

# AQUIFER USE AND MAINTENANCE

10 YEARS OF HISTORY



# FORWARD-LOOKING STATEMENT



Certain statements in this presentation constitute “forward-looking statements” or “forward-looking information”. All of the forward-looking statements in this presentation are qualified by the assumptions that are stated or inherent in such forward-looking statements. Although Nexen believes these assumptions are reasonable, the reader should not place an undue reliance on these assumptions and such forward-looking statements.

The forward-looking statements are subject to known and unknown risks and uncertainties and other factors that may cause actual results, levels of activity and achievements to differ materially from those expressed or implied by such statements. Except as required by law, Nexen undertakes no obligation to update publicly or revise any forward-looking statements, whether as a result of new information, future events or otherwise. The forward-looking statements contained herein are expressly qualified by this cautionary statement. Readers should also refer to the risk factors and uncertainties contained in our 2012 Annual Information Form and to the quantitative disclosures about market risk and our forward-looking statements contained in our 2012 Management Discussion and Analysis available at [www.nexeninc.com](http://www.nexeninc.com) or [www.sedar.com](http://www.sedar.com), or in CNOOC Limited’s Annual Report on Form 20-F, which is available at [www.cnooc ltd.com](http://www.cnooc ltd.com) or [www.sec.gov](http://www.sec.gov).

Any reserves estimates in this disclosure were prepared February 2013 with an effective date of December 31, 2012. The estimates of reserves and future net revenue have been prepared by an internal qualified reserves evaluator in accordance with National Instrument 51-101 Standards of Disclosure for Oil and Gas Activities (“NI 51-101”) and the Canadian Oil and Gas Evaluation Handbook (“COGE Handbook”). Nexen’s estimates of reserves are prepared in accordance with SEC requirements and are attached to our 2012 Annual Information Form.

All financial information contained within this presentation is in Canadian dollars unless noted otherwise.

Nexen Energy ULC is a wholly-owned subsidiary of CNOOC Limited, which is listed on the NYSE, the Stock Exchange of Hong Kong and the TSX. Information regarding CNOOC Limited is available at [www.cnooc ltd.com](http://www.cnooc ltd.com).

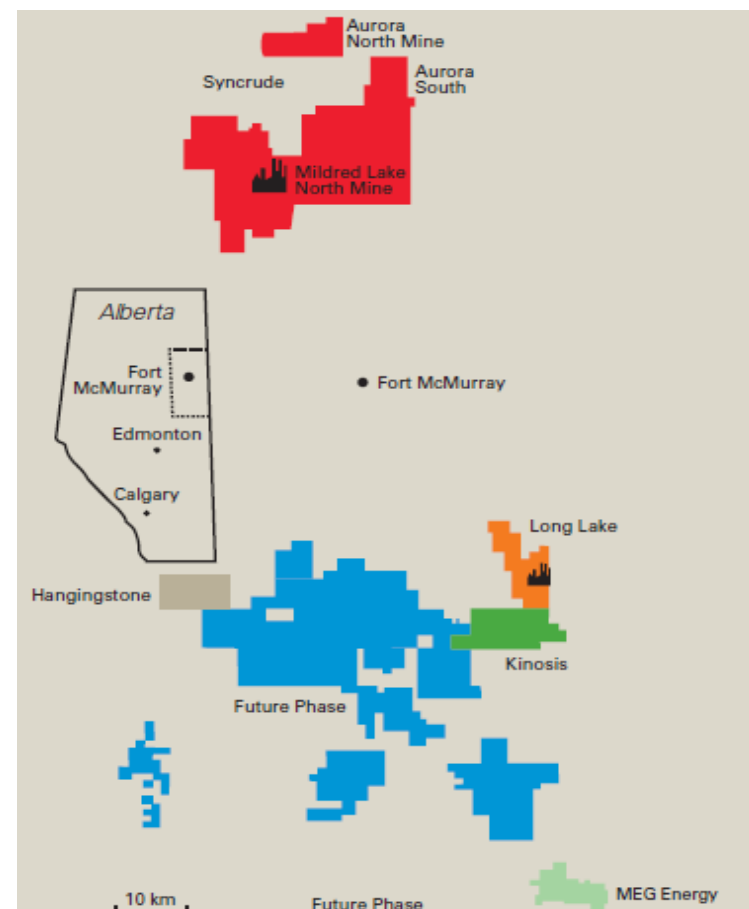
# CNOOC LIMITED: GLOBAL ASSETS



# NEXEN OIL SANDS



- Nexen holds billions of barrels of contingent recoverable oil sands resource, including:
  - Long Lake
  - Kinosis
  - Syncrude Canada – 7.23% WI
  - Hangingstone – 25% WI
  - Other projects
- Expected to produce decades of steady production, cash flow & value
- On behalf of CNOOC Limited, Nexen provides strategic oversight for an equity interest of 12.39 % in MEG Energy



- Long Lake Acreage ■ Kinosis Acreage ■ Hangingstone
- Future Phase Acreage ■ Upgrader ■ MEG Energy
- Syncrude

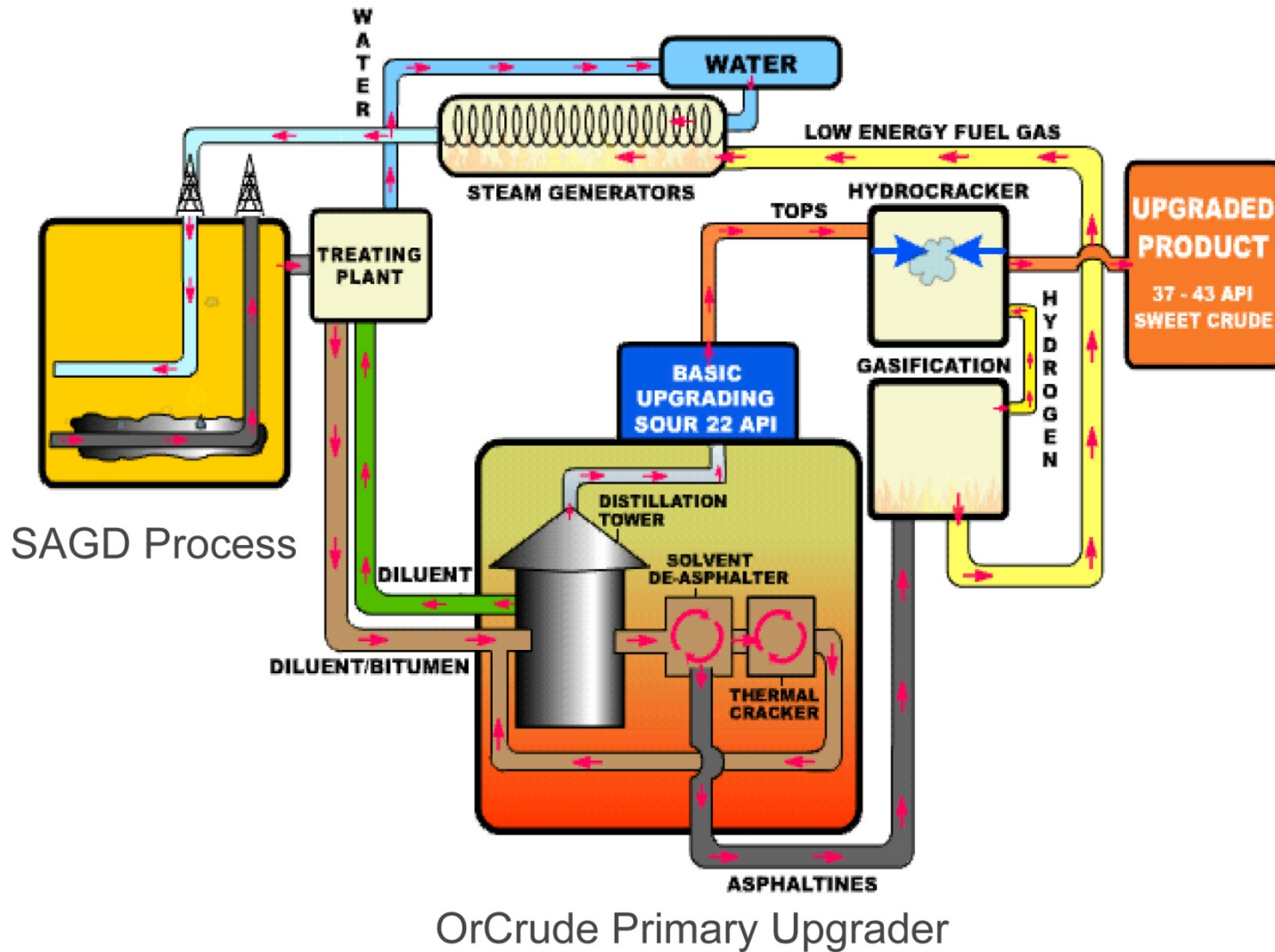
\*For information about our oil sands resource estimates, see our November 15, 2010 news release, available at [www.nexeninc.com](http://www.nexeninc.com) or [www.sedar.com](http://www.sedar.com)

# LONG LAKE

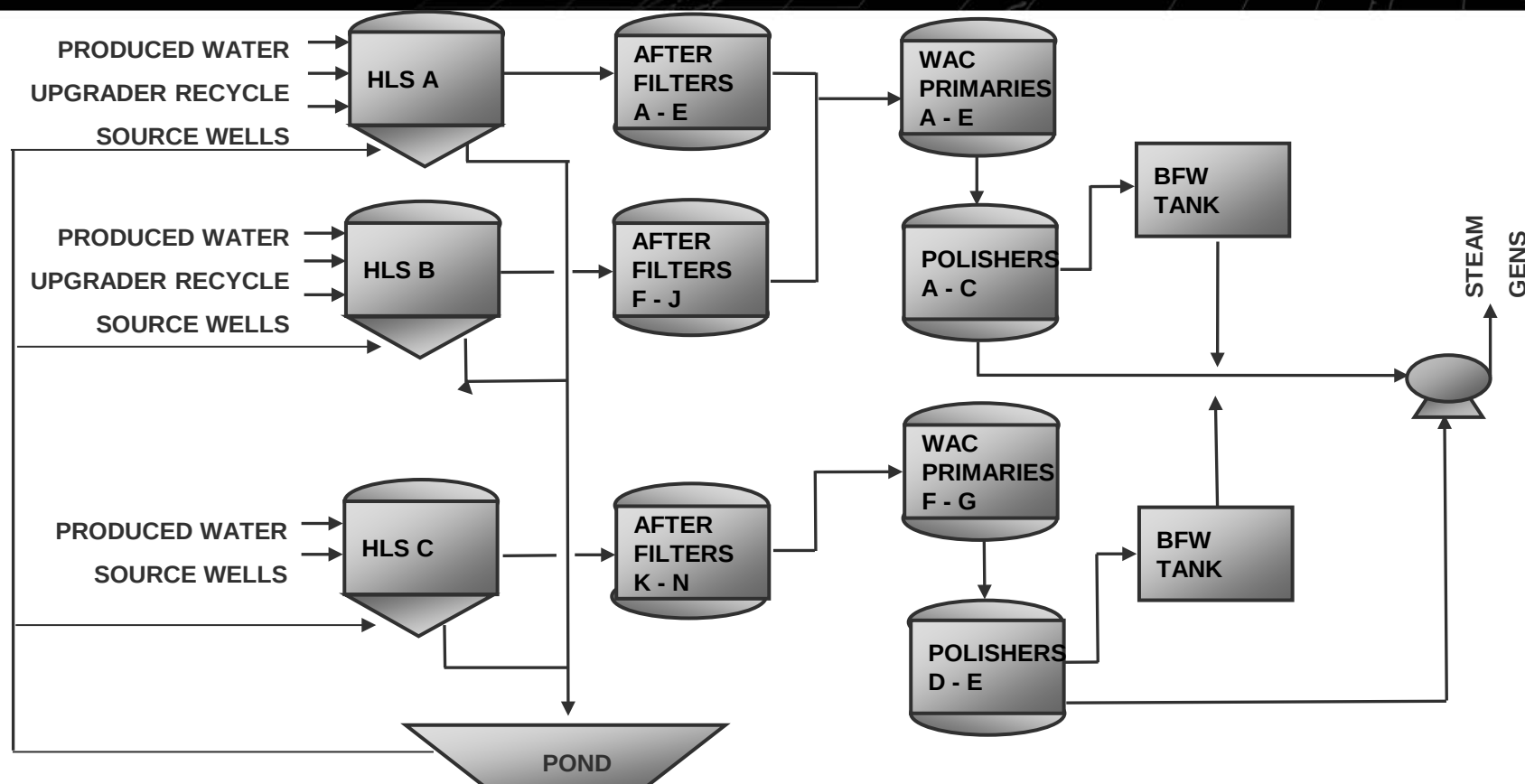
- In-situ oil sands extraction project 40 km south east of Fort McMurray
- Uses steam assisted gravity drainage and integrated upgrading on site
- OrCrude technology and hydrocracking/gasification used to produce Premium Synthetic Crude (PSC™)
- Pilot (Pad 1) from March 2003 to August 2006
- Commercial production of bitumen in 2008, first PSC™ production in 2009



# LONG LAKE – UNIQUE PROCESS



# PRODUCED WATER TREATMENT

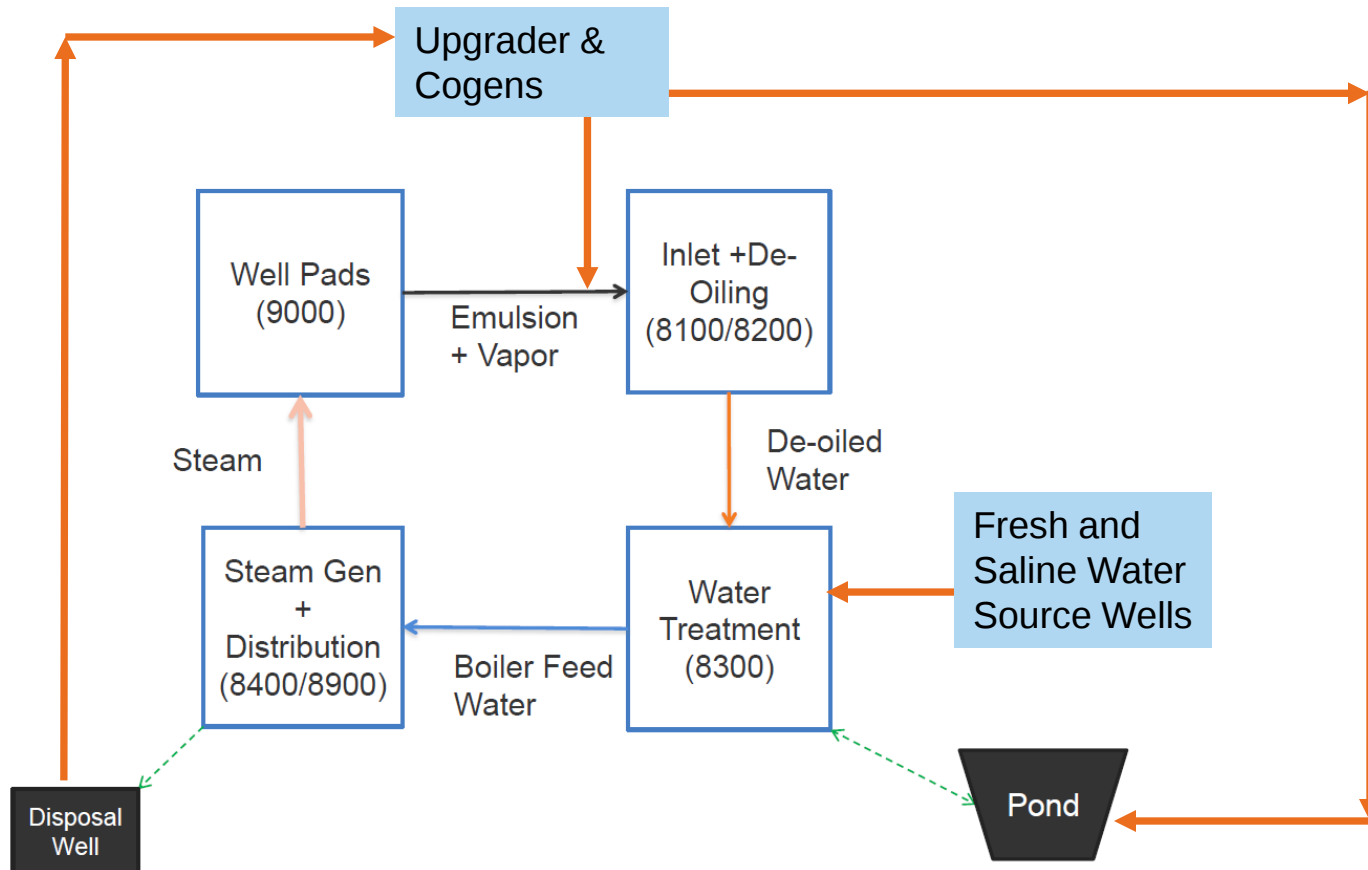


## Water Usage

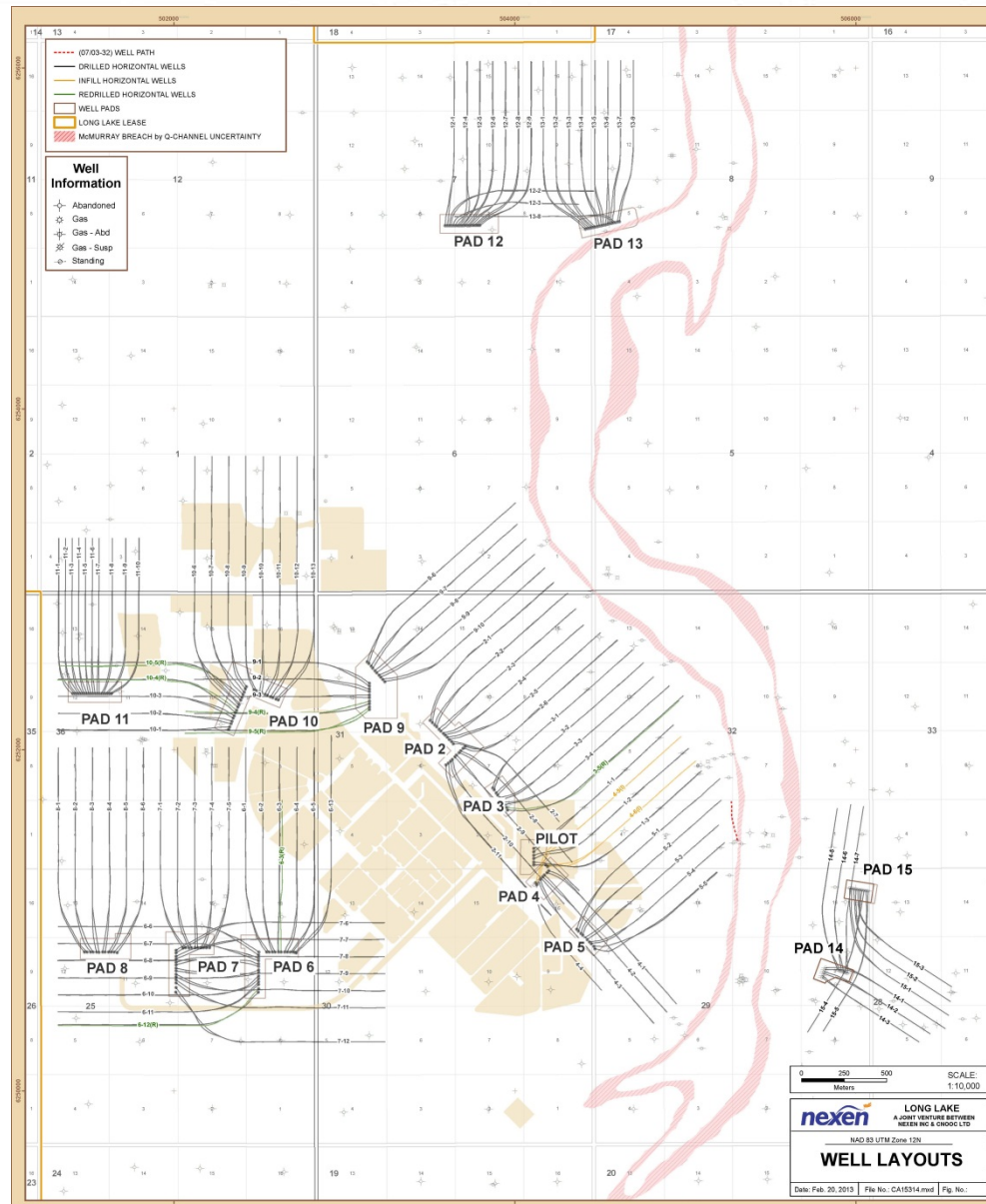
Groundwater and pond water makeup to Hot Lime Softeners

Reduced losses (near zero in 2013) in the reservoir have led to low use of brackish water (273 m<sup>3</sup>/day) and low recycle rate

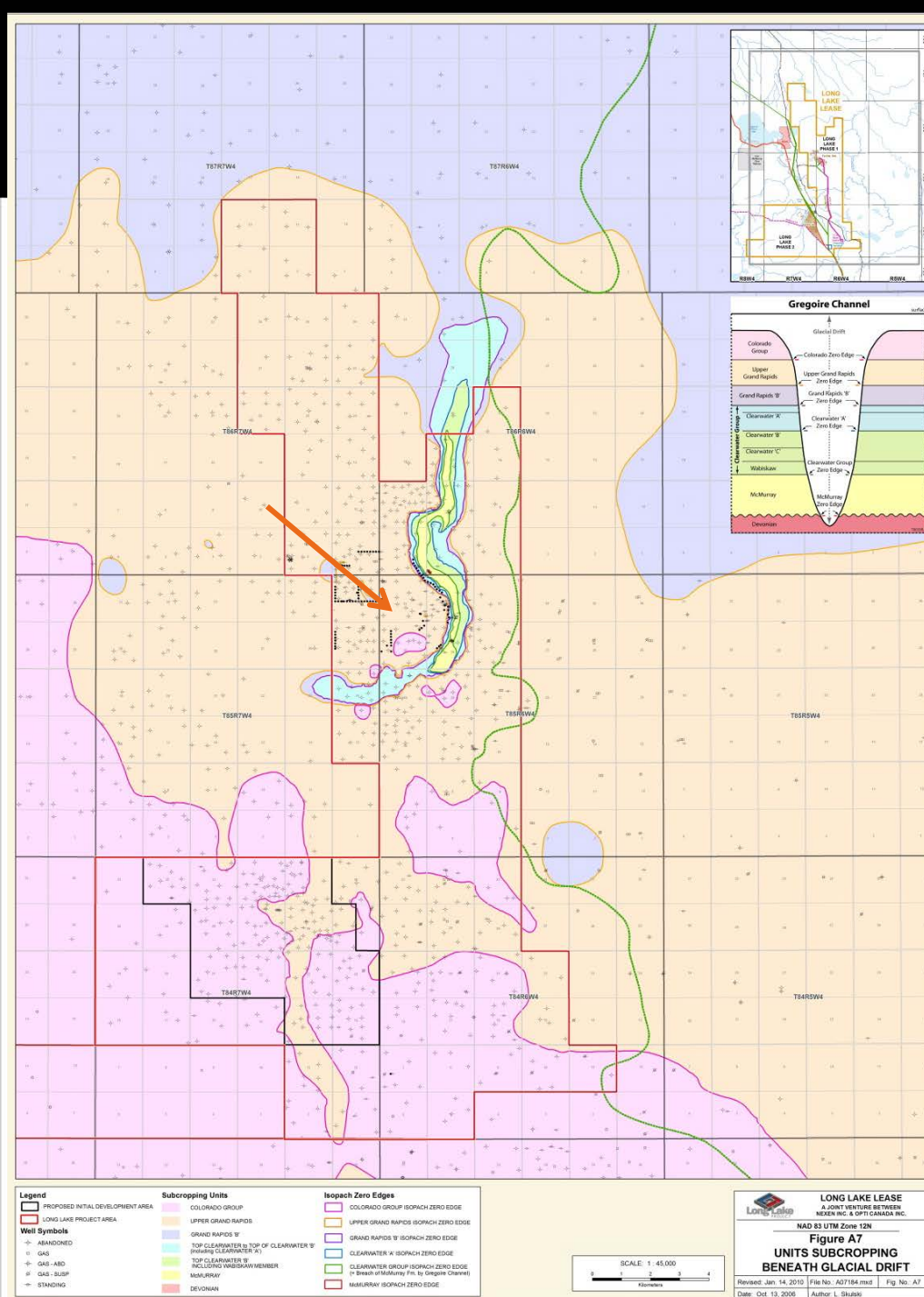
# PROCESS OVERVIEW



# LONG LAKE SAGD WELLS AND CENTRAL PROCESSING FACILITY



## Local geology and hydrostratigraphy

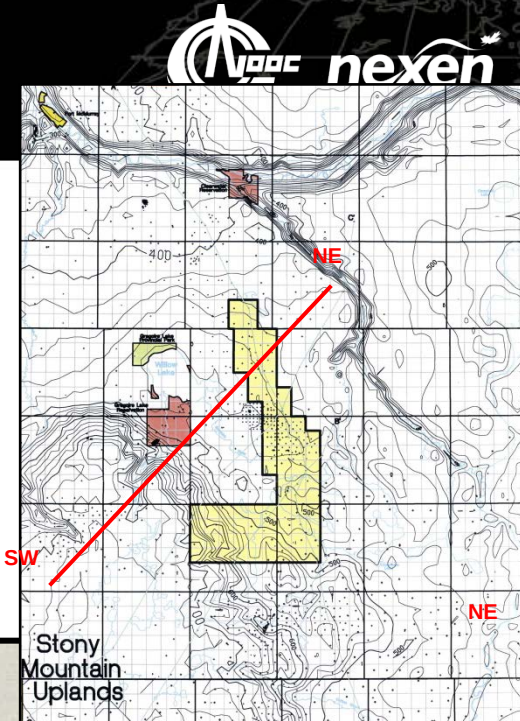
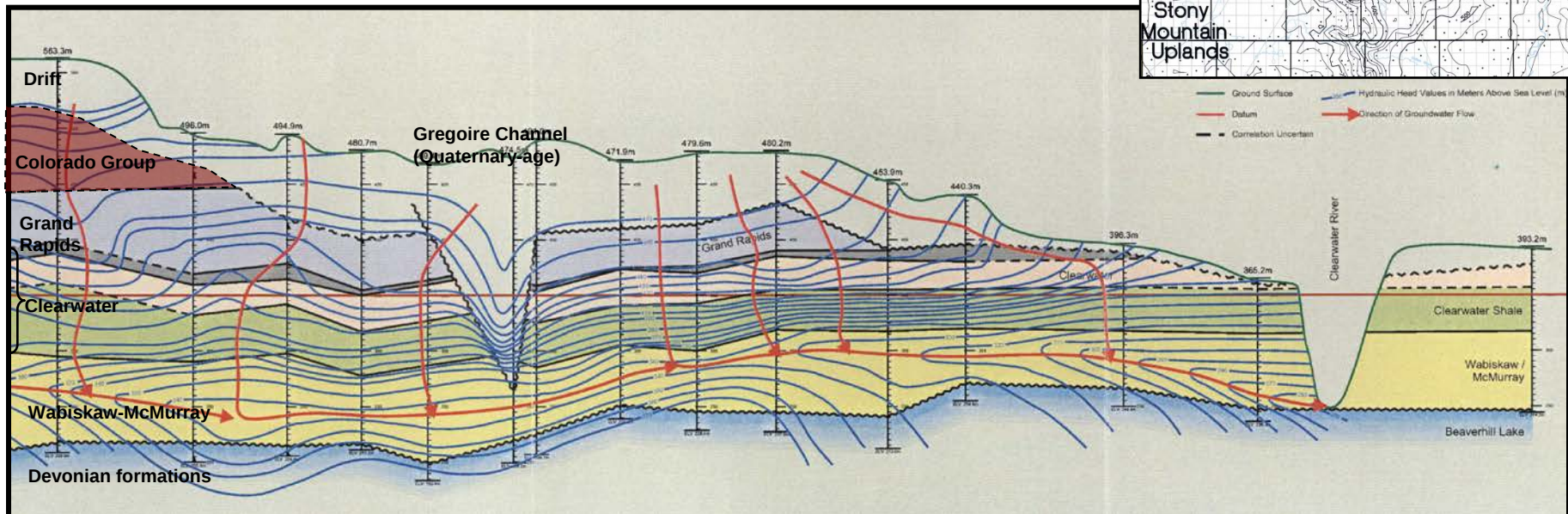


| ERA       | PERIOD     | EPOCH | GROUP     | FORMATION                                                                              | LOCAL HYDROSTRATIGRAPHIC UNIT                                          |
|-----------|------------|-------|-----------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| CENOZOIC  | QUATERNARY |       |           | GRAND CENTRE<br>MARIE CREEK<br>ETHEL LAKE<br>BONNYVILLE                                | UPPER TILL AQUITARD<br>UNDIFFERENTIATED OVERBURDEN<br>AQUIFER/AQUITARD |
|           |            |       |           | EMPRESS UNIT 3                                                                         |                                                                        |
|           |            |       |           |                                                                                        |                                                                        |
|           |            |       |           |                                                                                        |                                                                        |
| MESOZOIC  | CRETACEOUS | U     | COLORADO  | LaBICHE<br>1st WHITE SPECKLED SHALE<br>2nd WHITE SPECKLED SHALE<br>BASE OF FISH SCALES | GREGOIRE CHANNEL AQUIFER<br>COLORADO GROUP AQUITARD                    |
|           |            |       |           | VIKING                                                                                 |                                                                        |
|           |            |       |           | JOLI FOU                                                                               |                                                                        |
|           |            | L     | MANNVILLE | UPPER GRAND RAPIDS                                                                     | UPPER GRAND RAPIDS AQUIFER/AQUITARD                                    |
|           |            |       |           | GRAND RAPIDS B SAND                                                                    | LOWER GRAND RAPIDS AQUIFER                                             |
|           |            |       |           | CLEARWATER A                                                                           | CLEARWATER AQUITARD                                                    |
|           |            |       |           | CLEARWATER B SAND                                                                      | CLEARWATER B AQUIFER                                                   |
|           |            |       |           | CLEARWATER B                                                                           |                                                                        |
|           |            |       |           | CLEARWATER C                                                                           | CLEARWATER CAP ROCK AQUITARD                                           |
|           |            |       |           | WABISKAW MEMBER                                                                        | WABISKAW AQUIFER                                                       |
|           |            |       |           |                                                                                        | McMURRAY BITUMEN/SHALE AQUITARD                                        |
|           |            |       |           | McMURRAY                                                                               | McMURRAY AQUIFER                                                       |
| PALEOZOIC | DEVONIAN   | U     | WOODBEND  | GROSMONT<br>CAMROSE<br>IRETON<br>LEDUC                                                 | NOT PRESENT IN STUDY AREA                                              |
|           |            |       |           | COOKING LAKE                                                                           | BEAVERHILL LAKE AQUIFER / AQUITARD                                     |
|           |            |       |           | WATER WAYS                                                                             |                                                                        |
|           |            |       |           | SLAVE POINT                                                                            |                                                                        |
|           |            | M     | ELK POINT | FORT VERMILION                                                                         | WATT MOUNTAIN AQUITARD                                                 |
|           |            |       |           | WATT MOUNTAIN                                                                          |                                                                        |
|           |            |       |           | PRAIRIE EVAPORITE                                                                      | PRAIRIE AQUICLUDE                                                      |
|           |            |       |           |                                                                                        | KEG RIVER AQUIFER                                                      |
|           |            |       |           |                                                                                        |                                                                        |
|           |            |       |           | KEG RIVER / WINNIPEGOSIS                                                               |                                                                        |

# SUB-REGIONAL FLOW

1. Topographically-driven system from hills to rivers
2. Groundwater flows:
  - > vertically in aquitards (low k units)
  - > laterally in aquifers
3. 'Slow' system:
  - > vertical recharge = low 10s of mm/year (a few % of annual precipitation)
  - > velocities in aquifers = a few to low 10s of m/year
4. Bedrock units are (severely) sub-hydrostatic
  - > McMurray pressures are commonly 1000-1500 kPa sub-hydrostatic
  - > Slow recharge combined with great horizontal k and deeply incised rivers

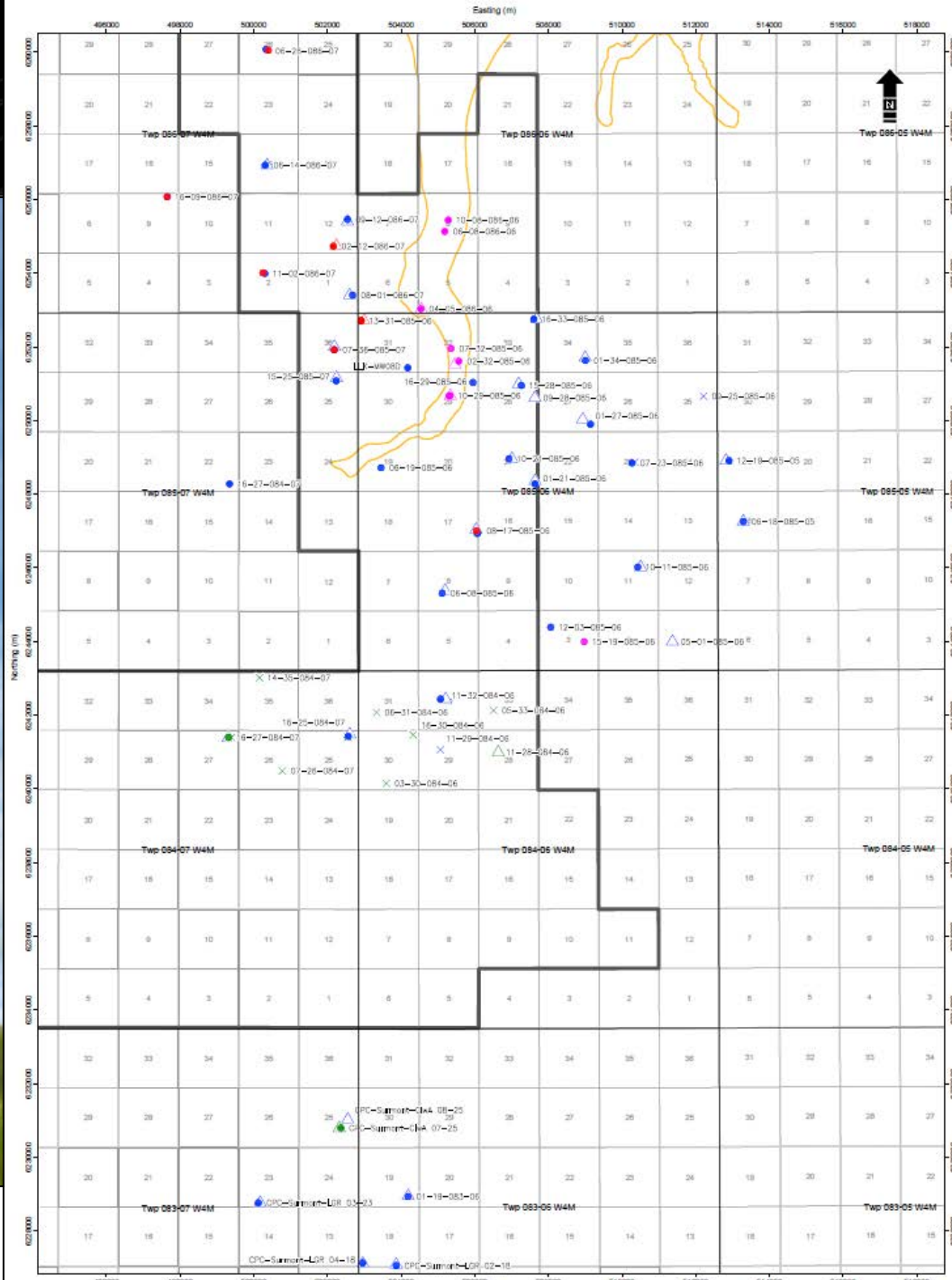
SW



Adapted from Rakhit 2002

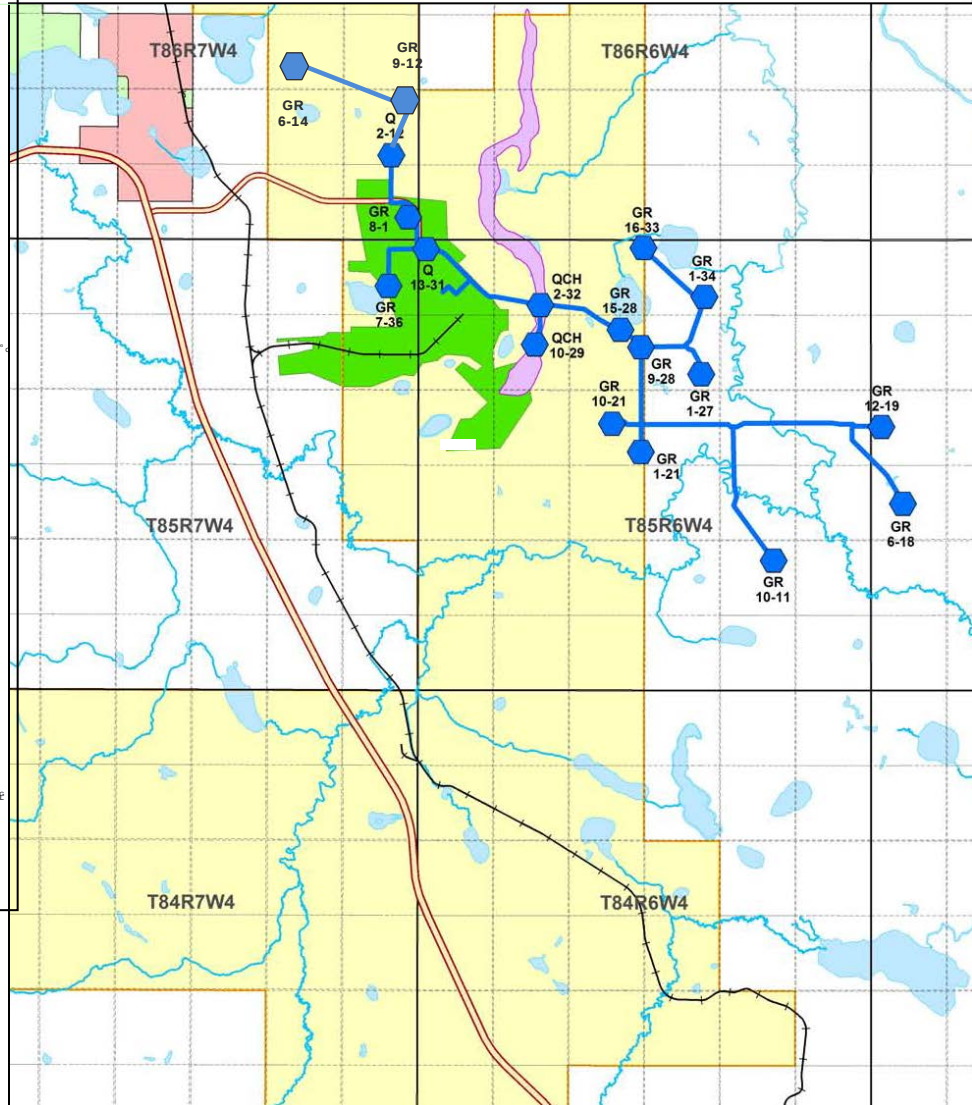
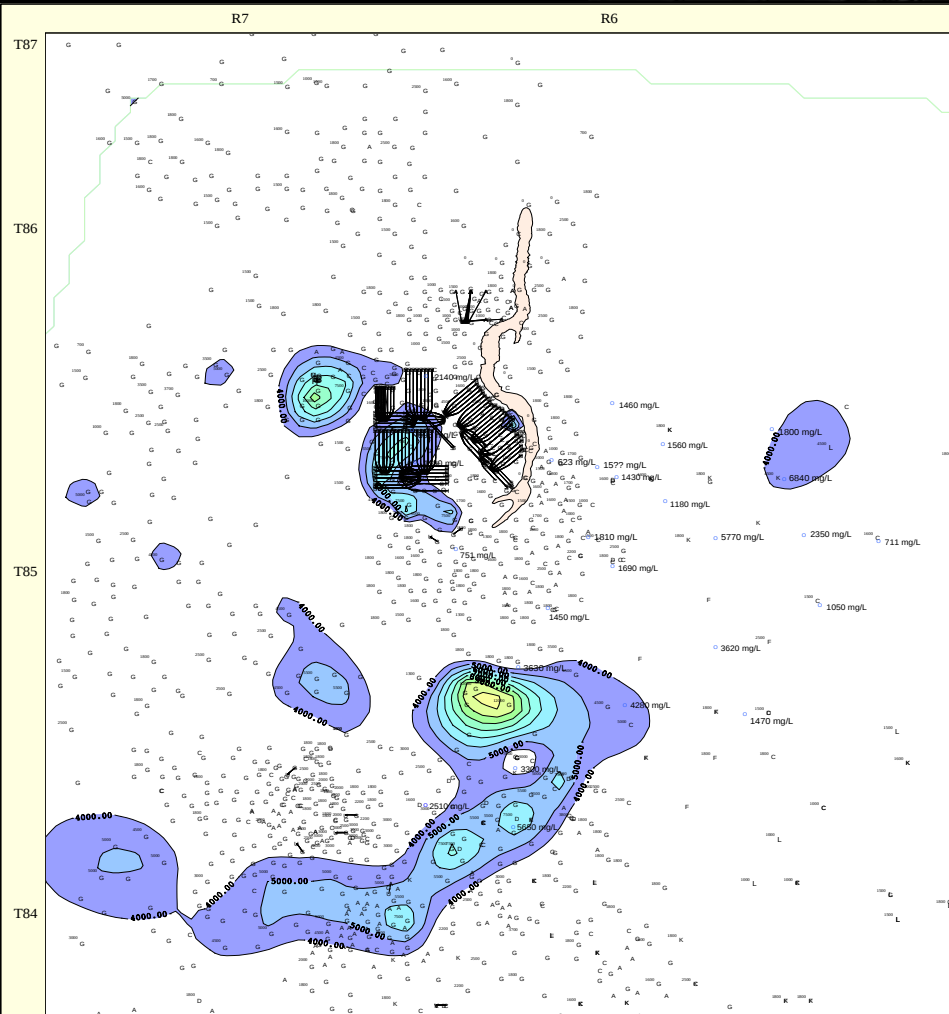
# GROUNDWATER MONITORING NETWORK

- Water source and monitoring wells in various aquifers:
  - Quaternary sediments
  - Gregoire Channel
  - Grand Rapids B
  - Clearwater A
  - McMurray



Map Reference:  
 2013 Annual Groundwater Use Report: Quaternary, Grand Rapids and Clearwater Source Wells,  
 Long Lake Project (Water Act Licence No. 00235895-01-00)  
 Matrix Solutions Inc., March 2014

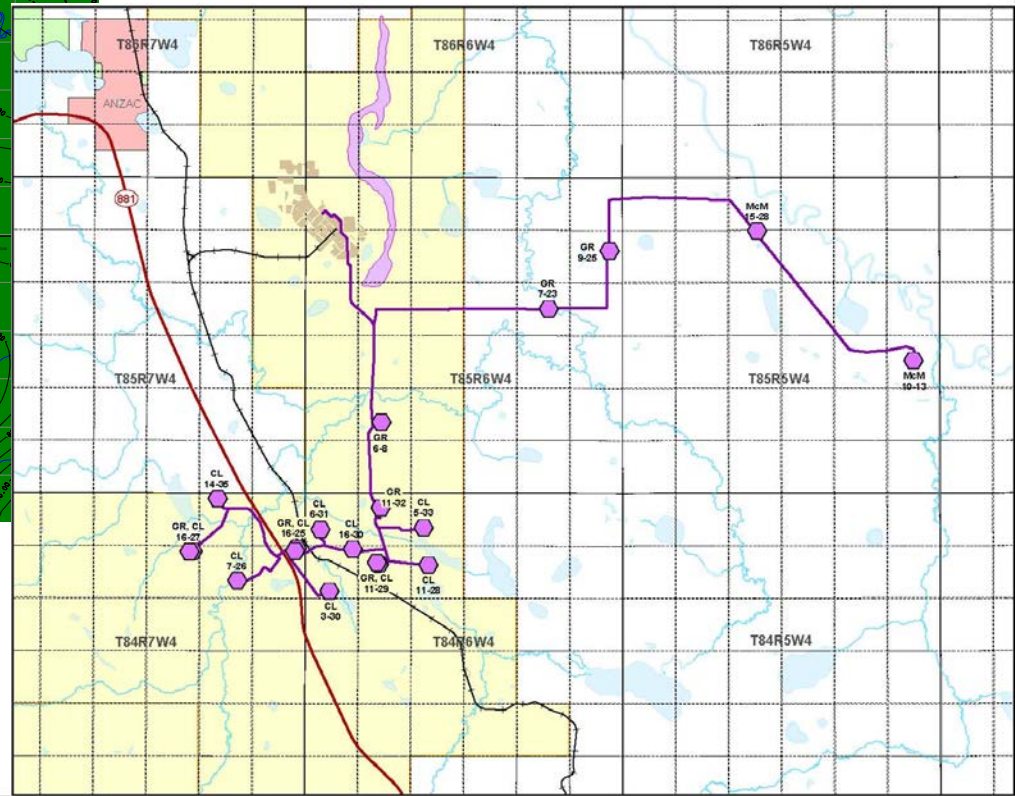
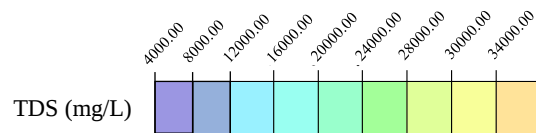
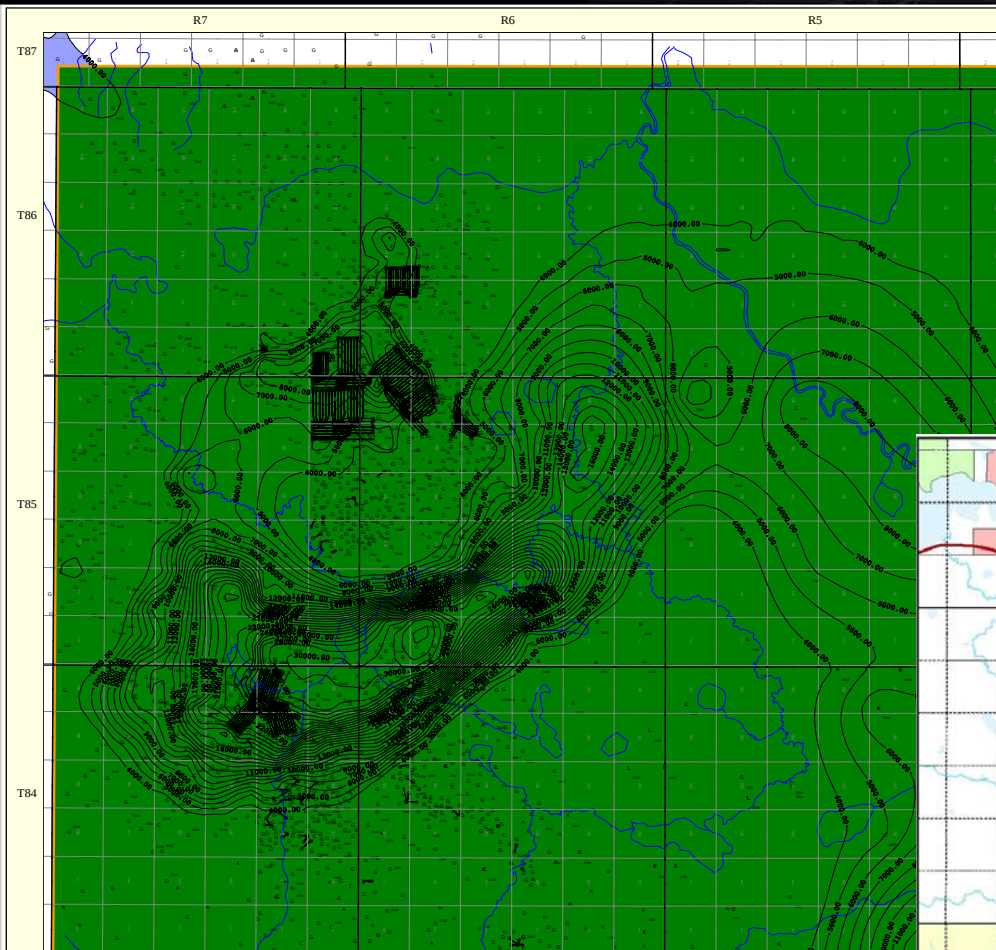
# Grand Rapids Salinity Mapping



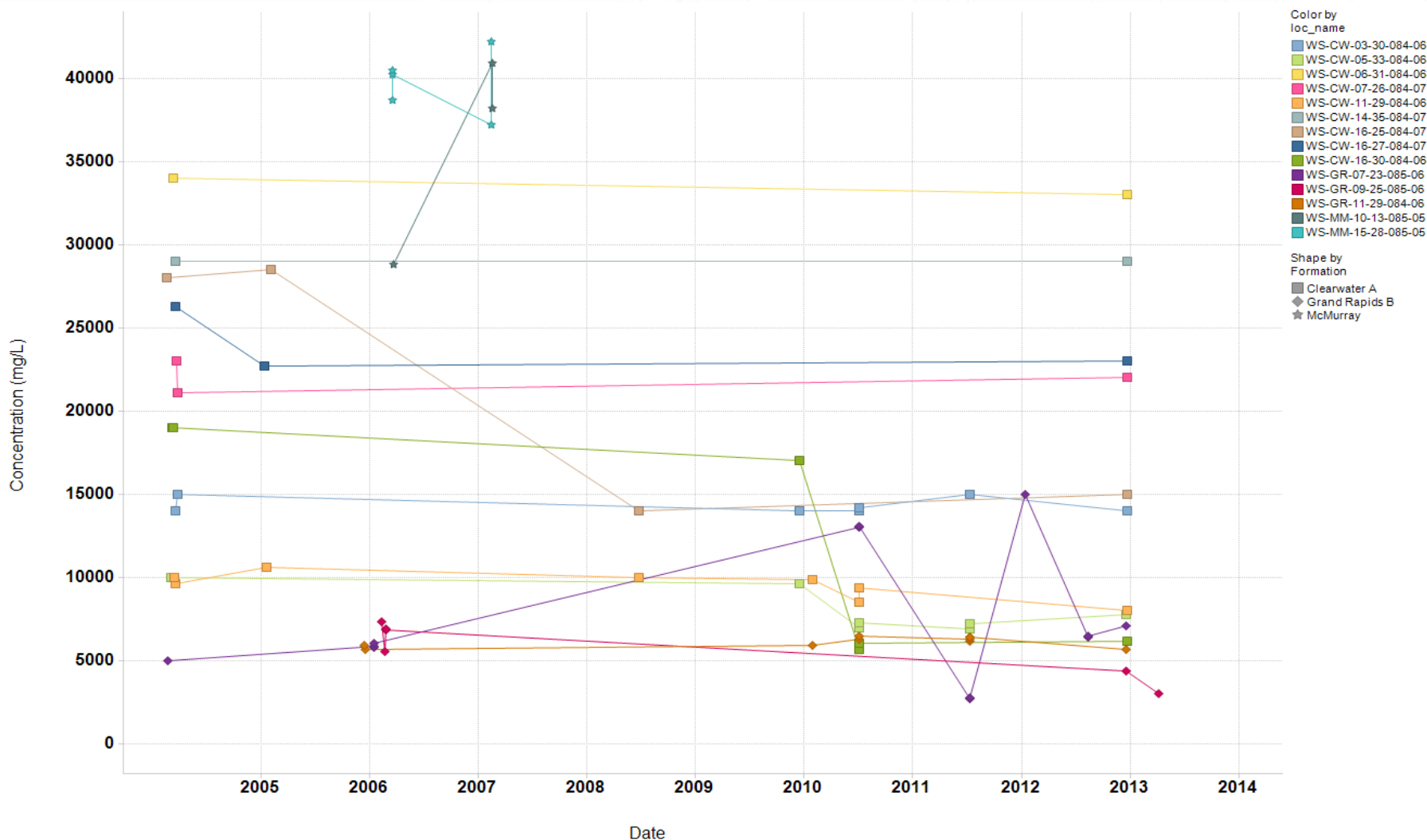
# Fresh Source Wells – Water Quality - TDS



# Clearwater A Salinity Mapping



# Saline Source Wells – Water Quality - TDS



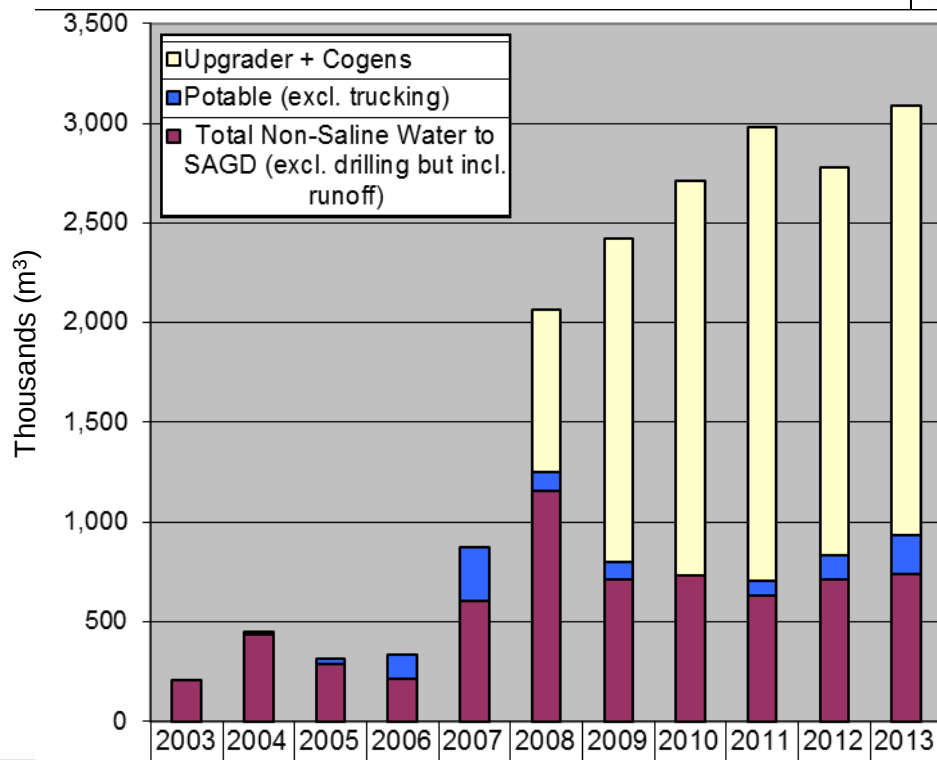
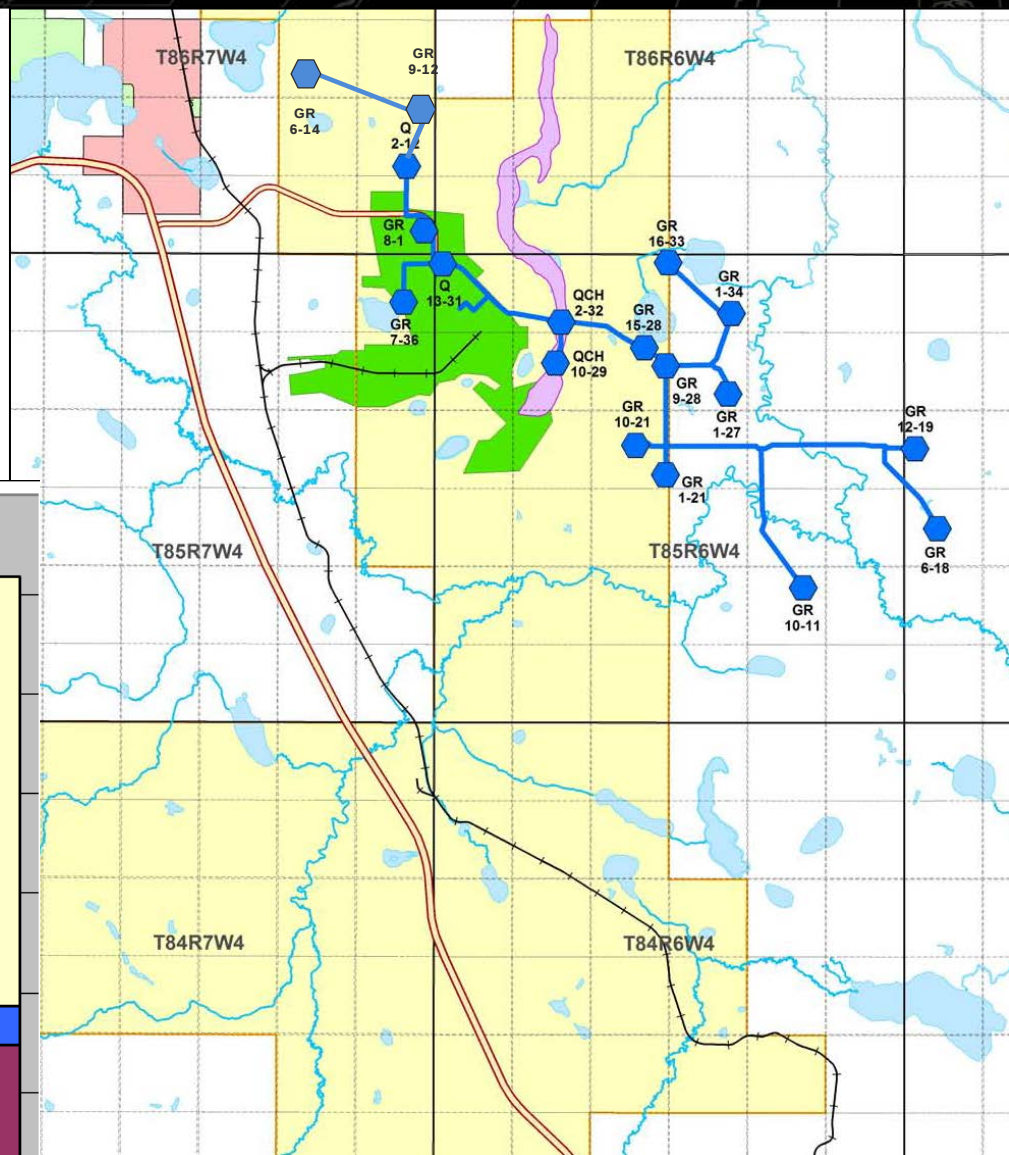
Note:

- Saline source wells have not been produced very much (yet)
- Wells not sample in 2013 due to extreme cold and equipment malfunction

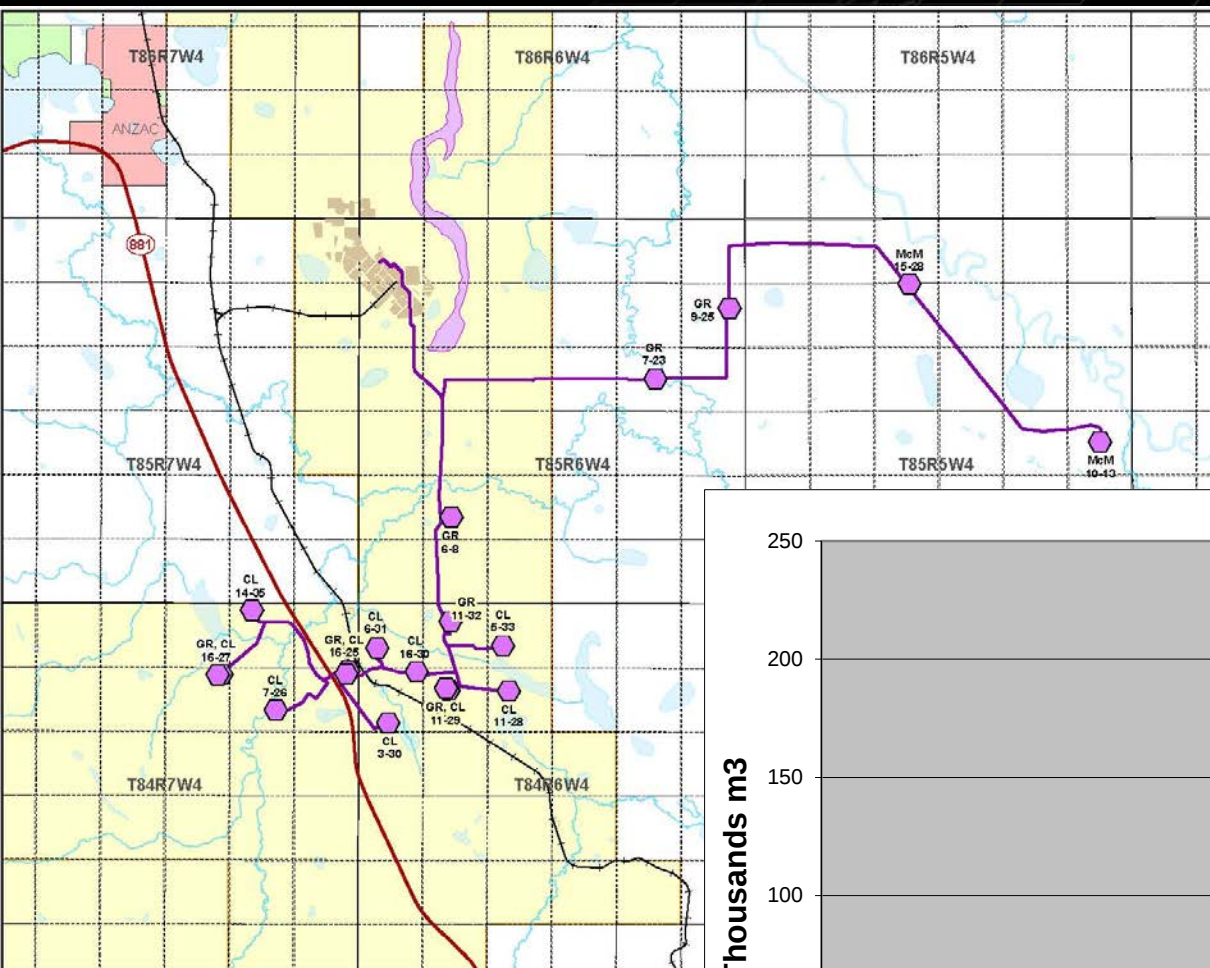
# Freshwater Use at Long Lake

- Use of Freshwater:

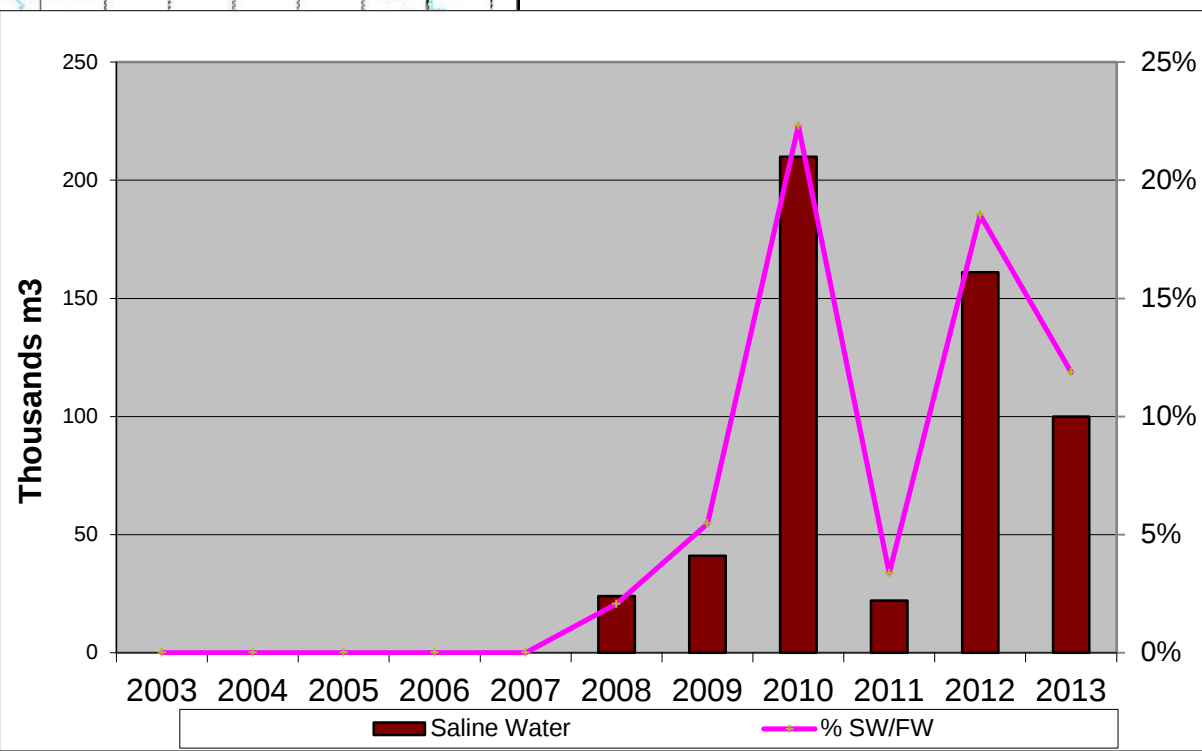
1. Demineralized water make-up (UPG and cogens)
2. Utility and plant use (UPG and SAGD)
3. SAGD steam make-up (HLS's)
4. Potable
5. Others (incl. drilling)



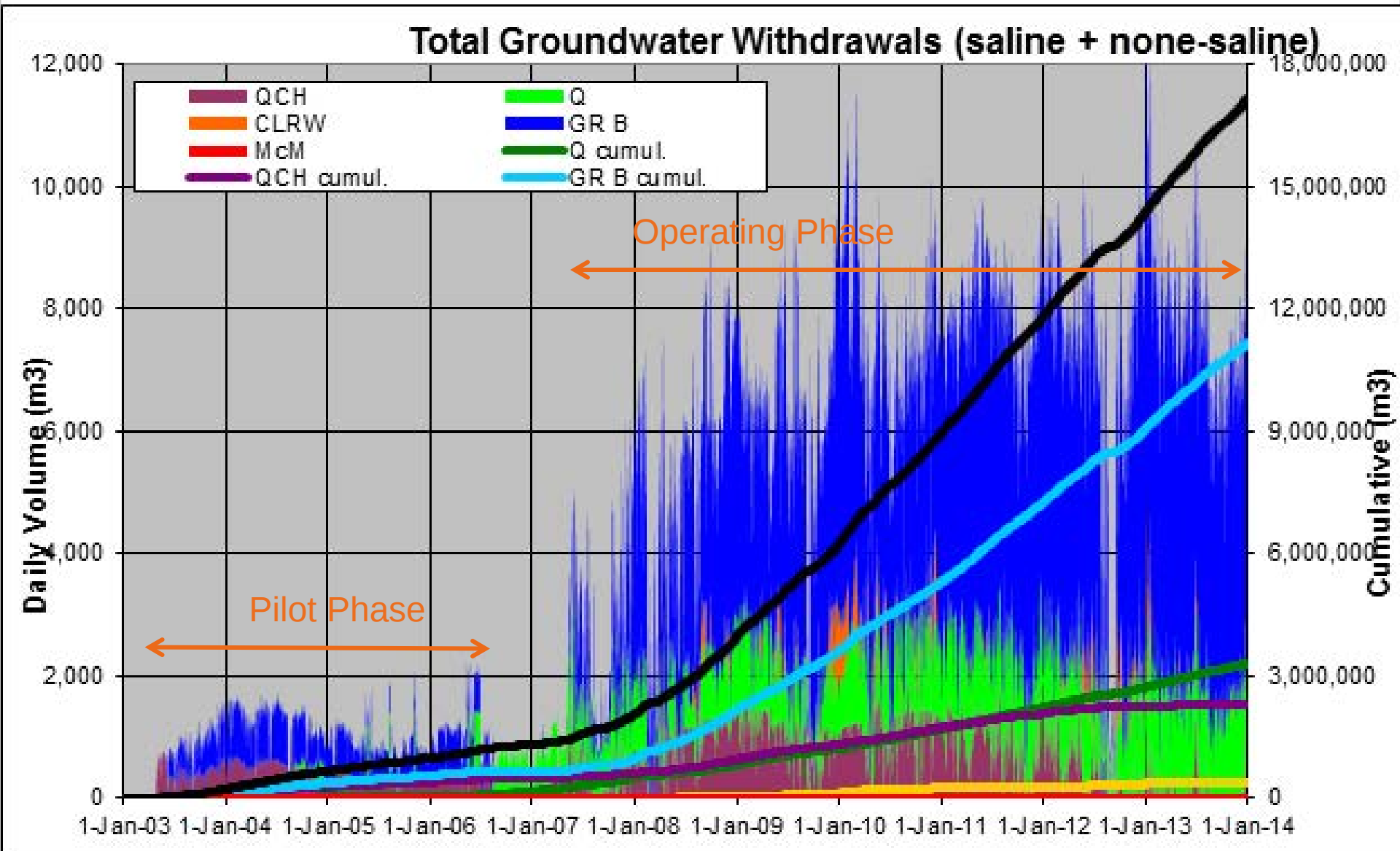
# Saline Water Use at Long Lake



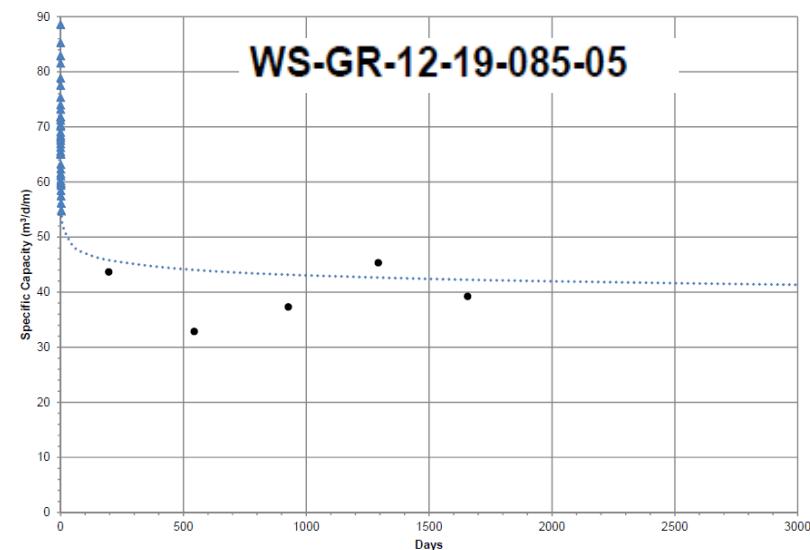
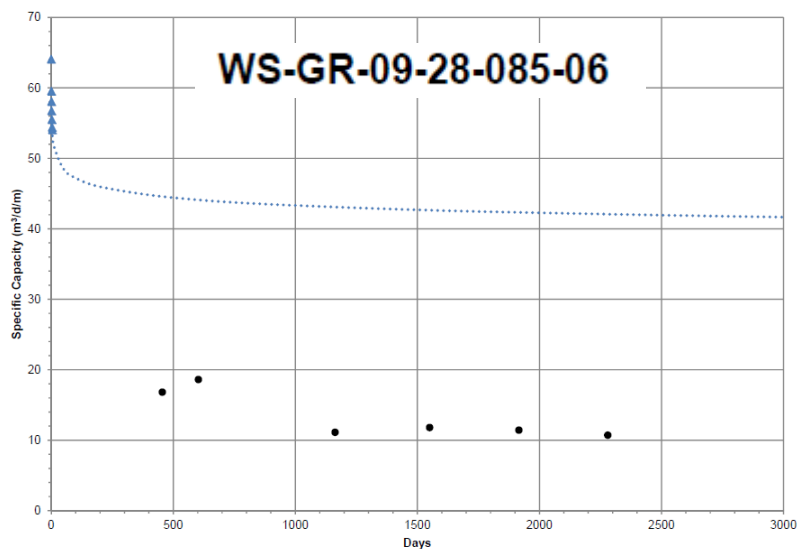
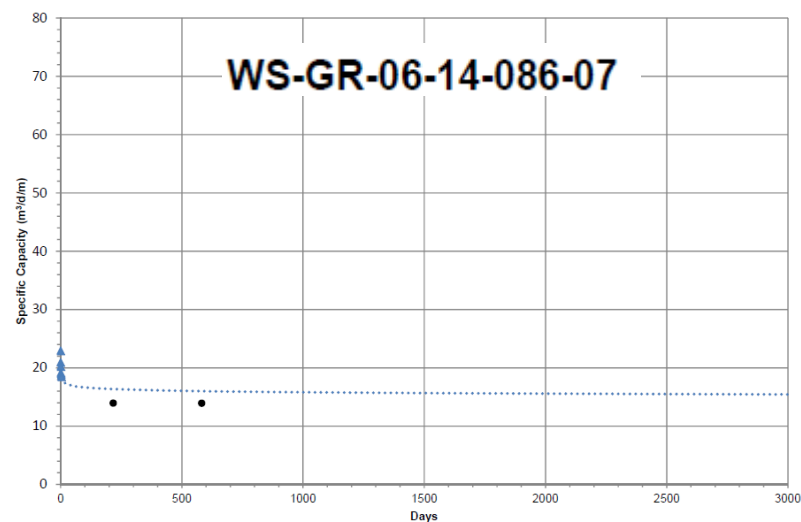
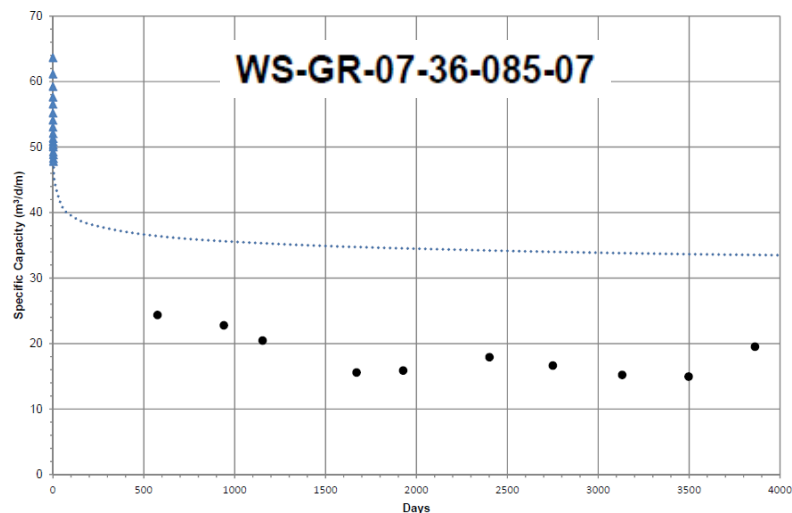
- Saline water make-up:
  - 99,777 m<sup>3</sup> in 2013 for steam make-up (HLS's)



# HISTORIC AQUIFER USE

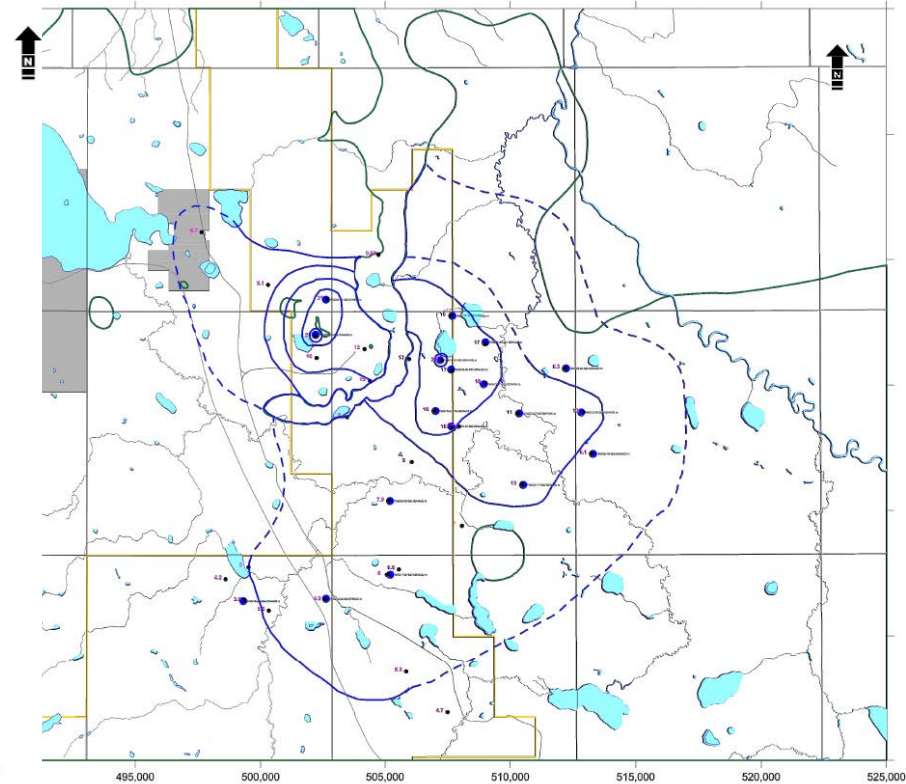
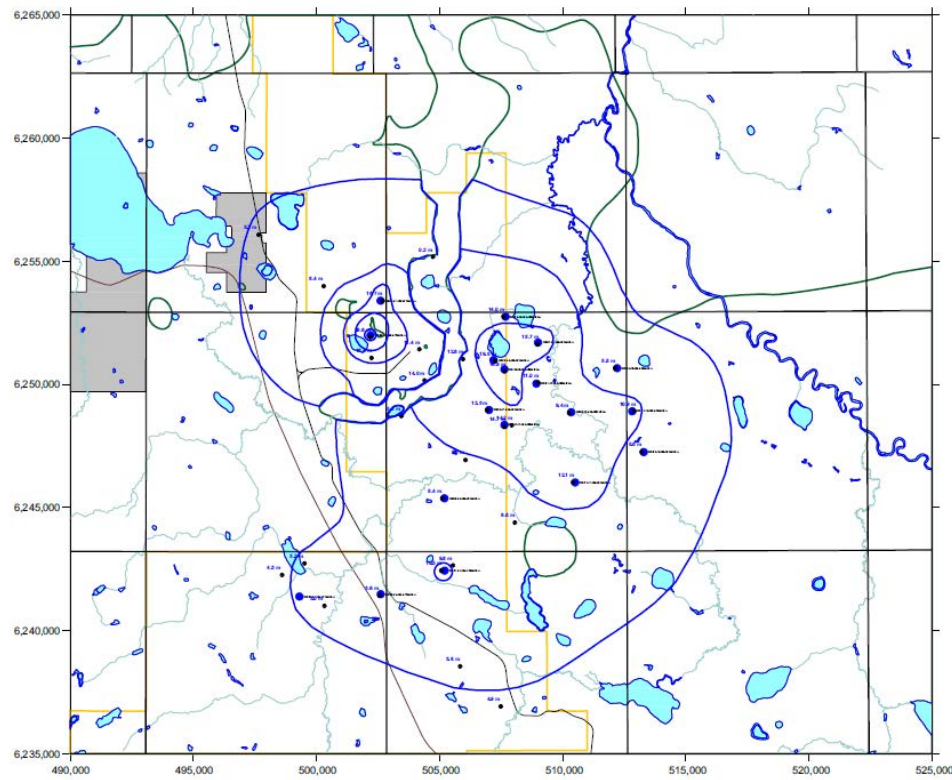


# WELL AND AQUIFER PERFORMANCE



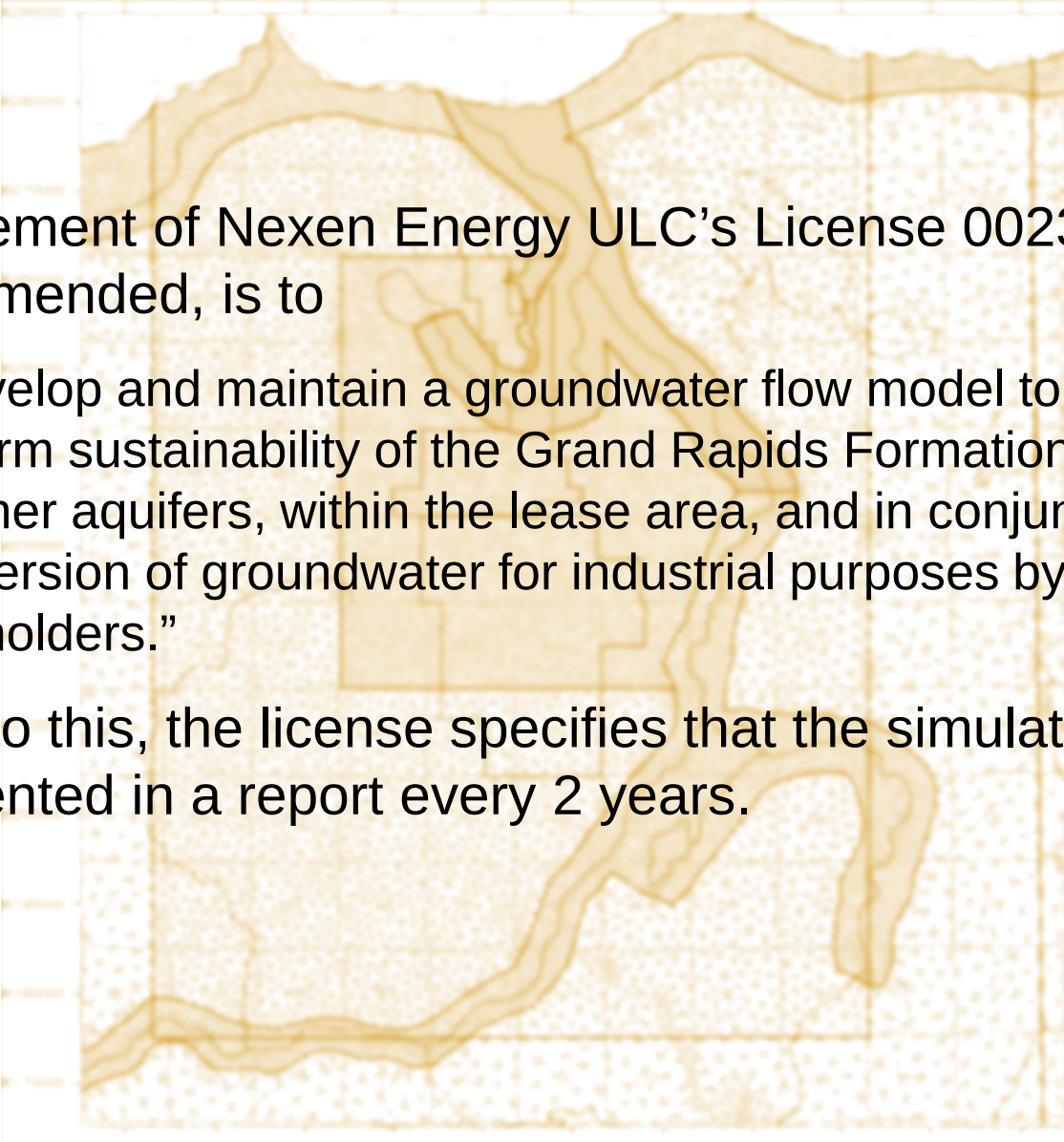
▲ Pumping Test Data      ..... Predicted Specific Capacity      ● Computed Specific Capacity

# COMPARISON 2012 TO 2013 DRAWDOWN



-  Upper Grand Rapids Zero Edge Isopach  
(also GR B aquifer breach by Gregoire Channel)
-  Drawdown contours (C.I. 5m from 5 to 25m)
-  Water Source Well - Grand Rapids B
-  Measured Drawdown (m) - Grand Rapids

# WATER USE REPORT REQUIREMENTS

- 
- A requirement of Nexen Energy ULC's License 00235895-01-00, as amended, is to
    - "... develop and maintain a groundwater flow model to ensure the long term sustainability of the Grand Rapids Formation aquifer(s) and other aquifers, within the lease area, and in conjunction with the diversion of groundwater for industrial purposes by adjacent lease holders."
  - Further to this, the license specifies that the simulations are to be presented in a report every 2 years.

# GROUNDWATER MODEL HISTORY

- Nexen and CPC developed independent models in in 2007
- Nexen and CPC retained Golder to construct and calibrate a Joint Regional Groundwater Flow Model in 2010 – 2011
- Model worked on by Matrix Solutions Inc. for 2013 Water Use report (minor modifications)

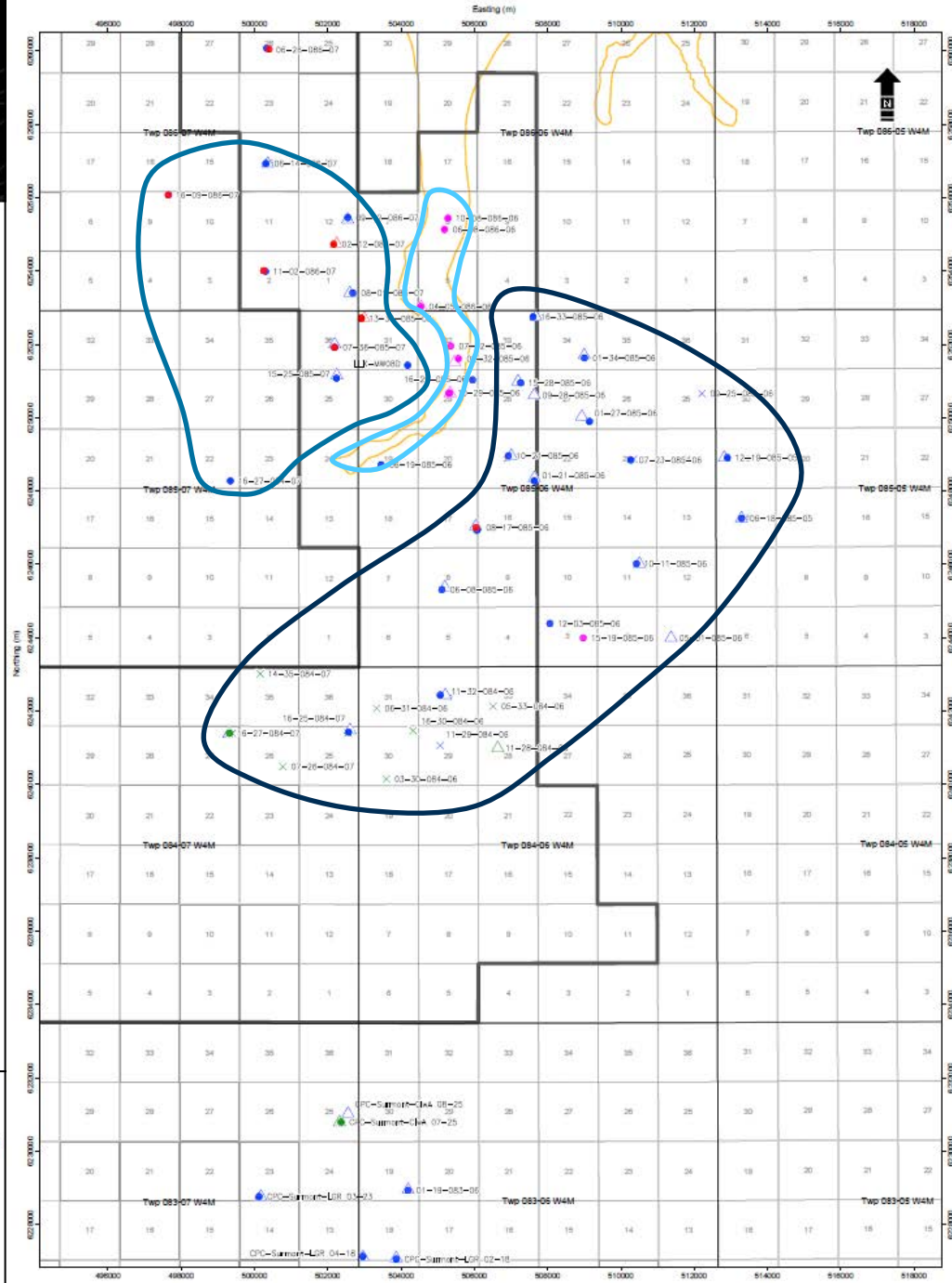
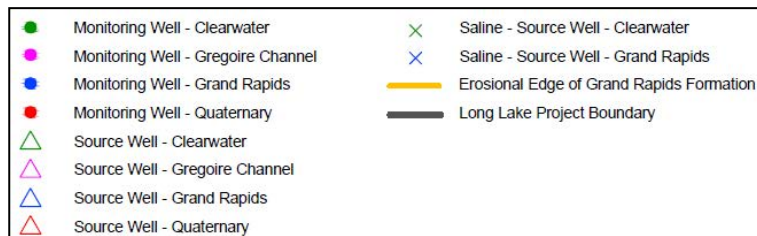


## LEGEND

- |                                |                                                    |
|--------------------------------|----------------------------------------------------|
| — AB SK BORDER                 | SUPER-ELEMENT FEATURES (ACCORDING TO MESH DENSITY) |
| □ TOWNSHIP GRIDS AND LABELS    | ■ RIVER ESCARPMENT                                 |
| □ LEASES                       | ■ GREGOIRE CHANNEL                                 |
| SUPER-ELEMENT LINE FEATURES    |                                                    |
| — RIVER OR STREAM              | ■ LEASE AREA                                       |
| — COLORADO ZERO EDGE           | ■ OUTSIDE LEASE AREA                               |
| — UPPER GRAND RAPIDS ZERO EDGE | ■ REGIONAL ALBERTA                                 |
| — CLEARWATER ZERO EDGE         | ■ REGIONAL SASKATCHEWAN                            |
| — BITUMEN SATURATION LINE      |                                                    |

# WELLS IN 2013 MODEL

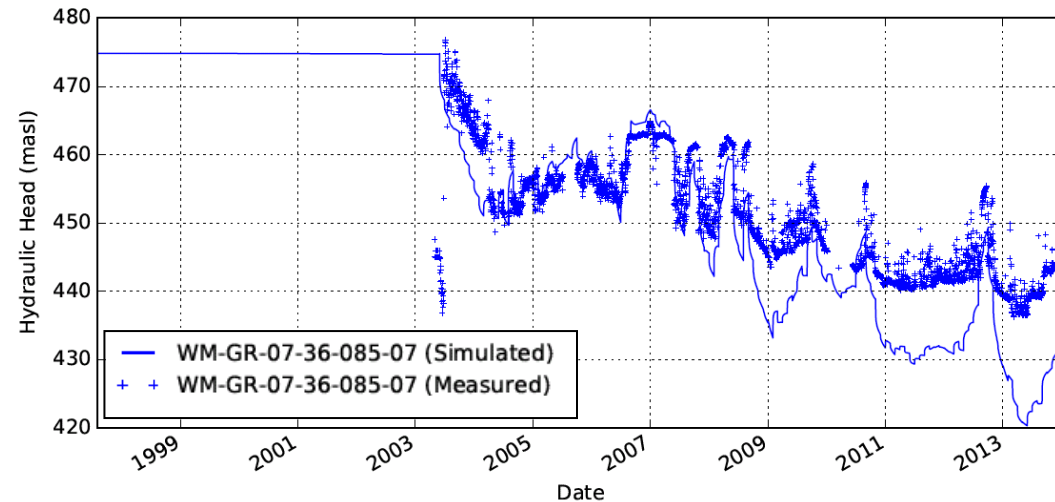
- Model includes water source wells in:
  - Grand Rapids
  - Clearwater
  - Quaternary
  - Gregoire Channel
- Both non saline and saline water use
- Divided into 3 main areas
  - West of GC
  - Gregoire Channel (GC)
  - East and South of GC



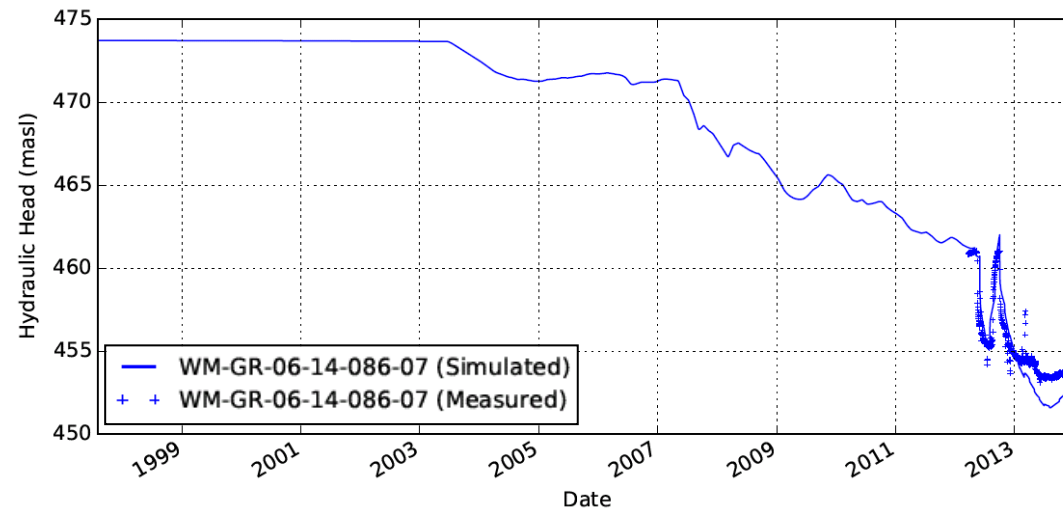
# GR WELLS WEST OF GREGOIRE CHANNEL



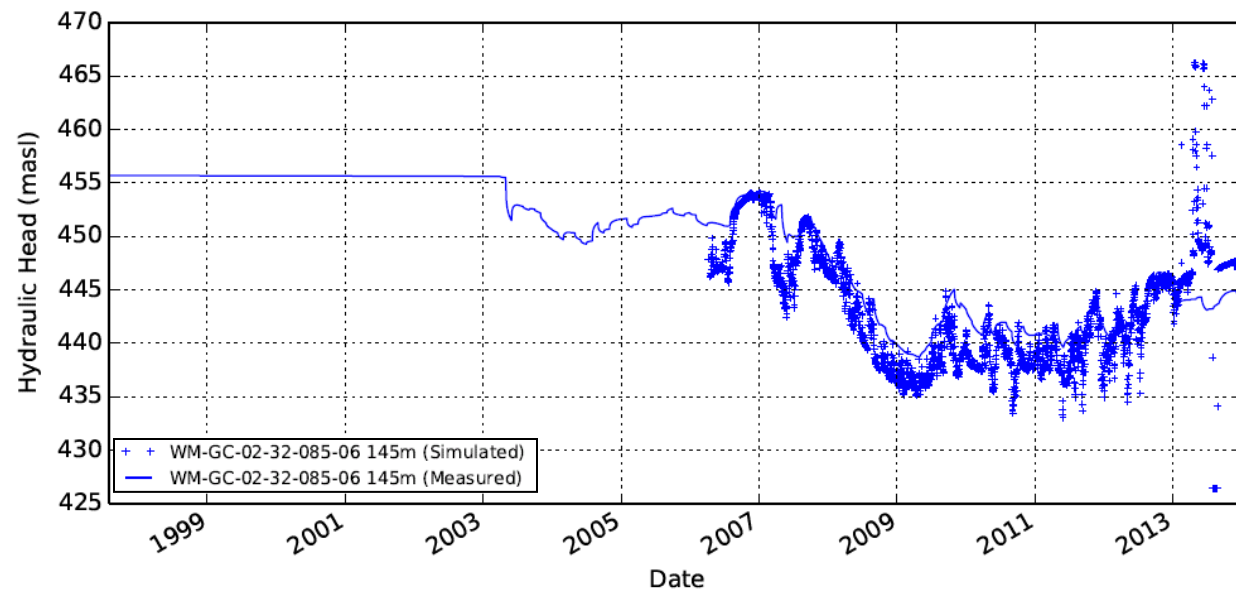
- Good match on trends but over predicts in some wells



- Furthest and most western well (closest to Anzac) has a very good match



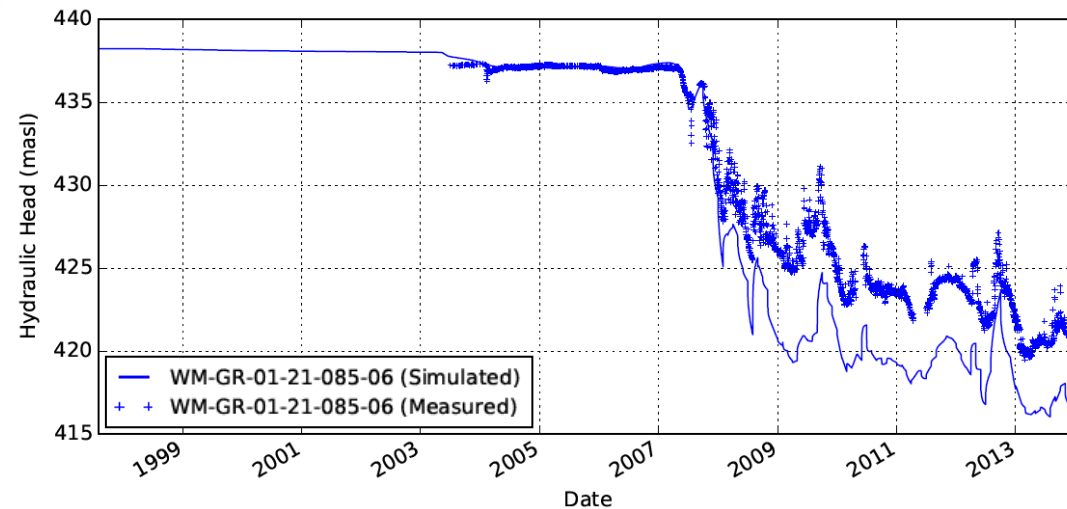
# GREGOIRE CHANNEL WELL



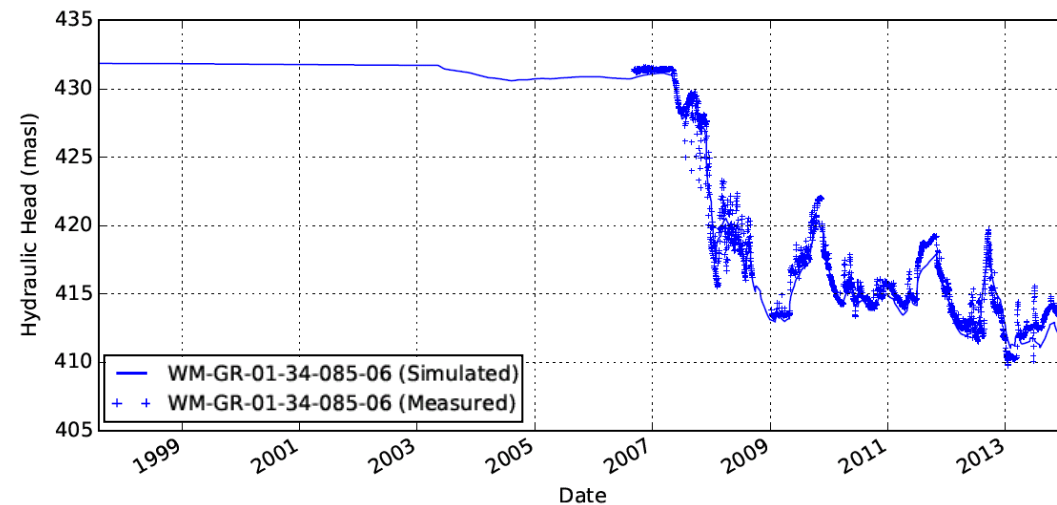
# GR WELLS EAST OF GREGOIRE CHANNEL



- Good match on trends but over predicts in some wells (but less than in wells west of GC)

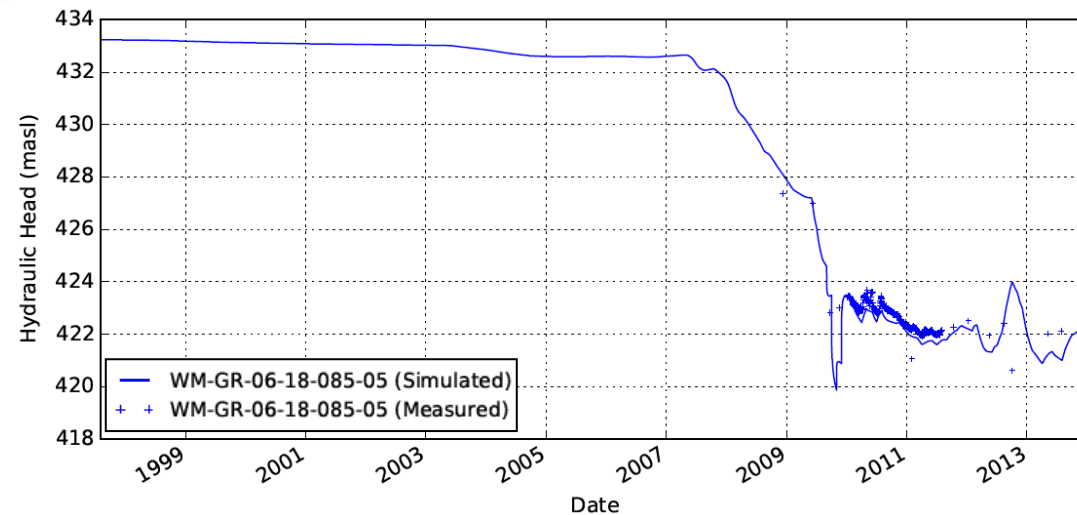


- Some very good matches

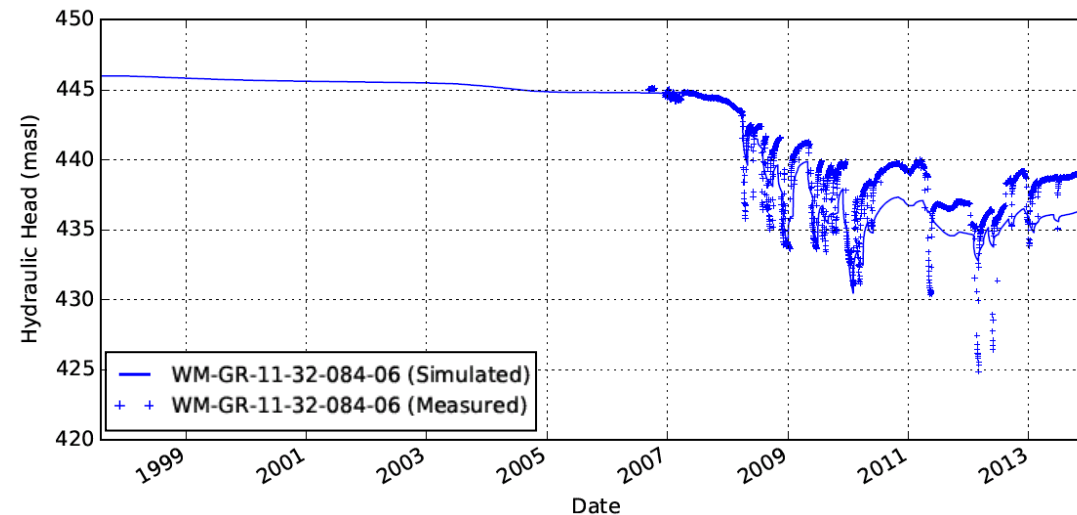


# SOUTHERN AND KINOSIS WELLS

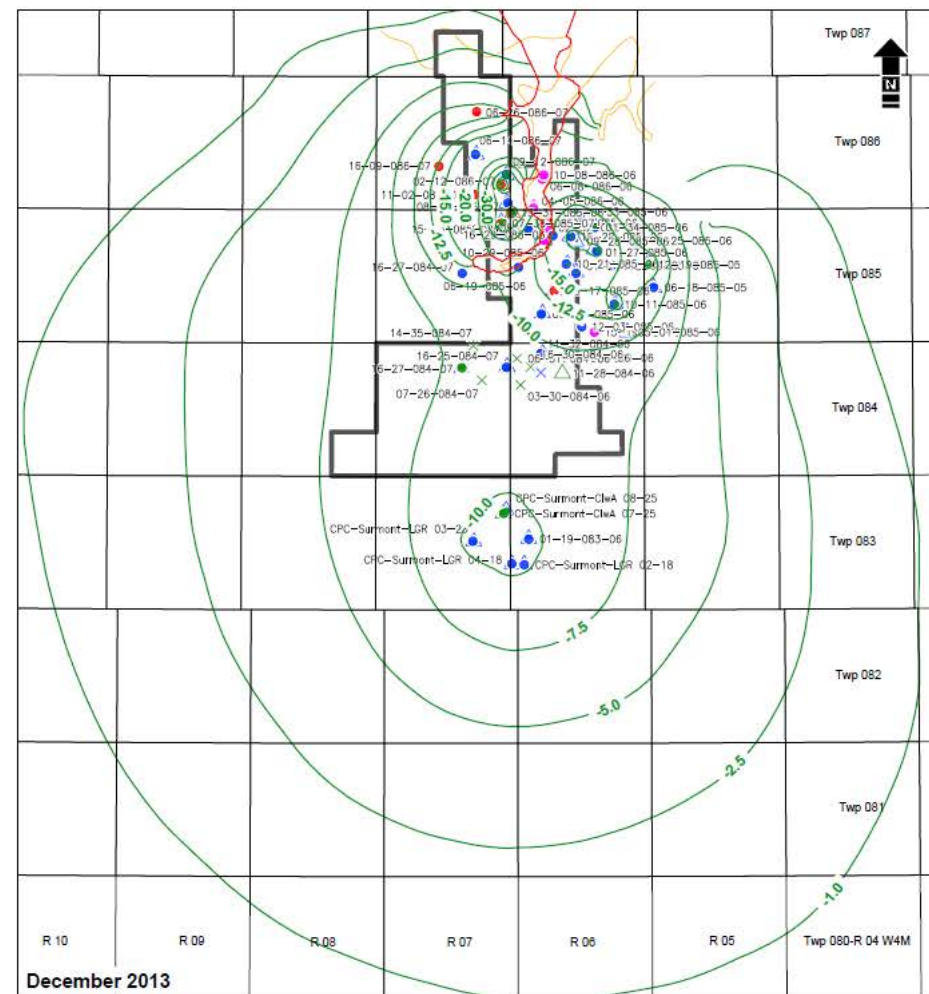
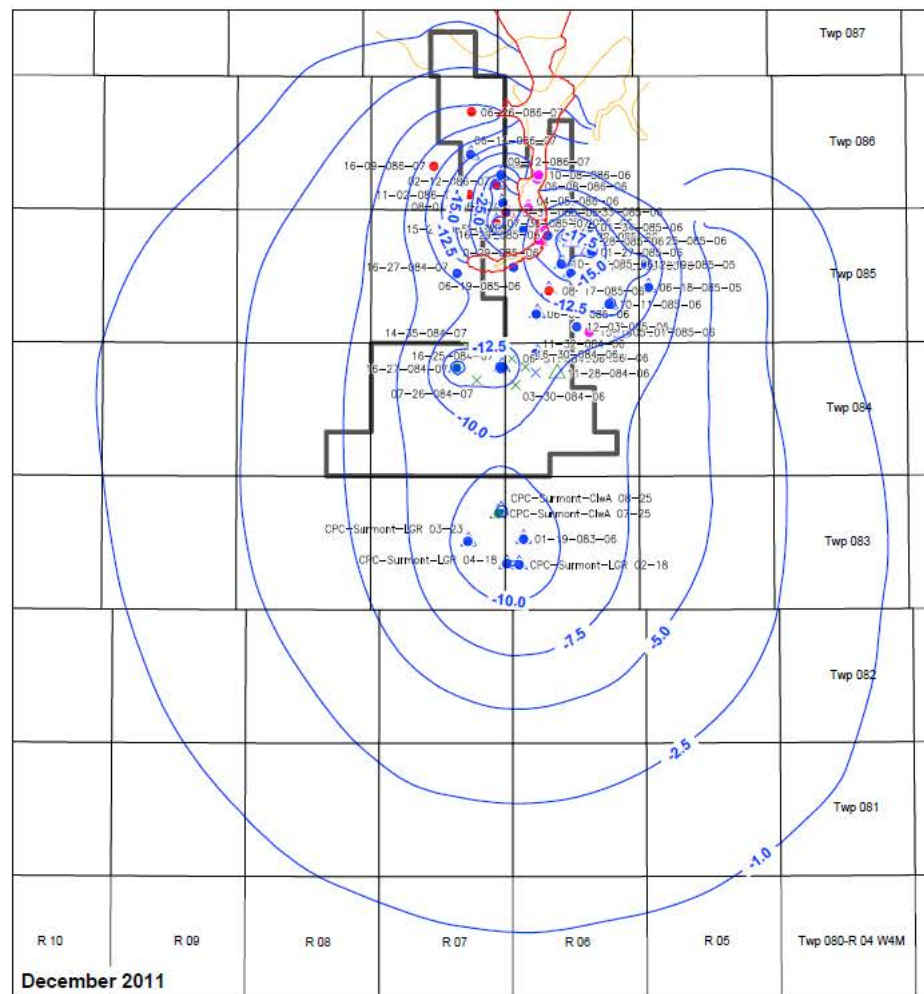
- Good to reasonable matches



- Drawdown in Clearwater wells is over predicted



# GRAND RAPIDS DRAWDOWN 2011 VS 2013

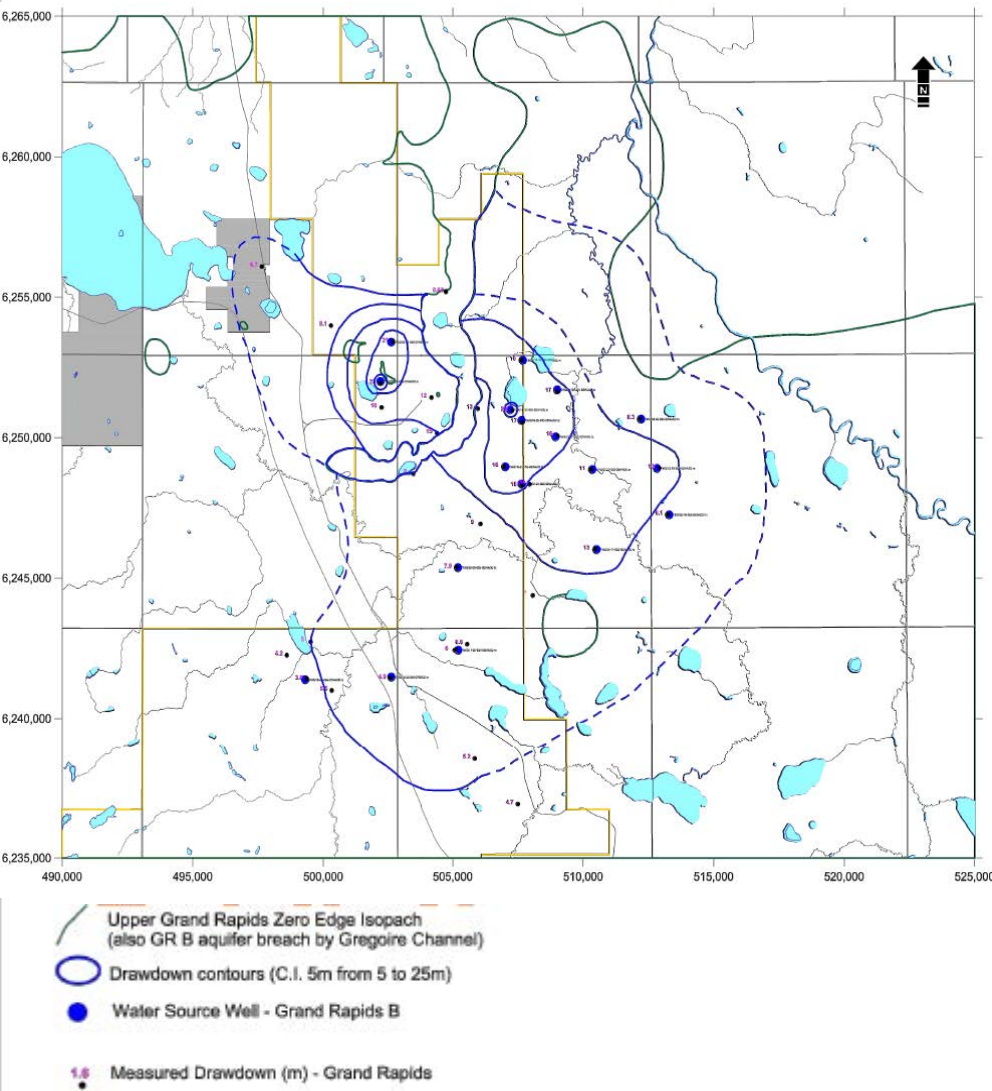


- Monitoring Well - Clearwater
- Monitoring Well - Gregoire Channel
- Monitoring Well - Grand Rapids
- Monitoring Well - Quaternary
- △ Source Well - Clearwater
- △ Source Well - Gregoire Channel
- △ Source Well - Grand Rapids
- △ Source Well - Quaternary
- × Saline - Source Well - Clearwater
- × Saline - Source Well - Grand Rapids
- Drawdown Grand Rapids December 2011
- Drawdown Grand Rapids December 2013
- Erosional Edge of Grand Rapids Formation
- Long Lake Project Boundary
- Gregoire Channel

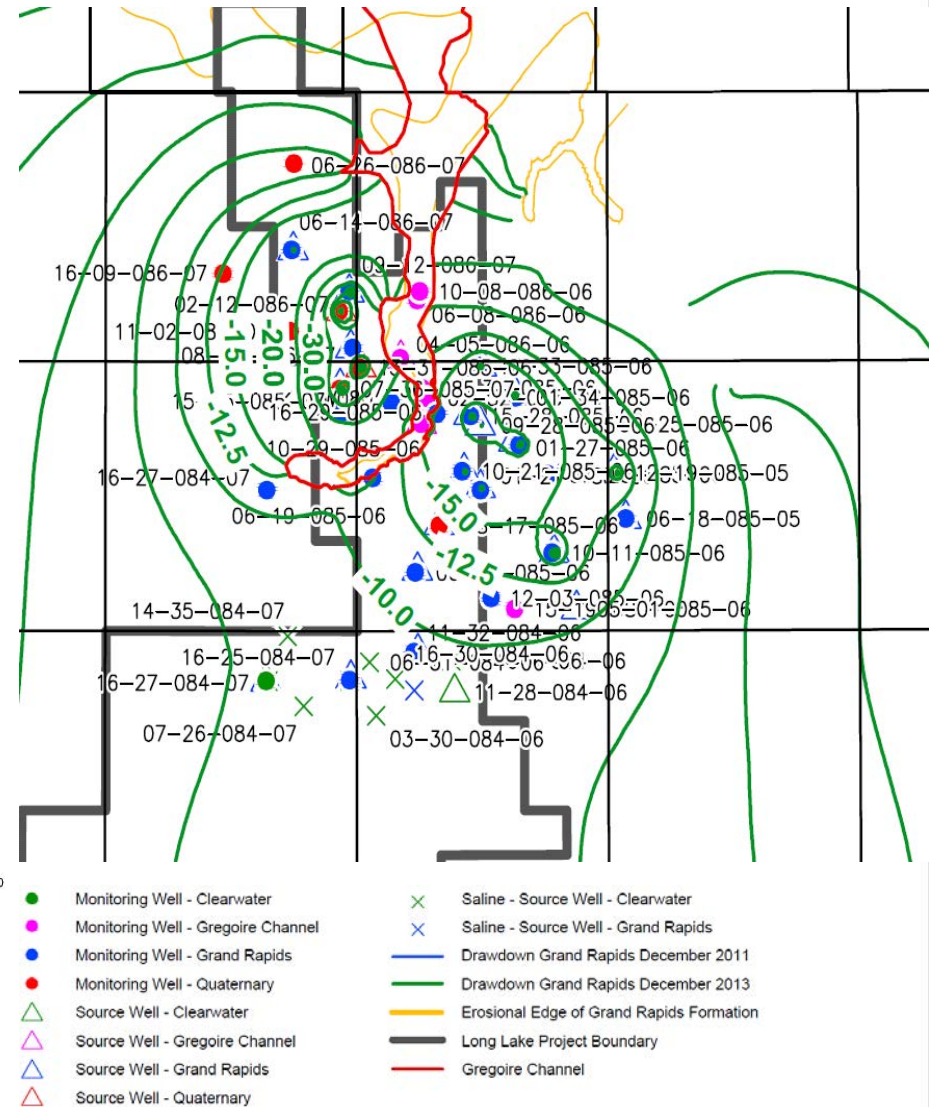
Reference:  
2013 Annual Groundwater Use Report: Quaternary, Grand Rapids and Clearwater Source Wells,  
Long Lake Project (Water Act Licence No. 00235895-01-00).  
Matrix Solutions Inc., March 2014

# COMPARISON TO MEASURED

## Measured



## Simulated



# SUMMARY

- Nexen Long Lake uses steam assisted gravity drainage and integrated upgrading on site
- Freshwater Use for:
  1. Demineralized water make-up (UPG and cogens)
  2. Utility and plant use (UPG and SAGD)
  3. SAGD steam make-up (HLS's)
  4. Potable
  5. Others (incl. drilling)
- Saline water Make-up for SAGD steam (HLS's)
- Groundwater model performs relatively well and shows good match on trends
- Nexen's groundwater monitoring network capably measures the effects of groundwater diversion at Long Lake



# THE END

- Acknowledgements
  - Nexen would like to thank:
    - Golder Associates
    - Matrix Solutions Inc.
- Questions?

