Suggested Practices to Reduce Zinc Concentrations in Industrial Stormwater Discharges

Water Quality Program

June 2008
Publication Number 08-10-025

DEPARTMENT OF
ECOLOGY
State of Washington

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Water Quality Program

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June 2008

Publication Number 08-10-025

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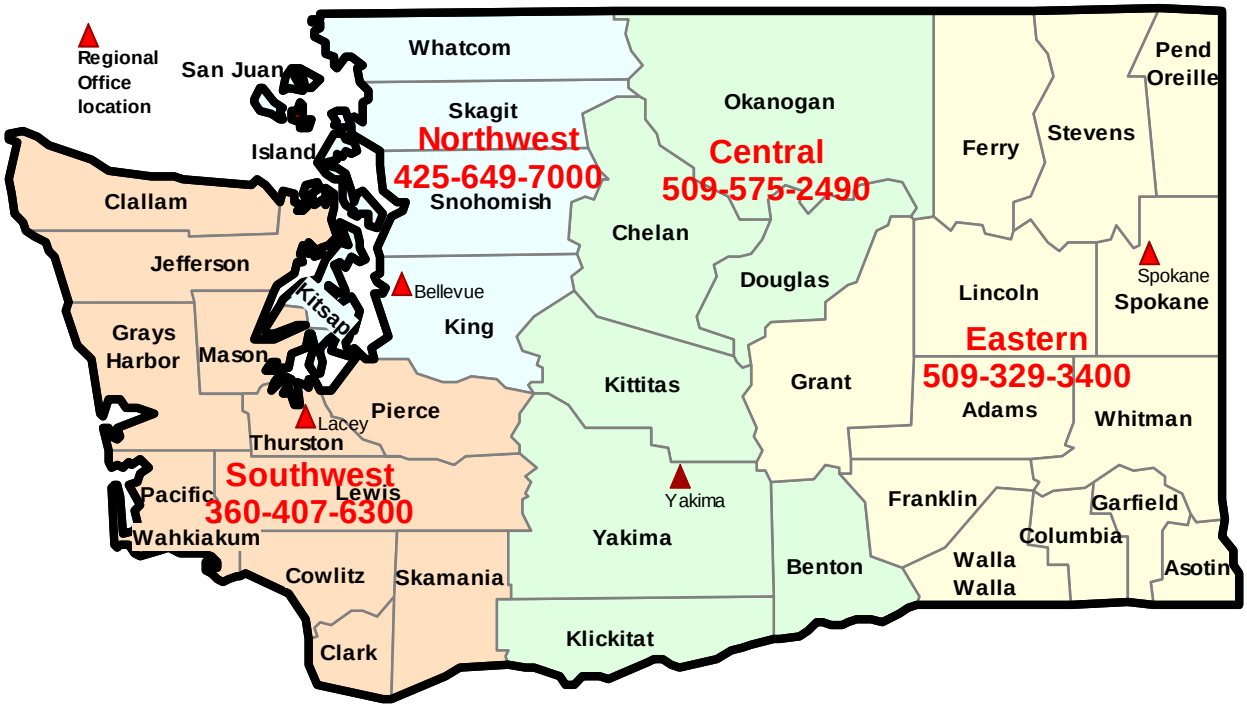

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Introduction

Many facilities under the Industrial Stormwater General Permit (ISWGP) have found high levels of zinc in their stormwater discharges. Zinc from stormwater harms fish and other aquatic life. Zinc can bind to fish gills and cause suffocation. You can take steps to comply with the zinc levels specified in your permit, and at the same time protect Washington's waters.

Ecology prepared this document to help you reduce zinc in your stormwater discharge. The idea is to use source control measures. Source control is removing or covering sources of zinc before they become part of stormwater runoff. This is often more effective than trying to remove zinc once it is in the stormwater. Methods for treating stormwater may be found elsewhere. An earlier Ecology Publication, *A Survey of Zinc Concentrations in Industrial Stormwater Runoff* shows the results of testing zinc in runoff as well as inventories of zinc sources at 28 industrial facilities (http://www.ecy.wa.gov/biblio/0603009.html).

This guide identifies the major sources of zinc and tells you how to remove or reduce them. Two ways in particular work well together. They are:

1. Sweeping grounds to remove dust and debris.
2. Painting galvanized surfaces to keep zinc out of runoff.

The section, "Two Ways to Reduce Sources of Zinc," appear on page 11.

Reading this guidance, you will be able to identify sources of zinc at your facility and take some simple measures to deal with them. To help in this regard, this guide includes a detailed form for walking you through a source inventory

Appendix A presents a general discussion of sources of zinc in the environment.

Appendix B presents data showing contributions of zinc from a number of actual cases.

Major Sources of Zinc in Industrial Runoff

The following sources of zinc are found at many industrial facilities:

- Galvanized metal surfaces
- Motor oil and hydraulic fluid
- Tire dust

Galvanized metal surfaces

There are galvanized metals at many industrial facilities. They are coated with zinc to protect them from corrosion or rust. As the zinc protects the metal, zinc is gradually dissolved when in contact with water.

From the perspective of water quality, zinc in runoff from these metals can be high, between about 1,000 – 15,000 µg/L (parts per billion). Galvanized surfaces include ducts, HVAC units, turbines, and equipment boxes on roofs. Roofs with these can produce high concentrations of zinc in their runoff. A limited study found runoff from a roof with galvanized ducts ranging from 400 -500 µg/L zinc. An identical roof, but without galvanized surfaces, had only 50 µg/L in its runoff (Golding, 2006).

The following list includes commonly galvanized items:

- Roofs
- Roof HVAC, ductwork, turbines, equipment boxes
- Downspouts
- Roof gutters
- Storm sewer pipe

Chain-link fence

- Light poles
- Bay doors
- Steps
- Truck trailer panels

Galvanized chain-link fence can be a major source of zinc, especially when the fence is on paved rather than vegetated ground.

Replacing these with other materials may eliminate the source. You may want to paint galvanized materials rather than replacing them. Information on painting galvanized materials begins on page 13.

Materials that do not add to zinc pollution include aluminum, steel, or rigid PVC. These materials can be used to replace many surfaces.

Galvanized roof gutters and downspouts are common. Galvanized roofs release high concentrations of zinc. Most smaller facilities do not have galvanized roofs. Chain link fence can also contribute considerable amounts of zinc to runoff. But in many cases fences are located along property boundaries where there is soil and vegetation to soak up much of the fence runoff.

Galvanized metal storm sewers can be a major source. You can identify them by looking at discharge points or in catch basins for spiraled metal pipe. Some galvanized pipes are coated with tar or other materials and may not contribute significant amounts of zinc. Alternative pipe materials that are not significant sources of zinc include concrete and rigid PVC.

Mechanisms of release and capture

Zinc in stormwater runoff can be dissolved or attached to soil particles. Zinc washed off from galvanized surfaces is almost all in dissolved form. In one study, zinc in runoff from roofs with galvanized ductwork and galvanized downspouts ranged between 98% - 100% dissolved (Golding, 2006).

Zinc in dissolved form is difficult to remove once it enters runoff. A good way to prevent this is to replace or paint/coat galvanized surfaces.

Solid particles such as dust, soil, bark dust, and leaves, can soak up zinc in runoff. When exposed to rain they can enter runoff. Cleaning paved surfaces can remove zinc as it removes the particles. In some cases, cleaning roof gutters may also remove zinc contained in solids.

Galvanized HVAC or other ductwork on facility roofs is a common source of zinc in runoff.

When the source controls described in this guide are not enough, treatment BMPs may be needed to reduce zinc concentrations. The Washington Department of Ecology stormwater manual (http://ecy.wa.gov/programs/wq/stormwater/manual.html) lists treatment types that Ecology recommends for reduction of metals in stormwater runoff..

Some downspouts are made of galvanized steel. They can contribute significant amounts of zinc in the discharged stormwater.

Some storm sewers are made of galvanized steel. You may see the sewer pipe at the outfall to a ditch or water body. You may also see the pipe where it leads into catch-basins. The appearance of metal and spiral construction is an indication. Pipes with parallel ribbing are of PVC or other materials.

Roof-mounted air-pollution scrubbers may have large surfaces of galvanized metals

Motor oil and hydraulic fluid

Both motor oil and hydraulic fluid contain high concentrations of zinc, about 0.1% by weight (1,000,000 µg/L). To get a sense of the extent these fluids can add zinc to runoff, when ½ cup of motor oil is added to an area 100 feet x 100 feet of paved surface, the runoff is calculated to be about 250 µg/L or parts per billion. This is for a depth of water of 0.02 inch rain, typically sufficient rainfall to cause runoff.

Common sources of zinc in both motor oil and hydraulic fluid at facilities include cars, trucks, and forklifts on parking lots, loading docks, and other surfaces.

Ways that zinc in oil and fluids is released and captured

Motor oil and hydraulic fluids have such high zinc concentrations, it is best to prevent them from ever coming in contact with precipitation or runoff. The most effective source control is to prevent leaks from vehicles and equipment at their source. If you see puddles or spots of oil or fluid, clean them up directly. Solid particles such as dust and dirt can absorb motor oil and hydraulic fluid. When this happens, you may not notice that the fluids are present, or underestimate their amount. See section on vacuum sweeping (page 11).

Motor oil on pavement at loading dock. If the pavement has few loose particles (if it is fairly clean other than oil and hydraulic fluid spots, you may need to pressure wash with vacuum pickup.

Smaller oil spots are typically found in parking lots.

Hydraulic equipment at the front of a forklift

Forklifts tend to leak hydraulic fluid if not well-maintained.

Debris on the ground, such as dust, sawdust, dry leaves, or bark dust, may soak up oil and/or hydraulic fluid. These can become a major source of zinc with rainfall and runoff. Sweeping with vacuum sweepers removes the large and small particles, in some cases greatly reducing zinc in runoff.

Tire dust

Zinc is used in the manufacture of tires. Tires contain zinc at about 1% by weight. Tire tread wear releases particles of zinc laden dust. Common sources of tire dust are forklifts, trucks, and truck trailers. When they make tight turns, a considerable amount of zinc is released.

Jeff Davis, an engineer with the fruit processor, Tree Top, Inc, found this to be true. His staff has seen fine black powder coating railings and storage shelving (Davis, 2005). Fine black tire dust has been found at a number of other warehouse facilities (Stasch, 2007).

Because it is a solid, you can remove the dust-containing zinc by sweeping and vacuuming (page 11).

Fork lift tires can be a large source of tire dust. The tires rub and release dust when making tight turns.

Trailer tires are also a source of tire dust, particularly in settings where they must make tight turns.

Other sources of zinc

Moss control is not often practiced at industrial facilities. But when it is, it can be a large source of zinc in runoff. Zinc is the active ingredient in some moss killers at concentrations up to 99% zinc. Some manufacturers recommend applying up to three pounds for every 600 feet. (Oregon State University).

Some white paints contain zinc oxide and may contaminate stormwater runoff with zinc. Some paints contain zinc to provide galvanic protection. Some wood preservatives also contain zinc (2% zinc in some cases). Avoid using these materials if they contain zinc.

Summary

In most cases the major sources of zinc contributing to stormwater runoff are:

- Galvanized metals
- Motor oils / hydraulic fluids exposed on the ground, or absorbed by solid particles such as dust and dirt.
- Tire dust from forklifts, trucks, and other vehicles.

For practical, effective remedies for preventing these particular sources from entering stormwater runoff, see the section of this document: “Tackle the Problem: Two Ways to Reduce Sources of Zinc.”

To help you gain a sense of the amount of zinc released to runoff from real cases, see Appendix B (page 27).

General Source Control Measures to Reduce Zinc

This section deals with general source control measures that apply to most facilities. The section that follows this one, “Tackle the Problem - Two Ways to Reduce Sources of Zinc” takes a closer look at two effective methods of zinc removal: vacuum sweeping and painting galvanized surfaces.

Often the way to stop zinc at its source begins with good housekeeping practices. These include covering materials and working areas, providing containment for fluid storage, and adopting cleanup measures. The list below shows some of these. Source control BMPs are discussed at length in chapter IV of Stormwater Management Manual for Western Washington: Source Control BMPs. http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

These guidelines apply to most industrial facilities:

- Prevent water from contacting working areas.
- Practice spill prevention.
- Cover outdoor materials storage and handling areas.
- If you handle bulk materials outdoors, keep them covered, appropriately contained and protected from stormwater.
- Load and unload bulk materials only at designated loading areas. This isolates potential pollutants to areas that can be controlled.

- Visually inspect your access roads and parking lots regularly to identify and clean up spills.
- Designate consistent parking spots for each employee so that if you notice a leak on the ground you can notify the vehicle owner.

Measures for existing facilities

Galvanized materials

- Replace galvanized items.
- Paint galvanized surfaces as an alternative to replacing them.
- Place chain-link fence on vegetated, not paved areas to reduce runoff and absorb metals.
- When galvanized chain-link is on a paved surface, consider replacing it with aluminum chain-link. They cost about the same. Aluminum fence is said to have a life of 10 – 15 years as compared with 30 years for galvanized.
- Cover galvanized surfaces to prevent exposure to water.
- Use vacuum sweepers to remove motor oil on particles and debris as well as tire dust. Vacuum sweepers are discussed on page 11.

Motor oil/hydraulic fluids

- Maintain/repair equipment regularly. Check for equipment leaks. Establish a schedule to routinely check hydraulic systems and motor oil levels. Where possible, park equipment in the same location(s) so that you may detect leaks more quickly. Clean evident spills or oily/liquid spots.
- Cover outdoor operations. Prevent stormwater from flowing into the covered areas.
- Use a vacuum sweeper to remove coarse and fine solid particles.
- Pave areas where oil and hydraulic fluid may leak. This provides a surface for thorough cleaning.

Tire dust

- Reduce the amount of traffic maneuvering in tight turns.
- Remove dust from surfaces exposed to rain or runoff. Sweep with industrial vacuum sweepers to clean paved areas. Cleaning methods should be appropriate for other surfaces such as product containers and railings.
- Consider using forklift tires made from non-rubber materials. Some do not contain zinc such as polyurethane. (roadrunnertires.com; orbitindustrial.com).

Other measures:

- Do not use (white) paints containing zinc oxide.
- Do not use zinc-rich paints intended to provide galvanic protection.
- Do not use a moss remover containing zinc.
- Avoid the application of fertilizers that contain zinc. Do not over-apply.

Measures to reduce zinc at new facilities

Measures to reduce zinc in runoff for new facilities include the following. You can adapt some of these measures for existing facilities.

- Install metal HVAC, ductwork, and other equipment that is painted with non-zinc paints.
- Use roofing materials other than galvanized materials (such as aluminized paint over bitumen, acrylic or latex paints, or rubberized coatings).
- Use non-galvanized materials for downspouts (such as aluminum, steel, or PVC).
- Use non-galvanized storm sewer culverts (such as concrete or corrugated steel).
- Use aluminum chain-link fence.
- Design the site to minimize the need for tight turns by trucks and forklifts.
- Provide covered areas for truck loading and forklift operation when practical. Design loading areas so that stormwater will not run on to them.

Tackle the Problem: Two Ways to Reduce Sources of Zinc

This guide has shown many ways to reduce or prevent contamination of stormwater from zinc. If you follow the two methods described below, you will likely focus on the major sources of zinc to runoff: fluids, oils, tire dust, galvanized runoff.

- Remove zinc from paved areas using appropriate sweeper equipment.
- Cover zinc on galvanized surfaces by replacing, painting or coating.

In this section we take a closer look at two methods.

Option 1: Sweeping grounds

Sweeping parking areas, loading docks, and other paved surfaces can effectively stop much zinc from entering runoff. Sweeping removes large and small particles and with them, motor oil,

hydraulic fluid, tire dust, and in some cases zinc from galvanized metal runoff. This is an important source control BMP. Use the sweeper types specified below.

Some companies offer both sweeping and power-washing services. Power washing is appropriate for maintenance when pavement areas have oil or hydraulic fluid spots or small slick areas on pavement but few particles to sweep. The service company disposes of the sweepings or the power wash water.

You can find sweeping service companies throughout the state, especially in most metropolitan areas. Look in phone directories under headings such as "Street Sweeping" or "Industrial Sweeping." Some pavement contractors also offer this service.

Your staff or a sweeping service will need to sweep your facility's grounds between once per week and once per month, depending on the rate of particle accumulation. The best approach is to establish a regular schedule to keep particles on pavement from building up. Keep track of dates of sweeping and the time interval between sweeping in your Stormwater Pollution Prevention Plan or site log book. Also study the results of your stormwater discharge sampling. Evaluate dates of sweeping intervals and compare them with the sampling results for zinc and other parameters. Together, the information may help you decide on a sweeping interval that keeps your pollutant concentrations below benchmarks.

Vacuum sweepers are effective

Whether you choose to use a sweeper service or to buy a sweeper, it is important to select one that effectively removes fine particles.

Several studies have found that sweepers using vacuum technology are much more effective, than mechanical sweepers. One study by USGS, summarized in Table 1, found that vacuum technology is much more effective at removing street-dirt accumulations than mechanical sweepers (Table 1). (USGS, 2005).

Table 1 – Removal rates of street dirt for two types of sweeper technologies.

Type of Sweeper	**Removal Rate**
Mechanical	20 – 31%
Vacuum assisted	60 – 92%

A fact sheet from the U.S. DOT, Federal Highway Administration discusses types of sweepers. It states that vacuum-assisted sweepers are more effective than mechanical sweepers at removing fine sediments. It is these fine materials that bind a high proportion of heavy metals including zinc. Tests conducted on newer vacuum-assisted dry sweepers have projected suspended solids removals (particles smaller than sand) of up to 79 percent. (U.S. DOT; http://www.fhwa.dot.gov/environment/ultraurb/3fs16.htm).

Most sweeping services provide several kinds of sweepers. It is important to select a sweeping service that uses vacuum technology. When contacting a sweeping service company, discuss available sweeper types with them. Typical types are listed below. Be aware that sweeping services may refer to these by other names.

This list is in order of more desirable to less desirable (U.S. Department of Transportation). Avoid using mechanical sweepers with no vacuum.

More effective

Less effective

- **Vacuum assisted dry sweepers most effectively remove solids including fines.** The machines employ mechanical sweeping followed by vacuuming. The use of these machines may provide the best surface cleaning and remove most of the zinc bound to solids.
- **Vacuum assisted wet sweepers** are more effective than mechanical sweepers, but may be less effective than vacuum assisted dry sweepers. The machines also employ mechanical sweeping followed by vacuuming.
- **Sweepers that use air followed by vacuuming** are generally not as effective as sweepers with combined mechanical sweeping and vacuuming. They may effectively remove small particles, but if substantial amounts of sediments and solids have accumulated on the grounds, they may work less well. Solids that have soaked up oils and fluids may be hard to dislodge with this method.
- **Mechanical sweepers with rotating gutter brooms** are not effective at removing small particles and the zinc and other pollutants associated with them. Ecology does not recommend using mechanical sweepers.

The Department of Transportation website (http://www.fhwa.dot.gov/environment/ultraurb/3fs16.htm) provides additional information concerning removal of pollutants by street sweeping.

Option 2: Painting/coating galvanized surfaces

Painting galvanized surfaces may substantially reduce zinc in your stormwater discharge.

You may hire a painting company to paint galvanized surfaces. Some companies specialize in commercial / industrial painting, including painting galvanized surfaces. If using a contractor, ask for the Material Safety Data Sheet (MSDS) for the project they will use. The MSDS lists all ingredients in the paint. Check to see that the paint does not contain zinc.

You may also decide to have facility personnel paint galvanized surfaces. Retail paint companies can suggest products and methods. A list of steps to paint galvanized surfaces is shown below. The procedure is supported in the literature but has not been evaluated by Ecology.

Before purchasing paint, review the manufacturer's MSDS to determine that it does not contain zinc. Some metals primers contain zinc. Use of these primers is acceptable, but less desirable to use them. If you use a zinc-containing primer, be sure to cover it completely with a non-zinc paint coating. Inspect the paint at least once per year to determine if it is still covering the primer.

How to paint over galvanized surfaces

The following procedure for painting galvanized materials is from information found in the literature. But it is up to the individual permittee to employ the most appropriate methods for the site.

Some people assume painting to cover galvanized surfaces is difficult, but according to Langill (2006), in most cases, it is not. (Langill, 2006) The procedure is from sources including an in-depth article from the American Galvanizer's Association (Thomas Langill, Technical Director).

http://www.galvanizeit.org/resources/files/AGA%20PDFs/paintsteel.pdf

When a galvanized steel surface has weathered for at least one year, painting it presents few difficulties. The zinc metal on the surface converts to zinc oxide and then washes off with rain. This leaves a layer of zinc carbonate within the first 12 months of exposure to the environment. Paint readily adheres to the zinc carbonate layer. (Langill, 2006).

Painting over newly galvanized surfaces (less than one year old) may present greater difficulties. After one wet season, the coating will wash off and no special treatment is required for painting.

Ecology has not tested, verified, nor validated the following step-by-step method. While it appears to be practical, but the permittee is solely responsible for implementing any method.

Steps for painting galvanized surfaces:

- Make sure the surface is at least one-year old.
- Remove any rust.
- Clean surface of oil and grease, with a solvent. You can use mineral spirits, turpentine, high flash naphtha, or other typical cleaning solvents. Apply the solvent with lint-free rags or soft bristle brushes. Change the rags and brushes often to prevent reapplying the contaminants.
- After cleaning, rinse thoroughly with hot water and allow the surface to dry completely.
- You can use a primer compatible with galvanized metal surfaces before painting. Consult specialty paint stores such as Sherwin-Williams or Pittsburgh paints for information on painting galvanized surfaces. (Some primers for galvanized surfaces contain zinc, but are acceptable if fully covered by an outer coat of paint.)

- Apply the outer coat of paint. Make certain that the paint contains no zinc and is not intended to provide galvanized protection.

Some concerns about painting galvanized surfaces

Painting galvanized materials may reduce their 30-year maintenance-free life. Painted surfaces require repainting at more frequent intervals. Painting galvanized roofs may in some cases invalidate a warrantee. Inspect painted surfaces at least once per year to be sure the paint coating remains intact.

Conducting a Simple Facility Inventory of Zinc Sources

A simple inventory can provide an overview of the major sources of zinc in your stormwater discharge and help identify possible solutions. A walk-through of the facility and grounds can provide a quick, useful assessment of zinc sources and their extent. When taking inventory of potential zinc sources, pay close attention to drainage patterns. This will help you determine whether a zinc source enters the runoff and where. Ecology recommends you review your facility's SWPPP (Stormwater Pollution Prevention Plan).

Refer to the inventory form on page 17. It identifies common sources of zinc to help with the inventory.

The report, *A Survey of Zinc Concentrations in Industrial Stormwater Runoff* (Golding, 2006), includes example inventories Ecology conducted at 28 facilities. (http://www.ecy.wa.gov/biblio/0603009.html)

Zinc Source Inventory Worksheet

As a first step you should review your Stormwater Pollution Prevention Plan (SWPPP). Conduct a walk-through inspection to see that your facility is following measures in the SWPPP. The SWPPP facility diagram shows areas of potential sources and measures to contain them. The diagram also shows runoff routing and stormwater conveyances. Record your observations on a worksheet such as the one below.

1. Ground cleanliness
    a. Oily fluid spot/puddles (extent, size of spots/puddles)
    b. Dirt, dust particles: degree and extent of area
    c. Other absorbent materials (saw dust, wood chips, leaves, etc.)

Observations: _____

_____

_____

_____

2. Stormwater conveyance (check for galvanized materials)
    a. Downspouts
    b. Storm sewers

Observations: _____

_____

_____

_____

3. Ground activity
    a. Hydraulic fluid / tire dust (such as forklifts / trucks / heavy equipment)
    b. Motor oil (cars and trucks)

Other sources (manufacture or storage) and observations: _____

_____

_____

_____

_____

4. Galvanized materials on grounds (such as process-related materials, storage, scrap piles, parked equipment)

Observations: _____

_____

_____

_____

5. Spill prevention measures (such as covered areas over exposed materials, operations indoors where suitable)

Observations of spill measures in place: _____

_____

_____

_____

6. Chain-link fence

    a. Material
    b. Length
    c. Location within facility or on perimeter, over vegetation or over pavement

Observations: _____

_____

_____

_____

7. Roof (note galvanized surfaces)

    a. Roof material, type of coating, area
    b. Galvanized ductwork, area: HVAC, equipment housings, turbines, etc.
    c. Roof gutters
    d. Galvanized metal strips or wires for moss control
    e. Periodic application of moss control liquids or powders

Observations: _____

_____

_____

_____

8. Buildings

    a. Galvanized materials such as garage doors
    b. Paint containing zinc (see the MSDS for the particular paint)

Observations: _____

_____

_____

_____

9. Other sources / possible sources not noted above_____

_____

_____

_____

Reviewing Self-Reported Data

Results from grab samples may provide information that helps identify sources of zinc in stormwater discharges. Sometimes grab results show high zinc levels but few sources have been found. In this case a more thorough inventory may point to additional sources that had not been considered. These may include an overlooked roof surface, previously unnoticed solid particles on paved areas, and materials that at first were thought not to be galvanized.

While Ecology does not require it, monitoring runoff by taking grab samples at additional locations at the facility where there is runoff can help you identify sources within the facility. Taking samples again after taking actions to reduce zinc may indicate the extent of improvement.

After you have taken measures to reduce zinc in runoff, grab samples will often show lower concentrations of zinc in the stormwater discharge. With proper attention you can reduce high concentrations to lower than benchmark concentrations.

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Appendix A – An Introduction to Zinc in the Environment

Zinc is one of the most common elements in the earth's crust. (www.eco-USA.net) Zinc is found in the air, soil, and water and is present in all foods. In its pure elemental (or metallic) form, zinc is a bluish-white shiny metal. There is no information on the taste and odor of metallic zinc. Powdered zinc is explosive and may burst into flames if stored in damp places. Metallic zinc has many uses in industry. A common use is as a coating for iron or other metals so that they do not rust or corrode. Metallic zinc is also mixed with other metals to form alloys such as brass and bronze. A zinc and copper alloy is used to make pennies in the United States. Metallic zinc is also used to make dry cell batteries.

Zinc can also combine with other elements, such as chlorine, oxygen, and sulfur, to form zinc compounds. Zinc compounds that may be found at hazardous waste sites are zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide. This profile focuses primarily on metallic zinc and commonly found or used zinc compounds. Most zinc ore found naturally in the environment is in the form of zinc sulfide.

Uses – where it is found

Zinc compounds are widely used in industry. Zinc compounds are not explosive or flammable.

Zinc sulfide is gray-white or yellow-white, and zinc oxide is white. Both of these compounds are used to make white paints, ceramics, and several other products. Zinc oxide is also used in producing rubber.

Zinc compounds, such as zinc acetate, zinc chloride, and zinc sulfate, are used in preserving wood and in manufacturing and dyeing fabrics. Zinc chloride is also the major ingredient in smoke from smoke bombs.

Zinc compounds are also used by the drug industry as ingredients in some common products, such as sun blocks, diaper rash ointments, deodorants, athlete's foot preparations, acne and poison ivy preparations, and antidandruff shampoos.

Zinc is an essential food element needed by the body in small amounts. Too little zinc in the diet can lead to poor health, reproductive problems, and lowered ability to resist disease. Too much zinc can be harmful to health.

Fate and Transport

Zinc enters the air, water, and soil as a result of both natural processes and human activities. Most zinc enters the environment as the result of human activities, such as mining, purifying of zinc, lead, and cadmium ores, steel production, coal burning, and burning of wastes. These releases can increase zinc levels in the atmosphere. Waste streams from zinc and other metal manufacturing and zinc chemical industries, domestic waste water, and run-off from soil containing zinc can discharge zinc into waterways. The level of zinc in soil increases mainly from disposal of zinc wastes from metal manufacturing industries and coal ash from electric utilities. In air, zinc is present mostly as fine dust particles. This dust eventually settles over land and water.

Zinc in lakes, rivers, and streams

Rain and snow aid in removing zinc from air. Most of the zinc in bodies of water, such as lakes or rivers, settles on the bottom. However, a small amount may remain either dissolved in water or as fine suspended particles. The level of dissolved zinc in water may increase as the acidity of water increases. Some fish can collect zinc in their bodies if they live in water containing zinc.

Most of the zinc in soil is bound to the soil and does not dissolve in water. However, depending on the characteristics of the soil, some zinc may reach groundwater. Hazardous waste sites have contaminated groundwater. Animals eating soil or drinking water containing zinc may take up zinc. If other animals eat these animals, they will also have increased amounts of zinc in their bodies. (ECO-USA)

Appendix B – Supporting Data: Potential Concentrations of Sources in Industrial Stormwater

Downspouts as Sources of Zinc in Stormwater:

The following two cases show zinc increases of ten times or more due to galvanized downspouts. The data show in general that galvanized materials may produce high concentrations of zinc in runoff.

- Bellingham WWTP: Roof above downspouts: 6 – 100 µg/L

  Stormwater from downspouts: 1,670; 5,630 µg/L

(Reducing Zinc Concentrations in Stormwater, City of Bellingham Department of Public Works, Post Point Laboratory.)

- SR520 Bridge: Bridge deck: 180 µg/L

  (n = 4, 5) Galvanized metal downspouts: 2,030 µg/L

(Herrera Environmental Consultants, 2005.)

Painting Galvanized Surfaces

The Port of Seattle at SEATAC Airport ran tests of two roof areas, one of Galvalume, the other Galvalume painted with primer and acrylic paint. (Galvalume is similar to galvanized steel but with aluminum as a constituent). The tests were conducted with simulated rainfall, so the data may be valid only in a relative sense.

Galvalume roof (unpainted): 1,590 µg/L

Galvalume roof (painted): 298 µg/L

(Taylor Associates, 2004)

Roof Gutters – Cleaning Dirt and Sediments:

SEATAC airport:

Cleaning roof gutters: removing 1 inch of sediments in the roof gutters reduced zinc concentrations 37%.

(Tobiason, 2006)

Roofs with Galvanized Ductwork, Equipment Boxes

Four grab samples each were collected from downspouts from two roofs. The roofs were identically painted and of the same size. One roof had galvanized ductwork and equipment boxes (217- 433 µg/L). The other had no galvanized surfaces (47 – 167 µg/L).

(Golding, 2006)

Motor oil / Hydraulic Fluids and Debris on Paved Surfaces

- A machine shop with a three year accumulation of debris including wood chips on pavement showed grab samples with 430 µg/L and 200 µg/L zinc. After cleanup, zinc concentration was 46 µg/L zinc.

  (Golding, 2006.)

- A welding shop with old, poorly maintained forklifts leaked so that floor was considered a slip hazard. Zinc concentrations before maintenance and cleanup: 794 µg/L; 530 µg/L

  Zinc concentrations after maintenance and cleanup: 89; 25; 280; 25 µg/L

  (Golding, 2006.)