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RECLAMATION CONSIDERATIONS FOR OIL AND GAS LEASE CONTRACTS ON PRIVATE LANDS

This bulletin provides general information appropriate for all Wyoming ecological sites.

Fifth in a series by the University of Wyoming Extension Reclamation Issue Team and the Wyoming Reclamation and Restoration Center that describes strategies for restoring ecological functions to disturbed Wyoming lands. For this series, reclamation means restoration of components that support desired ecological functions, such as forage for livestock grazing, wildlife forage and cover, water supply, water quality protection, and aesthetic values.

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Contents

This bulletin provides information most relevant to reducing impacts of energy developments to sagebrush wildlife habitats in Wyoming. The information applies to sites where energy development is planned, is progressing, or has occurred. The bulletin is framed to provide information to avoid or lessen impacts to sagebrush wildlife habitats including fragmentation and human disturbance that could adversely affect wildlife habitats and populations.

Summary

Landowners entering lease agreements with energy exploration and production companies need to be aware of steps and procedures involved in the often-difficult process of successfully restoring landscape functions and productivity following disturbance. The process of reestablishing a viable plant community in Wyoming can be difficult. Success depends upon timing and amount of precipitation, soil types, vegetation present prior to disturbance, and many other factors. Communicate with the reclamation contractor to plan seed mixes, seeding rates, and timing. Ask what the procedure is if the initial seeding is a failure and results in the introduction of weedy species or increased wind erosion from bare soils. In a survey of Wyoming oil and gas operators, Anderson and Coupal (2009) found that reclamation costs $2,551 per acre for dirt work and $2,986 per mile for road removal. Chenoweth et al (2012) estimate reclamation costs per well pad in the Piceance Basin at $16,000-$17,000, and failed reclamation efforts may cost an additional $20,000-$23,000 for level pads and up to $40,000 for steep slopes. These higher costs are associated with retrieving sediment, repairing washouts, regrading, reseeding and implementing new best management practices to prevent another failure. And redo's still do not guarantee success. Failures also set back vegetation recovery periods and add to the loss of production from disturbed areas. It is critical to design and implement a sound reclamation plan so dollars are well spent.

This bulletin describes critical components that should be considered and discussed by landowners and contractors before a lease agreement is signed. A reclamation plan should be agreed upon prior to the construction phase of oil or natural gas wells.

Well pad before seeding

Checklist for Reclamation Plan

	Components of Reclamation Plan
	Reclamation standard: Determine extent to which existing functions and values should be restored.
	Conduct predisturbance baseline inventory 1. Baseline photo points cardinal photos (N,E,S,W) from center 2. Landscape and topography features and drainages described 3. Systematic plant community description 4. Map of suitable soil with depth to and description of limiting properties (e.g., too high pH, salts, selenium, clays, gravel content)
	Salvage suitable soil to appropriate depths (communicate to contractor) and stockpile adjacent to pad.
	Use best management practices to stabilize soil stockpiles, cut and fill slopes, roadsides, and other areas vulnerable to erosion and sediment production, prior to during, and after construction.
	Monitor and address erosion and weeds during well construction phase.
	Perform interim reclamation (for production phase of well).
	Identify seed mix: use baseline inventory and ESD's (if available or adjacent reference area) to identify species and proportions.
	Use dormant seeding, late fall seeding (after October 15, or soil temperature below 50°F at 5 cm)
	Seedbed preparation and seeding: 1. Deep ripping to alleviate compaction prior to topsoil spreading 2. Prepare firm seed bed (foot print sinks in less than ½ inch) 3. Drill-seed or broadcast grasses at proper rates based on pure live seed guidelines 4. Broadcast forb and shrub seeds and follow with cultipacker 5. Mulch with certified weed-free straw or grass hay and crimp into soil surface with straight disk, crimper, or imprinter, and amend as needed
	6. Monitoring for seeding success, weeds, and erosion: systematic monitoring plan until the reclamation standard is met.
	7. Weed control: if noxious weeds appear, control by recommended methods. Annual weeds such as lambsquarters and Russian thistle can provide a cover crop and are often not controlled because seeded species take over within a few years. Landowner could choose to stipulate control if annual weeds reach a certain density, for instance.
	8. Erosion: Use best management practices to control wind and water erosion until vegetation recovers and to treat problems as they arise.
	Final reclamation (shut-in phase: well closed; permanent reclamation)
	1. Establish long-term responsibility for permanent reclamation
	2. Reclaim well head, tank pads, roads, pipelines, and all other areas used during production phase and disturbed during closing as above for interim reclamation using best management practices

Introduction

In the cold, dry environment of Wyoming, restoration of predisturbance functions and values, such as forage production, wildlife habitat, and soil water storage, can be a long and difficult process that is too often unsuccessful. Lease agreements that simply state final reclamation standards may not be sufficient because successful reclamation results from properly carrying out several steps. Failure at the end without stipulating proper procedures can lead to either a long process of starting over on reclamation or evading responsibility due to claims of drought or other factors beyond a contractor's control. This bulletin provides a checklist and descriptions of critical components that should be clearly described in the reclamation plan and included in oil and gas development lease agreements.

The guidelines discussed here pertain mainly to interim reclamation, which occurs immediately following the well construction phase and stays in place during the production phase. Any lease agreement should contain similar requirements for final reclamation, which occurs following final closing of the well and reclamation of all access roads, the wellhead, etc.

I. Determine reclamation objectives

The goal for any reclamation project is to restore important predisturbance soil and vegetation characteristics that underlie ecological functions of a site to be disturbed by construction of oil or gas operations. Important functions that many Wyoming rangelands provide, and that can be harmed by well construction activities, include wildlife habitat, forage for livestock and wildlife, watershed and water quality protection, and others. A thorough pre-disturbance inventory provides the basis for describing important functions and setting reclamation objectives. Reclamation means restoration of components that support desired ecological functions, such as livestock grazing, wildlife forage and cover, water quality protection, and aesthetic values.

This may be achieved using native or introduced species. Natural resources conservation Service (NRCS) plant Material Technical Note WY 15 (http://www.wy.nrcs.usda.gov/technical/Plant/tech_notes.html) provides information for selecting native or introduced species for reclamation. If the inventory indicates the site is degraded or disturbed prior to well construction, then reclamation plans might include broader rangeland rehabilitation or pasture improvement.

Finding your Ecological Site Description

For western Wyoming, start by using keys developed by NRCS (available from the WRRC website under "reclamation information"). For other parts of the state, go by soil texture and precipitation to choose from the ESDs for your region. Once you've determined the name of the ESD that applies (for example, Loamy 7-9" Green River and Great Divide Basin) you can find it on the Ecological Site Information System:

1. Go to http://esis.sc.egov.usda.gov/ESIS/;
2. Click on Ecological Site Description in the center of the screen;
3. Click on Approved ESD Reports in the upper left;
4. Scroll down and, under State, select Wyoming and Submit.
5. Find the ESD and click on the ID;
6. Make sure your site lies within the area highlighted on the map, then click on Plant Communities along the left side of the screen;
7. This screen gives a great deal of information about interactions among rainfall, management, and plant community composition. Scroll down to see the state and transition model of plant community response to management and disturbance. Scroll down farther to see the list of plants and their high- and low-end production for the historical climax plant community. Compare this information to your observations of the site and to availability of seed to design a seed mix. Plant cover data does not directly correlate with the percent composition by weight data on the ESDs, but both provide similar information about plant community composition. Eventually, NRCS will include cover data on the ESDs.

II. Predisturbance/baseline inventory

A predisturbance or baseline inventory provides information on general characteristics of a site, such as wildlife habitat and use, forage production, water quality protection, aesthetics, or others, as well as specific soil, vegetation, and landscape characteristics that underlie those values and functions. Clearly identified photographs of the site are a valuable part of baseline inventory. The inventory should establish a framework for post-reclamation monitoring and evaluation. The baseline inventory includes two steps: 1) gathering existing site-specific information and 2) on-site evaluation of ecosystem functions that need maintained or restored. Visit the Wyoming Reclamation and Restoration (WRRC) website to view Extension Bulletin B-1212 on how to conduct a predisturbance inventory. http://www.uwyo.edu/wrrc/bulletins.html.

Important components for which both preexisting and actual on-site information need to be gathered include:

1. Topsoil depth based on texture, pH, salinity, and other properties that affect suitability for plant growth (the UW Extension Bulletin 1222R *Identifying*

suitable soil for Salvage Prior to Disturbance). The topsoil stripping depth should be marked in the field with labeled stakes indicating the required depth across the area to be disturbed. (Table 1)

2. Properties of subsoil and underlying materials that affect drainage and water-holding capacity.
3. Vegetation types (including threatened or endangered plant species) and their cover, productivity, species diversity, and species composition. Wetlands are regulated by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act and should be avoided (see Recognizing Wetlands U.S. Army Corps of Engineers for more information on wetlands and section 404).
4. Topography, landforms, and surface water hydrology as they affect post disturbance functions to be restored.
5. Wildlife habitat and use, including threatened or endangered species, as indicated by site features and signs of use like fecal pellets, ungulate tracks, small mammal burrows, and bird nests. Consult the Wyoming Game and Fish Department to identify species and critical habitats within a given area. Threatened and endangered species fall under the jurisdiction of the U.S. Fish and Wildlife Service.

Archaeological and historical resources: The Wyoming State Historical Preservation Office (http://wyoshpo.state.wy.us/) provides information and assistance for determining if there are any significant cultural/historical features/artifacts that may need to be preserved. If the exploration for oil/gas on private land requires federal approval, via permitting, funding, or the federal government owns the minerals, it requires compliance with Section 106 (16 U.S.C. 470f) of the National Historic Preservation Act 1966 (NHPA). A ground survey may or may not be needed; a previous survey or other issues may exempt further action. If it is not a federal undertaking (funding, permitting, or approval), there is no legal requirement to conduct a cultural resources survey.

III. Salvage (strip) and separate suitable soil

Prior to any construction activities the Storm Water Pollution Prevention Plan must be submitted to the regulatory agency-Wyoming DEQ Land Quality Division. For more information, see Storm Water Pollution Prevention Plan at http://cfpub.epa.gov/npdes/stormwater/swppp.cfm#guide.

Stripping: Topsoil stripping should carefully follow the predisturbance plan, and operators should avoid stripping too deeply, which mixes topsoil with salty, clayey, or rocky subsoils and reduces the reclamation potential of the topsoil.

Table 1: Guidelines for suitable soil as defined by the Wyoming Department of Environmental Quality Land Quality Division (See http://deq.state.wy.us/lqd/guidelns/guide1.pdf).

Parameter and method	Suitable	Marginal[1]	Unsuitable
pH (acidity or alkalinity)	5.5-8.5	5.0-5.5 8.5-9.0	< 5.0 > 9.0
EC (mmhos/cm) Soil lab value[2:]	0-8	8-12	> 12
Texture by feel[3]	Loam < 28% clay < 50% sand < 50% silt	Clay loam, sandy loam, silt loam	clay, sand, silt
Gravel (>2mm)(% vol)[3]	<25%	25-35%	>35%
Sodium ion activity (Sodium Adsorption Ratio)(Lab analysis	0-10	[1]10-12, clay soils 10-15, other soils	>15
Selenium	<0.1 ppm	>0.1 ppm	

[1] Many Wyoming soils fall outside the "suitable" range for these properties but still support important plant communities adapted to saline, sodic, or drouhty conditions. Soils must be evaluated site by site to assess their suitability to meet site-specific restoration objectives.

[2] Field EC meters often use a different scale. Be sure to convert to the laboratory scale according to instructions for any field meter.

[3] Texture and gravel content of undisturbed Wyoming soils varies a great deal, but too much sand, graval, or clay will create difficulties for establishment of reclamation plant species.

Stripping depth should vary with the depth of the soil across a site because the thickness of the topsoil typically varies, especially on sites with sloping or undulating topography. This requires a skilled equipment operator trained to visually recognize when the correct depth is being stripped. The topsoil stripping depth should be marked with labeled stakes indicating the depth. Operators should keep in mind that the lower slopes and swales usually have deeper soils while upper slopes, knolls, and ridge tops have shallower soils. Eroded sites may have no salvageable topsoil.

Stockpiling: Topsoil is a living entity soil microbes rapidly cycle dead plant and animal material, providing nutrients for plant growth and organic materials that improve soil quality. However, sustained soil quality and plant growth depends upon annual inputs of plant residues that do not occur in topsoil stockpiles. Decomposition continues – or even - accelerates because of mixing and exposure to air, but plant inputs cease. If topsoil will be stockpiled for more than one month, stockpiles should be ridged (roughened) to maximize surface area and planted to fast-growing sterile annual grains or early-succession natives like bee plant or slender wheatgrass to compete with weeds, prevent erosion, and contribute organic materials. Topsoil, subsoil, and underlying materials should be stored in separate piles and clearly labeled. They should be stockpiled on stable areas protected from wind and water erosion and from unnecessary compaction. Stockpiles should be seeded and protected from erosion by constructing silt fences or using straw bales, trenches, or other erosion-control practices around them as soon as possible. For more information on salvaging topsoil, see Extension Bulletin B-1222 available on the WRRC website (http://www.uwyo.edu/wrrc/bulletins.html).

Stripping topsoil

Respreading topsoil

IV. Backfill, grade, compact, and contour disturbed areas

Backfilling with subsoil and underlying materials (marginal/unsuitable soil, Appendix A) and grading to the original topography, along with reestablishing drainage properties, set the stage for successful reclamation. Where subsoil and underlying materials have been stripped in hillslope cuts, the original hydraulic conductivity should be recovered by careful compaction or ripping. Keeping slopes less than 3:1, or 33-percent gradient, minimizes erosion after reclamation. The original topography of the site should be recovered to a surface configuration consistent with post disturbance land use and that blends with adjacent topography. Surface drainage patterns should be rebuilt to reestablish essential hydrologic functions and minimize erosion.

V. Reapply soil and prepare seedbed

Before topsoil is respread on the graded surface, sites should be deep ripped to reduce compaction of the subsoil/underlying material to appropriate rooting depth (at least 12 to 18 inches deep). Ripping soils allows for greater water infiltration, greater aeration of the soil. The most common primary tillage practices prior to spreading topsoil are deep ripping, deep chisel plowing, deep disking, and scarifying on the contour to control erosion.

After working the graded area, topsoil should be respread to depths consistent with the original depths. Topsoil should be chiseled, disked, and firmed with, a roller harrow on the contour to control erosion and prepare a proper seedbed. A common rule of thumb for ensuring good seed-

soil contact is that the seedbed should be firm enough a 170-pound person leaves a footprint one-half inch deep (depending on soil type). Fluffy seedbeds dry out quickly, killing new seedlings. Prior to seeding, respread topsoil should be visually inspected for ponding or gullying, which may require deep ripping or other tillage operations.

Accelerated decomposition in topsoil stockpiles causes accumulation of plant-available nutrients, especially nitrogen. Retesting stockpiled soils at the time of spreading and comparing to levels from the baseline inventory indicates types and quantities of amendments, like organic materials, that may be beneficial. The goal of amending the soil is to improve the surface conditions for plant establishment and to restore the potential productivity to predisturbance levels but not to change the basic potential of the site. If results of predisturbance soil analyses are not available, test soils after spreading and use the typical productivity as the yield goal. Productivity can be estimated from the ecological site descriptions (ESDs), or by clipping some plots on an adjacent undisturbed site, drying, and weighing to convert to pounds per acre production. This prevents unnecessary amendment application and/or over-fertilization, which promote robust growth of weeds.

VI. Plant appropriate native/required species

Seeding technique and equipment depends upon seed size, which determines the proper depth of seeding and the seeding rate for each. Most grasses and some forbs have relatively large seeds, meaning higher seeding rates (relatively few seeds per pound) and deeper depths, while many shrubs and forbs have very small seeds. Bluebunch wheatgrass, for instance, has about 126,000 seeds per pound and should be planted one-quarter to one-half inch deep, while Wyoming big sagebrush has about 2,500,000 seeds per pound and should be planted less than one-eighth inch deep. When seeding grasses with a seed drill, 20 seeds per square foot is a sufficient rate; however, when the mix contains grasses, shrubs, and forbs, a better rate is 50-100 seeds per square foot (usually 10-16 pounds per acre > 12" precipitation). Large-seeded species are typically planted with a grass-seed drill while small-seeded, trashy, or fluffy species should be planted with a broadcast seeder. The NRCS recommends doubling rates for broadcast seeding. Ideally, one seed mix should be designed for drilling and another for broadcasting.

ESD's, together with the seeding worksheet developed for Wyoming by the NRCS, are excellent tools for planning site-specific seed mixes. You can find links to these tools and other information on the WRRC website under Reclamation Information (http://www.uwyo.edu/wrrc/).

Seeding time is crucial and, for Wyoming, reclamation seed mixes should be seeded in the fall after the soil temperature is around 40°F but before ground freezes (typically after October 15). Most native species need to be planted in the fall to break dormancy. Seeding times may vary by year and region within Wyoming. A spring seeding prior to April 15 is possible depending upon precipitation zone (≥15-17 in) and if reliable precipitation routinely occurs in the spring or early summer. Seeding in July and August should generally be avoided. Some shrubs and forbs may be broadcast during the winter if conditions are favorable for planting. For instance, some reclamationists get excellent results by broadcasting sagebrush seed on snow cover.

For more information on seeding, see Bulletin B-1204 *Seeding Essentials* available on the WRRC website (http://www.uwyo.edu/wrrc/bulletins.html).

VII. Monitor for restored functionality

Developing and following a long-term monitoring plan is crucial so problems can be identified and controlled early before they threaten the success of the reclamation project. Close attention should be paid to seeding success, noxious weeds, and erosion. Planted seedlings should start to show in the first season, but a proliferation of annual weeds is not unusual. By the second season, seeded plants should occur throughout the site but may be small compared to annual weeds and require a close look to find and identify them. A step-toe transect is a good, quick way to look for seedlings across a site: simply walk in a line across the seeded area and look at the square foot in front of your toes on each step. Record the number of seedlings you see. It is best to repeat step-toe transects through the seeded area. Quadrats may also be used for monitoring the reclaimed and reference areas for measuring reclamation progress toward success. Establishing a seeded plant community in Wyoming often takes three to four years and some shrubs may take that long just to germinate.

Annual broadleaf weeds like Russian thistle, lambsquarters, mustards, and others are not unusual in new seedings and usually disappear as seeded species take over. Noxious weeds (by law) must be controlled with pulling or spraying before they spread or produce seed. This may be a multi-year task in the early stages of reclamation. Determining a successful reclamation effort may take up to five years and longer in harsh environments (5-9" precip zone).

While monitoring vegetation, any instability or erosion issues should be noted. Uncontrolled erosion can rapidly degrade a reclaimed site and pollute land and water down slope, which not only degrades onsite productivity, but is illegal and needs to be immediately addressed immediately. Carefully look for gully erosion and for sediment deposition, especially after rainstorms. If substantial erosion is noted and appears to be getting worse, control measures that slow and divert runoff flow must be implemented. These include installation of erosion control best management practices and sediment runoff control measures (e.g., rock check dams, wattles, silt fences, straw bales, trenches, etc.) For more information on erosion control technique's go to the Wyoming Department of Transportation website, click on Manuals and Publications, and scroll down to Storm Water Control During Construction for the field guide for erosion control during construction.

http://www.dot.state.wy.us/files/content/sites/wydot/files/shared/Construction/WYDOT-field-guide, 4-6-11%5B1%5D.pdf

More information

Wyoming Reclamation and Restoration Center: source for reclamation bulletins
http://www.uwyo.edu/wrrc/bulletins.html

Wyoming topographic maps: Wyoming State Geological Survey at (307) 766-2286 or http://www.wsgs.uwyo.edu/.

Wyoming soil maps and information: Wyoming Soil Survey Office at (307) 233-6774 or http://websoilsurvey.nrcs.usda. gov/app.

Wyoming ecological site descriptions and seeding information: NRCS state range specialist at (307) 233-6766 or http://esis.sc.egov. usda.gov.

Existing baseline inventory information from state-permitted sites: Wyoming Land Quality Division at (307) 777-7756 or http://deq.state.wy.us/lqd/.

Archaeological and historical information: Wyoming State Historic Preservation Office at (307) 777-7697 or http:// wyoshpo.state.wy.us.

Critical wildlife habitat and migration corridors: Wyoming Game and Fish Department at (307) 772-2374 or http://gf.state. wy.us.

Noxious weeds: Wyoming Weed and Pest Council at (307) 777-6585 or http://www.wyoweed.org; http://ces.uwyo.edu/ wyoweed/wyoweed.htm; http://plants.usda.gov/java/noxious ?rptType=State&statefips=56.

References

Anderson, M., Coupal, R., 2009 Economic Issues and policies affecting reclamation in Wyoming oil and gas industry. 11th Billings Land Reclamation Symposium

Chenoweth, D., Holland, D., Jacob, G., Kruckenberg, L., Rizza, J., Whitely, B., 2012 The Economic Benefits of Completing Initial Reclamation Successfully For Oil and Gas. Integrated Petroleum Environmental Consortium (IPEC) conference, Tulsa, OK. www.oilgasbmps.org/docs/GEN176-chenweth.pdf

Monsen, S. B., Stevens, R., Shaw, N. L., compilers. 2004. "Re-storing Western Ranges and Wildlands." General Technical Report RMRS-136, vol. 1-3, Fort Collins, Colorado: US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Munshower, F. F. 1994. *Practical handbook of disturbed land revegetation*. Lewis Publishers, New York.

National Historic Preservation Act of 1966
http://www.nps.gov/history/local-law/nhpa1966.htm

Steward D.G. (coordinating editor). 2006. *Handbook of Western Reclamation Techniques*, published by Office of Surface Mining Reclamation and Enforcement, Denver, Colorado.
http://www.techtransfer.osmre.gov/NTTMainSite/Library/hbmanual/westrecl-2ED.shtm

United States Department of the Interior and United States Department of Agriculture. 2007. *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* (Gold book). BLM/WO/ST-06/021+3071/ REV 07. Bureau of Land Management. Denver, Colorado. 84 pp.
http://www.blm.gov/wo/st/en/prog/energy/oil_and_ gas/best_management_practices.html

Whisenant, S.G. 1999. *Repairing damaged wildlands: A process-oriented, landscape-scale approach*. Cambridge University Press, Cambridge.

Wyoming Department of Transportation
http://www.dot.state.wy.us/files/content/sites/wydot/files/shared/Construction/WYDOT-field-guide,4-6-11%5B1%5D.pdf

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http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/RelatedResources.aspx

Reclaimed well pad

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