Appendix D – Soil and Water

List of Municipal Water Sources

General Herbicide Properties in Relation to Soil

Sensitive Soil Sites Identified

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List of Municipal Water Sources found on the Wallowa-Whitman National Forest

Several towns, recreation sites and other infrastructure facilities found in or near National Forest System Lands rely on the Forest for municipal water. The following lists those drawing municipal or domestic water, the watershed source and acres, and the approximate population served

Municipality name	Watershed name	Population	NFS acres
Anthony Lakes CG, GS, SA, SH	Tumbleoff Spring	360.00	30
Bird Track campground	Bird Track Spring	69.00	7
City of Granite	unnamed spring	70.00	38
City of Greenhorn	unnamed springs #1 and #2	30.00	300
Fish Lake Campground	Fish Lake Campground Spring	40.00	2
Oregon campground	Oregon Campground Spring	30.00	250
South Fork campground	Southfork Spring	40.00	10
Union Creek Campground	Union Creek Campground Spring	246.00	1,720
Wallowa Lake County Service Dist.	Lower Chief Joseph Spring	2,500.00	19
Wallowa Lake County Service Dist.	Upper Chief Joseph Spring	2,500.00	19
Wallowa Lake County Service Dist.	State Park Spring	2,500.00	320
Wetmore Campground	Wetmore Campground Spring	30.00	41
Yellow Pine campground	Yellowpine Spring	40.00	235
Blackhorse campground	Blackhouse Campground spring	30.00	120
Cache Creek Ranch	Cache Creek Ranch Spring	100.00	3,510
Coverdale Campground/Guard Station	Coverdale Spring	28.00	12
North Pine Rest Stop	North Pine Rest Stop Spring	25.00	2
Pittsburg Landing Campground	Lower Landing Spring	40.00	13
Baker City	Little Salmon Spring	10,000.00	25
Baker City	Marble Spring	10,000.00	670
Baker City	Camper Spring	10,000.00	95
Baker City	Henry Spring	1,000.00	130
Baker City	Byam Spring	10,000.00	50
Baker City	Finley Spring	10,000.00	60
City of LaGrande	Hidden Spring	12,000.00	340
City of Granite	Boulder Creek	70.00	2,190
City of Joseph	Wallow River	1,270.00	28,550
City of Joseph	Wallowa Lake	1,270.00	28,550
City of Richland	Eagle Creek	300.00	100,400
City of Sumpter	McCully Fork	500.00	5,100
City of Sumpter	O'Farrel Gulch	500.00	1,170
City of Sumpter	Cracker Creek	500.00	17,960
Lakeshore Water Development District	Harris Spring Creek	400.00	258
Baker City	Goodrich Creek	10,000.00	1,430
Baker City	Little Mill Creek	10,000.00	615
Baker City	Little Marble Creek	10,000.00	350
Baker City	Mill Creek	10,000.00	1,000
Baker City	Little Salmon Creek	10,000.00	420
Baker City	Goodrich Lake Reservoir	10,000.00	346
Baker City	Salmon Creek	10,000.00	700
Baker City	Elk Creek	10,000.00	1,635
City of LaGrande	West Fork Beaver Creek	12,000.00	2,680
City of LaGrande	Elk Creek	12,000.00	274
City of LaGrande	Cove Creek	12,000.00	860
City of LaGrande	BEAVER CREEK	12,000.00	8,210
City of LaGrande	LaGrande Reservoir	12,000.00	8,940
City of Unity	Unity RS annex well #2	110.00	860
City of Unity	Unity RS compound well	110.00	860
Eagle Forks Campground	Eagle Forks Well	35.00	11,750
Oregon Trail Blue Mtn. Crossing	Blue Mountain Crossing Well	50.00	1
Wallowa Lake County Service Dist.	WLCSD Well	2,500.00	20,500

Indian Crossing Campground	Indian Crossing Well	35.00	42,840
Ollokot Campground	Ollocot Well	35.00	59,600
			356,067

General Herbicide Properties in Relation to Soil

General characteristics for the proposed herbicides are displayed below; these were compiled from the R6 2005 FEIS, label information and SERA Risk Assessments, the Mount Hood National Forest and Columbia River Gorge National Scenic Area (Oregon side) Site-Specific Invasive Plant Treatment FEIS, and the Deschutes, Ochoco and Crooked River National Grasslands Invasive Plants EIS.

Chlorsulfuron

Studies on the effects of chlorsulfuron on soil biota include lab and field studies on nematodes; fungi; populations of actinomycetes, bacteria, and fungi; and soil microorganisms.

- No effects of chlorsulfuron were found for soil biota at recommended application rates, with the exception of transient decreases in soil nitrification.
- The ‘no observable effects concentration’ for soil is 10 mg/kg, based on cellulose and protein degradation.
- Chlorsulfuron degrades in aerobic soil.
- Non-microbial hydrolysis plays an important role in chlorsulfuron breakdown, and hydrolysis rates increase as pH increases.
- Adsorption to soil particles, which affects the runoff potential of chlorsulfuron, is strongly related to the amount of organic material in the soil.
- Chlorsulfuron adsorption to clay is low.
- Chlorsulfuron is moderately mobile at high pH.
- Leaching is reduced when pH is less than six.
- Modeling results indicate that runoff would be negligible in sandy or loamy soils.
- In clay soils, off-site loss could be substantial (up to about 55 percent of the applied amount) in regions with annual rainfall rates of 15 to 250 inches.

Clopyralid

Studies of clopyralid effects on soil invertebrates have been conducted, including field studies on the effects to microorganisms.

- Soil concentrations from USDA Forest Service applications are expected to be 1,000 less than concentrations that would cause toxic effects. Therefore, no effects to soil invertebrates or microorganisms are expected from use of clopyralid.
- Clopyralid is degraded by soil microbes, with an estimated half-life of 14 to 29 days, meaning that one-half of the amount applied remains in the soils after 90 days, one-fourth of the applied amount remains after 28 to 58 days, one –eight after 42 to 87 days, and so on.
- Increased soil moisture decreases degradation time.

- Clopyralid is weakly adsorbed and has a moderate leaching potential overall but high leaching potential in sandy soils.
- Modeling results indicate clopyralid runoff is highest in clay soils with peaks after rainfall events.
- Clopyralid percolation is highest in sandy loam soils.

Glyphosate

Numerous soil bacteria, fungi, invertebrates, and other microorganisms have been studied for effects of glyphosate application.

- Studies suggest glyphosate does not adversely affect soil organisms.
- Glyphosate is readily metabolized by soil microorganisms and some species can use glyphosate as a sole source of carbon.
- It is degraded by microbial action in both soil and water.
- Sylvia and Jarstfer (1997) found that after 3 years, pine trees in plots with grassy invasive plants had 75 percent fewer mycorrhizal root tips than plots that had been treated 3 times per year with a mixture of glyphosate and metsulfuron methyl to remove invasive plants.
- Glyphosate degrades in soil, with an estimated half-life of 30 days.
- Glyphosate is highly soluble, but adsorbs rapidly and binds tightly to soil.
- Glyphosate has low leaching potential because it binds so tightly to soil.
- Modeling results indicate glyphosate runoff is highest in loam soils with peaks after the first rainfall.

Imazapic

Imazapic is a relatively new herbicide, and there are no studies on the effects of imazapic on either soil invertebrates or soil microorganisms.

- If imazapic was extremely toxic to soil microorganisms, it is reasonable to assume that secondary signs of injury to microbial populations would have been reported.
- Imazapic degrades in soil, with a half-life of about 113 days.
- Half-life is decreased by the presence of microflora.
- Imazapic is primarily degraded by microbes and it does not degrade appreciably under anaerobic conditions.
- Imazapic is weakly adsorbed in high soil pH, but adsorption increases with lower pH (acidic soils) and increasing clay and organic matter content.
- Field studies indicate that imazapic remains in the top 12 to 18 inches of soil and do not indicate any potential for imazapic to move with surface water.
- Modeling results indicate imazapic runoff is highest in clay and loam soils with peaks after the first rainfall.

- Imazapic percolation is highest in sandy soils.

Imazapyr

There are no studies on the effects of imazapyr on soil invertebrates, and incomplete information on the effects on soil microorganisms.

- One study indicates cellulose decomposition, a function of soil microorganisms, can be decreased by soil concentrations higher than concentrations expected from USDA Forest Service applications.
- There is no basis for asserting adverse effects to soil microorganisms.
- Imazapyr degrades in soil, with a half-life of 25 to 180 days.
- Degradation rates are highly dependent on microbial action.
- Anaerobic conditions slow degradation.
- Adsorption increases with time as soil dries and is reversible.
- Field studies indicate that imazapyr remains in the top 20 inches of soil and do not indicate any potential for imazapyr to move with surface water.
- In forest field studies, imazapyr did not run off and there was no evidence of lateral movement.
- Modeling results indicate imazapyr runoff is highest in clay and loam soils with peaks after the first rainfall.
- Imazapyr percolation is highest in sandy soils

Metsulfuron methyl

Studies on the effects of metsulfuron methyl on soil biota are limited to Pseudomonas species, though there are a few studies of insects that live in soil. The lowest observed effect concentration is 5 mg/kg, based on the Psuedomonas study. At recommended use rates, no effects are expected for insects.

- Effects to soil microorganisms appear to be transient
- Metsulfuron methyl degrades in soil, with a variable half-life up to 120 days.
- Half-life is decreased by the presence of organic matter though microbial degradation of metsulfuron methyl is slow.
- Non-microbial hydrolysis is slow at high pH but rapid at lower pH.
- Adsorption to soil particles, which affects the runoff potential of metsulfuron methyl, increased with increased pH and organic matter.
- Metsulfuron methyl has low adsorption to clay.
- Modeling results indicate that off-site movement due to runoff could be significant in clay soils.
- Metsulfuron methyl percolates in sandy soils.

Picloram

Picloram is a restricted use pesticide in the state of Washington, meaning it may only be used by a certified applicator (this is also a standard for all herbicide use on the Gifford Pinchot National Forest and Columbia River Gorge National Scenic Area). The persistence of picloram increases with soil concentration, thus increasing the likelihood that it becomes toxic to soil microorganisms in the short-term (1 to 3 years).

- Since picloram is toxic to microorganisms at low levels, toxic effects can last for some time after application.
- Persistence in soils could affect soil microorganisms by decreasing nitrification.
- Long-term effects to soil microorganisms are unknown.
- Picloram applied at a typical application rate is likely to change microbial metabolism, though detectable effects to soil productivity are not expected.
- Field studies have not noted substantial adverse effects associated with the normal application of picloram that might be expected if soil microbial activity were substantially damaged.
- Substantial effects to soil productivity from the use of picloram over the last 40 years have not been noted.
- Picloram has been studied on a number of soil invertebrates.
- Metabolites may increase toxicity for some soil microorganisms.
- Picloram has a typical half-life of 90 days. However, picloram soil degradation rates vary in soil, depending on application rate and soil depth.
- Picloram is water soluble, poorly bound to soils that are low in clays or organics, has a high leaching potential, and is most toxic in acidic soil.
- Picloram should not be used on coarse-textured soils with a shallow water table, where groundwater contamination is most likely to occur.
- Picloram percolation is highest in loam and sandy soils. However, modeling results indicate picloram runoff (not percolation) is highest in clay soils.

Sethoxydim

Sethoxydim has not been studied on soil invertebrates.

- Assays of soil microorganisms noted transient shifts in species composition at soil concentration levels far exceeding concentrations expected from USDA Forest Service application.
- No adverse effects to soil organisms are expected.
- Sethoxydim is degraded by soil microbes, with an estimated half-life of 1 to 60 days. Adsorption of sethoxydim varies with organic material content.
- Modeling results indicate sethoxydim runoff is highest in clay and loam soils with peaks after the first rainfall.

Sulfometuron methyl

There are no studies on the effects of sulfometuron methyl on soil invertebrates. However, it is toxic to soil microorganisms. Microbial inhibition is likely to occur at typical application rates and could be substantial. Soil residues may alter composition of soil microorganisms. Sulfometuron methyl applied to vegetation at rates to control undesirable vegetation would probably be accompanied by secondary changes in the local environment that affect the soil microbial community more certainly than direct toxic action of sulfometuron methyl on microorganisms.

- The typical half-life for sulfometuron methyl varies from 10 to 100 days, depending on soil texture. Half-life decreases as soil particle size decreases. Presence of soil microorganisms also decreases half-life, though microbial breakdown occurs slowly. Sulfometuron methyl degradation occurs most rapidly at lower pH soils where rates are dominated by hydrolysis.
- Sulfometuron methyl mobility is generally greater at higher soil pH and lower organic matter content.
- Modeling results indicate sulfometuron methyl runoff is highest in clay and loam soils with peaks after the first rainfall. Sulfometuron methyl percolation is highest in sandy soils. Monitoring results generally support modeling results.
- Sulfometuron methyl applied to vegetation at typical application rates would probably be accompanied by secondary changes to vegetation that affect the soil microbial community more certainly than direct toxic action of sulfometuron methyl on soil microorganisms.

Triclopyr

The five commercial formulations of triclopyr contain one of two forms of triclopyr, BEE (butoxyethyl ester) or TEA (triethylamine). Triclopyr BEE is much more toxic to aquatic organisms than triclopyr TEA. A breakdown product, TCP (3,5,6-trichloro-2-pyridinol), is more toxic than either form of triclopyr. Site-specific cumulative effects analysis buffer determinations need to consider the form of triclopyr used and the proximity of any aquatic triclopyr applications, as well as toxicity to aquatic organisms.

- Triclopyr has not been studied on soil invertebrates.
- Soil fungi growth was inhibited at concentrations 2 to 5 times higher than concentrations expected from USDA Forest Service application rates.
- Triclopyr has an average half-life in soil of 46 days, while TCP has an average half-life in soil of 70 days. Warmer temperatures decrease the time to degrade triclopyr.
- Soil adsorption is increased as organic material increases and decreased as pH increases. Triclopyr is weakly adsorbed to soil, though adsorption varies with organic matter and clay content. Both light and microbes degrade triclopyr.

Sites with Sensitive Soils Identified

Sites were identified that have a high risk for either contamination to groundwater or relocation by wind for select herbicides. The risk for groundwater contamination is from soluble persistent herbicides as detailed in the hydrology analysis. The main risk is for picloram (Tordon K, 22K) and sulfometuron methyl (Oust, Oust XP) in soils coarser than loam, and chlorpyralid (Reclaim, Curtail, Transline) in loamy sand to sand soils according to herbicide labels. Also, there is a risk for wind relocation of chlorsulfuron (Telar, DF, and Glean) if applied on dry fine textured soils; chlorsulfuron has strong absorption, especially in clay soils. Where there is high risk, these herbicides were excluded from application unless site specific field verification proves lower risk.

As a coarse guide, the site locations were correlated to soils from completed soil mapping as of June 2008 (Terrestrial Ecosystem Unit Survey for Wallowa Whitman NF Unpublished). Soil clay content, saturated conductivity and water table depth were key variables used to delineate high risk sites. Initially, drainage from shallow bedrock soils was considered, though feedback from Forest personnel suggested that risk would be low since most of the bedrock is not extensively fractured within range soils that are primarily targeted for chemical treatments (Busskohl 2008, personal communication). Soil drainage was also considered within the landscape context. Footslope and bottomland soils were deemed higher risk for groundwater contamination than upland ridges and steep sideslopes.

The following sites represent an approximation since these findings rely on geographical information system analysis. Ultimately, the infield examination of soil texture and site context will prove the most reliable judgment for appropriate herbicide use. Table D-1 below shows weed sites with target weed species and appropriate herbicide alternatives.

Table D- 1 Wallowa Whitman NF chemical treatment sites with greater risk for groundwater contamination and wind translocation.

Site	Plant Code	Site	Portion Acreage	Herbicide1	Herbicide2	Herbicide3	Soil Limitation
6160600111	EUES	12	11	Glyphosate	Imazapic		Excessively Well Drained, Shallow water table
6160700017	CADR	27	6	Chlorsulfuron	Imazapic	Metsulfuron methyl	Excessively Well Drained, Shallow water table
6160600183	CEDI3	134	13	Glyphosate			Excessively Well Drained, Shallow water table
6160600049	EUES	2	2	Glyphosate	Imazapic		Excessively Well Drained, Shallow water table
6160600048	CEDI3	66	64	Glyphosate			Excessively Well Drained, Shallow water table
6160600183	CEDI3	134	85	Glyphosate			Excessively Well Drained, Shallow water table
6160900092	ONAC	13	9	Chlorsulfuron	Metsulfuron methyl		Shallow water table
6160600204	CIAR4	8	3	Chlorsulfuron	Glyphosate		Shallow water table
6160400007	CEMA4	232	47	Glyphosate			Well Drained
6160400075	CIAR4	677	47	Chlorsulfuron			Well Drained
6160400007	CEMA4	232	50	Glyphosate			Well Drained
6160200024	CEDI3	1	1	Glyphosate			Shallow water table
6160200141	CEDI3	4	3	Glyphosate			Shallow water table
6160200142	CEDI3	1	1	Glyphosate			Shallow water table
6160200227	CEMA4	58	11	Glyphosate			Shallow water table
6160100154	HYPE	1	1	Metsulfuron methyl	Glyphosate		Shallow water table

Site	Plant Code	Site	Portion Acreage	Herbicide1	Herbicide2	Herbicide3	Soil Limitation
6160900097	CEDI3	8	8	Glyphosate			Shallow water table
6160100076	HYPE	10	4	Glyphosate			Well drained
6160100078	CEDI3	2	2	Glyphosate			Well drained
6160100071	CYOF	7	3	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160500009	LIDA	3	1	Metsulfuron methyl (forested sites)	Imazapic (in native grasses)	Aquatic labeled Glyphosate	Well Drained
6160400185	CEDI3	1	1	Glyphosate			Well Drained
6160600265	CIAR4	6	6	Chlorsulfuron			Well Drained
6160400075	CIAR4	677	42	Chlorsulfuron			Well Drained
6160100001	CIAR4	9	5	Chlorsulfuron			Well Drained
6160700172	CIAR4	3	3	Chlorsulfuron	Glyphosate		Shallow water table
6160200054	CYSC4	115	10	Triclopyr	Glyphosate		Well Drained
6160700123	CEDI3	2	2	Glyphosate			Well Drained
6160700075	CYOF	3	3	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160700104	CYOF	50	21	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160700099	CYOF	10	3	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160700109	CYOF	51	45	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160900070	CEMA4	3	3	Glyphosate			Well Drained

Site	Plant Code	Site	Portion Acreage	Herbicide1	Herbicide2	Herbicide3	Soil Limitation
6160900213	CEDI3	2	2	Glyphosate			Well Drained
6160900039	CEMA4	23	18	Glyphosate			Well Drained
6160600240	CIAR4	88	18	Chlorsulfuron			Well Drained
6160600241	CIAR4	9	4	Chlorsulfuron			Well Drained
6160600248	CIAR4	28	14	Chlorsulfuron			Well Drained
6160600248	CIAR4	28	5	Chlorsulfuron			Well Drained
6160900108	LIDA	10	10	Metsulfuron methyl (forested sites)	Imazapic (native grasses)	Aquatic labeled Glyphosate	Clay
6160900002	LIDA	50	37	Metsulfuron methyl (forested sites)	Imazapic (native grasses)	Aquatic labeled Glyphosate	Clay
6160200007	CIAR4	50	22	Chlorsulfuron	Glyphosate		Shallow water table
6160900105	EUES	14	8	Picloram	Glyphosate	Imazapic	Clay
6160600250	CIAR4	1	1	Chlorsulfuron			Well Drained
6160600240	CIAR4	88	15	Chlorsulfuron			Well Drained
6160400007	CEMA4	232	25	Glyphosate			Well Drained
6160400007	CEMA4	232	13	Glyphosate			Well Drained
6160400075	CIAR4	677	25	Chlorsulfuron			Well Drained
6160400007	CEMA4	232	20	Glyphosate			Well Drained

Site	Plant Code	Site	Portion Acreage	Herbicide1	Herbicide2	Herbicide3	Soil Limitation
6160600199	EUES	6	3	Glyphosate	Imazapic		Well Drained
6160600349	PORE5	9	5	Metsulfuron methyl			Well Drained
6160900156	CIAR4	7	5	Chlorsulfuron			Well Drained
6160900109	ONAC	9	7	Clopyralid	Chlorsulfuron	Metsulfuron	Well Drained
6160900100	ONAC	10	5	Clopyralid	Chlorsulfuron	Metsulfuron	Well Drained
6160900155	CYOF	7	7	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160900231	CADR	3	2	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160900027	CADR	10	3	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160900036	CEMA4	18	16	Glyphosate			Well Drained
6160900157	CIAR4	7	4	Chlorsulfuron			Well Drained
6160600216	CYOF	40	12	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
6160900056	CADR	10	5	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160700116	CEDI3	6	3	Glyphosate			Well Drained
6160700052	CEDI3	13	8	Glyphosate			Well Drained
6160700119	HYPE	1	1	Glyphosate			Well Drained
6160700109	CYOF	51	6	Chlorsulfuron	Imazapic	Glyphosate	Well Drained

Site	Plant Code	Sit e	Portion Acreage	Herbicide1	Herbicide2	Herbicide3	Soil Limitation
616070000 6	CADR	6	2	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
616070007 8	CYOF	6	5	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
616070007 6	CADR	1	1	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
616070010 5	PORE5	3	3	Metsulfuron methyl			Well Drained
616070003 4	CIAR4	16	11	Chlorsulfuron			Well Drained
616070010 4	CYOF	50	29	Chlorsulfuron	Imazapic	Glyphosate	Well Drained
616070007 4	CADR	1	1	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
616070003 3	CADR	20	9	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
616070004 8	CEDI3	9	6	Glyphosate			Well Drained
616070006 1	TACA8	91 4	88	Imazapic	Sethoxydim	Glyphosate	Well Drained
616070002 7	CEDI3	30	23	Glyphosate			Well Drained
616070001 0	CEDI3	75	18	Glyphosate			Well Drained
616070009 1	CEDI3	3	2	Glyphosate			Well Drained
616070006 1	TACA8	91 4	53	Imazapic	Sethoxydim	Glyphosate	Well Drained
616070006 1	TACA8	91 4	33	Imazapic	Sethoxydim	Glyphosate	Well Drained
616060018 9	CEDI3	2	2	Clopyralid	Picloram	Glyphosate	Clay

Site	Plant Code	Site	Portion Acreage	Herbicide1	Herbicide2	Herbicide3	Soil Limitation
6160700033	CADR	20	8	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160700047	CADR	19	13	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160700012	CADR	6	3	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160700065	CEDI3	20	13	Glyphosate			Well Drained
6160700145	PORE5	1	1	Metsulfuron methyl			Well Drained
6160700062	CADR	8	8	Chlorsulfuron	Imazapic	Metsulfuron methyl	Well Drained
6160700010	CEDI3	75	25	Glyphosate			Well Drained
6160700055	CEDI3	9	9	Glyphosate			Well Drained
6160100014	CEDI3	79	11	Glyphosate			Well Drained
6160100058	CEDI3	20	6	Glyphosate			Well Drained
6160100144	HYPE	2	2	Glyphosate			Well Drained