Shallow buried pasture pipeline development in the Great Sand Hills

An overview prepared for the Great Sand Hills Regional Environmental Study

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Introduction

Water is a major limiting factor for the survival and growth of domestic livestock in arid environments. As a result, watering points are often the main foci of animal activities (Andrew 1988) and one of the largest factors controlling livestock distribution. In large pastures it is common to find severe overgrazing near watering sites and little to no grazing effects in areas distant from water (Holechek et al. 1998). Along with grazing effects, the accumulation of feces, the development of livestock trails, soil compaction, increased amounts of bare soil, and defoliation have all been found to be most extreme near the water source, gradually decreasing to zero beyond the normal grazing range of the animals (Andrew 1988). One of the recommended range management practices to improve livestock distribution and to better manage habitats is to increase the number and locations of watering points (Holechek et al. 1998; Andrew 1988).

The installation of shallow buried pipelines, also known as shallow pasture pipelines, is one method of livestock watering that enables watering points to be added at a number of locations for a relatively low cost. As such, these pipelines have become increasingly common, particularly with large provincially and federally funded community pastures. They are recommended by agricultural divisions of government provincially, federally, and internationally, as an alternative to traditional dugouts and windmills with many benefits to the producer and to the environment. The environmental costs however, are more rarely discussed.

In south-west Saskatchewan, the installation of shallow buried pipelines has increased over the last 10 years. Within the Great Sand Hills (GSH) Review Area, shallow buried pipelines have been installed extensively in the Millie Provincial Community pasture, as well as in the Gull Lake PFRA pasture. A number of private producers have also installed shallow buried pipeline, and those who are planning to develop pipeline are eligible to apply for government cost-share incentives for best management practices, which provide up to 50% of the cost.

This report is an overview of the details of the pipeline workings, agricultural and environmental benefits and drawbacks, potential extent of watering point development, and expected uptake by private producers in the GSH area. The information was obtained through a literature search as well as though interviews with Blake Kohls (Regional Manager for the Saskatchewan Pastures Program, Saskatchewan Agriculture and Food), Trevor Dyck (land manager for Swift Current District Community Pastures, PFRA), Terry Neudorf (Water Technician, PFRA), Cheri Sykes (Saskatchewan Manager of Stewardship, Nature Conservancy of Canada), and Bill Houston (Manager Range and Biodiversity Division, PFRA), all of whom work in the GSH area and/or with shallow buried pipeline in some way. A brief interview was also conducted with Ruth Magee of Meadow Piping, a local company who installs pipeline for private producers in southern Saskatchewan.
Pipeline System Details

Shallow buried pasture pipeline allows livestock watering at a distance from a water source. Pipeline systems can range from a relatively simple system with one to two miles of pipeline leading to two or three troughs, to an extensive water system with many miles of pipeline feeding dozens of troughs. With a good quality source of water and power available at that source, pipeline systems of several miles are considered to be both practical and economical, as well as very efficient watering systems.

A pasture pipeline system is a buried pressurized water line with the following components: 1) a water source: most often a well. 2) a power source: electricity is considered to be the most reliable and efficient; solar or wind chargers are used on shorter pipelines, but as they do not function at all times, a significant amount of storage is required for times without sun or wind; diesel generators have also been used. 3) a pump: usually a 0.5-2.5 horse power submersible pump, but could also be a jet pump, or variable speed drive pump. 4) pipeline: most of the pipe used is 1.5” diameter high density polyethylene, although for long distances 2” diameter pipeline is used. These pipelines can typically withstand up to 100 psi (1.5”), although they are typically run at 75 psi. 5) troughs: These vary from the 500 gallon reinforced plastic troughs on the Millie, to the 1000 gallon mining truck rubber fire troughs installed by Meadow Piping.

Prior to installation the pipe is fused together with heat or attached using compression couplings. A tractor with plough and cutter attachments is then used to install the pipe - the cutter cuts through extensive creeping juniper cover, the plough flips over the sod, and the pipe is fed in to a depth of 1 to 1 ½ ft. Returning along the pipeline, the tractor packs the sod back down. This procedure causes little disturbance, and within 2-3 years the route of the pipeline is difficult to find (Dyck).

The system operates by pumping water from the source into the water line, increasing the pressure in the line and drawing the water along. At the troughs the water flows in until full and is then stopped by a float-valve system similar to that used in a toilet tank. Once the pressure is up in the line the pump turns off, so there’s no wasting water or energy.

These pipelines are for summer use only, and are run from early May to mid-October. In the fall, pipelines are blown out, troughs are drained, valves are opened and pumps are taken into storage. In the spring, it can take up to 2 weeks to fill all of the troughs in an extensive (80 mile) system such as that on the Millie.

The cost of these systems varies by the size of pipeline (which depends on the distance water will be transported), the size of troughs (which depends on the number of cattle to be watered), and the need to develop a water and/or power source. With a power source available, the cost of having a custom operator install these pipelines is $0.68/ft, which includes the cost of the pipe ($0.53/ft), fittings, and installation ($0.15/ft) (Magee). Troughs range from $300-1500 each, floats and fittings can be ~$100-200 per trough, and the development of a new well as a water source can be $500-600. Maintenance is
relatively low with respect to cost (~$500/year for Sykes), and easy for most producers to
do on their own, with the greatest maintenance activity being clearing the lines in the fall.
With the potential for mechanical failure in this system however, each trough must be
checked every 2-3 days.

One mile (5280ft/1.6km) of pipe installed ($3590), with 2 - 1000 gallon tire
troughs ($1400) and 2 floats ($200), and a new well ($600) would cost approximately
$5790. Compare this to one new dugout that can easily cost $6000, and if open to cattle,
requires cleaning out every 3 years or so, at a cost of ~$2000 each time. Or compare it
to a new windmill that could easily run $5000-8000, needs a large amount of storage, is
dangerous to repair, is not effective on hot windless summer days, and draws water from
a well that could collapse or fail within 10 years in the GSH (Kohls). Solar pumps are
also a more expensive option and require fencing, although they have some storage with
the batteries and will last 20 years or more (Neudorf). Without the cost of developing a
well, a pipeline system could be even less expensive. Buchanan and Madden give an
example comparing a pipeline and a dugout where a water source is already developed:
For 1 dugout for 100 cow/calf pairs consuming 15 gallons water/pair/day, their costs is
$6450, whereas pipeline for the same would cost $2550.

Benefits and Costs

There are several agricultural and environmental costs in any watering system
where livestock have access directly to a water source such as a dugout, or a stream.
These include damage to stream banks and dugouts leading to loss of water storage,
damage to riparian habitats and vegetation, deterioration of water quality from rapid
nutrient and bacterial build-up, both in the source and downstream, and rapid growth of
weeds and algae (Alberta Agriculture, Food and Rural Development 2003). These can
seriously affect herd health through exposure to water-transmitted diseases and
infections, toxins, foot rot and leg injuries, stress and death by drowning (Alberta
Agriculture, Food and Rural Development 2003)

With pipeline watering systems, livestock do not have access to the source, and
watering points can be installed in a number of chosen locations, providing solutions to
many of these problems and providing other agricultural benefits as well.

Agricultural Benefits and Costs

The main agricultural reasons to install pasture pipeline are 1) the desire to better
distribute livestock and 2) to use a better quality, more reliable water source.

Pipeline systems not only allow more watering points to be developed at
relatively low cost, they also allow watering points to be developed where the producer
prefers – often into a field where a lack of water previously limited cattle distribution.
The distribution of watering points is no longer limited to locations of high water table,
which limit dugout locations in the Great Sand Hills (Neudorf). By supplying water to
new areas, grazing occurs in areas where cattle have never been before (Dyck), range is
used more extensively, with a more even distribution of grazing, and a potential for increased stocking rates (Houston). More watering locations also mean improved nutrient recycling of manure and urine throughout the pasture instead of near the water source where there’s additional risk of water contamination (Bartlett 2006; Buchanan & Madden).

With long travel times to water, cattle expend energy that would otherwise go into production; they also spend less time grazing, all of which can lead to poor production (Holechek et al. 1998). With more watering points, livestock do not have as far to travel and are more energy efficient (Wells 1996). They also tend to come to the watering points in smaller groups, and spend less time right at the water (Kohls). With pipeline, there are also increased opportunities to do rotational grazing, where parts of the pasture can be rested by closing off the water (Fleischner 1994). With more even grazing effects, and the potential to rotate cattle, pastures are in better range condition going into a drought, and can continue to be used in a drought year – there is no longer a need to reduce grazing pressures in times of drought (Dyck). More forage is also carried over to the next year (Dyck).

Pasture pipelines are typically constructed on deeper more secure sources of water, that are not as subject to evaporation and drought as the shallow ground water used for dugouts and windmills (Dyck, Houston). The water source is protected from livestock, thereby guaranteeing a longer water source life as well (Alberta Agriculture Food and Rural Development 2003). Water quality is also greater, and access is easier, which both lead to increased water consumption, which will in turn lead to increased food intake - the net result being increased weight gain and greater production (Alberta Agriculture Food and Rural development 2003, Houston). Herd health is also greatly improved with improved water quality (Alberta Agriculture Food and Rural development 2003, Kohls).

Pipeline systems often pay for themselves just in reduced fencing costs (Buchanan and Madden), whether in fencing for pasture division, or for keeping livestock out of dugouts or natural water sources. When a trough is supplied near an unfenced natural water source or dugout, livestock have been found to effectively reduce the amount of time spent in the source (Godwin & Miner 1996).

The major agricultural drawback of the pipeline system is that as a mechanical system, there is always a risk of system failure. If this system fails and goes unnoticed for several days, cattle will die.

*Environmental Benefits and Costs*

Shallow pasture pipeline is often recommended as being a more environmentally friendly way of watering livestock, 1) because livestock are not given access to the source, or are provided with water away from the source and thereby decrease their use of riparian areas (Godwin and Miner 1996), and 2) because the system is designed to create
a more even distribution of livestock across the landscape, and a resulting more even, presumably less severe distribution of grazing effects.

By limiting access to water sources and riparian areas, water quality is increased both for the livestock and for others downstream. The risk of contaminating sources with fecal bacteria and urine are considerably reduced (Neudorf). Sykes indicates that with increased water quality, however, forage utilization will increase so there will be a greater impact on the grass.

Where watering holes are infrequent, Holechek et al. (1998) indicate that large sacrifice areas around the watering points have often occurred. These areas are characterized by high erosion, soil compaction, and accumulated feces and urine. They are often bare when dry, and dominated by unpalatable trample resistant plant species when wet (James et al. 1999). There is usually also a reduction in palatable native grasses in these areas due to selective grazing (James et al. 1999). With a greater number of watering points, there is a greater number of sacrifice zones, although the severity or extent of sacrifice areas is considered reduced at each watering point, and potentially reduced overall, although no studies have been conducted to quantify this (Kohls, Dyck). In Australia, James et al. (1999) recommend close and even distribution of watering points for the most efficient utilization of forage with the least damage to the soil. With pipeline systems the opportunity to practice rotational grazing may also be used to allow heavily grazed areas to recover.

Series of cattle trails are created when animals must travel large distances between water and forage, gradually becoming larger and more numerous (Holechek et al. 1998). With more watering points closer together and cattle travelling shorter distances to water, it is presumed that fewer cattle trails will develop (Dyck).

More watering points for cattle also mean more watering points for wildlife. This has affected the distribution of wildlife such as antelope and mule deer in the GSH (Kohls).

While the development of pasture pipeline systems has many positive environmental effects, there are also negative effects. A more even distribution of grazing effects means less patchiness, and a less diverse range of habitats that will support a less diverse range of species. In South Africa, Thrash (1998) documented changing basal vegetation cover around artificial water sources. While grazing effects were only evident for a few kilometres from the watering points, they drew attention to the loss of habitat diversity at greater distances due to the increased density of watering points. In a review of the ecological costs of livestock grazing, Fleischner (1994) lists the consequences of grazing from several studies: Grazing has been found to reduce the density and biomass of many plant and animal species, reduce biodiversity, aid the spread of exotic species, interrupt ecological succession, impede the cycling of the most important limiting nutrient (nitrogen), change habitat structure, and disturb community organization. All of these are possible over a greater area with a greater distribution of watering points.
In the GSH an increase in grazed areas may result in the reduction of suitable habitat for grassland birds. A reduction in the nest density of Upland Sandpipers was found on grazed areas in North Dakota (Bowen & Kruse 1993). As grazing can affect different bird species by altering preferred habitats (James et al. 1999), there may also be similar effects for other grassland species, such as Sprague’s pipits, and Baird’s sparrows, while there may be increases in horned larks and other species that tend to use more heavily grazed areas. More even grazing may result in the reduction of rare plant species that are associated with disturbed areas, however with increased watering points, an increase in rare disturbance-associated species could also occur.

An increased number of watering points will also lead to an increase in vehicle trails, as each point is checked every 2-3 days by truck, ATV, or horse, and is serviced by truck a few times a year (Neudorf, Dyck). This could lead to further habitat fragmentation, and spread of weeds. The installation of pipeline could also provide an avenue for weeds (Sykes), as it is not the current practice to wash the tractor and plough between contracts (Magee).

Some maintain that without grazing there will be an accumulation of litter that will stifle production and reduce biodiversity because of the litter on the surface. Houston suggests that while this may be true of tall grass prairies and moist environments, it is unlikely the case in arid environments such as the Great Sand Hills. Fleischner (1994) also indicates that evidence for overcompensation by plants comes mostly from other ecosystems, not arid rangelands. It is also thought by many that cattle have simply taken the role of bison, however, the 2 species graze very differently: cattle spend a disproportionate amount of time near water, whereas bison roam more widely (Fleischner 1994).

Potential watering system development

In order to understand the extent that watering systems may be developed in the Great Sand Hills, the scale of grazing and livestock activity must be considered. Holechek et al. (1998) consider the travel distance to water in sandy country or dunes to be approximately 1.6 km or 1 mile. This translates into up to 2 miles between watering sites in an ideal watering point distribution. Those interviewed indicated that they would not develop water closer than 0.75-1 mile and would also ideally want watering points 1-2 miles apart, although none had watering points developed to that extent. In any habitat, areas over 2 miles from water are generally considered unusable for livestock (Holechek et al. 1998). Even with the current or ideal extent of watering point development in the Great Sand Hills, there will still be ungrazed areas (Houston). Terrain may also affect the development of watering holes. As livestock use of slopes over 10% is considered to be greatly diminished (Holechek et al. 1998), there may be areas of the GSH with high slopes where it would not be appropriate to develop water.

Environmental guidelines and practices that may influence the location of watering sites should also be considered. Watering systems in the Millie and Community pastures have and will be developed to avoid heritages resources (e.g. tipi rings), rare
species, dunes, large hills, and rough vegetation (Kohls, Dyck). Most of these considerations are attributed to common sense - not wanting to push water up and down hills if they don’t have to, and avoiding sensitive areas prone to erosion. The Millie development went through an approval process similar to what oil and gas development would have to go through with Saskatchewan Environment (Kohls), whereas the community pastures undergo a similar internal process, with their own biologists checking routes for rare and endangered species habitat and heritage resources. Similar factors are considered when producers apply to the cost-share programs, however it is not thought that these limitations would apply to private producers that do not use these programs (Kohls), as no one would necessarily hear about the development (Neudorf). On lease land, the lands branch of Saskatchewan Environment would be contacted for any development (Neudorf).

The development of pasture pipeline by private producers in the GSH

Assistance

Two cost-share incentives exist that may aid or encourage development of pasture pipeline by private producers in the GSH.

Producers may attend two workshops and ultimately complete an Environmental Farm Plan. After their plan is reviewed, Saskatchewan producers may apply to the Canada-Saskatchewan Farm Stewardship Program which offers cost-shared incentives to assist in the adoption of environmentally beneficial management practices, including alternative water systems to protect riparian areas, and protecting existing water wells from contamination (Agriculture and Agri-food Canada 2006a). A 30% or 50% cost share is offered, depending on whether the project has more benefits to the public (environment; 50%) or the producer (30%) (Houston).

The Canada-Saskatchewan Water Supply Expansion Program also provides technical and financial support for the planning and development of projects that will enhance long-term sustainable agricultural water supplies, including pasture pipelines. Up to one third of the cost will be provided through this program, to a maximum of $5000 per project and up to $15,000 per applicant (Agriculture and Agri-Food Canada 2006b)

Promotion by government agencies may also aid in pipeline development. In the past, PFRA promoted the development of pasture pipelines to private producers by providing a plough for private producers to use (Dyck). PFRA currently promotes the idea as a good practice, with benefits from both the production and environmental viewpoints, and presents the technology at workshops, conferences and field days (Houston).
Constraints

Several significant constraints may limit the development of pasture pipelines by private producers in the GSH.

Without a good quality reliable water source in the right location, and a source of power at the water source, pipeline development is not likely (Neudorf, Dyck).

There are several limitations with respect to power. 1) The GSH does not have an extensive power grid throughout the Review Area. 2) The cost of developing remote power is $15,000-16,000/mile which would limit most, if not all, private producers. 3) Even with overhead power at the site, the cost of putting in a service from that line is $1000-3000. When electricity is not available, alternatives are possible, although there were very mixed reviews among those questioned. Kohls indicated that solar chargers required too many panels and too much storage to be practical, while others use solar, albeit on their smallest projects (Dyck). Diesel generators are also used on occasion, however they also have a significant cost ($8000) as well as installation, fuel and maintenance costs. Where gas wells exist, private producers may get around this limitation by approaching gas companies to purchase a power supply (Magee).

Other costs that may be limiting include the need to cross a road where a culvert does not exist and directional boring is necessary.

The current economic situation of the region and the industry must also be considered. With BSE and the border being closed, there’s just not a lot of money available (Sykes).

Other possible limitations include the limited access to remote areas of pasture within the Great Sand Hills review area. These systems require checking every 2-3 days, and within the GSH lengthy drive times to check each watering site may limit the number of producers interested in developing these systems (Neudorf). Some producers install larger troughs than necessary to try to decrease the risks involved, however, free access to a water source or dugout is the only fool proof way of ensuring cattle always have water.

Government regulations may slow or stop development. This includes 1) a once a year spring deadline for the Canada-Saskatchewan Water Supply Expansion Program with decisions made in the fall while producers want to develop in the spring (Houston, Magee), 2) the need for easements if crossing someone else’s land, even with their permission (Neudorf, Magee) and 3) the need for a license from Saskatchewan Watershed Authority if crossing a quarter section line, road allowance, or other type of boundary (Neudorf). Magee indicated that producers sometimes go ahead without government approval and funding because of the length of the process.
Expected uptake by private producers in the GSH

Of those interviewed, half thought that the expected uptake of pipeline watering systems by private producers would increase, especially with drought. They also indicated that most of those installing pipeline were part of the younger generation of ranchers (ages 30-50). The other half thought either costs were too limiting, especially for those areas without power, or that producers would stay with the tried and true, and that there would be little uptake, at least until younger generation of producers take over.

The information needed to quantify a trend in increasing pipeline development in the GSH area is incomplete. There have been 5 large projects in the GSH in the last 5 years by the main custom operator in the area (Magee), whereas Terry Neudorf, who helps to administer the Canada-Saskatchewan Water Supply Expansion Program in the south-west, has not been in the Great Sand Hills for 3 to 4 years. PFRA did supply a figure of pipeline projects in the Great Sand Hills Area from 1985-2003, as well as a spreadsheet with the pipeline lengths and approximate locations. Figure 1 breaks that information down into yearly development, where the majority of the development occurs in 2000-2002. Information on pipeline developments in the area for the 2004-2006 period has been requested. Without this information, it is difficult to determine current trends in the GSH.

Figure 1. Shallow buried pipeline developments in the Great Sand Hills Region (1985-2003)

One indication of an increasing trend in pasture pipeline development comes from Meadow Piping, who install pipeline throughout south-west Saskatchewan. From the start of their business five years ago, the amount of pipe used per year has quadrupled, from 1 truck/year to 4 trucks/year (Magee).
We also know that producers who have developed pipeline are pleased with the results, and often want to expand their systems once they see how well it works (Neudorf, Houston).

References


**Interviews**


Houston, Bill. Manager, Range and Biodiversity Division, PFRA. Interview. October 11, 2006.


