Oregon Department of **ENERGY**

Summer NRDA Internship

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Agenda

1. Pathways of historical and current releases into the Columbia River
   - Single-pass reactors
2. Sediment transport downriver of the Hanford Reach
   - Accumulation behind McNary Dam
3. Review of data reports and data gaps found
4. Conclusions

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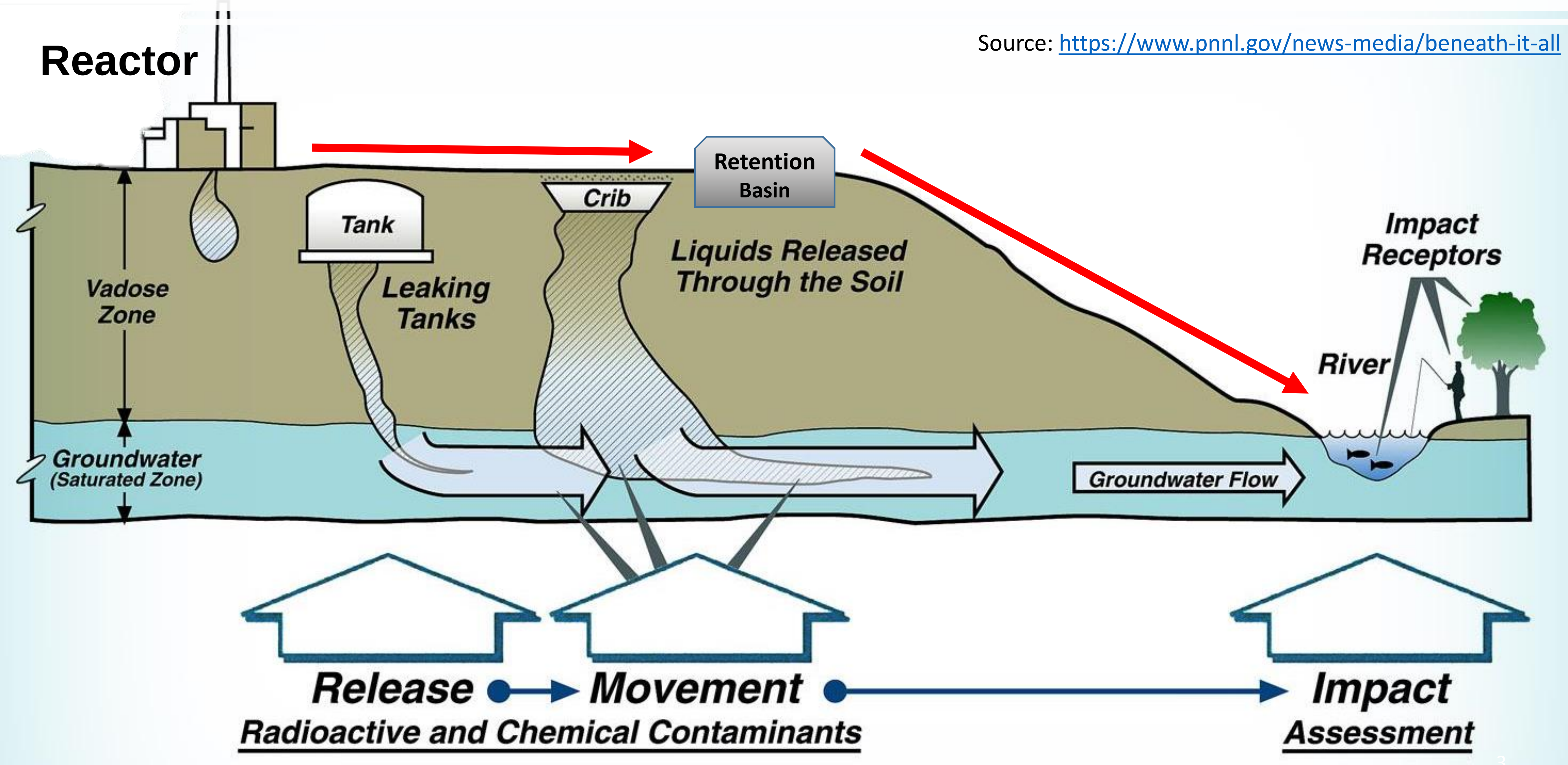
Environmental Contamination Pathways

Source: https://www.pnnl.gov/news-media/beneath-it-all



Single-pass reactor

Source: Moeller, D.W. “Radionuclides in Reactor Cooling Water – Identification, source, and control”

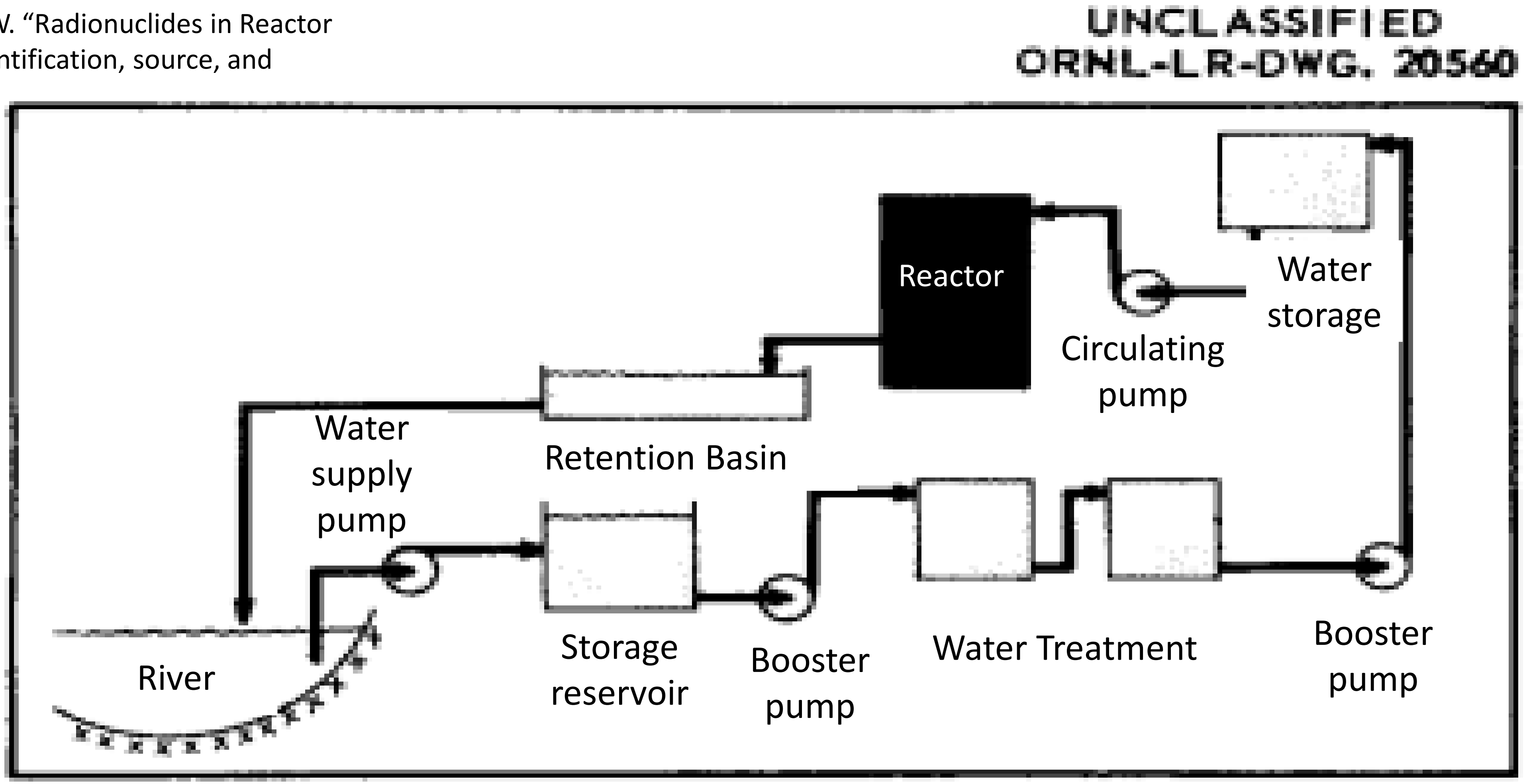
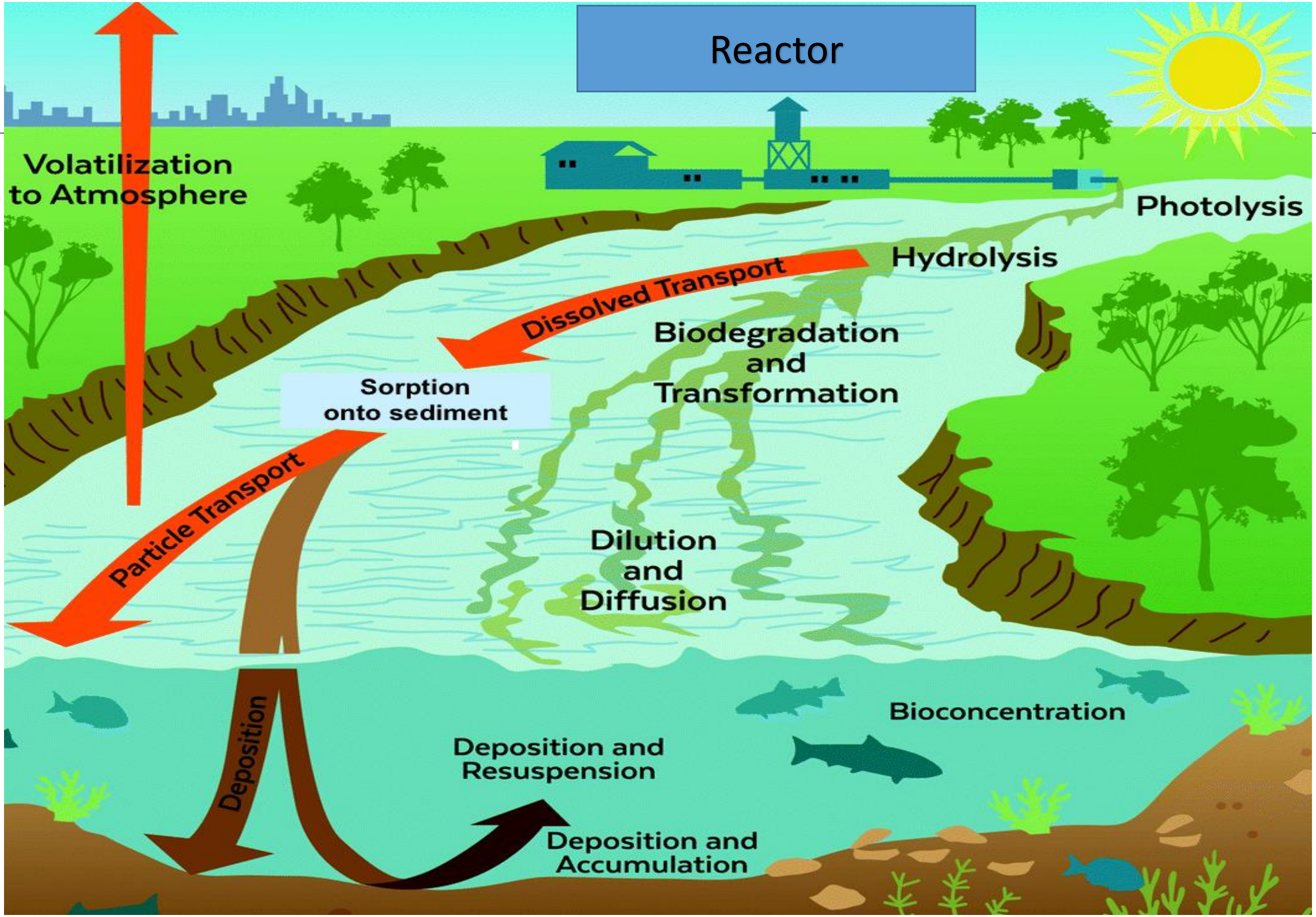


Fig. 1. Schematic Flowsheet: Single Pass Cooling Water System.


Reactor
Volatilization to Atmosphere
Photolysis
Hydrolysis
Dissolved Transport
Biodegradation and Transformation
Sorption onto sediment
Particle Transport
Dilution and Diffusion
Deposition
Bioconcentration
Deposition and Resuspension
Deposition and Accumulation

Chemicals of Concern – Single pass reactors

1. 113 million curies of radionuclides
   - Activation products
   - Fission products & transuranic elements
2. Heavy Metals & Inorganics
   - Dichromate (hexavalent chromium) and aluminum
3. Organics
   - TCE

General Rules of Sorption
Ion-exchange
Polyvalent > divalent > monovalent
Radionuclides behave similarly to non-radioactive isotope
pH, temperature, redox potential, TOC
Clay > Silt > Sand > Gravel

Accumulation Behind McNary Dam

- Completed in 1953
- 95% of releases occurred after completion
- Sediments in McNary Reservoir represent 20 - 37% of Columbia River sediment load
- Up to 18 cm / year accumulate

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Data Review – Summary of Findings

Organics	Delistraty and Yokel, 2005	Patton and Priddy 2005	Tiller & Marceau 2006
Aroclor-1254/1260/1262	Y		Y
Benzo(a)pyrene		Y	Y
Carbon tetrachloride			
Cyanide			
Dichloromethane			
DDT/DDE	Y	Y	
PCBs		Y	Y
PAHs	Y	Y	
TCE			

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Radionuclides	Robertson & Fix 1977	Beasley & Jennings 1984	Heeb & Bates 1994	Patton & Priddy 2005	Tiller & Marceau 2006	Patton & Dirkes, 2007	Hulstrom 2011
Am-241	Y	Y					
C-14							
Co-60	Y	Y		Y	Y	Y	Y
Cs-137	Y	Y		Y	Y	Y	Y
Eu-152,154	Y			Y	Y	Y	Y
I-129							
Pu-239/240	Y	Y		Y	Y	Y	
Ra-226/228	Y				Y	Y	
Sr-90				Y	Y	Y	Y
Tc-99							
Th-232						Y	
Tritium							
U-233/234/235/238				Y	Y	Y	
Th-228	Y				Y		
Na-24			Y				
P-32			Y				
Sc-46			Y				
Cr-51			Y				
Mn-56			Y				
Zn-65			Y			Y	
Ga-72			Y				
As-76			Y				
Y-90			Y				
I-131			Y				
K-40				Y			

Inorganics	Delistraty and Yokel, 2005	Patton and Priddy 2005	Tiller & Marceau 2006	Hulstrom 2011
Antimony		Y	Y	
Arsenic	Y	Y	Y	
Barium*		Y	Y	
Boron*				
Cadmium	Y	Y	Y	Y
Chromium (III & VI)	Y	Y	Y	Y
Copper	Y	Y	Y	
Fluoride*				
Lead	Y	Y	Y	Y
Manganese		Y		
Mercury		Y	Y	Y
Nickle	Y			
Nitrate				
Scandium	Y			
Uranium			Y	
Vanadium		Y		
Zinc	Y	Y	Y	
Aluminum		Y		
Beryllium		Y		
Calcium		Y		
Colbalt		Y		
Iron		Y		
Magnesium		Y		
Potassium		Y		
Silver		Y	Y	
Thallium		Y		

Data Review – Summary

- Surficial sediments were more regularly monitored than deep sediment
- Monitored radionuclides were limited
- Missing release estimates for long-lived radionuclides, metals, and organics
- Industry along river complicates interpretation, particularly for metals

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Conclusions

1. Data
   - Deep sediments
   - Groundwater contributions
2. Detailed site characterization to identify areas of fine-grained sediment accumulation
3. Model sediment transport after dam removal or failure