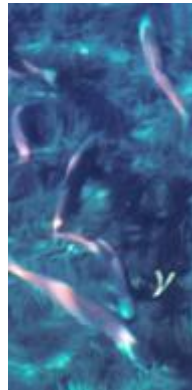




# Streamlining Superfund Risk Assessment and Natural Resource Damage Assessment

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# Superfund Cleanup vs Natural Resource Damage Assessment (NRDA)



## Authority

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)



## Process

Remedial Program/Cleanup

NRDA



## Purpose

Cleanup to minimize risk to humans and the environment

Restore injured natural resources to baseline conditions



## Lead Agency

EPA (typically)

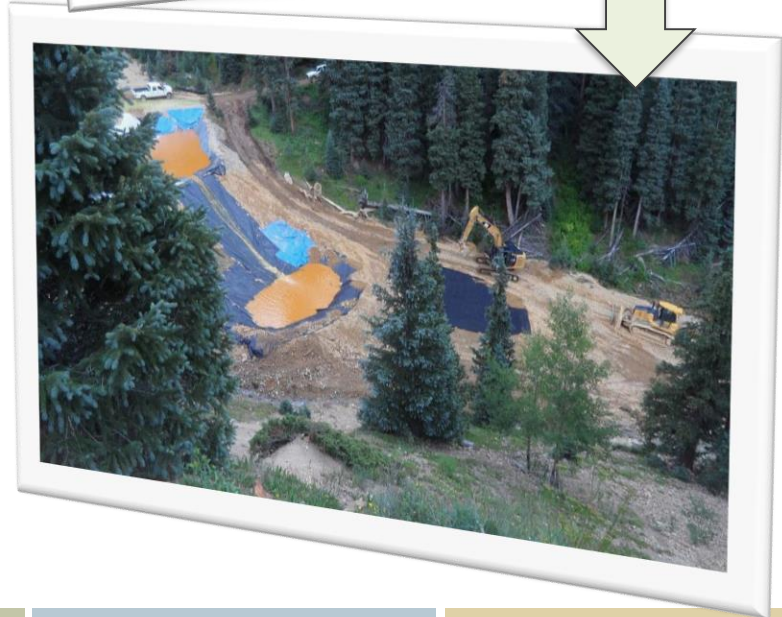
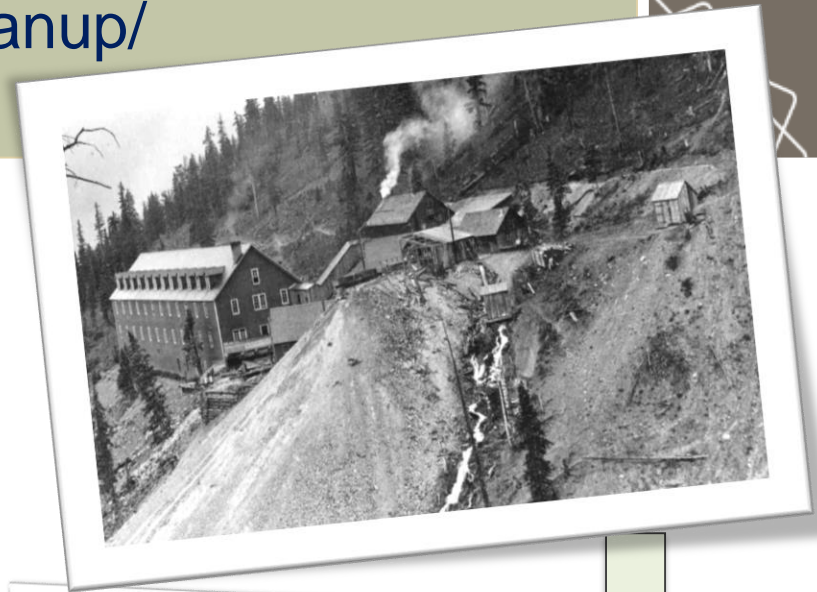
Trustees – Federal, State, Tribes



# What is the Superfund Cleanup/ Remedial Program?

## Remedial Program/Cleanup

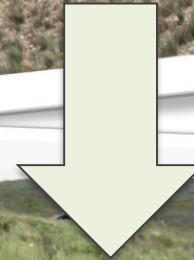
- Long-term cleanup actions to stop or substantially reduce releases or threats of releases of hazardous substances
- For the protection of human health and the environment
- Authorized under CERCLA



# What is NRDA?

## Natural Resource Damage Assessment

- Process of determining:
  - The injury (harm) caused by releases of hazardous chemicals/oil on natural resources and the services they provide
  - The amount of restoration necessary to compensate for the injury over time
- Authorized under CERCLA, CWA, OPA; DOI regulations at 43 C.F.R., part 11



# What is Injury?

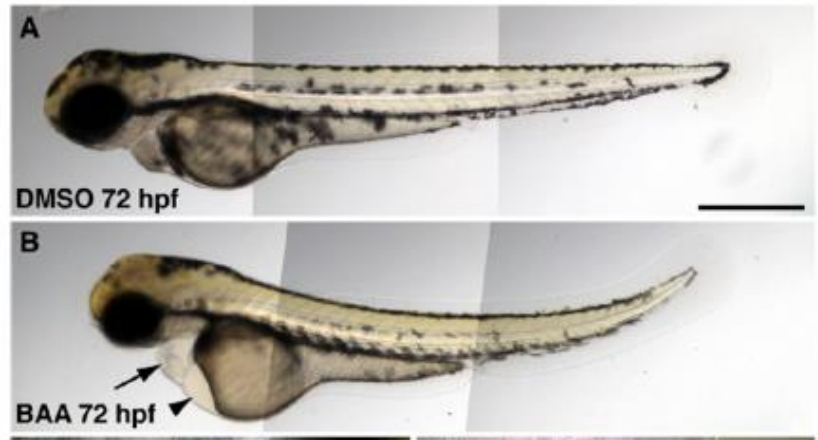
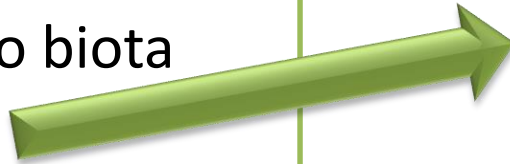


Injury:

A measurable adverse change in the quality or viability of a natural resource resulting from exposure to a release of a hazardous substance (43 C.F.R. § 11.14(v))

Injury: Adverse impacts to biota viability

- Toxicity
- Loss of habitat
- Loss of food resources

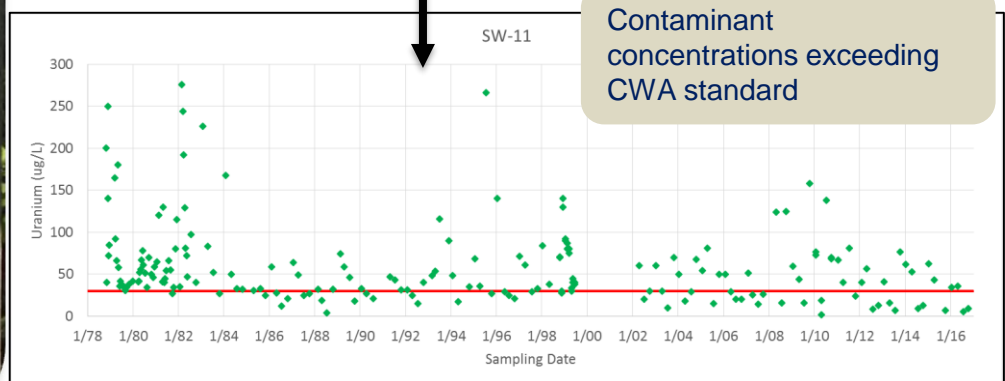


Edema (heart swelling)

# What is Injury?

Injury – Exceedances of criteria/standards:

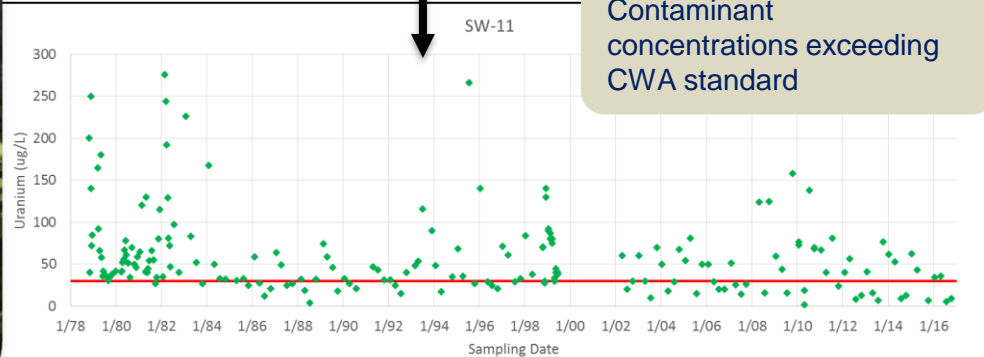
- Clean Water Act standards
- Aquatic life criteria/standards
- Institutional controls
- Consumption tolerance levels



# What is Injury?

Injury – Exceedances of criteria/standards:

- Clean Water Act standards
- Aquatic life criteria/standards
- Institutional controls
- Consumption tolerance levels



# Superfund Cleanup and NRDA: Parallels and Distinctions





# Superfund Cleanup and NRDA: Parallels



Cleanup

NRDA

# Superfund Cleanup & NRDA: Parallels



Cleanup

NRDA

Preliminary Assessment/Site Investigation  
National Priorities List



# Superfund Cleanup & NRDA: Parallels



Cleanup

NRDA

Preliminary Assessment/Site Investigation  
National Priorities List

Pre Assessment Screen



# Superfund Cleanup & NRDA: Parallels



## Cleanup

Preliminary Assessment/Site Investigation  
National Priorities List



Remedial Investigation/Feasibility Study



## NRDA

Pre Assessment Screen



Assessment Plan/Injury Assessment



# Superfund Cleanup & NRDA: Parallels



## Cleanup

## NRDA

Preliminary Assessment/Site Investigation  
National Priorities List

Pre Assessment Screen

Remedial Investigation/Feasibility Study

Assessment Plan/Injury Assessment

Record of Decision (Remedy)

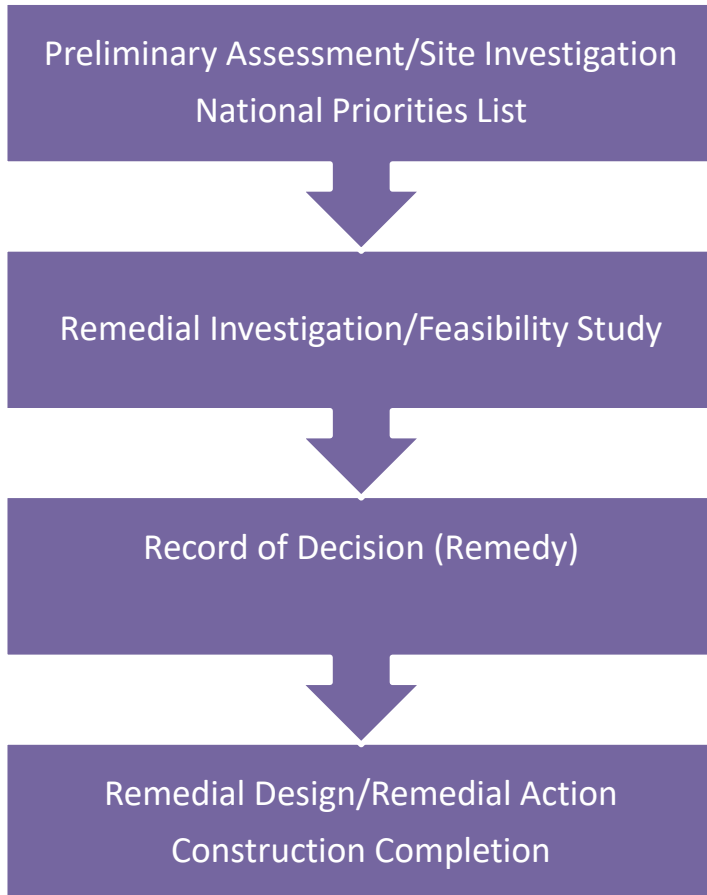
Restoration Plan



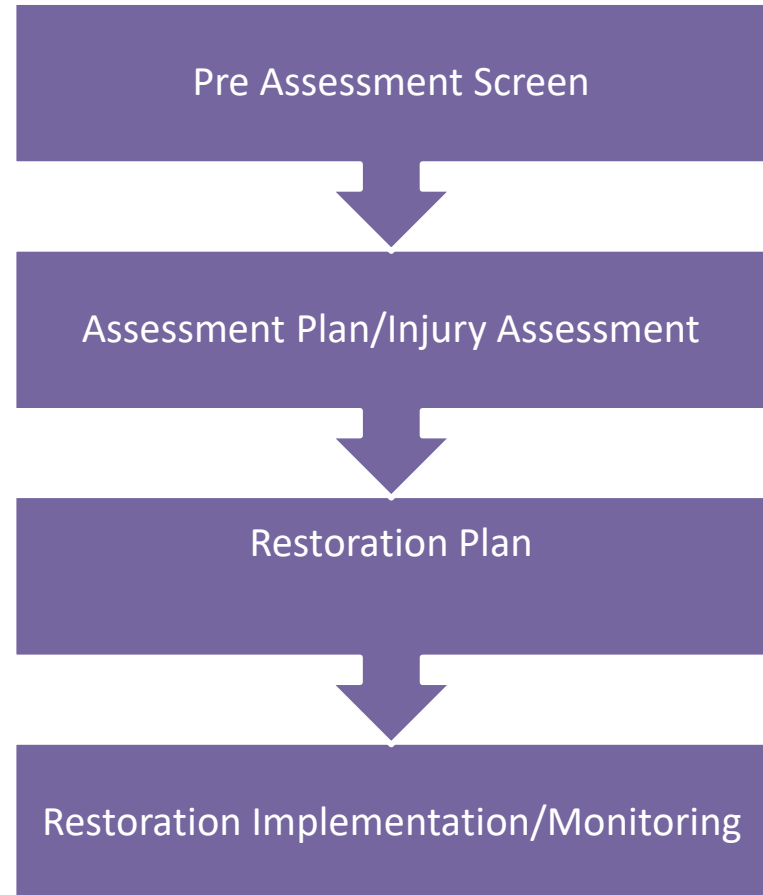
# Superfund Cleanup and NRDA: Parallels



## Cleanup



## NRDA

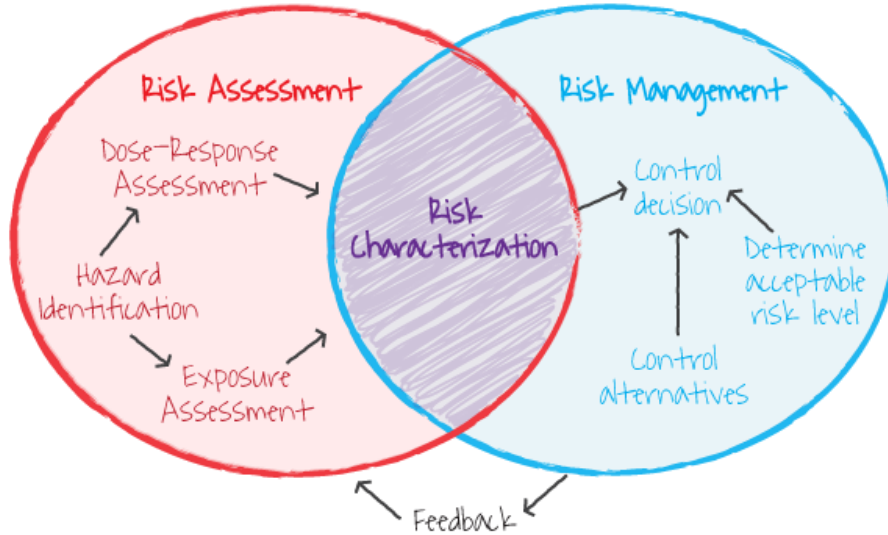


# Superfund Cleanup and NRDA: Distinctions



Goals

Cleanup



NRDA



<https://toxtutor.nlm.nih.gov/06-001.html>

# Superfund Cleanup and NRDA: Distinctions



Impacts & Endpoints

Cleanup



Survival  
Growth  
Reproduction

NRDA

Death

Cancer

Reproductive dysfunction

Endocrine effects

Genetic effects

Behavioral changes

Immuno-suppression

Biochemical changes





# Superfund Cleanup and NRDA: Distinctions



Time & Space



# Superfund Cleanup and NRDA: Distinctions



Time & Space



Cleanup

# Superfund Cleanup and NRDA: Distinctions



Time & Space



NRDA

# Superfund Cleanup and NRDA: Distinctions



	Cleanup	NRDA
Goal	Cleanup to manage risks to human health and the environment.	Restore injured natural resources to baseline conditions.
Impacts Evaluation, and Endpoints	<ul style="list-style-type: none"> <li>• Risk to human health and the environment – to select appropriate remedial actions.</li> <li>• Usually population-level risks (except for special status species). Usually focused on survival, growth, and reproduction.</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate “measurable adverse change” and service loss – to determine damages and select restoration.</li> <li>• Individual to population level. Measures include variety of responses, including sub-lethal.</li> </ul>
Spatial and Temporal Focus	Source of hazardous substances and where they are presently located.	Where exposure and injury may have occurred (including the past, present, and future); future dependent on outcome of cleanup.

# Streamlining Cleanup and NRDA



## Cleanup

Preliminary Assessment/Site Investigation  
National Priorities List

Remedial Investigation/Feasibility Study

Record of Decisions (Remedy)

Remedial Design/Remedial Action  
Construction Completion

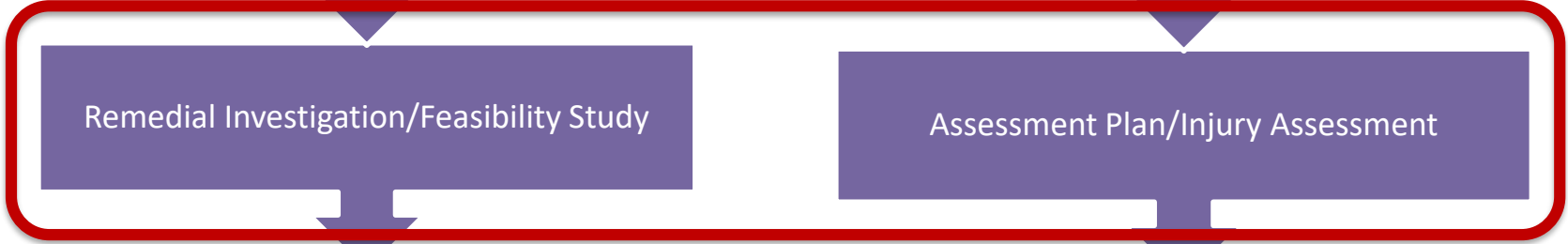
## NRDA

Pre Assessment Screen

Assessment Plan/Injury Assessment

Restoration Plan

Restoration Implementation/Monitoring



# Streamlining Cleanup and NRDA



## Cleanup

Preliminary Assessment/Site Investigation  
National Priorities List



Remedial Investigation/Feasibility Study

Human Health Risk Assessment

Record of Decisions (Remedy)



Remedial Design/Remedial Action  
Construction Completion

## NRDA

Pre Assessment Screen



Assessment Plan/Injury Assessment

Biological Injury Assessment

Restoration Plan



Restoration Implementation/Monitoring

# Streamlining Cleanup and NRDA



Cleanup

NRDA

Remedial Investigation/Feasibility Study

Human Health Risk Assessment

Assessment Plan/Injury Assessment

Biological Injury Assessment

## Combined Tribal Human Health Risk Assessment (HHRA) and Injury Assessment:

- Collect/compile dietary tissue data
- Use the data in both the HHRA and NRDA injury analyses
- Approach relies upon particular injury definitions in the NRDA regulations based on human consumption tolerance levels

# Relevant NRDA Injury Definitions



- DOI NRDA regulations state that an injury to a biological resource has resulted...if the concentration of the substance is sufficient to...
  - **Exceed action or tolerance levels** established under Section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. 342, in **edible portions of organisms** [43 CFR § 11.62(f)(1)(ii)]





# Relevant NRDA Injury Definitions



- Regulations further state that methodologies for testing for injury to biological resources

“...as such injury is defined in 43 CFR §11.62(f)(1)(ii)...may be determined by **using methods acceptable to or used by the Food and Drug Administration or the appropriate State health agency** in determining the levels defined in that paragraph”  
**[43 CFR §11.64(f)(3)]**



# Advantages of Streamlining HHRA and NRDA Injury Assessment



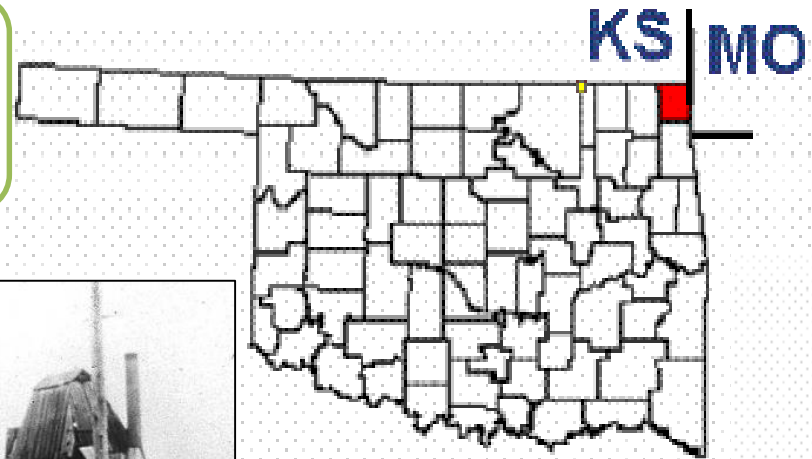
- **Cost-effectiveness** – collect only one set of data for both processes
- **Timeliness** – injury assessment can occur in parallel with RI/FS
- A means to incorporate **Traditional Lifeways** into both the RI/FS and NRDA



# Case Study: Tar Creek Superfund Site



- Located within the OK portion of the Tri-State Mining District (TSMD)
- Lead and zinc mining from the 1900s to 1960s



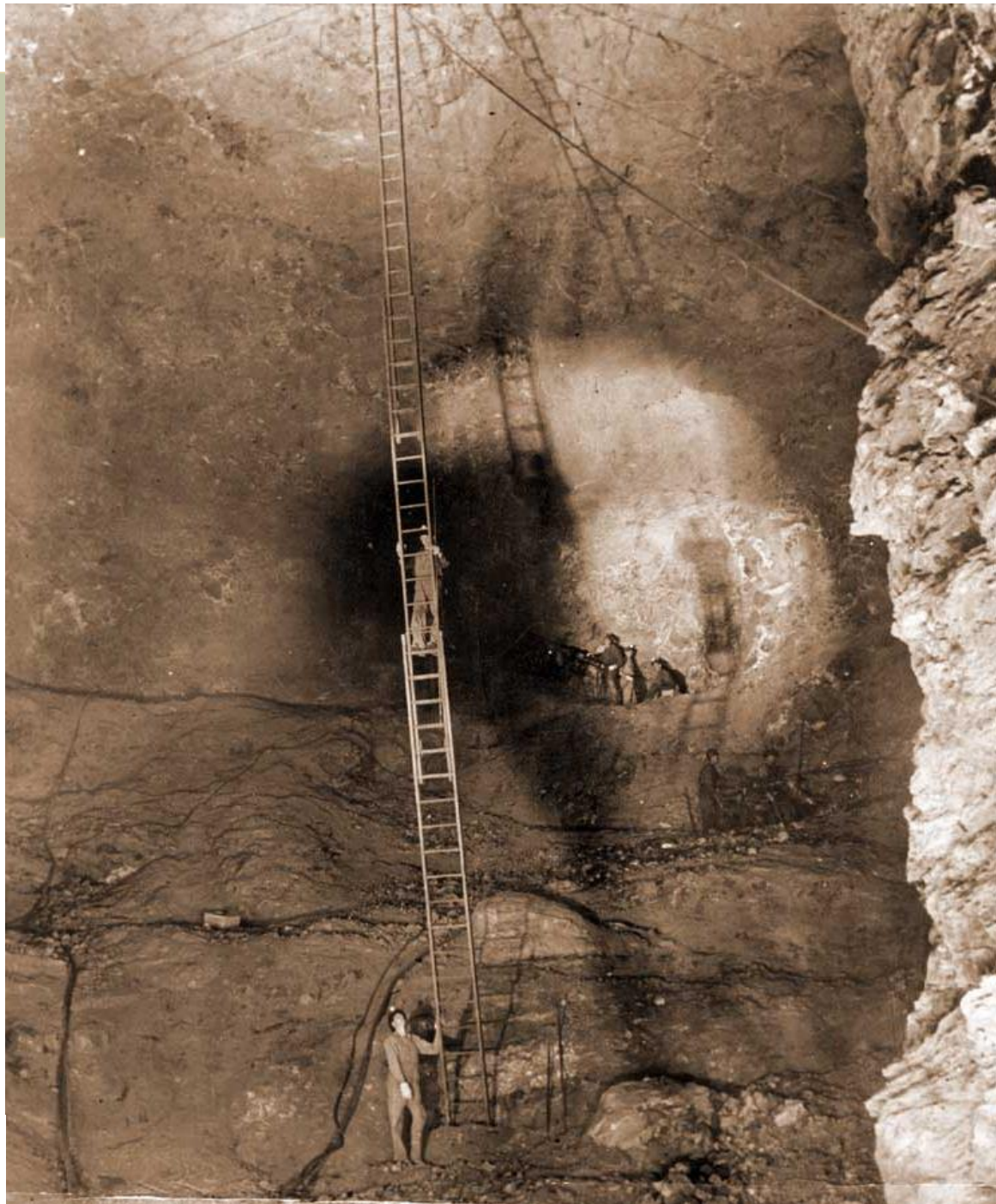
<http://www.cardinkids.com>; <http://www.deq.state.ok.us/lpdnew/SF/Superfund%20Project/SF%20Site%20Summaries/TarCreek.html>

# Tar Creek Mining History

- 300 miles of underground mine tunnels/cavities
- > 1,320 mine shafts and boreholes

<http://www.cardinkids.com>

<http://www.deq.state.ok.us/lpdnew/SF/Superfund%20Project/SF%20Site%20Summaries/TarCreek.html>



# Tar Creek Mining History



- 31 million cubic yards of mine waste – “chat piles”
- Covering 770 acres of land



<http://www.cardinkids.com>; [https://www.fws.gov/southwest/es/oklahoma/Documents/Contaminants/draft\\_Tar\\_Creek\\_AP.pdf](https://www.fws.gov/southwest/es/oklahoma/Documents/Contaminants/draft_Tar_Creek_AP.pdf)  
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# Tar Creek Mining Legacy



# Tar Creek Mining Legacy – Picher, OK in 2007



Kansas

Treece

69

Oklahoma

Picher

Cardin

Elm Creek

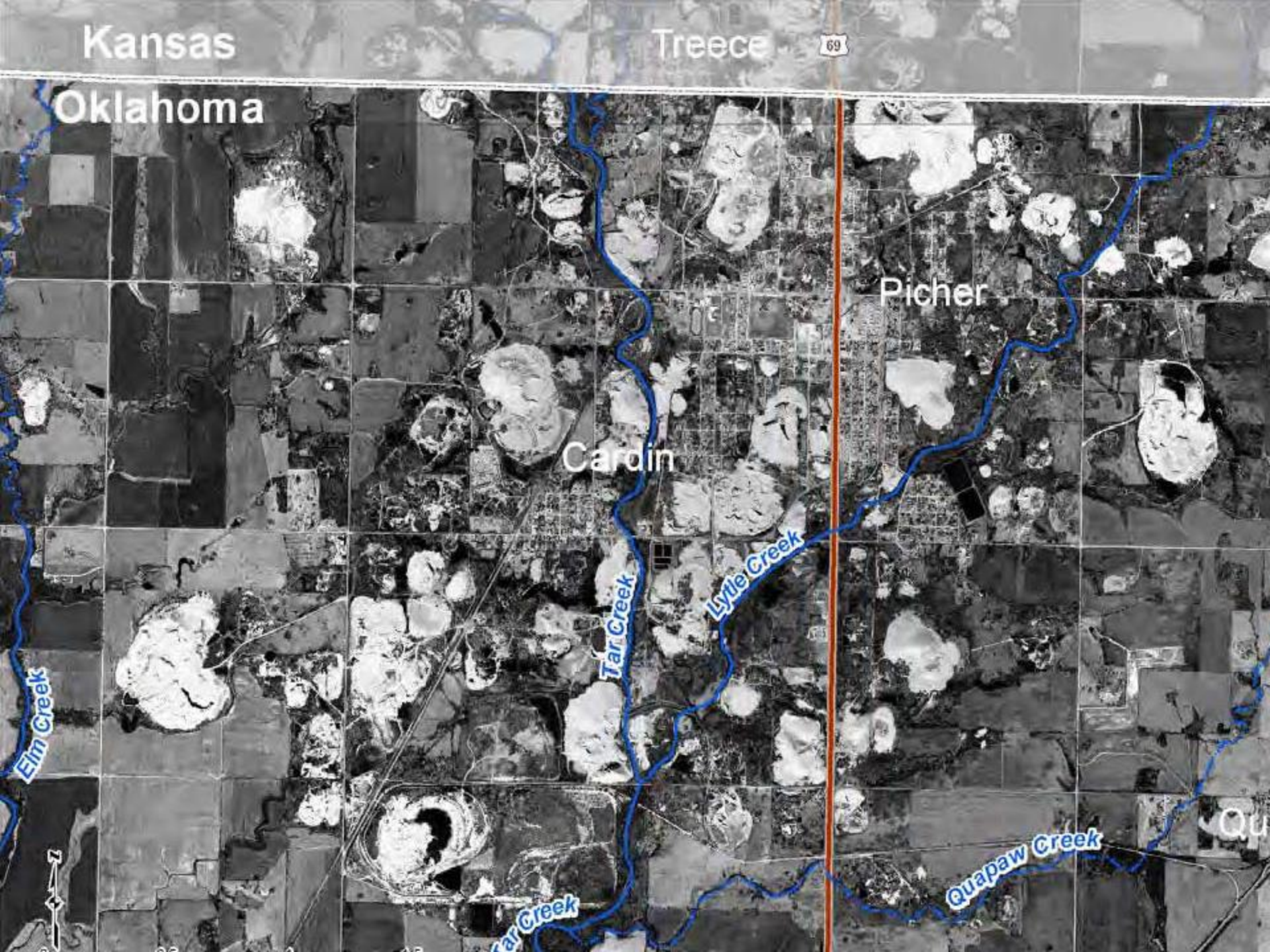
Tar Creek

Lytle Creek

Quapaw Creek

Tar Creek

Qu





# Tar Creek Mining Legacy



- Main hazardous substances: lead, zinc, and cadmium
- 34% of Native American children tested by Indian Health Service in 1994 had blood lead levels  $> 10 \mu\text{g}/\text{dL}$



# Remedial Investigation and Natural Resource Damage Assessment Site History



Tar Creek was added to the National Priorities (Superfund) list in 1983

Response agencies: EPA Region 6, Oklahoma DEQ; coordinating with TCTCIT

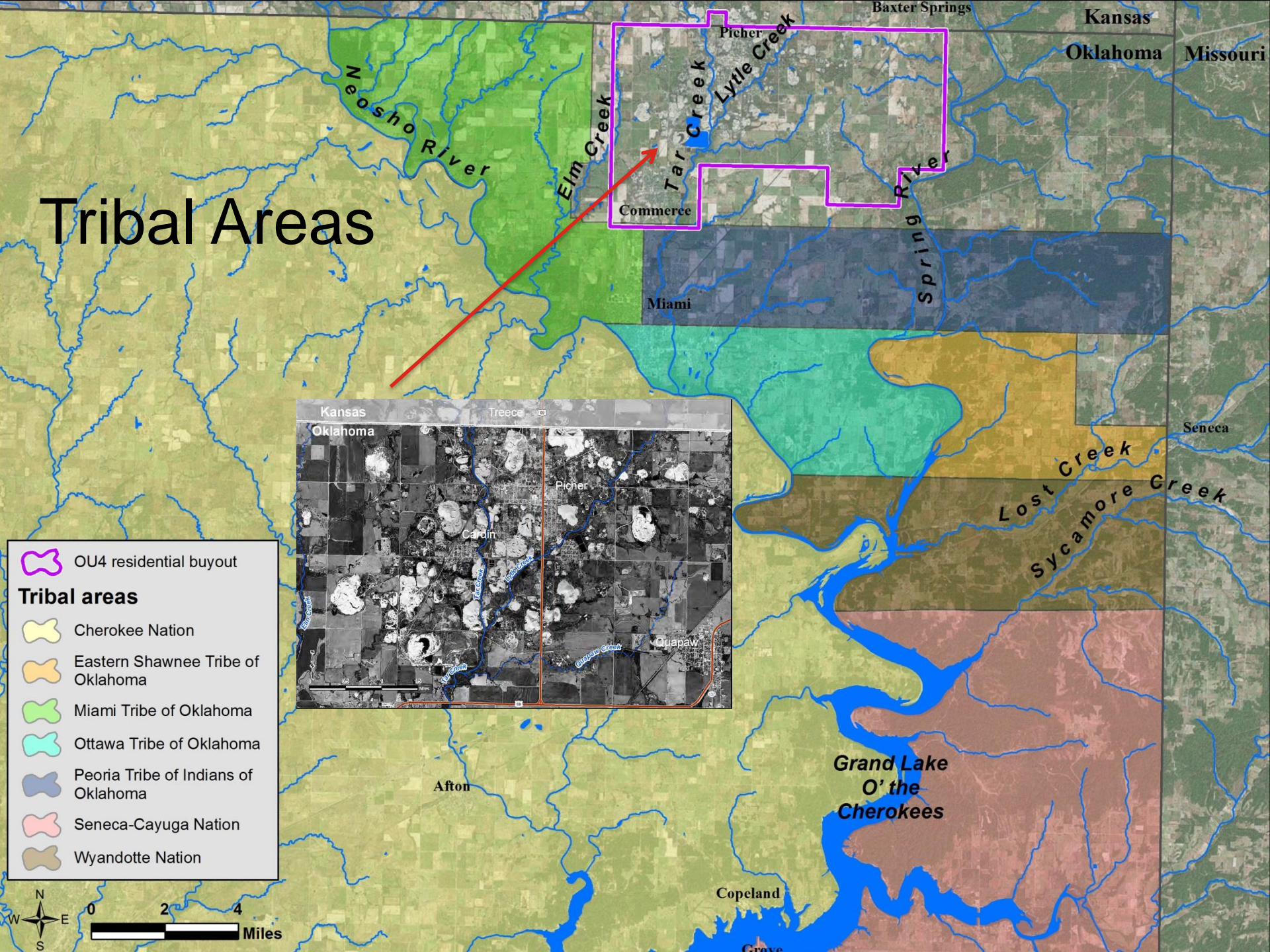
NRDA initiated in 2004, with the Pre-Assessment Screen (PAS)

Trustees: TCTCIT, Department of Interior (FWS, BIA), State of Oklahoma

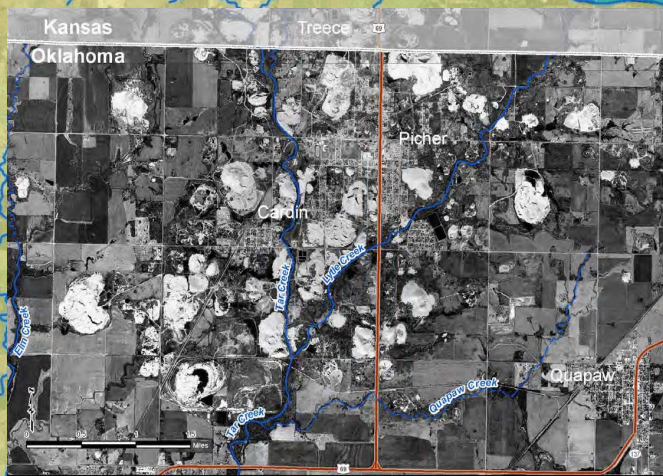
<http://www.deq.state.ok.us/lpdnew/SF/Superfund%20Project/SF%20Site%20Summaries/TarCreek.html>  
[https://www.fws.gov/southwest/es/oklahoma/Documents/Contaminants/draft\\_Tar\\_Creek\\_AP.pdf](https://www.fws.gov/southwest/es/oklahoma/Documents/Contaminants/draft_Tar_Creek_AP.pdf)



# Tribal Areas



-  OU4 residential buyout
- Tribal areas**
-  Cherokee Nation
-  Eastern Shawnee Tribe of Oklahoma
-  Miami Tribe of Oklahoma
-  Ottawa Tribe of Oklahoma
-  Peoria Tribe of Indians of Oklahoma
-  Seneca-Cayuga Nation
-  Wyandotte Nation



# Cultural and Subsistence Use of Natural Resources



The Tribes hunt, fish, and gather throughout the site

Many biota have subsistence and cultural importance:

- Fish (“non game” fish)

- Plants

- Crayfish

- Frogs

- Mussels

- Birds

- Furbearers – muskrat, raccoon

- Wild game – deer, rabbit



Gigging for fish

<https://www.youtube.com/watch?v=QzWVCKbXgx4>

# Cultural and Subsistence Use of Natural Resources



Gigging for fish

Preparation of fish with bones intact – deep frying, canning

<https://www.youtube.com/watch?v=QzWVCKbXgx4>

# Combined Tribal HHRA/Injury Analysis



Traditional Tribal Diet

Exposure

Risk/Injury Analysis

# Combined Tribal HHRA/Injury Analysis



Traditional Tribal Diet

- Identify biological resources (dietary items) consumed by the Tribes and amount consumed



Exposure

Risk/Injury Analysis

# Combined Tribal HHRA/Injury Analysis



Traditional Tribal Diet

- Identify biological resources (dietary items) consumed by the Tribes and amount consumed



Exposure

- Compile tissue contaminant concentration data
- Calculate contaminant exposure levels based on tissue data and Tribal diet

Oklahoma, USGS, EPA, Tribal data

Risk/Injury Analysis



# Combined Tribal HHRA/Injury Analysis



## Traditional Tribal Diet

- Identify biological resources (dietary items) consumed by the Tribes and amount consumed



## Exposure

- Compile tissue contaminant concentration data
- Calculate contaminant exposure levels based on tissue data and Tribal diet

Oklahoma, USGS, EPA, Tribal data

## Risk/Injury Analysis

- Identify FDA and WHO tolerance levels; EPA reference doses
- Compare exposure levels to tolerance levels/reference doses



# Traditional Tribal Diet



Elevated lead (and other metals) measured in many items that the Tribes consume

## Traditional Tribal Dietary Items

Fish and other aquatic organisms

Nuts, grains, and seeds

Roots and bulbs

Fruits and berries

Greens and sweets

Fowl

Large game

Small game

Corn

Legumes

Squash, other veg



Crayfish –  
boiled,  
baked, eaten  
with  
carapace



Redhorse sucker – deep  
fried, canned, and eaten with  
bones



Arrowhead – root, stem leaves consumed and  
used for medicinal purposes



Frog – fried legs

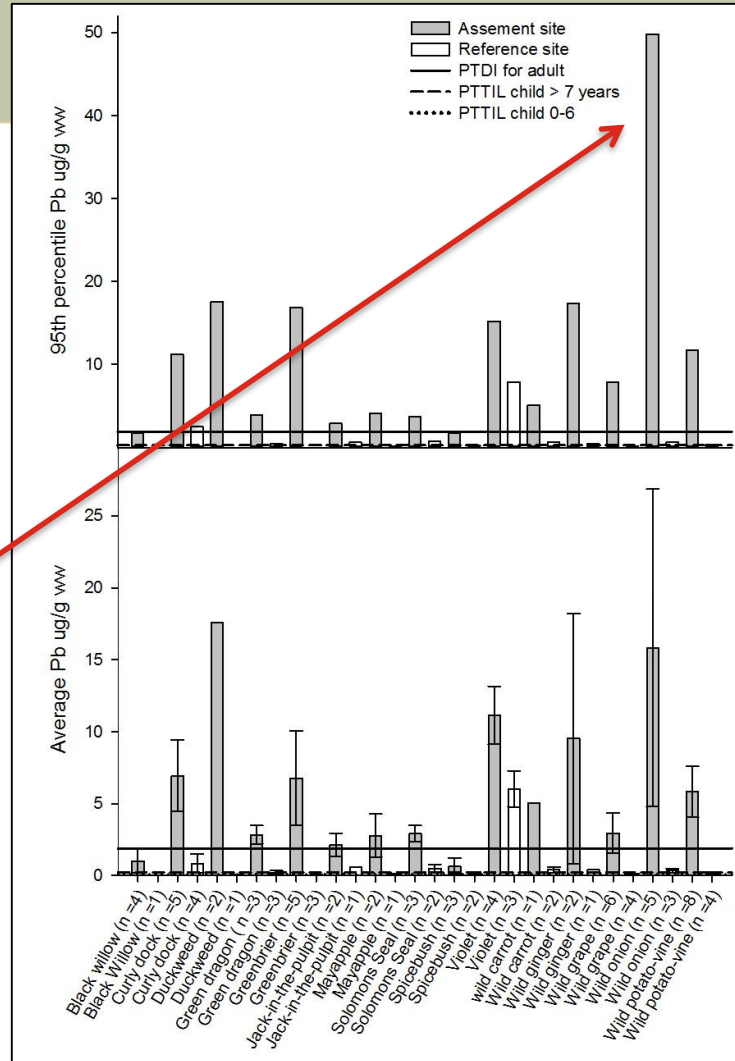
Traditional Tribal dietary items and  
consumption rates from Harper (2008)

# Lead in Plants

Lead levels are elevated in plants the Tribes consume, compared to tolerance levels set by the FDA



Wild Onion



PTDI = Provisional tolerable daily intake

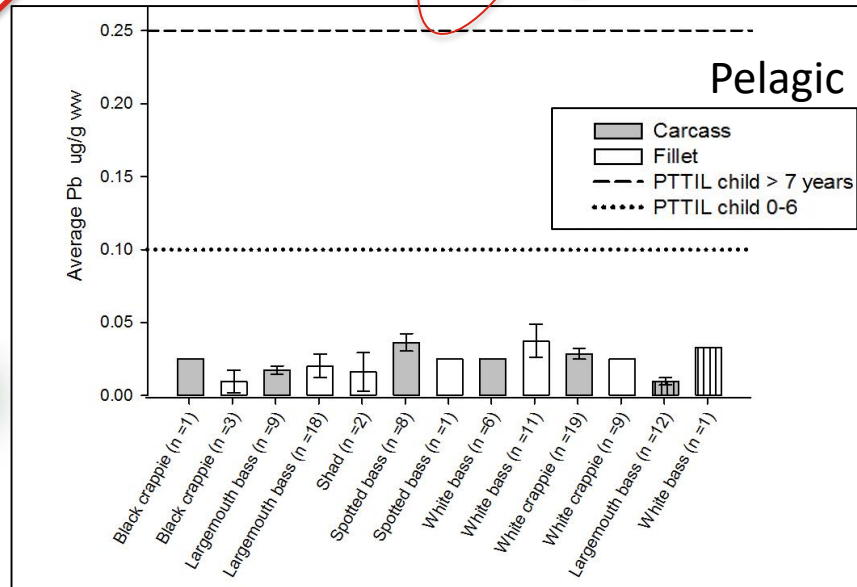
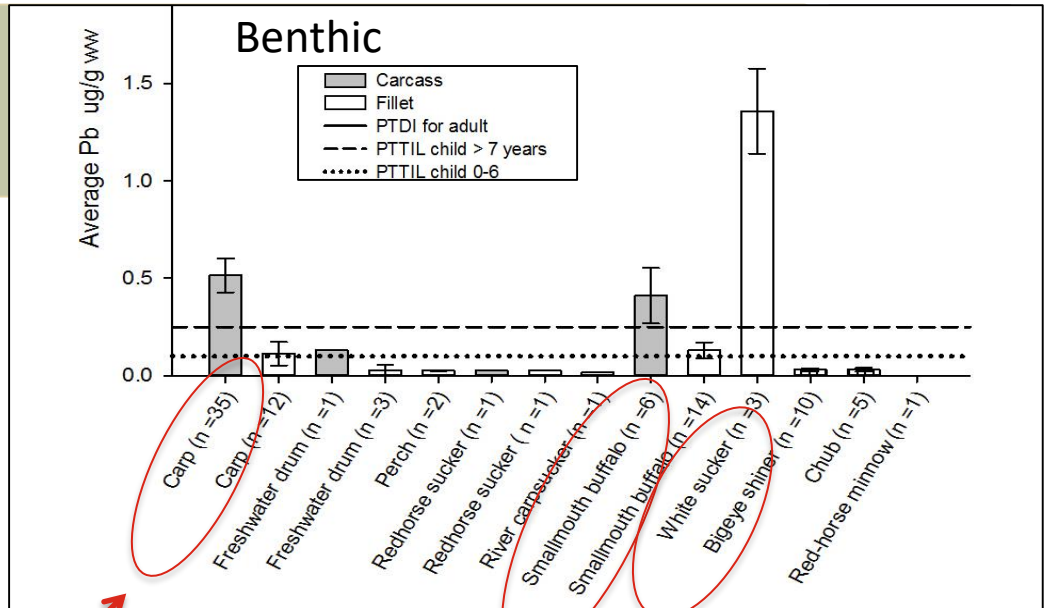
PTTIL = Provisional total tolerable intake level

# Lead in Fish

Lead levels are above tolerance levels set by the FDA – particularly in benthic, or “rough” fish that are targeted for consumption by the Tribes



Carp



# Exceedance of Lead Tolerance Levels (Child 95th percentile)



Biological resource	PTTIL exceedance (children 0–6 years; FDA)	PTTIL exceedance (children ≥ 7 years; FDA)	PTDI exceedance (JECFA)	ML exceedance (WHO)
<b>Fish (prepared as carcasses)</b>				
Benthic	4.99	2.00	0.58	2.5
Catfish	1.45	0.58	0.17	0.7
Sunfish	3.70	1.48	0.43	1.9
<b>Fish (prepared as fillets)</b>				
Benthic	9.90	3.96	1.15	5.0
<b>Other aquatic organisms</b>				
Mussel	75.65	30.26	8.77	15.1
Crayfish	7.49	3.00	0.87	1.5
<b>Wild game</b>				
Small game (rabbit)	20.08	8.03	2.33	n/a
<b>Plants</b>				
Roots and bulbs	178	71.1	20.6	n/a
Fruits and berries	82.0	32.8	9.50	n/a
Greens and sweets	291	116	33.7	n/a

PTDI = Provisional tolerable daily intake; PTTIL = Provisional total tolerable intake levels; ML = Maximum allowable concentration; WHO = World Health Organization; FDA = Food and Drug Administration; JECFA = Joint FAO/WHO Expert Committee on Food Additives

# Summary



Streamlining HHRA and NRDA injury analyses can provide Tribes with a cost-effective, timely method that places the focus on tribal Traditional Lifeways