

bentonite, and includes the Kneehills Member, a 2.5- to 30-cm-thick tuff bed. The Whitemud Formation is composed mainly of shale, siltstone, sandstone and bentonite. The Battle and Whitemud formations are significant geologic markers, and were used in the preparation of various geological surfaces within the bedrock. Because of the ubiquitous nature of the bentonite in the Battle and Whitemud formations, there is very little significant permeability within these two formations and there will be no direct review of the Battle and Whitemud formations.

The Horseshoe Canyon Formation is the lower part of the Edmonton Group and has three separate designations: Upper, Middle and Lower. In the County, the Upper Horseshoe Canyon has a maximum thickness of 250 metres; the Middle Horseshoe Canyon has a maximum thickness of 155 metres, and the Lower Horseshoe Canyon has a maximum thickness of 450 metres.

The Horseshoe Canyon Formation consists of deltaic²⁰ and fluvial sandstone, siltstone and shale with interbedded coal seams, bentonite and thin nodular beds of limestone and ironstone. Because of the low-energy environment in which deposition occurred, the sandstones, when present, tend to be finer grained. The lower 60 to 70 metres and the upper 30 to 50 metres of the Horseshoe Canyon Formation can include coarser grained sandstone deposits.

There will be no direct review of the Middle or Lower Horseshoe Canyon formations in the text of this report; there are insufficient or no hydrogeological data within the study area to prepare meaningful maps.

5.3.3 Upper Bedrock Completion Aquifer(s)

Of the 5,855 water wells in the database, 3,483 were defined as being completed below the top of bedrock, based on lithologic information and water well completion details. However, at least a reported completion depth is available for 4,939 water wells completed below the bedrock surface. Of these 4,939 water wells, one is completed below the upper bedrock in the Lower Horseshoe Canyon Formation, giving a total of 4,938 water wells completed in upper bedrock aquifer(s). Assigning a water well to a specific geologic unit is possible only if the completion interval is identified. In order to make use of additional information within the groundwater database, it was assumed that the top of the completion interval was 80% of the total completed depth of a water well. With this assumption, it has been possible to designate the specific bedrock aquifer of completion for an additional 745 bedrock water wells, giving a total of 4,228 water wells. The remaining 711 of the total 4,939 upper bedrock water wells are identified as being completed in more than one bedrock aquifer, as shown in Table 6. The bedrock water wells are mainly completed in the Dalehurst Aquifer.

Geologic Unit	No. of Bedrock Water Wells
Disturbed Belt	348
Dalehurst	3,126
Upper Lacombe	461
Lower Lacombe	181
Haynes	59
Upper Scollard	27
Lower Scollard	8
Battle and Whitemud	3
Upper Horseshoe Canyon	14
Middle Horseshoe Canyon	0
Lower Horseshoe Canyon	1
Multiple Completions	711
Total	4,939

Table 6. Completion Aquifer for Upper Bedrock Water Wells

²⁰ See glossary

There are 1,912 records for bedrock water wells that have apparent yield values, which is 28% of the 6,930 bedrock water wells in the County. Yields for water wells completed in the upper bedrock aquifer(s) are mainly between 10 and 100 m³/day and have a median apparent yield of more than 70 m³/day. The areas in the southwestern part of the County where apparent yields of less than ten m³/day are shown are a result of the gridding process using limited data control. In addition to the 1,912 records for bedrock water wells with apparent yield values, there are 57 records that indicate that the water well/water test hole is dry, or abandoned with “insufficient water”.

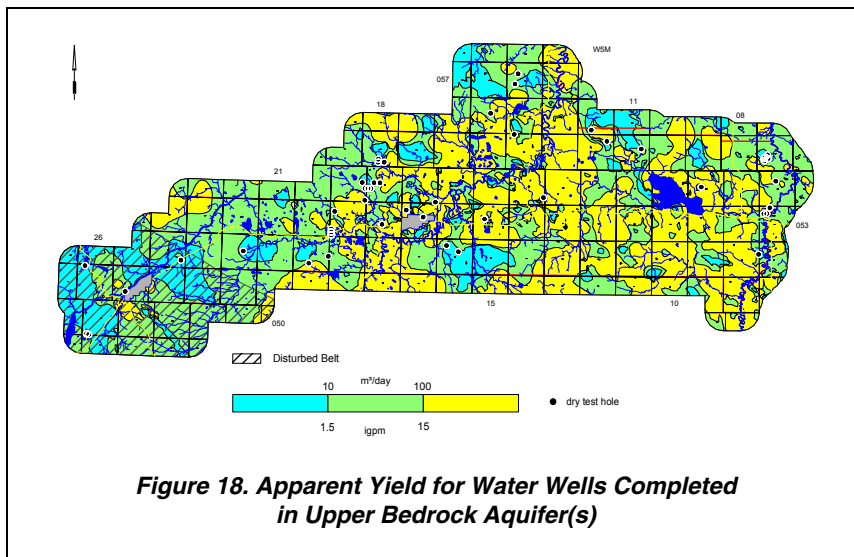


Figure 18. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the 57 dry water test holes prior to gridding.

Aquifer	No. of Water Wells with Values for Apparent Yield (*)	Number of Water Wells with Apparent Yields		
		<10 m ³ /day	10 to 100 m ³ /day	>100 m ³ /day
Disturbed Belt	73	34	26	13
Dalehurst	1,269	110	612	547
Upper Lacombe	196	6	79	111
Lower Lacombe	84	5	39	40
Haynes	22	2	12	8
Battle and Whitemud	2	1	1	0
Upper Scollard	16	1	10	5
Lower Scollard	5	0	5	0
Upper Horseshoe Canyon	8	1	6	1
Multiple Completions	310	30	151	129
Totals	1,912	156	915	841

Table 7. Apparent Yields of Bedrock Aquifers

Of the 1,912 water well records with apparent yield values, 1,602 have been assigned to aquifers associated with specific geologic units. Eight percent (156) of the 1,912 water wells completed in bedrock aquifers have apparent yields that are less than ten m³/day, 48% (915) have apparent yield values that range from 10 to 100 m³/day, and 44% (841) have apparent yield values that are greater than 100 m³/day, as shown in Table 7. In the Dalehurst Aquifer, nearly 45% of the apparent yield values are greater than 100 m³/day.

5.3.4 Chemical Quality of Groundwater

The Piper tri-linear diagram for bedrock aquifers (page A-26) shows that groundwaters from bedrock aquifers are mainly sodium-bicarbonate or calcium-magnesium-type waters.

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 200 mg/L to more than 1,000 mg/L, with most of the groundwaters with higher TDS concentrations occurring in the eastern part of the County.

The relationship between TDS and sulfate concentrations shows that when TDS values in the groundwaters from the upper bedrock aquifer(s) exceed 1,100 mg/L, the sulfate concentrations exceed 400 mg/L. The sulfate concentrations in groundwaters from the upper bedrock aquifer(s) were compared to the distance of completion depth from the top of the Upper Lacombe Member. The maximum sulfate concentrations generally increase with depth, as shown below in Figure 20, with the exception being the Lower Horseshoe Canyon Aquifer as a result of having limited data for sulfate concentrations.

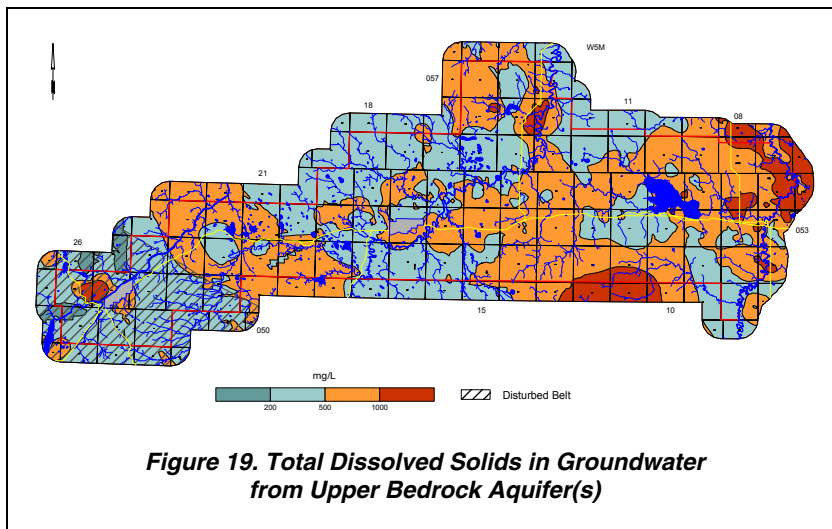


Figure 19. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

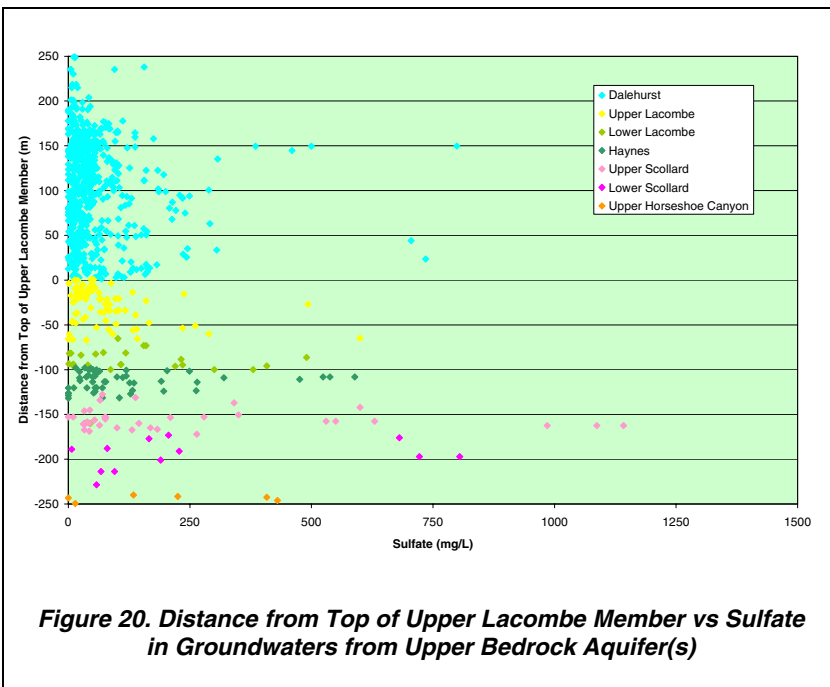


Figure 20. Distance from Top of Upper Lacombe Member vs Sulfate in Groundwaters from Upper Bedrock Aquifer(s)

In the County, more than 95% of the chloride concentrations in the groundwaters from the upper bedrock aquifer(s) are less than 50 mg/L. Chloride concentrations of greater than 50 mg/L are mainly associated with groundwaters from the Upper Horseshoe Canyon Aquifer.

The Nitrate + Nitrite (as N) concentrations are less than 0.1 mg/L in 81% of the chemical analyses for upper bedrock water wells. Approximately 55% of the total hardness values in the groundwaters from the upper bedrock aquifer(s) are less than 200 mg/L.

In the County, approximately 70% of the groundwater samples from upper bedrock aquifer(s) have fluoride concentrations that are too low (less than 0.5 mg/L) to meet the

recommended daily needs of people. Approximately 21% of the groundwater samples from the entire County are between 0.5 and 1.5 mg/L and approximately 9% exceed the MAC for fluoride of 1.5 mg/L. Fluoride concentrations of greater than 1.5 mg/L are mainly associated with groundwaters from the Upper Horseshoe Canyon Aquifer.

5.3.5 Disturbed Belt Aquifer

The Disturbed Belt Aquifer comprises the permeable parts of the Disturbed Belt, as defined for the present program. The regional groundwater flow direction in the Disturbed Belt Aquifer is toward the Athabasca River (see CD-ROM).

5.3.5.1 Depth to Top

The depth to the top of the Disturbed Belt is mainly greater than ten metres and is a reflection of the thickness of the surficial deposits (page A-30).

5.3.5.2 Apparent Yield

The apparent yields for individual water wells completed through the Disturbed Belt Aquifer are mainly less than ten m³/day as shown on Figure 21. The areas showing water wells with yields of greater than 100 m³/day are expected to be in the Town of Hinton vicinity. There are no available apparent yield data for water wells completed through the Disturbed Belt Aquifer in township 050, ranges 21 to 24, W5M.

Shown on the adjacent map are the locations of six dry water test holes (page A-31).

There are two non-exempt groundwater users that have water wells completed through the Disturbed Belt Aquifer, for a total groundwater diversion of four m³/day.

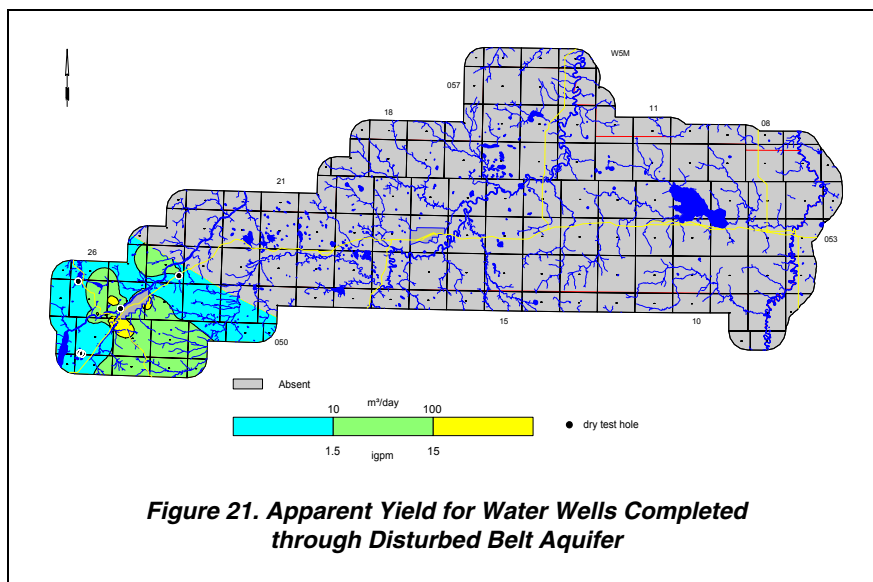
Of the two non-exempt authorizations, one could be linked to a water well in the AENV groundwater database; the water well is the Jasper-Hinton Airport water supply well.

An extended aquifer test was conducted with the Jasper-Hinton Airport water supply well in August 1977 by Hydrogeological Consultants Ltd. (HCL, October 1977). The airport water supply well in NW 16-050-26 W5M is completed open hole from 14.9 to 45.7 metres below ground surface in the Disturbed Belt. The extended aquifer test conducted with the Jasper-Hinton Airport water supply well indicated a long-term yield of 50 m³/day, based on an effective transmissivity of 3.8 metres squared per day (m²/day). The water supply well is licensed to divert 3.4 m³/day.

5.3.5.3 Quality

The groundwaters from the Disturbed Belt Aquifer are mainly a bicarbonate type, with no dominant cation (see Piper diagram on CD-ROM), with more than 65% of the groundwater samples having TDS concentrations of less than 500 mg/L (page A-32). Nearly 90% of the sulfate concentrations in groundwaters from the Disturbed Belt Aquifer are less than 200 mg/L. Nearly 75% of the chloride concentrations from the Disturbed Belt Aquifer are less than ten mg/L.

A chemical analysis of a groundwater sample collected in August 1977 from the Jasper-Hinton Airport water supply well indicates the groundwater is a calcium-magnesium-bicarbonate type, with a TDS of 379 mg/L, a



sulfate concentration of 5 mg/L, a chloride concentration of 2 mg/L, a fluoride concentration of 0.25 mg/L, and a total hardness of 324 mg/L (HCL, October 1977).

Of the five constituents that have been compared to the SGCDWQ, none of the constituents exceed the bedrock median values, except for fluoride, and none exceed the SGCDWQ.

Constituent	No. of Analyses	Range for County in mg/L			All Bedrock Median	Recommended Maximum Concentration SGCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	130	28	6,932	406	523	500
Sodium	111	0	1,012	128	131	200
Sulfate	130	0	440	18	32	500
Chloride	127	0	463	2	2	250
Fluoride	106	0	4	0.5	0.2	1.5

Concentration in milligrams per litre unless otherwise stated
 Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)
 SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
 Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 8. Apparent Concentrations of Constituents in Groundwaters from Disturbed Belt Aquifer

5.3.6 Dalehurst Aquifer

The Dalehurst Aquifer comprises the permeable parts of the Dalehurst Member, as defined for the present program. The Dalehurst Member subcrops under the surficial deposits in most of the County. The structure contours show that the Dalehurst Member ranges in elevation from less than 800 to more than 1,350 metres AMSL and has a maximum thickness of 500 metres. The regional groundwater flow direction in the Dalehurst Aquifer is mainly toward the McLeod River (see CD-ROM).

5.3.6.1 Depth to Top

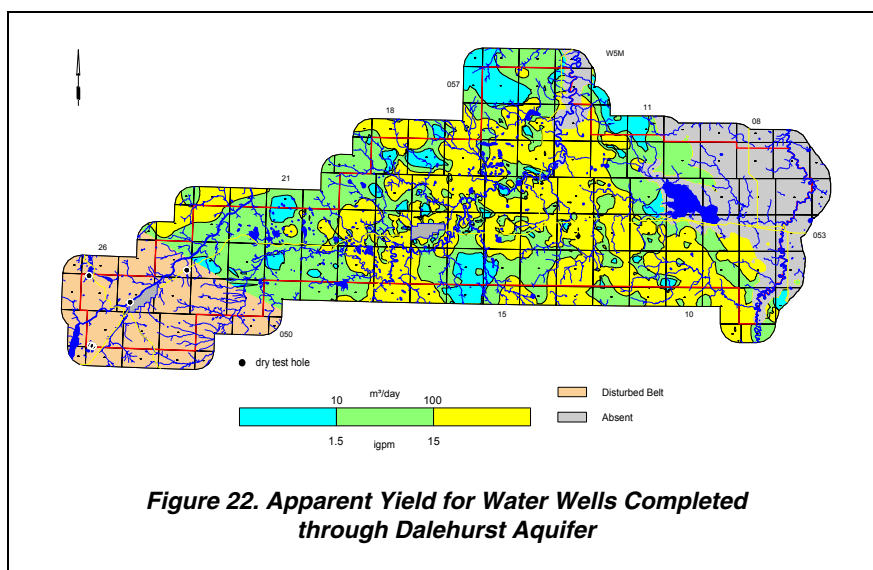
The depth to the top of the Dalehurst Member ranges from less than ten metres to more than 30 metres in the northern part and also on the southern and western edges of the County (page A-33).

5.3.6.2 Apparent Yield

The apparent yields for individual water wells completed through the Dalehurst Aquifer are mainly between 10 to 100 m³/day, as shown on Figure 22. The areas showing water wells with yields of greater than 100 m³/day are expected to be throughout the areal extent of the Aquifer.

Shown on the adjacent map are the locations of 28 dry water test holes.

There are 266 non-exempt groundwater users that have water wells completed through the Dalehurst Aquifer, for a total authorized groundwater diversion of 10,514 m³/day.



Of the 266 non-exempt authorizations, 126 could be linked to water wells in the AENV groundwater database.

The highest non-exempt groundwater use is for eight authorizations that allow the Town of Edson to divert up to 4,233 m³/day from six water supply wells completed in the Dalehurst Aquifer for municipal purposes and one water supply well completed in both the Lower Sand and Gravel Aquifer and the Dalehurst Aquifer. The remaining water supply well is completed in the Lower Sand and Gravel Aquifer. The highest authorization of 1,504 m³/day is for WSW No. 15, which is completed from 44.8 to 65.5 metres below ground surface in the Dalehurst Aquifer.

Touchstone Petroleum Inc. is authorized to divert up to 240 m³/day from Water Source Well (WSW) No. 1-96 in the Carrot Creek Area in NW 12-053-13 W5M. The water source well is completed from 64.6 to 82.9 metres below ground surface in the Dalehurst Aquifer. Water-level monitoring since 1996 with WSW No. 1-96 and Observation Water Well (Obs WW) No. 2-96 indicated an effective transmissivity of 12 m²/day and corresponding storativity of 0.008 (HCL, March 2003).

5.3.6.3 Quality

The groundwaters from the Dalehurst Aquifer are mainly a bicarbonate type, with no dominant cation (see Piper diagram on CD-ROM), with 50% of the groundwater samples having TDS concentrations of less than 500 mg/L (page A-35). Seventy percent of the sulfate concentrations in groundwaters from the Dalehurst Aquifer are less than 50 mg/L. Nearly 90% of the chloride concentrations from the Dalehurst Aquifer are less than ten mg/L.

Chemical analyses collected from 1973 to 2000 from the six active Town of Edson water supply wells completed in the Dalehurst Aquifer indicate that the groundwaters are mainly a sodium-bicarbonate-type, with TDS concentrations being mainly less than 550 mg/L, sulfate concentrations mainly less than 50 mg/L, chloride concentrations mainly less than four mg/L, and fluoride concentrations mainly less than one mg/L. Chemical analyses collected from 1986 to 2000 from two of the six active water supply wells completed in the Dalehurst Aquifer in west Edson have TDS concentrations of greater than 550 mg/L, chloride concentrations ranging from 12 to 21 mg/L, and fluoride concentrations ranging from 2.4 to 3.3 mg/L (Komex International Ltd., March 2001).

A chemical analysis of a groundwater sample collected in February 1996 from WSW No. 1-96 and Obs WW No. 2-96 in NW 12-053-13 W5M indicates the groundwater is a sodium-bicarbonate type, with a TDS concentration of less than 600 mg/L, a sulfate concentration of less than 15 mg/L, a chloride concentration of less than 41 mg/L, and a fluoride concentration of in the order of three mg/L (HCL, April 1996).

Of the five constituents that have been compared to the SGCDWQ, all are below the guidelines. All median concentrations in the Dalehurst Aquifer are equal to or below the median concentrations from water wells completed in all upper bedrock aquifer(s).

Constituent	No. of Analyses	Range for County in mg/L			All Bedrock Median	Recommended Maximum Concentration SGCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	843	3.83	2,764	497	523	500
Sodium	791	2	781	114	131	200
Sulfate	864	0	1701	29	32	500
Chloride	827	0	93	2	2	250
Fluoride	798	0	22	0.2	0.2	1.5

Concentration in milligrams per litre unless otherwise stated
 Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)
 SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
 Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 9. Apparent Concentrations of Constituents in Groundwaters from Dalehurst Aquifer