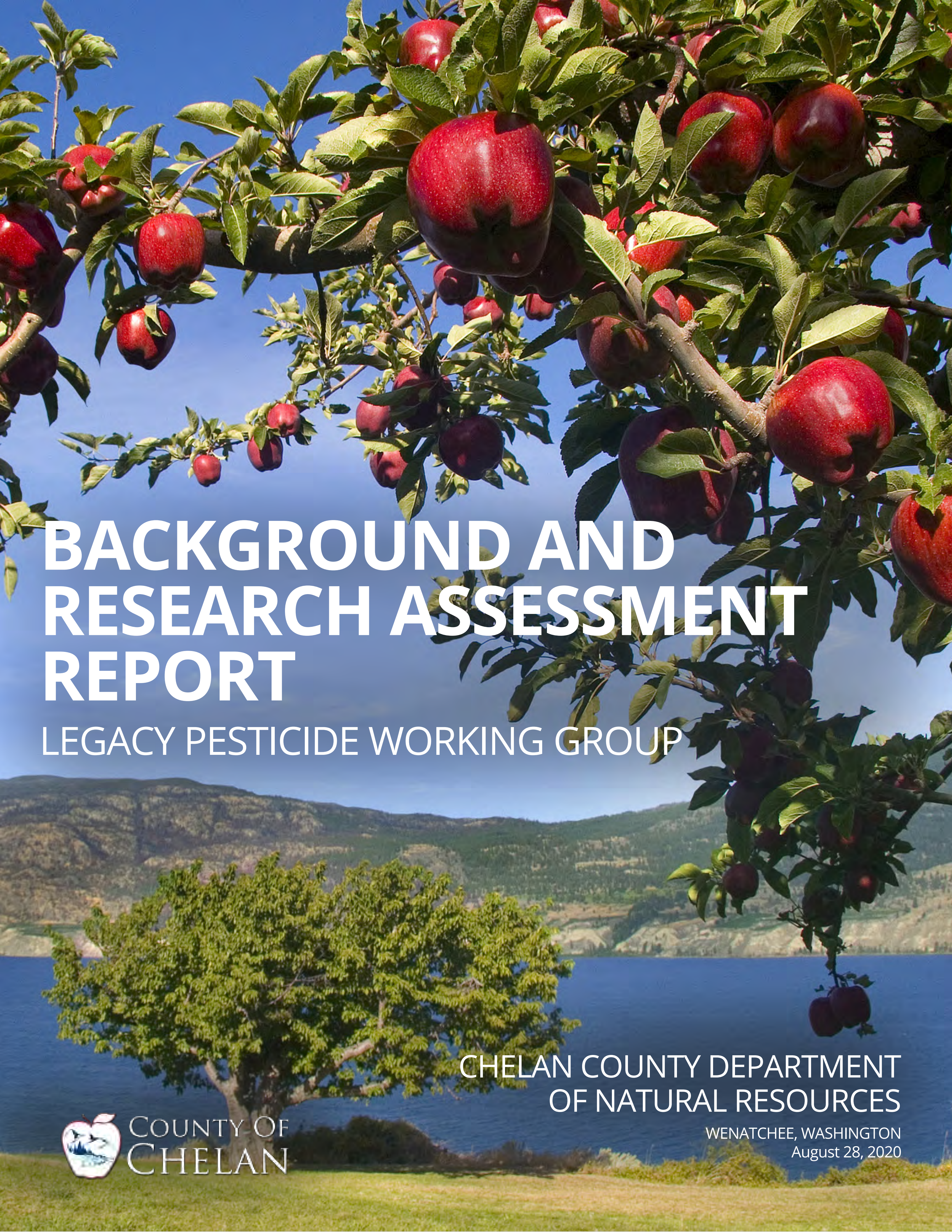

BACKGROUND AND RESEARCH ASSESSMENT REPORT

LEGACY PESTICIDE WORKING GROUP

CHELAN COUNTY DEPARTMENT OF NATURAL RESOURCES

WENATCHEE, WASHINGTON

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COUNTY OF CHELAN

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BACKGROUND AND RESEARCH ASSESSMENT

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
BLRV	blood lead reference value
BMP	best management practice
CDC	Center for Disease Control
DATCP	Wisconsin Department of Agriculture, Trade and Consumer Protection
DNS	Determination of Nonsignificance
DS	Determination of Significance
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HPTCF	Historic Pesticide Contamination Task Force
LA	lead arsenate
LPWG	Legacy Pesticide Working Group
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act
NJDEP	New Jersey Department of Environmental Protection
ppm	parts per million
SEPA	State Environmental Policy Act
ug/dL	micrograms per deciliter

INTRODUCTION

Tree fruit orchards have been an important economic and cultural resource in Central Washington communities since the late 1800s. Increasing demand for housing and related community growth has resulted in conversion of historical orchards to other, nonagricultural activities, including residential development. Historical application of lead arsenate pesticides on tree fruit orchards has resulted in the presence of lead and arsenic in shallow soil at levels that may be harmful to human health if converted to a residential use.

BACKGROUND

Tree fruit orchards have been an important economic and cultural resource in Central Washington communities since the late 1800s. Until approximately 1950, agricultural activities at tree fruit orchards often included the use of lead arsenate (LA) pesticides to mitigate insect damage. In some cases, historic application of LA pesticides has resulted in concentrations of lead and arsenic contamination in shallow soils that exceed Washington State cleanup levels. According to the Washington State Agricultural Census from 1947, compiled by the Washington State Department of Ecology (Ecology), nearly 188,000 acres of land in Washington have been historical orchard areas subject to application of LA pesticides, and are therefore considered potentially contaminated by lead and arsenic. Of those areas, approximately 115,000 acres of potentially impacted tree fruit orchard lands are in Yakima, Chelan, Douglas, Okanogan, and Benton counties.

Growth in these counties has resulted in the transition of tree fruit orchards to nonagricultural uses (e.g., residential or commercial), increasing the potential for more frequent, direct exposure to shallow soil that may have elevated concentrations of lead and arsenic that could adversely impact human health. In many cases, the concentration of lead and arsenic in the historical orchard soil exceeds the Washington Model Toxics Control Act (MTCA) cleanup levels for these compounds. MTCA requires appropriate assessment, notification, and mitigation tools to ensure sufficient protection of potential, current and future residents living in historical tree fruit orchard areas where lead and arsenic may be present at levels of concern.

PREVIOUS STUDIES

Historical orchards that may have been contaminated by LA pesticide and then transitioned to nonagricultural uses, increase the potential for human health risks, and remain a primary concern. There has been a community discussion on how to deal with development of former orchards for many years. Since the mid- to late-1990s, various conversations and processes have occurred among state agencies and stakeholders on the topic of area-wide contamination, including the historical use of LA pesticides on former agricultural lands. Because area-wide contamination covers large areas, the methods of assessment, notification, and mitigation are distinct from those applicable to the more typical, site-specific occurrences of contamination. As new development takes place, a wide variety of health, environmental, and market considerations arise. These issues are likely to trigger review and mitigation actions, at both the state and local levels.

Figure 1. Historical Tree Fruit Orchards in Yakima, Washington

Source: Washington State Historical Society

Figure 2. Color Illustrated Apple Crate Label

Source: Washington State Historical Society

In 2002, Ecology formed the Area Wide Lead and Arsenic Task Force. The task force members represented community and business interests. The task force's work was led by the Washington State departments of Health, Ecology, and Commerce, and evaluated concerns about area-wide soil contamination, including, among others, those associated with LA pesticide application on historical tree fruit orchards. The task force developed recommendations on how to address the issues associated with contamination from orchard operations. The following recommendations were incorporated into a report prepared by Ecology (Ecology, 2003):

- Describe where LA area-wide contamination is most likely to be located.
- Provide guidance on assessment and sampling of individual properties.
- Outline a broad-based approach to education and awareness about lead and arsenic soil contamination.
- Describe steps to take in child-use, residential, and commercial areas, and on open land, to limit exposure to LA pesticide in soil.
- Address real estate disclosure issues and the application of MTCA in areas affected by area-wide LA pesticide soil contamination (Ecology, 2003).

The recommendations dealt with several different known sources of area-wide contamination that occur throughout the state, affecting more than 677,000 acres. Several of the specific recommendations have been implemented, including mapping the location of historical orchards in Central Washington. There are additional ideas and recommendations that have not been put into action but that may help to inform the current efforts.

CURRENT STUDY EFFORT

The Legacy Pesticide Working Group (LPWG) was formed in February 2020 and includes a diverse group of stakeholders, representing private and public interests, throughout Central Washington. As described on Ecology's website for this effort, the purpose of the LPWG is "*to address the complex issues surrounding lead and arsenic contamination on former orchard lands*".

The primary objectives are:

- Creating a process for all properties to be evaluated.
- Notifying buyers and/or current homeowners concerning the specifics of LA pesticide contamination on their property.
- Identifying actions that meet Ecology's cleanup regulations.
- Creating a broad-based strategy for educating the public about the manageable risk from LA pesticide contamination.

This report has been prepared in support of the LPWG's efforts and is intended to assist in developing a common understanding of the status of the issue by addressing the following topics:

- Describe the current Ecology-sponsored stakeholder process to address the issue of transitioning historical tree fruit orchards to nonagricultural uses, potential health concerns, and related community concerns.
- Describe the risks to human health from lead and arsenic.
- Outline applicable state and federal regulations associated with lead and arsenic concentrations in soil.
- Identify sampling strategies for determining if shallow soil is impacted at levels that could threaten human health.
- Through the review of case studies of similar large-scale environmental issues, identify approaches used in other states dealing with similar situations.

To accomplish the stated objectives of the current LPWG process, the program/approach that is recommended will likely integrate land use planning with MTCA cleanup policy by providing planning and development tools, notification and guidance as well as standard assessment and remediation approaches, public education and outreach, and funding.

COMMUNITY CONCERNS

In addition to community concerns received by Ecology, LPWG members have voiced concerns about the impacts of historic LA pesticide contamination and how development in areas potentially affected by LA pesticides are evaluated. Four main areas of concern were identified: (1) how residents are informed about potential LA pesticide impacts, (2) Ecology's review of proposed development projects, (3) the preliminary maps of potentially affected areas, and (4) the impact of each of these on future development, particularly affordable housing.

There are three consistent themes that surfaced as the LPWG members expressed their concerns related to these topic areas:

- **Health:** Many are concerned with the increased health risks for people living in areas with historical use of LA pesticides, particularly if they are unaware of the contamination.
- **Costs:** There is a concern there will be increased costs associated with addressing LA pesticide contamination, particularly as new residential development in historic orchard areas occurs. Increased development costs (e.g. those associated with perception, assessment, mitigation, and remedies) could disproportionately increase the cost of housing, resulting in a shortage of housing. Where an inadequate supply and mix of housing types exists, the affordability of what does exist in the market is negatively affected, often across a variety of income sectors.
- **Notification, Education and Outreach:** Currently, there is significant confusion about the LA pesticide contamination issue, in a variety of circumstances, resulting in a need for an education and outreach effort that reaches a wide variety of stakeholders. Areas of concern related to confusion and a lack of awareness of the issue include ensuring all potential stakeholders (e.g., homeowners, developers) are aware of the issue; understanding who may be liable for historic LA pesticide contamination and required cleanup activities; creating consistent messaging and guidance

related to process, timing and obligations for compliance as property is being developed; and making sure updated, accurate data is used to create easy to find mapping resources to help stakeholders understand if their property/ project may be affected by historic LA pesticide applications.

A more detailed discussion of these existing community concerns is provided below to assist in understanding the issues/topics to be considered as further analysis of methods to achieve compliance with applicable regulations occurs during the current LPWG process.

NOTIFICATION

There is concern that buyers or renters in affected areas may not be adequately informed of the presence of soil contamination. In real estate transactions, sellers are required to disclose soil contamination or other environmental concerns if it has been confirmed through soil sampling (Ecology, 2019a). But it is unclear if these disclosures are consistently being made in areas affected by historic LA pesticide application, and there does not appear to be a consistent requirement for disclosure in place for rental properties. A homebuyer or renter could purchase or lease a home without being aware of the potential risk posed by LA pesticide impacted soils. Without this awareness, homeowners and renters may not know that they need to implement remedies and best practices that can help to protect and manage human health impacts from these contaminants.

The confusion about how and when to disclose, and who is responsible for disclosing potential LA pesticide contamination, may cause delays and disagreements between sellers and buyers. It could also complicate the mortgage lending process. A deed restriction or notification related to a health and safety issue may complicate the title insurance process, making it more difficult to obtain a mortgage. Lenders, whether direct to buyers or in the secondary market, will likely require that any type of health and safety issue related to potential LA pesticide contamination be addressed in some manner before moving forward with a mortgage loan.

One existing notification process that the LPWG identified as a potential model for potential LA pesticide on historical, former orchard lands is the disclosure regarding lead-based paint hazards in housing. As a result of the passage of the Federal Residential Lead-Based Paint Hazard Reduction Act of 1992, this federally required disclosure mandates that buyers or renters of any residential dwelling built prior to 1978 be provided the formal notification and disclosure as part of the sale or lease contract, and that the buyer or renter be provided with educational materials about protecting their family from lead in the home (U.S. Environmental Protection Agency [EPA] and HUD, 1996). If a similar notice could be provided in areas potentially contaminated by historic LA pesticide application, without prohibiting or negatively affecting the sale or lease transaction, future buyers and residents could make informed decisions and become knowledgeable about the many remedies and best management practices that will protect them from impacts from lead and/or arsenic that may be present.

DEVELOPMENT PERMIT PROCEDURAL CONCERNS

Cities and counties are the decision-making authorities for new development projects, such as land divisions, building construction, and other types of changes in land use. In this role, they often have a coordinating function, ensuring that impacts from the new development are identified and mitigated, if necessary, even when those impacts may be regulated by a different agency or entity. During the application review process, the city or county will share the proposed project information with other agencies that have jurisdiction over a project (e.g., a water district, sewer district, health district, power and telecommunications companies), and they will collect comments and develop conditions that the applicant must comply with as part of the approval process for their project. Most application reviews include an iterative process that allows for several different opportunities to interact with all the agencies that may govern the applicant's project. This process begins before an application is submitted and continues through to a final decision. This allows the proponents to decide if they want to continue with their project, given the array of requirements and associated potential costs, or if they want to delay or discontinue their development if they are not able or willing to meet the requirements and carry the costs.

The State Environmental Policy Act (SEPA) was adopted in Washington in 1971, and is intended to ensure the potential impacts on both the built and natural environment are considered as state and local agencies make decisions, including those decisions related to permitting and authorizing certain larger development proposals and changes in land use. The administrative rules implementing SEPA allow cities and counties to individually identify, within established limits, what types and sizes of minor new construction will be exempt from SEPA review. For example, cities and counties may choose to exempt residential developments at any level between 4 and 30 dwelling units in the urban growth area. The exemption for commercial buildings can range between 4,000 and 30,000 square feet. These "flexible thresholds" must be designated through ordinance or resolution by the city or county. If this has not been done, the minimum levels identified in WAC 197-11-800 will apply.

For those larger project proposals that are not exempt from SEPA review, cities and counties are required to cast a wider net in terms of asking for comments from other agencies, including providing Ecology with notice and information about the application. Recently, Ecology has provided comment on site-specific development proposals for areas potentially affected by LA pesticide contamination as a component of the agency's obligation to enforce MTCA requirements. Members of the LPWG have identified several concerns about the timing and implementation of these comments, including the following:

- Often, Ecology's comments are received later in the development permit process, which can make it difficult to incorporate sampling and remediation efforts early in the process. This can result in delays in obtaining project approval.
- Stakeholders have expressed concern that Ecology's comments lack clear guidance on how to address LA pesticides.
- Smaller development proposals are exempt from the SEPA review process and provide no opportunity for Ecology to review or comment on the proposal. This includes raising or addressing concerns specifically about LA pesticide contamination.

These issues create uncertainty for development projects, potentially lead to decreased new housing development and create negative impacts on housing affordability in an already undersupplied housing market.

EXTENT OF IMPACTED AREA

Ecology has developed maps that represent an estimation of potentially affected historical orchard areas in Chelan, Okanogan, and Yakima counties. Using historical aerial photos from approximately 1945 to 1955, these maps show areas below 2,500 feet in elevation (2,000 feet for Yakima County) that are privately owned and represent areas most likely to have been used for orchards when LA pesticides would have been used. These maps are available on Ecology's website: https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Cleanup-sites/Toxic-cleanup-sites/Former-orchard-lands.

Stakeholders have expressed concern that the maps define potentially affected areas too broadly and may include areas that have already been redeveloped or that have limited, or no LA pesticide impacts. For example, some areas near the communities of Chelan and Manson, in Chelan County, appear to be almost entirely identified as "areas where historical orchards may have been located." The LPWG expressed interest in conducting additional analysis to refine how potentially affected areas are identified, so developments are not unnecessarily subjected to additional review or requirements. Additionally, the LPWG has expressed support for providing online mapping resources that are clear, easy to find, centrally located and widely accessible.

It is important to note that Ecology acknowledges the maps currently accessible on their website were prepared as part of an internal informationgathering assessment and may therefore need updating. Ecology also notes that the maps are not intended to be relied upon to determine if a historical orchard was present on a property, or to determine whether LA pesticide contamination is present. Ecology is leading an effort to update historical aerial photos into a database that will more accurately identify suspected orchard areas on which historic application of LA pesticides occurred. It is important to note that initial sampling has shown that the aerial mapping to date is highly accurate in predicting increased levels of lead and arsenic on historical tree fruit orchard lands.

IMPLICATIONS FOR AFFORDABLE HOUSING

Each of the concerns discussed above present challenges to housing affordability in the communities dealing with potential historic LA pesticide contamination. There are potential direct impacts to would-be developers if procedural concerns add uncertainty and significant new costs to development projects. If sampling and/or cleanup actions are required, construction could be delayed, adding unknown additional costs to a project. Additionally, because of potential health and safety as well as liability concerns, lenders may be hesitant to issue development loans on projects if contamination exists or is suspected to be present. These scenarios raise a concern that developers might choose to avoid projects in areas that have been identified as potentially being affected by historic LA pesticide contamination.

Currently, communities in eastern Washington and across the state lack sufficient housing supply, especially units accessible to lower income residents. For example, the Washington State Department of Commerce's 2018 analysis found that 338,000 housing units are needed statewide to serve families that make less than 50 percent of the area median income. If concerns over LA pesticide contamination act as a barrier to development of new housing units, whether single family or multi-family, the already constrained housing supply could be more restricted and access to affordable housing further exacerbated.

Figure 3. Affordable Housing Development

NATURE OF RISK ASSOCIATED WITH LEGACY LEAD AND ARSENIC CONTAMINATION

Lead and arsenic are toxic to humans, even at low concentrations. Children are especially vulnerable to the health risks associated with lead and arsenic exposure. Prevention of exposure is the best way to mitigate potential health risks.

POTENTIAL IMPACTS TO PUBLIC HEALTH

From the 1900s until the late 1940s, LA pesticides were the treatment of choice to prevent insect damage to tree fruit orchards. At that time, LA pesticides were recommended for use by the U.S. Department of Agriculture and were legally applied to millions of acres throughout the United States, particularly on apple orchards. Although these applications took place many years ago, lead and arsenic strongly bind to soil and remain present in the initial application area. The dry, arid climate of Central Washington contributes to the persistence of these chemicals in shallow soil. Typically, the highest concentrations of lead and arsenic have been observed within the top 6 inches of soil, with concentrations decreasing dramatically at deeper depths and impacts generally not extending past 30 inches. Based on available data from Ecology, shallow soil concentrations on orchards where LA pesticides were applied frequently range up to 200 milligrams per kilogram (mg/kg) or parts per million (ppm) for arsenic and 1,500 mg/kg or ppm for lead in Central Washington. These concentrations are up to ten times higher than MTCA cleanup levels developed for protection of human health.

Lead and arsenic are persistent in the environment and are known to be toxic. Arsenic has been linked to various cancers,[1] heart disease, and diabetes (Agency for Toxic Substances and Disease Registry [ATSDR], 2007).[2] For carcinogenic substances such as arsenic, there is no safe threshold and the effects of repeated doses accumulate. That means cancer risk increases with even the smallest level of exposure. Lead is known to cause neurological damage and reduced physical growth, especially in children (ATSDR, 2019). Frequent or regular exposure to these chemicals results in the highest likelihood of these health risks.

It is unlikely that a single, one-time exposure would pose an immediate health risk, and virtually no instances of short-term adverse health effects have been documented in people living on orchard properties where LA pesticides have been applied (Hood, 2006). However, it is known that excessive and repeated exposure to either substance can adversely impact health in the long term. Therefore, it is important to understand potential exposure scenarios for children and adults who would regularly contact shallow soil on potentially contaminated historical orchards when considering appropriate actions to protect long-term human health.

EXPOSURE PATHWAYS

Ingestion or inhalation of contaminated soil is the primary pathway for exposure to arsenic and lead (ATSDR, 2007, 2019). This can include eating with dirty hands, placing dirty fingers in mouths, or inadvertently breathing in dust during soil-disturbing activities. Contaminated soil can also be brought inside homes by the wind, on shoes, and by pets, resulting in elevated concentrations in house dust (Wolz et al., 2003).

Young children are the most susceptible to lead and arsenic and are also the most likely to become exposed. Exposure to lead and arsenic is more likely to result in short- or long-term health risks for children than for adults, since children are still developing.[3] Children also more frequently come into close contact with dust on floors and dirt outdoors and are more likely than others to swallow contaminated soil and dust from their hands and toys.

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[1] The International Agency for Research on Cancer classifies arsenic and inorganic arsenic compounds as “carcinogenic to humans.”

[2] Arsenic can occur in two forms: inorganic and organic. Inorganic arsenic is highly toxic to human health, while organic arsenic is less harmful to human health. It is assumed that, in discussions of health risks associated with arsenic, inorganic arsenic concentrations are being considered.

[3] Children absorb approximately 40 to 90 percent more ingested heavy metals than adults do, and the mechanisms needed to metabolize and eliminate heavy metals evolve throughout childhood.

Adults with frequent, long-term soil interaction that may result in incidental ingestion or inhalation are also at greater risk. These include construction workers, landscapers, and gardeners. Agricultural workers who are employed primarily in fieldwork in the tree fruit industry aren't necessarily at greater risk because once an orchard is planted and the ground cover is established and maintained, regular soil disruption isn't prevalent in tree fruit production.

Other exposure pathways are less likely to contribute to health risks. Direct skin contact, such as touching contaminated soil with bare hands, is less likely to result in harmful exposure if dirty hands are washed prior to eating and drinking. Eating fruits or vegetables grown in soil with elevated concentrations of lead and arsenic poses little risk, if the produce is thoroughly washed to remove any residual dirt before the plants are eaten. Root and tuberous crops (e.g., potatoes and carrots) grown in contaminated soil pose minimal risk if pared prior to consumption and no discarded plant material with soil is consumed. Some edible plants do take up and accumulate metals; therefore, to minimize the potential risk it is often recommended that raised garden beds be used at properties with elevated concentrations of metals in soil.

The typical distribution of lead and arsenic concentrations in soil at historic orchard properties oftentimes have consistent patterns at different depths. For example, arsenic is more mobile than lead and therefore typically leaches to a greater depth in soil than lead. A typical profile of arsenic and lead concentrations is provided on page 18.

Figure 4. Potential Exposure Pathways for Soil Contaminated with Lead and Arsenic

Source: Maul Foster & Alongi, Inc.

BLOOD SCREENING LEVELS AND ASSESSMENTS

Blood testing can be conducted to determine if a person has been exposed to elevated lead concentrations (ATSDR, 2019). The Centers for Disease Control and Prevention (CDC) currently relies on a blood lead reference value (BLRV) of 5 micrograms per deciliter (ug/dL).[4] The BLRV represents blood lead levels that are much higher than most children's levels and is used to identify individuals at greatest risk of negative health impacts and to implement intervention actions as needed. However, the CDC notes that there is no blood lead level in children without risk (CDC, 2020).

Hair, urine, and fingernails can be tested for arsenic concentrations (ATSDR, 2007). An arsenic test will determine only if someone has been exposed to above-average concentrations of arsenic and cannot predict whether those concentrations will directly affect the person's health.

Conducting human blood or other human subject testing is often impractical, expensive, and when a problem is identified, it is too late because negative health impacts are already occurring. Lead and arsenic concentrations are typically measured in environmental media (such as soil) and compared with screening criteria developed by state and federal agencies. The screening levels are the concentrations of a chemical considered protective of the most sensitive populations that may become exposed to the chemical. Screening criteria for environmental media are based on models that account for the toxicity of the chemical and are set at concentration levels above which unacceptable risk to an exposed person is predicted. Evaluating and ultimately regulating lead and arsenic concentrations in environmental media is the standard approach taken by both the Federal EPA and by individual states across the United States.

It is important to note that MTCA does not evaluate or regulate blood levels. In Washington State, concentrations of chemicals in environmental media are regulated under MTCA, as outlined in Washington Administrative Code 173 - 340 and Chapter 70.105D of the Revised Code of Washington. Under MTCA, Ecology has developed soil cleanup levels that account for blood level guidelines (for lead), based on models that consider the reasonable maximum exposure assumptions that best predict unacceptable risk to the most sensitive populations.

COMPARATIVE STUDIES RELATED TO LEAD BLOOD LEVELS

In Washington State, the testing of blood lead levels is conducted on a voluntary basis, resulting in low testing rates when compared to other areas of the United States. The statewide testing rate in the three-year period between 2016 and 2018 was 4 percent. This low testing rate likely resulted in an underestimation of elevated blood lead cases, making it difficult to draw any definitive conclusions or develop an accurate understanding of elevated blood lead levels in Washington. The Washington State Department of Health recommends that healthcare providers assess all children for risk of lead poisoning at 12 and 24 months of age.[5] In addition, federal law mandates screening for all children covered by Medicaid.[6]

Testing rates in Chelan, Douglas, and Okanogan counties were lower than the state average of 4 percent. As described above, the lack of available blood lead level data in Washington does not allow for an accurate conclusion of blood lead levels in the state. Consequently, it is difficult to view the data presented by the

[4] In the past, the BLRV was set at 10 micrograms per liter; the new, lower, value is intended to allow parents, doctors, public health officials, and communities to take action earlier to reduce a child's future exposure to lead.

[5] Washington State Department of Health. Blood lead testing, information for health care providers, who to test for lead poisoning, 2020. https://www.doh.wa.gov/ForPublicHealthandHealthcareProviders/HealthcareProfessionsandFacilities/ProfessionalResources/BloodLeadTestingandReporting (accessed September 21, 2020).

[6] Washington State Department of Health. A targeted approach to blood lead screening in children (Washington State: 2015 Expert Panel Recommendations), DOH 334-383, p. 19, 2015. https://www.doh.wa.gov/Portals/1/Documents/Pubs/334-383.pdf (accessed September 21, 2020). Revised May 2016.

Washington State Department of Health as accurately representative of the prevalence of elevated blood lead levels in the state. Results for elevated blood lead level rates (BLRV greater than 5 ug/dL) in children (three years and under) tested between 2016 and 2018 in Washington State showed elevated blood lead levels were detected in 2 percent of children tested. Similar or higher rates were reported for Central Washington counties (1 to 6 percent), indicating higher incidences of elevated blood lead levels in some counties. However, it is difficult to draw conclusions from these comparisons because many factors (e.g., number of tested subjects, demographics) can affect the results. Because there are many potential sources of lead (e.g., soil, paints, pottery/dishes), it is also difficult to determine what sources are related to the detected elevated blood levels.

The limited data that has been compiled by the CDC in 2016 suggests that Central Washington counties do not appear to show significantly higher incidences of blood levels in children (five years and under) at or above 5 ug/dL compared to other counties in Washington state (CDC, 2020). For example, Chelan, Benton, and Douglas counties had fewer than six cases of detectable blood levels at or above 5 ug/dL in those children tested, which is like most eastern and western Washington counties in 2016. Yakima County showed 1.2 percent of cases with a BLRV higher than 5 ug/dL. This result is like King and Pierce counties[7] in Western Washington, which showed 1.6 percent and 0.5 percent, respectively, of children tested at a BLRV of 5 ug/dL or greater. As described above, the lack of available blood lead level data in Washington does not allow for an accurate conclusion of blood lead levels in the state. Consequently, it is difficult to view the data presented by the CDC as accurately representative of the prevalence of elevated blood lead levels in the state.

In 2020, the Washington State Department of Health presented results for elevated blood level rates (BLRV greater than 5 ug/dL) in children (three years and under) tested between 2014 and 2018 in Washington State. In this study, only 5 percent of children in Washington state were tested. Elevated blood lead levels were detected in 2 percent of children tested. Similar or higher rates were reported for Central Washington counties (1 to 6 percent), indicating higher incidences of elevated blood levels in some counties. However, it is difficult to draw conclusions from these comparisons because many factors (e.g., number of tested subjects, demographics) can affect the results. Because there are many potential sources of lead (e.g., soil, paints, pottery/dishes), it is also difficult to determine what sources are related to the detected elevated blood levels.

STUDIES RELATED TO LEAD HEALTH IMPACTS

Numerous studies have been conducted to evaluate the correlation of increased blood lead levels in children and concentrations of lead in the environment (e.g., lead in soil and dust) (Yankel, et al, 1977; Duggan 1983; Mielke, 1999; Benson, 2014). Studies have included rural and urban settings, proximity to smelters and heavy traffic, and areas with naturally occurring high concentrations of lead in soil (Duggan, 1983; Gallacher, et al, 1984).

These studies have largely concluded that children are at most risk for lead uptake, and that children living in areas with elevated lead concentrations in the environment have higher blood lead levels (Duggan, 1983). Typically, the highest concentrations of blood lead levels in children occur between 2 and 3 years of age. This has been largely attributed to the fact that young children interact closely to the ground and often place dirty items or hands in their mouth.

[7] The slightly higher incidence in King and Pierce counties may be related to increased testing and/or exposure related to the Tacoma Asarco Smelter site.

In northern Idaho, the operation of a lead smelter left widespread elevated concentrations of lead in shallow soil throughout nearby communities, including within areas of residential development (Yankel, et al, 1977). In the mid-1970s, shortly before closure of the smelter, elevated blood lead levels were documented in 80 percent of 370 tested children and 41 of those children were identified as having clinical lead poisoning (Snow, 2012). The magnitude of lead concentrations in soil near the former smelter are significant and regularly ranged up to 10,000 mg/kg (1 percent).

It was also shown that the two strongest variables resulting in an increased probability of a child experiencing an elevated blood lead level were: ambient air lead concentrations (i.e., airborne dust) and lead concentrations in soil. Because children are at highest risk for exposure to lead in the environment it was concluded that regulatory standards should be developed to ensure protection of children from exposure.

Although the concentrations of lead are typically lower in areas of historical orchards than at the Bunker Hill Superfund Site, the studies referenced show that concentrations present in the soil where LA pesticides were historically applied have the potential to result in elevated blood levels that can be associated with health impacts, particularly in children.


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APPLICABLE REGULATIONS

Federal and state regulatory authorities provide guidance on the appropriate cleanup levels for lead and arsenic in soil. These regulations account for regional natural background as well as the reasonable maximum exposure scenarios predicted to be harmful to human health and the environment. State regulations, as implemented by cities and counties, also govern land use development activities, including projects that convert historical orchard areas potentially contaminated with LA pesticides to other nonagricultural uses including residences.

Federal and state regulatory agencies (e.g., EPA and Ecology, respectively) determine cleanup levels for chemicals in environmental media, based on models that account for risk-based exposure. In all states, including Washington, cleanup levels must be at least as stringent as the most stringent concentrations established under applicable federal law.

State regulations, as implemented by cities and counties, also govern land use development activities, including projects that result in the conversion of historical orchard areas potentially subject to LA pesticide contamination to other, nonagricultural, uses, including residences. This chapter provides an overview of the environmental and land use regulatory framework that is applicable to this topic.

FEDERAL REGULATIONS

EPA regulates environmental contamination according to the Comprehensive Environmental Response, Compensation, and Liability Act. EPA and Ecology use similar risk assessment methodologies to develop cleanup levels for lead and arsenic contamination; however, they sometimes employ different exposure assumptions or acceptable levels of risk that can create discrepancies between cleanup values, depending on which entity has jurisdiction over the cleanup site.

In Washington State, unless a site has been deemed a Superfund site or is of similar designation over which a federal agency has authority, MTCA is the legislative rule for determining cleanup levels. Tree fruit orchard lands on which LA pesticides were applied are not currently, and are not anticipated to be, regulated under federal authority, and are therefore regulated solely through MTCA.

STATE REGULATIONS

MODEL TOXICS CONTROL ACT

MTCA, the environmental cleanup law for Washington State, was created in 1989 by a vote of the people through a citizens' initiative process. MTCA is triggered when one or more releases (or a threatened release) of a hazardous substance has been suspected or confirmed at a site that requires cleanup. MTCA provides guidelines for investigation, cleanup, and prevention of site contamination. Ecology is responsible for implementing and enforcing MTCA to protect human health and the environment.

MTCA authorizes Ecology to investigate and remediate toxic contamination or require potentially liable parties to conduct investigation and cleanup (Revised Code of Washington [RCW] Chapter 70.105D). MTCA has been amended 23 times (most recently in 2013); however, key principles remain in place today, including:

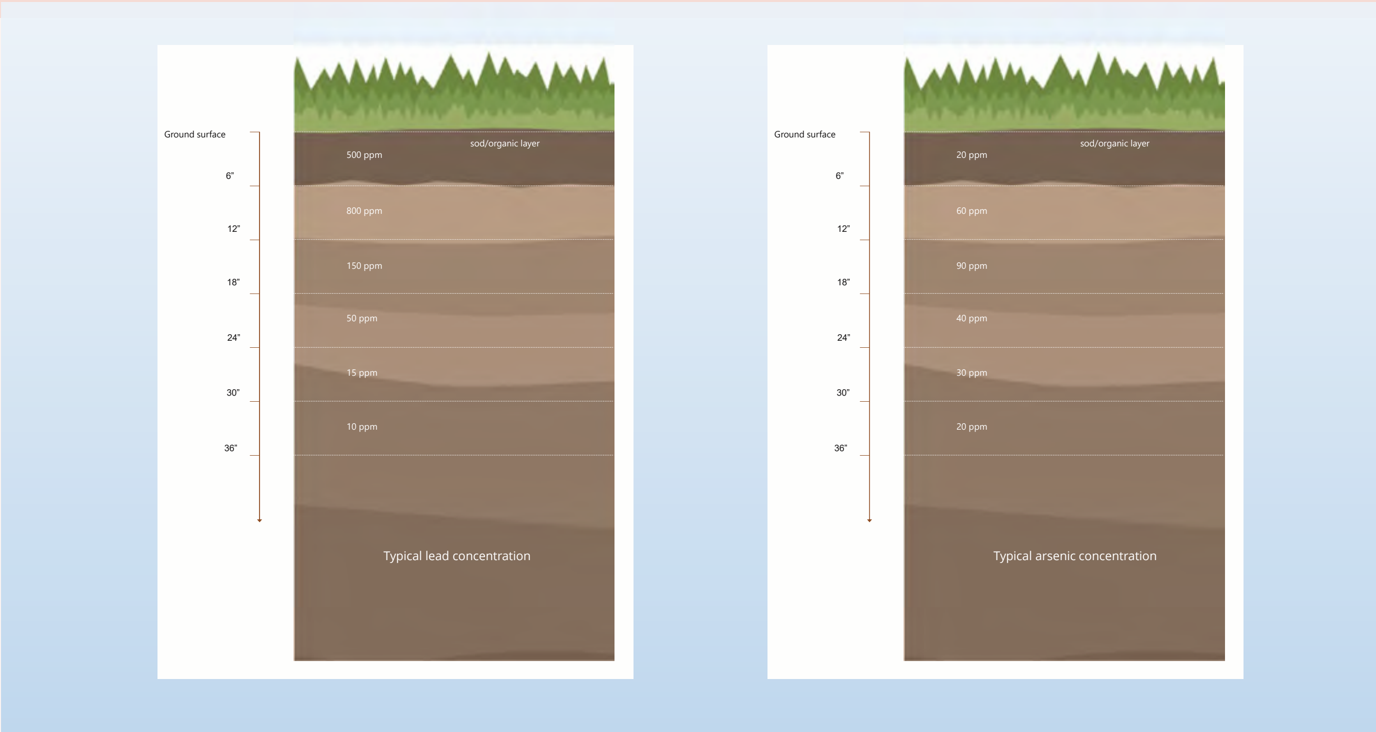
- Cleanups must be as permanent as possible.
- Public participation is required.
- Processes must demonstrate a bias toward action, permanence, and innovation.

Ecology is charged with implementing MTCA and has promulgated administrative rules that establish the process for determining standards for cleanup and how remediation is conducted (Washington Administrative Code [WAC] 173-340). Ecology developed the first cleanup rule in 1991 and most recently amended it in 2007. In 2018, Ecology began another multi-year process to update the rule.

MTCA also established a tax on hazardous substances, including petroleum, when they enter Washington State. The revenues from these taxes are used to support the state's hazardous waste management and cleanup programs and to provide grants to local government. Grants are available to counties, cities, ports, and other special purpose districts to support planning, assessment, and cleanup of contaminated sites.

In addition, the MTCA cleanup rule establishes cleanup levels for environmental media (e.g. soil), including shallow soil in historic, former orchards that are undergoing redevelopment. Under MTCA, a cleanup level is a level at which contaminant concentrations are determined to be protective of human health and the environment, based on reasonably expected exposure scenarios for people and ecological receptors (e.g., wildlife and plants). Concentrations above the cleanup level are considered to result in unacceptable risk. MTCA cleanup levels can vary based on the current or intended land use (e.g., residential versus

Figure 5. Conceptual Profile of Arsenic and Lead Concentrations at Depth



Source: Washington State Department of Ecology

industrial), however less stringent cleanup levels result in significant restrictions to how a property can be used or developed. The cleanup levels determined by MTCA are based on toxicology data that are continuously updated. As a result, MTCA cleanup levels are updated every five years to ensure the most recent data is incorporated.

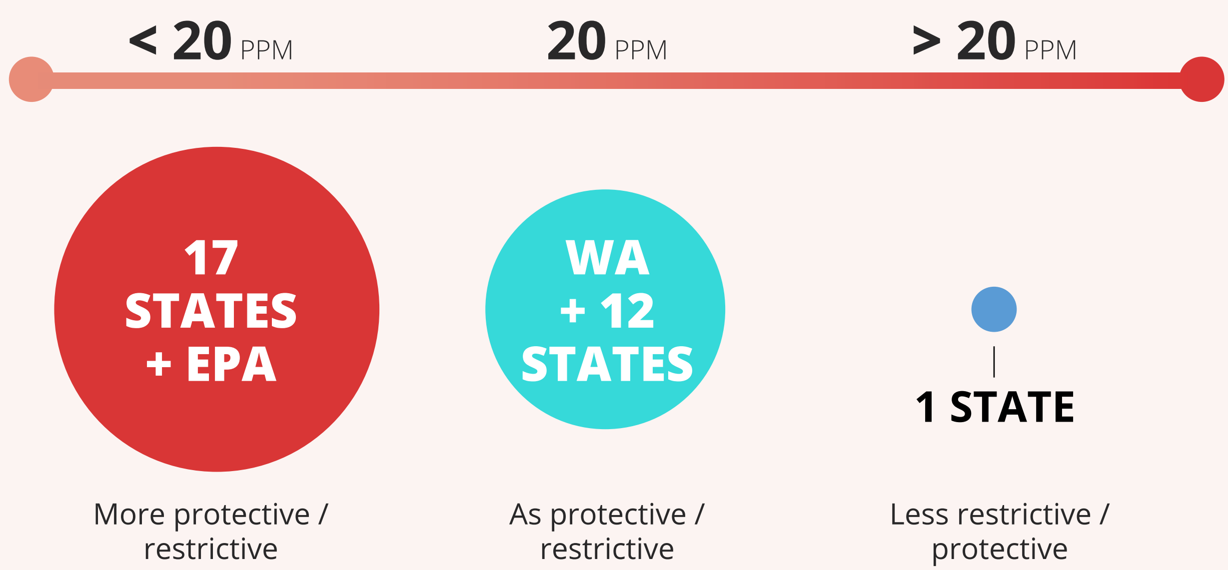
SOIL CLEANUP LEVELS FOR ARSENIC AND LEAD

Arsenic and lead are the primary contaminants associated with LA pesticides that were historically, legally applied to tree fruit orchards. For orchards that may be contaminated from historic application of LA pesticides, the applicable cleanup levels (i.e. MTCA Method A) are 20 mg/kg or ppm for arsenic and 250 mg/kg or ppm for lead for unrestricted land uses.[1]

Under MTCA, cleanup levels for residential properties are typically developed using risk-based criteria so that the additional lifetime risk of cancer (i.e., probability) from any one chemical (with known or suspected cancer effects) is one in one million or less. The calculated risk-based number for arsenic is 0.67 mg/kg or ppm. However, concentrations of arsenic occur naturally throughout Washington State at much higher concentrations. MTCA allows for upward adjustment of the arsenic cleanup level, since it is not reasonable to require cleanup of soil below natural background concentrations. Therefore, Ecology determined the 20 mg/kg or ppm cleanup level for arsenic by evaluating the upper end of the normal range of naturally occurring arsenic concentrations in Washington State. This higher cleanup level means that the probability of additional cancer cases due to arsenic exposure is increased from one in one million to 30 in one million, based on the MTCA models. Based on available data provided by Ecology, concentrations of arsenic in shallow soil at historic orchards have been identified around 200 mg/kg

[1] MTCA contains other clean up levels (i.e. MTCA Method C) for other types of land uses, such as industrial.

Figure 6. Arsenic in Soil—Cleanup Levels in PPM



Source: Washington State Department of Ecology

or ppm, ten times the cleanup level for arsenic.

In comparison to other state-specific arsenic cleanup levels, the arsenic cleanup level of 20 mg/kg or ppm used in Washington is higher than criteria used in many other states. Texas is the only state with a slightly higher cleanup level at 26 mg/kg or ppm. Similarly, the EPA screening level for arsenic is much lower at 0.68 mg/kg or ppm. Therefore, almost all states and the EPA use criteria that are as strict or stricter than the MTCA cleanup level.

The MTCA cleanup level for lead is 250 mg/kg or ppm.[2] The cleanup level for lead is unique as it is the only cleanup level that is directly based on acceptable blood levels. The cleanup level was developed using the Integrated Exposure Uptake Biokinetic (IEUBK) model so that there would be a less than 1 percent chance of causing blood lead levels above 15 ug/dl. Based on available data provided by Ecology, concentrations of lead in shallow soil at historic orchards have been documented at, or above 1000 mg/kg or ppm, four times the cleanup level for lead. By comparison, the EPA also developed a lead screening level for residential soil using the IEUBK model but selected a different acceptable risk threshold than Washington. The EPA screening level is 400 mg/kg or ppm, higher than the MTCA cleanup level of 250 mg/kg or ppm and is therefore less strict.

On historic orchard properties, where LA pesticides were likely used, the magnitude of cleanup level exceedances is typically higher for arsenic (up to ten times higher) than for lead (up to four times higher). Arsenic is also more mobile in soil than lead, often resulting in elevated concentrations of arsenic at deeper depths in soil than lead. As a result, historic orchard property cleanups are typically driven by arsenic cleanup level exceedances (a cleanup level which is higher and less restrictive in Washington relative to other states) and not by lead cleanup level exceedances.

STATE ENVIRONMENTAL POLICY ACT

Washington's SEPA was adopted in 1971 in

[2]The natural background concentrations of lead in Washington (less than 25 mg/kg or ppm) are much lower than the lead risk-based criteria of 250 mg/kg or ppm (Ecology, 1994). Therefore, setting the cleanup level for lead did not require adjustment for natural background concentrations.

response to concerns that government policy decisions and approved projects had failed to adequately consider and mitigate environmental impacts. SEPA environmental review is triggered by state and local government agency actions that can include both policy-level decisions such as the adoption of a new comprehensive plan, and project-level decisions such as permit approval for a proposed private development.

For private development projects, once it is determined that a review under SEPA is required and the lead agency is identified, the applicant prepares and submits a SEPA checklist. The checklist includes a series of questions about the likely impacts of the project on both the built and natural environments, and proposed measures to reduce negative impacts. After consulting with other affected government agencies and asking for additional information from the applicant if needed, the SEPA lead agency issues a decision (called a threshold determination) as to whether additional analysis of environmental impacts is needed. There are two basic threshold determinations that inform the level of review used to evaluate the private development project:

- Determination of Nonsignificance (DNS): If the agency determines that the proposal is unlikely to have significant negative environmental impacts, or that the proposal has already sufficiently addressed potential negative impacts, then the agency may issue a DNS.
- Determination of Significance (DS): If the agency determines that the proposal is likely to have significant negative environmental impacts that have not been adequately addressed, they may issue a DS. Projects that receive a DS are required to complete additional environmental impact analysis by undertaking an environmental impact statement, which will identify several alternatives for how the development could take place, including taking no action, and then analyze the likely environmental impacts of each alternative.

Interagency coordination is encouraged throughout the SEPA review process. Typically, where a city or county is responsible for authorizing a private development project, the jurisdiction is also the lead agency for SEPA review. For example, if a large multifamily development or residential subdivision is proposed on a historical orchard on which LA pesticides were applied, the city or county reaches out to Ecology after the SEPA checklist is complete and a threshold determination has been made by the jurisdiction. Ecology can also provide formal comment during public comment periods throughout the development permit review process.

It is important to note that some small, new construction projects are exempt from the SEPA review process and are therefore not generally submitted to Ecology for comment prior to the jurisdiction's approval of the application. Examples of smaller developments not subject to SEPA review include residential developments with four or fewer units and commercial developments of less than 4,000 square feet. Additionally, cities and counties are authorized by the state statute to adopt flexible exemption thresholds, within a range of established parameters, which means that the threshold at which a SEPA review is required is not standardized across every city and county that issues development permits.

LOCAL LAND USE REGULATORY CONTROLS

Several Washington State statutes govern how cities and counties manage growth and development in their communities over time. These state statutes provide an overall framework; however, each city and county create and adopts its own land use policies and regulations for implementing the statewide framework, including establishing processes for intake and review of development permits.

Most jurisdictions in Central Washington, except Okanogan County and its cities, implement their development permit review processes consistent with the requirements of Washington State's Local Project Review (Revised Code of Washington 36.70B). In addition to establishing basic process requirements for public notices, hearings, and appeals, the Local Project Review requirements seek to ensure that cities and counties integrate environmental review into their permit processes.

For jurisdictions implementing the Local Project Review law, the common steps in most development permit review processes include the following:

Preapplication: Usually involves a meeting that is conducted before submittal of application materials. It often includes the project proponent and various departments from the jurisdiction responsible for authorizing the permit, as well as other, outside agencies that may have permits or regulations applicable to a project proposal. This meeting allows the project proponent to discuss their project and gather information about what may be required for their proposal, including whether additional studies may be required.

Application review: Once a project proponent decides to submit their application materials, the formal review process begins. Depending on the complexity of the proposal, and after the application is determined to be complete and ready for processing, there is a comment period that the jurisdiction uses to collect comments from internal departments, other agencies, and the public. For projects that require a SEPA review process, this comment period is also when comments are gathered following a DNS. The jurisdiction gathers the comments received, evaluates the proposal for compliance with applicable regulations, and prepares either a decision document for those projects that do not require a public hearing, or a staff report that is intended to support the decisionmaker conducting the public hearing.

Public hearing, if required: The purpose of a public hearing is to allow another opportunity for review of the proposal, and for interested parties, including the general public, to provide comments about the development project before a final decision is made. The decisionmaker considers the staff report, as well as the testimony provided by interested parties at the public hearing and develops a decision.

Decision: For a significant number of development permit proposals, the final approval decision will include conditions with which the project proponent must comply. For example, for subdivision proposals (creating additional building lots), this typically includes development of on-site infrastructure and utilities (roads, stormwater facilities, water, sewer, power, and telecommunications), and in some cases additional, off-site improvements may be required. For other types of land use permits, conditions of approval may obligate the project proponent to change different aspects of their project or require them to conduct their activities in a certain manner to reduce potentially negative impacts to surrounding properties.

SOIL SAMPLING

Soil sampling can be conducted to determine if a property contains lead and arsenic impacts due to historical applications of LA pesticides on tree fruit orchards. Determining the best soil sampling technique for a property involves understanding that property's historical, current, and future use. Results from soil sampling help determine if mitigation strategies are needed and what those strategies should be.

Figure 7. Historical Pesticide Spraying Applications on Tree Fruit Orchards

Source: Washington State Historical Society

Tree fruit orchards used LA pesticides until 1950 (Ecology, 2019a; Hood, 2006). Properties that were devoted to tree fruit production during this time may contain concentrations of lead and arsenic in soil that exceed MTCA cleanup levels. If a property is suspected or known to have been an orchard during this time, soil sampling may be conducted to determine if elevated concentrations of lead and arsenic are present in the soil at levels that could adversely impact human health. Currently, Ecology is conducting soil sampling for lead and arsenic free of charge when requested by potentially affected property owners.

Ecology is digitizing the footprint of former orchard areas based on historical aerial photos to identify potentially affected areas of orchard land in Central Washington. This information is intended to be a tool for current and future homeowners and developers to easily assess the likelihood that a historical orchard operated on the property of interest during the period when LA pesticides were commonly applied. The maps may also be used to identify areas where certain activities (e.g., LA pesticide loading and staging activities) likely took place. This information can then be used to determine the need for sampling, including planning the sampling approach.

Aerial photographs from before 1950 can show if an orchard was present on a property when LA pesticides were widely used (Hood, 2006). Aerial photographs can also show locations where loading or mixing of an LA pesticide may have taken place (i.e., access roads or equipment staging areas). Loading and mixing of LA pesticides can result in localized, elevated concentrations of arsenic and lead. Many orchards designated an area to mix the LA pesticides with water and then load them into sprayers. The lead and arsenic concentrations in soil are generally much higher in these areas and can require additional cleanup and/or mitigation strategies.

SAMPLING CONSIDERATIONS

Elevated concentrations of lead and arsenic in Central Washington are typically observed within the top 30 inches of soil.[1] Previous sampling efforts conducted at sites with orchards where LA pesticides may have been applied consisted largely of analyzing individual (i.e., discrete) samples from 6 inches below ground surface. Sampling from 6 inches below ground surface is conducted as an initial assessment of the presence or absence of elevated lead or arsenic concentrations that informs the need for additional characterization.[2] The depth at which a sample is collected, is critical to characterizing a property.

Two primary sampling methods are used to characterize shallow soil: discrete (i.e., individual samples) and composite (i.e., many individual samples combined). Before selecting a sampling technique, it is important to consider the historical, existing, and future uses of a property.

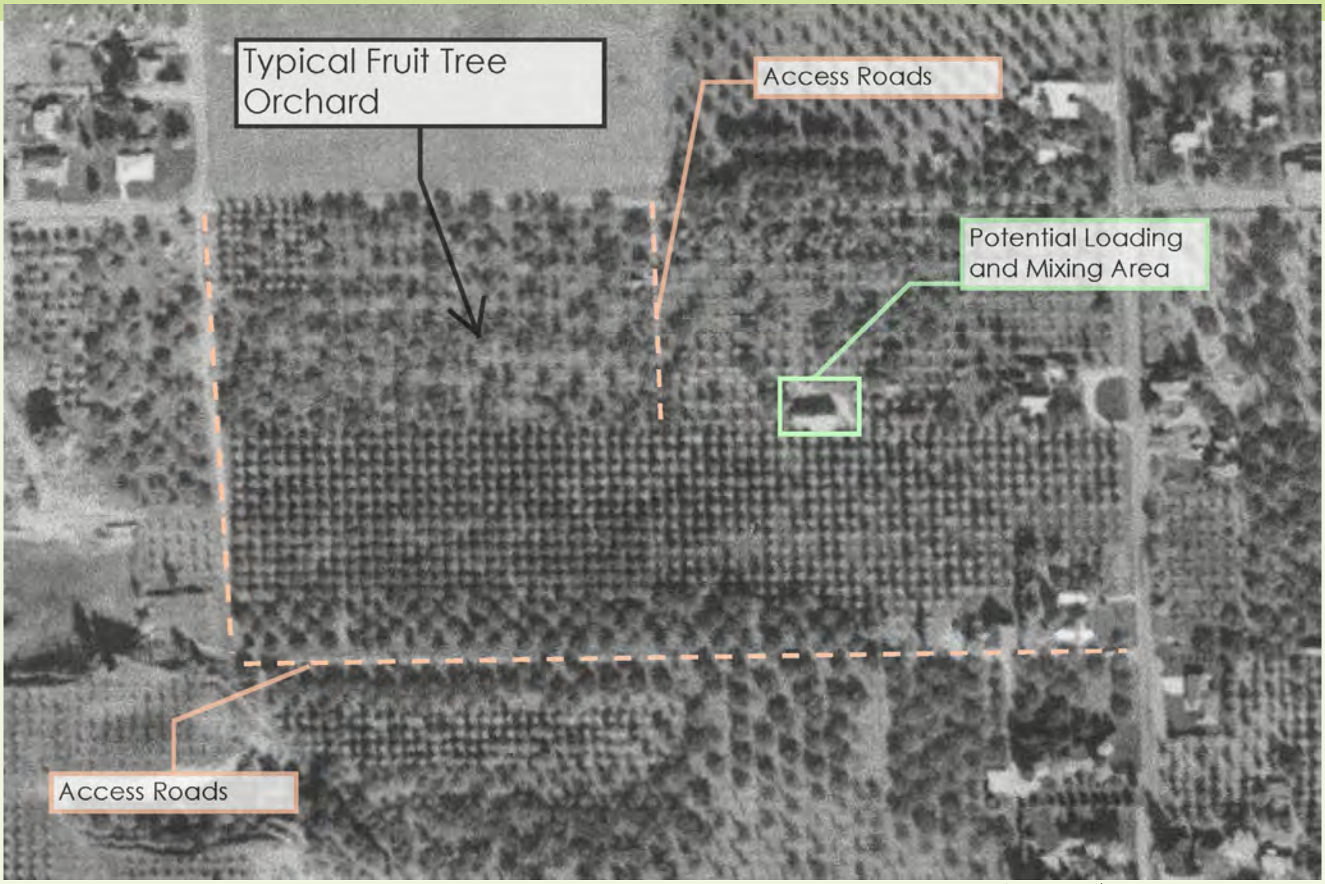
Of the properties already developed and known to be historical orchards on which LA pesticides were applied, the areas that have remained largely undisturbed since the 1950s likely contain higher concentrations of lead and arsenic than areas that have been regraded or filled.

Understanding future uses of a property on which LA pesticides were applied can help inform

[1] Based on available Ecology data collected during soil evaluations of school and parks on former orchard lands, soil samples collected at these sites were limited largely to the top half foot of soil to determine the presence or absence of impacts related to LA pesticide use in soil; therefore, there is greater uncertainty regarding the typical depth of elevated concentrations deeper than a half foot below ground surface.

[2] If a property is impacted by LA pesticides, typically the highest concentrations of lead are found between 4 and 10 inches below ground surface and the highest concentrations of arsenic are found between 6 and 18 inches below ground surface.

Figure 8. Aerial Example of Typical Tree Fruit Orchard



Source: Environmental Data Resources, Inc.

sampling and cleanup strategies. Covering soil with permanent features, such as buildings and pavement, eliminates or reduces exposure to contaminated soils. Exposed surface soil (e.g., landscaped areas, yards, or fields) will have greater potential for direct contact.

Currently, Ecology representatives can assist interested parties with determining the appropriate sampling and analytical methods for a property. Ecology can also support individual property owners or developers on how to conduct soil sampling on a property. With support from Ecology, an environmental consultant is not necessarily required to assess a property for potential LA pesticide impacts.

SAMPLING METHODS

DISCRETE SAMPLING

A discrete soil sample is a sample of soil that is collected from one location. A discrete sample will provide the concentrations of lead and arsenic at a specific location.

Advantages: Collecting discrete samples is a good way to characterize an area with many different uses, sources, or variability in soil.

Figure 9. Soil Sampling

Shallow soil sampling on a historical orchard property.
Source: Maul Foster & Alongi, Inc., 2019

Discrete sampling can identify and target areas with localized concentrations and inform varied cleanup strategies over large areas. Areas used for loading and mixing LA pesticides may be best characterized with discrete samples to identify and target areas of potentially high concentrations of lead and arsenic.

Disadvantages: A discrete sample gives you a concentration only at that specific location. To ensure that a discrete sample concentration does not misrepresent a large area (high or low), many samples would have to be collected. Field areas of tree fruit orchards can span significant areas of land and typically have had consistent LA pesticide use and applications resulting in generally consistent concentrations throughout. However, many discrete samples would have to be collected to characterize the area, resulting in increased time and cost.

COMPOSITE SAMPLING

A composite soil sample consists of one combination of samples collected from many locations. A composite sample will provide a single concentration of lead and arsenic over a large area.

Advantages: Collecting composite samples is a good way to characterize an area with one use or source, or with little variability in soil. A composite sample can reduce the number of collected samples while still assessing a large area. This can greatly reduce the time and logistics involved to collect samples and the costs to analyze them. Other than the loading and mixing areas, LA pesticides were typically applied evenly across the orchard; therefore, a composite sample could effectively determine the average concentration over that area without requiring collection and analysis of multiple individual samples.

Disadvantages: If a composite sample is collected in an area with significantly varied concentrations due to different historical uses, sources, or degrees of pesticide applications, the resulting final concentration maybe biased high or low. This could result in a misrepresentation of the concentration of lead and/or arsenic over an area and misidentify appropriate cleanup actions. A composite sample collected across an orchard and including a mixing or storage area would not allow distinction between areas of varying concentrations and could misrepresent the concentrations of the two different areas.

ANALYTICAL METHODS

FIELD PORTABLE X-RAY FLUORESCENCE

A field portable x-ray fluorescence (XRF) device, can provide instant results for lead and arsenic in a soil sample. The quality of the XRF data can vary because of site conditions, soil composition, and sample preparation; and therefore, these data cannot completely substitute for analytical results from a laboratory. However, XRF results can quickly show if a property contains elevated concentrations of lead or arsenic that may require further characterization. Discrete or composite samples can be analyzed by an XRF.

Costs to rent an XRF typically range between $350 and $450 per day. Often equipment-rental businesses will have reduced rates for longer-term-rental XRFs. Currently, representatives from Ecology can provide free sampling using XRF when requested by an entity as resources allow. Therefore, this type of sampling for interested parties can be conducted at little or no cost.

ANALYTICAL LABORATORY

Soil sample collection for submittal to an analytical laboratory generally requires clean, stainless-steel tools, a wash bucket with cleaning solutions (i.e., soap and rinse water), and a clean glass container that can be filled with at least 4 ounces of soil.

Soil samples must be analyzed in an analytical laboratory and tested for lead and arsenic to evaluate potential impacts associated with LA pesticide use. Typical costs to perform these analyses can range between $40 and $60 per sample. These costs can increase if results are needed sooner than the typical two-week turnaround. As discussed above, Ecology can assist property owners or developers with information on how to collect and submit soil samples to an analytical laboratory. By providing guidance for individuals to perform the sampling themselves, the overall cost of the sampling effort can be reduced.

Figure 10. Soil Sampling with XRF

A field portable XRF can be used to receive instant lead and arsenic results in soil. Source: Maul Foster & Alongi, Inc., 2019

CASE STUDIES

Characterization and cleanup of contamination related to lead and arsenic in shallow soil is not uncommon. Several characterization and cleanup strategies have been effectively implemented at lead- and arsenic-contaminated sites in Washington State and throughout the United States.

Lead and arsenic contamination in shallow soil have impacted many communities in Washington and the United States. This contamination is often the result of historical, legal LA pesticide use as well as other industrial activities and sources.

WASHINGTON

TACOMA SMELTER PLUME PROJECT

In the Puget Sound area, approximately 1,000 square miles of surface soil have been contaminated with heavy metals, including arsenic and lead, from the former Asarco Copper Smelter (Ecology, 2012). Air emissions containing concentrations of heavy metals associated with the operation of the smelter extended across communities in Pierce, Thurston, and King counties.

Ecology developed an online mapping tool to identify properties with higher risk of potential shallow soil contamination associated with the smelter. This tool allows the public to easily review the map and determine their properties' position relative to the smelter-related arsenic and lead concentrations in soil. This tool also allows the public to review available data from tested properties.

EPA conducted an initial soil study on properties believed to be most impacted by the smelter. Property access was obtained from property owners prior to sample collection. Results from this study were used to develop boundaries for a yard program service area. If a property was not previously sampled but is in the program service area or a few selected areas in King County, a property owner may request that Ecology sample the soil at no cost to the owner. If a property is outside the yard service area, but the owners wish to have their soil tested, they are responsible for collecting the sample and sending it to an accredited lab for analysis. Ecology provides online resources for requesting soil sampling on a property as well as instructions on how owners can perform the testing themselves.

Ecology has published many "healthy action" public service announcements to define simple, healthy living practices for residents within the smelter plume boundary. These public service announcements provide clear and consistent guidelines for reducing potential exposure to lead- and arsenic-contaminated soil at their residential property without implementing costly remedial actions.

Over the last 20 years, EPA and Ecology have worked to characterize and clean up shallow-soil contamination in existing residential neighborhoods closest to the smelter with soil containing levels of lead and arsenic that exceed action levels. Cleanup actions associated with these residential properties involve, primarily, excavating and replacing the contaminated soil in areas with exposed ground cover (e.g., yards and playgrounds). Capping implemented at these properties includes three types of caps (Ecology, 2019b):

- Type 1 soil cap: Can only be used to cap soil with average arsenic concentrations less than 100 mg/kg or ppm and average lead concentrations less than 500 mg/kg or ppm. Requires at least 12 inches of clean soil and a geotextile fabric placed over contaminated soil.
- Type 2 soil cap: Can be used to cap soil with any concentration of lead or arsenic. Requires at least 24 inches of clean soil and a geotextile fabric placed over contaminated soil.
- Type 2 hard cap: Can be used to cap soil with any concentration of lead or arsenic. Requires at least 3 inches of concrete, asphalt, paving blocks or building foundation.
- Additional techniques such as mixing, consolidation and capping, can also be implemented at these properties.

The yard cleanup program is voluntary for property owners and is funded with a significant portion of a $94 million settlement from the smelter operators. Property owners also have the option to file a voluntary deed restriction to record environmental work conducted on their properties. Characterization and cleanup of shallow soil associated with the smelter continues today at existing properties. In the case of new residential developments, permanent remedies with complete removal of contamination are required, avoiding the need for deed restrictions.

NORTHPORT SMELTER PLUME PROJECT

The LeRoi Co Smelter site covers approximately 30 acres at the northeast end of Northport, Washington. Operating from 1896 until 1921, the smelter was determined to be the source of arsenic and lead in surface soils at and around the smelter. Between 1993 and 2004, EPA conducted site investigations and identified local commercial and residential properties that required further remedial actions, based on the regulatory levels created by Ecology for the project. Three different concentration ranges were used to determine whether a property would be subject to exposure-reduction measures, removal or containment for play areas, or complete removal or containment. Exposure-reduction measures were best management practices (BMPs) the property owner was responsible for implementing, including frequent hand washing, removing shoes before entering homes, using gloves while gardening, washing fruits and vegetables before consumption, and bathing pets. The removal and containment measures included soil excavation and capping. Roughly 30 properties were remediated by EPA using excavation or capping methods.

RIDGEFIELD RESIDENTIAL CLEANUP

In Ridgefield, Washington, the Pacific Wood Treating Co. plant was the source of dioxin contamination in surface soils near the facility. Over approximately two months, Ecology led public outreach, yard-specific sampling plans were developed and approved, access agreements were obtained, and a comprehensive sampling regimen was completed. Incremental sampling methodology was used to acquire representative soil samples from exposure areas potentially impacted by former wood-treating operations. It was determined that nearby residential properties had concentrations above regulatory levels at depths that reached approximately 18 inches.

After the initial assessment was conducted, Ecology developed a cleanup plan for remediating approximately 30 residential yards. Participation in the cleanup program was voluntary. Based on existing grades and conditions at the properties, it was determined that capping was not a feasible cleanup option. A more costly excavation and soil replacement program was selected as the final remediation alternative. The program required extensive coordination with affected homeowners to develop a construction plan and finalize site conditions.

SCHOOL AND PARK CLEANUPS ON FORMER ORCHARD LANDS

Ecology has funded the cleanup of 26 schools and two parks on historical tree fruit orchards on which LA pesticides were applied in Chelan, Douglas, Okanogan, Yakima, and Spokane counties (Ecology, 2020). These cleanups focused on mitigating contamination of lead and arsenic in shallow soil associated with LA pesticides applied on orchard lands redeveloped as school grounds where children are most likely to interact with the exposed ground surface (e.g., playgrounds and ballfields).

The two primary cleanup strategies for these school and park properties were:

- Removal of soil with the highest concentrations of lead and arsenic, deep mixing (tilling) of areas with less elevated concentrations, and/or a combination of the two. Both mitigation strategies required clean topsoil and new seed, or sod placed on the cleanup areas to reestablish grass.
- Capping with 8 to 12 inches of clean topsoil on a geotextile fabric overlying the contaminated soils, and execution of an environmental covenant for the property. An environmental covenant provides a permanent legal record of the contamination that remains under the cap at the property and is intended to prevent any activities that might disturb or damage the soil cap.

UNITED STATES

WISCONSIN

It is estimated that approximately 50,000 acres of tree fruit orchards in Wisconsin may have been contaminated with the use of LA pesticides between the 1890s and the 1960s (Hood, 2006).

The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) has responded to this regional problem with the creation of two primary guidance documents for public use: a frequently asked questions information sheet and a soil sampling guide for homeowners.

No mapping tools are available to the public. Individuals wishing to determine if a property they own or are interested in purchasing was once an orchard are directed to the Land Conservation Department for historical aerial photos. Property owners are required to disclose at the time of sale if they know that a property was once an orchard, but they are not required to sample. Due diligence is the responsibility of the potential purchasers. Common BMPs recommended by the DATCP include keeping lawns vegetated, using raised garden beds, and keeping kids from playing in exposed soil (DATCP, 2012a).

Homeowners who are concerned that their property may be contaminated can follow procedures outlined in the soil sampling guidance to determine if concentrations require further action. The DATCP requires that concentrations of arsenic above 5 ppm and lead above 50 ppm be reported to the DATCP and/or the department of natural resources (DATCP, 2012b). In cases where concentrations of arsenic and lead exceed regulatory standards, the DATCP evaluates whether additional actions are necessary to protect human health. Specific examples of further actions or cleanup are not identified by the DATCP documentation. It is likely that remedies including excavations and capping are applied on a case-by-case basis as determined by the DATCP.

In Wisconsin, cleanup levels are developed on a site-specific basis. Chapter NR 720 of the Wisconsin administrative code requires that "cleanup levels are the lowest concentration from among the following as applicable: the ceiling limit concentrations, the soil saturation concentration if the contaminant is a volatile, a land use specific direct contact level, a groundwater quality protective level, a concentration calculated for a pathway of concern set forth in s. NR 720.13." It is unclear how the DATCP created their reporting levels.

IDAHO

In Northern Idaho, early mining and milling methods led to areawide impacts from mining waste. Mining operations included smelting, and elevated concentrations of various heavy metals were identified on many residential properties. This region has been identified as the Bunker Hill Superfund Site, and assessment and cleanup activities are ongoing. The site consisting of 1,500 square miles, is one of the largest and most complex Superfund sites. Because of the scale of the project, several different assessment and cleanup programs are being conducted.

One of the programs that was developed for the Bunker Hill Superfund Site is the Basin Property Remediation Program. Since the 1980s, over 7,000 individual properties have been remediated, and while remedies are site-specific, most of these projects follow the same general procedure. Often, the top 6 to 12 inches of contaminated soils is removed from a property and disposed of at a repository (Idaho Department of Environmental Quality, 2020). If contamination remains on the property, a demarcation layer is placed, and the property is capped. In some communities, stormwater infrastructure improvements were required to prevent the erosion of the caps.

In addition to a residential yard cleanup program, the Panhandle Health District runs an institutional control program that includes clean fill and soil disposal services. Residents are allotted 1 cubic yard of gravel or topsoil to maintain their caps. The program also provides, at no cost, disposal containers for contaminated soil disturbed by regular home improvement or landscaping projects. Residents can fill out an application to receive access to these services (Panhandle Health District, 2020).

NEW JERSEY

New Jersey has evaluated effective ways to transition tree fruit orchards on which LA pesticides were applied to residential uses, including strategies for reducing potential exposure to soil contaminated with lead and arsenic. New Jersey has determined that up to 5 percent of the state's acreage may have been impacted by LA pesticides. Rising concerns from developers and lenders prompted the formation of the Historic Pesticide Contamination Task Force (HPCTF) to identify technically and economically viable strategies that would be protective of human health and the environment. In 1999, and later, in 2015 and 2018, and with the support of the HPCTF, New Jersey developed technical guidance for historically applied pesticide sites (New Jersey Department of Environmental Protection [NJDEP], 2018).

The cleanup strategies developed by the HPCTF included capping contaminated soil with clean fill and a deed notice, mixing contaminated soil with clean soil to reduce concentrations, and excavation and off-site disposal. New Jersey also allowed for the possibility of excavation and relocation of contaminated soils to adjacent properties that would remain in agricultural use. The technical assessment guidelines included the option for an evaluation of a property based on site use (e.g., duration and type of historical crops) to inform sample collection and data evaluation. New Jersey provides online historical aerial databases to help inform a property owner or developer regarding the likelihood that a property historically contained a tree fruit orchard.

With the support of the HPCTF, New Jersey provided the following recommendations for identifying and mitigating health risks associated with orchards on which LA pesticides had been applied for homeowners, home buyers, and builders:

- Conduct soil sampling when an agricultural property changes land use (e.g., transitions to residential).
- Conduct soil sampling at former agricultural areas used intensively by children (schools, playgrounds).
- Coordinate with the state regulatory agency if a property owner would like approval of their proposed investigation of lead and arsenic concentrations on their property.
- Consult the regulatory agency for guidance on sampling procedures if a homeowner would like to test soil concentrations on their own property.
- Implement BMPs to minimize the chance of direct contact with contamination that may be in the soil (e.g., maintain grass coverage, wash fruits and vegetables from the garden, wash hands and face after being outside, clean indoor surfaces where children play.)

The party primarily responsible for implementing assessment and cleanup of historical orchard properties where LA pesticides were applied are New Jersey developers. This evaluation is intended to be part of the due diligence process for developers. Because the initial guidance was issued in 1999, it is expected that anyone developing land in New Jersey will be aware of the assessment and cleanup process for historically applied pesticides.

New Jersey has specific environmental regulations that address contamination associated with historical orchard properties where LA pesticides were applied. If sampling results indicate that contaminants (i.e., lead and arsenic) are present at concentrations exceeding applicable standards, pursuant to the Administrative Requirements for the Remediation of Contaminated Sites (New Jersey Administrative Code 7:26C) and the Technical Requirements, then remediation must be conducted consistent with all relevant department rules and guidance. New Jersey does allow the deferment of remediation at active agricultural properties or golf courses until the property is no longer used for those purposes.

However, if a property is suspected of being a historical orchard where LA pesticides were applied and is redeveloped as a school, childcare center, residence, or playground, then it must be investigated, and all department rules and guidance applied.

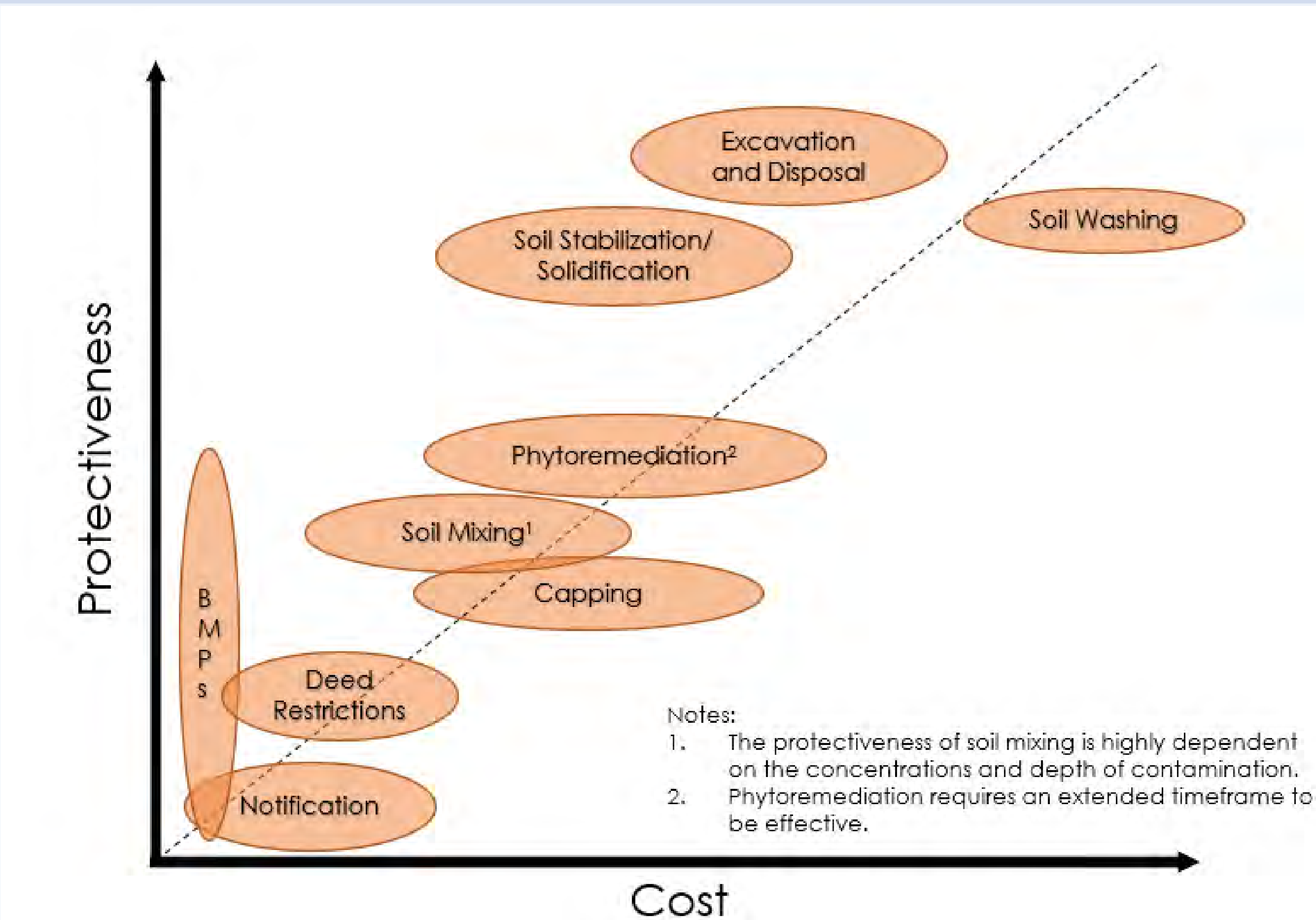
If remedial actions at a property implement institutional controls (e.g., deed notice) and/or engineering controls (e.g., soil cap), a remedial action permit for soil to be issued by the NJDEP is also required. This permit will require long-term maintenance of any engineering control, as well as biennial certifications submitted to the NJDEP. Soil with lead and arsenic concentrations above New Jersey cleanup levels can also be consolidated on the site if placed in an area with similar concentrations and under a suitable engineering control (i.e., building,, landscaping, or aesthetic berm) to prevent direct exposure.

Little information is available regarding when assessment of soil concentrations associated with a former tree fruit orchard at an existing property would be required or recommended. In New Jersey, investigation and remediation of these sites appear to be driven primarily by changes in land use.

GENERAL MITIGATION STRATEGIES

Among the various case studies are common practices that are recognized as effective mitigation strategies to reduce and eliminate exposure risks from soils impacted by LA pesticides. Soil excavation, capping, soil mixing, deed restrictions, and other methods are frequently applied mitigation techniques. There can be significant cost differences between these mitigation technologies. These technologies also vary in their abilities to protect the public from exposure. While the costs and protectiveness of a technology are dependent on the specific characteristics of a property, the technologies can be generally mapped for their protectiveness and cost.

Figure 11. Mitigation Technology Ranking



This figure is a high-level comparison of mitigation technologies. Additional factors such as implementation risk, time to complete, effectiveness over the long term, and constructability can also have significant impact on the cost and application of a technology.
Source: Maul Foster & Alongi, Inc., 2020

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

ATSDR. 2007. Toxicological profile for arsenic (update). Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service.

ATSDR. 2019. Toxicological profile for lead (draft for public comment). Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service.

Benson, S. 2014. Epidemiological investigation to assess environmental contributions to childhood blood lead levels. University of Pittsburgh. May 20.

CDC. 2020. Blood lead levels in children. Centers for Disease Control and Prevention. https://www.cdc.gov/nceh/lead/prevention/blood-lead-levels.htm (accessed June, 11, 2020). May 28.

DATCP. 2012a. Lead and arsenic in soil at old fruit orchards: Frequently asked questions. https://datcp.wi.gov/Documents/ArmPub99.pdf

DATCP. 2012b. Lead arsenate soil sampling guidance for homeowners. https://datcp.wi.gov/Documents/ArmPub219.pdf

Duggan, M. J. 1983. Contribution of lead in dust to children's blood lead. Environmental Health Perspectives. Vol. 50, pp. 371-381.

Ecology. 1994. Natural background soil metals concentrations in Washington state. Publication number 94-115. Toxics cleanup program, Washington State Department of Ecology. October.

Ecology. 2003. Area-wide soil contamination strategy: implementation of task force recommendations. Publication number 03-09-102. Washington State Department of Ecology, Washington State Department of Agriculture, Washington State Department of Health, State of Washington Department of Community, Trade, and Economic Development. October 1.

Ecology. 2012. Asarco Tacoma smelter site, final interim action plan for the Tacoma smelter plume. Publication number 12-09-086. Tacoma smelter plume team, Washington State Department of Ecology. June.

Ecology. 2019a. FAQs: sampling for lead and arsenic soil contamination in former orchard lands. Publication number 19-09-008. Washington State Department of Ecology. October. https://fortress.wa.gov/ecy/publications/SummaryPages/1909008.html.

Ecology. 2019b. Tacoma Smelter plume model remedies guidance, sampling and cleanup of arsenic and lead contaminated soils, for: formal cleanup sites, voluntary cleanup program properties under development projects involving soil movement. Publication number 19-09-101. Washington State Department of Ecology. July.

Ecology. 2020. School and park cleanups on former orchard lands. Washington State Department of Ecology. https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Cleanup-sites/Toxic-cleanup-sites/Former-orchard-lands/School-park-cleanups (accessed June 10, 2020).

EPA and HUD. 1996. Fact Sheet: EPA and HUD move to protect children from lead-based paint poisoning; disclosure of lead-based paint hazards in housing. U. S. Environmental Protection Agency. https://www.epa.gov/sites/production/files/documents/fs-discl.pdf.

EPA. 2019. USGS background soil-lead survey: state data. U.S. Environmental Protection Agency. https://www.epa.gov/superfund/usgs-background-soil-lead-survey-state-data#WA (accessed July 13, 2020).

Gallacher, J. E., P. C. Elwood, K. M. Phillips, B. E. Davies, and D. T. Jones, 1984. Relation between pica and blood lead in areas of differing lead exposure. Archives of Disease in Childhood. 59; 40-44.

Hood, E. 2006. The apple bites back: claiming old orchards for residential development. Environmental health perspectives 114(8), A470–A476. https://doi.org/10.1289/ehp.114-a470.

Idaho Department of Environmental Quality. 2020. Basin property remediation program. https://www.deq.idaho.gov/regional-offices-issues/coeur-dalene/bunker-hill-superfund-site/basin-property-remediation/ (accessed June 14, 2020).

Maisonet, M., F. J. Bove, and W. E. Kaye. 1997. A case-control study to determine risk factors for elevated blood lead levels in children, Idaho. Toxicology and Industrial Health, Vol. 13, No. 1.

Mielke, H.W. 1999. Lead in the inner cities: policies to reduce children's exposure to lead may be overlooking a major source of lead in the environment. American Scientist. 87(1):62-73.

NJDEP. 2018. Historically applied pesticide technical guidance. Vers. 3.0. New Jersey Department of Environmental Protection, Site Remediation and Waste Management Program. December.

Panhandle Health District. 2020, Institutional controls program. https://panhandlehealthdistrict.org/institutional-controls-program/#:~:text=All%20residents%20are%20eligible%20to,undertaking%20a%20small%20excavation%20project. (accessed June 14, 2020).

Patterson, B. 2020. Lake Chelan Valley soil contamination issue: potential impact on local children. February.

Smith, D.B., Cannon, W.F., Woodruff, L.G., Solano, Federico, Kilburn, J.E., and Fey, D.L. 2013. Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, 19 p., https://pubs.usgs.gov/ds/801/ (accessed July 13, 2020).

Snee, R. 1982. Silver valley lead study: further analysis of the relationship between blood lead and air lead. Journal of the Air Pollution Control Association. Vol. 32. No. 2. March.

Snow, B. 2012. Living with lead: an environmental history of Idaho's Coeur d'Alenes, 1885-2011. Montana State University, Bozeman, Montana. April.

Tollestrup, K., J.R. Daling, and J. Allard. 1995. Mortality in a cohort of orchard workers exposed to lead arsenate pesticide spray. Arch. Environ. Health. May/June Vol. 50 (3):221-9.

Washington State Department of Commerce. 2018. 2017 affordable housing update: current state of affordable housing needs. https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=Commerce-AHAB-annual-report-2018_0fe5c4e4-7c44-4032-845e-9cf53a41d18b.pdf.

Wolz, S., R. A. Fenske, N. J. Simcox, G. Palcisko, and J. C. Kissel. 2003. Residential arsenic and lead levels in an agricultural community with a history of lead arsenate use. Environ Res. 2003;93(3):293-300. doi:10.1016/s0013-9351(03)00064-1. November. https://pubmed.ncbi.nlm.nih.gov/14615240/ (accessed June 17, 2020).

Yankel, A. J., I. H. von Lindern, S. D. Walter. 1977. The silver valley lead study. The relationship between childhood blood lead levels and environmental exposure. Journal of the Air Pollution Control Association, 27:8, 763-767. August.

FIGURE

Comparison of Case Studies

State		Regulatory Agency	Regulatory Framework	Risk-Based Soil Cleanup Level?	Responsible Party for Implementing Cleanup	Funding Source	Remediation Strategies						
							Notification	BMPs	Soil Capping	Soil Removal	Soil Mixing	Deed Restrictions	Other
Idaho		DEQ	Idaho Environmental Protection and Health Act	Yes	Coeur d'Alene Trust	Coeur d'Alene Trust	$	$	$$	$$$	--	$	$$[a]
New Jersey		NJDEP	Site Remediation Reform Act	Yes	Developers	Property Owners, Developers	$	$	$$	$$$	$$	$	$[b]
Washington	Tacoma Smelter Plume Project	Ecology	Model Toxics Control Act	Yes	Asarco; Ecology; Developers	Asarco; Ecology	$	$	$$	$$$	$$	$	$[b]
	Northport Smelter Plume Project				EPA; Tech American	EPA	$	$	$	$$$	--	$	--
	Ridgefield Residential Cleanup				Ecology	Ecology	$	--	--	$$$	--	--	--
	School and Park Cleanups on Former Orchard Land				Ecology	Ecology	$	$	$	$	$$	$	--
Wisconsin		DATCP	Agricultural Chemical Cleanup Program	Yes	Property Owners, Developers	Agricultural Chemical Cleanup Program; EPA	$	$	$$	$$$	--	--	--

NOTES:
Cost estimates for remediation strategies are highly variable and influenced by many factors that impact cost.
-- = not implemented.
$ = low
$$ = medium
$$$ = high
BMPs = best management practices.
DATCP = Wisconsin Department of Agriculture, Trade and Consumer Protection.
DEQ = Department of Environmental Quality.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
NJDEP = New Jersey Department of Environmental Protection.
[a]Residential free soil disposal and clean material program for homeowners conducting small projects on contaminated properties.
[b]Soil consolidation involving removal of contaminated soils, consolidating them in one place, and covering them with a soil cap or hard cap.

This is a high-level comparison of case studies technologies.
Source: Maul Foster & Alongi, Inc., 2020