Rapid Monitoring Protocol

Developed by Tamarisk Coalition
in Coordination with Colorado Water Conservation Board
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Rapid Monitoring Protocol

Introduction & Background

INTRODUCTION

Vegetation monitoring efforts on a restoration site can take many forms. Government agencies, mining companies, academic researchers, and other private and public land managers all have different questions they may want to answer and different minimum requirements for what their monitoring efforts should look like. As such, vegetation monitoring efforts on restoration sites vary widely across the West, and it can be difficult to find common ground on monitoring protocols. For example, even within a single watershed, a restoration partnership devoted to a common cause may still have as many potential monitoring protocols as there are number of partners, as each entity must ensure that their minimum monitoring needs are being met.

The Rapid Monitoring Protocol is not an effort to force a particular monitoring protocol onto grantees who may already have other types of vegetation monitoring they are required to perform, but more so to provide an outline of suggested monitoring efforts that could be conducted on a restoration site in order to efficiently track restoration progress and inform the planning and implementation of management activities.

The following sections provide: (1) An overview of three of the most commonly used types of vegetation monitoring efforts being used by our Partners on riparian restoration sites, (2) An explanation of how the Rapid Monitoring Protocol aligns with these commonly used monitoring efforts and its potential utility, (3) A detailed description of the components of the Protocol, (4) Suggestions for preparing for and conducting the Rapid Monitoring Protocol, and (5) Some caveats and considerations to be aware of when using the Rapid Monitoring Protocol. These sections are followed by Appendices, which includes all relevant datasheets, spreadsheets, and guide sheets/packets associated with the Protocol.

THREE COMMONLY USED TYPES OF VEGETATION MONITORING

The following provides an overview of three of the most common types of vegetation monitoring efforts being conducted on restoration sites.

Photo Point Monitoring

Photo point monitoring is an easy and effective method of monitoring vegetation and ecosystem change. It is inexpensive, and requires very little equipment or training. This qualitative method of monitoring generally consists of taking repeat photos of a given restoration area or site over a period of time from select vantage points. Photos are taken from the same location and range of view each time.

Ease of access and amount of time available generally dictate the number of photo points established at a given site. The point(s) from which the photos are taken are marked and/or documented well so that it is possible for different personnel to take exactly replicated photographs each year (or every few years). Photographs obtained from photo point monitoring are not only useful for tracking changes over time within a given project, but can also be useful for presentations and reports to demonstrate 'before and after' conditions, and demonstrate success. *Photo point monitoring can also be incorporated into the below types of monitoring.*

'Rapid Monitoring' or 'Project Tracking'

This type of monitoring is also a relatively easy form of monitoring and requires very little equipment. It can be very effective for tracking success of management efforts on a site, and for planning for further restoration activities (e.g. noxious weed spraying, planting efforts) in the coming year. This type of monitoring can take the form of both qualitative and quantitative data collection, and is useful for ensuring that adaptive management is occurring on a site. A typical monitoring effort would consist of conducting a survey of the entire site and tracking key vegetation parameters such as size and location of noxious weed populations, and establishment success of seeding or planting efforts. Qualitative data may also be collected, ranging from noting signs of wildlife/herbivory to observing the effects of a flooding event. This information can then be utilized (for example) to plan for spraying of newly discovered noxious weed infestations, ordering more plants for replanting, installing more anti-herbivory protection on young plantings, redesigning further restoration efforts based on extent of catastrophic flooding, etc. In conjunction with this type of monitoring (and the below type of monitoring) it can be useful to collect soil samples and determine water table depth on site to inform project planning and provide insight into success or failure of restoration efforts (for example, discovering that a site has highly saline soils or a deep water table may require that original restoration plans be modified).

'Research-Based Monitoring' or 'Long-Term Monitoring'

This type of monitoring is more commonly conducted when specific questions are being asked in conjunction with restoration efforts (e.g. Which restoration method works best in this area?), or if there are other reasons why statistically valid data collection is necessary. This type of monitoring effort is designed to be statistically valid, is a more scientifically rigorous method of monitoring, and typically involves the collection of quantitative vegetation data (e.g. plant cover, density, diversity) and other ground cover data using a transect line or quadrats (squares or rectangles within which vegetation cover [and other groundcover] is estimated). Data is collected within representative or randomly located areas, and then random or stratified random plots are located within these to represent that area. So, the entire site is not surveyed, only a representative portion. The purpose of this type of monitoring is to

be able to draw objective rather than subjective conclusions about the status of a given site. Methodologies such as Rapid Monitoring that depend on judgment calls (e.g. “condition of a site”) or non-systematic sampling (e.g. “walking the whole site”) cannot be used to statistically compare data between years or sites, especially when the surveys are performed by different individuals. Analysis of this type of data can be as simple as comparing average vegetation cover for selected species of interest, or as complex as conducting a variety of statistical analyses. Photos are typically taken of the transect lines or plots for additional documentation. Soils data and water table depth information (along with other information of interest) may also often be collected to inform data analyses and assist with project planning.

In summary, all three of these types of monitoring efforts can provide useful information; it simply depends on the needs of the land manager as to which type(s) of monitoring will most efficiently help the land manager accomplish their goals. Regardless of the method used, these monitoring efforts are typically conducted annually (when possible), and at the same time each year. Additionally, the first year of monitoring typically occurs prior to any work being done on a site (unless this is impossible), so that a solid picture of the ‘before’ conditions are documented for later comparison.

HOW THE RAPID MONITORING PROTOCOL ALIGNS WITH OTHER TYPES OF MONITORING

The Rapid Monitoring Protocol aligns with the above described types of monitoring efforts by combining the Photo Point Monitoring and Rapid Monitoring methods (and as well incorporates some ‘support documents’ to facilitate management activity tracking and decision-making). We feel that the combination of Photo Point Monitoring and Rapid Monitoring methods is an efficient way of gaining the minimum information needed in order to successfully track progress on a site and inform annual planning and implementation of management activities.

It bears repeating at this point that vegetation data collected through this method is not statistically valid and thus cannot be used to answer research questions or to truly compare the effectiveness of one restoration method versus another. To gain this information, it is critical that ‘Research Based’ monitoring such as described above be conducted.

THE UTILITY OF CONDUCTING RAPID MONITORING ON YOUR SITE(S)

This Protocol was developed as a guide to provide suggestions for data that one might want to be collecting on a given restoration site to inform management activities and track progress, but collection of any or all of this data is optional. The intent is for you to choose what might be useful for you, and disregard the rest. Also, in all likelihood you may already be collecting some or all of the data outlined in this Protocol through other means, in which case you may have no need for this Protocol other than to help guide missing data collection.

Components of the Protocol

The Rapid Monitoring Protocol itself consists of three parts:

I. **Initial Site Assessment Data Collection**: *Ideally conducted prior to any management activity implementation; this information provides baseline information about a site that will facilitate later management activity decision-making.*

II. **Management Activity Tracking**: *This is a suggested method for tracking all management activities conducted on a site. This information directly feeds into Rapid Monitoring efforts for a given year, and in turn information gained through Rapid Monitoring can inform decision-making, planning, and implementation of future management activities.*

III. **Rapid Monitoring Data Collection**: *As mentioned above, this information can directly inform decision-making, planning, and implementation of future management activities.*

Initial Site Assessment Data Collection

The Initial Site Assessment Data Collection is intended to be conducted at the initiation of a project. This information can then be updated as needed. The relevant datasheets associated with this portion of the Rapid Monitoring Protocol are described below and can be found in Appendix A:

1) **Initial Site Assessment (ISA) Basics Datasheet:** *Collecting background information about the site including (1) Site Accessibility and Maneuverability, (2) Legal and Safety Considerations, and (3) Basic Site Vegetation and Animal Use.*
2) **ISA General Water Information Datasheet:** *Collecting background information about the site including (1) Water Availability/Quantity, and (2) Water Quality.*
3) **ISA Groundwater Datasheet:** *Collecting background information specifically associated with characterizing the groundwater on site. This information can feed into the General Water Information Datasheet.*
4) **ISA Soils Datasheet:** *Collecting background information about the soil characteristics of the site.*

Management Activity Tracking

Management Activity Tracking is intended to be conducted throughout the life of the project. This information is updated whenever management activities are conducted on site by any party. The relevant datasheet associated with this portion of the Rapid Monitoring Protocol is described below and can be found in Appendix A:

5) **Management Activity Tracking Spreadsheet:** *As stated above, this spreadsheet is designed to track all monitoring activities, and can be modified as needed to best support tracking of the variety of activities conducted on a given site.*

Rapid Monitoring Data Collection

The Rapid Monitoring Data Collection is intended to be conducted the first year of the project (ideally before any management activities have been conducted), and then ideally annually after that. The relevant datasheets associated with this portion of the Rapid Monitoring Protocol are described below and can be found in Appendix A:

6) **Rapid Monitoring Part 1 Data:** *This datasheet is designed to capture initial pre-treatment site data as well as track site data over time as a result of implemented management activities. This datasheet tracks (1) Woody invasive and secondary weed infestations, (2) Active revegetation efforts, (3) Vegetation/Groundcover data across the site as a whole, and (4) Additional Information associated with animal use, biocontrol presence, etc. on site (each user should modify as needed).*
7) **Rapid Monitoring Part 2 Photos:** *This datasheet is designed to support the capture of initial pre-treatment photo point data as well as track photo point data over time.*

Rapid Monitoring Data Collection was designed to be conducted annually (Parts 1 and 2), but an alternate scenario might be that Rapid Monitoring Data Collection is used (in conjunction with Initial Site Assessment Data Collection) to capture the initial 'before' picture at a given site and characterize initial management needs, and then Rapid Monitoring Data Collection might not be conducted again for another 2 to 3 years. HOWEVER, this alternate scenario is only effective if one has other means of tracking annual progress on the site as it relates to woody invasives, secondary weeds, and revegetation efforts.

It is important to decide what information is the most critical for you to be gaining from the Rapid Monitoring effort, and this will determine the most appropriate timing, frequency, and breadth of Rapid Monitoring that should be conducted on a given site.

Preparing for & Conducting Protocol

MAXIMIZING THE EFFECTIVENESS OF RAPID MONITORING DATA COLLECTION

The following provides some important tips for getting the most out of Rapid Monitoring:

- The first year of monitoring should occur prior to any management activities being conducted on the site (unless this is impossible), so that a solid picture of the 'before' conditions are documented for later comparison.
- After that, frequency of monitoring will depend on the reasons for conducting Rapid Monitoring, availability of alternate means of collecting information, and available time and money.
- If using monitoring to track progress, monitoring should be conducted at the same time within the growing season each year. Otherwise, when comparing vegetation cover from year to year, cover values may appear falsely high or low if you collect data at different times of the growing season.
- Determining the most appropriate time to monitor the site each year depends on what you are trying to accomplish with Rapid Monitoring, and which key plant species (exotic and native) you are trying to track (since certain species may be difficult to find at certain times of the year). Here are two examples:
    - Example 1: You are visiting a new site for the first time and it has been determined that Rapid Monitoring will be most useful for informing planning for the following year, and tracking progress over time. Your key exotic species of interest are tamarisk and knapweed, and you generally want to characterize the native plant species present. You might want to visit the site and conduct full Rapid Monitoring when most of the native and exotic plant species of interest will be at their peak, or perhaps past their peak but still visible. This will allow you to get a good picture of the size of the exotic infestations
    - Example 2: The site has been treated for knapweed and tamarisk for several years and you want to track progress on the site for woody invasives, secondary weeds, and native vegetation. You want to know how effective the knapweed and tamarisk treatments have been, whether any new invasive species are showing up on the site, and how the 50 plantings that you planted two years ago are doing. Based on the area sprayed last year, your herbicide sprayer was able to guesstimate a ballpark price/acreage in order to get the spraying contract in place for this year, so you were able to roughly plan for Implementation without conducting Rapid Monitoring last year. However, you still do not have an accurate accounting of how much knapweed and tamarisk is actually out there currently. You might want to conduct full Rapid Monitoring this year, or perhaps conduct an abbreviated version of Rapid Monitoring supplemented with herbicide sprayer records for this year.

METHODOLOGY FOR IMPLEMENTING RAPID MONITORING PROTOCOL

1. Initial Office Work:
    A. Determine which Initial Site Assessment (ISA) Data needs to be collected. For example, most managers will want to collect ISA Basics data, but not all managers may be interested in collecting the Soils and Water data.
    B. Develop system for tracking all management activities on site if this has not already been done (e.g. see sample Management Activity Tracking Spreadsheet).
    C. Determine what Rapid Monitoring data is already being collected (or will be collected) through other means on your site. Based on this information, determine what data (if any) still needs to be collected through Rapid Monitoring efforts as suggested here.

Rapid Monitoring Field Equipment List

- All maps/directions needed to navigate easily to each site
- GPS
- Camera
- Paper datasheets
- Pens/pencils
- Clipboard
- Large plant press and all associated plant pressing materials
- Plant ID books/other books
- All electronic charging gear and extra batteries
- First Aid kit for humans
- First Aid kit for vehicle (e.g. tire changing equipment, spare tire, flashlight, Stop a Flat spray, etc)
- Camping gear
- Personal gear, extra clothing, food, water, etc
- Additional equipment needed for Site Assessment activities (see other Guidesheets)
- Other?

2. Pre-Site Visit Office Work:
    A. Prepare datasheets and pull together equipment (see below for list of equipment).
    B. If using a Survey Crew:
        i. Review all background information with crew so that they know what to look for, especially as it relates to previously conducted management activities.
        ii. Make sure crew can accurately identify plant species of interest/concern, including new invasive species you might want them to be on the lookout for.
        iii. Review all maps/directions to site(s) and work with someone who has visited site(s) before to ensure that they know where they are going, how long it will take, potential hazards, appropriate vehicle and additional gear needed, etc.
        iv. Spend time with crew practicing how to estimate vegetation percent cover and size of invasive species infestation (if relevant), and practice using tools (such as GPS units) that can assist in these activities. (See **Guide Sheet for Estimating Vegetation Percent Cover and Area** [Appendix B])
        v. Develop Safety Plan and a designated person for the crew to check in with if they will be in the field for multiple days at a time and/or remote areas.

C. Discuss the type of GIS information that will be collected with your GIS archiving person or other relevant person. Most organizations have their own preference for which datum to operate in and how they might like the data collected.

3. Site Visit Field Work:
    A. To fill out **Initial Site Assessment (ISA) Datasheets:**
        i. Some information can be filled out in the office, but review this information in the field to ensure that nothing has been missed. See section below entitled 'Walking through Datasheets' for a detailed description of how to fill out the datasheets. There are also two support documents provided in Appendix B to assist with collection of the Water and Soil data collection: (1) A **Guide Sheet for Groundwater Well Installation & Monitoring**, and (2) **Soil Sampling Packet**.
    B. To fill out the **Rapid Monitoring Datasheets Parts 1 & 2**:
        i. Most information in these datasheets must be filled out in the field. See section below entitled 'Walking through Datasheets' for a detailed description of how to fill out the datasheets.
        ii. Asses the site by the most appropriate means. If it is a small site, walk the site once before collecting any data as it will give you a better sense of the relative amounts of different vegetation. You may not have that luxury on larger sites.
        iii. Select photo point locations if not already designated. If it is easy, walk entire site first before selecting photo points so that you have a better sense of the most important aspects of the site to take pictures of. For example, one might want to set up photo points that show large populations of noxious weeds, or other aspects of the site that you hope to improve. Think as if you are putting together your PowerPoint presentation that you will be giving 3 years from now, where you will be showing before and after pictures. What will you want to highlight in that presentation? Try to set up at least one photo point from a high vantage point that looks out over entire site. It is very helpful to set your camera to include the bearing, date and even the time on the photo (and GIS Photo Link or other GPS info if desired) in the event that you need to retrace your steps. Establish a minimum of three photo points.

4. Post-Site Visit Office Work:
    A. Transfer data collected into relevant electronic spreadsheets, including clearly labeling/archiving photo point photos.
    B. Utilize information gained to inform decision-making, planning, and implementation of management activities on site.
    C. Continue to track all management activities.
    D. Develop "Rapid Monitoring Summary Report" for season if desired or required, including photos

WALKING THROUGH THE DATASHEETS & SPREADSHEETS

The following provides a walk-through of filling out each datasheet/spreadsheet. See Appendix A for examples of how datasheets might be printed out.

Initial Site Assessment Data Collection

1) **Initial Site Assessment (ISA) Basics Datasheet:** *Collecting background information about the site including (1) Site Accessibility and Maneuverability, (2) Legal and Safety Considerations, and (3) Basic Site Vegetation and Animal Use.*

   This spreadsheet should be relatively self explanatory to fill out.

2) **ISA General Water Information Datasheet:** *Collecting background information about the site including (1) Water Availability/Quantity, and (2) Water Quality.*

   This spreadsheet provides information to help guide planting efforts (water quantity) and help track water quality issues of concern. Knowing the average precipitation for the area and whether or not the groundwater will be easily accessible for plantings can help guide revegetation plant selection on site. It is also helpful to think through potential irrigation options early in the planning process. There are also obviously a wide variety of questions that could be asked associated with water quality – these are just two overview questions to consider.

3) **ISA Groundwater Datasheet:** *Collecting background information specifically associated with characterizing the groundwater on site. This information can feed into the General Water Information Datasheet.*

   This spreadsheet should be relatively self explanatory to fill out when used in combination with the **Guide Sheet for Groundwater Well Installation & Monitoring** (Appendix B). This datasheet is divided into two sections:

   - Table 1 – Collects all data associated with well installation
   - Table 2 – Collects all monitoring data.

   Table 1 in the spreadsheet provides suggestions for minimum information to capture associated with well installation, but remember that you may be required to collect more and different information in order to satisfy permitting paperwork, etc. As such, there may be other information that you are required to collect that could be incorporated into this spreadsheet – these are just suggestions! The Tamarisk Coalition can provide some information on local

contractors and/or organizations that could assist you with monitoring well installation and monitoring if needed.

4) **ISA Soils Datasheet:** *Collecting background information about the soil characteristics of the site.*

This spreadsheet should be relatively self explanatory to fill out when used in combination with the **Soil Sampling Packet** (Appendix B). The minimum three soil characteristics that we recommend to be determined for your soil samples are pH, texture, and salinity (unless you already know that salinity will not be a concern on this site). Cost will likely be the primary driver for how many samples and analyses can be run. Plan ahead and contact the soils laboratory ahead of time to find out how long it will take for them to process your samples, as certain times of year can be particularly busy for them.

Management Activity Tracking

5) **Management Activity Tracking Spreadsheet:** *As stated above, this spreadsheet is designed to track all monitoring activities, and can be modified as needed to best support tracking of the variety of activities conducted on a given site.*

This spreadsheet should be relatively self explanatory to fill out. It is divided into two sections:

- Basic Information to Track Associated with Management Activities
- Suggested Additional Management Activity Tracking Data that might be useful

The Additional Management Activity Tracking Data section can be revised and elaborated on by the individual managers, as there is likely a variety of additional information that could be tracked in this section. The idea was to provide some suggestions for some additional information that could be collected so that down the road, when evaluating success or failure of some portion of the project, this information could potentially provide some insight.

Rapid Monitoring Data Collection

6) **Rapid Monitoring Part 1 Data:** *This datasheet is designed to capture initial pre-treatment site data as well as track site data over time as a result of implemented management activities. This datasheet tracks (A) Woody invasive and secondary weed infestations, (B) Active revegetation efforts, (C) Vegetation/Groundcover data across the site as a whole, and (D) Additional Information associated with animal use, biocontrol presence, etc. on site (each user should modify as needed).*

This datasheet was designed to be used for initial pre-treatment Rapid Monitoring as well as for Rapid Monitoring data collection once management activities have begun to be implemented. Certain portions of this datasheet may be less useful the first year versus in later years, and vice versa. For example, ideally no management activities will have been implemented prior to the initial visit, so there would be no active revegetation efforts to check on at that time.

Section A (Woody Invasive and Secondary Weed Tracking) is used to track new and existing infestations of Invasive Species of Concern. It is up to the land manager to determine which species of concern they want to track and treat. An option here is to track not only approximate size of infestation but also percent of this area that is infested (percent cover). This may be useful information to collect to show that even if area of weed infestation is barely decreasing over time, the percent cover may be decreasing dramatically with treatment over time. It may also be useful information when estimating how much chemical you might need for the site (although this number may be underestimated unless data collection occurs right at peak of vegetation). See **Guide Sheet for Estimating Vegetation Percent Cover and Area.**

Sections B and D are likely relatively self-explanatory to fill out.

Section C (Vegetation/Ground Cover Data and Progress Tracking) is a section that was created to support the establishment and tracking of vegetation/groundcover goals on a restoration site, to help determine when a site has successfully reached its restoration goals. Each manager would decide the appropriate goals for the site – this section simply offers a suggested method for tracking progress towards these goals. The **Guide Sheet for Tracking Progress** is an example of how one might establish goals, and the **Guide Sheet for Estimating Vegetation Percent Cover and Area** (Appendix B) explains how to collect the data for this spreadsheet.

7) **Rapid Monitoring Part 2 Photos:** *This datasheet is designed to support the capture of initial pre-treatment photo point data as well as track photo point data over time.*

This datasheet should be relatively self explanatory to fill out.

Caveats & Considerations for Using this Protocol

The following caveats and considerations should be reviewed prior to implementing this Protocol:

- **Pre-Activity Visits and Return Visits.** The Rapid Monitoring datasheets were designed so that they could be useful for both initial and return visits to sites. As such, collection of some data indicated in the spreadsheets may not be important for initial visits but may be for return visits, and vice versa. For example, ideally no management activities will have been implemented prior to the initial visit, so there would be no active revegetation efforts to check on at that time.

- **Watershed specificity**. The simple vegetation goals suggested for tracking progress stem from the Dolores River Restoration Action Plan (DR-RAP), and obviously may have little to no applicability for other watersheds conducting restoration who may have their own (different) set of goals, and may be experiencing significantly different social or ecological challenges.

- **Limitations of ocular vegetation estimates**. The percent vegetation cover estimates gained through Rapid Monitoring are completely based on ocular estimates ('eyeballing'). Obviously, these estimates could vary depending on the observer, so this is just a reminder that the data collected here would just be a rough estimate, and is not statistically valid. Because this is intended to be 'Rapid' monitoring, no transect lines or quadrats are used. If people require statistically valid data that could be more exactly replicated by different observers, it would be advisable to utilize a more rigorous methodology.

- **Option for paper or digital data collection**. The accompanying Excel spreadsheets were designed for dual purpose so that the same spreadsheet could be used for data collection and data entry. Thus data can be entered digitally directly in the field, or the data sheets can be printed out and filled out by hand.

- **The potential caveat for large sites**. Large sites can present challenges for conducting this method of Rapid Monitoring as it is written. Estimating vegetation cover data can become difficult on large sites (*e.g. sites that extend for multiple miles).* If a given site is very large, it may be useful to use aerial photography or other means to more efficiently and effectively estimate vegetation cover, versus (or in addition to) walking the site. Alternatively, it may be that a different method of monitoring may be more useful on large sites.

- **The potential caveat for sites with indiscrete boundaries**. In order to use this vegetation cover data to Track Progress on a given site through simple goals, it is necessary to define the boundaries of a given site. One cannot state that X % of the vegetative cover on a site is noxious weeds if one does not know where the boundaries are and where to 'stop counting'. On sites with discrete boundaries (e.g. property lines for a private landowner), this should be a non-issue. For sites with indiscrete boundaries (e.g. treated areas sprinkled across public lands stretching over hundreds or thousands of acres), it may be useful to create artificial site

boundaries within which to operate, such as drawing polygons on digital maps to create manageable sized ‘sites’ (this may also be a useful strategy for dealing with sites that are very large). This would obviously require developing maps/lists of coordinates for the Survey Crews so that they can easily determine when one ‘site’ ends and a new one begins.

Appendix A

I. Primary Rapid Monitoring Datasheets (Examples)
- Initial Site Assessment (ISA) Basics Datasheet
- Management Activity Tracking Spreadsheet
- Rapid Monitoring Parts 1 & 2 Datasheets

II. Other ISA Soils & Water Data Collection Datasheets (Examples)
- Initial Site Assessment (ISA) General Water Information Datasheet
- ISA Groundwater Datasheet
- ISA Soils Datasheet

Also see accompanying Excel spreadsheets for blank electronic versions of spreadsheets to be used both for data entry and can be printed out as datasheets once user has customized as needed.

- ***Rapid Monitoring_Initial_Site_Assess_Management_Activity_Tracking.xls***
- ***Other_ISA_Soils_Water_Data_Collection.xls***

Initial Site Assessment Basic Information (Example Spreadsheet)

Jurisdiction/Office	Site/Project Name	Date Information Collected	Name of Data Collector(s)	Name of Site Owner/Land Manager and Contact Info if Relevant
Main Office	**Restoration Site 1**	7/5/2013	Joe Smith	Joe Smith (970-555-5555)

BASIC SITE INFO & ACCESSIBILITY					
Good description of site location and directions for getting to site (tie in with map if useful)	**If site cannot be directly reached by car - what is approximate time hiking/boating to reach site from car?**	**Additional site notes (e.g. site hard to find, difficult river crossing to access, site hazards, etc that might be relevant for others visiting site)**	**Has basic physical or digital map been created for site showing property/site boundary, site access point(s), above ground hazards, etc? (map can be added to over time to show locations of management activities conducted, etc)**	**Equipment Accessibility - Site can be accessed by (a) Truck/heavy machinery, (b) ATV, (c) On foot only, (d) Boat only**	**Equipment Manueverability - If site can be accessed by truck/heavy machinery, what is maneuverability? (e.g. is site generally flat and unobstructed, or is terrain irregular and would be challenging to navigate with machinery?)**
From Intersection of North Ave & 1st St in Grand Junction: ……..	Site can be reached by car	Site easy to find but will need to have access key with you to unlock gate	Map has been created - see separate file	Site can be accessed by all of the above	Site is flat and machinery could easily manuever on site, but would need to be strategic as no bridge to cross irrigation ditch in middle of site

LEGAL & SAFETY CONSIDERATIONS ASSOCIATED WITH SITE						
Contamination Concerns - Does this site have a history of natural resource extraction or other potential contamination hazards or related legal concerns?	**Underground Digging Hazards - Are there any materials buried underground at this site that might present hazard for digging? (e.g. contaminated materials, irrigation pipe, electrical lines, cars, large chunks of cement, etc)**	**Wetland Status - Could this site be considered a wetland by Army Corps of Engineers (ACE)? If you do not know, then should consult with local ACE representative to determine any management activity limitations such as not being able to leave 'fill' on site.**	**National Pollutant Discharge Elimination System (NPDES) Compliance - If herbicide will be applied on site, you must ensure that all herbicide activities are NPDES compliant as of recent changes in regulations, or else liability concerns.**	**Endangered Species/Sensitive Wildlife - Are there endangered species to be concerned about for this site? Are there critical nesting periods or similar for non-endangered local wildlife that you will want to be careful about and schedule management activities around?**	**Groundwater Monitoring Well Installation Permitting - If want to install groundwater monitoring well, what are necessary permits to obtain in order to do this legally?**	**Other Concerns - Are there other legal or safety concerns associated with this site? (e.g. overhead power lines, other local regulations). If not familiar with site area, ask local officials or property owners if other potential concerns or issues they have dealt with.**
no history of contamination	old irrigation pipe is buried in northwest corner of site	site determined not considered wetland after consultation with local ACE rep (Rep name = John Johnson, phone: 970-333-3333)	yes herbicide spray contractor has been verified that operating in compliance with new NPDES regulations	no endangered species of concern; will limit activity on site in spring when nesting birds present	necessary permits have been obtained	no other known concerns

BASIC SITE VEGETATION & ANIMAL USE					
What is the dominant desirable vegetation (if any) present on site currently? (e.g. sagebrush, greasewood, rabbitbrush, willows, mixed grasses, etc)	**Do you see any desirable plant species in particular that seem to be growing well on site that might be good candidates to use for active revegetation? (if cannot ID plant(s), collect plant samples). Note whether plants growing in (1) sunny open area or shady cooler area, and (2) wet or dry environment**	**Are there weedy/ troublesome plant species on surrounding properties that could cause problems for this site? (if so, coordinate with those landowners to manage them, or make plan to prevent (re)infestation on your site)**	**Are there desirable plant species on surrounding properties that could spread onto this site? (may want to prioritize to work near these property lines first and reap potential passive restoration benefits)**	**Is there any evidence of herbivory on site? (e.g. grazing or browsing evidence, scat, tracks, etc) Will domestic livestock have access to this site? If potential impacts appear significant, will need to make plan to protect revegetation investment (e.g. fencing).**	**If tamarisk present, have any biocontrol beetles or associated defoliation been observed on this site? (don't need to do official sweep, just general observations)**
sagebrush and greasewood	slender wheatgrass growing well in southwest corner of site	adjacent site has tamarisk infestation also - contacted landowner and they will begin treatment next year	adjacent site covered with 4wing saltbush - perhaps could spread naturally onto site	heavy herbivory on few remaining willows; will need to cage any plantings	yes beetles observed but do not seem to be significantly defoliating tamarisk

Management Activity Tracking Page 1 (Example Spreadsheet)

			BASIC INFORMATION TO TRACK ASSOCIATED WITH MANAGEMENT ACTIVITIES										
Jurisdiction/Office	**Site/Project Name**	**Name of Supervisor of Activity**	**Date/Year of Treatment**	**Treatment Type (e.g. woody invasive, secondary weeds, active revegetation)**	**Species Treated or Species Planted/Seeded**	**Method of Treatment/ Specific Planting Method Used**	**Acreage Treated or Acreage/Volume Planted**	**Location of Treatment Within Site**	**ACTIVE REVEG ONLY - Antiherbivory protection installed? (e.g. caging, fencing)**	**ACTIVE REVEG ONLY Is planting area or individual plantings well marked? (e.g. flagging, tags) (If not, may be difficult to find/count later)**	**ACTIVE REVEG ONLY - Follow up watering or hand weeding conducted during this season? Ongoing need into next season? (If so, remember to schedule next year)**	**ACTIVE REVEG ONLY - Success rate of active reveg activity?** *(Import data from Rapid Monitoring to calculate success rate. For example, if planted 150 poles and 75 survived, success rate was 50%)*
Main Office	**Restoration Site 1**	Joe Smith	fall 2011	woody invasive	tamarisk	cut stump + herbicide, woody material piled and burned	10 acres	Throughout site	NA	NA	NA	NA
Main Office	**Restoration Site 1**	Joe Smith	fall 2012	woody invasive	tamarisk	resprout foliar herbicide	5 acres	Throughout site	NA	NA	NA	NA
Main Office	**Restoration Site 1**	Joe Smith	fall 2011	secondary weeds	Russian knapweed	Milestone herbicide applied at 7 oz/acre rate	4 acres	southwest corner of site	NA	NA	NA	NA
Main Office	**Restoration Site 1**	Joe Smith	fall 2012	secondary weeds	Russian knapweed	Milestone herbicide applied at 7 oz/acre rate	2 acres	southwest corner of site	NA	NA	NA	NA
Main Office	**Restoration Site 1**	Joe Smith	fall 2012	secondary weeds	Russian knapweed	Milestone herbicide applied at 7 oz/acre rate	0.5 acres	southeast corner of site along property line	NA	NA	NA	NA
Main Office	**Restoration Site 1**	Joe Smith	October 2012	active revegetation	Alkali sacaton, western wheatgrass, 4wing saltbush	Broadcast seeded mix by hand, raked in	10 lbs of seed spread over 2 acres (alkali sacaton x % of mix, western wheatgrass x % of mix, and 4wing saltbush x % of mix)	NW corner of site, near road	None	Seeded area obvious	None	50% success
Main Office	**Restoration Site 1**	Joe Smith	Feb 2012	active revegetation	coyote willow	whip plantings	150 whips planted across 2 acres	South edge of site, all along river	Cages installed on all plantings	Cages on plantings will serve as marking	None	50% success
Main Office	**Restoration Site 1**	Joe Smith	October 2012	active revegetation	shrubs X and Y	Planting of nursery grown potted plants	20 shrub x and 20 shrub y planted across 2 acres	NW corner of site, near seeded area	Cages installed on all plantings	Cages on plantings will serve as marking	Follow up watering as needed; hand weeding	25% success shrub x, 75% success shrub y

Management Activity Tracking Page 2 (Example Spreadsheet)

			ADDITIONAL MANAGEMENT ACTIVITY TRACKING DATA (May want to collect this data for use when evaluating success or failure of given treatment)											
				WOODY INVASIVES/SECONDARY WEEDS					ACTIVE REVEGETATION			WEATHER DATA	
Jurisdiction/Office	Site/Project Name	Name of Supervisor of Activity	Labor Source Used	Name of Herbicide and Rate Used	Additional Herbicide Application Info (Type & quantity of surfactant, etc)	(If relevant) Type of Heavy Machinery Used to Remove Woody Invasives	(If relevant) How Was Woody Material Dealt With Post-Cut? (e.g. mulched and left in piles, mulch scattered, piled and burned, etc)	Other Info to Track?	Source of Seed or Plant Material	(If relevant) Machinery Used for Seeding/Planting	Other Planting/Seeding Info to Track?	Growing Season Weather This Year	Dormant Season Weather This Year
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	Garlon 4 at x rate	x surfactant at x rate	NA	mulched and taken off site	NA	NA	NA	NA	NA	Winter 2011 unusually cold and very little snow cover to protect vegetation
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	Garlon 4 at x rate	x surfactant at x rate	NA	NA	NA	NA	NA	NA	Summer 2012 unusually hot and dry	Winter 2012 unusually dry
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	Milestone at 7 oz per acre	no surfactant was used	NA	NA	NA	NA	NA	NA	NA	Winter 2011 unusually cold and very little snow cover to protect vegetation
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	Milestone at 7 oz per acre	no surfactant was used	NA	NA	NA	NA	NA	NA	Summer 2012 unusually hot and dry	Winter 2012 unusually dry
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	Milestone at 7 oz per acre	no surfactant was used	NA	NA	NA	NA	NA	NA	Summer 2012 unusually hot and dry	Winter 2012 unusually dry
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	NA	NA	NA	NA	NA	Wildland Scapes	NA	Compare salty seed mix with riparian seed mix	Summer 2012 unusually hot and dry	Winter 2012 unusually dry
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	NA	NA	NA	NA	NA	wildcut at local site nearby	used hand held 'stinger'	all whips harvested from same local site	Summer 2012 unusually hot and dry	Winter 2012 unusually dry
Main Office	**Restoration Site 1**	Joe Smith	Western CO Conservation Corps	NA	NA	NA	NA	NA	Colorado State Forest Service	NA	NA	Summer 2012 unusually hot and dry	Winter 2012 unusually dry

Rapid Monitoring Data Tracking Page 1 (Example Spreadsheet)

*Note: Remember to take copy of **Management Activity Tracking Spreadsheet** to field, so can reference size, location, and other details of original treatments that you are checking on.*

Date: 7/5/13

Site/Project Name: Restoration Site 1

Size of Site: 8 acres

Time it took to Survey/Monitor Entire Site: 2.5 hours

Form Completed By: Joe Smith

				A - WOODY INVASIVE & SECONDARY WEED TRACKING						B - ACTIVE REVEGETATION TRACKING			
Jurisdiction/ Office	**Site/ Project Name**	**Date Monitored**	**Name of Data Collector(s)**	**Previous Woody/ Secondary Weed Treatments to Check On**	**New Infestations Discovered on this Visit**	**New Treatment Type Needed**	**Rough Estimate of Acres of Needed Treatment**	**Level of Infestation Within New Treatment Area (Estimated % Cover)**	**Location of New Acreage to be Treated, (including GPS coordinates of approx center point)**	**Previous Revegetation Treatments to Check On**	**Current Status of Active Reveg Plant Species**	**Current Status of Caging/ Fencing/ Herbivory**	**Follow Up Watering/ Weeding Needed?**
Main Office	Restoration Site 1	7/5/2013	Joe Smith	**Russian knapweed treatment in southwest corner of site at X GPS coordinates**		Continued Russian knapweed treatment	1.5 acres	25%	Same location as previous	**Broadcast seed mix of alkali sacaton, western wheatgrass, and 4wing saltbush across 2 acres in 2012**	Approximately half of the area seeded (1 acre) has germinated. Appears to be mostly alkali sacaton.	No protection installed, no herbivory observed	No
Main Office	Restoration Site 1	7/5/2013	Joe Smith	**Russian knapweed treatment in southeast corner of site along property line at X GPS coordinates**		Continued Russian knapweed treatment	0.25	50%	Same location as previous	**Whip planting of 150 coyote willows across 2 acres in 2012**	75 poles remaining alive out of original 150 – look healthy	Cages all look in good shape, no herbivory	No
Main Office	Restoration Site 1	7/5/2013	Joe Smith	**Tamarisk cut stump and resprout treatment throughout site**		Continued tamarisk resprout treatment	0.5 acres	75%	Northwest corner of site; center point GPS coordinates = 707604.29 m E 4327726.55 m N	**Planting of 20 shrub X and 20 Shrub Y across 2 acres in 2012**	5 of original 20 Shrub X are alive and healthy; 15 of original 20 Shrub Y are alive but mixed vigor	Cages in poor shape and all need to be replaced, signs of herbivory on Shrub Y	Shrub Y could use watering; both shrub species becoming overgrown by adjacent grasses - need weeding
Main Office	Restoration Site 1	7/5/2013	Joe Smith	NA	Whitetop infestation	New whitetop treatment	0.5 acres	25%	Northwest corner of site; center point GPS coordinates = 709001.29 m E 4327726.55 m N				

Rapid Monitoring Data Tracking Page 2 (Example Spreadsheet)

				C - CURRENT ESTIMATED VEGETATION/GROUND COVER DATA AND PROGRESS TRACKING						D - ADDITIONAL INFORMATION COLLECTED			
Jurisdiction/ Office	Site/ Project Name	Date Monitored	Name of Data Collector(s)	What is Total % Cover of Woody Invasive Species of Concern?	What is Total % Cover of Secondary Invasive Species of Concern?	What is Total % Cover of Native/Desirable Plant Species?	What is Total % Cover of All Other Undesirable/Non-native Plant Species?	What % of Site is Unvegetated/Bare Ground?	Related Notes/ Observations	Wildlife Usage/ Herbivory and Signs of Presence	Biocontrol Beetle Present? Signs of Defoliation?	Any Natural/Passive Revegetation Observations?	Other Notes/ Concerns
Main Office	Restoration Site 1	7/5/2013	Joe Smith	10%	40%	10%	40%	40%	"Native/Desirable Plant Species" comprised mostly of alkali sacaton, sagebrush, and greasewood	Beaver present	Yes, most trees show some sign of defoliation; brown leaves, saw beetles	Saltgrass moving into site across western property line	Potential yellowstar thistle plant sighted; contacted County Weed Manager to investigate
Main Office	Restoration Site 1	7/5/2013	Joe Smith										
Main Office	Restoration Site 1	7/5/2013	Joe Smith										
Main Office	Restoration Site 1	7/5/2013	Joe Smith										

Rapid Monitoring Part 2 - Photo Points (Example Spreadsheet)

*Note: See **Monitoring Protocol Methodology** for determining best location for photo points, and datum preference. There are many ways to track photo information digitally, this datasheet may not be needed if you can track this information in another way.*

Date: 7/5/13

Site/Project Name: Restoration Site 1

Establish a minimum of three photo points.

1) DATUM: UTM NAD-83 EASTING: 711916.20 NORTHING: 4326719.94 GPS ACCURACY: 2 meters
DATE: 3/29/13 TIME: 16:30 BEARING (center): 180
PHOTOGRAPHER: Joe Smith
PHOTO NUMBER: 08768
NOTES: Large patch of kochia in foreground; small saltgrass patch obscured

2) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

3) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

4) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

5) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

6) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

7) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

8) DATUM: _____ EASTING: _____ NORTHING: _____ GPS ACCURACY: _____
DATE: _____ TIME: _____ BEARING (center): _____
PHOTOGRAPHER: _____
PHOTO NUMBER: _____
NOTES: _____

General Water Quantity and Quality Site Information (Example Spreadsheet)

WATER QUANTITY: Any plant species seeded/planted on site will require water to establish and grow. Different plant species have different tolerances for water availability. Water can generally come from three sources: (1) Naturally from above (precipitation), (2) Artificially from above (irrigation), or (3) Naturally from below (groundwater). Knowing the information below will help determine which plant species will grow on this site.

WATER QUALITY: If natural groundwater or surface water on site contains elevated levels of contaminants, nutrients, minerals, or suspended solids this could negatively affect site restoration efforts. For example, if groundwater is highly saline, planting willows or cottonwoods on this site may not be possible. Conversely, if the river water you plan to irrigate with is highly saline or contains a lot of sediment, this could negatively impact plantings, and will require a plan for settling out sediments if using a sensitive irrigation system. If irrigation ditches will be used on site, they should be investigated to ensure that they are not going to be a significant source of weed seed. If concerned, investigate upstream/upslope/adjacent properties for history of contamination. Water temperature may also be a concern if restoring for certain fish species (for example) is a management goal for site.

				WATER QUANTITY/AVAILABILITY INFORMATION & ASSOCIATED LOGISTICS					WATER QUALITY CONCERNS	
Jurisdiction/ Office	**Site/Project Name**	**Information Compiled By**	**Year this Information Compiled**	**Average Precipitation for Area/Region**	**Depth to Water Table (at lowest and highest time of year; reference groundwater spreadsheet to track info)**	**Is there overbank flooding on site, at least periodically?**	**Supplemental Watering Options PART A - Can water from nearby river/stream/lake/ irrigation ditch legally and safely be used for irrigation purposes (e.g. for bucket watering, sprinkler system, etc)**	**Supplemental Watering Options PART B - If answer to PART A is 'No', can water be brought to site in another way (e.g. trucked in for hand watering, piped onto site, etc)?**	**Are there water quality concerns on site? If so, can they be resolved?**	**Are there water quality concerns upstream, upslope, or on adjacent properties that may affect your restoration success? If so, can they be resolved?**
Main Office	**Restoration Site 1**	Joe Smith	2013	8"	4-6'	No	No	Yes, watering truck available	No	No

Groundwater Data Collection (Example Spreadsheet)

GROUNDWATER DATA: Collection of groundwater data (ideally at least one year prior to planting) can be helpful in determining whether it is appropriate to plant species that will be solely dependent on groundwater for survival on this site, and if so, the best locations on the site to do this. Groundwater data may also be useful in preparation for use of certain herbicides that may have groundwater table depth restrictions for use.

I. Table 1. Groundwater Monitoring Well Installation

Jurisdiction/Office	Site/Project Name	Name of Data Collector(s) and Others Present for Well Installation	Name of Well/ Well Number	Date Installed	GPS Coordinates of Well	Is Location of Well Clearly Marked to Help in Locating It? (if so, how?) Otherwise provide description of how to find.	Describe Soil Profile/Layers (if possible and if desired/required)	Details of Well Installation (if desired to track) - (e.g. length of pipe used, machinery used, materials backfilled with, screen/filter type used, any problems encountered, etc)
Main Office	**Restoration Site 1**	Joe Smith (Supervisor); John Brown (Installer/Engineer); Jeff White (drilling contractor)	Well #1	3/28/2013	707604.29 m E 4327726.55 m N	Yes; capped and flagged	Primarily cobbles/large gravel	12' PVC40 used; no screen, difficult to use auger; backfiled with sand
Main Office	**Restoration Site 1**	Joe Smith (Supervisor); John Brown (Installer/Engineer); Jeff White (drilling contractor)	Well #2	3/28/2013	707604.29 m E 4327726.55 m N	Yes; capped and flagged	Primarily cobbles/large gravel	12' PVC40 used; no screen, difficult to use auger; backfiled with sand
Main Office	**Restoration Site 1**	Joe Smith (Supervisor); John Brown (Installer/Engineer); Jeff White (drilling contractor)	Well #3	3/28/2013	707604.29 m E 4327726.55 m N	Yes; capped and flagged	Primarily cobbles/large gravel	12' PVC40 used; no screen, difficult to use auger; backfiled with sand

II. Table 2. Groundwater Table Depth Tracking

				DEPTH TO GROUNDWATER		
Jurisdiction/Office	Site/Project Name	Name of Data Collector(s)	Date Read	Well 1	Well 2	Well 3
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	8.5 feet	7.5 feet	4.3 feet
Main Office	**Restoration Site 1**	Joe Smith	4/28/2013	6.2 feet	6.1 feet	3.0 feet
Main Office	**Restoration Site 1**	Joe Smith	5/28/2013	5.8 feet	5.7 feet	2.9 feet

Site Soils Data Collection (Example Spreadsheet)

SOILS: Plant species typically have a tolerance range for the three soil characteristics highlighted in yellow below (pH, texture, salinity). While there are other soil characteristics that may also be important for plant growth, knowledge of these three characteristics can go a long way towards determining which plant species will be best suited for this site. This soil information may also be useful in preparation for use of certain herbicides that may be significantly affected by soil pH or texture conditions on site.

			FIELD SOIL SAMPLE DATA COLLECTION						PLUG IN RESULTS FROM SOIL LAB ANALYSES HERE							
									Most Common Minimum Analyses to Run			Other Potentially Useful Analyses to Run				
Jurisdiction/Office	Site/Project Name	Name of Data Collector(s)	Date Soil Sample Collected	Name/ Number of Soil Pit	GPS Coordinates of Soil Pit	Dominant Vegetation near Soil Pit/Species of Note (if interested)	Soil Depth Sampled in Soil Pit	Exact Soil Sample Name/ Number Written On Bag to Send to Lab for Analyses	pH	Texture	Salinity (EC)	Sodium Adsorption Ratio (SAR)	% Organic Matter	Nitrogen (Nitrate, NO3-)	Phosphorus	Other
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 1	707604.29 m E 4327726.55 m N	sagebrush & greasewood	0-6 inches	Northwest 1A	6.2	sandy clay	8	7	0.5	50	25	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 1	707604.29 m E 4327726.55 m N	sagebrush & greasewood	6-12 inches	Northwest 1B	7	sandy clay	4	8	0.4	40	20	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 1	707604.29 m E 4327726.55 m N	sagebrush & greasewood	12-24 inches	Northwest 1C	6	sandy clay	4	7	0.4	30	20	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 2	707704.29 m E 4327826.55 m N	western wheatgrass	0-6 inches	Northwest 2A	7	sandy loam	4	7	0.4	50	30	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 2	707704.29 m E 4327826.55 m N	western wheatgrass	6-12 inches	Northwest 2B	8	sandy clay	5	8	0.5	50	30	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 2	707704.29 m E 4327826.55 m N	western wheatgrass	12-24 inches	Northwest 2C	6	sandy clay	4	8	0.4	50	30	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 3	707804.29 m E 4327926.55 m N	smooth brome	0-6 inches	Northwest 3A	7	clay loam	7	7	1	30	20	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 3	707804.29 m E 4327926.55 m N	smooth brome	6-12 inches	Northwest 3B	8	clay loam	4	6	0.4	30	20	
Main Office	**Restoration Site 1**	Joe Smith	3/28/2013	Northwest 3	707804.29 m E 4327926.55 m N	smooth brome	12-24 inches	Northwest 3C	6	clay loam	4	7	1	30	20	

Appendix B

Guidesheets and Packets

I. Guidesheet for Estimating Vegetation Percent Cover and Area

II. Guidesheet for Tracking Progress

III. Guide Sheet for Groundwater Well Installation & Monitoring

IV. Soil Sampling Packet
- Guidesheet for Collecting Soil Samples
- Soil Sampling Cost Estimate Sheet
- Colorado Soils Testing Locations

Guide Sheet for Estimating Vegetation Percent Cover and Area

Estimating Area (in Acres)

GPS-Enabled Device. One method for estimating the size of (for example) an invasive species infestation or revegetation area (besides just eyeballing it) is to use a GPS unit or similarly equipped device and walk the perimeter of the infested area. Most of these devices/ accompanying software can easily calculate the area that you walked. For very large infestations (for example), it can be helpful to walk the weed population perimeter once prior to mapping so that you have a clear understanding of where the infestation perimeter is, OR have a partner walk ahead of you and find the perimeter for you so that you don't miss portions of the infestation. It is helpful to practice using your GPS device by mapping a known area before going to the field. Downsides to this method: If you don't walk slowly enough with the GPS unit so that it has time to 'update' as you move, you can miss 'corners'/sections of the population; also in narrow canyons GPS readings may not be entirely accurate.

Pacing. Another method is to estimate the area by pacing it off. Prior to going to the field, practice walking a 50 foot length of measuring tape (for example) and determine the average number of steps it takes for you to walk 50 feet (this is probably a good idea to do anyway, in case you find yourself without a working GPS one day). Practice walking 50 feet up an incline, down a decline, and on flat ground to get a good sense of the variability you can get from walking on different types of terrain, and figure out the best method for you to keep your strides/steps consistent in varied terrain. Once you have a good sense of how many of your steps equals 50 feet, you can use this method to estimate the area of a weed infestation or revegetation area in the field.

Estimating Percent Vegetation Cover (Ocular Estimates)

Estimating vegetation cover on a site is not an exact science, and there can be significant variability between the estimates of two different observers for the same piece of ground. However, for the purposes of this effort, it is recognized that sometimes land managers/owners simply do not have time to conduct full-scale monitoring efforts on a given site, and are lucky if they even have time to visit a site and make an 'eyeball' estimate of the vegetation cover each year. The following assumes that the reader is one of these land managers/owners.

A. PREPARING TO COLLECT VEGETATION DATA VIA OCULAR ESTIMATE

1. **Establish the vegetation cover goals for each plant species/plant grouping of interest (e.g. Goal = Total Vegetation Cover of Native/Desirable plants should be ≥ 60%)**

   An example of what a set of vegetation cover goals might look like:

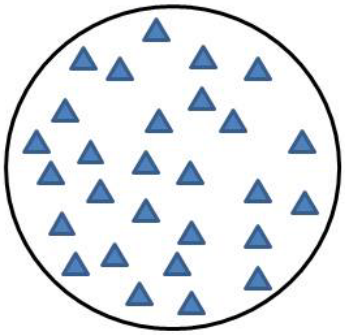
   - Goal for Woody Invasives of Concern: ≤ 10% Total Vegetation Cover
   - Goal for Secondary Invasives of Concern: ≤ 10% Total Vegetation Cover
   - Goal for Native/Desirable Plant Species: ≥ 60% Total Vegetation Cover
   - Goal for All Other Undesirable/Non-native Plant Species: ≤ 20% Total Vegetation Cover
   - Goal for % of Site Unvegetated/Bare Ground: ≤ 70% Bare Ground (will depend greatly on local environment)

2. **(tied to #1) Decide whether you want to collect TOTAL (ACTUAL) vegetation cover data, or RELATIVE vegetation cover data for each plant grouping. If collecting TOTAL vegetation cover data, you can just focus on the plant groups of interest and not worry about the other groups. If collecting RELATIVE vegetation cover data, then you need to be thinking about all plant groups present on the site and the relative percent cover of each group present.**

   TOTAL (ACTUAL) vegetation cover is the actual percentage of the site that is covered by a given species or plant grouping. RELATIVE vegetation cover is the percentage *of all the vegetation cover present on site* that is made up of a given species or plant grouping (see examples below).

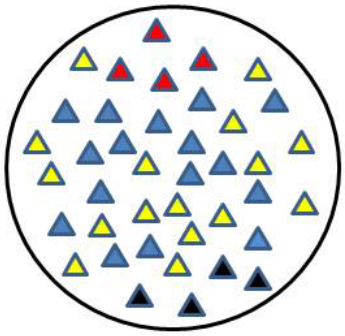
   Whether you ultimately want TOTAL vegetation cover values or RELATIVE vegetation cover values is dependent on what your goals are for your site. <u>It should be noted that if you decide you ultimately want RELATIVE cover data, it may be easier to first collect TOTAL cover data, then convert it to RELATIVE cover data, as it can be difficult to directly collect RELATIVE cover data in the field on sites that are large and/or have an overstory layer (but note that you can't really convert Cover Class data).</u>

TOTAL (ACTUAL) % Cover



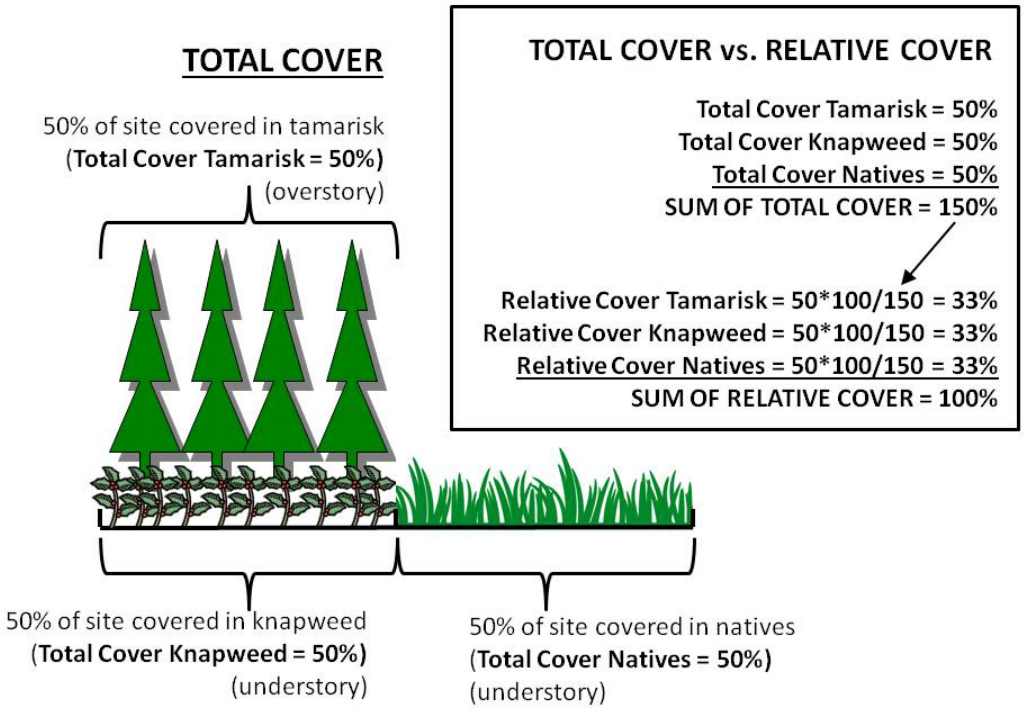
(Example)
Single knapweed
infestation covering ~25%
of the site
(Total Cover = 25%)

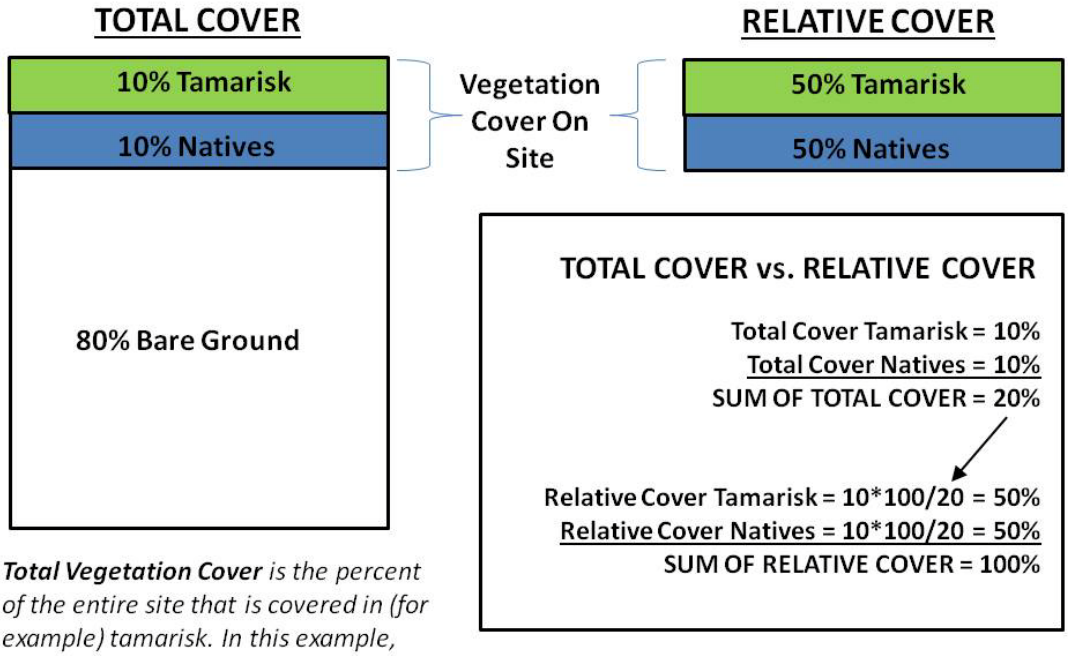
RELATIVE % Cover



(Example)
Of all the vegetation cover present on site:

- ~10% of it is made up of Woody Invasive Species of Concern
- ~10% of it is Secondary Invasive Species of Concern
- ~40 % is made up of Native/Desirable Species
- ~40% of it is made up of All Other Undesirable/Nonnative Species





Total Vegetation Cover *is the percent of the entire site that is covered in (for example) tamarisk. In this example, 10% of the site is covered in tamarisk so Total Cover for Tamarisk is 10%.*

Relative Vegetation Cover *only looks at the vegetation component of the site, and calculates relative proportions of (for example) tamarisk versus natives cover. In this example, the conversion of Total Cover to Relative Cover results in Relative Cover Tamarisk of 50%.*

3. **(tied to #1) Decide whether you want to collect vegetation cover data using Actual Percentages (e.g. 10% cover tamarisk) or Cover Classes (e.g. 5-25% cover tamarisk)**

Keep in mind that ocular estimation ('eyeballing') of percent vegetation cover is a very inexact science and it is impossible for the human eye to tell the difference between (for example) 32% cover and 33% cover in the field. As such, it is helpful to either estimate percent vegetation cover more roughly (e.g. by 5's or 10's or 25's), or use Cover Classes such as (<5%, 5-25%, 26-50%, 50-75%, >75%). See what you feel most comfortable with, and then adjust your vegetation goals accordingly (if necessary) to fit how you will be collecting data. Because ocular estimation at the site scale is so incredibly coarse, the best method for estimating percent vegetation cover across the site might be to use the following Cover Classes (<5%, 5-25%, 26-50%, >50%*). It just depends on what you feel comfortable with. The below provides an example of what this might look like to convert the original suggested goals into Cover Classes:

- Goal for Woody Invasives of Concern: ≤ 10% Total Vegetation Cover (or Cover Class 5-25%)
- Goal for Secondary Invasives of Concern: ≤ 10% Total Vegetation Cover (or Cover Class 5-25%)
- Goal for Native/Desirable Plant Species: ≥ 60% Total Vegetation Cover (or Cover Class > 50%)
- Goal for All Other Undesirable/Non-native Plant Species: ≤ 20% Total Vegetation Cover (or Cover Class 5-25%)
- Goal for % of Site Unvegetated/Bare Ground: ≤ 70% Bare Ground

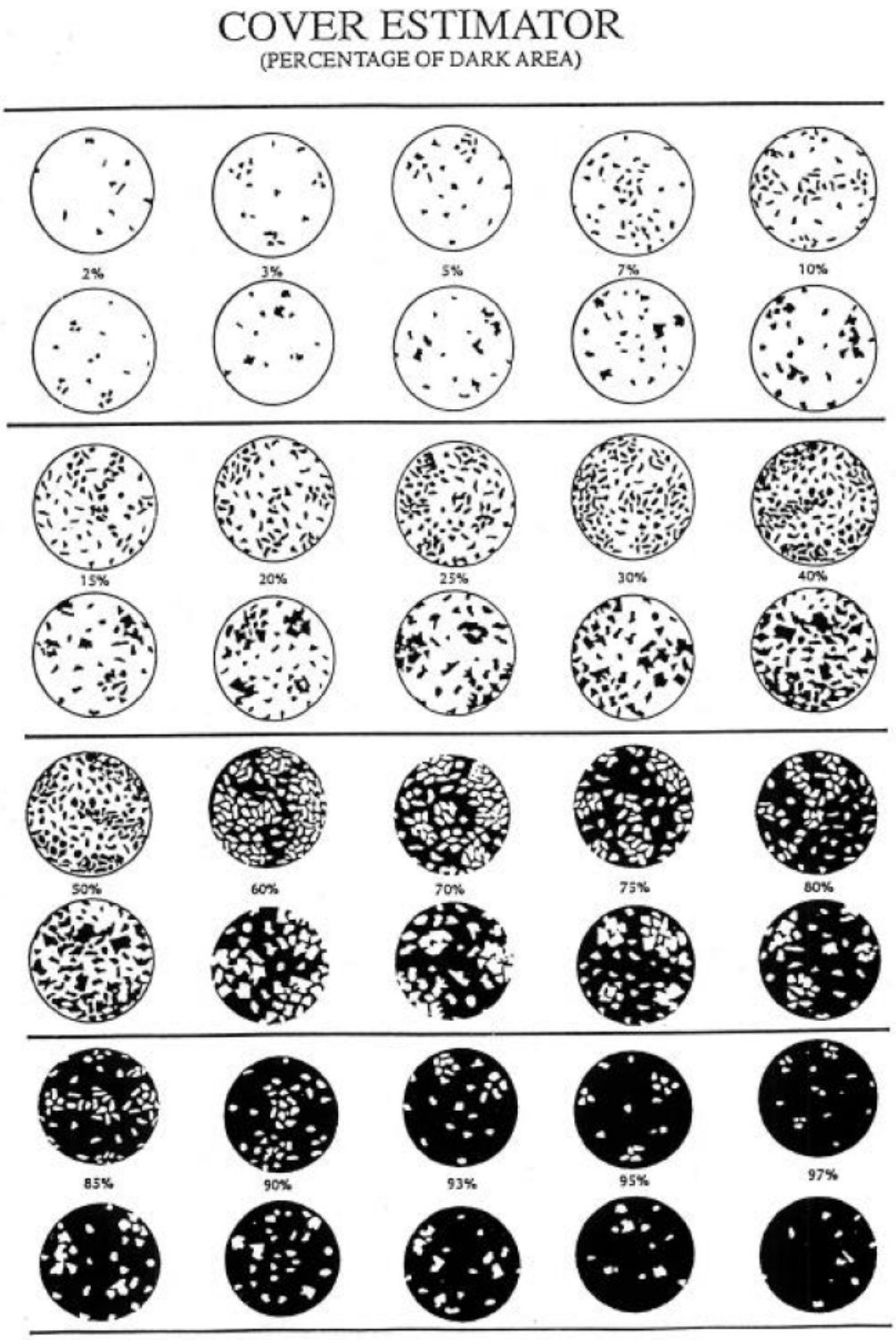
**These Cover Class categories are based on Daubenmire vegetation monitoring categories. It can be difficult for the human eye to differentiate between say 65% and 80% when estimating cover on a large scale (e.g. outside of a Daubenmire frame), hence the suggestion to just use a >50% category.*

4. **If grouping plant species into categories such as 'Native/Desirable Plants', make a list of the plant species you are likely to come across, and categorize each species according to the plant group they belong in (e.g. western wheatgrass = native/desirable plant)**

   If the land manager/owner is conducting this vegetation cover estimation (and not asking a separate crew to do this), then you may already have this list 'in your head' and there may be no need to physically write this down, unless other parties will need to know which species you placed in which groupings.

5. **Practice training your eyes to see vegetation cover in percentages.**

   Review the images on pages 7-8 to get an idea of what different vegetation cover percentages might look like in the field. When you get to the field - if the site is small enough – you may want to walk the site once first to get a feel for it, then walk it again and estimate the vegetation cover on this second round (this may be particularly critical if you are attempting to estimate Relative Cover directly in the field).



http://animalscience.ucdavis.edu/extension/Factsheets/RangelandResources/pdfs/Veg_Cover_Monitoring2.PDF

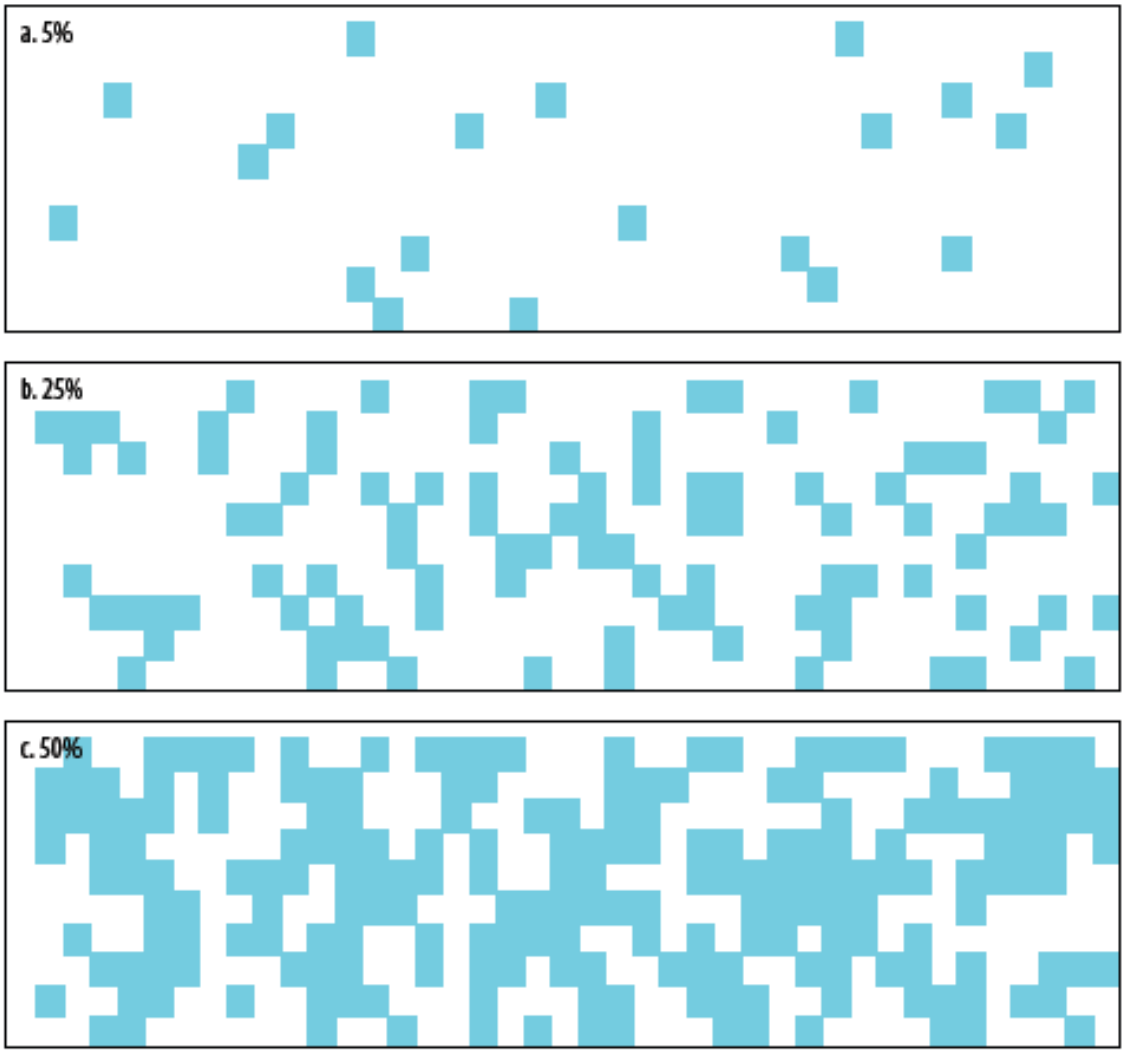


Figure 7. Shaded areas represent percent cover.

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/299360/Guidelines-for-monitoring-weed-control-and-recovery-of-native-vegetation.pdf

Guide Sheet For Tracking Progress – Establishing Simple Goals to Track Progress & Evaluate Restoration Success (An Example)

INTRODUCTION

There are many different goals that a land owner/manager may have for a restoration site, and many different ways that these goals can be evaluated and used to determine when a site has reached a satisfactory level of restoration 'success'. At a minimum, however, most land managers/owners typically have the following overarching restoration goals:

1. Reduce noxious weeds of concern
2. Increase native/desirable plant species
3. Decrease the amount of bare ground on a site (if extensive and unnatural)*

**Note: There are obviously many other important restoration goals such as increasing wildlife habitat, reducing streambank erosion, etc. These are not addressed specifically here, but they could easily be incorporated into this framework.*

The utility of establishing clear restoration goals for a site is that they provide something tangible to aim for, and they can be a great way to demonstrate progress/success to funders, supervisors, and others. Restoration is a very inexact science and it can often be difficult to extract tangible 'successes' in the face of the many challenges present on a typical restoration site.

It is important to clarify, however, that once a site has reached its minimum established goals, it is assumed that the land manager/owner will not consider themselves 'done' with the site. The site should still be periodically monitored to ensure that it continues to meet the minimum established goals and does not slide backwards (thus protecting the usually significant financial restoration investment). Some minimal management activities (e.g. herbicide spraying for noxious weeds) may still need to be conducted periodically during this window. This 'Monitoring and Maintenance Phase' should last approximately 5-10 years (or longer) and should be budgeted and planned for at the beginning of a project.

EXAMPLE OF ESTABLISHING SIMPLE GOALS FOR DETERMINING RESTORATION SUCCESS

The following goals were established (short-term land manager/owner goals) for this example site. The site will have reached an 'acceptable level of restoration success' once *at least the first three* goals are met:

1. **WOODY INVASIVE SPECIES OF CONCERN: Total Vegetation Cover of Woody Invasive Species of Concern*** (e.g. tamarisk) **will be ≤ 10%.** **The particular invasive species of concern selected will likely vary by land manager/owner.*

2. **SECONDARY INVASIVE SPECIES OF CONCERN: Total Vegetation Cover of Secondary Invasive Species of Concern***(e.g. knapweed, whitetop) **will be ≤ 10%**. **The particular invasive species of concern selected will likely vary by land manager/owner.*

3. **NATIVE/DESIRABLE PLANT SPECIES: Total Vegetation Cover of Native/Desirable Plant Species*** (e.g. native or exotic grasses considered desirable by land manager/owner) **will be ≥ 60%.** **Vegetation considered desirable will likely vary by land manager/owner.*

4. **ALL OTHER UNDESIRABLE/NON-NATIVE PLANT SPECIES: Total Vegetation Cover of All Other Undesirable/Non-native Plant Species will be ≤ 20%.** This category consists of low priority undesirable (usually exotic) plant species that are considered low priority because (a) they are not considered to be particularly invasive and/or (b) they are present in low enough amounts that based on the current health of the site they are not believed to present a significant threat to the continued long-term passive restoration of the site (e.g. certain mustard species, dandelions). This category may also include woody/secondary invasives not considered to be 'species of concern' for this site.

   EXCEPTIONS TO THIS GOAL:

   i. The **All Other Undesirable/Non-Native Plant Species** category may exceed 20% when:
      A. Undesirable species are present that are considered 'uncontrollable' at this time because of the overwhelming extent of invasion (e.g. some sites are overwhelmed by cheatgrass invasion), or
      B. Species that are considered undesirable by some are considered acceptable by this land owner/manager for wildlife habitat or other utility (e.g. kochia)

5. **UNVEGETATED/BARE GROUND: Goal to be established by land manager/owner since very site/region-specific goal (e.g. No more than 70% of the site will be comprised of unvegetated/bare ground).** What percent of site is unvegetated/bare ground? Is this a

natural/desirable phenomenon (e.g. flood scour), or is this of concern (e.g. large swaths of human/animal-caused bare ground that should be addressed)? Again, keep in mind that setting goals for Unvegetated/Bare Ground will be very different in a desert environment, where 60% bare ground might be acceptable, versus in a more lush environment, where a more acceptable goal for bare ground might be 30-40%.

Table 1. The following table shows the quantitative goals established for this example site.

GOALS FOR SITE ASSOCIATED WITH VEGETATION COVER				
WOODY INVASIVES OF CONCERN	**SECONDARY INVASIVES OF CONCERN**	**NATIVE/ DESIRABLE PLANT SPECIES**	**ALL OTHER UNDESIRABLE/ NON-NATIVE PLANT SPECIES**	**UNVEGETATED/ BARE GROUND**
GOAL: Less than or equal to 10% Total Vegetation Cover	**GOAL: Less than or equal to 10% Total Vegetation Cover**	**GOAL: Greater than or equal to 60% Total Vegetation Cover**	**GOAL: Less than or equal to 20% Total Vegetation Cover**	**GOAL: Variable and very site/ region dependent**

Guide Sheet for Groundwater Well Installation & Monitoring

While much can be garnered about the restoration potential of a site through observation and understanding of local hydrology, collection of groundwater data can be helpful in determining whether it is appropriate to plant species that will be solely dependent on groundwater for survival on your site, and if so, at what depth you may want to plant these species; water quality information that may affect plant growth, can also be obtained. Groundwater data may also be useful in preparation for use of certain herbicides that may have groundwater table depth restrictions for use.

How do I Install a Groundwater Monitoring Well?

While monitoring wells can vary in complexity and cost, a basic well is usually sufficient for restoration site assessment purposes. Monitoring can be achieved through the simple installation of a perforated PVC pipe in a hole dug into the water table.

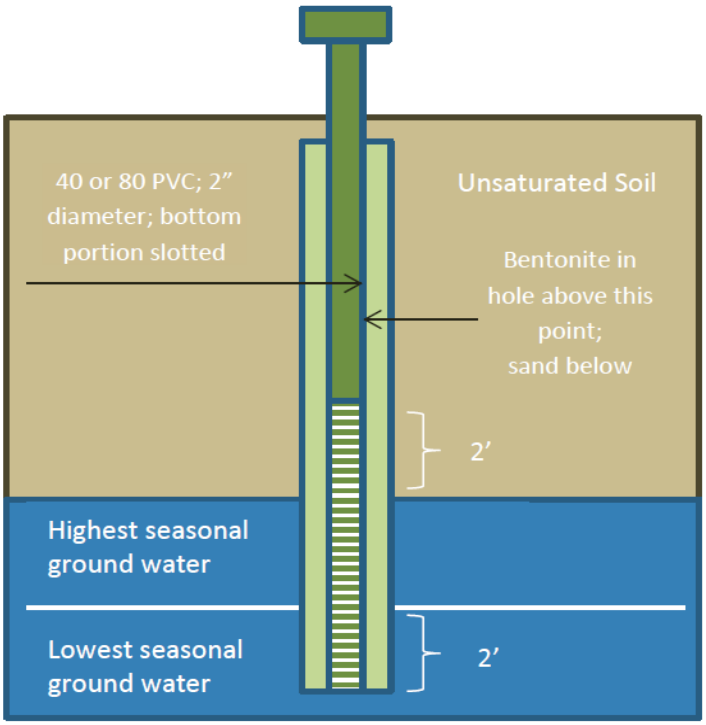
Depending on your soil type and your access to equipment, a number of tools can be used to install a well. Augers, push tools (such as a "stinger" bar), and back hoes may be useful. If you do not have access to any machinery, a hand auger or post-hole tool can suffice. If you are interested in recording the lithology and soil moisture content of the borehole, an auger should be utilized.

Monitoring Well Supply List

- 12' length of 40 or 80 PVC, 2" diameter
- PVC end caps, 2 per well
- Sorted medium-fine sand
- Hack saw with standard blade
- Tape measure
- Chalk
- Sharpie
- Notebook, pen
- Camera
- GPS
- Optional – filter fabric and knife

Approximate Cost ~$50 per well

If using an auger, it is important to drill slowly in order to assess moisture levels within the soil profile. If soil cuttings appear very moist or have a sheen-like quality, you have likely reached the capillary fringe. When soil begins to drip water, you have hit the water table. If a stinger tool is being utilized, push into the ground until you can observe water on the tip of the tool. If possible, it is best to continue drilling or pushing 2-4' into the water table before installing your well casing.



Groundwater well example; total length and distance between highest and lowest seasonal ground water will vary by site.

A simple monitoring well can easily be constructed from 2" diameter standard schedule 40 or 80 PVC pipe, available from most hardware stores. The bottom section of the pipe should be long enough to reach the bottom of the groundwater at its estimated lowest point, plus an additional 2-3'. The bottom portion of the pipe, extending approximately 2' above the seasonal low water table, will need to be slotted to allow for water flow. A hacksaw can be used to install the slots. The bottom of the pipe should be capped.

If your well is being installed in a location with very silty/fine soils, you may want to wrap the PVC in filter fabric to ensure that these fines do not get into the well.

In order to set the well, the use of sand (play sand) and bentonite are recommended. Sand should be packed 1-2' above the top of the slotted portion of the PVC. Bentonite chips or pellets should subsequently be poured to within 2' of the surface of the well. Three-five gallons of water will suffice in rehydrating the bentonite.

Depending on your site, you may want to leave a few feet of PVC extending above the ground surface, to aid in re-locating the well. In other areas, you may want to minimize the exposure of the well; in these instances a flush cut may be appropriate. In both instances, you will want to cap your well. In some cases, you may want to invest in a locking cap to reduce the potential of vandalism.

Remember to clearly mark your well locations; GPS points can be especially helpful in relocating wells for future monitoring. Well location information, along with well installation data, including soil profile descriptions, can be recorded in Table 1 of the Optional Groundwater Data Collection Spreadsheet.

When and Where to Install Groundwater Monitoring Wells

In some locations, groundwater monitoring wells may already exist in the vicinity of your restoration project. If you would like to check well status in a particular location, the Colorado Division of Water Resources maintains a database of permitted wells within the State of Colorado (http://water.state.co.us).

If you are establishing new wells on your site, one well per 2-3 acres is generally sufficient. It is advisable to establish a series of wells perpendicular to the river channel (e.g. every 10 to 50 feet) in order to provide a picture of how the water table changes in relation to the river/stream. If you are planning revegetation on upper terraces, be sure to install a well at this location also.

Select well sites based on the existing or historical distribution of vegetation on the site. If you are interested in replacing tamarisk with a native phreatophyte, for example, consider the zone in which you are planning active revegetation.

In order to assure your well is installed at the appropriate depth, it is best to install wells when the water table is at its lowest during the year. In Colorado, late fall is often a good time to install wells. Early spring, prior to spring runoff, may also be an appropriate time to install wells.

Permitting Requirements

The State of Colorado requires all permanent wells to be permitted with the Colorado Division of Water Resources. Each well permit currently costs $100.

For more information, please contact the Colorado Division of Water Resources (http://water.state.co.us/groundwater/wellpermit/Pages/default).

How to Monitor your Monitoring Wells

A number of tools can be used to obtain well data. Automated measuring systems, such as a Hyrdolab or Troll 9000, can record continual, real time measurements, including water depth and chemistry information. Flat tape water level meters, such as those manufactured by Solinst, can be used to electronically measure water depths.

The most inexpensive way to monitor groundwater depth is to use a stiff measuring tape marked with chalk. Groundwater depth can be obtained by recording the length of the tape above the wetted portion of the tape (where the chalk has been washed away) minus the height of the PVC aboveground.

If possible, it's best to gather groundwater level data before, during, and after restoration activities on your site. During the growing season, it is useful to gather data on a monthly basis.

While it would be ideal to collect data for several years on a site prior to planting, the minimum recommended time frame is one year pre-planting. For example, if you know that you have restoration work planned for the fall of 2014, a monitoring well should be installed in the fall of 2013.

Table 2 on the Groundwater Data Collection Sheet can be used to record depth to groundwater data.

For More Information

For more detailed information on the installation and use of groundwater monitoring wells, the following document provides useful information:

Groundwater Monitoring Well Drilling, Construction, and Decommissioning: State of Oregon Department of Environmental Quality (DEQ) Guidance Document: http://www.deq.state.or.us/lq/pubs/docs/tanks/GroundwaterMonitoringWellDrilling.pdf.

Guide Sheet for Collecting Soil Samples

The following provides an overview and some suggestions for why, when, where, and how one might collect soil samples on a restoration site.

Equipment Needed

- GPS and extra batteries
- 2 black permanent markers (Sharpies)
- Good hand trowel
- Good soil pit digging shovel
- Tape measure
- 1 box sanitary latex-free gloves or similar
- Good quality, 'freezer-weight', gallon size Ziploc bags
- Clipboard, pencil/pen
- (Optional) Ice chest with ice

Why To Collect Soil Samples

While there are many reasons to sample soils, it is assumed here that soil sampling would be conducted to (1) help determine whether the soils on a restoration site will even support active revegetation plantings, and/or (2) help determine the best species for planting given the current soil conditions. For many land managers/owners, it may already be clear the species that will grow well on a given site based on plants already growing in the immediate area, and no soil sampling may be needed. But if, for example, a restoration site is comprised of areas of bare ground (either historically bare or newly bare) and it is unclear what type of vegetation this area might support, then soil sampling may be useful.

When To Collect Soil Samples

Any time of year is acceptable to collect soils. However, it is generally ideal to collect soils when they are thawed and dry to avoid digging in frozen ground or collecting soaking wet soil samples. Not only are wet soils messy to collect, but soil samples typically need to be completely dry before they are analyzed (and soils lab may charge a fee for soil drying). It is also much more critical to keep wetter soils cool between time of collection and time of analyses (depending on what they are being analyzed for), because wet soils stored in sealed bags at warm temperatures create the perfect environment for chemical reactions to take place in the soil and change the soil chemistry from what it was at the time of collection.

Fall can be a good time of year to collect soils because soils are typically drier (depending on the site) but not frozen, and the air temperature is cooler, which makes it easier to keep collected soils cool while transporting (instead of lugging around an ice chest). Keep in mind that even in the dry months, many soil samples may still have residual soil moisture, so this is an important

consideration. It may be, however, that the most important consideration for when soils should be collected will be how soon the information is needed. If on a tight timetable, consult with the selected soils laboratory immediately to determine their typical turnaround time and slow/busy times of year. This more than anything may drive the timing of soil sample collection.

Where To Collect Soil Samples

The following provides suggestions on *where* to dig soil pits for collecting samples.

I. Location of Soil Pits: Determine the areas where active revegetation is desired. Dig soil pits spread out across these areas.

II. Depth of Soil Pits: If it is known the *types* of plant material that will be planted in this area (e.g. grasses/forbs versus shrubs/trees), this can help guide how deep to sample the soils. If you generally plan on seeding/planting shallower rooted plants like forbs and certain grasses, then you may not need to sample very deep (e.g. top 1-2 feet). But if you are hoping to deep plant shrubs (for example), then sampling deeper will be useful. Below are some examples of depths to collect samples from in a given soil pit (a separate sample would be collected at each depth):

Ideal Exploratory Soil Sampling	**Basic Shallow Soil Sampling if You Suspect Salinity or Other Issue Near Surface**	**Basic Shallow Soil Sampling if You Do Not Suspect Salinity or Other Issue Near Surface**	**Basic Deep Sampling**
• 0-6 inches • 6-12 inches • 12-24 inches • 24-36 inches • Deeper if needed	• 0-6 inches • 6-12 inches • 12-24 inches	• 0-12 inches • 12-24 inches	• 0-12 inches • 12-24 inches • 24-36 inches • Deeper if needed

Tip: Don't waste money sampling deep if no trees/shrubs/deep-rooting grasses will be planted.

III. Quantity of Soil Pits: This is the hardest decision, and usually directly correlated with size of soil sampling budget. If there is very little funding for soil sampling, perhaps sample a minimum of 3 soil pits spread across the potential planting area if area appears relatively uniform. If the area does not appear uniform, perhaps sample a minimum of 9 soil pits spread across the potential planting area (but understand that more is better). Some sources suggest collecting samples from multiple pits and then combining them to create one single 'bulk' sample for analyses. This bulk method allows for more samples to be collected and thus a better characterization of the 'average' conditions of the site is gained, but critical information about the *range* of soil conditions is lost by doing this, and is not recommended here.

How To Collect Soil Samples

The following provides suggestions on *how* to collect soil samples.

I. Preparation to Collect Sample

1. Find spot to dig first soil pit
2. Record name of collector, date, unique soil pit name/number, and GPS Coordinates (and datum) of soil pit on datasheet (See Optional Soils Data Collection Datasheet)
3. Record dominant vegetation/other plant species of interest in area if desired (might be helpful in determining appropriate planting species later)
4. Dig to first sampling depth (e.g. 0-6 inches).
5. Use hand trowel to clean/shear off side of soil pit to make a relatively smooth surface perpendicular to ground surface
6. Remove all litter (leaves, needles, etc) at surface in the spot where you will be sampling (this step only necessary for collecting soil sample near surface – e.g. 0-6 inches)

II. Collecting the Sample

7. Label soil collection bag with date, unique soil pit name/number, and soil sample depth.
8. Put on sanitary gloves (don't need new gloves for each sample). Use hand trowel to shear off enough soil from this depth of interest to fill bag. Collect an even amount from entire range of depth (e.g. don't collect more soil from 0-2 inches than from 3-6 inches).
9. Mix up the soil in the bag so well mixed
10. Check datasheet to make sure information on bag and datasheet match up

REPEAT ABOVE PROCESS FOR ADDITIONAL DEPTHS. FILL HOLE WHEN DONE.

III. Transporting and Processing the Samples

11. Samples should stay cool from time of collection until they are dried or sent to the soils laboratory. If air temperature is hot, use ice chest to keep soils cool.
12. Ask soils laboratory if they charge for drying soils prior to analyses. If so, soils can be dried in-house to save money. Buy some large sized art paper or similar and spread out each soil on a piece of this paper in a clean, dry area where soils will not be disturbed. Write name of each sample on each piece of paper (Warning: Do not just set bag near piece of paper as your label – bags are easily moved/blown around!). Turn bags inside out so they dry also. Use fan on low to move air and dry soils more quickly. Stir soils occasionally to help with drying process. Then re-bag soils and send to lab.
13. Minimum recommended soils analyses at lab = pH, EC, texture

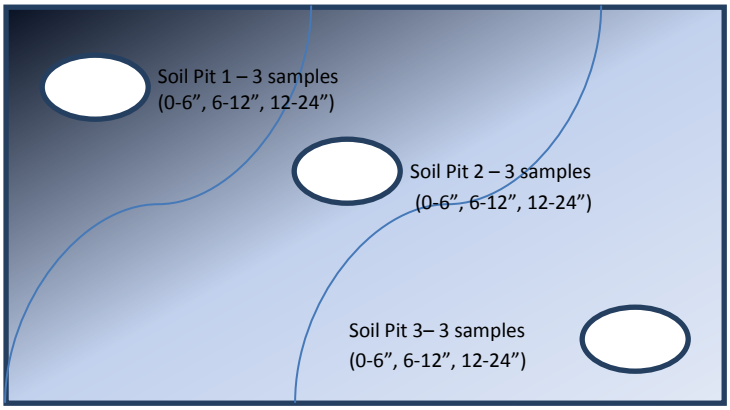
Soil Sampling Analysis Cost Estimate Sheet

The soil sampling analysis cost example provided is based on fees at Colorado State University's Soil, Water, and Plant Testing Laboratory (see "*Selecting an Analytical Laboratory*" for contact information).

Analysis Requested	Cost per Sample	
pH, EC, texture	$17.5	*10% discount for > than 25 samples*
Routine soil test*	$31	
Routine + SAR	$38	
*****Routine soil test includes: pH, EC, organic matter, nitrate, phosphorus, potassium, zinc, iron, copper, manganese, boron and lime & texture estimates - CSU Lab does not charge for soil drying-		

Sample Site Example:

Below is an example restoration site. The color gradient represents suspected variations in soils that you would like to test prior to implementing active revegetation. A total of nine samples are collected from the site.



Analysis Requested	Cost per Sample	Total for Example Site
pH, EC, texture	$17.5 *9	$157.5
Routine soil test*	$31*9	$279
Routine + SAR	$38 * 9	$342
*****Routine soil test includes: pH, EC, organic matter, nitrate, phosphorus, potassium, zinc, iron, copper, manganese, boron and lime & texture estimates		

Colorado State University
Extension

Selecting an Analytical Laboratory

Fact Sheet No. 0.520 Crop Series | Soil

by R.M. Waskom, T. Bauder, J.G. Davis and J.R. Self*

Soil and manure testing are the foundation of an economically and environmentally sound crop management program. Plant tissue analysis can be a useful method to assess crop nutrient status. In addition, rural homeowners should periodically test their well water to ensure it is safe for drinking.

There are a number of qualified laboratories in Colorado that provide these services. There also are commercially available quick test kits that are less accurate but can be used at home for testing both soil and water. Without an analysis, you may be buying unnecessary fertilizer or applying too much manure to your fields. Neither practice is sound. In some cases, a $35 soil analysis can save a crop producer thousands of dollars in unnecessary fertilizer costs.

Soil Testing

Yearly sampling of each crop field is recommended to make accurate nutrient management recommendations. Routine soil sampling also provides valuable information about soil salinity, pH and organic matter content. Obtaining a representative sample is the key to getting accurate results. For proper sampling steps, contact the analytical laboratory that will analyze your samples or see fact sheet 0.500, *Soil Sampling,* www.ext.colostate.edu.

To get a representative sample, use clean tools to collect soil cores from a variety of locations in the field. Combine 20 to 30 individual samples and mix thoroughly before transferring the soil to the sample bag. Avoid (or sample separately) any unusual areas that will bias your results. Break large fields into smaller sampling units based on crop, yield and fertilizer histories. Typically, soil is collected from the top 8 to 12 inches (plow layer) for routine analysis for fertilizer recommendations. Separate subsoil samples for nitrate analysis are suggested to determine accurate N recommendations for irrigated crops, such as corn, sugar beets and wheat.

Lawns and gardens also can be improved by soil analysis. Usually about a dozen soil cores to a depth of 4 to 6 inches are adequate for a typical urban lawn or garden sample.

Soils also can be analyzed for less common elements such as selenium or lead, as well as for organic compounds such as pesticides or hydrocarbons. Pesticide tests are expensive and not routinely recommended unless serious contamination problems are suspected. Check with an analytical laboratory concerning the submission of samples for pesticide testing. Sampling for organic compounds requires special handling.

Air dry soil samples as soon as possible by spreading them over a clean paper grocery sack (for boron analysis use plastic sheets) prior to mailing to the laboratory. Be sure to keep all samples cool until they can be air dried. For best results, deliver samples to the laboratory as soon as possible. The chemical composition of samples kept in warm, moist conditions may change substantially within just a few days and significantly alter fertilizer recommendations.

Water Testing

Public supplies have strict federal and state regulations governing water quality and testing. However, if you have a private water system, it is your responsibility to make sure your family's water is safe. Contaminated water may taste, look or smell the same as safe drinking water. Laboratory analysis is the only reliable method to determine the quality of drinking water.

If you are buying a new property or if you cannot remember when your well was

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Quick Facts

- Yearly sampling of each crop field is recommended to make accurate nutrient management recommendations.
- Lawn and garden management also can be improved by soil sampling. About a dozen soil cores are adequate for a typical urban lawn or garden sample.
- Manure testing is the best way to determine the fertilizer value of manure spread on fields or gardens.
- Annual water testing is suggested to help monitor the quality of your private water supply.

last tested, have your water analyzed by a reputable laboratory for bacteria, nitrate, sulfate, chloride, pH, total dissolved solids (TDS), hardness and conductivity to get baseline information on your well. Bacterial analysis is strongly recommended for all private water supplies, especially for a well close to septic systems or animal confinement facilities. Tests for pesticides, other organic contaminants and radon are expensive and usually not recommended unless you have reason to suspect contamination.

Annual water testing is suggested to help monitor the quality of your private water supply. If you see a decline in quality, more thorough investigation is warranted. These records will provide valuable information on the history of your well if your water is ever contaminated.

Follow your laboratory's sampling procedure when collecting water samples. Many laboratories provide clean containers with detailed instructions on sample collection. If one is not provided, use a clean plastic container. Rinse it three times with the well water before you collect the actual sample. Wash your hands prior to sampling and do not touch the inside of the container or lid. Let the water flow for about five minutes before sampling. Do not draw from an aerated faucet or a swing arm faucet. For best results, keep the sample cool and return to your lab within their recommended time frame. Do not ship samples on Thursday or Friday as they may not be delivered over the weekend or be analyzed with the appropriate time frame.

Manure Testing

Analyze manure for nitrogen, phosphorus, potassium and salt content. There are a number of qualified laboratories in Colorado that can provide these services.

Obtaining a representative manure sample can be challenging. For proper manure sampling, you need a clean bucket and sample jar. If you spread manure daily, take many small samples over a representative period. For periodic spreading from a manure pack or pile, use a clean shovel or fork to collect samples from a variety of locations in the pack or pile. Be sure to collect both manure and bedding if they are applied together. Agitate liquid manure handling systems before sampling and collect several separate samples.

Combine the individual spot samples from a particular lot or lagoon in the bucket and mix thoroughly before filling the sample jar. Keep the sample refrigerated and deliver it to the laboratory within 24 hours if possible. If a food refrigerator is used to store it, wrap the sample in several layers of clean plastic and put it in a tightly-sealed plastic container.

Collect the samples well in advance of your spreading date so you have time to obtain test results and calculate the correct application rate for the crop to be grown. If this isn't possible, it is still helpful to analyze a representative sample so you know how much to credit in the future. An accurate manure test is an excellent investment of time and money. It can help you save fertilizer costs and avoid water contamination problems.

Plant Analysis

Plant analysis during the growing season can help assess nutrient sufficiency in the growing plant. While nutrient deficiencies may be apparent, excess nutrient levels can be determined only by plant tissue analysis. Plant analysis allows producers to apply lower rates of fertilizer before planting, and to adjust plant nutrient status during the growing season. Plant analysis, when properly used, offers producers insurance that careful nutrient management will not negatively affect the bottom line. (See 0.116, *Plant Analysis*.)

Choosing a Laboratory

Individual laboratories vary in services offered, prices and the time they require for analysis. The following list of laboratories is not all-inclusive, and the list of services may change over time. To select a lab, consider convenience, services offered and quality.

There is a North American Laboratory Proficiency Program administered by Utah State University (1-801-797-2217). This program provides a manual with detailed descriptions of recommended analytical methods and also runs a Quality Assurance/Quality Control (QA/QC) program. Participating labs are sent samples to analyze throughout the year and their results are compared to other laboratories. These comparisons are sent back to the labs to help them improve techniques and methods.

Laboratories usually have a QA/QC program within their laboratory. By running duplicate samples and comparing results, or by periodically analyzing standards (samples with known values) during sample runs, a lab can determine if its results are reproducible and accurate.

Fertilizer recommendations are based on soil test results. However, there are differing nutrient management philosophies that will impact recommendations. Be sure your laboratory's philosophy is consistent with your objectives. One approach is to build up soil fertility levels, another approach is to replace the amount of nutrients taken up by a crop, and a third approach is to base fertilizer recommendations on crop requirements to maximize yield. The first two approaches result in higher fertilizer recommendations that can lead to a buildup of nitrogen and phosphorus in the soil and potential pollution of water sources.

Recordkeeping and Interpretation

Keep a record of your lab results as a reference for future testing. If you need help interpreting the results of your sample, the lab manager where the sample was analyzed or your Colorado State Extension county office can assist you. Different labs may vary in analytical tests used, reported concentration values, and in actual fertilizer recommendations. Ask your lab manager about their nutrient management philosophy to be sure it is consistent with your objectives.

References

J.R. Self. 2010. Plant Analysis. Colorado State University Extension Fact Sheet 0.116. Fort Collins, Colorado.

Self, J.R., and P.N. Soltanpour. 2010. Soil Sampling. Colorado State University Extension Fact Sheet 0.500. Fort Collins, Colorado.

Table 1: Commonly used laboratories and analysis summary.

	Soil Test	Water Analysis	Manure Analysis	Livestock Feed	Pesticide Analysis in Soil or Water	Bacteria Analysis
Price Range **Most Quoted Price**	**$15-80** **$20**	**$13-74.50** **$40**	**$28-80** **$45**	**$6-90** **$10**	*	**$10-50** **$20**
A & L Laboratories, Inc. P.O. Box 1590 302 34th St. Lubbock, TX 79408-1590 (806) 763-4278 E-mail: allabs@al-labs-plains.com www.al-labs-plains.com	X	X	X	X		X
ACZ Laboratories, Inc. 2773 Downhill Drive Steamboat Springs, CO 80487 (970) 879-6590, (800) 334-5493 E-mail: sales@acz.com www.acz.com	X	X			X	X
Agsource Harris Laboratories 300 Speedway Circle, Suite 2 Lincoln, NE 68502 (402) 476-0300 E-mail: info.ag@agsource.com http://harris.agsource.com	X	X	X	X		
Analytica Environmental Laboratories, Inc. 12189 Pennsylvania St. Thornton, CO 80241 (303) 469-8868, (800) 873-8707 E-mail: kellysuvada@analyticagroup.com www.analyticagroup.com	X	X			X	X
Colorado Analytical Laboratory 240 S. Main St. P.O. Box 507 Brighton, CO 80601 (303) 659-2313 E-mail: info@coloradolab.com www.coloradolab.com	X	X	X			X
Colorado Dept. Public Health and Environment -Laboratory Services Division 8100 Lowry Blvd. P.O. Box 17123 Denver, CO 80230 (303) 692-3090 E-mail: cdphe.lab@state.co.us www.cdphe.state.co.us/lr		X			X	X
Colorado State Soil, Water and Plant Testing Laboratory Room A319 NES Bldg. Fort Collins, CO 80523-1120 (970) 491-5061 E-mail: jself@agsci.colostate.edu www.extsoilcrop.colostate.edu/SoilLab/soillab.html	X	X	X	X		
Energy Laboratories, Inc. 2393 Salt Creek Highway P.O. Box 3258 Casper, WY 82602 (888) 235-0515 Voice: (307) 235-0515 www.energylab.com	X	X	X	X	X	X
Kansas State Research and Extension Soil Testing Laboratory Dept. of Agronomy 2004 Throckmorton Manhattan, KS 66506-5501 (785) 532-7897 E-mail: soiltesting@ksu.edu www.agronomy.ksu.edu/soiltesting/	X	X		X		

Table 1: Continued.

	Soil Test	Water Analysis	Manure Analysis	Livestock Feed	Pesticide Analysis in Soil or Water	Bacteria Analysis
Price Range **Most Quoted Price**	**$15-80** **$20**	**$13-74.50** **$40**	**$28-80** **$45**	**$6-90** **$10**	*	**$10-50** **$20**
Midwest Laboratories, Inc. 13611 B St. Omaha, NE 68144-3693 (402) 334-7770 www.midwestlabs.com/index3.html	X	X	X	X	X	X
Northeast Colorado Dept. of Public Health 700 Columbine Sterling CO, 80751-0316 (970) 522-3741 E-mail: juliem@nchd.org www.nchd.org						X
Olsen's Agricultural Laboratory, Inc. 210 East First McCook, NE 69001 (308) 345-3670 E-mail: info@olsenlab.com www.olsenlab.com	X	X	X	X		X
Quality-Water Bio-Lab 9999 Olde Wadsworth Blvd. Broomfield, CO 80021 (303) 466-7055						X
Servi-Tech Laboratories P.O. Box 1397 1816 E. Wyatt Earp Dodge City, KS 67801 (800) 557-7509 www.servitechlabs.com	X	X	X	X no pricing available		X
Servi-Tech Laboratories P.O. Box 169 1602 Park West Dr. Hastings, NE 68902 (402) 463-3522, (800) 468-5411 www.servitechlabs.com	X	X	X	X		X
Servi-Tech Laboratories 6921 South Bell Amarillo, TX 79109 (806) 677-0093, (800) 677-0093 www.servitechlabs.com	X	X	X	X	X	
Stewart Environmental 3801 Automation Way, Suite 200 Fort Collins, CO 80525 (970) 226-5500, (800) 373-1348 E-mail: Use website for inquiry www.stewartenv.com	X	X	X			X
Stukenholtz Laboratory P.O. Box 353 2924 Addison Ave. East Twin Falls, ID 83303 (208) 734-3050, (800) 759-3050 E-mail: paul@stukenholtz.com www.stukenholtz.com	X	X	X	X		X
TestAmerica Laboratories, Inc. 4955 Yarrow Street Arvada, CO 80002 (303) 736-0134 E-mail: debra.headerer@testamericainc.com www.testamericainc.com	X	X	X		X	X

Table 1: Continued.

	Soil Test	Water Analysis	Manure Analysis	Livestock Feed	Pesticide Analysis in Soil or Water	Bacteria Analysis
Price Range **Most Quoted Price**	**$15-80** **$20**	**$13-74.50** **$40**	**$28-80** **$45**	**$6-90** **$10**	*	**$10-50** **$20**
Ward Laboratories, Inc. P.O. Box 788 4007 Cherry Ave. Kearney, NE 68848 (308) 234-2418, (800) 887-7645 E-mail: rayward@wardlab.com www.wardlab.com	X	X	X	X		X
Weld County Dept. Public Health and Environment Laboratory 1555 N. 17th Ave. Greeley, CO 80631 (970) 304-6415 www.co.weld.co.us/departments/healthenvironment/index.html		X				X
Weld Laboratories, Inc. 1527 1st Ave. Greeley, CO 80631 (970) 353-8118 E-mail: info@weldlabs.com www.weldlabs.com	X	X	X	X		X
Western Laboratories P.O. Box 1020 Parma, ID 83660 (208) 722-6564, (800) 658-3858 E-mail: westernl@westernlaboratories.com www.westernlaboratories.com	X	X	X	X	X	X

X - indicates service provided
*Cost of analyzing soil or water for pesticides will vary depending on how many and which pesticides.

Laboratory services, prices and addresses may change. Contact the lab you intend to use prior to sample collection to get the most up-to-date information and specific sample collection information. Lab quality and turn-around may vary, so ask the lab manager about areas of expertise or seek references. The list of labs herein does not constitute endorsement nor does omission imply criticism.

Questions to Ask

Call the laboratory manager prior to sample collection to determine the laboratory's suitability and to get more detailed information. You may want to ask some of the following questions:

1. What analyses does your laboratory offer?
2. What do they cost?
3. How long will it take to get my results?
4. Do you participate in the North American Laboratory Proficiency Program? If so, how has your performance been?
5. Are your analytical methods EPA-approved or described in the North American Laboratory Proficiency Program lab manual?
6. Is the lab associated with a co-op or fertilizer company?
7. What is your lab history? How long have you been running analyses similar to what I need?
8. What is your philosophy in making fertilizer recommendations? Are your recommendations research-based?