NanoFASE

Fate and Exposure models for you - www.nanofase.eu

Life-cycle transformations of NMs

Stephen Lofts

representing NanoFASE

NERC SCIENCE OF THE ENVIRONMENT

Nanomaterials: Safe-by-Design
Bilbao, 24th April 2017

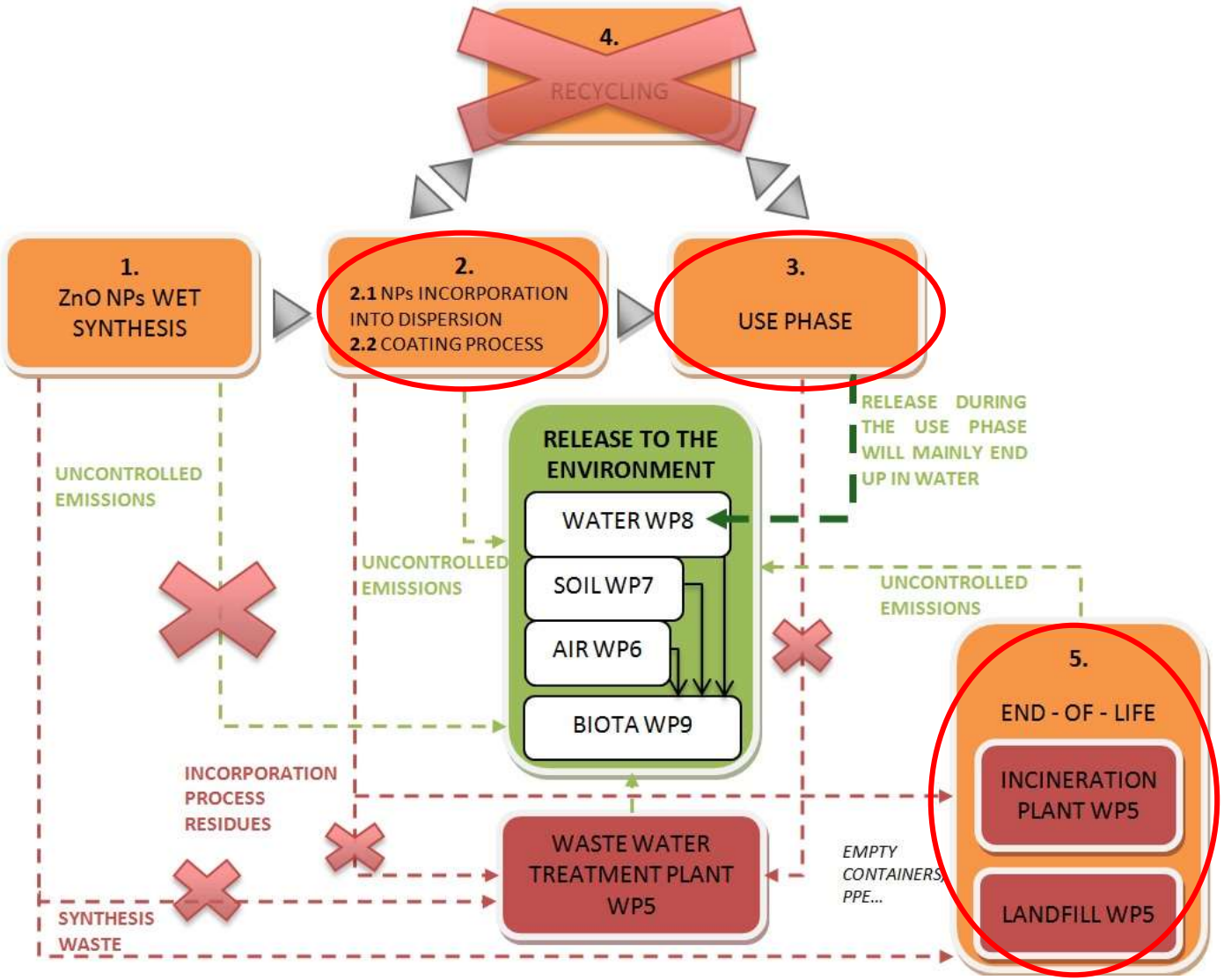
Outline

- Outline of NanoFASE
- Life cycle analyses
- Examples: life cycle and release point analyses
- Examples: transformations within the life cycle
- Summary

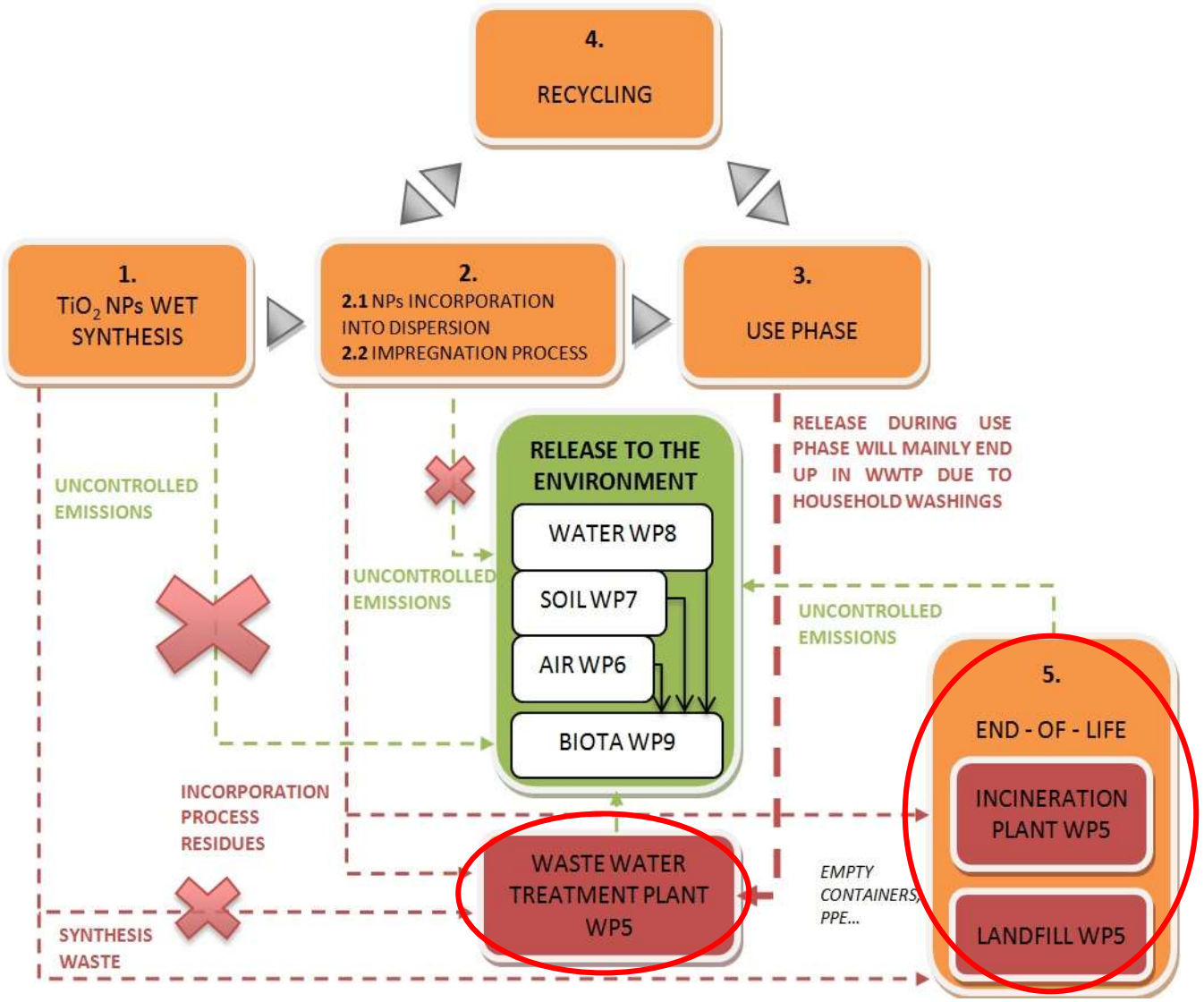
Outline of NanoFASE

- An ‘exposure assessment framework’ for environmental exposure
  - Analysis of NM life cycles for release points
  - Determination of transformations through the life cycle
  - Modelling tools to predict fate
    - NanoFASE model: detailed, fate and biouptake
    - SimpleBox4Nano: screening, fate

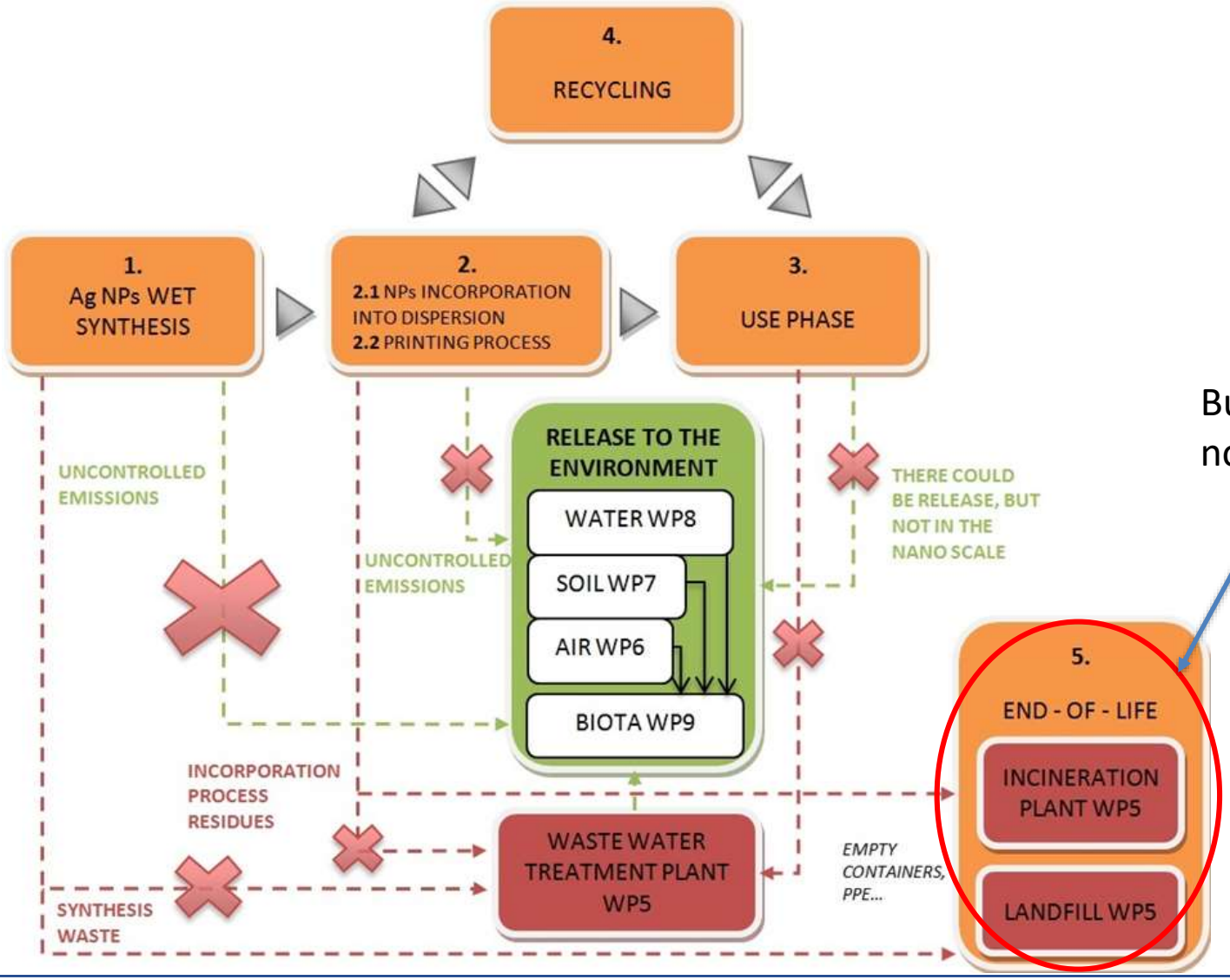
Life cycle analysis – antifouling paint



Life cycle analysis – NMs in textiles



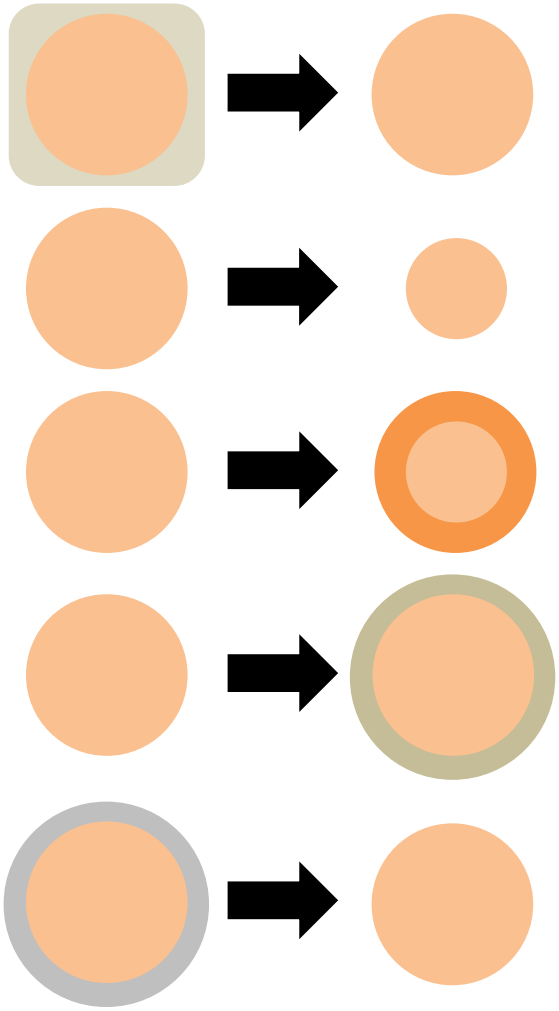
Life cycle analysis – nanosilver in printer inks



Other examples

- Cerium oxide – vehicle catalyst
  - Direct emissions to air, soil
- Quantum dots
  - biological imaging
  - photovoltaic devices e.g. solar cells
- Carbon nanotubes

Key transformations during the lifecycle



Release from matrix (Antifouling paints)

Dissolution (silver in textiles)

Chemical transformation (silver in WWTP)

Acquisition of sorbed material

Loss of manufactured coating

NERC SCIENCE OF THE ENVIRONMENT

NanoFASE

Example: Transformations in WWTP

Zinc oxide
Silver

Incineration

Land application

Sludge

Zinc sulphide
Silver sulphide

Surface water discharge

Functionalisation may increase retention in aqueous phase -> greater discharge to waters
Metals/metal oxides typically >70% removed to the sludge

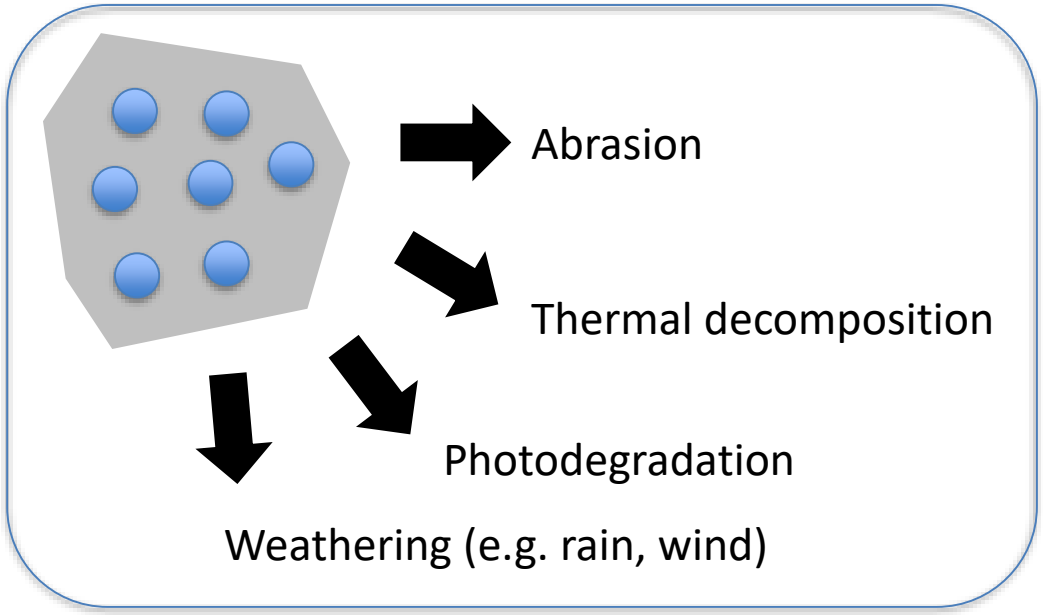
Example: transformations during incineration

Combustion temperature important for destruction of organics, e.g. CNTs
Thermal stability of products needs to be accounted for.

Slag/fly ash

Metal/metal oxide NMs remain
Chemical transformations may occur e.g. formation of metallic silver

Example: release of (MW)CNTs from nanocomposites

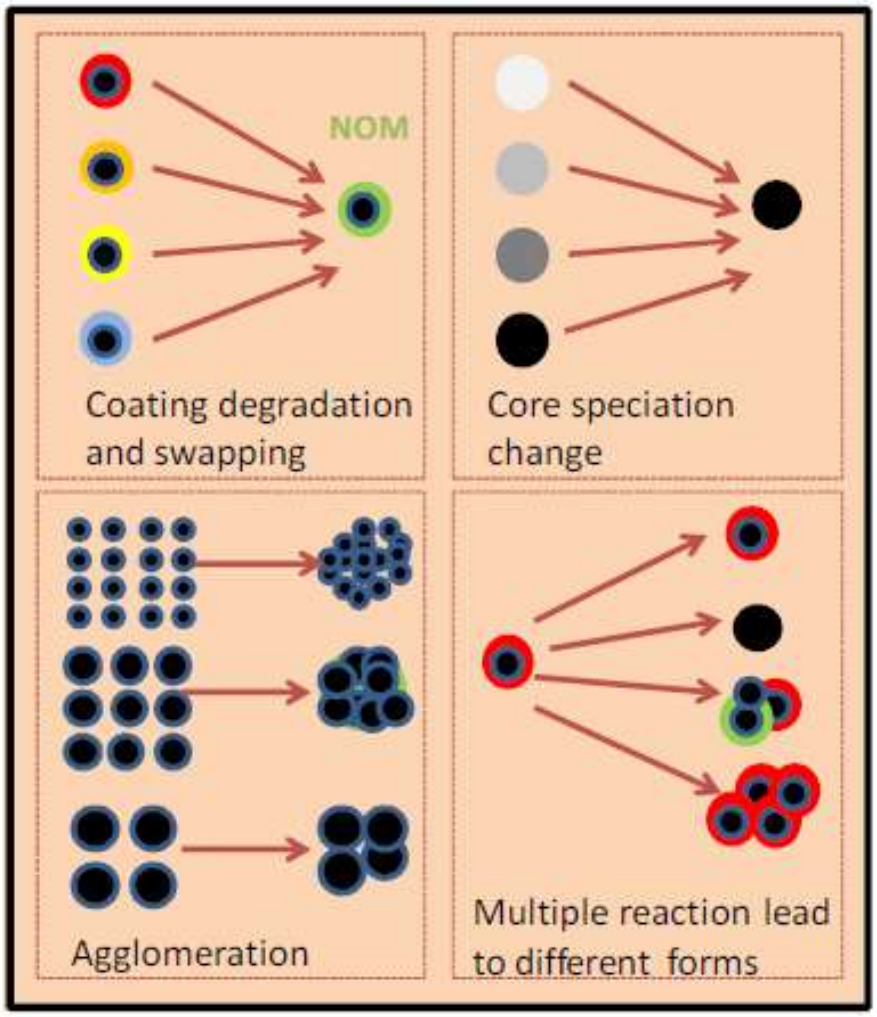


Release rate shown to depend on dispersion of (MW)CNTs within matrix

Use of functionalised (MW)CNTs shown to increase matrix stability but increase degradation rate

Released CNT fragments shorter than as manufactured -> reduction of pulmonary risks?

Environmental transformations



Convergence of forms
e.g. silver NMs with different coatings

or

Divergence of forms?

Summary

- ENMs may undergo extensive transformation through the life cycle, including prior to any exposure scenario
- Transformations are particularly important for reactive forms, e.g. metals/metal oxides
  - may be to less reactive forms
  - long term implications of transformations not necessarily clear
- Research continues on life cycle transformations
  - grouping of designs according to transformation behaviour?
- Tools need to assess role of transformation in hazard and risk

NanoFASE

Fate and Exposure models for you - www.nanofase.eu

Thank you for listening

Claus Svendsen, coordinator
csv@ceh.ac.uk

Stephen Lofts
stlo@ceh.ac.uk