



OREGON CITY PUBLIC WORKS POLICIES & PROCEDURES

City Code Reference (if applicable):

Subject: Trillium Park Dr and Waterboard Park Rd Slope Stability Monitoring - Standard Operating Procedure (SOP)

Effective Date: October 31, 2019

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Approved: Dayna Webb

Purpose

This program is for ongoing slope stability monitoring at Trillium Park Dr and Waterboard Park Rd. Monitoring includes slope movement at all wells at both locations using inclinometers, and groundwater levels using piezometers at Trillium Park Dr wells. GRI geotechnical consulting services are kept under retainer for assistance and on-call services. Monitoring supports mitigation and correction for capital improvement projects such as CI 17-010. The outcome of monitoring is to become aware of continued or substantial landslide movement prior to a detrimental slide occurring.

General Information

I. Logistics

Monitoring is scheduled for every 3 months during normal or dry weather. During wetter weather, monitoring should be conducted more frequently. See schedule in Appendix A. Data is provided to GRI annually as discussed in section VII. C.

Monitoring can be a two-person job but can also be done by one person if needed. One person can operate the process easily once the process is understood. A second person is beneficial when resources are available to assist, trade out duties, and keep an eye on traffic.

It is recommended to charge the batteries of all electronic equipment 24 hours prior to the scheduled monitoring trip.

II. Tools and supplies to bring

Tools are in the locked wall cabinet above the Engineering Technician's desk. The key to unlock the cabinet is hanging on the northern wall at the Public Works Administrative Assistant's desk. The key is 'UM 399' and is the

same key that unlocks the Engineering Counter cashiering pouch drawer. Traffic cones are the only exception and are found under the western desk at the Engineering Technician's workspace in a box labeled Traffic Cones.

Items to bring to the sites:

- Inclinator in case, which includes
 - Inclinator with knurled plug connector end cap
 - Black $\frac{3}{4}$ -circle guide with silver center jig
 - Double-sided, rectangular, flat box wrench
 - Lubricant and instruction pamphlets
- Inclinator cable reel, which includes:
 - Knurled silver plug connector end cap
 - Charging cord
 - Blue reel soft case
- Tablet computer with Otterbox case and charger cord/charger block
- City 2140 key (qty 2) on carabiner attached inside toolbag
- $\frac{3}{8}$ " drive socket wrench
- $\frac{9}{16}$ "-sized ($\frac{3}{8}$ " drive) socket
- $\frac{3}{4}$ "-sized ($\frac{3}{8}$ " drive) socket
- Compass with built-in case and declinator set key
- Safety cones
- Folding chair
- Kneeling pad
- Collapsible bowl
- 12" x 12" towels
- Safety vest
- Field shoes/boots

III. Site Locations

Two site locations are currently being monitored. These locations are known as "Trillium" (Trillium Park Drive) and "Waterboard Park" or "Armory" (Waterboard Park Rd).

Trillium consists of 4 monitoring wells as shown in Figure 1 of Appendix B: Wells B2 – B5.

Waterboard Park consists of 3 monitoring wells as shown in Figure 2 of Appendix B: Wells B19- B21.

Note for Trillium Sites B2 – B5: These four wells have the same cover type, which is white and inscribed with the words "Morris Industries, Inc" and "Monitor Well". There are three bolts holding the covers down.

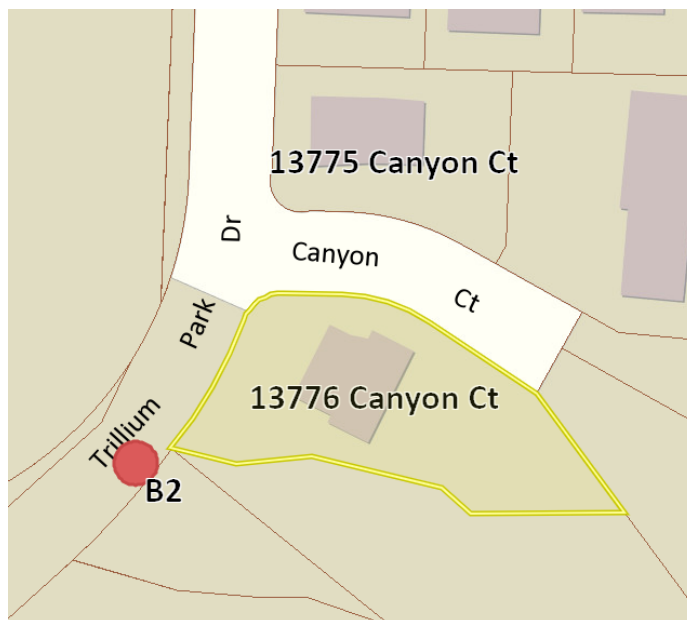
B2 – B5 typical well cover:



The following descriptions provide directions to each monitoring well:

B2: From Division St, turn east onto Davis Rd. Turn right onto Trillium Park Dr, then arrive at the street closure barricade just after Canyon Ct. The monitoring well is near the center of Trillium Park Dr, about 40 feet past the barricade.

B2 location map:

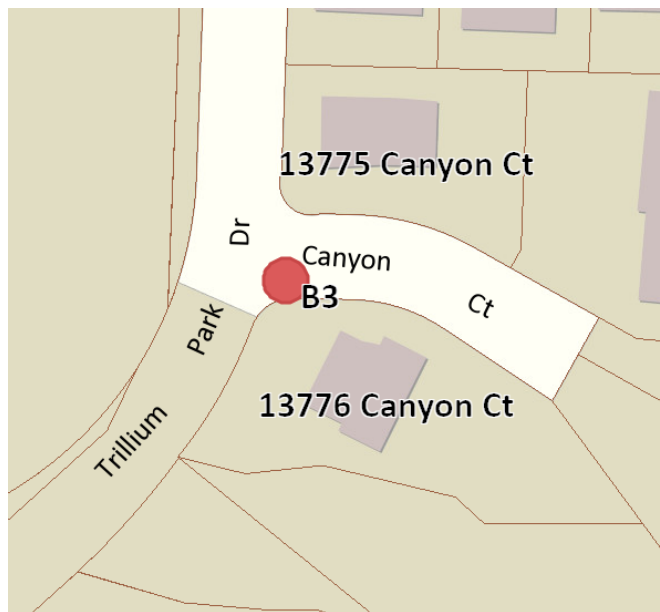


B2 location photo looking south (uphill) toward well:



B3: From the barricade described in B2 above, the monitoring well is near the southern corner of Trillium Park Dr and Canyon Ct, just down Canyon Ct 10 or so feet.

B3 location map:

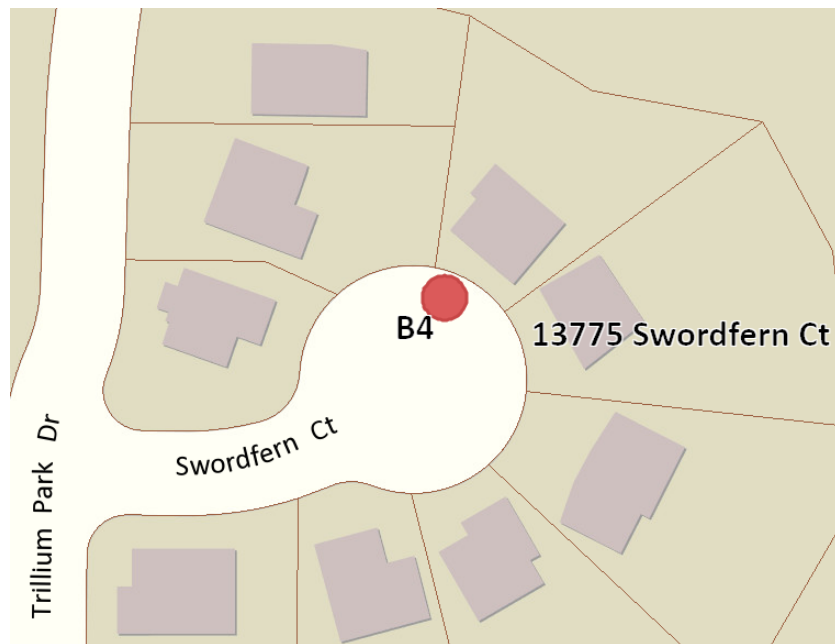


B3 location photo:



B4: From Division St, turn east onto Gilman Dr. Turn left onto Trillium Park Dr, then right on Swordfern Ct. At the bottom of Swordfern Ct, near the bottom of the cul-de-sac, is the monitoring well.

B4 location map:

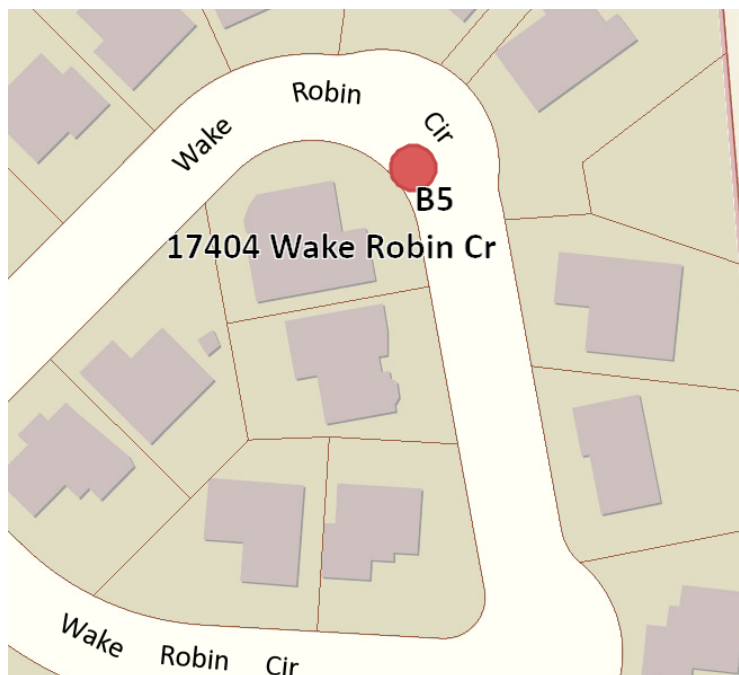


B4 location photo:



B5: From Division St, turn east onto Gilman Dr. Gilman Dr curves left and heads downhill. Stay left, then when the road turns right and flattens, the well is around the corner on the right side of the street facing south.

B5 location map:



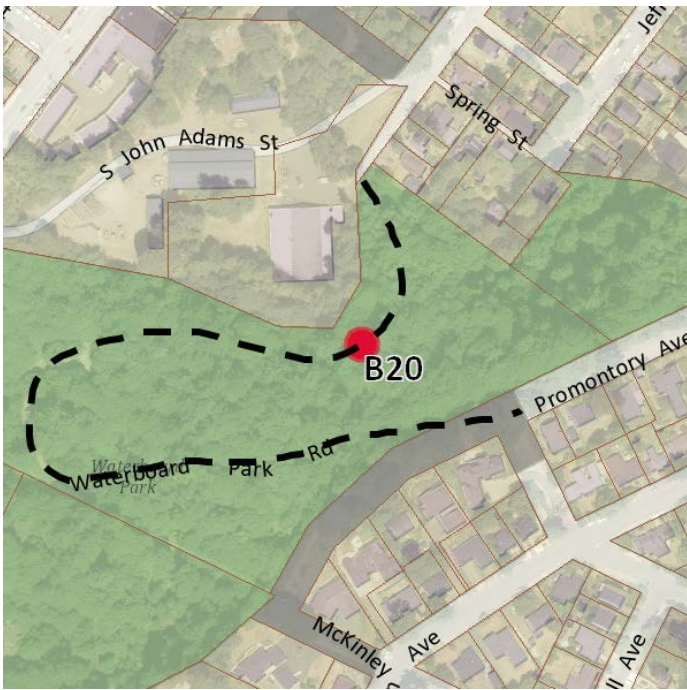
B5 location photo:



Directions to Waterboard Park Sites B19 – B21: Head south on John Adams St to 3rd St. Continue uphill on the narrower road after the 3rd St stop sign. Continue left (straight) at the fork. At the warehouse-type building, a road goes up the hill to the left. This is Waterboard Park Rd. See site map in Appendix B. There are locked bollards at the base of the road. Unlock the removable bollard with the City 2140 key and remove it. Note: road is buckled and in poor condition throughout – use caution.

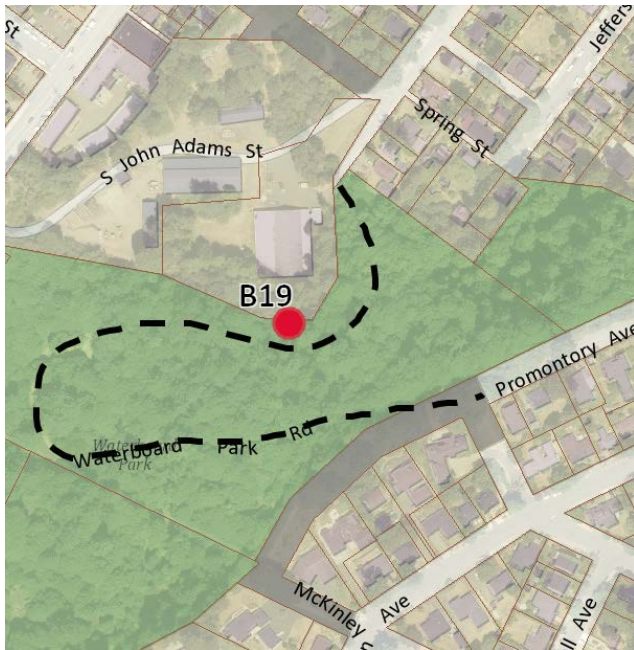
B20: After unlocking the bollard, drive up the road around the first curve to the right. B20 is within the right-going curve and is situated within the asphalt about 35 feet past the large boulder on the left on the left center of the road when facing uphill. The cover is marked with “B20” in Sharpie. The well has a brown, 8 ½”-diameter cover with “Monitoring Observation Well” inscribed on it. The cover has three bolts holding it down.

B20 location map and location photo showing boulder in background:



B19: From B20, head uphill around the right curve. As the road then curves left, then straightens to go uphill, the monitoring well is off the pavement to the right about 30 feet before the wooden bollards in the road. The cover is labeled B19 with a sharpie, and B19 with an indicator arrow is painted on the adjacent street in white. The well cover is just like that of B20: it has a brown, 8 ½"-diameter cover with "Monitoring Observation Well" inscribed on it. The cover has three bolts holding it down.

B19 location map and location photo:



B19 well cover:



B21: From B19, head up the road until the road curves left. The monitoring well is near the center of the road, as the road continues to curve up and to the left, across from a bench. The well cover is labeled B21 with a sharpie. The well has a white 12"-diameter cover with "Monitoring Well", "Morrison Dubuque", and "12FIG 418XA" inscribed on it. It has two larger bolts holding it down.

B21 location map and location photo showing bench in background:



B21 well cover:



Process

IV. Accessing the Monitoring Wells and Piezometers

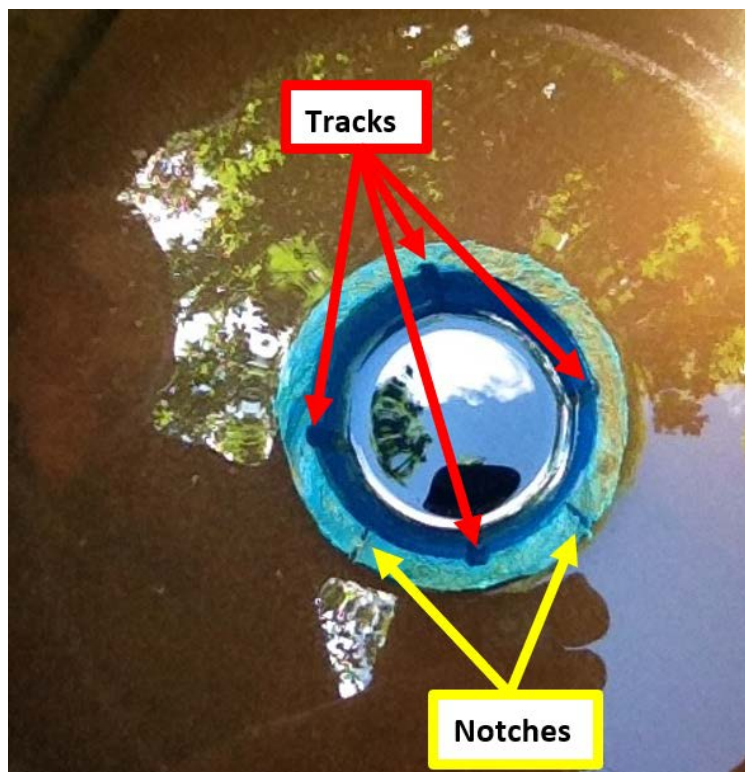
All wells except B21 use three 9/16"-headed bolts to hold their metal covers down. B21 uses two 3/4"-headed bolts. The tool kit contains a ratchet and both 9/16" and 3/4" sockets that fit the drive of the ratchet. Use the knee pad when kneeling to remove the bolts. Loosen the bolts by turning the bolt heads counterclockwise. The kit contains a flatheaded screwdriver to help pry the well cover up (once the bolts are removed). Use the screwdriver in the holes of the cover to pry up. Set aside and be careful not to lose the bolts.

Once the well cover is removed, standing water may be found in the well riser. Pull the blue well cap off the 2.5" PVC well pipe. Standing water may be present in the well pipe. Try to remove some of the water from the riser if possible by scooping with the collapsible bowl.

If the well is equipped with a piezometer (Trillium Wells B2 through B5), pull the piezometer data logger box out of the well riser and rest it on the ground.

The blue 2.5" well pipes have a 'plus' (+) shaped set of tracks. The initial/primary direction of measurement is called the A0 direction, and the secondary direction is called the A180 direction. The secondary direction is 180 degrees from the primary direction. Only one set of the tracks are used for the A0 and A180 directions; the other, perpendicular tracks in the 'plus' are not used. The pipe has two notches for aligning the black 3/4 circle guide. Both elements are described below under 'Collecting inclinometer data'.

Well pipe tracks and notches:



¾ circle guide:



V. Collecting inclinometer data

A. *Setup:*

Make sure the inclinometer cable reel is fully charged before using it in the field. The charging port is on the back of the reel body (not the frame). Push the power button on the front of the reel to turn on the Bluetooth for the reel. The power button will light green when turned on, and Bluetooth will flash blue until you open the reader application on the tablet (then it will turn solid blue).

Make sure the tablet is fully charged before using it in the field. To start the tablet and application, take the tablet out of its cover and turn it on by holding the power button (upper left-most button) for around one second then releasing. The screen will light up and say Samsung Galaxy; if it doesn't, hold the button a little longer before releasing. Swipe the screen to unlock, then click the icon in the upper right that looks like a box with 16 smaller boxes within it (Apps icon). Swipe the screen left to the additional apps screen (screen 2 of 2). Digitilt Reader is one of the icons. This is the reader application. Click the application to open it. The tablet's Bluetooth needs to be on to wirelessly connect the inclinometer device with the tablet. The cable reel needs to be powered on first for the laptop to detect it.

Unlock the inclinometer cable reel on its back side (picture on next page) by turning the lock bolt - looks like a small black lever within a circular well - counterclockwise until it moves freely. Unthread the reel end cover cap (silver, knurled) by turning counterclockwise. Open the inclinometer box and **carefully** pull out the inclinometer.

Cable reel unlock bolt:



CAUTION: It is very important not to drop the inclinometer in the case or outside of the case. This equipment is very sensitive. If dropped or hit, the equipment may need to be sent back to the manufacturer for repair or maintenance.

Unthread the end cover cap (silver, knurled) by turning counterclockwise. Pull a few feet of cable slack from the reel, line up the pins on the inclinometer and reel end, and thread the inclinometer male-threaded sheath onto the female-threaded cable end clockwise until just snug by hand (be careful not to cross-thread when beginning to thread together). Use the flat box wrench in the inclinometer box to tighten the connection an eighth to a quarter turn further than hand-tightened. Be careful not to grip the roller wheel assemblies to get leverage when tightening.

Cable reel knurled end cap:



Inclinometer male-threaded end:



Cable female-threaded end:



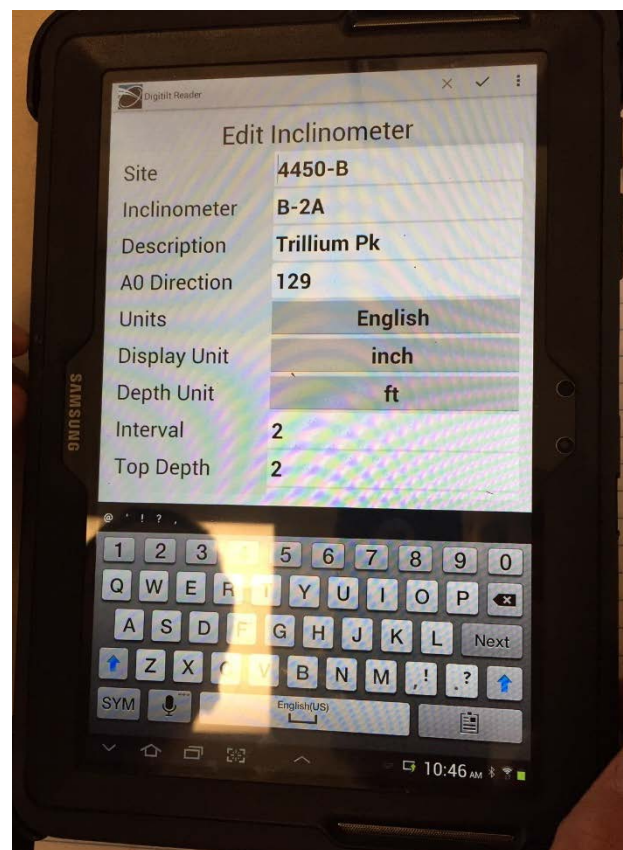
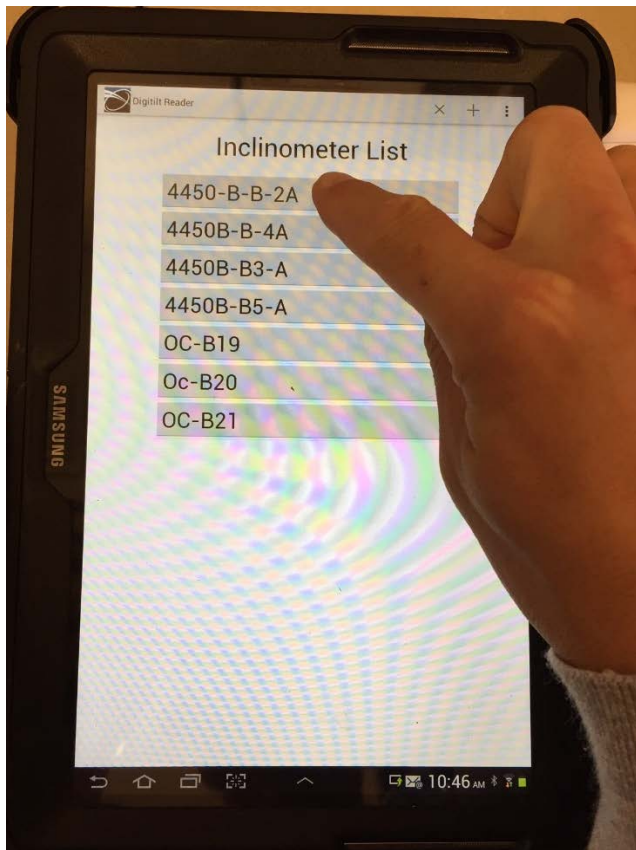
Inclinometer roller wheel assembly:



B. Taking readings:

1. In the Digitilt Reader software main screen, hit Survey
2. You will see a list of all inclinometer sites
3. Hold down on the site you're currently reading at for about one second until a site summary screen appears
 - Press the down-carrot in the very bottom left of the screen to hide the keyboard to see the entire summary

Hold down on B2 (for example) for one second to see site summary screen; B2 site summary screen:



4. Jot down the A0 direction, or initial/primary reading direction, and bottom depth, the nominal depth of the inclinometer well (the well is a foot or so deeper than nominally-defined)
5. Set the compass to the A0 direction by first flipping the cover open, then:
 - a. The compass is preset for magnetic declination for the Portland area by the small screw at its upper right (do not adjust)
 - b. Align the 360° to the top of the compass (closest to the mirror)
 - c. Rotate the compass (rotate yourself) until the red needle overlaps the red outline of the needle below it
 - True north is now the direction directly forward towards 360°

- d. Turn the bezel, or red outer ring, until the A0 direction (as noted from the tablet) is at the top of the compass
- e. Rotate yourself, with the compass in front of you, until the red needle overlaps the red outline
 - You are now facing the A0 direction – the A0 direction points toward the mirror
 - This is the direction of the first inclinometer reading

Setting the inclinometer wheels-up direction to the A0 direction indicated by the top of the compass:



6. Insert the inclinometer into the blue well pipe track with the 'wheels-up' direction towards the A0 direction
 - a. Guide the lower wheels in carefully by hand by depressing the wheels against their spring while inserting them in the tube
 - b. Once both wheels of the lower wheel assembly are in the tube, gently twist the inclinometer main body back and forth around its longitudinal axis to make sure that the wheels are engaged in the well pipe tracks
 - Be careful not to grab the upper wheel assembly during twisting – you may damage it
 - c. Repeat for the upper wheel assembly

7. Slowly lower the inclinometer on the first pass, perhaps two feet every second or slower, until you are near the nominal bottom depth
 - a. Each brass cable stop that is pressed around the cable represents 2 feet of insertion in to the well pipe – every other cable stop is marked for depth in feet
 - b. Lower slowly until bottom is near
 - c. Lower gently near the bottom until the inclinometer rests on the bottom of the well
8. Insert the black $\frac{3}{4}$ circle guide with silver jig center in the inclinometer box onto the blue well pipe
 - a. Make sure that the edges of the $\frac{1}{4}$ circle missing from the $\frac{3}{4}$ circle guide line up with the notches in the top of the pipe
 - See photo on page 11: *Well pipe tracks and notches*
 - b. Press down firmly on the guide to seat it

CAUTION: If the black circle guide is not firmly placed on the top of pipe, the readings will be off from previous readings causing an inaccurate measurement.

9. Pull the cable up, out of the well, until the brass cable stop that is named the same as the nominal bottom depth as noted from the tablet comes back out of the pipe, past the guide
 - For example, if the well nominal bottom depth is 96 feet, pull the cable up until the brass cable stop named '96' is above the guide
 - Note that only every other cable stop is marked with a number
 - Cable stops are every 2 feet, numbering on the stops is every 4 feet – you may need to refer the adjacent cable stop to know the depth number for your current reading
10. Center the cable into the guide's central silver jig, and lower the cable until the brass cable stop rests securely in the jig

Lowering the cable until the brass cable stop rests in the central silver jig:



CAUTION: Be careful to seat the cable – if the cable stop misses the guide and you let the cable go, the inclinometer will careen down the pipe and hit the bottom, damaging it

11. On the tablet, press the checkmark in the upper right of the Digitilt Reader site summary screen to go back to the site list

NOTE: Up to this point, you can always use the back arrow or home icon in the bottom left of the tablet screen to go back or go to the Apps, respectively

12. Press (don't hold down) on your current site (for example, B2) to start the survey
13. If the screen goes back to the Digitilt home screen, check that Bluetooth is turned on for both the reel and the tablet
14. Press "Start 0 Pass" at the bottom of the screen
15. When "Tap" appears in green, you are now able to mark the inclinometer readings for that depth
 - a. Current depth is shown on the tablet by the "D"
 - b. Press "Tap" (a chime sound will be heard)
 - c. "Saved" in black will be seen briefly
16. Now the next, shallower depth will appear by "D", and "Tap" in green will be shown (do not press "Tap" yet)
17. Unseat the brass cable stop from the jig by pulling directly up on the cable, move the cable over to somewhere in the open $\frac{1}{4}$ circle area, and pull the cable up 2 feet until the next brass cable stop is above the guide
 - a. Repeat step 9 – seat the cable stop in the jig

18. "Wait" in yellow will appear on the tablet until the cable stills/inclinometer reading stabilizes
19. Verify as needed that you are at the correct cable depth
20. When "Tap" again appears for this depth, press it
21. Repeat steps 16 through 19 for each 2-foot cable stop until you reach a 2-foot depth
22. After the 2-foot depth reading, press "End 0 Pass" on the tablet (note that there is not a 0-foot reading)
23. Remove the black guide, and gently pull the inclinometer out of the tube
 - a. As the top wheel of each wheel assembly on the inclinometer begins to emerge from the pipe, hold it compressed towards the inclinometer body so that the wheel does not snap out of the tube, jostling the unit
 - b. Gently release wheel assembly to extend the spring fully when both wheels of each set are out of the pipe
24. Rotate the inclinometer 180° so that the wheels are 'wheels-up' in the opposite direction to the first pass
25. Repeat lowering the inclinometer to the bottom, setting the guide to the same position as the first pass, and taking 2-foot readings from the bottom depth to the top of the tube:
 - a. Press "Start 180 Pass" on the tablet
 - b. Repeat steps 16 – 21
 - c. Press "End 180 Pass"

Readings are now complete at the monitoring well. You may now plot a graph of readings on the tablet for instant reference to allow you to see if the well is stable and has little to no movement. Plotting can be accomplished by pressing "Plot", pressing the monitoring well-of-interest, and pressing "Change from Last" or "Change from Initial". If significant movement is shown, reread the A0 and A180 readings completely again and ensure that all procedures are being followed.

C. Site closeout:

Dry off the inclinometer thoroughly with a towel. Oil the roller wheel pivot points with the light oil in the inclinometer case. Disconnect the inclinometer from the cable, and replace connector ends on both with their caps. There is little to no risk of electrical shock, though always use caution around electrical connectors. Carefully place the inclinometer back in its case. Turn off the reel Bluetooth via pressing the power button. Retract the reel, put the cable end into the mount, and lock the reel from unwinding via the lever on the back of the reel. Replace the well cover, bolting it back down firmly (but not too tightly). Power down the tablet by holding the power button and then following prompts.

VI. Sending and processing data

A. Sending data to an email:

Open the Digitilt Reader App and press the Send icon. Press Share, then use Gmail. Add the address you'd like to send to: click Compose email at the bottom of the files. The keyboard will appear. Click in the "To:" field, and the keyboard will remain to type out the email. In Settings, under General Settings, you can press "Add Account" to add a Gmail account that the emails send from. You must have the tablet on a Wi-Fi network to send emails.

B. Processing Data:

1. Download the .dux files from your email
 - Keep the .dux files in a new folder within [P:\PublicWorks\CIP_PS_RFQ_RFP\PS_Open\PS 19-008 Trillium Drive and Armory - GRI\PROJECT MONITORING/Data & Reports](P:\PublicWorks\CIP_PS_RFQ_RFP\PS_Open\PS 19-008 Trillium Drive and Armory - GRI\PROJECT MONITORING\Data & Reports), by site grouping (Trillium or Waterboard Park), and by reading date and reading party (City or GRI)
2. Install and open DigiPro2, available from DGSi Slope Indicator here:
<https://durhamgeo.com/product/digipro2-software/>
 - Click “Use Basic Features Only”
3. You need to start a database and add your files
 - Open the existing database or create a new one
 - The existing database is located here: P:\PublicWorks\CIP_PS_RFQ_RFP\PS_Open\PS 19-008 Trillium Drive and Armory - GRI\PROJECT MONITORING
4. In the “Digitilt AT” dropdown, click “Import Surveys”
5. Navigate to your .dux files and select them
6. Do not select “Clean Folder After Import” – this will clear the .dux files out of the folder
7. On the left is a list of the inclinometer sites
 - Click on the site of interest
8. In the Plot dropdown, go to Plot Inclinometer, then click Profile Change
9. You may limit which inclinometer reading dates are plotted by:
 - Click on the graph of interest – A or B direction
 - Click Surveys under Selected
 - Click in the checkboxes to include or exclude dates
 - Make sure to include at least one date other than the initial date
10. Plot graphs in PDF by hitting Print
11. Export data to Excel by hitting Export

C. Annual Requirements:

- Data should be provided annually to the City’s geotechnical consultant by providing each .dux file that has been created over the past 12 months.
- The consultant will review the data and provide an annual report that provides analysis of the data and guidance on what is needed over the next calendar year.
- When substantial movement has occurred between readings, consultation with the geotechnical consultant should be considered once it is determined the readings were taken correctly.

APPENDIX A

Schedule for Monitoring

All monitoring should be completed on a quarterly basis as a minimum*. The suggested months for monitoring are:

- February
- May
- August
- November

* Additional monitoring should be provided when the following rainfall events occur:

- Within 5 days after any daily rain event exceeding 1.0 inches
- Within 5 days after any continuous rainfall that sums to 2.5 inch or more in three consecutive days
- You may refer to <https://or.water.usgs.gov/non-usgs/bes/> for rainfall quantities

* For additional monitoring, selective locations may be used rather than collecting data at all locations. At least one location per area (Trillium and Waterboard Park) shall be collected (two samples total)

Appendix B

Site Maps

Figure 1: Trillium Park Dr sites B2 – B5

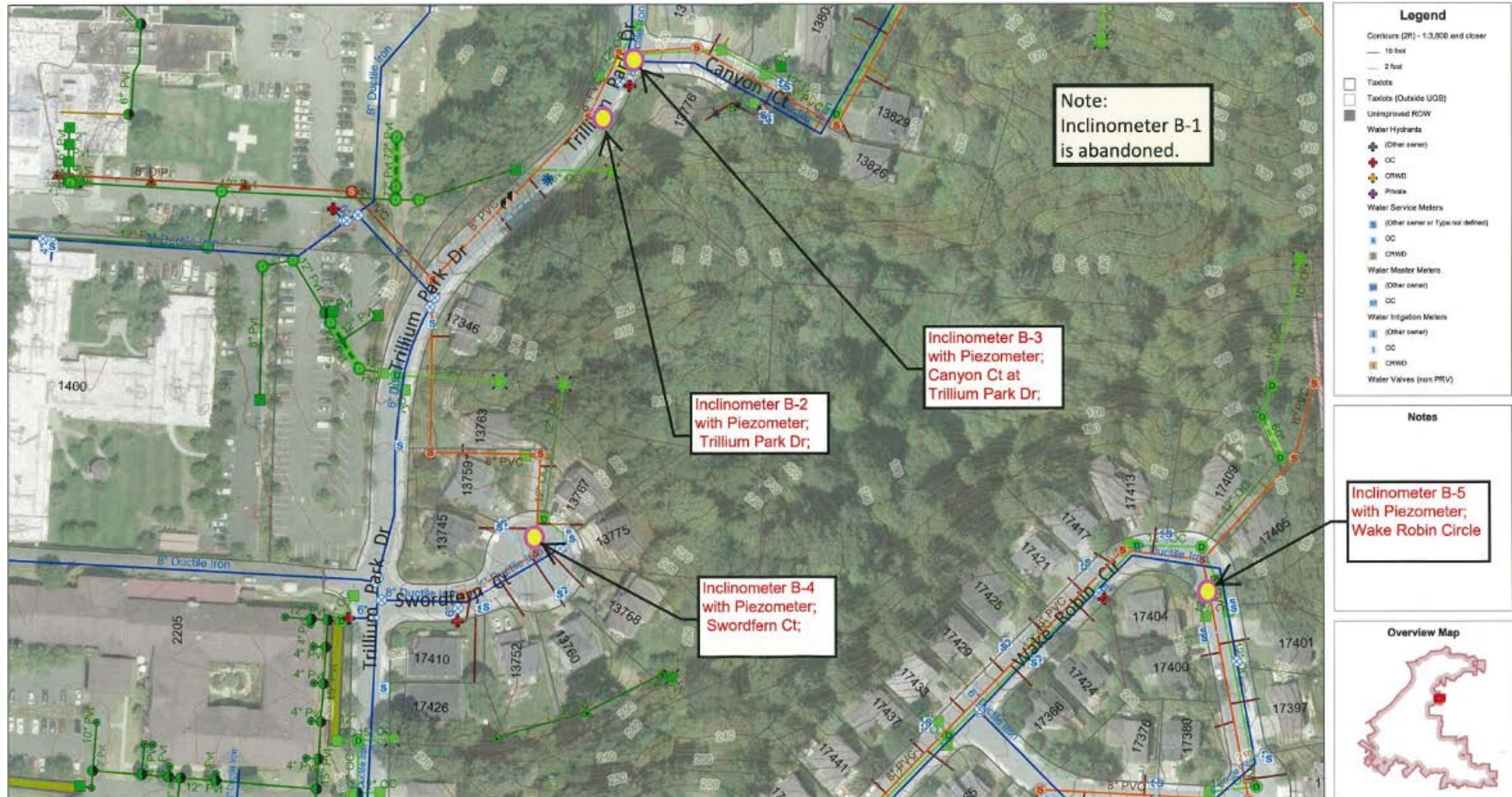
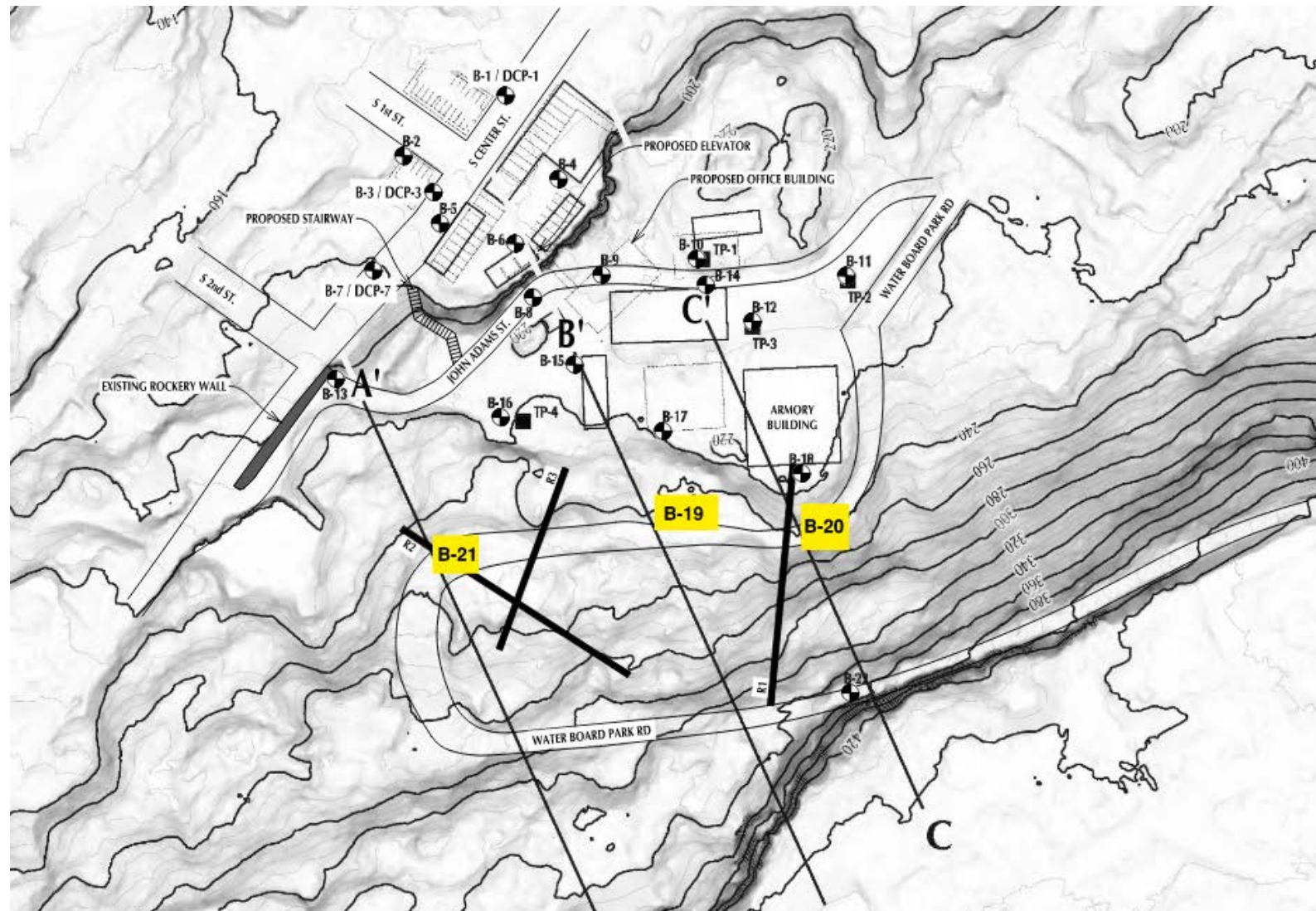


Figure 2: Waterboard Park Dr sites B19 – B21



Appendix C

Troubleshooting

- A. What do I do if I drop the inclinometer device?
- Contact the Western US Durham Geo (DGSi) customer service point-of-contact (POC) here:
<https://durhamgeo.com/contact-us/?location=or>
 - Reference the inclinometer part number, 50332500, and the inclinometer serial number, 739278, as referenced on the inclinometer case
 - Reference the cable reel Bluetooth ID, RNBT-816F, part number, 50334150, and serial number 1730324, as referenced on the top of the reel
 - The POC will ask for what happened and what symptoms are to be described in detail to assess what may need to be repaired within the inclinometer
- B. What do I do if the inclinometer cable is at a different elevation than what the tablet shows?
- If you mistakenly pull too much cable, hit “Tap” on the same depth twice, etc.:
 - Unseat and lower the cable down a stop or two
 - Note what new depth you are now at
 - Hold down on the depth number next to the “D” until you can edit the number
 - You may now scroll to the depth you have lowered to to redo it
 - Continue repeating steps 16 through 19 – pulling the cable up one stop at a time and taking readings – and pass through the mistaken reading area
 - All already-read readings starting at the lowest depth of the redo will be rerecorded
- C. See the document “digitilt-at-system-manual.pdf” for details on the inclinometer and cable reel product and their troubleshooting, found here: P:\PublicWorks\CIP_PS_RFQ_RFP\PS_Open\PS 19-008 Trillium Drive and Armory - GRI\BACKGROUND\Product Data