Online Help Centre for BC Small Water Systems

2022 Webinar Series

Well Operations & Maintenance: BEST PRACTICES

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BC Legislation

- The ***Groundwater Protection Regulation (GWPR)*** ensures that activities related to wells and groundwater are performed in an environmentally safe manner.
- Under the ***Water Sustainability Act* (WSA)**, the GWPR:

1. Regulates minimum standards for well construction, maintenance, deactivation and decommissioning, and
2. Recognizes the types of qualified people certified to drill wells, install well pumps and perform related services

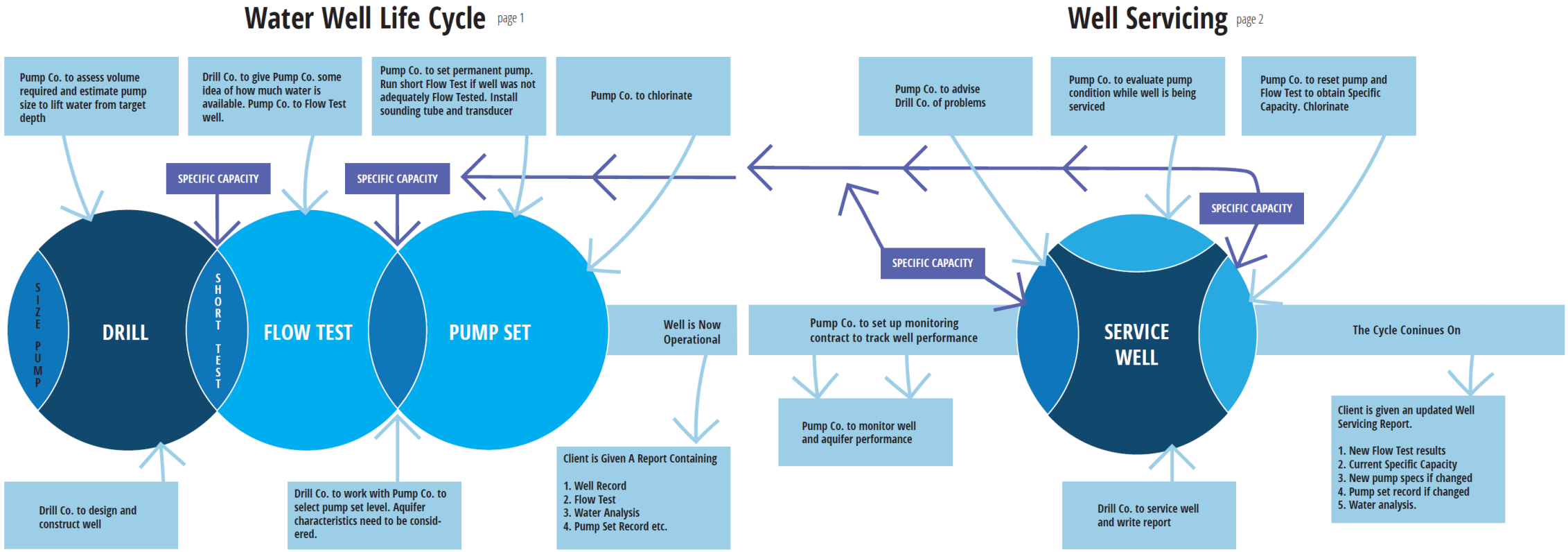
Certified - Well Drillers and Well Pump Installers

- Constructing and decommissioning wells, installing well pumps, disinfecting wells and conducting flow tests are restricted activities that can only be performed by qualified well drillers or well pump installers, or professional engineers and geoscientists.

Best Practices is Well maintenance

Long life and Maximum production – you can’t have one without the other.

Water Well Life Cycle



why wells fail

- Pumping test was not performed
- Specific Capacity at time of drilling was not recorded
- Pumping is not efficient
- Improper or lack of well maintenance
- Insufficient Funds
- Water analysis information is misinterpreted
- A combination of the above

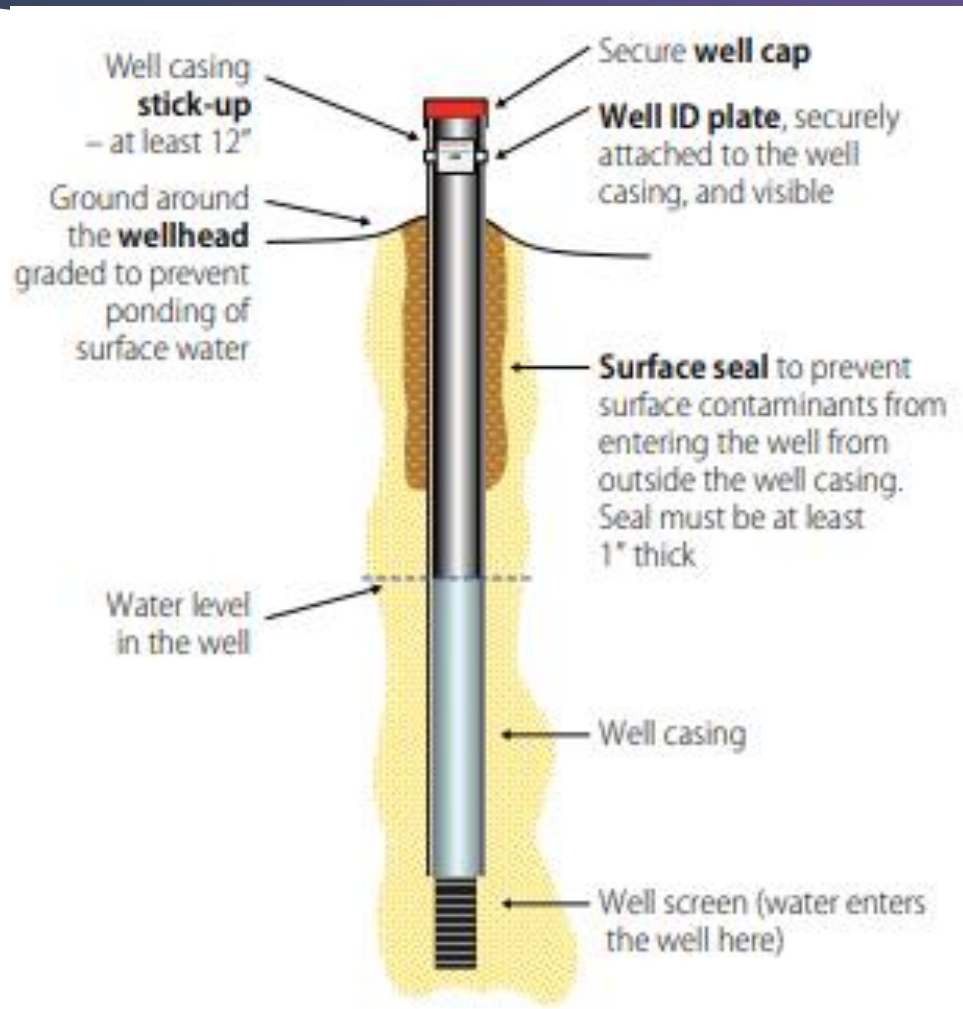
Construction of a well

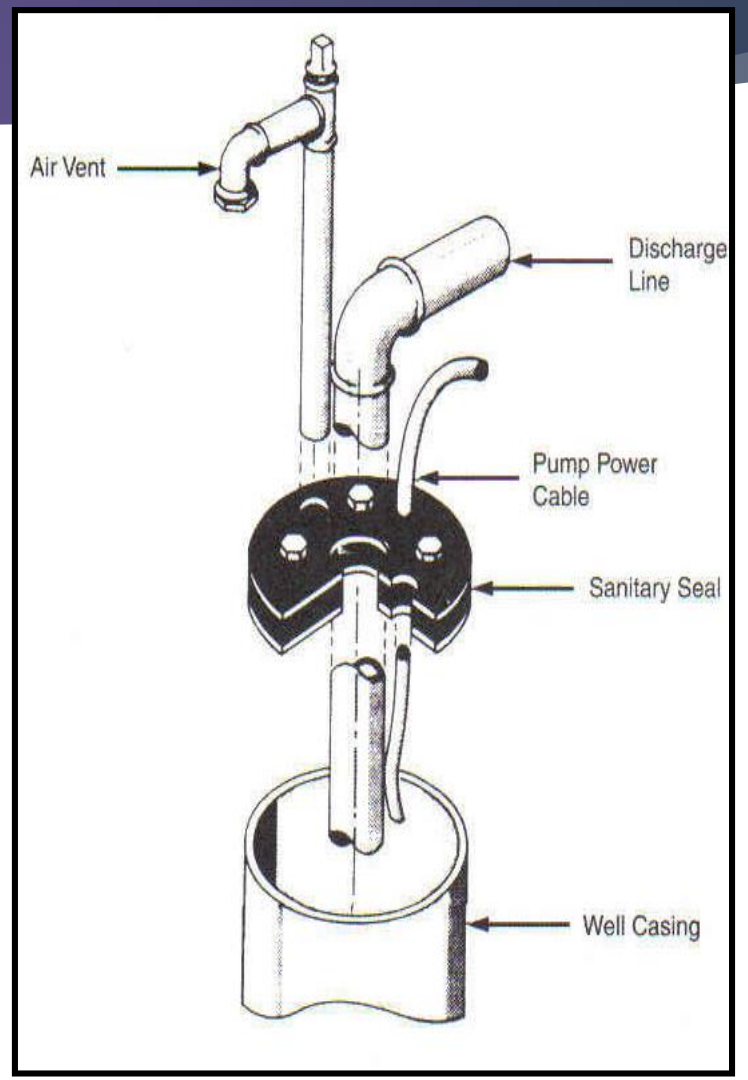
The well driller, professional or other person responsible for constructing a well is required to comply with the provisions of the GWPR related to how the well is constructed.

- This person must ensure that the well meets the minimum standards for the:
- casing material,
- wellhead completion,
- surface seal,
- well caps and covers and
- well identification.

The person must also submit a well construction report to the province if required.

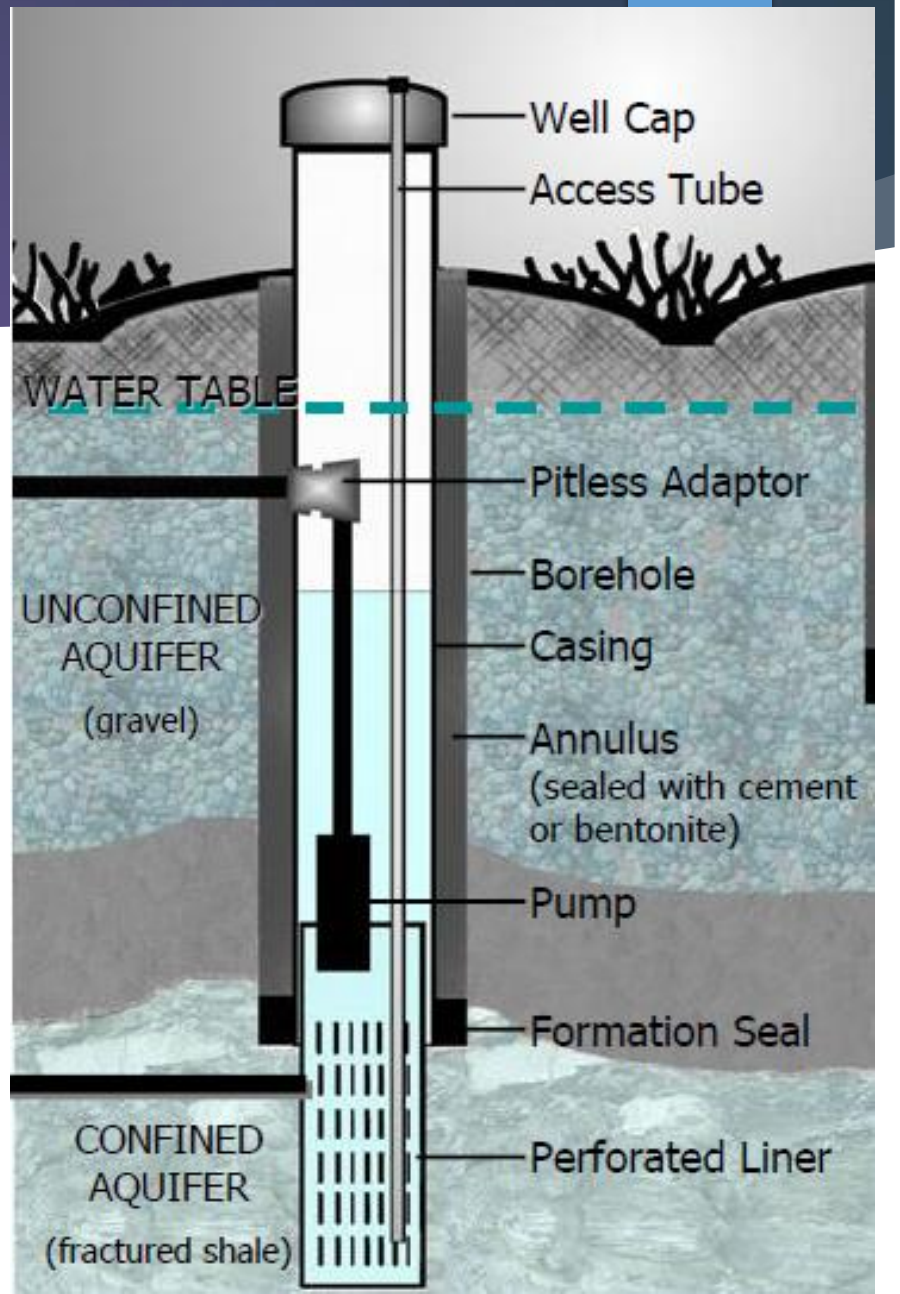
Parts of a Water Well





Well Cap

- It's a metal plate with a rubberized gasket around that fits on top of the well casing.

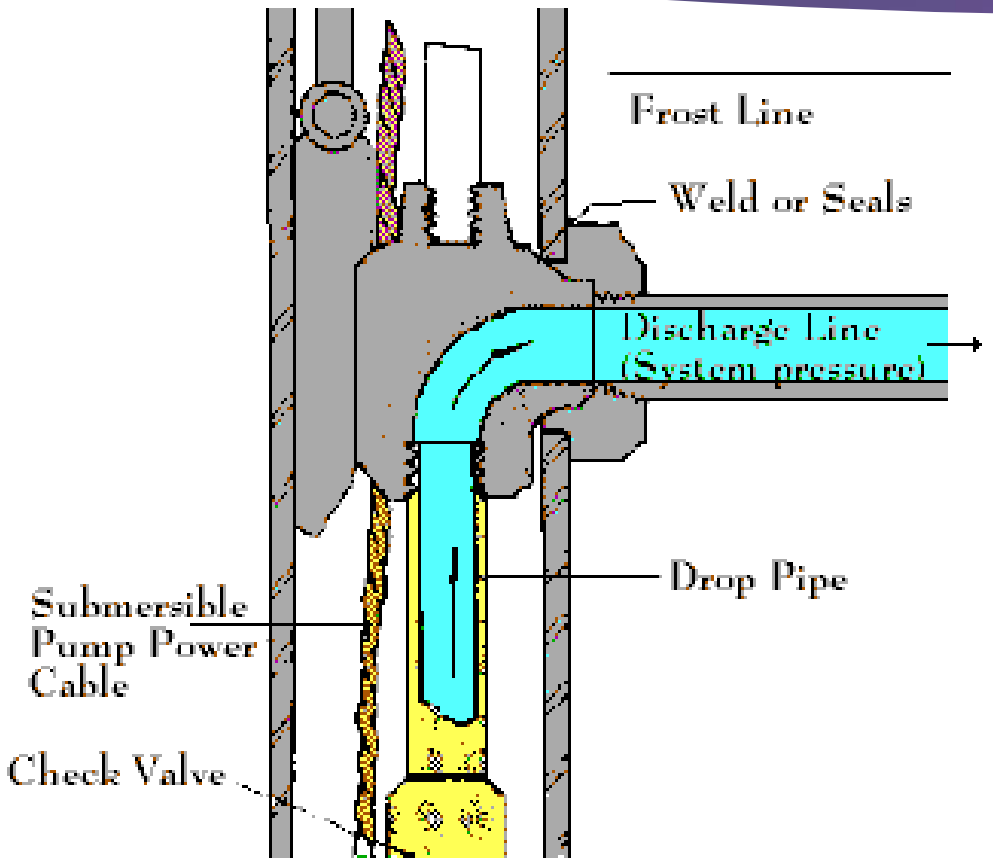


Well Cap

Well ID Plate

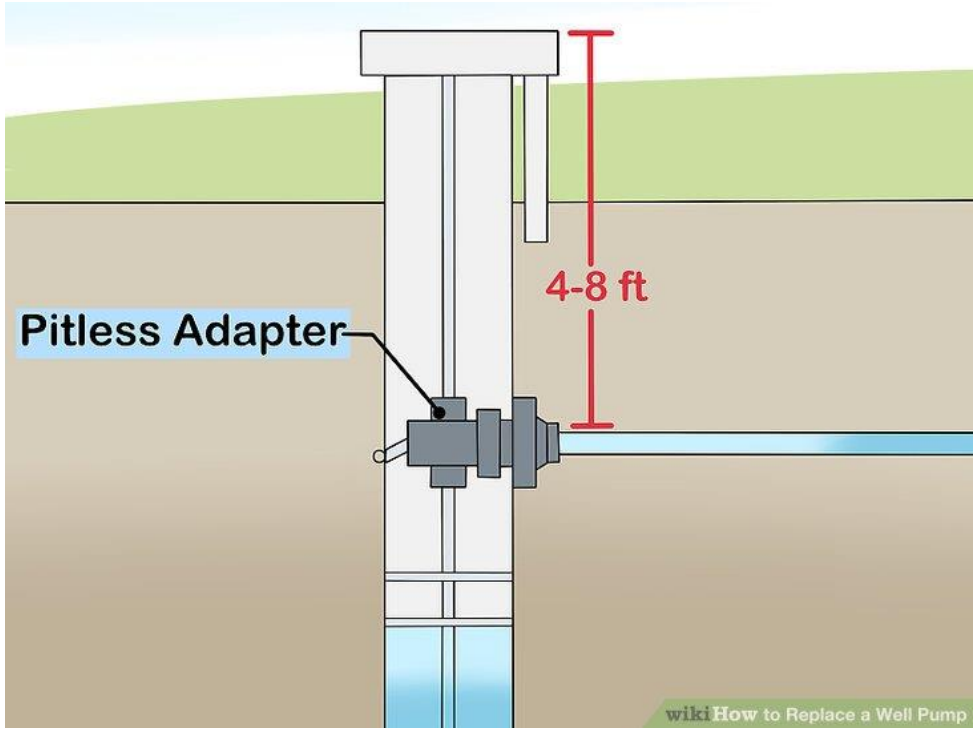
- Must be attached to the well and replacing it if it is damaged or lost.
- For a replacement well identification plate, contact: GroundWater@gov.bc.ca.

Pitless adapter



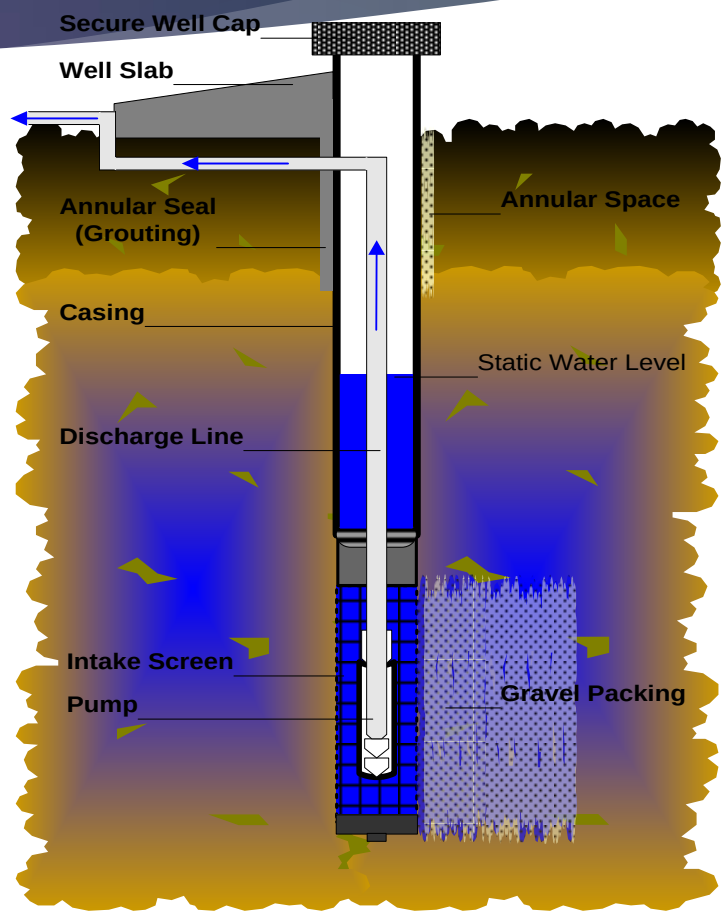
- Mechanical device attached to a casing for delivery of water to or from a well
- Its located subsurface, below the frost line

Pitless Adapter



Well Casing

- A pipe or tube installed into the borehole separating the well from the surrounding material
- Prevents sidewalls from collapsing
- Often composed of a “Construction Casing” and “Working Casing”



Intake Screen

- An intake screen allowing water to pass through
- Also prevents rock or soil from entering the well while

Annular Seal

After a borehole has been drilled for the well, casing and well screens are placed:

- Filling material is packed between the borehole and the screen,
- The annular space between the borehole and the casing is filled with an appropriate grout sealant/bentonite chips.

Well Terms

Static water level

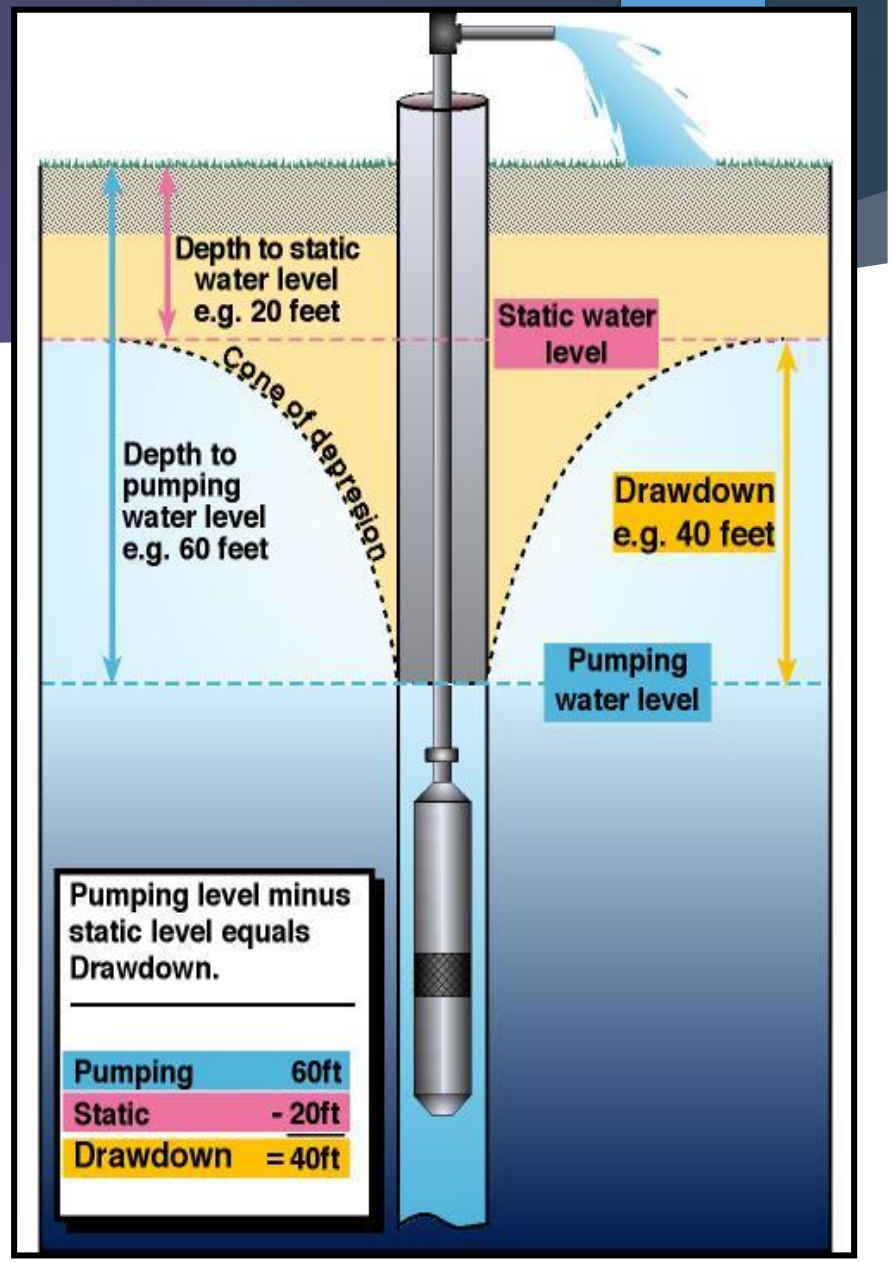
- the level of the water in the aquifer before any water is drawn from the well.

Pumping water level

- the level of water in the aquifer well when water is being drawn from the well.

Drawdown

- the difference between the static water level and the pumping level.



Well Yield

- It's the rate of water withdrawal that well can supply over a long period of time.
- The yield of small wells is measured litres per minute or per hour.
- For large wells its measured cubic meters per second or per hour
- A measure of a volume of water extracted from a well per unit of time
- Usually measured over a long period of time

Recharge rate

Recharge Rate

- The rate at which an aquifer is recharged after or during pumping.
- If pumping exceeds the rate of recharge, the well will eventually run dry.

Specific capacity

- A measure of well yield per specific unit of drawdown
- Specific capacity = Well yield /Drawdown
- Measured as GPM/ft Drawdown or LPM / Meter Drawdown
- It is used to measure pump and overall well performance
- When a well screen plugs or the pump begins to wear, the specific capacity may be reduced.

Pump Test

- A PUMPING TEST is a method of estimating well performance, well capacity, the zone of influence of the well and aquifer characteristics (e.g., the aquifer's ability to store and transmit water, anisotropy, aquifer extent, presence of boundary.
- It helps determine:

1. the maximum yield from a well;
2. assess impacts on neighboring wells or water bodies
3. obtain aquifer properties such as permeability and boundary conditions.

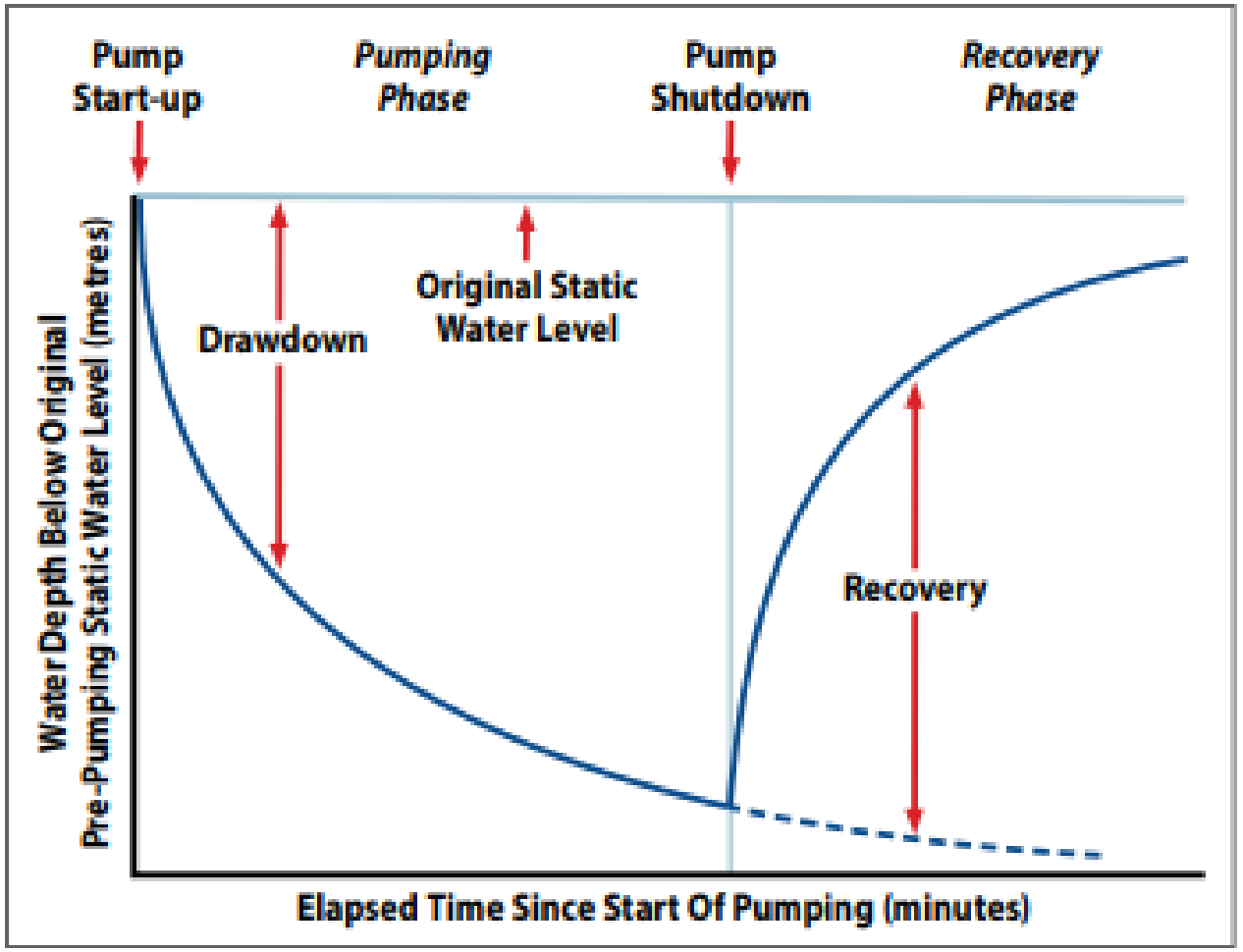


FIGURE 2 *Graph showing the different phases of a constant rate pumping test – the pumping phase and the recovery phase.*

Pumping Tests in a confined Aquifer

- Using a temporary pump, groundwater is pumped for 24 hours for a confined aquifer and for 72 hours for a well in an unconfined aquifer.
- A confined aquifer requires less pump test time because pumps in confined aquifers generally provide a constant head pressure, allowing for consistent pumping properties.
- In other words, as soon as a flow has been established during a pump performance test, it theoretically will continue as long as the supply continues to be replenished.

Pumping Tests in an Unconfined Aquifer

- Unconfined aquifers rely on gravity to replenish the well.
- When a well situated in an unconfined aquifer begins pumping, a cone of depression is created, changing the head pressure on the pump; this in turn affects the pumping performance.
- To ensure that the aquifer has been sufficiently challenged, pump tests are run for longer periods of time.
- Prior to performing a pump test, it is important to anticipate an appropriate pump flow. Over pumping will increase the drawdown beyond the capabilities of the aquifer and the pump test will fail.

Aquifer Performance Monitoring

- Well performance monitoring is performed to evaluate the well efficiency and to assist in identifying any potential problems.
- Deterioration in well yield could be the result of:

1. an inefficient pump,
2. plugging of the well intake area
3. reduced production from the aquifer.

- To assist in identifying the onset or cause of yield problems, well performance tests can be conducted periodically to determine if there are any changes in:

1. well yield,
2. drawdown (which is the difference between the initial non-pumping water level and the pumping water level at a specified time interval)
3. overall production of the well over the long-term.

- The results from these tests are then compared to the baseline data recorded when the well was first installed.
- Proper trending will provide good information and will aid in any decision making over the life of the well.
- If this baseline data is not available, periodic testing should commence immediately to accumulate data for future comparison.

Aquifer Performance Evaluation

Aquifer performance evaluations are necessary to establish:

- the long term yield of an aquifer.
- Should be conducted on a routine basis.
- **Especially**, after any changes of equipment or installation of additional wells in the same aquifer.

Water Level Monitoring

- Record water level measurements on a regular basis - non-pumping and pumping water levels should be taken at least a monthly basis.
- Changes in the non-pumping level or "static" water level may signal possible:

1. aquifer depletion,
2. changes in the pumping level may indicate a possible decline in well performance as a result of screen plugging.

Measuring Static Water Level

Best time to measure the static (non-pumping) water level is when the pump has been resting for quite some time; for instance, early in the morning prior to any water use.

- Ensure that the pump is shut off until the measurement is completed.
- If the pump has been running, wait at least 15 to 30 minutes to allow the water level to recover before taking a measurement; however, in a low permeable aquifer the recovery time may take several hours.
- After taking an initial measurement, wait another 15 to 30 minutes and measure again to ensure that the water level is stable and is actually the static water level.

Measuring Pumping Water Level

- The pumping water level is recorded while the well is operating.
- The pumping water level and the discharge measurements should be after the pump has been operating for 30 minutes.
- Any future measurements should then be taken after 30 minutes pumping.
- If the discharge rates are the same but the pumping water level has decreased than plugging of the well intake may have occurred.

Specific-Capacity Method

- The specific-capacity method measures the well yield per unit of drawdown.
- This method does not provide aquifer performance analysis to the same extent as do the Drawdown or Recovery methods;
- The specific-capacity method is useful for comparing production information of an aged well to production information of the same well when it was new.

Specific capacity test

- Specific Capacity is an assessment of the productivity of the well, and is defined as the well yield per unit drawdown (Imperial gallons per minute/foot (Igpm/ft) of drawdown).

- This translates into the amount of water level drop in a well at a designated pumping rate, over a specific time interval.

Specific Capacity

- Specific capacity should be measured when the well is new or when new screens have been installed.
- The specific capacity will change throughout the year with fluctuation in pumping rates, temperature, aquifer levels, and degree of screen efficiency.

The importance of Metrics

- A drop of 5% in specific capacity indicates problems with a well.
  - Catching problems at an early stage gives us the best chance of well re-hab.
- Specific Capacity is measured by a transducer installed in the well.
  - Accurate, reliable measurements are automatically taken at prescribed intervals. Data is available instantly.
- SC=GPM / total draw down of the well. (ft)
  - For example: 6.7= 100 / 15

- When and why to establish your well base line?
  - Establish the baseline right when the well is completed.
  - Why early on? So that the significance in changes in SC can be determined.
  - Transducer should be installed by the pump company at the time of well completion

Specific capacity calculation

- Must record:
  - Pumping Rate.
  - Static (non-pumping) water level at start of test (SWL).
  - Pumping Water level at end of test (PWL).
  - Note time duration of test.
  - Calculation: Pumping rate in (Imperial gallons per minute) ÷ (PWL - SWL (feet))

Operation and Maintenance

- The operation of domestic drinking water wells generally consists of routine monitoring and record keeping.
- It is the operator's responsibility to observe trends and to be able to identify changes in the pumping performance, aquifer levels, and water quality.
- In addition, the operator must ensure proper pump and equipment maintenance of the system as per the manufacturer's specifications.
- Furthermore, the operator should become aware of any potential emergencies and be prepared should a situation arise.

Well Performance Indicators

- Reduction in yield
- Changes in water pressure
- Corrosion
- Changes in water quality (Taste & Odour, colour, chemistry, biology)
- Sand or silt in water
- Dissolved gases in water
- Pump amps

Failing of the Well

- Structural Failure – casing & Screen
- Pumps breakdown – pumping sand or air
- Over-pumping – excessive drawdown
- Aquifer Depletion
- Well interference
- Incrustation, corrosion
- Fouling – bio fouling or Sand or silt fouling or plugging of screen
- Contamination
- Shorting of equipment

Over pumping

One of the most common causes of well failure

- Occurs when water is withdrawn at a faster rate then the well was designed for
- Problem increases if pump is placed below the top of the well screen and water is drawn-down below the top of the screen or slotted portion of the well

Well Maintenance

- Preventative maintenance is essential to ensure a safe and sustainable water well supply.
- It consists of regular inspections, monitoring and treatments combined to prevent the premature deterioration of a water well, infrastructure and water quality.
- The best preventative maintenance program starts with a proper well design and construction

Preventative Maintenance

- Scheduled preventative treatments assist in controlling anticipated well problems and in maintaining a safe and sustainable water supply.
- The costs associated with implementing preventative maintenance should be seen as a necessary expense in protecting the investment:

1. reduce operational problems
2. reduce pumping costs
3. eliminate or reduce frequency of extensive rehabilitation efforts
4. reduce interruptions in service and emergency costs

Inspect your Well

- Checklist from Health Canada - https://www.canada.ca/en/health-canada/services/publications/healthy-living/water-talk-protect-clean-well.html

1. An information tag on your wellhead. Note the tag number and any other information.
2. The well cap is secure and vents are not blocked.
3. There are no open gaps around the outside edges of the well casing.
4. There is no ground settling or water pooling around the well casing.
5. Potential contamination sources are properly managed and stored far from your well.
6. The pump, pressure tank and water treatment system are operating properly.
7. Your septic system is working properly.
8. If you discover an old, abandoned well, seek advice from a licensed well contractor and ensure it is properly sealed.

Monitoring of the Well Production

- date and time, note any changes to static water level, pumping water level, pumping rate
- collect and record operational data (hours of pumping, discharge rates)
- note any changes in in-take pump voltage and amperage readings
- conduct a well pumping test to measure the specific capacity of the well
- test water for bacteria at least two to four times a year
- test any water quality parameters of concern, such as nitrate, chlorine, sodium, iron, and manganese
- test for other chemicals if you have concerns with fuel spills, etc.
- ensure backflow prevention devices are in place and functioning

Protection against Contamination

- maintain at least a three-metre grassed buffer around the well
- ensure potential contamination sources are located down gradient of the well
- avoid chemical applications (pesticides, fertilizers) around the well
- locate and plug any nearby abandoned wells or test holes

Water Quality Monitoring

The best time to sample your well water is when there is the greatest chance of contamination:

- early spring just after the thaw
- in the fall rainy season
- after a long dry spell or drought
- after heavy rains, floods
- after the well has not been used for a long period of time.

Well Inspection

- With Camera, we look for the following:

1. Incrustation – calcium deposits
2. Bio-fouling – iron bacteria and manganese build-up (red water or worting)
3. Breach in casing
4. Integrity of well casing and screen
5. Sand coming through the screen
6. Milky water – calcium precipitates

Maintenance for biofouling

- Biofouling is a well is due to iron bacteria, H2S, sulfur reducing bacteria and manganese
- Iron bacteria forms jelly like slime
- Biofouling occurs where biofilm accumulations are sufficient to reduce water flow.
- Acid cleans with acetic acid

Cleaning method

For best results:

- Brush the well prior to chemical treatment. Brushing the well can remove interior screen deposits ensuring more uniform chemical access into the formation.
- Agitate the well with a tight-fitting surge block or other isolation tool
- This dislodges material softened by the chemical treatment and pushes the chemical solution further into areas it may otherwise not be able to reach.
  (note: The combination of both chemical and mechanical energy is important for penetrating and removing the plugging material)

Monitor while cleaning

- Monitor the pH during acid treatment.
- When acidizing a water well it is best to check the pH frequently.
- With pH levels above 3.0 the acid is losing strength and productivity.
- Check the pH after each agitation.
- If the pH rises above 3.0 add more acid.
- This process allows for a more accurate chemical treatment.

Maintenance for Fecal Contamination

- If a well is found to have Fecal contamination, its deemed not useable.

When should a well be disinfected?

- The micro-organisms found in the soil at or near the well site can be picked up on drilling tools, pipes and well pumps during construction or servicing of a well.
- If disease-causing organisms are present they may be introduced into the well. Therefore, the Regulation requires that every well, after construction or repair, must be disinfected
  - Following construction of a new well,
  - Following alteration of an existing well,
  - Following well pump installation, maintenance or repair, or
  - when the well has tested positive for coliforms or E. coli.

"Once the well is constructed, get it completed right away, install a transducer on each well, do specific capacity tests 6 monthly or annually and get to know your well"

Thank you.

Central Interior Pumps
Protectors of Groundwater