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WATER FACILITY MINIMUM SIZING AND RELIABILITY STANDARDS

8-06.0.0 WATER FACILITY MINIMUM SIZING AND RELIABILITY STANDARDS

8-06.1.0 General

1.1 Purpose

This section describes the design and reliability standards and requirements for the minimum sizing of public drinking water projects.

1.2 Definitions

Section 8-18 contains a list of definitions, abbreviations, and acronyms. Note: The word “customer” means “customer / property owner.”

1.3 Applicability

The requirements listed herein apply to all water projects. Additional requirements are contained in other design standards for the various types of projects.

8-06.2.0 Water Pressure

This subsection contains the following major topics:

- Water System Boundary
- Minimum Dynamic Pressure, State of Arizona
- Static Pressures, Tucson Water Standard
- Customer's Pressure Responsibilities
- Dynamic Pressure and Flow, Computerized Modeling

2.1 Water System Boundary

A. Public Water System
The public water distribution system ends at a location that includes the water meter.

B. Customer’s Water System
The customer’s private plumbing system begins at the discharge side of the water meter (AAC R18-5-101.91).

2.2 Minimum Dynamic Pressure, State of Arizona

A potable water distribution system shall be designed to maintain and shall maintain a pressure of at least twenty pounds per square inch at ground level at all points in the distribution system under all conditions of flow, as required by AAC R18-5-502.B, Minimum Design Criteria.

2.3 Static Pressures, Tucson Water Standard

A. Single Zones

Generally, water is to be provided at the utility's water service connection, the water meter, within a static pressure range of thirty-five pounds per square inch to eighty-five pounds per square inch. Due to localized topographic conditions, certain locations may receive pressure slightly less or greater than the stated range.

B. Dual Zones

In some areas, typically called dual zones or two zone lifts, a static pressure range of thirty-five pounds per square inch to 130 pounds per square inch may be provided.

Tucson Water may consider creation of dual zones where the elevation changes rapidly in a short distance and the service needs warrant it.

Customers located in the lower portion of the dual zone will be required to install a pressure reducing valve with an integral bypass in the service line and/or an expansion tank inside the home. The residence will then be in accordance with the Uniform Plumbing Code, 1994 Edition, as modified and adopted on 11/20/95 by Mayor and Council, as the Tucson Code, Section 6-124, including any more recent adoptions, hereinafter referred to as the Uniform Plumbing Code.

2.4 Customer's Pressure Responsibilities

A. Applicable Pressure Regulations

The Uniform Plumbing Code limits the water pressure within the customer's facility to a minimum of fifteen pounds per square inch and a maximum of eighty pounds per square inch in order to prevent damage to the customer's piping and fixtures.

B. Pressure Regulation Devices

- When the public water system minimum pressure described in paragraph 2.2 is met at the meter, it is the responsibility of the customer to increase the water pressure when the supply in the customer's plumbing is less than fifteen (15) pounds per square inch or if a plumbing fixture requirement is higher than fifteen (15) pounds per square inch.

- Reducing the pressure when it exceeds eighty (80) pounds per square inch is the responsibility of the customer.

- When a pressure reducer or a booster pump is installed, a closed system may be created. The customer is responsible for reviewing local plumbing codes for pressure relief and thermal expansion device requirements that are intended to prevent damage to the customer's piping and fixtures.

2.5 Dynamic Pressure and Flow, Computerized Modeling

Tucson Water maintains hydraulic computerized models of the existing water systems. They are used to determine specific capabilities and requirements of system improvements. These models assist in the sizing and alignment of facilities, surge protection, and contamination remediation.

A. Water Demand Models

The results of the analysis of computerized models of water demands are used to determine whether proposed water system improvements and/or land development projects meet requirements for water pressure, headloss, and velocity.

Real-time data is also used in analysis, system curves, pumping evaluation, and for control assessment purposes.

B. Surge Protection Models

Tucson Water will review proposed new pipelines, large services and facility plans for the surge protection needs of the Tucson Water system. Analysis of surge modeling shall help determine the need for mitigation of water hammer (see Section 8-16) in the design stage.

The engineer shall design and submit the methods and equipment proposed for surge protection of the Tucson Water system.

C. Modeling Performed by Design Engineers

Tucson Water will review all engineer-generated water demand computerized models for accurate and complete data inputs.

8-06.3.0 Water System Planning Criteria, Project-Level

The criteria used for water system planning and water system improvements due to an individual land development project include the following types of water use:

- General Service
- Fire Suppression Service

The land development project must include all the water system improvements needed to maintain water system pressure while meeting the land development project's future water demands. The water improvements may include pipelines, pumping stations, pressure reducing stations, storage facilities, and wells. They may be "on-site" and/or "off-site" depending upon the land development project's specific location and needs.

3.1 General Service

General service requirements for water demand include the rate of water delivered during a specified period. The periods that must be met by the water system improvements include yearly, monthly, daily, and hourly periods. Water demand can also vary from area to area, depending on the type of water users within that area.

A. Average Daily Demand

At the individual project level, average daily demand includes residential and nonresidential types of water uses averaged over a one-year period:

1. Residential Use
   a. The gallons per capita per day value is 110 for residential units to include single, multi-family, townhouse, and condominium.

   b. The persons per housing unit value is 2.7 for new residential units. Variations to this factor may be considered during the plan review process, at Tucson Water's sole discretion.

2. Nonresidential Use
   a. Commercial and Industrial Use – 2,000 gallons per acre per day (1.39 gallon per minute per acre) shall be used if no more specific data is available. Variations may be considered during the plan review process, at Tucson Water's sole discretion.

      Note: Section 27-31 of the Tucson Code defines industrial use as at least five (5) million gallons per month, or sixty (60) million gallons per calendar year. The use is specifically for manufacturing purposes; thus, the water use would not include landscape irrigation, restrooms, or drinking fountains.

   b. Turf – 0.8 acre-foot per acre of turf, total annual demand minimum (for types of turf typically used by schools in the southwest). Reclaimed water is required for all new golf courses. Some pumping facilities may not pump twenty-four hours per day, but only a maximum of six or eight hours per day. Therefore, flow rate and required pipeline size design increases accordingly.

   c. The project engineer shall provide detailed calculations for the land development project's intended use, including peak water demands.

B. Peak Water Demand Factors
If no more specific data is available, the factors to be used for determining peak water demand, except for higher factors as determined by Tucson Water, for individual land development project design include the following:

1. The average day of the peak month demand factor is 1.5 times the average daily demand.

2. The peak day demand factor is 1.8 times average daily demand.

3. The peak hour demand factor is 3.15 times average daily demand.

4. Maximum day factor for turf is 2.64 times average daily demand.

3.2 Fire Suppression Service

The water project design shall include the fire suppression service requirements of the fire suppression authority, or of Tucson Water, whichever is higher.

Since the fire flows listed herein are added to the peak day demand requirements, the total flow rates required through the pipeline will be greater than the fire flow requirements alone.

A. Fire Suppression Authority Requirements
1. For fire suppression service requirements of the structures in the project area, the design engineer shall consult with the fire suppression authority for:

   a. the fire flow rates, in gallons per minute, and
   b. the associated fire flow duration (in hours).

2. This information shall be provided on the water plans.

B. Tucson Water Fire Suppression Requirements
Additional minimum requirements for fire suppression from Tucson Water facilities, new system additions and extensions, and “fire hydrant only” projects include:

1. 1,000 gallons per minute for two hours, for single-family residential up to 3,600 sq. ft. Homes above 3,600 square feet require fire sprinklers and/or greater fire flow according to fire authority review and approval

2. 1,500 gallons per minute for two hours, for multi-family residential
3. 1,500 gallons per minute for two hours, for commercial
4. 4,000 gallons per minute for four hours, for industrial and downtown areas

8-06.4.0 Water Pipeline Sizing

When stating pipe or pipeline size, this refers to the inside diameter. This subsection contains the following major topics:

- Demand Conditions for Pipelines
- Minimum Pipeline Sizing
- Pipeline Velocity and Headloss Limitations
- Service Line Sizing for Single-Family Residential Units
- Valve Sizing for Pipelines
- Reliability Standards of Water Pipelines

4.1 Demand Conditions for Pipelines

The demand conditions in the water distribution system for each individual pipeline and appurtenance, such as pressure reducing valves, include peak day demand and fire suppression requirements.

The demands are based on the total service connections and the type of structures to be served by the pipeline. This includes future connections and structures if the land development project or water system improvement is constructed in phases, or where extensions of the pipeline are possible.

As previously stated, the pressure requirements of subsection 8-06.2 must be met for all distribution piping. Discussion can be found in ADEQ Engineering Bulletin No. 10, Chapter 7 – Distribution Systems, Section C. Water Main and System Design, subsection 2. System Pressures.

4.2 Minimum Pipeline Sizing

This subsection contains the following topics:

- Distribution System, Looped Pipeline, Minimum Size (6-inches)
- Distribution System, Dead-End Pipeline, Minimum Size (8-inches)
- Transmission Mains, Phasing
- Blow-off Valve Assembly
- Drain Valve Assembly

A. Distribution System, Looped Pipeline, Minimum Size (6-Inches)
Looped pipelines provide for equalization of pressure and flow by reducing the total headloss at any given customer location. This piping configuration significantly improves the reliability of service to customers because it improves water system operational flexibility by providing a backup water supply during a planned or unplanned shutdown to one portion of the pipeline.

1. Configuration of a Looped Pipeline
The ideal configuration for a looped pipeline has two independent sources of water supply. The number of customers who are still in service when one portion of the looped pipeline is out of service determines the degree of effectiveness of a looped pipeline. For example, if a pipeline (connected to the distribution system water main) is connected to itself at the point it goes into and out of a subdivision (forming a loop), the subdivision would not be effectively looped.

2. Minimum Size of Looped Pipelines
Where fire suppression is or may be required, the minimum size for a looped pipeline in the distribution system shall under no circumstance be less than six (6)-inches. Final determination of the pipe size will be based on hydraulic analysis of the area and may result in a larger, but not smaller, size.

B. Distribution System, Dead-End Pipeline Minimum Size (8-Inches)
Dead-end pipelines are defined as pipelines that are not looped or connected to a second pipeline or other water source in the distribution system.

Dead-end pipelines are normally not permitted because they create the potential for water to become stagnant. The disinfection residual can become depleted, allowing bacterial growth and the occurrence of taste and odor problems. Dead-end pipes also do not have a second source of water if the pipeline is out of service.

- When the use of a dead-end water main is unavoidable, a blow-off valve assembly or a drain valve assembly shall be provided at the terminal end of the water main. This will permit the flushing of the water main to improve water quality by discharging stagnant water and particulates, such as sand. Detailed requirements of these assemblies are provided below in the appropriate paragraphs of this subsection.

- Where fire suppression is or may be required, the minimum size for a dead-end pipeline in the distribution system shall under no circumstance be less than eight (8)-inches. Final determination of the pipe size will be based on hydraulic analysis of the area and may result in a larger, but not smaller, size.

Other sizes of dead-end pipelines may be considered and analyzed on an individual basis, if requested by the design engineer, as described below:

1. Two-Inch Dead-End Pipeline, No Fire Suppression Required
When using two-inch pipe in the distribution system, there shall be no more than five equivalent 5/8-inch meters connected:

   - where no fire suppression or fire hydrants are required,
   - where the pipe is less than 250 feet long, and
   - where no future extension is possible, as determined by Tucson Water.

2. Four-Inch Dead-End Pipeline, No Fire Suppression Required
When using four-inch pipe in the distribution system, there shall be no more than twenty equivalent 5/8-inch meters connected:

   - where no fire suppression or fire hydrants are required,
   - where the pipe is less than 350 feet long, and
   - where no future extension is possible, as determined by Tucson Water.

   Equivalent 5/8-inch meters are defined as follows:

   - 1-inch meter equals two and a half 5/8-inch meters
   - 1.5-inch meter equals five 5/8-inch meters
   - 2-inch meter equals eight 5/8-inch meters

C. Transmission Mains, Phasing

1. Justification for a Phased Pipeline
   All transmission mains may be "phased" (separated into equivalent capacity and installed over time) using two or more smaller pipelines:

   - when justified by an economic analysis,
   - provides other benefits to the water system such as reliability (a second source of water supply under phase two), and
   - must be acceptable to Tucson Water.

2. Projected Water Demands During Each Phase
   All pipelines shall be capable of providing water demands projected during each phase and associated time period of the transmission main, and shall meet any other minimum pipeline requirements addressed elsewhere in this manual.

D. Blow-off Valve Assembly
   See Tucson Water Standard Details for a description of blow-off valve assemblies and modified blow-off valve assemblies.

1. Location
   A blow-off valve assembly or modified blow-off valve assembly shall be provided at the terminal end of a dead-end pipeline and/or temporary stub out for flushing and disinfection.

2. Minimum Pipe Size
   The minimum pipe size in a blow-off valve assembly (or a modified blow-off) is two (2) inches for use with dead-end pipelines up to eight-inches in diameter.

3. Type to be Installed
   A modified blow-off valve assembly shall always be installed where a future water pipeline extension is possible. Where a future water pipeline is not possible, Tucson Water may approve installation of a blow-off valve assembly.

4. Minimum Pipeline Velocity
   The pipe in a blow-off valve assembly or a modified blow-off valve assembly shall be sized to maintain a minimum water main velocity of 2.5 feet per second (2.5 fps) which is intended to scour sand and silt from the water main. (AZ State Health Bulletin No. 8, Disinfection, Water Mains, Preliminary Flushing, p. 18)

E. Drain Valve Assembly
   Drain valve assemblies shall be provided at low points in pipelines to facilitate draining the pipe. These assemblies shall not be located in sidewalks or driveways.

1. Location
   Drain valve assemblies will be required on transmission mains sizes of thirty-six (36) inches or larger at approved locations.

2. Minimum Pipe Size
   The minimum pipe size in a drain valve assembly is six (6) inches.

4.3 Pipeline Velocity and Headloss Limitations

New pipelines shall have a minimum Hazen-Williams pipe roughness coefficient of 120.

A. Distribution System Pipelines

1. Peak Day Demand Conditions

For pipelines twelve (12) inches or less, the following criteria must be met under peak day demand conditions in the distribution system:

- the velocity shall not exceed five (5) feet per second, or
- the headloss shall not exceed ten (10) feet/1000 feet.

2. Peak Day Demand and Fire Flow Conditions

For pipelines twelve (12) inches or less, the following criteria must be met under peak day plus fire flow demand conditions in the distribution system:

- The velocity shall not exceed eight (8) feet per second, where extensions of the same pipeline are possible.

- The velocity shall not exceed eleven (11) feet per second, where no extensions of the same pipeline are possible.

B. Transmission Mains

In transmission mains sixteen (16) inches or larger, the following criteria must be met under any conditions of flow:

- the velocity shall not exceed five (5) feet per second, or
- the headloss shall not exceed three (3) feet/1000 feet.

4.4 Service Line Sizing for Single-Family Residential Units

This portion of the standard applies only to the size of a specific pipeline (service line) used for a specific customer classification (single-family residential).

For location requirements, refer to Section 8-08, Water Pipeline Design Standards.

- “Service line” means the pipeline located between the distribution system water main and the water meter.

- “Water service connection” means the service line and the water meter.

The following residential customer classifications of service are found in the Tucson Code, Article II, Rates and Charges, Section 27-31, Definitions:

Family Units:

- “Single-family unit” means one (1) residential unit, served by one meter.
- “Duplex unit” means two (2) residential units, served by one meter.
- “Triplex unit” means three (3) residential units, served by one meter.

Multi-Family Units:

- “Multi-family unit” means four (4) or more residential units, served by one meter.

A. Water Service Line – Minimum Size
The minimum service line size is one (1)-inch, nominal diameter, for a single-family residential unit using a 5/8-inch or a 1-inch water meter.

The minimum service line size for larger than a one (1)-inch nominal diameter meter shall be equal to the water meter nominal diameter, unless otherwise directed by the engineer.

B. Water Service Line Split – Not Permitted
The use of one common service line for two (2) or more single-family residential units, each connected at one branch piece (a.k.a. split, split service), but each unit using its own separate water meter, is not permitted.

4.5 Valve Sizing for Pipelines

In general, isolation or shut-off valves shall be the same size as the pipeline in which they are installed. Typical isolation or shut-off valves used are gate and butterfly valves.

A. Distribution System Valves
Gate valves in the distribution system shall not be downsized on pipe sixteen (16) inches or smaller in diameter.

B. Transmission Main Valves
1. Gate Valves
Gate valves in transmission mains may be downsized one standard size on pipe twenty-four (24) to forty-eight (48) inches in diameter provided the velocity through the valve does not exceed the valve manufacturer's specifications.

2. Butterfly Valves
Butterfly valves in transmission mains shall not be downsized on pipe sixteen (16) inches or smaller in diameter.

4.6 Reliability Standards of Water Pipelines

Reliability standards are intended to minimize disruption of service to customers by constructing facilities in a way that takes into account planned or unplanned interruption of operation of the facility.

The degree of reliability designed and constructed into the water system is based on a number of factors, including:

- the probable frequency of the emergency condition,
- the cost of such a condition in terms of loss of service and customer satisfaction, and
- the cost of providing the additional reliability.

The standard of Tucson Water is to maintain an acceptable level of customer service. This level of service is defined in terms of a water-demand scenario.

Tucson Water will provide pipeline redundancy whenever possible for increased reliability of service to Tucson Water customers. The redundancy is defined as follows:

At a minimum, the average daily demand (ADD) shall be met whenever any pipeline is out of service.

A. Parallel Pipelines
Parallel lines may be required at Tucson Water's discretion if looped pipelines are not feasible or where two different pressure zones converge to serve the project.

B. Looped Pipelines
Wherever practicable, new distribution system pipelines shall be connected to two separate pipelines in order to provide two separate sources of water supply in the event that one fails to function.

8-06.5.0 Water Storage Facility Sizing

This subsection contains the following topics:

- Types of Water Storage Facilities
- Sizing Components of Water Storage Facilities
- Reliability Standards of Water Storage Facilities
- Additional Requirements of Water Storage Facilities

5.1 Types of Water Storage Facilities

Storage capacity is met by use of elevated or ground storage facilities. For purposes of these design standards, Tucson Water uses the following terms:

- "high-water storage" will be used instead of "elevated storage," and
- "forebay" will be used instead of "ground."

A. High-Water Storage
Any storage facility is considered to be high-water storage if it is at an elevation above the upper zone boundary elevation of that portion of the distribution system it serves.

- Thus, ground or subsurface tanks built on high ground are called high-water storage (defined by ADEQ and American Water Works Association as elevated storage). High-water storage can also be referred to as gravity storage tanks or reservoirs depending on their size and materials.

- Most of the Tucson Water system's major water storage facilities are defined as high-water storage whose water surface level defines the hydraulic gradient elevation of that portion of the distribution system it serves.

- This type of configuration is classified as an open system because it is open to atmospheric pressure.

B. Forebay Storage
Forebay storage is typically used as a source of water supply that is re-pumped to another service area at a higher elevation. Also, forebay storage can be used to assist in meeting peak demands in a hydro-pneumatic pressure system since it functions as a source of water supply to that system.

C. Combined Storage
A storage facility can also be combined to serve both functions of forebay and high-water storage:

- Forebay Storage - A portion of the storage facility capacity is sized for use as forebay storage to serve a service area at the same or higher elevations.

- High-water Storage - Another portion of the storage facility capacity is sized for use as high-water storage to serve a service area by gravity.

5.2 Sizing Components of Water Storage Facilities

A. Objectives
For the water service area (area of influence) that the water storage facility is intended to serve, the total net (usable) capacity of the storage facility shall provide components:

- for flow and pressure equalization,
- for fire suppression, and
- for an emergency water supply.

Net capacity is less than gross capacity due to the unusable volume of the storage facility. This unusable capacity is dependent upon the shape of the storage facility and the elevation of the outlet pipe.

These objectives are also further explained in ADEQ Engineering Bulletin No. 10, Chapter 6, Water Storage. The storage facilities are called reservoirs or tanks, depending on their size and materials.

B. Equalization Storage Component
The storage components for equalization are required to meet water system demands in excess of water system delivery capabilities. Tucson Water's delivery capabilities (water supply facilities) are sized to meet the average day of the peak month demand. Therefore, the equalization storage component shall be at least equal to the peak day demand.

C. Fire Suppression Storage Component
The following criteria shall be used to determine the storage component for fire suppression of the total volume required initially and at full build-out of the water service area.

1. Area of Influence
   - Each storage facility shall be able to provide the fire suppression requirement within its area of influence.
   - The area of influence is a function of the water service area's peak day demands, fire-flow demands, and distribution piping configuration.

2. Minimum Fire Suppression Component
   The storage component for the minimum fire suppression requirement shall be based on the largest structure that requires the highest flow rate and associated

duration as determined by the fire suppression authority, or Tucson Water, whichever is higher.

D. Minimum Emergency Storage Component
To meet demands in the event of an emergency situation, such as a power outage, a line break or a pumping station failure:

1. The storage component for an emergency shall be at least five (5) percent of the peak day demand.

2. Due consideration shall be given to the water service area that the storage facility serves and the water system piping and storage facility arrangement. This may cause the minimum emergency net storage capacity percent to increase or decrease. A decrease will be allowed only if offset by an excess storage component in another storage facility located in the same pressure zone.

5.3 Reliability Standards of Water Storage Facilities

Reliability standards are intended to minimize disruption of service to customers by constructing facilities in a way that takes into account planned or unplanned interruption of operation of the facility.

A. Operational Requirements of Storage Facilities
1. To meet future demands and current water demands when the storage facility is out of service, the storage facility shall, at Tucson Water's discretion, be divided into multiple cells that can be operated independently to maintain service. This includes phase one if there is more than one phase.

2. If the storage facility is a tank, at Tucson Water's discretion, a second tank may be required in the site design for phase two.

B. Pipeline Redundancy Requirements for Storage Facilities
1. Looped pipelines from the storage facility to the service area shall be part of the pipeline design configuration. The pipelines shall start as near to the storage facility as possible.

2. Parallel pipelines may be required at Tucson Water's discretion if looped pipelines are not feasible.

5.4 Additional Requirements of Water Storage Facilities

A. Phasing of Storage Facilities
Storage facilities may be phased if justified by an economic, engineering, and operational analysis. Each storage facility shall meet all water demands projected for the duration of each phase.

The projected water demand for each phase of the land development project shall be submitted for Tucson Water review.

B. Elevation of Storage Facilities

1. For high-water storage, the upper operating level in the storage facility will be at the high-water elevation of the zone to be served by the storage facility.

2. The depth between the upper operating level and lower operating level of a storage facility shall be twenty-five (25) feet unless otherwise approved by Tucson Water.

3. Storage facilities shall be located above the 100-year flood prone area, with in-ground storage facilities also located above the groundwater table.

C. Pipeline Size for Storage Facilities

Pipelines serving the storage facility must be of sufficient size to provide the design flow out of the facility, as well as the refill flow into the facility, and to maintain water system pressure during peak flows.

The pipelines for each phase of the storage facility shall meet all water demands projected for the duration of that phase.

8-06.6.0 Pressure Reducing Valve Station Standards

Pressure reducing valve (PRV) stations provide a source of water supply that shall be available upon demand to a lower pressure zone from a higher pressure zone.

6.1 Sizing of PRV Stations

A. Water Demand

The Water System Planning Section of Tucson Water shall provide the water demand data, which may include a development project's demands, existing and future, as the basis for sizing of the pressure reducing valves (PRV) and associated piping.

B. Velocity in Piping

Velocity of the water shall not exceed five feet per second in the supply and discharge piping. Reducers and increasers shall be used to connect the typically larger onsite supply and discharge piping to meet pipeline velocity requirements before and after the pressure reducing valve.

Pressure reducing valves may be downsized from the inlet and outlet pipeline sizes to which they are connected, provided the velocity across the valve does not exceed the valve manufacturer's specifications.

6.2 Pressure Controls

All pressure reducing stations shall be equipped with pressure controls that allow the pressure settings to be adjusted.

A. Primary Source, Pressure Setting

Pressure reducing stations that serve as the primary source of water supply, where no other water production facility serves the area of influence, shall be set at the high-water of the pressure zone being served.

B. Supplemental or Backup Source, Pressure Setting
Pressure reducing stations that serve as the supplemental or back up source of water supply for meeting peaking or fire flow demand shall be set slightly below the high-water setting (i.e. 10+/- pounds per square inch below normal operating pressure).

Water system analysis shall be used to determine the optimum setting whereby pressure standards for all operational conditions are maintained. Back-up facilities are designated as such due to a secondary efficiency rating in a cost of energy comparison of water sources.

6.3 Reliability Standards of Pressure Reducing Stations

A. A pressure reducing station shall have two pressure regulating valves of the same size, installed in parallel, to provide reliability during maintenance periods or failure of components.

B. Each pressure reducing valve and lateral piping shall be sized to independently accommodate the full flow of the pressure reducing station, as determined in subsection 8-06.6.1.

C. Where another suitable pressure reducing station serves the same water service area, Tucson Water may determine the other to be of sufficient redundancy. To be considered, the other offsite pressure reducing station shall serve the same area of influence and be capable of meeting the total flow requirements.

8-06.7.0 Pumping Station Standards for Closed Systems

This subsection on pumping station requirements for closed systems contains the following major topics:

- General
- Pump and Pipe Sizing
- Pressure Tank Sizing
- Pump Elevation
- Reliability Standards for Closed Systems

A water system serving a water service area that is supplied by a pumping station is classified as a closed water system because it is not open to atmospheric pressure, as is the case when there is a high water storage facility.

This type of system uses a hydro-pneumatic pressure tank to assist in maintaining pressure, to minimize pump cycling, and to meet instantaneous water demand.

7.1 General

A. Principles of Operation of a Hydro-Pneumatic Pressure System

1. The basic types of applications and principles of operation of a hydro-pneumatic pressure system are explained in ADEQ Engineering Bulletin No. 10, Chapter 5, Hydro-Pneumatic Pressure Tanks.

2. At a minimum, all requirements in Chapter 5 must be met.

B. Purpose

The purpose of the hydro-pneumatic pressure tank system is:

- to develop and maintain pressure in the water system by means of compressed air as an alternative to high water storage, and

- to minimize pump cycling. (Cycling is the turning on-and-off of a pump, which increases the wear and tear on a pump much more than the constant running of a pump.)

- to protect the system from pressure transients (water hammer).

These closed water systems typically serve water service areas where it is not possible to construct a high water storage facility.

7.2 Pump and Pipe Sizing

A. Total Capacity of Pumping Station

1. Because there is no storage facility, the total capacity of the pumping station (or stations) must be sized to provide the water demand for the water service area at planned build-out. Total capacity shall include:

   - either peak day water demand plus fire suppression requirements,
   - or peak hour water demands, whichever is greater,

   - plus water demands being lifted or regulated to another pressure zone(s).

2. All piping within the pumping station shall be sized for the total water demand at planned build-out of the water service area.

3. A minimum of two (2) pumps shall be provided above a maximum instantaneous demand rate of 105 gallons per minute in accordance with ADEQ Bulletin 10, page 5-2.

B. Initial Pump Sizes

1. Sizing of Initial Pumps
   The initial set of pumps installed in the pumping station shall be sized for the total water demand during the pump's estimated life, usually ten (10) years.

2. Net Pump Capacity
   A sufficient number of pumps shall be selected to work together at the same discharge pressure in order to provide required total station capacity. In all cases, a larger "gross capacity" sum of the pumps is required to reach the net operating output required.

C. Pump Cavitation
Pump sizing shall not exceed capacity of the suction line or the NPSH requirements of the pump.

D. Onsite Pipelines of the Pumping Station

1. Velocity for Total Station Capacity
   Onsite pipelines of the pumping station shall be sized at five (5) feet per second maximum velocity for discharge piping, three (3) feet per second maximum for suction piping, based upon total station capacity. (See section 8-10 for information.)

2. Reserved Space for Pump Additions
   Typically, space along the manifold and ground at the pumping station site is reserved, with blind flanged lateral(s) provided, for future pump additions anticipated to meet total water demand at planned build-out of the area.

7.3 Pressure Tank Sizing

A. Discharge Pressure Tank Components
Pressure tanks shall be designed and sized to meet the purpose of the water pressure system as described in paragraph 7.1.B. Tucson Water's standard hydro-pneumatic pressure tank size for a typical pumping facility is 5,000 gallons. Tank size refers to the total internal volume for water and air. The water volume typically represents ten to fifty percent of the total tank volume.

1. Pump Cycling Component
The cycling reduction component of the total pressure tank volume shall include sufficient volume to minimize the frequency of on-off cycles of the water supply pumps. Normal pump cycling is in the range of two (2) to six (6) times per hour.

2. Minimum Instantaneous Demand Component
Determination of the tank size shall include a component for supplying the minimum instantaneous demand.

a. The hydro-pneumatic pressure tank must be sized together with the pumps so that the facility can supply instantaneous demand for a minimum of twenty minutes. (Subsection C, page 5-2, ADEQ Engineering Bulletin No. 10.), or

b. Instantaneous demand shall be determined from Table 3, Maximum Instantaneous Demand Flows for Residential Use, page 5-3, ADEQ Engineering Bulletin No. 10.

c. Instantaneous demand, Table 3, is used solely to provide a sizing component of the tank. Instantaneous demand is not the same as peak hour demand.

3. Water Hammer Component
Surge protection design calculations shall be provided.

B. Suction Pressure Tank Size
A suction pressure tank of the same size as the required discharge tank shall be required unless the suction supply is provided from an on-site forebay storage facility.

7.4 Pump Elevation

- The pumps shall be located so that they will not produce a negative pressure upon the suction lines.

- Intake pressure shall be at least twenty (20) pounds per square inch with automatic cutoff of pumps if the pressure falls to ten (10) pounds per square inch (subsection D, p. 3-7, ADEQ Engineering Bulletin No. 10).

- A stand-alone pumping station, not located at a reservoir site, shall not be placed above the lower zone boundary elevation of the pressure zone that the pumping station supplies.

7.5 Reliability Standards for Closed Systems

Reliability standards for the pumping stations are intended to minimize disruption of service to customers by constructing facilities in a way that takes into account planned or unplanned interruption of operation of the facility.

The degree of reliability designed and constructed into the water system is based on a number of factors, including:

- the probable frequency of the emergency condition,
- the cost of such a condition in terms of loss of service and customer satisfaction, and
- the cost of providing the additional reliability.

The standard of Tucson Water is to maintain an acceptable level of service defined in terms of a water-demand scenario.

Tucson Water will provide pumping station (closed system) redundancy whenever possible for increased reliability of service to Tucson Water customers. The redundancy is defined as follows:

> Average daily demand shall be met during an interruption of the power supply for the customers served by a pumping station.

A. Power Supply

There shall be an electrical connection and switching capability built in at panels for the pumping station to be operated by either of two independent sources of power supply. These normally consist of the main power supply and a backup supply.

B. Back Up Source of Power

1. In the event of an interruption of the main power supply, a backup power supply hook-up shall be provided for a portable generator to be placed on site to meet average daily water demands until the main power supply is restored.

2. There shall be an area reserved on-site for a self-powered portable electric generator near the backup power supply hook-up.

3. Where a natural gas main is unavailable to a facility, space for a portable fuel storage tank shall be provided in the event one needs to be transported to, and set up on, the site in an emergency. Placement of such fuel tanks shall meet all local fire and safety codes.

C. System Bypass of Pumping Station

1. A system bypass of the pumping station shall be available to minimize the number of affected customers when it is out of service or not operating as designed (refer to subsection D, page 3-7, ADEQ Engineering Bulletin No. 10).

2. A system bypass alternative can be accomplished if a closed zone-boundary valve is present on the water main supply located within the adjacent right-of-way.

3. Motor operated valves may also be designed to be remotely operated as a system bypass alternate.

D. Limit on Consecutive Chain of Pumping Stations
No more than two consecutive pumping stations for closed systems shall be built to serve adjacent water service areas, without high-water storage being constructed simultaneously for one of the service areas.

8-06.8.0 Pumping Station Standards for Open Systems

This subsection for pumping station requirements for open systems contains the following topics:

- General
- Pump and Pipe Sizing
- Pressure Tank Sizing
- Pump Station Elevation
- Reliability Standards for Open Systems

8.1 General

A. Principles of Operation of a Pumping Station

1. The basic types of applications and principles of operation of pumping stations are explained in ADEQ Engineering Bulletin No. 10, Chapter 3, Pumping Facilities.

2. At a minimum, all requirements in Chapter 3 must be met.

B. Purpose
The purpose of the pumping station is to provide a relatively constant source of water supply for the service area. For closed system requirements, refer to subsection 8-06.7.0. This includes refilling the storage facilities during low demand periods.

8.2 Pump and Pipe Sizing

A. Total Capacity of Pumping Station
The total capacity of the pumping station (or stations) must be sized to provide the water demand that will not be supplied from storage for the water service area at planned build-out. Total capacity shall include:

- either peak day water demand plus fire suppression requirements,
- or peak hour water demands, whichever is greater,

- plus water demands being lifted or regulated to another pressure zone(s).

B. Initial Pump Sizes

1. Sizing of Initial Pumps
The initial set of pumps installed in the pumping station shall be sized for the total water demand during the pump's estimated life, usually ten (10) years.

2. Net Pump Capacity
A sufficient number of pumps shall be selected to work together at the same discharge pressure in order to provide required total station capacity. In all cases, a larger "gross capacity" sum of the pumps is required to reach the net operating output required.

C. Pump Cavitation
Pump sizing shall not exceed capacity of the suction line or the NPSH requirements of the pump.

D. Onsite Pipelines of the Pumping Station
1. Velocity for Total Station Capacity
Onsite pipelines of the pumping station shall be sized at five (5) feet per second maximum velocity for discharge piping, three (3) feet per second maximum for suction piping, based upon total station capacity. (See Section 8-10 for information.)

2. Reserved Space for Pump Additions
Typically, space along the manifold and ground at the pumping station site is reserved, with blind-flanged lateral(s) provided, for future pump additions anticipated to meet total water demand at planned build-out of the area.

8.3 Pressure Tank Sizing

A. Discharge Pressure Tank Sizing
Pressure tanks shall be designed and sized to accommodate water hammer. Surge protection design calculations shall be provided.

B. Suction Tank Size
A suction pressure tank of the same size as the required discharge tank shall be required unless the suction supply is provided from an on-site forebay storage facility.

8.4 Pump Elevation

- The pumps shall be located so that they will not produce a negative pressure upon the suction lines.

- Intake pressure shall be at least twenty (20) pounds per square inch with automatic cutoff of the pump if the pressure falls to ten (10) pounds per square inch (Subsection D, p. 3-7, ADEQ Engineering Bulletin No. 10).

- A stand-alone pumping station, not located at a reservoir site, shall not be placed above the lower zone boundary elevation of the pressure zone that the pumping station supplies.

8.5 Reliability Standards for Open Systems

Reliability standards for the pumping stations are intended to minimize disruption of service to customers by constructing facilities in a way that takes into account planned or unplanned interruption of operation of the facility.

The degree of reliability designed and constructed into the water system is based on a number of factors, including:

- the probable frequency of the emergency condition,
- the cost of such a condition in terms of loss of service and customer satisfaction, and
- the cost of providing the additional reliability.

The standard of Tucson Water is to maintain an acceptable level of service defined in terms of a water-demand scenario.

Tucson Water will provide pumping station (open system) redundancy whenever possible for increased reliability of service to Tucson Water customers. The redundancy is defined as follows:

> Average daily demand shall be met during an interruption of the power supply for the customers served by a pumping station.

A. Power Supply
Where sufficient high-water storage is available to the pumping station, no back-up power supply is needed to cover the duration of the typical power outage.

B. Back Up Source of Power
If the high-water storage is insufficient or is located too far from the pumping station to provide an adequate emergency supply to the entire service area, then a back up source of power is required at the pumping station.

1. In the event of an interruption of the main power supply, a backup power supply hook-up shall be provided for a portable generator to be placed on site to meet average daily water demands until the main power supply is restored.

2. There shall be an area reserved on-site for a self-powered portable electric generator near the backup power supply hook-up.

3. Where a natural gas main is unavailable to a facility, space for a portable fuel storage tank shall be provided in the event one needs to be transported to, and set up on, the site in an emergency. Placement of such fuel tanks shall meet all local fire and safety codes.

C. System Bypass of the Pumping Station
1. A system bypass of the pumping station shall be available to minimize the number of affected customers when it is out of service or not operating as designed (refer to subsection D, page 3-7, ADEQ Engineering Bulletin No. 10).

2. A system bypass alternative can be accomplished if a closed zone-boundary valve is present on the water main supply located within the adjacent right-of-way.

3. Motor operated valves may also be designed to be remotely operated as a system bypass alternate.

8-06.9.0 Water Well Minimums

9.1 General

A. Central Water System
The total water supply for the central water system shall equal 1.5 times the central water system average daily demand. The source of the water supply includes wells as well as the Clearwater facility.

B. Isolated Water Systems
Where practicable, there shall be a minimum of two (2) wells for the reliability of isolated systems.

9.2 Minimum Physical Requirements

A. Size of Well Site
The minimum well site size is 120 feet by 120 feet. Plant Design Section shall review any proposed site configuration variation of equivalent size, for sufficient room for:

- a second well,
- storage or pressure tanks,
- parking,
- equipment crane,
- an emergency source of power, and
- turn around access.

Lot size minimums of local zoning code shall also be met, whichever is greater. (See Section 8-10.5.0.)

B. Well Casing Size and Acceptance Criteria
1. The typical well size minimum standard consists of well casing diameters of sixteen and twenty inches.

2. Aquifer testing shall determine aquifer parameters and maximum sustainable yield for the well.

3. Developed well shall contain no more than 0.1 mg of silt and suspended solids per liter of water at maximum discharge capacity.

C. Source Protection
1. The minimum depth for watertight protection from surface contamination shall be ten feet. Additional discussion can be found in ADEQ Engineering Bulletin No. 10, Chapter 2 – Source Development and Construction, Section D. Groundwater Source Development, subsection 5. Source Protection.

2. Well casing vents shall consist of tamper-resistant materials and be secured with a commercial grade pick-resistant lock, to prevent unauthorized access.

3. Comprehensive water quality testing meeting or exceeding minimum State and Federal listed constituent's standards shall be performed, taking into account local mineralogy and history.

D. Supply Pipeline
The minimum size of a well supply pipeline to the distribution system shall be sized to maintain maximum velocity of five (5) feet per second based on the well yield.

E. Location of Well Site
The Resources and Technical Support Section shall review proposed well sites to ensure each site does not adversely affect existing wells, aquifers, or neighborhoods. Sites shall meet or exceed well site restrictions as detailed in AAC R12-15-818 (Well Location); and ARS Title 45 (Waters). Article 4 (Groundwater Rights and Uses In General), Article 10 (Wells).

9.3 Reliability Standards of Water Wells

These standards are intended to minimize the number of affected customers when the water facility does not operate properly.

A. Power Supply
There shall be an electrical connection and switching capability built-in at panels for the water facility to be operated by either of two independent sources of power supply. These normally consist of the main power supply and a backup supply.

B. Back Up Source of Power
1. In an emergency, a backup power supply hook-up shall be provided for a portable generator to be placed on site to meet water demands until the main power supply is restored.

2. There shall be an area reserved on-site for a self-powered portable electric generator near the backup power supply hook-up.

3. Where a natural gas main is unavailable to a water facility, space for a portable fuel storage tank shall be provided in the event one needs to be transported to and set up on the site in an emergency. Placement of such fuel tanks shall meet all local fire and safety codes.

8-06.10.0 Water Source and Supply Facility Minimums

10.1 Minimum Number of Water Supply Facilities

Water supply facilities serving a water service area may include a well, pipeline, pressure reducing station, storage facility, pumping station, or any combination of these facilities.

At least two water supply facilities are needed for reliability of service to each water service area in the water system, whenever practicable.

10.2 Minimum Capability of Water Supply Facilities

The combination of all water supply facilities (see 9.1 above) shall be capable of providing peak day demand plus fire suppression requirements, or the peak hour demand whichever is greater, of each water service area.

10.3 Water Sources

A. Quantity of Source
Unless other arrangements are permitted, all developer-financed projects shall provide one-half (½) acre-foot per year wet water source per equivalent residential unit, or provide transfer of an equivalent amount of the property's State of Arizona Central Arizona Project allocation if applicable.

B. Wells
When a second well facility is not practicable in an isolated system, calculate the number of services allowed on the system using a safety factor of two (2) designed into the total well capacity.

C. Pipelines
Wherever practicable, each pipeline segment of a loop shall be sized so that remaining pipelines can provide the total supply when one pipeline is out of service for repair or replacement.

D. Isolated Systems
- The total yield from the supply facilities shall be at least twice the peak day demand.
- The amount of on-site storage required shall be twice the average daily demand.
- The total pumping station capacity shall meet peak hour demand.