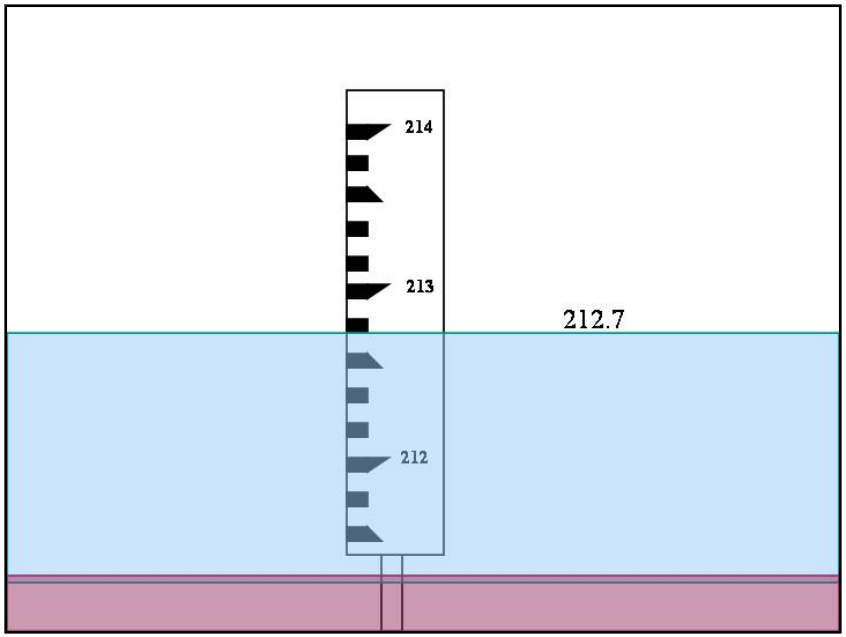
Water Gauges:

Checking to Determine if a Water Gauge Has Changed Elevation From One Date to Another.

Hal Laskowski October 13, 2005



Why Check the Gauge?

- Water gauges are used to measure, evaluate, and plan annual hydrology within a managed wetland.
  - Water gauge readings are used as a surrogate to determine what type of habitat (water depth) is being provided within a wetland. Water gauge readings are also used to measure rates of drawdown or flood-up.
  - New refuge staff who might be unfamiliar with specific habitat conditions within an impoundment, might rely heavily upon previous water gauge readings at specific dates, to duplicate previously provided habitat conditions within an impoundment.
  - Refuge staff often have previous knowledge that providing specific drawdowns or water levels at certain times of year, will result in desirable vegetation communities or habitat conditions to meet objectives. Thus for planning purposes, refuge staff frequently base upcoming water manipulations on previous water gauge readings.

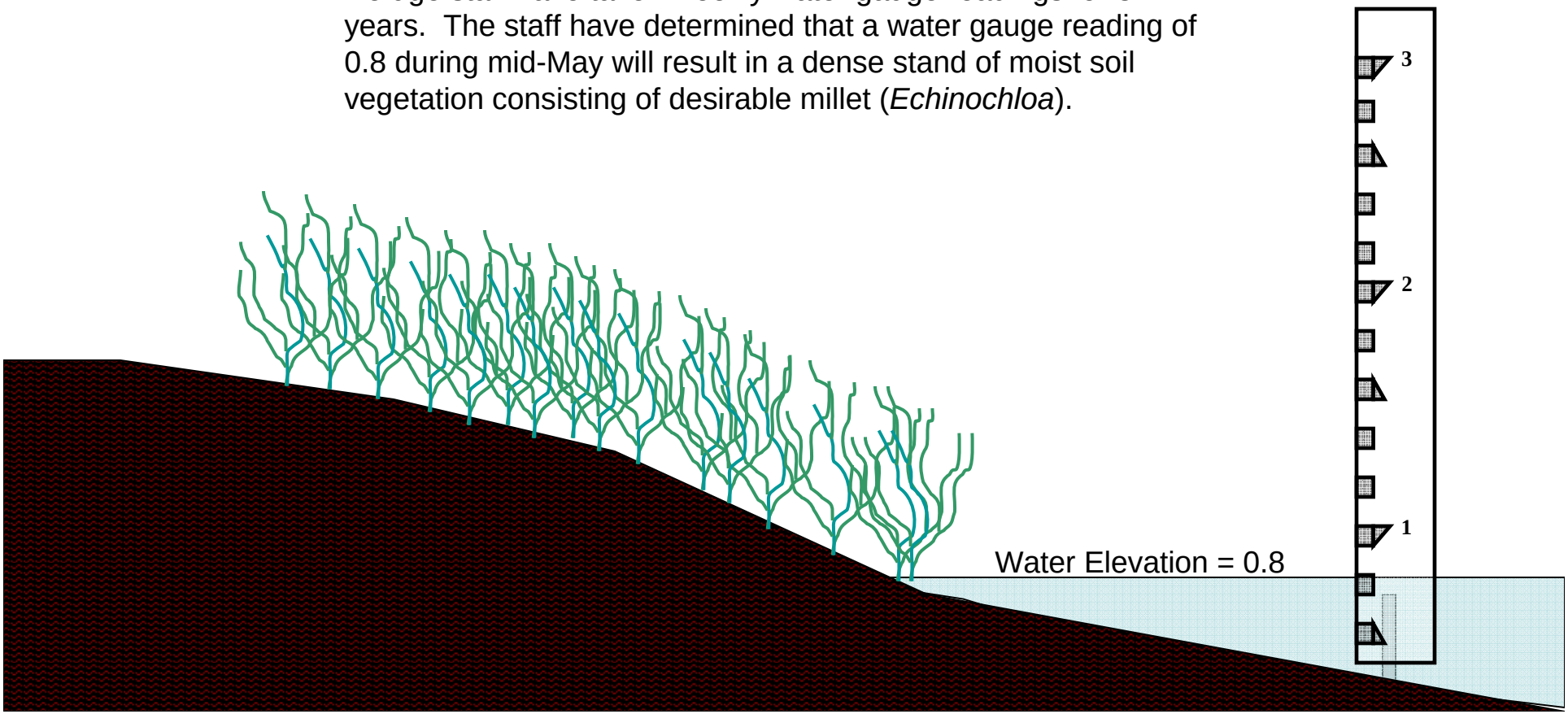
- If a water gauge changes elevation as a result of ice, wind, or other factor, without refuge staff knowledge, then previously collected data can not validly be compared to current data, or used in making any management decisions. Previously collected data can continue to be used however, if the amount of error (change in gauge level) can be determined.

Example of the Problem:

The below water gauge was simply attached to a post in the water. There is no relationship between the water gauge readings and any known vertical datum.

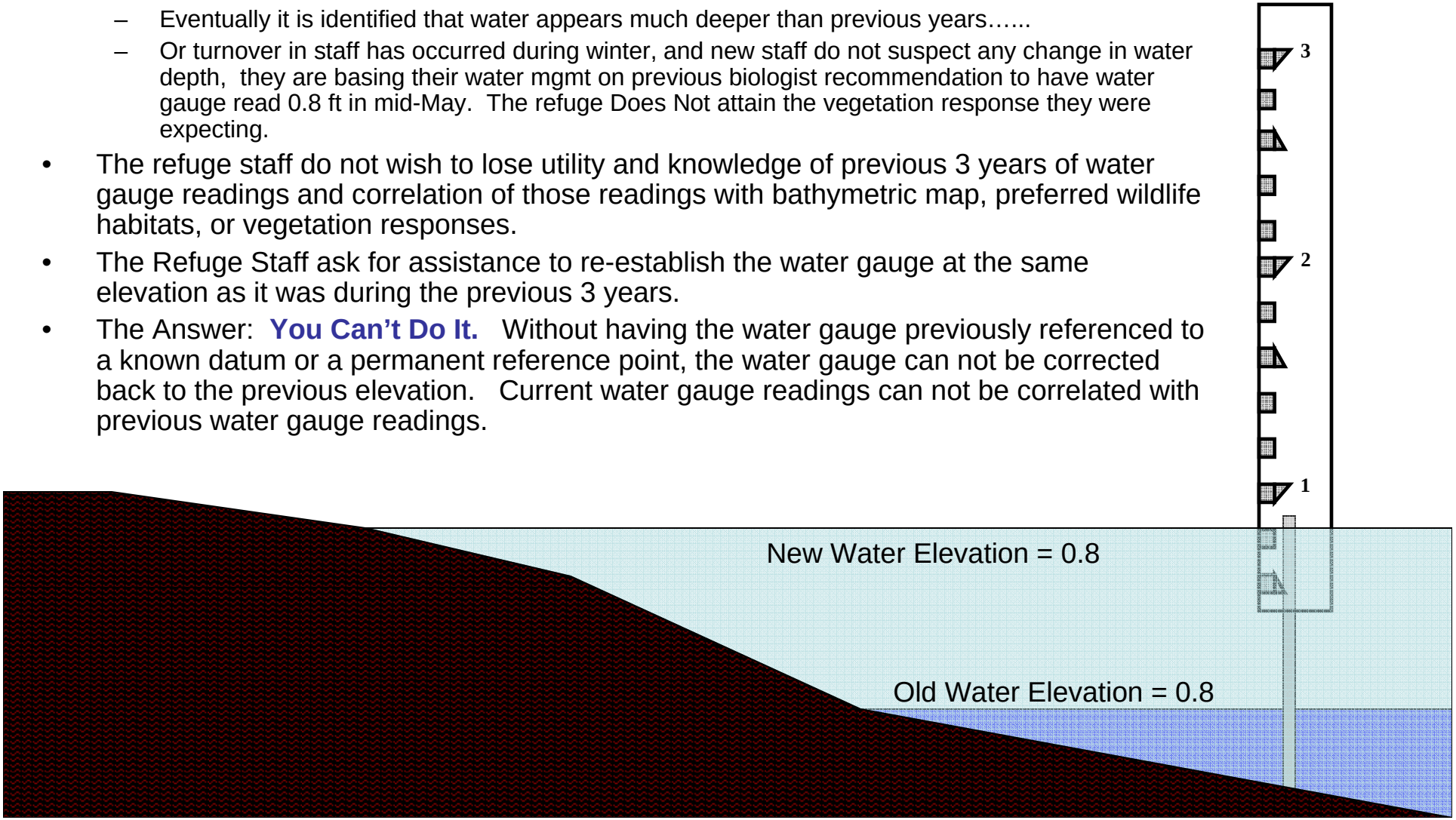
Alternatively, there is no known relationship between the water gauge (a temporary object) and a permanent object such as top of WCS Headwall, or some other permanent reference point.

Refuge staff have taken weekly water gauge readings for 3 years. The staff have determined that a water gauge reading of 0.8 during mid-May will result in a dense stand of moist soil vegetation consisting of desirable millet (*Echinochloa*).

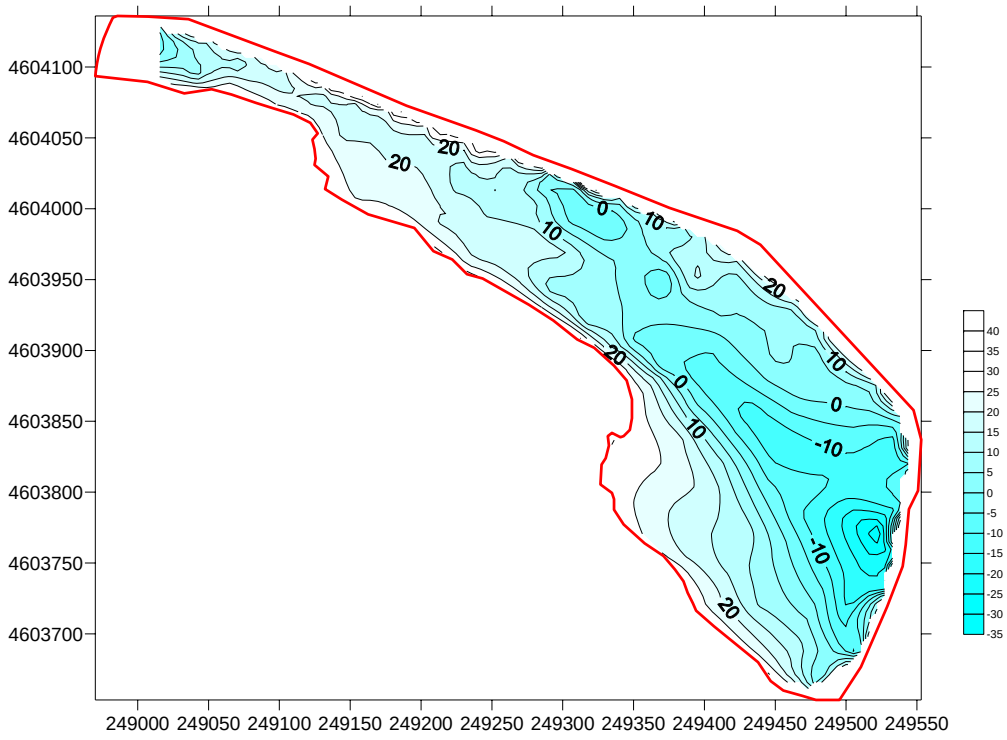


Example of the Problem:

- During the winter, ice and a flood lift the water gauge on its post.
  - Refuge staff are unaware this has occurred.
  - The water gauge is not checked and is assumed to be at same elevation as the previous 3 years.
  - Refuge staff complete an Annual Habitat Mgmt Plan and identify a spring drawdown with water gauge readings leading to elevation of 0.8 ft in mid-May to promote a stand of millet.
  - Eventually it is identified that water appears much deeper than previous years……
  - Or turnover in staff has occurred during winter, and new staff do not suspect any change in water depth, they are basing their water mgmt on previous biologist recommendation to have water gauge read 0.8 ft in mid-May. The refuge Does Not attain the vegetation response they were expecting.
- The refuge staff do not wish to lose utility and knowledge of previous 3 years of water gauge readings and correlation of those readings with bathymetric map, preferred wildlife habitats, or vegetation responses.
- The Refuge Staff ask for assistance to re-establish the water gauge at the same elevation as it was during the previous 3 years.
- The Answer: **You Can't Do It.** Without having the water gauge previously referenced to a known datum or a permanent reference point, the water gauge can not be corrected back to the previous elevation. Current water gauge readings can not be correlated with previous water gauge readings.



Example of Problem



- Refuge has constructed a bathymetric map of water depths for an impoundment based upon the existing water gauge.
- The map is used to determine area of impoundment within different depth categories at specified water gauge readings.
- Map also, identifies germination conditions for different vegetation zones by correlating water gauge readings (in spring of year) with vegetation sample plots at time of germination.
- If the water gauge is destroyed and can not be re-established at the same elevation due to lack of reference to permanent object, then the map loses its usefulness, as it will not be referenced to the new water gauge.

Accuracy of Water Gauges.

- Accuracy of a water gauge
  - Is determined by how close the water gauge is established to a known datum. Thus, if mean sea level is the datum and the actual impoundment water level is determined to be 97.6 ft above sea level using an established benchmark, and at the same time the water gauge reads 97.5 ft, then the water gauge is inaccurate by 0.1 ft.
  - At some refuges, the water gauge is not established relative to any known datum, but rather the gauge is simply installed at an unknown elevation. This is an ASSUMED datum. This is fine, as long as the water gauge is referenced to an immovable object which can be used to re-establish the water gauge at the same ASSUMED elevation.

When to Check Gauge for Accuracy

- Water gauges are most often damaged or destroyed during winter. Ice and lifting action of flood, floating logs, high wind, or vandalism, may all influence accuracy of the gauge from one season to the next.
- We recommend that each water gauge be checked for accuracy once in Fall season prior to ice-up, and again in Spring season after any severe flooding. Additionally, check the water gauge after any significant event where the suspicion exists that the gauge may have been altered.
- Records of how to check for accuracy and results, should be maintained in Refuge Files. Each time a water gauge is checked for precision, the date, gauge location, and results of the check should be recorded.

Procedure to Check Water Gauge:

- Several methods are identified to check a water gauge for accuracy, depending upon equipment available and the location of the gauge.
  - When checking the water gauge, we assume the gauge is established at the correct elevation to begin with. Thus, in lieu of beginning the process at a known Benchmark elevation, we will start the process in reverse at the water gauge itself and determine a reference elevation relative to the water gauge onto a permanent inmovable object (i.e., headwall of a water control structure (wcs)).
  - It is acknowledged that some refuge staff have the appropriate equipment and expertise to both check the accuracy and precision of a water gauge beginning at a known benchmark. For those refuge staff's with this ability, this is strongly encouraged.

Checking Your Water Gauge for Accuracy.

Depending Upon How and Where Your Gauge is Mounted, You Might Use One of the Following Lists of Equipment

1. Straight 1 x4 x L Board and 4 ft Carpenters Level.
2. Ruler that measures in tenths of feet.
3. Inexpensive Laser Level purchased at Home Depot, and ruler that measures in tenths of feet.
4. Engineer’s Level, tripod and surveyors rod.
5. Engineer’s Laser Level, tripod and surveyors rod.

Water Gauge Attached to WCS.

Top of WCS Headwall

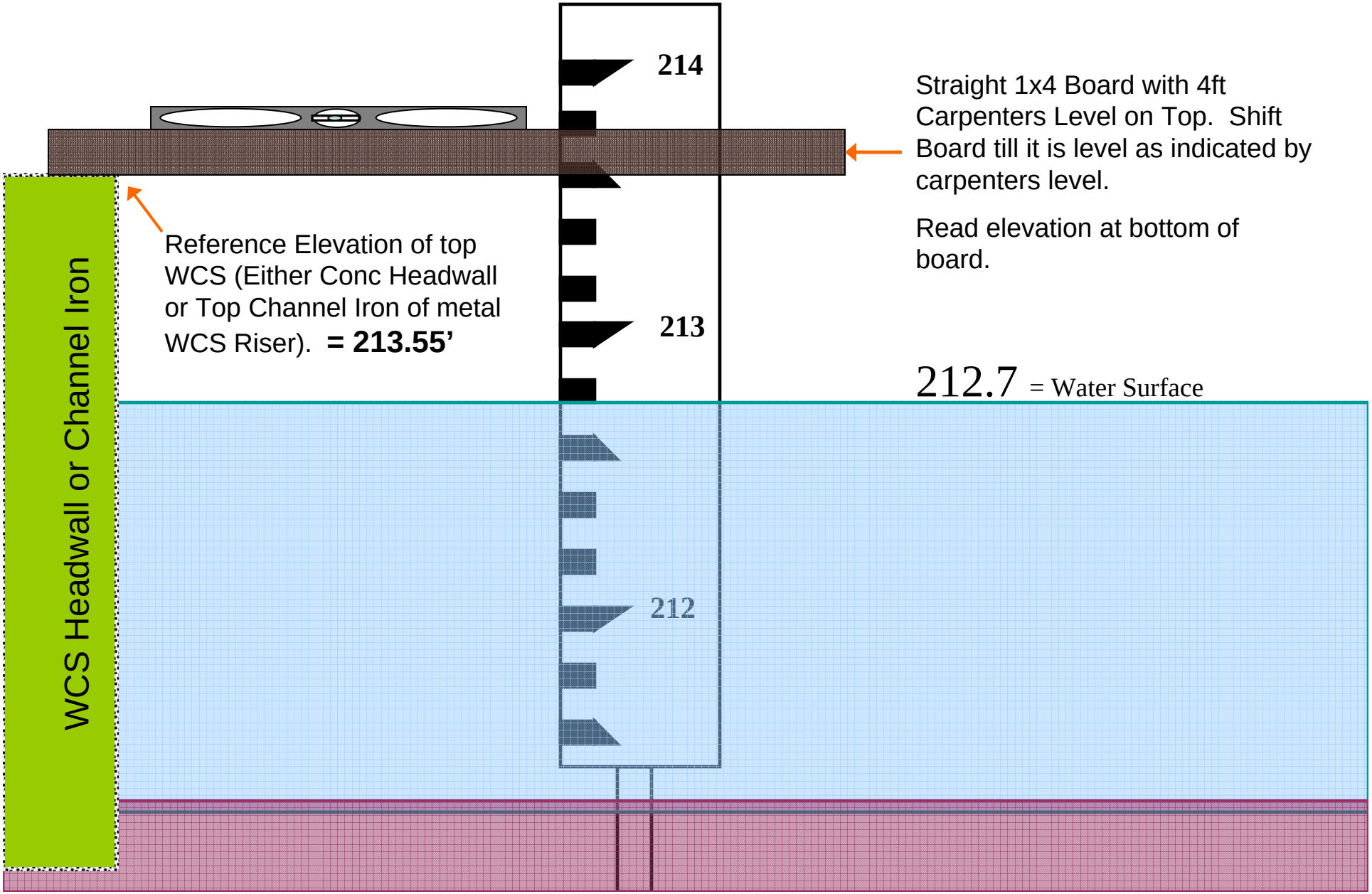
Top of water gauge

Simply measure distance from top of gauge to top of headwall. Add distance to top of gauge reading to provide elevation of top of headwall. Record date and headwall elevation in refuge files.

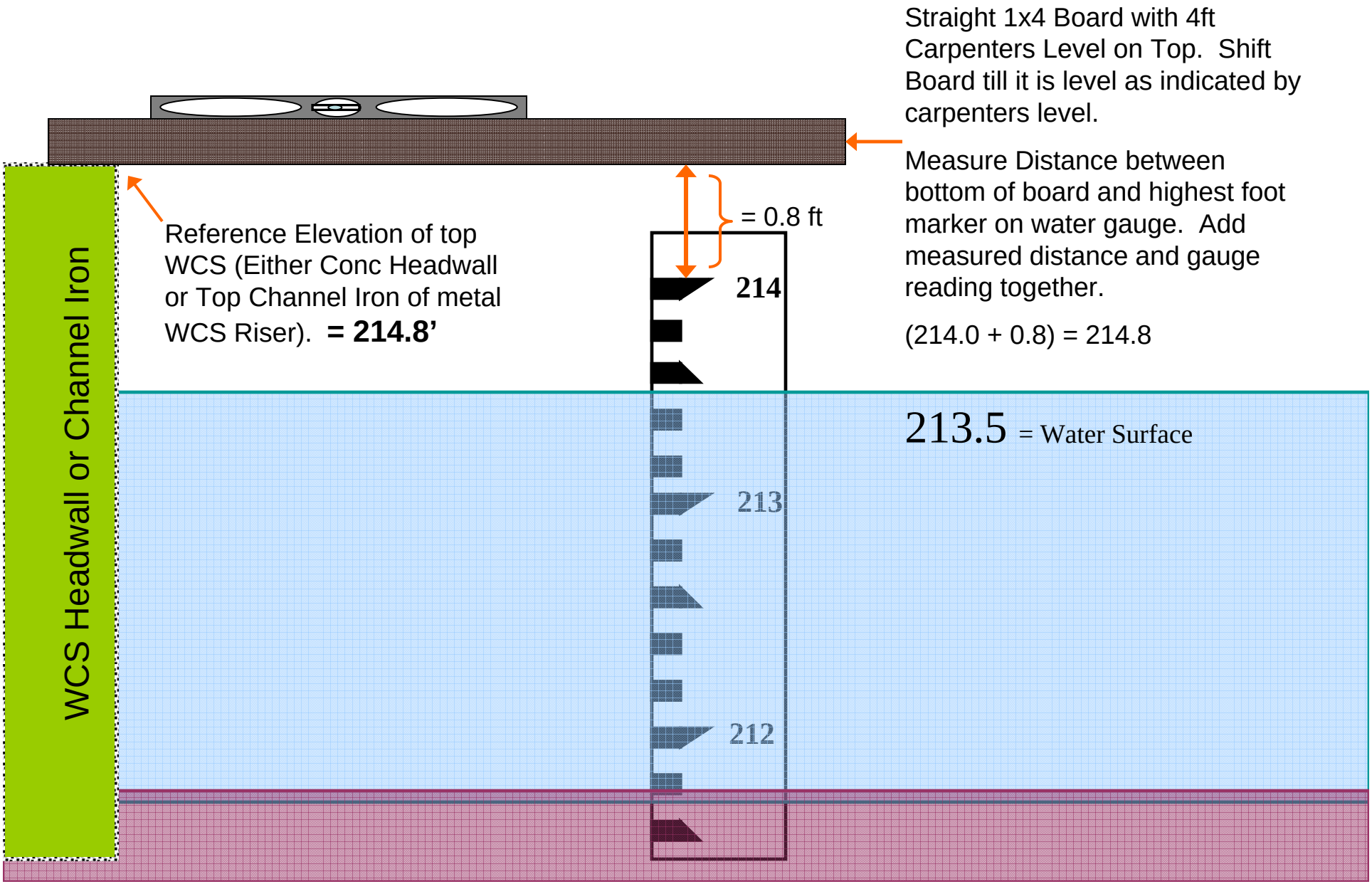
Water Gauge extends above headwall. Simply read top of headwall elevation from water gauge. Record date and headwall elevation in Refuge Files.

Water Gauge Mounted on Post in Front of WCS.

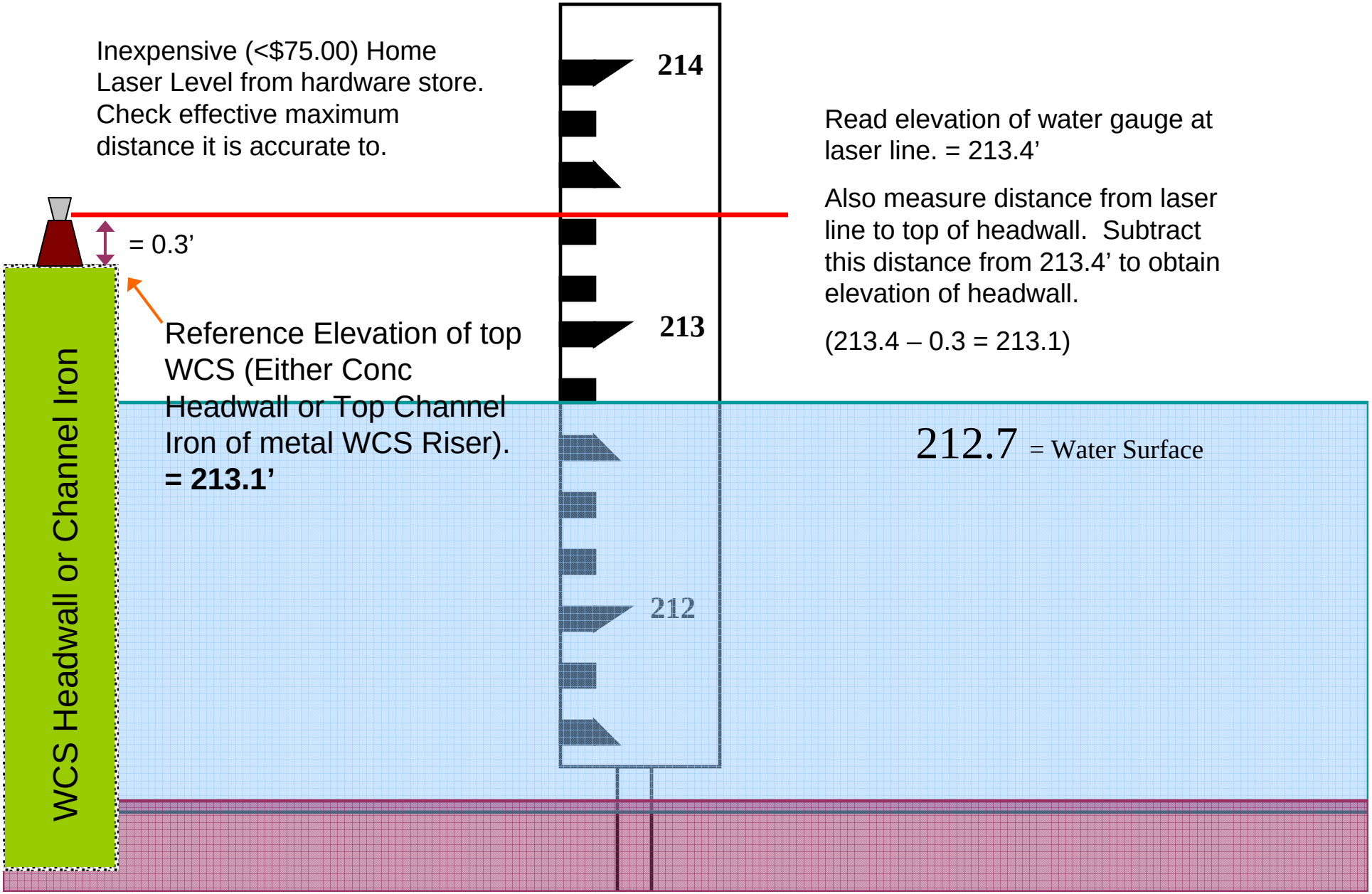
Water Gauge Above WCS and < 14’ from WCS



Water Gauge Below WCS and < 14’ from WCS

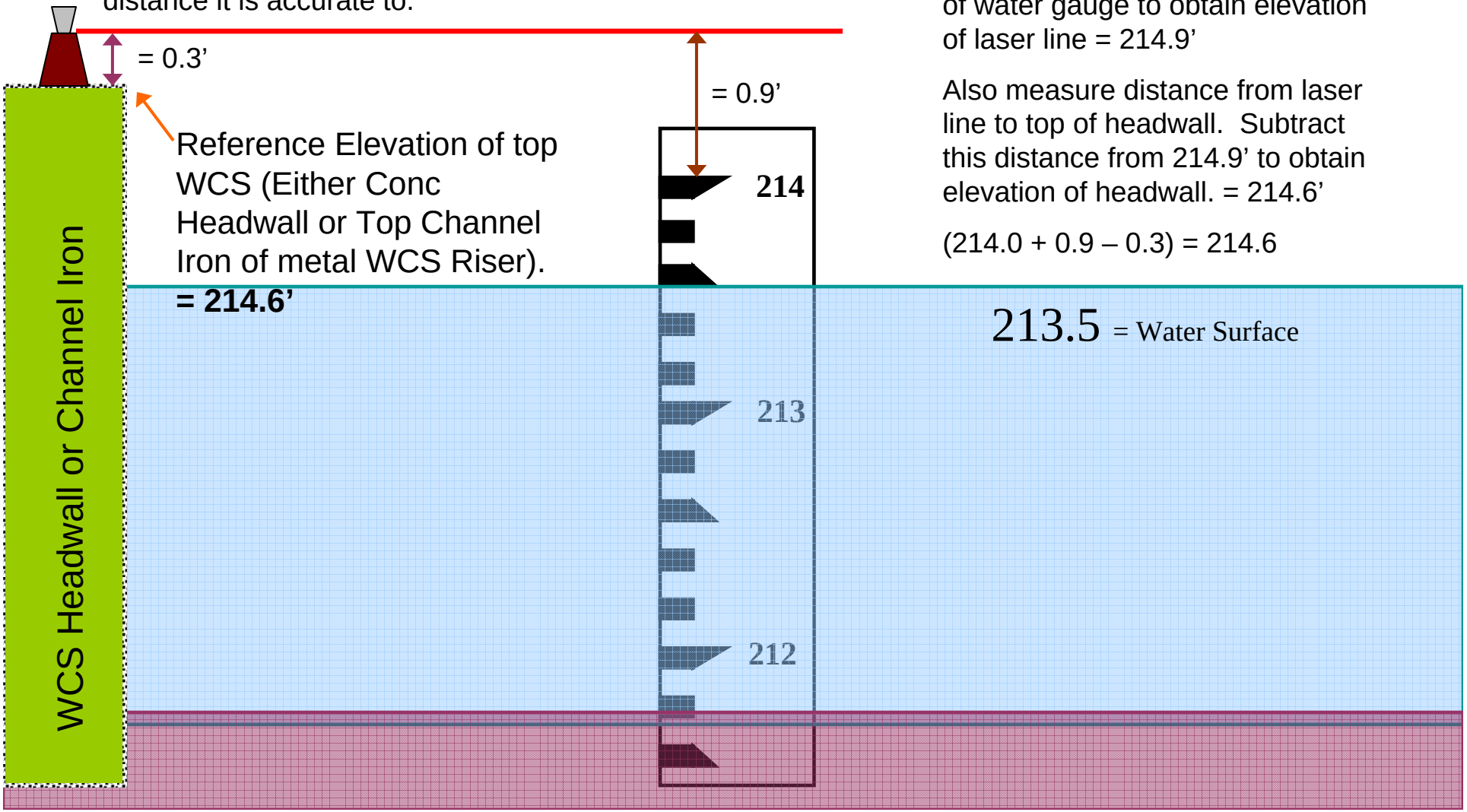


Water Gauge Above WCS and Beyond Distance Where You can Use Straight Board.



Water Gauge Below WCS Using Homeowner's Laser Level.

Inexpensive (<$75.00) Home Laser Level from hardware store. Check effective maximum distance it is accurate to.



Measure from laser line down to foot marker on water gauge.

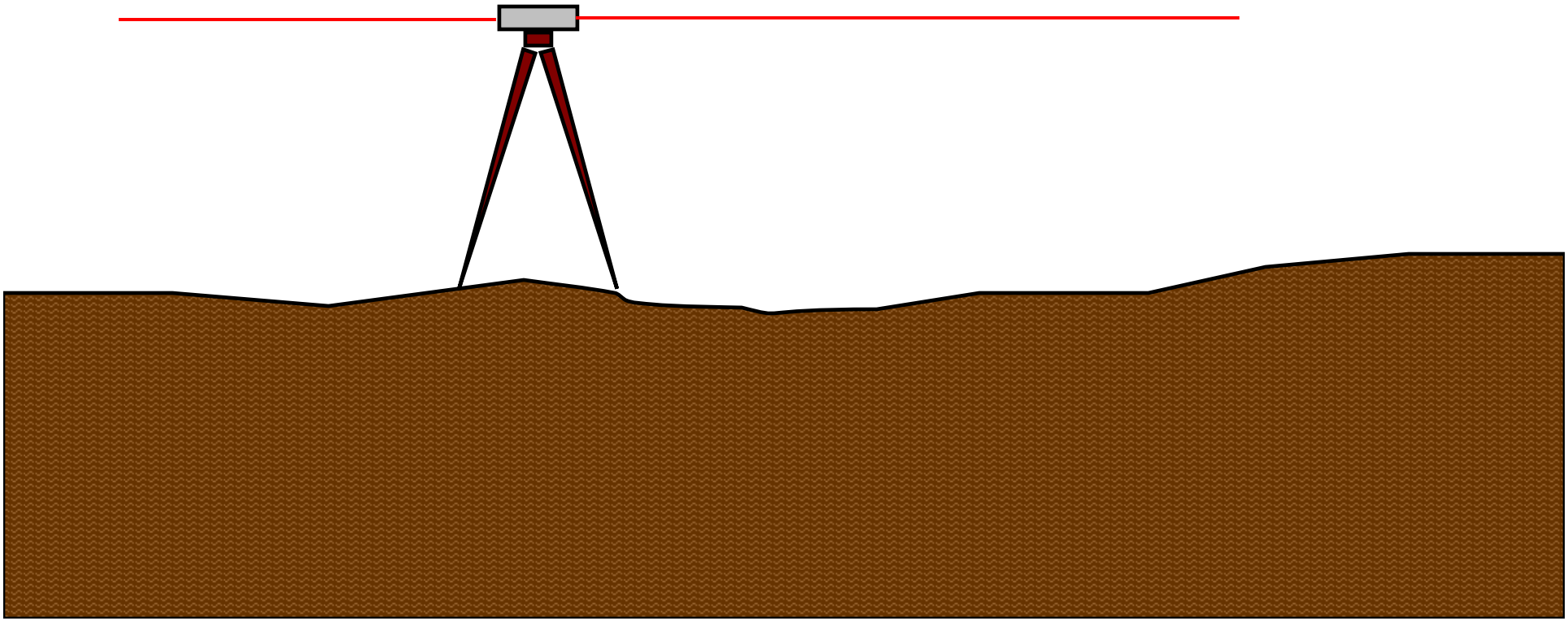
Add measurement to foot marker of water gauge to obtain elevation of laser line = 214.9'

Also measure distance from laser line to top of headwall. Subtract this distance from 214.9' to obtain elevation of headwall. = 214.6'

(214.0 + 0.9 – 0.3) = 214.6

Check Water Gauge Using Engineers Level or Laser Level

Utilize exact same process as outlined for the homeowner's laser level, except that instead of having the laser level sitting directly atop the wcs, the level will be set-up on a tripod a short distance away on dry ground.



Water Gauge Precision Data

Date	Water Gauge Name/Location	Describe Location Reference Elevation	Reference Elevation	Difference in Elevation between last check.	Observer
10/17/2005	Pool 1 water gauge at 24” wcs.	Top of northeast channel iron of WCS.	245.60	-	HPL
10/21/2005	Mallard Pool water gauge at twin 48” wcs	Top of east headwall of WCS.	231.8	-	HPL
04/14/2006	Pool 1 water gauge at 24” wcs.	Top of northeast channel iron of WCS.	245.65	- 0.05[A]	HPL

Note[A] : The top of the water control structure is permanent. Thus, the top elevation of the WCS remains at 245.60, what has actually occurred is the water gauge has settled (lowered) by 0.05 ft.

What To Do if the Gauge is Found to Have Moved Up or Down?

- If water gauge is found to be in error > 0.1 ft.
- Simply reverse the procedure you used to establish a reference elevation on the WCS headwall.
- Using the WCS Headwall elevation, and:
  - board and carpenters level,
  - laser level, etc.
    - Determine known elevation of board or laser line and move new water gauge up or down on post until it reads at the correct elevation.
    - Or more simply, from top of headwall reference elevation, determine current water elevation and establish new water gauge to correctly read water level at that elevation.

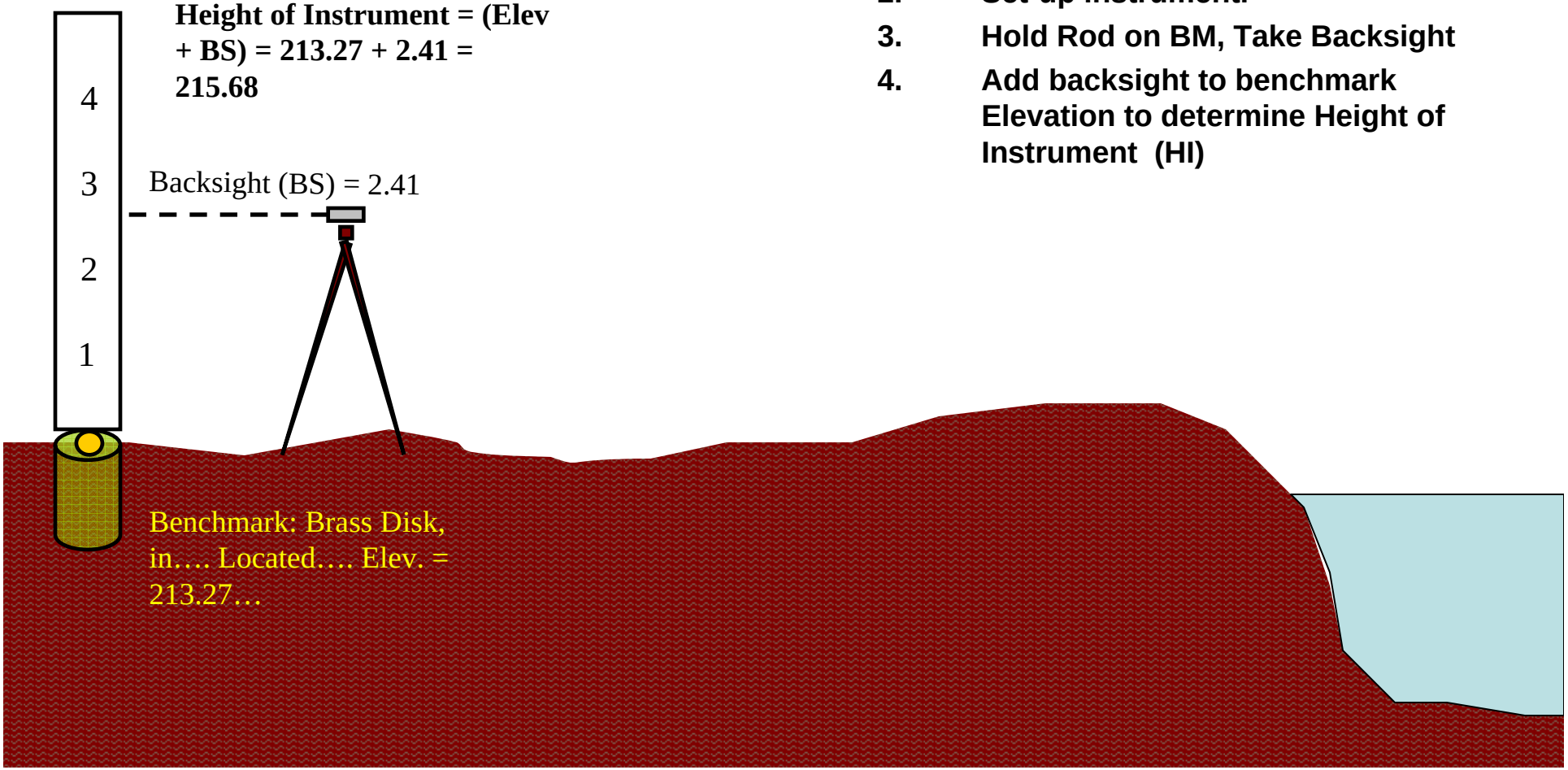
Following is Separate Process to Reference a Water Gauge to a Known Datum.

Establishing a New Water Gauge or Converting a Water Gauge Established at an Assumed Datum to a Known Datum
(i.e.,Mean Sea Level)

- What is Required:
  - Engineers Level, Tripod, Rod.
  - Expertise in use of level.
  - Location of a nearby Benchmark
    - Benchmarks throughout the U.S. may be located at: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl
- Note:
  - Establishing water gauges referenced to a known datum is preferred. In this manner water levels may be correlated with topographic maps of the refuge, or water levels of other nearby impoundments.

Begin at Known Elevation, Benchmark of a Known Vertical Datum (i.e., Mean Sea Level)

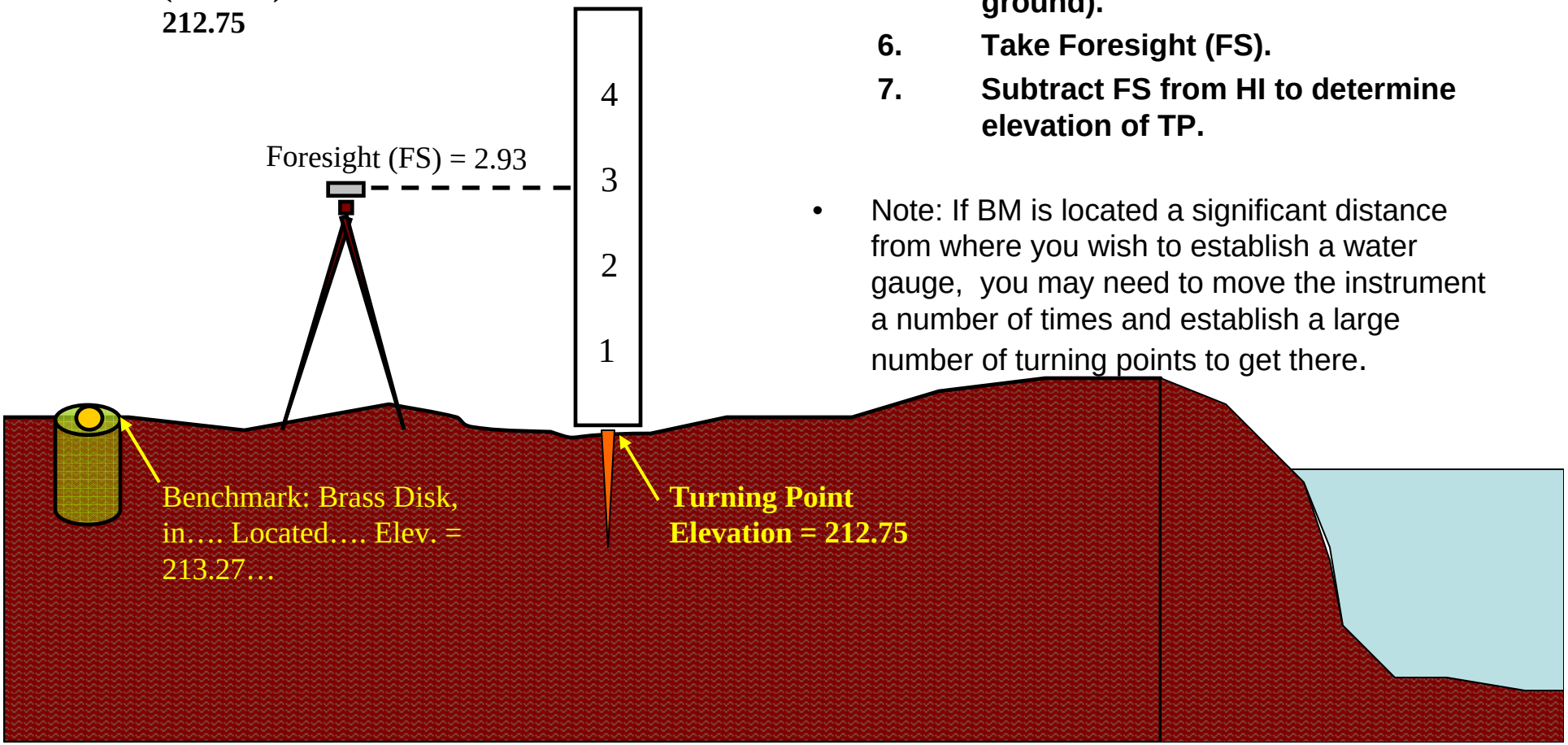
1. **Locate Benchmark (BM)**
2. **Set-up instrument.**
3. **Hold Rod on BM, Take Backsight**
4. **Add backsight to benchmark Elevation to determine Height of Instrument (HI)**



Measuring Elevation of a Turning Point:

1. Locate Benchmark (BM)
2. Set-up instrument.
3. Hold Rod on BM, Take Backsight
4. Add backsight to benchmark Elevation to determine Height of Instrument (HI)
5. **Create Turning Point (TP) (stake in ground).**
6. **Take Foresight (FS).**
7. **Subtract FS from HI to determine elevation of TP.**

Turning Point Elevation = (HI – FS) = 215.68 – 2.93 = 212.75

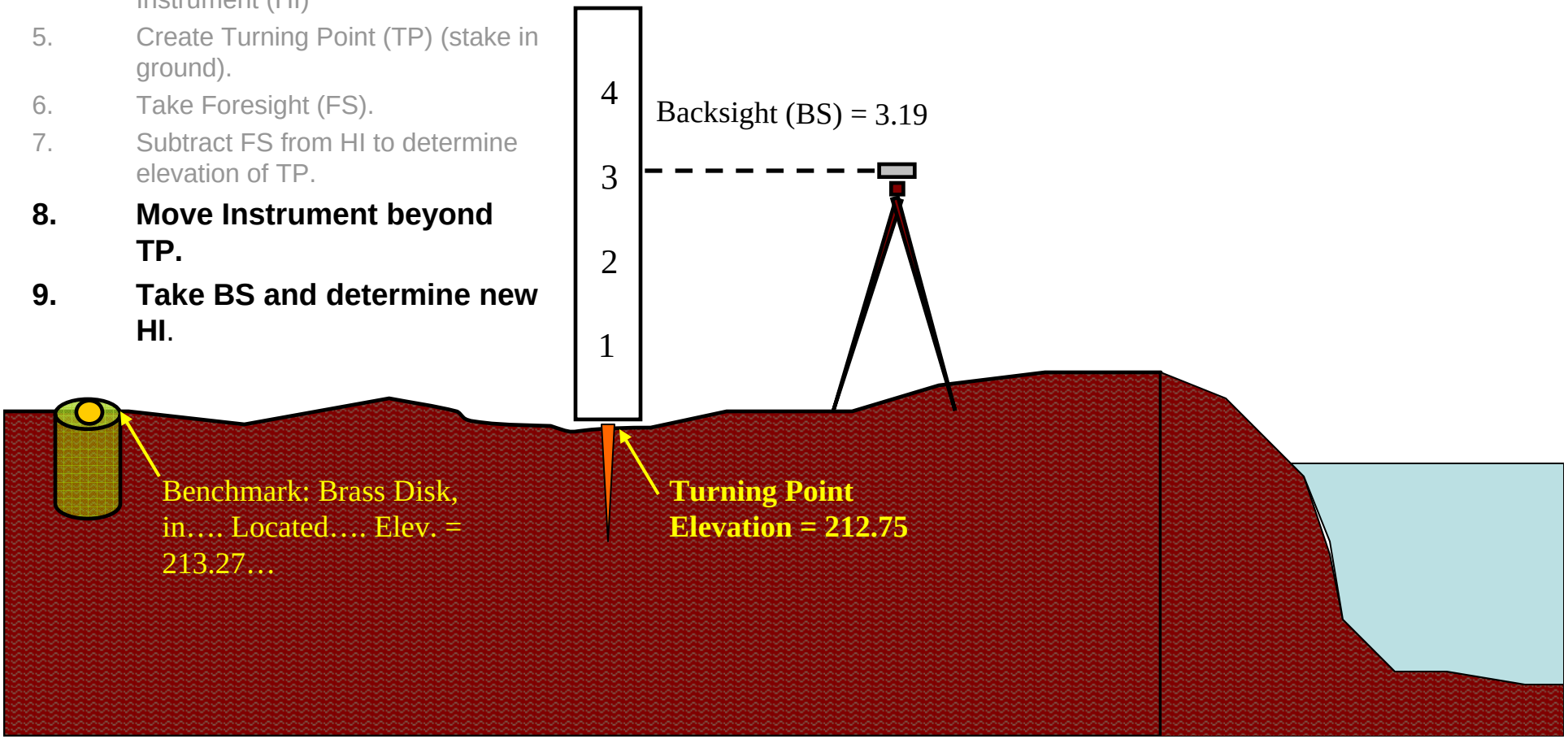


- Note: If BM is located a significant distance from where you wish to establish a water gauge, you may need to move the instrument a number of times and establish a large number of turning points to get there.

Determine New Height of Instrument from Previous Turning Point:

1. Locate Benchmark (BM)
2. Set-up instrument.
3. Hold Rod on BM, Take Backsight
4. Add backsight to benchmark Elevation to determine Height of Instrument (HI)
5. Create Turning Point (TP) (stake in ground).
6. Take Foresight (FS).
7. Subtract FS from HI to determine elevation of TP.
8. **Move Instrument beyond TP.**
9. **Take BS and determine new HI**.

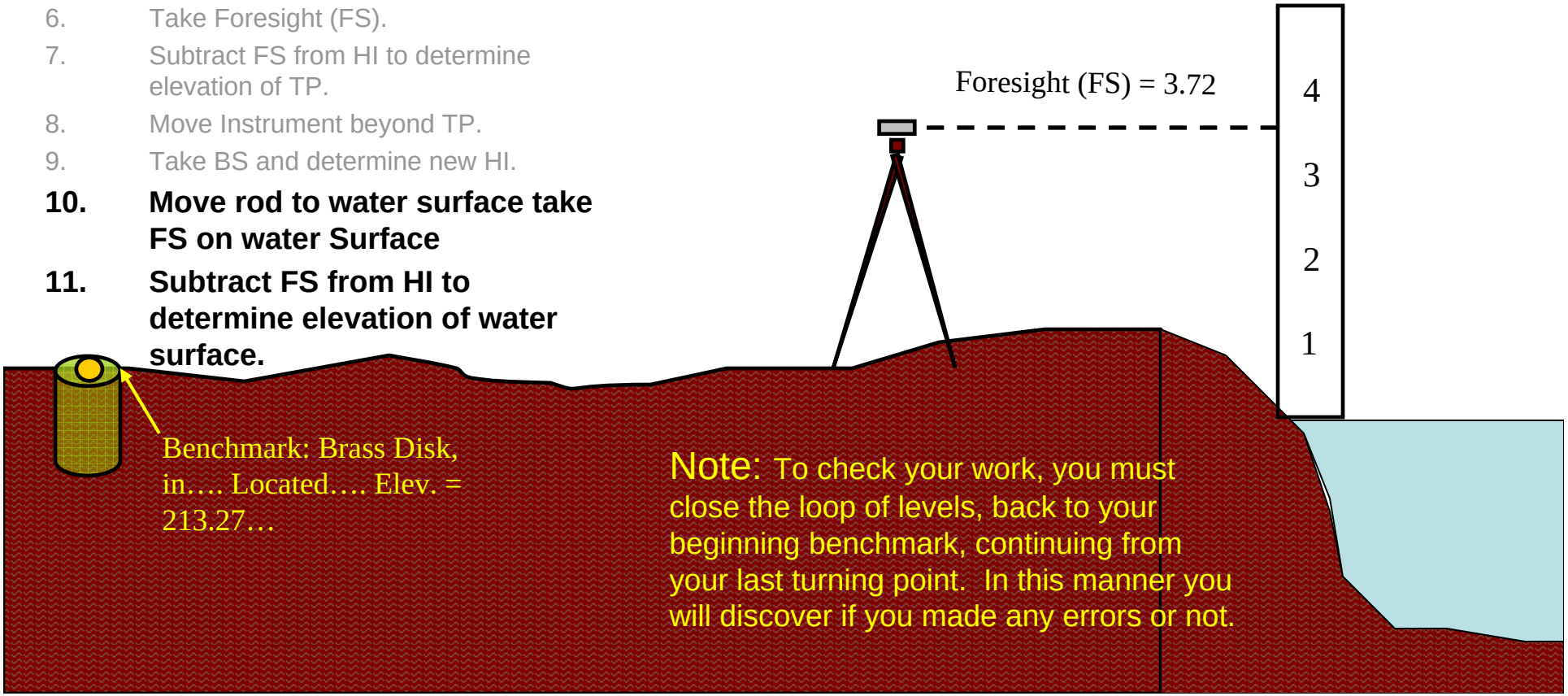
Height of Instrument = (Elev + BS) = 212.75 + 3.19 = 215.94



Measure Elevation of Water Surface:

1. Locate Benchmark (BM)
2. Set-up instrument.
3. Hold Rod on BM, Take Backsight
4. Add backsight to benchmark Elevation to determine Height of Instrument (HI)
5. Create Turning Point (TP) (stake in ground).
6. Take Foresight (FS).
7. Subtract FS from HI to determine elevation of TP.
8. Move Instrument beyond TP.
9. Take BS and determine new HI.
10. **Move rod to water surface take FS on water Surface**
11. **Subtract FS from HI to determine elevation of water surface.**

Elevation of Water Surface = (HI – FS) = 215.94 – 3.72 = 212. 22



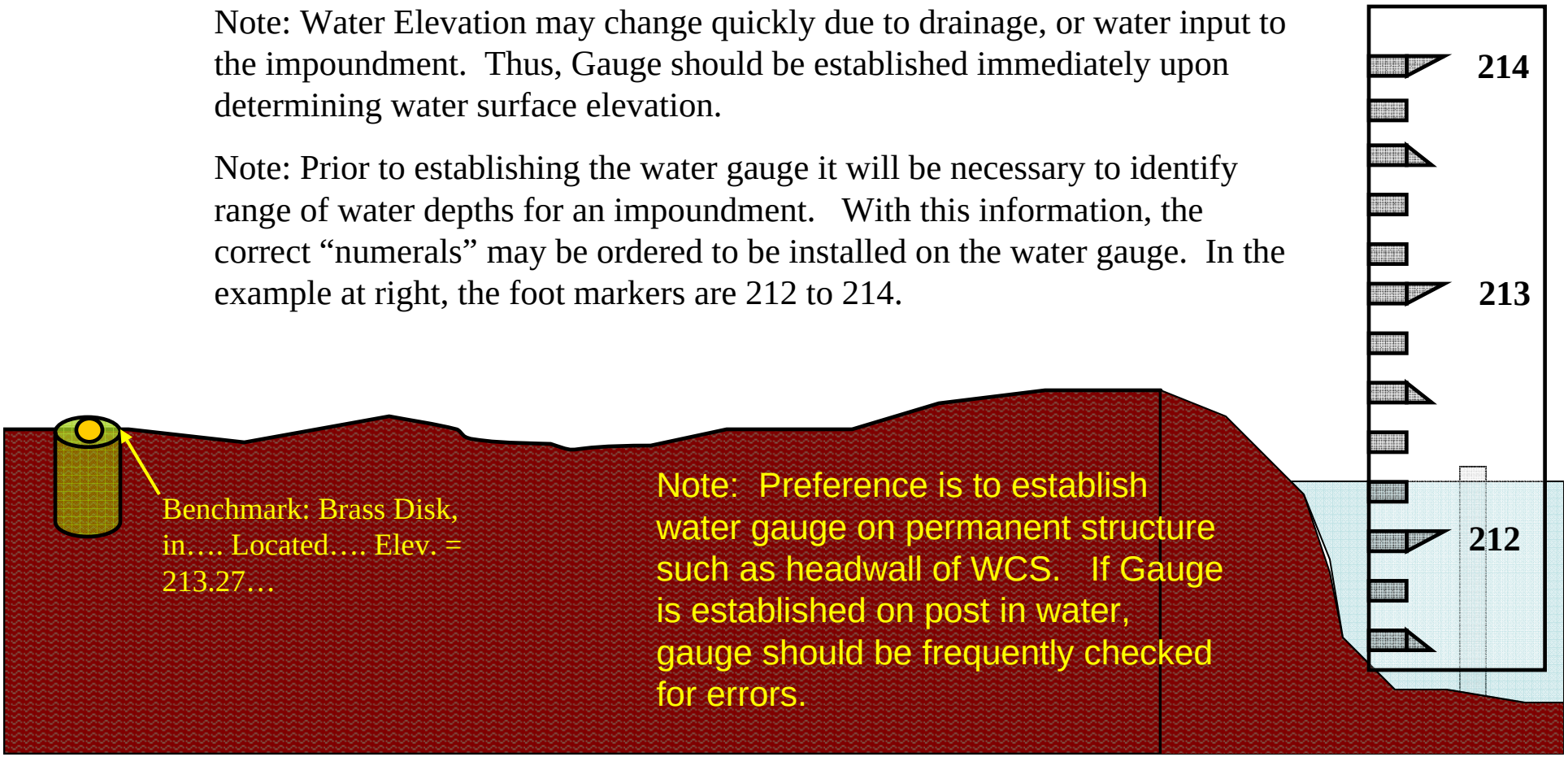
Establish Water Gauge:

Elevation of Water Surface = (HI – FS) = 215.94 – 3.72 = 212. 22

Set post or other support, place water gauge on post and move up or down until gauge reads 212.2 ft. Attach gauge permanently to post.

Note: Water Elevation may change quickly due to drainage, or water input to the impoundment. Thus, Gauge should be established immediately upon determining water surface elevation.

Note: Prior to establishing the water gauge it will be necessary to identify range of water depths for an impoundment. With this information, the correct "numerals" may be ordered to be installed on the water gauge. In the example at right, the foot markers are 212 to 214.



Sample Notes When Running a Level Loop

Note: Actual Readings from Previous Slides Used In Notes

Description	BS +	HI	FS -	Elev.
Benchmark: USGS Brass disk set in concrete on north side of Road 34 approx 50 ft east of Village Road. UTMs = ….. And …..				213.27
	2.41	215.68		
Turning Point #1			2.93	212.75
	3.19	215.94		
Surface of Water at Pintail Pool			3.72	212.22
Turning Point # 2 Top of northeast headwall of WCS #2 (Note: 2 elevations were taken from same HI. Also, this begins loop back to BM)			3.17	212.74
	2.61	215.35		
CHECK at Benchmark:Brass disk set in concrete on north side of Road 34 approx 50 ft east of Village Road. UTMs = ….. And …..			2.06	213.29 Versus 213.27

Note: When we completed loop back to BM, we determined elevation of BM to be 213.29. This represents a 0.02 error within our work. This would be an acceptable amount of error. If it were > 0.10, we would be concerned.

Note: Turning Point #2 creates a permanent reference elevation nearby the water gauge.