How to Handle Seepage From Farm Silos

FACTSHEET

ISSN 1198-712X

Agdex#:	240
Publication Date:	2015/05
Order#:	15-003
Last Reviewed:	
History:	Replaces OMAFRA Factsheet 04-031, of the same name
Written by:	S. Clarke, P.Eng., and D. Hilborn, P.Eng

Table of Contents

Introduction

Silage seepage presents two concerns for the agricultural industry - water pollution, and corrosion and deterioration caused by the silo silage juices.

When silage is harvested and stored at low moisture contents less than 70% for horizontal silos and 60% for tower silos, there is minimal corrosion and pollution threat. Above this moisture level, significant flow of silage juices (or seepage) from silos may occur (**Table 1** and Figure 1). Corrosion happens where the seepage is trapped for a period of time.

The production of seepage can be reduced or eliminated through cropping techniques and harvest timing (see the OMAFRA Factsheet, *Harvesting Corn Silage at the Right Moisture*).

However, there are conditions where seepage can't be avoided. For example, weather conditions may force a farmer to harvest wet silage or ensile by-products such as sweet corn materials. Both will result in seepage production.

Table 1. Tower silo - maximum moisture content to minimize seepage, whole-plant silages

Silo Size	Max. Moisture Content
3 m x 11 m (12 ft x 40 ft)	72%
4 m x 15 m (14 ft x 50 ft)	70%
5 m x 18 m (16 ft x 60 ft)	68%
6 m x 21 m (20 ft x 70 ft)	66%

7 m x 26 m (24 ft x 85 ft)	63%
9 m x 33 m (30 ft x 110 ft)	60%

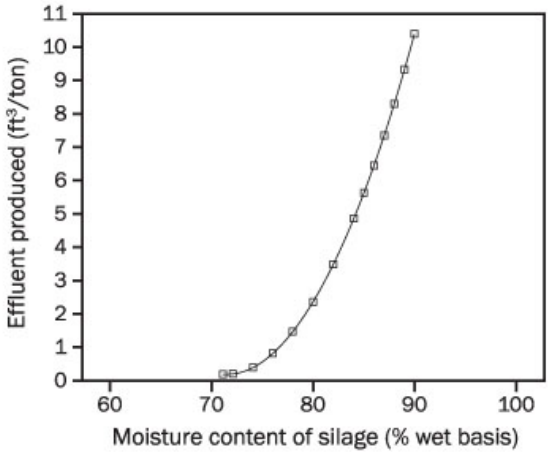

Figure 1. Horizontal silo - seepage production based on silage moisture content.

Most of the environmental problems associated with silage/haylage seepage on farms come from improper or inadequate collection and retention of the seepage draining from the silos. An adequate collection and storage/treatment system is essential if seepage is anticipated.

Table 2 provides information on the acids in silage seepage that cause silo corrosion. Detailed information on silo corrosion is available in the OMAFRA Factsheet, *Deterioration of Concrete Tower Silos*.

Table 2. Aggressive constituents of silage seepage

Constituents	Quantity
Lactic acid	4%-6%
Acetic acid	1%-2%
Butyric acid	normally less than 1%
pH	3.5-5.5

Table 3. Constituents of Silage Seepage

Constituents	Silage Seepage (typical)	Dairy Manure Liquid (typical)
Dry matter	5% (2%-10%)	5%
Total nitrogen	1,500-4,400 mg/L	2,600 mg/L
Phosphorus	300-600 mg/L	1,100 mg/L
Potassium	3,400-5,200 mg/L	2,500 mg/L
pH	4.0 (3.6-5.5)	7.4
Biochemical oxygen demand	12,000-90,000 mg/L	5,000-10,000 mg/L

Source: Cornell University 1994 and OMAFRA

Seepage is an Environmental Problem

In 2013, farmers in Ontario made 5 million tonnes of corn fodder, producing in the process over 20 million L of silage seepage effluent. Silage seepage in an undiluted form has extremely high BOD (biochemical oxygen demand) values, ranging from 12,000-90,000 mg/L (**Table 3**), which is approximately 60-450 times stronger than domestic sanitary sewage. Even a small discharge of seepage into a watercourse can remove enough oxygen for a fish kill to occur. Reports from Pennsylvania, New York and Ontario have linked silage seepage to fish kills. In addition, cases of silage seepage contaminating wells in Ontario and the U.S. have been reported.

Table 3 shows that seepage contains significant nutrient concentrations (similar to liquid dairy manure). Seepage is an excellent nutrient source for growing crops if properly applied to land. However, similar to other nutrients, seepage can become a pollutant if it enters surface water or groundwater.

Rate and Volume of Seepage Production

The greatest percentage of silage seepage is produced within 5-10 days of storage loading. For normal silage and haylage production, the remaining seepage is usually produced within the following 30 days. The volumes produced are dependent on the vertical pressure in the silo and the initial moisture content of the crop (Figure 1). The addition of acid additives to silage facilitates higher crop moisture, which can result in a higher initial rate of silo seepage.

The ensiling of wetter materials such as sweet corn by-products or corn silage for biogas facilities results in much higher seepage production. This can occur throughout the entire period that the crop is stored.

Seepage flow out of vertical silos is the greatest during the first month of storage. In silos with good internal drainage (i.e., a network of floor drains to carry out leachate), it tapers off after that. Where internal drainage of the silo is poor (or the ensiled material is higher moisture), flow will occur throughout the total storage period as the silo is being emptied. Rainwater on uncovered silage can produce additional effluent.

For horizontal silos, the rain runoff or snow melt from the floor area inside the storage and feed preparation area adds more effluent to the collection system. The highly concentrated effluent base flow will be increased on occasion by rainstorms and snowmelt.

It is important that all the base flow from the silo along with the first flush of precipitation runoff is collected and stored, since this material has higher concentrations of organic matter and nutrients.

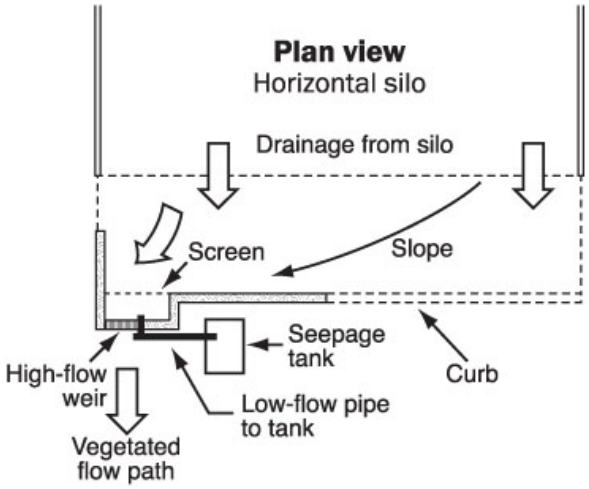

Figure 2. Horizontal silo front-flow seepage system - diluted liquid to vegetated area.

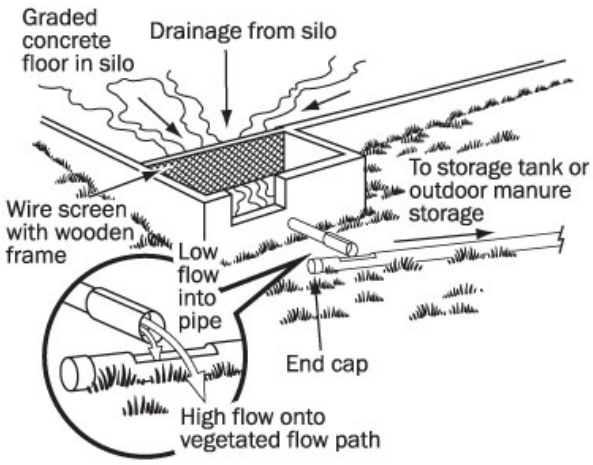

Figure 3. Low-flow collection system diagram. (Source: AEM)

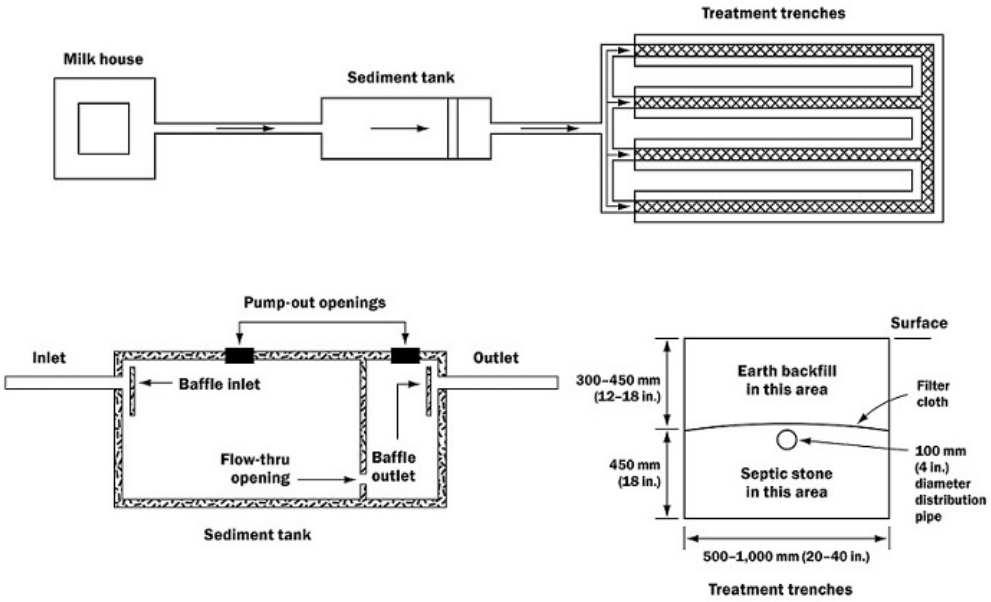

Figure 4. Low-flow collection system.

Storage and Treatment of Silage Seepage

Collect the seepage and runoff in a small storage at the silo site and transfer it to an outdoor liquid manure or runoff storage on the farm. Do not contain silage leachate in an under-barn storage (located below animals), because dangerous gases may be produced when the effluent and manure are mixed. Where outdoor liquid manure or runoff storages are not available on the farm, provide a separate storage to contain seepage plus runoff material. During the cropping season, apply seepage on land in the same way as you would apply manure. If seepage is applied to the land, account for the nutrients in the seepage in the Nutrient Management Plan.

Another means of handling and treating seepage involves collecting and storing only the low-flow rates of concentrated leachate from the silo in a storage tank (Figure 2). Allow the diluted high-flow rates of material to flow to a vegetated flow path. Use a low-flow collection system (Figures 3 and 4) to separate the concentrated low-flow seepage.

Reduction of Seepage

Harvest silage/haylage at low moisture:

- <65% moisture content for tower silos less than 12 m (40 ft) deep
- <60% moisture content for tower silos over 12 m (40 ft) deep
- <70% for horizontal silos

Planting shorter-season varieties of corn will result in a drier crop, lowering seepage production. Avoid ensiling wet by-products such as sweet corn residue.

Bunker Silo Sealing/Covering Systems

Using a bunker silo sealing or covering system will reduce silage infiltration by air and water. A sealing system consists of a layer of white or black plastic used as a cover and seal. Old tires are placed edge to edge over the surface of this plastic to help seal the silage.

Figure 5. Tarpaulin and sausage bag system for silage protection.

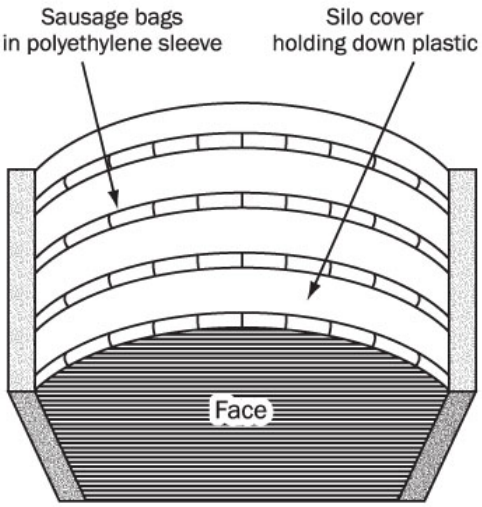

Figure 6. Sausage bag placement.

New Silo Sealing System - "No Tires Used"

In this system, traditional plastic sheeting is covered with a second layer. Instead of tires, sausage-bags filled with sand or gravel anchor the cover in place (Figures 5 and 6). The advantages of this system are the added protection, improved sealing, flexibility, and ease of installation and storage of the sandbags.

- A polyethylene sleeve holds together several of the sausage-bags across the width of a silo. This product reduces the chance of air infiltration between the sausage bags. Figure 6 shows sausage bag placement.
- Use the sausage bags directly on the silo plastic, to reduce the cost and replace the use of tires. This is a good solution if birds or animals tear the plastic seal.
- Adding absorbents designed to take up excess moisture will result in very low or no seepage production. Materials include oatmeal, dried sugar beet pulp, dried corncobs, ground corn and hay cubes. To be effective, add enough material to absorb the anticipated seepage. Proper use of these materials is necessary. It may be possible to feed these materials, however, first get proper advice on how to make sure the material is safe as a feed source.
- On many occasions it may not be possible to wilt the forage adequately or harvest at the desired dry matter content. If the forage is too wet, seepage is likely. Add absorbent materials to "absorb" this seepage. Table 4 lists the water-holding capacity of various materials.

Table 4. Water-holding capacity of various materials

Moisture content	Material (on an air-dry basis)	Water-holding capacity (kg/100 kg of material) (lb/100 lb of material)
10%	Ground corn grain	58
	Ground oats	69
	Ground wheat	61
	Corn cob: Coarse grind ($^1/_2$ in.)	143
	Corn cob: Medium-to-fine grind	192
	Corn cob: Fine grind ($^1/_{16}$ in.)	192
12%	Sugar beet pulp	248
	Alfalfa hay	194
	Mixed grass hay	195
	Oat straw	218

Source: University of Minnesota (1980)

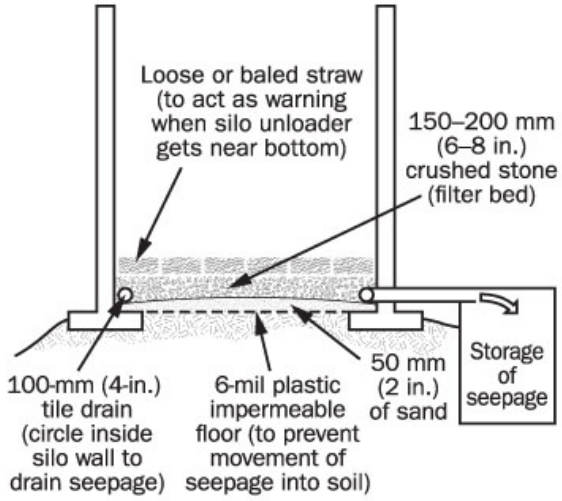

Figure 7. Tower silo seepage storage system.

Managing Silo Seepage and Precipitation Runoff

Recommended practices for managing silo seepage include:

- Cover the silo - this prevents precipitation from entering and leaching through the silage/haylage.
- Divert all surface water away from the silo site, as this is considered clean water and does not require collection and storage.
- For new silos where any seepage is expected, install a seepage collection and storage system as shown in Figures 2, 7 or 8.
- Inspect the interior silo surface each time the silo is empty for signs of corrosion. Wherever corrosion is severe, recoat the inside of the silo.
- For horizontal silos, there are several options to manage seepage:
  - Existing horizontal silos: Place a 100-mm (4-in.) tile drain on the floor where the wall meets the silo floor (Option A, Figure 9)
  - New silos: Form holes in the wall to drain silo seepage to an outside drain (Option B, Figure 9.) CAUTION: Protect steel from silage acids with adequate (75 mm (3 in.)) concrete cover.
  - Existing or new horizontal silos with good floor drainage to the front of the silo: Install a

catch basin that collects seepage and drains to a long-term storage tank (Figures 3, 4 and 10).

- Flow may occur throughout the total storage period as the silo is emptied. Diluted flow or flow in periods where seepage is not collected must not directly enter a watercourse or catch basin or run across land with shallow bedrock (Figure 2).

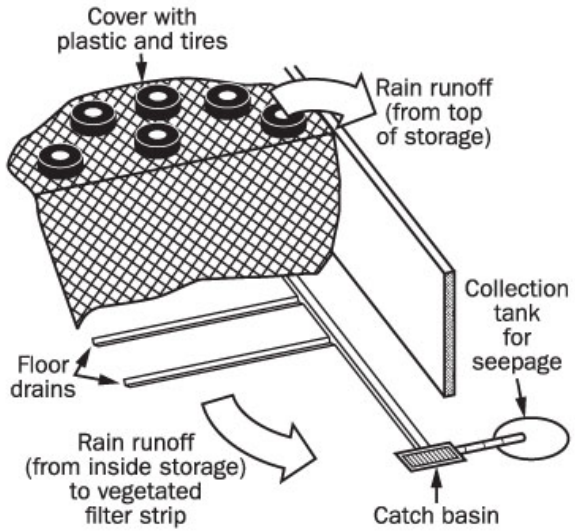

Figure 8. Horizontal silo seepage floor-drain collection system.

Notes:
Install cross drains 75 mm x 75 mm (3 in. x 3 in.) on 6-m (20-ft) spacing, filled with 20 mm (7?8 in.) of clear stone. Drain should pick up seepage and first flush of rain runoff.
Drain cross drains to storage tank with header drain 100 mm x 100 mm (4 in. x 4 in.).
Rain runoff from top of storage may be considered as clean water and will not reach the collection system.
Collect, store and spread rain runoff from inside of the storage on cropland.
Treat diluted rain runoff using an approved vegetated filter strip.

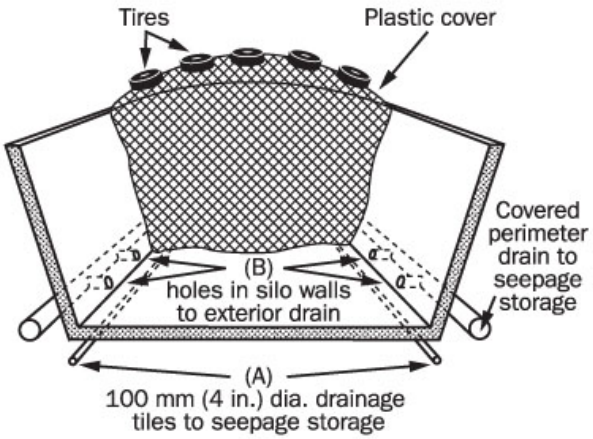

Figure 9. Outside-drain collection system for existing horizontal silo.

Notes:
(A) 100-mm (4-in.) diameter tile drains placed on silo floor.
(B) Holes in silo walls lead to an exterior covered drain. Collect, store and spread rain runoff from inside storage on cropland. Treat diluted rain runoff using an approved vegetated filter strip.

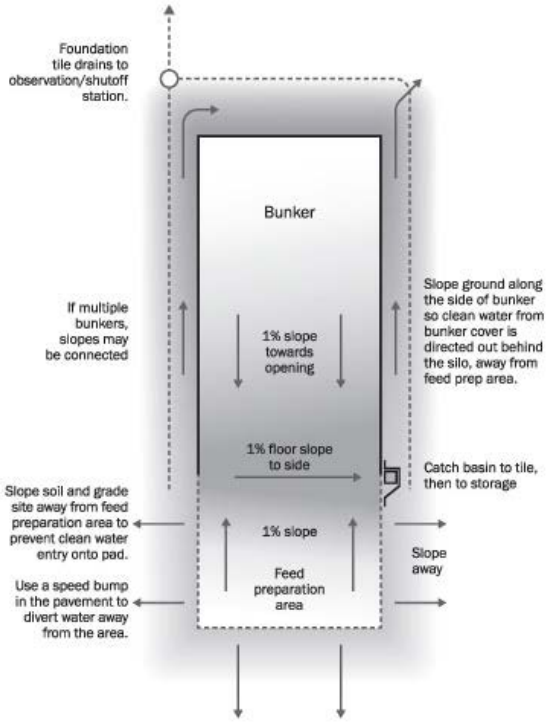

Figure 10. Bunker seepage and clean water run-off system.

Caution: Never mix silage effluent in enclosed tanks, especially tanks within barns, because silage effluent mixed with manure slurry will accelerate the release of hydrogen sulphide gas. Add seepage only to uncovered outdoor storages.

Management of Seepage

Concentrated seepage may have to be mixed with the same amount of water (1:1) for application directly onto crops. Seepage is considered a nutrient, and the amount being applied must be accounted for in the Nutrient Management Plan.

Seepage is also used as a supplementary feed. Due to its high potassium and nitrate levels, only feed seepage after getting expert advice.

Seepage can also be used as an input for a digester system. To avoid operational issues, make sure it is introduced slowly.

Release any dilute material or runoff to a vegetated area. Do not do this if the vegetated area is on shallow bedrock. Make sure adequate distance to surface water or tile drain inlets exists.

Site Locations for Seepage Collection Tanks and Vegetated Flow Paths

As a good management practice, the Environmental Farm Plan recommends:

- locating seepage collection tanks at a distance of 60 m (200 ft) or greater from surface water (i.e., streams, ditches, ponds or tile inlets)
- setting separation distances between seepage tanks and wells at 23 m (76 ft) or
- greater for a drilled well and 46 m (151 ft) or greater for a bored/dug well

Locate storage sites for bagged, wrapped or tubed haylage (baylage) at least 9 m (30 ft) from surface water sources and field drainage tiles to reduce the risk of contamination.

Sizing of Small Seepage Tanks

Install additional storage to deal with wet years when seepage production is higher. Size the storage to include expected seepage volumes and runoff calculated at 0.0015 m^3/m^2/day (0.005 ft^3/ft^2/day) for the period of time that the flow is directed to the tank. Often the tank is sized to collect seepage for 1-2

months after the last filling of the silo occurred.

If the material in the seepage storage tank is not used immediately, leave enough freeboard in the tank for direct rainwater entry. Often, a 240-day period is used, requiring 0.6 m (2 ft) of freeboard.

Horizontal Silos

- If the crop is stored at >80% moisture, size the storage for 10 m^3/100 tonnes (320 ft^3/100 ton) of crop storage.
- If the crop is stored at 70%-80% moisture, size the seepage storage for 3.1 m^3/100 tonnes (100 ft^3/100 tons) of crop stored.
- If the crop is stored at <70% moisture, use 1.55 m^3/100 tonnes (50 ft^3/100 tons) of crop stored.

Size a storage to contain seepage and runoff from a horizontal silo measuring 12 m x 30 m x 3.5 m (40 ft x 100 ft x 12 ft) for a 1-month period. Feed preparation apron area is 12 m x 6 m (40 ft x 20 ft). Crop moisture content is 75%. See Tables 5, 6 and 7.

Storage Capacity (T)

T70 = 980 tonnes (1,080 tons) (see Tables 5, 6 and 7)
(storage capacity at 70% moisture)

T75 = 0.3 (T70)/(1-M) (storage capacity at 75% moisture)
= 0.3 (1,080)/(1-0.75)
= 1,180 tonnes (1,296 tons)

Seepage Storage Volume
Seepage = 3.1 m^3/100 tonnes x 1,180 tonnes
(100 ft^3/100 tons x 1,296 tons)
= 36.5 m^3 (1,296 ft^3)
Rainfall Storage Volume
= 0.0015 m^3/100 tonnes (0.005 ft^3/ft^2/day)
x 30 days x (area of silo m^2 (ft^2) + apron area m^2 (ft^2))
= 20 m^3 (720 ft^3)

Required Storage Size
= 3.65 m^3 + 20 m^3 (1,296 ft^3+ 720 ft^3)
= 56.5 m^3 (2,016 ft^3)

Seepage and Precipitation Storage Size 614 m^3 (2,016 ft^3)
Use Table 9 to find the dimensions of the required storage capacity = width x length x height

57 m^3 (2,016 ft^3) = 4.3 x 4.9 x 2.7 m (14 x 16 x 9 ft)
In addition, a flow path or vegetated area must be available to manage flows during the 11-month period when seepage is not expected. Do not design the flow path over tiles or shallow bedrock.

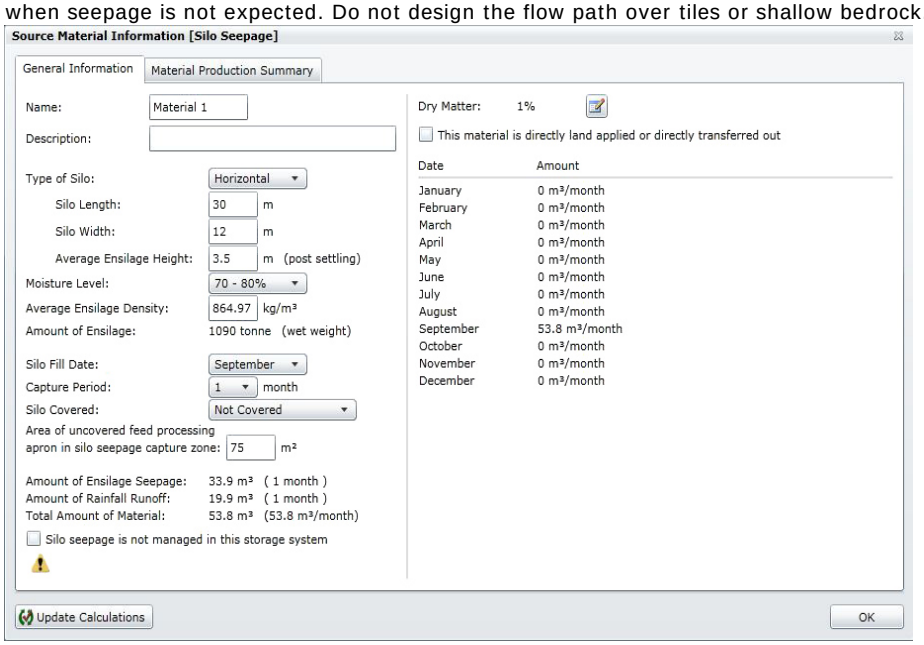

Figure 11. NMAN source material information for silo seepage.

Seepage Calculations in Software

OMAFRA has a software program called Agrisuite that includes the ability to complete silo seepage calculations. This information is in the MStor worksheet of this software. Figure 11 shows an MStor calculation for information described in Example 1.
Agrisuite is available from the **OMAFRA website**. Search for Agrisuite.

Tower Silos

- If the crop is stored at >70% moisture, size the seepage storage for 3.1 m^3/100 tonnes (100 ft^3/100 tons) of crop stored.
- If the crop is stored at/or below 70% moisture, use 1.55 m^3/100 tonnes (50 ft^3/100 tons) of crop stored.
- The design criteria will give a minimum of 2 days of storage for the seepage material. Provide up to 1 year of storage with very low-moisture crops (i.e., <60% moisture).
  Cover tower silos with roofs to keep out rain.

Example 2:

Size a seepage tank based on the following criteria:

- tower concrete silo measuring 6 m x 21 m (20 ft x 70 ft)
- alfalfa silage at 70% moisture
- see Table 8 for capacity

Storage capacity

= 640 tonnes (703 tons)

Required seepage storage size

= 1.55 m^3/100 tonnes x 640 tonnes (50 ft^3/100 tons x 703 tons)
= 10 m^3 (352 ft^3)

Table 5. Capacities for Common Horizontal Silo Sizes (Capacity is in tons for a grass or corn silage density of 45 pounds per cubic ft at 70% moisture)

The following tables list the approximate wet tons capacity for a number of common silo sizes. The tables take into account a 1:2 sloping front face. Widths given are inside to inside and do not include space taken up by posts and planking. When using these tables, calculate the daily feed removal to ensure enough feed is removed to prevent spoilage. For capacity in Tonnes, multiply figures shown by 0.91.

Average Silage Density (lbs/cu ft)	Silo Height (ft)	Silo Width (ft)	Removal Rate (tons/day)			Silo Capacity (tons) Silo Length (ft)						
			4" /day	6" /day	12" /day	100	110	120	130	140	150	160
45	8	20	1.2	1.8	3.6	360	396	432	468	504	540	576
45	8	24	1.4	2.2	4.3	432	475	518	562	605	648	691
45	8	30	1.8	2.7	5.4	540	594	648	702	756	810	864
45	8	40	2.4	3.6	7.2	720	792	864	936	1008	1080	1152
45	8	50	3.0	4.5	9.0	900	990	1080	1170	1260	1350	1440
45	8	60	3.6	5.4	10.8	1080	1188	1296	1404	1512	1620	1728
45	10	20	1.5	2.3	4.5	450	495	540	585	630	675	720
45	10	24	1.8	2.7	5.4	540	594	648	702	756	810	864
45	10	30	2.3	3.4	6.8	675	743	810	878	945	1013	1080
45	10	40	3.0	4.5	9.0	900	990	1080	1170	1260	1350	1440
45	10	50	3.8	5.6	11.3	1125	1238	1350	1463	1575	1688	1800
45	10	60	4.5	6.8	13.5	1350	1485	1620	1755	1890	2025	2160
45	12	20	1.8	2.7	5.4	540	594	648	702	756	810	864
45	12	24	2.2	3.2	6.5	648	713	778	842	907	972	1037
45	12	30	2.7	4.1	8.1	810	891	972	1053	1134	1215	1296

45	12	40	3.6	5.4	10.8	1080	1188	1296	1404	1512	1620	1728
45	12	50	4.5	6.8	13.5	1350	1485	1620	1755	1890	2025	2160
45	12	60	5.4	8.1	16.2	1620	1782	1944	2106	2268	2430	2592
45	14	20	2.1	3.2	6.3	630	693	756	819	882	945	1008
45	14	24	2.5	3.8	7.6	756	832	907	983	1058	1134	1210
45	14	30	3.2	4.7	9.5	945	1040	1134	1229	1323	1418	1512
45	14	40	4.2	6.3	12.6	1260	1386	1512	1638	1764	1890	2016
45	14	50	5.3	7.9	15.8	1575	1733	1890	2048	2205	2363	2520
45	14	60	6.3	9.5	18.9	1890	2079	2268	2457	2646	2835	3024
45	16	20	2.4	3.6	7.2	720	792	864	936	1008	1080	1152
45	16	24	2.9	4.3	8.6	864	950	1037	1123	1210	1296	1382
45	16	30	3.6	5.4	10.8	1080	1188	1296	1404	1512	1620	1728
45	16	40	4.8	7.2	14.4	1440	1584	1728	1872	2016	2160	2304
45	16	50	6.0	9.0	18.0	1800	1980	2160	2340	2520	2700	2880
45	16	60	7.2	10.8	21.6	2160	2376	2592	2808	3024	3240	3456
45	18	20	2.7	4.1	8.1	810	891	972	1053	1134	1215	1296
45	18	24	3.2	4.9	9.7	972	1069	1166	1264	1361	1458	1555
45	18	30	4.1	6.1	12.2	1215	1337	1458	1580	1701	1823	1944
45	18	40	5.4	8.1	16.2	1620	1782	1944	2106	2268	2430	2592
45	18	50	6.8	10.1	20.3	2025	2228	2430	2633	2835	3038	3240
45	18	60	8.1	12.2	24.3	2430	2673	2916	3159	3402	3645	3888

Table 6. Capacities for Common Horizontal Silo Sizes (Silo Length 170-230 ft)
(Capacity is in tons for a grass or corn silage density of 45 pounds per cubic ft at 70% moisture)

Average Silage Density (lbs/cu ft)	Silo Height (ft)	Silo Width (ft)	Removal Rate (tons/day)			Silo Capacity (tons) Silo Length (ft)						
			4" /day	6" /day	12" /day	170	180	190	200	210	220	230
45	8	20	1.2	1.8	3.6	612	648	684	720	756	792	828
45	8	24	1.4	2.2	4.3	734	778	821	864	907	950	994
45	8	30	1.8	2.7	5.4	918	972	1026	1080	1134	1188	1242
45	8	40	2.4	3.6	7.2	1224	1296	1368	1440	1512	1584	1656
45	8	50	3.0	4.5	9.0	1530	1620	1710	1800	1890	1980	2070
45	8	60	3.6	5.4	10.8	1836	1944	2052	2160	2268	2376	2484
45	10	20	1.5	2.3	4.5	765	810	855	900	945	990	1035
45	10	24	1.8	2.7	5.4	918	972	1026	1080	1134	1188	1242
45	10	30	2.3	3.4	6.8	1148	1215	1283	1350	1418	1485	1553
45	10	40	3.0	4.5	9.0	1530	1620	1710	1800	1890	1980	2070
45	10	50	3.8	5.6	11.3	1913	2025	2138	2250	2363	2475	2588
45	10	60	4.5	6.8	13.5	2295	2430	2565	2700	2835	2970	3105
45	12	20	1.8	2.7	5.4	918	972	1026	1080	1134	1188	1242
45	12	24	2.2	3.2	6.5	1102	1166	1231	1296	1361	1426	1490
45	12	30	2.7	4.1	8.1	1377	1458	1539	1620	1701	1782	1863
45	12	40	3.6	5.4	10.8	1836	1944	2052	2160	2268	2376	2484
45	12	50	4.5	6.8	13.5	2295	2430	2565	2700	2835	2970	3105
45	12	60	5.4	8.1	16.2	2754	2916	3078	3240	3402	3564	3726
45	14	20	2.1	3.2	6.3	1071	1134	1197	1260	1323	1386	1449
45	14	24	2.5	3.8	7.6	1285	1361	1436	1512	1588	1663	1739
45	14	30	3.2	4.7	9.5	1607	1701	1796	1890	1985	2079	2174
45	14	40	4.2	6.3	12.6	2142	2268	2394	2520	2646	2772	2898
45	14	50	5.3	7.9	15.8	2678	2835	2993	3150	3308	3465	3623

45	14	60	6.3	9.5	18.9	3213	3402	3591	3780	3969	4158	4347
45	16	20	2.4	3.6	7.2	1224	1296	1368	1440	1512	1584	1656
45	16	24	2.9	4.3	8.6	1469	1555	1642	1728	1814	1901	1987
45	16	30	3.6	5.4	10.8	1836	1944	2052	2160	2268	2376	2484
45	16	40	4.8	7.2	14.4	2448	2592	2736	2880	3024	3168	3312
45	16	50	6.0	9.0	18.0	3060	3240	3420	3600	3780	3960	4140
45	16	60	7.2	10.8	21.6	3672	3888	4104	4320	4536	4752	4968
45	18	20	2.7	4.1	8.1	1377	1458	1539	1620	1701	1782	1863
45	18	24	3.2	4.9	9.7	1652	1750	1847	1944	2041	2138	2236
45	18	30	4.1	6.1	12.2	2066	2187	2309	2430	2552	2673	2795
45	18	40	5.4	8.1	16.2	2754	2916	3078	3240	3402	3564	3726
45	18	50	6.8	10.1	20.3	3443	3645	3848	4050	4253	4455	4658
45	18	60	8.1	12.2	24.3	4131	4374	4617	4860	5103	5346	5589

Table 7. Capacities for Common Horizontal Silo Sizes (Silo Length 240-300 ft)
(Capacity is in tons for a grass or corn silage density of 45 pounds per cubic ft at 70% moisture)

Average Silage Density (lbs/cu ft)	Silo Height (ft)	Silo Width (ft)	Removal Rate (tons/day)			Silo Capacity (tons) Silo Length (ft)						
			4" /day	6" /day	12" /day	240	250	260	270	280	290	300
45	8	20	1.2	1.8	3.6	864	900	936	972	1008	1044	1080
45	8	24	1.4	2.2	4.3	1037	1080	1123	1166	1210	1253	1296
45	8	30	1.8	2.7	5.4	1296	1350	1404	1458	1512	1566	1620
45	8	40	2.4	3.6	7.2	1728	1800	1872	1944	2016	2088	2160
45	8	50	3.0	4.5	9.0	2160	2250	2340	2430	2520	2610	2700
45	8	60	3.6	5.4	10.8	2592	2700	2808	2916	3024	3132	3240
45	10	20	1.5	2.3	4.5	1080	1125	1170	1215	1260	1305	1350
45	10	24	1.8	2.7	5.4	1296	1350	1404	1458	1512	1566	1620
45	10	30	2.3	3.4	6.8	1620	1688	1755	1823	1890	1958	2025
45	10	40	3.0	4.5	9.0	2160	2250	2340	2430	2520	2610	2700
45	10	50	3.8	5.6	11.3	2700	2813	2925	3038	3150	3263	3375
45	10	60	4.5	6.8	13.5	3240	3375	3510	3645	3780	3915	4050
45	12	20	1.8	2.7	5.4	1296	1350	1404	1458	1512	1566	1620
45	12	24	2.2	3.2	6.5	1555	1620	1685	1750	1814	1879	1944
45	12	30	2.7	4.1	8.1	1944	2025	2106	2187	2268	2349	2430
45	12	40	3.6	5.4	10.8	2592	2700	2808	2916	3024	3132	3240
45	12	50	4.5	6.8	13.5	3240	3375	3510	3645	3780	3915	4050
45	12	60	5.4	8.1	16.2	3888	4050	4212	4374	4536	4698	4860
45	14	20	2.1	3.2	6.3	1512	1575	1638	1701	1764	1827	1890
45	14	24	2.5	3.8	7.6	1814	1890	1966	2041	2117	2192	2268
45	14	30	3.2	4.7	9.5	2268	2363	2457	2552	2646	2741	2835
45	14	40	4.2	6.3	12.6	3024	3150	3276	3402	3528	3654	3780
45	14	50	5.3	7.9	15.8	3780	3938	4095	4253	4410	4568	4725
45	14	60	6.3	9.5	18.9	4536	4725	4914	5103	5292	5481	5670
45	16	20	2.4	3.6	7.2	1728	1800	1872	1944	2016	2088	2160
45	16	24	2.9	4.3	8.6	2074	2160	2246	2333	2419	2506	2592
45	16	30	3.6	5.4	10.8	2592	2700	2808	2916	3024	3132	3240
45	16	40	4.8	7.2	14.4	3456	3600	3744	3888	4032	4176	4320
45	16	50	6.0	9.0	18.0	4320	4500	4680	4860	5040	5220	5400
45	16	60	7.2	10.8	21.6	5184	5400	5616	5832	6048	6264	6480
45	18	20	2.7	4.1	8.1	1944	2025	2106	2187	2268	2349	2430
45	18	24	3.2	4.9	9.7	2333	2430	2527	2624	2722	2819	2916

45	18	30	4.1	6.1	12.2	2916	3038	3159	3281	3402	3524	3645
45	18	40	5.4	8.1	16.2	3888	4050	4212	4374	4536	4698	4860
45	18	50	6.8	10.1	20.3	4860	5063	5265	5468	5670	5873	6075
45	18	60	8.1	12.2	24.3	5832	6075	6318	6561	6804	7047	7290

The following table lists the approximate wet tons capacity for a number of common silo sizes.

Table 8a. Estimated Silo Capacities for Forages in Concrete Tower Silos

Silo Diameter X Settled Depth (ft)	Alfalfa Silage (Tons)			
	40% m.c.	50% m.c.	60% m.c.	70% m.c.
12 x 30	35	44	57	83
12 x 40	50	62	80	116
12 x 50	63	78	103	150
14 x 40	69	86	113	163
14 x 50	89	111	147	212
14 x 55	99	124	164	237
16 x 50	120	151	199	287
16 x 60	149	186	246	355
16 x 65	162	204	270	389
18 x 50	156	196	260	373
18 x 60	194	243	322	463
18 x 70	232	290	386	554
20 x 60	246	309	409	586
20 x 70	295	371	491	703
20 x 80	345	433	574	821
24 x 60	372	465	615	876
24 x 70	448	562	741	1052
24 x 80	527	660	869	1230
24 x 90	606	759	999	1409
30 x 80	876	1092	1427	1994
30 x 90	1012	1261	1643	2287
30 x 100	1151	1431	1861	2581
30 x 110	1290	1603	2080	2875

Source: OMAFRA Factsheet **Tower Silo Capacities**, Order No. 88-033.

Table 8b. Estimated Silo Capacities for Forages in Concrete Tower Silos

Silo Diameter X Settled Depth (ft)	Corn Silage (Tons)			
	55% m.c.	60% m.c.	65% m.c.	70% m.c.
12 x 30	47	54	62	74
12 x 40	66	75	87	102
12 x 50	85	97	111	132
14 x 40	92	106	121	143
14 x 50	121	136	157	185
14 x 55	134	153	175	206
16 x 50	163	184	210	246
16 x 60	200	227	259	303
16 x 65	220	248	284	330
18 x 50	210	238	272	317
18 x 60	261	293	334	388
18 x 70	311	349	397	461
20 x 60	328	369	419	486

20 x 70	393	439	498	576
20 x 80	457	510	579	668
24 x 60	486	543	616	712
24 x 70	582	649	734	844
24 x 80	678	754	850	977
24 x 90	774	860	968	1110
30 x 80	1088	1280	1477	1628
30 x 90	1242	1475	1702	1877
30 x 100	1397	1672	1929	2127
30 x 110	1552	1871	2158	2382

Source: OMAFRA Factsheet **Tower Silo Capacities**, Order No. 88-033.

Table 9. Seepage and Precipitation Storage Sizes (ft^3)

Width Length (ft)	Height (ft)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
5 x 5	25	50	75	100	125	150	175	200	225	250	275	300
6 x 6	36	72	108	144	180	216	252	288	324	360	396	432
7 x 7	49	98	147	196	245	294	343	392	441	490	539	588
8 x 8	64	128	192	256	320	384	448	512	576	640	704	768
9 x 9	81	162	243	324	405	486	567	648	729	810	891	972
10 x 10	100	200	300	400	500	600	700	800	900	1000	1100	1200
11 x 11	121	242	363	484	605	726	847	968	1089	1210	1331	1452
12 x 12	144	288	432	576	720	864	1008	1152	1296	1440	1584	1728
13 x 13	169	338	507	676	845	1014	1183	1352	1521	1690	1859	2028
14 x 14	196	392	588	784	980	1176	1372	1568	1764	1960	2156	2352
15 x 15	225	450	675	900	1125	1350	1575	1800	2025	2250	2475	2700
16 x 16	256	512	768	1024	1280	1536	1792	2048	2304	2560	2816	3072
17 x 17	289	578	867	1156	1445	1734	2023	2312	2601	2890	3179	3468
18 x 18	324	648	972	1296	1620	1944	2268	2592	2916	3240	3564	3888
19 x 19	361	722	1083	1444	1805	2166	2527	2888	3249	3610	3971	4332
20 x 20	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800
21 x 21	441	882	1323	1764	2205	2646	3087	3528	3969	4410	4851	5292
22 x 22	484	968	1452	1936	2420	2904	3388	3872	4356	4840	5324	5808
23 x 23	529	1058	1587	2116	2645	3174	3703	4232	4761	5290	5819	6348
24 x 24	576	1152	1728	2304	2880	3456	4032	4608	5184	5760	6336	6912
25 x 25	625	1250	1875	2500	3125	3750	4375	5000	5625	6250	6875	7500

Summary

Silo seepage can be a pollutant or safety hazard if managed incorrectly. The methods to properly manage silo seepage include collection, storage and use of the nutrient rich source on the farm and elimination of the liquid seepage.

This Factsheet was revised by Don Hilborn, P.Eng., By-Products Engineer, OMAFRA, Woodstock, and Steve Clarke, P.Eng., Energy & Crop Engineer, OMAFRA, Kemptville.

Do you know about Ontario's Nutrient Management Act?

The provincial *Nutrient Management Act* (NMA) and the Regulation 267/03 regulate the storage, handling and application of nutrients that could be applied to agricultural cropland. The objective is to protect Ontario's surface and groundwater resources.

Please consult the regulation and protocols for the specific legal details. This Factsheet is not meant to provide legal advice. Consult your lawyer if you have questions about your legal obligations.

For more information on the NMA, call the Agricultural Information Contact Centre at 1-877-424-1300, **e-mail** or visit our **website**.

Factsheets are continually being updated, so please ensure that you have the most recent version.

For more information:
Toll Free: 1-877-424-1300
E-mail: **ag.info.omafra@ontario.ca**