Teton Waters Ranch Beef Protocols

Teton Waters Ranch (TWR) is dedicated to sourcing the healthiest and most environmentally beneficial grassfed beef by selectively promoting and supporting ranchers across the globe who raise 100% grassfed beef per TWR standards. Accordingly, TWR beef will always adhere to the following set of attributes:

- 100% grassfed– no grain, ever
- Raised on pasture – no CAFOs or conventional feedlots
- No antibiotics and no added hormones, ever
- Restorative agricultural practices to promote pasture health/recovery/vitality
- Certified Humane® – grassfed and humane treatment certified

Additionally, all cattle entering the TWR program must be fully documented and have traceability to birth. Adherence to TWR standards and protocols will be controlled by TWR and certified by third-party audit. The protocols detailed herein are both complementary to and augmentations of the HFAC Beef Cattle Standards that are the basis to the Certified Humane® program.

At TWR, we believe that grassfed beef done right — raised with care, provided proper nutrition, integrated into restorative land management practices, harvested humanely — will provide health benefits to our consumers, can create stronger resilience for our ranchers, improve cattle health, and help promote pasture health and vitality. These protocols are the basis for our definition of "doing grassfed right."

Grazing livestock are part of a sustainable agricultural future. Vast amounts of land all around the world can only be used for grazing. It is either too arid or the terrain is too rough for growing crops. Rotating cattle, sheep, or other livestock between different pastures can improve both soil health and plant biodiversity… Successful grazing programs must be adapted to local conditions. When grazing is performed correctly, it will improve the land. – Dr. Temple Grandin

Grandin, T. Grazing Cattle, Sheep, and Goats Are Important Parts of a Sustainable Agricultural Future. *Animals 2022, 12, 2092.*

These TWR Beef Protocols were developed under guidance and input from:

- *Dr. Temple Grandin,* faculty member with Animal Sciences in the College of Agricultural Sciences at Colorado State University and renowned animal behaviorist
- *Mimi Stein, Executive Director, Humane Farm Animal Care and Certified Humane®*
- *Dr. Joe E Brummer, Associate Professor of Forage Science – Soil and Crop Sciences, Colorado State University - College of Agricultural Sciences*
- *Dr Jim Ippolito,Professor of Soil Health/Soil Fertility – Soil and Crop Sciences, Colorado State University - College of Agricultural Sciences*

Table of Contents

Grassfed Standards

Grazing and foraging

Cattle must be on pasture with continuous access to forage throughout the growing season, on hay or silage as needed to keep cattle on a steady plane of nutrition. Only cases of extreme weather (drought, flood, etc.) permit and require cattle to be removed from pasture for their well-being. Any such instances shall be documented and forwardly reported to TWR.

Permissible feed

Grassfed cattle under this program are to have a diet that consists entirely of grass and other forages. Limited feed supplements are permissible for animal health including molasses, kelp and apple cider vinegar. Mineral supplementation is permitted and encouraged for animal health. All vitamin and mineral supplements must be free of grain and grain by-products.

Incidental ingestion of seeds naturally attached to grass and forage, on an exception basis only, shall be documented and reviewed for program eligibility. Any intentional feeding of seeds or grain is **prohibited** and could result in exclusion from grassfed status and program eligibility.

Prohibited feed

Any grain, grain by-products or any form of feed concentrate is explicitly **prohibited**, including but not limited to barley, corn, oats, rye, rice, soy, triticale, wheat, millet, sorghum, and spent distiller grain. Grazing the plants that produce these grains in their pre-seed growth stage or after seed harvest is permissible. Feeding cattle urea is **prohibited**.

Cattle Attributes

Genetics

Cattle permissible within the TWR program must be of British/Continental decent. Dairy-specific and brahman breeds are **prohibited**.

Age

Grassfed cattle take longer to mature and longer to achieve optimal weight than cattle raised in confined feeding operations. Accordingly, we target harvest when cattle are 30 months of age or younger (never old or spent dairy cattle).

Hormones and growth promotants

Bovine growth hormones or any exogenous hormone, whether supplied via injection, implants, or any manner is **prohibited**. Additionally, the use of beta-agonists is **prohibited**.

Antibiotics

The use of antibiotics in cattle, whether in the form of injection, bolus or an ingredient in feed or water, is **prohibited**. Producers shall treat sick cattle with antibiotics where needed per veterinary recommendation, and treated animals must be marked for exclusion from the TWR program. Producers may utilize a variety of methods to identify treated animals, so long as it is consistent, documented, and auditable. These methods may include:

- Ear tagging the treated animal
- Notching an existing ear tag
- Electronic ear tag with records on the individual animal

Any animal that has lost its tag must be classified as treated and removed from the TWR program, unless adequate records exist to determine that the animal was not treated.

Vaccination

A vaccination program for program cattle is **required** for animal welfare and must be tailored to the localized environment of the ranching operation. Appropriate vaccinations are critical to the health of cattle and shall be recommended by consulting veterinarians based on localized conditions and health risks. This is to ensure cattle health and humane treatment.

Traceability

All cattle in the TWR program **must have** full documentation and traceability to birth. All parties involved with the raising, care, and harvest of the cattle must be known to TWR. Each party must be identified and documented that they raised and treated the cattle in accordance with TWR and HFAC protocols. Cattle without documented history for the entire duration from birth to harvest are prohibited in the TWR program.

Electronic (RFID) ear tags are the preferred form of cattle identification, though not required. Commonly used livestock ear tags work well when matched with robust documentation on a per-animal basis. Complete history—from birth to slaughter—of cattle provenance, medical treatment, and grassfed status shall be available for audit and inspection at all times.

Cattle Management

Weaning

Calves in this program are to stay with their mothers for at least 6 months after birth. Low-stress weaning methods are compulsory within the program and are in the best interest of the calf and their growth. Fenceline weaning offers a humane and stress-reducing approach to weaning. Additional considerations and recommendations can be found in Appendix 2 of the HFAC Beef Cattle Welfare Standards.

Handling

The core principal behind specific cattle handling procedures detailed in the HFAC Cattle Welfare Standards (Section B) is animal stress avoidance and stress mitigation. Cattle are herd

animals and prefer to stay together as a herd. Human handlers shall act as herd leaders where possible, rather than mimic predator-like behavior such as chasing and cornering. In all settings, moving cattle at a slow, comfortable pace is essential to reduce injury and minimize animal stress. Stress minimization promotes healthier and stronger growth. Thorough training of handlers is the basis for effective and humane animal handling.

Egregious or intentional abuse of cattle in any form can immediately eliminate producers from the TWR program. Such examples include but are not limited to dragging or beating cattle, poking cattle in sensitive areas, breaking tails, and unnecessary use of electric cattle prods.

Per the HFAC Cattle Welfare Standards, the broader understanding of natural cattle behaviors and bovine adaptations allows the handlers to move or work the animals in harmony. Here is an excerpt from "M 10" within the *Handling* section:

> *Cattle have the following behavioral characteristics, which must be taken into consideration when cows are moved:*
> - *They have a wide field of vision and may startle if they see moving objects even at long distances.*
> - *They have acute hearing, so they should not be subjected to loud noises.*
> - *They are herd animals and, if possible, should not be left in isolation*

Body Condition

Grassfed cattle perform best when provided a steady plane of nutrition allowing them to grow healthily and consistently. Genetics, quality of feed/forage, environmental conditions and seasonality all play into determining appropriate fat cover on an animal. Producers in this program will use a scoring method to monitor and document body condition of the cattle to focus attention on animal health and wellbeing.

The broadly utilized Beef Cattle Body Condition Scoring (BCS) is based around a 1-9 scoring rubric outlined as follows:

Score	Appearance	Condition	TWR Conformance
1	emaciated	skeletal	unacceptable for
2	poor	very thin with bony protuberance	TWR program
3	thin	thin fat cover	∨
4	borderline	light fat cover over ribs, shoulder, hip	targeted range for
5	moderate	light fat cover over all body parts	healthy grassfed
6	good	medium fat cover	cattle
7	very good	frame fat cover is balanced	∧
8	fat	fat deposits, tailhead, dewlap	requires diet
9	obese	excessive fat deposits, tailhead, etc.	modification

A score of 3 or higher is required for participation in the TWR program, with a score of 5-7 being appropriate for grassfed cattle at time of harvest. Cattle with a BCS of 1 or 2 are considered mal-treated/mal-nourished and fall outside the parameter set forth within HFAC Cattle Welfare Standards. Individual animals with a BCS of 1 or 2 shall receive veterinary

attention and may be reintroduced to the program per veterinary recommendation. Observation of cattle with BCS 1-2 in over 30% of the herd signals mishandling or maintenance of inappropriate conditions for cattle and will result in suspension from the TWR program.

Feed and Water Access

Cattle must have unrestricted, continuous access to nutritious, wholesome, and clean feed and water at all times. Standing/attached forage, such as grasses and alfalfa, must be plentiful and appropriate for the age and growth of the animal or must be complemented with hay-based feed to ensure cattle access to clean and balanced nutrition per the National Research Council's *Nutrient Requirements of Beef Cattle*. Written records of all feed provided to cattle beyond grazing and forage shall be kept, including detail of feed ingredients and percentages thereof, as well as overall feed quantity.

All feed supplied to cattle must have adequate fiber and protein to maintain proper rumination and ensure cattle health. Feed shall be clean, free of mold, and supplied in a manner to ensure equitable access that most appropriately mimics grazing and foraging, both for cattle and land health.

Clean, fresh drinking water must be available to cattle at all times. Per HFAC, "grazing cattle should not have to walk long distances to access water: less than ½ mile (0.8km) in steep, rough terrain to up to 2 miles (3.2km) in smooth, flat terrain." Environmental considerations and local, state, and federal laws must be adhered to if using rivers, ponds, or streams as a water source for cattle.

Animal Health Plan

Under consultation of a veterinarian, an Animal Health Plan (AHP) shall be established in consideration of breed, environment, age, and cattle attributes. The AHP must address cattle nutrition, vaccination, parasite control/prevention, infectious disease, and pain management. In addition, the AHP shall outline protocols surrounding biosecurity, procedures for handling non-ambulatory cattle, and a euthanasia plan for emergencies. The AHP must be kept up to date with changing conditions and all records of medical/animal health procedures must be documented and available for review.

Land Management

Farm Plan

TWR requires that every farming/ranching operation develop and maintain a Farm Plan. This plan serves as a central repository for all records, checklists, land management practices, water management practices, restorative agricultural practices, maps, pest control methods, standard operating procedures, emergency procedures, and internal policies. The farm plan should include clear practices for measuring and tracking soil health, specifically encompassing soil compaction, water infiltration, ground cover, plant diversity, and vegetative vigor. This Farm Plan shall be made available for review to TWR and the HFAC inspector.

Restorative agricultural practices

Restorative agricultural practices implemented through grazing must be documented in the Farm Plan. Actively and intentionally managing grazing practices is key to quality grassfed beef both for cattle health and continuous soil improvement. Rotational grazing as compared to continuous grazing mimics historical herd movements driven by predator activity. Within this, concentrated herds are observed grazing pasture more uniformly for a limited period before moving to new pasture. This pattern allows for optimal plant/forage generation, regeneration, and health. Pasture managed via rotational grazing increases yields and soil vitality, all while reducing need for additional fertilizers and external inputs.

Soil health is the basis of restorative agriculture. To distill the science, we follow *The Five Principles of Soil Health*, as detailed by Jay Furher, NRCS Soil Health Specialist:

The Five Principles of Soil Health (See Appendix A)

Principle 1: Maintenance of soil armor/soil cover
Principle 2: Minimization of soil disturbance
Principle 3: Promotion of plant diversity
Principle 4: Continual live plant/root
Principle 5: Livestock integration

In adherence to the principles of soil health, TWR provides a set of management practices to help ranchers and farmers restore pasture vitality and increase their yields:

The Five Management Practices for Pasture Vitality (See Appendix B)

Practice 1: Graze the pasture
Practice 2: Promote biodiversity
Practice 3: Sustain soil cover
Practice 4: Tread lightly on the soil
Practice 5: Monitor and track soil health

Non-GMO

Genetically Modified Organisms (GMOs) shall not be planted in grazing pastures, nor intentionally introduced into any portion of the grazing operation.

Transportation and Processing

Cattle Transportation

TWR expectations for cattle transportation fall in line with the requirements laid out in the HFAC Cattle Beef Welfare Standards (Part 6: Transportation). Per the document, the objectives are clear: “Animal transport systems must be designed and managed to ensure livestock are not subjected to unnecessary distress or discomfort. Cattle may be penned, sorted, segregated into holding pens prior to shipping for a period of time of no more than 10 days. The transport and handling of livestock must be kept to an absolute minimum. Personnel involved in transport must be thoroughly trained and competent to carry out the tasks required of them.”

Key aspects to the HFAC requirements for transportation include specific guidelines around the following:

- Loading and unloading of cattle must be conducted in a manner consistent with humane treatment standards, whereby cattle are moved calmly and efficiently.
- Ramps and passageways need to offer the animals good footing at all times to prevent slipping and injury.
- Environmental elements that could cause cattle distress and agitation—such as excessive noise, foreign odors, and unfamiliar visual elements—need to be scrutinized and identified by the handlers in an effort to minimize and mitigate.
- Transportation of cattle shall not exceed 8 hours without specific review and approval by HFAC for any derogation.
- Detailed transportation records need to be kept and made available for review by HFAC inspectors and TWR in historical catalogue for a minimum of two years. This includes all transport to harvest facilities, between ranches, and on-ranch transfers.

Cattle Harvesting

TWR expectations for cattle harvest and processing fall in line with the detailed, best-in-class practices elaborately developed by North American Meat Institute (NAMI) and Certified Humane® as captured in this NAMI Publication. Handling practices for cattle in holding pens after being unloaded from transport must be consistent with HFAC standards and observant of the intention to reduce animal distress through environmental observation and modification.

All harvest facilities utilized for TWR must:

- be inspected and approved by Certified Humane® through HFAC Inspection
- file and retain full traceability records on a per animal basis
- maintain proper sanitation and facility upkeep
- provide handler training on low-stress cattle management and movement
- be available for physical inspection by TWR with advanced notice of 48 hours

Auditing and Inspection

Third-Party Auditing

Annually, all ranching operations—from cow-calf operations, to backgrounders, to finishing operations—must be audited and approved by Certified Humane® through their HFAC audit system. Slaughter and processing plants must also be audited by Certified Humane® for humane handling and dispatch, as well as complete segregation throughout the supply chain. In addition, HFAC audits for the integrity of the TWR grassfed claim.

TWR Inspection

Annually, TWR will perform inspections and audits either in partnership with Certified Humane® or separately to validate claims and approve land management practices. All suppliers into the TWR program need to be explicitly reviewed and approved in writing by TWR.

Non-Conformances and Corrections

Any non-conformance identified in the audit and inspection process must be documented and will be classified per the following schedule:

Type	Example	Result
Oversight	Pasture maps are missing from Farm Plan	Corrective actions addressed within 5 business days, with no need for further on-site inspection
Problem	Soil erosion noted in pasture	Corrective action plan addressed within 30 days, prompting follow-up audit and validation
Failure	Cattle are stressed due to inadequate access to water	Immediate suspension from TWR program pending a reaudit

Audit and Inspection Cadence

All producers in the TWR program will be audited annually through a combination of TWR Inspection and Third-Party Auditing, as outlined above. If non-conformances are identified, additional inspections, audits, and documentation review will be required as needed for program participation.

Professional Resources

TWR engages with professionals throughout multiple segments of the industry to ensure the latest information on grassfed systems, humane handling, and restorative agricultural practices are available to program participants. Regular revision of the TWR Beef Protocols and additional training presented to program participants is often based on new developments in health, nutrition, humane handling, and agricultural developments offered to TWR by outside professional advisors and industry experts.

Colorado State University College of Agricultural Sciences: https://agsci.colostate.edu/
Humane Farm Animal Care (Certified Humane®): https://certifiedhumane.org/
The Savory Institute: https://savory.global/
North American Meat Institute: https://www.meatinstitute.org/
Non-GMO Project: https://www.nongmoproject.org/
The Carbon Underground https://thecarbonunderground.org/

Well-managed grazing systems can be truly sustainable and improve soil health, help sequester carbon, and maintain plant biodiversity. The grazing animals are part of the cycle of life and the natural grass ecosystem. They are a natural part of the land. – Temple Grandin

Grandin, T. Grazing Cattle, Sheep, and Goats Are Important Parts of a Sustainable Agricultural Future. *Animals 2022, 12, 2092.*

Appendix A: The Five Principles of Soil Health

Principle 1 – Soil Armor

Soil armor, or cover, provides numerous benefits for cropland, rangeland, hayland, gardens, orchards, road ditches, and more. Let's take a closer look at some of the soil armor benefits:

- *Controlling Wind and Water Erosion – armor protects soil from wind and/or water as it moves across the soil surface. It holds the soil in place along with valuable soil organic matter and nutrients.*
- *Evaporation Rates – armor reduces soil evaporation rates, keeping more moisture available for plant use.*
- *Soil Temperatures – armor helps soils maintain a more moderate range of soil temperatures, keeping soil warmer in cold weather, and cooler in hot weather. Like us, the soil food web functions best when soil temperatures are moderate.*
- *Compaction – rainfall on bare soils is one cause of soil compaction. When rainfall hits the armor instead of bare soil, much of the raindrop energy is dissipated.*
- *Suppresses Weed Growth – limits the amount of sunlight available to weed seedlings.*
- *Habitat – provides a protective habitat for the soil food web's surface dwellers.*

Principle 2 – Minimizing Soil Disturbance

Soil disturbance can generally occur in different forms:

- ***Biological disturbance**, such as overgrazing, which limits the plant's ability to harvest CO2 and sunlight.*
- ***Chemical disturbance**, such as over application of nutrients and pesticides, can disrupt the soil food web functions.*
- ***Physical disturbance**, such as tillage.*

A typical soil is approximately 45% mineral (sand, silt, and clay), 5% soil organic matter, 25% water, and 25% air. The water and air portions exist in the pore spaces between the soil aggregates. Over time, tillage implements reduce and remove the pore spaces from our soils; restricting infiltration and destroying the biological glues which hold our soils together.

Ultimately tillage results in one or more of the following:

- *water erosion – transporting soil, nutrient, and water to offsite locations, which negatively impacts water quality and quantity.*
- *wind erosion – transporting soil, and nutrient to offsite locations, which negatively impacts air quality, human health, and animal health.*
- *ponding water – which stays saturated on the surface for long periods of time, a result of reduced infiltration and increased runoff.*
- *crusting easily, which restricts plant emergence.*
- *soil organic matter depletion.*

Principle 3 – Plant Diversity

The Journals of Lewis and Clark describe the northern plains landscape as having abundant plant diversity. Numerous species where observed, working together as a plant community to provide forage for large herbivore populations. Our soils were built over geological time in this environment.

However, settlement of the plains brought agriculture, which resulted in the polyculture perennial landscape being replaced by a monoculture annual landscape. Where the soil food web use to receive carbon exudates (food) from a diversity of perennial plants harvesting

sunlight and carbon dioxide; it now receives carbon exudates from only one annual plant at a time.

We can start to mimic the original plant community by using crop rotations which include all four crop types. Diverse crop rotations provide more biodiversity, benefiting the soil food web, which in turn improves rainfall infiltration and nutrient cycling, while reducing disease and pests. Crop rotations can also be designed to include crops which are: high water users, low water users, tap root, fibrous root, high carbon crops, low carbon crops, legumes, and nonlegumes to name a few.

The following lists the four crop types with a few common crop examples of each:

- *Warm Season Grass – corn, sudan, and millet.*
- *Warm Season Broadleaf – sunflower, and soybean.*
- *Cool Season Grass – wheat, oat, barley, and rye.*
- *Cool Season Broadleaf – flax, pea, and lentil.*

Diverse crop rotations mimic our original plant diversity landscapes. They are important to the long-term sustainability of our soil resource and food security.

<u>Principle 4 – Continual Live Plant/Root</u>
Our perennial grasslands consist of cool season grasses, warm season grasses, and flowering forbs. Consequently, adaptable plants are able to grow during the cool spring and fall weather, as well as the summer heat. Allowing for a continual live plant feeding carbon exudates to the soil food web during the entire growing season.

Our cropland systems typically grow cool or warm season annual cash crops, which have a dormant period before planting and/or after harvest. Cover crops are able to fill in the dormant period and provide the missing live root exudate, which is the primary food source for the soil food web. Cover crops may be incorporated into a cropping system as annuals, biennials, or perennials. Starting on a small acre scale will allow farmers and ranchers to find the best fit for their operation. Cover crops can address a number of resource concerns:

- *Harvest CO2 and sunlight, providing the carbon exudates to the soil food web.*
- *Building soil aggregates and pore spaces, which improves soil infiltration.*
- *Cover the soil, controlling wind and water erosion, soil temperature, and rainfall compaction*
- *Catch and release of inorganic nutrients, improving water quality.*
- *Salinity management.*
- *Pollinator food and habitat.*
- *Weed suppression.*
- *Wildlife food, habitat and space.*
- *Livestock integration.*
- *Adding crop diversity*
- *Adjusting the cover crop combination's carbon/nitrogen ratio, to either accelerate or slow decomposition.*

<u>Principle 5 – Livestock Integration</u>
Animals, plants, and soils have played a synergistic role together over geological time. In recent years, animals are playing a reduced role due to being placed in confinement and fewer farms now include livestock as part of their overall operation.

Why do we want to return livestock to the landscape?

- *Fall or winter grazing to convert high carbon annual crop residue to low carbon organic material; balancing the carbon/nitrogen ratio and managing our crop rotation residue for no-till seeding.*
- *Spring or summer grazing annual and/or perennial plants with short exposure periods followed by long recovery periods; allows the plants to regrow and harvest additional sunlight and CO2.*
- *Reduce nutrient export from our cropland and hayland fields. In lieu of transporting feed to a feed lot, we can reverse the roles and have the livestock graze the material in place. Recycling the majority of nutrients, minerals, vitamins, and carbon.*
- *Manage weed pressure by grazing in lieu of an herbicide.*
- *Grazing cover crops and/or crop residues allow us to take the livestock off the perennial grasslands earlier in the fall. Extending the grass recovery period and providing a higher livestock nutritional diet.*
- *Grazing reduces livestock waste associated with confinement; helping manage our water quality and nutrient management concerns. Allowing cattle and sheep to be herbivores by securing their energy needs from plants.*

How do we return livestock to the landscape?

- *Winter and fall grazing cover crops and annual crop residues.*
- *Summer grazing a full season cover crop, allowing adequate plant recovery, followed by a second grazing during the fall or winter.*
- *Winter feeding on hayland fields by rolling out bales or bale grazing.*
- *Seed rotational perennials, graze and manage as part of the crop rotation.*

Appendix B: The Five Management Practices for Pasture Vitality

Practice 1 – Graze the pasture

Ranchers must commit to grazing their pastures annually with ruminant animals.

Proactively integrating ruminant animals onto pasture is essential to improving pasture resilience and vitality. Grasses and forage depend on grazing animals to effectively trim and control the biomatter they produce, and to provide additional soil nutrients through natural fertilization. Additionally, the hoof prints left behind create depressions that aid in water capture and water infiltration, as well as erosion control.

Specific approaches to introducing grazing animals will depend on the land and the environmental conditions, but some practices are broadly applicable across landscapes:

- Cattle are high-volume grazers and a good choice for regenerating soil in compromised pastureland. Their frame as compared to the cervid family of ruminants (deer, elk, moose, caribou, etc.) allow for them to be easily contained by traditional fencing or high tensile electric fencing. The same holds true compared to larger bovid ruminants of North America (bison), whereby traditional fencing is inadequate.
- Rotational grazing, also called management-intensive grazing, is a best practice for land management and soil creation. Careful and intentional pasture rotation allows the rancher to graze down paddocks to a targeted point and then let the paddock rest for

optimal plant recovery. This practice stimulates plant growth above (forage) and below ground (root system). The living root and additional organic matter in the soil (humus) sequesters carbon from the atmosphere and provides habitat for microbiological activity in the soil. As general guidance, Dr. Temple Grandin recommends grazing the forage down to approximately half intact plant height (but no less than 4 inches of residual for most species) before moving the cattle to new pasture so as to allow optimal plant recovery after grazing, with exceptions made for specific forage types.

Practice 2: Promote biodiversity

Ranchers must commit to planting or sustaining diverse mixtures of perennial grasses and annual crops to promote rather than diminishing biological diversity.

Just as it is important for humans to eat a balanced diet, it is critical to animal health to ingest a varied diet. For cattle and other grazing animals, that means a breadth of grasses and other forages. In turn, pasture needs to host and sustain a diverse selection of plants to propagate diverse microbiology responsible for breaking down and spreading nutrients throughout the soil system.

- Diversity of forage – the rancher can plant a variety of plants to create a balance of nutrients available for forage, a diversity of root types and root systems underground, a diversity of drought resistance, and resilience to seasonal temperature and moisture fluctuations.
- Diversity of microorganisms – a diverse array of plants will attract and sustain a breadth of microorganisms within the soil. Among them, fungi, bacteria, algae, and protozoa, will help with the decomposition and storage of organic matter into more available and consumable nutrients for the plants and insects.
- Diversity of insects and animals – with a healthy soil will come macrofauna such as worms, beetles, and spiders. These species will aerate the soil, move nutrients around and attract other animals such as birds and bats. Flowering plants will attract pollinators such as bees and butterflies that will in turn play a part in the balanced ecosystem. Cattle and other foragers will eat and distribute plant nutrients as a pivotal component of the pastoral nutrient chain.

Destroying or killing of any portion of this balanced ecosystem will result in an imbalance which will in turn open the system to dominant species to take over such as weeds, fungi or dominant insects.

Practice 3: Sustain soil cover

Ranchers must commit to keeping soil vegetated and covered.

The diversity of life described above creates a balanced system that feeds and builds upon itself. However, it needs a base habitat in which to do so. Plants serve as the basis of the habitat for these other organisms. Keeping pasture and farmland planted with vegetation year-round is the best approach to protecting the organisms that build and sustain the soil. In addition to feeding this life, plants provide the following:

- Erosion control – plants hold the soil together with its roots. A heavy rain hitting bare soil will pool and run off the land, carrying with it that valuable topsoil.
- Water infiltration – plants roots serve as conduits to guide water into the ground. When a heavy rain hits bare soil, it turns to mud and can suffocate the aerobic organisms in the ground.
- Evaporation control – plants hold moisture in the ground, near their roots where they can utilize it when they photosynthesize. Bare soil leaches moisture into the air and eventually hardens and cracks allowing for further evaporation. The rapid change in humidity observed in bare soil creates for more rapid temperature swings to which the insects struggle to adapt and face population decline.

Practice 4: Tread lightly on the soil

Ranchers must commit to eliminate broadscale deep-tillage and herbicide/pesticide use to kill off pasture vegetation and biology.

Soil intrusion disrupts biological equilibrium. If every year, a major earthquake toppled each of our homes, we would face significant challenges as a human race. Our homes provide us shelter, create for a safe environment to raise our young, and allow us to store food and water to get us through the winter or other times of need. The soil represents this habitat for plants, insects and microorganisms. Deeply, broadly, and frequently tilling the soil is akin to that disastrous earthquake and requires significant time for recovery. Instead, farmers should leave the soil structure largely intact and integrate less intrusive farming practices.

- No-till production practices – with today's advances in technology, there is little need to till the soil as there are seed drills that allow farmers to plant seeds into the ground with minimal soil disturbance. While still technically a tilling mechanism, these drills make small slits in the ground, deposit seeds at a predetermined rate, and push topsoil back over the seeds for germination.
- Minimize external inputs – Modern-day industrial agriculture is largely dependent on external inputs such as synthetic fertilizer, herbicides, and specialized seedstock. This dependency is costly and creates for additional dependencies on subsidies. A farmer building rich topsoil is working to minimize external inputs. Over time, fertile ground will need fewer amendments, weeds will be managed as part of the balanced ecosystem, and the need for hybrid or herbicide-resistant seed will wane.

Practice 5: Analyze and track soil health

Ranchers must commit to analyze and track their soil health for year-over-year changes in the following areas: organic matter content, water infiltration and retention, and biological diversity.

Annual soil testing will help ranchers track soil health and monitor restorative pasture management results, where needed. Data from these tests must be collected and retained for review upon audit.

- Annual monitoring practices – these soil testing methods are designed to allow the ranchers to collect significant data with basic, readily available tools. These annual tests include:
    - **Soil compaction test**: with use of a pocketknife or small blade, a simple soil compaction test can be performed. To do so, select a test area and note the conditions. This test shall only be performed in dry conditions, with the latest rain being at least 72 hours previous. Insert the blade into the ground and simply determine the ease with which the blade enters the soil. Thriving soils will be less compact and thus allow the blade entry into the soil with ease.
    - **Water infiltration test**: healthy soils will readily infiltrate and retain precipitation. This simple test allows ranchers to quickly assess water infiltration and is performed by swiftly pouring about a quart (~one liter) of water onto a flat test site in the pasture and recording how long it takes for the water to fully percolate. Water pooling or soil turning to mud within this test are indications of poor soil quality. The more readily water is absorbed into the soil, the more resilient pasture is during significant weather events such as heavy storms, floods or extended periods of drought.
    - **Ground cover measurement**: this observational analysis method is suggested to look for and address problem areas in the pasture where vegetation has been depleted either as a result of over-grazing, chemical or mechanical disruption, or excessive animal traffic. Some areas of pasture will inevitably be impacted by traffic, such as shaded areas in the summer and areas surrounding watering points. These areas need careful attention to ensure proper rest, replanting and healing. The measurement is visual and should be an approximation, as a percentage, of bare, uncovered (unarmored) soil.

- **Biological diversity count**: best performed in the morning hours or later in the afternoon, this simple count allows ranchers to simply stop and observe a selected quadrat of pasture, one yard by one yard (about one square meter). Some marking devices should be used to identify a site and then get down close to the soil to count plant and macrofauna (insects, etc) species. The greater breadth of species will add to the nutrition of cattle forage, the health of the pasture, and the resilience to changing weather conditions.
- P**hotographic vegetation vigor analysis**: once yearly, within the same month, a photographic assessment will be captured and analyzed to track soil productiveness and vegetation vigor. Factors such as total precipitation and growing degree days shall be factored in to normalize assessment results. The analysis comes in the form of a comparative study between years of photographic material, with normalization for environmental conditions. Comparative photos that capture both land that is managed under restorative practices and a separate parcel that is not can be particularly helpful in tracking year-over-year pasture restoration results.

- Every five years, ranchers will collect a 2" deep soil sample from a set testing area and measure the organic carbon content of the soil, through laboratory analysis. Through restorative agricultural practices, total organic carbon should increase. The rancher is to capture the change in the organic carbon content of their pasture to track their restorative agriculture progress.

Appendix C: Soil health evaluation rubric

Restorative Agriculture Soil Health Monitoring

Teton Waters Ranch encourages all ranchers in the system to adopt a workable soil health monitoring plan to track and help improve soil vitality over an extended period of time.

Evaluation Rubric (circle your answers for each soil indicator measurement)

Soil Indicator	Field Test	S	O	I	L
Compaction	Knife test	Full blade sunk right in	blade needed moderate pressure to fully sink	blade needed strong pressure and lateral action to fully sink	full blade was not able to penetrate the soil
	How much resistance was felt in driving the full length of the blade into the soil?				
Water Infiltration	Rill/gully observation	No observable rills or gullies	Some rill formation noted	Abundant and deep rill formation	Pervasive gully formation
	Look broadly at the land. Do you see the formation of rill or gullies?				
Ground cover	Broad visual assessment	less than 5%	5-10%	10-25%	over 25%
	Looking broadly at the land, what percentage of the soil is unvegetated and bare? (do not count areas that have dead plant material)				
Plant diversity	Quadrant count	over 8	4-8	2-4	0-2

	How many plant species do you count within the quadrant?				
Vegetation vigor	Photographic assessment	greatly improved	some improvement	no change	degraded
	Compared to the previous years' photo, how does the vegetation vigor look?				
Tally your circles:					
		"S" count	"O" count	"I" count	"L" count

"S" count _____	X	4	=	
"O" count _____	X	3	=	
"I" count _____	X	2	=	
"L" count _____	X	1	=	
			TOTAL SCORE:	/20

Interpreting the Total Score

Total Score	Assessment
16-20	Pasture is functioning as a thriving and balanced system
11-15	Pasture is healthy, needing only select improvements
6-10	Opportunity exists for soil and pasture improvement
5 or under	Significant opportunity for pasture restoration work

Environmental conditions, soil types, and previous land uses will all significantly affect the need for pasture improvement and the speed at which restoration occurs.