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Liquid Secondary Waste Grout Formulation and Preliminary Waste Form Qualification

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March 2016

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Executive Summary

This report describes the results from liquid secondary waste (LSW) grout formulation and waste form qualification tests performed at Pacific Northwest National Laboratory (PNNL) for Washington River Protection Solutions (WRPS) to evaluate new formulations for preparing a grout waste form with high-sulfate secondary waste simulants and the release of key constituents from these grout monoliths.

Specific objectives of the LSW grout formulation and waste form qualification tests described in this report focused on five activities:

1. preparing new formulations for the LSW grout waste form with high-sulfate LSW simulants and solid characterization of the cured LSW grout waste form
2. conducting the U.S. Environmental Protection Agency (EPA) Method 1313 leach test (EPA 2012) on the grout prepared with the new formulations, which solidify sulfate-rich Hanford Tank Waste Treatment and Immobilization Plant (WTP) off-gas condensate secondary waste simulant, using deionized water (DIW)
3. conducting the EPA Method 1315 leach tests (EPA 2013) on the grout monoliths made with the new dry blend formulations and three LSW simulants (242-A evaporator condensate, Environmental Restoration Disposal Facility (ERDF) leachate, and WTP off-gas condensate) using two leachants, DIW and simulated Hanford Integrated Disposal Facility (IDF) Site vadose zone pore water (VZPW)
4. estimating the ^{99}Tc desorption K_d (distribution coefficient) values for ^{99}Tc transport in oxidizing conditions to support the IDF performance assessment (PA)
5. estimating the solubility of ^{99}Tc(IV)-bearing solid phases for ^{99}Tc transport in reducing conditions to support the IDF PA.

The key findings from this work are listed below and supported by the following summarized results:

1. The hydrated lime (HL)-based grout formulation instead of fly ash (FA) could replace the Cast Stone formulation based on FA for sulfate-rich LSW streams. Both HL-based formulations with 20 wt% HL, 35 wt% ordinary Portland cement (OPC), and 45 wt% blast furnace slag (BFS) dry ingredients and 20 wt% HL, 10 wt% OPC, and 70 wt% BFS dry ingredients worked well with two water-to-dry mix ratios (0.5 and 0.6).
2. The conservative average values for ^{99}Tc leachability for either of these new LSWG formulations were determined from 28-day to 140-day leaching intervals of EPA Method 1315; they are $D_{eff} = 10^{-12.5\pm1.0}$ cm^2/s (or LI = 12.5±1.0) in either DIW or VZPW under 100% saturation conditions. These values include effects from physical and/or chemical processes that can control ^{99}Tc release in addition to diffusion retarded ^{99}Tc releases during the later leaching periods.
3. For ^{99}Tc release under oxidizing conditions (E_h values > +100 mV and after 30 days desorption reaction), a ^{99}Tc desorption K_d value of 24±5.4 mL/g is measured for ^{99}Tc release. However, the redox condition was not 100% oxidized, because of the remainng BFS could still behave as reductant.
4. For ^{99}Tc release under reducing conditions, a value of $4.3\pm3.8 \times 10^{-9}$ M for the solubility of ^{99}Tc(IV)-bearing solid phases was measured at 12.5 pH and -400 mV E_h conditions after 51-days reaction.

Additional data with longer reaction time are needed to confirm steady state condition and update the ^{99}Tc solubility value.

The new dry blend formulations for the LSW grout waste forms were developed with addition of hydrated lime (HL) to form ettringite and increase pH to activate BFS. The HL-based grout formulations consisting of 20 wt% HL, 35 wt% OPC, and 45 wt% BFS or 20 wt% HL, 10 wt% OPC, and 70 wt% BFS were chosen to form the grout monoliths and tested to compare the results with the current Cast Stone dry blend formulation (8 wt% OPC, 45 wt% FA, and 47 wt% BFS dry ingredients) and an additional FA-containing Cast Stone formulation (20 wt% OPC, 35 wt% FA, and 45 wt% BFS). All the grout monoliths were successfully formed by adding a water-reducing agent (MasterGlenium 3030 from BASF Corp.) to reduce viscosity and improve flowability of the mix. The resultant 28-day cured grout monoliths did not show any free water or noticeable defects. All the new formulations with HL (20 wt%) formed both ettringite [$Ca_6Al_2(SO_4)_3(OH)_{12}•26H_2O$] and portlandite [$Ca(OH)_2(s)$] minerals upon setting. However, the LSW grout monoliths prepared with FA for the WTP off-gas simulant only formed ettringite with no evidence of forming portlandite. The grout monoliths that lack portlandite mineral are considered more vulnerable to chemical attack and carbonation reactions, which could react with the hydrated matrix and degrade the mechanical properties of the grout monolith as weathering processes proceed (Kutchko et al. 2007).

The EPA Method 1313 leach test results showed that ^{99}Tc release increased as pH increased. In general, the highest ^{99}Tc releases were found from the samples of grout monolith T11 prepared with FA (20 wt% OPC, 35 wt% FA, and 45 wt% BFS dry ingredients) compared to the other grout samples prepared with HL (T3 and T6 prepared with 35 wt% OPC, 20 wt% HL, and 45 wt% BFS dry ingredients). The new formulation of LSW grout using HL addition and 0.5 w/dm ratio resulted in the lowest ^{99}Tc release from the EPA Method 1313 leach tests.

The grout monoliths prepared with the new HL formulation also showed lower ^{99}Tc effective diffusivity (D_{eff}) values than the current FA-based Cast Stone formulation in EPA Method 1315 leach tests conducted on 18 grout formulations spiked with ^{99}Tc. The average ^{99}Tc D_{eff} value for grout monolith T13 prepared with the current Cast Stone formulation at 0.6 w/dm ratio with the WTP off-gas simulant from 28-day to 140-day leaching intervals in DIW leaching solution was about one order of magnitude higher than the ^{99}Tc D_{eff} value determined for the grout monolith T6 prepared with HL under the same formulation conditions. The ^{99}Tc releases from the FA-based current Cast Stone grout (T13) were controlled by diffusion, showing a good linearity and a slope within acceptable limits (a slope of 0.5 ± 0.15). However, the low releases of ^{99}Tc from most of the HL-based grouts did not seem to follow a pure diffusion mechanism. Additional physical and/or chemical processes resulted in the low ^{99}Tc releases for the HL-based grouts, especially for later leaching periods. The grout monoliths prepared with the admixture (Xypex Admix C-500) or both ^{99}Tc getters (Sn-apatite and $SnCl_2$) and Xypex did not show any significant decrease in ^{99}Tc D_{eff} values compared to the grout monoliths prepared with HL, with or without Xypex and/or ^{99}Tc getters.

For ^{99}Tc desorption K_d (distribution coefficient) measurements on crushed LSW grouts, desorption of ^{99}Tc for the relatively finer size fractions under oxidizing conditions showed decreasing ^{99}Tc desorption K_d values with increasing desorption times. Average ^{99}Tc desorption values were determined using 5–20 mm size-fraction samples for both 7 and 30 days of contact between ^{99}Tc-laden crushed LSW grout and uncontaminated $Ca(OH)_2$-saturated grout pore water. The resultant ^{99}Tc desorption K_d values were 17.9±3.8, 28.0±4.6, and 26.2±5.1 mL/g for the grouts T19, T20, and T21, respectively. However, some

BFS likely remained and worked as a reductant for 30 days reaction time so that the redox condition was not 100% oxidized.

^{99}Tc solubility test results showed that the aqueous ^{99}Tc concentration of each sample of crushed LSW grout decreased with increasing reaction times for all samples. After 51 days reaction time under reducing conditions, the aqueous ^{99}Tc concentrations in all samples converged to average values of 0.34 µg/L (or 3.4×10^{-9} M), 0.43 µg/L (or 4.3×10^{-9} M), and 0.51 µg/L (or 5.1×10^{-9} M) at similar pH (~12.5) for the LSW grouts T19, T20, and T21, respectively. These final effluent ^{99}Tc concentrations suggest that a single-value empirical solubility of ~$4.3 \pm 3.8 \times 10^{-9}$ M (or 0.42±0.37 µg/L) based on 51 days of testing at 12.5 pH and -400 mV E_h conditions can be used for ^{99}Tc release in the reducing near-field IDF conditions and that a ^{99}Tc(IV)-bearing solid phase is controlling ^{99}Tc release from LSW grouts. Additional testing beyond 51 days reaction time should be conducted to confirm steady-state conditions and provide additional data to support the ^{99}Tc solubility value under reducing conditions.

Based on the results, the new LSW grout formulations using HL, even without adding ^{99}Tc getters or Xypex are good enough to limit ^{99}Tc diffusivity to below 10^{-12} cm^2/s. The new formulation using HL instead of FA should replace the Cast Stone formulation for sulfate-rich LSW streams. The results obtained in this task can help fill existing data gaps, support final selection of a LSWG waste form, and improve the technical defensibility of long-term waste form performance estimates for the upcoming IDF performance assessment.

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Acronyms and Abbreviations

ASTM	ASTM International (West Conshohocken, PA)
BFS	blast furnace slag
Ca_2S	dicalcium silicates
Ca_3S	tricalcium silicate
C-S-H	calcium-silicate-hydrate
DDI	double deionized
D_{eff}	effective diffusivity
DFLAW	direct-feed low-activity waste
DIW	deionized water (18.2 MΩ·cm)
DOE	U.S. Department of Energy
EC	electrical conductivity
EDS	energy dispersive spectroscopy
E_h	oxidation/reduction potential
EPA	U.S. Environmental Protection Agency
EQL	estimated quantification limit
ERDF	Environmental Restoration Disposal Facility
ETF	effluent treatment facility
FA	fly ash
HDEHP (or DEHPA)	di-(2-ethylhexyl) phosphoric acid
HL	hydrated lime, $Ca(OH)_2$
IC	ion chromatography
ICP-MS	inductively coupled plasma mass spectroscopy
ICP-OES	inductively coupled plasma optical emission spectroscopy
IDF	Integrated Disposal Facility
K_d	distribution coefficient
LAW	low-activity waste (Hanford)
LI	leachability index
LSW	liquid secondary waste
LSWG	liquid secondary waste grout
MC	moisture content
NEA	nuclear energy agency
ND	not detected
NIST	National Institute of Standards and Technology
NR	not reportable
OPC	ordinary Portland cement
PA	performance assessment
PNNL	Pacific Northwest National Laboratory

PVDF	polyvinylidene fluoride
QA	quality assurance
rad	radiological
R&D	research and development
RCRA	Resource Conservation and Recovery Act of 1976
SEM	scanning electron microscopy
SHE	standard hydrogen electrode
SRNL	Savannah River National Laboratory
SWCS	secondary waste Cast Stone
TCLP	toxicity characteristic leaching procedure
UHC	underlying hazardous constituent
USGS	U.S. Geological Survey
UTS	universal treatment standard
VZPW	vadose zone pore water
w/dm	water-to-dry-mix ratio
WRA	water-reducing additive
WRPS	Washington River Protection Solutions
WTP	Hanford Tank Waste Treatment and Immobilization Plant
WWFTP	WRPS waste form testing program
XRD	x-ray diffraction

Units of Measure

°C	temperature in degrees Celsius [T(°C) = T(K) − 273.15]
cm	centimeter
cm^2/s	square centimeter(s) per second
d	day
g	gram
K	kelvin
L	liter
m	meter
M	molarity, mole/liter
mL	milliliter
mm	millimeter
mol	mole
ppm	parts per million
rpm	revolutions per minute
s	second(s)
S	siemens
wt%	weight percent
µ	micro (prefix, 10^{-6})
µeq	microequivalent(s)

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1.0 Introduction

The Hanford Site, in south-central Washington State, holds approximately 56 million gallons of radioactive waste in 177 underground storage tanks generated by over four decades of nuclear fuel processing to produce plutonium for the nation's nuclear weapons arsenal. The U.S. Department of Energy (DOE) is proceeding with plans to retrieve the waste from the tanks, separate the low-activity waste (LAW) fraction from the high-level waste fraction, and immobilize both fractions in glass waste forms in preparation for final disposal.

As a prime contractor to the DOE, Washington River Protection Solutions (WRPS) has responsibility for operating the Hanford Site Effluent Treatment Facility (ETF). The ETF currently treats aqueous waste streams including evaporator condensates from the Hanford 242-A Evaporator, Hanford Environmental Restoration Disposal Facility (ERDF) and future Integrated Disposal Facility (IDF) leachates, laboratory wastes, and contaminated groundwater. The ETF currently produces a primary waste stream consisting of purified water and a secondary waste stream consisting of dried powder packaged in drums. A solidification process is being developed to produce a stabilized waste form suitable for disposal in the IDF once the Hanford Waste Treatment and Immobilization Plant (WTP) begins waste treatment operations. When operational, the WTP will generate secondary waste streams from primary and secondary off-gas capture systems that will be sent to the ETF for treatment. The solidification process will be used to stabilize concentrated brine from the ETF secondary waste treatment train that is currently dried in a rotary evaporator and packaged in drums for disposal. These ETF waste streams will be solidified in a cementitious waste form to meet anticipated waste acceptance criteria for disposal in the IDF. In 2005, Lockrem (2005) documented testing leading to the selection of a cementitious waste form called "Cast Stone" for stabilization of Hanford LAW. A dry blend mix of 47 wt% blast furnace slag (BFS), 45 wt% class F fly ash (FA), and 8 wt% ordinary Portland cement (OPC) was the selected formulation for the Cast Stone. Sundaram et al. (2011) conducted a set of screening tests to evaluate the impact of waste composition, waste concentration, source of dry blend materials, and mix ratio (ratio of mass of free water in the liquid waste to mass of dry mix) on waste form performance. Based on the testing results, Cast Stone was selected as a low-temperature cementitious waste form for stabilization of the ETF-treated wastes.

However, subsequent to the completion of the Cast Stone selection process, additional information about the future liquid wastes to be treated in the ETF indicated that the waste streams to be solidified will be relatively high in sulfate. In this case, the standard Cast Stone formulation with OPC, FA, and BFS may not be adequate for solidifying high-sulfate waste streams. For the purposes of this report, formulations different from the current Cast Stone formulation (47% BFS, 45% FA, and 8% OPC) are referred to as LSW grouts (LSWGs). Cooke et al. (2006) conducted a testing program to develop a cementitious waste form for the solidification of high-sulfate wastes after treatment in the ETF. Their recommended dry blend mix included 36 wt% OPC, 36 wt% BFS, and 28 wt% hydrated lime (HL), and the waste simulant was at 30 wt% total solids evaporator condensate. In new grout formulation, the HL [$Ca(OH)_2$] is added to initially form ettringite [$Ca_6Al_2(SO_4)_3(OH)_{12}$•$26(H_2O)$] to tie up sulfate so that ettringite does not form after the cement waste form has set and become a hardened monolith. Late formation of ettringite can lead to undesired swelling and cracking of hardended cementitious waste forms (Taylor 1997).

WRPS has contracted with Pacific Northwest National Laboratory (PNNL) and Savannah River National Laboratory (SRNL) to conduct a technology development program to address the technology needs in support of the design and operation of the future ETF waste solidification unit, including waste form performance, process development, process design, and process operations. High-priority activities include simulant development, grout formulation development, and waste form qualification. The simulant development activity includes preparing simulants for three different waste streams (from the 242-A evaporator condensate, ERDF leachates, and WTP off-gas condensates) following treatment through the ETF. The formulation development activity in PNNL encompasses work including dry materials characterization, LSWG formulation, and characterization. The waste form qualification activity is composed of work to demonstrate that the LSWG will meet waste acceptance criteria for the IDF (Burbank, 2002; DOE, 2012), demonstrate the equivalency of the LSWG performance prepared with actual and/or spiked radioactive wastes, and provide long-term waste form performance data and information on waste form degradation and contaminant release mechanisms to support future IDF performance assessments.

The test matrix for LSW solidification testing in this report was built upon the lessons learned from previous testing programs and additional screening tests. The LSWG formulation and testing in this report focused on selection of a baseline grout waste form for LSW and demonstrated that LSWG can meet expected waste form requirements for disposal in the IDF (Burbank, 2002; DOE, 2012). The testing results and database will be used to develop a new formulation of LSWG for sulfate-rich liquid waste streams.

1.1 Objectives

The overall objectives of the LSWG testing program are to

- develop new grout formulation(s) for the LSWG waste form
- demonstrate that the new formulation(s) are compliant with respect to
    - LSW composition to be treated at the ETF
    - variability in the waste solidification process
- provide contaminant release data for IDF PA and risk assessment evaluations.

1.2 Report Contents and Organization

This report consists of nine sections. Section 1 provides an introduction and describes key objectives of the tests conducted for this study. Section 2 summarizes the characterization and analysis techniques used for solution and solid samples. Section 3 shows LSWG formulation and characterization. Section 4 describes U.S. Environmental Protection Agency (EPA) 1313 pH leaching tests and Section 5 presents EPA 1315 effective diffusivity leaching tests. Section 6 provides results of measurements of ^{99}Tc desorption distribution coefficients (K_d) and discusses their implications. Section 7 presents ^{99}Tc solubility results. Section 8 provides a summary and recommendations, while Section 9 is a list of references cited throughout the report. Additional data and information are given in the Appendices.

1.3 Quality Assurance

This work was funded by WRPS under contract 36437-161, *Secondary Waste Cast Stone Formulation and Waste Form Qualification*. The work was conducted as part of PNNL Project 66595, Secondary Waste Cast Stone.

All research and development (R&D) work at PNNL is performed in accordance with PNNL's Laboratory-level Quality Management Program, which is based on a graded application of NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications*, to R&D activities. In addition to the PNNL-wide quality assurance (QA) controls, the QA controls of the WRPS Waste Form Testing Program (WWFTP) QA program were also implemented for the work. The WWFTP QA program consists of the WWFTP Quality Assurance Plan (QA-WWFTP-001) and associated QA-NSLW-numbered procedures that provide detailed instructions for implementing NQA-1 requirements for R&D work. The WWFTP QA program is based on the requirements of NQA-1-2008, *Quality Assurance Requirements for Nuclear Facility Applications*, and NQA-1a-2009, *Addenda to ASME NQA-1-2008 Quality Assurance Requirements for Nuclear Facility Applications*, graded on the approach presented in NQA-1-2008, Part IV, Subpart 4.2, "Guidance on Graded Application of Quality Assurance (QA) for Nuclear-Related Research and Development".

Performance of this work and preparation of this report were assigned the technology level "Applied Research" and were conducted in accordance with procedure QA-NSLW-1102, *Scientific Investigation for Applied Research.* All staff members contributing to the work have technical expertise in the subject matter and received QA training prior to performing quality-affecting work. The "Applied Research" technology level provides adequate controls to ensure that the activities were performed correctly. Use of both the PNNL-wide and WWFTP QA controls ensured that all client QA expectations were addressed in performing the work."

2.0 Characterization and Analysis Methods

This section describes the characterization techniques used for leachate solution and solid sample analyses of the LSWG formulation and testing. The characterization types are divided into two categories, solution and solid analysis, depending on the purpose and goal of the characterization. A summary of each characterization and analysis method used in this report is provided below.

2.1 Solution Analysis

The following instruments were used for analyzing solution samples (simulants, leachates, and digests) from the grout waste forms to identify species or elements and to measure the concentration of each constituent identified.

2.1.1 pH and Electrical Conductivity Measurement

The pH of the solution samples was measured with a solid-state YSI Inc. pH electrode and a pH meter (YSI MultiLab 4010-3). Before measurement, the pH probe was calibrated with National Institute of Standards and Technology (NIST)-traceable buffers (pH = 2.0, 4.0, 7.0, 10.0, or 13.0 at 25°C). The precision of each pH measurement was ±0.10 pH units. A YSI conductivity sensor was used to measure the electrical conductivity (EC) of leachate solutions. The cell constant of the sensor was calibrated with a 1,413 µS/cm standard, and then the calibration was checked with a range of potassium chloride standard solutions, ranging from 100 µS/cm to 10,000 µS/cm.

2.1.2 Alkalinity Measurement

The alkalinity (mg/L as $CaCO_3$) was measured with a standard acid titration method (total alkalinity at pH = 4.5). The alkalinity measurement procedure is equivalent to the U.S. Geological Survey method in the National Field Manual for the Collection of Water-Quality Data (USGS 2004).

2.1.3 Redox Potential Measurement

A YSI 4210 redox potential probe (connected to a YSI MultiLab 4010-3 meter) or a Hanna H3131B redox probe (connected to a Hanna H15521 meter) was used to measure the redox potential of the leachate solutions (Manahan, 1994). The calibration of the probe was verified with ZoBell's standard solution (+230 mV at 20°C). The redox potential, E_h values discussed in this report were corrected to E_h Standard Hydrogen Electrode (SHE) values by adding 211 mV to the value measured by a YSI probe with the 3 M KCl reference, or by adding 208 mV to the value measured by a Hanna probe with the 3.5 M KCl reference.

2.1.4 Analysis of Cations, Anions, ^{99}Tc, and Resource Conservation and Recovery Act (RCRA) Metals

Concentrations of major cations in simulant, leachates, and digests were analyzed using inductively coupled plasma optical emission spectroscopy (ICP-OES), while major anions were analyzed using ion chromatography (IC). Concentrations of ^{99}Tc were analyzed using inductively coupled plasma mass spectroscopy (ICP-MS).

2.1.5 Ammonia Analysis

An ammonia-specific ion-selective electrode (Cole Parmer) connected to an Oakton meter (Cole Parmer) was used to determine ammonia concentration in simulant and leachates based on ASTM International standard D1426-08. The ammonia electrode was calibrated in conjunction with the Oakton meter using a pre-developed calibration curve with four standard solutions (0.5, 5.0, 50.0, and 500.0 ppm) prepared quantitatively using NIST-certified ammonia standard solution. An aliquot of leachate of about 10 mL was filtered through a 0.45 micron polyvinylidene fluoride (PVDF) syringe filter and used for ammonia concentration analysis with a stir bar and plate for gentle stirring. The ammonia electrode was immersed in the solution being stirred in the beaker and positioned at a 20° angle in order to prevent air bubble formation at the membrane level. The ammonia concentration was directly read as mg/L (or ppm) from the Oakton meter screen as soon as the “stable” prompt appeared on the meter screen.

2.2 Solid Analysis

The instruments described below were used for identifying elements, minerals, solid phase morphology, and chemical composition of the bulk solid samples.

2.2.1 Microwave-Assisted Digestion

Microwave-assisted, strong acid digestion was conducted using about 0.05 gram of solid sample mixed with 9.0 mL of 16 M HNO_3, 2 mL of 12 M HCl, and 2 mL of 29 M HF, all Optima grade concentrated reagents. Once the first stage of the microwave procedure was completed, 20 mL of 5% H_3BO_3 was added to the microwave digestion vessels for complete digestion with complexing fluoride. After cooling in open atmosphere, double deionized (DDI) water was used to wash off the residue from the microwave digestion vessels and the resulting digested sample aliquot was prepared with a final total sample volume of 35 mL in a pre-weighed 50 mL centrifuge tube before analysis.

2.2.2 X-Ray Diffraction (XRD) Analysis

The mineralogy of solid samples was determined using a Rigaku Miniflex II XRD unit equipped with a Cu Kα radiation (λ=1.5418 Å with 40 kV and 15 mA) source. The bulk samples were homogenized by grinding in an agate mortar and pestle and loaded into zero background quartz sample holders, held within custom containers with Kapton windows to prevent dispersion of the radiological powders (when present) before scanning from 3 to 100 degrees 2θ (See Figure 2.1). Mineral identification was done using Jade software (Materials Data Incorporated, California) with the International Centre for Diffraction Data XRD database. Quantification was performed by the whole pattern fitting (Rietveld) method using Topas software (v5, Bruker AXS, Germany) with the pattern for each phase calculated from published crystal structures (Inorganic Crystal Structure Database, Fachinformationszentrum Karlsruhe, Germany). For most samples, the phase fractions were scaled to 100% and a weighed amount of TiO_2 standard (10 wt%) was mixed in, which allowed determination of absolute quantities of minerals and therefore amorphous material by difference.

2.2.3 Scanning Electron Microscopy and Energy Dispersive Spectrometry

Non-^{99}Tc-spiked crushed specimens were mounted on an aluminum stub with double-sided carbon tape and sputter coated with Pt (Polaron Range SC7640, Quorum Technologies Ltd., East Sussex, England) for scanning electron microscopy–energy dispersive spectrometry (SEM/EDS) analysis. The Pt-coated samples were analyzed using a JSM-7001F field emission gun scanning electron microscope (SEM, JEOL USA, Inc., Peabody, MA), and the EDS analysis was done using a Bruker xFlash 6|60 silicon drift detector (Bruker AXS, Inc., Madison, WI). The acceleration voltage during the analysis was 15 kV. For all of the analyses, Kα positions were considered for the calculations. The EDS spectra were collected for 20 s each at 80 k–100 k counts/s. Background noise subtraction and the estimation of atomic ratios were done using ESPRIT software (v1.9, Bruker AXS, Inc.).

For ^{99}Tc-spiked samples, powdered samples were also mounted with double-sided carbon tape attached to an aluminum stub. The sample was coated with carbon in a vacuum to improve the conductivity of the samples and the quality of the SEM images. An FEI Quanta 250FEG SEM was used to provide images of these samples. Mostly secondary electron images were obtained, and some backscattered electron images were recorded if necessary. EDS was used to determine the chemical compositions of observed features for different powdered samples prepared from different locations on LSWG monoliths. An EDAX Genesis EDS System was used to collect EDS spectra for qualitative elemental analysis.

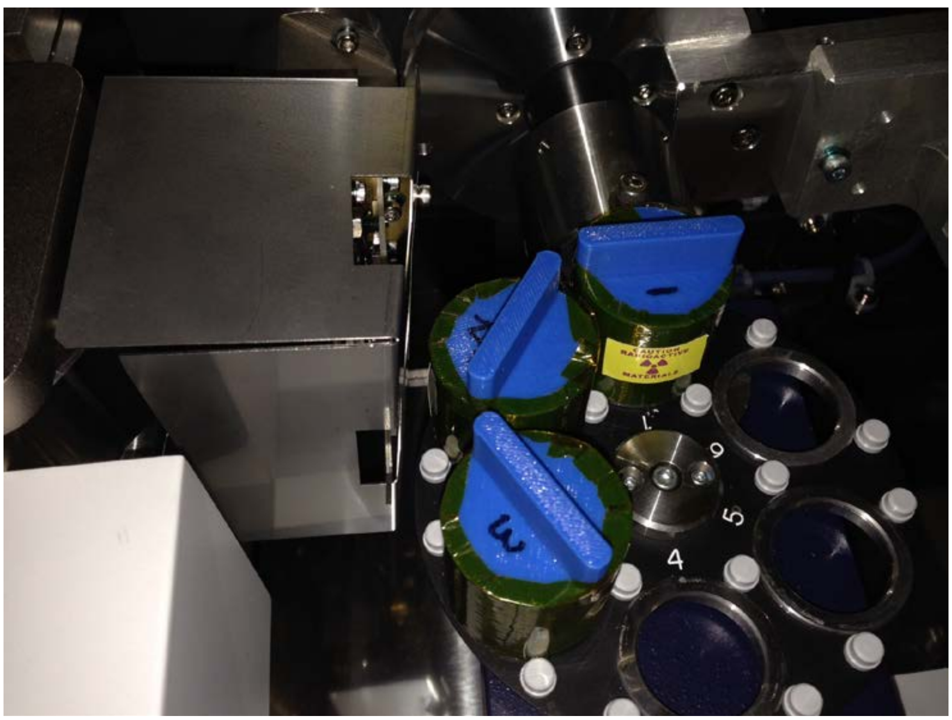


Figure 2.1. X-Ray Diffraction Setting for LSWG ^{99}Tc-Spiked Samples (Powder sample was prepared with quartz sample holder, which is located inside blue-colored capsule).

3.0 Liquid Secondary Waste Grout Formulation

Twenty-one monolith formulations (18 ^{99}Tc-spiked and 3 non-^{99}Tc-spiked monoliths) were prepared for performance testing of different grout compositions. These compositional variations included ^{99}Tc content, liquid waste simulant composition, dry solids composition, free water-to-dry mix (w/dm) ratio, commercially available additive and admixture used to modify mixing and curing characteristics, and two ^{99}Tc getters (Sn-treated apatite and $SnCl_2$) used to test for ^{99}Tc leachability. The test matrix is shown in Table 3.1 for both ^{99}Tc-spiked and non-^{99}Tc-spiked monoliths. Among the 21 grout formulations, 18 [Test (or T) 1 through 18] contained ^{99}Tc(VII), while three (T19 through T21) contained no ^{99}Tc. Four of the formulations contained ^{99}Tc getters consisting of Sn-treated apatite and $SnCl_2$. Further details on selection of ^{99}Tc getters can be found in Qafoku et al. (2014). Two of the 18 ^{99}Tc-spiked grout formulations were duplicates of other formulations (T2 used the same formulation as T7, and T6 used the same formulation as T8).

Liquids used to make the grout monoliths consisted of three secondary waste simulants. These simulants were designed to mimic Hanford 242-A Evaporator condensates, Hanford ERDF leachates, and WTP off-gas condensates after treatment through the ETF. Nominal compositions of these simulants are found in Table 3.2. Prior to combining each of these simulants with the dry materials, simulant aliquots were spiked with ^{99}Tc using ^{99}Tc stock solution (~10,000 mg/L of $NaTcO_4$). An additive to improve rheology of the grout slurry/paste before curing, MasterGlenium 3030 (MG 3030) from BASF Corp., was also used in monolith formulations as a water-reducing additive (WRA).

The grout dry materials consist of four primary components. These components are hydrated lime [HL, $Ca(OH)_2$], OPC, BFS, and FA. Xypex, a secondary dry material (Admix C-500 from Xypex Chemical Corp.) consisting of pulverized Portland cement, silica sand, and an alkaline earth compound (zeolite) was used as admixture in five grout formulations in order to reduce the porosity of the cured monoliths. Prior to mix with liquid components, dry materials were well blended so they could be added to the liquid waste as one homogeneous mixture.

Table 3.1. Liquid Secondary Waste Grout Test Matrix

Test #	Replicate	Simulant[(a)] (g)	Water-to-Dry Mix Ratio	Dry Blend Addition[(b)]	Dry Materials	Admix[(c)]	Getter[(d)]	WRA[(e)]	^{99}Tc [(f)] (µg/L)
1	-	242-A (648.3)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	13900
2	-	ERDF (648.3)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	15100
3	-	WTP (711.6	0.5	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	14800
4	-	242-A (778.0)	0.6	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	14200
5	-	ERDF (778.0)	0.6	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	15100
6	-	WTP (853.9)	0.6	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	15000
7	Rep 2	ERDF (648.3)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	14200
8	Rep 6	WTP (853.9)	0.6	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	14900
9	-	242-A (648.3)	0.5	20%, 10%, 70%	HL, OPC, BFS	-	-	3030	14300
10	-	WTP (711.6)	0.5	20%, 10%, 70%	HL, OPC, BFS	-	-	3030	14800
11	-	WTP (853.9)	0.6	20%, 35%, 45%	OPC, FA, BFS	Xypex	-	3030	15100
12	-	242-A (778.0)	0.6	20%, 35%, 45%	OPC, FA, BFS	Xypex	-	3030	14100
13	-	WTP (853.9)	0.6	8%, 45%, 47%	OPC, FA, BFS	-	-	3030	17800
14	-	242-A+ERDF[(g)] (648.3)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	14300
15	-	WTP (711.6)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	Tc1	3030	15000
16	-	WTP (711.6)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	Tc2	3030	15200
17	-	WTP (711.6)	0.5	20%, 10%, 70%	HL, OPC, BFS	Xypex	Tc1	3030	14900
18	-	WTP (711.6)	0.5	20%, 10%, 70%	HL, OPC, BFS	Xypex	Tc2	3030	14800
19	-	WTP (711.6)	0.5	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	-
20	-	WTP (853.9)	0.6	20%, 35%, 45%	HL, OPC, BFS	-	-	3030	-
21	-	WTP (853.9)	0.6	20%, 35%, 45%	OPC, FA, BFS	Xypex	-	3030	-

BFS = blast furnace slag; FA = fly ash; OPC = ordinary Portland cement; HL = hydrated lime; total dry materials mass is 1,167 g.
(a) See Table 3.2 for simulant compositions (Russell et al. 2015). Simulant mass (gram) used is shown in parenthesis.
(b) The three dry blend materials were mixed together by placing the dry ingredients into a single plastic bag and manipulating the bag until the dry mixture appeared to be homogeneous.
(c) Xypex was used as additional admixture based on 5 wt% of dry mix.
(d) T15–18 were prepared with Tc getters: Tc1 = Sn-treated apatite (~1 gram) and Tc2 = $SnCl_2$ (~0.3 gram). The amount of getters added was determined to make complete ^{99}Tc reduction in simulant based on the measured reductive capacity of getters by Qafoku et al. (2014).
(e) Water-reducing additive (WRA): MG 3030 was used to enhance the cement rheology based on 0.6 mL of MG 3030 per 100 g of dry mix.
(f) ^{99}Tc concentration measured in each simulant before mixing with dry ingredients.
(g) Simulant in T14 was prepared using a mixture of 242-A and ERDF simulants at a 1:1 ratio based on mass.

3.1 Liquid Secondary Waste Simulants

The ETF currently treats 242-A evaporator condensates, ERDF leachates, and miscellaneous laboratory and groundwater liquid wastes. In the future, the IDF leachates and WTP off-gas liquid wastes will be also sent to the ETF for treatment. LSW simulants were developed to mimic the chemical compositions of three primary waste streams that are anticipated to be treated at the ETF. Experimental work performed for this report considered the sources of three LSW streams: 1) the 242-A evaporator condensates, 2) the ERDF leachates, and 3) the WTP off-gas condensates. Table 3.2 identifies the chemical starting point for development of these simulants. The simulants are high in sulfate because the ETF uses sulfuric acid to adjust pH of the wastes. More details on simulant preparation can be found in Russell et al. (2015).

Table 3.2. Nominal Waste Compositions as Starting Point for Simulants (relative molar amount)

Chemical Constituents	242-A Evaporator Condensates	ERDF Leachates	WTP Off-Gas Condensates
NH_4^+	0.541	-[(a)]	0.330
Ca^{2+}	0.023	0.171	-
Cl^-	0.013	0.162	0.006
F^-	-	-	0.001
Na^+	0.075	0.222	0.295
K^+	0.003	-	-
Mg^+	0.009	0.092	-
NO_3^-	-	0.117	0.117
NO_2^-	-	-	0.001
SO_4^{2-}	0.324	0.235	0.250
Si^{4+}	0.011	-	-
Total Moles	1.0	1.0	1.0

(a) "-" = not reported, and therefore not added to the simulants. More details on simulant preparation and chemical constituents can be found in Russell et al. (2015).

To understand the retention and release of radionuclides of concern, all 18 ^{99}Tc-spiked LSWG monolith batches were spiked with ^{99}Tc in the range of 14 to 18 mg/L in the simulants. The maximum concentration levels of spikes for the RCRA metals, radionuclides, and underlying hazardous constituents (UHCs) are shown in Table 3.3. Much higher ^{99}Tc initial concentrations in simulants compared to the ^{99}Tc spike level of each simulant in Table 3.3 were prepared to detect ^{99}Tc concentration in EPA 1315 test leachates so that they would be above the estimated quantification limit (EQL) of ICP-MS: 0.0165 µg/L. No radioactive or stable iodine was spiked and tested for these monoliths. In addition, because the calculated total concentration of each RCRA metal (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag) and UHC (Sb, Be, Ni, and Tl) in the grout monolith after the 20-fold dilution factor applied was lower than that of the universal treatment standard (UTS) of each element for the Toxicity Characteristic Leaching Procedure (TCLP) test (EPA 1992), no RCRA metals or UHCs were spiked in simulants and used for these grout formulations. The UTS values in 40 CFR 268, *Land Disposal Restrictions*, are also shown in Table 3.3.

Table 3.3. Spike Levels for RCRA Metals, Hazardous Constituents, and Radionuclides

Waste Constituent	242-A Evaporator Condensate	ERDF Leachates	WTP Off-Gas Condensates	UTS in TCLP Leachate
RCRA Metals (mg/L)				
As	7.34E-1	5.56E+0	1.92E-1	5.0
Ba	1.92E+0	ND(a)	2.16E-6	21
Cd	ND	9.30E-1	9.58E-5	0.11
Cr	1.12E+0	9.28E-1	ND	0.60
Pb	2.65E-1	1.33E+2	4.88E-2	0.75
Hg	1.91E-2	9.29E-1	1.30E+0	0.025
Se	1.22E-1	1.04E-4	ND	5.7
Ag	ND	ND	3.88E-4	0.14
Underlying Hazardous Constituents (mg/L)				
Sb	ND	1.86E+0	4.45E-2	1.15
Be	ND	ND	ND	1.22
Ni	1.53E+0	5.58E+0	2.40E-5	11
Tl	NR(b)	NR	ND	0.20
Radionuclide				
	Ci / mole Na(c)	Ci / mole Na(d)	Ci / mole Na(e)	-
^{99}Tc	2.04E-7	3.78E-8	4.67E-6	-

"-" = not considered.
(a) Not detected and thus was not spiked into the simulants
(b) Not reported and thus was not spiked into the simulants
(c) Derived from Evaporator Brine column in Table A-2 of Halgren (2013)
(d) Derived from ERDF Leachate column in Table A-1 of Halgren (2012)
(e) Derived from G-2 model output by Mahoney (2015)

Each simulant was divided into monolith formulation batch-specific aliquots according to Table 3.1. Aliquots were made based on weight and each aliquot from a particular simulant was representative of the original simulant. In order to achieve this, the original simulant was stirred continuously for complete mixing while aliquots were collected for use. These aliquots were sealed, labeled, and stored for future use.

3.1.1 Three Simulants Preparation and Analysis

The 2013 ETF process campaign (Halgren 2013) was used as a baseline guide for the chemical composition of the 242-A evaporator LSW simulant. The total solids composition of 242-A evaporator condensate simulant was determined to be 10.2 wt%, and the recipe for a 6.0 kg quantity is provided in Table 3.4. For ERDF leachate simulant, the 2012 ETF process campaign (Halgren 2012) was used as a baseline guide for the chemical composition. The total solids composition of ERDF leachate simulant was determined to be 10.0 wt%, and the recipe for a 5.0 kg quantity is provided in Table 3.4. The WTP off-gas condensate simulant was based on an estimated average chemical composition from direct-feed low-activity waste (DFLAW) operations and the calculated total solids composition was 18.9 wt%. The recipe for 12.0 kg of the WTP off-gas condensate simulant is also provided in Table 3.4.

Table 3.4. Recipes for 242-A Evaporator, ERDF Leachate, and WTP Off-Gas Condensate Simulants

Chemical	242-A Evaporator Condensate [(a)]	ERDF Leachate [(b)]	WTP Off-Gas Condensate [(c)]
	Weight Required (g)		
$CaCl_2$	9.76	90.02	-
$CaSO_4$	30.22	43.64	-
$Ca(NO_3)_2$	-	96.57	-
K_2SO_4	3.88	-	-
$MgSO_4$	14.70	111.66	-
Na_2SO_4	-	158.08	-
$NaNO_3$	-	-	510.30
$NaNO_2$	-	-	3.54
NaCl	-	-	17.99
NaF	-	-	2.15
Na_2SiO_3•$9H_2O$	40.50	-	-
Na_2SO_4•$10H_2O$	118.01	-	1405.4
$(NH_4)_2SO_4$	484.96	-	1118.9
Density (g/cm^3)	1.06	1.05	1.13
pH	8.25	9.4	5.6
Wt% total solid	10.2	10.0	18.9

"-" = not added to the simulants
(a) mass used to make 6 Kg of simulant; (b) mass used to make 5 Kg of simulant;
(c) mass used to make 12 Kg of simulant

The final compositions of the three simulants used for LSWG preparation were analyzed for cations and anions, and compared to the calculated values. The analyses are based on samples of the large batches prepared for each simulant before ^{99}Tc spike. Before sampling the large batches of simulants, a mechanical shaker was used to stir the simulants for complete mixing. After complete mixing, an aliquot of each simulant was poured into a vessel and a portion of the aliquot was digested by 40 times more volume of Optima HNO_3 acid (16 M). The final digests were diluted and used for cation analysis by ICP-OES. For anions, initial aliquots of simulants were diluted with deionized water (DIW) and analyzed using IC. Concentrations of ammonia ion in 242-A and WTP off-gas condensate simulants were determined using an ion-selective ammonia electrode after diluting the aliquots with DIW. Simulant analysis results for both calculated and measured concentrations are shown in Table 3.5. Calculated elemental concentrations are based on the chemical recipe used to prepare each simulant in Table 3.4.

The measured concentrations of each element in the three simulants were reviewed for differences between calculated and measured concentrations. For WTP off-gas condensate simulant, most of the cations and anions showed differences within ±20%, a reasonably acceptable variation except for nitrate. For ERDF leachate simulant, the measured sulfate concentration was lower than the calculated value, but the measured and calculated concentrations for the others were within ±20% variance. For 242-A evaporator condensate simulant, most of the major constituents (sulfate, sodium, ammonia, silicon, and potassium) showed high differences between the measured and calculated concentrations, while others (chloride, calcium, and magnesium) were within ±20% variation. It is not clear why several constituents in the simulants show differences greater than ±20% from the calculated concentrations, but it may result from 1) incomplete digestion of solids in simulants prepared using Optima HNO_3, 2) impurities in chemicals used to prepare the simulants, and/or 3) unavoidable errors and uncertainties from simulant preparation and analyses.

Table 3.5. Calculated and Measured Concentrations of Elements in Three Simulants

Elements	242-A Evaporator Condensate (g/mL)		ERDF Leachate (g/mL)		WTP Off-Gas Condensate (g/mL)	
	Calculated	Measured[(a)]	Calculated	Measured[(a)]	Calculated	Measured[(a)]
Cations						
Ca^{2+}	0.00175	0.00141	0.01313	0.01420	-[(b)]	-
K^{+}	0.00025	0.00032	-	-	-	-
Mg^{2+}	0.00042	0.00048	0.00430	0.00424	-	-
Na^{+}	0.00330	0.00452	0.00975	0.01180	0.03452	0.03052
NH^{4+}	0.01870	0.02272	-	-	0.03029	0.02800
Si^{4+}	0.00057	0.00015	-	-	-	-
Anions						
Cl^{-}	0.00088	0.00106	0.01095	0.01240	0.00108	0.00100
NO_3^{-}	-	-	0.01390	0.01650	0.02607	0.03490
NO_2^{-}	-	-	-	-	0.00017	ND[(c)]
SO_4^{2-}	0.00996	0.07110	0.04320	0.01570	0.12221	0.11800
F^{-}	-	-	-	-	0.00010	ND

(a) Acceptability of ±20% difference is valide based on inorganic quality control (PNNL, 2008).
(b) "-" = not added to the simulants
(c) ND indicates "not detected" for sample concentration below quantification level for NO_2^{-} (<0.0005 g/mL) and F^{-} (<0.0001 g/mL).

3.2 Preparation of Liquid Secondary Waste Grout Monoliths

The LSWG monoliths were prepared in the sequence as indicated by the column labeled "Test #" in Table 3.1 except that the three non-^{99}Tc-spiked monoliths (T19–T21 in Table 3.1) were prepared first. Prior to mixing batches of grout, each liquid simulant and mix of dry materials was prepared separately. The three dry blend materials (either HL + OPC + BFS or FA + OPC + BFS) were mixed together by placing the dry ingredients into a sealed plastic bag. The bag was then manually manipulated until the dry mixture appeared to be homogeneous. Xypex was added to the relevant test batches after initial dry-blend homogenization and then the mixture was re-homogenized by hand mixing. The previously prepared simulant aliquots were spiked with ^{99}Tc immediately prior to mixing with the particular dry ingredients for each grout test batch. For batches T15 through T18, ^{99}Tc getter (Tc1 = Sn-treated apatite [~1 gram] or Tc2 = $SnCl_2$ [~0.3 gram]) was added to each simulant spiked with ^{99}Tc and reacted for 24 h. After reacting with ^{99}Tc getter for 24 h, a small aliquot (~1 mL) was removed from each reacted simulant and analyzed for ^{99}Tc concentration change after addition of the ^{99}Tc getter. Then, the remaining simulant containing ^{99}Tc getter was mixed with the dry ingredients as shown in Table 3.1.

3.2.1 Dry Ingredients

The grout monoliths were made using three primary dry ingredients that were blended together in different ratios. The primary three dry ingredients consisted of HL + OPC + BFS or FA + OPC + BFS. In each case, these specific materials were selected for high-volume commercial availability and continuity with previous experimental work.

The OPC was supplied by Lafarge North America Inc. in Pasco, Washington. According to mill test report R-TI-15-04, this is a Type I/II Portland cement produced in Richmond, British Columbia. The BFS was sourced from Lafarge North America Inc. in Pasco, Washington. This product is also commonly referred to by the trade name NewCem®. This BFS meets ASTM C-989 requirements for class 100 ground granulated BFS and is processed at Lafarge's Seattle, Washington plant. While not specifically documented, it is believed that all BFS commonly available in the western United States originates in Asia. The FA used for this work was also supplied by Lafarge North America Inc. It qualifies as both class F and class C FA. The source of this product was the Centralia, Washington power plant. The OPC, BFS, and FA are the same materials used in previous work detailed in Westsik et al. (2013) and Serne et al. (2015).

The hydrated lime (HL) or calcium hydroxide [$Ca(OH)_2$] was sourced from the Graymont Rivergate facility in Portland, Oregon. At this time, the source limestone is mined in Utah and processed in Portland to produce a high-calcium product that assays at 92–100 wt% calcium hydroxide. According to company representatives, this limestone deposit is quite large and will be a viable source for quite a long time. Published data from Graymont states that 95% of this $Ca(OH)_2$ passes through a 0.600 mm sieve. In the laboratory, it was found to be a fine powder and was used without further particle size reduction.

As a secondary dry ingredient in Table 3.1, Xypex was also added as an admixture to help reduce porosity of the cured monoliths (Cozzi et al. 2015). Xypex (Admix C-500), a product of the Xypex Chemical Corporation, was supplied by SRNL and added for test batches T11, T12, T17, T18, and T21 (See Table 3.1) based on 5% of the total dry mix mass. Other dry ingredients (with or without ^{99}Tc getter) were prepared after being normalized to the ratio of 0.95 and mixed with Xypex.

3.2.2 Grout Mixing/Monolith Production

Grout mixing and monolith production followed the procedure outlined in Westsik et al. (2013). That procedure was recommended as a method that had been improved over time and would provide good comparability of results from work performed at different locations.

3.2.2.1 Grout Mixing Summary

Grout mixing and monolith production followed this general outline;

1. addition of dry ingredients to stirring simulant, 5 minute target duration
2. addition of MG 3030 to wetted dry-blend–simulant mixture
3. continued mixing, total of 15 minutes from start of step 1 above
4. filling of monolith forms

5. de-airing of filled forms
6. 28-day curing in a humid environment at room temperature.

One significant difference between current and previous work is the use of MG 3030 as a WRA. This material was obtained from BASF Corp. through American Rock Products in Richland, Washington. While the HL used in the grout formulation was hydrated, it was still quite hygroscopic. Preliminary testing, not included in this report, revealed that the HL sorbed most available water, which resulted in a very stiff mix and occasional insufficient wetting of all dry ingredients during mixing. MG 3030 was added near the mixing vortex soon after all dry ingredients had been incorporated into the simulant. This greatly improved the mixing and workability characteristics of the grout slurry evidenced by a rapid and notable decrease in viscosity of the mix.

3.2.2.2 Grout Monolith Production

For each of the grout formulations described in Table 3.1, the necessary liquid and dry material aliquots were prepared ahead of time in order to have all of the monoliths begin curing at approximately the same time. Each simulant mass (gram) used to prepare grout monolith is shown in Table 3.1. In the case of the dry materials, the different components for each test batch were weighed separately and then combined into one large plastic bag. The large plastic bag was then sealed and manipulated from the outside in order to homogenize the contents. Homogeneity was determined on a visual basis, but all dry blend aliquots were homogenized after mixing for 5–10 minutes.

Grout mixing was performed with a Caframo BDC1850 variable speed “overhead stirrer” (Figure 3.1). This style of mixer was recommended by SRNL in order to accommodate a custom 3.5" diameter impeller design—also provided by SRNL. The impeller and mixer head were joined by a 3/8" shaft. The combined mixer apparatus was supported by a Caframo A210 heavy-duty stand and A120 heavy-duty clamp. The mixer shaft was lowered into a two-liter plastic mixing beaker until the bottom of the impeller was between 0.75 and 1.25 inches from the bottom of the beaker. The beaker was offset from the mixer shaft so that the impeller was between 0.25 and 0.5 inches from one sidewall. This offset helped to minimize the creation of a central vortex, and thus air entrainment, during mixing. With the beaker of simulant in place under the mixer, the mixer was started at about 200 rpm. Vortex creation and modest air entrainment is acceptable at this point. With the mixer turning at about 200 rpm, the homogenized bag of dry ingredient pre-mix was slowly added to the simulant. To facilitate clean transfer from the bag to the beaker, a 2" diagonal cut was made across one corner of the bag. This corner opening funnels the pre-mix into the desired location and allows for good control during addition to the beaker. A timer was used to make sure that all dry ingredients were added to the mixing beaker within approximately 5 minutes. As pre-mix was added, the mixer rotation speed was increased in order to maintain obvious surface movement with minimal central vortex and associated air entrainment.

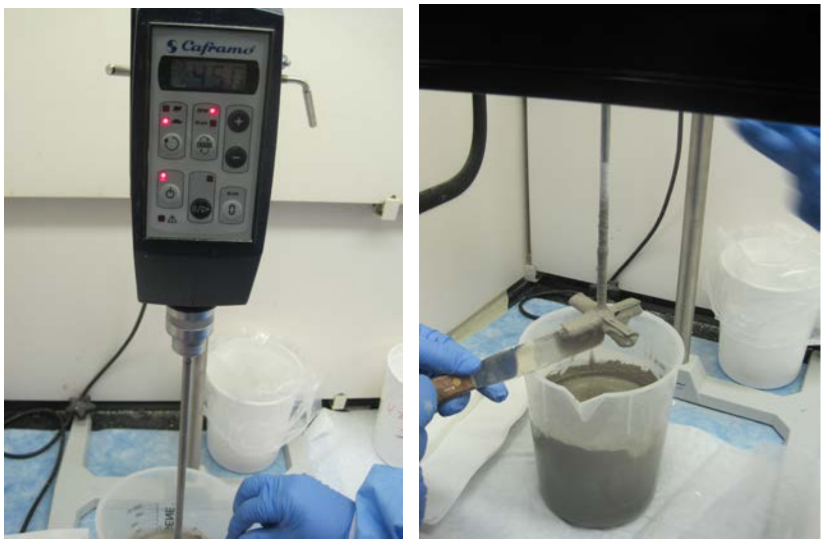


Figure 3.1. Overhead Mixer (left) and Mixing Impeller (right)

As soon as all of the pre-mix had been added to the mixing beaker, MG 3030 was slowly added near the vortex. The MG 3030 significantly reduced viscosity and allowed the grout to be “burped” to release entrained air by stopping the mixer for 15–30 seconds and tapping the beaker on the benchtop. Mixing continued until 15 minutes had elapsed since the beginning of pre-mix addition. This time was spent ensuring grout homogeneity by scraping the beaker sides and mixer shaft with a spatula as needed (Figure 3.2). Mixer speed was adjusted to the highest possible level without risking air entrainment. This speed varied from batch to batch and was occasionally decreased during mixing as grout shear properties changed over time.

Figure 3.2. Homogeneous Grout Slurry Mixing (left) and Filling Form with Grout Slurry (right).

At the end of the mixing period, the grout slurry was poured into 2" internal diameter × 4" height cylindrical forms (Figure 3.2). These forms consist of relatively thin-walled plastic mailing tubes with push-on plastic caps. These mailing tubes were sourced from Icon Plastics in Costa Mesa, California. Each batch of grout was expected to fill approximately five to six forms. The forms were initially filled about three-quarters full. This allowed mechanical agitation to achieve de-airing with minimal risk of spillage. Not all grouts appeared to have entrained air, but all monoliths were agitated to make sure that minimal entrained air was cured into the monoliths. De-airing required a minute or less per monolith. De-airing was considered complete when visual inspection detected the cessation of new bubbles rising to the surface of the grout slurry. The forms were then filled to their tops, gently de-aired, and covered with perforated caps. The caps were left a few millimeters higher than the upper surface of the grout in order to allow the grout surface to find its own level and minimize surface imperfections induced by contact with the cap. One last form, filled one-quarter to one-half full, was also prepared for each grout monolith and used for moisture content (MC) measurement. Each form was labeled with the date and a sample identifier of the following format:

15-SWCS-T#-N

where	15	=	last two digits of calendar year
	SWCS	=	secondary waste Cast Stone
	T#	=	Test # from Table 3.1
	N	=	monolith number (1–6).

The filled and capped forms were placed into racks, which were then stacked into 5-gallon buckets. Before the racks were installed, the buckets were pre-loaded with 3/8" to 1" of DI water to maintain a humid environment (relative humidity: ~80-100 %) inside the sealed bucket at room temperature. Monoliths were allowed to cure at room temperature and high humidity for a minimum of 28 days inside the sealed buckets.

3.3 Grout Monolith Characterizations

After the monoliths had cured for at least 28 days, the forms were removed from the buckets to observe the monoliths for any free liquids, surface cracks, surface voids, irregular shapes, and/or loose chips. The diameter and length of each monolith were measured using calipers in a minimum of three places (diameter at three axial locations—bottom, middle, and top—and length at three rotational orientations mutually separated by about 120 degrees from an arbitrary starting location) to determine average length and diameter dimensions of the grout monoliths. Each monolith was weighed and stored individually in two moisture-proof resealable bags with a wet paper towel in the outer bag to maintain humidity, and the inner bag, which contained the monolith, left open to allow moisture to equilibrate.

3.3.1 Moisture Content Measurement of Grout Monoliths

One of the 28-day cured grout monoliths from a form that was one-quarter or one-half full was selected and placed in an oven set at 105 ± 3°C for 48 h ± 1 h for moisture content (MC) measurement. To assure a constant dry mass of the monolith sample, the grout monolith was removed from the oven after 48 h ± 1 h, and allowed to cool at room temperature in a desiccated environment before obtaining a dry weight measurement of the monolith sample. Then the monolith was returned to the same oven for an additional 24 h ± 1 h drying time before it was cooled to room temperature and the dry mass was measured. The two dry mass readings had to be within 1.0% of one another for the dry mass to be considered constant. If a constant mass was not obtained, the procedure above was repeated for one or more additional 24-hour drying cycles until two sequential readings for dry mass met the constant-mass requirements. Moisture content of the selected monolith was determined by difference in the masses of the monolith sample before and after oven drying at 105 ± 3°C using Equation (3.1) below:

$$MC\ (\%) = [(MASS_{wet} - MASS_{dry})/MASS_{wet}] \times 100 \qquad (3.1)$$

where $MASS_{wet}$ = initial wet mass of monolith (g)

$MASS_{dry}$ = next-to-last dry mass of monolith after oven drying (g)

The final moisture content and dry solids fraction {1 − [MC(%)/100]} of each grout monolith are shown in Table 3.6. The MC of batches T1 to T3 grout monoliths prepared with three different simulants with 0.5 w/dm ratio ranged from 25% to 27%, which are lower than those (29% to 31%) of grout monolith T4 to T6 samples prepared with 0.6 w/dm ratio. Grout monoliths prepared with 242-A simulant showed the highest MC compared to others prepared with ERDF and WTP simulants at the same w/dm ratio. Grout monoliths T7 and T8 samples that are replicates of T2 and T6 showed very similar MC and dry solids fraction values. The grout monolith T9 and T10 prepared with higher BFS content (70%) and lower OPC (10%) than the T1 and T3 monoliths prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS at 0.5 w/dm ratio did not show any noticeable differences in MC. Batch T11 and T12 monoliths prepared with 35 wt% FA, 20 wt% OPC, 45 wt% BFS, and Xypex filler for WTP and 242-A simulant showed relatively higher MC (~30%) than the T13 monolith (27%) prepared with the original Cast Stone formulation (45 wt% FA, 8 wt% OPC, and 47 wt% BFS). Even though the T11 monolith was prepared with 5% Xypex addition, the value of MC in the T11 monolith did not decrease, because there was more OPC (20 wt%) in the T11 than T13 (8 wt% OPC). The grout monolith T14 prepared with a mixture of 242-A and ERDF simulant had a MC (26%) that is approximately between the MC values of T1 and T2 (25–27%). The grout monolith T15 and T16 prepared with ^{99}Tc getters also showed MC values very similar to those of the grout monolith T1 prepared without getter under the same formation condition. The grout monolith T17 and T18 prepared with ^{99}Tc getters and Xypex showed slightly reduced MC (~Δ1%) compared to the T10 monolith (28%). Under the same formulation condition, Xypex addition might reduce MC slightly. In general, all 21 grout monoliths, including the three non-^{99}Tc-spiked monoliths, showed a range of MC from 25 to 31%, which is similar to those found in previous LAW Cast Stone monoliths (Westsik et al. 2013).

Table 3.6. Moisture Content, Dry Solids Fraction, and XRD Analysis for Mineral Content

Test Batch #	MC (%)[a]	Dry Solids Fraction	XRD Analysis (wt%)[b]						
			Ettringite	Portlandite	Calcite	Larnite	Hydrocalumite	Quartz	Amorphous
1	27.13	0.729	12	11	9.0	4.2	-	3.0	61
2	25.03	0.750	9.8	14	6.9	4.5	6.1	-	58
3	25.14	0.749	14	11	6.8	4.4	-	-	64
4	30.63	0.694	9.3	12	6.8	4.9	-	-	66
5	29.42	0.706	9.4	12	3.3	6.4	5.4	-	63
6	29.74	0.703	17	9.7	5.4	4.5	-	-	63
7	25.48	0.745	9.7	15	7.2	4.9	5.5	0.3	58
8	29.79	0.702	16	10	9.9	5.1	-	0.9	58
9	27.89	0.721	11	9.1	5.8	2.4	-	0.4	71
10	27.52	0.725	16	8.1	6.8	3.7	-	0.6	65
11	30.44	0.696	15	-	4.5	4.1	-	2.0	75
12	29.63	0.704	14	-	3.7	2.4	-	1.5	78
13	26.64	0.734	12	-	4.2	2.0	-	4.1	78
14	25.77	0.742	8.9	14	8.6	4.6	2.8	1.3	60
15	24.99	0.750	19	8.9	5.7	6.5	-	-	60
16	25.43	0.746	16	11	4.6	4.0	-	0.4	63
17	26.66	0.733	13	7.9	4.1	3.9	-	0.6	70
18	26.46	0.735	13	7.8	4.0	4.1	-	1.2	70
19 [c]	26.21	0.738	13	9.5	-	5.3	-	-	72
20 [c]	29.74	0.703	15	8.0	-	4.4	-	-	73
21 [c]	31.21	0.688	12	-	-	3.7	-	1.8	82

(a) MC = moisture content
(b) chemical formulas of minerals: ettringite [$Ca_6Al_2(SO_4)_3(OH)_{12}$•$26H_2O$], portlandite [$Ca(OH)_2$], calcite [$CaCl_2$], larnite [$Ca_2SiO_4$], hydrocalumite [$Ca_4Al_2(OH)_{12}(OH)_2$•$6H_2O$)], and quartz [$SiO_2$]
(c) non-^{99}Tc-spiked grout monoliths (T19, T20, and T21)

3.3.2 Mineral Content XRD Analysis

The XRD analysis of the HL showed ~97 wt% portlandite, $Ca(OH)_2$, as a major mineral with minor amounts of calcite (2.6 wt%), MgO (0.7 wt%), and quartz (0.2%), consistent with published data from Graymont (Figure 3.3). The XRD results for Xypex showed that Xypex was composed of 42 wt% hatrurite (Ca_3SiO_5), 21 wt% portlandite, 15 wt% larnite (Ca_2SiO_4), 15 wt% brucite ($Mg(OH)_2$), 3.9 wt% calcite ($CaCO_3$), and 3.3 wt% quartz (Figure 3.3). Other major dry ingredients (OPC, FA, and BFS) were well characterized by previous works (Mattigod et al. 2011; Sundaram et al. 2011).

The XRD analysis of 18 ^{99}Tc-spiked and 3 non-^{99}Tc-spiked powdered grout monolith bulk samples were conducted and the XRD patterns of the monoliths are shown in Figure 3.4 and Figure 3.5. Semi-quantitative analyses of mineral contributions were also conducted by analyzing the XRD patterns with reference added (TiO_2, 10 wt%). Major mineral contents of each monolith are shown in Table 3.6. All grout samples showed the presence of ettringite as the primary crystalline phase, with a range of content from 9 to 17 wt%. For the 18 ^{99}Tc-spiked grout samples, the XRD patterns collected are very similar except for the grout monoliths T11, T12, and T13, which were prepared with FA, OPC, and BFS. No HL was used to prepare these grout monoliths (Table 3.1). Even though most of the ^{99}Tc-spiked grout monoliths formed portlandite as a second major mineral ranging from 8 to 12 wt%, these three monoliths (T11, T12, and T13) did not form portlandite (Table 3.6). This finding is the same as for three non-^{99}Tc-spiked monoliths; grout monoliths T19 and T20 showed both ettringite and portlandite formation, but T21, prepared with FA, did not form portlandite either. Lack of portlandite formation in grout monoliths prepared without HL addition can be attributed to the limited availability of Ca^{2+}. Addition of HL in the new formulation for these LSWs containing high sulfate can provide enough Ca^{2+} for formation of both early stage ettringite and portlandite. However, the original Cast Stone formulation does not have enough Ca^{2+} to form both ettringite and portlandite during 28-day curing. In this case, ettringite would be formed first by consuming all available Ca^{2+} in the original Cast Stone formulation with high-sulfate WTP simulant, which cannot make enough portlandite. Instead of forming portlandite, the grout monolith T13 prepared with the original Cast Stone formulation with FA showed the highest quartz contents, identified as a sharp peak in the 26.5 2θ region (Figure 3.4). The quartz likely was in the FA used in this dry blend mix. Most of the cured grout monoliths were dominated by amorphous phases ranging from 63 to 84 wt%, which is attributed to calcium-silicate-hydrate (C-S-H) gel in the grout.

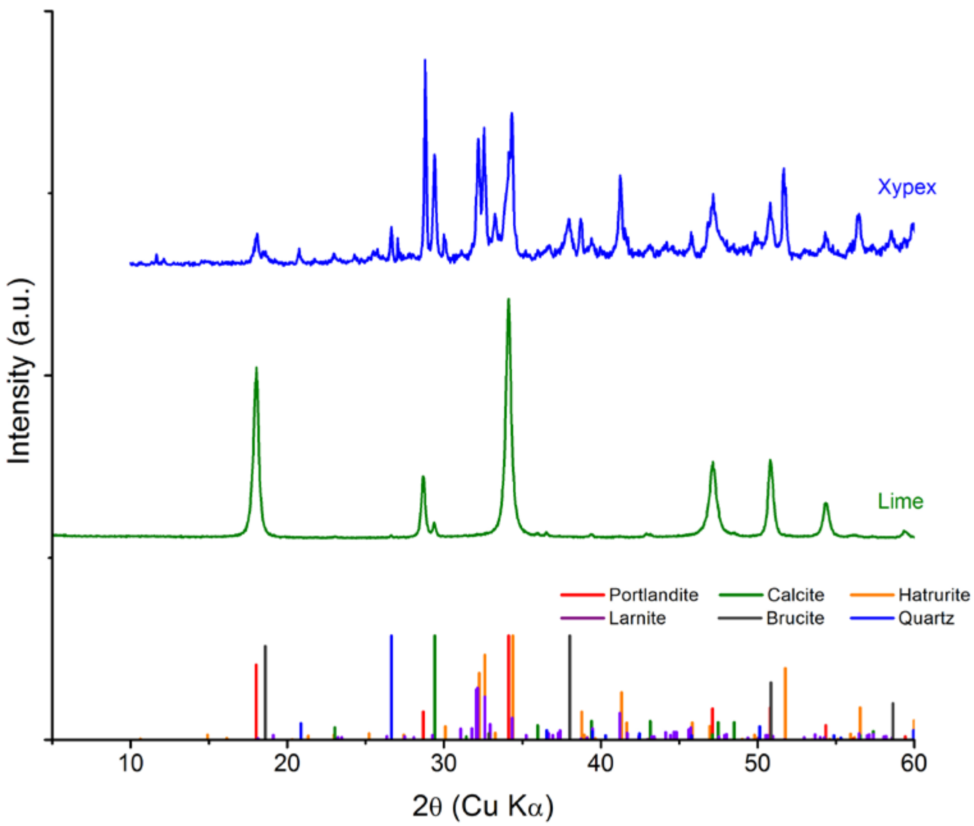


Figure 3.3. XRD Patterns of Hydrated Lime and Xypex

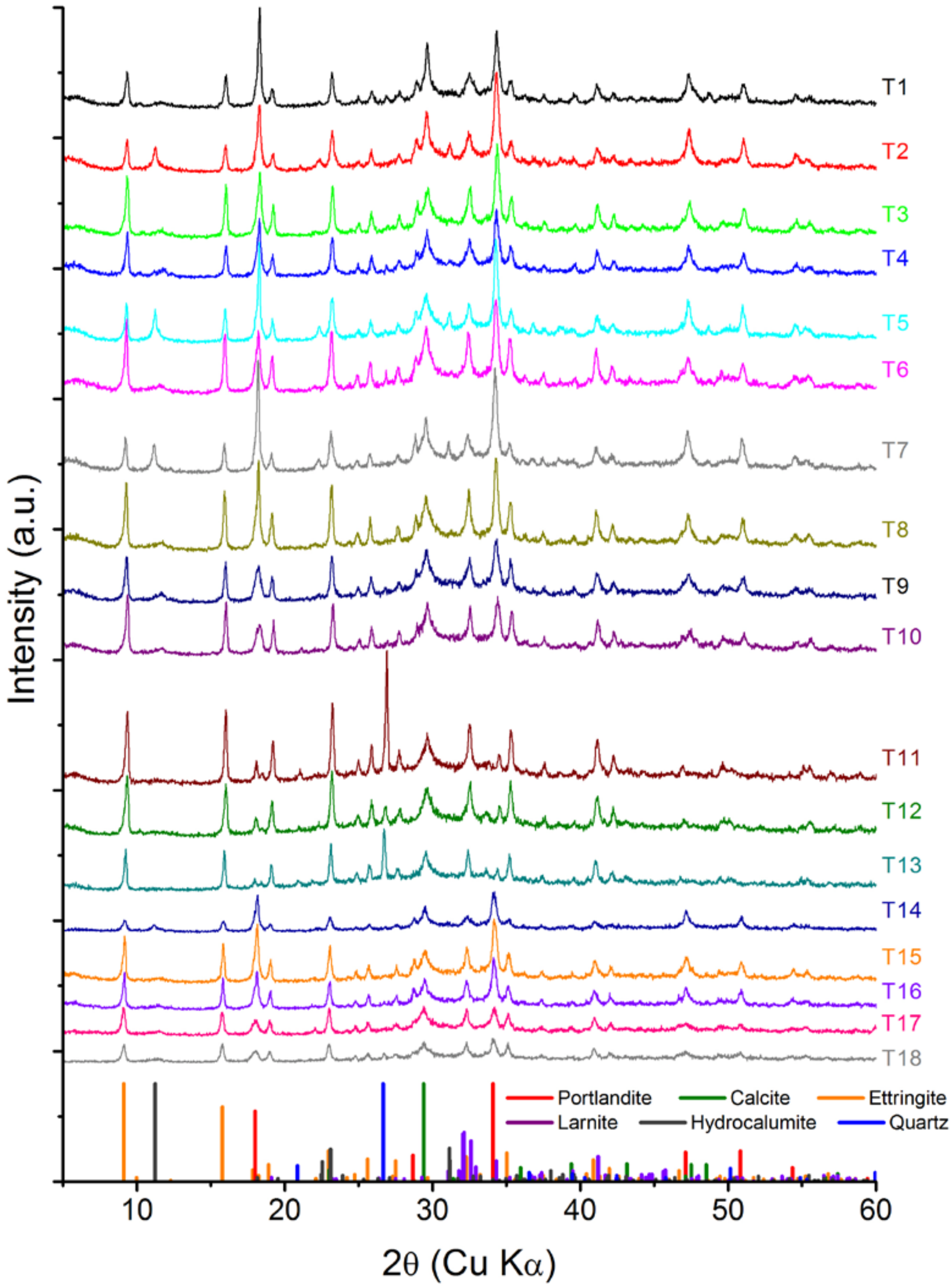


Figure 3.4. XRD Patterns of 18 ^{99}Tc-Spiked Grout Monoliths. Numbers to the right of each trace are the grout monolith test numbers from Table 3.1.

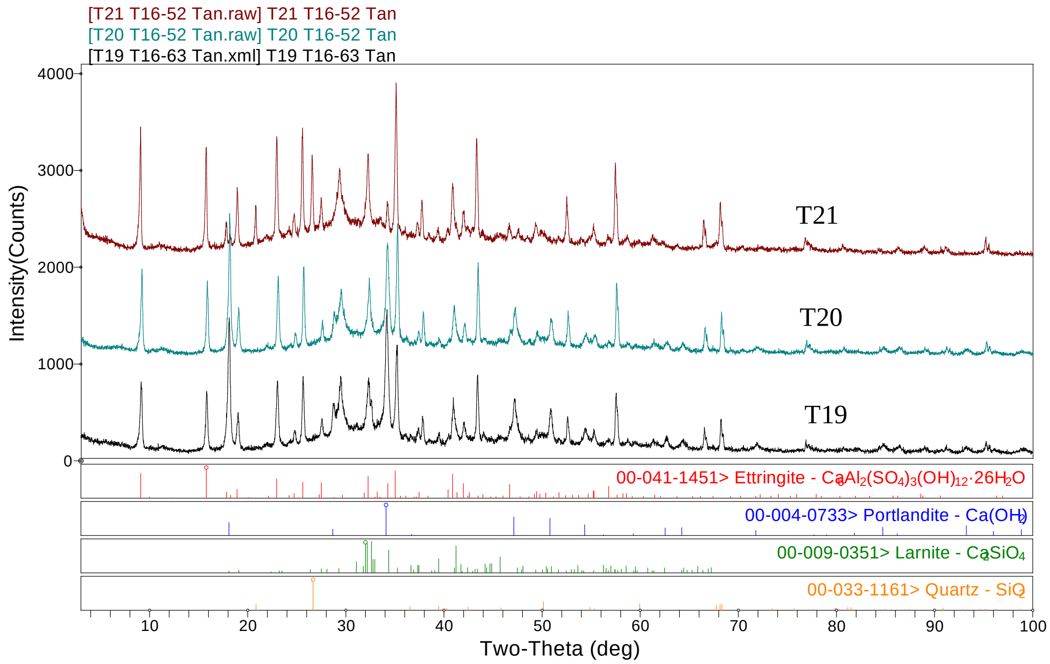


Figure 3.5. XRD Patterns of Three Non-^{99}Tc-Spiked Monoliths

3.3.3 SEM/EDS Analysis

SEM images and EDS data for the non-^{99}Tc-spiked grout monolith (grout monolith T20) are shown in Figure 3.6. As with the XRD analysis, needle-shaped ettringite was found and the major elements in the selected area were identified as Ca, S, Al, Si, and Na.

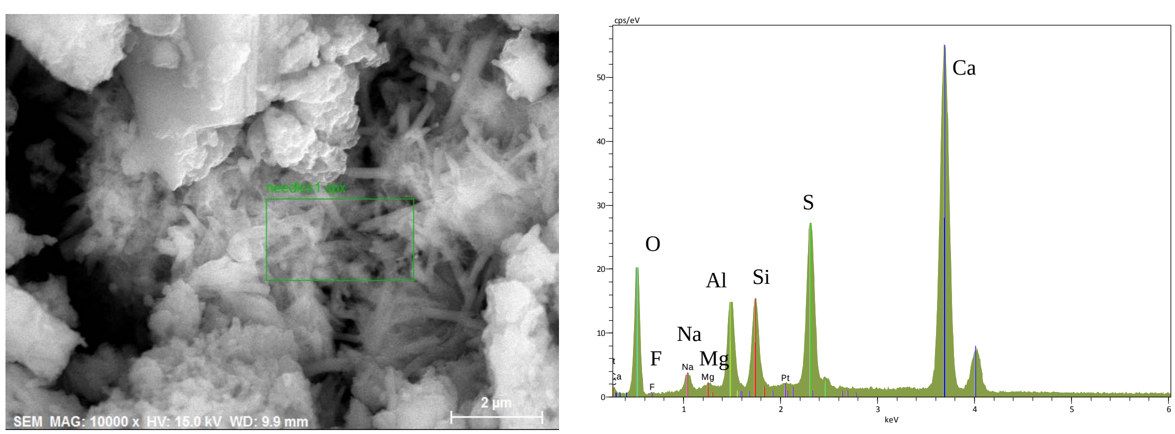


Figure 3.6. SEM Image of Non-^{99}Tc-Spiked Grout (Monolith T20) Showing Needle Shapes of Ettringite (left) and EDS Result (right) Showing Atomic Percentages of Ca (25.5%), S (7.4%), Al (4.5%), Si (4.1%), Na (1.5%), F (0.7%), Mg (0.2%), and O (56.1%) in the Area Outlined in the SEM Image

Analysis of SEM/EDS for the selected ^{99}Tc-spiked grout powder samples also showed needle-shaped particles of ettringite (Figure 3.7). The grout particles looked very similar although there were some regions where there were more fine crystallites. Analysis with EDS showed that Ca, Si, S, Al, Na, Mg, and Fe are the major elements (Figure 3.8). In addition, ^{99}Tc was found in most of the ^{99}Tc-spiked sample particles, and relatively high ^{99}Tc concentration found in EDS seems to correlate with high S and Fe. More SEM and EDS data for the selected radiological samples are shown in Appendix A.1.

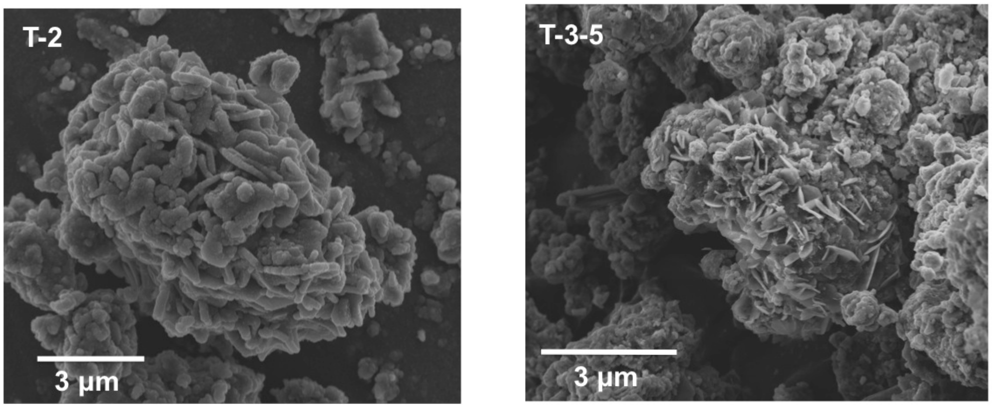
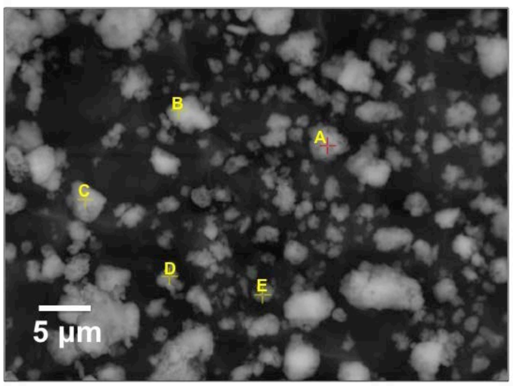


Figure 3.7. SEM Images of ^{99}Tc-Spiked Grout Samples (Monoliths T2 and T3)



Element (wt%)					
Sample	T3-5				
	A	B	C	D	E
NaK	2.71	6.45	3.05	5.68	6.17
MgK	3.30	3.71	1.04	1.87	2.83
AlK	9.84	6.24	6.53	5.84	9.35
SiK	12.31	16.46	10.48	23.84	19.59
SK	14.86	4.88	7.37	6.80	8.29
TcL	1.31	0.66	0.61	0.67	0.14
CaK	53.11	60.61	70.21	54.02	51.64
FeK	2.56	0.99	0.71	1.30	1.99

Figure 3.8. SEM and EDS Analysis of ^{99}Tc-Spiked Grout Sample (Monolith T3)

4.0 EPA 1313 Leaching Test

The EPA Method 1313 test, *Liquid-Solid Partitioning as a Function of Extract pH Using A Parallel Batch Extraction Procedure,* is a static test method designed to provide a liquid-solid partitioning curve as a function of pH (EPA 2012). A set of parallel batch extraction experiments were conducted using dilute nitric acid or potassium hydroxide base in DIW in a fixed pH range from 2 to 13 and at a fixed liquid-to-solid ratio of 10 mL/gram.

4.1 Methods and Materials

Prior to starting the EPA Method 1313 static leaching test, pre-titrations were conducted at fixed liquid-to-solid ratios (10 mL/g) on <0.3 mm non-^{99}Tc-spiked powdered secondary waste grout samples (monoliths T19, T20, and T21 in Table 3.1). They were prepared using the same formulation conditions as ^{99}Tc-spiked grout monoliths, T3, T6, and T11, respectively. Since the measured pH of the leachate solutions for the secondary waste grouts were expected to be high (pH ~12 to 13) based on previous Cast Stone leachates (Westsik et al 2013; Serne et al 2015), the pre-titration added variable amounts of nitric acid (HNO_3) to decrease the pH to several lower target pH values after 24 hours of equilibration. Nitric acid stock solutions of 2 N and 4 N concentrations were prepared using HNO_3 Optima (16 M) for the pre-titrations and the final EPA Method 1313 batch tests. The MC of the size-reduced powdered grout samples were also determined using the same procedure described in Section 3.3 and were used to determine the correct volume of reagent water required to bring each batch container to a liquid-to-solid ratio of exactly 10 mL/g-dry solid. Based on the pre-titration and MC results, the EPA Method 1313 static leaching test samples were prepared by adding 20 g of <0.3 mm size-fraction crushed grout to a predetermined amount of 2 N or 4 N HNO_3 solution. Because the grout monolith T11 prepared with FA showed a lower natural pH (~12.5), which was measured in DIW with no acid or base added, 1 N KOH was added to this sample to achieve the final target pH of 13. All samples were brought to a final volume with DIW at a fixed liquid-to-solid ratio of 10 mL/g. After the addition of solution to each crushed grout sample, the sample tubes were taped shut to prevent leaking, placed on a platform (or end-over-end) shaker, and allowed to mix at room temperature (23 ±2°C) for 24 hours. After mixing for 24 hours, the tubes were removed from the shaker and allowed to stand for 15 minutes prior to filtering the solution using a 0.45 µm PVDF vacuum filter unit. One aliquot of filtrate was used to measure pH, EC, and E_h, and the remaining filtrate was submitted for ^{99}Tc and other chemical analyses using ICP-MS and ICP-OES.

4.2 Results and Discussion

The MCs of the size-reduced powdered (crushed) grout samples used for EPA Method 1313 leaching tests are shown in Table 4.1 as the averages from triplicate measurements. The MC showed a very narrow range (22 to 26%) and there was no significant difference among the different grout samples. Relatively lower MCs of the fine particles (<0.3 mm) were found compared to those measured for the same monolith samples (25 to 30% in Table 3.6) likely caused by loss of moisture during the crushing process.

Table 4.1. Average Moisture Content of Powdered Secondary Waste Grouts for EPA Method 1313 Tests

Secondary Waste Grout Monoliths	Moisture Content (wt%)
T3	22.0
T6	24.3
T11	25.8

The measured pH, EC, and E_h for the EPA Method 1313 filtrates are shown in Table 4.2, Figure 4.1, and Figure 4.2. The EC increased as pH decreased for each batch of secondary waste grout. The higher EC values indicate that the concentration of dissolved ions in solution including hydrogen ion is increasing at low pH conditions. This suggests that the acid is dissolving some of the grout solids, increasing the dissolved ions in solution. There was no discernible difference in EC between the batches of grout prepared with HL (monoliths T3 and T6), but slightly lower EC values were found in the filtrate from grout monolith T11, which was prepared with FA instead of HL. The E_h values for the EPA Method 1313 leachates also increased as pH decreased for each batch of grout. All the measured redox potential values were corrected to E_h (Standard Hydrogen Electrode, SHE) values by adding +208 or 211 mV to the measured redox potential value depending on the probe used. In general, the high E_h values indicate oxidizing conditions at lower pH compared to slightly reducing conditions (<200 mV) at higher pH. Similar to the EC measurements, there was no discernible difference between the E_h measurements among the three different batches of grouts. It is important to note that it is difficult to obtain the stable E_h value for a sample that is open to the atmosphere, which can cause the E_h values to change continuously as the leachates absorb oxygen. Additionally, redox conditions are highly influenced by the pH of the leachate.

The ^{99}Tc concentrations measured in the filtrate per gram of solid of the three grout monoliths are shown as a function of pH in Table 4.2 and Figure 4.3. In general, all three grout monoliths samples showed slightly increasing ^{99}Tc release as pH increased, because of higher anionic sorption of pertechnetate onto the crushed grout at low pH conditions. In addition, grout T11, which was prepared with FA (Table 3.1), displayed the highest ^{99}Tc release, more than the two grouts powders (T3 and T6) prepared with HL. For grout T6, the released ^{99}Tc concentrations stayed fairly steady even though there were a couple of increases or decreases between pH values of 8.5 and 11. Grouts T3 and T6 powders displayed comparable ^{99}Tc release amounts at higher pH (>~9.5), and grout T3 sample displayed the lowest ^{99}Tc release at pH below 9.5. The lower ^{99}Tc concentration in grout T3 filtrate at low pH values (<9.5) compared to grout T6 resulted from lower ^{99}Tc initial concentration in the T3 grout due to lower w/dm ratio (0.5 vs. 0.6 w/dm in Table 3.1) than grout T6. The only difference between grout monoliths T3 and T6 is the w/dm ratio, which induces different initial ^{99}Tc concentrations in the cured grout (6.63 Tc-mg/kg-dry vs. 7.98 Tc-mg/kg-dry from Table 5.2 of Section 5 below). Additionally, in the range of pH 3 to 13, grout T3 leached 4– 15% of the starting inventory of ^{99}Tc, grout T6 leached 9–14% of the starting inventory of ^{99}Tc, and grout T11 leached 17–30% of the ^{99}Tc initial concentration. Grout T11, which showed the highest ^{99}Tc release percentage was made with FA, OPC, and BFS, while grout monoliths T3 and T6 were prepared with HL, OPC, and BFS. These results indicate that the substitution of HL in place of FA resulted in lower release of ^{99}Tc in these grouts prepared with high-sulfate-containing WTP off-gas condensate LSW simulant. It is also important to note that by using the <0.3 mm fraction of the crushed grout monoliths, an equilibrium was assumed to reach after 24 hrs reaction in EPA 1313 Method test. Therefore, the percentage of ^{99}Tc leached in the EPA Method 1313 leaching test is expected to be higher than that found in intact monolith samples of the same grout composition leached in similar solutions for 24 hrs.

Table 4.2. Measured pH, EC, E_h, and ^{99}Tc in Solution from EPA Method 1313 Leaching Test

Monolith #	pH	EC (mS/cm)	E_h (mV)	^{99}Tc concentration (µg/g)
T3	12.6	16.9	153.8	0.988
	12.1	24.9	185	0.778
	10.7	50.1	263.2	1.01
	9.33	74.1	350	0.571
	9.12	76.2	358	0.65
	8.5	80.3	369	0.502
	7.4	84.2	414	0.293
	5.32	94.5	327	0.322
	3.4	100	526	0.437
T6	12.4	18.2	148.2	0.951
	12.1	25.5	176.4	0.931
	10.4	51.3	252.6	0.873
	9.77	66.1	287.6	0.715
	8.9	75.1	326	0.939
	8.46	77.4	339	1.08
	6.57	85.8	402	0.863
	4.87	92.4	374	0.818
	3.76	95.8	481	0.897
T11	12.6	27.7	123.6	2.44
	12.3	10.4	147.2	1.78
	9.89	27	270.7	2.22
	9.22	38.7	317	2.18
	8.72	44.4	340	2.18
	7.55	52.7	393	1.88
	6.49	60.3	388	1.98
	3.9	74.1	455	1.42
	2.83	92.8	593	1.65

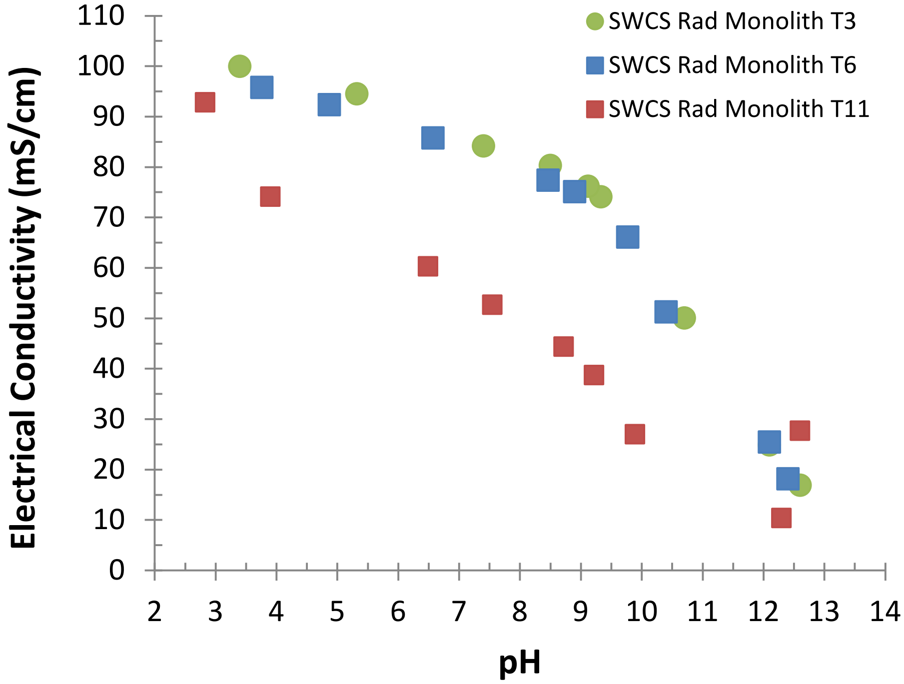


Figure 4.1. EC Values in Filtrates from Three Grout Monolith Powders Measured by EPA Method 1313

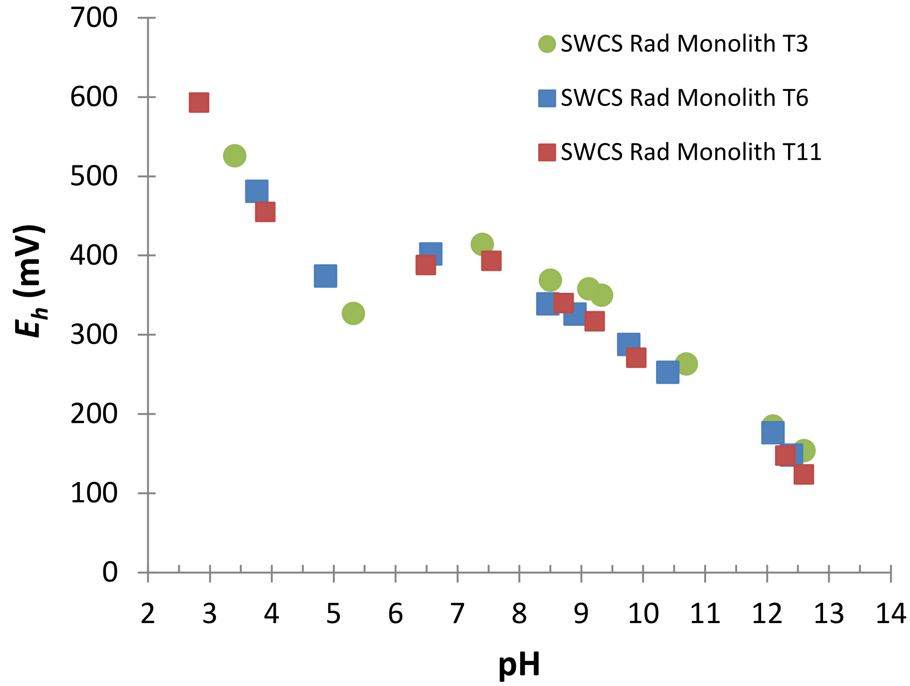


Figure 4.2. E_h Values in Filtrates from Three Grout Monolith Powders Measured by EPA Method 1313

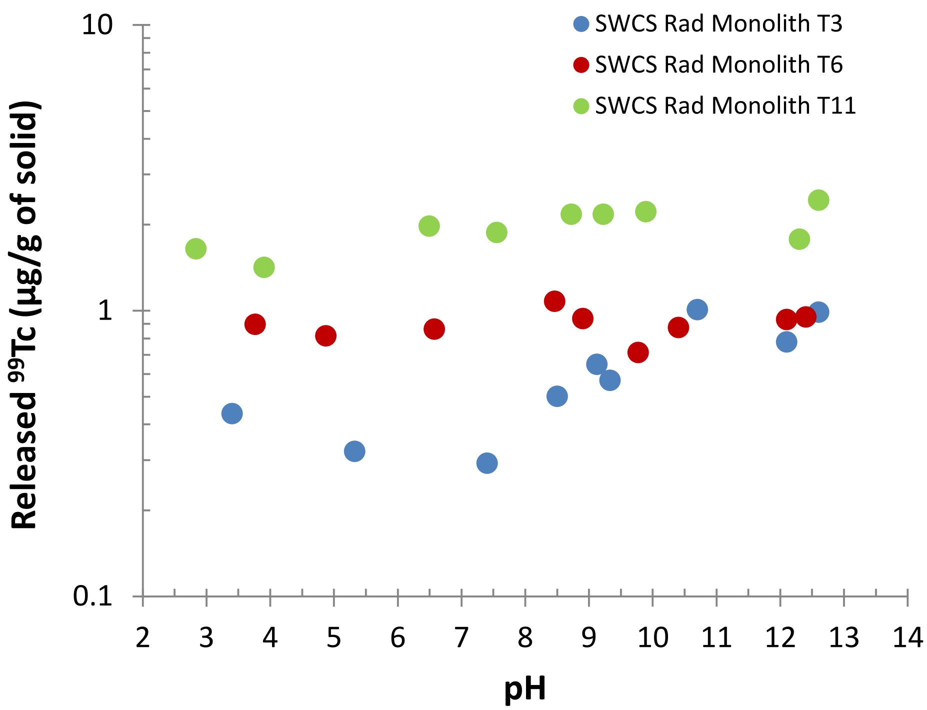


Figure 4.3. Leached ^{99}Tc (µg/g) Values in Filtrates from Three Grout Monolith Powders by EPA Method 1313

The measured concentrations of major cations in the EPA Method 1313 filtrates are shown in Table 4.3. The concentrations of the major cations generally decreased with an increase in pH values, which is consistent with EC measurements due to low solubility and high sorption affinity of cations at high pH values. Fe ions were not detected (ND) in filtrates at pH levels higher than 6.5, which results from high potential of $Fe(OH)_3$(s) to precipitate at high pH. Absence of Fe at pH higher than 6.5 might also increase the E_h value shortly before showing continuous decreasing E_h values from pH higher than 7.5. Increasing total S (mostly sulfate) concentrations as pH decreased also resulted from higher dissolution of S-containing grouts at low pH than at high pH. Dissolved Si concentrations in the filtrates from grout monoliths T3 and T6 were very low (or ND) at pH higher than 12, which is contrary to that found in grout monolith T11, in which total dissolved Si increased again at pH higher than 12. In general, more dissolved Si was found in the filtrates from grout monolith T11 than in the filtrates from monoliths T3 and T6 due to abundance of Si from the FA and Xypex used.

Table 4.3. Concentrations of Major Cations in Filtrate Collected for EPA Method 1313 Leaching Test

Monolith #	pH	Na (µg/L)	K (µg/L)	Si (µg/L)	S (µg/L)	Fe (µg/L)
T3	12.6	1.55E+06	2.04E+05	ND[(a)]	1.29E+04	ND
	12.1	3.79E+05	4.06E+04	2.14E+03	1.15E+04	ND
	10.7	2.46E+05	3.14E+04	3.20E+03	2.50E+04	ND
	9.33	2.54E+05	3.81E+04	3.22E+03	1.52E+05	ND
	9.12	4.43E+05	2.85E+04	2.86E+03	1.26E+05	ND
	8.5	3.66E+05	2.91E+04	5.62E+03	2.39E+05	ND
	7.4	2.11E+05	1.84E+04	1.94E+03	1.40E+05	ND
	5.32	4.49E+05	4.68E+04	1.32E+04	3.35E+05	1.43E+05
	3.4	2.10E+06	2.67E+05	4.98E+04	5.90E+05	3.93E+05
T6	12.4	1.83E+06	1.78E+05	ND	1.44E+04	ND
	12.1	7.30E+05	7.42E+04	ND	3.89E+04	ND
	10.4	3.80E+05	3.36E+04	3.13E+03	1.09E+05	ND
	9.77	2.67E+05	3.19E+04	3.91E+03	1.92E+05	ND
	8.9	2.02E+05	1.73E+04	1.84E+03	1.41E+05	ND
	8.46	3.04E+05	3.00E+04	1.28E+03	1.25E+05	ND
	6.57	2.21E+06	1.78E+05	7.01E+03	5.71E+05	ND
	4.87	2.25E+06	2.15E+05	1.93E+04	5.96E+05	2.44E+05
	3.76	2.25E+06	2.33E+05	3.84E+04	5.85E+05	3.11E+05
T11	12.6	1.78E+06	NA[(b)]	2.35E+04	3.01E+05	NR[(c)]
	12.3	1.60E+06	1.17E+05	1.42E+04	2.55E+05	NR
	9.89	1.32E+06	9.65E+04	6.43E+03	8.56E+05	ND
	9.22	2.13E+06	1.27E+05	4.19E+03	4.76E+05	ND
	8.72	2.22E+06	1.34E+05	3.37E+03	4.90E+05	ND
	7.55	2.25E+06	1.41E+05	4.67E+03	5.08E+05	ND
	6.49	2.30E+06	1.62E+05	1.07E+04	5.05E+05	ND
	3.9	2.38E+06	2.27E+05	5.82E+04	5.08E+05	2.94E+05
	2.83	2.91E+06	3.48E+05	1.01E+05	6.67E+05	6.03E+05

(a) ND indicates "not detected," sample concentration below quantification level for Si (<548 µg/L) and Fe (<100 µg/L).
(b) NA indicates K for T11, pH 12.6, is not applicable; KOH was added to this sample to adjust the pH.
(c) NR = not reportable (due to high iron in blanks)

5.0 EPA Method 1315 Leaching Test

The EPA Method 1315 leach test measures the effective diffusivity of key constituents including technetium, nitrate, and sodium using a semi-dynamic leaching procedure, on cured LSWG cylindrical monoliths for a minimum of 63 days leaching in DIW. Leach testing was performed in accordance with the instructions and approach described in EPA Method 1315 (EPA 2013); however the cumulative leaching time was extended and a second leachant IDF vadose zone pore water (VZPW) was also used besides DIW to leach companion LSWG monoliths.

5.1 Methods and Materials

The EPA Method 1315 test is a semi-dynamic leach test that consists of submerging a monolithic sample in leachant at a fixed ratio of liquid volume to solid geometric surface area. Monoliths from Table 3.1 were placed into the centers of leaching vessels containing sufficient leachant as DIW or VZPW to maintain a solution-to-solid geometric surface area ratio of 9 ± 1 mL of leachant per square centimeter of grout monolith geometric surface area. Grout monolith stands and holders were used to maximize the contact area of the monolith with the leaching solution. The surface area of each monolith and the DIW or VZPW target volume were previously determined and used for the EPA 1315 Method leaching test. The VZPW simulant was prepared using the recipe shown in Table 5.1. The recipe was based on several direct measurements of actual VZPW removed from Hanford formation sediments from boreholes in the 200 E Area where the IDF is located; more details on the VZPW simulant and recipe can be found in Serne et al. (2015). Appropriate containers (2-liter plastic buckets) with lids were used to allow the monolith to be fully immersed in the leaching solution. Duplicate monoliths were leached in each leaching solution with monoliths in DIW labeled 1 and 2 and monoliths in VZPW labeled 3 and 4. The sampling was done at fixed intervals, at cumulative leaching times of 0.08, 1, 2, 7, 14, 28, 42, 49, and 63 days. Additional leachate samplings were conducted at cumulative leaching times of 90 and 140 days, which are beyond the times prescribed in EPA Method 1315. At each sampling interval, all the DIW and VZPW leaching fluids were removed and replaced with fresh leachant, while the monolith mass was recorded. The leachate pH, E_h, EC, alkalinity, and ammonium ion concentration were measured using a meter and probe at each time interval and recorded on the data sheet. The remaining leaching solution was subsampled into several aliquots (each ~20 mL) for subsequent analysis. Analysis was focused on leached components for which effective diffusivities are needed (e.g., Tc, nitrate, and Na) and overall chemical composition. Leachate analytical methods used include ICP-OES for cations concentrations, ICP-MS for ^{99}Tc concentration, and IC for anions concentrations. Total ^{99}Tc and nitrate concentrations in the cured grout monoliths were calculated by using the measured ^{99}Tc and nitrate concentrations in each simulant before making the individual grout monoliths (Table 3.1) and the masses of dry ingredients and liquid simulant used. This equates to assuming there is no leachable ^{99}Tc or nitrate sources in the dry ingredients. However, because the dry ingredients used to prepare each monolith may contain a sodium source, total sodium concentration was measured directly by ICP-OES analysis of microwave-assisted digests for each grout powder used for the EPA Method 1313 test. Initial concentrations of the constituents of interest are given in Table 5.2.

Table 5.1. Vadose Zone Pore Water Simulant Preparation

Order of Dissolution	Molarity (mol/L)	Chemical Reagents	Molecular Weight (g)	Grams for 1 L	Grams for 600 L	Grams for 900 L
1	0.012	$CaSO_4 \cdot 2H_2O$	172.1723	2.0661	1239.641	1859.461
2	0.0017	NaCl	58.4430	0.0994	59.612	89.418
3	0.0004	$NaHCO_3$	84.0068	0.0336	20.162	30.242
4	0.0034	$NaNO_3$	84.9948	0.2890	173.389	260.084
5	0.0026	$MgSO_4$	120.3660	0.3130	187.771	281.656
6	0.0024	$MgCl_2 \cdot 6H_2O$	203.3034	0.4879	292.757	439.135
7	0.0007	KCl	74.5515	0.0522	31.312	46.967
The pH was adjusted to 7.0–7.2 by adding sodium hydroxide or sulfuric acid.						

The observed effective diffusivities for ^{99}Tc, nitrate, and sodium were calculated using the analytical solution for Fick's second law using Equation (5.1), for simple radial diffusion from a cylinder into an infinite bath as used in EPA Method 1315 (2013). The term effective diffusion coefficient, D_{eff} used in this report is called observed diffusion coefficient in EPA Method 1315 document accounting for all physical and chemical retention factors influencing mass transfer. ANSI/ANS16.1 uses the symbol D with no subscript and names D =effective diffusion coefficient. ASTM C1308 method uses the symbol D_e and name effective diffusion coefficient. In some literature this parameter, the D_e value in Equation (5.1) is called apparent diffusion coefficient, D_a (See for example Grathwohl (1998)). All three names are equivalent and are "quantified" in standard leach tests.

$$D_{obs(i)} = \pi[\frac{M_{ti}}{2\rho C_0\,(\sqrt{t_i}-\sqrt{t_{i-1}})}]^2 \tag{5.1}$$

where
- $D_{obs(i)}$ = observed effective diffusivity of a specific constituent for leaching interval i (m^2/s)
- M_{ti} = mass of specific constituent released during leaching interval i (mg/m^2)
- t_i = cumulative contact time after leaching interval, i (s)
- $t_i - 1$ = cumulative contact time after leaching interval, $i - 1$ (s)
- C_o = initial concentration of constituent in the dry grout (mg/kg-dry)
- ρ = grout dry bulk density (kg-dry/m^3).

The leachability index (LI), a unitless parameter derived from the interval effective diffusion coefficient values, is calculated using Equation (5.2), in which β is a defined constant (1.0 cm^2/s) from ANSI/ANS 16.1 (2003). A low diffusivity results in a larger LI.

$$LI_i = \frac{1}{n}\sum_1^n[\log\left(\frac{\beta}{D_i}\right)]_n \tag{5.2}$$

Table 5.2. Initial Concentrations [C(0) inventory] of ^{99}Tc, NO_3^- and Na^+ used in Diffusivity Calculations

Test Batch #	^{99}Tc (mg/kg-dry)	NO_3^- (mg/kg-dry)	Na^+ (mg/kg-dry)
1	6.43	-	3.94E+03
2	6.85	7.49E+03	7.14E+03
3	6.63	1.56E+04	1.55E+04
4	7.73	-	4.71E+03
5	8.15	8.91E+03	8.05E+03
6	7.98	1.86E+04	1.99E+04
7	6.48	7.53E+03	7.15E+03
8	7.94	1.86E+04	2.02E+04
9	6.68	-	3.73E+03
10	6.85	1.61E+04	1.64E+04
11	8.12	1.88E+04	2.59E+04
12	7.56	-	1.23E+04
13	9.07	1.78E+04	2.26E+04
14	6.52	3.76E+03	5.56E+03
15	6.70	1.56E+04	1.52E+04
16	6.83	1.57E+04	1.64E+04
17	6.81	1.60E+04	1.98E+04
18	6.75	1.59E+04	1.94E+04
- : No nitrate in the simulant			

5.2 Results and Discussion

The calculated effective diffusivity (D_{eff}) and LI values of ^{99}Tc, NO_3^-, and Na^+ for each set of duplicate monoliths in either DIW or VZPW leaching solution up to the cumulative 140-day leaching are shown in Table 5.3 and Table 5.4, respectively. For DIW and VZPW leaching solutions, each monolith was tested in duplicate so that, for example, T1-1 and T1-2 indicate grout monolith T1 test for duplicates in DIW in Table 5.3 and T1-3 and T1-4 indicate grout monolith T1 test for duplicates in VZPW leaching solution in Table 5.4. For non-detected (ND) ^{99}Tc concentration in the leachates, the EQL value of ICP-MS for ^{99}Tc concentration analysis was used to determine ^{99}Tc D_{eff} (and LI) values. Background (blank buckets containing only leachant) leaching samples in either DIW or VZPW leaching solution were also collected for each leaching interval and used to correct the leached concentrations of these three constituents by subtracting the background concentration from the measured concentration of each constituent for the cumulative 140-day leaching. No zero or negative values for blank corrected DIW leachates for ^{99}Tc, Na^+, or NO_3^- were found during the cumulative 140-day leaching test. However, three Na^+ and several NO_3^- blank corrected VZPW leachates showed zero or negative values due to the Na^+ and NO_3^- concentration in VZPW leachates being the same or smaller than the concentrations in the blank solution (Table 5.1). For these sampling intervals, the average value of actual concentrations collected before and after the constituent's leaching interval was used to determine D_{eff} and LI values for Na^+ and NO_3^-. Because NO_3^- concentrations in three simulants used for this study were relatively low compared to previous LAW simulants (Serne et al. 2015), more than 3 or 4 consecutive NO_3^- samples showed zero or negative blank corrected values for NO_3^- concentrations in VZPW leaching solution. In these cases, the EQL value of NO_3^- analysis using IC was used instead of zero or negative values of NO_3^- samples. D_{eff} and LI values determined using the EQL value for Na^+ or NO_3^- concentrations are shown in red color in Table 5.4. Because no NO_3^- was added to the 242-A evaporator condensate simulant, the NO_3^- D_{eff} calculation for test batches T1, T4, T9, and T12 was not performed.

Table 5.3. Diffusivity and LI Values of ^{99}Tc, NO_3^-, and Na^+ in DIW Leaching Solution

Cumulative Leach Time (day)	T1-1 for ^{99}Tc		T1-2 for ^{99}Tc		T1-1 for NO_3^-		T1-2 for NO_3^-		T1-1 for Na^+		T1-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.53E-12	11.3	1.02E-12	12.0	-	-	-	-	1.81E-08	7.74	5.18E-09	8.29
1.0	5.06E-12	11.3	6.25E-12	11.2	-	-	-	-	1.00E-08	8.00	8.84E-09	8.05
2.0	5.25E-12	11.3	4.71E-12	11.3	-	-	-	-	7.47E-09	8.13	3.76E-09	8.42
7.0	6.05E-12	11.2	5.03E-12	11.3	-	-	-	-	4.91E-09	8.31	3.29E-09	8.48
14.0	4.15E-13	12.4	6.78E-13	12.2	-	-	-	-	2.95E-09	8.53	2.52E-09	8.60
28.0	2.38E-15	14.6	1.61E-15	14.8	-	-	-	-	1.20E-09	8.92	1.09E-09	8.96
42.0	2.67E-15	14.6	2.10E-15	14.7	-	-	-	-	6.79E-10	9.17	6.95E-10	9.16
49.0	1.09E-14	14.0	1.10E-14	14.0	-	-	-	-	6.19E-10	9.21	7.13E-10	9.15
63.0	3.34E-15	14.5	3.39E-15	14.5	-	-	-	-	6.59E-10	9.18	6.71E-10	9.17
90.0	2.29E-15	14.6	1.56E-15	14.8	-	-	-	-	3.13E-10	9.51	4.66E-10	9.33
140.0	4.46E-15	14.4	8.03E-16	15.1	-	-	-	-	3.22E-10	9.49	3.75E-10	9.43

Cumulative Leach Time (day)	T2-1 for ^{99}Tc		T2-2 for ^{99}Tc		T2-1 for NO_3^-		T2-2 for NO_3^-		T2-1 for Na^+		T2-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.75E-10	9.32	3.95E-10	9.40	7.08E-10	9.15	6.08E-10	9.22	1.23E-08	7.91	1.14E-08	7.94
1.0	2.03E-10	9.69	8.86E-11	10.1	3.22E-10	9.49	1.62E-10	9.79	4.54E-09	8.34	2.33E-09	8.63
2.0	7.45E-11	10.1	1.06E-10	10.0	1.74E-10	9.76	2.54E-10	9.60	2.20E-09	8.66	3.14E-09	8.50
7.0	1.48E-10	9.83	1.31E-10	9.88	2.76E-10	9.56	2.34E-10	9.63	3.73E-09	8.43	3.40E-09	8.47
14.0	3.00E-11	10.5	2.88E-11	10.5	2.94E-10	9.53	2.75E-10	9.56	2.79E-09	8.55	2.82E-09	8.55
28.0	9.66E-14	13.0	1.72E-13	12.8	1.75E-10	9.76	1.64E-10	9.78	1.61E-09	8.79	1.68E-09	8.78
42.0	3.14E-14	13.5	1.57E-13	12.8	1.16E-10	9.93	1.08E-10	10.0	1.12E-09	8.95	1.19E-09	8.93
49.0	9.20E-14	13.0	1.84E-13	12.7	1.88E-10	9.73	1.49E-10	9.83	1.20E-09	8.92	1.08E-09	8.97
63.0	3.15E-14	13.5	2.28E-13	12.6	9.62E-11	10.0	9.08E-11	10.0	1.32E-09	8.88	1.27E-09	8.89
90.0	3.40E-14	13.5	2.68E-13	12.6	7.55E-11	10.1	7.93E-11	10.1	9.02E-10	9.04	9.20E-10	9.04
140.0	3.43E-14	13.5	9.13E-14	13.0	5.62E-11	10.3	5.18E-11	10.3	6.89E-10	9.16	6.79E-10	9.17

Cumulative Leach Time (day)	T3-1 for ^{99}Tc		T3-2 for ^{99}Tc		T3-1 for NO_3^-		T3-2 for NO_3^-		T3-1 for Na^+		T3-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.37E-10	9.86	8.93E-11	10.0	3.22E-09	8.49	2.65E-09	8.58	3.70E-08	7.43	3.45E-08	7.46
1.0	1.13E-10	9.95	5.75E-11	10.2	1.42E-09	8.85	1.20E-09	8.92	1.20E-08	7.92	1.23E-08	7.91
2.0	1.23E-10	9.91	5.52E-11	10.3	1.19E-09	8.92	8.46E-10	9.07	9.03E-09	8.04	1.19E-08	7.93
7.0	7.17E-11	10.1	3.68E-11	10.4	9.91E-10	9.00	1.21E-09	8.92	7.95E-09	8.10	1.01E-08	8.00
14.0	4.34E-12	11.4	2.02E-12	11.7	1.36E-09	8.87	1.36E-09	8.87	8.90E-09	8.05	9.24E-09	8.03
28.0	1.07E-14	14.0	3.43E-14	13.5	1.92E-09	8.72	7.76E-10	9.11	7.17E-09	8.14	4.90E-09	8.31
42.0	9.21E-15	14.0	1.55E-14	13.8	4.55E-10	9.34	4.77E-10	9.32	3.47E-09	8.46	3.44E-09	8.46
49.0	9.50E-15	14.0	9.38E-15	14.0	4.84E-10	9.32	4.78E-10	9.32	3.01E-09	8.52	2.73E-09	8.56
63.0	6.86E-15	14.2	1.31E-14	13.9	3.67E-10	9.44	3.68E-10	9.43	3.22E-09	8.49	3.08E-09	8.51
90.0	4.57E-14	13.3	6.25E-15	14.2	2.91E-10	9.54	2.65E-10	9.58	1.84E-09	8.73	1.75E-09	8.76
140.0	6.12E-15	14.2	1.33E-14	13.9	1.88E-10	9.73	1.88E-10	9.72	1.11E-09	8.95	1.31E-09	8.88
Cumulative Leach Time (day)	T4-1 for ^{99}Tc		T4-2 for ^{99}Tc		T4-1 for NO_3^-		T4-2 for NO_3^-		T4-1 for Na^+		T4-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	6.85E-11	10.2	1.53E-10	9.82	-	-	-	-	5.28E-09	8.28	9.26E-09	8.03
1.0	4.69E-10	9.33	3.01E-10	9.52	-	-	-	-	1.02E-08	7.99	5.76E-09	8.24
2.0	4.88E-10	9.31	3.44E-10	9.46	-	-	-	-	1.04E-08	7.98	6.28E-09	8.20
7.0	3.89E-10	9.41	4.70E-10	9.33	-	-	-	-	6.99E-09	8.16	5.94E-09	8.23
14.0	2.29E-10	9.64	2.97E-10	9.53	-	-	-	-	5.35E-09	8.27	4.68E-09	8.33
28.0	1.41E-12	11.9	2.30E-12	11.6	-	-	-	-	2.06E-09	8.69	1.98E-09	8.70
42.0	1.69E-14	13.8	8.90E-15	14.1	-	-	-	-	9.90E-10	9.00	9.02E-10	9.04
49.0	1.45E-14	13.8	1.17E-14	13.9	-	-	-	-	7.54E-10	9.12	8.00E-10	9.10
63.0	3.19E-14	13.5	2.69E-14	13.6	-	-	-	-	9.12E-10	9.04	8.04E-10	9.09
90.0	1.05E-14	14.0	1.72E-14	13.8	-	-	-	-	4.75E-10	9.32	4.80E-10	9.32
140.0	1.79E-14	13.7	1.53E-14	13.8	-	-	-	-	3.79E-10	9.42	3.26E-10	9.49

Cumulative Leach Time (day)	T5-1 for ^{99}Tc		T5-2 for ^{99}Tc		T5-1 for NO_3^-		T5-2 for NO_3^-		T5-1 for Na^+		T5-2 for Na^+	
	DD_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	2.36E-11	10.6	7.67E-12	11.1	7.40E-11	10.1	1.11E-10	10.0	3.29E-09	8.48	4.39E-09	8.36
1.0	9.90E-11	10.0	2.37E-11	10.6	2.92E-10	9.53	2.54E-10	9.60	5.35E-09	8.27	4.73E-09	8.33
2.0	1.47E-10	9.83	2.41E-11	10.6	4.67E-10	9.33	3.12E-10	9.51	7.43E-09	8.13	4.45E-09	8.35
7.0	1.12E-10	9.95	3.22E-11	10.5	3.14E-10	9.50	2.89E-10	9.54	5.30E-09	8.28	5.32E-09	8.27
14.0	3.09E-11	10.5	6.70E-12	11.2	3.77E-10	9.42	3.27E-10	9.49	4.79E-09	8.32	4.50E-09	8.35
28.0	3.28E-13	12.5	7.93E-14	13.1	2.35E-10	9.63	2.20E-10	9.66	2.72E-09	8.57	2.75E-09	8.56
42.0	7.60E-14	13.1	3.11E-14	13.5	1.52E-10	9.82	1.49E-10	9.83	1.72E-09	8.77	1.85E-09	8.73
49.0	5.94E-14	13.2	6.76E-14	13.2	2.24E-10	9.65	2.37E-10	9.63	1.86E-09	8.73	2.01E-09	8.70
63.0	1.09E-13	13.0	6.58E-14	13.2	1.33E-10	9.88	1.32E-10	9.88	2.04E-09	8.69	2.12E-09	8.67
90.0	1.02E-13	13.0	2.70E-14	13.6	9.88E-11	10.0	9.28E-11	10.0	1.54E-09	8.81	1.45E-09	8.84
140.0	5.00E-14	13.3	2.25E-14	13.6	7.29E-11	10.1	7.42E-11	10.1	9.99E-10	9.00	1.11E-09	8.95
Cumulative Leach Time (day)	T6-1 for ^{99}Tc		T6-2 for ^{99}Tc		T6-1 for NO_3^-		T6-2 for NO_3^-		T6-1 for Na^+		T6-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	5.64E-11	10.2	5.38E-11	10.3	7.45E-10	9.13	3.70E-10	9.43	7.79E-09	8.11	4.86E-09	8.31
1.0	3.76E-10	9.42	6.07E-10	9.22	1.67E-09	8.78	1.45E-09	8.84	1.27E-08	7.90	1.33E-08	7.88
2.0	6.85E-10	9.16	6.02E-10	9.22	2.51E-09	8.60	1.93E-09	8.71	1.69E-08	7.77	1.23E-08	7.91
7.0	6.19E-10	9.21	9.01E-10	9.05	2.11E-09	8.68	2.13E-09	8.67	1.33E-08	7.88	1.34E-08	7.87
14.0	2.80E-10	9.55	4.53E-10	9.34	2.20E-09	8.66	2.35E-09	8.63	1.12E-08	7.95	1.17E-08	7.93
28.0	7.05E-12	11.2	1.30E-11	10.9	1.32E-09	8.88	1.34E-09	8.87	7.00E-09	8.16	7.41E-09	8.13
42.0	1.51E-13	12.8	1.37E-13	12.9	7.00E-10	9.15	7.59E-10	9.12	4.40E-09	8.36	4.46E-09	8.35
49.0	1.72E-13	12.8	1.09E-13	13.0	7.42E-10	9.13	7.73E-10	9.11	4.01E-09	8.40	4.07E-09	8.39
63.0	1.93E-13	12.7	1.65E-13	12.8	5.73E-10	9.24	6.05E-10	9.22	4.29E-09	8.37	4.60E-09	8.34
90.0	1.54E-13	12.8	1.62E-13	12.8	4.29E-10	9.37	4.67E-10	9.33	2.61E-09	8.58	2.52E-09	8.60
140.0	9.30E-14	13.0	4.80E-14	13.3	3.20E-10	9.49	3.06E-10	9.51	1.63E-09	8.79	1.49E-09	8.83

Cumulative Leach Time (day)	T7-1 for ^{99}Tc		T7-2 for ^{99}Tc		T7-1 for NO_3^-		T7-2 for NO_3^-		T7-1 for Na^+		T7-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.27E-11	10.4	6.24E-11	10.2	1.04E-10	10.0	1.63E-10	9.79	3.03E-09	8.52	3.35E-09	8.48
1.0	9.69E-11	10.0	1.33E-10	9.88	1.82E-10	9.74	2.16E-10	9.66	2.67E-09	8.57	2.76E-09	8.56
2.0	1.73E-10	9.76	1.09E-10	10.0	3.88E-10	9.41	2.61E-10	9.58	4.51E-09	8.35	2.51E-09	8.60
7.0	1.52E-10	9.82	1.57E-10	9.80	3.10E-10	9.51	2.81E-10	9.55	3.99E-09	8.40	3.33E-09	8.48
14.0	3.28E-11	10.5	3.44E-11	10.5	3.14E-10	9.50	3.47E-10	9.46	2.83E-09	8.55	2.86E-09	8.54
28.0	1.79E-13	12.7	2.02E-13	12.7	2.03E-10	9.69	2.01E-10	9.70	1.72E-09	8.76	1.63E-09	8.79
42.0	1.01E-13	13.0	1.67E-13	12.8	1.25E-10	9.90	1.35E-10	9.87	1.16E-09	8.94	1.23E-09	8.91
49.0	1.21E-13	12.9	1.07E-13	13.0	1.81E-10	9.74	1.87E-10	9.73	1.30E-09	8.89	1.31E-09	8.88
63.0	3.91E-13	12.4	1.57E-13	12.8	1.24E-10	9.91	1.09E-10	10.0	1.59E-09	8.80	1.42E-09	8.85
90.0	4.15E-13	12.4	2.97E-13	12.5	9.10E-11	10.0	9.24E-11	10.0	9.35E-10	9.03	9.53E-10	9.02
140.0	2.65E-13	12.6	1.73E-13	12.8	6.49E-11	10.2	6.45E-11	10.2	6.93E-10	9.16	6.68E-10	9.18
Cumulative Leach Time (day)	T8-1 for ^{99}Tc		T8-2 for ^{99}Tc		T8-1 for NO_3^-		T8-2 for NO_3^-		T8-1 for Na^+		T8-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.56E-11	10.3	2.34E-11	10.6	5.19E-10	9.28	3.93E-10	9.41	6.30E-09	8.20	4.91E-09	8.31
1.0	4.31E-10	9.37	3.20E-10	9.50	2.33E-09	8.63	2.08E-09	8.68	1.73E-08	7.76	1.65E-08	7.78
2.0	3.08E-10	9.51	3.06E-10	9.51	1.96E-09	8.71	1.71E-09	8.77	1.18E-08	7.93	1.23E-08	7.91
7.0	2.97E-10	9.53	3.93E-10	9.41	2.05E-09	8.69	2.58E-09	8.59	1.18E-08	7.93	1.59E-08	7.80
14.0	1.44E-10	9.84	1.28E-10	9.89	2.50E-09	8.60	2.28E-09	8.64	1.09E-08	7.96	1.12E-08	7.95
28.0	3.28E-12	11.5	1.73E-12	11.8	1.43E-09	8.85	1.32E-09	8.88	6.47E-09	8.19	6.37E-09	8.20
42.0	8.63E-14	13.1	3.45E-14	13.5	7.76E-10	9.11	8.17E-10	9.09	4.07E-09	8.39	4.07E-09	8.39
49.0	7.39E-14	13.1	3.66E-14	13.4	7.71E-10	9.11	7.59E-10	9.12	3.83E-09	8.42	3.91E-09	8.41
63.0	7.09E-14	13.1	6.96E-14	13.2	5.82E-10	9.24	5.46E-10	9.26	3.93E-09	8.41	3.74E-09	8.43
90.0	8.31E-14	13.1	2.88E-14	13.5	4.71E-10	9.33	3.83E-10	9.42	2.26E-09	8.65	2.07E-09	8.68
140.0	4.11E-14	13.4	1.07E-14	14.0	3.16E-10	9.50	2.72E-10	9.57	1.40E-09	8.85	1.43E-09	8.84

Cumulative Leach Time (day)	T9-1 for ^{99}Tc		T9-2 for ^{99}Tc		T9-1 for NO_3^-		T9-2 for NO_3^-		T9-1 for Na^+		T9-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	7.34E-13	12.1	9.43E-13	12.0	-	-	-	-	7.38E-09	8.13	5.63E-09	8.25
1.0	1.32E-12	11.9	1.06E-12	12.0	-	-	-	-	2.38E-09	8.62	3.18E-09	8.50
2.0	6.75E-13	12.2	8.43E-13	12.1	-	-	-	-	2.04E-09	8.69	1.82E-09	8.74
7.0	1.02E-13	13.0	1.76E-13	12.8	-	-	-	-	1.86E-09	8.73	1.67E-09	8.78
14.0	1.92E-14	13.7	2.84E-14	13.5	-	-	-	-	8.87E-10	9.05	9.70E-10	9.01
28.0	2.92E-14	13.5	3.40E-14	13.5	-	-	-	-	4.33E-10	9.36	4.80E-10	9.32
42.0	7.24E-14	13.1	3.93E-14	13.4	-	-	-	-	2.66E-10	9.57	2.61E-10	9.58
49.0	1.08E-13	13.0	5.17E-14	13.3	-	-	-	-	3.26E-10	9.49	2.87E-10	9.54
63.0	9.50E-14	13.0	1.12E-13	13.0	-	-	-	-	4.39E-10	9.36	3.25E-10	9.49
90.0	1.13E-13	12.9	1.33E-13	12.9	-	-	-	-	2.34E-10	9.63	2.00E-10	9.70
140.0	7.48E-14	13.1	5.49E-14	13.3	-	-	-	-	1.75E-10	9.76	1.49E-10	9.83

Cumulative Leach Time (day)	T10-1 for ^{99}Tc		T10-2 for ^{99}Tc		T10-1 for NO_3^-		T10-2 for NO_3^-		T10-1 for Na^+		T10-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.20E-10	9.38	2.74E-10	9.56	1.15E-09	8.94	8.30E-10	9.08	1.77E-08	7.75	1.32E-08	7.88
1.0	7.60E-10	9.12	1.42E-09	8.85	1.53E-09	8.81	2.64E-09	8.58	1.20E-08	7.92	2.04E-08	7.69
2.0	2.42E-10	9.62	5.46E-10	9.26	9.33E-10	9.03	2.00E-09	8.70	6.16E-09	8.21	1.27E-08	7.90
7.0	1.75E-10	9.76	1.08E-10	10.0	1.60E-09	8.80	1.34E-09	8.87	9.60E-09	8.02	8.42E-09	8.07
14.0	1.38E-12	11.9	6.92E-13	12.2	8.19E-10	9.09	7.45E-10	9.13	4.69E-09	8.33	4.32E-09	8.36
28.0	7.75E-14	13.1	4.91E-14	13.3	3.05E-10	9.52	2.98E-10	9.53	1.97E-09	8.71	2.12E-09	8.67
42.0	6.31E-14	13.2	3.40E-14	13.5	1.36E-10	9.87	1.29E-10	9.89	1.04E-09	8.98	1.01E-09	9.00
49.0	8.19E-14	13.1	9.18E-14	13.0	1.28E-10	9.89	1.49E-10	9.83	8.10E-10	9.09	9.82E-10	9.01
63.0	1.33E-13	12.9	8.48E-14	13.1	8.65E-11	10.1	1.09E-10	10.0	8.29E-10	9.08	9.08E-10	9.04
90.0	1.30E-13	12.9	1.03E-13	13.0	5.59E-11	10.3	6.11E-11	10.2	4.54E-10	9.34	4.63E-10	9.33
140.0	8.44E-14	13.1	7.23E-14	13.1	3.49E-11	10.5	3.93E-11	10.4	3.35E-10	9.47	3.48E-10	9.46

Cumulative Leach Time (day)	T11-1 for ^{99}Tc		T11-2 for ^{99}Tc		T11-1 for NO_3^-		T11-2 for NO_3^-		T11-1 for Na^+		T11-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.78E-12	11.7	8.36E-12	11.1	3.66E-10	9.44	5.05E-10	9.30	1.41E-09	8.85	1.88E-09	8.73
1.0	1.12E-11	11.0	8.29E-11	10.1	1.52E-09	8.82	2.39E-09	8.62	4.63E-09	8.33	7.77E-09	8.11
2.0	2.98E-11	10.5	1.02E-10	10.0	3.18E-09	8.50	2.26E-09	8.65	7.54E-09	8.12	5.35E-09	8.27
7.0	2.02E-11	10.7	1.14E-10	9.94	2.72E-09	8.57	2.98E-09	8.53	6.09E-09	8.22	6.46E-09	8.19
14.0	9.74E-13	12.0	6.13E-12	11.2	1.81E-09	8.74	2.03E-09	8.69	4.20E-09	8.38	4.34E-09	8.36
28.0	3.29E-14	13.5	7.11E-14	13.1	1.15E-09	8.94	1.34E-09	8.87	2.83E-09	8.55	3.09E-09	8.51
42.0	3.71E-14	13.4	6.08E-14	13.2	1.78E-09	8.75	9.53E-10	9.02	3.00E-09	8.52	3.09E-09	8.51
49.0	3.51E-14	13.5	7.79E-14	13.1	7.12E-10	9.15	8.19E-10	9.09	2.59E-09	8.59	3.21E-09	8.49
63.0	3.73E-14	13.4	9.23E-14	13.0	5.45E-10	9.26	6.19E-10	9.21	1.66E-09	8.78	1.94E-09	8.71
90.0	4.42E-14	13.4	9.16E-14	13.0	4.00E-10	9.40	4.36E-10	9.36	1.22E-09	8.92	1.28E-09	8.89
140.0	4.15E-14	13.4	6.31E-14	13.2	2.45E-10	9.61	2.53E-10	9.60	8.14E-10	9.09	8.44E-10	9.07
Cumulative Leach Time (day)	T12-1 for ^{99}Tc		T12-2 for ^{99}Tc		T12-1 for NO_3^-		T12-2 for NO_3^-		T12-1 for Na^+		T12-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.08E-11	10.4	4.81E-11	10.3	-	-	-	-	2.55E-09	8.59	3.37E-09	8.47
1.0	1.25E-10	9.90	1.22E-10	9.91	-	-	-	-	6.79E-09	8.17	5.70E-09	8.24
2.0	1.22E-10	9.91	1.42E-10	9.85	-	-	-	-	4.61E-09	8.34	5.15E-09	8.29
7.0	1.38E-10	9.86	1.53E-10	9.82	-	-	-	-	4.37E-09	8.36	4.02E-09	8.40
14.0	4.17E-11	10.4	1.50E-10	9.82	-	-	-	-	2.65E-09	8.58	2.96E-09	8.53
28.0	2.53E-12	11.6	1.33E-11	10.9	-	-	-	-	1.36E-09	8.87	1.41E-09	8.85
42.0	9.41E-13	12.0	4.21E-13	12.4	-	-	-	-	9.06E-10	9.04	1.03E-09	8.99
49.0	1.03E-12	12.0	2.84E-13	12.5	-	-	-	-	7.78E-10	9.11	8.74E-10	9.06
63.0	1.00E-12	12.0	2.47E-13	12.6	-	-	-	-	4.27E-10	9.37	4.34E-10	9.36
90.0	1.00E-12	12.0	2.64E-13	12.6	-	-	-	-	2.80E-10	9.55	2.62E-10	9.58
140.0	7.00E-13	12.2	1.82E-13	12.7	-	-	-	-	1.69E-10	9.77	1.57E-10	9.80

Cumulative Leach Time (day)	T13-1 for ^{99}Tc		T13-2 for ^{99}Tc		T13-1 for NO_3^-		T13-2 for NO_3^-		T13-1 for Na^+		T13-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	9.26E-11	10.0	5.96E-11	10.2	6.36E-09	8.20	5.09E-09	8.29	7.15E-09	8.15	5.86E-09	8.23
1.0	3.82E-11	10.4	4.19E-11	10.4	7.42E-09	8.13	1.01E-08	7.99	1.26E-08	7.90	1.84E-08	7.74
2.0	8.61E-12	11.1	4.95E-12	11.3	6.19E-09	8.21	6.12E-09	8.21	1.06E-08	7.97	1.03E-08	7.99
7.0	1.56E-11	10.8	7.24E-12	11.1	3.58E-09	8.45	3.26E-09	8.49	5.68E-09	8.25	5.46E-09	8.26
14.0	2.32E-11	10.6	1.24E-11	10.9	1.36E-09	8.87	1.31E-09	8.88	2.73E-09	8.56	2.63E-09	8.58
28.0	3.27E-11	10.5	1.80E-11	10.7	5.15E-10	9.29	5.29E-10	9.28	1.49E-09	8.83	1.58E-09	8.80
42.0	2.99E-11	10.5	1.62E-11	10.8	2.65E-10	9.58	3.36E-10	9.47	1.27E-09	8.90	1.32E-09	8.88
49.0	2.28E-11	10.6	1.47E-11	10.8	2.08E-10	9.68	2.33E-10	9.63	1.21E-09	8.92	1.43E-09	8.84
63.0	1.89E-11	10.7	1.13E-11	10.9	1.40E-10	9.86	1.52E-10	9.82	7.36E-10	9.13	8.53E-10	9.07
90.0	1.83E-11	10.7	1.05E-11	11.0	1.09E-10	10.0	1.11E-10	10.0	5.43E-10	9.27	5.91E-10	9.23
140.0	9.91E-12	11.0	4.95E-12	11.3	1.31E-10	9.88	1.14E-10	9.94	5.05E-10	9.30	4.68E-10	9.33
Cumulative Leach Time (day)	T14-1 for ^{99}Tc		T14-2 for ^{99}Tc		T14-1 for NO_3^-		T14-2 for NO_3^-		T14-1 for Na^+		T14-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	5.47E-11	10.3	1.86E-10	9.73	9.04E-11	10.0	9.08E-11	10.0	4.05E-09	8.39	5.30E-09	8.28
1.0	2.43E-10	9.61	3.20E-10	9.49	5.16E-11	10.3	4.06E-11	10.4	5.73E-09	8.24	4.70E-09	8.33
2.0	1.59E-10	9.80	3.02E-10	9.52	8.75E-11	10.1	7.29E-11	10.1	2.92E-09	8.53	3.63E-09	8.44
7.0	2.36E-10	9.63	3.24E-10	9.49	6.80E-11	10.2	6.53E-11	10.2	4.32E-09	8.36	4.03E-09	8.40
14.0	3.58E-11	10.4	5.32E-11	10.3	6.11E-11	10.2	6.21E-11	10.2	1.97E-09	8.71	2.13E-09	8.67
28.0	9.27E-14	13.0	7.41E-14	13.1	3.58E-11	10.4	3.35E-11	10.5	1.11E-09	8.95	1.10E-09	8.96
42.0	4.96E-14	13.3	2.28E-14	13.6	3.33E-11	10.5	3.29E-11	10.5	1.03E-09	8.99	1.06E-09	8.98
49.0	6.84E-14	13.2	4.60E-14	13.3	5.82E-11	10.2	6.19E-11	10.2	1.10E-09	8.96	9.94E-10	9.00
63.0	1.46E-13	12.8	6.59E-14	13.2	3.50E-11	10.5	3.33E-11	10.5	8.43E-10	9.07	8.17E-10	9.09
90.0	9.15E-14	13.0	7.64E-14	13.1	2.15E-11	10.7	2.16E-11	10.7	6.09E-10	9.22	6.00E-10	9.22
140.0	2.13E-14	13.7	4.51E-14	13.3	1.56E-11	10.8	1.32E-11	10.9	4.64E-10	9.33	5.00E-10	9.30

Cumulative Leach Time (day)	T15-1 for ^{99}Tc		T15-2 for ^{99}Tc		T15-1 for NO_3^-		T15-2 for NO_3^-		T15-1 for Na^+		T15-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.97E-11	10.7	5.76E-12	11.2	5.53E-10	9.26	2.89E-10	9.54	8.20E-09	8.09	4.59E-09	8.34
1.0	9.92E-11	10.0	5.27E-11	10.3	1.75E-09	8.76	1.57E-09	8.80	1.32E-08	7.88	1.44E-08	7.84
2.0	1.29E-10	9.89	9.37E-11	10.0	1.91E-09	8.72	2.36E-09	8.63	1.15E-08	7.94	1.53E-08	7.82
7.0	1.43E-10	9.85	9.44E-11	10.0	2.24E-09	8.65	2.12E-09	8.67	1.37E-08	7.86	1.28E-08	7.89
14.0	1.59E-11	10.8	8.31E-12	11.1	1.66E-09	8.78	1.65E-09	8.78	8.73E-09	8.06	8.79E-09	8.06
28.0	1.30E-13	12.9	1.55E-13	12.8	9.14E-10	9.04	8.79E-10	9.06	5.65E-09	8.25	5.14E-09	8.29
42.0	8.57E-14	13.1	1.39E-13	12.9	6.28E-10	9.20	6.10E-10	9.21	4.53E-09	8.34	4.51E-09	8.35
49.0	1.71E-13	12.8	2.43E-13	12.6	5.23E-10	9.28	5.06E-10	9.30	3.69E-09	8.43	3.84E-09	8.42
63.0	2.33E-13	12.6	2.15E-13	12.7	3.74E-10	9.43	3.43E-10	9.46	2.22E-09	8.65	2.21E-09	8.66
90.0	1.19E-13	12.9	1.45E-13	12.8	2.84E-10	9.55	2.78E-10	9.56	1.73E-09	8.76	1.67E-09	8.78
140.0	6.78E-14	13.2	6.25E-14	13.2	1.93E-10	9.72	1.94E-10	9.71	1.20E-09	8.92	1.25E-09	8.90
Cumulative Leach Time (day)	T16-1 for ^{99}Tc		T16-2 for ^{99}Tc		T16-1 for NO_3^-		T16-2 for NO_3^-		T16-1 for Na^+		T16-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.20E-10	9.92	9.20E-11	10.0	2.96E-10	9.53	4.18E-10	9.38	4.20E-09	8.38	4.70E-09	8.33
1.0	7.02E-10	9.15	1.22E-09	8.91	1.49E-09	8.83	2.58E-09	8.59	1.19E-08	7.92	1.97E-08	7.71
2.0	7.12E-10	9.15	1.09E-09	8.96	1.80E-09	8.75	2.74E-09	8.56	1.01E-08	7.99	1.59E-08	7.80
7.0	7.64E-10	9.12	5.46E-10	9.26	2.45E-09	8.61	2.04E-09	8.69	1.38E-08	7.86	1.15E-08	7.94
14.0	5.99E-11	10.2	6.03E-11	10.2	1.54E-09	8.81	1.47E-09	8.83	7.52E-09	8.12	7.28E-09	8.14
28.0	2.25E-12	11.6	1.93E-12	11.7	8.48E-10	9.07	8.61E-10	9.07	4.89E-09	8.31	4.73E-09	8.32
42.0	1.78E-12	11.7	2.38E-12	11.6	5.63E-10	9.25	5.59E-10	9.25	3.80E-09	8.42	3.80E-09	8.42
49.0	2.48E-12	11.6	2.30E-12	11.6	4.52E-10	9.34	4.41E-10	9.36	2.95E-09	8.53	2.85E-09	8.55
63.0	2.94E-12	11.5	3.15E-12	11.5	3.67E-10	9.44	3.37E-10	9.47	2.16E-09	8.67	1.89E-09	8.72
90.0	1.56E-12	11.8	2.29E-12	11.6	2.62E-10	9.58	2.68E-10	9.57	1.49E-09	8.83	1.49E-09	8.83
140.0	6.85E-13	12.2	1.09E-12	12.0	1.83E-10	9.74	1.92E-10	9.72	1.05E-09	8.98	1.03E-09	8.99

Cumulative Leach Time (day)	T17-1 for ^{99}Tc		T17-2 for ^{99}Tc		T17-1 for NO_3^-		T17-2 for NO_3^-		T17-1 for Na^+		T17-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.80E-10	9.74	1.92E-10	9.72	4.23E-10	9.37	4.24E-10	9.37	6.11E-09	8.21	6.32E-09	8.20
1.0	1.48E-09	8.83	1.72E-09	8.77	2.91E-09	8.54	3.32E-09	8.48	1.81E-08	7.74	2.48E-08	7.61
2.0	6.12E-10	9.21	5.98E-10	9.22	1.89E-09	8.72	2.73E-09	8.56	8.29E-09	8.08	1.23E-08	7.91
7.0	2.55E-10	9.59	1.38E-10	9.86	2.65E-09	8.58	2.42E-09	8.62	1.12E-08	7.95	1.03E-08	7.99
14.0	8.74E-13	12.1	5.13E-13	12.3	1.21E-09	8.92	1.21E-09	8.92	5.53E-09	8.26	5.80E-09	8.24
28.0	1.98E-13	12.7	1.39E-13	12.9	4.27E-10	9.37	4.13E-10	9.38	2.63E-09	8.58	2.64E-09	8.58
42.0	1.80E-13	12.7	2.17E-13	12.7	1.76E-10	9.76	1.94E-10	9.71	1.74E-09	8.76	1.78E-09	8.75
49.0	3.35E-13	12.5	4.71E-13	12.3	1.46E-10	9.84	1.57E-10	9.80	1.23E-09	8.91	1.29E-09	8.89
63.0	2.65E-13	12.6	2.64E-13	12.6	9.73E-11	10.0	9.03E-11	10.0	7.67E-10	9.12	7.05E-10	9.15
90.0	1.75E-13	12.8	2.27E-13	12.6	6.70E-11	10.2	6.89E-11	10.2	4.64E-10	9.33	4.83E-10	9.32
140.0	1.26E-13	12.9	1.57E-13	12.8	4.00E-11	10.4	3.57E-11	10.4	2.90E-10	9.54	2.87E-10	9.54
Cumulative Leach Time (day)	T18-1 for ^{99}Tc		T18-2 for ^{99}Tc		T18-1 for NO_3^-		T18-2 for NO_3^-		T18-1 for Na^+		T18-2 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.70E-10	9.77	1.31E-10	9.88	2.47E-10	9.61	2.83E-10	9.55	3.83E-09	8.42	3.99E-09	8.40
1.0	1.69E-09	8.77	5.65E-10	9.25	2.19E-09	8.66	1.05E-09	8.98	1.64E-08	7.79	8.38E-09	8.08
2.0	4.97E-10	9.30	4.18E-10	9.38	1.25E-09	8.90	1.65E-09	8.78	5.66E-09	8.25	7.62E-09	8.12
7.0	2.99E-10	9.52	1.35E-10	9.87	2.29E-09	8.64	1.96E-09	8.71	1.02E-08	7.99	8.84E-09	8.05
14.0	3.68E-12	11.4	2.20E-12	11.7	1.29E-09	8.89	1.16E-09	8.93	6.14E-09	8.21	5.57E-09	8.25
28.0	1.01E-12	12.0	1.24E-12	11.9	4.95E-10	9.31	4.34E-10	9.36	2.84E-09	8.55	2.57E-09	8.59
42.0	1.43E-12	11.8	1.74E-12	11.8	2.29E-10	9.64	2.10E-10	9.68	1.96E-09	8.71	1.86E-09	8.73
49.0	2.16E-12	11.7	2.43E-12	11.6	1.64E-10	9.79	1.54E-10	9.81	1.35E-09	8.87	1.28E-09	8.89
63.0	2.58E-12	11.6	3.33E-12	11.5	1.24E-10	9.91	1.17E-10	9.93	8.86E-10	9.05	8.35E-10	9.08
90.0	1.63E-12	11.8	1.63E-12	11.8	8.14E-11	10.1	7.42E-11	10.1	5.58E-10	9.25	5.48E-10	9.26
140.0	5.58E-13	12.3	6.21E-13	12.2	4.49E-11	10.3	4.28E-11	10.4	3.35E-10	9.47	3.42E-10	9.47

Table 5.4. Diffusivity and LI Values of ^{99}Tc, NO_3^-, and Na^+ in VZPW Leaching Solution

Cumulative Leach Time (day)	T1-3 for ^{99}Tc		T1-4 for ^{99}Tc		T1-3 for NO_3^-		T1-4 for NO_3^-		T1-3 for Na^+		T1-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.57E-12	11.8	2.51E-12	11.6	-	-	-	-	3.17E-09	8.50	8.65E-09	8.06
1.0	6.90E-12	11.2	3.40E-12	11.5	-	-	-	-	7.01E-09	8.15	8.20E-09	8.09
2.0	1.34E-11	10.9	3.34E-12	11.5	-	-	-	-	6.84E-10	9.17	6.72E-10	9.17
7.0	7.70E-12	11.1	1.46E-12	11.8	-	-	-	-	4.35E-09	8.36	3.73E-09	8.43
14.0	3.67E-13	12.4	8.18E-14	13.1	-	-	-	-	2.44E-09	8.61	2.40E-09	8.62
28.0	3.03E-15	14.5	3.46E-15	14.5	-	-	-	-	2.39E-09	8.62	2.35E-09	8.63
42.0	2.12E-15	14.7	2.08E-15	14.7	-	-	-	-	2.51E-09	8.60	3.44E-09	8.46
49.0	1.11E-14	14.0	1.09E-14	14.0	-	-	-	-	8.81E-09	8.06	4.28E-10	9.37
63.0	3.41E-15	14.5	5.13E-15	14.3	-	-	-	-	1.64E-09	8.79	1.61E-09	8.79
90.0	1.25E-15	14.9	1.23E-15	14.9	-	-	-	-	7.82E-10	9.11	7.68E-10	9.11
140.0	1.35E-15	14.9	3.42E-15	14.5	-	-	-	-	1.36E-09	8.86	1.03E-09	8.99
Cumulative Leach Time (day)	T2-3 for ^{99}Tc		T2-4 for ^{99}Tc		T2-3 for NO_3^-		T2-4 for NO_3^-		T2-3 for Na^+		T2-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	2.96E-10	9.53	4.02E-10	9.40	2.25E-09	8.65	8.67E-11	10.1	9.89E-09	8.00	1.15E-08	7.94
1.0	6.24E-11	10.2	8.55E-11	10.1	1.81E-10	9.74	5.71E-11	10.2	2.75E-09	8.56	3.54E-09	8.45
2.0	3.55E-11	10.4	3.79E-11	10.4	1.75E-10	9.76	3.79E-10	9.42	3.07E-09	8.51	2.97E-09	8.53
7.0	2.78E-11	10.6	2.83E-11	10.5	3.34E-09	8.48	3.35E-09	8.48	5.22E-09	8.28	5.37E-09	8.27
14.0	1.59E-11	10.8	1.89E-11	10.7	1.56E-08	7.81	1.50E-08	7.82	4.64E-09	8.33	5.57E-09	8.25
28.0	2.63E-13	12.6	3.08E-13	12.5	7.79E-09	8.11	7.52E-09	8.12	4.45E-09	8.35	3.61E-09	8.44
42.0	2.06E-14	13.7	1.96E-14	13.7	1.32E-08	7.88	1.28E-08	7.89	5.24E-09	8.28	3.24E-09	8.49
49.0	2.11E-14	13.7	1.00E-14	14.0	6.94E-08	7.16	6.70E-08	7.17	4.89E-10	9.31	1.06E-09	8.97
63.0	1.87E-14	13.7	1.34E-14	13.9	2.13E-08	7.67	2.06E-08	7.69	3.04E-09	8.52	2.93E-09	8.53
90.0	1.13E-14	13.9	1.01E-14	14.0	7.79E-09	8.11	7.52E-09	8.12	1.66E-09	8.78	1.46E-09	8.84
140.0	1.97E-14	13.7	2.04E-14	13.7	3.40E-09	8.47	3.28E-09	8.48	1.26E-09	8.90	1.48E-09	8.83

Cumulative Leach Time (day)	T3-3 for ^{99}Tc		T3-4 for ^{99}Tc		T3-3 for NO_3^-		T3-4 for NO_3^-		T3-3 for Na^+		T3-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	6.57E-11	10.2	7.45E-11	10.1	2.92E-09	8.53	2.02E-09	8.69	3.14E-08	7.50	2.52E-08	7.60
1.0	5.76E-11	10.2	5.41E-11	10.3	4.81E-10	9.32	4.79E-10	9.32	1.35E-08	7.87	1.30E-08	7.89
2.0	1.51E-10	9.82	8.39E-11	10.1	2.85E-09	8.55	3.18E-09	8.50	1.85E-08	7.73	1.68E-08	7.78
7.0	7.43E-11	10.1	3.65E-11	10.4	7.54E-10	9.12	6.94E-10	9.16	1.37E-08	7.86	1.25E-08	7.90
14.0	4.12E-12	11.4	2.33E-12	11.6	5.92E-10	9.23	3.51E-11	10.5	9.87E-09	8.01	1.06E-08	7.98
28.0	1.08E-14	14.0	2.09E-14	13.7	1.58E-10	9.80	3.09E-10	9.51	6.06E-09	8.22	6.04E-09	8.22
42.0	1.81E-15	14.7	1.80E-15	14.7	1.08E-11	11.0	9.65E-11	10.0	5.30E-09	8.28	5.77E-09	8.24
49.0	9.50E-15	14.0	9.46E-15	14.0	4.41E-09	8.36	5.62E-11	10.3	2.30E-09	8.64	2.80E-09	8.55
63.0	3.13E-15	14.5	2.90E-15	14.5	4.81E-09	8.32	1.55E-10	9.81	6.59E-09	8.18	4.88E-09	8.31
90.0	1.07E-15	15.0	1.06E-15	15.0	1.76E-09	8.75	3.44E-11	10.5	3.03E-09	8.52	3.40E-09	8.47
140.0	2.27E-15	14.6	3.02E-15	14.5	1.51E-11	10.8	7.65E-12	11.1	3.07E-09	8.51	2.87E-09	8.54
Cumulative Leach Time (day)	T4-3 for ^{99}Tc		T4-4 for ^{99}Tc		T4-3 for NO_3^-		T4-4 for NO_3^-		T4-3 for Na^+		T4-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	6.84E-11	10.2	3.53E-10	9.45	-	-	-	-	4.76E-09	8.32	7.16E-09	8.15
1.0	3.25E-10	9.49	6.61E-10	9.18	-	-	-	-	7.06E-09	8.15	6.79E-09	8.17
2.0	3.66E-10	9.44	8.07E-10	9.09	-	-	-	-	2.08E-08	7.68	8.90E-09	8.05
7.0	2.73E-10	9.56	5.68E-10	9.25	-	-	-	-	7.21E-09	8.14	6.29E-09	8.20
14.0	6.82E-11	10.2	1.32E-10	9.88	-	-	-	-	8.26E-09	8.08	7.17E-09	8.14
28.0	3.93E-13	12.4	3.78E-13	12.4	-	-	-	-	2.64E-09	8.58	2.23E-09	8.65
42.0	3.85E-15	14.4	1.71E-15	14.8	-	-	-	-	3.95E-09	8.40	4.87E-09	8.31
49.0	9.32E-15	14.0	8.96E-15	14.0	-	-	-	-	1.93E-08	7.71	7.96E-10	9.10
63.0	8.12E-15	14.1	2.75E-15	14.6	-	-	-	-	5.53E-09	8.26	4.59E-09	8.34
90.0	4.18E-15	14.4	1.06E-15	15.0	-	-	-	-	1.11E-09	8.96	1.29E-09	8.89
140.0	2.07E-14	13.7	1.23E-14	13.9	-	-	-	-	1.29E-09	8.89	1.24E-09	8.91

Cumulative Leach Time (day)	T5-3 for ^{99}Tc		T5-4 for ^{99}Tc		T5-3 for NO_3^-		T5-4 for NO_3^-		T5-3 for Na^+		T5-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	2.17E-10	9.66	1.36E-10	9.87	6.81E-10	9.17	1.94E-09	8.71	1.12E-08	7.95	1.15E-08	7.94
1.0	7.59E-11	10.1	7.40E-11	10.1	1.53E-10	9.82	1.57E-10	9.80	6.10E-09	8.21	6.92E-09	8.16
2.0	5.11E-11	10.3	7.98E-11	10.1	5.88E-10	9.23	1.51E-10	9.82	7.61E-09	8.12	1.19E-08	7.93
7.0	3.10E-11	10.5	2.43E-11	10.6	3.03E-09	8.52	2.89E-09	8.54	5.21E-09	8.28	4.71E-09	8.33
14.0	9.79E-12	11.0	7.10E-12	11.1	1.31E-08	7.88	1.35E-08	7.87	5.41E-09	8.27	6.36E-09	8.20
28.0	3.13E-13	12.5	5.44E-13	12.3	6.56E-09	8.18	6.75E-09	8.17	4.64E-09	8.33	5.03E-09	8.30
42.0	2.30E-14	13.6	2.97E-14	13.5	1.11E-08	7.95	3.10E-09	8.51	5.59E-09	8.25	5.40E-09	8.27
49.0	2.91E-14	13.5	2.51E-14	13.6	5.84E-08	7.23	9.62E-11	10.0	1.83E-09	8.74	1.89E-09	8.72
63.0	2.75E-14	13.6	1.52E-14	13.8	1.79E-08	7.75	4.99E-09	8.30	7.91E-09	8.10	1.05E-08	7.98
90.0	6.68E-14	13.2	1.41E-14	13.9	6.56E-09	8.18	6.75E-09	8.17	2.51E-09	8.60	2.22E-09	8.65
140.0	2.42E-13	12.6	9.96E-14	13.0	2.86E-09	8.54	2.95E-09	8.53	2.45E-09	8.61	2.65E-09	8.58
Cumulative Leach Time (day)	T6-3 for ^{99}Tc		T6-4 for ^{99}Tc		T6-3 for NO_3^-		T6-4 for NO_3^-		T6-3 for Na^+		T6-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	3.98E-10	9.40	1.39E-10	9.86	1.10E-09	8.96	6.41E-10	9.19	2.04E-08	7.69	9.68E-09	8.01
1.0	5.02E-10	9.30	5.93E-10	9.23	1.02E-09	8.99	1.69E-09	8.77	1.53E-08	7.81	2.25E-08	7.65
2.0	1.38E-09	8.86	1.18E-09	8.93	1.41E-09	8.85	1.70E-09	8.77	2.97E-08	7.53	3.18E-08	7.50
7.0	9.16E-10	9.04	7.89E-10	9.10	1.43E-09	8.84	1.49E-09	8.83	1.75E-08	7.76	1.99E-08	7.70
14.0	3.17E-10	9.50	3.00E-10	9.52	1.14E-09	8.94	1.35E-09	8.87	1.23E-08	7.91	1.37E-08	7.86
28.0	2.23E-11	10.7	1.52E-11	10.8	3.15E-10	9.50	4.51E-10	9.35	8.21E-09	8.09	9.08E-09	8.04
42.0	8.82E-14	13.1	5.24E-14	13.3	3.65E-10	9.44	3.40E-10	9.47	7.60E-09	8.12	7.23E-09	8.14
49.0	1.25E-14	13.9	1.50E-14	13.8	4.29E-10	9.37	4.46E-10	9.35	5.64E-09	8.25	5.21E-09	8.28
63.0	7.41E-15	14.1	4.05E-14	13.4	9.15E-11	10.0	1.69E-10	9.77	8.38E-09	8.08	9.64E-09	8.02
90.0	4.29E-15	14.4	1.17E-14	13.9	2.14E-11	10.7	7.48E-11	10.1	4.29E-09	8.37	5.09E-09	8.29
140.0	1.89E-14	13.7	2.36E-14	13.6	2.50E-10	9.60	2.12E-10	9.67	4.51E-09	8.35	3.81E-09	8.42

Cumulative Leach Time (day)	T7-3 for ^{99}Tc		T7-4 for ^{99}Tc		T7-3 for NO_3^-		T7-4 for NO_3^-		T7-3 for Na^+		T7-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.64E-10	9.78	1.71E-10	9.77	2.22E-09	8.65	2.17E-09	8.66	7.99E-09	8.10	1.38E-08	7.86
1.0	8.89E-11	10.1	8.34E-11	10.1	1.46E-11	10.8	5.71E-11	10.2	8.59E-09	8.07	8.38E-09	8.08
2.0	7.71E-11	10.1	4.83E-11	10.3	2.81E-08	7.55	2.85E-08	7.55	3.06E-09	8.51	3.78E-09	8.42
7.0	3.46E-11	10.5	1.79E-11	10.7	1.22E-08	7.91	1.19E-08	7.92	2.12E-08	7.67	1.93E-08	7.71
14.0	2.16E-11	10.7	1.06E-11	11.0	1.54E-08	7.81	1.50E-08	7.82	4.62E-09	8.33	4.51E-09	8.35
28.0	2.88E-13	12.5	2.00E-13	12.7	7.71E-09	8.11	7.52E-09	8.12	3.95E-09	8.40	3.21E-09	8.49
42.0	1.56E-14	13.8	8.89E-15	14.1	1.31E-08	7.88	1.28E-08	7.89	2.32E-09	8.63	2.27E-09	8.64
49.0	1.41E-14	13.9	1.15E-14	13.9	6.87E-08	7.16	6.70E-08	7.17	2.47E-09	8.61	3.59E-09	8.44
63.0	1.30E-14	13.9	2.18E-14	13.7	2.11E-08	7.68	2.06E-08	7.69	4.12E-09	8.38	4.41E-09	8.36
90.0	1.83E-14	13.7	2.08E-14	13.7	7.71E-09	8.11	7.52E-09	8.12	1.24E-09	8.91	1.47E-09	8.83
140.0	4.31E-14	13.4	3.78E-14	13.4	3.37E-09	8.47	3.28E-09	8.48	1.09E-09	8.96	1.31E-09	8.88

Cumulative Leach Time (day)	T8-3 for ^{99}Tc		T8-4 for ^{99}Tc		T8-3 for NO_3^-		T8-4 for NO_3^-		T8-3 for Na^+		T8-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	1.54E-10	9.81	1.32E-10	9.88	4.42E-10	9.35	6.22E-10	9.21	1.09E-08	7.96	1.06E-08	7.97
1.0	5.02E-10	9.30	6.58E-10	9.18	2.12E-09	8.67	2.92E-09	8.54	2.36E-08	7.63	2.75E-08	7.56
2.0	8.91E-10	9.05	8.05E-10	9.09	1.45E-09	8.84	1.42E-09	8.85	2.36E-08	7.63	2.47E-08	7.61
7.0	4.42E-10	9.35	3.97E-10	9.40	1.19E-09	8.92	1.37E-09	8.86	2.30E-08	7.64	2.44E-08	7.61
14.0	1.42E-10	9.85	9.91E-11	10.0	3.54E-10	9.45	3.07E-10	9.51	1.23E-08	7.91	1.14E-08	7.94
28.0	5.86E-12	11.2	4.90E-12	11.3	7.51E-10	9.12	4.37E-10	9.36	8.35E-09	8.08	8.17E-09	8.09
42.0	3.20E-14	13.5	6.76E-14	13.2	6.66E-11	10.2	8.25E-11	10.1	5.63E-09	8.25	5.51E-09	8.26
49.0	1.75E-14	13.8	4.39E-14	13.4	1.65E-10	9.78	1.62E-10	9.79	5.98E-09	8.22	7.59E-09	8.12
63.0	4.65E-15	14.3	1.17E-14	13.9	1.51E-11	10.8	6.56E-12	11.2	6.55E-09	8.18	8.65E-09	8.06
90.0	9.48E-15	14.0	5.40E-15	14.3	1.20E-10	9.92	7.26E-11	10.1	4.48E-09	8.35	3.58E-09	8.45
140.0	4.19E-15	14.4	9.75E-15	14.0	1.42E-10	9.85	1.77E-10	9.75	3.10E-09	8.51	3.91E-09	8.41

Cumulative Leach Time (day)	T9-3 for ^{99}Tc		T9-4 for ^{99}Tc		T9-3 for NO_3^-		T9-4 for NO_3^-		T9-3 for Na^+		T9-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	7.16E-12	11.1	8.35E-12	11.1	-	-	-	-	1.46E-08	7.84	1.48E-08	7.83
1.0	1.43E-11	10.8	1.50E-11	10.8	-	-	-	-	9.62E-09	8.02	1.33E-08	7.88
2.0	3.11E-12	11.5	3.53E-12	11.5	-	-	-	-	1.77E-09	8.75	8.01E-10	9.10
7.0	6.66E-14	13.2	4.38E-14	13.4	-	-	-	-	4.03E-08	7.39	3.90E-08	7.41
14.0	1.08E-14	14.0	8.90E-15	14.1	-	-	-	-	1.38E-09	8.86	1.03E-09	8.99
28.0	1.90E-15	14.7	1.61E-15	14.8	-	-	-	-	6.90E-10	9.16	1.16E-09	8.94
42.0	2.03E-15	14.7	2.06E-15	14.7	-	-	-	-	9.56E-11	10.0	3.88E-10	9.41
49.0	1.06E-14	14.0	1.08E-14	14.0	-	-	-	-	3.14E-09	8.50	1.15E-09	8.94
63.0	3.27E-15	14.5	3.32E-15	14.5	-	-	-	-	1.89E-09	8.72	1.92E-09	8.72
90.0	1.19E-15	14.9	1.21E-15	14.9	-	-	-	-	5.07E-10	9.29	3.58E-10	9.45
140.0	3.73E-15	14.4	2.79E-15	14.6	-	-	-	-	3.93E-10	9.41	6.24E-10	9.20
Cumulative Leach Time (day)	T10-3 for ^{99}Tc		T10-4 for ^{99}Tc		T10-3 for NO_3^-		T10-4 for NO_3^-		T10-3 for Na^+		T10-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	2.46E-09	8.61	4.71E-10	9.33	1.01E-09	9.00	7.47E-10	9.13	5.60E-08	7.25	1.46E-08	7.83
1.0	1.51E-09	8.82	1.09E-09	8.96	1.50E-09	8.82	1.65E-09	8.78	2.26E-08	7.65	2.01E-08	7.70
2.0	8.68E-10	9.06	8.93E-10	9.05	6.41E-10	9.19	1.01E-09	9.00	1.79E-08	7.75	1.72E-08	7.76
7.0	1.04E-10	9.98	1.02E-10	10.0	3.27E-10	9.49	2.92E-10	9.53	1.92E-08	7.72	1.60E-08	7.80
14.0	4.39E-13	12.4	2.54E-13	12.6	1.89E-10	9.72	2.43E-10	9.61	5.32E-09	8.27	5.18E-09	8.29
28.0	9.35E-15	14.0	1.04E-14	14.0	2.57E-11	10.6	7.20E-11	10.1	3.29E-09	8.48	3.41E-09	8.47
42.0	4.78E-15	14.3	4.63E-15	14.3	9.52E-10	9.02	1.10E-09	8.96	1.88E-09	8.73	1.53E-09	8.81
49.0	9.64E-15	14.0	9.71E-15	14.0	1.59E-08	7.80	1.60E-08	7.79	2.00E-09	8.70	3.00E-09	8.52
63.0	2.96E-15	14.5	2.98E-15	14.5	4.89E-09	8.31	4.92E-09	8.31	3.02E-09	8.52	2.20E-09	8.66
90.0	1.11E-15	15.0	1.09E-15	15.0	1.79E-09	8.75	1.80E-09	8.74	1.40E-09	8.85	1.35E-09	8.87
140.0	8.56E-16	15.1	9.74E-16	15.0	7.81E-10	9.11	7.86E-10	9.10	1.02E-09	8.99	1.13E-09	8.95

Cumulative Leach Time (day)	T11-3 for ^{99}Tc		T11-4 for ^{99}Tc		T11-3 for NO_3^-		T11-4 for NO_3^-		T11-3 for Na^+		T11-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	7.91E-12	11.1	6.11E-12	11.2	8.57E-10	9.07	6.14E-10	9.21	2.98E-09	8.53	2.29E-09	8.64
1.0	3.51E-11	10.5	3.20E-11	10.5	1.22E-08	7.91	9.77E-09	8.01	1.54E-08	7.81	1.42E-08	7.85
2.0	4.91E-11	10.3	4.17E-11	10.4	2.46E-09	8.61	2.68E-09	8.57	1.07E-08	7.97	6.96E-09	8.16
7.0	2.69E-11	10.6	2.62E-11	10.6	2.12E-09	8.67	1.81E-09	8.74	5.68E-09	8.25	6.06E-09	8.22
14.0	1.04E-12	12.0	1.56E-12	11.8	1.17E-09	8.93	1.29E-09	8.89	3.31E-09	8.48	3.98E-09	8.40
28.0	4.78E-15	14.3	7.99E-15	14.1	1.40E-09	8.85	1.04E-09	8.98	2.09E-09	8.68	2.04E-09	8.69
42.0	2.57E-15	14.6	1.74E-15	14.8	2.32E-10	9.63	2.90E-10	9.54	1.35E-09	8.87	2.30E-09	8.64
49.0	7.86E-15	14.1	7.66E-15	14.1	1.35E-10	9.87	2.58E-10	9.59	8.21E-10	9.09	1.87E-09	8.73
63.0	3.07E-15	14.5	4.03E-15	14.4	1.34E-10	9.87	1.17E-10	9.93	1.67E-08	7.78	1.60E-08	7.80
90.0	8.83E-16	15.1	1.31E-15	14.9	1.03E-10	9.99	5.91E-11	10.2	4.37E-10	9.36	7.46E-10	9.13
140.0	4.09E-16	15.4	3.76E-16	15.4	3.21E-11	10.5	3.72E-11	10.4	3.34E-10	9.48	4.41E-10	9.36

Cumulative Leach Time (day)	T12-3 for ^{99}Tc		T12-4 for ^{99}Tc		T12-3 for NO_3^-		T12-4 for NO_3^-		T12-3 for Na^+		T12-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.94E-11	10.3	3.29E-11	10.5	-	-	-	-	4.05E-09	8.39	3.25E-09	8.49
1.0	5.79E-11	10.2	1.81E-10	9.74	-	-	-	-	1.35E-08	7.87	2.07E-08	7.68
2.0	5.42E-11	10.3	2.59E-10	9.59	-	-	-	-	3.85E-09	8.41	1.03E-08	7.99
7.0	4.72E-11	10.3	1.85E-10	9.73	-	-	-	-	2.72E-09	8.56	3.19E-09	8.50
14.0	1.88E-11	10.7	2.75E-11	10.6	-	-	-	-	1.76E-09	8.76	1.35E-09	8.87
28.0	9.30E-13	12.0	2.38E-13	12.6	-	-	-	-	1.26E-09	8.90	8.71E-10	9.06
42.0	2.43E-15	14.6	3.12E-15	14.5	-	-	-	-	8.61E-10	9.06	6.06E-10	9.22
49.0	9.02E-15	14.0	8.95E-15	14.0	-	-	-	-	2.00E-10	9.70	1.01E-09	9.00
63.0	2.87E-15	14.5	4.84E-15	14.3	-	-	-	-	5.36E-08	7.27	5.06E-08	7.30
90.0	1.01E-15	15.0	1.94E-15	14.7	-	-	-	-	5.06E-11	10.3	3.48E-11	10.5
140.0	4.42E-16	15.4	6.32E-16	15.2	-	-	-	-	4.97E-11	10.3	3.89E-11	10.4

Cumulative Leach Time (day)	T13-3 for ^{99}Tc		T13-4 for ^{99}Tc		T13-3 for NO_3^-		T13-4 for NO_3^-		T13-3 for Na^+		T13-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	3.48E-11	10.5	3.05E-11	10.5	8.66E-09	8.06	4.21E-09	8.38	7.37E-09	8.13	4.48E-09	8.35
1.0	1.89E-11	10.7	2.63E-11	10.6	2.38E-08	7.62	2.10E-08	7.68	2.82E-08	7.55	2.06E-08	7.69
2.0	1.16E-12	11.9	2.45E-13	12.6	7.16E-09	8.15	3.86E-09	8.41	1.09E-08	7.96	8.70E-09	8.06
7.0	7.68E-14	13.1	6.45E-13	12.2	1.66E-09	8.78	4.30E-09	8.37	5.02E-09	8.30	6.51E-09	8.19
14.0	5.53E-13	12.3	7.99E-14	13.1	9.55E-10	9.02	6.03E-10	9.22	2.96E-09	8.53	2.62E-09	8.58
28.0	3.01E-13	12.5	3.94E-14	13.4	7.78E-10	9.11	6.99E-10	9.16	1.53E-09	8.82	1.35E-09	8.87
42.0	2.28E-13	12.6	3.37E-14	13.5	2.17E-10	9.66	1.17E-10	9.93	1.15E-09	8.94	1.27E-09	8.90
49.0	2.44E-13	12.6	2.94E-14	13.5	1.82E-10	9.74	8.13E-11	10.1	8.00E-10	9.10	3.14E-10	9.50
63.0	1.61E-13	12.8	2.80E-14	13.6	7.61E-11	10.1	9.98E-11	10.0	1.70E-08	7.77	1.71E-08	7.77
90.0	1.05E-13	13.0	1.67E-14	13.8	3.64E-11	10.4	8.21E-11	10.1	2.75E-10	9.56	2.76E-10	9.56
140.0	5.04E-14	13.3	4.85E-15	14.3	6.35E-11	10.2	3.01E-11	10.5	2.21E-10	9.66	2.46E-10	9.61

Cumulative Leach Time (day)	T14-3 for ^{99}Tc		T14-4 for ^{99}Tc		T14-3 for NO_3^-		T14-4 for NO_3^-		T14-3 for Na^+		T14-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	5.08E-11	10.3	7.70E-11	10.1	9.32E-07	6.03	9.19E-07	6.04	6.83E-10	9.17	1.51E-09	8.82
1.0	9.19E-11	10.0	1.36E-10	9.87	1.54E-07	6.81	1.51E-07	6.82	1.01E-08	7.99	8.98E-09	8.05
2.0	7.69E-11	10.1	8.28E-11	10.1	4.52E-07	6.34	4.46E-07	6.35	1.40E-08	7.85	5.23E-09	8.28
7.0	4.65E-11	10.3	5.97E-11	10.2	5.12E-08	7.29	5.05E-08	7.30	3.75E-09	8.43	4.48E-09	8.35
14.0	1.39E-11	10.9	1.81E-11	10.7	6.47E-08	7.19	6.38E-08	7.20	2.32E-09	8.63	2.29E-09	8.64
28.0	3.40E-14	13.5	3.21E-14	13.5	3.23E-08	7.49	3.19E-08	7.50	2.37E-09	8.63	1.31E-09	8.88
42.0	1.30E-14	13.9	6.40E-15	14.2	5.49E-08	7.26	5.42E-08	7.27	5.32E-09	8.27	3.97E-09	8.40
49.0	1.04E-14	14.0	1.03E-14	14.0	2.88E-07	6.54	2.84E-07	6.55	4.75E-10	9.32	1.87E-09	8.73
63.0	1.49E-14	13.8	1.17E-14	13.9	8.85E-08	7.05	8.72E-08	7.06	2.19E-07	6.66	2.23E-07	6.65
90.0	4.78E-15	14.3	9.70E-15	14.0	3.24E-08	7.49	3.19E-08	7.50	2.37E-11	10.6	2.48E-08	7.61
140.0	1.17E-14	13.9	2.94E-14	13.5	1.41E-08	7.85	1.39E-08	7.86	7.47E-10	9.13	3.67E-10	9.44

Cumulative Leach Time (day)	T15-3 for ^{99}Tc		T15-4 for ^{99}Tc		T15-3 for NO_3^-		T15-4 for NO_3^-		T15-3 for Na^+		T15-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	2.92E-11	10.5	2.05E-11	10.7	4.96E-10	9.30	5.09E-10	9.29	7.55E-09	8.12	1.14E-08	7.94
1.0	1.82E-10	9.74	1.21E-10	9.92	2.38E-09	8.62	2.45E-09	8.61	3.38E-08	7.47	3.46E-08	7.46
2.0	2.17E-10	9.66	1.25E-10	9.90	9.64E-10	9.02	8.02E-10	9.10	2.34E-08	7.63	1.75E-08	7.76
7.0	1.39E-10	9.86	8.75E-11	10.1	6.82E-10	9.17	5.42E-10	9.27	1.63E-08	7.79	1.76E-08	7.76
14.0	1.72E-11	10.8	9.26E-12	11.0	1.38E-10	9.86	1.71E-10	9.77	9.76E-09	8.01	1.10E-08	7.96
28.0	1.04E-13	13.0	6.37E-14	13.2	3.33E-10	9.48	3.12E-10	9.51	5.75E-09	8.24	6.86E-09	8.16
42.0	8.53E-15	14.1	1.17E-14	13.9	1.52E-09	8.82	1.51E-09	8.82	5.87E-09	8.23	6.02E-09	8.22
49.0	9.60E-15	14.0	3.60E-14	13.4	1.53E-08	7.81	1.57E-08	7.80	5.44E-09	8.26	6.38E-09	8.20
63.0	6.22E-15	14.2	8.92E-15	14.0	4.71E-09	8.33	1.31E-09	8.88	4.60E-08	7.34	4.79E-08	7.32
90.0	1.02E-15	15.0	1.33E-14	13.9	1.72E-09	8.76	2.83E-12	11.5	1.60E-09	8.80	1.86E-09	8.73
140.0	1.65E-15	14.8	3.09E-14	13.5	3.64E-11	10.4	1.98E-11	10.7	2.86E-09	8.54	2.87E-09	8.54
Cumulative Leach Time (day)	T16-3 for ^{99}Tc		T16-4 for ^{99}Tc		T16-3 for NO_3^-		T16-4 for NO_3^-		T16-3 for Na^+		T16-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	2.54E-10	9.60	2.79E-10	9.55	3.25E-10	9.49	1.86E-10	9.73	6.05E-09	8.22	6.86E-09	8.16
1.0	1.27E-09	8.90	1.24E-09	8.91	9.66E-10	9.01	2.67E-09	8.57	2.66E-08	7.58	2.65E-08	7.58
2.0	1.01E-09	9.00	1.09E-09	8.96	1.19E-09	8.92	1.00E-09	9.00	1.68E-08	7.78	1.79E-08	7.75
7.0	4.71E-10	9.33	5.62E-10	9.25	5.90E-10	9.23	8.90E-10	9.05	1.38E-08	7.86	1.55E-08	7.81
14.0	7.84E-11	10.1	6.49E-11	10.2	2.03E-10	9.69	1.16E-10	9.94	7.68E-09	8.11	9.31E-09	8.03
28.0	8.45E-13	12.1	5.23E-13	12.3	3.73E-10	9.43	3.16E-10	9.50	5.72E-09	8.24	5.70E-09	8.24
42.0	1.84E-14	13.7	9.81E-15	14.0	1.59E-09	8.80	3.04E-09	8.52	5.55E-09	8.26	6.30E-09	8.20
49.0	1.57E-14	13.8	9.17E-15	14.0	1.57E-08	7.80	4.83E-09	8.32	3.05E-09	8.52	3.97E-09	8.40
63.0	4.69E-15	14.3	3.31E-15	14.5	1.35E-09	8.87	4.90E-11	10.3	3.95E-08	7.40	4.24E-08	7.37
90.0	1.56E-14	13.8	2.25E-15	14.6	6.34E-12	11.2	2.87E-12	11.5	1.82E-09	8.74	1.58E-09	8.80
140.0	8.34E-15	14.1	4.16E-15	14.4	1.51E-11	10.8	3.79E-11	10.4	2.50E-09	8.60	2.65E-09	8.58

Cumulative Leach Time (day)	T17-3 for ^{99}Tc		T17-4 for ^{99}Tc		T17-3 for NO_3^-		T17-4 for NO_3^-		T17-3 for Na^+		T17-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.78E-10	9.32	4.31E-10	9.37	5.29E-10	9.28	5.21E-10	9.28	5.51E-09	8.26	9.90E-09	8.00
1.0	1.53E-09	8.82	8.64E-10	9.06	1.26E-09	8.90	8.59E-11	10.1	2.27E-08	7.64	1.81E-08	7.74
2.0	7.23E-10	9.14	5.73E-10	9.24	1.74E-09	8.76	1.71E-09	8.77	1.48E-08	7.83	1.40E-08	7.86
7.0	6.33E-11	10.2	8.15E-11	10.1	3.77E-10	9.42	1.39E-10	9.86	9.84E-09	8.01	1.15E-08	7.94
14.0	5.10E-14	13.3	1.91E-13	12.7	2.68E-10	9.57	3.62E-11	10.4	5.09E-09	8.29	5.73E-09	8.24
28.0	1.97E-15	14.7	1.59E-15	14.8	5.95E-11	10.2	1.81E-11	10.7	3.45E-09	8.46	3.40E-09	8.47
42.0	2.00E-15	14.7	1.84E-15	14.7	4.99E-12	11.3	9.30E-10	9.03	2.83E-09	8.55	2.88E-09	8.54
49.0	9.77E-15	14.0	9.63E-15	14.0	5.30E-10	9.28	1.61E-08	7.79	1.54E-09	8.81	1.52E-09	8.82
63.0	5.48E-15	14.3	2.96E-15	14.5	5.14E-10	9.29	1.98E-10	9.70	2.74E-08	7.56	2.89E-08	7.54
90.0	1.10E-15	15.0	1.08E-15	15.0	8.00E-10	9.10	6.52E-10	9.19	9.26E-10	9.03	9.97E-10	9.00
140.0	4.79E-16	15.3	4.72E-16	15.3	8.02E-10	9.10	7.90E-10	9.10	8.29E-10	9.08	9.24E-10	9.03
Cumulative Leach Time (day)	T18-3 for ^{99}Tc		T18-4 for ^{99}Tc		T18-3 for NO_3^-		T18-4 for NO_3^-		T18-3 for Na^+		T18-4 for Na^+	
	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]	D_{eff} (cm^2/s)	LI [-]
0.08	4.54E-09	8.34	4.20E-10	9.38	2.99E-09	8.52	3.42E-10	9.47	4.36E-08	7.36	5.17E-09	8.29
1.0	2.56E-09	8.59	1.03E-09	8.99	1.97E-09	8.71	1.41E-09	8.85	2.53E-08	7.60	1.33E-08	7.88
2.0	9.81E-10	9.01	1.41E-09	8.85	1.45E-09	8.84	1.26E-09	8.90	1.25E-08	7.90	1.41E-08	7.85
7.0	1.26E-10	9.90	2.92E-10	9.53	2.92E-10	9.53	4.23E-11	10.4	9.42E-09	8.03	9.18E-09	8.04
14.0	7.55E-14	13.1	3.92E-13	12.4	1.30E-11	10.9	1.48E-12	11.8	5.01E-09	8.30	5.89E-09	8.23
28.0	5.31E-15	14.3	1.14E-15	14.9	5.84E-11	10.2	2.67E-11	10.6	3.49E-09	8.46	3.50E-09	8.46
42.0	4.67E-15	14.3	6.56E-15	14.2	1.07E-09	8.97	9.88E-10	9.01	2.48E-09	8.61	2.94E-09	8.53
49.0	9.72E-15	14.0	1.00E-14	14.0	1.61E-08	7.79	1.65E-08	7.78	2.08E-09	8.68	1.95E-09	8.71
63.0	2.98E-15	14.5	3.07E-15	14.5	5.70E-10	9.24	2.45E-10	9.61	2.89E-08	7.54	2.97E-08	7.53
90.0	1.09E-15	15.0	1.12E-15	14.9	8.10E-10	9.09	6.90E-10	9.16	1.11E-09	8.95	1.24E-09	8.91
140.0	4.77E-16	15.3	4.90E-16	15.3	7.87E-10	9.10	8.10E-10	9.09	9.18E-10	9.04	9.16E-10	9.04

In addition to the D_{eff} and LI values for each leaching interval up to 140-day leaching in Table 5.3 and Table 5.4, average D_{eff} values of each constituent for individual monoliths from the cumulative 28-day to 140-day leaching in DIW or VZPW leaching solution were calculated to provide a time-invarint ^{99}Tc D_{eff} value, and the values are shown in Table 5.5 with the fraction of total released mass of each constituent compared to the initial mass of the constituent. Because the fractions of total released mass of ^{99}Tc from the early leach periods, 0.08 to 14 days, are less than 2% of the total ^{99}Tc, a time-invariant ^{99}Tc D_{eff} value was determined from the later stages between the 28-day and 140-day leaching periods. This approach will also be supported by the less significant effect of the early stage from a full-sized cementitious waste form in the IDF. In addition, average ^{99}Tc D_{eff} values with their uncertainty ranges can cover the minor deviations that might result from the early-stage leaching, if there are any.

For most of the LSWG monoliths (see Table 3.1) leached in DIW or VZPW solution, the average total fraction of ^{99}Tc mass leached was 0.2%–3.3%, and did not exceed 20% of the initial ^{99}Tc mass over 140-day cumulative leaching. The total fraction of ^{99}Tc mass released from the monoliths in both DIW and VZPW leaching solutions being less than 20% of the initial ^{99}Tc in the monoliths indicates that D_{eff} values determined from EPA Method 1315 leach tests are valid to use because the data meet the semi-infinite source term assumption and effective diffusion coefficient calculations based on Equation (5.2) per discussion in ANSI/ANS 16.1. That is, correction for inventory depletion is not necessary for ^{99}Tc from the 18 grout monoliths for 140-day cumulative leaching in either DIW or VZPW leaching solutions. The average total fraction of NO_3^- mass released from all 18 monoliths for the cumulative 140-day leaching in DIW solution was also in a low range, between 0.24% and 12.6% (Table 5.5). Most of the total fractions of NO_3^- mass released from the monoliths in VZPW leaching solution for the cumulative 140-day leaching also were less than 20%, except four monoliths (batches T2, T5, T7, and T14). For monolith T14, all the blank corrected NO_3^- concentrations in the leaching intervals were zero or negative, so the EQL value of IC for NO_3^- was used to calculate the total fraction of NO_3^- mass released; this can create very high uncertainty, like complete NO_3^- mass release, for the 140-day leaching. Because of the highly leachable behavior of Na^+, most fractions of total Na^+ leached from the monoliths were higher than those of ^{99}Tc and NO_3^-. Eight grout monoliths (T3, T5, T6, T8, T11, T15, T16, and T17) out of the total of 18 monoliths showed an average fraction of total Na^+ mass released higher than 20% in the DIW leaching solution, but in VZPW leaching solution, 16 out of 18 monoliths showed an average fraction of Na^+ mass released greater than 20%, ranging from 21% to 38%, for the cumulative 140-day leaching.

Table 5.5. Averaged D_{eff} values of ^{99}Tc, NO_3^-, Na^+ from the Cumulative 28-Day to 140-Day Leaching with Average Fraction of Released Mass in Duplicates of Individual Monolith Batch

Test Batch	DIW Leaching Solution						VZPW Leaching Solution					
	^{99}Tc D_{eff} [cm^2/s]	F*	NO_3^- D_{eff} [cm^2/s]	F*	Na^+ D_{eff} [cm^2/s]	F*	^{99}Tc D_{eff} [cm^2/s]	F*	NO_3^- D_{eff} [cm^2/s]	F*	Na^+ D_{eff} [cm^2/s]	F*
1	$10^{-14.4}$	0.002	-	-	$10^{-9.19}$	0.154	$10^{-14.4}$	0.002	-	-	$10^{-8.65}$	0.187
2	$10^{-12.9}$	0.014	$10^{-9.95}$	0.047	$10^{-8.94}$	0.163	$10^{-13.2}$	0.009	$10^{-7.70}$	***0.349***	$10^{-8.60}$	***0.217***
3	$10^{-13.8}$	0.008	$10^{-9.28}$	0.102	$10^{-8.51}$	***0.273***	$10^{-14.2}$	0.008	$10^{-9.01}$	0.079	$10^{-8.36}$	***0.321***
4	$10^{-12.5}$	0.024	-	-	$10^{-9.04}$	0.176	$10^{-13.2}$	0.022	-	-	$10^{-8.39}$	***0.244***
5	$10^{-13.1}$	0.009	$10^{-9.82}$	0.053	$10^{-8.73}$	***0.200***	$10^{-12.9}$	0.009	$10^{-7.97}$	***0.286***	$10^{-8.36}$	***0.267***
6	$10^{-11.7}$	0.003	$10^{-9.16}$	0.121	$10^{-8.39}$	***0.296***	$10^{-11.5}$	0.033	$10^{-9.58}$	0.086	$10^{-8.18}$	***0.376***
7	$10^{-12.7}$	0.013	$10^{-9.88}$	0.049	$10^{-8.91}$	0.159	$10^{-13.2}$	0.009	$10^{-7.70}$	***0.391***	$10^{-8.58}$	***0.250***
8	$10^{-12.3}$	0.021	$10^{-9.15}$	0.123	$10^{-8.44}$	***0.290***	$10^{-12.0}$	0.025	$10^{-9.74}$	0.075	$10^{-8.22}$	***0.370***
9	$10^{-13.1}$	0.001	-	-	$10^{-9.53}$	0.099	$10^{-14.4}$	0.002	-	-	$10^{-8.99}$	***0.207***
10	$10^{-13.1}$	0.018	$10^{-9.89}$	0.072	$10^{-9.03}$	0.195	$10^{-14.3}$	0.021	$10^{-8.39}$	0.133	$10^{-8.68}$	***0.267***
11	$10^{-13.2}$	0.007	$10^{-9.11}$	0.126	$10^{-8.67}$	***0.204***	$10^{-14.4}$	0.005	$10^{-9.49}$	0.106	$10^{-8.43}$	***0.216***
12	$10^{-11.7}$	0.016	-	-	$10^{-9.17}$	0.142	$10^{-13.0}$	0.011	-	-	$10^{-8.04}$	0.198
13	$10^{-10.8}$	0.016	$10^{-9.63}$	0.117	$10^{-9.00}$	0.181	$10^{-13.0}$	0.003	$10^{-9.69}$	0.119	$10^{-8.46}$	***0.208***
14	$10^{-13.2}$	0.017	$10^{-10.5}$	0.024	$10^{-9.07}$	0.150	$10^{-13.8}$	0.009	$10^{-7.07}$	***1.018***	$10^{-7.39}$	***0.345***
15	$10^{-12.8}$	0.011	$10^{-9.32}$	0.107	$10^{-8.50}$	***0.271***	$10^{-13.6}$	0.011	$10^{-8.45}$	0.111	$10^{-7.94}$	***0.381***
16	$10^{-11.7}$	0.029	$10^{-9.35}$	0.106	$10^{-8.57}$	***0.258***	$10^{-12.9}$	0.028	$10^{-8.64}$	0.089	$10^{-8.00}$	***0.352***
17	$10^{-12.6}$	0.021	$10^{-9.80}$	0.085	$10^{-8.92}$	***0.208***	$10^{-14.5}$	0.017	$10^{-8.75}$	0.088	$10^{-8.20}$	***0.278***
18	$10^{-11.8}$	0.021	$10^{-9.74}$	0.080	$10^{-8.89}$	0.197	$10^{-14.4}$	0.025	$10^{-8.49}$	0.104	$10^{-8.18}$	***0.282***

F indicates fraction of total mass released for each constituent in DIW or VZPW leaching solution compared to initial mass of constituent in each monolith. Bold italic numbers indicate that the average fraction of total mass released from the monolith was higher than 20% of the initial mass of the constituent.

5.2.1 Different w/dm Mix Ratios for ^{99}Tc Leachability

Two different w/dm ratios (0.5 vs. 0.6) were used to solidify the three different simulants before performing the EPA Method 1315 leach test in DIW or VZPW leaching solution. The results for the cumulative 140-day leaching for ^{99}Tc in DIW are shown in Figure 5.1. In general, ^{99}Tc D_{eff} values for the grout monoliths prepared with 0.5 w/dm ratio (T1, T2, T3, and T7) were similar to those for the grout monoliths prepared with 0.6 w/dm ratio (T4, T5, T6, and T8). These eight grout monoliths were prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients (See Table 3.1 for formulation conditions for the grout monoliths). Two monoliths (T7 and T8) were prepared as duplicates for T2 and T6, respectively, and the ^{99}Tc D_{eff} values are very similar for these pairs of duplicates. The ^{99}Tc D_{eff} values decreased from 10^{-9} to 10^{-12} (or 10^{-14}) cm^2/s during the early leaching periods from 0.08 to 28 (or 42) days, and the constant ^{99}Tc D_{eff} values were reached after 28 days for the 0.5 w/dm ratio grouts and after 42 days for the 0.6 w/dm ratio grouts. Slightly higher ^{99}Tc D_{eff} values were found in the grout monoliths prepared with 0.6 w/dm ratio (T3, T4, T5, and T8) than ^{99}Tc D_{eff} values in the 0.5 w/dm monoliths (T1, T2, T3, and T7). We believe that this difference in ^{99}Tc D_{eff} values resulted from the higher moisture content of monoliths prepared with 0.6 w/dm ratio than moisture content of 0.5 w/dm ratio monoliths (29––31% for T4–T6 vs. 25–27% for T1–T3 in Table 3.6). Averaged ^{99}Tc D_{eff} values from 28-day to 140-day leaching intervals also were higher in 0.6 w/dm monoliths compared to those prepared with 0.5 w/dm leached in both DIW and VZPW solutions (Table 5.5). In addition, ^{99}Tc D_{eff} values in VZPW leaching solution were lower than ^{99}Tc D_{eff} values in DIW solution for both w/dm ratios, as shown in Table 5.3 to Table 5.5, which are consistent with previous results by Serne et al (2015). More details of comparison for ^{99}Tc D_{eff} values between DIW and VZPW leaching solutions can be found in Section 5.2.6.

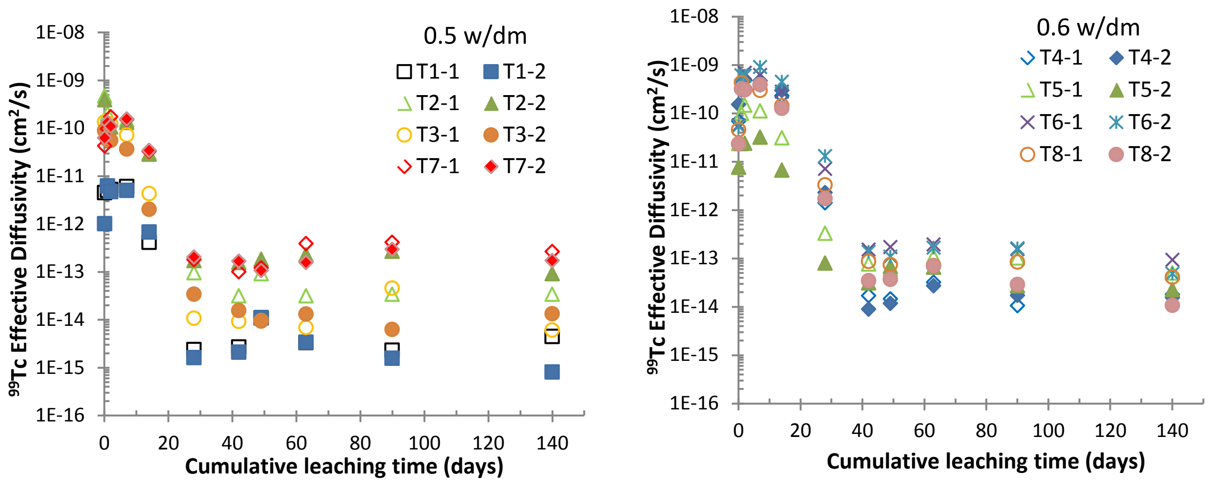


Figure 5.1. Effective Diffusivity Values of ^{99}Tc from the Grout Monoliths Prepared with Different w/dm Ratios for the Cumulative 140-day Leaching in DIW

5.2.2 Effects of Different OPC and BFS Content on ^{99}Tc Leachability

Two new formulations with HL addition were tested and compared for ^{99}Tc leachability in both DIW and VZPW leaching solutions. Grout monoliths T1 and T3 were prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients at 0.5 w/dm ratio for 242-A evaporator condensate and WTP off-gas condensate simulant, respectively. To compare different formulation effects, monoliths T9 and T10 were prepared with 20 wt% HL, 10 wt% OPC, and 70 wt% BFS dry ingredients under the same conditions of monoliths T1 and T3, respectively. The main difference in these monolith pairs was the different OPC and BFS contents in the LSWG formulation. The results of ^{99}Tc D_{eff} values for the cumulative 140-day leaching in DIW solution are shown in Figure 5.2 and Table 5.3–Table 5.5. For both simulants, higher OPC (35 wt%) and lower BFS (45 wt%) contents used for monoliths T1 and T3 produced lower ^{99}Tc D_{eff} values in DIW leaching solution compared to monoliths T9 and T10. The same results of lower ^{99}Tc D_{eff} values were also found in monoliths T1 and T3 leached in VZPW leaching solution (Table 5.4 and Table 5.5). Thus the formulation 20 wt% HL, 35 wt% OPC, and 45 wt% BFS leads to a better grout than the 20 wt% HL, 10 wt% OPC, and 70 wt% BFS formulation in regards to ^{99}Tc leaching.

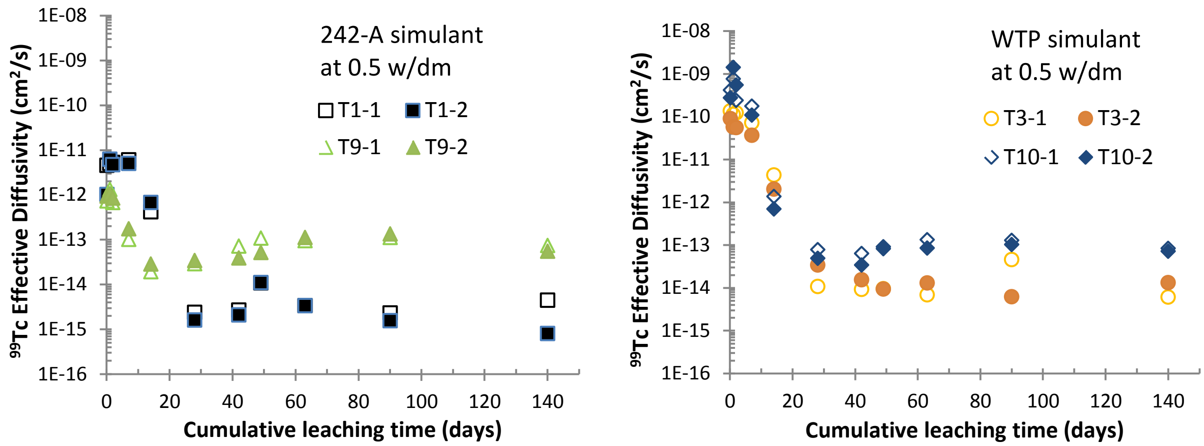


Figure 5.2. ^{99}Tc D_{eff} Values in DI Water for the Grout Monoliths Prepared with Different OPC and BFS Formulations

5.2.3 Different Formulations with HL or FA for ^{99}Tc Leachability

New formulations for LSWG with HL addition were tested and the ^{99}Tc leachabilities were compared with the current Cast Stone formulation prepared with FA, OPC, and BFS dry ingredients. Grout monolith T4 was prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients without Xypex at 0.6 w/dm ratio for 242-A evaporator condensate simulant, while monolith T12 was prepared with 35 wt% FA, 20 wt% OPC, and 45 wt% BFS dry ingredients with Xypex under the same w/dm ratio and simulant conditions as monolith T4. Grout monolith T6 was prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients without Xypex at 0.6 w/dm ratio for WTP off-gas condensate simulant, while monolith T11 was prepared with 35 wt% FA, 20 wt% OPC, and 45 wt% BFS dry ingredients with Xypex under the same w/dm ratio and simulant conditions as monolith T6. Monolith T13 was prepared with 45 wt% FA, 8 wt% OPC, and 47 wt% BFS dry ingredients, which is the current Cast Stone formulation, at 0.6 w/dm ratio using WTP off-gas condensate simulant. The new formulation of LSWG with HL addition (monolith T4) showed lower ^{99}Tc D_{eff} values in DIW leaching solution for the 140-day cumulative leaching than monolith T12 prepared with 35 wt% FA, 20 wt% OPC, and 45 wt% BFS dry ingredients for 242-A simulant (Figure 5.3 and Table 5.3). Even though Xypex was added as an additional admixture to reduce the porosity of the final cured monolith T12, its ^{99}Tc D_{eff} values in DIW leaching solution were higher than those of monolith T4. Thus adding Xypex to monolith T12 did not improve (lower) the leachability of ^{99}Tc when leached in DIW. In addition, average ^{99}Tc D_{eff} values for 28-day to 140-day leaching intervals in VZPW leaching solution were similar to each other ($10^{-13.2}$ vs. $10^{-13.0}$ cm^2/s) for monoliths T4 and T12, respectively (Table 5.5). Thus addition of Xypex to LSWG made with 242-A simulant did not show any improvement in ^{99}Tc leachability. For LSWG monoliths made with WTP simulant, both monoliths T6 (with no Xype) and T11 (contained Xypex) showed similar ^{99}Tc D_{eff} values (especially after 42-day leaching) in DIW leaching solution. The results for monoliths T6 and T11 also suggest that addition of Xypex did not improve ^{99}Tc leachability significantly.

The current Cast Stone formulation, monolith T13, showed noticeably higher ^{99}Tc D_{eff} values compared to monoliths T6 and T11 in Figure 5.3. In addition, monolith T13 was the worst formulation for ^{99}Tc leachability (high D_{eff} and low LI) compared to all other monoliths prepared for testing in both DIW and VZPW leaching solutions (Table 5.3–Table 5.5). The average ^{99}Tc D_{eff} values for monolith T13 were $10^{-10.8}$ cm^2/s in DIW and $10^{-13.0}$ cm^2/s in VZPW leaching solutions. The new formulation with HL addition is recommended to use for solidification of sulfate-rich LSW streams. Otherwise, use of high OPC content (>20 wt%) such as used to make monoliths T11 and T12 might still be used as revised formulation of the current Cast Stone formulation (45 wt% FA, 8 wt% OPC, and 47 wt% BFS). However, due to lack of portlandite mineral formation during curing even in monoliths T11 and T12 (See XRD analysis results in Table 3.6), the monoliths prepared without HL addition can be more vulnerable to long-term weathering and carbonation processes.

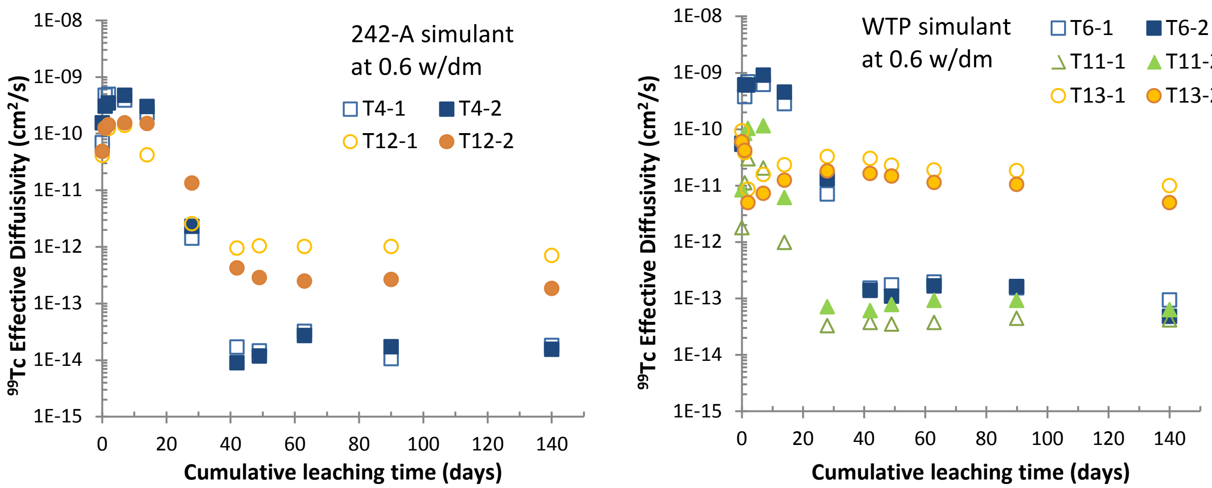


Figure 5.3. ^{99}Tc D_{eff} Values in DI Water for the Grout Monoliths Prepared with Different Lime and FA Formulations

5.2.4 ^{99}Tc Leachability from 242-A and ERDF Simulant Monoliths

The D_{eff} values of ^{99}Tc from the monolith (T14) prepared with a mixture of 242-A and ERDF simulants at a 1:1 mass ratio were determined and compared with those from the monoliths prepared with 100% 242-A simulant (T1) and 100% ERDF simulant (T2). ^{99}Tc D_{eff} values from both DIW and VZPW leaching solutions are shown in Figure 5.4. The ^{99}Tc D_{eff} values from monolith T1 in DIW leaching solution were slightly lower than those from the other two monoliths, T2 and T14. Although the average ^{99}Tc D_{eff} values from 28-day to 140-day cumulative leaching intervals are slightly lower in VZPW leaching solution than DIW, the differences are very small or equal, $10^{-14.4}$ cm^2/s vs. $10^{-14.4}$ cm^2/s for monolith T1, $10^{-12.9}$ cm^2/s vs. $10^{-13.2}$ cm^2/s for monolith T2, and $10^{-13.2}$ cm^2/s vs. $10^{-13.8}$ cm^2/s for monolith T14 (Table 5.5). Monolith T14, prepared with a mixture of 242-A and ERDF simulant, showed ^{99}Tc D_{eff} values between those from monolith T1 and T2 in both DIW and VZPW leaching solutions. Thus the monolith T1, with 242-A simulant gives slightly better ^{99}Tc leaching performance in DIW than the monolith T2 made with the ERDF simulant and the monolith T14 with a mixture of the two simulants exhibited ^{99}Tc leach performance intermediate between the two monoliths made with pure simulants. When leached in VZPW, monolith T1 shows the best ^{99}Tc leach performance (lowest D_{eff}) and the ^{99}Tc D_{eff} values for monoliths T2 and T14 are quite similar. It is difficult to state that the 242-A waste simulant is less concentrated than the ERDF simulant based on compositions shown in Tables 3.4 and 3.5 so no reasons are offered for the slightly better performance for monolith T1 in comparison to monoliths T2 and T14.

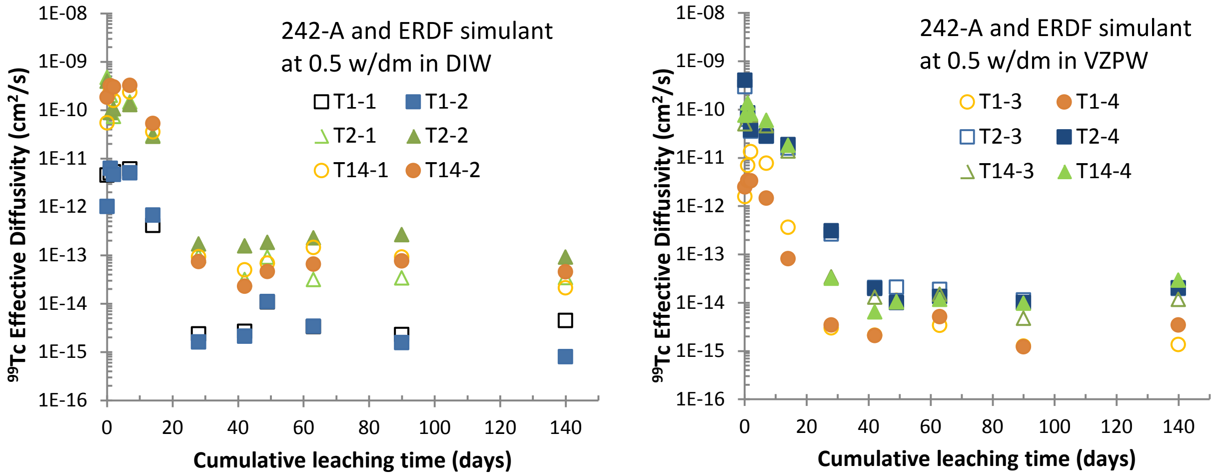


Figure 5.4. ^{99}Tc D_{eff} Values in DI Water and VZPW Leaching Solutions for the Grout Monoliths Prepared with 242-A and/or ERDF Simulants

5.2.5 Effects of ^{99}Tc Getters and Xypex on ^{99}Tc Leachability

Effects of ^{99}Tc getters (Sn-treated apatite and $SnCl_2$) and Xypex on ^{99}Tc leachability were tested using the monoliths prepared with Sn-treated apatite (T15) and $SnCl_2$ (T16). No Xypex was added to prepare monoliths T15 and T16. Monolith T3 was also used to compare the results because no getter was added in preparing monolith T3, but the other variables (waste simulant, w/dm ratio, and dry blend composition) were held constant. The new formulation for monoliths T3, T15, and T16 was 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients at 0.5 w/dm ratio for WTP simulant. For monoliths T17 and T18, both getters (Sn-treated apatite for T17 and $SnCl_2$ for T18) and Xypex were added to prepare the monoliths. Neither getter nor Xypex were added to prepare monolith T10, while the new formulation for three monoliths, T10, T17, and T18, was 20 wt% HL, 10 wt% OPC, and 70 wt% BFS dry ingredients at 0.5 w/dm ratio for WTP simulant. Three times less $SnCl_2$ than Sn-treated apatite was used to compensate for their different reduction capacities (Um et al. 2011, 2015; Qafoku 2014). Getters were reacted with ^{99}Tc-spiked WTP simulant for 24 h before the simulant was mixed with the dry ingredients. After 24 h reaction between the getters and the simulant, an aliquot of the WTP simulant was collected and analyzed for ^{99}Tc concentration after filtration. Based on ^{99}Tc analysis before and after reaction with getters, Sn-treated apatite showed 54% ^{99}Tc removal from WTP simulant used for making monolith T15 and 51% ^{99}Tc removal from WTP simulant used to make monolith T17, while 39.6 % and 44.1 % ^{99}Tc removal from WTP simulants were measured for monoliths T16 and T18, respectively, in which $SnCl_2$ getter was included. The ^{99}Tc D_{eff} values were measured for the monoliths prepared with getters and Xypex, and the results were compared with ^{99}Tc D_{eff} values for the monolith prepared without getters or Xypex (Figure 5.5). Contrary to our expectation, neither getter in monoliths T15 and T16 resulted in lower ^{99}Tc D_{eff} values when leached in DIW than monolith T3 (prepared without getter under the same formulation conditions as monoliths T15 and T16). Small amounts of getter added in grout monolith based on the new formulation were not effective for lowering ^{99}Tc D_{eff} values in DIW leaching solution. When the monoliths of the same compositions were leached in VZPW, average ^{99}Tc D_{eff} values of the cumulative leaching from 28 to 140 days are $10^{-13.6}$ cm^2/s and $10^{-12.9}$ cm^2/s for monoliths T15 and T16, respectively, which are higher than the value of $10^{-14.2}$ cm^2/s found in monolith T3 (Table 5.5). Addition of getter in monoliths T15 and T16 yielded more ^{99}Tc leaching in VZPW than ^{99}Tc leached from the companion monolith T3 with no getters. Thus for this LSWG composition including either getter led to slightly worse performance in ^{99}Tc release.

For limiting ^{99}Tc leachability, Sn-treated apatite worked slightly better than $SnCl_2$. However, any negative impact and compatibility issues with the LSWG dry ingredients should be tested carefully before considering the potential use of ^{99}Tc getters, if needed. The two monoliths prepared with both getter and Xypex (T17 and T18) also did not show any significant decrease of ^{99}Tc D_{eff} values, as shown in Figure 5.5. Even though Xypex was added with getter, the average ^{99}Tc D_{eff} value from 28-day to 140-day cumulative leaching intervals in DIW was $10^{-13.1}$ cm^2/s for monolith T10, which is still lower than the values of $10^{-12.6}$ cm^2/s and $10^{-11.8}$ cm^2/s from the two monoliths (T17 and T18) that contained the getters, respectively. When leached in VZPW, ^{99}Tc D_{eff} values from monoliths T17 and T18 ($10^{-14.5}$ cm^2/s and $10^{-14.4}$ cm^2/s, respectively) are similar to or slightly lower than that of monolith T10 ($10^{-14.3}$ cm^2/s), but it may result from an additional effect of secondary precipitates found on the outer surface of monoliths leached in VZPW solution for an extended time (Serne et al. 2015). The new formulation with HL addition, even without getter or Xypex addition, is good enough to limit ^{99}Tc diffusivity to lower than 10^{-12} cm^2/s.

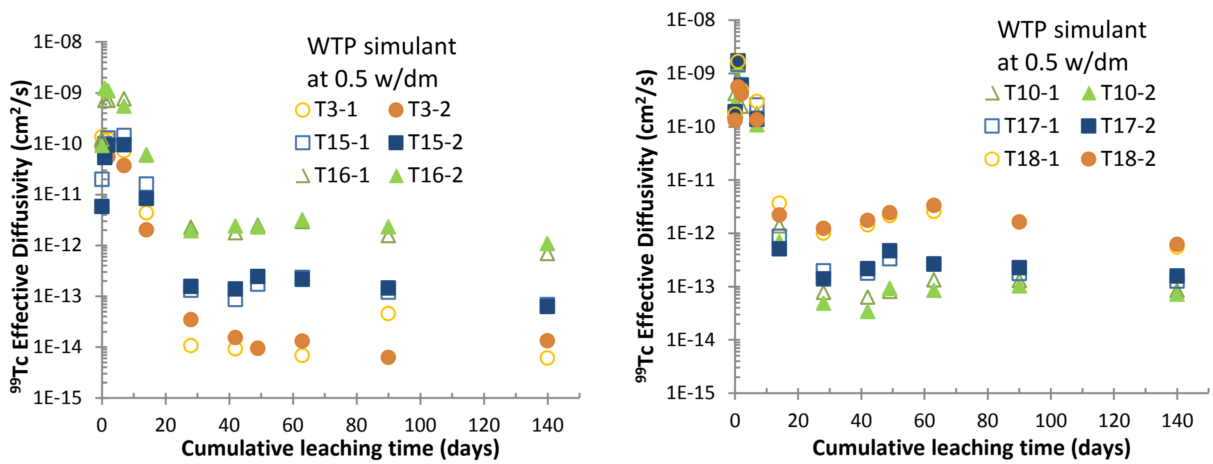


Figure 5.5. ^{99}Tc D_{eff} Values from the Monoliths Prepared with ^{99}Tc Getters and Xypex in DI Water

5.2.6 ^{99}Tc Leachability in DI Water and VZPW Leaching Solutions

In general, most of the ^{99}Tc D_{eff} values in VZPW leaching solution are lower than those in DIW leaching solution (Table 5.5). This result agrees well with previous results from Serne et al. (2015), but not much significant in the HL-based grouts. Secondary precipitate coatings formed on the outside surfaces of monoliths leached in VZPW for extended times. The white precipitates found after 140-day cumulative leaching in VZPW on the surfaces of monoliths are shown in Figure 5.6. The white precipitates on the monolith surfaces leached in VZPW solution were identified as aragonite (a polymorph of calcium carbonate) with some brucite [$Mg(OH)_2$] and perhaps some calcite and gypsum, based on XRD analysis (Serne et al. 2015).

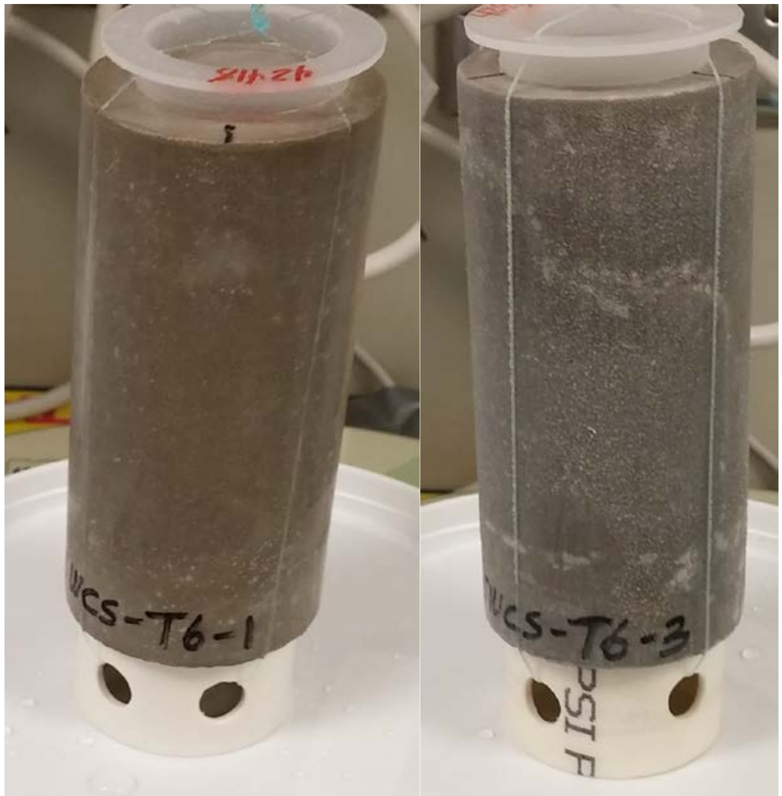


Figure 5.6. Photographs of Two Monoliths (T6-1 and T6-3) after 140 Days of Cumulative Leaching in DI Water (left) and VZPW Leaching Solution (right)

5.2.7 Leachabilities of NO_3^- and Na^+ in DI Water and VZPW Leaching Solutions

Calculated D_{eff} and LI values for NO_3^- and Na^+ for each leaching interval up to 140-day leaching and averaged D_{eff} values from 28 days to 140 days in both DIW and VZPW leaching solutions are shown in Table 5.3–Table 5.5. In general, average NO_3^- D_{eff} values from 28-day to 140-day leaching are higher than average ^{99}Tc D_{eff} values, because NO_3^- is highly mobile and behaves like a non-reactive tracer. In DIW leaching, most of the average NO_3^- D_{eff} values ranged from $10^{-10.5}$ cm^2/s to $10^{-9.11}$ cm^2/s, which are 1–3 orders of magnitude higher than average ^{99}Tc D_{eff} values in DIW leaching solution (Table 5.5). In VZPW leaching solution, average NO_3^- D_{eff} values fluctuated more, ranging from $10^{-9.69}$ cm^2/s to $10^{-7.07}$ cm^2/s, which is attributed to different low initial NO_3^- concentrations in simulants, potential $NaNO_3$ salt precipitates, and NO_3^- mass release greater than 20% (only in three monoliths), which increased the relatively high uncertainty in the calculated D_{eff} or LI values. Average Na^+ D_{eff} values in both DIW and VZPW leaching solutions for the cumulative 140-day leaching ranged from $10^{-9.53}$ cm^2/s to $10^{-7.39}$ cm^2/s. These D_{eff} values are much higher than average ^{99}Tc D_{eff} values because of high Na^+ mobility. In DIW leaching solution, the average fraction of Na^+ mass released from 28-day to 140-day leaching is less than 20% for some of monoliths tested excepting eight monoliths (T3, T5, T6, T8, T11, T15, T16, and T17), which provides credible D_{eff} and LI values for Na^+ in DIW. However, because the fraction of Na^+ mass released in VZPW leaching solution exceeded 20% of the initial Na^+ in most of the monoliths (16 out of total 18), those calculated Na^+ D_{eff} and LI values in VZPW leaching solution should be corrected for inventory depletion and used only for qualitative comparison. Additional cations and anions measured in EPA 1315 Method leaching tests can be found in Appendix A.2.

5.2.8 Other Measurements in the Leachates

Other measurements including major cations, anions, ammonia, pH, EC, E_h, and alkalinity were made for each leachate sample for each individual monolith at every leaching interval. The measured pH in the leachates in DIW showed a narrow range between 11 and 12, while a slightly wider range of pH between 10 and 12 was found in VZPW leaching solution for most of the 18 monoliths during the 140-day cumulative leaching period. One example of the leachate pH values measured for both DIW and VZPW leaching solutions for monolith T3 are shown in Figure 5.7. Additional pH values and other measurements can be found in Appendix A.3.

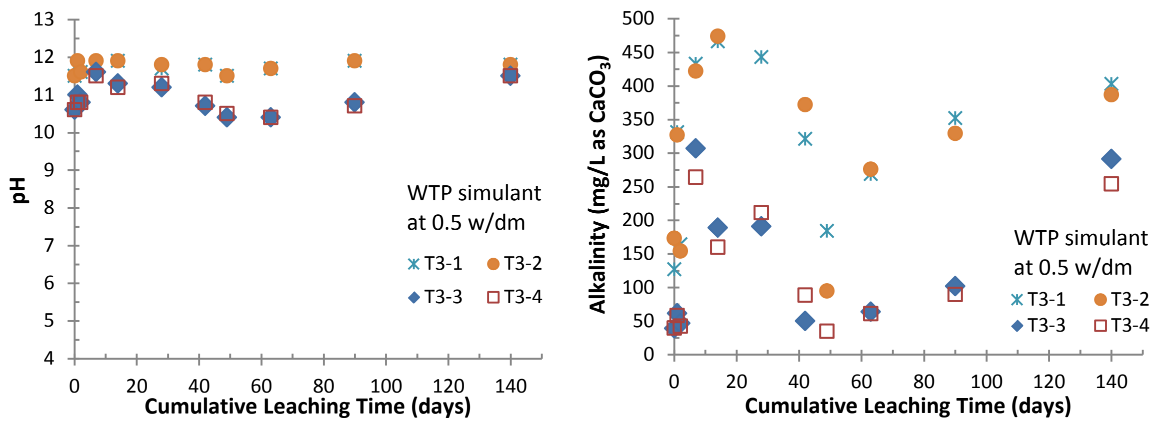


Figure 5.7. Measured pH and Alkalinity Data in the Leachates from Monolith T3 for the Cumulative 140-Day Leaching

The measured ECs in both leaching solutions were low, ranging from 0.3 to 2.6 mS/cm in DIW leaching solution, indicating that there were no major broken pieces and significant dissolution occurring for all 18 monoliths during the 140-day cumulative leaching period. Alkalinity values continuously increased with cumulative leaching time up to 140 days in DIW leaching solution, because of continuous leaching of hydroxyl and carbonate ions. However, alkalinity values in VZPW leaching solution increased initially until 28-day or 42-day leaching, then showed a decreasing trend to 140-day leaching. This decreasing alkalinity after 28 or 42 days cumulative leaching in VZPW solution is attributed to precipitation of carbonate minerals (aragonite and calcite) and/or gypsum. Similar decreasing trends of Ca^{2+} and total sulfur (mostly sulfate) concentrations were also detected in VZPW leaching solution after 28- or 42-day leaching, while continuous increases of total sulfur and alkalinity values were found in DIW. Ammonia concentrations were measured in each leachate, but showed no high concentrations or trends versus time, ranging from zero to 50 mg/L. Compared to the initial high ammonia concentration in the 242-A and WTP simulants, the measured ammonia concentrations in leachates from monoliths made with these two simulants were not too high; this is because ammonia gas releases occurred during the simulant preparation and monolith preparation. The measured and corrected E_h values are mostly higher than 170 mV, up to 380 mV, which indicates oxic conditions prevailed when the sample collections were conducted. More data can be found in Appendix A.3.

5.2.9 Diffusion Process and Controlling Mechanism for the ^{99}Tc Leach

A calculated diffusivity for each constituent can be determined using a linearity by plotting the cumulative released mass versus the square root of the cumulative time. Alternatively, in the case of a diffusion-controlled mechanism, the logarithm of the cumulative released mass plotted versus the logarithm of cumulative time can be used; this plot is expected to be a straight line with a slope of 0.5 ± 0.15 (EPA 1315, 2013).

The ^{99}Tc releases in DIW from the FA-based current Cast Stone grout (T13 prepared with 45 wt% FA, 8 wt% OPC, and 47 wt% BFS dry ingredients) were controlled by diffusion, showing a good linearity and a slope of 0.4, which is within acceptable limits for the EPA 1315 method (a slope of 0.5 ± 0.15) (Figure 5.8). The cumulative releases of mobile NO_3^- and Na^+ also showed a good linearity; more data for the logarithm of the cumulative release plotted versus the logarithm of cumulative time can be found in Appendix A.4.

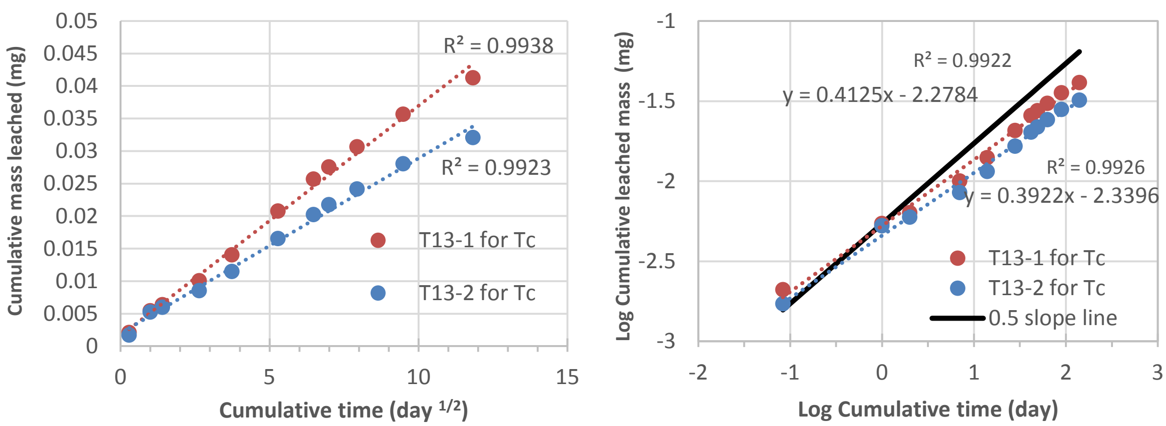


Figure 5.8. Linear Dependence of the Cumulative ^{99}Tc Release vs. the Cumulative Leaching Time, $t^{1/2}$, for T13 Grout (left) and the Logarithm of the Cumulative ^{99}Tc Release Plotted vs. the Logarithm of Cumulative Time for T13 Grout with a Slope of 0.5 ± 0.15 (right)

However, the release of ^{99}Tc from most of the HL-based grouts did not follow a pure diffusion trend. When plotted by either approach stated above, the results are linear but with two slopes as a function of the cumulative leaching time. The ^{99}Tc releases in DIW from grout T6 (prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients, which differs from the current Cast Stone formulation grout) showed two different linear slopes: an initial linearity with high slope up to 7 (or 14) days leaching, and another linearity with slope lower than 0.5 between the 14- (or 28)-day and 140-day leaching intervals (Figure 5.9). Initial ^{99}Tc releases up to 7 (or 14) days leaching followed diffusion-controlled ^{99}Tc releases even though small deviation outside the slope range 0.5 ± 0.15 was found. However, ^{99}Tc releases after 14 (or 28) days leaching was linear with slope lower than 0.5, which suggests that additional effects from the physical and/or chemical processes retarded ^{99}Tc releases during these relatively later leaching periods. Although the mechanism for this low ^{99}Tc release in a later leaching period for the HL-based grouts is not clear, we hypothesize that the low ^{99}Tc leach rate results from some chemical reaction that sequesters ^{99}Tc rather than some physical factors such as reduced porosity and permeability (or tortuosity). We hypothesize a ^{99}Tc-specific chemical process, because the releases of NO_3^- and Na^+ for T6 and other HL-based grouts showed good linearity with a slope close to the required 0.5 value, which signifies that their releases are controlled by the diffusion process for 140-days leaching (Figure 5.9 and

Appendix A.4). Chemical reactions that might slow the release of ^{99}Tc could be (1) ^{99}Tc incorporation into ettringite in either the pre-leached cured grout or a newly formed ettringite from transformation of portlandite during the active leaching stage, (2) ion exchange between ^{99}Tc and sulfate in ettringite, (3) ^{99}Tc removal by continuous and slow hydration reactions in the HL-based grouts, or (4) continuous slow ^{99}Tc reduction (or incorporation to mineral phase) by slow dissolution of BFS. All these possible scenarios will be tested in a future task to understand ^{99}Tc releases from the HL-based grout.

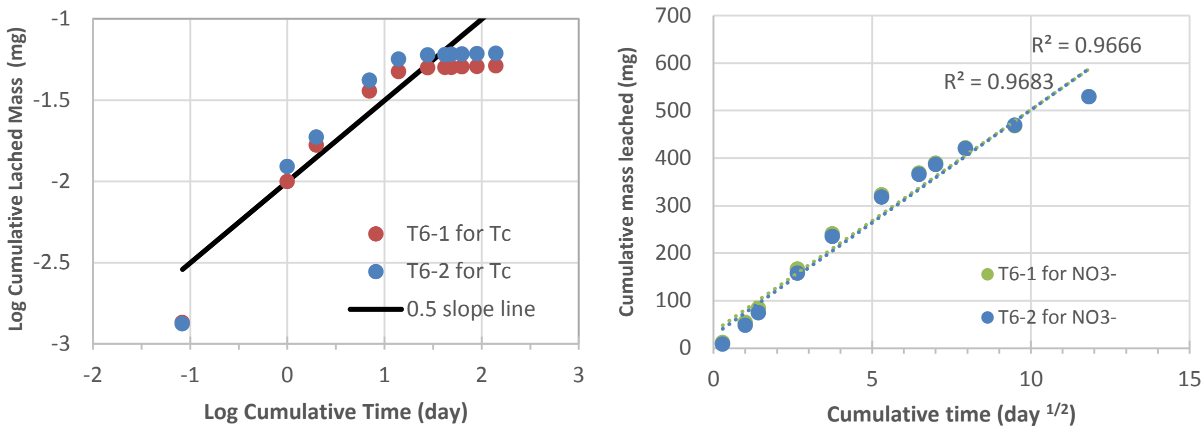


Figure 5.9. Logarithm of the Cumulative ^{99}Tc Release Plotted vs. the Logarithm of Cumulative Time for T6 grout along with a 0.5-slope line (left); Cumulative NO_3^- Release vs. the Cumulative Leaching Time, $t^{1/2}$, for T6 grout (right). R^2 is the correlation coefficient.

6.0 ^{99}Tc Desorption K_d Measurements

This section presents the ^{99}Tc desorption K_d measurements. The ^{99}Tc desorption K_d tests were conducted using ^{99}Tc-spiked monolith powders for K_d desorption tests and non-^{99}Tc spiked monolith powders for K_d sorption following desorption tests. Both reducing and oxidizing conditions were used for ^{99}Tc desorption tests.

6.1 Methods and Materials

Six monoliths were selected for use in these ^{99}Tc desorption measurements. Three of the selected ^{99}Tc-spiked monoliths—T3, T6, and T11 (see Table 3.1)—were crushed into powder and used for direct measurements of ^{99}Tc desorption K_d. Another three non-^{99}Tc-spiked grout monoliths (T19, T20, and T21) were prepared with the same formulation and WTP simulant but not spiked with ^{99}Tc. Monoliths T19, T20, and T21 were also crushed and used first for ^{99}Tc sorption tests followed by ^{99}Tc desorption tests. Monoliths T3 and T19 were prepared with the new formation of 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients at a w/dm ratio of 0.5 using WTP simulant. Monoliths T6 and T20 were prepared using the same new formulation as T3 and T19 but with a w/dm ratio of 0.6. Monoliths T11 and T21 were prepared with 35 wt% FA, 20 wt% OPC, and 45 wt% BFS dry ingredients at a w/dm ratio of 0.6 again using WTP simulant.

6.1.1 ^{99}Tc Sorption and Desorption K_d using Three Non-^{99}Tc-Spiked Grout Monoliths

6.1.1.1 Material Preparation

After 28-day curing, the three non-^{99}Tc-spiked grout monoliths T19, T20, and T21 were removed from their forms and crushed using chemically inert instrument (hammer) inside an anoxic chamber filled with a mixture of N_2 (98%) and H_2 (2%) gases. Three different size fractions of <0.3 mm (F3), 0.3 mm–2 mm (F1), and 5 mm–20 mm (F2) were generated from the crushed grout through dry sieving inside the anoxic chamber. The most-interior crushed solid materials had an olive green color (see Figure 6.1) and were used for the sorption-desorption tests. Near-surface portions of the monolith after crushing were not used as they might have been oxidized during crushing.

Figure 6.1. F2 (5–20 mm) Size-Fraction Samples of Monolith T21 used for Sorption/Desorption Experiments

6.1.1.2 Sorption Experiment using the Three Non-^{99}Tc-Spiked Grout Monoliths

$Ca(OH)_2$-saturated solutions that had been pre-equilibrated with the respective crushed non-^{99}Tc-spiked grout monolith materials were used for all the ^{99}Tc sorption/desorption experiments. The pre-equilibration step was used to prevent large changes in pH and aqueous chemistry composition during the sorption phase in hopes of minimizing other processes such as ^{99}Tc precipitation that could affect the sorption behavior and change the pH of the $Ca(OH)_2$-saturated solution (Almond et al. 2012; Kaplan 2010). The $Ca(OH)_2$-saturated solution simulates young/moderately aged cement pore solution. The $Ca(OH)_2$-saturated solution was prepared by adding approximately 20 g of reagent grade $Ca(OH)_2$(s) to 2 liters of DIW and stirred for at least one day. After filtering using a 0.45 µm filter, the solutions were purged with N_2 gas for 2 hours to remove oxygen, and were immediately moved into the anoxic chamber. Inside the chamber, the N_2-purged $Ca(OH)_2$-saturated solution was equilibrated with the respective non-^{99}Tc-spiked grout monolith chunk materials (T19, T20, and T21) at a solid-to-solution ratio of 25g/L for one day, followed by filtering using 0.45 µm filters. This LSWG equilibrated N_2-purged $Ca(OH)_2$-saturated solution was used in the ^{99}Tc sorption phase of testing.

All sorption batch experiments were performed inside an anoxic chamber. About 21 mL of the ^{99}Tc(VII)-spiked (1.0 ppb) pre-equilibrated saturated $Ca(OH)_2$ solution was added to each 50 mL centrifuge tube containing ~3 g of crushed powders so that the solid-to-solution ratio was 3 g/21 mL. Duplicate reaction vials were set up for the finest (F3) sized powder solids, while triplicate reaction vials were prepared for each of the two crushed size fractions. Enough centrifuge tubes containing the crushed LSWG and ^{99}Tc-spiked equilibrated N_2-purged $Ca(OH)_2$-saturated solution were used to allow sampling at two different sorption reaction times (7 and 30 days). Triplicate tubes were used for the F1 and F2 size-fraction solid materials, because higher variability in ^{99}Tc sorption results was expected for the vials prepared with relatively bigger-sized fractions, F1 and F2. Duplicate control samples for each of the two sorption reaction times (7 and 30 days) consisting of 21 mL of the 1.0 ppb ^{99}Tc(VII)-spiked pre-equilibrated $Ca(OH)_2$ in 50 mL centrifuge tubes without solids added were also prepared and reacted for the same two contact times. All the sorption vials were hand shaken (inside the chamber) daily in the first week and 1–2 times per week thereafter. After 7 or 30 days, the grout solids were separated by self-settlement overnight and centrifugation (3,000 rpm for 30 min). After centrifugation outside the anoxic chamber, the samples were carefully moved back inside the chamber so as not to disturb the segregated solids. The supernatants were removed and collected by pipette inside the anoxic chamber. During the supernatant removal process, care was taken to avoid any solid loss by slowly pipetting supernate aliquots several times into a clean vial. About a quarter of the collected supernatant (~5 mL) was filtered using a 0.45 µm filter, and the remaining unfiltered supernatant was used for pH and E_h measurements using a Hanna Instruments meter inside the chamber. The E_h values were corrected by adding 208 mV to the value measured by a Hanna probe. Part of the filtered supernatant was subsampled for ^{99}Tc speciation analysis, while the remaining filtered solution was used for total ^{99}Tc concentration analysis by ICP-MS.

^{99}Tc species concentrations in solution were measured using a method adapted from Boggs et al. (2010) for each filtered sample. Briefly, 0.4 mL of the collected aqueous filtrate was mixed with 0.6 mL of an acetate buffer solution with pH 4.6 (±0.2) and 0.5 mL of 0.1 M bis-(2-ethylhexyl) phosphoric acid (HDEHP) in hexane. The mixture was shaken vigorously for one minute using a vortex mixer, and the organic and aqueous phases were separated by overnight settlement. Under these conditions, ^{99}Tc(IV) partitions within the organic-HDEHP complexed phase and ^{99}Tc(VII) remains in the aqueous phase. The aqueous phase was only sampled by pipette separately and submitted for ^{99}Tc(VII) concentration analysis using ICP-MS. The Tc(IV) concentration was estimated by the difference in the total ^{99}Tc concentration and the ^{99}Tc(VII) concentration.

The ^{99}Tc sorption coefficient K_d was calculated as shown below in Equation (6.1):

$$K_d = \frac{(C_i - C_t)V}{C_t m_{solid}} \tag{6.1}$$

where C_i is the initial aqueous total ^{99}Tc concentration (µg/mL) in the supernate from the control samples
C_t is the final aqueous equilibrated ^{99}Tc concentration (µg/mL)
V is the solution volume in the final equilibrated suspension (mL)
m_{solid} is the dry solid mass of the grout sample (g)

The dry solid mass of the grout monolith was corrected by the measured MC for each size fraction, F1, F2, and F3, using the same process as above (see Equation 3.1). The MCs of grout monoliths in Table 3.6 were used for the MC of the F2 size fraction (0.5–2 cm), while the MCs of powder samples (<0.3 mm) that were used in the EPA Method 1313 test (See Section 4 and Table 4.1) were used for the F3 size fraction (<0.3 mm). Other MCs were measured on the crushed LSWG samples created for these sorption tests and the values are shown in Table 6.1.

Table 6.1. Average Moisture Contents of Different Size-Fractioned Grouts

Grout Monolith Test Batch	Size Fraction	Moisture Content (%)
^{99}Tc-Spiked Grout		
T3	F1 (0.3 mm–2 mm)	25.5*
	F2 (5 mm–20 mm)	25.1
	F3 (<0.3 mm)	22.0
T6	F1 (0.3 mm–2 mm)	25.8
	F2 (5 mm–20 mm)	29.7
	F3 (<0.3 mm)	24.3
T11	F1 (0.3 mm–2 mm)	27.9
	F2 (5 mm–20 mm)	30.4
	F3 (<0.3 mm)	25.8
Non-^{99}Tc-Spiked Grout		
T19	F1 (0.3 mm–2 mm)	25.5
	F2 (5 mm–20 mm)	26.2
	F3 (<0.3 mm)	24.3
T20	F1 (0.3mm–2 mm)	27.4
	F2 (5 mm–20 mm)	29.7
	F3 (<0.3 mm)	23.4
T21	F1 (0.3 mm–2 mm)	26.3
	F2 (5 mm–20 mm)	31.2
	F3 (<0.3 mm)	20.4

* F1 size fraction of monolith T3 was not prepared, unfortunately, so the F1 size fraction MC value of monolith T19 was used.

6.1.1.3 Desorption ^{99}Tc K_d Measurements using ^{99}Tc-Sorbed Grout Samples

The same crushed non-^{99}Tc-spiked LSWG samples that were first used to measure sorption K_d*s* were used for ^{99}Tc desorption tests for two different desorption reaction times (7 and 30 days) under both oxidizing and reducing conditions using the pre-equilibrated $Ca(OH)_2$-saturated solution. Because ^{99}Tc sorption did not reach equilibrium for the F2 size fraction (5–20 mm) within 7 days reaction (See section 6.2.1), ^{99}Tc desorption K_ds for the F2 sized LSWG were measured using only 30-day ^{99}Tc-sorbed grout samples. Because more than 90% of the spiked ^{99}Tc sorbed onto the various fractions of crushed T19, T20, and T21 after 30 days sorption except for the 5–20 mm size fraction of T 21 (which showed ~80% ^{99}Tc sorption), little ^{99}Tc should have remained in the final supernate, which can minimize the errors in determining total sorbed ^{99}Tc mass on solids that will be used for ^{99}Tc desorption K_d calculation. See Section 6.2.1 for details.

After removing solution present in the centrifuge tubes after the ^{99}Tc sorption phase for 30 days sorption, the weight of wet slurry remaining in each 50 mL centrifuge tube was recorded before the ^{99}Tc desorption process was started. In addition, ^{99}Tc mass remaining in the interstitial solution was determined by multiplying ^{99}Tc concentration in sorption samples (µg/mL) at steady state and the remaining sorption solution volume (mL) based on the measured weight of slurry before starting desorption. Recall that the 7-day adsorption tubes had not reached ^{99}Tc sorption equilibrium and thus were not used in the desorption phase of these tests. The desorption phase of the tests was accomplished by adding a fresh 21 mL pre-equilibrated $Ca(OH)_2$-saturated solution into the centrifuge tube containing the ^{99}Tc-laden crushed LSWG material. Because ^{99}Tc desorption tests were conducted under both reducing and oxidizing conditions, half of the desorption vials stayed inside the anoxic chamber, while the other half of the desorption vials were moved outside the chamber and the lids of these vials were loosely capped to enable the solution to contact air. The desorption vials were also shaken by hand daily for the first week, after which they were shaken one to two times per week during the desorption phase of the tests under reducing conditions. Two desorption reaction times (7 and 30 days) were used, with triplicate samples prepared for each set of desorption tests for F1 and F2 size fractions, while duplicate samples were prepared for the F3 size fraction. After 7- or 30-day desorption reaction, the same solid separation and supernatant collection techniques as used for the sorption phase of the test (see Section 6.1.1.2) were applied for collecting desorption supernatant solution. The final pH, E_h, and total ^{99}Tc concentration, as well as ^{99}Tc concentration of different species in the supernatant solutions, were determined using the same methods as described above.

The desorption K_d for total ^{99}Tc was calculated using Equation (6.2),

$$K_d = \frac{C_s}{C_t} = \frac{(\frac{m_r}{V} - C_t)V}{m_{solid}C_t} \tag{6.2}$$

where
- m_r = remaining ^{99}Tc mass (µg) in the sorption tube at the start of the desorption experiment, which was calculated based on the ^{99}Tc mass by multiplying ^{99}Tc concentration in sorption samples (µg/mL) at steady state determined by no ^{99}Tc concentration changed and the remaining sorption solution (mL) based on the weight of slurry before starting desorption
- C_s = final ^{99}Tc concentration (µg/g) on solid after the desorption test and determined by the difference between the initially sorbed ^{99}Tc mass on the solids and the final ^{99}Tc mass in the desorption solution at steady state
- C_t = final aqueous ^{99}Tc concentration at steady state for the desorption test (µg/mL)
- V = total solution volume in the final equilibrated desorption suspension (including the residual volume of sorption liquid plus the ~21 mL of fresh desorption solution added) (mL)
- m_{solid} = dry solid mass (g) of the grout monolith sample corrected for moisture content as shown in Table 6.1.

6.1.2 Desorption ^{99}Tc K_d Measurement using ^{99}Tc-Spiked Grout Samples

6.1.2.1 Material Preparation

After 28-day curing, the three ^{99}Tc-spiked grout monoliths T3, T6, and T11 were removed from their forms and particle size reduction was conducted by crushing and grinding the monoliths using chemically inert materials inside an anoxic chamber filled with a mixture of N_2 (98%) and H_2 (2%) gases. For grout monoliths T6 and T11, three different size fractions of <0.3 mm (F3), 0.3–2 mm (F1), and 5–20 mm (F2) were collected through dry sieving, whereas only one F3 size fraction was available and used for the T3 grout monolith.

6.1.2.2 Desorption Tests

^{99}Tc desorption tests using ^{99}Tc-spiked grout monoliths powders were conducted under both reducing and oxidizing conditions using the pre-equilibrated $Ca(OH)_2$-saturated solution described in Section 6.1.1.2. All desorption batch experiments were initially prepared inside the anoxic chamber. About 21 mL of pre-equilibrated saturated $Ca(OH)_2$ solution was added to each tube containing ~3 g crushed grout solid so that the solid-to-solution ratio was 3g/21 mL in the 50 mL centrifuge tubes, which is the same as the sorption/desorption experimental conditions for non-^{99}Tc-spiked grout samples described in Section 6.1.1. Duplicate reaction vials for each of two desorption reaction times (30 and 45 days) were prepared for each F1, F2, and F3 size-fraction crushed LSWG. Half of the reaction vials were mixed inside the anoxic chamber, while the other half of the desorption vials were moved out and reacted outside the chamber with loosely fastened lids. All the desorption vials inside and outside the anoxic chamber were hand shaken daily in the first week and 1–2 times per week thereafter. After 30 and 45 days desorption reaction times, the supernates were separated by centrifugation and the final solution pH and E_h were measured. Concentrations of total ^{99}Tc and different ^{99}Tc species in the supernatants were determined using supernatant filtered with a 0.45 µm syringe filter. ^{99}Tc analyses and speciation were determined using the same methods as described in Section 6.1.1.2 above.

The desorption K_d for total ^{99}Tc was calculated using Equation (6.3):

$$K_d = \frac{C_s}{C_w} = \frac{([C_{initial-grout} M_{grout}] - [C_w V])}{M_{grout} C_w} \tag{6.3}$$

where C_s = final ^{99}Tc concentration on desorbed grout solid (µg/g) as determined by subtracting the desorbed ^{99}Tc mass in desorption solution after the desorption test from the initial total ^{99}Tc mass in each cured ^{99}Tc-spiked grout monolith (T3, T6, and T11, see Table 5.2)

$C_{initial-grout}$ = ^{99}Tc concentration in cured grout before being placed in desorption solution (µg/g)

M_{grout} = dry mass of cured grout used for K_d desorption test (g) corrected for moisture content

C_w = measured concentration (µg/mL) of ^{99}Tc in the aqueous phase at the end of the desorption experiment

V = volume of pre-equilibrated $Ca(OH)_2$ desorption solution added in the test plus moisture volume of the used grout samples determined by sample mass multiplied by moisture content (mL).

6.2 Results and Discussion

Six selected grout monoliths were used for ^{99}Tc desorption K_d measurements after crushing the monoliths to three size fractions. Three non-^{99}Tc-spiked grout monoliths, T19, T20, and T21 were prepared using the same formulation and simulant as used for three ^{99}Tc-spiked monoliths (T3, T6, and T11), respectively. Crushed monoliths T19, T20, and T21 were used for ^{99}Tc desorption K_ds following an initial ^{99}Tc sorption phase, while the three selected ^{99}Tc-spiked grout monoliths (T3, T6, and T11) were used for direct ^{99}Tc desorption K_d measurements.

6.2.1 ^{99}Tc Sorption on Non-^{99}Tc-Spiked Grout Monoliths

All ^{99}Tc sorption tests were conducted inside an anoxic chamber maintaining reducing conditions with an initial ^{99}Tc concentration of 1.0 µg/L present in N_2-purged $Ca(OH)_2$-saturated solution. The measured redox potential values in the collected supernatant at the end of sorption phase of the tests were corrected to E_h values by adding 208 mV to the measured values and showed an average of -341 and -381 mV for 7-day and 30-day sorption, respectively. Very constant pH values of ~12.5 indicate no significant pH and chemistry changes occurred during sorption phase of the tests because the pre-equilibrated saturated $Ca(OH)_2$ solution had a pH equal to 12.5. Overall, high pH and reducing conditions (E_h <-300 mV) were maintained in all tubes during the sorption phase. The pH and E_h values for each vial are listed in Appendix A.4.

The measured ^{99}Tc concentrations in aqueous supernatants for the sorption and control vials associated with the crushed T19, T20, and T21 LSWGs at the end of sorption experiments are shown in Figure 6.2–Figure 6.4. The measured ^{99}Tc aqueous concentration in all control samples (tubes with no crushed LSWG solids) was maintained well and showed ^{99}Tc-spiked concentrations close to the initial ^{99}Tc target concentration (1.0 µg/L or ~10^{-8} M). This demonstrates that the initial ^{99}Tc remained soluble over the entire course of the sorption experiments and reductive $^{99}TcO_2(s)$ or ^{99}Tc(IV)-bearing solid phase precipitation did not occur, at least in the control samples, indicating that the reducing condition inside the anoxic chamber was not low enough to cause ^{99}Tc(IV)-bearing solid phase precipitation from the initial solutions with 1.0 µg/L ^{99}Tc concentration. In parallel sorption and solubility experiments, the same results were also found under the same chamber conditions for control vials prepared with high initial ^{99}Tc concentrations of 10 and 25 µg/L. No black colored $^{99}TcO_2(s)$ precipitate was found in any of the ^{99}Tc control samples prepared.

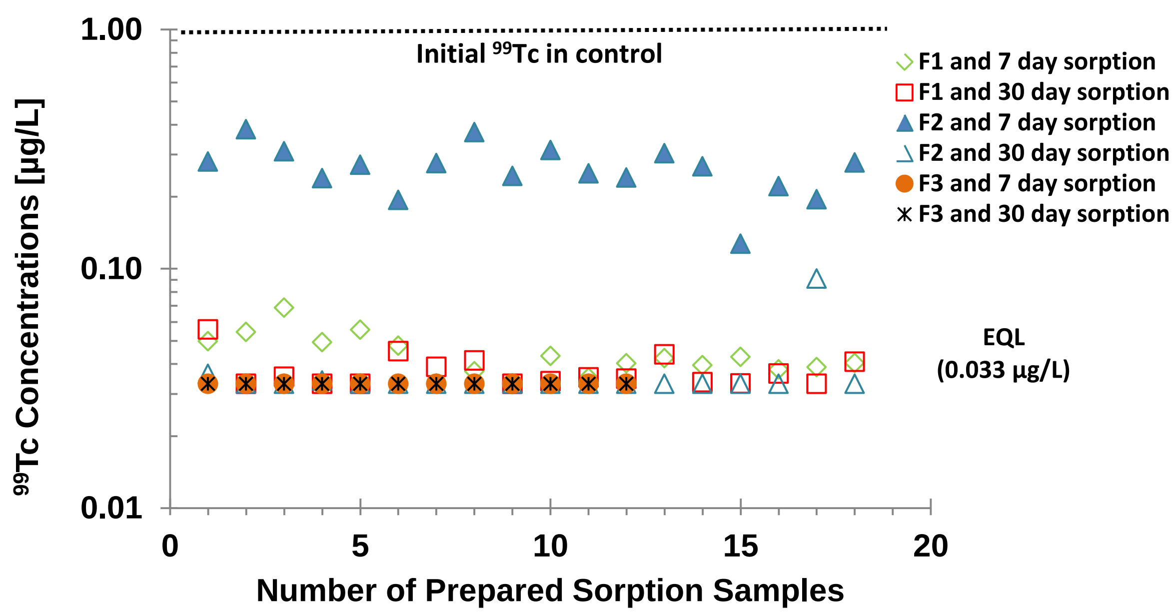


Figure 6.2. ^{99}Tc Concentrations in Final Sorption Supernatants as a Function of Size Fraction and Reaction Time using Crushed Non-^{99}Tc-Spiked Grout T19

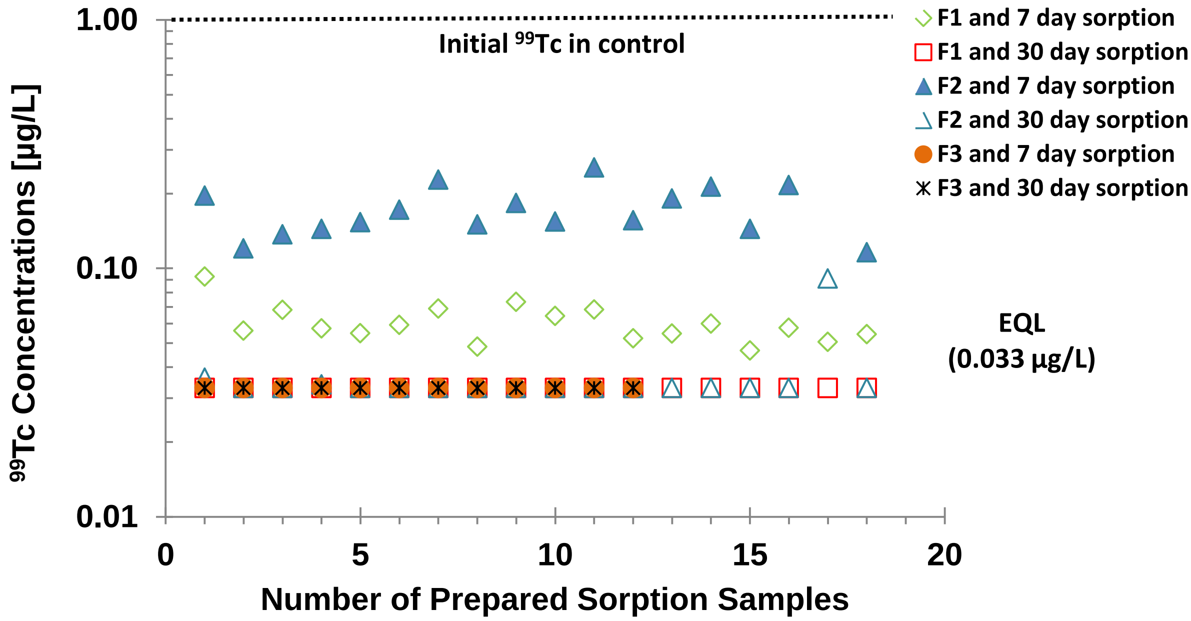


Figure 6.3. ^{99}Tc Concentrations in Final Sorption Supernatants as a Function of Size Fraction and Reaction Time using Crushed Non-^{99}Tc-Spiked Grout T20

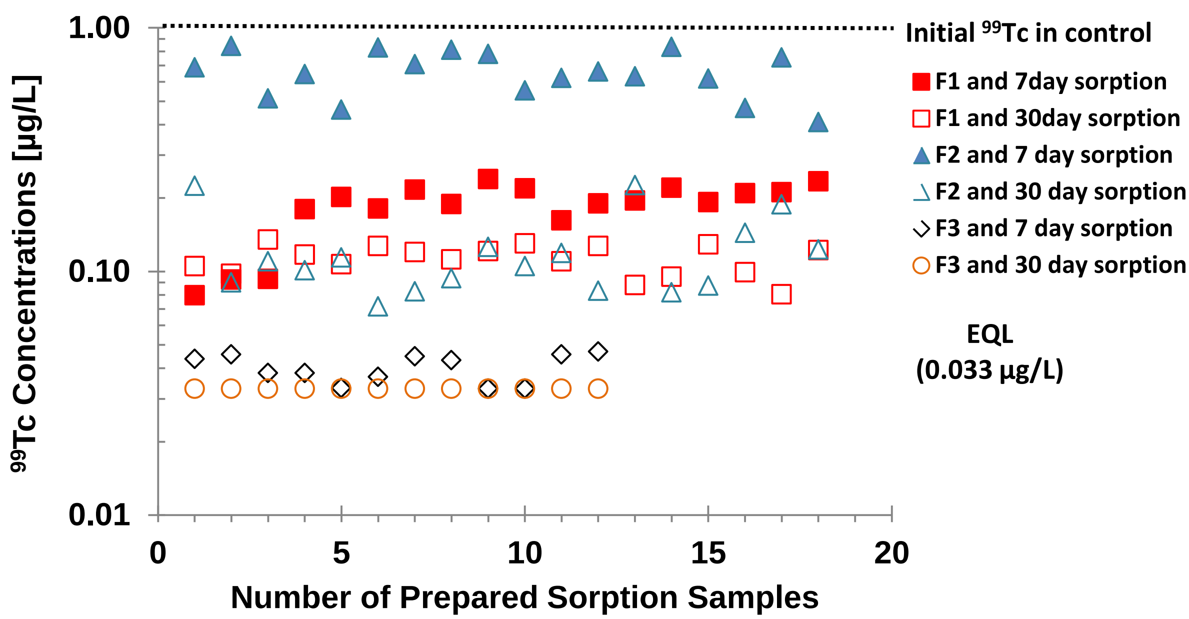


Figure 6.4. ^{99}Tc Concentrations in Final Sorption Supernatants as a Function of Size Fraction and Reaction Time using Crushed Non-^{99}Tc-Spiked Grout T21

Interestingly, ^{99}Tc sorption (or removal) by the crushed LSWG was high under the reducing condition, resulting in ^{99}Tc concentrations in the supernatants of T19 and T20 samples after 7 days sorption below the ^{99}Tc EQL value of the ICP-MS analysis. In the case of monoliths T19 and T20, only the F1 (0.3–2 mm) and F2 (5–20 mm) size fraction for 7-day sorption and part of F2 (5–20 mm) size fraction for 30-day sorption samples showed ^{99}Tc concentrations above the EQL value. All other ^{99}Tc sorption tests for T19 and T20 samples showed the measured ^{99}Tc concentrations in final supernatants below the EQL, including all F3 (<0.3 mm) size-fraction samples for 7- and 30-day sorption as well as F1 (0.3–2 mm) and F2 (5–20 mm) size-fraction samples for 30-day sorption (Figure 6.2 and Figure 6.3). Because of the very fine sized powders in the F3 size fraction (<0.3 mm), most of the initial ^{99}Tc was completely removed from solution by T19 and T20 samples even after the short 7-day sorption. However, for the largest size fraction, F2 (5–20 mm) most of the initial ^{99}Tc was removed from solution only after 30-day sorption, not 7-day sorption. In general, ^{99}Tc sorption on the T20 grout monolith sample was also higher than on the T19 sample, because of the different w/dm ratios (0.5 vs. 0.6) used to prepare T19 and T20, respectively. The higher w/dm ratio used for the T20 monolith resulted in a measured moisture content of T20 (29.7% in Table 6.1) higher than the MC for T19 (26.2% in Table 6.1), so monolith T20 could provide more internal pore openings for ^{99}Tc to pass easily through the large chunk samples in the F2 (5–20 mm) size fraction and react with more reactive internal sorption sites. In addition, a small amount of nitrite was added to prepare the WTP simulant (See Table 3.4) so that the higher w/dm ratio of 0.6 used for the T20 monolith might provide slightly more reducing conditions in internal pores of F2 chunk samples. For monolith T21, all the measured ^{99}Tc concentrations, even after 30-day sorption, were above the EQL value, except the sorption onto the F3 size fraction for 30-day sorption (Figure 6.4). Considering that the same initial ^{99}Tc concentration and similar pH and E_h conditions were used for ^{99}Tc sorption experiments, it is clear that T21 prepared with FA and Xypex showed less ^{99}Tc sorption than T19 and T20 LSWG samples prepared with HL.

The average distribution between $^{99}Tc(VII)$ and $^{99}Tc(IV)$ species in the control samples for 7 and 30 days sorption was 60:40 from the ^{99}Tc speciation tests. Both $^{99}TcO(OH)_2(aq)$ and $^{99}TcO(OH)_3^-$ can be present as $^{99}Tc(IV)$ aqueous species in reducing conditions. However, based on the thermodynamic data from the Organisation for Economic Co-operation and Development Nuclear Energy Agency (NEA) (Guillaumont et al. 2003), dissolved total $^{99}Tc(IV)$ speciation is 10^{-8} M, which is close to the ^{99}Tc initial concentration used for ^{99}Tc sorption experiments here (~1 µg/L). In addition, under the same reducing conditions ($E_h = -500$ mV), dissolved $^{99}Tc(IV)$ speciation is dominated by $^{99}TcO(OH)_2(aq)$ species at pH < 11 and $^{99}TcO(OH)_3^-$ species at pH > 11, respectively (Ochs et al. 2015).

Because of the low detectable ^{99}Tc concentrations (<EQL) in the sorption supernatants with the F3 (<0.3 mm) size fraction for the three grouts (T19, T20, and T21) for both 7- and 30-day sorption, ^{99}Tc speciation tests were not successful and did not provide credible information for ^{99}Tc speciation in these samples. For the F1 (0.3–2 mm) size fraction, only T21 grout supernatants for 7-day sorption yielded useful ^{99}Tc speciation data, showing an average 44% of $^{99}Tc(VII)$ in the supernatant. Other F1 (0.3–2 mm) size-fraction samples for the three grouts did not provide credible data for ^{99}Tc speciation because ^{99}Tc concentrations in their supernatants were below the EQL value. However, for the F2 (5–20 mm) size fraction of grout T19, the average $^{99}Tc(VII)$ species concentration was about 41% for 7-day sorption, while an average of 42% $^{99}Tc(VII)$ species was found for the 30-day sorption supernatant. Thus, this supernatant does not show any significant decrease in $^{99}Tc(VII)$ species content with increasing sorption reaction time. For the F2 (5–20 mm) size fraction of grout T20, an average 37% of $^{99}Tc(VII)$ species was found in both 7- and 30-day sorption samples. For F2 (5–20 mm) size fraction of grout T21, averages of 44% and 45% of $^{99}Tc(VII)$ species were found for 7-and 30-day sorption, respectively. Although ^{99}Tc speciation tests provided very limited credible data, the lowest content of $^{99}Tc(VII)$ species in the F2 (5–20 mm) size fraction of grout T20 (~37%) compared to those in grout T19 and T21 (41 to 45%) can be correlated with the highest ^{99}Tc sorption in grout T20 compared to T19 and T21, as shown in Figure 6.2–Figure 6.4. In addition, relatively lower $^{99}Tc(VII)$ species contents in sorption samples (37%

to 45%) compared to those of control samples (60%) are attributed to heterogeneous ^{99}Tc reduction in sorption samples because of the presence of additional solid reductant (BFS) in grout samples. Therefore, even though no $^{99}TcO_2(s)$ precipitate was found in the control samples because the solubility limit of $^{99}TcO_2(s)$ was not exceeded based on Equation (6.4) and the NEA database (Guillaumont et al. 2003), more reducing conditions were created in the sorption slurries. The more reducing conditions in the slurries might have lowered the solubility of $^{99}TcO_2(s)$, thus promoting ^{99}Tc removal from solution. However, because $^{99}TcO(OH)_3^-$ is dominant in ^{99}Tc(IV) aqueous species at alkaline pH (>11), the solubility of $TcO_2 \bullet 1.6H_2O(s)$ at pH = 12.0 and in reducing conditions can be estimated from Equation (6.4); the result is about 5.0×10^{-8} M, which is higher than the ^{99}Tc initial concentration (~10^{-8} M) used for ^{99}Tc sorption experiments under similar pH and E_h conditions. Thus if the thermodynamic data are correct our sorption supernatants did not have high enough ^{99}Tc concentrations to exceed the solubility limit for $TcO_2 \bullet 1.6H_2O(s)$ and it should not have been precipitated.

$$TcO_2 \bullet 1.6H_2O(s) + 0.4H_2O = TcO(OH)_3^- + H^+ \qquad \text{Log K } (=-19.3004 \text{ at } 25^oC) \qquad (6.4)$$

The calculated ^{99}Tc empirical sorption K_d values for the three non-^{99}Tc-spiked LSWG (T19, T20, and T21) at different size fractions for both 7 and 30 days sorption are shown in Figure 6.5. In cases where the measured aqueous ^{99}Tc concentration in the supernatants was below the EQL, the EQL value of 0.033 µg/L was used for the K_d calculation. For the fine powders F3 (< 0.3 mm) size fraction, the ^{99}Tc sorption seemed to reach equilibrium, at least in monoliths T19 and T20, after 30 days reaction. However, this cannot be confirmed because the aqueous ^{99}Tc concentrations in all F3 (< 0.3 mm) size-fraction samples for both 7- and 30-day reaction were below the EQL. For all three monolith samples, the difference in the calculated K_ds between 7- and 30-day sorption times increased with increasing sample size-fraction in the order F2 (5–20 mm) > F1 (0.3–2 mm) > F3 (< 0.3 mm) size fraction, indicating slow sorption kinetics were occurring for ^{99}Tc mass transfer in the largest size-fraction samples. Based on the K_d values of the F2 (5–20 mm) size fraction with 7-day sorption, where all the measured aqueous ^{99}Tc concentrations were above the EQL value in all three monoliths, the ^{99}Tc sorption K_d comparison between three monoliths also confirmed that the T21 sample prepared with FA and Xypex showed the lowest ^{99}Tc sorption compared to the other two monoliths (T19 and T20) prepared with HA. In general, the calculated ^{99}Tc sorption K_d values after 30-day reaction for all three LSWG are less than 310 mL/g in the reducing condition. It is also noteworthy that a higher solid-to-solution ratio (3 g/21 mL) was used to load as much ^{99}Tc on the solid for ^{99}Tc desorption K_d measurement.

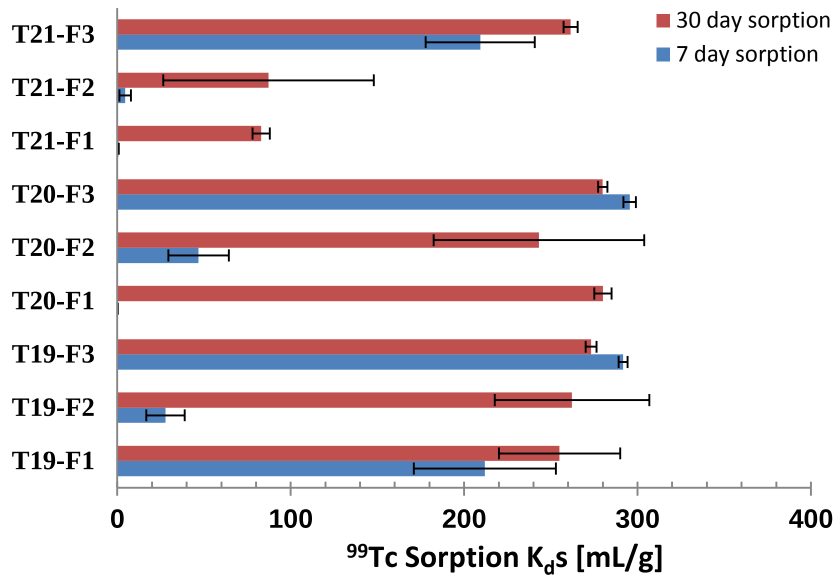


Figure 6.5. Calculated ^{99}Tc Empirical Sorption K_d Values as a Function of Size Fraction and Sorption Reaction Time using Three Non-^{99}Tc-Spiked Crushed LSWG Samples (T19, T20, and T21) with Uncertainties Determined by Standard Deviation of Triplicate Measurements.

6.2.2 ^{99}Tc Desorption K_ds using ^{99}Tc Sorbed Grout Monolith Samples

^{99}Tc desorption K_d measurements were conducted using the remaining wet slurry after the ^{99}Tc sorption phase of testing by refilling fresh 21 mL pre-equilibrated saturated $Ca(OH)_2$ solution into the same vials as used for ^{99}Tc sorption tests. The ^{99}Tc-laden LSWG slurries were available in both reducing and oxidizing conditions (slurries kept in the anoxic chamber and slurries on the bench-top open to air), respectively. The E_h and pH for each desorption tube was monitored at the end of desorption reactions using the supernatant solutions. High pH (~12.5) and low E_h (~−400 mV) conditions similar to those found in the previous sorption phase of testing were constantly maintained in all desorption samples inside the anoxic chamber. However, much higher E_h values (~+100 mV) with similar high pH values (~12) were found in the desorption samples outside the chamber, indicating that these desorption slurries were maintained under oxidizing conditions outside the chamber. The measured E_h and pH values for the final desorption supernatants of each crushed LSWG size fraction for both inside and outside the anoxic chamber conditions are listed in Appendix A.4.

The desorption test matrix and the cases in which the measured aqueous ^{99}Tc concentrations were below the ICP-MS EQL values are shown in Table 6.2. All the desorbed ^{99}Tc concentrations conducted in reducing conditions (inside the anoxic chamber) were below the ^{99}Tc EQL value. However, for all desorption experiments in oxidizing conditions (outside the chamber), the measured desorbed ^{99}Tc concentrations were above the EQL value, except for F1 (0.3–2 mm) size-fraction samples for T19 and T20 for the 7-day desorption and F3 (< 0.3 mm) size-fraction samples for T19 for the 7-day desorption due to relatively short desorption reaction time. It is clear that much more ^{99}Tc desorbed from the ^{99}Tc-sorbed solid phase into the aqueous solutions in the oxidizing condition.

Table 6.2. Desorption Test Matrix, Desorption ^{99}Tc K_ds, and ^{99}Tc Concentrations Measured Below the EQL (0.033µg/L) Value

Monolith and Size Fraction	Sorption Time (days)	Desorption Time (days)	Oxidizing (O) or Reducing (R) Conditions	Desorbed ^{99}Tc Concentrations Below (or Above) the EQL in Different Monoliths			Desorption ^{99}Tc K_d (mL/g)		
				T19 (µg/L)	T20 (µg/L)	T21 (µg/L)	T19	T20	T21
F1 (0.3–2 mm)	30	7	O	0.014 0.020 0.030	*0.034** 0.015 0.030	*0.047** *0.049** *0.041**	272±5.6	272±8.9	195±14
			R	0.005 0.004 0.002	0.003 0.003 0.006	0.014 0.008 0.009	280±0.9	276±7.6	269±5.9
		30	O	*0.128** *0.123** *0.109**	*0.099** *0.076** *0.050**	*0.103** *0.118** *0.110**	68.7±7.1	125±50	74.1±5.8
			R	0.003 0.001 0.002	0.006 0.001 0.002	0.002 0.005 0.010	270±3.4	272±4.0	273±5.5
F2 (5–20 mm)	30	7	O	0.351* 0.336* 0.273*	0.292* 0.218* 0.302*	0.294* 0.246* 0.263*	18.6±4.6	26.1±5.3	24.5±5.5
			R	0.004 0.005 0.006	0.005 0.008 0.009	0.022 0.010 0.009	263±9.0	280±9.5	279±6.5
		30	O	0.318* 0.399* 0.317*	0.225* 0.272* 0.225*	0.220* 0.253* 0.307*	17.2±3.8	29.8±3.9	27.8±5.2
			R	0.005 0.002 0.003	0.004 0.003 0.002	0.017 0.010 0.010	267±11	280±7.4	272±26
F3 (< 0.3 mm)	30	7	O	0.016 0.031	0.038* 0.040*	0.086* 0.092*	265±1.4	233±7.6	87.4±3.6
			R	0.002 0.003	0.003 0.005	0.004 0.004	262±0.1	270±2.3	255±2.2
		30	O	0.111* 0.149*	0.170* 0.124*	0.125* 0.143*	61.0±15	54.0±15	54.0±6.8
			R	0.002 0.001	0.002 0.003	0.003 0.001	260±1.4	271±1.1	250±1.2

* These values are higher than the EQL (0.033 µg/L).

Different ^{99}Tc desorption results from the three 30-day ^{99}Tc-sorbed grout samples (T19, T20, and T21) with three different grain size fractions (F1, F2, and F3) for two different desorption times (7 and 30 days) are shown in Figure 6.6. Both oxidizing (Figure 6.6a) and reducing (Figure 6.6b) conditions were used for the two ^{99}Tc desorption times. Desorption of ^{99}Tc for the two smaller size fractions, F1 (0.3–2 mm) and F3 (< 0.3 mm), showed decreasing ^{99}Tc desorption K_d values with increasing desorption times. Low ^{99}Tc desorption K_ds indicate less sorbed ^{99}Tc remaining on the solid, which means more ^{99}Tc concentration in solution after desorption. Because ^{99}Tc desorption did not reach equilibrium for these smaller size-fraction samples, additional data for the extended ^{99}Tc desorption are required to confirm that ^{99}Tc desorption is reached equilibrium before calculating ^{99}Tc desorption K_d values for these size fractions. However, there was no difference between ^{99}Tc desorption K_ds measured with largest 5–20 mm (F2) size fraction for 7 and 30 days desorption from a statistical point of view, because each averaged ^{99}Tc desorption K_d value for 7 or 30 days desorption was clearly within their standard deviation ranges (Figure 6.6a). Therefore, ^{99}Tc desorption for F2 (5–20 mm) size-fraction samples reached equilibrium after 7 days desorption. This results from a hysteresis process for molecule sorption and desorption on different size pores, consistent with faster sorption of ^{99}Tc on the finer size-fraction sorbent while ^{99}Tc desorbs faster from the larger size-fraction sorbent. Averaged ^{99}Tc desorption values for F2 (5–20 mm) size-fraction samples were calculated using ^{99}Tc desorption K_ds for both 7 and 30 days desorption, and the results show 17.8, 28.0, and 26.2 mL/g for LSWG T19, T20, and T21, respectively. The highest ^{99}Tc desorption K_d value was found for grout T20 compared to the others, T19 and T21.

For ^{99}Tc desorption in the reducing condition (Figure 6.6b), all the measured aqueous ^{99}Tc concentrations were below the EQL, thus the ^{99}Tc desorption K_ds were calculated using the EQL value (0.033 µg/L). Calculated ^{99}Tc desorption K_d values ranged between 250 and 280 mL/g under reducing conditions, which is similar to the ^{99}Tc sorption K_ds for 30 days in Figure 6.5 except for the F1 (0.3–2 mm) and F2 (5–20 mm) size fractions of grout T21 samples. The similar values for sorption and desorption K_ds indicate that ^{99}Tc release is not considered to be controlled by a desorption process in reducing conditions.

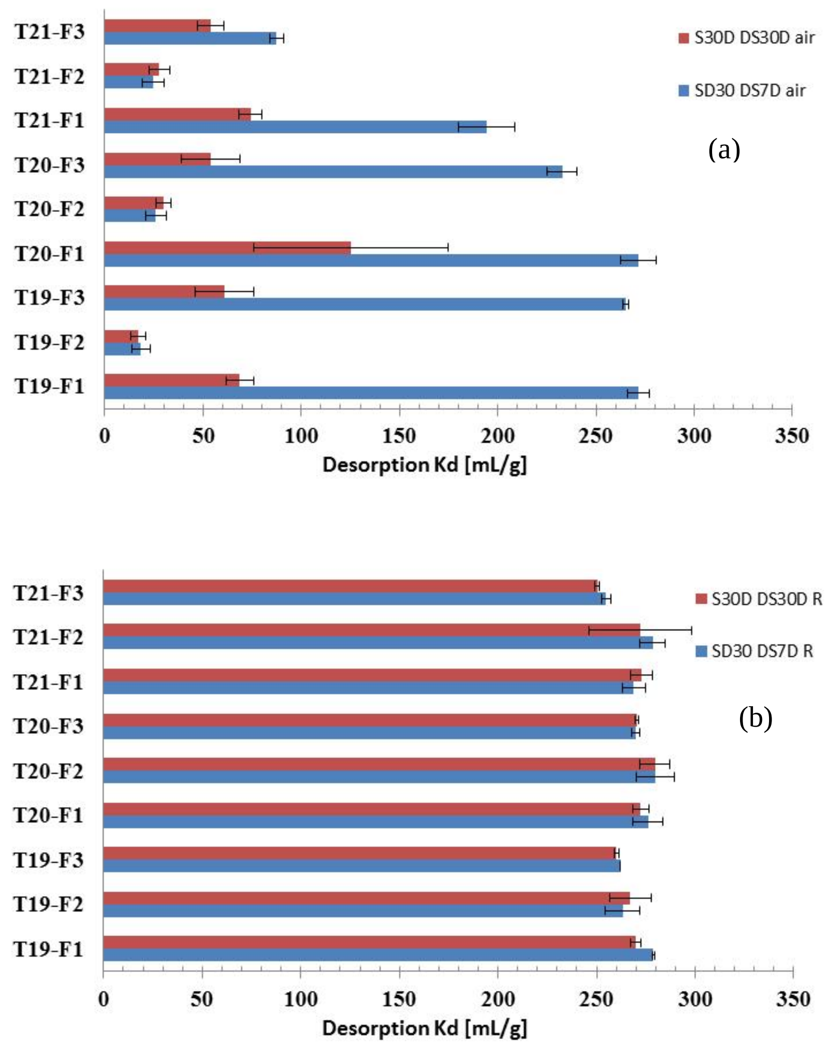


Figure 6.6. ^{99}Tc Desorption K_d Values Calculated for 7- and 30-Day Desorption Times Using 30-Day ^{99}Tc-Sorbed Grouts (T19, T20, and T21) with Different Size Fractions in Either Oxidizing (a) or Reducing (b) Conditions with Uncertainties Determined by Standard Deviation of Triplicate Measurements.

6.2.3 ^{99}Tc Desorption using ^{99}Tc-Spiked LSWG Samples

^{99}Tc desorption tests using three ^{99}Tc-spiked LSWG monoliths (T3, T6, and T11) were conducted for the three different size fractions both inside and outside an anoxic chamber to maintain reducing and oxidizing conditions, respectively. Unfortunately, only the F3 (<0.3 mm) size fraction was prepared for grout T3 and used for ^{99}Tc desorption experiments. The ^{99}Tc desorption K_d measurements were conducted using about 3.0 g (oven dry basis) of different size-fraction samples of each ^{99}Tc-spiked grout in contact with 21 mL of fresh pre-equilibrated saturated $Ca(OH)_2$ solution with the respective size fractions of each LSWG in the vials for 30- and 45-day desorption times. The final measured E_h and pH values for each size-fraction individual grouts' supernatants were similar to those found in previous ^{99}Tc desorption supernatants using ^{99}Tc-sorbed grouts (T19, T20, and T21). High pH (~12) and reducing conditions (E_h ~−450 mV) were maintained inside the anoxic chamber for all ^{99}Tc desorption samples throughout the desorption tests, while much higher E_h values (~130 mV) were found for all the samples outside the chamber indicating oxidizing conditions prevailed in tests conducted in air.

The calculated ^{99}Tc desorption K_d values for three ^{99}Tc-spiked grouts with three different grain size fractions for 30 and 45 days desorption are shown for oxidizing (Figure 6.7a) and reducing (Figure 6.7b) conditions. It is noteworthy to remember that these ^{99}Tc-spiked grout specimens were prepared with high ^{99}Tc initial concentration (~15 mg/L) in WTP off-gas simulant and stored about 3 months, including the original 28-day curing, before use for ^{99}Tc desorption tests. This high ^{99}Tc initial concentration should definitely exceed the solubility limit of ^{99}Tc(IV) precipitates within the internal pore water and form ^{99}Tc(IV) precipitates inside the grouts. Therefore, we anticipate that released ^{99}Tc from these ^{99}Tc-spiked crushed grout samples is controlled by solubility processes and not pure desorption processes even for those ^{99}Tc-spiked specimens placed under oxidizing conditions. That is ^{99}Tc release from the ^{99}Tc-spiked grouts likely did not result from desorption processes as with ^{99}Tc desorption K_ds found in Section 6.2.2. Because solubility- and/or diffusion-controlled ^{99}Tc releases may be controlling the ^{99}Tc desorption in the crushed ^{99}Tc-spiked samples, it is highly recommended to use these ^{99}Tc desorption K_ds only for qualitative comparison with previous ^{99}Tc desorption K_d values in Section 6.2.2.

For the ^{99}Tc desorption K_ds, from crushed LSWG grouts of compositions T3, T6, and T11, measured in oxidizing conditions, the K_d differences between 30- and 45-day desorption indicate that ^{99}Tc desorption did not reach equilibrium within the 45-day desorption time for the three different size-fraction samples (Figure 6.7a). In general, for all ^{99}Tc desorption samples except the largest 5-20 mm size fraction, the longer desorption time (45 days vs. 30 days) resulted in more ^{99}Tc being desorbed, so that lower ^{99}Tc desorption K_d values were determined. However, in the case of the 5-20 mm size-fraction samples, the opposite tendency, i.e., longer desorption time resulted in higher desorption K_ds in both T6 and T11 grout samples, which might result from diffusion process in the relatively large size chunk. The chemical gradient that is a driving force in the diffusion process is becoming less and less as the diffusion time increases, as found in previous EPA Method 1315 leaching tests. The other two, finer size-fraction (<0.3 mm and 0.3-2 mm), samples showed a much narrower range of ^{99}Tc desorption K_ds between 30- and 45-day desorption. The lowest ^{99}Tc desorption K_ds were determined for the smallest <0.3 mm size fraction, which was prepared as the finest powders (<0.3 mm); this is contrary to ^{99}Tc desorption results found in Section 6.2.2 and Figure 6.5a. The fact that the lowest ^{99}Tc desorption K_ds were determined for the smallest size fraction indicates that ^{99}Tc release was controlled by the solubility of ^{99}Tc(IV) precipitates. The average ^{99}Tc desorption K_ds for the F3 size fraction of each grout sample after 45-day desorption are 24.8, 49.5, and 30.61 mL/g for the grouts T3, T6, and T11, respectively, which are slightly higher than the ^{99}Tc desorption K_ds in Section 6.2.2., namely 17.8, 28.0, and 26.2 mL/g for the grouts T19, T20, and T21, respectively. This difference is attributed to the nonequilibrium ^{99}Tc desorption for the <0.3 mm size-fraction samples of T3, T6, and T11 grouts even after 45-day desorption.

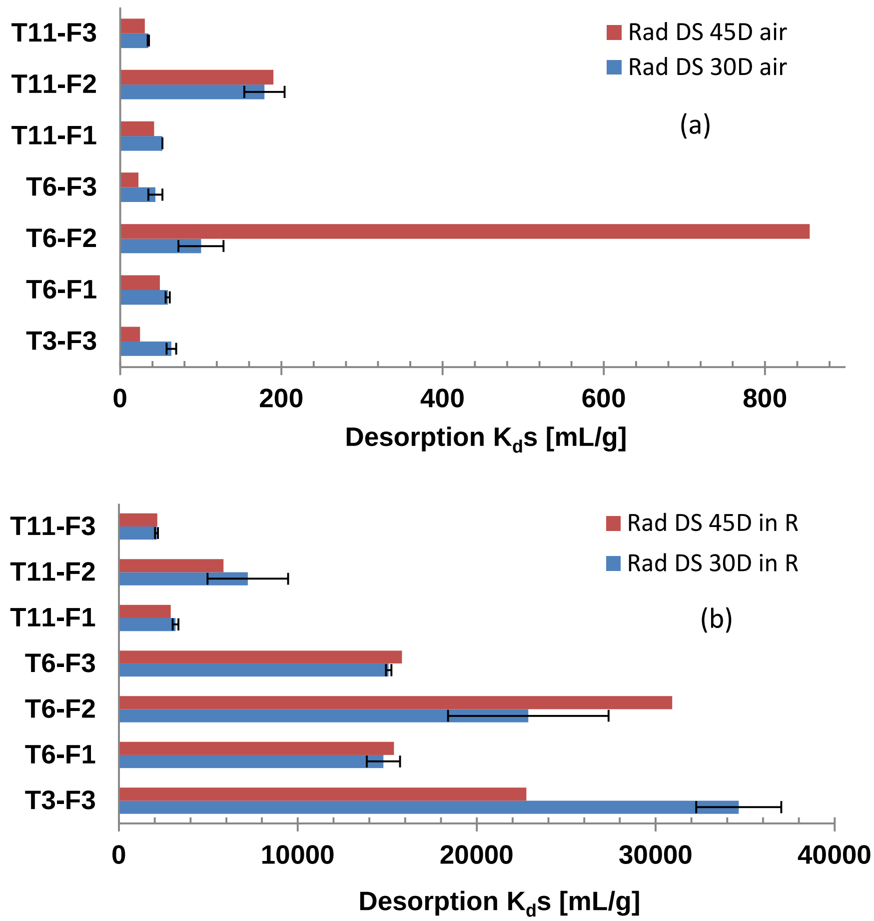


Figure 6.7. ^{99}Tc Desorption K_d Values Calculated for 30- and 45-Day Desorption Times Using ^{99}Tc-Spiked Grouts (T3, T6, and T11) with Different Size Fractions in Either Oxidizing (a) or Reducing (b) Conditions with Uncertainties Determined by Standard Deviation of Triplicate Measurements.

For ^{99}Tc desorption in reducing conditions, among the three radiological grout samples tested, T11 showed the lowest ^{99}Tc desorption K_d values for all three size fractions. However, the lowest ^{99}Tc desorption K_d values for the F3 (<0.3 mm) size fraction of grout T11 for 30- and 45-day desorption in reducing conditions were ~2,100 mL/g (Figure 6.7b), and still much higher than the ^{99}Tc desorption K_ds in oxidizing conditions (Figure 6.7a). Desorption of ^{99}Tc under reducing conditions showed much higher ^{99}Tc desorption K_d values by two orders of magnitude compared to those in oxidizing conditions, indicating the very low ^{99}Tc release potential from these grouts as long as reducing conditions are constantly maintained.

7.0 ^{99}Tc Solubility Measurements

This section presents the ^{99}Tc solubility (mol/L) determination using the method recommended by Estes et al. (2012) that uses crushed cementitious waste forms contacting simulated cement paste pore water that has been spiked with various concentrations of ^{99}Tc. The batch tests are performed under reducing conditions. For our LSWG ^{99}Tc solubility tests we used three non-^{99}Tc-spiked grout powder samples (T19, T20, and T21) with varied initial ^{99}Tc concentrations. The hypothesis of this method is the following: if the equilibrium aqueous ^{99}Tc concentration of the batch of crushed LSWG is controlled by the solubility of a ^{99}Tc(IV)-bearing solid phase, then the equilibrium aqueous concentration of ^{99}Tc should be similar among the tested grout monolith samples and be independent of the initial ^{99}Tc concentrations added to each batch system. The aqueous ^{99}Tc concentrations in the supernatants of three LSWG batch tests that started with different ^{99}Tc spiking levels are expected to converge to a single constant ^{99}Tc concentration in the supernatant solution kept under the reducing conditions at a fixed pH (Estes et al. 2012), which is the practical ^{99}Tc solubility with respect to individual grout chemistry.

7.1 Methods and Materials

7.1.1 Material Preparation

All ^{99}Tc batch solubility experiments were conducted in an anoxic chamber filled with a mixture of N_2 (98%) and H_2 (2%) gases, and with two palladium catalysts that convert O_2(g) to water via reaction with H_2(g). After 28-day curing, the three non-^{99}Tc-spiked LSWG monoliths T19, T20, and T21 were removed from their forms and particle size reduction was conducted by crushing and grinding the monoliths using chemically inert instruments inside the anoxic chamber, as described in Section 6.1.1.1. The size fraction of F1 (0.3–2 mm) was used for ^{99}Tc solubility measurement. The ^{99}Tc solubility tests were only conducted under reducing conditions inside the anoxic chamber using the pre-equilibrated $Ca(OH)_2$-saturated solution that was described in Section 6.1.1.2. Aliquots of this N_2-purged $Ca(OH)_2$-saturated solution were spiked with different concentrations of ^{99}Tc(VII).

7.1.2 ^{99}Tc Solubility Measurements

Three initial concentrations of 2.5, 10, and 25 µg/L (or ppb) ^{99}Tc(VII) were prepared by spiking the pre-equilibrated saturated $Ca(OH)_2$ solutions. A volume of 40 mL of each ^{99}Tc(VII)-spiked saturated $Ca(OH)_2$ solution was added into each crushed grout vial containing 1 g solid so that the solid-to-solution ratio was 1 g/40 mL in 50 mL centrifuge tubes. Triplicate reaction tubes for each crushed LSWG, each starting ^{99}Tc concentration, and each reaction time were prepared. In addition, triplicate control samples (three for each of the three initial ^{99}Tc concentrations, for a total of nine) consisting of 40 mL of the 2.5, 10, and 25 ppb ^{99}Tc(VII)-spiked $Ca(OH)_2$ in a 50 mL centrifuge tube were also reacted in parallel. Three different sorption reaction times, 14, 30, and 51 days were initially chosen to provide data. All the tubes were hand shaken (inside the anoxic chamber) daily in the first week and then 1–2 times per week thereafter. After each reaction time, the supernate solution was removed from the slurry after settling overnight using a pipette and then the supernatants were filtered using a 0.45 µm syringe filter. The solution final pH and E_h, ^{99}Tc total concentration, and different ^{99}Tc species concentrations in the filtered supernatants were determined using the same methods described in Section 6.1.1.2. By plotting aqueous total ^{99}Tc concentration vs. reaction times, an aqueous ^{99}Tc concentration plateau was expected, suggesting steady state condition with respect to ^{99}Tc partitioning has been reached. The samples initially receiving 2.5, 10, and 25 ppb total ^{99}Tc concentrations in the supernatants were expected to converge on a single concentration value, resulting in the solubility value of $^{99}Tc(IV)$−bearing solid phase as (mol/L).

7.2 Results and Discussion

The solubility of ^{99}Tc in the three non-^{99}Tc-spiked crushed LSWG (T19, T20, and T21) with the F1 (0.3–2 mm) size fraction test was conducted for 14, 30, and 51 days in reducing conditions inside the anoxic chamber. The measured average E_h and pH for each LSWG' supernatants were similar to those described in Section 6, and the values were ~12.5 for pH and ~−400 mV for E_h, indicating that reducing conditions prevailed due to the presence of BFS and H_2(2%) inside the chamber during the entire test duration.

The measured average aqueous ^{99}Tc concentrations in the supernatants from the crushed LSWG for different reaction times are shown in Figure 7.1. No precipitates or significant ^{99}Tc losses were observed in any of control samples prepared with initial spiked ^{99}Tc concentrations of 2.5, 10, and 25 µg/L inside the chamber. This demonstrates that the ^{99}Tc remained soluble over the entire course of the solubility experiments and reductive precipitation of $^{99}Tc(IV)$ did not occur, indicating the reducing conditions in the anoxic chamber were not sufficient to facilitate $^{99}Tc(IV)$ precipitation in the absence of additional reductant or reductant-bearing solids. Aqueous ^{99}Tc concentrations in all supernatants isolated from the crushed LSWG slurries decreased with increasing reaction times, and the difference of ^{99}Tc aqueous concentration between the three initial concentrations (2.5, 10, and 25 µg/L) also decreased with reaction time.

Up to 51 days reaction, the aqueous ^{99}Tc concentrations in all supernatants seemed to level off, despite the different initial ^{99}Tc concentrations of 2.5, 10, and 25 µg/L. For LSWG T19 batch slurries that started with ^{99}Tc aqueous concentrations of 2.5, 10, and 25 µg/L, the final ^{99}Tc aqueous concentrations in the remaining supernatants after 51-day were 0.10, 0.17, and 0.74 µg/L with an average value of 0.34 µg/L. Similar final supernatant values for grouts T20 and T21 were 0.10, 0.38, and 0.80 µg/L with an average value of 0.43 µg/L for T20 and 0.06, 0.37, and 1.10 µg/L with an average value of 0.51 µg/L for T21. It appears that the final supernatant ^{99}Tc concentrations converged on a single ^{99}Tc aqueous concentration with an average value of 0.34 µg/L (or 3.4×10^{-9} M), 0.43 µg/L (or 4.3×10^{-9} M), and 0.51 µg/L (or 5.1×10^{-9} M) for the three LSWGs, T19, T20, and T21, respectively, based on the samples reacted up to 51 days.

Because ^{99}Tc concentrations in all the supernatants converged on a similar single ^{99}Tc aqueous concentration despite the different initial ^{99}Tc concentrations and the type of grouts (Figure 7.1), the final aqueous ^{99}Tc concentration controlled by the solubility of $^{99}Tc(IV)$-bearing solid phase seems to be independent of the grout formulation even though the grout monolith T21 (35 wt% FA, 20 wt% OPC, and 45 wt% BFS dry ingredients) was prepared differently from the grouts T19 and T20 (20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients). However, the amount of BFS used in the three grouts is the same, 45 wt%, which controlled the solubility of $^{99}Tc(IV)$-bearing solid phases under reducing conditions. The overall average value of the solubility for $^{99}Tc(IV)$ bearing solid phase is about $4.3 \pm 3.8 \times 10^{-9}$ M, which agrees well with the study of Estes et al. (2012), who reported solubility values of 10^{-9} to 10^{-8} M for empirical solubility experiments, conducted under reducing conditions in an anoxic chamber with several different cementitious samples. However, it should be noted that in our empirical solubility tests full steady-state conditions had not yet been reached within 51 days. Therefore, data for at least one or two additional extended contact times should be collected in the near future to confirm that steady state is finally attained such that a more accurate estimation of the empirical solubility constant for $^{99}Tc(IV)$ solids under reducing conditions can be measured. Figure 7.1 shows the ^{99}Tc concentrations in the supernatants from the three crushed LSWG empirical solubility tests conducted in an anoxic chamber as a function of contact time and initial ^{99}Tc concentrations spiked into N_2-purged $Ca(OH)_2$-saturated solution that had been pre-equilibrated with the corresponding crushed grout. We should check whether the supernatant ^{99}Tc concentrations have reached a constant value after 51-day contact with additional data from longer reactions, and the data will be updated.

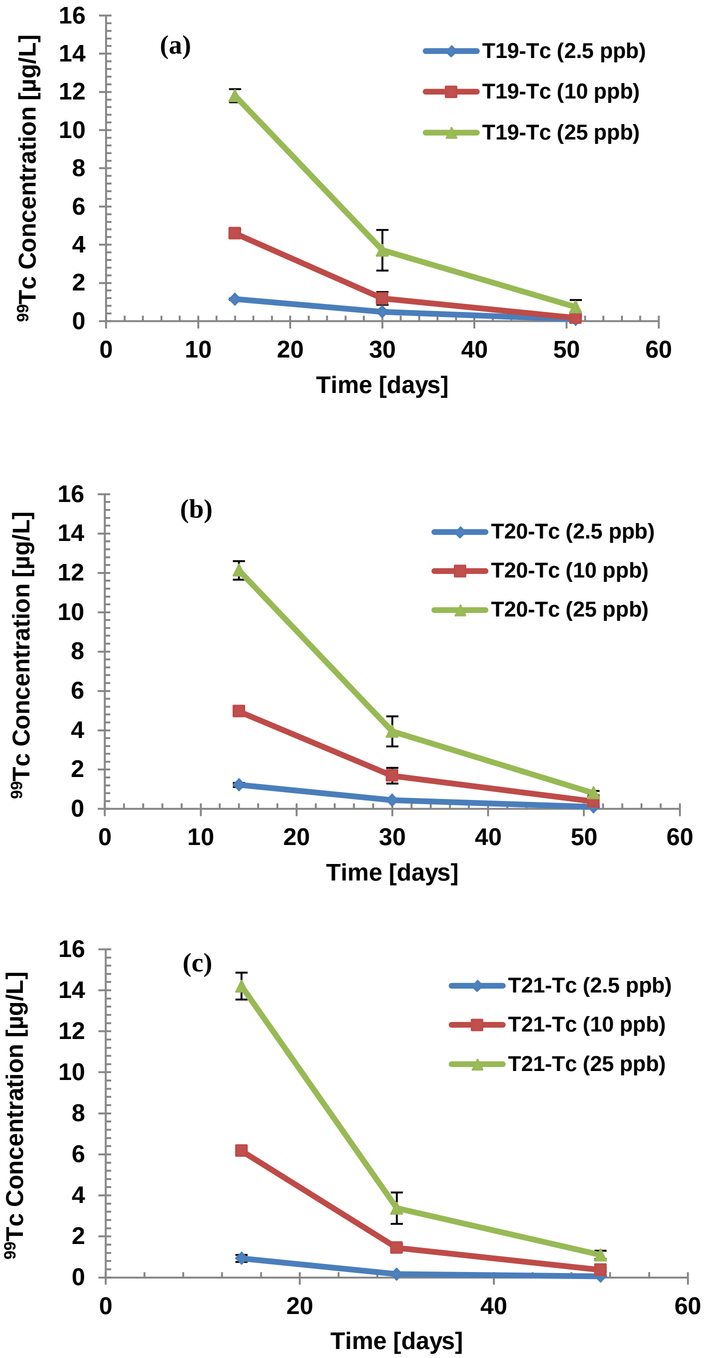


Figure 7.1. Measured Average Aqueous ^{99}Tc Concentrations for Different Sorption Reaction Times using Three Grout Samples T19, T20, and T21. The blue, red, and green symbols indicate sorption reactors spiked with initial ^{99}Tc concentration of 2.5, 10, and 25 µg/L, respectively. The error bars were determined by standard deviation of triplicate measurements.

8.0 Summary and Recommendations

This section summarizes the key conclusions from each activity performed to date in the LSWG formulation and testing project and some recommendations for further testing that will be needed to provide additional information for LSWG waste form development and the IDF PA. Subtasks of LSWG formulation and testing project performed in FY 2015 include

1. new formulation of LSWG waste form for high-sulfate waste simulants
2. solid characterization of the cured LSWG waste form
3. EPA Method 1313 leaching test for ^{99}Tc leachability as a function of pH
4. EPA Method 1315 leaching test for determination of effective diffusivity (and LI) values for ^{99}Tc in both DIW and VZPW leaching solutions
5. ^{99}Tc desorption K_d measurements in oxidizing conditions
6. ^{99}Tc empirical solubility measurements in reducing conditions.

8.1 Conclusions

New formulations for LSW waste forms were developed by using hydrated lime (HL) instead of fly ash (FA). The new HL-based formulation was tested for three LSW simulants (242-A evaporator condensate, ERDF leachate, and WTP off-gas condensate after treatment in the ETF). Addition of HL was used to provide enough Ca^{2+} source to form ettringite mineral during the early stage of the curing, preventing late-stage ettringite formation that can cause severe cracks or fractures in hardened cementitious waste forms. A total of 18 LSWG formulations spiked with ^{99}Tc were prepared to observe the effects of different w/dm ratios (0.5 vs. 0.6), different formulations of dry ingredients with addition of HL instead of FA, different amounts of FA, OPC, and BFS dry ingredients, and presence of the admixture (Xypex) and ^{99}Tc getters (Sn-treated apatite and $SnCl_2$). Additional grout monoliths based on the current Cast Stone formulation (8 wt% OPC, 45 wt% FA, and 47 wt% BFS dry ingredients) were prepared at a w/dm ratio of 0.6 for WTP simulant and used for ^{99}Tc leachability and other measurements for comparison to the new formulations featuring HL replacing FA. Three sets of non-^{99}Tc-spiked LSWG monoliths (T19, T20, and T21) were also prepared with the same formulation as ^{99}Tc-spiked grout monoliths (T3, T6, and T11) using WTP off-gas condensate waste simulant. These non-^{99}Tc-spiked LSWG were used for ^{99}Tc sorption/desorption and empirical ^{99}Tc solubility testings. Production of monoliths with the addition of a water-reducing agent was successful using a procedure developed at PNNL, and the 28-day cured grout monoliths did not show any free water or noticeable defects.

Solid phase characterization of the cured grout monoliths showed ettringite mineral formation as a major mineral phase in all the cured LSW grout monoliths. Ettringite content ranged from 9 to 19 wt%; the highest ettringite content was found in the LSWG monolith (T15) prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS at 0.5 w/dm ratio with WTP simulant and Sn-treated apatite getter. Interestingly, all the new LSWGs prepared with HL (20 wt%) formed both ettringite and portlandite, $Ca(OH)_2(s)$, even if their contents varied slightly depending on w/dm ratio and the type of simulant used. However, the four formulations prepared with FA instead of HA (T11, T12, T13, and T21) formed ettringite (12 to 15%) but not portlandite. Because portlandite forms from tricalcium silicates (Ca_3S) and, to a lesser extent from dicalcium silicate (Ca_2S), through cement hydration reactions, lack of portlandite formation in monoliths prepared without HL is attributed to insufficient Ca^{2+} source during the curing. Otherwise, portlandite formed through cement hydration can be quickly consumed to provide additional C-S-H phase with mineral admixtures; as much as 75 to 82% of amorphous C-S-H phase was found in grout monoliths prepared with FA and BFS. The grout monoliths that lack portlandite will be more vulnerable to chemical attack and carbonation reactions, because portlandite is believed to protect the C-S-H phase (Taylor, 1977; Kutchko et al, 2007) from rapid weathering. Without portlandite, Ca^{2+} could be directly released from the C-S-H phase during carbonation, which increases the potential for mechanical degradation of the grout matrix with increasing weathering. In addition, because portlandite plays a role in limiting the amount of shrinkage that occurs when the grout monolith is dried, the new formulation of grout monolith using HL can provide a more durable and less permeable waste form for burial in the IDF in which unsaturated conditions prevail.

The three crushed ^{99}Tc-spiked grout monoliths (T3, T6, and T11) subjected to EPA Method 1313 leaching tests showed that ^{99}Tc releases increased as pH increased, because of lower anionic sorption onto the LSWG surfaces at higher pH. In general, the highest ^{99}Tc releases were found from the grout T11 prepared with no HL (20 wt% OPC, 35 wt% FA, and 45 wt% BFS) compared to the other two grouts (T3 and T6 prepared with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS). The T3 and T6 grouts showed similar amounts of ^{99}Tc release at higher pH (>~9.5), while the T3 grout displayed the lowest ^{99}Tc release at pH below 9.5. Lower ^{99}Tc release from the T3 grout at low pH (<9.5) than release from the T6 grout is attributed to lower ^{99}Tc initial concentration in the grout T3 because of the lower 0.5 w/dm ratio than the 0.6 w/dm used for the grout T6. Over the range of pH from 3 to 13, about 4 to 15% of the total ^{99}Tc leached from the T3 grout, while 9 to 14% of the total ^{99}Tc leached from the T6 grout and 17–30% of the total ^{99}Tc leached from the T11 grout. The new formulation of LSWG with HL and 0.5 w/dm ratio resulted in the lowest ^{99}Tc release.

The EPA Method 1315 leach tests on 18 ^{99}Tc-spiked LSWG monoliths prepared with different formulations and simulants with two different w/dm ratios were performed for extended times (up to 140 days). The leach results showed that the ^{99}Tc diffusivity for the grout monoliths followed a trend of slow decreases in ^{99}Tc diffusivity with time up to 28-day leaching, but almost constant ^{99}Tc diffusivities were obtained from 28- to 140-days of leaching. The new formulation for LSWG waste forms using HL (20 wt%) showed lower ^{99}Tc D_{eff} and higher LI values than the current Cast Stone formulation. The grout monolith (T13) prepared with the current Cast Stone formulation (45 wt% FA, 8 wt% OPC, and 47 wt% BFS dry ingredients) at 0.6 w/dm ratio for WTP off-gas condensate simulant showed the highest ^{99}Tc D_{eff} values for the cumulative 140-day leaching in both DIW and VZPW leaching solutions among the 18 grout monoliths tested. The ^{99}Tc releases from the FA-based current Cast Stone grout (T13) were controlled by diffusion, showing a good linearity and a slope of 0.4, which is within acceptable limits for the EPA 1315 method (a slope of 0.5 ± 0.15). The cumulative releases of mobile NO_3^- and Na^+ also showed a good linearity. However, the release of ^{99}Tc from most of the HL-based grouts did not follow a pure diffusion trend. Initial ^{99}Tc releases up to 7 (or 14) days leaching followed diffusion-controlled ^{99}Tc releases and ^{99}Tc releases after 14 (or 28) days leaching was linear with slope lower than 0.5, which suggests that additional effects from the physical and/or chemical processes retarded ^{99}Tc releases during these relatively later leaching periods. The average ^{99}Tc D_{eff} value of the T13 grout monolith from 28-day to 140-day leaching intervals in DIW leaching solutions is $10^{-10.8}$ cm^2/s, higher than $10^{-11.7}$ cm^2/s value determined from the grout monolith (T6) prepared with HL addition under the same formulation conditions. LSWG monoliths T1 to T3 and T7 made with HL at low w/dm ratio (0.5) showed lower ^{99}Tc D_{eff} values than comparable LSWG monoliths (T3 to T6 and T8) made with 0.6 w/dm ratio. The average

^{99}Tc D_{eff} values (over intervals 28-day to 140-day cumulative leach times) for the eleven monoliths (T1 through T8, and T14 to T16) made with 20 wt % HL, 35 wt% OPC, and 45 wt% BFS are generally lower than or equal to $10^{-12.0}$ cm^2/s both in DIW and VZPW leaching solution. The grout monoliths prepared with Xypex or both ^{99}Tc getter and Xypex did not show any significant decrease (or improvement) of ^{99}Tc D_{eff} values compared to the grout monoliths prepared with no Xypex and/or ^{99}Tc getters. For VZPW leaching solution, ^{99}Tc D_{eff} values from the grout monoliths T17 and T18 are similar to or slightly lower than that ($10^{-14.3}$ cm^2/s) of the grout monolith T10, but this small difference may be from an additional effect of secondary precipitates found on the outer surfaces of monoliths leached in VZPW solution for an extended time. The new LSW grout dry blend formulations using HL, (20 wt% HL, 35 wt% OPC, and 45 wt% BFS) or (20 wt% HL, 10 wt% OPC, and 70 wt% BFS), even without getter or Xypex addition, are good enough to limit ^{99}Tc diffusivity to below $10^{-12.0}$ cm^2/s in both DIW and VZPW solutions.

^{99}Tc desorption K_ds were determined using three 30-day ^{99}Tc-laden crushed grout monoliths (T19, T20, and T21) with different size fractions (<0.3 mm, 0.3-2 mm, and 5-20 mm). Initial ^{99}Tc sorption was conducted inside an anoxic chamber to maintain reducing conditions, with an initial ^{99}Tc concentration of 1.0 µg/L and a solid-to-solution ratio of 3 g/21 mL. After ^{99}Tc sorption, these crushed grouts were subjected to desorption experiments conducted both inside and outside the anoxic chamber to maintain reducing and oxidizing conditions, respectively. Desorption of ^{99}Tc from the two smaller size fractions under oxidizing conditions showed decreasing ^{99}Tc desorption K_d values with increasing desorption times (i.e., more ^{99}Tc releases from the crushed grout with time). However, because desorption reached steady state for the 5–20 mm size-fraction samples after 7-day desorption in oxidizing conditions, there was no difference in the measured ^{99}Tc desorption K_d values between 7 and 30 days desorption. Average ^{99}Tc desorption values for the 5-20 mm size-fraction samples were calculated using ^{99}Tc desorption K_ds for both 7 and 30 days desorption, and the results were 17.8, 28.0, and 26.2 mL/g for the grouts T19, T20, and T21, respectively. The single average value for ^{99}Tc desorption K_d in oxidizing conditions (E_h > +100 mV) is 24±5.4 mL/g. However, these ^{99}Tc desorption K_d values should be used with care because the BFS in the grout might still have some reductive capacity.

^{99}Tc solubility measurements were conducted inside an anoxic chamber using non-^{99}Tc-spiked crushed LSWG (0.3-2 mm size fraction) with three different initial ^{99}Tc concentrations (2.5, 10, and 25 µg/L). The results showed that the aqueous ^{99}Tc concentration of each sample decreased with increasing reaction times for all ^{99}Tc solubility samples. In addition, the difference in ^{99}Tc aqueous concentration between supernatants obtained from the slurries and individual initial control samples decreased with reaction time. After 51 days of reaction, the aqueous ^{99}Tc concentrations in all samples seemed to level off, despite the different initial ^{99}Tc concentrations of 2.5, 10, and 25 µg/L. For T19 supernatants, corresponding to the three different initial ^{99}Tc aqueous concentrations (2.5, 10, and 25 µg/L), the final ^{99}Tc aqueous concentration remaining in the supernatants after the 51-day reaction were 0.10, 0.17, and 0.74 µg/L, with an average value of 0.34 µg/L. The same final supernatants ^{99}Tc values for the grouts T20 and T21 were as follows: 0.10, 0.38, and 0.80 µg/L with an average value of 0.43 µg/L for T20, and 0.06, 0.37, and 1.10 µg/L with an average value of 0.51 µg/L for T21. Because the amount of BFS used in the three grouts is the same at 45 wt% and BFS controls the solubility of ^{99}Tc(IV)-bearing solid phases under reducing conditions, the overall single average value for the solubility for the ^{99}Tc(IV)-bearing solid phase is estimated to be $4.3 \pm 3.8 \times 10^{-9}$ M (or 0.42 ± 0.37 µg/L) based on 51 days of testing. However, 51 days reaction was not enough to reach steady state condition and additional data beyond 51 days reaction will be provided to confirm steady-state conditions and update the ^{99}Tc solubility values under reducing conditions.

A summary of the suggested values for IDF PA modeling is provided in Table 8.1 below. However, these values are dependent on the specific conditions where the values were measured, and more data with longer reaction times and additional testing will be provided to update these values.

Table 8.1. Summary of the Measured ^{99}Tc D_{eff}, Desorption ^{99}Tc K_ds, and ^{99}Tc Solubility Values

Experiments and Conditions	^{99}Tc D_{eff} DIW or VZPW (100% saturation)	Desorption ^{99}Tc K_d in oxidizing conditions (E_h > +100 mV and pH ~ 12)	^{99}Tc Solubility in reducing conditions (E_h = −400 mV and pH ~ 12)
Suggested Values	$10^{-12.5 \pm 1.0}$ cm^2/s	24 ± 5.4 mL/g	0.42 ± 0.37 µg/L (or $4.3 \pm 3.8 \times 10^{-9}$ M)

8.2 Recommendations

The results obtained in this task help fill existing data gaps and should support final selection of a LSWG waste form. Recommendations for additional studies to provide even more technical defensibility for long-term waste form performance are listed below:

1. The new formulation with HL addition should replace the Cast Stone formulation for sulfate-rich LSW streams. Both new formulations with 20 wt% HL, 35 wt% OPC, and 45 wt% BFS dry ingredients and 20 wt% HL, 10 wt% OPC, and 70 wt% BFS dry ingredients will work well with a 0.5 w/dm ratio.
2. For future IDF PA predictive modeling, the conservative average values for ^{99}Tc leachability determined from 28-day to 140-day leaching intervals of the EPA 1315 method are limited to 100% saturation condition and should be used with care because the IDF is in an unsaturated environment. Additional tests for ^{99}Tc D_{eff} values with varying saturation levels are needed to provide more reliable ^{99}Tc D_{eff} values for unsaturated conditions.
3. The extended LSWG leach tests, including post-leaching solid phase characterization, should be conducted to confirm the values suggested in this report. Additional tasks should include varying the curing times and detailed mineralogical solid-phase characterization as a function of curing time and leaching times to provide information for evaluating different mechanisms that might be controlling ^{99}Tc releases from the HL-based grout. Our key interest is in evaluating the possibility that ^{99}Tc is being sequestered by ettringite and/or a transformation process from portlandite during a later leaching time.
4. The HL-based formulations of LSWG should be tested for new secondary waste simulants with different chemical compositions and/or at production scale. Additional physical parameters such as porosity, hydraulic conductivity, and the relation between permeability and saturation levels should be measured for the HL-based grouts to provide more reliable data for the IDF PA modeling.
5. Additional long-term ^{99}Tc speciation and oxidation-state investigations should be conducted with macroscopic and spectroscopic techniques to monitor ^{99}Tc oxidation evolution in the grout waste form as a function of accelerated weathering and longer leaching times. Because re-oxidation of ^{99}Tc(IV) species occurs when the waste form is exposed to atmospheric oxygen, a predictive model for changes in the ^{99}Tc oxidation state and ^{99}Tc diffusivity as a function of aging and weathering processes in the grout with known information on the rate of oxygen ingress should be developed for

the new LSWG formulations so that more technically defensible long-term PA predictive modeling can be performed for LSWG waste forms to be disposed of in the IDF repository.

6. The reductive capacity and sulfide chemistry changes for BFS should be better understood in the LSWG to estimate the upper bound reductive capacity of BFS or the LSWG waste form itself when exposed to air. Residual reductive capacity as well as Fe and S species should be measured after varying accelerated weathering exposures using carbonation and oxygenation treatments. The kinetics of how soon the BFS loses total reductive capacity because of O_2(g) diffusion is a key data gap that needs to be addressed.

7. More scientific studies of pore structure and permeability changes in the LSWG before and after carbonation reactions, and the relationship of the pore structure changes with permeability changes should be conducted to develop a predictive model for ^{99}Tc leachability variations caused by pore structure changes due to physicochemical reactions. Longer-term carbonation investigations are also required to evaluate the overall effects on the grout physical properties.

9.0 References

40 CFR 268. 2015. “Land Disposal Restrictions.” Code of Federal Regulations, U.S. Environmental Protection Agency.

Almond PM, DI Kaplan, and EP Shine. 2012. *Variability of K_d Values in Cementitious Materials and Sediments*. SRNL-STI-2011-00672, Savannah River National Laboratory, Aiken, South Carolina.

ANSI/ANS – American National Standards Institute/American Nuclear Society. 2003. *Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure*. ANSI/ANS-16.1, La Grange Park, Illinois.

ASME – American Society of Mechanical Engineers. 2000. *Quality Assurance Requirements for Nuclear Facility Applications*. ASME-NQA-1-2000. New York, NY.

ASTM C-989/C989M-14. 2014. *Standard Specification for Slag Cement for Use in Concrete and Mortars*. ASTM International, West Conshohocken, PA.

ASTM D1426-08. 2008. *Standard Test Methods for Ammonia Nitrogen in Water*. ASTM International, West Conshohocken, Pennsylvania.

Boggs MA, W Dong, B Du, and NA Wall. 2010. “Complexation of Tc(IV) with Acetate at Varying Ionic Strengths.” *Radiochimica Acta* 98:583–587.

Burbank DA. 2002. *Waste Acceptance Criteria for the Immobilized Low-Activity Waste Disposal Facility*. RPP-8402, Rev.0, CH2M Hill Hanford Group, Richland, Washington.

Cooke GA, LL Lockrem, M Avila, and RA Westberg. 2006. *Effluent Treatment Facility Waste Stream Monolith Testing Phase II*. RPP-RPT-31077, CH2M Hill Hanford Group, Richland, Washington.

Cozzi AD, KM Fox, EK Hansen, and KA Roberts. 2015. *Supplemental Immobilization of Hanford Low-Activity Waste: Cast Stone Augmented Formulation Matrix Tests*. SRNL-STI-2014-00619, Rev.0. Accessed December 8, 2015 at http://sti.srs.gov/fulltext/SRNL-STI-2014-00619.pdf.

DOE – U.S. Department of Energy. 2012. *Annual Summary of the Integrated Disposal Facility Performance Assessment 2012*, DOE/RL-2012-57 Rev.0, U.S. DOE, Richland, Richland, Washington.

EPA – U.S. Environmental Protection Agency. 1992. *Toxicity Characteristic Leaching Procedure*. EPA Method 1311, Revision 0, U.S. Environmental Protection Agency, Washington, D.C.

EPA – U.S. Environmental Protection Agency. 2012. “Method 1313, Revision 0 – Liquid-Solid Partitioning as a Function of Eluate pH using a Parallel Batch Procedure.” In *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. EPA SW-846, U.S. Environmental Protection Agency, Washington, D.C.

EPA – U.S. Environmental Protection Agency. 2013. *Method 1315, Revision 0 – Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure*. U.S. Environmental Protection Agency, Washington, D.C.

Estes SL, DI Kaplan, and BA Powell. 2012. *Technetium Sorption by Cementitious Materials Under Reducing Conditions*. SRNL-STI-2012-00596. Savannah River National Laboratory, Aiken, South Carolina.

Grathwohl P. *Diffusion in Natural Porous Media: Contaminant Transport, Sorption/desorption and Dissolution Kinetics*. Kluwer Academic Publishers, 1998, ISBN 0-7923-8102-5.

Guillaumont R, T Fanghänel, J Fuger, I Grenthe, V Neck, DA Palmer, and MH Rand. 2003. *Update on the Chemical Thermodynamics of Uranium, Neptunium, Plutonium, Americium and Technetium.* Elsevier International Publishing.

Halgren DL. 2012. *200 Area Effluent Treatment Facility Basin 43 2012 Campaign Process Control Plan*. CHPRC-01871, Revision 1, CH2MHill Plateau Remediation Company, Richland, Washington.

Halgren DL. 2013. *200 Area Effluent Treatment Facility Basin 42 Campaign 2013 Process Control Plan*. CHPRC-02039, Revision 0, CH2MHill Plateau Remediation Company, Richland, Washington.

Kaplan DI. 2010. *Geochemical Data Package for Performance Assessment Calculations Related to the Savannah River Site*. SRNL-STI-2009-00473, Savannah River National Laboratory, Aiken, South Carolina.

Kutchko B, B Strazisar, GV Lowry, DA Dzombak, and N Thaulow. 2007. "Degradation of well cement by CO_2 under geologic sequestration conditions." *Environmental Science & Technology* 41:4787–4792.

Lockrem LL. 2005. *Hanford Containerized Cast Stone Facility Task 1 – Process Testing and Development Final Report*. RPP-RPT-26742, Revision 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

Mahoney J. 2015. E-mail message from J. Mahoney (Washington River Protection Solutions) to Renee Russell and Wooyong Um (Pacific Northwest National Laboratory), "EMF Brine Simulant and Hazardous Constituent Information," March 3, 2015.

Manahan SE. 1994. *Environmental Chemistry.6th Eds.* Lewis Publishers.

Mattigod SV, JH Westsik, Jr, CW Chung, MJ Lindberg, and KE Parker. 2011. *Waste Acceptance Testing of Secondary Waste Forms: Cast Stone, Ceramicrete and DuraLith*. PNNL-20632, Pacific Northwest National Laboratory, Richland, Washington.

Ochs M, D Mallants, and L Wang. 2015. *Radionuclide and Metal Sorption on Cement and Concrete*. Springer International Publishing.

PNNL, 2008. *Inorganic Quality Control Document*, http://geosciences.pnnl.gov/docs/conducting-work/ex8.stm, Pacific Northwest National Laboratory, Richland, Washington.

Qafoku NP, JJ Neeway, AR Lawter, TG Levitskaia, RJ Serne, JH Westsik, Jr., and MM Valenta Snyder. 2014. *Technetium and Iodine Getters to Improve Cast Stone Performance.* PNNL-23282, Pacific Northwest National Laboratory, Richland, Washington.

Russell RL, JH Westsik, Jr., DE Rinehart, DJ Swanberg, and J Mahoney. 2015. *Secondary Waste Simulant Development for Cast Stone Formulation Testing*. PNNL-24195; RPT-SWCS-003, Rev. 0. Pacific Northwest National Laboratory, Richland, Washington.

Serne RJ, JH Westsik, Jr., BD Williams, HB Jung, and G Wang. 2015. *Extended Leach Testing of Simulated LAW Cast Stone Monoliths.* PNNL-24297, Pacific Northwest National Laboratory, Richland, Washington.

Sundaram SK, CW Chung, KE Parker, ML Kimura, MM Valenta, CA Burns, SG Pitman, W Um, J Chun, and JH Westsik, Jr. 2011. *Secondary Waste Form Development and Optimization—Cast Stone*. PNNL-20159 Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

Taylor HFW. 1997. *Cement Chemistry*. Second Edition. Thomas Telford Publishing, London. p. 459.

Um W, RJ Serne, MM Valenta, KE Parker, C-W Chung, G Wang, JS Yang, KJ Cantrell, MH Engelhard, and JH Westsik, Jr. 2011. *Radionuclide Retention Mechanisms in Secondary Waste-Form Testing: Phase II*, PNNL-20753, Pacific Northwest National Laboratory, Richland, WA.

Um W, J-S Yang, RJ Serne, and JH Westsik Jr. 2015. "Reductive Capacity Measurement of Waste Forms for Secondary Radioactive Wastes." *Journal of Nuclear Materials* 467:251–259.

USGS – U.S. Geological Survey. 2004. "Alkalinity and Acid Neutralizing Capacity." In: *National Field Manual for the Collection of Water-Quality Data*, Second Edition. SA Rounds and FD Wilde, Editors. Accessed December 8, 2015 at http://water.usgs.gov/owq/FieldManual/Chapter6/section6.6/html/section6.6.htm.

Westsik, Jr. JH, GF Piepel, MJ Lindberg, PG Heasler, TM Mercier, RL Russell, AD Cozzi, WE Daniel RE Eibling, EK Hansen, MM Reigel, and DJ Swanberg. 2013. *Supplemental Immobilization of Hanford Low-Activity Waste: Cast Stone Screening Tests*. PNNL-22747, Pacific Northwest National Laboratory, Richland, Washington. SRNL-STI-2013, Savannah River National Laboratory, Aiken, South Carolina.

Appendix A

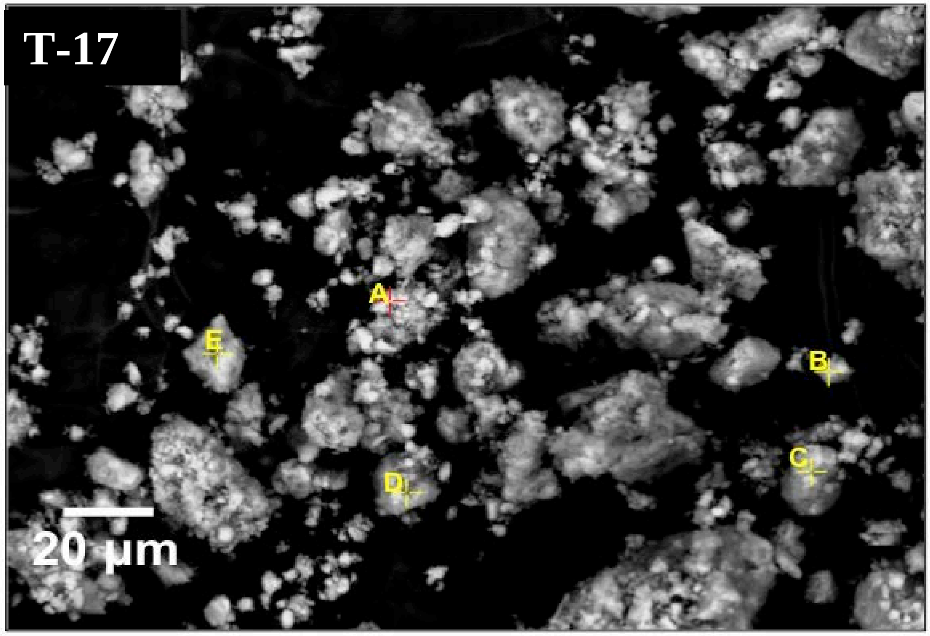
Additional Data

Appendix A

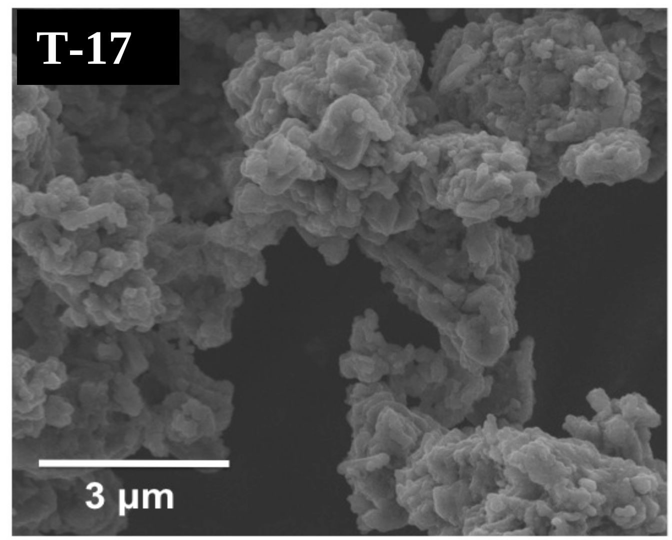
Additional Data

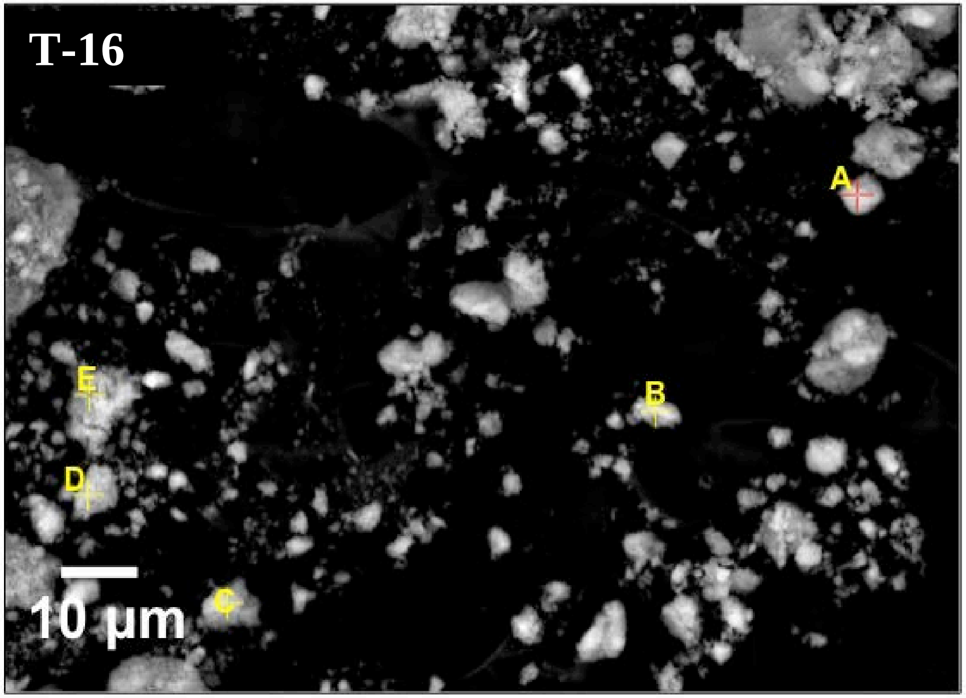
A.1 Additional SEM/EDS Data for the Selected Liquid Secondary Waste Grout Samples (T1, T2, T4, T6, T7, T8, T9, T11, T16, and T17)

A.2

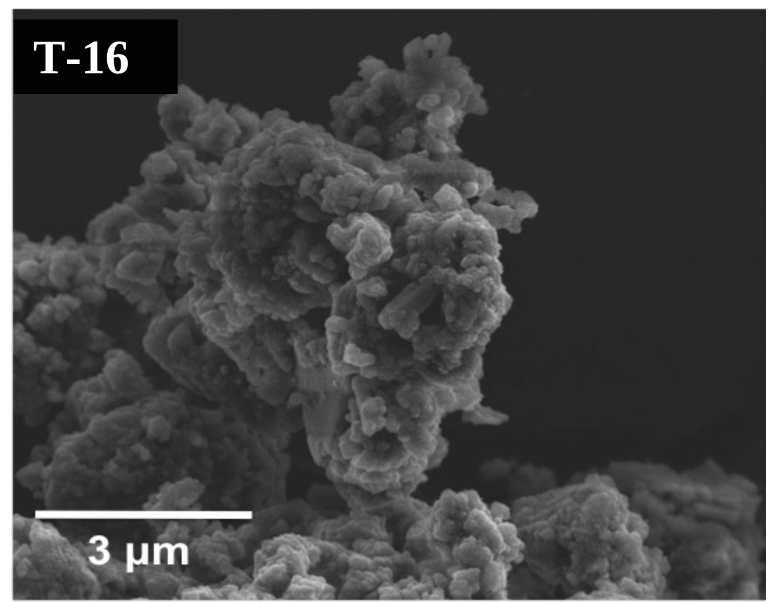


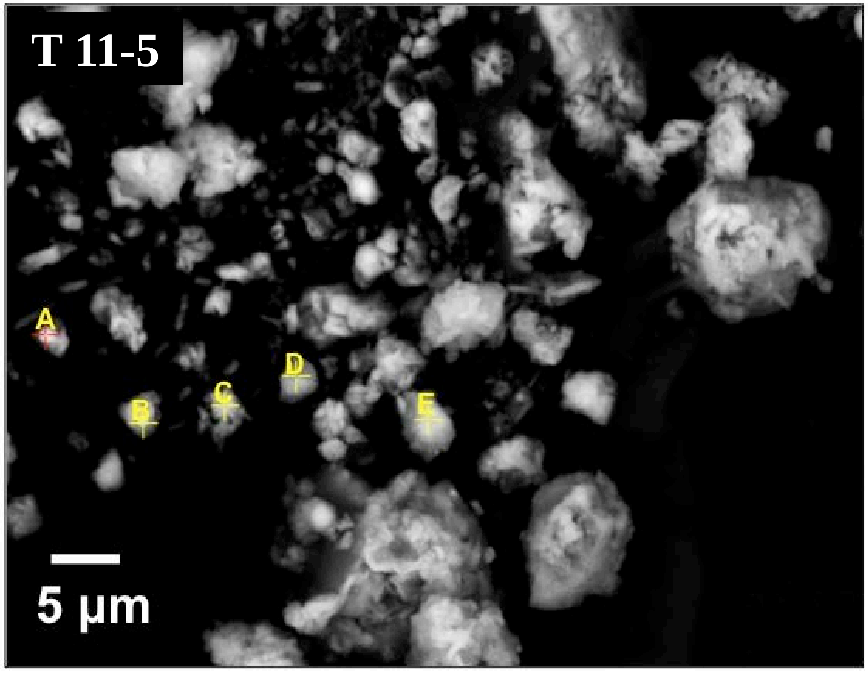
Element (wt%)					
Sample	T-17				
	A	B	C	D	E
NaK	4.95	0.88	3.64	4.43	6.15
MgK	3.12	2.43	7.08	7.57	3.71
AlK	8.39	7.95	12.34	11.67	7.47
SiK	16.36	19.55	28.15	27.60	12.67
SK	9.00	3.95	1.81	3.42	8.41
TcL	1.18	0.98	0.24	0.17	1.37
CaK	55.87	63.39	45.44	44.51	59.23
FeK	0.78	0.51	1.07	0.41	0.70
CuK	0.35	0.36	0.22	0.22	0.28



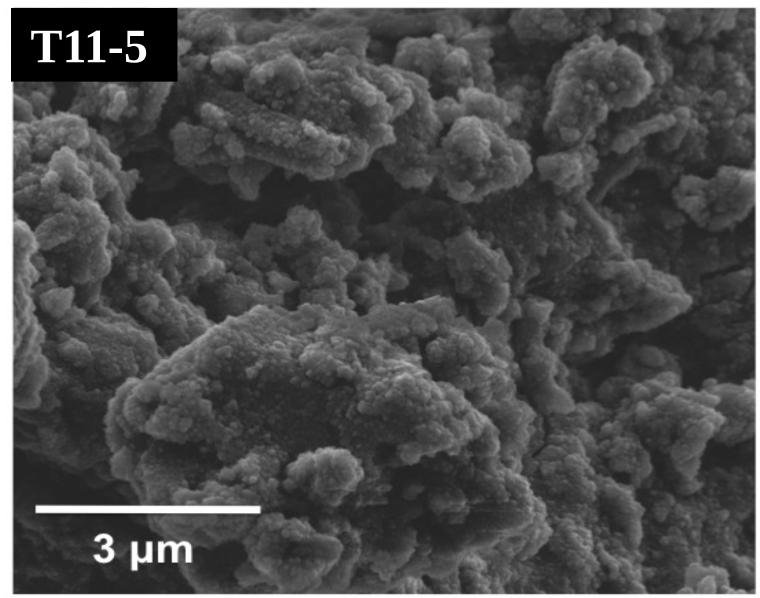


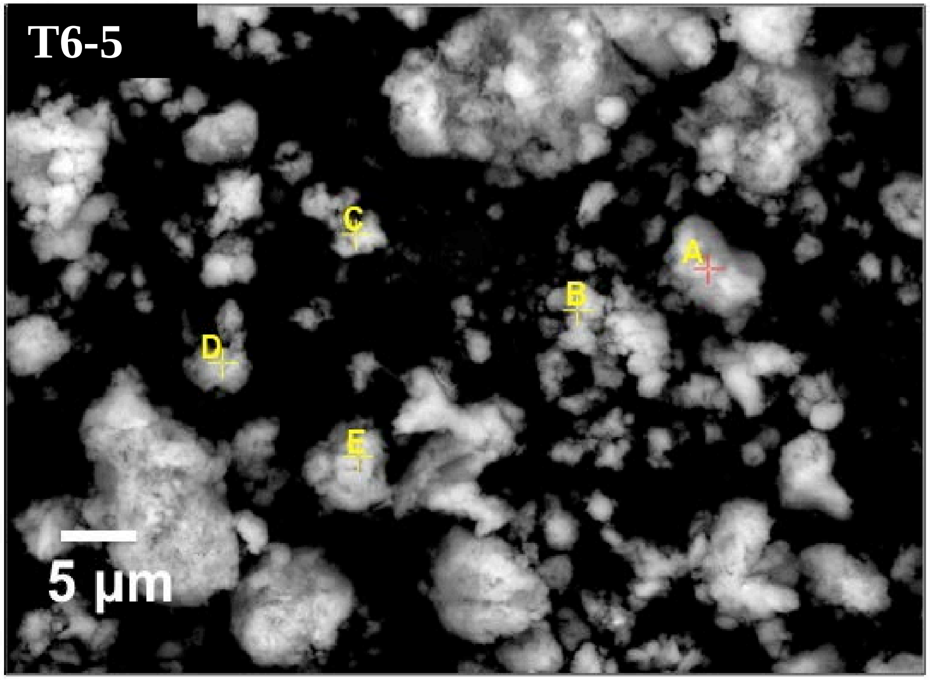
Element (wt%)					
Sample	T-16				
	A	B	C	D	E
NaK	5.08	3.04	5.03	2.20	5.05
MgK	1.99	0.95	1.98	4.07	2.76
AlK	3.58	8.40	7.25	4.97	12.82
SiK	13.00	17.23	20.04	22.88	13.98
SK	1.83	10.45	8.89	5.07	9.45
TcL	0.11	0.84	0.73	0.33	1.33
CaK	74.05	55.51	55.04	59.73	54.17
FeK	0.33	3.54	1.04	0.69	0.44
CuK	0.04	0.04	0.00	0.06	0.00



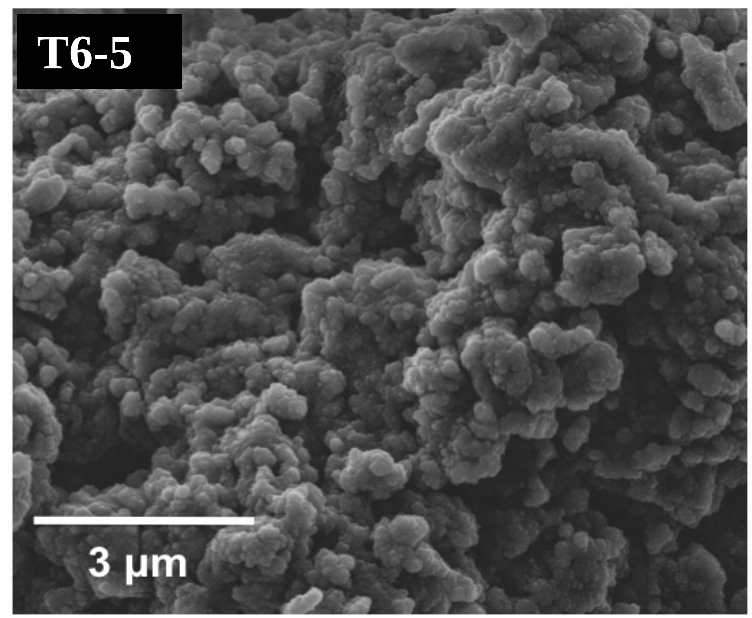


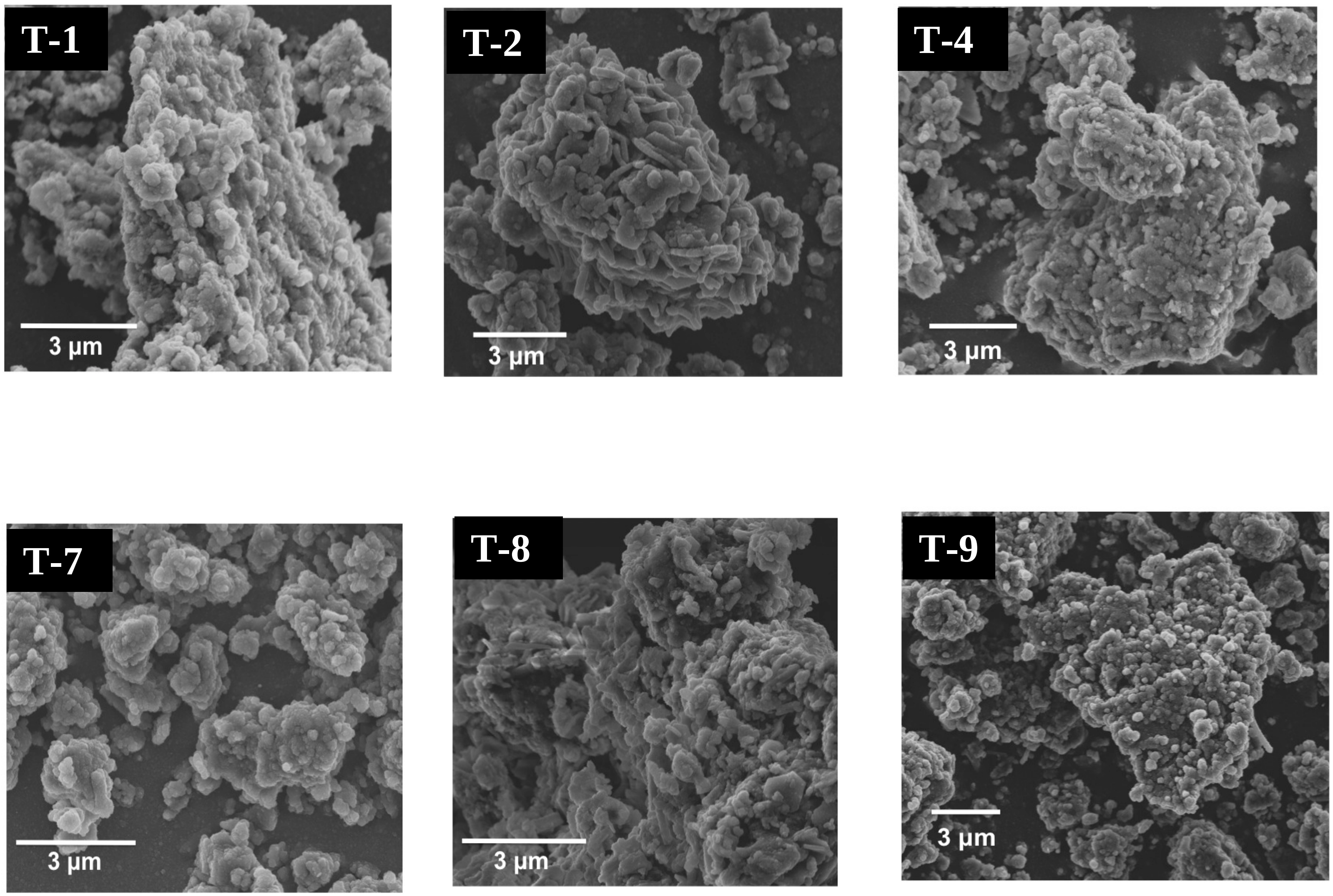
Element (wt%)					
Sample	T11-5				
	A	B	C	D	E
NaK	6.99	8.72	7.35	9.27	9.55
MgK	4.96	7.12	1.18	3.06	4.20
AlK	16.62	13.85	11.69	9.53	10.45
SiK	39.93	33.43	17.94	27.17	30.90
SK	4.86	4.53	13.53	6.93	8.21
TcL	0.46	0.46	1.12	0.60	0.61
CaK	19.90	27.27	45.07	41.61	33.18
FeK	6.27	4.62	2.13	1.84	2.89





Element (wt%)					
Sample	T6-5				
	A	B	C	D	E
NaK	6.30	5.33	6.36	6.05	4.02
MgK	11.63	3.89	2.45	0.98	2.56
AlK	9.74	8.36	5.64	5.14	6.59
SiK	21.22	19.95	21.05	30.10	14.91
SK	5.98	8.15	5.52	4.02	6.92
TcL	0.62	0.75	0.30	0.13	1.30
CaK	43.64	52.32	57.56	52.13	62.45
FeK	0.87	1.24	1.12	1.45	1.24




T-1
3 µm
T-2
3 µm
T-4
3 µm
T-7
3 µm
T-8
3 µm
T-9
3 µm

A.2 Additional Results for Cations and Anions from EPA Method 1315 Tests

Table A.1. Concentrations of Major Cations Measured in Leachates from EPA Method 1315 Tests

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T1-1-0.08d	35.4	0.101	0.023	0.00811	5.03	0.483	0.198	0.164	7.24	0.134	ND	0.122	0.35	0.143	ND	10
15-SWCS-T1-1-1d	98.7	0.101	0.0263	0.00811	9.4	0.483	1.16	0.164	13.3	0.134	ND	0.122	1.43	0.143	11.3	5
15-SWCS-T1-1-2d	63	0.101	0.0399	0.00811	4.44	0.483	1.67	0.164	6.68	0.134	ND	0.122	1.49	0.143	7.40	5
15-SWCS-T1-1-7d	121	0.101	0.037	0.00811	11.6	0.483	3.02	0.164	16.1	0.134	0.162	0.122	2.04	0.143	16.3	5
15-SWCS-T1-1-14d	108	0.101	0.0325	0.00811	8.07	0.483	3.83	0.164	11.1	0.134	ND	0.122	1.86	0.143	13.3	5
15-SWCS-T1-1-28d	108	0.168	0.0641	0.0135	5.22	0.806	4.19	0.274	10	0.223	0.277	0.204	2.28	0.239	23.0	5
15-SWCS-T1-1-42d	92.7	0.168	0.0372	0.0135	3.91	0.806	5.27	0.274	5.78	0.223	ND	0.204	2.55	0.239	16.3	5
15-SWCS-T1-1-49d	61.5	0.168	0.0648	0.0135	1.47	0.806	5.22	0.274	2.41	0.223	ND	0.204	2.65	0.239	6.20	5
15-SWCS-T1-1-63d	72.7	0.168	0.0597	0.0135	2.87	0.806	5.72	0.274	4.49	0.223	ND	0.204	2.29	0.239	ND	5
15-SWCS-T1-1-90d	71.6	0.168	0.031	0.0135	3.44	0.806	4.7	0.274	5.11	0.223	ND	0.204	1.88	0.239	2.25	0.5
15-SWCS-T1-1-140d	90.4	0.168	0.0204	0.0135	6.35	0.806	5.22	0.274	7.85	0.223	ND	0.204	2.2	0.239	31.1	5
15-SWCS-T1-2-0.08d	17.3	0.101	0.0183	0.00811	2.94	0.483	ND	0.164	3.85	0.134	ND	0.122	0.198	0.143	ND	10
15-SWCS-T1-2-1d	99.2	0.101	0.0276	0.00811	8.81	0.483	1.13	0.164	12.4	0.134	ND	0.122	1.31	0.143	11.7	5
15-SWCS-T1-2-2d	51.7	0.101	0.0314	0.00811	2.98	0.483	1.27	0.164	4.71	0.134	ND	0.122	1.17	0.143	ND	5
15-SWCS-T1-2-7d	109	0.101	0.0389	0.00811	9.45	0.483	2.67	0.164	13.1	0.134	0.208	0.122	1.98	0.143	15.4	5
15-SWCS-T1-2-14d	106	0.101	0.0323	0.00811	7.4	0.483	3.8	0.164	10.2	0.134	ND	0.122	2	0.143	13.3	5
15-SWCS-T1-2-28d	106	0.168	0.0419	0.0135	4.72	0.806	4.12	0.274	9.49	0.223	0.272	0.204	2.27	0.239	19.1	5
15-SWCS-T1-2-42d	87.3	0.168	0.0402	0.0135	4.08	0.806	5.34	0.274	5.81	0.223	ND	0.204	2.64	0.239	16.7	5
15-SWCS-T1-2-49d	62.9	0.168	0.056	0.0135	1.7	0.806	4.87	0.274	2.57	0.223	ND	0.204	2.58	0.239	5.60	5
15-SWCS-T1-2-63d	71.4	0.168	0.0634	0.0135	2.87	0.806	5.62	0.274	4.5	0.223	ND	0.204	2.4	0.239	ND	5
15-SWCS-T1-2-90d	80.4	0.168	0.0737	0.0135	3.96	0.806	5.3	0.274	6.2	0.223	ND	0.204	2.24	0.239	2.28	0.5
15-SWCS-T1-2-140d	84.4	0.168	0.0267	0.0135	6.36	0.806	5.45	0.274	8.42	0.223	ND	0.204	2.26	0.239	29.1	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T1-3-0.08d	513	0.101	100	0.0811	29.4	0.483	ND	0.164	142	0.134	0.243	0.122	470	0.143	ND	10
15-SWCS-T1-3-1d	622	0.101	24.6	0.00811	34.7	0.483	0.323	0.164	151	0.134	0.213	0.122	456	0.143	11.0	5
15-SWCS-T1-3-2d	569	0.101	48.6	0.00811	30.4	0.483	0.441	0.164	144	0.134	0.26	0.122	454	0.143	5.50	5
15-SWCS-T1-3-7d	616	0.101	2.21	0.00811	37.9	0.483	0.365	0.164	155	0.134	0.4	0.122	397	0.143	16.5	5
15-SWCS-T1-3-14d	516	0.101	15.2	0.00811	34.9	0.483	ND	0.164	134	0.134	0.253	0.122	392	0.143	17.4	5
15-SWCS-T1-3-28d	490	0.168	6.37	0.0135	33	0.806	ND	0.274	134	0.223	0.544	0.204	328	0.239	27.3	5
15-SWCS-T1-3-42d	507	0.168	37.4	0.0135	32.5	0.806	ND	0.274	133	0.223	ND	0.204	429	0.239	19.9	5
15-SWCS-T1-3-49d	494	0.168	83.1	0.0135	28.6	0.806	ND	0.274	125	0.223	0.227	0.204	470	0.239	7.10	5
15-SWCS-T1-3-63d	410	0.168	61	0.0135	29.8	0.806	ND	0.274	151	0.223	0.361	0.204	363	0.239	8.60	5
15-SWCS-T1-3-90d	502	0.168	29.1	0.0135	29.9	0.806	ND	0.274	141	0.223	ND	0.204	365	0.239	2.95	0.5
15-SWCS-T1-3-140d	501	0.168	0.834	0.0135	35.6	0.806	ND	0.274	140	0.223	0.404	0.204	303	0.239	38.5	5
15-SWCS-T1-4-0.08d	532	0.101	99.1	0.0811	31.6	0.483	ND	0.164	144	0.134	0.218	0.122	468	0.143	ND	10
15-SWCS-T1-4-1d	640	0.101	30.4	0.00811	35.6	0.483	0.466	0.164	152	0.134	0.246	0.122	454	0.143	12.5	5
15-SWCS-T1-4-2d	566	0.101	51.6	0.00811	29.9	0.483	0.406	0.164	144	0.134	0.253	0.122	456	0.143	5.60	5
15-SWCS-T1-4-7d	605	0.101	3.22	0.00811	37.5	0.483	0.261	0.164	154	0.134	0.402	0.122	398	0.143	16.9	5
15-SWCS-T1-4-14d	514	0.101	10.3	0.00811	34.8	0.483	ND	0.164	134	0.134	0.233	0.122	378	0.143	15.5	5
15-SWCS-T1-4-28d	491	0.168	4.67	0.0135	33.1	0.806	ND	0.274	134	0.223	0.526	0.204	323	0.239	27.6	5
15-SWCS-T1-4-42d	517	0.168	34.5	0.0135	32.4	0.806	ND	0.274	135	0.223	ND	0.204	428	0.239	23.4	5
15-SWCS-T1-4-49d	501	0.168	84.3	0.0135	29.1	0.806	ND	0.274	127	0.223	0.208	0.204	476	0.239	7.30	5
15-SWCS-T1-4-63d	405	0.168	68.3	0.0135	29.8	0.806	ND	0.274	151	0.223	0.361	0.204	369	0.239	8.70	5
15-SWCS-T1-4-90d	502	0.168	35.8	0.0135	30.1	0.806	ND	0.274	141	0.223	ND	0.204	377	0.239	2.83	0.5
15-SWCS-T1-4-140d	481	0.168	4.63	0.0135	35.2	0.806	ND	0.274	138	0.223	0.252	0.204	320	0.239	37.7	5
15-SWCS-T2-1-0.08d	39.7	0.101	0.0268	0.00811	3.1	0.483	0.165	0.164	11.3	0.134	ND	0.122	0.379	0.143	ND	10
15-SWCS-T2-1-1d	97.9	0.101	0.0178	0.00811	5.16	0.483	0.8	0.164	16.9	0.134	ND	0.122	1.59	0.143	ND	5
15-SWCS-T2-1-2d	46.1	0.101	0.0237	0.00811	1.98	0.483	0.983	0.164	6.84	0.134	ND	0.122	1.33	0.143	ND	5
15-SWCS-T2-1-7d	111	0.101	0.0447	0.00811	8.73	0.483	2.42	0.164	26.5	0.134	0.143	0.122	2.37	0.143	ND	5
15-SWCS-T2-1-14d	96.5	0.101	0.0299	0.00811	7.03	0.483	3.1	0.164	20.4	0.134	ND	0.122	2.19	0.143	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T2-1-28d	102	0.168	0.0198	0.0135	5.4	0.806	3.29	0.274	21.9	0.223	0.263	0.204	2.2	0.239	ND	5
15-SWCS-T2-1-42d	86.5	0.168	0.0328	0.0135	4.35	0.806	4.23	0.274	14	0.223	ND	0.204	2.35	0.239	ND	5
15-SWCS-T2-1-49d	64.1	0.168	0.0511	0.0135	1.96	0.806	4.32	0.274	6.35	0.223	ND	0.204	2.4	0.239	ND	5
15-SWCS-T2-1-63d	69.2	0.168	0.0494	0.0135	3.31	0.806	4.82	0.274	12	0.223	ND	0.204	2.04	0.239	ND	5
15-SWCS-T2-1-90d	82.9	0.168	0.0528	0.0135	4.79	0.806	4.58	0.274	16.4	0.223	ND	0.204	2.26	0.239	ND	0.5
15-SWCS-T2-1-140d	85.8	0.168	0.0201	0.0135	7.94	0.806	4.74	0.274	21.7	0.223	ND	0.204	2.2	0.239	ND	5
15-SWCS-T2-2-0.08d	40.3	0.101	0.0187	0.00811	2.86	0.483	0.165	0.164	10.7	0.134	ND	0.122	0.399	0.143	ND	10
15-SWCS-T2-2-1d	67.7	0.101	0.0136	0.00811	3.58	0.483	0.586	0.164	11.9	0.134	ND	0.122	1.15	0.143	ND	5
15-SWCS-T2-2-2d	49.6	0.101	0.0231	0.00811	2.33	0.483	1.14	0.164	8.05	0.134	ND	0.122	1.4	0.143	ND	5
15-SWCS-T2-2-7d	107	0.101	0.04	0.00811	8.37	0.483	2.41	0.164	24.9	0.134	0.191	0.122	2.09	0.143	ND	5
15-SWCS-T2-2-14d	96.6	0.101	0.0283	0.00811	6.95	0.483	3.04	0.164	20.2	0.134	ND	0.122	1.96	0.143	ND	5
15-SWCS-T2-2-28d	104	0.168	0.0209	0.0135	5.34	0.806	3.26	0.274	22	0.223	0.222	0.204	2.17	0.239	ND	5
15-SWCS-T2-2-42d	86.3	0.168	0.0332	0.0135	4.45	0.806	4.43	0.274	14.2	0.223	ND	0.204	2.34	0.239	ND	5
15-SWCS-T2-2-49d	57.8	0.168	0.0508	0.0135	1.62	0.806	4.31	0.274	5.91	0.223	ND	0.204	2.24	0.239	ND	5
15-SWCS-T2-2-63d	69.2	0.168	0.048	0.0135	3.16	0.806	4.92	0.274	11.6	0.223	ND	0.204	2.02	0.239	ND	5
15-SWCS-T2-2-90d	85.2	0.168	0.0351	0.0135	4.65	0.806	4.32	0.274	16.3	0.223	ND	0.204	2.09	0.239	ND	0.5
15-SWCS-T2-2-140d	87.9	0.168	0.0189	0.0135	7.83	0.806	4.57	0.274	21.2	0.223	ND	0.204	2.08	0.239	ND	5
15-SWCS-T2-3-0.08d	551	0.101	94.8	0.00811	28.6	0.483	ND	0.164	149	0.134	0.225	0.122	464	0.143	ND	10
15-SWCS-T2-3-1d	580	0.101	37.7	0.00811	31	0.483	0.297	0.164	153	0.134	0.22	0.122	455	0.143	ND	5
15-SWCS-T2-3-2d	541	0.101	59.3	0.00811	29.3	0.483	0.253	0.164	150	0.134	0.264	0.122	449	0.143	ND	5
15-SWCS-T2-3-7d	538	0.101	13.3	0.00811	37.2	0.483	ND	0.164	171	0.134	0.369	0.122	384	0.143	ND	5
15-SWCS-T2-3-14d	497	0.101	14.5	0.00811	35.9	0.483	ND	0.164	150	0.134	0.268	0.122	374	0.143	ND	5
15-SWCS-T2-3-28d	498	0.168	2.4	0.0135	35.2	0.806	ND	0.274	156	0.223	0.449	0.204	315	0.239	ND	5
15-SWCS-T2-3-42d	527	0.168	31.9	0.0135	34.6	0.806	ND	0.274	152	0.223	ND	0.204	424	0.239	ND	5
15-SWCS-T2-3-49d	486	0.168	80	0.0135	29	0.806	ND	0.274	129	0.223	ND	0.204	465	0.239	ND	5
15-SWCS-T2-3-63d	414	0.168	61.4	0.0135	30	0.806	ND	0.274	162	0.223	0.319	0.204	365	0.239	ND	5
15-SWCS-T2-3-90d	505	0.168	23.2	0.0135	31	0.806	ND	0.274	155	0.223	ND	0.204	359	0.239	ND	0.5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T2-3-140d	487	0.168	0.89	0.0135	35.9	0.806	ND	0.274	153	0.223	0.323	0.204	306	0.239	ND	5
15-SWCS-T2-4-0.08d	554	0.101	91.3	0.00811	29	0.483	ND	0.164	150	0.134	0.247	0.122	475	0.143	ND	10
15-SWCS-T2-4-1d	588	0.101	35.6	0.00811	31.3	0.483	0.326	0.164	155	0.134	0.253	0.122	449	0.143	ND	5
15-SWCS-T2-4-2d	536	0.101	62.7	0.00811	29.1	0.483	0.179	0.164	150	0.134	0.227	0.122	447	0.143	ND	5
15-SWCS-T2-4-7d	546	0.101	11.6	0.00811	37.9	0.483	ND	0.164	172	0.134	0.476	0.122	385	0.143	ND	5
15-SWCS-T2-4-14d	504	0.101	16.1	0.00811	36.2	0.483	ND	0.164	153	0.134	0.242	0.122	375	0.143	ND	5
15-SWCS-T2-4-28d	489	0.168	1.88	0.0135	34.6	0.806	ND	0.274	153	0.223	0.522	0.204	315	0.239	ND	5
15-SWCS-T2-4-42d	509	0.168	24.8	0.0135	33.4	0.806	ND	0.274	146	0.223	ND	0.204	417	0.239	ND	5
15-SWCS-T2-4-49d	498	0.168	81.3	0.0135	29.4	0.806	ND	0.274	131	0.223	0.224	0.204	476	0.239	ND	5
15-SWCS-T2-4-63d	418	0.168	57.8	0.0135	30.1	0.806	ND	0.274	162	0.223	0.284	0.204	358	0.239	ND	5
15-SWCS-T2-4-90d	511	0.168	21.5	0.0135	31	0.806	ND	0.274	154	0.223	ND	0.204	359	0.239	ND	0.5
15-SWCS-T2-4-140d	491	0.168	0.794	0.0135	36.7	0.806	ND	0.274	156	0.223	0.392	0.204	307	0.239	ND	5
15-SWCS-T3-1-0.08d	37.8	0.101	0.0225	0.00811	4.4	0.483	0.19	0.164	42.3	0.134	ND	0.122	1.13	0.143	ND	10
15-SWCS-T3-1-1d	84.4	0.101	0.0207	0.00811	6.65	0.483	0.722	0.164	59.4	0.134	ND	0.122	1.94	0.143	15.2	5
15-SWCS-T3-1-2d	56.8	0.101	0.0334	0.00811	3.27	0.483	1.2	0.164	30	0.134	ND	0.122	1.41	0.143	5.50	5
15-SWCS-T3-1-7d	107	0.101	0.045	0.00811	10.2	0.483	2.45	0.164	83.7	0.134	0.155	0.122	2.53	0.143	17.4	5
15-SWCS-T3-1-14d	102	0.101	0.0272	0.00811	9.71	0.483	3.79	0.164	78.8	0.134	ND	0.122	2.65	0.143	22.0	5
15-SWCS-T3-1-28d	112	0.168	0.0145	0.0135	12	0.806	2.29	0.274	100	0.223	0.314	0.204	28.5	0.239	26.9	5
15-SWCS-T3-1-42d	75.9	0.168	0.0176	0.0135	6.42	0.806	3.96	0.274	53.4	0.223	ND	0.204	4.91	0.239	19.5	5
15-SWCS-T3-1-49d	52.2	0.168	0.0356	0.0135	2.59	0.806	3.42	0.274	21.7	0.223	ND	0.204	3.78	0.239	8.70	5
15-SWCS-T3-1-63d	64.9	0.168	0.0319	0.0135	4.3	0.806	4.39	0.274	40.5	0.223	ND	0.204	2.73	0.239	8.10	5
15-SWCS-T3-1-90d	83.5	0.168	0.0601	0.0135	5.7	0.806	4.37	0.274	50.7	0.223	ND	0.204	3.59	0.239	2.76	0.5
15-SWCS-T3-1-140d	78.5	0.168	ND	0.0135	8.39	0.806	4.73	0.274	59.6	0.223	ND	0.204	3.08	0.239	40.9	5
15-SWCS-T3-2-0.08d	39.2	0.101	0.0185	0.00811	4.43	0.483	0.18	0.164	41.1	0.134	ND	0.122	1.38	0.143	ND	10
15-SWCS-T3-2-1d	85	0.101	0.0189	0.00811	6.88	0.483	0.684	0.164	60.5	0.134	ND	0.122	2.05	0.143	15.3	5
15-SWCS-T3-2-2d	63	0.101	0.0245	0.00811	3.76	0.483	1.27	0.164	34.6	0.134	ND	0.122	1.61	0.143	ND	5
15-SWCS-T3-2-7d	114	0.101	0.0266	0.00811	11.4	0.483	2.68	0.164	94.9	0.134	0.187	0.122	2.49	0.143	18.9	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T3-2-14d	102	0.101	0.027	0.00811	10	0.483	3.7	0.164	80.8	0.134	ND	0.122	2.72	0.143	20.3	5
15-SWCS-T3-2-28d	98.5	0.168	0.0153	0.0135	8.36	0.806	4.24	0.274	83.2	0.223	0.305	0.204	2.6	0.239	28.0	5
15-SWCS-T3-2-42d	87.3	0.168	0.0276	0.0135	6.6	0.806	5.4	0.274	53.5	0.223	ND	0.204	2.89	0.239	20.0	5
15-SWCS-T3-2-49d	59.4	0.168	0.0532	0.0135	2.42	0.806	5.05	0.274	20.8	0.223	ND	0.204	3.09	0.239	6.60	5
15-SWCS-T3-2-63d	73.3	0.168	0.0436	0.0135	4.27	0.806	5.7	0.274	39.9	0.223	ND	0.204	2.86	0.239	7.90	5
15-SWCS-T3-2-90d	77.5	0.168	0.0292	0.0135	5.56	0.806	5.23	0.274	49.7	0.223	ND	0.204	2.81	0.239	2.49	0.5
15-SWCS-T3-2-140d	82.4	0.168	0.0173	0.0135	9.09	0.806	5.31	0.274	65.1	0.223	ND	0.204	2.93	0.239	39.4	5
15-SWCS-T3-3-0.08d	539	0.101	86.2	0.00811	30	0.483	ND	0.164	178	0.134	0.247	0.122	476	0.143	ND	10
15-SWCS-T3-3-1d	603	0.101	29.4	0.00811	33.3	0.483	0.301	0.164	203	0.134	0.256	0.122	473	0.143	ND	5
15-SWCS-T3-3-2d	579	0.101	38.8	0.00811	31.2	0.483	0.359	0.164	185	0.134	0.278	0.122	457	0.143	7.05	5
15-SWCS-T3-3-7d	616	0.101	1.67	0.00811	39.9	0.483	0.521	0.164	250	0.134	0.396	0.122	418	0.143	22.8	5
15-SWCS-T3-3-14d	539	0.101	2.23	0.00811	37.1	0.483	ND	0.164	207	0.134	0.28	0.122	402	0.143	18.9	5
15-SWCS-T3-3-28d	478	0.168	2.46	0.0135	35.5	0.806	ND	0.274	212	0.223	0.48	0.204	349	0.239	38.4	5
15-SWCS-T3-3-42d	504	0.168	26.1	0.0135	34.5	0.806	ND	0.274	188	0.223	ND	0.204	443	0.239	23.5	5
15-SWCS-T3-3-49d	484	0.168	80.4	0.0135	29.1	0.806	ND	0.274	144	0.223	ND	0.204	479	0.239	9.20	5
15-SWCS-T3-3-63d	405	0.168	56.6	0.0135	32.2	0.806	ND	0.274	202	0.223	0.286	0.204	369	0.239	11.0	5
15-SWCS-T3-3-90d	500	0.168	21.2	0.0135	31.3	0.806	ND	0.274	198	0.223	ND	0.204	377	0.239	2.95	0.5
15-SWCS-T3-3-140d	491	0.168	0.331	0.0135	38.3	0.806	ND	0.274	223	0.223	0.278	0.204	325	0.239	37.1	5
15-SWCS-T3-4-0.08d	548	0.101	85.4	0.00811	29.7	0.483	ND	0.164	174	0.134	0.25	0.122	478	0.143	ND	10
15-SWCS-T3-4-1d	598	0.101	33.9	0.00811	33.6	0.483	0.367	0.164	202	0.134	0.286	0.122	477	0.143	7.70	5
15-SWCS-T3-4-2d	572	0.101	43.3	0.00811	31.2	0.483	0.333	0.164	183	0.134	0.274	0.122	463	0.143	7.23	5
15-SWCS-T3-4-7d	604	0.101	1.91	0.00811	39.8	0.483	0.368	0.164	245	0.134	0.369	0.122	419	0.143	19.8	5
15-SWCS-T3-4-14d	530	0.101	3.96	0.00811	37.5	0.483	ND	0.164	210	0.134	0.275	0.122	402	0.143	16.7	5
15-SWCS-T3-4-28d	477	0.168	1.67	0.0135	35.8	0.806	ND	0.274	212	0.223	0.503	0.204	343	0.239	27.7	5
15-SWCS-T3-4-42d	517	0.168	21.1	0.0135	34.4	0.806	ND	0.274	191	0.223	ND	0.204	441	0.239	20.9	5
15-SWCS-T3-4-49d	493	0.168	76.6	0.0135	29.5	0.806	ND	0.274	146	0.223	ND	0.204	476	0.239	8.10	5
15-SWCS-T3-4-63d	401	0.168	61.2	0.0135	31.5	0.806	ND	0.274	194	0.223	0.379	0.204	377	0.239	10.1	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T3-4-90d	512	0.168	24.3	0.0135	31.9	0.806	ND	0.274	202	0.223	ND	0.204	387	0.239	2.84	0.5
15-SWCS-T3-4-140d	494	0.168	0.417	0.0135	38.4	0.806	ND	0.274	220	0.223	0.331	0.204	330	0.239	34.8	5
15-SWCS-T4-1-0.08d	19.8	0.101	0.0216	0.00811	3	0.483	0.184	0.164	4.24	0.134	ND	0.122	0.236	0.143	ND	10
15-SWCS-T4-1-1d	104	0.101	0.229	0.00811	9.53	0.483	0.989	0.164	14.5	0.134	ND	0.122	1.93	0.143	20.1	5
15-SWCS-T4-1-2d	70.5	0.101	0.037	0.00811	5.24	0.483	1.47	0.164	8.54	0.134	ND	0.122	1.55	0.143	10.6	5
15-SWCS-T4-1-7d	123	0.101	0.0377	0.00811	13.6	0.483	2.65	0.164	20.8	0.134	0.184	0.122	2.34	0.143	22.6	5
15-SWCS-T4-1-14d	111	0.101	0.032	0.00811	10.4	0.483	3.66	0.164	16.2	0.134	ND	0.122	2.35	0.143	22.0	5
15-SWCS-T4-1-28d	112	0.168	0.0222	0.0135	7.29	0.806	4.09	0.274	14.2	0.223	0.304	0.204	2.26	0.239	28.6	5
15-SWCS-T4-1-42d	91.2	0.168	0.0331	0.0135	4.73	0.806	5.13	0.274	7.56	0.223	ND	0.204	2.56	0.239	14.8	5
15-SWCS-T4-1-49d	60.7	0.168	0.0712	0.0135	1.75	0.806	5.02	0.274	2.88	0.223	ND	0.204	2.94	0.239	5.30	5
15-SWCS-T4-1-63d	74.1	0.168	0.0557	0.0135	3.14	0.806	5.63	0.274	5.72	0.223	ND	0.204	2.46	0.239	6.40	5
15-SWCS-T4-1-90d	85.4	0.168	0.0469	0.0135	4.14	0.806	5.34	0.274	6.82	0.223	0.241	0.204	2.38	0.239	2.10	0.5
15-SWCS-T4-1-140d	91.9	0.168	0.02	0.0135	7.14	0.806	5.32	0.274	9.23	0.223	ND	0.204	2.42	0.239	13.1	5
15-SWCS-T4-2-0.08d	23.6	0.101	0.019	0.00811	4.02	0.483	0.169	0.164	5.56	0.134	ND	0.122	0.28	0.143	ND	10
15-SWCS-T4-2-1d	86.3	0.101	0.0224	0.00811	7.05	0.483	0.737	0.164	10.8	0.134	ND	0.122	1.18	0.143	16.2	5
15-SWCS-T4-2-2d	61.7	0.101	0.0293	0.00811	4.09	0.483	1.19	0.164	6.57	0.134	ND	0.122	1.4	0.143	8.50	5
15-SWCS-T4-2-7d	127	0.101	0.0368	0.00811	12.6	0.483	2.46	0.164	19	0.134	0.194	0.122	2.26	0.143	22.0	5
15-SWCS-T4-2-14d	111	0.101	0.0277	0.00811	9.71	0.483	3.61	0.164	15	0.134	ND	0.122	2.32	0.143	22.5	5
15-SWCS-T4-2-28d	113	0.168	0.0174	0.0135	7.02	0.806	3.81	0.274	13.8	0.223	0.264	0.204	2.41	0.239	30.9	5
15-SWCS-T4-2-42d	91.4	0.168	0.0329	0.0135	4.52	0.806	5.13	0.274	7.15	0.223	ND	0.204	2.73	0.239	15.4	5
15-SWCS-T4-2-49d	61.8	0.168	0.0609	0.0135	1.71	0.806	4.96	0.274	2.94	0.223	ND	0.204	3.11	0.239	5.10	5
15-SWCS-T4-2-63d	72.1	0.168	0.0559	0.0135	2.86	0.806	5.65	0.274	5.32	0.223	ND	0.204	2.64	0.239	6.50	5
15-SWCS-T4-2-90d	81.7	0.168	0.038	0.0135	3.96	0.806	5.21	0.274	6.56	0.223	0.211	0.204	2.39	0.239	2.14	0.5
15-SWCS-T4-2-140d	86.9	0.168	0.0205	0.0135	6.63	0.806	5.36	0.274	8.51	0.223	ND	0.204	2.54	0.239	14.7	5
15-SWCS-T4-3-0.08d	514	0.101	101	0.0811	29.1	0.483	ND	0.164	141	0.134	0.215	0.122	479	0.143	ND	10
15-SWCS-T4-3-1d	629	0.101	21	0.00811	36.6	0.483	0.406	0.164	152	0.134	0.259	0.122	464	0.143	20.6	5
15-SWCS-T4-3-2d	593	0.101	44.9	0.00811	32.2	0.483	0.464	0.164	152	0.134	0.289	0.122	448	0.143	9.26	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T4-3-7d	623	0.101	2.08	0.00811	42.1	0.483	0.381	0.164	164	0.134	0.35	0.122	395	0.143	23.2	5
15-SWCS-T4-3-14d	544	0.101	3.23	0.00811	38	0.483	ND	0.164	143	0.134	0.295	0.122	375	0.143	21.0	5
15-SWCS-T4-3-28d	509	0.168	0.664	0.0135	34.3	0.806	ND	0.274	138	0.223	0.452	0.204	311	0.239	27.2	5
15-SWCS-T4-3-42d	521	0.168	15.9	0.0135	33.1	0.806	ND	0.274	136	0.223	ND	0.204	414	0.239	17.1	5
15-SWCS-T4-3-49d	499	0.168	70.6	0.0135	29.2	0.806	ND	0.274	125	0.223	ND	0.204	463	0.239	5.20	5
15-SWCS-T4-3-63d	428	0.168	49.1	0.0135	29.8	0.806	ND	0.274	152	0.223	0.291	0.204	354	0.239	7.70	5
15-SWCS-T4-3-90d	535	0.168	16.1	0.0135	30.8	0.806	ND	0.274	144	0.223	ND	0.204	368	0.239	2.71	0.5
15-SWCS-T4-3-140d	506	0.168	0.53	0.0135	35.9	0.806	ND	0.274	140	0.223	0.338	0.204	305	0.239	26.3	5
15-SWCS-T4-4-0.08d	521	0.101	96.4	0.00811	29.9	0.483	ND	0.164	142	0.134	0.208	0.122	481	0.143	10.8	10
15-SWCS-T4-4-1d	628	0.101	20.8	0.00811	36.4	0.483	0.427	0.164	152	0.134	0.235	0.122	458	0.143	26.3	5
15-SWCS-T4-4-2d	584	0.101	41.7	0.00811	32.1	0.483	0.441	0.164	148	0.134	0.191	0.122	447	0.143	11.7	5
15-SWCS-T4-4-7d	650	0.101	0.958	0.00811	42.6	0.483	0.556	0.164	163	0.134	0.397	0.122	396	0.143	26.7	5
15-SWCS-T4-4-14d	564	0.101	2.31	0.00811	37.5	0.483	ND	0.164	142	0.134	0.286	0.122	382	0.143	29.7	5
15-SWCS-T4-4-28d	497	0.168	1.92	0.0135	34.8	0.806	ND	0.274	137	0.223	0.516	0.204	326	0.239	32.6	5
15-SWCS-T4-4-42d	518	0.168	24.1	0.0135	32.9	0.806	ND	0.274	138	0.223	ND	0.204	418	0.239	19.5	5
15-SWCS-T4-4-49d	514	0.168	73.3	0.0135	29.1	0.806	ND	0.274	128	0.223	ND	0.204	473	0.239	6.80	5
15-SWCS-T4-4-63d	412	0.168	55.7	0.0135	29.9	0.806	ND	0.274	151	0.223	0.328	0.204	362	0.239	8.50	5
15-SWCS-T4-4-90d	553	0.168	16.8	0.0135	31.2	0.806	ND	0.274	145	0.223	ND	0.204	384	0.239	3.36	0.5
15-SWCS-T4-4-140d	521	0.168	0.199	0.0135	36.5	0.806	ND	0.274	140	0.223	0.346	0.204	291	0.239	32.7	5
15-SWCS-T5-1-0.08d	14.5	0.101	0.0279	0.00811	1.92	0.483	ND	0.164	5.98	0.134	ND	0.122	0.223	0.143	ND	10
15-SWCS-T5-1-1d	73.9	0.101	0.0651	0.00811	5.11	0.483	0.666	0.164	18.8	0.134	ND	0.122	2.3	0.143	ND	5
15-SWCS-T5-1-2d	59.4	0.101	0.0268	0.00811	3.51	0.483	1.36	0.164	12.9	0.134	ND	0.122	1.39	0.143	ND	5
15-SWCS-T5-1-7d	110	0.101	0.0319	0.00811	9.73	0.483	2.44	0.164	32.4	0.134	0.195	0.122	2.1	0.143	ND	5
15-SWCS-T5-1-14d	109	0.101	0.0244	0.00811	8.37	0.483	2.9	0.164	27.4	0.134	0.126	0.122	2.18	0.143	ND	5
15-SWCS-T5-1-28d	114	0.168	0.0172	0.0135	6.87	0.806	2.93	0.274	29.2	0.223	0.305	0.204	2.05	0.239	ND	5
15-SWCS-T5-1-42d	93.8	0.168	0.0267	0.0135	5.27	0.806	3.85	0.274	17.8	0.223	ND	0.204	2.05	0.239	ND	5
15-SWCS-T5-1-49d	65.1	0.168	0.041	0.0135	2.25	0.806	4.09	0.274	8.08	0.223	ND	0.204	2.37	0.239	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T5-1-63d	76	0.168	0.036	0.0135	3.96	0.806	4.52	0.274	15.3	0.223	ND	0.204	1.88	0.239	ND	5
15-SWCS-T5-1-90d	92.1	0.168	0.0331	0.0135	5.73	0.806	4.12	0.274	21.2	0.223	ND	0.204	2.18	0.239	ND	0.5
15-SWCS-T5-1-140d	97.6	0.168	0.0171	0.0135	9.04	0.806	4.02	0.274	26.9	0.223	ND	0.204	2.14	0.239	ND	5
15-SWCS-T5-2-0.08d	18.2	0.101	0.0365	0.00811	1.93	0.483	ND	0.164	6.92	0.134	ND	0.122	0.306	0.143	ND	10
15-SWCS-T5-2-1d	74	0.101	0.0146	0.00811	4.89	0.483	0.717	0.164	17.7	0.134	ND	0.122	1.23	0.143	ND	5
15-SWCS-T5-2-2d	49.8	0.101	0.0336	0.00811	2.71	0.483	1.23	0.164	10	0.134	ND	0.122	1.25	0.143	ND	5
15-SWCS-T5-2-7d	110	0.101	0.028	0.00811	9.64	0.483	2.6	0.164	32.5	0.134	0.199	0.122	2.14	0.143	ND	5
15-SWCS-T5-2-14d	101	0.101	0.0209	0.00811	8.14	0.483	2.72	0.164	26.6	0.134	ND	0.122	1.89	0.143	ND	5
15-SWCS-T5-2-28d	107	0.168	0.0162	0.0135	6.93	0.806	3.07	0.274	29.4	0.223	0.338	0.204	1.98	0.239	ND	5
15-SWCS-T5-2-42d	90.4	0.168	0.0275	0.0135	5.26	0.806	3.97	0.274	18.5	0.223	ND	0.204	2.14	0.239	ND	5
15-SWCS-T5-2-49d	63.6	0.168	0.0404	0.0135	2.28	0.806	4.18	0.274	8.43	0.223	ND	0.204	2.46	0.239	ND	5
15-SWCS-T5-2-63d	72.8	0.168	0.039	0.0135	4.01	0.806	4.65	0.274	15.6	0.223	ND	0.204	1.98	0.239	ND	5
15-SWCS-T5-2-90d	83.3	0.168	0.0314	0.0135	5.58	0.806	4.23	0.274	20.6	0.223	ND	0.204	2.1	0.239	ND	0.5
15-SWCS-T5-2-140d	94.7	0.168	0.0169	0.0135	9.22	0.806	4.16	0.274	28.4	0.223	ND	0.204	2.07	0.239	ND	5
15-SWCS-T5-3-0.08d	541	0.101	84.9	0.00811	29	0.483	ND	0.164	148	0.134	0.247	0.122	482	0.143	ND	10
15-SWCS-T5-3-1d	575	0.101	39.2	0.00811	31.9	0.483	0.301	0.164	160	0.134	0.236	0.122	457	0.143	ND	5
15-SWCS-T5-3-2d	542	0.101	60.9	0.00811	30	0.483	0.329	0.164	153	0.134	0.297	0.122	447	0.143	ND	5
15-SWCS-T5-3-7d	548	0.101	12	0.00811	38.4	0.483	0.2	0.164	175	0.134	0.441	0.122	400	0.143	ND	5
15-SWCS-T5-3-14d	483	0.101	25.5	0.00811	36	0.483	ND	0.164	152	0.134	0.242	0.122	388	0.143	ND	5
15-SWCS-T5-3-28d	477	0.168	2.83	0.0135	36	0.806	ND	0.274	160	0.223	0.436	0.204	321	0.239	ND	5
15-SWCS-T5-3-42d	517	0.168	9.98	0.0135	34.6	0.806	ND	0.274	153	0.223	ND	0.204	393	0.239	ND	5
15-SWCS-T5-3-49d	499	0.168	66.1	0.0135	29.3	0.806	ND	0.274	133	0.223	ND	0.204	454	0.239	ND	5
15-SWCS-T5-3-63d	421	0.168	36	0.0135	31.6	0.806	ND	0.274	168	0.223	0.361	0.204	338	0.239	ND	5
15-SWCS-T5-3-90d	450	0.168	1.12	0.0135	32.1	0.806	ND	0.274	161	0.223	ND	0.204	259	0.239	ND	0.5
15-SWCS-T5-3-140d	547	0.168	0.0737	0.0135	38.9	0.806	ND	0.274	165	0.223	0.312	0.204	281	0.239	ND	5
15-SWCS-T5-4-0.08d	534	0.101	87.4	0.00811	28.5	0.483	ND	0.164	148	0.134	0.219	0.122	482	0.143	ND	10
15-SWCS-T5-41d	579	0.101	41.9	0.00811	32.3	0.483	0.306	0.164	161	0.134	0.28	0.122	456	0.143	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T5-4-2d	551	0.101	52.5	0.00811	30.5	0.483	0.389	0.164	156	0.134	0.307	0.122	442	0.143	ND	5
15-SWCS-T5-4-7d	539	0.101	16.5	0.00811	37.3	0.483	ND	0.164	173	0.134	0.416	0.122	403	0.143	ND	5
15-SWCS-T5-4-14d	491	0.101	29.9	0.00811	36.2	0.483	ND	0.164	154	0.134	0.276	0.122	396	0.143	ND	5
15-SWCS-T5-4-28d	481	0.168	2.99	0.0135	36.2	0.806	ND	0.274	161	0.223	0.415	0.204	322	0.239	ND	5
15-SWCS-T5-4-42d	514	0.168	7.47	0.0135	34.5	0.806	ND	0.274	152	0.223	ND	0.204	390	0.239	ND	5
15-SWCS-T5-4-49d	503	0.168	62.4	0.0135	29.7	0.806	ND	0.274	133	0.223	0.211	0.204	455	0.239	ND	5
15-SWCS-T5-4-63d	430	0.168	34.6	0.0135	31.7	0.806	ND	0.274	172	0.223	0.33	0.204	342	0.239	ND	5
15-SWCS-T5-4-90d	446	0.168	1.84	0.0135	31.9	0.806	ND	0.274	159	0.223	0.272	0.204	265	0.239	ND	0.5
15-SWCS-T5-4-140d	545	0.168	0.122	0.0135	38.7	0.806	ND	0.274	166	0.223	0.389	0.204	291	0.239	ND	5
15-SWCS-T6-1-0.08d	13.3	0.101	0.0205	0.00811	2.37	0.483	ND	0.164	22.4	0.134	ND	0.122	0.42	0.143	ND	10
15-SWCS-T6-1-1d	73.1	0.101	0.0206	0.00811	7.03	0.483	0.596	0.164	70.4	0.134	ND	0.122	1.64	0.143	16.0	5
15-SWCS-T6-1-2d	68.1	0.101	0.101	0.00811	4.51	0.483	1.16	0.164	47.3	0.134	ND	0.122	2.18	0.143	9.42	5
15-SWCS-T6-1-7d	132	0.101	0.0416	0.00811	13.1	0.483	1.82	0.164	125	0.134	0.238	0.122	2.91	0.143	21.0	5
15-SWCS-T6-1-14d	113	0.101	0.033	0.00811	10.9	0.483	2.86	0.164	102	0.134	ND	0.122	2.83	0.143	26.4	5
15-SWCS-T6-1-28d	103	0.168	ND	0.0135	10.2	0.806	3.44	0.274	114	0.223	0.325	0.204	3.01	0.239	38.2	5
15-SWCS-T6-1-42d	79.7	0.168	0.0201	0.0135	7.39	0.806	4.85	0.274	69.4	0.223	ND	0.204	3.3	0.239	40.9	5
15-SWCS-T6-1-49d	59.7	0.168	0.0381	0.0135	2.99	0.806	4.78	0.274	28.9	0.223	ND	0.204	3.8	0.239	13.1	5
15-SWCS-T6-1-63d	68.1	0.168	0.0399	0.0135	5	0.806	5.45	0.274	54	0.223	ND	0.204	3.37	0.239	10.5	5
15-SWCS-T6-1-90d	63.6	0.168	0.029	0.0135	6.76	0.806	5.21	0.274	67.2	0.223	ND	0.204	3.39	0.239	3.91	0.5
15-SWCS-T6-1-140d	73	0.168	0.0201	0.0135	10.1	0.806	5.17	0.274	83.6	0.223	ND	0.204	3.28	0.239	47.3	5
15-SWCS-T6-2-0.08d	11.2	0.101	0.0164	0.00811	2.08	0.483	ND	0.164	17.8	0.134	ND	0.122	0.291	0.143	ND	10
15-SWCS-T6-2-1d	73.5	0.101	0.0176	0.00811	7.28	0.483	0.636	0.164	72.5	0.134	ND	0.122	1.56	0.143	14.9	5
15-SWCS-T6-2-2d	58.3	0.101	0.0202	0.00811	3.86	0.483	1.05	0.164	40.7	0.134	ND	0.122	1.37	0.143	7.54	5
15-SWCS-T6-2-7d	131	0.101	0.0208	0.00811	13.2	0.483	1.97	0.164	126	0.134	0.147	0.122	2.75	0.143	24.2	5
15-SWCS-T6-2-14d	114	0.101	0.0281	0.00811	11.2	0.483	2.87	0.164	105	0.134	ND	0.122	2.77	0.143	27.7	5
15-SWCS-T6-2-28d	107	0.168	ND	0.0135	10.7	0.806	3.5	0.274	118	0.223	0.274	0.204	2.86	0.239	35.9	5
15-SWCS-T6-2-42d	83.8	0.168	0.0194	0.0135	7.53	0.806	4.86	0.274	70.2	0.223	ND	0.204	3.18	0.239	33.7	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T6-2-49d	60.1	0.168	0.0357	0.0135	3.1	0.806	4.66	0.274	29.3	0.223	ND	0.204	3.62	0.239	11.6	5
15-SWCS-T6-2-63d	69.1	0.168	0.0309	0.0135	5.29	0.806	5.28	0.274	56.2	0.223	ND	0.204	3.17	0.239	11.0	5
15-SWCS-T6-2-90d	79.3	0.168	0.0226	0.0135	6.72	0.806	4.7	0.274	66.4	0.223	0.29	0.204	3.28	0.239	3.67	0.5
15-SWCS-T6-2-140d	74.5	0.168	0.0159	0.0135	10.1	0.806	5.03	0.274	80.5	0.223	ND	0.204	3.29	0.239	36.8	5
15-SWCS-T6-3-0.08d	520	0.101	86	0.00811	29.7	0.483	ND	0.164	174	0.134	0.212	0.122	481	0.143	ND	10
15-SWCS-T6-3-1d	593	0.101	25.2	0.00811	34.3	0.483	0.197	0.164	219	0.134	0.2	0.122	474	0.143	18.1	5
15-SWCS-T6-3-2d	596	0.101	31.9	0.00811	32.3	0.483	0.329	0.164	204	0.134	0.283	0.122	460	0.143	8.60	5
15-SWCS-T6-3-7d	648	0.101	2.98	0.00811	42.4	0.483	0.539	0.164	289	0.134	0.358	0.122	430	0.143	26.0	5
15-SWCS-T6-3-14d	540	0.101	0.686	0.00811	38.6	0.483	ND	0.164	232	0.134	0.319	0.122	389	0.143	27.3	5
15-SWCS-T6-3-28d	511	0.168	0.0994	0.0135	38.2	0.806	ND	0.274	248	0.223	0.466	0.204	328	0.239	38.7	5
15-SWCS-T6-3-42d	548	0.168	0.905	0.0135	36.3	0.806	ND	0.274	214	0.223	ND	0.204	420	0.239	45.6	5
15-SWCS-T6-3-49d	518	0.168	56.9	0.0135	31.1	0.806	ND	0.274	160	0.223	ND	0.204	465	0.239	11.1	5
15-SWCS-T6-3-63d	422	0.168	31.4	0.0135	32.6	0.806	ND	0.274	215	0.223	0.321	0.204	368	0.239	17.2	5
15-SWCS-T6-3-90d	434	0.168	2.01	0.0135	32.8	0.806	ND	0.274	222	0.223	0.216	0.204	307	0.239	5.32	0.5
15-SWCS-T6-3-140d	499	0.168	0.138	0.0135	42.1	0.806	ND	0.274	265	0.223	0.329	0.204	336	0.239	73.9	5
15-SWCS-T6-4-0.08d	505	0.101	94.5	0.00811	28.2	0.483	ND	0.164	162	0.134	0.196	0.122	484	0.143	ND	10
15-SWCS-T6-4-1d	618	0.101	21.9	0.00811	35.6	0.483	0.251	0.164	234	0.134	0.231	0.122	471	0.143	18.4	5
15-SWCS-T6-4-2d	593	0.101	32.1	0.00811	32.6	0.483	0.319	0.164	205	0.134	0.327	0.122	456	0.143	8.97	5
15-SWCS-T6-4-7d	639	0.101	2.12	0.00811	43.7	0.483	0.61	0.164	296	0.134	0.367	0.122	426	0.143	23.6	5
15-SWCS-T6-4-14d	544	0.101	0.593	0.00811	39.3	0.483	ND	0.164	236	0.134	0.273	0.122	389	0.143	27.0	5
15-SWCS-T6-4-28d	514	0.168	0.104	0.0135	38.2	0.806	ND	0.274	252	0.223	0.417	0.204	323	0.239	39.1	5
15-SWCS-T6-4-42d	537	0.168	1.44	0.0135	35.5	0.806	ND	0.274	210	0.223	ND	0.204	412	0.239	36.1	5
15-SWCS-T6-4-49d	514	0.168	58.2	0.0135	30.9	0.806	ND	0.274	158	0.223	ND	0.204	472	0.239	11.6	5
15-SWCS-T6-4-63d	429	0.168	26.2	0.0135	33	0.806	ND	0.274	219	0.223	0.237	0.204	368	0.239	18.7	5
15-SWCS-T6-4-90d	438	0.168	1.51	0.0135	33.4	0.806	ND	0.274	228	0.223	0.3	0.204	308	0.239	5.22	0.5
15-SWCS-T6-4-140d	493	0.168	0.123	0.0135	40.6	0.806	ND	0.274	251	0.223	0.347	0.204	330	0.239	58.6	5
15-SWCS-T7-1-0.08d	16.6	0.101	0.0316	0.00811	1.68	0.483	ND	0.164	5.53	0.134	ND	0.122	0.255	0.143	ND	10

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T7-1-1d	57.4	0.101	0.015	0.00811	3.95	0.483	0.678	0.164	12.8	0.134	ND	0.122	1.07	0.143	ND	5
15-SWCS-T7-1-2d	53.7	0.101	0.0244	0.00811	2.8	0.483	1.43	0.164	9.69	0.134	ND	0.122	1.23	0.143	ND	5
15-SWCS-T7-1-7d	108	0.101	0.041	0.00811	8.87	0.483	2.3	0.164	27.1	0.134	0.161	0.122	3.17	0.143	ND	5
15-SWCS-T7-1-14d	99.1	0.101	0.028	0.00811	6.95	0.483	3	0.164	20.3	0.134	ND	0.122	1.86	0.143	ND	5
15-SWCS-T7-1-28d	102	0.168	0.0179	0.0135	5.54	0.806	3.3	0.274	22.4	0.223	0.3	0.204	2.01	0.239	ND	5
15-SWCS-T7-1-42d	86.9	0.168	0.0291	0.0135	4.49	0.806	4.23	0.274	14.1	0.223	ND	0.204	2.13	0.239	ND	5
15-SWCS-T7-1-49d	60.7	0.168	0.0486	0.0135	1.96	0.806	4.4	0.274	6.52	0.223	ND	0.204	2.33	0.239	ND	5
15-SWCS-T7-1-63d	72.8	0.168	0.0459	0.0135	3.51	0.806	4.92	0.274	13	0.223	ND	0.204	1.94	0.239	ND	5
15-SWCS-T7-1-90d	85.2	0.168	0.026	0.0135	4.89	0.806	4.48	0.274	16.5	0.223	ND	0.204	2.15	0.239	ND	0.5
15-SWCS-T7-1-140d	86.7	0.168	0.0234	0.0135	7.8	0.806	4.54	0.274	21.5	0.223	ND	0.204	2.05	0.239	ND	5
15-SWCS-T7-2-0.08d	15.3	0.101	0.0189	0.00811	1.76	0.483	ND	0.164	5.76	0.134	ND	0.122	0.243	0.143	ND	10
15-SWCS-T7-2-1d	61.7	0.101	0.0168	0.00811	3.89	0.483	0.649	0.164	12.9	0.134	ND	0.122	1.07	0.143	ND	5
15-SWCS-T7-2-2d	45.3	0.101	0.0222	0.00811	2.01	0.483	1.08	0.164	7.16	0.134	ND	0.122	0.941	0.143	ND	5
15-SWCS-T7-2-7d	107	0.101	0.0295	0.00811	8.17	0.483	2.27	0.164	24.5	0.134	0.183	0.122	1.93	0.143	ND	5
15-SWCS-T7-2-14d	105	0.101	0.0264	0.00811	6.96	0.483	2.85	0.164	20.2	0.134	0.136	0.122	1.93	0.143	ND	5
15-SWCS-T7-2-28d	104	0.168	0.017	0.0135	5.29	0.806	3.14	0.274	21.6	0.223	0.244	0.204	2.1	0.239	ND	5
15-SWCS-T7-2-42d	89.6	0.168	0.0277	0.0135	4.69	0.806	4.1	0.274	14.4	0.223	ND	0.204	2.21	0.239	ND	5
15-SWCS-T7-2-49d	62.6	0.168	0.0444	0.0135	2.03	0.806	4.23	0.274	6.49	0.223	ND	0.204	2.48	0.239	ND	5
15-SWCS-T7-2-63d	69.8	0.168	0.0418	0.0135	3.26	0.806	4.86	0.274	12.2	0.223	ND	0.204	1.96	0.239	ND	5
15-SWCS-T7-2-90d	84.9	0.168	0.0257	0.0135	4.9	0.806	4.42	0.274	16.5	0.223	ND	0.204	2.14	0.239	ND	0.5
15-SWCS-T7-2-140d	88.2	0.168	0.0292	0.0135	7.68	0.806	4.41	0.274	20.9	0.223	ND	0.204	2.14	0.239	ND	5
15-SWCS-T7-3-0.08d	533	0.101	88.7	0.00811	27.7	0.483	ND	0.164	144	0.134	0.244	0.122	480	0.143	ND	10
15-SWCS-T7-3-1d	583	0.101	39.4	0.00811	31.6	0.483	0.31	0.164	159	0.134	0.247	0.122	451	0.143	ND	5
15-SWCS-T7-3-2d	535	0.101	56.8	0.00811	30.2	0.483	0.247	0.164	152	0.134	0.27	0.122	436	0.143	ND	5
15-SWCS-T7-3-7d	525	0.101	17.3	0.00811	38.3	0.483	ND	0.164	160	0.134	0.28	0.122	373	0.143	ND	5
15-SWCS-T7-3-14d	498	0.101	17.8	0.00811	35.6	0.483	ND	0.164	149	0.134	0.243	0.122	377	0.143	ND	5
15-SWCS-T7-3-28d	493	0.168	3.09	0.0135	34.8	0.806	ND	0.274	154	0.223	0.492	0.204	318	0.239	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T7-3-42d	514	0.168	29.6	0.0135	33.2	0.806	ND	0.274	145	0.223	ND	0.204	421	0.239	ND	5
15-SWCS-T7-3-49d	495	0.168	81.8	0.0135	29.3	0.806	ND	0.274	130	0.223	ND	0.204	471	0.239	ND	5
15-SWCS-T7-3-63d	411	0.168	61	0.0135	30.6	0.806	ND	0.274	162	0.223	0.39	0.204	367	0.239	ND	5
15-SWCS-T7-3-90d	411	0.168	23.2	0.0135	30.2	0.806	ND	0.274	148	0.223	ND	0.204	300	0.239	ND	0.5
15-SWCS-T7-3-140d	466	0.168	0.95	0.0135	36.1	0.806	ND	0.274	150	0.223	0.295	0.204	300	0.239	ND	5
15-SWCS-T7-4-0.08d	533	0.101	86.9	0.00811	28.6	0.483	ND	0.164	147	0.134	0.246	0.122	483	0.143	ND	10
15-SWCS-T7-4-1d	585	0.101	39.4	0.00811	31.6	0.483	0.28	0.164	159	0.134	0.292	0.122	448	0.143	ND	5
15-SWCS-T7-4-2d	547	0.101	56.4	0.00811	29.8	0.483	0.23	0.164	153	0.134	0.264	0.122	437	0.143	ND	5
15-SWCS-T7-4-7d	529	0.101	14.9	0.00811	37.9	0.483	ND	0.164	158	0.134	0.417	0.122	375	0.143	ND	5
15-SWCS-T7-4-14d	507	0.101	11.5	0.00811	35.8	0.483	ND	0.164	149	0.134	0.291	0.122	372	0.143	ND	5
15-SWCS-T7-4-28d	487	0.168	1.85	0.0135	34.6	0.806	ND	0.274	151	0.223	0.427	0.204	316	0.239	ND	5
15-SWCS-T7-4-42d	510	0.168	26.4	0.0135	33.6	0.806	ND	0.274	145	0.223	ND	0.204	417	0.239	ND	5
15-SWCS-T7-4-49d	501	0.168	82.6	0.0135	29.7	0.806	ND	0.274	132	0.223	0.204	0.204	476	0.239	ND	5
15-SWCS-T7-4-63d	415	0.168	60	0.0135	30.4	0.806	ND	0.274	163	0.223	0.38	0.204	365	0.239	ND	5
15-SWCS-T7-4-90d	421	0.168	21.1	0.0135	30.3	0.806	ND	0.274	150	0.223	ND	0.204	301	0.239	ND	0.5
15-SWCS-T7-4-140d	476	0.168	2.21	0.0135	36.2	0.806	ND	0.274	153	0.223	0.311	0.204	316	0.239	ND	5
15-SWCS-T8-1-0.08d	12.1	0.101	0.0202	0.00811	2.35	0.483	ND	0.164	20.4	0.134	ND	0.122	0.464	0.143	ND	10
15-SWCS-T8-1-1d	84.5	0.101	0.0806	0.00811	8.11	0.483	0.599	0.164	83.3	0.134	ND	0.122	3.27	0.143	16.0	5
15-SWCS-T8-1-2d	62.9	0.101	0.0318	0.00811	3.79	0.483	0.956	0.164	40.1	0.134	ND	0.122	1.64	0.143	6.49	5
15-SWCS-T8-1-7d	135	0.101	0.0279	0.00811	12.5	0.483	1.77	0.164	119	0.134	0.189	0.122	2.76	0.143	18.4	5
15-SWCS-T8-1-14d	117	0.101	0.0145	0.00811	11	0.483	2.84	0.164	102	0.134	ND	0.122	2.6	0.143	23.7	5
15-SWCS-T8-1-28d	104	0.168	ND	0.0135	9.82	0.806	3.56	0.274	111	0.223	0.247	0.204	2.92	0.239	27.1	5
15-SWCS-T8-1-42d	84.5	0.168	0.0199	0.0135	7.05	0.806	4.78	0.274	67.5	0.223	ND	0.204	3.21	0.239	24.8	5
15-SWCS-T8-1-49d	59.5	0.168	0.0386	0.0135	2.71	0.806	4.68	0.274	28.6	0.223	ND	0.204	3.62	0.239	7.90	5
15-SWCS-T8-1-63d	67.4	0.168	0.038	0.0135	4.88	0.806	5.45	0.274	52.3	0.223	ND	0.204	3.22	0.239	8.10	5
15-SWCS-T8-1-90d	79.1	0.168	0.0244	0.0135	6.68	0.806	4.83	0.274	65.6	0.223	ND	0.204	3.26	0.239	3.13	0.5
15-SWCS-T8-1-140d	74	0.168	0.0179	0.0135	9.67	0.806	5.06	0.274	78.2	0.223	ND	0.204	3.34	0.239	41.2	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T8-2-0.08d	10.6	0.101	0.019	0.00811	2.07	0.483	ND	0.164	18	0.134	ND	0.122	0.388	0.143	ND	10
15-SWCS-T8-2-1d	85.2	0.101	0.0207	0.00811	7.87	0.483	0.665	0.164	81.4	0.134	ND	0.122	2.57	0.143	17.1	5
15-SWCS-T8-2-2d	65.2	0.101	0.0276	0.00811	3.77	0.483	1.02	0.164	40.8	0.134	ND	0.122	1.53	0.143	6.21	5
15-SWCS-T8-2-7d	155	0.101	0.0188	0.00811	14.4	0.483	1.94	0.164	138	0.134	0.22	0.122	2.81	0.143	25.4	5
15-SWCS-T8-2-14d	120	0.101	0.0148	0.00811	11.1	0.483	2.99	0.164	103	0.134	ND	0.122	2.51	0.143	25.4	5
15-SWCS-T8-2-28d	105	0.168	ND	0.0135	9.74	0.806	3.56	0.274	110	0.223	0.215	0.204	2.71	0.239	31.4	5
15-SWCS-T8-2-42d	86.9	0.168	0.019	0.0135	7.25	0.806	4.87	0.274	67.5	0.223	ND	0.204	3.11	0.239	21.5	5
15-SWCS-T8-2-49d	63.9	0.168	0.0349	0.0135	3.05	0.806	4.78	0.274	28.9	0.223	ND	0.204	3.63	0.239	8.90	5
15-SWCS-T8-2-63d	73.3	0.168	0.0318	0.0135	5.13	0.806	5.3	0.274	51	0.223	ND	0.204	3.22	0.239	9.90	5
15-SWCS-T8-2-90d	75	0.168	0.0236	0.0135	6.41	0.806	4.97	0.274	62.7	0.223	0.229	0.204	3.04	0.239	3.22	0.5
15-SWCS-T8-2-140d	74.5	0.168	0.0199	0.0135	9.97	0.806	5.32	0.274	79	0.223	ND	0.204	3.26	0.239	42.6	5
15-SWCS-T8-3-0.08d	503	0.101	92.7	0.00811	28.6	0.483	ND	0.164	162	0.134	0.242	0.122	486	0.143	ND	10
15-SWCS-T8-3-1d	616	0.101	20.9	0.00811	35.5	0.483	0.223	0.164	234	0.134	0.242	0.122	474	0.143	8.83	5
15-SWCS-T8-3-2d	595	0.101	27.3	0.00811	32.3	0.483	0.342	0.164	201	0.134	0.241	0.122	454	0.143	9.70	5
15-SWCS-T8-3-7d	635	0.101	1.22	0.00811	42.6	0.483	0.409	0.164	265	0.134	0.425	0.122	408	0.143	20.8	5
15-SWCS-T8-3-14d	557	0.101	2.66	0.00811	38.6	0.483	ND	0.164	232	0.134	0.239	0.122	386	0.143	26.0	5
15-SWCS-T8-3-28d	515	0.168	0.115	0.0135	37.3	0.806	ND	0.274	247	0.223	0.484	0.204	329	0.239	40.5	5
15-SWCS-T8-3-42d	535	0.168	1.75	0.0135	34.9	0.806	ND	0.274	205	0.223	ND	0.204	414	0.239	37.3	5
15-SWCS-T8-3-49d	513	0.168	57.5	0.0135	30.6	0.806	ND	0.274	157	0.223	ND	0.204	469	0.239	12.2	5
15-SWCS-T8-3-63d	425	0.168	32.8	0.0135	31.9	0.806	ND	0.274	209	0.223	0.36	0.204	363	0.239	14.7	5
15-SWCS-T8-3-90d	442	0.168	2.19	0.0135	32.9	0.806	ND	0.274	222	0.223	ND	0.204	310	0.239	5.00	0.5
15-SWCS-T8-3-140d	476	0.168	0.238	0.0135	39.9	0.806	ND	0.274	240	0.223	0.268	0.204	337	0.239	71.3	5
15-SWCS-T8-4-0.08d	502	0.101	92.2	0.00811	28.3	0.483	ND	0.164	162	0.134	0.263	0.122	478	0.143	ND	10
15-SWCS-T8-4-1d	631	0.101	14.6	0.00811	36.5	0.483	0.27	0.164	243	0.134	0.224	0.122	478	0.143	10.2	5
15-SWCS-T8-4-2d	600	0.101	25.8	0.00811	32.1	0.483	0.37	0.164	203	0.134	0.259	0.122	455	0.143	9.12	5
15-SWCS-T8-4-7d	636	0.101	0.893	0.00811	42.7	0.483	0.384	0.164	272	0.134	0.448	0.122	410	0.143	23.2	5
15-SWCS-T8-4-14d	536	0.101	0.666	0.00811	38.3	0.483	ND	0.164	229	0.134	0.243	0.122	387	0.143	24.2	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T8-4-28d	513	0.168	0.109	0.0135	37.5	0.806	ND	0.274	247	0.223	0.448	0.204	325	0.239	38.5	5
15-SWCS-T8-4-42d	537	0.168	1.75	0.0135	35.3	0.806	ND	0.274	205	0.223	ND	0.204	418	0.239	29.1	5
15-SWCS-T8-4-49d	524	0.168	49.9	0.0135	31.1	0.806	ND	0.274	162	0.223	ND	0.204	467	0.239	10.7	5
15-SWCS-T8-4-63d	424	0.168	33.1	0.0135	33.3	0.806	ND	0.274	220	0.223	0.319	0.204	366	0.239	15.2	5
15-SWCS-T8-4-90d	417	0.168	3.28	0.0135	32.1	0.806	ND	0.274	213	0.223	0.285	0.204	303	0.239	4.87	0.5
15-SWCS-T8-4-140d	504	0.168	0.149	0.0135	41	0.806	ND	0.274	256	0.223	0.22	0.204	341	0.239	75.3	5
15-SWCS-T9-1-0.08d	20.4	0.101	0.138	0.00811	2.94	0.483	0.229	0.164	4.23	0.134	ND	0.122	3.69	0.143	ND	10
15-SWCS-T9-1-1d	48.3	0.101	0.0555	0.00811	3.78	0.483	1.16	0.164	5.92	0.134	ND	0.122	1.21	0.143	ND	5
15-SWCS-T9-1-2d	34.8	0.101	0.124	0.00811	1.59	0.483	1.49	0.164	3.19	0.134	ND	0.122	2.12	0.143	ND	5
15-SWCS-T9-1-7d	83	0.101	0.0716	0.00811	5.89	0.483	3.58	0.164	9.06	0.134	0.188	0.122	2.17	0.143	10.2	5
15-SWCS-T9-1-14d	75.3	0.101	0.0612	0.00811	3.79	0.483	4.9	0.164	5.57	0.134	ND	0.122	2.44	0.143	9.80	5
15-SWCS-T9-1-28d	78.8	0.168	0.0389	0.0135	1.74	0.806	5.44	0.274	5.5	0.223	0.222	0.204	2.66	0.239	12.5	5
15-SWCS-T9-1-42d	66.8	0.168	0.0673	0.0135	2.04	0.806	6.14	0.274	3.31	0.223	ND	0.204	2.59	0.239	8.90	5
15-SWCS-T9-1-49d	47.6	0.168	0.136	0.0135	1	0.806	5.71	0.274	1.6	0.223	ND	0.204	2.31	0.239	ND	5
15-SWCS-T9-1-63d	51.1	0.168	0.118	0.0135	1.5	0.806	6.48	0.274	3.35	0.223	ND	0.204	2.04	0.239	ND	5
15-SWCS-T9-1-90d	60.9	0.168	0.05	0.0135	2.31	0.806	6.51	0.274	4.04	0.223	0.215	0.204	2.2	0.239	1.19	0.5
15-SWCS-T9-1-140d	65.6	0.168	0.0326	0.0135	4.16	0.806	6.86	0.274	5.29	0.223	ND	0.204	2.44	0.239	17.6	5
15-SWCS-T9-2-0.08d	17.9	0.101	0.0279	0.00811	2.59	0.483	0.217	0.164	3.72	0.134	ND	0.122	0.364	0.143	ND	10
15-SWCS-T9-2-1d	44.3	0.101	0.0598	0.00811	3.37	0.483	1.06	0.164	6.89	0.134	ND	0.122	1.17	0.143	ND	5
15-SWCS-T9-2-2d	37.3	0.101	0.0782	0.00811	1.66	0.483	1.68	0.164	3.03	0.134	ND	0.122	1.14	0.143	ND	5
15-SWCS-T9-2-7d	87.8	0.101	0.0786	0.00811	5.73	0.483	4.35	0.164	8.65	0.134	0.217	0.122	2.19	0.143	10.0	5
15-SWCS-T9-2-14d	75.7	0.101	0.0651	0.00811	4.2	0.483	5.15	0.164	5.86	0.134	ND	0.122	2.31	0.143	9.80	5
15-SWCS-T9-2-28d	79.2	0.168	0.0377	0.0135	2.09	0.806	5.65	0.274	5.83	0.223	0.231	0.204	2.63	0.239	15.1	5
15-SWCS-T9-2-42d	64	0.168	0.0824	0.0135	2.03	0.806	6.38	0.274	3.3	0.223	ND	0.204	2.58	0.239	9.00	5
15-SWCS-T9-2-49d	41.9	0.168	0.153	0.0135	ND	0.806	5.91	0.274	1.51	0.223	ND	0.204	2.26	0.239	ND	5
15-SWCS-T9-2-63d	55.1	0.168	0.103	0.0135	1.69	0.806	6.7	0.274	2.9	0.223	ND	0.204	2.26	0.239	ND	5
15-SWCS-T9-2-90d	61.6	0.168	0.045	0.0135	2.13	0.806	6.48	0.274	3.76	0.223	ND	0.204	2.28	0.239	1.32	0.5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T9-2-140d	61.9	0.168	0.0358	0.0135	4.1	0.806	6.93	0.274	4.91	0.223	ND	0.204	2.46	0.239	17.1	5
15-SWCS-T9-3-0.08d	514	0.101	102	0.0811	29.3	0.483	ND	0.164	141	0.134	0.281	0.122	493	0.143	ND	10
15-SWCS-T9-3-1d	600	0.101	42	0.00811	32.7	0.483	0.449	0.164	148	0.134	0.302	0.122	463	0.143	6.44	5
15-SWCS-T9-3-2d	554	0.101	70.5	0.00811	28.8	0.483	0.268	0.164	147	0.134	0.292	0.122	454	0.143	ND	5
15-SWCS-T9-3-7d	551	0.101	29.5	0.00811	34.6	0.483	ND	0.164	140	0.134	0.391	0.122	403	0.143	13.0	5
15-SWCS-T9-3-14d	485	0.101	54.5	0.00811	32	0.483	ND	0.164	130	0.134	0.288	0.122	417	0.143	11.4	5
15-SWCS-T9-3-28d	454	0.168	49.2	0.0135	29.6	0.806	ND	0.274	127	0.223	0.558	0.204	363	0.239	20.9	5
15-SWCS-T9-3-42d	478	0.168	81.7	0.0135	29.8	0.806	ND	0.274	127	0.223	0.386	0.204	465	0.239	9.20	5
15-SWCS-T9-3-49d	492	0.168	103	0.0135	28.3	0.806	ND	0.274	126	0.223	ND	0.204	501	0.239	ND	5
15-SWCS-T9-3-63d	399	0.168	96.1	0.0135	28.5	0.806	ND	0.274	148	0.223	0.366	0.204	397	0.239	ND	5
15-SWCS-T9-3-90d	371	0.168	88.4	0.0135	27.4	0.806	ND	0.274	135	0.223	ND	0.204	349	0.239	2.31	0.5
15-SWCS-T9-3-140d	408	0.168	71.9	0.0135	31.8	0.806	ND	0.274	131	0.223	0.279	0.204	368	0.239	25.4	5
15-SWCS-T9-4-0.08d	516	0.101	99	0.0811	29.4	0.483	ND	0.164	141	0.134	0.232	0.122	486	0.143	ND	10
15-SWCS-T9-4-1d	604	0.101	42.8	0.00811	32.5	0.483	0.435	0.164	150	0.134	0.258	0.122	462	0.143	7.14	5
15-SWCS-T9-4-2d	558	0.101	69.9	0.00811	28.7	0.483	0.36	0.164	146	0.134	0.299	0.122	453	0.143	ND	5
15-SWCS-T9-4-7d	542	0.101	31.3	0.00811	34.7	0.483	ND	0.164	139	0.134	0.389	0.122	401	0.143	12.2	5
15-SWCS-T9-4-14d	479	0.101	54.1	0.00811	31.4	0.483	ND	0.164	129	0.134	0.247	0.122	414	0.143	11.5	5
15-SWCS-T9-4-28d	464	0.168	41.8	0.0135	29.7	0.806	ND	0.274	129	0.223	0.469	0.204	359	0.239	19.1	5
15-SWCS-T9-4-42d	495	0.168	78.4	0.0135	30	0.806	ND	0.274	129	0.223	0.262	0.204	469	0.239	12.0	5
15-SWCS-T9-4-49d	484	0.168	103	0.0135	28	0.806	ND	0.274	124	0.223	ND	0.204	503	0.239	ND	5
15-SWCS-T9-4-63d	394	0.168	97.6	0.0135	28.8	0.806	ND	0.274	148	0.223	0.353	0.204	401	0.239	5.00	5
15-SWCS-T9-4-90d	385	0.168	79.7	0.0135	27.7	0.806	ND	0.274	134	0.223	ND	0.204	345	0.239	2.28	0.5
15-SWCS-T9-4-140d	427	0.168	64.3	0.0135	32.4	0.806	ND	0.274	133	0.223	0.314	0.204	369	0.239	30.1	5
15-SWCS-T10-1-0.08d	19.4	0.101	0.0364	0.00811	3.35	0.483	0.192	0.164	29.9	0.134	ND	0.122	1.06	0.143	ND	10
15-SWCS-T10-1-1d	70	0.101	0.0268	0.00811	5.83	0.483	0.767	0.164	60.5	0.134	ND	0.122	2.1	0.143	7.02	5
15-SWCS-T10-1-2d	43.1	0.101	0.0416	0.00811	2.22	0.483	0.971	0.164	25.3	0.134	ND	0.122	1.14	0.143	ND	5
15-SWCS-T10-1-7d	127	0.101	0.0495	0.00811	9.8	0.483	3.12	0.164	93.9	0.134	0.178	0.122	3.14	0.143	11.9	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T10-1-14d	82.3	0.101	0.0466	0.00811	6.57	0.483	3.82	0.164	58.4	0.134	ND	0.122	3.07	0.143	11.9	5
15-SWCS-T10-1-28d	76.6	0.168	0.0233	0.0135	4.21	0.806	5.33	0.274	53.5	0.223	0.214	0.204	3.83	0.239	10.8	5
15-SWCS-T10-1-42d	62.3	0.168	0.0484	0.0135	3.41	0.806	6.01	0.274	29.8	0.223	ND	0.204	4.03	0.239	8.20	5
15-SWCS-T10-1-49d	45.6	0.168	0.123	0.0135	1.25	0.806	5.75	0.274	11.5	0.223	ND	0.204	4	0.239	ND	5
15-SWCS-T10-1-63d	50.1	0.168	0.0895	0.0135	2.32	0.806	6.72	0.274	21	0.223	ND	0.204	3.49	0.239	ND	5
15-SWCS-T10-1-90d	51.7	0.168	0.0699	0.0135	2.75	0.806	6.76	0.274	25.7	0.223	ND	0.204	3.49	0.239	1.24	0.5
15-SWCS-T10-1-140d	43.9	0.168	0.0383	0.0135	4.67	0.806	7.6	0.274	33.4	0.223	ND	0.204	3.71	0.239	17.2	5
15-SWCS-T10-2-0.08d	16.2	0.101	0.0211	0.00811	2.9	0.483	0.178	0.164	25.5	0.134	ND	0.122	0.581	0.143	ND	10
15-SWCS-T10-2-1d	103	0.101	0.0311	0.00811	7.75	0.483	0.984	0.164	78.1	0.134	ND	0.122	2.25	0.143	7.33	5
15-SWCS-T10-2-2d	69	0.101	0.0409	0.00811	3.25	0.483	1.49	0.164	35.8	0.134	ND	0.122	1.51	0.143	ND	5
15-SWCS-T10-2-7d	120	0.101	0.035	0.00811	9.19	0.483	2.91	0.164	86.8	0.134	0.213	0.122	2.77	0.143	12.2	5
15-SWCS-T10-2-14d	82.6	0.101	0.0436	0.00811	6.27	0.483	4.59	0.164	55.3	0.134	ND	0.122	3.31	0.143	12.7	5
15-SWCS-T10-2-28d	74.1	0.168	0.024	0.0135	4.48	0.806	5.58	0.274	54.8	0.223	0.25	0.204	3.74	0.239	12.7	5
15-SWCS-T10-2-42d	59	0.168	0.0555	0.0135	3.29	0.806	6.28	0.274	29	0.223	ND	0.204	3.65	0.239	8.70	5
15-SWCS-T10-2-49d	47.5	0.168	0.11	0.0135	1.25	0.806	5.64	0.274	12.5	0.223	ND	0.204	3.67	0.239	ND	5
15-SWCS-T10-2-63d	50.5	0.168	0.0905	0.0135	2.35	0.806	6.75	0.274	21.7	0.223	ND	0.204	3.47	0.239	6.00	5
15-SWCS-T10-2-90d	57.4	0.168	0.0593	0.0135	2.71	0.806	6.63	0.274	25.6	0.223	ND	0.204	3.43	0.239	1.21	0.5
15-SWCS-T10-2-140d	57.9	0.168	0.0313	0.0135	4.72	0.806	7.2	0.274	33.6	0.223	ND	0.204	3.82	0.239	15.8	5
15-SWCS-T10-3-0.08d	535	0.101	83.8	0.00811	31.6	0.483	ND	0.164	188	0.134	0.249	0.122	486	0.143	ND	10
15-SWCS-T10-3-1d	607	0.101	24.1	0.00811	34	0.483	0.265	0.164	219	0.134	0.284	0.122	468	0.143	7.20	5
15-SWCS-T10-3-2d	581	0.101	42.4	0.00811	30.3	0.483	0.394	0.164	187	0.134	0.28	0.122	456	0.143	ND	5
15-SWCS-T10-3-7d	585	0.101	2.86	0.00811	38.3	0.483	0.382	0.164	230	0.134	0.337	0.122	415	0.143	15.6	5
15-SWCS-T10-3-14d	518	0.101	20.2	0.00811	34	0.483	ND	0.164	185	0.134	0.224	0.122	423	0.143	12.5	5
15-SWCS-T10-3-28d	474	0.168	27.3	0.0135	32.3	0.806	ND	0.274	189	0.223	0.486	0.204	378	0.239	13.0	5
15-SWCS-T10-3-42d	496	0.168	60.5	0.0135	31.9	0.806	ND	0.274	165	0.223	ND	0.204	468	0.239	11.7	5
15-SWCS-T10-3-49d	492	0.168	95.3	0.0135	28.5	0.806	ND	0.274	139	0.223	ND	0.204	498	0.239	ND	5
15-SWCS-T10-3-63d	394	0.168	90	0.0135	30.7	0.806	ND	0.274	181	0.223	0.378	0.204	406	0.239	6.50	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T10-3-90d	398	0.168	63.9	0.0135	28.2	0.806	ND	0.274	174	0.223	ND	0.204	349	0.239	2.53	0.5
15-SWCS-T10-3-140d	429	0.168	49.5	0.0135	33.8	0.806	ND	0.274	181	0.223	0.385	0.204	379	0.239	30.5	5
15-SWCS-T10-4-0.08d	507	0.101	99.1	0.0811	28.9	0.483	ND	0.164	162	0.134	0.225	0.122	487	0.143	ND	10
15-SWCS-T10-4-1d	600	0.101	31.3	0.00811	33.3	0.483	0.248	0.164	214	0.134	0.216	0.122	467	0.143	5.25	5
15-SWCS-T10-4-2d	579	0.101	45.7	0.00811	30.6	0.483	0.444	0.164	186	0.134	0.296	0.122	456	0.143	ND	5
15-SWCS-T10-4-7d	566	0.101	4.45	0.00811	37.5	0.483	0.227	0.164	218	0.134	0.356	0.122	412	0.143	11.3	5
15-SWCS-T10-4-14d	500	0.101	27.8	0.00811	34.1	0.483	ND	0.164	184	0.134	0.285	0.122	417	0.143	13.0	5
15-SWCS-T10-4-28d	474	0.168	15.6	0.0135	31.9	0.806	ND	0.274	190	0.223	0.445	0.204	363	0.239	14.2	5
15-SWCS-T10-4-42d	488	0.168	57.8	0.0135	30.8	0.806	ND	0.274	161	0.223	0.236	0.204	453	0.239	9.40	5
15-SWCS-T10-4-49d	506	0.168	96.3	0.0135	29.6	0.806	ND	0.274	143	0.223	0.233	0.204	503	0.239	ND	5
15-SWCS-T10-4-63d	397	0.168	89	0.0135	29.2	0.806	ND	0.274	175	0.223	0.308	0.204	407	0.239	6.90	5
15-SWCS-T10-4-90d	392	0.168	65.8	0.0135	28.4	0.806	ND	0.274	173	0.223	ND	0.204	345	0.239	1.99	0.5
15-SWCS-T10-4-140d	423	0.168	59.7	0.0135	33.9	0.806	ND	0.274	184	0.223	0.313	0.204	386	0.239	31.4	5
15-SWCS-T11-1-0.08d	1.19	0.101	0.0155	0.00811	0.973	0.483	0.23	0.164	12.3	0.134	ND	0.122	1.43	0.143	ND	5
15-SWCS-T11-1-1d	10.3	0.101	0.0486	0.00811	4.01	0.483	1.67	0.164	54.9	0.134	0.13	0.122	7.45	0.143	9.00	5
15-SWCS-T11-1-2d	14.9	0.168	0.124	0.0135	1.17	0.806	2.63	0.274	40.8	0.223	ND	0.204	5.53	0.239	8.30	5
15-SWCS-T11-1-7d	31.7	0.101	0.0559	0.00811	8.44	0.483	7.85	0.164	109	0.134	ND	0.122	12.3	0.143	25.9	5
15-SWCS-T11-1-14d	31	0.101	0.1	0.00811	6.29	0.483	7.31	0.164	80.6	0.134	ND	0.122	8.15	0.143	12.7	5
15-SWCS-T11-1-28d	35.5	0.168	0.065	0.0135	6.87	0.806	8.83	0.274	93.5	0.223	ND	0.204	9.15	0.239	30.2	5
15-SWCS-T11-1-42d	32.9	0.168	0.0728	0.0135	5.04	0.806	7.8	0.274	73.9	0.223	ND	0.204	7.03	0.239	13.4	5
15-SWCS-T11-1-49d	25.8	0.168	0.143	0.0135	2.26	0.806	5.46	0.274	30	0.223	ND	0.204	4.53	0.239	ND	5
15-SWCS-T11-1-63d	32.1	0.168	0.104	0.0135	2.73	0.806	7.67	0.274	43.3	0.223	ND	0.204	6.01	0.239	11.3	5
15-SWCS-T11-1-90d	24.8	0.168	0.0494	0.0135	5.37	0.806	8.15	0.274	61.3	0.223	ND	0.204	6.2	0.239	1.24	0.5
15-SWCS-T11-1-140d	17.2	0.168	0.0335	0.0135	6.24	0.806	9.58	0.274	75.9	0.223	ND	0.204	6.47	0.239	1.02	0.5
15-SWCS-T11-2-0.08d	1.59	0.101	0.0153	0.00811	1.09	0.483	0.236	0.164	14.3	0.134	ND	0.122	1.89	0.143	ND	5
15-SWCS-T11-2-1d	16	0.101	0.0646	0.00811	5.36	0.483	2.55	0.164	71.6	0.134	ND	0.122	11.1	0.143	11.8	5
15-SWCS-T11-2-2d	14	0.168	0.113	0.0135	ND	0.806	2.25	0.274	34.6	0.223	ND	0.204	4.87	0.239	7.30	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T11-2-7d	33.5	0.101	0.0338	0.00811	8.6	0.483	8.04	0.164	113	0.134	ND	0.122	12.7	0.143	25.4	5
15-SWCS-T11-2-14d	31.3	0.101	0.0885	0.00811	6.54	0.483	7.51	0.164	82.4	0.134	ND	0.122	8.26	0.143	14.5	5
15-SWCS-T11-2-28d	35.8	0.168	0.0612	0.0135	7.25	0.806	8.99	0.274	98.4	0.223	ND	0.204	9.17	0.239	22.3	5
15-SWCS-T11-2-42d	28.2	0.168	0.0787	0.0135	5.23	0.806	7.92	0.274	75.5	0.223	ND	0.204	6.87	0.239	12.9	5
15-SWCS-T11-2-49d	25.7	0.168	0.146	0.0135	2.34	0.806	5.73	0.274	33.6	0.223	ND	0.204	4.83	0.239	ND	5
15-SWCS-T11-2-63d	31.7	0.168	0.0945	0.0135	2.92	0.806	7.87	0.274	47.2	0.223	ND	0.204	6.2	0.239	8.60	5
15-SWCS-T11-2-90d	28.6	0.168	0.0426	0.0135	5.43	0.806	8.31	0.274	63.3	0.223	ND	0.204	6.04	0.239	0.990	0.5
15-SWCS-T11-2-140d	14.7	0.168	0.033	0.0135	6.6	0.806	9.63	0.274	77.8	0.223	ND	0.204	6.34	0.239	1.01	0.5
15-SWCS-T11-3-0.08d	496	0.101	107	0.0811	30.1	0.483	ND	0.164	150	0.134	0.394	0.122	466	0.143	ND	5
15-SWCS-T11-3-1d	568	0.101	106	0.0811	39.4	0.483	0.668	0.164	234	0.134	0.41	0.122	528	0.143	13.6	5
15-SWCS-T11-3-2d	530	0.168	103	0.0135	32.7	0.806	0.377	0.274	186	0.223	0.596	0.204	466	0.239	8.60	5
15-SWCS-T11-3-7d	540	0.101	83.1	0.00811	39.9	0.483	ND	0.164	252	0.134	0.292	0.122	536	0.143	21.6	5
15-SWCS-T11-3-14d	473	0.101	79.8	0.00811	33.2	0.483	ND	0.164	198	0.134	0.247	0.122	466	0.143	12.1	5
15-SWCS-T11-3-28d	514	0.168	87.5	0.0135	34.4	0.806	ND	0.274	212	0.223	ND	0.204	502	0.239	19.1	5
15-SWCS-T11-3-42d	470	0.168	102	0.0135	31.5	0.806	ND	0.274	194	0.223	0.29	0.204	493	0.239	14.2	5
15-SWCS-T11-3-49d	385	0.168	115	0.0135	27.8	0.806	ND	0.274	163	0.223	0.315	0.204	432	0.239	ND	5
15-SWCS-T11-3-63d	419	0.168	111	0.0135	29	0.806	0.344	0.274	166	0.223	0.435	0.204	433	0.239	9.30	5
15-SWCS-T11-3-90d	379	0.168	105	0.0135	30.1	0.806	ND	0.274	170	0.223	0.219	0.204	403	0.239	1.16	0.5
15-SWCS-T11-3-140d	386	0.168	106	0.0135	30.5	0.806	ND	0.274	181	0.223	0.324	0.204	414	0.239	1.22	0.5
15-SWCS-T11-4-0.08d	494	0.101	104	0.0811	30	0.483	ND	0.164	148	0.134	0.458	0.122	464	0.143	ND	5
15-SWCS-T11-4-1d	560	0.101	105	0.0811	38.7	0.483	0.693	0.164	231	0.134	0.429	0.122	524	0.143	12.9	5
15-SWCS-T11-4-2d	515	0.168	104	0.0135	31.7	0.806	0.393	0.274	177	0.223	0.506	0.204	470	0.239	9.50	5
15-SWCS-T11-4-7d	557	0.101	83.7	0.00811	39.8	0.483	ND	0.164	257	0.134	0.329	0.122	540	0.143	21.7	5
15-SWCS-T11-4-14d	492	0.101	78.8	0.00811	33.4	0.483	ND	0.164	206	0.134	0.303	0.122	473	0.143	12.5	5
15-SWCS-T11-4-28d	503	0.168	85.1	0.0135	34	0.806	ND	0.274	212	0.223	0.206	0.204	493	0.239	20.0	5
15-SWCS-T11-4-42d	473	0.168	99.2	0.0135	33.5	0.806	ND	0.274	210	0.223	0.207	0.204	500	0.239	13.0	5
15-SWCS-T11-4-49d	387	0.168	117	0.0135	28.8	0.806	ND	0.274	172	0.223	ND	0.204	438	0.239	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T11-4-63d	413	0.168	108	0.0135	28.8	0.806	ND	0.274	165	0.223	0.44	0.204	424	0.239	11.5	5
15-SWCS-T11-4-90d	409	0.168	102	0.0135	31.6	0.806	ND	0.274	182	0.223	0.262	0.204	408	0.239	1.23	0.5
15-SWCS-T11-4-140d	394	0.168	110	0.0135	32.3	0.806	ND	0.274	189	0.223	0.304	0.204	418	0.239	1.32	0.5
15-SWCS-T12-1-0.08d	3.11	0.101	0.0713	0.00811	2.93	0.483	0.177	0.164	7.99	0.134	ND	0.122	0.563	0.143	5.00	5
15-SWCS-T12-1-1d	23.1	0.101	0.12	0.00811	10.4	0.483	1.86	0.164	32.1	0.134	ND	0.122	3.29	0.143	23.4	5
15-SWCS-T12-1-2d	18.5	0.168	0.192	0.0135	3.12	0.806	1.86	0.274	15.4	0.223	0.251	0.204	2.31	0.239	13.0	5
15-SWCS-T12-1-7d	44.1	0.101	0.0475	0.00811	14.3	0.483	5.53	0.164	44.6	0.134	ND	0.122	3.16	0.143	29.9	5
15-SWCS-T12-1-14d	44.5	0.101	0.148	0.00811	9.65	0.483	5.48	0.164	30.9	0.134	ND	0.122	2.83	0.143	13.3	5
15-SWCS-T12-1-28d	51.9	0.168	0.101	0.0135	9.18	0.806	6.46	0.274	31.3	0.223	ND	0.204	3.56	0.239	21.7	5
15-SWCS-T12-1-42d	36.8	0.168	0.146	0.0135	5.28	0.806	5.89	0.274	19.6	0.223	ND	0.204	2.91	0.239	12.9	5
15-SWCS-T12-1-49d	30.8	0.168	0.229	0.0135	2.18	0.806	4.66	0.274	7.93	0.223	ND	0.204	2.72	0.239	ND	5
15-SWCS-T12-1-63d	37.2	0.168	0.191	0.0135	2.49	0.806	6.05	0.274	10.6	0.223	0.216	0.204	3.03	0.239	10.4	5
15-SWCS-T12-1-90d	33	0.168	0.127	0.0135	4.9	0.806	6.07	0.274	14.2	0.223	ND	0.204	3.04	0.239	1.35	0.5
15-SWCS-T12-1-140d	32.6	0.168	0.079	0.0135	5.41	0.806	6.73	0.274	16.7	0.223	ND	0.204	3.17	0.239	1.24	0.5
15-SWCS-T12-2-0.08d	3.05	0.101	0.0252	0.00811	3.34	0.483	0.187	0.164	9.01	0.134	ND	0.122	0.345	0.143	7.30	5
15-SWCS-T12-2-1d	20.5	0.101	0.0815	0.00811	9.26	0.483	1.44	0.164	28.9	0.134	ND	0.122	2.55	0.143	22.0	5
15-SWCS-T12-2-2d	21.5	0.168	0.166	0.0135	3.24	0.806	2	0.274	16	0.223	0.26	0.204	2.34	0.239	14.2	5
15-SWCS-T12-2-7d	48.5	0.101	0.039	0.00811	13.5	0.483	5.47	0.164	42	0.134	ND	0.122	3.51	0.143	28.5	5
15-SWCS-T12-2-14d	47.5	0.101	0.154	0.00811	10.1	0.483	5.41	0.164	32.1	0.134	ND	0.122	3	0.143	13.9	5
15-SWCS-T12-2-28d	60.5	0.168	0.0875	0.0135	9.11	0.806	6.41	0.274	31.3	0.223	ND	0.204	3.56	0.239	22.4	5
15-SWCS-T12-2-42d	38.6	0.168	0.135	0.0135	5.48	0.806	5.83	0.274	20.5	0.223	ND	0.204	3.02	0.239	10.2	5
15-SWCS-T12-2-49d	30.8	0.168	0.215	0.0135	2.08	0.806	4.54	0.274	8.26	0.223	ND	0.204	2.6	0.239	ND	5
15-SWCS-T12-2-63d	39.2	0.168	0.199	0.0135	2.55	0.806	6.15	0.274	10.5	0.223	ND	0.204	3.51	0.239	9.40	5
15-SWCS-T12-2-90d	43.5	0.168	0.083	0.0135	4.8	0.806	6.35	0.274	13.5	0.223	ND	0.204	3.04	0.239	1.12	0.5
15-SWCS-T12-2-140d	36.3	0.168	0.0674	0.0135	5.26	0.806	6.66	0.274	15.8	0.223	ND	0.204	2.97	0.239	1.14	0.5
15-SWCS-T12-3-0.08d	490	0.101	100	0.0811	32.9	0.483	ND	0.164	142	0.134	0.422	0.122	457	0.143	7.40	5
15-SWCS-T12-3-1d	562	0.101	105	0.0811	42.5	0.483	0.352	0.164	178	0.134	0.425	0.122	511	0.143	23.6	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T12-3-2d	521	0.168	107	0.0135	33.4	0.806	ND	0.274	151	0.223	0.611	0.204	463	0.239	12.6	5
15-SWCS-T12-3-7d	557	0.101	89.8	0.00811	44.2	0.483	ND	0.164	181	0.134	0.343	0.122	520	0.143	32.2	5
15-SWCS-T12-3-14d	479	0.101	83.7	0.00811	36	0.483	ND	0.164	151	0.134	0.312	0.122	455	0.143	13.7	5
15-SWCS-T12-3-28d	513	0.168	91.1	0.0135	36.9	0.806	ND	0.274	161	0.223	0.248	0.204	473	0.239	19.1	5
15-SWCS-T12-3-42d	474	0.168	107	0.0135	33.2	0.806	ND	0.274	163	0.223	0.278	0.204	485	0.239	10.0	5
15-SWCS-T12-3-49d	392	0.168	119	0.0135	28.5	0.806	ND	0.274	150	0.223	0.249	0.204	435	0.239	ND	5
15-SWCS-T12-3-63d	439	0.168	112	0.0135	31.3	0.806	ND	0.274	146	0.223	0.289	0.204	427	0.239	10.3	5
15-SWCS-T12-3-90d	386	0.168	107	0.0135	30.8	0.806	ND	0.274	139	0.223	0.272	0.204	382	0.239	1.07	0.5
15-SWCS-T12-3-140d	403	0.168	110	0.0135	32.3	0.806	ND	0.274	141	0.223	0.35	0.204	404	0.239	1.18	0.5
15-SWCS-T12-4-0.08d	507	0.101	106	0.0811	31.5	0.483	ND	0.164	141	0.134	0.426	0.122	465	0.143	7.80	5
15-SWCS-T12-4-1d	576	0.101	104	0.0811	44.7	0.483	0.409	0.164	189	0.134	0.412	0.122	514	0.143	21.5	5
15-SWCS-T12-4-2d	543	0.168	105	0.0135	35.7	0.806	ND	0.274	160	0.223	0.443	0.204	463	0.239	12.7	5
15-SWCS-T12-4-7d	553	0.101	86.6	0.00811	45.2	0.483	ND	0.164	184	0.134	0.242	0.122	516	0.143	25.4	5
15-SWCS-T12-4-14d	475	0.101	82.4	0.00811	35.4	0.483	ND	0.164	148	0.134	0.208	0.122	454	0.143	12.7	5
15-SWCS-T12-4-28d	510	0.168	91.8	0.0135	35.5	0.806	ND	0.274	156	0.223	0.284	0.204	475	0.239	17.5	5
15-SWCS-T12-4-42d	478	0.168	108	0.0135	33.2	0.806	ND	0.274	160	0.223	0.331	0.204	491	0.239	10.1	5
15-SWCS-T12-4-49d	390	0.168	118	0.0135	30	0.806	ND	0.274	155	0.223	0.238	0.204	436	0.239	ND	5
15-SWCS-T12-4-63d	430	0.168	112	0.0135	30.4	0.806	ND	0.274	143	0.223	0.536	0.204	430	0.239	8.60	5
15-SWCS-T12-4-90d	393	0.168	108	0.0135	30.6	0.806	ND	0.274	138	0.223	0.221	0.204	396	0.239	1.14	0.5
15-SWCS-T12-4-140d	411	0.168	108	0.0135	31.9	0.806	ND	0.274	140	0.223	0.308	0.204	412	0.239	1.27	0.5
15-SWCS-T13-1-0.08d	4.04	0.101	0.0595	0.00811	2.61	0.483	0.39	0.164	26.3	0.134	ND	0.122	6.71	0.143	5.10	5
15-SWCS-T13-1-1d	18.5	0.101	0.0827	0.00811	7.28	0.483	3.02	0.164	86	0.134	0.14	0.122	19.6	0.143	12.0	5
15-SWCS-T13-1-2d	21.6	0.168	0.14	0.0135	2.57	0.806	4.07	0.274	46	0.223	0.217	0.204	6.98	0.239	6.90	5
15-SWCS-T13-1-7d	52.1	0.101	0.0313	0.00811	10.4	0.483	11.2	0.164	100	0.134	ND	0.122	18.2	0.143	18.4	5
15-SWCS-T13-1-14d	55.3	0.101	0.116	0.00811	7.24	0.483	10.1	0.164	61.7	0.134	ND	0.122	11.5	0.143	9.60	5
15-SWCS-T13-1-28d	66.1	0.168	0.0558	0.0135	7.06	0.806	11.2	0.274	64.4	0.223	ND	0.204	10.4	0.239	13.7	5
15-SWCS-T13-1-42d	57.8	0.168	0.058	0.0135	5.05	0.806	10.1	0.274	45.6	0.223	ND	0.204	6.87	0.239	6.70	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T13-1-49d	41.1	0.168	0.11	0.0135	2.46	0.806	7.02	0.274	19.5	0.223	ND	0.204	3.73	0.239	ND	5
15-SWCS-T13-1-63d	52	0.168	0.174	0.0135	2.96	0.806	9.19	0.274	27.4	0.223	ND	0.204	5.81	0.239	5.90	5
15-SWCS-T13-1-90d	49	0.168	0.0592	0.0135	5.34	0.806	9.55	0.274	38.9	0.223	ND	0.204	5.89	0.239	0.880	0.5
15-SWCS-T13-1-140d	41	0.168	0.0388	0.0135	7	0.806	10.6	0.274	56.8	0.223	ND	0.204	6.66	0.239	1.47	0.5
15-SWCS-T13-2-0.08d	3.44	0.101	0.0274	0.00811	2.26	0.483	0.361	0.164	24.3	0.134	ND	0.122	6.7	0.143	5.00	5
15-SWCS-T13-2-1d	25.2	0.101	0.0989	0.00811	8.93	0.483	4.18	0.164	106	0.134	0.139	0.122	28.3	0.143	11.8	5
15-SWCS-T13-2-2d	21.9	0.168	0.18	0.0135	2.72	0.806	4.3	0.274	46.2	0.223	0.262	0.204	7.29	0.239	6.60	5
15-SWCS-T13-2-7d	52.4	0.101	0.0244	0.00811	9.97	0.483	11	0.164	100	0.134	ND	0.122	18.2	0.143	18.8	5
15-SWCS-T13-2-14d	55.7	0.101	0.0923	0.00811	7.11	0.483	10.3	0.164	61.8	0.134	ND	0.122	11.3	0.143	10.9	5
15-SWCS-T13-2-28d	65.5	0.168	0.0528	0.0135	7.15	0.806	11.4	0.274	67.8	0.223	ND	0.204	10.5	0.239	14.4	5
15-SWCS-T13-2-42d	51.6	0.168	0.069	0.0135	5.17	0.806	10.2	0.274	47.5	0.223	ND	0.204	6.8	0.239	6.90	5
15-SWCS-T13-2-49d	40.4	0.168	0.11	0.0135	2.65	0.806	7.34	0.274	21.6	0.223	ND	0.204	3.87	0.239	ND	5
15-SWCS-T13-2-63d	47.6	0.168	0.112	0.0135	3.14	0.806	9.49	0.274	30.1	0.223	ND	0.204	5.85	0.239	6.30	5
15-SWCS-T13-2-90d	50.3	0.168	0.0552	0.0135	5.42	0.806	9.78	0.274	41.4	0.223	ND	0.204	6.21	0.239	0.940	0.5
15-SWCS-T13-2-140d	41.3	0.168	0.0346	0.0135	6.73	0.806	10.7	0.274	55.8	0.223	ND	0.204	6.48	0.239	1.36	0.5
15-SWCS-T13-3-0.08d	496	0.101	104	0.0811	30.9	0.483	ND	0.164	159	0.134	0.372	0.122	465	0.143	5.70	5
15-SWCS-T13-3-1d	556	0.101	96.8	0.00811	42.4	0.483	1.07	0.164	263	0.134	0.465	0.122	521	0.143	15.2	5
15-SWCS-T13-3-2d	517	0.168	101	0.0135	33.5	0.806	0.338	0.274	184	0.223	0.555	0.204	463	0.239	6.30	5
15-SWCS-T13-3-7d	551	0.101	77.6	0.00811	41.6	0.483	ND	0.164	241	0.134	0.259	0.122	529	0.143	18.4	5
15-SWCS-T13-3-14d	486	0.101	76.6	0.00811	34.9	0.483	ND	0.164	191	0.134	0.306	0.122	465	0.143	12.0	5
15-SWCS-T13-3-28d	511	0.168	80.9	0.0135	34.7	0.806	ND	0.274	197	0.223	0.246	0.204	485	0.239	20.9	5
15-SWCS-T13-3-42d	481	0.168	96.3	0.0135	33.1	0.806	ND	0.274	188	0.223	0.334	0.204	492	0.239	14.9	5
15-SWCS-T13-3-49d	399	0.168	115	0.0135	28.2	0.806	ND	0.274	162	0.223	0.288	0.204	432	0.239	ND	5
15-SWCS-T13-3-63d	435	0.168	108	0.0135	30.1	0.806	ND	0.274	161	0.223	0.46	0.204	430	0.239	9.70	5
15-SWCS-T13-3-90d	388	0.168	103	0.0135	30.9	0.806	ND	0.274	161	0.223	0.206	0.204	398	0.239	0.930	0.5
15-SWCS-T13-3-140d	392	0.168	103	0.0135	32	0.806	ND	0.274	170	0.223	0.307	0.204	411	0.239	1.01	0.5
15-SWCS-T13-4-0.08d	492	0.101	101	0.0811	30.3	0.483	ND	0.164	153	0.134	0.424	0.122	456	0.143	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T13-4-1d	561	0.101	100	0.0811	40.3	0.483	0.888	0.164	244	0.134	0.489	0.122	526	0.143	12.0	5
15-SWCS-T13-4-2d	517	0.168	101	0.0135	32.5	0.806	0.335	0.274	179	0.223	0.597	0.204	464	0.239	6.50	5
15-SWCS-T13-4-7d	557	0.101	78.4	0.00811	42.1	0.483	ND	0.164	254	0.134	0.249	0.122	531	0.143	19.1	5
15-SWCS-T13-4-14d	488	0.101	75.9	0.00811	34.4	0.483	ND	0.164	187	0.134	0.227	0.122	464	0.143	10.9	5
15-SWCS-T13-4-28d	509	0.168	81.5	0.0135	35.1	0.806	ND	0.274	193	0.223	ND	0.204	486	0.239	15.1	5
15-SWCS-T13-4-42d	487	0.168	97.4	0.0135	33.5	0.806	ND	0.274	190	0.223	0.214	0.204	496	0.239	13.0	5
15-SWCS-T13-4-49d	26.8	0.168	ND	0.0135	26.2	0.806	593	0.274	156	0.223	ND	0.204	73.9	0.239	ND	5
15-SWCS-T13-4-63d	425	0.168	108	0.0135	30.1	0.806	ND	0.274	161	0.223	0.373	0.204	428	0.239	9.30	5
15-SWCS-T13-4-90d	387	0.168	101	0.0135	31	0.806	ND	0.274	161	0.223	ND	0.204	397	0.239	0.880	0.5
15-SWCS-T13-4-140d	407	0.168	99.9	0.0135	32.3	0.806	ND	0.274	172	0.223	0.322	0.204	411	0.239	1.14	0.5
15-SWCS-T14-1-0.08d	20.6	0.101	0.0448	0.00811	2.23	0.483	ND	0.164	4.95	0.134	ND	0.122	0.421	0.143	ND	5
15-SWCS-T14-1-1d	84.3	0.101	0.0741	0.00811	6.45	0.483	0.872	0.164	14.5	0.134	0.183	0.122	1.9	0.143	7.10	5
15-SWCS-T14-1-2d	49.8	0.168	0.0809	0.0135	0.853	0.806	1.15	0.274	6.03	0.223	0.261	0.204	1.36	0.239	5.00	5
15-SWCS-T14-1-7d	130	0.101	0.0601	0.00811	9.92	0.483	2.45	0.164	21.8	0.134	0.124	0.122	2.27	0.143	14.6	5
15-SWCS-T14-1-14d	107	0.101	0.0372	0.00811	6.29	0.483	3.01	0.164	13.1	0.134	ND	0.122	2.06	0.143	9.20	5
15-SWCS-T14-1-28d	116	0.168	0.0249	0.0135	6.07	0.806	3.73	0.274	13.9	0.223	ND	0.204	2.25	0.239	12.6	5
15-SWCS-T14-1-42d	87	0.168	0.0357	0.0135	4.22	0.806	4.34	0.274	10.3	0.223	ND	0.204	2.35	0.239	12.0	5
15-SWCS-T14-1-49d	57.3	0.168	0.0503	0.0135	1.71	0.806	4.16	0.274	4.64	0.223	ND	0.204	2.2	0.239	ND	5
15-SWCS-T14-1-63d	75.2	0.168	0.11	0.0135	2.59	0.806	5.26	0.274	7.33	0.223	ND	0.204	2.75	0.239	10.0	5
15-SWCS-T14-1-90d	80	0.168	0.0424	0.0135	5.17	0.806	4.72	0.274	10.3	0.223	ND	0.204	2.37	0.239	1.02	0.5
15-SWCS-T14-1-140d	81.4	0.168	0.0504	0.0135	6.31	0.806	4.65	0.274	13.6	0.223	ND	0.204	2.41	0.239	1.36	0.5
15-SWCS-T14-2-0.08d	24.8	0.101	0.0202	0.00811	2.59	0.483	ND	0.164	5.65	0.134	0.136	0.122	0.37	0.143	ND	5
15-SWCS-T14-2-1d	81.5	0.101	0.0687	0.00811	5.82	0.483	0.788	0.164	13.1	0.134	0.247	0.122	1.74	0.143	5.70	5
15-SWCS-T14-2-2d	55.3	0.168	0.0716	0.0135	1.19	0.806	1.27	0.274	6.71	0.223	0.276	0.204	1.24	0.239	5.10	5
15-SWCS-T14-2-7d	127	0.101	0.0403	0.00811	10	0.483	2.49	0.164	21	0.134	ND	0.122	2.22	0.143	15.6	5
15-SWCS-T14-2-14d	109	0.101	0.0374	0.00811	6.49	0.483	2.98	0.164	13.6	0.134	ND	0.122	2.13	0.143	9.10	5
15-SWCS-T14-2-28d	113	0.168	0.0362	0.0135	6.16	0.806	3.82	0.274	13.8	0.223	ND	0.204	2.34	0.239	12.0	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T14-2-42d	84.9	0.168	0.0336	0.0135	4.22	0.806	4.34	0.274	10.4	0.223	ND	0.204	2.48	0.239	11.7	5
15-SWCS-T14-2-49d	57.7	0.168	0.0513	0.0135	1.75	0.806	4.33	0.274	4.4	0.223	ND	0.204	2.38	0.239	ND	5
15-SWCS-T14-2-63d	74.8	0.168	0.0679	0.0135	2.56	0.806	5.18	0.274	7.2	0.223	ND	0.204	2.55	0.239	9.20	5
15-SWCS-T14-2-90d	78.8	0.168	0.0376	0.0135	5.14	0.806	4.76	0.274	10.2	0.223	ND	0.204	2.28	0.239	1.06	0.5
15-SWCS-T14-2-140d	77	0.168	0.0271	0.0135	6.71	0.806	4.73	0.274	14.1	0.223	ND	0.204	2.1	0.239	1.12	0.5
15-SWCS-T14-3-0.08d	520	0.101	94	0.00811	31.7	0.483	ND	0.164	136	0.134	0.435	0.122	457	0.143	ND	5
15-SWCS-T14-3-1d	667	0.101	35.9	0.00811	40.8	0.483	0.317	0.164	169	0.134	0.462	0.122	480	0.143	7.60	5
15-SWCS-T14-3-2d	598	0.168	54.5	0.0135	34.1	0.806	0.353	0.274	153	0.223	0.573	0.204	425	0.239	5.70	5
15-SWCS-T14-3-7d	594	0.101	11.1	0.00811	41.3	0.483	ND	0.164	163	0.134	0.255	0.122	435	0.143	14.8	5
15-SWCS-T14-3-14d	505	0.101	18.6	0.00811	35.3	0.483	ND	0.164	141	0.134	0.222	0.122	384	0.143	9.50	5
15-SWCS-T14-3-28d	552	0.168	5.01	0.0135	37.6	0.806	ND	0.274	154	0.223	ND	0.204	385	0.239	14.8	5
15-SWCS-T14-3-42d	493	0.168	25.5	0.0135	35.8	0.806	ND	0.274	165	0.223	0.337	0.204	405	0.239	11.2	5
15-SWCS-T14-3-49d	399	0.168	89.1	0.0135	28.2	0.806	ND	0.274	146	0.223	ND	0.204	398	0.239	ND	5
15-SWCS-T14-3-63d	445	0.168	53.5	0.0135	30.4	0.806	ND	0.274	141	0.223	0.441	0.204	354	0.239	13.7	5
15-SWCS-T14-3-90d	428	0.168	32.6	0.0135	32.9	0.806	ND	0.274	141	0.223	0.253	0.204	317	0.239	1.43	0.5
15-SWCS-T14-3-140d	463	0.168	8.49	0.0135	36.4	0.806	ND	0.274	146	0.223	0.33	0.204	307	0.239	1.83	0.5
15-SWCS-T14-4-0.08d	522	0.101	93.9	0.00811	31.6	0.483	ND	0.164	137	0.134	0.475	0.122	453	0.143	ND	5
15-SWCS-T14-4-1d	667	0.101	36.3	0.00811	40.8	0.483	0.304	0.164	168	0.134	0.467	0.122	472	0.143	6.90	5
15-SWCS-T14-4-2d	580	0.168	60.5	0.0135	33	0.806	0.274	0.274	148	0.223	0.594	0.204	429	0.239	ND	5
15-SWCS-T14-4-7d	594	0.101	9.16	0.00811	41.7	0.483	ND	0.164	165	0.134	0.254	0.122	429	0.143	14.1	5
15-SWCS-T14-4-14d	504	0.101	14.8	0.00811	35.5	0.483	ND	0.164	141	0.134	0.234	0.122	379	0.143	10.1	5
15-SWCS-T14-4-28d	542	0.168	3.72	0.0135	36.7	0.806	ND	0.274	149	0.223	ND	0.204	389	0.239	14.3	5
15-SWCS-T14-4-42d	491	0.168	29.1	0.0135	35.2	0.806	ND	0.274	162	0.223	0.326	0.204	411	0.239	11.5	5
15-SWCS-T14-4-49d	408	0.168	88.9	0.0135	28.7	0.806	ND	0.274	149	0.223	0.222	0.204	402	0.239	ND	5
15-SWCS-T14-4-63d	444	0.168	66.8	0.0135	30.8	0.806	ND	0.274	143	0.223	0.463	0.204	378	0.239	11.3	5
15-SWCS-T14-4-90d	422	0.168	31.7	0.0135	33	0.806	ND	0.274	137	0.223	0.244	0.204	317	0.239	1.45	0.5
15-SWCS-T14-4-140d	462	0.168	5.65	0.0135	35	0.806	ND	0.274	141	0.223	0.381	0.204	308	0.239	1.49	0.5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T15-1-0.08d	16.1	0.101	0.0896	0.00811	2.38	0.483	ND	0.164	19.4	0.134	ND	0.122	0.835	0.143	ND	5
15-SWCS-T15-1-1d	72	0.101	0.033	0.00811	6.8	0.483	0.7	0.164	60.6	0.134	0.211	0.122	2.05	0.143	12.0	5
15-SWCS-T15-1-2d	58.3	0.168	0.0347	0.0135	1.96	0.806	1.29	0.274	32.9	0.223	0.293	0.204	1.44	0.239	8.90	5
15-SWCS-T15-1-7d	119	0.101	0.0213	0.00811	13.2	0.483	1.95	0.164	107	0.134	ND	0.122	2.36	0.143	31.4	5
15-SWCS-T15-1-14d	110	0.101	0.0191	0.00811	9.52	0.483	3.1	0.164	76	0.134	ND	0.122	2.56	0.143	19.6	5
15-SWCS-T15-1-28d	117	0.168	0.0278	0.0135	10.3	0.806	4.09	0.274	86.5	0.223	ND	0.204	2.93	0.239	33.3	5
15-SWCS-T15-1-42d	84.9	0.168	0.0262	0.0135	6.65	0.806	4.67	0.274	59.4	0.223	ND	0.204	3.16	0.239	22.8	5
15-SWCS-T15-1-49d	60.7	0.168	0.0525	0.0135	2.71	0.806	4.55	0.274	23.4	0.223	ND	0.204	3.22	0.239	5.00	5
15-SWCS-T15-1-63d	72.6	0.168	0.0722	0.0135	3.53	0.806	5.38	0.274	32.8	0.223	0.235	0.204	3.43	0.239	16.7	5
15-SWCS-T15-1-90d	76.8	0.168	0.0305	0.0135	6.74	0.806	5.2	0.274	47.8	0.223	ND	0.204	3.16	0.239	2.03	0.5
15-SWCS-T15-1-140d	67.4	0.168	0.0192	0.0135	7.91	0.806	5.2	0.274	60.4	0.223	ND	0.204	2.99	0.239	2.77	0.5
15-SWCS-T15-2-0.08d	10.8	0.101	0.0252	0.00811	1.84	0.483	ND	0.164	14.6	0.134	ND	0.122	0.543	0.143	ND	5
15-SWCS-T15-2-1d	76.3	0.101	0.0244	0.00811	7.16	0.483	0.672	0.164	63.7	0.134	0.2	0.122	2.26	0.143	12.6	5
15-SWCS-T15-2-2d	65	0.168	0.035	0.0135	2.72	0.806	1.29	0.274	38.2	0.223	0.272	0.204	1.75	0.239	8.60	5
15-SWCS-T15-2-7d	125	0.101	0.0199	0.00811	12.8	0.483	2.34	0.164	104	0.134	0.141	0.122	2.76	0.143	28.4	5
15-SWCS-T15-2-14d	108	0.101	0.0175	0.00811	9.63	0.483	3.12	0.164	76.7	0.134	ND	0.122	2.73	0.143	23.7	5
15-SWCS-T15-2-28d	112	0.168	0.0278	0.0135	9.85	0.806	4.17	0.274	82.9	0.223	ND	0.204	3.03	0.239	30.5	5
15-SWCS-T15-2-42d	88.6	0.168	0.027	0.0135	6.65	0.806	4.68	0.274	59.6	0.223	ND	0.204	3.24	0.239	22.0	5
15-SWCS-T15-2-49d	61.4	0.168	0.049	0.0135	2.59	0.806	4.68	0.274	24	0.223	ND	0.204	3.34	0.239	ND	5
15-SWCS-T15-2-63d	70.4	0.168	0.0615	0.0135	3.52	0.806	5.54	0.274	32.9	0.223	ND	0.204	3.38	0.239	18.7	5
15-SWCS-T15-2-90d	74.4	0.168	0.0279	0.0135	6.55	0.806	5.18	0.274	47.3	0.223	ND	0.204	3.06	0.239	2.36	0.5
15-SWCS-T15-2-140d	79.8	0.168	0.0291	0.0135	8.32	0.806	5.02	0.274	62	0.223	ND	0.204	3.1	0.239	3.13	0.5
15-SWCS-T15-3-0.08d	511	0.101	95.1	0.00811	31.5	0.483	ND	0.164	153	0.134	0.403	0.122	455	0.143	ND	5
15-SWCS-T15-3-1d	705	0.101	13.5	0.00811	45	0.483	0.369	0.164	249	0.134	0.476	0.122	489	0.143	16.9	5
15-SWCS-T15-3-2d	607	0.168	41.7	0.0135	34.7	0.806	0.368	0.274	188	0.223	0.645	0.204	439	0.239	8.70	5
15-SWCS-T15-3-7d	660	0.101	0.53	0.00811	45.8	0.483	0.266	0.164	262	0.134	0.298	0.122	465	0.143	29.6	5
15-SWCS-T15-3-14d	530	0.101	2.1	0.00811	37.7	0.483	ND	0.164	209	0.134	0.197	0.122	394	0.143	19.7	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T15-3-28d	538	0.168	0.609	0.0135	38.8	0.806	ND	0.274	223	0.223	ND	0.204	398	0.239	32.4	5
15-SWCS-T15-3-42d	497	0.168	10.8	0.0135	35.5	0.806	ND	0.274	211	0.223	0.23	0.204	415	0.239	28.1	5
15-SWCS-T15-3-49d	402	0.168	83.1	0.0135	28.8	0.806	ND	0.274	172	0.223	0.292	0.204	404	0.239	5.70	5
15-SWCS-T15-3-63d	446	0.168	56.5	0.0135	32.1	0.806	ND	0.274	177	0.223	0.456	0.204	375	0.239	20.6	5
15-SWCS-T15-3-90d	414	0.168	25.2	0.0135	34	0.806	ND	0.274	186	0.223	0.213	0.204	335	0.239	3.07	0.5
15-SWCS-T15-3-140d	454	0.168	2.69	0.0135	38.6	0.806	ND	0.274	224	0.223	0.315	0.204	336	0.239	4.77	0.5
15-SWCS-T15-4-0.08d	524	0.101	95	0.00811	31.9	0.483	ND	0.164	157	0.134	0.455	0.122	459	0.143	ND	5
15-SWCS-T15-4-1d	693	0.101	21.1	0.00811	44.7	0.483	0.363	0.164	249	0.134	0.453	0.122	493	0.143	17.4	5
15-SWCS-T15-4-2d	575	0.168	49.4	0.0135	34.1	0.806	0.35	0.274	181	0.223	0.598	0.204	438	0.239	10.2	5
15-SWCS-T15-4-7d	630	0.101	0.595	0.00811	45.9	0.483	ND	0.164	265	0.134	0.28	0.122	451	0.143	28.1	5
15-SWCS-T15-4-14d	528	0.101	2.45	0.00811	37.9	0.483	ND	0.164	213	0.134	0.268	0.122	392	0.143	22.1	5
15-SWCS-T15-4-28d	548	0.168	0.972	0.0135	39.5	0.806	ND	0.274	230	0.223	ND	0.204	412	0.239	32.3	5
15-SWCS-T15-4-42d	495	0.168	17.4	0.0135	35.6	0.806	ND	0.274	211	0.223	ND	0.204	428	0.239	26.5	5
15-SWCS-T15-4-49d	407	0.168	83.3	0.0135	29.2	0.806	ND	0.274	174	0.223	0.25	0.204	408	0.239	5.40	5
15-SWCS-T15-4-63d	456	0.168	59.6	0.0135	32.4	0.806	ND	0.274	178	0.223	0.379	0.204	387	0.239	17.1	5
15-SWCS-T15-4-90d	430	0.168	16.4	0.0135	34.2	0.806	ND	0.274	189	0.223	ND	0.204	332	0.239	2.95	0.5
15-SWCS-T15-4-140d	447	0.168	2.32	0.0135	38.8	0.806	ND	0.274	223	0.223	0.308	0.204	339	0.239	5.09	0.5
15-SWCS-T16-1-0.08d	13.2	0.101	0.0598	0.00811	2.03	0.483	ND	0.164	15	0.134	ND	0.122	0.548	0.143	ND	5
15-SWCS-T16-1-1d	78.5	0.101	0.0269	0.00811	7.25	0.483	0.667	0.164	62.3	0.134	0.192	0.122	2.03	0.143	11.2	5
15-SWCS-T16-1-2d	57.2	0.168	0.0341	0.0135	1.81	0.806	1.29	0.274	33.4	0.223	0.259	0.204	1.59	0.239	8.50	5
15-SWCS-T16-1-7d	128	0.101	0.0175	0.00811	14.1	0.483	2.65	0.164	116	0.134	ND	0.122	2.97	0.143	30.7	5
15-SWCS-T16-1-14d	103	0.101	0.0193	0.00811	9.61	0.483	3.4	0.164	76.2	0.134	ND	0.122	2.86	0.143	20.2	5
15-SWCS-T16-1-28d	114	0.168	0.0267	0.0135	10.5	0.806	4.39	0.274	86.9	0.223	ND	0.204	3.06	0.239	35.6	5
15-SWCS-T16-1-42d	81.6	0.168	0.0279	0.0135	6.55	0.806	5	0.274	58.8	0.223	ND	0.204	3.29	0.239	20.0	5
15-SWCS-T16-1-49d	57.3	0.168	0.054	0.0135	2.55	0.806	4.67	0.274	22.6	0.223	ND	0.204	3.07	0.239	7.60	5
15-SWCS-T16-1-63d	69.3	0.168	0.0642	0.0135	3.82	0.806	5.68	0.274	34.9	0.223	ND	0.204	3.52	0.239	10.5	5
15-SWCS-T16-1-90d	69.9	0.168	0.0261	0.0135	6.74	0.806	5.24	0.274	47.9	0.223	ND	0.204	3.07	0.239	2.32	0.5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T16-1-140d	58.8	0.168	0.0183	0.0135	8.01	0.806	5.42	0.274	61	0.223	ND	0.204	3.12	0.239	3.19	0.5
15-SWCS-T16-2-0.08d	12.9	0.101	0.0213	0.00811	2.09	0.483	ND	0.164	15.7	0.134	ND	0.122	0.377	0.143	ND	5
15-SWCS-T16-2-1d	105	0.101	0.025	0.00811	8.99	0.483	0.721	0.164	79.2	0.134	0.207	0.122	2.73	0.143	12.5	5
15-SWCS-T16-2-2d	75.3	0.168	0.0286	0.0135	2.93	0.806	1.33	0.274	41.4	0.223	0.241	0.204	1.76	0.239	10.1	5
15-SWCS-T16-2-7d	126	0.101	0.0149	0.00811	13	0.483	1.99	0.164	105	0.134	ND	0.122	2.58	0.143	28.7	5
15-SWCS-T16-2-14d	104	0.101	0.0208	0.00811	9.43	0.483	3.16	0.164	74.2	0.134	ND	0.122	3.08	0.143	18.9	5
15-SWCS-T16-2-28d	107	0.168	0.0245	0.0135	10.3	0.806	4.2	0.274	84.6	0.223	ND	0.204	3.18	0.239	38.2	5
15-SWCS-T16-2-42d	76.3	0.168	0.024	0.0135	6.56	0.806	4.65	0.274	58.2	0.223	ND	0.204	3.12	0.239	20.8	5
15-SWCS-T16-2-49d	56.2	0.168	0.0526	0.0135	2.4	0.806	4.63	0.274	22	0.223	ND	0.204	3.31	0.239	5.50	5
15-SWCS-T16-2-63d	64.8	0.168	0.0582	0.0135	3.24	0.806	5.83	0.274	32.3	0.223	ND	0.204	3.7	0.239	11.5	5
15-SWCS-T16-2-90d	66.4	0.168	0.0238	0.0135	6.59	0.806	5.45	0.274	47.5	0.223	ND	0.204	3.15	0.239	2.19	0.5
15-SWCS-T16-2-140d	69.5	0.168	0.0156	0.0135	7.8	0.806	5.27	0.274	59.7	0.223	ND	0.204	3.13	0.239	2.55	0.5
15-SWCS-T16-3-0.08d	511	0.101	94.6	0.00811	31.7	0.483	ND	0.164	152	0.134	0.481	0.122	460	0.143	ND	5
15-SWCS-T16-3-1d	701	0.101	18.9	0.00811	44	0.483	0.301	0.164	243	0.134	0.435	0.122	496	0.143	14.9	5
15-SWCS-T16-3-2d	587	0.168	44.3	0.0135	34.2	0.806	0.346	0.274	183	0.223	0.571	0.204	433	0.239	9.70	5
15-SWCS-T16-3-7d	625	0.101	1.05	0.00811	45.8	0.483	ND	0.164	259	0.134	0.286	0.122	453	0.143	31.5	5
15-SWCS-T16-3-14d	511	0.101	3.36	0.00811	37.3	0.483	ND	0.164	204	0.134	0.233	0.122	390	0.143	19.5	5
15-SWCS-T16-3-28d	559	0.168	0.355	0.0135	39.3	0.806	ND	0.274	228	0.223	0.211	0.204	408	0.239	34.4	5
15-SWCS-T16-3-42d	497	0.168	15.6	0.0135	35.2	0.806	ND	0.274	213	0.223	0.284	0.204	420	0.239	24.4	5
15-SWCS-T16-3-49d	407	0.168	83.9	0.0135	28.4	0.806	ND	0.274	166	0.223	0.212	0.204	405	0.239	6.40	5
15-SWCS-T16-3-63d	443	0.168	59.8	0.0135	31.3	0.806	ND	0.274	174	0.223	0.458	0.204	388	0.239	14.6	5
15-SWCS-T16-3-90d	439	0.168	18.2	0.0135	34.9	0.806	ND	0.274	192	0.223	0.308	0.204	331	0.239	2.80	0.5
15-SWCS-T16-3-140d	462	0.168	2.46	0.0135	38.7	0.806	ND	0.274	223	0.223	0.299	0.204	341	0.239	3.73	0.5
15-SWCS-T16-4-0.08d	520	0.101	94.1	0.00811	31.1	0.483	ND	0.164	153	0.134	0.38	0.122	455	0.143	ND	5
15-SWCS-T16-4-1d	700	0.101	19.3	0.00811	44.2	0.483	0.361	0.164	242	0.134	0.455	0.122	497	0.143	14.5	5
15-SWCS-T16-4-2d	591	0.168	49.5	0.0135	34.2	0.806	0.362	0.274	184	0.223	0.49	0.204	440	0.239	10.0	5
15-SWCS-T16-4-7d	634	0.101	1.07	0.00811	46.1	0.483	ND	0.164	265	0.134	0.275	0.122	464	0.143	31.7	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T16-4-14d	513	0.101	3.72	0.00811	38.1	0.483	0.272	0.164	211	0.134	0.243	0.122	398	0.143	19.8	5
15-SWCS-T16-4-28d	540	0.168	0.471	0.0135	39.5	0.806	ND	0.274	227	0.223	ND	0.204	406	0.239	36.5	5
15-SWCS-T16-4-42d	506	0.168	12.9	0.0135	35.7	0.806	ND	0.274	217	0.223	0.246	0.204	421	0.239	21.0	5
15-SWCS-T16-4-49d	411	0.168	87.8	0.0135	28.7	0.806	ND	0.274	169	0.223	0.283	0.204	408	0.239	6.10	5
15-SWCS-T16-4-63d	445	0.168	59.3	0.0135	32.2	0.806	ND	0.274	178	0.223	0.45	0.204	389	0.239	14.1	5
15-SWCS-T16-4-90d	426	0.168	18.7	0.0135	34.3	0.806	ND	0.274	188	0.223	ND	0.204	331	0.239	2.95	0.5
15-SWCS-T16-4-140d	465	0.168	2.2	0.0135	39.1	0.806	ND	0.274	225	0.223	0.25	0.204	343	0.239	5.17	0.5
15-SWCS-T17-1-0.08d	14	0.101	0.0539	0.00811	2.38	0.483	ND	0.164	21.3	0.134	0.146	0.122	1.1	0.143	ND	5
15-SWCS-T17-1-1d	97.9	0.101	0.0417	0.00811	8.57	0.483	0.901	0.164	90.3	0.134	0.188	0.122	3.92	0.143	16.3	5
15-SWCS-T17-1-2d	57.3	0.168	0.0347	0.0135	1.38	0.806	1.31	0.274	35.6	0.223	0.362	0.204	1.6	0.239	8.00	5
15-SWCS-T17-1-7d	121	0.101	0.0183	0.00811	12.2	0.483	3.36	0.164	123	0.134	ND	0.122	3.11	0.143	25.8	5
15-SWCS-T17-1-14d	80.6	0.101	0.0306	0.00811	7.9	0.483	4.69	0.164	76.9	0.134	ND	0.122	3.51	0.143	12.0	5
15-SWCS-T17-1-28d	77.4	0.168	0.0326	0.0135	7.27	0.806	6.3	0.274	75	0.223	ND	0.204	4.33	0.239	20.3	5
15-SWCS-T17-1-42d	53	0.168	0.0498	0.0135	4.46	0.806	6.34	0.274	46.8	0.223	ND	0.204	3.75	0.239	8.10	5
15-SWCS-T17-1-49d	39.5	0.168	0.135	0.0135	1.6	0.806	5.85	0.274	17.2	0.223	ND	0.204	3.43	0.239	ND	5
15-SWCS-T17-1-63d	41.8	0.168	0.132	0.0135	1.99	0.806	7.14	0.274	24.5	0.223	ND	0.204	3.65	0.239	6.40	5
15-SWCS-T17-1-90d	51.1	0.168	0.0471	0.0135	3.92	0.806	7.24	0.274	31.5	0.223	ND	0.204	3.37	0.239	0.950	0.5
15-SWCS-T17-1-140d	41.3	0.168	0.0281	0.0135	4.48	0.806	7.51	0.274	37.7	0.223	ND	0.204	3.41	0.239	1.14	0.5
15-SWCS-T17-2-0.08d	13.4	0.101	0.0326	0.00811	2.3	0.483	ND	0.164	21.3	0.134	ND	0.122	1.02	0.143	ND	5
15-SWCS-T17-2-1d	111	0.101	0.0281	0.00811	9.81	0.483	0.909	0.164	104	0.134	0.182	0.122	4.79	0.143	17.0	5
15-SWCS-T17-2-2d	63.8	0.168	0.0369	0.0135	2.23	0.806	1.46	0.274	42.7	0.223	0.304	0.204	1.82	0.239	9.20	5
15-SWCS-T17-2-7d	114	0.101	0.0194	0.00811	11.4	0.483	3.14	0.164	116	0.134	ND	0.122	2.87	0.143	22.6	5
15-SWCS-T17-2-14d	79.7	0.101	0.0227	0.00811	7.75	0.483	4.58	0.164	77.5	0.134	ND	0.122	3.34	0.143	12.2	5
15-SWCS-T17-2-28d	73	0.168	0.0251	0.0135	7.32	0.806	6.25	0.274	73.9	0.223	ND	0.204	4.08	0.239	18.0	5
15-SWCS-T17-2-42d	50.9	0.168	0.0499	0.0135	4.31	0.806	6.42	0.274	46.6	0.223	ND	0.204	3.71	0.239	9.30	5
15-SWCS-T17-2-49d	40.6	0.168	0.122	0.0135	1.68	0.806	5.83	0.274	17.3	0.223	ND	0.204	3.52	0.239	ND	5
15-SWCS-T17-2-63d	39.5	0.168	0.13	0.0135	1.98	0.806	7.18	0.274	23.1	0.223	ND	0.204	3.54	0.239	5.30	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T17-2-90d	43.9	0.168	0.0514	0.0135	3.93	0.806	7.16	0.274	31.6	0.223	ND	0.204	3.3	0.239	0.790	0.5
15-SWCS-T17-2-140d	25.9	0.168	0.0493	0.0135	4.26	0.806	8.12	0.274	36.9	0.223	ND	0.204	3.52	0.239	0.900	0.5
15-SWCS-T17-3-0.08d	499	0.101	98.5	0.00811	31	0.483	ND	0.164	153	0.134	0.401	0.122	457	0.143	ND	5
15-SWCS-T17-3-1d	687	0.101	32.8	0.00811	42.7	0.483	0.296	0.164	251	0.134	0.511	0.122	495	0.143	16.4	5
15-SWCS-T17-3-2d	590	0.168	54.9	0.0135	33.4	0.806	0.343	0.274	190	0.223	0.503	0.204	446	0.239	10.2	5
15-SWCS-T17-3-7d	626	0.101	6.03	0.00811	41.9	0.483	ND	0.164	253	0.134	0.272	0.122	486	0.143	23.2	5
15-SWCS-T17-3-14d	493	0.101	35.1	0.00811	34.7	0.483	ND	0.164	195	0.134	0.297	0.122	425	0.143	12.0	5
15-SWCS-T17-3-28d	509	0.168	27.8	0.0135	36.1	0.806	ND	0.274	213	0.223	ND	0.204	452	0.239	18.3	5
15-SWCS-T17-3-42d	464	0.168	62.6	0.0135	32.4	0.806	ND	0.274	199	0.223	0.348	0.204	452	0.239	10.8	5
15-SWCS-T17-3-49d	397	0.168	102	0.0135	27.6	0.806	ND	0.274	164	0.223	0.228	0.204	424	0.239	ND	5
15-SWCS-T17-3-63d	427	0.168	80.8	0.0135	28.9	0.806	ND	0.274	161	0.223	0.46	0.204	397	0.239	6.30	5
15-SWCS-T17-3-90d	408	0.168	70.4	0.0135	31.7	0.806	ND	0.274	175	0.223	0.246	0.204	379	0.239	1.17	0.5
15-SWCS-T17-3-140d	422	0.168	58.5	0.0135	32.6	0.806	ND	0.274	183	0.223	0.291	0.204	389	0.239	3.44	0.5
15-SWCS-T17-4-0.08d	520	0.101	98.9	0.00811	31.6	0.483	ND	0.164	160	0.134	0.366	0.122	465	0.143	ND	5
15-SWCS-T17-4-1d	683	0.101	22.7	0.00811	35.1	0.483	ND	0.164	200	0.134	0.239	0.122	422	0.143	14.4	5
15-SWCS-T17-4-2d	597	0.168	42.5	0.00811	41.4	0.483	0.29	0.164	241	0.134	0.477	0.122	500	0.143	10.1	5
15-SWCS-T17-4-7d	658	0.101	29.9	0.0135	36.3	0.806	ND	0.274	213	0.223	0.218	0.204	462	0.239	21.0	5
15-SWCS-T17-4-14d	511	0.101	52.9	0.0135	33.5	0.806	0.347	0.274	189	0.223	0.51	0.204	450	0.239	12.1	5
15-SWCS-T17-4-28d	525	0.168	68.5	0.0135	32.9	0.806	ND	0.274	200	0.223	0.251	0.204	457	0.239	18.1	5
15-SWCS-T17-4-42d	470	0.168	108	0.0135	27.9	0.806	ND	0.274	164	0.223	0.25	0.204	430	0.239	10.5	5
15-SWCS-T17-4-49d	401	0.168	91.7	0.0135	29.7	0.806	ND	0.274	166	0.223	0.407	0.204	412	0.239	ND	5
15-SWCS-T17-4-63d	433	0.168	3.17	0.00811	43.1	0.483	0.205	0.164	263	0.134	0.3	0.122	493	0.143	6.80	5
15-SWCS-T17-4-90d	413	0.168	70.7	0.0135	32.3	0.806	ND	0.274	177	0.223	ND	0.204	372	0.239	1.29	0.5
15-SWCS-T17-4-140d	444	0.168	62.6	0.0135	33.2	0.806	ND	0.274	187	0.223	0.301	0.204	401	0.239	2.05	0.5
15-SWCS-T18-1-0.08d	10.4	0.101	0.0263	0.00811	1.78	0.483	ND	0.164	16.4	0.134	ND	0.122	0.858	0.143	ND	5
15-SWCS-T18-1-1d	89.2	0.101	0.0312	0.00811	8.04	0.483	0.86	0.164	83.5	0.134	0.262	0.122	4.16	0.143	11.0	5
15-SWCS-T18-1-2d	46.3	0.168	0.0617	0.0135	ND	0.806	1.1	0.274	28.6	0.223	0.282	0.204	1.47	0.239	5.20	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T18-1-7d	114	0.101	0.0244	0.00811	11.5	0.483	3.08	0.164	114	0.134	ND	0.122	3.17	0.143	16.5	5
15-SWCS-T18-1-14d	83.5	0.101	0.0301	0.00811	8.01	0.483	4.49	0.164	78.8	0.134	ND	0.122	3.37	0.143	7.50	5
15-SWCS-T18-1-28d	78.6	0.168	0.0269	0.0135	7.51	0.806	6.23	0.274	75.8	0.223	ND	0.204	4.16	0.239	10.0	5
15-SWCS-T18-1-42d	58.7	0.168	0.0428	0.0135	4.58	0.806	6.08	0.274	48.3	0.223	ND	0.204	3.82	0.239	6.40	5
15-SWCS-T18-1-49d	42.1	0.168	0.118	0.0135	1.53	0.806	5.6	0.274	17.5	0.223	ND	0.204	3.5	0.239	ND	5
15-SWCS-T18-1-63d	51.3	0.168	0.0825	0.0135	1.95	0.806	6.56	0.274	25.6	0.223	ND	0.204	3.74	0.239	ND	5
15-SWCS-T18-1-90d	53.9	0.168	0.0418	0.0135	4.09	0.806	6.74	0.274	33.6	0.223	ND	0.204	3.54	0.239	0.790	0.5
15-SWCS-T18-1-140d	42.5	0.168	0.0311	0.0135	4.59	0.806	7.33	0.274	39.4	0.223	ND	0.204	3.53	0.239	1.13	0.5
15-SWCS-T18-2-0.08d	11.6	0.101	0.0227	0.00811	1.86	0.483	ND	0.164	16.7	0.134	0.151	0.122	0.83	0.143	ND	5
15-SWCS-T18-2-1d	65.1	0.101	0.0258	0.00811	5.72	0.483	0.664	0.164	59.6	0.134	0.205	0.122	2.94	0.143	9.60	5
15-SWCS-T18-2-2d	51.5	0.168	0.046	0.0135	1.18	0.806	1.32	0.274	33.1	0.223	0.286	0.204	1.67	0.239	5.30	5
15-SWCS-T18-2-7d	103	0.101	0.0227	0.00811	10.8	0.483	3.35	0.164	106	0.134	ND	0.122	3.05	0.143	17.6	5
15-SWCS-T18-2-14d	78.9	0.101	0.0358	0.00811	7.61	0.483	4.68	0.164	74.9	0.134	ND	0.122	3.5	0.143	8.40	5
15-SWCS-T18-2-28d	75.5	0.168	0.0249	0.0135	6.91	0.806	6.07	0.274	72	0.223	ND	0.204	4.13	0.239	12.1	5
15-SWCS-T18-2-42d	54.5	0.168	0.0451	0.0135	4.3	0.806	6.11	0.274	47	0.223	ND	0.204	3.91	0.239	6.20	5
15-SWCS-T18-2-49d	41.1	0.168	0.124	0.0135	1.54	0.806	5.57	0.274	17	0.223	ND	0.204	3.47	0.239	ND	5
15-SWCS-T18-2-63d	46.6	0.168	0.0878	0.0135	2	0.806	6.65	0.274	24.8	0.223	ND	0.204	3.75	0.239	ND	5
15-SWCS-T18-2-90d	52.8	0.168	0.0459	0.0135	4.08	0.806	6.84	0.274	33.2	0.223	ND	0.204	3.39	0.239	0.670	0.5
15-SWCS-T18-2-140d	33.4	0.168	0.0379	0.0135	4.62	0.806	7.54	0.274	39.7	0.223	ND	0.204	3.6	0.239	0.980	0.5
15-SWCS-T18-3-0.08d	537	0.101	85.9	0.00811	34.1	0.483	ND	0.164	189	0.134	0.333	0.122	459	0.143	5.70	5
15-SWCS-T18-3-1d	684	0.101	28.8	0.00811	43.1	0.483	0.258	0.164	256	0.134	0.425	0.122	495	0.143	11.5	5
15-SWCS-T18-3-2d	586	0.168	57.1	0.0135	32.8	0.806	0.292	0.274	186	0.223	0.555	0.204	442	0.239	6.60	5
15-SWCS-T18-3-7d	609	0.101	6.68	0.00811	42.1	0.483	ND	0.164	250	0.134	0.24	0.122	477	0.143	15.6	5
15-SWCS-T18-3-14d	487	0.101	30.1	0.00811	34.5	0.483	ND	0.164	194	0.134	0.212	0.122	416	0.143	12.7	5
15-SWCS-T18-3-28d	509	0.168	17.1	0.0135	35.3	0.806	ND	0.274	213	0.223	ND	0.204	432	0.239	32.3	5
15-SWCS-T18-3-42d	465	0.168	55.7	0.0135	32.6	0.806	ND	0.274	195	0.223	ND	0.204	440	0.239	9.40	5
15-SWCS-T18-3-49d	403	0.168	103	0.0135	27.8	0.806	ND	0.274	167	0.223	0.246	0.204	422	0.239	ND	5

Sample Name	Ca (mg/L)	EQL	Mg (mg/L)	EQL	K (mg/L)	EQL	Si (mg/L)	EQL	Na (mg/L)	EQL	P (mg/L)	EQL	S (mg/L)	EQL	NH_4^+ (mg/L)	EQL
15-SWCS-T18-3-63d	427	0.168	89.3	0.0135	29.6	0.806	ND	0.274	164	0.223	0.379	0.204	409	0.239	7.40	5
15-SWCS-T18-3-90d	411	0.168	70.6	0.0135	32.5	0.806	ND	0.274	179	0.223	0.256	0.204	366	0.239	1.33	0.5
15-SWCS-T18-3-140d	413	0.168	73.5	0.0135	33.1	0.806	ND	0.274	186	0.223	0.352	0.204	403	0.239	2.00	0.5
15-SWCS-T18-4-0.08d	506	0.101	97.4	0.00811	30.8	0.483	ND	0.164	152	0.134	0.371	0.122	456	0.143	ND	5
15-SWCS-T18-4-1d	643	0.101	57.4	0.00811	40.5	0.483	0.208	0.164	226	0.134	0.5	0.122	504	0.143	9.80	5
15-SWCS-T18-4-2d	578	0.168	54.5	0.0135	33	0.806	0.302	0.274	188	0.223	0.602	0.204	445	0.239	7.40	5
15-SWCS-T18-4-7d	557	0.101	2.2	0.00811	39.6	0.483	ND	0.164	247	0.134	0.258	0.122	423	0.143	15.8	5
15-SWCS-T18-4-14d	490	0.101	24.6	0.00811	35.1	0.483	ND	0.164	199	0.134	0.235	0.122	417	0.143	9.30	5
15-SWCS-T18-4-28d	496	0.168	26.2	0.0135	35.4	0.806	ND	0.274	212	0.223	ND	0.204	444	0.239	16.4	5
15-SWCS-T18-4-42d	467	0.168	57.6	0.0135	33.2	0.806	ND	0.274	199	0.223	0.285	0.204	446	0.239	9.70	5
15-SWCS-T18-4-49d	411	0.168	105	0.0135	27.4	0.806	ND	0.274	166	0.223	0.252	0.204	425	0.239	ND	5
15-SWCS-T18-4-63d	427	0.168	89.5	0.0135	29.8	0.806	ND	0.274	164	0.223	0.463	0.204	412	0.239	6.50	5
15-SWCS-T18-4-90d	418	0.168	68.1	0.0135	32.2	0.806	ND	0.274	181	0.223	0.285	0.204	364	0.239	1.11	0.5
15-SWCS-T18-4-140d	418	0.168	74.7	0.0135	32.9	0.806	ND	0.274	185	0.223	0.279	0.204	398	0.239	1.64	0.5

Table A.2. Concentrations of Major Anions and ^{99}Tc Measured in Leachates from EPA Method 1315 Tests

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (μg/L)	EQL
15-SWCS-T1-1-0.08d	ND	2.5	ND	1	ND	5	ND	5	ND	7.5	0.187	0.0099
15-SWCS-T1-1-1d	0.79	0.25	ND	0.1	ND	0.5	ND	0.5	2.16	0.75	0.487	0.0099
15-SWCS-T1-1-2d	0.428	0.25	ND	0.1	ND	0.5	ND	0.5	2.13	0.75	0.289	0.0099
15-SWCS-T1-1-7d	1.16	0.25	ND	0.1	ND	0.5	ND	0.5	2.44	0.75	0.922	0.0099
15-SWCS-T1-1-14d	1.02	0.25	ND	0.1	ND	0.5	ND	0.5	3.54	0.75	0.215	0.0165
15-SWCS-T1-1-28d	1.13	0.25	ND	0.1	ND	0.5	ND	0.5	4.18	0.75	0.023	0.0165
15-SWCS-T1-1-42d	0.715	0.25	ND	0.1	ND	0.5	ND	0.5	4.59	0.75	0.0187	0.0165
15-SWCS-T1-1-49d	0.299	0.25	ND	0.1	ND	0.5	ND	0.5	5.39	0.75	ND	0.0165
15-SWCS-T1-1-63d	0.482	0.25	ND	0.1	ND	0.5	ND	0.5	5.24	0.75	ND	0.0165
15-SWCS-T1-1-90d	0.73	0.25	ND	0.1	ND	0.5	ND	0.5	4.84	0.75	0.0226	0.0165
15-SWCS-T1-1-140d	1.04	0.25	ND	0.1	ND	0.5	ND	0.5	4.93	0.75	0.0477	0.0165
15-SWCS-T1-2-0.08d	ND	2.5	ND	1	ND	5	ND	5	ND	7.5	0.0882	0.0099
15-SWCS-T1-2-1d	0.812	0.25	ND	0.1	ND	0.5	ND	0.5	1.93	0.75	0.538	0.0099
15-SWCS-T1-2-2d	0.362	0.25	ND	0.1	ND	0.5	ND	0.5	1.74	0.75	0.272	0.0099
15-SWCS-T1-2-7d	1.02	0.25	ND	0.1	ND	0.5	ND	0.5	2.41	0.75	0.836	0.0099
15-SWCS-T1-2-14d	1.01	0.25	ND	0.1	ND	0.5	ND	0.5	3.87	0.75	0.273	0.0165
15-SWCS-T1-2-28d	1.12	0.25	ND	0.1	ND	0.5	ND	0.5	4.32	0.75	0.0188	0.0165
15-SWCS-T1-2-42d	0.672	0.25	ND	0.1	ND	0.5	ND	0.5	4.68	0.75	ND	0.0165
15-SWCS-T1-2-49d	0.351	0.25	ND	0.1	ND	0.5	ND	0.5	5.35	0.75	ND	0.0165
15-SWCS-T1-2-63d	0.49	0.25	ND	0.1	ND	0.5	ND	0.5	5.58	0.75	ND	0.0165
15-SWCS-T1-2-90d	0.751	0.25	ND	0.1	ND	0.5	ND	0.5	5.08	0.75	0.0185	0.0165
15-SWCS-T1-2-140d	0.992	0.25	ND	0.1	ND	0.5	ND	0.5	5.09	0.75	0.0201	0.0165
15-SWCS-T1-3-0.08d	249	2.5	ND	1	206	5	ND	5	1360	7.5	0.109	0.0099
15-SWCS-T1-3-1d	244	2.5	ND	1	201	5	ND	5	1280	7.5	0.563	0.0099
15-SWCS-T1-3-2d	251	2.5	ND	1	207	5	ND	5	1360	7.5	0.457	0.0099
15-SWCS-T1-3-7d	245	25	ND	10	194	50	ND	50	1140	75	1.03	0.0099
15-SWCS-T1-3-14d	238	25	ND	10	189	50	ND	50	1330	75	0.200	0.0165
15-SWCS-T1-3-28d	232	25	ND	10	185	50	ND	50	1080	75	0.0257	0.0165
15-SWCS-T1-3-42d	231	25	ND	10	186	50	ND	50	1200	75	ND	0.0165
15-SWCS-T1-3-49d	248	25	ND	10	202	50	ND	50	1320	75	ND	0.0165
15-SWCS-T1-3-63d	239	25	ND	10	194	50	ND	50	1220	75	ND	0.0165
15-SWCS-T1-3-90d	239	25	ND	10	190	50	ND	50	1190	75	ND	0.0165
15-SWCS-T1-3-140d	238	25	ND	10	185	50	ND	50	996	75	0.026	0.0165
15-SWCS-T1-4-0.08d	249	2.5	ND	1	206	5	ND	5	1360	7.5	0.139	0.0099
15-SWCS-T1-4-1d	246	2.5	ND	1	202	5	ND	5	1270	7.5	0.399	0.0099
15-SWCS-T1-4-2d	251	2.5	ND	1	207	5	ND	5	1370	7.5	0.23	0.0099
15-SWCS-T1-4-7d	246	25	ND	10	195	50	ND	50	1150	75	0.452	0.0099
15-SWCS-T1-4-14d	234	25	ND	10	186	50	ND	50	1130	75	0.0953	0.0165
15-SWCS-T1-4-28d	235	25	ND	10	189	50	ND	50	1060	75	0.0277	0.0165
15-SWCS-T1-4-42d	235	25	ND	10	189	50	ND	50	1120	75	ND	0.0165
15-SWCS-T1-4-49d	252	25	ND	10	206	50	ND	50	1340	75	ND	0.0165
15-SWCS-T1-4-63d	238	25	ND	10	192	50	ND	50	1150	75	0.0204	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (μg/L)	EQL
15-SWCS-T1-4-90d	235	25	ND	10	189	50	ND	50	1230	75	ND	0.0165
15-SWCS-T1-4-140d	229	25	ND	10	180	50	ND	50	995	75	0.0417	0.0165
15-SWCS-T2-1-0.08d	5.78	0.25	ND	1	2.84	0.5	ND	5	ND	0.75	2.13	0.0099
15-SWCS-T2-1-1d	10.2	0.25	ND	0.1	4.72	0.5	ND	0.5	2.2	0.75	3.43	0.0099
15-SWCS-T2-1-2d	3.8	0.25	ND	0.1	2.02	0.5	ND	0.5	1.76	0.75	1.21	0.0099
15-SWCS-T2-1-7d	15.5	0.25	ND	0.1	7.56	0.5	ND	0.5	2.77	0.75	5.07	0.0099
15-SWCS-T2-1-14d	13	0.25	ND	0.1	6.95	0.5	ND	0.5	3.89	0.75	2.03	0.0165
15-SWCS-T2-1-28d	13.5	0.25	ND	0.1	7.59	0.5	ND	0.5	4.05	0.75	0.163	0.0165
15-SWCS-T2-1-42d	7.95	0.25	ND	0.1	4.74	0.5	ND	0.5	4.18	0.75	0.0713	0.0165
15-SWCS-T2-1-49d	3.85	0.25	ND	0.1	2.63	0.5	ND	0.5	4.91	0.75	0.0533	0.0165
15-SWCS-T2-1-63d	5.3	0.25	ND	0.1	3.4	0.5	ND	0.5	4.84	0.75	0.0563	0.0165
15-SWCS-T2-1-90d	8.08	0.25	ND	0.1	4.98	0.5	ND	0.5	4.62	0.75	0.0967	0.0165
15-SWCS-T2-1-140d	10.5	0.25	ND	0.1	6.5	0.5	ND	0.5	4.55	0.75	0.147	0.0165
15-SWCS-T2-2-0.08d	5.62	0.25	ND	1	2.59	0.5	ND	5	ND	0.75	1.91	0.0099
15-SWCS-T2-2-1d	7.37	0.25	ND	0.1	3.29	0.5	ND	0.5	1.76	0.75	2.23	0.0099
15-SWCS-T2-2-2d	4.83	0.25	ND	0.1	2.4	0.5	ND	0.5	2.15	0.75	1.42	0.0099
15-SWCS-T2-2-7d	14.6	0.25	ND	0.1	6.86	0.5	ND	0.5	2.55	0.75	4.69	0.0099
15-SWCS-T2-2-14d	12.7	0.25	ND	0.1	6.61	0.5	ND	0.5	3.55	0.75	1.96	0.0165
15-SWCS-T2-2-28d	13.3	0.25	ND	0.1	7.23	0.5	ND	0.5	3.73	0.75	0.214	0.0165
15-SWCS-T2-2-42d	7.74	0.25	ND	0.1	4.49	0.5	ND	0.5	3.91	0.75	0.157	0.0165
15-SWCS-T2-2-49d	3.25	0.25	ND	0.1	2.31	0.5	ND	0.5	4.73	0.75	0.0742	0.0165
15-SWCS-T2-2-63d	5.23	0.25	ND	0.1	3.25	0.5	ND	0.5	4.56	0.75	0.149	0.0165
15-SWCS-T2-2-90d	8.62	0.25	ND	0.1	5.02	0.5	ND	0.5	4.24	0.75	0.267	0.0165
15-SWCS-T2-2-140d	10.2	0.25	ND	0.1	6.14	0.5	ND	0.5	4.51	0.75	0.236	0.0165
15-SWCS-T2-3-0.08d	256	2.5	ND	1	211	5	ND	5	1370	7.5	1.66	0.0099
15-SWCS-T2-3-1d	253	2.5	ND	1	207	5	ND	5	1270	7.5	1.88	0.0099
15-SWCS-T2-3-2d	254	2.5	ND	1	209	5	ND	5	1360	7.5	0.826	0.0099
15-SWCS-T2-3-7d	253	25	ND	10	203	50	ND	50	1120	75	2.17	0.0099
15-SWCS-T2-3-14d	242	25	ND	10	193	50	ND	50	1110	75	1.46	0.0165
15-SWCS-T2-3-28d	252	25	ND	10	200	50	ND	50	1030	75	0.266	0.0165
15-SWCS-T2-3-42d	249	25	ND	10	201	50	ND	50	1120	75	0.0571	0.0165
15-SWCS-T2-3-49d	252	25	ND	10	205	50	ND	50	1300	75	0.0252	0.0165
15-SWCS-T2-3-63d	244	25	ND	10	198	50	ND	50	1070	75	0.0429	0.0165
15-SWCS-T2-3-90d	248	25	ND	10	198	50	ND	50	1160	75	0.0551	0.0165
15-SWCS-T2-3-140d	248	25	ND	10	193	50	ND	50	960	75	0.110	0.0165
15-SWCS-T2-4-0.08d	258	2.5	ND	1	213	5	ND	5	1380	7.5	1.97	0.0099
15-SWCS-T2-4-1d	254	2.5	ND	1	208	5	ND	5	1260	7.5	2.24	0.0099
15-SWCS-T2-4-2d	254	2.5	ND	1	210	5	ND	5	1350	7.5	0.868	0.0099
15-SWCS-T2-4-7d	251	25	ND	10	201	50	ND	50	1100	75	2.23	0.0099
15-SWCS-T2-4-14d	251	25	ND	10	200	50	ND	50	1120	75	1.62	0.0165
15-SWCS-T2-4-28d	233	25	ND	10	185	50	ND	50	945	75	0.293	0.0165
15-SWCS-T2-4-42d	246	25	ND	10	198	50	ND	50	1090	75	0.0567	0.0165
15-SWCS-T2-4-49d	243	25	ND	10	197	50	ND	50	1250	75	0.0177	0.0165
15-SWCS-T2-4-63d	247	25	ND	10	200	50	ND	50	1140	75	0.037	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T2-4-90d	251	25	ND	10	200	50	ND	50	1180	75	0.0529	0.0165
15-SWCS-T2-4-140d	249	25	ND	10	193	50	ND	50	948	75	0.114	0.0165
15-SWCS-T3-1-0.08d	ND	2.5	ND	1	12.6	5	ND	5	ND	7.5	1.10	0.0099
15-SWCS-T3-1-1d	1.27	0.25	ND	0.1	20.6	0.5	ND	0.5	3.37	0.75	2.47	0.0099
15-SWCS-T3-1-2d	0.657	0.25	ND	0.1	11	0.5	ND	0.5	2.68	0.75	1.50	0.0099
15-SWCS-T3-1-7d	1.79	0.25	ND	0.1	29.8	0.5	ND	0.5	3.58	0.75	3.40	0.0099
15-SWCS-T3-1-14d	1.8	0.25	ND	0.1	31.1	0.5	ND	0.5	5.17	0.75	0.744	0.0165
15-SWCS-T3-1-28d	33.3	0.25	ND	0.1	52.2	0.5	ND	0.5	90	0.75	0.0523	0.0165
15-SWCS-T3-1-42d	2.69	0.25	ND	0.1	19.5	0.5	ND	0.5	11.3	0.75	0.0372	0.0165
15-SWCS-T3-1-49d	0.794	0.25	ND	0.1	8.78	0.5	ND	0.5	8.5	0.75	ND	0.0165
15-SWCS-T3-1-63d	1.16	0.25	ND	0.1	13.8	0.5	ND	0.5	6.84	0.75	0.0253	0.0165
15-SWCS-T3-1-90d	1.53	0.25	ND	0.1	20.3	0.5	ND	0.5	7.25	0.75	0.108	0.0165
15-SWCS-T3-1-140d	2.16	0.25	ND	0.1	24.7	0.5	ND	0.5	7.69	0.75	0.0598	0.0165
15-SWCS-T3-2-0.08d	ND	2.5	ND	1	11.5	5	ND	5	ND	7.5	0.895	0.0099
15-SWCS-T3-2-1d	1.18	0.25	ND	0.1	19.1	0.5	ND	0.5	3.72	0.75	1.77	0.0099
15-SWCS-T3-2-2d	0.56	0.25	ND	0.1	9.32	0.5	ND	0.5	2.43	0.75	1.01	0.0099
15-SWCS-T3-2-7d	1.97	0.25	ND	0.1	33.2	0.5	ND	0.5	3.6	0.75	2.45	0.0099
15-SWCS-T3-2-14d	1.83	0.25	ND	0.1	31.3	0.5	ND	0.5	5.3	0.75	0.511	0.0165
15-SWCS-T3-2-28d	1.95	0.25	ND	0.1	33.4	0.5	ND	0.5	5.42	0.75	0.0942	0.0165
15-SWCS-T3-2-42d	1.17	0.25	ND	0.1	20.1	0.5	ND	0.5	5.52	0.75	0.0485	0.0165
15-SWCS-T3-2-49d	0.469	0.25	ND	0.1	8.78	0.5	ND	0.5	6.44	0.75	ND	0.0165
15-SWCS-T3-2-63d	0.77	0.25	ND	0.1	13.9	0.5	ND	0.5	6.59	0.75	0.0352	0.0165
15-SWCS-T3-2-90d	1.09	0.25	ND	0.1	19.5	0.5	ND	0.5	6.62	0.75	0.0402	0.0165
15-SWCS-T3-2-140d	1.42	0.25	ND	0.1	24.9	0.5	ND	0.5	7.25	0.75	0.0886	0.0165
15-SWCS-T3-3-0.08d	254	2.5	ND	1	224	5	ND	5	1390	7.5	0.763	0.0099
15-SWCS-T3-3-1d	246	2.5	ND	1	223	5	ND	5	1310	7.5	1.76	0.0099
15-SWCS-T3-3-2d	254	2.5	ND	1	224	5	ND	5	1390	7.5	1.66	0.0099
15-SWCS-T3-3-7d	250	25	ND	10	235	50	ND	50	1210	75	3.46	0.0099
15-SWCS-T3-3-14d	230	25	ND	10	205	50	ND	50	1130	75	0.725	0.0165
15-SWCS-T3-3-28d	236	25	ND	10	215	50	ND	50	1140	75	0.0524	0.0165
15-SWCS-T3-3-42d	247	25	ND	10	217	50	ND	50	1190	75	ND	0.0165
15-SWCS-T3-3-49d	249	25	ND	10	210	50	ND	50	1330	75	ND	0.0165
15-SWCS-T3-3-63d	241	25	ND	10	208	50	ND	50	1180	75	0.0171	0.0165
15-SWCS-T3-3-90d	247	25	ND	10	217	50	ND	50	1250	75	ND	0.0165
15-SWCS-T3-3-140d	246	25	ND	10	223	50	ND	50	1010	75	0.0364	0.0165
15-SWCS-T3-4-0.08d	255	2.5	ND	1	222	5	ND	5	1400	7.5	0.814	0.0099
15-SWCS-T3-4-1d	247	2.5	ND	1	223	5	ND	5	1330	7.5	1.71	0.0099
15-SWCS-T3-4-2d	255	2.5	ND	1	225	5	ND	5	1400	7.5	1.24	0.0099
15-SWCS-T3-4-7d	250	25	ND	10	234	50	ND	50	1220	75	2.43	0.0099
15-SWCS-T3-4-14d	243	25	ND	10	218	50	ND	50	1190	75	0.547	0.0165
15-SWCS-T3-4-28d	241	25	ND	10	221	50	ND	50	1120	75	0.0733	0.0165
15-SWCS-T3-4-42d	253	25	ND	10	223	50	ND	50	1200	75	ND	0.0165
15-SWCS-T3-4-49d	254	25	ND	10	215	50	ND	50	1340	75	ND	0.0165
15-SWCS-T3-4-63d	252	25	ND	10	217	50	ND	50	1190	75	0.0165	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T3-4-90d	245	25	ND	10	216	50	ND	50	1250	75	ND	0.0165
15-SWCS-T3-4-140d	245	25	ND	10	221	50	ND	50	1020	75	0.0421	0.0165
15-SWCS-T4-1-0.08d	ND	2.5	ND	1	ND	5	ND	5	ND	7.5	0.791	0.0099
15-SWCS-T4-1-1d	0.875	0.25	ND	0.1	ND	0.5	ND	0.5	1.99	0.75	5.10	0.0099
15-SWCS-T4-1-2d	0.565	0.25	ND	0.1	ND	0.5	ND	0.5	2.22	0.75	3.03	0.0099
15-SWCS-T4-1-7d	1.3	0.25	ND	0.1	ND	0.5	ND	0.5	2.4	0.75	8.04	0.0099
15-SWCS-T4-1-14d	1.32	0.25	ND	0.1	ND	0.5	ND	0.5	3.88	0.75	5.49	0.0165
15-SWCS-T4-1-28d	1.39	0.25	ND	0.1	ND	0.5	ND	0.5	4.34	0.75	0.609	0.0165
15-SWCS-T4-1-42d	0.868	0.25	ND	0.1	ND	0.5	ND	0.5	4.72	0.75	0.0512	0.0165
15-SWCS-T4-1-49d	0.357	0.25	ND	0.1	ND	0.5	ND	0.5	5.97	0.75	0.0207	0.0165
15-SWCS-T4-1-63d	0.593	0.25	ND	0.1	ND	0.5	ND	0.5	5.67	0.75	0.0554	0.0165
15-SWCS-T4-1-90d	0.812	0.25	ND	0.1	ND	0.5	ND	0.5	5.07	0.75	0.0526	0.0165
15-SWCS-T4-1-140d	1.16	0.25	ND	0.1	ND	0.5	ND	0.5	5.3	0.75	0.104	0.0165
15-SWCS-T4-2-0.08d	ND	2.5	ND	1	ND	5	ND	5	ND	7.5	1.17	0.0099
15-SWCS-T4-2-1d	0.645	0.25	ND	0.1	ND	0.5	ND	0.5	1.52	0.75	4.05	0.0099
15-SWCS-T4-2-2d	0.462	0.25	ND	0.1	ND	0.5	ND	0.5	2.1	0.75	2.52	0.0099
15-SWCS-T4-2-7d	1.31	0.25	ND	0.1	ND	0.5	ND	0.5	2.63	0.75	8.76	0.0099
15-SWCS-T4-2-14d	1.26	0.25	ND	0.1	ND	0.5	ND	0.5	4.27	0.75	6.20	0.0165
15-SWCS-T4-2-28d	1.49	0.25	ND	0.1	ND	0.5	ND	0.5	4.32	0.75	0.771	0.0165
15-SWCS-T4-2-42d	0.81	0.25	ND	0.1	ND	0.5	ND	0.5	5.1	0.75	0.0368	0.0165
15-SWCS-T4-2-49d	0.376	0.25	ND	0.1	ND	0.5	ND	0.5	6.57	0.75	0.0184	0.0165
15-SWCS-T4-2-63d	0.571	0.25	ND	0.1	ND	0.5	ND	0.5	6.2	0.75	0.0504	0.0165
15-SWCS-T4-2-90d	0.833	0.25	ND	0.1	ND	0.5	ND	0.5	5.34	0.75	0.0666	0.0165
15-SWCS-T4-2-140d	1.14	0.25	ND	0.1	ND	0.5	ND	0.5	5.4	0.75	0.0952	0.0165
15-SWCS-T4-3-0.08d	252	2.5	ND	1	211	5	ND	5	1390	7.5	0.786	0.0099
15-SWCS-T4-3-1d	247	2.5	ND	1	201	5	ND	5	1270	7.5	4.22	0.0099
15-SWCS-T4-3-2d	249	2.5	ND	1	205	5	ND	5	1360	7.5	2.61	0.0099
15-SWCS-T4-3-7d	243	25	ND	10	190	50	ND	50	1140	75	6.70	0.0099
15-SWCS-T4-3-14d	233	25	ND	10	182	50	ND	50	1110	75	2.98	0.0165
15-SWCS-T4-3-28d	233	25	ND	10	182	50	ND	50	1000	75	0.32	0.0165
15-SWCS-T4-3-42d	237	25	ND	10	189	50	ND	50	1090	75	0.0243	0.0165
15-SWCS-T4-3-49d	246	25	ND	10	198	50	ND	50	1280	75	ND	0.0165
15-SWCS-T4-3-63d	235	25	ND	10	188	50	ND	50	1130	75	0.0278	0.0165
15-SWCS-T4-3-90d	239	25	ND	10	187	50	ND	50	1200	75	0.033	0.0165
15-SWCS-T4-3-140d	237	25	ND	10	179	50	ND	50	956	75	0.111	0.0165
15-SWCS-T4-4-0.08d	252	2.5	ND	1	210	5	ND	5	1380	7.5	1.82	0.0099
15-SWCS-T4-4-1d	245	2.5	ND	1	199	5	ND	5	1270	7.5	6.14	0.0099
15-SWCS-T4-4-2d	253	2.5	ND	1	207	5	ND	5	1380	7.5	3.95	0.0099
15-SWCS-T4-4-7d	247	25	ND	10	192	50	ND	50	1150	75	9.85	0.0099
15-SWCS-T4-4-14d	238	25	ND	10	185	50	ND	50	1140	75	4.22	0.0165
15-SWCS-T4-4-28d	218	25	ND	10	169	50	ND	50	1020	75	0.32	0.0165
15-SWCS-T4-4-42d	235	25	ND	10	186	50	ND	50	1130	75	ND	0.0165
15-SWCS-T4-4-49d	245	25	ND	10	198	50	ND	50	1300	75	ND	0.0165
15-SWCS-T4-4-63d	229	25	ND	10	182	50	ND	50	1080	75	ND	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T4-4-90d	239	25	ND	10	185	50	ND	50	1240	75	0.0169	0.0165
15-SWCS-T4-4-140d	247	25	ND	10	183	50	ND	50	906	75	0.0872	0.0165
15-SWCS-T5-1-0.08d	2.26	0.25	ND	1	0.993	0.5	ND	5	ND	0.75	0.513	0.0099
15-SWCS-T5-1-1d	10.8	0.25	ND	0.1	4.86	0.5	ND	0.5	1.88	0.75	2.59	0.0099
15-SWCS-T5-1-2d	7.2	0.25	ND	0.1	3.58	0.5	ND	0.5	2.38	0.75	1.84	0.0099
15-SWCS-T5-1-7d	18.4	0.25	ND	0.1	8.73	0.5	ND	0.5	2.32	0.75	4.78	0.0099
15-SWCS-T5-1-14d	17	0.25	ND	0.1	8.51	0.5	ND	0.5	3.04	0.75	2.23	0.0165
15-SWCS-T5-1-28d	18.3	0.25	ND	0.1	9.5	0.5	ND	0.5	3.12	0.75	0.325	0.0165
15-SWCS-T5-1-42d	10.6	0.25	ND	0.1	5.87	0.5	ND	0.5	3.42	0.75	0.120	0.0165
15-SWCS-T5-1-49d	4.56	0.25	ND	0.1	3.11	0.5	ND	0.5	4.59	0.75	0.0463	0.0165
15-SWCS-T5-1-63d	7.42	0.25	ND	0.1	4.32	0.5	ND	0.5	4.36	0.75	0.113	0.0165
15-SWCS-T5-1-90d	10.8	0.25	ND	0.1	6.16	0.5	ND	0.5	4.29	0.75	0.181	0.0165
15-SWCS-T5-1-140d	13.8	0.25	ND	0.1	8.01	0.5	ND	0.5	4.31	0.75	0.192	0.0165
15-SWCS-T5-2-0.08d	2.64	0.25	ND	1	1.22	0.5	ND	5	ND	0.75	0.293	0.0099
15-SWCS-T5-2-1d	10.1	0.25	ND	0.1	4.54	0.5	ND	0.5	1.78	0.75	1.27	0.0099
15-SWCS-T5-2-2d	5.78	0.25	ND	0.1	2.93	0.5	ND	0.5	2.13	0.75	0.746	0.0099
15-SWCS-T5-2-7d	18	0.25	ND	0.1	8.38	0.5	ND	0.5	2.55	0.75	2.56	0.0099
15-SWCS-T5-2-14d	16.1	0.25	ND	0.1	7.94	0.5	ND	0.5	2.88	0.75	1.04	0.0165
15-SWCS-T5-2-28d	17.6	0.25	ND	0.1	9.2	0.5	ND	0.5	3.42	0.75	0.16	0.0165
15-SWCS-T5-2-42d	10.5	0.25	ND	0.1	5.82	0.5	ND	0.5	3.58	0.75	0.0769	0.0165
15-SWCS-T5-2-49d	4.9	0.25	ND	0.1	3.2	0.5	ND	0.5	4.61	0.75	0.0495	0.0165
15-SWCS-T5-2-63d	7.23	0.25	ND	0.1	4.31	0.5	ND	0.5	4.59	0.75	0.0881	0.0165
15-SWCS-T5-2-90d	10.3	0.25	ND	0.1	5.98	0.5	ND	0.5	4.29	0.75	0.0934	0.0165
15-SWCS-T5-2-140d	13.9	0.25	ND	0.1	8.09	0.5	ND	0.5	6.39	0.75	0.129	0.0165
15-SWCS-T5-3-0.08d	260	2.5	ND	1	215	5	ND	5	1390	7.5	1.55	0.0099
15-SWCS-T5-3-1d	255	2.5	ND	1	208	5	ND	5	1280	7.5	2.26	0.0099
15-SWCS-T5-3-2d	258	2.5	ND	1	212	5	ND	5	1380	7.5	1.08	0.0099
15-SWCS-T5-3-7d	252	25	ND	10	202	50	ND	50	1140	75	2.50	0.0099
15-SWCS-T5-3-14d	238	25	ND	10	190	50	ND	50	1190	75	1.25	0.0165
15-SWCS-T5-3-28d	239	25	ND	10	188	50	ND	50	1010	75	0.316	0.0165
15-SWCS-T5-3-42d	237	25	ND	10	188	50	ND	50	980	75	0.0658	0.0165
15-SWCS-T5-3-49d	252	25	ND	10	203	50	ND	50	1250	75	0.0323	0.0165
15-SWCS-T5-3-63d	249	25	ND	10	197	50	ND	50	1010	75	0.0567	0.0165
15-SWCS-T5-3-90d	261	25	ND	10	199	50	ND	50	848	75	0.146	0.0165
15-SWCS-T5-3-140d	278	25	ND	10	199	50	ND	50	870	75	0.421	0.0165
15-SWCS-T5-4-0.08d	256	2.5	ND	1	212	5	ND	5	1380	7.5	1.21	0.0099
15-SWCS-T5-41d	255	2.5	ND	1	208	5	ND	5	1280	7.5	2.20	0.0099
15-SWCS-T5-4-2d	256	2.5	ND	1	210	5	ND	5	1340	7.5	1.33	0.0099
15-SWCS-T5-4-7d	249	25	ND	10	199	50	ND	50	1160	75	2.18	0.0099
15-SWCS-T5-4-14d	235	25	ND	10	188	50	ND	50	1200	75	1.05	0.0165
15-SWCS-T5-4-28d	248	25	ND	10	194	50	ND	50	1040	75	0.411	0.0165
15-SWCS-T5-4-42d	246	25	ND	10	194	50	ND	50	999	75	0.0737	0.0165
15-SWCS-T5-4-49d	255	25	ND	10	205	50	ND	50	1250	75	0.0296	0.0165
15-SWCS-T5-4-63d	249	25	ND	10	197	50	ND	50	995	75	0.0415	0.0165
15-SWCS-T5-4-90d	259	25	ND	10	198	50	ND	50	860	75	0.0661	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T5-4-140d	277	25	ND	10	199	50	ND	50	887	75	0.266	0.0165
15-SWCS-T6-1-0.08d	0.403	0.25	ND	0.1	6.46	0.5	ND	0.5	1.41	0.75	0.764	0.0099
15-SWCS-T6-1-1d	1.42	0.25	ND	0.1	23.8	0.5	ND	0.5	2.82	0.75	4.86	0.0099
15-SWCS-T6-1-2d	1	0.25	ND	0.1	17	0.5	ND	0.5	3.59	0.75	3.82	0.0099
15-SWCS-T6-1-7d	2.63	0.25	ND	0.1	46.4	0.5	ND	0.5	3.98	0.75	10.8	0.0099
15-SWCS-T6-1-14d	2.34	0.25	ND	0.1	42.1	0.5	ND	0.5	5.52	0.75	6.46	0.0165
15-SWCS-T6-1-28d	2.61	0.25	ND	0.1	46.2	0.5	ND	0.5	6.67	0.75	1.45	0.0165
15-SWCS-T6-1-42d	1.48	0.25	ND	0.1	25.8	0.5	ND	0.5	6.85	0.75	0.163	0.0165
15-SWCS-T6-1-49d	0.605	0.25	ND	0.1	11.6	0.5	ND	0.5	8.39	0.75	0.0758	0.0165
15-SWCS-T6-1-63d	1.01	0.25	ND	0.1	18.4	0.5	ND	0.5	8.3	0.75	0.145	0.0165
15-SWCS-T6-1-90d	1.44	0.25	ND	0.1	26.3	0.5	ND	0.5	8.13	0.75	0.214	0.0165
15-SWCS-T6-1-140d	1.88	0.25	ND	0.1	34.4	0.5	ND	0.5	8.15	0.75	0.252	0.0165
15-SWCS-T6-2-0.08d	0.518	0.25	ND	0.1	4.58	0.5	ND	0.5	ND	0.75	0.75	0.0099
15-SWCS-T6-2-1d	1.34	0.25	ND	0.1	22.3	0.5	ND	0.5	2.19	0.75	6.21	0.0099
15-SWCS-T6-2-2d	0.882	0.25	ND	0.1	15	0.5	ND	0.5	3.14	0.75	3.60	0.0099
15-SWCS-T6-2-7d	2.69	0.25	ND	0.1	46.9	0.5	ND	0.5	3.81	0.75	13.1	0.0099
15-SWCS-T6-2-14d	2.43	0.25	ND	0.1	43.8	0.5	ND	0.5	5.33	0.75	8.26	0.0165
15-SWCS-T6-2-28d	ND	0.25	ND	0.1	46.8	0.5	ND	0.5	6.15	0.75	1.98	0.0165
15-SWCS-T6-2-42d	1.48	0.25	ND	0.1	27	0.5	ND	0.5	6.64	0.75	0.156	0.0165
15-SWCS-T6-2-49d	0.611	0.25	ND	0.1	11.9	0.5	ND	0.5	8.08	0.75	0.0608	0.0165
15-SWCS-T6-2-63d	1.02	0.25	ND	0.1	19	0.5	ND	0.5	7.93	0.75	0.135	0.0165
15-SWCS-T6-2-90d	1.5	0.25	ND	0.1	27.6	0.5	ND	0.5	7.71	0.75	0.221	0.0165
15-SWCS-T6-2-140d	1.82	0.25	ND	0.1	33.8	0.5	ND	0.5	7.94	0.75	0.182	0.0165
15-SWCS-T6-3-0.08d	250	2.5	ND	1	220	5	ND	5	1380	7.5	2.07	0.0099
15-SWCS-T6-3-1d	248	2.5	ND	1	232	5	ND	5	1330	7.5	5.73	0.0099
15-SWCS-T6-3-2d	246	2.5	ND	1	221	5	ND	5	1310	7.5	5.53	0.0099
15-SWCS-T6-3-7d	252	25	ND	10	250	50	ND	50	1240	75	13.4	0.0099
15-SWCS-T6-3-14d	249	25	ND	10	234	50	ND	50	1260	75	7.01	0.0165
15-SWCS-T6-3-28d	245	25	ND	10	238	50	ND	50	1050	75	2.63	0.0165
15-SWCS-T6-3-42d	248	25	ND	10	223	50	ND	50	1090	75	0.127	0.0165
15-SWCS-T6-3-49d	249	25	ND	10	212	50	ND	50	1290	75	0.0209	0.0165
15-SWCS-T6-3-63d	239	25	ND	10	209	50	ND	50	1070	75	0.029	0.0165
15-SWCS-T6-3-90d	244	25	ND	10	221	50	ND	50	978	75	0.0365	0.0165
15-SWCS-T6-3-140d	251	25	ND	10	242	50	ND	50	1030	75	0.116	0.0165
15-SWCS-T6-4-0.08d	249	2.5	ND	1	218	5	ND	5	1380	7.5	1.20	0.0099
15-SWCS-T6-4-1d	251	2.5	ND	1	237	5	ND	5	1350	7.5	6.11	0.0099
15-SWCS-T6-4-2d	246	2.5	ND	1	222	5	ND	5	1310	7.5	5.01	0.0099
15-SWCS-T6-4-7d	252	25	ND	10	250	50	ND	50	1220	75	12.2	0.0099
15-SWCS-T6-4-14d	249	25	ND	10	236	50	ND	50	1230	75	6.69	0.0165
15-SWCS-T6-4-28d	247	25	ND	10	242	50	ND	50	1050	75	2.13	0.0165
15-SWCS-T6-4-42d	246	25	ND	10	222	50	ND	50	1100	75	0.096	0.0165
15-SWCS-T6-4-49d	249	25	ND	10	212	50	ND	50	1290	75	0.0224	0.0165
15-SWCS-T6-4-63d	239	25	ND	10	211	50	ND	50	1040	75	0.0665	0.0165
15-SWCS-T6-4-90d	245	25	ND	10	226	50	ND	50	979	75	0.0591	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T6-4-140d	248	25	ND	10	239	50	ND	50	1020	75	0.127	0.0165
15-SWCS-T7-1-0.08d	2.07	0.25	ND	0.1	1.08	0.5	ND	0.5	ND	0.75	0.595	0.0099
15-SWCS-T7-1-1d	6.98	0.25	ND	0.1	3.52	0.5	ND	0.5	1.64	0.75	2.21	0.0099
15-SWCS-T7-1-2d	5.43	0.25	ND	0.1	2.99	0.5	ND	0.5	2.81	0.75	1.72	0.0099
15-SWCS-T7-1-7d	15.3	0.25	ND	0.1	7.95	0.5	ND	0.5	2.07	0.75	4.79	0.0099
15-SWCS-T7-1-14d	12.7	0.25	ND	0.1	7.12	0.5	ND	0.5	3.21	0.75	1.98	0.0165
15-SWCS-T7-1-28d	13.9	0.25	ND	0.1	8.1	0.5	ND	0.5	3.53	0.75	0.207	0.0165
15-SWCS-T7-1-42d	8	0.25	ND	0.1	4.87	0.5	ND	0.5	3.56	0.75	0.119	0.0165
15-SWCS-T7-1-49d	3.58	0.25	ND	0.1	2.56	0.5	ND	0.5	4.51	0.75	0.0569	0.0165
15-SWCS-T7-1-63d	6.05	0.25	ND	0.1	3.83	0.5	ND	0.5	4.43	0.75	0.185	0.0165
15-SWCS-T7-1-90d	8.73	0.25	ND	0.1	5.42	0.5	ND	0.5	4.15	0.75	0.315	0.0165
15-SWCS-T7-1-140d	11	0.25	ND	0.1	6.93	0.5	ND	0.5	4.22	0.75	0.381	0.0165
15-SWCS-T7-2-0.08d	2.57	0.25	ND	0.1	1.34	0.5	ND	0.5	ND	0.75	0.713	0.0099
15-SWCS-T7-2-1d	7.4	0.25	ND	0.1	3.8	0.5	ND	0.5	1.39	0.75	2.56	0.0099
15-SWCS-T7-2-2d	4.25	0.25	ND	0.1	2.43	0.5	ND	0.5	2.29	0.75	1.35	0.0099
15-SWCS-T7-2-7d	14.4	0.25	ND	0.1	7.5	0.5	ND	0.5	2.17	0.75	4.82	0.0099
15-SWCS-T7-2-14d	13.3	0.25	ND	0.1	7.41	0.5	ND	0.5	3.24	0.75	2.01	0.0165
15-SWCS-T7-2-28d	13.5	0.25	ND	0.1	7.99	0.5	ND	0.5	3.65	0.75	0.218	0.0165
15-SWCS-T7-2-42d	8.2	0.25	ND	0.1	5.02	0.5	ND	0.5	3.68	0.75	0.152	0.0165
15-SWCS-T7-2-49d	3.51	0.25	ND	0.1	2.58	0.5	ND	0.5	4.66	0.75	0.0531	0.0165
15-SWCS-T7-2-63d	5.46	0.25	ND	0.1	3.55	0.5	ND	0.5	4.42	0.75	0.116	0.0165
15-SWCS-T7-2-90d	8.52	0.25	ND	0.1	5.41	0.5	ND	0.5	4.42	0.75	0.264	0.0165
15-SWCS-T7-2-140d	10.6	0.25	ND	0.1	6.84	0.5	ND	0.5	4.43	0.75	0.305	0.0165
15-SWCS-T7-3-0.08d	253	2.5	ND	1	211	5	ND	5	1380	7.5	1.17	0.0099
15-SWCS-T7-3-1d	257	2.5	ND	1	211	5	ND	5	1290	7.5	2.12	0.0099
15-SWCS-T7-3-2d	247	2.5	ND	1	203	5	ND	5	1260	7.5	1.15	0.0099
15-SWCS-T7-3-7d	253	25	ND	10	202	50	ND	50	1070	75	2.29	0.0099
15-SWCS-T7-3-14d	257	25	ND	10	205	50	ND	50	1150	75	1.61	0.0165
15-SWCS-T7-3-28d	253	25	ND	10	202	50	ND	50	1030	75	0.263	0.0165
15-SWCS-T7-3-42d	253	25	ND	10	203	50	ND	50	1110	75	0.0469	0.0165
15-SWCS-T7-3-49d	239	25	ND	10	195	50	ND	50	1230	75	0.0195	0.0165
15-SWCS-T7-3-63d	246	25	ND	10	199	50	ND	50	1070	75	0.0338	0.0165
15-SWCS-T7-3-90d	246	25	ND	10	196	50	ND	50	969	75	0.0663	0.0165
15-SWCS-T7-3-140d	251	25	ND	10	194	50	ND	50	937	75	0.154	0.0165
15-SWCS-T7-4-0.08d	253	2.5	ND	1	212	5	ND	5	1370	7.5	1.21	0.0099
15-SWCS-T7-4-1d	257	2.5	ND	1	212	5	ND	5	1290	7.5	2.08	0.0099
15-SWCS-T7-4-2d	249	2.5	ND	1	204	5	ND	5	1260	7.5	0.922	0.0099
15-SWCS-T7-4-7d	252	25	ND	10	202	50	ND	50	1060	75	1.67	0.0099
15-SWCS-T7-4-14d	256	25	ND	10	205	50	ND	50	1170	75	1.14	0.0165
15-SWCS-T7-4-28d	252	25	ND	10	200	50	ND	50	1010	75	0.222	0.0165
15-SWCS-T7-4-42d	252	25	ND	10	203	50	ND	50	1100	75	0.0359	0.0165
15-SWCS-T7-4-49d	253	25	ND	10	206	50	ND	50	1300	75	0.0178	0.0165
15-SWCS-T7-4-63d	240	25	ND	10	195	50	ND	50	1050	75	0.0443	0.0165
15-SWCS-T7-4-90d	246	25	ND	10	196	50	ND	50	966	75	0.0716	0.0165
15-SWCS-T7-4-140d	249	25	ND	10	195	50	ND	50	967	75	0.146	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (μg/L)	EQL
15-SWCS-T8-1-0.08d	0.342	0.25	ND	0.1	5.38	0.5	ND	0.5	1.2	0.75	0.681	0.0099
15-SWCS-T8-1-1d	1.62	0.25	ND	0.1	28.1	0.5	ND	0.5	5.42	0.75	5.16	0.0099
15-SWCS-T8-1-2d	0.861	0.25	ND	0.1	15	0.5	ND	0.5	3.67	0.75	2.54	0.0099
15-SWCS-T8-1-7d	2.53	0.25	ND	0.1	45.6	0.5	ND	0.5	3.76	0.75	7.41	0.0099
15-SWCS-T8-1-14d	2.41	0.25	ND	0.1	44.8	0.5	ND	0.5	5.3	0.75	4.59	0.0165
15-SWCS-T8-1-28d	2.58	0.25	ND	0.1	47.9	0.5	ND	0.5	6.14	0.75	0.981	0.0165
15-SWCS-T8-1-42d	1.46	0.25	ND	0.1	27.1	0.5	ND	0.5	6.5	0.75	0.122	0.0165
15-SWCS-T8-1-49d	0.591	0.25	ND	0.1	11.8	0.5	ND	0.5	8.05	0.75	0.0493	0.0165
15-SWCS-T8-1-63d	0.971	0.25	ND	0.1	18.5	0.5	ND	0.5	7.84	0.75	0.0872	0.0165
15-SWCS-T8-1-90d	1.46	0.25	ND	0.1	27.5	0.5	ND	0.5	7.76	0.75	0.156	0.0165
15-SWCS-T8-1-140d	1.79	0.25	ND	0.1	34.1	0.5	ND	0.5	8.08	0.75	0.166	0.0165
15-SWCS-T8-2-0.08d	0.306	0.25	ND	0.1	4.68	0.5	ND	0.5	1	0.75	0.488	0.0099
15-SWCS-T8-2-1d	1.57	0.25	ND	0.1	26.5	0.5	ND	0.5	4.94	0.75	4.44	0.0099
15-SWCS-T8-2-2d	0.823	0.25	ND	0.1	14	0.5	ND	0.5	3.29	0.75	2.53	0.0099
15-SWCS-T8-2-7d	2.91	0.25	ND	0.1	51.1	0.5	ND	0.5	3.64	0.75	8.52	0.0099
15-SWCS-T8-2-14d	2.36	0.25	ND	0.1	42.8	0.5	ND	0.5	4.83	0.75	4.32	0.0165
15-SWCS-T8-2-28d	2.56	0.25	ND	0.1	46	0.5	ND	0.5	5.76	0.75	0.711	0.0165
15-SWCS-T8-2-42d	1.41	0.25	ND	0.1	27.8	0.5	ND	0.5	6.31	0.75	0.0771	0.0165
15-SWCS-T8-2-49d	0.605	0.25	ND	0.1	11.7	0.5	ND	0.5	7.92	0.75	0.0347	0.0165
15-SWCS-T8-2-63d	0.956	0.25	ND	0.1	17.9	0.5	ND	0.5	7.63	0.75	0.0863	0.0165
15-SWCS-T8-2-90d	1.32	0.25	ND	0.1	24.8	0.5	ND	0.5	7.52	0.75	0.0918	0.0165
15-SWCS-T8-2-140d	1.69	0.25	ND	0.1	31.6	0.5	ND	0.5	7.84	0.75	0.0848	0.0165
15-SWCS-T8-3-0.08d	251	2.5	ND	1	218	5	ND	5	1390	7.5	1.26	0.0099
15-SWCS-T8-3-1d	250	2.5	ND	1	237	5	ND	5	1340	7.5	5.61	0.0099
15-SWCS-T8-3-2d	245	2.5	ND	1	222	5	ND	5	1300	7.5	4.35	0.0099
15-SWCS-T8-3-7d	251	25	ND	10	244	50	ND	50	1190	75	9.11	0.0099
15-SWCS-T8-3-14d	247	25	ND	10	230	50	ND	50	1150	75	4.60	0.0165
15-SWCS-T8-3-28d	247	25	ND	10	237	50	ND	50	1060	75	1.32	0.0165
15-SWCS-T8-3-42d	246	25	ND	10	221	50	ND	50	1100	75	0.0748	0.0165
15-SWCS-T8-3-49d	249	25	ND	10	212	50	ND	50	1290	75	0.0242	0.0165
15-SWCS-T8-3-63d	243	25	ND	10	212	50	ND	50	1080	75	0.0225	0.0165
15-SWCS-T8-3-90d	248	25	ND	10	224	50	ND	50	998	75	0.0531	0.0165
15-SWCS-T8-3-140d	249	25	ND	10	235	50	ND	50	1050	75	0.0534	0.0165
15-SWCS-T8-4-0.08d	251	2.5	ND	1	219	5	ND	5	1380	7.5	1.18	0.0099
15-SWCS-T8-4-1d	251	2.5	ND	1	242	5	ND	5	1340	7.5	6.49	0.0099
15-SWCS-T8-4-2d	247	2.5	ND	1	222	5	ND	5	1310	7.5	4.18	0.0099
15-SWCS-T8-4-7d	253	25	ND	10	247	50	ND	50	1190	75	8.73	0.0099
15-SWCS-T8-4-14d	244	25	ND	10	229	50	ND	50	1200	75	3.88	0.0165
15-SWCS-T8-4-28d	236	25	ND	10	229	50	ND	50	998	75	1.22	0.0165
15-SWCS-T8-4-42d	247	25	ND	10	222	50	ND	50	1090	75	0.110	0.0165
15-SWCS-T8-4-49d	249	25	ND	10	213	50	ND	50	1280	75	0.0387	0.0165
15-SWCS-T8-4-63d	242	25	ND	10	211	50	ND	50	1070	75	0.036	0.0165
15-SWCS-T8-4-90d	245	25	ND	10	221	50	ND	50	987	75	0.0405	0.0165
15-SWCS-T8-4-140d	250	25	ND	10	238	50	ND	50	1050	75	0.0824	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T9-1-0.08d	ND	0.25	ND	0.1	ND	0.5	ND	0.5	ND	0.75	0.0756	0.0099
15-SWCS-T9-1-1d	0.517	0.25	ND	0.1	ND	0.5	ND	0.5	2.04	0.75	0.25	0.0099
15-SWCS-T9-1-2d	0.341	0.25	ND	0.1	ND	0.5	ND	0.5	3.12	0.75	0.104	0.0099
15-SWCS-T9-1-7d	1.21	0.25	ND	0.1	ND	0.5	ND	0.5	3.08	0.75	0.12	0.0099
15-SWCS-T9-1-14d	0.915	0.25	ND	0.1	ND	0.5	ND	0.5	4.65	0.75	0.0464	0.0165
15-SWCS-T9-1-28d	1.03	0.25	ND	0.1	ND	0.5	ND	0.5	5.53	0.75	0.0809	0.0165
15-SWCS-T9-1-42d	0.609	0.25	ND	0.1	ND	0.5	ND	0.5	4.76	0.75	0.0978	0.0165
15-SWCS-T9-1-49d	ND	0.25	ND	0.1	ND	0.5	ND	0.5	4.59	0.75	0.0521	0.0165
15-SWCS-T9-1-63d	0.391	0.25	ND	0.1	ND	0.5	ND	0.5	4.56	0.75	0.0883	0.0165
15-SWCS-T9-1-90d	0.626	0.25	ND	0.1	ND	0.5	ND	0.5	4.63	0.75	0.159	0.0165
15-SWCS-T9-1-140d	0.823	0.25	ND	0.1	ND	0.5	ND	0.5	4.91	0.75	0.196	0.0165
15-SWCS-T9-2-0.08d	ND	0.25	ND	0.1	ND	0.5	ND	0.5	ND	0.75	0.0862	0.0099
15-SWCS-T9-2-1d	0.472	0.25	ND	0.1	ND	0.5	ND	0.5	2.07	0.75	0.225	0.0099
15-SWCS-T9-2-2d	0.321	0.25	ND	0.1	ND	0.5	ND	0.5	2.8	0.75	0.117	0.0099
15-SWCS-T9-2-7d	1.08	0.25	ND	0.1	ND	0.5	ND	0.5	3.03	0.75	0.159	0.0099
15-SWCS-T9-2-14d	0.926	0.25	ND	0.1	ND	0.5	ND	0.5	4.63	0.75	0.0568	0.0165
15-SWCS-T9-2-28d	1.06	0.25	ND	0.1	ND	0.5	ND	0.5	5.62	0.75	0.0879	0.0165
15-SWCS-T9-2-42d	0.573	0.25	ND	0.1	ND	0.5	ND	0.5	4.72	0.75	0.0725	0.0165
15-SWCS-T9-2-49d	ND	0.25	ND	0.1	ND	0.5	ND	0.5	4.48	0.75	0.0363	0.0165
15-SWCS-T9-2-63d	0.432	0.25	ND	0.1	ND	0.5	ND	0.5	4.91	0.75	0.0965	0.0165
15-SWCS-T9-2-90d	0.645	0.25	ND	0.1	ND	0.5	ND	0.5	4.62	0.75	0.174	0.0165
15-SWCS-T9-2-140d	0.804	0.25	ND	0.1	ND	0.5	ND	0.5	4.94	0.75	0.169	0.0165
15-SWCS-T9-3-0.08d	253	2.5	ND	1	210	5	ND	5	1390	7.5	0.238	0.0099
15-SWCS-T9-3-1d	251	2.5	ND	1	205	5	ND	5	1320	7.5	0.828	0.0099
15-SWCS-T9-3-2d	245	2.5	ND	1	200	5	ND	5	1300	7.5	0.225	0.0099
15-SWCS-T9-3-7d	239	25	ND	10	188	50	ND	50	1170	75	0.0979	0.0099
15-SWCS-T9-3-14d	234	25	ND	10	186	50	ND	50	1270	75	0.0351	0.0165
15-SWCS-T9-3-28d	229	25	ND	10	183	50	ND	50	1200	75	0.0208	0.0165
15-SWCS-T9-3-42d	238	25	ND	10	195	50	ND	50	1260	75	ND	0.0165
15-SWCS-T9-3-49d	247	25	ND	10	204	50	ND	50	1380	75	ND	0.0165
15-SWCS-T9-3-63d	238	25	ND	10	196	50	ND	50	1170	75	ND	0.0165
15-SWCS-T9-3-90d	229	25	ND	10	187	50	ND	50	1140	75	ND	0.0165
15-SWCS-T9-3-140d	222	25	ND	10	178	50	ND	50	1180	75	0.0441	0.0165
15-SWCS-T9-4-0.08d	250	2.5	ND	1	209	5	ND	5	1390	7.5	0.255	0.0099
15-SWCS-T9-4-1d	252	2.5	ND	1	206	5	ND	5	1330	7.5	0.841	0.0099
15-SWCS-T9-4-2d	246	2.5	ND	1	201	5	ND	5	1310	7.5	0.238	0.0099
15-SWCS-T9-4-7d	240	25	ND	10	190	50	ND	50	1160	75	0.0788	0.0099
15-SWCS-T9-4-14d	237	25	ND	10	188	50	ND	50	1270	75	0.0316	0.0165
15-SWCS-T9-4-28d	222	25	ND	10	177	50	ND	50	1120	75	0.019	0.0165
15-SWCS-T9-4-42d	239	25	ND	10	195	50	ND	50	1240	75	ND	0.0165
15-SWCS-T9-4-49d	248	25	ND	10	204	50	ND	50	1370	75	ND	0.0165
15-SWCS-T9-4-63d	241	25	ND	10	198	50	ND	50	1180	75	ND	0.0165
15-SWCS-T9-4-90d	233	25	ND	10	191	50	ND	50	1130	75	ND	0.0165
15-SWCS-T9-4-140d	226	25	ND	10	182	50	ND	50	1160	75	0.0379	0.0165
15-SWCS-T10-1-0.08d	0.568	0.25	ND	0.1	7.5	0.5	ND	0.5	2.62	0.75	1.92	0.0099

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T10-1-1d	1.44	0.25	ND	0.1	21.3	0.5	ND	0.5	4.7	0.75	6.36	0.0099
15-SWCS-T10-1-2d	0.672	0.25	ND	0.1	9.68	0.5	ND	0.5	2.74	0.75	2.09	0.0099
15-SWCS-T10-1-7d	2.51	0.25	ND	0.1	37.7	0.5	ND	0.5	4.43	0.75	5.29	0.0099
15-SWCS-T10-1-14d	1.6	0.25	ND	0.1	24	0.5	ND	0.5	6.28	0.75	0.417	0.0165
15-SWCS-T10-1-28d	1.41	0.25	ND	0.1	20.7	0.5	ND	0.5	9.58	0.75	0.14	0.0165
15-SWCS-T10-1-42d	0.703	0.25	ND	0.1	10.6	0.5	ND	0.5	8.46	0.75	0.0969	0.0165
15-SWCS-T10-1-49d	0.256	0.25	ND	0.1	4.49	0.5	ND	0.5	8.72	0.75	0.0482	0.0165
15-SWCS-T10-1-63d	0.45	0.25	ND	0.1	6.67	0.5	ND	0.5	8.8	0.75	0.111	0.0165
15-SWCS-T10-1-90d	0.579	0.25	ND	0.1	8.86	0.5	ND	0.5	8.41	0.75	0.181	0.0165
15-SWCS-T10-1-140d	0.717	0.25	ND	0.1	10.6	0.5	ND	0.5	8.92	0.75	0.221	0.0165
15-SWCS-T10-2-0.08d	0.454	0.25	ND	0.1	6.28	0.5	ND	0.5	1.32	0.75	1.53	0.0099
15-SWCS-T10-2-1d	1.81	0.25	ND	0.1	27.6	0.5	ND	0.5	3.83	0.75	8.60	0.0099
15-SWCS-T10-2-2d	0.929	0.25	ND	0.1	14	0.5	ND	0.5	3.33	0.75	3.10	0.0099
15-SWCS-T10-2-7d	2.29	0.25	ND	0.1	34.1	0.5	ND	0.5	3.89	0.75	4.10	0.0099
15-SWCS-T10-2-14d	1.52	0.25	ND	0.1	22.6	0.5	ND	0.5	7.21	0.75	0.292	0.0165
15-SWCS-T10-2-28d	1.4	0.25	ND	0.1	20.2	0.5	ND	0.5	9.43	0.75	0.11	0.0165
15-SWCS-T10-2-42d	0.678	0.25	ND	0.1	10.2	0.5	ND	0.5	8.02	0.75	0.0702	0.0165
15-SWCS-T10-2-49d	0.269	0.25	ND	0.1	4.78	0.5	ND	0.5	8.4	0.75	0.0504	0.0165
15-SWCS-T10-2-63d	0.404	0.25	ND	0.1	7.38	0.5	ND	0.5	8.43	0.75	0.0874	0.0165
15-SWCS-T10-2-90d	0.596	0.25	ND	0.1	9.15	0.5	ND	0.5	8.42	0.75	0.159	0.0165
15-SWCS-T10-2-140d	0.746	0.25	ND	0.1	11.1	0.5	ND	0.5	9.08	0.75	0.202	0.0165
15-SWCS-T10-3-0.08d	254	2.5	ND	1	220	5	ND	5	1410	7.5	4.63	0.0099
15-SWCS-T10-3-1d	249	2.5	ND	1	231	5	ND	5	1330	7.5	8.93	0.0099
15-SWCS-T10-3-2d	246	2.5	ND	1	217	5	ND	5	1310	7.5	3.95	0.0099
15-SWCS-T10-3-7d	250	25	ND	10	226	50	ND	50	1190	75	4.06	0.0099
15-SWCS-T10-3-14d	241	25	ND	10	207	50	ND	50	1260	75	0.235	0.0165
15-SWCS-T10-3-28d	239	25	ND	10	208	50	ND	50	1220	75	0.0485	0.0165
15-SWCS-T10-3-42d	248	25	ND	10	210	50	ND	50	1250	75	0.0266	0.0165
15-SWCS-T10-3-49d	251	25	ND	10	209	50	ND	50	1370	75	ND	0.0165
15-SWCS-T10-3-63d	244	25	ND	10	204	50	ND	50	1180	75	ND	0.0165
15-SWCS-T10-3-90d	242	25	ND	10	204	50	ND	50	1120	75	0.0167	0.0165
15-SWCS-T10-3-140d	245	25	ND	10	208	50	ND	50	1200	75	0.0222	0.0165
15-SWCS-T10-4-0.08d	253	2.5	ND	1	219	5	ND	5	1400	7.5	2.02	0.0099
15-SWCS-T10-4-1d	250	2.5	ND	1	232	5	ND	5	1350	7.5	7.56	0.0099
15-SWCS-T10-4-2d	249	2.5	ND	1	219	5	ND	5	1330	7.5	3.99	0.0099
15-SWCS-T10-4-7d	250	25	ND	10	225	50	ND	50	1190	75	4.01	0.0099
15-SWCS-T10-4-14d	241	25	ND	10	207	50	ND	50	1260	75	0.178	0.0165
15-SWCS-T10-4-28d	243	25	ND	10	212	50	ND	50	1160	75	0.051	0.0165
15-SWCS-T10-4-42d	243	25	ND	10	192	50	ND	50	1230	75	0.0261	0.0165
15-SWCS-T10-4-49d	253	25	ND	10	210	50	ND	50	1370	75	ND	0.0165
15-SWCS-T10-4-63d	245	25	ND	10	205	50	ND	50	1180	75	ND	0.0165
15-SWCS-T10-4-90d	244	25	ND	10	205	50	ND	50	1140	75	ND	0.0165
15-SWCS-T10-4-140d	244	25	ND	10	208	50	ND	50	1220	75	0.0236	0.0165
15-SWCS-T11-1-0.08d	0.287	0.25	ND	0.1	4.54	0.5	ND	0.5	3.89	0.75	0.137	0.0099
15-SWCS-T11-1-1d	1.33	0.25	ND	0.1	22.8	0.5	ND	0.5	20.3	0.75	0.846	0.0099

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T11-1-2d	1.13	0.25	ND	0.1	19.2	0.5	ND	0.5	16.6	0.75	0.805	0.0099
15-SWCS-T11-1-7d	3.09	0.25	0.136	0.1	52.8	0.5	0.51	0.5	30.1	0.75	1.97	0.0165
15-SWCS-T11-1-14d	2.19	0.25	ND	0.1	38.3	0.5	ND	0.5	20.2	0.75	0.385	0.0165
15-SWCS-T11-1-28d	2.44	0.25	0.127	0.1	43.3	0.5	ND	0.5	21.1	0.75	0.100	0.0165
15-SWCS-T11-1-42d	1.56	0.25	0.103	0.1	41.3	0.5	ND	0.5	16.6	0.75	0.0815	0.0165
15-SWCS-T11-1-49d	0.589	0.25	ND	0.1	11.4	0.5	ND	0.5	11.6	0.75	0.0346	0.0165
15-SWCS-T11-1-63d	0.947	0.25	ND	0.1	18	0.5	ND	0.5	14.8	0.75	0.0644	0.0165
15-SWCS-T11-1-90d	1.35	0.25	ND	0.1	25.5	0.5	ND	0.5	16.5	0.75	0.116	0.0165
15-SWCS-T11-1-140d	1.58	0.25	0.131	0.1	30.2	0.5	ND	0.5	17.9	0.75	0.170	0.0165
15-SWCS-T11-2-0.08d	0.333	0.25	ND	0.1	5.37	0.5	ND	0.5	5.21	0.75	0.299	0.0099
15-SWCS-T11-2-1d	1.74	0.25	ND	0.1	28.8	0.5	ND	0.5	30.4	0.75	2.32	0.0099
15-SWCS-T11-2-2d	0.957	0.25	ND	0.1	16.3	0.5	ND	0.5	14.8	0.75	1.50	0.0099
15-SWCS-T11-2-7d	3.27	0.25	0.143	0.1	55.7	0.5	0.552	0.5	31.7	0.75	4.71	0.0165
15-SWCS-T11-2-14d	2.35	0.25	ND	0.1	40.9	0.5	ND	0.5	20.3	0.75	0.972	0.0165
15-SWCS-T11-2-28d	2.66	0.25	0.131	0.1	47	0.5	ND	0.5	21.3	0.75	0.148	0.0165
15-SWCS-T11-2-42d	1.65	0.25	0.102	0.1	30.4	0.5	ND	0.5	16.1	0.75	0.105	0.0165
15-SWCS-T11-2-49d	0.625	0.25	ND	0.1	12.3	0.5	ND	0.5	12.2	0.75	0.0519	0.0165
15-SWCS-T11-2-63d	1.03	0.25	ND	0.1	19.3	0.5	ND	0.5	15.4	0.75	0.102	0.0165
15-SWCS-T11-2-90d	1.39	0.25	ND	0.1	26.8	0.5	ND	0.5	15.7	0.75	0.168	0.0165
15-SWCS-T11-2-140d	1.58	0.25	0.126	0.1	30.9	0.5	ND	0.5	17.3	0.75	0.211	0.0165
15-SWCS-T11-3-0.08d	256	25	ND	10	219	50	ND	50	1400	75	0.291	0.0099
15-SWCS-T11-3-1d	288	25	ND	10	274	50	ND	50	1590	75	1.51	0.0099
15-SWCS-T11-3-2d	284	25	ND	10	255	50	ND	50	1550	75	1.04	0.0099
15-SWCS-T11-3-7d	288	25	ND	10	288	50	ND	50	1590	75	2.29	0.0165
15-SWCS-T11-3-14d	257	25	ND	10	244	50	ND	50	1400	75	0.400	0.0165
15-SWCS-T11-3-28d	269	25	ND	10	251	50	ND	50	1480	75	0.0384	0.0165
15-SWCS-T11-3-42d	261	25	ND	10	231	50	ND	50	1430	75	0.0216	0.0165
15-SWCS-T11-3-49d	251	25	ND	10	214	50	ND	50	1230	75	ND	0.0165
15-SWCS-T11-3-63d	252	25	ND	10	218	50	ND	50	1270	75	0.0186	0.0165
15-SWCS-T11-3-90d	259	25	ND	10	226	50	ND	50	1330	75	ND	0.0165
15-SWCS-T11-3-140d	252	25	ND	10	220	50	ND	50	1320	75	0.017	0.0165
15-SWCS-T11-4-0.08d	256	25	ND	10	218	50	ND	50	1400	75	0.259	0.0099
15-SWCS-T11-4-1d	288	25	ND	10	268	50	ND	50	1570	75	1.46	0.0099
15-SWCS-T11-4-2d	288	25	ND	10	256	50	ND	50	1570	75	0.971	0.0099
15-SWCS-T11-4-7d	288	25	ND	10	285	50	ND	50	1580	75	2.29	0.0165
15-SWCS-T11-4-14d	257	25	ND	10	246	50	ND	50	1410	75	0.497	0.0165
15-SWCS-T11-4-28d	259	25	ND	10	245	50	ND	50	1420	75	0.0503	0.0165
15-SWCS-T11-4-42d	261	25	ND	10	233	50	ND	50	1440	75	0.018	0.0165
15-SWCS-T11-4-49d	252	25	ND	10	216	50	ND	50	1250	75	ND	0.0165
15-SWCS-T11-4-63d	254	25	ND	10	221	50	ND	50	1280	75	0.0216	0.0165
15-SWCS-T11-4-90d	253	25	ND	10	223	50	ND	50	1250	75	0.0204	0.0165
15-SWCS-T11-4-140d	253	25	ND	10	221	50	ND	50	1320	75	0.0165	0.0165
15-SWCS-T12-1-0.08d	0.382	0.25	ND	0.1	ND	0.5	ND	0.5	ND	0.75	0.620	0.0099
15-SWCS-T12-1-1d	1.34	0.25	ND	0.1	ND	0.5	ND	0.5	7.98	0.75	2.68	0.0099
15-SWCS-T12-1-2d	0.729	0.25	ND	0.1	ND	0.5	ND	0.5	5.74	0.75	1.54	0.0099

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T12-1-7d	2.35	0.25	ND	0.1	ND	0.5	ND	0.5	6.98	0.75	4.86	0.0165
15-SWCS-T12-1-14d	1.71	0.25	ND	0.1	ND	0.5	ND	0.5	5.84	0.75	2.38	0.0165
15-SWCS-T12-1-28d	1.81	0.25	ND	0.1	ND	0.5	ND	0.5	7.27	0.75	0.829	0.0165
15-SWCS-T12-1-42d	1.1	0.25	ND	0.1	ND	0.5	ND	0.5	6.24	0.75	0.388	0.0165
15-SWCS-T12-1-49d	0.443	0.25	ND	0.1	ND	0.5	ND	0.5	6.53	0.75	0.177	0.0165
15-SWCS-T12-1-63d	0.704	0.25	ND	0.1	ND	0.5	ND	0.5	6.89	0.75	0.316	0.0165
15-SWCS-T12-1-90d	0.995	0.25	ND	0.1	ND	0.5	ND	0.5	6.76	0.75	0.522	0.0165
15-SWCS-T12-1-140d	1.24	0.25	ND	0.1	ND	0.5	ND	0.5	7.25	0.75	0.66	0.0165
15-SWCS-T12-2-0.08d	0.459	0.25	ND	0.1	ND	0.5	ND	0.5	ND	0.75	0.662	0.0099
15-SWCS-T12-2-1d	1.22	0.25	ND	0.1	ND	0.5	ND	0.5	6.32	0.75	2.60	0.0099
15-SWCS-T12-2-2d	0.78	0.25	ND	0.1	ND	0.5	ND	0.5	5.95	0.75	1.63	0.0099
15-SWCS-T12-2-7d	2.32	0.25	ND	0.1	ND	0.5	ND	0.5	7.73	0.75	5.03	0.0165
15-SWCS-T12-2-14d	1.93	0.25	ND	0.1	ND	0.5	ND	0.5	6.16	0.75	4.44	0.0165
15-SWCS-T12-2-28d	2.01	0.25	ND	0.1	ND	0.5	ND	0.5	6.82	0.75	1.87	0.0165
15-SWCS-T12-2-42d	1.21	0.25	ND	0.1	ND	0.5	ND	0.5	6.41	0.75	0.255	0.0165
15-SWCS-T12-2-49d	0.472	0.25	ND	0.1	ND	0.5	ND	0.5	6.25	0.75	0.0914	0.0165
15-SWCS-T12-2-63d	0.742	0.25	ND	0.1	ND	0.5	ND	0.5	7.33	0.75	0.154	0.0165
15-SWCS-T12-2-90d	1.06	0.25	ND	0.1	ND	0.5	ND	0.5	6.7	0.75	0.263	0.0165
15-SWCS-T12-2-140d	1.26	0.25	ND	0.1	ND	0.5	ND	0.5	6.52	0.75	0.331	0.0165
15-SWCS-T12-3-0.08d	257	25	ND	10	212	50	ND	50	1400	75	0.679	0.0099
15-SWCS-T12-3-1d	285	25	ND	10	235	50	ND	50	1520	75	1.81	0.0099
15-SWCS-T12-3-2d	285	25	ND	10	235	50	ND	50	1550	75	1.02	0.0099
15-SWCS-T12-3-7d	285	25	ND	10	232	50	ND	50	1540	75	2.83	0.0165
15-SWCS-T12-3-14d	253	25	ND	10	206	50	ND	50	1360	75	1.59	0.0165
15-SWCS-T12-3-28d	255	25	ND	10	208	50	ND	50	1380	75	0.5	0.0165
15-SWCS-T12-3-42d	257	25	ND	10	211	50	ND	50	1410	75	0.0196	0.0165
15-SWCS-T12-3-49d	250	25	ND	10	206	50	ND	50	1230	75	ND	0.0165
15-SWCS-T12-3-63d	254	25	ND	10	208	50	ND	50	1280	75	0.0168	0.0165
15-SWCS-T12-3-90d	254	25	ND	10	209	50	ND	50	1320	75	ND	0.0165
15-SWCS-T12-3-140d	248	25	ND	10	202	50	ND	50	1290	75	ND	0.0165
15-SWCS-T12-4-0.08d	256	25	ND	10	213	50	ND	50	1400	75	0.556	0.0099
15-SWCS-T12-4-1d	288	25	ND	10	237	50	ND	50	1540	75	3.21	0.0099
15-SWCS-T12-4-2d	288	25	ND	10	237	50	ND	50	1560	75	2.24	0.0099
15-SWCS-T12-4-7d	284	25	ND	10	231	50	ND	50	1530	75	5.62	0.0165
15-SWCS-T12-4-14d	256	25	ND	10	208	50	ND	50	1370	75	1.93	0.0165
15-SWCS-T12-4-28d	254	25	ND	10	207	50	ND	50	1370	75	0.254	0.0165
15-SWCS-T12-4-42d	257	25	ND	10	211	50	ND	50	1410	75	0.0223	0.0165
15-SWCS-T12-4-49d	251	25	ND	10	207	50	ND	50	1230	75	ND	0.0165
15-SWCS-T12-4-63d	253	25	ND	10	208	50	ND	50	1270	75	0.0219	0.0165
15-SWCS-T12-4-90d	258	25	ND	10	212	50	ND	50	1380	75	0.0229	0.0165
15-SWCS-T12-4-140d	249	25	ND	10	204	50	ND	50	1290	75	0.0198	0.0165
15-SWCS-T13-1-0.08d	1.17	0.25	ND	0.1	19.5	0.5	ND	0.5	17.6	0.75	1.20	0.0099
15-SWCS-T13-1-1d	2.93	0.25	ND	0.1	51.9	0.5	ND	0.5	48.4	0.75	1.90	0.0099
15-SWCS-T13-1-2d	1.56	0.25	ND	0.1	27.6	0.5	ND	0.5	17.2	0.75	0.525	0.0099

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T13-1-7d	3.49	0.25	0.249	0.1	62.4	0.5	ND	0.5	30.7	0.75	2.10	0.0165
15-SWCS-T13-1-14d	1.87	0.25	ND	0.1	34.2	0.5	ND	0.5	19.6	0.75	2.28	0.0165
15-SWCS-T13-1-28d	1.62	0.25	0.255	0.1	29.8	0.5	ND	0.5	20	0.75	3.83	0.0165
15-SWCS-T13-1-42d	0.873	0.25	0.216	0.1	16.4	0.5	ND	0.5	13.1	0.75	2.81	0.0165
15-SWCS-T13-1-49d	0.335	0.25	0.123	0.1	6.35	0.5	ND	0.5	7.51	0.75	1.07	0.0165
15-SWCS-T13-1-63d	0.493	0.25	0.166	0.1	9.38	0.5	ND	0.5	11.8	0.75	1.76	0.0165
15-SWCS-T13-1-90d	0.756	0.25	ND	0.1	13.7	0.5	ND	0.5	13.3	0.75	2.86	0.0165
15-SWCS-T13-1-140d	1.34	0.25	0.248	0.1	22.7	0.5	ND	0.5	15.7	0.75	3.19	0.0165
15-SWCS-T13-2-0.08d	1.08	0.25	ND	0.1	17.8	0.5	ND	0.5	18.3	0.75	0.982	0.0099
15-SWCS-T13-2-1d	3.49	0.25	ND	0.1	61.9	0.5	ND	0.5	71.8	0.75	2.03	0.0099
15-SWCS-T13-2-2d	1.56	0.25	ND	0.1	28	0.5	ND	0.5	18.1	0.75	0.406	0.0099
15-SWCS-T13-2-7d	3.4	0.25	0.254	0.1	60.8	0.5	ND	0.5	31.9	0.75	1.46	0.0165
15-SWCS-T13-2-14d	1.88	0.25	ND	0.1	34.3	0.5	ND	0.5	19.7	0.75	1.70	0.0165
15-SWCS-T13-2-28d	1.69	0.25	0.26	0.1	30.8	0.5	ND	0.5	20.5	0.75	2.90	0.0165
15-SWCS-T13-2-42d	0.917	0.25	0.218	0.1	ND	0.5	ND	0.5	13.4	0.75	2.11	0.0165
15-SWCS-T13-2-49d	0.35	0.25	0.131	0.1	6.85	0.5	ND	0.5	8.08	0.75	0.876	0.0165
15-SWCS-T13-2-63d	0.523	0.25	0.177	0.1	10	0.5	ND	0.5	12.5	0.75	1.39	0.0165
15-SWCS-T13-2-90d	0.79	0.25	ND	0.1	14.1	0.5	ND	0.5	13.9	0.75	2.21	0.0165
15-SWCS-T13-2-140d	1.26	0.25	0.252	0.1	21.6	0.5	ND	0.5	15.2	0.75	2.30	0.0165
15-SWCS-T13-3-0.08d	258	25	ND	10	235	50	ND	50	1410	75	0.744	0.0099
15-SWCS-T13-3-1d	282	25	ND	10	303	50	ND	50	1510	75	1.35	0.0099
15-SWCS-T13-3-2d	288	25	ND	10	268	50	ND	50	1560	75	0.195	0.0099
15-SWCS-T13-3-7d	290	25	ND	10	284	50	ND	50	1570	75	0.149	0.0165
15-SWCS-T13-3-14d	256	25	ND	10	242	50	ND	50	1380	75	0.356	0.0165
15-SWCS-T13-3-28d	258	25	ND	10	240	50	ND	50	1400	75	0.371	0.0165
15-SWCS-T13-3-42d	261	25	ND	10	231	50	ND	50	1420	75	0.248	0.0165
15-SWCS-T13-3-49d	252	25	ND	10	215	50	ND	50	1230	75	0.112	0.0165
15-SWCS-T13-3-63d	254	25	ND	10	219	50	ND	50	1280	75	0.164	0.0165
15-SWCS-T13-3-90d	254	25	ND	10	221	50	ND	50	1240	75	0.219	0.0165
15-SWCS-T13-3-140d	254	25	ND	10	225	50	ND	50	1300	75	0.230	0.0165
15-SWCS-T13-4-0.08d	256	25	ND	10	228	50	ND	50	1410	75	0.695	0.0099
15-SWCS-T13-4-1d	294	25	ND	10	297	50	ND	50	1610	75	1.59	0.0099
15-SWCS-T13-4-2d	288	25	ND	10	260	50	ND	50	1560	75	0.0893	0.0099
15-SWCS-T13-4-7d	300	25	ND	10	310	50	ND	50	1620	75	0.431	0.0165
15-SWCS-T13-4-14d	256	25	ND	10	236	50	ND	50	1380	75	0.135	0.0165
15-SWCS-T13-4-28d	261	25	ND	10	238	50	ND	50	1420	75	0.134	0.0165
15-SWCS-T13-4-42d	260	25	ND	10	227	50	ND	50	1420	75	0.0952	0.0165
15-SWCS-T13-4-49d	252	25	ND	10	213	50	ND	50	1230	75	0.0388	0.0165
15-SWCS-T13-4-63d	257	25	ND	10	219	50	ND	50	1280	75	0.0683	0.0165
15-SWCS-T13-4-90d	261	25	ND	10	225	50	ND	50	1380	75	0.0872	0.0165
15-SWCS-T13-4-140d	254	25	ND	10	220	50	ND	50	1300	75	0.0712	0.0165
15-SWCS-T14-1-0.08d	1.07	0.25	ND	0.1	ND	0.5	ND	0.5	ND	0.75	0.674	0.0099
15-SWCS-T14-1-1d	4.76	0.25	ND	0.1	0.931	0.5	ND	0.5	1.98	0.75	3.50	0.0099
15-SWCS-T14-1-2d	2.29	0.25	ND	0.1	0.706	0.5	ND	0.5	2.21	0.75	1.65	0.0099
15-SWCS-T14-1-7d	8.55	0.25	ND	0.1	1.85	0.5	ND	0.5	2.98	0.75	5.98	0.0165

Sample Name	Cl^{-} (mg/L)	EQL	F^{-} (mg/L)	EQL	NO_3^{-} (mg/L)	EQL	NO_2^{-} (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^{-} (µg/L)	EQL
15-SWCS-T14-1-14d	5.9	0.25	ND	0.1	1.56	0.5	ND	0.5	3.55	0.75	2.07	0.0165
15-SWCS-T14-1-28d	6.16	0.25	ND	0.1	1.69	0.5	ND	0.5	3.61	0.75	0.149	0.0165
15-SWCS-T14-1-42d	3.93	0.25	ND	0.1	1.25	0.5	ND	0.5	4.52	0.75	0.0836	0.0165
15-SWCS-T14-1-49d	1.54	0.25	ND	0.1	0.722	0.5	ND	0.5	5.2	0.75	0.0429	0.0165
15-SWCS-T14-1-63d	2.6	0.25	ND	0.1	1.01	0.5	ND	0.5	5.37	0.75	0.113	0.0165
15-SWCS-T14-1-90d	3.86	0.25	ND	0.1	1.31	0.5	ND	0.5	4.84	0.75	0.148	0.0165
15-SWCS-T14-1-140d	4.91	0.25	ND	0.1	1.69	0.5	ND	0.5	5.45	0.75	0.108	0.0165
15-SWCS-T14-2-0.08d	1.45	0.25	ND	0.1	ND	0.5	ND	0.5	ND	0.75	1.24	0.0099
15-SWCS-T14-2-1d	4.47	0.25	ND	0.1	0.824	0.5	ND	0.5	1.79	0.75	4.01	0.0099
15-SWCS-T14-2-2d	2.64	0.25	ND	0.1	0.643	0.5	ND	0.5	2.35	0.75	2.27	0.0099
15-SWCS-T14-2-7d	8.48	0.25	ND	0.1	1.81	0.5	ND	0.5	3	0.75	6.99	0.0165
15-SWCS-T14-2-14d	6.04	0.25	ND	0.1	1.57	0.5	ND	0.5	3.62	0.75	2.52	0.0165
15-SWCS-T14-2-28d	5.83	0.25	ND	0.1	1.63	0.5	ND	0.5	3.86	0.75	0.133	0.0165
15-SWCS-T14-2-42d	3.82	0.25	ND	0.1	1.24	0.5	ND	0.5	4.8	0.75	0.0566	0.0165
15-SWCS-T14-2-49d	1.63	0.25	ND	0.1	0.743	0.5	ND	0.5	5.34	0.75	0.0351	0.0165
15-SWCS-T14-2-63d	2.55	0.25	ND	0.1	0.983	0.5	ND	0.5	5.21	0.75	0.0758	0.0165
15-SWCS-T14-2-90d	3.84	0.25	ND	0.1	1.31	0.5	ND	0.5	4.87	0.75	0.135	0.0165
15-SWCS-T14-2-140d	4.78	0.25	ND	0.1	1.55	0.5	ND	0.5	4.75	0.75	0.157	0.0165
15-SWCS-T14-3-0.08d	254	25	ND	10	208	50	ND	50	1370	75	0.640	0.0099
15-SWCS-T14-3-1d	281	25	ND	10	229	50	ND	50	1410	75	2.12	0.0099
15-SWCS-T14-3-2d	282	25	ND	10	229	50	ND	50	1420	75	1.13	0.0099
15-SWCS-T14-3-7d	274	25	ND	10	217	50	ND	50	1270	75	2.61	0.0165
15-SWCS-T14-3-14d	229	25	ND	10	182	50	ND	50	1050	75	1.27	0.0165
15-SWCS-T14-3-28d	237	25	ND	10	186	50	ND	50	1040	75	0.0889	0.0165
15-SWCS-T14-3-42d	249	25	ND	10	198	50	ND	50	1150	75	0.0421	0.0165
15-SWCS-T14-3-49d	246	25	ND	10	200	50	ND	50	1140	75	ND	0.0165
15-SWCS-T14-3-63d	243	25	ND	10	196	50	ND	50	1100	75	0.0356	0.0165
15-SWCS-T14-3-90d	245	25	ND	10	195	50	ND	50	1080	75	0.0333	0.0165
15-SWCS-T14-3-140d	239	25	ND	10	186	50	ND	50	988	75	0.0788	0.0165
15-SWCS-T14-4-0.08d	256	25	ND	10	210	50	ND	50	1380	75	0.793	0.0099
15-SWCS-T14-4-1d	287	25	ND	10	231	50	ND	50	1410	75	2.60	0.0099
15-SWCS-T14-4-2d	283	25	ND	10	231	50	ND	50	1430	75	1.18	0.0099
15-SWCS-T14-4-7d	274	25	ND	10	217	50	ND	50	1250	75	2.98	0.0165
15-SWCS-T14-4-14d	245	25	ND	10	195	50	ND	50	1110	75	1.46	0.0165
15-SWCS-T14-4-28d	240	25	ND	10	188	50	ND	50	1050	75	0.0869	0.0165
15-SWCS-T14-4-42d	247	25	ND	10	196	50	ND	50	1150	75	0.0298	0.0165
15-SWCS-T14-4-49d	246	25	ND	10	200	50	ND	50	1150	75	ND	0.0165
15-SWCS-T14-4-63d	243	25	ND	10	196	50	ND	50	1130	75	0.0317	0.0165
15-SWCS-T14-4-90d	244	25	ND	10	194	50	ND	50	1090	75	0.0478	0.0165
15-SWCS-T14-4-140d	239	25	ND	10	186	50	ND	50	994	75	0.126	0.0165
15-SWCS-T15-1-0.08d	0.313	0.25	ND	0.1	5.17	0.5	ND	0.5	0.764	0.75	0.420	0.0099
15-SWCS-T15-1-1d	1.17	0.25	ND	0.1	22.7	0.5	ND	0.5	3.31	0.75	2.32	0.0099
15-SWCS-T15-1-2d	0.744	0.25	ND	0.1	13.8	0.5	ND	0.5	3.28	0.75	1.54	0.0099
15-SWCS-T15-1-7d	2.43	0.25	ND	0.1	44.4	0.5	ND	0.5	3.86	0.75	4.82	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T15-1-14d	1.82	0.25	ND	0.1	34	0.5	ND	0.5	4.82	0.75	1.43	0.0165
15-SWCS-T15-1-28d	1.92	0.25	ND	0.1	35.7	0.5	ND	0.5	5.13	0.75	0.183	0.0165
15-SWCS-T15-1-42d	1.22	0.25	ND	0.1	22.7	0.5	ND	0.5	6.5	0.75	0.114	0.0165
15-SWCS-T15-1-49d	0.46	0.25	ND	0.1	9.05	0.5	ND	0.5	7.51	0.75	0.0704	0.0165
15-SWCS-T15-1-63d	0.723	0.25	ND	0.1	13.8	0.5	ND	0.5	7.6	0.75	0.148	0.0165
15-SWCS-T15-1-90d	1.06	0.25	ND	0.1	19.9	0.5	ND	0.5	7.23	0.75	0.175	0.0165
15-SWCS-T15-1-140d	1.34	0.25	ND	0.1	24.8	0.5	ND	0.5	7.42	0.75	0.200	0.0165
15-SWCS-T15-2-0.08d	ND	0.25	ND	0.1	3.76	0.5	ND	0.5	ND	0.75	0.228	0.0099
15-SWCS-T15-2-1d	1.21	0.25	ND	0.1	21.6	0.5	ND	0.5	3.74	0.75	1.70	0.0099
15-SWCS-T15-2-2d	0.849	0.25	ND	0.1	15.4	0.5	ND	0.5	3.68	0.75	1.32	0.0099
15-SWCS-T15-2-7d	2.37	0.25	ND	0.1	43.4	0.5	ND	0.5	4.82	0.75	3.94	0.0165
15-SWCS-T15-2-14d	1.84	0.25	ND	0.1	34.1	0.5	ND	0.5	5.41	0.75	1.04	0.0165
15-SWCS-T15-2-28d	1.89	0.25	ND	0.1	35.2	0.5	ND	0.5	5.69	0.75	0.201	0.0165
15-SWCS-T15-2-42d	1.21	0.25	ND	0.1	22.5	0.5	ND	0.5	6.86	0.75	0.146	0.0165
15-SWCS-T15-2-49d	0.449	0.25	ND	0.1	8.95	0.5	ND	0.5	7.82	0.75	0.0842	0.0165
15-SWCS-T15-2-63d	0.693	0.25	ND	0.1	13.3	0.5	ND	0.5	7.65	0.75	0.143	0.0165
15-SWCS-T15-2-90d	1.05	0.25	ND	0.1	19.8	0.5	ND	0.5	7.32	0.75	0.194	0.0165
15-SWCS-T15-2-140d	1.36	0.25	ND	0.1	25	0.5	ND	0.5	7.45	0.75	0.193	0.0165
15-SWCS-T15-3-0.08d	254	25	ND	10	216	50	ND	50	1380	75	0.521	0.0099
15-SWCS-T15-3-1d	290	25	ND	10	267	50	ND	50	1480	75	3.21	0.0099
15-SWCS-T15-3-2d	284	25	ND	10	248	50	ND	50	1460	75	2.04	0.0099
15-SWCS-T15-3-7d	280	25	ND	10	263	50	ND	50	1340	75	4.85	0.0165
15-SWCS-T15-3-14d	243	25	ND	10	221	50	ND	50	1150	75	1.52	0.0165
15-SWCS-T15-3-28d	249	25	ND	10	226	50	ND	50	1130	75	0.167	0.0165
15-SWCS-T15-3-42d	246	25	ND	10	215	50	ND	50	1170	75	0.0367	0.0165
15-SWCS-T15-3-49d	245	25	ND	10	207	50	ND	50	1150	75	0.017	0.0165
15-SWCS-T15-3-63d	244	25	ND	10	209	50	ND	50	1150	75	0.0247	0.0165
15-SWCS-T15-3-90d	240	25	ND	10	210	50	ND	50	1050	75	ND	0.0165
15-SWCS-T15-3-140d	246	25	ND	10	222	50	ND	50	1090	75	0.0318	0.0165
15-SWCS-T15-4-0.08d	254	25	ND	10	216	50	ND	50	1390	75	0.431	0.0099
15-SWCS-T15-4-1d	290	25	ND	10	267	50	ND	50	1470	75	2.58	0.0099
15-SWCS-T15-4-2d	284	25	ND	10	247	50	ND	50	1470	75	1.53	0.0099
15-SWCS-T15-4-7d	279	25	ND	10	260	50	ND	50	1310	75	3.80	0.0165
15-SWCS-T15-4-14d	246	25	ND	10	222	50	ND	50	1140	75	1.10	0.0165
15-SWCS-T15-4-28d	249	25	ND	10	225	50	ND	50	1150	75	0.129	0.0165
15-SWCS-T15-4-42d	247	25	ND	10	215	50	ND	50	1200	75	0.0425	0.0165
15-SWCS-T15-4-49d	245	25	ND	10	207	50	ND	50	1150	75	0.0325	0.0165
15-SWCS-T15-4-63d	243	25	ND	10	209	50	ND	50	1160	75	0.0292	0.0165
15-SWCS-T15-4-90d	242	25	ND	10	212	50	ND	50	1040	75	0.059	0.0165
15-SWCS-T15-4-140d	241	25	ND	10	219	50	ND	50	1080	75	0.136	0.0165
15-SWCS-T16-1-0.08d	0.254	0.25	ND	0.1	3.82	0.5	ND	0.5	ND	0.75	1.06	0.0099
15-SWCS-T16-1-1d	1.37	0.25	ND	0.1	21.1	0.5	ND	0.5	3.24	0.75	6.31	0.0099
15-SWCS-T16-1-2d	0.859	0.25	ND	0.1	13.5	0.5	ND	0.5	3.54	0.75	3.70	0.0099
15-SWCS-T16-1-7d	2.96	0.25	ND	0.1	46.9	0.5	ND	0.5	5.03	0.75	11.4	0.0165
15-SWCS-T16-1-14d	2.06	0.25	ND	0.1	33.1	0.5	ND	0.5	5.7	0.75	2.84	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T16-1-28d	2.16	0.25	ND	0.1	34.7	0.5	ND	0.5	5.71	0.75	0.779	0.0165
15-SWCS-T16-1-42d	1.33	0.25	ND	0.1	21.7	0.5	ND	0.5	6.7	0.75	0.531	0.0165
15-SWCS-T16-1-49d	0.485	0.25	ND	0.1	8.49	0.5	ND	0.5	7.38	0.75	0.274	0.0165
15-SWCS-T16-1-63d	0.831	0.25	ND	0.1	13.8	0.5	ND	0.5	7.72	0.75	0.538	0.0165
15-SWCS-T16-1-90d	1.18	0.25	ND	0.1	19.3	0.5	ND	0.5	7.33	0.75	0.648	0.0165
15-SWCS-T16-1-140d	1.53	0.25	ND	0.1	24.4	0.5	ND	0.5	7.87	0.75	0.650	0.0165
15-SWCS-T16-2-0.08d	0.271	0.25	ND	0.1	4.49	0.5	ND	0.5	ND	0.75	0.918	0.0099
15-SWCS-T16-2-1d	1.78	0.25	ND	0.1	27.5	0.5	ND	0.5	4.34	0.75	8.25	0.0099
15-SWCS-T16-2-2d	1.05	0.25	ND	0.1	16.5	0.5	ND	0.5	3.81	0.75	4.53	0.0099
15-SWCS-T16-2-7d	2.68	0.25	ND	0.1	42.3	0.5	ND	0.5	4.57	0.75	9.54	0.0165
15-SWCS-T16-2-14d	1.98	0.25	ND	0.1	32	0.5	ND	0.5	5.64	0.75	2.82	0.0165
15-SWCS-T16-2-28d	2.14	0.25	ND	0.1	34.6	0.5	ND	0.5	5.87	0.75	0.714	0.0165
15-SWCS-T16-2-42d	1.3	0.25	ND	0.1	21.4	0.5	ND	0.5	6.95	0.75	0.608	0.0165
15-SWCS-T16-2-49d	0.47	0.25	ND	0.1	8.3	0.5	ND	0.5	8.09	0.75	0.261	0.0165
15-SWCS-T16-2-63d	0.791	0.25	ND	0.1	13.1	0.5	ND	0.5	8.19	0.75	0.551	0.0165
15-SWCS-T16-2-90d	1.17	0.25	ND	0.1	19.3	0.5	ND	0.5	7.83	0.75	0.777	0.0165
15-SWCS-T16-2-140d	1.52	0.25	ND	0.1	24.7	0.5	ND	0.5	7.89	0.75	0.81	0.0165
15-SWCS-T16-3-0.08d	253	25	ND	10	215	50	ND	50	1380	75	1.54	0.0099
15-SWCS-T16-3-1d	282	25	ND	10	257	50	ND	50	1430	75	8.48	0.0099
15-SWCS-T16-3-2d	286	25	ND	10	249	50	ND	50	1470	75	4.41	0.0099
15-SWCS-T16-3-7d	280	25	ND	10	261	50	ND	50	1310	75	8.95	0.0165
15-SWCS-T16-3-14d	247	25	ND	10	223	50	ND	50	1140	75	3.25	0.0165
15-SWCS-T16-3-28d	250	25	ND	10	227	50	ND	50	1140	75	0.477	0.0165
15-SWCS-T16-3-42d	246	25	ND	10	214	50	ND	50	1190	75	0.054	0.0165
15-SWCS-T16-3-49d	246	25	ND	10	208	50	ND	50	1160	75	0.0218	0.0165
15-SWCS-T16-3-63d	243	25	ND	10	208	50	ND	50	1180	75	0.0215	0.0165
15-SWCS-T16-3-90d	243	25	ND	10	213	50	ND	50	1050	75	0.0649	0.0165
15-SWCS-T16-3-140d	241	25	ND	10	218	50	ND	50	1090	75	0.0717	0.0165
15-SWCS-T16-4-0.08d	253	25	ND	10	214	50	ND	50	1380	75	1.60	0.0099
15-SWCS-T16-4-1d	295	25	ND	10	268	50	ND	50	1520	75	8.30	0.0099
15-SWCS-T16-4-2d	285	25	ND	10	248	50	ND	50	1480	75	4.53	0.0099
15-SWCS-T16-4-7d	284	25	ND	10	266	50	ND	50	1460	75	9.69	0.0165
15-SWCS-T16-4-14d	244	25	ND	10	220	50	ND	50	1160	75	2.93	0.0165
15-SWCS-T16-4-28d	247	25	ND	10	225	50	ND	50	1120	75	0.372	0.0165
15-SWCS-T16-4-42d	245	25	ND	10	214	50	ND	50	1170	75	0.0391	0.0165
15-SWCS-T16-4-49d	246	25	ND	10	208	50	ND	50	1160	75	ND	0.0165
15-SWCS-T16-4-63d	250	25	ND	10	215	50	ND	50	1300	75	0.0179	0.0165
15-SWCS-T16-4-90d	242	25	ND	10	212	50	ND	50	1050	75	0.0244	0.0165
15-SWCS-T16-4-140d	243	25	ND	10	222	50	ND	50	1100	75	0.0502	0.0165
15-SWCS-T17-1-0.08d	0.315	0.25	ND	0.1	4.52	0.5	ND	0.5	2.11	0.75	1.26	0.0099
15-SWCS-T17-1-1d	1.89	0.25	ND	0.1	29.2	0.5	ND	0.5	6.57	0.75	8.91	0.0099
15-SWCS-T17-1-2d	0.895	0.25	ND	0.1	13.7	0.5	ND	0.5	3.29	0.75	3.33	0.0099
15-SWCS-T17-1-7d	3.1	0.25	ND	0.1	48.3	0.5	0.538	0.5	4.95	0.75	6.39	0.0165
15-SWCS-T17-1-14d	1.82	0.25	ND	0.1	29	0.5	ND	0.5	7.19	0.75	0.333	0.0165

Sample Name	Cl^- (mg/L)	EQL	F^- (mg/L)	EQL	NO_3^- (mg/L)	EQL	NO_2^- (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^- (µg/L)	EQL
15-SWCS-T17-1-28d	1.55	0.25	ND	0.1	24.4	0.5	ND	0.5	9.24	0.75	0.224	0.0165
15-SWCS-T17-1-42d	0.74	0.25	ND	0.1	12	0.5	ND	0.5	8.84	0.75	0.164	0.0165
15-SWCS-T17-1-49d	0.264	0.25	ND	0.1	4.77	0.5	ND	0.5	8.65	0.75	0.0977	0.0165
15-SWCS-T17-1-63d	0.415	0.25	ND	0.1	7.04	0.5	ND	0.5	8.68	0.75	0.157	0.0165
15-SWCS-T17-1-90d	0.591	0.25	ND	0.1	9.66	0.5	ND	0.5	8.1	0.75	0.211	0.0165
15-SWCS-T17-1-140d	0.719	0.25	ND	0.1	11.3	0.5	ND	0.5	8.84	0.75	0.271	0.0165
15-SWCS-T17-2-0.08d	0.336	0.25	ND	0.1	4.45	0.5	ND	0.5	2.3	0.75	1.28	0.0099
15-SWCS-T17-2-1d	2.07	0.25	ND	0.1	30.7	0.5	ND	0.5	9.7	0.75	9.42	0.0099
15-SWCS-T17-2-2d	1.07	0.25	ND	0.1	16.2	0.5	ND	0.5	3.67	0.75	3.24	0.0099
15-SWCS-T17-2-7d	2.95	0.25	ND	0.1	45.4	0.5	ND	0.5	4.89	0.75	4.62	0.0165
15-SWCS-T17-2-14d	1.84	0.25	ND	0.1	28.5	0.5	ND	0.5	7.22	0.75	0.251	0.0165
15-SWCS-T17-2-28d	1.53	0.25	ND	0.1	23.6	0.5	ND	0.5	8.67	0.75	0.185	0.0165
15-SWCS-T17-2-42d	0.774	0.25	ND	0.1	12.4	0.5	ND	0.5	8.8	0.75	0.177	0.0165
15-SWCS-T17-2-49d	0.263	0.25	ND	0.1	4.87	0.5	ND	0.5	8.86	0.75	0.114	0.0165
15-SWCS-T17-2-63d	0.391	0.25	ND	0.1	6.67	0.5	ND	0.5	8.41	0.75	0.154	0.0165
15-SWCS-T17-2-90d	0.6	0.25	ND	0.1	9.63	0.5	ND	0.5	8.32	0.75	0.236	0.0165
15-SWCS-T17-2-140d	0.678	0.25	ND	0.1	10.5	0.5	ND	0.5	9.52	0.75	0.297	0.0165
15-SWCS-T17-3-0.08d	254	25	ND	10	216	50	ND	50	1390	75	2.03	0.0099
15-SWCS-T17-3-1d	289	25	ND	10	264	50	ND	50	1480	75	8.93	0.0099
15-SWCS-T17-3-2d	288	25	ND	10	251	50	ND	50	1510	75	3.58	0.0099
15-SWCS-T17-3-7d	279	25	ND	10	255	50	ND	50	1450	75	3.15	0.0165
15-SWCS-T17-3-14d	228	25	ND	10	199	50	ND	50	1200	75	0.0796	0.0165
15-SWCS-T17-3-28d	250	25	ND	10	218	50	ND	50	1260	75	0.0221	0.0165
15-SWCS-T17-3-42d	251	25	ND	10	214	50	ND	50	1290	75	0.0171	0.0165
15-SWCS-T17-3-49d	249	25	ND	10	209	50	ND	50	1210	75	ND	0.0165
15-SWCS-T17-3-63d	254	25	ND	10	214	50	ND	50	1250	75	0.0223	0.0165
15-SWCS-T17-3-90d	242	25	ND	10	204	50	ND	50	1160	75	ND	0.0165
15-SWCS-T17-3-140d	241	25	ND	10	204	50	ND	50	1230	75	ND	0.0165
15-SWCS-T17-4-0.08d	254	25	ND	10	216	50	ND	50	1380	75	1.94	0.0099
15-SWCS-T17-4-1d	277	25	ND	10	250	50	ND	50	1410	75	6.77	0.0099
15-SWCS-T17-4-2d	287	25	ND	10	251	50	ND	50	1500	75	3.21	0.0099
15-SWCS-T17-4-7d	268	25	ND	10	248	50	ND	50	1350	75	3.60	0.0165
15-SWCS-T17-4-14d	246	25	ND	10	216	50	ND	50	1260	75	0.155	0.0165
15-SWCS-T17-4-28d	247	25	ND	10	214	50	ND	50	1270	75	0.0200	0.0165
15-SWCS-T17-4-42d	248	25	ND	10	209	50	ND	50	1310	75	ND	0.0165
15-SWCS-T17-4-49d	249	25	ND	10	208	50	ND	50	1220	75	ND	0.0165
15-SWCS-T17-4-63d	248	25	ND	10	208	50	ND	50	1250	75	ND	0.0165
15-SWCS-T17-4-90d	245	25	ND	10	207	50	ND	50	1190	75	ND	0.0165
15-SWCS-T17-4-140d	242	25	ND	10	206	50	ND	50	1260	75	ND	0.0165
15-SWCS-T18-1-0.08d	0.279	0.25	ND	0.1	3.41	0.5	ND	0.5	1.86	0.75	1.20	0.0099
15-SWCS-T18-1-1d	1.9	0.25	ND	0.1	25	0.5	ND	0.5	8.96	0.75	9.30	0.0099
15-SWCS-T18-1-2d	0.784	0.25	ND	0.1	11	0.5	ND	0.5	3.32	0.75	2.94	0.0099
15-SWCS-T18-1-7d	3.2	0.25	ND	0.1	44.3	0.5	ND	0.5	5.18	0.75	6.78	0.0165
15-SWCS-T18-1-14d	2.09	0.25	ND	0.1	29.6	0.5	ND	0.5	6.8	0.75	0.669	0.0165
15-SWCS-T18-1-28d	1.82	0.25	ND	0.1	25.9	0.5	ND	0.5	8.52	0.75	0.495	0.0165

Sample Name	Cl^{-} (mg/L)	EQL	F^{-} (mg/L)	EQL	NO_3^{-} (mg/L)	EQL	NO_2^{-} (mg/L)	EQL	SO_4^{2-} (mg/L)	EQL	TcO_4^{-} (µg/L)	EQL
15-SWCS-T18-1-42d	0.94	0.25	ND	0.1	13.5	0.5	ND	0.5	8.89	0.75	0.453	0.0165
15-SWCS-T18-1-49d	0.309	0.25	ND	0.1	4.99	0.5	ND	0.5	8.7	0.75	0.243	0.0165
15-SWCS-T18-1-63d	0.55	0.25	ND	0.1	7.84	0.5	ND	0.5	9.32	0.75	0.479	0.0165
15-SWCS-T18-1-90d	0.73	0.25	ND	0.1	10.5	0.5	ND	0.5	8.69	0.75	0.630	0.0165
15-SWCS-T18-1-140d	0.878	0.25	ND	0.1	11.8	0.5	ND	0.5	9.35	0.75	0.558	0.0165
15-SWCS-T18-2-0.08d	0.281	0.25	ND	0.1	3.64	0.5	ND	0.5	1.76	0.75	1.05	0.0099
15-SWCS-T18-2-1d	1.3	0.25	ND	0.1	17.3	0.5	ND	0.5	6.55	0.75	5.37	0.0099
15-SWCS-T18-2-2d	0.922	0.25	ND	0.1	12.6	0.5	ND	0.5	3.85	0.75	2.69	0.0099
15-SWCS-T18-2-7d	3.02	0.25	ND	0.1	40.8	0.5	ND	0.5	5.62	0.75	4.54	0.0165
15-SWCS-T18-2-14d	2.02	0.25	ND	0.1	28	0.5	ND	0.5	7.3	0.75	0.516	0.0165
15-SWCS-T18-2-28d	1.73	0.25	ND	0.1	24.2	0.5	ND	0.5	8.54	0.75	0.548	0.0165
15-SWCS-T18-2-42d	0.893	0.25	ND	0.1	12.9	0.5	ND	0.5	9.22	0.75	0.498	0.0165
15-SWCS-T18-2-49d	0.291	0.25	ND	0.1	4.82	0.5	ND	0.5	8.75	0.75	0.257	0.0165
15-SWCS-T18-2-63d	0.509	0.25	ND	0.1	7.58	0.5	ND	0.5	9.02	0.75	0.543	0.0165
15-SWCS-T18-2-90d	0.699	0.25	ND	0.1	10	0.5	ND	0.5	8.52	0.75	0.629	0.0165
15-SWCS-T18-2-140d	0.867	0.25	ND	0.1	11.5	0.5	ND	0.5	9.61	0.75	0.587	0.0165
15-SWCS-T18-3-0.08d	255	25	ND	10	223	50	ND	50	1370	75	6.27	0.0099
15-SWCS-T18-3-1d	294	25	ND	10	269	50	ND	50	1500	75	11.6	0.0099
15-SWCS-T18-3-2d	287	25	ND	10	250	50	ND	50	1500	75	4.18	0.0099
15-SWCS-T18-3-7d	279	25	ND	10	253	50	ND	50	1380	75	4.46	0.0165
15-SWCS-T18-3-14d	246	25	ND	10	214	50	ND	50	1250	75	0.097	0.0165
15-SWCS-T18-3-28d	252	25	ND	10	218	50	ND	50	1210	75	0.0364	0.0165
15-SWCS-T18-3-42d	250	25	ND	10	211	50	ND	50	1280	75	0.0262	0.0165
15-SWCS-T18-3-49d	250	25	ND	10	208	50	ND	50	1210	75	ND	0.0165
15-SWCS-T18-3-63d	256	25	ND	10	215	50	ND	50	1390	75	ND	0.0165
15-SWCS-T18-3-90d	246	25	ND	10	207	50	ND	50	1170	75	ND	0.0165
15-SWCS-T18-3-140d	244	25	ND	10	206	50	ND	50	1270	75	ND	0.0165
15-SWCS-T18-4-0.08d	255	25	ND	10	215	50	ND	50	1390	75	1.88	0.0099
15-SWCS-T18-4-1d	296	25	ND	10	265	50	ND	50	1560	75	7.24	0.0099
15-SWCS-T18-4-2d	285	25	ND	10	249	50	ND	50	1490	75	4.94	0.0099
15-SWCS-T18-4-7d	250	25	ND	10	233	50	ND	50	1220	75	6.69	0.0165
15-SWCS-T18-4-14d	243	25	ND	10	212	50	ND	50	1240	75	0.218	0.0165
15-SWCS-T18-4-28d	248	25	ND	10	215	50	ND	50	1220	75	0.0166	0.0165
15-SWCS-T18-4-42d	250	25	ND	10	211	50	ND	50	1280	75	0.0306	0.0165
15-SWCS-T18-4-49d	249	25	ND	10	208	50	ND	50	1210	75	ND	0.0165
15-SWCS-T18-4-63d	250	25	ND	10	209	50	ND	50	1250	75	ND	0.0165
15-SWCS-T18-4-90d	244	25	ND	10	206	50	ND	50	1160	75	ND	0.0165
15-SWCS-T18-4-140d	243	25	ND	10	205	50	ND	50	1260	75	ND	0.0165

A.3 Additional Results of Alkalinity, Electrical Conductivity, Oxidation/Reduction Potential and pH from EPA Method 1315 Tests

Table A.3. Results of Alkalinity, pH, Electrical Conductivity, and Oxidation/Reduction Potential Measured in Leachates from EPA Method 1315 Tests

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T1-1-0.08d	11.3	0.513	105	206.1
15-SWCS-T1-1-1d	11.8	1.33	323	181.5
15-SWCS-T1-1-2d	11.5	0.774	170	195.3
15-SWCS-T1-1-7d	11.8	1.49	397	170.4
15-SWCS-T1-1-14d	11.8	1.41	343	181.5
15-SWCS-T1-1-28d	11.7	1.42	360	181.5
15-SWCS-T1-1-42d	11.7	1.11	294	251
15-SWCS-T1-1-49d	11.4	0.685	169	284.1
15-SWCS-T1-1-63d	11.6	0.844	214	261
15-SWCS-T1-1-90d	11.8	0.979	259	223.8
15-SWCS-T1-1-140d	11.7	1.11	300	280.1
15-SWCS-T1-2-0.08d	10.7	0.136	56.2	231.5
15-SWCS-T1-2-1d	11.8	1.32	306	194.4
15-SWCS-T1-2-2d	11.5	0.689	141	200
15-SWCS-T1-2-7d	11.8	1.42	362	175.9
15-SWCS-T1-2-14d	11.8	1.38	341	184.1
15-SWCS-T1-2-28d	11.7	1.41	367	184.6
15-SWCS-T1-2-42d	11.7	1.03	270	256.8
15-SWCS-T1-2-49d	11.5	0.709	169	290.8
15-SWCS-T1-2-63d	11.6	0.842	210	244.1
15-SWCS-T1-2-90d	11.8	0.957	256	219.7
15-SWCS-T1-2-140d	11.7	1.04	289	253.1
15-SWCS-T1-3-0.08d	10.3	3.33	30.4	283
15-SWCS-T1-3-1d	11	3.42	60.4	256
15-SWCS-T1-3-2d	10.8	3.30	34.4	264.3
15-SWCS-T1-3-7d	11.4	3.62	219	195.1
15-SWCS-T1-3-14d	11	3.10	106	242.7
15-SWCS-T1-3-28d	11	3.06	137	220.2
15-SWCS-T1-3-42d	10.6	3.01	364	307
15-SWCS-T1-3-49d	10.4	3.13	ND	352
15-SWCS-T1-3-63d	10.4	2.82	56.7	324
15-SWCS-T1-3-90d	10.7	2.96	86.7	299.8
15-SWCS-T1-3-140d	11.3	3.03	192	268.2
15-SWCS-T1-4-0.08d	10.4	3.34	40.1	268.8
15-SWCS-T1-4-1d	11.2	3.53	109	231.8
15-SWCS-T1-4-2d	10.8	3.30	33.9	271.3
15-SWCS-T1-4-7d	11.3	3.52	197	200.9
15-SWCS-T1-4-14d	11	3.07	107	233.6
15-SWCS-T1-4-28d	11.1	3.07	136	220.2
15-SWCS-T1-4-42d	10.6	3.02	73.0	312
15-SWCS-T1-4-49d	10.5	3.13	ND	376
15-SWCS-T1-4-63d	10.4	2.84	52.2	315
15-SWCS-T1-4-90d	10.6	2.98	75.6	288.4

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T1-4-140d	11.1	2.86	155	250.1
15-SWCS-T2-1-0.08d	11.4	0.599	109	236.9
15-SWCS-T2-1-1d	11.8	1.30	259	204.1
15-SWCS-T2-1-2d	11.4	0.608	79.1	231.1
15-SWCS-T2-1-7d	11.7	1.47	346	204.9
15-SWCS-T2-1-14d	11.8	1.36	278	211.7
15-SWCS-T2-1-28d	11.7	1.45	303	218
15-SWCS-T2-1-42d	11.7	1.10	116	269.5
15-SWCS-T2-1-49d	11.5	0.764	154	315
15-SWCS-T2-1-63d	11.6	0.871	185	284.2
15-SWCS-T2-1-90d	11.8	1.06	231	249
15-SWCS-T2-1-140d	11.7	1.16	249	249.4
15-SWCS-T2-2-0.08d	11.4	0.607	92.4	239.6
15-SWCS-T2-2-1d	11.7	1.08	194	227.4
15-SWCS-T2-2-2d	11.5	0.641	107	230
15-SWCS-T2-2-7d	11.8	1.41	314	208.9
15-SWCS-T2-2-14d	11.8	1.35	278	216.4
15-SWCS-T2-2-28d	11.7	1.45	308	224.8
15-SWCS-T2-2-42d	11.7	1.08	221	249.7
15-SWCS-T2-2-49d	11.5	0.677	150	317
15-SWCS-T2-2-63d	11.6	0.873	188	266.8
15-SWCS-T2-2-90d	11.8	1.11	238	241.7
15-SWCS-T2-2-140d	11.8	1.17	257	242.2
15-SWCS-T2-3-0.08d	10.5	3.35	ND	357
15-SWCS-T2-3-1d	10.9	3.34	ND	302.7
15-SWCS-T2-3-2d	10.7	3.27	ND	304.7
15-SWCS-T2-3-7d	11.1	3.29	65.0	262.3
15-SWCS-T2-3-14d	10.9	3.09	55.3	286.4
15-SWCS-T2-3-28d	11.2	3.19	88.9	265.1
15-SWCS-T2-3-42d	10.7	3.03	36.1	333
15-SWCS-T2-3-49d	10.4	3.13	25.8	385
15-SWCS-T2-3-63d	10.4	2.83	27.4	349
15-SWCS-T2-3-90d	10.8	2.99	34.0	317
15-SWCS-T2-3-140d	11.4	3.13	128	272.8
15-SWCS-T2-4-0.08d	10.4	3.34	ND	340
15-SWCS-T2-4-1d	10.9	3.34	ND	295.1
15-SWCS-T2-4-2d	10.7	3.26	ND	310.6
15-SWCS-T2-4-7d	11.2	3.28	43.9	263.6
15-SWCS-T2-4-14d	11	3.11	58.2	295.8
15-SWCS-T2-4-28d	11.2	3.23	104	267.9
15-SWCS-T2-4-42d	10.8	3.04	37.3	320
15-SWCS-T2-4-49d	10.4	3.14	26.2	389
15-SWCS-T2-4-63d	10.5	2.84	26.5	341
15-SWCS-T2-4-90d	10.8	3.01	39.5	306.4
15-SWCS-T2-4-140d	11.4	3.09	127	261.9
15-SWCS-T3-1-0.08d	11.5	0.836	127	191.1
15-SWCS-T3-1-1d	11.8	1.61	331	179.1
15-SWCS-T3-1-2d	11.6	0.999	164	192
15-SWCS-T3-1-7d	11.8	2.11	433	166.6

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T3-1-14d	11.9	1.95	466	173.1
15-SWCS-T3-1-28d	11.7	2.06	443	179.8
15-SWCS-T3-1-42d	11.8	1.37	321	250.4
15-SWCS-T3-1-49d	11.5	0.768	184	269.4
15-SWCS-T3-1-63d	11.7	1.06	269	280.1
15-SWCS-T3-1-90d	11.9	1.40	352	236
15-SWCS-T3-1-140d	11.8	1.53	403	275
15-SWCS-T3-2-0.08d	11.5	0.830	173	190.1
15-SWCS-T3-2-1d	11.9	1.73	327	178.8
15-SWCS-T3-2-2d	11.6	1.06	154	191.7
15-SWCS-T3-2-7d	11.9	2.22	422	163.1
15-SWCS-T3-2-14d	11.9	1.98	474	171.7
15-SWCS-T3-2-28d	11.8	2.04	529	170
15-SWCS-T3-2-42d	11.8	1.47	372	205.2
15-SWCS-T3-2-49d	11.5	0.846	94.6	254.1
15-SWCS-T3-2-63d	11.7	1.13	276	256.2
15-SWCS-T3-2-90d	11.9	1.30	329	215.1
15-SWCS-T3-2-140d	11.8	1.47	387	247.9
15-SWCS-T3-3-0.08d	10.6	3.43	38.8	278.4
15-SWCS-T3-3-1d	11	3.55	61.5	256.5
15-SWCS-T3-3-2d	10.8	3.42	46.7	260.6
15-SWCS-T3-3-7d	11.6	4.18	307	183.8
15-SWCS-T3-3-14d	11.3	3.55	189	203
15-SWCS-T3-3-28d	11.2	3.41	191	205.5
15-SWCS-T3-3-42d	10.7	3.16	49.8	268
15-SWCS-T3-3-49d	10.4	3.19	ND	331
15-SWCS-T3-3-63d	10.4	2.90	63.7	325
15-SWCS-T3-3-90d	10.8	3.14	102	307.1
15-SWCS-T3-3-140d	11.5	3.41	291	219.4
15-SWCS-T3-4-0.08d	10.6	3.42	39.7	271.5
15-SWCS-T3-4-1d	10.8	3.49	58.0	253.6
15-SWCS-T3-4-2d	10.8	3.40	42.3	267.1
15-SWCS-T3-4-7d	11.5	3.98	264	185.6
15-SWCS-T3-4-14d	11.2	3.44	160	212.1
15-SWCS-T3-4-28d	11.3	3.46	211	200.9
15-SWCS-T3-4-42d	10.8	3.18	88.6	258.2
15-SWCS-T3-4-49d	10.5	3.18	34.8	341
15-SWCS-T3-4-63d	10.4	2.92	60.8	307.7
15-SWCS-T3-4-90d	10.7	3.15	89.3	277
15-SWCS-T3-4-140d	11.5	3.37	254	215.1
15-SWCS-T4-1-0.08d	11	0.241	48.3	274.1
15-SWCS-T4-1-1d	11.8	1.40	345	182.8
15-SWCS-T4-1-2d	11.6	0.890	184	223.8
15-SWCS-T4-1-7d	11.8	1.61	396	170.5
15-SWCS-T4-1-14d	11.8	1.49	395	178.3
15-SWCS-T4-1-28d	11.7	1.48	401	176.8
15-SWCS-T4-1-42d	11.7	1.11	111	262.3
15-SWCS-T4-1-49d	11.4	0.678	166	282.2
15-SWCS-T4-1-63d	11.6	0.875	217	293

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T4-1-90d	11.7	0.957	252	241.9
15-SWCS-T4-1-140d	11.6	1.06	297	281.5
15-SWCS-T4-2-0.08d	10.9	0.244	84.4	217.6
15-SWCS-T4-2-1d	11.7	1.20	259	187.4
15-SWCS-T4-2-2d	11.6	0.817	172	192.7
15-SWCS-T4-2-7d	11.8	1.71	409	170
15-SWCS-T4-2-14d	11.8	1.48	130	178.9
15-SWCS-T4-2-28d	11.7	1.52	410	178
15-SWCS-T4-2-42d	11.7	1.08	208	260
15-SWCS-T4-2-49d	11.4	0.679	160	303
15-SWCS-T4-2-63d	11.6	0.844	213	275.4
15-SWCS-T4-2-90d	11.8	0.965	251	227.2
15-SWCS-T4-2-140d	11.7	1.05	291	263.8
15-SWCS-T4-3-0.08d	10.3	3.32	38.4	276.7
15-SWCS-T4-3-1d	11	3.43	95.7	235
15-SWCS-T4-3-2d	10.8	3.30	24.9	266.7
15-SWCS-T4-3-7d	11.5	3.73	264	193.3
15-SWCS-T4-3-14d	11.3	3.24	85.7	209.2
15-SWCS-T4-3-28d	11.4	3.33	242	199.3
15-SWCS-T4-3-42d	10.9	3.00	33.5	272.4
15-SWCS-T4-3-49d	10.4	3.09	25.4	359
15-SWCS-T4-3-63d	10.5	2.78	57.3	348
15-SWCS-T4-3-90d	10.8	3.01	92.0	305.5
15-SWCS-T4-3-140d	11.4	3.15	219	249.5
15-SWCS-T4-4-0.08d	10.3	3.33	40.4	275.6
15-SWCS-T4-4-1d	11	3.43	137	228.8
15-SWCS-T4-4-2d	10.8	3.31	52.2	260.4
15-SWCS-T4-4-7d	11.6	3.98	340	180.1
15-SWCS-T4-4-14d	11.4	3.35	184	202.7
15-SWCS-T4-4-28d	11.2	3.19	203	203
15-SWCS-T4-4-42d	10.8	2.99	24.7	262.8
15-SWCS-T4-4-49d	10.4	3.10	ND	356
15-SWCS-T4-4-63d	10.5	2.78	60.2	337
15-SWCS-T4-4-90d	10.8	3.07	105	300.2
15-SWCS-T4-4-140d	11.6	3.37	307	205.3
15-SWCS-T5-1-0.08d	10.9	0.234	47.9	281.2
15-SWCS-T5-1-1d	11.7	1.13	216	203.5
15-SWCS-T5-1-2d	11.5	0.784	147	241.2
15-SWCS-T5-1-7d	11.7	1.58	309	206.3
15-SWCS-T5-1-14d	11.8	1.55	321	224.7
15-SWCS-T5-1-28d	11.7	1.68	399	232.4
15-SWCS-T5-1-42d	11.7	1.23	252	282.9
15-SWCS-T5-1-49d	11.4	0.751	161	295.3
15-SWCS-T5-1-63d	11.6	0.993	213	300.1
15-SWCS-T5-1-90d	11.8	1.17	248	249.2
15-SWCS-T5-1-140d	11.7	1.35	283	281.1
15-SWCS-T5-2-0.08d	11	0.260	48.7	252.5
15-SWCS-T5-2-1d	11.6	1.02	213	199.5
15-SWCS-T5-2-2d	11.5	0.742	120	234.8

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T5-2-7d	11.7	1.55	250	201.9
15-SWCS-T5-2-14d	11.8	1.45	295	228.6
15-SWCS-T5-2-28d	11.7	1.59	355	232.6
15-SWCS-T5-2-42d	11.7	1.20	241	265.6
15-SWCS-T5-2-49d	11.5	0.781	167	304.5
15-SWCS-T5-2-63d	11.6	0.942	201	287.1
15-SWCS-T5-2-90d	11.8	1.12	237	239
15-SWCS-T5-2-140d	11.8	1.32	285	271.2
15-SWCS-T5-3-0.08d	10.3	3.34	ND	340
15-SWCS-T5-3-1d	10.6	3.31	ND	286.2
15-SWCS-T5-3-2d	10.7	3.28	ND	309
15-SWCS-T5-3-7d	11.2	3.35	ND	278
15-SWCS-T5-3-14d	10.8	3.09	46.5	316
15-SWCS-T5-3-28d	11.1	3.21	113	287.2
15-SWCS-T5-3-42d	11	3.06	55.8	306.2
15-SWCS-T5-3-49d	10.4	3.08	26.5	368
15-SWCS-T5-3-63d	10.6	2.79	30.9	345
15-SWCS-T5-3-90d	11.5	3.01	126	274.6
15-SWCS-T5-3-140d	11.8	3.90	314	252.6
15-SWCS-T5-4-0.08d	10.3	3.33	ND	360
15-SWCS-T5-41d	10.7	3.31	25.8	279.2
15-SWCS-T5-4-2d	10.7	3.27	ND	311
15-SWCS-T5-4-7d	11.1	3.30	34.6	280.2
15-SWCS-T5-4-14d	10.8	3.10	44.1	342
15-SWCS-T5-4-28d	11.1	3.20	99.3	211
15-SWCS-T5-4-42d	11	3.08	64.4	288.1
15-SWCS-T5-4-49d	10.5	3.08	26.0	359
15-SWCS-T5-4-63d	10.6	2.79	34.0	327
15-SWCS-T5-4-90d	11.4	2.96	110	258.4
15-SWCS-T5-4-140d	11.8	3.82	298	239.5
15-SWCS-T6-1-0.08d	11.2	0.427	92.4	214.9
15-SWCS-T6-1-1d	11.9	1.82	324	177.7
15-SWCS-T6-1-2d	11.7	1.19	241	181.6
15-SWCS-T6-1-7d	11.9	2.64	582	157.3
15-SWCS-T6-1-14d	12	2.28	547	166.6
15-SWCS-T6-1-28d	11.9	2.35	630	164.4
15-SWCS-T6-1-42d	11.8	1.55	365	210.1
15-SWCS-T6-1-49d	11.6	0.916	215	260.2
15-SWCS-T6-1-63d	11.7	1.19	303	267.7
15-SWCS-T6-1-90d	11.8	1.32	343	243.5
15-SWCS-T6-1-140d	11.8	1.58	438	224
15-SWCS-T6-2-0.08d	11.1	0.305	49.8	224.5
15-SWCS-T6-2-1d	11.9	1.76	304	177.2
15-SWCS-T6-2-2d	11.7	1.20	214	183.9
15-SWCS-T6-2-7d	12	2.85	595	156.9
15-SWCS-T6-2-14d	12	2.33	567	165.6
15-SWCS-T6-2-28d	11.9	2.36	611	163.9
15-SWCS-T6-2-42d	11.9	1.60	79.4	200.5
15-SWCS-T6-2-49d	11.6	0.926	218	228.7

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T6-2-63d	11.8	1.24	302	240.3
15-SWCS-T6-2-90d	11.9	1.51	377	214
15-SWCS-T6-2-140d	11.9	1.60	426	198.3
15-SWCS-T6-3-0.08d	10.3	3.37	35.0	282.7
15-SWCS-T6-3-1d	11	3.58	77.2	234.7
15-SWCS-T6-3-2d	10.8	3.46	55.8	251.2
15-SWCS-T6-3-7d	11.7	4.52	351	175.5
15-SWCS-T6-3-14d	11.6	3.82	268	191.7
15-SWCS-T6-3-28d	11.7	4.18	431	181.1
15-SWCS-T6-3-42d	11.4	3.53	83.4	222.6
15-SWCS-T6-3-49d	10.5	3.14	26.9	343
15-SWCS-T6-3-63d	10.7	2.92	95.5	338
15-SWCS-T6-3-90d	11.4	3.13	214	236.1
15-SWCS-T6-3-140d	11.8	3.93	447	197
15-SWCS-T6-4-0.08d	10.3	3.36	38.8	285.5
15-SWCS-T6-4-1d	11.1	3.64	94.2	232.8
15-SWCS-T6-4-2d	10.9	3.47	55.6	250.3
15-SWCS-T6-4-7d	11.8	4.61	425	176
15-SWCS-T6-4-14d	11.6	3.87	287	190.7
15-SWCS-T6-4-28d	11.7	4.20	436	181.6
15-SWCS-T6-4-42d	11.4	3.46	192	222.5
15-SWCS-T6-4-49d	10.5	3.15	57.5	343
15-SWCS-T6-4-63d	10.7	2.94	99.4	313
15-SWCS-T6-4-90d	11.4	3.18	214	218.1
15-SWCS-T6-4-140d	11.7	3.83	393	202.6
15-SWCS-T7-1-0.08d	11.3	0.257	56.5	417
15-SWCS-T7-1-1d	11.9	0.855	170	213.1
15-SWCS-T7-1-2d	11.6	0.674	121	211.8
15-SWCS-T7-1-7d	11.7	1.43	295	190.8
15-SWCS-T7-1-14d	11.9	1.37	280	210.6
15-SWCS-T7-1-28d	11.9	1.48	328	209.3
15-SWCS-T7-1-42d	11.9	1.11	231	283.8
15-SWCS-T7-1-49d	11.7	0.697	153	287.7
15-SWCS-T7-1-63d	11.8	0.921	207	283.2
15-SWCS-T7-1-90d	11.9	1.11	241	277.4
15-SWCS-T7-1-140d	11.6	1.20	265	302
15-SWCS-T7-2-0.08d	11	0.283	51.8	258.4
15-SWCS-T7-2-1d	11.7	0.962	172	204.4
15-SWCS-T7-2-2d	11.5	0.652	92.6	230.7
15-SWCS-T7-2-7d	11.9	1.46	281	189.8
15-SWCS-T7-2-14d	11.9	1.44	301	214
15-SWCS-T7-2-28d	11.8	1.50	328	208.4
15-SWCS-T7-2-42d	11.8	1.13	230	252.3
15-SWCS-T7-2-49d	11.6	0.700	150	270.1
15-SWCS-T7-2-63d	11.8	0.888	196	270.2
15-SWCS-T7-2-90d	11.9	1.09	239	266.3
15-SWCS-T7-2-140d	11.7	1.21	266	292.3
15-SWCS-T7-3-0.08d	10.3	3.31	ND	350
15-SWCS-T7-3-1d	10.8	3.32	ND	310.2

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T7-3-2d	10.7	3.27	ND	300
15-SWCS-T7-3-7d	11.1	3.17	35.7	273.3
15-SWCS-T7-3-14d	10.9	3.08	51.1	321
15-SWCS-T7-3-28d	11.2	3.18	126	284.6
15-SWCS-T7-3-42d	10.7	3.05	26.7	356
15-SWCS-T7-3-49d	10.5	3.13	28.7	380
15-SWCS-T7-3-63d	10.5	2.86	26.4	367
15-SWCS-T7-3-90d	10.7	2.72	37.0	343
15-SWCS-T7-3-140d	11.3	3.07	120	314
15-SWCS-T7-4-0.08d	10.2	3.33	ND	361
15-SWCS-T7-4-1d	10.7	3.31	ND	299.3
15-SWCS-T7-4-2d	10.8	3.26	ND	316
15-SWCS-T7-4-7d	11.1	3.17	34.8	282.5
15-SWCS-T7-4-14d	11	3.10	58.9	323
15-SWCS-T7-4-28d	11.2	3.24	131	292
15-SWCS-T7-4-42d	10.8	3.04	ND	343
15-SWCS-T7-4-49d	10.5	3.14	26.7	367
15-SWCS-T7-4-63d	10.5	2.86	30.4	357
15-SWCS-T7-4-90d	10.8	2.73	39.3	327
15-SWCS-T7-4-140d	11.2	2.98	355	304
15-SWCS-T8-1-0.08d	11.2	0.440	60.6	219.3
15-SWCS-T8-1-1d	11.9	1.80	324	170.6
15-SWCS-T8-1-2d	11.7	1.19	206	183.2
15-SWCS-T8-1-7d	11.9	2.74	556	158.3
15-SWCS-T8-1-14d	12	2.33	534	166.3
15-SWCS-T8-1-28d	11.9	2.34	582	165
15-SWCS-T8-1-42d	11.9	1.60	370	255.9
15-SWCS-T8-1-49d	11.6	0.897	124	285.9
15-SWCS-T8-1-63d	11.7	1.17	276	276.1
15-SWCS-T8-1-90d	11.9	1.49	366	267.3
15-SWCS-T8-1-140d	11.8	1.60	428	269.8
15-SWCS-T8-2-0.08d	11.1	0.382	50.7	227.4
15-SWCS-T8-2-1d	11.9	1.92	350	172
15-SWCS-T8-2-2d	11.7	1.28	219	183.9
15-SWCS-T8-2-7d	12	2.83	662	177.6
15-SWCS-T8-2-14d	12	2.34	554	167.1
15-SWCS-T8-2-28d	12	2.36	679	164
15-SWCS-T8-2-42d	11.9	1.61	328	206
15-SWCS-T8-2-49d	11.6	0.959	141	248.8
15-SWCS-T8-2-63d	11.8	1.24	294	246.2
15-SWCS-T8-2-90d	11.9	1.42	344	242.5
15-SWCS-T8-2-140d	11.8	1.55	407	251.3
15-SWCS-T8-3-0.08d	10.3	3.37	34.4	278.6
15-SWCS-T8-3-1d	11.1	3.64	94.6	225.7
15-SWCS-T8-3-2d	10.9	3.47	38.6	245.6
15-SWCS-T8-3-7d	11.7	4.50	398	174.7
15-SWCS-T8-3-14d	11.6	3.98	320	189.6
15-SWCS-T8-3-28d	11.7	4.13	410	181.6
15-SWCS-T8-3-42d	11.3	3.43	186	266.9

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T8-3-49d	10.5	3.16	58.4	368
15-SWCS-T8-3-63d	10.6	2.95	91.5	307.3
15-SWCS-T8-3-90d	11.4	3.15	196	227
15-SWCS-T8-3-140d	11.6	3.70	372	210.5
15-SWCS-T8-4-0.08d	10.3	3.35	30.7	285.1
15-SWCS-T8-4-1d	11.3	3.88	127	207.1
15-SWCS-T8-4-2d	10.9	3.47	56.5	253.3
15-SWCS-T8-4-7d	11.8	4.44	383	175.7
15-SWCS-T8-4-14d	11.6	3.81	275	193.5
15-SWCS-T8-4-28d	11.6	4.13	437	182.3
15-SWCS-T8-4-42d	11.4	3.44	180	227.3
15-SWCS-T8-4-49d	10.6	3.15	62.6	341
15-SWCS-T8-4-63d	10.6	2.95	87.3	294.6
15-SWCS-T8-4-90d	11.2	3.03	172	226.5
15-SWCS-T8-4-140d	11.7	3.81	415	199.7
15-SWCS-T9-1-0.08d	11	0.225	72.3	234.8
15-SWCS-T9-1-1d	11.5	0.684	134	205.4
15-SWCS-T9-1-2d	11.3	0.457	78.3	215
15-SWCS-T9-1-7d	11.6	1.02	233	184
15-SWCS-T9-1-14d	11.6	0.904	227	197.8
15-SWCS-T9-1-28d	11.6	0.962	273	198.9
15-SWCS-T9-1-42d	11.5	0.751	208	202.2
15-SWCS-T9-1-49d	11.3	0.482	104	233.1
15-SWCS-T9-1-63d	11.4	0.557	151	205
15-SWCS-T9-1-90d	11.6	0.669	186	233.1
15-SWCS-T9-1-140d	11.4	0.729	207	240.7
15-SWCS-T9-2-0.08d	10.9	0.223	63.9	241.3
15-SWCS-T9-2-1d	11.4	0.630	154	199.8
15-SWCS-T9-2-2d	11.3	0.441	87.1	211.4
15-SWCS-T9-2-7d	11.6	1.00	235	180.5
15-SWCS-T9-2-14d	11.6	0.908	234	193.1
15-SWCS-T9-2-28d	11.6	0.968	261	193.1
15-SWCS-T9-2-42d	11.5	0.694	69.9	198.1
15-SWCS-T9-2-49d	11.3	0.426	43.9	207.6
15-SWCS-T9-2-63d	11.4	0.597	151	202.2
15-SWCS-T9-2-90d	11.6	0.694	192	212.2
15-SWCS-T9-2-140d	11.5	0.693	204	219.1
15-SWCS-T9-3-0.08d	10.2	3.34	34.4	271.5
15-SWCS-T9-3-1d	10.7	3.34	54.5	268.6
15-SWCS-T9-3-2d	10.6	3.30	31.1	297.9
15-SWCS-T9-3-7d	10.7	3.12	66.2	258.1
15-SWCS-T9-3-14d	10.5	3.09	61.1	289.4
15-SWCS-T9-3-28d	10.4	3.07	80.5	297.7
15-SWCS-T9-3-42d	10.5	3.14	36.1	220.4
15-SWCS-T9-3-49d	10.4	3.19	37.5	274.4
15-SWCS-T9-3-63d	10.2	2.93	43.2	213.8
15-SWCS-T9-3-90d	10.3	2.82	49.4	222.6
15-SWCS-T9-3-140d	10.2	2.87	73.3	225.3
15-SWCS-T9-4-0.08d	10.2	3.34	34.4	274.6

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T9-4-1d	10.7	3.34	48.7	278.4
15-SWCS-T9-4-2d	10.6	3.30	30.6	288.8
15-SWCS-T9-4-7d	10.7	3.12	56.9	258.6
15-SWCS-T9-4-14d	10.5	3.09	60.0	299.4
15-SWCS-T9-4-28d	10.5	3.05	80.9	290.1
15-SWCS-T9-4-42d	10.5	3.13	52.7	218.7
15-SWCS-T9-4-49d	10.4	3.19	ND	229.6
15-SWCS-T9-4-63d	10.3	2.94	34.4	220
15-SWCS-T9-4-90d	10.3	2.83	53.1	218.9
15-SWCS-T9-4-140d	10.3	2.86	75.0	217.6
15-SWCS-T10-1-0.08d	11.2	0.527	111	204.3
15-SWCS-T10-1-1d	11.8	1.58	283	175.6
15-SWCS-T10-1-2d	11.5	0.727	146	196.3
15-SWCS-T10-1-7d	11.8	2.20	478	162
15-SWCS-T10-1-14d	11.8	1.50	343	180.1
15-SWCS-T10-1-28d	11.7	1.42	350	183.6
15-SWCS-T10-1-42d	11.6	0.960	230	196.5
15-SWCS-T10-1-49d	11.3	0.567	97.6	204.6
15-SWCS-T10-1-63d	11.5	0.698	77.6	200.1
15-SWCS-T10-1-90d	11.6	0.774	201	199.5
15-SWCS-T10-1-140d	11.5	0.770	211	212.4
15-SWCS-T10-2-0.08d	11.1	0.390	69.7	211.6
15-SWCS-T10-2-1d	11.9	1.91	382	169.3
15-SWCS-T10-2-2d	11.7	1.10	216	187.3
15-SWCS-T10-2-7d	11.9	2.10	444	162.9
15-SWCS-T10-2-14d	11.8	1.47	331	180.6
15-SWCS-T10-2-28d	11.6	1.36	346	181.5
15-SWCS-T10-2-42d	11.6	0.899	213	194.2
15-SWCS-T10-2-49d	11.4	0.580	50.6	200.3
15-SWCS-T10-2-63d	11.5	0.696	158	199.3
15-SWCS-T10-2-90d	11.7	0.832	207	195.2
15-SWCS-T10-2-140d	11.6	0.922	244	201.8
15-SWCS-T10-3-0.08d	10.3	3.37	30.4	275.7
15-SWCS-T10-3-1d	11	3.59	70.8	251.9
15-SWCS-T10-3-2d	10.8	3.42	39.7	257.4
15-SWCS-T10-3-7d	11.4	3.74	194	195.8
15-SWCS-T10-3-14d	10.8	3.25	81.6	245
15-SWCS-T10-3-28d	10.6	3.22	107	253.9
15-SWCS-T10-3-42d	10.5	3.20	44.5	202.3
15-SWCS-T10-3-49d	10.4	3.22	30.6	216.1
15-SWCS-T10-3-63d	10.3	3.00	30.9	208.8
15-SWCS-T10-3-90d	10.4	2.92	58.9	213.8
15-SWCS-T10-3-140d	10.4	3.06	88.7	218.2
15-SWCS-T10-4-0.08d	10.3	3.37	30.6	281.4
15-SWCS-T10-4-1d	10.9	3.53	60.8	255.7
15-SWCS-T10-4-2d	10.7	3.40	38.2	264.9
15-SWCS-T10-4-7d	11.3	3.61	158	201.9
15-SWCS-T10-4-14d	10.8	3.23	76.3	265.7
15-SWCS-T10-4-28d	10.8	3.22	97.4	239.3

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T10-4-42d	10.5	3.20	25.6	198
15-SWCS-T10-4-49d	10.4	3.22	36.8	211.2
15-SWCS-T10-4-63d	10.3	3.00	43.6	209.8
15-SWCS-T10-4-90d	10.4	2.93	58.0	214.9
15-SWCS-T10-4-140d	10.3	3.06	89.1	219.2
15-SWCS-T11-1-0.08d	10.4	0.0956	25.1	308.8
15-SWCS-T11-1-1d	11.2	0.602	109	228.9
15-SWCS-T11-1-2d	11.1	0.455	116	231.9
15-SWCS-T11-1-7d	11.6	1.17	267	195.4
15-SWCS-T11-1-14d	11.5	0.967	241	204.5
15-SWCS-T11-1-28d	11.5	1.10	320	197.3
15-SWCS-T11-1-42d	11.5	0.838	215	198.7
15-SWCS-T11-1-49d	11.2	0.471	123	212.3
15-SWCS-T11-1-63d	11.4	0.626	102	208.2
15-SWCS-T11-1-90d	11.5	0.753	195	221.1
15-SWCS-T11-1-140d	11.4	0.826	219	211.7
15-SWCS-T11-2-0.08d	10.5	0.120	32.0	413
15-SWCS-T11-2-1d	11.2	0.639	136	215.6
15-SWCS-T11-2-2d	11	0.420	93.3	245.2
15-SWCS-T11-2-7d	11.6	1.19	302	192.4
15-SWCS-T11-2-14d	11.5	1.01	247	207.7
15-SWCS-T11-2-28d	11.6	1.15	316	199.1
15-SWCS-T11-2-42d	11.5	0.805	205	194.9
15-SWCS-T11-2-49d	11.3	0.493	126	213.2
15-SWCS-T11-2-63d	11.4	0.648	92.0	208.1
15-SWCS-T11-2-90d	11.5	0.814	199	207.5
15-SWCS-T11-2-140d	11.4	0.796	205	232.1
15-SWCS-T11-3-0.08d	9.5	3.32	ND	333
15-SWCS-T11-3-1d	10.4	3.85	47.1	304.4
15-SWCS-T11-3-2d	10.2	3.75	26.4	355
15-SWCS-T11-3-7d	10.6	3.94	113	274.7
15-SWCS-T11-3-14d	10.5	3.49	72.3	283
15-SWCS-T11-3-28d	10.5	3.61	78.3	307.9
15-SWCS-T11-3-42d	10.4	3.39	54.4	291
15-SWCS-T11-3-49d	10.3	3.11	35.0	285.7
15-SWCS-T11-3-63d	10.3	3.18	39.3	325
15-SWCS-T11-3-90d	10.3	3.14	48.5	303.5
15-SWCS-T11-3-140d	10.2	3.28	51.9	328
15-SWCS-T11-4-0.08d	9.35	3.29	ND	414
15-SWCS-T11-4-1d	10.4	3.86	47.8	302.8
15-SWCS-T11-4-2d	10.3	3.76	27.3	366
15-SWCS-T11-4-7d	10.6	3.95	111	281.1
15-SWCS-T11-4-14d	10.5	3.50	80.7	282.2
15-SWCS-T11-4-28d	10.5	3.55	87.8	309.1
15-SWCS-T11-4-42d	10.5	3.40	58.7	278.5
15-SWCS-T11-4-49d	10.3	3.12	37.0	287.7
15-SWCS-T11-4-63d	10.3	3.19	43.2	314
15-SWCS-T11-4-90d	10.4	3.14	54.0	294.2
15-SWCS-T11-4-140d	10.2	3.28	54.1	339

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T12-1-0.08d	10.4	0.0884	39.2	266
15-SWCS-T12-1-1d	11.2	0.487	167	206.2
15-SWCS-T12-1-2d	11	0.335	102	216.7
15-SWCS-T12-1-7d	11.5	0.832	248	185.8
15-SWCS-T12-1-14d	11.4	0.722	216	196.5
15-SWCS-T12-1-28d	11.4	0.761	243	189.9
15-SWCS-T12-1-42d	11.3	0.504	160	216.1
15-SWCS-T12-1-49d	11.1	0.352	53.1	226.2
15-SWCS-T12-1-63d	11.2	0.440	131	250.3
15-SWCS-T12-1-90d	11.2	0.433	135	255.7
15-SWCS-T12-1-140d	11.2	0.474	163	254.1
15-SWCS-T12-2-0.08d	10.5	0.0984	48.1	258.3
15-SWCS-T12-2-1d	11.2	0.448	159	208.7
15-SWCS-T12-2-2d	11.1	0.364	106	216.1
15-SWCS-T12-2-7d	11.5	0.855	279	188.2
15-SWCS-T12-2-14d	11.4	0.760	224	193.1
15-SWCS-T12-2-28d	11.5	0.846	270	187.7
15-SWCS-T12-2-42d	11.3	0.526	154	211.6
15-SWCS-T12-2-49d	11.1	0.358	101	222.2
15-SWCS-T12-2-63d	11.3	0.443	129	225.2
15-SWCS-T12-2-90d	11.4	0.556	152	228.6
15-SWCS-T12-2-140d	11.3	0.515	164	274.1
15-SWCS-T12-3-0.08d	9.77	3.29	23.6	340
15-SWCS-T12-3-1d	10.5	3.71	81.8	267.7
15-SWCS-T12-3-2d	10.2	3.67	45.9	298.7
15-SWCS-T12-3-7d	10.6	3.72	107	258.2
15-SWCS-T12-3-14d	10.5	3.34	75.6	263.2
15-SWCS-T12-3-28d	10.4	3.37	233	268.3
15-SWCS-T12-3-42d	10.3	3.28	50.0	295.8
15-SWCS-T12-3-49d	10.2	3.07	36.4	289.3
15-SWCS-T12-3-63d	10.3	3.11	35.0	339
15-SWCS-T12-3-90d	10.2	3.04	44.3	311
15-SWCS-T12-3-140d	10.2	3.16	51.0	339
15-SWCS-T12-4-0.08d	9.54	3.29	ND	385
15-SWCS-T12-4-1d	10.5	3.74	81.3	264.2
15-SWCS-T12-4-2d	10.3	3.68	42.1	305.3
15-SWCS-T12-4-7d	10.6	3.73	103	256.3
15-SWCS-T12-4-14d	10.5	3.32	74.8	266
15-SWCS-T12-4-28d	10.4	3.35	62.2	275.1
15-SWCS-T12-4-42d	10.4	3.28	48.5	284.8
15-SWCS-T12-4-49d	10.3	3.07	35.7	288.5
15-SWCS-T12-4-63d	10.4	3.11	43.0	325
15-SWCS-T12-4-90d	10.4	3.05	48.7	303.5
15-SWCS-T12-4-140d	10.2	3.17	53.5	340
15-SWCS-T13-1-0.08d	10.6	0.212	45.0	252
15-SWCS-T13-1-1d	11.3	0.897	148	211.5
15-SWCS-T13-1-2d	11.2	0.568	122	236.3
15-SWCS-T13-1-7d	11.6	1.33	307	195.4
15-SWCS-T13-1-14d	11.6	1.11	257	223.6

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T13-1-28d	11.6	1.20	320	207.4
15-SWCS-T13-1-42d	11.6	0.927	225	169.2
15-SWCS-T13-1-49d	11.3	0.571	147	180.7
15-SWCS-T13-1-63d	11.4	0.702	71.7	184.3
15-SWCS-T13-1-90d	11.5	0.815	212	183.7
15-SWCS-T13-1-140d	11.5	0.914	247	187.6
15-SWCS-T13-2-0.08d	10.6	0.201	40.3	267.9
15-SWCS-T13-2-1d	11.3	0.932	172	205.1
15-SWCS-T13-2-2d	11.3	0.622	132	242.2
15-SWCS-T13-2-7d	11.6	1.35	303	195.7
15-SWCS-T13-2-14d	11.6	1.12	258	216
15-SWCS-T13-2-28d	11.6	1.20	314	216
15-SWCS-T13-2-42d	11.6	0.880	213	166.3
15-SWCS-T13-2-49d	11.4	0.584	148	177.3
15-SWCS-T13-2-63d	11.5	0.695	152	180.3
15-SWCS-T13-2-90d	11.6	0.864	218	179.2
15-SWCS-T13-2-140d	11.6	0.912	243	186.4
15-SWCS-T13-3-0.08d	9.82	3.37	ND	349
15-SWCS-T13-3-1d	10.5	4.00	72.8	274.8
15-SWCS-T13-3-2d	10.4	3.77	33.7	349
15-SWCS-T13-3-7d	10.6	3.85	73.2	279
15-SWCS-T13-3-14d	10.5	3.46	73.7	279.5
15-SWCS-T13-3-28d	10.5	3.49	78.3	298.3
15-SWCS-T13-3-42d	10.4	3.36	52.0	271
15-SWCS-T13-3-49d	10.3	3.10	33.7	258.1
15-SWCS-T13-3-63d	10.3	3.15	38.8	310.1
15-SWCS-T13-3-90d	10.4	3.11	45.9	270
15-SWCS-T13-3-140d	10.3	3.24	62.5	308
15-SWCS-T13-4-0.08d	9.55	3.34	ND	396
15-SWCS-T13-4-1d	10.4	3.93	45.4	299.3
15-SWCS-T13-4-2d	10.4	3.74	26.7	366
15-SWCS-T13-4-7d	10.5	3.91	94.6	283.6
15-SWCS-T13-4-14d	10.5	3.42	60.4	285.4
15-SWCS-T13-4-28d	10.5	3.46	60.4	323
15-SWCS-T13-4-42d	10.4	3.35	46.3	246.2
15-SWCS-T13-4-49d	10.3	3.09	31.1	252
15-SWCS-T13-4-63d	10.3	3.14	30.2	278
15-SWCS-T13-4-90d	10.3	3.09	44.3	300
15-SWCS-T13-4-140d	10.2	3.22	51.0	337
15-SWCS-T14-1-0.08d	11.1	0.304	58.0	223.5
15-SWCS-T14-1-1d	11.7	1.18	232	191
15-SWCS-T14-1-2d	11.4	0.738	128	218.9
15-SWCS-T14-1-7d	11.9	1.70	385	186
15-SWCS-T14-1-14d	11.7	1.40	322	215.7
15-SWCS-T14-1-28d	11.8	1.44	351	198
15-SWCS-T14-1-42d	11.7	1.08	236	251.5
15-SWCS-T14-1-49d	11.5	0.689	164	268
15-SWCS-T14-1-63d	11.6	0.867	105	266.5
15-SWCS-T14-1-90d	11.7	1.00	243	268.2

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T14-1-140d	11.7	1.10	265	260.3
15-SWCS-T14-2-0.08d	11.2	0.362	47.6	217
15-SWCS-T14-2-1d	11.7	1.02	233	192.9
15-SWCS-T14-2-2d	11.5	0.730	147	225.7
15-SWCS-T14-2-7d	11.9	1.69	375	188.8
15-SWCS-T14-2-14d	11.8	1.41	320	205.6
15-SWCS-T14-2-28d	11.8	1.39	354	205.4
15-SWCS-T14-2-42d	11.7	1.07	236	228.4
15-SWCS-T14-2-49d	11.5	0.684	163	252.5
15-SWCS-T14-2-63d	11.6	0.854	140	252.8
15-SWCS-T14-2-90d	11.7	0.995	244	242
15-SWCS-T14-2-140d	11.7	1.03	256	307.2
15-SWCS-T14-3-0.08d	10.3	3.28	24.2	292.3
15-SWCS-T14-3-1d	10.8	3.58	38.2	283.1
15-SWCS-T14-3-2d	10.7	3.55	26.7	343
15-SWCS-T14-3-7d	11.1	3.48	103	243.7
15-SWCS-T14-3-14d	10.8	3.06	77.2	273.2
15-SWCS-T14-3-28d	11.1	3.14	115	254.3
15-SWCS-T14-3-42d	10.7	2.98	61.7	330
15-SWCS-T14-3-49d	10.3	2.93	32.0	342
15-SWCS-T14-3-63d	10.4	2.87	35.0	353
15-SWCS-T14-3-90d	10.6	2.74	59.1	283
15-SWCS-T14-3-140d	10.9	2.84	93.1	310.8
15-SWCS-T14-4-0.08d	10.4	3.29	24.3	289.6
15-SWCS-T14-4-1d	10.8	3.58	37.3	400
15-SWCS-T14-4-2d	10.7	3.55	ND	343
15-SWCS-T14-4-7d	11.1	3.48	103	243.6
15-SWCS-T14-4-14d	10.9	3.07	77.8	274
15-SWCS-T14-4-28d	11.2	3.18	120	255.1
15-SWCS-T14-4-42d	10.7	2.96	56.5	312
15-SWCS-T14-4-49d	10.3	2.94	34.4	330
15-SWCS-T14-4-63d	10.4	2.90	34.6	346
15-SWCS-T14-4-90d	10.6	2.76	58.7	282.1
15-SWCS-T14-4-140d	11	2.89	100	329
15-SWCS-T15-1-0.08d	11.1	0.337	73.9	217
15-SWCS-T15-1-1d	11.7	1.54	283	179
15-SWCS-T15-1-2d	11.5	1.17	208	191.2
15-SWCS-T15-1-7d	12	2.35	546	165
15-SWCS-T15-1-14d	11.8	2.02	473	178
15-SWCS-T15-1-28d	11.8	2.04	510	174.5
15-SWCS-T15-1-42d	11.7	1.47	349	234.4
15-SWCS-T15-1-49d	11.5	0.873	202	231.7
15-SWCS-T15-1-63d	11.6	1.11	264	250
15-SWCS-T15-1-90d	11.8	1.30	322	266.4
15-SWCS-T15-1-140d	11.7	1.39	356	274.8
15-SWCS-T15-2-0.08d	11	0.255	59.3	232.5
15-SWCS-T15-2-1d	11.8	1.56	291	178.9
15-SWCS-T15-2-2d	11.6	1.26	236	189.8
15-SWCS-T15-2-7d	12	2.56	565	166.8

Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T15-2-14d	11.9	2.01	469	173.4
15-SWCS-T15-2-28d	11.9	2.02	529	175.2
15-SWCS-T15-2-42d	11.8	1.52	352	209.1
15-SWCS-T15-2-49d	11.6	0.888	211	221
15-SWCS-T15-2-63d	11.6	1.08	132	273.3
15-SWCS-T15-2-90d	11.8	1.29	323	240.1
15-SWCS-T15-2-140d	11.8	1.50	389	267.7
15-SWCS-T15-3-0.08d	10.3	3.31	24.7	293
15-SWCS-T15-3-1d	11.4	4.10	151	210.8
15-SWCS-T15-3-2d	10.8	3.69	44.1	307.9
15-SWCS-T15-3-7d	11.6	4.47	349	186.7
15-SWCS-T15-3-14d	11.3	3.50	187	207.8
15-SWCS-T15-3-28d	11.5	3.65	249	199.5
15-SWCS-T15-3-42d	10.9	3.13	104	278.2
15-SWCS-T15-3-49d	10.3	2.98	49.9	359
15-SWCS-T15-3-63d	10.3	2.98	27.4	345
15-SWCS-T15-3-90d	10.6	2.90	102	332
15-SWCS-T15-3-140d	11.1	3.24	200	313
15-SWCS-T15-4-0.08d	10.4	3.31	24.0	297.7
15-SWCS-T15-4-1d	11.1	3.90	112	224.4
15-SWCS-T15-4-2d	10.7	3.67	39.9	315
15-SWCS-T15-4-7d	11.6	4.33	326	195.8
15-SWCS-T15-4-14d	11.3	3.47	179	213.2
15-SWCS-T15-4-28d	11.4	3.57	232	208.5
15-SWCS-T15-4-42d	10.8	3.12	94.1	274.9
15-SWCS-T15-4-49d	10.3	2.98	47.0	347
15-SWCS-T15-4-63d	10.4	3.00	30.6	328
15-SWCS-T15-4-90d	10.8	2.92	106	313
15-SWCS-T15-4-140d	11.1	3.22	205	277.5
15-SWCS-T16-1-0.08d	11	0.290	54.7	227.2
15-SWCS-T16-1-1d	11.8	1.81	298	178.3
15-SWCS-T16-1-2d	11.6	1.19	214	191.5
15-SWCS-T16-1-7d	12	2.54	589	163.8
15-SWCS-T16-1-14d	11.8	1.99	455	176.8
15-SWCS-T16-1-28d	11.9	2.01	531	173.9
15-SWCS-T16-1-42d	11.8	1.43	334	215
15-SWCS-T16-1-49d	11.5	0.825	195	253.1
15-SWCS-T16-1-63d	11.6	1.05	255	281.9
15-SWCS-T16-1-90d	11.8	1.20	306	259.5
15-SWCS-T16-1-140d	11.7	1.28	334	295.4
15-SWCS-T16-2-0.08d	11.1	0.289	62.0	225.6
15-SWCS-T16-2-1d	11.9	2.00	226	169.5
15-SWCS-T16-2-2d	11.7	1.33	269	183.6
15-SWCS-T16-2-7d	12	2.49	560	163.9
15-SWCS-T16-2-14d	11.9	1.92	470	176.4
15-SWCS-T16-2-28d	11.9	1.97	523	174
15-SWCS-T16-2-42d	11.8	1.36	324	204.2
15-SWCS-T16-2-49d	11.5	0.798	193	237.3
15-SWCS-T16-2-63d	11.7	1.02	254	258.4

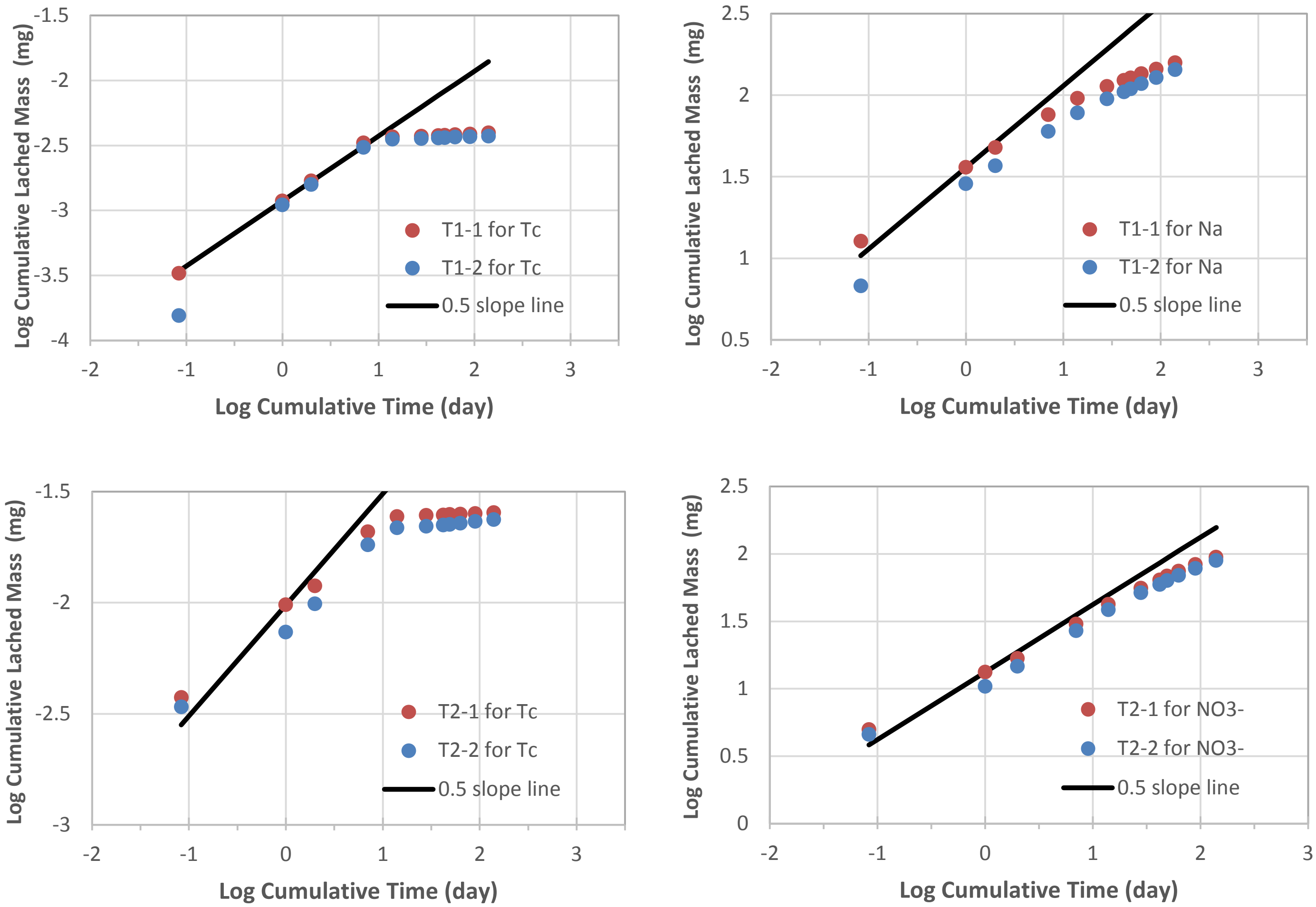
Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T16-2-90d	11.8	1.18	300	243
15-SWCS-T16-2-140d	11.7	1.39	363	301.6
15-SWCS-T16-3-0.08d	10.3	3.30	26.0	295.4
15-SWCS-T16-3-1d	11.2	3.98	93.3	231.1
15-SWCS-T16-3-2d	10.7	3.67	40.1	293.7
15-SWCS-T16-3-7d	11.6	4.18	281	193.7
15-SWCS-T16-3-14d	11.2	3.44	173	212.2
15-SWCS-T16-3-28d	11.5	3.76	288	198.3
15-SWCS-T16-3-42d	10.8	3.13	97.7	293
15-SWCS-T16-3-49d	10.3	2.99	44.8	306.1
15-SWCS-T16-3-63d	10.4	3.00	57.6	358
15-SWCS-T16-3-90d	10.7	2.91	105	319
15-SWCS-T16-3-140d	11.1	3.21	207	329
15-SWCS-T16-4-0.08d	10.3	3.31	ND	310.3
15-SWCS-T16-4-1d	11.1	3.90	101	228.2
15-SWCS-T16-4-2d	10.7	3.68	43.2	298.3
15-SWCS-T16-4-7d	11.6	4.23	273	192.4
15-SWCS-T16-4-14d	11.2	3.41	164	213.4
15-SWCS-T16-4-28d	11.5	3.67	262	198.6
15-SWCS-T16-4-42d	10.9	3.12	102	274.5
15-SWCS-T16-4-49d	10.3	2.98	45.4	304.2
15-SWCS-T16-4-63d	10.4	2.99	61.3	342
15-SWCS-T16-4-90d	10.7	2.91	102	305.8
15-SWCS-T16-4-140d	11.3	3.23	214	292.8
15-SWCS-T17-1-0.08d	11.3	0.346	69.0	217.2
15-SWCS-T17-1-1d	12	1.88	399	169
15-SWCS-T17-1-2d	11.8	1.04	205	189.6
15-SWCS-T17-1-7d	12.1	2.44	546	162.8
15-SWCS-T17-1-14d	12	1.66	406	180.6
15-SWCS-T17-1-28d	12	1.54	397	178.7
15-SWCS-T17-1-42d	11.7	0.959	222	200.3
15-SWCS-T17-1-49d	11.5	0.545	128	208
15-SWCS-T17-1-63d	11.7	0.630	150	231.9
15-SWCS-T17-1-90d	11.7	0.796	208	230
15-SWCS-T17-1-140d	11.5	0.795	172	233.2
15-SWCS-T17-2-0.08d	11.2	0.313	59.5	218.7
15-SWCS-T17-2-1d	12	1.96	437	166.3
15-SWCS-T17-2-2d	11.8	1.17	242	184.1
15-SWCS-T17-2-7d	12	2.40	533	161.7
15-SWCS-T17-2-14d	11.9	1.65	391	179.9
15-SWCS-T17-2-28d	11.9	1.45	393	177.8
15-SWCS-T17-2-42d	11.7	0.931	228	195.5
15-SWCS-T17-2-49d	11.4	0.558	133	205.8
15-SWCS-T17-2-63d	11.6	0.585	69.9	212.2
15-SWCS-T17-2-90d	11.6	0.734	185	214.6
15-SWCS-T17-2-140d	11.3	0.593	208	242.3
15-SWCS-T17-3-0.08d	10.3	3.33	28.5	284.6
15-SWCS-T17-3-1d	11	3.92	85.5	252.2
15-SWCS-T17-3-2d	10.6	3.72	44.7	297.1

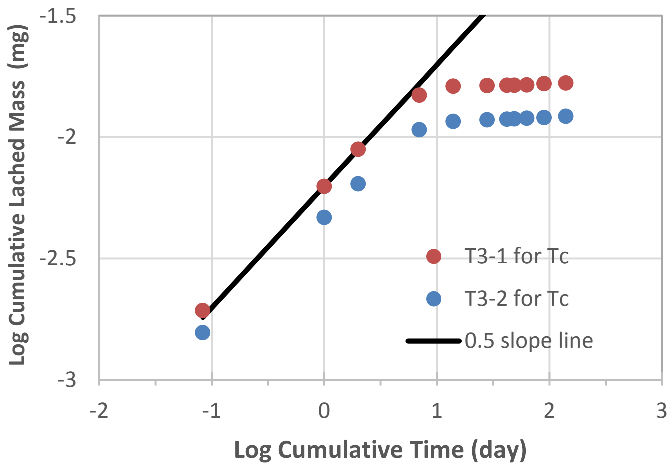
Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T17-3-7d	11.3	3.96	170	209.2
15-SWCS-T17-3-14d	10.7	3.26	76.9	257.1
15-SWCS-T17-3-28d	10.7	3.30	86.7	241.5
15-SWCS-T17-3-42d	10.5	3.17	52.7	216.5
15-SWCS-T17-3-49d	10.3	3.04	30.7	229.8
15-SWCS-T17-3-63d	10.4	3.06	35.0	224.4
15-SWCS-T17-3-90d	10.3	2.98	51.8	248.2
15-SWCS-T17-3-140d	10.3	3.09	62.5	237.2
15-SWCS-T17-4-0.08d	10.3	3.34	33.1	277.2
15-SWCS-T17-4-1d	11	3.90	75.9	260.4
15-SWCS-T17-4-2d	10.7	3.72	48.1	281.1
15-SWCS-T17-4-7d	11.4	4.15	213	196.2
15-SWCS-T17-4-14d	10.8	3.31	93.7	251.9
15-SWCS-T17-4-28d	10.7	3.29	87.5	245.7
15-SWCS-T17-4-42d	10.5	3.18	53.1	210.7
15-SWCS-T17-4-49d	10.3	3.04	30.6	225.4
15-SWCS-T17-4-63d	10.3	3.08	25.4	226.1
15-SWCS-T17-4-90d	10.3	2.99	51.6	237.4
15-SWCS-T17-4-140d	10.2	3.12	66.4	319
15-SWCS-T18-1-0.08d	11	0.268	62.2	222.2
15-SWCS-T18-1-1d	11.8	1.77	370	169.6
15-SWCS-T18-1-2d	11.5	0.942	171	193.1
15-SWCS-T18-1-7d	12	2.30	522	162.6
15-SWCS-T18-1-14d	11.8	1.69	391	178.3
15-SWCS-T18-1-28d	11.8	1.55	390	176.6
15-SWCS-T18-1-42d	11.6	1.03	238	193.5
15-SWCS-T18-1-49d	11.4	0.581	138	204
15-SWCS-T18-1-63d	11.5	0.751	180	206.4
15-SWCS-T18-1-90d	11.6	0.855	205	219
15-SWCS-T18-1-140d	11.5	0.825	209	298.1
15-SWCS-T18-2-0.08d	11	0.260	62.6	223.4
15-SWCS-T18-2-1d	11.8	1.55	301	179
15-SWCS-T18-2-2d	11.6	0.996	191	191.2
15-SWCS-T18-2-7d	12	2.13	494	163.9
15-SWCS-T18-2-14d	11.8	1.62	369	178.7
15-SWCS-T18-2-28d	11.8	1.47	393	178.1
15-SWCS-T18-2-42d	11.6	0.973	221	192
15-SWCS-T18-2-49d	11.4	0.559	130	205
15-SWCS-T18-2-63d	11.5	0.687	121	205.1
15-SWCS-T18-2-90d	11.6	0.809	204	206.6
15-SWCS-T18-2-140d	11.4	0.716	187	307.5
15-SWCS-T18-3-0.08d	10.3	3.37	44.8	268.8
15-SWCS-T18-3-1d	11	3.95	86.0	257.4
15-SWCS-T18-3-2d	10.6	3.70	40.3	290.1
15-SWCS-T18-3-7d	11.2	3.89	160	219
15-SWCS-T18-3-14d	10.7	3.25	77.6	257.9
15-SWCS-T18-3-28d	10.8	3.24	95.5	235
15-SWCS-T18-3-42d	10.5	3.15	54.9	208.5
15-SWCS-T18-3-49d	10.2	3.04	34.4	230.9

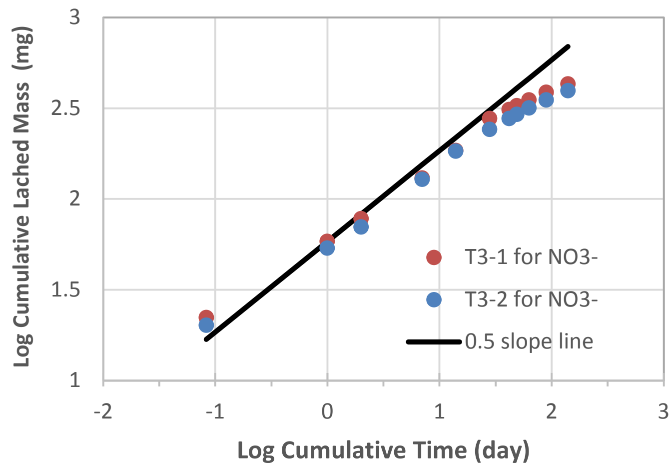
Sample Name	pH	Electrical Conductivity (mS/cm)	Alkalinity (mg/L)	E_h (mV)
15-SWCS-T18-3-63d	10.3	3.08	34.0	233
15-SWCS-T18-3-90d	10.3	2.98	52.9	241.5
15-SWCS-T18-3-140d	10.1	3.12	65.6	258.3
15-SWCS-T18-4-0.08d	10.3	3.31	ND	288
15-SWCS-T18-4-1d	10.8	3.84	48.1	274.3
15-SWCS-T18-4-2d	10.7	3.71	40.6	299
15-SWCS-T18-4-7d	11.4	3.77	199	197.3
15-SWCS-T18-4-14d	10.8	3.27	78.0	257.7
15-SWCS-T18-4-28d	10.7	3.21	78.0	243.4
15-SWCS-T18-4-42d	10.5	3.14	47.0	208.9
15-SWCS-T18-4-49d	10.2	3.04	31.8	228.6
15-SWCS-T18-4-63d	10.3	3.07	26.4	226.1
15-SWCS-T18-4-90d	10.3	2.96	47.8	232.2
15-SWCS-T18-4-140d	10.2	3.09	56.5	256

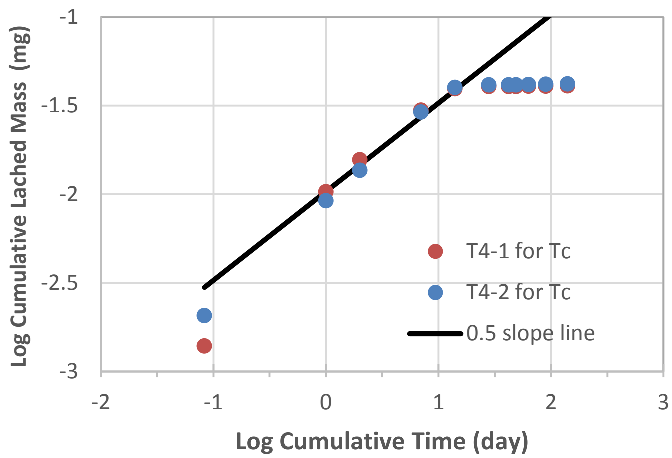
A.4 Additional Results for the Logarithm of the Cumulative Releases of ^{99}Tc and NO_3^- (or Na^+) Plotted vs. the Logarithm of Cumulative Time for the Tested Grouts in DIW Leaching Solutions

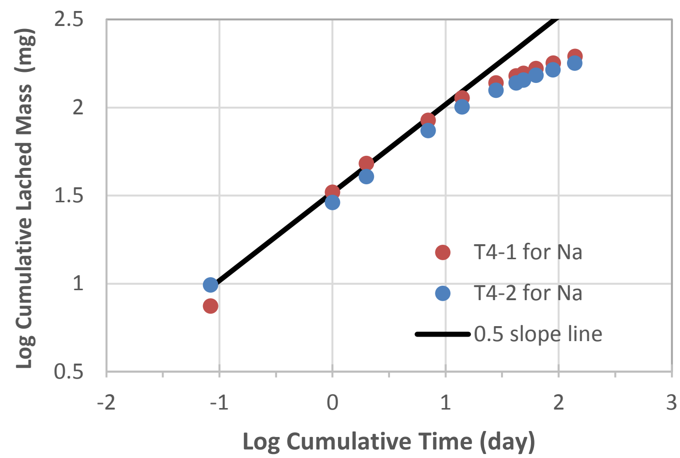
Figure A.1. Results of the Cumulative Releases of ^{99}Tc and NO_3^- (or Na^+ if there was no NO_3^- in 242-A evaporator condensate simulant) Plotted vs. the Logarithm of Cumulative Time for the Tested Grouts in DIW Leaching Solution

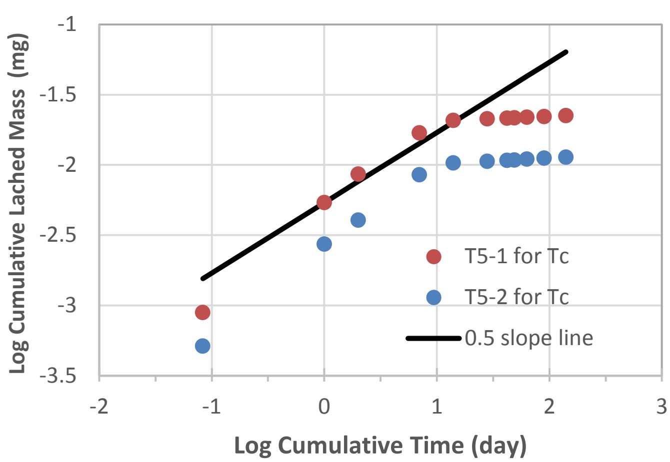


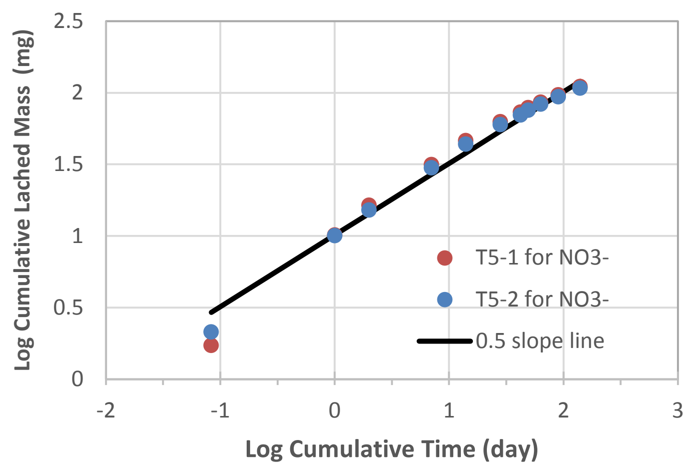

Log Cumulative Lached Mass (mg)
-1.5
-2
-2.5
-3
-2
-1
0
1
2
3
Log Cumulative Time (day)
T3-1 for Tc
T3-2 for Tc
0.5 slope line

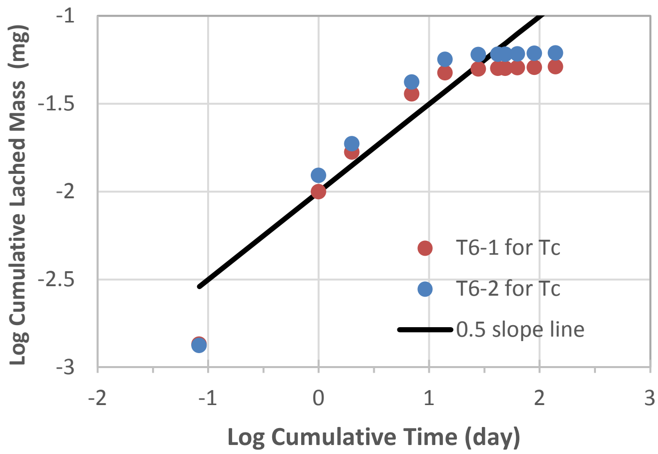

Log Cumulative Lached Mass (mg)
3
2.5
2
1.5
1
-2
-1
0
1
2
3
Log Cumulative Time (day)
T3-1 for NO3-
T3-2 for NO3-
0.5 slope line

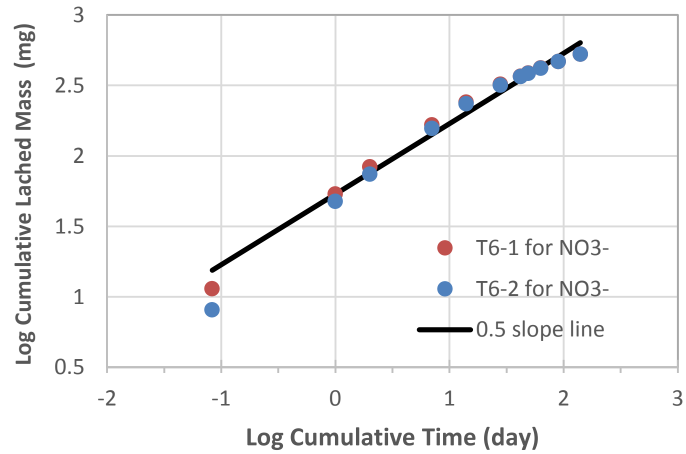

Log Cumulative Lached Mass (mg)
-1
-1.5
-2
-2.5
-3
-2
-1
0
1
2
3
Log Cumulative Time (day)
T4-1 for Tc
T4-2 for Tc
0.5 slope line

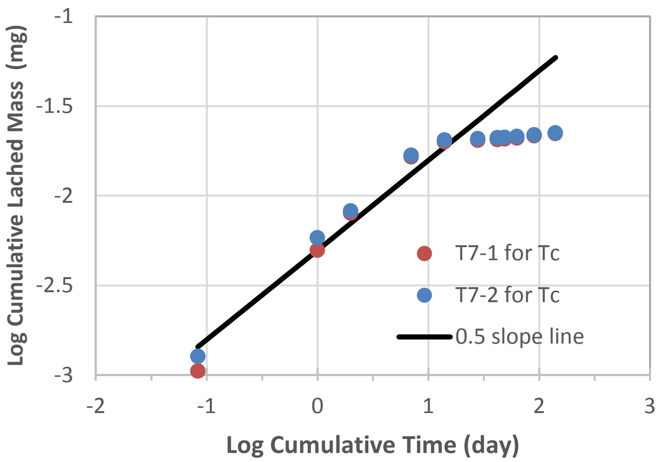

Log Cumulative Lached Mass (mg)
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T4-1 for Na
T4-2 for Na
0.5 slope line

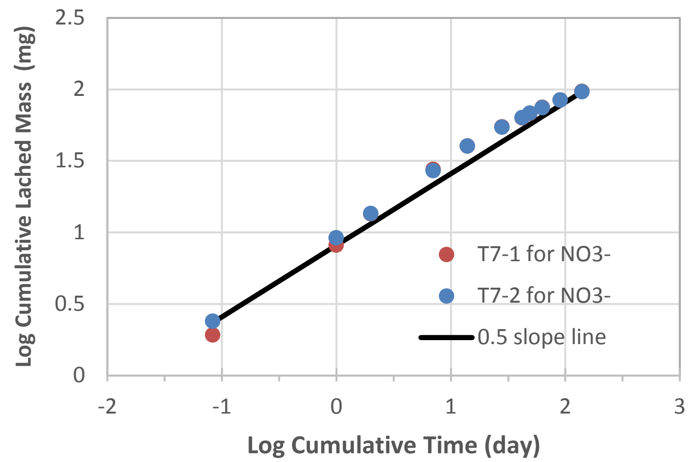

Log Cumulative Lached Mass (mg)
-1
-1.5
-2
-2.5
-3
-3.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T5-1 for Tc
T5-2 for Tc
0.5 slope line

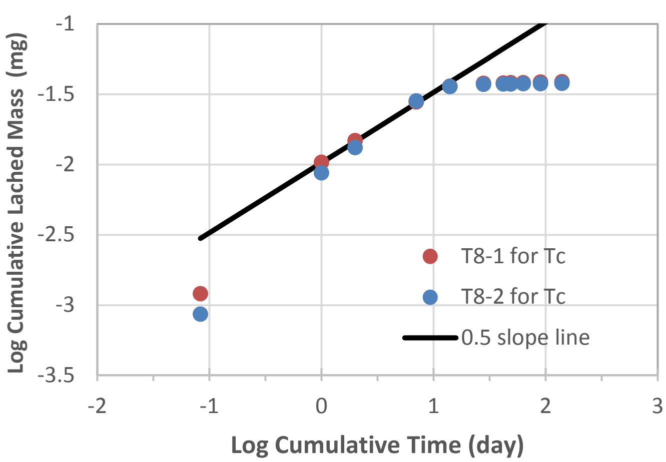

Log Cumulative Lached Mass (mg)
2.5
2
1.5
1
0.5
0
-2
-1
0
1
2
3
Log Cumulative Time (day)
T5-1 for NO3-
T5-2 for NO3-
0.5 slope line

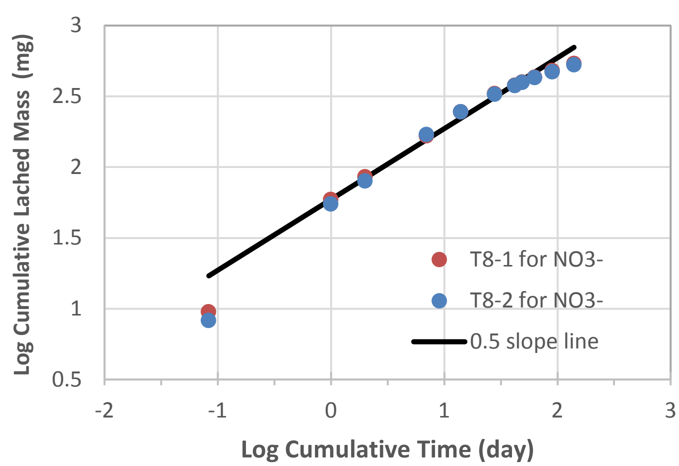

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T6-1 for Tc
T6-2 for Tc
0.5 slope line
-1
-1.5
-2
-2.5
-3
-2
-1
0
1
2
3

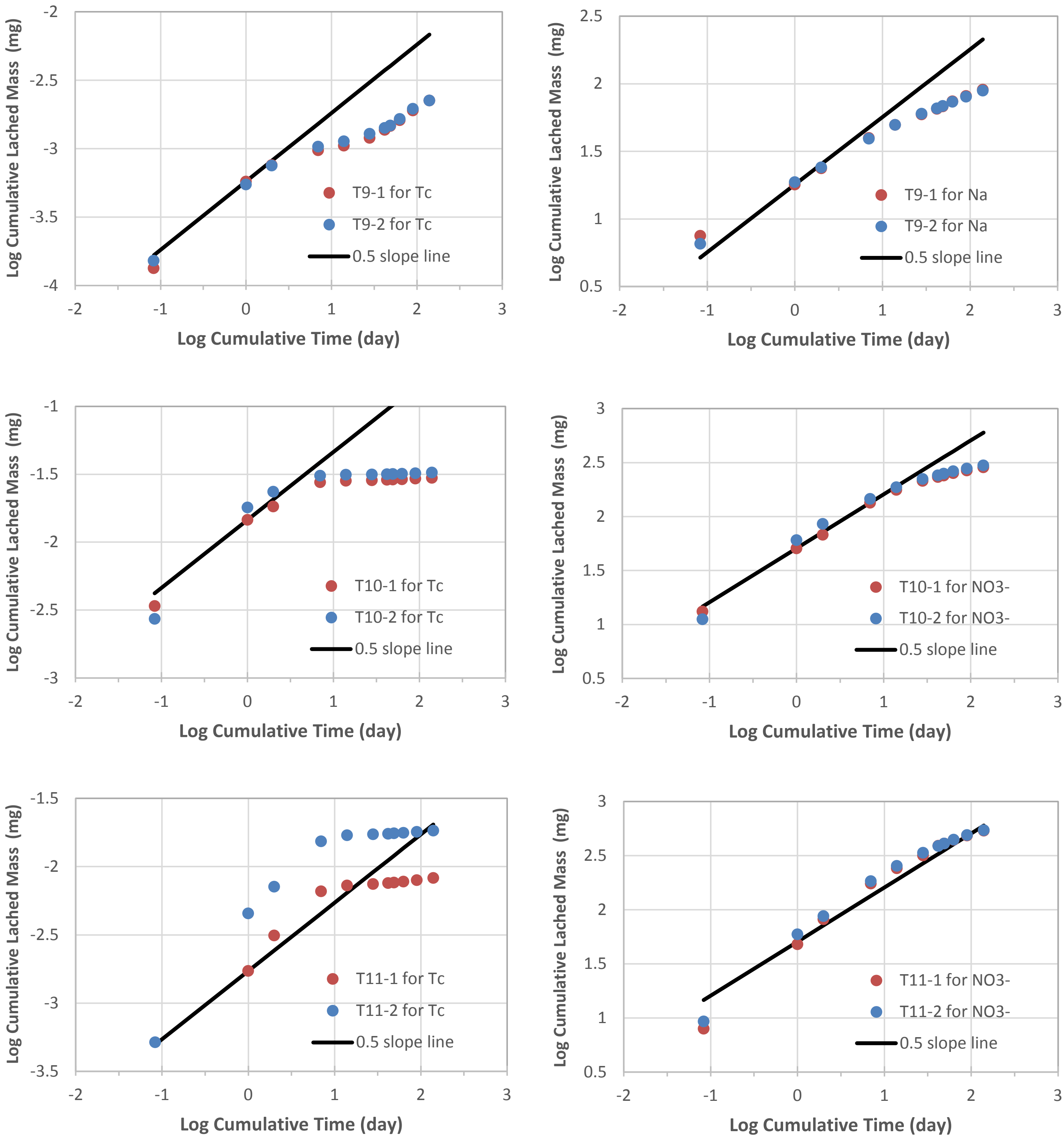

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T6-1 for NO3-
T6-2 for NO3-
0.5 slope line
3
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3


Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T7-1 for Tc
T7-2 for Tc
0.5 slope line
-1
-1.5
-2
-2.5
-3
-2
-1
0
1
2
3

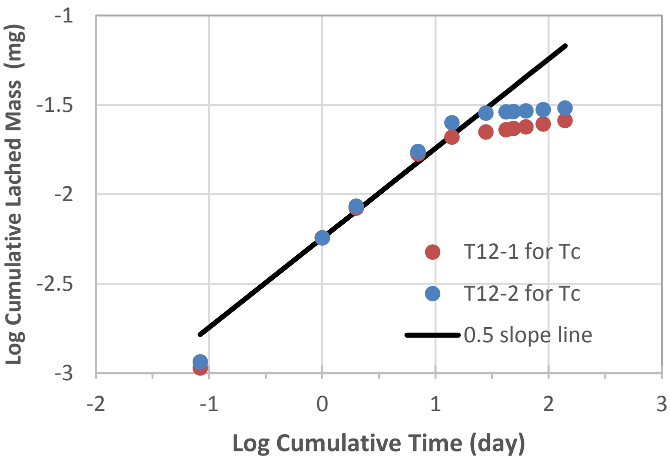

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T7-1 for NO3-
T7-2 for NO3-
0.5 slope line
2.5
2
1.5
1
0.5
0
-2
-1
0
1
2
3

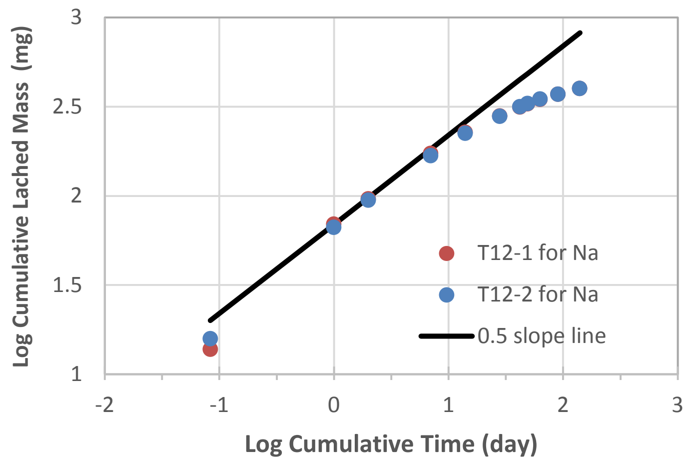

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T8-1 for Tc
T8-2 for Tc
0.5 slope line
-1
-1.5
-2
-2.5
-3
-3.5
-2
-1
0
1
2
3

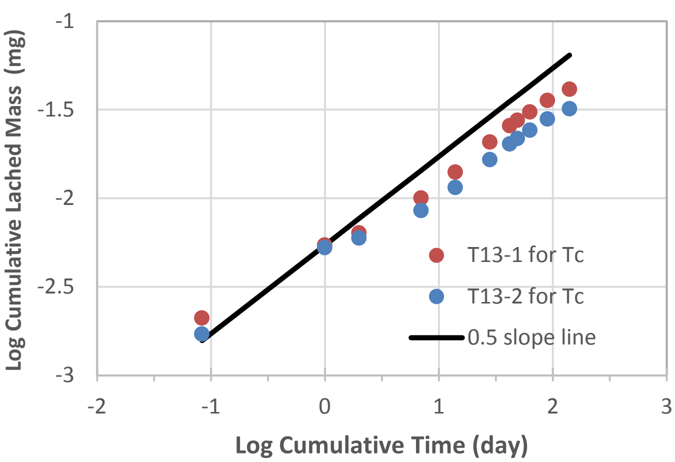

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T8-1 for NO3-
T8-2 for NO3-
0.5 slope line
3
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3

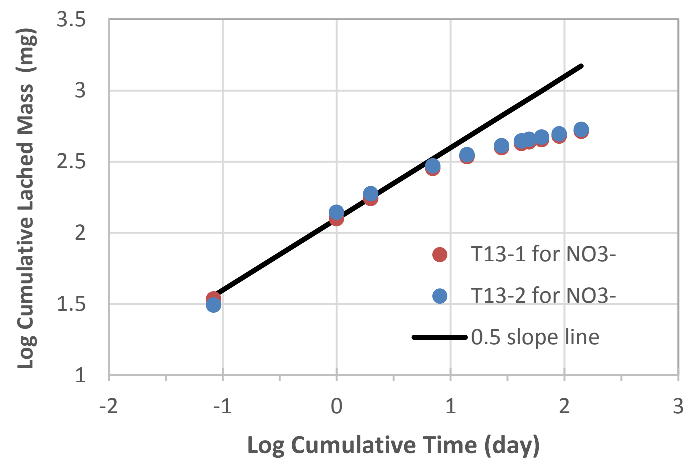


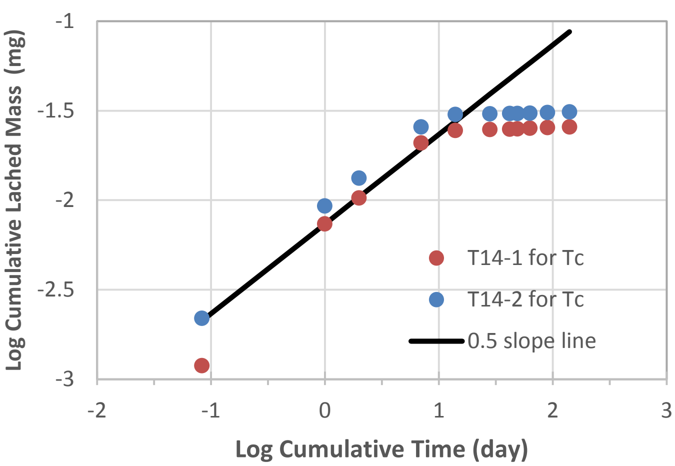
Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T9-1 for Tc
T9-2 for Tc
0.5 slope line
T9-1 for Na
T9-2 for Na
T10-1 for Tc
T10-2 for Tc
T10-1 for NO3-
T10-2 for NO3-
T11-1 for Tc
T11-2 for Tc
T11-1 for NO3-
T11-2 for NO3-

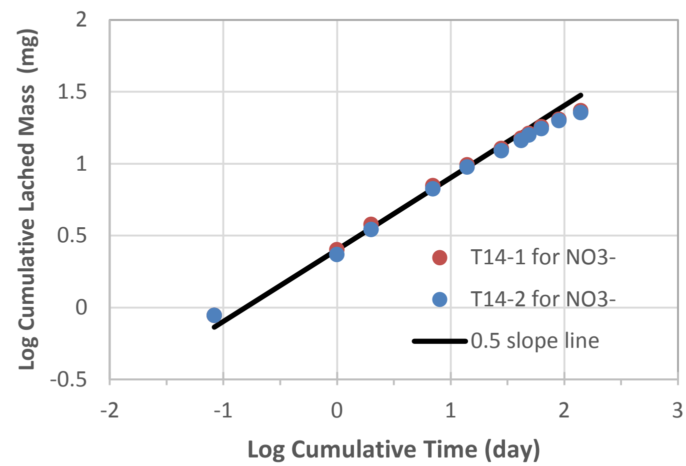

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T12-1 for Tc
T12-2 for Tc
0.5 slope line

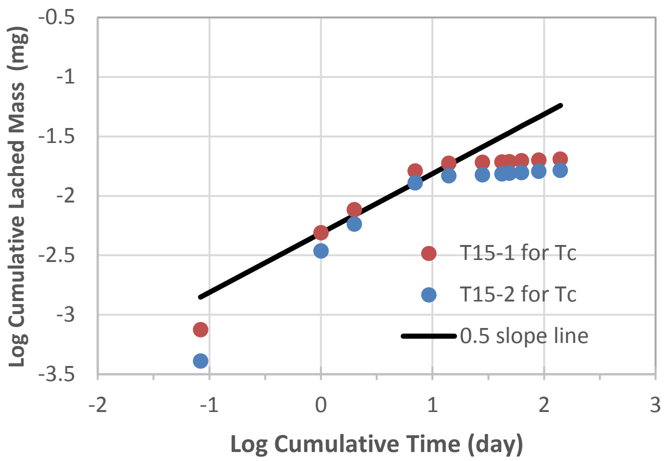

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T12-1 for Na
T12-2 for Na
0.5 slope line

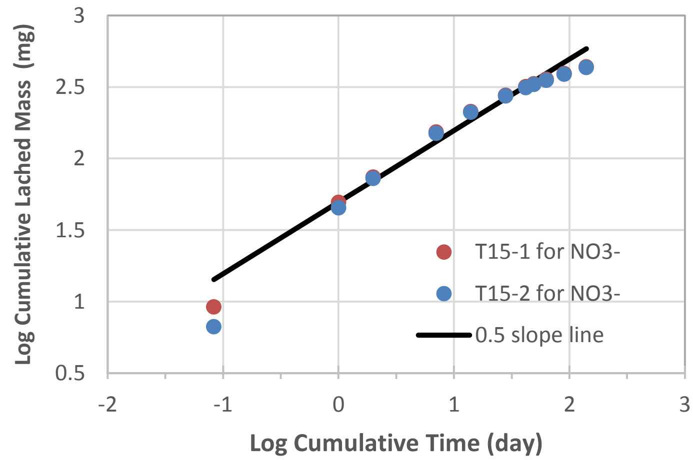

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T13-1 for Tc
T13-2 for Tc
0.5 slope line

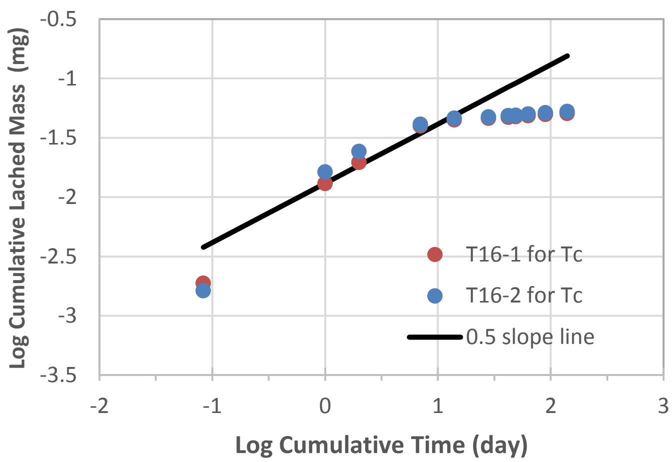

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T13-1 for NO3-
T13-2 for NO3-
0.5 slope line

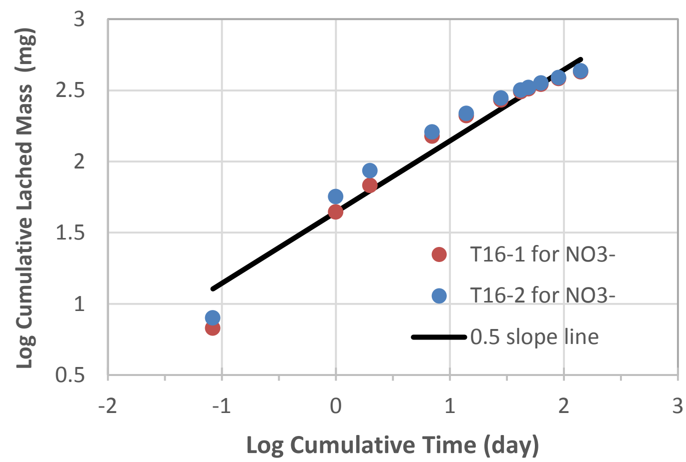

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T14-1 for Tc
T14-2 for Tc
0.5 slope line

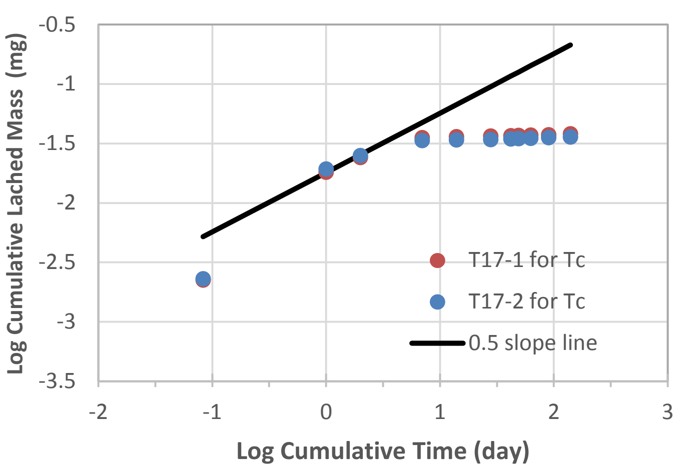

Log Cumulative Lached Mass (mg)
Log Cumulative Time (day)
T14-1 for NO3-
T14-2 for NO3-
0.5 slope line

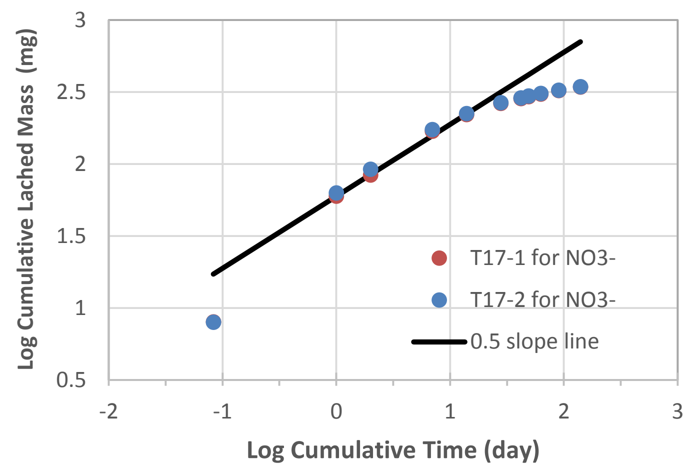

Log Cumulative Lached Mass (mg)
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T15-1 for Tc
T15-2 for Tc
0.5 slope line

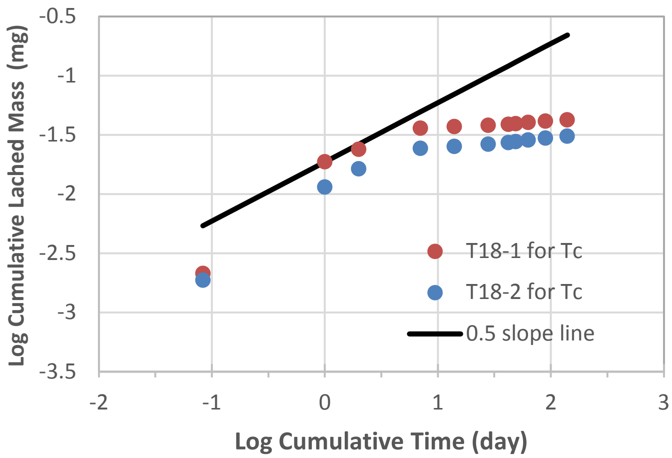

Log Cumulative Lached Mass (mg)
3
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T15-1 for NO3-
T15-2 for NO3-
0.5 slope line


Log Cumulative Lached Mass (mg)
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T16-1 for Tc
T16-2 for Tc
0.5 slope line

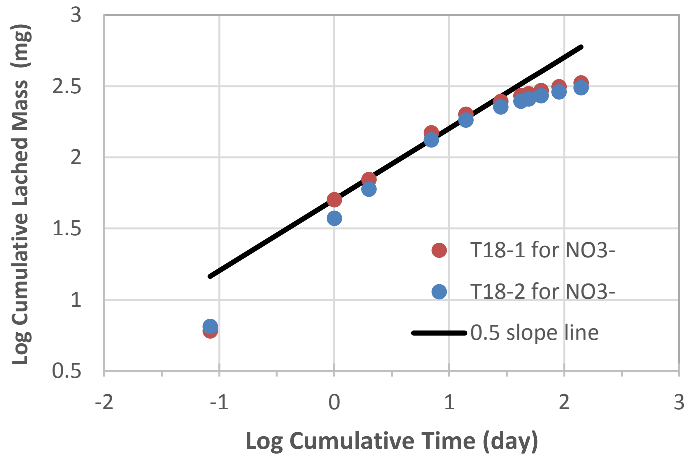

Log Cumulative Lached Mass (mg)
3
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T16-1 for NO3-
T16-2 for NO3-
0.5 slope line


Log Cumulative Lached Mass (mg)
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T17-1 for Tc
T17-2 for Tc
0.5 slope line


Log Cumulative Lached Mass (mg)
3
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T17-1 for NO3-
T17-2 for NO3-
0.5 slope line



Log Cumulative Lached Mass (mg)
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T18-1 for Tc
T18-2 for Tc
0.5 slope line



Log Cumulative Lached Mass (mg)
3
2.5
2
1.5
1
0.5
-2
-1
0
1
2
3
Log Cumulative Time (day)
T18-1 for NO3-
T18-2 for NO3-
0.5 slope line

A.5 Additional Results of pH and E_h from ^{99}Tc K_d Desorption and SolubilityTests

Table A.4. Additional Results of pH and E_h from ^{99}Tc K_d Desorption Tests

Label format for ^{99}Tc sorption test for ^{99}Tc desorption: KS-T19/20/21(for monolith number)-S(for different samples)-F1/2/3(for different size fractions)-S7/30(for 7 and 30 day sorption).
Label format for ^{99}Tc desorption test: KS-T19/20/21(for monolith number)-S(for different samples)-F1/2/3(for different size fraction)-D7/30(for different desorption times)-O/R(for oxidizing or reducing condition)
"C" indicates the control sample for ^{99}Tc solubility and K_d desorption tests.

^{99}Tc Sorption Tests						^{99}Tc Desorption Tests		
Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)
KS-T19-S1-F1-D7	12.73	-304.2	KS-T19-S27-F1-D30	12.76	-318.9	KD-T19-S19-F1-D7-O	12.61	105.1
KS-T19-S2-F1-D7	12.73	-321.3	KS-T19-S28-F1-D30	12.75	-316.3	KD-T19-S20-F1-D7-O	12.64	129.9
KS-T19-S3-F1-D7	12.75	-327.8	KS-T19-S29-F1-D30	12.71	-315.0	KD-T19-S21-F1-D7-O	12.61	115.8
KS-T19-S4-F1-D7	12.74	-316.0	KS-T19-S30-F1-D30	12.73	-321.0	KD-T19-S19-F2-D7-O	12.60	161.6
KS-T19-S5-F1-D7	12.74	-322.9	KS-T19-S31-F1-D30	12.75	-316.2	KD-T19-S20-F2-D7-O	12.58	152.7
KS-T19-S6-F1-D7	12.74	-324.1	KS-T19-S32-F1-D30	12.76	-317.4	KD-T19-S21-F2-D7-O	12.57	164.6
KS-T19-S7-F1-D7	12.74	-331.0	KS-T19-S33-F1-D30	12.75	-317.2	KD-T20-S19-F1-D7-O	12.65	141.4
KS-T19-S8-F1-D7	12.73	-326.1	KS-T19-S34-F1-D30	12.75	-319.1	KD-T20-S20-F1-D7-O	12.64	126.5
KS-T19-S9-F1-D7	12.74	-328.7	KS-T19-S35-F1-D30	12.75	-314.8	KD-T20-S21-F1-D7-O	12.65	145.7
KS-T19-S10-F1-D7	12.73	-329.9	KS-T19-S36-F1-D30	12.75	-316.2	KD-T20-S19-F2-D7-O	12.68	161.9
KS-T19-S11-F1-D7	12.72	-417.4	KS-T19-S19-F2-D30	12.73	-299.2	KD-T20-S20-F2-D7-O	12.64	137.5
KS-T19-S12-F1-D7	12.75	-409.4	KS-T19-S20-F2-D30	12.73	-294.8	KD-T20-S21-F2-D7-O	12.63	162.5
KS-T19-S13-F1-D7	12.75	-402.4	KS-T19-S21-F2-D30	12.63	-209.8	KD-T21-S19-F1-D7-O	12.40	156.8
KS-T19-S14-F1-D7	12.76	-394.5	KS-T19-S22-F2-D30	12.72	-259.8	KD-T21-S20-F1-D7-O	12.42	157.3
KS-T19-S15-F1-D7	12.75	-394.2	KS-T19-S23-F2-D30	12.70	-244.2	KD-T21-S21-F1-D7-O	12.37	169.3
KS-T19-S16-F1-D7	12.75	-383.2	KS-T19-S24-F2-D30	12.72	-255.1	KD-T21-S19-F2-D7-O	12.41	182.6
KS-T19-S17-F1-D7	12.74	-374.5	KS-T19-S25-F2-D30	12.75	-280.3	KD-T21-S20-F2-D7-O	12.37	175.3
KS-T19-S18-F1-D7	12.75	-373.7	KS-T19-S26-F2-D30	12.73	-255.5	KD-T21-S21-F2-D7-O	12.41	178.2
KS-T19-S1-F2-D7	12.71	-355.6	KS-T19-S27-F2-D30	12.72	-268.1	KD-T3-S1-F3-D30-O	12.77	127.8
KS-T19-S2-F2-D7	12.68	-318.6	KS-T19-S28-F2-D30	12.71	-261.7	KD-T3-S2-F3-D30-O	12.79	135.4
KS-T19-S3-F2-D7	12.66	-341.2	KS-T19-S29-F2-D30	12.74	-257.4	KD-T6-S1-F1-D30-O	12.78	129.8
KS-T19-S4-F2-D7	12.70	-343.8	KS-T19-S30-F2-D30	12.70	-258.7	KD-T6-S2-F1-D30-O	12.79	130.3
KS-T19-S5-F2-D7	12.69	-338.5	KS-T19-S31-F2-D30	12.74	-347.5	KD-T6-S1-F2-D30-O	12.76	129.0
KS-T19-S6-F2-D7	12.69	-355.0	KS-T19-S32-F2-D30	12.74	-348.8	KD-T6-S2-F2-D30-O	12.76	129.5
KS-T19-S7-F2-D7	12.70	-342.7	KS-T19-S33-F2-D30	12.74	-415.9	KD-T6-S1-F3-D30-O	12.80	130.9
KS-T19-S8-F2-D7	12.70	-335.2	KS-T19-S34-F2-D30	12.75	-428.5	KD-T6-S2-F3-D30-O	12.79	132.0
KS-T19-S9-F2-D7	12.71	-345.4	KS-T19-S35-F2-D30	12.76	-430.4	KD-T11-S1-F1-D30-O	12.48	132.3
KS-T19-S10-F2-D7	12.71	-327.5	KS-T19-S36-F2-D30	12.76	-446.4	KD-T11-S2-F1-D30-O	12.46	135.3
KS-T19-S11-F2-D7	12.70	-339.1	KS-T19-C1-D30	12.40	-216.50	KD-T11-S1-F2-D30-O	12.44	133.1
KS-T19-S12-F2-D7	12.69	-353.1	KS-T19-C2-D30	12.37	-50.20	KD-T11-S2-F2-D30-O	12.49	130.6
KS-T19-S13-F2-D7	12.67	-451.4	KS-T20-S19-F1-D30	12.77	-446.2	KD-T11-S1-F3-D30-O	12.53	133.6
KS-T19-S14-F2-D7	12.68	-383.1	KS-T20-S20-F1-D30	12.77	-437.4	KD-T11-S2-F3-D30-O	12.55	132.8
KS-T19-S15-F2-D7	12.71	-382.8	KS-T20-S21-F1-D30	12.72	-387.5	KD-T19-S22-F1-D30-O	12.52	168.0
KS-T19-S16-F2-D7	12.70	-373.9	KS-T20-S22-F1-D30	12.74	-428.8	KD-T19-S23-F1-D30-O	12.50	161.9
KS-T19-S17-F2-D7	12.68	-369.5	KS-T20-S23-F1-D30	12.76	-435.3	KD-T19-S24-F1-D30-O	12.51	162.5
KS-T19-S18-F2-D7	12.69	-352.4	KS-T20-S24-F1-D30	12.76	-456.5	KD-T19-S22-F2-D30-O	12.49	162.7
KS-T19-C1-D7	12.55	no sample	KS-T20-S25-F1-D30	12.76	-416.8	KD-T19-S23-F2-D30-O	12.49	163.4
KS-T19-C2-D7	12.55	-401.9	KS-T20-S26-F1-D30	12.76	-443.3	KD-T19-S24-F2-D30-O	12.48	167.8
KS-T20-S1-F1-D7	12.67	-341.9	KS-T20-S27-F1-D30	12.76	-461.5	KD-T20-S22-F1-D30-O	12.50	166.2
KS-T20-S2-F1-D7	12.77	-345.1	KS-T20-S28-F1-D30	12.76	-439.6	KD-T20-S23-F1-D30-O	12.51	163.4
KS-T20-S3-F1-D7	12.79	-339.7	KS-T20-S29-F1-D30	12.76	-402.5	KD-T20-S24-F1-D30-O	12.52	165.5

^{99}Tc Sorption Tests (continued)						^{99}Tc Desorption Tests (continued)		
Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)
KS-T20-S4-F1-D7	12.79	-345.9	KS-T20-S30-F1-D30	12.78	-415.9	KD-T20-S22-F2-D30-O	12.50	166.3
KS-T20-S5-F1-D7	12.78	-450.5	KS-T20-S31-F1-D30	12.70	-420.2	KD-T20-S23-F2-D30-O	12.49	166.2
KS-T20-S6-F1-D7	12.79	-446.8	KS-T20-S32-F1-D30	12.74	-401.1	KD-T20-S24-F2-D30-O	12.49	165.8
KS-T20-S7-F1-D7	12.80	-445.2	KS-T20-S33-F1-D30	12.75	-421.3	KD-T21-S22-F1-D30-O	12.22	168.8
KS-T20-S8-F1-D7	12.80	-443.9	KS-T20-S34-F1-D30	12.76	-404.7	KD-T21-S23-F1-D30-O	12.20	170.8
KS-T20-S9-F1-D7	12.80	-444.3	KS-T20-S35-F1-D30	12.75	-401.8	KD-T21-S24-F1-D30-O	12.20	175.8
KS-T20-S10-F1-D7	12.76	-440.2	KS-T20-S36-F1-D30	12.75	-397.9	KD-T21-S22-F2-D30-O	12.26	177.2
KS-T20-S11-F1-D7	12.77	-417.4	KS-T20-S19-F2-D30	12.76	-466.8	KD-T21-S23-F2-D30-O	12.25	176.9
KS-T20-S12-F1-D7	12.77	-405.1	KS-T20-S20-F2-D30	12.76	-469.2	KD-T21-S24-F2-D30-O	12.26	177.9
KS-T20-S13-F1-D7	12.79	-389.8	KS-T20-S21-F2-D30	12.73	-465.4	KD-T19-S13-F3-D7-O	12.56	157.8
KS-T20-S14-F1-D7	12.78	-368.4	KS-T20-S22-F2-D30	12.75	-470.3	KD-T19-S14-F3-D7-O	12.62	167.2
KS-T20-S15-F1-D7	12.80	-354.2	KS-T20-S23-F2-D30	12.71	-499.8	KD-T20-S13-F3-D7-O	12.49	162.3
KS-T20-S16-F1-D7	12.78	-348.6	KS-T20-S24-F2-D30	12.73	-483.7	KD-T20-S14-F3-D7-O	12.61	163.8
KS-T20-S17-F1-D7	12.79	-347.2	KS-T20-S25-F2-D30	12.74	-508.8	KD-T21-S13-F3-D7-O	12.27	161.3
KS-T20-S18-F1-D7	12.80	-344.6	KS-T20-S26-F2-D30	12.73	-493.6	KD-T21-S14-F3-D7-O	12.29	165.3
KS-T20-S1-F2-D7	12.75	-330.3	KS-T20-S27-F2-D30	12.74	-472.6	KD-T19-S15-F3-D23-O	12.56	101.9
KS-T20-S2-F2-D7	12.77	-359.1	KS-T20-S28-F2-D30	12.74	-459.5	KD-T19-S16-F3-D23-O	12.54	117.5
KS-T20-S3-F2-D7	12.73	-323.5	KS-T20-S29-F2-D30	12.76	-495.9	KD-T20-S15-F3-D23-O	12.61	118.7
KS-T20-S4-F2-D7	12.76	-318.8	KS-T20-S30-F2-D30	12.74	-430.7	KD-T20-S16-F3-D23-O	12.58	119.3
KS-T20-S5-F2-D7	12.77	-329.9	KS-T20-S31-F2-D30	12.75	-484.5	KD-T21-S15-F3-D23-O	12.33	115.8
KS-T20-S6-F2-D7	12.77	-324.2	KS-T20-S32-F2-D30	12.76	-500.7	KD-T21-S16-F3-D23-O	12.29	119.6
KS-T20-S7-F2-D7	12.75	-316.3	KS-T20-S33-F2-D30	12.76	-381.2	KD-T19-S28-F1-D7-R	12.27	-508.3
KS-T20-S8-F2-D7	12.77	-321.1	KS-T20-S34-F2-D30	12.73	-433.4	KD-T19-S29-F1-D7-R	12.53	-507.7
KS-T20-S9-F2-D7	12.78	-329.2	KS-T20-S35-F2-D30	12.75	-469.7	KD-T19-S30-F1-D7-R	12.43	-513.3
KS-T20-S10-F2-D7	12.76	-340.7	KS-T20-S36-F2-D30	12.73	-492.1	KD-T19-S28-F2-D7-R	12.45	-487.9
KS-T20-S11-F2-D7	12.76	-346.0	KS-T20-C1-D30	12.35	-53.3	KD-T19-S29-F2-D7-R	12.50	-472.7
KS-T20-S12-F2-D7	12.75	-320.1	KS-T20-C2-D30	12.34	-122.5	KD-T19-S30-F2-D7-R	12.44	-511.2
KS-T20-S13-F2-D7	12.71	-316.8	KS-T21-S19-F1-D30	12.58	-465.0	KD-T20-S28-F1-D7-R	12.51	-492.4
KS-T20-S14-F2-D7	12.73	-320.2	KS-T21-S20-F1-D30	12.55	-519.3	KD-T20-S29-F1-D7-R	12.51	-491.5
KS-T20-S15-F2-D7	12.78	-318.5	KS-T21-S21-F1-D30	12.53	-491.3	KD-T20-S30-F1-D7-R	12.54	-477.0
KS-T20-S16-F2-D7	12.73	-307.1	KS-T21-S22-F1-D30	12.54	-526.1	KD-T20-S28-F2-D7-R	12.50	-529.4
KS-T20-S17-F2-D7	12.76	-255.6	KS-T21-S23-F1-D30	12.52	-361.4	KD-T20-S29-F2-D7-R	12.48	-467.3
KS-T20-S18-F2-D7	12.75	-335.8	KS-T21-S24-F1-D30	12.53	-426.9	KD-T20-S30-F2-D7-R	12.50	-496.6
KS-T20-C1-D7	12.70	-45.3	KS-T21-S25-F1-D30	12.53	-497.9	KD-T21-S28-F1-D7-R	12.28	-473.4
KS-T20-C2-D7	no sample	-66.6	KS-T21-S26-F1-D30	12.53	-511.5	KD-T21-S29-F1-D7-R	12.29	-468.5
KS-T21-S1-F1-D7	12.52	-285.9	KS-T21-S27-F1-D30	12.53	-512.5	KD-T21-S30-F1-D7-R	12.28	-452.3
KS-T21-S2-F1-D7	12.54	-333.1	KS-T21-S28-F1-D30	12.53	-485.8	KD-T21-S28-F2-D7-R	12.21	-404.7
KS-T21-S3-F1-D7	12.48	-321.4	KS-T21-S29-F1-D30	12.53	-507.5	KD-T21-S29-F2-D7-R	12.21	-400.1
KS-T21-S4-F1-D7	12.57	-346.7	KS-T21-S30-F1-D30	12.53	-509.8	KD-T21-S30-F2-D7-R	12.22	-408.9
KS-T21-S5-F1-D7	12.57	-338.0	KS-T21-S31-F1-D30	12.53	-497.6	KD-T19-S31-F1-D30-R	12.38	-543.6
KS-T21-S6-F1-D7	12.57	-348.9	KS-T21-S32-F1-D30	12.53	-499.3	KD-T19-S32-F1-D30-R	12.38	-559.6
KS-T21-S7-F1-D7	12.58	-354.6	KS-T21-S33-F1-D30	12.48	-501.1	KD-T19-S33-F1-D30-R	12.38	-555.2
KS-T21-S8-F1-D7	12.56	-348.2	KS-T21-S34-F1-D30	12.51	-501.9	KD-T19-S31-F2-D30-R	12.39	-525.6
KS-T21-S9-F1-D7	12.57	-347.3	KS-T21-S35-F1-D30	12.52	-508.3	KD-T19-S32-F2-D30-R	12.38	-536.4
KS-T21-S10-F1-D7	12.56	-350.1	KS-T21-S36-F1-D30	12.50	-332.4	KD-T19-S33-F2-D30-R	12.41	-551.3
KS-T21-S11-F1-D7	12.51	-302.4	KS-T21-S19-F2-D30	12.50	-213.4	KD-T20-S31-F1-D30-R	12.37	-550.5
KS-T21-S12-F1-D7	12.38	-317.1	KS-T21-S20-F2-D30	12.52	-283.1	KD-T20-S32-F1-D30-R	12.38	-545.5
KS-T21-S13-F1-D7	12.56	-326.9	KS-T21-S21-F2-D30	12.56	-288.5	KD-T20-S33-F1-D30-R	12.38	-547.5
KS-T21-S14-F1-D7	12.56	-333.2	KS-T21-S22-F2-D30	12.56	-272.6	KD-T20-S31-F2-D30-R	12.35	-510.9
KS-T21-S15-F1-D7	12.56	-332.1	KS-T21-S23-F2-D30	12.56	-367.0	KD-T20-S32-F2-D30-R	12.36	-565.5
KS-T21-S16-F1-D7	12.47	-337.5	KS-T21-S24-F2-D30	12.58	-329.2	KD-T20-S33-F2-D30-R	12.36	-574.4
KS-T21-S17-F1-D7	12.56	-338.9	KS-T21-S25-F2-D30	12.51	-207.9	KD-T21-S31-F1-D30-R	12.08	-541.4

^{99}Tc Sorption Tests (continued)						^{99}Tc Desorption Tests (continued)		
Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)
KS-T21-S18-F1-D7	12.56	-340.2	KS-T21-S26-F2-D30	12.53	-229.9	KD-T21-S32-F1-D30-R	12.06	-536.5
KS-T21-S1-F2-D7	12.56	-313.1	KS-T21-S27-F2-D30	12.54	-242.4	KD-T21-S33-F1-D30-R	12.06	-534.8
KS-T21-S2-F2-D7	12.54	-306.8	KS-T21-S28-F2-D30	12.54	-251.1	KD-T21-S31-F2-D30-R	12.12	-533.7
KS-T21-S3-F2-D7	12.55	-317.8	KS-T21-S29-F2-D30	12.54	-256.2	KD-T21-S32-F2-D30-R	12.11	-554.8
KS-T21-S4-F2-D7	12.55	-305.5	KS-T21-S30-F2-D30	12.55	-269.2	KD-T21-S33-F2-D30-R	12.12	-541.7
KS-T21-S5-F2-D7	12.55	-325.8	KS-T21-S31-F2-D30	12.56	-317.2	KD-T19-S19-F3-D7-R	12.55	-403.7
KS-T21-S6-F2-D7	12.54	-288.6	KS-T21-S32-F2-D30	12.58	-329.4	KD-T19-S20-F3-D7-R	12.54	-392.9
KS-T21-S7-F2-D7	12.55	-304.6	KS-T21-S33-F2-D30	12.56	-325.2	KD-T20-S19-F3-D7-R	12.53	-375.4
KS-T21-S8-F2-D7	12.53	-292.9	KS-T21-S34-F2-D30	12.56	-376.6	KD-T20-S20-F3-D7-R	12.51	-394.5
KS-T21-S9-F2-D7	12.57	-289.3	KS-T21-S35-F2-D30	12.51	-198.7	KD-T21-S19-F3-D7-R	12.27	-371.2
KS-T21-S10-F2-D7	12.59	-307.9	KS-T21-S36-F2-D30	12.57	-223.3	KD-T21-S20-F3-D7-R	12.28	-399.2
KS-T21-S11-F2-D7	12.56	-297.2	KS-T21-C1-D30	12.33	-56.1	KD-T19-S21-F3-D23-R	12.53	-427.4
KS-T21-S12-F2-D7	12.54	-296.3	KS-T21-C2-D30	12.33	-66.2	KD-T19-S22-F3-D23-R	12.54	-445.7
KS-T21-S13-F2-D7	12.52	-241.4	KS-T19-S1-F3-D7	12.71	-364.9	KD-T20-S21-F3-D23-R	12.52	-462.6
KS-T21-S14-F2-D7	12.52	-233.5	KS-T19-S2-F3-D7	12.70	-291.5	KD-T20-S22-F3-D23-R	12.50	-441.5
KS-T21-S15-F2-D7	12.54	-262.0	KS-T19-S3-F3-D7	12.72	-328.7	KD-T21-S21-F3-D23-R	12.19	-447.2
KS-T21-S16-F2-D7	12.56	-289.3	KS-T19-S4-F3-D7	12.74	-334.0	KD-T21-S22-F3-D23-R	12.20	-427.7
KS-T21-S17-F2-D7	12.53	-277.3	KS-T19-S5-F3-D7	12.75	-312.7	KD-T3-S1-F3-D30-R	12.70	-296.7
KS-T21-S18-F2-D7	12.59	-297.9	KS-T19-S6-F3-D7	12.75	-329.7	KD-T3-S2-F3-D30-R	12.72	-275.6
KS-T21-C1-D7	12.43	-243.5	KS-T19-S7-F3-D7	12.75	-326.0	KD-T6-S1-F1-D30-R	12.73	-274.3
KS-T21-C2-D7	12.45	-257.2	KS-T19-S8-F3-D7	12.76	-321.7	KD-T6-S2-F1-D30-R	12.73	-275.8
KS-T19-S19-F1-D30	12.72	-383.2	KS-T19-S9-F3-D7	12.76	-312.4	KD-T6-S1-F2-D30-R	12.71	-231.7
KS-T19-S20-F1-D30	12.72	-324.8	KS-T19-S10-F3-D7	12.77	-334.0	KD-T6-S2-F2-D30-R	12.73	-248.4
KS-T19-S21-F1-D30	12.73	-322.8	KS-T19-S11-F3-D7	12.72	-312.8	KD-T6-S1-F3-D30-R	12.74	-307.2
KS-T19-S22-F1-D30	12.74	-314.1	KS-T19-S12-F3-D7	12.74	-313.7	KD-T6-S2-F3-D30-R	12.74	-325.2
KS-T19-S23-F1-D30	12.75	-316.5	KS-T19-F3-C1-D7	12.59	-30.4	KD-T11-S1-F1-D30-R	12.44	-274.8
KS-T19-S24-F1-D30	12.74	-320.6	KS-T19-F3-C2-D7	12.55	-80.2	KD-T11-S2-F1-D30-R	12.42	-304.3
KS-T19-S25-F1-D30	12.74	-316.2	KS-T20-S1-F3-D7	12.76	-287.4	KD-T11-S1-F2-D30-R	12.35	-227.3
KS-T19-S26-F1-D30	12.75	-317.1	KS-T20-S2-F3-D7	12.76	-272.0	KD-T11-S2-F2-D30-R	12.41	-222.5
KS-T20-S3-F3-D7	12.77	-296.8	KS-T19-S19-F3-D30	12.63	-169.3	KD-T11-S1-F3-D30-R	12.48	-321.7
KS-T20-S4-F3-D7	12.77	-303.7	KS-T19-S20-F3-D30	12.62	-170.0	KD-T11-S2-F3-D30-R	12.48	-323.3
KS-T20-S5-F3-D7	12.77	-305.4	KS-T19-S21-F3-D30	12.62	-177.3			
KS-T20-S6-F3-D7	12.77	-305.3	KS-T19-S22-F3-D30	12.67	-195.9			
KS-T20-S7-F3-D7	12.72	-276.1	KS-T19-S23-F3-D30	12.63	-176.7			
KS-T20-S8-F3-D7	12.74	-282.5	KS-T19-S24-F3-D30	12.61	-184.8			
KS-T20-S9-F3-D7	12.73	-309.3	KS-T19-F3-C1-D30	11.60	-1.7			
KS-T20-S10-F3-D7	12.75	-304.7	KS-T19-F3-C2-D30	12.27	5.4			
KS-T20-S11-F3-D7	12.75	-308.7	KS-T20-S13-F3-D30	12.61	-200.6			
KS-T20-S12-F3-D7	12.76	-301.3	KS-T20-S14-F3-D30	12.63	-196.2			
KS-T20-F3-C1-D7	12.53	-225.1	KS-T20-S15-F3-D30	12.61	-204.7			
KS-T20-F3-C2-D7	12.52	-203.1	KS-T20-S16-F3-D30	12.63	-206.6			
KS-T21-S1-F3-D7	12.58	-310.0	KS-T20-S17-F3-D30	12.66	-187.4			
KS-T21-S2-F3-D7	12.57	-314.5	KS-T20-S18-F3-D30	12.64	-180.2			
KS-T21-S3-F3-D7	12.50	-295.6	KS-T20-S19-F3-D30	12.63	-174.4			
KS-T21-S4-F3-D7	12.52	-319.8	KS-T20-S20-F3-D30	12.62	-172.5			
KS-T21-S5-F3-D7	12.54	-318.5	KS-T20-S21-F3-D30	12.63	-173.8			
KS-T21-S6-F3-D7	12.54	-324.6	KS-T20-S22-F3-D30	12.62	-179.7			
KS-T21-S7-F3-D7	12.54	-295.7	KS-T19-S17-F3-D30	12.62	-208.5	KS-T21-S19-F3-D30	12.47	-149.8
KS-T21-S8-F3-D7	12.54	-295.6	KS-T19-S18-F3-D30	12.64	-184.2	KS-T21-S20-F3-D30	12.47	-153.3
KS-T21-S9-F3-D7	12.55	-322.4	KS-T20-S23-F3-D30	12.62	-185.6	KS-T21-S21-F3-D30	12.49	-153.2
KS-T21-S10-F3-D7	12.55	-329.4	KS-T20-S24-F3-D30	12.62	-179.5	KS-T21-S22-F3-D30	12.49	-160.9
KS-T21-S11-F3-D7	12.54	-343.8	KS-T20-F3-C1-D30	11.85	3.5	KS-T21-S23-F3-D30	12.47	-159.8

^{99}Tc Sorption Tests (continued)						^{99}Tc Desorption Tests (continued)		
Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)
KS-T21-S12-F3-D7	12.55	-336.1	KS-T20-F3-C2-D30	11.54	40.8	KS-T21-S24-F3-D30	12.49	-131.2
KS-T21-F3-C1-D7	12.42	-27.5	KS-T21-S13-F3-D30	12.44	-160.3			
KS-T21-F3-C2-D7	12.44	-44.6	KS-T21-S14-F3-D30	12.45	-163.1			
KS-T19-S13-F3-D30	12.63	-515.8	KS-T21-S15-F3-D30	12.49	-167.8			
KS-T19-S14-F3-D30	12.62	-496.1	KS-T21-S16-F3-D30	12.48	-157.0			
KS-T19-S15-F3-D30	12.65	-210.0	KS-T21-S17-F3-D30	12.48	-156.6			
KS-T19-S16-F3-D30	12.63	-161.4	KS-T21-S18-F3-D30	12.47	-163.8			

Table A.5. Additional Results of pH and E_h from ^{99}Tc Solubility Tests

Label format for ^{99}Tc solubility test: SOL-T19/20/21(for monolith number)-S1/2/3(for triplicates)-Tc2.5/10/25(for initial Tc concentration of 2.5, 10, or 25 ppb)-D14/30/51(for different reaction times)

^{99}Tc Solubility Tests								
Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)
SOL-T19-S1-Tc2.5-D14	12.43	-509.4	SOL-T20-C2-Tc25-D14	12.02	-430.3	SOL-T19-S3-Tc25-D30	12.40	-258.2
SOL-T19-S2-Tc2.5-D14	12.45	-543.1	SOL-T20-C3-Tc25-D14	12.07	-443.4	SOL-T19-C1-Tc25-D30	12.15	-197.7
SOL-T19-S3-Tc2.5-D14	12.45	-546.7	SOL-T21-S1-Tc2.5-D14	12.10	-439.5	SOL-T19-C2-Tc25-D30	12.52	-346.9
SOL-T19-C1-Tc2.5-D14	12.13	-520.8	SOL-T21-S2-Tc2.5-D14	12.13	-434.7	SOL-T19-C3-Tc25-D30	12.15	-340.7
SOL-T19-C2-Tc2.5-D14	12.11	-415.4	SOL-T21-S3-Tc2.5-D14	12.11	-429.5	SOL-T20-S1-Tc2.5-D30	12.41	-277.4
SOL-T19-C3-Tc2.5-D14	12.14	-507.4	SOL-T21-C1-Tc2.5-D14	11.93	-381.9	SOL-T20-S2-Tc2.5-D30	12.46	-284.1
SOL-T19-S1-Tc10-D14	12.54	-447.6	SOL-T21-C2-Tc2.5-D14	11.83	-96.3	SOL-T20-S3-Tc2.5-D30	12.45	-314.5
SOL-T19-S2-Tc10-D14	12.49	-468.6	SOL-T21-C3-Tc2.5-D14	11.90	-122.4	SOL-T20-C1-Tc2.5-D30	12.16	-161.8
SOL-T19-S3-Tc10-D14	12.46	-479.6	SOL-T21-S1-Tc10-D14	12.09	-280.2	SOL-T20-C2-Tc2.5-D30	12.14	-196.4
SOL-T19-C1-Tc10-D14	12.15	-464.7	SOL-T21-S2-Tc10-D14	12.12	-306.2	SOL-T20-C3-Tc2.5-D30	12.16	-218.3
SOL-T19-C2-Tc10-D14	12.09	-459.1	SOL-T21-S3-Tc10-D14	12.13	-322.4	SOL-T20-S1-Tc10-D30	12.50	-317.6
SOL-T19-C3-Tc10-D14	12.12	-494.8	SOL-T21-C1-Tc10-D14	11.94	-244.9	SOL-T20-S2-Tc10-D30	12.48	-404.4
SOL-T19-S1-Tc25-D14	12.43	-541.0	SOL-T21-C2-Tc10-D14	11.93	-196.7	SOL-T20-S3-Tc10-D30	12.53	-386.9
SOL-T19-S2-Tc25-D14	12.43	-556.8	SOL-T21-C3-Tc10-D14	11.94	-113.4	SOL-T20-C1-Tc10-D30	12.14	-204.1
SOL-T19-S3-Tc25-D14	12.44	-565.8	SOL-T21-S1-Tc25-D14	12.10	-332.8	SOL-T20-C2-Tc10-D30	12.12	-260.8
SOL-T19-C1-Tc25-D14	12.13	-530.9	SOL-T21-S2-Tc25-D14	12.10	-350.8	SOL-T20-C3-Tc10-D30	12.13	-252.6
SOL-T19-C2-Tc25-D14	12.13	-537.8	SOL-T21-S3-Tc25-D14	12.06	-375.9	SOL-T20-S1-Tc25-D30	12.47	-360.3
SOL-T19-C3-Tc25-D14	12.14	-553.1	SOL-T21-C1-Tc25-D14	11.90	-335.8	SOL-T20-S2-Tc25-D30	12.50	-235.4
SOL-T20-S1-Tc2.5-D14	12.41	-566.2	SOL-T21-C2-Tc25-D14	11.91	-283.3	SOL-T20-S3-Tc25-D30	12.50	-265.3
SOL-T20-S2-Tc2.5-D14	12.43	-570.7	SOL-T21-C3-Tc25-D14	11.93	-310.7	SOL-T20-C1-Tc25-D30	12.11	-204.5
SOL-T20-S3-Tc2.5-D14	12.39	-457.3	SOL-T19-S1-Tc2.5-D30	12.49	-262.4	SOL-T20-C2-Tc25-D30	12.10	-197.2
SOL-T20-C1-Tc2.5-D14	12.13	-452.4	SOL-T19-S2-Tc2.5-D30	12.49	-300.3	SOL-T20-C3-Tc25-D30	12.11	-171.1
SOL-T20-C2-Tc2.5-D14	12.10	-463.1	SOL-T19-S3-Tc2.5-D30	12.47	-338.2	SOL-T21-S1-Tc2.5-D30	12.09	-337.7
SOL-T20-C3-Tc2.5-D14	12.11	-475.4	SOL-T19-C1-Tc2.5-D30	12.17	-210.0	SOL-T21-S2-Tc2.5-D30	12.08	-359.4
SOL-T20-S1-Tc10-D14	12.41	-521.8	SOL-T19-C2-Tc2.5-D30	12.18	-254.5	SOL-T21-S3-Tc2.5-D30	12.09	-354.5
SOL-T20-S2-Tc10-D14	12.44	-525.6	SOL-T19-C3-Tc2.5-D30	12.17	-348.6	SOL-T21-C1-Tc2.5-D30	11.96	-257.1
SOL-T20-S3-Tc10-D14	12.51	-520.9	SOL-T19-S1-Tc10-D30	12.44	-386.0	SOL-T21-C2-Tc2.5-D30	11.92	-297.7
SOL-T20-C1-Tc10-D14	12.09	-489.6	SOL-T19-S2-Tc10-D30	12.46	-353.3	SOL-T21-C3-Tc2.5-D30	11.93	-338.2
SOL-T20-C2-Tc10-D14	12.09	-490.5	SOL-T19-S3-Tc10-D30	12.51	-393.1	SOL-T21-S1-Tc10-D30	12.08	-378.6
SOL-T20-C3-Tc10-D14	12.06	-501.6	SOL-T19-C1-Tc10-D30	12.17	-359.7	SOL-T21-S2-Tc10-D30	12.10	-417.7
SOL-T20-S1-Tc25-D14	12.37	-399.3	SOL-T19-C2-Tc10-D30	12.11	-324.9	SOL-T21-S3-Tc10-D30	12.08	-448.4
SOL-T20-S2-Tc25-D14	12.46	-407.9	SOL-T19-C3-Tc10-D30	12.15	-340.6	SOL-T21-C1-Tc10-D30	11.95	-349.3

^{99}Tc Solubility Tests (continued)								
Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)	Sample Name	pH	E_h (mV)
SOL-T20-S3-Tc25-D14	12.46	-447.3	SOL-T19-S1-Tc25-D30	12.51	-320.5	SOL-T21-C2-Tc10-D30	11.96	-442.7
SOL-T20-C1-Tc25-D14	12.04	-435.2	SOL-T19-S2-Tc25-D30	12.52	-276.9	SOL-T21-C3-Tc10-D30	11.97	-400.8
SOL-T21-S1-Tc25-D30	12.13	-474.6	SOL-T20-C1-Tc10-D51	12.11	-499.3			
SOL-T21-S2-Tc25-D30	12.13	-435.9	SOL-T20-C2-Tc10-D51	12.14	-487.5			
SOL-T21-S3-Tc25-D30	12.08	-463.4	SOL-T20-C3-Tc10-D51	12.07	-505.6			
SOL-T21-C1-Tc25-D30	11.94	-287.2	SOL-T20-S1-Tc25-D51	12.49	-460.3			
SOL-T21-C2-Tc25-D30	11.93	-376.5	SOL-T20-S2-Tc25-D51	12.54	-426.9			
SOL-T21-C3-Tc25-D30	11.94	-385.3	SOL-T20-S3-Tc25-D51	12.59	-444.6			
SOL-T19-S1-Tc2.5-D51	12.46	-435.9	SOL-T20-C1-Tc25-D51	12.16	-453.7			
SOL-T19-S2-Tc2.5-D51	12.52	-409.7	SOL-T20-C2-Tc25-D51	12.10	-475.4			
SOL-T19-S3-Tc2.5-D51	12.54	-384.2	SOL-T20-C3-Tc25-D51	12.11	-473.5			
SOL-T19-C1-Tc2.5-D51	12.15	-379.9	SOL-T21-S1-Tc2.5-D51	12.15	-439.6			
SOL-T19-C2-Tc2.5-D51	12.13	-419.2	SOL-T21-S2-Tc2.5-D51	12.09	-419.0			
SOL-T19-C3-Tc2.5-D51	12.10	-440.4	SOL-T21-S3-Tc2.5-D51	12.09	-442.7			
SOL-T19-S1-Tc10-D51	12.50	-436.5	SOL-T21-C1-Tc2.5-D51	11.91	-466.6			
SOL-T19-S2-Tc10-D51	12.54	-396.3	SOL-T21-C2-Tc2.5-D51	11.90	-482.4			
SOL-T19-S3-Tc10-D51	12.54	-376.7	SOL-T21-C3-Tc2.5-D51	11.91	-494.2			
SOL-T19-C1-Tc10-D51	12.14	-381.9	SOL-T21-S1-Tc10-D51	12.04	-452.4			
SOL-T19-C2-Tc10-D51	12.06	-441.7	SOL-T21-S2-Tc10-D51	12.11	-411.2			
SOL-T19-C3-Tc10-D51	12.10	-432.2	SOL-T21-S3-Tc10-D51	12.10	-411.7			
SOL-T19-S1-Tc25-D51	12.49	-399.9	SOL-T21-C1-Tc10-D51	11.94	-439.6			
SOL-T19-S2-Tc25-D51	12.51	-413.6	SOL-T21-C2-Tc10-D51	11.92	-435.9			
SOL-T19-S3-Tc25-D51	12.53	-433.3	SOL-T21-C3-Tc10-D51	11.91	-416.8			
SOL-T19-C1-Tc25-D51	12.17	-357.8	SOL-T21-S1-Tc25-D51	12.11	-400.2			
SOL-T19-C2-Tc25-D51	12.14	-418.3	SOL-T21-S2-Tc25-D51	12.12	-382.9			
SOL-T19-C3-Tc25-D51	12.12	-451.3	SOL-T21-S3-Tc25-D51	12.06	-412.8			
SOL-T20-S1-Tc2.5-D51	12.49	-429.2	SOL-T21-C1-Tc25-D51	11.92	-426.8			
SOL-T20-S2-Tc2.5-D51	12.50	-456.7	SOL-T21-C2-Tc25-D51	11.91	-395.5			
SOL-T20-S3-Tc2.5-D51	12.46	-460.5	SOL-T21-C3-Tc25-D51	11.93	-415.3			
SOL-T20-C1-Tc2.5-D51	12.04	-472.9						
SOL-T20-C2-Tc2.5-D51	12.06	-499.0						
SOL-T20-C3-Tc2.5-D51	12.04	-509.7						
SOL-T20-S1-Tc10-D51	12.47	-552.5						
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SOL-T20-S3-Tc10-D51	12.50	-532.4						

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