May 1996

Summary Report
Draft Buffalo Slough Risk Assessment

Columbia Slough Sediment Project
(Columbia Slough Sediment
Remedial Investigation/Feasibility Study)

City of Portland
Bureau of Environmental Services

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Section 1

Introduction

The **Buffalo Slough Risk Assessment** evaluates risks to humans, wildlife, and aquatic life from exposure to contaminated sediments in Buffalo Slough. It is part of the Columbia Slough Sediment Project being conducted by the City of Portland's Bureau of Environmental Services, as required by the Oregon Department of Environmental Quality.

This summary report describes the methods and findings presented in the Buffalo Slough Risk Assessment draft report. First, it explains the relationship of the risk assessment to other studies. Next it describes how samples were collected from Buffalo Slough and analyzed for contamination. It then discusses how risks to human health, wildlife, and aquatic organisms are evaluated and summarizes the results. Finally, next steps are outlined.

Results At A Glance

- *Eating fish caught in Buffalo Slough may pose an increased human cancer risk of up to 1 in 1,000. This finding is consistent with the current health advisory against eating fish caught throughout the Columbia Slough.*
- *Noncancer risks to humans from eating Buffalo Slough fish are slightly above levels of concern.*
- *The primary chemicals of concern for cancer risks are PCBs, arsenic, and chlordane. For noncancer risks, the chemicals of concern are chlordane and mercury.*
- *Risks to great blue herons and river otters from eating Buffalo Slough fish and sediments are negligible. (Herons and otters are used as representative wildlife species for the study.)*
- *Benthic (sediment-dwelling) organisms may be at significant risk from chemicals in Buffalo Slough. The chemicals of most concern are lead, copper, zinc, cobalt, and possibly toxaphene.*

Where Is Buffalo Slough?

Buffalo Slough (also known as Broadmoor Lake) is part of the Columbia Slough system--an 18-mile stretch of shallow waterways and lakes in the Columbia River floodplain. Buffalo Slough is approximately 1 mile long and is connected at its west end to the Middle Columbia Slough Reach. It is divided into four sub-basins, which are separated by earth-filled dikes and connected by submerged culverts. Buffalo Slough is surrounded by commercial, residential, and recreational land uses.

Like other parts of the Columbia Slough, Buffalo Slough is polluted. Various contaminants are found in its waters and sediments. They come from a variety of sources, and pose potential risks to both humans and the environment.

What Are Sediments And How Do They Become Contaminated?

Sediments are the materials on the bottom of the Slough. They are composed of many natural materials (such as sand, soil, clay, small gravel, and organic matter), as well as contaminated particles that wash into the Slough and settle to the bottom.

Sediments can also become contaminated when chemicals that enter the Slough become attached to them by various chemical and physical processes. Once the sediments are contaminated, they can in turn contaminate the water around them as some of the chemicals are released back into the water.

How Does The Buffalo Slough Risk Assessment Relate To Other Studies?

The Buffalo Slough Risk Assessment is one element of the Columbia Slough Sediment Project. It builds on the results of a previous project element, called the Screening Level Risk Assessment (SLRA). The following overview and Figure 2 explain this relationship.

The Columbia Slough Sediment Project has the following goals:

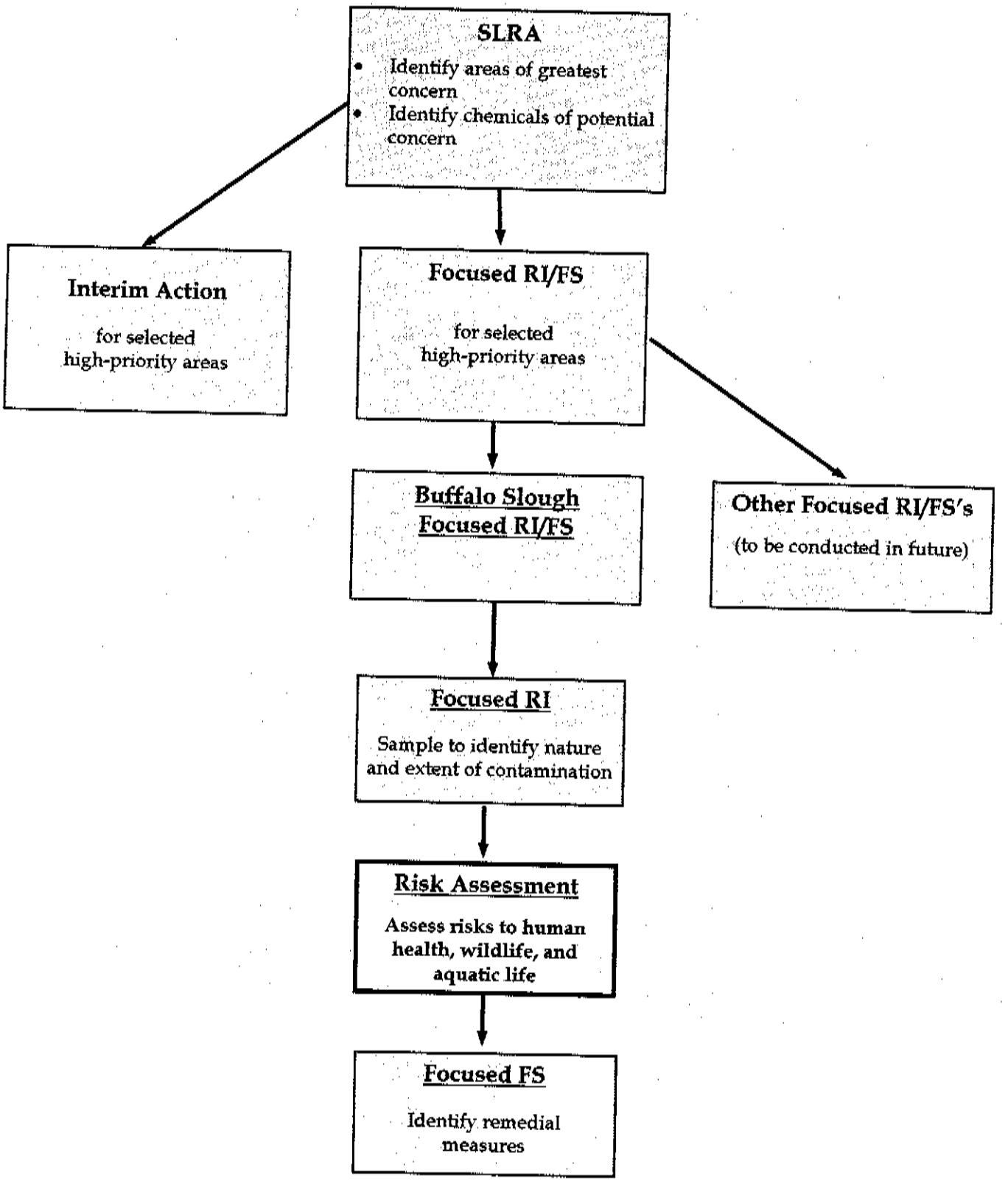
- Determine the extent of contamination in Slough sediments
- Identify specific contaminants of concern
- Evaluate risks to human health and the environment
- Identify cleanup options, targeting the most severe problems first

The Screening Level Risk Assessment was conducted in 1994 and 1995 to provide an initial "screening" of the Columbia Slough. It evaluated 300 sites to determine the type and level of contamination present. Based on the results, 16 general areas were identified as posing the greatest risk to humans, wildlife, and aquatic life.

Interim actions are now being implemented for some of these 16 high-priority areas. These are short-term actions (such as source control and signage) taken to reduce human exposure to potential risk. For other areas, a more detailed followup study (called a focused Remedial Investigation and Feasibility Study, or focused RI/FS) is being conducted. Buffalo Slough was selected for a focused RI/FS because of its relatively high potential risks and its proximity to residential, commercial, and recreational areas.

The Buffalo Slough Risk Assessment is one part of the focused RI/FS. It provides a detailed evaluation of the risks posed to humans, wildlife, and aquatic life from contact with Buffalo Slough sediments. This information will be used to help identify the most feasible and appropriate remedial measures for Buffalo Slough.

Figure 2
Columbia Slough Sediment Project Process



A Detailed Look at Risks

The Buffalo Slough Risk Assessment provides a more detailed look at risks than the Screening Level Risk Assessment.

- *It uses extensive new data on Buffalo Slough chemical concentrations.*
- *It considers conditions specific to Buffalo Slough. For example, it assumes that river otters feed only about 5 percent of the time from Buffalo Slough compared with other areas within their home range.*
- *It looks at a range of possible exposures and risks. For example, it estimates the average risk that most people are likely to experience, as well as the highest ("worst-case") risk that has a 5 percent chance of occurring. This provides a more comprehensive understanding of risk probabilities.*

Even with this more detailed approach, some uncertainties are still inherent in the risk assessment process. It is not always known how chemical exposure may affect people or animals. The Buffalo Slough Risk Assessment includes a margin of error to compensate for these uncertainties to the extent possible.

Section 2

Sampling Buffalo Slough

Sampling for the Buffalo Slough Risk Assessment was conducted in late summer 1995. Samples were taken from sediments, pore water (the water between sediment particles), and fish tissue. The samples were then analyzed to determine the types and levels of chemicals they contained.

- **Sediments** were sampled from 49 locations throughout Buffalo Slough. This included both surface sediments (at the top of the sediment layer) and at-depth sediments. The sediments were analyzed for 62 "chemicals of potential concern"--those chemicals identified in the Screening Level Risk Assessment as posing a potential risk.

- **Pore water** was sampled at 13 locations throughout Buffalo Slough. The samples were analyzed for 32 chemicals of potential concern.

- **Fish tissue** was analyzed from five carp. Carp were selected for analysis because carp tissue is generally fattier than other fish, so it tends to accumulate organic chemicals to a larger extent. In addition, carp are abundant in the Columbia Slough and are known to be caught and eaten.

  The fish tissue samples were analyzed for 39 chemicals of potential concern to human health and wildlife. The analysis looked at chemical concentrations in both the fillet and the whole body of the fish (which incudes fattier portions such as the skin and internal organs).

Section 3

Looking At Human Health Risks

The Buffalo Slough Risk Assessment evaluates human health risks associated with eating fish from Buffalo Slough. It also identifies which chemicals are of greatest concern. This section outlines the evaluation process that is used and summarizes the findings.

Who Is Exposed To The Contamination, And How?

People who eat fish caught from Buffalo Slough are exposed to contamination. Two groups of people are considered:

- People who eat only the fish fillets. This group is called the general population.
- People who eat the whole fish (including skin, internal organs, or head). This group is called the high-use population.

The Screening Level Risk Assessment also considered other possible kinds of human exposure: direct exposure to sediments (through skin contact or by accidentally eating small amounts of sediment) and exposure to contaminated water (through skin contact or by accidentally drinking small amounts of water). It found the risks from these kinds of exposure to be insignificant for Buffalo Slough. For that reason, the Buffalo Slough Risk Assessment does not consider them further.

How Much Contamination Are People Exposed To?

The Buffalo Slough Risk Assessment calculates the average daily "dose" of each chemical that a person may get from eating contaminated fish. The calculations are based on:

- The **chemical concentration:** how much of the chemical is contained in the fish tissue--either the fillet for the general population or the whole fish for the high-use population
- The **ingestion rate:** the average number of 8-ounce (1/2-pound) meals a person eats each year
- The **length of exposure:** the number of years a person eats Buffalo Slough fish

The Screening Level Risk Assessment calculated risks by looking at only one level of exposure to contaminants. It assumed that the entire exposed human population ate a certain amount of fish containing a certain chemical concentration. The risk calculations were based on that single level of exposure.

The Buffalo Slough Risk Assessment, on the other hand, looks at a range of exposure that people may reasonably experience. It assumes that people may eat varying amounts of fish, containing varying chemical concentrations. This approach makes it possible to look at a range of risk levels, based on different exposure assumptions. For example, risks can be estimated for the average exposure that is most likely to occur, as well as for the highest ("worst-case") exposure that has a 5 percent chance of occurring.

How Toxic Are The Chemicals?

A chemical's toxicity is its potential to cause health effects in exposed individuals. In other words, it is a measure of how harmful a chemical is at certain doses over a long period of time.

The assessment evaluates the chemicals of potential concern to humans to determine their potential for causing both carcinogenic (cancer-causing) and

noncarcinogenic (noncancer) health effects. (Noncancer health effects can include such things as blood disorders or neurological impairment.)

How Are Potential Health Risks Determined?

Noncancer risks to human health are determined by comparing the estimated exposure ("dose") with the "safe" dose. (A dose is considered safe if daily exposure to it over a long period of time is not likely to have harmful effects to the human population, including sensitive subpopulations.)

Cancer risks are expressed as the probability of developing cancer during a lifetime. For example, a certain dose of a chemical may result in an increased cancer risk of 1 in 100,000. This means that if 100,000 people were exposed to the chemical at that level, one of them might develop cancer during his or her lifetime as a result of that exposure. (Another way to think of it is that a person exposed to the chemical at that level would have 1 chance in 100,000 of developing cancer.) These risks are in addition to the "background" risk of cancer, which in the United States is about one chance in three of developing cancer over a lifetime.

In estimating the health risks, it is assumed that a person is exposed to all of the chemicals present in the fish, and that the effect of the chemicals is additive (that is, the risks from all the chemicals are added together).

Results

Cancer Risks

- People who regularly eat fish from Buffalo Slough may have an increased cancer risk of between 1 in 10,000 and 1 in 1,000. "Regularly" is defined as one 8-ounce (1/2-pound) serving every 1 to 2 weeks over a 30-year period.

- People who eat fish from Buffalo Slough less often, or over a shorter period of time, have

a proportionately lower cancer risk. For example, the cancer risk decreases to between 1 in 100,000 and 1 in 10,000 for people who eat one to two 8-ounce servings per year over 30 years or one 8-ounce serving every 1 to 2 weeks for 1 year.

- The risk of cancer is about twice as great for the high-use population (people who eat the whole fish) as for the general population (people who eat just the fish fillet).

- The worst-case risks (with a 5 percent chance of occurring) are 1-1/2 to 2 times higher than the average risks.

- The primary chemicals of concern, accounting for 93 percent of the total cancer risks, are PCBs, chlordane, and arsenic. The chemicals contributing to the remaining 7 percent of the cancer risks are dieldrin, beryllium, mercury, DDD/DDE, 3'3-dichlorobenzidine, heptachlorepoxide, and beta-BHC. PCBs, chlordane, DDD/DDE, and dieldrin are now banned from use in the United States, so the potential risks are from past contamination. (See Appendix 1 for more information about chemicals of concern.)

Noncancer Risks

- Noncancer risks from eating Buffalo Slough fish are slightly above levels of concern, for both the general population and the high-use population.

- The chemicals of concern for noncancer risks are mercury and chlordane.

- The worst-case risks are 1-1/2 to 8 times higher than the average risks.

Section 4

Looking At Risks To Wildlife

The Buffalo Slough Risk Assessment evaluates risks to wildlife from exposure to Buffalo Slough fish and sediments. It also identifies which chemicals are of greatest concern. This section outlines the evaluation process that is used and summarizes the findings.

What Wildlife Is Exposed To The Contamination?

A wide variety of wildlife, including amphibians, reptiles, birds, and mammals, use Buffalo Slough and the surrounding habitat. For the Buffalo Slough Risk Assessment, two species that have the highest potential exposure to sediment-related contamination are used as "representative" wildlife species: river otters and great blue herons.

River otters were selected because they are the only mammal in the Buffalo Slough area that feeds predominantly on fish. Fish-eating wildlife are assumed to receive higher chemical doses than other wildlife that consume a combination of fish, invertebrates, and plants. This is because fish are at the top of the aquatic food chain and therefore accumulate the highest concentrations of chemicals in their tissues.

Great blue herons were also selected because they feed primarily on fish. In addition, they are year-round residents of Buffalo Slough, in contrast to bald eagles, which feed over a large area.

Studying the risks to highly exposed mammal and bird species helps ensure that wildlife with lower exposures will also be protected.

How Is The Wildlife Exposed?

The Buffalo Slough Risk Assessment assumes that otters and herons are exposed to contamination from eating fish and from accidentally swallowing sediments. Both surface sediments (at the top of the sediment layer) and at-depth sediments (which may be exposed during storms, dredging, or other future events) are considered.

The Screening Level Risk Assessment looked at exposure from eating crayfish and from drinking Slough water, as well, but found the risks to be insignificant for Buffalo Slough. For that reason, the Buffalo Slough Risk Assessment does not further consider those types of exposure.

How Much Contamination Is The Wildlife Exposed To?

The Buffalo Slough Risk Assessment calculates the chemical "dose" that herons and otters may get from eating fish and sediments. These calculations are based on:

- The **chemical concentration** in the fish or sediments. It is assumed that the chemical concentrations are 100 percent *bioavailable* to wildlife (that is, they are completely absorbed by the wildlife when ingested).
- The **ingestion rate** (the amount of fish and sediments eaten)

  The **percentage of diet** that is made up of fish and sediments
- The **area use factor** (how much time the heron and otter feed in Buffalo Slough compared with other areas in their home range)

The Screening Level Risk Assessment calculated risks by looking at only one level of exposure to contaminants. In other words, it was assumed that all otters (and, similarly, all herons) receive the same dose of chemicals. The risk calculations were based on that single level of exposure.

The Buffalo Slough Risk Assessment, on the other hand, looks at a range of exposure. It considers varying ingestion rates and chemical concentrations, and estimates risks for these different exposure levels. This approach makes it possible to estimate risks for the average exposure that is most likely to occur, as well as for the highest (worst-case) exposure that has a 5 percent chance of occurring.

How Toxic Are The Chemicals?

A chemical concentration is assumed to be "safe" if long-term exposure to it would have no adverse effects on the survival of the population, such as effects on reproduction or development. The risk assessment identifies safe levels for all of the chemicals of potential concern.

How Are Potential Risks Determined?

Risks to wildlife are determined by comparing the estimated exposure ("dose") with the safe dose.

In estimating risks, it is assumed that herons and otters are exposed to all of the chemicals present in the fish and sediments, and that the effect of the chemicals is additive (that is, the risks from all the chemicals are added together).

Results

- There are no significant risks to great blue herons and river otters from eating Buffalo Slough fish or surface sediments.
- There are no significant risks to herons and otters from possible future ingestion of at-depth sediments (which are currently buried).
- The worst-case risks to herons and otters (with a 5 percent chance of occurring) are 1-1/2 to 2 times higher than the average risks. However, they are still below levels of concern.

Section 5

Looking At Risks To The Benthic Community

The Buffalo Slough Risk Assessment evaluates risks to benthic organisms from exposure to pore water (the water between sediment particles) in Buffalo Slough. It also identifies which chemicals are of greatest concern. This section outlines the evaluation process that is used and summarizes the findings.

What Organisms Are Exposed To The Contamination?

Benthic organisms are bottom-dwelling organisms that live within sediments. They include midges, worms, and mollusks (for example, clams). Assessing risks to benthic organisms is important because they are a major food source for fish and other aquatic life. Chemicals contained in benthic organisms will be passed along the food chain to larger fish, birds, wildlife, and humans.

The Screening Level Risk Assessment found negligible risks to "water column organisms" (fish, invertebrates such as water fleas and snails, and aquatic plants) that live in Columbia Slough waters. Those organisms are therefore not further considered in the Buffalo Slough Risk Assessment.

How Are Benthic Organisms Exposed?

Benthic organisms are exposed to contamination in the pore water between sediment particles. Exposure occurs through respiration (breathing)

and ingesting sediments. Both surface sediments and at-depth sediments are considered.

How Much Contamination Are Benthic Organisms Exposed To?

All benthic organisms are assumed to have chronic (long-term) exposure to the chemical concentrations in the water. Acute (short-term) risks are also assessed to evaluate short-term exposure to possible localized "hot spots."

It is assumed that the chemical concentrations are 100 percent *bioavailable* to the organisms.

The Screening Level Risk Assessment calculated risks by assuming that all benthic organisms are exposed to the same chemical concentrations in pore water. The Buffalo Slough Risk Assessment, on the other hand, looks at a range of exposure. It recognizes that chemical concentrations vary throughout Buffalo Slough, resulting in varying levels of exposure. It therefore estimates risks for both the average exposure that is most likely to occur, as well as for the highest (worst-case) exposure that has a 5 percent chance of occurring.

How Toxic Are The Chemicals?

A chemical concentration is assumed to be safe if exposure to it would produce no adverse effects on 95 percent of the species in the benthic community. (Adverse effects include effects on growth, survival, and reproduction during sensitive stages in the life cycle.) The risk assessment identifies safe levels for all of the chemicals of potential concern.

How Are Potential Risks Determined?

Risks to the benthic community are determined by comparing the exposure of the organisms (that is, the chemical concentration in the water) to the safe exposure concentration.

It is assumed that the organisms are exposed to all of the chemicals present in the water, and that the effect of certain groups of chemicals is additive (that is, the risks from these chemicals are added together).

Results

- Chronic (long-term) exposure to sediment pore water may pose significant risks to benthic organisms.
- The primary chemicals contributing to chronic benthic risks are lead, copper, zinc, cobalt, and possibly toxaphene.
- Acute (short-term) risks are identified for lead, copper, and zinc. However, acute risks are, on average, 10 times lower than chronic risks.
- Chemicals are relatively evenly distributed throughout the four Buffalo Slough sub-basins. As a result, estimated risk levels are approximately equal in the four subbasins.
- Chemicals are relatively evenly distributed throughout surface sediments and at-depth sediments. As a result, estimated risk levels are approximately equal from exposure to surface sediments and from potential future exposure to sediments that are currently buried.
- The worst-case risks to benthic organisms (with a 5 percent chance of occurring) are 3 to 4 times higher than the average risks.

Section 6

What Happens Next?

The Buffalo Slough Risk Assessment is part of the focused Remedial Investigation and Feasibility Study for Buffalo Slough. The next steps in the focused RI/FS process are:

- The Remedial Investigation report will be reviewed by the Oregon Department of Environmental Quality (DEQ), other regulatory and resource agencies, and interested citizens.
- The Buffalo Slough Risk Assessment report will be reviewed by DEQ, regulatory and resource agencies, and interested citizens.
- The results of the Buffalo Slough Risk Assessment will be used in the focused Feasibility Study, which will identify appropriate and feasible remedial measures for Buffalo Slough.

For More Information

If you would like a copy of the draft report for the Buffalo Slough Risk Assessment, or want more information about this or other aspects of the Columbia Slough Sediment Project, please contact:

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Appendix 1

Chemicals Of Concern To Human Health

The primary chemicals of concern, accounting for 93 percent of the total human cancer risks, are PCBs, chlordane, and arsenic. These chemicals, and their percent contribution, are described below.

The chemicals contributing to the remaining 7 percent of the cancer risks are dieldrin, beryllium, mercury, DDD/DDE, 3'3-dichlorobenzidine, heptachlorepoxide, and beta-BHC.

Arsenic (12%): A naturally occurring element that is ubiquitous in the environment at low levels. Arsenic has also been used commercially as a wood preservative, insecticide, and herbicide. Fish and shellfish can build up arsenic in their tissues in an organic form that is not very toxic. Long-term exposure to the inorganic form of arsenic may cause cancer and other health problems.

Chlordane (13%): An organochlorine pesticide used extensively in the U.S. until it was banned for most applications in 1988. Before 1978, it was used on agricultural crops, lawns, and gardens. Because of health concerns, EPA canceled the use of chlordane on food crops and phased out most other uses over the next 5 years. From 1983 until 1988, chlordane's only approved use was to control termites in houses. Although all approved uses of chlordane were stopped in the U.S. in 1988, it is still manufactured for export.

Because of its persistence and wide use, chlordane is still commonly found in the environment. It can enter the food chain and become more concentrated in higher level consumers, such as fish. Fish concentrations can sometimes be high enough to pose a health risk to fish consumers.

PCBs (68%): Polychlorinated Biphenyls (PCBs) are mixtures of chemicals used as insulators in transformers and other electrical equipment. The manufacture of PCBs was banned in 1977, but the chemicals can still be found in pre-1977 products. Since PCBs do not break down easily, they can persist in the environment. Exposure to PCBs has been shown to have a wide range of health effects, including cancer. Pregnant women and nursing mothers are at particular risk.

Appendix 2

A Guide To The Buffalo Slough Risk Assessment Draft Report

People who would like more information about the Buffalo Slough Risk Assessment may want to read the full draft report. This guide is provided to help understand that report.

Terminology

The full report is called the *Endangerment Assessment for Buffalo Slough.* It is called an Endangerment Assessment because it includes the results of both the Screening Level Risk Assessment and the more detailed risk assessment conducted specifically for Buffalo Slough. In the full report, the more detailed risk assessment is called the "baseline risk assessment." In this summary report, it is called the "Buffalo Slough Risk Assessment."

ENDANGERMENT ASSESSMENT =

SCREENING LEVEL RISK ASSESSMENT

+

BASELINE RISK ASSESSMENT
(BUFFALO SLOUGH RISK ASSESSMENT)

The Risk Assessment Process

The risk assessment process has four major steps, which are summarized below. Some of the key terms used in the report are also shown.

Step 1: Problem Formulation

- **Who or what is exposed to the contamination?**
  *These are called **receptors**. They include humans, wildlife, and benthic organisms.*

- **How are the receptors exposed to the contamination?**
  *Contamination occurs in various **environmental media** (for example, sediments, fish tissue, and pore water). Receptors can be exposed to these environmental media in a number of ways, such as eating fish or ingesting sediments. These are called **exposure pathways**.*

- **What chemicals are of potential concern?**
  ***Chemicals of potential concern** are those chemicals that pose a possible risk to human health, wildlife, or benthic organisms.*

Step 2: Exposure Assessment

- **How much contamination are the receptors exposed to?**
  *The amount of exposure depends on a number of factors, including the **concentration** of chemicals in the environmental media, the **ingestion rate**, the **length of exposure**, and the **area use factor**.*

Step 3: Toxicity Assessment Or Ecological Effects Characterization

- **How toxic are the contaminants? What "doses" may cause harmful effects?**
  *For humans, a **toxicity assessment** is conducted to find this information. For wildlife and benthic organisms, it is called an **ecological effects characterization**.*

Step 4: Risk Characterization

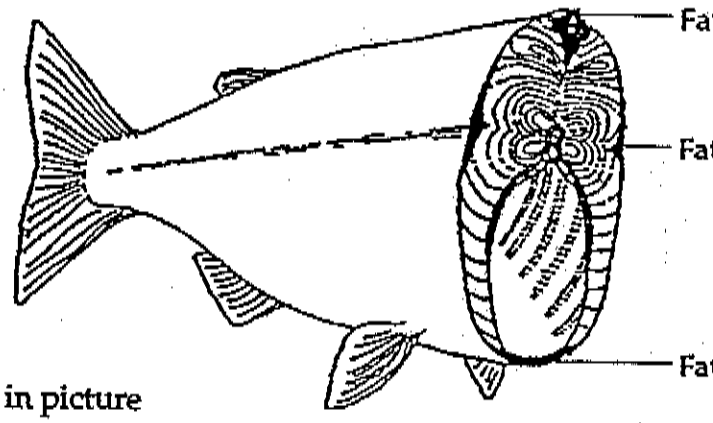
- **What are the potential risks to the receptors?**
  *In the **risk characterization**, the results of Step 2 (exposure) and Step 3 (toxicity) are compared to provide numerical estimates of risk. The risks to wildlife and benthic organisms, and the noncarcinogenic risks to humans, are presented as **hazard quotients**. Cancer risks to humans are expressed as **excess cancer risks** (the probability of developing cancer during a lifetime, in excess of the "background" incidence of cancer).*

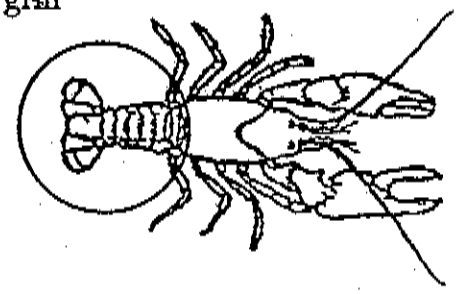
Contaminated Fish Have Been Found In The Columbia Slough

City of Portland tests have shown DDE/DDT and PCBs in fish caught in the Columbia Slough. These chemicals may cause cancer and other health effects and can be particularly harmful for children and pregnant and nursing women. Health officials recommend that people avoid eating fish from the Columbia Slough.

To be cautious, we recommend that you do not eat the fish caught from the Columbia Slough. However, if you choose to eat fish from the Slough, you should take the following safety precautions:

- Eat slough fish less often
- Keep and eat smaller, younger fish
- Eat smaller portions
- Discard all internal organs
- Thoroughly cut away and discard fatty parts, and fillet fish before eating
- Remove all skin before cooking
- Do not eat raw fish meat
- Cut away fatty parts of fish, as shown in picture
- Thoroughly clean and trim fish if making stew or soup
- Bake or broil the skinned, trimmed fish on a rack or grill so more fat drips off, do not use any drippings
- If eating crayfish, eat only the tail meat





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ENVIRONMENTAL SERVICES
CITY OF PORTLAND
CLEAN RIVER WORKS

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