Modeling Methodology Analysis

West Fork San Jacinto River Watershed Protection Plan

1.0 Introduction

To serve the development of a watershed protection plan (WPP) for the West Fork San Jacinto River and Lake Creek[1], the Houston-Galveston Area Council (H-GAC) will use a variety of data analysis and modeling tools to support stakeholder decisions. This analysis document outlines the modeling needs of the project, the models reviewed, and the rationale for model selection. Greater detail on the development and operation of the models/tools selected is contained in the Modeling Quality Assurance Project Plan (QAPP) for this project. The general emphasis of developing this modeling approach has been toward matching the complexity and character of the tools used to the questions that need to be answered.

2.0 Modeling Needs

The primary focus of the WPP development will be on identifying causes and sources of fecal bacteria, establishing load reductions, and estimating the scale of implementation needed to address them. Additionally, nutrient loading will be generally characterized to aid in discussion of low dissolved oxygen (DO) issues. Models and data analysis tools will be used at various points in the stakeholder process to inform decisions. The modeling approach needs to be efficient, and its complexity needs to match the level of support stakeholder decisions.

Bacteria Source Identification and Loading – To address bacteria sources, the stakeholders will need to understand the distribution and prominence of various source categories. This information needs to be generated for current and future conditions, and be able to be compared between subwatershed areas. Additionally, the change in bacteria loading and source prominence during different flow regimes should be examined. The development of the information also needs to be in line with the assumptions and stakeholder feedback from the original TMDL process, and with that of similar watershed projects to ensure comparable results.

Bacteria Load Reductions – To establish the scale of implementation efforts needed, H-GAC must establish the reductions necessary to attain and maintain compliance with applicable water quality standards. Instream concentrations should be used as the benchmark for establishing reductions, as they will be the metric by which compliance is measured. The scale of

[1] This document also refers to the model selection for the Spring and Cypress Creek characterization studies, included as part of a larger 319(h) grant project between TCEQ and H-GAC.

BMPs will be based on the number of representative source units needed to be addressed to meet load reduction requirements.

Dissolved Oxygen and Constituent Loading – To understand threats to DO levels, a modeling approach needs to be developed that provides general information on the level of DO issues during various flow regimes, and attempts to characterize source loading of primary constituents that lead to low DO conditions. The primary focus of source loading should be on nutrients.

3.0 Model Selection

To develop a comprehensive modeling approach, H-GAC discussed various models/tools, combinations, and assumptions with TCEQ and other local partners. In selecting models, H-GAC considered available data, time estimates for successful operation of the models, cost, match to stakeholder information needs, previous experiences with modeling packages, and comparability with other similar modeling efforts. The general modeling approach was developed as part of the project grant application, with specific elements developed or refined subsequent to project initiation. The following is a description of the modeling approach, including the models/tools selected, alternatives considered, and the rationale for model suitability. Prior to final implementation of the modeling strategy, the stakeholders will review and approve the modeling methodologies.

Bacteria Source Identification and Loading – Several modeling packages exist to estimate bacteria causes and sources, ranging in complexity from simple (mass balance models like Tidal Prism) to highly complex (watershed simulations like SWAT, EPDRiv1, etc). Based on the presumed stakeholder level of need, a low-to-moderate complexity modeling approach was chosen.

SELECT - At this tier of modeling, the Spatially Explicit Load Enrichment Calculation Tool (SELECT) is the model most widely used for WPPs to determine source loading. SELECT allows for source loading by land cover types, specific point sources, animal populations, and other factors. It meets the criteria established in Section 2, can be run with existing staff resources, and provides ample opportunity for stakeholder input. A “buffer” approach in which greater weighting is placed on riparian corridors will be used alongside a standard operation of the SELECT model to evaluate the potential change in source prominence based on discrepancies in aggregate source location. Prior to implementing SELECT, project staff will review the qualitative feedback of stakeholders from the original TMDL development process, and quantitative data and assumptions used, with particular attention to the NPS loading data and methodology(ies). H-GAC will review the TMDL NPS information as a comparative guide for developing SELECT model assumptions (evaluating representativeness of original versus current assumptions, identifying detail of original assumptions versus the needs of the WPP project, etc.) H-GAC will work with stakeholders as part of the SELECT review process to determine how to handle any discrepancies between NPS loading approaches between the two projects, other than currency of data.

Bacteria Load Reductions – Similar to loading models, several modeling packages exist to estimate bacteria reductions based on instream concentrations. There is great variability in model complexity among potential alternatives. However, based on the criteria discussed in section 2, a simple model that would determine load reductions and also examine flow regimes was best suited to the project needs. The use of Load Duration Curves (LDCs) as part of a Total Maximum Daily Load (TMDL) project for this watershed also influenced the model selection.

LDCs – LDCs were chosen as the tool for establishing bacteria reductions based on the project emphasis on efficiency and matched complexity. However, LDCs have been used for this purpose in many similar WPP modeling efforts. LDCs were used in the West Fork TMDL process, and therefore the results would be expected to be comparable. The LDC approach selected was to use established LDC tools (LOADEST) and current data. The previous TMDL LDC approach was evaluated and will be mirrored to the greatest extent practicable in terms of evaluating the assumptions used in identifying reduction thresholds, and any other qualitative or quantitative modifications made by project staff or in response to stakeholder feedback. While this information will serve as a guide for LDC development in this WPP, the final decision on approach will be approved by the WPP stakeholders based on their review and feedback. The resulting load reductions (in percentages) will be applied directly to the source loading established using SELECT to determine source load reductions. This approach assumes a generally linear relationship between instream concentrations and source loading. While this is a simpler load reduction estimation methodology than those employed using full watershed simulations, it is sufficient to guide stakeholder decisions and set preliminary reduction goals and is comparable to similar efforts in the region.

Dissolved Oxygen and Constituent Loading –In determining the best way to approach modeling DO precursors, H-GAC project staff conferred with TCEQ on expectations and criteria for model selection. In evaluating DO conditions, H-GAC differentiated between evaluating DO concentrations in relation to flow regimes, and potential loading of precursor constituents. The full rationale for the selection/development of a DO constituent modeling approach is contained in Appendix A.

LDCs – LDCs were chosen as the tool to characterize DO conditions during different flow regimes. No simple alternatives exist, and this approach is comparable to similar efforts, including the bacteria TMDLs and the bacteria LDCs in this project. LDCs will be used to evaluate fluctuation of DO based on flow severity, and the relationship between observed levels and water quality criteria. Additional review of DO conditions will be developed as part of 24-hour DO data collection and evaluation under this project.

GLAM – The Geospatial Load Assessment Methodology (GLAM) was developed by H-GAC to provide a simple means of estimating nutrient loading, assumed to be a primary constituent of low DO issues. Various models were evaluated, but due to the lack of existing DO impairment in the WPP watersheds, and the time and budget constraints of the project, a simple approach was considered best to meet stakeholder needs. GLAM projects source load based on land cover types. Literature values for loading per land cover type are used to find aggregate loading for each subwatershed for current and future scenarios. The intent of this approach is to provide a general estimation of nutrient loading and to understand the relative prominence of specific land cover types and subwatershed areas. Because GLAM is a new methodology without previous implementation, robust stakeholder review will be requested prior to its use.

4.0 Summary

The modeling approach described in this analysis places an emphasis on efficiency, flexibility, and suitability for addressing stakeholder needs. The narrative of the approach, in summary, is that SELECT will be used to identify and quantify bacteria source loads. LDCs will be used to evaluate loading in different flow conditions, and establish bacteria source reductions. LDCs will also be used to characterize DO during differing flow conditions, and GLAM will be used to show loading characteristics for nutrients precursors to low DO conditions. The stakeholders will use this information to understand the challenges facing them, prioritize sources to address, develop voluntary solutions, and scale the implementation of solutions to meet water quality standards in current and future conditions. This modeling approach is simpler than a full watershed simulation, but is ample to provide the data needed for the development of the WPP. Additional modeling may be needed in the future to address specific items of concern or changes in the watershed. Additional discussion about data considerations and the results of data acquisition efforts to populate these models are included in Appendix B.

Appendix A – GLAM methodology proposal

Geospatial Analysis Approach to Nutrient Loading

West Fork San Jacinto River Watershed Protection Plan

Introduction

In the West Fork San Jacinto River Watershed Protection Plan project area, dissolved oxygen (DO) levels are generally meeting state water quality standards[2], although there are DO concerns in Lake Creek (Segment 1015, for screening level) and for potential precursors the main stem (Segment 1004, for screening level of nitrate). However, there are impairments for DO (Segment 1008, 5c) and many nutrient and DO concerns in the tributary watersheds outside of the WPP area (throughout Segments 1008 and 1009), for which characterization work is being completed.

Moreover, rapid growth in these segments' watersheds is likely to exacerbate nutrient-related DO issues in the future, based on regional demographic projections and developmental trends over the past decade.

Under the watershed protection plan development project between TCEQ and H-GAC, modeling is being used to assess the location and relative contributions of various pollutant sources. While the primary focus is on elevated levels of fecal bacteria, the project includes tasks for assessing DO and nutrients.

This proposal is a methodology for general nutrient source load assessment based on land cover types. It is intended to be used to help stakeholders understand the impacts of various land cover types on nutrient loading and relative contribution of different areas of the watershed. It is not intended to establish a linkage or predictive model of fate and transport of nutrient constituents as they impact instream concentrations.

Modeling Need

Because there are no DO impairments in the WPP project area, the purposes for evaluating precursors to depressed DO are primarily based on understanding potential future issues that may impact meeting water quality standards, and educating stakeholders to shape decisions on implementation.

As with fecal bacteria, load duration curves will be used to evaluate the degree to which DO precursor pollutant loads exceed standards in varying flow conditions. Bacteria LDCs can be used to indicate the degree of load reduction needed. However, as DO is a condition, and not a tangible constituent, a load of DO cannot be established. While LDCs can indicate the degree of variance from the standard or

[2] However, in the extended project area of Spring and Cypress Creeks, nutrient and DO issues are more pronounced with one impairment for DO, and numerous nutrient based concerns.

screening level, this does not translate into a single constituent source load reduction. Many factors, including temperature, natural processes, hydrologic character, and pollutant sources can impact DO levels, each with multiple potential causes. Without utilizing more complex modeling approaches beyond the scope of this project's modeling criteria, a full understanding of the various sources and fate and transport of precursors to depressed dissolved oxygen cannot be developed. However, the value of modeling information for this watershed effort does not depend on this level of detail; corresponding source load modeling for bacteria is done with SELECT, a simple model approach. It is not expected that best management practices specific to DO will be a prominent aspect of the WPP, due to the lack of impairment.

Based on the character of the watersheds, the most likely precursors to DO are nonpoint source pollutants (including nonpoint source pollution channeled through stormwater systems) and the physical properties of the watersheds. Of the potential pollutants, nutrients (nitrogen and phosphorus compounds) are the primary focus.

Therefore the DO/nutrient source load modeling need for this project is descriptive rather than prescriptive and not intended to establish complex linkage with instream DO concentrations. It should indicate a general assessment of the nutrient loading in a way that may guide stakeholder decisions and future modeling efforts.

Model Selection

In determining the best way to approach modeling DO precursors, H-GAC project staff conferred with TCEQ on expectations and criteria for model selection. The overall emphasis for the project was on developing a model approach that was simple, and whose cost and time expense did not exceed the benefit it provided in informing stakeholder decisions. More complex modeling approaches like SWAT, HSPF, etc. were ruled out. As indicated, the corresponding source load approach for bacteria is to use SELECT, which will determine total potential load, and total potential load as modified by the application of weighting on the riparian corridor ("buffer approach").

H-GAC reviewed several modeling packages to determine the best way to model nutrients and/or DO in conjunction with LDCs. The models reviewed, and the outcomes are as follows:

1) **SELECT** – The original intent of the modeling effort was to use SELECT for all source load modeling. However, while SELECT is well documented in use for bacteria source load estimation, it has not been used for nutrient loading. In a more thorough review of potential means by which to adapt SELECT to nutrient load estimation, H-GAC staff determined that, to the best of our professional judgment, there was a lack of literature values and common assumptions for nutrients on which to base the load estimation. For example, SELECT develops loading for livestock by using assumptions of fecal bacteria load per unit of waste, units of waste per fecal event, and so on. No corresponding literature values applicable to a SELECT framework were available for nutrients. Additionally, project staff were concerned that natural sources of load or

impacts thereon (the impact of vegetative uptake, bacterial nitrification and denitrification, etc.) were either not easily adapted to the SELECT framework, or could not easily be estimated.

2) **SPARROW –** The USGS's Spatially Referenced Regression on Watershed Attributes (SPARROW) model has been widely used for nutrient load and fate and transport modeling. It was reviewed by staff as an alternative based on the potential to give defensible, comparable results within the same budget and timeframe limitations of SELECT. However, in discussions with TCEQ and EPA, concerns were raised about the scale (the model has been used almost exclusively on larger scales – major river basins, etc.), time series (annual time step versus smaller units in other modeling approaches), and the unneeded element of fate and transport (as opposed to simple potential loading). The outcome of the discussions with TCEQ were that this model was too complicated for the use of the date, untested at smaller scales, ineffective for urban areas, and was not a good match to the modeling need given the lack of impairment to address in the WPP watersheds.
3) **GWLF/BasinSim –** The Generalized Watershed Loading Functions (GWLF), and the desktop derivative BasinSim, were recommended by EPA and TCEQ as potential models for review. In looking at the relative complexity of the models as matched to the criteria and need for the project, BasinSim appears to be a good match. It provides robust assessment and is specialized to small and medium sized watersheds. However, there were no local examples of its successful implementation, and the extent of its budget and time implications was unknown at the time of writing. H-GAC staff would recommend further consideration of this model as the project progresses or in implementation, especially for those project watersheds in which impairments or multiple concerns exist. However, for the interim, it was decided that this model had too many unknowns to recommend for the initial modeling activities.
4) **GLAM** – The Geospatial Loading Assessment Methodology (GLAM) approach would be a newly developed approach by H-GAC project staff. This simple assessment tool would not be based on calibration to existing water quality data, or on multiple layers of loading. The intent would be to assign N and P average values to land cover types, and estimate average loads for each subwatershed through the sum of loads per land cover. Land cover would be derived from existing land cover data and subwatershed delineations utilized in the SELECT model (NOAA/NLCD, USGS HUC 12s, etc). The assessment tool would generate potential average loads, and would be able to generate future loads based on change in land cover data. It would also show relative contributions from respective subwatersheds. Project staff estimates that because the data to create this tool already exists, time and budget implications would be equal to or less than the corresponding approach for bacteria (SELECT). This basic level of data would be sufficient, absent an impairment, for stakeholder information in the WPP watersheds.

Based on time and budget considerations, modeling criteria, and the match of modeling need to output, H-GAC is proposing the use of the GLAM tool. The detail of the proposed methodology is found in the next section.

Proposed GLAM Methodology

Based on the model evaluation and selection process, H-GAC is proposing to use a simple geospatial analysis approach based on land cover types. As stated, the intent of this approach is to provide basic information on the potential nutrient loads in a subwatershed, and to show the relative contributions for each subwatershed. This approach will inform stakeholder consideration of potential future nutrient/DO issues in the WPP watersheds, provide a basis for further modeling of the characterization watersheds, and allow for basic prioritization of any efforts addressing nutrients by showing relative contributions by subwatershed areas. It will not, however, establish linkage between nutrient loads and instream concentrations, perform fate and transport modeling, or establish relative contribution by individual sources (loading is based on average loads for land cover, assumed to encompass all sources specific to that land cover type.).

This approach was developed specifically for this project effort, and will be completed and implemented by H-GAC project staff.

Data Needs - The GLAM approach is advantageous in that it does not require large amounts of acquired water quality data or long time series. The data required to operate the tool are:

- Land cover – H-GAC maintains several land cover datasets, as described in the draft QAPP. The land cover dataset used for SELECT will be used for GLAM.
- Loading values – loading values for land cover types will be taken from established literature values[3].
- Watersheds – delineations of watersheds and subwatersheds will be based on USGS HUCs or relative spatial extent, as developed in the SELECT modeling effort. It is expected the HUCs may be modified to fit on-the-ground conditions more accurately.
- Hydrology – H-GAC maintains hydrology datasets for the entire region. These are the same datasets to be used for the SELECT model.
- Future Land Cover Change – existing H-GAC regional demographic data will be used to estimate change in land cover for future conditions. The same data and time frame from the SELECT effort will be used.
- Other data – As needed for demonstrative purposes, H-GAC may add GIS layers for permitted outfalls, monitoring stations, or other spatial data pertinent to display. Layers for these and other spatial data are already in existence and will be identical to those used in SELECT.

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[3] Literature values will be taken from NRCS data on agricultural land cover nutrient loading (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_013288.pdf, for example), EPA loading estimates (http://www2.epa.gov/sites/production/files/documents/wetlands_19nutrientloading.pdf, etc.), and other values found in similar projects (such as https://www.tacoma.uw.edu/sites/default/files/global/documents/ias/UWaTERS_11/Moore.pdf). Project staff will review the full range of values and select most locally-appropriate values in conjunction with TCEQ review.

No data gaps exist for the implementation of this model.

Tool Development Steps- The tool will be developed and implemented using the following steps:

1) QAPP coverage – prior to development, the tool will be detailed in a QAPP. Work will not begin prior to QAPP approval by TCEQ.

2) Data Acquisition – Data will be acquired from existing sources detailed above, subsequent to the development of some layers during the SELECT modeling effort.

3) Base Map Development – A base map will be developed in GIS that will include political boundaries, land cover, hydrology, watershed delineations, and other data pertinent to display. The map will be developed in an ArcGIS environment.

4) Literature Value Review – Review of the existing range of literature values for N and P loading by land cover type will be completed, with a selection of final values to use. H-GAC will provide TCEQ with the chance to review the selections to ensure they are acceptable.

5) Land Cover Categorization - Based on the final selection of literature values, existing land cover categories will be re-categorized (simplified/lumped by similar type) based on the categories used in the values. For example, if the land cover data breaks out different types of wetlands, but the chosen literature value for N loading treats all wetlands the same, the land cover for all wetland types will be lumped together in a single category.

6) Buffer Development – A buffer application similar to SELECT will be developed to weight land cover contributions adjacent to riparian corridors. Both buffered and non-buffered runs can be estimated. The buffer will conform to the extent and weighting used in the SELECT model.

7) Land Cover Extraction – GIS will be used to extract the acres of each land cover category in each subwatershed, and for the segment watersheds as a whole. For example, subwatershed 1 will be characterized as having x acres of forest, y acres of wetlands, etc. This process will also be conducted for future conditions. The end result will be a series of tables showing total acres by each land cover category for each watershed/subwatershed unit, and the respective percentage it represents of total area in that unit.

8) Estimation of Nutrient Loading – using the tables created in step 7, the literature values will be applied to generate loadings for each subwatershed, and the component watersheds.
    a. Land cover acreage will be multiplied by the corresponding literature value for load per acre.
    b. The resulting loads for each category in each watershed unit will be summed to provide a total potential load.

c. The buffer will be applied in a second estimation to conduct the same process, but with weighting applied to the riparian areas.

9) Future Conditions – Steps 7 and 8 will be repeated using the future land cover data to estimate future loadings.

10) Spatial Display – the resulting tables will be imported into GIS to provide a spatial display of nutrient loading using color ramps or other symbology. Other charts and tables can be developed in GIS or Excel as needed for informative purposes.

Appendix B – Modeling Data Summary Report

Purpose

The purpose of this Appendix is to detail the water quality data retrieved and assessed as part of project efforts to review current and historical water quality data[4]. Its intent is to describe the extent of data acquired, the sufficiency of the data, the use of the data in the modeling efforts[5], and any data gaps identified. A separate detailed report of modeling results will be generated subsequent to modeling efforts and stakeholder review.

Project Data Sources

A variety of data sources, both qualitative and quantitative, are used in the development of a watershed protection plan project. For the assessment of the West Fork San Jacinto River watersheds, several modeling efforts will be employed to generate information to guide and inform stakeholder decisions. To the greatest degree practicable, the most representative and highest quality data available are used in these efforts. The data used include water quality monitoring results, spatial datasets, and literature values/assumptions. This report focuses on the monitoring data acquired as part of the project[6].

Data Needs

Three modeling efforts received data generated under these assessments:

- flow/load characterization and reduction assessment using Load Duration Curves (LDCs);
- bacteria load estimation and characterization using the Spatially Explicit Load Enrichment Calculation Tool (SELECT); and
- load estimation for nutrients using the Geospatial Load Assessment Methodology (GLAM).

[4] Subtask 3.1 and 3.3 of 319(h) grant project 582-15-56349 between H-GAC and TCEQ. A separate report on water quality monitoring data trends and analyses can be found at www.westforkwpp.com
[5] Further information on the specific use and provenance of the data can be found in the Modeling Quality Assurance Project Plan for this project.
[6] Further information on the assessment and sufficiency of spatial datasets and development of final modeling assumptions will be found in the upcoming report on modeling activities and outcomes. This report appendix focuses solely on data described and assessed as part of contract task 3.1 of project 582-15-56349.

Data Acquisition

Monitoring data used under this project was acquired from TCEQ's SWQMIS database[7]. Data from this source is generated by TCEQ and partners under the Clean Rivers Program's monitoring activities in the region. Data was acquired for all stations in the watershed After initial trends and variability analyses were conducted on the data, the portions necessary to populate the models were identified. The SWQMIS data used for each effort[8] includes:

- LDCs
  - Instantaneous flow
  - *E. coli*
  - Dissolved oxygen (grab)
- SELECT
  - *E. coli* (ancillary to primary model operation)
- GLAM
  - Nitrogen compounds (ancillary to primary model operation)
  - Phosphorus compounds(ancillary to primary model operation)
  - Dissolved oxygen (grab, ancillary to primary model operation))

Data Sufficiency and Characterization

In general, the data available through SWQMIS was sufficient to meet the needs of the modeling efforts (as described below). The primary data gaps identified during the assessment involve other data sources (USGS stream gauge data, etc.). The specific assessment of data for each modeling effort is discussed as follows.

LDCs

LDCs require three basic sets of data to operate: stream flows (either continuous, instantaneous, or extrapolated from existing data); bacteriological samples; and dissolved oxygen samples. Ancillary data (site name, watershed size, etc.) may be used

[7] This data source is the primary clearinghouse for quality-assured water quality data in the state, is the sole source for CRP data for these stations, and is specifically required in the WPP development contract. Therefore, no water quality data source evaluation/comparison was completed for this effort.

[8] Additional data sources, as described with each modeling effort, were used to generate these models (e.g. spatial datasets, literature values, etc.) However, these data sources are not part of the task 3.1 data collection and evaluation effort which this report refers to. The data listed here reflect only the water quality monitoring data used for these efforts and should not be taken to constitute a full accounting of all data used for this project. Further information on additional data can be found in the modeling report(s) for the modeling effort.

but are not specific to the water quality data collected from SWQMIS. Of these, stream flow is most often met using continuous flow data from USGS or similar gauges. In some instances, instantaneous flow results from ambient sampling can be used to construct extrapolated flows where gauges are not present. For this effort, at least 5 years of water quality data (and often more than 10) were available for all LDC stations. Instantaneous flow data was sufficient for those stations where they were needed. The LDCs were able to be run using the *E. coli* and DO grab sample data available in the SWQMIS dataset. As with other datasets, the lack of sampling in the highest flow conditions due to the logistics of fielding crews in storm events means there is a slight bias in the dataset as it exists. However, this is not an adverse finding for the LDC effort, and this is a universal assumption, not specific to this particular data or reflecting on its sufficiency. Some stations in the Lake Creek and West Fork watersheds had data gaps in the early year of the 10 year data period evaluated. However, there was sufficient data in the last five years and in prior years to operate the model with acceptable levels of uncertainty.

SELECT

SELECT estimates potential pollutant loading based on geospatial land cover characteristics and populations of sources generated from known data and literature values (e.g. cattle populations from agricultural census data, estimates of failing OSSFs). It is not calibrated to actual water quality concentrations, and it does not attempt to model fate and transport of loads between origination and eventual introduction to the water body. Therefore, it does not use water quality data in its setup or operation[9].

GLAM

GLAM estimates potential pollutant loading based on geospatial land cover characteristics and literature values (e.g. estimated pounds of nitrogen from a pasture land cover type). It is not calibrated to actual water quality concentrations, and it does not attempt to model fate and transport of loads between origination and eventual

[9] However, staff often use water quality concentrations as a rough indicator of what may be occurring in a given monitoring station's subwatershed. This is not part of the model process, nor is it a methodology of operating the model. However, great disparities between instream concentrations and SELECT current potential load estimation may indicate that assumptions in SELECT need to be revisited. This is not intended to be a calibration process. For this purpose, the *E. coli* data acquired from SWQMIS is sufficient.

introduction to the water body. Therefore, it does not use water quality data in its setup or operation[10].

Data Summary

The data obtained from SWQMIS for the modeling efforts of this project are primarily flow, bacteria, nutrients, and dissolved oxygen. Only the LDC effort relies on SWQMIS data for its primary operation, and for this purpose the data was more than sufficient. The use of the data for the SELECT and GLAM efforts is ancillary, and used primarily to inform stakeholder understanding of the models. For this purpose the data was sufficient.

[10] As with SELECT, staff may use nitrogen and phosphorus compounds and DO concentrations from SWQMIS data as an informal check on GLAM, though not one considered part of the modeling process. In general, this data is most likely to be used to inform discussions of the model results with the stakeholders.