St. Johns Landfill

Conceptual Landfill Vegetation and Wildlife Habitat Management Plan

March 2004

INTRODUCTION

Metro is assessing ways to improve the vegetative cover of St. Johns Landfill (SJL), its 238-acre North Portland (Oregon) facility near the confluence of the Columbia and Willamette Rivers and within the Smith and Bybee Lakes Wildlife Area. Since the early 1990's, several attempts have been made to determine methods by which native grasses and forbs could be used to replace or be integrated with existing, less desirable vegetation. The overall goal was to develop vegetation that was protective to the landfill and the environment, cost-effective to install, would minimize maintenance, enhance existing habitat, and improve aesthetics (Metro 1997). This basic goal has not changed significantly since it was expressed: The first and foremost role of vegetation remains the protection of the landfill, its associated facilities, and the environment. This portion of the goal has generally been met, though adding native components has been difficult. However, Metro is moving forward using knowledge from previous activities and other research that will take a different approach to vegetation management, while retaining the same basic goal.

BACKGROUND

The landfill was first covered during the 1980's. Cover consisted of a layer of soil that was approximately two feet thick planted with eight non-native species of grasses and legumes, which provided good erosion control and were suitable for grazing. Beginning in 1989 with the issuance of the *Revised Closure and Financial Assurance Plan for St. John's Landfill*, a new multilayer liner system was implemented. Construction of landfill closure cover was completed sequentially for each of the landfill's five sections or "Sub-Areas" between 1992 and 1996. As cover for each sub-area was constructed, various planting strategies and/or experimental designs were implemented. In 1990, the landfill was included in the newly formed Smith and Bybee Lakes Management Area. A bulleted summary of these activities, their outcome, and any knowledge gained follows. More detailed descriptions of these activities may be found in reports completed by and for Metro (Metro 1997, Wilson et al. 1998, Wilson et al. 1999), particularly Wilson et al. 1998.

- 1992-1993 – A plan was developed (Fishman 1992) to prepare a weed-free seedbed for Sub-Area 1 and plant with native species. A survey of soil types and depths was performed for the approximately 30 acres of the Sub-Area 1. A simple design was also implemented to evaluate techniques for soil preparation, seeding, and the use of two seed mixes based on landscape hydrology and position (i.e., mesic versus xeric). Both the overall planting and the evaluation of planting techniques and materials were confounded by imported soils with seed

banks rich in non-native species. Several species of shrubs were also planted but survival was poor and complicated by deer and sheep herbivory.

- 1993 & 1994 –. Sub-Areas 2 and 3 were planted with sterile wheatgrass on low fertility soils in 1993 and 1994, respectively. Due to poor growing conditions during the fall and a host of other factors, significant erosion occurred. This heightened Metro's awareness of the risk of erosion during such undertakings.

- 1994 – An experiment involving a series of eight un-replicated test plots was conducted in 1994 to examine a series of different planting and rye grass management treatments. Results were mixed but pre-treating solarization was found to improve recruitment of native grasses.

- 1995 – A test plot was established in Sub-Area 5 and blue wildrye (*Elymus glaucus*[1]) was planted and fertilized in unprepared soils. Results were confounded by herbivory and being mowed before it could drop seed. In any case, blue wildrye comprised only about fifty percent of the stand, rye grass being at least co-dominant.

- 1996 – In 1996, three test plots were established in several areas in and around Sub-Areas 4 and 5 using sterile soils mixed with sewage sludge and fertilizer. California brome and blue wildrye were used. In 1997, these plants were evident but not dominant.

VEGETATION MANAGEMENT CONSIDERATIONS

As a closed, yet actively managed facility, St. John's Landfill poses challenges for landscape management. Facilities such as roads, gas and monitoring well headers, and structures, as well as access to these facilities or the landfill as a whole, for monitoring or general maintenance, may potentially conflict with vegetation and wildlife habitat management. Some of the main constraints include, but are not limited to the following:

- The landfill cover liner must remain intact. Large plants (e.g., trees) that have tap root systems that could promote wear or damage to the liner, or that might encourage the presence of burrowing animals that could penetrate the liner, must be avoided. Plant density must provide adequate erosion control to prevent the transport of soil into surface waters as well as landfill liner exposure and damage.

- Vegetation and wildlife habitat planning and implementation must consider landfill infrastructure, including but not limited to roads, power lines, buildings, gas collection systems, and stormwater facilities. Some facilities may require buffering or other consideration with regard to some plan elements, e.g., possible conflicts between mowing and fire control.

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[1] A comprehensive list of plants that occur on and in proximity to St. John's Landfill is included as Appendix X. Note that not all species have accepted common names. Where such species are cited in the document, only scientific names will be used.

- Gas facilities must be accessible and protected from harm, including risk of fire. Vegetation must provide erosion control and other services without causing unacceptable risk to the integrity of the gas system (e.g., horizontal surface pipes and headers) or posing a significant fire hazard. Zones or perimeters associated with maintenance of gas facilities must be considered so that conflicts with vegetation do not arise, e.g., well drilling equipment or equipment used to move pipe encountering significant vegetation (e.g., shrubs) or non-mobile, artificial habitat elements within the needed work footprint or path. Vegetation must also be managed in a way that allows routine monitoring of the landfill surface for gas leaks.

- Groundwater monitoring wellheads must be accessible for monitoring and maintenance and protected in much the same way as gas facilities, though to a lesser degree. Vegetation must not prevent access to wellheads or monitoring.

- Vegetation management plans and practices must adhere to Metro's Integrated Pest Management Policy. Prior to conducting weed control, staff will prepare a pest management plan that includes a review of the plant's life cycle, a quantifiable monitoring program, and options for control (including alternatives to using herbicides, pesticides, and similar materials).

- Metro policies regarding sustainability must be considered as part of vegetation and wildlife habitat planning. While the methods suggested here carry a relatively low environmental burden, opportunities do exist to include "recycled" materials in the proposed structures. Less mowing will also greatly reduce fuel use, related emissions, and equipment use.

GOAL AND OBJECTIVES FOR VEGETATION MANAGEMENT

This plan is somewhat different than previous vegetation management plans in that it more directly addresses wildlife habitat rather than just vegetation: Vegetation management is used as a means to improve wildlife habitat, rather than addressing only the native versus non-native vegetation issue. The planning team (Metro and Jones & Stokes) has also decided that future management should favor a grassland setting, in that 1) the management plan calls for the landfill to be managed as a meadow, 2) large areas of uncultivated grassland are not particularly common in the Metro area, and 3) such areas may provide habitat for grassland species that have been nearly extirpated from the Willamette Valley.

The basic method of this plan is to 1) understand the site in its current condition and determine conditions that optimize its value as wildlife habitat, then 2) augment or alter the site in ways that promote wildlife and habitat composed of native plants, consistent with management objectives regarding health and safety. To that end, the current landfill vegetation team has established new goal and objective statements to help guide the process:

GOAL: Establish a landfill cover with a diversity of plant species and structural components that encourage grassland wildlife use, are protective of landfill infrastructure and the environment, and that minimize maintenance.

Management Objectives

1. ***Develop a St. John's Landfill Vegetation Management Plan (VMP) with the following elements:***
   - A grassland-based vegetative landfill cover that encourages and supports native grassland plant (grasses and forbs, with occasional shrubs and small trees) and animal (e.g., northern harrier, western meadowlark) species and discourages noxious weeds.
   - A set of modular designs for structural elements, both natural (e.g., shrub islands, rock piles, etc.) and artificial (e.g., perching stands, nesting boxes), that will increase wildlife habitat focusing on grassland species.
   - A schedule and methods for periodic vegetation management, including mowing, weed control, and planting.
2. ***Ensure that the plan will facilitate cost-effective and sustainable management of the landfill cover, while minimizing risks to public health and safety, and the environment.***
   - Ensure that the plan will prevent erosion or other potential sources of vegetation-related damage to the landfill liner system.
   - Ensure that the likelihood of vegetation-related damage to the landfill gas system, monitoring wells, and other infrastructure is minimized.

CURRENT CONDITON

Jones & Stokes assessed the current condition of the landfill by reviewing reports of past activities and current information during several spring and summer site visits. Robert Altman, a noted ornithologist, attended one of the visits (August 13, 2003) to address current and potential habitat suitability for grassland birds, particularly western meadowlark and horned lark. A map of the various cover forms (Figure 1) as evidenced in the current aerial photo and on the ground has been created and annotated. The following discussion qualitatively addresses the current state of the landfill cover with regard to the aforementioned wildlife habitat and vegetation management goal.

Species Composition and Structure

The landfill cover vegetation is composed of a mosaic of grass, forb, and shrub species that form loosely defined communities (see Appendix A for plant list). Appendix 2 of Wilson et al. 1998 still provides a good summary of current conditions. Though some areas may have changed due, for instance, to hydrological changes, the same basic vegetation assemblages still exist. The following is a general list of landfill vegetation communities:

A) Perimeter slopes generally contain large, dense stands composed mostly of annual and perennial ryegrass (non-native grasses). While not a native community, these grasses provide a high level of erosion control and surface stability for these sensitive areas. Other dominant species that occur in these areas may include but are not limited to colonial bentgrass (*Agrostis tenuis*), velvetgrass (*Holcus lanatus),* and various leguminous forbs (e.g., *Vicea* spp.).

B) Many of the more open, dryer, flatter areas tend to exhibit a higher species and structural diversity than slopes, being composed of a number of native and many naturalized, non-native species. Dominant species, all non-native, include *Bromus japonicus*, *B. hordeaceus*, and colonial bentgrass.

C) Areas that received past planting of native species, particularly areas 2E, 3N, and 3S, are generally composed of species in 2 above, with traces of the planted native California brome (B. *carinatus*) and blue wildrye (blue wildrye tends to occur only where there is increased hydrology, e.g., along ditch edges or ponded areas, and where heavier soils tend to hold moisture for longer periods). These areas also tend to have a more open structure, forming a mosaic of bare ground with varying degrees of cover, including a variety of other graminoids and forbs. This phenomenon seems to be related to disturbance(s) associated with the various experimental/restoration treatments these areas received and is clearly evident in aerial photos taken during the spring (Figure 1).

D) Wet areas are fairly rare on the landfill cover and are kept at a minimum to help ensure cover integrity. However, there are many drainage ways, ditches, and incidental ponded areas that provide valuable habitat for plants and wildlife. It is these areas that can have some of the greatest potential for both native and, unfortunately, non-native species such as reed canary grass *(Phalaris arundinacea)*. Several seasonally inundated areas host a variety of native plants and provide very good habitat for shorebirds. Other areas usually associated with longer hydroperiods, such as ditches, tend to harbor non-native stands comprised mostly of reed canary grass and meadow foxtail (*Alopecurus pratensis*). Observation in the field and communications with landfill personnel indicate that maintaining shallow seasonally ponded areas may be a possibility, while the latter situation involving drainage ways is simply an on-going consequence of the landform. It should be noted that while undesirable, reed canary grass, though an invasive non-native, does provide good erosion control.

In summary, the landfill is a mosaic of at least the four major vegetation communities outlined above, plus the many transitions, between communities. Non-native grasses dominate all four communities. Structure, function, and visible species composition may vary by season, month, or variation in weather. For instance, many native grasses emerge later in the season than non-natives, e.g., blue wildrye is generally only apparent after June.

Function and Value of Plant Species and Communities

Plants, whether native, non-native, weedy, invasive, or a combination of these, provide functions and have value in the communities in which they exist. Communities composed of these species also provide functions and have values, though on a larger scale. Functions and values may be positive or negative, and may affect the ecosystem in various ways. There are several aspects of function that one might consider as we evaluate the current landfill cover and plan future projects. Examples of two of these are listed here:

1. Some species that would normally be considered invasive or potentially invasive (e.g., reed canary grass, thistles, poison hemlock, etc.) do not currently seem to pose a significant risk at a landscape level, at least for the landfill. This is mainly because they tend to be constrained by hydrological regimes, soil types, or other differences in the landfill cover. In limited quantities, some of these species may provide valuable habitat elements for wildlife until such time as they may be replaced with native elements. However, due mainly to the proposed cessation of heavy mowing, some species (e.g., blackberry, thistles, etc.) may pose greater challenges to control. These species may also pose potential detrimental effects to adjacent areas (e.g., Smith and Bybee Lakes). Therefore, the positive

and negative attributes of each of these species should be evaluated, and the appropriate management priority and methods established for each.

2. Flowering forbs are relatively uncommon on the landfill. Those that do exist tend to be non-native plants associated with areas of human disturbance that tend to out-compete native species. Both native and non-native forbs may contribute valuable resources for wildlife. For instance, oxeye daisy *(Chrysanthemum leucanthemum)* and teasel *(Dipsacus fullonum)* provide valuable seed and nectar sources for many birds and insects. While native analogues are preferred, these and similar species may continue to provide resources until such time as they may be replaced with natives. In any case, it is likely that these species *will* continue to occur on the landfill for the foreseeable future and should be evaluated as to their value or risk and dealt with appropriately.

PROPOSAL

The following is the proposed preliminary approach to meeting the goals and objectives outlined above. This approach is based on the premise that a number of small pilot projects will be used to form the basis of a broader project or set of projects, the scope and phasing of which will ultimately depend on available resources with which to implement them. Thus, the final vegetation management plan will be designed to be modular and scalable so that Metro may maintain flexibility in implementation.

Vegetation Management

The landfill is already in the process of implementing a refined vegetation management plan and schedule. Previously, landfill staff mowed a large portion of the landfill's grassy areas and practiced vigorous weed control. The revised plan involves the following elements:

Mowing

Vegetation Structure - Personnel will mow only those areas associated with landfill infrastructure maintenance and monitoring, or where mowing is prescribed for weed control. The absence of mowing over much of the landfill will allow grasses and forbs to attain their mature heights and thereby provide greater vegetative structural (vertical and local horizontal) diversity. Additionally, mowing will provide a modicum of lower, more open areas that some species will likely find advantageous. While the majority of resulting structural diversity occurs within the herbaceous scale, between approximately 2 inches and 4 feet, such small differences in height are often significant to grassland wildlife.

Vegetation Composition – Reduced mowing will allow grasses and forbs to grow to fruition, providing food and structural habitat throughout their life history. For instance, plants may produce foods for various wildlife that might include any plant part, both vegetative (e.g., roots, root crown, stem, leaves, thorns, etc.) and reproductive (e.g., flowers, pollen, seed, etc.). Portions of these plants might also provide critical hosting opportunities for invertebrates, as well as provide nesting materials for larger wildlife.

Vegetation Diversity – Long-term mowing and replacement seeding of non-native species has likely reduced the landfill cover's species richness and structural complexity. Reduced mowing will likely result in greater species richness. However, some of the new species may be desirable (e.g., natives) and some undesirable (e.g., invasive weeds, such as blackberry). Therefore, while less mowing may be required, focused promotion of natives and management of non-natives may result in the same or greater effort than

mowing. However, effort would now be spent directly on improving the plant community and associated wildlife habitat rather than on simply controlling vegetation.

Other Habitat Improvements

A number of designs are proposed to augment grassland community habitats. It is the opinion of Bob Altman, a recognized authority on grassland birds (particularly western meadowlarks), that the various wellheads and other landfill infrastructure provide adequate perch sites for grassland bird species. Therefore, several structures are described that may be used to augment existing perching opportunities where they may be scarce. In addition, three structures are described that will provide habitat for a variety of other species.

Low Perching Structures

Low perching structures constructed of wood may provide additional perching opportunities where they are currently scarce or where vegetation islands are not necessarily practical. They may also serve as a temporary solution until such time that a vegetation island might be established. These structures are simple, light, and moveable, allowing mowing or other management to take place by simply moving them aside.

Vegetation Islands

Islands of native vegetation have the potential to provide the most benefit to a variety of species. Constructed vegetation islands, such as that shown in Figure 2, may also serve as nuclei for larger areas of native grassland restoration. A preliminary list of species recommended for the islands is presented in Table 1 below, the final list being contingent on availability, suitability, or other considerations, as determined Metro. The list may be increased as soil and micro-climactic conditions will allow, as well as limitations of the Portland Plant List, which is currently in revision.

The islands will be constructed atop a counter sunk, impermeable liner that will hold water for a much longer period than the existing cover, which is designed to move water quickly off the landfill cover; it will also serve as a root barrier for island plantings. The island liner may be placed above the existing cover layer or preferably countersunk into the landfill cover soils, or a combination of the two. The liner will be filled to an even grade or slightly mounded to provide room for plants to root adequately. Shrubs will be placed toward the middle, deeper portion of the island, smaller grasses and forbs throughout and toward the outside edge.

The area surrounding the island may be further enhanced with plantings of native grasses and forbs from Table 1.

Table 1. Recommended species for vegetation islands at St. Johns Landfill

Common Name	Scientific Name	Cost (Bare root/ 1Gal.)
Shrubs		
oceanspray	*Holodiscus discolor*	*$4.50 / $6.95*
red-flowering currant	*Ribes sanguineum*	*$3.95 / $7.95*
blue elderberry	*Sambucus cerulea*	$4.25/ $7.95
serviceberry	*Amlelanchier alnifolia*	$6.75 / $6.95
snowberry	*Symphoricarpos alba*	$3.75 / $7.95
Grasses		(Seed per pound)
blue wild rye	*Elymus glaucus*	$15
California brome	*Bromus carinatus*	$10
prairie junegrass	*Koeleria macrantha*	$60
Roemer's fescue	*Festuca roemeri*	TBD 2004
Forbs		(Bare root/ 1Gal.)
pearly everlasting	*Anaphalis margaritaces*	-- / $8.00
yarrow	*Achillea millefolium*	--- / $6.00
milkweed	*Asclepias speciosa* *A. fascicularis*	$0.35 / ---
Giant blue-eyed Mary	*Collinsia grandiflora*	$45 per lb. seed
Bluefield gilia	*Gilia capitata*	$24 per lb. seed
Many-leaved lupine	*Lupinus polyphyllus*	
Cinquefoil	*Potentilla glandulosa* *P. gracilis*	
Self-heal	*Prunella vulgaris*	
Oregon iris	*Iris tenax*	$8.00

Rock and Brush Piles

Rock and brush piles are easy to install and provide habitat for a variety of reptiles, amphibians, small mammals, birds, and invertebrates. Rock piles tend to favor reptiles and amphibians by providing open basking areas and sheltering interstices that are easy to access. Brush piles tend to favor small mammals and birds. Both provide excellent habitat for invertebrates. Care should be taken in the placement of these features in that they could provide habitat for many of the species that would pray on the eggs or young of ground-nesting birds.

Rock piles may be of any size and constructed of a variety of materials. The rocks should be of a variety of sizes (2 inches and larger), and of shapes and hardness sufficient to preclude compaction, both of which will result in the loss of interstitial habitat.

Brush piles are generally constructed in two parts: a base and a cover. The base should be constructed of courser rock (10 inches and larger) and/or woody materials, such as larger trunks, limbs, stumps, and root wads. Hardwoods should be favored to ensure a reasonable amount of time before the base breaks down, typically 15 years or more. The base should be fashioned to partly support the brush cover so that a variety of interstices are formed. The cover may be composed of any number of smaller materials.

Care must be taken to ensure that the landfill liner is not damaged during or after installation of these structures. Piles should be considered permanent in that moving them will reduce much, if not all, habitat value for at least the current season and likely longer. Thus, like the vegetation islands, they should be placed in areas where infrastructural management is expected to be minimal.

With regard to specifications, we recommend that landfill staff assess pile materials as they become available in an effort to re-use existing materials and thereby promote sustainability.

Wildlife-Friendly Infrastructure

Metro may want to consider conducting an assessment of existing (and possibly planned) structures with regard to possible effects to wildlife. For instance, bird-friendly power lines may be used to replace older style power lines when the latter are due for service or replacement. Likewise, if particular areas seem to attract species which Metro would like to encourage on the landfill, then special consideration may be given these areas, in the form of special signage, structures, or protection.

EXPECTED MANAGEMENT EFFORTS

This plan has been designed to be scalable to meet Metro's needs based on available resources: Habitat structures may be developed in varying numbers and, in some cases, varying size (e.g., vegetation islands and brush piles). However, the pricing estimate schedule below is based on what we consider a basic size for each structure, with consideration of recycled materials being used, which would likely reduce cost. We also suggest a number of hours a single person would likely take to complete each structure, along with the cost of large equipment, if applicable.

Table 2. Estimated costs for habitat structures.

Structure	Cost	Labor
Low perching structures	$20-$100 (wood)	2-6 hrs
Vegetation Islands	$ 40 (4 bare root shrubs/seed)	24 hrs (2 people, bobcat)
Topsoil, Compost	$25/yd, $18/yd ($35 for delivery)	
Liner	Free (assume available)	
Irrigation	Free (assume available)	1 hr weekly during summer/fall for 2+ years (with water truck)
Rock pile	$28 / $119 delivered. (rock)	1 hr (dump truck)
Brush pile	Free (assume refuse/reuse)	4-8 hrs (2 people, bobcat)

INVASIVE SPECIES CONTROL

See attached Appendix B for Invasive Species Control Plan.

SCHEDULE

Most structures may be constructed during any part of the year, though it may be best to construct/place during the fall, so as to not disrupt spring breeding. We suggest preparing, grading, and seeding vegetation island during the fall prior to the onset of rain and planting shrubs mid winter (December through February).

SUGGESTED PLANT MATRERIAL VENDORS

Triangle Farms (seed)
5648 Evans Valley Rd.
Silverton, OR 97381
503-873-5190

Pacific Northwest Natives (seed)
1525 Laurel Heights Drive Northwest
Albany, Oregon 97321
(541) 928-8239
Fax: (541) 924-8855
Email: cwe@proaxis.com

Northwest Native Plants (container, bare root)
2158 Bower Ct S.E.
Salem, Oregon 97301
(503) 581-2638
Fax (503) 581-9957
E-Mail: plants@nwplants.com

Balance Restoration Nursery
(wholesale, bare root stock only)
27995 Chambers Mill Rd.
Lorane OR 97451
541-942-5530

Native Seed Network (many vendors)
www.nativeseednetwork.org

Portland BES
Toby Query
503-823-4205

SOIL TESTING

A&L Western Agricultural Laboratories
10220 SW Nimbus Ave., Bldg. K-9
Portland, Oregon 97223
(503) 968-9225

TOPSOIL & COMPOST

American Compost and Recycling
9707 Columbia Blvd.
Portland, Oregon
(503) 286-0886

A list of all analytical testing labs in Oregon is available at
http://wwwagcomm.ads.orst.edu/AgComWebFile/EdMat/EM8677.pdf.

REFERENCES

Fishman Environmental Services (Fishman). 1992. St. John's Landfill Cover Vegetation Plan, Final Report. August 1992.

Metro. 1997. Native Vegetation at St. Johns Landfill. Metro. 15 pp.+

Wilson, M.G., L. Brophy, L. Wilson. 1999. Establishment of Native Vegetation at St. Johns Landfill, Experimental Test Plot Monitoring. Metro. 5 pp. +.

Wilson, M.G., L. Brophy, L. Wilson. 1998. Establishment of Native Vegetation at St. Johns Landfill, Final Report. Metro. 48 pp. +.

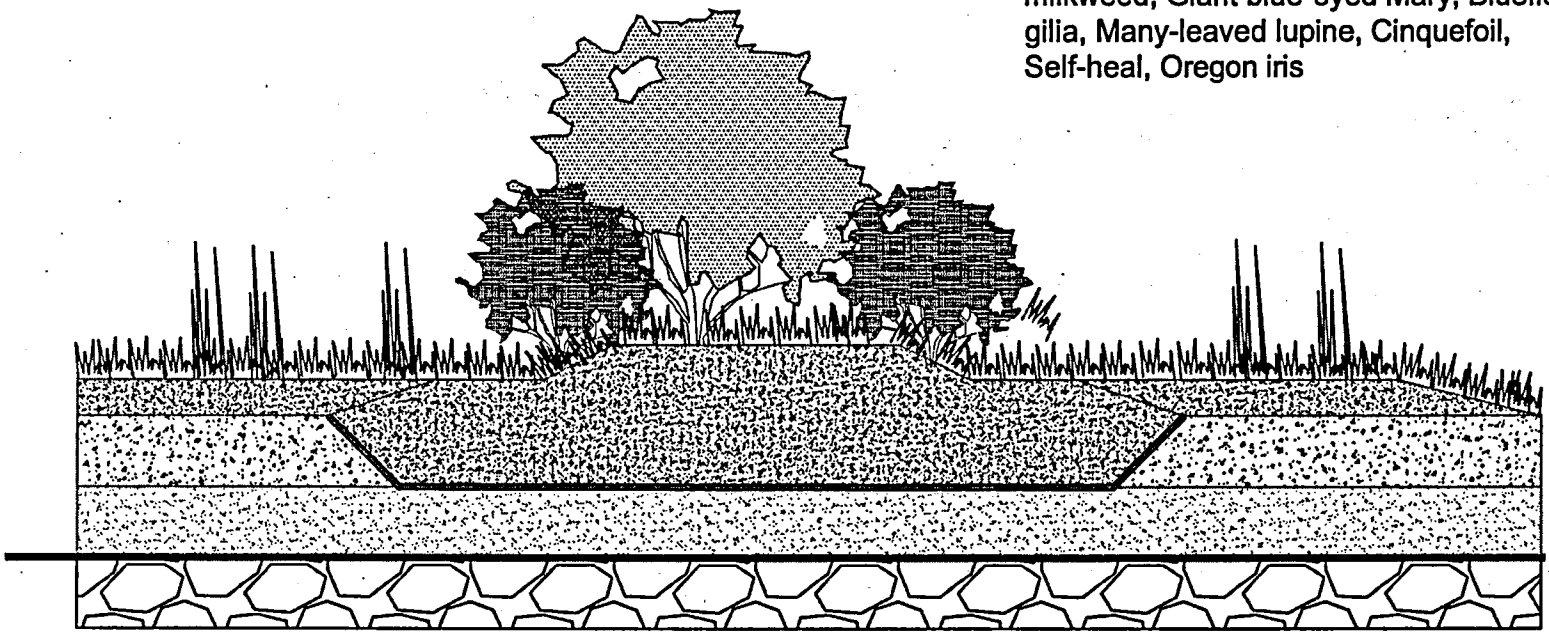
REPORT FIGURES

NOT FOR CONSTRUCTION

Jones & Stokes 317 SW Alder Street, Suite 800 Portland, OR 97204	METRO	Vegetation and Habitat Map	St. Johns Landfill METRO	Author: S. Lathrop Mar 08, 2004 – 3:34pm	FIGURE NO. 1 PROJECT NO. 03137.03

Shrubs
Inner: oceanspray, blue elderberry, serviceberry
Outer: red-flowering currant, snowberry

Grasses & Forbs
Grasses: blue wild rye, California brome, prairie junegrass, Roemer's fescue
Forbs: pearly everlasting, yarrow, milkweed, Giant blue-eyed Mary, Bluefield gilia, Many-leaved lupine, Cinquefoil, Self-heal, Oregon iris



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1/10/03

St. Johns Landfill
Portland, Oregon

DIAGRAM OF PROPOSED VEGETATION ISLAND

Jones & Stokes

APPENDIX A

PLANT LIST

A list of plants noted on the St. Johns Landfill
during 2003 and by Wilson et al. 1998

LAYER	*SCIENTIFIC NAME*	COMMON NAME
F	*Achillea millefolium*	yarrow
F	*Allium vineale**	field garlic
F	*Anthemis cotula**	mayweed
F	Anthriscus *scandicina**	bur chervil
F	*Arctium* sp*	burdock
F	*Bidens* sp	beggars-tick
F	*Brassica campestris**	field mustard
F	*Capsella bursa-pastoris**	shepherd's-purse
F	*Chenopodium album**	lambsquarter; white goosefoot
F	*Chenopodium botrys**	Jerusalem-oak
F	*Chrysanthemum leucanthemum**	ox-eye daisy
F	*Cichorium inrybus**	chicory
F	*Cirsium arvense**	Canada thistle
F	*Cirsium vulgare**	bull thistle
F	*Conium maculatum**	poison-hemlock
F	*Convolvulus sepium**	hedge bindweed
F	*Crepis capillaris**	smooth hawksbeard
F	*Crepis setosa**	rough hawksbeard
F	*Daucus carota**	Queen Anne's lace
F	*Dipsacus sylvestris**	teasel
F	*Epilobium angustifolium*	fireweed
F	*Epilobium paniculatum*	autumn willow-weed
F	*Epilobium watsonii*	Watson's willow-weed
F	*Equisetum arvense*	common horsetail
F	*Erodium cicutarium**	filaree
F	*Galium parisiense**	wall bedstraw
F	*Geranium dissecrum**	cut-leaf geranium
F	*Geranium molle**	dovefoot geranium
F	*Gnaphalium palustre*	marsh cudweed
F	*Gnaphalium uliginosum**	low cudweed
F	*Hypericum perforatum**	St. John's wort
F	*Hypochaeris radicata**	hairy cat's-ear
F	*Lactuca serriola**	prickly lettuce
F	*Leontodon nudicaulis**	hairy hawkbit
F	*Lichnis alba**	white campion
F	*Lotus corniculatus**	bird's-foot trefoil
F	*Lotus purshianus*	Spanish clover
F	*Lupinus sp.*	lupine
F	*Madia sativa*	coast tarweed
F	*Marricaria matricarioides*	pineappleweed
F	*Medicago sativa**	alfalfa
F	*Melilolus alba**	white sweet-clover
F	*Oenothera strigosa*	common evening-primrose
F	*Parentucellia viscosa**	yellow parentucellia
F	*Phacelia nemoralis*	woodland phacelia
F	*Planiago lanceolata**	English plantain
F	*Planiago major**	nippleseed plantain
F	*Plantago psillium**	sand plantain
F	*Polygonum aviculare*	prostrate knotweed
F	*Polygonum persicaria*	lady's-thumb
F	*Ranunculus sceleratus*	celery-leaved buttercup
F	*Raphanus sativus**	wild radish
F	*Rorippa curvisiliqua*	curve-pod watercress
F	*Rumex acetosella**	sheep sorrel
F	*Rumex conglomeratus**	clustered dock
F	*Rumex crispus**	curly dock

LAYER	*SCIENTIFIC NAME*	COMMON NAME
F	*Rumex obtusifolius**	bitterdock
F	*Senecio jacobaea**	tans ragwort
F	*Senecio vulgaris**	common groundsel
F	*Silybum marianum**	blessed thistle; milk thistle
F	*Sisymbrium officinale**	hedge mustard
F	*Solidago canadensis*	Canada goldenrod
F	*Sonchus asper**	prickly sow-thistle
F	*Sonchus oleraceus**	common sow-thistle
F	*Tanacerum vulgare**	common tansy
F	*Taraxacum officinale**	dandelion
F	*Trifolium arvense**	rabbit-foot clover
F	*Trifolium dubium**	least hop clover
F	*Trifolium fragiferum*	strawberry clover
F	*Trifolium hybridum**	alsike clover
F	*Trifolium pratense**	red clover
F	*Trifolium procumbens**	hop clover
F	*Trifolium repens**	white clover
F	*Urica dioica**	stinging nettle
F	*Verbascum blattaria**	moth mullein
F	*Verbascum thapsus**	flannel mullein
F	*Veronica arvensis**	common speedwell
F	*Vicia cracca**	cat peas
F	*Vicia hirsuta**	hairy vetch; tiny vetch
F	*Vicia sativa**	common vetch
G	*Agropyron repens**	quackgrass
G	*Agrostis exarata*	spike bentgrass
G	*Agrostis scabra*	winter bentgrass; tickle8rass
G	*Agrostis stolonifera**	spreading bentgrass
G	*Agrostis renuis**	Colonial bentgrass
G	*Alopecurus geniculatus*	water foxtail
G	*Alopecurus pratensis**	meadow foxtail
G	*Anthoxanthum odoratum**	sweet vernalgrass
G	*Bromus carinatus*	California brome
G	*Bromus hordeaceus** (*Bromus mollis*)	soft brome
G	*Bromus japonicus**	
G	*Bromus diandrus** (*Bromus rigidus*)	rip-gut brome
G	*Bromus secalinus**	ryebrome
G	*Bromus sterilis**	barren brome
G	*Bromus tecrorum**	cbeat grass
G	*Carex feta*	green-sbeathed sedge
G	*Carex pachystachya*	thick-beaded sedge
G	*Carex unilateralis*	one-sided sedge
G	*Dacrylis glomerata**	orchardgrass
G	*Deschampsia cespitosa*	tufted hairgrass
G	*Echinochloa crusgalli**	barnyard grass
G	*Elymus glaucus*	blue wildrye
G	*Festuca arundinacee*	tall fescue
G	*Festuca megalura**	fox-tail fescue
G	*Festuca myuros**	rat-tail fescue
G	*Glyceria occidentalis*	mannagrass
G	*Holcus lanatus**	common velvetgrass
G	*Holcus mollis**	creeping velvetgrass
G	*Hordeum geniculatum**	Mediterranean barley
G	*Hordeum jubatum*	fox-tail barley
G	*Hordeum murinum**	mouse barley

LAYER	*SCIENTIFIC NAME*	COMMON NAME
G	*Juncus bufonius*	toad rush
G	*Juncus effusus*	soft rush
G	*Juncus tenuis*	slender rush
G	*Lolium mulfiflorum**	Italian ryegrass
G	*Lolium perenne**	perennial ryegrass
G	*Phalaris arundinacea*	reed canarygrass
G	*Phleum pratense**	timothy
G	*Poa annua**	annual bluegrass
G	*Poa pratensis**	Kentucky bluegrass
G	*Poa trivialis**	rough bluegrass
G	*Polypogon monspeliensis**	rabbit-foot grass
W	*Acer macrophyllum*	big-leaf maple
W	*Alnus rubra*	red alder
W	*Buddleja davidii**	butterfly-bush
W	*Cytisus scoparius**	Scot's broom
W	*Populus alba**	white poplar; silver poplar
W	*Populus trichocarpa*	black cottonwood
W	*Rubus discolor**	Himalayan blackberry
W	*Salix hookeriana*	Hooker willow
W	*Salx lasiandra*	Pacific willow
W	*Salix scouleriana*	Scouler willow
W	*Salix sessilifolia*	northwest willow
W	*Salix sitchensis*	Sitka willow
W	*Sambucus racemosa*	red elderberry
W	*Solanum dulcamara**	climbing nightshade

APPENDIX B

INVASIVE SPECIES CONTROL PLAN

(Includes weed information from Wilson et al., 1998)

Centaurea maculosa
(spotted knapweed)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Spotted knapweed is a highly invasive biennial or short lived perennial found on disturbed xeric and mesic soils. It has a stout taproot and is usually from 1-3 feet tall with pinkish-purple, thistle like flowers. There is evidence that many species of the *Centaurea* genus hybridize and also release chemical substances that inhibit surrounding vegetation. Spotted knapweed's range has been primarily east of the Cascades and southern Oregon, but according to the Oregon Department of Agriculture (ODA), several small infestations have been found in the past few years along the Columbia River in Portland and on Port of Portland Property near the Columbia Slough. The ODA has designated spotted knapweed as a "T' (target) species and identified it for control efforts by the department's Weed Control Program. During the summer 1998 vegetation survey of the landfill, one plant was found in the vicinity of the railroad crossing on the landfill entry road. The plant, just coming into bloom, was pulled and destroyed.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: The one plant found at SJL summer 1998 does not constitute an immediate threat. However, knapweeds wind disperse great numbers of viable seed, and taking no action would have most likely result in an increased infestation.

Manual/Mechanical Control: Small populations of knapweed can be controlled by hand pulling when the ground is soft in the fall and spring. The entire plant should be pulled, bagged and destroyed.

Cultural Control: No known cultural controls exist, but minimizing bare and or soil disturbance will minimize infestation and spread.

Chemical Control: Many herbicides are approved for control of spotted knapweed. Consult the current edition of The PNW Weed Control Handbook for herbicide recommendations and application rates.

Biological Control: In areas of large infestations biological control may be effective. Twelve insect species have been released in Oregon. Contact ODA for information.

RECOMMENDATIONS

Contact the ODA regarding the finding of the single plant at SJL.
Monitoring: As only one plant has been found at SJL to date, surveying during the growing season should be done several times yearly, especially near the location of the found plant and along travel corridors. Found plants should be pulled and destroyed.

Cirsium arvense
(Canada thistle)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Cirsium arvense is a rhizomatous herbaceous perennial found on mesic soils in disturbed areas such as roadsides, old fields and overgrazed or abandoned pastures throughout the Portland metro area. The Oregon Department of Agriculture (ODA) classifies Canada Thistle as a "B" list noxious weed; as such it is subject to intensive control on a case by case basis. Populations of Canada thistle at SJL are especially common along methane pipes.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: No control effort will result in the continued spread and establishment of thistle throughout the upland grasslands of SJL especially within the path of the prevailing winds.

Mechanical Control: Mowing/String line trimming- A single mowing/trimming of thistle at the early bud stage weakens the plant at a time when root carbohydrate reserves are at a yearly low (Hodgson 1968). Mowing should be timed to coincide with the period between the early flower bud stage and the first sign of purple bloom. As Canada thistle is a long day plant flowering has been observed only in daylengths of 14 to 18 hours (Hunter and Smith 1972); monitoring of the site to determine a mowing schedule should thus begin in early June.

Cultural Control: Although the term is no longer used, smother crops of grasses continue to be used in integrated pest management systems for Canada thistle (Hodgson 1968). Shading with appropriate native shrubs and trees will prevent seedling establishment and may prevent the spread of existing patches (Hodgson 1968). Small areas of early successional woodlands planted to grasses, would be good locations for monitoring the long term effect of this thistle control method. (McLendon 1987) speculates that some change in soil processes or characteristics occurs during plant succession and that this is what eventually may push Canada thistle out of an area. The management of all riparian areas on or adjacent to the landfill in such a way as to hasten their succession to wet, mesic and xeric woodlands may control Canada thistle over time. Soil solarization may also be used to control small patches of thistle if solarizing plastic sheeting is placed after cultivating the affected area.

Chemical Control: Canada thistle control using herbicides is difficult due to the plant's deep, well-developed root system. Most herbicides that would be used to control broad-leaved perennial do not translocate easily into the root system (Baradari et al. 1980, Marriage 1981). Effectiveness of phenoxy herbicides (2,4-D) is greatest when root carbohydrate reserves are low in late spring/early summer (Marriage 1981). Consult the current edition of The Pacific Northwest Weed Control Handbook for specific recommendations.

Biological Control: Coombs (1995) of the Oregon Department of Agriculture report that a European insect, the crown weevil (*Ceutorhynchus litura*) is establishing well in six counties in Oregon (Miller, personal communication). Although the insect has not provided total thistle control in other release areas in the western U.S., it does weaken and damage the plants by mining the stem pith (Peschken and Wilkinson 1981, Coombs 1995). Other useful thistle biocontrol agents established in Oregon include the stem gall fly (*Urophora cardui*) which is locally abundant in Benton County and the seed head weevil (*Rhinocyllus conicus*) which also attacks thistle in several counties (Coombs 1995). The native painted lady butterfly (*Vanessa cadui*) occasionally defoliates Canada thistle. During some years the damage is quite severe, but it does not control the plant.
In addition, a plant rust species (*Puccinia punctiformis*) is a possible thistle biological control agent in Oregon; especially for thistles growing in wet areas (Coombs 1993). Again, the damage inflicted does not seem to be sufficient to control thistle on its own (Ososki et al 1979, Turner et al. 1980) but preliminary results in England suggest that the rust can be used in conjunction with 2,4-D in an integrated program of thistle control (Haggar et al. 1986). In Ontario there appears to be a synergistic relationship between the rust (*Puccinia puntiformis*) and the weevil (*Ceutorhynchus litura*); 87% of rust infected thistles were mined by the weevil compared with 32% of uninfected shoots (Peschken and Beecher 1973). Similar results were not obtained in trails conducted in western Canada however (Peschken and Wilkinson 1981). No information has been found regarding the tolerance of the weevil to herbicides other than the 2,4-D study above (Haggar et al. 1986). The USDA is presently evaluating the use of the rust as a bio-control agent. Contact Eric Coombs at the Oregon State Department of Agriculture for additional information.

RECOMMENDATIONS

Cirsium arvense is a good candidate for an integrated weed management program that uses a combination of control treatments. Populations of Canada thistle growing in grasslands on the capped portion of SJL should be controlled by timely mowing (or string line trimming) of the plants in the early summer when the plants are between the flower bud and bloom stage. Low mowing in such a way as to scrape or scarify the ground should be avoided; bare ground is an ideal substrate for thistle seed. In areas where thistle is intermixed with successful herbaceous and woody plantings, soil solarization or early summer flaming with a propane torch followed by fall reseeding with noninvasive or native grasses to control regrowth should be attempted. Optional spot treatment with either wick applied or back pack applied herbicides enriched with nitrogen and phosphorus fertilizers should be applied before the plant flowers and mowing begins. In the long term encouraging the rapid succession of all areas of the landfill to a combination of riparian woodlands and upland grasslands may minimize the kinds of open canopy disturbed habitats Canada thistle prefers. The State of Oregon Department of Agriculture should be contacted in the spring of 1997 in order to determine the suitability of the site as a Canada thistle biocontrol test site.

Monitoring

All Canada thistle control efforts should be thoroughly documented and then monitored for at least three years thereafter.

Cirsium vulgare
(bull thistle)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Cirsium vulgare is an herbaceous biennial with a short fleshy taproot. First year growth is limited to a rosette of leaves; the second year, the rosette develops a 2-5 foot tall flowering stalk. Bull thistle is differentiated from Canada thistle by examining the leaves. Bull thistle leaves are prickly-hairy above and cottony below. Canada thistle leaves are smooth above and smooth or hairy beneath. It is found on mesic soils in disturbed areas such as roadsides, old fields and overgrazed or abandoned pastures throughout the Portland metro area. The Oregon Department of Agriculture (ODA) classifies bull thistle as a "B" list noxious weed; as such it is subject to intensive control on a case by case basis. Bull thistle populations have increased since sheep grazing has been used to control grasses at SJL.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: No control effort will result in the continued spread and establishment of thistle throughout the upland grasslands of SJL especially within the path of the prevailing winds.

Mechanical Control: The careful hand hoeing of first year rosettes will slow the spread of the plant. Ground disturbance should be minimized. The ground around the base of mature plants should be checked for rosette seedlings. Mowing or string line trimming of mature (second year) plants will also produce some control. If the stalk is removed in July or August at the 6 inch height after flower formation (at the first sign of color) but before full bloom, the plant will not send up another flower stalk. The flower stalk should be bagged and destroyed carefully as thistle seed after-ripens.

Cultural Control: Although the term is no longer used, smother crops of grasses continue to be used in integrated pest management systems for bull thistle (Hodgson 1968). Shading with appropriate native shrubs and trees will prevent seedling establishment and may prevent the spread of existing patches (Hodgson 1968). Small areas of early successional woodlands planted to grasses, would be good locations for monitoring the long term effect of this thistle control method. (McLendon 1987) speculates that some change in soil processes or characteristics occurs during plant succession and that this is what eventually may push bull thistle out of an area. Soil solarization may also be used to control small patches of first year thistle rosettes.

Chemical Control:
Consult the current edition of The Pacific Northwest Weed Control Handbook for specific herbicide recommendations and application rates.

Biological Control: The Oregon Department of Agriculture (ODA) has released the seedhead gall fly (*Urophora stylata*) in the Willamette Valley for control of bull thistle. This seed eating insect has provided some measure of control in dense stands.

RECOMMENDATIONS

Effective sheep grazing management techniques such as timely field rotation will minimize ground disturbance, which favors the spread of bull thistle. Timely manual and mechanical means of thistle control during the growing season, should keep infestations of bull thistle at SJL in check.

Monitoring

Given the large seed production of each thistle plant and it's attractiveness to seed eating birds such as finches and goldfinches, monitoring of manual/mechanical control efforts should be carried out several times during the growing season.

Conium maculatum
(poison hemlock)

DESCRIPTION & ACTUAL/POTENTIAL THREATS
Poison hemlock is a biennial that grows 6-10 feet tall. Stems are purple spotted and ridged. Flowers are white and umbrella shaped. All parts of the plant are poison. It occurs on poorly drained soils throughout the Portland metro area and the population at SJL is found on lower slopes on the edge of the capped portion of the landfill and in the riparian fringe adjacent to the Columbia Slough. The current population is sizable but easily controllable.

DISCUSSION OF MANAGEMENT OPTIONS
No Action: The current population will spread to all mesic soil areas on the perimeter of the landfill if not controlled.

Manual/Mechanical Control: The existing population should be pulled when the ground is soft in spring and fall. Several years of pulling will be necessary to eradicate the existing stands.

Cultural Control: none known

Chemical Control: not appropriate

Biological Control: The leaf tying moth *Agonopterix alstromeriana* is widespread throughout Oregon. Although the moth severely defoliates the plants, stand reduction has not been documented.

RECOMMENDATIONS
Hand pull all plants during the spring and fall of each year. Initiate grazing practices that minimize ground disturbance.
Monitoring
Survey mesic soil areas of the landfill for two years after control. Focus particularly on areas where the plant has formerly grown.

Cytisus scoparius
(Scotch broom)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Cytisus scoparius is a widespread woody perennial pest plant found throughout the Pacific Northwest on disturbed xeric to mesic soils. Scotch broom actively invades overgrazed pastures, cultivated fields, grasslands, roadsides and the dikes and berms along many streams in the Portland metro area. Its spread has been encouraged by its production and sale in Oregon nurseries, old plantings in ornamental landscapes and former use along freeway right-of-ways. Its success is due to its tolerance of many soil types and conditions; its ability to fix nitrogen and grow most of the year; and its production of seeds that remain viable for many years. The State of Oregon Department of Agriculture classifies Scotch broom as a "B" list noxious weed; as such it is subject to intensive control on a case by case basis. Scotch broom at the landfill can potentially become the most serious long term pest plant unless control measures are carried out several times yearly.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: No control effort will result in the spread and establishment of broom on the upland grasslands, and on berms, dikes, and along roadways at SJL.

Manual/Mechanical Control: Research by Williams (1983) suggests that Scotch broom is an early successional plant which can be replaced by later seral stages if a desirable groundlayer plant community is left undisturbed when the plant is removed. Any soil disturbance should be kept to a minimum as bare soil provides an ideal rooting substrate for Scotch broom seedlings. Manual methods of *Cytisus* control range from the use of the "Weed Wrench" tool or cutting for the removal of large plants, to hand pulling or mowing for the control of small seedlings. The Bradley Method (Fuller and Barbe 1985) is a systematic method of hand pulling. This method consists of hand weeding small areas of infestation in a specific sequence, starting with the best stands of desirable vegetation and working towards those stands with the worst pest plant infestation. Initially, outlier pest plants that occur singly or in small groups at the edge of large patches of infestation should be eliminated. The next areas to work on are those containing pest plants growing intermixed with desirable vegetation. Finally, work should focus on clearing the most dense pest plant patches. The following manual control guidelines are suggested by Miller: (Broom/Gorse Quarterly 1992)

> *Cut all broom with stem diameters of greater than 1" in late summer during time of maximum drought stress; regrowth should be limited. Broom plants with stems less than 1" in diameter it should be pulled out or cut and then treated with an herbicide.*

Cultural Control: The green stems of broom are able to photosynthesize during mild winter days and are also able to fix nitrogen throughout the winter (Wheeler et al. 1979). However, Broom's nitrogen fixation is limited by soil pH due to the fact that the *Rhizobium* bacterium on the plants root nodules require much less acidity than is found in many Western Oregon soils (Wheeler et al. 1987). Also, Williams (1981) found that phosphorus and sulfur availability strongly influences broom growth.

Chemical Control: Consult the current edition of The Pacific Northwest Weed Control Handbook for specific herbicide recommendations and application rates.

Biological Control: Thus far, the population of broom at SJL is small and manageable. Biological control of broom would only be feasible at SJL if the site had a very large population of plants and if all other control methods fail. Miller (1993 personal communication) states that: ..."All we have at this time [for broom biocontrol] is the seed feeding weevil *Apion fuscirostre*. It eats a lot of seeds but the effect is impossible to measure. It is useful when all else is hopeless." For an up to date analysis of current broom biocontrol efforts and possibilities see the Oregon Department of Agriculture publication: Broom/Gorse Quarterly or the subsequent publication: Weed Watchers Guide. The ODA also was a sponsor of an international broom symposium in April 1996; proceedings are not yet available.

RECOMMENDATIONS

Broom plants growing on the site should be relatively easy to eradicate using manual treatments. Adult plants can be pulled (or "Weed Wrench"ed) when they are in bloom during the months of May and June. The area around the adult plants should be checked for seedlings, which should be easy to pull by hand if the ground is moist.

Monitoring

A yearly surveying and monitoring program is necessary given broom's invasive tendencies. Surveying should focus on all upland grassland areas on the capped portion of the landfill and at the edge of the riparian forest on the perimeter during the flowering season. Monitoring should document the results of eradication efforts.

(Wilson 1993). Soil solarization of one year old seedlings and rosettes should be attempted in areas where non selective control is appropriate.

Chemical Control: Consult the current edition of The Pacific Northwest Weed Control Handbook for specific herbicide recommendations and application rates.
Biological Control: None available.

RECOMMENDATIONS
With persistence and the use of good timing, teasel on and adjacent to the site could eventually be controlled using mowing/cutting techniques. If cutting timing is off herbicide application may be required; early spring or fall application is the preferred method. Soil solarization should be tried on small infestations. Minimizing bare ground and any soil disturbance will reduce preferred teasel habitat. Encouraging the rapid succession of all upland areas to grasslands may minimize the kinds of disturbed habitats common teasel prefers.

Monitoring
All teasel control efforts should be thoroughly documented and then surveyed and monitored for at least three years thereafter.

Dipacus sylvestris
(common teasel)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Dipsacus is a wide spread biennial or short lived perennial that grows on mesic to hydric soils on the edges of agricultural fields, roadsides, old fields and overgrazed pastures. In the Portland metro area it is a commonly found pest plant along dikes and berms, railroad right-of-ways, and on the edges of wetlands. The State of Oregon Department of Agriculture does not classify Common Teasel as a noxious weed.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: If controls are not implemented teasel will continue spread and establish throughout the riparian areas along the Columbia Slough and on mesic upland areas at SJL. As teasel is suspected of also being able to water disperse seed may be also move off the project site to adjacent areas.

Manual/Mechanical Control: Mowing/Cutting Repeated mowing and cutting has proven to be an effective method of controlling teasel (Werner 1979). The timing of these operations is critical. Flowering stalks should be cut at ground level once flowering has initiated. In teasel, flowering begins in a ring around the center of the flowerhead and then progresses both upward and downward (Ferguson 1965). If plants are cut at this time most plants should not reflower and will die at the end of the season. If flower stalks are cut before flowering begins, the plant will respond by sending up several flowering stalks. All cut flower stalks should be removed from the field because immature seeds can produce viable seed on the stem even after cutting. Solecki (1989) has found that seed shaken from cut stalks of teasel had a 95% germination rate in a laboratory setting seven months after cutting (teasel samples were cut at the same flowering stage as described above). After cutting some plants may reflower if the stalks were not cut low enough the first time. Areas of infestation should be checked one additional time after cutting for this reason. Mowing should not be done with a flail mower as the mowing action will shatter the seedheads. A sidecutter mower, attached to the PTO and 3 point of a tractor will lay down the seed stalks and minimize seed shatter. Suitable cutting tools include: "Weed Wacker" hand tool or gas powered "Weedeater" string line trimmer (fitted with blade for old stands). Small hand tools may be the most effective means of removing the cut stems from the site. As teasel seed is viable for up to two years, mowing/cutting may need to be repeated for several years.

Cultural Control: Werner (1975) found that *Dipsacus sylvestris* seed did not require cold treatment, scarification or a specific period of light or dark to germinate. But, Werner also reports (Ibid) a negative correlation between teasel seed germination and the percent cover of leaf and stem litter. Teasel germination may be hindered by heavy litter cover such as that found on prairies that have not been burned or mowed (Solecki 1989). The use of prescribed fire is a very successful method of removing large dense patches of standing dead teasel stalks; however, followup cutting or herbicide treatment is necessary

Equisetum arvense
(western horsetail)
and
Equisetum telmateia
(giant horsetail)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Both species are aggressive Pacific Northwest native plants that have extensive shallow tuber forming roots. *Equisetum* stands are very competitive due to the shallowness of the extensive root system. Both species favor mesic soils with high water tables. Stands at SJL are small in size and are restricted to poorly drained soils on the cap and in ditches.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: In poorly drained areas that pose no threat to the cap, no control action is recommended.

Manual/Mechanical Control:

In steep areas, where winter vegetative cover is desirable to control erosion, hand or mechanical excavation followed by correction of the drainage problem is recommended. The excavated Equisetum should be destroyed and weed free, replacement soil should be used for fill.

Cultural Control: Correct poor drainage [see above]

Chemical Control: Not recommended. Chemical control is difficult due to the smallness of the leaf surface and the ability of the plant to block systemic herbicide translocation.

Biological Control: none known

RECOMMENDATIONS

No action except in areas where cap damage may result.

Monitoring

Survey low spots and drainage areas of SJL during the wet times of year to determine need for control action.

Hypericum perforatum
(St. Johnswort) [Klamath weed]

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Klamath weed is a 1-3 foot perennial that grows on dry soils throughout the west. Grazing is often associated with it's spread, due to the reduction and trampling of competitive grass. The plant has numerous branches covered with opposite leaves with no petiole. The small, oval leaves are covered with tiny transparent dots. Flowers are ¾" in diameter and have 5 yellow petals. The weed contains a toxic substance which affects white haired animals. Affected animals often loose weight and develop a skin irritation when exposed to sunlight. The population at SJL is sparse but distributed widely, especially on the dryer ridge slopes.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: To date Klamath weed populations are fairly low and no action is justified. Future monitoring of the population is recommended however, especially if sheep grazing continues to be used for grass control.

Manual/Mechanical Control: not needed

Cultural Control: none known

Chemical Control: Many herbicides are approved for Klamath weed control. Consult the current edition of The Pacific Northwest Weed Control Handbook for specific herbicide recommendations and application rates.

Biological Control: Defoliation of the plant by the Klamath weed beetles, *Chrysolina* spp., has resulted in spectacular control since their release in the late 1940's. The two beetle species are widespread throughout Oregon, but in the last several years their populations have declined, allowing the host plants to increase in local areas. The ODA should be asked to sample the SJL population to determine if a reintroduction is warranted.

RECOMMENDATIONS

No action other than contacting ODA to determine if existing populations would support reintroduction of the biocontrol beetles. Practice good grazing management in order to avoid overgrazing (severe reduction of grass cover).

Monitoring

Yearly surveying of SJL during the growing season is recommended to determine if populations are greatly increasing.

Phalaris arundinacea
(reed canary grass)

DESCRIPTION & ACTUAL/POTENTIAL THREATS

Phalaris arundinacea is a perennial grass that reproduces from rhizomes and seed. The U.S. Fish and Wildlife Service classifies *Phalaris* as a facultative wetland plant (a plant that grows 66% of the time in wetlands and 33% of the time on uplands). *Phalaris* is found throughout the Pacific Northwest on disturbed sites such as: urban stream floodplains, irrigation canals, old pastures, and in ditches along roadsides; it also actively invades natural wetlands especially wet prairies and emergent marshes. The spread of the species is intensified along stream courses which serve as dispersal corridors; proliferation is enhanced greatly because seeds have no dormancy requirements and germinate immediately after ripening (Piper 1924). The State of Oregon Department of Agriculture does not classify *Phalaris* as a noxious weed. However, it is considered an invasive weed in wetlands.

The taxonomy of *Phalaris* is unclear; some authorities, including Hitchcock and Cronquist (1973), classify it as a north American native, other as an exotic. If it is native it seems unlikely that it is indigenous to the Pacific Northwest; its rampant growth here is a product of the twentieth century. *Phalaris* is now widely represented in the U.S. through its introduction for agricultural purposes (Anderson 1961). Until the 1960's *Phalaris* was promoted by several federal agencies as a forage crop and for use in erosion control (Wilkins and Hugh 1932). Some have suggested that *Phalaris* was not in the Portland metro area until it was planted along dikes for erosion control. *Phalaris arundinacea* is often confused with a closely related species *Phalaris aquatalis* (Harding Grass) which is also fairly common in the metro area. The difference between the two species is in the lengths of the sterile lemmas; *arundinacea* has 1 mm lemmas, *aquatilis* 1.5 mm lemmas (Peterson/TNC E.S.A. 1988). Harding grass also seems to favor slightly drier soil conditions.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: It is unclear, at this time, if the populations of *Phalaris* on capped portions of SJL will continue to spread due to their upland position. The unchecked spread of *Phalaris* in the riparian fringe (on the perimeter of the landfill) may, however, endanger the existing native plantings and subsequent succession in the emergent wetlands and riparian areas along the Columbia Slough.

Mechanical Control: On the capped portion of SJL, the digging of small isolated plants can slow the spread of *Phalaris*, but total control is difficult due to the improbability of removing all rhizome pieces. Removing seed heads by clipping after anthesis but before seed dehiscence will slow the spread of new plants from seed. Mowing alone will delay anthesis but won't provide control. Mowing can be more affective when combined with herbicide wicking. *Phalaris* growing along the riparian perimeter of SJL should be mowed or string line trimmed several times during each growing season in order to slow it's rank

growth and reduce seed formation. Mowing *Phalaris* will lessen its ability to compete with the established woody vegetation for water and nutrients.

Cultural Control: Controlled burning of monoculture stands of *Phalaris* in selected areas on the perimeter of SJL along the Columbia Slough should be explored. Connelly and Kauffman (1991) in a review of the role of fire in wetland and riparian areas, suggest that wetland burning can be useful for the enhancement of waterfowl forage and habitat and for the management of threatened and endangered plant species. The burning of *Phalaris* in wet prairies in early spring as well as in early fall has been tried in control attempts in the United Kingdom, the Midwest U.S. as well as in Western Oregon. The flooding of *Phalaris* has also been attempted. At the Oaks Bottom Urban Natural Area in Portland, a water control structure was constructed to raise the water level in an area of willow (*Salix* spp.) and *Phalaris*. After 9 months of inundation during the growing season (January through September), the *Phalaris* appeared dead and a stand of sedge (*Carex aperta*) has reestablished (Rogers, personal communication). Prolonged flooding is necessary for success; and if possible, *Phalaris* should be mowed before flooding to a level higher than the apical meristem of the plant (Wilson, personal experience). The control of *Phalaris* by solarization with clear plastic sheeting has recently been attempted on a project at Fern Ridge Lake (Fishman, Wilson, et al., unpublished). Using ideas proposed by Bainbridge (1990) a small un-replicated test plot was setup in the summer of 1992 to compare the efficacy of four pest plant eradication techniques: prescribed burning, tillage, tillage with herbicide, and solarization. After one year, preliminary observations verified that solarization provided more effective *Phalaris* control than the other three methods tried. By the summer of 1995, however, *Phalaris* rhizomes had reinvaded the small 300 square foot test plot from the untreated edges.. Shading has also been tried as a method of control for small isolated patches, using black plastic sheeting to prevent the plant from photosynthesizing (Alverson, personal communication).

Chemical Control: The most effective herbicide for the control of *Phalaris* is either Roundup or Rodeo (glyphosate) (Comes et al. 1981, Apfelbaum 1991, M.G. Wilson 1993). The 1997 Pacific Northwest Weed Control Handbook also recommends Roundup or Rodeo.

Biological Control: None available

RECOMMENDATIONS

There are significant infestations of *Phalaris* in three different settings on (or adjacent to) SJL:

1. *Phalaris* growing as a monoculture stand on large open floodplains of the Columbia Slough and Smith and Bybee Lakes at the perimeter of SJL.

2. *Phalaris* growing as understory to native woody trees and shrubs (e.g. Oregon Ash (*Fraxinus latifolia*) and Willow (*Salix* spp.) on the banks of the Columbia Slough.

3. *Phalaris* growing as a co-dominant intermixed with desirable upland grasses on the capped portion of the landfill (primarily in Subarea 1).

Following are prescriptions for each of these settings:

Non selective Control on floodplains using herbicide and flooding or prescribed fire:

Spring/Summer- Apply herbicide as a spray to the entire infested area before seedhead emergence. Repeat application three weeks later. Mow the standing dead *Phalaris*.

Fall-. After fall regrowth of the *Phalaris* has begun, reapply herbicide as a spray. If water impoundment is not possible, prescribe burn the herbicide killed *Phalaris* to destroy the seedbank.

Late Fall- If water impoundment is possible, adjust control structure as needed to insure that the water level is higher than the herbicide killed and mowed *Phalaris* through the winter and into the late spring.

Repeat yearly until *Phalaris* control is achieved. Plant with wetland emergent plugs and reseed with native/non-native grasses.

Selective Management in existing woodlands, emergent marshes, or wet prairies:

Late summer- Mow or string line trim areas to be treated. Repeat monthly. Maintain *Phalaris* as a low growing grass until desirable woody plantings provide total canopy coverage.

Early spring and fall- Apply optional herbicide to woodland, marsh or prairie infestations using the wicking method. Repeat as needed. Reseed/replant with desirable vegetation.

CAUTION: Herbicide should not be applied on or near desirable woodland trees, shrubs or herbaceous plants unless they are dormant.

Fall- After control (using herbicides) is achieved, plant groundlayer with wetland emergent plugs or reseed with desirable emergents or native or non invasive grasses.

Selective Control on upland grasslands:

Remove seed heads to prevent spread of plant. Repeated shallow tillage during the growing season has proven somewhat beneficial (Wilson, personal experience). Monthly discing during two successive growing seasons has proven necessary to kill *Phalaris* rhizomes or seedbank. At the end of the first growing season, seed a non-invasive grass to control erosion during the winter. The soil solarization or the

shading with black plastic of small isolated patches of *Phalaris* during the growing season will also provide some control. After control is achieved, dense seedings of native/non-native grasses should be made.

Monitoring and Maintenance

After *Phalaris* control has been implemented, surveying and monitoring of the site should be conducted monthly during the following three growing seasons in the years thereafter. Monitor to determine the level of sustained maintenance effort needed to control the spread of the plant.

Rubus discolor
(Himalayan blackberry)

ACTUAL/POTENTIAL THREATS

Rubus discolor (procerus) is a widespread woody perennial pest plant found throughout the Pacific Northwest on disturbed mesic soils. This introduced blackberry actively invades overgrazed pastures, hedgerows, woodland edges and the dikes and berms along seasonal waterways throughout the Portland metro area. It's success is due to it's tolerance of many soil types and conditions, and it's ability to propagate readily from seed, tip runners and underground rhizomes. The fruits of this species are very attractive to several species of wildlife and birds and localized infestations are often associated with perching trees or shrubs. The State of Oregon Department of Agriculture classifies Himalayan blackberry as a noxious weed; however it is not considered a priority "target" weed for the focus of state control efforts.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: Continued spread and establishment on upland areas of SJL. particularly on the edges of mesic riparian woodland areas.

Mechanical and Manual Control: Mechanical removal with tractor mounted flail mower, brush cutters, power saws, machetes, and burning may be the most effective method of removing mature canes; but followup treatments are necessary as the root crown will simply resprout and produce more canes. Harris (1992), Miller (personal communication) and Wilson (personal experience) report success with repeated mowings with a flail mower (2-3 times per year) or weedeater trimmer affixed with a cutting blade or string line. If only a single mowing can be done, the best time is when the plants are in flower as the plant is its weakest. If mowing is done before seed set the piles of debris may be left for enhancement of wildlife habitat or burned; debris can also be chipped and used for mulch for revegetation plantings. Care should be taken to prevent vegetative reproduction of cuttings, however, which root readily. Harris (1992) also reports success with repeated mowing followed by hand grubbing of the root crowns with a claw mattox. Hand grubbing of seedlings should be done after a rain when the soil is loose. Hand hoeing is effective in areas where desirable vegetation prevents mowing. The goal of hoeing is to cut off the resprouts or seedlings at ground level without going too deeply into the soil. Hoeing several times during the growing season will gradually weaken the plant but removal of mature canes alone will not control blackberry. If repeated tillage is used a means of control, repeating for 2-3 growing seasons is necessary (Wilson personal experience).

Cultural Control: Blackberries growing is full sun produce good seed crops nearly every year. Amor (1974) reports that birds disperse the seed and that the passage of seed through their digestive tracts improves germination. Trees and large shrubs at edges of sunny openings, are often infested with blackberries due to the spread of seed by perching birds. Blackberry is somewhat intolerant of shading by overhead trees with a dense canopy, particularly evergreens (Wilson, personal experience). In Australia, Amor (1974) found that blackberry seedlings receiving less than 44% of full sunlight did not survive.

The susceptibility of seedlings to shading suggests that few seedlings will survive in dense grasslands or conifer forests; seedling establishment is more common in open habitats such as land neglected after cultivation or along eroded stream banks.

Chemical Control: Treatment with herbicides following burning or mechanical removal of the canes should be conducted cautiously for several reasons: 1) the herbicide may be translocated to unforeseen locations by running water and 2) some herbicides promote vegetative regrowth from lateral roots. When applying herbicides a dye should be used in the chemical mix in order to identify treated plants. Consult the current edition of the Pacific Northwest Weed Control Manual for specific herbicide recommendations and application rates.

Biological Control: None available. To date the ODA will not support introductions of bio-control agents due to their potential threat to commercially important *Rubus* species.

RECOMMENDATIONS

Most probably the combination of mechanical and chemical treatments will be necessary to control blackberry on the SJL site. In the spring of the growing season flail mow or use blade trimmer or other hand tools to remove top growth; repeat as required. Before berry set, paint freshly cut stems with herbicide. On highly disturbed flat ground shallow tillage with a disc for 2-3 growing seasons followed by the dense seeding of a nonpersistant cereal will provide control to small patches of blackberry (Wilson personal experience).

Monitoring

All Himalayan blackberry control efforts should be thoroughly documented and then monitored for at least three years thereafter. Project sites should be monitored twice yearly for reinfestation.

Senecio jacobaea
(tansy ragwort)

DESCRIPTION & ACTUAL/POTENTIAL THREATS
Tansy ragwort is a biennial or short lived perennial. The plant is 1-6 feet tall with numerous yellow, daisy like, flower heads in terminal clusters. The plant is widespread throughout the northwest and California and is very toxic to horses and cattle. The population at SJL is small but widely distributed, particularly along travel corridors and roads.

DISCUSSION OF MANAGEMENT OPTIONS
No Action: No action, other than monitoring the existing population, is recommended at this time.

Manual/Mechanical Control: If future monitoring indicates that the population of tansy is increasing, hand pulling during the late spring when the soil is still moist and the plant is just beginning to flower can be used to prevent spread of the plant. A followup removal of the flower heads of missed plants will prevent seeding.

Cultural Control: Promote growth and retention of grass cover to encourage competition. Continuous grazing using sheep, which are not affected by the plant toxin, will keep tansy vegetative and prevent it from going to seed. Practice sound grazing management practices to insure good field rotation.

Chemical Control: Not recommended at this time.

Biological Control: Three insects have been released by ODA as tansy biocontrol agents. The ragwort flea beetle, *Longitarsus jacobaeae*; the seed head fly, *Pegohylemyia seniciella*; and the cinnabar moth, *Tyria jacobaeae*. The combination of flea beetle and cinnabar moth have nearly eliminated flowering ragwort in many areas and ODA makes collections of the insects on an as needed basis. Contact ODA for further information regarding required minimum population densities for tansy for biocontrol success.

RECOMMENDATIONS
No control action is recommended at this time. Contact ODA for biocontrol information.
Monitoring
The landfill should be surveyed several times during the growing season to determine if the existing population increases.

Silybum marianum
(milk thistle)

ACTUAL/POTENTIAL THREATS

Milk thistle is a biennial or winter annual that prefers moist soil conditions and can reach 6 feet in height. The plant has ridged stems and the leaves have spiny margins with distinctive white marbling on the leaf veins. The flowers are red-purple. Milk thistle is infrequently found in the Portland metro area and only one plant was found at SJL during the summer 1998 vegetation inventory. Because of it's invasive tendencies, it is a plant to monitor.

DISCUSSION OF MANAGEMENT OPTIONS

No Action: No action, other than flower removal [see below] is recommended at this time.

Manual/Mechanical Control: The one existing plant at SJL was found in a ditch midway along the south side of the east-west road that bisects subareas 2 and 3. When the plant shows sign of bloom, the flowering stalk should be removed as close to the ground as possible. Check again a few weeks later to be sure that the plant has not sent up another flowering stalk.

Cultural Control: none known

Chemical Control: Consult the current edition of the Pacific Northwest Weed Control Manual for herbicide recommendations and application rates.

Biological Control: A seed head weevil, *Rhinocyllus conicus* was introduced by the ODA in the late 1970's but it's ability to control the plant is questionable.

RECOMMENDATIONS

Remove flower stalk from the one plant found [see manual control above].

Monitoring

Survey SJL several times during the growing season to identify additional plants.