
# SLEMA
# July 2010
# Environmental Update

Zhong Liu

July 31, 2009

# Outline

1. Mine Update
2. Inspection Update
3. Regulator Update
4. Reviews
5. Predictions for Calcium and Chloride in Snap Lake

# Acronyms

- ARD – Acid Rock Drainage
- AEMP – Aquatic Effects Monitoring Program
- AN – Ammonia Nitrate
- EAR – Environmental Assessment Report
- ENR – Department of Environment and Natural Resources, GNWT
- GNWT – Government of the Northwest Territories
- INAC – India and Northern Affairs Canada
- MVLWB – Mackenzie Valley Land and Water Board
- PK – Processed Kimberlite
- SLEMA – Snap Lake Environmental Monitoring Agency
- SNP – Surveillance Network Program
- TDS – Total Dissolved Solids
- WEMP – Wildlife Effects Monitoring Program
- WTP – Water Treatment Plant
- WMP – Water Management Pond

# 1.1 Mine Update – June 2009

- Production rate:  82.6% of its capacity (78,0859 tonnes of kimberlite processed)
- 5,179 $m^3$ of water withdrawn from Snap Lake
- 668,218 $m^3$ of treated water discharged into Snap Lake
- 67,170 tonnes of coarse reject and, 56,315 $m^3$ of slimes deposited in the North Pile
- 14 spills (1 reportable )
- Water sampled in 12 monitoring stations
  - The monthly average for all parameters met compliance except for a slightly elevated Faecal Coliform and Escherchia Coli, which are suspect due to the hold time exceedance prior to arrival at the laboratory
- Ongoing construction of the East Cell Sump #3, #5 and permanent camp

# 1.2 Impacts of Ammonia Nitrate Storage Facilities

- Historically, accidental release of ammonia nitrate from the storage pad has been a concern
  - Monitored by SNP stations – SNP 02-07.1, SNP 02-07.2, SNP 02-07.3, and SNP 02-09
- New nitrate materials storage building was constructed and operated in September 2009
  - Monitored by SNP stations – SNP 02-07.4, SNP 02-07.5 and SNP 02-07.6

# SNP Stations

# SNP Data Analysis

- No results in June 2010 were above reference limits (SNP 02-17, ammonia-N and nitrate-N)
  - The new Nitrate Materials Storage Building appears to be working properly
- Continuous monitoring is required

# 2. Inspection Update

- INAC Inspector – Tracy Covey
- Water Licence Inspections
  - June 2, 2010

# 2.1 Water Licence Inspection

- Inspected Waste Management, Water Management, and Closure and Reclamation on June 2, 2010
- Environmental risk was identified
  - Soil stockpiling – reclamation related research and reporting
  - Spill #10-154

# The tent to minimize the dust and splashes associated with drilling activities

Instrumentation strings to monitor the movement of seepage past the perimeter sump system

# Historic AN Storage Pad Vs. New Bulk Nitrate Storage Building

# 3. Regulator Update

- AEMP 5-Year Review
  - De Beers submitted draft review report on July 19, 2010
  - MVLWB requested for comment, due by August 20
  - NSMA asked for a ten-day extension for the public comment deadline on July 22
  - MVLWB extend the deadline until 5pm on August 30

# 4. Reviews

- Annual Reports Submissions
- Guideline for Developing a Waste Management Plan
- Draft 5-Year AEMP Review Report

# 4.1 Annual Reports Submission

- Annual reports except Water Licence 2009 Annual Report (including AEMP and ARD) were past due

| Reporting Requirements | Submission Due Date |
|---|---|
| Water Licence<br>• AEMP, ARD, ***Hydrology*** | March 31 of Each Year |
| Fisheries Authorization<br>• DO, TDS | July 31 of Each Year |
| *Environmental Agreement*<br>• *Wildlife, Air Quality, Vegetation* | June 30 of Each Year<br>(De Beers voluntary due date, based on the agreement with Jason Ash, De Beers Permitting/ Environmental Superintendent, on January 21, 2010) |

# 4.2 Guideline for Developing a Waste Management Plan

- Second draft dated July 9, 2010, distributed for review on July 12
- Developed by the Standard Procedures and Consistency Working Groups of the Water Boards of Mackenzie Valley
  - intended to provide greater clarity, consistency and certainty to all parties involved in the Boards' regulatory processes
- Good reference for SLEMA to review waste management plans when De Beers updates them

# 4.3 Draft 5-Year AEMP Review Report

- Submitted on July 19, 2010
  - Summarized AEMP monitoring, results analysis and recommendations from the past 5 years (2005-2009)
  - Provided preliminary considerations for the AEMP update
  - More information needed to finalize recommendations for updating the AEMP

# Environmental Analyst Comments

- The draft is satisfactory, but more specific recommendations/proposals expected for discussion of updating the AEMP
  - Proposed number, location of AEMP monitoring stations
- To streamline Water Management Plan, Adaptive Management Plan, AEMP and/or SNP
  - Water quality modeling, thresholds, monitoring of AEMP stations and SNP stations

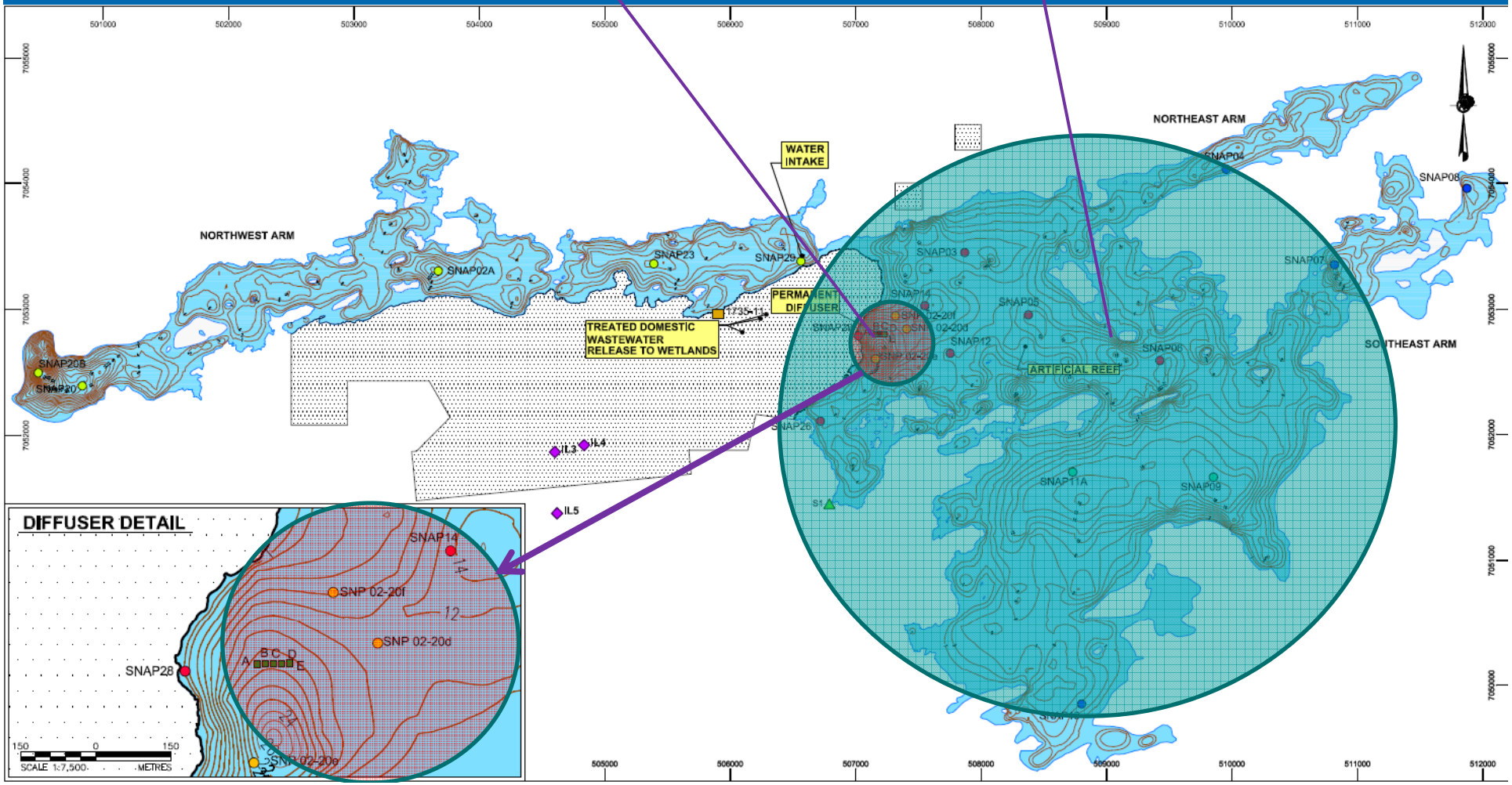
# 5. Predictions for Calcium and Chloride in Snap Lake

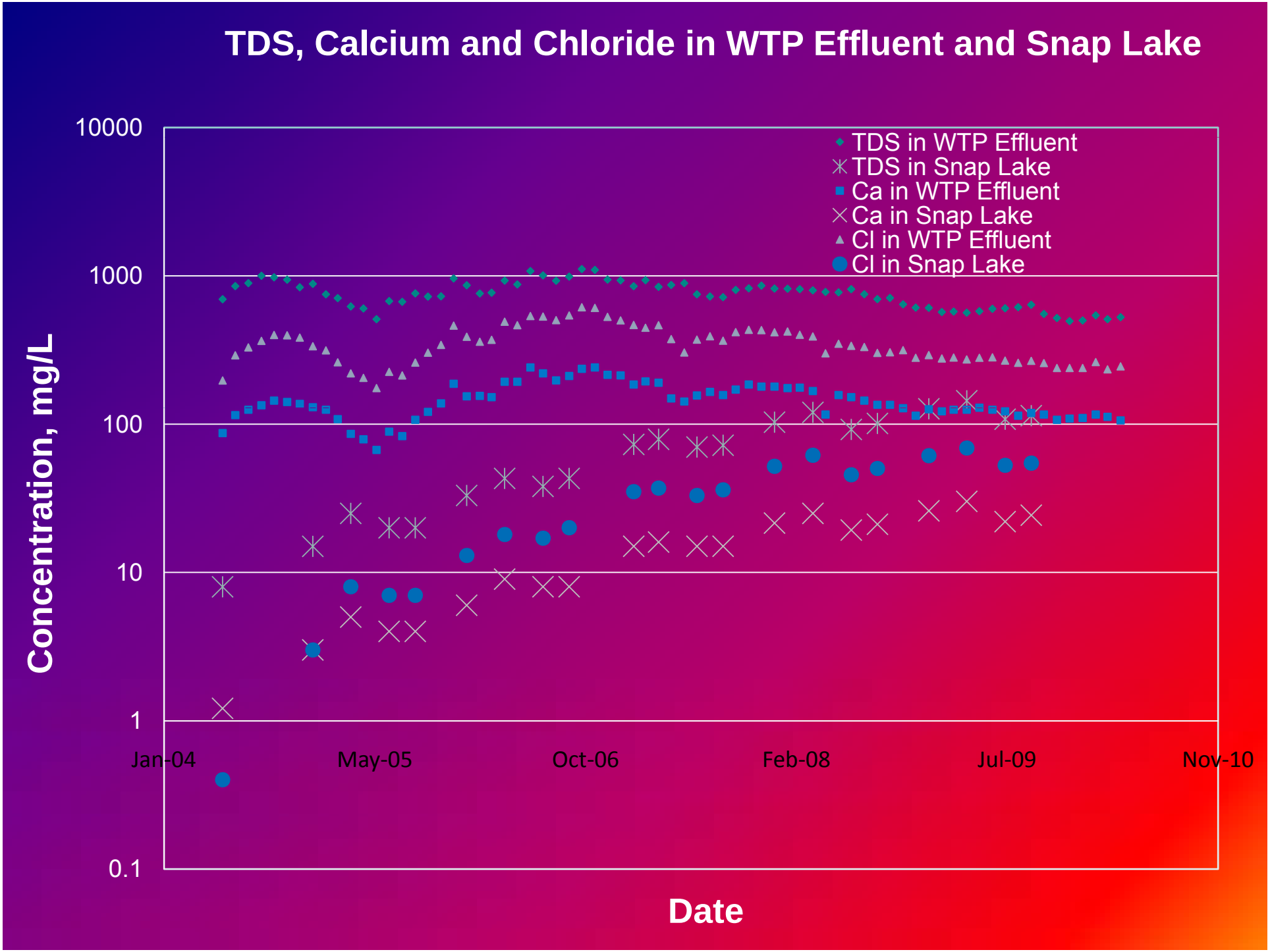
- Calcium (Ca) and chloride (Cl) are the most important components of total dissolved solids (TDS)
- There are strong correlations between Ca and TDS, and between Cl and TDS, in both the WTP effluent and lake water
  - The major ion composition in Snap Lake closely reflect the ionic composition of the treated effluent
- SLEMA water quality model could be applied not only to TDS, but also to Ca and Cl

# Important Numbers

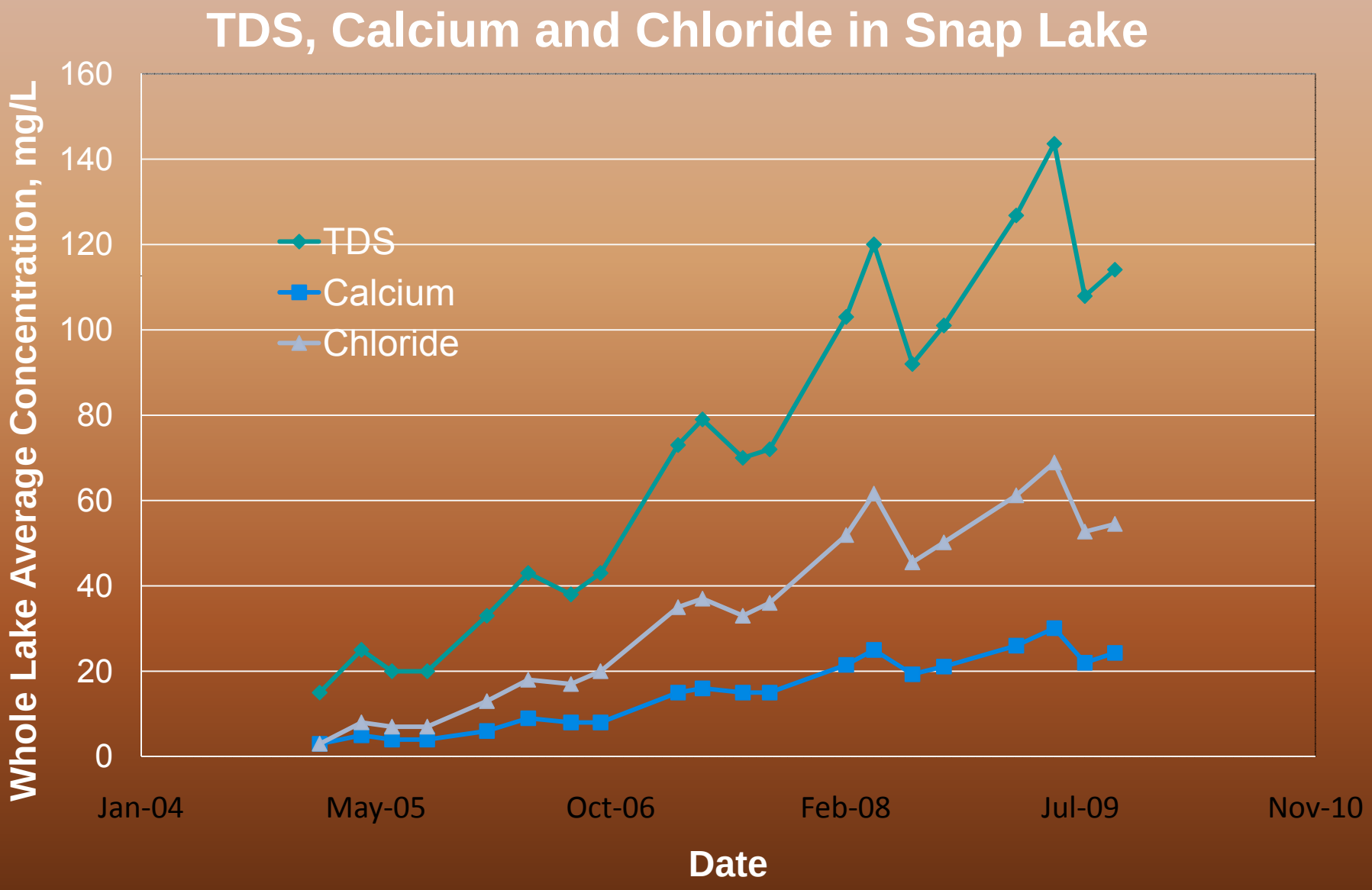
| Parameter | EA Prediction, mg/L | Trigger for Adaptive Management, mg/L | Water Licence Limit, mg/L | Guideline Criteria, mg/L |
|---|---|---|---|---|
| TDS | 350 | **600** | 350 | ≤500 |
| Cl | 137 | **160** | | ≤250<br><br>230 for aquatic life (USEPA) |
| Ca | 88 | **110** | | |
| Note | Maximum predicted whole-lake annual average concentrations | **Concentrations beyond the diffuser mixing zone (hotspot area)** | Whole-lake average concentration | Aesthetic objective for drinking water |

# Hotspot Area vs. Whole-Lake (Average)

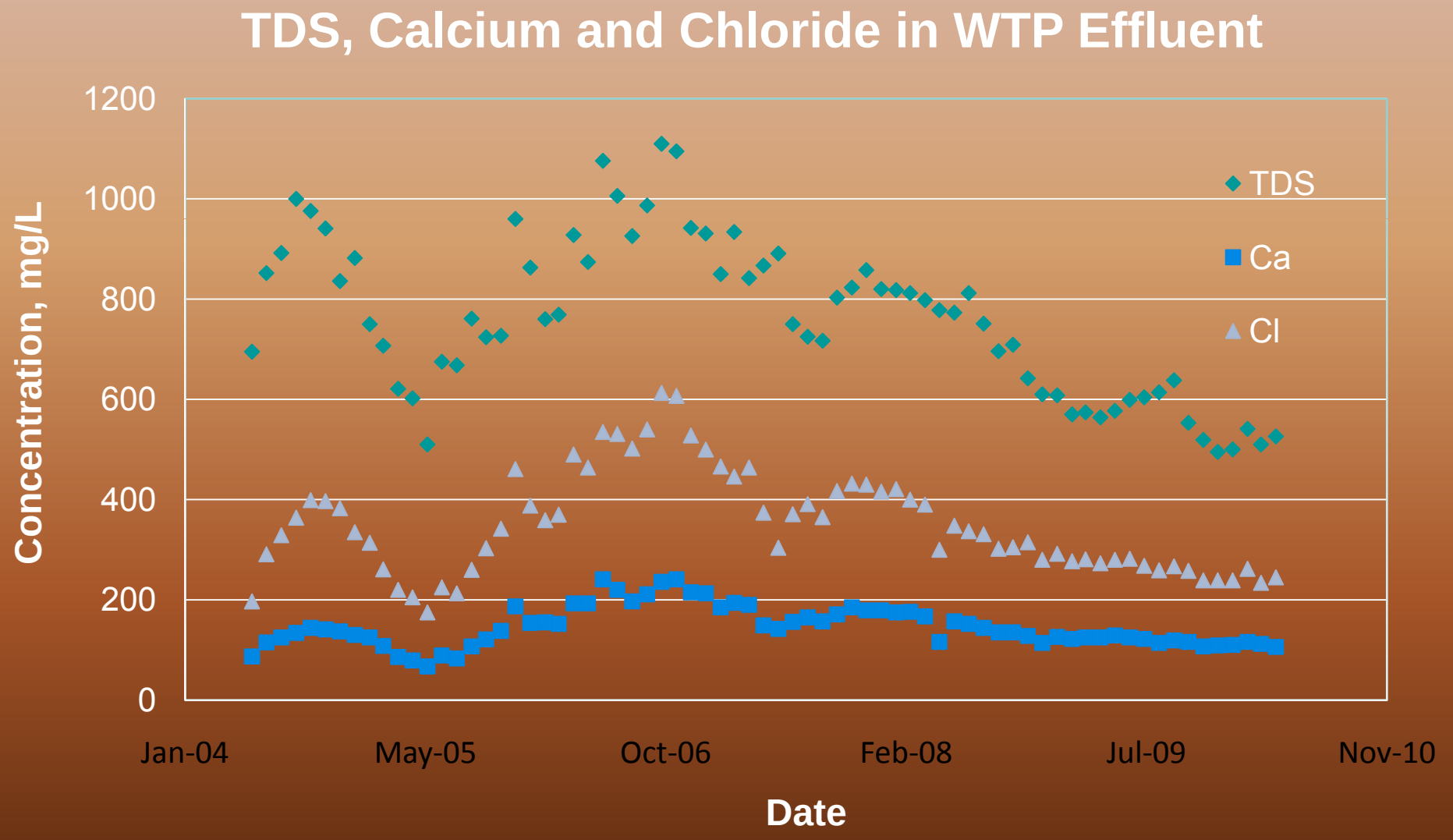



TDS, Calcium and Chloride in WTP Effluent and Snap Lake
10000
1000
100
10
1
0.1
Concentration, mg/L
TDS in WTP Effluent
TDS in Snap Lake
Ca in WTP Effluent
Ca in Snap Lake
Cl in WTP Effluent
Cl in Snap Lake
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date

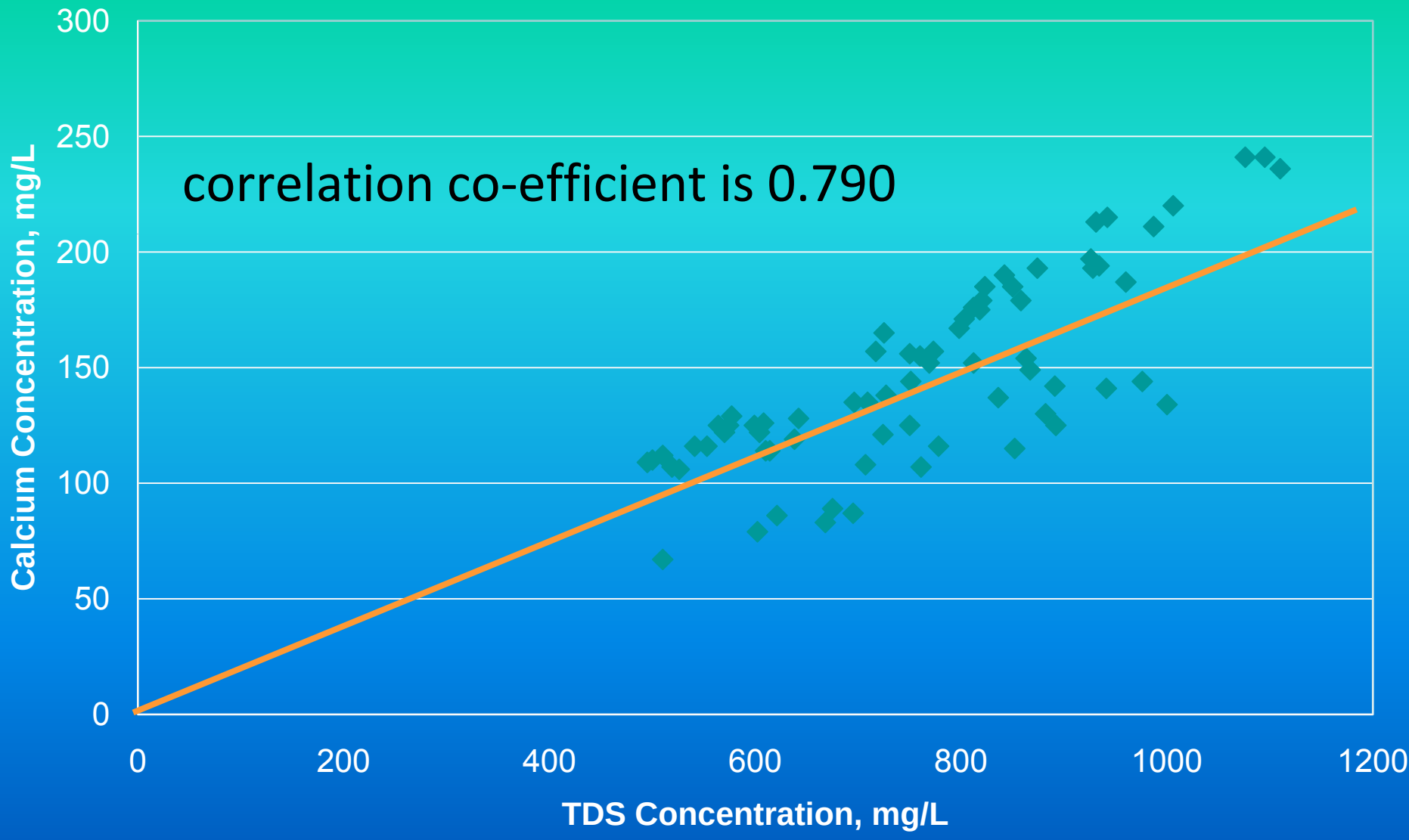
# Increase in concentrations of TDS results from WTP effluent



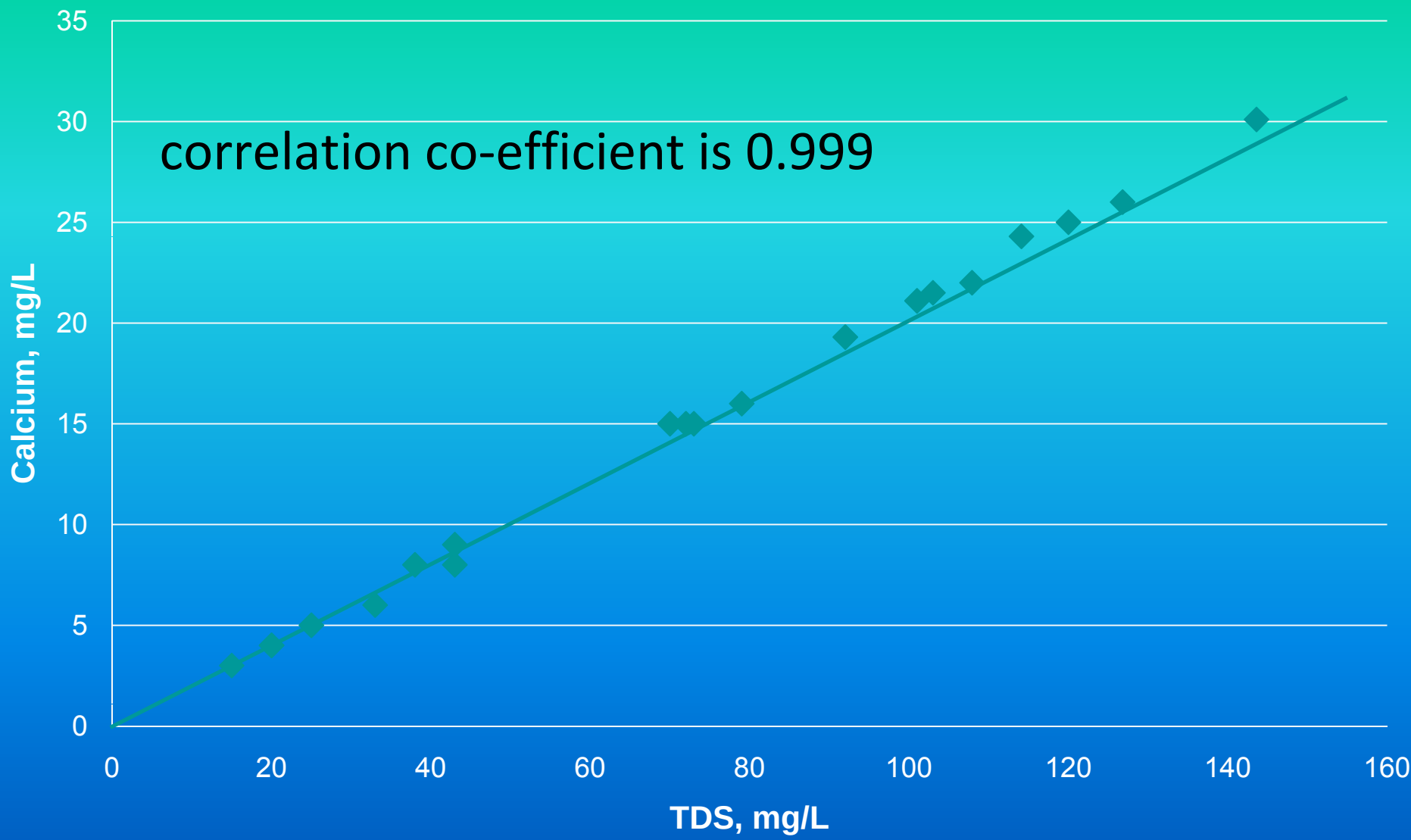
# Strong Correlations among TDS, Calcium and Chloride



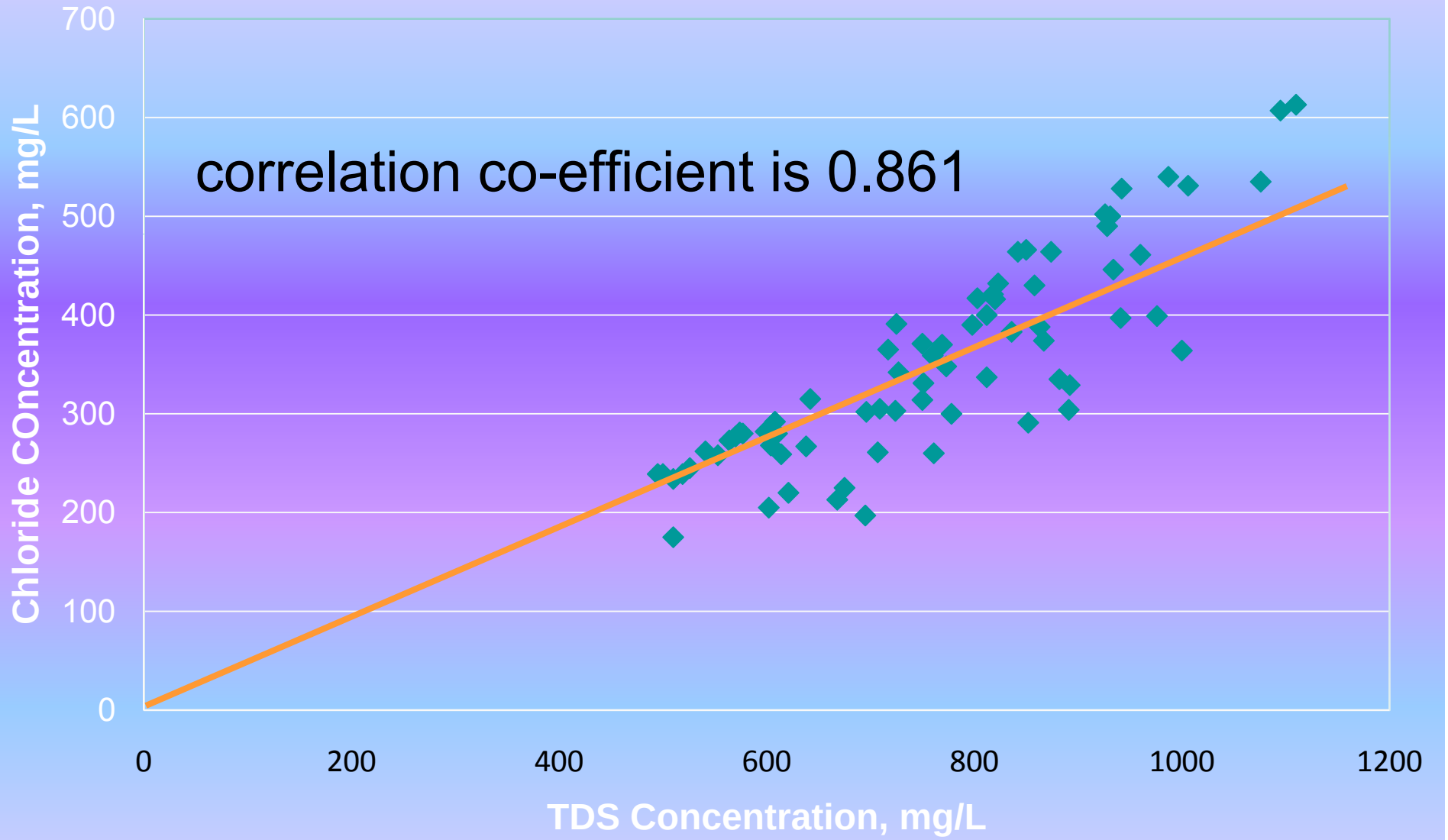
# [Ca]=0.2018[TDS] @ WTP Effluent



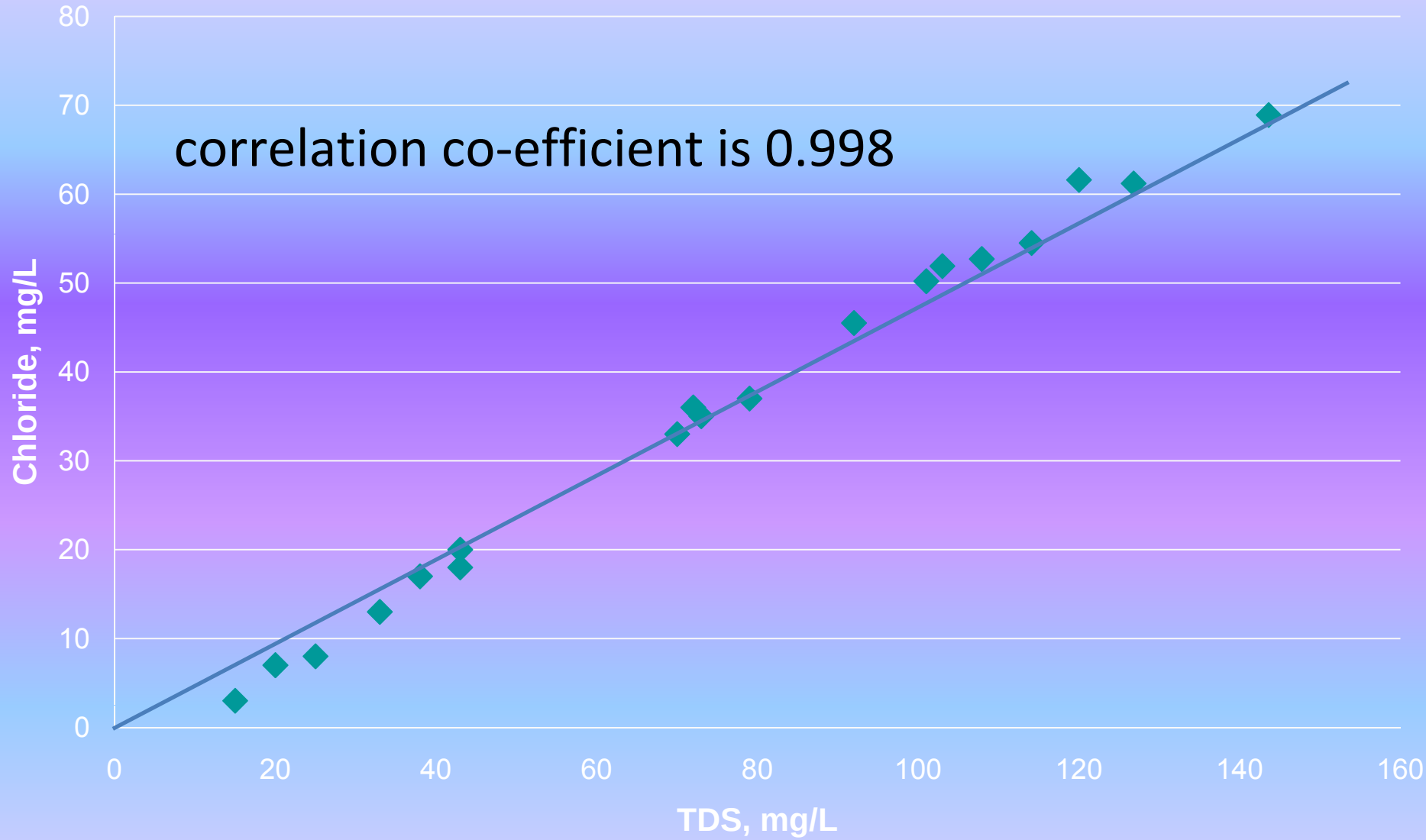
# [Ca]=0.211[TDS] @ Lake Water

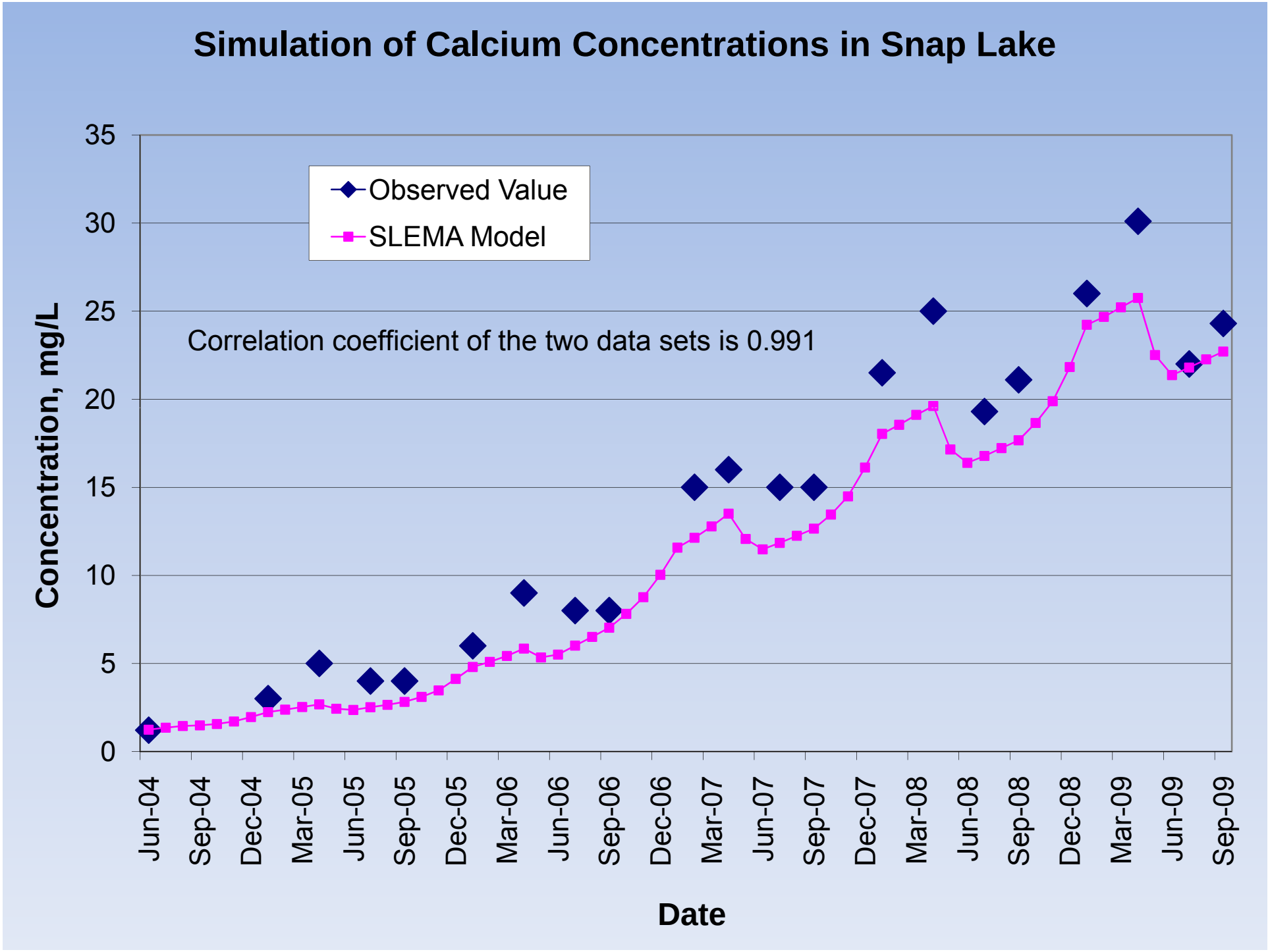


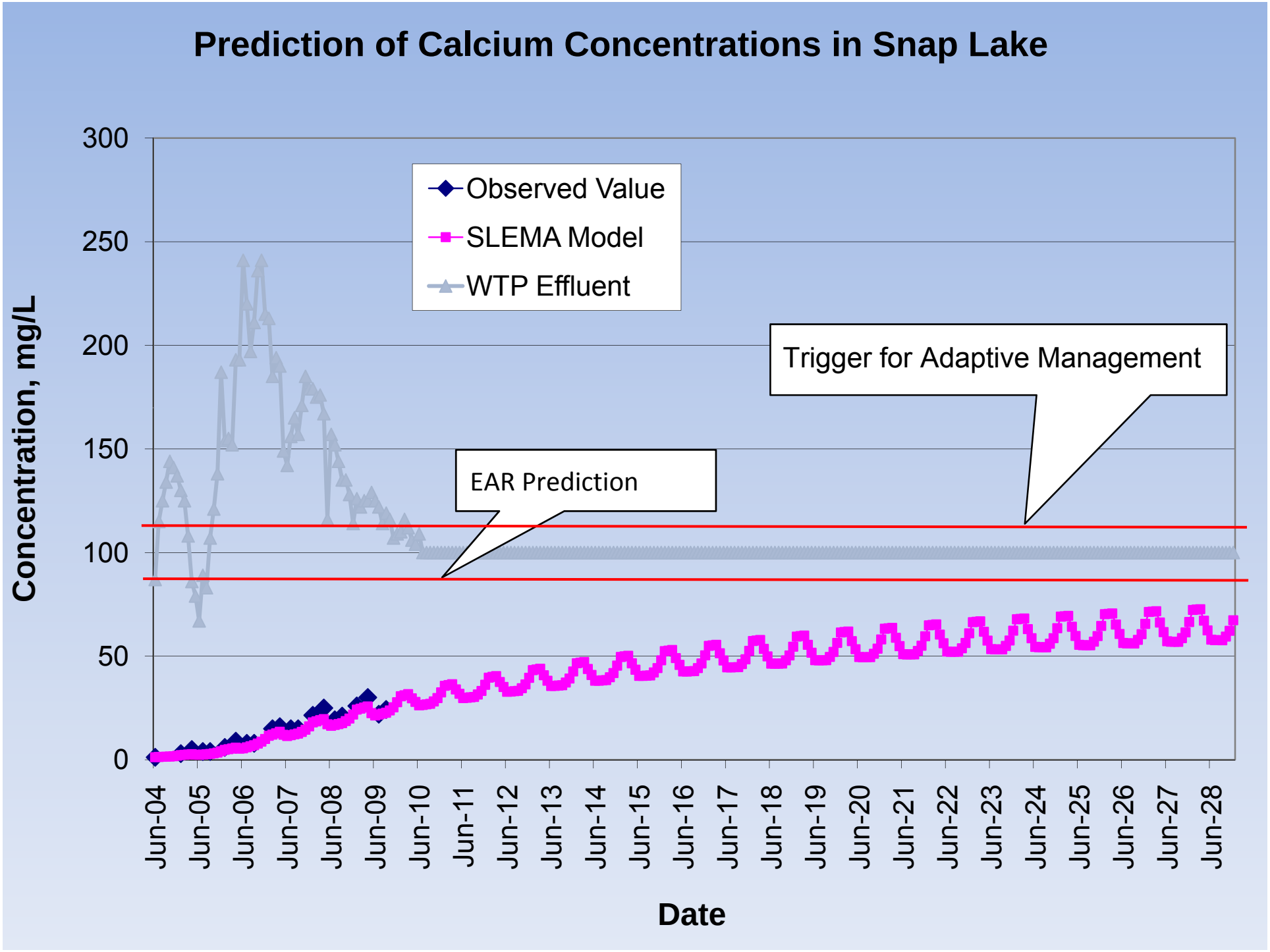
# [Cl]=0.5572[TDS] @ WTP Effluent



# [Cl]=0.523[TDS] @ Lake Water

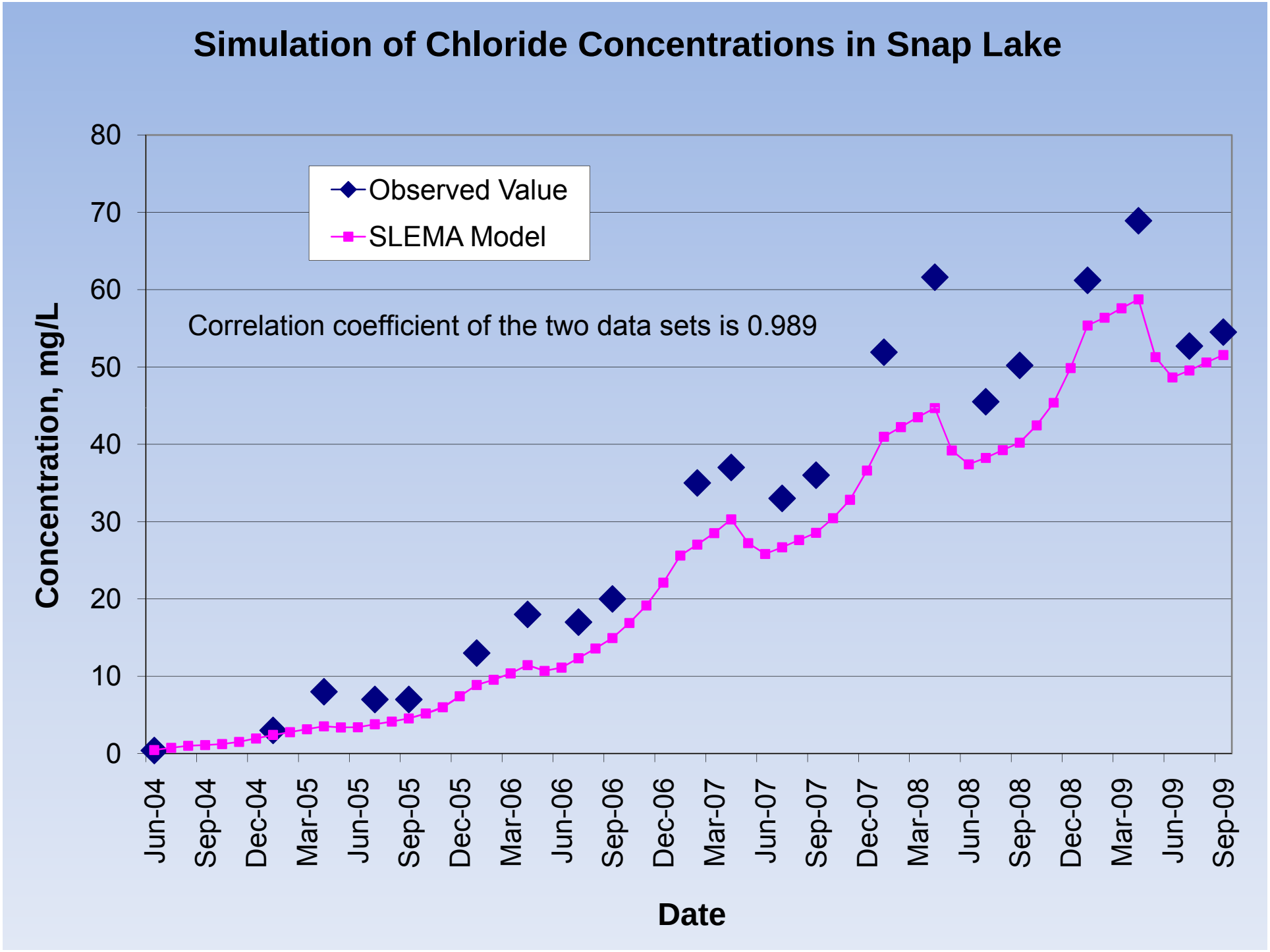


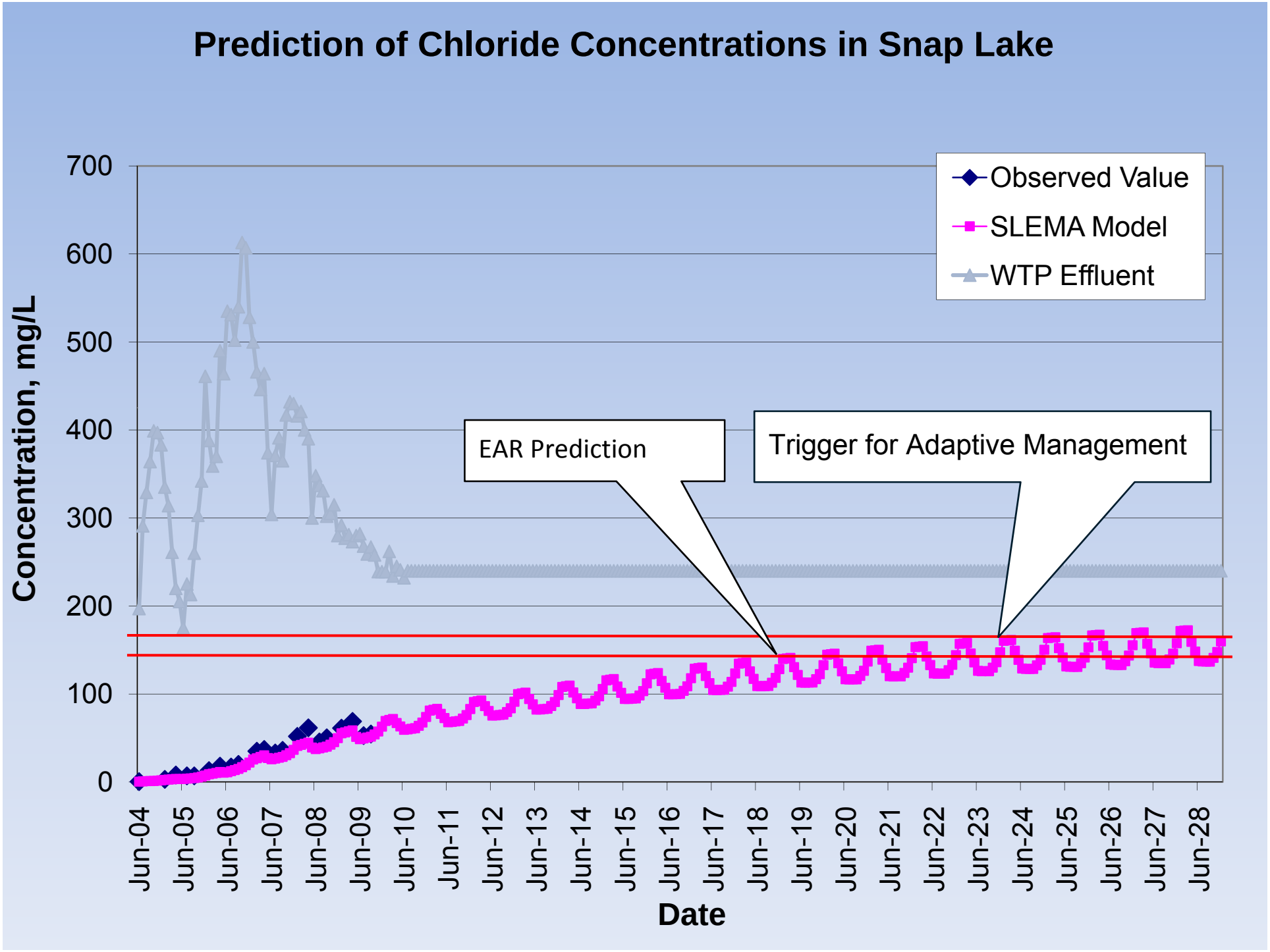

Simulation of Calcium Concentrations in Snap Lake
Observed Value
SLEMA Model
Correlation coefficient of the two data sets is 0.991
Concentration, mg/L
0
5
10
15
20
25
30
35
Jun-04
Sep-04
Dec-04
Mar-05
Jun-05
Sep-05
Dec-05
Mar-06
Jun-06
Sep-06
Dec-06
Mar-07
Jun-07
Sep-07
Dec-07
Mar-08
Jun-08
Sep-08
Dec-08
Mar-09
Jun-09
Sep-09
Date


Prediction of Calcium Concentrations in Snap Lake
Concentration, mg/L
300
250
200
150
100
50
0
Observed Value
SLEMA Model
WTP Effluent
Trigger for Adaptive Management
EAR Prediction
Jun-04
Jun-05
Jun-06
Jun-07
Jun-08
Jun-09
Jun-10
Jun-11
Jun-12
Jun-13
Jun-14
Jun-15
Jun-16
Jun-17
Jun-18
Jun-19
Jun-20
Jun-21
Jun-22
Jun-23
Jun-24
Jun-25
Jun-26
Jun-27
Jun-28
Date

# Analysis for Calcium

- The correlation co-efficient of observed values and simulated values is 0.991, as a result, the modeling is acceptable and the model could be used for prediction of whole lake average concentration for calcium
- If current WTP discharge level continues, i.e. 500,000 $m^3$/month with calcium concentration of 100 mg/L, the calcium level in Snap Lake is expected to be below the EAR prediction (88 mg/L) and the trigger for adaptive management (110 mg/L) by 2028


Simulation of Chloride Concentrations in Snap Lake
Observed Value
SLEMA Model
Correlation coefficient of the two data sets is 0.989
Concentration, mg/L
0
10
20
30
40
50
60
70
80
Jun-04
Sep-04
Dec-04
Mar-05
Jun-05
Sep-05
Dec-05
Mar-06
Jun-06
Sep-06
Dec-06
Mar-07
Jun-07
Sep-07
Dec-07
Mar-08
Jun-08
Sep-08
Dec-08
Mar-09
Jun-09
Sep-09
Date


Prediction of Chloride Concentrations in Snap Lake
Concentration, mg/L
700
600
500
400
300
200
100
0
Observed Value
SLEMA Model
WTP Effluent
EAR Prediction
Trigger for Adaptive Management
Jun-04
Jun-05
Jun-06
Jun-07
Jun-08
Jun-09
Jun-10
Jun-11
Jun-12
Jun-13
Jun-14
Jun-15
Jun-16
Jun-17
Jun-18
Jun-19
Jun-20
Jun-21
Jun-22
Jun-23
Jun-24
Jun-25
Jun-26
Jun-27
Jun-28
Date

# Analysis for Chloride

- The correlation co-efficient of observed values and simulated values is 0.989, as a result, the modeling is acceptable and the model could be used for prediction of whole lake average concentration for chloride
- If current WTP discharge level continues, i.e. 500,000 $m^3$/month with chloride concentration of 240 mg/L, the chloride level in Snap Lake is expected to be above the EAR prediction (137 mg/L) in January 2019
  - The whole lake average concentration of chloride is expected to be above the trigger for adaptive management (160 mg/L) in January 2024, then chloride concentration in hotspot area of Snap Lake must have been above the trigger earlier than 2024 and mitigation measures should have been triggered much earlier than 2024.

# Adaptive Management

- "If the concentrations of TDS, **chloride** and calcium in Snap Lake outside of the initial mixing zone are forecast to exceed 600 mg/L, 160 mg/L and 110 mg/L, respectively, the following actions would be taken:
  - Review the forecasts to make sure that future concentrations really have a reasonable potential to exceed these levels.
  - If they do, then undertake studies required to determine actual effects thresholds in Snap Lake. This could include literature review, toxicity testing and/or mesocosm (medium-sized biological communities) studies. Compare forecast concentrations to effects thresholds.
  - If forecast concentrations are greater than effects thresholds, undertake an evaluation of the risk to aquatic life."

*- Adaptive Management Plan (August 2004)*

# Recommendations

- De Beers to model the chloride concentrations in Snap Lake and confirm whether 160 mg/L will be exceeded or not in the future
  - If yes, mitigation measures should be triggered
- Based on the Sampling Plan for TDS, Calcium and Chloride, reporting requirements should be fulfilled in the coming annual reports (either in AEMP annual reports or separate TDS/Ca/Cl annual reports)
  - Results of the mass balance modeling
  - Time-series plots for forecasted whole lake average concentrations of TDS, Ca and Cl
  - Summary and discussion of historical and forecasted loadings of Ca and Cl