

Group B Water System Design Guidelines



*Design information for
new or expanding
Group B water systems*

**This workbook supports the Group B
rule that goes into effect January 1, 2014.**



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CHAPTER 1 Introduction

The Washington State Department of Health Office of Drinking Water (DOH) developed these *Group B Water System Design Guidelines*. They explain how to design Group B water systems to ensure safe, adequate, and reliable drinking water for those the water system will serve. They will also help you prepare a complete *Group B Design Workbook*, which you must submit for approval before you start constructing your new or expanding Group B water system.

We recommend you review these *Guidelines* before beginning your Group B water system design. We organized the chapters by subject matter (basic water system information, estimating water demand, source of supply, and so forth).

The Appendices contain helpful references, such as how to perform and report the results of a well pump test, using special well pump controls, an outline for a water users' agreement, and how to complete an inventory of your proposed water system.

Group B information is available on our website at

<http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/WaterSystemAssistance/GroupB.aspx>

Group B Design Workbook

These *Guidelines* will help you prepare a complete *Group B Design Workbook* (workbook) that meets each applicable requirement of chapter 246-291 WAC in an efficient manner that reflects sound water system design practices and public health principles. You will submit the workbook to the reviewing authority for approval. You can view, download, or order a CD of the workbook from DOH at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

Before you send your completed workbook to the reviewing agency, make copies of all plans, design drawings, worksheets, equipment information, operations and maintenance manuals, legal documents, and forms. Keep this information with your other project documents. It will help you and others manage and operate the new water system successfully. You also may want to keep your copy of these *Guidelines* there. Do not submit the *Guidelines* with your workbook.

Online Group B Resources

We developed the following Group B resources to help you from pre-approval of your water system design through operation and maintenance:

- All the forms you need to meet the submittal requirements for a new or expanding Group B water system.
- Guidance to help you operate and maintain your small system. We urge you to review this information before you begin operating your new or expanded system.

They are online at

<http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/WaterSystemAssistance/GroupB/GroupBResources.aspx>

Regulations

You should become familiar with Washington's Group B water system rule (chapter 246-291 WAC) and the information in these *Guidelines* before starting your design. The Group B rule is online at <http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/RegulationandCompliance/Rules.aspx>

If you have questions about these *Guidelines* or the State Board of Health rules on Group B Water Systems (chapter 246-291 WAC), contact the state Department of Health (see Table 1.1) or your local health jurisdiction (LHJ).

1.0 Purpose and Scope

These *Guidelines* will help developers, locally certified designers, and design engineers meet the approval requirements for a new or expanding Group B public water system by:

- Establishing uniform and simplistic concepts for very small water system designs.
- Meeting the submittal requirements described in chapter 246-291 WAC.
- Helping DOH regional engineers and LHJ reviewers to apply consistent review procedures.

1.0.1 Expanding Systems

Unless otherwise noted, these *Guidelines* apply to new and expanding systems. For example, suppose your successfully operating existing Group B water system has approval to serve four residential connections. To expand the system to serve additional residences, your existing system **must** meet all current regulatory requirements, regardless of the past approval (chapter 246-291 WAC). You must prepare a complete workbook for review and approval by the reviewing authority before expanding your water system.

Designers may use design approaches other than those in these *Guidelines* as long as the alternate approach does not conflict with chapter 246-291 WAC, and they give appropriate justification for taking an alternate approach.

1.1 “Must” versus “Should”

Throughout these *Guidelines* we use the terms “**must**,” “**will**,” “**shall**” or “**required**” when design practice is sufficiently standardized to permit specific delineation of requirements, or where safeguarding the public health justifies definitive criteria or action (for example, when a state statute or rule mandates a requirement). The terms “*should*” or “*recommend*” indicate procedures, criteria, or methods that are not required. You can approach these with some degree of flexibility. Designers and design engineers need to explain the basis of the altered approach or, in specific circumstances, why another approach may be more applicable.

1.2 Jurisdiction and Standards

Many local health jurisdictions (LHJs) assist DOH with at least some Group B drinking water program administration. Others direct the Group B program within their jurisdictions, including approval of Group B water system designs. In these *Guidelines*, the term "department" refers to the agency that is responsible for reviewing and approving a Group B water system design in the particular county.

1.2.1 Reviewing Authority

An LHJ has authority to adopt and implement its own Group B regulations, if they are at least as stringent as chapter 246-291 WAC. Before beginning your Group B workbook, we strongly recommend that you contact your LHJ to ask:

1. **Is it the LHJ or DOH that is responsible for reviewing and approving the Group B workbook?** If the LHJ is responsible, you must submit the completed Group B workbook to the LHJ for approval.
2. **Has the LHJ adopted its own Group B regulations?** If so, ask for a copy. This could affect who is permitted to prepare the design, and the design options available.
3. **Does the LHJ regulate one- or two-connection Group B systems?** (Ask if you intend to construct a one- or two-connection Group B water system).

We based statements in these *Guidelines* on the requirements and limitations in chapter 246-291 WAC. Your LHJ may adopt its own regulations that offer broader design options and impose increased regulation (WAC 246-291-030 (1)(a)). Moreover, if your LHJ does adopt its own regulations, it may develop its own accompanying design guidelines and Group B design workbook.

1.2.2 Project Location

The location of your project affects whether you can create a new Group B water system and the standards that apply to its design and approval. Before beginning your Group B design, we strongly recommend you **ask the reviewing authority whether the location of your proposed Group B water system is in:**

1. **An area the Department of Ecology has closed to all future appropriation of groundwater, including small groundwater withdrawals that are normally exempt from the water right permitting process.** If so, this could significantly affect the feasibility, scope, cost, and timing of your project.
2. **A Critical Water Supply Service Area** (as established under the Public Water System Coordination Act of 1977). If so, you must request service from the existing water utility serving the area of your proposed Group B water system.
3. **An area served by one or more Satellite Management Agency (SMA).** If so, an available SMA must own, or manage and operate your proposed Group B water system before the department can approve the water system.

1.3 Basic Design Standards

The following standards apply to the approval of a Group B water system workbook from chapter 246-291 WAC. It's possible that your LHI adopted regulations that offer broader design options and impose increased regulation (WAC 246-291-030 (1)(a)). Ask your LHI whether it adopted a set of regulations that affect the standards for design approval.

1. No supply source will be approved other than a drilled well that meets the requirements of chapter 173-160 WAC, or an agency-approved intertie with an approved Group A or Group B water system (WAC 246-291-125). New or expanding Group B systems cannot use a lake, river, spring, dug well, groundwater under the direct influence of surface water (GWI), rainfall catchment, or seawater source (WAC 246-291-125).
2. No supply source for a new or expanding Group B water system that exceeds a primary drinking water standard (such as nitrate, arsenic, coliform) will be approved (WAC 246-291-125(1) and -170(5)).
3. An LHI or DOH **must** inspect the location ("well site") of any existing or proposed well. You must submit the inspector's written well site inspection report with the water system workbook (WAC 246-291-125(3)).
4. Applicants for a new or expanding water system **must** receive written approval of the workbook from the reviewing authority before starting any construction (WAC 246-291-120(1)).
5. Unless the proposal meets the exemption criteria for an engineer, new and expanding Group B water systems **must** be designed by a professional engineer licensed in Washington State (WAC 246-291-120(3) and (4)). Throughout these *Guidelines*, we cite "may require a professional engineer," in recognition of the exemption criteria. Designers should note that a professional engineer **must** prepare and submit the workbook whenever DOH is the reviewing authority (WAC 246-291-120(3) and (4)).
6. New or expanding water systems designed and intended to serve 10 or more dwelling units **must** follow the Group A public water system approval process (WAC 246-291-200(2)).
7. The design **must** demonstrate source capacity of at least 750 gallons per day per dwelling unit for systems located west of the Cascade Mountain crest, and 1,250 gallons per day per dwelling unit east of the Cascade Mountain crest (WAC 246-291-125(4)).
8. If a Satellite Management Agency (SMA) is available in the location of a new Group B water system, then the workbook **must** document that a SMA will either own or manage and operate the water system (WAC 246-291-090). This requirement **does not apply** to an existing Group B water system seeking to expand its number of approved connections.
9. If a proposed Group B water system is in a Critical Water Supply Service Area, then the workbook **must** show that you requested water service from the water utility operating in the area of the proposed system (WAC 246-291-090). This requirement **does not apply** to an existing Group B water system seeking to expand its number of approved connections if the new connections are in the Group B's existing service area.

10. Conducting a well site inspection and undertaking review of a new or expanding Group B water system workbook are fee-supported activities. The LHJ or DOH will charge fees. For DOH review fees, see WAC 246-290-990.

1.4 Project Submittals

You **must** submit a complete Group B workbook to the department for written approval before construction begins whenever a new Group B water system is being developed, and whenever an existing Group B water system seeks an increase the number of approved connections (an expanding system) (WAC 246-291-120(1)).

Construction projects may be subject to local permits or approvals. Compliance with DOH requirements does *not* guarantee full compliance with local rules. Purveyors must ensure they follow local approval processes. Typically, the county building department and environmental health program will have information describing the local approval process.



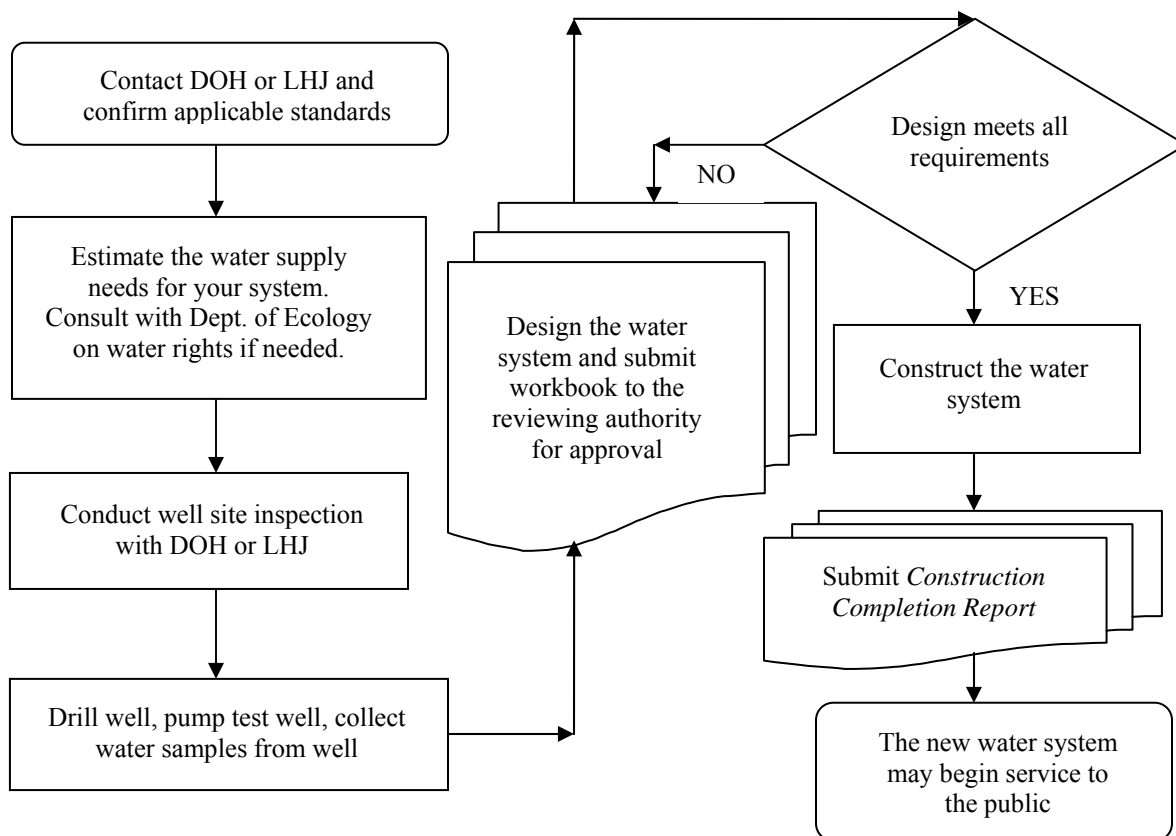
The designer must verify that construction was completed according to the approved plans and specifications. The designer or inspecting engineer must complete a *Construction Completion Report* and submit it to the department within 60 days of project completion and before providing water to the public (WAC 246-291-120(5)). A *Construction Completion Report* form is online at <http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/WaterSystemAssistance/GroupB/GroupBResources.aspx>

If the engineer considers significant changes from the approved project plans during construction, the engineer **must** submit a description of the changes and justification for them to the department. The department must approve the proposed changes before they are constructed (WAC 246-291-120 (6)). Significant change means:

- The size, number, elevation, depth, material, and/or capacity of water system components are different than those described in the approved workbook
- Testing procedures differ from those described in the approved workbook

See Figure 1.1 for the project design, submittal, review, and construction process.

Figure 1.1: Design, Submittal, Review, and Construction Process



1.5 Requirements for a Professional Engineer

The design report workbook **must** be prepared by a professional engineer licensed in Washington State (chapter 18.43 RCW (WAC 246-290-120 (3))). Exceptions to the professional engineer requirement are only possible when the local health jurisdiction has accepted primary responsibility for review and approval of Group B design report workbooks, and the local Board of Health rules provide an exception to the professional engineer requirement, and all of the following design conditions are satisfied:

- No variable speed pumps
- No fire flow
- No special hydraulic considerations
- No atmospheric storage in which the bottom elevation of the storage reservoir is below the ground surface
- No more than nine service connections to be served

1.6 Other Referenced Documents and Standards

We cite other waterworks-related laws, guides, standards, and documents in these *Guidelines* to provide appropriate references. These references form a part of these *Guidelines*, but it is not our intent to duplicate them.

All water system designs **must** comply with locally adopted national model codes, such as the International Building Code (IBC) and Uniform Plumbing Code (UPC), and conform to other applicable industry standards and guidance, such as that from the American Water Works Association (AWWA), American Society of Civil Engineers (ASCE), and the American Public Works Association (APWA) (WAC 246-291-200(1)).

1.7 Department of Health Contacts

The designer or design engineer should contact the department with questions or design concerns. DOH contact information is in Table 1.1. You can get contact information for your LHJ from your local information sources or online at

<http://www.doh.wa.gov/AboutUs/PublicHealthSystem/LocalHealthJurisdictions.aspx>

**Table 1.1
Office of Drinking Water Regional Offices**

Eastern Region	Serving
Drinking Water Eastern Regional Office 16201 E. Indiana Ave., Suite 1500 Spokane Valley, WA 99216 Phone: 509-329-2100 Fax: 509-329-2104 TDD Relay: 1-800-833-6388	Adams, Asotin, Benton, Chelan, Columbia, Douglas, Franklin, Ferry, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman, and Yakima counties.
Northwest Region	Serving
Drinking Water Northwest Regional Office 20425 – 72nd Avenue South, Suite 310 Kent, WA 98032 Phone: 253-395-6750 Fax: 253-395-6760 TDD Relay: 1-800-833-6388	Island, King, Pierce, San Juan, Skagit, Snohomish, and Whatcom counties.
Southwest Region	Serving
Drinking Water Southwest Regional Office Physical: 243 Israel Road <b style="padding-left: 40px;">Tumwater, WA 98501 Mailing: P O Box 47823 <b style="padding-left: 40px;">Olympia, WA 98504-7823 Phone: 360-236-3030 Fax: 360-664-8058 TDD Relay: 1-800-833-6388	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Kitsap, Lewis, Mason, Pacific, Skamania, Thurston, and Wahkiakum counties.

CHAPTER 2 Basic Water System Information

Chapter 2 covers the basic water system information required for most submittals. This includes the location, size, system classification, and future ownership and management of the water system.

2.0 Public Water System Classification

Different types of water systems are subject to different regulations. Start by establishing whether your proposed water system is a public water system. Next, determine the system classification.

A public water system is any system providing water for human consumption, excluding a system serving only one single-family residence, or a system with four or fewer service connections all of which serve residences on the same farm. See the complete definition in WAC 246-291-010.

We base public water system classification on population and number of connections served. There are two classifications, Group A and Group B.

- **Group A water systems** serve 15 or more connections, OR an average of 25 or more people per day for 60 or more days within a calendar year.
- **Group B water systems** serve fewer than 15 service connections and fewer than 25 people per day, OR 25 or more people per day for fewer than 60 days per year provided the system doesn't serve 1,000 or more people for two consecutive days (WAC 246-291-005).

These *Guidelines* cover the design standards applicable to Group B public water systems.

2.0.1 Connections Served

Determine the total number of connections by counting each single-family home, each dwelling unit in a multifamily building, and each nonresidential building the water system serves. The complete definition of “service connection” is in WAC 246-291-010.

An accessory dwelling unit (ADU) is not always considered a separate dwelling unit. After hearing a case about ADUs in rural areas, the Growth Management Hearings Board ruled that counties should consider ADUs that are separate structures as additional dwelling units.

In the following examples, we applied the definitions of “service connection” in WAC 246-291-010 and the Hearings Board decision:

- A system serving two duplexes and two single-family homes serves a total of six dwelling units. Each dwelling unit is considered a separate connection.
- A system serving four single-family homes, each with an accessory dwelling unit incorporated into the main structure of the home, serves a total of four dwelling units, and therefore four connections.

- A system serving four single-family homes, each with an accessory dwelling unit built as a separate structure on the same parcel, serves a total of eight dwelling units, and therefore eight connections.
- A system serves three single-family homes. One home has an attached shop with piped water that serves as a place of employment for people from outside the home. The other two homes each have a separate structure with piped water that serves as a retail or commercial business open to customers or clients. This system serves three dwelling units plus three nonresidential connections, for a total of six connections.

Section 2.0 of the workbook explains how to report the number of residential and nonresidential connections your Group B water system will serve.

2.0.2 Population Served

The population you must count is the number of people that have *access* to piped water for human consumption. The population served is either residential (people living in a residence), or nonresidential (tourists, customers, employees) entering the premises and given the opportunity to access tap water.

2.0.2.1 Residential Population

For the purposes of design, and to identify the appropriate water system approval standards, 2.5 residents **must** be assigned to each dwelling unit (WAC 246-291-200(2)). Therefore, if your proposed system serves 10 or more dwelling units, the department will review your proposal under the approval standards for Group A public water systems (chapter 246-290 WAC). Group A system approval standards are different from Group B system approval standards. See Section 2.0.3 below.

2.0.2.2 Nonresidential Population

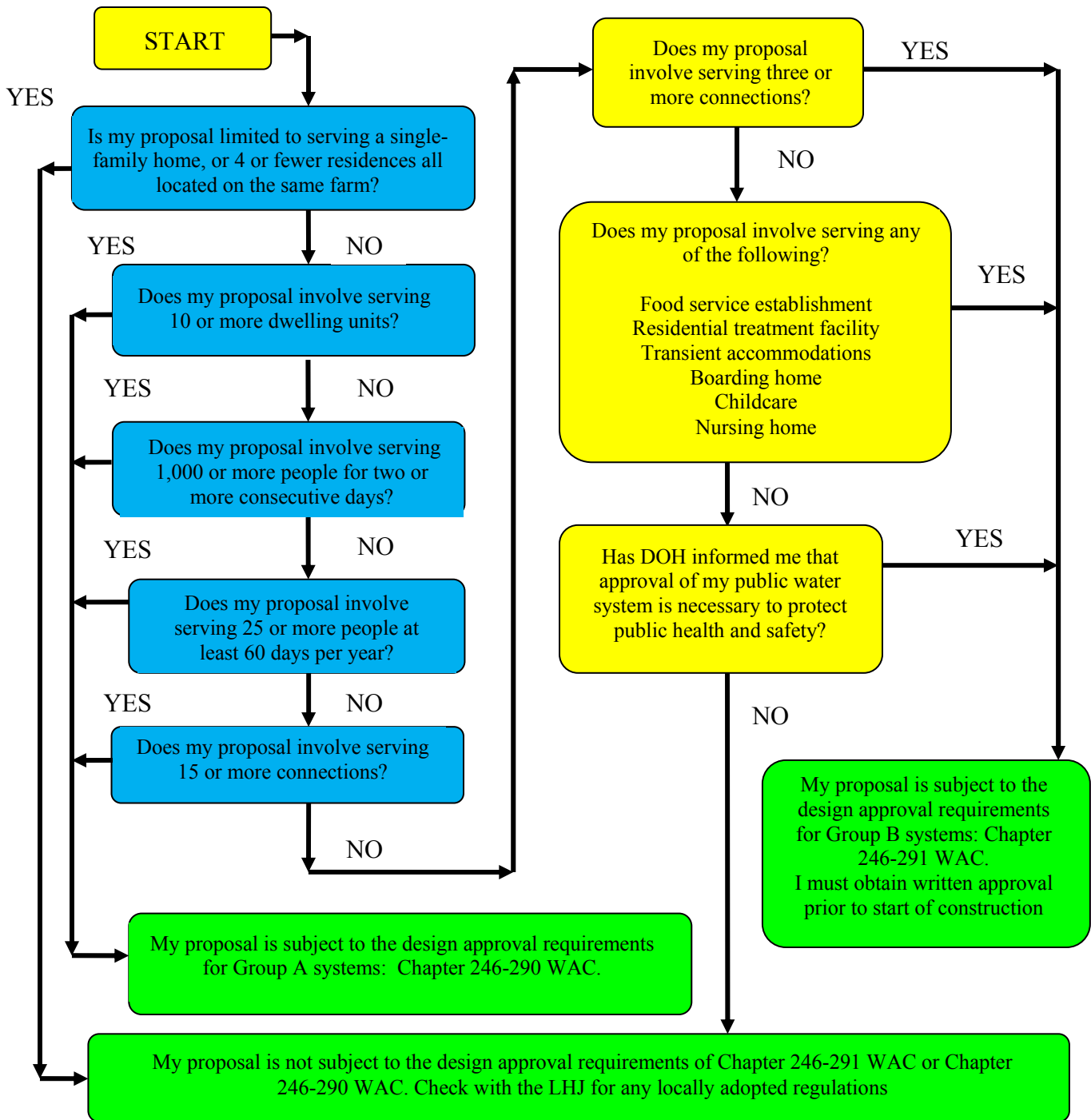
A water system designed to serve 25 or more persons for 60 or more days per year will be considered a Group A water system (WAC 246-290-005). Our data system uses the information you provide on your *Water Facilities Inventory Form* (WFI) to calculate a daily average for each calendar month. (See Section 2.9.) If your expected average daily service population for two or more calendar months exceeds 24 persons, the department will review your proposal under the approval standards for Group A public water systems. See Section 2.0.3 below.

2.0.3 Application of Group A Public Water System Approval Standards

If the department concludes that the scope of your project places your proposed water system into the Group A classification, the department will return your Group B workbook to you with an explanation. Contact your DOH regional office to discuss the department's conclusion and, as applicable to your circumstance, the Group A public water system approval process.

2.1 Applicability

Based on public water system definitions and classifications (see Section 2.0), the following flow chart will help you decide whether your proposed Group B public water system is subject to the Group B design approval process. Please note that the department is responsible for properly classifying public water systems. Your use of this flow chart does not replace the department's responsibility.



2.2 Project Approval Application Form

A *Group B Project Approval Application Form* offers the designer the means to provide the information necessary for the proper review and processing of the application. This information includes:

- Contact information for both the water system and the person submitting the project.
- The number and type of connections that are or will be served.
- The type of project.

The *Group B Project Approval Application Form* is online at <http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/WaterSystemAssistance/GroupB/GroupBResources.aspx>

2.3 Service Area Map and Location

Applicants for a new or expanding water system **must** also provide a scaled map of the proposed service area (WAC 246-291-140(1)). You can use the same map submitted with a land use application or one that is similarly detailed. The map you use should include the boundaries of the proposed service area, roads, property lines, parcel numbers, and other features helpful in locating the project and individual features. You can use the same map to show the proposed distribution system, or use a separate map.

2.4 Public Water System Coordination Act

The *Public Water System Coordination Act of 1977* (RCW 70.116) requires applicants seeking development of a new public water system to determine whether the proposed system is in the future service area of an existing utility. The intent of the Coordination Act is to avoid creating new water systems whenever an existing water system is available and willing to provide service.

If your project is in a Critical Water Supply Service Area, ask the reviewing authority to identify the utility providing service. You **must** request water service from that utility. If the utility can provide service in a timely and reasonable manner, you **must** obtain water service from the utility and abandon plans to develop a new water system (WAC 246-291-090). This requirement **does not apply** to an existing Group B water system seeking to expand its number of approved connections if the new connections are in the Group B's existing service area.

To ensure compliance with this statute, you **must** include a written record of the request for water service, and the water supplier's written response to that request in your workbook (WAC 246-291-120). An example of a letter requesting water service is in the Appendix.

If your project is outside a Critical Water Supply Service Area, you may develop a new water system. However, your application is subject to the Satellite Management Agency requirement (WAC 246-291-090).

2.5 Satellite Management Agency (SMA)

A Satellite Management Agency (SMA) is an individual, water system, or other entity approved by DOH to own or operate public water systems on a regional or countywide basis. The law requires all new water systems to be owned or operated by an approved SMA, if one is available (RCW 70.119A.060). The intent of the SMA requirement is to place ownership, or operations and management, of all new public water systems in the hands of experienced water suppliers whenever possible. This requirement **does not apply** to an existing Group B water system seeking to expand its number of approved connections.

Some counties do not have any approved SMAs, but most do. You should choose the one that best meets your needs. The current approved SMA list is online at http://www.doh.wa.gov/Portals/1/Documents/4200/sma_list.pdf

If your project is in the service area of one or more approved SMA, ask each one whether it is available to provide ownership or management services to the proposed public water system. An example of a letter requesting SMA services is in Appendix B.

You **must** either provide a copy of an SMA agreement with your project submittal or proof that no approved SMA is available (WAC 246-291-090 and -120).

- YES, an SMA is available** to own the proposed water system or provide management services. You must **provide a copy of the agreement** with the project submittal.
- NO SMA is available.** You must **provide a written record of each SMA rejection** with your project submittal.

Your SMA may require you to submit your water system design for review and acceptance before you submit your application to the department for approval, particularly if the SMA will become the owner of the new water system.

2.6 Disclosure on Property Title

You **must** record an informational notice on the title of each property to be served by your new water system (WAC 246-291-140(2)). A sample notice is in the Appendix. When submitting your workbook to the reviewing authority, provide a copy of the content you will record on the title of each property your water system will serve. List all parcel numbers available at the time you submit your completed Group B design workbook. The actual recorded document must include the actual parcel numbers the water system will serve.

Ask your County Auditor which form you should use to record notice to title.

2.7 Protective Covenants

Protective covenants are required to secure the area around a public drinking water supply from future use and development that may threaten water quality and public health (WAC 246-291-125(5)). Section 4.3 explains how to provide legal protection for the area around a public drinking water supply well. When submitting your workbook to the reviewing authority, provide a copy of the actual protective covenants on record with the County Auditor for each public drinking water supply well.

These covenants must be on each of the affected properties, and filed with the County Auditor. Check with your local government; you may be allowed to establish the covenant on the subdivision plat.

Ask your County Auditor which format you should use to record the protective covenants for each public drinking water supply well.

2.8 Water Users' Agreement

You should establish a water users' agreement for all new Group B water systems that include residences or multiple property owners. All owners of the water system should sign the users' agreement when the system is constructed and operational. An outline for a water users' agreement is in the Appendix.

You may need to complete your water system design before you can finalize your draft water users' agreement.

2.9 Water Facilities Inventory

We recommend that you complete a *Water Facilities Inventory Form* (WFI) and include it with your Group B workbook. To ensure the information in our data system is correct, answer all the questions on the WFI. Instructions for Group B systems and a sample WFI form are in the Appendix. If you plan to submit a workbook for an expanding Group B system, please submit a marked-up version of your existing WFI form.

2.10 Easements

Your Group B workbook **must** show the location and dimension of easements you intend to secure in order to adequately access and maintain all distribution system components, reservoirs, wells, and pumping stations (WAC 246-291-120).

CHAPTER 3 Estimating Water Demands

Chapter 3 explains how to estimate expected maximum daily demand (MDD) and peak hour demand (PHD) for your proposed water system. Engineers need water demand estimates to size pumping equipment, transmission lines, distribution mains, and water storage facilities properly.

Demand estimates combined with information about your water supply source will ensure the water system can meet all the demands you expect it to meet over the year. Establishing the expected MDD also determines whether you need a water right (RCW 90.44.050).

If you do need a water right, you must get the appropriate documents from the Department of Ecology and include them in your workbook (WAC 246-291-125(3)).

If the department believes you need a water right, but you don't provide a copy with your submittal, we will return your submittal to you. We will also explain our decision and recommend that you consult with the Department of Ecology before resubmitting your design.

3.0 Water Rights

3.0.1 Water Right Permit Exempt Wells

The Department of Ecology administers the regulatory and permitting processes for water rights. Newly designed Group B water systems may only obtain water from a groundwater source. Most Group B water systems use the groundwater permit exemption (RCW 90.44.050) rather than obtaining a permit from Ecology prior to using any water.

An owner of a permit-exempt well may withdraw up to 5,000 gallons per day for single or group domestic uses. In addition, the owner gets a separate allowance to irrigate lawns or noncommercial gardens. This separate irrigation allowance is not limited in terms of gallons per day; it is limited by the size of the area you are permitted to irrigate with water from the well. In addition to the 5,000 gallons per day limit for domestic use, an owner of a permit-exempt well may withdraw any amount of water for irrigating not to exceed a combined total of ½ acre of lawns and noncommercial gardens.

For a complete description of the legal uses of a permit-exempt well, see RCW 90.44.050 and the Attorney General's *Exempt Ground Water Withdrawals: 2009 AG Opinion* (No. 6) online at <http://www.atg.wa.gov/AGOOpinions/Opinion.aspx?section=archive&id=23864>

The Attorney General's opinion affects the design of new and expanding Group B water systems:

- If the expected maximum daily demand for domestic use (water used inside residences) combined with nonresidential business or commercial water use exceeds 5,000 gallons per day, you **must** submit documents confirming a water right exists for the project (WAC 246-291-125(3)).
- If the water supply will be used to irrigate more than ½ acre (21,780 square feet) of lawn(s) and noncommercial garden(s) for all parcels combined, you **must** submit documents confirming a water right exists for the project (WAC 246-291-125(3)).

Permit-exempt wells are exempt only from the duty to obtain a permit to use groundwater, not the other provisions of the Water Code. A right established through a permit-exempt well has the same legal effect and must abide by the same requirements of prior appropriation and state regulation of water resources as a permitted withdrawal. In other words, use of water from a permit-exempt well must be regulated or curtailed, where necessary, to protect and prevent impairment to more senior water rights. Even if your Group B water supply is a permit-exempt well, it's subject to curtailment if Ecology finds such action necessary to protect senior rights or public waters.

When assessing the need for a water right, you should assume that the **domestic in-home portion** of your total system maximum daily demand (MDD) will be at least **350 gallons per day (gpd) per dwelling unit**. The domestic in-home demand is the portion of the total system MDD that counts toward the 5,000-gallon-per-day limit described above.

3.0.2 Basins Closed to Further Appropriation

Ecology may close a basin to all further appropriation or establish reservations of water for permit-exempt wells to protect senior water right holders and minimum instream values. However, Ecology may create a pathway for an applicant of a new Group B water system to follow a basin-specific process to secure permission to withdraw groundwater to supply the system.

A basin-specific process may involve developing and implementing a mitigation plan. To determine whether your project is located in a closed basin, contact the Department of Ecology. If so, you **must** submit Ecology's written permission to withdraw the groundwater you need with your Group B water system workbook. While such permission, if granted, is not a "water right," we apply the requirement of WAC 246-291-125 (3) to such circumstances.

3.0.3 Multiple Permit-Exempt Withdrawals

The rule permits only one exemption for any one project, no matter how many wells and separate small systems are established to supply the project.

If you intend to develop two or more separate, contiguous Group B water systems, you may not have the legal authority to do so. Contact the Department of Ecology for assistance on this legal requirement.

3.0.4 Group B Applicants with a Water Right

A water right may state the number of connections that can be served. With one exception (see below), the number of connections shown on the water right is a limiting factor for a new or expanding system intended to serve fewer than 15 residential connections. In other words, if the water right specifies that it applies to serving six single family homes, then the maximum number of homes that can be served by the water system is six, even if the instantaneous and annual volume permitted under the right could supply more homes.

The one exception is when an existing *municipal water supplier* owns the new or expanding Group B system. Applicants who want to know whether their organization is a *municipal water supplier* should contact their DOH regional office.

3.1 Residential Water Demand

3.1.1 Residential MDD

The MDD is the maximum single-day demand the water supply must meet. It consists of in-home domestic demand (see Section 3.0.1), outdoor demand, nonresidential demand, and distribution system leakage. It's important to establish the proposed water system's MDD before you drill and test the water supply well.

WAC 246-291-125 (4) specifies the minimum source capacity and minimum MDD for residential service connections (see Table 3.1).

Table 3.1
Standards for Minimum Source Capacity and
Minimum MDD for Residential Service Connections

County	Gallons per day per dwelling unit
Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skamania, Skagit, Snohomish, Thurston, Wahkiakum, and Whatcom	750
Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman, and Yakima	1,250

Because residential MDD includes inside and outside uses, the actual demand could be considerably higher than the minimum values listed in Table 3.1. In general, the demand for water increases along with lot size, home size, and average summer temperatures. Other site-specific considerations, such as the development's *Covenant, Conditions, and Restrictions*; cost of water; soil type; and irrigation system technology, may also affect water demand. The designer and design engineer should strongly consider whether the minimum values in Table 3.1 are sufficient to meet the expected demands of future customers. The effect of under-estimating the MDD includes low pressure, summertime water rationing, dissatisfied customers, and increased vulnerability to backsiphonage of nonpotable water into the distribution system.

3.1.2 Residential PHD

It's important to establish the peak hourly demand (PHD) before designing the system of wells, pumps, pipes, and pressure tanks. The relationship between PHD, sustained well yield, and well pump capacity will determine whether the proposed water system requires atmospheric storage to supplement the supply source(s) to meet the expected PHD. See Chapter 5 for details.

Table 3.2 provides guidance on establishing the minimum PHD for residential demand. For the same reasons cited in 3.1.1 above, the actual PHD of the customers your proposed Group B system will serve could be considerably higher than the values in Table 3.2. The effect of under-estimating the PHD includes low pressure, dissatisfied customers, and increased vulnerability to backsiphonage of nonpotable water or other potential contaminants into the distribution system.

Table 3.2
Guide for Minimum Residential Peak Hourly Demand

Number of dwelling units	Peak Hour Demand (in gallons per minute)
2	23
3	26
4	28
5	31
6	34
7	36
8	39
9	41

Source: Adapted from *DOH Water System Design Manual*

3.2 Nonresidential Water Demand

3.2.1 Nonresidential MDD

Table 3.3 provides guidance on nonresidential average maximum daily demand (MDD). We use the values here as guidance with the following assumptions:

- Unit nonresidential demand will vary little from day to day.
- MDD is based on a full facility (the campsite or hotel is fully occupied or the school is operating at capacity).

Table 3.3
Guide for Nonresidential Water Demand

Type of Establishment	Maximum Daily Demand (in gallons per day)
Bathroom (per bather)	10
Boardinghouse (per boarder)	50
Additional kitchen requirements for nonresident boarders	10
Camp:	
Construction, semi-permanent (per worker)	50
Day, no meals served (per camper)	15
Luxury (per camper)	100 - 150
Resort, day and night, limited plumbing (per camper)	50
Tourist, central bath and toilet facilities (per person)	35
Factory (gallons per person per shift)	15 - 35
Highway rest area (per person)	5
Hotel:	
Private baths (2 persons per room)	50
No private baths (per person)	50
Institution other than hospital (per person)	75 - 125
Laundry, self-serviced (gallons per washing (per customer))	50
Motel:	
Bath, toilet, and kitchen facilities (per bed space)	50
Bed and toilet (per bed space)	40

Type of Establishment	Maximum Daily Demand (in gallons per day)
Park:	
Overnight, flush toilets (per camper)	25
Trailer, individual bath units, no sewer connection (per trailer)	25
Trailer, individual baths, connected to sewer (per person)	50
Picnic:	
Bathhouses, showers, and flush toilets (per picnicker)	20
Toilet facilities only (gallons per picnicker)	10
Restaurant:	
Toilet facilities (per patron)	7 - 10
No toilet facilities (per patron)	2 ½ - 3
Bar and cocktail lounge (additional quantity per patron)	2
School:	
Day, cafeteria, gymnasiums, and showers (per pupil)	25
Day, cafeteria, no gymnasiums or showers (per pupil)	20
Day, no cafeteria, gymnasiums or showers (per pupil)	15
Service station (per vehicle)	10
Store (per toilet room)	400
Worker:	
Construction (per person per shift)	50
Day (school or offices, per person per shift)	15

Sources: Adapted from *Design and Construction of Small Water Systems* American Water Works Association, 1984; and *Planning for an Individual Water System*. American Assoc. for Vocational Instruction Materials, 1982.

3.2.2 Nonresidential PHD

Tables 3.4 and 3.5 provide guidance on establishing nonresidential PHD.

**Table 3.4
Demand Weight in Fixture Units**

Fixture Type	Weight in Fixture Units per Fixture Type
Shower	2
Kitchen sink	1.5
Urinal	3
Toilet (flushometer)	5
Toilet (tank flush)	2.5
Bathroom sink (lavatory)	1
Clothes washer	4.0
Drinking fountain	0.5
Dishwasher	1.5
Hose Bibb	2.5

Source: Adapted from the 2009 Uniform Plumbing Code, Appendix A, Table A-2

After determining the total number of fixture units (sum of fixture type times fixture weight), round the total to the next value given in Table 3.5, and determine the peak hourly demand.

**Table 3.5
Nonresidential Peak Hourly Demand
Based on Total Fixture Units**

Total Number of Fixture Units	PHD (gpm)
10	8
15	12
20	15
25	18
30	20
35	22
40	25
50	29
60	32
70	35
80	38
90	41
100	43

Source: Adapted from the 2009 Uniform Plumbing Code, Appendix A

3.3 Examples

Example 3-1

A new Group B water system proposed east of the Cascade Mountains consists of six single-family homes. The plan for development allows each lot to irrigate up to 3,500 square feet, for a total irrigated area of 21,000 square feet. The design relies on supply from a permit-exempt well. The system will not supply fire-suppression requirements (fire hydrants or residential sprinkler systems).

Check water right:

- ✓ Maximum daily residential in-home demand is assumed to be 350 gpd per residence

$$6 \text{ residences} \times 350 \text{ gpd per residence} = 2,100 \text{ gpd}$$

This is less than the 5,000-gpd limitation on a permit-exempt well. OKAY

- ✓ Total irrigated area is below the maximum 21,780 square feet allowed without a water right. OKAY

$$\begin{aligned} \text{Minimum required MDD and water supply capacity} &= 6 \text{ homes} \times 1,250 \text{ gpd/home (per Table 3.1)} \\ &= 7,500 \text{ gpd} \end{aligned}$$

$$\text{PHD} = 34 \text{ gpm (per Table 3.2)}$$

Example 3-2

A new Group B water system proposed west of the Cascade Mountains consists of four single-family homes. The plan for development allows each lot to irrigate up to 5,000 square feet, for a total irrigated area of 20,000 square feet. The design relies on supply from a permit-exempt well.

The system will not supply fire-suppression requirements (fire hydrants or residential sprinkler systems).

Check water right:

- ✓ Maximum daily residential in-home demand is assumed to be 350 gpd per residence

$$4 \text{ residences} \times 350 \text{ gpd per residence} = 1,400 \text{ gpd.}$$

This is less than the 5,000 limitation on a permit-exempt well. OKAY

- ✓ Total irrigated area is below the maximum 21,780 square feet allowed without a water right. OKAY

$$\begin{aligned} \text{Minimum required MDD and water supply capacity} &= 4 \text{ homes} \times 750 \text{ gpd/home (per Table 3.1)} \\ &= 3,000 \text{ gpd} \end{aligned}$$

$$\text{PHD} = 28 \text{ gpm (per Table 3.2)}$$

Example 3-3

A new water system proposed east of the Cascade Mountains consists of nine single-family homes. The planning documents for this development indicate that each lot is 10 acres and each lot owner will be allowed to irrigate up to 5,000 square feet. The design relies on supply from a permit-exempt well. The system will not supply fire-suppression requirements (fire hydrants or residential sprinkler systems).

Check water right:

- ✓ Maximum daily residential in-home demand is assumed to be 350 gpd per residence

$$9 \text{ residences} \times 350 \text{ gpd per residence} = 3,150 \text{ gpd}$$

This is less than the 5,000 limitation on a permit-exempt well. OKAY

- × Total irrigated area is 45,000 square feet (9 x 5,000). This exceeds the area allowed without a water right. NOT OKAY.

The department will return the workbook with instruction to change the irrigation allowance, or obtain a water right.

Example 3-4

An existing Group B water system located west of the Cascade Mountains consists of six single-family homes. The owner wishes to add five single-family homes to the existing system. The department approved the existing system in 2001.

As described in Section 1.4, the Group B design requirements apply to new and expanding Group B systems. There is no “grandfathering” of existing system design when the owner of the system proposes an expansion. So, the owner must apply the requirements of the current Group B Rule to all 11 connections (6 existing and 5 proposed), including such standards as minimum MDD and demonstrated source capacity per dwelling unit, population per dwelling unit, notice to title, and limits on irrigation per parcel.

An expanding system proposing to serve 11 single-family homes must meet the planning, engineering, and design standards for Group A public water systems because the design population exceeds 24 people (WAC 246-291-200(2)).

$$11 \text{ dwelling units} \times 2.5 \text{ people per dwelling unit} = 28 \text{ people}$$

Example 3-5

A proposed catering business in Western Washington will employ 20 daytime employees and have no visitors. The proposed building will have its own drinking water system, using a permit-exempt well. The area around the building to be irrigated is 3,000 sq. feet. A fire pond filled by a nonpotable water supply will meet the building's fire-suppression requirements. The fire pond and associated fire-suppression piping have no physical connection with the potable water system.

To determine the need for a water right, follow the steps below.

Step 1: Apply the fixture weight to each fixture type (Table 3.4), and determine the building's total fixture units.

Fixture Type	Number of Fixtures x Fixture Weight = Fixture Units		
Drinking fountain	2	0.5	1
Toilet (tank flush)	4	2.5	10
Urinal	1	3	3
Lavatory	2	1	2
Kitchen sink	2	1.5	1.5
Dishwasher	2	1.5	3
Total			22

Step 2: Round the total fixture units from 22 up to 25 (the next increment in Table 3.5).

Step 3: Use Table 3.5 to establish peak hourly demand for internal use within the building. Nonresidential internal PHD is 18 gallons per minute. If the irrigation system is not operated while the building is occupied, then the estimated design PHD should be 18 gpm. If the irrigation system can be operated while the building is occupied, then the design estimate for PHD should include both the internal PHD (18 gpm in this example) plus the peak flow rate of the irrigation system.

Check water right:

- ✓ To estimate nonresidential MDD, multiply 20 workers x 15 gallons per day (per Table 3.3). Therefore, the nonresidential MDD is 300 gpd.
The water supply for food preparation is estimated at 1,000 gpd. Total water use in the building is 1,300 gpd. This is less than the 5,000 limitation on a permit-exempt well. OKAY
- ✓ Total irrigated area is below the maximum 21,780 square feet allowed without a water right. OKAY

3.4 Fire Suppression

If the project is in a Critical Water Supply Service Area, the water system design **must** provide the minimum stipulated fire suppression capacity (WAC 246-291-090 (1)). The local fire authority may require greater fire suppression capacity for the proposed water system. Minimum fire-flow requirements for public water systems in a Critical Water Supply Service Area are in WAC 246-293-640.

If the project is not in a Critical Water Supply Service Area, we recommend you consult with the local fire authority to determine what, if any, fire suppression capacity it expects from the proposed water system.

3.4.1 Design for Individual Structure Sprinkler Systems

If the water system will provide the direct supply of water to individual sprinkler systems in homes or other nonresidential structures, you **must** include the added supply and pressure requirements these sprinkler systems demand (WAC 246-291-200 and -210).

If you intend to design a water system capable of providing fire flow, either through hydrants or individual structure sprinklers, a professional engineer licensed in Washington State **must** prepare and submit the water system design (WAC 246-291-120(4)). For further guidance, please see our *Water System Design Manual* (331-123) online at <http://www.doh.wa.gov/portals/1/Documents/pubs/331-123.pdf>

References

WSDOH, 2009. *Water System Design Manual*, DOH 331-123, Washington State Department of Health, Olympia, WA.

American Association for Vocational Instructional Materials. 1982. *Planning for an Individual Water System*, 4th Edition, American Association for Vocational Instructional Materials, Athens, GA.

AWWA. 1984. *Design and Construction of Small Water Systems*, American Water Works Association, Denver, CO.

Chapter 4 Sources of Supply

Chapter 4 covers design considerations for your water source(s). The first consideration and a potential limiting factor in small water system design is the capacity of the source(s). The goal of your water system design is to provide the quantity of water needed to reliably meet the expected maximum day and peak hourly demands of your future customers.

The rule permits two types of sources for new or expanding Group B water systems: a well or an intertie with an existing, approved public water system (chapter 246-291 WAC).

If you intend to supply your proposed water system with an intertie, please refer to Section 4.4. The rest of this chapter is devoted exclusively to using a well as your Group B water supply.

4.0 Well Construction

In your workbook, you **must** demonstrate that your Group B groundwater supply:

- Is a drilled well, constructed according to chapter 173-160 WAC (WAC 246-291-125(1)). The department will not approve springs, surface water, dug wells, and wells found to be under the direct influence of surface water as a Group B water supply.
- Is capable of reliably delivering the minimum supply described in WAC 246-291-125(4).
- May be used in compliance with Washington's Water Code and other applicable regulations (WAC 246-291-125(3)) and the water right discussion in Chapter 3.
- Is physically connected to the distribution system. Trucked or hauled water is not an acceptable Group B public water supply, regardless of the trucked water source (WAC 246-291-125(1)).
- Meets all primary water quality standards without needing treatment (WAC 246-291-125(1) and -170(5)).
- Is protected adequately from potential contamination sources. Protective covenants establishing the minimum sanitary control area **must** be filed for each source (WAC 246-291-125(5)).

A totalizing source meter and sample tap are **required** on each new supply source (WAC 246-291-200). In addition, we recommend individual service meters on each service connection.

The well casing **must** extend at least 6-inches above the finished ground surface, or at least 6-inches above the pump house finished floor. Further, the top of the well casing must be at least 24 inches above the 100-year flood elevation (WAC 246-291-125(1) and chapter 173-160 WAC). Your submitted workbook must document the height of the well casing above the finished ground surface or floor. You may find flood-mapping information at your local planning office. If your well is in the 100-year flood plain, you must note this on your drawings. (See Section 5.3.)

The pitless adaptor or pitless unit, and the well cap **must** be manufactured according to Standard PAS-97 (04) (WAC 246-291-200 (13)).

4.1 Source Water Quantity

Groundwater is the most common form of public drinking water supply in Washington State. Your groundwater source(s) **must** provide sufficient water to meet the maximum daily demand (MDD) for your water system (WAC 246-291-125(4)). If your well can produce the maximum daily demand, but not the peak hour demand (PHD), you **must** provide equalizing water storage (WAC 246-291-200 (5)). If storage is required, a professional engineer may need to design the water system (WAC 246-291-120(4)).



4.1.1 Well Log

The well log, otherwise known as a “water well report,” provides important information about the construction of your well and its vulnerability to contamination. It also contains information about your aquifer and sometimes your well capacity and pump setting. You **must** include a copy of the well log in the workbook, even when the design intends to use an existing well (WAC 246-291-125(3)).

If a well log is not available, the department may not approve the source, or it may require additional information before considering the source for approval.

4.1.2 Pump Tests

All wells submitted for approval **must** be pump tested (WAC 246-291-125(3)). The goal of the pump test is to demonstrate the source’s capacity to meet or exceed proposed water system demand during a range of conditions likely to occur over the course of a year and the life of the well. See Appendix F for detailed pump test guidance.

The pump test must provide the:

- Static water level
- Sustainable yield
- Drawdown
- Recovery rate
- Duration of pumping

To demonstrate sustainable yield, a successful pump test must show the proposed well (or combination of wells) can provide a sustainable and reliable yield equal to or exceeding the minimum supply requirements in WAC 246-291-125 (4)(d). In addition, the water level in the proposed well must recover to 95 percent or more of the pre-test water level within a normal 24-hour operational period.

A successful pump test will provide data needed for source approval, well design, and water system planning decisions. By analyzing the pump test data, you can:

- Identify the capacity and reliability of your well.
- Establish well pump settings (depth and discharge rate).
- Define the area of influence of your well.
- Identify whether the system requires a water supply contingency plan because of a low-yield well (defined as 5.0 gpm or less) (WAC 246-291-140 (1)).

4.1.2.1 Elements of a Pump Test

A pump test is an aquifer and well stress test. The test subjects the well to a series of controlled pump and recovery (rest) challenges. Pumping rates and the water level in the well are monitored and recorded. The designer can use an analysis of the data to identify aquifer characteristics, such as transmissivity, hydraulic capacity, and specific yield.

A design engineer can use the capacity of the well (in gallons per minute), established from the pump test, and the required pump head (in feet) to select the proper pump size, pump placement and determine overall well efficiency.

Because aquifer conditions vary, the Appendix describes three different pump test procedures, each suited for different hydrologic conditions.

Test Procedure		Application
1	Standard Step Drawdown/ Constant Rate	Complex or unknown hydrologic settings
2	Extended Step Drawdown	Small systems with low demand located in high yield aquifers
3	Alternating Pump and Recovery	Very small systems in very low yield aquifers

Every pump test must include regularly recorded pumping and water level measurements taken before the test begins (pre-pumping conditions), during the pumping phase (drawdown), after the pump is shut off, and as water levels return to pre-pumping or near normal conditions (recovery). Pre-pumping and recovery water level measurements are as important as measurements taken during the pumping phase of a test.

A pump test must be long enough to demonstrate that the well can produce the minimum supply requirements defined in WAC 246-291-125 (4)(d) and recover to at least 95 percent of pre-pumping levels within a normal 24-hour operational period. The length of an individual pump test will vary based on the structure of the test and the aquifer conditions. Pump tests may take longer than 24 hours to complete and still be considered successful. It is the analysis of the data collected during the pump and recovery tests that demonstrates sustainable operating conditions. The designer is responsible for ensuring that a pump test provides sufficient data to achieve its objectives.

To conduct a pump test on an existing drinking water supply (to an individual home or an existing Group B water system), you must disconnect the pump discharge from the distribution system and any pressure tanks. This will allow you to measure the unrestricted pump discharge. Be sure to disinfect the well and pump discharge piping after completing the pump test and before placing the well pump back into service. Follow the disinfection standards in WAC 246-291-220.

If not already present, the designer **must** install an access port permitting “depth to water” measurement prior to the pump test (WAC 173-160). We recommend that you measure water levels to the nearest 0.01 ft. However, not all measuring devices have the same level of accuracy. Many electric tapes and loggers can provide accuracy of 0.01 ft. Sonic loggers may not show the same level of accuracy (typically 0.1 ft) but can provide more frequent and consistent measurements. To ensure recovery data is accurate, the designer should install check valve(s) to prevent water in the riser pipe from flowing back into the well when the well shuts off.

If aquifer conditions are unknown or hydrologically complex, you should consider getting help from a hydrogeologist or licensed water resource professional. Before conducting a pump test in areas subject to seawater intrusion, contact the local health jurisdiction. The LHJ may have pump test requirements or standards in addition to those in these *Guidelines*.

4.1.2.2 Low Well-Yield Water Supply Contingency Plan

If the pump test indicates the well yield is 5.0 gpm or less, the design **must** include a contingency plan describing short-term and long-term measures to restore water to consumers if the supply is ever inadequate to meet demand (WAC 246-291-140). When the supply begins with such a low yielding well, any decline in well yield of even a few gallons per minute will significantly affect the water system’s ability to satisfy demand.

Such a contingency plan should address both the supply constraint and consumer demand, and consider how the costs associated with a remedy will be met. The plan should identify how the system will continue to provide at least 350 gallons per day per residence of safe drinking water. Maintaining this minimum level of supply presumes the community is capable of prohibiting all outdoor water use, and that distribution system leakage is virtually nonexistent. There will likely be costs associated with pursuing a remedy to a low-yield source that suffers from declining yield, such as well rehabilitation or constructing a new source. The plan should contemplate how and when the system would establish a fund for such work.

4.2 Source Water Quality

The statements in this section, and throughout these *Guidelines*, assume the requirements and limitations in chapter 246-291 WAC are in effect in your project’s jurisdiction. It is possible that your local health jurisdiction adopted its own regulations that offer broader design options and impose increased regulation to protect against public health risks associated with those options (WAC 246-291-030 (1)(a)). Ask your local health jurisdiction if it has adopted regulations that differ from chapter 246-291 WAC.

All supply sources used for public water system service **must** meet minimum public health water quality standards. These standards, known as maximum contaminant levels, are in WAC 246-291-170. A state accredited lab **must** analyze all source samples to ensure they meet these standards (WAC 246-291-170(1)). A list of certified labs for the analysis of potable water can be found at <https://fortress.wa.gov/ecy/laboratorysearch/>

Source water sample taps **must** be provided (WAC 246-291-200(9)). We recommend you install the sample tap as close to the source as practical. If your design requires treatment for a secondary contaminant (WAC 246-291-170(6)), install a second sample tap after treatment and prior to entry to the distribution system.

4.2.1 Coliform Bacteria

All groundwater sources must be disinfected, flushed, and subsequently tested for coliform bacteria, and you must include the coliform bacteria test results with the workbook (WAC 246-291-170(2)). If coliform is present in the initial well sample, at least two follow-up coliform samples must be collected after re-disinfecting and re-flushing the well. If coliform is present in any of these follow-up coliform samples, the department will not approve the well as a Group B public water supply (WAC 246-291-170(5)).

4.2.2 Inorganic Contaminants

All groundwater sources submitted for approval must be tested for complete inorganic chemicals (IOC), and **must** meet the listed primary water quality standards without treatment (WAC 246-291-170(2)). If your proposed groundwater source exceeds an IOC primary water quality standard, you must collect a second (confirmation) sample. If the average of the two samples exceeds the drinking water standard, the department will not approve the well as a Group B public water supply WAC 246-291-170(5)).

If your proposed groundwater source exceeds an IOC secondary water quality standard (iron, manganese), your workbook **must** include treatment for its effective removal (WAC 246-291-170(6)). See Chapter 9 for guidance on treatment for secondary contaminants.

4.2.2.1 *Groundwater with High Initial Turbidity*

While not a regulated contaminant, turbidity is commonly included in a complete inorganic chemical analysis. A new well may show high turbidity in the post-pump test IOC sample. If so, you should thoroughly purge and pump the well to remove any construction residuals. High turbidity can be an indication of a poorly developed well. Iron or manganese may also cause high turbidity. Finally, turbidity may be an indication that the well is under the influence of nearby surface water (a serious problem).

Turbidity can cause distribution-related problems and customer complaints. Turbidity in groundwater, and particularly turbidity without any reasonable or logical explanation, is a significant concern. The design engineer should contact the reviewing authority for additional guidance.

4.2.3 Other Site-Specific Contaminants

The department may require you to sample the well for volatile or synthetic organic chemicals, or radionuclides if your proposed Group B groundwater source is in an area of known or suspected contamination (WAC 246-291-170(2)). If the initial sample shows the well exceeding a public health water quality standard, you must take a confirmation sample. If the average of the initial and confirmation samples exceeds the drinking water standard, the department will not approve the well as a Group B water supply (WAC 246-291-170(5)).

4.2.4 Potential Groundwater under the Direct Influence of Surface Water

You **must** evaluate all sources that meet the definition of potential groundwater under the direct influence of surface water (GWI) before submitting your completed Group B design for approval (WAC 246-291-125(1)). If your proposed groundwater supply is within 200 feet of surface water and the first open interval (top of well screen, first perforations in the well casing, and so on) is less than 50 feet below the ground surface, then your proposed groundwater supply is considered a potential GWI.

The department will not approve a potential GWI source until a licensed hydrogeologist or engineer completes a hydrogeologic evaluation that determines the source is not GWI (WAC 246-291-125(1)). The department will charge a separate fee to review your GWI evaluation.

4.2.5 Seawater Intrusion

Wells developed close to seawater are potentially vulnerable to seawater intrusion. You should avoid supply sources at risk of seawater intrusion.

Wells are at risk for seawater intrusion if they are:

- Within ½ mile of the shoreline and pump water from a depth below sea level.
- Within ½ mile of a groundwater source with chloride concentrations over 100 mg/L.

The Department of Ecology may condition water right permits to provide for reduced pumping rates, or even to require sources be abandoned if seawater intrusion threatens senior water right permits. In addition, several counties have policies or ordinances that affect water systems in areas vulnerable to seawater intrusion. You should contact Ecology and the local health jurisdiction for current policies and rules on well development where seawater intrusion may be a concern.

If you intend to develop a brackish well, and intend to apply reverse osmosis to desalinate the groundwater supply, be aware that you may only apply desalination for the removal of secondary contaminants. If the untreated groundwater supply from a brackish well exceeds a primary drinking water standard, such as those in Sections 4.2.1, 4.2.2, and 4.2.3 of these *Guidelines*, the department will not approve the source (WAC 246-291-170(5)).

4.3 Source Protection

You **must** have your well site inspected and approved before submitting your design for approval (WAC 246-291-125(3)). We strongly recommend that you have the well site inspected before drilling a new well. Ask your local health jurisdiction if it offers this service. If not, DOH will conduct the well site inspection. The department charges a separate fee for well site inspections.

You **must** maintain a sanitary control area of at least 100 feet around each well, unless adequate engineering justification is provided, to protect against existing or potential sources of contamination (WAC 246-291-125(5)).

You must prepare and file legal documents with the County Auditor to protect the sanitary control area from sources of contamination (WAC 246-291-125(5)). Information explaining how to file these legal documents, known as covenants, is in *Covenants for Group B Public Water Supply Protection*. General guidance on sanitary control area protection is in *Sanitary Control Area Protection* (331-453). Both publications are online at <http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/WaterSystemAssistance/GroupB/GroupBResources.aspx>

4.4 Interties

An intertie is a connection between a wholesale (supplying) public water system and a consecutive (receiving) public water system, permitting the exchange or delivery of water between those systems. There are two types of interties:

1. **Non-emergency intertie:** The piped connection supplies water from the wholesaler to meet the routine day-to-day needs of the consecutive system. If you plan to supply your proposed system through a non-emergency intertie, contact your DOH regional office and discuss it before moving too far into the design of your water system.
2. **Emergency intertie:** The piped connection provides a standby water supply from the wholesaler to the consecutive system necessary to meet the emergency water supply needs of the consecutive system. This may include help providing fire flow or serving as back up if one or more of the consecutive system's own sources fail. There are no regulatory requirements in chapter 246-291 WAC concerning emergency interties with another approved public water system.

This section describes the considerations you should make when designing your Group B water system as a consecutive system supplied by a non-emergency intertie.

4.4.1 Effect on Wholesale Purveyor

The wholesale system must demonstrate that it has enough department-approved connections to serve the total number of connections contemplated by your proposal. If the wholesale system does not have enough approved connections to accommodate its own customers plus your proposed customers, the wholesale purveyor **must** submit the appropriate planning and design documents to the department for written approval. The wholesale system will have to construct any needed improvements before the department will begin reviewing your workbook (WAC 246-291-120 (1)).

Even when your design reflects that the wholesale purveyor has the approved service capacity to serve your proposed water system, your workbook **must** include an analysis of the wholesaler's capacity. The analysis must show the wholesale system can deliver the water supply your proposed system demands while maintaining minimum acceptable service in the wholesale system (WAC 246-291-200 (4) and WAC 246-291-135 (1)).

If your proposed consecutive system's service connections and service population, when combined with the wholesale system's connections and service population add up to 15 or more service connections, or 25 or more people served at least 60 days per year, then the wholesale system will be considered a Group A water system.

If so, the wholesale system **must** meet all the applicable planning, engineering, and design requirements in chapter 246-290 (WAC 246-291-005). It may take the wholesale system considerable time to meet these requirements, if it isn't already a Group A water system.

4.4.2 Intertie Agreement

The intertie agreement has particular significance. If the intertie agreement between you and the wholesale purveyor cannot satisfy all the water supply requirements you identify in Chapter 3, you **must** show how your proposed system will meet the MDD and PHD reliably and consistently (WAC 246-291-200 (3) and (4)).

If the intertie agreement is not valid in perpetuity, your completed workbook **must** identify the alternative source(s) your system will use when the intertie agreement expires (WAC 246-291-135 (1)). In other words, planning your supply around an intertie agreement that is not valid in perpetuity requires you to spend the resources necessary to secure your own source that complies with the requirements of chapter 246-291 WAC before getting approval to be supplied by the intertie.

References

AWWA, 1999. *Design and Construction of Small Water Systems*, 2nd Edition, American Water Works Association, Denver, CO.

USEPA, 1991. *Manual of Small Public Water Supply Systems*, EPA 570/9-91-003.

WSDOH, 2007. *Covenants for public water supply protection*, DOH 331-048, Washington State Department of Health, Olympia, WA.

CHAPTER 5 Well Pump, Bladder Tanks, and Pump House



Chapter 5 explains how to make well pumps and pressure tanks work together as a single system capable of reliably providing safe drinking water to customers of new Group B water systems.

5.0 Well Pump

Your job is to select a well pump suited to the specific needs of your proposed water system. It's not enough to consider the horsepower rating of the pump motor (such as "*I need a 5-hp pump*"). In fact, before you select the pump motor size you must properly identify the right pump for your well.

5.0.1 Calculate Minimum Well Pump Discharge Rate

Begin your well pump selection process by referencing how much water your well can produce, as determined by your pump test (Section 4.1.2). If your well can produce up to the PHD determined for your proposed system (Sections 3.1 and 3.2), we recommend you select your well pump based on the PHD. A well pump capable of meeting the PHD of the proposed water system eliminates the need for equalizing storage (Section 5.3.1). If there is no requirement to provide fire suppression, then a well and well pump capable of supplying the PHD enables you to design your Group B water system using only one pump (the well pump) and pressurized storage (Section 5.1). This is the simplest, least expensive design option.

If your well cannot produce at least the PHD, then your design will have to include additional equipment, including an atmospheric storage tank and likely a booster pump. This equipment will add considerably to the cost of constructing your water system. In this instance, selecting a well pump that takes maximum advantage of the well capacity will minimize the size of your atmospheric storage tank.

5.0.2 Calculate Minimum Required Well-Pump Discharge Pressure

After you determine the well-pump discharge rate, you have to determine the pressure that the well pump must generate at the selected discharge flow rate. When you know the pump discharge rate and the pressure the pump must generate, you can begin the process of selecting the appropriate well pump.

There are two well-pump design scenarios:

1. **A simple system** consists of only a well pump and bladder tanks; the well pump is the only pump in the system. The well pump **must** generate enough flow and pressure to supply at least the PHD, and to provide at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system (WAC 246-291-200 (4)).

2. **A complex system** consists of a well pump and an atmospheric storage tank. The well pump must generate enough pressure to lift the water to fill the atmospheric tank. In some designs, the storage tank is next to or near the well, and the system will include a booster pump to move the water from the storage tank to the distribution system. In others, the storage tank will be on top of a hill or elevated sufficiently high above the service area so that the reservoir provides adequate pressure to serve customers without a booster pump.

The pressure the well pump must generate sometimes is measured in “feet,” as in “feet of head.” Water at a depth of 2.31 feet creates exactly 1 psi of pressure. In other words, if you had a pressure gauge connected to the bottom of a water tank, and the gauge read 30 psi, you’d know that there is 69 feet of water standing inside the water tank ($30 \times 2.31 = 69$). Some well pump manufacturers refer to a pump’s discharge capacity in gpm and “feet,” rather than gpm and psi. Just remember that “feet” and “psi” are interchangeable terms.

The following describes the design considerations for a simple system consisting of a well pump capable of delivering the peak hourly demand and one or more pressure tanks. This is the most common design scenario.

Total Dynamic Head

The total dynamic head of a pump is the sum of the total static head, the pressure head, and the friction head. We explain these terms below.

Equation 5-1: $TDH = SH + FH + PH$

Where:

- TDH** = Total dynamic head, measured in feet
- SH** = Static head, measured in feet
- FH** = Friction head, measured in feet
- PH** = Pressure head, measured in feet

Static Head

The total static head is the difference in elevation between the water surface in the well while the well pump is running (not the elevation of the pump itself) and your customers. This is a major factor in determining the pressure your well pump must generate, so be sure to base it on accurate measurements. To calculate the difference in elevation, you must know:

- The elevation of the top of your well casing and the elevation of the water surface in the well at the selected well pump discharge rate (this distance is measured during the pump test); and
- The elevation of the top of your well casing and the ground surface elevation along the planned distribution system piping to your customers.

Pressure Head

Public water systems **must** provide at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system (WAC 246-291-200 (4)). You can convert the pressure head at any point

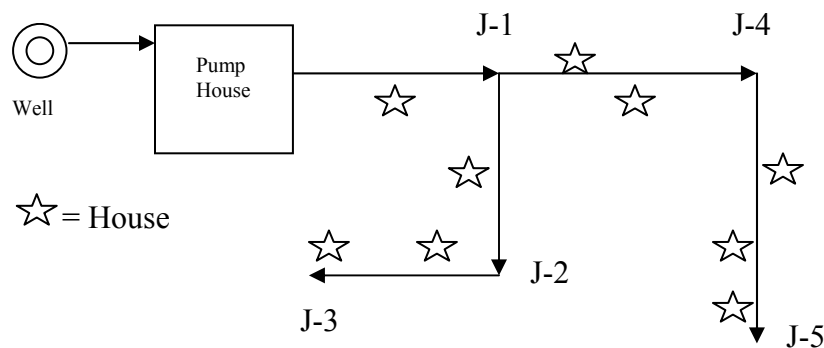
along the distribution pipeline from pressure (psi) to pressure head (feet) by multiplying the pressure by 2.31. For example, 30 psi is equal to $30 \times 2.31 = 69$ feet of head. This means that the minimum allowable value for the pressure head is 69 feet.

Friction Head

Your well pump moves water up the discharge pipe in the well, through all the pipes and valves in your pump house, and then out into the distribution system to your customers. While on this journey, the water is constantly losing energy due to friction of the water flowing inside the pipes, fittings, and valves. This energy loss may be described as the loss of “feet,” as in “*At 50 gpm, water flowing through a 2-inch Schedule 40 PVC pipe results in 4.2 feet of head loss per 100 feet of pipe.*” The 4.2 feet of head loss is equal to about 2 psi.

The friction head for a piping system is the sum of all the friction losses from the well to the end-user. Friction loss occurs through valves, meters, and fittings in greater proportion than through an equal length of pipe. To accommodate these added sources of friction loss, Worksheet 5-1 provides an allowance of 10 ft of friction loss (4 psi) for these common well house features.

Use the information from Table 5.1 and 5.2 to complete Worksheet 5-1. Estimating friction head loss in the piping system requires estimating the flow through each pipe segment. We recommend using the values in Table 3.2 and 3.3, and assigning water demand at the end of each pipe segment equal to the number of houses or nonresidential uses within and downstream of the end of the pipe segment. For example:



Pipe Segment	Homes downstream	Flow (gpm)
Well to Pump House	9	50
Pump House to J-1	9	50
J-1 to J-2	3	29
J-2 to J-3	2	24
J-1 to J-4	5	37
J-4 to J-5	3	29

Alternatively, you can use a computer-based hydraulic model to identify the total dynamic head required to maintain the minimum pressures throughout the distribution system. EPANET, distribution system hydraulic modeling software, is available free at <http://www.epa.gov/nrmrl/wswrd/dw/epanet.html> There are also other, more sophisticated hydraulic modeling software tools available for purchase.

Table 5.1
Head loss, ft/100 ft of pipe
For PVC Pipe Schedule 40

Flow rate, gpm	Pipe Size (inches)						
	1	1 ¼	1 ½	2	2 ½	3	4
5	1.7	0.4	0.2			Not meaningful	
10	6.0	1.6	0.7	0.2			
15	12.8	3.3	1.5	0.5			
20	21.8	5.6	2.6	0.8	0.3		
25	Not recommended	8.5	4.0	1.2	0.5		
30		11.9	5.5	1.6	0.7		0.2
35		15.8	7.4	2.2	0.9		0.3
40		20.2	9.4	2.8	1.2		0.4
45		11.7	3.4	1.4	0.5		
50		14.3	4.2	1.8	0.6		0.2
60		20.0	5.8	2.5	0.9	0.2	
70			7.8	3.3	1.1	0.3	

Table 5.2
Head loss, ft/100 ft of pipe
For PVC Pipe Schedule 80

Flow rate, gpm	Pipe Size (inches)						
	1	1 ¼	1 ½	2	2 ½	3	4
5	2.6	0.7	0.3			Not meaningful	
10	9.6	2.3	1.0	0.3			
15	20.4	4.9	2.2	0.6			
20	Not recommended	8.3	3.8	1.1	0.4		
25		12.6	5.7	1.6	0.7		
30		17.6	8.0	2.3	0.9		0.3
35		23.4	10.6	3.0	1.3		0.4
40		13.6	3.8	1.6	0.5		
45		16.9	4.8	2.0	0.7		
50		20.5	5.8	2.4	0.8		0.2
60	28.7	8.1	3.4	1.1	0.3		
70			10.8	4.5	1.5	0.4	

**Worksheet 5-1 (included with Group B Workbook)
Total Dynamic Head Calculation**

Friction Head Calculation								Static Head Calculation, Assume top of well casing elevation is 0 ft.			Min. Pressure Head, ft	Min. Total Dynamic Head, ft
Pipe Segment	From	To	Pump or Flow Rate, gpm	Pipe Size, inches	Friction Loss per 100 ft	Pipeline Length, ft	Pipe Segment Friction Loss, ft	Top of well casing to water while pumping, ft	Ground Elev. at "to"	Elevation difference, ft		
1	Well pump	Top of well casing									69	
2	Top of well casing										69	
3											69	
4											69	
5											69	
6											69	
7											69	
8											69	
9											69	

With a simple system consisting of only a well pump and bladder tanks, the well pump is the only pump in the system. Without a storage tank, the well pump **must** generate enough flow and pressure to supply at least the PHD, and to provide at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system.

For the segment that includes the well house, add 10 feet of friction loss to account for losses related to fittings and valves. If you intend to use a cycle stop valve, add additional friction loss per manufacturer's data (Section 5.0.6)

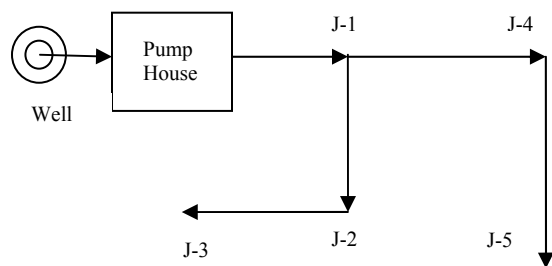
Total up the "pipe segment friction loss" for each pipe segment + "elevation difference" + "minimum pressure head" values. The highest total dynamic head (TDH) is the minimum pressure, expressed in "feet of head" that the well pump must generate while pumping the peak hourly demand. You may wish to select a pump with a TDH greater than the required minimum.

Example 5-1 Total Dynamic Head

Friction Head Calculation								Static Head Calculation, Assume top of well casing elevation is 0 ft.			Min. Pressure Head, ft	Min. Total Dynamic Head, ft
Pipe Segment	From	To	Pump or Flow Rate, gpm	Pipe Size, inches	Friction Loss per 100 ft	Pipeline Length, ft	Pipe Segment Friction Loss, ft	Top of well casing to water while pumping, ft	Ground Elev. at "to"	Elevation difference, ft		
1	Well pump	Top of well casing	50	2	5.8	160	9.3	119.3	0	119.3	69	197.6
2	Top of well casing	Exit pump house	50	2	5.8	75	4.3 + 10 = 14.3	119.3	0	119.3	69	211.9
3	Exit pump house	Junction #1	50	3	0.8	400	3.2	119.3	20	139.3	69	235.1
4	Junction #1	Junction #2	29	2	2.3	300	6.9	119.3	30	149.3	69	252.0
5	Junction #2	Junction #3	24	2	1.6	250	4.1	119.3	50	169.3	69	276.1
6	Junction #1	Junction #4	37	2	3.0	500	15	119.3	30	149.3	69	260.1
7	Junction #4	Junction #5	29	2	2.3	500	11.5	119.3	10	129.3	69	251.6

Objective: Determine minimum total dynamic head required at the end of each pipe segment. Choose the highest total dynamic head value.

Conclusion: The well pump must be capable of producing at least 276 feet of total dynamic head at 50 gpm. See below.



Pump lift from water level in the well to the top of the well casing = 119.3 ft

Elevation change (increase) from top of well casing to Junction #3 = 50 ft

Total static head (SH) from well pump to Junction #3 = 169.3 ft

Total friction head (FH) between well pump and Junction #3 = 9.3 + 14.3 + 3.2 + 6.9 + 4.1 = 37.8 ft

Total (minimum) pressure head (PH) required at Junction #3 = 69 ft (provides 30 psi at the customer)

Eq. 5-1: Total dynamic head = SH + FH + PH
 TDH = 169.3 + 37.8 + 69 = 276.1 ft (equal to 119 psi at the pump itself) at 50 gpm

5.0.3 Well Pump Selection and Controls with Pressure Tanks

With bladder tanks and no storage tank, a pressure switch located in the pump house, near the bladder tank(s), will control the well pump. The “pump-on” pressure **must** be set so that the pressure is at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system, just before the well pump comes on to recharge the pressure tanks (WAC 246-291-200 (4)).

Continuing with our Example 5-1, to maintain 30 psi at Junction #3 with the well pump off, the pressure in the well house must be $276.1 \text{ ft} - 119.3 \text{ ft} - 9.3 \text{ ft} - 14.3 \text{ ft} = 133.2 \text{ ft} = \mathbf{57 \text{ psi}}$. In our example, this is the pressure at which the well pump must come on (“pump-on” setting) to maintain a minimum of 30 psi everywhere in the distribution system.

The pump-off setting should be about 20 psi greater than the pump-on setting. In this example, **80 psi** as the pump-off setting would work fine. In our example, this corresponds to a “pump head” of:

$$80 \text{ psi} \times 2.31 = 185 \text{ ft (pressure head inside the pump house)} + 119.3 \text{ (vertical distance from the water level in the well to the pump house)} + 9.3 + 14.3 = 327.9 \text{ TDH (use 330 ft).}$$

In this example, the pressure in the distribution system will not exceed 80 psi or fall below 30 psi between the “pump on” and “pump off.”

5.0.4 Well Pump Selection and Control with a Storage Tank

The principles above also apply to determining the TDH of the well pump when pumping to a storage tank. Here are the major differences: When applying **equation 5-1**, the pressure head (PH) is zero because the storage tank is open to the atmosphere (unpressurized storage); and the static head (SH) must include the difference in elevation between the water level in the well and the water level in the reservoir.

You may need to include a reservoir in your Group B water system design for many reasons. For example:

- The well and well pump cannot produce enough water to satisfy the peak hour demand. Water stored in a reservoir can provide the supplemental supply needed to serve the distribution system.
- The owner of the water system seeks the higher level of service reliability that a reservoir offers.
- The water system must be capable of providing fire protection.

A reservoir design may supply water to the distribution system directly or by gravity. Gravity uses the elevation difference between the water in the reservoir and customers. This difference in elevation **must** provide at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system (WAC 246-291-200 (4)). Alternately, you may design a reservoir without sufficient difference in elevation between water in the reservoir and customers if the water is re-pumped from the reservoir into the distribution system so that the 30-psi standard is met.

The well may pump to a reservoir directly through a dedicated water main from well to reservoir or indirectly through the distribution system (where the pipe between the well pump and reservoir also serves customers). In either case, the level of the reservoir must control the well-pump function. The operating range between the “well pump off” and “well pump on” defines the “operating storage” volume in your reservoir (Section 7.0). Float switches in the reservoir usually control these two levels by sending a signal to the well-pump controller through direct wire or wireless (radio frequency) communication.

The basis of the well pump control system design is the reservoir volume between pump “on” and pump “off,” and the well pump discharge. The reservoir design should provide the volume required to prevent excessive cycling (starting and stopping) of the pump motor. Unless the well-pump motor manufacturer specifically allows starts more frequently, the pump should not be called to fill the reservoir more than six times in an hour.

To simplify the well pump control system design, set the well pump “on” and pump “off” levels in the reservoir so that the volumetric difference between these two levels is equal to 10 times the discharge rate of the well pump. For example:

Suppose the water system design presented in Example 5-1 has a 3,500-gallon polyethylene tank that’s 8 feet in diameter and 10 feet tall. The well pump produces 50 gpm, and pumps directly to the reservoir. No pressure tanks are connected to the well pump discharge. The reservoir is right outside the well house, and the base of the tank is at the same elevation as the wellhead.

Because the difference between the pump-on and pump-off level switches should provide a volume about 10 times more than the discharge rate of the well pump, the pump-on level should be set about 15 inches below the pump-off level (15 inches of depth in this particular tank is equal to about 500 gallons).

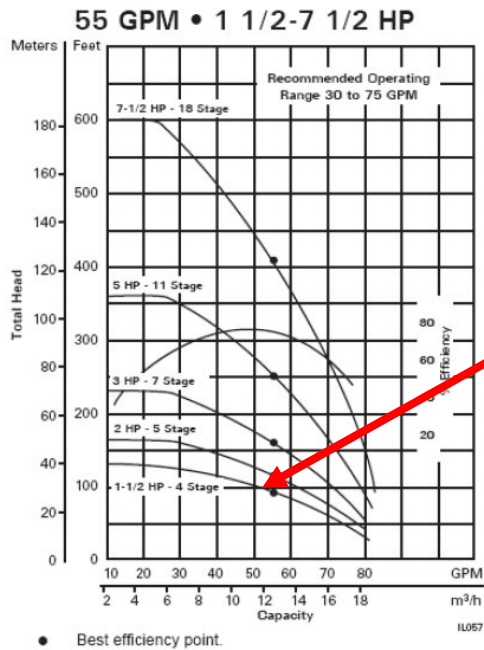
The total dynamic head (TDH) the well pump must pump against is equal to (see Example 5-1):

- The pipe segment friction loss for pipe segments 1 and 2 ($9.3 \text{ ft} + 14.3 \text{ ft} = 23.6 \text{ ft}$)
- Top of well casing down to the stabilized water level in the well while the pump is on (119.3 ft)
- Top of the well casing to top of the 3,500-gallon tank (10 ft)
- TDH the well pump must overcome to produce 50 gpm is $23.6 + 119.3 + 10 = 152.9 \text{ ft}$.

The water in the reservoir will have to be re-pumped into the distribution system to provide at least 30 psi throughout the distribution system during peak hour demand (see Chapter 8 for booster pump design).

5.0.5 Well Pump Selection

In this section, we will use the example water system introduced in Example 5-1 above.



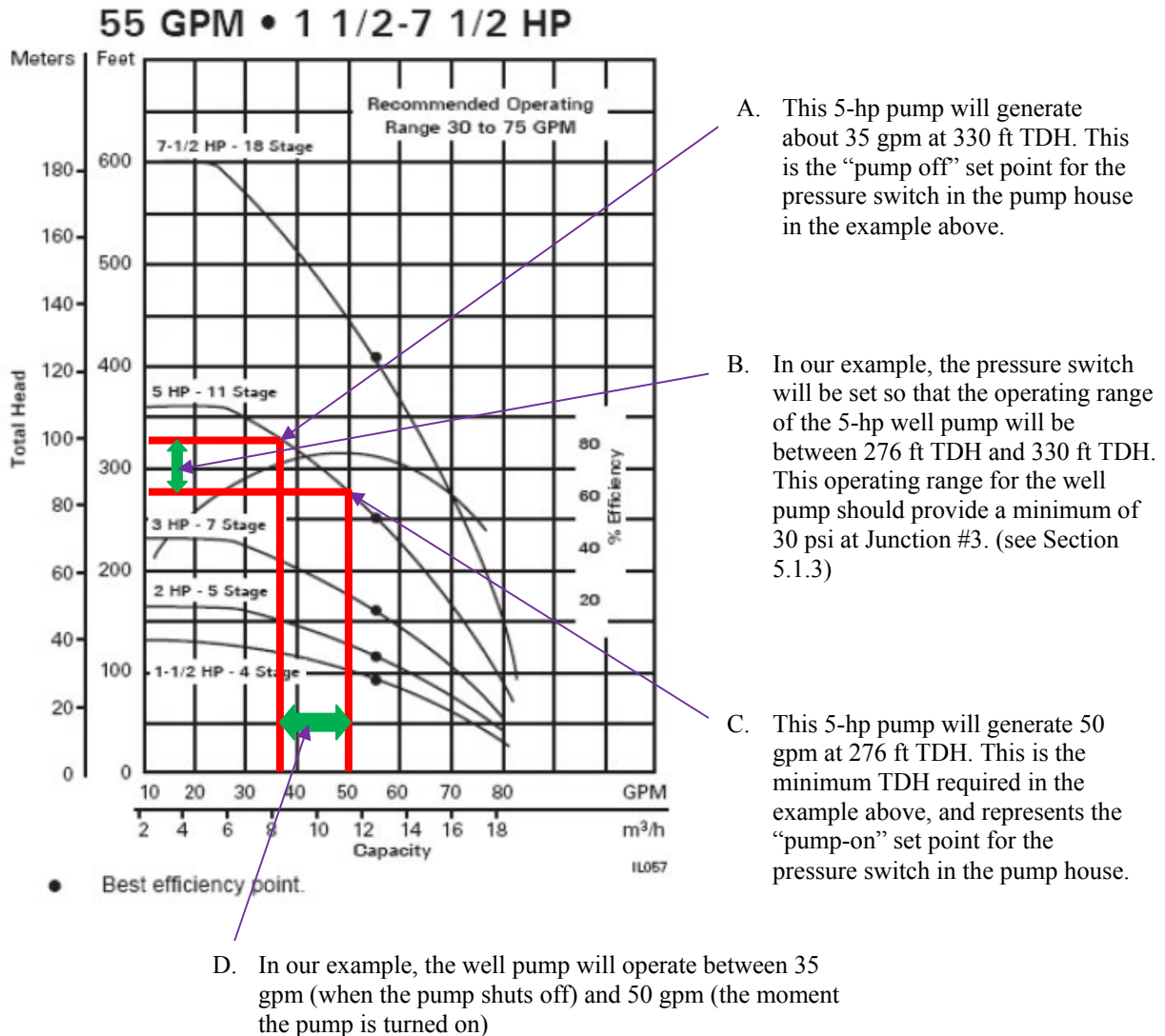
The figure at left is a family of pump curves, beginning with a 7½-hp pump (top) down to a 1½-hp pump (bottom).

A pump curve expresses the relationship between discharge pressure (“total head” or TDH) shown on the vertical axis, and discharge pumping capacity (gpm) shown on the horizontal axis.

For example, look at the 1½-hp pump curve. It shows this particular pump is capable of producing 50 gpm at 100 ft TDH.

The rising and falling curve in the middle of graph is the pump efficiency curve. As you can see, this family of pumps is most efficient between 35-60 gpm.

In our example, we are looking for a pump that can produce 50 gpm while generating at least 276 ft TDH. In the set of pump curves below, the 5-hp pump can produce 50 gpm at about 275-280 ft TDH (see C below). This same pump will produce about 35 gpm at 330 ft TDH (see A below). The operating pumping range for the 5-hp pump will be between 35 gpm (the “pump off” setting) and 50 gpm (the “pump on” setting - see B and D).



5.0.6 Using a Cycle Stop Valve

If you choose to use a cycle stop valve (CSV), be sure to include the head loss through the valve when determining the friction loss within the pump house. The 10-foot head loss allowance suggested in Worksheet 5-1 is for normal valves and fittings, and does not make any allowance for a CSV.

As described more fully in Appendix G, the CSV is designed to keep the pump operating nearly all the time. Much of this time, especially at night, water demand will be very low, resulting in prolonged pump operation at the upper end of its pump curve (near where the pump curve intersects the vertical axis of the graph). That is the point of extremely low pump efficiency, and may cause early failure of the pump if the manufacturer did not design the pump-motor for prolonged operation at a very low flow rate and very high pressure.

If your design includes a CSV, consult directly with the pump vendor or manufacturer to make sure the pump is compatible with the type of service you intend for it.

5.0.7 Using Variable Frequency Drive

Identifying the right well pump based on the design flow at the “pump on” pressure setting does not change if you are considering a variable frequency drive (VFD) system for your well pump. Designers may consider using VFDs because of the potential for reducing power bills and lowering overall water system construction costs (fewer bladder tanks). For further information, see Appendix H.

If you intend to design a water system using a variable frequency pumping system, a professional engineer licensed in Washington State **must** prepare and submit the water system design (WAC 246-291-120 (4)).

5.1 Pressure Tanks

Water systems use pressure tanks with well pumps and when re-pumping water, such as from a reservoir into a distribution system. Pressure tanks make it possible to deliver water within a selected pressure range without continuously operating pumps or having the pumps start every time there is a minor demand for water.

Two types of pressure tanks are used to protect water system pumps. Each has its own basic design procedures. **Conventional tanks**, also called hydropneumatic tanks, allow air-water contact. **Bladder tanks** have a membrane separating the air from the water.

5.1.1 Conventional (Hydropneumatic) Tanks

Designers use conventional tanks in well pump installations that are usually larger than necessary for Group B water systems. If you intend to design a conventional tank system, please see our *Water System Design Manual* (331-123) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

5.1.2 Bladder Tanks

Bladder tank sizing depends on the number of “selected-size” tanks needed to provide pump protection. Bladder tanks have pre-charged air bladders with a pressure of 2 psi below the low operating (pump-on) pressure for the system. Engineers should call out this stipulation in the design specifications.

For more information, see *Troubleshooting Bladder Pressure Tanks* (331-342) online at <http://www.doh.wa.gov/portals/1/Documents/pubs/331-342.pdf>

5.1.2.1 Bladder Tank Sizing Equation

Equation 5-2:
$$T_s \geq \frac{(R)(Q_p)}{(N_c)(V_B)}$$

Where:

$R = \frac{15(P_1 + 14.7)(P_2 + 14.7)}{(P_1 - P_2)(P_2 + 9.7)}$ (or refer to Table 5.3)

V_B = The gross volume of an individual bladder tank in gallons, or bladder tank size (“86-gallon tank,” for example).

T_s = The number of bladder tanks of gross volume V_B

P_1, P_2 = Pressures selected for water system operation in psig (gauge pressures). P_1 corresponds to the pump-off pressure and P_2 to the pump-on pressure

N_c = Number of pump operating cycles per hour. This should be the maximum number of pump motor starts per hour as justified and documented by the pump or motor manufacturers' warranty. Without such information, this should be no more than six cycles per hour.

Q_p = Pump delivery capacity in gallons per minute at a midpoint of the selected pressure range. Determine this by examining pump curves or tables. If this value is not used, the designer **must** use the Q_p that occurs at P_2 (pump-on).

5.1.2.2 Bladder Tank Design Procedure

1. Based on water system hydraulic requirements, select the operating range of pressure, P_1 (pump-off) and P_2 (pump-on).
2. Select the operating cycles per hour, N_c . The value for N_c should not exceed six cycles per hour unless documented manufacturers' warranties justify larger values. For multiple pump installations, N_c may be increased if an automatic pump switchover system is installed to automatically alternate pumps. The actual increase in N_c should be justified by documented manufacturers' warranties.
3. Determine the delivery capacity, Q_p , for the midpoint of the operating pressure range $[(P_1 + P_2)/2]$. The pump capacity **must** meet system requirements at P_2 pressure (see WAC 246-291-200 (4)).
4. Select an appropriate gross volume, V_B , for each bladder tank (bladder tank size). This volume should be available from bladder tank manufacturers. Do not select bladder tank sizes larger than 120 gallons gross volume.
5. Calculate the value of R . For convenience, Table 5.3 gives R -values for several commonly used pressure ranges.
6. Use Equation 5-2 (see above).
7. Round up the value determined in Step 6 to the nearest whole number. This is the number of tanks, each with the selected volume, V_B , to be used for pump protection.

Table 5.3
R Values for Various Pressure Tank Ranges

P₂ pump-on pressure (gauge)	P₁ pump-off pressure (gauge)				
	55 psi	60 psi	65 psi	70 psi	80 psi
35 psi	58.1	49.8	44.3		
40 psi	76.7	61.7	52.6	46.6	
45 psi		81.5	65.2	55.5	
50 psi			86.4	68.8	51.3
60 psi					76.1

Example 5-2

For a mid-pressure range pumping rate, Q_p , of 40 gpm, a selected cycling of six cycles per hour, a bladder tank gross volume of 86 gallons, and a selected pressure range of 60/80, the number of 86-gallon tanks required is determined as follows:

$$Q_p = 40; N = 6; V_B = 86$$

Using Table 5.3 for $P_2/P_1 = 60/80$, $R = 76.1$

Using Equation 5-2:

$$T_s > \frac{(R)(Q_p)}{(N_c)(V_B)}$$

$$T_s > \frac{(76.1)(40)}{(6)(86)} = 5.9$$

Select six 86-gallon bladder tanks for pump protection, pre-charged to 58 psi (2 psi below pump-on pressure).

5.1.3 Labor and Industries Standards for Pressure Tanks

Many pressure tanks used in water systems are “unfired pressure vessels” that must comply with chapter 70.79 RCW and the Department of Labor and Industries’ (L&I) regulation (chapter 296-104 WAC). These regulations require all pressure tanks more than 5 cubic feet (37.5 gallons) in volume to be constructed according to the latest edition of ASME specifications (RCW 70.79.080). While all pressure tanks used by water systems **must** meet the construction and installation requirements of chapter 296-104 WAC, they are exempt from routine L&I inspections and fees (RCW 70.79.090(6)).

All pressure tanks **must** have a safety valve to protect against over-pressurization, such as a properly sized and installed ASME-approved pressure relief valve (PRV) (WAC 296-104-316). You **must** install the PRV on top of the tank or on outlet piping as close as possible to the vessel. There must be no valves between the PRV and the pressure tank (WAC 296-104-235). The “set” pressure of the PRV must not exceed the design pressure of the vessel.

For design requirements and other guidance, see *Pressure Relief Valves on Pressure Tanks* (DOH 331-429) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

The maximum allowable working pressure for a tank is on the nameplate attached to the tank. For nonstandard pressure vessels, engineers can determine the maximum allowable working pressure with the L&I formula in WAC 296-104-405. A properly sized ASME PRV should have a relieving capacity that will prevent pressure in the vessel from rising more than 10 percent or 3 psi above the maximum design set pressure of the PRV, whichever is greater.

5.2 Pump House Design and Construction Recommendations

The pump house design and construction should allow convenient, safe access for removal and service of equipment. When you construct your Group B well house, be sure to:

- Install a wall-mounted thermostat-controlled wall heater.
- Use PVC Schedule 80, galvanized iron, or copper piping for all internal piping.
- Support all internal piping properly.
- Install unions and isolation valves at pressure tanks, booster pumps, and other equipment to allow for equipment removal.
- Secure any booster pump to the floor.
- Install ASME pressure relief valve(s) properly sized based on flow.
- Install a totalizing source meter inside the pump house.
- Install all pressure tanks on the floor.
- Install the raw water tap at least 6-inches above the floor.
- Position pressure gauges so they are easily readable.
- Be sure to install a keyed lock on door.

5.3 Well and Pump House Detailed Drawings and Specifications

The design submittal **must** include drawings of each project component, including location, orientation, and size (WAC 246-291-120 (2)). The drawing(s) and specifications of the well pump, pressure tank(s), and pump house appurtenances should include:

- a. Pump-house building specifications.
- b. A plan view with a scale of not more than 10 feet to the inch. It must show the location of the well and proposed pump house, water mains, fittings, valves, construction and maintenance easements, sanitary control area, existing above ground and underground utilities (gas, electric, power, sewer, irrigation, and so forth), and other natural or man-made features important to the proper construction of the pump house.
- c. Location, size, capacity, and construction materials of all pipes, pumps, valves, sample tap, water meter, pressure gauges, pressure switch, pressure tanks, pressure relief valves, and other key components inside the pump house.
- d. Manufacturer's catalog information on the specific well pump showing operating pump-on and pump-off limits.
- e. Manufacturer's catalog information on the specific bladder tanks and pressure switch.
- f. Settings for the pressure switch, pressure relief valves, CSV (if any).
- g. Elevation of the top of the well casing above the ground or pump house floor, and whether the wellhead is located in the 100-year flood plain.
- h. Disinfection procedures for well-after-pump installation.
- i. Disinfection and pressure testing procedures for all well and pump house piping and tanks.
- j. Physical protection of the wellhead (if located outside the pump house).
- k. Location of required generator disconnect switch (WAC 246-291-200(11)).
- l. Specification for well casing cap, well pitless adaptor, or pitless unit.
- m. Typical details of thrust blocking or restraints for internal and below-building piping.
- n. All other buried utilities, including storm and sanitary sewers, dry wells, telephone, natural gas, power and TV cable lines in the project area (existing or proposed concurrent with pipeline construction) to the extent possible, given existing available records. Construction details should note that all buried utilities are to be field located prior to construction.

You must show the following accessories on the drawings:

- Generator disconnect switch (WAC 246-291-200 (11))
- Source water meter (WAC 246-291-200 (9))
- Source sample tap (WAC 246-291-200 (9))
- Each pressure tank equipped with an isolation valve and an ASME pressure relief valve (WAC 296-104-316)
- A lock on the pump house door (WAC 246-291-140 (1))

References

WSDOH, 2009. *Water System Design Manual* (331-123), Washington State Department of Health, Olympia, WA.

CHAPTER 6 Piping Design and Construction

Chapter 6 explains how to design and construct the distribution system so that it can deliver a safe and reliable water supply from the well to the system's customers. This guidance, combined with the information on friction loss and distribution system design from Chapter 5, assumes your proposed water system will not provide fire suppression (fire flow).

If you intend to design a water system capable of providing fire flow, a professional engineer licensed in Washington State **must** prepare and submit the water system design (WAC 246-291-120(4)). For further guidance, see our *Water System Design Manual* (331-123) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

6.0 Piping Material

When designing a water main, it is important to consider the type of pipe and the pressure needs of the system. Excessive system pressure can increase the risk of pipe failure and cause customers to waste water. Distribution system pressure should not exceed 100 psi. All distribution piping should be rated to withstand the maximum pressure they may experience during operations and pressure testing.

PVC pipe is the most common pipe material used in small water systems. Other pipe material includes ductile iron, steel, high-density polyethylene (HDPE), and cross-linked polyethylene, commonly abbreviated PEX or XLPE. The use of asbestos-cement, cast iron, or galvanized iron pipe in distribution system design is not recommended. In addition, the use of irrigation pipe, drainpipe, or other thin-walled pipe material is strictly prohibited for potable water systems. The designer or design engineer **must** use established standards, such as AWWA or ASTM, when justifying the material and class of pipe and pipe fittings selected (WAC 246-291-200(1)).

PVC pipe "schedule" refers to a specific ratio of the outside diameter of the pipe and the pipe wall thickness, known as the dimensional ratio (DR). PVC pipe "class" reflects the working pressure rating of the pipe. For example, PVC Schedule 80 pipe (DR 11) has a greater pressure rating than PVC Schedule 40 pipe (DR 16) because of a thicker pipe wall. Because both pipe schedules have the same outside diameter ("OD"), the Schedule 80 pipe (with the thicker pipe wall) has a smaller inside diameter ("ID"). The head loss difference between Tables 5.1 and 5.2 reflect the difference in the pipes' inside diameter. You should use flow rate, pressure, and allowable head loss as the basis for selecting a pipeline size and schedule.

We recommend using a minimum 1½-inch diameter and maximum DR 21 pipe in all distribution main designs. The recommended minimum size provides for conveyance without undue friction loss. Larger pipe sizes may be needed. The recommended maximum DR (measure of wall thickness) provides an allowance for hydrostatic testing pressure (Section 6.4), less than perfect installation (depth of bury, bedding, joints, expansion and contraction), unusual pressure conditions (surge pressures, poorly controlled leak testing), and a general design factor of safety. Applying a maximum DR 21 excludes ASTM D2241 PVC Class 160 and AWWA C900 Class 100 pipe.

Any specified and installed pipe and pipe fittings **must** conform to material standards for contact with potable water, ANSI/NSF Standard 61 (WAC 246-291-205).

6.1 Pipe Burial, Bedding, and Thrust Blocks

Pipelines **must** be installed below the frost line, and “bedded” with uniform material that doesn’t present a risk to the pipe. PVC pipe is brittle, and has little resistance to the forces of a sharp or heavy rock pressing on it or its fittings. Poor bedding material, and failure to compact the bedding material around the pipe, may result in pipeline failure. You should place, spread, and compact bedding at a minimum of 6-inches beneath, beside, and over the pipe.

Pipes should be buried below the frost line as determined by the most severe cold weather on record; otherwise, pipelines should be protected against freezing by some other means (insulation, heat tracing). When determining proper depth, designers should evaluate temperature variations in the area, especially at high altitudes, in Eastern Washington, and beneath regularly plowed paved surfaces. The minimum fill depth over the top of the pipe should be at least 36 inches, even in temperate areas. The designer may justify another depth (for example, to avoid underground obstructions or rocky conditions). If providing less than 36 inches of cover, you should consider the pipe load rating and the location of the installation (to avoid crushing the pipeline due to traffic loads).

Depending on the pressure and the size of the pipe, a change in pipe direction can cause substantial forces at pipe fittings such as bends, tees, crosses, and dead-end caps. You should consider installing thrust blocks to protect the new pipeline from these forces. Thrust blocks are typically made of concrete poured in place between the fitting and the solid, undisturbed earth wall of the pipe trench. Restrained joint pipe may be used instead of thrust blocks to prevent pipe separation due to unequal hydraulic forces at pipe fittings.

6.2 Isolation Valves, Flushing Hydrants, and Air Release Valves

Isolation valves provide a way to isolate sections of the distribution system. Your Group B water system should have enough valves on water mains to minimize the number of customers without water service and minimize hazards during repairs. We recommend valves on each branch of pipeline “tees” and “crosses.”

Pipelines should be flushed from time to time, especially dead-end lines. To flush a pipeline, you must generate sufficient flow velocity and have an appropriate egress point for the flushed water. The minimum effective flush velocity is 2.5 feet per second. For example, it takes about 14 gpm to generate 2.5 fps flow velocity in a 1½-inch pipeline, and it takes about 25 gpm to generate the same flushing velocity in a 2-inch diameter pipe. A small flushing device installed at the end of dead-end lines will facilitate pipeline flushing. To view options for flushing, conduct an Internet search under “yard hydrants” or “flushing hydrants.”

You may not use yard hydrants that drain the riser into the ground. The weep hole presents a risk of contamination to the distribution system through a cross connection with contaminated groundwater. If you choose to use a yard hydrant, the Uniform Plumbing Code requires you to use a model that does not drain into the ground. Yard hydrants that conform to American Society of Sanitary Engineers Standard 1057 are acceptable because they do not drain into the ground.

You should provide air release valves at high points on distribution lines to release accumulated air. These valves can be automatic (they release air when it accumulates at the valve) or manual (they release accumulated air only when a person manually opens them). If accumulated air is not released it can restrict or even completely block the flow of water through the pipe.

6.3 Distribution System Pipeline Easements

Distribution system pipelines **must** be installed in the public right-of-way or within private property easements. The water system owner must have access to maintain pipelines and all related components, such as valves, meters, flushing hydrants, and so on. Your design submittal must show all distribution system components either within the public right-of-way or within a private property easement. The easement must be wide enough to accommodate all work (excavation, equipment access, and turning radius). We recommend a width of at least 15-feet (7.5 feet on each side of the pipeline).

6.4 Pressure and Leakage Test

To check the quality of pipe joints and fittings, it's necessary to conduct a pressure and leakage test. The test **must** follow the testing procedures the designer or design engineer specified in the approved design submittal (WAC 246-291-200(1)). The project engineer or the owner's representative should be present during this critical test to verify that it meets the specifications. Pressure testing standards are in the *Standard Specifications for Road, Bridge and Municipal Construction* (WSDOT/APWA 2012), available free on the WSDOT website. These standards state:

All water mains and appurtenances shall be tested in sections of convenient length under a hydrostatic pressure equal to 150 psi in excess of that under which they will operate, or in no case shall the test pressure be less than 200 psi.

6.5 Disinfection

Purveyors **must** properly disinfect all components of a new or expanding Group B water system before putting the new or expanded system into service. The disinfection process **must** meet the specifications approved for the water system, such as AWWA C651 or WSDOT/APWA (2012) for all sizes of water mains; AWWA C652 for water storage facilities; and AWWA C654 for well disinfection (WAC 246-291-220(1) and (2)).

6.6 Microbiological Testing

Each of the disinfection standards listed in Section 6.5 includes a requirement for coliform bacteria testing. Water systems **must** complete and report satisfactory coliform testing done as part of disinfecting all the components of a new or expanding Group B system. The engineer **must** note the satisfactory test results on the *Construction Completion Report* form (WAC 246-291-120(5)). To ensure the samples properly represent water quality in the water system, purveyors should not take water samples before sufficiently flushing the new lines or equipment.

6.7 Separation from Nonpotable Piping Systems

The water system design should provide at least a 10-foot horizontal and 18-inch vertical separation above nonpotable pipelines (sanitary sewers, reclaimed water piping, irrigation lines, and so on). The 18-inch vertical separation should be the measured distance between the closest sides of the two pipes. If the nonpotable line is a sewer line, the designer should refer to Section C1-9 of *Criteria for Sewage Works Design* (WSDOE 2006) for appropriate sewer design requirements. For additional guidance on potable and nonpotable pipe separation, consult *Pipeline Separation Design and Installation Reference Guide* (WSDOE and DOH 2006).

6.8 Service Connections

6.8.1 Service meters and service lines

We recommend that you install the water service line at the same depth and with the same bedding as the water main. The water service line should be least 1-inch in diameter and be made of PVC, copper, HDPE, or PEX. Using a 1-inch service line instead of a ¾-inch service line decreases friction loss due to flow from the water main to the building by a factor of three. For many homeowners and businesses, installing a 1-inch service line is worthwhile because it noticeably improves the level of service.

Residential fire sprinkler systems demand higher flow and pressure. Therefore, a residence with fire sprinklers may require a larger diameter water service line. Consult your local building code for guidance.

You should install a separate curb or meter “stop” (valve) for each service connection. These valves allow system managers or the property owner to shut off an individual connection without interrupting service to other customers. A curb stop is a valve installed at the property line if there is no meter at the property line. You can operate a curb stop from the surface. A meter stop is a valve installed just upstream or downstream of the meter.

Service meters are not required, but we recommend every designer include them because they enable the system manager to proportion the cost of service fairly, and reduce the incidence of over-use at the expense of the other consumers.

6.8.2 Cross-connection control

A cross connection is any actual or potential physical connection between a public water system or a consumer's water system and any source of nonpotable liquid, solid, or gas that could contaminate the potable water supply by backflow. Because all Group B water system users share a common distribution system, contamination from one connection has the potential to move about the distribution system and contaminate the water supply to other connections.

On certain premises, the contamination hazard associated with the plumbing and water use may require a cross-connection control assembly. This special valve assembly prevents water from flowing back into the distribution system. For guidance, see *Cross Connection Control for Small Water Systems* (331-234) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

Many commercial properties involve water uses that pose a threat of a cross connection. You should consult the local building official to determine what, if any, cross-connection control assembly is needed on a commercial customer's service line.

Most single-family homes do not pose a high health hazard to the Group B water system users. There is a potential for problems if single-family homes have access to a separate water supply. Your development's covenants, conditions, and restrictions (CC & Rs) should require proper cross-connection control assemblies on service connections if your service area is supplied by a separate irrigation system, or individual homeowners are entitled to drill their own wells.

You must test all cross-connection control assemblies installed on service lines annually to ensure they continue to function properly. You should include the authority to require such testing in the development's CC & Rs.

6.9 Individual Pressure Reducing Valves

If you anticipate that pressure at any service connection will exceed 80 psi, you are responsible for recommending that those customers install and maintain individual pressure reducing valves (PRVs) as delineated in the Uniform Plumbing Code (UPC). Water systems should install individual customer PRVs only if they have a written agreement with the customer showing who is responsible for required PRV maintenance, repair, or replacement. The water system should check for local ordinances or service agreements on PRV use.

6.10 Distribution System Detail Drawings and Specifications

The workbook **must** include drawings of each project component, including location, orientation, and size (WAC 246-291-120 (2)). The drawing(s) and specifications of the distribution system should include:

- a. A plan view with a scale of not more than 100 feet to the inch showing the location of the proposed water mains, fitting, valves, service meters, flushing hydrants, construction or maintenance easements, existing above-ground and underground utilities (gas, electric, power, sewer, irrigation), and other natural or man-made features important to the proper construction of the water main.
- b. Location, size, capacity, and construction materials of all proposed pipelines in the project area. Show all flushing hydrants, valves, meters, air release valves, blow-off valves, and so on.
- c. Identification of lots served under the project scope of work by new distribution mains serving plats or subdivisions.
- d. Typical construction details of all new pipeline tie-ins to existing pipelines.
- e. Typical details of pipeline trench cross-section indicating bedding, backfill, and compaction requirements.
- f. Typical details of thrust blocking or other type of pipe restraint.
- g. Disinfection and pressure-testing procedures for all new pipelines.
- h. Service connection details, where appropriate.

- i. All other buried utilities, including storm and sanitary sewers, dry wells, telephone, natural gas, power and TV cable lines in the project area (existing or proposed concurrent with pipeline construction) to the extent possible, given existing available records. Construction documents **must** clearly state that all buried utilities are to be field located prior to construction (RCW 19.122).

References

WSDOH, 2009. *Water System Design Manual* (331-123), Washington State Department of Health, Olympia, WA.

WSDOE, 2008. *Criteria for Sewage Work Design*. WSDOE Pub. 98-37. Washington State Department of Ecology, Olympia, WA.

WSDOE and DOH, 2006. *Pipeline Separation Design and Installation Reference Guide*. WSDOE Pub. 06-10-029. Washington State Department of Ecology, Olympia, WA.

CHAPTER 7 Atmospheric Storage Tanks

Chapter 7 covers the design and construction of an atmospheric storage tank (unpressurized storage). Group B water systems use atmospheric storage tanks to:

- Directly supply the distribution system by providing the minimum pressure requirement of 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system (WAC 246-291-200 (4)). An example of this is a tank constructed on top of a hill, high above all the customers.
- Indirectly supply the distribution system by collecting water pumped from the well and supplying it to the distribution system via water pumped through a booster pump. An example is a small tank constructed right outside the well and booster pump house.

Most Group B water systems construct atmospheric storage when the well and well pump are not able to supply the PHD, or must provide fire flow. If the design calls for construction of the storage tank with the tank bottom below the finished ground surface, a professional engineer **must** prepare and submit the entire Group B water system design (WAC 246-291-120 (4)).

7.0 Operating Storage Volume

Operating storage (OS) is the volume of the reservoir devoted to supplying the water system while, under normal operating conditions, the source of supply (such as a well pump) is in “off” status. Every atmospheric reservoir needs OS.

This volume will vary according to two main factors:

1. The sensitivity of the water level sensors controlling the well pump(s).
2. The configuration of the tank designed to provide the volume required to prevent excessive cycling (starting and stopping) of the source pump motor.

The OS volume should be sufficient to avoid pump cycling in excess of the well pump motor manufacturer's recommendation. Without the specific pump motor manufacturer's standards, you should design OS to limit the well pump motor to no more than six starts per hour.

7.1 Equalizing Storage Volume and Elevation

7.1.1 Equalizing storage volume

When source pumping capacity cannot meet the peak hourly demand, the water system **must** provide equalizing storage (ES) (WAC 246-291-200 (5)). Generally, the most practical way to provide needed ES is to design atmospheric storage.

Designers are cautioned against attempting to provide ES with bladder tanks. Pressurized bladder tanks provide only a small volume of usable “drawdown” volume within a given pressure range. For example, an 86-gallon bladder tank will release about 18 gallons when the tank is drawn down from 80 psi to 60 psi. The design **must** provide for at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system *when equalizing storage volume is exhausted* (WAC 246-291-200 (4)). It is considered impractical to provide ES with an array of bladder tanks.

Designers should use Equation 7-1 to estimate the ES requirement for residential water systems. They must add the OS volume to calculated ES volume.

Equation 7-1:

ES = (PHD - Q_s) x T, but in no case less than zero

Where:

ES = Equalizing storage, in gallons

PHD = Peak hourly demand, in gpm, as defined in Chapter 3 of these *Guidelines*

Q_s = The installed well pumping capacity at the “pump-on” pressure setting

T = See Table 7.1 below

For extremely small water systems, design standards suggest 30 percent of the MDD should be provided as ES when the source pumping rate (Q_s) matches the MDD pumping rate (assume 24-hour pumping at a constant rate). Any fraction of Q_s that is in excess of the MDD pumping rate will reduce ES from this baseline volume. The minimum “T” values shown in Table 7.1 convert the deficit between PHD and Q_s into ES volume. “T” increases with the number of connections, reflecting the higher probability of a longer period of overlapping demand among an increasing number of residential users.

Table 7.1

Number of Residential Connections	Minimum “T”
2	35
3	47
4	60
5	68
6	76
7	85
8	91
9	98

ES needs will vary greatly for nonresidential water systems, depending on the daily water demand pattern during the highest demand days. If the daily demand pattern can be predicted, use this information to determine an appropriate volume of ES. If not, use Equation 7-2 to estimate ES for a nonresidential water system:

Equation 7-2:

$$ES = [0.30 \times MDD] \times [1 - Q_s/PHD] \times [1 + (MDD/1440)/PHD]$$

Where:

- ES = Equalizing storage, in gallons
- Q_s = The installed well pumping capacity at the “pump on” pressure setting
- PHD = Peak hourly demand, in gpm, as defined in Chapter 3 of these *Guidelines*
- MDD = System-wide maximum daily demand, in gallons per day

7.1.2 Equalizing storage elevation

An atmospheric storage tank supplying a system by gravity **must** provide at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system (WAC 246-291-200(4)). To do so, there must be sufficient difference in the elevation between the bottom of equalizing storage volume in the tank and the highest point in the distribution system, taking head loss into account.

7.2 Standby Storage Volume

Standby storage (SB) is not required, and not usually provided in Group B system design. SB volume provides a measure of reliability in case sources fail or unusual conditions impose higher demands than anticipated. If you contemplate providing SB volume, we recommend you provide the volume equivalent to the MDD for your entire system.

7.3 Fire Suppression

The local fire protection authority or county fire marshal determines a fire flow requirement for water systems. This fire suppression storage (FSS) level depends on the maximum flow *rate* and *duration*. If your Group B water system must provide fire suppression capacity, the design **must** enable the water system to meet fire flow requirements while maintaining 20 psi pressure throughout the distribution system under MDD conditions (WAC 246-291-200(8)).

Water systems in areas governed under the *Public Water System Coordination Act of 1977* (chapter 70.116 RCW) **must** meet the act’s specified minimum flow rates and durations for residential, commercial, and industrial developments (WAC 246-293-640). The local fire protection authority, county fire marshal, or a locally adopted coordinated water system plan may specify greater FSS requirements.

If you intend to design a water system capable of providing fire flow, a professional engineer licensed in Washington State **must** prepare and submit the water system design (WAC 246-291-120(4)). For further guidance, please see our *Water System Design Manual* (331-123) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

7.3.1 Minimum FSS Volume

The minimum FSS volume for water systems served by single or multiple supply sources is the product of the required flow rate (expressed in gpm) multiplied by the flow duration (expressed in minutes). See Equation 7-3.

Equation 7-3:

$$\text{FSS} = (\text{FF})(t_m)$$

Where:

- FF** = Required fire flow rate, expressed in gpm, as specified by fire protection authority or under WAC 246-293-640, whichever is greater
- t_m** = Duration of FF rate, expressed in minutes, as specified by fire protection authority or under WAC 246-293-640, whichever is greater

7.4 Dead Storage Volume

Dead storage (DS) is the volume of stored water not available to all consumers at the minimum design pressures required under WAC 246-291-200 (30 psi during PHD conditions and 20 psi during MDD plus needed fire flow throughout the distribution system). Every atmospheric reservoir has some amount of dead storage due to the geometry of the outlet pipe and the tank bottom. For example, if the top of a reservoir outlet pipe is 12 inches above the reservoir floor, and an allowance of 6 inches is made to ensure the outlet pipe is always submerged, then the bottom 18 inches of the reservoir is “dead storage.” The depth of DS is convertible to water volume based on the geometry of the tank (volume in gallons = area (sf) x depth (ft) x 7.48 gallons per cubic foot). The DS volume must be added to the OS and ES volumes determined above.

7.5 Total Storage Volume

The total atmospheric storage tank volume is the sum of OS, ES, SB, FSS and DS. See Equation 7-4.

$$\text{Equation 7-4: } \text{TS} = \text{OS} + \text{ES} + \text{SS} + \text{FSS} + \text{DS}$$

Where TS = total storage volume, in gallons.

7.5.1 Water Quality Concerns With Excessive Storage

Water stored in a reservoir for an extended time will undergo physical, chemical, and biological changes, causing deterioration in water quality. Excessive water age can be caused by under-utilization (water is not cycled through the tank), and poor mixing within the reservoir. Such changes include temperature increases, microbial growth, and changes in color, taste, and odor.

Numerous factors contribute to these changes. For example, temperature, system hydraulics, mixing, and nutrient availability all affect the microbial growth rate. Aged, stale water provides an environment conducive to the growth and formation of taste and odor-causing microorganisms and substances. (USEPA, *Finished Water Storage Facilities*, 2002) Standards for the states of Georgia, Virginia, and Ohio call for a minimal daily “turnover” rate of 20 to 33 percent. Turnover refers to the portion of stored water exchanged with new water.

To avoid deterioration of water quality in the reservoir, we recommend operating the tank so that one-fifth to one-third of the tank volume is exchanged with new water each day. To prevent poor mixing, we recommend designing the inlet and outlet tank piping to maximize mixing of the water stored in the reservoir.

7.6 Reservoir Design Requirements and Considerations

The design submittal **must** include drawings of each project component, including location, orientation, and size (WAC 246-291-120 (2)). A number of companies manufacture prefabricated concrete, plastic (polyethylene, polypropylene), and fiberglass potable water storage tanks that meet National Sanitation Foundation Standard 61. If you choose to use a prefabricated tank, make sure the manufacturer's drawing(s) and specifications demonstrate compliance with the requirements below.

7.6.1 Reservoir Design Requirements

The following are **mandatory** elements of reservoir design:

- a. If any of the following is true, then a professional engineer licensed in Washington State **must** prepare and submit the design report workbook (WAC 246-291-120(3) and (4)).
 - The bottom of the storage tank is below the finished ground surface.
 - The design of the Group B water system depends on gravity to deliver sufficient flow and pressure from the atmospheric tank to meet the minimum performance standards in WAC 246-291-200 (4).

For further guidance on atmospheric reservoir design, see our *Water System Design Manual* (331-123) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

- b. Designed and installed overflow pipe with atmospheric discharge or other suitable means to prevent cross connection contamination. Overflows **must** be covered with a 24-mesh non-corrodible screen or mechanical device, such as a flap valve or duckbill valve, to keep animals, insects or other contamination sources out of the reservoir (WAC 246-291-210 (1)).
- c. Tank materials in contact with potable water **must** meet ANSI/NSF Standard 61 (WAC 246-291-205 (1)).
- d. Locate and show other buried utilities, including storm and sanitary sewers, dry wells, telephone, natural gas, and power and TV cable lines in the project area (existing or proposed concurrent with pipeline construction) to the extent possible, given existing available records. Construction documents **must** clearly state that all buried utilities are to be field located prior to construction (RCW 19.122).
- e. Designed and installed drain facilities that drain to daylight (WAC 246-291-210 (1)).
- f. Tank roof atmospheric vent, with a noncorroding 24-mesh insect screen (WAC 246-291-210 (1)).
- g. Locking mechanism on all openings into the reservoir (WAC 246-291-140 (1)(g)).
- h. Water tight, insect proof access hatch and vent (WAC 246-291-210 (1)).
- i. Leakage testing and disinfection per accepted standards, such as AWWA (WAC 246-291-220 (1)).

- j. Reservoir isolation valve(s), which permit isolating the tank from the water system (WAC 246-291-210 (1)).
- k. Smooth-nosed sample tap on the tank side of the isolation valve (WAC 246-291-210 (1)).
- l. Design calculations identifying the elevation at the bottom of the equalizing storage volume necessary to provide at least 30 psi during PHD conditions along property lines adjacent to distribution mains and at the point of service to each customer connected to the distribution system, if gravity storage provides equalizing storage.
- m. Design calculations identifying the elevation at the bottom of the fire-suppression storage volume necessary to provide 20 psi throughout the distribution system under needed fire flow plus MDD conditions, if gravity storage provides fire suppression storage.

7.6.2 Reservoir Design Considerations

We **recommend** the storage tank design include:

- a. High- and low-level alarm system that directly notifies operations personnel.
- b. Access ways and ladders necessary to provide access for safe maintenance.
- c. A silt-stop on the outlet pipe to keep sediment from entering the distribution system.
- d. The slope of the reservoir roof should be at least 2 percent ($\frac{1}{4}$ inch per foot).

7.6.3 Reservoir Plan Submittal

The drawings and specifications for a reservoir should be prepared as follows:

- a. A plan view and a profile (elevation) view with a scale of not more than 10 feet to the inch showing the location and dimensions of the proposed tank, water mains, drain, overflow, and valves.
- b. Indicate the elevation of the tank bottom and tank overflow level.
- c. Identify easements and property lines.
- d. Describe the tank level control system.
- e. Provide manufacturer's information, construction details, and specifications for the reservoir roof hatch and vent.
- f. Provide details on the foundation design and requirements to prepare the site for installation of the foundation.
- g. Locate existing above ground and underground utilities (gas, electric, power, sewer, irrigation, and so forth), and other natural or man-made features important to the proper construction and operation of the tank.

References

WSDOH. 2009. *Water System Design Manual (331-123)*, Washington State Department of Health, Olympia, WA.

USEPA. 2002. *Finished Water Storage Facilities*, prepared by AWWA and Economic and Engineering Services, Inc., for U.S. Environmental Protection Agency Office of Ground Water and Drinking Water Standards and Risk Management Division

CHAPTER 8 Booster Pumps

For most Group B water systems, booster pumps are designed to pressurize water taken from a storage tank to maintain a consistent pressure range in the distribution system. In that regard, the booster pump acts just like the well pump, working to pressurize water taken from a well to maintain a consistent pressure range in the distribution system. The design of a booster pumping system should follow the same, general principles described for well pumps in Chapter 5.

If you intend to design a booster pump station, please see our *Water System Design Manual* (331-123) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

8.0 Booster Pump Station Detailed Drawings and Specifications

The design submittal **must** include drawings of each project component, including location, orientation, and size (WAC 246-291-120 (2)). The drawing(s) and specifications of the booster pumps and appurtenances should include:

- a. Booster pump station building specifications (only if the building is separate from the pump house addressed in Sections 5.2 and 5.3).
- b. A plan view with a scale of not more than 10 feet to the inch showing the location of the booster pump station, water mains, fittings, valves, construction and maintenance easements, existing above ground and underground utilities (gas, electric, power, sewer, irrigation, and so on), and other natural or man-made features important to the proper construction of the pump house.
- c. Location, size, capacity, and construction materials of all pipes, pumps, valves, sample tap, water meter, pressure gauges, pressure switch, pressure tanks, pressure relief valves, and other key components inside the booster pump station.
- d. Manufacturer's catalog information on the specific booster pumps, with the operating limits (pump on, pump off) identified.
- e. Manufacturer's catalog information on the specific bladder tanks and pressure switch to be installed.
- f. Settings for the pressure switch, pressure relief valves, CSV (if any).
- g. Alarm conditions (if any), and alarming system.
- h. Disinfection and pressure testing procedures for all piping and tanks.
- i. Typical details of thrust blocking or restraints for internal and below-building piping.
- j. All other buried utilities, including storm and sanitary sewers, dry wells, telephone, natural gas, and power and TV cable lines in the project area (existing or proposed concurrent with pipeline construction) to the extent possible, given existing available records. Construction documents **must** clearly state that all buried utilities are to be field located prior to construction (RCW 19.122).

References

WSDOH. 2009. *Water System Design Manual*, 331-123, Washington State Department of Health, Olympia, WA.

CHAPTER 9 Treatment for Secondary Contaminants

This chapter discusses design and construction of treatment systems for secondary contaminants in drinking water. Secondary contaminants include iron, manganese, total dissolved solids, chloride, and sulfate. The department will not approve your proposed Group B water supply well if it exceeds the standard for a primary contaminant, such as coliform, arsenic, or nitrate (WAC 246-291-170 (5)).

9.0 Secondary Treatment Design

If the untreated well water contains a secondary contaminant above the drinking water standard (WAC 246-291-170, Table 2 and Table 3), the workbook **must** include design and construction information on the selected treatment process (WAC 246-291-170 (6)).

9.1 Common Strategies for Iron and Manganese Removal

9.1.1 Oxidation and filtration

When removal of iron or manganese is required, the most common removal methods are oxidation, followed by sedimentation and filtration. Oxidation may be affected by aeration, chlorination, or potassium permanganate. Treatment is most effective at higher pH levels, usually in excess of pH 7.5. The best oxidant for manganese removal is potassium permanganate, which has been shown effective over wide ranges of pH. Chemical additives and filter media **must** be approved for use in potable water service (National Sanitation Foundation listing 60 and 61, respectively) (WAC 246-291-205).

9.1.2 Ion exchange

Ion exchange technologies can also be used to remove iron (Fe) or manganese (Mn). These methods require special care to prevent oxidation before the iron and manganese enter the exchange media. Fouling of the exchange bed can occur if the iron or manganese is not maintained in a chemically reduced state. Lime-softening processes can be used for iron or manganese removal, but this practice is normally used adjunct to water softening, which is not common in Washington State. Ion exchange resins **must** be approved for contact with potable water (National Sanitation Foundation listing 61) (WAC 246-291-205).

9.1.3 Iron and Manganese Sequestering

We do not recommend sequestering (also called stabilization, chelation, or dispersion) as a strategy to address excess levels of iron and/or manganese.

9.2 Secondary Treatment Detail Drawings and Specifications

The design report **must** include drawings of each project component, including location, orientation, and size (WAC 246-291-120 (2)). The drawing(s) and specifications of the secondary treatment process should include:

- a. Treatment process and maximum daily treated water production capacity.
- b. Hydraulic considerations and headloss calculations.
- c. Actual water quality data from the proposed drinking water well supporting the selection of the treatment process, including analytes targeted for removal and analytes that may interfere with treatment efficacy
- d. Treatment flow rate.
- e. Backwash or regeneration flow rate.
- f. Treatment waste volume.
- g. Waste disposal.
- h. Chemicals, media, and or resins used.
- i. Control system.
- j. Monitoring employed to ensure proper operation.
- k. Location, size, capacity, and construction materials of all pipes, pumps, valves, sample tap, gauges, switches, tanks, and other vendor-supplied secondary treatment components. Explain how this system works with the well pump, reservoir or bladder tanks, and booster pump (if any). Include the operations and maintenance manual for the treatment system.

If design and construction of a secondary contaminant treatment process is necessary, see additional secondary treatment design guidance in our *Water System Design Manual* (331-123) online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

9.3 Consumer Notification Required

Whenever treatment is used to remove or control a secondary contaminant, you **must** include in the Notice to Title a description of the form of treatment or control being applied and the secondary contaminant(s) of concern (WAC 246-291-140).

If sequestration is used, your Notice to Title should inform property owners that they might experience problems with the hot water portion of their home plumbing. You should also let them know that you must periodically flush remote portions of the water distribution system to remove precipitated iron or manganese.

9.4 Treatment Waste Disposal

Wastes associated with secondary treatment applications (such as brine discharges or filter backwash wastewater) must be disposed of properly. The Department of Ecology should be contacted to determine the disposal requirements.

References

WSDOH. 2009. *Water System Design Manual*, 331-123, Washington State Department of Health, Olympia, WA.

AWWA and American Society of Civil Engineers (ASCE). 1990. *Water Treatment Plant Design*, 2nd Edition, Chapter 11: "Iron and Manganese Removal," McGraw-Hill. New York, NY.

HDR Engineering, Inc. 2001. *Handbook of Public Water Supplies*, 2nd Edition, Chapter 14: "Iron and Manganese Removal," John Wiley & Sons, New York, NY. Sommerfeld, E.O. 1999. *Iron and Manganese Removal Handbook*, AWWA, Denver, CO.

CHAPTER 10 Financial Viability

Chapter 10 covers the preparation of a realistic, balanced budget necessary to cover the total cost of operating and maintaining a safe and reliable water system. If you are creating a new or expanding Group B water system, you **must** show how much revenue is needed to operate and maintain the system, and present a plan to meet these revenue needs (WAC 246-291-140 (1)).

Financial viability is the ability to obtain sufficient funds to develop, construct, operate, maintain, and manage a public water system, on a continuing basis. A viable water system generates enough revenue to meet or exceed its expenses and the owner(s) manage the financial resources in a manner that accounts for future capital needs. The owner of a water system is responsible for proper budgeting and ensuring sufficient funds are available to support the operation, maintenance, and infrastructure replacement needs of the system.

At some point, a water system will require funds for extraordinary events, such as the unexpected failure of a well pump. Every small water system should consider replacement of every element of the system, even those not expected to fail or wear out for many decades.

We recommend creating an emergency reserve fund and an asset-replacement reserve account because loans, when needed, may be hard to obtain quickly.

10.0 Completing the Financial Viability Worksheet

For additional information about the items in the worksheet, see the following publications online at <https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm>

- *Financial Viability Manual for New and Expanding Small Water Systems* (331-104)
- *Financial Viability for Small Water Systems* (331-405)

Note: Owners of a new or expanding Group B water system serving commercial facilities that will not charge customers for water should complete lines 1 through 12 on Worksheet 10-1. (The worksheet is on Page 69 of these *Guidelines*.)

10.1 Disclosure to Customers

Section 2.6 of these *Guidelines* describes the requirement to disclose certain information to water system customers. A template for an informational notice to customers on property your Group B water system serves is included in the Appendix. The notice should let customers know:

- Whether customers are metered
- Whether water will be billed on the basis of metered use
- How often water bills will be issued
- The initial water rate and how often a bill will be sent
- How you will develop an annual water system budget
- How you will fund and administer a reserve account

10.2 Explanation of Terms

Below is an explanation of the line items on Worksheet 10-1:

Wages and Benefits (Operator) *(Line 1)*

Include all compensation to employees of your utility when the work is related to the utility's O&M.

Electricity and Other Utilities *(Line 2)*

Include the cost of all electric power, water, telephone, and any other utility-related expenses incurred in producing and delivering water.

Chemicals and Treatment *(Line 3)*

Include the cost of all chemicals used or manufactured by the utility in the treatment of water.

Monitoring *(Line 4)*

Include all water monitoring costs for samples you intend to take each year. We suggest you budget for the collection and analysis of at least one coliform sample each year, and one nitrate sample every three years.

Materials and Supplies *(Line 5)*

Include all materials and supplies used in the O&M of the water system and in producing and delivering water to the customer. Include all materials and supplies used in the administration of the water system, including office supplies, computers, postage, copier charges, and paper.

Repairs and Parts *(Line 6)*

Include any repairs or parts incurred in producing and delivering water, including grease, oil, and minor repairs to equipment.

Emergency Reserve *(Line 7)*

There are two parts of an emergency reserve to consider:

- **Minimum required balance:** This cost to replace the most vulnerable and critical facilities or equipment that may affect the reliability of the system.
- **Annual installment:** Include the amount you plan to add to the emergency reserve each year. We suggest fully funding the emergency reserve account within 6 years.

Asset Replacement Reserve *(Line 8)*

- Include the amount you plan to add to the asset replacement reserve each year. You can assign infrastructure components by their expected lifespan. You can expect to replace shorter-lived assets, such as the well pump, electrical components, pressure tanks, booster pumps, and meters, within 20 years. Longer-lived assets, expected to last beyond 20 years, include the structures (well house), well, reservoir, and distribution system.

Principal and Interest Payments *(Line 9)*

Include payments associated with short-term and long-term borrowing.

Taxes and Assessments *(Line 10)*

Include taxes on the utility, such as state utility tax, property tax, or business and occupation (B&O) tax. You can account for each of these taxes separately in the operating budget.

Insurance and Miscellaneous Expenses *(Line 11)*

Include all insurance costs associated with coverage for the property, general liability, workers' compensation, and other insurance costs related to the operation and administration of the water system. Include any other expenses incurred producing and delivering water. If the LHJ has an annual fee for Group B water systems, include the cost of the fee. If your system intends to retain the services of an accountant or engineer, include those costs.

Hook-up and Other Fees *(Line 13)*

Include fees and charges for service provided, including connection fees. Examples are bad check fees, reconnect fees, late payment fees, meter-testing fees, and initial first-time hookup charges.

Interest Earned *(Line 14)*

Include interest earned on savings deposits.

Other Revenues *(Line 15)*

Include all other expected sources of revenue.

Average Water Rate *(Line 19)*

The last step in the worksheet is to project the average monthly water bill. This figure is based on the estimated revenue from water rates needed to cover all expenses, divided by the number of connections expected to be in service each year. It represents a simple average. If you intend to charge each customer based on metered consumption (we recommend this approach to recovering the cost of water service), you must estimate annual demand to assess the cost per unit volume of water.

For example, if you intend to install service meters on each customer and base the cost of service on metered consumption, begin by estimating that the average residential customer will consume 50 percent of the MDD value given in Table 3.1 each day of the year. Using 50 percent of the MDD as the average daily demand, an average dwelling unit would consume 19,000 gallons per month in Eastern Washington and 11,500 gallons per month in Western Washington. Multiply the number of dwelling units you expect to be in service by the average monthly water demand per dwelling unit, to arrive at a total average monthly demand. Then divide the value in line 17 by the total demand to arrive at a water rate. Water rates are usually expressed in dollars per 1,000 gallons of water.

References

WSDOH, 1995. *Financial Viability Manual for New and Expanding Small Water Systems*, Washington State Department of Health, Olympia, WA.

WSDOH, 2011. *Small Water System Management Program: A Guide for Small Non-Expanding Community Group A Water Systems (331-134)*, Washington State Department of Health, Olympia, WA.

WSDOH, 2008. *Financial Viability for Small Water Systems (331-405)*, Washington State Department of Health, Olympia, WA.

Financial Viability Worksheet 10-1

TOTAL EXPENSES	1st Yr.	2nd Yr.	3rd Yr.	4th Yr.
1. Wages & Benefits (incl. SMA costs)	\$ _____	\$ _____	\$ _____	\$ _____
2. Electricity & Other Utilities	\$ _____	\$ _____	\$ _____	\$ _____
3. Chemical & Treatment	\$ _____	\$ _____	\$ _____	\$ _____
4. Monitoring Costs	\$ _____	\$ _____	\$ _____	\$ _____
5. Materials & Supplies	\$ _____	\$ _____	\$ _____	\$ _____
6. Repairs/Parts	\$ _____	\$ _____	\$ _____	\$ _____
7. Emergency Reserve Contribution	\$ _____	\$ _____	\$ _____	\$ _____
8. Asset Replacement Reserve Contribution	\$ _____	\$ _____	\$ _____	\$ _____
9. Principal & Interest Payments (if there are any loans outstanding)	\$ _____	\$ _____	\$ _____	\$ _____
10. Taxes/Assessments	\$ _____	\$ _____	\$ _____	\$ _____
11. Insurance/Misc. Expenses	\$ _____	\$ _____	\$ _____	\$ _____
12. Total Expenses (Sum lines 1-11)	\$ _____	\$ _____	\$ _____	\$ _____

TOTAL REVENUE FROM SOURCES OTHER THAN WATER RATES

13. Hook Up/Other User Fees	\$ _____	\$ _____	\$ _____	\$ _____
14. Interest Earned	\$ _____	\$ _____	\$ _____	\$ _____
15. Other Revenue	\$ _____	\$ _____	\$ _____	\$ _____
16. Total Revenue (Sum lines 13-15)	\$ _____	\$ _____	\$ _____	\$ _____

WATER RATE CALCULATIONS

17. Remaining Revenue Required (Line 12 minus Line 16)	\$ _____	\$ _____	\$ _____	\$ _____
18. Number of Connections	_____	_____	_____	_____
19. Average Water Rate (Line 17 divided by Line 18)	\$ _____	\$ _____	\$ _____	\$ _____

APPENDICES

- A** Public Water System Coordination Act
 - A.1** Sample letter to request water service for a Group B project located inside a Critical Water Supply Service Area and a water utility's future service area (Section 2.4)
 - A.2** Sample letter to request water service for a Group B project located inside a Critical Water Supply Service Area and outside any water utility's future service area (Section 2.4)
- B** Sample letter requesting the services of a Satellite Management Agency (Section 2.5)
- C** Template for informational notice to titles on property served by the Group B water system (Section 2.6)
- D** Outline for Water Users' Agreement (Section 2.8)
- E** Water Facilities Inventory form (Section 2.9)
 - E.1** *Water Facilities Inventory* form (Section 2.9)
 - E.2** *Water Facilities Inventory* instructions (Section 2.9)
- F** Pump Test Procedure (Section 4.1)
 - F.1** Group B Pump Test Guidance
 - F.2** Step Draw Down/Constant Rate Pump Test Procedure
 - F.3** Extended Step Draw Down Pump Test Procedure
 - F.4** Alternating Pump and Recovery Test
- G** Cycle Stop Valves (Section 5.0.6)
- H** Variable Frequency Drive

Sample Letter to Request Water Service
Group B Project Located in a Critical Water Supply Service Area and
Inside a Water Utility's Future Service Area
(See Section 2.4)

Date

Dear Local Purveyor,

I am pursuing approval of a project that requires approval of a new public water system, or approval of an existing public water system not yet approved by either the local health jurisdiction or the state Department of Health.

Under the Public Water System Coordination Act, I am required to request water service from you because my project lies within your utility's future service area. Details concerning my project, including its exact location and its water supply and fire suppression requirements, are attached for your reference.

Please provide me with a written response to my request for water service within 30 days of the date of this letter. In your response, please let me know if your utility can provide water service. If not, I will proceed with the design and/or approval of a Group B public water system.

If there are requirements that my project connect with your utility in the future, when such a connection is feasible, please provide me with whatever legal agreement you require me to sign before I may operate a new public water system within your future service area.

If you have any questions, please contact me at _____ or
_____.

Thank you in advance for your response to this inquiry.

Sincerely,

Sample Letter to Request Water Service
Group B Project Located in a Critical Water Supply Service Area and
Outside any Water Utility's Future Service Area
(See Section 2.4)

Date

Dear Local Purveyor,

I am pursuing approval of a project that requires approval of a new public water system, or approval of an existing public water system not yet approved by either the local health jurisdiction or the state Department of Health.

Under the Public Water System Coordination Act, I am required to request water service from the nearest water supplier when my project is located outside of any purveyor's future service area. Details concerning my project, including its exact location and its water supply and fire suppression requirements, are attached for your reference.

Please provide me with a written response to my request for water service within 30 days of the date of this letter. In your response, please let me know if your utility can provide water service. If not, I will proceed with the design and approval of a Group B public water system.

If you have any questions, please contact me at _____ or
_____.

Thank you in advance for your response to this inquiry.

Sincerely,

Request for Satellite Management Services
(See Section 2.5)

Date

Dear Satellite Manager,

I am pursuing approval of a project that requires approval of a new public water system, or approval of an existing public water system not yet approved by either the local health jurisdiction or the state Department of Health.

Under the Satellite System Management Agency regulations, I am required to obtain the services of an approved satellite management agency (SMA) to own or operate my water system, if one is available. In order to gain approval of my water system without the services of an SMA, I must demonstrate that I have requested SMA services from all approved SMAs in my project area, and each SMA has declined my request for service.

Please provide me with a written response to my request for SMA services within 30 days of the date of this letter. In your response, please let me know if you can provide ownership or management services.

If you are available to provide SMA services to my water system, please provide me with information about the scope and cost of your services. I will consider your information as I explore all my options for compliance with the SMA requirement.

If you are not available to provide SMA services to my water system, please send me a note with your SMA name, signature, and date, and reference to this letter.

If you have any questions, please contact me at _____ or
_____.

Thank you in advance for your response to this inquiry.

Sincerely,

Informational Notice to Titles on Property Served

(See Section 2.6)

The Washington State Department of Health and local health jurisdictions share administration of drinking water regulations. Contact your local health jurisdiction to determine which agency has administrative responsibility.

This property is served by a Group B public water system that received (check box that applies):

- Design approval under chapter 246-291 Washington Administrative Code from the Washington Department of Health
- Design approval under chapter 246-291 Washington Administrative Code or a local code from the _____ (local health jurisdiction)

When this water system was approved:

Water System Name	
Water System Identification Number	
Water System Owner and address	

Record the parcel numbers of all parcels approved to be served by this water system:

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

There are legal limits on the volume of water that can be withdrawn from the ground, and there may be limits on the total area that can be irrigated from this water system. Based on the design of this water system, each of the above parcels is permitted to irrigate no more than _____ square feet of lawn and garden. This limitation runs with the land and is not transferable to another property.

This water system has been granted one or more exceptions from specific provisions of the regulations, or a waiver (check all boxes that apply):

- No exceptions or waivers were granted
- A reduction in sanitary control area from 100 feet to _____ feet was approved
- An exception or waiver was granted (describe) _____

- The capacity of the water supply for this water system was tested and (check the box that applies):
- Determined to yield more than 5 gallons per minute
 - Determined to yield 5 gallons per minute or less, and a low water supply contingency plan is available for review.

- Some small water systems are required by the local fire authority to provide fire suppression capacity. This water system (check box that applies):
- Is designed and constructed to provide fire suppression
 - Is not designed and constructed to provide fire suppression

- Ownership and/or operation and management by a Satellite Management Agency (SMA) were required at the time this water system was approved, provided an SMA was available at the time of approval (check box that applies).
- The name of the SMA is: _____.
 - No SMA was available when this water system was approved. This requirement may be applied at any time in the future.

- When this water system was approved, the financial plan indicated the following water rate structure would be implemented (check all boxes that apply):
- All customers are metered
 - Water will be billed based on metered use
 - Water bills will be issued every _____ months.
 - The water rate will be \$ _____ every billing cycle, plus \$ _____ per _____ 1,000 gallons/100 cubic feet (circle one)
 - The method for establishing the annual water system budget is attached.
 - The process for funding a water system reserve account is attached.
 - Other _____

Routine water quality sampling is encouraged, but not required. At the time of approval, the owner of the water system (check box that applies):

- Intends to conduct the following routine water quality sampling:

Analyte and Location	Frequency	Reporting Results
<i>e.g., coliform bacteria in the distribution system</i>	<i>e.g., every three months</i>	<i>e.g., by phone within 24 hours</i>

- Does not intend to conduct any routine sampling

When this water system was approval (check box that applies):

- The source is not treated for a secondary contaminant (i.e., a contaminant that impacts the aesthetic quality of the water, but is not known to affect human health, such as iron or manganese).
- The source is treated for a secondary contaminant. The secondary contaminant being removed is from the well is _____

When this water system was approval, a water users' agreement (check box that applies):

- Exists and a copy can be obtained from _____
- Was not prepared

Describe the public notification procedure(s) that will be used to communicate with customers:

- By phone or email (assumes the maintenance of an accurate phone or email list)
- By posting to each customer's property (door hanger)
- Other: _____

Outline for Water Users' Agreement
(See Section 2.8)

- I. Ownership**
 - A. Governing Board
 - B. Election of Officers
 - C. Responsibilities
 - D. Authorities
 - E. Communication with customers
 - F. Transferring ownership
- II. Decision-Making**
 - A. Quorum
 - B. Annual meeting
 - C. Special meeting
 - D. Meeting announcement
- III. Annual Operating Budget**
 - A. Basis for collecting revenue to cover the full cost of service
 - B. Rate-setting basis
 - C. Frequency of budgeting process
 - D. Responsible parties
 - E. Process for setting and approving an annual budget
 - F. Financial and accounting controls
- IV. Long-Term Capital Budget**
 - A. Provision for special assessment
 - B. Provision for annual assessment
- V. Fees**
 - A. Connection fees
 - B. Other fees and charges
- VI. Recordkeeping**
 - A. Original (approved) design documents
 - B. Equipment catalog information
 - C. Water production and water consumption records
 - D. "As-built" construction documents, including all easements and covenants
 - E. Water quality sampling results
 - F. Complaints
- VII. Standard design and construction details**
 - A. Service connection, service meter, service valves, location, and so on.
 - B. Pipes
 - C. Valves
 - D. Easements

- VIII. Reporting to customers**
- IX. Authorized parties to perform maintenance and repair**
- X. Prohibited practices**
- XI. Heirs, successors, and assigns**
- XII. Enforcement of agreement on nonconforming parties and properties**
- XIII. Changing the water users' agreement**

Group B Water Facilities Inventory (WFI) Form

INSTRUCTIONS (See WFI Form on Page 82)

Cross out outdated information on the WFI, and then write corrections in any adjacent space available

	Field Number and Field Name	Instruction
ADDRESSES & PHONE NUMBERS	6. PRIMARY CONTACT NAME & MAILING ADDRESS	<p>Enter the name of the person we should contact about the water system's day-to-day operations. Most DOH mailings will be sent to this person.</p> <p>Enter only the mailing address in this part of the box Do not combine a PO Box with a street address).</p> <p>Enter the <i>Physical Delivery Address</i> for the contact person if it is different than the normal mailing address. (This address will be used to ship sampling containers or other materials that cannot be delivered to a P.O. Box). Example:</p> <p>Name & Mailing Address ANN SMITH ATTN (optional) P O BOX 3030 ANYTOWN WA 98000</p> <p>Physical Delivery Address, if different from Above ATTN (Optional) 1231 MAIN ST ANYTOWN WA 98000</p>
	7. OWNER NAME & MAILING ADDRESS	Enter the name of the person or organization that is the legal owner of the water system. Follow the directions and example in field 6 (above). <i>If the owner is an organization, you must list an individual as the contact for the organization.</i>
	9. 24 HOUR PRIMARY CONTACT INFORMATION	Enter phone and fax numbers including area code (and extension, if applicable) for the primary contact for the water system. The email address may be for the system or the primary contact.
	10. OWNER CONTACT INFORMATION	Enter the phone and fax numbers including area code (and extension, if applicable) for the owner of the water system.
CHECK BOXES	11. SATELLITE MANAGEMENT AGENCY (SMA)	If the system is NOT owned or managed by a Satellite Management Agency (SMA), check "Not Applicable" and go to 12. If the system IS owned or managed by a SMA, check the applicable box and enter the name of the SMA. <i>The SMA number is assigned by DOH.</i>
	12. WATER SYSTEM CHARACTERISTICS	<p>Mark ALL boxes that apply to your system. You may check more than one box for each service. For example, a restaurant may be "Food Service" and "Commercial."</p> <ul style="list-style-type: none"> * Agricultural: Commercial crop irrigation/Farming * Commercial / Business: Office & retail complexes, nurseries, golf courses. * Day Care: Child or adult care facilities (in home or stand alone where the clients do not live 24 hrs. per day). * Food Service/Food Permit: Restaurant, coffee shop, bakery, tavern, catering facility, deli, grocer, mini-mart. * 1,000 or more person event for 2 or more days per year: Major event that significantly effects your system, such as a fair, town festival, or major concert. * Hospital/Clinic: Medical / Dental office or clinic, Surgery Center, Emergency Care Facility. * Industrial: Manufacturing, assembly facility, food processing facility. * Licensed Residential Facility: Nursing home, adult boarding home, foster home. * Lodging: Hotel, motel, inn, bed and breakfast, resort. * Recreational / RV Park: Connections serving parks, beaches, ball fields, playground, campgrounds, picnic areas, ski areas, transient recreational vehicle facilities. * Residential: Units designed to house one or more family (such as single family houses, apartments, duplexes, condominiums, mobile home parks, etc.) no matter how many days per year they are occupied. * School: K-12 grades, community college, technical training facility, colleges. * Temporary Farm Worker Housing / Labor Camp: Facility that provides temporary facilities for workers and their families. May or may not meet the criteria for DOH Temporary Worker Housing licensing. * Other: If choosing "other," please write a brief description in the blank provided (fire station, fraternal organization, grange).

	13. WATER SYSTEM OWNERSHIP	<p>Mark only one type of organization that best describes the owner of the water system.</p> <p>Association: A non-government water system owned by its consumers (sometimes called "members"). It includes "mutual" water companies.</p> <p>City / Town: A city or town that has been incorporated according to the applicable RCW.</p> <p>County: A water system owned by county government, such as a county park, or public works maintenance facility.</p> <p>Federal: A water system owned by the federal government, such as a veterans' hospital, national park, forest service facility.</p> <p>Investor: A privately owned water system operated with the intent of making profit. The owner may be regulated (or potentially regulated) by the Washington Utilities and Transportation Commission (WUTC).</p> <p>Private: A privately owned water system, not including Associations, that is not operated with the intent of making a profit. Examples are water systems serving mobile home parks, stores, industries, and so on.</p> <p>Special District: A special purpose district created according to applicable RCW, such as a Water or Sewer District, Public Utility District, School District, Fire District or Port District.</p> <p>State: A water system owned by the state, such as a state park, correctional facility, or a Department of Transportation rest area or maintenance facility.</p>
	14. STORAGE CAPACITY	Enter the total storage capacity (in gallons) available for distribution to users (if 1,000 gallons or greater). Do not include pressure tank(s) in the total.
SOURCES	16. SOURCE NAME	Enter your name for the source (such as, Park Well). If the source is purchased or an intertie, list the name of the system providing the water. Each well in a well field or spring in a spring field must be identified. Please provide Well Tag number if available.
	17. INTERTIE	Enter the ID number of the system providing purchased water or intertie. If you do not know the ID number, contact your DOH regional office.
	18. SOURCE CATEGORY	Mark the box that best describes this source. Each source can have only one code. Each well in a well field, and spring in a spring field must be identified individually.
	19. USE	<p>Mark the box that best describes how this source is used.</p> <p>Permanent: A source that is used regularly each year for <u>more than 3 consecutive months within a 12-month period</u>. For systems that are in operation for 3 or less months, their sources shall also be considered permanent.</p> <p>Seasonal: A source that is used on a regular basis and does not meet the definition of either permanent or emergency source. Seasonal source <i>could</i> be used to supply peak demand.</p> <p>Emergency: A source that has been approved by DOH for emergency use and is <i>not</i> used for routine or seasonal peak water demands.</p>
	20. SOURCE METERED	Mark this box if this source has a water meter installed.
	21. TREATMENT	If this source is not treated, mark "none," otherwise mark the box(es) for each type of treatment provided for this source. If a well in a well field or a spring in a spring field has its own individual treatment, mark the appropriate box. If all the wells in a well field or springs in a spring field are treated together at one location, mark the appropriate box on the well or spring field line. Treatment for an intertie refers only to <u>additional</u> treatment by the receiving system.
	22. DEPTH TO FIRST OPEN INTERVAL	For <u>cased</u> wells, enter depth to top of uppermost well screen or perforated casing; for wells <u>completed in rock</u> , enter depth to bottom of sealed casing; for <u>dug</u> wells, enter depth to first unsealed casing joint below the well seal; and for well fields, enter depth of shallowest well. Round off to the nearest whole number.
23. CAPACITY	Enter the actual current capacity of the source, in gallons per minute (gpm) that is available to enter the distribution system under operating conditions. For example, if the source is a well with a pump test of 100 gpm, but only has a 20-gpm pump installed, enter 20 gpm.	
	24. SOURCE LOCATION	Enter the quarter / quarter designation, section number, township and range location for each source. For Example, SE/SW, Sec.1, T18N, R3E. Source locations can be found on well logs, water right documents, or property descriptions.

CONNECTIONS	25-A. FULL TIME SINGLE-FAMILY RESIDENCES	Enter the number of single-family residences (including mobile homes) occupied any 180 days or more a year that are served by the water system. If you enter a number in this field, you also need to enter a number for the corresponding population residing in these connections in field 29. A connection is considered active until it is physically disconnected from the water system.	
	25-B. PART TIME SINGLE-FAMILY RESIDENCES	Enter the number of single-family residences (including mobile homes) occupied less than 180 days a year that are served by the water system. (These part-timers most likely inhabit vacation homes that are not used as a primary residence) If you enter a number in this field, you also need to enter data for the corresponding population residing in these connections in rows 30A and 30B. A connection is considered active until it is physically disconnected from the water system.	
	26-A. APARTMENT BUILDINGS, CONDOS, OTHER MULTIFAMILY BUILDINGS, BARRACKS, DORMS	Enter the number of apartment buildings, condominium buildings, duplex buildings, barracks, and dormitory buildings, and so on served by your water system.	
	26-B. FULL TIME RESIDENTIAL UNITS	<i>If the water system serves multifamily residential buildings, enter the total number of residential units that are occupied any 180 days or more a year. If you enter a number in this field, you also need to enter a number for the corresponding population residing in these connections in field 29.</i>	
	26-C. PART TIME RESIDENTIAL UNITS	<i>If the water system serves multifamily residential buildings, enter the number of individual dwelling units that are occupied less than 180 days a year. If you enter a number in this field, you also need to enter data for the corresponding population residing in these connections in rows 30A and 30B.</i>	
	27-A. RECREATIONAL SERVICES OR TRANSIENT ACCOMMODATIONS CALL YOUR REGIONAL OFFICE IF YOU ARE UNSURE WHETHER YOURS IS A COMMUNITY, NONCOMMUNITY, OR GROUP B SYSTEM	COMMUNITY SYSTEMS: Leave this field empty. Include in field 27B the actual number of RV parks, campgrounds, hotels, motels, and so on served.	NONCOMMUNITY and GROUP B SYSTEMS: Enter the actual number of RV sites, campsites, spigots, etc., and hotel/motel/overnight units that are served by the water system. Enter the corresponding nonresidential population and use-days in rows 31A and 31B.
27-B. INSTITUTIONAL, COMMERCIAL, OR INDUSTRIAL SERVICES	COMMUNITY SYSTEMS: Enter the number of all service connections not used for residential purposes. Include RV parks, campgrounds, hotels, motels, etc. in your count of commercial connections. If you enter a number in this field, enter the corresponding non-resident population and use-days in rows 31A, 31B, 32A, and 32B.	NONCOMMUNITY and GROUP B SYSTEMS: Enter the number of all service connections not used for residential purposes and not otherwise accounted for in field 27A. If you enter a number in this field, enter the corresponding non-resident population and use-days in rows 31A, 31B, 32A, and 32B.	
POPULATIONS	29. FULL TIME RESIDENTIAL POPULATION	Enter the total number of residents that are served by the water system for any 180 days or more per year.	
	30-A. PART TIME RESIDENTS PER MONTH	Enter the TOTAL number of seasonal or weekend <u>residents</u> that are present each month . (These part-timers most likely inhabit vacation homes that are not used as a primary residence).	
	30-B. PART TIME RESIDENT USE DAYS PER MONTH	Enter how many days part-time residents are present each month.	
	31-A. TEMPORARY & TRANSIENT USERS PER MONTH	Enter the TOTAL number of temporary or transient users served by the water system each month . This includes all visitors, attendees, travelers, campers, patients, or customers with access to establishments connected to the water system. <i>Visitors must be counted for every day that they have access to the water system. For example, an individual attending a weeklong camping session (seven days) must be counted seven times.</i>	
	31-B. TEMPORARY & TRANSIENT USE DAYS PER MONTH	Enter the TOTAL number of days per month this system is accessible or available to the public.	
	32-A. REGULAR NONRESIDENTIAL USERS PER MONTH	Enter the number of students, daycare children, and all employees that are served by the water system during each month.	
	32-B. REGULAR NONRESIDENTIAL USE DAYS PER MONTH	Enter the number of days per month that students, daycare children, and employees have access to the water.	
SIGNATURE	35. REASON FOR SUBMITTING THE WFI	Check the appropriate box. If you are submitting this WFI as requested by DOH, please refer to the instructions in the letter.	
	36. CERTIFICATION	Please sign and print your name and the date you are signing the WFI. Please include your title or relationship with this water system.	

	ACTIVE SERVICE CONNECTIONS	DOH USE ONLY! CALCULATED ACTIVE CONNECTIONS	DOH USE ONLY! APPROVED CONNECTIONS
25. SINGLE FAMILY RESIDENCES (How many of the following do you have?)			
A. Full Time Single Family Residences (Occupied 180 days or more per year)			
B. Part Time Single Family Residences (Occupied less than 180 days per year)			
26. MULTIFAMILY RESIDENTIAL BUILDINGS (How many of the following do you have?)			
A. Apartment Buildings, condos, duplexes, barracks, dorms			
B. Full Time Residential Units in Apartments, Condos, Duplexes, Dorms that are occupied more than 180 days/year			
C. Part Time Residential Units in the Apartments, Condos, Duplexes, Dorms, that are occupied less than 180 days/year			
27. NONRESIDENTIAL CONNECTIONS (How many of the following do you have?)			
A. Recreational Services (Campsites, RV Sites, Spigots, etc.)			
B. Institutional, Commercial/Business or Industrial Services			
28. TOTAL SERVICE CONNECTIONS			

29. FULL-TIME RESIDENTIAL POPULATION
How many residents are served by this system 180 or more days per year? _____

30. PART-TIME RESIDENTIAL POPULATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many part-time residents are present each month?												
B. How many days per month are they present?												
31. TEMPORARY & TRANSIENT USERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many total visitors, attendees, travelers, campers, patients, or customers have access to the water system each month?												
B. How many days per month is water accessible to the public?												
32. REGULAR NONRESIDENTIAL USERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. If you have schools, daycares, or businesses connected to your water system, how many students, daycare children, or employees are present each month?												
B. How many days per month are they present?												

Comments:

33. ROUTINE COLIFORM SCHEDULE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
34. GROUP B NITRATE SCHEDULE	QUARTERLY			ANNUALLY			ONCE EVERY 3 YEARS					
	N/A			N/A			N/A					

35. REASON FOR SUBMITTING WFI:

New System **Other** _____

36. I CERTIFY THAT THE INFORMATION STATED ON THIS WFI FORM IS CORRECT TO THE BEST OF MY KNOWLEDGE.	
SIGNATURE: _____	DATE: _____
PRINT NAME: _____	TITLE: _____

Group B Pump Test Guidance

Objective: To demonstrate that a proposed well (or wells) can provide sustainable and reliable water production equal to or exceeding the minimum supply requirements needed to supply the proposed number of water systems connections (WAC 246-291-125 (4)(d)). A pump test is the best way to demonstrate this. A pump test is a well and localized aquifer stress test. It involves recording and evaluating periodic measurement of pumping rate and water level changes during a series of controlled pump and recovery (“rest”) test cycles. The results show how both the well and the localized aquifer react to periods of intense pumping. Evaluating the degree of water level drawdown and the rate of water level recovery helps to characterize the aquifer’s yield and establish optimal well pump placement and operating conditions.

When executed correctly, a pump test provides sufficient information to demonstrate the capacity of a well or collection of wells to produce enough water in a 24-hour period to service the water system as designed.

- A successful pump test must show the proposed well (or combination of wells) can provide a sustainable and reliable production of water (yield) equal to or exceeding the minimum supply requirements in WAC 246-291-125 (4)(d) and recover to pre-pumping level within a normal 24-hour operational period.
- A failed pump test is one that cannot demonstrate the required level of production and recovery within a normal 24-hour operational period.

Part 1: Select and Run a Recommended Group B Pump Test

Pump Test Procedure	Recommended Conditions for Use
Standard Step Drawdown/Constant Rate Test See Appendix F-1	For sources located in: <ul style="list-style-type: none"> • Fractured rock, shale, bedrock, or hard rock (consolidated) aquifers. • Areas of known or suspected seawater intrusion. • Aquifers with highly variable seasonal water tables. • Aquifers with limited recharge. • An area with nearby large capacity wells that could affect local water levels and well yields.
Extended Step Drawdown Test See Appendix F-2	<ul style="list-style-type: none"> • Low projected water demand wells in a high-flow aquifer setting. • <i>Most common for small Group B systems with proposed wells in sand and gravel aquifers.</i>
Alternating Pump and Recovery Test See Appendix F-3	<ul style="list-style-type: none"> • Very small systems (2-6 connections) <i>and</i> • Very low flow aquifer conditions <i>or</i> • Failure on other tests

Part 2: Pump Test Report and Analysis:

The Pump Test Report (See Appendix F-4) documents the results of the pump tests, provides an analysis of the well, and localized aquifer responses to the challenge of sustained pumping. The designer can use that data to estimate aquifer characteristics, and determine pump and well operational factors and well efficiency.

Elements of a complete report should discuss:

- ✓ Well yield
- ✓ Expected operational drawdown
- ✓ Pumping rates and recommended pump operational cycles
- ✓ Recommended pump placement
- ✓ Estimate of well efficiency
- ✓ An estimate of the aquifer's specific yield, hydraulic conductivity, or transmissivity (to support evidence of sustainability and aquifer capacity consistent with proposed use of the well)

If a pump test is unable to demonstrate a clear sustained yield as defined above, then the designer should re-run the test with different operational assumptions and conditions (lower pumping rate, add additional sources, or reduced total volume and associated connections). The designer might need to consider using an alternative test.

Part 3: Additional considerations

- Low well yield contingency plan.
- Water quality test results.
- Risks of seawater intrusion (if appropriate).
- Reasons why stabilization was not achieved during testing.
- Well interference and well field considerations.

In challenging aquifer settings, a pump test can provide a starting point in the analysis and potential mitigation of any localized aquifer conditions that could adversely affect long-term use of the well (including concerns about saltwater intrusion, declining aquifer levels, consolidated and fracture rock aquifers, aquifers with limited recharge, and high seasonal water level variability). The pump test report is an appropriate place to highlight those issues and discuss supply-related options.

Part 4: Recommended Pump Test Procedures:

The following sections lay out step-by-step procedures for the three recommended pump tests. Site conditions and equipment must be factored into any pump test design and implementation. While we recommend these procedures, they are still guidelines so the designer may modify them based on professional expertise, experience, and on-site conditions. The result should be a test, analysis and report that documents the sustainable use of the well as dictated by the water system design criteria and the Group B rule.

In addition to the recommended pump test procedures, this Appendix includes data collection templates for both the drawdown and recovery phases of a pump test. A successful test will likely require multiple pages of each.

Examples of pump and recovery test data collected under the different test procedures are online at

<http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/WaterSystemAssistance/GroupB/GroupBResources.aspx>

Step Drawdown/Constant Rate Pump Test Procedure

Phase 1: Step Drawdown Pump Test

Objective: To evaluate well performance, and identify successful pumping conditions for phase 2 of the pump test (constant rate). This information will allow a determination of the optimal pump settings (depth and pumping rate) and well efficiency for the well.

Elements:

1. We recommend that a qualified water professional (hydrogeologist or engineer) oversee testing of the well and review data analysis and interpretations.
2. An access port to allow depth-to-water measurements **must** be installed, if not already present, and maintained (WAC 173-160-355).
3. The step drawdown test should include at least four consecutive constant rate discharge steps as described below, with a higher pumping rate used for each step. Each step should be at least 60 minutes long.
4. The third step of the drawdown test should use a flow rate no less than the minimum supply requirement in WAC 246-291-125 (4)(d). The remaining pumping rates should be determined by multiplying this flow rate (in gallons per minute) by 0.50, 0.75, and 1.25.
5. Drawdown should be measured in the pumped well at least as frequently as:

Time after pumping started	Time Intervals
0 to 10 minutes	1 minute
10 to 60 minutes	5 minutes
60 to 240 minutes	15 minutes
240 to 600 minutes	60 minutes
600 to 1,440 minutes	120 minutes

6. Recovery should be measured beginning at the end of the last step (immediately after the pump is turned off) and ending when the water level returns to at least 95 percent of the initial, pre-pumping static water level. Measurement frequency should follow the specifications in the table above measured from the moment when pumping stopped. Initial measurement intervals will be short and expand as recovery progresses. The pump should not be removed until the water level returns to 95 percent of the pre-pumping static water level.
7. Determine the maximum pumping rate and pumping depth as established from the step drawdown test. Use these values for conducting the constant rate discharge test, if the test is applicable.

Phase 2: Constant Rate Pump Test

Objective: To determine the capacity of the well and aquifer to provide a reliable yield of water at the desired rate. The pumping and recovery data from the test can be used to estimate aquifer transmissivity and a sustainable yield for the well. This test procedure is recommended for sources in complex hydrologic settings where the nature of the aquifer could adversely affect long-term continuous use of the source. Sources with the potential for seawater intrusion should also conduct the additional elements provided at the end of this document.

Elements:

1. We recommend that a qualified water professional (hydrogeologist or engineer) oversee testing of the well.
2. An access port to allow depth to water measurements **must** be installed, if not already present, and maintained (WAC 173-160-355).
3. The source should be pump tested at no less than the maximum rate determined from the step drawdown test. The constant rate discharge test should not be conducted until after the water levels in the aquifer have achieved at least 95 percent recovery from the step drawdown test pre-pumping static water level conditions.
4. The constant rate discharge test should be at least 24 hours long. If, at 24 hours, four hours of stabilized drawdown have been observed, the pump may be shut off and measurements of recovery begun. If stabilized drawdown has not been observed within a total of 36 hours, the pump may be shut off and recovery measurements begun. Stabilization is defined as a drop in water level of less than or equal to 0.1 feet per hour.
5. Drawdown should be measured in the pumped well at least as frequently as:

Time after pumping started	Time intervals
0 to 10 minutes	1 minute
10 to 60 minutes	5 minutes
60 to 240 minutes	30 minutes
240 to 600 minutes	60 minutes
600 to 1440 minutes	120 minutes

6. Water samples must be collected from the source using proper sampling procedures and analyzed by a DOH-certified laboratory. Water samples must be taken within the last 15 minutes of pumping and analyzed for the following water quality parameters:
 - Coliform (bacteria)
 - Inorganic Chemicals (IOCs)
 - Additional Volatile and/or Synthetic Organic Chemicals (VOCs /SOCs)*

**If required by DOH because the well is in areas of known or expected contamination*

7. After pumping, recovery data should be collected until 95 percent recovery of the pre-pumping static water level is achieved. Recovery should be measured in the same manner and at the same frequency as the table above. To facilitate accurate recovery data collection, the pump test piping should incorporate backflow check-valve(s) that prevent water within the riser pipe from flowing back into the well when the pump is shut off.
8. When the pumping test is completed, the data should be compiled into a report and submitted to DOH. The report should include:
 - a. All data on pumping rates and water levels (including static water levels) from the pumping test and recovery period, and appropriate graphical presentations of the data.
 - b. An estimate of the aquifer's specific yield, hydraulic conductivity, and transmissivity (to support evidence of sustainability and aquifer capacity consistent with proposed use of the well).
 - c. A map and description ($\frac{1}{4}$, $\frac{1}{4}$, Section Township Range) accurately indicating the well location, and the land surface elevation to the nearest foot above sea level. Address and parcel number should be provided.
 - d. Summary, conclusions, and recommendations on pump settings, operational regimes, and source reliability.
 - e. A well construction report (well log) for the pumping well and all observation wells (if any).
 - f. Distance, to the nearest foot, from pumping well to all observation wells and a map indicating all well locations.
 - g. A copy of all laboratory test results.

Additional Steps for Potential Seawater Intrusion Areas

- For the source well (the well pumped during the aquifer test), chloride and conductivity samples should be collected at the following intervals:
 - One sample during the initial 30 to 60 minutes.
 - One sample during the 6th hour (360 to 420 minutes).
 - One sample during the 12th hour (720 to 780 minutes).
 - One sample within the last 15 minutes of the aquifer test pumping phase.
- For at least one observation well, two chloride and conductivity samples should be collected: one base sample before initiating the aquifer test and the other after recovery data collection is complete. An observation well should first be pumped by an amount equal to three times the volume of water inside its well casing before actually collecting the base sample. Following collection of the base sample, observation wells should be given adequate time to recover to static water level before initiating the aquifer test. *Note: We recommend that a field test kit be used to monitor chloride levels within the pumping well during the pumping phase.*

The report should include:

1. Tidal influence on the pumping well. Data on pumping water levels, chlorides, and tidal fluctuations (corrected to point) should be plotted on a single graph with respect to time.
2. Potential for seawater intrusion into this or other seaward wells.

Extended Step Drawdown Pump Test Procedure

Objective: To evaluate well performance and determine whether a source over an aquifer with an expected high yield can produce a sustainable yield. The test results can be used to determine optimal pump settings and well efficiency. The extended pumping and recovery data is used to estimate aquifer transmissivity and confirm that there are no underlying aquifer conditions likely to adversely affect long term use of the source. This test is most appropriate for sources with a small demand within a high yield aquifer.

Elements:

1. We recommend that a qualified water professional (hydrogeologist or engineer) oversee testing of the well and review data analysis and interpretations.
2. An access port to allow depth to water measurements **must** be installed, if not already present, and maintained (WAC 173-160-355).
3. The step drawdown test should include at least four consecutive constant rate discharge steps, with a higher pumping rate used at each step. The first three steps should be at least 60 minutes long. The fourth step is extended until 4 hours of stabilization occurs or until 12 hours total pumping time has elapsed. Stabilization means less than 0.1 foot of drawdown fluctuation per hour in 4 hours of drawdown measurement.
4. The third step of the drawdown test should use a flow rate no less than the minimum supply requirement in WAC 246-291-125 (4)(d). The remaining pumping rates should be determined by multiplying this flow rate (in gallons per minute) by 0.50, 0.75, and 1.25.
5. Drawdown should be measured in the pumped well at least as frequently as:

Time After Pumping Started	Time Intervals
0 to 10 minutes	1 minute
10 to 60 minutes	5 minutes
60 to 240 minutes	15 minutes
240 to 600 minutes	60 minutes
600 to 1440 minutes	120 minutes

6. Water samples must be collected from the source using proper sampling procedures and analyzed by a DOH-certified laboratory. Water samples should be taken within the last 15 minutes of pumping and must be analyzed for the following water quality parameters:
 - Coliform (bacteria)
 - Inorganic Chemicals (IOCs)
 - Additional Volatile and/or Synthetic Organic Chemicals (VOCs /SOCs)*

**If required by DOH because the well is in an area of known or expected contamination*

7. Recovery should be measured beginning at the end of the last step (immediately after the pump is turned off) and ending when the water level returns to within 95 percent of the initial, pre-pumping static water level. Measurement frequency should follow the specifications in the table above measured from the moment pumping stopped. Initial measurement intervals will be short and expand as recovery progresses. The pump should not be removed until the water level returns to 95 percent of the pre-pumping static water level.
8. Determine the maximum pumping rate and pumping depth as established from the step drawdown test. Use the data from this final step to plot the time (drawdown graph) and determine transmissivity, storage coefficient, and hydraulic conductivity.
9. When the pump test is complete, the data should be compiled into a report and submitted to DOH. The report should include:
 - a. All data on pumping rates and water levels (including static water levels) from the pumping test and recovery period, and appropriate graphical presentations of the data.
 - b. An estimate of the aquifer's specific yield, hydraulic conductivity, and transmissivity (to support evidence of sustainability and aquifer capacity consistent with proposed use of the well).
 - c. A map and description ($\frac{1}{4}$, $\frac{1}{4}$, Section Township Range) accurately indicating the well location and the land surface elevation to the nearest foot above sea level. Address and parcel number should be provided.
 - d. Summary, conclusions, and recommendations on pump settings, operational regimes, and source reliability.
 - e. A well construction report (well log) for the pumping well and all observation wells (if any).
 - f. Distance, to the nearest foot, from pumping well to all observation wells and a map indicating all well locations.
 - g. A copy of all laboratory test results.

Alternating Pump and Recovery Test

Objective: To evaluate whether a proposed source in a low-flow environment can produce the estimated daily demand and recover within a 24-hour operational period. You should use this test only when aquifer yield is low and cannot maintain the sustained periods of pumping needed for either a step-drawdown or a constant-rate test. The pumping and recovery data obtained during the test will help identify a sustainable operating regime that supports approval of a water source for a Group B water system.

Elements:

1. **Because of the complex and nonstandard nature of this test, we recommend that a licensed water resource professional direct the work needed to complete it.**
2. An access port to allow depth-to-water measurements **must** be installed, if not already present, and maintained (WAC 173-160-355).
3. The test consists of a series of alternating pump and recovery cycles.
 - Each pumping cycle should last for a standard period of time at an intermediate flow rate (usually 2-6 hours). At the end of that time, the pump is turned off and water levels are allowed to recover to pre-pumping or near normal condition. During both pumping and recovery parts of the cycle, water levels are recorded at the time intervals described below.
 - The pump and recovery cycle is continued for at least 24 hours or until the combined pumped volume equals or exceeds the maximum daily demand. Pumping rate and periods can be changed between cycles, but pumping rate must be constant within each cycle. Pumping time, volume pumped and water level changes must be recorded for each cycle. Pumping periods should be no shorter than 2 hours.
 - Because of the iterative nature of the test, it may be necessary to run the test longer than 24 hours to identify the appropriate combination of operational conditions that will produce maximum daily demand and still allow for recovery within a 24-hour operational regime.
 - The pump test cycle must be repeated until a combined pumping volume from all pump cycles has produced a total volume in excess of the *minimum maximum daily demand* for the proposed system. **The test is not complete until recovery occurs after the last pump cycle is completed.**
4. Drawdown and recovery should be measured in the pumped well for each pump and recovery cycle at least as frequently as:

Time after pumping started	Time intervals
0 to 10 minutes	1 minute
10 to 60 minutes	5 minutes
60 to 240 minutes	15 minutes
240 to 600 minutes	60 minutes
600 to 1440 minutes	120 minutes

5. Water samples must be collected from the source using proper sampling procedures and analyzed by a DOH-certified laboratory. Water samples should be taken within the last 15 minutes of pumping and must be analyzed for the following water quality parameters:
 - Coliform (bacteria)
 - Inorganic Chemicals (IOCs)
 - Additional Volatile and/or Synthetic Organic Chemicals (VOCs /SOCs)*
 - *If required by DOH because the well is in an area of known or expected contamination*
6. Recovery should be measured beginning at the end of each pump cycle (immediately after the pump is turned off) and ending when the water level returns to within 95 percent of the initial, pre-pumping static water level. Measurement frequency should follow the specifications in the table above.
7. Determine the maximum pumping rate and pumping depth and plot the time (drawdown graph) and recovery data to determine transmissivity, storage coefficient, and hydraulic conductivity.
8. When the pump test is complete, the data should be compiled into a report and submitted to DOH. The report should include:
 - a. All data on pumping rates and water levels (including static water levels) from the pumping and recovery periods, and appropriate graphical presentations of the data.
 - b. An estimate of the aquifer's specific yield, hydraulic conductivity, and transmissivity (to support evidence of sustainability and aquifer capacity consistent with proposed use of the well).
 - c. A map and description ($\frac{1}{4}$, $\frac{1}{4}$, Section Township Range) accurately indicating the well location and the land surface elevation to the nearest foot above sea level. Address and parcel number should be provided.
 - d. Summary, conclusions, and recommendations on pump settings, operational regimes, and source reliability.
 - e. A well construction report (well log) for the pumping well and all observation wells (if any).
 - f. Distance, to the nearest foot, from pumping well to all observation wells and a map indicating all well locations.
 - g. A copy of all laboratory test results.

Cycle Stop Valves

A device called a “cycle stop valve (CSV)” was developed to maintain and control the pressure in a distribution system. Essentially a modified pressure-reducing valve, it maintains a constant downstream pressure over a wide range of flows. Depending on the model, the CSV will stop pump operation at a pre-set threshold flow of 1 to 2 gpm for wells sized to supply Group B water systems. At flows higher than that, the valve will open or close in response to system demands for water while the pump is in continuous operation.

The CSV will maintain pressure until the flow goes to some prescribed low level, at which point the CSV will signal shut-off of the pump. One or more pressure tanks are needed with the CSV to accommodate the need for pump motor cycling control at the low flow settings. The number and size of pressure tanks will depend on the design setting pre-established for the CSV, but the number and size always will be less than that required if a CSV had not been installed.

The advantages of using a CSV with a well pump include:

1. Limiting well pump on-off cycling.
2. Reducing the size or number of pressure tanks required for any given installation.
3. Reducing the potential for damaging transient pressure waves (“water hammer”) resulting from pump-start and pump-stop conditions.

The CSV is installed between the pump(s) and pressure switch (the pressure switch determines whether the well pump is “on” or “off”). The CSV downstream pressure setting should be a little bit below the “pump-off” pressure setting of the pressure switch. As the demand in the water system varies, the CSV adjusts the flow coming from the well pump while maintaining a constant downstream pressure. In essence, with the CSV the pump acts as a variable capacity pump whose output matches the water system demand on an instantaneous basis. The pump-on phase of the pump cycle will be extended until the water system demand drops below 2 gpm. For some water systems where the demand (including leaks) seldom if ever drops below the set-point of 2 gpm, the pump may be “on” indefinitely.

Only when water system demand drops below the minimum flow setting of the CSV (recommended at no less than 2 gpm) would the well pump shut off. At that point, all water demand would be satisfied by water released from a pressure tank. The length of the “pump-off” period depends on water system demand and the available withdrawal volume of the pressure tank(s). The sizing of the tank(s), therefore, consists of determining both the:

- Probable water system demand during the pump-off period.
- Recommended length of time before the pump re-starts, for example, the pump-off period.

DOH recommends a minimum drawdown volume of 10 times the minimum flow designed for the CSV, giving an estimated 10 minutes of pump-off time when the demand is low before restarting.

Considering the DOH recommendation, a CSV manufacturer’s suggestions, and the drawdown volume of bladder tanks, the following number and size of pressure tanks should be used:

Size/Number of Pressure Tanks with Cycle Stop Valve

Operating Pressure Range (P ₁ /P ₂)	Bladder Tank Nominal Size, gal	Number of Bladder Tanks Needed with CSV
60-40	42	2
	86	1
	119	1
80-60	42	3
	86	2
	119	1

CSV Design Considerations

- The CSV itself can impose significant energy loss (“head loss”) at the high end of its flow range (a 1¼-inch CSV valve causes the loss of about 10 psi at 50 gpm). The well pump design must account for the head loss imposed by the CSV.
- It is difficult to predict whether the savings through limiting the number of “pump-start” events and reduced initial capital cost associated with fewer bladder tanks will offset the cost of the additional energy used in prolonging the pump-on portion of the cycle.
- Water quality may affect CSV performance. Particulate matter (sand) may adversely affect the performance of the CSV.
- At low flow conditions, the pressure on the upstream side of the CSV could approach the shut-off head of the pump, which could be very high. You should pay attention to the design, material specifications, and construction of the well pump to ensure it can operate at or near its shut-off head for extended periods, and for the pressure rating of the piping on the upstream side of the CSV.

Variable-Frequency Drive¹

A variable-frequency drive is an electronic controller that adjusts the speed of an electric motor by modulating the delivered power. Variable-frequency drives provide continuous control by matching motor speed to the specific demands of the work being performed.

Variable-frequency drives are an excellent choice for adjustable-speed drive users because they allow operators to fine-tune processes while reducing costs for energy and equipment maintenance.

Use in the water or wastewater treatment process

Variable-frequency drives are becoming more popular at water and wastewater facilities, where the greatest energy draw comes from pumping and aeration—two applications particularly suited to variable-frequency drives.

Using mechanical devices, such as flow-restricting valves, to control flow for applications where flow requirements vary is akin to driving a car at full throttle while using the brake to control speed. It uses excessive energy and may create punishing conditions for the mechanical equipment involved. Variable-frequency drives enable pumps to accommodate fluctuating demand, running pumps at lower speeds and drawing less energy while still meeting pumping needs. Figure 1 illustrates the reduced energy consumption of variable-frequency drives over throttled valve control systems (such as cycle stop valves).

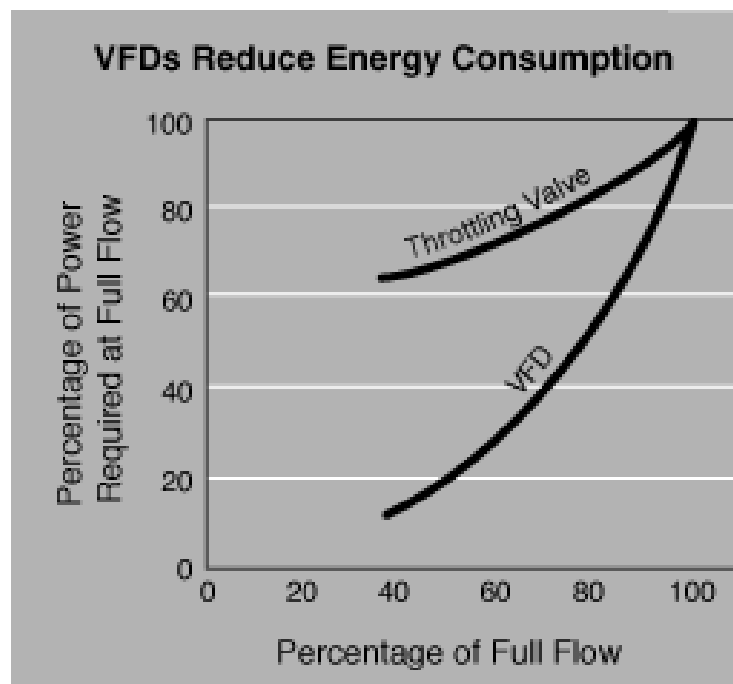


Figure 1. Energy consumption of VFDs and throttling valves.

Variable-frequency drives work with most three-phase electric motors. Therefore, you can specify variable-frequency drives for new equipment or retrofit existing pumps that use throttling devices.

Benefits

Single-speed drives start motors abruptly, subjecting the motor to high torque and current surges up to 10 times the full-load current. In contrast, variable-frequency drives offer a "soft start" capability, gradually ramping up a motor to operating speed. This lessens mechanical and electrical stress on the motor system, can reduce maintenance and repair costs, and extend motor life.

Variable-frequency drives allow precise control of processes, such as water production and distribution. They can also maintain pressure in water distribution systems to closer tolerances.

Energy savings from variable-frequency drives can be significant. Affinity laws for centrifugal pumps suggest that even a small reduction in motor speed will highly leverage your energy savings. Variable-frequency drives can reduce a pump's energy use by as much as 50 percent. A variable frequency drive controlling a pump motor that usually runs less than full speed can substantially reduce energy consumption over a motor running at constant speed for the same period. For example:

Consider a 25 horsepower motor running 23 hours per day (2 hours at 100 percent speed; 8 hours at 75 percent; 8 hours at 67 percent; and 5 hours at 50 percent). A variable-frequency drive can reduce energy use by 45 percent. At \$0.10 per kilowatt-hour, this saves \$5,374 annually. Because benefits vary from application to application, it is important to calculate benefits for each application before specifying a variable-frequency drive.

1. Adapted from the State of California's Energy Office publication on VFDs