AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

Agdex 716 (B32)

Seepage Control in Dugouts

Seepage from dugouts often results in serious water losses. In many parts of the province, dugouts provide the only available water source, owing to poor quality or unavailable groundwater. In these areas, it is important to reduce seepage losses. The amount of seepage loss in a dugout depends on the soil in which the dugout is constructed. A careful consideration of these properties is recommended when selecting dugout locations.

Soil types and seepage

Sandy soils are more permeable than clayey soils and permit high seepage losses. Clayey soils with isolated sandy areas, called "sand lenses," also permit seepage losses. Calcium deposits in soils cause the soil structure to change, resulting in a cubelike structure often called "fractured till." Fractured till is porous and permits seepage losses.

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Methods of sealing dugouts

Gleization

An old method, used successfully in Russia for years, is to line the dugout with organic material, such as straw, and to cover it with soil. Micro-organisms growing in the submerged straw gradually develop a blue-grey layer, which is impermeable to water. This method is particularly effective in dugouts that leak due to fractured till formations.

Method – Modify the dugout side slopes to 3:1. Disc or rotivate the area to be sealed, and evenly spread 150 mm (6 inches) of straw on the surface. Compact the straw with a roller or tractor. Now, spread 150 mm (6 inches) of clay on the straw and compact it. Protect the inlet area with riprap. Allow the dugout to fill with water.

The success of the gleization method requires time. The process of gleization occurs gradually, taking several months to a year. Water losses in the first few months will be high but should gradually decrease after a year or so.

Clay lining

The choice of clay lining is governed by the cost of hauling the borrowed clay earth. The success of the lining depends on the clay content of the borrowed earth. When in doubt run a ring test:

- take a handful of the earth sample from the prospective borrow area
- moisten the earth and roll on a flat surface to form a rod (about the thickness of the last finger)
- the borrowed earth is suitable if a closed ring can be formed from the rolled clay rod without the rod breaking

Method – Modify the dugout slide slopes to 2:1 or flatter. The earthwork is completed by removing large stones, sticks and irregularities. Moisten the soil surface by spraying water on it, and evenly spread 300 mm (12 inches) of moist clay on the surface. Smooth the surface with a harrow, and compact the clay with a roller or heavy tractor. Protect the inlet area with riprap. Fill the dugout with water. Approximately 90 to 110 m^3 (3000-4000 ft^3) of clay is required to line a typical 3.2 million litre (700,000 gal) dugout.

Polyethylene liner

Dugouts that are to be lined with polyethylene membranes require side slopes of 3:1 or flatter on all four sides (Figure 1). This sloping will minimize creeping and sliding of back-fill on the membrane. The polyethylene membrane should have a minimum thickness of 0.162 mm (6 mil). The membranes are available in rolls of 6 m x 50 m (20 ft x 100 ft) or 12 m x 30 m (40 ft x 100 ft). Individual membranes should be joined together by overlapping and connecting with two-sided tape. This method should form a continuous watertight lining.

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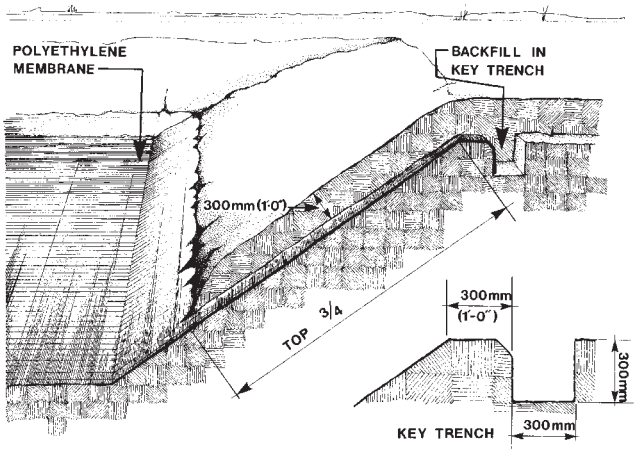

Figure 1. Details of plastic lining

Made-to-measure polyethylene membranes are also available, but may require time for fabrication.

Method – Finish the earthwork by removing large stones, sticks and irregularities. Compact the soil and dig a key trench on the top perimeter of the dugout. (See Figure 1). Place the top edges of the membrane in the key trench, and key it around the top and backfill the trench. Provide sufficient slack in the membrane to allow placement of the covering material without stretching or puncturing.

After the membrane is installed, cover with a 150 to 300 mm (6-12 inch)layer of soil, free of stones and lumps. Equipment should always be driven on pre-deposited earth, not directly on the membrane. It is only necessary to cover the membrane on the top three quarters of the dugout. The bottom and the remaining slopes need not be covered.

Butyl rubber liner

Butyl rubber membranes can be used as an alternative to polyethylene membrane. They are reliable, relatively long lasting and will not deteriorate if exposed directly to sunlight.

Chemical methods

Sodium carbonate

Chemical dispersing agents, such as sodium carbonate, reduce soil permeability by re-orienting clay particles in the soil to form a more compact, less porous soil mass. Sodium carbonate is more effective in soils that have a high percentage of calcium that can be exchanged for sodium. The success of the method depends on a careful estimation of the percentage of exchangeable calcium. This factor determines the application rate of the sodium carbonate. You may contact the regional engineering technologists for a soil test and recommendations on application rates.

Method – Finish the earthwork by removing vegetation or plough it under and till the soil surface. Apply the sodium carbonate with a fertilizer spreader and incorporate it by tilling the soil. Compact the soil with a roller or tractor and then fill the dugout with water. Sealing should occur in a few days.

Bentonite

Bentonite or driller's mud is highly plastic clay prepared from volcanic ash. When wet, bentonite swells and disperses, filling spaces between the soil particles and decreasing soil permeability. It is best added dry and worked into the soil surface before filling the dugout, It can also be added to the water after filling. The second method usually has less chance of success.

Dry method – Remove or plough under all vegetation and smooth the soil surface. Remove large rocks, fill large holes and cover gravel pockets with 150 mm (6 in.) of clay or clay loam soil. Grade the soil surface and broadcast the bentonite at a rate of 5 to 10 kg/m^2 (1-2 lb/ft^2). Mix the bentonite into the soil by tilling to a depth of 75 to 100 mm (3-4 in.). Compact the soil with a roller or tractor. The dugout can now be filled with water. Sealing should occur in a few days.

Wet method – Determine the total amount of bentonite required to cover the dugout sides and bottom. The calculation is based on an application rate of 10 to 20 kg/m^2 (2-4 lb/ft). Broadcast the bentonite on the water surface in the dugout and mix thoroughly. The mixing can be done using a pump, air compressor or a motor boat. Keep the bentonite in suspension for several days by agitating the water. This method is not as effective as the dry method.

Soil cement

Method – Soil cement is used primarily in sandy soils. Remove or plough under all vegetation and till the soil to a depth of 75 to 150 mm (3-6 inches). Allow the top 300 mm (12 in.) of the soil to dry. Do not apply cement to the wet soil. Broadcast cement on the soil surface at the rate of 20 to 30 kg/m^2 (4-6 lb/ft^2) and mix thoroughly by tilling. Spray on water to raise the moisture content of the mixture to 12 to 15 per cent.

If you are having difficulties determining soil moisture content, please contact the Regional Engineering Technologist, or refer to *Soil Cement* (Agdex 715-1).

Smooth the surface with a harrow and compact the soil with a roller or tractor. Allow the soil cement to cure for two to four weeks, keeping the surface moist for the first week. If any cracks develop, they could be repaired by applying a second richer soil cement mix. This mix should be plastered on and trowelled smooth.

Conclusion

The physical methods of sealing dugouts have relatively longer service life than chemical methods. The chemical methods need to be repeated once every few years.

The relative costs of sealing an entire dugout:

Methods	Cost
Gleization	Least expensive
Clay liner	(very variable)
Polyethylene liner	
Sodium carbonate	
Bentonite	
Soil cement	
Butyl rubber	Most expensive

If the dugout is sealed by one of the chemical methods, it is advisable to have the dugout water chemically analyzed before drinking it. This analysis should be done after the sealing is completed.

For further information, contact the Alberta Agriculture, Food and Rural Development regional engineering technologists or the Agricultural Engineering branch at the following locations:

Lethbridge	Phone: 381-5112
Red Deer	Phone: 340-5324
Barrhead	Phone: 674-8252
Airdrie	Phone: 948-8537
Edmonton	Phone: 427-2181

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Agriculutural Engineering

Issued 04/96
08/01/2M