Chapter V: Environmental Consequences

A. Methodology

This section contains the methods / criteria used to assess impacts for specific resource topics. The definitions of impacts adhere to those generally used under the National Environmental Policy Act (NEPA) to describe impacts as well as those used by Section 106 of the National Historic Preservation Act (NHPA) and those used under Section 7 of the Endangered Species Act (ESA).

NEPA requires that environmental documents disclose the environmental impacts of the proposed federal action, reasonable alternatives to that action, and any adverse environmental effects that cannot be avoided should the proposed action be implemented. This section analyzes the environmental impacts of project alternatives on affected park resources. These analyses provide the basis for comparing the effects of the alternatives. NEPA requires consideration of context, intensity and duration of impacts, indirect impacts, cumulative impacts, and measures to mitigate impacts. In addition to determining the environmental consequences of the preferred and other alternatives, *Management Policies* (NPS 2006) and Director's Order-12, *Conservation Planning, Environmental Impact Analysis, and Decision-making* require analysis of potential effects to determine if actions would impair park resources. Impact analysis for historic properties is based on NHPA 36 CFR Part 800 criteria of effect as detailed below.

A. Environmental Impact Analysis

The environmental consequences for each impact topic were defined based on the following information regarding context, type of impact, duration of impact, area of impact and the cumulative context. Unless otherwise stated in the resource section in Environmental Consequences, analysis is based on a qualitative assessment of impacts.

a) Context of Impact

Setting within which impacts are analyzed – such as the project area or region, or for cultural resources – the area of potential effects.

b) Type of Impact

A measure of whether the impact would improve or harm the resource and whether that harm occurs immediately or at some later point in time.

Beneficial: Reduces or improves impact being discussed.
Adverse: Increases or results in impact being discussed.
Direct: Caused by and occurring at the same time and place as the action, including such impacts as animal and plant mortality, damage to cultural resources, etc.
Indirect: Caused by the action, but occurring later in time at another place or to another resource, including changes in species composition, vegetation structure, range of wildlife, offsite erosion or changes in general economic conditions tied to park activities.

c) Duration of Impact

Duration is a measure of the time period over which the effects of an impact persist. The duration of impacts evaluated in this EA may be one of the following:

Short-term: Often quickly reversible and associated with a specific event, one to five years.
Long-term: Reversible over a much longer period, or may occur continuously based on normal activity, or for more than five years.

d) Area of Impact

Localized: Detectable only in the vicinity of the activity.
Widespread: Detectable on a landscape or regional scale.

e) Impact Mitigation

Avoid conducting management activities in an area of the affected resource
Minimize the type, duration or intensity of the impact to an affected resource

Mitigate the impact by:
Repairing localized damage to the affected resource immediately after an adverse impact.
Rehabilitating an affected resource with a combination of additional management activities.
Compensating a major long-term adverse direct impact through additional strategies designed to improve an affected resource to the degree practicable.

f) Intensity Threshold for All Impacts Except Special Status Species and Cultural Resources

Note: Special Status Species and Cultural Resources impact determinations are formally determined under the Endangered Species Act (Section 7) and the National Historic Preservation Act (Section 106), respectively.

Negligible: Measurable or anticipated degree of change would not be detectable or would be only slightly detectable. Localized or at the lowest level of detection.

Minor: Measurable or anticipated degree of change would have a slight effect, causing a slightly noticeable change of approximately less than 20 percent compared to existing conditions, often localized.

Moderate: Measurable or anticipated degree of change is readily apparent and appreciable and would be noticed by most people, with a change likely to be between 21 and 50 percent compared to existing conditions, may be localized or widespread.

Major: Measurable or anticipated degree of change would be substantial, causing a highly noticeable change of approximately greater than 50 percent compared to existing conditions, often widespread.

g) Intensity Threshold for Special Status Species

No Effect: The project (or action) is located outside suitable habitat and there would be no disturbance or other direct or indirect impacts on the species. The action will not affect the listed species or its designated critical habitat (USFWS 1998).

May Affect, Not Likely to Adversely Affect: The project (or action) occurs in suitable habitat or results in indirect impacts on the species, but the effect on the species is likely to be entirely beneficial, discountable, or insignificant. The action may pose effects on listed species or designated critical habitat but given circumstances or mitigation conditions, the effects may be discounted, insignificant, or completely beneficial. Insignificant effects would not result in take. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not 1) be able to meaningfully measure, detect, or evaluate insignificant effects or 2) expect discountable effects to occur (USFWS 1998).

May Affect, Likely to Adversely Affect: The project (or action) would have an adverse effect on a listed species as a result of direct, indirect, interrelated, or interdependent actions. An adverse effect on a listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions and the effect is not: discountable, insignificant, or beneficial (USFWS 1998).

h) Intensity Threshold for Cultural Resources Impacts

Note: Cultural resources impacts are also initially characterized as noted above, however the conclusion follows the format below, and makes a formal determination of effect under Section 106 of the National Historic Preservation Act. In accordance with *Management Policies* (NPS 2006), the analysis in this EA fulfills the responsibilities of the NPS under Section 106 of the National Historic Preservation Act.

No effect: There are no historic properties in the Area of Potential Effect (APE); or, there are historic properties in the APE, but the undertaking will have no impact on them.

No adverse effect: There will be an effect on the historic property by the undertaking, but the effect does not meet the criteria in 36 CFR Part 800.5(a)(1) and will not alter characteristics that make it eligible for listing on the National Register. The undertaking is modified or conditions are imposed to avoid or minimize adverse effects. This category of effects is encumbered with effects that may be considered beneficial under NEPA, such as restoration, stabilization, rehabilitation, and preservation projects. Under the terms of the 1999 PA, data recovery can mitigate affect to archeological properties that are eligible for listing on the NR under criterion d. However, some archeological sites are eligible as traditional cultural places under criterion A, and such mitigation may not be sufficient or appropriate.

Adverse effect: The undertaking will alter, directly or indirectly, the characteristics of the property making it eligible for listing on the National Register. An adverse effect may be resolved in accordance with the Stipulation VIII of 1999 Programmatic Agreement, or by developing a memorandum or program agreement in consultation with the SHPO, ACHP, American Indian tribes, other consulting parties, and the public to avoid, minimize, or mitigate the adverse effects (36 CFR Part 800.6(a)).

Significant Impact: An impact to a National Register historic property would be considered significant when an adverse effect cannot be resolved by agreement among SHPO, ACHP, American Indian tribes, other consulting and interested parties, and the public. The impact will diminish the integrity of location, design, setting, materials, workmanship, feeling or association characteristics that make the historic property eligible for inclusion in the National Register Historic Places. The resolution must be documented in a memorandum or programmatic agreement or the FONSI.

i) Cumulative Impacts

Cumulative impacts are the effects on the environment that would result from the incremental impacts of the action when added to other past, present and reasonably foreseeable future actions.

The Council on Environmental Quality (CEQ) describes a cumulative impact as follows (Regulation 1508.7):

> A "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative projects addressed in this analysis include past and present actions, as well as any planning or development activity currently being implemented or planned for implementation in the reasonably foreseeable future. Cumulative actions are evaluated in conjunction with the impacts of an alternative to determine if they have any additive effects on a particular resource. Because most of the cumulative projects are in the early planning stages, the evaluation of cumulative impacts was based on a general description of the project. Ongoing or reasonably foreseeable future projects were identified for the 10 parks and, where previously identified by the parks, for the surrounding region. The geographic scope for this analysis includes actions within the boundaries of the 10 parks for most resources, however because impacts within the parks are affected by regional boundaries for some resources topics (such as air quality, wildlife and special status species) the region is used as the reference area for these impact analyses. Because this implementation plan would likely be in use for a period of approximately 10 years, the temporal scope of the cumulative impacts analysis includes known projects within that range as have been identified in the NPS Park Planning website (PEPC). Therefore the following projects are included in the cumulative effects analysis presented in Chapter V: *Environmental Consequences* of this document.

Projects Included in the Cumulative Effects Analysis for the Invasive Plant Management Plan

- *Nonnative Invasive Plant Management on Adjacent Lands Conducted by Other Federal Agencies (All Parks) (Ongoing)*

Most of the parks are bordered by adjacent federal lands, where nonnative invasive species management is conducted.

- *Nonnative Invasive Plant Management on Adjacent Lands Conducted by Private Landowners (All Parks) (Ongoing)*

Many of the parks are bordered by or contain private lands, where private landowners are required to treat nonnative invasive species on county and state lists.

- *City of Rocks General Management Plan (Proposed)*

This general management plan would update and revise the 1996 Comprehensive Management Plan. GMPs are intended to guide park management operations for 15-20 years.

- *Circle Creek Overlook Parking Lot Relocation (City of Rocks) (FONSI 2010)*

The purpose of this project is to remove the existing parking area from the viewshed of the California National Historic Trail and therefore to improve the cultural landscape. The project is also intended to solve safety issues associated with traffic flow and resource impacts on vegetation.

- *City of Rocks Grazing Management Plan (Proposed)*

This proposed revision to the grazing management plan identifies the appropriate levels and types of grazing uses, the impacts associated with these uses, and the levels and kinds of mitigating management actions necessary to ensure long-term protection of park resources and values.

- *Entrance Sign Replacement (Craters of the Moon) (FONSI 2008)*

The purpose of the proposed project was to identify and mark the expanded boundary of Craters of the Moon National Monument and Preserve (Monument) for travelers along U.S. Highway 20/26/93 and to allow visitors the opportunity to take a scenic photograph from either the west (near Carey) or east (near Arco) boundary of this unit.

- *Construct Accessible Trail from Visitor Center to Lava Campground (Craters of the Moon) (2010)*

This project improved pedestrian visitor access from the visitor center to Lava Campground.

- *Install Solar Photovoltaic System (Craters of the Moon) (2010) (Completed)*

This project is likely to produce approximately 60 percent of the monument's energy needs.

- *Resurface and Improve Park Spur Roads and Parking Areas (Completed)*

This project expanded and improved the roads and parking areas off the Loop Road within the monument.

- *Improve Accessibility of North Crater Flow Trail (Craters of the Moon) (Proposed)*

The proposed rehabilitation of the North Crater Flow Trail would improve accessibility and interpretive and educational features for visitors.

- *Rehabilitate Lava Campground (Craters of the Moon) (Proposed)*

The proposed rehabilitation would improve accessibility at the campground, decrease long-term maintenance needs and better accommodate visitor use.

- *Cundick Spring Water System Upgrade (Fossil Butte) (2010) (Completed)*

This project improved the water distribution system from Cundick Spring for BLM and park use and decreased resource degradation in the vicinity of the spring.

- *Picnic Area and Picnic Area Water System Rehabilitation (Fossil Butte) (2006)*

This project improved the picnic area water system and upgraded picnic facilities to better accommodate visitor use.

- *Golden Spike General Management Plan (Proposed)*

This general management plan would update and revise the 1976 General Management Plan. GMPs are intended to guide park management operations for 15-20 years.

- *Cheatgrass Resource Study (Golden Spike) (Proposed)*

This project is being conducted by Utah State University to study the effects of climate change on cheatgrass.

- *Grant-Kohrs Foundation for Management) (Proposed)*

This statement improved the park's description of its purpose in preparation to supplement the GMP.

- *Superfund Site (Grant-Kohrs) (Proposed)*

The Clark Fork River and its flood plain along the length of the park is designated as a Superfund site due to upstream mining and smelting and a 1908 flood that deposited heavy metals onto the landscape. The 2004 Record of Decision calls for prescribed remediation of Grant-Kohrs Ranch lands with additional opportunities and funding for reclamation. Heavily contaminated soils in areas with no vegetation (perhaps as much as 26 acres) will be removed and replaced with similar healthy soils; other less impacted areas (as indicated by limited vegetation) will have in-situ treatment of lime to neutralize pH to facilitate vegetation growth, lastly revegetation and bank stabilization would be used to complete treatment. Specific designs for the ranch are proposed. It is likely that remediation and restoration will begin around 2015.

- *Paleontological Research Center (Hagerman Fossil Beds)*

This project resulted in creation of a monument paleontological research center.

- *Fire Recovery (Hagerman Fossil Beds) (Ongoing)*

A large fire occurred at the monument in summer 2010. Post-fire recovery efforts include reseeding of native plants and treatment of burned areas to prevent nonnative invasive plant establishment.

- *Construction / Replacement of 12 Miles of Boundary Fence (Hagerman Fossil Beds) (2010) (Completed)*

Under this project boundary fence was constructed or replaced to improve resource protection by preventing trespass livestock.

- *Carnivore Cove Amphitheater Construction (2008) (Completed)*

Under this project an amphitheater was constructed at the Oregon Trail Overlook in the monument.

- *Lower Salmon Falls Hydroelectric Project (Hagerman Fossil Beds) (Ongoing)*

The Snake River is impounded approximately one-half mile downstream of the northern boundary of Hagerman Fossil Beds by the Lower Salmon Falls Dam. Normal maximum surface elevation of the reservoir is 2798 feet, while minimum surface elevation is 2792 feet, making periodic fluctuations of 2-3 feet typical, and up to six feet on occasion. Raytheon (1995) identified 44 shoreline erosion and landslide sites. No data collection monitoring program is in place to document impacts to Hagerman Fossil Beds resources. The lower Salmon Falls Dam project is licensed by the Federal Energy Regulatory Commission (FERC). Idaho Power filed an application for a new license in 1995. Fluctuating water levels from the dam would continue to facilitate or impede invasive species at Hagerman Fossil Beds(NPS HAFO 2003:13).

- *Bell Rapids Mutual Irrigation Company Project (Hagerman Fossil Beds) (Ongoing)*

Irrigation water from the Snake River is pumped to fields west of the monument. Approximately 10 acres within the monument are used for pumping stations and pipelines. Water is pumped via high-lift stations from the Lower Salmon Falls Reservoir some 600 feet up the bluffs to the plateau and then distributed through mostly unlined canals. When the irrigation project began, there were two pump systems. However, a landslide destroyed the Bell Rapids 'south' pump station and pipeline in 1987. During the 1987 irrigation season, the Fossil Gulch canal carried larger volumes of water in response to the non-usable Bell Rapids canal so lateral line aqueducts could transfer water to the areas previously supplied by the Bell Rapids canal. Hagerman Fossil Beds was affected by landslides and tamarisk invasion from bluff discharge of groundwater until recently, when discharge was modified to prevent impacts to the fossil beds. Water is still transferred to the western portion of the Bell Rapids canal from the Fossil Gulch canal via an underground pipe.

- *Vegetation Composition, Structure and Soils Monitoring (Little Bighorn) (Ongoing)*

The purpose of this NPS long-term project is to determine the status and trends of vegetation structure (such as the presence of bunchgrasses vs. rhizomatous grasses vs. shrubs) and that status of soil and presence of invasive plants related to vegetation structure.

- *Restore Historic Viewshed (Quonset Site) (Little Bighorn) (Completed)*

Removal of non-historic items, staging area and unpaved road occurred to improve the viewshed and to restore a prairie and riparian area along the Little Bighorn River.

- *Restore Cultural and Natural Landscape (Ongoing)*

To preserve the natural and vegetative resources of Little Bighorn, this project would eliminate various noxious weeds throughout the park, especially along the tour road, and the Deep Ravine trail, which receive heavy visitor use traffic.

- *Trail and Perimeter Fence Construction (FONSI proposed Fall 2010/2011) (Minidoka) (Proposed)*

This proposed project calls for the construction of a trail to allow visitors to experience more of the park and perimeter fence construction in an historic location to show the site boundary.

- *Reconstruction of Block 22 Barracks and Mess Hall (Minidoka) (Proposed)*

Under this proposal, historically verified structures would be relocated to the Block 22 area and used to interpret the internee experience at the Relocation Center.

- *Acquisition of the Farm-in-a-Day Property (Herrman Homestead) (Minidoka) (Proposed)*

Under this proposal, the Herrman property would be acquired and the Farm-in-a-Day house, which has lost integrity on the interior, would be adaptively reused for park administrative functions but would retain its historic exterior.

- *Acquisition of the Robison Property (Military Police Housing Area) (Minidoka) (Proposed)*

Under this proposal, the Robison Property would be acquired and would become a potential future location for visitor parking, among other functions.

- *Construction of the Issei Memorial (Minidoka) (Proposed)*

Under this proposal, the Friends of Minidoka would seek and obtain funding for construction of a memorial to the Japanese elders interred at Minidoka. The proposed location overlooks the North Side Canal south of Hunt Road east of the current warehouse area / root cellar.

- *Reconstruction of the Entrance Guard Tower and Parking Area Modifications (Minidoka) (Proposed)*

Under this proposal, a park entrance sign would be located off Hunt Road and improvements would be made to the existing parking area near the stone structures to accommodate Guard Tower reconstruction and to rehabilitate the entrance area by removing non-historic features.

- *Adaptive Reuse of the Warehouse for a Visitor Contact Facility (Minidoka) (Proposed)*

Under this proposal, Warehouse Building #6 would become a visitor contact facility and parking, circulation and trail connections would be designated.

- *Reconstruction of the former Entrance Road for Visitor Access to the Site (Minidoka) (Proposed)*

Under this proposal, the former entry road to the site would parallel the proposed trail through the Administrative / Central Staff Housing Area to the proposed visitor contact facility.

- *Vault Toilet Rehabilitation (Bear Paw Battlefield) (Completed)*

This project improved the vault toilet in the Battlefield parking area.

- *Picnic Shelter and Wind Screen Rehabilitation (Bear Paw Battlefield) (Completed)*

This project rehabilitated the picnic shelter and wind screen in the Battlefield parking area.

- *Visitor Information Center (Bear Paw Battlefield) (Proposed)*

Under this proposal a new visitor information structure would be located and either rehabilitated or constructed.

- *Transplant Native Vegetation from Roadsides for Use in Revegetation / Restoration (Big Hole) (Completed)*

This project called for removal of native plants growing the road shoulder to be transplanted elsewhere in the park, rather than just to be removed.

- *Remove Vegetation from Canal #3 (Big Hole) (Completed)*

Under this project overgrown vegetation (including nonnative invasive species) was removed from Canal #3.

- *Big Hole National Battlefield Irrigation Canal Rehabilitation (Completed)*

This project reduced canal leakage by lining two irrigation canals. The leakage altered the historic viewshed, a important component of the cultural landscape, by promoting the growth and spread of vegetation along the canal corridors. The encroachment of these plants replaced native grassland that was present at the time of the 1877 Battle of the Big Hole. By reducing canal leakage, the encroachment of these species was discouraged and the growth of native grass which dominated the landscape at the time of the 1877 battle was encouraged.

j) Impairment

In addition to determining the environmental consequences of the preferred and other alternatives, NPS *Management Policies* (NPS 2006) and Director's Order-12, Conservation Planning, Environmental Impact Analysis, and Decision-making, require analysis of potential effects to determine if actions would impair park resources. The following sections from *Management Policies* define impairment and highlight the difference between an impact and impairment.

1.4.3 The NPS Obligation to Conserve and Provide for Enjoyment of Park Resources and Values

> The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. This mandate is independent of the separate prohibition on impairment and applies all the time with respect to all park resources and values, even when there is no risk that any park resources or values may be impaired. NPS managers must always seek ways to avoid, or

to minimize to the greatest extent practicable, adverse impacts on park resources and values. The laws do give the Service the management discretion, however, to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impact does not constitute impairment of the affected resources and values.

The fundamental purpose of all parks also includes providing for the enjoyment of park resources and values by the people of the United States. The enjoyment that is contemplated by the statute is broad; it is the enjoyment of all the people of the United States and includes enjoyment both by people who visit parks and by those who appreciate them from afar. It also includes deriving benefit (including scientific knowledge) and inspiration from parks, as well as other forms of enjoyment and inspiration. Congress, recognizing that the enjoyment by future generations of the national parks can be ensured only if the superb quality of park resources and values is left unimpaired, has provided that when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant. This is how courts have consistently interpreted the Organic Act.

1.4.4 The Prohibition on Impairment of Park Resources and Values

While Congress has given the Service the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally enforceable by the federal courts) that the Park Service must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the NPS. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities for enjoyment of them.

The impairment of park resources and values may not be allowed by the Service unless directly and specifically provided for by legislation or by the proclamation establishing the park. The relevant legislation or proclamation must provide explicitly (not by implication or inference) for the activity, in terms that keep the Service from having the authority to manage the activity so as to avoid the impairment.

1.4.5 What Constitutes Impairment of Park Resources and Values

The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact to any park resource or value may, but does not necessarily, constitute an impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, or
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or
- identified in the park's GMP or other relevant NPS planning documents as being of significance.

An impact would be less likely to constitute an impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated. An impact that may, but would not necessarily, lead to impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park. . .

1.4.6 What Constitutes Park Resources and Values

The "park resources and values" that are subject to the no-impairment standard include: the park's scenery, natural and historic objects, and wildlife, and the processes and conditions that sustain them, including, to the extent present in the park: the ecological, biological, and physical processes that created the park and continue to act upon it; scenic features; natural visibility, both in daytime and at night; natural landscapes; natural soundscapes and smells; water and air resources; soils; geological resources; paleontological resources; archeological resources; cultural landscapes; ethnographic resources; historic and prehistoric sites, structures, and objects; museum collections; and native plants and animals;

appropriate opportunities to experience enjoyment of the above resources, to the extent that can be done without impairing them;

the park's role in contributing to the national dignity, the high public value and integrity, and the superlative environmental quality of the national park system, and the benefit and inspiration provided to the American people by the national park system; and

any additional attributes encompassed by the specific values and purposes for which the park was established.

1.4.7 Decision-making Requirements to Identify and Avoid Impairments

Before approving a proposed action that could lead to an impairment of park resources and values, an NPS decision-maker must consider the impacts of the proposed action and determine, in writing, that the activity will not lead to an impairment of park resources and values. If there would be an impairment, the action must not be approved.

In this EA determinations of impairment are provided in the conclusion section under each applicable resource topic for each alternative. Impairment determinations, however, are not made for health and safety, visitor use, maintenance, operations, socio-economic resources and other non-natural or cultural resources topics.

k) Mitigation Measures Incorporated into the Action Alternatives

The measures found in Appendix K which are also listed under each resource section in *Environmental Consequences* have been developed to lessen the potential adverse effects of the action alternatives.

B. Analysis of Impacts

Potential impacts of invasive plant management actions are described for physical, biological, cultural, and recreation/social resources topics (e.g. air quality, vegetation, archeological resources, visitor experience, etc.) listed below. Under each resource topic, impacts are generally assessed in the following order (where applicable): manual / mechanical treatments; cultural treatments; herbicide treatments; biological control treatments; and prescribed fire treatments.

C. Physical Resources Impacts

1. Air Quality Impacts

Alternative 1 Impacts

Air quality impacts from manual / mechanical, cultural, chemical, biological control and prescribed fire would be generated from:

- Particulate (dust and ash) emissions from earth disturbing activities (including pulling and digging, tilling and prescribed fire),

- Exhaust emissions (from transportation and use of motorized equipment), and from
- Evaporative emissions (from herbicide spraying or painting, from the use of herbivores in some parks, and burning of organic compounds in vegetation).

Among the activities that would generate particulate emissions would be: hand-pulling or digging, driving vehicles over unpaved roads, mowing in dry areas, and smoke from prescribed fires, as well as negligible impacts from foot traffic to access sites. Exhaust emissions would be generated by the use of gasoline or diesel powered mechanical equipment, including chainsaws, motor vehicles (such as trucks and OHVs), mowers, and aircraft used for surveys or widespread treatment of weeds.

Air quality impacts from manual / mechanical and/or cultural treatments would include temporary increases in fugitive dust from vehicles, increases in emissions from vehicle exhaust and equipment, and temporary increases in fugitive dust from soil disturbing activities. Most impacts would be negligible to minor, would quickly disperse, and would not be detectable outside the treatment area.

There would also be negligible effects from stump painting pesticide use techniques and minor to moderate localized adverse effects from target directed hand spraying of pesticides. Infrequent aerial spraying of limited areas, as at Grant-Kohrs in the past, could have minor to moderate adverse effects, depending on weather conditions and the type of equipment used. Where spraying activities impacted many acres and took place over a short-period of time, impacts would be moderate but would remain localized. Although indirect impacts could occur on breezy days, pesticide label requirements would limit application during these times. Therefore, limited dispersion (negligible to minor impacts) by wind would occur because herbicides would be applied in accordance with label specifications and application of sprayed chemicals would therefore be avoided on windy days. Limited pesticide drift could also occur with pelletized dry applications, depending on weather conditions. Although some volatization (evaporative) emissions of pesticides would occur as sprayed chemicals dried or pelletized chemicals were absorbed, these would be minor because of primarily ongoing hand treatment of small areas. Most pesticides have low volatility. Those that have higher volatility are used in low concentrations. Among those herbicides that would likely be used, evaporative emissions is considered low from applications of currently used herbicides (Table 37: *Environmental Effects of Current and Proposed Herbicides*).

No known changes in air quality would occur from most biological control treatments. Use of small numbers of livestock at Grant-Kohrs Ranch, however would continue to result in negligible to minor, localized methane and other chemical emissions from digestion and from decomposition of excrement. Use of livestock would also continue to have negligible to minor particulate and exhaust emissions at Grant-Kohrs Ranch as the animals were moved to different grazing areas or encountered dusty conditions in pastures.

There would be limited effects from the use of prescribed fire, since most parks do not have FMPs that would allow for the use of prescribed fire to treat non-native plants. There would be no effects on air quality from the use of prescribed fire at City of Rocks, Craters of the Moon, Hagerman Fossil Beds, Minidoka, Little Bighorn or Nez Perce (Big Hole or Bear Paw). At Fossil Butte, Golden Spike, and Grant-Kohrs, where prescribed fire has been used in a limited way to treat invasive plants or is allowed for by the park's current Fire Management Plan, there would be short-term localized to widespread minor to moderate adverse impacts from smoke. Generally, most fires would be small and would be conducted in accordance with specific prescriptions that would favor smoke dispersal. Effects would include temporary increases in particulates and other combustion by-products and reduced visibility of scenic vistas from smoke.

Smoke from wildfires and prescribed burning is a complex mixture of carbon, tars, liquids, and gases. The major pollutants are particulates, volatile organic compounds (VOCs), and carbon monoxide (CO). Other pollutants, such as oxides of nitrogen (NO_x), SO_2 and mercury are also produced, but in a relatively small quantity when compared to other pollutants. Particulates can remain suspended in the atmosphere for a few days to several months, and can reduce visibility as well as contribute to respiratory problems. Very small particulates can travel great distances and add to regional haze problems. Regional haze can also result from multiple burn days and/or multiple owners burning within an airshed over too short a period of time to allow for dispersion.

Conducting prescribed fires to meet nonnative plant management resource objectives would result in an additional minor to moderate degree of air quality impacts, including particulate emissions and diminished visibility. Impacts would be localized and would be limited in scope and effect. Fires that did not meet prescriptions would not be ignited or would be suppressed. Each fire would be managed within a predetermined area and, as a result, would be relatively small. Most would be conducted as either research burns to achieve specific resource objectives (for instance to remove fine fuels in a specific community to stimulate natural regeneration of native plants) or as actions to decrease the density of nonnative plants not tolerant of fire. Upon development and peer review, park prescribed fire plans would undergo additional environmental analysis.

If a wildland fire occurred shortly after nonnative plants were treated with herbicides, indirect effects from combustion of treated vegetation would vary. Some pesticides would have been immediately broken down or would be within unburned soil, whereas others could generate volatile byproducts. Based on risk analysis profiles of pesticides that have been used, there are no known combustion products that would cause other than minor to moderate localized adverse effects if burned. In addition, because treatment areas have generally been fairly small, the potential for releases would also be small.

Alternative 2 Impacts
Impacts from Alternative 1 would continue. In addition, there would be minor to moderate localized adverse impacts in some parks from expanded treatment of invasive plants, such as from potential aerial spraying at Craters of the Moon or from the use of prescribed fire at parks that have not previously used this technique to treat invasive plants, such as Little Bighorn. As a result, treated areas could increase in some parks.

Because there has generally been both an increase in the number of weeds and the area they cover over time in many areas, impacts associated with their treatment would also continue to increase. Over time, however, the systematic analysis of high priority weeds and the comprehensive program associated with weed treatment in this alternative would likely begin to reduce the number of acres and therefore the disturbance associated with treating them, including effects on air quality. In addition, there would be long-term beneficial effects on reducing impacts to air quality from more systematic implementation of mitigation measures.

Impact Avoidance, Minimization or Mitigation Measures
In addition to measures noted in Chapter III: *Alternatives*, the following measures would also be included (as appropriate to the alternative actions) to minimize impacts to air quality:

- Because pesticide use requires approval from Regional and/or National IPM Coordinators, pesticides used would continue to be of low toxicity.
- Chain saws would be properly maintained, and would use low-smoke non-petroleum oil.

Additional Measures for Use of Prescribed Fire:

- There would be limits on the number of acres and amount of fuel burned as noted in prescribed fire plans.
- The timing and method of ignition would be selected to limit effects on air quality.
- Burning during optimal fuel moisture conditions would limit effects on air quality.
- Use of prescribed fire would include increased communication, cooperation and coordination with adjacent agencies and landowners to limit the number of fires occurring simultaneously.
- Prescribed fire plans would be developed for each prescribed fire. Appropriate signing would be posted if smoke would affect roadways or designated visitor areas (such as visitor centers or

campgrounds) and the appropriate authorities would be contacted regarding other measures to limit smoke or decreased visibility.

Cumulative Impacts: Over time, in the regions affected by the parks, human impacts such as the development of roads, businesses and housing have contributed to increasing vehicle travel to obtain goods and services and to access recreational experiences. In Idaho, Montana, Utah, and Wyoming, as elsewhere, population increases have resulted in dramatic increases in the number of vehicle miles traveled and in other widespread air pollution impacts. With passage of federal and some state clean air acts, emissions controls have been implemented on stationary and mobile sources of air quality degradation. Some states have been proactive in establishing vehicle emissions standards for urban areas and for some industries. Over time, these standards have resulted in moderating the effects of increasing populations and industries.

In Alternatives 1 and 2, there would be short-term impacts from manual/mechanical treatments, use of vehicles for transportation and access to sites, and use of motorized equipment for treatment that would continue to cause localized negligible to minor short-term adverse effects, but would not contribute to cumulative adverse effects on air quality. Use of pesticides would also result in short-term negligible to minor localized adverse effects. Where aerial spraying was employed, these effects could occur over a wider area, but based on the limited extent to which it would be used in the parks, aerial spraying would have short-term minor cumulative effects on air quality. Decades of fire suppression have resulted in minimal air quality emissions in the parks related to fire. The limited use of prescribed fire could result in short periods of diminished visibility and air quality but would not result in long-term cumulative impacts because pollutants would disperse readily with ambient mass air movement. When added to impacts from past, present and future projects at the parks, such as rehabilitation of the Circle Creek Overlook at City of Rocks, rehabilitation of roads and parking areas at Craters of the Moon and Little Bighorn, and construction or rehabilitation of a visitor facility at Bear Paw, there would be minor cumulative adverse impacts to air quality. Impacts from treatment of invasive plants would contribute negligible cumulative adverse impacts to air quality. Cumulative beneficial impacts would occur from the installation of a photovoltaic system at Craters of the Moon.

Conclusion: Impacts on air quality associated with Alternatives 1 and 2 would be short-term and negligible to moderate. No long-term sources of air quality degradation are proposed in the alternatives. Because impacts would be short-term and negligible to moderate, there would be no impairment of air quality or air quality values.

2. Geology / Soils Impacts

Alternative 1 Impacts

There would be negligible to minor adverse effects on soils and negligible effects on geology from compaction related to motor vehicle or foot access to treatment sites, surface disturbing activities such as manual / mechanical treatment (including hand-pulling or digging, tilling), cultural treatments (planting, or using a drill seeder, or other heavy equipment for reseeding large areas for restoration), use of herbicides, use of herbivores as biological control agents, and/or from use of prescribed fire

Access to sites on foot or by using motor vehicles could result in minor to moderate localized adverse effects on soils from compaction, trampling of vegetation, and potential loss of plant cover from repeated access, especially by motor vehicles. Although it is possible that heavy equipment or motorized vehicle use could affect sensitive soils or geologic sites, initial surveys of proposed treatment areas would continue to take these potential consequences into account and would continue to avoid such use in these areas. Methods used to access sites would, however, continue to be considered and if necessary the method of access would be modified to limit potential moderate adverse effects. Overall impacts would be minor to moderate and short term depending on the frequency. Impacts would be adverse and long-term if sites are accessed when soils are wet. (This compacts soils, changes drainage patterns, and more easily damages plants.) To avoid long-term adverse impacts, traveling to sites when soils are wet would be avoided, if possible.

Manual and mechanical treatments would cause negligible to minor short-term localized adverse effects on geology and soils. Effects could include disturbance of the upper layers of soil during hand-pulling, digging plants up by the roots. If the soils were wet or very dry, impacts would be greater and could cause indirect effects nearby, such as changes in soil surface conditions from access depressions or from future windblown loss of soils.

Cultural treatments, including tilling (where it is employed) and restoration (reseeding, planting or scarification to decrease compaction) would cause negligible to moderate short-term adverse effects on soils and geology. Restoration could also be unsuccessful, temporarily leaving areas of bare ground that could result in soil erosion, a short-term localized minor adverse effect.

Herbicide impacts on soils vary depending on three soil characteristics: percent organic matter, available water capacity, and soil permeability. When incorporated into the soil, part of the herbicide dissolves in the soil water and part is adsorbed onto soil particles (primarily organic matter). The amount of herbicide adsorbed onto soil particles depends on the characteristics of the chemical and on the amount of organic matter and fine material in the soil (see Table 37: *Environmental Effects of Current and Proposed Herbicides*). Herbicide that remains in water in the soil is available for uptake by plant roots. If the water moves off-site or out of the rooting zone, however, it takes some of the dissolved herbicide with it. Depending on the distance of travel, the concentration of the herbicide, and type of herbicide used, this herbicide movement may affect other susceptible plants and other organisms (USDA-USFS 1996 in NPS DINO 2005:D-52).

All herbicides dissolve to some extent in water and can be absorbed fairly readily from soil moisture when susceptible plants are present and actively growing. Some of these herbicides can also move as water leaches through the soil. Soil permeability and water-holding capacity determine how much water moves through the soil into groundwater or in surface water after rainfall. If the soil retains a large quantity of water in its upper horizons for later use by plants, the water and dissolved herbicide would have little opportunity to move into groundwater, riparian areas, and other non-target locations. In contrast, if soil is highly permeable and has little water-holding capacity, water passes through the soil rapidly and could carry some of the herbicide with it potentially contaminating groundwater and other non-target areas (USDA-USFS 1996 in NPS DINO 2005:D-52).

Herbicide use can discolor geologic resources from overspray of herbicide mixtures containing marker dyes; however these effects would likely be negligible to minor due to targeted treatment methods.

For those herbicides that may also persist in soils, Table 37: *Environmental Effects of Current and Proposed Herbicides* shows the length of time herbicides are active in soil where this information is available. Most dissipate within few days to a few weeks, with minor indirect adverse effects. Some last longer and affect plants the next season and may have moderate indirect adverse effects away from target plants and areas. Coarse to medium-textured soils are less likely to retain herbicides, while medium and fine-textured soils with higher organic matter content have a greater potential to retain herbicides (NPS NGP EA 2005:4-21). Most herbicides used would have limited toxicity and potential for soil persistence. For example 2,4-D persists for up to 30 days, while the half-life of other herbicides varies from 3-120 days (glyphosate products) to 15-287 days (clopyralid products), 46 days (triclopyr products), with several around 120 days (metsulfuron methyl 30-180 days, imazapic 120-140 days, etc.) and are as high as 1,000 days. Some currently used herbicides continue to be absorbed by plants through soil after initial application and may persist from one week to two years in soil, a short-term moderate indirect adverse effect. Where effective, herbicides with a shorter half-life would be selected.

Although accidental spills of herbicides could occur and affect soils, spill response equipment is required to be on site associated with herbicide use, therefore potential effects would likely be short-term and minor to moderate and localized, depending on the amount of the spill, the area affected, soil type, and type of chemical. Licensed applicators (required by all states in parks affected by this plan) are aware of procedures for clean-up of herbicides, which would reduce response time and decrease potential impacts. In addition, having the right equipment and training available could also improve response time and reduce impacts.

Biological control (the use of insects or pathogens) would continue to have no effect, or negligible to minor short- to long-term effects on soils and no effect on geology. Minor effects are possible due to an increase in the release of allelochemicals into soils by some plants, such as spotted knapweed (*Centaurea stoebe*) when attacked by some biological control agents (Callaway *et al.* 1999). Increased levels of allelochemicals in soils may reduce the growth of desirable species that are susceptible to them. The use of herbivores at Grant-Kohrs could also result in potential effects from trampling which could cause loss of vegetation, thereby affecting soil erosion in some small areas. Currently used areas, however, are not comprised of sensitive soils or geologic resources and effects would be negligible to minor.

Prescribed fires would have no effect at parks that do not use this treatment as an invasive plant management tool. At parks that would employ prescribed fire, its use could result in deposits of carbon, blackening rock and soil surfaces. Because these impacts would primarily occur in heavily vegetated, rather than sparsely vegetated rocky areas, effects would likely be short-term localized and minor. Other potential effects related to fire would include mechanical disturbance related to the use of heavy equipment from fire fighting or clean-up. In accordance with fire management planning, such use would not be approved in areas with sensitive resources and as a result would be anticipated to have negligible to minor adverse effects. Loss of vegetation from fire could also cause short-term negligible to moderate localized decreases in infiltration rates and increases in water runoff from soils, affecting erosion and sedimentation rates. Prescribed fires would also have a variety of long-term beneficial effects on soils, including from an increase in nutrient availability for plants and an overall increase in soil productivity.

Fires may cause changes in organic horizons, water repellency, infiltration capacity, porosity, structure, temperature, hydrologic properties, and may increase or decrease erosion. Depending on the slope, fire may increase the potential for accelerating erosion through its effects on vegetation, organic matter, and the physical properties (including limiting water infiltration) of the soil. In the absence of vegetative cover, dry raveling can also increase on steep slopes after fire.

Burning wood hydrocarbons, which diffuse both up in smoke and down through the soil, may cause water repellant soils. Hydrocarbons moving down sometimes coat soil particles with wax, causing them to repel water. In combination, these can create limited opportunities for plant growth. Changes in soil composition are usually the result of the volatilization of elements during combustion of fuel and organic matter. Nutrients in the soil are also lost as ash via air currents, convection or as a result of leaching through the soil.

Fires also change the cycling of nutrients and the physical and biotic characteristics of soils. The magnitude and longevity of these effects depends on many factors including fire regime, fire severity, vegetation type, soil type, topography, season, and pre- and post-fire weather conditions. Fire effects may also cause indirect effects, including changes in soil microorganisms and erosion rates. There would be a short to long-term benefit to soil nutrient reserves by the release of nutrients to ash deposited during fires, resulting in increased natural fertilization of the soil and attendant increases in soil capacity to grow vegetation. The added organic material would work in combination with dead and dying root systems to make the soil more porous, better able to retain water, and less compact, while increasing needed surface area for essential microorganisms, mycorrhizae and roots (Vogl 1979, Wright and Bailey 1980).

Alternative 2 Impacts

Impacts noted in Alternative 1 would continue. In addition, the comprehensive program of identification and treatment of nonnative invasive plants in Alternative 2 would initially result in a different array of impacts, targeting plants that may or may not have been treated as effectively beforehand. Because there would be more systematic identification of nonnative invasive species through the early detection and rapid response protocol and because the most invasive species would likely be treated as a high priority, there would be fewer opportunities for nonnative invasive plants to attain a strong dominance and therefore overall fewer impacts on soils from nonnative plant characteristics such as from changes in nutrient characteristics or allelopathy, and fewer impacts related to their removal once established. Over the long-term, there would be beneficial effects on soil from removing nonnative invasive plants and restoring native plant cover. For example, studies have shown that sites dominated by spotted knapweed display substantially higher surface water runoff and stream sediment yield than comparable sites dominated by native perennial bunchgrasses (Lacey *et al.* 1989 in BLM 2007a). Cheatgrass dominance and the associated increase in fires also reduce biological soil crusts, which affect nutrient cycling, water infiltration, and potential soil erosion (Belnap *et al.* 2001 in BLM 2007a).

There would be long-term beneficial effects on soils from using alternate methods to treat invasive plants, such as a wider variety of insect biological control. Where insects were used for biological control, there would be no effect on soils.

More systematic analysis of the right treatment methods with the fewest impacts in this alternative would result in additional beneficial impacts. Efforts would likely become more effective and efficient, thereby meaning fewer return visits for retreatment. Retreatment would require smaller crews, therefore decreasing effects from access, such as compaction. Where insects were used for biological control, the impact would be the same as described in Alternative 1. Thorough analysis would be used to determine whether herbicide use or mechanical treatment would be most effective, therefore avoiding excess use of chemicals or soil disturbance. Presumed increases in the reduction in, or removal of, nonnative invasive plants in Alternative 2 would also result in long-term beneficial effects on native soil microorganisms, soil chemistry and hydrologic conditions.

Impact Avoidance, Minimization or Mitigation Measures
In addition to measures noted in Chapter III: *Alternatives*, the following measures would also be included (as appropriate to the alternative actions) to minimize impacts to geology/soils:

- Soils would be protected from accelerated or unnatural erosion from and after ground-disturbing activities, especially associated with prescribed fire and removal of nonnative invasive plant cover. For example, post-fire stabilization efforts would protect erosion-prone soils through natural and assisted revegetation.
- Equipment and vehicles would use existing roads and trails to the maximum extent possible.
- OHVs would be transported by trailer where possible and would avoid unnecessary cross-country travel. Where cross-country travel was permitted, existing pathways and routes that would cause little or no damage would be selected.
- Staff and equipment would avoid areas having sensitive soils, soils prone to erosion or compaction, or saturated soils during treatment of invasive plants.

Cumulative Impacts: Past projects, including construction, restoration and landscape modification at the parks and treatment of nonnative invasive plants by adjacent federal and private landowners have resulted in a wide array of impacts to soils and geology, including loss of soil, covering of soil with impermeable surfacing, such as buildings and pavement, excavation of soil for building foundations and other structures, and loss of soil and geologic features associated with road construction and other development. Future adverse impacts to geology and soils would continue to occur from construction and rehabilitation projects in the parks. When added to impacts from past, present and future projects at the parks, such as nonnative invasive plant treatment occurring outside the parks, construction of accessible trails at Craters of the Moon and Minidoka, constructing or rehabilitating boundary fence at Hagerman, and transplanting native plants from roadsides at Big Hole, there would be cumulative minor to moderate localized adverse impacts to soils under Alternatives 1 and 2. Impacts to soils from removal of nonnative invasive plants would continue to contribute negligible to minor adverse cumulative and long-term beneficial effects to soils.

Conclusion: Alternatives 1 and 2 would continue to have negligible to moderate adverse and long-term beneficial impacts to soils and negligible to minor adverse impacts to geology. There would be no impairment of soils or geological resources or values.

Table 37: Environmental Effects of *Current* and Proposed Herbicides

Updated from Table II-6 (NPS NGP EA 2005). Note: Currently used herbicides are bold italic and proposed herbicides are bold underline.

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
2,4-D acid; 2,4-D BEE (butoxyethyl ester); 2,4-D dimethylamine salt (Cimarron Max); 2,4-D triisopropanolamine salt (Curtail)	High. The active ingredient in the amine salt form will dissociate to 2,4-D acid within the first few minutes following application. 2,4-D acid is moderately soluble in water and adheres very poorly to all soil types.	1-30 (mean=6)	2,4-D acid and ester: 569 dimethylamine salt: 7,290; triisopropanolamine salt: 4,610	<120	2,4-D acid: 639; butoxyethyl ester and triisopropanolo-amine salt: 866; dimethylamine salt: 949.	250	Single-dose toxicity testing of 2,4-D indicates that it is moderately toxic to mammals and birds, and practically non-toxic to bees, frogs, and aquatic organisms. Exposures to 2,4-D after an herbicidal application to lawn can (continued below)	The hazards associated with the herbicide active ingredient 2,4-D are considered high for mobility, moderate for persistence, and low for bioaccumulation.
Non-Target Toxicity Comments Continued: expose children and adults to concentrations that are considered high in hazard for toxicity. Note: Thurston Health Department (which did extremely thorough reviews for the majority of these herbicides) failed to approve 2,4-D for the toxicity to humans when applied to lawns. In the parks, it would not be applied to areas where people would be resting or residing.								
Aminopyralid (Milestone)	High based on solubility in water and that it adheres poorly to soils.	Up to 32 (terrestrial field test). 72 (abiotic half life)	2480	1.05	>5,000	>100	Acute toxicity testing indicates that aminopyralid is practically non-toxic to mammals, birds, insects, worms, fish, crustaceans, mollusks, and amphibians.	Manure and urine from animals consuming treated grass or hay may contain enough aminopyralid to cause injury to sensitive broadleaf plants (this is problematic if manure would be used for compost). See label for more information.
Bromacil (Hyvar X) (considered for *Bromus inermis* only)	Very high	60	700	32	1,300	36	Not described.	Bromacil has been found in groundwater as a result of normal field use. It would not be applied in areas where soils are permeable, particularly where groundwater is used for drinking water.
Chlorsulfuron (Telar)	High. Reduced in acidic soils (pH <6.0).	40 (30 days in slightly acidic, 90 days for alkaline soils)	7000	40	5,500	>122	Practically non-toxic to most fish and other aquatic invertebrates. It is not expected to accumulate in fish or animals and is considered low in toxicity to animals, bees, and birds.	Persistence tests in the field and in the laboratory indicate that chlorsulfuron can breakdown to half of the applied concentration as quickly as 10 days or it may (continued below)
Misc. Comments Continued: take over 180 days (depending on the environmental conditions). In field test the data indicates that it is a moderate hazard for persistence but laboratory tests indicate								

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
that it has the potential to be high hazard for persistence. Overall, the persistence hazard for chlorsulfuron is rated as moderate due to the field tests ranging from 11 days to 70 days (with 60 days being the cut off for high persistence). (Thurston County Health Department).								
Clethodim (Select)	EPA has stated "under present use patterns and under most circumstances clethodim does not appear to threaten groundwater"	3	6,630. Highly depen-dent on soil pH	0.49 @ pH=9; 40 @ pH=7; >3,000 @ pH=5	>5,000	67	Slightly toxic to fish and aquatic invertebrates. Practically non-toxic to honeybees. Very low toxicity to birds.	Controls annual and perennial grasses in broad leaf crops.
Clopyralid (Transline)	Very high	40 (15 - 287 days)	300,000	6	>5,000	>100 mg/L in most sensitive Aquatic organ-isms tested	Aquatic animals - low toxicity to fish and aquatic invertebrates. Clopyralid does not bioaccumulate in fat tissues. Terrestrial animals - low toxicity to birds and mammals. Not toxic to bees.	High potential for leaching is due to high solubility in water, does not adsorb to soil particles, and is not readily decomposed in soils. It has been found in groundwater in Montana (RAVE 2nd Edition). Clopyralid would not be applied where soils show rapid permeability throughout the profile (such as loamy sand to sand) and the water table of an underlying aquifer is shallow, or soils containing sinkholes over limestone bedrock, severely fractured surfaces, and substrates which would allow direct introduction into an aquifer.
Diquat (Helm) FROM: http://extoxnet.orst.edu/pips/diquatdi.htm	Not applicable. This is an aquatic herbicide. Following applications to water bodies, diquat can rarely be detected 10 days after application and is often below detection 3 days after treatment. Diquat is very persistent but due to its strong soil absorptive properties, it is unlikely to be a groundwater contaminant. When applied to surface water systems, diquat will	Typically 1,000 days[5] Rapidly adsorbs to clay. Will deactivate in a few days due to soil binding.	700,000	Average is 1,000,000 mL/g (est.)[5] Very low mobility in soil.	120	5	Acute oral toxicity in mammals is moderate. Acute effects on aquatic organisms in the field are unlikely at rates used for vegetation control. Little or no bioconcentration in fish will occur... No residues were detected in organs or tissues of channel catfish collected from pools 5 months after a single application or 2 months after a second treatment of 1 ppm diquat. Residual activity on non-target plants beyond the application date (impacts on non-target plants days or weeks later) is not expected. Once diquat	Diquat is removed rapidly from aquatic systems, principally by adsorption. If adsorption is initially to weeds, biodegradation to soluble or volatile products occurs in several weeks. When bound to sediment, little or no degradation probably occurs. In both cases, the diquat disappears from the water in 2-4 weeks. Diquat will photodegrade in surface layers of water in 1-3 or more weeks when not adsorbed to particulate matter. Information above is from

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
	most likely be associated with the sediment (USEPA, 1994).						reaches sediment, it is tightly bound and is biologically unavailable.	"Technical Factsheet on Drinking Water" National Primary Drinking Water Regulations available at: (continued below)
Misc. Comments Continued: http://www.epa.gov/ogwdw000/pdfs/factsheets/soc/tech/diquat.pdf Decaying vegetation caused by treatment with diquat may deplete oxygen content in the water. For this reason, it is recommended that only 1/3 to 1/2 of an area containing dense vegetation be treated with diquat at a time with a 14-day waiting period (http://www.mass.gov/agr/pesticides/aquatic/docs/diquat.pdf).								
Dicamba acid (Banvel)	Very high (soluble, adheres poorly to all soil types)	14	400,000 Thurston: 6,500	2 Thurston Koc: <21	566	135	Single-dose toxicity testing of dicamba indicates that it is moderately toxic to mammals and low in toxicity to birds, insects, fish and other aquatic organisms.	Dicamba containing herbicides are rated as conditional due to high potential for acute toxicity to birds and for chronic toxicity to small mammals when applied at high rates. Therefore, use of these products at a rate below 0.75 pounds of active ingredient per acre is recommended to reduce potential hazards. (Thurston County Health Department)
Endothall (*Aquathol K*)	Moderate	4-5 clay, 9 for soils high in organic matter	100,000	110-138	51.5 (disodium endothall on rats) moderately toxic	107-528.7	The toxicity of endothall to aquatic organisms depends on the formulation used. The amine salt formulation, called Hydrothol 191 is particularly effective against filamentous algae but is more toxic to fish. The dipotassium salt formulation, Aquathol K, exhibits a lower organism toxicity and is more appropriate for use in important fisheries areas. The dipotassium salt of endothall (i.e., Aquathol) is generally not toxic to aquatic organisms at recommended application rates of 0.5-5 ppm.	A relatively water-soluble contact herbicide. Controls submersed weeds. Endothall exhibits a relatively short persistence time in the aquatic environment, usually undergoing complete degradation by microbial action in 30-60 days (USEPA, 1992a). Endothall does not adsorb to sediments nor does it bioconcentrate in aquatic organisms to any appreciable degree. Since endothall is (continued below)
Misc. Comments Continued: effective in treating a large range of plants, it may have a widespread effect on non-target plants, especially when applied as a whole-pond treatment. In addition to direct toxic effects of the herbicide, treatment of a pond with endothall may also cause indirect impacts including dissolved oxygen depletion and habitat loss. These impacts may cause general weakening and/or death of plants on a large scale (Aquatic Plants Management Program for Washington State, 1992).								

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
Fluazifop-p-butyl (Fusilade)	Very low	15	2	5700	>5,000	1.4	Toxic to fish and invertebrates. Slightly toxic to birds. Practically non-toxic to bees. This product is toxic to grasses and other monocot plants.	Not persistent in soil or water. Immobile in soil. Fluazifop-p-butyl is known to leach through soil into groundwater under certain conditions as a result of use, and mitigation measures are noted on the label to prevent leaching into groundwater. (continued below)
Misc. Comments Continued: This product may impact surface water quality due to runoff of rain water, especially for poorly draining soils and soils with shallow groundwater. Its classified as having high potential for reaching surface water via runoff for several months or more after application. A level, well-maintained vegetative buffer strip between areas to which this product is applied and surface water features such as ponds, streams, and springs would reduce the potential runoff water and sediment. Runoff of this product would be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours.								
Fenoxaprop (+ Fluazifop-P in Fusion)	Extremely low (NPIC), but it has leached into groundwater (according to Fusion label)	9	0.8	9490	3,154	1.4	Practically non-toxic to birds, bees, but moderately to highly toxic to fish and other aquatic organisms.	For control of annual and perennial grass weeds. Slightly soluble in water, absorbs strongly to soils, and has low mobility. (continued below)
Misc. Comments Continued: This chemical may leach into groundwater if used in areas where soils are permeable, particularly where the water table is shallow. This product is toxic to fish. It would not be applied directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. It would not be applied when weather conditions favor drift from target area. This product may impact surface water quality due to runoff of rain water. This is especially true for poorly draining soils and soils with shallow groundwater. This product is classified as having high potential for reaching surface water via runoff for several months or more after application. A level, well-maintained vegetative buffer strip between areas to which this product is applied and surface water features such as ponds, streams, and springs would reduce the potential loading of fluazifopp-butyl from runoff water and sediment. Runoff of this product would be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours.								
Glyphosate (Roundup Pro)	Extremely low	47	900,000 10,000 (Thurston)	24,000	>5,000	86 ppm	Acute toxicity hazards to aquatic organisms may increase depending on the glyphosate product chosen because some of the other ingredients and surfactants that are added.	While highly soluble, it has a strong adherence to soil meaning it is not expected to leach deeply into soils or migrate from the application site. Surfactants can increase the mobility of glyphosate by decreasing its ability to adhere to soil. Glyphosate products are considered low in mobility hazard so are not considered likely to reach aquatic environments after a land application.

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
Imazapic (Plateau)	High (Montana RAVE model)	120-140. Soil bacteria don't seem to significantly degrade it	2,150-36,000	112 Adsorption increases with decreasing pH, increasing clay and organic matter.	>5,000	>100	Moderately toxic to fish. Low toxicity to birds, bees and mammals. Does not bioaccumulate in animals, and is rapidly excreted in urine and feces.	Even though imazapic is considered low in toxicity to all tested organisms, and the risk of toxicity from an herbicide exposure is low in hazard, it also caused developmental toxicity without maternal toxicity. Imazapic has high mobility and persistence. It is likely to take more than100 days for it to break down to half of the applied concentration. In anaerobic settings (aquatic sediments or deep soil) the compound may persist for many years. The overall persistence hazard is considered high.
Imazapyr (Habitat, Arsenal)	High	90	11,000; 1,100 (Thurston)	100	>5,000	>100	Low toxicity in all species tested	Since imazapyr is very water soluble and does not adhere strongly to soil, it has the potential to move with water off the site of application. And, because sunlight plays a major role in degrading imazapyr, it is recommended to use imazapyr products when no rain is expected for several days.
Imazapyr (+ metsulfuron methyl in Lineage clearstand) (Proposed for Bromus inermis, yellow sweet clover, knotweeds, western salsify)	High	90	11,000; 1,100 (Thurston)	100	5,000	100	Has very little effect on soil microorganisms. Plants - non-toxic to conifers, but is toxic to many other non-target plants. Low in toxicity to invertebrates and practically non-toxic to fish. It is not expected to build up in aquatic animals. Practically non-toxic to mammals and birds. It is of low toxicity to bees. Imazapyr is rapidly excreted by animals.	Imazapyr may move from treated areas to streams. Most movement of imazapyr was found in runoff from storms. Use of a streamside management zone can significantly reduce the amount of off-site movement in streamflow. Half-life in water is about 4 days.

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
MCPA dimethylamine salt	High	25	866,000	20	1,876	117	Moderately toxic to mammals and birds, practically non-toxic to bees and fish but highly toxic to other aquatic organisms. Ecotoxicity studies show that there is a potential short-term exposure to birds that eat short grass that exceeds the EPA's level of concern at application rates of 1.5 pounds of active ingredient per acre or greater (Thurston County Health Department).	
MCPA ester	Low high	825 (formerly 25)	825 (formerly 5)	1,000 50-60	1,793	117	Moderately toxic to animals and birds, practically non-toxic to bees and fish, but highly toxic to other aquatic organisms. Ecotoxicity studies show that there is a potential short-term exposure to birds that eat short grass that exceeds the EPA's level of concern at application rates of 1.5 pounds of active ingredient per acre or greater.	MCPA 2-ethylhexyl ester will quickly break down in the environment to create the herbicidally active chemical MCPA acid. MCPA acid is considered high in hazard for mobility, moderately persistent, and is not considered a hazard for bioaccumulation. The potential chemical (continued below)
Misc. Comments Continued: exposures to adults mixing and applying herbicides containing MCPA 2-ethylhexyl ester and to women working in treated turf grass, are considered high in hazard for toxicity. The risk to birds eating short grass that has been treated with MCPA exceeds the EPA's level of concern which Thurston County rates as high in hazard for non-target toxicity. Herbicides containing MCPA 2-ethylhexyl ester fail Thurston County's review criteria due to the risks to non-target organisms at expected environmental concentrations.								
Metsulfuron methyl (Escort, Cimarron)	High. Leaches through silt loam and sand soils.	30 (but may be 180)	9,500 Thurston: 2,790	35	>5,000	>150	Low in toxicity to mammals, birds, bees, worms, fish and other aquatic organisms.	Persistence testing of metsulfuron methyl has produced a wide range of values indicating that the length of time for this chemical to degrade to half of the applied concentration is very dependent on the site conditions where it is used (soil moisture, pH, and temperature are highly influential). The persistence hazard is rated as moderate (Thurston County Health Department)

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
Paraquat (Gramoxone Max)	Extremely low	1000	620,000	1,000,000	283 Slightly toxic	55 ppm	Practically non-toxic to bees. Slightly toxic to fish and birds. Moderately toxic to invertebrates. Toxic to wildlife. Gramoxone Max is a contact herbicide that desiccates all green plant tissue.	Low bioaccumulation potential, persistent in soil, not persistent in water, immobile in soil (MSDS).
Picloram (Tordon)	Very high	90	200,000	16	>5,000	1 - 10 mg/L in most sensitive species tested	Moderately toxic to aquatic organisms on an acute basis. Practically non toxic to birds. This herbicide is toxic to some plants at very low concentrations.	Non-target plants may be adversely affected if herbicide is allowed to drift from areas of application.
Misc. Comments Continued: Users should especially avoid application of picloram where soils have a rapid to very rapid permeability throughout the profile (such as loamy sand to sand) and the water table of an underlying aquifer is shallow or to soils containing sinkholes over limestone bedrock have severely fractured surfaces, and substrates which would allow direct introduction into an aquifer. This chemical can contaminate surface water through spray drift. Under some conditions, picloram may also have a high potential for runoff into surface water (primarily via dissolution in runoff water). These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, areas over-laying extremely shallow groundwater, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and areas over-laying tile drainage systems that drain to surface water.								
Quinclorac (Paramount) FROM: http://www.pesticideinfo.org/Docs/ref_regulatoryCA.html#PANGWrating	Potential groundwater contaminant.	211	72	37	>2,000	>100	Birds: oral LD50: 2000 mg/kg. Slightly toxic to fish.	Not to be applied directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. The use of this chemical where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.
Quizalofop P-Ethyl (Assure II)	Moderate. See Miscellaneous comments.	60	0.31	510	4,100 female, 5,900 male rats	1,072 (fathead minnow)	Causes irreversible eye damage. Harmful if swallowed, inhaled, or absorbed through the skin (human impacts).	Use for annual and perennial grasses. This herbicide is toxic to invertebrates and fish. This product may contaminate water through drift of spray in wind; has a potential for runoff for several months after application. Poorly drained soils/ shallow water tables are more prone to produce runoff.
Sethoxydim (Poast)	Low	5	4390	100	4,285 (female rat, >5,000 male rat)	170	Not acutely harmful to fish. Acutely harmful for aquatic invertebrates. Not acutely harmful to terrestrial organisms. Acutely toxic to honeybees. It causes substantial but temporary eye injury (human impacts).	For terrestrial uses only; toxic to aquatic organisms.

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
Simazine (Princep 4L)	High. Simazine can travel (seep or leach) through soil and can enter groundwater which may be used as drinking water and it has been found in groundwater.	60	6.2	130	>5000	>10 ppm	This herbicide is toxic to aquatic invertebrates. It would not be applied directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark (n/a). Runoff and drift from treated areas may be hazardous to aquatic organisms in neighboring areas. See label for additional restrictions.	Low bioaccumulation potential, not persistent in soil. Users are advised not to apply simazine to sand and loamy sand soils where the water table (groundwater) is close to the surface and where these soils are very permeable; i.e., well-drained. Users must assess soil type and location of groundwater before applying.
Sulfometuron methyl (Oust)	Moderate	60.9 (2 weeks-6 months; slower in high pH soils)	70	78	>5000	> 148	Practically non-toxic to freshwater fish, birds, and small mammals on an acute toxicity basis	NPIC listed soil persistence as 20. US EPA lists the average as 70. FROM: http://pi.ace.orst.edu/search/getDocketDocument.s?document=EPA-HQ-OPP-2008-0129-0015#xml=http://pi.ace.orst.edu/search/pdfHL.s?docNum=1
Triasulfuron (Amber)	Not persistent in soil or water. Moderate mobility in soil.	11-91 (degradation slow at high pH) (Gennari 2008)	815	Not found.	>5,050	>100 ppm	Harmful if inhaled. May be harmful in contact with skin, causes mild eye irritation (human impacts). Very toxic to aquatic life.	Amber has been identified in groundwater sampling from a field research study under vulnerable conditions. Amber may leach through soil to groundwater, especially where soils are coarse and groundwater is near the surface. Determine soil permeability and aquifer vulnerability in your area . See Amber label for additional restrictions.
Triclopyr amine (TEA) (Garlon 3a)	Very high Triclopyr TEA will convert to triclopyr acid almost immediately after application, which is highly water soluble and adheres poorly to soil, therefore, it is considered high in mobility hazard.	46	2,100,000	25-384	2,574 (male rats) 1,847 (female rats) 630 (triclopyr acid degradate)	240	Moderately toxic to oysters, and low in toxicity to birds, insects, fish and crustaceans. Risk of toxicity to non-target birds and small foraging animals (liver and kidney damage) is considered moderate or high depending on application rates and location.	Rates that exceed 2 pounds of active ingredient per acre (read product label for mixing and application rate information), are considered high in hazard for toxicity to birds and small mammals and should not be used (Thurston County Health Department)

Active Ingredient	Leaching Potential/ Herbicide Movement Rating[1]	Soil Half-Life (days)[1a]	Water solubility (mg/L)[1b]	Soil Sorption Coefficient (Koc)[1c]	Mammalian toxicity LD 50 (oral) mg/kg[2]	Fish LC 50 (mg/l)[2]	Non-Target toxicity[3, 4]	Miscellaneous comments
	(Thurston County Health Department)							
Triclopyr ester (BEE) (Garlon 4 Ultra)	Low (NPIC). Triclopyr BEE will quickly convert to triclopyr acid after application, which is highly water soluble and adheres poorly to soil, therefore, herbicides containing triclopyr BEE are considered high in mobility hazard. (Thurston County Health Department)	1-39 Abiotic half-life <730	23	780	630 (triclopyr acid) 1338 (triclopyr BEE)	0.36 ppm	Moderate to highly toxic to fish and aquatic organisms. Low toxicity to insects and crustaceans. Risk of toxicity to birds and small foraging animals varies from moderate to high depending on application rates and location. The EPA made the following statements about triclopyr BEE: "There is a high potential for acute risk to birds from triclopyr BEE." And "Endangered species of birds, mammals, fish, aquatic invertebrates, estuarine/marine species, and plants may be affected by triclopyr BEE."	Not for use in aquatic environments. Rates that exceed 2 pounds of active ingredient per acre (read product label for mixing and application rate information), are considered high in hazard for toxicity to birds and small mammals and should not be used (Thurston County Health Department). Toxicity risks are low when applied as spot treatment to cut stumps or basal bark.

Footnotes:

1. Leaching potential/Pesticide movement rating, soil half-life, water solubility, and soil sorption co-efficient are to assess potential for movement into water (National Pesticide Information Center):

1a. The Pesticide Movement Rating is based on the GUS or Groundwater Ubiquity Score, an empirically derived value that relates pesticide persistence (half-life) and sorption in soil (sorption coefficient, Koc). The GUS may be used to rank pesticides for their potential to move toward groundwater. GUS = log10 (half-life) x [4 - log10 (Koc)].

1b. Soil half-life is a measure of the persistence of a pesticide in soil. Pesticides can be categorized on the basis of their half-life as non-persistent, degrading to half the original concentration in less than 30 days; moderately persistent, degrading to half the original concentration in 30 to 100 days; or persistent, taking longer than 100 days to degrade to half the original concentration. A "typical soil half-life" value is an approximation and may vary greatly because persistence is sensitive to variations in site, soil, and climate.

1c. Solubility is the ability of a pesticide to absorb into water. High solubility means the pesticide can move more easily in the environment.

1d. The soil sorption coefficient (Koc) describes the tendency of a pesticide to bind to soil particles. Sorption retards movement, and may also increase persistence because the pesticide is protected from degradation. The higher the Koc, the greater the sorption potential. Koc is derived from laboratory data. Many soil and pesticide factors may influence the actual sorption of a pesticide to soil. High values mean the herbicide is neutralized quickly. For example, glyphosate has very high value, it becomes inert upon contact with soil.

2. LD50 values are included to measure acute toxicity. "The acute toxicity of a chemical refers to its ability to cause unwanted effects from one exposure. This is derived by applying various concentrations of pesticide to a test subject's eyes, skin, mouth and in the air the subject breathes (only oral LD50 values are presented here). Data from these trials are converted into LD50 (lethal dose 50 percent) or LC50 (lethal concentration 50 percent) values. These values are the doses or concentrations at which 50 percent of the animals tested die. Lower values are more toxic than higher values. LD50 values are expressed in mg/kg (chemical weight/animal weight), while LC50 values are expressed in mg/l (chemical particles/air or water particles) but sometime ppm (parts per million). These two values are nearly the same. (Tharp 2008). LC50 are for rainbow trout unless specified otherwise.

3. Except where noted, for all herbicides - contact with non-target plants may injure or kill plants.

4. Environmental effects listed here are based on users following all labeled guidelines. This includes not contaminating water when cleaning equipment or disposing of equipment wash waters or rinsate. Unless the herbicide is specifically labeled for use around water, these effects assume herbicides are not applied directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark.

5. Senseman, Scott A. (ed.). 2007. Herbicide Handbook, 9th Ed., Weed Science Society of America.

Note: Leaching potential/Pesticide movement rating, Soil half-life, Water solubility, Soil sorption co-efficient (all to assess potential for movement into water) are from the NPIC (National Pesticide Information Center): http://npic.orst.edu/ppdmove.htm if available. If not listed there, material was gathered from http://extoxnet.orst.edu/. LD50 values are from MSDS accessed from www.greenbook.net. Non-target toxicity and miscellaneous comments are from herbicide labels (accessed from greenbook.net), and from the Thurston County Health Department (Washington) which thoroughly reviewed many of the herbicides described here. http://www.co.thurston.wa.us/health/ehipm/ehipm_terrestrialreview.html

3. Paleontological Resources Impacts

Alternative 1 Impacts

Two parks were established primarily for their paleontological resources (Fossil Butte and Hagerman Fossil Beds). Two other parks also have important paleontological resources (Craters of the Moon and Little Bighorn). In addition, based on nearby evidence, there is potential for previously undiscovered paleontological resources at Bear Paw and Big Hole. There are no known or nearby paleontological resources at City of Rocks, Golden Spike, Grant-Kohrs, or Minidoka and therefore no effect to paleontological resources would occur at these parks under this alternative.

Treatment of nonnative invasive plants by manual / mechanical, cultural or other methods involving the use of vehicles and/or equipment could cause surface disturbance and affect unknown paleontological resources. In fossil locations, these methods are generally avoided unless the extent of the fossil resources is known (such as known location at greater depths than would be disturbed by removing nonnative invasive plants). Nonetheless, ground disturbing restoration or revegetation activities such as cultivation, raking, digging, vehicle (tractor, OHV) and foot traffic could potentially damage previously undiscovered resources. Negligible to minor adverse effects could also occur from removal of weed / soil cover protecting these resources, while long-term beneficial effects would occur from reducing impacts associated with root growth.

There would be no effect on paleontological resources from the use of insect biological control measures. Biological control using livestock could potentially affect paleontological resources from the hoof action and rubbing/scratching of grazing animals and/or the erection of fences or containment pens. These can potentially damage resources close to or above soil and rock surfaces and also accelerate erosion around artifacts. No livestock use, however, has occurred or is proposed to treat nonnative invasive species at parks with paleontological resources, therefore there would continue to be no effect. (Livestock trailing at Fossil Butte occurs outside of fossil-rich locations.)

Wildland fires burning in fossil rich areas that also contain fire fuels can potentially affect fossils (DINO 2005: 3-82). Severe fires – those that burn in heavy fuel loads and exhibit long residence time and therefore a substantial downward heat pulse – may damage buried organic and inorganic materials. Organic matter may be distilled or destroyed at temperatures of 392-572°F. Although foot and vehicle traffic caused by prescribed fire containment or suppression activities could damage fossils by displacing surface materials that protect them, these activities are limited during prescribed fires in sensitive paleontological areas. Similarly, hand line construction activities could expose buried materials and indirectly lead to erosion or theft. With implementation of mitigation measures associated with the development of prescribed fire plans, these effects would be negligible to minor.

Alternative 2 Impacts

Impacts would be the same as in Alternative 1, with negligible to minor adverse effects where paleontological resources are present. Fewer impacts may also occur because of potential expanded use of insect biological control agents, because of a potentially wider range of herbicides with which to treat nonnative invasive plants, and because of more systematic application of mitigation measures. Overall, the more systematic and comprehensive identification and treatment of nonnative invasive plants would likely have beneficial effects on the preservation of paleontological resources from the removal of nonnative invasive plants currently affecting these resources.

Impact Avoidance, Minimization or Mitigation Measures

In addition to measures noted in Chapter III: *Alternatives*, the following measures would also be included (as appropriate to the alternative actions) to minimize impacts to paleontological resources:

- Areas with potential paleontological resources (Fossil Butte and Hagerman Fossil Beds) would be surveyed prior to nonnative plant treatments to avoid impacts to potentially sensitive resources.

- Surface disturbing activities would be avoided in sensitive areas, such as known paleontological sites unless consultation with a paleontologist indicated that proposed treatment would have no adverse effects.
- Application of herbicides would occur only after investigation determined that these would have no effects on paleontological resources.
- Foot and vehicle traffic would be limited to established roads, trails and vegetated areas where possible to protect vulnerable paleontological resources.
- Consultation with a paleontologist during planning phase of invasive plant management projects at Hagerman Fossil Beds and Fossil Butte would help to determine sensitive areas and acceptable levels of disturbance.
- When practical and possible, areas rich in paleontological resources would be temporarily fenced or avoided during grazing.
- Equipment used for revegetation and restoration projects would be evaluated and selected to be the most effective to accomplish restoration goals while causing the least disturbance to paleontological resources.

Additional Measures for Use of Prescribed Fire:

- Prior to authorizing surface disturbing activities, areas would be surveyed for unique, rare, or special geologic resources, including fossils.
- Severity of fire-related effects would be controlled where possible by controlling the fireline intensity in resource-rich areas at the time of the burn and inventories of previously unsurveyed areas would be conducted before and after the burn.
- Sites in or near the proposed prescribed burn footprint would be protected when practical and without causing damage by various methods, including ‘blacklining’, treating with fire retardant, and or/ establishing sprinkler systems prior to fire ignition.
- Fire crews would be briefed about working in and protecting paleontological sites.
- Ground disturbance would be avoided during preparation and fire mitigation in paleontological resource areas.
- Prescribed fires, where parks have approved fire management plans for the treatment of invasive plants would be planned and performed in areas suspected or known to contain resources of paleontological value only after consultation with a paleontologist (Fossil Butte and Hagerman Fossil Beds).

Cumulative Impacts: Past land practices, such as ranching and farming in the vicinity of some of the parks with paleontological resources, as well as collecting that occurred prior to establishment of the parks has likely resulted in the disturbance of, damage to and loss of paleontological resources. Because mitigation measures are now employed there have likely been fewer adverse impacts to paleontological resources from ground disturbance by park activities since then. Present and future projects would continue to employ mitigation measures to avoid disturbance to paleontological resources. When added to impacts from past, present and future projects in the 10 parks, such as rehabilitation of a water system at Fossil Butte and construction of a paleontological research center at Hagerman, as well as projects that occurred prior to protection of these resources, cumulative impacts would be minor to moderate. Because of mitigation measures the contribution of Alternatives 1 or 2 to cumulative impacts on paleontological resources would be negligible.

Conclusion: Alternatives 1 and 2 would have short- and long-term negligible to minor adverse effects on paleontological resources at the parks with these resources. There would be no impairment of paleontological resources or values.

4. Water Resources Impacts

Alternative 1 Impacts

Hydrology and Water Quantity

Accessing sites using established routes is expected to have no effect to negligible effects on hydrology and water quantity. Manual/mechanical treatments such as removal of deep-rooted or large numbers of plants could continue to result in negligible to minor localized adverse or beneficial impacts from changing the way water runs over an area during rain or snowmelt, changing infiltration rates or increasing ponding or channelization. Removal of nonnative invasive plants, such as Russian olive, tamarisk and purple loosestrife, from riparian areas (restoration) would have ongoing long-term localized beneficial effects from reducing the amount of water taken up by these plants and allowing that water to be used by native riparian species. Beneficial effects on streamflow characteristics have been noted at Golden Spike and Little Bighorn from the removal of tamarisk.

Use of water for cultural techniques, such as for irrigation and for routine washing of vehicles before moving from infested areas, would continue to have negligible to minor localized adverse effects on hydrology and water quantity, depending on the source of water and existing water balance conditions based on regional weather patterns. Use of irrigation during droughts would tend to have minor to moderate adverse effects, while use during other times would have negligible to minor effects but would not be expected to result in ground or surface water depletion. If used, irrigation to establish restored areas could also have negligible to minor adverse effects.

There would be limited use of water to mix with the concentrated chemical before it is applied to nonnative plants. For the most part, the tanks and backpack sprayers would be pre-mixed near a facility, but water from rivers or other water sources could also be used if necessary, a negligible to minor adverse effect.

There would be no effect on hydrology or water quantity from the use of insect biological control. Use of livestock for biological control, however, could result in trampling of plants, nitrogen deposition (from cattle at Grant-Kohrs) or wet areas and local changes in runoff, along with additional use of water for livestock use, a long-term localized minor to moderate adverse effect on water quantity.

As noted under Soils and Geology, the use of prescribed fire can cause temporary water repellency in soils from volatization of organic chemicals and hydrocarbons. If this was extensive, areas affected by it could have localized increases in runoff and decreased infiltration, increasing the rate at which water from rain or snowmelt reaches nearby surface water, such as streams and ponds, a short-term negligible to moderate localized adverse effect in parks that use prescribed fire. Downstream scouring may result from increased water runoff and cause minor flooding. Such flooding can result in substantial loss of soil and alteration of water resources, including stream channel movement and vegetation removal and/or changes in floodplain boundaries. Generally, because of the limited size of the areas associated with prescribed fire treatment for nonnative invasive plants and because of limited surface water resources in the parks, these effects would not be expected to occur and overall effects in the parks that use prescribed fire would be negligible to minor.

Water Quality

There are few surface water resources in the partner parks because most occur in fairly arid environments with limited precipitation from rain and snow generally between six and 18 inches. Nonetheless, potential impacts to water quality would occur from accessing treatment areas, manual/mechanical treatments, use of livestock for biological control, use of herbicides, and from fire.

There would also be short-term increases in turbidity at some locations where nonnative plant treatment crews needed to walk through mud or water to access and treat plants growing in or near water. To the extent that boats or other means could be used for access, these impacts would remain small (negligible to minor). Impacts could also occur from accessing treatment areas using heavy equipment or all-terrain or utility vehicles. Negligible to minor impacts have been observed at Grant-Kohrs and Golden Spike, where this equipment has been used most frequently. If access vehicles cross intermittent drainages or are used in areas of sparse plant cover or that are very dry or have high clay soil content, such use could cause soils to loosen and to erode during future rain or snowmelt if areas are not stabilized beforehand. Because access is generally over established pathways and on consolidated soils, direct and indirect impacts from access, such as sedimentation, would continue to be negligible to minor, short-term and localized but could range to moderate if used in wet soils.

Removal of plant cover using any technique, but particularly through manual /mechanical means, such as hand-pulling or tilling, would continue to result in negligible to minor or localized moderated adverse effects on water quality from the increased likelihood of eroding loose soil into water runoff during rain or snowmelt causing erosion and sedimentation of nearby surface water (wetlands, streams and rivers). Until vegetation is reestablished, there could be slight spikes in sedimentation, within the natural range of variability, in some surface water resources from the removal of native plant cover.

Use of herbicides within or adjacent to surface waters would continue to be highly controlled, both as to the type of herbicide used and to additional analysis of its potential effects, including alternatives to its use, prior to application. Only herbicides approved for use within or near water would be used in these areas. Requirements or specifications regarding use, including distance from surface water for other herbicides, would also be strictly followed. Additional best management practices such as target, rather than broadcast or aerial spraying in nearby areas would also be used to limit herbicide drift effects over water. Aquatic herbicides designed for use in water do not harm water quality because they break down and come out of solution quickly, and are non-toxic to aquatic wildlife. In addition, because these are generally used in flowing water, their limited effects dissipate quickly. Overall effects would vary from negligible to moderate.

The potential for herbicides to impact ground or surface water, however, would vary. For those parks that currently use the Relative Aquifer Vulnerability Evaluation (RAVE) system (Appendix O) such as at Little Bighorn, herbicides would pose a minor risk to groundwater from leaching. Resource managers that apply herbicides in areas with high water tables would assess the risk of leaching using RAVE or another model. In those areas with high leaching potential, alternative treatments, herbicides, or herbicide application rates would be used. As a result, herbicide application would therefore likely cause minimal detectable changes in chemical water quality standards.

Where the RAVE or a similar impact analysis system is not currently used, or at parks with shallow groundwater or that used herbicides near surface waters without adequate buffer zones, impacts could be minor to moderate, but would not be expected to be widespread. Groundwater would be more likely to become contaminated in areas of heavy precipitation or in areas with sandy soils (BLM 2007a in BLM 2009). Based on Table 37: *Environmental Effects of Current and Proposed Herbicides*, use of several herbicides near water, including high groundwater, would not occur because of their potential for contamination. In addition, the following herbicides are among those that have the ability to leach into groundwater and their use in these areas would also be limited, dependent on area conditions: chlorosulfuron, metsulfuron methyl, picloram, and triclopyr (under certain conditions). Because of the sensitivity of water resources and park management goals, park staff would both consider other means of controlling nonnative invasive species and use best management practices in all applications near surface waters.

There are no known direct or indirect impacts from the use of insect biological control agents near surface waters. Impacts of biological treatments on water resources would be negligible. Use of livestock for biological control would continue to have the potential to affect surface water resources from improper handling of excrement, from allowing livestock access to surface water resources, and from heavy runoff through livestock pastures. Effects would range from negligible to moderate. Because best management practices would continue to be employed, most would be negligible to minor.

Use of prescribed fire would have no effect at parks that currently do not use this treatment (City of Rocks, Hagerman Fossil Beds, Little Bighorn, Minidoka, Bear Paw and Big Hole). Where prescribed fire is or has been used for nonnative plant treatment (such as at Golden Spike), loss of vegetation ground cover from fire or changes in vegetation ground cover from fire could result in negligible to moderate short-term increases in effects on water quality from temporary increases in erosion, leading to sedimentation. Runoff from burned areas would also have a negligible to minor short- or long-term adverse effects on water quality from changes in the chemical composition of runoff, including from transporting layers of ash. The alkaline nature of ash or influx of nutrients causing algae blooms may also result in pH changes to water quality. If plant communities near water are consumed by fire, increased water temperatures may result, due to limited shading and increased nutrient cycling, therefore decreasing the availability of oxygen to fish and other aquatic organisms. There may be less organic material available to decrease runoff and downstream flooding may occur. Additional erosion of ash and soil may result in gullying and loss of topsoil, which may result in aggradation of the stream channel and temporarily alter water depths. In addition, a short-term flush of sedimentation in river and stream channels often occurs after the first rains. Due to limited water resources at the parks that do or could use fire to treat nonnative invasive plants and the limited likelihood that burn areas would be near water, effects on water resources would be negligible to minor.

There could also be limited impacts from the potential for use of chemical fire retardant and foam upon fire escape or for suppression activities if fires went out of prescription. Other uses of foam would be to prevent damage to sensitive cultural resources. Because use of chemical retardants and foam would be limited near surface water resources, impacts would be expected to be negligible to minor.

Restoration would generally have long-term beneficial effects from promoting the reestablishment of native vegetation through seeding or planting, which could help reduce existing erosion and sedimentation of surface waters from increasing plant cover and therefore retention of water for uptake by plants and interruption of soil loss. There would also be a potential that restoration would be unsuccessful, temporarily leaving areas of bare ground. Unless, loss of plant cover occurred over a wide area or for a long period, most changes in water quality would be localized and beneficial (such as reduced sediment transport to surface waters).

Wetlands

Ground disturbing activities may cause direct impacts to native wetland plants. Physical disturbance to wetlands could result in higher relative impacts to these wetland communities because of their sensitivity and greater likelihood of having fine-grained soils and plants that are more susceptible to impacts due to their presence in or near water. Most impacts from manual/mechanical treatments and from cultural treatments that involved ground disturbance would be short-term, localized and negligible to minor. Occasional moderate impacts could occur where actions affected large areas or where wetlands were heavily infested with nonnative species, such as where large areas of Canada thistle occur. In these areas, there could be short-term loss of streambank cover and temporary increases in erosion. These weeds and others such as Russian olive, tamarisk, knapweeds and perennial pepperweed, however often adversely affect hydrological function and fish habitat. Long-term beneficial impacts from removing these nonnative species and restoring native species would outweigh adverse effects from their removal.

Biological control agents released in the parks would continue to be those approved by APHIS and regional and/or national NPS IPM coordinators. Because biological control agents are specific to a target nonnative plant, there would be no impacts to non-target wetland or other non-target plant species. Impacts to target plants would be direct and beneficial and generally would be minor to moderate, with containment or control taking more than one year. Where biological control has been used at Grant-Kohrs, effects have been negligible to minor.

Where the use of herbicides was employed in or near wetlands, there would be both adverse and beneficial effects. Occasionally, non-target plants would be subjected to herbicide drift and could experience no effect, reduced vigor, or death depending on the sensitivity of the plant species to the specific herbicide and the dose the plant was subjected to. For most weeds occurring along riparian areas, such as purple loosestrife, or most Canada thistle patches, herbicides are 'spot sprayed', or sprayed on the target weed, not broadcast sprayed. In some cases, however, where weeds are especially dense and intermixed with native plants, non-target effects would be higher. Overall, use of chemical treatments would have infrequent adverse, short-term, minor to moderate impacts on non-target plants in wetlands. Use of chemical treatments would have negligible adverse effects on wetlands at the population, community or process level. For some weed species, herbicides temporarily suppress weeds, requiring repeated applications. Impacts from trampling, and re-application of herbicides to the wetland could reduce native plant cover and/or diversity. For weed species which respond to herbicides, there could be long-term beneficial effects on wetland plant populations and communities by removal of nonnative invasive plants that prevent native wetland plants from reaching their full stature or presence in the community.

Wetland and riparian communities would benefit from the removal of nonnative invasive species, particularly from decreased competition with invasive plants from adversely impacting growth, seed production and competitiveness of the invasive plants, thereby allowing reestablishment of native species.

For those parks that use prescribed fire to treat nonnative plants, effects on wetlands would be both adverse and beneficial. Most wetlands are too wet to carry a continuous fire front that could result in changes to wetland plant communities. During drought conditions, it is likely that prescribed fire would not be used as a tool because the dominant fire management strategy would likely be suppression. Wetlands, like other plant communities, however, have developed under a natural fire regime. Fire can benefit the long-term presence of wetlands by maintaining open water systems, delaying succession, and increasing nutrient cycling; combined, these would be long-term beneficial effects. Generally wetlands would be only minimally affected by fire, having a natural ability to withstand fire due to high fuel moisture levels and (very often) standing water. Wetlands are also often used as natural fire breaks.

In wetlands, fire would primarily be used to remove undesirable vegetation. Fires would remove senescent or dead plants and the accumulation of downed wood and plant parts and convert it to ash and charcoal. Fires would likely increase species diversity, and reduce woody species relative to grass and forb species, depending on fire tolerance. Wetland functions, including water holding and storage capacity and nutrient cycling, may improve from the restoration of native vegetation. As a result, there would be short-term minor to moderate adverse and long-term beneficial effects if prescribed fire was used to control nonnative plants in or near wetlands.

Alternative 2 Impacts

Hydrology and Water Quantity

Impacts would be similar to Alternative 1. There would also be additional minor adverse impacts on water quantity as a result of more systematic implementation of washing of vehicles and equipment before moving these from one area to another. Increased beneficial impacts would occur from the additional removal of nonnative water-loving species such as tamarisk and Russian olive that would allow increased water availability.

Water Quality

Impacts would be similar to Alternative 1. Overall, however, there would be more use of a program to analyze the risk of groundwater contamination from herbicides where this risk is currently unknown (see Table 37: *Environmental Effects of Current and Proposed Herbicides*). Northern Rocky Mountain parks would systematically use the RAVE model (Appendix O) or a similar system to evaluate the risk of groundwater contamination in areas where leaching is possible. RAVE considers several factors, including:

- Irrigation practice,
- Depth to groundwater,

- Distance to surface water,
- Soil texture,
- Percent organic matter,
- Herbicide application frequency,
- Herbicide application method,
- Herbicide leachability, and
- Topographic position.

If a herbicide is determined through RAVE to have a high potential for groundwater contamination, an alternative herbicide or alternative application method would be used, decreasing effects to negligible to minor or moderate.

There would also be long-term beneficial impacts on water quality from better information about the success of restoration as gained from monitoring programs, which would lead to additional restoration efforts where it was minimally successful. This would result in less erosion of bare soils from runoff.

Wetlands

Most impacts would be the same as in Alternative 1. Use of adaptive management and biological control in Alternative 2, however, would likely improve nonnative invasive plant treatment and control and would therefore minimize impacts to wetlands. Insect biological control organisms could allow treatments to target and contain some nonnative invasive plants that occur in wetlands, a long-term beneficial effect, with fewer adverse impacts compared to other treatment methods. For example, biological controls insects such as *Galerucella calmariensis* have been very effective on purple loosestrife (Coombs *et al.* 2004), but they have not been released or observed at Hagerman Fossil Beds. Combining herbicidal control with *G. calmariensis* may be more effective than either treatment applied alone (Jacobs and Mangold 2008). Adaptive management would also allow the potential use of newly approved herbicides that could pose less risk to wetlands than currently used herbicides and/or use of herbicides that were more effective in treating target species. Both could lead to improving the effectiveness of treatments in wetland and riparian communities while decreasing overall impacts.

Under Alternative 2, programmatic measures to protect wetlands would have a long-term, minor, beneficial impact on wetlands. Control actions would increase the area of restored wetlands resulting in short-term, negligible adverse impacts and long-term, beneficial impact on wetlands.

Impact Avoidance, Minimization or Mitigation Measures

In addition to measures noted in Chapter III: *Alternatives*, the following measures would also be included (as appropriate to the alternative actions) to minimize impacts to water resources (including floodplains and wetlands) include:

- Equipment used would be inspected daily for fuel, oil, hydraulic fluid and other potential leaks.
- Hazardous spill clean-up materials would be on site during operations.
- No herbicide would be used in areas adjacent to or near water unless it has been approved by the EPA for aquatic application and reviewed and approved by the appropriate regional NPS IPM Coordinator.
- The RAVE (Appendix O) or a similar model would be used by the parks to evaluate the risk of groundwater contamination in areas and with herbicides where leaching is possible.
- If a herbicide is determined through RAVE to have a high potential for groundwater contamination, an alternative treatment method, herbicide or application method would be used.
- Where use of small motorized vehicles occurred to access non-wilderness treatment sites, this access would generally be over established trails and pathways. If crossing of intermittent stream drainages occurred, it would be at right angles to the stream to minimize disturbance and would be done during conditions that would minimize sedimentation.
- Managers would monitor so they are able to recognize areas that repeatedly require reapplication of herbicides. For some weeds, herbicide applications would be ineffective if native plant

propagules (seeds or rhizomes) are not present to fill in and suppress the weeds. In such cases, reseeding, or revegetation would be combined with herbicides to reduce or eliminate the need for repeated herbicide applications.

- Herbicides applied near potable water supplies would include the following additional mitigation measures in use at Little Bighorn: 1) Only herbicides that do not leach from the root system to the soil or groundwater would be used. Only herbicides that are specifically approved on their label for use over/on/near public water supply intakes would be considered for use. 2) No herbicides where the label specifically prohibits application over or near public water systems intakes would be used. 3) Application methods that allow herbicide to directly contact the soil would not be used. For example, applying herbicide by foliar spray would be excluded, but cut/stump method, where herbicide is painted on a freshly-cut stump would be allowed. 4) With all herbicide used in the area surrounding potable water intakes, special attention would be given to application procedures and label instructions (which include set-back distances) with regards to public water supply intakes. Required setbacks would be calculated from the edge of the indicated zone.

Cumulative Impacts: Many of the parks have been historically or are currently adversely affected by agricultural runoff from surrounding or intervening irrigation of farms and ranchlands. Several of the parks contain easements associated with irrigation canal management for nearby croplands, including Big Hole and Minidoka. Grazing also occurs within or surrounding many of the parks (such as City of Rocks, Fossil Butte, Craters of the Moon, Little Bighorn, Bear Paw and Big Hole) and is an important component of Grant-Kohrs Ranch. Because most parks also occur in arid areas, withdrawal of groundwater for irrigation and use of herbicides and grazing on adjacent or lands within the park boundaries has resulted in long-term minor to moderate adverse impacts on water quantity and quality. In addition, contaminants in stormwater from use of hardened or gravel roads also adversely affect water quality conditions. Impacts to wetlands have varied but primarily have resulted from landscape disturbance along the rivers in Big Hole, Grant-Kohrs and Little Bighorn, and from the addition of water to formerly arid landscapes, such as at Minidoka.

Because overall success of nonnative plant management programs would vary among the parks, there would be both short-term negligible to moderate adverse and short- and long-term beneficial impacts on hydrology and water quantity, water quality and wetlands. These actions would contribute negligible to minor cumulative adverse and beneficial effects. Overall success of nonnative plant management programs would likely be greater under Alternative 2, with more effective treatment methods and a wider array of management strategies and tools that would promote the growth of native plants over nonnative plants. Both Alternatives 1 and 2 would contribute cumulative beneficial effects from improving surface water flow, natural floodplain and wetland values, where nonnative invasive plants were removed from these areas. When the impacts from past, present and future impacts, such as ongoing use of water to provide visitor services at the parks and rehabilitation of water system infrastructure at Fossil Butte and Big Hole as well as non-NPS projects near Hagerman Fossil Beds are added to those contributed by the proposed plan under Alternatives 1 or 2, overall impacts to water resources would be moderate.

Conclusion: Although impacts from the alternatives would be similar, Alternative 2 would employ a more systematic and comprehensive program that would improve water resources more than or perhaps sooner than in Alternative 1. Improvements would also occur in Alternative 2 because a broader array of treatments would be available to the parks and because more stringent mitigation measures would be employed. Overall effects under both alternatives would be short- and long-term and negligible to moderate. There would be no impairment of water resources or water resources values from the implementation of either alternative.