Salinity Mapping for Resource Management

within the M.D. of Willow Creek, Alberta

J. Kwiatkowski
L.C. Marciak
D. Wentz
C.R. King

Conservation and Development Branch
Alberta Agriculture, Food and Rural Development

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Abstract

This report presents a methodology to map salinity at a municipal scale and applies this procedure to the Municipal District of Willow Creek, a rural municipality in southern Alberta. The methodology was developed for the County of Vulcan (Kwiatkowski et al. 1994) and is being applied to other Alberta municipalities which have identified soil salinity as a concern.

Soil salinity is a major conservation issue in the Municipal District of Willow Creek. The information on salinity location, extent, type and control measures presented in this report will help Municipal District planners to target salinity control and resource management programs.

The methodology has four steps:

1. The location and extent of saline areas are mapped based on existing information including aerial photographs, maps, the Lethbridge Northern Irrigation District map, assessment data and technical reports, as well as information from local personnel and field inspections.

2. Saline areas are classified on the basis of the mechanism causing salinity. The mechanism is important because it determines which control measures are appropriate. Eight salinity types are recognized within the Municipal District of Willow Creek. These are: contact/slope change salinity, outcrop salinity, artesian salinity, depression bottom salinity, coulee bottom salinity, slough ring salinity, irrigation canal seepage salinity and natural/irrigation salinity.

3. Cost-effective, practical control measures are identified for each salinity type.

4. A colour-coded map at a scale of 1:100 000 is prepared showing salinity location, extent and type.

Analysis of the mapping data shows that 1 070 saline areas occur in the Municipal District and these areas occupy a total of 7 148 ha (17 753 ac). Salinity affects 1.5% of the M.D.'s area (464 538 ha). Only saline areas visible on the soil surface are mapped. The surrounding lands may have saline subsurface soils which can reduce yields of sensitive crops. Thus, salinity control practices may benefit crop yields over a much broader area than just the visible seep.

Depression bottom salinity is the most common salinity type (44.8% of saline areas in the Municipal District), followed by coulee bottom salinity (21.7% of saline areas), contact/slope change salinity (18.5%), outcrop salinity (5.1%), natural/irrigation salinity (4.9%), and irrigation salinity (3.6%). Artesian salinity and slough ring salinity are minor, totalling only 1.4% of saline areas.

Acknowledgements

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1.0 Introduction

1.1 Goal and Objectives

The goal of this project is to present information on salinity location, extent and type in the Municipal District (M.D.) of Willow Creek. Soil degradation is a key issue in conservation planning and salinity is one of the most visible soil degradation problems affecting the M.D. according to its Canada-Alberta Environmentally Sustainable Agriculture (CAESA) Agreement action plan. Therefore this mapping project aims to better define the salinity problem for the M.D. of Willow Creek.

The project's goal is achieved through the following objectives:

1. To derive and integrate existing salinity information for agricultural land in the M.D. of Willow Creek.
2. To determine the salinity type based on the salinity mechanism.
3. To recommend appropriate control methods for each type of salinity.
4. To compile a map depicting salinity location, extent and type.

The project differs from most salinity surveys by specifying the type, exact locations and control measures. This information can be used in municipal and farm conservation planning.

1.2 Methodology

The methodology for mapping salinity was developed for the County of Vulcan by Kwiatkowski et al. (1994). It is being applied to other Alberta municipalities where soil salinity is a concern. The process of salinity mapping consists of four stages:

1. Scan aerial photographs and digitize saline areas on a municipal base map.

2. Determine the types of salinity occurring in the municipality, based on hydrogeology, surface water flow, geology, topography, irrigation and soils. Determine appropriate cost-effective, practical control measures based on salinity types.

3. Field check the salinity data and submit the draft salinity information to a technical team consisting of a project manager, hydrogeologist, salinity specialist, and the local Agricultural Fieldman and District Specialist for review.

4. Prepare a colour-coded 1:100 000 map, showing salinity location, extent and type, and an accompanying report with a map in scale 1:200 000.

1.3 Information Sources

A variety of maps, aerial photographs and other information sources were used for this project. Information on climate, soils, parent material and hydrogeology was taken from four reports:

1. Soil Map at a scale of 1:126,720 - Lethbridge Area NW 82H (Kocaoglu 1977)
2. Soil Survey of Gleichen SW (82ISW) and SE (82ISE) map sheets (Walker et al. in press)
3. Hydrogeology of the Lethbridge-Fernie area, Alberta (Tokarsky 1973)
4. Hydrogeology of the Kananaskis Lake Area, Alberta (Borneuf 1980)

The Saline/Waterlogged Lands Map (in scale 1:100 000) from the Lethbridge Northern Irrigation District (1990) provided information on salinity in two categories: moderately and severely affected areas. The data were collected in 1982 and include sloughs, stock-watering ponds and small, temporary water bodies. This map covers only small area of the M.D. of Willow Creek north of Fort MacLeod. The main causes of salinization and waterlogging within irrigation districts are seepage from canals, poor water management, poor irrigation practices and inadequate drainage.

Aerial photographs from 1990 (scale of 1:30 000) were used to help determine the location, extent and type of salinity on a section-by-section basis.

Prairie Farm Rehabilitation Administration (PFRA) Salinity Investigation Reports for 25 sites throughout the M.D. were also valuable information sources (Prairie Farm Rehabilitation Administration various dates). These reports provided detailed data including information on drilling investigations, the severity and extent of salinity, and recommended control methods.

To ensure the accuracy of the salinity map, about two-thirds of the M.D. was field checked. Local personnel were also consulted to verify the findings.

2.0 Classification and Management of Saline Seeps

2.1 Transportation of Salts

The dominant salts in the M.D. of Willow Creek consist of sodium and magnesium sulphates. Analyses of groundwater, saline soils and parent material suggest that the primary source of salts is bedrock, and the secondary source is glacial till (Greenlee et al. 1968). Soils developed on the Bearpaw bedrock formations contain high salt levels.

Saline seeps form when saline groundwater rises to the ground surface. Contact and slope change seeps (described in Section 2.2.1) develop when water in a recharge area percolates down through the soil profile beyond the root zone and dissolves soluble salts (Figure 1). The water moves laterally to a lower position in the landscape and through capillarity rises to the surface, resulting in a saline seep. High evapotranspiration rates cause the capillary rise and the deposition of salts on the soil surface.

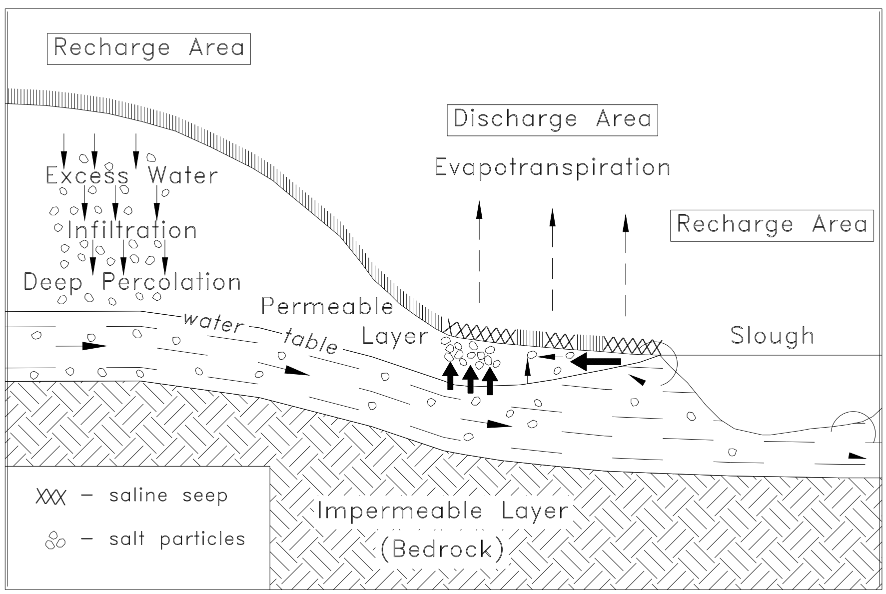


Figure 1. Generalized saline seepage mechanisms

Three different types of flow may be recognized within a groundwater basin: local, intermediate and regional. A local flow system occupies a relatively small area, with the recharge area at a higher elevation than the discharge area. An intermediate system consists of several interconnected local systems. A regional system has its recharge area at the water divide of a basin while the discharge area lies at the bottom of the basin. In the M.D. of Willow Creek, most of the groundwater flow systems are local, and the recharge areas are within a few hundred metres of their discharge area. Intermediate flow systems extend beyond 1 km (0.6 mi) of their discharge area. Regional flow systems extend over several kilometres.

Groundwater movement is influenced by topography as follows:

- In large, flat areas, groundwater movement is minimal or even impeded.
- In areas with well-defined local relief (e.g. hummocky or rolling landscapes), local systems are prevalent.
- In areas with one large slope, regional systems are prevalent.
- In large valleys, regional systems predominate.

2.2 Salinity Types

Based on hydrogeology, surface water flow, geology, topography, irrigation and soils, eight types of salinity are recognized within the M.D. of Willow Creek. The eight types can be grouped into six dryland (rainfed land) and two irrigation types as follows.

2.2.1 Dryland Salinity Types

1. Contact/Slope Change Salinity
Contact salinity and slope change salinity are grouped together because they cannot be differentiated on aerial photographs and because the same methods are used to control both types (see Section 2.3). The two types are described as follows:

a. *Contact salinity* occurs where a permeable water-bearing surface layer thins out above a less permeable layer (such as a fine textured layer). This forces the groundwater flow closer to the surface (Figure 2). Contact salinity dominates in sandy, gently rolling areas, mostly in the central portion (Granum and Claresholm areas, Twp. 10 Rge. 26, and Twp. 12, 13 Rge. 27) and northern portion (Parkland area, Twp. 15 Rge. 27, 28) of the M.D. Contact salinity also occurs at the shoulders of coulees or as seeps that are not necessarily associated with the low lying areas scattered throughout the M.D.

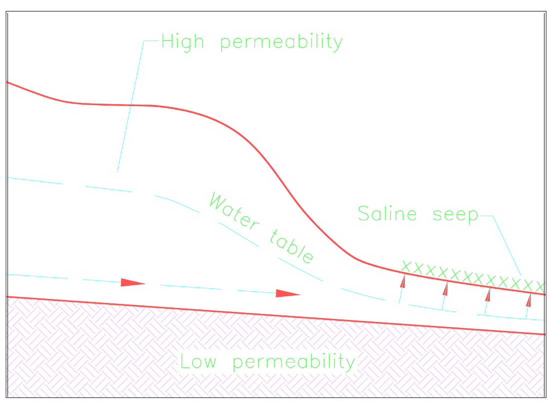


Figure 2. Contact salinity

b. *Slope change salinity* occurs where the slope decreases. This decrease results in a slowing of the groundwater flow and a shallower water table (Figure 3). This type of seep expands upslope. It occurs throughout the M.D. of Willow Creek.

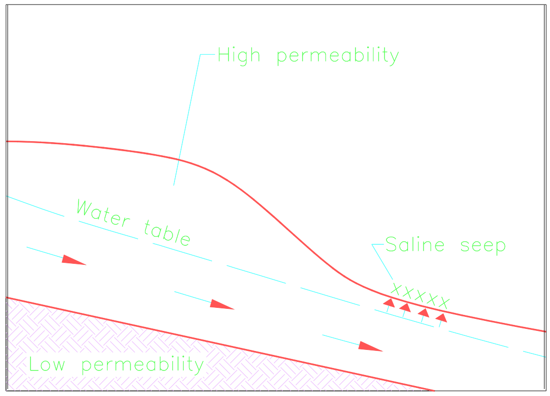


Figure 3. Slope change salinity

2. Outcrop Salinity

Outcrop salinity occurs where a permeable, water-bearing layer, such as a coal seam or fractured bedrock layer, outcrops at or near the surface (Figure 4). Outcrop salinity occurs along a slope at similar elevations. In the M.D. of Willow Creek, large areas of outcrop salinity occur west of Parkland (Twp. 15 Rge. 28) and southwest of Nanton (Twp. 16 Rge. 28).

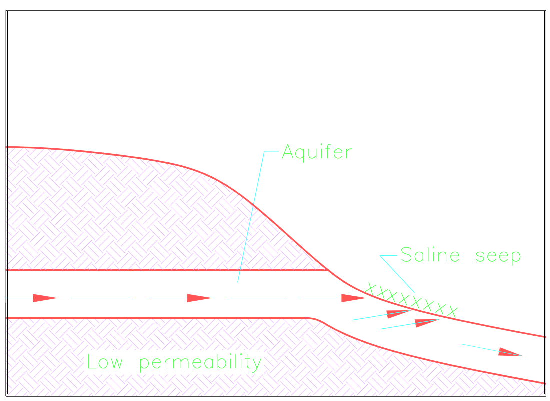


Figure 4. Outcrop salinity

3. Artesian Salinity

Artesian salinity occurs where water from a pressurized aquifer rises to or near the ground surface (Figure 5). It is usually associated with intermediate or regional groundwater flow systems. If the pressure is large enough, the water flows to the surface and produces a flowing well, spring or soap hole. Artesian seeps can be identified from the presence of these flow features and from hydrogeological maps.

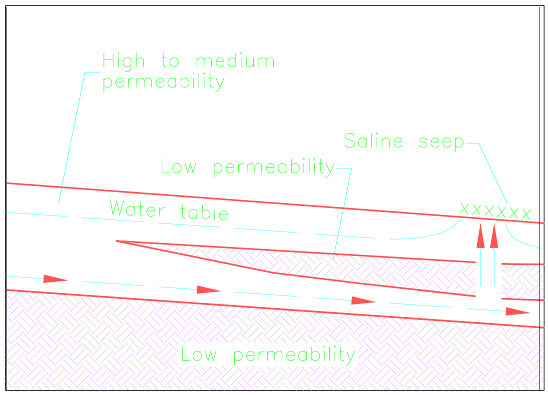


Figure 5. Artesian salinity

4. Depression Bottom Salinity

This salinity type occurs in low lying areas. Surface water is trapped temporarily in low areas until the water drains off and/or infiltrates the soil. The water in the soil flows upslope through the upper soil in an unsaturated state and then surfaces to evaporate and deposit salt at the edge of the ponded area (Figure 6). Once the surface water has disappeared, groundwater from the water table rises by capillary action to the surface in and around the previously ponded area. Depression bottom seeps are well defined with distinct, rounded edges. In the M.D. of Willow Creek, depression bottom salinity is the most common salinity type. The seeps occur in several landscapes with poor drainage, particularly in rolling and hummocky areas. They are also associated with Solonetzic soils which occur throughout the M.D. The seeps occur mainly in the Clear Lake area (Twp. 13, 14 Rge. 26, 26) and in the Mud Lake area (Twp. 9 Rge. 28).

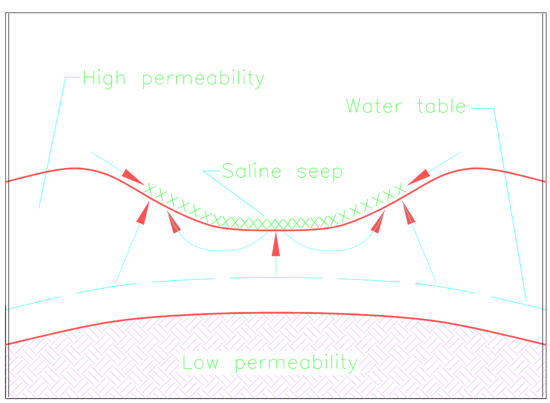


Figure 6. Depression bottom salinity

5. Coulee Bottom Salinity
Coulee bottom salinity forms in the bottoms of coulees and watercourses by the same mechanism as depression bottom salinity but on a larger scale. It typically develops over long periods of time so most lands affected by coulee bottom salinity have never been in agricultural production. It occurs extensively in the Pine Coulee and its tributaries and some coulees in the Nanton area (Twp. 15, 16 Rge. 28).

6. Slough Ring Salinity
This type of salinity occurs as a ring of salt immediately adjacent to a permanent water body (Figure 7). Water infiltrates from the water body into the permeable upper soil layer and flows upslope as shallow groundwater in an unsaturated state through this layer. The water may also flow downward, raising the water table. Water from the unsaturated flow and water raised from the water table by capillary action emerges at the surface where it evaporates, leaving salts at the edge of the slough. This salinity type occurs mainly in the vicinity of Clear Lake (Twp. 13 Rge. 25 and Twp. 14 Rge. 26).

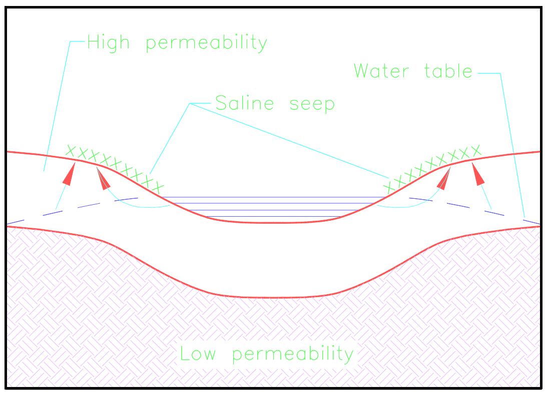


Figure 7. Slough ring salinity

2.2.2 Irrigation Salinity Types

1. Canal Seepage Salinity
This type of seep is dominant in irrigated areas where leakage from canals contributes to seeps (Figure 8). Because many canals are located along a topographic break, canal seepage often aggravates natural salinity. Lethbridge Northern Irrigation District covers small part of the M.D. of Willow Creek. Canal seepage salinity occurs only north of Fort MacLeod (Twp. 9, 10 Rge. 25, 26).

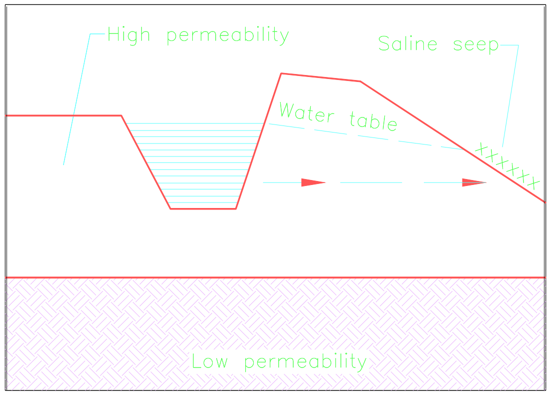


Figure 8. Canal seepage salinity

2. Natural/Irrigation Salinity
These seeps result from one or more of: natural seepage, canal seepage and excess irrigation. All seeps located on irrigated land and some distance from canals and supply ditches are given this classification.

2.3 Salinity Controls

Salinity is a complex problem caused by climatic, hydrogeological and agricultural factors. The opportunities for moderating the effects of climate and hydrogeological processes are limited and/or expensive. Therefore appropriate agricultural practices are used to help prevent or control saline seeps. The emphasis in this report is on cost-effective, agronomic measures. Specifically, cropping systems that intercept the available soil water in a recharge area before the water moves below the crop root zone are recommended.

Recommended control methods for the types of salinity found in the M.D. of Willow Creek are summarized in Table 1 and described in more detail in Sections 2.3.1 and 2.3.2.

2.3.1 Biological Controls

2.3.1.1 Salt-Tolerant Crops

Saline areas should not be left bare for extended periods. Very saline soils should be seeded to a mixture of salt-tolerant forage crops (Table 2). Saline areas are often wet, so crops may need to be tolerant of both salt and excess moisture. When electrical conductivity measurements exceed 8 to 10 mS/cm, salt-tolerant seed mixtures usually give the best results.

Establishing deep-rooted vegetation on a saline seep can be very difficult. Salt-tolerant grasses can be seeded in the fall when the saline seeps are dry and accessible. Seeding rates for saline seeps, especially when planted in the fall, should be double those for non-saline areas.

2.3.1.2 Deep-Rooted Crops

Deep-rooted crops prevent the buildup of groundwater, lower the water table, dry out the subsoil and restore the water storage capacity of the soil (Brown et al. 1982). The most commonly grown deep-rooted dryland crop is alfalfa. It roots up to 6 m (20 ft) in four to five

Table 1. Salinity types and control methods in the M.D. of Willow Creek

Salinity Type	Control
1. contact/slope change salinity	- salt-tolerant grasses in saline area and alfalfa in upslope recharge area (recharge area may be about three times area of seep)
2. outcrop salinity	- salt-tolerant grasses in saline area
3. artesian salinity	- salt-tolerant grasses in saline area - where applicable, install relief wells connected to suitable outlet
4. depression bottom salinity	- salt-tolerant grasses in saline area and along edge of depression in band 50 to 150 m (165 to 490 ft) wide - appropriate structural controls
5. coulee bottom salinity	- salt-tolerant grasses in saline area - appropriate structural controls
6. slough ring salinity	- deep-rooted and salt-tolerant grasses in a 20 to 60 m (65 to 195 ft) band around slough - appropriate structural controls
7. irrigation canal seepage salinity	- structural controls to prevent canal seepage (canal lining, cut-off curtains) and/or subsurface drainage of affected area
8. natural/irrigation salinity	- appropriate structural controls for irrigation-related salinity - salt-tolerant grasses for natural salinity

years and uses more than 760 mm (30 in.) of water per year. Perennial deep-rooted crops also increase soil organic matter content, improve soil structure and reduce soil erosion.

Alfalfa should be seeded into a firm, moist seed bed as shallowly as possible at a rate of about 7 kg/ha (6.2 lbs/ac). It can be seeded using a conventional seeder. Hoe drills often give the most effective results because of good depth control and packing capability. Disk drills work best if the seed bed is uniform and moderately firm. However, in loose soil, disk drills may place the seed too deeply, and in very firm soil, they may leave the seed on the soil surface. Both conditions result in poor germination.

Recharge areas identified during a salinity investigation should be seeded to alfalfa. On average, recharge areas are about three times larger than their saline seep. The best time for seeding alfalfa is early spring. Alfalfa should be seeded without any companion crops because competition will deter establishment of the alfalfa stand.

Table 2. **Forage crops for saline soils and flooded areas (Henry et al. 1987)**

Salinity Rating (EC)*	Forage Mix	Seeding Rate for Hay or Pasture (kg/ha)
	a. Soils with Little or No Spring Flooding (up to 2 weeks)	
Slight to Moderate (2-6 dS/m)	bromegrass + Russian wild ryegrass + alfalfa (Rambler)	4+4+4
	bromegrass + slender wheatgrass + alfalfa (Rambler)	4+4+4
	Russian wild ryegrass + alfalfa	6+3
	altai wild ryegrass + alfalfa	10+3
	crested wheatgrass + alfalfa	7+3
	altai wild ryegrass	11
	slender wheatgrass + sweet clover (short-term stands and not over 1 week of flooding)	8+6
Severe (6-10 dS/m)	bromegrass + Russian wild ryegrass + slender wheatgrass	4+4+4
	altai wild ryegrass + alfalfa	10+3
	altai wild ryegrass	11
	tall wheatgrass (moist districts or seepage areas)	12
Very Severe (10-15 dS/m)	Russian wild ryegrass + slender wheatgrass	4+4
	altai wild ryegrass + alfalfa	10+3
	altai wild ryegrass	10
	tall wheatgrass (moist districts or seepage areas)	12
	b. Soils with Spring Flooding (2 to 5 weeks)	
Little or No (0-2 dS/m)	reed canarygrass + bromegrass	4+6
	reed canarygrass + timothy	4+4
	timothy + bromegrass	4+6
	altai wild ryegrass + alfalfa	10+3
	altai wild ryegrass	11
Slight to Moderate (2-6 dS/m)	reed canarygrass + bromegrass	4+6
	reed canarygrass + bromegrass + slender wheatgrass	4+6+6
	altai wild ryegrass + alfalfa	10+3
	altai wild ryegrass	11
Severe to Very Severe (6-15 dS/m)	altai wild ryegrass + alfalfa	10+3
	slender wheatgrass	8
	altai wild ryegrass	11
	tall wheatgrass	12

* EC - electrical conductivity based on saturated paste, in deciSiemens per metre

Alfalfa has the ability to use atmospheric nitrogen through a symbiotic relationship with rhizobia nodule bacteria. Therefore, alfalfa inoculated with rhizobia will require less nitrogen fertilizer. Phosphorus, potassium and sulphur are important nutrients for optimum production. Alfalfa requires 5 kg of phosphorus per tonne of yield (10 lbs per ton of yield). This nutrient is very immobile in the soil and so application prior to seeding is highly recommended.

When alfalfa is seeded in a recharge area, it usually takes about five years to lower the water table in the associated saline seep. Once the water table is lowered to an acceptable level, the recharge area may be converted to cereal crops for a few years. The best approach is usually to establish a rotation of five years of alfalfa followed by three years of cereal crops. The cereals should be continuously cropped.

2.3.1.3 Flexible Cropping

In *flexible cropping*, fields are seeded if stored soil moisture and rainfall probabilities are favourable for satisfactory crop yields, and they are fallowed only if yield prospects are unfavourable (Jackson and Krall 1978). Flexible cropping involves careful management and planning; it is often simpler to use continuous cropping.

Snow trapping may increase stored soil moisture for recropping. Techniques to trap and manage snow include:
- *tall stubble/alternate height stubble* - Leaving tall stubble or strips of stubble at different heights increases stored soil moisture.
- *shelterbelts* - The ability of shelterbelts to trap snow can be manipulated by such practices as tree pruning and species selection.

Snow trapping should distribute snow evenly to avoid local accumulations of snowmelt from large drifts.

2.3.2 Structural Controls

2.3.2.1 Surface Drainage

Surface drainage of recharge areas and/or discharge areas can be used to control seeps (VanderPluym 1982). An open, shallow trench is normally used; deep trenches will obstruct farming operations. Trenches can be constructed with farm or contractor's equipment at a reasonable cost.

Grassed waterways are often used to drain excess surface water from recharge areas. Typical grassed waterways are broad, shallow channels with shallow slopes that carry water at slow speeds, preventing soil erosion. Grassed waterways ideally have channel slopes of less than 1% and side slopes of less than 25%. The channel should be at least 15 cm (5.9 in.) deep and

5 m (16 ft) wide. The grass should extend at least 5 m (16 ft) on both sides of the channel. A commonly used forage mix for grassed waterways is:

- brome or pubescent wheatgrass	- 10 kg/ha (9 lbs/ac), plus
- creeping red fescue	- 5 kg/ha (4.5 lbs/ac), plus
- crested wheatgrass	- 5 kg/ha (4.5 lbs/ac), plus
- alfalfa	- 10 kg/ha (9 lbs/ac), plus
- fall rye	- 1 kg/ha (0.9 lbs/ac)

2.3.2.2 Subsurface Drainage

Although subsurface (tile) drainage is used on irrigated lands to control salinity and waterlogging, it is not commonly used to control dryland salinity. However, a subsurface drainage system will satisfactorily lower water tables in dryland seeps if the system is properly designed, installed and managed. If the water is of good quality, it could be stored and used for stock water.

2.3.2.3 Relief Wells

Relief wells are costly but they can effectively control springs and soapholes associated with artesian salinity. The wells should be completed in the pressurized water-bearing layer. The wells may flow free and could be connected to a buried pipe 1 to 2 m (3.3 to 6.6 ft) deep. If the water is of good quality, it could be used for domestic or livestock purposes.

3.0 Salinity Distribution

The following statistical analysis describes the number and size of saline seeps for all types of salinity and for contact/slope change salinity in the M.D. of Willow Creek. These two examples indicate the general tendencies for the other salinity types.

The M.D. has 1 070 saline seeps which occupy a total of 7 185 ha (17 754 ac). This project depicts salinity which is visible on the soil surface. Most of these visible saline areas are out of agricultural production or have significantly reduced crop yields. However, the effects of salinity on crop yields are not usually limited to the visible saline areas. Often the surrounding lands have weakly to very weakly saline subsoils, reducing yields of sensitive crops. Thus, salinity control practices may benefit crop yields over a much broader area than just the visible seep.

Table 3 and Figure 9 present the area and percentage of saline seeps for each of the eight salinity types. Depression bottom salinity is the most common type (44.8% of the saline land), followed by coulee bottom salinity (21.7%), contact/slope change salinity (18.5%), outcrop salinity (5.1%), natural/irrigation salinity (4.9%), canal seepage salinity (3.6%), artesian salinity (0.8%), and outcrop salinity (0.6%).

Figure 10 shows the number of saline seeps by type. Overall, there are many small contact/slope change saline seeps and a few large coulee bottom saline seeps. Depression bottom salinity consists of 436 seeps and occupies 3 216 ha (7 946 ac). Contact/slope change salinity consists of 301 seeps and occupies 1 330 ha (3 286 ac). Coulee bottom salinity consists only 119 seeps and occupies 1 560 ha (3 855 ac). Average seep sizes are: 4.40 ha (10.87 ac) for contact/slope change saline seeps; 7.37 ha (18.20 ac) for depression bottom saline seeps; and 26.99 ha (66.69 ac) for coulee bottom saline seeps.

Figure 11 shows the frequency of different size ranges for all saline seeps. The seep areas vary from 183 m^2 to 366 ha (904 ac). Thirty percent of the seeps are between 0 and 1.0 ha (from 0 to 2.47 ac). Thirty-four percent are larger than 4 ha (9.9 ac); they are mainly coulee bottom or depression bottom salinity types. Only one seep, located in Pine Creek coulee, is greater than 300 ha (741 ac).

The areas for the contact/slope change saline seeps show a similar distribution (Figure 12). Of the 301 contact/slope change seeps, 163 (54%) are between 0 and 1.0 ha (0 and 2.47 ac), and 18% are larger than 6 ha (14.8 ac).

The typical measures to control contact/slope change salinity are to grow salt-tolerant grasses in the saline area and alfalfa in the recharge area. On average, recharge areas are about three times the size of their saline area. Thus, as a general guide, a recharge area about three times the size of the seep will need to be converted to alfalfa to control contact/slope change seeps.

Table 3. Salinity distribution by type in the M.D. of Willow Creek

Salinity Type	No. of Seeps	Area (ac)	Area (ha)	Percent of Total Saline Area
1. contact/slope change salinity	301	3 286.30	1 329.95	18.5
2. outcrop salinity	96	905.05	366.27	5.1
3. artesian salinity	16	134.38	54.38	0.8
4. depression bottom salinity	436	7 945.82	3 215.63	44.8
5. coulee bottom salinity	57	3 855.04	1 560.11	21.7
6. slough ring salinity	9	116.44	47.12	0.6
7. irrigation canal seepage salinity	36	640.07	259.03	3.6
8. natural/irrigation salinity	119	870.50	352.28	4.9
Total	1 070	17 753.60	7 184.77	100.0

Figure 9. Salinity Area by Type in the M.D. of Willow Creek

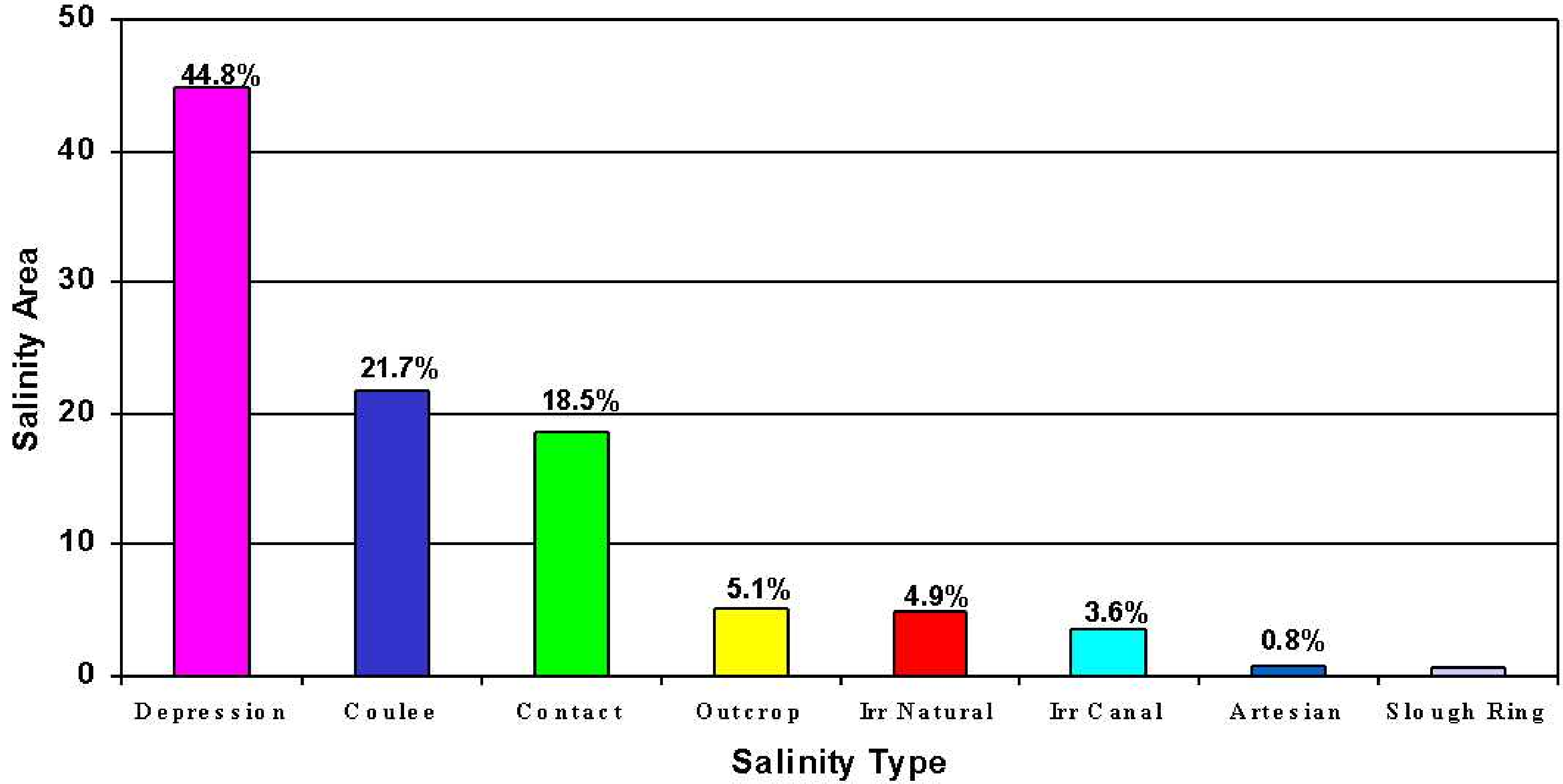


Figure 10. Number of Saline Seeps by Type in the M.D. of Willow Creek

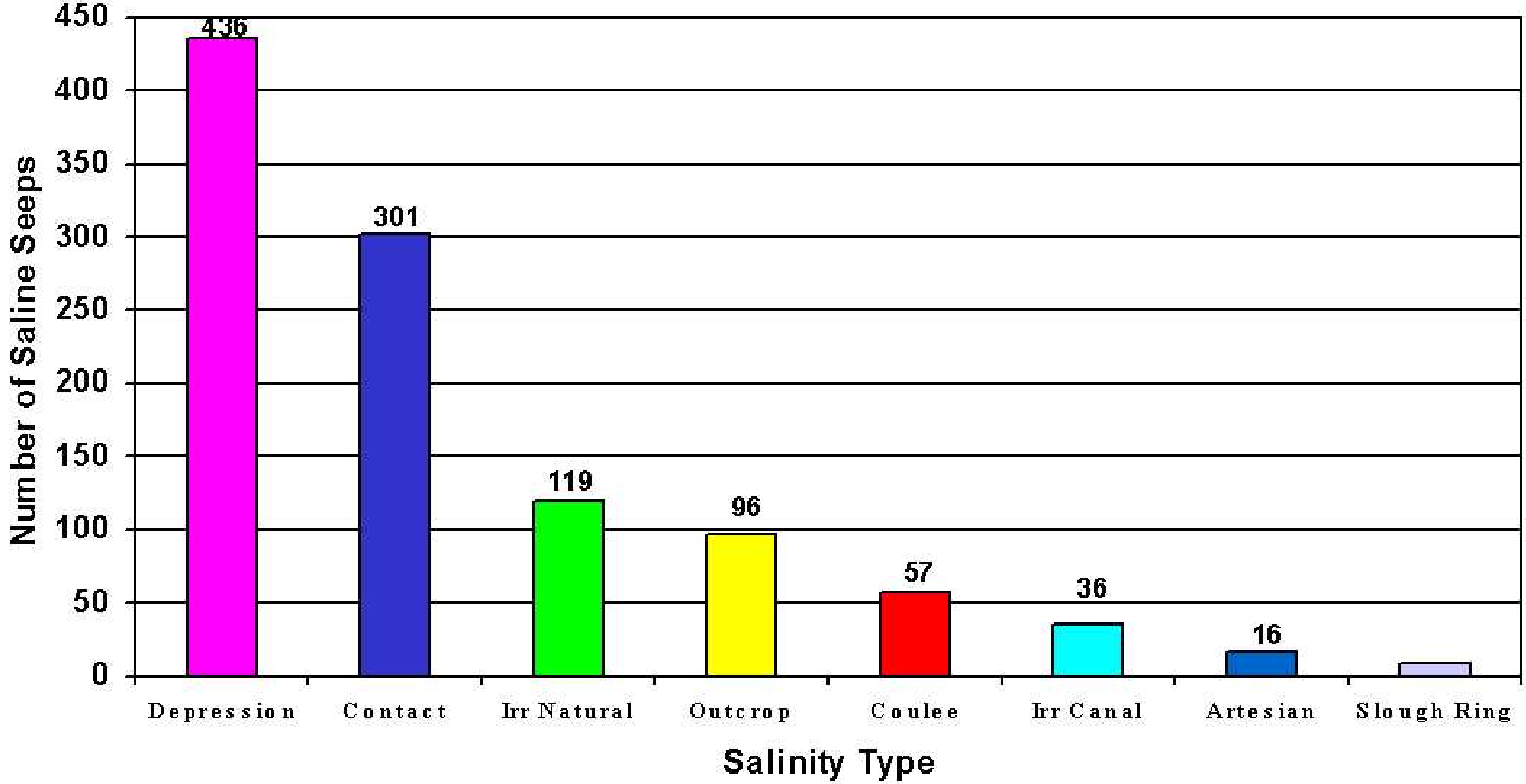


Figure 11. Number and Size of Saline Seeps in the M.D. of Willow Creek

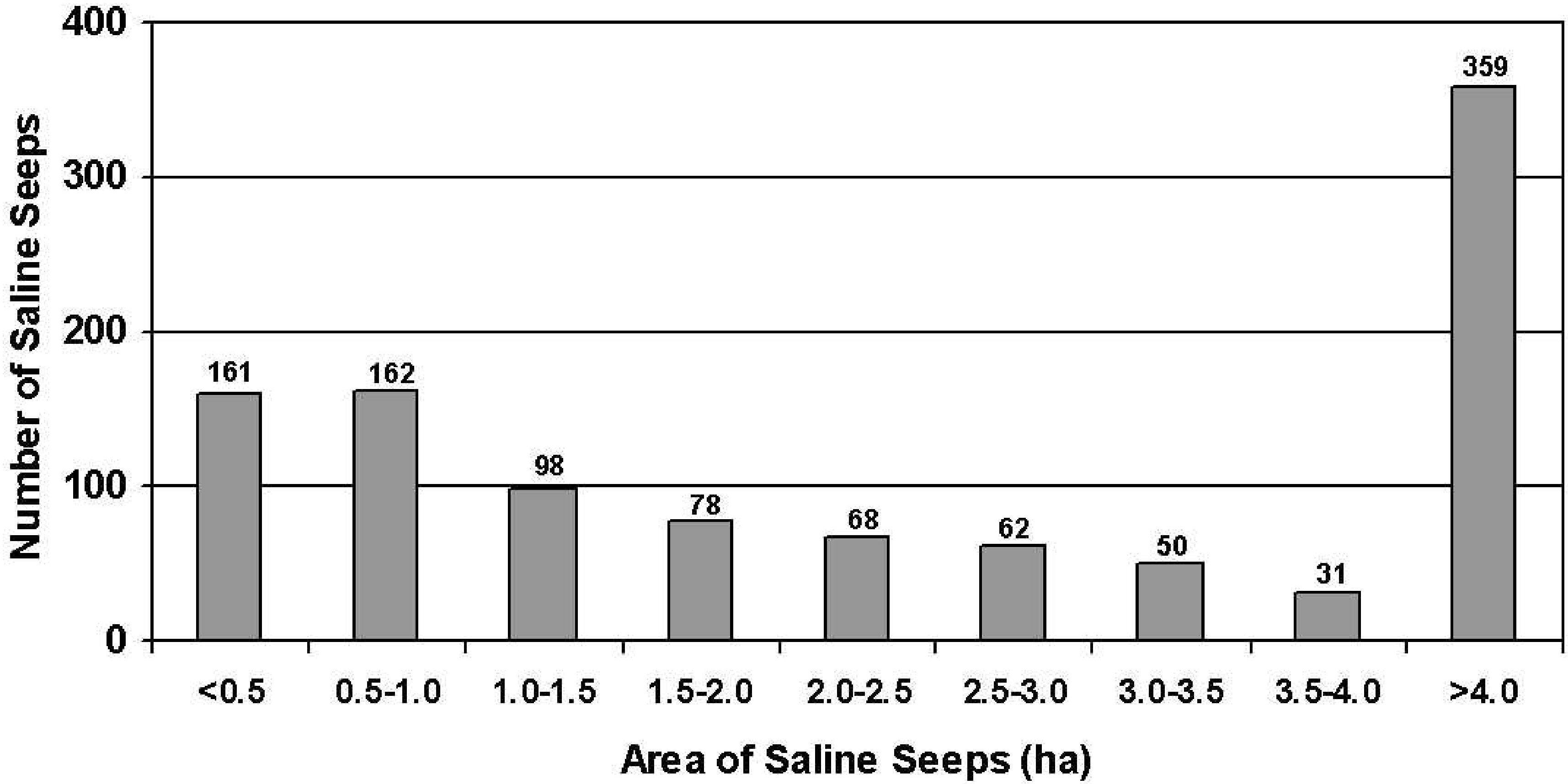
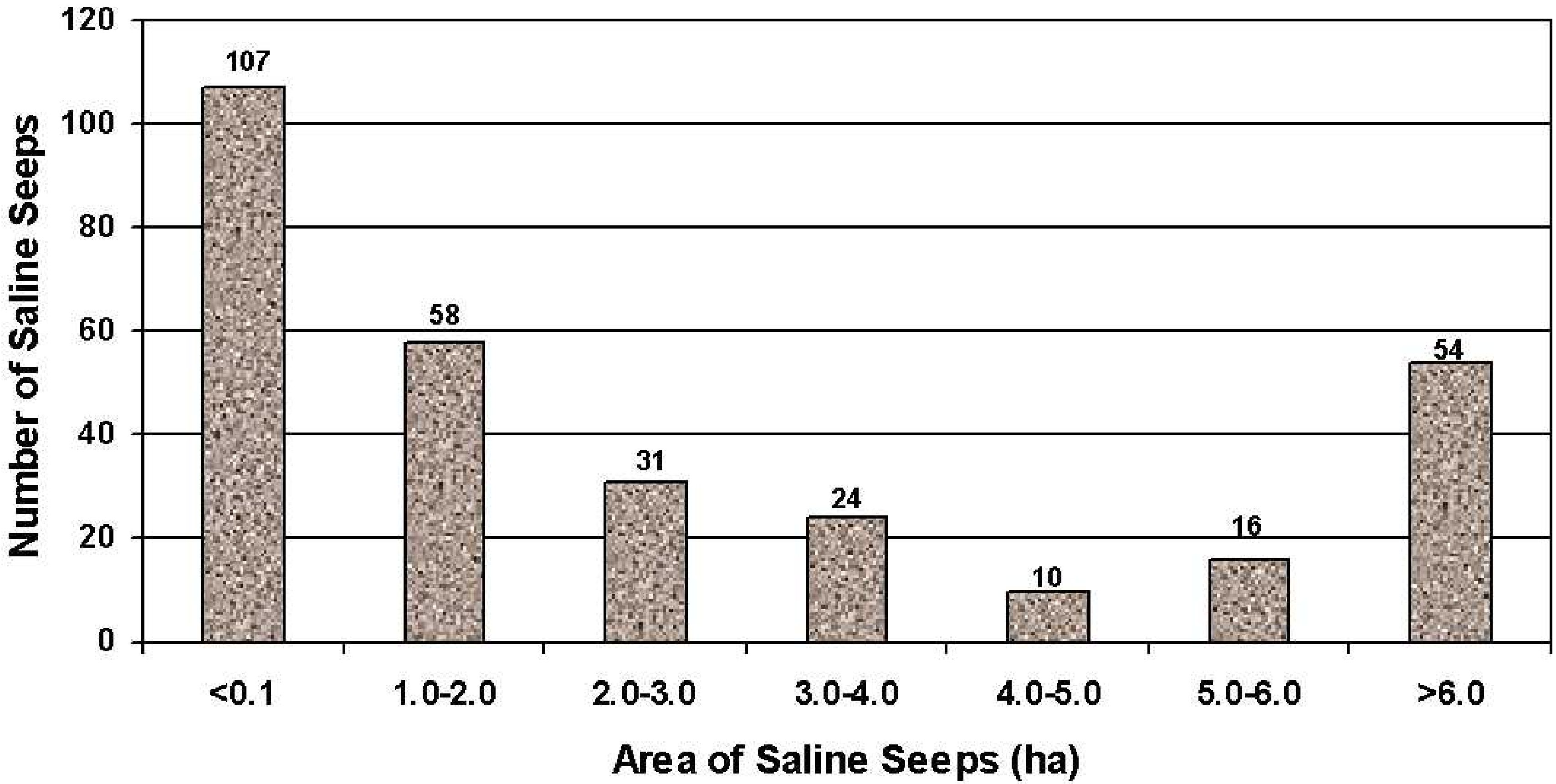


Figure 12. Number and Size of Contact/Slope Change Saline Seeps in the M.D. of Willow Creek



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Glossary

Aquifer - A body of earth material capable of transmitting water through its pores at a rate sufficient for water supply purposes. (VanderPluym and Harron 1992)

Artesian groundwater - Groundwater confined under an aquiclude or an aquifuge, so that water rises above the base of the aquiclude or aquifuge in a non-pumping well which penetrates it. (VanderPluym and Harron 1992)

Bedrock - The solid rock that underlies the soil and regolith or that is exposed at the surface. (Agriculture Canada 1976)

Capillary action - The action by which the surface of a liquid, where it is in contact with a solid, is elevated or depressed depending on the forces of adhesion and cohesion.

Electrical conductivity - A method of expressing salinity. An electrical conductivity (EC) measurement can be used to determine the salt content of soil in a saturated soil paste extract. The EC value is usually expressed in deciSiemens/metre (dS/m). For example, topsoil with an EC value of 2 dS/m is considered non-saline; topsoil with an EC value of 16 is very saline.

Flexible cropping - Cropping according to spring soil moisture conditions. That is, seeding when the spring soil moisture is adequate.

Groundwater - 1) Water that is passing through or standing in the soil and the underlying strata. It is free to move by gravity. (Agriculture Canada 1976). 2) Water in the ground that is in the zone of saturation, from which wells, springs and groundwater runoff are supplied. (VanderPluym and Harron 1992)

Parent material - The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil has developed by pedogenic processes. (Agriculture Canada 1976)

Permeability, soil - The ease with which gases and liquids penetrate or pass through a bulk mass of soil or a layer of soil. (Agriculture Canada 1976)

Saline soil - A non-sodic soil containing enough soluble salts to interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 dS/m (at 25°C), the exchangeable sodium percentage is less than 15, and the pH is usually less than 8.5. (Agriculture Canada 1976)

Seepage - 1) The emergence of water from the soil along an extensive line, in contrast to a spring where water emerges from a local spot. (Agriculture Canada 1976). 2) The slow movement of water through small cracks, pores, interstices, etc. of a material into or out of a body of surface or subsurface water (VanderPluym and Harron 1992).

Till - Unstratified sediment deposited directly by a glacier and consisting of clay, sand, gravel and boulders intermingled in any proportion. (Agriculture Canada 1976)

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