# Treatment of Saline Water

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June 2013

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# Acknowledgements


- PTAC Steering Committee:
  - Jennifer Ezekiel
  - Andrew MacKenzie
  - James Armstrong
  - Jon Remmer

- Millennium Project Team:
  - Ian Mitchell
  - Nancy Grainger
  - Dan Stein
  - Lindsey Mooney
  - Miles Tindal
  - David Williams
  - Geneva Robins
  - Seth Xeflide
  - Don Chen


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# Objectives

- Investigation of feasibility of treating saline water to a freshwater criterion for storage in earthen reservoirs for transportation via overland pipelines
- Development of risk-based treatment criteria
- Focus on Pipestone and Gordondale areas

# Project Rationale

- Alternatives to freshwater
- Proactive water management planning
- Potential environmental risks with saline water
- Use of saline water with minimal risk

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# Project Scope

- Phase I: Regulatory Review
  - Review of guidelines for saline water storage and transport
  - Review of groundwater quality data (Pipestone & Gordondale)
  - Development of risk-based criteria
- Phase II: Liability Assessment

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# Regulatory Review (Key Findings)

- Saline water: >4,000 mg/L TDS (Alberta, BC, Saskatchewan, Manitoba)
- TDS, sodium and chloride guidelines published for water uses (drinking, livestock, irrigation, aquatic life)
- Saline water storage regulated by AER (ESRD, ERCB), Alberta Infrastructure & Transportation (road salt only)
- Freshwater storage licensed under Water Act

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# Regulatory Review (Key Findings)

| Guidelines for Saline Water Storage | |
|---|---|
| **Regulatory Body or Guideline** | Guideline |
| **Alberta Infrastructure and Transportation** | Pond lining and secondary containment is required.<br>Storage and freeboard requirements are to be based on normal storm events.<br>Discharge from ponds is not allowed. |
| **ERCB Directive 050** | Site must be secure.<br>Water must be tied to original source.<br>Cannot be within 100 m of a water body. |
| **ERCB Directive 058** | 30 m delineation from DUA, 10 m delineation from fractured bedrock.<br>Cannot be within a recharge area of an unconfined aquifer.<br>Must be Further than 300 m from a surface water body.<br>Must remain 1.5 m above seasonal high water table.<br>TDS must be less than 2,000 mg/L in groundwater. |
| **ERCB Directive 055** | Excavation must be lined with secondary containment.<br>Cannot be within 100 m of high water mark for surface water or wells.<br>Some limitations on storage duration. |
| **BC OGC** | Excavations used for storage must be lined with material of at least 30 mil.<br>Minimum 1 m freeboard.<br>Registration of storage site with OGC is required. |

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# Groundwater Quality Review

- Data available for Pipestone (~20 wells)
- Only 1 well identified in Gordondale
  - Below base of groundwater protection
  - → Pipestone applied for entire area
- Bedrock wells ~29 to 159 m
  - TDS 1081 mg/L, Na 390 mg/L, Cl 14 mg/L (mean)
- Drift material wells ~ 9 to 61 m
  - TDS 1451 mg/L (mean)
- Groundwater generally considered potable

# Development of Risk Based Criteria

- Two scenarios defined:
- Gordondale – up to 50,000 m3 water stored; untreated TDS 20,000 ppm
- Pipestone – up to 15,000 m3 water stored; untreated TDS 2,000 ppm
- Unlined reservoir, depth 5 m
- Clay soils (Hydraulic conductivity $1 \times 10^{-8}$ m/s or lower)

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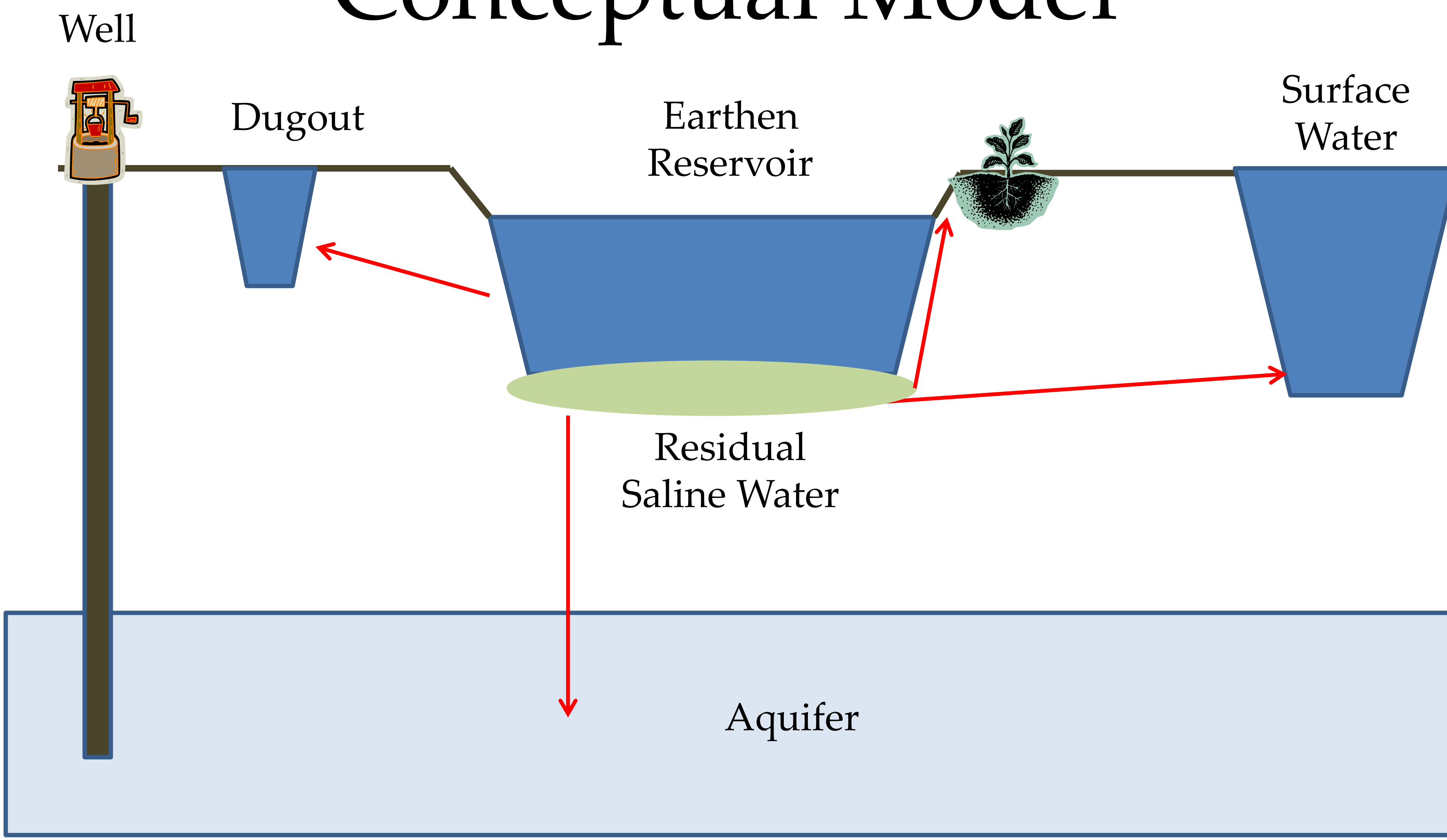
# Conceptual Model



# Conceptual Model

| Conceptual Model Assumptions | |
|---|---|
| Parameter | Value |
| Pond Volume | 50,000 $m^3$ |
| Pond Length | 100 m |
| Pond Width | 100 m |
| Pond Depth | 5 m |
| Hydraulic Conductivity of Native Material | $1 \times 10^{-8}$ m/s |
| Climate Moisture Index | 2 scenarios: moist and dry |
| Soil porosity, bulk density, moisture | ESRD (2010) fine grained defaults |
| Water table | 2 scenarios: 1.5 m and 10 m |
| DUA Depth | 30 m |

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# Modelling Approach

- No existing models identified that would apply for the scenarios
- Combination of Subsoil Salinity Tool and groundwater mixing/dilution model applied
- Mass balance model used to adjust for evaporation
- Sensitivity analysis performed reflecting range of potential conditions

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# Modelling Results

- 5th percentile of all runs in sensitivity analysis: 5000 mg/L TDS
- Scenarios modelled did not result in a lower guideline
- This value deemed appropriate for screening
- Site-specific value could be higher
  - Dry climate, deep DUA favourable

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# Liability Assessment

- Fault tree approach
  - Possible release scenarios, likelihood and consequence of each
- Four components:
  - Release or failure scenario
  - Nature and magnitude of spill
  - Extent of impact and media impacted
  - Remedial and/or risk management response
- Probabilities obtained from literature, empirical data, proprietary information

# Liability Assessment

| Table 12 Liability Scenario Matrix | | | | | | |
|---|---|---|---|---|---|---|
| Liability Scenario | | Failure Scenario | | | Cost Calculation | |
| Description | Overall Probability of Failure | Description | Probability of Scenario | Overall Probability for Scenario | By Failure Scenario | By Method |
| **Pipeline** | 0.25 | Catastrophic Failure | 0.11 | 0.03 | $29,179.21 | $265,265.50 |
| | | Gradual Release | 0.89 | 0.22 | $236,086.30 | |
| **Lined Pond** | 0.23 | Catastrophic Failure | 0.85 | 0.20 | $859,916.53 | $1,131,607.48 |
| | | Gradual Release | 0.15 | 0.03 | $271,690.95 | |
| **Unlined Pond** | 1 | Catastrophic Failure | 0.20 | 0.20 | $198,546.00 | $1,606,791.00 |
| | | Gradual Release | 0.8 | 0.8 | $1,408,245.00 | |

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# Conclusions

- 5000 mg/L TDS not expected to result in adverse environmental effects
- Potential liability higher with unlined pond than lined pond
- Further discussion with regulators needed before proceeding

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# Next steps

- External peer review underway
- Phase 3 funding approved by PTAC
  - field-scale research
  - detailed scope of work in progress
- Further discussions with regulators

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