

# TECHNICAL MEMORANDUM

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**To:** Nevada Environmental Response Trust

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**Cc:** Nevada Division of Environmental Protection  
United States Environmental Protection Agency

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**From:** Carl Lenker and Eric Klink

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**Date:** May 1, 2020

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**Subject:** Unit 4 Source Area In-Situ Bioremediation Treatability Study Monthly Progress Report

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At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this memorandum that summarizes Tetra Tech's progress made during March 2020 toward successfully implementing the Unit 4 Source Area In-Situ Bioremediation Treatability Study.

## Task Progress Update: March 2020

### Task M21 – Unit 4 Source Area In-Situ Bioremediation (ISB) Treatability Study

- Task Leader – Arul Ayyaswami
- Current Status
  - The University of Nevada – Las Vegas (UNLV) completed microcosm and column testing in accordance with the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Work Plan and Treatability Study Modification No. 1. As indicated in the February progress report, both the microcosm and column tests concluded on February 28, 2020 (day 554 of the microcosm testing and day 381 of the column testing). While there were minor delays in the analytical testing of samples during this period due to the implementation of COVID-19 policies at UNLV and laboratories contracted by UNLV, the overall schedule of the study remains largely unaffected. The following is a brief summary of the microcosm and column testing conducted and the analytical results received through the final samples collected in February:
    - **Microcosm Testing:** Microcosm testing was performed using primary and replicate microcosms with three initial total dissolved solids (TDS) concentrations (15,200 mg/L, 17,400 mg/L, and 21,000 mg/L). The degradation of hexavalent chromium, nitrate, chlorate, and perchlorate within the microcosms containing a combination of molasses, molasses with acetate, mixed microbial cultures, and soil and groundwater collected from boring and well locations near the Unit 4 Building are summarized below and presented in Figures 1 through 8:
      - (a) The average starting hexavalent chromium concentrations were up to 50.2 mg/L. Hexavalent chromium concentrations were reduced to less than 0.1 mg/L within 22 days in the microcosms containing molasses (Figure 1). In microcosms containing

- molasses and acetate, the average hexavalent chromium concentrations reduced from up to 50.2 mg/L to less than 0.1 mg/L within 84 days (Figure 2). Some of the hexavalent chromium reduction is likely due to abiotic degradation with molasses.
- (b) Nitrate reduction followed hexavalent chromium reduction. The average starting nitrate concentrations were up to 130 mg/L. Nitrate concentrations reduced to less than 3.7 mg/L within 77 days in the microcosms containing molasses (Figure 3). In microcosms containing molasses and acetate, the average nitrate concentrations reduced from up to 130 mg/L to less than 9 mg/L within 267 days (Figure 4).
  - (c) Chlorate reduction followed nitrate reduction. The average starting chlorate concentrations were up to 10,379 mg/L. Chlorate concentrations reduced to less than 2.5 mg/L within 267 days in the microcosms containing molasses (Figure 5). In microcosms containing molasses and acetate, average chlorate concentrations reduced from up to 10,379 mg/L to less than 5 mg/L within 337 days (Figure 6).
  - (d) Perchlorate reduction followed chlorate reduction. The results for microcosms containing molasses are summarized below based on initial TDS concentrations:
    - i. In microcosms with an initial TDS concentration of approximately 15,200 mg/L, perchlorate concentrations reduced from 1,507 mg/L to 945 mg/L after 554 days (Figure 7).
    - ii. In microcosms with an initial TDS concentration of approximately 17,400 mg/L, perchlorate concentrations reduced from 1,646 mg/L to less than 0.02 mg/L after 267 days and to less than 0.01 mg/L after 347 days (Figure 7).
    - iii. In microcosms with an initial TDS concentration of approximately 21,000 mg/L, perchlorate concentrations reduced from 1,878 mg/L to approximately 0.33 mg/L after 554 days (Figure 7).
  - (e) No significant reduction of perchlorate was observed in microcosms containing molasses and acetate (Figure 8). UNLV hypothesizes that the addition of acetate, in the form of sodium acetate, resulted in increased salinity (i.e., TDS concentrations) and contributed to reduced degradation in the microcosms. UNLV is testing this hypothesis by analyzing the liquid extract from the microcosm soils.
  - (f) Testing revealed that the addition of vitamin B12 did not impact chemical of potential concern (COPC) reduction and that the addition of mixed microbial cultures is necessary to promote degradation as very low numbers of bacteria are naturally present within the deep soil collected from boring locations near the Unit 4 Building.
- **Column Testing:** The following is a summary of available analytical results for the column tests collected from January 25, 2020 through February 28, 2020:
    - (a) Hexavalent chromium concentrations decreased from influent concentrations of 100 mg/L to less than 0.1 mg/L in the intermediate columns and from influent concentrations of 60 mg/L to less than 0.1 mg/L in the deep columns.
    - (b) Nitrate concentrations decreased from influent concentrations of approximately 40 mg/L to 10 mg/L in the intermediate columns and from influent concentrations of 140 mg/L to 6 mg/L in the deep columns.
    - (c) Chlorate concentrations decreased from influent concentrations of approximately 14,000 mg/L to 8,400 mg/L in the intermediate columns and from influent concentrations of approximately 11,000 mg/L to 7,800 mg/L in the deep columns.

- (d) Perchlorate concentrations decreased from influent concentrations of approximately 1,400 mg/L to 1,000 mg/L in the intermediate columns and from influent concentrations of approximately 1,800 mg/L to 1,500 mg/L in the deep columns.

Following the completion of the column testing, UNLV opened the columns to evaluate conditions and analyze the chemistry and microbiological content. The general geochemistry and microbiological data associated with the column contents are still being evaluated and a summary of the results will be included in future monthly progress reports and the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum.

- Schedule and Progress Updates
  - The following activities are scheduled to be conducted in April 2020:
    - Obtain and evaluate final analytical results for microcosm and column test samples that were delayed due to implementation of the COVID-19 policy at UNLV and laboratories contracted by UNLV. The results will be summarized in the April monthly progress report and the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum. While UNLV has implemented policies suspending on-campus activities, including bench-scale testing, the microcosm and column tests have concluded and additional impacts to the schedule due to COVID-19 are not anticipated at this time.
    - Development of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum for Phase 2 that is currently anticipated to be submitted early in the Third Quarter of 2020.
- Health and Safety
  - There were no health and safety incidents related to Task M21 during March 2020.
  - Tetra Tech and UNLV have implemented policies and are taking precautions to address the health and safety concerns associated with COVID-19.

## CERTIFICATION

### Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report

**Nevada Environmental Response Trust Site  
(Former Tronox LLC Site)  
Henderson, Nevada**

#### Nevada Environmental Response Trust (NERT) Representative Certification

I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the systems(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Le Petomane XXVII, not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

**Signature:** Jay A. Steinberg **Not Individually, but Solely as President of the Trustee**, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

**Name:** Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

**Title:** Solely as President and not individually

**Company:** Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

**Date:** 5/1/2020

## CERTIFICATION

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I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been prepared in a manner consistent with the current standards of the profession, and to the best of my knowledge, comply with all applicable federal, state, and local statutes, regulations, and ordinances. I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.

**Description of Services Provided:** Prepared Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report.



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**Kyle Hansen, CEM**  
Field Operations Manager/Geologist  
Tetra Tech, Inc.

May 1, 2020

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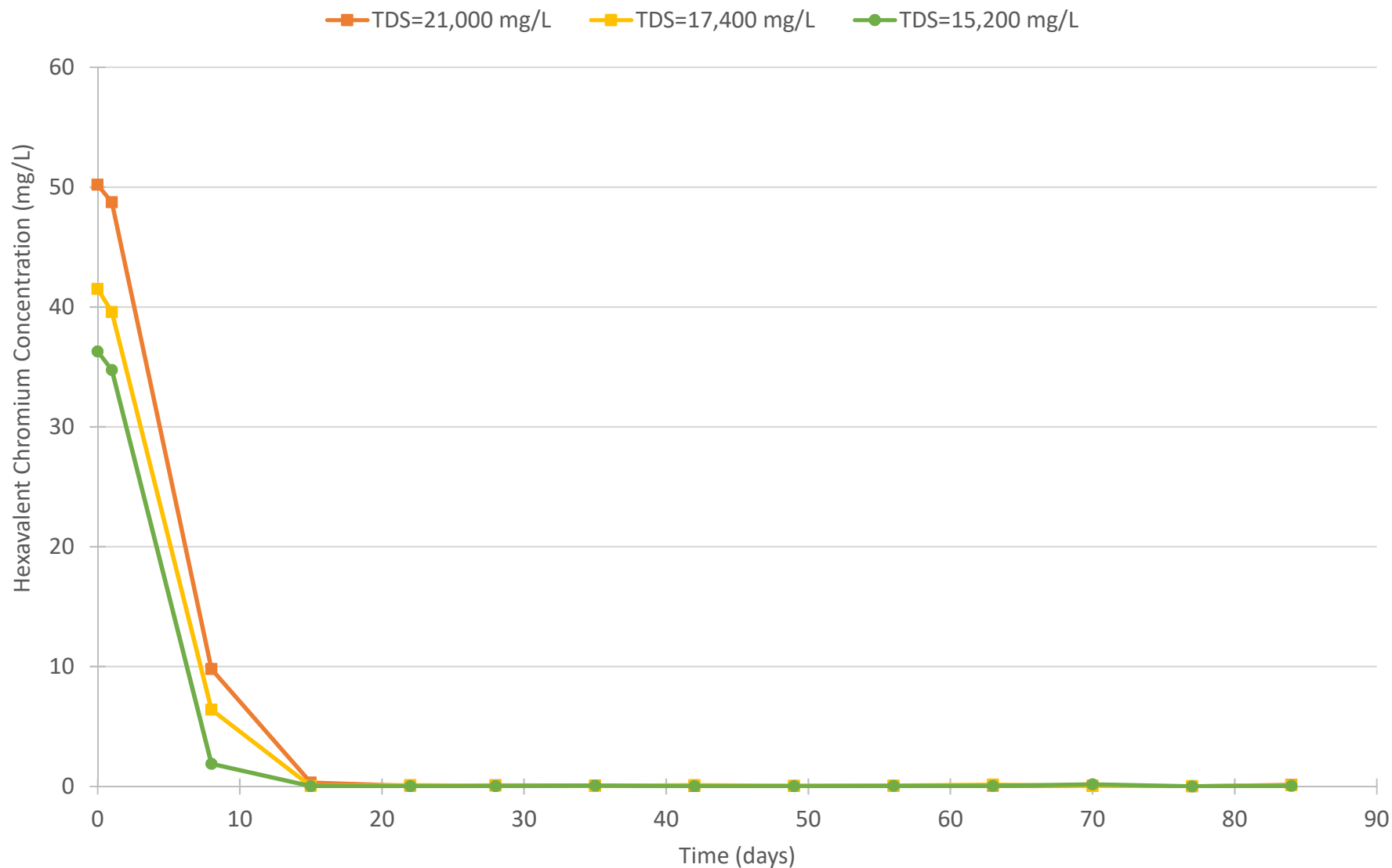
Date

Nevada CEM Certificate Number: 2167  
Nevada CEM Expiration Date: September 18, 2020

# Figures

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**Figure 1**  
**Hexavalent Chromium Concentrations in Phase II Microcosms with Molasses**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing

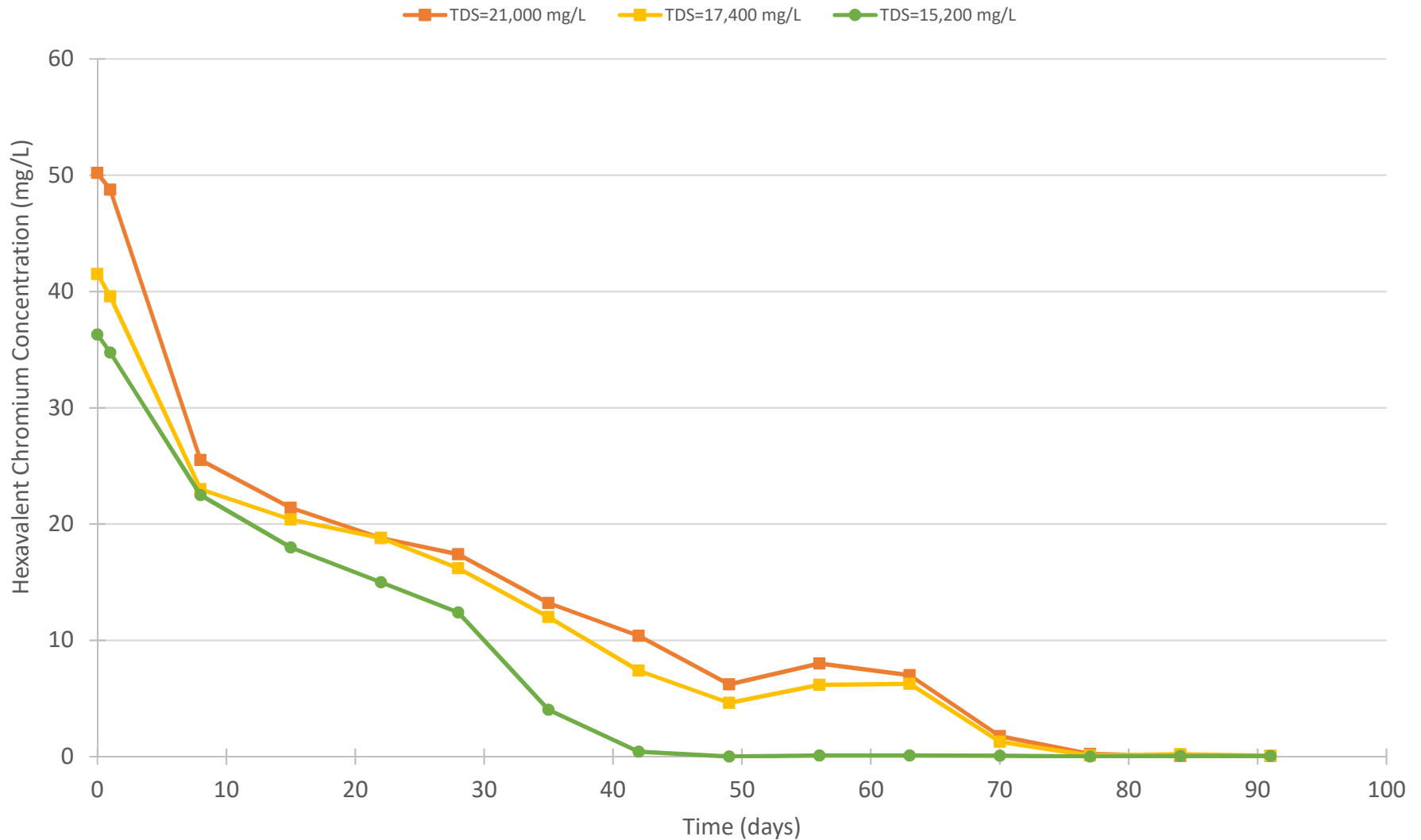


**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
- 2) Microcosms contain molasses, bacteria, and soil/groundwater from Unit 4 area.
- 3) TDS = Total Dissolved Solids

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**Figure 2**  
**Hexavalent Chromium Concentrations in Phase II Microcosms with Molasses and Acetate**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing



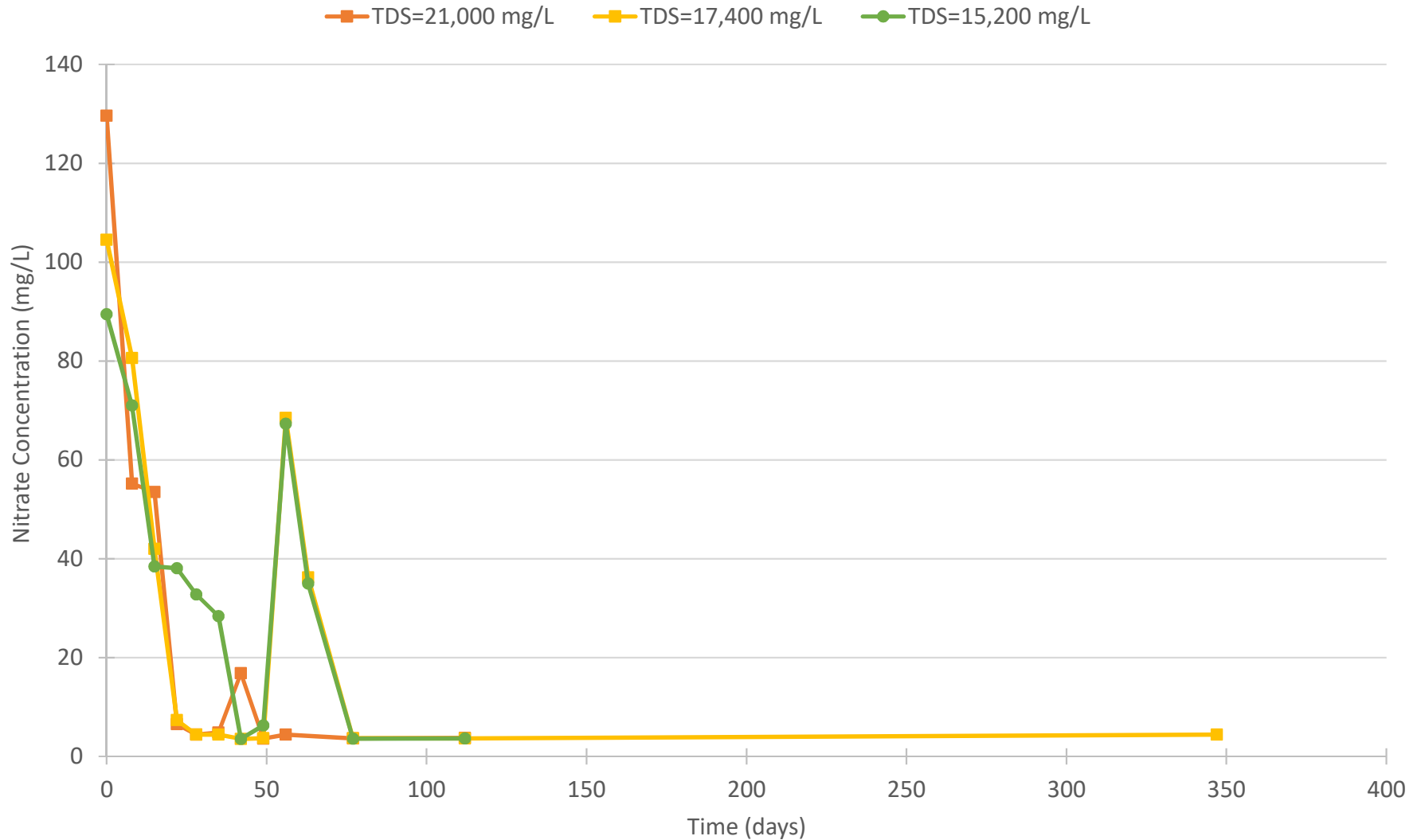
**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
- 2) Microcosms contain molasses and acetate, bacteria, and soil/groundwater from Unit 4 area.
- 3) TDS = Total Dissolved Solids



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**Figure 3**  
**Nitrate Concentrations in Phase II Microcosms with Molasses**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing

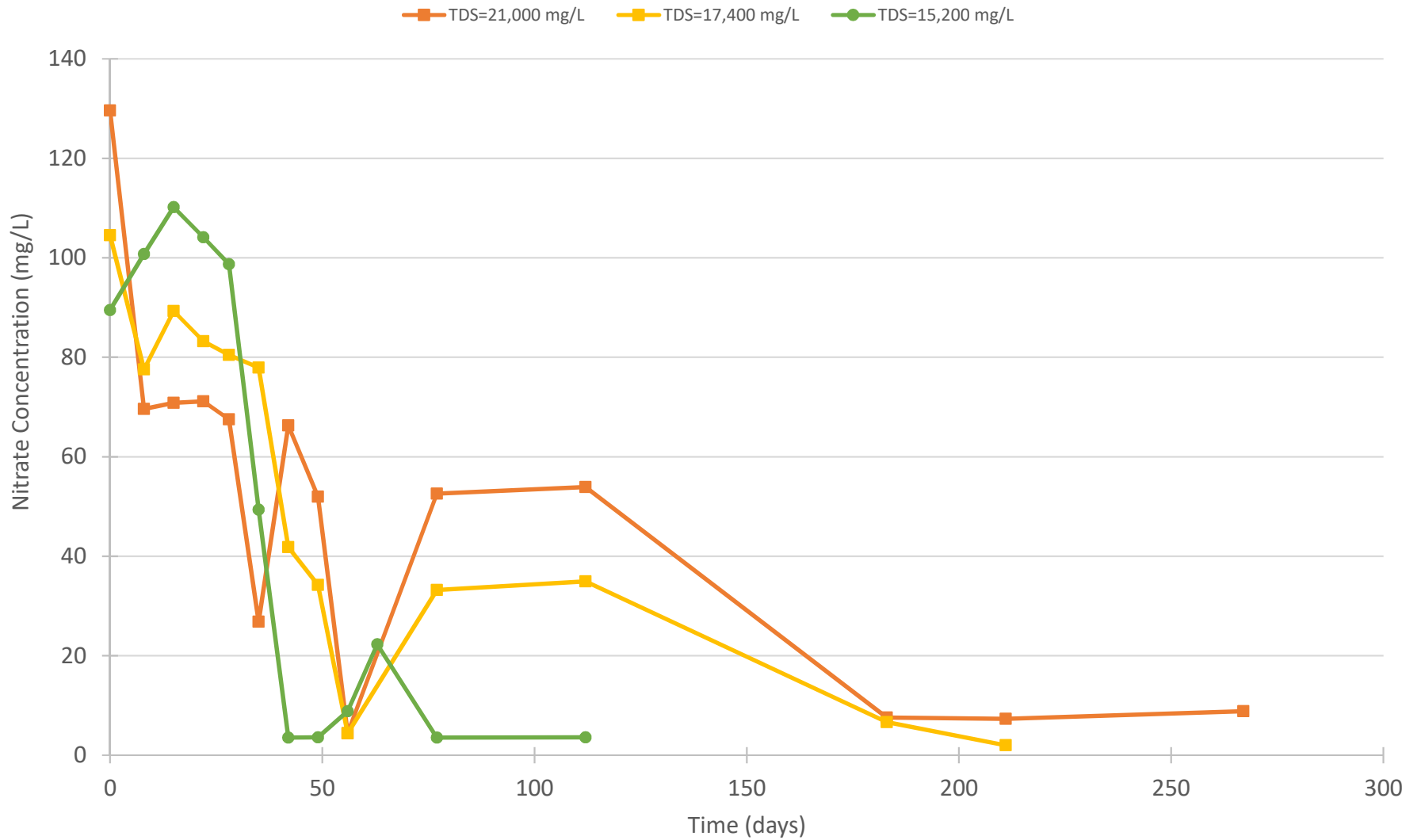


**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
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- 3) TDS = Total Dissolved Solids

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**Figure 4**  
**Nitrate Concentrations in Phase II Microcosms with Molasses and Acetate**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing

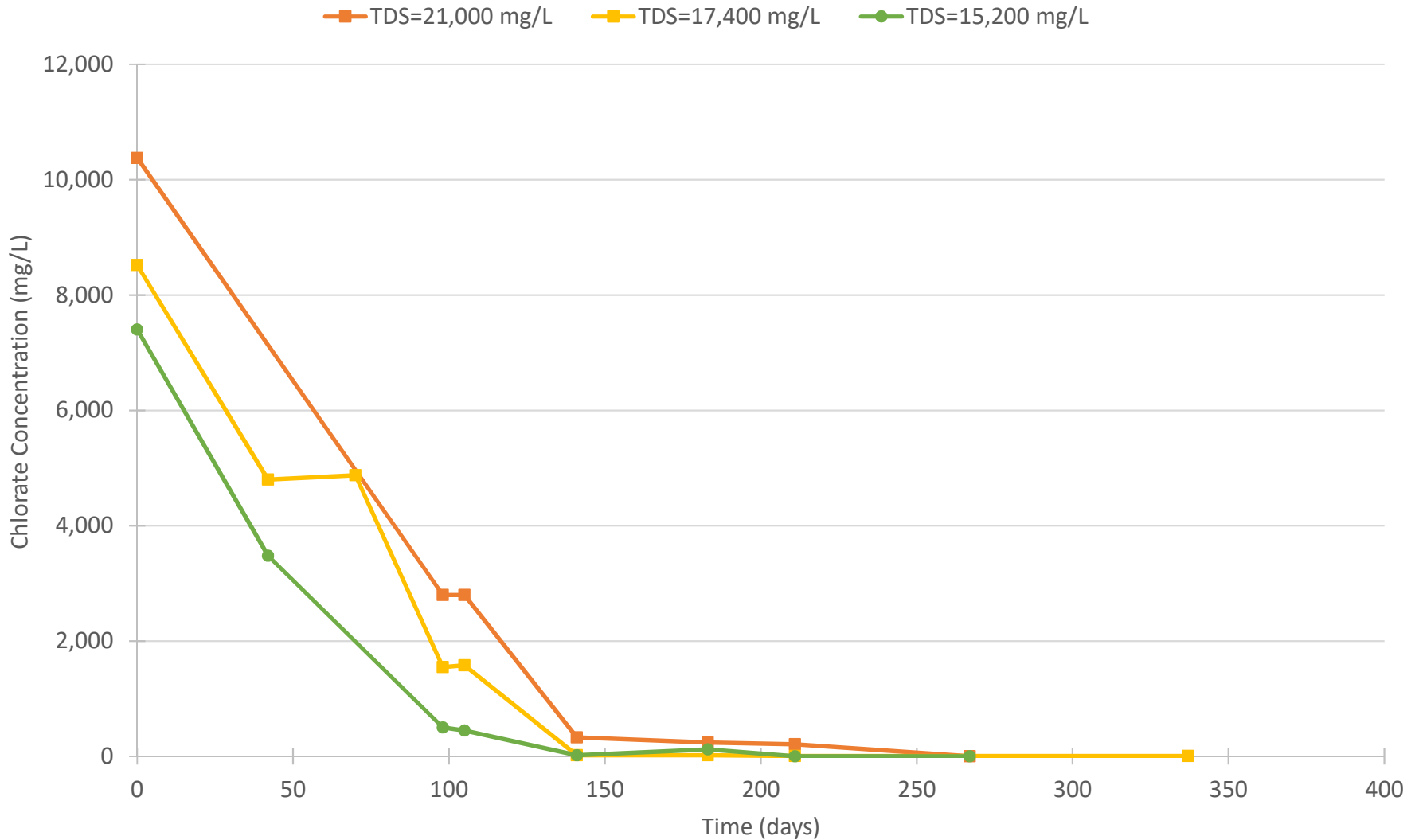


**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
- 2) Microcosms contain molasses and acetate, bacteria, and soil/groundwater from Unit 4 area.
- 3) TDS = Total Dissolved Solids

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**Figure 5**  
**Chlorate Concentrations in Phase II Microcosms with Molasses**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing

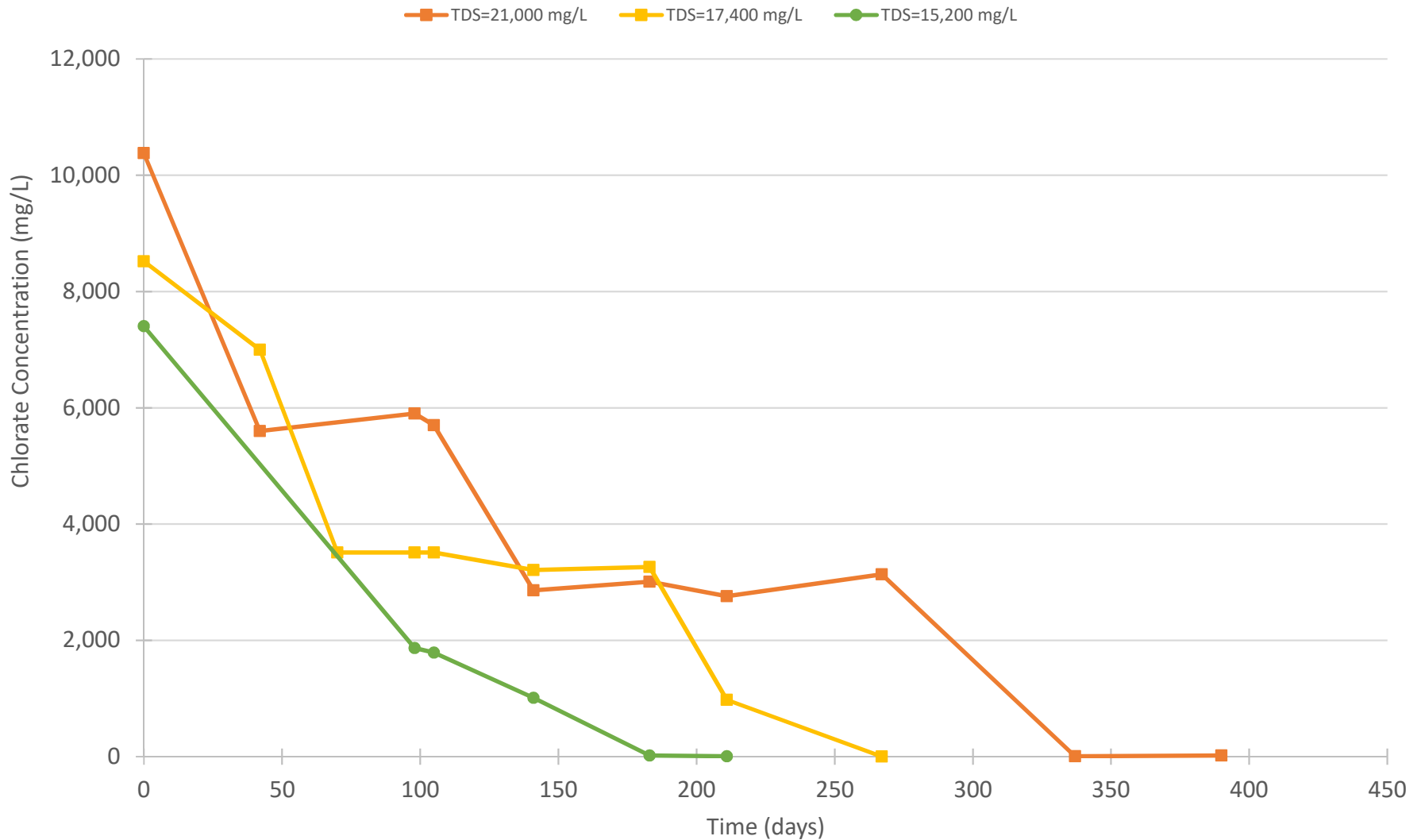


**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
- 2) Microcosms contain molasses, bacteria, and soil/groundwater from Unit 4 area.
- 3) TDS = Total Dissolved Solids

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**Figure 6**  
**Chlorate Concentrations in Phase II Microcosms with Molasses and Acetate**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing

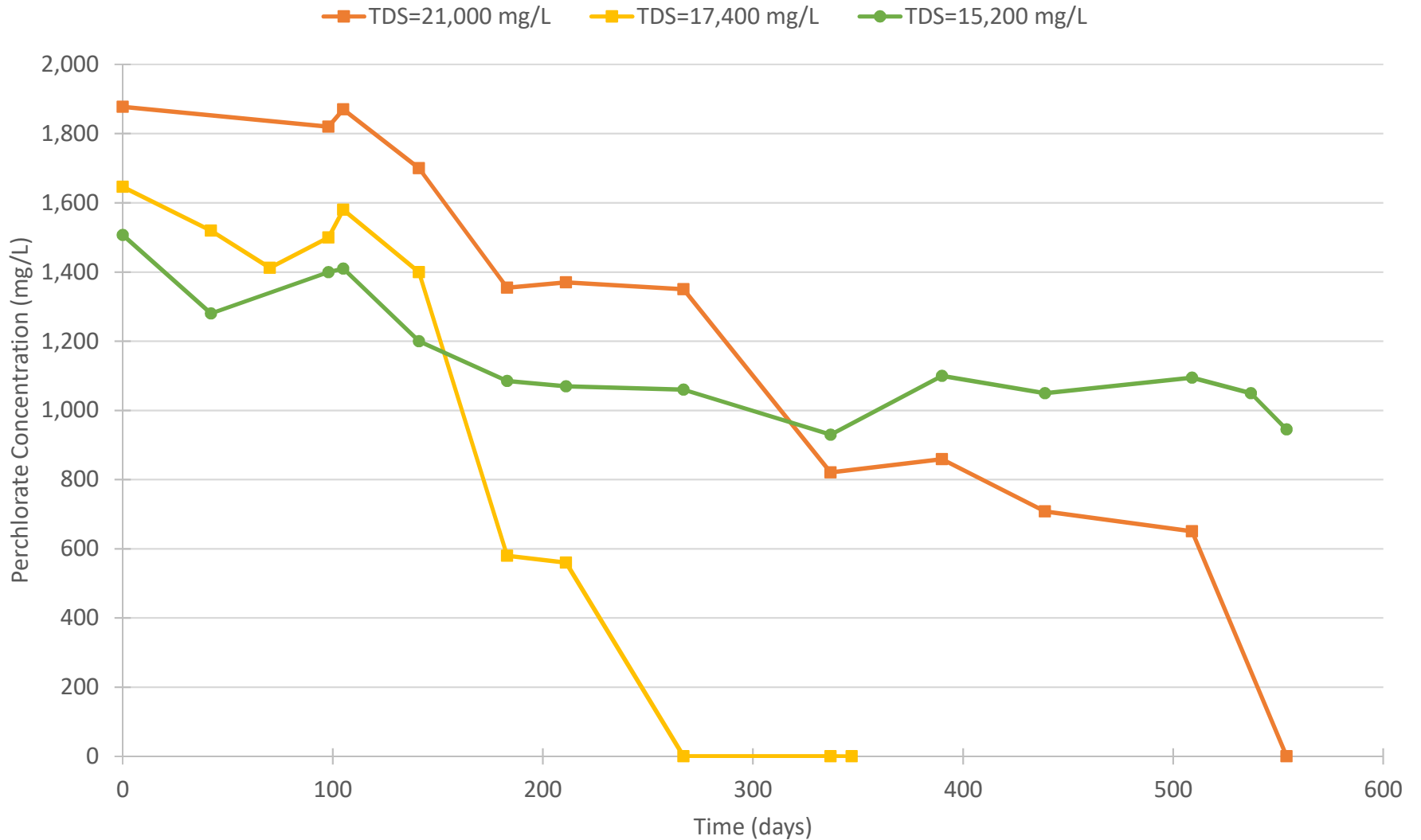


**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
- 2) Microcosms contain molasses and acetate, bacteria, and soil/groundwater from Unit 4 area.
- 3) TDS = Total Dissolved Solids

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**Figure 7**  
**Perchlorate Concentrations in Phase II Microcosms with Molasses**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing

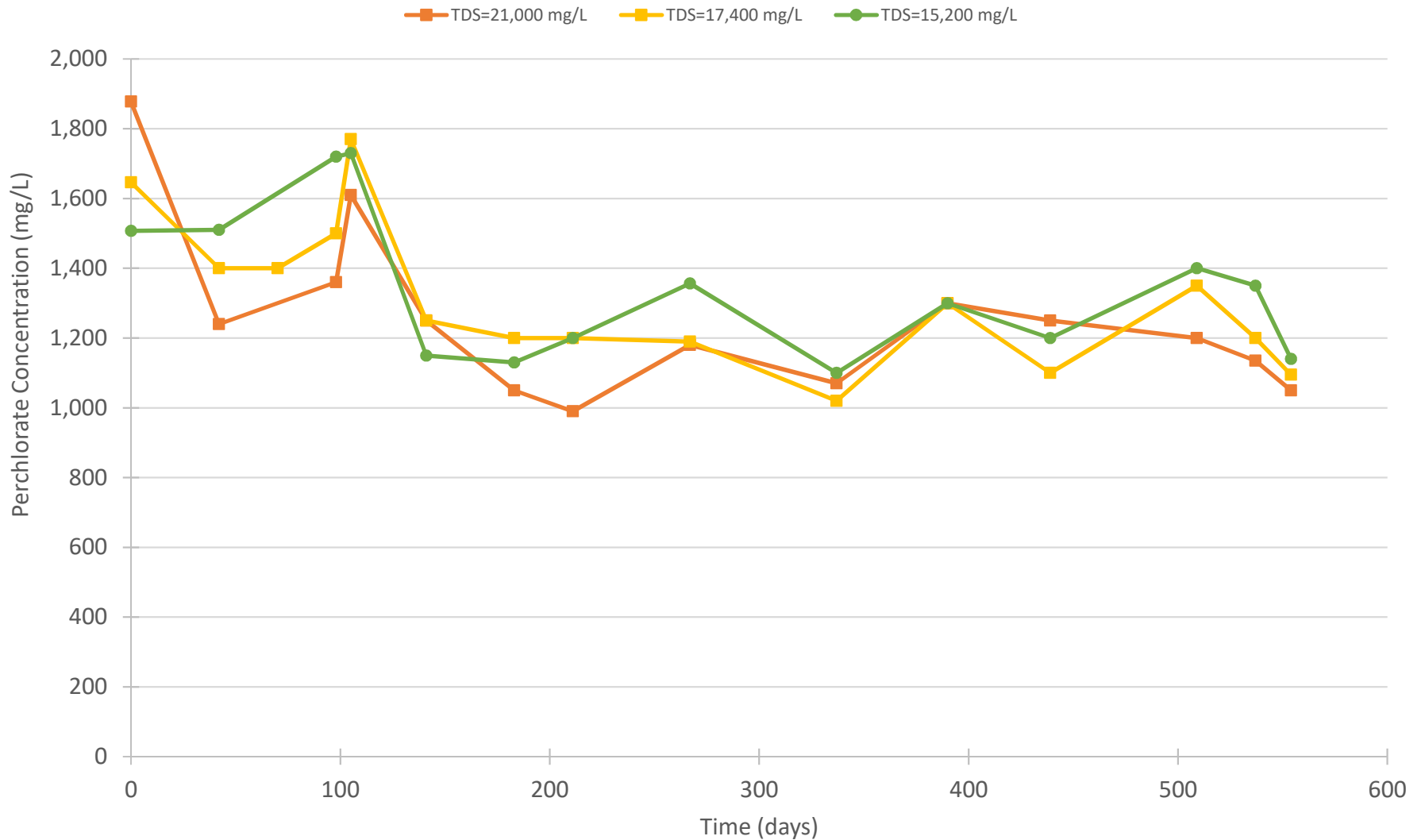


**Notes:**

- 1) The graph depicts average concentrations from the primary and replicate microcosms.
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**Figure 8**  
**Perchlorate Concentrations in Phase II Microcosms with Molasses and Acetate**  
Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Testing



**Notes:**

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- 2) Microcosms contain molasses and acetate, bacteria, and soil/groundwater from Unit 4 area.
- 3) TDS = Total Dissolved Solids