# Wyoming Small Public Water System Design and Operation Seminar

## Storage Tank Design

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# Presentation Overview

- Definition of Tanks
- Water Storage Tank Sizing
- Storage Tank Siting and Elevation
- Tank Design and Standards
- Tank Amenities

# Types of Water Storage Tanks

- Tank Materials
  - Welded Steel
  - Bolted Steel
  - Reinforced Concrete
- Tank Types
  - Reservoirs (diameter > height)
  - Standpipes (diameter < height)
  - Elevated
    - Multiple Column
    - Spherical Pedestal (Hydrosphere)
    - Modified Single Pedestal

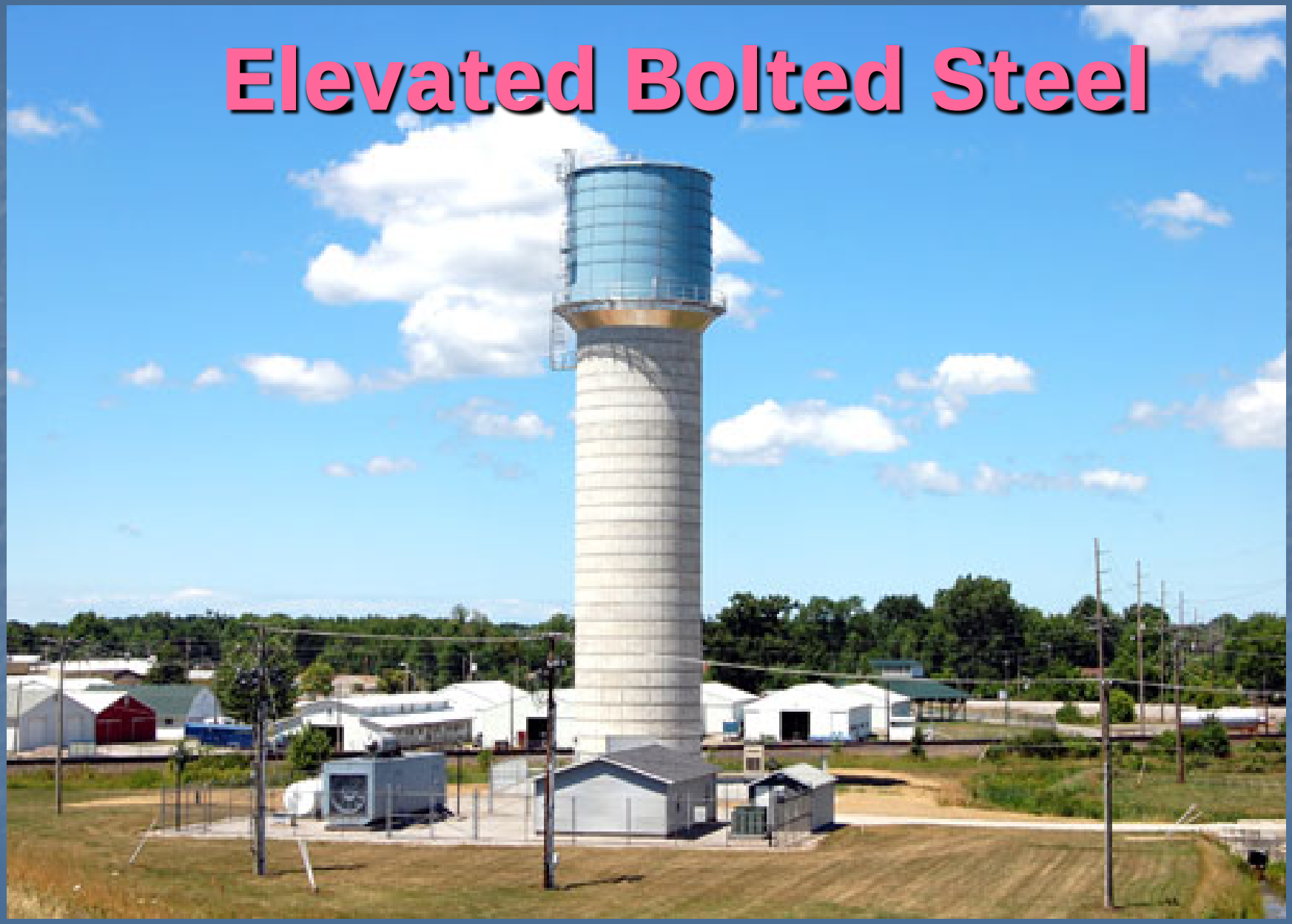
Reservoir

Standpipe

# Multi-Column Elevated

# Hydrosphere

# Elevated Bolted Steel

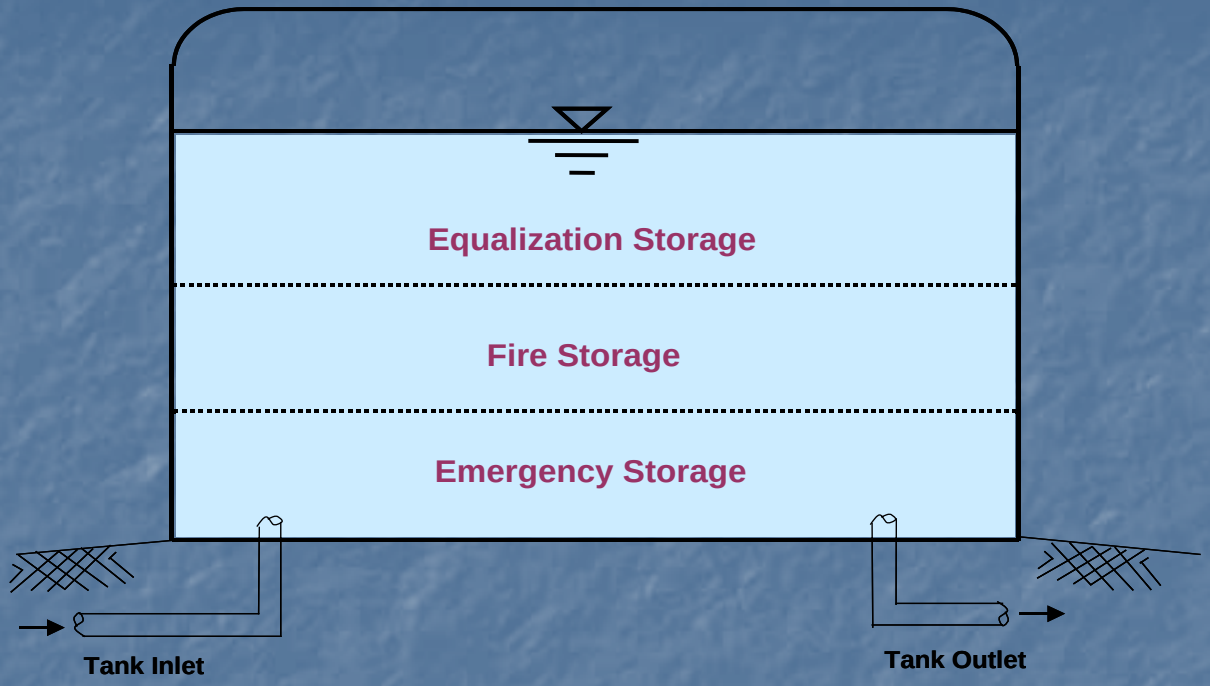


# Elevated Pedestal

# Design and Cost Considerations

| Reservoir | Standpipe | Elevated |
|---|---|---|
| ▪ Lowest Cost<br>▪ Low Visibility<br>▪ Usable Storage Volume<br>▪ Water Quality | ▪ Higher Cost<br>▪ High Visibility<br>▪ Geotechnical Considerations<br>▪ Low Usable Storage Volume<br>▪ Improve Pressures<br>▪ Reduce Transmission Main Length<br>▪ Water Quality | ▪ Highest Cost<br>▪ High Visibility<br>▪ Geotechnical Considerations<br>▪ Usable Storage Volume<br>▪ Improve Pressures<br>▪ Reduce Transmission Main Length<br>▪ Water Quality |

# Water Storage Tank Sizing Criteria




- DEQ Requirements
  - ADD < 50,000 gal/day – One day ADD
  - ADD: 50,000 to 500,000 gal/day – ADD + Fire Flow
  - ADD > 500,000 – 25% MDD + Fire Flow

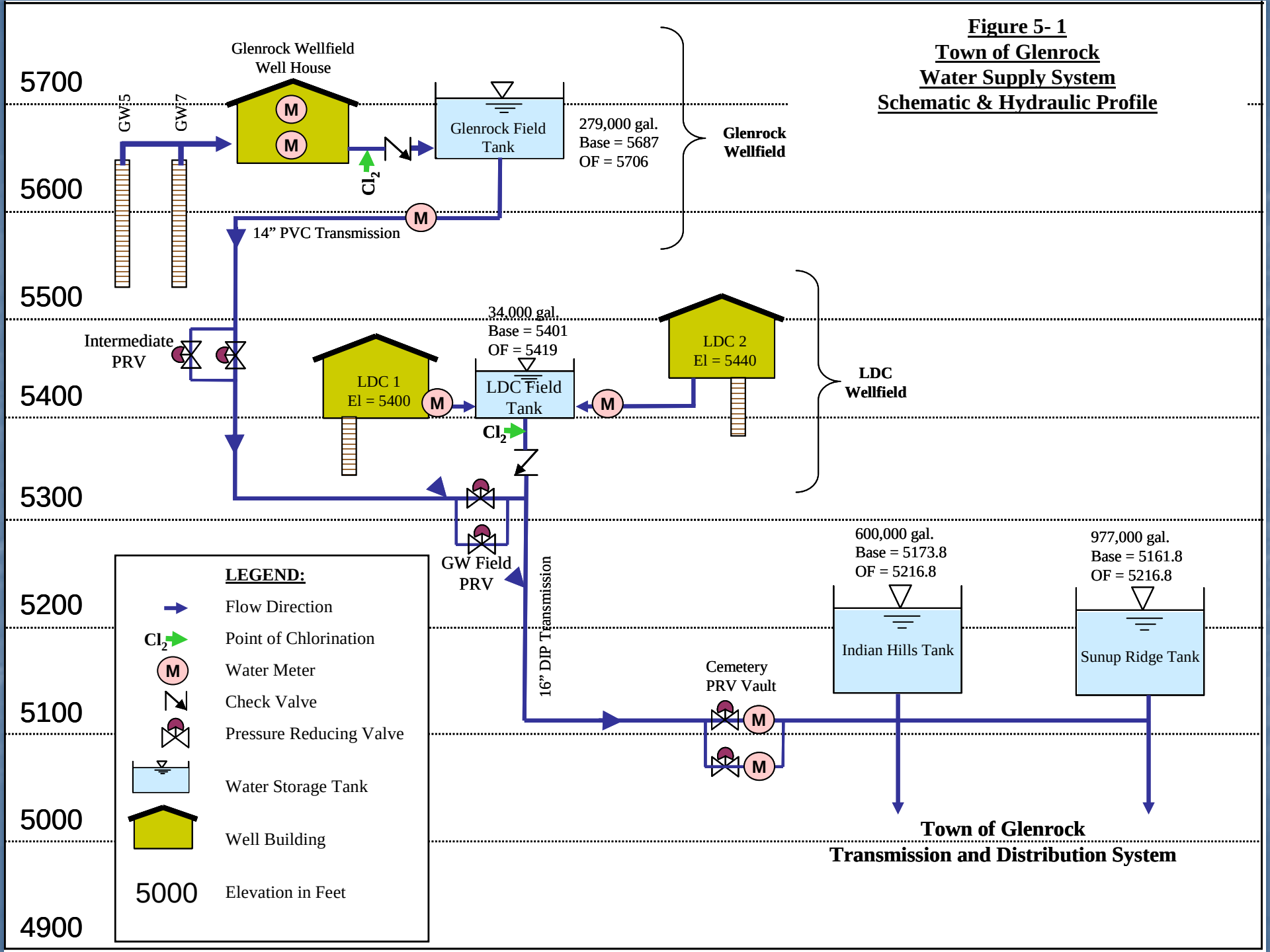
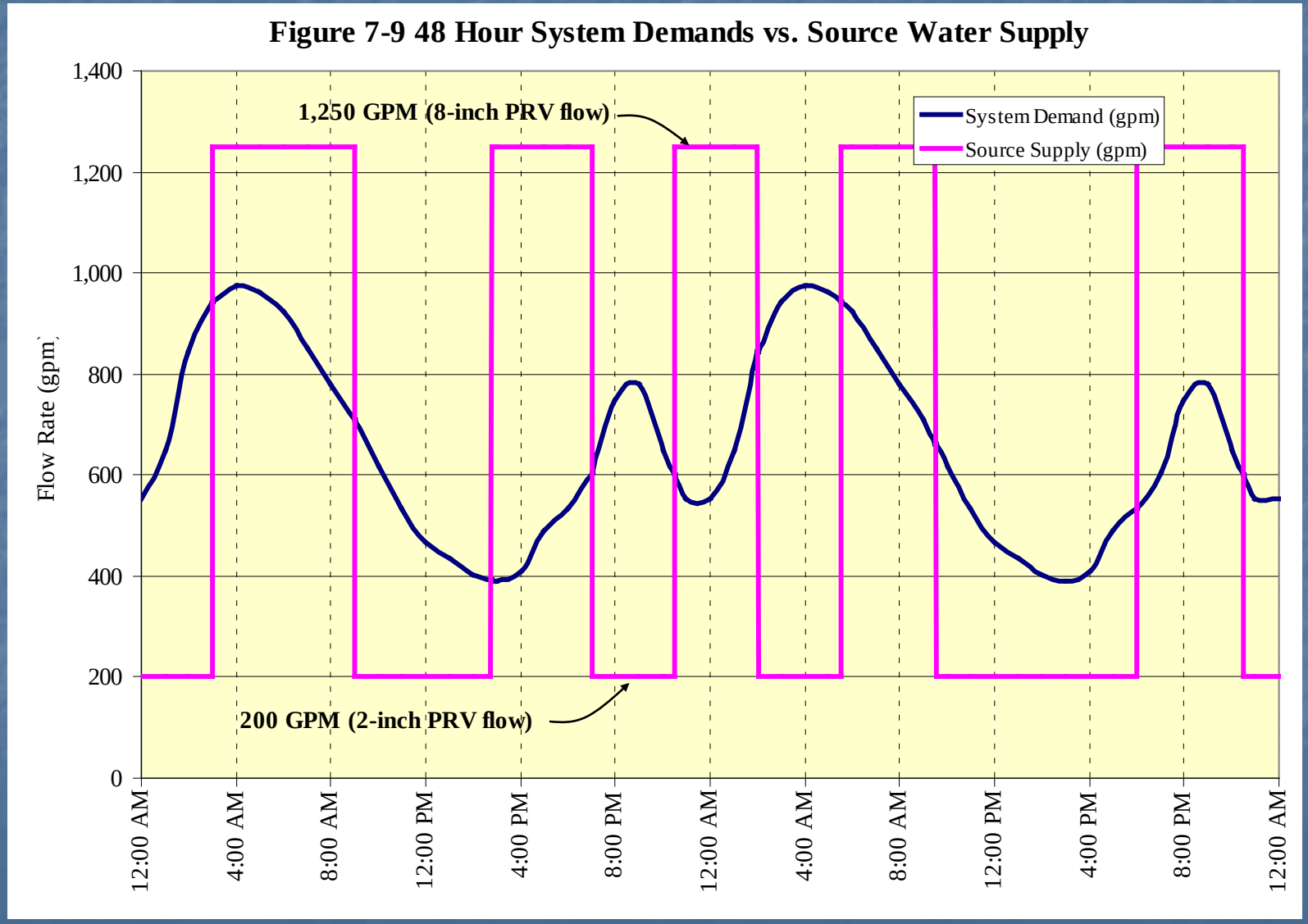


Figure 5- 1
Town of Glenrock
Water Supply System
Schematic & Hydraulic Profile
5700
5600
5500
5400
5300
5200
5100
5000
4900
Glenrock Wellfield
Well House
GW-5
GW-7
M
M
Glenrock Field Tank
279,000 gal.
Base = 5687
OF = 5706
Glenrock Wellfield
Cl2
14" PVC Transmission
M
Intermediate PRV
LDC 1
El = 5400
M
34,000 gal.
Base = 5401
OF = 5419
LDC Field Tank
M
LDC 2
El = 5440
LDC Wellfield
Cl2
GW Field PRV
16" DIP Transmission
600,000 gal.
Base = 5173.8
OF = 5216.8
Indian Hills Tank
977,000 gal.
Base = 5161.8
OF = 5216.8
Sunup Ridge Tank
Cemetery PRV Vault
M
M
LEGEND:
Flow Direction
Cl2
Point of Chlorination
M
Water Meter
Check Valve
Pressure Reducing Valve
Water Storage Tank
Well Building
5000
Elevation in Feet
Town of Glenrock
Transmission and Distribution System

# Glenrock Wellfield Supply Storage Analysis

- Fire Storage – None
- Emergency Storage – four wells with standby power for three wells – Minimal
- Equalization – Well cycle time, tank filling and draining cycles

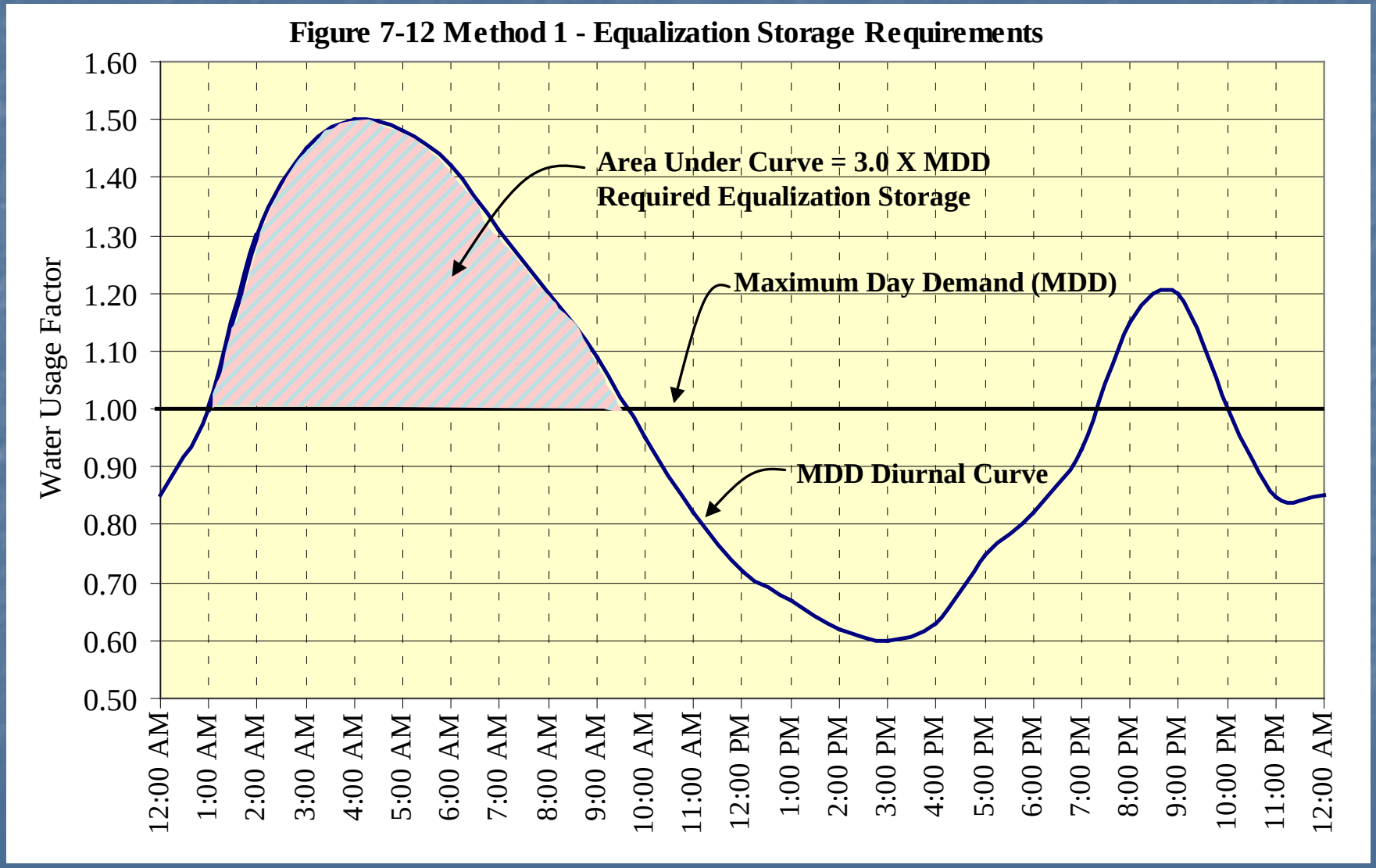
# Wellfield Equalization Storage



# Glenrock Distribution Storage Analysis

- Emergency Storage – 8 hours to repair well transmission pipeline at MDD
- Fire Flow Storage (ISO)
  - Residential – 1500 gpm 2 hour duration
  - Commercial – 2500 gpm 3 hour duration
- Equalization
  - MDD Diurnal Curve
  - 15 to 20% of ADD
  - 3 hours PHD less Supply Capacity

# Calculated Diurnal Equalization Storage



| Year | 2010 | 2020 | 2030 |
|---|---|---|---|
| MDD | 1,130 gpm | 1,230 gpm | 1,350 gpm |
| PHD | 1,700 gpm | 1,850 gpm | 2,030 gpm |
| Emergency Storage (8 hours X MDD) | 540,000 gal | 590,000 gal | 650,000 gal |
| Fire Flow Storage (2,500 gpm for 3 hours) | 450,000 gal | 450,000 gal | 450,000 gal |
| Equalization Storage | | | |
| Method 1 – 3.0hrs * MDD | 203,000 gal | 220,000 gal | 240,000 gal |
| Method 2 – 15% MDD | 240,000 gal | 270,000 gal | 290,000 gal |
| Method 3 – 3 hours X (PHD – 1,500 gpm) | 36,000 gal | 63,000 gal | 95,000 gal |
| Calculated Storage Required (minimum and maximum) | 1,030,000 to 1,230,000 gallons | 1,100,000 to 1,310,000 gallons | 1,200, 000 to 1,390,000 gallons |
| **Available Storage (Total)** | | **1,577,000 gal.** | |
| **Available Storage (Operational)** | | **1,420,000 gal.** | |
| DEQ Equalization Storage (25% of MDD) | 407,000 gal | 443,000 gal | 486,000 gal |
| DEQ Fire Storage (2,500 gpm for 3 hours) | 450,000 gal | 450,000 gal | 450,000 gal |
| Calculated DEQ Storage Required | 857,000 gal | 893,000 gal | 936,000 gal |

# Usable Storage vs. Available Storage

- Available Storage = Total Volume of Tanks
- Usable Storage = Volume Available to Maintain 35 psi @ PHD and 20 psi @ MDD w/ Fire Flow
- Reservoir Usable Storage
- Standpipe Usable Storage
- Elevated Tank Usable Storage
- Develop System and Demand Curves

# Tank Sizing Design Considerations

- Don’t be too Conservative!
  - Realistic Assumptions
  - Water Quality
- Sizing Considerations Assume:
  - Supply and Transmission Capacity = MDD
  - No standby power
  - Three components additive
  - Adjust your analysis accordingly
- Tank Cycling
  - Water Quality
  - System Operational Pressures
  - System Curves

# Tank Siting and Elevation

- System Operational Pressures
  - 35 psi normal; 20 psi MDD with Fire Flow
  - System Curves
  - Tank Cycling (ice and water quality)
  - Higher is better!
- Geotechnical Considerations
  - Collapsible Soils
  - Swell and Consolidation Analysis
  - Tank Drain and Overflow Piping
  - Slope Failure
- Transmission Supply
  - Proximity to Distribution
  - Transmission Storage
  - Water Quality

# Tank Design Standards

- DEQ Chapter 12
- AWWA D-100 (D-100-11 forthcoming)
- API Standards
- Reference Standards and Specify Tank
- Performance Specification vs. Structurally Designed Solution
- Provide Technical Specifications and Tank Elevations and Detail Drawings

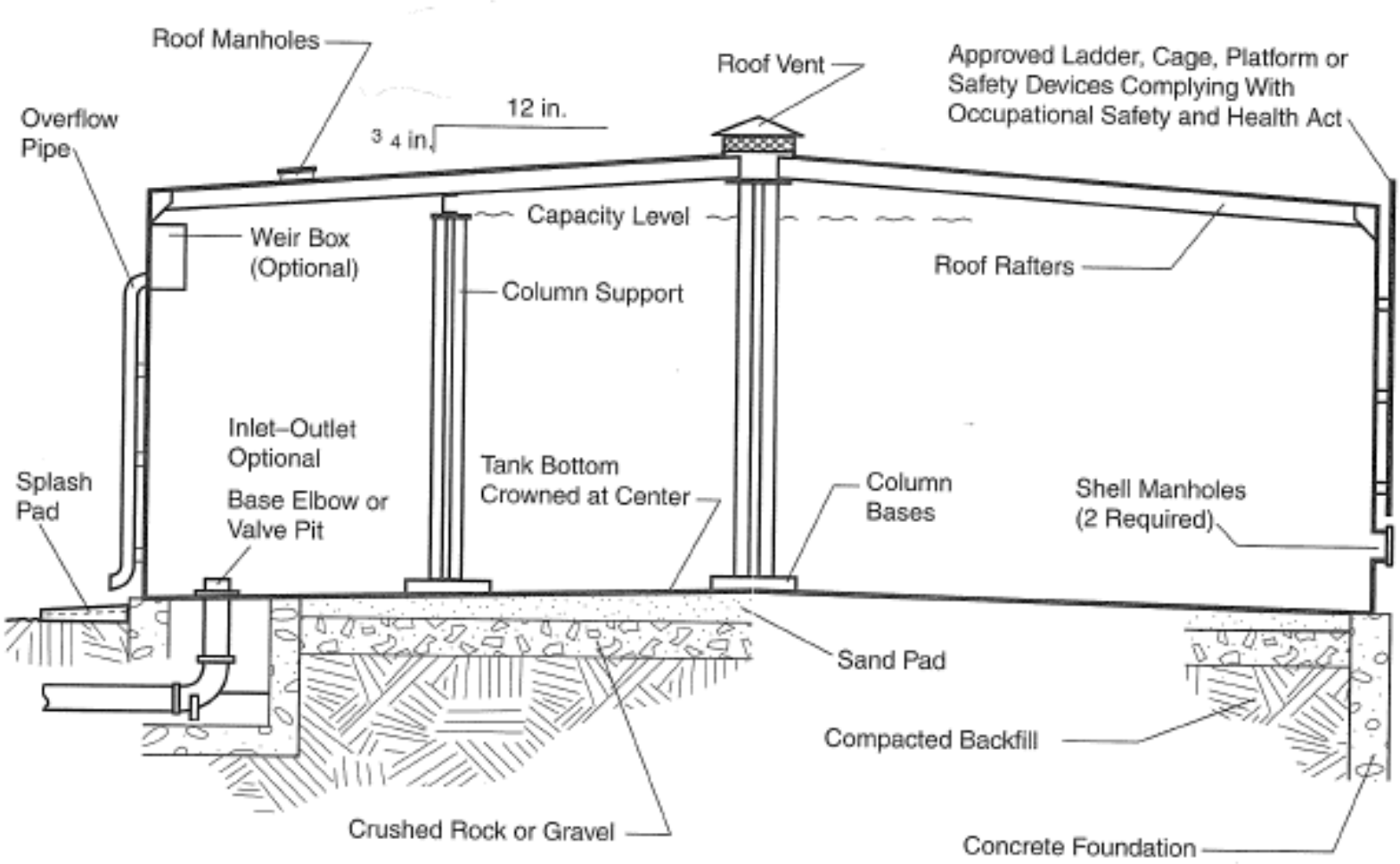



Figure 1-2 Cross-sectional view of a welded steel reservoir

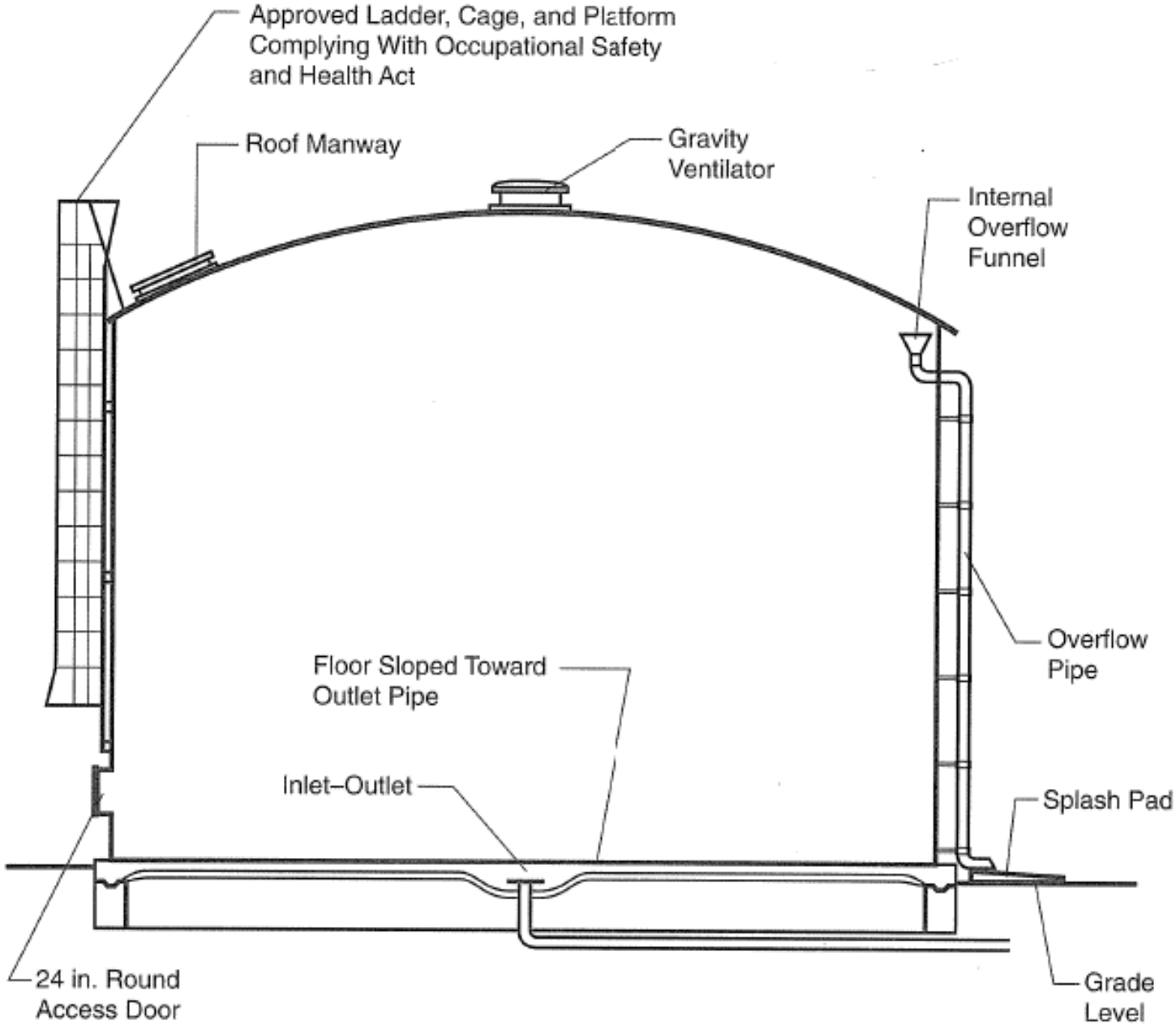
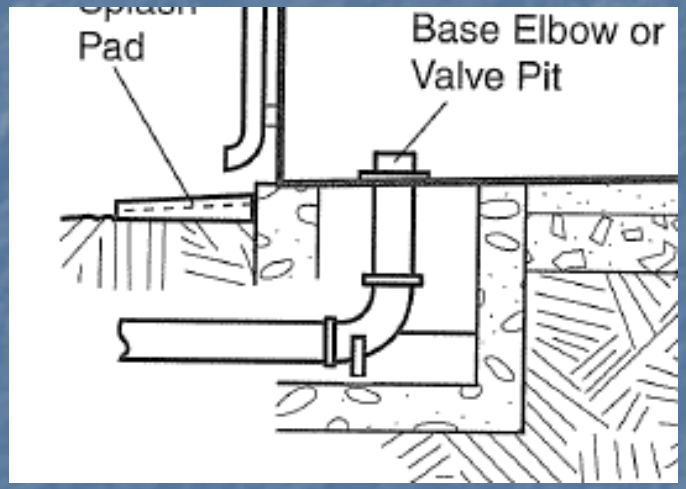



Figure 1-4 Cross-sectional view of a bolted steel reservoir

# Design Considerations - Tank Foundation

- Reinforced Concrete Ringwall
- Inlet and Outlet Piping
  - Concrete Boxes
  - Welded Steel Piping
  - Separate Inlet and Outlet Piping
  - Separate Drain Line
  - Silt Rings
- Structural Fill and Drainage Rock
- Floor Slope and Drain
- Floor Sheet Cathodic Protection
  - Anodes
  - Oil Soaked Sand



# Design Considerations – Steel Tank

- Roof Type
  - Knuckled Roof
  - Self Supporting Dome
  - Sloped Roof
- Overflow Piping
  - Internal vs. External Overflow
- Structural Members
  - Columns
  - Rafters
- Vents
  - Screening
  - Sizing
- Wind and Seismic Design

# Design Considerations – Amenities

- Ladder
  - Safety Cage
  - Platforms
  - Safety Climb Rail
- Access Hatches
  - Roof (directly over overflow pipe)
  - Shell (minimum of two, maximize size)
    - Internal
    - External

# Design Considerations - Ice

- Ice Formation (walls and roof)
- Free Board
- Ladders
- Overflow Piping
  - Internal
  - External
  - Weir Box
- Structural Stiffeners
- Tank Vents
- Cathodic Protection Systems
- Tank Cycling and Mixing

# Red Valve Tideflex Check Valves and Tank Mixing

- Tank Water Quality Issues
  - Chlorine Residual
  - Bacteriological Growth
- Multiport Tank Mixing Systems
  - No power requirements
  - Constant Velocity Orifice Valve
  - Tank Cycling is Still Important
- Check Valves (inlet, overflow and drain)

Mike Duer, P.E.
Red Valve Company, Inc.
Tideflex Technologies Division
600 North Bell Avenue
Carnegie, PA 15106
Tel: (412) 279-0044 x233

# Design Considerations - Tank Coating

- Bolted Steel Tanks
  - Glass Lined Tanks
  - Limited Number of Suppliers
- Surface Preparation
- Atmospheric Conditions
- Coating System
  - Three Coat w/ Stripe Coat
- Structural Design Limitations (columns, rafters, painters rail)
- Construction Monitoring and QA/QC Testing and Reporting
- Environmental Testing and Safety

# Reference Material

- AWWA M42 Steel Water Storage Tanks
- AWWA M32 Distributions Network Analysis for Water Utilities
- DEQ Chapter 12
- AWWA D100 Welded Steel Tanks
- AWWA D102 Coating Steel Water Storage Tanks
- AWWA C652 Disinfection of Water Storage Facilities
- AWWA D103 Factory Coated Bolted Steel Tanks
- AWWA D104 Automatically Controlled Impressed-Current Cathodic Protection Systems
- API Standards