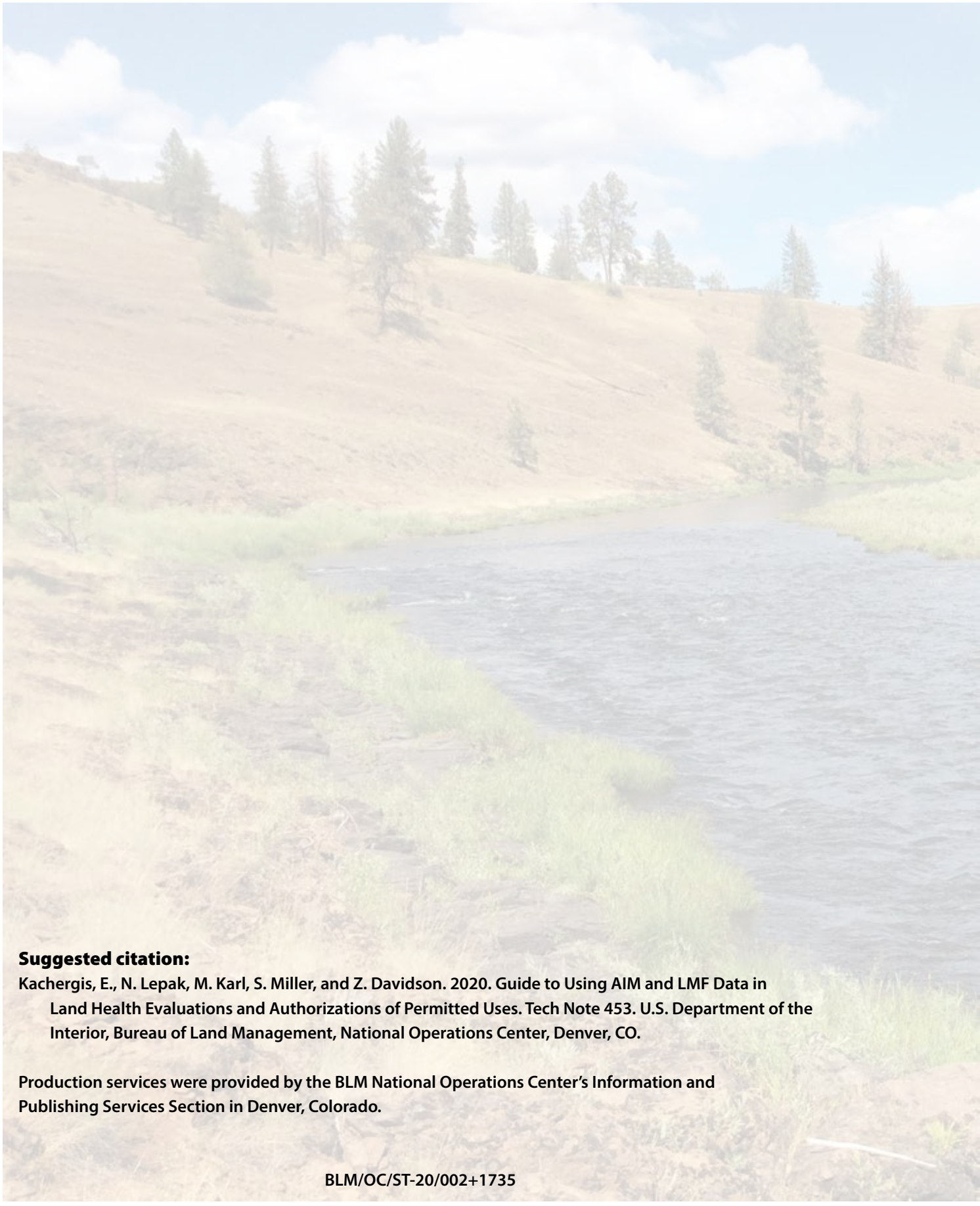
BUREAU OF LAND MANAGEMENT

Guide to Using AIM and LMF Data in Land Health Evaluations and Authorizations of Permitted Uses

Technical Note 453

July 2020



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Guide to Using AIM and LMF Data in Land Health Evaluations and Authorizations of Permitted Uses

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Abstract

The Bureau of Land Management (BLM) is responsible for the management of about 245 million acres of public land for a variety of uses, including livestock grazing, energy development and reclamation, wildlife habitat, timber harvesting, and outdoor recreation, while conserving natural, cultural, and historical resources. BLM Assessment, Inventory, and Monitoring (AIM) data represent one of the largest available datasets to inform resource management decisions on these lands. This technical note serves as a guide for using AIM data, along with other available data, to complete evaluations of land health and related authorizations of permitted uses as required by BLM policy (43 CFR Subpart 4180). The key steps for completing a land health evaluation for a given area using AIM data include: selecting indicators for each applicable land health standard; setting benchmark values that define good conditions for each selected indicator; identifying relevant AIM plots and grouping them appropriately for analysis; and summarizing which benchmarks are or are not attained at each plot. A land health evaluation report then draws conclusions about which of the applicable land health standards are or are not achieved, with justification from AIM data and other information sources. If land health standards are not achieved, a land health determination should be completed that addresses the cause(s) of land health standard nonachievement by incorporating additional data about land uses and natural disturbances. If changes in land uses or restoration actions are planned as a result of the determination, a National Environmental Policy Act (NEPA) document, such as an environmental assessment, should also be completed to analyze the potential environmental impacts of federal actions. AIM data and related conclusions from the land health evaluation and determination can inform many NEPA steps including assessing conformance with land use plan objectives and describing the affected environment, environmental consequences (effects analysis), and cumulative effects. AIM data, along with other BLM data, provide a tremendous opportunity to streamline, increase transparency, and improve outcomes of multiple-use public land management.

1. Introduction

1.1 Background Information

The Bureau of Land Management (BLM) oversees about 245 million acres of public lands, located primarily throughout 12 western states, including Alaska. In addition, the BLM administers about 700 million acres of subsurface mineral estate throughout the nation. Responsible for more land than any other federal agency, the BLM manages public lands for a variety of uses, including livestock grazing, energy development and reclamation, wildlife habitat, timber harvesting, and outdoor recreation, while conserving natural, cultural, and historical resources. The BLM has managed public lands under a multiple-use mandate since 1976, following the passage of the Federal Land Policy and Management Act.

The Department of the Interior's policy for managing healthy rangelands is 43 CFR Subpart 4180, which lists the four **fundamentals of rangeland health** (43 CFR §4180.1). The four fundamentals of rangeland health include:

- Watersheds are in, or are making significant progress toward, properly functioning physical condition, including their upland, riparian-wetland, and aquatic components; soil and plant conditions support infiltration, soil moisture storage, and the release of water that are in balance with climate and landform and maintain or improve water quality, water quantity, and timing and duration of flow.
- Ecological processes, including the hydrologic cycle, nutrient cycle, and energy flow, are maintained, or there is significant progress toward their attainment, in order to support healthy biotic populations and communities.
- Water quality complies with state water quality standards and achieves, or is making significant progress toward achieving, established BLM management objectives such as meeting wildlife needs.
- Habitats are, or are making significant progress toward being, restored or maintained for federal threatened and endangered species, federal proposed or candidate threatened and endangered species, and other special status species.

In accordance with 43 CFR §4180.2, individual states and regions are required to develop and amend **land health standards** for each of the four fundamentals of rangeland health determined to be critical to sustaining functioning ecosystems (Appendix 1). In 2005, with the release of BLM Handbook H-1601-1, "Land Use Planning Handbook," BLM policy determined land health standards are applicable to all ecosystems and management actions. As a result, the terms "rangeland health" and "land health" are used interchangeably in this tech note.

The purpose of the standards in 43 CFR §4180.2 is to provide measures to determine land health. Examples of practices and activities on BLM-managed public lands that are subject to land health standards include the development of grazing-related portions of activity plans; establishment of terms and conditions of permits, leases, and other grazing authorizations; and range improvement activities such as vegetation manipulation, fence construction, and development of water.

Consequently, the fundamentals of rangeland health provide a common set of interdisciplinary questions that the BLM seeks to answer from the scale of individual project locations, to grazing allotments, to ecoregions to ensure the sustainable management of functioning ecosystems. This requires the use of consistent resource condition and trend data to inform management decisions across multiple spatial scales (BLM 2015).

To improve the effectiveness and consistency of monitoring activities on BLM-managed public lands, the BLM undertook efforts that eventually led to the development of the "Assessment, Inventory, and Monitoring Strategy: For Integrated Renewable Resources Management" (AIM strategy) in 2011 (Toevs et al. 2011). The AIM strategy is a national strategy designed to facilitate integrated, cross-program resource monitoring at multiple spatial scales of management.

The AIM strategy provides a standardized process for the BLM to collect quantitative information on the status, condition, trend, amount, location, and spatial pattern of resources on BLM-managed public lands. The BLM uses data derived from the AIM program to make necessary management adjustments to meet resource management objectives described at project, activity plan, resource management plan, and national program levels.

While the four fundamentals of rangeland health provide a common set of management questions, it is the BLM's AIM strategy that provides a nationally consistent approach to monitor and assess the condition of public lands among field offices and states (i.e., standardized indicators, field methodologies, and survey designs). The BLM developed the AIM strategy to integrate and standardize monitoring activities within the BLM, to minimize redundancies in data collection, and to address multiple resource questions at multiple scales (BLM 2015). The foundation of the AIM strategy includes five guiding principles:

1. Structured implementation based on the particular management objectives and local ecosystems relevant to an assessment or monitoring effort.
2. Development and use of a standard set of core quantitative indicators and methods.
3. Application of a statistically valid—and defensible—sampling design, where appropriate.
4. Integration with remote sensing technologies.
5. Electronic data capture and management.

The AIM strategy uses core indicators for terrestrial and lotic (perennial streams and rivers) monitoring (Table 1) (MacKinnon et al. 2011; BLM 2015; BLM 2017a). AIM terrestrial and lotic core indicators are ecologically relevant and clearly tied to the fundamentals of rangeland health and federal and state water quality standards. It is important to note that not only are the indicators standardized, but the methods used to collect the data are also standardized (Herrick et al. 2017; BLM 2017a). This means that the same data are collected in the same way at each sampled site. The use of standardized methods helps ensure that AIM data are comparable (ARS 2019a).

Table 1. AIM terrestrial and lotic core and contingent* indicators.

Terrestrial Indicators	Lotic Indicators
Bare ground	pH
Nonnative invasive species	Specific conductance
Plant species of management concern	Temperature (instantaneous)
Proportion of large gaps between plant canopies	Pool dimensions
Vegetation composition	Streambed particle sizes
Vegetation height	Floodplain connectivity
Soil aggregate stability*	Large wood
	Benthic macroinvertebrates
	Priority noxious vegetation
	Bank stability and cover
	Canopy cover
	Turbidity*
	Total nitrogen* and total phosphorus*
	Bank angle*
	Thalweg depth profile*
	Pool tail fines*
	Greenline vegetation composition*

* Contingent indicator: measurable ecosystem component having the same cross-program utility and definition as core indicators but that is measured only where applicable. Contingent indicators are not expected to be informative or cost effective for every monitoring application and, thus, are only measured when there is reason to believe the resulting data will be important for management purposes.

Since development of the AIM strategy, AIM data have been collected and recorded for thousands of terrestrial sites and hundreds of streams and rivers for national, statewide, ecoregional, and small resource area purposes (Figure 1). These baseline data help natural resource managers and researchers understand the current state of western rangelands, rivers, and streams.

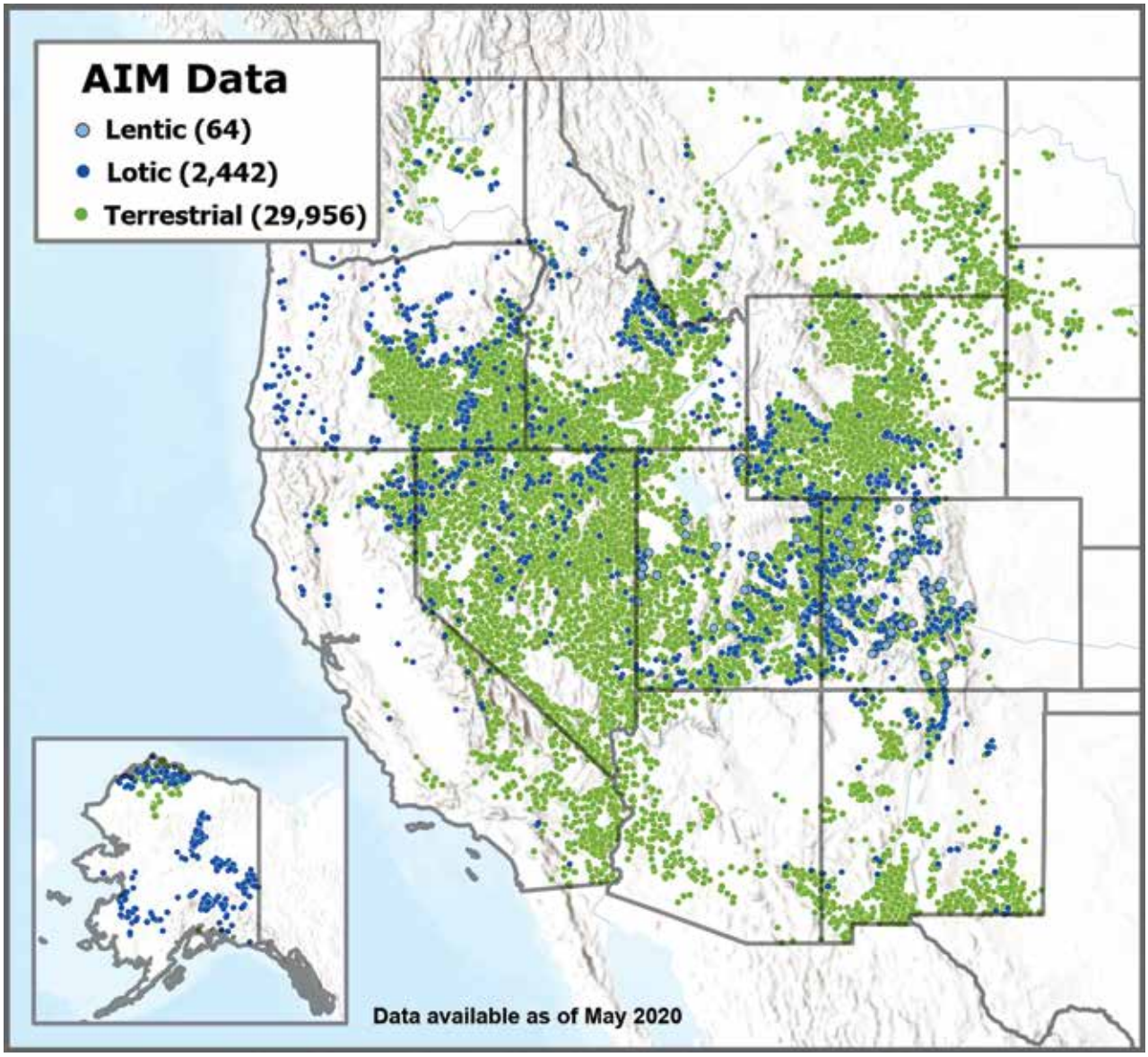


Figure 1. AIM terrestrial (green), lotic (dark blue), and lentic (light blue) data collection locations in the Western United States and Alaska as of May 2020.

A dataset for uplands monitoring is stored in the Terrestrial AIM Database (TerrADat), and a dataset for perennial streams and rivers monitoring is stored in the Aquatic AIM Database (AquADat). TerrADat and AquADat are centralized at the BLM National Operations Center (NOC) and are accessible while connected to the BLM network. Core and contingent indicator data are available to the public via the BLM Landscape Approach Data Portal (BLM 2019). While many AIM data are collected at the field office level, AIM includes two national efforts to assess resource condition and trend. These national-level datasets are also accessible from the NOC.

The Landscape Monitoring Framework (LMF) is a component of the AIM strategy and is used to assess and monitor renewable resources on BLM-managed rangelands in 13 western states (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming). The LMF provides data on terrestrial core and contingent indicators using AIM data collection methods and is a collaboration with the Natural Resources Conservation Service for the National Resources Inventory. LMF data are also available from the NOC alongside TerrADat in a separate database called LMF.

Similar to the LMF, the Western Rivers and Streams Assessment (WRSA) is also a component of AIM conducted in collaboration with the Environmental Protection Agency to assess stream and river condition and trend throughout the contiguous United States. All WRSA data are available in AquADat, and this program is not mentioned further in this publication.

Core indicators and a field protocol for wetland and riparian (lentic) areas are under development and field testing at the time of this publication. When the lentic indicators and protocol are finalized and implemented agencywide, the resulting data will be made available alongside TerrADat and AquADat.

For more information about AIM principles and history, including supporting documents, see *https://aim.landscapetoolbox.org/*.

1.2 Purpose of This Technical Note

BLM decisionmakers use AIM data to inform many types of management actions on BLM lands. These include land health evaluations and environmental assessments for authorizations of permitted uses within field offices, wildlife habitat assessments that may cross administrative boundaries, and to inform Congress of the condition and trend of public lands in the United States. This technical note serves as a guide for using existing AIM and LMF data during the land health evaluation process and related authorizations of permitted uses. The BLM's land health policies and practices are especially relevant to livestock grazing; therefore, this tech note focuses primarily on the land health evaluation and grazing permit renewal process. AIM and LMF data are similar to other data the BLM collects and uses to evaluate whether land health standards are being achieved. AIM terrestrial and lotic data, including LMF data, can be used in land health evaluations and subsequent National Environmental Policy Act (NEPA) analysis by following the principles and processes in this tech note. This tech note does not replace or supersede previous policy or guidance but, rather, assists with the use of new data sources in accordance with existing policy and guidance.

1.3 Determining Availability of AIM and LMF Data for a Project Area

AIM data are available electronically for each terrestrial plot and lotic stream reach—both referred to as "plots" and "sites" in this tech note. External data users can access AIM data from the BLM Landscape Approach Data Portal: *https://landscape.blm.gov/geoportal/catalog/AIM/AIM.page*. BLM staff can view AIM and LMF plots at the following links.

Terrestrial
ArcGIS Online data viewer: *https://aim.landscapetoolbox.org/aim-data-portal*

Geospatial Gateway: *https://doimspp.sharepoint.com/sites/blm-oc/drs/SitePages/BLM%20Terrestrial%20AIM%20Data%20(TerrADat%20and%20LMF).aspx*

Lotic
ArcGIS Online data viewer: *https://aim.landscapetoolbox.org/aim-data-portal*

Geospatial Gateway: *https://doimspp.sharepoint.com/sites/blm-oc/drs/SitePages/BLM%20Aquatics%20AIM%20Data.aspx*

Because there is a delay between data collection and data upload into TerrADat and AquADat, contact local or state AIM coordinators to determine if additional data may be available.

Contact the NOC for assistance in accessing raw data if needed to calculate additional indicator values for a land health evaluation.

1.4 What are Standards, Indicators, Objectives, and Other Terms in Relation to Land Health Policy?

The following terms and definitions provide context for understanding the land health evaluation and grazing permit renewal process. Most are from BLM Handbook H-4180-1, "Rangeland Health Standards," with additional

background information provided in some definitions. To promote understanding, the terms are listed in logical, rather than alphabetical, order.

fundamentals of rangeland health: overarching principles of rangeland health, listed at 43 CFR 4180.1, which establish the Department of the Interior's policy of managing for healthy rangelands. State or regional standards and guidelines must provide for conformance with the fundamentals of rangeland health (43 CFR 4180.2(b)). The fundamentals of rangeland health apply to all BLM programs and land uses (BLM 2005).

rangeland health: the degree to which the integrity of the soil, water, and ecological processes of rangeland ecosystems are sustained. Rangeland health exists when ecological processes are functioning properly to maintain the structure, organization, and activity of the ecosystem over time (BLM and USFS 1994).

land health standard: the level of physical and biological condition or degree of function required for healthy lands and sustainable uses and the minimum resource conditions that must be achieved and maintained. Each state or area with BLM-managed public lands has a set of land health standards in accordance with 43 CFR §4180.2 (Appendix 1). In total, 19 sets of land health standards and indicators correspond to administrative states or Resource Advisory Council areas (e.g., California has four sets of land health standards each corresponding to a Resource Advisory Council area within California, the administrative state of Oregon/Washington has one set of land health standards).

indicators: components of an ecosystem whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g., rangeland health attribute) that is not feasible or too expensive to measure (Pellant et al. 2005). Attributes could also include land health fundamentals or standards.

objective: a description of a desired future resource condition to be achieved in a specified timeframe to meet goals, such as achieving a land health standard.

benchmarks: indicator values or ranges of values that establish goals for resource conditions (e.g., land health, desired future conditions identified in land use planning documents) and are meaningful for management. Observed indicator values at assessed plots are compared to benchmark values to help decide whether land health standards are achieved. Benchmarks are a key part of monitoring objectives and operationalize the use of indicators for evaluating land health standards. Benchmarks for land health standards should be based on reference condition but may also be informed by other sources, including law, policy, reference sites, or ecological functionality (BLM 2001).

reference condition: reference condition (in the land health evaluation process) is the primary conceptual guide for developing benchmarks against which current conditions are compared. The concept of reference condition is interpreted differently among the land health fundamentals and standards.

For terrestrial ecosystems in general, in the context of an ecological site, reference condition is the condition that meets, or comes close to meeting, all relevant land health standards. Reference conditions are provided in published ecological site descriptions or in the records of ecological site inventories and soil surveys.

Reference conditions for water quality and habitat for listed species are frequently captured in state water quality standards and biological opinions, which are based on best available conditions or habitat requirements to maintain viable populations, respectively.

In a more general multiscale context, a reference condition will reflect and lie within the historic range of variability for environmental conditions, processes, and functions. These environmental conditions, processes, and functions can be operative at different scales, from the fine scale (e.g., organic matter content at the site-specific scale) to the large scale (e.g., plant community composition at the watershed or subbasin scale).

1.5 When to Use AIM and LMF Data in the Land Health Evaluation and Grazing Permit Renewal Process

AIM and LMF data can be used in land health assessments and evaluations of land health standards in the grazing permit renewal process, along with field office data that has been used traditionally to complete this work. The workflow for incorporating land health evaluation and determination into processing of grazing permits and leases involves a number of different steps (Figure 2) (BLM 2008). AIM and LMF data are especially relevant to the steps highlighted in green in Figure 2. Note that different BLM states or offices may have slightly varied workflows, with some steps combined or separate.

The next three sections of this tech note correspond to this workflow (Figure 2): Section 2. Land Health Assessment and Evaluation; Section 3. Determination of Causal Factors; and Section 4. NEPA Analysis and Documentation.

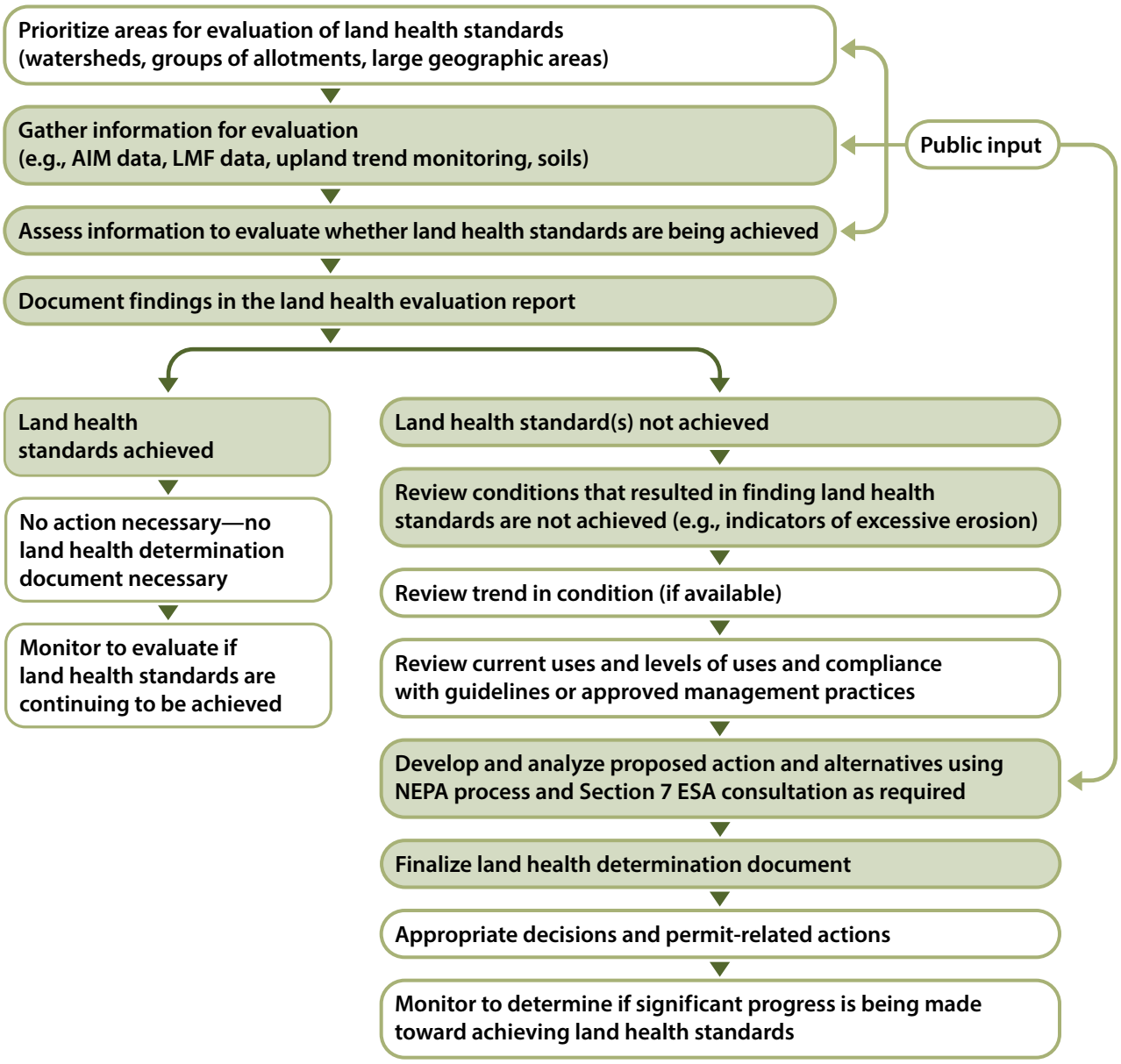


Figure 2. Workflow for incorporating land health evaluation and determination into processing of grazing permits and leases. Steps for which AIM and LMF data can be used are green. Adapted from BLM Instruction Memorandum No. 2009-007 (BLM 2008).

2. Land Health Assessment and Evaluation

The BLM conducts land health assessments in conformance with 43 CFR Subpart 4180 and applicable land health standards and guidelines for livestock grazing administration. A **land health assessment** is a synthesis of data and information available for an area of interest at a point in time. It describes historic and current management, as well as activities and natural disturbances that influence conditions. A land health assessment identifies areas where each land health standard applies, describes the current conditions relevant to each applicable land health standard, and examines changes or trends in land health over time using multiple lines of evidence. The land health assessment sets the stage for the **land health evaluation** report, which concludes whether or not each land health standard is achieved (Figure 2). The report clearly records all aspects of the evaluation and analysis and interpretation of available information, including inventory and monitoring data (BLM 2001).

Further guidance is available in BLM Instruction Memorandum No. 2009-007, titled "Process for Evaluating Status of Land Health and Making Determinations of Causal Factors When Land Health Standards Are Not Achieved" (BLM 2008) and in BLM Handbook H-4180-1, "Rangeland Health Standards" (BLM 2001, pp. III-6 to III-10). This technical note does not replace or supersede guidance in the instruction memorandum or handbook but, rather, is intended to assist with using new data sources when following their guidance.

The BLM should use the best available information when evaluating land health standards and making decisions about land uses. Therefore, it is important that each land health evaluation area is reviewed for availability of AIM and/or LMF data, as it represents the BLM's largest consistent and quality-controlled dataset about soils, vegetation, habitat, and water resource conditions. If AIM and/or LMF data are available but are not used for the land health evaluation, the evaluation report should disclose the reason(s) for not incorporating the available data.

Once the land health evaluation area has been selected and the areas where each land health standard applies have been identified, compile data that are relevant and available for the area. Relevant information will include land health indicators, as well as land use information. Multiple data and information sources, also known as "multiple lines of evidence," are beneficial to help develop defensible land health evaluation reports. Some examples of data and information that could be relevant and available for the land health evaluation area include:

- AIM, LMF, and other quantitative data
  - AIM terrestrial and lotic data (including LMF)
  - Upland vegetation trend monitoring data from other methods
  - Multiple indicator monitoring data (Burton et al. 2011)
  - Fuels and emergency stabilization and rehabilitation monitoring data
  - Special status species population surveys
- Multi-Scale Habitat Assessment Framework Report for sage-grouse, including fine-scale area(s) that intersect the land health evaluation areas (where applicable) (Stiver et al. 2015)
- Photos
- Qualitative assessments (e.g., riparian and lentic proper functioning condition method, interpreting indicators of rangeland health protocol) (Dickard et al. 2015; Pellant et al. 2005)

- Water quality data
- Air quality data
- Land treatments and land use history
- Fire and other natural disturbance history
- Remote sensing data (e.g., fractional cover mapping, LANDFIRE)

Land use and management information, such as livestock grazing use data, may be included in the land health evaluation report but should not be used to evaluate whether a standard is achieved. These data are considered when determining whether existing management or levels of use are causal in not achieving land health standards.

2.1 Data Needs/Adequacy

Adequate data and information, with respect to the land health assessment and land health evaluation for the grazing permit renewal process, is defined as having enough data and information to allow the interdisciplinary team to describe the current conditions of soils, vegetation, habitat, and water resources and ecological functionality within the evaluation area and evaluate whether each applicable land health standard is being achieved and, if not, whether significant progress is being made toward achievement.

BLM staff often use the interpreting indicators of rangeland health protocol (Pellant et al. 2005) and riparian proper functioning condition method (Dickard et al. 2015) to inform assessments and evaluations of land health standards. However, these qualitative field protocols are not required to assess and evaluate land health standards, and they do not address all of the land health standards. Available quantitative data can also be used to evaluate land health standards, either alone or in conjunction with qualitative assessments. Quantitative data may also be used as part of the process of completing qualitative field assessments.

When quantitative data are used in a land health evaluation, it is recommended to establish a set of quantitative indicators and benchmarks to evaluate whether applicable land health standards are being achieved. More information about benchmarks can be found in the sections that follow and Appendix 2, as well as at *https://aim.landscapetoolbox.org/benchmarks/* and *https://aim.landscapetoolbox.org/setting-benchmarks/*.

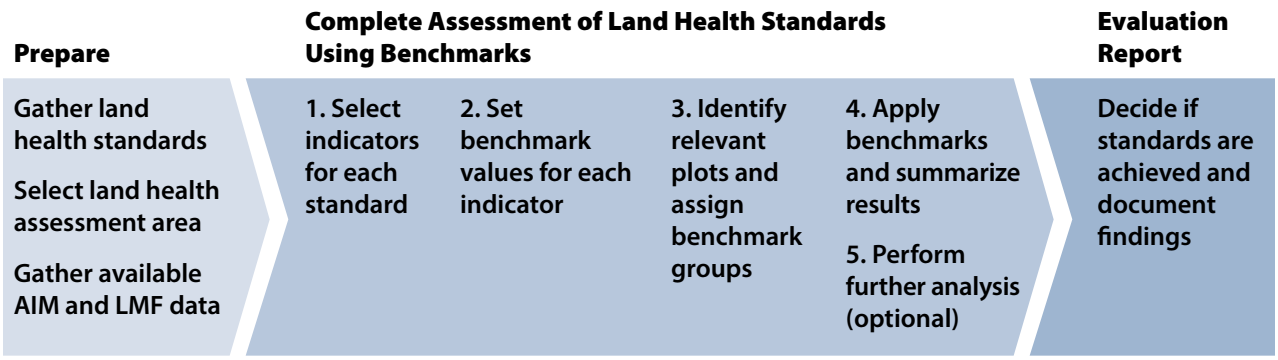
2.2 Using AIM and LMF Data in Land Health Evaluations

This section describes a five-step process for comparing indicator values to benchmark values to help evaluate land health standards. While this tech note focuses on the use of AIM terrestrial and lotic core and contingent indicators, other quantitative data sources and associated indicators can be used for this process as well. This tech note also focuses on the benchmark approach, which is a consistent, defensible, and logical approach that provides a pathway between data, indicator, land health standard, and conclusion, as recommended in BLM Handbook H-4180-1 (BLM 2001, p. III-11). However, the benchmark approach is not required. For other approaches, see Box 1 on page 17.

The use of AIM and LMF data to evaluate land health standards involves the following five steps, as illustrated in Figure 3.

1. Select indicators for each applicable land health standard to be evaluated.
2. Set benchmark values for each selected indicator.
3. Identify relevant plots and assign benchmark groups.
4. Apply benchmark values and document attainment/nonattainment.
5. Perform further analysis (optional).

A. Process



B. Example

Land Health Standard: Soil Health

Indicator (Benchmark)		Soil Stability[1] (≥ 4)[2]		Bare Ground[1] (≤ 30% for PJ; ≤ 20% for others)[2]		Canopy Gaps > 2 m[1] (< 20% for PJ; ≤ 10% for others)[2]	
Plot[3]	Benchmark Group[3]	Value	Achieving[4]	Value	Achieving[4]	Value	Achieving[4]
SAGE1	Sagebrush	5	Yes	35%	No	5%	Yes
SAGE2	Sagebrush	2	No	50%	No	8%	Yes
GRASS1	Grassland	6	Yes	5%	Yes	0%	Yes
PJ1	Pinyon-Juniper	5	Yes	25%	Yes	13%	Yes
Total Plots Achieving[4]		3 of 4		2 of 4		4 of 4	

Figure 3. (A) the process and (B) an example of applying AIM and LMF data to land health assessment and evaluation. Superscripts refer to the specific step at which each piece of information is compiled. A similar table could be used in a land health evaluation report to support the conclusion of whether a soils land health standard is being achieved.

Evaluation of land health standards is accomplished using a multiple lines of evidence approach because no single indicator fully describes a standard. Indicator values are compared to benchmark values to help evaluate land health standards. Attainment or nonattainment of a benchmark for one indicator can be considered as one line of evidence used in the assessment and evaluation.

2.2.1 Step 1: Select Indicators for Each Applicable Land Health Standard to be Evaluated

Each state or area with BLM-managed public lands that are managed for livestock grazing (with some exceptions) has a set of land health standards and indicators in accordance with 43 CFR 4180.2. For this step, select AIM indicators for the land health evaluation area that are related to the applicable state or area's land health standards. AIM terrestrial and lotic core and contingent indicators are listed in Table 1. Appendix 1 provides a crosswalk of the applicable indicators for evaluating each land health standard and relevant AIM core and contingent indicators. Appendix 1 serves as a thorough list to use for selecting indicators for each applicable land health standard to be evaluated. Note that each individual land health standard includes many applicable indicators;

it is acceptable to focus analysis on a subset of indicators, as long as justification is provided for the selected indicators.

Additional indicators (other than those in Table 1 or Appendix 1) can also be calculated from the core and contingent data collection methods at each plot (e.g., biotic soil crust cover can be calculated from line-point intercept data, substrate metrics can be calculated from streambed particle surveys). Indicators from site characteristics or other methods collected at each plot may also be available. Consult the full list of available indicators and associated metadata while finalizing the approach to evaluate land health standards.

2.2.2 Step 2: Set Benchmark Values for Each Selected Indicator

In this step, benchmark values are established for the indicators selected in step 1. **Benchmarks** are indicator values or ranges of values that establish goals for resource conditions (e.g., land health) and are meaningful for management. In step 4, indicator values at assessed plots are compared to benchmark values to help decide whether land health standards are achieved.

First, for each indicator selected in step 1, develop one or more quantitative monitoring objectives that include specific benchmarks. See the examples in Table 2. A helpful resource for creating monitoring objectives is chapter 4 of "Measuring and Monitoring Plant Populations" (Elzinga et al. 1998).

BLM Handbook H-4180-1 suggests that **reference conditions** should be the starting point for setting benchmarks and evaluating whether land health standards are achieved, since reference conditions help with understanding the direction or magnitude of change occurring. Reference conditions are defined as conditions that reflect and lie within the historic range of variability for environmental conditions, processes, and functions (BLM 2001). When a site is in reference condition, by definition, all land health standards are met or nearly met. However, many land health standards are written with a focus on ecological functionality, which can be achieved with some degree of departure from reference conditions.

For example, some land health standards for Idaho include nonnative seeded areas that are based on the concept that planting nonnative plants in an area may provide ecological functionality by stabilizing soils, despite the species composition being different from the documented ecological reference condition. Similarly, some degree of nutrient loading to streams and rivers greater than historical levels can occur without harming beneficial uses stipulated under the Clean Water Act. It is important to understand nuances of specific land health standards before setting benchmarks.

Benchmark values may come from existing policies and plans, ecological site descriptions (or range site writeups) (Caudle et al. 2013), reference sites, AIM and LMF data, professional judgment, or a combination (Figure 4). Ecological site descriptions

Table 2. Example monitoring objectives and benchmark values for a terrestrial and a lotic indicator.

	Terrestrial Example	Lotic Example
Management Objective	**Maintain soil stability to minimize wind and water erosion.**	**Maintain stream channel form and function within the natural ranges of local geomorphic conditions.**
Indicator	**Bare ground**	**Bank stability**
Monitoring Objective	**Maintain bare ground cover of less than 20%, with 80% confidence, for shrub/grasslands within the evaluation area.**	**Maintain bank stability greater than 80%, with 95% confidence, for streams within the evaluation area.**
Benchmark	**20% bare ground (maximum)**	**80% bank stability (minimum)**

and associated rangeland health reference sheets can assist in identifying benchmarks because they describe ecological site potential (Pellant et al. 2005). An example of policy from which established benchmarks can be obtained is state water quality standards.

Benchmark values should be appropriate for and applicable to the land health evaluation area. Given the environmental heterogeneity of rangelands, benchmarks are frequently expressed as ranges of values rather than absolute values. It may be necessary to set separate benchmarks within the land health evaluation area based on varying ecological potential within the area. For example, the benchmark amount of bare ground may differ among ecological sites or vegetation types because each has the potential to produce different amounts of bare ground (Caudle et al. 2013) (Figure 3B and Figure 5). Likewise, appropriate conditions for benthic macroinvertebrate communities may differ between large rivers and small wadeable streams or streams draining sedimentary versus igneous geologies.

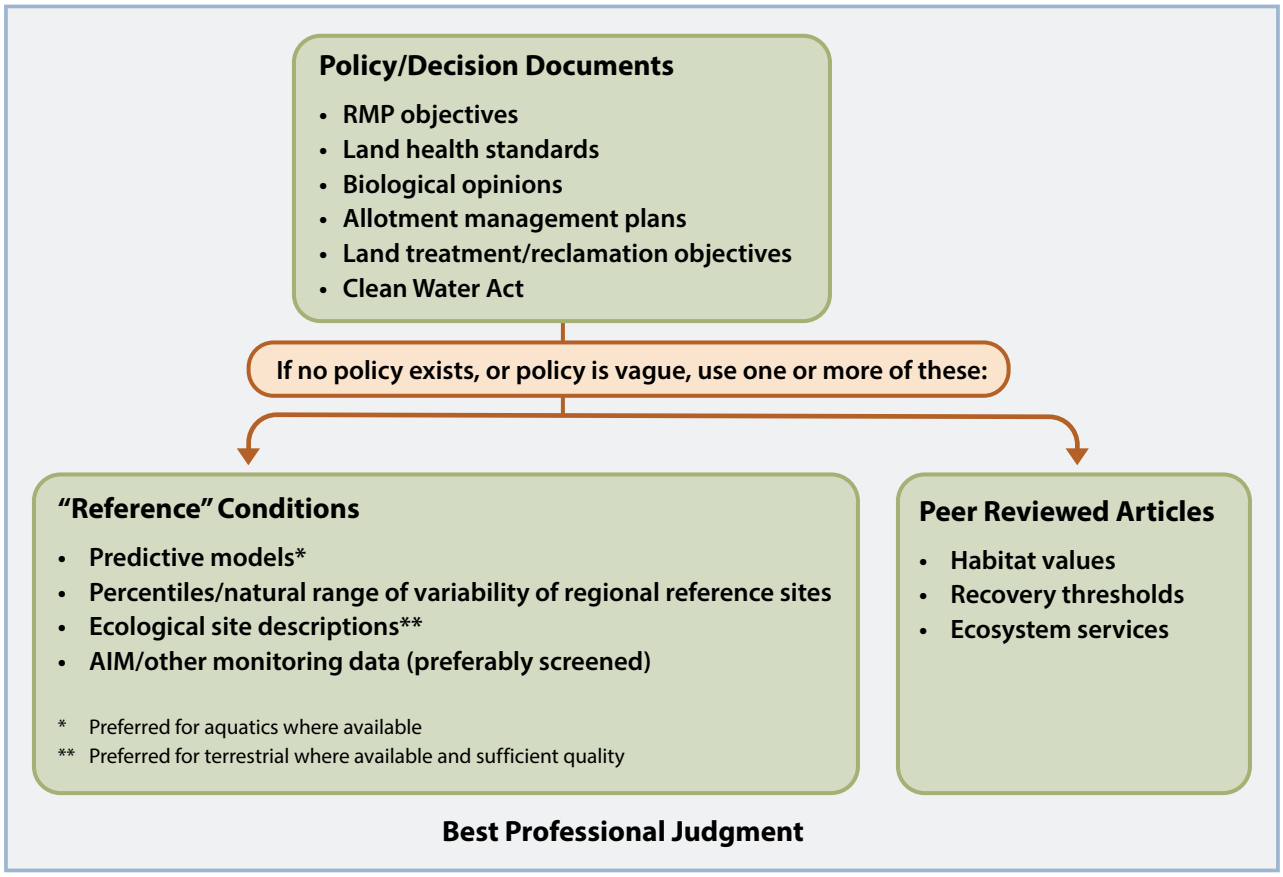


Figure 4. Example information sources that can be used for setting benchmarks.

Benchmark groups (Figure 5) are types or geographic areas of plots that have the same benchmark for evaluating success of a particular land health standard. Be sure to consider whether more than one benchmark group may exist in the evaluation area(s) when setting benchmarks for each indicator.

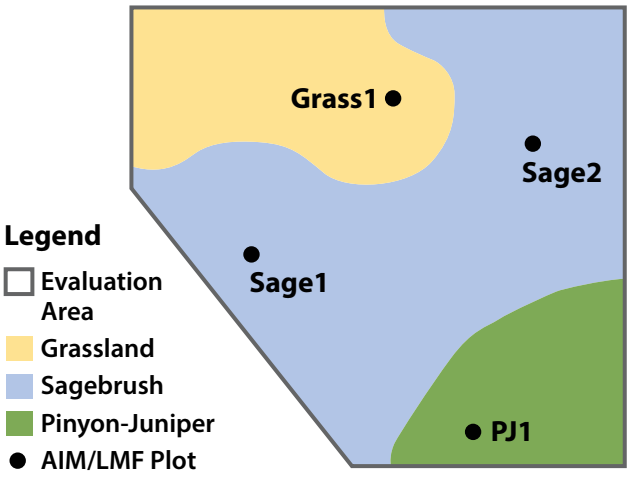


Figure 5. Example of a land health evaluation area with three different types of land that belong to different benchmark groups for some indicators (also see Figure 3B). Often, different types of land have different ecological potential and/or reference conditions and, therefore, require different benchmark values for evaluating land health. In this example, for soil stability, all three land types have the same benchmark value of greater than or equal to 4, so they are all in the same benchmark group. For bare ground, however, pinyon-juniper is in one benchmark group with a benchmark value of less than or equal to 30%, whereas sagebrush and grassland sites are in another benchmark group with a benchmark value of less than or equal to 20%.

AIM and LMF data can also be used to help establish appropriate benchmark values by reviewing existing monitoring data for sites that are in reference and/or functioning condition (see Section 1.3 to access AIM and LMF data). Use these data to characterize the natural range of variability throughout ecologically similar land units or regions. Appendix 2 suggests a step-by-step process for using existing monitoring data, including AIM and LMF data, to inform benchmark values. For example, data collected on AIM and LMF plots within an ecoregion or expected vegetation type can be summarized to determine a range of values for an indicator; then, an interdisciplinary team can review indicator ranges to set locally relevant benchmarks for that indicator. It is advisable to screen the monitoring data first to ensure that the sites being used to set benchmarks are in reference condition and/or are maintaining ecological functions in the context of the applicable land health standard (Appendix 2).

In areas where benchmark groups and/or their supporting data are not readily available, other land potential-based resource classifications, such as LANDFIRE biophysical settings or habitat types, can be used. Characterization data collected at each plot (e.g., slope, bankfull width, soil texture) (Table 3) and GIS-derived geospatial predictors (e.g., precipitation, aspect, elevation, geology) can also be used to understand how indicators naturally vary across the landscape and inform this process (Hobbs and McIntyre 2004; Herrick et al. 2006; Olson and Hawkins 2013).

The key to setting benchmarks is to document a clear and understandable rationale for the approach that was taken. This ensures justification for the use of quantitative data to support the conclusion about land health standard achievement, as is required.

For a more detailed overview of approaches to setting benchmarks, including best practices, see *https://aim.landscapetoolbox.org/setting-benchmarks/*.

2.2.3 Step 3: Identify Relevant Plots and Assign Benchmark Groups

Review existing AIM and LMF plots located within the evaluation area to identify how the plots will be used to inform the land health evaluation (see Section 1.3 to access AIM and LMF data). This process should be informed by the relevant land health standards and the related objectives and benchmarks previously set, including areas to which each land health standard applies. Be sure to document the approach, as the process of choosing plots and assigning benchmark groups could strongly influence the conclusion.

The type or location of the monitoring plot can influence the plot's relevance to a land health

evaluation or a particular land health standard in several ways. At the most basic level, determine which plots are inside the evaluation area, or a subset of the area, for which information is needed. Many land health standards will apply to the entire evaluation area, but some will not. For example, a land health standard that involves a special status species may only apply to potential habitats of that species within the evaluation area. In this circumstance, only plots in those habitats should be used to evaluate the land health standard.

In addition, certain types of plots may have specific benchmarks that apply based on plot characteristics or location. In this circumstance, each plot in the evaluation area should be assigned one or more benchmark groups to link it to the appropriate benchmark for evaluating achievement of each land health standard. For instance, in Figure 3B, the pinyon-juniper plot was identified so that the appropriate benchmark for bare ground could be applied to it. Similarly, Figure 5 illustrates a map of benchmark groups for the same example. Information about plot and stream reach characteristics is available when accessing AIM and LMF data (Table 3) and can help determine which plots belong in which benchmark groups. Importantly, benchmark groups enable a summary across the land health evaluation area of whether benchmarks are attained, despite variation in site characteristics.

Table 3. Information about plot and stream reach characteristics that is available when accessing AIM and LMF data and that can be used to help identify benchmark groups for each site.

Terrestrial Plot Characteristics	Lotic Stream Reach Characteristics
Location and elevation	Location and elevation
Slope (percent and shape)	Slope
Photos	Photos
Aspect	Bankfull width
Soil texture*	Flood-prone width
Soil clay content*	
Soil rock fragments*	
Ecological site (where available)	

* This characteristic applies to each horizon in a soil pit, usually near the center of the plot.

Document the expected level or intensity of grazing and other uses (e.g., recreation, wild horses) that each individual AIM and LMF plot receives. While land uses should not influence the evaluation of land health standard achievement, land use can provide context for interpreting assessment results and guide further analysis. Screening criteria can be applied to help identify the AIM and LMF plot locations that are most likely to provide information about effects of grazing use and other uses (e.g., recreation) on soils and vegetation. Criteria to consider may include slope, distance to water and access points, valley type, and vegetation or ecological site type. Identification of AIM and LMF plots that are likely to receive grazing use or other types of use (e.g., wildlife, energy impacts) will also be helpful to focus the subsequent evaluation and determination of causal factors (see Section 3).

2.2.4 Step 4: Apply Benchmark Values and Document Attainment/Nonattainment

In this step, determine whether AIM and LMF plots are meeting the quantitative objectives by comparing indicator values at each plot to the applicable benchmark (Figure 3B). This step can be accomplished by downloading a spreadsheet of indicator values from TerrADat or AquADat or by using the terrestrial or lotic benchmark tools available at: *https://aim.landscapetoolbox.org/analysis-reporting/analysis-and-reporting-tools/*. These Excel-based tools help in evaluating multiple objectives at multiple sites.

When summarizing results from multiple plots in the evaluation area, be sure to consider how the approach used to select each plot location could influence the findings. Plots identified using a randomized site-selection process may be more representative of the management unit and are required to formally extrapolate the results of quantitative assessments to larger landscape units (see step 5). However, plots that were identified based on specific resource or use concerns or based on professional knowledge also provide valuable information about specific areas. These include "key areas" or sites that have been purposefully selected to represent the effectiveness of management within a certain

type of land in a management unit (BLM 1989, p. I-7). AIM data include both randomly selected and nonrandomly selected plots; LMF plots are randomly selected in pairs within random quarter sections across BLM rangelands. Try to understand the site-selection approach for the plots used for the evaluation, and provide this information to the interdisciplinary team to inform their decision of whether or not land health standards are achieved and whether monitoring results can be extrapolated across the evaluation area. Monitoring design descriptions and related GIS files are a valuable source of information about how monitoring sites were selected. Request assistance from local, state, or NOC AIM leads for help finding sample design information for plots.

Summarize analysis results and other available data in the land health evaluation report. Tables, maps, and/or graphs showing where benchmarks are or are not attained, and the indicator values, are often helpful for presenting these results (e.g., Figure 3B, Figure 5).

2.2.5 Step 5: Perform Further Analysis (Optional)

Additional indepth analyses may be required by policy or may be warranted for very large areas with complex resource issues, where a known level of confidence is desired, and/or where sufficient resources are available to collect data points. A standard weighted analysis approach can be used to estimate the percentage of a landscape in a given condition with known levels of confidence. For example, a site-scale greater sage-grouse habitat assessment in Oregon estimated that 94% (89–98 at 80% confidence interval) of BLM-managed winter habitat was in suitable condition. The associated land health assessment referenced this sage-grouse habitat assessment, and further analysis found that 100% of the BLM-managed winter habitat within the O'Keeffe allotment was in suitable condition (BLM 2017b). This information was part of multiple lines of evidence that informed the evaluation of Oregon's land health standard involving native, threatened and endangered, and locally important species (BLM 2017b). For more information about this and other analysis approaches, see step 6 at: *https://aim.landscapetoolbox.org/analysis-reporting/analysis/preparing-for-analysis/*.

2.3 Land Health Evaluation Report

Working with the interdisciplinary team, document findings in the land health evaluation report. Evaluate whether or not each land health standard is being achieved for the evaluation area as a whole. Use convergent lines of evidence or a preponderance of evidence to draw conclusions about the land health evaluation area (BLM 2001, p. III-11).

Attainment or nonattainment of benchmarks at AIM and LMF plots (completed in Section 2.2.4, Step 4) provides one or more lines of evidence to support the interdisciplinary team's evaluation. Other lines of evidence may come from a weighted analysis (Section 2.2.5, Step 5), monitoring data at key areas or upland trend sites, other assessment methods (e.g., Pellant et al. 2005; Dickard et al. 2015), professional judgment, or remote sensing data. Present results visually if possible, in tables, figures, and graphs, accompanied by a brief discussion that clearly supports the interdisciplinary team's conclusion for each land health standard (e.g., Figure 3B). Ensure that the information is presented such that data are linked to conclusions in a consistent, logical, and defensible way. For more information on the evaluation report, see BLM Handbook H-4180-1, pp. III-10 through III-12.

If the interdisciplinary team concludes that available information is inadequate to complete the land health evaluation report, additional data should be collected. If the interdisciplinary team decides that more AIM data points are needed, several approaches may be used to obtain them.

(1) Additional randomly selected points can reduce bias in the site-selection process and also inform broader landscape conditions (with the right analysis approach). If it is decided that more randomly selected points are needed, communicate with the relevant local office or state AIM lead, and select more points to sample. Approaches include

selecting points from a broader existing design (e.g., land use plan) or creating new points with the Spatially Balanced Sampling Tool (*https://www.landscapetoolbox.org/sample-design-tools/*).

(2) Nonrandomly selected plots in key areas or other targeted locations are particularly useful for investigating specific questions or uncertainties raised by the initial assessment. How these plots are located depends on the question needing answered. For example, if the specific question is whether grazing is the cause of land health standards not being achieved, plots are required in areas that have received different amounts of grazing.

Box 1. Other approaches to incorporating AIM and LMF data in land health assessments and evaluations.

In this tech note, the benchmark approach is recommended because it is a consistent, defensible, and logical approach that provides a pathway between data, indicator, land health standard, and conclusion, as recommended in BLM Handbook H-4180-1 (BLM 2001, p. III-11). However, the benchmark approach is not required. AIM and LMF data may also be used in other ways to support land health assessment and evaluation, as follows.

DESCRIPTIVE APPROACH (NO BENCHMARKS)

Quantitative data are often used in a descriptive way to tell a story about conditions and evaluate whether land health standards are achieved. The descriptive approach is similar to the process described in this tech note. However, in the descriptive approach, benchmark values are not defined, so only steps 1 and 3 are completed. For each land health standard, a set of quantitative indicators from the relevant plots is presented in tables or graphs. These are often accompanied by the results of qualitative assessments (e.g., Pellant et al. 2005; Dickard et al. 2015), trend data, photographs, professional judgment, and/or other information. All of the information is then summarized in a way that tells a story or builds a case for the evaluation of land health standard achievement.

Ensure a clear and understandable rationale is documented for how the quantitative data was used in order to draw the conclusions. Failure to include a clear rationale may confuse the public or create an appearance of bias. In a legal situation, a decision relying upon unclear data analysis and interpretation may be found arbitrary and capricious.

TREND DATA

A possible outcome of a land health evaluation is a conclusion that the land health evaluation area is making significant progress toward achieving a land health standard—defined as "acceptable in terms of rate and magnitude" while also being "realistic," "expeditious," and "effective" (BLM 2001, p. I-7). This conclusion is only possible when the land health evaluation employs trend data (information about how resource conditions are changing over time). Trend should be derived from quantitative methods rather than repeated qualitative assessments. Trend data can be analyzed in many different ways, including a benchmark approach, statistical tests, or a more descriptive approach. Any analysis approach will involve completing steps 1 and 3 from this tech note, but other steps will vary. Trend results are often presented in a graph that shows indicator values at individual sites and how they change over time. This information is then used along with other information to evaluate whether land health standards are being achieved, and if not, whether significant progress is being made toward achievement. Trend can also be very useful for the land health determination because changes in indicators may correspond with changes in uses, strengthening the argument for causation.

3. Determination of Causal Factors

When one or more land health standards is not achieved, work with the interdisciplinary team to identify the causes for nonachievement (BLM 2001, p. III-12). This typically requires linking land use and disturbance information with conditions in the evaluation area, including at AIM and LMF plots.

- Review which land health standards are not achieved, including which specific sites and indicators resulted in this finding.
- Identify any patterns linking nonachievement of land health standards and one or more potential causes, including grazing. For example, if all burned sites are not achieving a land health standard involving soils, then fire is a probable cause. Likewise, if key areas where grazing occurs (and the ecological sites at which the key areas are located) are not achieving land health standards, then failure to achieve land health standards in the same ecological sites in other areas of the management unit (e.g., allotment) may also be attributable to grazing.
- AIM and LMF data from outside the land health evaluation area can provide helpful context for determining causation. For example, if an invasive species population is increasing across the landscape, management within one small management unit is likely not the cause.
- Take into account multiple lines of evidence to determine causation.
- For more information, see BLM Handbook H-4180-1, pp. III-12 to III-14 (BLM 2001), and BLM Instruction Memorandum No. 2009-007 (BLM 2008).

Complete the determination report. Present monitoring results, including any pertinent use monitoring such as grazing utilization and actual use records. These will help provide a clear rationale for the determination, as well as guide the alternatives in the NEPA document. For full decision and reporting requirements, see BLM Handbook H-4180-1, pp. III-13 to IV-2 (BLM 2001) and BLM Instruction Memorandum No. 2009-007 (BLM 2008).

4. NEPA Analysis and Documentation

If changes in permitted uses or other actions are planned as a result of the land health evaluation and determination, a NEPA document is usually required to analyze the potential environmental impacts of possible actions. Example NEPA documents include an environmental assessment or environmental impact statement. Both documents include sections addressing land use plan conformance, describing the affected environment, and analyzing the individual and cumulative effects of proposed actions and alternatives (more detailed descriptions follow). NEPA analyses for grazing permit decisions are likely to rely heavily on a preceding land health evaluation report and determination. However, in other cases, it may be appropriate to add to the information in the land health evaluation report, or the NEPA document may require a standalone summary or analysis of AIM and other data either directly in the NEPA document or as an appendix.

For examples of term permit renewals that use AIM and LMF data, see *https://aim.landscapetoolbox.org/analysis-reporting/reporting/*.

4.1 Conformance with Land Use Plan Objectives

The NEPA analysis process includes documentation of conformance with the guiding land use plan (LUP). Applicable objectives from the LUP should be reviewed and listed in the NEPA document. Newer plans may contain quantitative management objectives, whereas older plans usually list qualitative objectives or general management goal statements. State water quality standards and the greater sage-grouse plan amendments (*https://www.blm.gov/programs/fish-and-wildlife/sage-grouse*) are examples of plan components with quantitative objectives that can be compared to core and contingent indicator data collected on AIM and LMF plots. In addition to achieving or not achieving land health standards, status of an allotment's condition relative to LUP objectives should be included in the purpose and need statement, which will guide development of alternatives to be analyzed in the NEPA document.

For the purpose and need statement, the terrestrial and lotic benchmark tools can be used to compare AIM and LMF data to LUP objectives: *https://aim.landscapetoolbox.org/analysis-reporting/analysis-and-reporting-tools/*.

4.2 Describing the Affected Environment

When describing the affected environment in the NEPA document, describe the existing condition and trend of resource issues that may be affected by implementing the proposed action or an alternative (40 CFR 1508.14). Describe the specific elements of existing condition quantitatively, if possible, and in enough detail to serve as a baseline against which to measure the potential effects of implementing an action. Often, information compiled from the land health assessment, evaluation, and determination can be used as the basis for describing elements of the affected environment. An example might be to incorporate the cover percentages of species found at the plot(s), including any notable noxious weeds.

Summarize the results of a land health assessment and a land health evaluation report (and determination, if completed) in the affected environment section, and attach these documents

as appendices. The analysis of the current management alternative is the supporting documentation of land health standard achievement and is the baseline against which other alternatives are compared.

When a land health evaluation has been conducted for a project area but has not included data collected from AIM and/or LMF plots, AIM and/or LMF data can be incorporated at this point to more fully describe baseline conditions. Refer to Sections 2.2.4 and 2.2.5 on data analysis.

4.3 Environmental Consequences (Effects Analysis)

The environmental consequences section (40 CFR 1502.16) forms the scientific and analytic basis for the comparisons under the alternatives (40 CFR 1502.14). The environmental consequences section will include environmental impacts of the alternatives, including the proposed action. Describe effects in terms of indicator values or amounts (such as acres, miles, percentages, height, length) to quantify the affected environment description and environmental consequences section. AIM and LMF data can assist with the effects analysis by quantifying the amount of change in indicators, proportion of project area in which changes to indicators are expected under each alternative, etc. Make reasonable assumptions, and provide rationale for assumptions.

4.4 Cumulative Effects

The purpose of cumulative effects analysis is to ensure that federal decisionmakers consider how the impacts of considered alternatives may combine with other past, present, and reasonably foreseeable impacts from future actions by the BLM and other entities. Begin thinking of cumulative effects early in the NEPA process, during scoping, during evaluation of the area of potential effect, and while writing the narrative for the current conditions (residual effects of past actions that have led to the current conditions). Remember that the no action alternative can still contribute to changing conditions and impacts.

The geographic scope of the cumulative effects analysis is generally based on the boundaries of the affected resource and does not extend beyond the direct/indirect effects to a specific resource as a result of the action proposed. It may be necessary to describe a different boundary for each affected resource in the environmental assessment or environmental impact statement.

Because AIM and LMF plots transcend allotment and field office boundaries, the data collected on the AIM and LMF plots can assist in cumulative effects analysis. An example would be using AIM and/or LMF data to review conditions of connected wildlife habitat outside the project area and assess the effects of the analyzed alternatives and other impacts on that habitat area.

5. Summary

Land health evaluations, determinations, and related NEPA analyses represent key mechanisms for adaptive management of public lands that are rooted in BLM policy and widely applicable across BLM-managed lands and land uses. The increasing availability of AIM data provides a tremendous opportunity to streamline decisions, increase transparency, and improve land management outcomes. AIM data provide a core set of information about the health of BLM lands and waters that is complementary to and should be used alongside other types of data about land condition and use. The information in this tech note is intended to help accomplish multiple-use management of public lands.

Appendix 1. Land Health Standards and AIM Indicators Crosswalk

This appendix shows the relationships among land health standards, indicators associated with each land health standard, and AIM core and contingent indicators that can be used to evaluate each land health standard. To evaluate the achievement of land health fundamentals (43 CFR §4180.1), each BLM administrative state or Resource Advisory Council area identified a set of land health standards and related indicators. In total, 19 sets of land health standards correspond to administrative states or Resource Advisory Council areas (e.g., California has four sets of land health standards each corresponding to a Resource Advisory Council area within California, the administrative state of Oregon/Washington has one set of land health standards).

AIM data provide a consistent approach to evaluating whether the land health standards are being achieved, thus informing adaptive management at multiple spatial scales across BLM-managed public lands. The AIM terrestrial and lotic (streams and rivers) indicators (MacKinnon et al. 2011; BLM 2015) relate to each land health standard (Table A1) and can be used to evaluate a majority of the land health standards.

The AIM dataset contains additional indicators that are not listed in Table A1. Some are specific subsets of the core and contingent indicators, such as height of woody plants and height of herbaceous plants, or streambed sediment in specific size classes. Others are indicators that can be calculated from the core and contingent methods, as well as plot and stream reach characteristics; examples include basal cover of litter, rocks, and biotic crusts from line point intercept. In addition to Table A1, consult the full list of available indicators and metadata as the approach to evaluating land health standards is finalized.

Table A1. The 19 sets of land health standards (43 CFR §4180.2) for each BLM administrative state or Resource Advisory Council area; the indicators associated with each land health standard that can be used to evaluate if the land health standard is being achieved; and the AIM terrestrial and lotic core and contingent indicators that can be used to evaluate if the land health standard is being achieved.

Alaska

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Watershed function—uplands: To ensure that watersheds are in, or are making significant progress toward, a properly functioning physical condition that includes their upland, riparian, wetland, and aquatic areas. The infiltration and permeability rates, moisture storage, and stability of upland soils are appropriate to the watershed's soil, climate, and landform.	
• Amount and distribution of plant cover (including forest canopy cover) • Amount and distribution of permafrost • Soil temperature/depth profile • Soil moisture • Amount and distribution of plant litter • Accumulation/incorporation of organic matter • Amount and distribution of bare ground • Amount and distribution of rock, stone, and gravel • Plant composition and community structure • Thickness and continuity of the first layer of soil containing organic matter • Character of microrelief • Presence and integrity of biotic crusts • Root occupancy of the soil profile • Biological activity (plant, animal, and insect) • Absence of accelerated erosion and overland flow • Snow depth/moisture content	• Bare ground • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #2—Watershed function—riparian, wetland, aquatic areas: To ensure that watersheds are in, or are making significant progress toward, a properly functioning physical condition that applies to upland, riparian, wetland, and aquatic areas. The riparian, wetland, and aquatic areas are functioning properly at levels appropriate to the watershed's soil, climate, and landform.	
• Frequency of floodplain/wetland inundation • Amount and distribution of aufeis • Amount and distribution of permafrost • Hydrograph time/temperature graph • Plant composition, age class distribution, and community structure • Root mass • Point bars revegetating • Streambank/shoreline stability • Riparian area width • Sediment deposition • Active/stable beaver dams • Coarse/large woody debris • Watershed conditions of adjacent uplands • Frequency/duration of soil saturation • Water table fluctuation • Channel width/depth ratio • Entrenchment • Benthic communities • Channel sinuosity • Gradient	• Pool dimensions • Streambed particle sizes • Pool tail fines • Floodplain connectivity • Large wood • Benthic macroinvertebrates • Greenline vegetation composition • Bank stability and cover • Temperature • Bank angle

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #2—continued	
• Rocks and coarse and/or large woody debris • Overhanging banks • Pool/riffle ratio • Pool size and frequency • Stream embeddedness	
STANDARD #3—Ecological processes: To ensure that water and nutrient cycling and energy flow support healthy, productive, and diverse natural communities. Water and nutrient cycling and energy flow occur effectively to support healthy, productive, diverse communities at levels appropriate to the potential/capability of the site.	
• Plant composition and community structure • Fire history mapping • Fire return rate • Fire severity distribution • Animal migrations and other behavior patterns • Groundwater flow interruptions • Accumulation, distribution, incorporation of plant litter and organic matter into the soil • Animal community structure and composition • Root occupancy in the soil profile • Biological activity including plant growth, herbivory, and rodent, insect, and microbial activity	• Vegetation composition • Vegetation height • Soil aggregate stability • Benthic macroinvertebrates • Greenline vegetation composition
STANDARD #4—Water quality and yield: To ensure that surface water and groundwater quality (to the extent that BLM actions can influence water quality in the area) complies with state water quality standards.	
• Water temperature • Dissolved oxygen • Fecal coliform • Turbidity • pH • Populations of aquatic organisms • Effects on beneficial uses (i.e., effects of management activities on beneficial uses as defined under the Clean Water Act and state regulations) • Specific conductivity • Water chemistry, including nutrients and metals • Total sediment yield including bed load • Levels of chemicals in bioassays • Change in trophic status	• pH • Specific conductance • Temperature • Benthic macroinvertebrates • Turbidity • Total nitrogen and total phosphorous • Streambed particle sizes • Pool tail fines • Thalweg depth profile
STANDARD #5—Threatened, endangered, native, and locally important species: To ensure that habitats support healthy, productive, and diverse populations and communities of native plants and animals (including special status species and species of local importance, e.g., those used for subsistence).	
• Plant community composition, age class distribution, and productivity • Animal community composition and productivity • Habitat elements • Spatial distribution of habitat • Habitat connectivity • Population stability/resilience (within natural population cycles) • Fire history	• Vegetation composition • Vegetation height • Benthic macroinvertebrates • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

Arizona

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland sites: Upland soils exhibit infiltration, permeability, and erosion rates that are appropriate to soil type, climate, and landform (ecological site).	
Ground Cover: • Litter • Live vegetation, amount and type (e.g., grass, shrubs, trees) • Rock Signs of Erosion: • Flow pattern • Gullies • Rills • Plant pedestaling	• Bare ground • Vegetation composition • Proportion of large gaps between plant canopies
STANDARD #2—Riparian-wetland sites: Riparian-wetland areas are in properly functioning condition.	
• Gradient • Width/depth ratio • Channel roughness and sinuosity of stream channel • Bank stabilization • Reduced erosion • Captured sediment • Groundwater recharge • Dissipation of energy by vegetation	• Streambed particle sizes • Greenline vegetation composition • Bank stability and cover • Large wood • Pool tail fines
STANDARD #3—Desired resource conditions: Productive and diverse upland and riparian-wetland plant communities of native species exist and are maintained.	
• Composition • Structure • Distribution	• Vegetation composition • Vegetation height • Greenline vegetation composition

California (Northwest)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Soils: Soils exhibit characteristics of infiltration, fertility, permeability rates, and other functional biological and physical characteristics that are appropriate to soil type, climate, desired plant community, and landform.	
• Ground cover (vegetation and other types of ground cover such as rock) sufficient to protect sites from accelerated erosion. • Litter/residual dry matter evident, accumulating in place, and showing negligible movement by water. • A diversity of plant species, including native plants, with a variety of root depths, is present and plants are vigorous during the growing season. • There is minimal evidence of accelerated erosion in the form of rills, gullies, pedestaling of plants or rocks, flow patterns, physical soil crusts/ surface sealing, or compaction layers below the soil surface. • Biological (microphytic or cryptogamic) soil crusts, if present, are intact.	• Bare ground • Vegetation composition • Soil aggregate stability
STANDARD #2—Species: Viable, healthy, productive, and diverse populations of native and desired plant and animal species, particularly special status species, are maintained and/or being restored.	
• Wildlife habitats include seral stages, vegetation structure, and patch size to promote diverse and viable wildlife populations. • A variety of age classes is present for desired plant species. • Plant vigor is adequate to maintain desirable plants and ensure reproduction and recruitment of plants when favorable climatic events occur. • The spatial distribution of plant and animal species and their habitats allows for reproduction and recovery from localized catastrophic events. • A diversity of plant species with various developmental stages and rooting depths is present to extend the photosynthetic period and increase energy capture. • There is evidence of beneficial natural disturbances. • Nonnative, noxious, and invasive species are at acceptable levels. • Special status species and other local species of concern are healthy and in numbers that appear to ensure stable to increasing populations; habitat areas are large enough to support viable populations or are connected adequately with other similar habitat areas. • Adequate organic matter (litter and standing dead plant material) is present for site protection and decomposition to replenish soil nutrients and support nutrient cycling. • Where appropriate, biological soil crusts (also called microphytic or cryptogamic soil crusts) are present and not excessively fragmented.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Vegetation height • Soil aggregate stability • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)
STANDARD #3—Riparian: Riparian/wetland vegetation, structure and diversity, and stream channels and floodplains are functioning properly, and meeting regional and local management objectives.	
• Naturally occurring vegetation cover will protect banks and dissipate energy during high flows. • Age-class and structure of woody/riparian vegetation are diverse and appropriate for the site. Recruitment of preferred species is adequate for sustaining the community. • Where appropriate, habitat is sufficient to provide for plant and animal riparian-dependent species. There is diversity and abundance of insects and amphibians. • Where appropriate, there is adequate woody debris.	• Pool dimensions • Streambed particle sizes • Pool tail fines • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—continued	
• A diversity of plant species with various developmental stages and rooting depths is present. Root masses are sufficient to stabilize streambanks and shorelines. • Plant species present indicate that soil moisture characteristics are being maintained. • Shallow-rooted, invader plant species are not displacing native species. • Adequate organic matter (litter and standing dead plant material) is present to protect the site and to replenish soil nutrients through decomposition. • Point bars are becoming vegetated over time. • There is adequate streambank stability, morphology, pool frequency, stream width/depth ratio, and minimal substrate sediments and bare ground.	
STANDARD #4—Water quality: Surface and groundwater complies with objectives of the Clean Water Act and other applicable water quality requirements, including meeting the California State standards.	
• The following do not exceed the applicable requirements: chemical constituents, water temperature, nutrient loads, fecal coliform, turbidity, suspended sediment, and dissolved oxygen. • Achievement of the standards for riparian, wetlands, and water bodies. • Aquatic organisms and plants (e.g., macroinvertebrates, fish, algae and plants) indicate support for beneficial uses. • Monitoring results or other data that show water quality is meeting the standard.	• pH • Specific conductance • Temperature • Benthic macroinvertebrates • Total nitrogen and total phosphorous • Turbidity • Streambed particle sizes

California (Northeast) and Nevada (Northwest)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland soils: Upland soils exhibit infiltration and permeability rates that are appropriate to soil type, climate, and landform, and exhibit functional biological, chemical, and physical characteristics.	
• Ground cover (vegetation, litter, and other types of ground cover such as rock fragments) is sufficient to protect sites from accelerated erosion. • Evidence of wind and water erosion, such as rills and gullies, pedestaling, scour or sheet erosion, and deposition of dunes is either absent or, if present, does not exceed what is natural for the site. • Vegetation is vigorous, diverse in species composition and age class, and reflects the potential natural vegetation or desired plant community (DPC) for the site.	• Bare ground • Vegetation composition • Soil aggregate stability • Proportion of large gaps between plant canopies
STANDARD #2—Streams: Stream channel form and function are characteristic for the soil type, climate, and landform.	
• Gravel bars and other coarse textured stream deposits are successfully colonized and stabilized by woody riparian species. • Streambank vegetation is vigorous and diverse, mostly perennial, and holds and protects banks during high streamflow events. • The stream water surface has a high degree of shading, resulting in cooler water in summer and reduced icing in winter. • Portions of the primary floodplain are frequently flooded (inundated every 1-5 years).	• Pool dimensions • Streambed particle sizes • Pool tail fines • Floodplain connectivity • Bank stability and cover • Greenline vegetation composition • Canopy cover • Temperature
STANDARD #3—Water quality: Water will have characteristics suitable for existing or potential beneficial uses. Surface and groundwater complies with objectives of the Clean Water Act and other applicable water quality requirements, including meeting the California and Nevada State standards, excepting approved variances.	
• The following do not exceed the applicable requirements for physical, chemical, and biological constituents, including, but not limited to: temperature, nutrients, fecal coliform, turbidity, sediment, dissolved oxygen, and aquatic organisms and plants (e.g., indicator macroinvertebrates, fish, algae, and plants). • Achievement of the standards for riparian, wetlands, and water bodies. • Monitoring results or other data that show water quality is meeting the standard.	• pH • Specific conductance • Temperature • Total nitrogen and total phosphorous • Turbidity • Benthic macroinvertebrates • Streambed particle sizes
STANDARD #4—Riparian and wetland sites: Riparian and wetland areas are in properly functioning condition and are meeting regional and local management objectives.	
• Riparian vegetation is vigorous and mostly perennial and diverse in species composition, age class, and life form sufficient to stabilize streambanks and shorelines. • Riparian vegetation and large woody debris are well anchored and capable of withstanding high streamflow events. • Negligible accelerated erosion as a result of human related activities is evident. • Age class and structure of woody riparian and wetland vegetation are appropriate for the site.	• Large wood • Greenline vegetation composition • Bank stability and cover

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #5—Biodiversity: Viable, healthy, productive, and diverse populations of native and desired plant and animal species, including special status species, are maintained.	
• Wildlife habitats include seral stages, vegetation structure, and patch size to promote diverse and viable wildlife populations. • A variety of age classes is present for most species. • Vigor is adequate to maintain desirable levels of plant and animal species to ensure reproduction and recruitment of plants and animals when favorable events occur. • Distribution of plant species and their habitats allow for reproduction and recovery from localized catastrophic events. • Natural disturbances such as fire are evident but not catastrophic. • Nonnative plant and animal species are present at acceptable levels. • Habitat areas are sufficient to support diverse, viable, and desired populations and are connected adequately with other similar habitat areas. • Adequate organic matter (litter and standing dead plant material) is present for site protection and decomposition to replenish soil nutrients and maintain soil health.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Vegetation height • Benthic macroinvertebrates • Greenline vegetation composition • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

California (Central)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Soils: Soils exhibit functional biological and physical characteristics that are appropriate to soil type, climate, and landform.	
• Ground cover (vegetation and other types of ground cover such as rock) is sufficient to protect sites from accelerated erosion. • Litter/residual dry matter is evident, in sufficient amounts to protect the soil surface. • A diversity of plant species, with a variety of root depths, is present and plants are vigorous during the growing season. • There is minimal evidence of accelerated erosion in the form of rills, gullies, pedestaling of plants or rocks, flow patterns, physical soil crusts/ surface sealing, or compaction layers below the soil surface. • Biological (microphytic or cryptogamic) soil crusts are in place where appropriate.	• Bare ground • Proportion of large gaps between plant canopies • Soil aggregate stability • Vegetation composition
STANDARD #2—Species: Viable, healthy, productive, and diverse populations of native and desired species, including special status species (federal threatened and endangered, federal proposed, federal candidates, BLM sensitive, or California State threatened and endangered) are maintained or enhanced where appropriate.	
• Wildlife habitats include seral stages, vegetation structure, and patch size to promote diverse and viable wildlife populations. • A variety of age classes are present for most perennial plant species. • Plant vigor is adequate to maintain desirable plants and ensure reproduction and recruitment of plants when favorable climatic events occur. • The spatial distribution and cover of plant species and their habitats allows for reproduction and recovery from localized catastrophic events. • A diversity of plant species with various phenological stages and rooting depths are present on sites where appropriate. • Appropriate natural disturbances are evident. • Levels of nonnative plants and animals are at acceptable levels. • Special status species present are healthy and in numbers that appear to ensure stable to increasing populations; habitat areas are large enough to support viable populations or are connected adequately with other similar habitat areas. • Adequate organic matter (litter and standing dead plant material) is present for site protection and decomposition to replenish soil nutrients. • Where appropriate, biological soil crusts (also called microphytic or cryptogamic soil crusts) are present and not excessively fragmented. • Noxious and invasive species are contained at acceptable levels.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Vegetation height • Soil aggregate stability • Benthic macroinvertebrates • Greenline vegetation composition • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Riparian: Riparian/wetland vegetation, structure and diversity, and stream channels and floodplains are functioning properly, and meeting regional and local management objectives.	
Vegetation Attributes: • Vegetation cover is greater than 80% or the percentage that will protect banks and dissipate energy during high flows. • Age-class and structure of woody/riparian vegetation are diverse and appropriate for the site. • Where appropriate, shading is sufficient to provide adequate thermal regulation for fish and other riparian-dependent species. • Where appropriate, there is adequate woody debris. • A diversity of plant species with various phenological stages and rooting depths is present. Root masses are sufficient to stabilize streambanks and shorelines. • Plant species present indicate that soil moisture characteristics are being maintained. • There is minimal cover of invader/shallow-rooted species. • Adequate organic matter (litter and standing dead plant material) is present to protect the site and to replenish soil nutrients through decomposition. • Point bars are vegetated. Physical Indicators: • Streambank stability, pool frequency, substrate sediments, stream width, and bank angles are appropriate for the stream type.	• Pool dimensions • Streambed particle sizes • Pool tail fines • Thalweg depth profile • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Bank angle • Canopy cover
STANDARD #4—Water quality: Surface and groundwater complies with objectives of the Clean Water Act and other applicable water quality requirements, including meeting the California State standards.	
• The following do not exceed the applicable requirements: chemical constituents, water temperature, nutrient loads, fecal coliform, turbidity, suspended sediment, and dissolved oxygen. • Achievement of the standards for riparian, wetlands, and water bodies. • Aquatic organisms and plants (e.g., macroinvertebrates, fish, algae, and plants) indicate support for beneficial uses. • Monitoring results or other data that show water quality is meeting the standard.	• Temperature • Benthic macroinvertebrates • Total nitrogen and total phosphorous • Turbidity • pH • Streambed particle sizes

California Desert District

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland soils: Upland soils exhibit infiltration and permeability rates that are appropriate to soil type, climate, and landform.	
Pending approval	
STANDARD #2—Riparian-wetland areas: Riparian-wetland areas are in properly functioning condition.	
Pending approval	
STANDARD #3—Stream channel morphology: Stream channel morphology (including, but not limited to, gradient, width/depth ratio, channel roughness, and sinuosity) and functions are appropriate for the climate and landform.	
Pending approval	
STANDARD #4—Native species populations: Healthy, productive, and diverse populations of native species exist and are maintained.	
Pending approval	

Colorado

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland soils: Upland soils exhibit infiltration and permeability rates that are appropriate to soil type, climate, landform, and geologic processes. Adequate soil infiltration and permeability allows for the accumulation of soil moisture necessary for optimal plant growth and vigor, and minimizes surface runoff.	
• Expression of rills and soil pedestals is minimal. • Evidence of actively eroding gullies (incised channels) is minimal. • Canopy and ground cover are appropriate. • There is litter accumulating in place and is not sorted by normal overland water flow. • There is appropriate organic matter in soil. • There is diversity of plant species with a variety of root depths. • Upland swales have vegetation cover or density greater than that of adjacent uplands. • There are vigorous, desirable plants.	• Bare ground • Proportion of large gaps between plant canopies • Soil aggregate stability • Vegetation composition
STANDARD #2—Riparian systems: Riparian systems associated with both running and standing water function properly and have the ability to recover from major disturbance such as fire, severe grazing, or 100-year floods. Riparian vegetation captures sediment, and provides forage, habitat, and biodiversity. Water quality is improved or maintained. Stable soils store and release water slowly.	
• Vegetation is dominated by an appropriate mix of native or desirable introduced species. • Vigorous, desirable plants are present. • There is vegetation with diverse age class structure, appropriate vertical structure, and adequate composition, cover, and density. • Streambank vegetation is present and is comprised of species and communities that have root systems capable of withstanding high streamflow events. • Plant species present indicate maintenance of riparian moisture characteristics. • Stream is in balance with the water and sediment being supplied by the watershed (e.g., no headcutting, no excessive erosion or deposition). • Vegetation and free water indicate high water tables. • Vegetation colonizes point bars with a range of age classes and successional stages. • An active floodplain is present. • Residual floodplain vegetation is available to capture and retain sediment and dissipate flood energies. • Stream channels have appropriate size and meander patterns, for the stream's position in the landscape, and parent materials. • Woody debris contributes to the character of the stream channel morphology.	• Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Streambed particle sizes • Pool tail fines • Thalweg depth profile

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Native and other desirable species: Healthy, productive plant and animal communities of native and other desirable species are maintained at viable population levels commensurate with the species and habitat's potential. Plants and animals at both the community and population level are productive, resilient, diverse, vigorous, and able to reproduce and sustain natural fluctuations and ecological processes.	
• Noxious weeds and undesirable species are minimal in the overall plant community. • Native plant and animal communities are spatially distributed across the landscape with a density, composition, and frequency of species suitable to ensure reproductive capability and sustainability. • Plants and animals are present in mixed age classes sufficient to sustain recruitment and mortality fluctuations. • Landscapes exhibit connectivity of habitat or presence of corridors to prevent habitat fragmentation. • Photosynthetic activity is evident throughout the growing season. • Diversity and density of plant and animal species are in balance with habitat/landscape potential and exhibit resilience to human activities. • Appropriate plant litter accumulates and is evenly distributed across the landscape. • Landscapes are composed of several plant communities that may be in a variety of successional stages and patterns.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Vegetation height • Benthic macroinvertebrates
STANDARD #4—Special status, threatened and endangered, and other species: Special status, threatened and endangered species (federal and state), and other plants and animals officially designated by the BLM, and their habitats are maintained or enhanced by sustaining healthy, native plant and animal communities.	
• All the indicators associated with the plant and animal communities standard apply. • There are stable and increasing populations of endemic and protected species in suitable habitat. • Suitable habitat is available for recovery of endemic and protected species.	• Nonnative invasive species • Plant species of management concern • Vegetation composition
STANDARD #5—Water quality: The water quality of all water bodies, including groundwater where applicable, located on or influenced by BLM lands will achieve or exceed the water quality standards established by the State of Colorado. Water quality standards for surface and groundwaters include the designated beneficial uses, numeric criteria, narrative criteria, and antidegradation requirements set forth under state law as found in (5 CCR 1002-8), as required by Section 303(c) of the Clean Water Act.	
• Appropriate populations of macroinvertebrates, vertebrates, and algae are present. • Surface and groundwaters only contain substances (e.g., sediment, scum, floating debris, odor, heavy metal precipitates on channel substrate) attributable to humans within the amounts, concentrations, or combinations as directed by the water quality standards established by the State of Colorado (5 CCR 1002-8).	• pH • Specific conductance • Temperature • Total nitrogen and total phosphorous • Turbidity • Benthic macroinvertebrates • Streambed particle sizes

COLORADO

Idaho

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Watersheds: Watersheds provide for the proper infiltration, retention, and release of water appropriate to soil type, vegetation, climate, and landform to provide for proper nutrient cycling, hydrologic cycling, and energy flow.	
Indicators may include, but are not limited to: • The amount and distribution of ground cover, including litter, for identified ecological site(s) or soil-plant associations are appropriate for site stability. • Evidence of accelerated erosion in the form of rills and/or gullies, erosional pedestals, flow patterns, physical soil crusts/surface sealing, and compaction layers below the soil surface is minimal for soil type and landform.	• Bare ground • Proportion of large gaps between plant canopies • Soil aggregate stability
STANDARD #2—Riparian areas and wetlands: Riparian-wetland areas are in properly functioning condition appropriate to soil type, climate, geology, and landform to provide for proper nutrient cycling, hydrologic cycling, and energy flow.	
Indicators may include, but are not limited to: • The riparian/wetland vegetation is controlling erosion, stabilizing streambanks, shading water areas to reduce water temperature, stabilizing shorelines, filtering sediment, aiding in floodplain development, dissipating energy, delaying flood water, and increasing recharge of groundwater appropriate to site potential. • Riparian/wetland vegetation with deep strong binding roots is sufficient to stabilize streambanks and shorelines. Invader and shallow rooted species are a minor component of the floodplain. • Age class and structural diversity of riparian/wetland vegetation is appropriate for the site. • Noxious weeds are not increasing.	• Nonnative invasive species • Greenline vegetation composition • Bank stability and cover • Canopy cover • Large wood
STANDARD #3—Stream channel/floodplain: Stream channels and floodplains are properly functioning relative to the geomorphology (e.g., gradient, size, shape, roughness, confinement, and sinuosity) and climate to provide for proper nutrient cycling, hydrologic cycling, and energy flow.	
Indicators may include, but are not limited to: • Stream channels and floodplains dissipate energy of high water flows and transport sediment. Soils support appropriate riparian-wetland species, allowing water movement, sediment filtration, and water storage. Stream channels are not entrenching. • Stream width/depth ratio, gradient, sinuosity, and pool, riffle, and run frequency are appropriate for the valley bottom type, geology, hydrology, and soils. • Streams have access to their floodplains, and sediment deposition is evident. • There is little evidence of excessive soil compaction on the floodplain due to human activities. • Streambanks are within an appropriate range of stability according to site potential. • Noxious weeds are not increasing.	• Nonnative invasive species • Pool dimensions • Streambed particle sizes • Pool tail fines • Thalweg depth profile • Floodplain connectivity • Large wood

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #4—Native plant communities: Healthy, productive, and diverse native animal habitat and populations of native plants are maintained or promoted as appropriate to soil type, climate, and landform to provide for proper nutrient cycling, hydrologic cycling, and energy flow.	
Indicators may include, but are not limited to: • Native plant communities (flora and microbiotic crusts) are maintained or improved to ensure the proper functioning of ecological processes and continued productivity and diversity of native plant species. • The diversity of native species is maintained. • Plant vigor (total plant production, seed and seedstalk production, cover, etc.) is adequate to enable reproduction and recruitment of plants when favorable climatic events occur. • Noxious weeds are not increasing. • Adequate litter and standing dead plant material are present for site protection and for decomposition to replenish soil nutrients relative to site potential.	• Nonnative invasive species • Vegetation composition • Greenline vegetation composition
STANDARD #5—Seedings: Rangelands seeded with mixtures, including predominately nonnative plants, are functioning to maintain life form diversity, production, native animal habitat, nutrient cycling, energy flow, and the hydrologic cycle.	
Indicators may include, but are not limited to: • In established seedings, the diversity of perennial species is not diminishing over time. • Plant production, seed production, and cover are adequate to enable recruitment when favorable climatic events occur. • Noxious weeds are not increasing. • Adequate litter and standing dead plant material are present for site protection and for decomposition to replenish soil nutrients relative to site potential.	• Nonnative invasive species • Vegetation composition
STANDARD #6—Exotic plant communities, other than seedings: Exotic plant communities, other than seedings, will meet minimum requirements of soil stability and maintenance of existing native and seeded plants. These communities will be rehabilitated to perennial communities when feasible, cost-effective methods are developed.	
Indicators may include, but are not limited to: • Noxious weeds are not increasing. • The number of perennial species is not diminishing over time. • Plant vigor (production, seed and seedstalk production, cover, etc.) of remnant native or seeded (introduced) plants is maintained to enable reproduction and recruitment when favorable climatic or other environmental events occur. • Adequate litter and standing dead plant material is present for site protection and for decomposition to replenish soil nutrients relative to site potential.	• Nonnative invasive species • Vegetation composition • Greenline vegetation composition
STANDARD #7—Water quality: Surface and groundwater on public lands comply with the Idaho water quality standards.	
Indicators may include, but are not limited to: • Physical, chemical, and biologic parameters described in the Idaho water quality standards.	• pH • Specific conductance • Temperature • Total nitrogen and total phosphorous • Turbidity • Benthic macroinvertebrates • Streambed particle sizes

Idaho continued

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #8—Threatened and endangered plants and animals: Habitats are suitable to maintain viable populations of threatened and endangered, sensitive, and other special status species.	
Indicators may include, but are not limited to: • Parameters described in the Idaho water quality standards. • Riparian/wetland vegetation with deep, strong, binding roots is sufficient to stabilize streambanks and shorelines. Invader and shallow rooted species are a minor component of the floodplain. • Age class and structural diversity of riparian/wetland vegetation are appropriate for the site. • Native plant communities (flora and microbiotic crusts) are maintained or improved to ensure the proper functioning of ecological processes and continued productivity and diversity of native plant species. • The diversity of native species is maintained. • The amount and distribution of ground cover, including litter, for identified ecological site(s) or soil-plant associations are appropriate for site stability. • Noxious weeds are not increasing.	• Nonnative invasive species • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Greenline vegetation composition • Bank stability and cover • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

Montana (Butte, Dillon, and Missoula Field Offices)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Uplands: Uplands are in proper functioning condition.	
Physical Environment: • Erosional flow patterns • Surface litter • Soil movement by water and wind • Soil crusting and surface sealing • Compaction layer • Rills • Gullies • Cover amount • Cover distribution Biotic Environment: • Community diversity • Community structure • Exotic plants • Photosynthetic activity • Plant status • Seed production • Recruitment • Nutrient cycle	• Bare ground • Nonnative invasive species • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #2—Riparian and wetland areas: Riparian and wetland areas are in proper functioning condition.	
Hydrologic: • Floodplain inundated in relatively frequent events (1-3 years). • Amount of altered streambanks. • Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region). • Riparian zone widening. • Upland watershed not contributing to riparian degradation Erosion Deposition: • Floodplain and channel characteristics (i.e., rocks, coarse and/or woody debris) adequate to dissipate energy. • Point bars are vegetating. • Lateral stream movement is associated with natural sinuosity. • System is vertically stable. • Stream is in balance with water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). • Bare ground. Vegetation: • Reproduction and diverse age structure of vegetation. • Diverse composition of vegetation. • Species present indicate maintenance of riparian soil moisture characteristics. • Streambank vegetation is comprised of those plants or plant communities that have deep binding root masses capable of withstanding high streamflow events. • Utilization of trees and shrubs. • Riparian plants exhibit high vigor. • Adequate vegetative cover present to protect banks and dissipate energy during high flows. • Plant communities in the riparian area are an adequate source of large woody debris.	• Pool dimensions • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Streambed particle sizes • Pool tail fines • Thalweg depth profile

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Water quality: Water quality meets Montana State standards.	
• Dissolved oxygen concentration • pH • Turbidity • Temperature • Fecal coliform • Sediment • Color • Toxins • Ammonia, barium, boron, chlorides, chromium, cyanide, endosulfan, lindane, nitrates, phenols, phosphorus, sodium, sulfates, etc.	• pH • Turbidity • Temperature • Streambed particle sizes • Total nitrogen and total phosphorus
STANDARD #4—Air quality: Air quality meets Montana State standards.	
• PM-10 of 50ug/m3 annual average and 150 ug/m3 24-hr average* • Sulfur dioxide of 0.02 ppm annual average and 0.10 ppm 24-hr average* and 0.50 ppm 1-hr average** • Carbon monoxide of 23 ppm hourly average* and 9.0 ppm 8-hr average* • Nitrogen dioxide of 0.05 ppm annual average and 0.30 ppm hourly average* • Ozone of 0.10 ppm hourly average* • Lead of 1.5 ug/m3 90-day average • Foliar fluoride of 35 ug/g grazing season average and 50ug/g monthly average • Settled particulate matter (dustfall) of 10 mg/m2 30-day average • Hydrogen sulfide of 0.05 ppm hourly average* • Visibility - Particle scattering coefficient of 3 x 10^{-5} per meter annual average*** * Not to be exceeded more than once per year. ** Not to be exceeded more than 18 times per year. *** Applies to PSD mandatory Class I areas.	
STANDARD #5—Species: Provide habitat as necessary, to maintain a viable and diverse population of native plant and animal species, including special status species.	
• Plants and animals are diverse, vigorous, and reproducing satisfactorily; noxious weeds are absent or insignificant in the overall plant community. • Spatial distribution of species is suitable to ensure reproductive capability and recovery. • A variety of age classes are present. • Connectivity of habitat or presence of corridors prevents habitat fragmentation. • Diversity of species (including plants, animals, insects, and microbes) are represented. • Plant communities in a variety of successional stages are represented across the landscape.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Benthic macroinvertebrates

Montana (Lewistown and Malta Field Offices)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Uplands: Uplands are in proper functioning condition.	
Physical Environment: • Erosional flow patterns • Surface litter • Soil movement by water and wind • Soil crusting and surface sealing • Compaction layer • Rills • Gullies • Cover amount • Cover distribution Biotic Environment: • Community richness • Community structure • Exotic plants • Plant status • Seed production • Recruitment • Nutrient cycle	• Bare ground • Nonnative invasive species • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #2—Riparian and wetland areas: Riparian and wetland areas are in proper functioning condition.	
Hydrologic: • Floodplain inundated in relatively frequent events (1-3 years). • Amount of altered streambanks. • Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region). • Upland watershed not contributing to riparian degradation. Erosion Deposition: • Floodplain and channel characteristics (i.e., rocks, coarse and/or woody debris) adequate to dissipate energy. • Point bars are being created and older point bars are being vegetated. • Lateral stream movement is associated with natural sinuosity. • System is vertically stable. • Stream is in balance with water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). Vegetation: • Reproduction and diverse age class of vegetation. • Diverse composition of vegetation. • Species present indicate maintenance of riparian soil moisture characteristics. • Streambank vegetation is comprised of those plants or plant communities that have deep binding root masses capable of withstanding high streamflow events. • Utilization of trees and shrubs. • Riparian plants exhibit high vigor. • Adequate vegetative cover present to protect banks and dissipate energy during high flows. • Where appropriate, plant communities in the riparian area are an adequate source of woody debris.	• Pool dimensions • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Streambed particle sizes • Pool tail fines • Thalweg depth profile

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Water quality: Water quality meets Montana State standards.	
• Dissolved oxygen concentration • pH • Turbidity • Temperature • Fecal coliform • Sediment • Color • Toxins • Ammonia, barium, boron, chlorides, chromium, cyanide, endosulfan, lindane, nitrates, phenols, phosphorus, sodium, sulfates, etc.	• pH • Turbidity • Temperature • Benthic macroinvertebrates • Total nitrogen and total phosphorous • Streambed particle sizes
STANDARD #4—Air quality: Air quality meets Montana State standards.	
Section 176(c) Clean Air Act which states that activities of all federal agencies must conform to the intent of the appropriate State Air Quality Implementation Plan and not: • Cause or contribute to any violations of ambient air quality standards. • Increase the frequency of any existing violations. • Impede the state's progress in meeting their air quality goals.	
STANDARD #5—Species: Habitats are provided to maintain healthy, productive, and diverse populations of native plant and animal species, including special status species (federally threatened, endangered, candidate, or Montana species of special concern as defined in BLM Manual 6840, Special Status Species Management).	
• Plants and animals are diverse, vigorous, and reproducing satisfactorily; noxious weeds are absent or insignificant in the overall plant community. • Spatial distribution of species is suitable to ensure reproductive capability and recovery. • A variety of age classes are present. • Connectivity of habitat or presence of corridors prevents habitat fragmentation. • Diversity of species (including plants, animals, insects, and microbes) are represented. • Plant communities in a variety of successional stages are represented across the landscape.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Benthic macroinvertebrates

Montana (Miles City and Billings Field Offices)

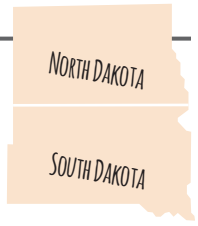
Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Uplands: Uplands are in proper functioning condition.	
Physical Environment: • Erosional flow patterns • Surface litter • Soil movement by water and wind • Infiltration • Soil crusting and surface sealing • Compaction layer • Rills • Gullies • Cover amount • Cover distribution Biotic Environment: • Community diversity • Community structure • Exotic plants • Photosynthetic activity • Plant status • Seed production • Recruitment • Nutrient cycle	• Bare ground • Nonnative invasive species • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #2—Riparian areas and wetlands: Riparian areas and wetlands are in proper functioning condition.	
Hydrologic: • Floodplain inundated in relatively frequent events. • Amount of altered streambanks. • Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region). • Riparian zone width. • Upland watershed not contributing to riparian degradation. Erosion Deposition: • Floodplain and channel characteristics (i.e., rocks, coarse and/or woody debris) adequate to dissipate energy. • Point bars are vegetating. • Lateral stream movement is associated with natural sinuosity. • System is vertically stable. • Stream is in balance with water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). • Bare ground. Vegetation: • Reproduction and diverse age structure of vegetation. • Diverse composition of vegetation. • Species present indicate maintenance of riparian soil moisture characteristics. • Streambank vegetation is comprised of those plants or plant communities that have deep binding root masses capable of withstanding high streamflow events. • Utilization of trees and shrubs. • Healthy riparian plants. • Adequate vegetative cover present to protect banks and dissipate energy during high flows.	• Pool dimensions • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Streambed particle sizes • Pool tail fines • Thalweg depth profile

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Water quality: Water quality meets Montana State standards.	
• Dissolved oxygen concentration • pH • Turbidity • Temperature • Fecal coliform • Sediment • Color • Toxins • Ammonia, barium, boron, chlorides, chromium, cyanide, endosulfan, lindane, nitrates, phenols, phosphorus, sodium, sulfates, etc.	• pH • Turbidity • Temperature • Streambed particle sizes • Total nitrogen and total phosphorous • Benthic macroinvertebrates
STANDARD #4—Air quality: Air quality meets Montana State standards.	
Section 176(c) Clean Air Act which states that activities of all federal agencies must conform to the intent of the appropriate State Air Quality Implementation Plan and not: • Cause or contribute to any violations of ambient air quality standards. • Increase the frequency of any existing violations. • Impede the state's progress in meeting their air quality goals.	
STANDARD #5—Species: Habitats are provided for healthy, productive, and diverse native plant and animal populations and communities. Habitats are improved or maintained for special status species (federally threatened, endangered, candidate, or Montana species of special concern).	
• Plants and animals are diverse, vigorous, and reproducing satisfactorily; noxious weeds are absent or insignificant in the overall plant community. • An effective weed management program is in place. • Spatial distribution of species is suitable to ensure reproductive capability and recovery. • A variety of age classes are present (at least two age classes). • Connectivity of habitat or presence of corridors prevents habitat fragmentation. • Diversity of species (including plants, animals, insects, and microbes) are represented. • Plant communities in a variety of successional stages are represented across the landscape. This will be accomplished by allowing progression of succession in conjunction with livestock grazing.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Benthic macroinvertebrates

North Dakota and South Dakota

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Uplands: Uplands are in proper functioning condition for site-specific conditions of climate, soils, and parent material.	
Physical Environment: • Erosional flow patterns • Surface litter • Soil movement by wind and water • Infiltration • Soil crusting and surface sealing • Rills • Gullies • Cover amount • Cover distribution Biotic Environment: • Community diversity • Community structure • Exotic plants • Photosynthetic activity • Plant status • Seed production • Recruitment • Nutrient cycle	• Bare ground • Nonnative invasive species • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #2—Riparian areas and wetlands: Riparian areas and wetlands are in proper functioning condition for site-specific conditions of climate, soils, and parent material.	
Hydrologic: • Floodplain inundated in relatively frequent events. • Amount of altered streambanks. • Upland watershed not contributing to riparian degradation • Stream channel morphology (including, but not limited to, gradient, width/depth ratio, channel roughness, and sinuosity) and functions are appropriate for the climate and landform. Erosion Deposition: • Floodplain and channel characteristics (i.e., rocks, coarse and/or woody debris) adequate to dissipate energy. • Lateral stream movement is associated with natural sinuosity. • System is vertically stable. • Stream is in balance with water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). • Bare ground. Vegetation: • Healthy, productive, and diverse populations of native species are being maintained. • Condition of trees and shrubs. • Riparian plants exhibit high vigor. • Adequate vegetative cover present to protect banks and dissipate energy during high flows.	• Pool dimensions • Streambed particle sizes • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Pool tail fines • Thalweg depth profile

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Water quality: Water quality meets assigned state water quality standards.	
• Dissolved oxygen concentration • pH • Turbidity • Temperature • Fecal coliform • Sediment • Color • Toxins • Ammonia, barium, boron, chlorides, chromium, cyanide, endosulfan, lindane, nitrates, phenols, phosphorus, sodium, sulfates, etc.	• pH • Turbidity • Temperature • Streambed particle sizes • Total nitrogen and total phosphorous
STANDARD #4—Air quality: Air quality meets state air quality standards.	
• PM-10 of 50ug/m3 annual average and 150 ug/m3 24-hr average* • Sulfur dioxide of 0.02 ppm annual average and 0.10 ppm 24-hr average* and 0.50 ppm 1-hr average** • Carbon monoxide of 23 ppm hourly average* and 9.0 ppm 8-hr average* • Nitrogen dioxide of 0.05 ppm annual average and 0.30 ppm hourly average* • Ozone of 0.10 ppm hourly average* • Lead of 1.5 ug/m3 90-day average • Foliar fluoride of 35 ug/g grazing season average and 50ug/g monthly average • Settled particulate matter (dustfall) of 10 mg/m2 30-day average • Hydrogen sulfide of 0.05 ppm hourly average* • Visibility - Particle scattering coefficient of 3 x 10^{-5} per meter annual average*** * Not to be exceeded more than once per year. ** Not to be exceeded more than 18 times per year. *** Applies to PSD mandatory Class I areas.	
STANDARD #5—Species: Habitats are maintained and/or restored, where appropriate, for healthy, productive, and diverse populations of native plant and animal species.	
• Plants and animals are diverse, vigorous, and reproducing satisfactorily; noxious weeds are absent or insignificant in the overall plant community. • Spatial distribution of species is suitable to ensure reproductive capability. These species may include special status species (federally threatened, endangered, candidate, or Montana/North Dakota/South Dakota species of special concern). • Species diversity (including plants, animals, insects, and microbes) is present. • Livestock grazing systems are designed to maintain rangeland health and to ensure a variety of plant communities are present. • Connectivity of habitat or presence of corridors prevents habitat fragmentation.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Benthic macroinvertebrates



Nevada (Mojave-Southern Great Basin Area)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Soils: Watershed soils and streambanks should have adequate stability to resist accelerated erosion, maintain soil productivity, and sustain the hydrologic cycle.	
• Ground cover (vegetation, litter, rock, bare ground) • Surfaces (e.g., biological crusts, pavement) • Compaction/infiltration • Streambank stability	• Bare ground • Proportion of large gaps between plant canopies • Soil aggregate stability • Bank stability and cover
STANDARD #2—Ecosystem components: Watersheds should possess the necessary ecological components to achieve state water quality criteria, maintain ecological processes, and sustain appropriate uses. Riparian and wetlands vegetation should have structural and species diversity characteristic of the stage of stream channel succession in order to provide forage and cover, capture sediment, and capture, retain, and safely release water (watershed function).	
Upland Indicators: • Canopy and ground cover, including litter, live vegetation, biological crust, and rock appropriate to the potential of the ecological site. • Ecological processes are adequate for the vegetative communities. Riparian Indicators: • Streamside riparian areas are functioning properly when adequate vegetation, large woody debris, or rock is present to dissipate stream energy associated with high water flows. • Elements indicating proper functioning condition, such as avoiding accelerating erosion, capturing sediment, and providing for groundwater recharge and release, are determined by the following measurements as appropriate to the site characteristics: - Width/depth ratio - Channel roughness - Sinuosity of stream channel - Bank stability - Vegetative cover (amount, spacing, life form) - Other cover (large woody debris, rock) • Natural springs, seeps, and marsh areas are functioning properly when adequate vegetation is present to facilitate water retention, filtering, and release as indicated by plant species and cover appropriate to the site characteristics. Water Quality Indicators: • Chemical, physical, and biological constituents do not exceed the state water quality standards.	• Bare ground • Proportion of large gaps between plant canopies • Vegetation composition • Large wood • Greenline vegetation composition • Bank stability and cover • Canopy cover • Streambed particle sizes • Pool tail fines • Thalweg depth profile • pH • Temperature • Specific conductance • Total nitrogen and total phosphorous • Turbidity • Benthic macroinvertebrates

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Habitat and biota: Habitats and watersheds should sustain a level of biodiversity appropriate for the area and conducive to appropriate uses. Habitats of special status species should be able to sustain viable populations of those species.	
• Vegetation composition (relative abundance of species) • Vegetation structure (life forms, cover, height, and age classes) • Vegetation distribution (patchiness, corridors) • Vegetation productivity • Vegetation nutritional value • Escape terrain • Relative abundance • Composition • Distribution • Nutritional value • Edge-patch snags	• Plant species of management concern • Vegetation composition • Vegetation height • Benthic macroinvertebrates • Greenline vegetation composition • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)
STANDARD #4—Wild horses and burros: Wild horses and burros within herd management areas should be managed for herd viability and sustainability. Herd management areas should be managed to maintain a healthy ecological balance among wild horse and/or burro populations, wildlife, livestock, and vegetation.	
Herd Health Indicators: • General horse and/or burro appearance: Problems are often apparent and can be easily identified by just looking at the herd. • Crippled or injured horses and/or burros: Excessive injuries can indicate problems. Herd Demographics Indicators: • Size of bands: A band with one stud or jack, one mare or jenny, and one foal indicates a problem. An oversized band also indicates there is a problem. Band sizes of 5-10 animals with one dominant stud per band is a good indicator. • Size of bachelor bands: Large bachelor bands in the immediate vicinity of other bands could indicate potential problems. Herd Viability Indicators: • Heavy trailing into water sources may indicate a significant problem with forage availability or water distribution. Animals may be traveling considerable distances to obtain water or forage. • Waiting for water. When available water becomes so scarce that a waiting line develops, horses and burros are in trouble. • Availability of water. Address legal and/or climatic considerations. Situations exist where wild horses and burros are present only because they currently have access to water which they could legally be deprived of under Nevada water laws. Situations exist where existing wild horse and burro populations are dependent upon water hauling. If water hauling were to cease these animals would die within a matter of days. • Depleted forage near all available water sources: Adequate water and forage adjacent to water sources are essential.	

Nevada (Sierra Front-Northwestern Great Basin Area)

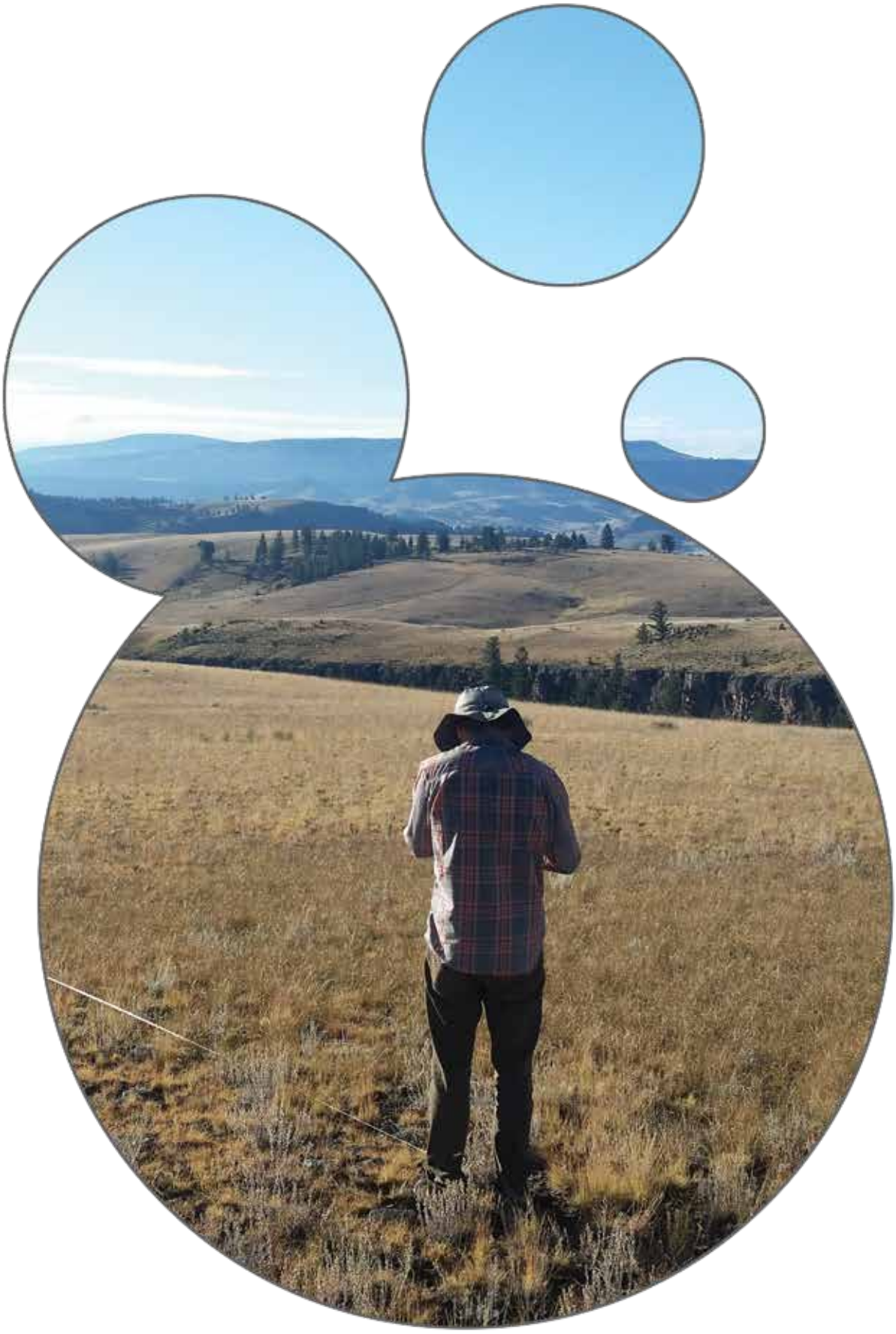
Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Soils: Soil processes will be appropriate to soil types, climate, and landform.	
• Surface litter is appropriate to the potential of the site. • Soil crusting formations in shrub interspaces and soil compaction are minimal or not in evidence, allowing for appropriate infiltration of water. • Hydrologic cycle, nutrient cycle, and energy flow are adequate for the vegetative communities. • Plant communities are diverse and vigorous, and there is evidence of recruitment. • Basal and canopy cover (vegetative) is appropriate for site potential.	• Bare ground • Proportion of large gaps between plant canopies • Vegetation composition • Soil aggregate stability • Canopy cover
STANDARD #2—Riparian/wetlands: Riparian/wetland systems are in properly functioning condition.	
• Sinuosity, width/depth ratio, and gradient are adequate to dissipate streamflow without excessive erosion or deposition. • Riparian vegetation is adequate to dissipate high flow energy and protect banks from excessive erosion. • Plant species diversity is appropriate to riparian-wetland systems.	• Greenline vegetation composition • Bank stability and cover • Floodplain connectivity
STANDARD #3—Water quality: Water quality criteria in Nevada or California State law shall be achieved or maintained.	
• Chemical constituents do not exceed the water quality standards. • Physical constituents do not exceed the water quality standards. • Biological constituents do not exceed the water quality standards. • The water quality of all water bodies, including groundwater located on or influenced by BLM lands, will meet or exceed the applicable Nevada or California water quality standards. Water quality standards for surface and groundwaters include the designated beneficial uses, numeric criteria, narrative criteria, and antidegradation requirements set forth under state law, and as found in Section 303(c) of the Clean Water Act.	• pH • Specific conductance • Temperature • Turbidity • Total nitrogen and total phosphorous • Streambed particle sizes • Benthic macroinvertebrates
STANDARD #4—Plant and animal habitat: Populations and communities of native plant species and habitats for native animal species are healthy, productive, and diverse.	
• Good representation of life forms and numbers of species. • Good diversity of height, size, and distribution of plants. • Number of wood stalks, seed stalks, and seed production adequate for stand maintenance. • Vegetative mosaic, vegetative corridors for wildlife, and minimal habitat fragmentation.	• Nonnative invasive species • Vegetation composition • Vegetation height • Benthic macroinvertebrates • Greenline vegetation composition
STANDARD #5—Special status species habitat: Habitat conditions meet the life cycle requirements of special status species.	
• Habitat areas are large enough to support viable populations of special status species. • Special status plant and animal numbers and ages appear to ensure stable populations. • Good diversity of height, size, and distribution of plants. • Number of wood stalks, seed stalks, and seed production adequate for stand maintenance. • Vegetative mosaic, vegetative corridors for wildlife, and minimal habitat fragmentation.	• Plant species of management concern • Vegetation composition • Vegetation height • Greenline vegetation composition • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

Nevada (Northeastern Great Basin Area)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland sites: Upland soils exhibit infiltration and permeability rates that are appropriate to soil type, climate, and landform.	
• Indicators are canopy and ground cover, including litter, live vegetation, and rock, appropriate to the potential of the site.	• Bare ground • Proportion of large gaps between plant canopies • Soil aggregate stability
STANDARD #2—Riparian and wetland sites: Riparian and wetland areas exhibit a properly functioning condition and achieve state water quality criteria.	
• Streamside riparian areas are functioning properly when adequate vegetation, large woody debris, or rock is present to dissipate stream energy associated with high water flows. Elements indicating proper functioning condition, such as avoiding accelerating erosion, capturing sediment, and providing for groundwater recharge and release, are determined by the following measurements as appropriate to the site characteristics: - Width/depth ratio - Channel roughness - Sinuosity of stream channel - Bank stability - Vegetative cover (amount, spacing, life form) - Other cover (large woody debris, rock) • Natural springs, seeps, and marsh areas are functioning properly when adequate vegetation is present to facilitate water retention, filtering, and release as indicated by plant species and cover appropriate to the site characteristics. • Chemical, physical, and biological water constituents are not exceeding the state water quality standards.	• pH • Specific conductance • Temperature • Turbidity • Total nitrogen and total phosphorous • Streambed particle sizes • Pool tail fines • Floodplain connectivity • Large wood • Benthic macroinvertebrates • Greenline vegetation composition • Bank stability and cover
STANDARD #3—Habitat: Habitats exhibit a healthy, productive, and diverse population of native and/or desirable plant species, appropriate to the site characteristics, to provide suitable feed, water, cover, and living space for animal species and maintain ecological processes. Habitat conditions meet the life cycle requirements of threatened and endangered species.	
• Vegetation composition (relative abundance of species) • Vegetation structure (life forms, cover, height, and age classes) • Vegetation distribution (patchiness, corridors) • Vegetation productivity • Vegetation nutritional value	• Plant species of management concern • Vegetation composition • Vegetation height • Greenline vegetation composition • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)
STANDARD #4—Cultural resources: Land use plans will recognize cultural resources within the context of multiple use.	
No indicators listed	
STANDARD #5—Healthy wild horse and burro populations: Wild horses and burros exhibit characteristics of a healthy, productive, and diverse population. Age structure and sex ratios are appropriate to maintain the long-term viability of the population as a distinct group. Herd management areas are able to provide suitable feed, water, cover, and living space for wild horses and burros and maintain historic patterns of habitat use.	
• Healthy rangelands that provide sufficient quantities and quality of forage and water to sustain the appropriate management level on a year-long basis within a herd management area. • Wild horses and/or burros managed on a year-long basis for a condition class greater than or equal to five to allow them normal chances for survival in the winter. • Highly adoptable wild horses and burros that are readily available from herd management areas. • Wild horse and burro herds that exhibit appropriate age structure and sex ratio for short- and long-term genetic and reproductive health.	

New Mexico

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland sites: Upland ecological sites are in a productive and sustainable condition within the capability of the site. Upland soils are stabilized and exhibit infiltration and permeability rates that are appropriate for the soil type, climate, and landform. The kind, amount, and/or pattern of vegetation provides protection on a given site to minimize erosion and assist in meeting state and tribal water quality standards.	
Indicators may include, but are not limited to: • Consistent with the capability of the ecological site, soils are stabilized by appropriate amounts of standing live vegetation, protective litter, and/or rock cover. • Erosion is indicated by flow patterns characteristic of surface litter soil movement, gullies and rills, and plant pedestalling. • Satisfactory plant protection is indicated by the amount and distribution of desired species necessary to prevent accelerated erosion.	• Bare ground • Proportion of large gaps between plant canopies • Vegetation composition • Soil aggregate stability
STANDARD #2—Biotic communities, including native, threatened, endangered, and special status species: Ecological processes, such as hydrologic cycle, nutrient cycle, and energy flow, support productive and diverse native biotic communities, including special status, threatened, and endangered species appropriate to site and species. Desired plant community goals maintain and conserve productive and diverse populations of plants and animals which sustain ecological functions and processes. Restoration should first be achieved with native and, when appropriate, nonnative plants.	
Indicators may include, but are not limited to: • Commensurate with the capability of the ecological site, plant and animal populations are: productive, resilient, diverse, and sustainable. • Landscapes are composed of communities in a variety of successional stages and patterns. • Diversity and composition of communities are indicated by the kinds and amount of species. • Endangered and special status species are secure and recovering, with the goal of delisting and ensuring that additional species need not be listed within New Mexico.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Benthic macroinvertebrates
STANDARD #3—Riparian sites: Riparian areas are in a productive, properly functioning, and sustainable condition, within the capability of that site. Adequate vegetation of diverse age and composition is present that will withstand high streamflow, capture sediment, provide for groundwater recharge, provide habitat, and assist in meeting state and tribal water quality standards.	
Indicators may include, but are not limited to: • Stream channel morphology and stability, as determined by gradient, width/depth ratio, channel roughness, and sinuosity. • Streambank stability, as determined by degree of shearing and sloughing and vegetative cover on the bank. • Appropriate riparian vegetation includes a mix of communities comprised of species with a range of age, density, and growth form.	• Pool dimensions • Streambed particle sizes • Pool tail fines • Floodplain connectivity • Greenline vegetation composition • Bank stability and cover • Large wood



Oregon and Washington

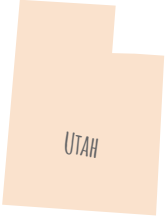
Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Watershed function - uplands: Upland soils exhibit infiltration and permeability rates, moisture storage, and stability that are appropriate to soil, climate, and landform.	
Protection of the soil surface from raindrop impact; detention of overland flow; maintenance of infiltration and permeability and protection of the soil surface from erosion, consistent with the potential/capability of the site, as evidenced by the: • Amount and distribution of plant cover (including forest canopy cover) • Amount and distribution of plant litter • Accumulation/incorporation of organic matter • Amount and distribution of bare ground • Amount and distribution of rock, stone, and gravel • Plant composition and community structure • Thickness and continuity of A horizon • Character of microrelief • Presence and integrity of biotic crusts • Root occupancy of the soil profile • Biological activity (plant, animal, and insect) • Absence of accelerated erosion and overland flow Soil and plant conditions promote moisture storage as evidenced by: • Amount and distribution of plant cover (including forest canopy cover) • Amount and distribution of plant litter • Plant composition and community structure • Accumulation/incorporation of organic matter	• Bare ground • Proportion of large gaps between plant canopies • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #2—Watershed function - riparian/wetland areas: Riparian-wetland areas are in properly functioning physical condition appropriate to soil, climate, and landform.	
Hydrologic, vegetative, and erosional/depositional processes interact in supporting physical function, consistent with the potential or capability of the site, as evidenced by: • Frequency of floodplain/wetland inundation • Plant composition, age class distribution, and community structure • Root mass • Point bars revegetating • Streambank/shoreline stability • Riparian area width • Sediment deposition • Active/stable beaver dams • Coarse/large woody debris • Upland watershed conditions • Frequency/duration of soil saturation • Water table fluctuation Stream channel characteristics are appropriate for landscape position as evidenced by: • Channel width/depth ratio • Channel sinuosity • Gradient • Rocks and coarse and/or large woody debris • Overhanging banks • Pool/riffle ratio • Pool size and frequency • Stream embeddedness	• Pool dimensions • Streambed particle sizes • Pool tail fines • Thalweg depth profile • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover • Bank angle

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #3—Ecological processes: Healthy, productive, and diverse plant and animal populations and communities appropriate to soil, climate, and landform are supported by ecological processes of nutrient cycling, energy flow, and the hydrologic cycle.	
Photosynthesis is effectively occurring throughout the potential growing season, consistent with the potential/capability of the site, as evidenced by plant composition and community structure. Nutrient cycling is occurring effectively, consistent with the potential/capability of the site, as evidenced by: • Plant composition and community structure • Accumulation, distribution, incorporation of plant litter and organic matter into the soil • Animal community structure and composition • Root occupancy in the soil profile • Biological activity including plant growth, herbivory, and rodent, insect, and microbial activity	• Vegetation composition • Vegetation height • Soil aggregate stability • Benthic macroinvertebrates • Greenline vegetation composition
STANDARD #4—Water quality: Surface water and groundwater quality, influenced by agency actions, complies with state water quality standards.	
• Water temperature • Dissolved oxygen • Fecal coliform • Turbidity • pH • Populations of aquatic organisms • Effects on beneficial uses (i.e., effects of management activities on beneficial uses as defined under the Clean Water Act and state implementing regulations)	• pH • Temperature • Turbidity • Benthic macroinvertebrates
STANDARD #5—Native, threatened and endangered, and locally important species: Habitats support healthy, productive, and diverse populations and communities of native plants and animals (including special status species and species of local importance) appropriate to soil, climate, and landform.	
Essential habitat elements for species, populations, and communities are present and available, consistent with the potential/capability of the landscape, as evidenced by: • Plant community composition, age class distribution, productivity • Animal community composition, productivity • Habitat elements • Spatial distribution of habitat • Habitat connectivity • Population stability/resilience	• Plant species of management concern • Vegetation composition • Floodplain connectivity • Benthic macroinvertebrates • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

Utah

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Upland soils: Upland soils exhibit permeability and infiltration rates that sustain or improve site productivity, considering the soil type, climate, and landform.	
• Sufficient cover and litter to protect the soil surface from excessive water and wind erosion, promote infiltration, detain surface flow, and retard soil moisture loss by evaporation. • The absence of indicators of excessive erosion such as rills, soil pedestals, and actively eroding gullies. • The appropriate amount, type, and distribution of vegetation reflecting the presence of (1) the desired plant community (DPC), where identified in a land use plan conforming to these standards, or (2) where the DPC is not identified, a community that equally sustains the desired level of productivity and properly functioning ecological conditions.	• Bare ground • Proportion of large gaps between plant canopies • Vegetation composition • Soil aggregate stability
STANDARD #2—Riparian and wetland areas: Riparian and wetland areas are in properly functioning condition. Stream channel morphology and functions are appropriate to soil type, climate, and landform.	
• Streambank vegetation consisting of, or showing a trend toward, species with root masses capable of withstanding high streamflow events. Vegetative cover adequate to protect streambanks and dissipate streamflow energy associated with high water flows, protect against accelerated erosion, capture sediment, and provide for groundwater recharge. • Vegetation reflecting: desired plant community, maintenance of riparian and wetland soil moisture characteristics, diverse age structure and composition, high vigor, large woody debris when site potential allows, and providing food, cover, and other habitat needs for dependent animal species. • Revegetating point bars; lateral stream movement associated with natural sinuosity; channel width, depth, pool frequency, and roughness appropriate to landscape position. • Active floodplain.	• Pool dimensions • Floodplain connectivity • Large wood • Greenline vegetation composition • Bank stability and cover
STANDARD #3—Species: Desired species, including native, threatened, endangered, and special status species, are maintained at a level appropriate for the site and species involved.	
• Frequency, diversity, density, age classes, and productivity of desired native species necessary to ensure reproductive capability and survival. • Habitats connected at a level to enhance species survival. • Native species reoccupy habitat niches and voids caused by disturbances unless management objectives call for introduction or maintenance of nonnative species. • Habitats for threatened, endangered, and special status species managed to provide for recovery and move species toward delisting. • Appropriate amount, type, and distribution of vegetation reflecting the presence of (1) the desired plant community (DPC), where identified in a land use plan conforming to these standards, or (2) where the DPC is not identified a community that equally sustains the desired level of productivity and properly functioning ecological processes.	• Nonnative invasive species • Plant species of management concern • Vegetation composition • Benthic macroinvertebrates • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #4—Water quality: The BLM will apply and comply with water quality standards established by the State of Utah (R.317-2) and the federal Clean Water and Safe Drinking Water Acts. Activities on BLM lands will fully support the designated beneficial uses described in the Utah water quality standards (R.317-2) for surface and groundwater.	
• Measurement of nutrient loads, total dissolved solids, chemical constituents, fecal coliform, water temperature, and other water quality parameters. • Macroinvertebrate communities that indicate water quality meets aquatic objectives.	• pH • Specific conductance • Turbidity • Temperature • Total nitrogen and total phosphorous • Benthic macroinvertebrates • Streambed particle sizes



Wyoming

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #1—Soils: Within the potential of the ecological site (soil type, landform, climate, and geology), soils are stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.	
Indicators may include, but are not limited to: • Water infiltration rates • Soil compaction • Erosion (rills, gullies, pedestals, capping) • Soil microorganisms • Vegetative cover (gully bottoms and slopes) • Bare ground and litter	• Bare ground • Proportion of large gaps between plant canopies • Soil aggregate stability • Vegetation composition • Greenline vegetation composition
STANDARD #2—Riparian and wetland vegetation: Riparian and wetland vegetation has structural, age, and species diversity characteristic of the stage of channel succession and is resilient and capable of recovering from natural and human disturbance in order to provide forage and cover, capture sediment, dissipate energy, and provide for groundwater recharge.	
Indicators may include, but are not limited to: • Erosion and deposition rate • Channel morphology and floodplain function • Channel succession and erosion cycle • Vegetative cover • Plant composition and diversity (species, age class, structure, successional stages, desired plant community, etc.) • Bank stability • Woody debris and instream cover • Bare ground and litter	• Bare ground • Large wood • Greenline vegetation composition • Bank stability and cover • Floodplain connectivity • Streambed particle sizes • Pool tail fines • Thalweg depth profile
STANDARD #3—Upland vegetation: Upland vegetation on each ecological site consists of plant communities appropriate to the site which are resilient, diverse, and able to recover from natural and human disturbance.	
Indicators may include, but are not limited to: • Vegetative cover • Plant composition and diversity (species, age class, structure, successional stages, desired plant community, etc.) • Bare ground and litter • Erosion (rills, gullies, pedestals, capping) • Water infiltration rates	• Bare ground • Vegetation composition • Vegetation height • Soil aggregate stability
STANDARD #4—Species: Rangelands are capable of sustaining viable populations and a diversity of native plant and animal species appropriate to the habitat. Habitats that support or could support threatened species, endangered species, species of special concern, or sensitive species will be maintained or enhanced.	
Indicators may include, but are not limited to: • Noxious weeds • Species diversity • Age class distribution • All indicators associated with the upland and riparian standards • Population trends • Habitat fragmentation	• Bare ground • Nonnative invasive species • Plant species of management concern • Vegetation composition • Vegetation height • Soil aggregate stability • Benthic macroinvertebrates • Greenline vegetation composition • Indicators listed for other standards related to aquatic species habitat requirements (e.g., temperature and fine sediment)
STANDARD #5—Water quality: Water quality meets state standards.	
Indicators may include, but are not limited to: • Chemical characteristics (e.g., pH, conductivity, dissolved oxygen) • Physical characteristics (e.g., sediment, temperature, color) • Biological characteristics (e.g., macro- and microinvertebrates, fecal coliform, and plant and animal species)	• pH • Specific conductance • Temperature • Turbidity • Streambed particle sizes • Benthic macroinvertebrates

Indicators Associated with Land Health Standard	AIM Terrestrial and Lotic Core and Contingent Indicators Associated with Land Health Standard
STANDARD #6—Air quality: Air quality meets state standards.	
Indicators may include, but are not limited to: • Particulate matter • Sulfur dioxide • Photochemical oxidants (ozone) • Volatile organic compounds (hydrocarbons) • Nitrogen oxides • Carbon monoxide • Odors • Visibility	

WYOMING

Appendix 2. Using Existing Monitoring Data to Inform Benchmark Values

Where benchmarks have not already been established, existing monitoring data can be used to characterize the natural range of variability for a given indicator. For many land health standards, the natural range of variability of minimally impacted or "best available" plots is a good approximation of reference condition and/or ecological function (see BLM 2001, pp. III-9 and III-10). Indicator ranges are frequently displayed as box plots or frequency distributions and can be used to inform benchmarks for land health (Figures A1 and A2).

To characterize the natural range of variability to inform benchmark values, follow these five steps:

Step 1: Identify AIM, LMF, and other comparable monitoring data within a broad, geographically similar area (e.g., ecoregion, watershed).

- The area(s) for gathering monitoring data should be broad and encompass environmental conditions of the area where land health standards are being evaluated. In some instances, this may include multiple ecoregions or ecological site types.
- Comparable data may include data collected on upland trend plots, data collected on riparian/lotic key monitoring areas, and other data, as long as the data collection methods and indicator calculations are compatible.
- Avoid circular reasoning. In other words, do not use the same dataset to both establish benchmarks and assess standard/benchmark attainment.

Step 2: Screen monitoring data to identify plots that represent reference conditions and/or that are maintaining ecological functions.

- Screening criteria should be justifiable, with a clear rationale for the link between each criteria and the conclusion that the plots are in reference condition and/or are maintaining ecological functions in the context of the applicable land health standard. Screening criteria should also be relevant to the geographic area and ecosystem type.
- Screening criteria may include reference site characteristics, functional characteristics, ecological states, natural and anthropogenic disturbance history, and other criteria. Specific examples could be percent development in the watershed, distance from roads or other human development, functional assessments of departure from the reference condition (Pellant et al. 2005), or departure from a natural disturbance regime (e.g., excessively frequent fires) (Miller et al. 2013).
- If screening results in the inclusion of plots that are not in reference condition and/or are not maintaining ecological function, the resulting benchmarks may not reflect achievement of land health standards.
- Note: The natural range of variability can also be characterized using unscreened or nonreference monitoring data (e.g., Figure A2), but in such instances more caution is needed when using the data to develop benchmarks (also see step 5).

Step 3: Group monitoring plots by geographic areas having similar climatic, topographic, geologic, vegetation, and soil conditions (e.g., ecoregions, ecological site types, stream types). This will organize the monitoring plots, basically, into benchmark groups.

- The goal is to account for natural indicator variability and environmental gradients. Ideally, this step ensures indicator variability is minimized within groups, and indicator differences are maximized among groups.
- In areas where existing benchmark groups are not readily available, other potential-based resource classifications, such as LANDFIRE biophysical settings or habitat types, can be used.
- Characterization data collected at each plot (e.g., slope, bankfull width, soil texture (Table 3)) and GIS-derived geospatial predictors (e.g., precipitation, aspect, elevation, geology) can also be used to understand how indicators naturally vary across the landscape (Hobbs and McIntyre 2004; Herrick et al. 2006; Olson and Hawkins 2013).
- In some cases, different indicators will require different benchmark groups, since site characteristics influence indicators in different ways.

Step 4: Visualize indicator values within each group using box plots or frequency distributions (Figures A1 and A2).

- Local, state, or NOC AIM leads can assist with this step.
- The goal is to characterize the natural range of variability for each indicator within a region.
- When graphing and assessing indicator ranges, look for outliers, skewed distributions, large interquartile ranges, and low sample sizes. All of these can have a strong influence on benchmark values.

Step 5: To establish benchmarks, select percentiles of the indicator value distribution (Figures A1 and A2).

- The resulting benchmarks indicate whether a site falls inside or outside the natural range of variability. The goal in selecting percentiles to establish benchmarks is to balance over- and underprotection of the resource. For example, selecting a higher percentile for indicators that have low values when conditions are good will lead to more plots meeting the benchmark. This can lead to underprotection of the resource. In contrast, a lower percentile may result in too few plots meeting the benchmark and therefore overprotection of the resource. Such decisions are best informed by the consequences of over- versus underprotecting a resource.
- Choose a percentile that is informed by the plot screening in step 2. For example, when working with reference distributions, the 70th or 90th percentile is frequently used as the benchmark limit for indicators that have low values when condition is good, and the 10th or 30th percentile is frequently used for indicators that have high values when condition is good. Some indicators may be bimodal, meaning that they have values that are both above the 90th percentile and below the 10th percentile and are degraded relative to the natural range of variability. The exact percentile cutoff may be selected by the interdisciplinary team, and the rationale should be documented.
- Select a more conservative percentile as the amount of degraded sites within the set of screened plots increases. In other words, choose a lower percentile for indicators that have low values when condition is good, and choose a higher percentile for indicators that have high values when condition is good. Note that the opposite approach is taken when dealing with a reference distribution (see previous bullet).

Reading Box Plots

Box plots are a way of visually standardizing the distribution of indicator values at a set of sites. The standard components of a box plot include the 25th percentile, 75th percentile, median, minimum and maximum values, and outliers. The bottom of the box is the 25th percentile (1st quartile), and the top of the box is the 75th percentile (3rd quartile). In other words, 25% of the data are lower than the bottom of the box, and 25% of the data are higher than the top of the box. The horizontal line through the middle of the box is the median, which represents the middle indicator value of all sites in the dataset. The vertical lines coming out of the bottom and top of the box represent the minimum and maximum values of the dataset, assuming a normal (bell-shaped) distribution. The dots on the outside represent outliers, again assuming a normal distribution. Boxplots are an effective way to show how indicator values vary across a landscape.

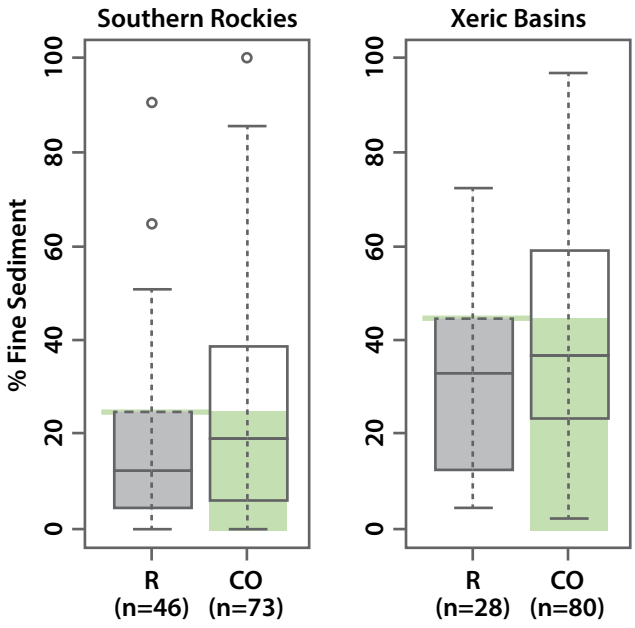


Figure A1. Box plots comparing percent fine sediment among sample reaches determined to be in best available condition (R) and random AIM points of unknown condition for the State of Colorado (CO). The reference distribution (R) was established by: (1) identifying available monitoring data with compatible field methods; (2) identifying stream reaches in best available condition by screening sample locations for disturbances that are known to degrade streams; and (3) grouping monitoring data by ecoregions. In this case, the Southern Rockies ecoregion has a narrower and lower range for fine sediment than the Xeric Basins. Sediment generally increases with degradation, and thus benchmarks were set at the 75th percentile of the reference distributions (dashed horizontal green lines). These values were then used to identify which sites fell within the natural range of variability for fine sediment within each of the two ecoregions (green area).

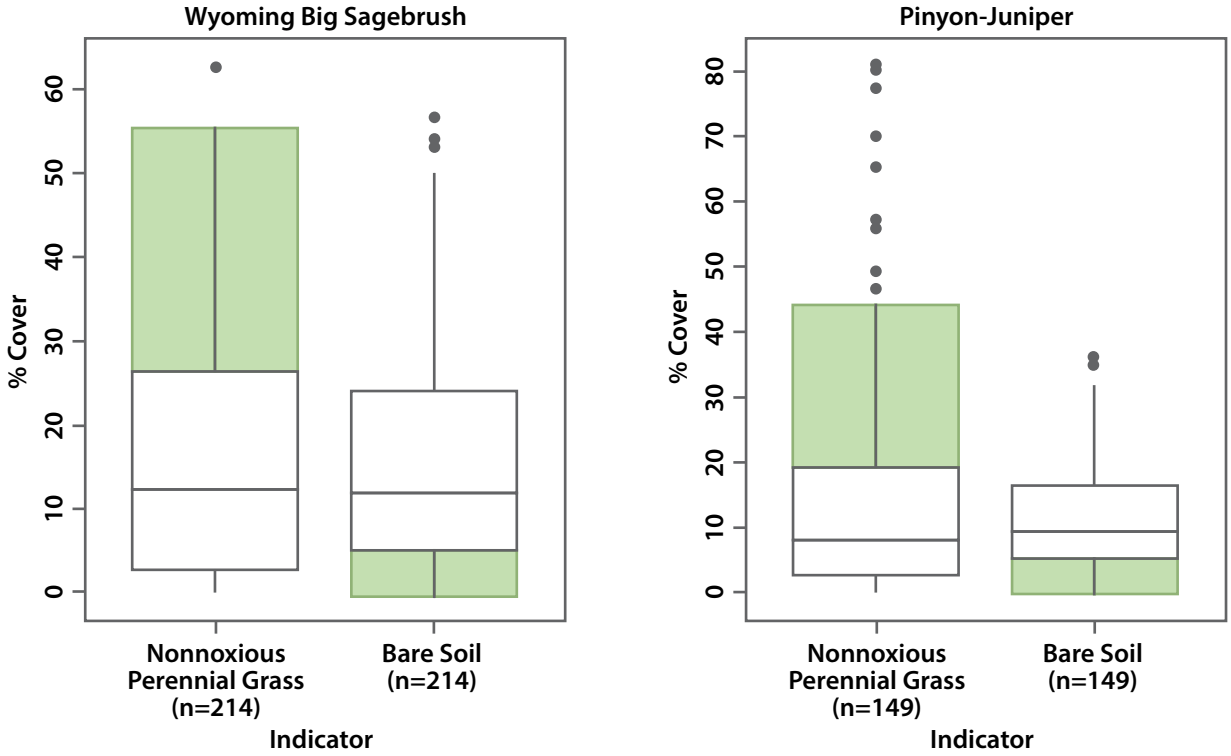


Figure A2. Box plots showing nonnoxious perennial grass cover and bare ground at all unburned terrestrial AIM and LMF sites in Wyoming big sagebrush and pinyon-juniper communities across the Colorado Plateau ecoregion. Benchmark ranges are identified by areas highlighted in green. In contrast to the lotic example (Figure A1) which used a broader set of criteria, step 2 in this example focuses only on screening out recently burned sites. As a result, it is likely that many more of these sites are in degraded condition. Thus, in step 5, a more conservative percentile was chosen. The interdisciplinary team selected benchmark values to be between the 75th and 95th percentiles for perennial grass, which has higher values when these communities are in reference condition. The team identified an upper benchmark also because overabundance of grass represents degradation in these communities. The team selected benchmark values to be between the 0 and 25th percentiles for bare ground, which has low values when these communities are in reference condition. The team also reviewed other lines of evidence, including available ecological site information, before they finalized the benchmarks.

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