GROUNDWATER EVALUATION

GUIDELINE

(Information Required when Submitting an Application under the *Water Act*)

February 5, 2003

Important Notes:

1. Revisions, February 5, 2003:

The guideline is revised to clarify the role of evaluation of surface water, non-potable groundwater and non-water alternatives for oilfield injection projects – as specified in the GROUNDWATER ALLOCATION POLICY FOR OILFIELD INJECTION PURPOSES (APPENDIX "A").

Evaluation of alternatives to the use of potable groundwater must precede evaluation of potable groundwater as a potential water supply for those oilfield injection projects in the white zone of the province. Oilfield injection projects should utilize alternative sources rather than potable groundwater whenever alternative sources are available.

Proponents of oilfield injection projects should contact department staff prior to proceeding with groundwater evaluations pursuant to this guideline.

Additions to the guideline, pursuant to this amendment, are included in:

- Part 1: Application Information (exemptions)
- 1.02(b)(xi)

2. Revisions, February 05, 2003

Appendix C (POLICY ON WATER DIVERSIONS FROM SANDS AND GRAVELS ADJACENT TO A WATER BODY, AND FROM SPRINGS) is revised to clarify the evaluation and application processing procedures applicable to sand and gravel operations near water bodies, and the evaluation and application processing procedures applicable to development of springs as water sources.

- Appendix C (revised and updated)

3. For more information, you may contact

Water Section (780) 427-7533
Science and Standards Branch
Environmental Assurance Division
Alberta Environment
4th floor, 9860-106 Street,
Edmonton, Alberta T5K 2J6

website:

http://www3.gov.ab.ca/env/water/Legislation/Guidelines/index.cfm

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Part 1: Application Information

Water is a valuable resource which must be managed and sustained for use by individuals, farming and municipal communities, and industries.

The *Water Act* (the "Act") provides the means to allocate water in an orderly and beneficial manner through the issuance of licences. There are two types of licences:

1. temporary diversion licences for short-term use of water (less than one year with no provision for extensions), and no further use is anticipated, and
2. licences for anticipated long term use (longer than one year).

The Act also has provision for regulating groundwater drainage for accessing gravel or other aggregate products, through the issuance of approvals.

Policies and other regulatory issues, as per attached Appendices, shall apply.

Household use does not require a licence and has the highest priority of use over all licences and registrations.

Exempt activities and Diversions Activities and diversions of water that are exempt from the requirement for an approval, and the requirement for a licence, are listed in schedules 1-4 of the *Water (Ministerial) Regulation.* Groundwater Evaluation, including pump testing conducted pursuant to this guideline, is exempt from the need to obtain an approval.

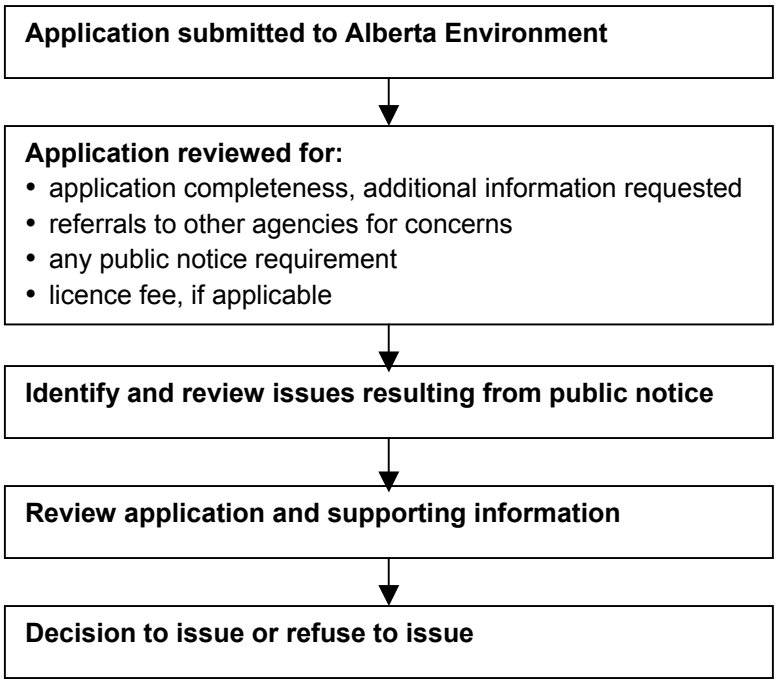
Note: the evaluation of saline groundwater sources is required prior to submission of an application for a license to utilize potable groundwater for oilfield injection purposes in the white zone of the province, although the diversion of saline groundwater is exempt from licensing requirements.

Priority of use is the date from which a user is allowed to use water. It is based on the date when a completed application was received.

Completed application is an application containing all the appropriate supporting information without the requirement for additional information. Application forms are available at any Alberta Environment regional office or from the Web page http://www.gov.ab.ca/env/water/legislation/index.html and look under "Approvals and Licences".

Groundwater diversion or drainage is the removal of groundwater for which a licence or approval is required.

Application process is the procedure for review of and decision on an application for a Director to either issue or refuse to issue a licence or an approval:



1.01 Information Required for Temporary Diversion Licences

The applicant must provide the following and submit to the nearest Alberta Environment's regional office shown on the application form:

(i) Name, address and telephone number of the person responsible for the diversion,

(ii) If applicable, name, address, and telephone number of a contact person,

(iii) Identify the supply as groundwater,

(iv) Legal land description of the diversion site(s),

(v) Volume of water to be diverted,

(vi) The approximate commencement date and duration period of the diversion,

(vii) The purpose (i.e. reason for the water diversion), and

(viii) Copy of a Water Well Drilling Report

Note: There may be cases which will require additional information

1.02 Information Required for Licences

The applicant (or consultant acting on behalf of the applicant) must supply the following and submit to the nearest Alberta Environment's regional office shown on the application form (see **Schedule 1** for specific requirements):

(a) An application form containing the

(i) applicant's name, address and telephone number,
(ii) legal land location of the proposed diversion site(s),
(iii) proposed use of the groundwater (agricultural, oilfield injection, municipal, etc),
(iv) water-bearing interval identified by a drilling report or an evaluation report prepared by a consultant,
(v) yearly water requirements and indicate if seasonal use,
(vi) maximum pumping rate (instantaneous rate), and
(vii) consultant's name, if one is contracted to conduct testing and evaluations

Note: Schedule 2 is a calculation sheet for determining stock water requirements

(b) Supporting information such as

(i) drilling report(s) for the water well(s), observation well(s), and other water wells in the area surrounding the proposed diversion site,
(ii) E-logs, if available,
(iii) field-verified survey of water wells, springs and dugouts within a one-kilometre radius of the proposed diversion site(s) including, if available
  (A) owner's/lessee's name
  (B) legal land location and surface elevation
  (C) type of water source (e.g. wells, springs, dugouts, etc.)
  (D) water source status (e.g. producing, standby, observation, abandoned, etc.)
  (E) well depth
  (F) purpose and estimated volume of water use
  (G) well completion details, completion interval (e.g. open hole, perforated, screened)
  (H) depth to the top of the aquifer and the amount of available head
  (I) pump intake depth
  (J) maximum pumping rate
  (K) distance from the proposed diversion site
  (L) original non-pumping water level and date,
  (M) current non-pumping water level, and
  (N) summary of historical chemical analyses.

Note: It is strongly recommended to conduct a public consultation prior to the commencement of the pumping test. This can be accomplished during a field-verified survey.

Public notice of an application will normally be required when the department receives an application.

(iv) hydrogeological cross sections and/or maps showing the possible hydraulic relationships among the source aquifer, other aquifer units in which surrounding wells are completed and nearby surface water bodies – indicate the source or data,
(v) geologic and hydrogeologic assessment and characterization of the aquifer including the areal extent and variability of the aquifer unit(s) and the hydraulic flow regime,

(vi) pumping test data sufficient to provide a reasonable quantitative assessment of the required volume, and
  (A) aquifer parameters and Q_{20}
  (B) response of the source aquifer and other aquifers to pumping over 1, 5, 10, and 20 years
  (C) effect on neighbouring water supplies,
(vii) water quality parameters and suitability for the intended purpose,
(viii) hydrographs and historical production information for expansion of ongoing projects or for areas where well interference between projects exists,
(ix) depending size of project, location, or purpose and the degree of groundwater/surface water interaction, additional site-specific data may be needed for projects where specific environmental issues arise, and
(x) for irrigation projects, an Agricultural Feasibility Report (see the guideline for preparing this report on the Web page http://www.gov.ab.ca/env/water/legislation/index.html), and
(xi) for oilfield injection projects in the "White Zone" of the province, an evaluation report assessing the availability of alternatives to the use of potable groundwater.

Note: This report for oil field injection project should be prepared by qualified specialists familiar with the evaluation techniques (in geology, petroleum reservoir engineering, hydrogeology, hydrology, etc.) needed to assess the alternative sources.

It is strongly recommended that proponents consult with department staff after completing evaluation of potential alternatives, and prior to proceeding with evaluation of potential potable groundwater sources.

1.03 Information Required for Approvals

Although approvals are not required for groundwater exploration, approvals are required for groundwater drainage or remediation.

1.03.01 Drainage

Drainage occurs where there is no "use" of water. Reasons to drain groundwater are to:

(a) Extract gravel or other mining products, and

(b) Eliminate flooding caused by high water tables.

The applicant (or consultant acting on behalf of the applicant) must supply the following and submit to the nearest Alberta Environment's regional office shown on the application form (see **Schedule 1** for specific requirements):

(a) An application form containing the

  (i) applicant's name, address and telephone number,
  (ii) legal land location of the proposed diversion site(s),
  (iii) purpose (drainage, remediation, etc),

(iv) water-bearing interval identified by a drilling report or an evaluation report prepared by a consultant,
(v) yearly water requirements and indicate if it is of seasonal nature, and
(vi) consultant's name, if one is contracted to conduct testing and evaluations,

(b) Supporting information such as

(j) drilling report(s) for observation well(s), and other water wells in the area surrounding the proposed drainage site,
(ii) E-logs, if available,
(iii) field-verified survey of water wells, springs and dugouts within a one-kilometre radius of the proposed drainage site including, if available
  (A) owner's/lessee's name
  (B) legal land location and surface elevation
  (C) type of water source (e.g. springs, wells, dugouts, etc.)
  (D) well status (e.g. producing, standby, observation, abandoned, etc.)
  (E) well depth
  (F) purpose and estimated volume of water use
  (G) well completion details, completion interval (e.g. open hole, perforated, screened)
  (H) depth to the top of the aquifer and the amount of available head
  (I) pump intake depth
  (J) maximum pumping rate
  (K) distance from the proposed drainage site
  (L) original non-pumping water level and date
  (M) current non-pumping water level
  (N) summary of historical chemical analyses
(iv) hydrogeological cross sections and/or maps showing the possible hydraulic relationships among the source aquifer, other aquifer units in which surrounding wells are completed and nearby surface water bodies – indicate the source or data,
(v) geologic and hydrogeologic assessment and characterization of the aquifer including the areal extent and variability of the aquifer unit(s) and the hydraulic flow regime,
(vi) pumping test data sufficient to provide a reasonable quantitative assessment of the required volume, aquifer parameters and Q_{20} , and effect on neighbouring water supplies,

Note: It is strongly recommended to conduct a public consultation prior to the commencement of the pumping test. This can be accomplished during a field-verified survey. Public notice of an application will normally be required when the department receives an application.

(iv) water quality parameters, point of discharge, and suitability for discharge.

1.03.02 Remediation

Remediation is the process where contaminated water is removed for treatment or disposal. If there is intended use of this water after treatment, a licence shall be considered in lieu of an approval. The information required is similar to those required under section 1.03.01.

Also, a description of the aquifer status and details of the proposed remediation project may be required in the form of a Remedial Action Plan under the provision of the *Environmental Protection and Enhancement Act*.

Part 2: Best Management Practice

The applicant/consultant shall have an evaluation program designed, including a field-verified survey of water users, a pumping test(s) using observation well(s) and/or existing household well(s), if warranted, among other things. The applicant shall submit a report, in support of an application to obtain a licence, demonstrating sufficient groundwater of a suitable quality is available for the intended purpose.

The following criteria identify the department's best management practice for information required with an application:

2.01 Description of Geology and Hydrogeology

The applicant or consultant shall submit a description of the geology and hydrogeology at the proposed project site based on information from:

(a) Alberta Research Council hydrogeological reconnaissance maps, cross-sections and reports, and any other report,

(b) Descriptions and aquifer parameters reported in other projects requiring licences or approvals, and

(c) Water well drilling reports and chemical analyses.

2.02 Field-Verified Survey

The radius of the field-verified survey shall be one kilometre or more according to the geologic and hydrogeologic conditions, the quantity of groundwater required by the proposed project and the number of water users in the area.

The field-verified survey shall consist of a

(a) Plan(s) showing the ownership and locations of all water wells, springs and/or dugouts within an appropriate radius of the project site, and

(b) Table containing (see Schedule 3 for an example)
- (i) owner's/lessee's names,
- (ii) legal land location and surface elevation,
- (iii) type of water source (e.g. wells, springs, dugouts, etc.)
- (iv) well status (e.g. producing, standby, observation, abandoned, etc.),
- (v) well depth,
- (vi) original non-pumping water level and date, and current non-pumping water level,
- (vii) well completion details, completion interval (open hole, perforated or screened),
- (viii) depth to the top of the aquifer and the amount of available head,
- (ix) pump intake depth,
- (x) maximum pumping rate,
- (xi) purpose of use (household/livestock/industrial, etc.) and current water daily/annual requirements,
- (xii) distance from the proposed groundwater diversion or drainage site, and
- (xiii) summary of historical chemical analyses

Notes: **Most of the information above should be obtained directly from the water source users. Water well drilling records should only be used to confirm communicated water source data or to complete the information if it is unknown to the users. If the user is absent during the survey, an effort must be made to obtain the information at a later date.**

When the field survey is properly conducted, any potential conflict among neighbours can be prevented early. Where a history of conflict exists, the consultant should consider monitoring neighbouring well(s) during the test.

Where water level measurements are difficult to obtain, an observation well may be constructed

(A) with the same water-bearing zone as the proposed production well or drainage site and

(B) in close proximity to the sites
- **of non-obtainable measurements or**
- **where measurements are required from a large subdivision/municipality).**

2.03 Pumping Test

The pumping test(s) shall be conducted on the proposed water well(s) to determine the hydraulic properties of the aquifer to enable determination of the extent and the sustainable yield of the aquifer.

During the pumping test, the proponent shall

(a) obtain water samples as identified in **2.07 (c)** and shall submit

(i) water temperature, date, and time of sampling,
(ii) date the analyses were performed, and
(iii) results of the analyses,

(b) have the flow rate at not less than the anticipated maximum production rate,

(c) have the maximum variation in pump rate at ± 5%,

(d) have the pumping continue for a period of time sufficient to identify any limiting boundary conditions (see Schedule 1 for standard lengths of pumping test),

(e) take recovery measurements for at least the same length of time as the proposed production well(s) was pumped,

(f) not deposit any substance at the pumping test site or in any water body receiving discharge which will adversely affect the water body, and

(g) not discharge groundwater to the land surface where it may adversely affect soils or vegetation, or cause any other environmental damage.

2.04 Water Level Monitoring Schedule

Water levels measured in the production well(s) and observation wells shall be recorded to the nearest one (1.0) centimetre during the pumping and recovery phases of the pumping test. The monitoring frequency and the accuracy of the water level measurements must be suitable to determine aquifer parameters.

The last water level during the pumping period should be taken just prior to the pump being turned off.
After the pump is turned off, the depth to water in the well(s) must also be measured while the water level "recovers" from the pumping

Monitoring frequency, during the recovery period, should be similar to the frequency during the pumping period.

Recovery measurements should be taken for at least the same length of time as the well was pumped or until the water level has recovered to within 90% of the pre-test non-pumping water level, which ever comes first.

The following water level monitoring schedule is an example of a suitable frequency:

From 0 to 10 minutes	every minute
From 10 to 30 minutes	every 5 minutes
From 30 to 60 minutes	every 10 minutes
From 1 to 2 hours	every 15 minutes
From 2 to 4 hours	every 30 minutes
From 4 to 12 hours	every hour
From 12 to 24 hours	every 2 hours
From 24 to 36 hours	every 4 hours
From 36 to 48 hours	every 6 hours
After 48 hours	every 8 to 12 hours

2.05 Observation Wells

When appropriate to the scale and potential impact of the project, an observation well(s) should be installed at a suggested distance of 15 and 150 metres from the proposed production well. The distance should be considered based on the aquifer type (e.g. confined, unconfined), intended pumping rate, anticipated drawdown based on the drilling reports, or any Policy/Regulation specifying other requirements.

The observation well(s) should be completed in the same aquifer as the proposed production well.

It may also be necessary to monitor household or previously licensed groundwater diversion and/or observation wells in other subsurface units depending on the geologic and hydrogeologic conditions and the proposed groundwater withdrawal rate at the diversion sites. Installation of additional observation wells may be required for monitoring purposes.

Water levels in the observation well(s) should be monitored on a schedule similar to monitoring schedule of water levels in the pumped well.

2.06 Interpretation of Pumping Test Data

A quantitative assessment of aquifer parameters (Transmissivity, Storativity, etc.), potential drawdown, and long-term yield is based on the

(a) Aquifer type and assumptions common to most analytical methods:
- (i) aquifer is assumed to have an infinite areal extent,
- (ii) water is bounded by a less permeable bed below in the case of an unconfined aquifer, and above and below in the case of a confined aquifer,
- (iii) aquifer is homogeneous, isotropic, and of uniform thickness,
- (iv) flow is laminar,
- (v) water is released from storage instantaneously with a decline in head, and
- (vi) aquifer is pumped at a constant discharge rate,

(b) Identification and location of any aquifer boundary causing a divergence of the test data from the straight-line and the type curve, Jacob and Theis methods respectively – the following conditions may cause departures resembling an aquifer response to either recharge or discharge (barrier) boundaries:
- (i) leakage from adjacent aquifers,
- (ii) an increase (or decrease) in the thickness of the aquifer,
- (iii) an increase (or decrease) in the permeability of the producing aquifer,
- (iv) cessation (or the initiation) of pumping from a nearby well,
- (v) decrease (or increase) in the rate of discharge from the well,
- (vi) facies change,
- (vii) secondary porosity (e.g. fracture porosity),
- (viii) delayed yield in unconfined aquifers (resembling recharge),
- (ix) mining effect, and
- (x) barometric effects – significant where minimal drawdown is incurred,

(c) Aquifer shall be analyzed (hydraulic conductivity, transmissivity and storativity coefficient) using
- (i) analytical solutions (type of analyzes used is a function of the aquifer and its geological and hydrogeological settings)
- (ii) numerical and computer models – type of analysis used is a function of the aquifer and its geological and hydrogeological settings, and
- (iii) the most appropriate method, however the applicant or representative is responsible for providing specified data and be prepared to defend the choice

(d) Pumping test data and data interpretation by various methods of which two (2) most commonly used are:
- (i) Theis method which determines the aquifer parameters from the production well data (transmissivity only) and observation well data (transmissivity and storativity) – it is also used for assessing the amount of potential drawdown, at various times and selected distances from the water well, and
- (ii) Cooper-Jacob method which is a modified Theis method when certain conditions are met,

(e) Determination of aquifer boundaries which is essential before the long-term yield of the aquifer can be determined,

(f) Theoretical long-term yield of a proposed production well determined by using either the

Farvolden Method

$Q_{20} = (0.68)(T)(H_A) \times (0.7)$

or the

Moell Method

$$Q_{20} = \frac{Q(H_A)}{s_{100} + 5\triangle s} \times 0.7$$

where

H_A = available head (in metres)
s_{100} = the drawdown at 100 minutes (in metres)
Q = well pumping rate during the pumping test (in cubic metres per day [m^3/d])
Q_{20} = sustainable yield for a 20-year period (in m^3/d)
$\triangle s$ = drawdown per log cycle of time
T = transmissivity (in square metres per day [m^2/d])
0.7 = 70% safety factor

The Moell formula is commonly used where large drawdowns occur at the beginning of the pumping period.

For confined aquifers, the available head (H_A) is equal to the distance between the non-pumping water level in the well prior to the pumping test and the top of the aquifer or the top of the completion interval, which ever is less.

For unconfined aquifers, the available head (H_A) is chosen to be equal to 2/3 of the difference between the base of the aquifer and the non-pumping water level in the well (or 2/3 of the saturated thickness of the aquifer).

2.07 Water Quality Assessment

The following will be required:

(a) Impact of effluent/discharge (return flow) from industrial, municipal, aquaculture, and livestock projects, etc. on the aquifer, nearby streams and water bodies which must be considered – suitable effluent management plans regulated through other agencies may be required,

(b) Reference to the "Surface Water Quality Guidelines For Use in Alberta" and consideration of flow rates and timing of discharge into receiving water bodies, and

(c) In most cases it will be sufficient to have the water sample, collected from the production well near the end of the pumping period, analysed for the parameters and constituent identified as “Routine Analysis” (“Detailed Analysis” should be submitted for central distribution water supply systems for municipal/household purposes).

List of Parameters for Routine and Detailed Analysis

Routine Analysis:
(i) Bicarbonate (HCO_3)
(ii) Calcium (Ca)
(iii) Carbonate (CO_3)
(iv) Chloride (Cl)
(v) Fluoride (F)
(vi) Iron (Fe)
(vii) Magnesium (Mg)
(viii) Manganese (Mn)
(ix) Nitrite + Nitrate ($NO_2 + NO_3$)
(x) pH
(xi) Potassium (K)
(xii) Sodium (Na)
(xiii) Sulphate (SO_4)
(xiv) Total Dissolved Solids
(xv) Total Alkalinity
(xvi) Total Hardness

Additional constituents may be analyzed as deemed necessary (i.e. in accordance with the surface water quality guidelines, etc.).

Note: Groundwater remediation projects may require additional parameters

Detailed Analysis:
(i) Arsenic (As)
(ii) Bicarbonate (HCO_3)
(iii) Calcium (Ca)
(iv) Carbonate (CO_3)
(v) Chloride (Cl)
(vi) Colour (TCU)
(vii) Copper (Cu)
(viii) Fluoride (F)
(ix) Iron (Fe)
(x) Lead (Pb)
(xi) Magnesium (Mg)
(xii) Manganese (Mn)
(xiii) Mercury
(xiv) Metals (total and dissolved)
(xv) Nitrite & Nitrate ($NO_2 + NO_3$)
(xvi) Nitrogen – Ammonia
(xvii) Total Kjeldahl Nitrogen(TKN)
(xviii) pH
(xix) Phenols
(xx) Phosphorus (P)
(xxi) Potassium (K)
(xxii) Sodium (Na)
(xxiii) Sulphate (SO_4)
(xxiv) Sulphide (H_2S)
(xxv) Total Alkalinity
(xxvi) Total Dissolved Solids(TDS)
(xxvii) Total Hardness
(xxviii) Turbidity (NTU)
(xxix) Zinc (Zn)

Bacteriological Analysis
(xxx) Coliforms – **Fecal** (mpn/100mL)
(xxxi) Coliforms – **Total** (mpn/100mL)

2.08 Effects on the Aquifer, Other Users, Other Water Bodies, and the Aquatic Environment

The following shall be considered in the assessment of both short-term and long-term impacts:

(a) Aquifer characterization determined from the analysis of pumping test data, chemical data, field-verified survey data and other hydrogeological reports and data (e.g. fracture dominated flow, limited areal extent, strong dynamic flow regime, extensive diversion from other projects, strong natural discharge, limited or abundant recharge, confined / unconfined conditions, etc.),

(b) Any interference with other local groundwater and surface water users,

(c) Proximity of surface water bodies (e.g. springs, dugouts, dams, sloughs, creeks, rivers, etc.),

(d) Evaluation of distance/time drawdown graphs and the calculation of the potential well interference effects,

(e) Predicted drawdown in the water well compared to amount of available head (the top of the aquifer and/or top of completion interval which ever is less) and to the pump intake depth in area wells,

(f) Evaluation of technical / hydrogeological or other valid concerns expressed in any response to public consultation regarding the proposed diversion and use of groundwater by the project,

(g) Identification of other environmental / hydrogeological issues requiring referral to other agencies – specific monitoring requirements may be required to address the specific concerns,

(h) Suitable analytical solutions or computer numerical models to properly represent “realistic” groundwater flow systems, which will include the entire length of time of groundwater diversion and use,

(i) Evaluation of impacts on watersheds at full water allocation limits or with other allocation controls (e.g. water management plans, licensing moratoria, apportionment limitations, etc.),

(j) Local sub-basins with sensitive water bodies (i.e. small contributing area to surface area ratios) or rare plants or animal species which must be specifically identified and protected,

(k) Areas adjacent to protected wetlands or "special places" which must be specifically identified and evaluated as a sensitive area,

(l) Evaluation of erosion potential and changes in fish habitat which may be required for large-scale mine or pit drainage projects,

(m) Evaluation of large diversions for effects caused by increased groundwater recharge which may be needed in recharge dominated flow systems or for drought sensitive local water bodies, and

(n) Changes in water quality as a result of the diversion or drainage (e.g. increased metal mobility, anaerboci/aerobic changes, salinity increase, etc.).

Note: It is assumed, when a licensee or approval holder cannot prove beyond a reasonable doubt the water diversion or drainage caused an alleged unreasonable impact, the water diversion or drainage did cause the unreasonable impact

2.09 Water Well Construction

Water wells must be constructed in accordance with the methods outlined in the *Water (Ministerial) Regulation* (the “Regulation”).

2.10 Technical Report

Where applicable, the applicant is responsible for submitting the supporting information together with an application which may in a form of a groundwater evaluation report prepared by a qualified groundwater specialist who is a member of the Association of Professional Engineers, Geologists and Geophysicists of Alberta (the “APEGGA”).

The report should provide, among other things, the

(a) Results from the field-verified water well survey of surrounding water well, spring, and dugout users,

(b) Pumping test program, and

(c) Historical monitoring data and any other aspect of the groundwater exploration program

Conclusions reached in the report should be based on an interpretation and conceptualization of the geology / hydrogeology in the area through the construction of cross-sections and interpretation of pumping test, monitoring, and water quality data.

The report shall confirm the proposed diversion or drainage of groundwater will not

(a) Unreasonably interfere with other water users or water sources,

(b) Negatively impact the aquifer or other aquifers and surface water bodies, and

(c) Harm the environment in general.

The report shall

(a) Identify the necessary remedial measures if unreasonable impact is anticipated, and

(b) Identify alternative sources of supply in case of potential water shortages.

2.11 Assessment of information

2.11.01 Why is Assessment Necessary?

Information is assessed to determine the feasibility of allocating groundwater in a manner based on “first in time first in right principles”, and to manage and sustain the groundwater resources for future generations.

The assessment of pumping test data and other information is necessary to determine the aquifer parameters. In the process of evaluating, the aquifer will be assessed if it is capable of providing the quantity and quality of groundwater required for the proposed project on an ongoing basis without unreasonably/negatively impacting the aquifer(s), existing water supplies, and surrounding water bodies.

If the assessment concludes there is sufficient groundwater for the proposed project, then the proponent will have an additional degree of assurance that the requested quantity of groundwater can be removed without impacting the aquifer or surrounding water bodies.

However if the available data indicate there is insufficient groundwater available to meet the proposed project’s requirements, alternative water sources (such as another aquifer or surface water) can be assessed to determine suitability.

The following questions should be considered when conducting a groundwater assessment:

(a) Is the proposed diversion technically feasible (e.g. well design, available head, maximum pumping rate, long-term yield, appropriate quality, etc.)?

(b) Is the proposed diversion sustainable throughout the life of the project, without damage to the aquifer?

(c) Will the proposed diversion have an adverse effect on other groundwater users in the area? Can the predicted effect(s) be mitigated?

(d) Will the proposed diversion have an adverse effect on other components of the environment, and especially on the aquatic environment?

(e) What monitoring conditions will provide data required to confirm initial predictions and to identify potential adverse effects in the future? This includes consideration of what information might be required to successfully conduct an investigation into an allegation(s) of well interference against the licensee or approval holder.

2.11.02 What is Assessed?

The technical report(s) filed in support of an application to divert or drain groundwater is assessed to determine if the aquifer is capable of supplying both the quantity and quality of groundwater required by the project on an ongoing basis.

Consultants preparing these reports are expected to use scientific methods and procedures providing the technical basis on which groundwater can be allocated. Factors limiting the diversion or use of groundwater required by the project must be identified in the report.

Groundwater availability in an area can vary from less than 10 cubic metres per day (m^3/d) to several thousands cubic metres per day depending on the aquifer characteristics. Pumping test data are assessed to determine the aquifer parameters at the project site and the sustainable rate at which groundwater can be withdrawn from the aquifer without causing either aquifer depletion or unreasonable impact to other aquifers or other groundwater users in the surrounding area. The effects of boundary conditions must also be taken into consideration during the evaluation process.

With the establishment of surface water restrictions (in-stream objectives, minimum flow levels, moratoria, etc.) the hydraulic relationship between groundwater and surrounding surface water sources must also be considered as part of the submission for review. One of the challenges of assessing a groundwater project in a restricted water basin is quantifying the hydraulic relationship between surface water and groundwater resources.

2.12 Multiple-Aquifer Completions

Where wells were constructed with multiple completion intervals prior to the Regulation governing well construction, there is no legislation to force well owners to reconstruct these wells according to the Regulation before obtaining a licence.

However where pumping test is required and in order to conduct a proper evaluation, the well must be re-completed in such a manner to isolate one aquifer interval. This will allow for proper testing of the interval and provide a more accurate assessment of the aquifer parameters. Thus for any application to obtain a licence and where testing is required, the owners may be directed to have the well re-completed or isolated with a single aquifer prior to the testing.

2.13 Replacement and Supplementary Water Wells

2.13.01 What is a Replacement Water Well?

A replacement water well is a new well constructed to replace an older (existing) well and shall be

(a) Installed with a drawdown and cone of depression similar to or better than the drawdown and

cone of depression of the existing well,

(b) Installed near and in the same aquifer as the existing well, and

(c) Completed in accordance with the Regulation governing well completion interval length at the time of the replacement,

and the existing well shall be abandoned in accordance with the Regulation.

Any licence for the existing well may be amended to reflect changes to the pumping rate and production interval.

Should an additional quantity of water be needed (operation expansion) at the time of drilling the replacement well, a new licence will be required.

2.13.02 What is a Supplementary Water Well?

A supplementary water well is a new well in addition to older (existing) wells and shall be

(a) Installed near the existing well where drawdown and the cone of depression is similar to or better than the drawdown and cone of depression of the existing well,

(b) Installed in the same aquifer as the existing well, and

(c) Completed in accordance with the Regulation governing well completion interval length at the time of the replacement.

The supplementary water well will be identified on any licence for the existing water well and will share the current allocation and priority number of the existing well if there is no additional quantity of water required.

Should an additional quantity of water be needed (operation expansion) at the time of drilling the supplementary well, a new licence will be required.

2.14 Water Level Below the Top of the Aquifer or the Completion Interval

The pumping water level in a water well should not be allowed to decline below the top of a confined aquifer or the top of the completion interval, which ever is nearer to the top of the well casing, during either normal or peak water use periods.

To prevent mining (de-watering) of confined aquifers, each water well completed in a confined aquifer shall be equipped with a low-level shut-off switch. Alternatively if a water well is not equipped with a low-level shut-off switch, the pump installer shall provide the Director with the position of the pump intake in the well relative to the top of the well casing.

2.15 Monitoring Requirements and Conditions for Licences and Approvals

Conditions and monitoring requirements are based on the

(a) Size of the diversion or drainage project,

(b) Type of water well supply system (e.g. multiple-well system, etc.),

(c) Potential impact on surrounding water users, in which case the conditions may include, but not limited to,
   (i) frequent or continuous water-level monitoring of the production well with automatic digital recording,
   (ii) frequent or continuous water-level monitoring of observation wells,
   (iii) installation of low-level shut-off switch in each production well, and
   (iv) depending on location and production intervals, specific allocation to each well (instead allowing the licensee/approval holder the option to pump various quantities from each well providing total withdrawal does not exceed the total allocation).

(d) Uncertainty regarding the Transmissivity (T) and Storativity Coefficient (S) values calculated from pumping test data (variations due to fracture permeability, limited aquifer extent, etc.), and the resulting uncertainty in predictions of impacts,

   Note: Observation wells, re-evaluation by consultants in annual water use reports, increased frequency of monitoring, and low-level shut-off requirements are common licence conditions warranted by such uncertainty.

(e) Discharge or return flow for remediation and aqua-culture projects which require specific conditions to monitor quality and quantity.

Multiple large groundwater diversion or drainage in the same area and development of groundwater diversion or drainage with high potential for increases in population or industrial use may warrant monitoring conditions to confirm or update impact predictions.

Monitoring conditions may include

(a) monitoring household wells in the area,

(b) constructing and monitoring additional wells,

(c) continuous or frequent monitoring production volume and water level , and

(d) annual water use evaluation reports.

Part 3: Background

3.01 Allocation Principle

In 1971, the *Water Resources Act* (the "WRA") was amended to specifically include the diversion and use of groundwater. It was deemed appropriate to begin licensing groundwater because the development of the resource was reaching the point where problems associated with the right to divert groundwater from some aquifers could be expected.

Under the WRA, and upon the proclamation of the *Water Act* (the "Act") on January 1, 1999, the allocation of groundwater followed the surface water practice in the Province. Neither the doctrine of riparian rights (land owners having the right to use the water on or under the land) nor appropriation (the first to beneficially use water has continual right to it) was desirable. The best alternative was allocation by administrative procedure.

The application process aims to

(a) Provide assurance of an adequate supply of water for the applicant's needs,

(b) Protect the aquifer from over development,

(c) Protect the water supplies of household users, registrants, and prior licence holders,

(d) Develop beneficial use of the resource, and

(e) Protect the environment.

3.02 *Water Act* – Approvals and Licences

In Alberta, water (surface water and groundwater) is legislated under the Act, *Water (Ministerial) Regulation* (the "Regulation") and the *Environmental Protection and Enhancement Act* to protect and sustain the water resources for future generations.

An approval allows the drainage of water for the purpose of subsurface soil drainage for aggregate mining, construction, or groundwater remediation where the water is not needed for any "use". The approval identifies the holder's name and address, legal land location, conditions under which the drainage can take place, and an expiry date (term of the approval), etc.

A licence allows the diversion and use of water. The licence identifies the holder's name and address, legal land location, maximum annual quantity (allocation) of water allowed for the diversion, priority for a right to divert (priority number) based on the date a completed application was received, the completion interval, the maximum pumping rate, conditions under which the diversion can take place, and an expiry date (term of the licence), etc.

A temporary diversion licences ("TDL") allows the short-term diversion (up to a total of one year) and contains conditions under which the diversion can take place. The TDL identifies the same information as a licence however it has no priority for a right – no priority number is assigned to a TDL.

Licences to divert and use groundwater are not required for household use, as defined in the Act.

The Regulation has provision for exemptions from requiring a licence for the following:

(a) Fire-fighting,

(b) Water wells equipped with hand pumps,

(c) "Saline" water which total dissolved solids exceeding 4000 milligrams per litre,

(d) Camp water supplies up to 1250 m^3 of water per year per camp, and

(e) Other purposes (as listed in Regulation Schedules 3 and 4).

3.03 What is groundwater?

An Environmental Protection Agency (EPA) publication entitled “Protection of Public Water Supplies from Ground-Water Contamination” provides the following:

All water beneath the land surface is referred to as *underground water* (or subsurface water). The equivalent term for water on the land surface is *surface water.* As figure 1 shows, underground water occurs in two different zones.

3.03.01 Unsaturated Zone

The unsaturated zone is immediately below the land surface in most areas, contains both water and air.

3.03.02 Saturated Zone

The saturated zone is usually below the unsaturated zone in which all interconnected openings are full of water. Water in the saturated zone is the only underground water available to supply wells and springs and is the only water to which the name *groundwater* is correctly applied. Recharge of the saturated zone occurs by percolation of water from the land surface through the unsaturated zone. The unsaturated zone is, therefore, of great importance to groundwater hydrology. This zone may be divided usefully into three parts: the soil zone, the intermediate zone, and the upper part of the capillary fringe.

The water table is the level in the saturated zone at which the hydraulic pressure is equal to atmospheric pressure and is represented by the water level in an unused well completed in an unconfined aquifer.

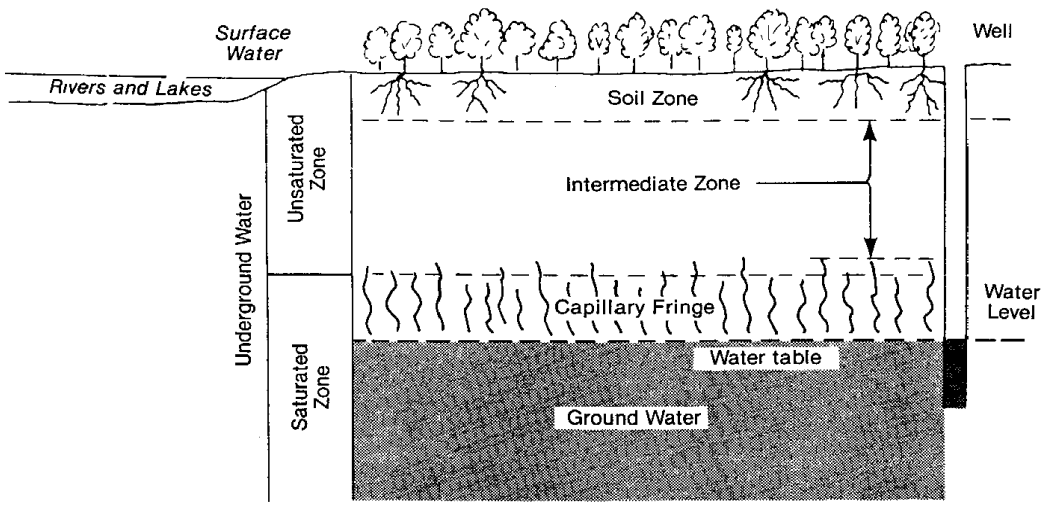


Figure 1: Underground Water Zones

3.04 What is an aquifer?

An aquifer is a geologic material sufficiently permeable to store, transmit and yield water in usable quantities to a well. Two main types of aquifers are the

(a) Unconfined aquifer which is the permeable material only partly filled with water and overlying a relatively impervious layer where

  (i) the upper boundary is the water table,
  (ii) all pores below the water table are filled with water, and
  (iii) and the non-pumping water level in a well completed in an unconfined aquifer represents the water table.

(b) Confined Aquifer which is a permeable material completely saturated with water and

  (i) whose upper and lower boundaries exhibit a considerably lower permeability than the aquifer itself, and
  (ii) the pressure of the water is usually higher than the atmosphere and the water in the well will rise above the top of the aquifer.

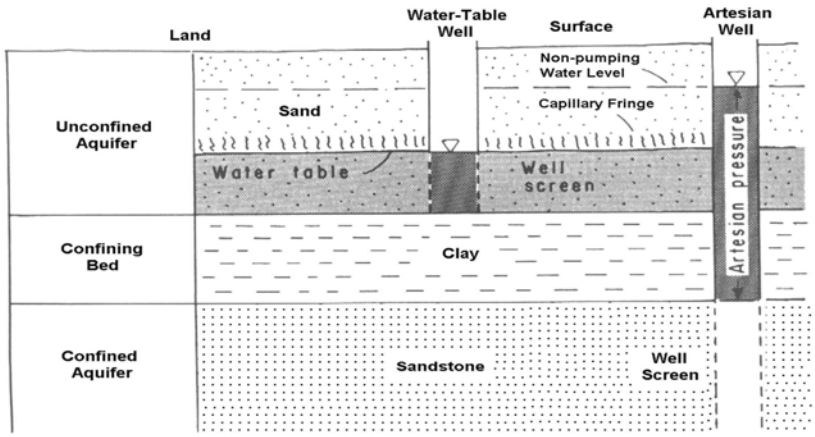


Figure 2: Unconfined and Confined Aquifers

It is recognized and should not be ignored, that leaking from the layer overlying an aquifer may occur because there is no material truly impervious. As a result, semi-confined aquifers also exist.

Determining whether an aquifer is confined or unconfined is sometimes difficult. The following questions should be considered:

(a) What if the aquifer in the beginning is confined (i.e. the non-pumping water level is above the top of the aquifer) and perhaps due to over-pumping (or over-use of the aquifer), the current non-pumping level is now below the top of the aquifer. In this case can the "then" confined aquifer be treated now as an unconfined aquifer? Or is "dewatering" taking place in the confined aquifer?

(b) If an aquifer has the water level at or below the top of the aquifer unit, does it mean there is no groundwater available because there is no available head?

(c) Is it damaging to lower the water level of an aquifer, occurring below a confined layer, but has a static water level already below the top of the aquifer? Should unconfined analyses apply?

(d) If an aquifer is confined at the water well location, but unconfined several kilometers away, is it considered confined or unconfined?

3.05 Where is groundwater located in Alberta?

The distribution of groundwater in Alberta is directly related to the geology and the occurrence of high permeability deposits. Groundwater availability therefore varies from one location to the next and **may or may not** be present in the quantities desired at any one location.

3.05.01 Consolidated aquifers:

Groundwater prospects from consolidated (bedrock) aquifers vary throughout the province such as:

(a) In northwest and north-central Alberta, groundwater is found in the Peace River sandstone and in the relatively thin sandstone beds of the Wapiti and Horseshoe Canyon Formations,

(b) (i) In northeast Alberta such as the Fort McMurray area, usable quantities of groundwater occur in the sandstone units of the Grand Rapids Formation.
(ii) Further south the uppermost bedrock is the Lea Park shale and can, in most instances, be disregarded as a source of supply because of its low yield and poor quality.

(c) (i) In east-central Alberta (Mundare, Two Hills, Lloydminster and Wainwright areas), groundwater conditions are somewhat better than those to the west and further north.
(ii) Sandstone units of the Belly River Formation are shown to be capable of providing groundwater in amounts suitable for agricultural, municipal and industrial purposes.
(i) Further south, groundwater information for the equivalent strata indicates the aquifers units generally produce limited quantities of poor quality groundwater, however, groundwater investigations established greater yields are possible in some localities.

(d) In west-central Alberta, the Paskapoo Formation is the most widespread and most important bedrock aquifer, and. groundwater conditions in this area are significantly better than in areas to the north and east, and

(e) (i) In south Alberta, the Milk River sandstone is the most prolific bedrock aquifer.
(ii) Sandstone units belonging to the Porcupine Hills and St. Mary Formations are also important sources of groundwater in this area of the province.

Consolidated aquifers can be either confined or unconfined aquifers.

3.05.02 Unconsolidated aquifers:

Groundwater is also found in the unconsolidated deposits overlying bedrock. Unconsolidated glacial, alluvial, lacustrine or aeolian sediments overly the consolidated bedrock deposits in most areas of Alberta, with the exception of the Rocky Mountains, portions of the Rocky Mountain Foothills and areas where deeply incised river valleys exposed the bedrock.

Large supplies of groundwater were developed from sand and/or gravel units found within buried valleys. The extensive network of buried valleys in Alberta represents the pre-glacial alluvial drainage system, now in-filled with pre-glacial alluvial sediments and Pleistocene glacial deposits. The lower aquifer units within the Helina and Sinclair Buried Valleys are an important source of groundwater for

the heavy oil industry in the Cold Lake area. Similar buried valleys provide large-scale groundwater supplies in other parts of the province.

Sand and/or gravel units found within the glacial overburden deposits may also provide a source of groundwater. Groundwater supplies from these aquifer units are generally limited due to their thickness and areal extent. In areas where these deposits are laterally extensive and relatively thick, such as the Grimshaw Gravels, there are possibilities of providing adequate water supplies except during extended periods of drought. Large diameter water wells may be capable of supplying small, individual households, volumes of groundwater from shallow glacial till or lacustrine deposits with relatively poor aquifer potential.

Unconsolidated aquifers usually are considered as unconfined aquifers.

3.06 What information is available on Groundwater?

Alberta Environment	**Other Government Agencies**
(Head Office, Regional Offices, District Offices)	ARC Earth Sciences Reports
Water well records	ARC Groundwater Reconnaissance Reports,
Chemical analyses	Cross-Sections & Maps (Bedrock, Drift, Soil & Yield)
Flowing Shot Hole reports	ARC Bulletins
Geophysical logs	ARC Open File Reports
Coal logs	ARC Memoirs
Piezometer records	Alberta Geologic Survey Reports
Observation well hydrographs (private & public)	Energy Utilities Board
	Alberta Energy
GIC Bibliography, Reports	Alberta Agricultural Reports
WRA/WA Licensing Reports including pumping test data & Interpretations	Irrigation Reports
	Environment Canada Reports
Annual Water Use Returns	PFRA Reports
Field-Verified Surveys	Scientific & Technical Papers
Environmental Impact Assessment Reports	County or Municipal water supply evaluation reports
County Maps (Historical & current)	
Water Management Plans	
Water supply evaluation reports	

Other Information Sites	
Country/Village/Town Offices	AENV Library
Offices of Consulting Engineers and Hydrogeologists	Other Department Libraries
University Libraries	Databases
Internet	

Schedule 1

Table Showing Length of Pumping Test and Information Required for the Anticipated Maximum Water Diversion/Drainage

Anticipated Daily Pumping Rate	Number of Days	Anticipated Maximum Yearly Water Requirement	Length of Pumping & Recovery test at Anticipated Maximum Pumping Rate	Observation/ Monitoring Site	Information Required Under 1.02 & 1.03 of Part 1
up to 10 m^3/day (2200 lgpd) (1.5 lgpm)	365	3650 m^3 (803,000 lg)	2 + 2 hours* (or longer) and at least 90% recovery	0	(a) (b)(i) (b)(ii) (b)(iii) (A) to (K) (b)(vii) (b)(ix)
10 to 35 m^3/d (2200 to 7700 lgpd) (1.5 to 5.3 lgpm)	applicant to enter	applicant to enter	24 + 24 hours (or longer) and at least 90% recovery	0 – 1	all of 2.0
35 to 65 m^3/d (7700 to 14,300 lgpd) (5.3 to 10.0 lgpm)	applicant to enter	applicant to enter	24 + 24 hours (or longer) and at least 90% recovery	1	all of 2.0
65 to 265 m^3/d 14,300 to 60,500 lgpd) (10.0 to 40.0 lgpm)	applicant to enter	applicant to enter	48 + 48 hours (or longer) and at least 90% recovery	1 – 2	all of 2.0
greater than 265 m^3/d	applicant to enter	applicant to enter	72 + 72 hours (or longer) and at least 90% recovery	1 – 2	all of 2.0

* In some cases, more information or longer pumping tests may be required.

Legend:
d = day
g = gallons
I = Imperial
m = minute
m^3 = cubic metre = 220 Imperial gallons

Notes:

- The reliability of the estimate on water supply will generally increase with the length of the pumping period and as the geological and hydrogeological conditions in the area become more clearly defined and understood. Therefore a longer pumping test is recommended.
- Household wells, and other types of water wells, could be considered potential monitoring sites.

Schedule 2

Guide to Calculate Quantities of Water for Raising Animals

Double click anywhere in the table to activate the Excel automatic calculations, enter the number of animals and press the tab key.

If required, change the "No. of Gallons" according to your needs after activating the table.

Water Used For		No. of Animals		No. of Gallons*		Quantity per Day (gallons)		No. of Days		Total Gallons per Year
Dairy	Milking Cows		x	30.0	=		x		=	
	Dry cows, replacements		x	10.0	=		x		=	
	Calves (up to 550 lbs)		x	3.0	=		x		=	
Beef	Cow/calf pairs		x	12.0	=		x		=	
	Calves (up to 550 lbs)		x	3.0	=		x		=	
Beef	Feeders (550 - 900 lbs)		x	6.0	=		x		=	
	(900 - 1250 lbs)		x	9.0	=		x		=	
Hogs	Sows (farrow to finish)		x	20.0	=		x		=	
	Sows (farrow to wean: 50 lbs)		x	6.5	=		x		=	
	Feeders (50 - 250 lbs)		x	1.5	=		x		=	
	Weaner (15 - 50 lbs)		x	0.5	=		x		=	
Chickens	Broilers/roasters		x	0.035	=		x		=	
	Layers/Breeders		x	0.055	=		x		=	
Turkeys			x	0.150	=		x		=	
Sheep/Goats	Milking ewes/does		x	3.0	=		x		=	
	Ewes/does		x	2.0	=		x		=	
	Feeders lambs		x	1.5	=		x		=	
Horses, Bison, Mules			x	10.0	=		x		=	
Elk, Donkeys			x	5.0	=		x		=	
Deer, Llamas, Alpacas			x	2.0	=		x		=	
Ostriches			x	1.0	=		x		=	
Other (specify):			x		=		x		=	
Pesticide Application							x		=	

*** NOTE: Quantities shown are averages only.**

TOTAL AMOUNT PER YEAR: _____

Schedule 3

Example Table for Field-Verified Survey

page 1 of ____

Parameters	Water Source #1	Water Source #2	Water Source #3	Water Source #4
owner/lessee name				
legal land location				
surface elevation				
type of water source				
water source status				
well depth				
pump intake depth				
depth to top of aquifer				
amount of available head				
maximum pumping rate				
well completion details				
distance from proposed water diversion or drainage site				
original non-pumping level & date				
current non-pumping level				
estimated daily use				
summary of historical chemical analyses				

Appendix "A"

Date: March 27, 1990 No. 209

Subject: GROUND WATER ALLOCATION
FOR OILFIELD INJECTION ANNOUNCED

Environment Minister, Honourable Ralph Klein, today announced the implementation of a policy on Ground Water Allocation for Oilfield Injection Purposes. The policy demonstrates a commitment to the principles of conservation and multi-purpose use of this valuable water resource.

"With continued economic development and population growth, there is an escalating demand on ground water for domestic, municipal, agricultural and industrial use," said Mr. Klein. "The policy addresses concerns about the increased demand for ground water by competing interests."

The new policy was prepared by Alberta Environment with input from various rural, agricultural and industrial groups. A variety of safeguards built into the new policy includes limitations on quantity withdrawals, time limit restrictions, monitoring being available to public scrutiny and the necessity for considering non-water, surface water and non-potable ground water alternatives.

Mr. Klein said the policy will substantially reduce the conflict over the use of potable ground water for oilfield injection in agricultural areas. The minister adds that the policy will allow the province to allocate some potable water for oilfield injection purposes.

"Management of this vital resource will prevent its overuse and waste and resolve potential conflicts between users," said Mr. Klein.

The Advisory Committee who reviewed and support this policy includes representation from the Alberta Water Resources Commission, the Office of the Farmer's Advocate, Alberta Agriculture, the Alberta Association of Municipal Districts and Counties, the Alberta Cattle Commission, the Energy Resources Conservation Board, the Canadian Petroleum Association, the Independent Petroleum Association of Canada, the Alberta Chamber of Resources and the Alberta Water Well Drilling Association.

fact sheet

Alberta
ENVIRONMENT

GROUND WATER ALLOCATION POLICY FOR OILFIELD INJECTION PURPOSES

PURPOSE

To manage the ground water resources of the Province of Alberta in such a manner as to provide continuing protection to the existing and future domestic, municipal, agricultural and industrial water users while maintaining the important principle of multi-purpose use of water.

QUANTITY LIMITATION

An applicant who proposes to use potable ground water for oilfield injection purposes will be restricted to a maximum of one half of the long term yield of a given aquifer in the immediate vicinity of the water source well. This will be enforced by limiting drawdown, as measured 150 metres from the water source well, to 35% during the first year of operation and no more than 50% over the life of the project. In addition, the monitoring stations must be available for inspection by designated local officials and affected parties to ensure that the community has immediate and accurate information on the aquifer performance.

TIME LIMIT RESTRICTION

All initial approvals will be limited to a one year time period. The first five year extension will be issued only if the aquifer is performing in accordance with the terms and conditions of approval and thus without unreasonable negative impact on other wells in the community. Future annual extensions will automatically be granted for five year time periods if the required conditions are met and no applications which exceed the remaining available aquifer capacity have been received from the surround community.

SURFACE WATER, NON-POTABLE GROUND WATER AND NON-WATER ALTERNATIVES

It is understood that an appropriate level of investigation into the use of surface water, non-potable ground water and non-water alternatives will be carried out by the applicant, prior to the submission of an application to develop a potable ground water source for oilfield injection purposes.

AREA OF APPLICABILITY OF THE POLICY

This policy will apply only to the agricultural (white zone) areas of the province.

AUTHORIZATION PROCEDURES

As is the past, terms and conditions designed to protect existing ground water supplies and aquifers will be attached to exploration permits or water use permits issued under the Water Resources Act, as deemed necessary on a site specific basis.

ADMINISTRATIVE POLICY ON WATER DIVERSIONS FROM WELLS

LOCATED IN RESTRICTED WATER BASINS

With the exception of diversions of water for the remediation of contaminated water, all proposed projects for developing water wells in major water basins where restrictions are in place will proceed as follows and in accordance with the appendices:

1. When an exploration permit or a licence application is received, it will be reviewed as a potential hydraulic connection to a surface-water body.

2. An exploration permit, outlining the testing requirements in support of a licence application, will be issued. Also, this permit will address the possibility of a hydraulic connection. The applicant will be asked to determine the component of water that may be produced from the surface-water body.

3. Placement of a public notice(s) for the proposed diversion and approval application process will be deferred until the evaluation of the report. If the report shows evidence of a hydraulic connection:

   - in a basin where limited diversion is allowed, the public notice(s) will contain parameters and restrictions applicable to that basin, or

   - in a basin where surface-water diversion is not allowed, the application for licence will be returned to the proponent or will be held in abeyance if the possibility exists for lifting the restriction; and,

   - subsequent approvals shall be subject to applicable restrictions.

4. There will be consultation between surface and ground water staff at all stages of the process; or,

5. If the works are not located in a restricted diversion area and if the works are proposed for completion in sand and gravel deposits adjacent to a surface-water body, the "Policy on Water Diversions from Sands and Gravels Adjacent to a Water Body, and From Springs" dated November 16, 1995 (Appendix II) will prevail.

November 4, 1997
Dated at Edmonton

_____
Controller of Water Resources

POLICY ON WATER DIVERSIONS FROM SANDS AND GRAVELS

ADJACENT TO A WATER BODY, AND FROM SPRINGS

1. (1) All projects in sand & gravel deposits adjacent to a water body (river, stream, lake, etc.) will be evaluated according to procedures for licensing and approval of surface water works and diversions.

(2) The Groundwater Evaluation Guideline should be utilized only:

(a) where the applicant proves no hydraulic connection between the sand and gravel deposits and the water body;

Note: In this case supporting information in accordance with this guideline should be provided with an application. Applicants should contact Department staff who process groundwater applications.

and,

(b) where effects on local ground water users may be significant.

Note: In this case, appropriate evaluation in accordance with the Groundwater Evaluation Guideline will be needed as well as evaluation of surface water issues. Applicants should contact Department staff who process surface water applications.

2. (1) All applications for diversion from springs will be evaluated using procedures for evaluation of surface water issues.

(2) Evaluation in accordance with the Groundwater Evaluation Guideline will be needed for development of a spring where the development will increase the groundwater flow rate.

Note: In this case supporting information in accordance with this guideline should be provided with an application. Applicants should contact Department staff who process groundwater applications.

3. Consultation among staff is encouraged at any stage of the process.

Issued 1995 11 16

Revised 2003 02 05

A P P E N D I X

Water Resources Act

SOUTH SASKATCHEWAN BASIN WATER ALLOCATION REGULATION

Table of Contents

Definitions

1 In this Regulation,

(a) "existing" means in existence on January 1990;

(b) "licence" includes an interim licence;

(c) "South Saskatchewan River Basin" means the land drained the by reach of the South Saskatchewan River and its tributaries, including the Red Deer River, the Bow River, the Oldman River and their tributaries;

(d) "South Saskatchewan River Sub-basin means the land drained by the reach of the South Sasktachewan River between the confluence of the Bow and Oldman Rivers and the Alberta-Saskatchewan boundary.

Reservation

2 All water in the South Saskatchewan River Basin that is not the subject of an existing licence or other authorization is reserved pursuant to section 12 of the *Water Resources Act*.

Authority to allocate reserved water

3 Water reserved under section 2 may be allocated in accordance with this Regulation

Existing irrigation districts

4(1) The total amount of water allocated for irrigation purposes from the river basins listed below to each named irrigation district under

(a) licences issued in accordance with the Regulation, and

(b) existing licences or other authorizations

must not exceed the amount sufficient for the irrigation of the total area of land specified for the irrigation district:

River Basin	Total Area of Land
Bow River Basin	
Western Irrigation District	95 000 acres
Bow River Irrigation District	210 000 acres
Eastern Irrigation District	275 000 acres;
Oldman River Basin	
St. Mary River Irrigation District	372 000 acres
Magrath Irrigation District	18 300 acres
Raymond Irrigation District	46 500 acres
Taber Irrigation District	82 200 acres
Lethbridge Northern Irrigation District	167 000 acres
United Irrigation District	34 000 acres
Mountain View Irrigation District	3700 acres
Leavitt Irrigation District	4770 acres
Aetna Irrigation District	3530 acres;
South Saskatchewan River Sub-basin	
Ross Creek Irrigation District	1200 acres.

(2) The total amount of water, in acre-feet, that is sufficient for the irrigation of the area given in subsection (1) for an irrigation district shall be determined by the Controller of Water Resources in accordance with the following criteria:

(a) water required at the farms;

(b) canal losses within the district;

(c) evaporation for district reservoirs;

(d) water flows returning to rivers.

(3) A determination under subsection (2) fixes the maximum volume of water that an irrigation district may divert and use under licence, but nothing in this section limits the number of acres in an irrigation district that may be irrigated with that water through improved efficiencies of water management and operation with the district.

Other irrigation

5(1) The total amount of water allocated for irrigation purposes from the Red Deer River Basin under

(a) licences issued in accordance with this Regulation, and

(b) existing licences

must not exceed an amount sufficient for the irrigation of 97 000 acres and, of the amount made available for allocation by this Regulation, an amount sufficient for the irrigation of 25 000 acres shall be available only for the Special Areas Water Supply Project,

(2) The total amount of water allocated for irrigation purposes from the Bow River Basin to land other than land in existing irrigation districts under

(a) licences issued in accordance with this Regulation, and

(b) existing licences

must not exceed an amount sufficient for the irrigation of 95 000 acres and, of the amount made available for allocation by this Regulation, amounts sufficient for the irrigation of the following areas shall be available only for the named projects:

15 000 acres	Blackfoot Indian Reserve Projects
20 000 acres	Little Bow/Clear Lake Project
10 000 acres	Keho/Barons Project. *(north)*

(3) The total amount of water allocated for irrigation purposes from the Oldman River Basin to land other than land in existing irrigation districts under

(a) licences issued in accordance with this Regulation, and

(b) existing licences

must not exceed an amount sufficient for the irrigation of 152 000 acres and, of the amount made available for allocation by this Regulation, amounts sufficient for the irrigation of the following areas shall be available only for the names projects:

25 000 acres	Blood Indian Reserve Project
15 000 acres	Peigan Indian Reserve Projects
10 000 acres	Keho/Barons Project *(south)*
6 000 acres	Western Oldman Area Projects
15 000 acres	Oldman River Reservoir Area Projects
13 000 acres	Willow Creek Projects

(4) The total amount of water allocated for irrigation purposes from the South Saskatchewan River Sub-basin to land other than land in existing irrigation districts under

(a) licences issued in accordance with this Regulation, and

(b) existing licences

must not exceed an amount sufficient for the irrigation of 52 000 acres

(5) The projects referred to in this section are the projects described in the Schedule.

Other purposes

6 Water may be allocated for

(a) domestic purposes,

(b) municipal purposes,

(c) agricultural purposes, other than irrigation

(d) industrial purposes,

(e) water power purposes,

(f) other like purposes, and

(g) purposes specified in section 11(1)(b) and (d) of the *Water Resources Act*.

Instream flows

7(1) Any licence issued in accordance with this Regulation may contain conditions limiting the amount of water that may be diverted and used when necessary to maintain minimum instream flows.

(2) The minimum instream flow for each of the following rivers is:

Waterton River	80 cubic feet per second measured above its confluence with the Belly River;
Belly River	33 cubic feet per second measured above its confluence with the Waterton River and above its confluence with the Oldman River;
St. Mary River	97 cubic feet per second measured above its confluence with the Oldman River.

Application of Regulation

8 This Regulation applies to existing applications and subsequent applications.

Prior reservations cancelled

9 *Orders in Council numbered O.C. 1038/33 and O.C. 546/49 are rescinded.*
6-91/07/22

SCHEDULE

1 "Special Areas Water Supply Project" means diversions from all or any of

(a) the proposed Nevis diversion pipeline and canal from the Red Deer River,

(b) Barry Creek upstream of Carolside Reservoir,

(c) Sounding Creek upstream of Highway 12,

(d) Blood Indian Creek, East Berry Creek, Monitor Creek, Nestor Creek and Spondin Creek,

(e) Craig Lake and its inlet and outlet channels,

(f) Contracosta Lake and its inlet and outlet channels, and

(g) reservoirs and lakes supplied by the above mentioned creeks including Bloor Lake, Oldman Lake, Antelope Lake, Sounding Creek Reservoir, Grassy Island Lake, McBride Reservoir, Bartman Reservoir, Cessford Reservoir, Blood Indian Reservoir and the proposed Oyen and Monitor Reservoirs

for irrigation of land within the Special Areas.

2 "Blackfoot Indian Reserve Projects" means diversions from the Bow River or Carseland-Bow River Headworks System, or both, for irrigation of land within the Blackfoot Indian Reserve.

3 "Little Bow/Clear Lake Project" means diversions from all or any of

(a) the Little Bow River between the proposed Little Bow River Reservoir and Travers Reservoir

(b) the proposed Little Bow River Reservoir, and

(c) Clear Lake

for irrigation of land within the County of Vulcan and the Municipal District of Willow Creek.

4 "Keho/Barons Project" means diversions from all or any of

(a) the Little Bow River between the proposed Little Bow River Reservoir and Travers Reservoir,

(b) the Oldman River at a point on the Peigan Indian Reserve (N½ 31-08-27-W4),

(c) the Lethbridge Northern Headworks System, and

(d) the Lethbridge Northern Irrigation District

for irrigation of land in the vicinity of the Villages of Carmangay and Barons

5 "Blood Indian Reserve Project" means diversions from all or any of

(a) the Belly River,

(b) the St. Mary River, and

(c) the Waterton-St. Mary Headworks System

for irrigation of land within the Blood Indian Reserve.

6 "Peigan Indian Reserve Projects" means diversions from the Oldman River for irrigation of land within the Peigan Indian Reserve.

7 "Western Oldman Area Projects" means diversions from the Oldman River between the eastern boundary of the Peigan Indian Reserve and the confluence with the Belly River for irrigation of land within the County of Lethbridge and the Municipal District of Willow Creek.

8 "Oldman River Reservoir Area Projects" means diversions from all or any of

(a) the Oldman River Reservoir,

(b) the Oldman River upstream of the western boundary of the Peigan Indian Reserve, and

(c) the Castle and Crowsnest Rivers

for irrigation of land within the Municipal District of Pincher Creek, the Municipality of Crowsnest Pass and Improvement District 6.

9 "Willow Creek Projects" means diversions from the proposed Pine Coulee Reservoir or Willow Creek downstream of the outlet from the proposed Pine Coulee Reservoir, or both, for irrigation of land within the Municipal District of Willow Creek.

ALBERTA ENVIRONMENT
COLD LAKE-BEAVER RIVER
LONG TERM
WATER MANAGEMENT PLAN

Introduction

Environment Minister Hon. Fred Bradley announced adoption of a long-term plan for water resources management in the Cold Lake region in October 1985.

The long-term water management plan applies to the surface and groundwater resources in the Cold Lake and lower Beaver River basins. The lower Beaver River basin includes the following sub-basins: Marie Creek, Jackfish Creek and Reita Creek. Implementation of the plan is expected to provide and adequate quantity and quality of water to meet the long-term domestic, municipal, industrial, agricultural, recreation, fisheries and wildlife requirements in the basins.

The water management plan is based on long-term industrial water supply to oil sands plants in the region by a privately owned and operated pipeline from the North Saskatchewan River. It replaces the short-term plan adopted in 1983, which met the withdrawal demands of users from local surface and groundwater sources.

Major Oil Sands Water Supply

1. **When the consumptive use limits of the short-term plan are reached, and by 1991 at the latest, all major oil sands plant withdrawals (greater than 500 dam^3/ year) will be net from outside the Cold Lake and Lower Beaver River Basins from surface water supplied by a single source pipeline from the North Saskatchewan River.**

During the water management study, three long-term water supply alternatives were evaluated: use of local sources, a reservoir on the Sand River and a pipeline importing water from outside the basin. On the basis of a technical evaluation and public review, the pipeline from the North Saskatchewan River was selected by the Alberta Government as the long-term source for the water requirements of oil sand plants.

In situ oil sands projects involve three stages of development: the initial testing and evaluation stage, the pilot plant or commercial development stage and the full commercial production stage. A decision on the viability of commercial production from the oil sands reservoir is usually not made until after the initial testing and evaluation stage. The water needs for this stage are usually small in quantity (less than 500 dam3/year) and short-term in duration. To avoid expenditures on supply works which may be costly and subsequently abandoned, oil sands users will not be required to convert to the pipeline until a decision is made to proceed to commercial development and water requirements exceed 500 dam3/year.
Individual water needs of phases or plants that are developed as part of one overall project will be combined in enforcing the 500 dam3/year limit for conversion to the pipeline.

The short-term water management plan, adopted in March 1983, set out consumptive withdrawal limits for local surface water and groundwater sources. Based on the water requirements of projects, either approved or proposed at the time of adoption of this plan, and assuming no significant changes in recovery technology, local shortages necessitating implementation of a long-term supply are currently anticipated to occur as early as 1988 and by 1991 at the latest.

2. The North Saskatchewan River Pipeline will be a closed system. No surface discharge of water to natural water bodies will be allowed.

The water management study concluded that measures should be taken to prevent the transfer of fish species and organisms by the pipeline into the Beaver River surface waters. The study found fish species, disease-producing agents and parasites in the North Saskatchewan River system that have not been detected to date in the Beaver River system. Although these species and organisms may in fact be present in the Beaver River, the consequence of transferring them is unknown at this time. As a result, the possibility of transfer through a pipeline break, storage reservoir seepage or oil sands plant wastewater discharge was examined. The study concluded that the risk of transfer was extremely remote if the water passed directly from the North Saskatchewan River by a pipeline and surface storage reservoir system to the steam injection facilities.

3. Industry is expected to jointly fund, own and operate the pipeline system in accordance with existing provincial statutes and regulations. Alberta Environment will ensure that the form of pipeline ownership and operation selected by oil sands water users meets the long-term needs of all users and is consistent with the intent of the long-term water management plan through approvals for the pipeline and/or individual water allocations under the Water Resources Act.

It is not the intent of Alberta Environment to direct industry on selection of and ownership and operation option or how the selected option should be implemented. Nevertheless, consistent with its mandate to manage the province's water resources, Alberta Environment has an interest in ensuring that the selected option will meet the long-term water management plan. In addition, Alberta Environment has as interest in ensuring that the fresh water allocations to individual users are appropriate, given their total water requirements and recycle ability.

4. All oil sands users with withdrawals from local surface water and groundwater sources in excess of 500 dam3 /year at the time of completion of the pipelines must discontinue these withdrawals within 1 year, except where a longer period is expressly set out in the conditions of an existing authorization, and convert the entire source of supply to the North Saskatchewan River pipeline. Users reaching the 500 dam3 /year limit after the pipeline is operational must convert their entire supply at the time they exceed the limit.

Consistent with the publicly reviewed concepts of long-term supply via the pipeline, oil sands industrial users with withdrawals greater than 500 dam3 /year will be given a maximum of one year from time of completion of the pipeline, to discontinue use from their local surface water or groundwater source. The one year period will not apply to existing projects for that portion of water supply which has been allocated with conditions in the authorization clearly allowing a longer period to convert to the pipeline.

New oil sands water users will users will be expected to make necessary arrangements with the pipeline owner/operator to meet all of their water needs from the pipeline once requirements exceed 500 dam^3 /year.

Municipal, Agricultural, Industrial and Minor Oil Sands Water Supply

5. All municipal, agricultural, non-oil sands industrial and minor oil sands industrial withdrawals are expected to be met from within the Cold Lake and Lower Beaver River Basins using local surface water and groundwater sources as follows:

(A) Surface water withdrawals will be limited to the Beaver River and the following lakes with maximum net depletion use from each as indicated:

	Maximum Available Net Depletion (dam^3 /year)	
Lake	**Natural Outlet**	**Controlled Outlet**
Cold	20,000	Not Applicable
Wolf	850	6,300
Moose	Not Applicable	3,000
Burnt	250	1,000
Angling	190	900
Caribou	4,500	6,300
Ethel	Not Applicable	700
Marie	425	1,200

River	**Amount**
Beaver	2,000

[1] Available withdrawal will be less if other withdrawals are taken from the Marie Creek System.
[2] Annual available withdrawal will be subject to a monthly limit required to maintain preferred instream flows for fisheries, wildlife, recreation and water quality.

(B) Surface water withdrawals may be allowed from other lakes subject to detailed studies to demonstrate that preferred lake levels and downstream flows will be maintained.

(C) Continuous groundwater withdrawals from the surficial aquifers, bedrock channel aquifers and bedrock aquifer will be allowed on a site specific basis within a maximum use limit.

(D) Groundwater and /or surface water withdrawals will be allowed on a site specific basis to supply a contingency or temporary demand by using such measures as storage and conjunctive use of surface water and groundwater.

The water management study determined the net depletions that are permissible from individual lakes while maintaining acceptable downstream flows and lake levels for fisheries, wildlife and recreation. The net depletions for controlled outlets are the amounts available provided a control structure is constructed at the lake outlet in accordance with the design criteria established during the study.

Exploration and analysis of groundwater data has shown that substantially more groundwater than the 4000 dam3 /year amount established in the short-term plan can be safely withdrawn from the bedrock channel aquifers. Additional amounts of groundwater are available from surficial aquifers and bedrock aquifers. A detailed groundwater analysis will be undertaken to establish withdrawal limits. Withdrawals will be permitted on a site specific basis within these limits.

6. Authorization for withdrawals from lakes will specify lake levels at which industrial withdrawals will be reduced or suspended.

The water management study determined the lake elevations at which lake withdrawals should be reduced or suspended to ensure that lake levels and downstream flow requirements for domestic and municipal use, fisheries, wildlife and recreation are not violated. These elevations are included in the appendix for several of the eight lakes designated for withdrawals. The remainder of the lakes have limited recorded data on surface levels. The levels for these lakes will be specified at the time of an application for withdrawal so that additional hydrologic information collected between the date of this study and the date of application can be analyzed in order to refine the minimum lake level criteria. The resumption of withdrawals would be allowed once the lake levels have risen above the minimum level.

The water management study determined that up to a 30 percent reduction in withdrawals for approximately 15 weeks and up to 100 percent suspension in withdrawals for approximately six weeks may be required in order to maintain lake levels and downstream flows during drought periods. The amount and duration of the reductions will increase as the total withdrawal amounts increase toward the maximum allowable.

Water Supply - General

7. Alberta Environment will maintain management control of all new and existing multipurpose lake outlet control works, either through direct ownership or strictly enforced permit/conditional licence conditions.

Outlet control structures will be required at the lakes designated for withdrawals if proposed withdrawals are greater than the natural outlet limits. In these cases the withdrawal water user may be required to undertake and fund land acquisition and structure construction, in accordance with design criteria and specifications provided by Alberta Environment. However, the control of structures to regulate water levels and flows cannot rest with individual withdrawal water users where other users (fisheries, wildlife and recreation) depend on specified lake levels and downstream flows being maintained. As a result, Alberta Environment will either assume direct ownership and maintenance of the structure or will require the withdrawal water user to maintain the structure through strictly enforced permit/conditional licence conditions. In either case, the withdrawal water user may be required to modify or remove the structure and reclaim the structure site when the source of supply is converted to pipeline.

8. Approvals for oil sands withdrawals from local sources will be on a permit/conditional licence basis for a fixed duration and with an annual review to allow for adjustment in permit/conditional licence conditions if other water users are adversely affected or to ensure conversion to the North Saskatchewan River Pipeline

Approvals for oil sands water withdrawals from local sources will be on a temporary basis with regular review. This approval procedure will allow for adjustment in permit/conditional licence conditions in the event that lake level or stream flow criteria are not being met or in the case of groundwater level decline restrictions. It will also ensure conversion of the source of water supply to North Saskatchewan River pipeline when the withdrawal by oil sands users exceeds 500 dam^3/ year and the pipeline is operative.

Water Quality

9. No surface discharge of in situ oil sands recovery or upgrading process wastewater will be allowed in the basin: these industrial waste effluents will be disposed to deep wells or treated and reused.

The Prairie Provinces Water Board (PPWB) has developed water quality guidelines for the Beaver River. Although the guidelines have not been finalized and formally adopted by the PPWB, Alberta, as a member of the Board, is working towards their adoptions. The guidelines allow for only a small variation from the average existing concentrations for most parameters. As a result, effluent discharges would be quite small and would have to be strictly controlled to ensure the guidelines were met. In recognition of public concerns about oil sands surface discharges and Alberta's commitment to meet the proposed guidelines, no surface discharge of wastewater from either the in situ recovery process or the upgrading process will be allowed.

10. Alberta Environment will undertake detailed studies in order to establish the future limits on deep well disposal and to ensure that future industrial wastewater volumes disposed by deep well injection do not exceed these limits.

Wastewaters from the in situ recovery process are currently disposed by injection into deep wells. Approvals for deep well disposal are based on submission of adequate technical information to demonstrate that the receiving formation has sufficient capacity to accept the wastes and that there in no danger of possible migration to, contamination of , potable groundwater and surface waters. Public concern has been expressed about the future cumulative impact of deep well disposal as injection rates increase with the growth in the oil sands projects in the area. Alberta Environment is currently funding studies through the Alberta Research Council to examine these future cumulative impacts and to determine limits on disposal rates and volumes. In the event the limits established are restrictive, Alberta Environment will require industry to undertake measures, such as reduction in waste discharges through recycle, to ensure these limits are not exceeded. The need for additional monitoring of deep well disposal will be evaluated following the current studies being undertaken by the Research Council.

11. Alberta Environment will continue to monitor water quality on the Beaver River in order to assess the impact of waste discharges on water quality and will work with the municipalities to ensure that wastewater discharges do not exceed allowable loadings established by the PPWB water quality guidelines.

Natural dissolved oxygen concentrations are extremely low in the Beaver River in the winter. these levels, and concentrations of other water quality variables, may be adversely affected by increased waste discharges from municipalities, land use changes, etc. unless measures are taken to improve waste treatment or reduce the discharge as growth takes place in the basin.

General

12. No withdrawals will be allowed from May, Manatokan, Muriel, Reita and Tucker Lakes. These lakes will be managed for the purposes of conservation, fisheries, wildlife or recreation.

The water management study has determined that, because of fisheries, wildlife or recreation importance and their sensitivity to any water level or flow manipulations, the above noted lakes should

not be considered for withdrawals. Emergency withdrawals may be allowed if it can be demonstrated that no other water sources are available.

13. Approvals for oil sands plants will require operators to maximize recycle of water.

Water is recovered with bitumen in the steam injection recovery process. Recycle of this water reduces the wastewater the wastewater volumes disposed by deep well and reduces the raw water requirements. The experience of some companies indicates that a recycling standard of 100% reuse of the recovered water is feasible. It is recognized that the achievable rate may vary with location and oil sands formation depending upon the quantity and quality of the recovered water. It is also recognized that some phasing in of the recycle capacity may be required as operating experience, technical knowledge and plant size increase. In situ oil sands plants will be required to maximize recycle within these constraints.

14. Industrial and agricultural (irrigation) water users will be encouraged to use municipal or other effluent to reduce consumption on fresh water and to reduce the amount of effluent being discharged into the Beaver River system. Oil sands users will not be required to switch their source of supply to the North Saskatchewan River pipeline if they can meet their needs from effluent.

Water quality studies completed to date indicate that as population levels increase municipal waste loadings to the Beaver River may require additional treatment in order to meet Alberta's surface water quality objectives and the Prairie Provinces Water Board interim water quality guidelines for the Beaver River. Use of effluent by industry or for irrigation will reduce both consumption of fresh water and the waste loading to the Beaver River. Oil sands plants using effluent may be allowed a minor withdrawal (less than 500 dam3 /year) in addition to the use of effluent if it will assist in meeting water needs provided that efficient use is being made of the effluent.

15. Alberta Environment will ensure that a comprehensive groundwater, streamflow and lake level monitoring program is maintained for those ground and surface water sources affected by water withdrawals.

Groundwater levels, lake levels and streamflow must be closely monitored to ensure that level and flow criteria are being met and other water users are not being adversely affected. Any withdrawals by industry from local sources, whether interim until the long term plan is in place or a minor withdrawal allowed after construction of the pipeline, will be accompanied by a comprehensive monitoring program.

Appendix

Minimum lake elevations at which industrial withdrawals will be reduced or suspended

Lake	Elevation (ASL)
Cold	534.55
Ethel	540.60
Moose	532.60
Wolf	597.20