assist the practitioners (and make auditors' lives easier), while informing the layperson?