APPENDIX F

Chemistry Data Quality Assurance Review of the StormGarden Monitoring Project

Herrera Environmental Consultants, Inc.

Internal Memorandum

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From: Gina Catarra

Subject: Chemistry Data Quality Assurance Review of the Rotondo Water Quality Monitoring Data

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This memorandum presents a review of data quality for 71 water samples (including 5 field duplicate samples and 4 rinsate blank samples) collected for the StormGarden Modular Stormwater Bio-Filtration Performance Certification Project between April 14, 2017, and November 22, 2018. Analytical Resources, Inc. (ARI), of Tukwila, Washington analyzed the samples for:

- Total phosphorus (TP) by Standard Method 4500-P B
- Orthophosphorus (OP) by Standard Method 4500-P E
- Hardness by calculation by Standard Method 2340B and EPA method 6010C
- Total and dissolved metals (copper and zinc) by EPA method 200.8
- Total petroleum hydrocarbons (TPH) by Ecology's NWTPH-Dx method
- TSS by Standard Method 2540D (11/22/18 samples).

In addition, Environmental Technical Services (ETS), of Petaluma, California analyzed the samples for:

- Particle size distribution (PSD) by ASTM D3977 C
- TSS by ASTM D3977 C.

Results for the following samples were validated.

Sample ID	Lab SDG	Date Collected	Analyses
WB-In[a]	17D0242	4/14/17	TSS,TP, OP, total and dissolved metals
WB-Out[a]	17D0242	4/14/17	TSS,TP, OP, total and dissolved metals
Biopod-In	17D0437	4/27/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
Biopod-Out	17D0437	4/27/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Side	17E0144	5/10/17	TSS, TP, OP, hardness, total and dissolved metals, TPH
WB-In	17E0198	5/11/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17E0198	5/11/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out Dup[b]	17E0198	5/11/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17E0158	5/11/17	TPH
WB-Out	17E0158	5/11/17	TPH
SG-In	17E0234	5/16/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
SG-Out	17E0234	5/16/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Side	17E0292	5/19/17	TSS, TP, OP, hardness, total and dissolved metals, TPH
WB-In	17F0104	6/08/17	TPH
WB-Out	17F0104	6/08/17	TPH
WB-In	17F0166	6/09/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17F0166	6/09/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In (QA)[b]	17F0166	6/09/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17F0274	6/15/17	TPH
WB-Out	17F0274	6/15/17	TPH
WB-In[a]	17J0269	10/16/17	TSS,TP, OP, total and dissolved metals
WB-Out[a]	17J0269	10/16/17	TSS,TP, OP, total and dissolved metals
WB-In	17K0045	11/02/17	TPH
WB-Out	17K0045	11/02/17	TPH
WB-In	17K0067	11/03/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17K0067	11/03/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
IN[b]	17K0067	11/03/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17K0091	11/06/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17K0091	11/06/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In Dup[b]	17K0091	11/06/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17K0174	11/10/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17K0174	11/10/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In Dup[b]	17K0174	11/10/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17K0195	11/13/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17K0195	11/13/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17K0391	11/20/17	TSS, TP, OP, hardness, total and dissolved metals
WB-Out	17K0391	11/20/17	TSS, TP, OP, hardness, total and dissolved metals
WB-In	17K0456	11/22/17	TPH
WB-Out	17K0456	11/22/17	TPH
WB-In QA[b]	17K0456	11/22/17	TPH
WB-In	17K0463	11/22/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17K0463	11/22/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17K0674	11/30/17	TPH

Sample ID	Lab SDG	Date Collected	Analyses
WB-Out	17K0674	11/30/17	TPH
WB-In	17L0009	12/1/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17L0009	12/1/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17L0041	12/4/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17L0041	12/4/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	17L0482	12/29/17	TPH
WB-Out	17L0482	12/29/17	TPH
WB-In	17L0477	12/29/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	17L0477	12/29/17	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18A0074	1/05/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18A0074	1/05/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18A0110	1/09/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18A0110	1/09/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18A0267	1/17/18	TPH
WB-Out	18A0267	1/17/18	TPH
WB-In	18A0265	1/18/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18A0265	1/18/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18A0364	1/24/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18A0364	1/24/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18A0435	1/27/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18A0435	1/27/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18B0037	2/01/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18B0037	2/01/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18B0057	2/03/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18B0057	2/03/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18B0196	2/14/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-Out	18B0196	2/14/18	TSS, PSD, TP, OP, hardness, total and dissolved metals
WB-In	18K0311	11/22/18	TSS, TP, OP, hardness, total and dissolved metals
WB-Out	18K0311	11/22/18	TSS, TP, OP, hardness, total and dissolved metals

[a] Rinsate blank sample

[b] Field duplicate sample

The laboratory's performance was reviewed in accordance with quality control (QC) criteria established in the *StormBarden Modular Stormwater Bio-Filtration System Performance Certification Project Quality Assurance Project Plan* (QAPP) (Herrera 2016), by the laboratory, and in the specified methods.

Quality control data summaries submitted by the laboratories were reviewed; raw data were not submitted by the laboratories. Data qualifiers (flags) were added to the sample results in the laboratory reports. Data validation results are summarized below, followed by definitions of data qualifiers.

Custody, Preservation, Holding Times, and Completeness—Acceptable with Qualification

The samples were properly preserved, and sample custody was maintained from sample collection to receipt at the laboratories, with the exception noted below for temperature exceedance. With the exceptions noted below, samples were analyzed within the required method holding times. The laboratory reports were complete and contained results for all samples and tests requested on the chain-of-custody (COC) forms.

The temperature exceeded the less than 6 degrees Celsius criterion for TPH samples collected on 11/2/17. Samples were received at 12.1 degrees Celsius and were qualified as estimated (flagged J) due to sample temperature exceedance, as shown in the table below.

Date Collected	Parameter	Sample IDs	Reason for Qualification	Data Flag
11/02/17	TPH	WB-In, WB-Out	Temperature Exceedance	J

The holding time (7 days) was exceeded for all PSD analyses, and all TSS analyses with the exception of samples collected on May 10 and 19, 2017, and November 22, 2018. The filtration holding time (less than 12 hours) was exceeded for several OP and dissolved metals analyses. Samples were qualified as estimated (flagged J) due to the holding time exceedances, as shown in the table below.

Date Collected	Parameters	Sample IDs	Reason for Qualification	Data Flag
4/27/17	TSS, PSD	Biopod-In, Biopod-Out	Holding Time Exceedance	J
5/12/17	TSS, PSD, OP, dissolved metals	WB-In, WB-Out, WB-Out(QA)	Holding Time Exceedance	J
5/16/17	TSS, PSD, OP, dissolved metals	Storm garden-In, Storm garden-Out	Holding Time Exceedance	J
6/09/17	TSS, PSD	WB-In, WB-Out, WB-In(QA)	Holding Time Exceedance	J
11/03/17	TSS, PSD, OP, dissolved metals	WB-In, WB-Out, IN (QA)	Holding Time Exceedance	J
11/06/17	TSS, PSD	WB-In, WB-Out, WB-In Dup	Holding Time Exceedance	J
11/10/17	TSS, PSD, dissolved metals	WB-In, WB-Out, WB-In Dup	Holding Time Exceedance	J
11/13/17	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
11/20/17	TSS, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
11/22/17	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
12/01/17	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
12/04/17	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J

Date Collected	Parameters	Sample IDs	Reason for Qualification	Data Flag
12/29/17	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
1/05/18	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
1/09/18	TSS, PSD, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
1/18/18	TSS, PSD	WB-In, WB-Out	Holding Time Exceedance	J
1/24/18	TSS, PSD, OP, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
1/27/18	TSS, PSD, OP, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
2/01/18	TSS, PSD, OP, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
2/03/18	TSS, PSD, OP, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
2/14/18	TSS, PSD, OP, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J
11/22/18	OP, dissolved metals	WB-In, WB-Out	Holding Time Exceedance	J

Laboratory Reporting Limits—Acceptable

The laboratory reporting limits met those established in the QAPP. No data were qualified based on laboratory reporting limits.

Method Blank Analysis—Acceptable

Method blanks were analyzed at the required frequency. Method blanks did not contain levels of target analytes above the laboratory reporting limits.

Rinsate Blank Analysis—Acceptable with Discussion

Rinsate blanks were analyzed at the required frequency. Rinsate blanks did not contain levels of target analytes above two times the laboratory reporting limits, with the exceptions noted below.

The rinsate blank samples collected on 10/16/17, had reported results for total copper in samples WB-In (1.64 µg/L) and WB-Out (1.27 µg/L), and for dissolved copper in sample WB-In (1.15 µg/L) that were greater than two times the RL (0.5 µg/L). However, no data were qualified because all associated sample results were greater than five times the rinsate blank results.

Laboratory Control Sample Analysis—Acceptable with Qualification

Blank spike (BS) samples were analyzed for total phosphorus, orthophosphorus, hardness, total and dissolved metals, and TPH. The percent recovery values met the criteria (80 to 120 percent for hardness and metals, 75 to 125 percent for TP and OP, and 60 to 120 percent for TPH) established in the QAPP.

The BS percent recoveries for dissolved zinc (140 and 128 percent) for sample batch 18A0110 exceeded the 80 to 120 percent criteria. Associated samples WB-In and WB-Out collected on 1/09/18 were qualified as estimated (flagged J), as shown in the table below.

Date Collected	Parameter	Sample ID	Reason for Qualification	Data Flag
1/09/18	Dissolved zinc	WB-In	BS percent recovery exceedance	J
1/09/18	Dissolved zinc	WB-Out	BS percent recovery exceedance	J

Matrix Spike Analysis—Acceptable with Qualification

Matrix spike samples were analyzed for total phosphorus, orthophosphorus, hardness, and dissolved metals. The percent recovery values (ranging from 95 to 109 percent) met the control limits (75 to 125 percent) established in the QAPP, with the exception noted below.

The MS percent recovery for total phosphorus (68 percent) for sample WB-In collected on 11/03/17, exceeded the 75 to 125 percent criteria. Sample WB-In was qualified as estimated (flagged J), as shown in the table below.

Date Collected	Parameter	Sample ID	Reason for Qualification	Data Flag
11/03/17	TP	WB-In	MS percent recovery exceedance	J

Laboratory Duplicate Analysis—Acceptable

Laboratory duplicate samples were analyzed for TSS, total phosphorus, orthophosphorus, hardness, and dissolved metals. The relative percent difference (RPD) values (ranging from 0 to 10 percent) met the control limits (less than 25 percent for TSS, and less than 20 percent for all other parameters) established in the QAPP.

Field Duplicate Analysis—Acceptable

Field duplicates were analyzed for all parameters at a frequency of 8.3 percent (5 field duplicate analyzed in total), which did not meet the 10 percent frequency specified in the QAPP. The RPD values (ranging from 0 to 15 percent) met the control limits (less than 25 percent for TSS, less than 30 percent for TPH, and less than 20 percent for all other parameters) established in the QAPP.

Definition of Data Qualifiers

The following data qualifier definitions are taken from the QAPP (Herrera 2016).

Data Qualifier	Definition
J	Value is an estimate based on analytical results
R	Value is rejected based on analytical results
U	Value is below the reporting limit
UJ	Value is below the reporting limit and is an estimate based on analytical results

References

Herrera. 2016. StormGarden Modular Stormwater Bio-Filtration System Performance Certification Project Quality Assurance Project Plan. Prepared for Rotondo Environmental Solutions, LLC, Alexandria, Virginia by Herrera Environmental Consultants in Seattle, Washington. March.