HYDRAULIC MODEL DESIGN ELEMENTS & SYSTEM CAPACITY – EXPANSION REPORT

Standard Report Format
August 2015

_____
(Project Name)

_____
(Water System Number)

_____
(Water System Name)

_____
(DDW File Number, If Available)

_____
(Date)

Author (Professional Engineer's Name)
Author Contact Information (Affiliation, Address, Phone Number, and E-mail Address)
Report Completion Date
*(*This report must be signed, sealed, and dated by a professional engineer.)*

TABLE OF CONTENTS

Use this Standard Report Format to develop a *Hydraulic Model Design Elements & System Capacity – Expansion Report* for **regional or system-wide** proposed modifications to drinking water systems. If the standard report format identified in this document is followed, the Division of Drinking Water (DDW) should be able to provide a timely review and response. If the standard format is not followed, the author must ensure that each rule requirement is adequately addressed and clearly identified in the report. Letters of response will always reference sections of this document. To ensure that each plan is complete, please number each section of the *Hydraulic Model Design Elements & System Capacity – Expansion Report* to match the sections of the standard report format.

The purpose of the *Hydraulic Model Design Elements & System Capacity – Expansion Report* is to document the requirements of a water system's capacity, ability to expand, and hydraulic modeling requirements in a single report. The document includes the analysis of a water system's existing, proposed, and projected facilities and connections, modeling methodology, model analysis, and results of a water system's hydraulic modeling requirement as set forth in *R309-511, Hydraulic Modeling Requirements,* and *R309-110-4, Definitions – Master Plan or System Capacity and Expansion Report*. The purpose of the Hydraulic Modeling Requirements rule is to ensure that the increased water demand created by new and projected construction will not adversely affect existing or new water users. This purpose will be accomplished by requiring the public water system or its agent to evaluate the water delivery system by doing the following:

1. Determining existing connections and water demands
2. Projecting future connections and water demands
3. Developing a hydraulic model that will evaluate existing and proposed water demands
4. Certify to the Division that proposed and projected projects will not adversely impact the system.

It is intended that the public water system or its agent will use the findings of the capacity and expansion report and the system hydraulic model to design improvements providing satisfactory service to both existing and new water users. R309-511 requires the public water system or its agent to certify that the design meets minimum flow requirements of *R309-510* and pressure requirements as set forth in rule *R309-105-9*.

R309-511 applies to public drinking water systems categorized as community water systems as defined by rule *R309-100-4(4)* and to non-transient non-community water systems that have system demands higher than required by *R309-510* or with demands for fire suppression. All public drinking water systems are still required to comply with *R309-550-5* with respect to water main design which may require a hydraulic analysis. Further, certifications as defined by R309-511, shall be part of the submission of plans for any public drinking water project as defined in rule *R309-500-5(1),* except projects that meet the criteria established in *R309-511-4(1)(a)(i).*

All *Hydraulic Model Design Elements & System Capacity – Expansion Reports* shall be signed, dated, and stamped by a registered professional engineer, licensed to practice in the State of Utah.

HYDRAULIC MODEL DESIGN ELEMENTS & SYSTEM CAPACITY EXPANSION REPORT

HYDRAULIC ANALYSIS CERTIFICATION

I hereby certify that the hydraulic modeling analysis for:

_____
(Project Name or Description)

_____
(Water System Name)

_____
(Water System Number)

_____
(DDW File Number, If Available)

Meets all requirements as set forth in *R309-511* (*Hydraulic Modeling Requirements*) and complies with the provisions thereof, as well as the sizing requirements of *R309-510*, and the minimum water pressures of *R309-105-9*. Where applicable the proposed additions to the distribution system will not cause the pressures at any new or existing connections to be less than those specified in *R309-105-9*. The model is sufficiently calibrated and accurate to represent the conditions within this water system. The velocities in the model are not excessive and are within industry standards. The hydraulic modeling method is *[e.g., use of computer software or hand calculations]***, and the computer software used was** *[software name and version]***.**

Signature _____

Print Name _____

State of Utah P.E. License No. _____

Date _____

(* This page must be **signed, sealed, and dated** by a professional engineer who oversees the completion of this hydraulic modeling analysis.)

EXECUTIVE SUMMARY

Include a brief summary of this report.

1.0 INTRODUCTION

1.1 System Information:

Include the water system name, number, and address. Is it a new or an existing water system? Is it a public or a non-public water system? If public, is it a community, a non-transient/non-community, or a transient/non-community water system? The first name of a new water system submitted to DDW will be the name under which it will be tracked in the future. Please ensure, to the best of your ability, that the name established for the water system will remain the same.

1.2 Existing System Description:

Provide a brief description of existing water system facilities including a system schematic map.

1.3 Proposed & Projected Additions and Improvements to the System:

Provide a brief description of proposed and projected additions and improvements to the water system. Include a schematic of the proposed and projected system additions and improvements.

2.0 SOURCES AND FACILTIES

2.1 Sources:

Provide a listing of sources including: the source name, the source type (i.e., well, spring, reservoir, stream, etc.) for both existing sources and additional sources identified as needed for system expansion, the minimum reliable flow of the source in gallons per minute, the status of the water right, and the flow capacity of the water right.

2.2 Storage Facilities:

Provide a listing of storage facilities including: the storage tank name, the type of material (i.e., steel, concrete, etc.), the diameter, the total volume in gallons, and the elevation of the overflow, the lowest level (elevation) of the equalization volume, the fire suppression volume, and the emergency volume or the outlet elevation.

2.3 Pump Stations:

Provide a listing of pump stations including: the pump station name and the pumping capacity in gallons per minute. Under this requirement one does not need to list well pump stations as they are provided in requirement 2.1 above.

2.4 Distribution System:

Provide a listing of the various pipeline sizes within the distribution system with their associated pipe materials and, if readily available, the approximate length of pipe in each size and material category. A schematic of the distribution piping showing node points, elevations, length and size of lines, pressure zones, demands, and coefficients used for the hydraulic analysis required below will suffice.

3.0 EXISTING AND FUTURE CONNECTIONS

3.1 Service Area

Provide a description of the nature and extent of the area currently served by the water system and a plan of action to control addition of new service connections or expansion of the public drinking water system to serve new development(s). The plan shall include the current number of service connections as well as land use projections and forecasts of future water connections.

3.2 ERC Evaluation:

Provide a description of the total number of equivalent residential connections (ERC) including existing connections, connections that the public drinking water system is committed to serve, but has not yet physically connected to the infrastructure; anticipated new connections associated with the project; and projected connections that have been forecast in Section 3.1. The number of ERC's must include high as well as low volume water users. Describe how the ERCs are determined (i.e., single family residence, 40 unit condominium complex, elementary school, junior high school, high school, hospital, post office, industry, commercial, etc.). The determination of the equivalent residential connections shall be based on flow requirements using the anticipated demand as outlined in R309-510, or based on alternative sources of information that are deemed acceptable by the Director.

3.3 Growth Management Alternatives:

Provide a description of potential alternatives to manage system growth, including interconnections with other existing public drinking water systems, developer responsibilities and requirements, water rights issues, source and storage capacity issues and distribution issues.

4.0 WATER DEMAND CRITERIA

4.1 Indoor Demand:

Include a description of the existing and proposed indoor demand requirements. Indoor demand criteria should be as outlined in R309-510-7 for peak day demands. Describe indoor peak day and peak instantaneous demands to the water system's facilities. These demands may be peak day and peak instantaneous demands per *R309-510*, a reduced demand approved by the Director per *R309-510-5*, or the demands experienced by the water system which exceed the values listed in R309-510. Describe how the indoor peak day and peak instantaneous demands are determined and calculated.

4.2 Outdoor Demand:

Describe the existing and proposed outdoor use peak day and peak instantaneous demands and the criteria utilized to calculate those demands for each ERC/connection. Table 510-5 and Table 510-7 in *R309-510* should be utilized to determine outdoor peak day and peak instantaneous irrigation use, respectively, in the absence of compiled data. If the irrigation demands are based on the map in *R309-510-7(3)* the report must identify the irrigation zone number, a statement and/or map of how the irrigated acreage is spatially distributed, and the total estimated irrigated acreage. If the irrigation demand map in *R309-510-7(3)* is not used, the report shall provide justification for the alternative demands used.

4.3 Fire Flow Requirements:

Include a statement stating either "yes fire hydrants exist or will exist within the system" or "there are no fire hydrants connected to the system and there is no plan to add fire hydrants with this project." Provide the local fire authority's name, address and contact information for either statement.

If the system provides fire flows, include a description of the water system's existing and proposed fire flow quantity and duration requirements. Where no local fire authority exists fire flow requirements shall be per *R309-510-9(4) & R309-550-5(5)*.

4.4 Other Demand:

This section applies if the system has other water demand, such as consecutive connections or significant industrial water uses, in addition to indoor and outdoor water uses and fire flow requirements. Describe the nature and extent of the demand, and the criteria utilized to calculate those demands.

4.5 Demand Versus Existing and/or Proposed Capacities

Provide a comparison between the demands listed in this section and the system's known (and/or proposed) capacity.

5.0 METHODOLOGY AND ANALYSIS

5.1 Hydraulic Model Used:

Include a description of the hydraulic modeling method used. If a computer model was used identify the software and its source. Include a description of the model and the parameters input into the model, as well as any assumptions behind the model or input values.

5.2 Hydraulic Model Input:

Provide the methodology used for allocating indoor, outdoor, and fire flow demands to the model; a summary of pipe length by diameter; a hydraulic schematic of the distribution piping showing pressure zones, general pipe connectivity between facilities and pressure zones, storage, elevation and sources; and a list or ranges of values of friction coefficients used in the hydraulic model according to pipe material and condition in the system. All coefficients of friction used in the hydraulic analysis shall be consistent with standard practices.

Include a description of scenarios modeled and their purpose.

5.3 Field Calibration Methodology:

Describe the calibration method, provide details of how field measurements were calibrated with the model, and provide a quantitative summary of the calibration results (i.e., comparison tables, graphs)

5.4 Hydraulic Model Analysis:

The hydraulic model analysis is required to model existing and proposed water demand scenarios. Water systems that provide outdoor irrigation and fire flow will include these demands in their scenarios. Provide a description of the hydraulic analysis of each model scenario required to account for the varying water demand conditions. In some cases, extended period simulations are needed to evaluate changes in operating conditions over time. This will depend on the complexity of the water system, extent of anticipated fire event and nature of the new expansion.

Include printouts of the data or graphical presentations from the computer program used for modeling. Raw data and other output from the computer program may be included in an appendix.

6.0 ANALYSIS RESULTS & CONCLUSION

6.1 Hydraulic Model Results:

Provide a description of the results for each scenario modeled to include existing and proposed conditions. Describe the locations of the lowest pressures within the distribution system, and areas identified by the hydraulic model as not meeting the minimum pressure requirements in *R309-105-9*.

6.2 Comparison of Field Measurements and Model Results:

Provide a description of the model results and the comparison with the field measurements.

6.3 Conclusion of Project Impact from Model Results:

Provide a concluding paragraph(s) that describes how the proposed project will impact minimum flow and pressure requirements and the consequences to existing or new water users.

6.4 If supported by the modeling results include rule compliance conclusion language that states in effect:

a) With the designed improvements all existing and new water users will be provided the quantity of water at pressures compliant with State rules (*R309-105-9 Administration: General Requirements of Public Water Systems – Minimum Water Pressure*), or

b) If applicable, add an exception or exclusion to the above statement explaining the area and reason why the State rule requirements are not being met.

APPENDIX

CHECKLIST FOR HYDRAULIC MODEL DESIGN ELEMENTS REPORT

The hydraulic model checklist below identifies the components included in the Hydraulic Model Design Elements Report for

_____
(Project Name or Description)

_____
(Water System Number)

_____
(Water System Name)

_____
(Date)

The checkmarks and/or P.E. initials after each item indicate the conditions supporting P.E. Certification of this Report.

1. The Report contains:

   (a) A listing of sources including: the source name, the source type (i.e., well, spring, reservoir, stream etc.) for both existing sources and additional sources identified as needed for system expansion, the minimum reliable flow of the source in gallons per minute, the status of the water right and the flow capacity of the water right. *[R309-110-4 "Master Plan" definition]* ☐ _____

   (b) A listing of storage facilities including: the storage tank name, the type of material (i.e., steel, concrete etc.), the diameter, the total volume in gallons, and the elevation of the overflow, the lowest level (elevation) of the equalization volume, the fire suppression volume, and the emergency volume or the outlet. *[R309-110-4 "Master Plan" definition]* ☐ _____

   (c) A listing of pump stations including: the pump station name and the pumping capacity in gallons per minute. Under this requirement one does not need to list well pump stations as they are provided in requirement (a) above. *[R309-110-4 "Master Plan" definition]* ☐ _____

   (d) A listing of the various pipeline sizes within the distribution system with their associated pipe materials and, if readily available, the approximate length of pipe in each size and material category. A schematic of the distribution piping showing

node points, elevations, length and size of lines, pressure zones, demands, and coefficients used for the hydraulic analysis required by (h) below will suffice. *[R309-110-4 "Master Plan" definition]* ☐ _____

(e) A listing by customer type (i.e., single family residence, 40 unit condominium complex, elementary school, junior high school, high school, hospital, post office, industry, commercial etc.) along with an assessment of their associated number of ERCs. *[R309-110-4 "Master Plan" definition]* ☐ _____

(f) The number of connections along with their associated ERC value that the public drinking water system is committed to serve, but has not yet physically connected to the infrastructure. *[R309-110-4 "Master Plan" definition]* ☐ _____

(g) A description of the nature and extent of the area currently served by the water system and a plan of action to control addition of new service connections or expansion of the public drinking water system to serve new development(s). The plan shall include current number of service connections and water usage as well as land use projections and forecasts of future water usage. *[R309-110-4 "Master Plan" definition]* ☐ _____

(h) A hydraulic analysis of the existing distribution system along with any proposed distribution system expansion identified in (g) above. *[R309-110-4 "Master Plan" definition]* ☐ _____

(i) A description of potential alternatives to manage system growth, including interconnections with other existing public drinking water systems, developer responsibilities and requirements, water rights issues, source and storage capacity issues and distribution issues. *[R309-110-4 "Master Plan" definition]* ☐ _____

2. At least 80% of the total pipe lengths in the distribution system affected by the proposed project are included in the model. *[R309-511-5(1)]* ☐ _____

3. 100% of the flow in the distribution system affected by the proposed project is included in the model. If customer usage in the system is metered, water demand allocations in the model account for at least 80% of the flow delivered by the distribution system affected by the proposed project. *[R309-511-5(2)]* ☐ _____

4. All 8-inch diameter and larger pipes are included in the model. Pipes smaller than 8-inch diameter are also included if they connect pressure zones, storage facilities, major demand areas, pumps, and control valves, or if they are known or expected to be significant conveyers of water such as fire suppression demand. *[R309-511-5(3)]* ☐ _____

5. All pipes serving areas at higher elevations, dead ends, remote areas of a distribution system, and areas with known under-sized pipelines are included in the model. *[R309-511-5(4)]* ☐ _____

6. All storage facilities and accompanying controls or settings applied to govern the open/closed status of the facility for standard operations are included in the model. *[R309-511-5(5)]* ☐ _____

7. Any applicable pump stations, drivers (constant or variable speed), and accompanying controls and settings applied to govern their on/off/speed status for various operating conditions and drivers are included in the model. *[R309-511-5(6)]* ☐ _____

8. Any control valves or other system features that could significantly affect the flow of water through the distribution system (i.e. interconnections with other systems, pressure reducing valves between pressure zones) for various operating conditions are included in the model. *[R309-511-5(7)]* ☐ _____

9. Imposed peak day and peak instantaneous demands to the water system's facilities are included in the model. The Hydraulic Model Design Elements Report explains which of the Rule-recognized standards for peak day and peak instantaneous demands are implemented in the model (i.e., (i) peak day and peak instantaneous demand values per *R309-510, Minimum Sizing Requirements*, (ii) reduced peak day and peak instantaneous demand values approved by the Director per *R309-510-5, Reduction of Sizing Requirements*, or (iii) peak day and peak instantaneous demand values expected by the water system in excess of the values in *R309-510, Minimum Sizing Requirements*). The Hydraulic Model Design Elements Report explains the multiple model simulations to account for the varying water demand conditions, or it clearly explains why such simulations are not included in the model. The Hydraulic Model Design Elements Report explains the extended period simulations in the model needed to evaluate changes in operating conditions over time, or it clearly explains (e.g., in the context of the water system, the extent of anticipated fire event, or the nature of the new expansion) why such simulations are not included in the model. *[R309-511-5(8) & R309-511-6(1)(b)]* ☐ _____

10. The hydraulic model incorporates the appropriate demand requirements as specified in *R309-510, Minimum Sizing Requirements*, and *R309-511, Hydraulic Modeling Requirements*, in the evaluation of various operating conditions of the public drinking water system. The Report includes:
    - the methodology used for calculating demand and allocating it to the model;
    - a summary of pipe length by diameter;

- a hydraulic schematic of the distribution piping showing pressure zones, general pipe connectivity between facilities and pressure zones, storage, elevation, and sources; and
- a list or ranges of values of friction coefficient used in the hydraulic model according to pipe material and condition in the system. In accordance with Rule stipulation, all coefficients of friction used in the hydraulic analysis are consistent with standard practices.

[R309-511-7(4)] ☐ _____

11. The Hydraulic Model Design Elements Report documents the calibration methodology used for the hydraulic model and quantitative summary of the calibration results (i.e., comparison tables or graphs). The hydraulic model is sufficiently accurate to represent conditions likely to be experienced in the water delivery system. The model is calibrated to adequately represent the actual field conditions using field measurements and observations. *[R309-511-4(2)(b), R309-511-5(9), R309-511-6(1)(e) & R309-511-7(7)]* ☐ _____

12. The Hydraulic Model Design Elements Report includes a statement regarding whether fire hydrants exist within the system. Where fire hydrants are connected to the distribution system, the model incorporates required fire suppression flow standards. The statement that appears in the Report also identifies the local fire authority's name, address, and contact information, as well as the standards for fire flow and duration explicitly adopted from *R309-510-9(4), Fireflow*, or alternatively established by the local fire suppression agency, pursuant to *R309-510-9(4), Fireflow*. The Hydraulic Model Design Elements Report explains if a steady-state model was deemed sufficient for residential fire suppression demand, or acknowledges that significant fire suppression demand warrants extended model simulations and explains the run time used in the simulations for the period of the anticipated fire event. *[R309-511-5(10) & R309-511-7(5)]* ☐ _____

13. If the public drinking water system provides water for outdoor use, the Report describes the criteria used to estimate this demand. If the irrigation demand map in *R309-510-7(3), Irrigation Use*, is not used, the report provides justification for the alternative demands used in the model. If the irrigation demands are based on the map in *R309-510-7(3), Irrigation Use*, the Report identifies the irrigation zone number, a statement and/or map of how the irrigated acreage is spatially distributed, and the total estimated irrigated acreage. The indicated irrigation demands are used in the model simulations in accordance with Rule stipulation. The model accounts for outdoor water use, such as irrigation, if the drinking water system supplies water for outdoor use. *[R309-511-5(11) & R309-511-7(1)]* ☐ _____

14. The Report states the total number of connections served by the water system including existing connections and anticipated new connections served by the water system after completion of the construction of the project. *[R309-511-7(2)]* ☐ _____

15. The Report states the total number of equivalent residential connections (ERC) including both existing connections as well as anticipated new connections associated with the project. In accordance with Rule stipulation, the number of ERC's includes high as well as low volume water users. In accordance with Rule stipulation, the determination of the equivalent residential connections is based on flow requirements using the anticipated demand as outlined in *R309-510, Minimum Sizing Requirements*, or is based on alternative sources of information that are deemed acceptable by the Director. *[R309-511-7(3)]* ☐ _____

16. The Report identifies the locations of the lowest pressures within the distribution system, and areas identified by the hydraulic model as not meeting each scenario of the minimum pressure requirements in *R309-105-9, Minimum Water Pressure*. *[R309-511-7(6)]* ☐ _____

17. The Hydraulic Model Design Elements Report identifies the hydraulic modeling method, and if computer software was used, the Report identifies the software name and version used. *[R309-511-6(1)(f)]* ☐ _____

18. For community water system models, the community water system management has been provided with a copy of input and output data for the hydraulic model with the simulation that shows the worst case results in terms of water system pressure and flow. *[R309-511-6(2)(c)]* ☐ _____

19. The hydraulic model predicts that new construction will not result in any service connection within the new expansion area not meeting the minimum distribution system pressures as specified in *R309-105-9, Minimum Water Pressure*. *[R309-511-6(1)(c)]* ☐ _____

20. The hydraulic model predicts that new construction will not decrease the pressures within the existing water system such that the minimum pressures as specified in *R309-105-9, Minimum Water Pressure* are not met. *[R309-511-6(1)(d)]* ☐ _____

21. The velocities in the model are not excessive and are within industry standards. ☐ _____