JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: February 27, 2018 – June 3, 2018 (Increment 55), Including SpX-14 and Cygnus OA-9 Ingress

SUMMARY: Based on these data, air quality was acceptable on ISS for this period and potable water remains acceptable for crew consumption.

AIR QUALITY

Six archive air samples were scheduled to be collected in mini grab sample containers (mGSCs) on ISS during Increment 55 and were returned on SpX-14 and SpX-15. Upon receipt in the laboratory, it was determined that the sample pressures in two of the returned mGSCs were below the expected range. Low sample pressures tend to be indicative of incomplete/non-representative sample collection. The affected samples were the nominal US Lab (LAB) sample collected in May and the first ingress sample collected in the OA-9 vehicle. No analyses were performed on these two samples. Sample pressures in the other four mGSCs indicate that representative samples were collected during SpX-14 ingress and routine sampling in April (LAB and Russian Service Module (SM)) and May (Japanese Pressurized Module (JPM)). Two pairs of passive-diffusion formaldehyde badges were deployed in the LAB and SM on 2/27/18, 4/11/18, and 5/23/18 and were returned on SpX-15 and Soyuz 53.

Table 1. Analytical summary of ISS air analyses

Return Flight	Sample Location	Sample Date	Freon 218 (mg/m^3)	Alcohols[a] (mg/m^3)	T-Value[b] (units)	Formaldehyde ($\mu g/m^3$)[d]
SpX-15	LAB	2/27/2018	---	---	---	32
SpX-15	SM	2/27/2018	---	---	---	26
SpX-14	SpX-14 Ingress	4/5/2018	263	9.3	0.4 (0.2)	---
SpX-14/ Soyuz 53	LAB	4/11/2018	273	9.8	0.3	36
SpX-14/ Soyuz 53	SM	4/11/2018	245	8.9	0.3	29
Soyuz 53	LAB	5/23/2018	---	---	---	36
Soyuz 53	SM	5/23/2018	---	---	---	23
SpX-15	JPM	5/25/2018	200	17	0.3	---
Guideline			---	*<5*	*<1*[c]	*<120*

[a]Includes acetone
[b]Sum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO_2; parentheses indicate value based on 7-day SMACs and applicable to first ingress
[c]T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
[d]Average from pair of formaldehyde badges

Data tables containing measured concentrations and corresponding T-values based on appropriate Spacecraft Maximum Allowable Concentrations (SMACs) for compounds present at levels above the laboratory reporting limit are attached to this report. Complete data tables, which include compounds assessed but not detected, are available upon request. The mean relative recoveries of the three surrogate

standards in the mGSC samples and the positive formaldehyde laboratory control were all within acceptable limits.

The Air Quality Monitors (AQMs) automatically collect samples every 73 hours, which results in 2-3 sampling sessions per unit per week. Monthly average concentrations as well as the increment average concentrations for compounds measured on the AQMs are presented in Table 2.

Table 2. Average monthly concentrations (mg/m^3) of AQM target compounds

Compound	March Average	April Average	May Average	Increment Average
2-Propanol	0.2	0.1	0.2	0.2
Acetone	0.2	0.3	0.3	0.3
Acrolein	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND
Decamethylcyclopentasiloxane#	0.2	0.2	0.2	0.2
Hexanal	ND	ND	ND	ND
Hexane	ND	ND	ND	ND
m,p-Xylenes#	ND	ND	ND	ND
Methanol	0.2	0.2	0.3	0.2
o-Xylene#	TRACE	TRACE	TRACE	TRACE
Octamethylcylcotetrasiloxane#	TRACE	TRACE	TRACE	TRACE
Toluene#	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND
Acetaldehyde	0.3	0.3	0.4	0.3
Dichloromethane	ND	ND	ND	ND
Ethanol	5.3	4.0	2.0	3.7
Ethyl Acetate	0.1	0.1	TRACE	0.1
Hexamethycyclotrisiloxane#	0.1	0.1	0.04	0.1
n-Butanol	0.1	0.1	0.04	0.1
Trimethylsilanol	0.1	0.1	0.1	0.1

Obtained from prime unit
ND: Not detected; <MDL (Minimum Detection Limit)
TRACE= >MDL, <MQL (Minimum Quantification Limit)
Note: Increment 55 included 2 days in February and 3 days in June.

Toxicological Evaluation of ISS Air Quality

Routine air quality monitoring is performed in-flight using the AQMs. Archive air samples (mGSCs and formaldehyde badges) are collected during each increment and returned for analysis in the Toxicology and Environmental Chemistry (TEC) Air Quality Laboratory. Data from the ground analyses complement the in-flight data and provide a more complete understanding of air quality on the ISS. The routine archive samples for this increment that returned on SpX-14 confirmed air quality was acceptable during Increment 55. **All measured values for routine samples (mGSC and AQM) met 180-d T-value guideline criteria (T < 1), indicating no concern for crew health.** The average rounded T-value calculated from the Increment 55 mGSC samples was 0.3 (Figure 1). T-values calculated from mGSC results and AQM (Figure 2) were in reasonable agreement given the differences between the analytical techniques and the number of target compounds used in the calculation.

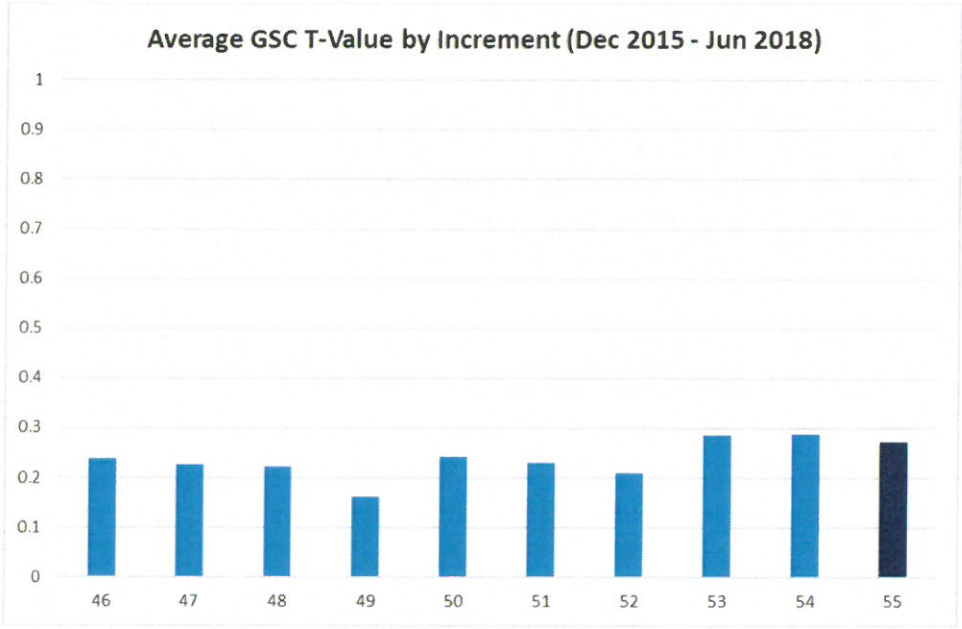

Figure 1. mGSC-Derived T-values for Increments 46- 55

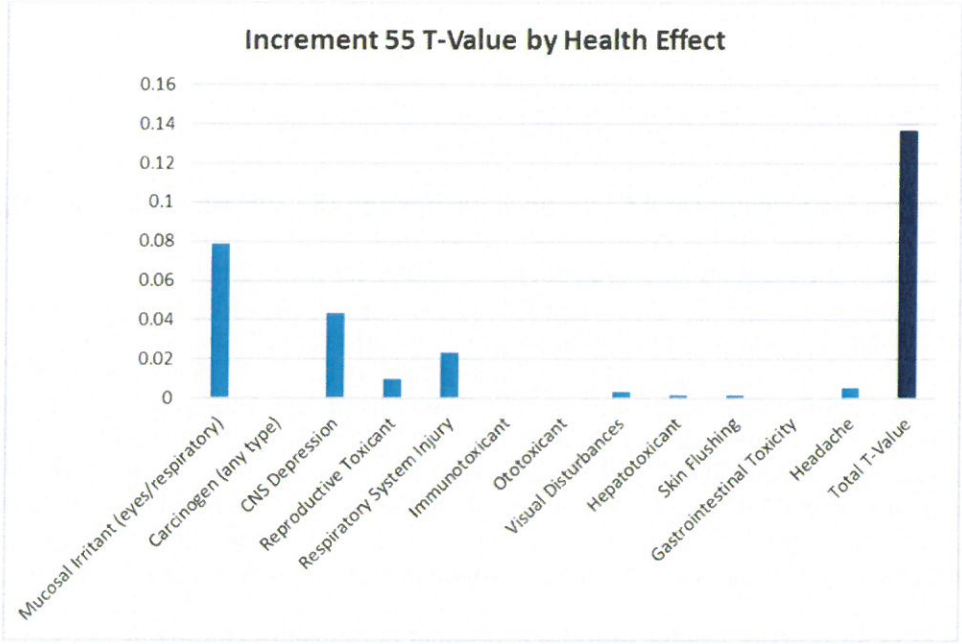

Figure 2. AQM-Derived T-Values by Health Effect for Increment 55

Generally, the reported concentrations for the compounds detected during Increment 55 are similar to levels detected during recent increments. Atmospheric concentrations of siloxanes (i.e., TMS, OMCTS, and HMCTS) were similar to those observed during Increment 54.

Two of the nominal mGSC samples contained a CO_2 concentration below the increment limit documented in Chit 14468, which requests that the 24 hour average concentration not exceed 3.0 mmHg (7100 mg/m^3) on the US segment. One sample, collected on April 11, 2018 in the Russian Service Module, was slightly above this limit (7400 mg/m^3). While mGSC CO_2 sampling provides a snap-shot of the CO_2 concentration, the major constituent analyzer (MCA) routinely monitors CO_2 levels in the US segment. For this reason, data from the MCA are better suited for evaluation of short and long-term trends in CO_2. Concentrations measured by the MCA fluctuate as a function of multiple factors including the number of crew on ISS, current scrubbing capability, and processes and activities that generate CO_2.

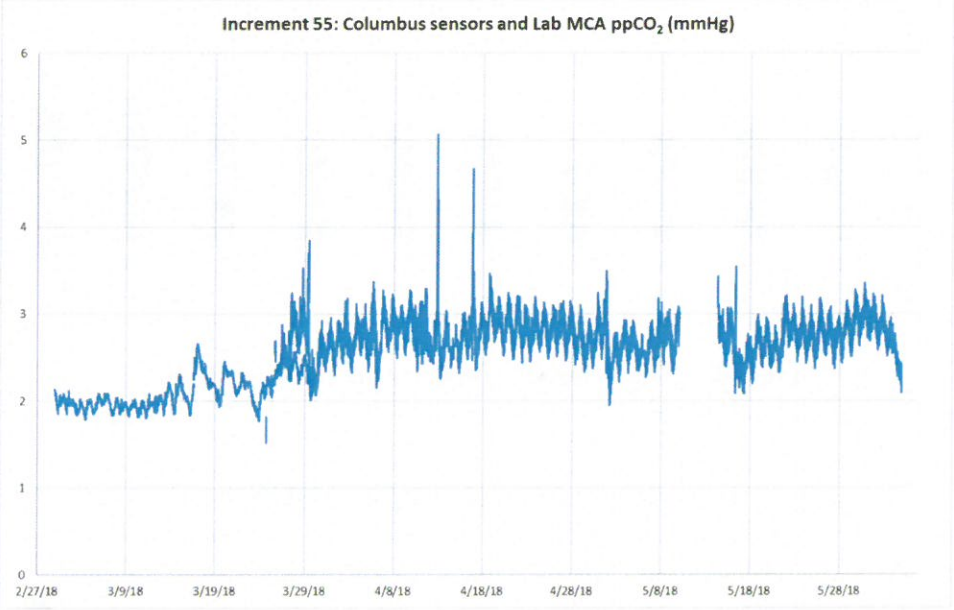

Figure 3. Environmental CO_2 Concentrations on ISS Increment 55 in mmHg

Overall, CO_2 concentrations were well controlled throughout the increment. Data for the month of March were obtained from sensors in Columbus, as neither the LAB nor Node 3 MCAs were functional. The LAB MCA began functioning within specification accuracy on March 27th, and all data for the rest of the increment was obtained from that instrument, including support for the EVA on March 29th. There were 3 crew on ISS from February 27th until the arrival of 54S on March 23rd. During six-crew ops, the CO_2 level rose by approximately 1 mmHg and hovered under 3 mmHg for most of the rest of the mission. MetOx regeneration activities conducted on April 12th and April 16th coincide with two notable but brief increases in CO_2. The LAB Carbon Dioxide Removal Assembly (CDRA) experienced a hardware fault and stopped functioning for approximately an hour on April 30th, which also led to some fluctuation. No data are available between May 10th and May 14th due to a communication loss with the LAB MCA.

Alcohol values in all routine archive samples continued to exceed the guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. These levels are primarily due to ethanol in the ISS atmosphere. Ethanol levels observed in mGSC samples during Increment 55 were markedly higher (7.6-11 mg/m^3) than those observed during Increment 54. The total alcohols reported in the sole mGSC sample from May were 17 mg/m^3. It is possible that the higher concentrations of alcohols in the JPM observed in the May 25th sampling event represent an isolated event given that the average concentrations of ethanol, methanol, and acetone on AQM decreased from May 2018 to June 2018. However, the notable increase in total alcohols in mGSC samples from mid-April to late May warrants continued monitoring of the trend.

Octafluoropropane (Freon 218) levels continued to decrease (200-273 mg/m^3) following the release during Increment 53 on 10/25 (peak concentration 865 mg/m^3). This concentration is more than two orders of magnitude below the 180-d SMAC value (85,000 mg/m^3) and does not constitute a toxicological risk.

Formaldehyde levels in the US LAB (shown in Table 1 and Figure 4) are generally consistent with historic levels and remain well below the 180-day SMAC of 120 μg/m^3. Another set deployed on January 2 also remains on ISS.

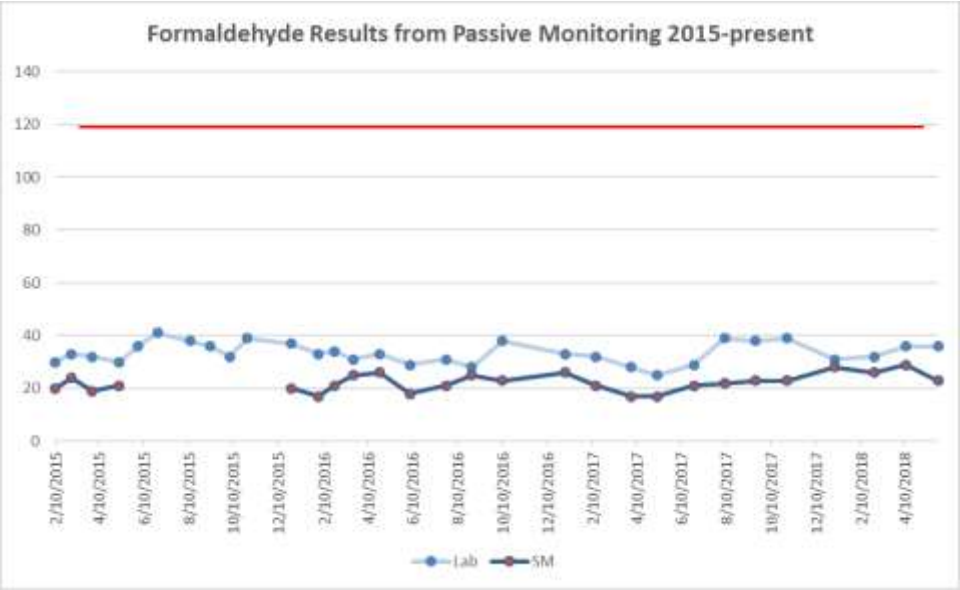

Figure 4. Trends in Formaldehyde from Passive Sampling of US LAB and Russian Service Module 2015 - Present.

SpX-14 Ingress

A mGSC sample was collected upon ingress into SpX-14 on 4/5/2018, approximately eleven minutes after hatch opening. No background concentration of Freon 218 (octafluoropropane), a marker for ISS air dilution of first entry samples, was available near the time of first ingress sampling for comparison. However, the concentration of Freon 218 in the ingress sample was 263 mg/m^3, which is consistent with the level detected in the LAB on April 11th, 2018 (273 mg/m^3). Additionally, the concentration of total non-methane hydrocarbons in the ingress sample was 273 mg/m^3 was in close agreement with the samples from the LAB and SM collected on 4/11/2018 (284 and 255 mg/m^3, respectively). Therefore, we expect that nearly complete dilution occurred prior to sample collection, and the sample does not represent trace contaminant contributions from the visiting vehicle. This precludes verification of the low projected t-value from baselined Dragon-1 pre-flight off-gas testing.

OA-9 Ingress

Crew attempted to collect a mGSC sample during OA-9 ingress on May 24th, approximately 9 minutes after hatch opening. However, as noted above, the sample pressure measured in the mGSC (0.6 psia) was similar to the expected pressure resulting from preflight dosing of the mGSC with surrogate compounds. Due to the low sample pressure analysis was not possible, and no data are reported for this sample. As with the SpX-14 ingress sample, this invalid sample does not allow us to verify preflight off-gas predictions.

WATER QUALITY

Eight archive water samples were collected from the US segment during Increment 55 and returned on SpX-14 and Soyuz 53. The sample set included four samples of multifiltration (MF) bed effluent as well as samples of WPA wastewater, US condensate, hot water from the US Potable Water Dispenser (PWD), and ambient water from the PWD. Complete data tables with results for all measured parameters can be found in reports 2018-TEC-WQ-004 and 2018-TEC-WQ-005. A summary of select analytical results from the Increment 55 samples is provided in Table 3. Expanded summary tables containing organic carbon recoveries and results for all analytes present at concentrations above reporting limits are included as attachments to this report.

Table 3. Analytical Summary of ISS Water Analyses

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpX-14	WPA Wastewater ORU	4/6/2018	73.6	25	0.14	192	NA
SpX-14	WPA Condensate Sample Port	4/11/2018	150	34	0.20	280	NA
SpX-14	MF Bed Effluent	4/23/2018	50.1	18	0.17	20	NA
SpX-14	MF Bed Effluent	4/23/2018	57.2	NA	NA	31	NA
SpX-14	MF Bed Effluent	4/23/2018	35.5	19	0.12	2	NA
SpX-14	MF Bed Effluent	4/23/2018	35.1	NA	NA	2	NA
53S	WPA PWD Hot[a]	4/10/2018	1.60	4.2	0.13	2	<0.05
53S	WPA PWD Ambient[a]	5/15/2018	1.59	4.8	0.12	2	<0.05

NA: not analyzed

[a]Samples representing crew consumption/exposure

Toxicological Evaluation of ISS Water Quality: Routine water quality monitoring is performed in-flight using the total organic carbon analyzer (TOCA). Results from these analyses provide a general indication of overall water quality. Archive water samples are collected during each increment and returned for comprehensive analysis in ground laboratories. Data from the ground analyses complement the in-flight data and provide a more complete understanding of water quality on the ISS.

Potable Water

Concentrations of all chemicals detected in the potable water samples met the requirements listed in SSP 41000, *System Specification for the International Space Station* and JSC 63414, Spacecraft Water Exposure Guidelines (SWEGs). Total organic carbon (TOC) concentrations from in-flight (PWD TOC and WPA TOC) and ground analyses (Archive TOC) performed between June 2016 and June 2018 are shown in Figure 5. The TOC concentration was elevated in both potable samples (Ambient: 1.59 mg/L.; Hot: 1.60 mg/L) but measured concentrations were well below both the U.S. Segment Specification (3000 µg/L) and the 100-day SWEG (5000 µg/L). DMSD was the primary compound responsible for the TOC in both potable samples. While not a crew health risk, the increased levels of methyl sulfone in both samples could indicate that the WPA is not removing this compound efficiently. Additionally, the TOCA continued to under-report TOC results compared to the archival samples even though the TOCA calibration checks meet their accuracy requirement of +/- 25%. Monitoring these water quality parameters should continue to assess whether maintenance or corrective action is needed.

The source of the TOC in the potable samples was primarily DMSD (>4 mg/L in both samples). Methyl sulfone, another minor contributor to the TOC, was detected in hot and ambient water samples at levels similar to Increment 53 (0.1-0.15 mg/L) and lower than observed in Increment 54 (0.31 mg/L), but still higher than the historical average for both ports (0.06-0.08 mg/L). Although the concentration of this

compound has been trending upward over the past several increments, levels are still well below the SWEG of 1,500 mg/L. Silicon levels in the potable samples were similar to Increment 54 (1.4-1.5 mg/L). Levels of nickel (7 µg/L in both samples) were similar to the previous Increment, and barium (<2 µg/L) decreased.

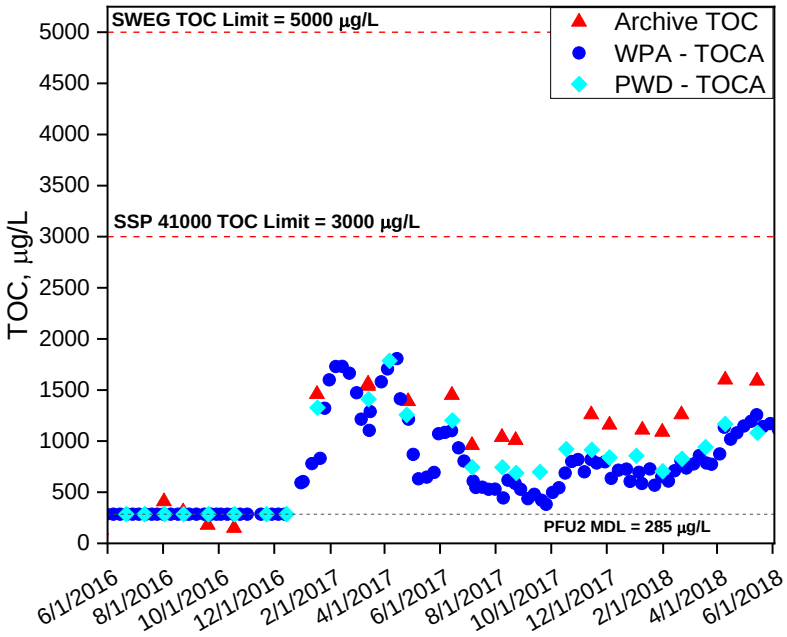

Figure 5. Total Organic Carbon (TOC) trending in US Potable Water

Iodine is a biocide used on the US segment. It is added to the water produced by the WPA, but removed prior to crew consumption to avoid potential thyroid dysfunction. The total iodine level in the samples collected from the PWD were below the reporting limit (0.05 mg/L), indicating effective removal of iodine in water intended for consumption. For additional information regarding microbial analyses, please see the Increment 55 post-flight report issued by the JSC Environmental Microbiology Laboratory.

Condensate

The condensate sample collected on 4/11/2018 contained a TOC level of 150 mg/L, which is below the historical average (162 mg/L). These results are consistent with AQM results indicating that ISS air quality was well managed for the increment. Non-metal compounds detected at levels greater than 1 mg/L included DMSD (34 mg/L), ammonium (39 mg/L), silicon (14.6 mg/L), benzoic acid (1.6 mg/L), benzyl alcohol (13.1 mg/L), 2-(2-Butoxyethoxy)ethanol (1.6 mg/L), 2-Phenoxyethanol (3.6 mg/L), acetone (2.85 mg/L), ethanol (84.4 mg/L), methanol (7.06 mg/L), lactate (23.7 mg/L), propylene glycol (10.2 mg/L), and acetate (41.2 mg/L). Zinc (7.52 mg/L), nickel (0.22 mg/L), and traces of other metals were also present in this non-potable sample. All of these compounds were effectively removed by the water recovery system, as evidenced by the low or undetectable levels in the potable samples.

Wastewater

The wastewater sample collected on April 6, 2018 contained a TOC level of 73.6 mg/L, which was markedly higher than recent wastewater samples and the historical average of 44.6 mg/L. Ethanol was detected at 54.6 mg/L, the highest measured in wastewater. The DMSD concentration was 25 mg/L, and acetone was present at (7.01 mg/L). Other non-metal compounds detected at levels greater than 1 mg/L included ammonium (27.8 mg/L) and silicon (10.1 mg/L). Metals detected above 0.1 mg/L in the samples

were zinc (1.9 mg/L) and nickel (0.20 mg/L). Traces of other aluminum, boron, chromium, manganese, and silver were also present.

MF Bed Samples

MF bed samples were collected to determine what compounds are responsible for the elevated conductivity readings downstream of the MF beds and to determine whether smaller compounds (e.g., bicarbonate, acetate) are displacing DMSD from the MF beds. Results from analysis of previous MF bed samples suggested that CO_2 diffusion through the Teflon sample bags was affecting the carbonate and bicarbonate concentrations in the samples. In an effort to characterize the potential for diffusion of CO_2, two sample aliquots were collected from each MF bed. One of the aliquots was collected in a standard Teflon bag while the second was collected in a smaller Teflon bag that was sealed in a Mylar pouch. Analysis of the aliquots returned in the Mylar pouches seems to confirm that some gas diffusion is occurring in the Teflon bags, and that carbonate, bicarbonate, and carboxylate species (i.e., acetate, propionate, butyrate) are being affected. Microbial catabolism may also be playing a role in the loss of the carboxylate species. Additional testing is underway to explore the potential mechanisms responsible for loss for carboxylate species.

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Concurrence by Valerie Ryder, Ph.D., DABT
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Enclosures

Table 1A: Analytical concentrations of compounds quantified in the mGSC returned on SpaceX-14

Table 1B: Analytical concentrations of compounds quantified in mGSCs returned on SpaceX-15

Table 2A: T-values corresponding to concentrations for the SpX-14 Ingress sample in Table 1A, based on 7-day and 180-day SMACs

Table 2B: T-values corresponding to concentrations in Table 1A, based on 180-day SMACs

Table 2C: T-values corresponding to concentrations in Table 1B, based on 180-day SMACs

Table 3: Analytical concentrations of compounds quantified in condensate, wastewater, and MF effluent samples returned on SpX-14

Table 4: Analytical concentrations of compounds quantified in PWD hot and ambient samples returned on Soyuz 53

TABLE 1A
ANALYTICAL RESULTS OF SPACEX-14 RETURN

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)		
	AQ180135 SN2085 SpaceX-14 Ingress 04/05/18 @ 08:27 GMT	**AQ180136 SN2111 LAB 04/11/18 @ 16:20 GMT**	**AQ180137 SN2112 SM 04/11/18 @ 16:25 GMT**
TARGET COMPOUNDS (TO-15) **			
1,1,1,2-Tetrafluoroethane (Norflurane)	<0.050	0.051	0.059
Methanol	0.62	0.61	0.65
Acetaldehyde	0.46	0.48	0.45
Ethanol *	**7.7**	**8.4**	**7.6**
Acetone	0.45	0.36	0.33
2-Propanol (Isopropanol)	0.37	0.24	0.24
Isoprene (2-Methyl-1,3-butadiene)	0.048	0.041	0.045
1-Propanol	0.035	0.14	0.055
Trimethylsilanol	0.13	0.11	0.093
2-Butanone (Methyl ethyl ketone)	<0.025	TRACE	<0.025
Ethyl acetate	0.055	0.056	0.053
1-Butanol	0.077	0.12	0.085
o-Xylene	TRACE	TRACE	TRACE
Decamethylcyclopentasiloxane	0.51	0.33	0.27
Octafluoropropane (Perfluoropropane) *	**263**	**273**	**245**
SPECIAL INTEREST COMPOUNDS ***			
Hexamethylcyclotrisiloxane #	0.23	<0.20	<0.20
NON-TARGET COMPOUNDS			
All Non-Target Compounds were below their reportng limit.			
TOTAL ALCOHOLS PLUS ACETONE	**9.3**	**9.8**	**8.9**
TARGET COMPOUNDS (GC) **			
Methane	10	15	16
Carbon dioxide	6400	6400	7400
Hydrogen	3.7	3.7	3.7
Carbon monoxide	1.4	0.85	0.79
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**273**	**284**	**255**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**11**	**11**	**9.9**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

*** Quantified using "B" response factor except where noted; concentrations are estimates only.

Response factor generated from an internal study

< : Value is less than the laboratory reporting limit.

TRACE: Amount detected is sufficient for compound identification only. One-half of the reporting limit was used in the Total Concentratic summation.

OFP - Octafluoropropane

TABLE 1B
ANALYTICAL RESULTS OF SPACEX-15 RETURN

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M3) AQ180281 SN2015 JPM 5/25/18 @ 14:57 GMT
TARGET COMPOUNDS (TO-15) **	
1,1,1,2-Tetrafluoroethane (Norflurane)	0.053
Methanol *	**4.3**
Acetaldehyde	0.47
Ethanol *****	**11**
Acetone	0.36
2-Propanol (Isopropanol)	0.43
Isoprene (2-Methyl-1,3-butadiene)	0.044
1-Propanol	0.043
Trimethylsilanol	0.16
2-Butanone (Methyl ethyl ketone)	TRACE
Ethyl acetate	TRACE
1-Butanol	0.086
Decamethylcyclopentasiloxane	0.35
Octafluoropropane (Perfluoropropane) *	**200**
SPECIAL INTEREST COMPOUNDS	
All Special Interest compounds were below their reporting limit.	
NON-TARGET COMPOUNDS	
All Non-Target compounds were below their reporting limit.	
TOTAL ALCOHOLS PLUS ACETONE	**17**
TARGET COMPOUNDS (GC) **	
Methane	25
Carbon dioxide	6600
Hydrogen	2.8
Carbon monoxide	0.56
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**218**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**18**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

< : Value is less than the laboratory reporting limit.

TRACE: Amount detected is sufficient for compound identification only.

One-half of the reporting limit was used in the Total Concentration summation.

OFP - Octafluoropropane

TABLE 2A
T-VALUES FOR SPACEX-14 INGRESS

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AQ180135 SN2085 SpaceX-14 Ingress 04/05/18 @ 08:27 GMT	**AQ180135 SN2085 SpaceX-14 Ingress 04/05/18 @ 08:27 GMT**
TARGET COMPOUNDS (TO-15)		
Methanol	0.00691	0.00691
Acetaldehyde	0.11400	0.11400
Ethanol	0.00386	0.00386
Acetone	0.00858	0.00858
2-Propanol (Isopropanol)	0.00246	0.00246
Isoprene (2-Methyl-1,3-butadiene)	0.00804	0.01608
1-Propanol	0.00036	0.00036
Trimethylsilanol	0.03268	0.03268
Ethyl acetate	0.00031	0.00031
1-Butanol	0.00097	0.00193
o-Xylene	0.00034	0.00068
Decamethylcyclopentasiloxane	0.00510	0.03400
Octafluoropropane (Perfluoropropane)	0.00309	0.00309
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane	0.00261	0.02609
NON-TARGET COMPOUNDS		
All Non-Target compounds were below their reporting limit.		
TARGET COMPOUNDS (GC)		
Methane	0.00294	0.00294
Hydrogen	0.01084	0.01084
Carbon monoxide	0.02224	0.08244
TOTAL T-VALUE	**0.22532**	**0.34723**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2B
T-VALUES FOR SPACEX-14 RETURN

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ180136 SN2111 LAB 04/11/18 @ 16:20 GMT	**AQ180137 SN2112 SM 04/11/18 @ 16:25 GMT**
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.00026	0.00030
Methanol	0.00680	0.00728
Acetaldehyde	0.11980	0.11133
Ethanol	0.00418	0.00379
Acetone	0.00687	0.00630
2-Propanol (Isopropanol)	0.00161	0.00158
Isoprene (2-Methyl-1,3-butadiene)	0.01362	0.01486
1-Propanol	0.00141	0.00056
Trimethylsilanol	0.02804	0.02328
2-Butanone (Methyl ethyl ketone)	0.00042	ND
Ethyl acetate	0.00031	0.00029
1-Butanol	0.00305	0.00211
o-Xylene	0.00068	0.00068
Decamethylcyclopentasiloxane	0.02181	0.01831
Octafluoropropane (Perfluoropropane)	0.00321	0.00288
SPECIAL INTEREST COMPOUNDS		
All Special Interest compounds were below their reporting limit.		
NON-TARGET COMPOUNDS		
All Non-Target compounds were below their reporting limit.		
TARGET COMPOUNDS (GC)		
Methane	0.00437	0.00460
Hydrogen	0.01074	0.01092
Carbon monoxide	0.05026	0.04622
TOTAL T-VALUE	**0.27744**	**0.25529**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2C
T-VALUES FOR SPACEX-15 RETURN

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC) AQ180281 SN2015 JPM 5/25/18 @ 14:57 GMT
TARGET COMPOUNDS (TO-15)	
1,1,1,2-Tetrafluoroethane (Norflurane)	0.00001
Methanol	0.04798
Acetaldehyde	0.11852
Ethanol	0.00565
Acetone	0.00701
2-Propanol (Isopropanol)	0.00289
Isoprene (2-Methyl-1,3-butadiene)	0.01455
1-Propanol	0.00058
Trimethylsilanol	0.04042
2-Butanone (Methyl ethyl ketone)	0.00042
Ethyl acetate	0.00007
1-Butanol	0.00215
Decamethylcyclopentasiloxane	0.02320
Octafluoropropane (Perfluoropropane)	0.00236
SPECIAL INTEREST COMPOUNDS	
All Special Interest compounds were below their reporting limit.	
NON-TARGET COMPOUNDS	
All Non-Target compounds were below their reporting limit.	
TARGET COMPOUNDS (GC)	
Methane	0.00712
Hydrogen	0.00814
Carbon monoxide	0.03306
TOTAL T-VALUE	**0.31411**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

Table 3: Analytical Concentrations of Compounds Quantified in Condensate, Wastewater and MF Effluent Samples Returned on SpaceX-14

Increment					55					
Mission					SpaceX-14					
Sample Location			Potable Water		WPA MF Bed #1 ORU S/N 00016	WPA MF Bed #1 ORU S/N 00016	WPA MF Bed #2 ORU S/N 00017	WPA MF Bed #2 ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	MF Bed Effluent	MF Bed Effluent	MF Bed Effluent	MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date					4/23/2018	4/23/2018	4/23/2018	4/23/2018	4/6/2018	4/11/2018
Analysis/Sample ID	Units				WQ180287	WQ180288	WQ180289	WQ180290	WQ180293	WQ180294
Physical Characteristics										
Conductivity	µS/cm	U.S.			20	31	2	2	192	280
pH	pH units	U.S.	4.5-8.5	41000	4.24	4.06	5.47	5.47	7.54	7.55
Anions IC										
Bromide	mg/L	U.S.			< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1
Fluoride	mg/L	U.S.			< 0.1	< 0.1	< 0.1	< 0.1	0.4	0.2
Cations IC										
Ammonium (as N)	mg/L	U.S.	1	SWEG& 41000	<0.25	< 0.25	< 0.25	< 0.25	27.8	39.0
Minerals ICPMS										
Calcium	mg/L	U.S.	30	41000	0.04	NA	0.04	NA	0.07	0.08
Potassium	mg/L	U.S.	340	41000	0.03	NA	< 0.02	NA	0.05	< 0.02
Sodium	mg/L	U.S.			0.03	NA	< 0.02	NA	0.04	< 0.02
Trace Metals ICPMS										
Aluminum	µg/L	U.S.			2	NA	< 2	NA	4	9
Boron	µg/L	U.S.			36	NA	33	NA	63	76
Chromium	µg/L	U.S.	230	41000	5	NA	2	NA	14	4
Copper	µg/L	U.S.	1,000	41000	< 2	NA	< 2	NA	< 2	2
Manganese	µg/L	U.S.	300	SWEG& 41000	< 2	NA	< 2	NA	5	11
Nickel	µg/L	U.S.	300	SWEG& 41000	39	NA	85	NA	198	221
Silver	µg/L	U.S.	400	SWEG& 41000	< 2	NA	< 2	NA	2	5
Zinc	µg/L	U.S.	2,000	SWEG& 41000	13	NA	14	NA	1,900	7,520
Silicon ICPMS										
Silicon	µg/L	U.S.			5,910	NA	6,050	NA	10,100	14,600
Total Organic Carbon-Sievers & Total Organic Carbon-OI										
Total Inorganic Carbon (TIC)	mg/L	U.S.			2.51	3.23	0.70	0.63	19.2	18.6
Total Organic Carbon (TOC)	mg/L	U.S.		SWEG / 41000	50.1	57.2	35.5	35.1	73.6	150
Volatile Organics-Targets										
2-Butanone (Methyl ethyl ketone)	µg/L	U.S.	54,000	SWEG	578	630	< 50	50	227	< 50
Volatile Organics-Special Interest Compounds (Semi-quantitative)										
Acetaldehyde	µg/L	U.S.			not found	not found	770	not found	not found	not found
Trimethylsilanol	µg/L	U.S.			not found	60.0	not found	not found	240	310
Volatile Organics-Non-Targets (estimated conc.)										
Dimethyl sulfide	µg/L	U.S.			92	110	not found	35	not found	not found
Semi-volatile Organics-Targets										
Benzothiazole	µg/L	U.S.			< 40	NA	< 40	NA	92	98
Decamethylcyclopentasiloxane (DMCPS)	µg/L	U.S.			< 40	NA	< 40	NA	107	80
Dodecamethylcyclohexasiloxane	µg/L	U.S.			< 40	NA	< 40	NA	79	67
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	172	NA	118	NA	143	199
N-n-Butylbenzenesulfonamide	µg/L	U.S.			< 40	NA	< 40	NA	101	108

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether

Table 3: Analytical Concentrations of Compounds Quantified in Condensate, Wastewater and MF Effluent Samples Returned on SpaceX-14

Increment					55					
Mission					SpaceX-14					
Sample Location			Potable Water		WPA MF Bed #1 ORU S/N 00016	WPA MF Bed #1 ORU S/N 00016	WPA MF Bed #2 ORU S/N 00017	WPA MF Bed #2 ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	MF Bed Effluent	MF Bed Effluent	MF Bed Effluent	MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date					4/23/2018	4/23/2018	4/23/2018	4/23/2018	4/6/2018	4/11/2018
Analysis/Sample ID	Units				WQ180287	WQ180288	WQ180289	WQ180290	WQ180293	WQ180294
Tris(2-Chloroethyl)phosphate	µg/L	U.S.			< 40	NA	< 40	NA	134	129
Acid Extractables-EPA 625 List GCMS										
4-Methylphenol (p-Cresol)	µg/L	U.S.			< 40	NA	< 40	NA	60	43
Benzoic acid	µg/L	U.S.			< 200	NA	< 200	NA	340	1,610
Phenol	µg/L	U.S.	4,000	SWEG	< 40	NA	< 40	NA	535	478
Base and Neutral Extractables-EPA 625 List GCMS										
Benzyl alcohol	µg/L	U.S.			< 40	NA	< 40	NA	5,970	13,100
Di-n-butylphthalate	µg/L	U.S.	40,000	SWEG	< 40	NA	< 40	NA	166	242
Diethylphthalate	µg/L	U.S.			< 40	NA	< 40	NA	771	958
Semi-volatile Organics-Special Interest Compounds (Semi-quantitative)										
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.			not found	NA	not found	NA	59	73
1-Methyl-2-pyrrolidinone	µg/L	U.S.			not found	NA	not found	NA	390	570
2-(2-Butoxyethoxy)ethanol	µg/L	U.S.			not found	NA	not found	NA	760	1,600
2-Butoxyethanol	µg/L	U.S.			not found	NA	not found	NA	200	280
2-Ethoxyethanol	µg/L	U.S.			230	NA	370	NA	440	530
2-Ethyl-1-hexanol	µg/L	U.S.			not found	NA	not found	NA	240	300
2-Ethylhexanoic acid	µg/L	U.S.			not found	NA	not found	NA	not found	240
2-Phenoxyethanol	µg/L	U.S.			not found	NA	not found	NA	1,600	3,600
2-Phenyl-2-propanol	µg/L	U.S.			not found	NA	not found	NA	190	220
Acetophenone	µg/L	U.S.			not found	NA	not found	NA	26	29
Benzaldehyde	µg/L	U.S.			not found	NA	not found	NA	94	130
Butylated hydroxyanisole (BHA)	µg/L	U.S.			not found	NA	not found	NA	280	330
Diethylene glycol monoethyl ether	µg/L	U.S.			not found	NA	not found	NA	160	210
Dipropylene glycol methyl ether	µg/L	U.S.			not found	NA	not found	NA	370	540
Hexanoic acid (Caprolate)	µg/L	U.S.			not found	NA	not found	NA	not found	810
Monomethyl phthalate	µg/L	U.S.			not found	NA	not found	NA	130	130
N,N-Diethylformamide	µg/L	U.S.			not found	NA	not found	NA	54	62
N,N-Dimethyl acetamide	µg/L	U.S.			490	NA	not found	NA	500	620
N,N-Dimethylformamide	µg/L	U.S.			370	NA	390	NA	570	680
Neomenthol	µg/L	U.S.			not found	NA	not found	NA	79	80
Phenethyl alcohol	µg/L	U.S.			not found	NA	not found	NA	not found	49
Tetramethyl thiourea	µg/L	U.S.			not found	NA	not found	NA	29	30
Tributyl phosphate	µg/L	U.S.			not found	NA	not found	NA	57	61
Alcohols & Acetone GCMS										
1-Butanol	µg/L	U.S.			< 400	< 400	< 400	< 400	< 400	716
1-Propanol	µg/L	U.S.			761	599	578	434	< 400	< 400
2-Pentanol (sec-Amyl alcohol)	µg/L	U.S.			< 400	< 400	< 400	< 400	< 400	532
2-Propanol (Isopropanol)	µg/L	U.S.			4,530	4,010	3,920	2,800	< 400	846
Acetone	µg/L	U.S.	15000	SWEG	5,550	6,610	6,160	8,010	7,010	2,850

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether

Table 3: Analytical Concentrations of Compounds Quantified in Condensate, Wastewater and MF Effluent Samples Returned on SpaceX-14

Increment					55					
Mission					SpaceX-14					
Sample Location			Potable Water		WPA MF Bed #1 ORU S/N 00016	WPA MF Bed #1 ORU S/N 00016	WPA MF Bed #2 ORU S/N 00017	WPA MF Bed #2 ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	MF Bed Effluent	MF Bed Effluent	MF Bed Effluent	MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date					4/23/2018	4/23/2018	4/23/2018	4/23/2018	4/6/2018	4/11/2018
Analysis/Sample ID	Units				WQ180287	WQ180288	WQ180289	WQ180290	WQ180293	WQ180294
Ethanol	µg/L	U.S.			50,700	55,900	42,900	43,700	54,600	84,400
Methanol	µg/L	U.S.	40,000	SWEG	4,730	5,490	3,710	3,820	6,210	7,060
Glycols GCMS										
1,2-Propanediol (Propylene glycol)	µg/L	U.S.	1,700,000	SWEG	2,050	NA	< 1000	NA	3,880	10,200
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)										
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	18,000	NA	19,000	NA	25,000	34,000
Carboxylates IC										
Acetate	µg/L	U.S.			1,970	10,200	< 500	< 500	< 500	41,200
Butyrate	µg/L	U.S.			< 500	968	< 500	< 500	< 500	< 500
Lactate	µg/L	U.S.			< 500	< 500	< 500	< 500	< 500	23,700
Propionate	µg/L	U.S.			< 500	4,030	< 500	< 500	< 500	< 500
Aldehydes GCMS										
Formaldehyde	µg/L	U.S.	12,000	SWEG	< 10	NA	< 10	NA	< 10	119
Non-volatile Organics LC										
Caprolactam	µg/L	U.S.	100,000	SWEG	< 500	NA	< 500	NA	1,060	1,880
Organic Carbon Recovery	percent	U.S.			84.48	N/A	101.59	N/A	74.04	73.90
Unaccounted Organic Carbon	mg/L	U.S.			7.78	N/A	0.00	N/A	19.11	39.14

Comments: WQ180288 & WQ180290: Samples were collected in ITCS sample bags and contained in Mylar pouches.

Data Qualifiers: WQ180287 & 288: Acetate possible low bias.
WQ180287 to 294: Fluoride possible low bias (MS Rec. 65%).
WQ180288: Acetone possible bias high (MS Rec.139%)

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether

Table 4: Analytical Concentrations of Compounds Quantified in PWD Hot and Ambient Samples Returned on Soyuz 53

Increment					55	
Mission					Soyuz 53	
Sample Location			Potable Water		WPA PWD Hot	WPA PWD Ambient
Sample Description		Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Potable Water	Potable Water
Sample Date					4/10/2018	5/15/2018
Analysis/Sample ID	Units				WQ180386	WQ180387
Physical Characteristics						
Conductivity	µS/cm	U.S.			2	2
pH	pH units	U.S.	4.5-8.5	41000	6.55	6.28
Minerals ICPMS						
Calcium	mg/L	U.S.	30	41000	0.03	0.02
Potassium	mg/L	U.S.	340	41000	0.01	< 0.01
Trace Metals ICPMS						
Nickel	µg/L	U.S.	300	SWEG& 41000	7	7
Zinc	µg/L	U.S.	2,000	SWEG& 41000	2	2
Silicon ICPMS						
Silicon	µg/L	U.S.			1,350	1,500
Total Organic Carbon-Sievers & Total Organic Carbon-OI						
Total Inorganic Carbon (TIC)	mg/L	U.S.			1.02	1.05
Total Organic Carbon (TOC)	mg/L	U.S.		SWEG / 41000	1.60	1.59
Semi-volatile Organics-Targets						
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	130	122
Base and Neutral Extractables-EPA 625 List GCMS						
Diethylphthalate	µg/L	U.S.			20	< 20
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)						
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	4,200	4,800
Carboxylates IC						
Organic Carbon Recovery	percent	U.S.			71.25	80.57
Unaccounted Organic Carbon	mg/L	U.S.			0.46	0.31

Comments: None

Data Qualifiers: WQ1800386: Diethylphthalate - Possible high bias- 2/3 surrogates biased high.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether