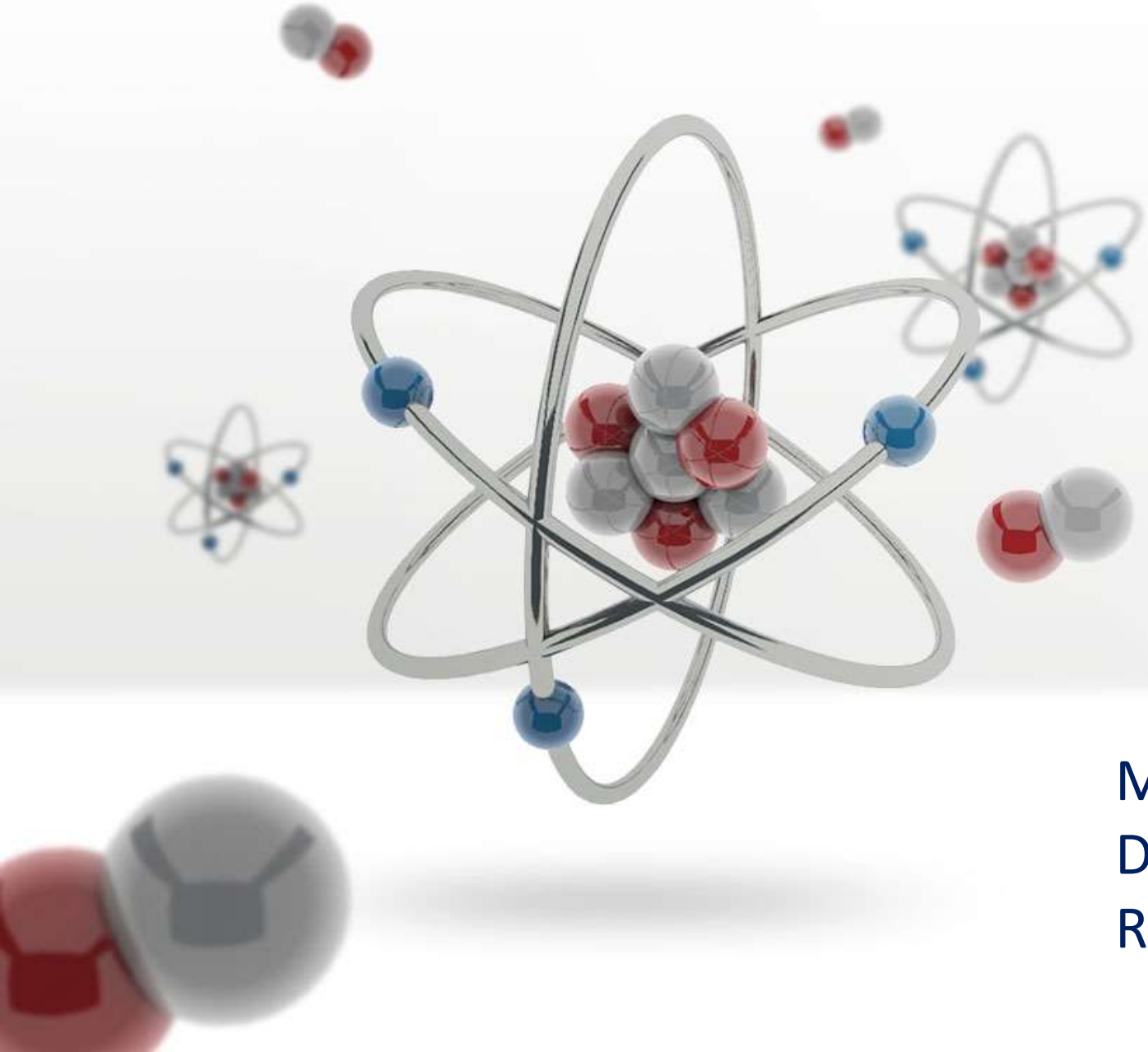

1,4-Dioxane Remediation Considerations

Michael King, Pace Analytical
Director of Specialty Services
Remediation Short Courses 2018

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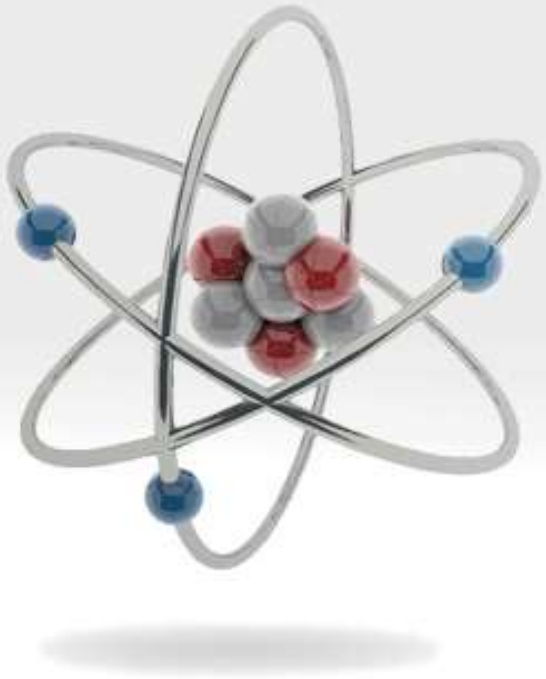
What Will Be Discussed Today



What is 1,4-Dioxane
Sources of 1,4-Dioxane
Environmental Impacts
Human Routes of Exposure
Methods Available for Site Evaluation
Potential Treatment Approaches
1,4-Dioxane Case Studies

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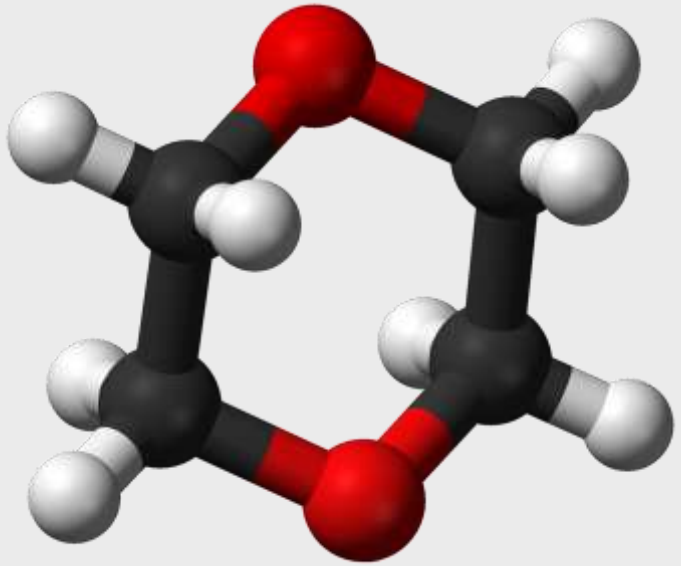
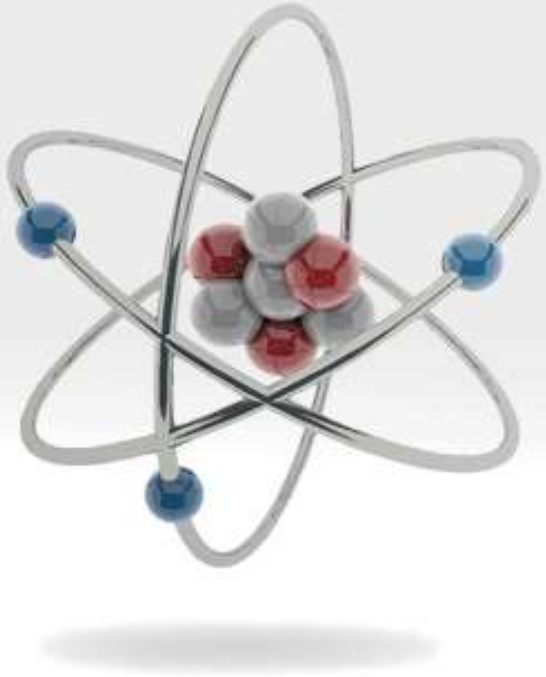
What is 1,4-Dioxane





1,4-Dioxane is a synthetic industrial chemical
It is completely miscible in water
Unstable at high temperature (fire/explosion)
A very likely contaminant at chlorinated sites
A probable human carcinogen (animal studies)
Detected in drinking water across the country

https://www.epa.gov/fedfac/technical-fact-sheet-14-dioxane

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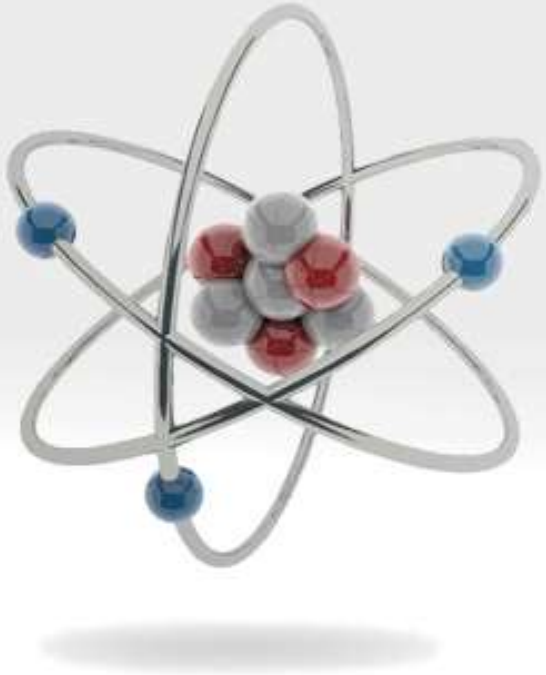
Where has 1,4-Dioxane Been Used



As a stabilizer in chlorinated solvents e.g. TCA
As a cryoscopic laboratory solvent
In consumer products: Varnish, Dyes, Paint Stripper
In a number of industrial processes
- Textile Manufacturing
- Purification of Drugs

Trace amounts found in shampoos and cosmetics

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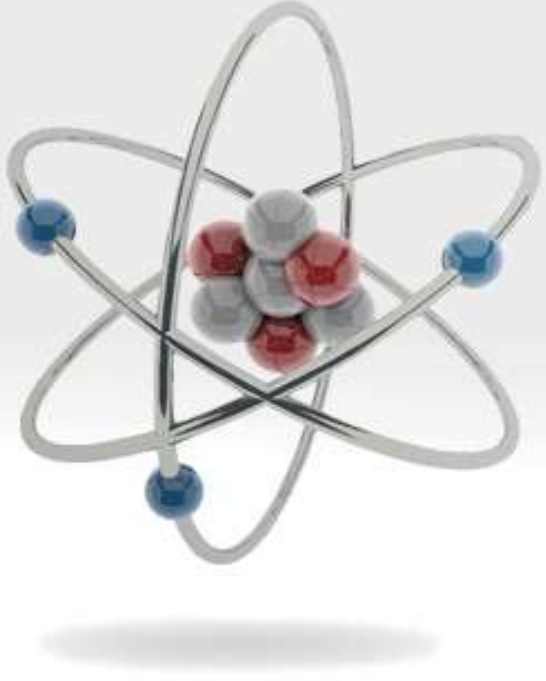
1,4-Dioxane in Drinking Water



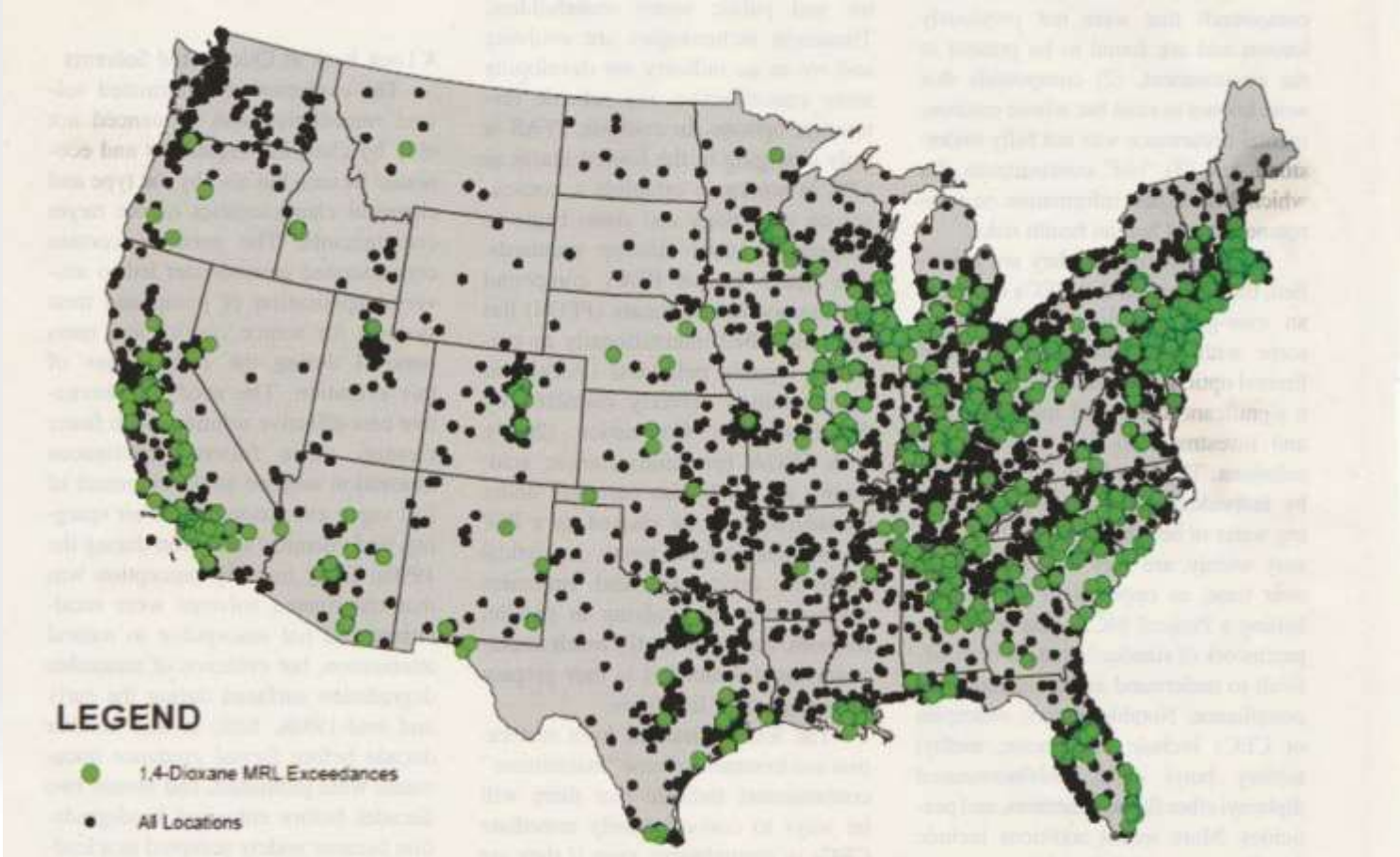


Figure 1. 1,4-dioxane public water supply sampling results from USEPA Unregulated Contaminant Monitoring Rule 3 (UCMR 3) (EPA 2015). Based on results reported through June 2015, nearly 7% of public water supplies tested showed exceedances of the health advisory levels for 1,4-dioxane.

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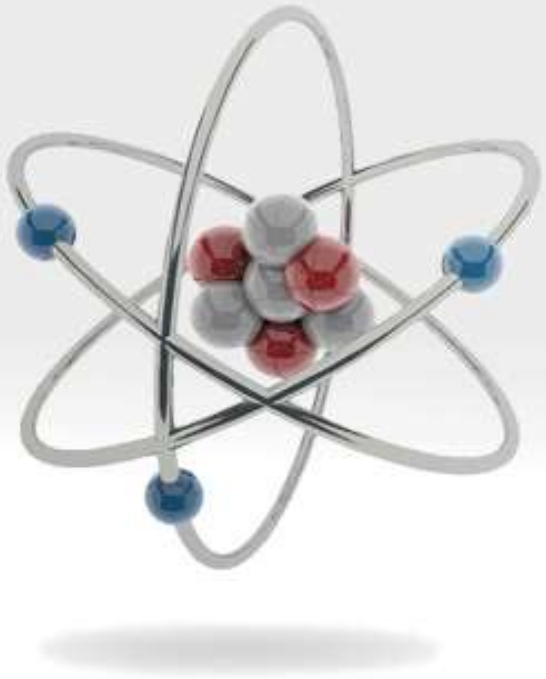
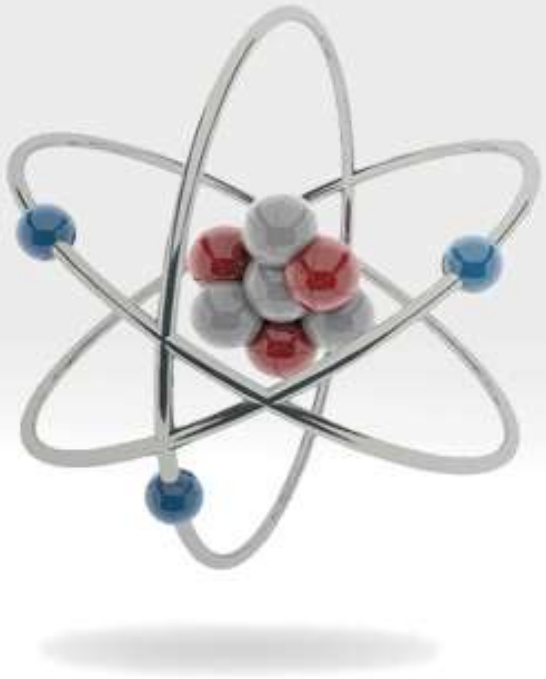
Environmental Impacts of 1,4-Dioxane



Released to the environment from multiple users
Short-lived in the air (1-3 day half life)
Mildly retarded by sorption to soil
Moves rapidly in subsurface soil
Migrates rapidly in groundwater
Relatively resistant to degradation

Routes of Exposure to 1,4-Dioxane



To workers during production
To consumers in products, DW and reservoirs*
Inhalation is the most common exposure
Short term exposure – eye, nose, throat irritation
Dermal pathway is also possible
Ingestion in food or water
Vapor Intrusion potential
Long term exposure – kidney and liver damage

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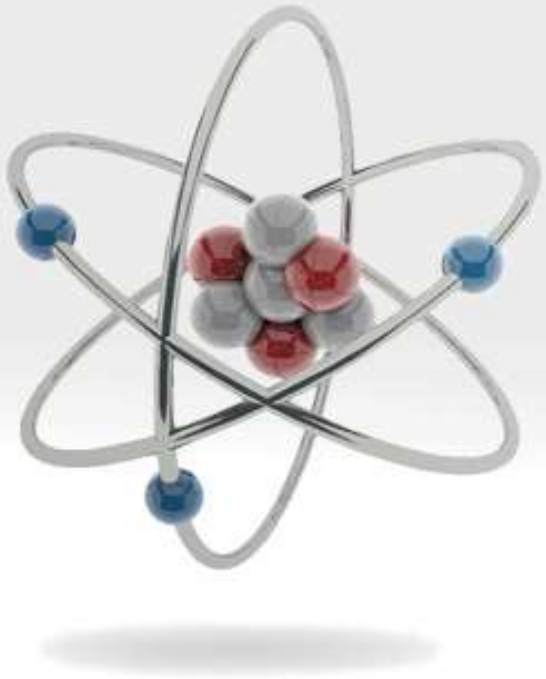
1,4-Dioxane Plume Characteristics



1,4-Dioxane plumes generally dilute (365ug/L median)

Typically lack an easily targeted source zone

High penetration of low K zones – back diffusion

Often co-located with chlorinated solvents

- With 1,1,1-TCA most often (70%)
- With 1,1-DCE nearly as often (69%)
- With TCE at (52%)

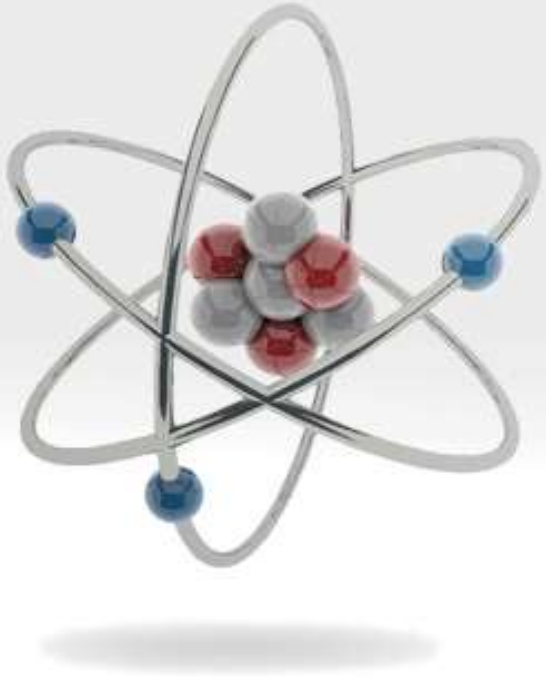
Plume may be much longer than chlorinated (21%)

Can be shorter, possibly due to later introduction (56%)

Hundreds of chlorinated sites not evaluated in CA (75%)

http://www.dtic.mil/dtic/tr/fulltext/u2/1030260.pdf

Methods to Characterize 1,4-Dioxane



Concentration 8260 SIM @ .5ug/L
8270 SIM @ .1ug/L
522 @ .07ug/L

Mobile Lab SPME 8270 SIM @ .2ug/L

qPCR to determine microbial type and quantity

1 D CSIA evaluate biodegradation - Carbon

2 D CSIA evaluation of sources – Carbon/Hydrogen

TO-17 in air to evaluate vapor intrusion

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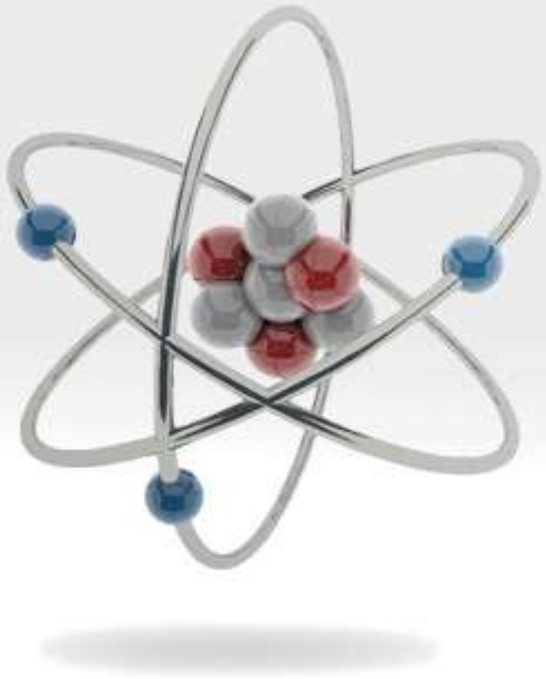
Treatment Technologies



Dissolved oxygen correlates with 1,4-D attenuation

But 1,4D attenuation inhibited by presence of CVOCs

Strategy - Treatment Train

- Removal of inhibiting compounds, CVOCs
- Followed by bioaugmentation with 1,4-D degraders

Use biomarkers to assess aerobic degradation - CB1109

Treatability studies can assess specific site needs

MNA may be more effective than previously thought

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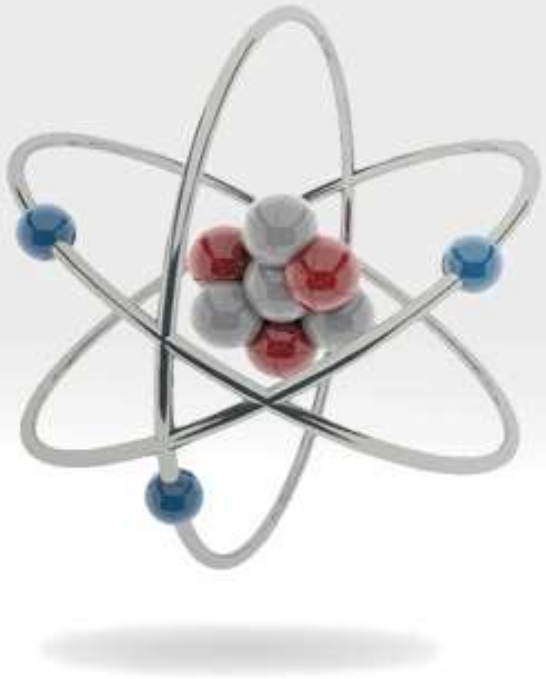
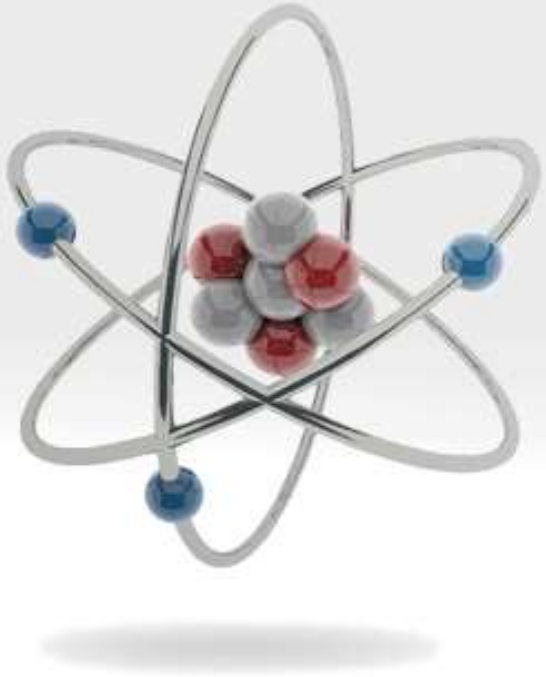
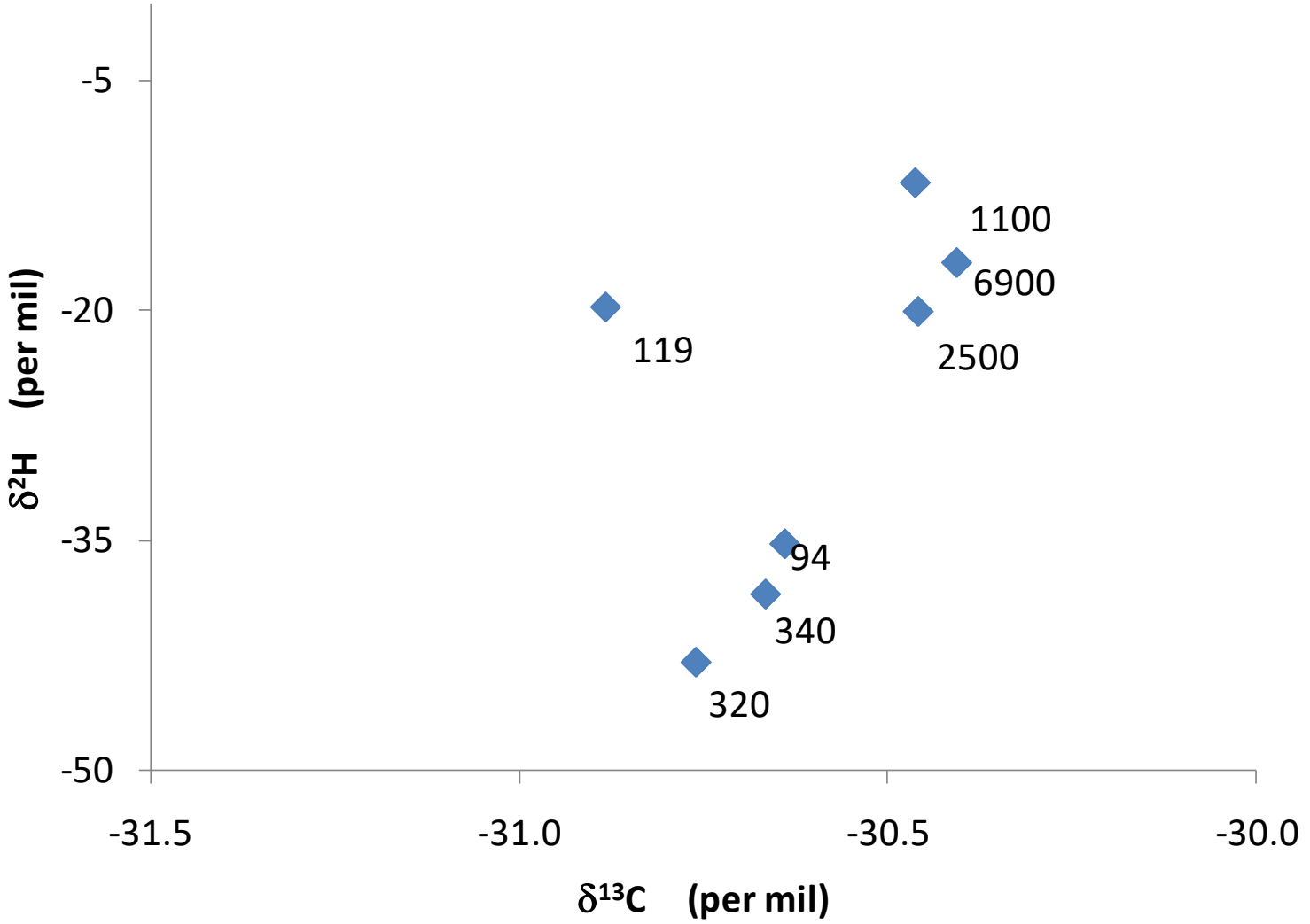
Case Studies - Forensics



Large confidential site, industrial area near LAX
Multiple CVOC plumes including TCA and 1,4-D
RP suspected other sources of 1,4-Dioxane
7 samples at strategic wells, 2 D CSIA Carbon/Hydrogen
Plot on next page indicates two distinct sources
One line of evidence for multiple source argument
Could amount to millions in total savings

Case Study – Forensics by CSIA





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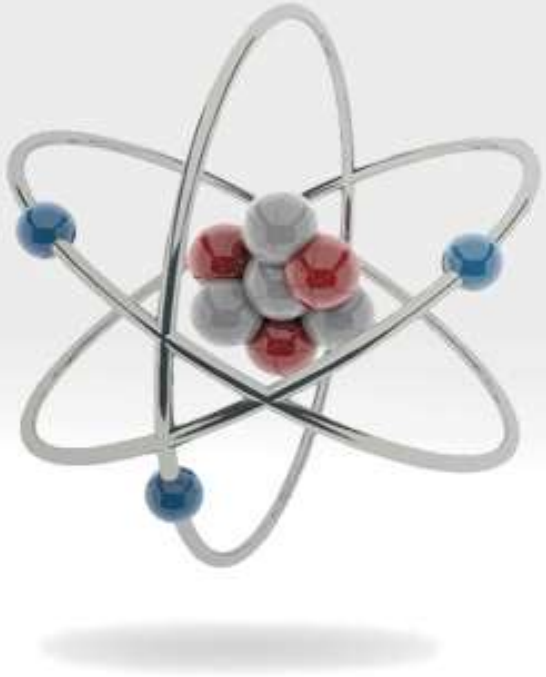
Case Study – 1,4-Dioxane Treatability



CSIA supports 1,4-D degradation in microcosm study

Carbon becomes enriched as concentration declines

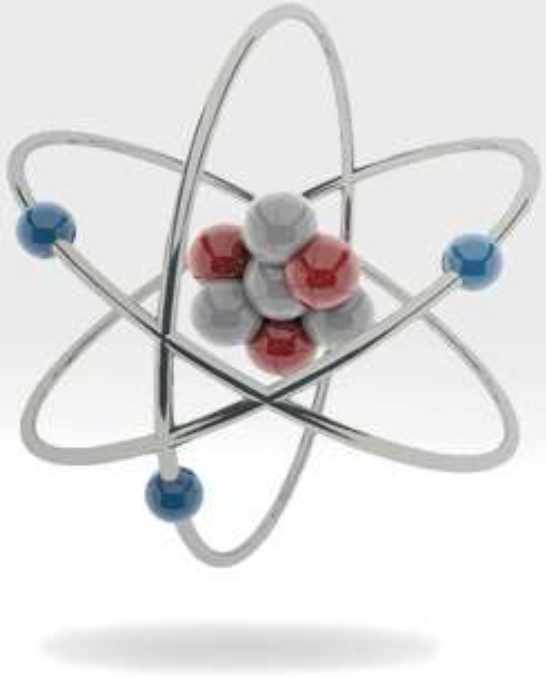
Two microorganisms confirmed as degraders

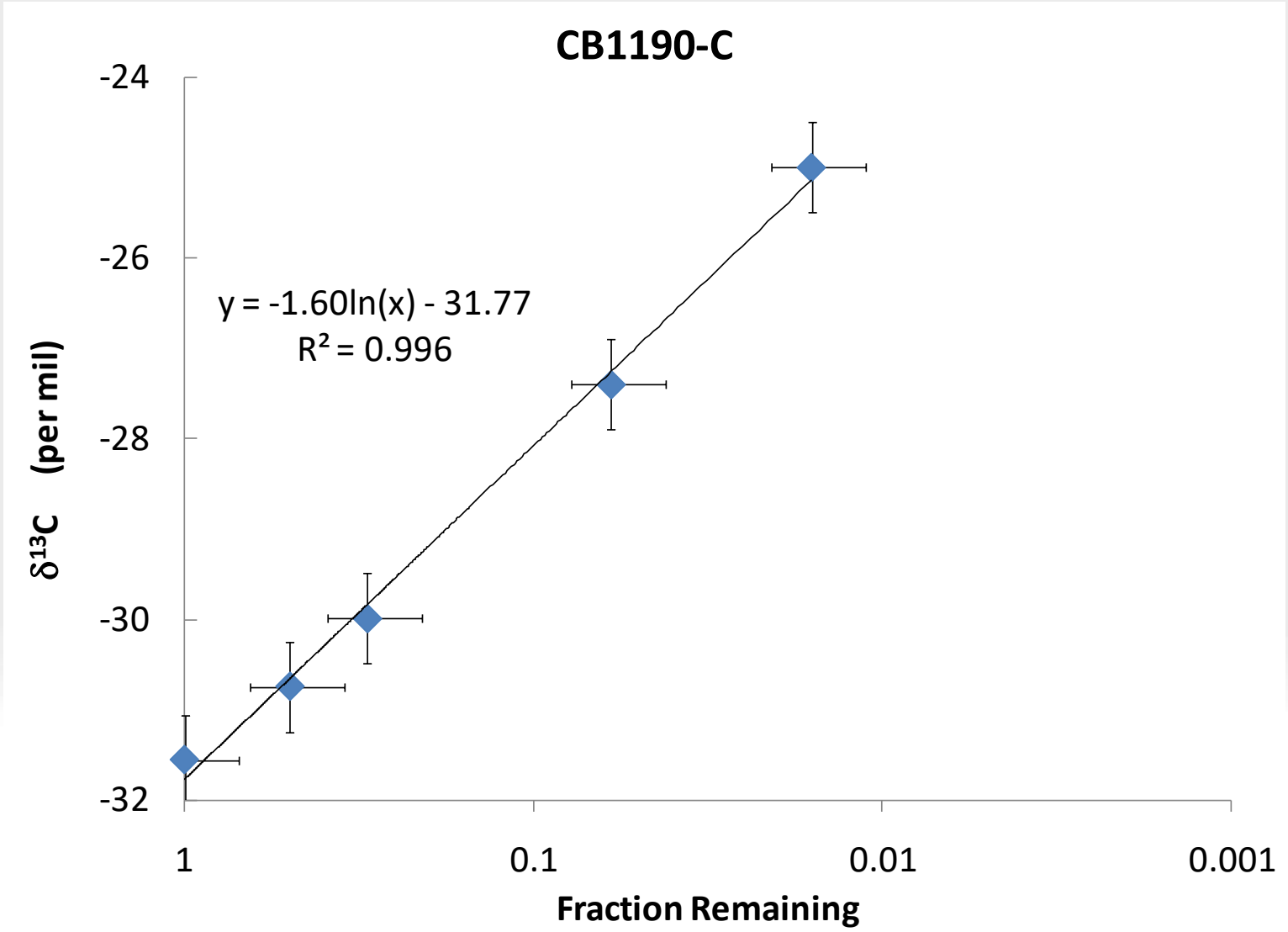
- CB1109-C
- PH06-C

Strong correlation coefficient indicated for both

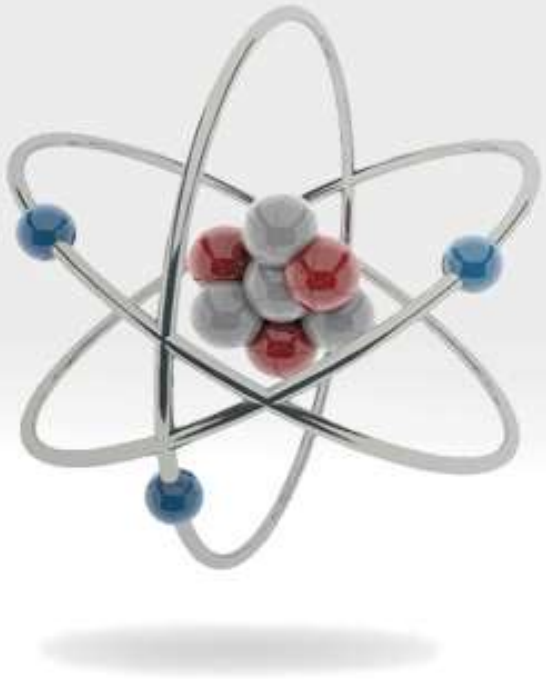
CSIA provides additional line of evidence in treatability

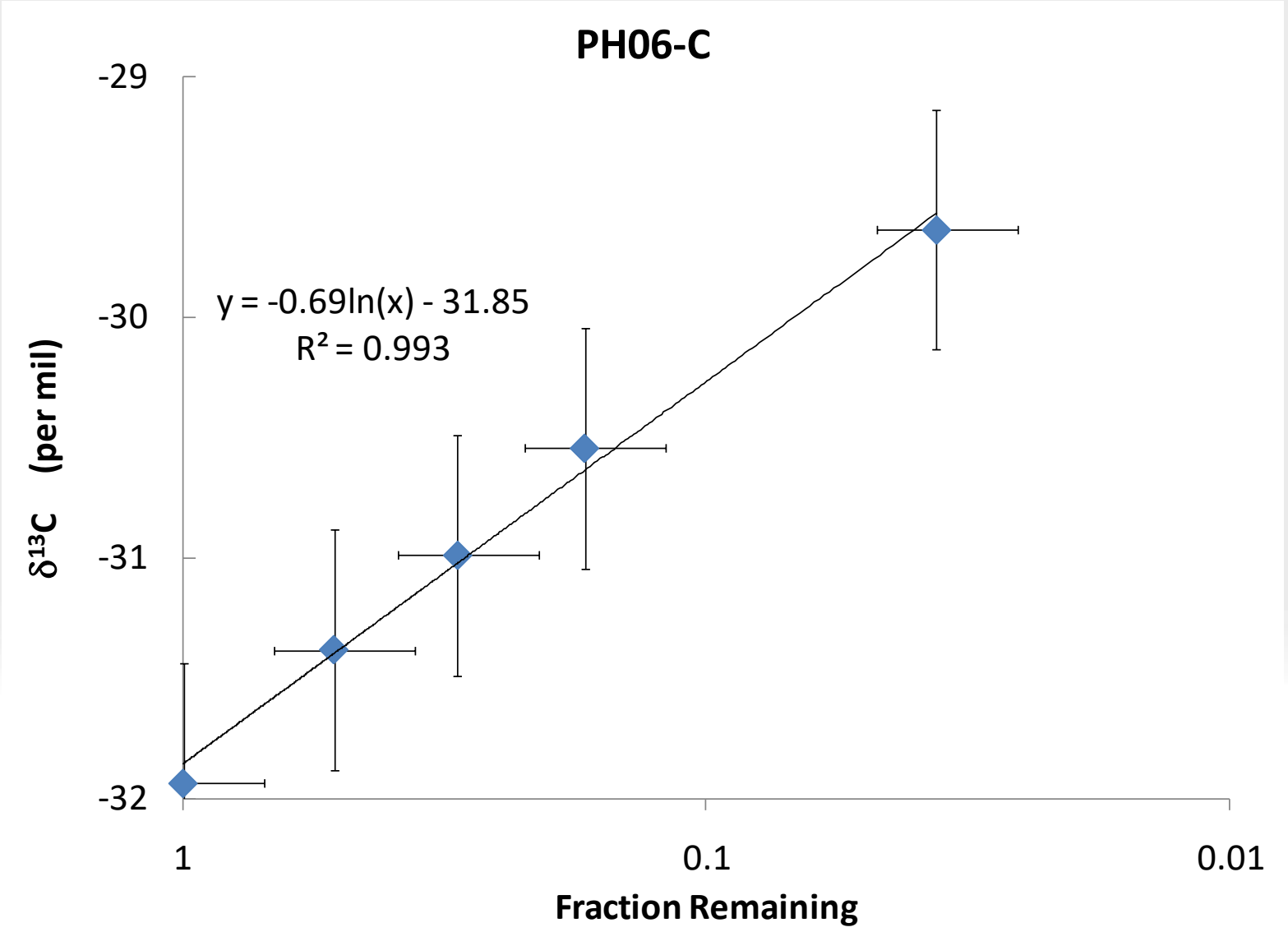
Case Study – 1,4-Dioxane Treatability





Case Study – 1,4-Dioxane Treatability





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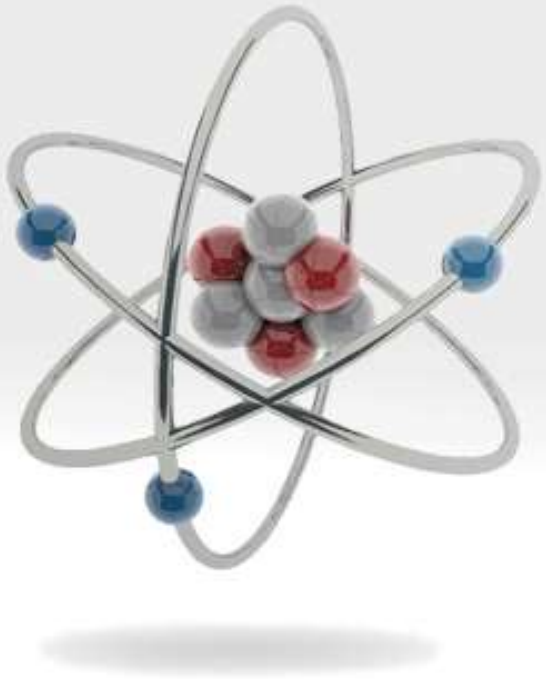
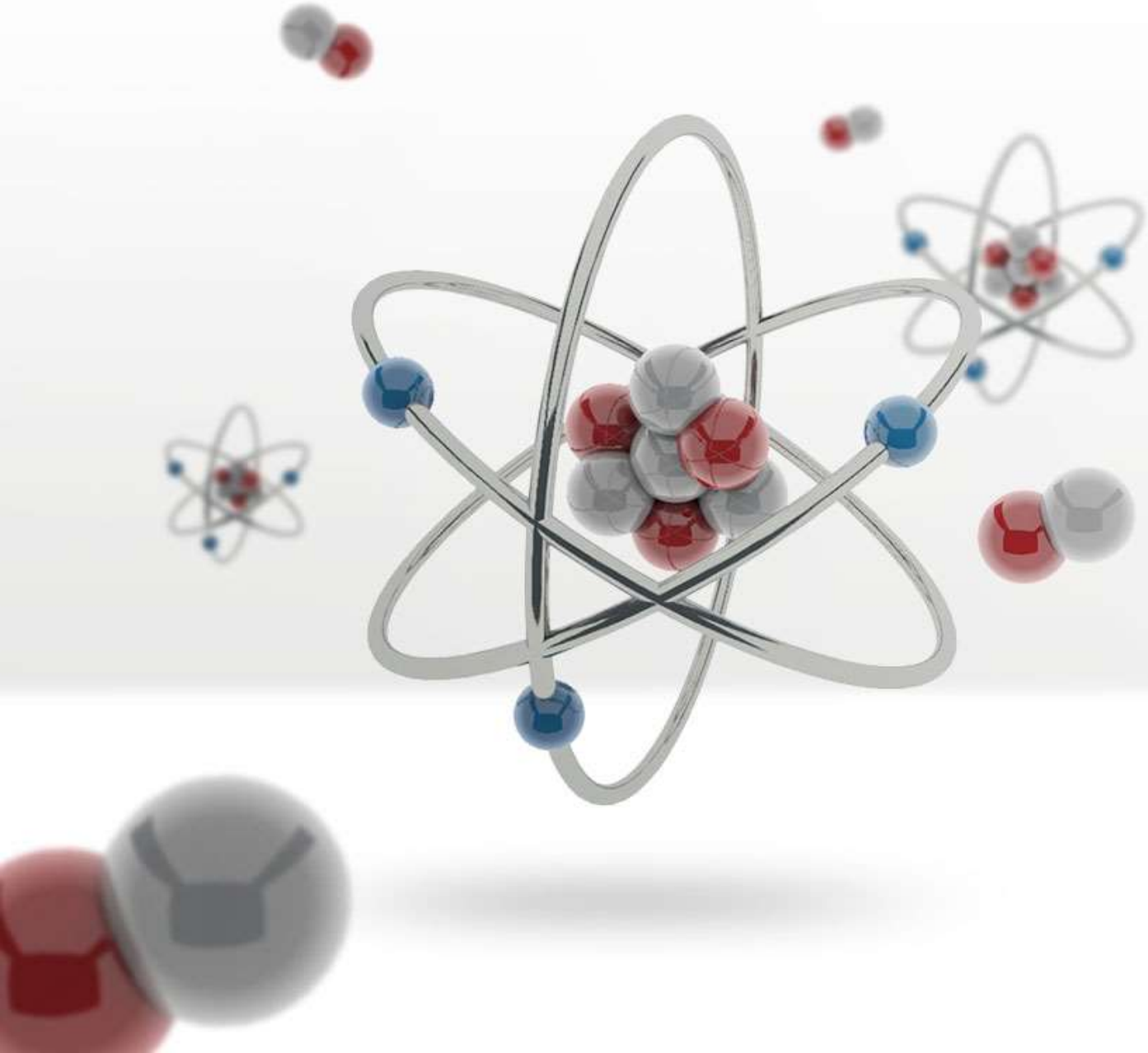
1,4-Dioxane In Summary



- 1,4-Dioxane has been widely used in the US
  - Has been found in our Drinking Water
  - Probably at many CVOC sites not yet evaluated
- 1,4-D is a probable human carcinogen
- State and Federal clean up levels are developed
- Methods available to evaluate & monitor activity
- Effective treatments are becoming available
- You have the tools to address this challenge



Thank you

Questions?

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