TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE   STATE OF COLORADO   NATURAL RESOURCES CONSERVATION SERVICE

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To: All Area and Field Offices

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CONSIDERATIONS IN PLANNING LIVESTOCK WATER DEVELOPMENTS

This technical note updates the 1979 Range Technical Note 17 and includes additional planning considerations and guidelines for planning livestock water developments.

Purpose and Objectives:

The purpose of this range technical note is to provide Natural Resource Conservation Service (NRCS) personnel and others, where appropriate, with an updated version of the 1979 Range Technical Note #17 and include additional planning guidance and recommendations for livestock water developments on grazing land.

According to the Conservation Practice 614 standard the purpose of development of livestock water is to meet daily livestock water needs and/or improve animal distribution.

The National Range and Pasture Handbook (NRPH), Engineering Manuals, NRCS Standards and Specifications and other related documents must be used in conjunction with the planning guidance offered in this technical note. Best available guidance and data should always be used, whether it is included or not, in this technical note.

This note provides planning guidance recommendations. If through the planning process and working with landowner knowledge, you determine that you need to plan outside of these parameters, route your justification and supporting documentation through the area office to the State Rangeland Management Specialist for approval by the State Resource Conservationist. Regarding variance requests for 614 Standard/Specification/Drawings or engineering requirements; these need to be routed through the Area Office Engineer for approval.

Planning of a proper livestock watering system can be complex and expensive. Proper planning will help create a livestock watering system that achieves the purposes of the landowner, facilitates grazing management, addresses resource issues, and provides economical alternatives.

Introduction:

The correct location of stockwater can be used to facilitate a grazing strategy and improve distribution of grazing. Adequate clean and dependable water supplies are essential for livestock health, as well as facilitating good grazing management.

The when, where and how to use livestock watering facilities will be highly variable depending on the on-site considerations, therefore, it is always important to follow good resource planning procedures. Consider the following typical types of stockwater problems when planning existing and new stockwater developments (Vallentine, 1989):

- There are too few watering places.
- Water yield, storage or both are inadequate.
- Water sources are poorly distributed.
- Water development is wasteful because of leakage or high evaporation.
- Erosion problems possible or present at the existing or planned facilities.

The planning process must be followed even when we are working with a cooperator who assumes they know exactly what they want done, or we are in a rush due to work load. To do otherwise frequently leads to such problems as:

- The livestock watering systems does not adress the resource needs and management goals.
- The livestock watering system does not meet the needs of the cooperator.
- Lack of long term viability of the system or potential expansion of the system.
- Potentially an overly expensive system

Planning Proceedures:

A. Objectives

The landowner objectives are essential to the success of grazing plan; as well as being instrumental in a well planned livestock watering system. Does the cooperator want a more dependable supply of water, better grazing distribution, better quality water or to avoid use in a riparian area? These considerations, as well as, how the watering facility will be operated and maintained are important planning considerations that need to be worked out with the landowner. But we also need to remember that if NRCS is involved that NRCS has planning objectives as well.

The National Range and Pasture Handbook, NRPH, states that the objectives for conservation planning on grazing land are to assist the client with:

- Understanding the basic ecolocial principles association with managing their land – the soil, water, air, plants, animals, energy and humans, SWAPAE + H.
- Realizing they are a part of the complex ecosystem and their management decisions influence the ecolgocial changes that occur.
- Realizing their responsibility and the importance of protecting the environment and maintaining future options for the use of the resource.
- Developing a plan that meets the needs of the resources and their management objectives.

A grazing strategy when coupled with any necessary facilitating and accelerating practices, will meet planning criteria and conservation planning objectives. Since livestock water is a facilitating practice, one can not consider livestock water developments without discussing grazing management strategies with the landowner.

B. Resource Inventory

During the resource inventory phase you will be collecting information that will assist with conservation planning, as well as any planning considerations for livestock water development.

Here is some information that relates to livestock water development that should be obtained when planning a watering system:

- Inventory of resources and identification of resource concerns – planning criteria or benchmarck conditions.
- Existing watering locations and seasonality of other available water sources.
- Quantity and quality of existing water sources.
- Pasture sizes and structure.
- Forage availability and diversity of forage available.
- Distribution of utilization.
- The annual grazing period.
- Types and the planned maximum number of livestock and wildlife which will have access to the water at any given time.
- Outline of grazing strategy to be used.
- Desirable watering locations, based on an analysis of range use patterns, range conditions, forage types, geology and topography.
- Ease of access to water for existing and planned water locations.
- Landowner operational and management considerations.
- Desired conditions of planned water, delivery requirements, seasonality of use and operational considerations.
- Property lines and ownership considerations.
- The view from the highway, recreation areas, etc.

C. System Alternatives

Livestock water sources should be distributed and spaced within pastures to distribute utilization of available forage and to minimize excessive livestock impact to the rangeland's biotic community, hydrologic function, and/or soil condition. Management plans need to include forage demand and availability, as well as allow adequate recovery periods and other factors outlined in the Prescribed Grazing Standard/Specification and other planning documents.

If it has been determined that there is inadequate stock water available then there should be a water balance done to determine that the quantity of water or the current flow rate does not meet the water demands of the livestock herd and other uses. An example of a water balance is provided in Attachment 1.

Guidelines determining need, suitability, practicability and size of development:

A. Stockwater Quantity Requirements

Water development should provide dependable water supply to provide adequate livestock water for the periods of planned grazing use.

You should plan watering quantity for the planned number of animal units depending on the *expected* resource considerations and landowner goals and objectives. The amount of livestock water should normally be designed to meet the water needed for the sustainable *potential* stocking rate and should consider potential changes to the prescribed grazing plan for the ranch. A prescribed grazing plan begins with an inventory of the ecological sites or forages for pastureland in each field, and an estimate of the current production. Along with the landowner, this information is used to establish the initial stocking rate of the prescribed grazing plan, the inventory along with the plan helps determine the *potential* sustainable stocking rate and herd size.

There may be circumstances where water supply can not possibly meet the livestock demands, for example poor yielding wells etc. In these situations, limit the initial stocking rate in the grazing management plan needs based on the water supply, flow and recharge capacity.

If authorized animal numbers on a Tribal, State, or Federal administered grazing allotment is significantly below the potential stocking rate, then livestock water should be designed for the realistic animal numbers that *might* be authorized. If authorized animal numbers are significantly higher than the NRCS estimate of potential sustainable stocking rate, then the amount of livestock water should be designed for the NRCS estimate of sustainable potential stocking rate.

Table 1: Recommended guidelines for daily water requirements per day (USDA/NRCS, 1992)

Species	Water Consumption (gallons per day)
Cattle	
Yearling	7-10 gal/day
Cow	15-20 gal/day
Cow and Calf	20-25 gal/day
Dairy Cow	25 per head
Bull	20-25 gal/day
Horse	15-20
Sheep/Goat	1-3
Swine	2-4
Poultry	8-15 per 100 birds
Mule Deer	2
Antelope	2
Elk	8

The ranges are given to accommodate most considerations, use the number within the range provided depending the planning considerations and ranch management factors that were identified in the planning process. Factors that increase or decrease these recommendations include some of the following considerations:

- Grazing Management Strategy - If the grazing strategy includes more intensive management, and there are larger animal numbers for a shorter period of time, then consider the higher gals/day. For example, a cow in a conventional grazing strategy using 15 gal/day will ushually provide more than enough water demand but 20 gals per day might be needed for an intensive grazing strategy (USDA NRCS, 1992).

- Temperature – as air temperature increase consumption generally increases. Consumption by livestock in normal conditions can sometimes be as much as 40% higher in the summer than in the winter (Markwick, 2007).

- Water Quality – Water with higher salt content will increase water consumption, especially when compounded with temperature (Markwick, 2007).

- Drought Conditions – During drought, livestock are forced to select more fibrous and less digestible feed. Livestock will require more water to maintain movement of the course feed in the gut (Markwick, 2007).

- Breed difference – there are differences in livestock breeds and the quantity of water comsumed. For example Indian cattle (*Bos Indicus)* or Indian cattle cross breeds of cattle tend to drink less water under hot conditions than do European (*Bos Taurus)* cattle (USDA/NRCS, 2003).

- Age and condition class of livestock – Lactating stock have higher consumption requirements than dry or young stock.

By utlizing the agency handbooks and the landowner's knowledge of the herd and how much water historically they have noted consumed, you can determine a good "average" gal/day to be used on the individual operation. <u>Economics, storage and flow rate also have an important role in determinining the total daily water needs.</u>

B. Qualitiy of Water

Quality of water is important in maintaining satisfactory production by livestock. The principle factors that affect water quality for consumption are salinity, acidity or alkalinity (ph), toxic elements or compounds (Markwick 2007).

Where water quality is a concern for productivity losses, the problem can be investigated by a veterinarian or livestock adviser. Investigation would most likely include a water analysis and examination of livestock. Colorado Extension Fact Sheet No. 0520 Selecting an Analytical Laboratory by R.M. Wasksom et al. offers guidance about how to select a lab for soil, water, manure, and plant testhing. You may also refer to the Colorado NRCS Standard and Spec 355 for Water Well Testing guidance.

Salinity

Dissolved salts are a main factor for determining suitability for use. Saline water can upset the electrolyte balance in animals and can result in symptoms similar to dehydration (German et al. 2008). Dissolved salts in water are expressed as milligrams/liter (mg/l) which is equivalent to parts per million (ppm).

There are many factors that influence the animal's ability to tolerate the concentration of salts in the drinking water. But here are some guidelines for use of saline water by livestock.

Table 2: Guidelines for effects of use of water with saline for Livestock (USDA/NRCS, 1992; German et al. 2008)

Total Dissolved Soids (mg/l)	Effect
1,000 - 3,000	Very satisfactory for all classes of livestock. May cause temporary and mild diarrhea in livestock not accustomed to them.

3,000 - 5,000	Satisfactory for livestock but may cause diarrhea or be refused at first by animals not accustomed to them. Poor water for poultry.
5,000 – 7,000	Can be used with reasonable safety for dairy and beef cattle, sheep, swine, and horses. May want to avoid use for pregnant or lactating animals for extended period of time. Not acceptable for poultry
7,000 – 10,000	Unfit for poultry and probably for swine. Considerable risk in use for lactating cows, horses, sheep, or for the young of these species. In genereal, use should be avoided although older ruminants, horses, and swine may subsist under certain conditions.
Over 10,000	Risks with these hghly saline waters are so great that they should not be recommended for use under any conditions.

Water with high salt levels can also cause problems with the long term viability of steel watering troughs. Consider design construction alternatives in areas with lower quality water.

Sulfate

Sulfur is a necessary mineral for rumen microorganisms, but livestock can be sensitive to excessive sulfur intake through feed or water. Sodium Sulfate is the primary salt causing elevated water TDS in Colorado (Ellis, 2013).

Sulfate levels can be higher in a watering trough than directly from the water source due to evaporation. Consider management activities such as draining the water trough frequently or ensuring that the herd drinks the water to low levels befor allowing for the water to refill might help keep sulfate levels at acceptable levels. Or consider using pastures with the highest sulfate water during times of lowest water intake such as during cold (or at least cool) weather and when water requirements are lowest (dry vs. lactating cows).

Polioencephalomalacia (PEM) is a metabolic/neurological condition of cattle that is associated with high sulfur intakes.

Table 3: Interpretation of water sulfate levels for livesock (Ellis 2013, German et al. 2008)

Sulfate Levels (ppm)	Effect
<500	Safe for Drinking
500 – 1500	Generally Safe, trace mineral availability may be reduced, may decrease performance in confined cattle
1500 – 3000	Poor water for poultry at higher levels. At lower levels generally no harmful effect for livestock – except some temporary diarrhea. Marginal, may be unsuitable for confined cattle during hot weather, performance may be reduced, sporadic cases of PEM may occur.
3000 – 4000	Very laxative, unacceptable for poultry. Unsuitable, not recommended for use for pregnant or lactating ruminants or horses or animals in confinement. Decreased performance on grazing cattle may occur, and risks for PEM in confined cattle is increased.
>4000	Dangerous, health problems expected and substantial reduction in cattle performance, secondary copper deficiency likely.

Nitrates

Table 4. Guidelines for effects of nitrates on livestock (USDA/NRCS, 1992)

Nitrate Concentration (mg/l NO3 as N)	Effect
10 – 30	Slight possibility of harm

30 - 50	Risky, especially over a long period of time
50 – 100	Interference syndrome likely (trempling, weakness, discolored urine)
100 – 145	More serious; acute losses
145 – 195	Increased acute loses, secondary diseases
>195	Acute losses

Acidity or alkalinity (pH)
Water with a pH level below 6.5 (acid) or above above 8.5 (alkaline) can cause digestive problems in livestock which can result in rejection of water, loss of appetite and consequent loss of production (Markwick, 2007)

Algae growth or bloom
Algae can occur naturally in both fresh and braskish waters. Algae blooms are most likely to occur when water is still, warm and contains high nutrient levels.

The following information on blue-green algae is from Dr. Bill Epperson, South Dakota University Cooperative Extension Service, EX11007. Blue-green algae (cyanobacteria) occur naturally in ponds. There are many different species, some of which are harmless but some under specific environmental conditions can be come toxic. The blue-green algae can become stagnant following hote, dry and calm days and can contaminant the the drinking water with a scum, "skin" or "paint" on or just below the water surface. It can appear in many different forms, but it is not the type of algae that grows in mats of plant materials along shorelines, blue-green algae disperses in water and will not hang together in a stringy mass.

Blue-green algae poisoning affects the nervous system and the liver. The nervous system toxins cause, muscle tremors, decreased movement and breathing, causing collapse and convulsions. Many time resulting in death. When the liver toxins affect animals, they may show weakness, pale color moucous membranes, mental derangement, bloody diarrhea and ultimately death.

Even if the animal survives the poisoning, they may lose weight, and become chronically poor conditions.

Because algae poisoning is unpredictable and sporadic it is difficult to manage. It is more likely in stagnangt natural waters following hot days. So management must include monitoring and watching for agae blooms in hot weather.

Other management options include:

- Fence off downwind drinking areas and force animals to drink from areas where a concentration of blue-green algae organisms is unlikely.
- Pump water from serveral yards below the surface of a fenced off pond to a near by tank,
- Use other water sources if available during high temperatures
- Add an algaecide if the stie has a history of repeated blue-green algae blooms.

C. Site selection

It is difficult to manipulate which plants livestock will graze due to fine and coarse spatial and temporal scales of animal selectivity, but water development is a tool that allows us to manage which parts of the pasture livestock graze (Bailey et al. 2011). Water development can dramatically alter grazing distribution, especially if pastures contain areas that are horizontally or vertically far from water (Bailey et al. 2011).

Where pasture size allows for only one water facility, it should be located as near the center of the area to be grazed as possible and practical. For increasing distribution of livestock, consider locations that would draw the animals into a desired location or away from undesired locations.

Water needs to be located away from critical areas where livestock concentration could result in water quality issues, or severe erosion.

Distance between watering facilities needs to be determined by looking at distribution of utilization. Often the operator can provide you historical grazing use patterns of the herd; as well as correct documentation of utilization patterns observed during the ranch inventory can help you understand the resource concerns and how/if water development will help address the concerns. Areas inaccessible to livestock grazing due to slope, natural barriers or other reasons should not be considered in determining the water distribution needs.

The provided distances are recommendations based on topography and distance between water facility locations, assuming that cattle can travel distances between waters and graze herbaceous forage.

Table 5: Recommended guidance on water spacing baced on topography and distance.

Topographic Relief	**Recommended distance between watering points**	**Sample Description of Site Condition**
Gentle to Rolling	1 mile to maximum 2 miles	Smooth to gently rolling lands producing fairly uniform forage to gently rolling or hummocky sandy land or deep sands having few ridges, dunes or gullies which create minor grazing distribution problems.
Strongly Rolling to Broken	1 mile to maximum 1 1/2 miles	Rolling lands intersected with steep ridges and drainages general having some changes in kinds of vegetation or stony ridges that are difficult to secure satisfactory grazing distribution.
Steep, rough or dissected by interspersed ridges and drainages	1/2 mile to maximum 1 mile	Slopes over 15%. Intersected by steep and sharp ridges or drainages, rugged hills, and steep mountain terrains having limited livestock crossings which result in difficult grazing problems.

Other considerations in site selection:

Animal Behavior:

- Breed types, as well as familiarity with the “home territory or range”, highly determine distance that livestock are willing to travel for water. GPS tracking data make it clear that adapted cattle travel long distances from water and do not remain in one area near water even when pastures are large and stocking densities are low (Bailey et al. 2011). For example, in a study by Bailey et al. 2010, Brangus cattle native to their home range traveled over 2.3 miles and grazed a larger area than new or unfamiliar Brangus cattle that traveled less than 1.8 miles from water, which was still farther than the breeds that were from European (*Bos Taurus*) decent. All the breeds averaged together, native cattle on average traveled approximately 1 mile from water, while naïve cattle traveled approximately 0.5 miles from water. Naïve cattle can transition to new locations but plan on that taking approximately a year to adjust (L-5409, 12-01)
- Animals that have shade near water may have an increased likelihood of congregating and resting at the watering facility site.
- Fenced watering facilities tend to create a “corraled” feel for livestock and usually will create a situation where once aquainted with the site, they will water and then leave the site. But consideration of wildlife use also needs to be evaluatued when fencing watering facilities.
- How comfortable or how fearful an animal is has a lot to do with herd dynamics, individual disposition, breeding, etc. Their individual behavior will change if in a herd mentality (groups) or is alone or in small pairs. This knowledge from the operator helps when thinking about how an animal will graze and use water.

Soils/Topography:

- Avoid placing watering facilities in soils with erosive charateristics. If erosive soils can not be avoided refer to CO NRCS Heavy Use Protection Standard/Specification 561 or alter design to include a concrete or compacted gravel pad apron around the watering facility. Vegetation immediately surrounding the facility can be compromised because of animal congregation. Consider the design of the foundation of the trough and avoid situations where the trough may pedastal due to increased erosion. If the erosion is severe this can cause a situation where the trough is elevated to the point where it makes it difficult for livestock especially young animals to access water.
- Consider location of animal trailing and erosion factors to minimize potential areas of concern; also location of existing animal trails and walkways in your design can improve access to the watering facility.
- The relationship between slope and animal grazing distribution is not linear, and is a function of animal behavior, familiarity to the terrain, breed and other factors. In general, research has shown that cattle will graze within 150 feet elevation above the water source (Roath, per.comm). Consideration of trough location relative to slopes and access for livestcok is very important. Consider contour access into locations and understand that they tend to travel down slope from the location better than upslope. (Roath, per. comm) Slopes in excess of 60% typically will not be used by cattle regardless of vegetation types (Roath et al. 1982). Sheep have different grazing patterns and typically can use steeper slopes. Sheep often are herded into or between watering locations.

Roads and Public Acces:

- Consider public access and public perception when placing locations. Due to possible heavy concentrations of livestock, consider locating away from heavy traffic areas, away from roads etc.
- If public access is a consideration then placing waters away from direct ingress locations to property will minimize issues with gates being left open or separation of cattle etc.
- Consider operator access for construction, operation and maintenance.
- Consider special situations where vandalism that may affect operation and maintenance success and the lifespan of the practice.

Fences:

- Where possible avoid cross fencing watering facilities. This decreases the spatial area of the trough available to livestock and can create overcrowing issues. This can also create unnessesary pressure on fence lines.
- Also cross fencing watering facilities can create problems for wildlife that may use watering troughs as a water supply.
- In these situations consider using multiple troughs or use a small corral or water enclosure to water multiple pastures instead of cross fencing; or make sure that the planned trough is large enough to accommodate wildlife considerations.
- If using a watering corral, plan your enclosure large enough to let animals access the water facility easily but small as possible to encourage animals to water and leave quickly. Water enclosures can discourage wildlife use by larger wildlife species, so if you are planning that corral to be used by wildlife consider fencing with wildlife in mind as well as consider increasing the size of the enclosure. Leaving gates open when not in use by livestock will also promote use by wildlife.

Other Planning Considerations in Relationship to Water Development

A. Grazing Strategies and Pasture Layout

There is more to grazing management than building water and fences. Adequate, reliable and properly distributed livestock water of good quality is critical to ensuring that a prescribed grazing plan will work. Locations of facilitative practices such as water and fencing can be diverse and complicated. All the factors need to be discussed with the landowner so the best planning is considered. Facilitative practices are used to manage animal foraging behavorior.

When water is intended to move animals amoung different parts of a pasture over time, and will be utilized by rotating water availability, the location needs to be distributed far enough in distance between sources so that the majority of the grazing animals do not regraze or over utilize areas that are intended for rest. Use the higher recommendations of spacing based on topograpyhy, as well as, discussing with landowner the typical distances cattle graze from water. Water enclosures can also be used to limit water to intended areas for rotational purposes.

Consider the use of water corrals for ability to access water from multiple pasture locations. Dividing pastures into smaller pasture size with a single water source by radiating out from that source does not necessarily reduce the distance to water on any part of that pasture or provide a new location of water (Hart et el. 1993). Providing new water sources can reduce the distance to water on large pastures without the need for fencing or pasture subdivision (Hart et al. 1993). Fencing and water development are facilitating practices for the grazing strategy so these alternatives need to be carefully evaluated with the landowner to consider the resource concerns, plant resource need, livestock needs, and economical considerations as well.

Water availability, reliability, and quality needs to be considered in drought contingency planning. If there are pastures that do not have reliable, permanent water, they should not be considered as available forage in a contingency plan unless alternative options, such as water hauling are provided.

B. Wildlife and Riparian Management

Water is a very important critical factor when examining abundance and distribution of wildlife as well as managing habitats (Taylor and Tuttle, 2007) Keeping wildlife considerations in mind during livestock water planning is important; livestock water developments are crucial for many species, because they can utilize the water source in areas where natural sources are diminishing or where natural historical water is not available (Taylor and Tuttle, 2007). Livestock water can improve quality of surrounding habitat and allow some species to exand their habitat into previoiusly unsuitable areas, as well as provide permanent water druing time of stress such as drought, high temperatures or rearing young (Taylor and Tuttle, 2007). Working with the landowner and local wildlife professionals, utilize the knowledge of local animal kind and numbers to determine location, quantity and designing considerations that would benefit the wildlife management goals of the operator and wildlife managers.

Water for Wildlife: A Handbook for Ranchers and Range Managers by Taylor and Tuttle published by Bat Conservation International in 2007, provides many guidelines and design considerations for enhancing wildlife safety and access, improving wildlife escape structures and increasing wildlife access.

Livestock are attracted to riparian areas and often use them at a disproportionately higher rate than surrounding areas. Management strategies need to be tailored to the specific riparian ecosystem and objectives. Providing off-stream water sources can effectively alter livestock distribution patterns in riparian areas and uplands (Porath et al. 2002, USDI/BLM 1997). Other management techniques such as fencing, herding, salt/mineral placement, turn in locations, and selective culling of animals based on home range preference are other considerations that can be included in a grazing strategy for riparian areas (USDI/BLM 1997, Howery et al. 1996, and Roath and Krueger, 1982).

Some Design Considerations

A. Flow and Storage

Flow and Storage are critical planning and designing elements. Without both adequate flow and storage the system may have critical periods of time where it does not function properly or meet the needs of the herd. Livestock who have to travel long distances for water and then are left dry will tend to not use these watering points in the future or on a consistent basis. Also if the water is not delivered fast enough to the source, then “loafing” of the herd at the water source while waiting for water can lead to overcrowding the trough, and possible damage and harm to the watering facility and the animals.

In pastures of sufficient size to need two or more livestock waters, based on the livestock water distribution criteria, the combined flow and storage of water sources should be adequate that remaining water sources are able to meet the entire water need in the event one water source fails. For example, if a pasture requires two water sources to adequately distribute livestock within the pasture, each water source should be designed to be able to meet the water needs of the entire herd; in a pasture with three water sources any two water sources should be able to meet the water needs of the entire herd, etc.

If the combined water flow and water storage is not adequate to supply a substantial amount of the livestock water needed it will be considered an inadequate source of livestock water and the animal units will need to be balanced to the water supply. An example would be a “reliable” spring that can only supply enough water for ten head of livestock where the herd size is three hundred head. Make sure that the water provided within the pasture can provide the water needs for the planned herd during the time of grazing within that pasture.

There are no hard and fast rules about how much water storage is adequate. According to the Colorado Specification – a minimum is 4 days for unreliable sources and 10 % of the total daily water needs for tanks that have an adqeuate water supply (USDA/NRCS, 2012). Other sources recommend as much as 10 days for unreliable sources (USDA/NRCS, 1992). How much is enough depends on the reliabilitiy of source, hazards of the system, reliabilitiy of the supply and the management decisions of the operator. These factors need to be thoroughly discussed with the operator so that their decision on water storage can be determined (USDA/NRCS, 1992). Document these decisions accordingly within the file for future design purposes.

B. Access to Water Facility

It is generally assumed that livestock come to water less frequently when the traveling distance to water is excessive, therefor they may come in larger numbers if the trips are less frequent (Hart et al. 1993). The larger the possible herd size watering at a given time the larger the size of trough needed.

For example, for cattle ensure trough access for a minimum of 5-10% of the herd at a time, and that there is approximately 12” of perimiter available for circular tanks and 18” available per head for straight tanks for cattle (USDA/NRCS, 2010). Other class of livestock will have different access requirements. In general, the trough should be large enough to allow animals to drink without shoving and crowding. This minimizes possibility of injury and stress. Rate of water flow into the trough, is still more critical than size of trough.

Provide access to water for young livestock. Tank configuration should be considered to provide access to water. For example, calves generally do not reach deeper than 20 inches below the top of the rim (USDA/NRCS, 2010). Access to the trough and trough height should be considered for watering access as well for calves, lambs and other young animals.

Summary

Providing livestock water is an essential tool for providing adeqate quantity and quality of water; having water properly distributed and designed to facilitate grazing distribution and management strategies is important to the success of conservation planning, improved resources and good manangement. Planning for alternatives and use of adaptive management will allow operators to have the flexibility needed to alter management to continue to meet resource objectives.

This document provides guidance recommendations, these considerations need to be tailored to the individual livestock operation, resource objectives, grazing strategies and operator's needs.

If you have additional questions or need additional assistance regarding planning considerations, please contact the Colorado State Rangeland Management Specialist.

Appendix 1: Flow Rate Requirements for Daily Needs based on 4-hour, 6-hour and 12-hour period. (USDA/NRCS, 2009)

The minimum pipeline design flow rate must be at least equal the flow rate, in gallons per minute, required to provide the peak daily water requirements in a 24-hour period, for the maximum number of livestock in the pasture. It is often desirable to design for a higher flow rate to allow tanks to refill more rapidly during times of peak usage. Reasonable practice is to design pipeline flow rates to provide the full daily water needs in a 4-hour, 6-hour, or 12-hour period.

Figure 1.1 thru 1.4 shows flow rates required to meet daily needs in a 4-hour, 6-hour, and 12-hour period. These charts assume a 10 percent loss for evaporation and waste.

Figure 1.1: FLOW RATE REQUIRED FOR DAILY NEEDS (SUPPLIED IN 4 HRS)

Based on Additional 10% for Evaporation and Waste

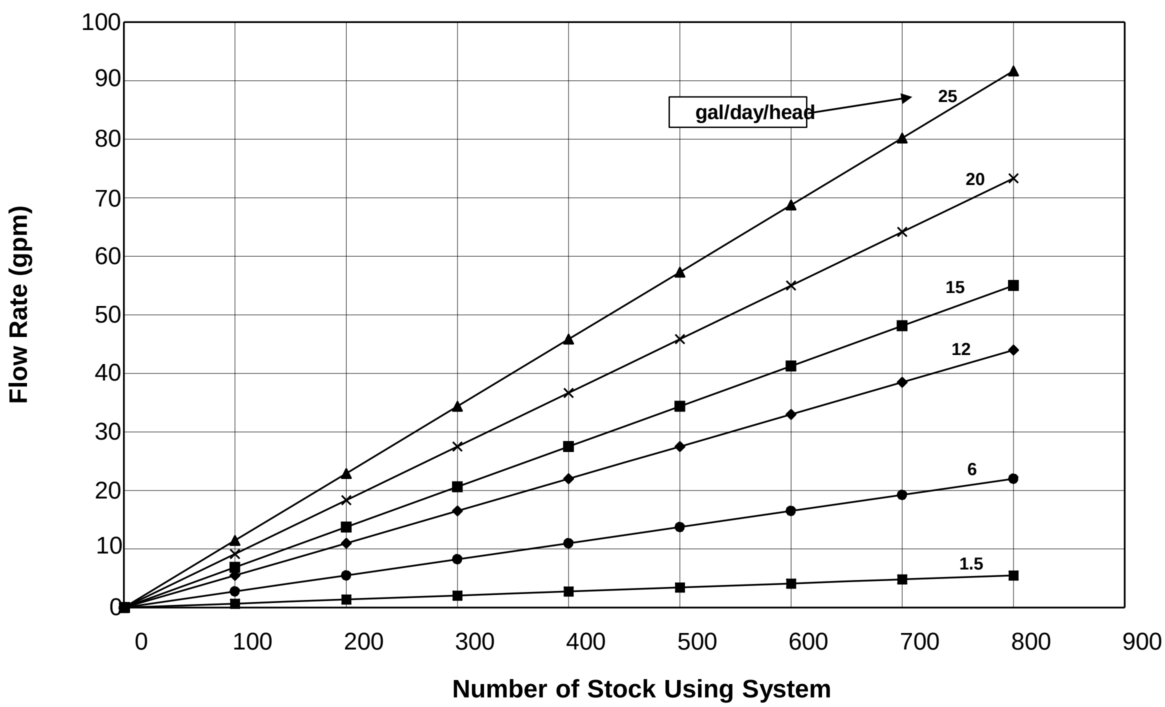


Figure 1.2: FLOW RATE REQUIRED FOR DAILY NEEDS (SUPPLIED IN 6 HRS)

Based on Additional 10% for Evaporation and Waste

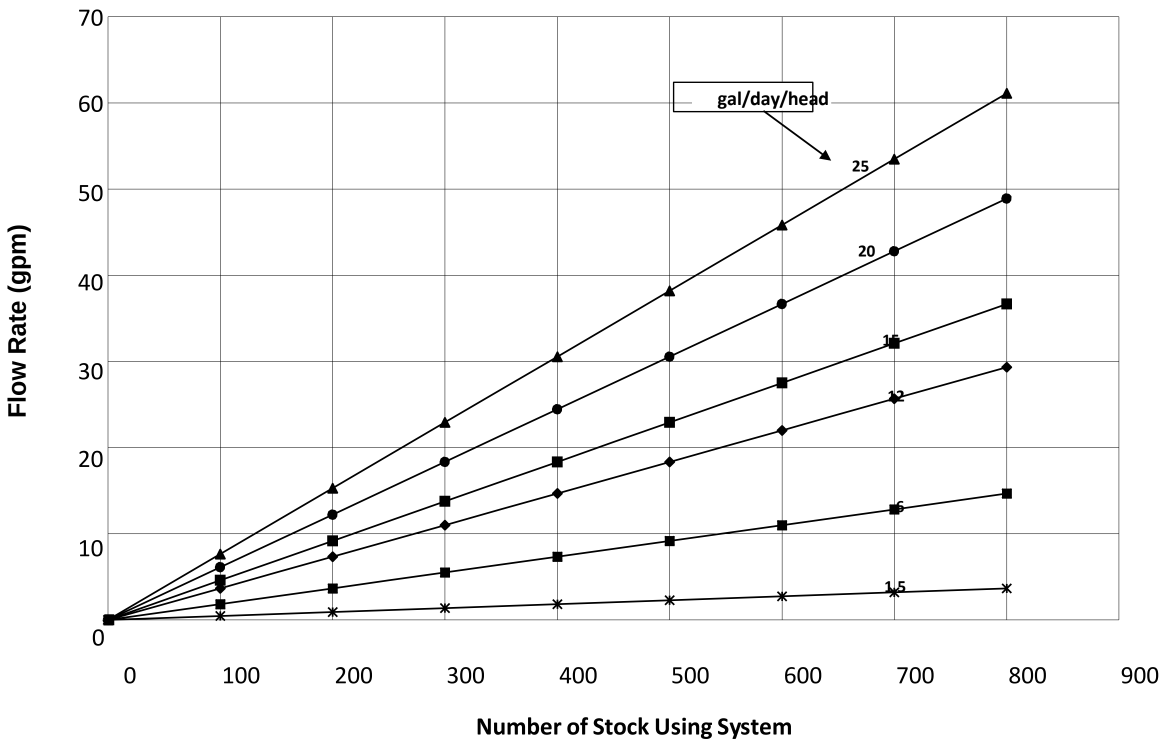
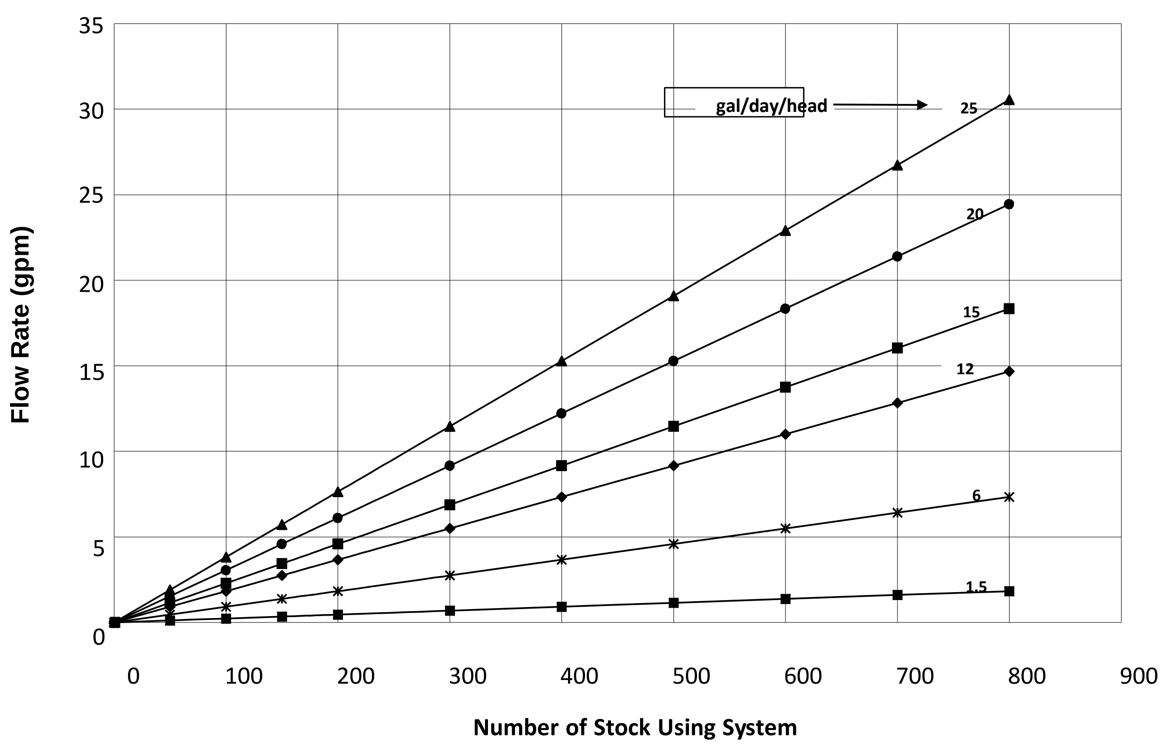


Figure 1.3: FLOW RATE REQUIRED FOR DAILY NEEDS (SUPPLIED IN 12 HRS)

Based on Additional 10% for Evaporation and Waste



Appendix 2: Water Storage Requirements (USDA/NRCS, 2009)

Table 2.1 shows approximate total stockwater requirements during a peak usage day. This table provides for an additional 10 percent allowance for evaporation and spillage.

The capacity of the water storage facilities within a pasture must be determined on an individual basis in close consultation with the operator. Adequate storage capacity shall be required to provide emergency storage to the watering facility during times when water cannot be delivered to the facility. This storage may be supplied by gravity flow from an external storage tank or reservoir or within the facility itself. The storage amount should be based on location of the facility and local power considerations.

The size of watering facilities should be based upon storage volume and access space. Minimum storage volume required depends the reliability of the source, herd watering habits, the hazards of exposure of the pipeline, management provided by the operator and how easy it is to move livestock if the water supply fails. Additionally, the facility needs to be sized to provide adequate space for the number of animals expected to use the facility at any given time.

These factors should be thoroughly discussed with the operator.

Table 2.1: TOTAL DAILY STOCKWATER REQUIREMENTS

Gallons/Day
Based on Additional 10% for Evaporation and Waste

Number of Stock Using System	WATER REQUIREMENTS - Gallons/Day/Head					
	2	8	12	15	20	25
25	55	220	330	413	550	688
50	110	440	660	825	1,100	1,375
75	165	660	990	1,238	1,650	2,063
100	220	880	1,320	1,650	2,200	2,750
125	275	1,100	1,650	2,063	2,750	3,438
150	330	1,320	1,980	2,475	3,300	4,125
175	385	1,540	2,310	2,888	3,850	4,813
200	440	1,760	2,640	3,300	4,400	5,500
250	550	2,200	3,300	4,125	5,500	6,875
300	660	2,640	3,960	4,950	6,600	8,250
350	770	3,080	4,620	5,775	7,700	9,625
400	880	3,520	5,280	6,600	8,800	11,000
450	990	3,960	5,940	7,425	9,900	12,375
500	1,100	4,400	6,600	8,250	11,000	13,750
600	1,320	5,280	7,920	9,900	13,200	16,500
700	1,540	6,160	9,240	11,550	15,400	19,250
800	1,760	7,040	10,560	13,200	17,600	22,000
900	1,980	7,920	11,880	14,850	19,800	24,750
1000	2,200	8,800	13,200	16,500	22,000	27,500

Table 2.2 tabulates storage capacity for round stock tanks and calculated tank diameter and tank perimeter in feet.

Table 2.2: ROUND STOCK TANK STORAGE CAPACITY

Gallons

Tank Diameter (feet)	TANK DEPTH (feet) (Filled to within 3" of top)						TANK PERIMETER (feet)
	1.0	1.5	2.0	2.5	3.0	3.5	
4	70	117	164	211	258	305	12.6
6	159	264	370	476	582	687	18.8
8	282	470	658	846	1,034	1,222	25.1
10	441	734	1,028	1,322	1,615	1,909	31.4
12	634	1,057	1,480	1,903	2,326	2,749	37.7
15	991	1,652	2,313	2,974	3,635	4,296	47.1
20	1,762	2,937	4,112	5,287	6,462	7,637	62.8
25	2,754	4,589	6,425	8,261	10,096	11,932	78.5
30	3,965	6,609	9,252	11,896	14,539	17,182	94.2
36	5,710	9,516	13,323	17,130	20,936	24,743	113.0
40	7,049	11,749	16,448	21,148	25,847	30,546	125.6

When using a tank not similar to the above round stock tank (i.e. rubber tire tank), use sound engineering judgment or appropriate worksheets to determine available storage.

The determination of adequate emergency storage is a management decision that should be made with the operator after thorough discussion of all factors involved. All water sources within the pasture may be used in determination of available stored water.

Appendix 3: Water Balance Inventory Worksheet (USDA/NRCS, 2009)

STOCKWATER PIPELINE RESOURCE INVENTORY WORKSHEET

Land user ______________________________Field Office_________________________________

Job description____

Location ____

Planner__________Date_______________Checked by_____________Date ____________

Type of livestock____

Type of grazing system: ☐ Conventional ☐ Intensive

Maximum number of livestock (No.) _____________

Typical dates stock will be in field: From ________to __________

Water requirements per head (V)__________gal/day/head at peak use.

Total usage per day (T) = No. x V =________x________=_________gal/day.

Add 10% for evaporation and spillage: (GT) = T x 1.1 (optional)
GT =________x 1.1 =___________gal/day

Minimum required flow rate (Qm) =. $\frac{GT}{1440} = \frac{3300}{1440} = \underline{2.29}$ gpm.

Desired number of hours for entire days needs to be delivered:

TOT (Total Operating TimelDay) = _____________hrs

Design Flow Rate: (Q) = $\frac{24}{TOT}$ x Qm

Q= $\frac{24}{\_\_\_\_\_\_\_\_ (TOT)}$ x________=______________gpm

Desired reserve storage time (RST) =___________days

Total reserve storage required: (RS) = RST x GT
RS =__________x ________= ________gallons total storage in pasture.

Other water sources available in the field: ____

Dependability of water sources ____

Quality of water sources:____

Comments: ____ __

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