# Disinfecting Your System

Advanced Small Water System Course


PUBLIC HEALTH DIVISION
Center for Health Protection, Drinking Water Services

# Reasons To Disinfect

An example scenario…

- *E. coli* positive sample in distribution system
- Source of contamination identified
- Boil water notice is immediately delivered to customers
- Entire water system is disinfected & flushed
- Follow-up sampling verified problem as corrected
- Customers notified that drinking water is again safe

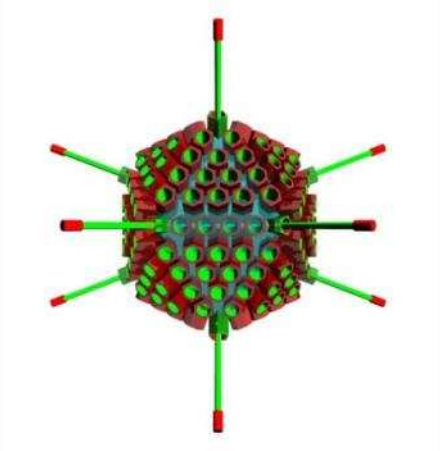
| Sample Date | # Samples | Sample Type | Coliform Type | Results-ID | Repeat of Sample ID | Sample Site | Facility |
|---|---|---|---|---|---|---|---|
| Jul 06, 2011 | 1 | RT | Total | Absent--513308-4 | | | DIST-A |
| Jul 06, 2011 | 1 | RT | Total | Absent--513308-3 | | | DIST-A |
| Jul 06, 2011 | 1 | RT | Total | Absent--513308-2 | | | DIST-A |
| Jul 06, 2011 | 1 | RT | Total | Absent--513308-1 | | | |
| Jun 20, 2011 | 1 | RP | Total | Absent--512419 | 511664 | 211 water st sink | |
| Jun 20, 2011 | 1 | RP | Total | Absent--512418 | 511664 | 1st st sample statio | |
| Jun 09, 2011 | 1 | TG | Total | Absent--511864 | 511664 | well #4 | |
| Jun 09, 2011 | 1 | RP | Total | POSITIVE--511863 | 511664 | 504 Franklin sink | |
| | | RP | E.coli | POSITIVE--511863 | 511664 | 504 Franklin sink | |
| Jun 09, 2011 | 1 | RP | Total | POSITIVE--511862 | 511664 | First St. ss | |
| | | RP | E.coli | POSITIVE--511862 | 511664 | First St. ss | |
| Jun 09, 2011 | 1 | RP | Total | POSITIVE--511861 | 511664 | 413 Franklin sink | |
| | | RP | E.coli | POSITIVE--511861 | 511664 | 413 Franklin sink | |
| Jun 07, 2011 | 1 | RT | Total | POSITIVE--511664 | | first street sample | |
| | | RT | E.coli | POSITIVE--511664 | | first street sample | |
| May 03, 2011 | 1 | RT | Total | Absent--509735 | | | |
| Apr 05, 2011 | 1 | RT | Total | Absent--508133 | | | |
| Mar 02, 2011 | 1 | RT | Total | Absent--506369 | | | |
| Feb 01, 2011 | 1 | RT | Total | Absent--504582 | | | |
| Jan 04, 2011 | 1 | RT | Total | Absent--502938 | | | |

# Why Disinfect?

To inactivate pathogens (i.e., protozoa, bacteria & viruses) that may cause illness or effect human health

Microbiological indicators that may require disinfection:

- Total coliform or *E. coli* in distribution system
- Total coliform or *E. coli* in source water



*Adenovirus photo credit: http://cronodon.com/*

*E. coli photo credit:* photobucket

# Water System Facilities To Disinfect

- Source Water – Wells, springs
- Storage Facilities – Reservoirs, cisterns, pressure tanks
- Distribution System – Transmission lines
- Wetted System Components – New or repaired pipes, fittings, valves & pumps

# Options for Chlorination

- One-time event
  - Shock chlorination
  - Target dose and exposure time is considered
- Continuous application
  - Persistent coliform bacteria
  - Chlorine equipment is permanently installed
  - Requires state approval

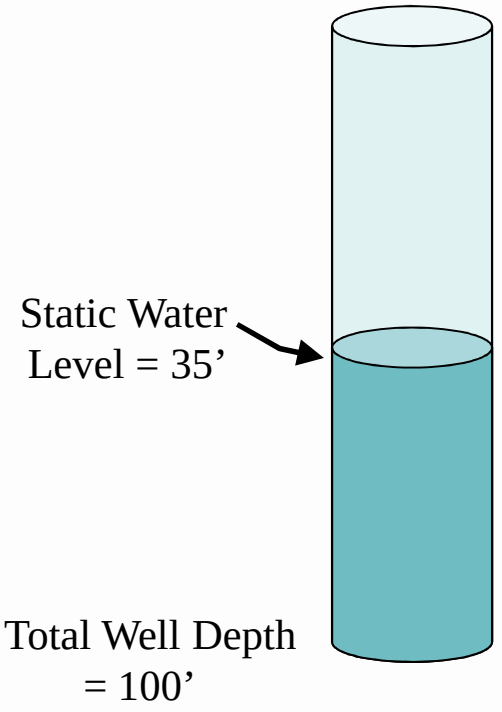
# Events Requiring Disinfection

*Disinfection is recommended after:*

- Confirmed presence of total coliform or E. coli
- Construction of a new well
- Maintenance activities
  - After broken pipe repair
- Biofilm or biological growth
- Others?

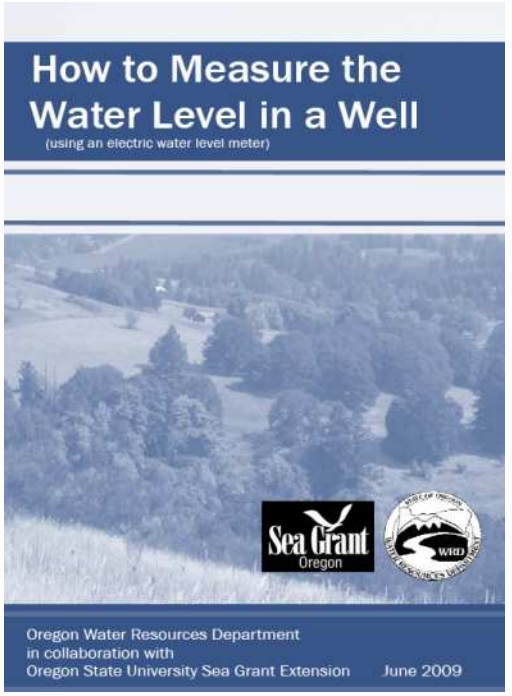
# Calculating Well Volume

- Well *total depth* & *static water level* are needed.
- Determine the static water level by:
  - Taking a current measurement
  - Using a recent measurement
    - SWL can vary seasonally
  - Using the well log/driller's report
    - Apply total depth for worst-case



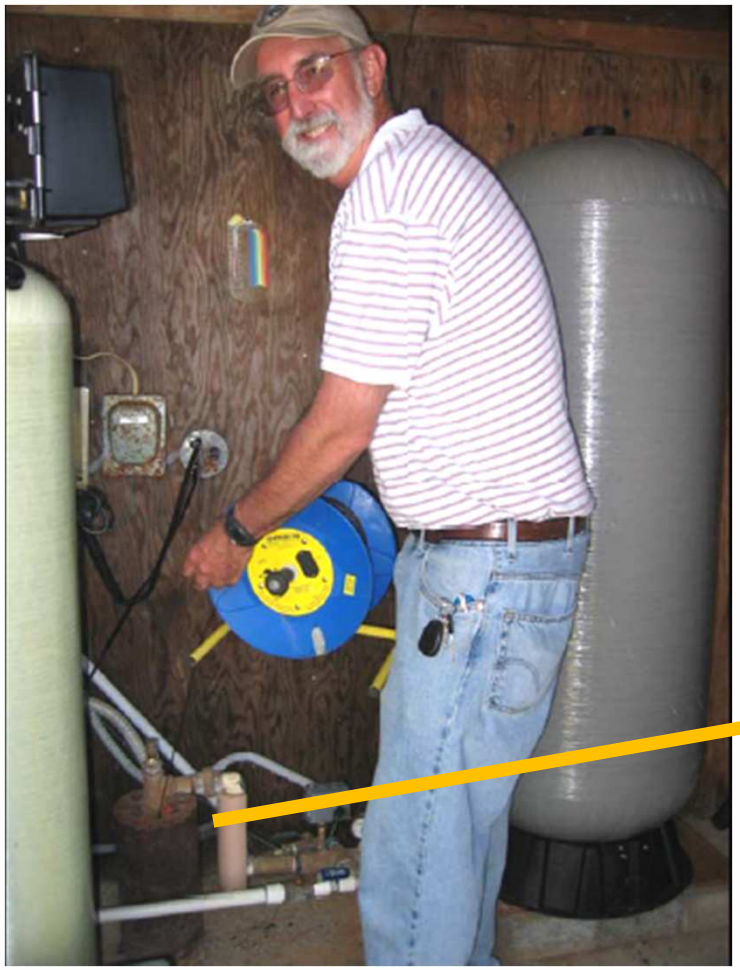
# Measuring Static Water Level

- Borrow or rent equipment from:
  - Water Resources Department
  - Environmental consultants
  - Drillers
  - Laboratories
  - Search web for resources




Oregon Department of Water Resources:
http://www.oregon.gov/owrd/gw/docs/water_level_booklet.pdf
Oregon State University Extension Service:
http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/19007/ec1368.pdf

# Measuring Static Water Level



Go slow to avoid getting water level meter stuck in the well.

# Measuring Static Water Level

# Well Log Information

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
AUG 6 1979
WATER RESOURCES DEPT
SALEM, OREGON

**WATER WELL REPORT**
**STATE OF OREGON**
(Please type or print)
(Do not write above this line)

Jackson 6075

State Well No. 36s/1w-21
State Permit No.

**(1) OWNER:**
Name:
Address:

**(2) TYPE OF WORK (check):**
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

**(3) TYPE OF WELL:**
Rotary ☑ Driven ☐
Cable ☐ Jetted ☐
Bored ☐

**(4) PROPOSED USE (check):**
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**CASING INSTALLED:** Threaded ☐ Welded ☑
6" Diam. from +2 ft. to 38 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

**PERFORATIONS:** Perforated? ☐ Yes ☑ No.
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

**(10) LOCATION OF WELL:**
County Jackson Driller's well number 61-79
¼ ¼ Section 21A T. 36 R. 1W W.M.
Bearing and distance from section or subdivision corner
TAX LOT 400 AVE C & 29TH WHITE CITY, OR

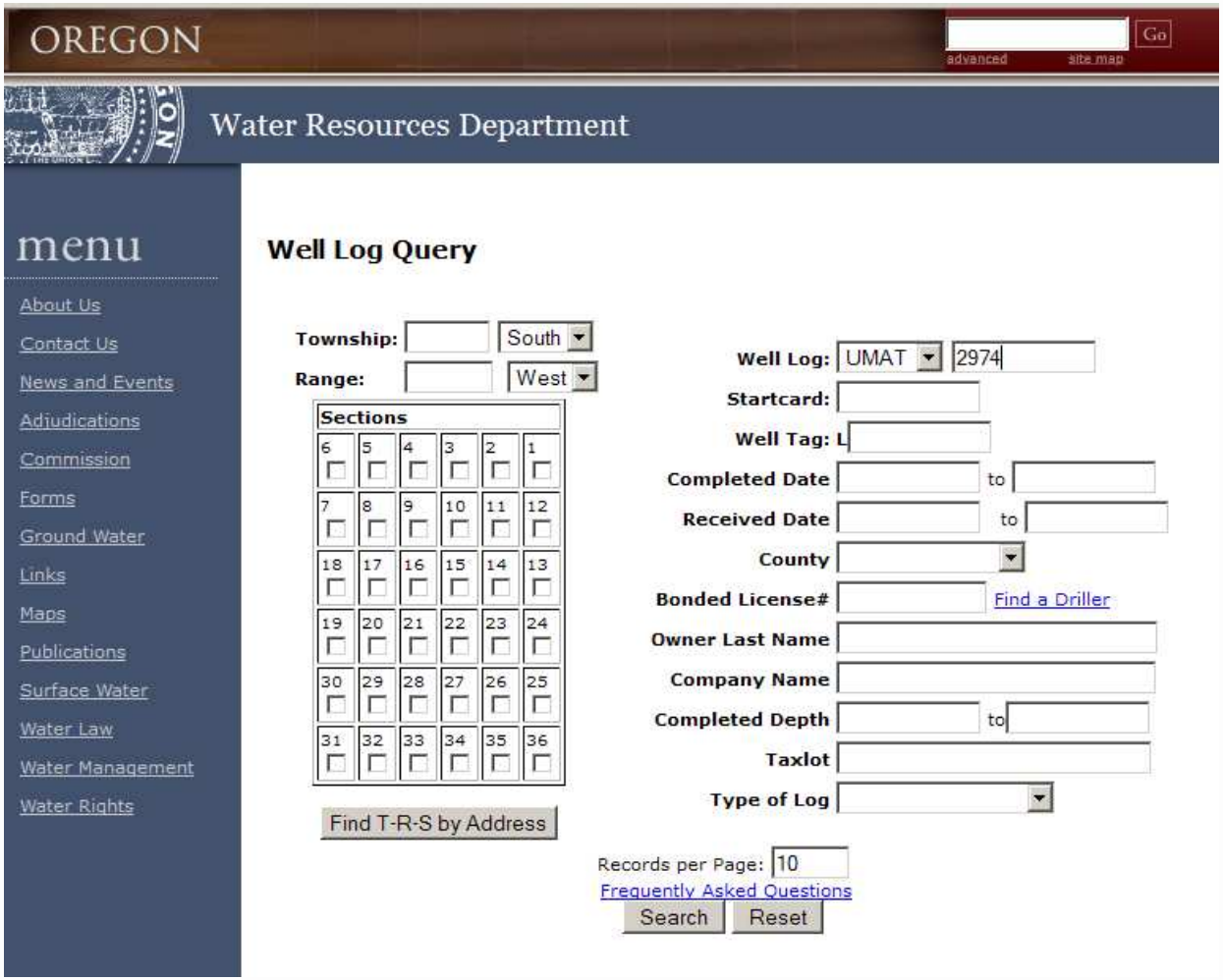
**(11) WATER LEVEL: Completed well.**
Depth at which water was first found 69 ft.
Static level 10 ft. below land surface. Date 7-30-79
Artesian pressure lbs. per square inch. Date

**(12) WELL LOG:** Diameter of well below casing 6"
Depth drilled 180 ft. Depth of completed well 180 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

| MATERIAL | From | To | SWL |
|---|---|---|---|
| SOIL-BROWN | 0 | 3 | |
| CLAY-BROWN | | | |
| W/GRAVEL | 3 | 16 | |
| CLAY-BROWN | 16 | 33 | |

# Searching for Well Log




http://apps.wrd.state.or.us/apps/gw/well_log/

# Calculating Well Volume

Well volume can be calculated using the following formulas:

$V = 3.14 \times r^2 \times L$, or

$V = d^2 \times 0.785 \times L$

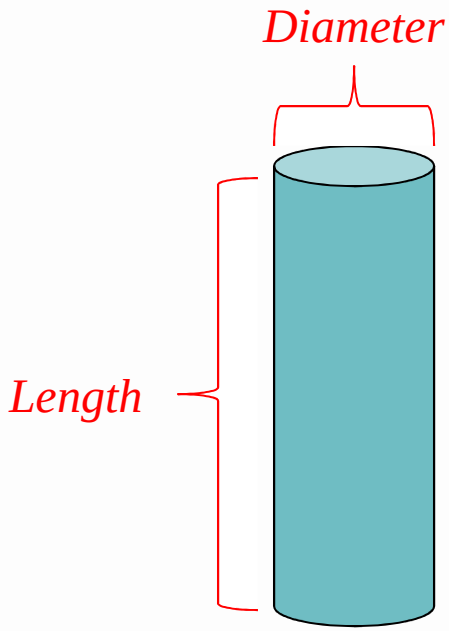
*Where:*

V = volume ($ft^3$)

r = radius (ft)

d = diameter (ft)

L = length or height(ft)



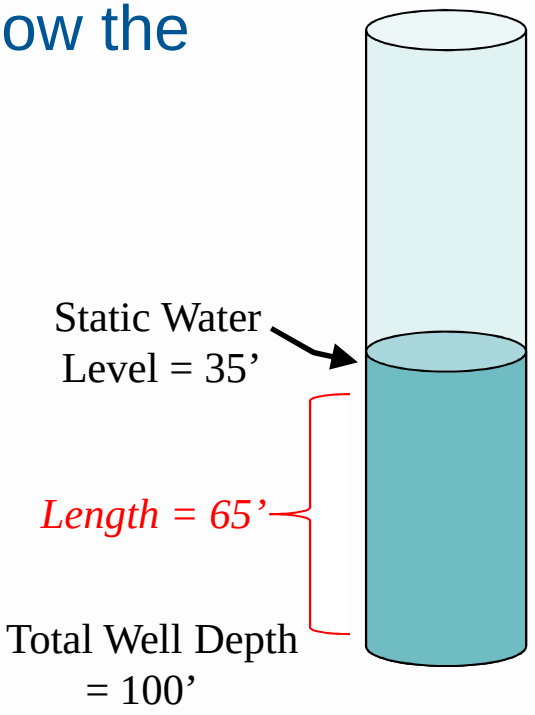

*All units of measure must be the same*

Convert volume to gallons:

1 cubic foot = 7.48 gallons

# Calculating Well Volume

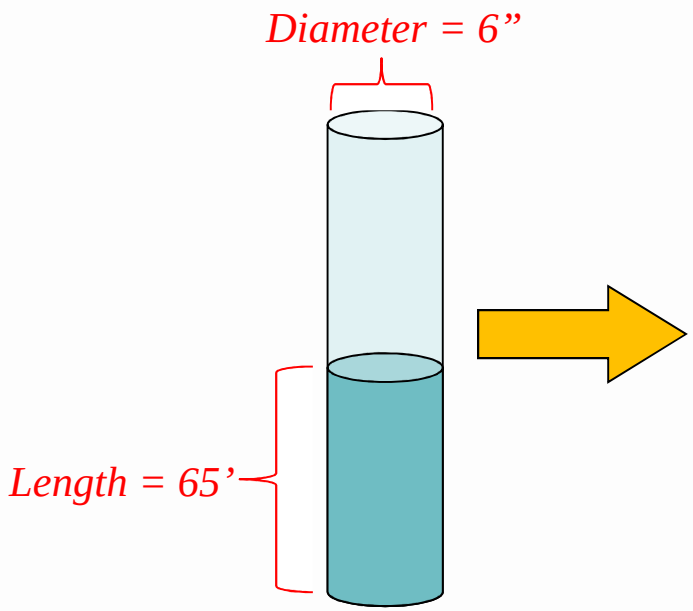
- To determine volume, need to know the water length in well column:
  - Total well depth = 100 feet
  - Static water level = 35 feet
  - Length or height = ? in feet




Length = *100 ft (total depth) – 35 ft (SWL)* = ***65 ft***

# Well Volume to Disinfect

*Example:* A 6-inch diameter well contains 65 feet of water.
What is the volume in gallons?



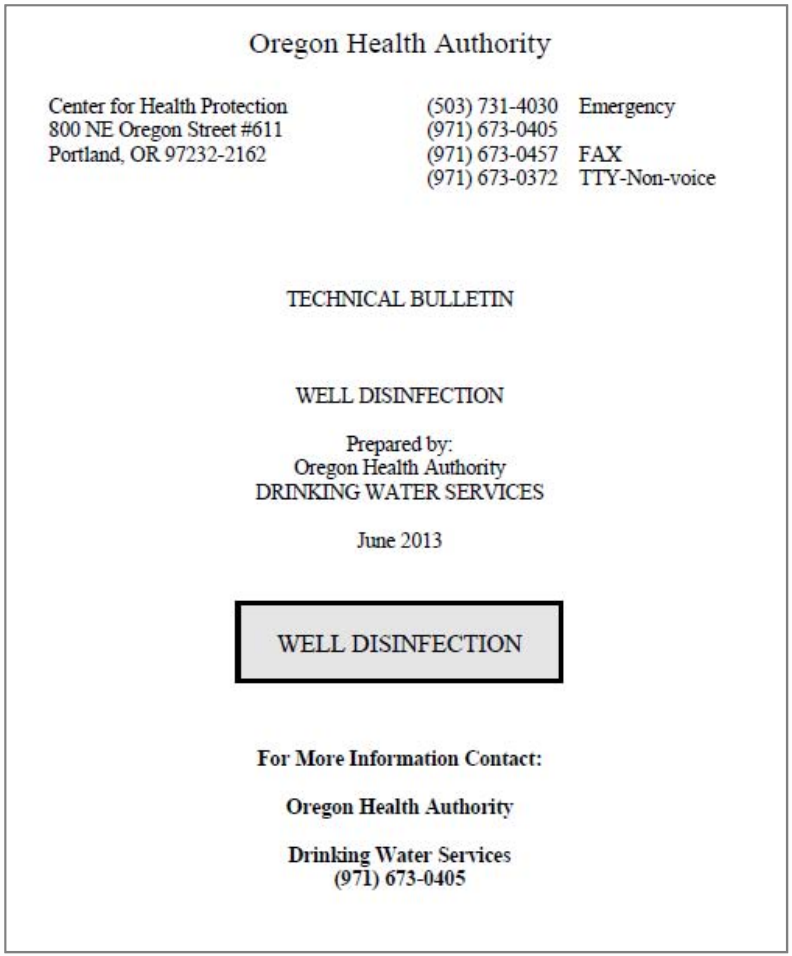

| Main Diameter (inches) | Gallons/ foot of length |
|---|---|
| 2 | 0.16 |
| 4 | 0.65 |
| 6 | 1.5 |
| 8 | 2.6 |
| 10 | 4.1 |
| 12 | 5.9 |

*Formula to use: (Length) x (Gallons/foot of length) = Gallons in well*

65 ft x 1.5 gal/ft = 97.5 or 100 gallons of water in well

# Calculating Well Volume

**Well Disinfection Technical Bulletin** on the DWS website for calculating well volume



Oregon Health Authority

Center for Health Protection
800 NE Oregon Street #611
Portland, OR 97232-2162

(503) 731-4030 Emergency
(971) 673-0405
(971) 673-0457 FAX
(971) 673-0372 TTY-Non-voice

TECHNICAL BULLETIN

WELL DISINFECTION

Prepared by:
Oregon Health Authority
DRINKING WATER SERVICES

June 2013

WELL DISINFECTION

**For More Information Contact:**

**Oregon Health Authority**

**Drinking Water Services**
**(971) 673-0405**

http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/welldisinfection.pdf

# Type of Chlorine to Use

- Percent of available chlorine is generally shown on the product's label.
  - 1% by weight is equal to 10,000 mg/L, for example:
  - 8% bleach would contain 80,000 mg/L chlorine
- **Sodium hypochlorite** (liquid)
  - Strength varies from 5%, 8% (household bleach) to 12.5% (industrial grade)



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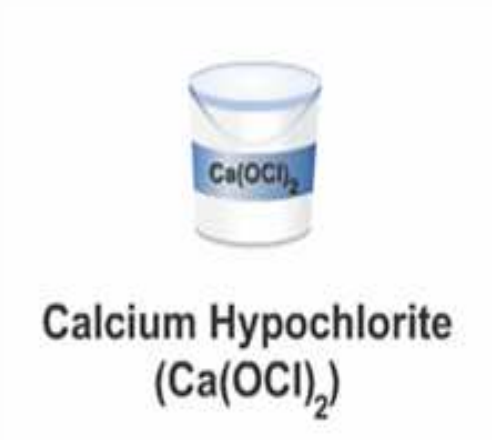
# Type of Chlorine to Use

- **Calcium hypochlorite** (dry powder/pellet)
  - Strength is usually 65% available chlorine
  - More commonly used for deep wells & storage tanks
- Avoid using ~~stabilized chlorine~~ (e.g. dichlor, trichlor) for swimming pools and spas









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# Chlorine

- Chlorine loses its strength over time
- Bleach stored at about 70˚F maintains strength noted on the product label for about 3 to 5 months


~~Scented~~

Half life of 12.5% sodium hypochlorite at various temperatures

| Degrees F | Number of Days |
|---|---|
| 77° | 220 |
| 87° | 110 |
| 97° | 55 |
| 107° | 27 |

# Certified products

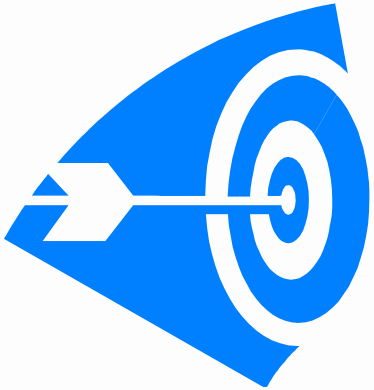
- The National Sanitation Foundation certifies products for use in public drinking water
- *Look for NSF logo – Recommended but not required if system is flushed before use*
- When ordering chemicals ask for product that is safe for drinking water
- Go to www.wqa.org/ or other ANSI-accredited organizations to verify product as certified

# Safety Considerations When Using Chlorine

- Chlorine bleach is a strong oxidant
- Highly corrosive
  - Especially at levels >100 mg/L
- May cause skin & eye irritation or damage
- Use goggles & rubber gloves when handling
- Wear protective clothing
  - Splash apron & rubber boots
- Provide good ventilation in work space

# Calculating Chlorine For Wells

- Wells are commonly chlorinated to:
  - 50 mg/L (target dose) for
  - 12 to 24 hours (exposure time).
- Decide on appropriate chlorine product to use
- Based on volume of water and desired target dose, calculate chlorine amount needed to achieve target dose.



# Calculating Chlorine Amount

*Example 1: Formula to determine volume of chlorine bleach solution =*

$$\frac{\text{(target concentration in mg/L)(volume to be disinfected in gal)}}{\text{(chlorine concentration as \%)(10,000 mg/L/\%)}}$$

- Target Concentration = **50 mg/L**
- Volume = 97.5 gallons round up to **100 gallons**
- Chlorine concentration = **8%** *(*Verify product strength)*
- Bleach amount = $\frac{(50\ \text{mg/L})(100\ \text{gal})}{(8\%)(10{,}000\ \text{mg/L/\%})} = \frac{5{,}000}{80{,}000} = 0.0625$ gal
- Convert to cups = (0.0625 gal)(16 cups/gal) **= 1 cup**

mg/L = milligrams per liter = ppm = parts per million



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# Calculating Chlorine Amount

*Example 2: Calculate weight of calcium hypochlorite powder needed =*

***Using the Pounds Formula:***
**(volume in MG) x (8.34 lb/gal) x (target concentration in mg/L)**

- Volume = **5,000 gallons/1 million = 0.005 MG**
- Target Concentration = **2 mg/L**
- Available chlorine = **65% or 0.65** (**Verify the available chlorine in product)*
- Lbs of chlorine = $\frac{(0.005\ \text{MG}) \times (8.34\ \text{lb/gal}) \times (2\ \text{mg/L})}{0.65}$

**= 0.128 lbs or ~2 ounces**

mg/L = milligrams per liter = ppm = parts per million



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# Need Help With Conversions?

*Refer to the **Basics for Small Water Systems in Oregon Manual***

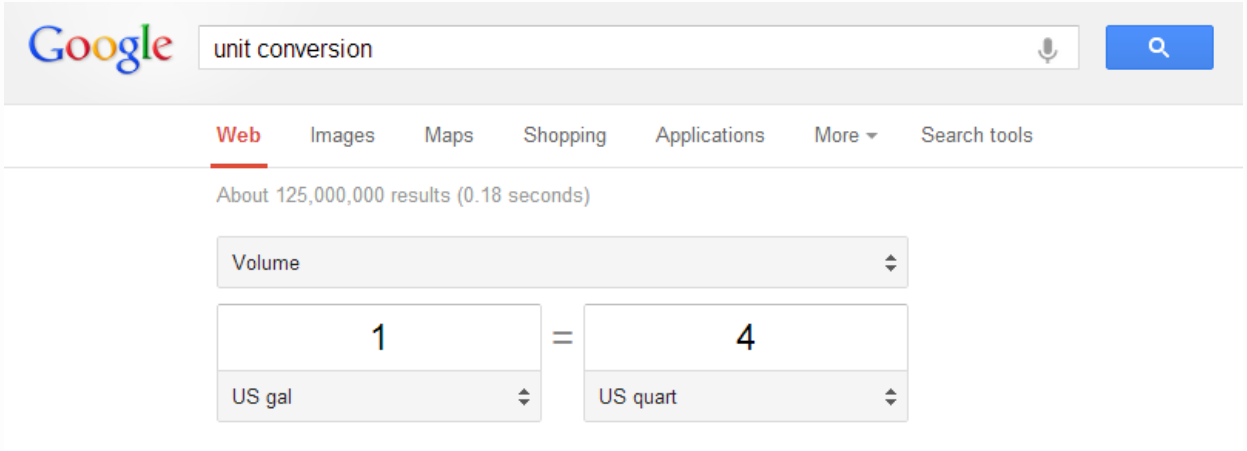
FACT SHEET 4.7 – Basic Math: Common Calculations for Small Water Systems

| Abbreviations: | | | | | |
|---|---|---|---|---|---|
| **ft** | = | Feet | **lb** | = | pounds |
| **gpd** | = | gallons per day | **mg/L** | = | milligrams per liter |
| **gpm** | = | gallons per minute | **mL** | = | milliliter |
| **MGD** | = | million gallons per day | **L** | = | liter |

| Conversion Factors: | | |
|---|---|---|
| | | |
| 1 acre | = | 43,560 square feet |
| 1acre foot | = | 43,560 cubic feet |
| 1 cubic foot | = | 7.48 gallons |
| 1 foot | = | 0.305 meters |
| I gallon | = | 3.79 liters |
| 1 gallon of water | = | 8.34 pounds |
| 1 horsepower | = | 0.746 kilowatts |
| 1 million gallons per day | = | 694 gallons per minute |
| 1 pound | = | 0.454 kilograms (454 grams) |
| 1 Liter | = | 1000 mL |
| 1 Liter of water | = | 1000 grams |
| 1 gram | = | 1000 kg |
| 1 pound per square inch (psi) | = | 2.31 feet of water (head) |
| 1% | = | 10,000 mg/L |
| Degrees Celsius | = | (Degrees Fahrenheit - 32)($^5/_9$) |
| Degrees Fahrenheit | = | (Degrees Celsius)($^9/_5$) + 32 |
| $\pi$ | = | 3.14 |

# Online Conversion Tools

- Use any number of online conversion tools by doing a search on “unit conversion”, or
- Type the value to be converted into the search bar (e.g., “25 tablespoons to cups” yields a result of “25 US tablespoons = 1.5625 US cups”).



# Chlorine Sampling Methods

- Measure chlorine residual using DPD or other EPA approved method (Unless doing gross evaluation of chlorine levels)
- Check expiration dates on reagent packets
- Be familiar with instrument's range
- Color wheels can fade over time

**Drinking water approved methods**

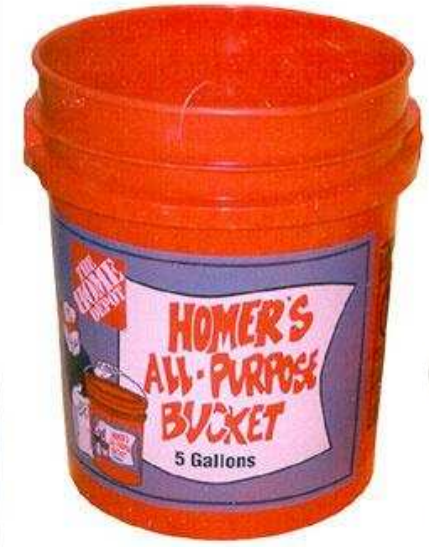

**Unapproved methods for drinking water**


**Restaurant inspector's tape**

# How to Measure Higher Concentrations

*Using Dilution Method*

- Achieve target dosage of **50 mg/L** chlorine solution in a 5 gallon bucket
- Cut solution to 1:25 to get to **2 mg/L** (chlorine test kit's mid-range)
- 1 Tbsp:25 Tbsp = **1 Tbsp (solution) to 25 Tbsp (water)**



# High Dose Considerations

- It can raise pH which lowers chlorine effectiveness
- Can corrode & damage equipment
- Takes more time to completely flush
- Disposing super-chlorinated water can be difficult
  - Hazardous to wildlife
  - Other safety considerations
- Adding excessive amounts of chlorine into a well is not a good idea

# Disposal Of Chlorinated Water

- DEQ has requirements for discharging super-chlorinated water (> 4 mg/L total chlorine residual)
- Regardless of volume, **super-chlorinated water must not be discharged to surface waters or storm sewers**.
- Non-discharge alternatives:
  - Sanitary sewer disposal (connect to a sanitary sewer or haul to a sewage treatment plant)
  - Land disposal or irrigation
- Discharging chlorinated water into on-site septic systems can cause damage by inactivate microbes

# Disposal Of Chlorinated Water

Discharge Options when there is insufficient dilution and/or travel time:

- Dechlorinate to 0.1 mg/L residual chlorine or less if discharge is to a stream with flow less than 50 cubic feet per second (cfs). Test prior to discharge.
- Collect and hold water in a detention pond or tank and allow chlorine to dissipate into the air. Again, the maximum is 0.1 mg/L if discharging to a stream with flow less than 50 cfs. Test before discharging.
- Refer to *DEQ Memorandum & Decision Matrix on Chlorinated Water Discharges*

http://www.deq.state.or.us/wq/pubs/bmps/chlorwaterdisp.pdf

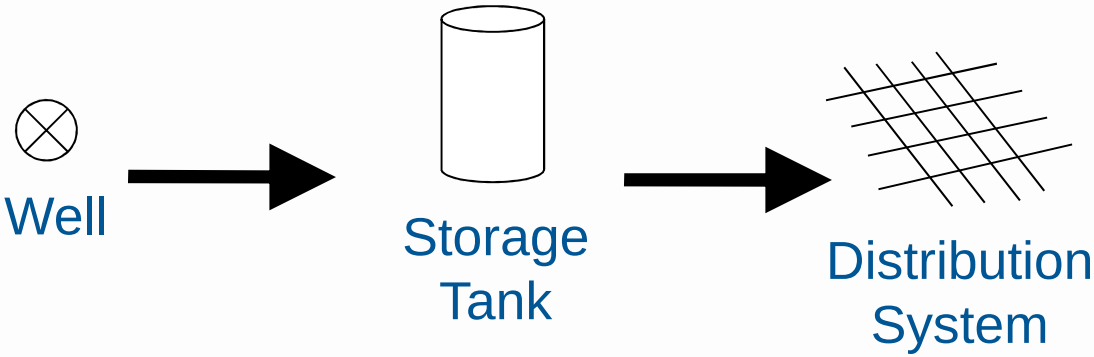
# Dechlorination

- Commercial products are available to dechlorinate potable water
- Chlorine is neutralized using Sodium sulfite, Sodium thiosulfate or Ascorbic Acid (Vitamin C)

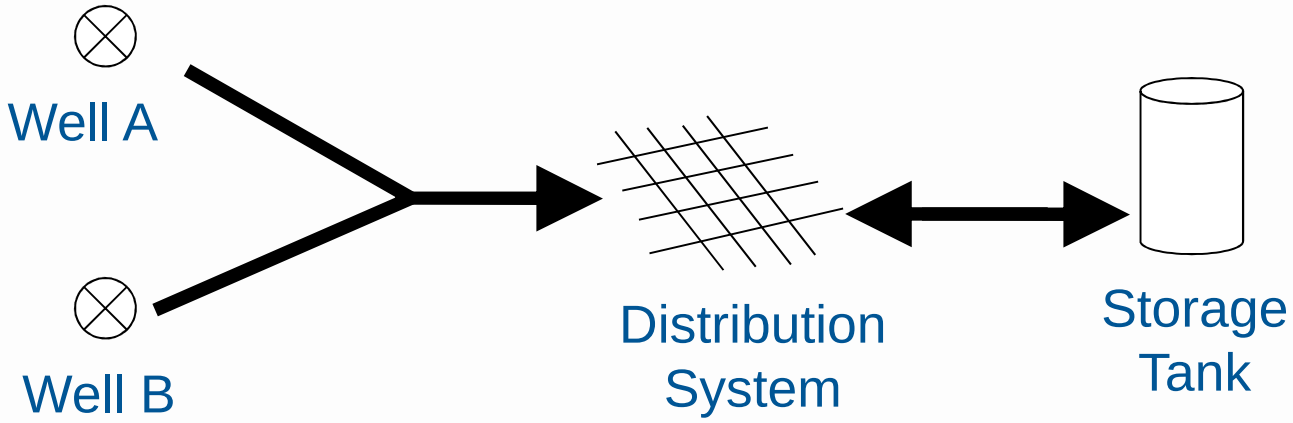
# Water System Disinfection

*What components will require disinfection?*

***Scenario 1:***



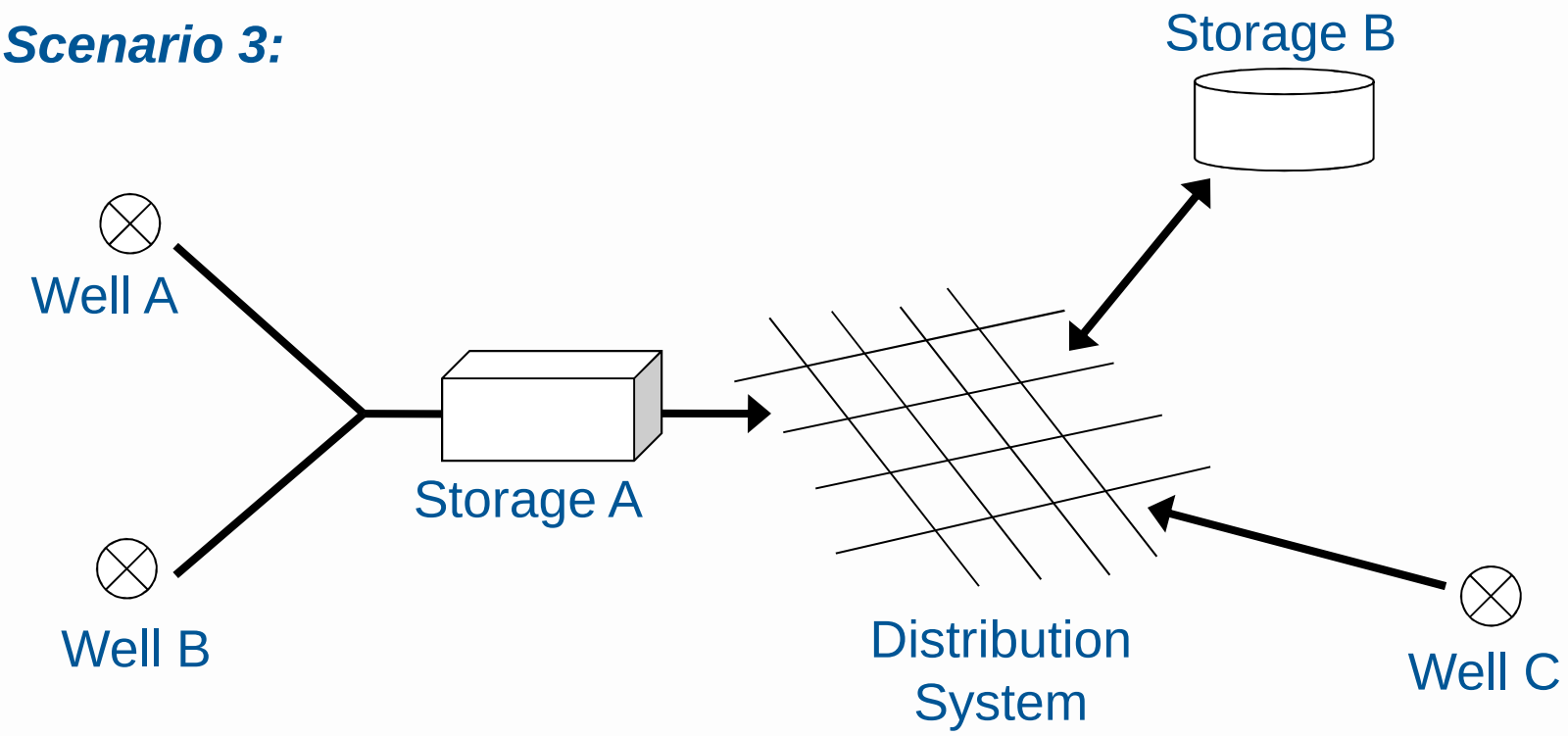

***Scenario 2:***



# Water System Disinfection

*What components will require disinfection?*

***Scenario 3:***



# Well Chlorination Options

*Option 1 – Bottom Up Injection*

- Achieve **50 mg/L** throughout water column
- Run tube into casing to bottom of well
- Withdraw tube while injecting chlorine solution

*Option 2 – Down-Hole Method*

- If bottom-up injection method is not feasible, dilute chlorine into at least 5 gallons of (warm) water and mix
- Make sure chlorine mixes thoroughly with dilution water
- Pour into well with a funnel through a plug or casing vent hole at the top of the sanitary seal

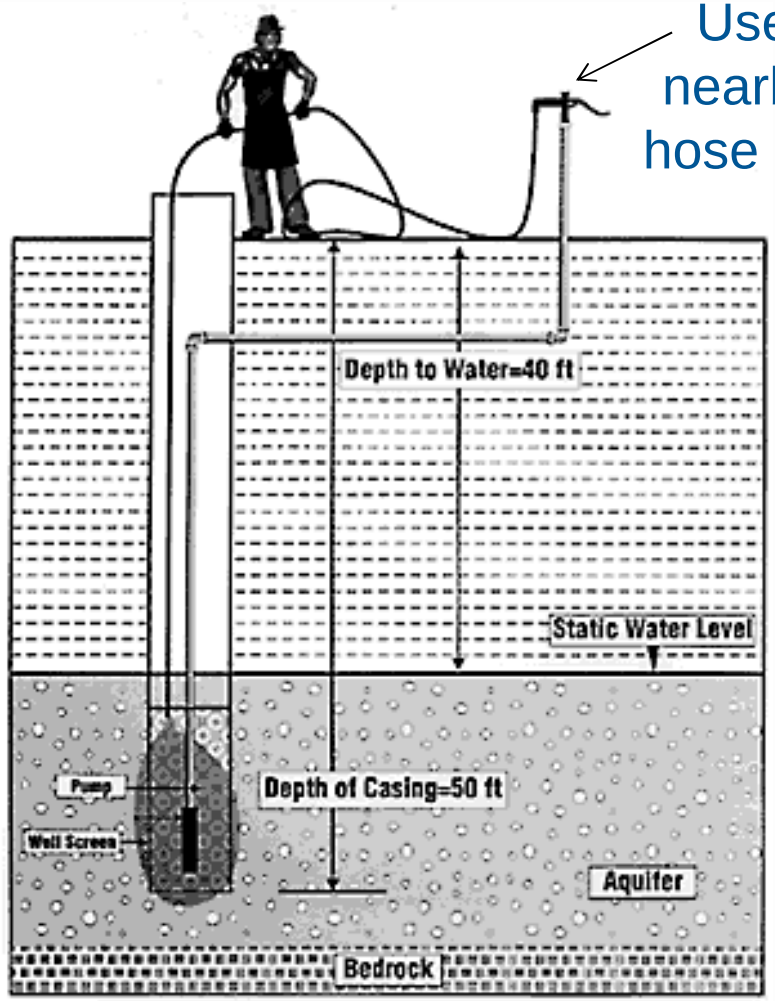
# Disinfecting Through Well Caps

- Three common types of well caps:
  - *Turtle Back* with or without access plug
  - Sanitary well cap
  - Other types?
- The right tools are needed to unbolt the well cap
- Use care when exposing wiring to prevent damage

# Well Chlorination

- To mix solution within well, attach a hose to nearest downstream tap (before any unpressurized storage tanks).
- Recirculate water from tap back into well for at least 15 minutes.
- *Note:* When restricting the well pump's outflow through one hose (during recirculation), back pressure on the pump could cause damage or trip the pump off. If needed, use a buffer or surge tank and siphon it back into well in batches.

# Example of how to recirculate water down a well




http://infohouse.p2ric.org/ref/20/19703.htm#SHOCKCHLORINATE

# Well Chlorination

- Verify target dose & let mixed disinfectant remain in the well for 12-24 hours.

- Flush by using a flow splitter and re-circulate half the water down the casing while pumping half to waste until no chlorine is detected.  Be sure to flush inside well casing & other internal components to prevent corrosion.

# Steps After Flushing

- After a zero chlorine residual has been verified,
- Continue to pump well to waste for about 15 minutes.
- Next, collect coliform samples
  - At least 2 samples spaced 30 minutes apart
- If samples are positive, repeat pump to waste and collect additional samples
- If samples are still positive, repeat chlorination and retest
- Additional corrective action may be needed. Consult with a well professional or circuit rider.

***Newly constructed wells use solution strengths of up to 100 mg/L for 24 hours (AWWA Standard A100-06)***

# Water System Disinfection

- Wells, storage tanks & piping may need to be separately disinfected.
- Coordinate timing for storage & distribution system disinfection.
- Calculate volume of water in storage or use tank dimensions.

*Rectangular Tank Volume Formula:*

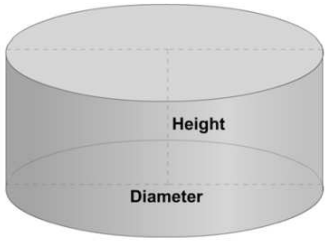
**V (gal) = L (ft) x W (ft) x H (ft) x 7.48 gal/ft$^3$**

- For H, use height to overflow
- To be conservative use total height

*Cylindrical Tank Formula*:

**V (gal) = d$^2$ (ft) x 0.785 x H (ft) x 7.48 gal/ft$^3$**

- Can also use formula, V = 3.14 x r$^2$ x h

# Calculating Volume Review

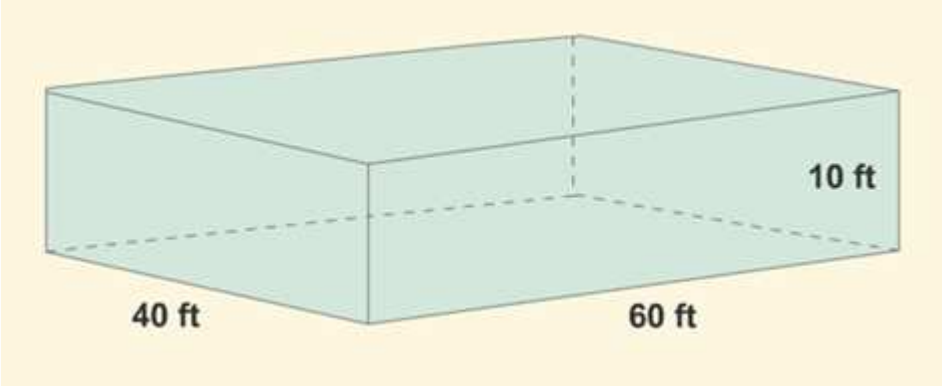
*Rectangular Basin - Example*

60’ long, by 40’ wide, by 10’ deep (at overflow).

**What is the total volume this reservoir can hold in cubic feet?**

*Formula:* V = L × W × H

60’ × 40’ × 10’ = *24,000 ft³*




Convert cubic feet to gallons:

*24,000 ft³ × 7.48 gal/ft³*

*= 179,520 gal (round to180,000 gal)*

# Calculating Volume Review

*Cylindrical Basin - Example*

A tank has a diameter of 40 feet and is 10 feet deep at the overflow.
**How many gallons can the tank hold?**

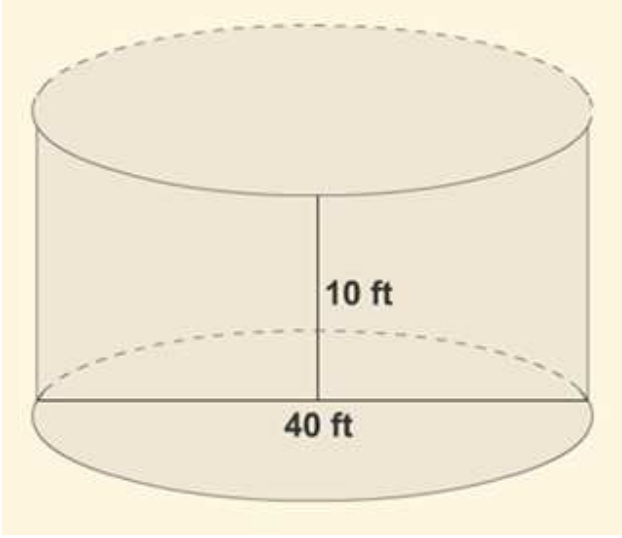
Calculate the volume:

$d^2 \times 0.785 \times h = \text{Volume } (ft^3)$

*$40' \times 40' \times 0.785 \times 10' = 12{,}560\ ft^3$*

Convert cubic feet to gallons:

*$12{,}560\ ft^3 \times 7.48\ gal/ft^3 = 93{,}949$ gallons*



# Storage Tank Chlorination

- Establish method exposure time
  - AWWA exposure times are 3, 6 & 24 hours
- Exposure time depends on chlorine concentration and if chlorine can be added at time of filling storage to improve mixing.
  - Combining time & concentration is referred to as a method (per AWWA Standard C652-02).
- Longer exposure times are more conservative and may improve disinfection.

**Refer to Storage Tank Chlorination Tool on DWS website**

# Storage Tank Chlorination Tool

**Basics for Small Water Systems in Oregon:**
**Storage Tank Chlorination**

Disinfection concentrations and times are based on AWWA Standard C652 for storage tanks cited in: OAR 333-061-0050 "Construction Standards" (10)(d) dated 19 Apr 2010, page 297

**Options for Disinfection by Chlorination:**

**Method A**. Filling the tank or reservoir with a ***10*** *mg/L* chlorine solution and allowing it to remain for ***6***[a] or ***24*** *hours* (see Table).

**Method B**. Filling the reservoir with a ***50*** mg/L chlorine solution and allowing it to stand for ***6*** *hours* (see Table).

**Method C**. Spraying or brushing on a 200 mg/L chlorine solution and allowing it to remain for 3 hours (calculation not provided).

**Question: How much chlorine is added to a tank?**

Volume to be disinfected = 500 gallons

(input tank volume above in yellow shaded cell)

| Chlorination Dose for Storage Tank of Volume Specified Above | Method A[b] | Method B[c] | *Units* |
|---|---|---|---|
| Chlorine Concentration | 10 | 50 | *mg/L* |
| *Method Exposure Time* | *6*[a] *or 24* | *6* | *hours* |
| Chlorine Source Material… | | | |
| Bleach 5% Solution | 0.10 | 0.50 | *gallons*[d] |
| Bleach 8.25% Solution | 0.06 | 0.30 | *gallons*[d] |
| Bleach 12.5% Solution | 0.04 | 0.20 | *gallons* |
| Dry Chlorine (65% by wt) | 0.06 | 0.32 | *pounds* |
| | 0.029 | 0.147 | *kilograms* |

(Chlorine Concentration values [yellow, or grey, cells] can be changed for custom calculations)

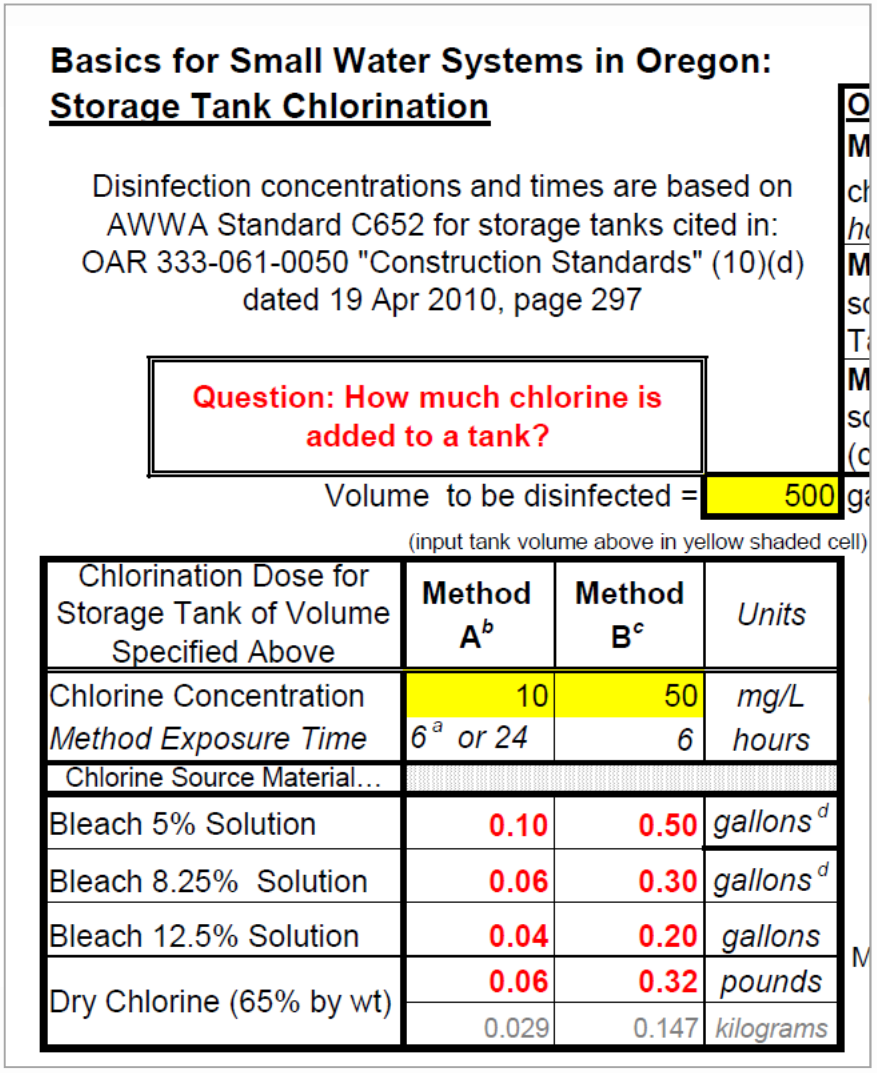
☜ Note that to achieve Method concentration ***add more*** chlorine than specified here.

Important: Measure chlorine concentration to confirm Method's target concentration. Test strips used in restaurant inspection (for detecting higher chlorine levels) may be useful, or dilute a sample to your test kit range

http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/ShockChloroCalc.xls

# Storage Tank Chlorination Tool

- Enter *Volume to be disinfected.*
- *Chlorine Source Material* values automatically change to achieve target chlorine dose based on volume entered.
- Chlorine concentrations are calculated as a function of the *method*.
- Amount of chlorine material needed is in red text.



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# Storage Tank Chlorination Tool

- The target dose is either 10 or 50 mg/L, unless the *method* is *spray application* at 200 mg/L.
- Wait the full duration of *method* disinfection time listed in the spreadsheet.

| Chlorination Dose for Storage Tank of Volume Specified Above | **Method A**[b] | **Method B**[c] | *Units* |
|---|---|---|---|
| Chlorine Concentration | 10 | 50 | *mg/L* |
| *Method Exposure Time* | 6[a] or 24 | 6 | *hours* |
| Chlorine Source Material… | | | |
| Bleach 5% Solution | **0.10** | **0.50** | *gallons*[d] |
| Bleach 8.25% Solution | **0.06** | **0.30** | *gallons*[d] |
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# Storage Tank Chlorination Example

- Only one storage tank holding 10,000 gallons.
- The target dose is 50 mg/L & a 6-hour time frame will be used (Method B) to minimize service interruption.
- How much normal (5%) household bleach is needed to disinfect the storage tank?

# Storage Tank Chlorination Example

- Only one storage tank holding 10,000 gallons.
- The target dose is 50 mg/L & a 6-hour time frame will be used (Method B) to minimize service interruption.
- How much normal (5%) household bleach is needed to disinfect the storage tank?

*Answer*:

Add **10 gallons** of normal household (5%) bleach to the storage tank & mix by recirculating. Measure the chlorine concentration. If the solution mixed in tank measures a bit low (e.g. 45 mg/L), add about 10% of original dose, or 1 gallon of bleach & mix again. If concentration is now > than 50 mg/L, start clock on the 6-hour interval.

# Storage & Distribution Chlorination

- Flush storage volume through distribution until chlorine concentration is achieved & detected at distribution taps.
- Once contact time has been met in distribution (12-24 hours) begin flushing entire system.
- Flushing may need to be done in multiple phases depending on source yield & distribution volume (refilling storage with hauled water may be necessary).

# Storage & Distribution Chlorination

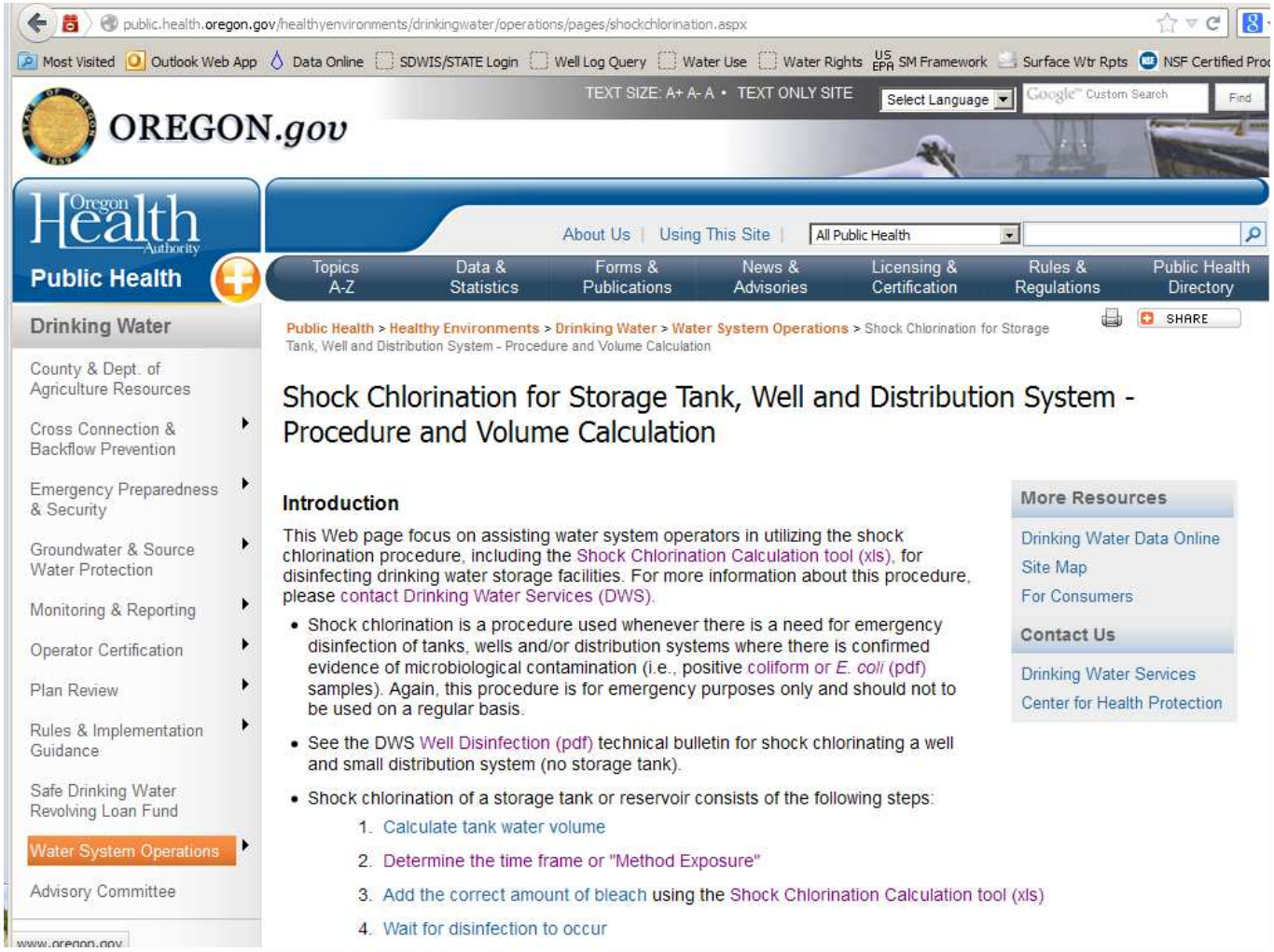
Continued…

- After zero chlorine residual is verified at all distribution taps, collect a representative number of coliform samples using sites designated in the coliform sampling plan.
- Repeat disinfection process as needed if any samples are coliform positive.

# Potential Disinfection Complications

- Chlorination process is not an exact science.
- Dosage calculations will address worst case scenario.
- High-volume, unidirectional flushing alone may resolve the problem.
- Determining extent of bacteria colonization can be difficult
  - Heterotrophic plate counts (HPC) may help determine this
- Each situation may have mechanical & electrical challenges:
  - Overloading well pumps
  - Overriding storage tank float switches
  - Inadequate taps & valves for effective recirculation
  - Other issues?

# Resources Available On DWS Website



# Helpful Links

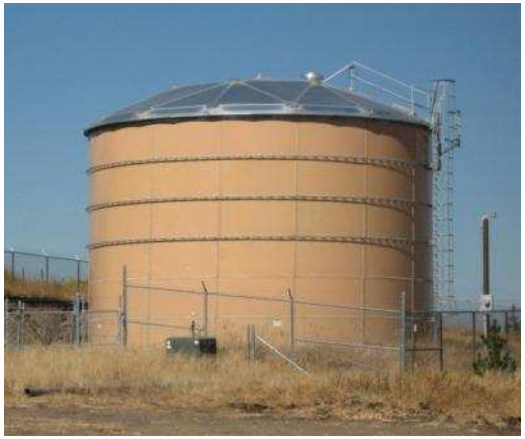
- *How to disinfect a well*: http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/welldisinfection.pdf
- *Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation*: http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Pages/shockchlorination.aspx
- *Basics for Small Water Systems in Oregon* - Unit 4 http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/OperatorCertification/SmallWaterSystems/Documents/BasicsForSmallPWS.pdf
- *American Water Works Association*: http://www.awwa.org/

# Exercise & Discussion

# Class Exercise (Part 1):

## *Calculate system volumes for your water system*

*Determine well, storage, & distribution pipe volumes*



Shock Chlorination Worksheet

Water System Name: _____

**Well disinfection** Casing Diameter (in) _____ Total Well Depth _____ ft
minus Static Water Level _____ ft
= Well water depth _____ ft

Gallons in well = Depth of water (ft) X Gallons per foot of depth (based on table with casing diameter)

= _____ X _____ = _____ gallons of water to be treated in well

**How much bleach product would you need to add to the well to achieve at least 50 ppm?**
(Use excel form or this formula)

Cups of bleach product = (target concntr., ppm)(water vol., gal)(16 cups/gal) / (bleach concentration as %)(10,000 ppm/%)

= 50 ppm x ____ gals in well x 16 / ___ % bleach product X 10,000

= ____ cups

(Also, remember the rule of thumb of approximately 1 cup of 5% bleach per 100 gallons to get 50 ppm.)

**Storage Tank** Same question, **to achieve 50 ppm in the storage tank you would need....**

Gallons to be disinfected in tank: _____

Gallons of bleach product = 50 ppm x _____ gals in tank / ___ % bleach product X 10,000

= _____ gallons bleach product

(Notice we skipped the gallons-to-cups conversion this time, because a storage tank usually has a large enough volume to use gallons units for the bleach product)

**Mixing is important – recirculate in tank!**

**Distribution System** **Disinfect pipes to achieve 50 ppm...**

1. Length of pipe (L) from point of disinfection to first user: _____ feet
2. Diameter of pipe (D) between point of disinfection and first user: _____ inches
3. Volume of pipe (V) = (L X D2) ÷ 24.5 or (L X D X D) ÷ 24.5 or
   (Line 1 X Line 2 X Line 2) ÷ 24.5 = _____ gallons
4. Repeat calculations if additional lengths of pipe
   Volume of pipe ($V_2$) = ($L_2$ X $D_2$ X $D_2$) ÷ 24.5 = _____ gallons
5. Total Volume of pipes ($V_{total}$) = $V_1$ + $V_2$ + . . . = _____ gallons
6. Gallons of bleach product = 50 ppm x _____ gals in tank , or multiply by 16 to get _____ cups / ___ % bleach product X 10,000

# Class Exercise (Part 2):

*Design Your Own Disinfection Process*

1. Determine chlorine amount needed based on your system's volume.
2. Develop a strategy in steps (e.g. add chlorine to well & then batch dose from the reservoir into distribution, etc.).
3. Plan the public notification process.
   - Customers must be informed of timelines & water use restrictions to protect their health.
   - Dishes and household cleaning are about the only things you can do with shock chlorinated water.
   - Notify customers when it's all over.
4. Document chlorination events.
   - What worked & ways to improve the process

# Summary

1. Chlorination is effective to address microbial contamination.
2. Know volumes of wells, storage tanks and distribution piping to calculate amount of bleach needed for effective dosages.
3. Evaluate public health risk and customer service needs when determining your method- exposure time and target dose.
4. How will you notify customers?
   - when contamination is confirmed
   - when superchlorinating the water system
   - when the issue is resolved
5. Record system volumes and chlorine calculations for future reference in your operating procedures.
6. Before shock chlorinating, consult with your regulator!