Lead Hazard
Reduction Program Report

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and
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Bureau of Water Works

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Executive Summary

Overview

This report provides a description of the proposed Lead Hazard Reduction Program that has been developed as an alternative to Lead and Copper Rule (LCR) requirements for corrosion control treatment and public education. The goal of this alternative approach is to achieve better public health protection from lead exposure, at an equivalent lower cost than would have been achieved with LCR requirements.

Background

In 1991, the EPA promulgated the Lead and Copper Rule. LCR requirements include corrosion control treatment to minimize lead and copper at the customer's tap. Such treatment would involve increasing the pH of Bull Run water from current levels of about 6.8 to 9.0-9.5, and increasing alkalinity from current levels of 6-12 mg/L to at least 25 mg/L as $CaCO_3$ (Montgomery Watson and EES, 1994).

In June 1994, the Portland City Council directed the Water Bureau to conduct a study to investigate alternatives for LCR compliance. Several pivotal conclusions of this study are:

Drinking water is not a major route of lead exposure in the Portland area. The median lead level in samples of running water from customers' taps is less than 1 ug/L (non-detectable).

Although water treatment would provide some reduction of lead and copper exposure through drinking water in the community, water treatment alone would not sufficiently reduce exposure in some homes with a very significant source of lead in water; and

The most significant source of lead exposure in the Portland metropolitan area is lead-based paint, and efforts focused on preventing exposures from this source could provide a significant health benefit to the community.

The proposed Lead Hazard Reduction Program presented in this report was developed in partnership with the Oregon Health Division; Multnomah, Washington and Clackamas County Health Departments, and the Water Managers Advisory Board.

Program Design Concepts

The goal of the Lead Hazard Reduction Program is to achieve better public health protection from lead exposure, at an equivalent or lower cost, than would have been achieved with the corrosion control treatment and public education requirements of the Lead and Copper Rule.

Interventions to reduce lead exposures should be targeted at those exposure pathways that have the greatest impact on the health of the child by reducing his or her body-lead burden (EPA, 1995). EPA has estimated that for a typical 2 year old child living in an urban environment, or in a non-urban house with interior lead-based paint, household dust and soil accounts for over 90% of the child's daily intake of lead (EPA, 1995). In the Portland area, 60% of recent cases of elevated blood lead levels are believed to be related to exposure to lead-based paint.

As part of the LHRP, corrosion control treatment would be provided, but at a reduced level than that defined as optimal by the Lead and Copper Rule. The savings in capital and operating costs would be used to fund interventions that reduce lead exposures that would be expected to provide the greatest benefits to children at most risk.

The Lead Hazard Reduction Program should:

1. Be implemented throughout entire Bull Run service area

2. Focus efforts on those lead source and exposure pathways that would be expected to have the greatest impact on reducing a child's body lead burden

3. Focus efforts on those persons living within the Bull Run service area who are at most risk to significant lead exposure

4. Focus efforts on primary prevention

5. Focus on implementing feasible and cost-effective methods for reducing lead hazards

6. Supplement or complement efforts performed by other organizations with similar objectives, including state and county health agencies, and community-based groups

7. Develop and support community participation in lead hazard reduction efforts

8. Be evaluated on a regular basis for effectiveness in achieving objectives, and modified as necessary or desired to enhance effectiveness

9. Be developed in partnership with and supported by Oregon Health Division's Drinking Water program, State and County Health Departments, Portland's wholesale water customers, and interested organizations and individuals within the community, and other stakeholders

10. Be conducted to serve as a demonstration project for community lead hazard reduction efforts

nationwide.

Program Description

There are four main components to the Lead Hazard Reduction Program:

1. Water Treatment for Corrosion Control

Corrosion control treatment would consist of raising pH to about 7.3 in the distribution system, or slightly higher if necessary to meet copper action levels. It is estimated that this level of treatment would reduce lead levels in standing water by 40%, and copper levels by 55%. With this treatment, as also for the higher "optimal" level of treatment, the lead action level would likely not be met in Bull Run water systems.

This moderate increase in pH should provide substantial benefits related to decreased copper levels, including less copper discharged into the environment from wastewater treatment plants, and many fewer problems with blue staining of sinks and bathtubs. This treatment will also provide significant reductions in lead levels in standing water for those customers with a source(s) of lead in their water plumbing system.

2. Free Lead-in-Water Testing Program

The purpose of this component is to identify customers within the Bull Run service area that may be at significant risk from elevated lead levels in drinking water and assist them in reducing the risk of lead exposure from this source.

Two major activities are associated with this component. The first is modification and expansion of the Portland Water Bureau's free lead in water testing program. The program would be expanded to include customers within the entire Bull Run service area, but would probably be limited to customers living in homes with plumbing systems that are likely to be associated with significant risk for elevated lead in water levels.

The second activity would be providing assistance to customers with elevated lead levels. This assistance would, at least initially in the program, take the form of an offer of a home plumbing system inspection to determine the specific source of lead and to recommend practical and effective ways of reducing exposure.

3. Home Lead Hazard Reduction

The purpose of this component is to reduce actual or potential risks of significant lead exposure from lead-based paint and other sources in at-risk homes in highest risk neighborhoods. This component is a cornerstone activity in the LHRP and could become one of the most substantial lead hazard reduction projects undertaken in the country.

Data from the Oregon Childhood Lead Poisoning Prevention Project (OCLPPP) for

Multnomah County shows an strong positive relationship between increasing occurrence of elevated blood lead levels and increasing age of home. Prevalence of older homes and other risk factors would be used to identify highest risk neighborhoods within the service area. Within each high-risk neighborhood, a base of support would be developed for the LHRP. The neighborhood support groups assistance and advice would be sought throughout program implementation. Within each neighborhood, a survey will be conducted to identify significant non-residential lead exposure sources for children in the neighborhood.

Home lead risk evaluations would be offered to all eligible homes in the neighborhood. Several people from the neighborhood ("neighborhood peers") would be hired and trained to offer and conduct these evaluations.

These home lead risk evaluations will consist primarily of 1) completing a checklist of questions about the home that are relevant to estimating the level of lead risk exposure in the home, 2) collecting a sample of household dust and/or soil for laboratory analysis, and 3) in-home education of potential lead exposure risks. Blood lead level testing for children age 6 or younger will be offered through the OCLPPP program. A packet of information would be left at each eligible residence, whether or not a risk evaluation was accepted by the residents.

Recommendations for hazard reduction would be offered to tenants or property owners in which an actual or potential lead hazard was identified. A range of potential in-home interventions would be recommended based on the nature and extent of hazards identified, taking into account any relevant circumstances associated with the particular residence.

Recommendations would be consistent with HUD/EPA recommended treatments for lead-based maintenance and hazard control in rental housing, such as correcting conditions in which painted surfaces could produce lead dust, specialized cleaning, and covering bare residential soil and performing essential maintenance (HUD, 1995).

LHRP staff will encourage the resident or rental property owner to control the hazard as recommended by developing a workplan with the resident, and offering assistance in the form of training and/or basic supplies (such as protective plastic sheeting, tape, respirator, access to HEPA vacuum cleaner). Additional resources in the form of financial assistance to low income families may be provided if the ongoing implementation evaluation indicates that lack of financial assistance poses an obstacle to reducing lead hazards and no other avenues for assistance are available.

The "Community Mobilization Framework" (CMF) approach, used by the CDC in demonstration projects to prevent HIV infection in women and children (Person and Cotten, 1996), may be useful to consider for this project. The CMF includes becoming familiar with the organizations and individuals within the community to identify potential partners; asking them for support, ranging from simple endorsement to active participation in coalitions; and recruiting community residents ("peer networkers") to promote program messages and conduct intervention activities. This approach offers the potential advantages of 1) extending limited resources of single agencies; 2) maximizing exposure to program through collaboration; 3) building on unique strengths and access channels of organizations and individuals in the community; and 4) allowing agencies, such as state and county health departments to develop credible relationships with non-traditional community partners.

This component would be evaluated on an on-going basis to assess the program's effectiveness and would be modified as necessary for improvement.

4. Lead Exposure Prevention Education

The purpose of this component is to provide primary prevention of lead exposure through public education. The goal is to increase the awareness of the entire community about lead health risks and make special efforts to effectively provide relevant information to those at greatest risk of lead exposure. A well designed and implemented public education program has the potential to be the most effective means of preventing lead exposure.

The proposed education program would be more effective than the required LCR program in preventing significant lead exposures in the community for a number of reasons. Messages delivered in this program address multiple potential sources of lead exposure, not just water. Message would be delivered to a large set of target audiences, the most important of which may be those providing general care and health care to young children. Also, a Lead Hazard Reduction Information Center would be developed and operated as part of this program.

Administration

The proposed administrative structure of the Lead Hazard Reduction Program is shown in Exhibit ES-1.

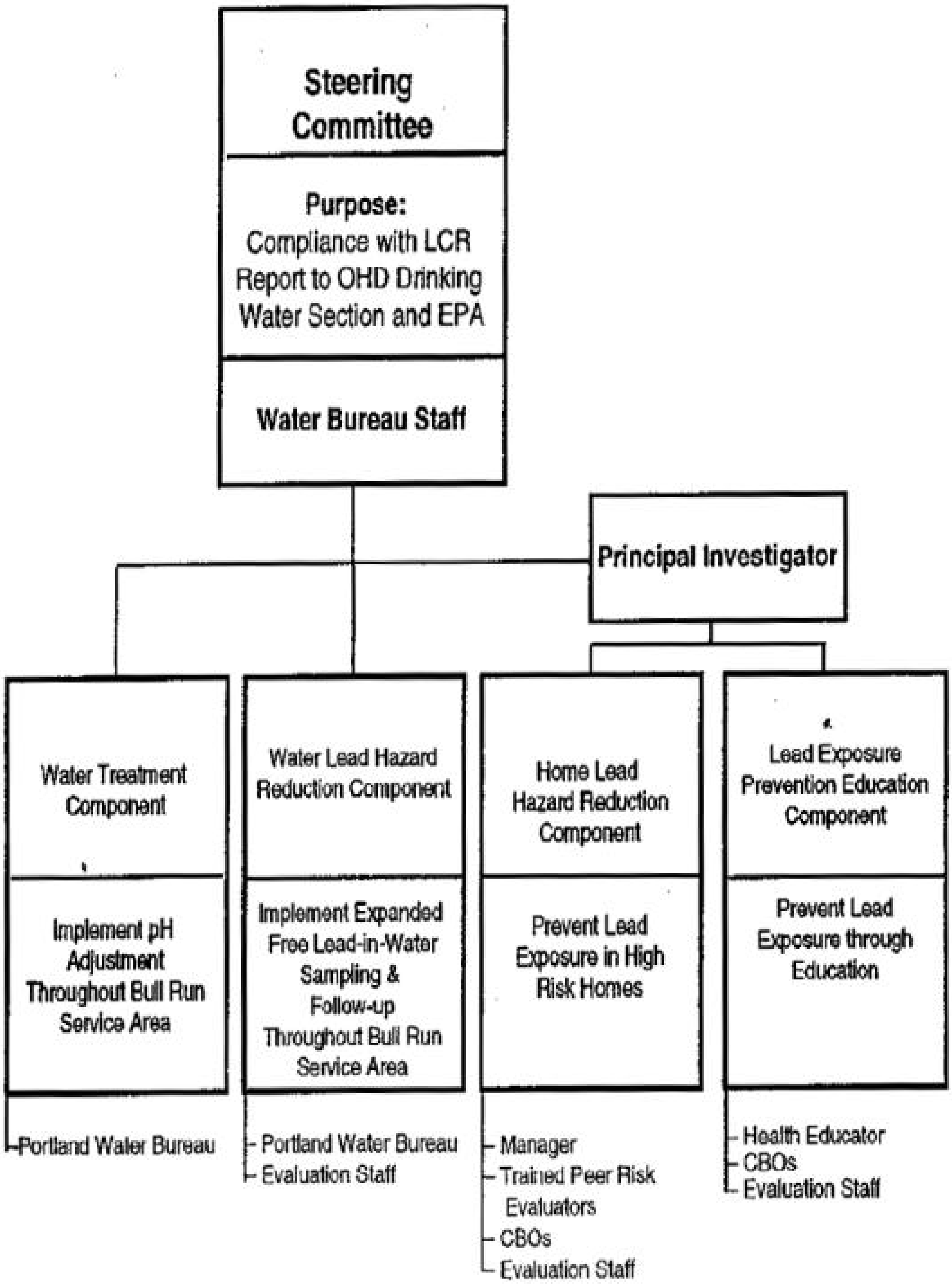
A steering committee will be developed to ensure that the objectives of the Lead Hazard Reduction Program are met. The steering committee should include representatives from the Portland Water Bureau, Water Managers Advisory Board, Oregon Health Division Occupational, Environmental and Injury Epidemiology (OEI-EPI) Section, Multnomah County Health Department, Washington County Health Department, Clackamas County Health Department, OHD/Multnomah County Program Design and Evaluation Services (PDES) Staff, and representatives from community based organizations. A program manager will be designated by the Water Bureau to ensure that regulatory requirements are met throughout the LHRP.

The Water Treatment Component and the Lead-in-Water Testing Component would be conducted by the Water Bureau. The PDES staff will evaluate the effectiveness of the lead-in-water testing component.

A Principal Investigator will be responsible for the Home Lead Hazard Reduction Component and the Lead Exposure Prevention Education component. The Home Lead Hazard Reduction Component will be carried out by a Manager and a group of trained neighborhood peers who will conduct much of the field work. The Lead Exposure Prevention Education component will be carried out by a health educator and community based organizations (CBOs). The activities for both these components will be evaluated by the PDES staff.

Contractual arrangements in the form of interagency agreements will be used to establish the working relationships and will include detailed workplans and budgets.

Exhibit ES-1
Responsibilities by Component



Budget

A five year budget for this program has been developed and is summarized in Table ES-1.

Table ES-1
Preliminary Cost Estimates for Lead Hazard Reduction Program

Component	1996	1997	1998	1999	2000	2001
Water Treatment	$1,210,000	392,000	407,680	423,987	440,947	458,585
Water Lead Hazard Reduction		75,000	104,000	108,160	112,486	116,986
Home Lead Hazard Reduction		314,000	434,000	451,360	469,414	488,191
Prevention Education		218,000	167,700	174,408	181,384	188,640
Oversight		55,000	40,000	41,600	43,264	59,995
TOTAL LHRP	1,210,000	1,054,000	1,153,380	1,199,515	1,247,496	1,312,396
LCR Approach	3,210,000	1,310,520	1,362,941	1,417,458	1,474,157	1,533,123
LHRP Savings	2,000,000	256,520	209,561	217,943	226,661	220,727

The LCR required approach is estimated to cost an additional $2.00 million in capital costs and an additional $200,000 or more per year to operate as compared to the Lead Hazard Reduction Program.

Section 1
Introduction

1.1 The Lead and Copper Rule

In 1991, EPA promulgated the Lead and Copper Rule (LCR) to reduce lead and copper at customers' taps. This set of regulations (Federal Register, 1991) establishes a treatment technique that includes a regulatory schedule and requirements for corrosion control treatment, public education, and monitoring for various water quality parameters.

Large systems such as Portland's are required to determine the optimal type of corrosion control treatment for their system and provide this treatment by January 1997. The LCR defines this as treatment that minimizes lead and copper levels in drinking water without causing violations of other drinking water standards.

The LCR also requires implementation of a specified public education program as long as lead action levels are exceeded. The lead action level is exceeded if the concentration of lead in more than 10 percent of standing tap water samples collected from a group of homes that are believed to be at highest risk of having elevated lead in water is greater than 0.015 mg/L. During initial monitoring conducted in 1992, lead and copper action levels were exceeded in the City of Portland and other water systems using Bull Run water.

An Alternative Lead and Copper Rule Compliance Approach

In June 1994, the City of Portland's Bureau of Water Works (Water Bureau) completed its corrosion control study as required by the LCR. This study (Montgomery Watson and EES, 1994) indicates that minimizing lead and copper in Bull Run water would involve increasing pH in the distribution system from current levels of about 6.8 to pH 9.0-9.5, and also increasing alkalinity from current levels of 6-12 mg/L to at least 25 mg/L as $CaCO3$.

Also in June 1994, the Portland City Council, in accordance with recommendations from the citizens' Water Quality Advisory Committee, and the Water Managers Advisory Board (managers of water systems purchasing Bull Run water), directed the Water Bureau to pursue a strategy for LCR compliance that included:

- design of a corrosion control treatment facility
- a study to investigate alternatives for compliance; and
- a decision regarding the construction of corrosion control treatment facilities based on the results of the study.

In August 1995, the Water Bureau completed the study to investigate alternatives for LCR compliance (EES, 1995). The study included development of a model to estimate the effects of various interventions on lead exposure through drinking water, as indicated by predicted changes in blood lead levels. The interventions considered included several different levels of corrosion control treatment (ranging from treatment to minimize lead and copper levels to no treatment), removal of sources of lead in water (such as solder and faucets), and combinations thereof. Several pivotal conclusions of this study are:

Drinking water is not a major route of lead exposure in the Portland area. The median lead level in samples of running water from customers' taps is less than 1 ug/L (non-detectable).

Although water treatment would provide some reduction of lead and copper exposure through drinking water in the community, water treatment alone would not sufficiently reduce exposure in some homes with a very significant source of lead in water; and

The most significant source of lead exposure in the Portland metropolitan area is lead-based paint, and efforts focused on preventing exposures from this source could provide a significant health benefit to the community.

1.3 Lead Hazard Reduction Program Development

The Water Bureau assembled the following group of stakeholders and consultant team to help develop the Lead Hazard Reduction Program (LHRP):

Table 1-1
Lead Hazard Reduction Program Development Committee

Portland Bureau of Water Works	Babette Faris Rosemary Menard Mort Anoushiravani Darren Kipper
Water Managers Advisory Board	Dean Fritzke (Tualatin Valley Water District) Dave Gilbey (Powell Valley Road Water District) Keely Thompson (City of Gresham)
Oregon Health Division - Drinking Water Section	Dave Leland Chris Hughes
Oregon Health Division - OEI - EPI Section	Narda Tolentino Rick Leiker
Oregon Childhood Lead Poisoning Prevention Program (OCLPPP)	Chris Johnson
Multnomah County Health Department	Hilda Adams
Washington County Health Department	Clay Parton
Multnomah County Health Department	Dr. Harold Osterrud
Oregon Health Division/Multnomah County Evaluation Section	Dr. Mike Stark
Urban League of Portland	Don Francis
Consultant Team	Lee Odell (EES) Gregg Kirmeyer (EES) Greg Wetterau (EES) Dr. William Morton (OHSU)

The development committee held four workshops since May 1996 and numerous subcommittee meetings to develop the LHRP. The objective of the first workshop was to identify which lead exposure prevention related activities were already being conducted by other agencies in the community and to identify which activities potentially could be included in the LHRP. The objective of the second workshop was to prioritize these activities and recommend program design concepts. The objective of the third workshop was to identify the major program components and the objective of the fourth workshop was to develop these components.

Section 2
Background

2.1 Lead Health Effects

Lead is most hazardous to children under the age of 6, whose still developing nervous systems are particularly vulnerable to lead and whose normal activities expose them to lead-contaminated dust and soil. High levels in the blood of young children can produce permanent nervous system damage. Recent research indicates that relatively low blood lead levels can produce significant nervous system effects, such as reduction in intelligence and attention span, reading and learning disabilities, and behavior problems. These relatively low blood levels are typically not accompanied by identifiable symptoms.

The Centers for Disease Control (CDC) indicate that, because 10 ug/dL is the lower level of the range at which effects are now identified, primary prevention activities - efforts to prevent exposure through community-wide environmental interventions and nutritional and educational campaigns - should be directed at reducing children's blood lead levels at least to below 10 ug/dL. Some studies have suggested harmful effects at even lower levels, but information currently available is not adequate for effects below about 10 ug/dL to be evaluated definitively. As yet, no threshold has been identified for the harmful effects of lead. (CDC, 1991).

2.2 Sources of Lead Exposure (CDC, 1991; HUD, 1995, EPA, 1995)

When considering the effectiveness of an intervention strategy for reducing a child's body-lead burden, it is important to recognize the many different avenues by which a child may encounter lead. Major sources of lead in the environment include paint, industrial emissions, gasoline, and solder. Lead from these sources can accumulate in soil, dust, air, food, and water. Regulations on lead solder in cans and leaded gasoline emissions have greatly reduced the concentrations of lead in food and in air. Relatively little has been done to reduce hazards from lead-based paint in housing and from lead-contaminated soil. Lead-based paint, and lead-contaminated dust and soil have been identified as the principal sources of lead exposure for children.

Lead-based paint is the most widespread and dangerous high-dose source of lead exposure for pre-school children. Dust lead comes from chipping or peeling lead-based paint and is created by friction or impact or when disturbed during repainting or remodeling projects. The other significant pathway of lead exposure is dust from bare lead-contaminated soil. Soil contamination can be traced to past widespread use of leaded gasoline, to deteriorating exterior paint (on houses, bridges, and industrial facilities), and in some areas, to industrial sources of lead. Other, usually less common, sources of lead can include drinking water (where lead solder was used in the home), imported ceramic tableware with lead glaze, old toys or furniture painted with lead-based paint, parental clothing (where a parent's work or hobby involves high levels of lead), and home remedies used by some ethnic groups.

2.3 Blood Lead Levels in the United States

At the time the Lead and Copper Rule was developed, the best available study of blood lead levels in the United States was the National Health and Nutrition Examination Survey II (NHANES II) (Brody, et.al., 1994). The NHANES II study included measurement of blood lead levels in over 40,000 random samples collected from 1978 to 1983 from people across the country. Results indicated that the median blood lead level was 12.8 ug/dL and that nearly 80% of Americans had blood lead levels above 10 ug/dL, the current level of concern, as shown in Exhibit 2-1. The preamble to the Lead and Copper Rule states that "because many children now have blood lead levels above the level of concern, EPA's policy goal continues to be that drinking water should contribute minimal additional lead to existing body burdens of lead" (Federal Register, 1991).

In 1994, the results of the first phase of the follow-up study, NHANES III, were published (Brody, et.al., 1994). The NHANES III study included blood lead level measurements collected from 1988 to 1991. Results indicated that the median blood lead level had dropped to 2.8 ug/dL and that about 20% of Americans had blood lead levels above the level of concern, a tremendous reduction in blood lead levels from 1978-1983 levels, as shown in Exhibit 2-2. This dramatic reduction in blood lead levels is primarily attributed to the increased use of non-leaded gasoline (Pirkle, et.al., 1994).

Exhibit 2-1

US Blood Lead Levels
NHANES II Study
Measured in 1978-1983 (from Brody, et.al., 1994)

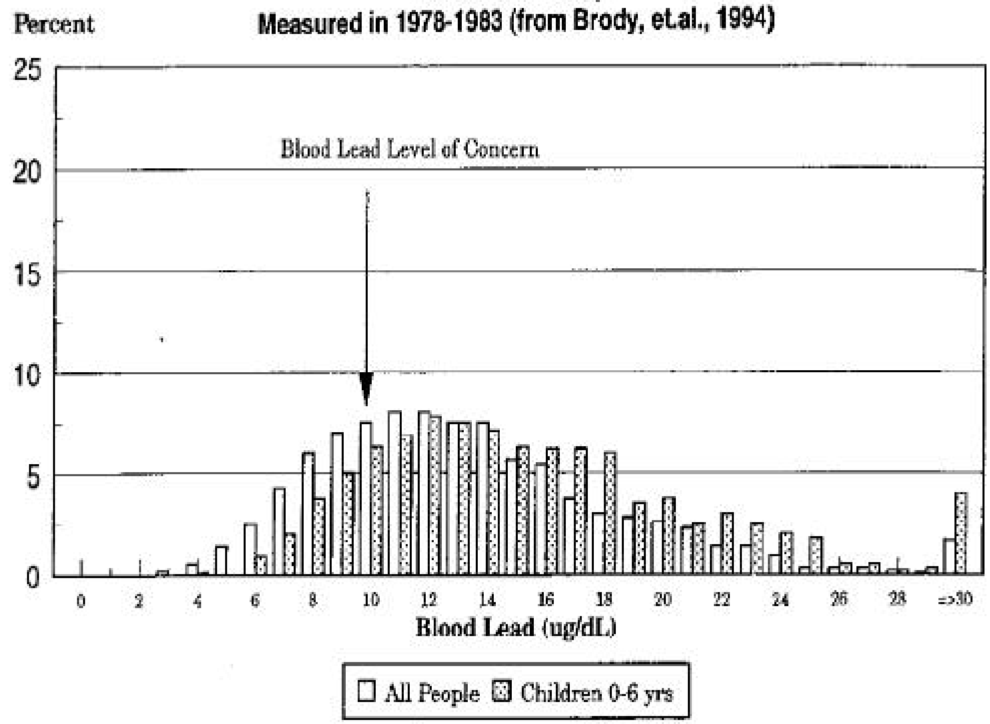
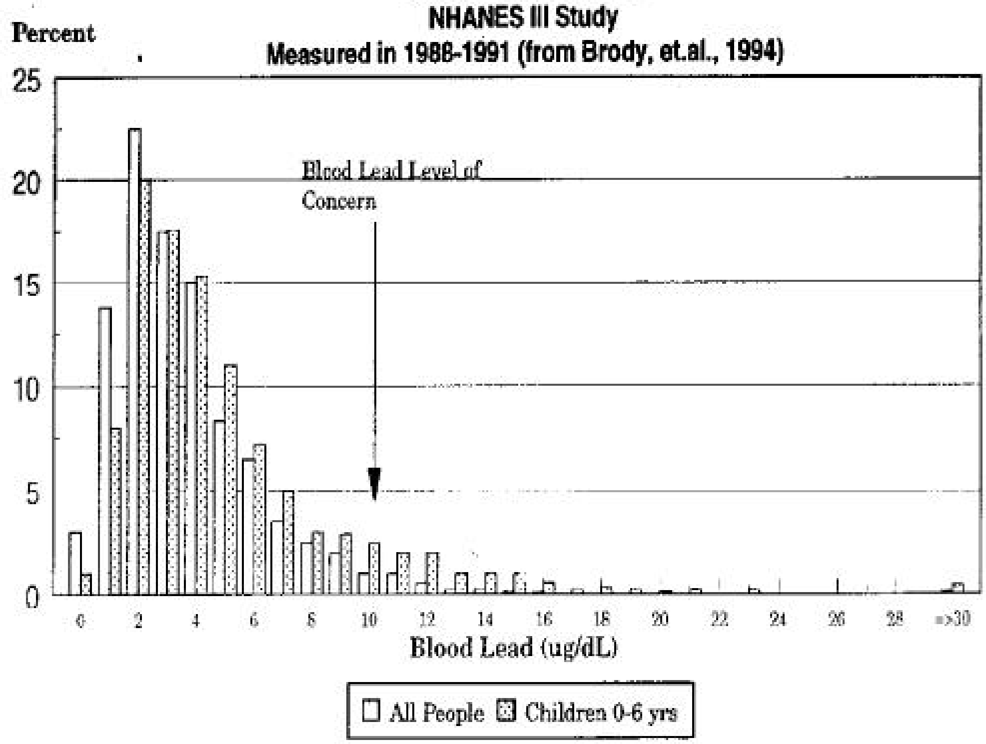


Exhibit 2-2

US Blood Lead Levels
NHANES III Study
Measured in 1988-1991 (from Brody, et.al., 1994)



2.4 Blood Lead Levels and Major Sources of Lead Exposure in the Portland Area

As part of the study to evaluate alternatives for LCR compliance (EES, 1995) blood lead level distribution data were evaluated with the help of the Oregon Health Division (OHD) Occupational, Environmental and Injury Epidemiology (OEI-EPI) section. It was concluded that the best available data to characterize the existing distribution of blood lead levels in the Portland area is:

- ☐ For infants and children less than 6 years of age: Oregon Childhood Lead Poisoning Prevention Project (OCLPPP) screening data from Multnomah County, 1992 through 1994. (OCLPPP, 1994)

- ☐ For all others: National Health and Nutrition Examination Survey (NHANES) III, Phase I National Summary Statistics, 1988 through 1991**.** (Brody, et.al, 1994)

The OCLPPP screening data were collected by the Multnomah County Health Department from 1992 through 1994 as part of a four-county blood lead screening project coordinated by the Oregon Health Division and funded by the CDC.

Table 2-1 is a summary of the blood lead level distributions for these two sets of data.

Table 2-1
Summary of Best Available Data to Characterize Blood Lead Levels in the Portland Area

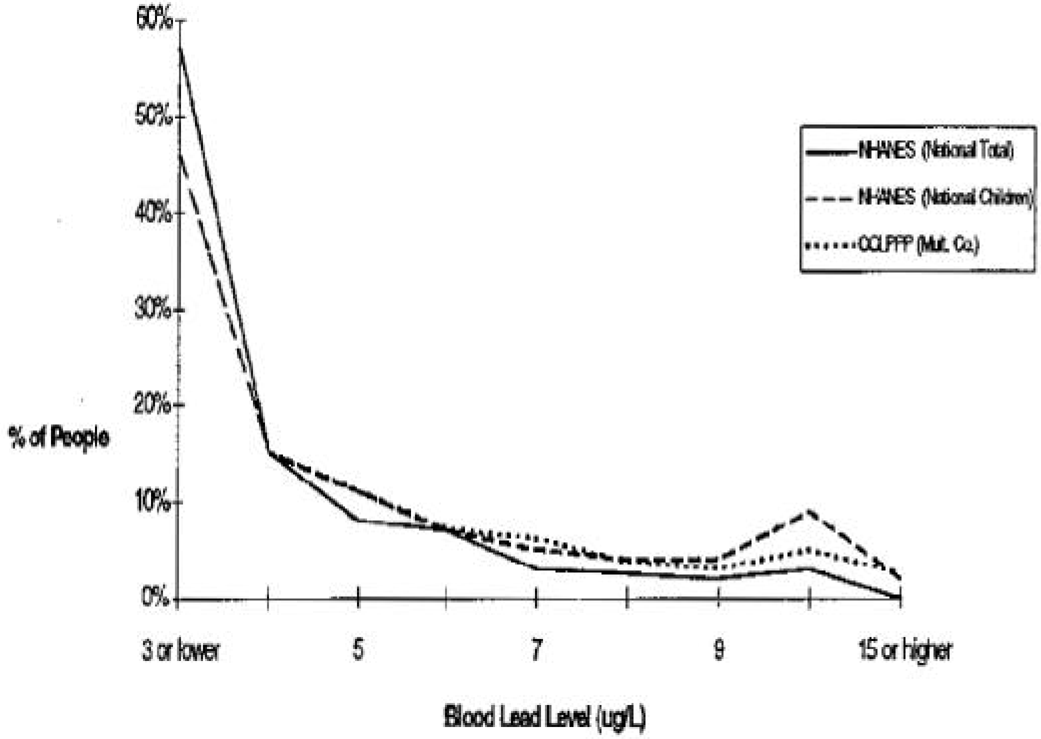
Statistic	Children: OCLPPP (1)	Adults: NHANES III (2)
50th percentile (median)	3.8 ug/dL	3 ug/dL
90th percentile	10 ug/dL	7.3 ug/dL
95th percentile	16 ug/dL	9.4 ug/dL
Number of samples	2,169	40,000

(1) Oregon Childhood Lead Poisoning Prevention Project, Multnomah County, 1992 through 1994, children 0-6 years of age. Children tested were county clinic patients or were at community screening locations.

(2) National Health and Nutrition Examination Survey, Phase III, 1989 through 1991.`

The blood lead level distributions indicated by the Multnomah County OCLPPP data and NHANES III data are very similar, as shown in Exhibit 2-3.

Exhibit 2-3
Multnomah County Screening and NHANES III Blood Lead Level Comparison



The OCLPPP data for Multnomah County show a strong positive relationship between occurrence of elevated blood lead levels and age of home, as indicated in Table 2-2 and Exhibit 2-4. About 1 out of 6 children tested who were living in homes built before 1930 had elevated blood lead levels (≥10 ug/dL). Also, children living in homes built before 1930 were more than 2.5 times more likely to have elevated blood lead levels than children living in homes built after 1930.

The OCLPPP data also suggest that various subpopulations may be at higher than average risk: for example, children 2-3 years old, African-American children, and Hispanic children.

Table 2-2

Blood Lead Level and Home Age
OCLPPP Data (1992 - 1994)
Multnomah County
Children 0-6 years old

Blood Lead Level (ug/dL)	Number and % of children tested living in homes built before 1930	Number and % of children tested living in homes built in 1930 or after	Total number and % of children tested
< 10	790(41%)	1137(59%)	1927 (100%)
10-14	96(60%)	65(40%)	161 (100%)
15-19	45(76%)	14(24%)	59 (100%)
20 or more	28(88%)	4(12%)	32 (100%)
			2179 = Total
Chances of having an elevated blood lead level, EBLL:			
>= 10 ug/dL	1 in 6 (17.6%)	1 in 15 (6.8%)	
>= 15 ug/dL	1 in 13 (7.6%)	1 in 68 (1.5%)	
>= 20 ug/dL	1 in 34 (2.9%)	1 in 305 (0.3%)	

Medical laboratories in Oregon are required to report cases of elevated blood lead levels (EBLLs) of 10 or more ug/dL to the Oregon Health Division. These reports are followed-up by County public health professionals in several ways, depending on the reported blood lead level.

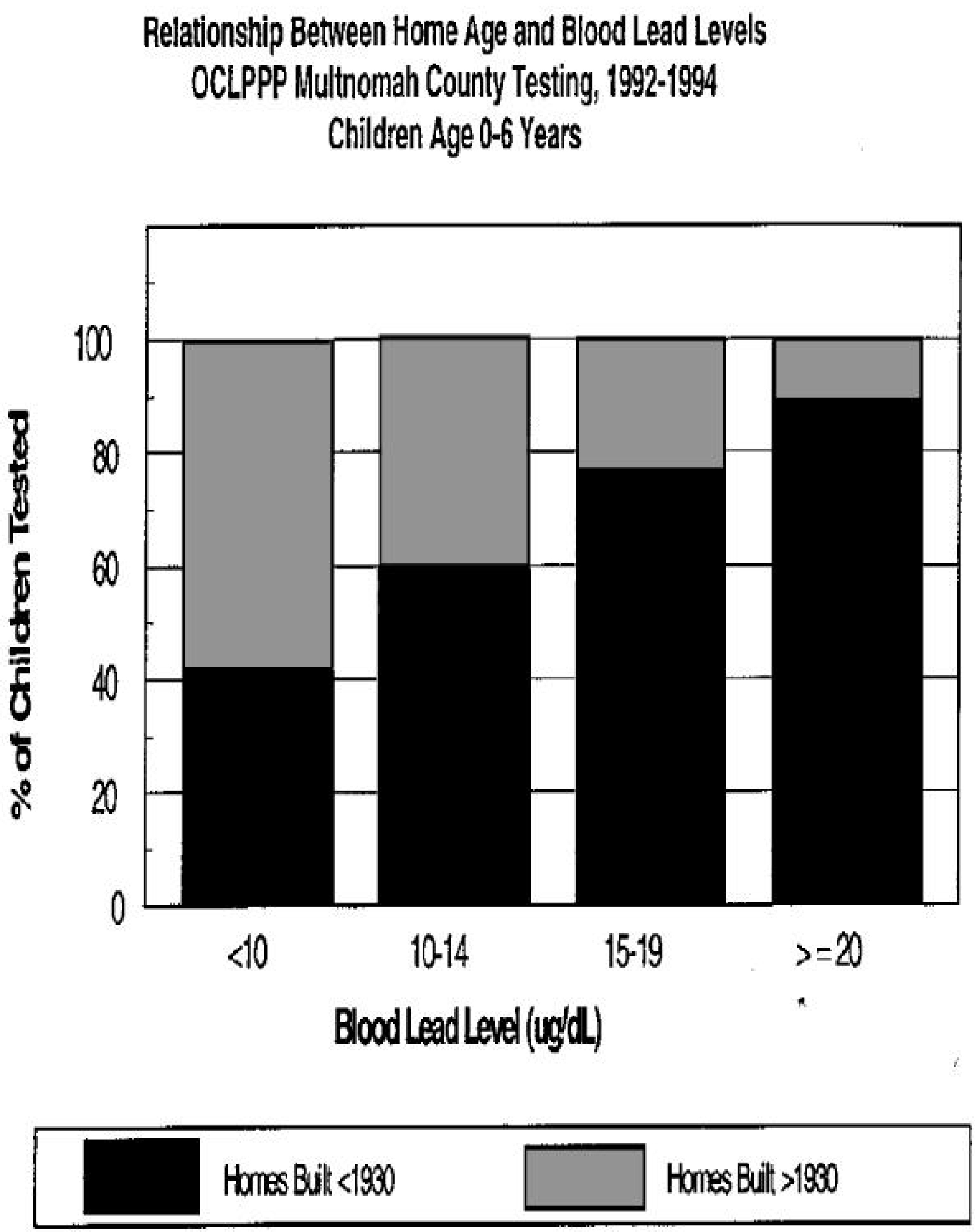
The results of about 110 recent investigations of EBLL cases (15 or more ug/dL) in Multnomah and Washington Counties indicate that:

- approximately 60% of the cases of are related to exposure of lead-based paint, through ingestion or inhalation of paint chips, or lead-contaminated soil or dust;

- approximately 20% are attributed to exposure to lead from a variety of sources including occupational or hobby related sources, sources from country of origin of recent immigrants; and water (1 case);

- for approximately 20% of the cases, the source(s) of lead exposure could not be determined by the investigation.

Exhibit 2-4


Relationship Between Home Age and Blood Lead Levels
OCLPPP Multnomah County Testing, 1992-1994
Children Age 0-6 Years
% of Children Tested
100
80
60
40
20
0
<10
10-14
15-19
>=20
Blood Lead Level (ug/dL)
Homes Built <1930
Homes Built >1930

2.5 Lead Levels In Portland Area Drinking Water

There is no detectable amount of lead and very low levels of copper in Portland's Bull Run source water. Lead and copper enter drinking water primarily as a result of corrosion of building plumbing materials. The most common sources of these metals include lead-soldered joints in copper pipe and faucets and other fixtures made from lead-bearing brass.

The Water Bureau has two sets of data for lead and copper concentrations in water at customers' taps:

1) Lead and Copper Rule Compliance Monitoring

   The LCR requires every water system to collect water samples from homes likely to be at highest risk for elevated levels of lead and/or copper in drinking water. The LCR required the Water Bureau to collect standing water samples from at least 100 of these homes twice in 1992.

2) Customer Requests for Free Lead-in-Water Analysis

   The Water Bureau maintains a data base of results of drinking water analyses requested by customers. Most of the requests for lead analyses are in response to the Bureau's ongoing offer of free lead-in-water testing to its customers. Standing samples, which are mostly likely to contain elevated lead and copper levels, are collected. Running samples have significantly lower levels of metals than standing samples. Running samples better represent water actually consumed by most people than do standing samples. Although this set of data is not a true random sample of homes in the Portland area, it contains more than 1,000 samples from all areas of the City and all ages of homes and it is the best data set available to estimate the distribution of lead and copper in Portland's drinking water.

Table 2-3 summarizes data regarding lead in the City of Portland's drinking water.

Table 2-3
Lead Levels at Customers' Taps

Sample Type	STANDING (1)	STANDING (1)	RUNNING(2)
	Samples from "Highest Risk" Homes as defined by LCR (3)	Samples from Homes Requesting Water Analysis (4)	Samples from Homes Requesting Water Analysis (5)
50th percentile (50% of the samples are below this value)	10 ug/L	6 ug/L	< 1 ug/L
90th percentile (90% of the samples are below this value)	49 ug/L	26 ug/L	4 ug/L
99th percentile (99% of the samples are below this value)	200 ug/L	99 ug/L	
Percentage of samples that exceed the lead "action level", 15 ug/L (6)	29%	19%	2%

Number of samples	251	1063	3048

ug/L: micrograms per liter (parts per billion)

(1) Samples taken from a kitchen or bathroom sink that have stood in contact with home plumbing materials for about 8 hours.
(2) Samples taken from a kitchen or bathroom sink that have been allowed to flow for at least a minute.
(3) Samples from homes in Portland likely to be at highest risk for elevated levels of lead and/or copper in drinking water as per the LCR, i.e., homes contain copper pipe joined with lead-containing solder built 1982-1985 ("Tier 1" homes), 1992.
(4) Customer requests for free lead in water analysis, 1992-1994.
(5) Customer requests for free lead in water analysis, 1980-1994.
(6) The percentage of samples from "Tier 1" homes above the "action level" determines what actions a water system must take to comply with the LCR. Portland and other Bull Run water systems must implement public education programs.

Data presented in Table 2-4 indicate that lead levels in standing water samples are not directly related to home age. This is probably due to 1) replacement of galvanized pipe in older homes with new copper pipe joined with lead-based solder, and 2) widespread use of faucets with lead-bearing brass. These data indicate that at-risk homes cannot be identified on the basis of housing age alone.

Table 2-4
Lead Levels at Customers' Taps by Home Age

Standing Samples (1)

Year Home Built	Number of samples	Median (50th percentile) (ug/L)	90th percentile (ug/L)
Before 1930 (3)	466	6	24
1930-1939 (3)	44	5	46
1940-1949 (3)	70	6	28
1950-1959 (3)	71	4	19
1960-1969 (3)	54	8	34
1970-1979 (3)	72	10	32
1980-1984 (2)(3)	264	7	49
1985-1995 (3)	17	4	14

(1) Samples from a kitchen or bathroom sink, that have stood in contact with home plumbing materials for about 8 hours.
(2) Samples from homes likely to be at highest risk for elevated levels of lead and/or copper in drinking water as per the LCR, i.e., homes contain copper pipe joined with lead-containing solder built 1982-1985.
(3) Customer requests for free lead in water analysis, 1992-1994.

2.6 Reduction of Lead and Copper Levels in Drinking Water with Corrosion Control Treatment

A number of sources of information were evaluated to estimate the extent to which pH adjustments in the range of 7.5 - 9.5 would result in reduced lower lead and copper levels in drinking water. These include theoretical solubility calculations, bench scale electrochemical and pipe loop testing of Bull Run water, and analogous system data. Table 2-5 presents a summary of estimated extent of lead and copper reductions, expressed in terms of percent reductions from existing levels (EES, 1995). These were used to estimate changes in lead levels in standing samples at customers' taps and resulting potential changes in blood lead levels.

Table 2-5
Predicted Reductions in Lead and Copper Levels from Existing Levels for Various pH Adjustments (EES, 1995)

	pH 7-7.5	pH 8-8.5	pH 9-9.5
Lead Reduction	40%	60%	70%
Copper Reduction	55%	70%	80%

Note: predicted reductions are in standing water levels at customer taps.

Preliminary design of treatment requirements to meet each pH level were prepared. Treatment requirements are summarized in Table 2-6.

Table 2-6
Treatment Plant Requirements to Meet pH Objectives

pH Objective	Chemicals Fed	Capital Cost	Annual O&M Cost
pH 7 - 7.5	Sodium Hydroxide	$1,210,000	$392,000
pH 9 - 9.5	Sodium Hydroxide, Soda Ash, CO_2	$3,210,000	$1,188,000

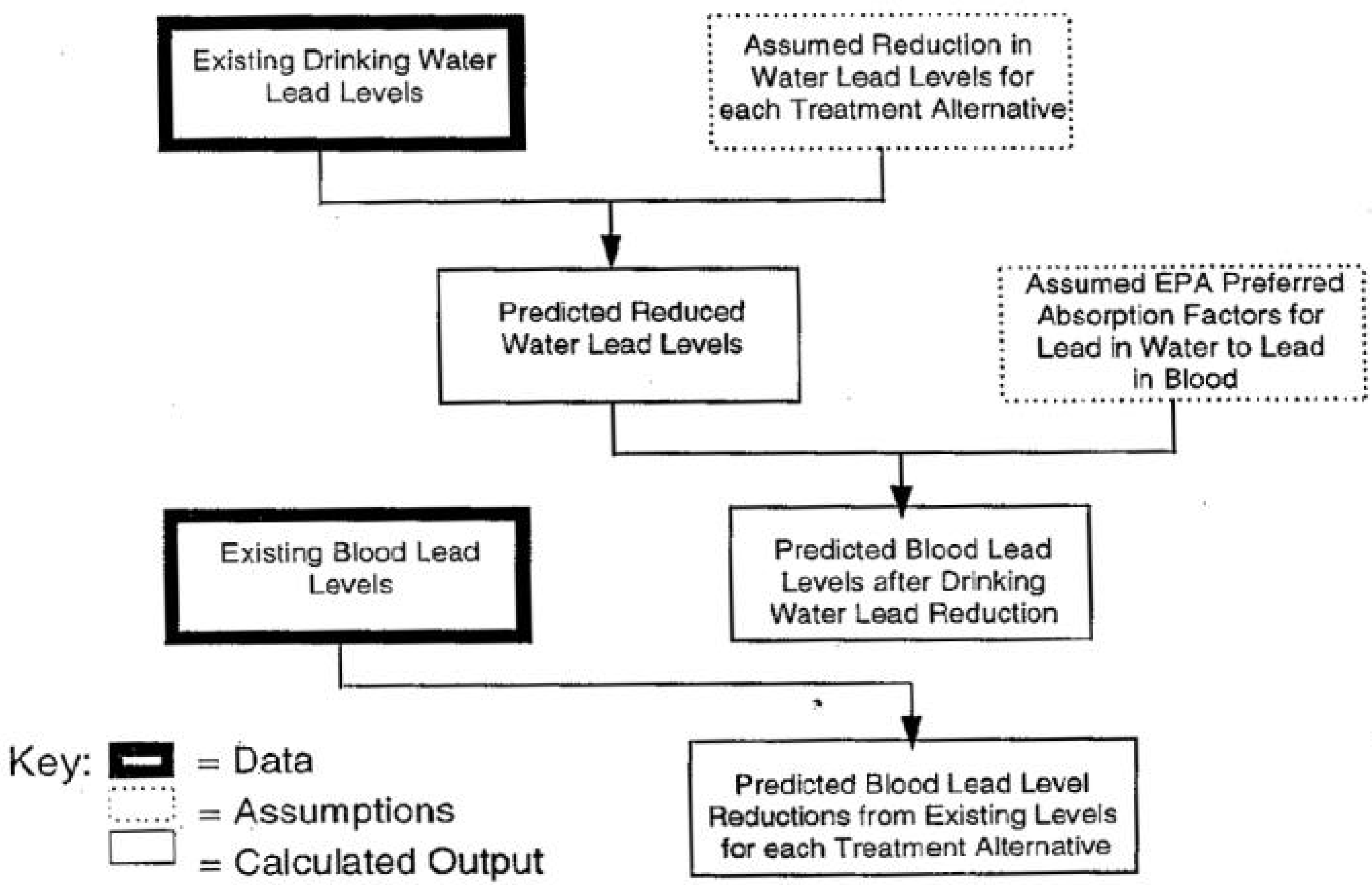
Source: Montgomery Watson (1996)

2.7 Model to Estimate the Potential Reductions in Blood Lead Levels Due to Corrosion Control Treatment

As part of the study to evaluate alternatives for LCR compliance (EES, 1995), a model was developed to estimate the potential reduction in blood lead levels that could be obtained as a result of corrosion control treatment. Exhibit 2-5 is a schematic diagram of the model approach.

Reductions in blood lead levels were estimated on a "population basis" and on an "individual basis". "Population-based" modeling was used to compare the existing distribution of blood lead levels in the community to predicted distributions after implementation of various treatment alternatives. "Individual-based" modeling was used to predict the reduction in blood lead level that an infant, child or adult would experience as a result of consuming water with a specified lead concentration.

Exhibit 2-5
Model to Estimate Potential Reductions in Blood Lead Levels Due to Corrosion Control Treatment



Some of the conclusions drawn from the modeling efforts are:

Drinking water is not a major route of lead exposure in the Portland area. The median lead level in samples of running water from customers' taps is less than 1 ug/L (non-detectable).

However, it is possible that lead in drinking water could significantly contribute to an individual's total lead exposure if that individual regularly consumes standing water drawn from a plumbing system containing significant sources of lead.

In about 50% of Portland area homes, this very unlikely but possible consumption scenario could result in a contribution of at least 1.5 ug/dL to an infant's blood lead level; in about 1% of homes, the contribution could be at least 7 ug/dL.

In homes where significantly elevated levels of lead in standing water occur, and standing water is regularly consumed, corrosion control treatment alone would not preclude the possibility of lead from water substantially contributing to an individual's total lead exposure.

For example, an infant regularly consuming only formula or juice made with standing water with 100 ug/L of lead could experience a blood lead level contribution of 7.3 ug/dL from this source. Corrosion control treatment to minimize lead levels in drinking water (pH 9.0-9.5) would be expected to reduce the water lead level by 70% to 30 ug/L and result in a still substantial blood lead level contribution of 4.5 ug/dL.

In homes where significantly elevated levels of lead in standing water occur, only lead source removal (solder or faucet), or in most cases tap flushing to remove standing water before consumption, would eliminate the possibility of substantial contributions of lead from water to an individual's total lead exposure.

The reduction in blood lead levels that would be expected as a result of corrosion control treatment to minimize levels (pH 9.0 to 9.5) compared to a lesser extent of treatment (pH 7.0 to 7.5) are estimated with these examples:

As described above, regular consumption of standing water with 100 ug/L of lead could result in a blood lead level concentration of 7.3 ug/dL for infants. Corrosion control treatments involving pH adjustments to pH 9.0-9.5 or pH 7.0-7.5 could result in reduced blood level contributions of 4.5 ug/dL or 5.7 ug/dL, respectively.

The estimated maximum number of children in Multnomah County whose blood lead levels could be reduced from above to below 10 µg/dL (the current level of concern) through corrosion control treatment ranges from about 300 children with pH adjustment to 9.0-9.5, to about 200 children with pH adjustment to 7.0-7.5 (based on the assumption that all children drink only standing, not running water).

The estimated maximum number of children in Multnomah County whose blood lead levels could be reduced by more than 2 µg/dL through corrosion control treatment ranges from about 2700 children with pH adjustment to 9.0-9.5, to about 800 children with pH adjustment to 7.0-7.5 (again, based on the assumption that all children drink only standing, not running water).

2.8 Lead-Based Paint Hazard Reduction and Financing Task Force

In enacting Title X of the Housing and Community Development Act of 1992, Congress recognized that it did not have solutions for the problems posed by lead based paint in private housing. Congress directed the Secretary of the Department of Housing and Urban Development (HUD), in consultation with the Administrator of the Environmental Protection Agency (EPA), to create a task force to make recommendations on lead based paint hazard reduction and financing. The task force was comprised of 39 men and women representing a diversity of constituencies, opinions, professions, training, and experiences. The main focus of the task force was to provide recommendations to reduce hazards from lead based paint in pre-1978 housing and from lead contaminated soil. The task force found that changes were needed in virtually every aspect of the nation' approach to lead based paint hazards, including:

- How housing is maintained and renovated;
- How renovation activities are financed;
- How insurance and legal systems respond to injured children;
- How citizens are educated about lead hazards; and
- How governments respond when children are discovered to have elevated blood lead levels.

The task force also found that public financing will be necessary to control lead based paint hazards in older, economically distressed housing where much of the problem is concentrated. Of the key task force recommendations was a recommendation that State Legislatures and Regulators should adopt benchmark lead based paint maintenance and hazard control standards for rental housing. The benchmark standards are designed to be reasonable, protective, specific, and enforceable. As an example, standard treatments for houses not undergoing a risk assessment, would include:

- Safely repaired deteriorated paint,
- Provide smooth and cleanable horizontal surfaces,
- Correct conditions in which painted surfaces are rubbing, binding or being crushed that could produce lead dust,
- Cover or restrict access to bare residential soil,
- Specialized cleaning, and
- Perform sufficient dust testing to ensure safety.

These treatments were designed to be cost effective and reasonable for both home owners and protection of children exposed to lead. The task force also recommended essential maintenance practices for property owners that include:

- Safe work practices during work that disturbs paint,
- Visual examinations for deteriorating paint,
- Repair of deteriorated paint and the cause of the deterioration,
- Generic lead based paint hazard information to tenants,

- Written notice to tenants, and
- Training of maintenance staff.

The task force further identified recommendations that may affect federal, state, and local governments (HUD, 1995).

Section 3
Lead Hazard Reduction Program Goal and Design Concepts

3.1 Program Goal

The goal of the Lead Hazard Reduction Program is to achieve better public health protection from lead exposure, at an equivalent lower cost, than would have been achieved with the corrosion control treatment and public education requirements of the Lead and Copper Rule.

Interventions to reduce lead exposures should be targeted at those exposures pathways that have the greatest impact on the health of the child by reducing his or her body-lead burden (EPA, 1995). EPA has estimated that for a typical 2 year old child living in an urban environment, or in a non-urban house with interior lead-based paint, household dust and soil accounts for 90% of the child's daily intake of lead (EPA, 1995). In the Portland area, 60% of recent cases of elevated blood lead levels were found to be related to exposure of lead-based paint.

The LCR requires large water systems to begin providing optimal corrosion control treatment by January 1, 1997. Optimal corrosion control treatment is defined as treatment that minimizes lead and copper levels in drinking water without causing violations of other drinking water standards.

The Water Bureau's LCR Corrosion Control Study (Montgomery Watson and EES, 1994) indicates that minimizing lead and copper in Portland's water would involve increasing pH to 9-9.5 (moderately alkaline pH) from current values of 6.5-7 (slightly acidic to neutral pH) and increasing alkalinity to at least 25 mg/L as $CaCO_3$ to maintain a stable pH throughout the distribution system. Such treatment may reduce lead levels in standing water by an estimated 70% and copper levels by 80%. Construction of a treatment facility with the capability of feeding multiple chemicals would be required.

The LHRP is proposed as an alternative to the optimal corrosion control treatment requirements and public education requirements of the LCR. Under this proposal, "optimal treatment" for Bull Run water systems could be defined as "corrosion control treatment to reduce lead and copper levels in drinking water along with additional interventions to reduce lead exposures that have the greatest health impact on children at most risk." As part of the LHRP, corrosion control treatment would be provided, but at a reduced level than that defined as optimal by the Lead and Copper Rule. Corrosion control treatment would consist of raising pH to about 7.3 in the distribution system, which would be expected to reduce lead levels in standing water by 40% and copper levels by 55%. This would involve construction of a treatment facility with the capability of feeding sodium hydroxide only. The savings in capital and operating costs would be used to fund interventions that reduce lead exposures that would be expected to provide the greatest benefits to children at most risk.

3.2 Centers for Disease Control Lead Guidelines

In its 1991 Strategic Plan, CDC concluded that childhood lead poisoning is a major public health problem and identified a number of steps needed to eliminate the disease. These include; (1) establishing a national surveillance system to test and identify children with elevated levels of lead in their blood, (2) establishing a nationwide program to increase lead-based paint interventions, (3) increasing lead-poisoning prevention activities, and (4) reducing exposures from other lead sources, including contaminated soil.

The CDC's lead poisoning prevention branch is currently in the process of revising its 1991 guidance on screening for the prevention of lead poisoning. The final document is expected in 1996. These new guidelines will indicate more explicitly how to determine the communities in which universal screening efforts need to be enhanced and the communities in which other tools are more appropriate for addressing childhood lead poisoning. The guidelines also revise the goals and strategies necessary to end childhood lead poisoning as a public health problem. It is expected that for communities such as Portland a more targeted blood lead screening program will be recommended.

3.3 Interventions to Reduce Lead Hazards

Information presented in this section is from a recent comprehensive review of literature regarding the effectiveness of lead hazard interventions (EPA, 1995).

A lead hazard intervention is defined as any non-medical activity that seeks to prevent a child from being exposed to the lead in the surrounding environment. Interventions include activities that attempt to remove or isolate a source of lead exposure (such as abatement of lead-based paint, dust or soil with elevated lead levels), as well as activities that attempt to reduce a child's lead exposure by modifying behavior patterns (such as through in-home education of parents).

3.3.1 Targeted Lead Exposure Pathways

Interventions are not performed merely to reduce or eliminate environmental lead levels; the aim is always to positively impact the health of children or adults. Intervention to reduce lead exposures should be targeted at those exposure pathways that have the greatest impact on the health of the child by reducing his or her body-lead burden. An intervention can reduce a child's lead exposure no more than that consistent with the source of exposure targeted. Potentially, an intervention can be successful in reducing a particular environmental lead exposure and yet produce no positive impact in a child only marginally exposed to the abated lead hazard.

The EPA (1995) has estimated typical daily lead exposures for a 2-year old child from air, food, water, dust and soil for a particular type of residence. Table 3-1 describes the lead intake profile for a child living in an urban environment. Urban children whose lead exposure resembles this profile may benefit from interventions associated with exposure through household dust and/or soil. Table 3-2 describes the lead intake profile for a child whose non-urban residence contains lead-based paint. Abatement of both lead-based paint and elevated dust lead would be most effective at reducing lead intake for a child with this intake profile.

Table 3-1
Lead Intake for a Two-Year-Old Child in an Urban Environment (EPA, 1995)

Environmental Media	Pb Concentration	Daily Amount Consumed	Daily Pb Intake	% of Total Intake
Inhale Air	0.75 ug/m^3	5 m^3	3.75 ug	3
Food, Water, Beverages	0.0033 ug/g	1500 g	5.0 ug	4
Dust-Household	1000 ug/g	0.05 g	50 ug	42
Soil	1500 ug/g	0.04 g	60 ug	50
Dust-Occupational	150 ug/g	0.01 g	1.5 ug	1
Total			120.75 ug	100

Table 3-2
Lead Intake for a Two-Year-Old Child in a Non-Urban House with Interior Lead-Based Paint (EPA, 1995)

Environmental Media	Pb Concentration	Daily Amount Consumed	Daily Pb Intake	% of Total Intake
Inhale Air	0.10 ug/m^3	5 m^3	0.5 ug	0
Food, Water, Beverages	0.0033 ug/g	1500 g	5.0 ug	4
Dust-Household	2500 ug/g	0.05 g	125 ug	92
Soil	90 ug/g	0.04 g	4.5 ug	3
Dust-Occupational	150 ug/g	0.01 g	1.5 ug	1
Total			136.5 ug	100

3.3.2 Major Findings of the Review

Although the literature is limited in extent, the major findings of this review are:

Blood lead concentrations declined after lead hazard intervention, at least for children with blood lead levels > 20 ug/dL.

Short term increases in exposed children's blood lead concentrations may result when abatements are performed improperly.

There is insufficient information available to identify a particular intervention strategy as markedly more effective than others.

Comparable reduction in blood lead concentrations are observed resulting from abatement of lead-based paint, abatement of dust and soil with elevated lead levels, and in-home educational efforts.

It is unclear whether more-costly, large scale abatement strategies are more successful than less expensive (though sometimes more labor intensive), in-place management practices.

Information is lacking on the effectiveness of lead hazard interventions:

beyond 1 year following the intervention;
among children with blood lead levels <= 20 ug/dL; and
- that attempt to prevent elevated blood lead levels before they occur.

3.3.3 Issues Related to Assessing Intervention Efficacy

The goal is to utilize a measure(s) which adequately reflects the impact of the intervention on affected children.

It is often infeasible to directly assess particular health outcomes following an intervention. Some outcomes may not manifest themselves for a long time. Some outcomes are subtle and, as such, are complicated and costly to measure directly. This assessment is made more difficult when considering interventions targeted at children with low to moderate lead exposure.

Measures of body burden such as blood lead concentration may serve as alternative biomarkers of lead exposure and intervention effectiveness, because of the established association between elevated blood lead levels and adverse health effects. When it is impractical or inappropriate to measure blood lead concentrations, levels in environmental media, such as dust lead levels, can provide valuable information. Such measures cannot demonstrate an intervention's impact on affected children in terms of actual exposure or health effects, but they can be used to evaluate the effectiveness of a particular intervention in reducing or eliminating a targeted lead hazard.

The effect of an intervention on blood lead concentration (or other measures) is the change in concentration above and beyond that due to other factors other than the strategy itself, which can be characterized by examining a comparable control population.

A important issue in planning studies to assess intervention effectiveness is the timing of the measurements following the interventions. Pre-intervention measures should be collected to provide a basis for comparison, but the timing of post-intervention measures to best assess the effectiveness of an intervention can be difficult to determine.

Information is lacking on the efficacy achieved by preventing elevated blood lead concentrations before they occur.

3.4 Design Concepts

The Program Development Committee outlined these concepts as a basis for design of the project. The Lead Hazard Reduction Program should:

1. Be implemented throughout entire Bull Run service area

This includes the City of Portland's water service area, and the service areas of its wholesale water customers that use Bull Run water as their sole source or major source of supply during periods of normal operation. The Program should be funded by these water systems. The Portland Water Bureau should have the lead responsibility for administering and implementing the program on behalf of the Bull Run water systems.

2. Focus efforts on those lead source and exposure pathways that would be expected to have the greatest impact on reducing a child's body lead burden

Lead-based paint and lead-contaminated dusts and soils remain the primary sources and pathways of lead exposure for children. The LHRP should concentrate its efforts focus on these sources and pathways, but should also include efforts to reduce exposure through drinking water and other significant pathways.

3. **Focus efforts on those persons living within the Bull Run service area who are most risk to significant lead exposure**

Lead is most hazardous to children under the age of 6, whose still developing nervous systems are particularly vulnerable to lead and whose normal activities expose them to lead-contaminated dust and soil (CDC, 1991). Local lead risk assessment data indicate that children living in homes built before 1930 were 2.5 times more likely to have elevated blood lead levels than children living in homes built after 1930. Also, this data suggests that various subpopulations may be at higher than average risk: children 2-3 years old, African-American children, and Hispanic children.

Because the residences of children at most risk are not evenly distributed throughout the service area, some LHRP risk reduction efforts may not be applied uniformly throughout the service area.

4. **Focus efforts on primary prevention**

The CDC recommends that efforts need to be increasingly focused on preventing lead poisoning before it occurs, and notes that this will require community wide interventions as well as educational campaigns (CDC, 1991).

5. **Focus on implementing feasible and cost-effective methods for reducing lead hazards**

Currently information indicates that more costly, large scale abatement strategies are no more effective than less expensive, in-place management practices and in home education. Even if effective, applying abatement source isolation or removal methods to the nation's housing stock could prove to be prohibitively expensive (EPA, 1995). Many housing experts believe that on-going controls such as paint stabilization, specialized cleaning, and essential maintenance practices may be cost-effective, except where a major renovation is planned (HUD, 1995). A national task force has recently developed recommendations for cost effective measures that can prevent lead exposure and essential maintenance practices for property owners (HUD, 1995).

6. **Supplement or complement efforts performed by other organizations with similar objectives, including state and county health agencies, and community-based groups**

Currently state and county efforts involving lead revolve around people that have been identified as having an elevated blood lead level. An elevated blood lead level is defined as 10 ug/dL of lead in blood. The Oregon Health Division keeps records and analyzes available data on blood lead from several sources. From laboratories within the State, any elevated blood lead test is required to be reported. OHD also monitors the ongoing Oregon Childhood Lead Poisoning Prevention Program (OCLPPP) monitoring program and tracks all blood lead data below and above 10 ug/dL. Multnomah County, (e.g., Multnomah and Washington Counties) investigates all elevated blood lead levels that are reported and forwarded to them by the State Health Division. In addition, Multnomah County is also participating in the

OCLPPP program and houses staff that are leading the State-wide effort. The OCLPPP program is funded through a CDC grant in addition, other federal grant monies may apply to federally-owned housing through HUD.

7. Develop and support community participation in lead hazard reduction efforts

The implementation plan should be designed to maximize broad community participation in promoting, supporting, and delivering the LHRP in highest risk neighborhoods. The "Community Mobilization Framework" (CMF) approach, used by the CDC in demonstration projects to prevent HIV infection in women and children (Person and Cotten, 1996) may be useful to consider for this project. It includes, includes becoming familiar with the organizations and individuals within the community to identify potential partners; asking them for support, ranging from simple endorsement to active participation in coalitions; and recruiting community residents ("peer networkers") to promote program messages and conduct intervention activities.

8. Be evaluated on a regular basis for effectiveness in achieving objectives, and modified as necessary or desired to enhance effectiveness

The evaluation of the LHRP should consist of 1) formative evaluation, to assist in the design of the program's interventions; 2) implementation evaluation to determine the extent to which implementation objectives are achieved, including a description of problems encountered and solutions offered; 3) outcome evaluation to determine the degree to which the program's activities are associated with the reduction of lead hazards, and 4) cost evaluation to estimate the cost of obtaining the program's benefits. Specific measures that will be used to determine effectiveness of LHRP activities should be determined during design of program interventions.

Information is lacking on the effectiveness of lead hazard interventions 1) that attempt to prevent elevated blood lead levels before they occur; 2) among children with blood lead levels <= 20 ug/dL; and 3) beyond 1 year following the intervention (EPA, 1995). The LHRP may be able to contribute to the state of knowledge on these issues.

The LHRP's design should be flexible and dynamic and should be modified as necessary during implementation to enhance effectiveness.

9. Be developed in partnership with and supported by Oregon Health Division's Drinking Water program, State and County Health Departments, Portland's wholesale water customers, and interested organizations and individuals within the community, and other stakeholders

10. Be conducted to serve as a demonstration project for community lead hazard reduction efforts nationwide

It is estimated that LHRP development, implementation, and evaluation would require a period of about 5 years. The Portland Water Bureau and its wholesale water customers should commit to funding the LHRP for at least this amount of time. After this period of time, the future of the LHRP should be considered in terms of its value to the community (benefits achieved and potentially achievable), and value as an alternative to LCR optimal treatment and public education requirements.

Section 4
Lead Hazard Reduction Program Components

4.1 Introduction

The proposed Lead Hazard Reduction Program has 4 main components:

Water Treatment for Corrosion Control
Lead-in-Water Testing
o Home Lead Hazard Reduction Program for Homes in Highest Risk Neighborhoods
Lead Exposure Prevention Education for Other Targeted Groups.

Each of these components are described in this section, including the purpose of the component, the activities associated with the component, and how the component will be developed, implemented and evaluated as part of the LHRP.

The LHRP presented in this section represents the best efforts and current level of knowledge of the development committee in preparing an effective program for reducing lead risks from water and other routes of exposure. The program is envisioned to be not only one that will provide a significant public health benefit, but also one that has the opportunity to fill in a number of information data gaps with respect to the effectiveness of lead risk reduction interventions. During 1997, refinement of the program design and evaluation measures will be made in association with EPA and other interested stakeholders.

4.2 Water Treatment for Corrosion Control

4.2.1 Purpose

The purpose of the water treatment component is to reduce lead and copper levels in standing water samples at the customer's tap.

The Lead and Copper Rule requires treatment to minimize lead and copper levels in drinking water. For Bull Run water, this would involve raising pH in the distribution system from current levels of about 6.8 to 9.0-9.5 and increasing alkalinity to at least 25 mg/L as $CaCO_3$. It is estimated that this level of treatment would reduce lead levels in standing water by 70%, and copper levels by 80%. For water systems using Bull Run water, the copper action level would likely be met, but the lead action level may possibly not be met, even with this optimal level of treatment.
As part of the Lead Hazard Reduction Program, corrosion control treatment would be provided, but at a reduced level than that defined as optimal by the Lead and Copper Rule. Corrosion control treatment would consist of raising pH to about 7.3 in the distribution

system, or slightly higher if necessary to meet copper action levels. It is estimated that this level of treatment would reduce lead levels in standing water by 40%, and copper levels by 55%. With this treatment, as also for the higher "optimal" level of treatment, the lead action level would likely not be met in Bull Run water systems.

This moderate increase in pH should provide substantial benefits related to decreased copper levels, including less copper discharged into the environment from wastewater treatment plants, and many fewer problems with blue staining of sinks and bathtubs. This treatment will also provide significant reductions in lead levels in standing water for those customers with a source(s) of lead in their water plumbing system.

4.2.2 Activities

Activities associated with this component include construction and operation of a caustic soda feed facility at the Portland Water Bureau's Lusted Hill site. Approximately 1-2 mg/L of caustic soda would be fed to adjust pH in the distribution system to about 7.3. This treatment target will be reevaluated if the copper action level cannot be met, if pH is unstable within the distribution system, or if other water quality problems become apparent.

4.2.3 Development

The Water Bureau is responsible for the development of this component. The corrosion control treatment facility is currently under construction at the Water Bureau's Lusted Hill site. Also, changes in treatment operations plans, operator training, and monitoring plans are underway.

4.2.4 Implementation

The Water Bureau will provide corrosion control treatment for Bull Run water that is served to the City of Portland and the metropolitan area through its wholesale water customers. The LCR requires that corrosion control treatment be provided by January 1997, and that it continue indefinitely.

4.2.5 Outcome Evaluation

The effects of corrosion control treatment will be evaluated by monitoring required by the LCR and additional monitoring planned by the Water Bureau. This includes:

1) semi-annual monitoring of Tier 1 homes and evaluation of data collected "upon request" in monitoring of customer homes to determine the effectiveness of treatment in reducing lead and copper levels in standing tap water;

2) semi-annual monitoring of Tier 1 homes to determine if lead and copper action levels are being met;

3) monitoring to determine pH stability throughout the distribution system; and

4) monitoring to assess secondary changes in water quality, such as disinfection efficacy, taste, and others.

This evaluation will be conducted by the Portland Water Bureau in cooperation with is wholesale water customers.

4.3 Lead-in-Water Testing Component

4.3.1 Purpose

The purpose of this component is to identify customers within the Bull Run service area that may be at significant risk from elevated lead levels in drinking water and assist them in reducing the risk of lead exposure from this source.

Although most people within the Bull Run service area drink water that is essentially lead-free, some homes within the service area have a significant source of lead within the plumbing system, as indicated in Table 2-3, and standing water may contain significantly elevated lead levels. Analysis of data from Portland Water Bureau customers' homes indicates that as many as 1% of homes could have lead levels in standing water of about 100 or more micrograms per liter (parts per billion). The alternatives to compliance with the LCR study (EES, 1995) indicates that corrosion control treatment alone - either the level of treatment needed to minimize lead and copper (required by the LCR) or the reduced level of treatment (proposed in the LHRP) - would not be expected to sufficiently reduce lead levels in drinking water in homes with very significant water lead sources so that no other health protective actions would be advised. One of the most effective ways of reducing lead in drinking water in these homes is to let water run from the tap for a minute or so if water has not been used for 6 to 8 hours.

It is not easy to predict which homes may have a significant source of lead in their plumbing system. Analysis of data from Portland Water Bureau customers homes indicates that homes of any age can have elevated lead-in-water levels, although homes likely to have copper pipe joined with lead-based solder (plumbing installed from the mid-60's to the mid-1980's) are at greatest risk (See Table 2-4).

The Portland Water Bureau offers free lead-in-water testing to any of its customers who express concerns about lead in their tap water, although this program is not currently widely advertised. Customers taking advantage of this offer receive a form letter indicating the laboratory results and reminding them that flushing the tap is the most effective way of reducing lead levels in drinking water.

4.3.2 Activities

Two major activities are associated with this component. The first is modification and expansion of the Portland Water Bureau's free lead in water testing program. The program would be expanded to include customers within the entire Bull Run service area, but would probably be limited to customers living in homes with plumbing systems that are likely to be associated with significant risk for elevated lead in water levels.

The second activity would be providing assistance to customers with elevated lead levels. This assistance would, at least initially in the program, take the form of an offer of a home plumbing system assessment to determine the specific source of lead and to recommend practical and effective ways of reducing exposure.

4.3.3 Development

Development of this component's initial design would involve two main "formulative evaluation" steps: first, determining which characteristics of home plumbing systems are associated with elevated lead in water levels in the Portland area, so that free lead-in-water testing can be offered to customers with the highest risk; and second, determining appropriate types and levels of assistance that can be provided to reduce the risk of elevated water lead levels. These would best be accomplished by a review of lead data from customers' homes, including resampling and inspections of plumbing systems of some homes with the highest standing water lead levels.

Also, an initial implementation plan, including program advertising, request processing, sample collection, laboratory analysis, communicating results and providing appropriate follow-up assistance would be developed in cooperation with the wholesale water customers.

This work would be accomplished by the Portland Water Bureau and/or a contracting agency and the OHD/Multnomah County Program Evaluation staff . Development of this component may require up to 6 months to complete.

4.3.4 Implementation

This program would be implemented for the first 3-6 months in the form of a pilot program to gauge customer demand for the program, and to identify changes that should be made in the implementation plan to improve effectiveness. The program would then be implemented throughout the entire Bull Run service area. An ongoing implementation evaluation will be made to summarize the positive response rate to the testing offer, the rate of elevated water lead occurrence and the characteristics of the plumbing systems they occur in; and responses to the offer of assistance to reduce risk.

This component would be implemented by the Portland Water Bureau or a contracting agency. Implementation evaluation would be provided by the OHD/Multnomah County Program Evaluation staff.

4.3.5 Outcome Evaluation

This component will be evaluated for its effectiveness in:

1) identifying homes with significantly elevated lead in water levels; and
2) reducing this risk by educating and/or otherwise providing assistance to the homeowner.

This evaluation will be conducted by the OHD/Multnomah County Program Evaluation staff.

4.4 Home Lead Hazard Reduction Component

4.4.1 Purpose

The purpose of this component is to reduce actual or potential risks of significant lead exposure from lead-based paint and other sources in at-risk homes in highest risk neighborhoods. This component is a cornerstone activity in the LHRP and could become one of the most substantial lead hazard reduction projects undertaken in the country.

Data from the Oregon Childhood Lead Poisoning Prevention Project (OCLPPP) for Multnomah County shows an strong positive relationship between increasing occurrence of elevated blood lead levels and increasing age of home. Prevalence of older homes and other risk factors would be used to identify highest risk neighborhoods within the service area.

A flow chart indicating the risk evaluation, risk reduction, and component evaluation protocol is shown in Exhibit 4-1. Eligible homes within the neighborhood would be offered an evaluation of lead risks in their home, to be conducted by trained "neighborhood peers". If appropriate, a plan for reducing or eliminating the hazard would be developed with the resident. Assistance could be offered in the form of low cost supplies and in some cases labor, to help the resident get the job done.

The "Community Mobilization Framework" (CMF) approach, used by the CDC in demonstration projects to prevent HIV infection in women and children (Person and Cotten, 1996), may be useful to consider for this project. The CMF includes becoming familiar with the organizations and individuals within the community to identify potential partners; asking them for support, ranging from simple endorsement to active participation in coalitions; and recruiting community residents ("peer networkers") to promote program messages and conduct intervention activities. This approach offers the potential advantages of 1) extending limited resources of single agencies; 2) maximizing exposure to program through collaboration; 3) building on unique strengths and access channels of organizations and individuals in the community; and 4) allowing agencies, such as state and county health departments to develop credible relationships with non-traditional community partners.

This component would be evaluated on an on-going basis to assess the program's effectiveness and would be modified as necessary for improvement.

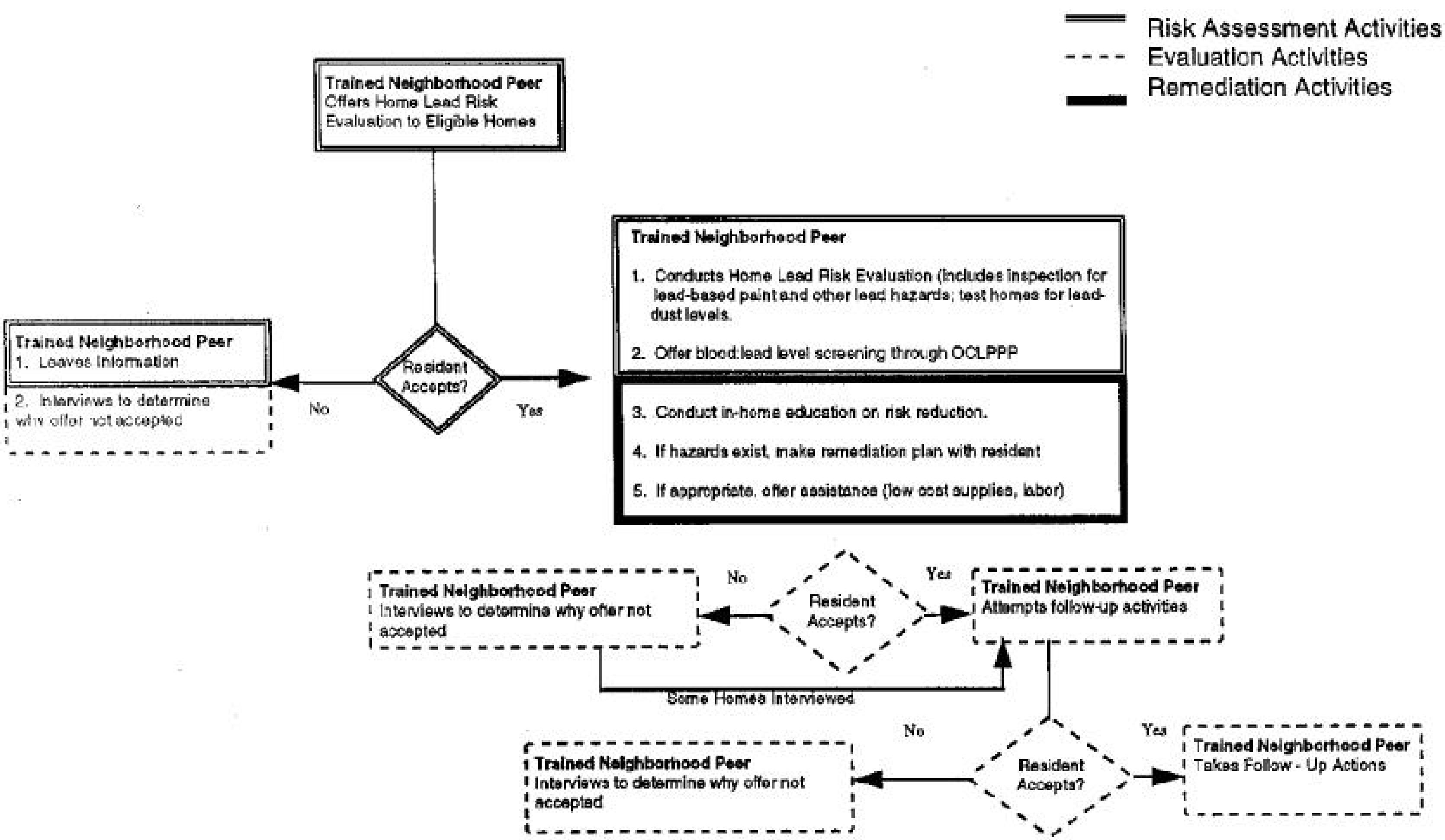
This Home Lead Hazard Reduction Component is similar in concept to the Community Lead Education and Reduction Corps (CLEAR Corps) program established by the National Paint and Coatings Association and the University of Maryland through an Americorps grant. The CLEAR Corps demonstration project will operate in 3 cities and will focus on targeted, feasible and cost-effective solutions to reduce exposure in at-risk neighborhoods (EH, November 1996).

4.4.2 Activities

Identify Highest Risk Neighborhoods

The OHD Occupational, Environmental and Injury Epidemiology (OEI-EPI) Section has developed a preliminary index for lead exposure to identify high risk neighborhoods within the Bull Run service area.

Exhibit 4-1
Home Lead Hazard Reduction Component
Home Lead Risk Evaluation, Risk Reduction and Component Evaluation Protocol



This index evaluates 1990 census variables known to correlate with elevated blood lead levels. The census variables included:

Percentage under 6 population below the poverty level
Percentage of total occupied housing units built prior to 1950
- Percentage of rental housing units built prior to 1950

The individual percentages for each census block group within the three counties in the Bull Run Service Area were standardized by transformation to z-scores. The three resulting scores were then summed to create a risk index score for each census block group. Census block groups with the highest scores were considered to be at highest risk.

Exhibit 4-2 is a map which shows the distribution of risk index levels within the Bull Run Service Area. The legend shows the range of risk from white for the 50% of census block groups at lowest risk to dark red indicating the 5% at highest risk. As can be seen, the areas at highest risk are served directly by the Portland Water Bureau.

Exhibit 4-3 is a map which shows the areas at highest risk in greater detail with neighborhood boundaries indicated by black lines. Table 4-1 shows the number of children under age 6 in poverty and the number of pre-1950 housing units in each of the ten neighborhoods with the highest concentration of high risk census block groups. The neighborhoods are listed in an approximate rank order of the calculated risk index. Refinement of the methodology used to calculate the risk index may result in some shifting in ranking of the neighborhoods.

Table 4-1
Preliminary Listing of 10 Highest Lead Risk Neighborhoods
Using 1990 U.S. Census Data

Neighborhood	**# Pre-1950 Homes**	**# Children Under** Age 6 in Poverty
Humboldt	1620	126
King	1750	221
Sabin	1117	51
Hosford-Abernethy	2832	59
Boise	841	140
Eliot	969	78
Portsmouth	1611	305
Buckman	3566	104
Overlook	2102	72
Arbor Lodge	2092	73

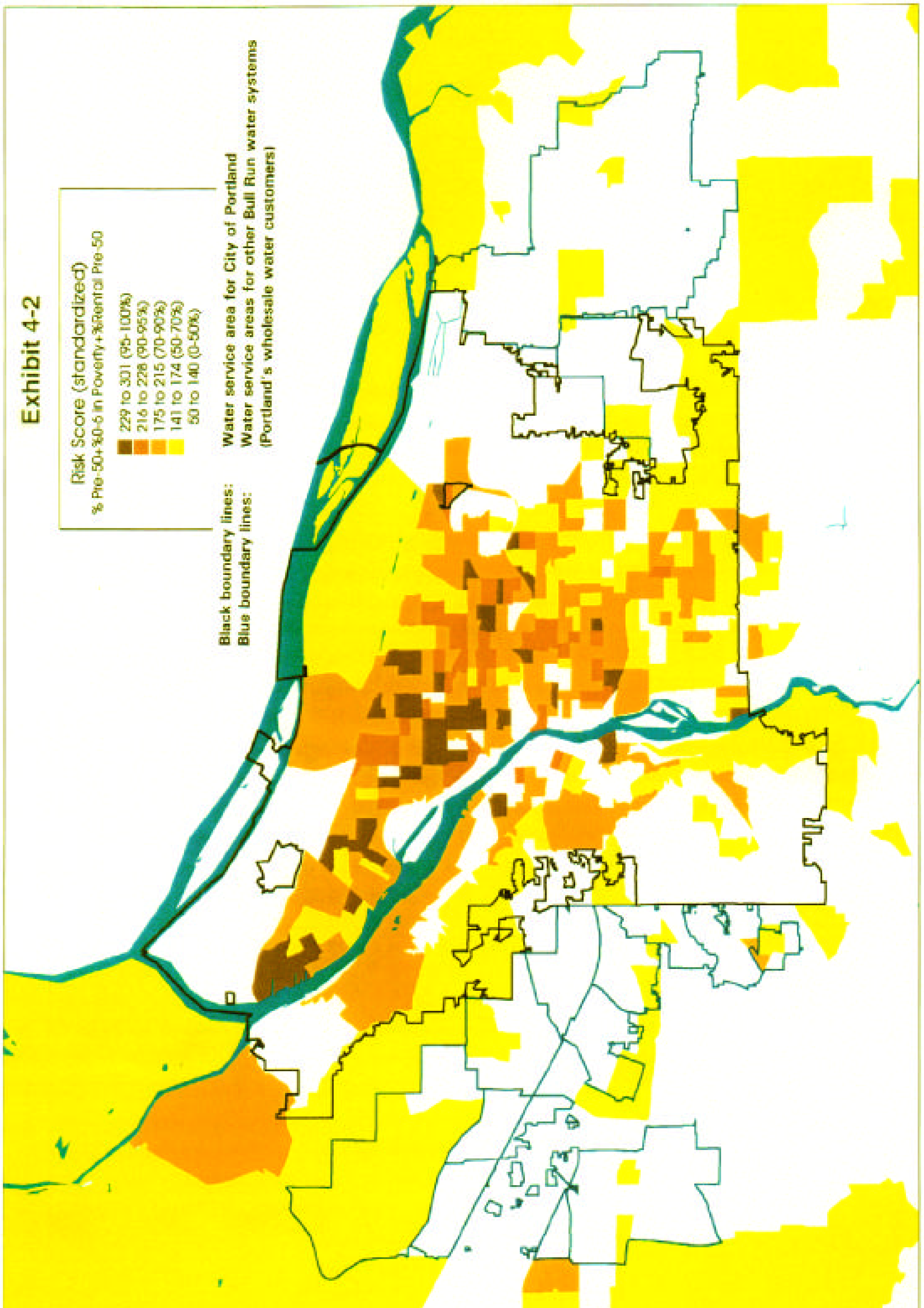


Exhibit 4-2
Risk Score (standardized)
% Pre-50+%0-6 in Poverty+%Rental Pre-50
229 to 301 (95-100%)
216 to 228 (90-95%)
175 to 215 (70-90%)
141 to 174 (50-70%)
50 to 140 (0-50%)
Black boundary lines: Water service area for City of Portland
Blue boundary lines: Water service areas for other Bull Run water systems
(Portland's wholesale water customers)

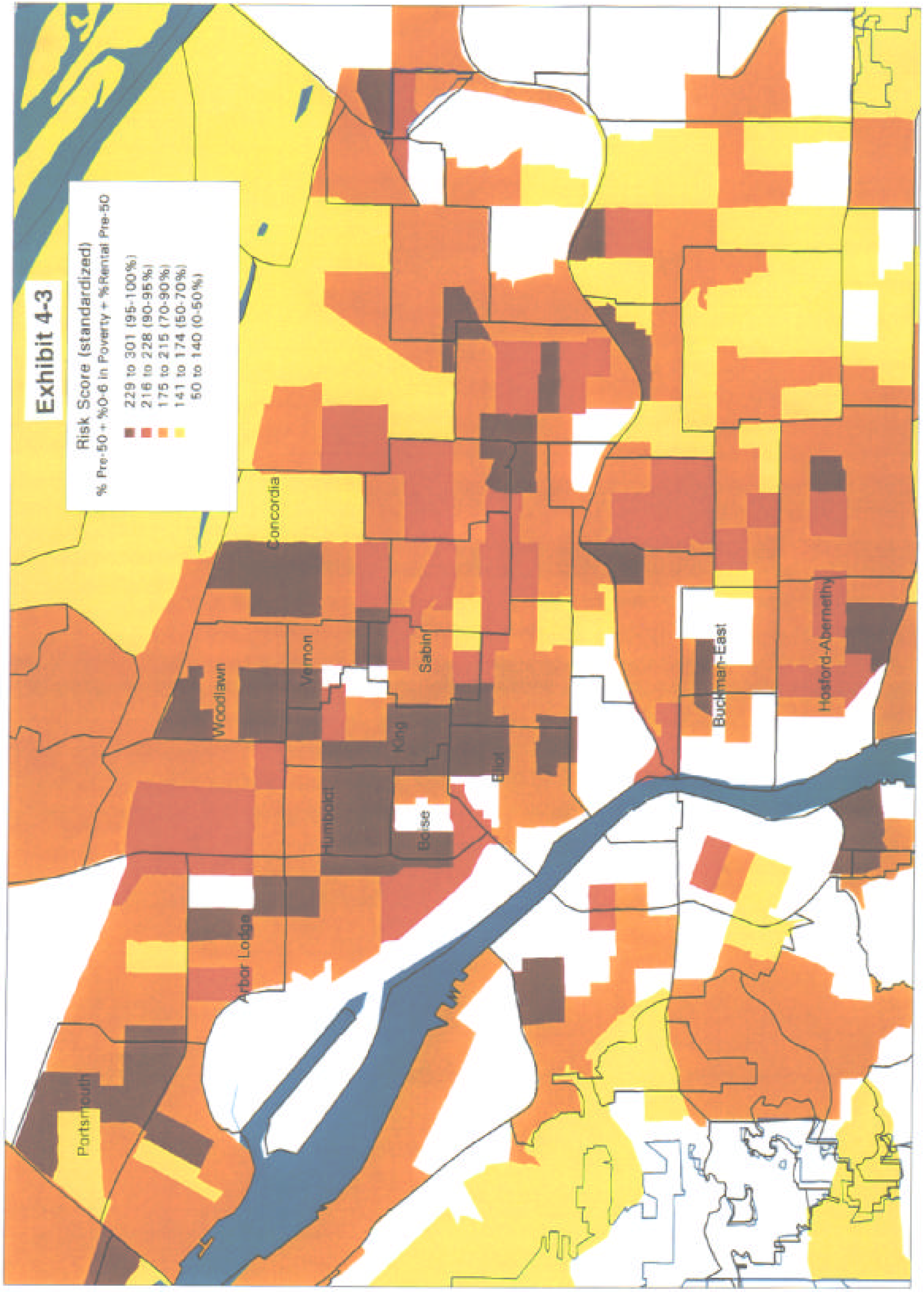


Exhibit 4-3
Risk Score (standardized)
% Pre-50 + %0-6 in Poverty + %Rental Pre-50
229 to 301 (95-100%)
216 to 228 (90-95%)
175 to 215 (70-90%)
141 to 174 (50-70%)
50 to 140 (0-50%)
Concordia
Woodlawn
Vernon
Sabin
King
Eliot
Humboldt
Boise
Arbor Lodge
Portsmouth
Buckman-East
Hosford-Abernethy

Develop a Home Lead Hazard Reduction Protocol

A workplan for the Home Lead Hazard Reduction Component would be developed based on concepts presented in this report, and any new information made available through literature searches, contact with other persons with expertise in lead hazard reduction, and/or contact with other organizations involved in similar efforts. The workplan would include protocols for:

neighborhood lead risk evaluation,
in-home lead risk evaluations,
o component evaluation,
data management, and
training and hiring staff.

The necessary "tools" would also be developed for this component, including training materials, promotional and educational materials, lead risk evaluation materials, arrangements with environmental testing laboratories and OCLPPP for blood lead level testing, materials for remediation assistance, and a project database.

Develop Neighborhood Support

Within each neighborhood, a base of support will be developed for the Home Lead Risk Reduction component. We would begin by contacting a variety of organizations and individuals within the neighborhood to introduce the component. Depending on the existing social and political climate in the neighborhood, the support for LHRP activities could be organized through an existing group or coalition, a new coalition, or a less formal network of organizations and individuals willing to support the program in various ways.

The neighborhood support group would be educated on lead exposure issues in general, how their neighborhood was identified as a high risk neighborhood, and the goals and proposed activities of the LHRP. The support group's assistance and advice would be sought in:

Reviewing the LHRP's approach to home lead risk evaluation and remediation, and identifying modifications that could be made to enhance its success;

preparing a specific neighborhood coverage plan for home lead risk evaluation;

advertising the LHRP (for example, by posting or distributing materials, hosting informational meetings);

recruiting neighborhood candidates for training and employment as peer risk evaluators;

conducting a neighborhood-specific lead risk evaluation, and

reviewing the LHRP's effectiveness in reducing risks of lead exposure in the neighborhood.

Conduct Neighborhood Lead Risk Evaluation

Within each neighborhood, a survey will be conducted to identify significant or potentially significant non-residential lead exposure sources for children in the neighborhood. (Residential risks will be evaluated in individual eligible homes). Non-residential lead sources may include active or abandoned industrial sites, play areas containing lead-based painted surfaces or lead-contaminated soil, bridges or other structures maintained with lead-based paint, and other sources. Testing of some environmental samples may be conducted. This work would be conducted by LHRP staff with active participation from the neighborhood support group. Management of any non-residential risks identified would be outside the scope of the Water Bureau's LHRP, and could be addressed by the neighborhood support group.

Conduct Home Lead Risk Evaluations

Home lead risk evaluations would be offered to all eligible homes in the neighborhood. Several people from the neighborhood ("neighborhood peers") would be hired and trained to offer and conduct these evaluations.

These home lead risk evaluations will consist primarily of 1) completing a checklist of questions about the home that are relevant to estimating the level of lead risk exposure in the home, 2) collecting a sample of household dust and/or soil for laboratory analysis, and 3) in-home education of potential lead exposure risks. Blood lead level testing for children age 6 or younger will be offered through the OCLPPP program. A packet of information would be left at each eligible residence, whether or not a risk evaluation was accepted by the residents.

Recommendations for hazard reduction would be offered to tenants or property owners in which an actual or potential lead hazard was identified. A range of potential in-home interventions would be recommended based on the nature and extent of hazards identified, taking into account any relevant circumstances associated with the particular residence.

Recommendations would be consistent with HUD/EPA recommended treatments for lead-based maintenance and hazard control in rental housing, such as correcting conditions in which painted surfaces could produce lead dust, specialized cleaning, and covering bare residential soil and performing essential maintenance (HUD, 1995).

LHRP staff will encourage the resident or rental property owner to control the hazard as recommended by developing a workplan with the resident, and offering assistance in the form of training and/or basic supplies (such as protective plastic sheeting, tape, respirator, access to HEPA vacuum cleaner). Additional resources in the form of financial assistance to low income families may be provided if the ongoing implementation evaluation indicates that lack of financial assistance poses an obstacle to reducing lead hazards and no other avenues for assistance are available.

Follow-up on Hazard Control Efforts

LHRP staff would follow-up with residents in homes where recommendations were made for lead hazard control. The purpose of this follow-up would be to encourage completion of the recommended work and collect samples to assess the intervention's effectiveness.

Outcome Evaluation

A detailed evaluation plan will be developed in conjunction with further development efforts for this component.

4.5 Public Education about Lead Health Risks

4.5.1 Purpose

The purpose of this component is to provide primary prevention of lead exposure through public education. The goal is to increase the awareness of the entire community about lead health risks and make special efforts to effectively provide relevant information to those at greatest risk of lead exposure. A well designed and implemented public education program has the potential to be the most effective means of preventing lead exposure.

The Lead and Copper Rule requires water systems that exceed the lead action level to carry out a prescribed public education program. This program consists of distributing mandatory text at specified frequencies to water system customers, various health care providers and social service agencies, schools, and the news media. These requirements are summarized in Table 4-2.

Table 4-2
Lead and Copper Rule - Required Public Education Program

Apparent Target	Item Ref.	Required Message	Required Medium	Required Delivery to	Required Delivery by	Required Frequency
General Public	1	EPA "long"	Written Notice	water system	mail with water	1/year
	2	EPA "long" message		editorial		1/year
	3	EPA Public Service		radio and TV		2/year
Health Care and/or Health Education	4	EPA "less long" message	Written Notice	public and private hospitals and		1/year
	5	"	"	family planning clinics		1/year
	6	"	"	pediatricians		1/year
	7	"	"	City or County Health		1/year
	8	"	"	WIC and/or Head Start agencies		1/year
	9	"	"	local welfare agencies		1/year
	10	"	"	public schools		1/year

The required public education program has a number of obstacles to optimum effectiveness. The mandatory message only addresses lead in drinking water, and does not address other sources of lead in the environment, such as lead-based paint, that are more likely to result in high levels of exposure. Sub-populations at significant risk to high lead exposure levels (such as "do-it-yourself" remodelers) do not receive relevant information as a part of this program. The mandatory message that water systems are required to distribute to customers is long (>1200 words) and complex (12th grade level reading level; a typical Hemingway short story is written at a 4th grade reading level). People who do not receive water bills (for example, people living in apartments) do not receive the mandatory message. Also, in the Portland metropolitan area, rarely has distribution of required information to the news media resulted in coverage of the issue of lead in drinking water.

4.5.2 Activities

The activities proposed in the public education component of the Lead Hazard Reduction Program are outlined in Table 4-3.

The proposed education component may be more effective than the required LCR program in preventing significant lead exposures in the community for a number of reasons. First, messages delivered in this program address multiple potential sources of lead exposure, not just water, and would be have the appropriate content level of complexity for their intended purpose and audience. Second, messages would be delivered to a larger set of target audiences, the most important of which may be those providing general care and health care to young children. Third, messages would be delivered to a potentially larger general audience by paid or donated advertising in newspapers and radio and mailings to targeted postal customers instead of water system customers. Last, messages to health care providers and social service agencies would be delivered more effectively, primarily by visit from a health educator rather than by mailing brochures to an institution. For example, the public health educator may meet with the hospital education coordinators, present information to physicians through continuing education programs, and meet with school administrators to make them aware of a short lead safety program available to school health teachers.

In addition to the specific activities listed in Table 4-3, a Lead Hazard Reduction Resource Center would be developed and operated as part of this program to serve as a central source of information to the community.

4.5.3 Development

A public health educator would have the primary responsibility for development of the public education program, in coordination with OHD/Multnomah County Program Evaluation staff. Existing materials, such as brochures developed by the EPA or National Lead Information Center should be used when possible, and modified for local conditions if necessary. This development is estimated to require up to 6 months to complete.

4.5.4 Implementation

A public health educator will be charged with implementing the public education program. As implementation strategies are developed, consideration will be given to the use of the "Community Mobilization Framework" model (Person and Cotton, 1996).

Table 4-3
Public Education Component

Target Audience	Item		Message	Medium	Delivery to	Delivery by	Frequency
General Public	1	Required by LCR	"long version" of mandatory text	written notice	water system customers	mail with water bill	1/year
		Comments	Too long (>1200 words) and complex (12th grade			people who don't receive water bills	
		Proposed	simple, brief, but	brochure or small	"at-risk" residential postal	mail separate or with	1/year
	2	Required by LCR	"long version" of mandatory text		editorial departments of newspapers		1/year
		Comments	lacks information about significant sources of lead		newspapers not obligated to publish information		
		Proposed	proposed message for Item	paid or donated	advertising departments of		1/year
	3	Required by LCR	mandatory Public Service Announcement text		radio and TV stations		2/year
		Comments	lacks information about significant sources of lead		radio and TV stations not obligated to broadcast PSA		
		Proposed	proposed message for Item	paid or donated	advertising departments of		2/year

Table 4-3 (Continued)
Public Education Component

Target Audience	Item		Message	Medium	Delivery to	Delivery by	Frequency
Health Care and/or Education	4	Required by LCR	"less long" version of mandatory text	written notice	public and private hospitals and clinics		1/year
		Comments	lacks information about			mailed brochure	
		Proposed	comprehensive message	information	education departments of	public health	1/year
	5	Required by LCR	same as for Item 4	same as Item 4	family planning clinics		1/year
		Comments	same as for Item 4			same as for Item 4	
		Proposed	same as for Item 4	same as Item 4	family planning clinics	same as for Item 4	1/year
	6	Required by LCR	same as for Item 4	same as Item 4	pediatricians		1/year
		Comments	same as for Item 4		should include other medical	same as for Item 4	
		Proposed	same as for Item 4	same as Item 4	pediatricians	public health	1/year

Table 4-3 (Continued)
Public Education Component

Target Audience	Item		Message	Medium	Delivery to	Delivery by	Frequency
Health Care and/or Education	7	Required by LCR	same as for Item 4	same as Item 4	City or County Health Departments		1/year
		Comments			County Health Departments are		
		Proposed	none				
	8	Required by LCR	same as for Item 4	same as Item 4	WIC and/or Head Start agencies		1/year
		Comments	same as for Item 4			same as for Item 4	
		Proposed for LHRP	same as for Item 4	same as Item 4	WIC and/or Head Start agencies	same as for Item 4	1/year
	9	Required by LCR	same as for Item 4	same as Item 4	local welfare agencies		1/year
		Comments	same as for Item 4			same as for Item 4	
		Proposed	same as for Item 4	same as Item 4	local welfare agencies	same as for Item 4	1/year
	10	Required by LCR	same as for Item 4	same as Item 4	public schools and/or school boards		1/year
		Comments	same as for Item 4				
		Proposed	lead safety information for	short lead safety	public and private school	public health	1/year

Table 4-3 (Continued)
Public Education Component

Target Audience	Item		Message	Medium	Delivery to	Delivery by	Frequency
General Care Providers for	11	Required by LCR	no				
		Proposed	proposed message for	brochure or small	parents of newborns, via	by visit from public	1/year
	12	Required by LCR	no				
		Proposed	same as for Item 11	same as for Item 11	parents and staff at day care	day care facilities	1/year
Non-professional	13	Required	no				
		Proposed	Information to reduce lead	brochures and/or	remodelers via retail "home	retail home	
Non-English	14	Required	no				
		Proposed	Messages for Items 1, 2,	as for Items 1, 2, 3,	as for Items 1, 2, 3, 11 and 13,	community-based	

4.5.5 Outcome Evaluation

Evaluation will be conducted by the OHD/Multnomah County PDES. General evaluations of effectiveness will be conducted by surveying a cross-sectional representative sample of the general public in the Bull Run service area to determine baseline knowledge and attitudes about lead hazards and ascertain changes in knowledge as the program progresses. The mechanism used to conduct this survey will be through additional questions provided to the ongoing Behavior Risk Factor Surveillance Survey (BRFSS). Specific evaluation process will also take place for targeted groups. For example, a sample of people obtaining remodeling permits could be surveyed to determine what steps were taken to reduce lead exposure during remodeling.

4.6 LHRP Summary and Schedule

Exhibit 4-4 presents a matrix that summarizes all of the activities to be conducted within the LHRP and incorporates a schedule showing when the component will be developed, when it will be implemented, evaluated and when reports will be prepared.

Section 5
Administration

The proposed administrative structure of the Lead Hazard Reduction Program is shown in Exhibit 5-1 and Table 5-1.

A steering committee will be developed to ensure that the objectives of the Lead Hazard Reduction Program are met. The steering committee should include representatives from the Portland Water Bureau, Water Managers Advisory Board, Oregon Health Division Occupational, Environmental and Injury Epidemiology (OEI-EPI) Section, Multnomah County Health Department, Washington County Health Department, Clackamas County Health Department, OHD/Multnomah County Program Design and Evaluation Services (PDES) Staff, and representatives from community-based organizations. A program manager will be designated by the Water Bureau to ensure that regulatory requirements are met throughout the LHRP.

The Water Treatment Component and the Lead-in-Water Testing Component would be conducted by the Water Bureau. The PDES staff will evaluate the effectiveness of the Lead-in-Water Testing Component.

A Principal Investigator will be responsible for the Home Lead Exposure Prevention component and the Lead Exposure Prevention Education component. The Home Lead Exposure Prevention component will be carried out by a Manager and a group of trained neighborhood peers who will conduct much of the field work. The Lead Exposure Prevention Education component will be carried out by a health educator and community based organizations (CBOs). The activities for both these components will be evaluated by a principal investigator and dedicated research assistant.

Contractual arrangements in the form of inter-agency agreements will be used to establish the working relationships and will include detailed workplans and budgets.

Exhibit 5-1
Responsibilities by Component

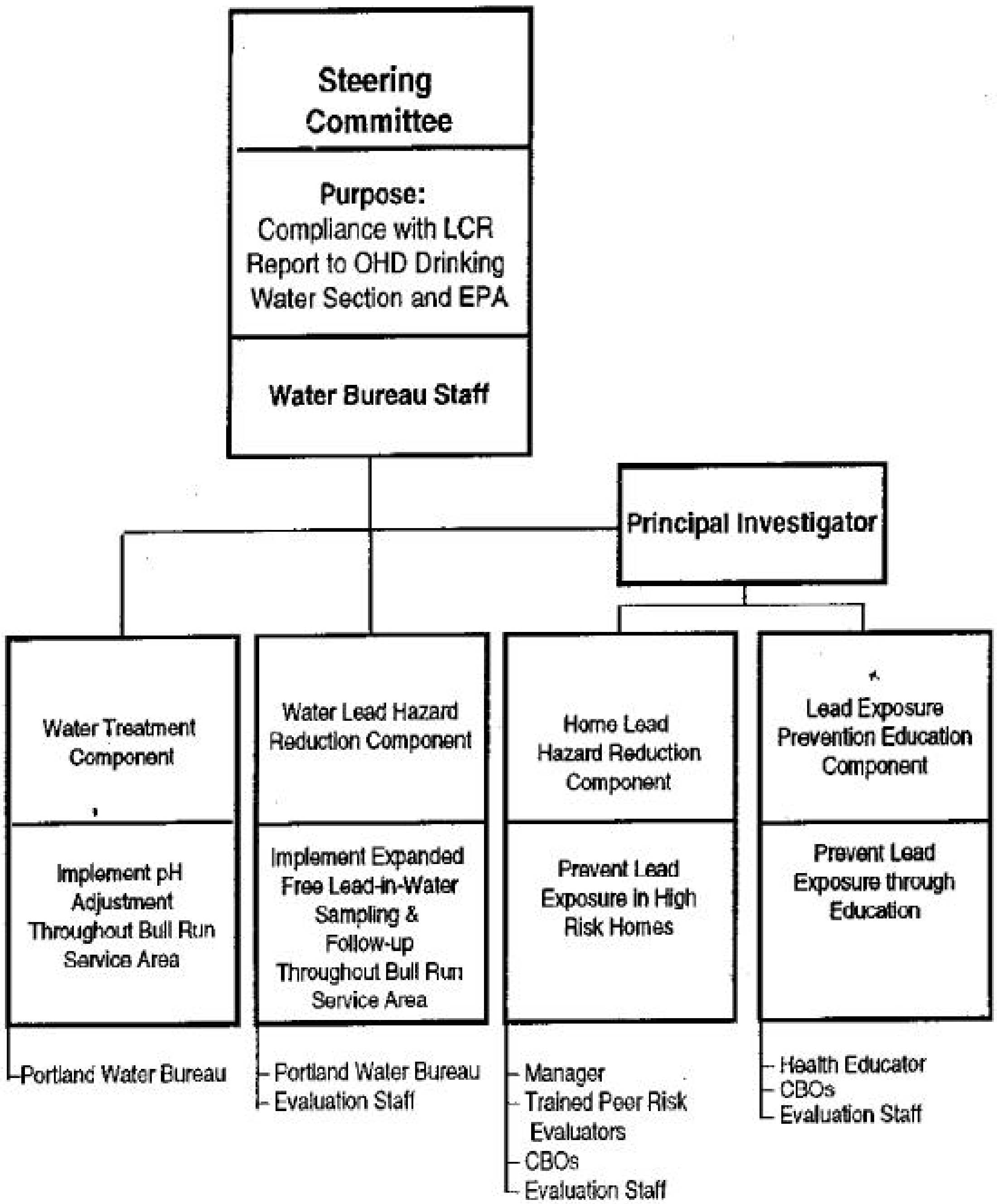


Table 5-1
LHRP - Organizational Responsibilities

Organization or Title	Water Treatment Component	Water Lead Risk Reduction Component	Home Lead Exposure Prevention Component	Lead Exposure Prevention Education Component	Overall LHRP Responsibility
Portland Water Bureau	Design, Implementation, Evaluation and Reporting of Activities	Design, Implementation and Reporting of Activities			Lead Steering Committee, Report to OHD Drinking Water Section
Water Managers Advisory Board					Participate in Steering Committee
Principal Investigator/ Evaluation Staff		Input to Design and Conduct Evaluations	Design, Monitor Implementation and Conduct Evaluations	Design and Conduct Evaluations	Participate in Steering Committee
Program Manager			Design and Implementation of Activities		Participate in Steering Committee
Health Educator			Provide Support for Educational Activities	Design and Implementation of Activities	Participate in Steering Committee

Section 6
Program Cost Estimate

Budget

A five year preliminary cost estimate for the LHRP has been developed and is summarized in Table 6-1. The budget for the water treatment components were developed by Montgomery Watson, 1996 and modified based on actual construction costs to date.. The preliminary cost estimates for the other three components of the LHRP were developed by the LHRP Development Committee.

The LCR required approach is estimated to cost an additional $2.00 million in capital costs and an additional $200,000 or more per year to operate as compared to the Lead Hazard Reduction Program.

It is estimated that LHRP development, implementation, and evaluation would require a period of about 5 years. The Portland Water Bureau and its wholesale water customers should commit to funding the LHRP for at least this amount of time. After this period of time, the future of the LHRP should be considered in terms of its value to the community (benefits achieved and potentially achievable), and value as an alternative to LCR optimal treatment and public education requirements.

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