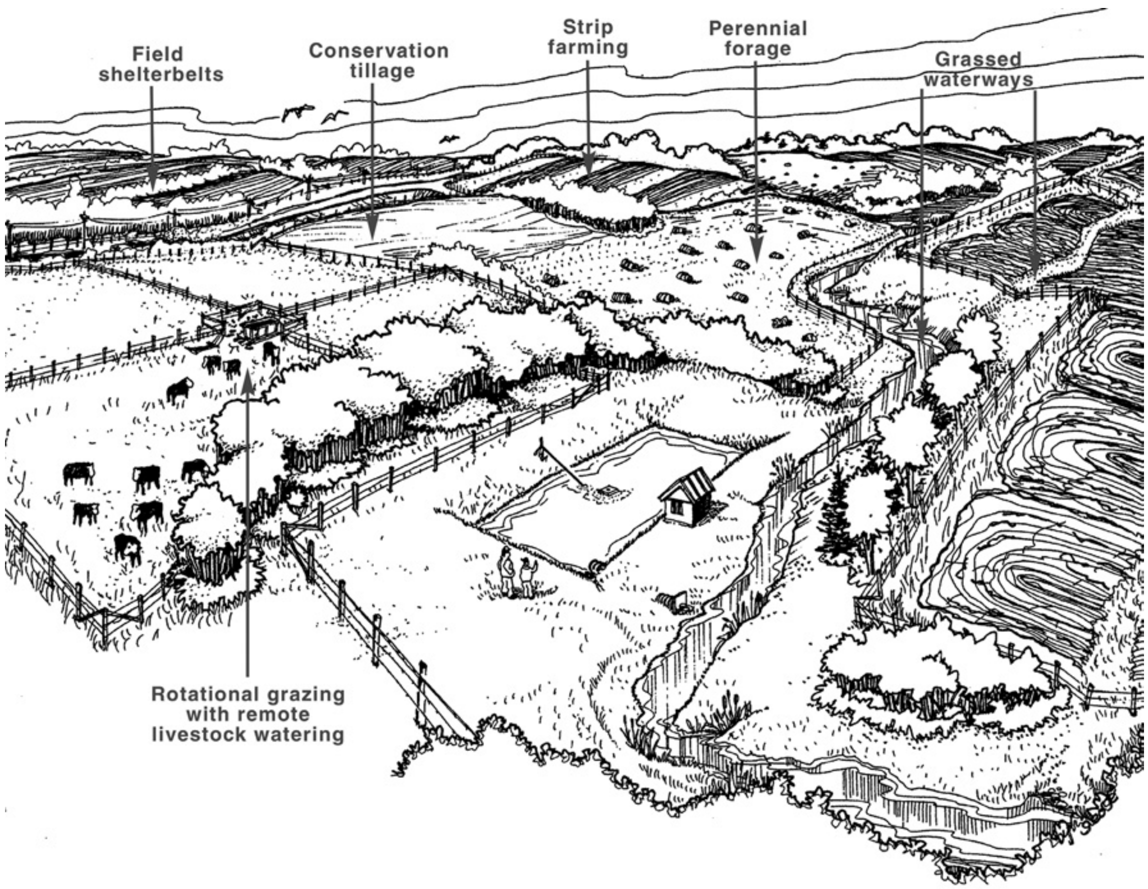
Dugout Sizing Worksheet



Joe Agricola Example

This example is provided to help you size your farm dugout and determine if the runoff area selected will supply sufficient water. A blank copy of this worksheet package is provided in the pocket inside the back cover.

Mr. Joe Agricola lives near Kindersley, Saskatchewan. He farms with his wife, son, daughter-in-law, and two grandchildren (six people in total). They currently have a 150 sow, farrow to finish hog operation and use two wells to supply water for the hogs and their two households. They also require water for their farmyard, gardens, and crop spraying. They plan to expand their farming operation to include 200 cow-calf pairs. The cattle will be at home for 7 months of the year and then moved away to summer pasture.

Joe is concerned that his existing farmyard wells may not supply sufficient water for the planned expansion. To determine this, he completed the **Annual Water Supply Inventory Worksheet** in **Step 1**. Joe calculated the total, annual water volume that could be expected from the two existing wells to be 1,226,400 gallons or
1.2 million Imperial gallons (mIg).

Joe then completed the **Annual Water Requirement Worksheet** in **Step 2**, and calculated this to be
1,773,025 gallons or 1.8 mIg. The two wells are connected into the same water system, and are currently supplying approximately 1,116,900 gallons or 1.1 mIg of this total. The household uses 131,400 gallons, and the hog operation uses 985,500 gallons annually.

In **Step 3**, Joe completed the **Sustainability of Water Sources Worksheet** and decided that his two wells are **only** sustainable to supply the existing water requirements for the two households and the hog operation resulting in a deficit of 546,625 gallons. From experience Joe knew it was extremely difficult to find a good producing well on his farm and therefore decided on a dugout to meet the remaining farm water requirements. After considering the recommendations of a water specialist, Joe decided to construct a new dugout large enough to hold a two-year supply of water. This included the losses expected from evaporation and ice tie-up.

In **Step 4**, Joe used the **Water Required From New Source Worksheet** to calculate the amount of water he will require from the new dugout. For the cattle he needed 504,000 gallons, plus 152,125 gallons for yard watering and crop spraying, for a total of 656,125 gallons or 0.7 mIg (rounded to the nearest 0.1).

From the **Evaporation Zones Map**, **Step 5**, he determined that his farm was located in Zone 4.

In **Step 6**, Joe used 0.7 million Imperial gallons from **Step 4**, for the **Required Dugout Capacity** table. This table enables the calculation of a two-year water supply, and includes the evaporation and ice tie-up factors that were explained to Joe by the water specialist. He located Zone 4 in the table and considered the options - 15,18, and
21 foot depths. He then compared the dugout capacities needed to supply 0.7 million Imperial gallons at the three depths, and easily recognized the smaller capacity of a deeper dugout. At 21 feet, the required dugout size is
2.70 mIg compared to 3.29 mIg at 18 feet, and 4.81 mIg at 15 feet. It was obvious that the construction costs would be significantly reduced with a deeper dugout, and therefore he decided on a 21 foot depth. He planned to confirm with his dugout construction contractor that this depth was possible at the proposed site.

In **Step 7**, Joe calculated the volume of earth to be excavated by converting the 2.7 mIg (2,700,000 Imperial gallons) from **Step 6** into cubic yards. He divided 2,700,000 by 169, which is the number of gallons contained in a cubic yard **(volume in Imperial gallons ÷ 169 gallons/cubic yard = cubic yards** therefore, 2,700,000 ÷ 169 = 15,976). Joe rounded it to 16,000 cubic yards for convenience.

Joe determined that by choosing to construct a 21 foot deep dugout, rather than a 15 foot deep dugout, he could save over **$12,000** in excavation costs based on a $1.00 per cubic yard estimated cost as shown below.

Dugout Depth	15 foot	18 foot	21 foot
Annual water requirement @ 0.7 million Imperial gallons (mIg)	4.81 mIg	3.29 mIg	2.70 mIg
Gallons to cubic yard conversion	28,461	19,467	15,976
Excavation cost @ $1.00 /cubic yard	$28,461	$19,467	$15,976
Construction Cost @ 15 foot minus 21 foot	$28,461 - $15,976 = **$12,485**		

Then in **Step 8**, Joe moves to the 21 foot depth **Dimensions and Capacity** table. Working through **Step 9**, Joe chose a 100 foot width. In **Step 10**, he moved down the table to find the closest capacity to 16,000 cubic yards as shown. In **Step 11**, he reads to the far left column to obtain the required length of dugout. The length required for a 21 foot deep, dugout with 1.5:1 end and side slopes was between 320 and 340 feet, and therefore 330 feet was chosen.

Joe located his farm on the **Runoff Map** in **Step 12**, to find that it required between 250 and 500 acres to fill a one million Imperial gallon dugout. To be safe he selected the higher end of the range at 500 acres.

In **Step 13**, he multiplied 500 acres by 2.7 million gallons to determine the size of the runoff area required for his dugout **(500 acres x 2.7 = 1,350 acres)**.

There appeared to be a good dugout location within 500 feet of the farmyard. With his calculated information in hand, and a local topography map, Joe set off on a field trip to determine local runoff patterns and confirm the location for the proposed dugout. At the site, 500 feet from his buildings, there was approximately **1,000** acres of runoff area, which was less than the **1,350** acres his dugout required. For this reason, he selected another site 500 feet further downstream where a second waterway contributes another 500 acres of runoff area. Joe considered the additional runoff water was well worth the costs for 500 feet of additional trenching and piping.

Note: For additional information on dugout and runoff area sizing contact a water specialist in your area.

Dugout Sizing Worksheets

Note: To use the dugout sizing exercise on-line, go to **http://www.agr.gc.ca/nlwis/** and navigate through **"Tools"** and select **"Quality Farm Dugouts"**. **Completing this exercise can potentially save you thousands of dollars in construction costs.** It is designed to enable producers to size their farm dugout, and determine if the runoff area will supply sufficient water to the dugout. The following tables and calculations are based on the assumption that all four sides of the dugout have a slope ratio of **1.5:1**. If it is not possible to excavate to these specifications, contact a local water specialist for assistance.

Enter all information calculated step by step in the recording section below as follows:

Step 1	**Annual Water Supply Inventory**	*1.2*	million Imperial gallons (mIg)
Step 2	**Annual Water Requirement**	*1.8*	million Imperial gallons (mIg)
Step 3	**Sustainability of Water Sources**	______ Yes, or	✓ No
Step 4	**Water Required From New Source**	*0.7*	million Imperial gallons (mIg)
Step 5	**Evaporation Zone Number**	*4*	
Step 6	**Dugout Capacity**	*2.7*	million Imperial gallons (mIg)
Step 7	**Volume of Excavation**	*16,000*	cubic yards
Step 8	**Dugout Depth**	*21*	feet
Step 9	**Dugout Width**	*100*	feet
Step 10	**No Data Recorded**		
Step 11	**Dugout Length**	*330*	feet
Step 12	**Runoff Area Required**	*500*	acres/mIg
Step 13	**Total Runoff Area Required**	*1,350*	acres

Store your completed information in the pocket at the back of this manual.

STEPS TO SIZE YOUR DUGOUT

Step 1 Complete the **Annual Water Supply Inventory Worksheet**, and calculate the total volume of water available from all existing farm and non-farm sources for the purpose intended – wells, other dugouts, pipelines, canals, springs, rivers, and hauling, etc. To calculate the Expected Annual Volume Supplied by each well, multiply its well production in gpm x 8 hours per day x 60 minutes per hour x 365 days per year. For existing dugouts and other sources determine the expected annual volume supplied, based on past use and experience with these sources. The table provided in **Step 2** can be used to calculate the water requirements for various farm uses. Convert gallons to million Imperial gallons and round to the nearest 0.1 mIg.

Step 2 Estimate the volume of water required from the dugout by using the **Annual Water Requirement Worksheet**, and fill in accurate data for your existing operation or planned expansion. Convert gallons to million Imperial gallons and round to the nearest 0.1 mIg.

Step 3 Complete the **Sustainability of Water Sources Worksheet** provided to determine if the supply, construction materials, and water quality will last. Start by subtracting the Annual Water Supply Inventory in **Step 1**, from the Annual Water Requirement in **Step 2** to determine either a water surplus or deficit. Based on all your responses in the worksheet are your sources sustainable?

Step 4 Complete the **Water Required From New Source Worksheet** by totalling only the water uses you plan to supply from this new water source. Use the totals or subtotals you calculated for the various farm water uses in **Step 1**. Convert gallons to million Imperial gallons and round to the nearest 0.1 mIg.

Step 5 Determine your Evaporation Zone number by locating your farm on the **Evaporation Zones Map**.

Step 6 Use the **Required Dugout Capacity** table for this step. Locate the **Water Required From New Source** as determined in **Step 4**, in the first column of or **21** foot dugout depth. The figure in the chosen column represents the necessary Dugout Capacity in millions of Imperial gallons. It is important to understand that this number designates the recommended **two-year supply of water, and allows for evaporation losses and ice.**

Step 7 Multiply the Dugout Capacity determined in **Step 6** by **1,000,000** to convert it to gallons and then divide by **169**, which is the number of Imperial gallons in a cubic yard. The resulting number is the Volume of Earth to be Excavated.

Step 8 From the **Dimensions and Capacity** tables, select the Dugout Depth chart you have chosen in **Step 6** (15, 18, or 21 foot chart).

Step 9 Using the chosen Dugout Depth chart from **Step 8**, select the desired Dugout Width from the top row of the table. As a rule of thumb for dugouts with a side slope ratio of **1.5:1**, **the width should be at least four times the depth.** This is a good starting point, although further adjustment may be required to include factors created by topography, road setbacks, water courses, and construction equipment. **Steps 9** and **10** may have to be repeated to finalize your dimensions.

Step 10 From your selected Dugout Width in **Step 9**, read down to find the required volume in cubic yards as determined in **Step 7**.

Step 11 From the volume number selected in **Step 10**, read back across to the far, left-hand column to obtain the required length of the dugout.

> **Note: Now that you have sized the dugout (length, width, depth, and capacity), you need to determine if the runoff area will supply sufficient water to the dugout.**

Step 12 Locate your farm on the **Runoff Map**. This map allows you to determine the number of acres of land area required to collect each million Imperial gallons of dugout capacity. Acres required is given as a range of values as indicated in the legend to the left of the map. Use an average value of the range in your calculation or use the higher value for increased confidence.

Step 13 Multiply the Number of Acres Required determined in **Step 12**, by the Dugout Capacity Required in millions of Imperial gallons as determined in **Step 6**. The resulting number is the total Runoff Area for the dugout.

> **Note: The calculated runoff acreage or watershed obtained in Step 13 represents the land area needed to supply sufficient water to this dugout. A field trip will be needed to confirm that the dugout site or sites you have chosen actually receive the expected runoff. If a particular watershed is too small to provide enough water, you have three choices:**
>
> - **Find another watershed.**
> - **Find an additional watershed and build a second dugout.**
> - **Find another water source.**
>
> **For further assistance on dugout and Watershed sizing, contact a local water specialist.**

Step 1 Annual Water Supply Inventory Worksheet

Existing Wells

Purpose	Land Location	Date Constructed	Depth (feet)	Casing Diameter (inches)	Well Production (gal/min)	Expected Annual Volume Supplied (gal)
1. *House*	*home 1/4*	*1990*	*110*	*6*	*1.5*	*262,800*
2. *Hogs*	*home 1/4*	*1995*	*220*	*6*	*5.5*	*963,600*
3.						
					Well Subtotal A	*1,226,400*

Existing Dugouts

Purpose	Land Location	Date Constructed	Length (feet)	Width (feet)	Depth (feet)	Capacity (million Imperial gallons)	Expected Annual Volume Supplied (gal)
1.							
2.							
3.							
						Dugout Subtotal B	

Other Existing Water Sources and Their Limitations (springs, creeks, rivers, and hauling, etc.)

1.	
2.	
3.	
Other Subtotal C	

Annual Water Supply Inventory Total (A+B+C)	= *1,226,400* gallons	Annual Water Supply Inventory	=	*1,226,400* gallons / 1,000,000	= *1.2* (nearest 0.1)	million Imperial gallons

Step 2 Annual Water Requirement Worksheet

This worksheet can be used to estimate the total annual farm water requirement, and assist producers in sizing farm dugouts. The water requirements are based on typical average outside or in-barn temperatures experienced throughout the year. Livestock water consumption is much higher on hot summer days and pumping capacity requirements must be considered when designing farm water systems.

Household Use	No. of People		Gallons Per Day (gpd)		No. of Days		Gallons Per Year		Totals
People	6	x	60.0 gpd	x	365	=	131,400	=	131,400

Livestock Use	Animal Size	No. of Animals		Gallons Per Day (gpd)		No. of Days		Gallons Per Year	Totals
Beef									
Feeder (on silage)	550 lb.		x	4.0 gpd	x		=		
	900 lb.		x	7.0 gpd	x		=		
	1250 lb.		x	10.0 gpd	x		=		
Cows with Calves	1300 lb.	200	x	12.0 gpd	x	210	=	504,000	
Dry Cow (on pasture or hay)	1300 lb.		x	10.0 gpd	x		=		
Calves	250 lb.		x	2.0 gpd	x		=		
						Sub Total A gallons per year		504,000	
Swine									
Farrow to Finish		150	x	18.0 gpd	x	365	=	985,500	
Farrow to Late Wean	50 lb.		x	6.5 gpd	x		=		
Farrow to Early Wean	15 lb.		x	5.5 gpd	x		=		
Feeder	50-250 lb.		x	1.5 gpd	x		=		
Weaner	15-50 lb.		x	0.5 gpd	x		=		
						Sub Total B gallons per year		985,500	

Livestock Use	Animal Size	No. of Animals		Gallons Per Day (gpd)	No. of Days		Gallons Per Year	Total
Dairy								
Milking Cow **	Holstein	________	x	30.0 gpd	x ________	=	________	
Dry Cows/Replacemen Heifer	Holstein	________	x	10.0 gpd	x ________	=	________	
Calves	600 lb.	________	x	5.0 gpd	x ________	=	________	
** includes 3 gpd/cow for wash water					**Sub Total C** gallons per year		________	
Poultry								
Broilers		________	x	0.035 gpd	x ________	=	________	
Roasters/Pullets		________	x	0.040 gpd	x ________	=	________	
Layers		________	x	0.055 gpd	x ________	=	________	
Breeders		________	x	0.070 gpd	x ________	=	________	
Turkey Growers		________	x	0.130 gpd	x ________	=	________	
Turkey Heavies		________	x	0.160 gpd	x ________	=	________	
					Sub Total D gallons per year		________	
Sheep/Goats/Horses								
Ewes/Does		________	x	2.0 gpd	x ________	=	________	
Milking Ewes/Does		________	x	3.0 gpd	x ________	=	________	
Horses		________	x	11.0 gpd	x ________	=	________	
					Sub Total E gallons per year		________	
				Livestock Total (A+B+C+D+E) gallons per year			= *1,489,500*	= *1,489,500*

Other Water Uses						Total
Irrigation of garden and yard use in the summer (assume 6 in. application)						
Irrigated area (sq ft)	0.5 ft x *43,560* sq ft	x	6.25 gal/ft³	=	*136,125* gal	
Chemical spraying (acres)	10 gal/acre	x	*1600* acres	=	*16,000* gal	
Greenhouse				=	________ gal	
Fire (1200 gal/2 hour period)				=	________ gal	
			Other Water Use Total gallons per year		= *152,125*	= *152,125*

Annual Water Requirement Total	= *1,773,025* gallons	**Annual Water Requirement**	=	*1,773,025* gallons / 1,000,000	= *1.8* (nearest 0.1)	million Imperial gallons

Step 3 Sustainability of Water Sources Worksheet

(a) To determine if the supply is sustainable:

1,226,400	gallons	-	*1,773,025*	gallons	=	*- 546,625* gallons
Annual Water Supply Inventory (Step 1)			Annual Water Requirement (Step 2)			Water Surplus or deficit

For wells:
Is your groundwater supply depleting, as indicated by a steady drop in non-pumping water levels over a period of months or years? ____ Yes, or _✓_ No

For dugouts:
Is the water level in your dugout(s) continuing to drop over a period of years? ____ Yes, or ____ No

Has your dugout(s) lost considerable volume and depth due to sediment deposition? ____ Yes, or ____ No

For other sources:
Are these sources sustainable? ____ Yes, or ____ No

(b) To determine if the construction materials will last:

For wells:
Does your well(s) have metal casing and/or liner? The life expectancy of this is about 20 years. ____ Yes, or _✓_ No

Do you notice more sediment being pumped from your well(s)? This can result from rusted well casing or liner. ____ Yes, or _✓_ No

(c) To determine if the water quality is sustainable:
Is it becoming increasingly difficult to maintain the water quality in your well or dugout by regular maintenance treatments such as shock chlorination for well(s) and algae and weed control in your dugout(s)? ____ Yes, or _✓_ No

Based on your previous experience with your water sources and your responses to (a), (b), and (c), in your opinion are your existing water sources sustainable for the next 5 year period?

____ Yes (No new water source is required - stop here!)

_✓_ No (A new water source is required, go to Step 4)

Step 4 Water Required From New Source Worksheet

Add together only the water uses to be supplied from this new water source.

________ gallons	+	*504,000* gallons	+	*152,125* gallons	=	*656,125*	gallons
Household Use		Livestock Use Subtotal or Total		Other Water Uses		Water Required From New Source	

Convert gallons to million Imperial gallons:	*656,125* gallons	÷	1,000,000	=	*0.7*	mIg
	Water Required From New Source				(nearest 0.1)	

Step 5 Evaporation Zones Map

Step 6 Required Dugout Capacity (millions of Imperial gallons)

Additional Annual Water Required	Zone 1			Zone 2			Zone 3			Zone 4		
	Capacity for a depth of 15 feet	Capacity for a depth of 18 feet	Capacity for a depth of 21 feet	Capacity for a depth of 15 feet	Capacity for a depth of 18 feet	Capacity for a depth of 21 feet	Capacity for a depth of 15 feet	Capacity for a depth of 18 feet	Capacity for a depth of 21 feet	Capacity) for a depth of 15 feet	Capacity for a depth of 18 feet	Capacity for a depth of 21 feet
0.20	0.79	0.65	0.58	0.94	0.73	0.64	1.08	0.81	0.70	1.35	0.94	0.78
0.25	1.00	0.81	0.73	1.19	0.92	0.80	1.35	1.01	0.87	1.69	1.17	0.97
0.30	1.21	0.98	0.87	1.43	1.10	0.96	1.63	1.21	1.04	2.04	1.40	1.16
0.35	1.42	1.15	1.02	1.68	1.29	1.12	1.91	1.42	1.21	2.38	1.64	1.35
0.40	1.63	1.32	1.17	1.93	1.49	1.28	2.19	1.63	1.38	2.73	1.87	1.54
0.45	1.84	1.49	1.32	2.18	1.68	1.45	2.46	1.83	1.56	3.07	2.11	1.74
0.50	2.06	1.67	1.47	2.43	1.87	1.61	2.74	2.04	1.73	3.42	2.35	1.93
0.60	2.48	2.01	1.77	2.93	2.25	1.94	3.30	2.46	2.08	4.11	2.82	2.32
0.70	2.91	2.36	2.08	3.43	2.64	2.27	3.87	2.87	2.44	4.81	3.29	2.70
0.80	3.34	2.71	2.39	3.93	3.03	2.61	4.43	3.29	2.79	5.50	3.77	3.09
0.90	3.77	3.05	2.69	4.43	3.42	2.94	4.99	3.71	3.14	6.20	4.25	3.48
1.00	4.20	3.40	3.00	4.94	3.81	3.27	5.56	4.13	3.50	6.90	4.73	3.87
1.20	5.06	4.11	3.62	5.95	4.59	3.94	6.69	4.97	4.21	8.29	5.68	4.65
1.40	5.92	4.81	4.24	6.97	5.37	4.62	7.82	5.81	4.92	9.69	6.64	5.43
1.60	6.79	5.52	4.86	7.98	6.16	5.29	8.96	6.66	5.63	11.09	7.60	6.22
1.80	7.66	6.22	5.49	9.00	6.94	5.97	10.09	7.50	6.35	12.49	8.56	7.00
2.00	8.53	6.93	6.11	10.02	7.73	6.65	11.23	8.35	7.07	13.90	9.53	7.79
2.20	9.36	7.61	6.72	11.00	8.49	7.30	12.32	9.17	7.76	15.24	10.45	8.54

Note: The shallower the dugout the larger its surface dimensions must be. A larger surface area produces increased losses to evaporation and water tied up as ice and unavailable during the winter. In Zone 4, for example, the surface dimensions of a 15 foot deep, dugout must be 45 percent larger than an 18 foot deep, dugout and 80 percent larger than a 21 foot, deep dugout.

Step 7 Volume of Excavation (cubic yards)

Dugout Capacity (Step 6) [*2.7*] mlg **x 1,000,000 =** [*2,700,000*] gallons ÷ **169** (gal/cubic yard) **= Volume of Earth to be Excavated** [*15,976* = *16,000*] round to nearest 100 cubic yards

Step 8-11 Dimensions and Capacity (cubic yards)

Chart for 15 Foot Depth

Width (feet)	50	60	70	80	90	100	110	120
Length (feet)								
60	700	900						
80	1000	1300	1600	1900				
100	1300	1700	2100	2600	3000	3400		
120	1600	2100	2700	3200	3800	4300	4800	5400
140	1900	2500	3200	3800	4500	5200	5800	6500
160	2200	3000	3700	4500	5300	6000	6800	7500
180	2500	3400	4300	5100	6000	6900	7800	8600
200	2800	3800	4800	5800	6800	7700	8700	9700
220	3100	4200	5300	6400	7500	8600	9700	10800
240	3400	4600	5800	7000	8300	9500	10700	11900
260	3700	5000	6400	7700	9000	10300	11600	13000
280	4000	5500	6900	8300	9800	11200	12600	14000
300	4300	5900	7400	9000	10500	12000	13600	15100
320	4600	6300	7900	9600	11300	12900	14600	16200
340	4900	6700	8500	10200	12000	13800	15500	17300
360	5300	7100	9000	10900	12800	14600	16500	18400
380	5600	7500	9500	11500	13500	15500	17500	19500
400	5900	8000	10100	12200	14300	16300	18400	20500
420	6200	8400	10600	12800	15000	17200	19400	21600
440	6500	8800	11100	13400	15800	18100	20400	22700
460	6800	9200	11600	14100	16500	18900	21400	23800

Note: Volumes in the table are in cubic yards and side and end slopes = 1.5:1

Step 8-11 Dimensions and Capacity (cubic yards)

Chart for 18 Foot Depth

Width (feet)	60	70	80	90	100	110	120	130
Length (feet)								
60	900							
80	1300	1700	2000					
100	1800	2300	2700	3200	3700			
120	2200	2800	3400	4100	4700	5300	5900	
140	2600	3400	4200	4900	5700	6400	7200	7900
160	3100	4000	4900	5700	6600	7500	8400	9300
180	3500	4500	5600	6600	7600	8600	9600	10700
200	4000	5100	6300	7400	8600	9700	10900	12000
220	4400	5700	7000	8300	9600	10800	12100	13400
240	4800	6300	7700	9100	10500	11900	13400	14800
260	5300	6800	8400	9900	11500	13100	14600	16200
280	5700	7400	9100	10800	12500	14200	15800	17500
300	6200	8000	9800	11600	13400	15300	17100	18900
320	6600	8600	10500	12500	14400	16400	18300	20300
340	7000	9100	11200	13300	15400	17500	19600	21700
360	7500	9700	11900	14100	16400	18600	20800	23000
380	7900	10300	12600	15000	17300	19700	22000	24400
400	8400	10900	13300	15800	18300	20800	23300	25800
420	8800	11400	14000	16700	19300	21900	24500	27100
440	9200	12000	14800	17500	20300	23000	25800	28500
460	9700	12600	15500	18300	21200	24100	27000	29900

Note: Volumes in the table are in cubic yards and side and end slopes = 1.5:1

Step 8-11 Dimensions and Capacity (cubic yards)

Step 8

Chart for 21 Foot Depth

Step 9

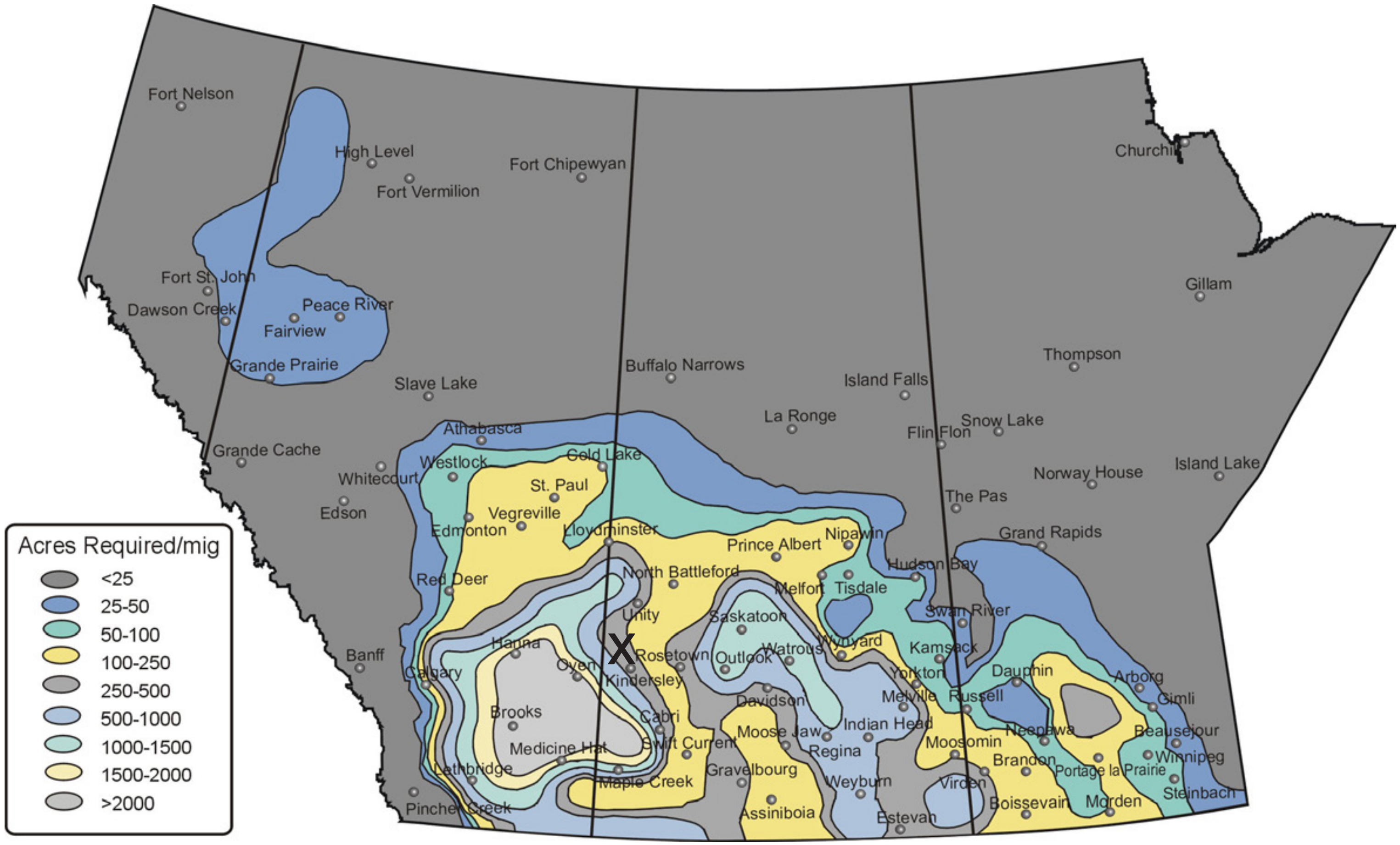
Step 10

Step 11

Width (feet)	70	80	90	100	110	120	130	140
Length (feet)								
80	1700	2100	2500					
100	2300	2800	3400	3900	4400			
120	2900	3600	4300	5000	5700	6300	7000	
140	3500	4400	5200	6000	6900	7700	8600	9400
160	4100	5100	6100	7100	8100	9100	10100	11100
180	4700	5900	7000	8200	9300	10500	11600	12800
200	5300	6600	7900	9200	10500	11900	13200	14500
220	5900	7400	8800	10300	11800	13200	14700	16200
240	6500	8100	9700	11400	13000	14600	16200	17900
260	7100	8900	10700	12400	14200	16000	17800	19500
280	7700	9600	11600	13500	15400	17400	19300	21200
300	8300	10400	12500	14600	16700	18700	20800	22900
320	8900	11100	13400	15600	17900	20100	22400	24600
340	9500	11900	14300	16700	19100	21500	23900	26300
360	10100	12600	15200	17800	20300	22900	25400	28000
380	10700	13400	16100	18800	21500	24200	27000	29700
400	11300	14200	17000	19900	22800	25600	28500	31400
420	11900	14900	17900	21000	24000	27000	30000	33000
440	12500	15700	18800	22000	25200	28400	31600	34700
460	13100	16400	19800	23100	26400	29800	33100	36400
480	13700	17200	20700	24200	27600	31100	34600	38100

Note: Volumes in the table are in cubic yards and side and end slopes = 1.5:1

Step 12 Runoff Map



Step 13 Runoff Area

Number of Acres Required (Step 12)	500	x	Dugout Capacity Required	2.7	=	Runoff Area	1,350
	acres required/mIg			mIg			acres