DEPARTMENT OF
ECOLOGY
State of Washington

Quality Assurance Project Plan

North Fork Palouse River
Fecal Coliform Bacteria
Data Evaluation

April 2015

Publication No. 15-03-108

Publication Information

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives.

This Quality Assurance Project Plan is available on Ecology's website at https://fortress.wa.gov/ecy/publications/SummaryPages/1503108.html

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Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search Study ID G0800097.

Ecology's Activity Tracker Code for this study is 14-004.

TMDL Study Code (Water Quality Program) is NPAR34FC.

Federal Clean Water Act 1996 303(d) Listings Addressed in this Study

See "Study area" and "Impairments addressed by this TMDL" sections.

Quality Assurance Project Plan

North Fork Palouse River Fecal Coliform Bacteria Data Evaluation

April 2015

Approved by:

Signature:	Date: April 2015
Elaine Snouwaert, Client, Water Quality Program, ERO	
Signature:	Date: April 2015
David Knight, Client's Unit Supervisor, Water Quality Program, ERO	
Signature:	Date: April 2015
James Bellatty, Client's Section Manager, Water Quality Program, ERO	
Signature:	Date: April 2015
James Ross, Author / Project Manager, EAP, ERO	
Signature:	Date: April 2015
Tom Mackie, Author's Section Manager, EAP	
Signature:	Date: April 2015
Bill Kammin, Ecology Quality Assurance Officer	

Signatures are not available on the Internet version.
ERO: Eastern Regional Office
EAP: Environmental Assessment Program
EIM: Environmental Information Management database

1.0 Title Page and Table of Contents

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2.0 Abstract

The North Fork Palouse River had been placed on Washington State's 303(d) list of impaired water bodies for not meeting the water quality standards for fecal coliform (FC) bacteria. A Total Maximum Daily Load study was completed in 2004 and approved by the Environmental Protection Agency in March of 2005. The associated Water Quality Implementation Plan was completed in 2006. Samples were collected by the Palouse Conservation District from May of 2008 through November of 2011. The Washington State Department of Ecology (Ecology) Water Quality Program has asked the Environmental Assessment Program (EAP) to evaluate data from these samples and from EAP's ambient station at Palouse to determine, if possible, the degree of improvement in water quality in the North Fork Palouse River.

Data collected by the Palouse Conservation District and Ecology will be evaluated for completeness, outliers, normality, and seasonality and then analyzed to determine concentration and loading of FC bacteria. The results will be compared with data collected during the development of the TMDL. Trend Analysis will be conducted, using a t-test or rank-sum test to compare FC bacteria concentrations found in the 2001-2003 study period with those found in the 2009-2011 study period. A technical memo will be delivered to the watershed lead.

3.0 Background

3.1 Study area and surroundings

The Palouse River basin drains over 3200 square miles in Washington and Idaho and discharges into the Snake River about ten miles southwest of the town of Hooper, WA. The segment of the Palouse River in Washington above the confluence of the South Fork Palouse River in Colfax is locally referred to as the North Fork Palouse River (NFPR). From the Idaho border, the NFPR drains about 127 square miles of primarily (96%) agricultural land. Major tributaries of NFPR are Duffield, Cedar, Silver and Clear Creeks. Figure 1, below, illustrates the study area and sampling locations being evaluated for this project.

3.1.1 Logistical problems

The existing data set is incomplete, especially flow data, so our ability to compare loading between data sets will be limited

3.1.2 History of study area

The NFPR had been placed on Washington State's 303(d) list of impaired water bodies for not meeting the water quality standards for fecal coliform (FC) bacteria. In 2000, the Palouse Conservation District (PCD) formed the North Fork Palouse River Watershed Committee and Technical Advisory Group. These groups met regularly and developed the North Fork Palouse River Water Quality Improvement Report (RPU, 2002). Resulting from this effort, a Total Maximum Daily Load study was completed in 2004 (Ahmed, 2004) and approved by the Environmental Protection Agency in March 2005. The associated Water Quality Implementation Plan was completed in 2006 (Snouwaert, 2006).

In 2008, the PCD received grant funding for implementation and monitoring activities on the NFPR. Data were collected from May 2008 through November 2011. Ecology's Water Quality Program would like to assess the data to determine, if possible, the degree of improvement in water quality in NFPR. During the 2012 project scoping process, the Water Quality Program proposed that Ecology's Environmental Assessment Program (EAP) work up the data from PCD and data from EAP's ambient monitoring program collected at Palouse and that EAP prepare a technical memo with their findings. This Quality Assurance Project Plan (QAPP) describes the process EAP will use to fulfill the project request.

3.1.3 Parameters of interest

The parameter of interest for this study is FC bacteria. In Washington State, water quality standards use FC as indicator bacteria for the state's freshwaters, e.g., lakes and streams. FC in water indicates the presence of waste from humans and/or other warm-blooded animals. Waste from warm-blooded animals is more likely to contain pathogens that will cause illness in humans than waste from cold-blooded animals. The FC criteria are set at levels that have been shown to maintain low rates of serious intestinal illness (gastroenteritis) in people.

3.1.4 Results of previous studies

Appendix A contains data used to develop the original TMDL. Appendix B contains the recently collected data to be evaluated, including data collected by Ecology at their long-term monitoring station at Palouse (34A170).

3.1.5 Regulatory criteria or standards

The water quality standards rule, WAC 173-201A, designates the NFPR as having a primary contact recreational use. The FC standard is a geometric mean of 100 cfu/100 mL and not more than 10% of the samples greater than 200 cfu/100 mL (90% of samples $\leq$ 200 cfu/100 mL).

Table 1 details load reductions from the TMDL that apply to targeted reaches of interest for this project.

Table 1. Target load reductions.

Location	Capacity (cfu/day)	Target reduction (%)	Water Quality standard basis for reduction	Critical period
NFPR11 Palouse River @ Stateline	No reduction required (based on limited data set)			
34A170 Palouse R @ Palouse	6×10^{10}	80	90% standard	August
NFPR12 Duffield Creek @ Mouth	No reduction required (based on limited data set)			
NFPR3 Cedar Creek @ Mouth	1.9×10^{10}	72	90% standard	June-Sept
NFPR5 Silver Creek above Garfield	3.7×10^{11}	54	90% standard	Mar-Jun
NFPR6 Silver Creek below Garfield	1.9×10^{11}	79	90% standard	Mar-Jun
NFPR9 Clear Creek @ Mouth	7×10^{9}	92	90% standard	July-Oct
NFPR8 Palouse River @ Glenwood Rd Bridge	6.8×10^{12}	47	90% standard	Dec-Mar

Table 2. Sampling locations for 2008-2011 NFPR FC study.

Location ID	Location Description	Latitude	Longitude
34A170	Palouse R @ Palouse (Ecology)	46.9091	-117.0768
34PAL112.4	Palouse R off Altergott Rd d/s of Palouse	46.94714	-117.145
NFPR11	Palouse R @ Stateline	46.91227	-117.04
NFPR12	Duffield Ck @ mouth	46.93067	-117.09
NFPR5	Silver Creek upstream of Garfield	47.00912	-117.121
NFPR5A	Silver Creek SE of Garfield	47.00358	-117.134
NFPR6	Silver Creek downstream of Garfield	47.00138	-117.188
NFPR6B	Silver Creek in Garfield	47.00567	-117.144
NFPR8	On NFPR at Glenwood Road bridge	46.93017	-117.286
NFPR8A	Palouse R 1/2 mile upstream of Clear Creek	46.92848	-117.279
NFPR9	Clear Creek near mouth	46.92772	-117.282
NFPR9A	Clear Creek upstream 1/4 mile from mouth	46.92448	-117.279
NFPR9B	Clear Creek at Hwy 272 and Glenwood Rd	46.91444	-117.273

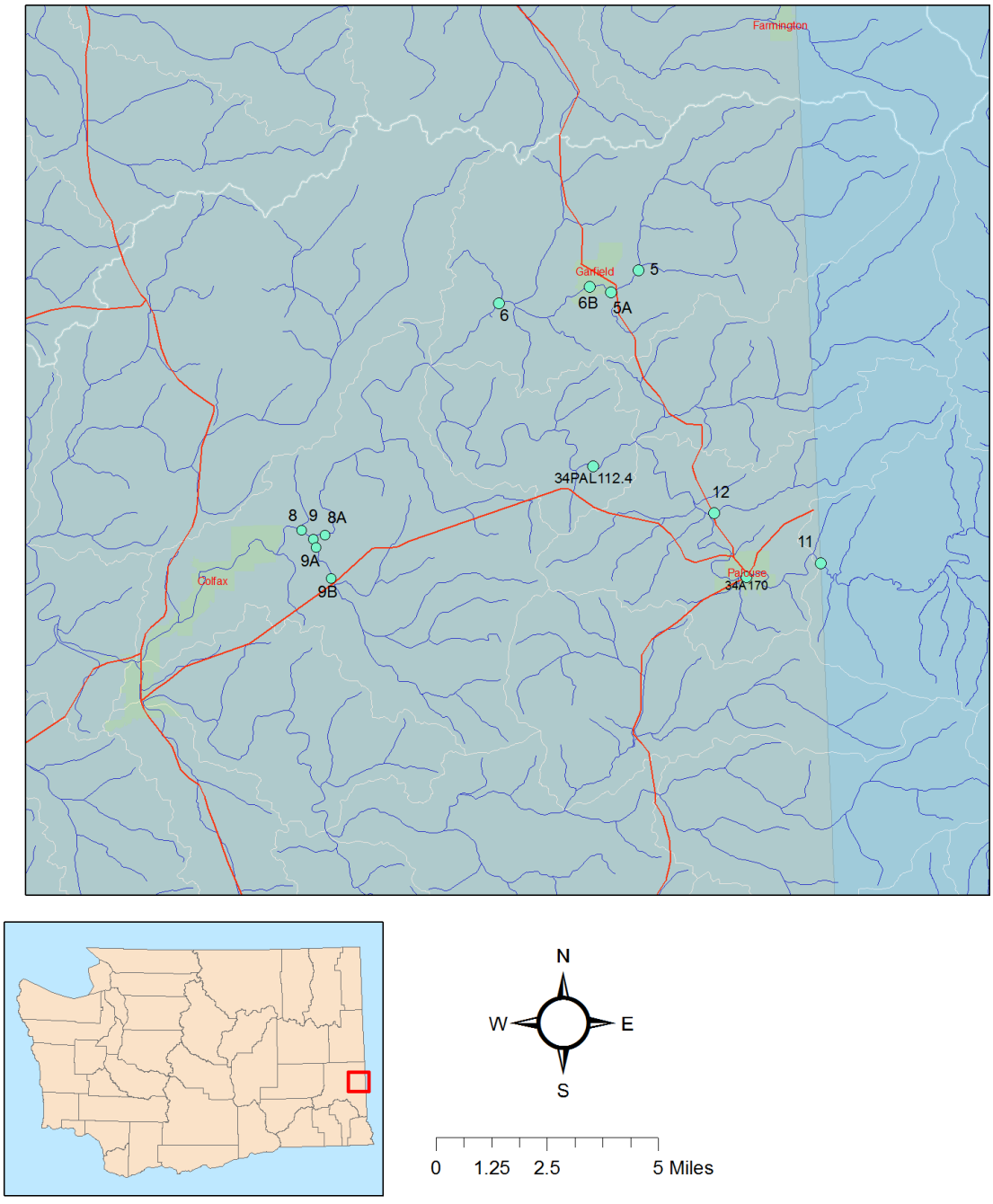

Figure 1. NF Palouse River study area.

4.0 Project Description

4.1 Project goals

The goal of this project is to evaluate previously collected data to determine if there has been any change in FC concentration or loads in the NFPR watershed between the initial evaluation in 2001-2003 and the latest effort in 2008-2011.

4.2 Project objectives

Data collected by the PCD will be evaluated for completeness and then analyzed to determine concentration and loading of FC bacteria. The results will be compared with data collected during the development of the TMDL. EAP will deliver a technical memo to the watershed lead.

4.3 Information needed and sources

All data to be used for this project are residing in Ecology's EIM database and summarized in Appendices A and B.

4.4 Target population

The target population is the FC bacteria present in the NFPR during sampling events conducted by the PCD and Ecology in 2008-2011.

4.5 Study boundaries

The study boundaries include the Palouse River watershed from the Idaho state line to the town of Colfax. In particular, Silver Creek, Clear Creek, and Duffield Creek drainages are the areas where the majority of samples were collected.

Water Resource Inventory Area (WRIA) and 8-digit Hydrologic Unit Code (HUC) numbers for the study area:

WRIA 34

HUC numbers

- HUC 8 Palouse 17060108
- HUC 12 Gnat Cr-Palouse R 170601080301
- HUC 12 Duffield Cr-Palouse R 170601080302
- HUC 12 Eden Valley-Palouse R 170601080304
- HUC 12 Silver Cr 170601080305
- HUC 12 Clear Cr-Palouse R 170601080306

4.6 Tasks required

The tasks necessary to complete this project are:

- Extract data from Ecology's EIM database
- Review PCD's QAPP
- Review NFPR FC TMDL
- Review NFPR FC Water Quality Improvement Plan
- Calculate load and geomean from PCD data
- Compare 2008-2011 loads and concentrations with 2001-2003
- Prepare a draft technical memo for Elaine Snouwaert
- Finalize and distribute memo

4.7 Practical constraints

The data analyzed by this project were collected and submitted to EIM following procedures established in the QAPP followed by PCD (Palouse Conservation District, 2008). We will rely on the qualifications made by PCD in their data collection to qualify or exclude analyzed data as appropriate.

4.8 Systematic planning process

Systematic planning for this project is described in this QAPP. The systematic planning for the EIM data that will be analyzed by this project was described in the PCD QAPP.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 3. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Elaine Snouwaert Water Quality Program ERO Phone: 509-329-3503	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Jim Ross Eastern Operations Section ERO Phone: 509-329-3425	Project Manager Principal Investigator	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Tom Mackie Eastern Operations Section Phone: 509-454-4244	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
ERO: Eastern Regional Office
QAPP: Quality Assurance Project Plan

5.2 Special training and certifications

Not applicable.

5.3 Organization chart

See Table 3, above.

5.4 Project schedule

Table 4. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Final technical memo	
Author lead / Support staff	Jim Ross
Schedule	
Draft due to supervisor	October 2015
Draft due to client/peer reviewer	November 2015
Final due	December 2015

5.5 Limitations on schedule

Not applicable.

5.6 Budget and funding

Not applicable.

6.0 Quality Objectives

6.1 Decision Quality Objectives (DQOs)

Not applicable.

6.2 Measurement Quality Objectives

Measurement Quality Objectives (MQOs) for the EIM data analyzed in this project were applied during data collection and compilation in the PCD QAPP.

The EIM data used in this analysis are assumed to have met MQOs set by the PCD QAPP.

6.2.1 Targets for Precision, Bias, and Sensitivity

See the PCD QAPP for these targets.

6.2.2 Targets for Comparability, Representativeness, and Completeness

See the PCD QAPP for these targets.

7.0 Sampling Process Design (Experimental Design)

7.1 Study Design

FC bacteria and flow are the parameters to be evaluated in this project.
All EIM data will be evaluated by sorting the 2001-2003 and 2009-2011 data by location and by parameter. The following activities will be conducted:

- FC Bacteria Geomean Concentrations and loads will be calculated
- Temporal trends in the data will be evaluated using either a t-test or a rank-sum test
- Box plots will be created for sites monitored during both 2001-2003 and 2009-2011 projects.

The data will be statistically evaluated to determine if there is a seasonal component to the data. If seasonality is present, then the data set will be adjusted before performing trend analysis.

An outlier is an extreme value that is not in the same distribution as the rest of the data. There are numerous reasons for outliers: an unnatural occurrence, inconsistent sampling, inconsistent analytical techniques, errors in transcription of data, or valid extreme measurements. Testing data for outliers is important to determine whether there is statistical evidence that an observation that appears to be extreme does not fit the distribution with the rest of the data.

The distribution for each data set will be identified. This information will determine whether data will be evaluated with a parametric or non-parametric test and whether the data needs to be transformed (normalized).

Trend Analysis will be conducted using either a t-test or a rank-sum test to compare FC concentrations from 2001-2003 with those from 2009-2011.

7.1.1 Field measurements

Field methods and measurements are described in the PCD QAPP.

7.1.2 Sampling location and frequency

See Table 2 and Figure 1 for sample site locations. Sample sites and frequency are described in detail in the PCD QAPP.

7.1.3 Parameters to be determined

We will analyze FC concentrations in the NFPR.

7.2 Maps or diagram

See section 3 above.

7.3 Assumptions underlying design

The EIM data collected by PCD are assumed to be representative of stream conditions at the time and location of collection.

The trend calculations and data transformations completed in this analysis are assumed to be representative of real world processes in the water body.

We assume PCD collected the EIM data correctly, according to their QAPP, and qualified any questionable data appropriately.

7.4 Relation to objectives and site characteristics

Initial review of existing data indicated a likelihood that missing flow data will make calculating the bacterial loading problematic. The lack of loading data will make comparison with historic loading difficult.

7.5 Characteristics of existing data

All data were collected under the guidance of an approved QAPP and deemed suitable for use before being entered into EIM. Missing data may impact our ability to make some evaluations, e.g., seasonality.

8.0 Sampling Procedures

8.1 Field measurement and field sampling SOPs

Not Applicable.

8.2 Containers, preservation methods, holding times

Not Applicable.

8.3 Invasive species evaluation

Not Applicable.

8.4 Equipment decontamination

Not Applicable.

8.5 Sample ID

Not Applicable.

8.6 Chain-of-custody, if required

Not Applicable.

8.7 Field log requirements

Not Applicable.

8.8 Other activities

Not Applicable.

9.0 Measurement Methods

9.1 Field procedures table/field analysis table

Not Applicable.

9.2 Lab procedures table.

Not Applicable.

9.3 Sample preparation method(s)

Not Applicable.

9.4 Special method requirements

Not Applicable.

9.5 Lab(s) accredited for method(s)

Not Applicable.

10.0 Quality Control (QC) Procedures

10.1 Table of field and lab QC required

Not Applicable.

10.2 Corrective action processes

Not Applicable.

11.0 Data Management Procedures

11.1 Data recording/reporting requirements

All EIM data will be evaluated by sorting the 2001-2003 and 2008-2011 data by location and by parameter. The following analysis will be conducted:

- The data set will be evaluated for normality.
- FC geometric mean concentrations and loads will be calculated.
- Temporal trends in the data will be evaluated using either a t-test or a rank-sum test.
- Box plots will be created for sites monitored during both 2001-2003 and 2008-2011 projects.

11.2 Laboratory data package requirements

Not Applicable. Data were already submitted to EIM.

11.3 Electronic transfer requirements

Not Applicable. Data were already submitted to EIM.

11.4 Acceptance criteria for existing data

We assume PCD completed data qualification on the EIM data according to their data collection QAPP.

11.5 EIM/STORET data upload procedures

Not Applicable. Data were already submitted to EIM.

12.0 Audits and Reports

12.1 Number, frequency, type, and schedule of audits

Not Applicable.

12.2 Responsible personnel

Not Applicable.

12.3 Frequency and distribution of report

A technical memo will present the results of this data evaluation. The memo will undergo a technical peer review by a designated Ecology employee with appropriate qualifications. An internal Water Quality Program review by the project client will provide an opportunity for comments and revision to the final memo.

12.4 Responsibility for reports

The final technical memo will be produced by Jim Ross or his designee. It is due by December 31, 2015.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

Not Applicable. This project is data review only. Field data verification is assumed to have been performed before data was accepted into EIM.

13.2 Lab data verification

Not Applicable. This project is data review only. Laboratory data verification is assumed to have been performed before data was accepted into EIM.

13.3 Validation requirements, if necessary

Not Applicable. This project is data review only.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining whether project objectives have been met

The project manager will thoroughly examine the data, using statistics and professional judgment, to determine if the PCD QAPP MQOs for completeness, representativeness, and comparability have been met. If the criteria have not been met, the project manager will decide how any qualified data will be used in the technical analysis.

14.2 Data analysis and presentation methods

The data set will be evaluated for normality. FC geomean concentrations and loads will be calculated where possible. Temporal trends in the data will be evaluated using either a t-test or a rank-sum test if possible. Finally, box plots will be created for sites monitored during both 2001-2003 and 2008-2011 projects.

FC data may be tested for trends, using a Seasonal Kendall trend test in SYSTAT® version 13. Any significant trends will be presented in a chart showing the direction of the trend and the associated data. A summary will be written, discussing the test statistics, significance, confidence intervals, and any assumptions. Summary statistics for all data will be generated using MS Excel®. These summary statistics will be presented in tables.

14.3 Treatment of non-detects

Any non-detects will be included in the study analysis. Non-detects will be treated as zero, or 1 (the detection limit) if log transformations are performed.

14.4 Sampling design evaluation

The project manager will decide whether the data package meets the MQOs, criteria for completeness, representativeness, and comparability. He will decide whether meaningful conclusions (with enough statistical power) can be drawn from the Seasonal Kendall and summary statistics. If so, the sampling design will be considered effective.

14.5 Documentation of assessment

In the technical report, the project manager will include a summary of the data quality assessment findings. This summary is usually included in the data quality section of reports. Documentation of assessment will occur in the final technical memo.

15.0 References

Ahmed, A. 2004. North Fork Palouse River Fecal Coliform Bacteria Total Maximum Daily Load Recommendations. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-022. https://fortress.wa.gov/ecy/publications/summarypages/0403022.html

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16.0 Figures

See Table of Contents for list of figures in the report.

17.0 Tables

See Table of Contents for list of tables in the report.

18.0 Appendices

See following pages.

Appendix A. 2001-2003 NFPR Data

	NFPR1		NFPR2		NFPR3		NFPR4		NFPR5		NFPR6	
	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow
Date	cfu/100 mL	CFS	cfu/100 mL	CFS	cfu/100 mL	CFS	cfu/100 mL	CFS	cfu/100 mL	CFS	cfu/100 mL	CFS
6/5/2001	133	309	64	98.9	296	0.8	106	63.6	790	1.3	590	0.9
6/25/2001	72	6	74	24.5	48	0.2	50	26.6	156	0.1	48	0.2
8/7/2001	152	178	44	7		0	11	4.2		0		0.1
8/29/2001	68	158	0	3		0	4/4	5.1		0	104	0.1
9/13/2001	48	146	40	2.7		0	44/60	6.6		0	0	0.1
9/25/2001	20	158	264	2.1		0	36	3.2		0	20	0
10/10/2001	36	158	64	2.2	28	0	0	5.7		0	20	0
10/29/2001	52	6	30/16	11.6	11/56	0	2/14	225.9	11/16	0	8/12	0.2
11/13/2001	0	199	8	11.1	8	0	0	21.9	8	0	0	0.1
11/28/2001	64	309	28	257	60	5	48	273	18	34	12	12.5
12/11/2001	32	292	36	151	12	6	14	248	14	34	16	19.8
1/15/2002	26/30		38		14		26		18		44	
1/30/2002	146		88		38		42				160	
2/11/2002	36	574	46	542	20	16	24/44	639	32	110	18	54.4
2/25/2002	90/26	1441	42	2001	8	22	50	1771	82	105	26	59.3
3/11/2002	568	775	392/360	1018	100	38	68	1117	220	257	120	148.5
3/25/2002	0/208	1369	200	1876	30	27	204	1683	20	144	40	80.2
5/29/2002	46	671	72	685	196/133	9	40	670	230	50	110	31.8
6/18/2002	0	345	0	211	0	0.9	0	81.3	0/0	0	0	2.1
7/8/2002	80	327	60	170	203/293	8	7	223	90	34	533	16.1
7/23/2002	100	199	246	20.7	20	0	19	21.5	50	27	270	5.7
8/7/2002	40	199	24	16			680	130	276	24	76/91	2.5
8/27/2002	60	199	84	10.8	24	0	47	14.9	73	21	13	5.7
9/10/2002	44/36	213	72	71	4	7	7	152	33	14	13	9
10/1/2002		364	33/13	10.3		0.1		10.3		0		12.5
10/16/2002	12	259	4	85	38/16	7	4	152	8	42	35	12.5
11/12/2002	32	292	66	116	28	9	32	223	36	46	22	19.8
11/25/2002	4	228	0	27.8	0	0.3	4	37.9	0/0	42	6	0.5
12/16/2002	346	346	474	281	56	9	166	176		58	90/154	12.5
1/7/2003	36	36	20	306	8/0	11	24	518	44	62	72	27.7
1/20/2003	12	309	12	190	4	11	0	248	8/0	54	12	23.7
2/4/2003	80	1005	44		30	22	14	1117	36	100	44	49.6
2/18/2003	32	748	28	762	18	20	11	800	20	105	40	49.6
3/10/2003	271	1131	160	1637	7	25	310	1349	45	110	255	59.3
3/24/2003	36	1441	20	2065	8	23	23	1771	220	110	144	59.3
4/7/2003	23	621	64	542	8	16	8	639	7	85	0	44.9
4/21/2003	97	484	152	387	8	13	28/33	461	10	71	8	36
5/14/2003	4	442	60	332	20	13	43	433	56	58	372	31.8
5/27/2003	72/100	422	40	306	40	13	60	405	36	50	88	27.7
6/9/2003	8	309	16/28	190	12	8	12	273	104	38	40	16.1
6/30/2003	116	228	62/35	29.7	120	0.1	12	7.7	140	0	140	0
7/16/2003	94	199	40	71	540	3	16/12	130	20	27	244	16.1
7/29/2003	116	158	32	4.9		0	20	6.6	232/264	21	260	0
8/12/2003	76	213	60	71		0	20	152	76	21	32	0
8/25/2003	28	185	32	1.8		0	28	2.4	15	24	92/60	0
9/9/2003	56/64	213	72	58	1296	8	120	152	16	14	320	16.1
9/29/2003	20	185	40/36	5.3	27	0.3	0	7.5	16	8	87	0.1

	NFPR7		NFPR8		NFPR9		NFPR10		NFPR11		34A170	
	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow
Date	cfu/ 100 mL	CFS	cfu/ 100 mL	CFS	cfu/ 100 mL	CFS	cfu/ 100 mL	CFS	cfu/ 100 mL	CFS	cfu/ 100 mL	CFS
6/5/2001	72	61.7	75	64.7	520	1.4	36/37				49	
6/25/2001	24	24.6	4/4	32.4	84	0.3	8				31	
8/7/2001	2	6.5	17	7	300	0.1	4				92	
8/29/2001	0	4.7	0	2.7	0	0.1						
9/13/2001	20	3.6	12	2.8	256	0.1	24					
9/25/2001	8/16	2.7	208	1.8	40	0	128					
10/10/2001	36/20	7.5	68	4.9	912	2.4	24				110	
10/29/2001	50/60	20.1	23/52	25.6	220/11770	0.4						
11/13/2001	8	15.6	4	16	40/160	0.4	16				12	
11/28/2001	28	208	14	83	20	0.3	14					
12/11/2001	8	208	18	167	140	2.4	12				57	
1/15/2002	24		18		0		10				82	
1/30/2002	58/60		40		40		40					
2/11/2002	54	847	26	780	16	16.5	32				23	
2/25/2002	24	2489	78	2619	36	16.5	50					
3/11/2002	100	2300	20	3728	360	29.7	120				240	
3/25/2002	170	2684	232	2494	70	29.7	168				23	
5/29/2002	20	908	13	780	120	4.6	0				32	
6/18/2002	0	97.5	0	227	0	2.8	0				22	
7/8/2002	70	1	107	119	1070	4.6	53				56	
7/23/2002	20	1	167	17.2	230	0.2	7/20					
8/7/2002	46	1	13	50	180	0.5	15				31	
8/27/2002	13	7.1	76	14.3	720	0.1	16		104			
9/10/2002	62	39	52		70	2.4	0		36		98	
10/1/2002		8.9		70		0.5						
10/16/2002	0	39	16	70	27	9.2	98				50	
11/12/2002	44	171	62	141	31	4.6	69		44		12	
11/25/2002	8	34.2	8	32.6	16	0.3	4		0			
12/16/2002	98	287	106	340	68		64		274		110	
1/7/2003		2489	52	340	76	4.6	24		32		88	
1/20/2003	3	171	16	195	44	4.6	8		4			
2/4/2003	23/13	1693	20	2026	36	21.6	68		124		100	
2/18/2003	10	1101	24/0	996	52	24.3	8		47			
3/10/2003	365	1693	3000	2026	320/325	24.3	2000		111		10	
3/24/2003	6	2684	16	2747	50	29.7	6/28		10			
4/7/2003	8	847	0	651	3	24.3	0		80		13	
4/21/2003	0	516	0	482	17	24.3	0		56			
5/14/2003	23	467	28	432	224	9.2	20		112/87		60	
5/27/2003	24	374	4	299	92	6.9	24		16			
6/9/2003	0	208	20	167	256	2.4	8		24		84	
6/30/2003	36	7.3	32	7	192	0.5	3		36			
7/16/2003	28	39	12	60	544	0.5	16		27		56	
7/29/2003	64	1.6	8	0.9		0	16/8		24			
8/12/2003	20/32	39	24/48	60		0	4		44		160	
8/25/2003	24	2.5	48	1.8		0	8		38/20			
9/9/2003	28	70	276	60	1600	0	4/80		52		1700	
9/29/2003	184	6.1	0	4.5	840	0.2	15		31			

Appendix B. 2008-2011 NFPR Data

	NFPR11		34PAL112.4		NFPR12		NFPR5		NFPR5A		NFPR6	
Date	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow
5/20/2008	38				100	0.19	88	1.46			68	1.95
6/9/2008	52				60	0.2	44	0.35			4	0.69
7/14/2008	24	29					112	-0.28			10	-0.01
8/11/2008	60	6.9					68	-0.07			12	
9/8/2008	12	2									8	
10/13/2008	16	2.4					8				36	
11/10/2008	12				12		12				8	
12/8/2008	0				0	0.13	37				4	-0.01
1/13/2009					104		20		72		73	
2/9/2009	4				8	0.54			4		20	8.37
3/10/2009	4				12	0.91			4		24	5.45
4/14/2009	96				76	0.5			36		12	3.21
5/12/2009	60				288	0.73			104	1.97	44	4.66
6/9/2009	36				140	0.69			100	0.69	44	0.62
7/21/2009	48	5.5							92		80	0.11
8/13/2009	52	4.1									124	
9/10/2009	76	2.7									4	
10/6/2009	60	3.4										
11/9/2009	4	5.3			8	0			16		12	0.06
12/14/2009	24				208						12	
1/11/2010	0	20			0	0.06			48	0.36	38	0.37
2/8/2010	0				0	0.16			4	0.29	4	0.63
3/9/2010	4				0	0.01			2	0.16	0	0.34
4/12/2010	10	36			4	0.06			12	0.1	20	0.24
5/11/2010	44	87			192	0.05			4	0.16	32	0.37
6/7/2010	68				22				268		24	
7/12/2010	40	9.9	48	10.18					201	-0.01	116	0.24
8/9/2010	104	2.3	108	2.06							36	
9/13/2010	48	2.6	23	3.12							4	
10/12/2010	100	14	52	7.4							284	
11/8/2010	4	27	8	24.73	8				96	0.04	52	0.31
12/13/2010	272	9.9	72		96	2.49			64		188	20.37
1/10/2011	4		1		12				32		12	
2/14/2011	0		0		8	3.48			0	7.16	64	12.26
5/9/2011	28		28		8				28		88	
6/9/2011	32		52		20	1.4			36	10.56	48	5.87
7/11/2011	51		32	39.24	36	0.03			200	0.2	102	0.33
8/8/2011	172	14	20	11.51	60				44		160	
9/12/2011	126	3.5	46	5.43	48						4	
10/10/2011	28	16	228	17.84	48						124	
11/14/2011	14	23	44	22.88	8	0.03			23	0.12	34	0.52

	NFPR6B		NFPR8		NFPR8A		NFPR9		NFPR9A		34A170	
Date	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow	FC	Flow
5/20/2008	316	-0.12	76		56		708	3.1	944	3.51	41	
6/9/2008	107	-1.27	124		88		260	1.05	180	1.2	27	
7/14/2008	153	-0.38	5	25.56	5	27.15	90	0.09	150	-0.08	63	
8/11/2008	44		32	2.11	0	1.03	10	0.06	0		170	
9/8/2008	47		72	2.32	4	2.29	100		100		210	
10/13/2008	69		28	3.9	127	3.42	362		976		43	
11/10/2008	267		56		72		180	0.16	44	0.16	31	
12/8/2008	52	0.12	4		12	22.64	128		80	0.21	56	
1/13/2009	44				72		48		32		210	
2/9/2009							12	2.24	20	2.23	4	
3/10/2009	24				8		16		28		44	
4/14/2009	12		60		48		76		40		83	
5/12/2009	168		12		24		88	1.22	140		200	
6/9/2009	124		38				212	0.63	204	0.83	57	
7/21/2009	140		24	6.67	8	7.03	238		328		67	
8/13/2009	500		52	4.73	24	5.41	300		292		150	
9/10/2009	64		98	0.92	88	0.92	184		244		54	
10/6/2009	32		84		52	6.78	184		104		40	
11/9/2009	172		16	29.18	4		14		5	0.16	9	
12/14/2009			8								31	
1/11/2010	8		13		0	24.19	4	0.91	20	0.87		
2/8/2010	4	0.12	0		0		24	0.71	20	0.86	3	
3/9/2010	4	0.03	4		0		212		184	0.11	2	
4/12/2010	64	-0.1	8	34.37	4	34.43	40	0.48	24	0.41	22	
5/11/2010	32	0.04	3		16	89.62	64	0.44		0.45	43	
6/7/2010	488		200		154		244				56	
7/12/2010	500		30	11.02	20	14.77	130	0	27		51	
8/9/2010	290		40	1.23	36	34.43	500		230		96	
9/13/2010	0		24	2.57	12	2.65	64		140		29	
10/12/2010	0				4	11.6	96	0.62	84		14	10
11/8/2010	76	0.13	12	33.34	0	27.69		0.52	32	0.74	28	44
12/13/2010	120		0		0		133				240	845
1/10/2011	16		10		0		12		12		100	2050
2/14/2011	8	5.36	0		0		44	4.7	24	4.35	60	373
											38	1500
											61	1300
5/9/2011	108		20		32		117		81		32	687
6/9/2011	20	4.04	8		4		484	4.74	184	3.9	33	80
7/11/2011		0.05	8				128	0.85	154	0.82	67	25
8/8/2011			68	8.55			208	-0.12	161	0.03	45	9.3
9/12/2011			68	3.4			200	0	380J			7.1
10/10/2011			48	16.88			115	0.32	53	0.23		15
11/14/2011			40	17.21			146	0.73	102	0.74	33	45

Appendix C. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Ambient: Background or away from point sources of contamination. Surrounding environmental condition.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Reach: A specific portion or segment of a stream.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

303(d) list: Section 303(d) of the federal Clean Water Act, requiring Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
e.g.	For example
EAP	Environmental Assessment Program
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
FC	Fecal coliform
i.e.	In other words
NFPR	North Fork Palouse River
PCD	Palouse Conservation District
QAPP	Quality Assurance Project Plan
TMDL	(See Glossary above)
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cfu	colony forming unit
mL	milliliter

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010)

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms precision and bias be used to convey the information associated with the term accuracy. (USGS, 1998)

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella. (Kammin, 2010)

Bias: The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system, and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI). (Kammin, 2010; Ecology, 2004)

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process. (USGS, 1998)

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured. (Ecology, 2004)

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards, but should be referred to by their actual designator, e.g., CRM, LCS. (Kammin, 2010; Ecology, 2004)

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator. (USEPA, 1997)

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator. (USEPA, 1997)

Continuing Calibration Verification Standard (CCV): A QC sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run. (Kammin, 2010)

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system. (Kammin, 2010; Ecology 2004)

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean. (Kammin, 2010)

Data Integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading. (Kammin, 2010)

Data Quality Indicators (DQI): Data Quality Indicators (DQIs) are commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity. (USEPA, 2006)

Data Quality Objectives (DQO): Data Quality Objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. (USEPA, 2006)

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010)

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment, and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability and integrity, as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).
- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier, data is usable for intended purposes.
- J (or a J variant), data is estimated, may be usable, may be biased high or low.
- REJ, data is rejected, cannot be used for intended purposes (Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set. (Ecology, 2004)

Detection limit (limit of detection)**:** The concentration or amount of an analyte that can be determined to a specified level of certainty to be greater than zero. (Ecology, 2004)

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis. (USEPA, 1997)

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport. (Ecology, 2004)

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples. (Kammin, 2010)

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples. (USEPA, 1997)

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects. (Ecology, 2004)

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness. (USEPA, 2006)

Measurement result: A value obtained by performing the procedure described in a method. (Ecology, 2004)

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed. (EPA, 1997)

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples. (Ecology, 2004; Kammin, 2010)

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of

an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero. (Federal Register, October 26, 1984)

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$\%RSD = (100 * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010)

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all "parameters." (Kammin, 2010; Ecology, 2004)

Population: The hypothetical set of all possible observations of the type being investigated. (Ecology, 2004)

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator. (USGS, 1998)

Quality Assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data. (Kammin, 2010)

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives. (Kammin, 2010; Ecology, 2004)

Quality Control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data. (Ecology, 2004)

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

$$[Abs(a-b)/((a + b)/2)] * 100$$

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled. (USGS, 1998)

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator. (USGS, 1998)

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population. (USGS, 1998)

Sample (statistical): A finite part or subset of a statistical population. (USEPA, 1997)

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit. (Ecology, 2004)

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method. (USEPA, 1997)

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency. (USEPA, 1997)

Split Sample: The term split sample denotes when a discrete sample is further subdivided into portions, usually duplicates. (Kammin, 2010)

Standard Operating Procedure (SOP): A document that describes in detail a reproducible and repeatable organized activity. (Kammin, 2010)

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis. (Kammin, 2010)

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning. (USEPA, 2006)

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