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APPENDIX A

Modeling Plan and Reporting

This appendix presents the SPU-preferred outlines for a Modeling Plan, Key Goals Technical Memorandum, Modeling Report, Flow Monitoring Plan, and Flow Monitoring Report.

Modeling Plan

All SPU projects with hydrologic and hydraulic (H/H) modeling must have a Modeling Plan. The Modeling Plan must follow the sample outline presented in Appendix A. SPU DWW LOB representative must approve any deviations from the plan. All approved deviations from the Modeling Plan must be documented in the Modeling Report.

The Modeling Plan is a roadmap the modeling team to follow and understand how key inputs, outputs, assumptions, and other decisions will be made. The following are key steps in developing a modeling plan:

1. Determine key goals for the project, including how others will use the results
2. Determine the areas covered by the model, identify boundary conditions, and level of detail required
3. Develop a Quality Assurance (QA) plan
4. Develop a documentation strategy
5. Determine model input requirements and data sources
6. Prepare a Flow Monitoring plan (if applicable)
7. Develop a strategy for calibrating and validating model (see [DSG section 7.9](#))
8. Develop a strategy for uncertainty analysis (if applicable).

All projects with flow monitoring must have a flow monitoring plan prepared before flow monitoring installation. See Flow Monitoring Plan and Report outline below.

Modeling Report

Table 1 shows the preferred content for an SPU modeling report.

Table 1
SPU Modeling Report Content

Section of Report	Content
Model Development	Documents work from project inception to pre-calibration: <ul style="list-style-type: none"> • Project definition, background, and purpose • Description of model construction for existing conditions • Data description, sources, reliability, and location of data storage. Data documentation should be as specific as possible. Reference firm or agency of origin, date, format, modifications, and any comments on data quality or assumptions.

	<ul style="list-style-type: none"> • Assumptions and simplifications • Naming conventions for maintenance holes, pipes, structures, etc. • Flow estimation methodology. • Deviations from Modeling Plan
Model Calibration and Validation	<p>Documents accuracy of the model against measured data:</p> <ul style="list-style-type: none"> • Calibration records including initial variable assumptions and justifications for variable adjustments • Metrics indicating the models compliance with calibration and validation standards. Refer to DSG section 7.9 Model Calibration and Validation. • Description and justification of changes to the model during calibration • Graphs comparing predicted to actual flow both for the calibration and validation period. Comments of the model's suitability for the intended use, particularly if the model does not meet one or more validation standards • Analysis used to evaluate the suitability of a model not conforming to the validation standards • Limitations of the model • Correlation of predicted and observed attributes specific to the project • Defined range acceptable for model calibration and validation results
Alternative Analysis (If applicable. This chapter is usually in the Preliminary Engineering Report)	<p>Documents how the model was used to identify capacity limitations, evaluate alternatives to improve service, and model future conditions. Particularly important when a model is used for design, evaluations for future conditions, and optimization. Project specific but should include details of changes made to the calibrated model:</p> <ul style="list-style-type: none"> • Capacity assessment results • Description of capital and/or operational project alternatives • Modeling of the alternatives • Future sewer flow projections and key assumptions • Operation changes such as pump replacements or modifications to flow control structures
Conclusions and Recommendations	<p>Project specific and can include:</p> <ul style="list-style-type: none"> • Existing system performance including key flow control facilities • Capacity limitations or surpluses • Rehabilitation recommendations • Surcharge prediction • Any limitations of the model for future use and what is needed to fill gap. • Any conclusions or recommendations developed using the model should be supported by the models output (e.g. graphs, surcharge depths, peak flows)
Appendices	<p>Additional documentation must include:</p> <ul style="list-style-type: none"> • Hydraulic and/or Hydrologic Model Development • Calibration and Validation • QA/QC documentation including Modeling QA/QC Checklist (see Appendix B) • Technical Memoranda

Modeling Plan and Report Outline

The following is the SPU preferred outline for H/H modeling plans and reports:

Executive Summary

Chapter 1 Introduction

- 1.1 Background and Project Goals and Objectives
- 1.2 Study Boundaries

Chapter 2 Basin Characterization

- 2.1 Overview
 - 2.1.1 Conveyance System
 - 2.1.2 Climate
 - 2.1.3 Land Use
 - 2.1.4 Soils
 - 2.1.5 Population
- 2.2 Sub-basin 1
- 2.3 Sub-basin 2
- 2.4 Sub-basin 3

Chapter 3 Data Collection

- 3.1 System Data
 - 3.1.1 Pipe and Maintenance Holes
 - 3.1.2 Special Structures
 - 3.1.3 Datum Adjustments
- 3.2 Population Data
- 3.3 Surface Data
- 3.4 Rainfall and Flow Meter Data
- 3.5 Filling Data Gaps

Chapter 4 Model Development

- 4.1 Modeling Platform
- 4.2 Hydraulic Model Construction
 - 4.2.1 Maintenance Holes
 - 4.2.2 Pipes and Open Channels
 - 4.2.3 Special Structures
 - 4.2.4 Outfalls
- 4.3 Hydrologic Model Construction
 - 4.3.1 Subcatchment Delineation
 - 4.3.2 Loading Points
 - 4.3.3 Dry-Weather Flow Conditions
 - 4.3.4 Wet-Weather Flow Conditions
- 4.4 Boundary Conditions

Chapter 5 Calibration

- 5.1 Calibration Process
- 5.2 Calibration Events
- 5.3 Target Calibration Criteria
- 5.4 Calibration Points
- 5.5 Preliminary Calibration (Manual Calibration)
- 5.6 Automated Calibration (if applicable)
 - 5.6.1 Sampled Parameters and Ranges
 - 5.6.2 Event and Meter Weighting Factors
- 5.7 Best Fit Parameter Sets and Goodness-of-Fit (if applicable)
- 5.8 Flow Calibration Results
- 5.9 Depth Calibration Results

Chapter 6 Existing System Performance

- 6.1 System Response to Rainfall
- 6.2 Capacity Limitations and Surface Flooding in the System
- 6.3 Performance of Control Facilities (if applicable)
- 6.4 Performance of Pump Stations (if applicable)
- 6.5 Performance of Recent Projects (if applicable)
- 6.6 Characteristics of Combined Sewer Overflows (if applicable)

Chapter 7 Long-Term System Performance

- 7.1 Existing Conditions
- 7.2 Future Conditions
- 7.3 Uncertainty Analysis

Chapter 8 QA/QC Review Process

- 8.1 Model Refinement
- 8.2 Calibration
- 8.3 Uncertainty Analysis

Chapter 9 Alternative Analysis (if applicable)**Chapter 10 Summary and Conclusions****Appendix****List of Tables****List of Figures**

Key Goal Technical Memorandum

The goals should be described in the project scope of work. Listing the key goals of the project helps the modeling team determine the necessary level of detail. The following are elements that could be included in key goals:

- Necessary level of detail (conceptual, planning, CIP-development, design, calibration)
- Type of hydraulics (simplified kinematic or fully hydrodynamic)
- Area of concerns (local or systemwide)
- Important physical processes (I/I, surface water runoff, hydraulic capacity limits, and control systems).

Flow Monitoring Plan and Report

All SPU projects with flow monitoring must have a Flow Monitoring Plan. The Flow Monitoring Plan must follow the sample outline presented below. SPU DWW LOB representative must approve any deviations from the plan. All approved deviations from the Flow Monitoring Plan must be documented in the Flow Monitoring Report.

The Flow Monitoring Plan is a roadmap for the modeling and monitoring team to follow and understand how key inputs, outputs, assumptions, and other decisions will be made. The following are key steps in developing a flow monitoring plan

- Determine key goals and objectives for the project, including how others will use the results
- Type and quality of data required. Determine if there is existing data available to fit project needs.
- Determine project boundaries and the areas covered by the monitoring, identify critical structures and/or flow control features to monitor

- Plan monitoring and precipitation locations
- Identify major milestones
- Develop a Quality Assurance (QA) plan
- Develop a documentation strategy
- Determine flow monitoring equipment requirements and procedures
- Develop data review and data management procedures which include data verification and validation process
- Develop a safety plan

Flow Monitoring Plan and Report Outline

The following is the SPU preferred outline for flow monitoring plans and reports:

Chapter 1 Introduction

- 1.1 Project Description
 - 1.1.1 Project Goals
 - 1.1.2 Project Objectives
 - 1.1.3 Information Requirements
 - 1.1.4 Study Boundaries
 - 1.1.5 Practical Constraints
 - 1.1.6 Data Collection
 - 1.1.7 Decision-making
- 1.2 Background
 - 1.2.1 Study Area
 - 1.2.2 Logistical Problems
 - 1.2.3 History
- 1.3 Parameters of Concern
 - 1.3.1 Previous Studies
 - 1.3.2 Criteria and/or Standards

Chapter 2 Organization and Schedule

- 2.1. Roles & Responsibilities
 - 2.1.1. Special Training Needs/Certification
- 2.2. Timeline/project schedule
 - 2.2.1. Project deliverables
 - 2.2.2. Project success factors
- 2.3. Document and Records
 - 2.3.1. Laboratory Data Reports
 - 2.3.2. Electronic Data
 - 2.3.3. Records and Documents Retention Requirements
 - 2.3.4. Revisions to the Flow Monitoring Plan
 - 2.3.5. Expedited Changes

Chapter 3 Quality Objectives

- 3.1. Measurement Quality Objectives
 - 3.1.1. Precision
 - 3.1.2. Bias
 - 3.1.3. Representativeness

- 3.1.4. Completeness
- 3.1.5. Comparability
- 3.1.6. Sensitivity (Reporting Limits)
- 3.2. Data Quality Objectives
 - 3.2.1. Percentage Raw Data Quality
 - 3.2.2. Percentage QA/QC Data Quality

Chapter 4 Sampling Process Design (Experimental Design)

- 4.1. Flow Monitors
- 4.2. SCADA Monitoring Locations

Chapter 5 Sampling Procedures

- 5.1. Sample Handling & Custody
- 5.2. Documentation of Field Sampling Activities
- 5.3. Non-direct Measurements

Chapter 6 Measurement Procedures

Chapter 7 Quality Control

- 7.1. Analytical Quality Control
 - 7.1.1. QC Samples
- 7.2. Field Quality Control
 - 7.2.1. QC Samples
 - 7.2.2. Instrument/Equipment Testing, Inspection, and Maintenance
 - 7.2.3. Instrument/Equipment Calibration and Frequency
 - 7.2.4. Inspection/Acceptance of Supplies and Consumables

Chapter 8 Data Management Procedures

- 8.1. Data Path
- 8.2. Record-keeping and Data Storage
- 8.3. Data Verification/Validation
- 8.4. Forms and Checklists
- 8.5. Data Handling
- 8.6. Hardware and Software Requirements
- 8.7. Information Resource Management Requirements

Chapter 9 Audits and Reports

- 9.1. Audits and Response Actions
- 9.2. Deficiencies, Nonconformances and Corrective Action
- 9.3. Reports to Management

Chapter 10 Data Verification and Validation

- 10.1. Data Review, Verification, and Validation
- 10.2. Verification and Validation Methods

Chapter 11 Data Quality (Usability) Assessment

- 11.1. Data Assessment Approach, Methods, and Presentation
- 11.2. Roles and Responsibility
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- Appendix D Flow Monitoring Quality Assurance and Implementation Plan
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