

Lake Roosevelt and Upper Columbia River

Remedial Investigation and Feasibility Study

2019 PUBLIC GUIDE

The logo for the Lake Roosevelt Forum. It features the word "Lake" in a serif font, with a stylized sun and wavy lines above it. Below "Lake" is the word "Roosevelt" in a larger, bold serif font, and "Forum" in a smaller serif font below that.

Lake
Roosevelt
Forum

Background



Contaminants in Lake Roosevelt, Upper Columbia River and the Upper Columbia River Valley

[Under the terms of a 2006 settlement agreement between the Environmental Protection Agency \(EPA\) and Teck American Incorporated \(Teck\)](#), an investigation is being performed to establish the nature, extent and possible human health and ecological risks of contaminants found in the Upper Columbia River, which includes Lake Roosevelt and the Upper Columbia River Valley. EPA refers to the investigation as the Upper Columbia River (UCR) Site Remedial Investigation and Feasibility Study (RI/FS). Teck has reported spending more than 100 million dollars over the past 13 years to fund this work.

As the history time line on page four shows, the legacy of contaminants entering the Columbia River and Lake Roosevelt dates back over a century. EPA has traced most of it to the [Trail Smelter](#), sited along the Columbia nine miles north of the U.S./Canada border. Waste from the smelter carried metals and other contaminants downstream into Lake Roosevelt.

Originally, the Trail Smelter processed copper and gold. The smelter capacity increased steadily, and it transformed into a leader of lead and zinc smelting. [Current integrated operations focus on smelting of zinc and lead for use in vehicles, batteries and numerous products](#). Teck discharged wastewater and millions of tons of granulated fumed slag containing various amounts of residual metals into the Columbia River.

In 1995, the Trail Smelter ceased discharging granulated waste slag into the Columbia River in British Columbia. In 1997, the smelter implemented the Trail Modernization Program which, along with prior efforts, significantly improved the quality of wastewater being discharged into the river and the facility's overall environmental performance.

Smelter emissions discharged into the air are another primary source of contamination at the UCR Site. Dating back to the 1920s, emissions were a source of concern in the Upper Columbia River Valley. [The two countries agreed to arbitration through an international joint commission and later a Tribunal to resolve Trail Smelter emission damage to vegetation](#). The UCR RI/FS includes studying the nature and extent of metals contamination to uplands caused by historic smelter emissions.

Assessing Human Health and Ecological Risks

The UCR RI/FS is being conducted consistent with the [United States Superfund law](#) (technically called the Comprehensive Environmental Response, Compensation and Liability Act, or CERCLA).

The RI/FS includes human health risk and ecological risk assessments as well as information related to the nature and extent of contamination. The human health and ecological risk assessments determine whether pollution at the UCR Site is likely to cause unacceptable risk to people or the environment, and generally where the unacceptable risk may exist. Together, the risk assessments inform the potential need for cleanup.

Under CERCLA, if EPA determines there is unacceptable risk, then a range of alternatives will be evaluated to perform cleanup. EPA can then direct site cleanup and compel responsible parties to fund these efforts.

Sites like the UCR Site (which stretches over 150 river miles and has over 600 miles of shoreline) are called mega-sites because of their size and complexity. As a result, like other mega-sites, the UCR RI/FS is taking several years to conduct. During this period, EPA can consider and take "time-critical removal action" to address findings considered to be an imminent threat to human health or the environment. [EPA reached a voluntary agreement with Teck to cleanup 18 residential properties in the Upper Columbia River Valley from 2015-2018](#).

Sharing What We Know

This public guide updates what is currently known and progress made since Forum publication of the 2015 RI/FS Public Guide. The 2011 and 2015 Public Guides are also available at www.lrf.org/environment. Collectively, these guides provide essential background and detailed information to support public desires for increased awareness and the ability to provide informed feedback.

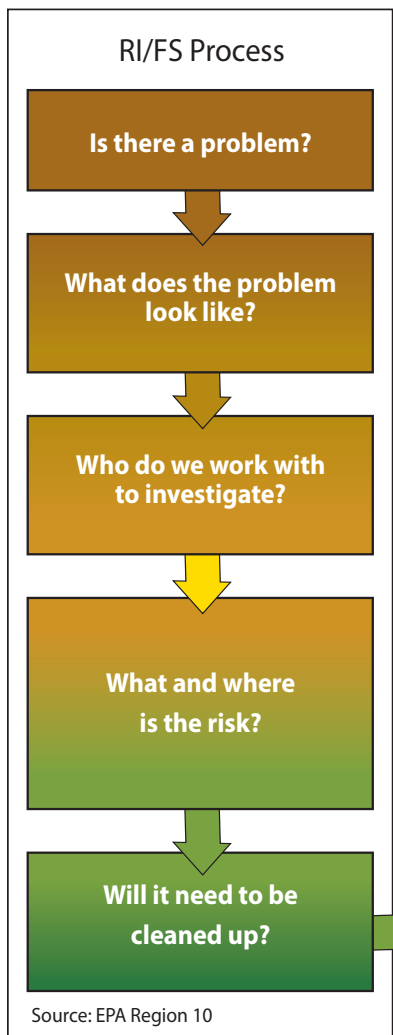
The web version of this Public Guide (www.lrf.org/publicguide2019) includes several links to related studies and information.



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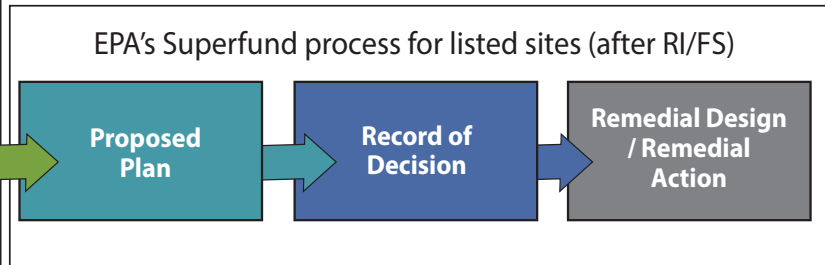
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EPA's Upper Columbia River RI/FS



RI/FS: Remedial Investigation and Feasibility Study

- The Remedial Investigation (RI) is a detailed study of the site to identify the nature and extent of pollution.
- The Feasibility Study (FS) is a description and analysis of potential cleanup alternatives for a site, including no-action.



History

1896 Trail, Canada facility built as a copper and gold smelter.

1900 – present Mining, milling, or smelter activities occurring at various times in watersheds of the Upper Columbia River, both in Canada and the United States.

1901 – 1916 Trail, Canada facility added lead smelting in 1901, and zinc production in 1916.

1922 Smelters permanently close at Northport, Grand Forks, Greenwood, and Boundary Falls.

1931 A new Canadian fertilizer plant becomes a primary source of phosphate discharges into the Columbia River.

1935 – 1941 [A joint U.S. and Canada tribunal](#) investigating effects of emissions in the Upper Columbia Valley reaches settlement for actions injuring vegetation.

1942 [Grand Coulee Dam](#) gates close, raising the waters behind the dam 380 feet. Water flows and bank erosion change, affecting depositional patterns of sediment contamination.

1959 Celgar Pulp Mill begins operation in Castlegar, Canada.

1990 – 1993 [WA Department of Ecology \(Ecology\) monitors dioxin, furan and trace metal concentrations in suspended particulate matter and fish tissues.](#) The Celgar pulp mill is considered the primary historical source for dioxin and furan contaminants. Celgar plant modernization designed to end discharges of dioxins and furans into the Columbia begins.

1992 [The U.S. Geological Survey \(USGS\) conducts a sediment study of Lake Roosevelt](#) describing the transport of metals, the presence of trace metals in bed sediment, and the toxicity of the sediment to benthic invertebrates.

1993 Ecology initiates studies resulting in Lake Roosevelt being placed on the federal Clean Water Act Section 303(d) list of impaired water bodies.

1994 Canadian fertilizer plant ceases discharge of phosphate into the Columbia.

1994 [USGS conducts a fish tissue study to determine the level of mercury and other metals in Walleye, Smallmouth Bass, and Rainbow Trout.](#) Based on findings, a fact sheet from the WA State Department of Health (WDOH) advises the public to limit consumption of Walleye.

1995 Discharges of slag from Trail Smelter cease.

1997 Teck implements Trail Modernization Program to further improve quality of effluent (wastewater) being discharged.

1998 In Canada, wide area human and ecological risk assessment initiated from Castlegar to the U.S. border.

1998 [USGS conducts a follow-up fish tissue study and finds that concentrations of metals had either not changed or decreased.](#) Ecology identifies temperature, total dissolved gas, mercury, polychlorinated biphenyls (PCBs) and pH as parameters for Lake Roosevelt inclusion on the Clean Water Act 303(d) list of impaired water bodies.

1999 Colville Confederated Tribes petition EPA to conduct an assessment of environmental contamination in Lake Roosevelt under federal Superfund program.

2001 – 2003 [EPA collects samples of river sediments. EPA recommends a RI/FS to assess environmental and human health risks.](#)

2002 – 2006 USGS collects data to determine concentrations of trace metals in reservoir wind-blown dust.

2003 During negotiations between EPA and Teck Cominco, EPA issues Unilateral Administrative Order under U.S. Superfund law to fund and conduct aspects of the RI/FS. Teck Cominco contests the order and EPA moves forward with the RI/FS using U.S. government funding.

2004 Canadian government issues a “Diplomatic Note” to the U.S. State Department regarding EPA enforcement order. United States and Canadian governments begin discussions regarding site.

2004 Colville Confederated Tribes and Washington State ask U.S. District Court to force Teck Cominco to comply with EPA order issued in 2003.

2004 Ecology updates Clean Water Act 303(d) impairment list for Lake Roosevelt to include temperature, total dissolved gas, and mercury.

2005 [EPA conducts a time-critical removal action at the Le Roi and Northport smelter sites separate from other UCR Site activities.](#) EPA replaced soils at several Northport residential properties and capped contaminated soils directly on the smelter site.

2005 EPA RI/FS studies begin by initiating sediment sampling and fish tissue studies.

2006 [EPA reaches an agreement with Teck to fund the RI/FS.](#) Teck was required to develop an EPA-approved RI/FS ecological work plan before studies can continue.

2006 Ninth Circuit U.S. Court of Appeals upholds a district court ruling that Superfund (CERCLA) law does apply to Teck’s Trail smelter.

2008 WDOH updates Lake Roosevelt fish advisory.

2009 [EPA approves RI/FS ecological and human health work plans. Teck Cominco \(now called Teck\) begins RI/FS studies under EPA oversight.](#)

2009 [2,327 fish were collected and composited into 507 samples. They were tested for metals, dioxins/furans, PCBs, pesticides, flame retardants and other organic compounds.](#)

2009 – 2010 [Columbia River and Lake Roosevelt surface water tested for inorganic compounds such as lead and arsenic, and organic compounds such as PCBs and pesticides.](#) Samples meet EPA water quality standards protective of people and aquatic life.



2009 – 2011 [43 beaches sampled for metals contamination. All but three beaches sampled are considered safe for recreational use.](#) One of these, Bossburg Flats, is closed by the National Park Service due to high lead levels from the former Young America Mine/Mill.

2010 [Teck reaches voluntary agreement with Ecology \(outside of the RI/FS\) to remove and replace with clean fill 9,100 tons of sediment containing granulated slag from Black Sand Beach.](#)

2011 EPA finds that soil concentrations of lead and other metals around the Young America Mill site and tailings impoundment are well above screening levels for human health risk.

2012 [EPA funds and conducts time-critical cleanup action to address human health risks related to Young America Mill site.](#)

2012 WDOH updates Lake Roosevelt fish consumption advisory.

2012 [Recreational Use Survey of visitors performed to support RI/FS human health risk assessment.](#)

2012 [Colville Confederated Tribal Use Survey performed to support RI/FS human health risk assessment.](#)

2013 [Phase 2 river sediment sampling from Canada to Grand Coulee Dam conducted for ecological risk assessment.](#)

2013 [Independent of the RI/FS, Ecology conducts initial upland surface soil sampling near the Canadian border and finds elevated metals concentrations.](#)

2014 EPA residential soil sampling conducted north of Northport to U.S./Canada border to support human health risk assessment.

2014 Teck samples non-residential soil across a 115-square-mile area along the Upper Columbia River Valley from China Bend northward to U.S./Canada border. Results will support ecological risk assessment.

2015 [Sampling from Bossburg Flats Beach to south of Evans Campground to determine extent and possible contribution of Young America Mine and Mill to elevated levels of metals; no connection found.](#)

2015 [14 residential properties and 3 tribal allotments had levels of lead exceeding 700 parts per million.](#)

An agreement between EPA and Teck resulted in property owners being offered voluntary cleanup of contaminated residential yard soils on their property at no cost. 13 property owners and 1 tribal allotment accepted this offer, and Teck conducted cleanups under the oversight of EPA.

2015 [Findings of 2014 upland soil sampling released.](#) Moving both south and downstream of the Canadian border and with increased distance from the river, lead concentrations in samples, on average, decreased. Lead concentrations were found generally to be greater in benchland areas on the west side of the Columbia.

2016 Ninth Circuit U.S. Court of Appeals rules Teck does not have CERCLA arranger liability for smelter air emissions.

2016 [Sampling of mussel and crayfish conducted to determine if chemicals are concentrating in tissues and considered a risk to human health or ecology.](#)

2016 [Residents in the Upper Columbia River Valley who did not request residential soil sampling in 2014 are given a second opportunity. Additional landowners as far south as China Bend are also given an opportunity to receive free soil sampling. 144 properties were sampled.](#)

2016 In support of reopening hatchery-raised White Sturgeon fishery season, fillets of 72 hatchery White Sturgeon of various sizes sampled. [WDOH issues an updated fish advisory adding White Sturgeon consumption to healthy choice category.](#)

2016 [Additional Bossburg Flats sampling results show the highest lead levels are localized in an upland area of the historic Bossburg town site that is about 5 acres in size.](#) The beach area remains closed to the public.

2017 – 2018 [Residential soil sampling conducted in 2016 resulted in 4 additional properties receiving contaminated soil cleanup.](#) 1 property and part of another were cleaned up in 2017, and the remainder in 2018.

2017 [Based on fish fillet sampling results, WDOH supports reopening of White Sturgeon fishery, placing them in the healthy choice category along with Kokanee, Rainbow Trout, and Lake Whitefish.](#)

2017 Ecology recommends to EPA that additional air quality monitoring in the Upper Columbia River Valley be undertaken as part of RI/FS human health risk assessment.

2018 EPA informs citizens that additional air monitoring in the Upper Columbia River Valley will not be conducted as part of the RI/FS. EPA determined that previously collected air monitoring data is protective and sufficient to meet requirements of the human health risk assessment.

2018 [Plant tissue sampling conducted in the Upper Columbia Valley to determine if concentrations of metals in the roots or tissues from a variety of plants may result in human health risk due to consumption or use.](#)

2018 [Due to increased presence and consumption of Northern Pike by anglers, sampling of these fish was conducted. Results were provided to the WDOH to determine safe fish consumption standards.](#)

2018 [Third phase of sediment sampling was started with collection of high-resolution data to identify and map sediment grain size and texture of the sediment bed in three areas of interest in the northern section of the Upper Columbia River: Deadman's Eddy, China Bend and Evans.](#)

Human Health

EPA has reached the point in the Remedial Investigation and Feasibility Study (RI/FS) process that a Human Health Risk Assessment (HHRA) is being developed. As described in the next section, the HHRA determines what (if any) potential human health threats exist in the absence of any remedial (cleanup) action taking place.

Although separate and distinct from the HHRA, agencies have provided some human health guidance over the years based on RI/FS study results.

Fish Consumption

The Washington Department of Health (WDOH) issues fish advisories for safe consumption of fish. The advisory on pages 10-11 provides the following fish consumption guidance:

Healthy Choice: Kokanee, Lake Whitefish, Rainbow Trout and White Sturgeon

Limit: Burbot, Longnose Sucker, Mountain Whitefish, Smallmouth Bass and Walleye

Caution: Largescale Sucker and Largemouth Bass

Based on age and other factors, the advisory lists the number of servings per week that may be consumed.

Mussel and Crayfish

WDOH issued the following guidance for mussel and crayfish:

Healthy Choice: Northern and Signal Crayfish

Do Not Consume: Fresh Mussels and Clams due to bacterial/viral concerns

Surface Water

All water samples met EPA aquatic water quality standards protective of people and aquatic life, providing assurance that Lake Roosevelt is safe for swimming and other recreational activities.

Beach Exposure

From 2005 – 2011, 43 beaches were sampled for potential public exposure to contaminants. For 40 of the 43 beaches, findings were consistent with the 2005 conclusion that there is “no apparent public health hazard.”

The three beaches with elevated levels included:

1. **Bossburg Flats.** As a precautionary measure, the beach area was closed in 2011 and remains closed. Further sampling shows the highest lead levels are on the beach and an open area of the historic Bossburg town site.
2. **Evans Campground.** Remains open with lead levels slightly above human health screening levels for residential land use.
3. **Swimming Hole Beach located near Sheep Creek.** Remains open. Samples showed arsenic levels may be slightly above human health screening levels.

Air Inhalation: Airborne Wind-Blown Dust along the Reservoir

[A 2010 report prepared for the U.S. Department of the Interior by Industrial Economics, Incorporated \(IEC\)](#) found that human inhalation of airborne sediment particles along the reservoir containing lead and other heavy metals are within EPA acceptable risk standards for cancer and non-cancer health effects resulting from both acute and chronic exposures.



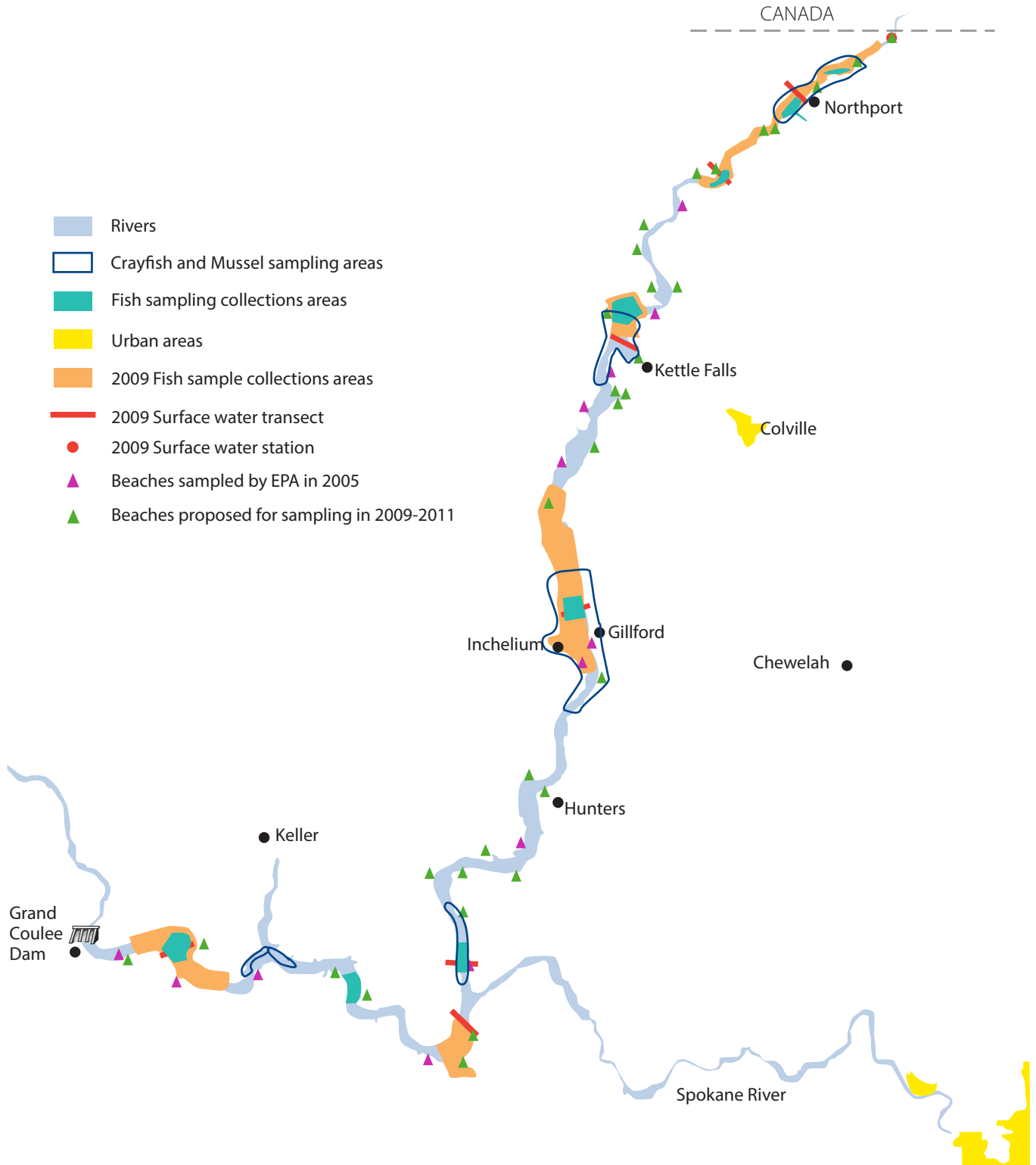
Fish Sampling Team



Beach Sampling



Study Areas for Fish, Surface Water, and Beach Sampling



Cleanup Activities

Remedial Investigation and Feasibility Study (RI/FS) activities began in 2005. These investigations will lead to human and ecological risk assessments that will inform whether cleanup actions are required.

Dating back to 2003, however, voluntary and other actions have resulted in cleanup activities taking place during this period. This section summarizes these cleanups activities, all of which occurred in locations on or near the Columbia River from the Canadian border to approximately 23 miles downstream.

Le Roi Smelter, Northport City Park and Northport Residential Properties

The Le Roi Smelter property is approximately 30 acres and located at the northeast end of the city of Northport. The smelter operated off and on between 1896 and 1921.

Separate and distinct from the UCR RI/FS, in 2003 EPA followed initial state studies with a Removal Site Evaluation of the smelter site and residential and community properties in Northport. [In 2004-05, cleanup activities of the smelter site and soil removal at residential yards began.](#) Activities



Le Roi Smelter

at the smelter included excavating and consolidating mine-waste-contaminated materials at the smelter, constructing a containment area and capping the area.

In 2005, BNSF Railway independently excavated and removed approximately 7,714 tons of arsenic and lead-contaminated soil in the area that is now Northport City Park.

Black Sand Beach

Located near Northport and about 3 miles south of the Canadian border, Black Sand Beach is a well-known attraction to residents. Its name comes from the black slag released from the Trail Smelter that naturally settled where the river bows here.

[Teck entered into a voluntary agreement with Ecology to remove about 9,100 tons \(6,300 cubic yards\) of sediments containing granulated slag from Black Sand Beach.](#)

Ecology reports that “clean fill material was used to establish the new beach, and the slag was hauled to Trail, British Columbia for recycling. The access road used during construction was restored to look more like its pre-construction state.”



Black Sand Beach during removal

Soil amendments being tested to reduce human exposure to lead

Identifying ways of reducing the potential for human exposure to lead in areas with expanses of undisturbed land is an ongoing opportunity in the Columbia River Valley (an area roughly defined as extending from China Bend through Northport and to the Canadian border).

With three tribal allotments being the initial focus of attention, EPA, Teck, and the Confederated Tribes of the Colville Reservation are working collaboratively on a [Soil Amendment Technology Evaluation Study](#) (the study) to address this need. The study objective is to identify an appropriate soil amendment technology or technologies that could be applied to cost effectively reduce the long-term potential for human exposure to lead in shallow soils. Methods that chemically or physically reduce lead bioavailability and/or increase soil and vegetative barriers to direct access to the affected soils are being studied. The application of the selected technology or technologies

should also minimize acute and long-term negative impacts to the ecology and land uses of treated properties.

The tribal allotment properties were selected for the study because soil sampling showed lead concentrations slightly above the human health time-critical removal action (TCRA) level. The properties, however, were not cleaned up because soil excavation and replacement would negatively alter the character of the forested and relatively undisturbed nature of these lands. The application of soil amendments on the ground surface can change the characteristics of surface soil in ways that can reduce the human exposure to lead, while minimizing disruption to the existing local ecology and land uses. The study is focusing on surface soil (the top 1 to 3 inches) because human exposure mainly occurs through ingestion of small amounts of soil and dust found in the first few inches of soil.

The public was closely consulted on the project and local companies were used for about 50 percent of the project work.

Young America and Other Ore Mills

Nestled into a nearly vertical limestone cliff, the Young America Mine/Mill was about 15 miles north of Kettle Falls. The mill processed ore from nearby mines and ceased operations around 1953.

Lead and other metals around the mill site and tailings impoundment, now a residential area, were well above safe levels. To address human health risks from contaminated dust and dirt that could be ingested, EPA conducted a removal action in fall 2012. [Cleanup actions included demolition and burying what remained of the old mill buildings, safely capping contaminated soils with a liner and “clean” soil on top, and other remedial actions.](#)

At least three other high-risk ore mill ruins scattered across the Upper Columbia River watershed in Stevens County have been or are slated for cleanup under federal and state oversight. These include the Anderson Calhoun and Sierra Zinc mills. Ecology is currently assessing cleanup options for the Van Stone Mine and Mill. Numerous other mines and mills have been evaluated and stabilized at various levels.

Study planning began in 2016. From 2017 to 2018, test plots were selected and characterized to establish baseline soil and vegetation conditions at the allotments, which are generally representative of common conditions in the region. This year, five soil amendments are being tested in a laboratory environment (bench-scale tests) to evaluate their effectiveness for treating site soil. Soil from the tribal allotments is being used in the laboratory tests. Amendments being tested are biosolids (organic matter recycled from municipal sewage), biochar (a carbon-rich charcoal), wood ash from a local source, organic compost, and phosphorus-containing fertilizer. These materials are readily available and each contains one or more components that may effectively transform lead in soil into more stable forms that reduce lead bioavailability. The bench-scale test results

Upper Columbia Valley Residential Properties

From as far south as China Bend to the Canadian border, residents were given the opportunity to receive soil sampling on their properties in 2014 and 2016 at no cost.

Teck entered into two separate voluntary agreements with EPA to fund and execute cleanup of residential properties. One agreement cleaned up properties with lead samples exceeding 700 parts per million (ppm); the second agreement cleaned up properties with lead samples exceeding 600 ppm. From 2015 – 2018, 18 residential properties received soil removal.



Cleanup activity at residential property

will also be used to identify and test secondary amendments that may be necessary to address unfavorable results or gaps in effectiveness of the primary amendments.

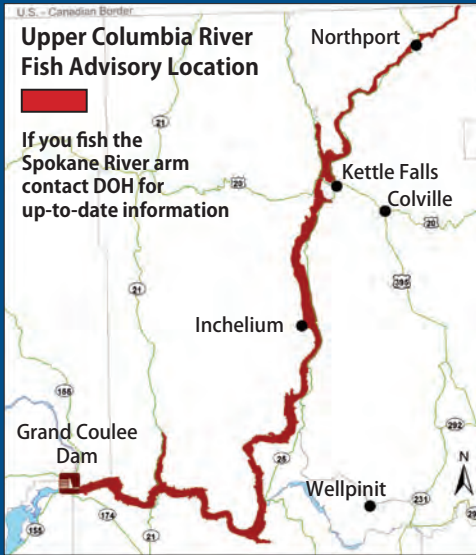
Based on the bench-scale test results, soil amendments will be selected and applied to the test plots, then soil and ecological conditions will be monitored for two to three years to evaluate the effectiveness of each technology alternative in meeting the study objectives. If the soil treatment technologies tested prove successful, they could be used on large tracts of land where soil excavation is not practical or desirable.

The results will inform EPA's feasibility study. Results could also be useful to property owners interested in treating soil on their property to reduce potential exposure to lead.

Fish Advisory

Upper Columbia River/Lake Roosevelt

Fish are nutritious (mercury and PCBs)
Babies and young children
Women who are pregnant
 should follow this advisory.



How much can I eat?

Women 18 - 45
 especially if pregnant



Children 1 - 17



2- 3 servings per week

Kokanee
 Lake Whitefish
 Rainbow Trout
 White Sturgeon



1 serving

4 servings
 of any combination
 of the fish

Women 46 and older
 and not pregnant



Men 18 and older



7 servings per week

Kokanee
 Lake Whitefish
 Rainbow Trout
 White Sturgeon



3 servings

12 servings
 of any combination
 of the fish

What is a serving?



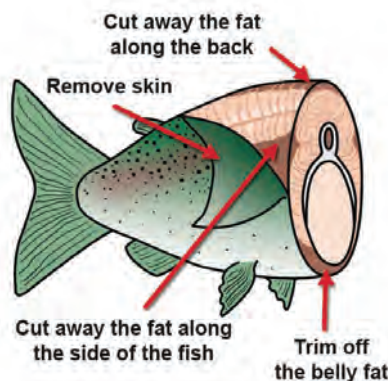
For Adults



For Children

A serving is about the size and thickness of your hand. Give children smaller servings.

Preparing Fish the Healthy Way



Fish are part of a healthy diet. Following these tips will help reduce the contaminants you eat. Mercury cannot be removed from fish.

- Before cooking remove the skin and fat.
- Eat younger and smaller fish.
- Eat a variety of fish.

ritious, but certain fish in the Upper Columbia River contain contaminants (and PCBs) that can harm your health.

children are most at-risk.

o are or might become pregnant, nursing mothers, and children
w all of this advisory.

LIMIT

Longnose Sucker
Kokanee
Smallmouth Bass

CAUTION

Largescale Sucker
Largemouth Bass

How to Use this Table

Women under age 46 and children under age 18 should eat from either the green or yellow column.

Examples:

If a child eats 1 serving of kokanee and 1 serving of rainbow trout, no other fish should be eaten that week.

If an 18-year-old man eats 3 servings of walleye in a week, no other fish should be eaten that week.

g per week
g per month
ombination
ese 5 fish

2 servings per month

Largescale Sucker
Largemouth Bass

DO NOT EAT

Northern Pikeminnow

g per week
g per month
ombination
ese 5 fish

5 servings per month

Largescale Sucker
Largemouth Bass

lthy diet.
will reduce the amount of chemical
t (like PCBs) that collect in the fat of fish.
duced; it builds up in fish meat (the fillet).
remove the skin, fat, and internal organs.
smaller fish (within legal limits).
fish.



Questions?
Department of Health
Toll Free: 1-877-485-7316
Visit: www.doh.wa.gov/fish

Updated from DOH 334-329 June 2015
Fish illustrations © Joseph R. Tomelleri
Available in other formats for people with disabilities
1-800-525-0127 (TDD/TTY ca

Human Health Risk Assessment

Creating a Human Health Risk Assessment for the Upper Columbia

A critical milestone of the Remedial Investigation and Feasibility Study (RI/FS) is development of a Human Health Risk Assessment (HHRA). [EPA describes this as "... the process to estimate the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future."](#)

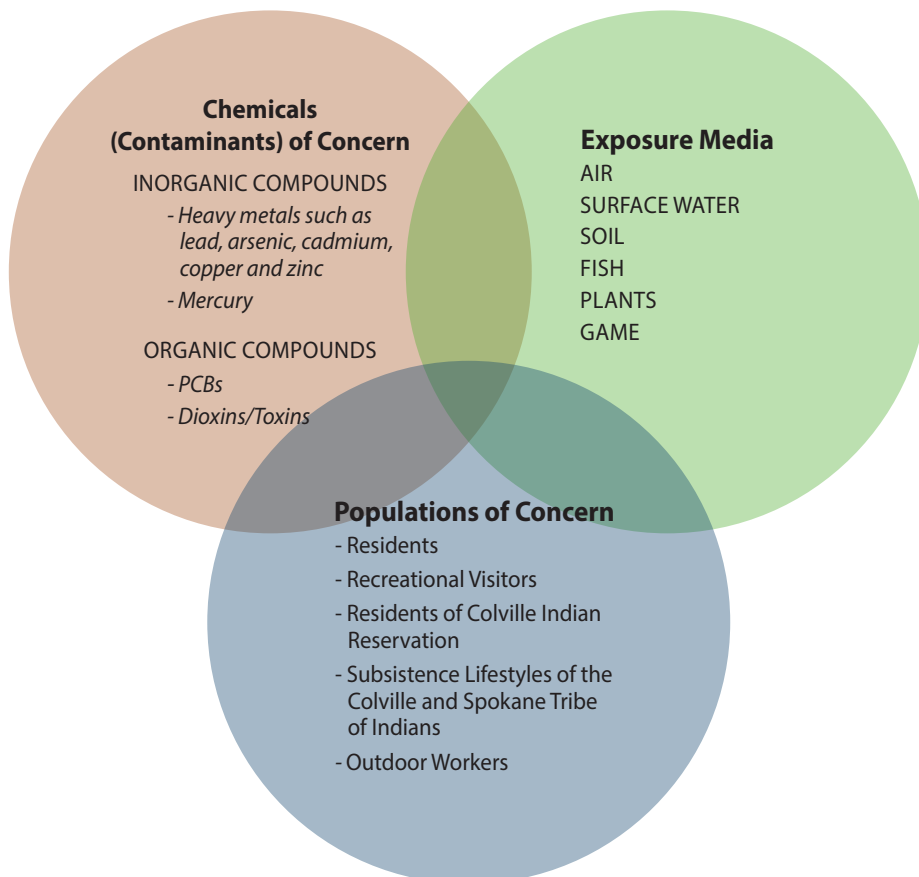
The studies necessary for the UCR HHRA have been completed over a period lasting more than 13 years. EPA is not planning further studies before publishing a draft UCR HHRA.

In 2018 EPA, supported by their consultant SRC, began evaluating data and compiling the HHRA. To expedite writing, the HHRA was broken into two parts. One part focuses on the river-associated portion of the site, and the other focuses on the upland portion of the site. The two parts will be integrated into a single draft risk assessment in 2019.

Draft documents for both parts are being reviewed and commented on by Ecology, Spokane Tribe of Indians, Colville Confederated Tribes, the U.S. Department of the Interior, Citizens for a Clean Columbia and Teck. Completion of an HHRA draft that the public can review and provide informed feedback to is expected in the next 6 to 18 months.

Completing studies to support the UCR HHRA took several years because the UCR Site is large and there are many factors to investigate, including multiple contaminants and sources and the ways people are exposed. Further, sometimes results require further investigation to achieve clarity; results from one investigation are needed before another one can be planned; or investigation results lead to new scientific questions requiring study.

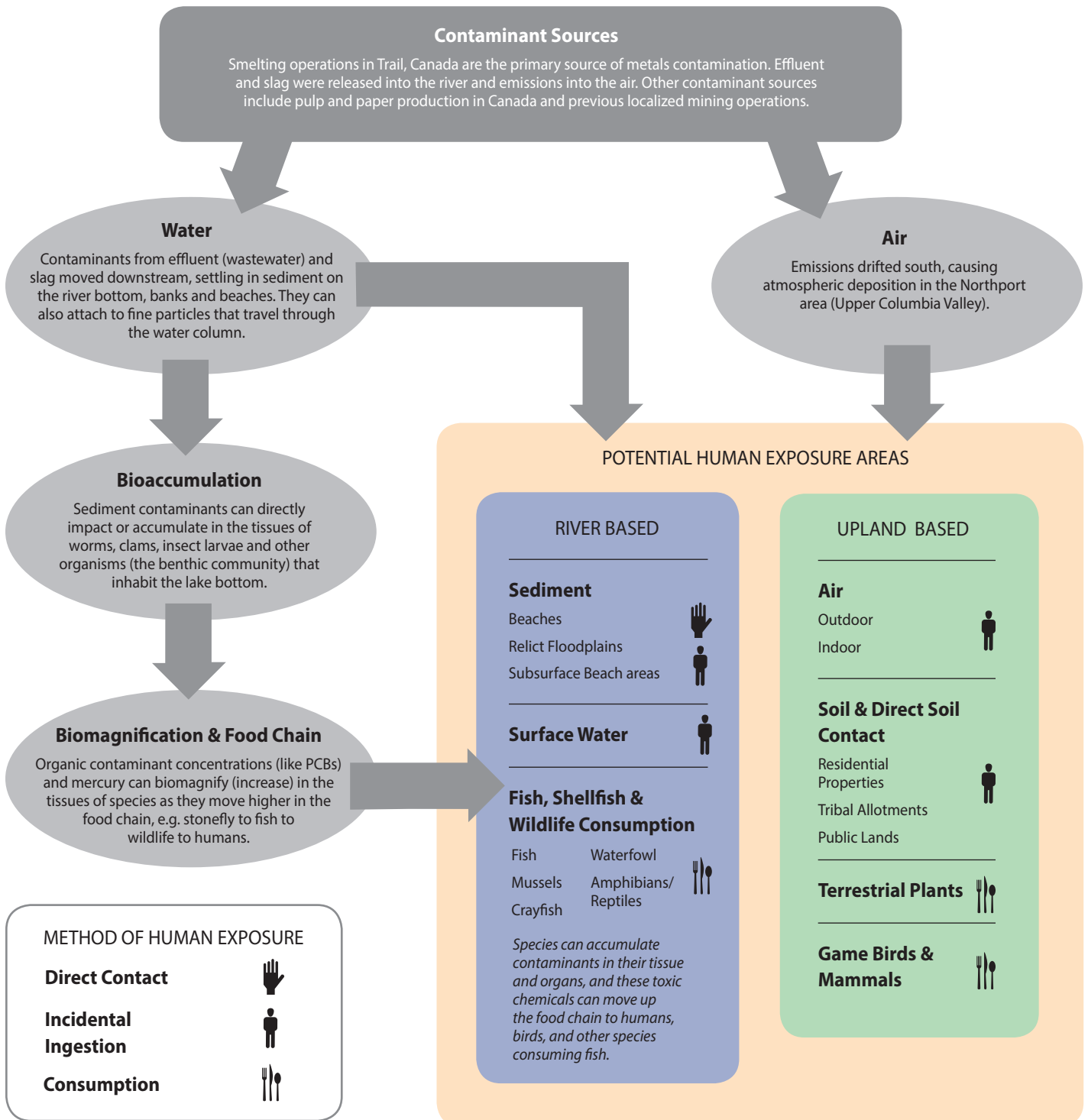
Focal Areas for Human Health Risk Assessment



The desired result of investigating complex relationships between chemicals of concern, exposure pathways, and exposed populations is to establish a safe level of human contact with chemicals of concern. EPA guidance says that, "For humans, this is a level at which ill health effects are unlikely and the probability of cancer is very small." This means the UCR HHRA begins with the assumption that human contact and interaction with chemicals of concern are neither reduced or remediated.

Upper Columbia Human Health Risk Assessment Exposure Pathways

This graphic provides a simplified understanding of how metals and other chemicals of concern entered, settled and resulted in human exposure within all or part of the Upper Columbia.



An Upper Columbia Conceptual Site Model

EPA developed a complex [Upper Columbia Conceptual Site Model](#) (CSM) to summarize and visualize known and hypothesized environmental pathways by which chemicals of concern could lead to human exposure and health effects.

To develop the CSM, EPA started by reviewing existing UCR information. This allowed EPA to identify data gaps and new information needed for RI/FS studies. RI/FS study results were used to further refine the CSM and determine if additional studies and data were needed.

The graphic below provides a simplified view of how the CSM explored one of many UCR exposure pathways. The data and analysis from RI/FS studies exploring this and other pathways is being integrated into the UCR HHRA.

Conceptual Site Model Example: Residential Soil Exposure

SOURCE(S)	TYPE OF RISK	EXPOSURE ROUTES	RECEPTORS	ENDPOINTS	RISK METRICS
How the pollutant originates and results in human exposure	Chemical, biological, and physical 'agents' that can affect human health due to exposure	The pathway(s) by which people are exposed to the chemicals of health concern	Exposed or likely exposed people at the site or in a population	How the chemicals of concern can affect the human body and be a risk to people	Estimate the health effect risks using studies of humans and animals
Trail Smelter emissions that settle on the ground through air deposition	Lead and other heavy metals deposited from smelter emissions	Inadvertent ingestion through residents swallowing small amounts of soil or dust on their properties, usually after soil on their hands is transferred to food.	Residents: adults and children	Cognitive reductions from lead, for example developmental losses affecting IQ	Define unsafe doses and effects
					EPA standard for soil-based lead exposure IEUBK modeling to estimate blood lead levels in young children

- Conceptual Site Model Path
- UCR Residential Soil Exposure Example

Graphic adapted from EPA publication ['Framework for Human Health Risk Assessment to Inform Decision Making.'](#)

Human Health Risk Characterization

Risk characterization integrates exposure and effects assessments to determine human health risks. Determining human cancer and non-cancer risks posed is what drives the HHRA.

Upper Columbia River Human Health Risk Characterization for Lead

Exposure to lead is of particular concern to RI/FS investigators and the community. The RI/FS has examined lead exposure occurring due to past smelter and local mining activities that are above background levels. The primary focus has been investigating the effects of slag deposited into the river system and air deposition as a result of emissions from the Trail Smelter in British Columbia.

Lead can cause a broad range of non-cancer health effects such as anemia or kidney and brain damage. It is particularly dangerous to children because their growing bodies absorb more lead than adults. Rapidly developing brains of children are more sensitive to adverse effects of lead on cognitive development, including IQ and self-control.

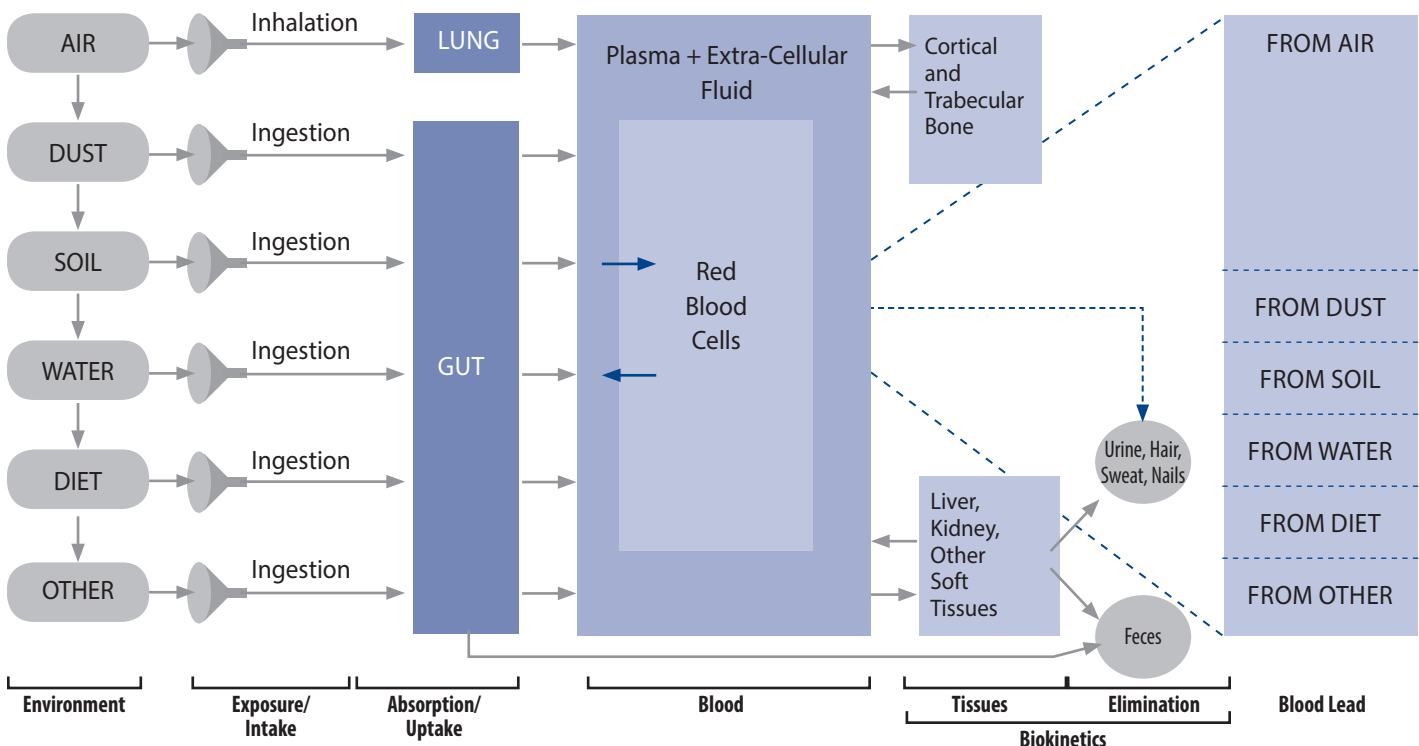
[Extensive soil testing for lead and other metals in the Upper Columbia Valley has occurred.](#) Beyond cleanup actions taken to date, the HHRA will use this soil testing to further consider health risks and needs for additional cleanup.

EPA will also use the Integrated Exposure Uptake Biokinetic (IEUBK) model to estimate blood lead levels in young children. Rather than determining risk by taking blood samples from individuals, IEUBK modeling estimates blood lead levels for populations potentially at-risk. This model is widely used nationally to evaluate lead exposure risks.

Examples of exposure scenarios modeled would be children from area communities living in homes, playing on beaches and leading a subsistence lifestyle; or recreational visitor exposure at beaches. The extensive Recreational Uses Survey conducted in 2010-2011 provided researchers human exposure information about lead and other contaminants throughout the Upper Columbia River.

The graphic shows components used for IEUBK modeling. RI/FS investigation data such as beach and residential soil sampling will be fed into this model and combined with complex mathematical computations to characterize human health risks.

IEUBK Modeling of Blood Lead Levels in Children



Source: EPA, 1994a. [Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children.](#)

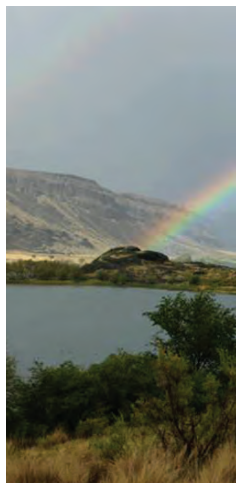
Upper Columbia Cancer and Non-Cancer Risk Models

Beyond IEUBK modeling for lead, benchmarks combined with cancer and non-cancer risk models for the UCR will be used to characterize human health risks. For each scenario being considered, a benchmark from best available science and/or regulation is used. Data and exposure estimates collected from studies are then entered into calculations to establish if benchmarks for human health risk are being exceeded.

This graphic provides an example of how calculations may be used to address various exposure scenarios. For instance, calculations can be used to determine at a 95 percent confidence level whether one or more populations has a health risk exceeding the benchmark for exposure.

	River Associated Exposure								Uplands Exposure			
	Beach	Beach Subsurface	Relict Floodplain	Surface	Fish	Crayfish	Mussel	Waterfowl	Soil	Outdoor Air	Terrestrial Plants	Game Birds & Mammals
Residents Adult Child Subsistence Lifestyle	<div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid gray; border-radius: 50%; width: 150px; height: 150px; display: flex; align-items: center; justify-content: center; margin-right: 20px;"> <p style="text-align: center; margin: 0;">CANCER AND NON-CANCER RISK MODELS</p> </div> <div> <p>Exposure Model: $CDI = \frac{C \times IR \times EF \times ED}{BW \times AT}$</p> <hr/> <p>Cancer Risk Model: $Risk = CDI \times CSF$</p> <hr/> <p>Non-cancer Risk Model: $HQ = \frac{CDI}{RfD}$</p> </div> </div>											
Recreational Visitors Adult Child												
Outdoor Workers Adult												
<p>CDI = Chronic Daily Intake of the chemical (mg/kg-day) HQ = Hazard Quotient</p> <p>C = Concentration of the chemical in and exposure medium (e.g.,mg/L) AT = Averaging Time (equal to ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens)</p> <p>IR = Ingestion Rate (e.g., L/day for water, mg/day for soil, etc.) CSF = Cancer Slope Factor (linear low-dose cancer potency factor) for the chemical (mg/kg-day)</p> <p>EF = Exposure Frequency (days/year) RfD = Reference Dose for the chemical for assessing noncancer health effects (mg/kg-day)</p> <p>ED = Exposure Duration (years)</p> <p>BW = Body Weight</p>												

From EPA publication, ["Risk Assessment Guidance for Superfund: Volume III - Part A, Process for Conducting Probabilistic Risk Assessment."](#)



Providing Informed Community Feedback

When a draft HHRA is released, the Lake Roosevelt Forum is committed to assisting the public in understanding key findings from the assessment and providing informed feedback.

This includes addressing questions like the following:

- What benchmarks and models were used to evaluate risks?
- For various exposure pathways, where were levels of risk found and not found?
- In the Upper Columbia Valley, what criterion (benchmark) for lead levels in soil will risk assessors use to consider further cleanup decisions?
- What are the risk management decisions being considered, who will make them and what is the timeline for a proposed plan?

Precautionary Measures

Metals in Contaminated Soil

People in contact with soil potentially contaminated with arsenic and lead are encouraged to take precautionary measures to protect their health. These metals can enter the body when eaten or breathed, with young children being the most vulnerable. Concerned residents can consult their family physician.

EPA and the Northeast Tri County Health District advise residents to take the following precautionary measures:

Inside Your Home

- Remove or leave shoes outside your home to avoid tracking in polluted soil.
- Wash hands and face thoroughly after working or playing in the soil, especially before cooking and eating.
- Use soap and water to wash – avoid hand sanitizer.
- Damp mop and wipe surfaces often to control dust.
- Wash toddler toys and pacifiers often.
- Scrub vegetables and fruits with soap and water, or peel them.
- After working in areas you know or believe have lead pollution in the soil, wash dirty clothes separately from other clothes.
- Repair painted surfaces in homes. Homes built before 1980 may contain lead-based paint. Older paint flakes can be a source of lead.
- Eat a balanced diet. Iron and calcium help keep lead from becoming a problem in the body.

Outside Your Home

- Keep children from playing in dirt you know is polluted with metals.
- Cover bare patches of dirt with bark, sod, decking or other materials, or fence off areas if you know they're polluted with metals.
- Dampen dusty soils before gardening or digging so you don't breathe in the dust.
- Wear gardening gloves.
- Do not eat or drink in metals-polluted areas.
- Grow your fruit and vegetables in raised beds with clean soil, or mix plenty of compost and other amendments in your garden soil to decrease the amount of pollution in the soil.
- Avoid railroad ties or pressure-treated lumber, they can contain chemicals that pollute soil.
- Do not plant food crops under the roof overhang of your home, where pollution may accumulate.
- Wipe pets' paws before entering the home, and wash them regularly to remove dust from fur.

This precautionary information for inside and outside your home was adapted from Northeast Tri County Health District outreach material. For more information, please contact them at 509-684-2262, or www.netchd.org. [Ecology's Dirt Alert web site](#) is another good source of information.



Ecology

Beyond human health risks, investigators must determine whether chemicals of interest pose ecological risks to the environment. For this Remedial Investigation and Feasibility Study (RI/FS), chemicals of interest include inorganic compounds (for example lead, arsenic, cadmium, copper and mercury) and organic compounds (for example PCBs and dioxins/furans).

With the focus being releases from smelter activities, pathways for chemicals entering the environment were identified. "Fate and transport" is the phrase used to consider the physical and chemical interactions that may create exposure and potential ecological risks to plants and wildlife.

[This section summarizes study activities informing the RI/FS Baseline Ecological Risk Assessment \(BERA\) that Teck is conducting under EPA oversight.](#) The BERA evaluates risk (e.g., the potential for adverse effects) to wildlife on land and in water.

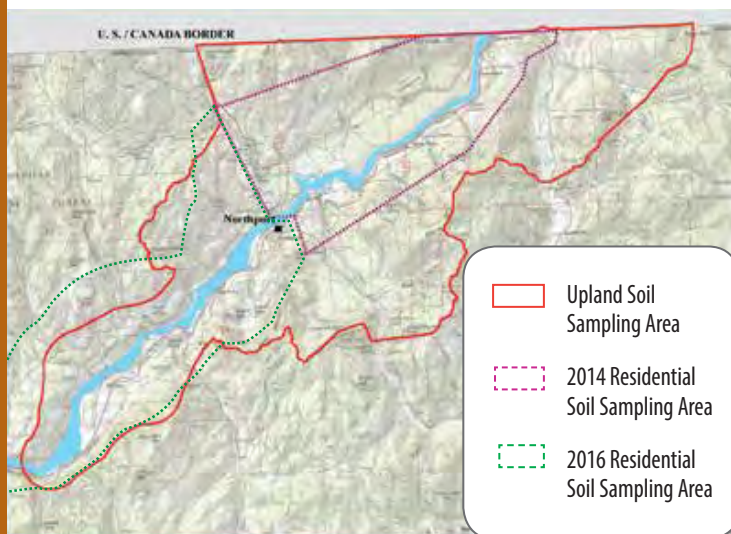
Sediment Sampling

A key question is whether slag containing various amounts of residual metals discharged into the Columbia River presents an unacceptable risk to the ecological health of the UCR Site. The movement of this material is a dynamic, on-going process as river flows cause erosion, repeatedly suspending sediment in the water.

[To assess ecological risk, two phases of sediment sampling are complete. A third sediment study began in 2018.](#)

Phase 3 activities focus on the area between Marcus and the Canadian border, which is approximately 40 river miles.

Residential and Upland Soil Sampling Areas



Source: EPA Region 10.

Investigators are primarily interested in assessing whether there are unacceptable risks to the river's benthic invertebrate community (aquatic sediment-dwelling bugs such as mayflies, mussels and crayfish) from exposure to metals and other chemicals. Investigations include:

- **Sediment sampling** to measure concentrations of metals and other chemicals,
- **Porewater sampling**, the water between the grains of sediment in the river, to measure metals in sediment leaching into porewater, and
- **Bioassays** to evaluate risks to organisms that come into contact with sediment or porewater through ingestion.

Phase 3 sampling will build on previous studies with additional sediment sampling, porewater sampling, and bioassays. Two new features will include:

- **Sediment Facies Mapping** to better characterize sediment bed attributes, and
- **A Benthic Invertebrate Community Survey** to better understand the composition and diversity of benthic communities.

Upland Soil Sampling

[In 2014, upland soil sampling was conducted in a 100-square-mile area from the U.S./Canada border south to approximately China Bend.](#)

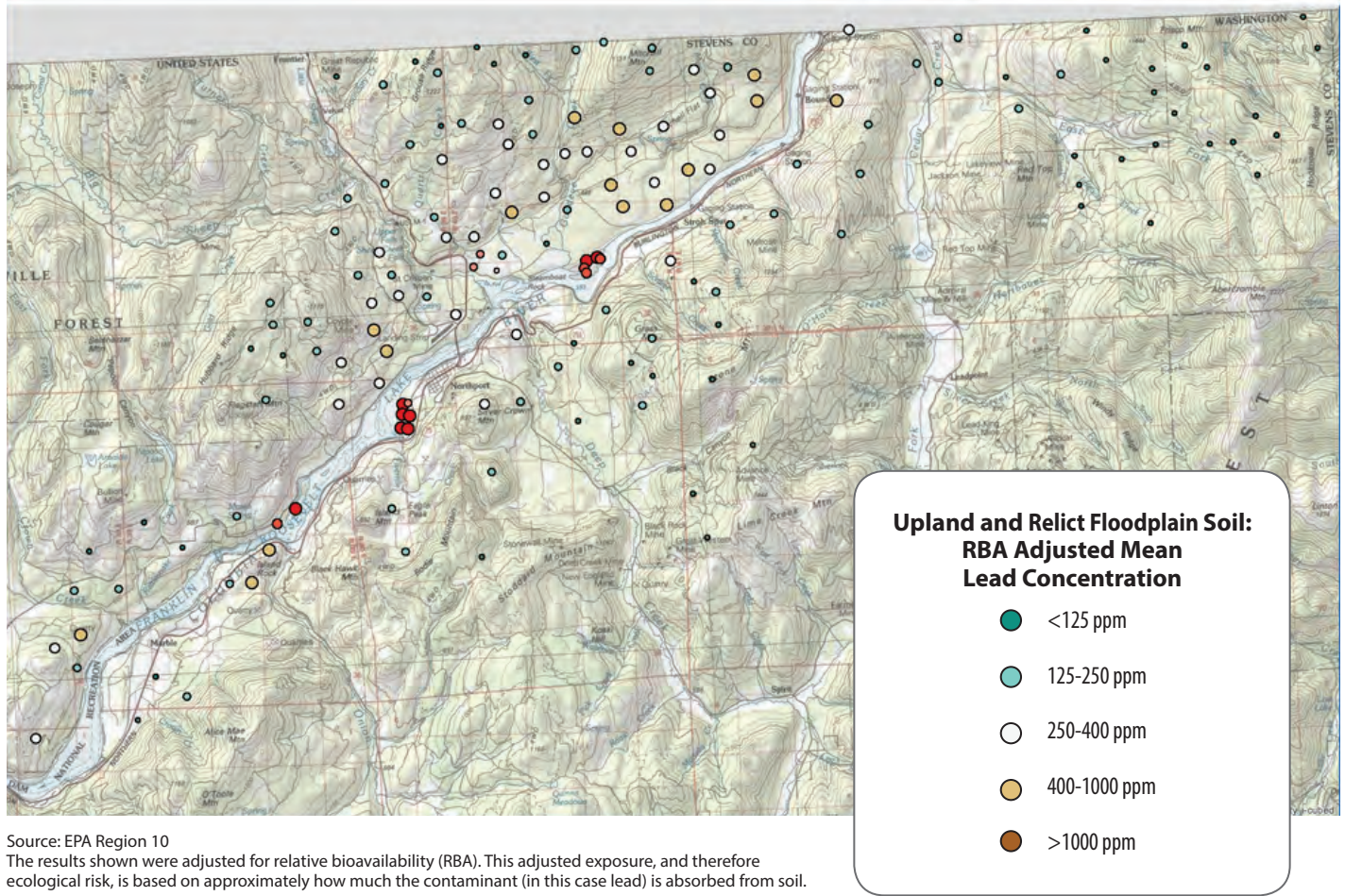
The study assessed concentrations of metals in the soil, the nature and extent of possible contamination, and whether metals found in soils present an unacceptable ecological risk. As with residential soil sampling, EPA considers aerial deposition (emissions that become air and windborne before coming to rest in the area shown) from the Trail Smelter a source of metals contamination in this area.

The area selected for upland soil sampling was larger than that for residential soil sampling. And in contrast to residential soil sampling, the upland soil sampling was three inches rather than one inch in depth.

The Upland Soil and Relict Floodplains Soil Sampling map shows lead concentration results. Relict floodplains are areas that were flooded under past free-flowing river conditions but are expected to flood less or not at all with current lake management controls.

In general terms, concentrations of lead reported for upland soil sampling were less than residential samples, which were based on different objectives and sampling design.

Upland and Relict Floodplain Soil Sampling: Lead Concentrations



RELATED ACTIVITIES

Legal Actions

Ongoing legal actions continue in United States federal court involving the Colville Confederated Tribes, the State of Washington, and Teck. They address concerns beyond Teck's 2006 Settlement Agreement with EPA to conduct the UCR RI/FS. Actions seek to ensure legal obligations for performing investigations, appropriate cleanups, and addressing natural resource injury claims under all aspects of United States environmental laws are met. More details can be found in the 2011 Public Guide, by contacting parties participating in the litigation, or by visiting [Ecology's Upper Columbia River Lake Roosevelt web site](#).

Natural Resource Trustees

The UCR Natural Resource Trustee Council was established to determine past and ongoing natural resource injuries with the goal of restoring or replacing the injured resources for the public. Their focus is investigating injury to natural resources caused by Trail Smelter pollution along the Upper Columbia River. The Trustees at the UCR Site are the State of Washington, Confederated Tribes of the Colville Reservation, Spokane Tribe of Indians, and U.S. Department of the Interior.

Trustees may bring claims to restore or replace injured public resources managed by state, tribe, and federal resource management agencies. Potentially injured natural resources evaluated include lands, fish, birds, other wildlife, biota, water, groundwater, associated uses, and tribal resources. The Trustee Council continues to conduct natural resource injury assessment work that is separate and independent of the EPA RI/FS activities. More details can be found in the 2011 Public Guide, by contacting the Trustee Council or by [visiting Ecology's Upper Columbia River Lake Roosevelt web site](#).



Committed to the
environmental and economic
well being of our communities

Lake Roosevelt Forum Members

Area Residents and Communities
Bonneville Power Administration
Bureau of Reclamation
Colville Confederated Tribes
Ferry County
Lincoln County
National Park Service
Spokane Tribe of Indians
Stevens County
Upper Columbia United Tribes
Washington Department of Ecology
Washington Department of Fish and Wildlife

Stay Informed

The Upper Columbia River (UCR) Remedial Investigation and Feasibility Study (RI/FS) investigation is very complex, spans hundreds of square miles, and is occurring over many years. In 2006, the United States reached an agreement with Teck Cominco Metals Ltd. (now called Teck Metals Ltd.) to conduct the RI/FS. Studying the issues of concern, however, began many years before and helps inform current activities.

Under this agreement, EPA oversees all RI/FS activities to ensure that they meet regulatory standards. EPA decisions are made with input by the UCR "Participating Parties." These include the Colville Confederated Tribes, the Spokane Tribe of Indians, the State of Washington (represented by the Washington Department of Ecology), and the U.S. Department of the Interior. Interior agencies include the Bureau of Reclamation, the National Park Service, Bureau of Indian Affairs, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey. Although not listed in the agreement, the Washington State Department of Health is also consulted.

Here are web sites that provide on-going information, including links to studies and related resources.

Lake Roosevelt Forum

Updates, sign-up for electronic newsletter, and general information: www.lrf.org

Copies of print newsletters: www.lrf.org/about-the-forum/newsletters

Electronic version of the Public Guide, including direct links to resources: www.lrf.org/2019publicguide

Environmental Protection Agency (EPA):

www.epa.gov/columbiariver/upper-columbia-river-remedial-investigation-feasibility-study

Washington Department of Ecology: <https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=12125>

Teck: www.ucr-rifs.com

United States Geological Survey: <https://www.usgs.gov/centers/wa-water/publications>

Washington Department of Health: www.doh.wa.gov/fish

Citizens for a Clean Columbia: www.cleancolumbia.org

EPA also maintains document repositories at Northport Town Hall, the Colville Public Library, Inchelium Tribal Resource Center, Nespelem Office of Environmental Trust, Grand Coulee Library, Wellpinit, and the Spokane Library.

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