Exhibit A

A PROPOSAL TO CONTINUE TO USE HERBICIDE TO MANAGE THE KNOTWEED INFESTATION IN THE CEDAR RIVER MUNICIPAL WATERSHED

SEATTLE PUBLIC UTILITIES

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BACKGROUND

Seattle Public Utilities (SPU) focuses on being effective stewards of the municipal watershed lands and resources it owns or controls. Maintaining healthy forests, wetlands, streams, and lakes in the municipal watersheds that supply Seattle-area residents with drinking water is a priority for SPU. It is these healthy ecosystems that provide the abundant and high quality drinking water on which the citizens of this region depend. Protecting water quality for human use also protects resources used by other species. Lands of the Cedar River Municipal Watershed (CRMW) are managed under the 50-year Habitat Conservation Plan (HCP), which requires that SPU promote and protect native diversity of plants and animals.

SPU has a policy that was enacted in 1989 to not use herbicides in the CRMW (part of the Secondary Use Policies, adopted by Ordinance 114632). The intent was to stop broadcast spraying of herbicide to control vegetation along forest roads, a typical forest management technique at that time. This was prior to the widespread recognition of the damage that certain non-native invasive plants can do to ecosystems and water quality. Since that time, many invasive species have become major ecological threats in our region, and some of these cannot practically be controlled by physical means.

Bohemian knotweed (*Polygonum* x *bohemica*, *P. cuspidata*, and *P. sachalinense*) is one such species, and it poses one of the greatest risks of any invasive plant in the watershed. Able to reproduce from tiny root fragments and occasionally from seed, it takes over habitats near water, completely displacing native species, degrading habitat of salmon and other species, and potentially degrading water quality by destabilizing stream banks and causing increased sediment in the streams. Knotweed is an aggressive, invasive plant that spreads rapidly downstream by flowing water and is extremely difficult and expensive to control by physical means alone. As a consequence, many organizations and land managers, including The Nature Conservancy, Forterra, and 17 counties, including King County, have been using a relatively safe herbicide, Imazapyr, to successfully control this weed immediately adjacent to streams, lakes, and wetlands. These agencies, along with many other landowners, have recognized that the risk to the environment posed by invasive species is far greater than the risk posed by responsible use of the herbicide.

In 2010, Seattle City Council agreed with this risk assessment and passed Ordinance Number 123365 authorizing the use of the herbicide Imazapyr to treat knotweed within the CRMW from 2010 through 2012. In 2013 City Council passed a follow-up ordinance, Number 124191, authorizing continued use of Imazapyr to treat knotweed through 2015.

During this time, approximately 18 acres of knotweed in the CRMW was treated with Imazapyr, with no herbicide detected in the municipal water supply. In 2010 knowledge about the number of herbicide treatments required to eradicate large knotweed patches was limited, but pointed to the possibility that three treatments might be sufficient. During the intervening years, much more data on knotweed control in western Washington has become available. Current data indicates that eight or more consecutive treatments of large knotweed patches result in 98 to 99% mortality within large patches. By the end of 2015, a total of 7.72 acres will have been treated with Imazapyr six times, 7.86 acres five times, 0.28 acres four times, and 2.15 acres three times.

SPU, King County, and Forterra have spent over $1,00,000 in the past seven years to control this destructive plant along the Cedar River below Landsburg, and continued upstream control in the CRMW is essential to the success of efforts to control it downstream.

This proposal is to allow the continued use of the herbicide Imazapyr to control infestations of knotweed in the CRMW through 2018 in a manner that will (1) not pose a public health risk, (2) have a net ecological benefit, and (3) cost only about $30,000 over three years (2016-2018) and have a high chance of success, compared to about $520,000 for physical means of control that has a very low chance of success. Continued use of herbicide to treat knotweed in the CRMW will require an additional ordinance change. This document summarizes the proposal to continue herbicide application and the associated rationale.

WHAT INVASIVE PLANT SPECIES IS BEING TARGETED AND WHY?

Non-native invasive species are organisms introduced deliberately or unintentionally outside their natural habitats, where they have the ability to establish, invade, and locally eliminate native species, and dominate their new environments. They pose serious challenges to the conservation and sustainable use of global, regional, and local biodiversity, with significant undesirable impacts on the goods and services provided by ecosystems. Their management costs include not only costs of prevention, control, and mitigation, but also the direct and indirect costs associated with the adverse impacts on ecological services such as the production of clean, abundant water and the maintenance of habitat for salmon and other fish and wildlife.

Among the numerous invasive species present in the CRMW, knotweed is considered to be one of the most threatening due to its rapid growth, ability to quickly displace native vegetation, and alter soil and water chemistry. Specifically, knotweed is suspected or known to:

- reduce the amount and diversity of native streamside vegetation through both competition and secreted chemicals that are toxic to other plants;

- alter the quality, quantity, timing, and chemistry of leaf inputs into streams, thereby reducing the food available for aquatic insects; fewer insects means less food for fish;
- change the soil nutrients and alter soil nutrient cycling, affecting the growth and development of native plant species and insects living in the soil;
- decrease the density and diversity of plant-eating insects – essentially no native insects feed on knotweed; fewer insects means less food for fish, birds, and small mammals;
- destabilize stream banks, changing the patterns and amounts of streamside erosion and sediment input into streams, decreasing habitat quality for fish and other aquatic animals;
- provide no food or nesting habitat for native birds and mammals;
- modify the microclimate, making the area inhospitable to many native wildlife species, including reducing amphibian foraging success.

Once knotweed becomes established, it forms large monotypic stands that eliminate all native vegetation, are persistent, and are extremely difficult to eradicate. It can reproduce from tiny root or stem fragments, which are readily transported by water, wildlife, and humans. If unchecked, stands continue to expand and provide propagules that exacerbate infestations downstream.

WHAT IS THE EXTENT OF THE PROBLEM IN THE WATERSHED?

The current infestation in the CRMW has been mapped to total of about 22.5 acres—widely distributed in the lower municipal Watershed, but also in the upper elevations (Figure 1). Fortunately, we do not have large infestations along the Cedar River. Most patches are concentrated along roads, in developed areas, old town sites, wetlands, and a limited number in riparian zones of small streams.

SPU's past attempts at controlling knotweed have included non-chemical methods on a total of 4.5 acres, including covering small knotweed patches with geotextile fabric and some very limited hand pulling and excavation. Covering with fabric appears to be effective on extremely small patches (less than 100 ft^2). However, on slightly larger patches, when the fabric was removed after eight years of continual covering, there was widespread re-growth. So it is uncertain whether this method will eventually be successful in killing the expansive root systems of this plant. In addition, this method is extremely costly and labor-intensive. It costs approximately $17,000/acre to install the fabric and $4,000/acre/year to maintain it. From 2004 through 2012, SPU spent a total of $198,000 to cover and maintain fabric on 4.5 acres of knotweed, for a cumulative cost of $44,000/acre.

The remaining approximately 18 acres of knotweed consists of large patches concentrated around Cedar Falls, the Education Center and Rattlesnake Lake, the Masonry Dam, and the old Taylor Town site. While none of these patches are immediately adjacent to a river, they do pose a substantial risk of being inadvertently spread into riparian areas via wildlife or people working in the watershed. Plus, there is the chance that a small proportion of the seed may be viable and spread by either wind or wildlife.

Other physical methods of control, such as hand pulling or cutting to starve the roots, have not been proven to be effective on larger patches. While these techniques may work on very small patches that are easily accessible, they are logistically impossible on large remote patches and are unlikely to result in eradication of the patch. Mowing and excavating the plant roots is not effective at controlling the plant and only serves to spread the infestation.

Of the 18.01 acres treated with herbicide from 2010 through 2014, only about 2.2 acres is on land that drains into the Cedar River. The remainder is located in areas that drain either to the Snoqualmie River or Issaquah Creek.

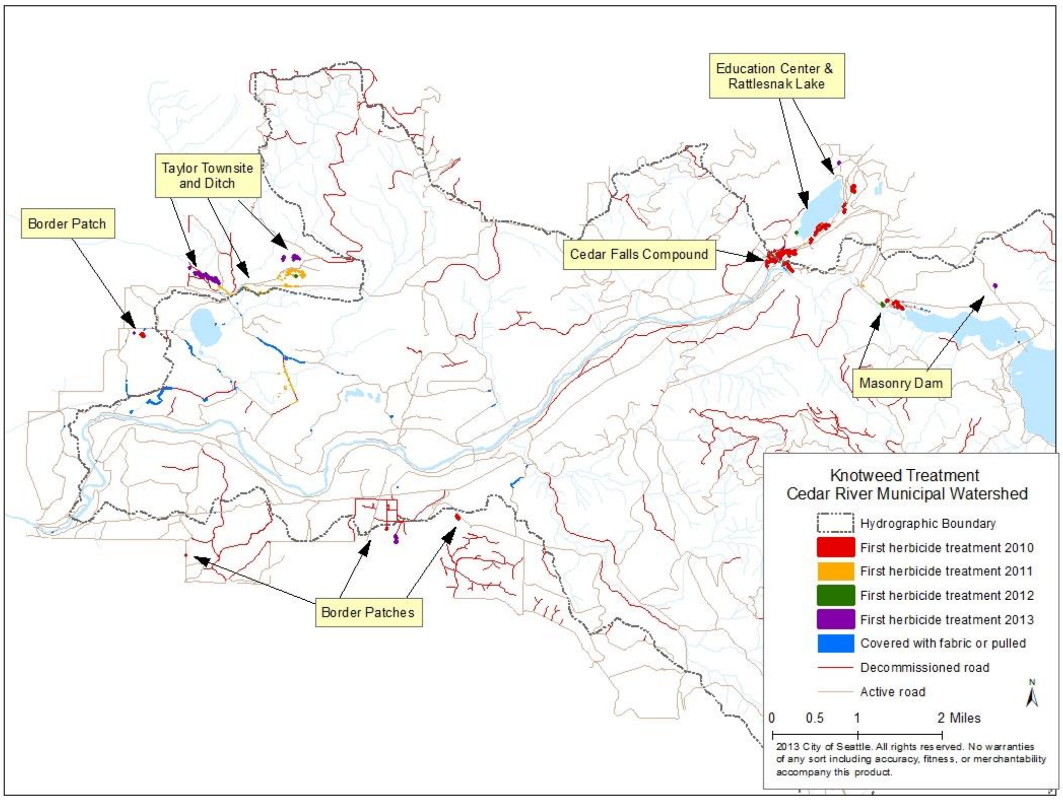

Figure 1. Location of knotweed patches in the CRMW and year first treated with Imazapyr. The Cedar River hydrographic boundary is shown as a dashed black line.

WHAT ARE OTHER ORGANIZATIONS DOING TO CONTROL KNOTWEED?

The Washington Toxics Coalition, generally advocating non-chemical control of invasive plants, has the following statement in its Weed Management brochure, available on its website: "Although non-chemical control tactics are favored, it may sometimes be necessary to resort to chemical herbicides when the problem involves aggressive perennial weeds or labor is not available for other control methods." That conclusion has also been reached by most land managers regarding the control of knotweed.

The King County Noxious Weed Control Program started treating knotweed along the Cedar River below the municipal water intake at Landsburg in 2008, funded by grants. SPU has treated knotweed on parcels it acquired in the lower Cedar River for HCP habitat protection, starting in 2009. Grant funding was obtained for 2010 and beyond, so SPU expanded its knotweed control efforts in the lower Cedar River to complement the King County's efforts. All of this treatment in the lower Cedar uses herbicide treatments. Scientists from the Washington State Extension Program and the King County Noxious Weed program have found that Imazapyr is the safest and most effective herbicide for treating knotweed, resulting in the highest mortality and using the smallest amount of chemical. Land managers throughout western Washington are using targeted foliar spray of 1% Imazapyr on knotweed, as it is currently the least toxic and most effective option.

Control of knotweed along the Cedar River (within 165 feet of the river) is legally required by King County. Knotweed control is already mandatory on the banks of the upper and middle Green River and its tributaries, and mandatory control may be required along other King County rivers in the future. Snohomish County currently requires all landowners to control knotweed anywhere within the county and herbicide is a recommended treatment.

Because of the scale of spread of knotweed and the extreme difficulty of control by physical means, The Nature Conservancy (TNC) has used herbicides as its primary means of control along rivers and near wetlands for many years and Imazapyr is its primary herbicide. Kitsap County is also using herbicides to control knotweed on Bainbridge Island, calling the plant "a cancer on our land." Many cities (including Port Townsend) and at least sixteen other counties in Washington also use herbicide to control knotweed, most in riparian zones. The Washington Department of Ecology, in its Integrated Pest Management Profile for knotweed states: "Except for small patches that might be controlled non-chemically, any management of the species will likely require some herbicide use." (WDOE 2007)

The City of Tacoma, with an unfiltered water supply, engages in spot application of herbicides for control of certain weeds, following a protocol approved by Washington Department of Health, which involves sampling in any nearby water bodies.

WHAT ARE THE COSTS OF CONTROL BY DIFERENT METHODS?

SPU staff used data from eight years of experience with physical control (installing and maintaining fabric) and the costs of using herbicide from 2010 through 2014 to compare the cost of controlling 18 acres of infestation (Table 1).

The cost estimate for covering is simply for comparative purposes because of the logistical impossibility and the demonstrated ineffectiveness of using this option on large knotweed patches. The option of taking no action was ruled out, as these areas could then be sources for knotweed that would undermine efforts by SPU and King County to control the plant in downstream areas, ultimately increasing the cost of control and/or resulting in substantial negative ecological impacts. All treated sites will be replanted to native trees and shrubs, as needed. Planting costs were assumed to be covered under the general watershed Invasive Species Project budget and are not included here.

Table 1. Analysis of controlling 18 acres of knotweed by covering or herbicide

Treatment Method	3-year Cumulative Cost	Ecological Risk from allowing knotweed to persist	Risk from Treatment[1]	Notes
Covering	$522,000	High	Low	Cost includes purchasing the fabric, contractor & staff labor to install and maintain fabric (average of $17,000/ac to install and $4,000/ac/yr to maintain).
Herbicide	$30,000	High	Low	Cost includes purchasing the herbicide, contractor time to apply the herbicide, water quality testing, and staff labor to supervise the work & monitor the sites.

[1] *Includes both ecological and public health risk*

WHAT IS THE PROPOSED HERBICIDE AND HOW WILL IT BE APPLIED?

The proposed herbicide application would be the same as used in 2010 – 2014, i.e., a 1% solution of Imazapyr (aquatic formulation approved for use in and near water) with 1% surfactant (modified vegetable oil) in water, applied strictly according to label instructions. This includes restrictions such as not applying during rain, wind, or when there is a temperature inversion. Imazapyr is a non-selective herbicide used for the control of a broad range of invasive plants including terrestrial annual and perennial grasses, broadleaved herbs, woody species, and riparian and emergent aquatic species. This combination of Imazapyr and surfactant is currently being used by the King County Noxious Weed Control Program in and around streams and water bodies, including along the Cedar River downstream of Landsburg, as well as by virtually every land manager in western Washington.

The herbicide solution is applied to knotweed foliage using targeted backpack sprayers. The solution includes a non-toxic dye that allows the applicator to see exactly where they have sprayed. This decreases the possibility of over-spraying an area. The only alternative to foliar spray is stem injection. Only glyphosate, which has higher toxicity than Imazapyr, is certified for use with stem injection. Experience has shown that the stem injection method typically uses about five times more herbicide than foliar spraying, with no greater knotweed mortality rates. The advantage of using stem injection can be lower mortality to adjacent native plants. However, experience in the watershed demonstrated that when foliar spray is correctly applied, there is no damage to adjacent plants.

Only Washington-State certified pesticide applicators and those under their direct supervision are allowed to apply the chemicals. They all work under supervision of SPU staff, who are also state certified. An annual application is made over the entire dispersed 18 acres of infestation during the pre-bud stage, which has been demonstrated to be the most effective growth stage for herbicide application. Prior to application, visual inspection is made to verify that the plants are 1) in the pre-bud stage at the time of application; and 2) are not actively being worked by pollinators on days conductive to such activity. An estimated 64 ounces of Imazapyr per acre of knotweed will be applied to any knotweed patches that have not yet received any treatment. We currently do not know of any patches with no treatment, but there is a small chance that additional patches will be found. An estimated 20 to 25 ounces of Imazapyr per acre of knotweed will be applied for the second annual application. An estimated ten ounces per acre will be applied for the third annual application, and four to six ounces per acre for subsequent applications.

Only 2.2 acres of knotweed are located on land that drains into the Cedar River. All of these patches will have received a minimum of three annual treatments by the end of 2015. So, less than 13 ounces of Imazapyr per year would be used on land that drains into the Cedar River from 2016-2018.

Most of the herbicide application will be applied in terrestrial environments and will not require any specific permit. All proposed treatment sites are more than 250 feet from the Cedar River and the nearest patch to the municipal water intake at Landsburg is over 10 miles. A small percentage of the application is anticipated to occur in a riparian area in the Issaquah Creek watershed and is covered by an Aquatic Noxious Weed General Permit from the Washington State Department of Ecology under the Washington State Department of Agriculture National Pollutant Discharge Elimination System (NPDES) general permit. This area does not drain into water that reaches the Cedar River and the municipal water intake at Landsburg. None of the herbicide application will occur in water.

HOW WILL THE TREATMENT BE MONITORED?

The Invasive Species Program Manager for SPU’s three major watersheds (currently a wildlife biologist and watershed ecologist with extensive training and experience and a certified pesticide applicator) will personally conduct compliance monitoring during all herbicide application conducted and contractors, and will apply the herbicide personally to the smaller patches. The Program Manager will be on site throughout application to ensure that:

- herbicide is only applied during dry calm weather
- chemicals are properly mixed
- spray is properly applied
- there is minimal or no spray of adjacent native vegetation
- safety precautions, including personal protective equipment, for the applicators are followed
- chemicals are properly stored

- all paperwork required by the Washington Department of Agriculture and Washington Department of Ecology is complete and accurate

The Program Manager will also personally collect all water samples for water quality testing (see below). Within one week of the treatment SPU staff will monitor all treated sites for any incidental wildlife mortality, searching especially for amphibians. Because Imazapyr has such low toxicity (see below) and virtually no native animals use large monocultures of knotweed as habitat, the changes of finding any animal mortality is remote. No animal mortality was found from 2010 – 2014.

After application, all sites treated with herbicide will be monitored by SPU staff for knotweed and adjacent vegetation response. All treated sites will be visited at least once per year prior to annual treatment.

Once all herbicide treatment is completed, all treated sites will be monitored at least twice a year for a minimum of five years to ensure that any re-growth is found early and treated immediately. If natural regeneration by native species is insufficient, treated sites will be replanted with native trees and shrubs, and these plantings will be monitored at the same time. If necessary, we will periodically plant additional native species to ensure that the habitat is restored to a functioning native system.

An annual monitoring report documenting the application, monitoring results, and water quality testing results will be completed each year. All reports will be placed on the City of Seattle HCP website, so will be available to the public for review.

ARE THESE CHEMICALS SAFE?

Imazapyr inhibits an enzyme only found in plants and is classified as a Category III (low toxicity) herbicide by the US Environmental Protection Agency. Imazapyr has relatively low toxicity to mammals, showing low toxicity if individuals get residues on their skin, and very low toxicity if it is eaten or inhaled. It is “practically non-toxic” to “slightly toxic” to fish and “practically non-toxic” to birds. Some formulations of Imazapyr can cause severe eye irritation if it gets directly into a workers eye. Although this has not been reported for the aquatic formulations used in the watershed, safety precautions, including legally required personal protective equipment, are required for all applicators and the applications are monitored to ensure worker safety.

In a 2004 risk assessment, the US Forest Service found that no adverse effects are likely to occur for a variety of mammals and birds, including herbivores and carnivores, with spraying at any typical application rate (Durkin and Follansbee 2004, Bautista 2005). Studies indicate that Imazapyr is rapidly excreted by mammalian systems, with no bioaccumulation (The Nature Conservancy 2004). A peer-reviewed field study found that there were no adverse effects on stream macroinvertebrates at application rates as high as 100 times normal (Fowlkes et al. 2003). Although herbicides contain inert ingredients that are considered proprietary, these toxicity tests were performed on the entire formulation, not just the active ingredient.

In toxicity tests on juvenile rainbow trout, the surfactant Agri-Dex® was found to be much less toxic than other surfactants. It took 271 parts per million (ppm) for an LC50 (the concentration at which 50% of the test subjects died), compared to 6, 17, and 74 ppm for the other commonly used surfactants tested (Smith et al 2004). It would require application directly into a stream and a water depth of less than 5 mm in order to reach the LC50 concentration for trout, a situation that would not occur in the field.

More details about the chemicals and their safety can be found in Appendix 1.

HOW IS IMAZAPYR BROKEN DOWN?

Imazapyr is water soluble and is broken down by sunlight in water with a reported half-life in water as short as two days (The Nature Conservancy 2004), but no longer than five days (Environmental Protection Agency 2006).

The half-life of Imazapyr in soils in the field have been has been reported to be as short as 10 days to as long as 17 months in humid temperate climates, depending on soil type and particle size, pH, temperature, moisture content, and organic material content. In soils Imazapyr is degraded by microbial metabolism. Because Imazapyr is water-soluble, it can move in soil and can potentially enter the ground water. However, amount of movement depends on soil pH. Below pH 5, adsorption capacity of Imazapyr increases and its movement in soils is limited (The Nature Conservancy 2004). Most forest soils in western Washington are acidic, with soils under Douglas-fir generally under pH 6, and under red alder (common in riparian areas) under pH 5 (pers comm. Darlene Zabowski, soil science professor, University of Washington).

Dr Allan Felsot, a well-known and respected toxicologist and Professor of Environmental Toxicology at Washington State University, was asked about the potential toxicity of breakdown products. He said that all of these compounds are biodegradable. When given to test animals in high doses, they result in similar breakdown products as would occur in the environment. Indeed, these breakdown products are even more bioavailable than any that would occur in the environment because they are already in systemic circulation. In the environment, bioavailability is limited by interactions with solid surfaces, such as soil, sediment, plant waxes, etc. Thus, these breakdown products, if toxic in and of themselves, would have affected the physiology of the test animals. Yet, all of the listed compounds do not cause acute toxicity at environmental levels of exposure. In fact, none of the compounds even cause subchronic or chronic toxicity at levels of environmental exposure.

HOW CAN SPU BE SURE THAT DRINKING WATER WILL NOT BE AFFECTED?

None of the 2.2 acres of knotweed patches proposed for herbicide treatment on land that drains into the Cedar River are adjacent to the river or any of its tributaries. The closest location is 250 feet from the river and over 10 miles from the municipal water intake at Landsburg. For terrestrial applications, the chance of Imazapyr entering the Cedar River via surface runoff is extremely remote because proper protocols will be followed (i.e., no applications when raining or windy, targeted hand-spray of only knotweed) and because there are no surface channels connecting any of the knotweed patches to the river or any of its tributaries. Because of the forest present between the knotweed patches and the Cedar River, no overland sheet flow occurs, even during large storm events.

For all years of herbicide treatment water samples are taken both before (baseline) and the day after (post-treatment) the herbicide application. All water samples are analyzed for Imazapyr at Pacific Agricultural Laboratory (PACLAB) in Portland, Oregon. This laboratory is accredited with the Washington Department of Ecology and was recommended by the SPU Water Quality Laboratory. PACLAB specializes in analysis of all types of pesticides and has an extremely low detection limit for Imazapyr of 0.02 ug/L, or 0.02 parts per billion.

For knotweed patches within the hydrographic boundary, baseline samples are taken prior to herbicide treatment in both the Cedar River (at the point closest to a knotweed patch = 250 feet away from a patch) and at the Landsburg water supply intake facility (over 10 miles downstream from the closest knotweed patch). Post-treatment samples are taken at these same sample locations in the morning following treatment (approximately 16 to 20 hours post-treatment). No Imazapyr was detected in any of these samples in all years of treatment.

Dr. Felsot prepared a worst case scenario in which the entire amount of herbicide used on all of the knotweed in the CRMW (not just that within the hydrographic boundary) was put directly into Lake Youngs, the municipal water storage lake. That would result in a concentration of 26.6 parts per trillion of Imazapyr. He assumed no breakdown of the chemical and evaluated the human health risk of this concentration in the drinking water. His data showed that this concentration was at least 600,000 times lower than a benchmark derived from an exposure that is already 100 times less than a dose that was found to cause no adverse effects on a human child. Thus the risk from this concentration could not be distinguished from nil.

For each annual herbicide application both baseline and one day post-treatment water quality samples will continue to be taken in the Cedar River at the point closest to a treatment knotweed patch and at the municipal water intake at Landsburg .

WHAT ABOUT WATERS THAT DON’T DRAIN INTO THE CEDAR RIVER?

Water samples are taken from Rattlesnake Lake (water drains to Snoqualmie River) prior to treatment of patches at the Education Center and Rattlesnake Lake, and in the morning following treatment of these patches at the location closest to a treated patch. No Imazapyr was detected in any of these samples in all years of treatment.

At Taylor Townsite there is a small creek (bankfull width less than three feet) that runs along the edge of and through a small portion of the large knotweed patch. It flows into the Taylor Overflow Ditch which eventually reaches Issaquah Creek. The Taylor Overflow Ditch is surface dry for much of the year and portions of the creek itself are often dry during summer. In the summer of 2011 there was a small amount of water in the creek at the location where knotweed spans both sides of the creek. We took water samples both the day before (baseline) and the morning after the 2011 treatment (first herbicide treatment), sampling at the site where knotweed was growing on both sides of the creek and within the creek bed itself. The water level was low, with very little flow during sampling. Most water had collected in a small pool at the sample site, although there was a small amount of surface flow continuing in the creek at this point. The creek, however, did go surface dry prior to reaching the Taylor Overflow Ditch, which was also surface dry, so there was no surface flow connectivity to Issaquah Creek.

PACLAB unexpectedly found 0.07 ug/L Imazapyr in the 2011 Taylor Townsite baseline sample. The laboratory did extensive testing for cross-contamination and re-ran the sample, finding the same result. The only plausible explanation was that when SPU staff collected the water sample, they stepped into the creek with boots that had been worn when walking through a different, recently treated site. It is likely that a small amount of Imazapyr adhered to the boots, was transferred to the stream during sampling, and was subsequently detected in the test, a definite indication that the laboratory test is extremely sensitive to even very small amounts of Imazapyr.

When the water sample was taken the day after treatment, several large knotweed canes that were treated the previous day had fallen into the creek and were floating in the small pool of water. We realized this would result in a positive reading of Imazapyr, and indeed the laboratory detected an Imazapyr concentration of 0.12 ug/L (=0.00012 mg/L) in the sample. This is an extremely low concentration, many orders of magnitude below levels that have been proven to have no adverse effect on humans or animals. For example, the No Observable Adverse Effect Level (NOAEL) of Imazapyr for a 10-kg human child is 250 mg/kg/day. To be extremely conservative, the Environmental Protection Agency uses a reference dose 100 times lower than the NOAEL, or 2.5 mg/kg/day. A child is assumed to consume 1.5 liters of water per day. If a child consumed 1.5 liters of the water from this creek, that would be a total of 0.00018 mg of Imazapyr, or a dose of 0.000018 mg/kg/day. This is approximately 140,000 times lower than an Imazapyr dose that is 100 times lower than a dose that has no adverse effects on a child.

This result demonstrated that even this worst-case scenario of recently treated canes falling directly into a very small amount of slowly flowing water resulted in only minute concentrations of Imazapyr in the water. We took additional samples from this same location on the creek 15 and 27 days after treatment. The concentration in the sample taken at 15 days post-treatment had decreased to 0.02ug/L, with the Imazapyr degrading in sunlight in water at the expected rate, decreasing by over three half lives (half-life of five days). As expected, there was no detectable Imazapyr in the final 2011 sample.

In 2012 there was a similar situation in the same small creek at the Taylor Townsite, where there were treated knotweed canes growing within and adjacent to a very small amount of slowly flowing water. This year the baseline sample had no detectable Imazapyr, but the sample taken the morning following the second herbicide application again had an Imazapyr concentration of 0.12 ug/L. A sample taken 34 days after treatment had no detectable Imazapyr in this small creek. In 2013 we found a large previously undetected patch of knotweed at Taylor Townsite. A small stream flows through this patch and the water sample was taken directly downstream. As expected, a small amount of Imazapyr was detected (0.46 Ug/L) after the first treatment of this patch. It also decayed to undetectable levels at the normal half-life. In all years, the creek went surface dry further downstream from the sample sites. No Imazapyr was found in the 2014 sample.

DO OTHER UTILITIES IN OUR REGION USE HERBICIDES?

SPU belongs to a group of six water utilities in the Pacific Northwest called the Pacific Northwest Watersheds Group (San Francisco, Portland, Tacoma, Seattle, Vancouver BC, and Victoria BC). Of these utilities, both Tacoma and San Francisco use various herbicides to treat a variety of invasive species, including knotweed. There is a growing awareness of the problem with invasive organisms and the cost implications of various control methods.

WHAT PROCESS APPROVALS ARE REQUIRED FOR THIS PROPOSAL?

Existing City Ordinance 114632 (“Cedar River Watershed Secondary Use Policies”) prohibits the use of herbicides in the Cedar. Thus, this proposed herbicide application would require a legislative change that must be approved by the Mayor’s Office and Seattle City Council. There is a requisite public review and comment period associated with changes in existing ordinances.

APPENDIX 1. DETAILS ABOUT THE CHEMICALS AND THEIR SAFETY

Obviously, herbicides are not safe for the targeted plants, which they are designed to kill. Information on the human health and environmental risks associated with Imazapyr and other chemicals is available on the Internet and in the scientific literature and is summarized below. This herbicide and other chemicals are tested and registered for use by the Environmental Protection Agency (EPA) to assure unintended harm to human and ecosystem health will not occur. In addition, most states regulate herbicide use, primarily to assure their safe application, storage, and disposal.

Imazapyr Mode of Action

The proposed herbicide application is an annual application of 1% solution of the isopropylamine salt of Imazapyr with 1% surfactant (modified vegetable oil - Agri-dex® if available), applied strictly according to label instructions. Imazapyr is absorbed quickly through plant tissue and can be taken up by roots. It is moved readily within the plant to the growing meristematic tissues, where it inhibits the enzyme acetohydroxy acid synthase (AHAS), also known as acetolactate synthase (ALS) (The Nature Conservancy 2004). ALS catalyzes the production of three essential amino acids required for protein synthesis and cell growth in the plant. The rate of plant death usually is slow (several weeks) and is likely related to the amount of stored amino acids available to the plant. Only plants have ALS and produce these three amino acids, therefore, Imazapyr is of low toxicity to animals (including birds, mammals, fish, and insects) (Durkin and Follansbee 2004, Bautista 2005).

Imazapyr is degraded slowly in soils primarily by microbial metabolism. It will undergo rapid photodegradation (breakdown by sunlight) in water, but there is little to no photodegradation of Imazapyr in soil, and it is not readily degraded by other chemical processes. Imazapyr does not bind strongly with soil particles, and depending on soil pH, can be neutral or negatively charged. When negatively charged, Imazapyr remains available in the environment for continued uptake by the target species until it is degraded by soil microbes.

In water Imazapyr initially photodegrades rapidly to two primary products, “CL 119060”, and “CL9140” (7-hydorxyfurol[3,4-b]pyridine-5(7H) and 2,3-pyridinedicarboxylic acid). According to the manufacturers, CL119060 is biologically oxidized to CL 9140, and eventually mineralizes to carbon dioxide (CO_2) following the cleavage of the pyridine ring structure. Both Imazapyr degradation products rapidly degrade, with half lives of two to five days (Mangels and Ritter 2000).

Imazapyr Toxicity Studies

Imazapyr is classified as a Category III (low toxicity) herbicide by the EPA. Imazapyr has relatively low toxicity to mammals, showing low toxicity if individuals get residues on their skin, and very low toxicity if it is eaten or inhaled. Some formulations (for instance, inert ingredients in some Imazapyr formulations such as Chopper® and Stalker®) can cause severe, irreversible eye damage. This has not been reported for aquatic formulations, however. The chemical formulation shows no mutagenic or potential for developmental malformations (The Nature Conservancy 2004).

Studies indicate Imazapyr is excreted rapidly in urine and feces by mammalian systems. Residues of Imazapyr did not accumulate in the liver, kidney, muscle, fat, or blood (Miller 1991). It is practically non-toxic to slightly toxic to fish, practically non-toxic to birds, and has low toxicity to algae. In a 2005 study, the US Forest Service found that no adverse effects should occur to a variety of mammals and birds with spraying at any typical application rate (Durkin and Follansbee 2004, Bautista 2005). The study evaluated both acute (single) and chronic (extending over the average species lifetime) exposures. Test animals included small mammals such as mice, small insectivorous mammals, both large and small herbivorous mammals, medium carnivorous mammals, fish-eating birds, herbivorous birds, predatory birds, and insectivorous birds. All of these toxicology tests were performed using the entire formulation, including the inert ingredients.

A peer-reviewed field study found that there were no adverse effects on benthic macroinvertebrates (including invertebrate biomass, community composition, and deformities) at rates as high as 100 times normal applications (Fowlkes et al. 2003). Another peer-reviewed study tested the embryos of zebra fish, an extremely sensitive in vivo test that reveals the effects of endocrine system dysfunction (Stehr et al. 2009). They found an "absence of toxicity at relatively high exposure concentrations".

Inert Ingredients and Surfactants

Formulations of herbicides often contain proprietary carriers and other so-called "inert" ingredients that are usually not identified on herbicide labels. Inert compounds are those that are intentionally added to a formulation, but have no herbicidal activity themselves and do not affect the herbicidal activity. Inerts are added to the formulation to facilitate its handling, stability, or mixing. Adjuvants are compounds added to the formulation to improve its performance. They can either enhance the activity of an herbicide's active ingredient (activator adjuvant) or offset any problems associated with its application (special purpose or utility modifiers). Surfactants are one type of adjuvant that makes the herbicide more effective by increasing absorption into the plant, for example.

Inerts and adjuvants, including surfactants, are not under the same registration guidelines as are pesticides. The EPA classifies these compounds into four lists based on the available toxicity information. List 1 contains "inerts of toxicological concern"; List 2 contains "potentially toxic inerts, high priority for testing"; List 3 contains "inerts of unknown toxicity"; and List 4 contains "minimal risk inerts" or "inerts for which EPA has sufficient information to conclude that their current use patterns will not adversely affect public health or the environment." If the compounds are not classified as toxic, then all information on them is considered proprietary and the manufacturer need not disclose their identity.

The identity of inert compounds used in Imazapyr formulations is generally confidential, but Syracuse Environmental Research Associates (SERA) reviewed them, using the Freedom of Information Act, for preparation of risk assessments conducted for the US Forest Service (Durkin and Follansbee 2004). They conducted very comprehensive searches of the literature and used peer-reviewed articles from public scientific literature, current U.S. Environmental Protection Agency (EPA) documents available to the public, and Confidential Business Information to evaluate toxicity and risk from the herbicides analyzed. Their work was summarized in a 2005 US Forest Service document (Bautista 2005). No apparently hazardous materials were identified in the review of the inerts used in aquatic formulations of Imazapyr.

Surfactants

Surfactants are proprietary blends of heavy-range paraffin-based petroleum oil, polyol fatty acid esters, and/or polyethoxylated derivatives thereof. There is scant information on the human health and environmental effects of such surfactants. However, they have been approved by EPA for use in aquatic systems, and no adverse effects from their use on knotweed have been observed or documented. Agri-Dex® is a nonionic blend of surfactants and spray oil. It improves pesticide application by modifying the wetting and deposition characteristics of the spray solution, resulting in a more even and uniform spray deposit on the leaves of the target species.

The 2008 MSDS for Agri-Dex® reports that it is expected to be adsorbed to soil and should be biodegradable. Bioaccumulation is unlikely due to the low water solubility of the product. Animal toxicity data for similar products required very large doses (>2,000 mg/kg) to cause mortality, showed low inhalation toxicity, and were practically non-irritating to skin and eye in tests on rabbits.

The effects of Agri-Dex® on aquatic organisms and garter snakes has not been studied in depth, however, aquatic acute toxicity studies by Washington State University have indicated that Agri-Dex® is practically non-toxic and is less toxic to fish and aquatic invertebrates than R-11®, a commonly used surfactant (Anderson unpubl report). Agri-Dex® was also shown to be less toxic to fish and aquatic invertebrates than R-11® in preliminary lab work conducted by the California Department of Fish and Game Aquatic Toxicology Lab (Anderson unpubl report).

In toxicity tests on rainbow trout performed by the Washington Cooperative Fish and Wildlife Unit at the University of Washington, Agri-Dex® was found to be by far the least toxic surfactant tested (Smith et al. 2004). In laboratory tests it took 271 parts per million (ppm) for an LC50 dose (the concentration at which 50% of the test subjects died), compared to only 6 ppm for R-11, 17 ppm for LI700, and 74 ppm for Hasten (Smith et al 2004). They also studied the relative concentrations of the surfactants in relation to water depths expected in the field. Even at the maximum allowed concentration of Agri-Dex® of 5% (five times that used in knotweed control), a trout stream would have to be sprayed directly and be less than 5 mm (or about ¼ inch) deep in order to reach the LC50 concentration for trout. Clearly trout could never survive in such shallow water, so in practice no mortality would occur.

When asked to approve the use of herbicides for water hyacinth control in California, NOAA-Fisheries offered the biological opinion that the use of Agri-Dex adjuvant would not cause an adverse impact on salmon.

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