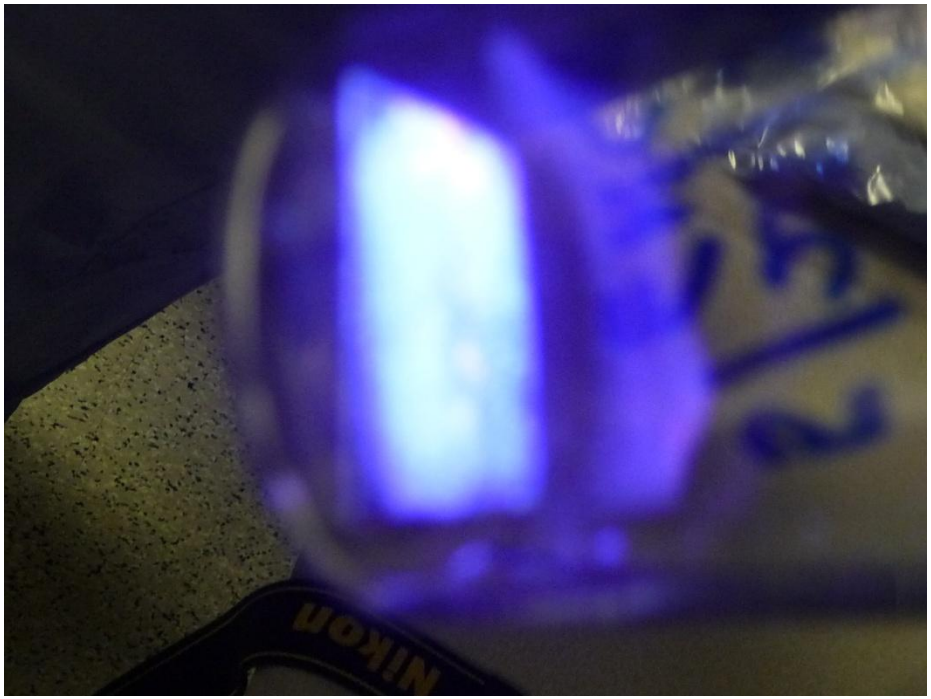
Investigating the Life Cycle Risks of a Nanomaterial in Paint using Nano LCRA



Jo Anne Shatkin[1], Walker Larsen[1], Robert Nick[2], Jocelyn Hospital[1] and Seth Coe-Sullivan[2]

[1]CLF Ventures, Inc. and [2]QD Vision

New England Nanomanufacturing Summit
June 22, 2010
UMASS Lowell

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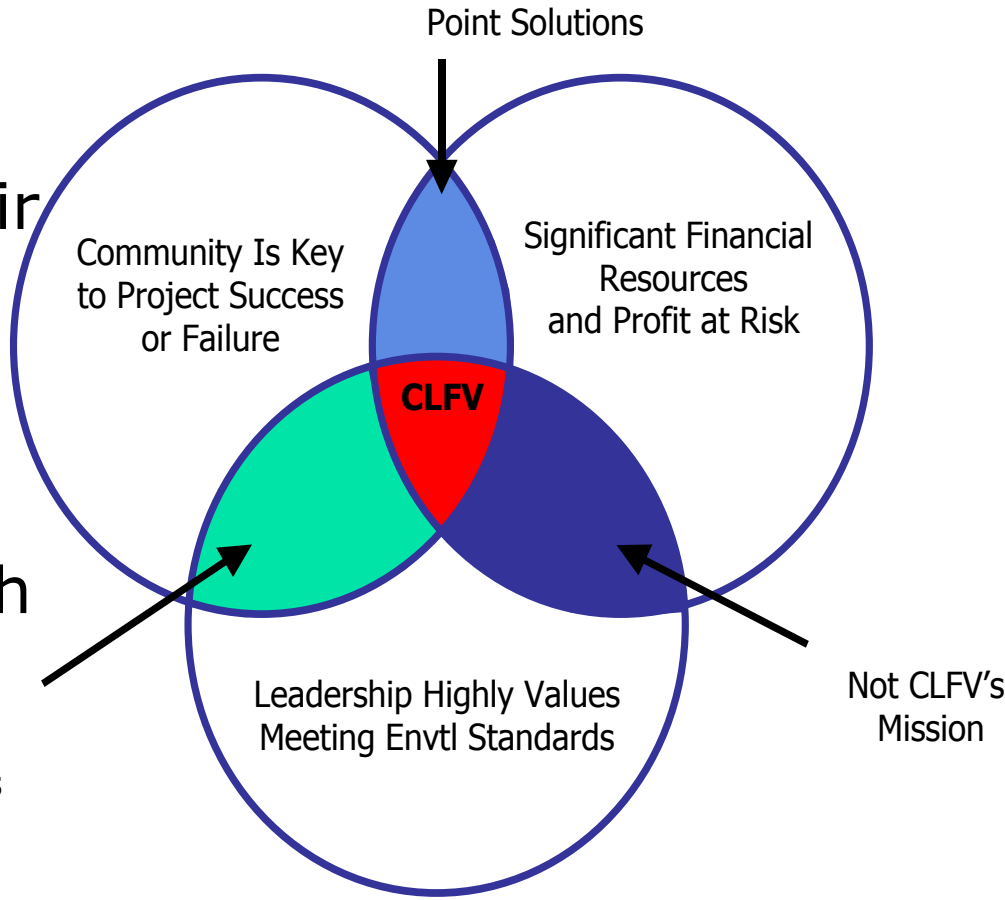
- We work at the intersection where organizations meet their stakeholders and the environment
- We help organizations implement projects with economic and environmental benefits.



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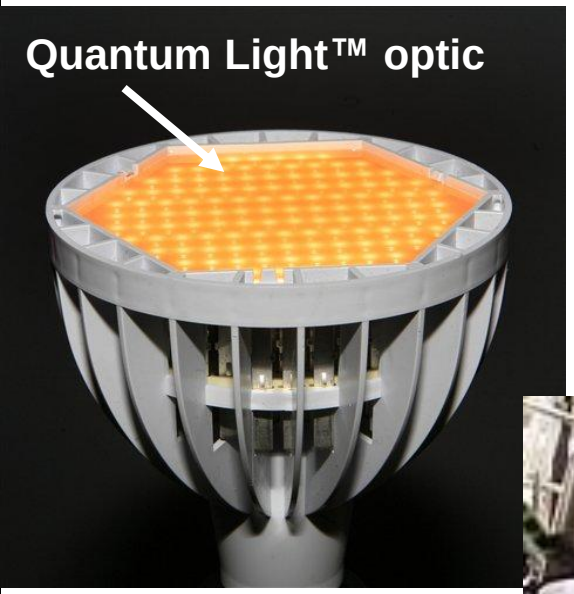
Project Partners

- QD Vision - Robert Nick, Seth Coe-Sullivan, Anne-Marie Baker, John Linton
- UMASS Lowell – Michael Ellenbecker, Candace Tsai
- Cold Spring Technologies- Rich Himmelwright

QD Vision – where color, power, and cost matter

- Founded 2004 out of MIT - 50+ employees (2009)
- Focus on displays & lighting markets
- First to market with quantum dot product for solid state lighting
- Thought leader in QD EH&S and technology



Nexxus PAR 30 LED Array

Presentation Overview

- Nano LCRA Framework
- Problem formulation
- Case study first iteration walk-through
- Case study interim product testing
- Case study second iteration walk-through
- Process evaluation

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Early Stage Life Cycle/Risk Analysis supports Sustainable Technology Development

- Can be proactive about identifying and reducing risk
  - Promotes environmentally sustainable technology development
  - If EHS concerns, need to develop approaches for assessment and management
- Engineering materials provides flexibility to address EHS concerns up-front, if identified
- Understanding impacts provides a competitive edge in efficiently managing them
  - When risks are anticipated, can plan for them, rather than reacting
  - Early stage analysis informs sound decisionmaking

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NANO LCRA Streamlined Framework

- A screening tool to identify and prioritize health and environmental/ process issues
- Complement with regulatory/ market competition/ societal concern analysis
- Analysis identifies key uncertainties – can inform product development
- Revisits early decisions with new information

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NANO LCRA Features

- Proactive, early stage, affordable, easily implementable process even with few available data.
- Develops risk management practices based on minimizing exposure and potential human health effects and environmental impacts.
- Applicable for NM research and development, product manufacturing, consumer applications, and evaluation of NM fate in the environment.
- Prioritizes future data needs.

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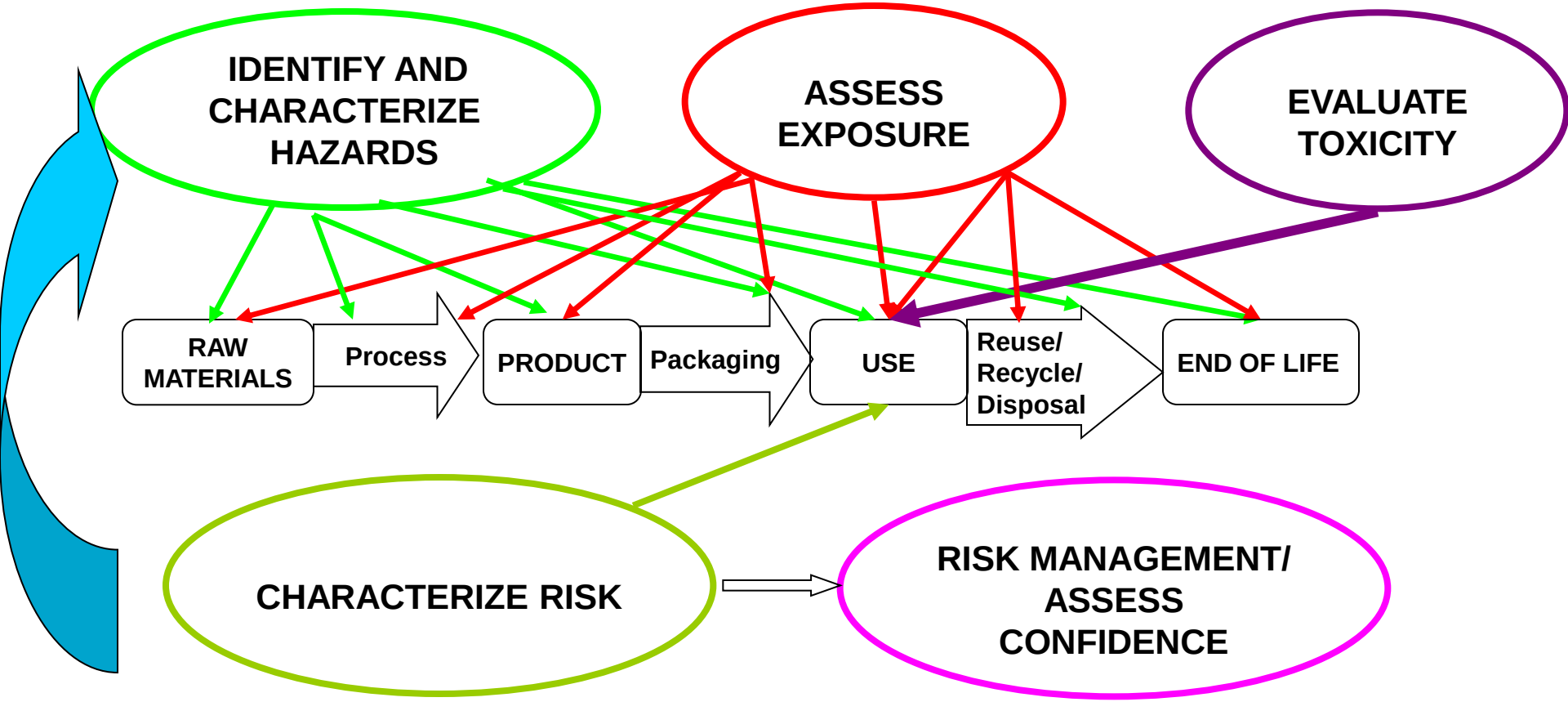
NANO LCRA

Adaptive Streamlined Life Cycle/ Risk Assessment Framework for Nano Materials (Shatkin 2008)



ITERATE

Project Summary

- Initial Risk Characterization
  - Hazard ID, Exposure Assessment, Toxicology Review, gap ID
- Exposure Assessment Collaboration
    - QD Vision-project sponsor, developed samples
    - CLF Ventures-testing design
    - Cold Spring Technologies- testing protocols and sample weathering
    - UMASS Lowell- laboratory testing and equipment design
- Second Iteration Risk Characterization
  - Updated Hazard ID
  - Revised exposure conclusions based on testing
  - Added recent studies

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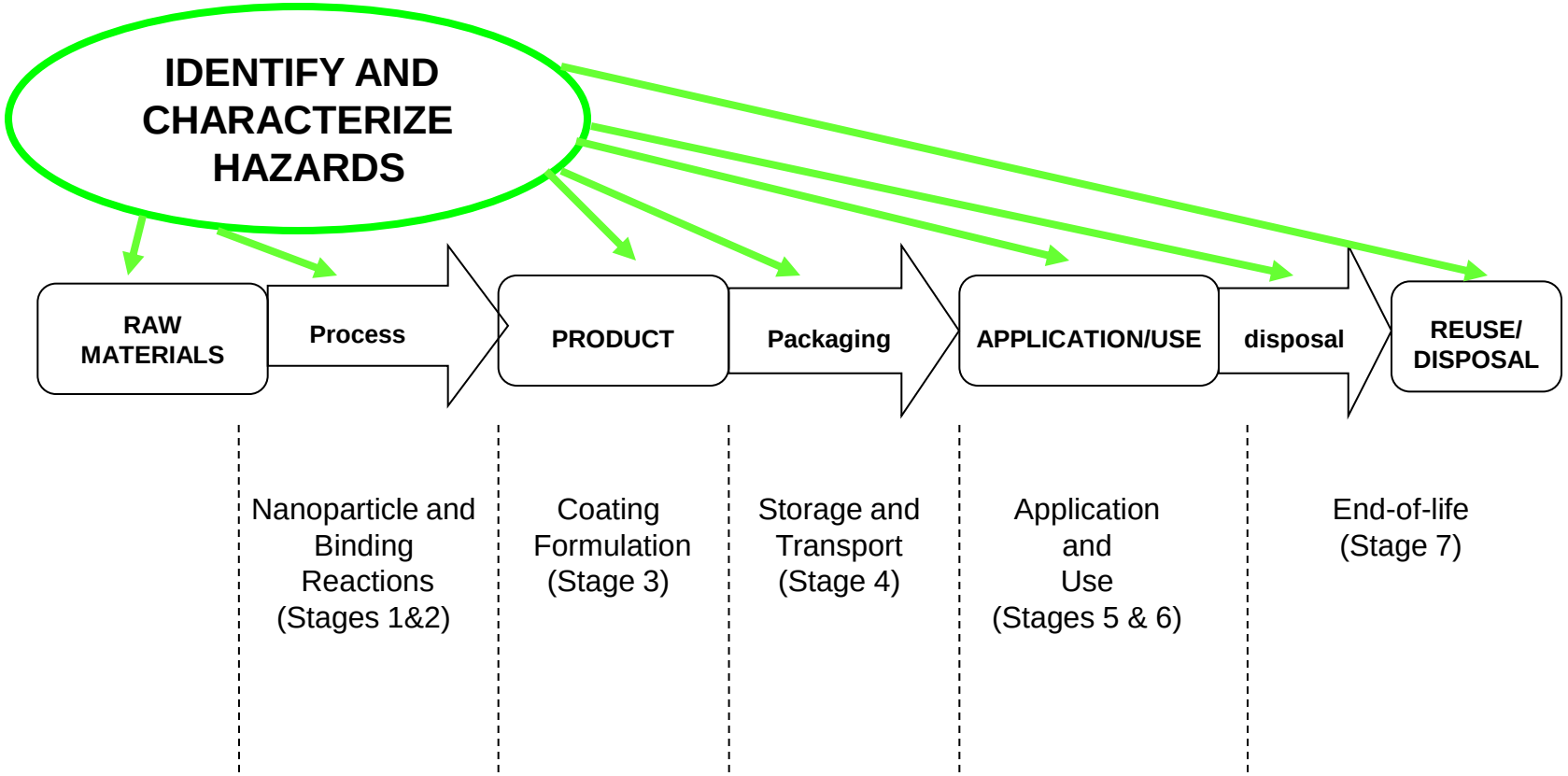
NANO LCRA
Hazard Identification



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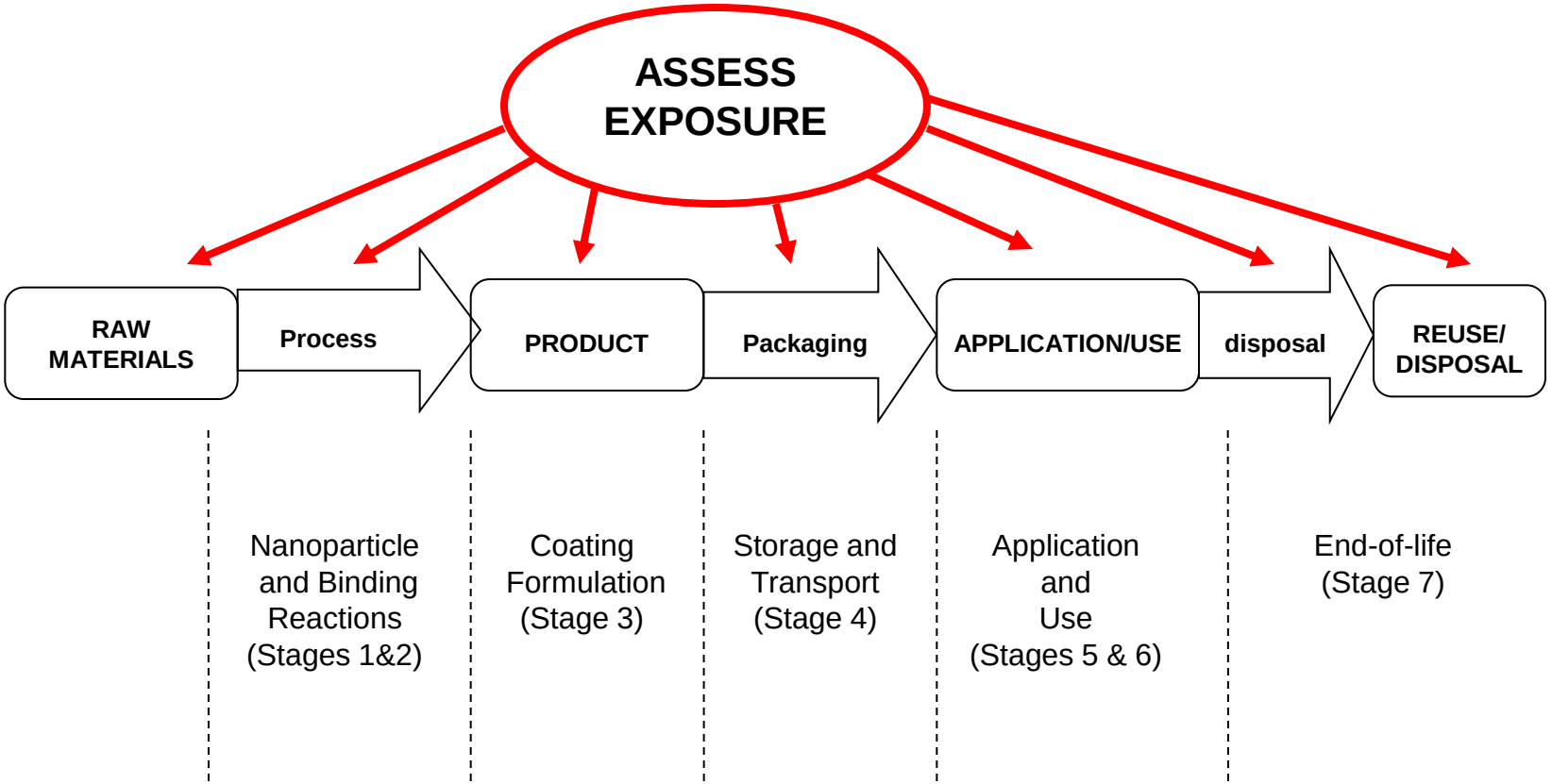
Min. Char. Physical-Chemical Properties Summary

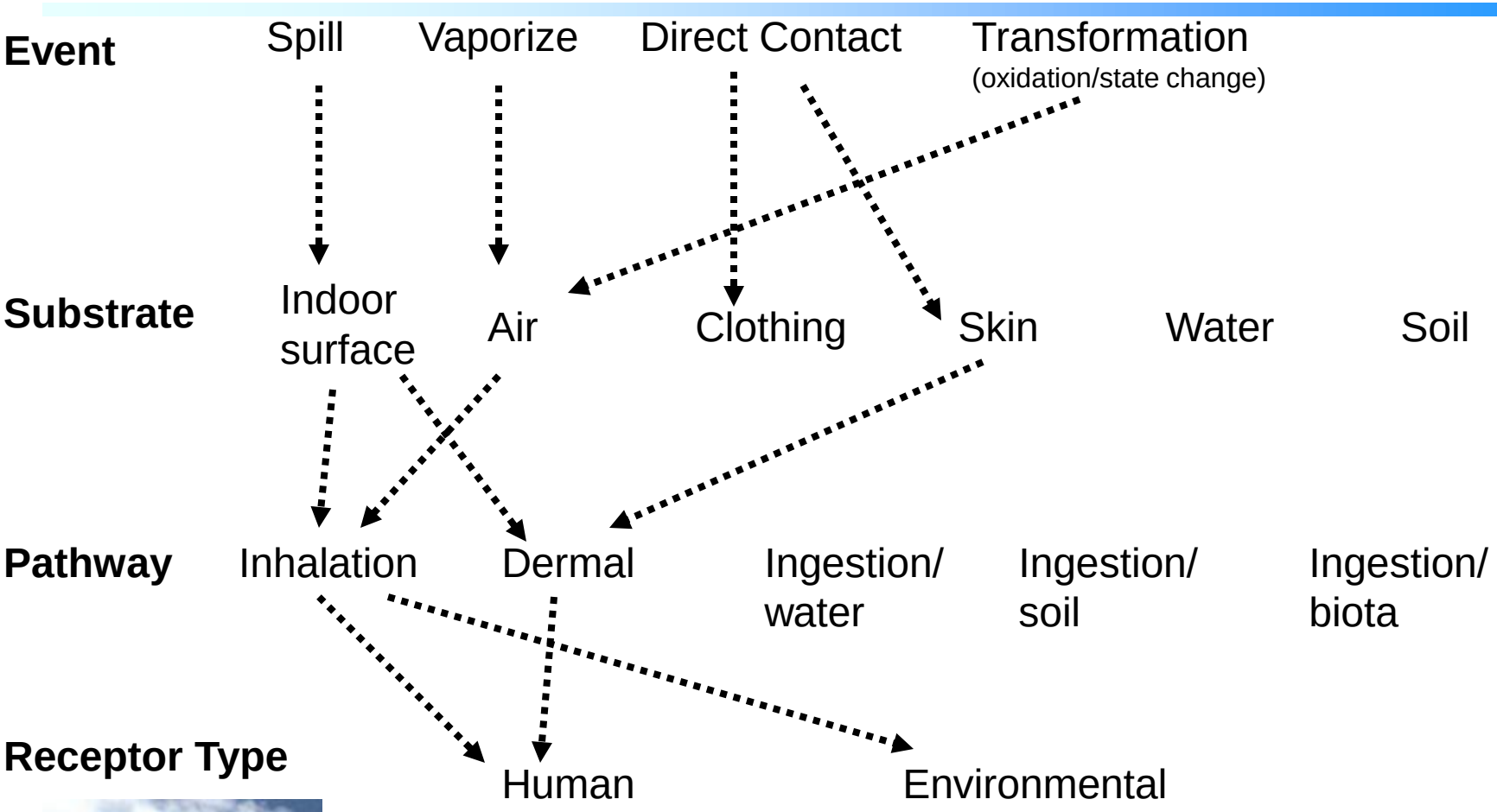
Life Cycle Stage	Description	Stage Product	Material weight (grams)	Agglomeration State/ Aggregation	Composition	Crystal Structure	Particle Size/Size Distribution	Porosity	Purity	Shape	Solubility	Stability	Surface Area per particle (m^2)	Nanomaterial Surface Area total per batch (m^2)*	Surface Chemistry	Surface Charge
1	QD reaction	Dots														
2	Binding reaction	Bound dots														
3	Product formulation	Coating														
4	Storage and Transport	Coating														
5	Application	Coated surface														
6	Use	Coated surface														
7	End-of-life	Unknown														

NANO LCRA
Exposure Assessment

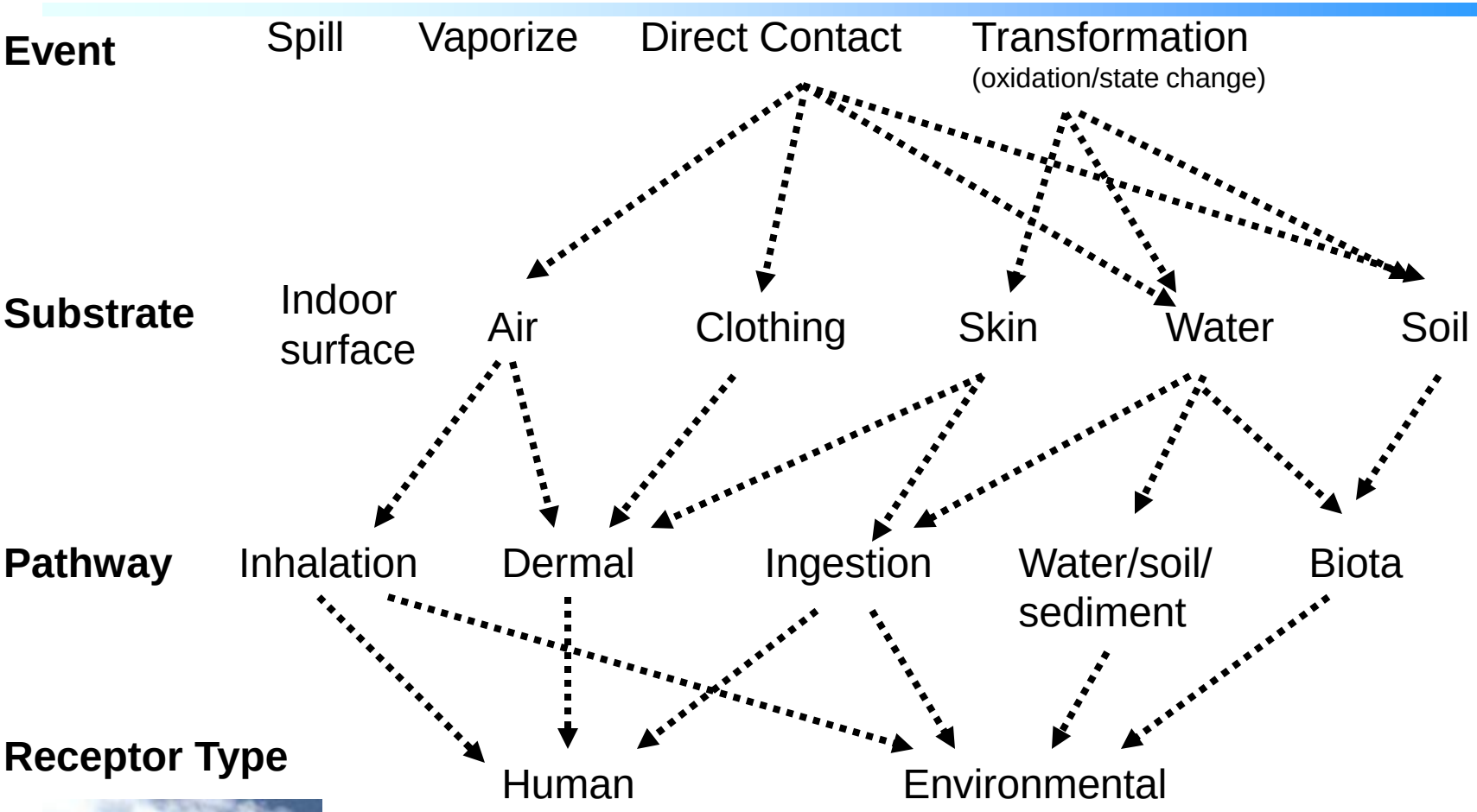
Event → Substrate → Pathway → Receptor Type



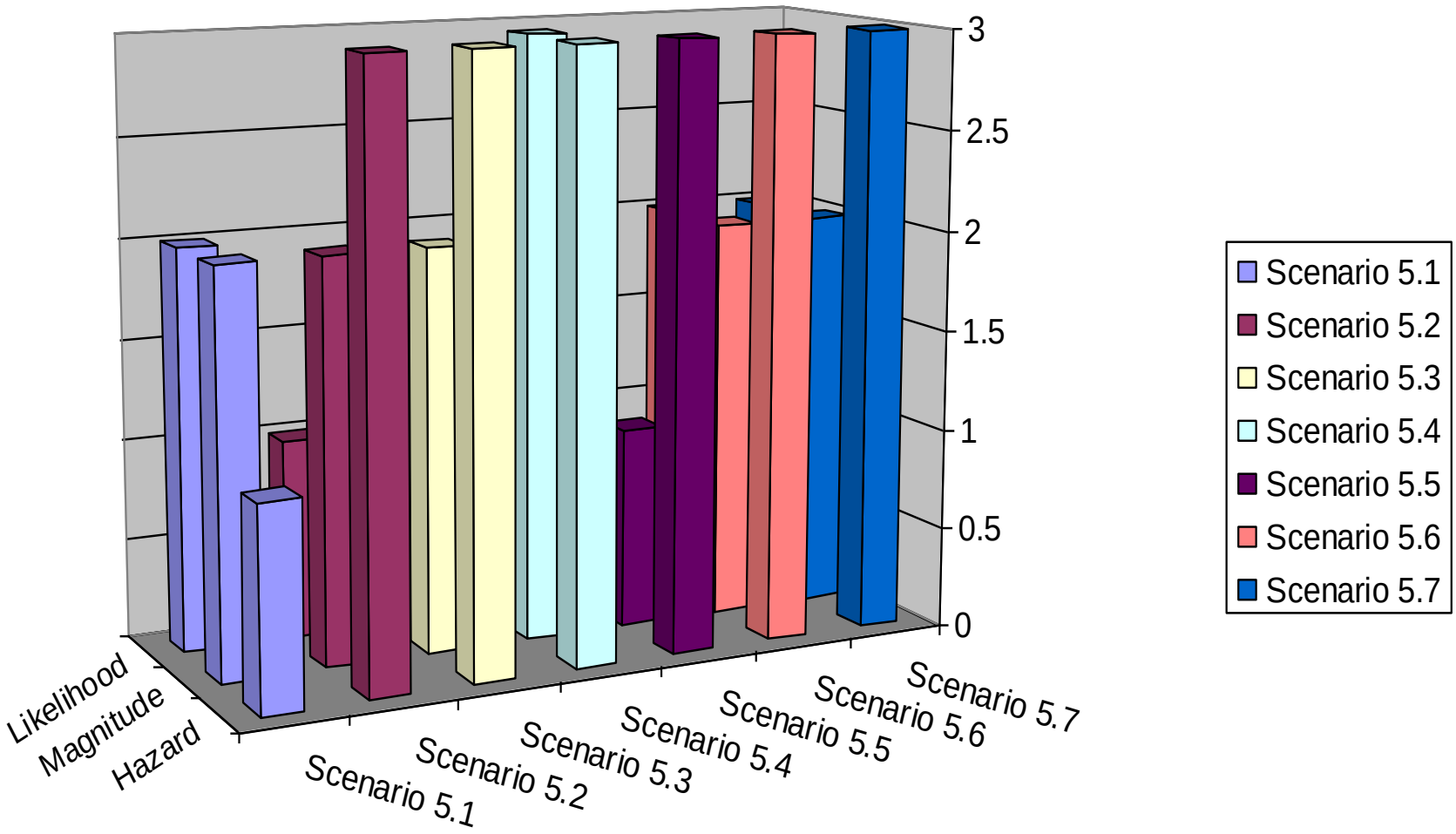
Potential Exposure – Stage 1
(In-lab example)



Potential Exposure – Stage 6
(Out-of-lab example)



Application Phase



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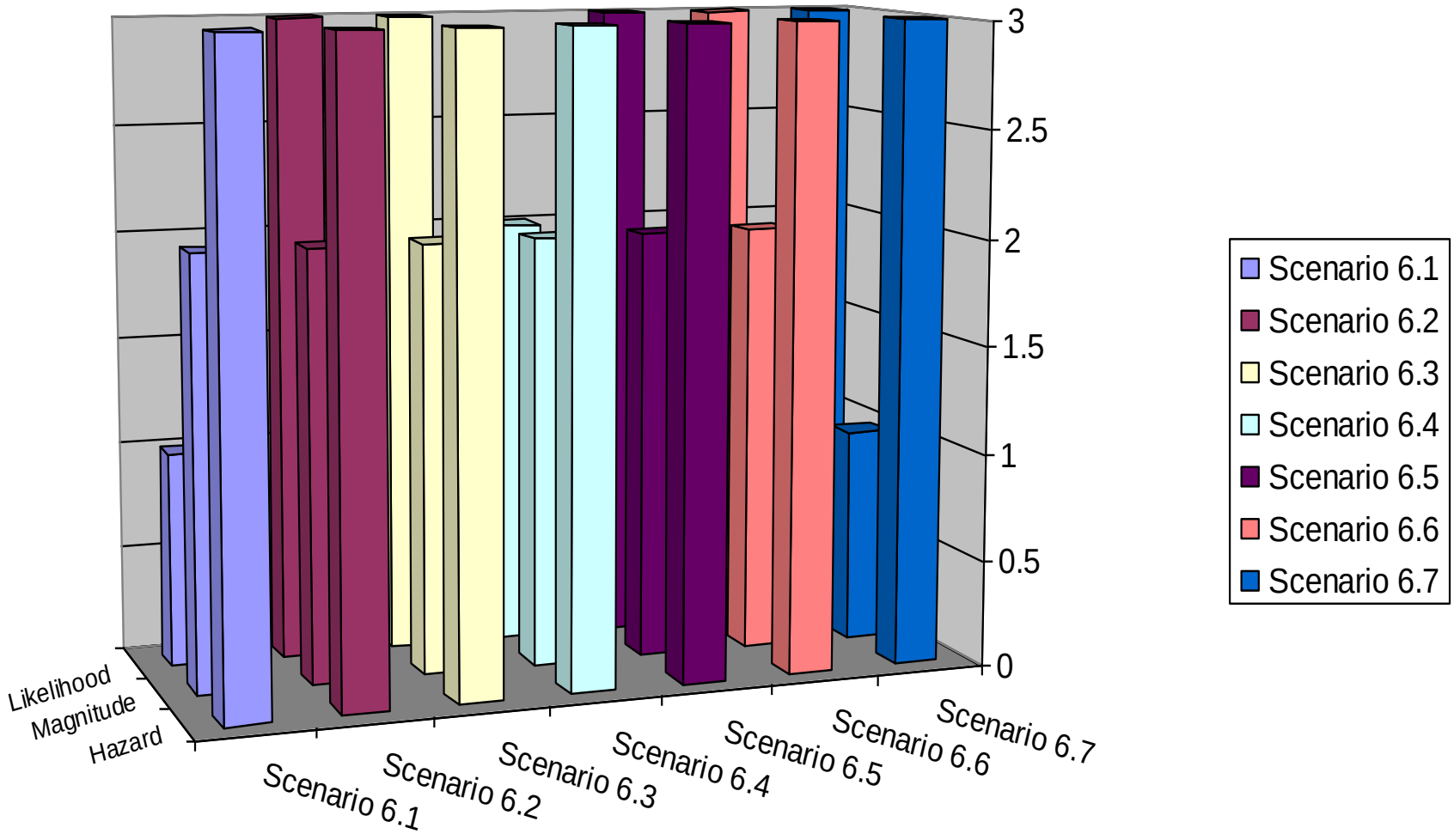
Use Phase



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Toxicity Review

- Limited data on toxicology of NPs
  - Lack of standardized assays
  - Issues with measurement
  - Absorption, distribution, excretion data
  - Mixture
    - data on components
    - at every stage
- Generally, coated particles are less toxic
  - depends on media
  - Possible toxicity beyond components
- Contains metals
  - assume material is toxic
  - Possible additional toxicity of particle and mixture

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First Iteration Risk Characterization

- Exposure Assessment suggested only a few high concern scenarios
  - Lab/production stages are well controlled
  - Designed and conducted product testing, to inform second iteration Exposure Assessment and Risk Characterization

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Exposure Assessment
Initial Product Testing

- Tested highest concern exposure scenarios
  - Inhalation during coated product application
  - Wear testing of applied/dried coating product

- Prepared coated plaques
- 1 year accelerated aging simulation
- Specially designed test lab
- Real time and electron microscopy

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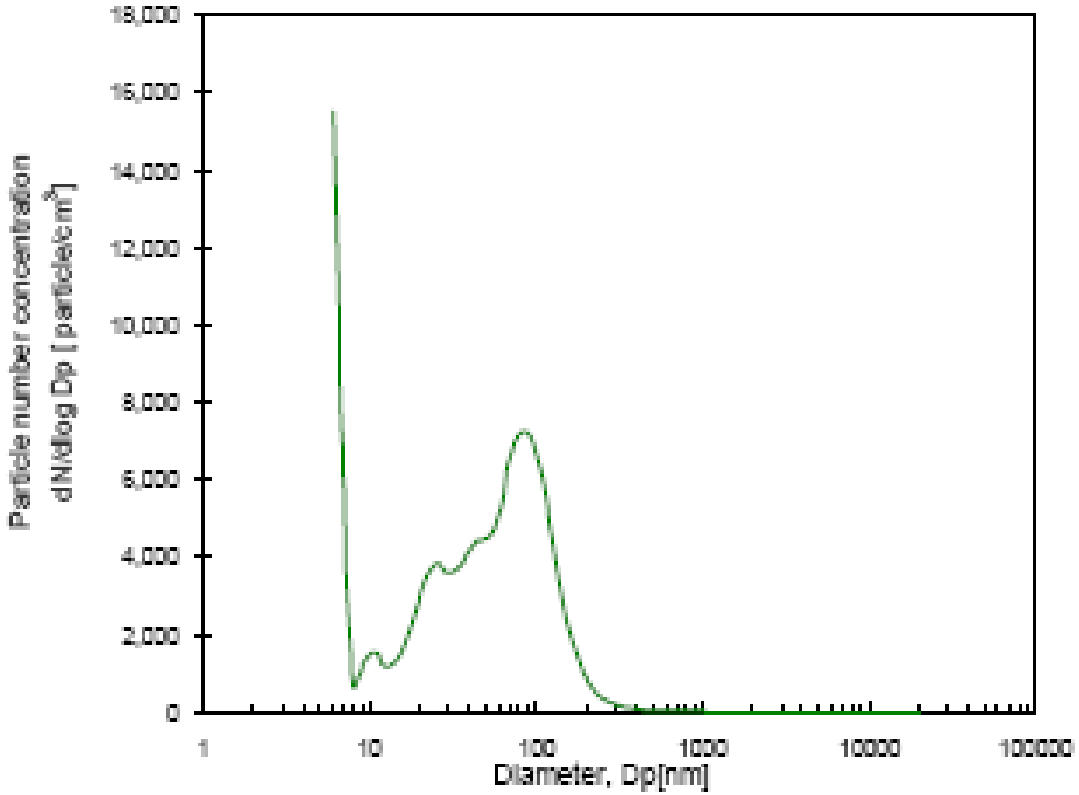
Measured Background Levels of Nanoparticles



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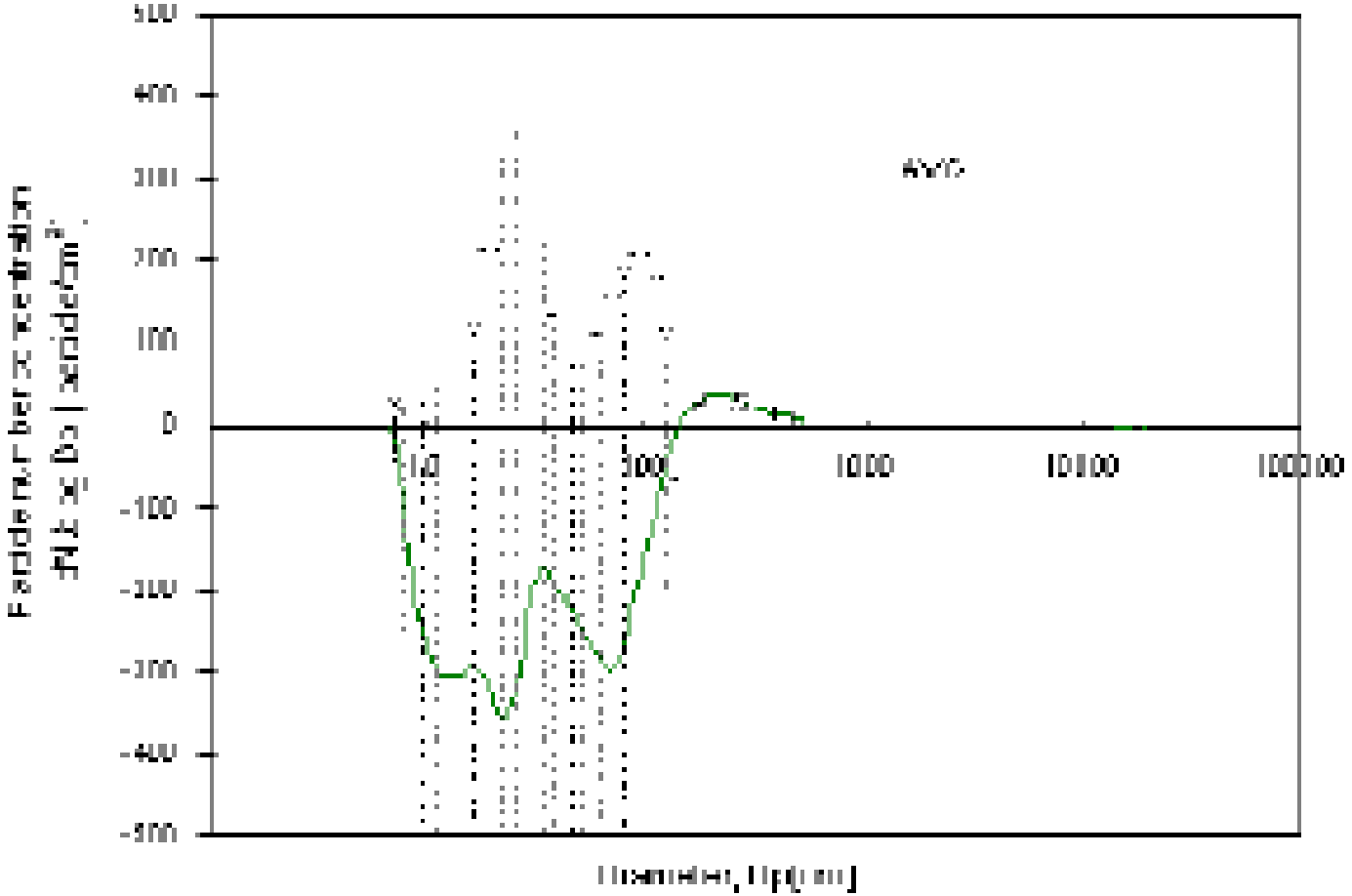
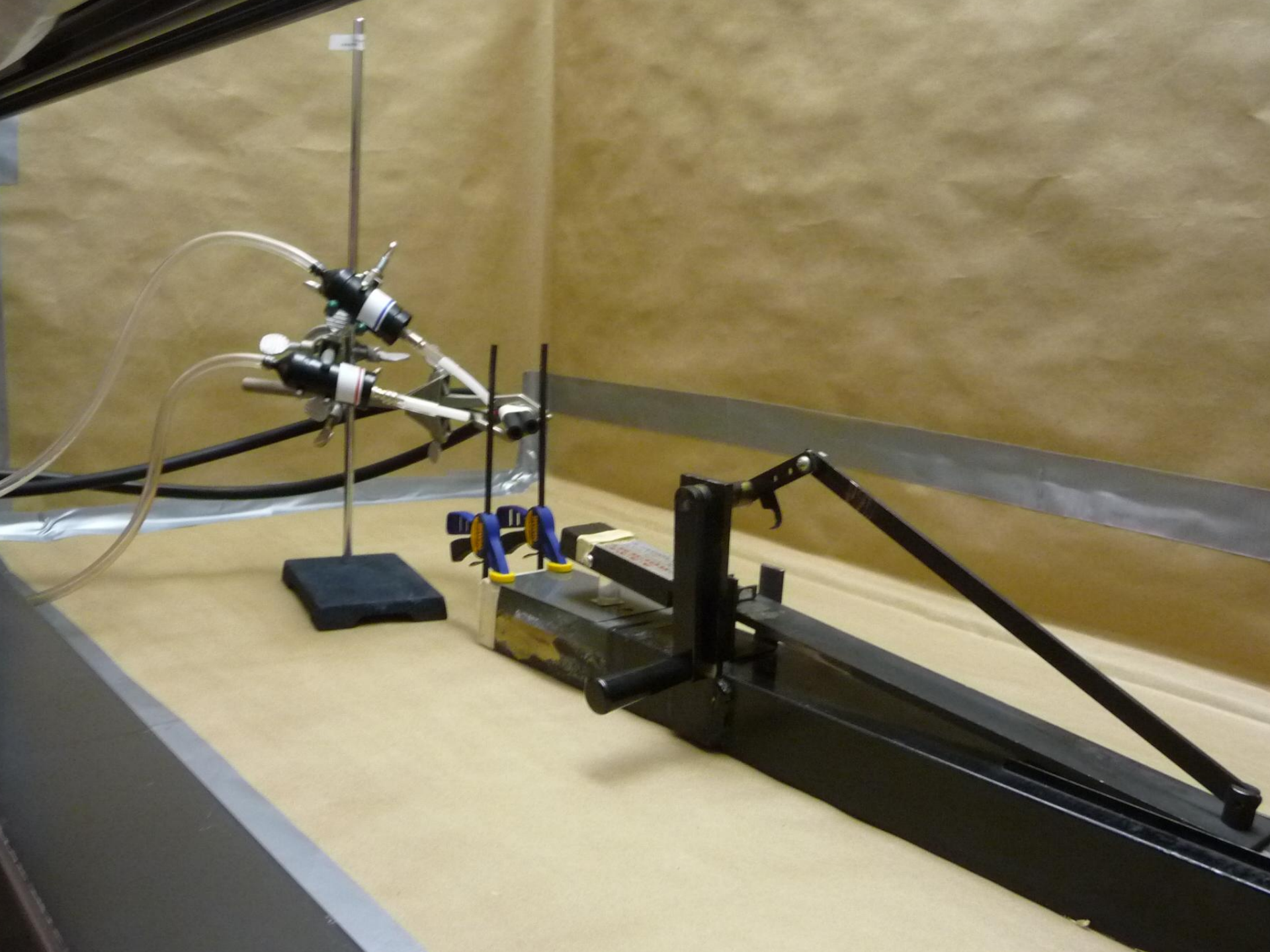
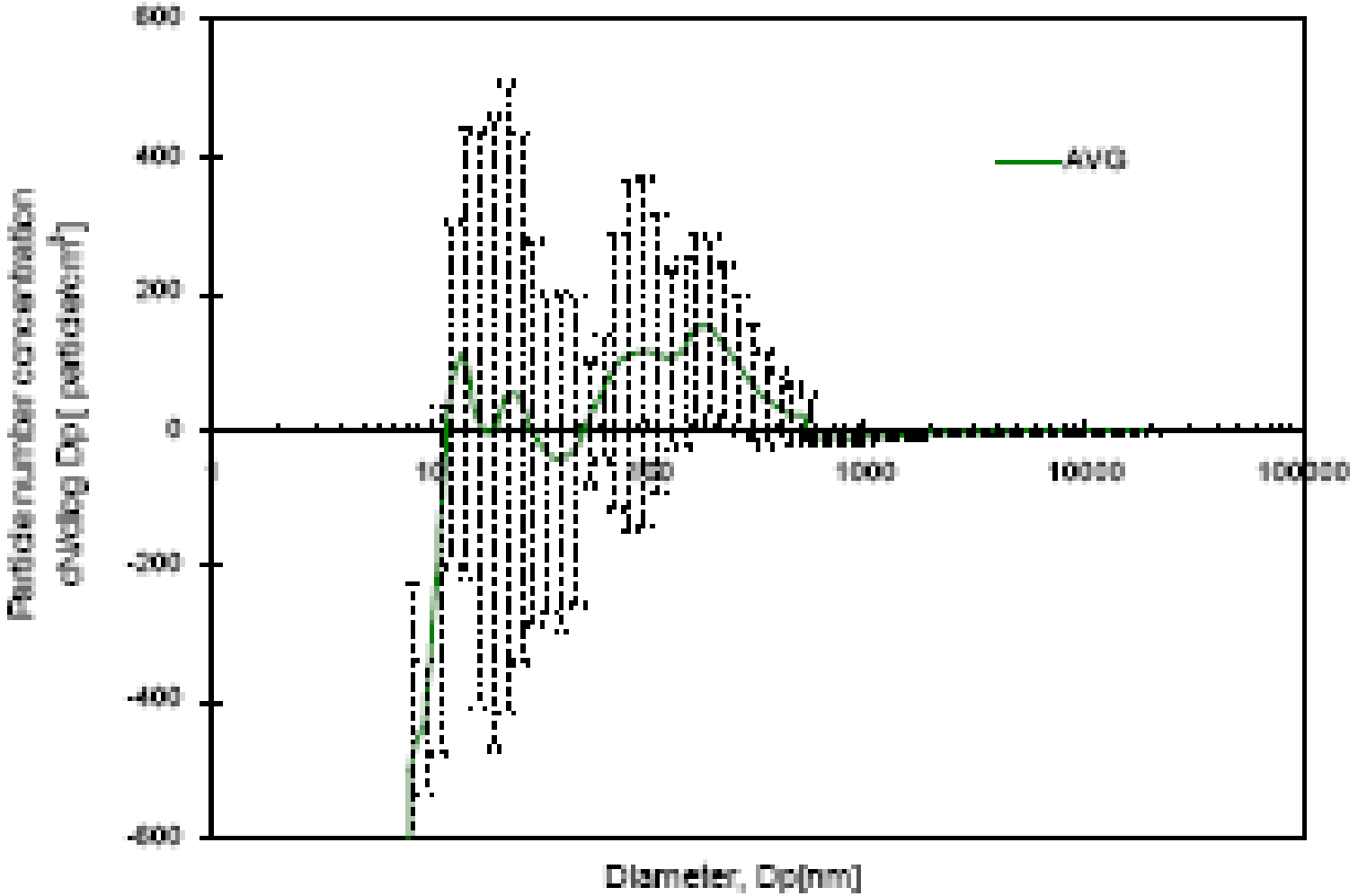
Nanoparticle counts - individual runs and average during spraying



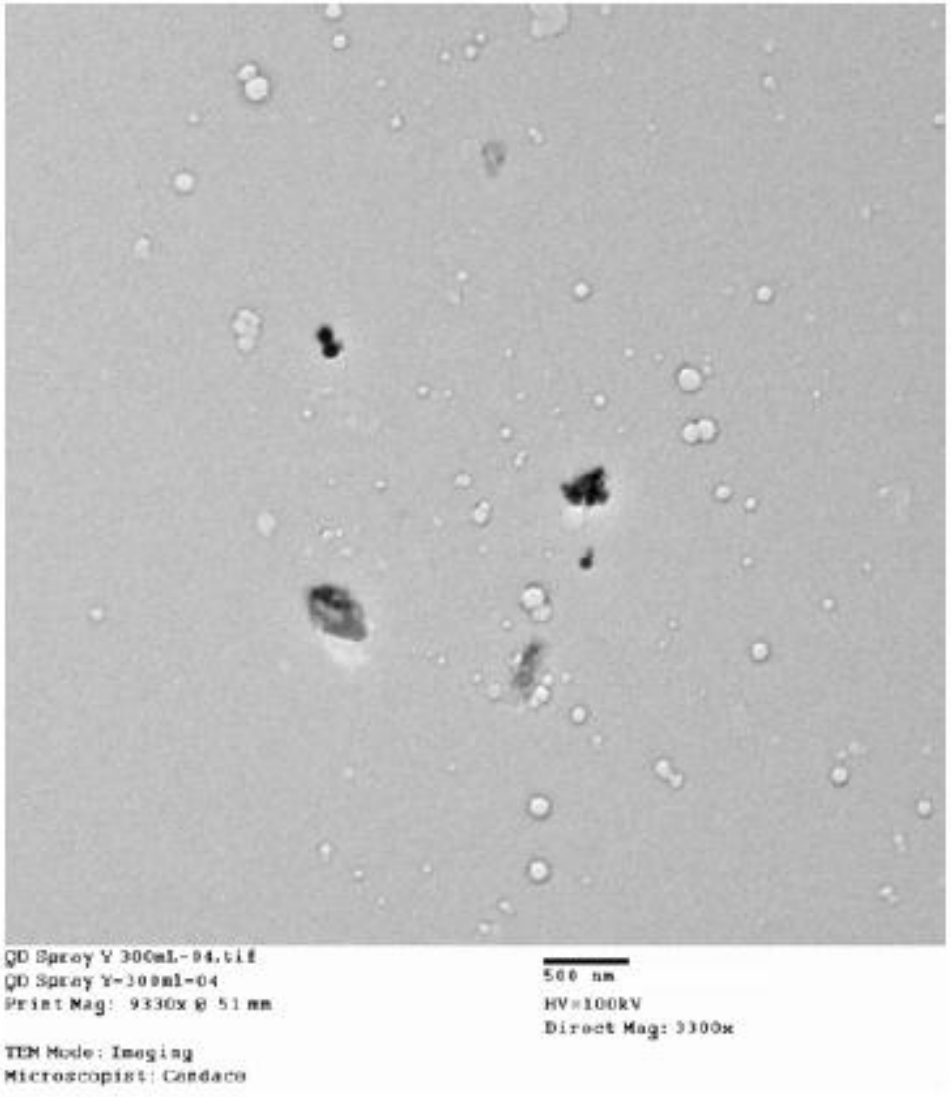
(b)



Nanoparticle counts – sanding tests



Transmission Electron Micrograph of Sprayed Paint Sample



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Second Iteration Risk Characterization

- Test results demonstrated very low exposure risk for application and use
- Risk Characterization updated – developed safe handling instructions
- Further review of recent literature lead to similar toxicity conclusions
- Overall product risk characterized as low

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Findings

- Life cycle exposure
  - Manufacturing and production phases well controlled
  - Exposure during application not distinguishable from background
  - Aggressive “wipe” testing produced no detectable exposure
  - End of life exposures uncontrolled
- Toxicity data extremely limited
  - recommendations for testing product as used
- Risk management focus on exposure prevention

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Questions?

THANK YOU!

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