Mileta Creek Nitrogen Source Tracking Study Quality Assurance Project Plan

Part of the Quartermaster Harbor Nitrogen Management Study

July 2010

King County

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Mileta Creek Nitrogen Source Tracking Study
Quality Assurance Project Plan

A Targeted Watershed Grant
under the
2008 Puget Sound Initiative

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ABSTRACT

This study is designed to identify locations on Mileta Creek where nitrate concentrations become elevated in winter. Mileta Creek is a relatively small tributary to Quartermaster Harbor. This nitrogen source tracking study will support a larger study – the Quartermaster Harbor Nitrogen Management Study. The expected outcome of the Mileta Creek nitrogen source tracing study is a better understanding of the location and potential causes of elevated winter nitrate concentrations in Mileta Creek. This study will also provide information that will be incorporated into the larger study identifying nitrogen loading sources and potential management strategies. The larger study is designed to evaluate the role of nitrogen in the control of dissolved oxygen in Quartermaster Harbor, a sensitive marine embayment of Vashon-Maury Island in Puget Sound.

1.0. INTRODUCTION

King County was awarded a West Coast Estuaries Initiative (WEI) grant by Region 10 of the U.S. Environmental Protection Agency (EPA) to conduct the Quartermaster Harbor Nitrogen Management Study. The goal of this study is to support the protection and restoration of Quartermaster Harbor – a high value, coastal aquatic resource on Vashon-Maury Island (VMI) in Puget Sound. Partners working with King County on this grant-funded study include the University of Washington-Tacoma (UWT) and the Washington Department of Ecology (Ecology). The WEI grant will also support the enhancement of aquatic resource protection programs in an area threatened by growth pressures. This Quality Assurance Project Plan (QAPP) describes the Mileta Creek Nitrogen Source Tracking study planned as part of the Quartermaster Harbor Nitrogen Management Study.

1.1 Study Need

Dissolved oxygen levels below state marine water quality standards have been observed periodically in Quartermaster Harbor over the last four years of monthly monitoring by King County (Figure 1). Dissolved oxygen is essential for fish and other marine life, which can become stressed or killed, or escape to more oxygenated waters if possible. Low dissolved oxygen levels combined with the high habitat value of Quartermaster Harbor, increased frequency of detections of nitrate nitrogen in VMI groundwater, and ongoing population growth, make this project a high priority for King County. Quartermaster Harbor has many similarities with other South Puget Sound embayments which do not meet state dissolved oxygen standards established for the protection of aquatic life.

Quartermaster Harbor was one of 19 areas of Puget Sound judged to be relatively sensitive to anthropogenic nutrient inputs (Rensel Associates and PTI 1991). Excess nutrients, nitrogen compounds in particular, can lead to excessive phytoplankton and algae growth which can then deplete oxygen concentrations when the algae die (Figure 2). Nitrogen and phosphorus are essential nutrients for marine plants and phytoplankton. Although phosphorus compounds are important for phytoplankton growth, nitrogen is generally considered to be the limiting nutrient in marine waters of Puget Sound (Rensel Associates and PTI 1991).

Elevated nitrate concentrations of over 4 mg/L have been observed during winter months in Mileta Creek since routine monthly water quality monitoring began in late 2006 (Figure 3). As part of a preliminary estimate of nutrient loading to Quartermaster Harbor, a recommendation was made to conduct a nitrogen source tracking study on Mileta Creek (King County, 2010). Mileta Creek is one of five streams on VMI that have been monitored routinely by King County for a variety of water quality parameters, including various forms of nitrogen (i.e., nitrate+nitrite, ammonium nitrogen, and total nitrogen). Although nitrate concentrations typically increase in rural King County streams during the winter, concentrations above 4 mg/L have been observed routinely in only one other King County creek – Newaukum Creek – a tributary to the Green River which drains a basin dominated by agricultural land uses (King County, 2005a; King County, 2007). However, elevated nitrate concentrations in Newaukum Creek coincide with elevated concentrations of ammonium.

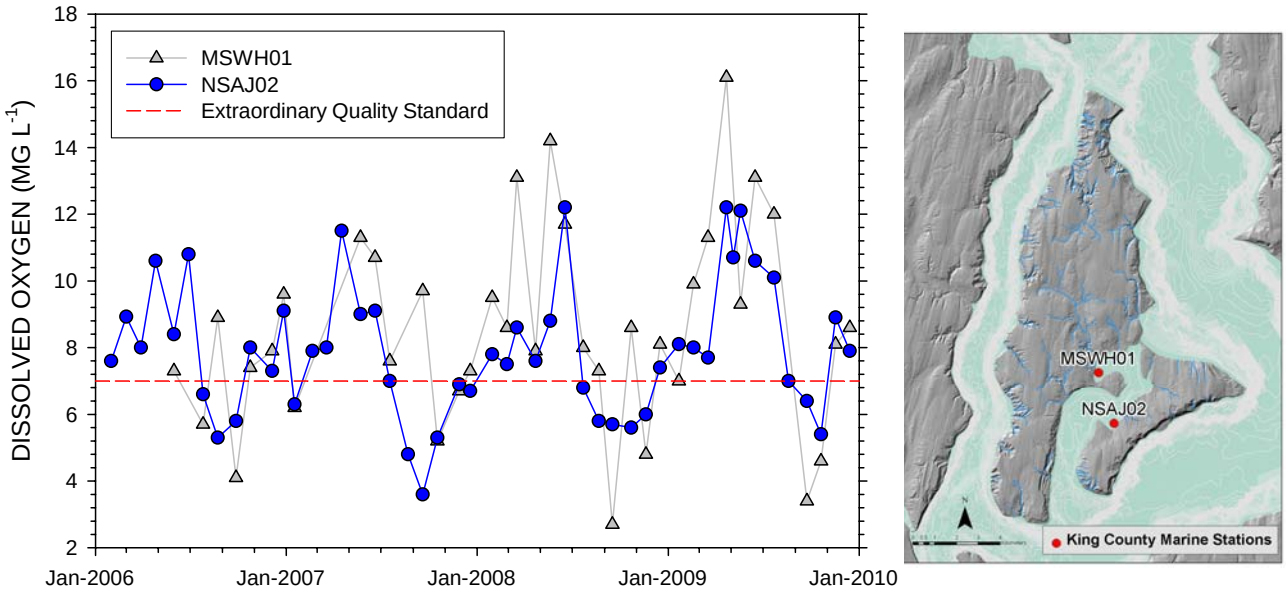

Figure 1. Monthly dissolved oxygen concentrations measured in bottom waters of Quartermaster Harbor by King County.

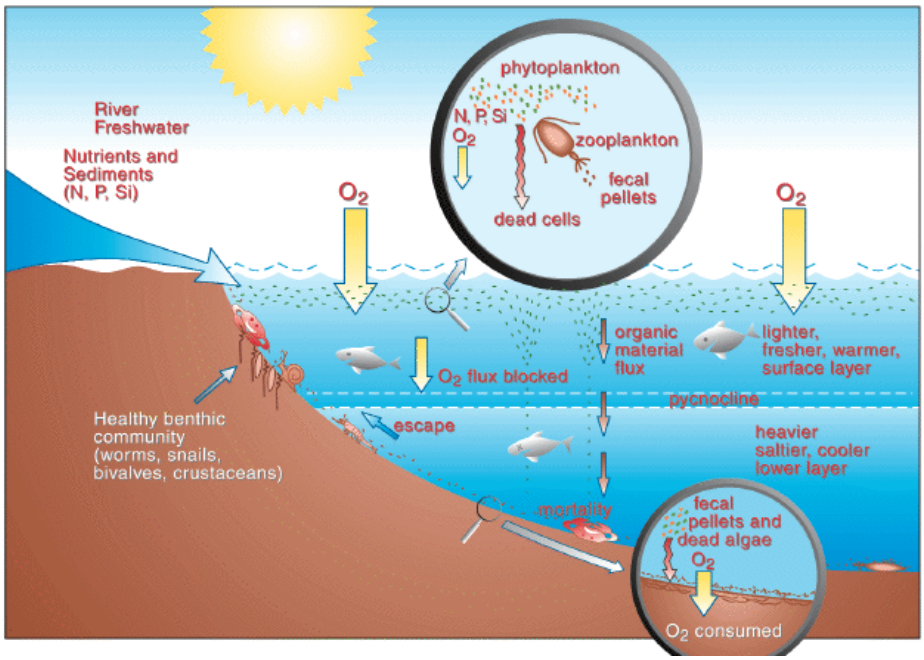

Figure 2. Conceptual diagram of marine nutrient-oxygen dynamics (Source: Downing JA, et al. Gulf of Mexico hypoxia: land and sea interactions).

Note: Task force report no. 134. Ames, IA:Council for Agricultural Science and Technology, 1999 (http://www.ehponline.org/docs/2000/108-3/focusfig2B.GIF)

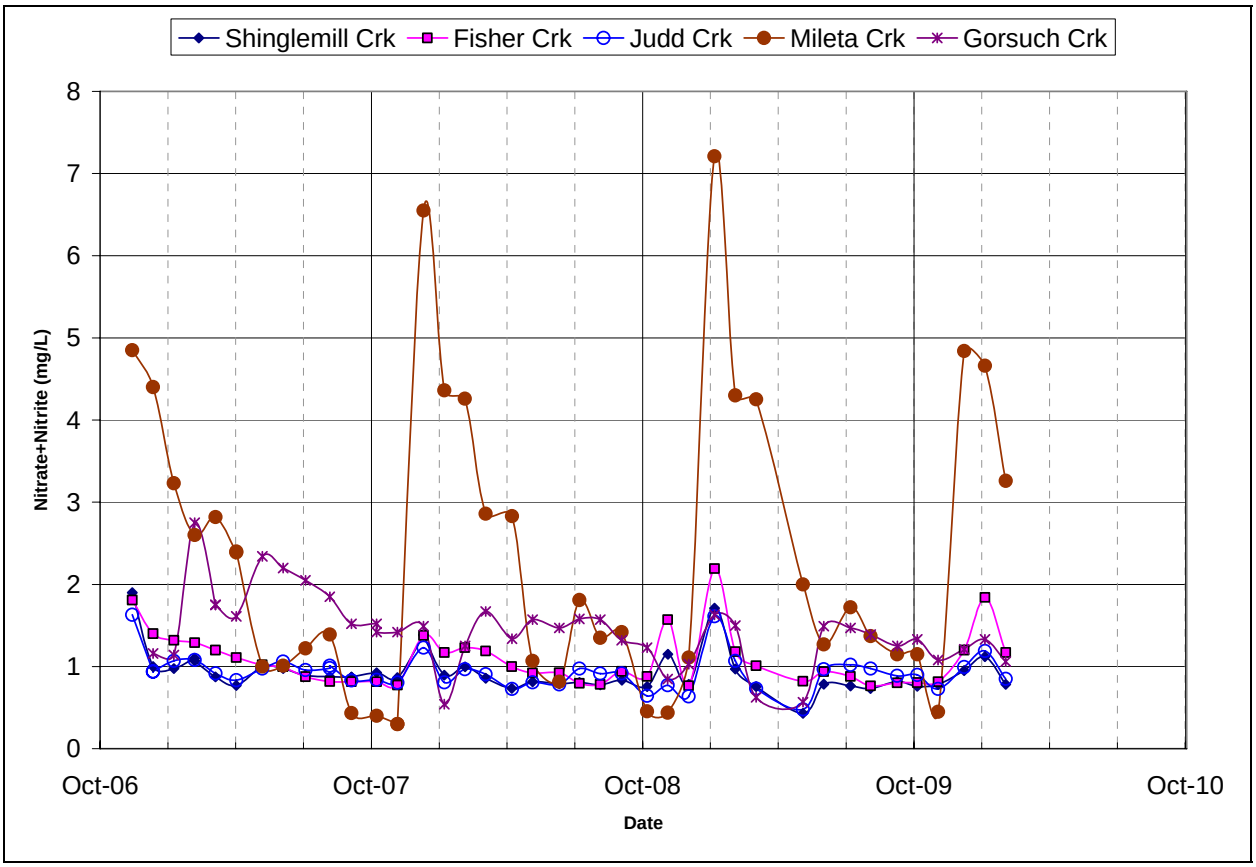

Figure 3. Nitrate + Nitrite water quality data from Vashon-Maury Island Creeks since November 2006 to February 2010. The sites sampled are Shingle Mill (VA12A), Fisher (VA41A), Judd (VA42A), Mileta (VA45A), and Gorsuch Creek (VA65A). Location of stream sampling sites can be seen in Figure 7.

nitrogen and soluble reactive phosphorus (SRP), while concentrations of ammonium and SRP in Mileta Creek remain low.

The cause of the elevated winter nitrate concentrations in Mileta Creek is unknown. This study is designed to determine if the source of nitrate nitrogen to the stream can be identified or if the location where it enters the stream can be located more precisely.

1.2 Description of Study Area

Vashon-Maury Island lies in Puget Sound within the boundaries of King County, Washington, and is situated southwest of Seattle and north of Tacoma. Vashon-Maury Island encompass approximately 37 square miles of which 29.7 square miles are on Vashon Island and 7.0 square miles on Maury Island (Figure 4). All of Vashon-Maury Island is designated as rural and as such is outside the urban growth boundary. Low-density residential development covers much of the Island with zoning of one home per five and ten acres. Higher density residential areas are

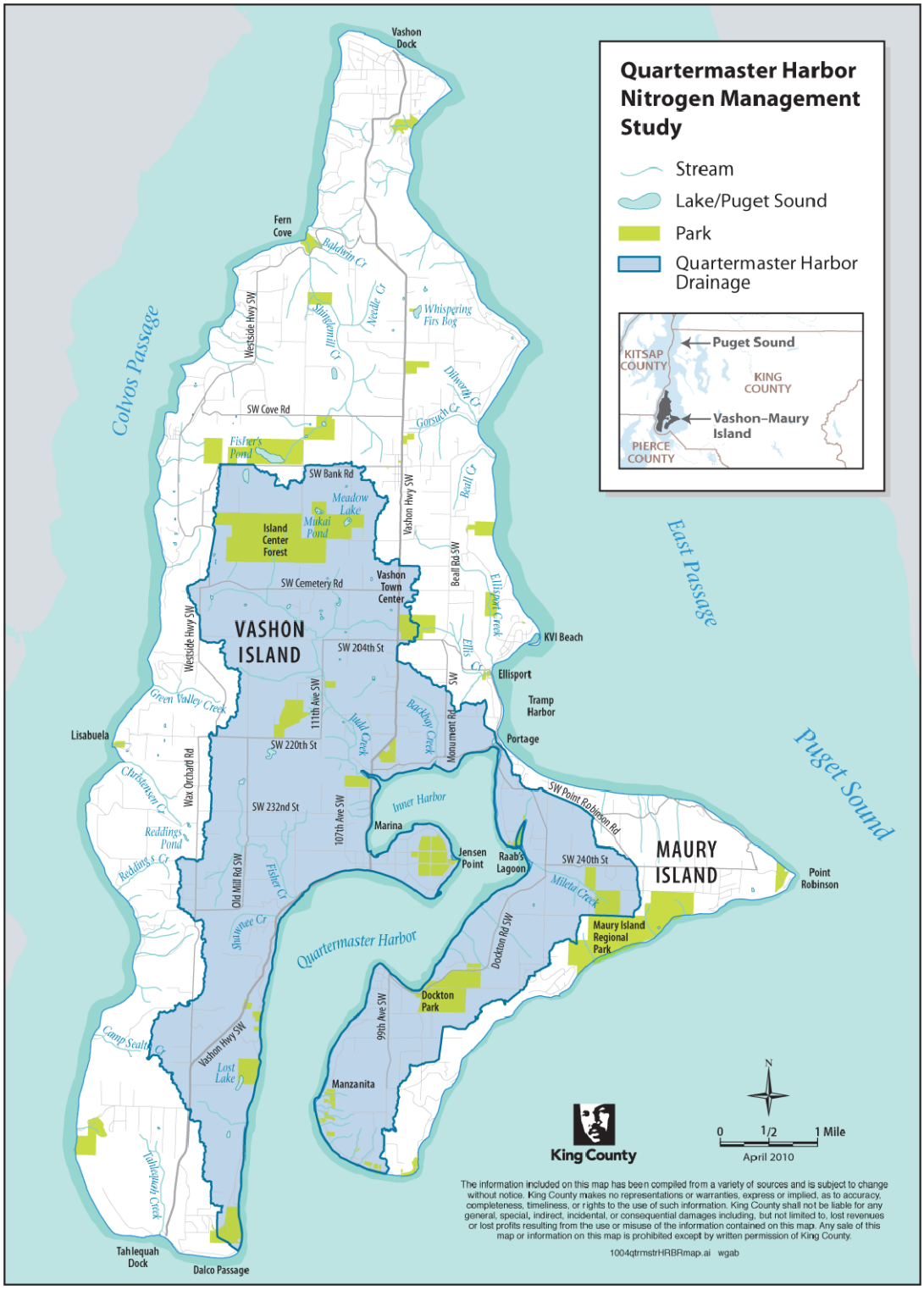

Figure 4. Map of Vashon-Maury Island highlighting the drainage area to Quartermaster Harbor.

concentrated in the Vashon Town Center, Vashon Heights, Burton, Dockton, and along parts of the shoreline (Figure 5).

Quartermaster Harbor, located between Vashon and Maury Islands, is sheltered from the wind and waves and receives runoff from about 40 percent of VMI. It is a shallow, protected embayment that comprises approximately 12.1 km^2 (3,000 acres) of water surface area in an inner and outer harbor. Inner QMH is especially sheltered and Judd Creek, located in the northwestern portion of the inner harbor, is the largest freshwater input. Transition zones between freshwater surface flows and the marine water within the bay include the estuaries at the mouth of Judd Creek, Fisher Creek, and Raab's Lagoon along with numerous smaller streams. Inner QMH is shallow, with a greatest depth of about 5 meters and very little tidal flushing. Outer QMH water depths range from about 11 to 46 meters with more rapid tidal flushing. Mileta Creek drains from Maury Island into inner Quartermaster Harbor (Figure 5). This basin is small with a total of 494 acres (0.8 sq mi) especially when compared to Judd Creek, the largest on VMI, with nearly 3,300 acres (5.1 sq mi). Mileta Creek basin is one of the largest basin areas delineated on Maury Island. The length of the main stream course is about 5,000 feet.

1.3 Historical Data Review

Vashon-Maury Island has been the subject of water quality and quantity investigations beginning at least as far back as the early 1970s. The studies summarized here are not intended to be exhaustive yet provide an overview of available data. The reader should refer to the original sources for more detailed information.

1.3.1 Vashon-Maury Island Water Resources Report

The first major report on Vashon-Maury Island water resources was completed in 1983 and is commonly referred to as the "Carr Report." The Carr Report concluded that precipitation is the only source of recharge to the Island aquifers. This finding was significant at the time, as many people then believed the Island's water supply came from distant sources such as the Olympic or Cascade Mountains.

The Carr Report documented the extent and water quality of the Island's water resources (Carr, 1983). The report primarily gathered data from wells and springs, yet some surface water assessment was done. Data for Mileta Creek was not specifically reported but a range of nitrate values of 0.8 to 3.0 mg/L was reported for the VMI creeks. The Carr Report discusses 'Nitrate Contamination' and listed potential sources as septic tank effluent, fertilizer and animal waste.

1.3.2 Vashon Maury Island Ground Water Management Plan

The Vashon-Maury Island Ground Water Management Plan (VMI GWAC, 1998) reported the collection of monthly water quality data from August 1991 through September 1992 from eight creeks including Mileta Creek. The sites were sampled for indicator bacteria, trace metals and nutrients including Nitrate+Nitrite. The groundwater management plan reports that 'nitrate

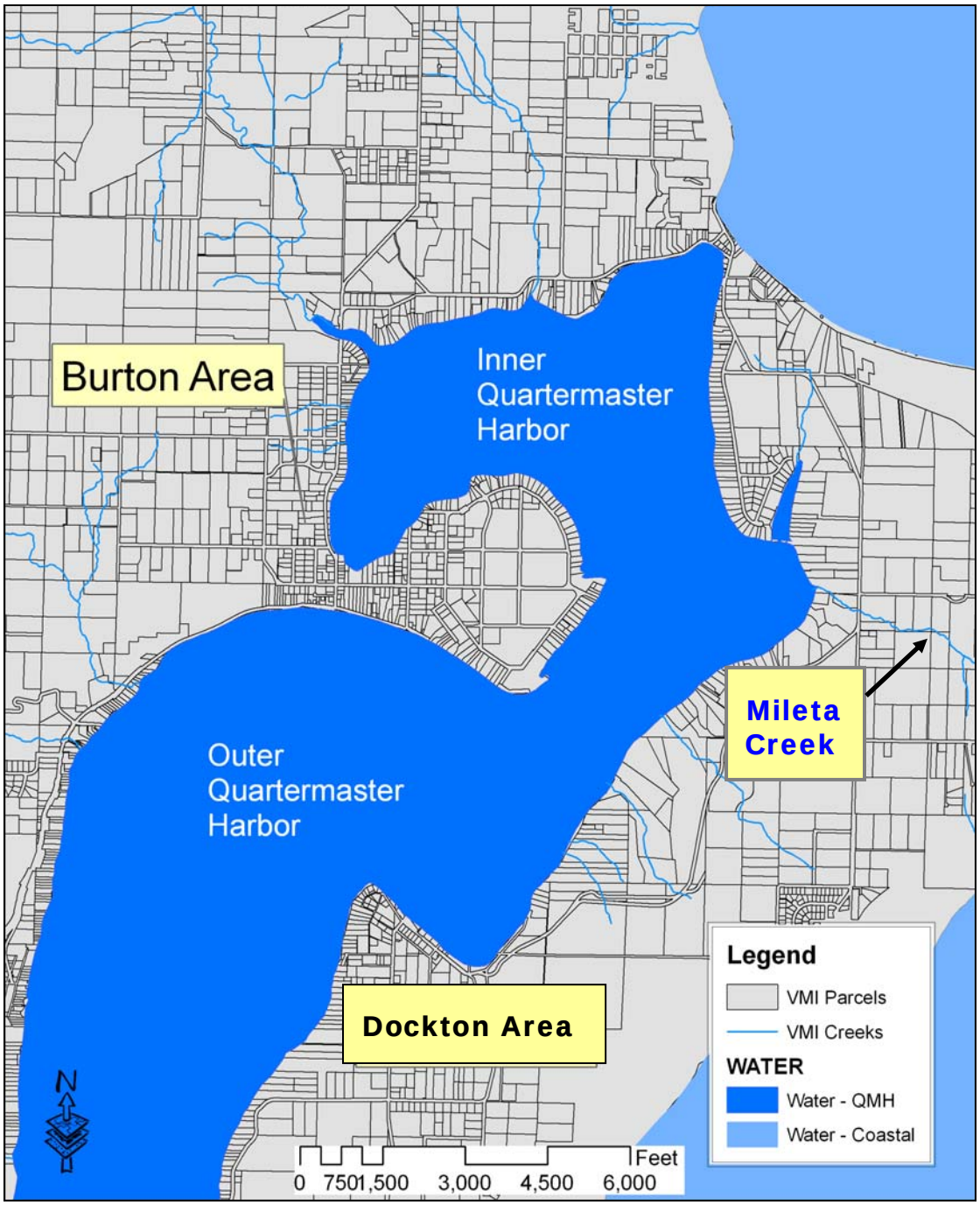

Figure 5. Map of Quartermaster Harbor showing the increased density of development along the shoreline areas of Inner and Outer Quartermaster Harbor.

levels were at or below Federal Drinking Water Standards'. No numeric values are presented within the plan. The federal standard for nitrate in drinking water is 10 mg/L.

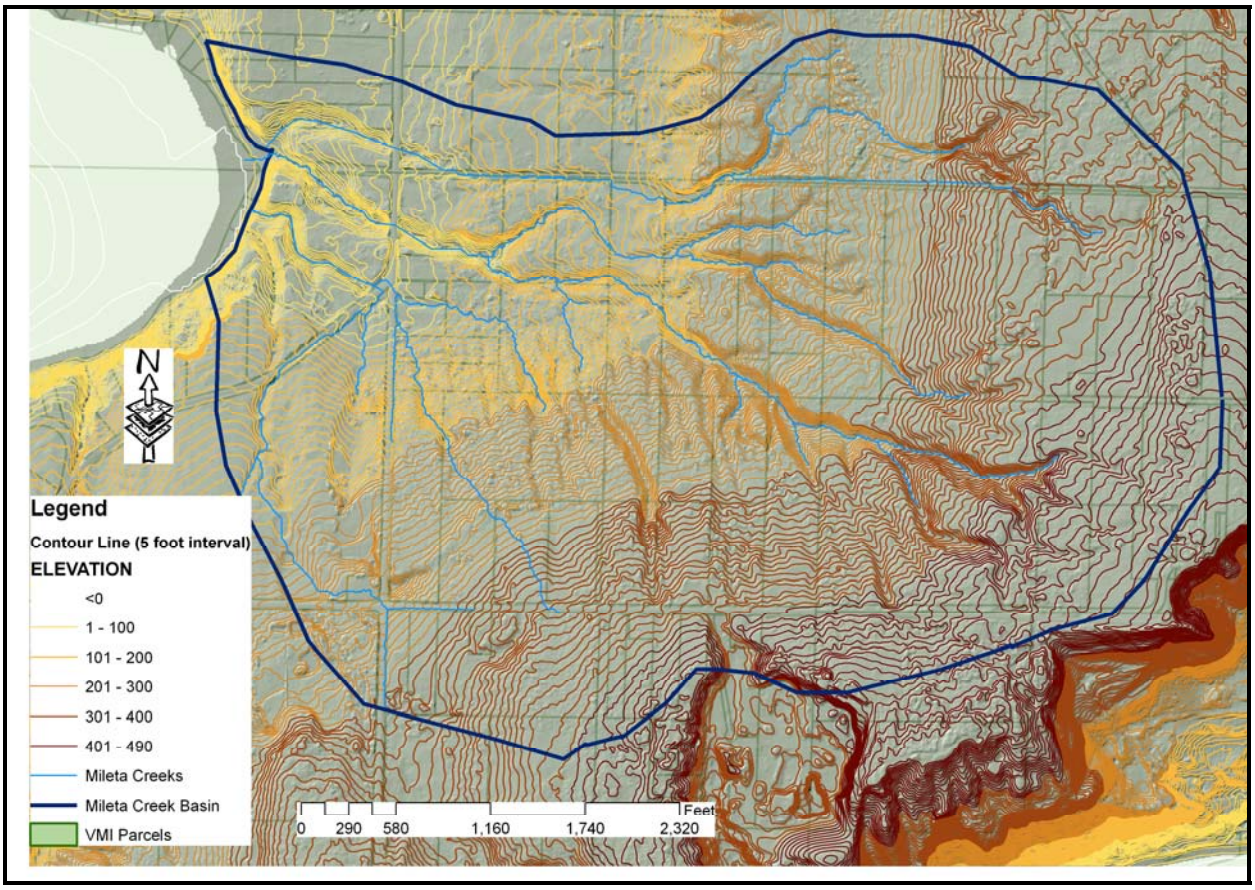

Figure 6. Mileta Creek drainage basin on Vashon-Maury Island.

Note: Contour lines with 5 foot interval shown. The elevation within the basin ranges from sea level to 480 feet.

1.3.3 King County Water Resources Evaluation

In 2004, King County created an island-wide water resources project, the Vashon-Maury Island Water Resource Evaluation (WRE), to assess the status of the water resources on VMI. These activities were initiated in support of the development of the Vashon-Maury Island Watershed Plan (King County, 2005). As part of this project, it was noted that a data gap existed for stream water quality data. No data had been regularly collected since the groundwater management plan data collection effort in the early 1990's. In November 2006, the WRE project started a 14-month water quality assessment by collecting data on a monthly basis at seven creek locations (Figure 7).

Stream water quality monitoring has focused on indicator bacteria, temperature, dissolved oxygen, specific conductance, pH, total suspended solids, and nutrients, including forms of nitrogen. Based on the initial observation of elevated nitrate levels, the stream monitoring has continued at five sites (King County, 2008). Sites on Christensen Creek (VA23A) and Tahlequah Creek (VA37A) were dropped in 2008 after the initial assessment due to budget limitations. As noted earlier, elevated Nitrate+Nitrite concentrations of over 4 mg/L have been

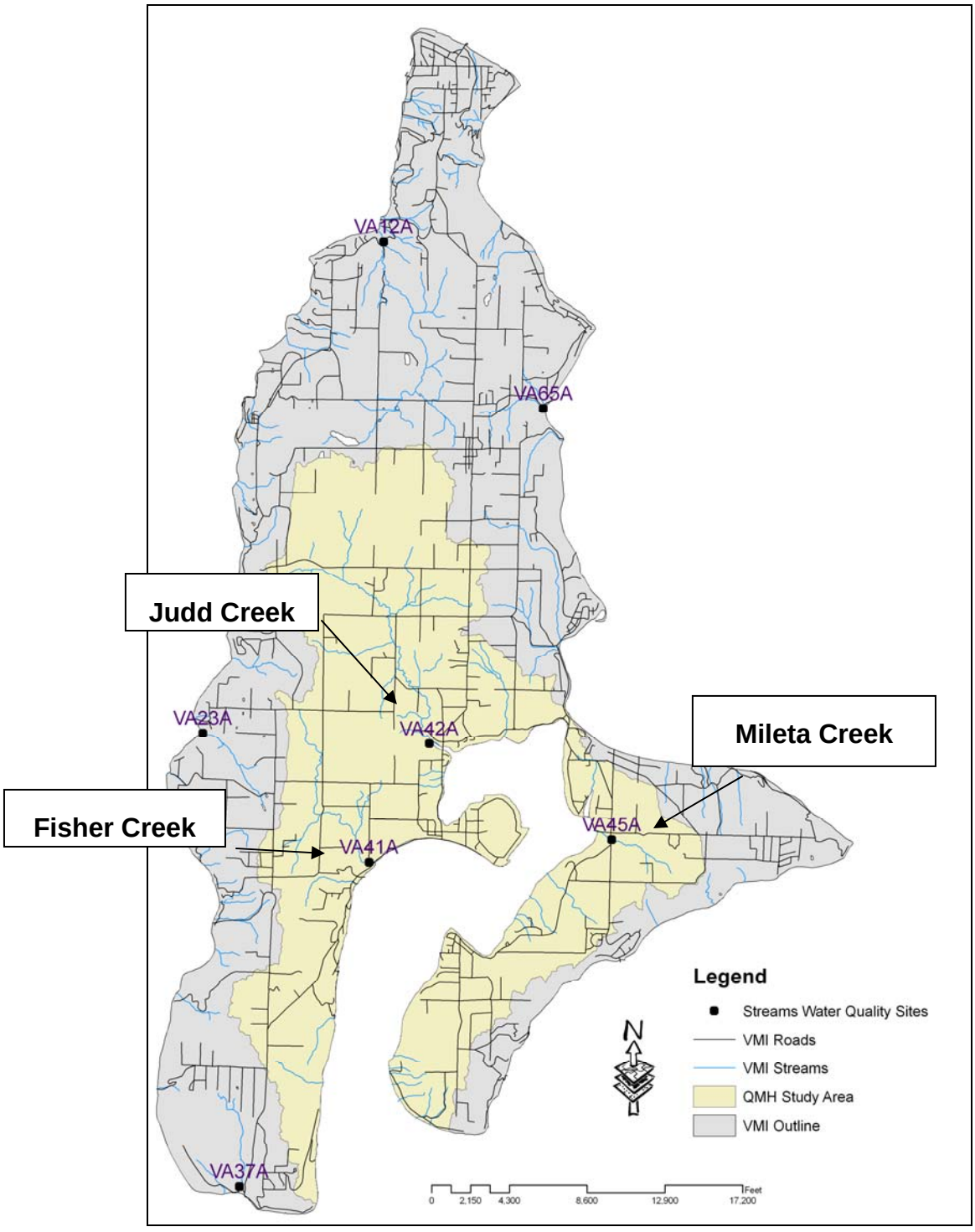

Figure 7. Stream water quality monitoring locations on Vashon-Maury Island.

Note: The active (as of 2009) sites sampled are Shingle Mill (VA12A), Fisher (VA41A), Judd (VA42A), Mileta (VA45A), and Gorsuch Creek (VA65A). Tahlequah (VA37A) and Christensen (VA23A) Creek were only sampled during the initial stream water quality assessment in 2007.

observed during winter months in Mileta Creek since November 2006 (see Figure 3). The cause of the elevated winter nitrate concentrations in Mileta Creek is unknown.

2.0. STUDY GOAL AND OBJECTIVES

2.1 Study Goal

The purpose of this study is to determine if the source of elevated nitrate nitrogen to Mileta Creek can be identified or if the location where it enters the stream can be located more precisely. Samples along the stream reach will help identify the location along the stream where elevated levels of nitrogen are entering the waterway. This information will be incorporated into the overall study identifying nitrogen loading sources and potential management strategies of those sources.

2.2 Project Management and Oversight

The overall Quartermaster Harbor Nitrogen Management Study is managed by King County and includes collaborators from the UWT, Ecology and the Groundwater Protection Committee. The Mileta Creek Nitrogen Source Tracking Study will be managed and implemented by King County. This QAPP and products resulting from this study will be reviewed by the project team and technical reviewers assigned by EPA Region 10, primarily the EPA Project Monitor assigned to this grant.

3.0. PROJECT DESIGN

Samples along the stream reach of Mileta Creek will be taken at predetermined locations to help identify areas within the basin where elevated levels of nitrogen are entering the waterway. This information will be incorporated into the overall Quartermaster Harbor Nitrogen Management study identifying nitrogen loading sources and potential management strategies of those sources.

Since the timing of the initial increase in nitrate concentrations appears to vary during the fall/early winter period, a threshold will be used to determine when sampling as part of this source tracking study will occur. Any month when the sample result for the nitrate+nitrite concentration at the long term Mileta Creek sampling site (VA45A) exceeds 4 mg/L then source tracking sampling will occur within the next two (2) weeks. The sampling will occur at the designated sites for field parameters — specific conductance, dissolved oxygen, temperature and pH; three forms of nitrogen — nitrate+nitrite; ammonia and total nitrogen and stream flow.

3.1 Source Tracking Study

Once the 4 mg/L nitrate threshold has been exceeded at station VA45A, a synoptic collection of samples at VA45A and 16 other locations through the Mileta creek basin will be take place within 2 weeks. The final locations of these stations will depend on access permission to private land and ease of access to the stream. Figure 8 and Table 1 show the preliminary locations identified for sampling.

Initial work with GIS and field surveys has shown that the Mileta Creek basin has at least three different waterways entering into Quartermaster Harbor (Figure 6). The monthly water quality site, VA45A, is on Mileta Creek. During a field survey, it was noted that tributaries to the north and the south of the main portion of Mileta Creek flow via culverts toward the harbor and not toward the main branch of Mileta Creek. For this study plan, these tributaries are being called North Mileta Creek and South Mileta Creek respectively (Figure 8).

3.1.1 Final Site Selection

The final sampling locations in this study will be determined based on site assessments and site access to Mileta Creek. An initial assessment will be done using geographic information system (GIS) data layers to provide areas and parcel information in order to contact property owners for the site to be considered. At these sites, it will be determined if and how access to Mileta Creek will occur. At the creek, information will be gathered about ability to obtain grab samples (as done with the routine monthly water quality sampling), safety of the site and usefulness of this site in the project design.

The number of sites will be determined after reconnaissance is completed and access agreements are signed. The number of samples collected will depend of the number of sites and will likely be less than 20 samples, including any field replicates.

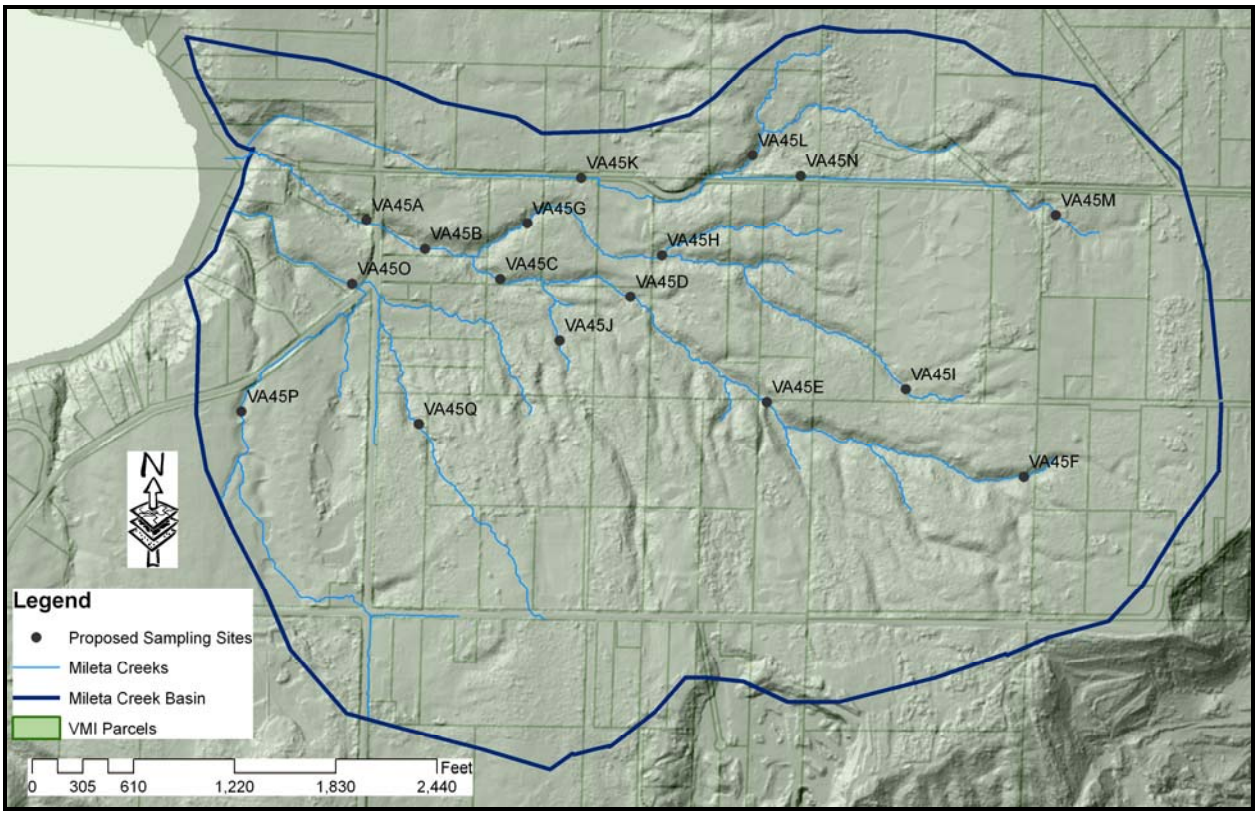

Figure 8. Proposed sampling location along Mileta Creek to assess elevated nitrogen levels. Site VA45A is the routine stream water quality monitoring location. The additional 16 sites are proposed to help assess the elevated nitrogen levels noted within this basin.

3.1.1.1 Stream Flow measurements

At each sample site, a stream flow measurement will be taken. This measurement will be taken by a King County WLRD Hydrologic Monitoring staff. During the final site assessment, staff will assess the ability to take stream flow measurements at a given location. Flow will be measured utilizing the same procedures as other stream sites around VMI (King County, 2009). Depending on the final number of sites selected, these measurements may be taken over a two-day period – starting on the day of the sampling.

3.1.2 Property Access

In order for a sampling site to be considered, the property owner(s) need to be contacted to obtain permission to access the site. As mentioned above, the parcel data will be used to target specific areas to gain access to Mileta Creek. A right of entry permission form will be signed by the landowner(s) prior to any sampling events.

Table 1. Proposed sampling locations for this study.

Station ID	Station Description	Stream Reach^ (feet)	Coordinates* (Easting/Northing)	
VA45A	Mileta Creek	800	1245495.1	145793.9
VA45B	Mileta - US of 75th Ave	1,200	1245847.7	145620.5
VA45C	Mileta - US of south trib	1,750	1246300.7	145439.1
VA45D	Mileta - US of north trib	2,500	1247084.8	145332.0
VA45E	Mileta - middle reach	3,550	1247907.2	144695.7
VA45F	Mileta - upper reach	5,300	1249455.5	144241.2
VA45G	Mileta - north trib	450	1246464.5	145773.6
VA45H	Mileta - north trib middle	1,450	1247274.5	145581.1
VA45I	Mileta - north trib upper	3,000	1248743.5	144772.9
VA45J	Mileta - south trib	500	1248743.5	144727.9
VA45K	North Mileta - Qva	1,100	1246787.7	146050.6
VA45L	North Mileta - middle	2,300	1247822.1	146189.6
VA45M	North Mileta - upper	4,300	1249647.6	145824.5
VA45N	North Mileta – 240th	3,000	1248110.4	146062.4
VA45O	South Mileta	950	1245408.6	145410.3
VA45P	South Mileta – middle	1,000	1244741.8	144637.9
VA45Q	South Mileta – south	2,000	1245810.1	144560.9

US refers upstream & DS refers to downstream.

^ = Distance upstream from the mouth; The confluence of the tributary is at 2,770ft; Tributary distance is from the confluence.

* = Coordinates are in Washington State Plane Feet North (HARN 1984)

Note: proposed station coordinates may change slightly depending on site conditions encountered during reconnaissance.

4.0. QUALITY OBJECTIVES

There are two types of quality objectives that need to be identified: Measurement Quality Objectives (MQOs) and Data Quality Objectives (DQOs). MQOs are "'acceptance criteria' for the quality attributes measured by project data quality indicators. They are quantitative measures of performance…" (USEPA, 2002). MQOs are the targets for precision, bias and sensitivity against which QC results are compared. Precision is assessed from the results of replicate analyses of samples and standards. Bias is assessed from blanks and check standards and compared to their expected values. Sensitivity is related to the detection and reporting limits for the measurement method used. DQOs are needed in projects where the results are compared to a standard or used to select between two alternative conditions.

4.1 Measurement Quality Objectives

The Measurement Quality Objectives for field and lab measurements are presented in Table 2. Field crews and the King County Environmental Lab are responsible for adherence to objectives. King County will be responsible for verifying all MQOs are met.

4.2 Laboratory Data Quality Objectives

The data quality objectives (DQOs) of this study are to collect data of sufficient quantity and quality to meet the study goals. Statistical analysis of data collected for this study will be performed to evaluate whether a sufficient quantity of data has been collected to meet the study goals.

The study goals are to characterize surface water concentrations of various constituents at different sampling locations to evaluate any differences between sites. Statistical analysis of data that are "undetected"; i.e., laboratory analysis results reported as "<MDL", will use binomial calculations on the probability of a sample with a detectable concentration of the specific constituent and the probability of finding two and three samples in succession with detectable values at a given site or depth. Statistical analysis of data for those constituents that are detected regularly or occasionally will be accomplished through the use of medians and interquartile ranges.

4.2.1 Precision, Accuracy and Bias

Precision is the agreement of a set of results among themselves and is a measure of the ability to reproduce a result. Accuracy is an estimate of the difference between the true value and the determined mean value. The accuracy of a result is affected by both systematic and random errors. Bias is a measure of the difference, due to a systematic factor, between an analytical result and the true value of an analyte. Precision, accuracy and bias for analytical chemistry may be evaluated by one or more of the following quality assurance/quality control (QA/QC) procedures (Table 2).

Table 2. Precision, accuracy and bias for analytical chemistry, field and laboratory

Measurement		Precision (RSD*)	Bias (% deviation from true value	Lowest Value/Range of Interest
pH	field	0.05 SU	N/A	1 to 14 SU
Temperature		0.01 °C	0.05 °C	0.1 °C
Dissolved Oxygen		10%	5%	0.1 mg/L
Specific Conductance		10%	5%	1 µS/cm
Ammonia Nitrogen	lab	20%	5%	0.02 mg/L
Nitrate + Nitrite Nitrogen		20%	5%	0.02 mg/L
Total Nitrogen		20%	5%	0.05 mg/L

*RSD (relative standard deviation) is calculated as the ratio of the standard deviation and the mean of several values

- Collection and analysis of field replicate samples. Field replicate results should exhibit a relative percent difference less than 150% in order for the evaluation of the spatial and temporal chemical concentrations to be meaningful; and

- Analysis of various laboratory QC samples such as blanks, spikes and replicates.

4.2.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point or an environmental condition. Water samples will be collected from stations with predetermined coordinates to represent specific site conditions and compared to other locations.

4.2.3 Completeness

Completeness is defined as the total number of samples analyzed for which acceptable analytical data are generated, compared to the total number of samples submitted for analysis. Sampling at stations with known position coordinates in favorable conditions, along with adherence to standardized sampling and testing protocols will aid in providing a complete set of data for this project. The goal for completeness is 100%. If 100% completeness is not achieved, the project team will evaluate if the data quality objectives can still be met or if additional samples may need to be collected and analyzed.

4.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal is achieved through using standard techniques to collect and analyze representative samples, along with standardized data validation and reporting procedures. By following the guidance of this QAPP, the goal of comparability between this study and other comparable studies conducted by King County will be achieved.

5.0. SAMPLING PROCEDURES

This section describes sample collection procedures that will be followed throughout the assessment to help ensure that project data quality objectives are met.

5.1 Sampling Methods

Samples are collected by grab sampling by hand dipping. These methods are described in section 5.1.2 and King County Environmental Lab's "River and Stream Water Sampling" SOP #214v3.

5.1.1 Field Measurements

A set of field parameters — specific conductance, dissolved oxygen, temperature and pH — will be measured at the time of sampling. The methods and detections limits for the field measurements are presented in 6.1.

5.1.2 Sample Collection

Samples will be collected by King County WLRD staff with the assistance of King County Environmental Lab staff as necessary via grab sampling by hand dipping. Grab samples will be collected while facing upstream to minimize contamination from field equipment. Whenever possible, the sampling should be conducted while facing the prevailing winds.

The conventional analysis bottle (for all parameters) will be filled by lowering the bottle, open with the neck faced down, into the stream to a depth of 1 to 3 inches. The bottle is rotated, allowed to fill up just below the top shoulder of the bottle, and capped after the container is removed from the stream flow.

After collection, samples will be capped and placed in a sample cooler, to be kept chilled at 4°C until delivery to KCEL for analysis. The sample cooler must be kept as clean as possible to minimize the potential for cross-contamination. Bottle caps will be checked to ensure they are tight and will not become loose when inserted in the cooler. Frozen icepacks or ice will be placed into the sample cooler such that they are not in direct contact with sample containers. The laboratory will analyze samples for the constituents listed below in Table 3.

Table 3. Sample containers, preservation and holding times for samples.

Analysis	Container	Preservation	Holding Time*
Ammonia and Nitrate+Nitrite	250mL HDPE, CWM	Filter within 1 day and freeze within 2 days @ -20 ^{o}C	14 days @ -20 ^{o}C
Total Nitrogen (collected together in the same bottle)	250mL HDPE, CWM	Digest or freeze within 2 days @ -20°C	28 days @-20 ^{o}C

6.0. MEASUREMENT PROCEDURES

6.1 Field Measurements

During the sampling events, field parameters – pH, temperature, conductivity and dissolved oxygen– will be measured to assess field conditions at the time of sampling. All field parameters are measured with a multi parameter probe (QED MP20 or similar probe). Calibration of field equipment will occur before any sampling event, as noted in section 7.1.2. The chamber of the probe will be filled with stream water collected at the time of sampling. The measurements for each of the field parameters will be recorded on the field sheet. The methods and detections limits for the field measurements are presented in Table 4.

6.1.1 Stream Flow measurements

At each sample site, a stream flow measurement will be taken. This measurement will be taken by a King County WLRD Hydrologic Monitoring staff utilizing the same procedures as other stream sites around VMI (section 6.2.1 within King County, 2009;). The discharge of the stream is measured by taking velocity measurements over segments within the stream channel. Depending on the final number of sites selected, these measurements may be taken over a two-day period – starting on the day of the sampling.

6.2 Laboratory Measurements

The Mileta Creek sampling sites will be analyzed for the following water quality parameters: ammonia nitrogen, nitrate+nitrite nitrogen and total nitrogen. The methods and detection limits for these parameters are presented in Table 4.

Table 4. Water Quality Parameter Method and detection limits for surface water sites.

Parameters		Method	Detection Limit
Dissolved Oxygen	**Field**	EPA 360.2	0.5 mg/L
Temperature		EPA 170.1	0.1 deg C
Specific Conductance		EPA 120.1	0.1 mhos/cm
pH		EPA 150.1	0.1
Ammonia Nitrogen	**Laboratory**	Kerouel & Aminot, 1997	0.005 mg/L
Nitrite + Nitrate Nitrogen		SM 4500–NO3-F	0.01 mg/L
Total Nitrogen		SM 4500–N-C	0.05 mg/L

7.0. QUALITY ASSURANCE AND CONTROL

Quality assurance and control will be provided by project manager oversight, project staff training, and adherence to standard operating procedures referenced previously.

7.1 Field Measurement QC Procedures

Field QC includes proper documentation of field activities and sampling/handling procedures, as described in Sections 6.1 and 8.0.

7.1.1 Field QC Samples

Field QC samples will consist of the following:

- One replicate per 10 samples, to be analyzed for the entire suite of laboratory analyses.

7.1.2 Calibration and Use of Meters

Before use, field equipment must be cleaned and checked for malfunctions. Meters must be calibrated each morning before use in the field, following manufacturers' procedures. Other field equipment will be calibrated at least daily. All field monitoring equipment will be calibrated consistent with manufacturers' procedures using instrument calibration standards prepared according to the manufacture's specifications.

7.2 Lab QC requirements

In general and at minimum, laboratory QC will consist of the following:

- One matrix spike (MS) per 20 samples
- One lab duplicate (LD) per 20 samples

Method-specific QA/QC samples may include the following, and are as follows:

- Method blanks. A method blank is an aliquot of a clean reference matrix, such as deionized, distilled water for water samples, which is processed through the entire analytical procedure. Method blank results are used to evaluate the levels of contamination that might be associated with the processing and analysis of samples. Method blank results should be "less than the MDL" for all target analytes.
- Matrix spike samples. A matrix spike (MS) is a known concentration of one or more target analytes, introduced into a second aliquot from one analytical sample. The spiked sample is processed through the entire analytical procedure. Analysis of the MS is used

as an indicator of sample matrix effect on the recovery of target analytes. Control limits are based on the percent recovery of the spiked compounds.

- Lab duplicate samples. A lab duplicate (LD) is a second aliquot removed from one analytical sample, processed through the entire analytical procedure as a separate sample. The RPD between the original sample and the LD is used as an indicator of method precision and sample homogeneity
- Spiked blank samples. A spiked blank (SB) is an aliquot of clean reference matrix, such as deionized distilled water for water samples, to which a known concentration of one or more target analytes has been added. The spiked aliquot is processed through the entire analytical procedure. SB analysis is used as an indicator of method performance and can be used in conjunction with matrix spike results as an indicator of sample matrix effects. Control limits are based on the percent recovery of the spiked compounds.
- Laboratory control samples. A laboratory control sample (LCS) is a sample of known analyte concentration(s) that is prepared in the lab from a separate source of analyte(s) relative to the calibration standards. Since the LCS analysis should follow the entire analytical process, it should be stored and prepared following the same procedures as a field sample. Analysis of a LCS is used as an indicator of method accuracy and long-term analytical precision.
- Performance Evaluation (PE) samples. KCEL participates twice annually in the Water Pollution and annually in Water Supply Performance Evaluation programs. These programs were designed by the EPA to evaluate lab performance for testing associated with the Clean Water Act and the Safe Drinking Water Act, respectively. PE samples are single-blind samples supplied to the lab through vendors approved by the Washington Department of Ecology Lab Accreditation Program.

QC sample results that exceed control limits will be evaluated to determine appropriate corrective actions. Samples will typically be reanalyzed if unacceptable QC results indicate a systematic problem with the overall analysis. Unacceptable QC results caused by a particular sample or matrix will not require reanalysis unless an allowed method modification would improve the results. Analytical results that are outside of QC control limits for some QC sample types will be qualified and flagged according to procedures outlined in Section 7.2.2.

7.2.1 Conventionals QC Parameters

Laboratory QC samples for conventionals analyses and associated control limits are summarized in Table 5. These QC samples will be analyzed at a frequency of one per analytical batch of 20 or fewer samples.

7.2.2 Laboratory Data Review and Analysis

Data evaluation will include checking holding times, method blank results, field and laboratory duplicate results, completeness, detection limits, laboratory control sample results and COC forms. After the data has been checked, it may be entered into a project database with any assigned data qualifiers. Data evaluation is critical for evaluating how well analytical data meet

project DQOs, and is performed, at some level, during several steps in the process of sample collection and analysis.

Table 5. Laboratory QC Requirements

Analysis	Method Blank	Duplicate RPD (%)	Positive Control % Recovery	Matrix Spike % Recovery
Ammonia Nitrogen	<MDL	20	85-115	75-125
Nitrate+Nitrite Nitrogen	<MDL	20	85-115	75-125
Total Nitrogen	<MDL	20	85-115	75-125

RPD = Relative Percent Difference

All analytical data are entered into KCEL's Laboratory Information Management System (LIMS). LIMS may perform additional calculations such as conversion of concentrations measured directly by laboratory instrumentation to final sample results. Automatic calculation of QC results is also performed within LIMS, as well as comparison to acceptance limits.

Laboratory analytical data are reviewed first by the primary analyst and then by a senior peer reviewer prior to entry of the data into LIMS. Analytical data are reviewed for completeness and QC sample data are viewed for compliance with project and method QA/QC requirements. If there are any QC failures at this point, corrective action may be taken or qualifier flags applied to the data.

A laboratory project manager (LPM) will provide the next data review step, at a project level. The LPM will verify the completeness of an entire data set (multiple parameters for a particular sampling event) and report any QC failures or anomalies. An internal King County project data validator may provide a final review of the data to ensure they meet the project DQOs. Data may then be reported in a variety of formats, depending on project needs.

All laboratory analytical data are maintained in *perpetuity* on LIMS. Data may be viewed on-line in LIMS by King County personnel only. Project data may also be downloaded from LIMS into a hard copy format using Microsoft Excel©. Analytical data will be reported on a routine basis in Excel© format along with an accompanying QA/QC review narrative.

Laboratory analytical data may be stored with data qualifier flags indicating QC failures. The flag "B" is used to indicate possible laboratory contamination of a sample and is applied when the parameter of interest is also detected in the laboratory method blank. Sample results that are less than five times the concentration detected in the method blank will be qualified with a "B" flag. Sample results between five and ten times the concentration detected in the method blank will be qualified with a "B3" flag. The flag "SH" is used to indicate a sample handling condition that did not meet method requirements. Handling conditions may include an improper sample container, improper preservation of the sample. The H flag will be applied when there is an exceedance of the method-specific holding time. The flag "J" may be applied to sample data at the discretion of the laboratory analyst, data reviewer, or data analyst, should control limits on

one or more QC samples not be met. The flag "J" indicates that sample numerical result should be viewed as *estimated*.

Analytical results from field blanks and field replicates will be reviewed to evaluate their impact on the quality and usability of sample analytical data. Results from field QC samples will not be used to flag sample analytical data but will be taken into consideration during final data review and analysis

8.0. DATA MANAGEMENT PROCEDURES

Except where noted otherwise, all field data and associated observations will be recorded on standardized field sheets (physical or electronic) as described above (see Sampling Procedures) and entered or transferred into one of several King County databases in a timely manner, generally within one week of collection. King County laboratory and field data will be stored in the King County Laboratory Information Management System.

The Project Manager will provide supervision of all data acquisition and management activities. The Data Management Section will maintain the project database and load data. Project staff will enter all other data manually or download from electronic field sheet.

9.0. AUDITS AND REPORTS

A quality assurance assessment will be conducted prior to using the data for analysis, and the results will be included in the final report for this project.

10.0.DATA VALIDATION

Data validation is critical in the evaluation of how well instrument data meet project DQOs. During data processing, data will be critically reviewed by a qualified reviewer to identify suspect data. Results that are suspect will be evaluated to determine appropriate corrective actions. Issues identified and any corrective action will be documented in reports associated with the use of these data in Quartermaster Harbor Nitrogen Management Study work products.

11.0.DATA ANALYSIS AND USE

The data will be analyzed using standard filtering and averaging techniques as appropriate to understand relationships between nitrogen concentrations, location of the sampling site, and meteorologic events. The usability of the data will be confirmed by comparing this data to other stream quality data collected by King County.

11.1 Reconciliation with User Requirements

Reports generated for this study will include identification of any data limitations determined through application of the Data Quality Objectives described in this project plan. This information will be communicated initially through annual project reports and will be mirrored in subsequent project reports that rely on data with known limitations, including, but not limited to, modeling reports and reports containing recommended updates to decision makers that update the King County Comprehensive Plan.

12.0.ORGANIZATION AND SCHEDULE

12.1 Project Staff list and roles

The project involves staff from King County Departments of Natural Resources and Parks (DNRP, including the King County Environmental Lab, KCEL) in collaboration with the UWT Environmental Science program, Washington Dept. of Ecology's Marine Monitoring Unit and the Vashon-Maury Island Groundwater Protection Committee. Detailed roles and responsibilities are:

Core Project Team:

Curtis DeGasperi–King County DNRP - Project Manager - responsible for: (1) supervising project implementation; (2) coordinating and tracking work, budgets and personnel; (3) preparing and presenting presentations and written reports; and team member for all surface water activities. Curtis will also assist with the selection and development of watershed and QMH water quality models.

Eric Ferguson–King County DNRP–Core Team Member–Lead team member for all groundwater related activities; developing and implementing project database and assist project manager as directed in all facets of project implementation. Conduct groundwater and surface water monitoring field work and deliver samples to KCEL for laboratory analysis.

Kimberle Stark–King County DNRP–Core Team Member - Lead team member for all marine water related activities.

Laurence Stockton–King County DNRP–Core Team Member–Lead team member in the development of policy and management recommendations and public outreach and communication activities.

Extended Project Team:

King County Environmental Laboratory (KCEL)–Deploy and maintain King County marine moorings and associated meteorological stations and conduct King County monthly marine ambient monitoring at QMH sub-tidal and inter-tidal stations.

King County DNRP Hydrologic Monitoring Support–Maintain stream gauges and continuous temperature monitoring equipment as well as land-based precipitation and meteorological observation stations on VMI.

Cooperators:

Dr. Cheryl Greengrove–University of Washington -Tacoma–Dr. Greengrove and her staff and students will provide oceanographic instrumentation and scientific expertise: conduct marine sampling activities in QMH to augment existing data sets and fill data gaps for nutrients and

dissolved oxygen for model ground truthing and assist in presenting results at scientific meetings, in reports and papers.

Skip Albertson - Washington Department of Ecology (Ecology) - Ecology staff will assist with model selection and develop the model selected to simulate the hydrodynamics of QMH. Skip will also collaborate on the coupling of the modeled hydrodynamics into the model selected and developed to simulate the effects of N-loadings on dissolved oxygen within QMH in current and Best Management Practice (BMP) scenario conditions.

Vashon-Maury Island Groundwater Protection Committee (GWPC)–Committee members will facilitate public outreach on VMI, assist in developing Best Management Practices and policy recommendations.

12.2 Major Activities and Timelines

The major activities for this study are outlined below and the timelines are presented in Table 6.

This special study will begin to assess sites in late spring/early summer 2010. After a list of locations have been obtained, site access will be obtained from land owner(s). Each site will be assessed for location and site usability such as ease of access and location within the study area.

Sampling will during late fall/early winter after the 4 mg/L NO23 threshold has been reached at location VA45A. An assessment of data will be done after the sampling event to determine if additional sampling events need to occur.

Starting in 2011, the collected data will be evaluated to help identify areas within the basin where elevated nitrogen sources are entering the waterway. Additional research may be done on current and previous land-use practices to help track potential source(s). This information will be incorporated into the overall study identifying nitrogen loading sources and potential management strategies of those sources.

Table 6. Timeline for the Mileta Creek Nitrogen Source Tracking study activities.

Phase1 activities	Timeline	Organization	Description
Mileta Creek Nitrogen Source Tracking Assessment QAPP	Spring 2010	King County - Lead	Write a Sampling and Analysis plan for this special study
Phase 2 activities	**Timeline**	**Organization**	**Description**
Site Reconnaissance and Selection	Summer 2010	King County	Actively solicit homeowners to participate & select appropriate locations for study
Data collection	2010-2011	King County	Sample Mileta Creek study sites
Phase 3 activities	**Timeline**	**Organization**	**Description**
Mileta Creek study report	2011	King County	Write report on the findings of this special study as a part of the QMH Nitrogen Management Study

13.0. REFERENCES

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