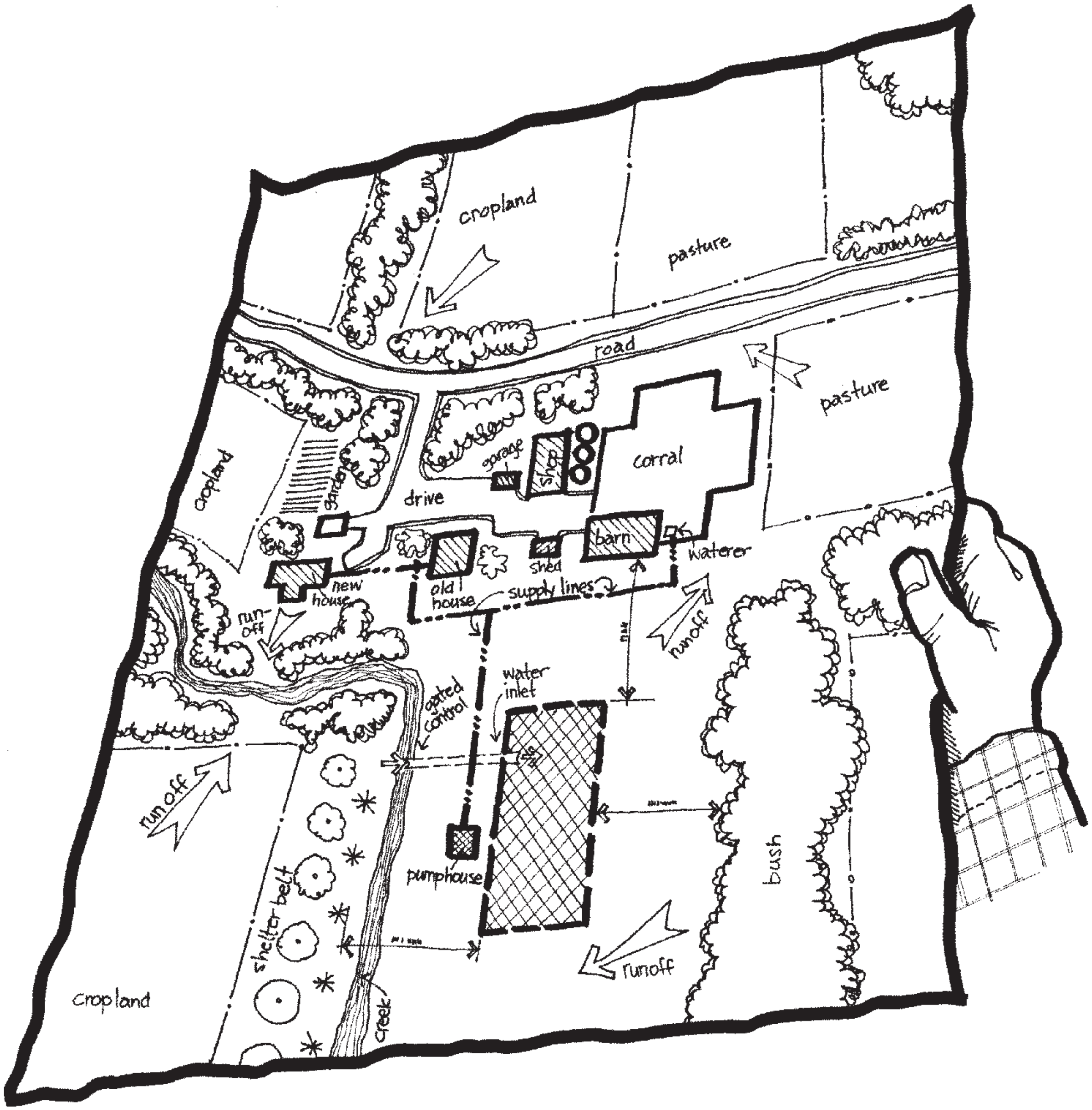
Planning


cropland
pasture
road
pasture
corral
garage
shop
cropland
garden
drive
barn
shed
waterer
new house
old house
supply lines
run-off
runoff
water inlet
gated control
runoff
bush
pumphouse
shelter-belt
runoff
cropland
creek

Planning Farm Water Supplies

Although a well-planned and designed water system may cost more initially, it will ultimately save you money. You can avoid costly changes to correct future problems.

The initial planning steps include:

- Determination of Water Requirements
  The first step in planning is to determine the amount of water required. Estimating future needs should take into account any anticipated changes such as an expansion or diversification of farm activities.

- Inventory of Water Sources
  The next step is to take an inventory of all water sources. Many farms use more than one water supply. Account for production rates, storage volumes, and any previous problems with water quantity or quality for each source. If the dugout is to be the only source of water, uncertainty of runoff volume should be factored into the sizing calculation. Because of frequent drought on the Prairies, it is recommended that all dugouts be constructed to hold at least a two-year water supply. In situations where the dugout is not critical to operations or alternate supplies are readily available, a smaller dugout may be chosen. Calculations in this manual, however, focus on the two-year supply.

- Land Use Planning to Protect Water Supply
  Activities within a watershed have a large impact on water quality and quantity. Evaluating and adapting farm practices where it affects runoff can do much to increase dugout utility.

Make sure you carefully plan your water system. You will need to determine water requirements, take an inventory of water sources, and plan for land use practices that protect water supply.

Regulatory and Funding Issues

Before constructing a new dugout, it is important to be aware of legal restrictions that may apply. Ownership of surface and groundwater is vested in the provinces. Provincial approval is required for the following uses:

- aquaculture
- commercial uses
- municipal uses

- tank-loading
- irrigation
- environmentally sensitive areas such as sloughs, streams, areas of wildlife habitat, etc
- areas short in water such as parts of the South Saskatchewan River Basin.

In most jurisdictions, municipal and provincial, there are also requirements for minimum setback distances from public roadways. Stocking of dugouts with fish is controlled to minimize the risks of discharges that could introduce disease and non-native species of fish into natural waterways.

Before constructing a dugout, consult appropriate authorities to ensure compliance with existing regulations. Obtain approvals well in advance to avoid delays in construction.

Provincial governments offer technical assistance for the construction or improvement of dugout water supplies. Financial assistance may be available for some projects. Regulations and funding vary significantly between provinces. Provincial regulation summaries are provided in Appendix 1 Provincial Regulations.

Watershed Runoff Potential and Water Quality

The size of the drainage area or watershed is the most important consideration when determining potential runoff into a dugout.

Both the quantity and quality of water are affected by the characteristics of the drainage area and the activities that take place within it. The most important characteristic in determining potential runoff into a dugout is the size of the drainage area or watershed. In addition, soil type, land use, topography, and vegetative cover all influence the total quantity of water that will flow into a dugout.

Watershed Runoff Potential and Dugout Sizing

This section discusses factors that should be considered when selecting a site for your dugout. It is essential that a dugout be located to capture the quantity of water required. There are many considerations when choosing a site. Inevitably, some trade-off between conflicting factors will be required. However, it is worth the time and trouble to find the best location for a dugout that will be in use for many years.

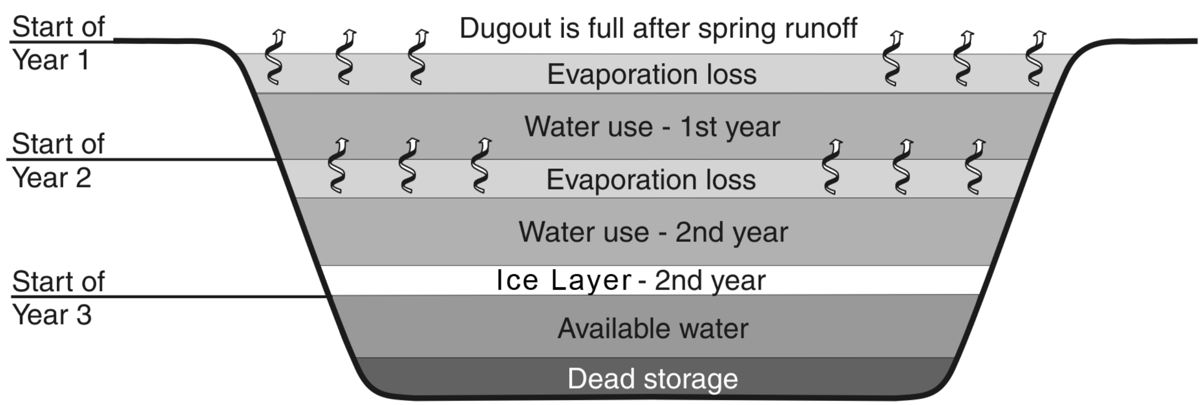
Dugout Sizing

Dugouts fill with runoff from the surrounding land. The most important factors to consider in sizing are the potential amount of runoff that will be captured, evaporation loss, and the shape and dimensions of the dugout.

Figure 3-1 Dugout Size vs. Available Water illustrates the necessity of sizing dugouts properly so they provide a dependable source of water. In this example, the dugout has received no runoff water in two years. The cross-sectional view shows how the supply of available water is reduced by farm use, lack of runoff, evaporation, and ice formation in winter. In addition to uses and losses, the water at the bottom of the dugout will be of such poor quality that it is rated as dead storage and unavailable for use.

Supply of available water is reduced by farm use, lack of runoff, evaporation, and ice formation.

Figure 3-1 Dugout Size vs. Available Water



Runoff volume is determined by the amount and timing of snowmelt or precipitation, plus vegetation, soil type, soil moisture, and topography. The smaller the quantity of runoff expected in an area, the larger the contributing area must be to fill a dugout. In some dry regions of southeastern Alberta and southwestern Saskatchewan, more than 2000 acres (800 ha) of land are required to produce enough runoff to fill a dugout with a capacity of one million Imperial gallons (4.5 million litres). In wetter areas of southeastern Manitoba, less than 25 acres (10 ha) would be required to supply the same volume.

Figure 3-2 Runoff Map shows the approximate area of land required to provide runoff water volume equal to or greater than one million Imperial gallons (4.5 million litres). Runoff varies a great deal from year to year. The map is based on long term runoff data. In eight out of every ten years, the specified amount or more runoff occurred. In two out of ten years, there was less runoff. The uncertainty of runoff should be kept in mind when planning dugout size. If a particular watershed is too small to provide enough runoff, you have two choices:

- find a larger watershed
- find an additional watershed and build a second dugout.

When faced with these choices, it is a good idea to consult a water specialist. Evaporation rate is an important factor in dugout sizing that varies widely between regions. Figure 3-3 Evaporation Zones is a map of evaporation loss zones on the Prairies. The greater the evaporative losses, the greater the storage volume must be to guarantee continuous supply.

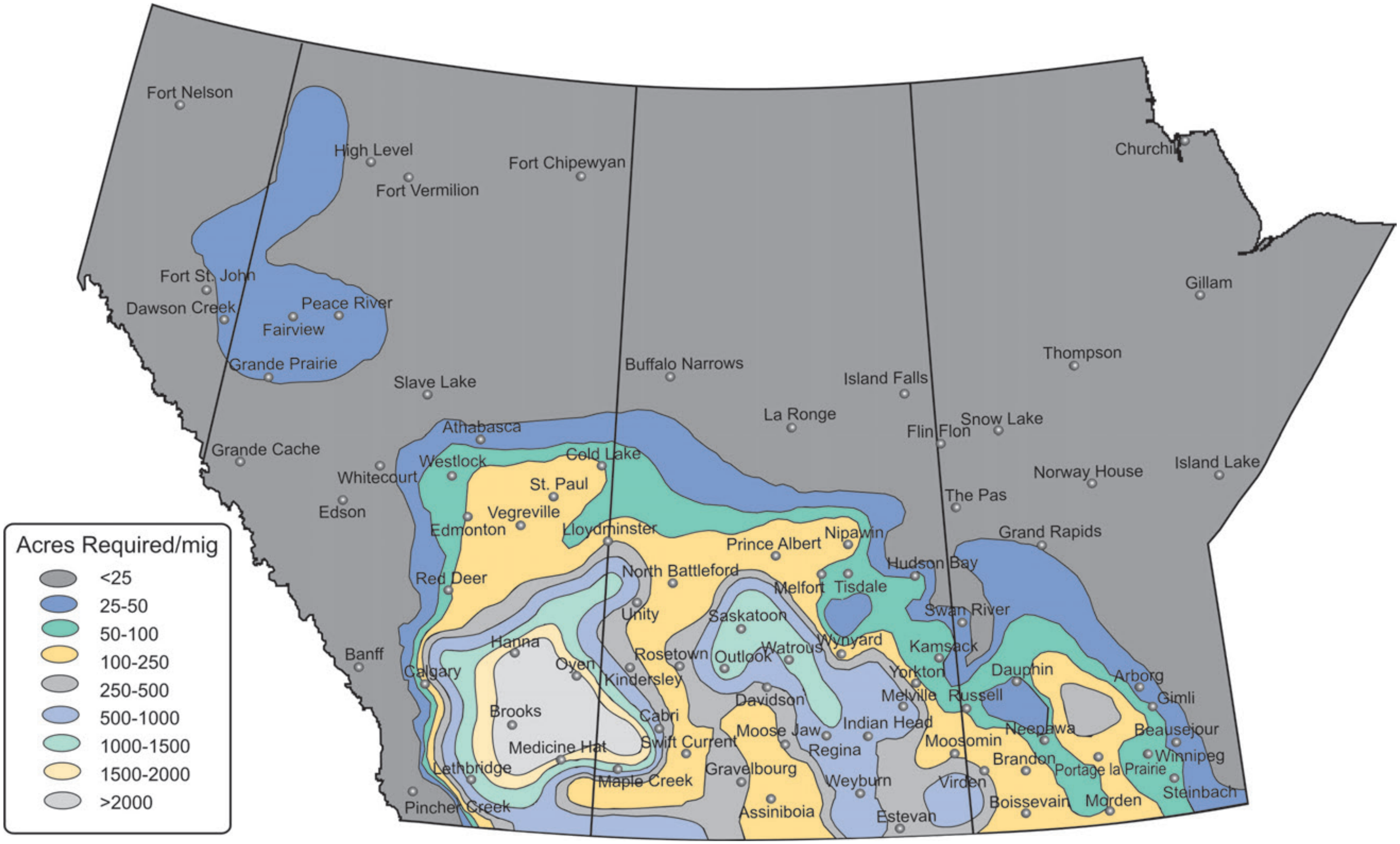
Consider both the area of land required to provide adequate runoff water and evaporation rate when you plan your dugout size.

The shape of a dugout has important implications for both the quantity and quality of the stored water. Historically, most dugouts have been about 12 feet (3.7 m) deep. However, new larger structures are being excavated to depths of 15, 18, and 21 feet (4.6, 5.5, and 6.4 m) and even deeper.

A deeper dugout is more efficient because it has less surface area for the same capacity, and thus loses less water to evaporation. This can have a significant effect on the required volume. For example, in Evaporation Zone 4, a 21 foot-deep (6.4 m) dugout can be constructed with approximately two-thirds the volume of a 15 foot (4.6 m) deep dugout and provide the same amount of available water. Deeper dugouts tend to have better water quality, particularly in winter. Three main concerns with deeper dugouts are high water tables, seepage losses, and increased safety hazard.

During winter, dugouts freeze and some of the stored water becomes unavailable for use. Ice can reach up to 2 to 3 feet (.6 - .9 m) in thickness, which may represent up to 20 to 40 per cent of total volume. Figure 3-1 Dugout Size vs. Available Water shows the amount of stored water that becomes unavailable for use during winter.

Figure 3-2 Runoff Map

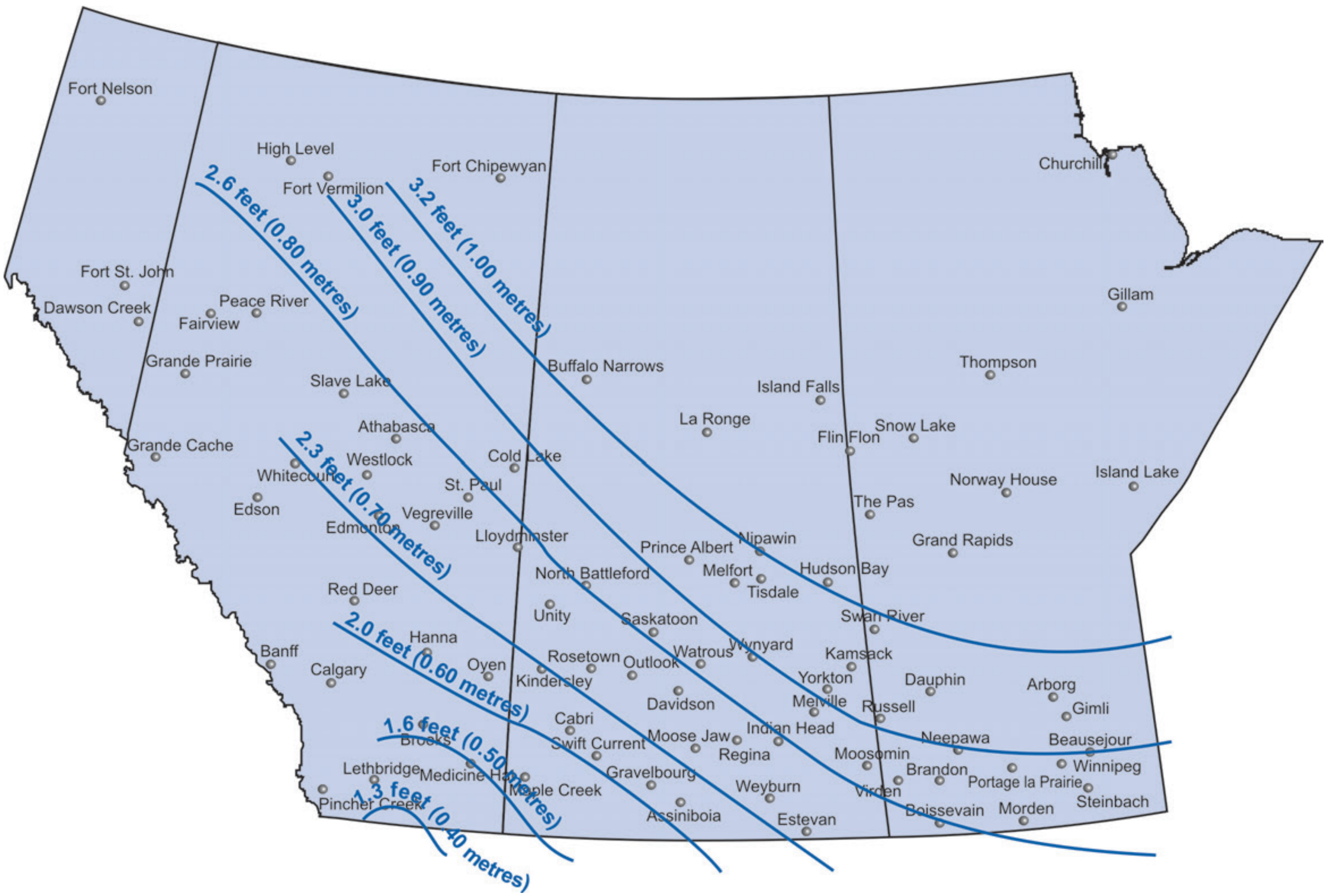


mig: million Imperial gallons

Figure 3-3 Evaporation Zones

In general, the colder the climate, the thicker the ice, and the greater the loss of available water. However, this can be offset by differences in snowfall. Snow cover on the ice insulates the water from further freezing. Figure 3-4 Ice Thickness Map shows average expected ice thickness on small water bodies in different parts of the Prairies.

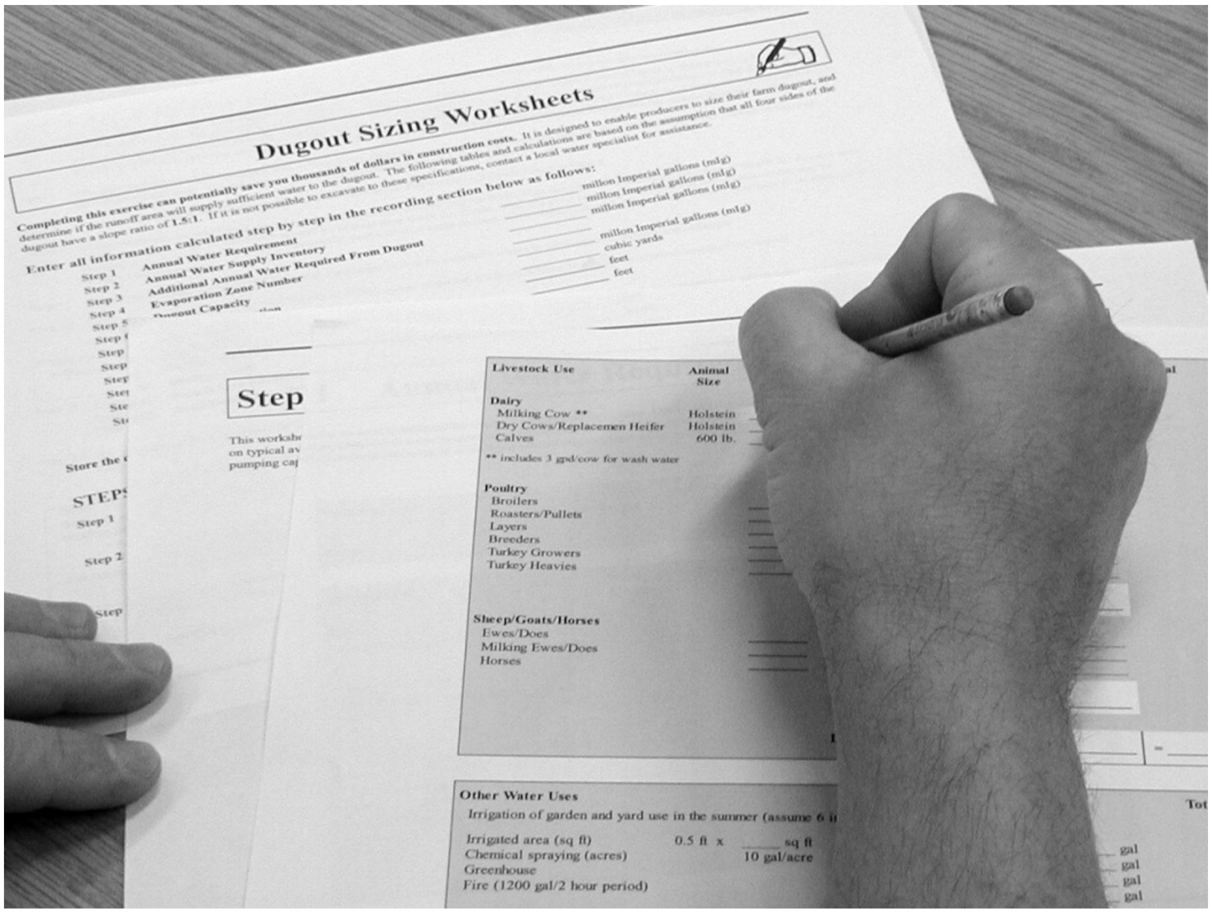
Figure 3-4 Ice Thickness Map



The climate and runoff information given previously is used to plan the size of a dugout for any location on the Prairies.

Figure 3-5 Dugout Sizing Example illustrates an example of the dugout sizing process for the Joe Agricola Family Farm at Stettler, Alberta. Remove the completed example from the pocket inside the front cover of the manual and work through it. **Completing this exercise can potentially save you thousands of dollars in construction costs.** Carefully follow the steps and calculations to understand the process. Blank forms for accurately sizing your farm dugout are located in the pocket inside the back cover of the manual.

Figure 3-5 Dugout Sizing Example



Water Quality and Watershed Management

Good watershed management is the first line of defense for ensuring good quality dugout water. Using what are termed Beneficial Management Practices or **BMPs** within the catchment or runoff area can minimize the possibility of dugout water contamination. Contamination occurs through a number of processes.

- Plant nutrients from natural sources, fertilizers, and manure entering a dugout in field runoff stimulate the growth of plants and algae.
- Pesticides can contaminate water when stored improperly, mixed carelessly, or spilled. They can also be present in runoff water from recently sprayed fields. Airborne drift clouds are able to travel long distances and may be deposited in streams, lakes, and dugouts.
- Runoff from livestock confinement areas is typically rich in nutrients and likely contaminated with bacteria, viruses, and parasites.
- Poorly sited waste disposal sites or inadequate storage facilities can contribute fuels, paints, solvents, and other hazardous chemicals to dugout in-flow water.
- Water erosion loads runoff water with soil, nutrients, and pesticides that may end up in dugouts. Long, steep slopes in the landscape, that are not under perennial cover, are very susceptible to water erosion events. Even relatively level fields can be subject to severe water erosion during spring runoff and heavy rainfall events. Silty soils are particularly susceptible to water erosion. Suspended solids in runoff water cause turbidity in dugouts, causing problems in water distribution systems and increasing the difficulty and cost of treatment.
- Wind erosion may lead to contamination of dugouts when soil is blown into the water from adjacent fields or livestock areas. Sandy soils and heavy clay soils are most susceptible to wind erosion.

Contamination of the watershed can come from plant nutrients, pesticides, livestock confinement areas, waste disposal sites and water and wind erosion.

Beneficial Management Practices in a Watershed

The following BMPs can reduce erosion and contamination of inflow water as illustrated in Figure 3-6 Watershed with Beneficial Management Practices:

- Agricultural fields in annual cultivation are prone to wind and water erosion, particularly when residue cover is poor in winter and early spring. Soil surface protection practices are highly effective ways of preventing erosion and include:
  - seeding erodible land to perennial forages
  - using conservation tillage
  - maintaining crop residues in the fall
  - using winter cover crops
  - using crop rotations that follow low-residue crops with those with higher straw-yield.

- Practices that slow water runoff velocity and reduce water erosion:
  - grassing waterways
  - contour planting that place rows perpendicular to the slope of a field.

- Practices that slow wind velocity and reduce wind erosion and include:
  - strip farming consisting of alternating bands of annual and perennial crops
  - planting and maintaining shelterbelts.

- The amount of fertilizers applied in a watershed can be minimized by proper nutrient management planning. Nutrient management is based on application of only enough fertilizer to make up the difference between the amount available in the soil and the crop requirement.

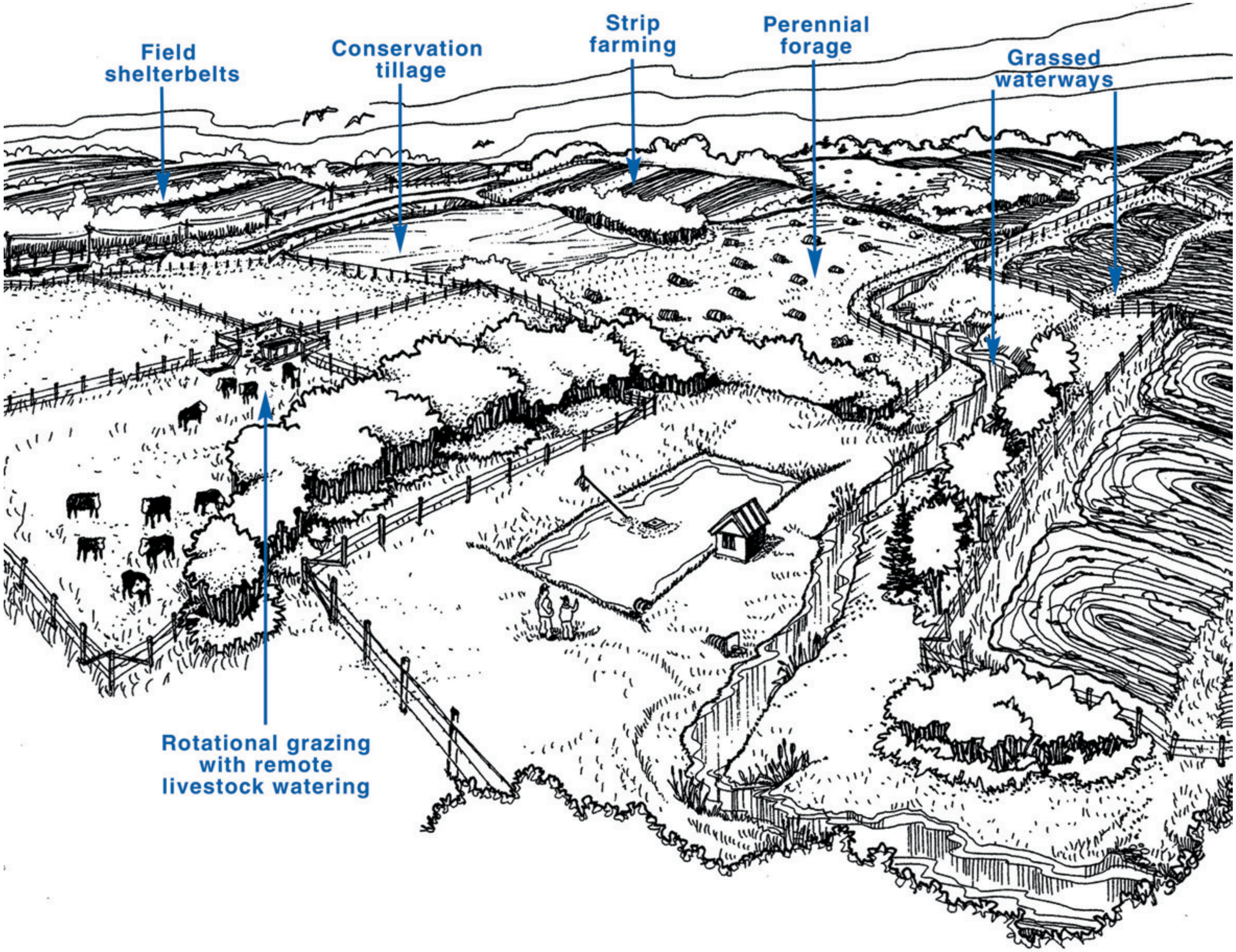
- Total amounts of pesticides applied to a watershed can be minimized through the principles of **integrated pest management** or "IPM". IPM is a pest management system using the application of a variety of management practices and control measures.

- Remote watering systems prevent livestock from having direct access to a dugout, or to other areas in the watershed that directly contribute runoff to a dugout.

- Good manure management protects water from contamination. As with chemical fertilizers, manure should not be applied in quantities that provide plant nutrients in amounts that exceed crop requirements.

- Good livestock management prevents over-grazing, which can leave soils susceptible to erosion. This can be prevented by using a rotational grazing system.

Figure 3-6 Watershed with Beneficial Management Practices



Dugout Siting

Locating a dugout to collect enough water is of primary importance, but there are other factors to consider when planning the location.

Proximity to Water Use

By locating a dugout close to places where the water will be used, construction and maintenance costs of water lines and power pumping costs can be minimized; however, these costs are insignificant relative to a location that does not reliably fill or is contaminated easily.

Proximity to Electrical Power

Most water delivery systems have the pump near the dugout. Nearby electrical power reduces costs for extending power lines. Ready access to power also allows for easy installation of an electric aeration system.

Trees

Properly placed trees can act as snow traps and increase the amount of runoff collected each spring; however, trees close to the dugout tend to block the wind and reduce the positive effects of wind on the mixing of dugout water. Trees also reduce the effectiveness of any windmill-driven mixing devices. Leaves and twigs that are dropped by trees and deposited into dugout water add organic matter and plant nutrients that encourage weed and algae growth and reduce water quality. Large trees planted close to a dugout can use much of the stored water if their roots can reach the reservoir. It is recommended that deciduous trees be planted no closer than 160 feet (50 m) and coniferous trees and shrubs no closer than 65 feet (20 m). Snow fencing may be a better alternative.

Proximity to Other Water Sources

If possible, locating a dugout near another water source is advisable. Dugout water quality can sometimes be improved by pumping water into a dugout from another source such as a creek or slough.

Contamination

Avoid sites that could be affected by contaminated runoff or leaching:

- manure storage areas
- animal confinement areas
- waste disposal sites
- pesticide and fertilizer storage areas
- septic fields
- commercial and industrial sites.