

# Asbestos in Soil

Presentation to **NSW Site Auditors**  
From **SafeWork NSW**

April 2021



# Land Contaminated with ACM

## How?

- Illegal dumping
- Inappropriate demolition of AC structures in the past
- Inadequate remediation of contaminated land sites



# WHS Asbestos Classification

**Friable asbestos** means material that is in powder form or that can be crumbled, pulverised or reduced to a powder by hand pressure when dry, and contains asbestos.

**Non-friable asbestos** means material containing asbestos that is not friable asbestos, including material containing asbestos fibres reinforced with bonding compound.

# Asbestos Removalists

## Class A

### Friable asbestos

- Friable licenses require a certified safety management system
- Clearance Certificate by LAA
- Air Monitoring during removal and as part of Clearance Inspection

## Class B

### Non friable asbestos

More than 10sq/m



# Minor Contamination

- Total amount of non-friable asbestos within the impacted soil is less than 10m<sup>2</sup> or 100kg; and
- Total amount of friable asbestos is below the NEPM Health Screening Levels.

*Determined by an Independent Competent Person. Must have results available in a report*

# Controls required during remediation

- Isolation (Signage/Barricades)
- Dust Control (i.e. Misting)
- Personal Protective Equipment
  - P2 ½ Face (Non Friable)
  - P3 Full Face (assessments if not utilised)
- Coveralls
- Gloves
- Wipeable Boots or Boot covers
- Decontamination facilities

*Asbestos removal area may only be reoccupied once a Clearance Certificate has been issued*

# Asbestos Notifications


Month period	Notifications per month
1-31 January 2021	1996
1-29 February 2021	2307
1-31 March 2021	2717
<b>TOTAL Asbestos Only</b>	<b>7020</b>

*At least 190 of these were notifications for Non-Friable Asbestos in Soil.  
Friable numbers unknown currently.*

# Further Information




SafeWork NSW

 13 10 50

 [asbestosdemolitionservices@safework.nsw.gov.au](mailto:asbestosdemolitionservices@safework.nsw.gov.au)

 [www.safework.nsw.gov.au](http://www.safework.nsw.gov.au)

 [www.asbestos.nsw.gov.au](http://www.asbestos.nsw.gov.au)

- ✓ **Work Health & Safety Regulation 2017: Part 8.7**
- ✓ **Code of Practice: How to Manage and Control Asbestos in the Workplace**
- ✓ **Code of Practice: How to Safely Remove Asbestos**
- ✓ **Guide: Managing Asbestos in or on soil**
-  Safe Work Australia





# Common Questions

*Do I need to develop an AMP if the concentration is below HSL's*

*The WHS Regulation cl.429 provides advice.*

*If it has the potential to become a workplace then an AMP shall be developed, as this provides identification for the presence of the ACM and suitable control measures.*

1. Identification
2. Decisions
3. Procedures for incidents and emergencies
4. Workers carrying out work involving ACM

# Common Questions

*If the levels are less than HSL's, what do I have to do?*

*WHS Requirements still apply if disturbing - Asbestos Related Work, Minimum Class B LARC*

# Common Questions

*Most 7x7mm fractions are non-friable and cannot be crushed by hand-pressure. Who conduct this work?*

*Class A or Class B Licensed contractor may conduct this work.*

# Common Questions

*We have located 3 fibre bundles in a sample of soil, this is the only asbestos identified on-site. What type of contractor is to be used to clean up the site.*

*Not licensed work – Minor Contamination*

# Common Questions

*ACM has been identified within the soil, can the soil be stockpiled by any excavator operator?*

*No, the act of stockpiling material containing asbestos would still be considered asbestos removal and requires to be conducted under controlled conditions by appropriately licensed contractors\*.*

*If the stockpile is considered waste, needs to be disposed of at a waste facility licensed to accept the waste as soon as reasonably practicable.*

*The ACM needs to be assessed by a competent person to determine friability, concentration and waste classification.*



Environment Protection Authority

# Waste documentation - Survey results

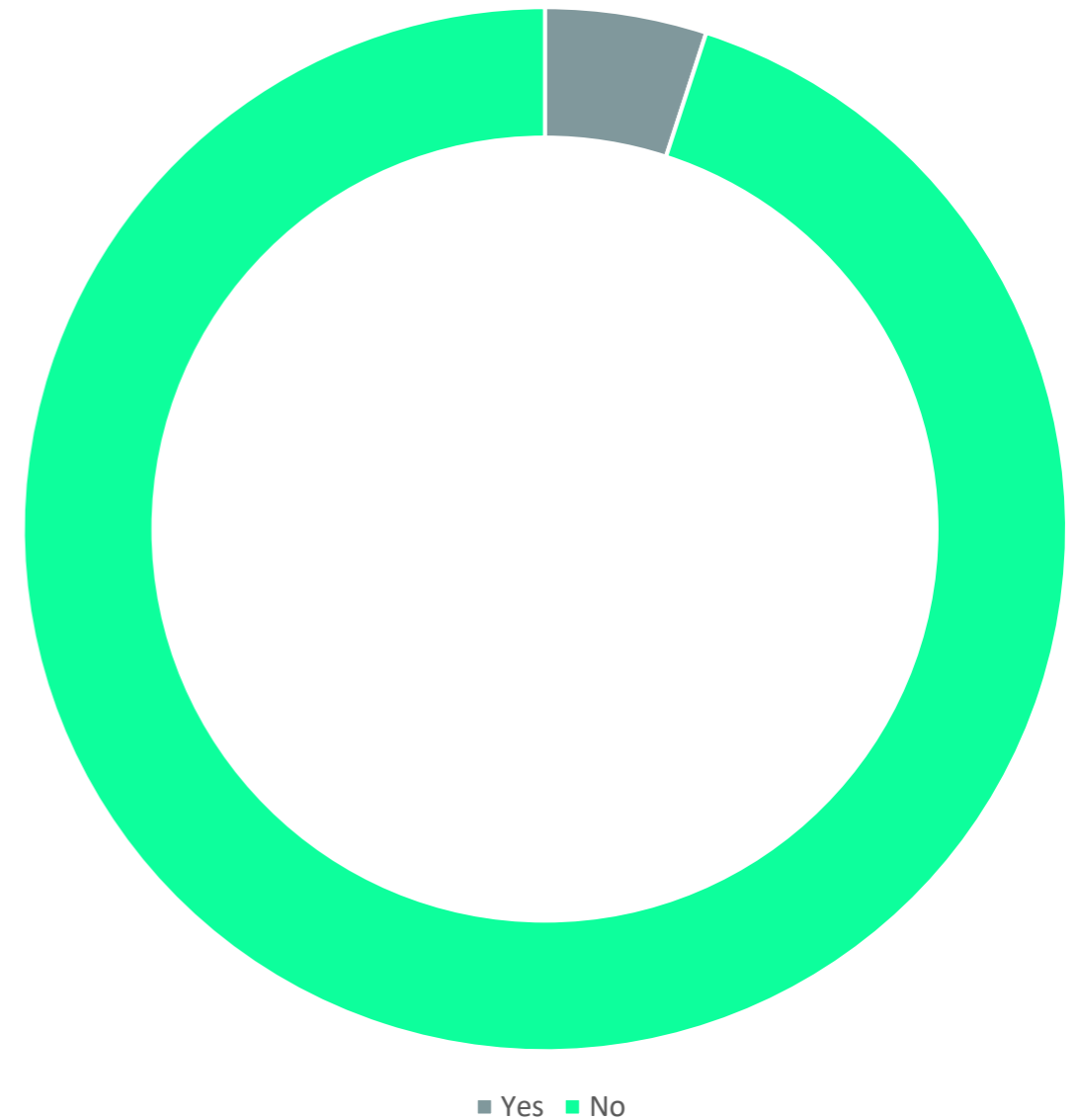
Helen Prifti, A/Director, Environmental  
Solutions – Chemicals, Land and Radiation

April 2021



## Redacted information or PO Box as delivery address

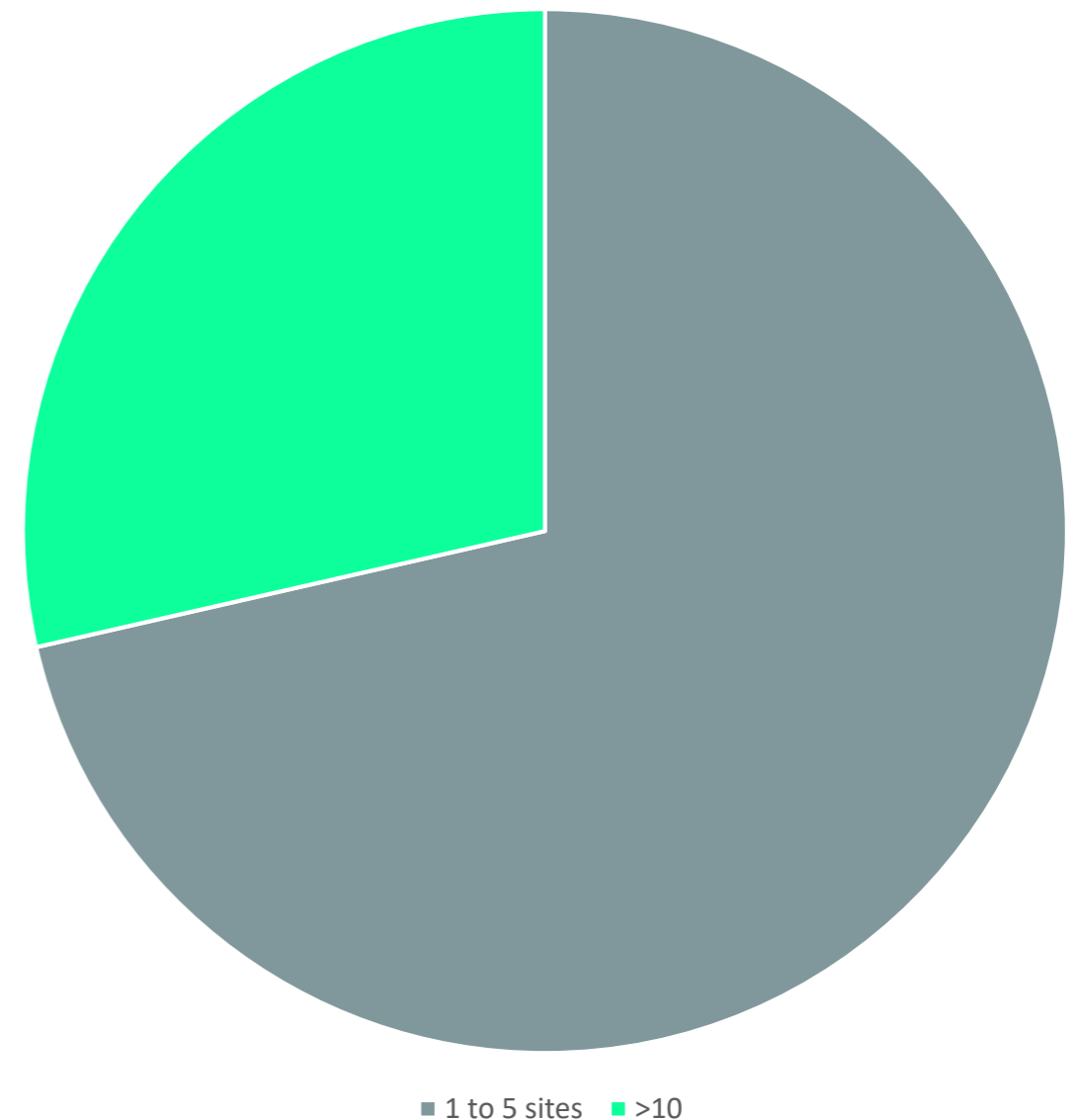
- 18/19 respondents had not come across these issues
- One auditor found these issues at 10 sites over the past 12 months.





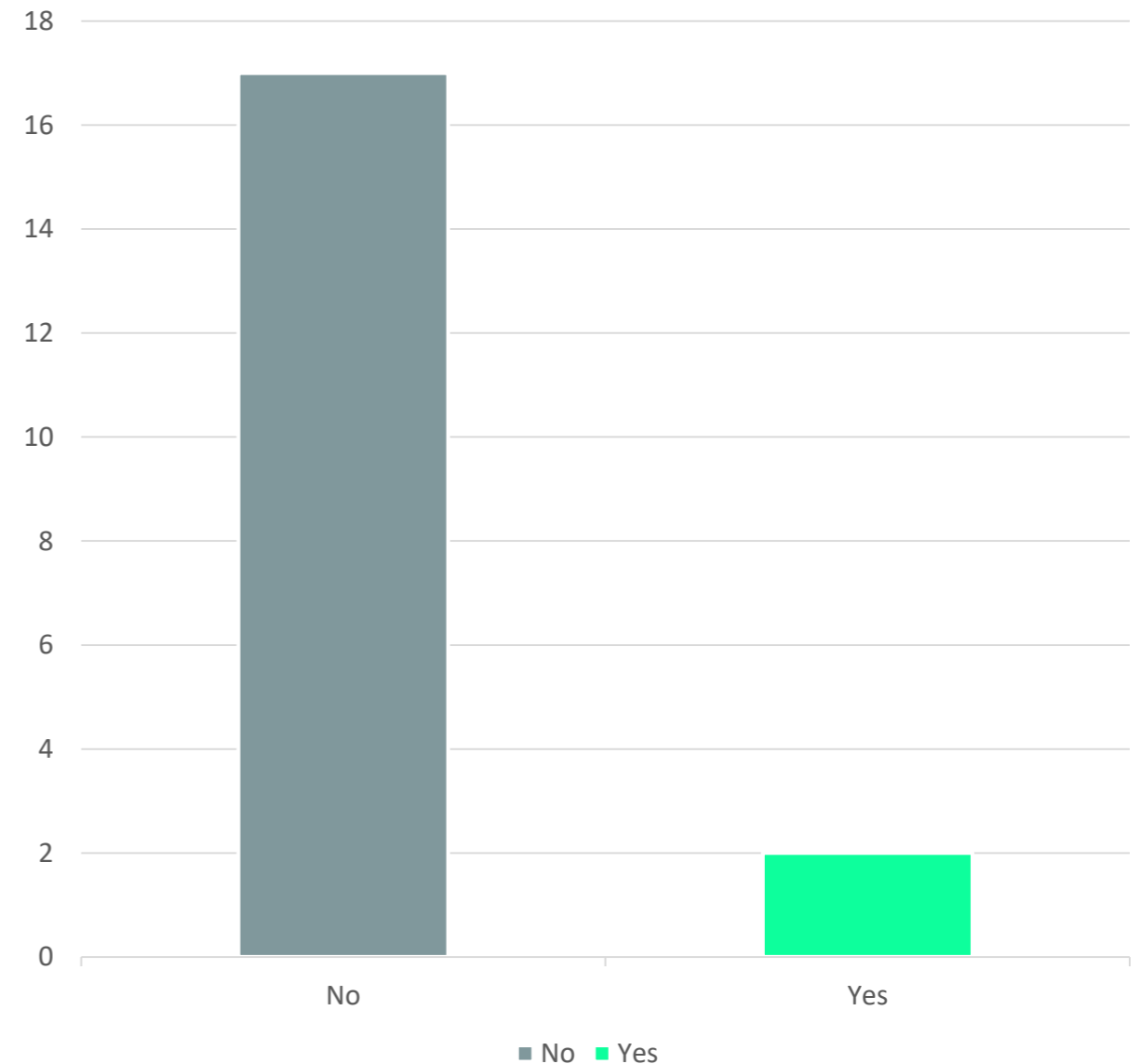
## Dockets from the same landfill varying in information provided

- 11 respondents had not come across this issue.
- The other 8 showed:
  - 5 auditors had found it on 1-5 sites in the past 12 months
  - 2 auditors had found it on >10 sites
  - 1 auditor found it at 50% of their sites



# Storage of waste at transport company holding facilities

- Only 2 respondents found this to be an issue:
  - 1 auditor found it on two sites
  - The other found it on five sites



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## Other issues found with waste dockets

- Poor quality dockets – barely legible
- Badly reconciled dockets, with documents missing
- Dockets missing reference numbers and EPL number of receiving landfill
- Lack of itemised computer-generated information
- Inappropriate classification or description of waste (i.e. “asbestos contaminated waste” or “restricted soil”)
- Difficult to assess if waste has gone to correct area of landfill, as only landfill address provided
- Waste that leaves site is expressed in cubic metres but landfill dockets show tonnages
- Dockets lack source site address
- Not clear whether waste has been received for recycling or disposal

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## Standardisation of dockets

- Address of source site
- Name of transport company
- Transport vehicle licence plate number
- Waste classification / description (in accordance with EPA Waste guidelines)
- Address of receiving waste facility
- EPL number of receiving waste facility
- Date and time load received
- Weighbridge details (i.e. Tare, Gross & Net weight)
- Disposal cost
- Information available electronically or in digital form

# Waste docket - Discussion

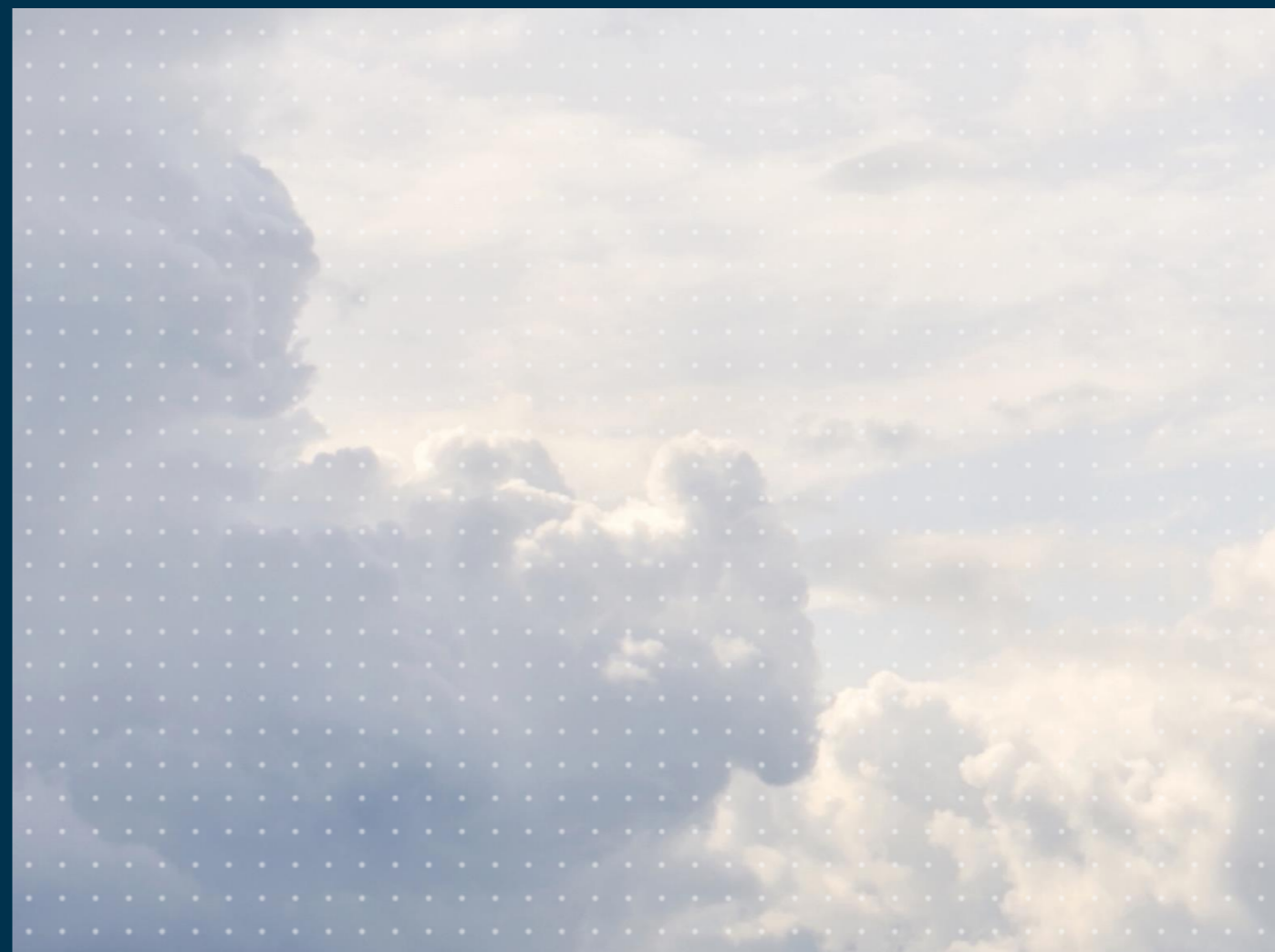


Environment Protection Authority

# Contaminated Land Advice and Audit Team Update

Sam Waskett, A/Senior Operations Officer

April 2021



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# General matters

## **Contaminated Land Management at the EPA**

- Contaminated Land Management regulation now managed across four operations teams
- Audit team located within the Environmental Solutions – Chemicals, Land and Radiation division
- Contact details – no change: [nswauditors@epa.nsw.gov.au](mailto:nswauditors@epa.nsw.gov.au)

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# Use of Ecological Investigation Levels in an urban setting

The NEPM states investigation and screening levels:

- are **not** clean-up criteria
- should be used for assessing existing contamination; and
- when they are exceeded, they should trigger consideration of an appropriate site-specific risk-based approach

## Auditor guidelines

- Auditors also need to consider section 4.3 of the auditor guidelines. Remediation needs to be environmentally justifiable and sustainable.
- Decisions need to be justified in the audit report



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# SEPP 55 – Planning guidelines update

- Planning guidelines still progressing
- DPIE have procured a consultant to help with certain aspects, including:
  - planning proposals and rezoning policy around contamination investigations
  - drafting case studies and fact sheets.

# Private certifiers training

- EPA developed Contaminated Land training module for private certifiers to begin testing in early May
- Module to be piloted with a small group of private certifiers for 1-2 weeks prior to final release (hopefully by June 2021)
- Training to be hosted on the EPA website, but made available to private certifiers via industry Continuing Professional Development learning providers.

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# Conditions on SASs – difficulties in obtaining written approval from Councils?

- Section 3.4.5 of the auditor guidelines states:

*“Where compliance with a condition could only be ensured with the involvement of an authority, auditors must seek written approval from the relevant authority before issuing a site audit statement with that condition. For example, auditors must have written approval from the EPA or a local authority before issuing conditions that involve the EPA or the local authority, respectively”*

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# Reminders

- Auditor inbox - [nswauditors@epa.nsw.gov.au](mailto:nswauditors@epa.nsw.gov.au)
- Annual returns
- SAS sign off

# Standard conditions – contaminated land

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# Agenda

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- Background
- Draft contaminated land conditions
- Enforcing conditions of consent
- Next steps
- Questions

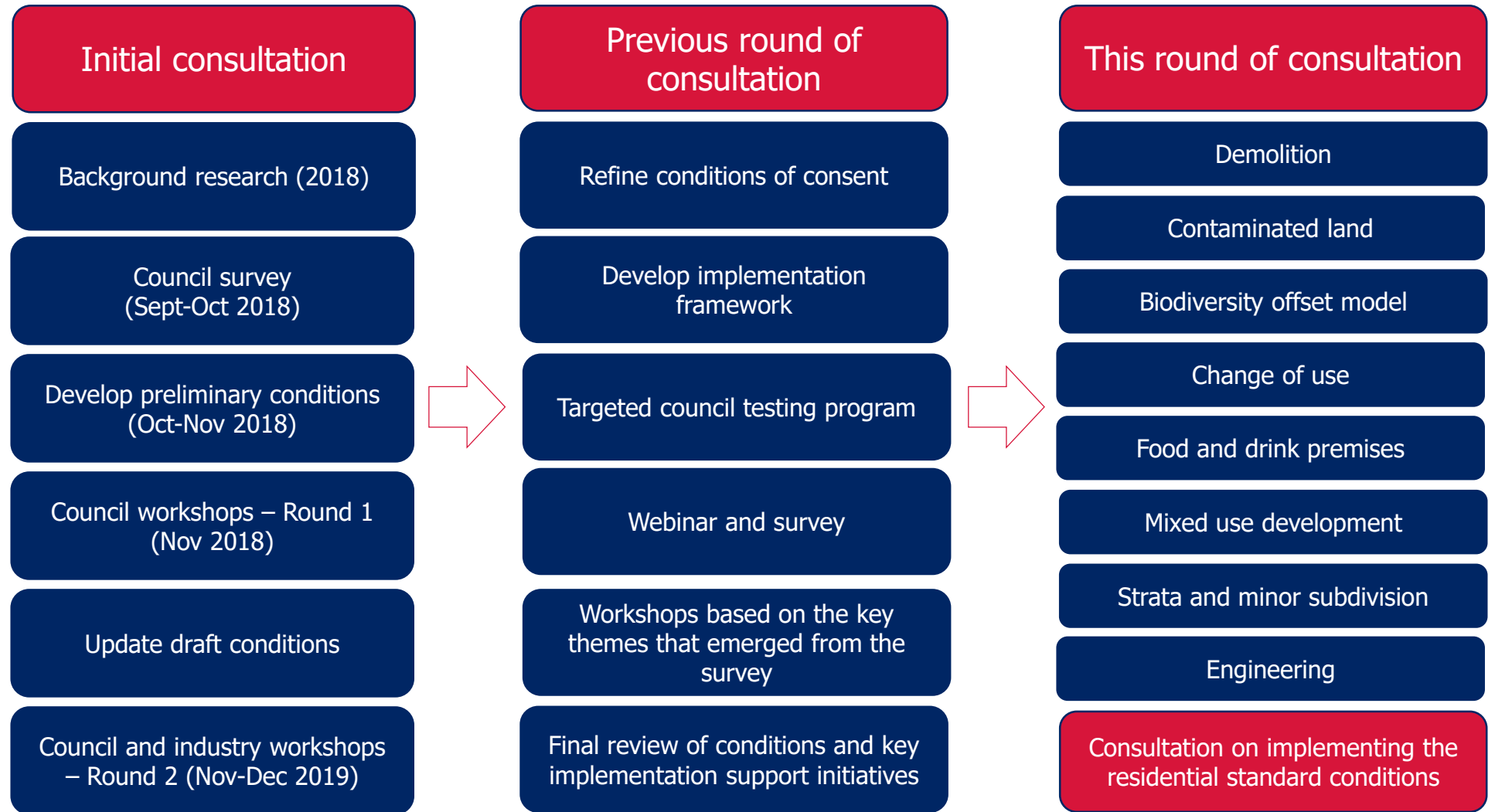


# Background

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# Consultation program





# Standard conditions

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Levels of conditions:

1. Mandatory conditions imposed on development consents for particular types of development or in specified circumstances
2. Model (optional) conditions that councils and planning panels can choose to use to improve clarity, certainty and consistency across council areas
3. Bespoke conditions that councils can continue to prepare for site specific issues



# Delivery

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Mandatory conditions to be included as prescribed conditions in the EP&A Regulation

The standard conditions to be available for consent authorities in the NSW Planning Portal

# Structure of development consents

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Development consent involving building work:

Part A – General conditions

Part B – Before the issue of a construction certificate

Part C – Before the commencement of building work

Part D – While building work is being carried out

Part E – Before the issue of an occupation certificate

Part F – Occupation and ongoing use

You may require additional steps. For example, a section on conditions before demolition work or before the issue of a subdivision certificate.

# Standard conditions - stages

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Standard conditions to be rolled out in three stages:

Stage	Development types
Stage 1 – April 2021	<ul style="list-style-type: none"><li>• Residential development</li></ul>
Stage 2 – June 2021	<ul style="list-style-type: none"><li>• Development involving contaminated land</li><li>• Demolition</li><li>• Development to which the <i>Biodiversity Conservation Act 2016</i> applies</li><li>• Food and drink premises</li><li>• Change of use</li><li>• Mixed use development</li></ul>
Stage 3 – September 2021	<ul style="list-style-type: none"><li>• Engineering</li><li>• Strata and minor land subdivision</li></ul>

# Draft contaminated land conditions

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# Draft contaminated land conditions

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Standard conditions are proposed to cover:

- **Before remediation work commences:**
  - Submission of a remedial action plan (if not submitted with the DA)
- **While remediation work is being carried out:**
  - Supervision of remediation
  - Maintenance of environmental site management measures
  - Notifying new information
  - Changes to the remedial action plan
  - Remedial action plan to be kept on site

# Draft contaminated land conditions (cont'd)

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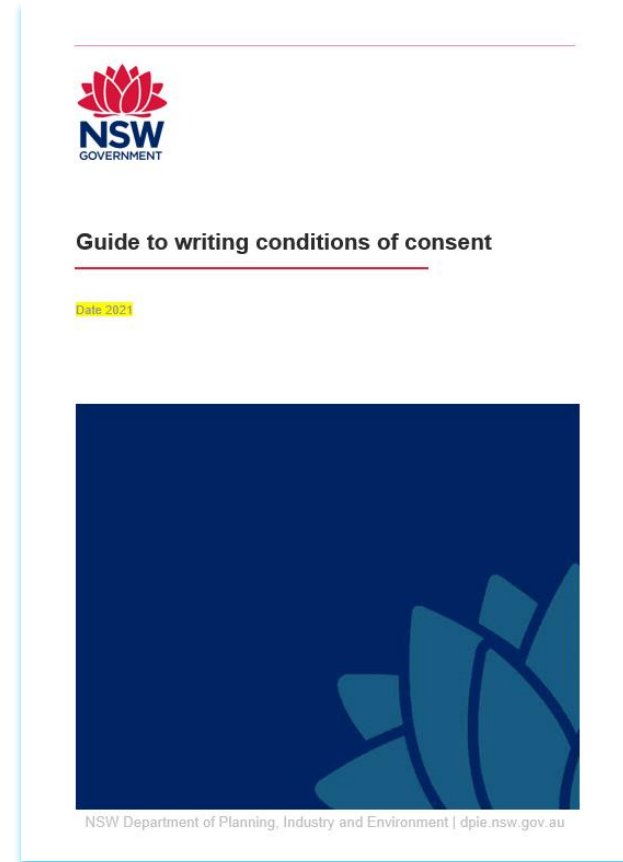
- **On completion of remediation work**
  - Validation report
  - Survey of contaminated containment area
  - Preparation and approval of ongoing environmental management plan (where required)
- **Before the issue of an occupation certificate**
  - Approval of validation report
  - Submission of a site audit statement certifying the site is suitable for the proposed use
- **Occupation and ongoing use**
  - Compliance with the approved environmental management plan

# Enforcing conditions of consent

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# Enforcing conditions of consent

- The standard conditions are intended to facilitate councils taking compliance and enforcement action where needed.
- The conditions are being written having regard to the new *Guide to writing conditions of consent*.
- Where an environmental management plan (EMP) is required as a condition of consent, the condition can be difficult to enforce if councils don't have resources to ensure the EMP is carried out.





# Next steps

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# Next steps

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- Revise draft contaminated land conditions for stakeholders to review
- Meet with site auditors in May
- Further refine the conditions having regard to feedback
- Consider feedback on which conditions could be mandatory

# Questions?

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# Nicole Malone

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[nicole.malone@planning.nsw.gov.au](mailto:nicole.malone@planning.nsw.gov.au)

Department of Planning, Industry and Environment

Environment Protection Authority

# POLICY UPDATE

Land and Resources Policy

Joanne Stuart

April 2021



## CONTENTS

- Sampling Design Guidelines
- EMP Practice Note
- Review of Certified Consultants Policy
- Miscellaneous matters



# Sampling Design Guidelines

What we heard and where we are  
up to



# SAMPLING DESIGN GUIDELINES



## What we heard and where we are up to

We received 44 submissions – 700 individual comments – from auditors, consultants, councils, labs and other industry professionals

### What we heard:

- *“the guidelines are possibly a bit too technical in nature and I believe would not be well understood at a local government assessment level when considered by contamination / environmental assessment officers or council planners.”*
- *“The guidelines are relatively easy to understand for those with a sound working knowledge of mathematics and statistics.”*
- *“The structure of the guidelines could be improved further by adopting an outline that is generally followed by the CLM practitioners...A flow chart showing various stages of CLM investigation and recommended methods for each would bring it all together.”*
- *“It is an excellent leap forwards over existing guidance and makes it clear that the EPA is prepared to accept statistically sound analysis and options that align with the intent of the NEPM.”*



# SAMPLING DESIGN GUIDELINES



## What we heard and where we are up to

### What we heard continued:

- Two distinct audiences – industry professionals and councils – have different needs - need to balance those without detracting from the key purpose
- Mixed feedback on updates to Table A
- Councils want checklists so they can feel confident when reviewing reports that this guideline has been complied with
- Others felt we could do with less and have only one part
- Some people didn't like the cover photo or the branding!



# SAMPLING DESIGN GUIDELINES

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## What we heard and where we are up to

### What now?

- EPA has made some of the relatively straight forward changes in response to issues raised
- Engaged JBS&G to work through some of the more technical issues and develop flow charts and checklists as requested
- Plan to hold a couple of workshops to discuss those technical details that were the subject of conflicting feedback and to road-test the changes we have made:
  - One for industry professionals
  - One for councils

# EMP Practice Note

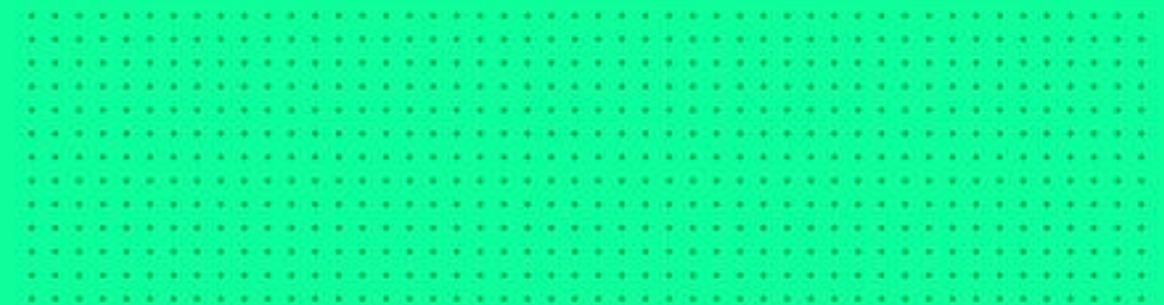
Consultation outcomes

Environment Protection Authority

## Preparing environmental management plans for contaminated land

Practice note

Consultation draft



# Finalising the EMP Practice Note



Targeted consultation only – 24 invitations sent out and 13 submissions were received from councils, consultants, site auditors, state government agency and a legal firm

## What we heard:

- Majority supported the content of the draft Practice Note subject to some amendments
- Legal enforceability was the key concern
- Requested additional information on when EMPs should be prepared and triggers for needing an EMP
- Currently finalising and hope to publish this soon. Further discussion will be required on the legal enforceability issue with auditors, consultants and other stakeholders



## Environmental management plans for contaminated land

Thank you for your feedback on a practice note for preparing environmental management plans for contaminated land

+ Follow

# Review of Contaminated Land Consultant Certification Policy

Consultation outcomes

## Contaminated Land Consultant Certification Policy

Version 2 November 2017



Cover of the Current Policy

# Scope of Review

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1. The number of practitioners becoming certified and the rate of uptake
2. Whether there is a diversity of practitioners from small, medium and large consulting firms
3. Any impacts on the cost of contaminated land consultant services
4. Any impacts on the availability of contaminated land consultant services in regional areas
5. Feedback from stakeholders on the use of certified practitioners and, in particular whether the needs of stakeholders in regional areas or stakeholders with smaller scale contamination are being met
6. The administration of the certification schemes
7. Whether there has been an overall improvement in the minimum standard of contaminated land work in NSW

# Consultation Survey Results

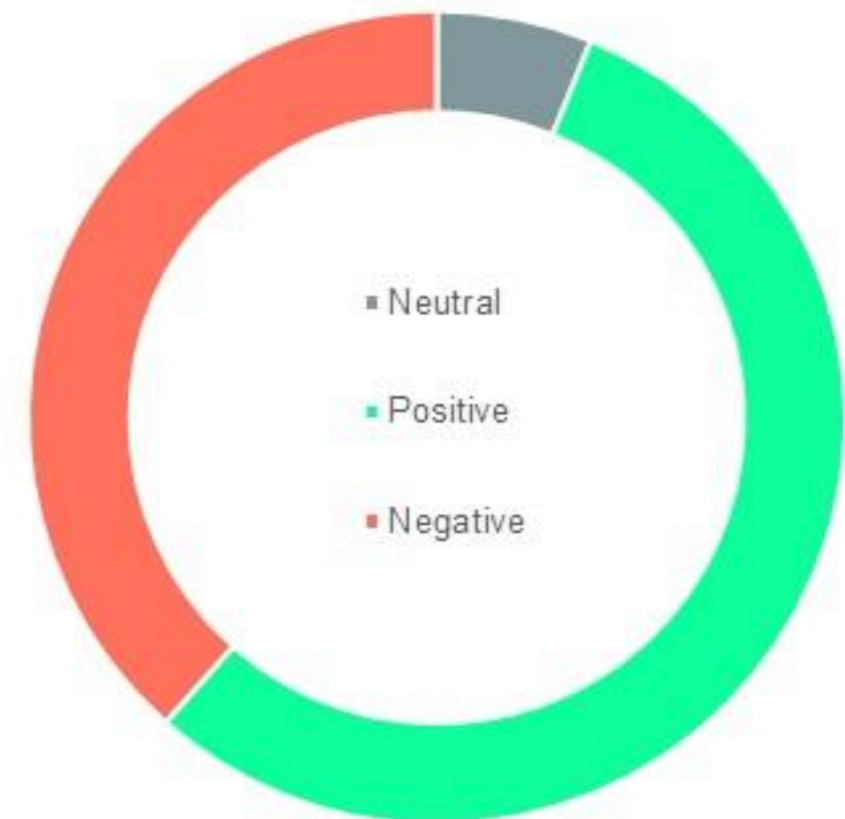


Received 56 survey responses – from site auditors, certified and non-certified consultants, local council staff, landowners/developers and EPA staff

## What we heard:

- introduction of the policy has result in some improvement in the standard of reports, but not overwhelmingly so
- More guidance for certified consultants reviewing work of non-certified consultants would be good
- Mixed uptake of requiring certified consultants by councils, especially in regional areas
- Small firms felt disadvantaged, especially sole operators
- Certification made consultants more competitive

## Sentiment



# Next steps

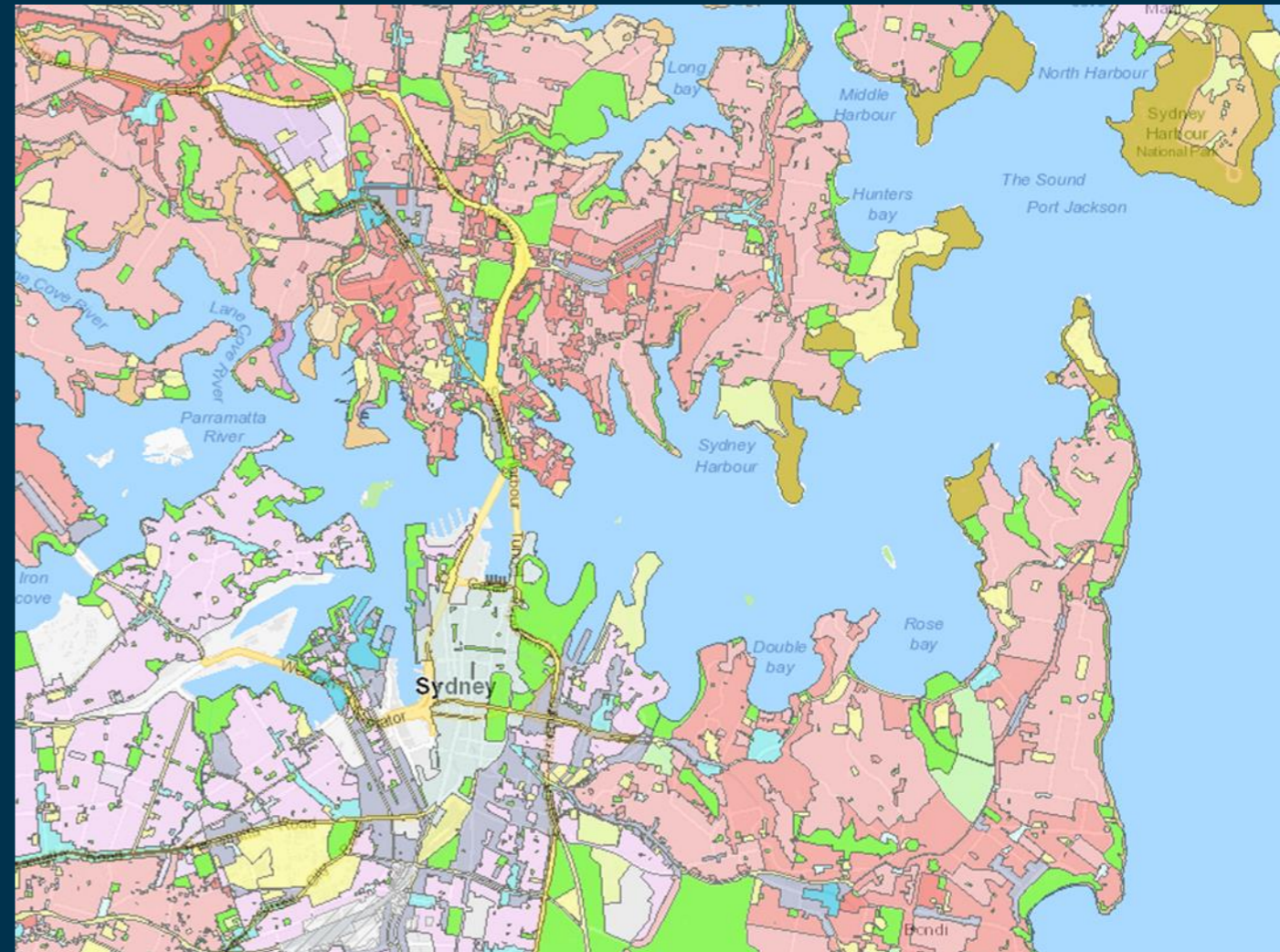
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1. Publish Consultation Summary
2. Review submissions
3. Further consultation with Certification Schemes
4. Publish Response to Submissions Report
5. Amend Policy if required





# Miscellaneous matters



Map of Sydney, taken from ePlanning Spatial Viewer

# Amendment to Codes SEPP

- Changes were made to Schedule 6 in February 2021:

## **11B Contamination discovered during works**

(1) If during works on the land comprising the lot, the land is found to be contaminated, within the meaning of the [Contaminated Land Management Act 1997](#)—

(a) all works must stop immediately, and

(b) the Environment Protection Authority and the council must be notified of the contamination.

(2) Land is found to be contaminated for the purposes of this clause if the person having the benefit of the complying development certificate or the principal certifying authority knows or should reasonably suspect the land is contaminated.

### **Note—**

Depending on the nature and level of the contamination, remediation of the land may be required before further work can continue.

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# Amendment to Codes SEPP

- Does not impact existing notification requirements under the CLM Act and will not necessarily be considered a formal notification under s. 60
- Ensures “unexpected finds” of contamination are assessed and addressed through the complying development process, although not upfront
- Notification will be through Environment Line
- EPA will liaise with councils to consider the significance and most appropriate approach
- Initially sites will not be included on our list of notified sites unless investigations indicate otherwise

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# Review of POEO Waste Regulation

- Currently scheduled to be remade by September 2022
- Due to resourcing issues and other priorities in the waste policy area, likely to be pushed out until September 2023
- EPA is proposing to consult with a range of stakeholders prior to redrafting the Regulation – no dates set for this as yet
- Consultation will also be undertaken on the draft Regulation and Better Regulation Statement

Questions?



Environment Protection Authority

# PFAS NEMP 2.0 – Consultation

Anthea White, Unit Head, CLA&A

April 2021



*Photo courtesy of Queensland Department of Environment and Science*

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## PFAS NEMP 2.0 - General

- PFAS NEMP is not approved under section 105 of the CLM Act
- NSW EPA has endorsed the PFAS NEMP

# Consultation with the environmental regulator

PFAS NEMP 2.0



*Photo courtesy of Queensland Department of Environment and Science*



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# Consultation with the environmental regulator

- PFAS NEMP refers to consultation with the environmental regulator on:
  - development of site-specific criteria (section 8.1 – *Considerations for using guideline values*); and
  - the reuse of soil impacted with PFAS (section 12.1.2 – *Decision tree for screening risk assessment for reuse of soil*)

## 8 PFAS environmental guideline values

The purpose of a guideline value is to identify the level of a contaminant that will minimise human health and ecological risks, based on the best available scientific evidence. Guideline values are developed using methods designed to address the specific sensitivities of the receptors. For example, aquatic wildlife may experience continuous PFAS exposure from the water they live in, whereas for humans the main sources are usually food and drinking water. In some cases, ecosystem guidance can be more stringent than human health guidance. This can arise due to some organisms being more sensitive to a contaminant than humans, and the different mechanisms by which PFASs accumulate (such as accumulation from water, sediment, food sources and trophic structures).

The following guideline values represent a nationally-agreed suite that should be used to inform site investigations and consideration of environmental management. The purpose of the guideline values is not intended to be as clean-up criteria or an authorisation to pollute up to these values. The values include a degree of conservatism. This is necessary when deriving in screening assessments to be protective of human health in circumstances where multiple exposure pathways may be present, and protective of ecological health in circumstances where there is variability in species sensitivity. This is especially important for bioaccumulative chemicals such as PFOS, PFHxS and PFOA.

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

### 8.1 Considerations for using guideline values

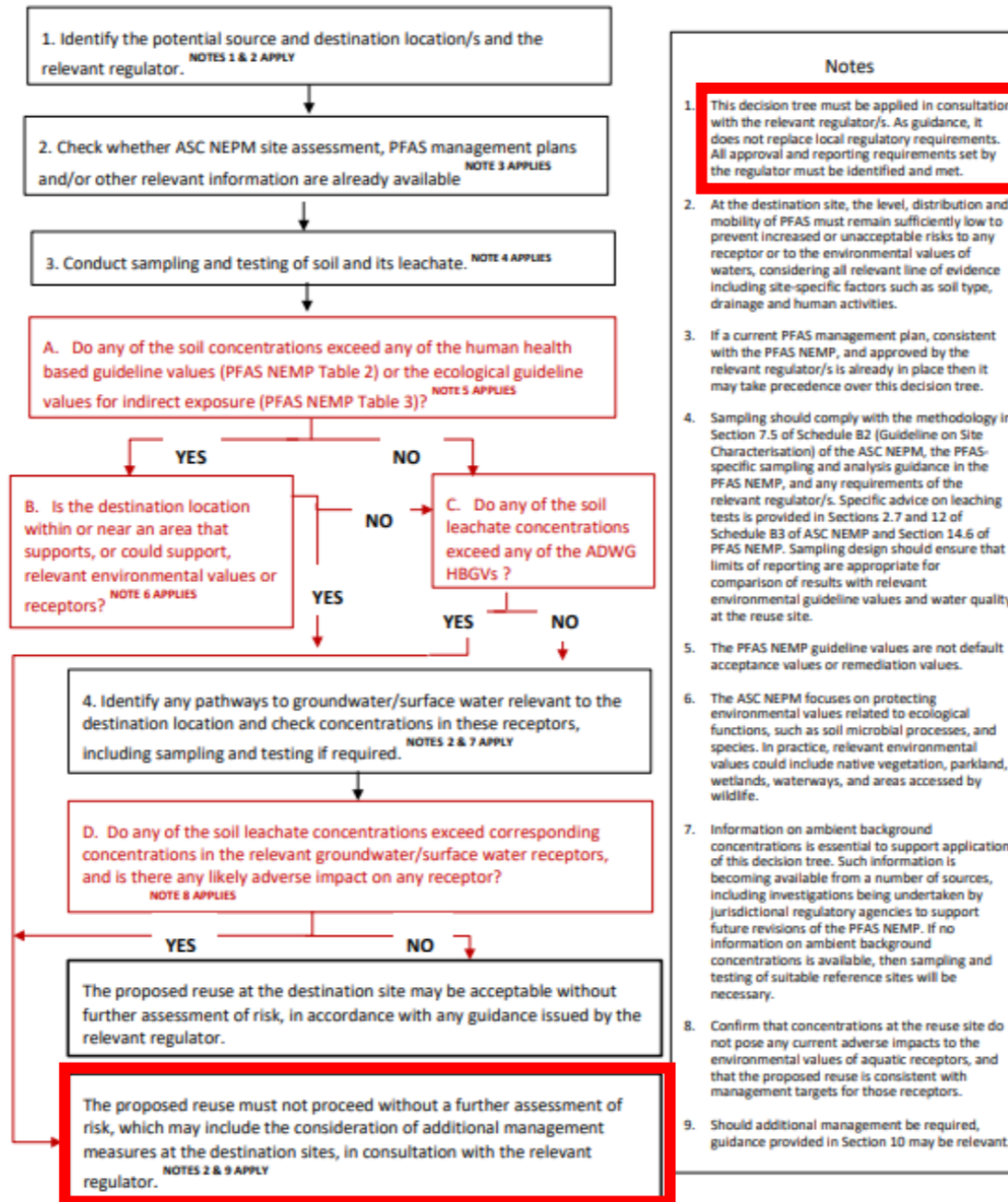
The identification of PFAS above relevant guideline values acts as a trigger to undertake further investigations (such as site-specific risk assessment, as opposed to the assumption that harm will have occurred). The guideline values can also prompt consideration of management action to meet the environmental values and mitigate, where practicable, human health and ecological risks.

When carrying out a site investigation, the following guidance should be considered (informed by the ASC NEPM guidance<sup>25</sup>):

- It is important that sufficient and appropriate characterisation of the contaminants is carried out when comparing site data with guideline values. This is required to ensure that the comparison is both meaningful and relevant for assessing potential risks to human health and the environment.
- The selection of the appropriate guideline values at a site should consider current, potential or future uses of the site, and any catchment or groundwater management requirements, with reference to the conceptual site model (CSM).

The selection of guideline values should have regard to the specific environmental values and characteristics of the site, drawing on relevant guidance<sup>25</sup> in consultation with the environmental regulator. It is important to note that regulators may specify, or environmental legislation may prescribe, the level of protection required.

Figure 5. Decision tree for reuse of soil  
**Decision Tree for Reuse of Soil**  
 to be applied consistent with PFAS NEMP provisions and local regulatory requirements



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# What information should auditors provide

**Site specific criteria:** Where relevant screening criteria from the PFAS NEMP have been exceeded and site specific criteria are derived, the following information should be provided to the EPA:

- A report outlining the derivation of the site specific criteria, including clear justification for all site specific assumptions (noting that these are 'site-specific' criteria/assumptions, so approval for use at another site is not sufficient justification alone).

**Soil re-use:** Where soil exceed relevant screening criteria from the PFAS NEMP or approved site specific criteria, the following information should be provided to the EPA:

- Concentrations of PFAS in the soil
- A RAP detailing where and how the soils will be reused
- A risk assessment to demonstrate that the proposed soil reuse options will not pose a risk to the environment and human health considering the CSM

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# What information should auditors consider?

## Site Specific Criteria

- Protective of most sensitive receptor
- Due to the complexity of PFAS exposure pathways, all receptors need to be considered.
- Criteria must be specifically developed for each site, not taken from other sites and applied.
- Criteria should be informed by a well-developed CSM and risk assessments
- Dilution and attenuation factors need to be well justified

## Soil Re-use

- Stop source/pathway/receptor linkage and consider sensitive receptors
- Limit groundwater and surface water interaction with reused material
- Limit leaching
- Minimise off site migration
- Capping/immobilisation could be considered

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## Where do I send PFAS enquiries?

Any auditor PFAS consultations should be sent to:

[nswauditors@epa.nsw.gov.au](mailto:nswauditors@epa.nsw.gov.au)

# OpenUCL

An online statistical summary tool to examine contaminated sites data sets



# Introduction

- ▼ **URL**

- ▼ <http://www.openstatsonline.com/>

- ▼ [openstatsonline@gmail.com](mailto:openstatsonline@gmail.com)

- ▼ **Authors**

- ▼ Tim Chambers

- ▼ Alex Mikov

- ▼ Marc Salmon

- ▼ **Purpose: Make it easy to examine your data**





# Why We Made OpenUCL

- ▼ **To provide a simpler statistical assessment tool which:**
  - ▼ Is tailored to Australian Contaminated Sites Assessment
  - ▼ Is platform independent
  - ▼ Encourages people to include graphical analysis of data



# Why We Made OpenUCL Free

- ▼ **Free to use (No cost):**
  - ▼ To encourage people to use it
- ▼ **Free Software (Open Source):**
  - ▼ To ensure transparency and encourage involvement



# Screenshots – Splash Page

Open Stats

[Home](#) [Contact Us](#)

Welcome to

## Open Stats Online

*"By a small sample, we may judge of the whole piece".*  
Don Quixote

### Open-source web based statistical tools

Open Stats Online has been developed as hub for free and open-source statistical tools starting with [OpenUCL](#).

#### Open UCL

Open UCL is a free online tool developed to provide a concise statistical summary of analytical data sets for contaminated land assessment and remediation projects. However, Open UCL may be used for any data set.

Open UCL is an open-source web-based application using R and Shiny to enable platform-independent access. It has the advantage of not requiring a particular operating system, hardware, or other software. All you need is internet access, a browser and a spreadsheet.

If the link does not work it may be due to a security feature of your browser or the network you are working from. In this case, cut and paste the following web address to go to the Open UCL App.

[https://openstatsonline.shinyapps.io/Open\\_UCL\\_Beta\\_V300/](https://openstatsonline.shinyapps.io/Open_UCL_Beta_V300/)

#### Student's t-test in R and by hand: how to compare two groups under different scenarios

These are a set of links to a blog and app by Antoine Soetewey that explain the procedure to conduct t-tests by hand, and with R. He steps through the calculations and includes the code for R. But if you don't know R, he also includes a Shiny application to help with the calculations and visualise the results.

He works through t-tests for paired and independent samples, equal, unequal, known and unknown variances.



Blog on t-tests. <https://statsandr.com/blog/student-s-t-test-in-r-and-by-hand-how-to-compare-two-groups-under-different-scenarios/>


App (Statistics 201 - Inference)


If you are interested in learning R, Antoine's early blog posts are also a great way to start.





# Screenshot – Main Page


 BETA V3.03 


 Introduction

 Basic Stats and UCL.

 Sample Size Calcs

 GOF Tests

 Trend Analysis



You are free to use the output of OpenUCL for your own purposes, private or commercial, without constraint.

The underlying code is publicly available and this work is considered by the Authors to be Open Source [LINK].

The underlying code is, however, licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

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**Feedback? Want to Help?**  
Contributions, feedback ideas for additions are welcomed. Please feel free to email us at [openstatsonline@gmail.com](mailto:openstatsonline@gmail.com).

**Fund Us**  
We donated our time for free to develop Open UCL but the IT bits we use cost \$\$. If you wish to contribute financially we will soon have a donorbox page or something similar.

Any funds raised will be used to pay for server costs and upgrades to Open UCL.

In return, we will list all contributors to Open UCL on the Open UCL app page.

**Developers & Contributors**  
T. Chambers, A.Mikov, M. Salmon  
A. Bull

## Open UCL

This is a Beta version of Open UCL, so some things may not work perfectly or may change without much notice as we make improvements

### 1 Overview

Open UCL is a free online tool developed to provide a concise statistical summary of analytical data sets for contaminated land assessment and remediation projects. However, Open UCL may be used for any data set. Open UCL is an open-source project. The code will be made available on a Github repository once out of testing, and Open UCL is at a reasonable level of development.

Open UCL is a Web-based application using R and Shiny to enable platform-independent access. It has the advantage of not requiring a particular operating system, hardware, or other software. All you need is internet access, a browser and a spreadsheet. Currently, recognised data formats for spreadsheets are Microsoft Excel (.xls or .xlsx), Open Document (.ods) and Comma Separated Value (.csv) files. The output is presented on the screen or downloaded in Portable Document Format (.pdf), so a PDF reader is also useful.

The website will timeout and disconnect if idle for a while. This feature is to reduce the overheads of running the website. Simply reload the page if this happens to continue.

If you are working on a project with contractual restrictions on data storage locations, you may want to avoid using Open UCL through the web interface as the data processing is conducted on international servers. **Note, however, that no data is stored once the web interface is closed.**

An alternative would be to download the R code and run it locally. Note there is nothing to stop you from anonymising your data to a set of numbers and generic labels.

Open UCL has been established as a free tool for industry professionals to use. If you like it, there will be an option to contribute to the running costs to pay for Web hosting, but this is not required.

Suggestions, comments and bug reports can be emailed to [openstatsonline@gmail.com](mailto:openstatsonline@gmail.com).

As noted, Open UCL is written in a language called R and Shiny, both of which are open source and free. There are numerous youtube videos on installing and using R and R studio, and it would not take long to learn the basics and enable you to run the Open UCL script locally.

### References for R and Shiny

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

Winston Chang, Joe Cheng, JJ Allaire, Yihui Xie and Jonathan McPherson (2020). shiny: Web Application Framework for R. <https://CRAN.R-project.org/package=shiny>

### 2 What it does do

- Open UCL provides you with a concise graphical and numerical summary of your data to support your data sets' statistical interpretation.
- The numerical summary includes descriptive statistics estimates of normality and calculations of the 95%UCL for normal, lognormal and undefined data distributions.
- The summary is (intended to be) clear, focused, and limited to a handful of pages, regardless of the number of analytes provided.

### 3 What it does not do

- Open UCL does not keep your data, and any uploads are purged when the application closes.
- Open UCL does not track you or your location, but it does keep track of how often it is used. This helps with planning for hosting needs.
- Open UCL does not interpret your data for you. We have resisted the temptation to "spoon-feed" users to encourage users to learn about the stats they use and what they mean.
- Open UCL does not do Trend analysis. Although we have been playing with Mann Kendal Trend analysis functionality and it is likely to appear as a feature soon.

### 4 What makes it different from Pro UCL

Pro UCL is a software package released by the USEPA which has a wide range of capabilities in the statistical analysis of environmental/contaminated sites data. Pro UCL is very popular and can determine UCL values for a wide range of statistical data distributions. Pro UCL includes a range of graphing and trend analysis tools as well.

However, Pro UCL requires the Windows operating system, and the output for each analyte can run to several pages, resulting in awkward data presentation and difficulty incorporating the results into reports. Graphical interpretation is separated from the statistical analysis by the structure of the software. The code is proprietary and is not easy to review or alter if so desired.

We aim to make a more straightforward tool that is readily accessible, provides a more concise output, and is focused on our industry's needs.


### 5 How to use it

There is a separate detailed instruction tab in each of the menu items on the left-hand panel. However, generally, the steps for use are as follows:

1. Prepare a data file. Analyte headings in the top row with columns of data below.
2. Input an optional title.
3. Browse for and upload your data file (browse or drag and drop). Accepted file types include Microsoft Excel (xls or xlsx), comma-separated value (csv) and open document spreadsheet (.ods).
4. Select how you want non detect values to be treated. Currently, there are only three options.
  - As a zero (some stats are not calculated with this option);
  - As a half value of the detection limit; or
  - As the detection limit.

Open UCL will process the data and return results to the screen for review. It will read the first row of data and use the information in that row as a menu selector for each data column. The different analytes uploaded into Open UCL can be selected, and it will re-calculate the stats, and a revised statistical summary display is updated.

A report button allows for preparing a pdf document for the current display or all analytes in the data set and downloaded.



# Screenshot – Input Page

Open UCL BETA V3.03


Introduction

Basic Stats and UCL

Sample Size Calcs

GOF Tests

Trend Analysis

 You are free to use the output of OpenUCL for your own purposes, private or commercial, without constraint.

The underlying code is publicly available and this work is considered by the Authors to be Open Source [LINK].

The underlying code is, however, licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

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**Feedback? Want to Help?**  
Contributors, feedback, ideas for additions are welcomed. Please feel free to email us at [openstatsonline@gmail.com](mailto:openstatsonline@gmail.com).

**Fund Us**  
We donated our time for free to develop Open UCL but the IT bills we use cost \$\$  
If you wish to contribute financially we will soon have a donorbox page or something similar.

Any funds raised will be used to pay for server costs and upgrades to Open UCL.

In return, we will list all contributors to Open UCL on the Open UCL app page.

**Developers & Contributors**  
T. Chambers, A.Mikov, M. Salmon  
A. Bull

Basic Stats and UCL | Instructions and Help | Which UCL to Use?

Enter a title in box below:  
eg: Natural Soil Data

**Data Upload :**  
Data file must be excel (xls orxlsx), comma separated value (csv) or open document spreadsheet (.ods).  
Less than symbols are ok. ND is not.  
The expected layout is:  
*First Row:* Column headings/labels. eg: As, Hg, PAH  
*Subsequent Rows:* Values. eg: 2.05, 1.10, <0.5

Browse... No file selected

**Non Detect :**  
How do you want to treat non-detect results (choose one only)

Assume zero  
 Half of Detection Limit  
 Detection Limit Value

**Confidence Level :**  
Select the desired level of confidence for UCL calculations. This does not affect the displayed values for the critical value of t, MOE or Z value calculations. These remain at alpha=0.05

50 95 99  
50 55 60 65 70 75 80 85 90 95 99

Select Sample Group :

Apply & Calculate

Data Review Panel:



# Screenshot - Output

Open UCL BETA V3.03

- Introduction
- Basic Stats and UCL
- Sample Size Calcs
- GOF Tests
- Trend Analysis

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Feedback? Want to Help? Contributions, feedback ideas for additions are welcomed. Please feel free to email us at openstatsonline@gmail.com.

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T. Chambers, A.Mikov, M. Salmon  
A. Bull

Basic Stats and UCL | Instructions and Help | Which UCL to Use?

Enter a title in box below:

Tim's Test Data

**Data Upload :**  
Data file must be excel (xls orxlsx), comma separated value (csv) or open document spreadsheet (.ods). Less than symbols are ok. ND is not.  
The expected layout is:  
First Row: Column headings/labels. eg: As, Hg, PAH  
Subsequent Rows: Values. eg: 2.05, 1.10, <0.5

sample\_data\_NSWEPA.xlsx  
Upload complete

**Non Detect :**  
How do you want to treat non-detect results (choose one only)

Assume zero  
 Half of Detection Limit  
 Detection Limit Value

**Confidence Level :**  
Select the desired level of confidence for UCL calculations. This does not affect the displayed values for the critical value of t, MOE or Z value calculations. These remain at alpha=0.05

50 95 99

Select Sample Group :  
As

Apply & Calculate

**Data Review Panel:**

Search:

	name	value
1	As	103
2	As	50
3	As	43
4	As	9
5	As	203
6	As	54
7	As	341

Showing 1 to 16 of 16 entries

## Tim's Test Data

As

### Descriptive Stats :

n	16
min	6
max	341
range	335
mean	66.312
gm	35.187
median	38.5
standard deviation (sd)	88.274
standard error of mean (sem)	22.068
coefficient of variation (cv)	1.331
skewness	2.462

### Log transformed stats :

Log min	1.792
Log max	5.832
Log mean	3.561
Log sd	1.16

### Normality Tests :

Shapiro-Wilks Value (raw)	0.672
Shapiro-Wilks p (raw)	0
Shapiro-Wilks Value (log)	0.973
Shapiro-Wilks p (log)	0.88

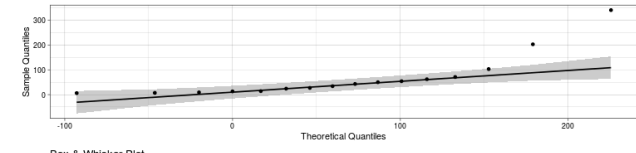
### UCLs :

Confidence Level (%)	95
Students t UCL	105
Lands HUCL	167.447
Zou UCL	163.324
Chebyshev 95% UCL	162.506

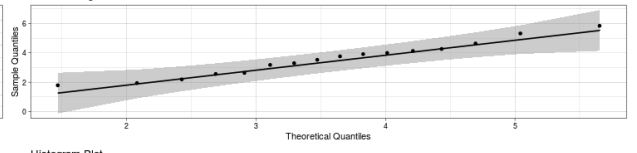
### Other:

CV High	TRUE
Normality Raw Data	FALSE
Normality Log Data	TRUE
Critical t (95%) 2 Sided	2.131
Margin of Error (MoE)	47.038
Z	211.51
Max Probable Error (MPE%)	70.933
Relative Standard Deviation (%RSD)	133.118

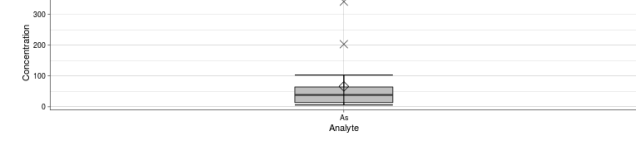
Q-Q Plot Raw Data



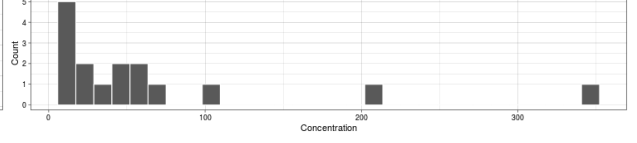
Q-Q Plot Log Data



Box & Whisker Plot



Histogram Plot



## Generate report

- The current display
- All data

Click to report



# Report Output

## Open UCL Report Rev8.1 (Open UCL Beta Ver 3.02)

Report Date & Time: 2021-04-19 01:50:31  
 Data File Name: sample\_data\_NSWEPA.xlsx  
 Report Title: Tim's Test Data

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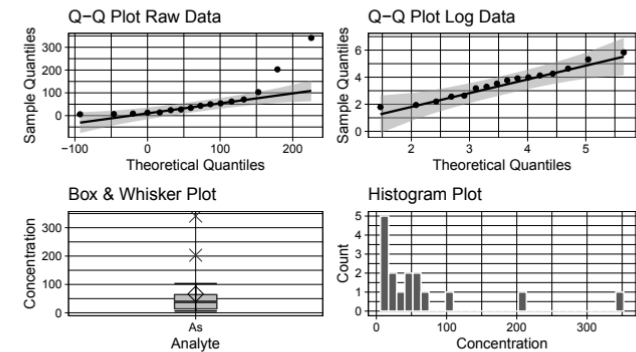
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We encourage the reporting of bugs, issues, new ideas and contributions. If you want to report a bug, issue or have an idea to add to Open UCL you can email [openstatsonline@gmail.com](mailto:openstatsonline@gmail.com). Or if you are on github you can also use this link to post an issue on the Open UCL Repository.

As

Descriptive Stats		Upper Conf Limits	
n	16	Confidence Level (%)	95
min	6	Students t UCL	105
max	341	Lands HUCL	167.447
range	335	Zou UCL	163.324
mean	66.312	Chebychev 95% UCL	162.506
gm	35.187	Other Results	
median	38.5	CV High	TRUE
standard deviation (sd)	88.274	Normality Raw Data	FALSE
standard error of mean (sem)	22.068	Normality Log Data	TRUE
coefficient of variation (cv)	1.331	Critical t (95%) 2 Sided	2.131
skewness	2.462	Margin of Error (MoE)	47.038
Log Transformed		Z	211.51
Log min	1.792	Max Probable Error (MPE%)	70.933
Log max	5.832	Relative Standard Deviation (%RSD)	133.118
Log mean	3.561		
Log sd	1.16		
Normality Tests			
Shapiro-Wilks Value (raw)	0.672		
Shapiro-Wilks p (raw)	0		
Shapiro-Wilks Value (log)	0.973		
Shapiro-Wilks p (log)	0.88		



# Screenshot – Additional Information

Open UCL BETA V3.03

Introduction

Basic Stats and UCL

Sample Size Calcs

GOF Tests

Trend Analysis

Basic Stats and UCL

Instructions and Help

Which UCL to Use?

## Guidance on Interpretation of Open UCL Results

This page aims to provide some guidance on the interpretation of results presented in the Open UCL output. This is not intended to be a detailed on-size-fits-all set of instructions for interpreting the data, but is intended to illustrate some concepts for which questions have been raised by users and may not be widely understood.

### Which UCL value should I use?

Unlike some other software packages, Open UCL does not provide a definitive specification for which of the several UCL values calculated is the one which applies to the data set.

There are a wide range of formulae for calculating confidence limits, including Upper Confidence Limits, or UCLs, which are a focus here. Most versions rely on knowing the statistical distribution of the underlying data, and using that knowledge to select and calculate an appropriate confidence interval. We have limited the UCL calculations to three data distributions, which is consistent with the approach in the current draft NSW EPA sampling design guideline:

1. Normal data distribution (Students t-test),
2. Lognormal data distribution (Lands H, and for large data sets, Zou), and
3. Neither Normal nor Lognormal distribution (Chebychev, which does not assume any underlying data distribution).

A statistical comparison of the data distribution to a normal distribution is made by Open UCL using the Shapiro-Wilks method. This gives two values, a Shapiro-Wilks Value, and a Shapiro-Wilks p-value. Where the p-value is greater than 0.05, the data is said to meet a normal distribution with 95% confidence. These values are listed for the data set in the output as the *Shapiro-Wilks Value (raw)* and *Shapiro-Wilks p (raw)* respectively.

In order to determine whether or not a data set has a lognormal distribution, Open UCL log transforms the data and runs the Shapiro-Wilks test on the transformed data. In this case, if the Shapiro-Wilks p-value is greater than 0.05, the data is said to be a lognormal distribution with greater than 95% confidence. The Shapiro-Wilks calculation values are listed for the data set in the output as the *Shapiro-Wilks Value (log)* and *Shapiro-Wilks p (log)* respectively.

To save having to remember this, there are two outputs listed by Open UCL; *Normality Raw Data* and *Normality Log Data*. These items are shown as *TRUE* if the relevant p-value exceeds 0.05, and *FALSE* otherwise.

However, it is strongly recommended not to rely on the numerical interpretation of data distribution alone, as some data sets may give unexpected results. You should always examine the QQ plots and the Histogram to confirm the statistical interpretation. The reading of QQ plots is discussed below.

To select an appropriate UCL value for the data set, examine the *Normality Raw Data* and *Normality Log Data* values in conjunction with examining the QQ plots and apply the following logic:

1. If your data is neither *normal* nor *lognormal* (i.e. neither value is *TRUE*), then it may best to use the Chebychev UCL.
2. If your data is statistically *normal* (i.e. *Normality Raw Data* is *TRUE*), use the Students t-test UCL.
3. If your data is statistically *lognormal* (i.e. *Normality Log Data* is *TRUE*), use the Lands H, or Zhou, UCL.

For some statistically small data sets, they will meet both the *normal* and *lognormal* distributions with 95% confidence. This is possibly an artefact of applying the formulae to small data sets, and it is not really possible to distinguish between them with confidence. In this case we consider the data distribution to not be clearly defined and recommend using the Chebychev UCL or collecting more data.

### Introduction to Reading a QQ Plot

The Q in QQ plot stands for *quartile*, and the plot is a graph of the calculated theoretical quartiles (in this case for a normal distribution) against the actual quartile values. For an ideal *normal* (or *normally distributed*) data set, this will result in the data plotting on a straight line. For a real world data set, the fit is never perfect, but the data will plot reasonably close to a straight line.

The further the data deviates from the ideal line, the worse the fit to that distribution. On the QQ plots provided in the Open UCL output, a theoretical straight line is provided for reference, and a shaded area representing a 95% confidence of fit is also displayed. Generally you would like to see most of the data points fit into the shaded area

It is common for data points at the extreme ends to lie some distance from the line, and this does not necessarily invalidate an otherwise good fit.

The Open UCL output includes a QQ plot for the raw data, and one for the log transformed data. This corresponds directly to the two versions of the Shapiro-Wilks assessment provided in the tabulated data.

We strongly recommend cross checking the QQ plot results against the Shapiro-Wilks numerical indicators of distribution before relying on a particular interpretation.

### Introduction to the Open UCL Box and Whisker Plot

The box and whisker plot provided in the Open UCL output includes the following features:

- A shaded box between the 25th and 75th percentiles (50% of the data values lie within this zone).
- A diamond shape marks the mean concentration.
- A horizontal line marks the median (50th percentile). Half the data lie above, and half below this value.
- An upper whisker (or hinge) and a lower whisker (vertical line terminating in a horizontal line). This line extends to 1.5 times the interquartile range (the 75th percentile minus the 25th percentile) beyond the upper or lower bound of the shaded box.
- Any values above or below the extent of the whiskers are plotted as an asterisk. These are the statistically extreme values in the data set. We loath to call them outliers as such data points are often the most interesting values in a data set.

### Histogram

Histograms give a good indication of the spread of data within grouped "bins", or data ranges. Most people are familiar with using data presented as a histogram and we have not provided much detail here for that reason.





# Documentation

server costs and upgrades to Open UCL.

In return, we will list all contributors to Open UCL on the Open UCL app page.

Developers & Contributors  
T. Chambers, A. Mikov, M. Salmon  
A. Butt

The report includes a cover page listing the version of OpenUCL, date and time of processing, name of the data file and the title you entered on the input page to reference the purpose of the data set. The title page also includes the licencing information (open source licence) for the OpenUCL code base.

## Statistical Terms in the Output

### Descriptive Statistics

#### Number of samples

Displays the number of valid sample entries identified for an analyte in the data set. This number is critical to the determination of most of the other statistical parameters. It is **strongly recommended** to cross-check with your data set to make sure that the expected number of samples have been identified. If there is a mismatch, it may be worth checking for stray non-numerical characters in your data file. We allowed for the data to be viewed on the bottom left of the summary screen to help with this verification.

#### Min

The minimum value reported for each analyte.

#### Max

The maximum value reported for each analyte.

#### Range

The difference between the minimum and maximum values in the data set.

#### Mean

Numerical average of the provided data set, commonly taken to be a representative value of the overall data set. The mean is prone to distortion due to the effects of small numbers of extreme values.

The mean will also change for any re-sampling events, so a mean value from one sampling event may not be accurately representative of the "real" mean concentration of an analyte at a target site. Accordingly, review of the data distribution and estimation of an appropriate upper confidence limit of the mean is often considered more reliable.

The mean ( $\bar{x}$ ) for a data set of  $n$  values  $x_1 \dots x_n$  is calculated as:

$$\bar{x} = \frac{\sum x_i}{n}$$

#### Geometric Mean

The geometric mean is calculated as the  $n^{\text{th}}$  root of  $n$  numbers, and presents a representative metric of the data set as an alternative to the arithmetic mean value based on the sum of the numbers, and will be equal to or less than the arithmetic mean when the data set includes only positive numbers. The geometric mean ( $GM$ ) is calculated as:

$$GM = \sqrt[n]{x_1, x_2, \dots, x_n}$$

#### Median

The median value (50th percentile) of reported values for each analyte. Half the values in the data set are higher and half lower than this value.

The median can be a better approximation of "typical" values than the mean as it is less prone to distortion by extreme values.

The median for a data set of  $n$  values  $x_1 \dots x_n$  is calculated as:

$$MEDIAN = \frac{x_{(n/2)} + x_{(n/2)+1}}{2}$$

#### Standard Deviation

The standard deviation is calculated by determining the absolute difference between each data point and the mean, then finding the average of those differences. The standard deviation is a fundamental measure of variability in the data set.

The standard deviation ( $s$ ) for a data set of  $n$  values  $x_1 \dots x_n$  with a mean ( $\bar{x}$ ) as described above, is calculated as:

$$s = \sqrt{\frac{\sum_{x_i} (x_i - \bar{x})^2}{n - 1}}$$

#### Standard Error of Mean (SEM)

The Standard Error of the Mean, sometimes referred to as just Standard Error, is calculated by dividing the standard deviation by the square root of the mean. This provides a measure of variability normalised to the size of the dataset and is useful for comparing variability between data sets of different sizes. It provides a measure of the dispersion of sample means around the population mean.

$$SEM = \frac{s}{\sqrt{\bar{x}}}$$

#### Coefficient of Variation

The coefficient of variation is a measure of the relative homogeneity of a distribution ( $CV = \text{standard deviation} / \text{mean}$ ). Low CV values ( $\leq 0.5$ ) indicating a fairly homogenous contaminant distribution, and high CV values ( $> 1$ ) indicating heterogeneous distributions and probably skewed to the right. Also known as the relative standard deviation (RSD) and expressed as %.

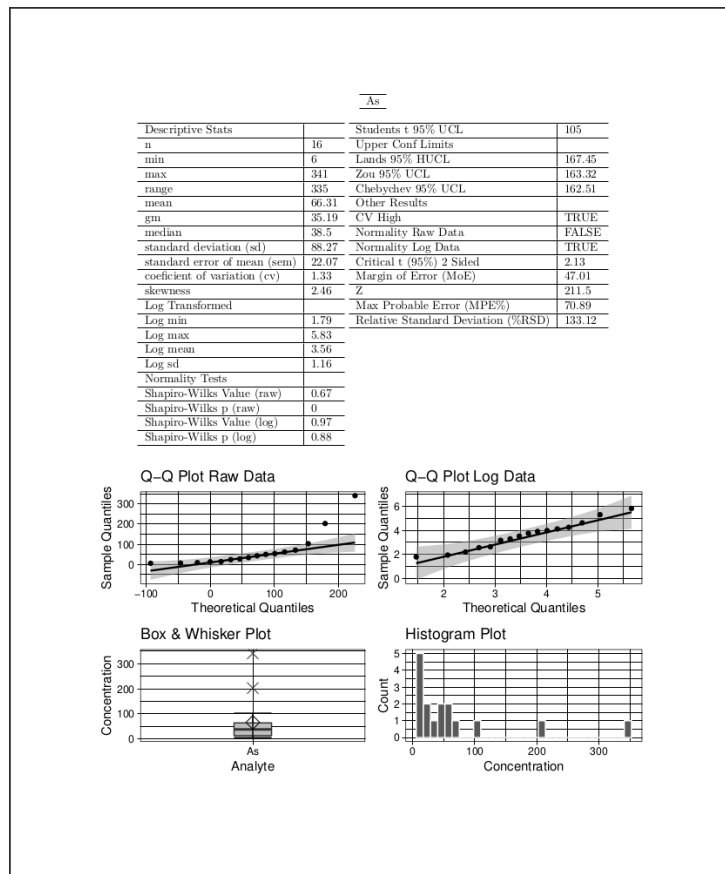
$$CV = \frac{s}{\bar{x}}$$

#### Skewness



# Comparison to ProUCL Output

## Test Data from the Draft Sampling Design Guidelines



UCL Statistics for Uncensored Full Data Sets			
User Selected Options			
Date/Time of Computation	ProUCL 5.13/03/2021 11:21:57 AM		
From File	sample_data_NSWEPA.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
As			
General Statistics			
Total Number of Observations	16	Number of Distinct Observations	16
		Number of Missing Observations	0
	Minimum	6	Mean
	Maximum	341	Median
	SD	88.27	Std. Error of Mean
	Coefficient of Variation	1.331	Skewness
			2.462
Normal GOF Test			
Shapiro Wilk Test Statistic	0.672	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.291	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.213	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	105	95% Adjusted-CLT UCL (Chen-1995)	117.1
		95% Modified-t UCL (Johnson-1978)	107.3
Gamma GOF Test			
A-D Test Statistic	0.454	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.767	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.151	Koimogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.92	k star (bias corrected MLE)	0.789
Theta hat (MLE)	72.08	Theta star (bias corrected MLE)	84.03
nu hat (MLE)	29.44	nu star (bias corrected)	25.25
MLE Mean (bias corrected)	66.31	MLE Sd (bias corrected)	74.65
		Approximate Chi Square Value (0.05)	14.81
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	13.9
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	113.1	95% Adjusted Gamma UCL (use when n<50)	120.5



# Comparison to ProUCL Output (Arsenic)

Descriptor	ProUCL	OpenUCL
Standard Deviation	88.27	88.27
Standard Error of the Mean	22.07	22.07
Coefficient of Variation	1.33	1.33
Skewness	2.46	2.46
95% UCL (students t-test)	105	105
95% UCL (Lands-H) - lognormal	167.4	167.45
95% UCL (Chebychev) - nonparametric	162.5	162.5



# Odds and Ends

- OpenUCL will ignore blank cells and garbage data in the input file
  - Easier to prepare data
- OpenUCL interprets “<X” to indicate values below the limit of reporting
  - No need for a second column of LOR values
- OpenUCL has an interactive data viewer to help identify unexpected values

Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	
	12<1		24	42	24<0.1		8	100
	10<1		26	18	22<0.1		6	30
	14<1		20	15	22<0.1		3	11
	10<1		27	10	23<0.1		6	14
	6<1		13	12	10<0.1		2	9
	5<1		10	840	32<0.1		10	1240
	9<1		19	20	20<0.1		11	40
	16<1		10	259	20<0.1		8	1420
	8<1		12	533	30<0.1		10	959
	12<1		8	119	22<0.1		58	268
	7<1		8	13	8<0.1		4	16
	13<1	fbblg		24	24<0.1		6	26
	7<1			14	7<0.1		2	8
	6<1		7	11	14<0.1		12	40
	8<1		45	20	27<0.1		11	50
	6<1		4	20	35<0.1		9	47
	8<1		21	29	37<0.1		13	80
	7<1		16	36	55<0.1		22	68
	10<1		33	9	23<0.1		5	14
	11<1		22	12	18<0.1		2	5
	9<1		20	16	13<0.1		4	12
	6<1		3	6	5<0.1		2	5
	9<1		20	9	34<0.1		5	22
	7<1		9	12	12<0.1		2	11
	6<1		37	19	21<0.1		3	11
	13<1			8	23<0.1		3	14
	11<1		34	16	35<0.1		5	18



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