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Framework for Springs Stewardship Program and Proposed Action Development:

**Spring Mountains National Recreation Area
Humboldt-Toiyabe National Forest**



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Cover Photo: Lower Horse Spring was dry when surveyed in 2010 (photo by USDA Forest Service, Northern Arizona University springs survey crew).

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Petroglyphs in the Northern Spring Mountains, October 2010 (photo by USDA Forest Service, Northern Arizona University springs survey crew).



Stellar Spring, September 2011, is a small spring covering 169 square meters (photo by USDA Forest Service, Northern Arizona University springs survey crew).

Framework for Springs Stewardship Program and Proposed Action Development: Spring Mountains National Recreation Area Humboldt-Toiyabe National Forest

Marc Coles-Ritchie, Stephen J. Solem,
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INTRODUCTION

In the desert Southwest, springs are an important ecological feature and serve as a focal point for both biological and human interactions on the landscape. As a result, attention has been placed on the stewardship and protection of these important resources. Management has traditionally focused on the more accessible and heavily used eastern canyons within the Spring Mountains National Recreation Area (SMNRA). This emphasis is reflected in the management guidance in the Toiyabe National Forest Forest Plan and the SMNRA General Management Plan (Toiyabe Forest Plan Amendment #4). As a result of implementing the SMNRA Landscape Assessment (ENTRIX 2008) and the Inventory and Monitoring Strategy (USDA Forest Service 2008), attention has been shifted to the larger landscape. Management programs have begun to address conservation needs outside the “developed canyons.”

During 2010–2012, the SMNRA undertook an inventory of all of the NRA springs that resulted in completion of a detailed inventory of 77 of the 149 known springs. Spring surveys were conducted by using the Forest Service Groundwater-Dependent Ecosystems (GDE) Level II Inventory Field Guide (USDA Forest Service 2012b) by field crews from Northern Arizona University under a Cooperative Agreement. These inventories have produced an impressive and consistent data set on these springs. The SMNRA staff sought guidance on how (1) to use these data to determine restoration needs and to prioritize restoration efforts and (2) to develop site-specific restoration proposals. This framework is designed to address those needs. Although designed for use on the SMNRA within the Humboldt-Toiyabe National Forest (HTNF), the methods described in this framework were reviewed and evaluated by national program leaders, scientists, and service team specialists to enhance their applicability at a broader scale.

The methods described in this framework were tested by using SMNRA springs inventory data; the resulting analysis for Phase I of this framework is presented in a separate report. (Coles-Ritchie et al., in progress). The framework was also tested and applied to a data set for 105 GDEs (including springs, fens, and other wetlands) from the Ashley National Forest consisting of data gathered by using the GDE Level I Inventory Field Guide (USDA Forest Service 2012a).

This framework was prepared in consultation with staff from the SMNRA, national groundwater and surface water program managers, National Minerals Service Team hydrogeologist, specialists from the Springs Stewardship Institute at Northern Arizona University, and members of the National Stream & Aquatic Ecology Center. Representatives from the U.S. Geological Survey and Bureau of Land Management

also participated in the development effort. Members of the Nevada Springs Restoration Workshop Committee (draft) have also participated in these discussions and provided information from their efforts that has been incorporated into the framework.

Background

Methods described in this framework build on (1) agency efforts to consistently inventory groundwater-dependent ecosystems, (2) methodologies used in assessing and formulating program budget needs used in watershed management and other program areas, and (3) the logic and approach outlined in the agency's Watershed Condition Framework (USDA Forest Service 2011).

Groundwater-dependent ecosystems (GDEs) are "communities of plants, animals, and other organisms whose extent and life processes are dependent on access to or discharge of groundwater" (USDA Forest Service 2012a). GDEs occur where groundwater emerges and include springs where flow is visible as well as wetlands where vegetation and soil obscure the groundwater as it emerges. GDEs have distinct characteristics compared to ecosystems supported primarily by surface water. GDEs generally have a more constant and steady source of water allowing animals and wetland plants to thrive, such as mosses, sedges, forbs, and springsnails. The continually waterlogged condition of some GDEs creates anaerobic conditions that slow decomposition of plant material facilitating development of organic soil, including peat and muck.

Focusing management attention on springs and other GDEs and their associated riparian areas is important because they sustain a disproportionate amount of biodiversity compared to adjacent uplands. Within the SMNRA recent surveys documented that 24 percent of the plant species known to exist within the SMNRA were found in the springs inventoried, which represented only 0.003 percent of the total land area. Springer et al. (in review) found similar results in Alberta, Canada, where 25 percent of plant species known to occur in the Province were found at the springs inventoried, which represented only 0.001 percent of the total land area. In addition, the Springs Stewardship Institute (2013) reported plant species densities at springs in Kaibab National Forest of 72.5 species per hectare, which was more than 23-fold higher than the average for the entire Forest. The cultural and economic significance of springs within local areas are also important factors, with their relative importance dependent on the context of the surrounding environments (e.g., the arid southwestern United States compared to the more mesic environments in the Northern Rockies).

With increasing recognition of the importance of groundwater-dependent ecosystems in supporting biological diversity and a host of cultural and economic needs, it is important to be able (a) to identify and describe maintenance and restoration-rehabilitation program needs and (b) to consistently implement cost-effective and scientifically supported maintenance and rehabilitation practices on these important sites.

Relationship to Other Methodologies

Methods described build upon other efforts to assess sites and to facilitate development of restoration project proposals. Descriptions of foundational documents used to develop this framework or considered by the authors are summarized below.

Watershed Condition Framework

Based on discussions with SMNRA managers, a primary objective was to develop a linkage with the Watershed Condition Framework (USDA Forest Service 2011),

including “nesting” GDE sites within those watersheds. The Watershed Condition Framework provides “a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands” and has become the agency’s primary avenue for focusing watershed management restoration and rehabilitation funding. Details on assessing the condition of watersheds are provided in the companion document Watershed Condition Classification Technical Guide (Potyondy and Geier 2011). Using a similar approach to Watershed Condition Classification for assessing site conditions was a second objective identified by SMNRA managers.

The process of adapting national condition assessment procedures to smaller areas of interest is also used in describing the status of hazardous fuels and ecological conditions described in Fire Regime and Condition Classes (FRCC) used in the interagency LANDFIRE program (see www.LANDFIRE.gov for additional information). National assessments of FRCC can be refined by using localized information and knowledge as described by the FRCC Guidebook (see www.frames.gov/partner-sites/frcc/frcc-guidebook-and-forms/ for additional information). The objectives of the methods described in this framework are similar to those described in the FRCC Guidebook related to the application of site-specific data to an area of interest.

Appendix 1 describes the criteria for assessing site condition using an approach that mirrors the logic and procedures presented in the Watershed Condition Classification Technical Guide (Potyondy and Geier 2011).

Forest Service Groundwater-Dependent Ecosystem Inventory Field Guides

The Forest Service has developed field guides for inventorying and assessing groundwater-dependent ecosystems. There are two protocol levels, Level I and Level II:

Level I inventories use methods described in the [GDE Level I Inventory Field Guide](#) (USDA Forest Service 2012a) and are designed to collect basic information regarding GDEs needed to protect and conserve these important features.

Level II inventories use methods described in the [GDE Level II Inventory Field Guide](#) (USDA Forest Service 2012b) and are designed to collect information needed to characterize GDE features or sites and in project planning.

Springs inventory data are stored in a national GDE Access database that can be queried to develop information used in the site condition and significance assessment processes. These data and other commonly available ancillary data sets were also used to test and refine the methods described in this paper.

SMNRA Implementation and Monitoring Audits

Implementation and monitoring audits (I/M Audits) of springs and riparian management projects conducted by METI, Inc. during 2011 (METI 2012) helped highlight the need for a more comprehensive approach to management and rehabilitation of springs within the SMNRA. A “management response framework” developed as part of the I/M Audit incorporates management direction in the Toiyabe Forest Plan (USDA Forest Service 1986) and the SMNRA General Management Plan (USDA Forest Service 1996) to the management of springs within the SMNRA. Specific common design features and management practices that could be applied during stewardship project proposal development on the SMNRA are identified in the Springs/Riparian Management Framework. Information on the management response framework is presented in Appendix 3.

Nevada Springs Restoration Workshop Committee

Specific springs' rehabilitation and restoration practices identified by the Nevada Springs Restoration Workshop Committee (2012) provide additional information regarding the effectiveness of these practices based on the collective experience of the committee. Meeting notes from the workshop were supplemented by Joseph T. Gurrieri (Nevada Springs Restoration Workshop Committee 2012) and have been incorporated into this framework, with some minor editing and formatting, as Appendix 4.

Spring/Wetland Condition Assessment Methods

There have been various efforts to assess the condition of wetlands: methods described by the EPA National Wetland Condition Assessment (U.S. EPA 2011), The Nature Conservancy methods guide on Groundwater and Biodiversity Conservation (Brown et al. 2007), U.S. Geological Survey National Wetlands Research Center, Desert Research Institute (Sada and Pohlman 2006), PFC for lentic systems (USDI 1999), Properly Functioning Condition for Fens (Weixelman and Cooper 2009), and the Springs Ecosystem Assessment Protocol (Springs Stewardship Institute, draft). However, those methods tend to have one or more of the following limitations: (a) they do not focus on groundwater-dependent ecosystems and their distinctive characteristics; (b) they only address a limited set of indicators (such as aquatic biota); or (c) they lack a process for prioritizing GDE sites.

Because of these limitations, these efforts could not be directly applied to the SMNRA. Therefore, it was necessary to develop the framework and analysis methods described in this document to assess springs within the SMNRA to formulate restoration-rehabilitation program needs and to provide a basis for consistently developing restoration-rehabilitation proposed actions.

Key Concepts and Terminology

The foundation of this framework is the concept of stewardship, which involves determining the condition of springs and GDEs and applying a variety of management strategies to maintain, rehabilitate, or restore these important ecosystems.

Restoration “is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” (SER 2004 as cited in USDA Forest Service 2006). Ecological restoration focuses on re-establishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions (see U.S. Forest Service Integrated Resource Restoration Glossary webpage: <http://www.fs.fed.us/restoration/IRR/glossary.shtml>). In the context of this document, restoration refers to all levels of site and habitat improvement efforts on the continuum of restoration regardless of the degree of similarity to an assumed pristine, pre-disturbance condition. Restoration includes both passive and active efforts as described below.

Rehabilitation, within the context of this framework, refers to a level of restoration that is defined by management objectives. Rehabilitation is not focused on restoring the site to pre-disturbance conditions, but rather improving the condition according to certain management objectives. Rehabilitation actions are generally constrained by funding, societal objectives, existing rights or agreements, or irreversible physical alteration limiting recovery potential.

Maintenance consists of those actions and management guidance that result in the maintenance of a spring or GDE site's existing ecological conditions and processes, particularly resiliency to disturbance.

Other key concepts related to springs and GDE stewardship used in this framework include active restoration/rehabilitation, passive restoration/rehabilitation, program budget formulation, program budget increments, and NEPA procedures.

Active restoration/rehabilitation is physical action designed to achieve desired conditions. Active restoration/rehabilitation involves physical manipulation of the site. The goal of active restoration/rehabilitation is to facilitate recovery and to allow natural processes to be re-established.

Passive restoration/rehabilitation is change in management that involves the reduction or removal of stressors. The goal of passive restoration/rehabilitation is to allow the site to recover on its own, through natural processes, without physical manipulation of the site.

Program budget formulation is the process used to develop and request program funding that supports the accomplishment of projects. Program budget formulation does not involve the summation of individual project proposals. Formulation relies on a combination of resource needs and organizational capacity to accomplish work. An implied goal of a program budget is to sustain a "stream" of projects over time within the capability of an organization and available skills.

Program budget increments represent various investment levels for program funding that are used within an area of interest as the basis for describing and characterizing stewardship program benefits and consequences for each increment.

NEPA procedures are established in the National Environmental Policy Act. Forest Service procedures and terms are described in detail in Forest Service Handbook (FSH) 1909.15. With a few exceptions, terms originating from these procedures are not further defined in this document and users will need to consult the FSH for the definition and a more complete description of agency procedures.

Methodology and Framework Overview

A phased approach for developing a springs and GDE restoration-rehabilitation program and project proposals is summarized in figure 1. The first phase involves determining where to focus stewardship program efforts within an area of interest. The second phase involves focusing on high priority sites to determine what actions to propose at those

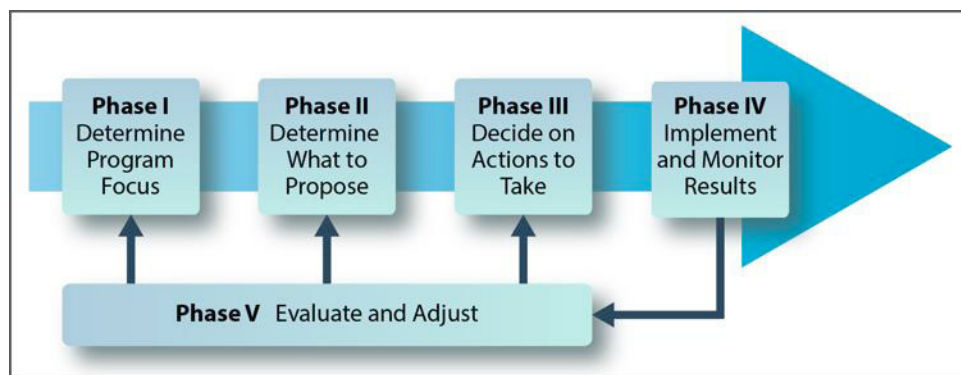


Figure 1. Restoration framework, development process.

sites. The third phase involves deciding on what actions to take and the fourth phase involves implementation of actions and monitoring results at specific sites. The fifth phase provides information that can be used to evaluate and adjust the other phases of the process.

The procedural steps associated with each phase of the restoration program development process are outlined in figure 2 and described in detail in the remainder of this document. Phase I of these methods was tested by using data from the SMNRA and Ashley National Forest.

The process presented here employs many concepts presented in the Watershed Condition Framework (USDA Forest Service 2011) and addresses similar needs to consistently represent conditions and restoration needs within the National Forest System (NFS), but at the site scale.

Key Point: Information presented for Phases II—V have not been tested and are provided to illustrate how the information used in program budget formulation (Phase I) can be used to develop agency proposed actions and their subsequent NEPA analysis and documentation. Because of time and contract limitations, Phase I analysis has relied on available information and will need to be reviewed and verified by SMNRA staff before these steps are considered as being completed.

Figure 2. Spring stewardship program formulation and proposed action development process.

Phase I—Determine Springs/GDE Stewardship Program Focus and Budget

- Step 1—Determine Site Condition Class
- Step 2—Determine Site Relative Significance
- Step 3—Determine Site Stewardship Priority
- Step 4—Characterize Stewardship Program Funding Needs
- Step 5—Formulate Springs/GDE Stewardship Program Budgets

Phase II—Determine What Actions to Propose at Priority Springs/GDE Sites

- Step 6—Determine Existing Condition
- Step 7—Describe Desired Condition
- Step 8—Determine the Purpose and Need for Action
- Step 9—Develop a Proposed Action

Phase III—Decide Which Actions to Take

- Step 10—Assess Environmental Effects
- Step 11—Document Environmental Analysis (DM, EA or EIS)
- Step 12—Issue NEPA Decision (DM, DN, or ROD)

Phase IV—Implement and Monitor Results

- Step 13—Develop Implementation Guidance
- Step 14—Implement Stewardship Actions
- Step 15—Report Accomplishments
- Step 16—Monitor Implementation and Effectiveness

Phase V—Evaluate and Adjust

Springs Stewardship Program Formulation and Proposed Action Development Process

This document describes procedures used to develop a spring's stewardship program budget and proposed actions for restoration/rehabilitation of high priority springs within the SMNRA.

Key Point: Methods described in this document are structured so that they could be used in other parts of the NFS and other public domain lands to provide a basis for consistently describing restoration program needs and a common foundation for developing maintenance and restoration-rehabilitation proposals for individual GDE sites. Program leads at the region and forest level would likely develop program funding proposals by using this process, with the goal of developing a program that leads to securing restoration project funding that could be used to implement site-specific proposals within a given area of interest.

Criteria used will need to be modified to address conditions and management concerns within the area of interest. Specific examples include: proposals for groundwater pumping or other water development that could affect GDEs or the evaluation of grazing impacts and prioritizing and planning restoration of grazed GDE sites.

This methodology is designed for application at broader scales to address needs for large numbers of GDE sites within an area of interest. Although many of the assessment and rehabilitation-restoration planning techniques described can be applied to a single GDE site, they are not designed for application at individual sites.

The framework's methodology was designed to use existing, available data sets to assess a large number of springs and other GDEs as the basis for describing program budget needs and for prioritizing sites for maintenance and rehabilitation-restoration efforts. The methodology is designed to serve as foundation for describing restoration-rehabilitation needs and the purpose of restoration-rehabilitation project proposals used to formulate agency proposed actions that initiate the agency's decision making under the National Environmental Policy Act (NEPA) procedures.

Phase I—Determine Springs/GDE Stewardship Program Focus and Budget

An important question facing managers on the Humboldt-Toiyabe National Forest, as in other locations, is where to focus GDE site maintenance and rehabilitation actions. Therefore, this phase was tested with actual spring inventory data from the SMNRA and the Ashley National Forest.

Ideally, site selection is done with an unbiased study design (such as systematic or random site selection) so that the data represent all of the springs for the area of interest. That was the case with the SMNRA data, which means that the data represent all of the springs of the SMNRA.

This phase involves five basic steps designed to determine relative priorities of springs or GDE sites and to characterize restoration program funding needs:

- Step 1—Determine Site Condition Class
- Step 2—Determine Site Relative Significance
- Step 3—Determine Site Stewardship Priority
- Step 4—Characterize Stewardship Program Funding Needs
- Step 5—Formulate Spring/GDE Stewardship Program Budgets

The objective of this phase is the characterization of spring/GDE site stewardship program funding needs to secure financial resources needed to accomplish spring or GDE site maintenance and rehabilitation. The premise is that without a sustained program of maintenance and rehabilitation within the area of interest, restoration efforts at individual sites will be ineffective in improving and maintaining the overall system of springs and GDE sites over time.

Key Point: Procedures described in this phase of the process were developed so they could be performed with GDE Level I Inventory data and other ancillary data and information commonly available to NFS administrative units.

Step 1: Determine Site Condition Class

The first step in the process was to assess the condition of each GDE site. This was intended to be a very general representation of the condition of the site to facilitate the prioritization process. This site condition classification was not intended to be a precise measure of a site's condition and therefore should not be used to evaluate status or trend.

The site condition classification uses indicators similar to those used in the Watershed Condition Classification Technical Guide (Potyondy and Geier 2011) that is part of the Watershed Condition Framework (USDA Forest Service 2011). Figure 3 displays the relationships and indicator sets used in Watershed Condition Assessment and Spring/GDE Site Condition Assessments. Springs or GDE site condition classes are determined for individual sites within individual watersheds. The 12 aquatic and terrestrial indicators used in the Watershed Condition Assessment process are summarized in figure 3. A total of eight indicators of physical and biological conditions are used in the springs/GDE site classification process (table 1).

Key Point: Watershed Condition Class determinations are made at the watershed scale and assess both aquatic and terrestrial conditions, whereas site condition classifications consider indicator conditions only within the spring or GDE site.

In designing the site condition classification, seven of the twelve Watershed Condition Assessment indicators were selected for use in the springs/GDE site condition classification because they apply at the site-level (see fig. 3). The other five watershed-scale indicators (Roads and Trails, Fire Regime or Wildfire, Forest Cover, Rangeland Vegetation, and Forest Health) were not used because they apply to the terrestrial uplands at the watershed-level rather than the site-scale. An additional indicator (which makes a total of eight) related to "Fauna" was added to the site condition classification to assess non-aquatic biota (such as mammals, birds, and insects) that may utilize the spring or GDE site. The Watershed Condition Classification indicator "Terrestrial Invasive Species" was broadened to include aquatic, as well as terrestrial, invasive species and was described as "Invasive Species" to account for invasive species effects on the condition of a spring/GDE site.

These indicators were then grouped into two categories (Physical and Biological) versus the four categories used in the Watershed Condition Assessment (Aquatic Physical, Aquatic Biological, Terrestrial Physical, and Terrestrial Biological). Weighting of indicator scores within these two categories was equal, just as the Aquatic Physical and Aquatic Biological categories had equal weight in the Watershed Condition Assessment process.

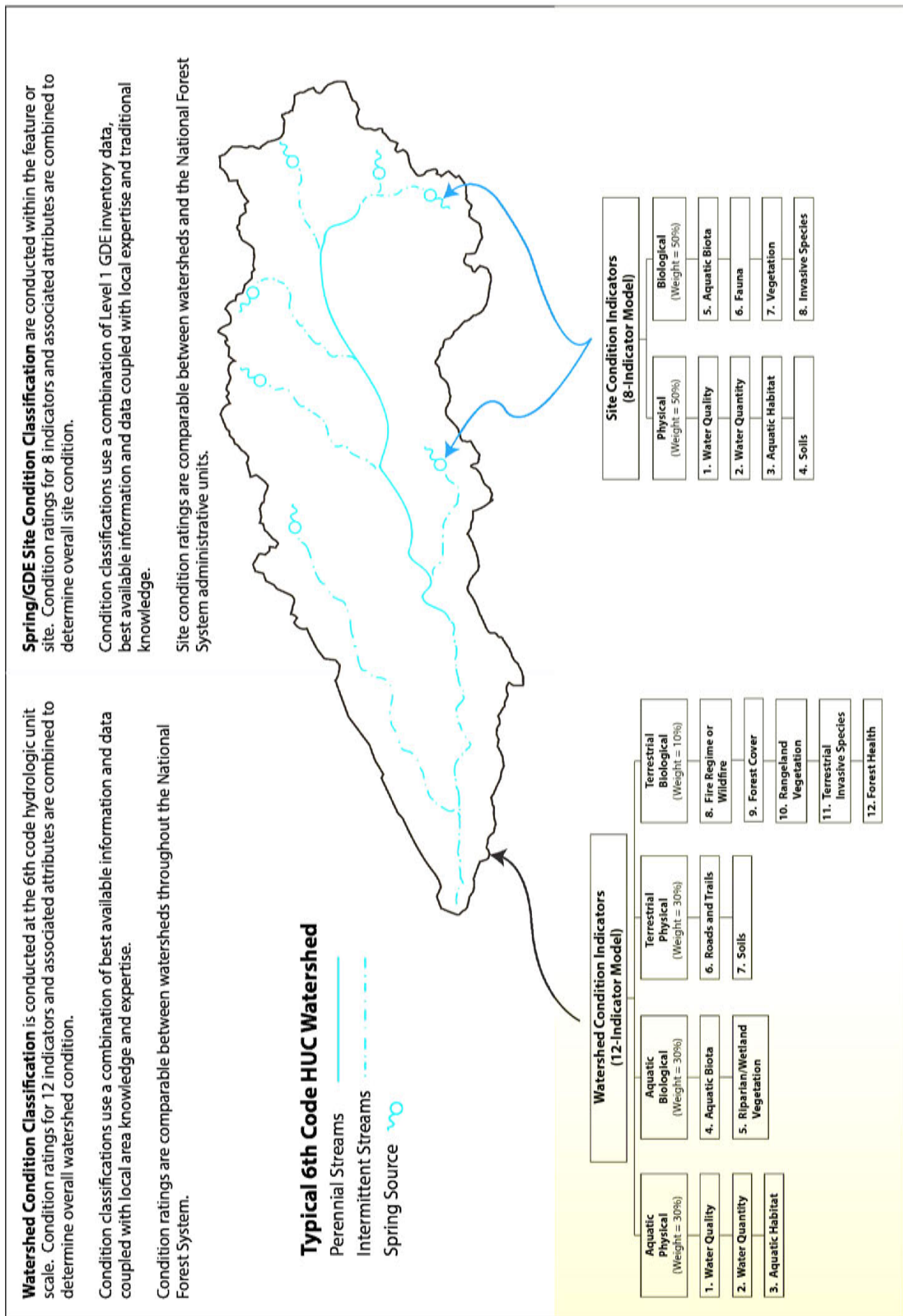


Figure 3. Comparison of watershed and site condition classification procedures.

Table 1—GDE inventory data used in the SMNRA spring condition classification.

Site Condition Indicator	Description	Supporting GDE Inventory Data and Ancillary Data Sets
Physical Indicators		
1. Water quality	Indicator of alteration of physical, biological or chemical, impacts to water quality.	“Water Quality: Changes in water quality (surface or subsurface) are not affecting the GDE site” (MIT #3). Disturbances, field notes and water quality data collected as part of the GDE inventories. Ancillary information such as other water quality data.
2. Water quantity	Addresses changes to the natural flow regime with respect to the magnitude, duration, or timing of the natural flow hydrograph.	“Flow Regulation: Flow regulation is not adversely affecting the site” (MIT #13). “Watershed Functionality: Within the watershed, no evidence suggests upstream/ up-gradient hydrologic alteration that could adversely affect the GDE site” (MIT #2). Supplemented with disturbances noted, flow measurement, and water table depth.
3. Aquatic habitat	Addresses aquatic habitat condition with respect to habitat fragmentation and channel shape and function.	“Runout Channel: The channel, if present, is functioning naturally and is not entrenched, eroded, or otherwise substantially altered” (MIT #5). Supplemented with disturbances noted and ancillary information.
4. Soils	Addresses alteration to natural soil condition, including productivity, erosion, and chemical contamination.	“Soil Integrity: Soils are intact and functional. For example, saturation is sufficient to maintain hydric soils, if present; there is not excessive erosion or deposition” (MIT #6). “Construction and Road Effects: Construction, reconstruction, or maintenance of physical improvements, including roads, are not adversely affecting the site” (MIT #14). “Recreational Effects: Recreational uses, including trails, are not adversely affecting the site” (MIT #17). “Landform Stability: No evidence indicates human-caused mass movement or other surface disturbance affecting the GDE site stability” (MIT #4). Supplemented with disturbances noted and other ancillary info on soils.

Table 1 (continued)—GDE inventory data used in the SMNRA spring condition classification.

Site Condition Indicator	Description	Supporting GDE Inventory Data and Ancillary Data Sets
Biological Indicators		
5. Aquatic Biota	Addresses the distribution, structure, and density of native and introduced aquatic fauna.	Insofar as they address aquatic fauna: “Faunal Species: Anticipated aquatic and terrestrial faunal species associated with the site environment are present” (MIT #10). “Threatened, endangered, or sensitive species; SOI/SOC; or focal faunal species: Anticipated faunal species are present (will vary by ecological region and will require some baseline information)” (MIT #11). Supplemented with observations and notes on aquatic fauna.
6. Fauna	Addresses the distribution, structure, and density of native and introduced terrestrial fauna at the GDE site.	Insofar as they address terrestrial fauna: “Faunal Species: Anticipated aquatic and terrestrial faunal species associated with the site environment are present” (MIT #10). “Threatened, endangered, or sensitive species; SOI/SOC; or focal faunal species: Anticipated faunal species are present (will vary by ecological region and will require some baseline information)” (MIT #11). Supplemented with observations and notes on terrestrial fauna.
7. Riparian-Wetland Vegetation	Addresses the function and condition of riparian vegetation along streams, waterbodies, and wetlands.	“Vegetation Composition: The site includes anticipated cover of plant species associated with the site environment, and no evidence suggests that upland species are replacing hydric species” (MIT #7). “Vegetation Condition: Vegetation exhibits seasonally appropriate health and vigor” (MIT #8). “Threatened, endangered, or sensitive species; SOI/SOC; or focal floral species: Anticipated floral species are present (will vary by ecological region and will require some baseline information)” (MIT #9). Supplemented with other information on the condition and abundance of wetland and native vegetation.
8. Invasive Species	Addresses potential effects to soil, vegetation, and water resources due to invasive species (including vertebrates, invertebrates, and plants).	“Invasive Species: Invasive floral and faunal species are not established at the site” (MIT #12) in terms of non-aquatic biota. Supplemented with observations of invasive species and Natural Resource Manager-Terra (noxious weeds and invasive species).

Appendix 1 contains a description of springs/GDE site condition indicators and rule sets for determining conditions at individual sites using GDE Level I inventory data and information and ancillary data sets commonly available to most NFS administrative units.

The site condition classification process described in this framework was developed so the analysis could be conducted by using data collected using the [GDE Level I Inventory Field Guide](#) (USDA Forest Service 2012b), or data collected using the [GDE Level II Inventory Field Guide](#) (USDA Forest Service 2012a)

Key GDE Level I Inventory Field Guide data used in the site condition classification include the following:

- The management indicator tool or MIT that consists of a series 25 questions (answered true or false) about the effects of management and other uses and activities at a spring or GDE site for the following categories: hydrology, geomorphology and soils, biology, disturbances, and administrative context. Some of those MIT questions address the eight site condition indicators and they are listed in table 1 (the MIT question and number that applies to each indicator are in the right-hand column).
- Information on disturbances observed as part of the GDE inventory was also used to determine or refine the site condition scores as noted in table 1.

Figure 4 illustrates how data from various sources are used to develop a rating for individual indicators. Table 1 describes how information from Level I Springs/GDE site inventories is used to assess springs/GDE site indicators for an area of interest. The table also identifies other ancillary data that could also be used to refine the site condition classification for each indicator, such as other data or reports from other studies (e.g., annual aerial insect and disease surveys).

Descriptions of each indicator and detailed rule sets developed for the SMNRA spring condition classification are presented in Appendix 1.

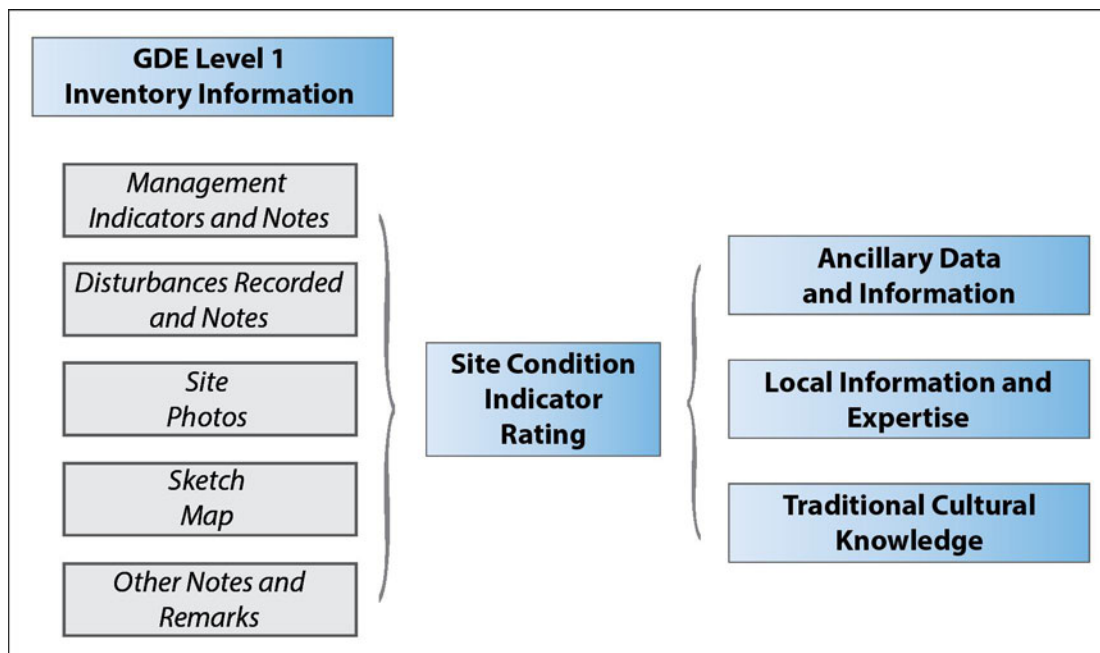


Figure 4. Data used to develop site condition indicator ratings.

Springs or GDE site condition class was determined using a similar process to the Watershed Condition Class Technical Guide (Potyondy and Geier 2011). That process uses qualitative data and converts it to a numeric score that is then used to calculate a composite score used to determine the condition class.

Condition classes for springs/GDE sites were determined by the following:

1. GDE Level II data and ancillary data were used to rate each of the eight indicators. A “yes” (good) answer was assigned a 1 value, and a “no” (poor) answer was assigned a 3 value. In some cases, disturbance or other ancillary data were used to change value to a 2 (from either 1 or 3).
2. The average of the indicator values within each of the Physical and Biological categories was then calculated.
3. The values for the two indicator categories were averaged (rounded to one decimal) to obtain a site condition score.
4. Sites were then assigned to a condition class based on the site condition score. The following class intervals were used to be consistent with those used in Watershed Condition Classification:

Site Condition Class 1 (Good) = 1.0 to 1.6

Site Condition Class 2 (Fair) = 1.7 to 2.2

Site Condition Class 3 (Poor) = 2.3 to 3.0

Key Point: The springs or GDE site condition scores are the result of qualitative assessment intended for determination of the site condition class. These scores or values should not be used to develop monitoring objectives or used to quantitatively describe sites and their conditions. Establishment of objectives for site or program monitoring would require quantitative data that are fully supported by and adequate statistical and sampling design.

Step 2: Determine Site Relative Significance

The next step was to determine the relative significance of springs/GDE sites within the area of interest to prioritize the sites for management activities. Significance “elements” appropriate to the SMNRA were developed to evaluate the rarity and importance of physical, biological, and social/cultural/economic characteristics of each site and the relationship of sites to each other (relative site significance). The significance elements are listed in table 2 and described in more detail in Appendix 2.

Because this is “relative” site significance, the scoring system was based on the range of values for the sites in the SMNRA. To determine the highest significance sites, the range of values was divided into thirds (tertiles, which is similar in concept to commonly used quartiles) and each third was associated with a relative-site significance class:

High = Total score in lowest third of range of values

Medium = Total score in middle third of range of values

Low = Total score in highest third of range of values

As with site condition, relative site significance is a qualitative assessment that was only intended for this prioritization process. Comparing site significance within the area of interest, the SMNRA in this case, is appropriate and useful; however, it would not be appropriate to compare significance for sites from different areas. Different elements would need to be developed for other geographical areas.

Table 2—Elements used to determine relative spring/site significance within the SMNRA.

Category	Element	Description	Rationale
Physical elements^a	Discharge	A measure of the amount of water (flow) that discharges from a spring or groundwater supported wetland (during the growing season).	Sites with larger discharge are generally uncommon therefore can be important ecologically because of their ability to support wetland flora and fauna.
	Contributing aquifer	The size of the contributing aquifer. The size may be within or beyond the extent of surface watershed.	Sites with larger aquifers are significant because they typically have more constant temperature and more unique water chemistry than small aquifers.
	GDE feature size or extent	The size of the GDE feature (in units such as m ² or acres or hectares).	Larger sites are generally less common and therefore potentially have unique ecological characteristics.
	Feature type	The type of spring or wetland in terms of the physical characteristics. Spring and wetland types from Springer and Stevens (2008) could be used to categorize each site.	Unusual types potentially have unique ecological characteristics.
	Isolation	A measure of the distance from the GDE feature to other GDE features that are not part of the same complex of groundwater discharge features.	Isolated GDE sites are particularly valuable ecologically (such as for wildlife) because of the limited availability of the habitat they provide.
	Surface water connectivity	A general determination of whether the spring contributes base-flow to a perennial stream.	Sites that have enough flow to support perennial streams may provide unique habitat.
Biological elements	TES and focal species	The presences of threatened, endangered, sensitive or focal species.	Sites that support TES and focal species are important because of the limited abundance of those species.
	Vegetation type	The vegetation type, which is a primarily based on the dominant (most abundant) plant species.	Sites that support unusual wetland vegetation types are important because of the rareness of such vegetation and associated habitat.
	Invasive or noxious species	The presence of invasive or noxious plant or animal species at the site (based on lists maintained by states or regions).	The ubiquity of invasive and noxious species makes sites without those species valuable ecologically.
Social and cultural significance	Social, cultural, and economic elements	Sites that are or have been used by people and societies. This includes sites with artifacts and structures and sites with significant meaning to certain communities, including cultural or religious significance.	Sites with important social, cultural and economic elements that have value to society or communities.

^a An additional element considered but not used for the SMNRA was the presence of “Organic Soils” at a spring or GDE site. Development of peat is an important criterion for differentiating fens from other groundwater-supported wetlands. Because there was little to no organic soil present at springs within the SMNRA, this element could not be used to differentiate relative site significance.

Step 3: Determine Site Stewardship Priority

After the GDE site condition and relative site significance were determined, the relative priority of GDE sites for stewardship program investments was established using a ranking process. Using the approach described in the Watershed Condition Framework (USDA Forest Service 2011), priority was placed on those sites that were in good condition. This follows the principle that “ecosystems, like Humpty Dumpty, are vastly easier to preserve than they are to reassemble” (Black 2003 as cited in Lavigne 2005) and that “it is always easier to protect ecosystems and ecological health than to restore it (Meine 2004 as cited in Lavigne 2005).

Table 3 was used to sort individual sites into different priority rankings by intersecting site condition ratings and relative site significance for the SMNRA. The highest priority ranking was given to sites that are both in good condition and have high relative ecological significance. Sites with the highest priority sites for stewardship investments are located in the upper left corner of table 3 and lowest priority sites in the lower right part of the table.

The pattern of priority ranking assignments places emphasis on stewardship actions associated with those sites with a “good” site condition rating of “high” or “medium” significance because of lower costs associated with monitoring and maintaining current conditions. The second area of focus within the priority setting process are those sites in condition class 2 with a site significance of “high” or “medium” because of a combination of their significance and the relative lower cost of restoring or rehabilitating these sites using the “Humpty Dumpty” model – easier to put back together than sites in “poor” condition. The third focus area within the priority setting process are those sites of “low” relative significance that are in “good” or “fair” condition because they are less ecologically significant than sites in the higher priority groups and can still be restored or rehabilitated with lower total investment costs. The lowest priority group consists of those sites in “poor” condition regardless of their significance because of the significantly higher cost of restoration or rehabilitation.

Table 3—Determining GDE site treatment priority rankings.

GDE Site Significance	GDE Site Condition Class 1 (Good; Functioning Properly)	GDE Site Condition Class 2 (Fair; Functioning At Risk)	GDE Site Condition Class 3 (Poor; Impaired)
High	Rank = A	Rank = C	Rank = G
Medium	Rank = B	Rank = D	Rank = H
Low	Rank = E	Rank = F	Rank = I

Note: Letters are used for the ranking to avoid confusion with condition class ratings.

Step 4: Characterize Stewardship Program Funding Needs

This step in the process considers the condition of the watershed surrounding individual sites to provide management context used to characterize program funding needs. For each spring, the watershed condition classification for the watershed in which the spring is located and the site’s condition and relative significance is used to determine the “budget class” associated with each site. Budget classes are then used to characterize stewardship program funding needs.

The rationale for this approach stems from the management strategy outlined in the Watershed Condition Framework. Just as “good” condition watersheds are a high priority for stewardship investments, “good” condition sites have a higher priority within restoration programs. Spending time and money to maintain and restore sites within “good” condition watersheds is a wise investment because those sites are less likely to be negatively impacted by problems in the watershed. Conversely, spending time and money on “poor” condition sites in “poor” condition watersheds warrants a lower priority for expending limited resources.

Criteria for assignment of individual sites to budget classes are presented in table 4, with the highest budget class priority in the upper left portion of the table and lowest priority budget class in the lower right part of the table.

Within the area of interest, each site is assigned to a specific budget class with a similar stewardship focus and rationale for stewardship actions as described in table 5.

In addition to helping characterize restoration needs, knowledge about the relative importance of individual sites fosters protection and conservation of these sites that are in good condition and have high significance.

Table 4—Characterization of springs stewardship program budget needs using budget classes.

Watershed Condition Class	Site Treatment Priority Rankings								
	A	B	C	D	E	F	G	H	I
1	M-1	M-1	R-1	R-2	R-3	R-4	R-4	R-4	R-4
2	M-1	M-1	R-2	R-3	R-4	R-4	R-4	R-4	R-4
3	M-2	M-2	R-3	R-4	R-4	R-4	R-4	R-4	R-4

Note: M = Maintenance and R = Restoration. Numbers represent budget classes within each cell.

Table 5—Springs/GDE stewardship program budget class descriptions.

Stewardship program budget classes	Stewardship focus	Rationale
Maintenance Class 1 (M-1)	Site condition: good Significance: high or medium Watershed CONDITION CLASS: good (class 1) or fair (class 2)	Departure from desired conditions is low while the significance of sites is relatively high. Maintenance costs are relatively low. These are core watershed features whose function must be maintained to sustain overall watershed condition. In some cases no action may be needed to maintain these sites. Awareness of these sites, and their unique characteristics, can facilitate their conservation and protection.
Maintenance Class 2 (M-2)	Site condition: good Significance: high or medium Watershed condition class: poor (WCC rating 3)	These are core watershed features whose function must be maintained to provide an anchor point for future restoration/rehabilitation of these watersheds. Without these sites remaining intact, the ability to restore proper watershed function is not feasible.
Restoration Class 1 (R-1)	Site condition: fair Significance: high Watershed condition class: good (WCC rating of 1)	Restoration of these high significance sites within watersheds that are functioning at risk could benefit the overall function of the watershed.
Restoration Class 2 (R-2)	Site condition: fair Significance: high or medium Watershed condition class: good or fair (WCC rating 1 or 2)	Efforts to improve these sites that are in fair condition, and of medium to high significance, can help improve watershed condition.
Restoration Class 3 (R-3)	Site condition: good or fair Significance: various Watershed condition class: various	Investments in rehabilitation and restoration could maintain or improve individual sites, but overall condition and significance of these sites and watersheds warrant a low investment priority.
Restoration Class 4 (R-4)	In combination, Site condition, Significance, and Watershed condition class are low or poor	The generally poor condition (site and watershed) and low significance of these sites warrant the lowest investment priority.

Step 5: Formulate Springs/GDE Stewardship Program Budgets

The goal of this step in the process is to portray total stewardship (maintenance and rehabilitation) program needs for all GDE sites inventoried within the SMNRA. Program funding needs are then represented as increments within the total program that serve as the basis for requesting funding from various sources. Program levels or increments can then be represented as shown in the following example:

Base Program = Maintenance Class M-1 and M-2 + Restoration Class R-1

Program Increment 1 = Restoration Class R-2 + Base Program

Program Increment 2 = Restoration Class R-3 + Base Program + Program Increment 1

Total Program Needs = All Maintenance and Rehabilitation needs, including Restoration Class R-4

Program increments can then be represented in both tabular and graphic form, as illustrated in figure 5 and table 6. A representation of program needs for different program funding horizons can also be displayed with 3-, 5-, and 10-year program horizons as depicted in table 6.

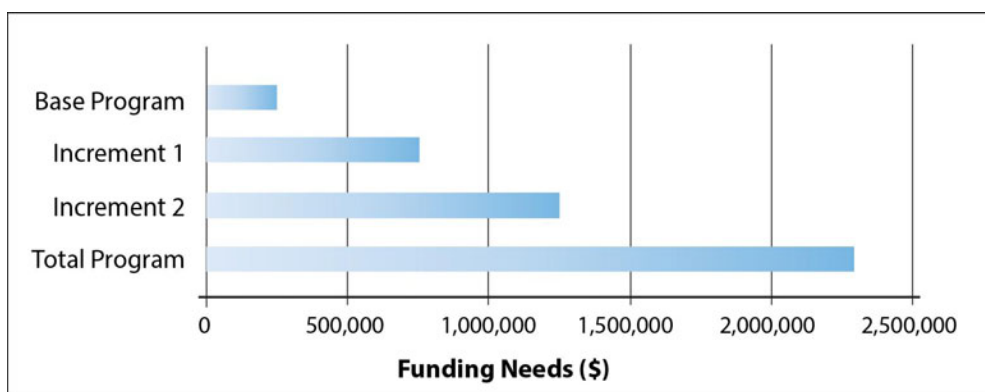


Figure 5. Hypothetical springs/GDE stewardship program cost representation (information presented in this table is for illustration only; program funding amounts are hypothetical and do not represent actual cost projections).

Table 6—Hypothetical springs/GDE stewardship program increments (information presented in this table is for illustration only; program funding amounts are hypothetical and do not represent actual cost projections).

Program Level	Total Funding Needs	Annual Needs 3-Year Program	Annual Needs 5-Year Program	Annual Needs 10-Year Program
Base program	\$94,550	\$31,517/year	\$18,910/year	\$9,455/year
Increment 1	\$308,718	\$102,906/year	\$61,744/year	\$30,872/year
Increment 2	\$616,000	\$205,333/year	\$123,200/year	\$61,600/year
Total program	\$2,275,000	\$758,333/year	\$455,000/year	\$227,500/year

Phase II—Determine What Site-Specific Actions to Propose at Priority Springs/GDEs

Phase II involves identification and proposal of actions to restore or rehabilitate a spring or other GDE site or group of sites to achieve or move toward desired conditions. Management actions designed to move springs/GDE sites toward desired conditions is important because of the valuable ecological functions of these systems including: sustaining endemic species; providing refugia for maintaining biological diversity; serving as source of individual species to recolonize adjacent sites following disturbance; sequestration of carbon; maintaining base streamflows in a watershed; providing water sources in large arid expanses; and as barometers of ecosystem health. The site condition indicators described in the steps below provide a tool to document impairment to these functions and the identification of spring/GDE site restoration-rehabilitation proposals.

Key Point: Phases II through IV have not been tested and are presented to demonstrate how information from Phase I can be used in the development, implementation, and monitoring of proposed actions.

Developing proposed restoration actions involves the following steps:

Step 6—Determine Existing Condition

Step 7—Describe Desired Condition

Step 8—Determine the Purpose and Need for Action

Step 9—Develop a Site-Specific Proposed Action

Key Point: Unlike the analysis conducted in Phase I, Phases II through IV require data from GDE Level II inventories to accomplish these analysis steps.

Information provided in the following appendices includes more detail and are referenced in one or more of the steps included in Phase II:

Appendix 1—Rule Sets for Determining Spring/GDE Site Conditions

Appendix 3—SMNRA Springs/Riparian Management Response Framework

Appendix 4—Nevada Springs Restoration Practices

Step 6—Determine Existing Condition

At this point in the process, more detailed data about the site should be collected using the GDE Level II Inventory Field Guide. Unlike Step 1 that uses GDE Level I data, Step 6 of the process applies this improved data set in characterizing the existing condition of an individual site using the rule sets described in Appendix 1.

The GDE Level II inventory data provide the ability to characterize vegetation, soil, hydrology, fauna, and disturbances at the site. Table 7 describes GDE Level II data and information that can be used to describe the existing condition of springs or GDE site indicators. These data can be compared to desired conditions (Step 7) to identify what needs to be done to achieve desired conditions (Step 8). The GDE Level II data can also provide a baseline of the current conditions that can be compared to conditions after management actions are implemented. This before and after comparison is a valuable tool in evaluating the success of restoration efforts (see Phase IV).

Table 7—Existing condition classification indicators from GDE level II data and information.

Site Condition Indicator	GDE Level II Inventory Data Used To Assess Existing Condition
Physical Indicators	
1. Water quality	Evaluate water chemistry data, which is collected systematically at the site. In addition use: Water Quality (MIT #3) Disturbances noted
2. Water quantity	Evaluate water table depth and/or spring flow rate, which are collected systematically at the site. In addition use: Flow Regulation (MIT #13) Watershed Functionality (MIT #2) Disturbances noted
3. Aquatic habitat	Evaluate vegetation data and associated settings of quadrats. In addition use: Runout Channel (MIT #5) Disturbances noted
4. Soils	Evaluate soils data, which are collected systematically at the site. In addition use: Soil Integrity (MIT #6) Landform Stability (MIT #4) Disturbances noted
Biological Indicators	
5. Aquatic biota	Evaluate data on presence or abundance of aquatic biota. In addition use: Faunal Species (MIT #10) in terms of aquatic biota TES, SOI/SOC, Focal Faunal Species (MIT #11) in terms of aquatic biota
6. Fauna	Evaluate data on presence or abundance of terrestrial biota. In addition use: Faunal Species (MIT #10) in terms of terrestrial biota TES, SOI/SOC, Focal Faunal Species (MIT #11) in terms of terrestrial biota
7. Riparian/ wetland vegetation	Evaluate data on abundance of plant species and summaries such as the prevalence index and cover of non-native species. In addition use: Vegetation Composition (MIT #7) Vegetation Condition (MIT #8) TES, SOI/SOC, Focal Floral Species (MIT #9)
8. Invasive species	Evaluate data on abundance of invasive species. In addition use: Invasive Species (MIT #12)

Step 7—Describe Desired Condition

Desired conditions are used to describe the needs and purpose of maintenance and restoration and provide the basis for developing proposed treatments. Desired conditions may be based on ecological or social objectives, or both. Desired ecological conditions are typically driven by the desire to reestablish the primary structural and functional components of an ecosystem. Desired conditions for local landscapes are developed by stakeholders and represented in terms of Forest Plan goals and objectives for individual management areas and are informed by the best available science. Desired conditions constitute a framework for ecological sustainability and should be clearly described to focus management proposals.

The characteristics used to describe desired conditions for a site should be described using the same indicators that are used to determine existing conditions (Step 6).

Table 8—Generic springs/GDEs desired condition descriptions.

Site Condition Indicator	Desired Condition
Physical Indicators	
1. Water quality	• Water chemistry is within the anticipated range of variability for the site, including suitability for the plants and animals present, or desired, at the site. • No pollution of water is evident at the site.
2. Water quantity	• Groundwater discharge is sufficient to support riparian/wetland communities of plants and animals. In some settings this means assuring that water levels remain at or near the surface to maintain saturated soil conditions and/or no net decomposition of peat. • No flow regulation at the site, or flow regulation does not adversely impact ecological function. • Spring flow (if expected for the site) is within the anticipated range of variability. • Surface and groundwater flow within the watershed are not significantly altered.
3. Aquatic habitat	• No channel incision or headcuts uncharacteristic of spring type. • No excessive erosion. • No habitat destruction by animals, people or vehicles. • Area of GDE is maintained, providing habitat for aquatic biota appropriate for the site, particularly for species of concern. • Culverts are designed and maintained to allow aquatic organism passage.
4. Soils	• Soils are intact and functional, consistent with the spring type. • Soils support (or have the capability to support) riparian/wetland vegetation. • Minimal erosion, trampling, excavation, or other disturbance to the soil at the site. • Roads do not pass through the site. • Roads adjacent to the site do not cause landform instability, sediment input or other negative effects to the site. • Trails have minimal impact on the site.
Biological Indicators	
5. Aquatic biota	• Anticipated abundance of native aquatic biota. • Non-native aquatic biota does not dominate the site.
6. Fauna	• Anticipated abundance of native terrestrial biota. • Non-native biota does not dominate the site.
7. Riparian/wetland vegetation	• Anticipated cover of native riparian/wetland plant communities that are in healthy condition. • Species indicate the presence of wetland soils and water table level appropriate for the site. No encroachment of upland vegetation.
8. Invasive species	• Native plant and animal species dominate the site. • Invasive species are not established at the site.

Generic desired condition statements are provided in table 8. These desired condition statements should be modified to reflect site-specific conditions and can rely on additional information gathered using GDE Level II Field Inventory data.

Refining Desired Condition Descriptions

The desired condition statements need to be based on the potential for a site, given the environmental conditions and constraints for the geographic location of the site. In some cases it may not be possible to restore a site to the pre-disturbance conditions because of the level of disturbance or changes in conditions in and around the site.

Desired condition descriptions for each of the indicators for the desired level of functionality may be refined using pre-disturbance conditions where historical information is available or from reference sites. Specific sources of information on desired condition include:

- Knowledge about the site's natural condition based on data, historic photographs, aerial photography, early site descriptions, surveys, journals, and, information gleaned from literature search, or personal accounts obtained from individuals knowledgeable about the history of the site.
- Conditions at a comparable reference site – a site that is minimally impacted by human activities or other factors such as introduced or invasive species.

It may be desirable to describe desired conditions to reflect a management determination that resulted in an irreversible condition (e.g., establishing a spring box for a community potable water supply) for some indicators or attributes. In these instances, desired conditions can be developed using the condition classification descriptions for each indicator or attribute in Appendix 1 at the “fair” or “poor” level.

Step 8—Determine the Purpose and Need for Action

Once the desired conditions are identified they can be compared to the existing conditions to determine those indicators needing improvement and the purpose of different actions. This information is used to propose actions needed to improve the site's conditions toward the desired conditions (Step 7). Examples of conditions that prevent a site from meeting the desired condition include:

- Water quality impairment,
- Flow alteration,
- Excessive erosion and sedimentation,
- Presence of non-native or invasive plant or animal species,
- Damage to vegetation or soil (by animals, vehicles, or people),
- Structures or activities that alter the hydrology of the site, and
- Roads or trails in or near the site that affect hydrology or produce sediment.

The impairments listed above, which are used to assess and remedy conditions that are not at desired levels, will be identified and addressed using the indicators described in this framework.

Maintenance and rehabilitation needs can be identified using table 9 to describe the need and purpose associated with each of the indicators used to assess the existing condition (Step 6) and desired condition (Step 7). The agency administrator or responsible official determines which of these needs to respond to within the overall context of managing the administrative unit. Although needs may exist on an individual site, the responsible official determines which of these to pursue as part of an agency proposal.

In developing and describing proposed actions, it is important to consistently describe the purpose of restoration using common terminology. The Key Concepts and Terminology section of this framework provides terms and definitions related to restoration. An example of how to identify the need for restoration-rehabilitation actions and their purpose is presented in table 9. This information (purpose and need) is used to formulate a proposed action (Step 9).

Table 9—Hypothetical restoration and rehabilitation project need and purpose for a rheocrene spring.

Site Condition Indicator	Existing Condition	Desired Condition	Maintenance or Rehabilitation Need and Purpose of Actions
Physical Indicators			
1. Water quality	Poor	Good	Need: The primary factors affecting water quality are damage to vegetation and soil caused by off-highway vehicle (OHV) use and ungulates. These disturbances in and adjacent to the spring site and outflow channel have led to erosion, channel widening, sediment in the channel and associated impairment of water quality. Purpose: Reduce unauthorized OHV use off designated routes upslope and divert overland flow from existing roads that provides sediment sources into the spring, and stabilize sediment sources. Maintain fences to limit ungulate use of riparian vegetation.
2. Water quantity	Good	Good	No action needed
3. Aquatic habitat	Good	Good	No action needed
4. Soils	Poor	Fair	Need: Roads that are open to OHV use and the FDR # XXX traverses this site. Sedimentation and culvert blockage on the FDR # XXX road have channeled overland flow along the road, causing erosion and sediment delivery to the creek. OHV use on designated routes above the spring source is incising and deepening the roadway channeling overland flow into the spring source. Purpose: Improve compliance with motor vehicle use restrictions. Repair road drainage and replace blocked culvert with hard native-surface low-water crossing.
Biological Indicators			
5. Aquatic biota	Fair	Good	Need: Recovery from past disturbance to the outflow channel has led to a proliferation of watercress, an aquatic colonizing species that may temporarily inhibit springsnails, but is useful for trapping sediment and re-building stream banks. Non-native fish have been introduced and may affect springsnails and may affect springsnail habitat, however, these effects are not understood. Purpose: Time without disturbance is needed for later successional plant species to establish on the stream margins, displacing watercress, and continuing the development of a narrower, deeper channel that will support aquatic biota. Restocking of non-native fish should be discouraged.
6. Fauna	Poor	Good	Need: Fences built in the past were not built to exclude elk. Therefore the fences need to be modified to keep elk out. Alternative water sources are available downstream from the existing enclosure. Purpose: Prevent elk from entering the spring/riparian zone and causing damage to vegetation, soil, streambanks and aquatic organisms.
7. Riparian/ wetland vegetation	Fair	Good	Need: Excessive disturbance in and around the spring orifice by wild horses, burros, and elk have altered the native plant communities, which has likely led to a decline in some butterfly host and nectar plant species. Purpose: Exclude wild horses, burros, and elk from the spring site. Design the enclosure to take advantage of natural features and anchor points. Wild horse and burro populations continue to exceed desired AMLs resulting in unacceptable impacts to riparian vegetation and aquatic biota (springsnails) therefore continued maintenance of the enclosure is needed.
8. Invasive species	Good	Good	No action needed

In this example, when an indicator's existing condition rating is the same as the desired condition, no actions other than site monitoring and maintenance are needed; therefore these actions are not carried forward as part of developing an agency proposed action since "no action" is required in the context of NEPA. In this example, the current condition for indicators of Water Quantity (#2), Aquatic Biota (#3), and Invasive Species (#8) are currently achieving desired conditions; therefore, no actions are warranted.

Step 9—Develop a Site-Specific Proposed Action¹

Proposed actions for restoration/rehabilitation of a site or GDE feature are developed based on the initial site condition classification (Step 6) and the identification of desired conditions (Step 7) that are used to determine if existing conditions for a spring or site do not meet the desired conditions (Step 8). Proposed actions should be developed, evaluated, and modified based on input from stakeholders prior to initiating the NEPA process. These efforts may include on-site discussions with interested and affected stakeholders.

Design and mitigation measures used to describe a proposed spring or GDE site restoration-rehabilitation proposed action should be developed from a combination of practices described in the SMNRA Springs Management Response Framework (Appendix 3) and by the Nevada Springs Restoration Workshop Committee (Appendix 4). Best management practices (BMPs) for the HTNF and those described in the Soil and Water Conservation Practices Handbook (USDA Forest Service, in progress)² should be incorporated into the proposed action as design measures.

Although planning restoration-rehabilitation actions for different sites will have a similar planning approach, each project presents unique requirements, challenges, constraints, and unknowns. In developing a proposed action, the strengths and weaknesses of various options should be evaluated by using considerations such as the following:

- Cost and available funding
- Constraints
 - o Structures
 - o Water rights
 - o Land and, or, water use
 - o Land ownership
 - o Cultural values
- Likelihood of success
- Time required for completion

The "management response framework" presented in Appendix 3 serves as a starting point for addressing objectives, standards, and guidelines that apply to the SMNRA that are described in the Toiyabe Forest Plan and the General Management Plan for the SMNRA (Forest Plan Amendment #4).

¹ The term "agency proposed action" is used here consistent with definitions in the National Environmental Policy Act (NEPA) and the FS NEPA Practices Handbook (FSH 1909.15). It represents a formal proposal made by the responsible official that initiates the NEPA process. Prior to this, point actions are considered "program proposals."

² The Forest Service is currently revising this Handbook, which addresses specific measures related to spring water source development.

These practices have been evaluated and determined to be effective based on the audit of projects implemented on the SMNRA (METI2012). Interdisciplinary teams are encouraged to use the design measures and management practices described in the management response framework as a starting point for developing proposed actions.

Proposed actions can be refined using the spring restoration practices presented in Appendix 4, which describes restoration actions that have been successfully used in Nevada. Information in this appendix characterizes restoration actions as either “passive” or “active.” These terms are defined in the Key Concepts and Terminology section of this framework.

Passive restoration examples include:

- ✓ Administrative regulations restricting or prohibiting vehicle use of a site to eliminate or reduce water pollution, site damage, and soil erosion;
- ✓ Reduction or cessation of water diversion to increase availability of water for aquatic biota and plants, and to support habitat for terrestrial and aquatic wildlife; and
- ✓ Reduction in livestock use to allow vegetation and soil conditions to improve, etc.

Active restoration examples include:

- ✓ Removal (manually or with chemicals) of invasive or non-native species,
- ✓ Fencing or barrier construction designed to prevent site access by vehicles or animals, and
- ✓ Construction of physical improvements designed to enhance a channel or wetland function.

Additional active and passive restoration actions appropriate for Nevada are provided in Appendix 4.

Key Point: In describing an agency proposed action, the use of active or passive restoration practices should be limited to those actions that require a NEPA decision document. In some instances, passive restoration measures do not require documentation in a NEPA decision document to implement (e.g., enforcement of vehicle use restrictions or prohibitions, establishment of public information or education programs, or the use of natural revegetation to restore vegetation cover composition and structure), while others do (e.g., establishing motor vehicle use restrictions or prohibitions using a forest supervisor’s special order). Additional guidance on this point is provided in FSH 1909.15, Section 11.2.

An illustration of how to identify maintenance and rehabilitation actions for a spring is provided in table 10. Information from table 10 is used to frame the proposed action and only those site condition indicators requiring action to achieve desired conditions are included in the example of developing an agency proposed action. Active and passive restoration actions are derived from the Management Response Framework (Appendix 3) and the Nevada Springs Restoration Workshop Committee (Appendix 4).

After developing a proposed project design, a funding proposal can be developed based on the estimated cost of the restoration actions. A well-written proposal is an important tool to explain the project, including the costs and anticipated accomplishments. The proposal is used to communicate the benefits and value of the project to stakeholders, particularly to potential funders.

Table 10—Example of developing an agency proposed restoration-rehabilitation action.

Site Condition Indicator	Restoration or Rehabilitation Need and Purpose	Potential Agency Restoration Actions
Physical Indicators		
1. Water quality	Need: The primary factors affecting water quality are damage to vegetation and soil caused by off-highway vehicle use and ungulates. These disturbances in and adjacent to the spring site and outflow channel have led to erosion, channel widening, sediment in the channel and associated impairment of water quality. Purpose: Reduce unauthorized OHV use off designated routes upslope and divert overland flow from existing roads that provides sediment sources into the spring, and stabilize sediment sources. Limit ungulate use of riparian vegetation.	Passive: Allow revegetation of disturbed areas to occur naturally. Active: Maintain the original enclosure fence design and maintain the fence. Divert channeled flow on OHV routes using rolling dips or other low maintenance drainage structures. Enforce the use of designated OHV routes within the watershed.
4. Soils	Need: Roads that are open to OHV use and the FDR # XXX traverses this site. Sedimentation and culvert blockage on the FDR # XXX road have diverted flow onto the road, causing erosion and eventually transporting sediment into the spring brook/creek. OHV use on designated routes is causing incising of the roadway channeling overland flow into the spring source. Purpose: Improve compliance with motor vehicle use restrictions. Repair road drainage structures and replace the FDR # XXX blocked culvert with hard native-surface low-water crossing.	Passive: No actions recommended. Active: Increase law enforcement and compliance with motor vehicle use restrictions. Repair road drainage structures replace the existing culvert with a hard native-surface low-water crossing.
Biological Indicators		
5. Aquatic biota	Need: Recovery from past disturbance to the outflow channel needs to continue. Rainbow trout have been introduced and may affect springsnails and their habitat; however, these effects are not understood. Purpose: Time without disturbance is needed for later successional plant species to establish on the stream margins to maintain a narrower deeper channel that will support aquatic biota. Restocking of non-native fish should be discouraged.	Passive: Discourage restocking of non-native fish until effects on springsnails petitioned for listing are better understood. Active: No actions recommended.
6. Fauna	Need: Fences built in the past were not built to exclude elk. Therefore the fences need to be modified to keep elk out. Alternative water sources are available downstream from the existing enclosure. No gate or exit was included in the existing enclosure to facilitate removal of horses, burros, or elk. Purpose: Prevent elk from entering the spring/riparian zone and causing damage to vegetation, soil, streambanks and aquatic organisms.	Passive: No actions recommended. Active: Reconstruct the original enclosure to exclude elk and wild horses/burros, expand the perimeter to include all riparian areas and anchor to physical feature, exclude elk use, and maintain the fence. Observe closure effectiveness weekly. Remove any wild horses within the enclosure and repair the fence as fast as possible once horses are observed. Design a gate for horse/elk removal.
7. Riparian/ wetland vegetation	Need: Excessive disturbance in and around the spring orifice by wild horses, burros, and elk have altered native plant communities, leading to a decline in some butterfly host and nectar species as well as springsnails. A post and cable enclosure was installed to exclude use. Effectiveness of this enclosure has been compromised because of damage to posts from vehicle traffic and snow loading. Purpose: Exclude wild horses, burros, and elk from the spring.	Passive: No actions recommended. Active: Reconstruct the original enclosure to exclude elk and wild horses/burros, expand the perimeter to include all riparian areas and anchor to physical feature, exclude elk use, and maintain the fence. Observe closure effectiveness weekly. Remove any wild horses within the enclosure and repair the fence as fast as possible once horses are observed.

Example of a Restoration Project Proposal

The purpose of this project is “recovery” of degraded GDE site ecosystem components to their proper function. Based on a site condition classification, specific areas of concern that need to be addressed include detrimental effects to water quality, aquatic biota, and fauna and riparian/wetland vegetation.

Water quality: The primary factors affecting water quality are damage to vegetation and soil caused by off-highway vehicle (OHV) use and ungulates. These disturbances in and adjacent to the spring site and outflow channel have led to erosion, channel widening, sediment in the channel and associated impairment of water quality. Roads that are open to OHV use and FDR # XXX, which traverses this site, are having detrimental effects on the spring and spring brook/creek. OHV use on designated routes is causing incising of the roadway and channeling overland flow into the spring source. Sedimentation and culvert blockage on the FDR # XXX road have channeled overland flow onto the road, causing erosion and sediment delivery to the stream.

Aquatic Biota: Recovery from past disturbance to the outflow channel has led to a proliferation of watercress, an aquatic colonizer species that may temporarily inhibit springsnails. Rainbow trout have been introduced and may affect springsnails and their habitat; however, these effects are not understood.

Fauna and Riparian/Wetland Vegetation: Excessive disturbance in and around the spring orifice by wild horses, burros, and elk have altered the native plant communities, which has likely led to a decline in some butterfly host and nectar species. Wild horse and elk grazing and browsing, trampling and loafing within the spring site and riparian area have caused extensive damage in the past. As a result, a post and cable exclosure was previously installed to exclude use, but designed to allow access by elk. The effectiveness of this exclosure has been compromised because of damage to posts from vehicle traffic and snow loading. Use by elk also resulted in damage to drip irrigation systems originally installed to establish riparian vegetation.

The purpose of the proposed action is to:

- Reduce unauthorized OHV use off designated routes upslope and divert overland flow from existing roads and trails that provides sediment sources into the spring;
- Limit unacceptable impacts to riparian vegetation and aquatic biota (springsnails) from wild horses, burros, and elk;
- Allow later successional plant species to establish on the stream margins to maintain a narrower deeper channel that will support aquatic biota;
- Avoid unanticipated effects to springsnails, proposed for listing under the Endangered Species Act, from non-native fish stocking; and
- Reduce delivery of sediment to the stream associated with the blocked culvert.
- Passive measures include:
 - Allowing revegetation of disturbed areas to occur naturally since the use of native species is costly and has a low probability of success;

- Discouraging restocking of non-native fish until effects on springsnails petitioned for listing are better understood; and
- Use of water sources downstream from the enclosure for elk and wild horses/burros.

Restoration of natural vegetation communities and conservation of aquatic biota will be accomplished by implementing the following actions, which are a combination of active and passive measures. Specific active restoration measures include:

- Repairing road drainage and installing a hard native-surface low-water crossing;
- Diverting channeled flow on OHV routes using rolling dips or other low maintenance drainage structures;
- Enforcing the use of designated OHV routes within the watershed by increasing law enforcement and compliance with motor vehicle use restrictions;
- Continuing to exclude wild horses, burros, and elk from the entire spring site by designing the enclosure to take advantage of natural features and anchor points using a post and 3-cable fence design;
- Maintaining and expanding the original enclosure fence to take advantage of topographic features and removing the section designed to allow access by elk; and
- Frequent monitoring of enclosure effectiveness and removing any wild horses from within the enclosure and repairing the fence as quickly as possible once horses are noted within the enclosure. A gate to facilitate removal of horses, burros, or elk will be incorporated into the fence reconstruction design.

Once the restoration measures above have been identified, determine which components of the proposal require a NEPA decision and those that can be implemented without a NEPA decision.³

Example of Proposed Project Cost Estimation

Costs used in table 11 are estimates and are only intended to provide an example of how to estimate cost elements for individual projects. Specific cost estimates should be generated using construction cost estimation guidelines for the Humboldt-Toiyabe National Forest and the Intermountain Region. Development of cost estimates and supporting information will vary by the type of funding sought and competition for funding.

³ Active or passive restoration actions do not directly translate to NEPA's definition of a proposed action as described in FSM 1950 and FSH 1909.15. Some passive restoration actions require a NEPA decision to implement (e.g., changes in motor vehicle use restrictions). In some cases active restoration actions (e.g., increased funding for law enforcement) do not require a NEPA decision to implement.

Table 11—Hypothetical costs for a proposed project.

Action Category	One-Time/ Install Cost	Annual Maintenance Cost
Passive management		
Visitor education—information signs/kiosk	\$1,500	\$500
Modify and implement travel and visitor use restrictions	\$5,000	\$0
Law enforcement (6 visits @ \$150/visit)	\$0	\$900
Wild horse and burro management—site observation (every 2 weeks)	\$0	\$4,800
Subtotal Passive Management Costs	\$2,500	\$6,200
Active Management		
Reconstruct/relocate perimeter fencing, install access gate	\$60,000	\$3,200
Hard native-surface stream crossings and water barriers	\$15,000	\$1,500
Trail re-location/barriers	\$5,000	\$1,000
Fence maintenance and repair	\$0	\$2,500
Site monitoring	\$0	\$1,500
Subtotal active management costs	\$80,000	\$9,700
Total costs	\$82,500	\$15,900
3-Year project cost	\$98,400	

Phase III—Decide Which Actions to Take

This phase of the restoration program process relies on established agency procedures for environmental compliance, including National Environmental Policy Act (NEPA) and other environmental compliance statutes. As a result, this section only discusses the relationships between these procedures and the previously described restoration program phases. Specific steps include:

Step 10—Assess Environmental Effects,

Step 11—Document Environmental Analysis (DM, EA or EIS), and

Step 12—Issue NEPA Decision (DM, DN or ROD).

The specific proposed action for the site is developed in Step 9 (Phase II). Not all actions that are identified require an agency NEPA decision, so the scope of the proposed action will need to reflect only those specific actions that require a decision (e.g., enforcement of motorized vehicle restrictions to designated routes).

Step 10—Assess Environmental Effects

Analysis and evaluation of environmental effects for individual sites can be supported using information developed during Phase I and II. A summary of information that is available to assess environmental effects is presented in table 12.

Step 11—Document Environmental Analysis (DM, EA or EIS)

Information described in different sections of environmental documents (decision memos, environmental assessments, and environmental impact statements) can be developed from the results of applying the processes described in this framework. Table 13 identifies specific information sources by environmental document section.

Table 12—Sources of environmental consequence descriptions by alternative for an individual site.

Typical Project Alternatives	Applicable Phase I and II Information
No action	Existing condition descriptions from Step 1 provides the basis for characterizing the consequences of taking no restoration action. Condition ratings for individual indicators and site function are primary descriptors of these environmental consequences.
Site rehabilitation	The focus of this alternative is the rehabilitation of selected condition indicators as a function of the probability of success, funding limitations, and program management emphasis. Desired condition descriptions for site condition indicators can be used to identify environmental effects likely from implementation of proposed actions. For active management actions, short-term direct and indirect effects can be assessed based on specific project design.
Site restoration	The focus of this alternative is on the restoration of all condition indicators that are currently not at desired conditions. Project cost and the probability of success are not used to limit the scope of the action. Desired condition descriptions for specific indicators can be used to identify environmental effects likely to occur from implementation of the proposal. For passive management actions it is important to address the rate or pace of restoration over time since natural processes are the principal mechanism. For active management actions, short-term direct and indirect effects can be assessed based on specific project design. Address the expected rate of restoration over time because the implied purpose of management action is to accelerate the rate of change.

Table 13—Sources of information for environmental document sections.

Environmental Document Section	Information Sources
Purpose and need	Derived from information developed in Step 7 (see table 8)
Environmental consequences	Derived from information from Step 10 (see table 12).
Affected environment	Derived from the GDE site condition classification conducted during Step 1 using rule sets described in appendix 1 and the resulting description of existing site conditions from Step 6.

Step 12—Issue NEPA Decision (DM, DN, or ROD)

The final step in Phase III is to issue an agency decision, including specific project design and mitigation measures and monitoring requirements. Keep in mind that when decisions include monitoring requirements, the responsible official must assure they can be accomplished as part of the decision document.

Developing Project Monitoring Requirements

The monitoring requirements should be related to the condition indicators addressed in the decision (table 14). These attributes will be used to determine whether post-restoration conditions are moving toward or have achieved desired conditions. The attributes can include both qualitative and quantitative data and information.

Quantitative monitoring data used to detect change may be obtained using methods described in the GDE Level II Inventory Field Guide (see table 14 for specific data attributes). Use of these standard protocols allows the use of the same method for monitoring across multiple projects. Large changes can generally be detected with the methods described in Level II Inventory Field Guide; however, small changes may not be accurately discerned because of error inherent in sampling. Generic desired condition statements are provided in the center column of table 14 and are derived from the indicator condition rule sets described in Appendix 1. The generic desired condition statements described in table 8 serve as the starting point for describing desired conditions in Step 7 and in identifying potential quantitative monitoring requirements.

Qualitative monitoring information can be obtained with photos (in conjunction with notes or drawings) recorded before and after the restoration project. The GDE field guides include procedures for establishing photo points that can be used to evaluate before and after conditions at a spring/GDE feature. Implementation and monitoring audits (METI 2012) provide another example of observing implementation and the effectiveness of the project design and associated mitigation measures.

It is also important to monitor the status of physical improvements (fences, road crossings, etc.) to determine whether they were properly installed and are being maintained to original specifications.

Table 14—Relationship of project monitoring requirements to GDE level II data attributes.

Site Condition Indicator	Generic or Typical Desired Conditions	Gde Level II Data Attributes
Physical Indicators		
1. Water quality	• Water chemistry is within the anticipated range of variability for the site, including suitability for the plants and animals present, or desired, at the site. • No pollution of water is evident at the site.	- Water quality parameters
2. Water quantity	• Groundwater discharge is sufficient to support riparian/wetland communities of plants and animals. In some settings this means assuring that water levels remain at or near the surface to maintain saturated soil conditions and, or, no net decomposition of peat. • No flow regulation at the site. • Spring flow (if expected for the site) is within the anticipated range of variability. • Surface and groundwater flow within the watershed are not significantly altered.	- Flow rate (for springs) - Water table depth (for wetlands)
3. Aquatic habitat	• No channel incision or headcuts. • No excessive erosion. • No habitat destruction by animals, people or vehicles. • Area of GDE is maintained, providing habitat for aquatic biota appropriate for the site, particularly for species of concern. • Culverts are designed and maintained to allow aquatic organism passage.	- Extent of GDE area
4. Soils	• Soils are intact and functional. • Soils support (or have the capability to support) riparian/wetland vegetation. • Minimal erosion, trampling, excavation, or other disturbance to the soil at the site. • Trails have minimal impact on the site. • Roads do not pass through the site. • Roads adjacent to the site do not cause landform instability, sediment input or other negative effects to the site.	- Soils data—change typically takes many years - Ground cover—particularly bare soil
Biological Indicators		
5. Aquatic biota	• Anticipated abundance of native aquatic biota.	-- Abundance or presence of animals of interest (e.g., spring snails)
6. Fauna	• Anticipated abundance of native terrestrial biota.	-- Abundance or presence of animals of interest
7. Riparian/wetland vegetation	• Anticipated cover of native riparian/wetland plant communities that are in healthy condition. • Species indicate the presence of wetland soils and water table level appropriate for the site. No encroachment of upland vegetation.	-- Plant species abundance -- Native species plant cover -- Woody plant cover -- Bryophyte abundance -- Wetland plant abundance (e.g., prevalence index)
8. Invasive species	• Native plant and animal species dominate the site. • Invasive species are not established at the site.	-- Cover of invasive plant species -- Presence of invasive animals species

Phase IV—Implement and Monitor Results

This phase of the process involves the following steps:

Step 13—Develop Implementation Guidance

Step 14—Implement Stewardship Actions

Step 15—Report Accomplishments

Step 16—Monitor Implementation and Effectiveness

Step 13—Develop Implementation Guidance

Develop contract specifications and design information or crew instructions detailing the specific actions to be taken and areas of concern that should be addressed during implementation.

Step 14—Implement Stewardship Practices

Project actions are implemented using contract, agency or partner staff, or, in the case of passive actions, the passage of time.

Step 15—Report Accomplishments

Restoration and rehabilitation accomplishments should be reported in the Watershed Classification and Assessment Tracking Tool (WCATT) database, which is used in the reporting accomplishment of essential projects and watershed improvement actions in “Step E” of the Watershed Condition Framework (USDA Forest Service 2011).

Step 16—Monitor Implementation and Effectiveness

There is often a lack of data collection on the implementation and effectiveness of restoration or rehabilitation actions (Ramstead et al. 2012). In a review of stream restoration efforts, only 10 percent of projects included monitoring data according to Bernhardt et al. (2005) and much of that monitoring did not provide information on the ecological effectiveness of the restoration actions. Therefore, it is important to monitor (a) the effectiveness of the results of restoration actions, and (b) the implementation of the restoration project to ensure the project was implemented as designed.

Implementation monitoring involves an evaluation of how well the plan was implemented (Did they do what they said they would do?). This post-project monitoring should include a review of contract or crew administration to ensure the design was implemented as planned or, if changes are made, that proper authorization for those changes are documented. An example of an implementation and effectiveness evaluation procedures is provided in the 2011 Implementation and Monitoring Audit (METI2012) that describes the implementation and effectiveness of riparian, springs, and recreation management practices in the SMNRA.

Effectiveness monitoring of the results of restoration-rehabilitation actions is intended to measure the success of the project in achieving desired conditions (Did the plan work?). Both qualitative and quantitative data are recommended for effectiveness monitoring (see Step 12). Quantitative attributes developed using methods described in the GDE Level II Inventory Field Guide can be gathered and used to evaluate changes (listed in the right column of table 14). It is important to use the same procedures or protocols for pre- and post-project conditions to provide for data consistency and change detection accuracy.

Qualitative data can be collected in the form of photos, notes, and drawings recorded before and after the restoration project. Photos in particular can be useful in demonstrating change, which can support or add to the information obtained from quantitative data. Structured on-site observation and reporting using the I/M Audit approach can also be used to generate qualitative monitoring data.

Phase V—Evaluate and Adjust

Information and experience gained from accomplishing all phases of this process can be used to adjust and refine the framework over time. These adjustments and refinements provide the basis for continuous improvement as well as provide an adaptive management system for use on the SMNRA and other NFS units.



Mummy Springs, July 2011, is an example of a rheocrene GDE on the Vegas Wash watershed (photo by USDA Forest Service, Northern Arizona University springs survey crew).

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Appendix 1 — Rule Sets for Site Condition Classification

The condition classification rule sets described in this appendix are derived from the condition indicators used in the Watershed Condition Classification process as described in Step 1.

Sources of information for site condition classification include data from the Groundwater-Dependent Ecosystem (GDE) inventory gathered using the GDE Inventory Field Guides (USDA Forest Service 2012a, 2012b), ancillary information, local information and expertise, and traditional cultural knowledge (figure A.1.1).

The primary GDE inventory data used for the condition classification are the “management indicator tool” and the “disturbance” observations that were part of the GDE Level II inventory of the springs of the SMNRA. The “management indicator tool” or MIT is a series of 25 questions (answered true or false) about the effects of management or activities for the following categories: hydrology, geomorphology and soils, biology, disturbances, and administrative context. The condition rating rule sets described in the tables below list a MIT question and number as a source of information to assess site condition.

Disturbance observations acquired using the GDE Level I inventory are observations of disturbances in the following categories: hydrologic alteration, soil alteration, structures, recreational effects, animal effects, and miscellaneous. Specific disturbances from the GDE inventory are listed in many of the condition rating rule sets below (tables A.1.1-A.1.8).

The site sketch map, observer notes, and photos from the GDE Level I or II inventories can also be helpful in characterizing site conditions and identifying impairment that may need to be addressed to achieve desired conditions.

It is also advisable to look for inventory and monitoring information available from internal and external sources that could be useful in characterizing existing site conditions. Ancillary data sets common on most National Forest System (NFS) lands are identified within the rule sets when they may be useful in assessing site condition.

Table A1.1. Water quality condition rating rule set.

Purpose—This indicator addresses the expressed alteration of water quality associated with physical, biological, or chemical impacts to water quality associated with a GDE site.

Water quality condition indicator	Minimal to no impairment to the water quality at the GDE site.	Minor impairment to the water quality at the GDE site.	Significant impairment to the water quality at the GDE site.
Attributes	Good (1) functioning properly	Fair (2) functioning at risk	Poor (3) impaired function
GDE Level I Inventory data and information			
Water quality conditions	Water Quality (MIT #3) is noted as "True."		
GDE Level I Information used to confirm or refine condition rating			
Water chemistry	Water chemistry is within range of variability suitable for the types of plant and animal assemblages present or desired at the site, for the following GDE inventory parameters; temperature, pH, specific conductance, oxidation-reduction potential (ORP), and dissolved oxygen (DO).		Water chemistry is not within range of variability suitable for the types of plant and animal assemblages present or desired at the site, for the following GDE inventory parameters; temperature, pH, specific conductance, oxidation-reduction potential (ORP), and dissolved oxygen (DO).
Disturbances and Pollution	No "pollution" noted under Disturbances/ Hydrologic Alteration. No "point source pollution" noted under Disturbances/ Structures.		"Pollution" noted under Disturbances/ Hydrologic Alteration. "Point source pollution" noted under Disturbances/ Structures.
Ancillary information			
Abandoned or active mines	Abandoned and active mines within the area show no evidence of water quality contamination.	Abandoned or active mines have documented evidence showing some adverse effects to surface or groundwater quality within the area.	Abandoned or active mines within the area have been determined to be adversely affecting surface or groundwater as a result of water quality sampling.
Atmospheric deposition	Atmospheric deposition is not known to contribute to water quality concerns within the area.		Atmospheric deposition is known to be contributing to water quality concerns within the area.

Additional guidance: None

Table A.1.2. Water quantity condition rating rule set.

Purpose—This indicator addresses changes to the natural discharge rates at springs and wetlands and flow regime of associated spring brooks.

Water quantity condition indicator	Spring discharge and surface outflow has no or minor departure from natural conditions	Spring discharge and surface outflow has moderate departures from natural conditions.	Spring discharge and surface outflow is significantly altered.
Attributes	Good (1) functioning properly	Fair (2) functioning at risk	Poor (3) impaired function
GDE Level I Inventory data and information			
Diversion and other flow alteration	Flow Regulation (MIT #13) is noted as "True."		Flow Regulation (MIT #13) is noted as "False."
Contributing watershed functionality	Watershed functionality (mit #2) is noted as "true."		Watershed functionality (mit #2) is noted as "false."
GDE Level I Information used to confirm or refine condition rating			
Diversion and other flow alteration	No "diversion" is noted under Disturbances/ Hydrologic Alteration. No "regulated water flow" is noted under Disturbances/ Hydrologic Alteration. No "extraction" is noted under Disturbances/ Hydrologic Alteration.	Diversion structures are stable, accommodating flows, and not degrading the ecology of the site. The amount of flow that is diverted is not causing the area of wetland vegetation and soils to contract. Erosion, leakage, trampling, ditching, excavation, or headcuts are not affecting the integrity of the site.	"Regulated water flow" is noted under Disturbances/ Hydrologic Alteration. "Extraction" is noted under Disturbances/ Hydrologic Alteration.
Flow rate	Flow rate is as anticipated for functioning site.	Flow rate is somewhat different than anticipated for functioning site.	Flow rate is dramatically different than anticipated for functioning site.
Water table depth	Water table is at or near the surface.	Water table is detected, but lower than expected.	Water table is much lower than expected or not detectable.
Ancillary information			
Environmental flows and groundwater levels (EF/L)	Groundwater flows and levels are not altered.	Groundwater flows and levels are maintained sufficient to support species richness and representative wetland species.	Groundwater flows and levels are insufficient to support species richness and representative wetland species.

Additional guidance: Large-scale industrial or municipality use from pumping would need to be present to measurably influence spring discharge or stream flow. In general, household groundwater use for domestic purposes will not have a significant influence of water quantity unless a watershed was developed to such an extent that it was closed to additional well developments by State water resource authorities. In some settings this means assuring that water levels remain at or near the surface to maintain saturated soil conditions and, or, to prevent loss (through decomposition) of peat.

Table A.1.3. Aquatic habitat condition rating rule set.

Purpose—This indicator addresses aquatic habitat condition with respect to habitat fragmentation, environmental flows and levels, and channel shape and function.

Aquatic habitat condition indicator	The GDE supports high-quality aquatic habitat and, where possible, high-quality stream channel conditions.	The GDE supports some high-quality aquatic habitat, but high-quality stream channel conditions, if present, show signs of being degraded.	The GDE supports minimal high-quality aquatic habitat, and stream channel conditions, if present, show evidence of being degraded by disturbance.
Attributes	Good (1) functioning properly	Fair (2) functioning at risk	Poor (3) impaired function
GDE Level I Inventory data and information			
Channel shape and function	Runout Channel (MIT #5) is noted as "True."		Runout Channel (MIT #5) is noted as "False."
GDE Level II Information used to confirm or refine condition rating			
Channel shape and function	No "channel erosion" is noted under Soil Alteration.		"Channel erosion" is noted under Soil Alteration.
Habitat fragmentation	No enclosures, such as spring house, spring box or concrete enclosures are noted under Structures. No negative effects to aquatic organism passage.	Maybe include a middle category for springs with diversion, but are managed such that some flow is undiverted and remains near orifice of spring?	Enclosures such as spring house, spring box or concrete enclosure are noted under Structures. Possible negative effects to aquatic organism passage.
Impoundments and Structures	No "regulated water flow" by impoundment/dam" is noted under Hydrologic Alteration.		"Regulated water flow" by impoundment/dam" is noted under Hydrologic Alteration.
Ancillary information			
Hydrology	Sufficient groundwater flows to prevent changes in trophic levels or littoral conditions that would be detrimental to important aquatic species or aquatic life assemblages. Flows prevent encroachment of upland or invasive plant species and to maintain habitat for aquatic species of concern.		Insufficient groundwater flows to cause changes in trophic levels or littoral conditions that are detrimental to important aquatic species or aquatic life assemblages. Flows allow encroachment of upland or invasive plant species and to maintain habitat for aquatic species of concern.
Aquatic habitat extent	Wetted area and spring brook length is adequate to maintain biological habitat and flows for basic biological function.		Wetted area and spring brook length is not adequate to maintain biological habitat and flows for basic biological function.

Additional guidance: In aquatic habitats lacking aquatic biota and, or, permanent habitat (e.g., some Southwest desert springs), evaluate conditions with respect to what would be expected to be present under natural conditions, or absent human-induced impacts.

Table A.1.4. Soils condition rating rule set.

Purpose—This indicator addresses alteration to natural soil condition, including productivity, erosion, and chemical contamination.

Soils condition indicator		Minor or no alteration to reference soil condition, including erosion, productivity, and chemical characteristics is evident.	Moderate amount of alteration to reference soil condition is evident. Overall soil disturbance is characterized as moderate.	Significant alteration to reference soil condition is evident. Overall soil disturbance is characterized as extensive.
Attributes		Good (1) functioning properly	Fair (2) functioning at risk	Poor (3) impaired function
GDE Level I inventory data and information				
Soil productivity		Soil Integrity (MIT #6) is noted as "True"		Soil Integrity (MIT #6) is noted as "False."
Soil erosion		Landform Stability (MIT #4) is noted as "True." Construction and Road Effects (MIT #14) is noted as "True." Recreational Effects (MIT #17) is noted as "True."		Landform Stability (MIT #4) is noted as "False." Construction and Road Effects (MIT #14) is noted as "False." Recreational Effects (MIT #17) is noted as "False."
GDE Level I information used to confirm or refine condition rating				
Soil erosion and other soil disturbance		"Erosion" under Disturbances/ Soil Alteration is not noted. No, or few, other soil disturbances under Disturbances/ Soil Alteration are noted.		"Erosion" under Disturbances/ Soil Alteration is noted. Other soil disturbances under Disturbances/ Soil Alteration are noted.
Ancillary information				
Soil contamination		Ancillary data do not indicate soil contamination resulting from abandoned mines, roads, refuse disposal, etc.		Ancillary data indicate soil contamination resulting from abandoned mines, roads, refuse disposal, etc.
Atmospheric deposition		Ancillary data do not indicate atmospheric deposition.		Ancillary data indicate atmospheric deposition.
Soil properties		Ancillary data do not indicate alteration to hydrologic cycling in soil, such as compaction, decreased porosity, decreased infiltration capacity, increased bulk density, loss of organic matter, loss of soil cover, loss of microbial activity, or other appropriate indicators.		Ancillary data indicate alteration to hydrologic cycling in soil, such as compaction, decreased porosity, decreased infiltration capacity, increased bulk density, loss of organic matter, loss of soil cover, loss of microbial activity, or other appropriate indicators.

Additional guidance: If a forest or regional direction exists for soil quality or soil management, these local thresholds may be used to determine the appropriate rating for soil attributes. Soil erosion should not double count road-related erosion effects considered in the roads and trails condition indicator.

Table A.1.5. Aquatic biota condition rating rule set.

Purpose—This indicator addresses the distribution, structure, and density of native and introduced aquatic fauna.

Aquatic biota condition indicator	All native aquatic communities and life histories appropriate to the site are present and self-maintaining.	Some native aquatic communities and life histories appropriate to the site are present and self-maintaining.	Few if any native aquatic communities and life histories appropriate to the site are present and self-maintaining. Exotic and/or aquatic invasive species are pervasive.
Attributes	Poor (3) Impaired function		
GDE Level I Inventory Data and Information			
Life form presence	Faunal Species (MIT #10) is noted as "True" in terms of aquatic biota. Lists of aquatic biota observed indicate presence of biota appropriate to the site.		Faunal Species (MIT #10) is noted as "False" in terms of aquatic biota. Lists of aquatic biota observed indicate presence of biota not appropriate to the site.
Native species	TES, SOI/SOC, Focal Faunal Species (MIT #11) is noted as "True" in terms of aquatic biota.		TES, SOI/SOC, Focal Faunal Species (MIT #11) is noted as "False" in terms of aquatic biota.
Aquatic exotic and/or invasive species	Invasive Species (MIT #12) is noted as "True" in terms of aquatic biota.		Invasive Species (MIT #12) is noted as "False" in terms of aquatic biota.
Ancillary information			
Species-specific or project surveys	Species-specific or project survey observations indicate presence of aquatic biota appropriate to the site.		Species-specific or project survey observations indicate aquatic biota appropriate to the site are absent.

Additional guidance: Avoid focus on single species; focus on communities. The presence of exotic and/or aquatic invasive species is used as an indicator of altered or impaired conditions. Although exotic and/or aquatic invasive species can significantly affect native aquatic faunal integrity, intra-species interactions are not considered for this assessment. For this assessment, the widespread presence of exotic and/or aquatic invasive species indicates poor conditions.

Table A.1.6. Fauna condition rating rule set.

Purpose—This indicator addresses the distribution, structure, and density of native and introduced terrestrial fauna.

Fauna biota condition indicator	All native terrestrial communities and life histories appropriate to the site are present and self-maintaining.	Some native terrestrial communities and life histories appropriate to the site are present and self-maintaining.	Few if any native terrestrial communities and life histories appropriate to the site are present and self-maintaining. Exotic and, or, aquatic invasive species are pervasive.
Attributes	Good (1) functioning properly	Fair (2) functioning at risk	Poor (3) Impaired function
GDE Level I Inventory data and information			
Life form presence	Faunal Species (MIT #10) is noted as "True" in terms of terrestrial biota. Lists of terrestrial biota observed indicate presence of biota appropriate to the site.		Faunal Species (MIT #10) is noted as "False" in terms of terrestrial biota. Lists of terrestrial biota observed indicate presence of biota not appropriate to the site.
Native species	TES, SOI/SOC, Focal Faunal Species (MIT #11) is noted as "True" in terms of terrestrial biota.		TES, SOI/SOC, Focal Faunal Species (MIT #11) is noted as "False" in terms of terrestrial biota.
Ancillary information			
Species-specific or project surveys	Species-specific or project survey observations indicate presence of terrestrial fauna appropriate to the site.		Species-specific or project survey observations indicate terrestrial fauna appropriate to the site are absent.

Additional guidance: Avoid focus on single species; focus on communities. The presence of exotic and, or, terrestrial invasive species is used as an indicator of altered or impaired conditions. Although exotic and/or terrestrial invasive species can significantly affect faunal integrity, intra-species interactions are not considered for this assessment. For this assessment, the widespread presence of exotic and/or terrestrial invasive species indicates poor conditions.

Table A.1.7. Riparian/wetland vegetation condition rating rule set.
Purpose—This indicator addresses the function and condition of native riparian vegetation along streams, water bodies, and wetlands.

Riparian/ wetland vegetation condition indicator	Native vegetation is functioning properly at the GDE site.		Disturbance partially compromises the properly functioning condition of native vegetation attributes at the GDE site.	A large percentage of native vegetation attributes at the GDE site is not functioning properly.
Attributes	Good (1) functioning properly		Fair (2) functioning at risk	Poor (3) impaired function
GDE Level I Inventory data and information				
Vegetation condition	Vegetation Composition (MIT #7) is noted as "True." Vegetation Condition (MIT #8) is noted as "True." TES, SOI/SOC, Focal Floral Species (MIT #9) is noted as "True." Lists of plants observed indicate presence of species appropriate to the site.			Vegetation Composition (MIT #7) is noted as "False." Vegetation Condition (MIT #8) is noted as "False." TES, SOI/SOC, Focal Floral Species (MIT #9) is noted as "False." Lists of plants observed indicate presence of species not appropriate to the site.
Ancillary information				
Vegetation composition	Riparian or wetland vegetation are indicative of wet soil conditions as anticipated for the site. Predominately native species; few non-native species.			Absence of riparian or wetland vegetation that would have indicated wet soil conditions. Predominately native species; non-native species are established and reproducing.
PFC assessments, vegetation attributes (based on USDI 1999)	Proper functioning condition		Functional at risk	Nonfunctional

Additional guidance: If land management plan riparian management direction exists for riparian/wetland vegetation, use the local thresholds derived from the plan standards and guidelines to determine the appropriate rating for this attribute.

Table A.1.8. Invasive species condition rating rule set.
Purpose—This indicator addresses potential impacts to soil, vegetation, and water resources due to invasive species (including vertebrates, invertebrates, and plants).

8. Invasive species indicator	Few or no populations of invasive species infest the site that could necessitate removal treatments that would affect soil and water resources.	Populations of invasive species are established within the site and, or, the rate of expansion and/or potential for impact on the site is moderate.	Invasive species populations infest significant portions of the, are expanding their range, and there is documentation of impacts to the resources of the site.
Attributes	Good (1) functioning properly	Fair (2) functioning at risk	Poor (3) impaired function
GDE Level I Inventory data and information			
Extent and rate of spread	Invasive Species (MIT #12) is noted as "True."		Invasive Species (MIT #12) is noted as "False."
GDE Level I Information used to confirm or refine condition rating			
Noxious and invasive species	No invasive plants or animals were recorded at the site (such as in the dominant plant species list or other observations).		Invasive plants or animals were recorded at the site (such as in the dominant plant species list or other observations).
Ancillary information			
Noxious and invasive species	Noxious weeds and or invasive species have not been identified within close proximity to the GDE site based on information in NRM-Terra.	Noxious weeds and or invasive species have identified within close proximity to the GDE site based on information in NRM-Terra.	Noxious weeds and or invasive species have been identified adjacent to or within the GDE site based on information in NRM-Terra.

Additional guidance: This indicator applies only to both aquatic and terrestrial vertebrates, invertebrates, and plants that may have an adverse effect on soil and water resources. Infestation extent is usually evaluated with risk assessments and other inventory and evaluation procedures at either the species level, site level, or project level. For example, the extent of the invasive species infestation of an individual species level may indicate that the condition rating is "good," but when viewed within the context of all the documented invasive species, the overall condition rating may be considered "poor."

Appendix 2—Elements Used to Determine Relative Site Significance for the SMNRA.

Elements	Relative significance rating		
	1—High	3—Medium	5—Low
Physical elements			
Discharge	For springs: Perennial flow that is large (or unusual) for the area of interest (top 50% of the range of values; it is acceptable to exclude large outliers when determining range); or For groundwater-dependent wetlands without outflow channel: Evidence of significant groundwater discharge, such as thick organic soil development, significant water at surface, or wetland vegetation dominates site.	For springs: Perennial or seasonal flow that is moderate for the area of interest (middle 40% of the range of values); or For groundwater-dependent wetlands without outflow channel: Evidence of moderate groundwater discharge, such as a small amount of organic soil, the presence of some water at surface and moderate amount of wetland vegetation at site.	For springs: Seasonal (not perennial) flow that is low (or common) for the area of interest (bottom 10% of the range of values); or For groundwater-dependent wetlands without outflow channel: Evidence suggests small amount of groundwater discharge, such as minimal water at surface and minimal wetland vegetation at site.
Contributing Aquifer	Regional – Beyond the extent of surface watershed		Local—Within the surface watershed
GDE feature size or extent	Site size within the top 50% of the range of values within the area of interest (okay to exclude large outliers when determining range).	Site size not within the middle 40% of the range of values of the area of interest.	Site size within the bottom 10% of the range of values within the area of interest.
Feature type	Unusual type within the area of interest.	Somewhat common type within the area of interest.	Common type within the area of interest.
Isolation	Distant (greater than 10,000 meters) from another spring or surface water feature (not in the complex of groundwater discharge features that the site is part of).	Moderately close (greater than 1,000 meters and less than 10,000 meters) to another spring or surface water feature (not in the complex of groundwater discharge features that the site is part of).	In close proximity (less than 1,000 meters) to another spring or surface water feature (not in the complex of groundwater discharge features that the site is part of).
Surface water connectivity	Groundwater discharge supports or contributes base-flow to a perennial stream.	Groundwater discharge supports a stream that disappears after a short to moderate distance.	Groundwater discharge does not support an outflow stream.
Biological elements			
TES and focal species	Threatened, endangered, sensitive or focal species present.	Threatened, endangered, sensitive or focal species expected but not found (requires understanding of sites and local spring and wetland ecology).	Threatened, endangered, sensitive or focal species not expected and not found (requires understanding of sites and local spring and wetland ecology).
Vegetation type	Unusual wetland vegetation type within the area of interest.	Somewhat common wetland vegetation type within the area of interest.	Common wetland vegetation type within the area of interest, or no wetland vegetation present.
Invasive or noxious species	Invasive or noxious plant or animal species absent. Use lists maintained by regions or states.	Invasive or noxious plant or animal species at very low abundance. Use lists maintained by regions or states.	Invasive or noxious plants or animal species established at the site. Use lists maintained by regions or states.
Social/Cultural/Economic elements			
Cultural significance	Determined in consultation with cultural resource specialist.		

Note: See table 2 for descriptions and definitions of significance elements.

Appendix 3—SMNRA Springs/Riparian Management Response Framework

As a result of the 2011 SMNRA Implementation and Monitoring Audit (I/M Audit) of springs and riparian management practices a “management response framework” was developed (METI2012). The management response framework uses a combination of (1) land management plan and the SMNRA General Management Plan objectives, standards and guidelines and (2) audit team evaluation of management practice effectiveness to determine “best practices” applicable within the SMNRA.

The I/M Audits are designed and conducted to strengthen organizational learning and provide for continuous improvement. They consist of a structured evaluation of management actions, bringing together inventory information, desired conditions from the Forest Plan, project planning, and completed implementation. Documentation and on-site project review focuses on two areas: Implementation monitoring and effectiveness monitoring.

Implementation monitoring: “Did we do what we said we would do?” If changes were made at any point, were the changes appropriately documented? Included in this step is an evaluation of the planning documents for completeness and relevance, as well as an evaluation of the translation of the planning documents to the implementation direction. Over the long term, implementation monitoring helps us evaluate whether there are patterns to changes in implementation, which would indicate a need to make systemic changes in planning procedures or documents.

Effectiveness monitoring: “Do the results reflect our desired outcomes?” What parts of the action worked? What parts need modification for the next project?

I/M Audits address questions that are best evaluated by using both qualitative and quantitative methods. The Fiscal Year (FY) 2011 I/M Audit focused on: management of riparian and spring areas, and management of motorized recreation with a focus on off-highway vehicle (OHV) management. To audit the implementation and effectiveness of these management activities, the following monitoring questions (MQ) identified in the SMNRA Inventory and Monitoring Strategy were addressed:

- How effective are efforts to reduce recreation effects to riparian and spring areas? (MQ 8)
- How effective is riparian fencing in protecting springs and riparian areas? What thresholds warrant this level of mitigation? (MQ 51)
- How effective are efforts to manage motorized recreation (OHV) and limit other uses (outfitters and guides) to the protection and conservation of SOC/SOI and their habitats? (MQ 5)

This round of IM Audits was conducted on projects selected by the Deputy Forest Supervisor during a 3-day workshop held October 25-27, 2011. Participants included the line and staff personnel involved in the management of recreation activities and riparian and spring areas. Five projects were selected, representing a variety of conditions and management activities, and included: West Mud Springs, Cold Creek, Willow Spring, Carpenter Canyon, and Mountain Springs area adjacent to the Rainbow Mountain Wilderness.



West Mud Springs, July 2011; this photo documents several types of disturbances (photo by USDA Forest Service, Northern Arizona University springs survey crew).



Willow Spring, October 2011, covers 462 square meters and is on the Sand Spring-Tikaboo Valleys watershed (photo by Larry Timchak, METI, Inc.).



Willow Spring, October 2012, covers 462 square meters and is on the Sand Spring-Tvikaboo Valleys watershed (photo by USDA Forest Service, Northern Arizona University springs survey crew).

Concepts and Factors Used in Developing the SMNRA Springs/Riparian Management Response Framework

Given the importance of water—springs, streams, and riparian areas—to the SMNRA, it is no surprise that these areas have been used by wildlife, livestock, and people for a long time; they provide habitat for endemic plant and animal communities. Many show the wear and tear that results from long-term use and the remnants of past management activities, including watering devices, diversions, and structures.

A key factor in determining when and how to establish riparian enclosure fences is the ecological significance of the spring/riparian area. Ecological significance is determined by a combination of factors and can be determined by using the information and data being collected in the springs inventory program. Preliminary discussions indicate that the following elements should contribute to the determination of ecological significance:

- Spring type
- Riparian area/feature size
- Surface flow
- Vegetation community
- Presence of Conservation Agreement (CA) species

The potential for disturbance or damage by wild horses/burros, elk, and recreation use are other factors to be considered. In some instances, drift fences established in lower portions of canyons are more effective alternatives to reducing potential effects from wild horses/burros and should be considered before fencing individual sites.

Elk use effects at springs are related to the distribution of the elk population across the SMNRA. Fences that effectively exclude elk are expensive to build and maintain. Use of external water sources is likely more effective in reducing use by elk than more elaborate fencing designs.

Recreation use effects can often be effectively managed by a combination of restricting use by physical barriers and designation of access routes and interpretive signing/visitor education.

Forest Plan standards and guidelines provide a starting point for developing a framework for managing recreation use at springs and in riparian areas. They also provide guidance for determining when fencing should be used to protect CA species and their habitats, as well as enclosure design. The following HTNF Forest Plan/GMP standards apply design elements included in this framework (numbers in parentheses refer to sections of the HTNF Forest plan, and Letters and numbers at the beginning of the bullet refer to the GMP):

- If a riparian area within a wild horse and burro territory is fenced, pipe water out of riparian areas for wild horse and burro use. (0.2)
- When developing water sources, pipe water from a point downstream of the source if snails or other sensitive species are present, or if the spring source has not been previously developed. (0.8)
- Remove existing water developments and debris from springs, providing they no longer serve their original purpose, are not critical to wildlife, and the items are not of historical significance. (0.13)
- Prohibit parking and camping within riparian areas. (0.2)
- MA 11—Provide protection of the riparian areas (in accordance with Nevada Revised Statute 503.660) at Cold and Willow Creeks through the use of new road alignments, vehicle barriers, and, or, signage. Redirect parking and camping away from riparian corridors. Allow only day-use, walk-in activities to occur within the riparian corridor. (11.1)
- MA 13—Develop low standard recreation facilities, including small campsites or restrooms, in Carpenter Canyon as a resource protection measure. Close the last section of road to prevent vehicle access through stream and riparian area. Make campsites walk-in access only. (13.17)

The following decision framework (table A.3.1) is recommended to determine proposed actions associated with springs/riparian management designed to reduce the effects of uses and disturbance on springs and riparian areas.

Table A.3.1. Springs/riparian management framework.

Common Design Features • <u>Drift Fences</u>—Evaluate opportunities to establish drift fences to control access to springs by wild horses/burros before proposing fencing at individual sites. • <u>Perimeter</u>—Consider fencing areas larger than the spring riparian area to provide better anchor points and screening. At a minimum, enclosure fences and management efforts should approximate the perimeter of the spring riparian area. Slope breaks and vegetation should be the primary factors used to determine the perimeter and location of fences and delimiting areas of use. • <u>Existing Developments</u>—Remove existing water developments and debris from springs, providing they no longer serve their original purpose, are not critical to wildlife, and the items are not of cultural significance. Restore and revegetate areas associated with these improvements. • <u>Maintenance and Monitoring</u>—Adhere to maintenance schedules established for each fencing design and associated monitoring schedules and focus.	
High ecological significance wild horses & burros present/elk use high – moderate recreation use	High ecological significance no wild horses & burros/elk use high – moderate recreation use
• Establish and maintain a post/wire rope enclosure • Exclude <u>all</u> wild horses and burros • Do not allow elk access • Provide external water source(s) • Restrict and manage recreation use/access using physical barriers/trail locations • Provide interpretive and recreation signing	• Restrict and manage recreation use/access using physical barriers/trail locations • Interpretive and recreation signing
Moderate ecological significance wild horses & burros present/elk use moderate – low recreation use	Moderate ecological significance no wild horses & burros/elk moderate – low recreation use
• Establish and maintain a t-post/barbed wire enclosure • Provide external water source • Restrict and manage recreation use/access using physical barriers/trail locations • Provide interpretive and recreation signing	• Restrict and manage recreation use/access using physical barriers/trail locations • Provide interpretive signing
Low ecological significance wild horses & burros present low recreation use	Low ecological significance no wild horses & burros/elk low recreation use
• No enclosure fence warranted. Site-specific exceptions may occur • Provide interpretive signing	• No enclosure fence warranted • No interpretive or recreation signing

Appendix 4—Nevada Springs Restoration Practices

This appendix is based on information developed by the Nevada Springs Restoration Workshop Committee (2012), as well as text written by Joe Gurrieri, Forest Service hydrogeologist and member of that Committee. The specific text from the Nevada Springs Restoration Workshop Committee was derived from Module 4 “Springs Restoration and Spring Source Water Management” authored by Rob Andress, Kathryn Boyer, R.J. Johnson, and Abraham E. Springer.

Although a large amount of general planning and implementation guidance is available for ecological restoration, a comprehensive summary of groundwater-dependent ecosystem (GDE) restoration projects has not been prepared nor have guidance documents, manuals, or methods specific to GDE restoration been published. Stacey et al. (2011) evaluated the success of several restoration efforts. The Society for Ecological Restoration (2004, 2005) provides relevant guidance regarding general planning and implementation guidelines on the practice of ecological restoration. Abela (2011) and Sada et al. (2001) are general publications on springs conservation in the West. Wetland restoration, enhancement, and creation are covered in a handbook by the USDA Natural Resources Conservation Service (2008). Biebighauser (2011) presents wetland restoration and construction from an eastern United States perspective. The Groundwater-Dependent Ecosystems: Level I and II Inventory Field Guides (USDA Forest Service 2012a, 2012b, respectively) are assessment protocols developed specifically for GDEs and can aid in the restoration planning process. Other inventory and assessment protocols for springs have been developed by Sada and Pohlman (2002, 2006), Brown et al. (2007) and by the Springs Stewardship Institute (Stevens et al. n.d.).

Invasive aquatic species, if present, may be the single most important consideration in restoration planning and design. The presence of invasive species can have a considerable effect on a restoration project to the degree that certain concessions must be made to achieve complete restoration of pristine or pre-disturbance physical and biological conditions. For example, if the spring discharge is not sufficient to sustain open channel flow for great distances, pre-disturbance conditions may have been characterized by a shallow marsh immediately downstream from the spring source. However, given the presence of crayfish (assuming eradication is not possible) it may be necessary to design the restoration such that an open channel will be maintained for the maximum extent of distance and time to reduce the amount of habitat most suitable for the invasive species.

Invasive species eradication may be the first step of a restoration project, but may also require substantial modification of habitat prior to restoration. For example, an attempt to eradicate crayfish may require complete diversion and desiccation of the spring source and outflow. The merit of this approach must be weighed on a project-by-project basis and the feasibility of complete eradication must be carefully assessed against the potential risks of such an effort (such as species loss). If native species remain in the system they must be salvaged prior to such an effort. Such an effort can greatly increase project cost and duration as it may require more than one year and multiple desiccation events or modifications of approach to achieve the eradication. The eradication of invasive fish species may require application of a pesticide prior to restoration and may also require native species salvage.

Passive Restoration

There are three types of passive restoration management actions: (1) protection of natural sites, (2) eliminating identified stressors to reduce impairment, and (3) management actions to prevent or alleviate potential, future threats. Common stressors impacting GDEs include groundwater extraction, impacts to groundwater quality, livestock grazing, surface water diversion, invasive species, or recreation impacts. Examples of management actions for the prevention or elimination of stressors are provided below.

Groundwater Extraction

Impacts due to groundwater extraction may include decreased or cessation of spring flow, reduction in overall wetland and aquatic habitat area, or changes in plant and animal composition. Methods to eliminating stressors related to groundwater extraction could include a management strategy to reduce impacts to spring source discharge by varying the pumping schedule or pumping location.

Impacts to Groundwater Quality

Impacts to groundwater quality could be due to nearby industrial or agricultural activities. Stagnation or eutrophication may also result in diminished water quality. Management strategies for stagnation could include improving nutrient flushing and removal by eliminating outflow blockage and improving source and outflow area flushing. Groundwater quality may also be impacted by the presence of livestock at the spring source and within the outflow habitat. Reducing impacts to groundwater quality may require the closure of the spring and outflow to livestock access. Management strategies could include monitored natural attenuation, removal of pollution source, and pollution source control and isolation.

Livestock Grazing

Changes in the duration, season, or intensity of grazing may be sufficient to eliminate impacts at a given site. In certain instances, it may also be necessary to

- Provide off-site watering away from GDEs to ensure they are protected;
- Install or repair float valves on water troughs to ensure flow does not run when not needed;
- Construct or repair enclosure fences around spring/seep sources;
- Trail livestock away, rather than through, GDEs; or
- Discontinue use of water resources in critical GDEs.

Surface Water Diversion

Diversion of surface water may result in decreased flow to a GDE or outflow stream. Impacts due to surface water diversion could include loss of overall wetland or aquatic habitat or area, and changes in plant and animal species composition. Management strategies to reduce impacts due to surface water diversion include changing the location of the diversion, reducing the quantity of water diverted, or allowing an increased amount of flow to discharge to the spring outflow habitat.

Invasive Species

Impacts due to invasive species may include changes in native plant and animal species composition, reduction or extirpation of native plant and animal species, or changes in

plant community composition and structure. Invasive species removal could include the mechanical removal of invasive plants, trapping of invasive animal species, or the application of herbicide and pesticide. In wetlands, raising the water table by filling ditches may decrease the competitive advantage of some invasive plants and favor native wetland species.

Recreation Impacts

Restoration of springs from recreational activities is generally similar to those for grazing impacts. Impacts due to recreation may include site trampling, soil compaction, surface water diversion, and accumulation of refuse. Reducing impacts due to recreation may range from complete site closure to building trails and boardwalks, and elimination of onsite camping and vehicular access.

Active Restoration

In general, the primary approach to active restoration of GDEs is the reshaping, reconstructing, or rehabilitation of the spring source and outflow channel or wetland. Most restoration designs are based on moderately to well-informed assumptions and species habitat requirement data. Undisturbed reference sites are rarely discovered but inferences can be made based on habitat requirements and preferences by target species, hydrology, geomorphology, historical documents and photographs, and occasionally paleoecology. Most restoration projects are initiated due to a decline in a single species or group of target species and focus on the reconstruction or rehabilitation of “pre-disturbance” physical conditions with the assumption that reconstructing or rehabilitating the physical conditions will result in improved biological conditions, species recovery and species preservation.

The specific actions required for restoration may range from the removal of manmade infrastructure such as spring boxes, tanks and piping to complete physical manipulation, and reconstruction of site conditions. Where natural topography, drainage, and geomorphology is determined to be largely intact and physical conditions will allow the desired conditions to be achieved, it may only be necessary to remove or modify infrastructure in a way that alleviates impacts and stressors. Complete physical reconstruction is typically required at sites where all pre-disturbance topography and natural drainage has been obliterated by site development and modification.

The overall approach to restoration will differ due to the GDE type, such as limnocrenes (pool-forming springs), rheocrenes (forming or discharging in distinct channels), and helocrenes (wetlands). It is necessary to recognize that the desired condition should match the GDE type and characteristics of the pre-disturbance condition as closely as possible. The site assessment should determine the overall feasibility of achieving the pre-disturbance spring condition based on the degree of physical alteration and impact at any given site. Careful consideration should be given to the expected trajectory of recovery for both biological and physical factors and processes when selecting the desired conditions and restoration design/strategy. Example approaches to the restoration of each type of spring are discussed below.

For the purpose of restoration planning, GDEs are divided into those that have water flowing in channels and those that do not. For GDEs that do not have flowing water in channels, groundwater level is the driver of ecological health. Springs that have water flowing in channels can be evaluated in a similar way to streams. However, a few differences exist in the geomorphic, biologic, and flow regime of spring channels that

differentiates them from streams. The low variability in the hydroperiod in springs results in habitats with specific community composition and relatively static spatial extent. This differs from streams, where the stream flow energy is essential for the maintenance of geomorphic and riparian processes and where the ecosystem is more dynamic.

Limnocrene

Pool-forming (limnocrene) springs are influenced by groundwater pumping, and may be subjected to stagnation, eutrophication, and deoxygenation changes that reduce habitat quality and functionality. Restoration challenges for limnocrenes may involve recreating natural water quality and desired pool area and pool habitat. Where a limnocrene spring has been over excavated in the past, it may be determined that a reduction in pool diameter similar to that of its pre-disturbance dimensions is preferable for improving habitat for target species or eliminating habitat for invasive species such as shallow margins where cattail, bullfrog, and crayfish may be prevalent. Without historical documentation (historical descriptions or photographs), it is difficult to determine the pre-disturbance pool size. However, it may be possible to use other limnocrene springs as an analog if the springs are relatively undisturbed, occur in similar substrate, and exhibit similar discharge. Similarly, springs of unequal discharge but occurring in similar substrate can be used to scale to the desired discharge. Be aware that many springs appear as limnocrenes today because they have been excavated to create a pool for watering of livestock or wildlife. Limnocrenes are more common on flat valley floors and rare in steeper mountainous terrain.

Rheocrene

A rheocrene is a spring where discharge emerges into a defined channel. Rheocrenes and associated spring brooks are often important for springs-specialist plants and animals. Modification of flow regulation structures (e.g., dams, diversions, spring boxes) may be necessary to restore the flow at the source and to restore the functionality of downstream spring brooks or wetlands. For example, installing a flow splitter, shifting the point of diversion downstream from the source, removing a dam, or modifying a spring box and pipes may help ensure flow at the spring's source, with the amount of diverted flow to be evaluated based on goals for the site.

Restoration of rheocrene springs can range from streambank stabilization to complete channel reconstruction. In circumstances where spring flow has been diverted from the historical channel, and the historic channel has not been obliterated, it may be possible to return flows to the historical channel. Where the historic outflow channel has been obliterated, it is necessary to reconstruct the stream channel by excavating or constructing a new channel. Selection of the appropriate channel dimension and morphology (width, depth, slope, sinuosity, substrate, single or multiple thread channel, etc.) is largely dependent on an analysis of drainage basin hydrology, historic channel form, habitat requirements of target species, and desired conditions.

The flow variability of springs is generally much smaller than streams making concepts such as channel geomorphology, bankfull flows, overbank flows, and sediment transport relatively less important in restoration. The dampened hydrograph and limited sediment input characteristics of springs leads to the formation of channels with steep, well-vegetated banks; armored beds; higher sinuosity values; and lower width-to-depth values (Griffiths et al. 2008). Springs with channelized flow can be divided into runoff-dominated springs that are located in perennial or intermittent channels and undergo periodic scouring, and spring-dominated channels that are on uplands and are never

scoured by flood flows. The disturbance regime has a large effect on the types of biota that inhabit the spring ecosystem. Discharge regime and sediment input are the major differences in controls on channel morphology that are found between spring-dominated and runoff-dominated channels.

Runoff-dominated springs are characterized by frequent flood events and considerable inter-annual flux in vegetation cover and diversity. Frequent scouring is a natural stressor that decreases species richness of aquatic communities. These springs therefore have lower resource value and recovery potential. Moderate to high variability in the size and spatial arrangement of vegetation patches or aquatic invertebrate composition in such settings is a normal system attribute; resilience to disturbance may be the only useable metric of ecosystem health other than wetted area or flow. Flow regulation may stabilize normally highly disturbed streamside spring ecosystems altering structural, functional, and trophic characteristics of springs. Spring-dominated channels are highly stable environments characterized by dampened hydrographs, and low erosion, sediment, and disturbance rates.

Helocrene

Wetland, wet meadows, cienegas or fen habitats (helocrene) are characterized by diffuse flow across shallow-gradient landscapes. The feasibility of restoring helocrene springs depends largely on existing site conditions and degree of alteration. Restoration of such habitats often involves filling in ditches, preventing erosional head-cutting with grade control structures, eliminating erosional channels, removing drainage tiles or subgrade water diversion structures to decrease groundwater depth, and replanting native wetland plant species. The goal of fen restoration is often to regenerate peat formation by recreating conditions that characterize an undisturbed fen. Where surface water diversion or ditching has reduced the overall wetland habitat area or lowered the water table, but the natural topography of the wetland remains, it may be sufficient to return flow to the original wetland area or raise the water table. However, where the original topography and wetland has been eliminated in its entirety it may be necessary to recreate the topography necessary to allow the development and recovery of wetland habitat.

All efforts should be made to recreate topography that will sustain wetland types and characteristics that would have been present prior to alteration of the site. A thorough analysis of drainage basin hydrology, analog wetland sites, and feasibility of achieving desired conditions should be made prior to selecting the final restoration design and strategy. For example, the feasibility of restoring a fen requires that suitable conditions are created for the development of a permanently saturated peat layer. If it is not possible to create the necessary site conditions for sustaining the desired condition, an alternative approach or restoration strategy should be considered.

The most important parameters to which helocrenes and dependent species respond are: (1) maintenance of a water table level within a natural range of variation (generally at or near the surface, which generates peat accumulation), (2) groundwater flux to the feature, (3) upward head gradients in the aquifer, and (4) water quality.

Spring Source Water Management

Guidance Documents on Spring Source Water Development

The Natural Resources Conservation Service has a number of handbooks that present information and engineering designs for source water development at springs (USDA

NRCS, 2006, 2010, 2011). These references, however, do not focus on conservation or restoration of spring habitats and use of the designs could result in ecosystem damage if conservation measures are not taken into account during the design phase.

Forest Service revised Best Management Practices (BMPs) that apply to National Forest System lands, as documented in the Soil and Water Conservation Practices Handbook, are currently under development (USDA Forest Service 2012c). At the time of publication, these practices had undergone internal review, but the formal process for adoption through the Administrative Procedures Act, including notification in the Federal Register and establishment of a public comment period on the draft BMPs, had not been initiated.

Environmental Flows and Levels Analysis

An environmental flows and levels analysis should be undertaken whenever a spring or spring-fed wetland is to be developed, redeveloped, restored or is to undergo maintenance of diversion or collection facilities. Determining quantitative environmental flows and levels (EF/L) for groundwater is critical for ensuring adequate water to sustain GDEs in cases where management activities, such as mining, wells for municipal water supply, and water withdrawals for livestock operations, affect groundwater flow to GDEs. EF/L for groundwater takes into account the ability of the site to adjust to changes in the water regime. Therefore, EF/L allows for an acceptable level of change to occur relative to the existing hydrologic conditions. When use of water resources shifts the hydrologic conditions below that defined by the EF/L, irreversible ecological harm may occur, including impairment or loss of ecological structure and function.

GDEs, by definition, are supported by aquifers. Any activity that lowers or raises the water table, piezometric surface, or groundwater discharge rate or timing, or alters the groundwater chemistry can affect the integrity of aquatic habitat. An EF/L establishes the limit to water level change for an aquifer or water body. It is the limit at which further withdrawals or flooding would be significantly harmful to the site. The establishment of an EF/L for a discharge wetland or phreatophyte community generally defines a limit on water-table drawdown or increase, or a reduction in discharge feeding the feature from the aquifer. If monitoring indicates the actual water levels or flows are below the defined EF/L, a recovery plan can be developed to reach acceptable levels. A strategy for developing EF/Ls for groundwater-dependent wetlands will be presented in the forthcoming USDA Forest Service, *Groundwater Inventory, Monitoring, and Assessment Technical Guide* (in development).

Approaches to Spring Source Water Development

Flow regulation structures at springs and wetlands are designed to capture and divert water for uses such as livestock watering, domestic use, or irrigation. Water developments are more common at springs than wetlands. Forms of spring flow alteration include diversion from the pre-orifice (prior to the point of emergence) or post-orifice (after emergence) environment. Pre-source diversion is often achieved by (1) sealing the springs orifice from bedrock (and sometimes sealing the surrounding bedrock fractures) and installing piping, or (2) excavating the springs source, installing a slotted pipe catchment system, back-filling the excavation, and piping the water. Post-orifice diversion is also common, particularly for livestock watering and development of ponds. Spring flows are commonly captured into open troughs or into covered tanks and then piped to troughs or ponds. These alterations may preserve some ecological function at the spring's source, but often eliminate spring channel and wetland functions. The most common types of spring source development are:

- Complete diversion;
- Spring source excavation;
- Fencing and offsite watering;
- Spring source capture, gravel trench, perforated pipe, tank, spring box;
- Spring source capture, drilling, piping, tank, spring box;
- Flow splitting;
- Float valve filling and discharge to natural outflow; and
- Spring source enclosure and offsite watering.

Extraction of groundwater from the aquifer may partially or wholly dewater individual springs or entire complexes of springs resulting in fragmentation of habitat, increasing isolation of springs ecosystems, and interruption of biogeographic processes.

Groundwater augmentation may occur when aquifers are artificially recharged by urban runoff, when reservoirs, ditches, or irrigation increase water tables, or through climate changes that increase precipitation. Increased springs flow is often accompanied by a change in flow chemistry and pollutants.

Diversions that remove very small amounts of water may minimally affect biota. Activities that occur infrequently and involve small disturbances may also minimally affect biota if sufficient time passes for the site to naturalize after each disturbance (it may take decades to naturalize after these types of disturbances). In general, species richness declines as diversion increases, and there are functional shifts in the structure of aquatic and riparian communities. Modification of flow regulation structures (e.g., dams, diversions, spring boxes) may be necessary to restore the flow at the source and the functionality of downstream spring brooks or wetlands. For example, installing a flow splitter, shifting the point of diversion downstream from the source, removing a dam, or modifying a spring box and pipes may help ensure flow at the spring's source, with the amount of diverted flow to be evaluated based on goals for the site.

Unlike streams, springs exhibit a relatively constant, year round temperature and chemistry. As groundwater emerges from the subsurface and flows down the spring brook channel, chemical changes take place as the water exchanges gases with the atmosphere and the temperature changes. Spring specific biota has evolved to require these stable aquatic conditions. Pre-orifice extraction of groundwater and post-orifice diversion and changes in channel geometry modify the pre-disturbance chemical and temperature regime.

Implementation of Spring Source Water Management Projects

Natural Resources Conservation Service guidance (USDA NRCS 2006, 2010, 2011) provides environmental compliance requirements and planning and installation guidelines for two primary types of spring source diversion or capture devices: spring boxes and capture trenches. These guides do not, however, present least impact alternatives.

The following items should be considered prior to the implementation of a spring source development project to ensure the least amount of impact to groundwater-dependent resources.

- Are native and, or, sensitive species present at or adjacent to the site?

- Are there steps that can be taken to increase the level of protection for native and sensitive species and adjacent habitat?
- Is there a project design that will ensure flow for native species and habitat?
- Are there alternative methods and solutions available that (1) will eliminate the need to modify the spring and associated habitat or (2) will allow the development of the spring source while protecting native species and habitat?

Sites with sensitive species (threatened, endangered, species of interest, species of concern) will require a more specialized and thorough assessment of site conditions and impact prevention/mitigation measures. However, due to the common occurrence of unique or rare species at springs and adjacent habitats, it should be assumed that sensitive species could very likely be present.

Each spring source development or rehabilitation project will present unique conditions and challenges. Therefore, the site assessment process will provide information regarding the condition of the site and will provide critical information necessary for decision making prior to implementation of spring source development or rehabilitation actions. Regardless of whether the primary project goal is site rehabilitation or spring source development, certain sites may benefit from the removal of infrastructure, while others may incur unnecessary disturbance if abandoned infrastructure is removed. For example, a historically developed site may have naturalized and ecological function may be largely intact after decades of abandonment. Conversely, if ecological function is impacted it would be desirable to remove infrastructure. Most spring source development projects will fall under the following categories:

- Development of a new source and associated installation of infrastructure
- Removal of existing infrastructure and replacement with new infrastructure
- Removal of existing infrastructure and site rehabilitation
- Site rehabilitation without removal of existing infrastructure

Avoiding Unnecessary Impacts

Species abundance and diversity is typically greatest at and immediately downstream from the spring source. Therefore, diversion of water downstream from the source provides for the greatest level of native species, habitat, and resource protection. Furthermore, the use of float valves or other mechanisms that divert water only when a demand is present will allow water to support habitat and prevent waste due to spillage or runoff from troughs and tanks. The following precautions can assist in the prevention of unnecessary impacts:

- Diversion of water downstream from the source area
- Flow splitting, or leaving the greatest percentage of flow in the existing outflow and associated habitat as possible
- The use of float valves or other flow control devices to provide flow only when a demand is present
- Minimization of source area disturbance
- Returning unused portions of flow diversion to outflow habitat
- Avoiding methods that utilize trenching or installation of grout walls or perforated pipe systems near spring sources

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