SME
9375 Chillicothe Road
Kirtland, OH 44094-8501
T (440) 256-6500
www.sme-usa.com

January 27, 2016

David R. Lastovka, P.E.
ODOT District 12 Transportation Engineer
Ohio Department of Transportation
5500 Transportation Boulevard
Garfield Heights, Ohio 44125-5396

Re: October 2015 Annual Report
CUY-90-15.24 Slope Monitoring
PID 96504
EDP Project No. 069032.00

Dear Mr. Lastovka:

Quarterly instrument readings for the CUY-90-15.24 Slope Monitoring project are presented in the attached report.

If you have any questions or comments regarding this report, please call.

Very truly yours,

SME

cosign

Alan J. Esser, P.E., D.GE
Chief Consultant

Attachments

Distribution via e-mail

OCTOBER 2015 QUARTERLY REPORT

CUY-90-15.24 SLOPE MONITORING
PID 96504
CLEVELAND, OHIO
SME PROJECT NO. 069032.00

JANUARY 27, 2016

SME
9375 Chillicothe Road
Kirtland, Ohio 44094-8501
P: (440) 256-6500 F: (440) 256-6507

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INTRODUCTION

Instrument readings and interpretations for October 2015 are presented in this report. Figures showing the arrangement of instrumentation are in Appendix A. Instrument plots are included in Appendix B. Labels like P-001-13 for the piezometers and I-001-13 for the inclinometer at that same location are used for all recently installed instruments. For earlier instruments, a label like B-101 is used for both the piezometers and inclinometers at the same location.

Critical Instruments Read Bi-weekly

Critical instruments are those that are judged to provide a clearer picture of slope performance (displacement and pore pressure changes). The following critical instruments are currently read and reported on a biweekly schedule.

Piezometers: P-001-13, P-002-13, P-003-10, P-004-13, P-009-13, B-05-03, B-05-04, B-05-11, and B-105.

Inclinometers: I-001-13, I-002-13, I-003-A-10, I-004-13, I-009-13, B-05-04, B-05-A-11, B-101, B-102, B-105A, Pier 1, Pier 9N, TGR I-2 and TGR I-4.

Refer to the bi-weekly reports for details and comments on those instruments. This report will only cover those instruments that are not included in the bi-weekly reading schedule, with the exception of the inclinometer at P-1, which is discussed in the inclinometer section below.

Status of Instruments

Instruments Currently Out of Service and Needing Repair or Replacement

B-105 and B-105A. The instruments at this location were damaged during excavation for repair of the bulkhead. We located the inclinometer tube and added a short extension that will allow us to continue readings until the excavation is backfilled and the slope tube is fully extended. We are working with the contractor to locate the ends of the tubing for the piezometers and hope to be able to splice onto the tubing and continue readings.

B-05-03. Cables for the piezometers at this location were extended to the east fence line for protection during construction. On or about December 24, 2015 the contractor dug through and severed the cables. The cable to the deep piezometer was previously damaged. With this recent incident both piezometers are now out of service. The ends of the cables have been located but need to be followed back to the location of the instruments where the cables can be spliced so that readings can continue.

The top of the inclinometer at this location was damaged in April 2015 during the excavation for the adjacent storm sewer. We flushed debris from the inclinometer tube, but were unable to lower the probe past 30 feet (40 feet below the original top of the tube). We believe this is due to shear displacement that has occurred over the past year. This slope tube is abandoned as unreadable and will be replaced when the adjacent bulkhead work is completed.

B-303 and I/P-008-10. A large amount of fill was placed over these instruments during the CCG1 contract. The inclinometer at I-008-10 is buried and inaccessible. Prior to placement of the fill the piezometer cables for P-008-10 and tubing for B-303 were extended to a clear area near the east fence where they could be read. The piezometers are now out of service having been cut during excavation for installation of the gas line. These instruments will be restored to service after the fill is removed. We are coordinating with the contractor to excavate and expose the cables at the location of the instruments.

I/P-004-13. To protect these instruments during construction nearby, the contractor installed a section of pipe around the instruments and then filled around the pipe leaving them inaccessible.

Recently Installed Instruments

I/P-004-13. An inclinometer and two vibrating wire piezometers were installed at this location between October 8 and 14, 2015. A baseline reading was taken on November 20, 2015.

TGR I-4. The contractor installed the inclinometer at this location on September 14, 2015. A baseline reading was taken on September 23, 2015. Readings are reported bi-weekly.

PIEZOMETERS

P-001-10. Total head in both piezometers at P-001-10 increased slightly during November and December 2014 and then remained constant through June 2015. The greatest rate of increase occurred during July 2015. Since the end of July, the total head in both piezometers decreased by about 1.5 feet. The net change in total head for the year was an increase of about 1 foot.

P-002-10. The total head in both piezometers at this location increased through June 2015. Total head began to decrease in early July 2015. The net change in total head over the past year has been an increase of about 0.5 feet in both piezometers.

P-007-13. Total head in the shallow piezometer at this location increased slightly during late June and into July 2015 but decreased soon after. There has been no significant change in total head in either piezometer at this location since we began taking readings in April 2015.

B-05-07. Pore pressure in the deepest piezometer continued to increase at a constant rate with an increase in total head of about 3.4 feet since April 2014. Readings in the two shallower piezometers showed no significant change through the first part of the year, but began increasing after April 2015. This increase continued until about the end of July, when pore pressures began to decrease. Net changes in total head for the year are increases of about 0.5 feet and 1 foot for the piezometers at 57 feet and 82 feet, respectively.

TGR P-3. In early October 2014, a large amount of fill was placed in the area adjacent to this location causing an increase of 7 to 7.5 feet of total head in all three piezometers. After the fill was in place, the pore pressures began to decrease with the rate of change decreasing over time. Pore pressure in the shallowest piezometer decreased rapidly during the first month and has been trending downward slowly ever since with a net change of about 2 feet for the year. Total head in the two deeper piezometers decrease at a fairly constant rate until about April 2015. At that time pore pressures in the deepest piezometer appeared to have reached equilibrium. In April 2015, pore pressures in the piezometer at 20 feet began to slowly to increase. Then beginning on or about August 20, total head in both piezometers increased by about 2.5 feet in one week. No indication of this increase is seen in the shallowest piezometer. Following this increase, total head in the piezometer at 20 feet began to decrease, while total head in the deepest piezometer continued to increase slowly. Total head readings in these two deeper piezometers now differ by only about 0.2 feet.

INCLINOMETERS

I-001-10. The April 2015 quarterly readings at this location indicated negative B-axis displacement of about 0.1 inches between 110 and 120 feet and between 190 and 200 feet. Since the April quarter displacements have been negligible.

I-002-10. Displacements in both axis directions continued to increase throughout the year. A-axis movement is occurring in the negative direction between 78 and 116 feet and in the positive direction between 142 and 180 feet. At both intervals, the maximum displacement is now about 0.12 inches. B-axis movement is occurring in the positive direction from the surface to a depth of about 110 feet. Displacement this past year has been about 0.1 inches.

I-007-13. This past quarter's readings indicate slight displacements in the positive B-axis direction between 65 and 145 feet. Movement in the A-axis direction has been negligible since the April 2015 baseline readings.

B-05-07. The April and July readings for this location indicated negative A-axis rotation from the surface to about 104 feet with a maximum displacement in July of about 0.32 inches at the surface. The April readings indicated a B-axis "bulge" between 20 and 140 feet with a maximum displacement in July of about 0.15 inches at 100 feet. The October 2015 readings indicate that the displacements in both axis directions reversed slightly towards the baseline.

INCLINOMETERS IN THE STABILIZATION STRUCTURE

P-1. The movement observed at Pier 1 of the stabilization structure has been perplexing. The area of concern extends from about 115 feet to the bottom of the pier. The inclinometer readings indicate relative large lateral displacement over this depth range with the largest displacement occurring between 120 and 140 feet. Movement is occurring in both the A and B-axis directions. In an attempt to better understand this movement we compiled a plot of the cumulative resultant displacement at a depth of 132 feet where the maximum displacement is occurring. This plot, which is based on the initial baseline readings taken in 1998, is included with the attachments.

The plot shows that there was about 1/2 inch of lateral displacement that occurred over about a three month period as the stabilization structure initially took up load. From then until July 2007 there was little increase in displacement. For the next two years, until July 2009, the plot indicates that displacement increased by about another 1/2 inch and then reversed cancelling out all the increase. From July 2009 to January 2015 displacement increased at a constant rate accumulating a total of about 0.9 inches of additional displacement. Then from January through

June 2015 the rate of movement increased significantly adding about 1.25 inches of displacement for a total of 2.5 inches of displacement since the pier was placed in service. Since the end of June 2015, the readings show a reversal with some back and forth and an overall downward trend at about the same rate as the rate of increase that was seen between January and June of this year. The total reversal was about 0.7 inches in September 2015. Then the displacement began to increase again so that by the time of the October readings, the total displacement was about 2.2 inches.

We should consider what affect the data interpretations have on the plots. The computer program that interprets the raw data, assumes fixity at the bottom of the slope tube. If the bottom of the tube is not fixed, this would affect the resulting plot. It seems apparent from the plots that the bottom of the pier may not be adequately fixed against both lateral movement and rotation. In addition, we have assumed that the top of the pier is fixed in the pier cap and the cap is not moving. This may not be true because the pier cap can move laterally parallel to the river since the only restraint, although substantial, is the stiffness of the piers. The pier cap can also rotate horizontally around a vertical axis, and it can tilt around the axis parallel to the river due to the eccentricity of the reactions from the tiebeams. Although the stabilization structure is very stiff, the applied earth loads are great enough to cause small movements which the inclinometer can measure. Thus, at least some of the apparent displacement seen in the plots may be due to the zero displacement boundary conditions forced in the data interpretation.

P-3. Since July 2014, inclinometer readings at this location have been showing increasing displacements in the negative A-axis direction at about 130 feet and in the positive B-axis direction between 51 and 103 feet. Larger increases occurred in January to April and July to October especially in the A-axis direction which has now reached about 0.25 inches at its maximum point of displacement compared to the January 2014 baseline.

P-8. Inclinometer readings at this location indicate continued movement throughout the length of the slope tube in both axis directions. Compared to the January 2014 baseline, the maximum displacement in the negative A-axis direction is about 0.35 inches and in the positive B-axis direction is about 0.62 inches. B-axis displacements increased by about 0.5 inches this past year.

P-9N. The plot for this location is included here relative to the discussion about the possible cause of the movements and reversals shown by the inclinometer plots. This slope tube is read weekly. See the weekly reports for more detail.

P-10. Continued movement is indicated at this location throughout the length of the slope tube in both axis directions. Maximum negative A-axis displacement has reached about 0.58 inches compared to the January 2014 baseline with about 0.5 inches of that occurring in the past year. Maximum positive B-axis displacement is about 0.3 inches compared to the baseline with the majority of that movement occurring in the past year.

P-17. About 0.1 inches of negative A-axis displacement occurred throughout the length of the slope tube in October 2014. Since that time, displacements have been small, now totaling about 0.15 inches at the maximum point. B-axis movements appeared to be negligible until April 2015 when displacements between 141 and 143 feet increased. Displacements have continued to increase at this depth and are now about 0.15 inches from the baseline.

To further understand what might be affecting the inclinometer plots for the stabilization structure, we are including plots of the absolute position of the slope tube in each of the piers. There is a fairly strong correlation between the shape of the slope tube and the location where the cumulative displacement plots show the most significant movement. For example the displacement plot for P-1 shows large A-axis displacement between 120 and 140 feet and the absolute position plot shows tight curvatures at the top and bottom of this depth range. We also see relatively large A-axis displacements between 50 and 80 feet with corresponding tight curvatures at the top and bottom of this depth range. A similar correlation is seen between the B-axis displacement and absolute position plots. Comparing the absolute position plot for P-1 and the other piers shows that P-1 has undergone the greatest amount of movement. The displacement and absolute position plots for P-9N show that this pier has undergone the least amount of movement. Similar correlations between the cumulative displacement and absolute position plots can be seen for most of the other piers.

We note also that displacements are more concentrated over depth ranges where the curvature of the slope tube is tight, and the displacements are more sweeping over depth ranges where the curvature of the slope tube is more gradual. The absolute position plots indicate some displacement at the pier cap at P-1, P-3, and P-17, and no displacement at P-8, P-9N, and P-10.

But why, if the piers are not undergoing displacement, do the plots indicate large displacements, and why are the displacements apparently reversing? Some of this is a matter of scale. Using a +/- 1 inch scale for the displacement plots exaggerates what are very small changes. The reversals may be due to a couple of factors. First the tops of the slope tubes are not cut square. Previously, with our Slope Indicator equipment the depth markers on the cable were used to determine the depths of the readings. Although the slope tube is marked so a consistent point is used to determine the stop points, slight differences could occur and might be exaggerated by the tight curvature of the slope tube. For our current readings with RST equipment a cap is placed in the top of the slope tube and the cable is hung from the cap so the stop points are more consistent. However, with the play in the fit of the cap into the slope tube, and with the tops of the slope tubes cut at an angle, there may be some slight differences in the stop points which again are exaggerated by the curvature of the slope tube. Secondly, although the cable is dimensionally stable, it must be affected by temperature. Time is allowed for the temperature of the probe to reach equilibrium, but because the cable is continuously raised and lowered, it does not reach equilibrium. With the depth of the readings, changes due to thermal expansion and contraction of the signal cable could vary the depth of the readings enough to show a reversal in those sections where there is a tight curvature of the slope tube.

STABILIZATION STRUCTURE

The general arrangement of the stabilization structure and its instrumentation is shown in Figures 2 and 3 in Appendix A. There is no data for the stabilization structure from January to April 2015 because both data loggers shut down. This is explained in the April 2015 quarterly report. A shut down has occurred in the same time period for the past three years.

Load Cells

Seasonal variations are apparent in the plots for all of the load cells with the usual increase in load in the summer months. Loads in Load Cells 1, 8 and 9 continue to trend downward. The plot for Load Cell 8 shows a sudden drop of about 50 kips in January 2015 followed by an equivalent increase in July 2015. This is due to one of the gauges failing and then recovering. The load in Load Cell 17 appears to be creeping upward slightly. The spikes in the plots, especially for Load Cells 1 and 8, occur when one or more of the gauges in a load cell fail to record. Table 1 shows which gauges were active in each of the load cells this quarter. A plot of the load cell data is included in Appendix C.

Table 1. Active gauges (indicated by check mark) in load cells on the four instrumented anchors.

Load Cell	Gauge					
	1	2	3	4	5	6
1	✓			✓	✓	✓
8	✓	✓	✓	✓	✓	✓
9	✓	✓	✓	✓	✓	✓
17	✓	✓	✓	✓	✓	✓

Anchors

Loads recorded for all active strandmeters on the instrumented anchors remained virtually constant this past quarter with the exception of an occasional spike caused by gauges failing to record. The plot for Gage 5 on Anchor 1 indicates a continued increase in load over the past year. This has been the trend since 2010. The magnitude of the load is obviously incorrect since it is unrealistically high and is much greater than the load indicated by the load cell. Most data for Gage 1 on Anchor 17 was erroneous between June 2014 and January 2015. Since then more valid data has been recorded but there are still frequent spikes in the data. Average loads this quarter for the load cells and active strandmeters are listed in Table 2. We also report the percent change in load from last quarter. Strandmeter gages that have failed are indicated by an "×" in the table.

Table 2. Average strandmeter loads and % change from last quarter, tension loads are positive.

Anchor	Load Cell (kips)	Strandmeter (kips)				
		1	2	3	4	5
1	451.5	-9.6	×	+/- 0	×	2013
% change		-4.0	×	0	×	1.2
8	357.6	28.5	65.4	-176.4	×	×
% change		6.3	0.2	-0.1	×	×
9	454.5	-19.4	8.5	2.1	194.1	771.5
% change		-0.5	-2.3	-12.5	0.1	0.2
17	369.8	-29.4	×	-23.9	×	232.6
% change		-15.8	×	-7.4	×	0.3

Driven piles

The large "jumps and drops" in the axial load plots for the driven piles and the loss of data for the first quarter of 2015 obscure the actual changes that are occurring. Generally it appears that the axial loads are increasing in all piles except for Pile 1. The data for Pile 1 has been so erratic since the middle of 2011 that it is impossible to draw any reliable conclusion about changes in that pile's load. For the other piles it appears that the loads increased by about 10 (Pile 34) to 15 (Pile 17) kips this past year. The large jumps and drops in the plots are caused by the intermittent loss of data for individual gauges. This also affects the bending moment plots.

Strong axis bending moments increased in all of the driven piles for the year. It is difficult to estimate the magnitude of the increases due to the effect of the gauge failures especially for Pile 1 where the actual increase is likely less than we can estimate from the plot. It appears that the increases may be in the range of about 10 kip-ft in Pile 34, to about 13-15 kip-ft in Piles 17, 18, and 19, to about 22 kip-ft in Pile 1. Weak axis bending moments increased slightly in all of the piles except Pile 34. The increases averaged about 3 kip-ft. The load in Pile 34 decreased by about 5 kip-ft. Due to gage failures, much of the bending moment data for Pile 19 has been removed from the plots.

Tiebeams General

Data for all the tiebeams continued to be erratic over the past year. A significant amount of erratic data was deleted to "clean up" the plots in the attachments. There are many erratic data points however underlying trends can still be seen although for this past year it takes a fair amount of imagination to see them. The following interpretations refer to these underlying trends. We found an error in the calculations for Tiebeam 1 on the anchor side. This has been corrected and the plots have been updated. The spikes in the plots are due to various gauges not recording and the straight lines in the plots for January through the end of March 2015 are due to the data loggers shutting down.

Tiebeams Anchor Side

The axial loads at the anchor end of the tiebeams again show the usual seasonal variations for the year with the maximum load occurring in May-June and the minimum load occurring in October-November. Looking at the trends for the past four years for Tiebeams 12, 13, and 14, there has been some up or down variation from year to year but overall the average axial loads appear to be constant. The axial load in Tiebeam 1 has been trending downward (decreasing) at an average rate of about 3 kips per year. Since 2013 the axial load in Tiebeam 26 has been trending downward at a two-year average rate of about 18 kips per year.

Strong axis bending moments remained constant in Tiebeams 12 and 13, and appear to have increased slightly in Tiebeam 14 and decreased slightly in Tiebeam 26. It is difficult to see what has happened to the bending moment in Tiebeam 1, although from the last few data points for the year we might conclude that the moment was about the same as it was a year ago.

Weak axis bending moments appear to be unchanged in Tiebeams 12 and 13 and appear to have increased slightly in Tiebeams 14 (more positive) and 26 (more negative). It is impossible to tell what change may have occurred in Tiebeam 1.

Tiebeams Drilled Pier Side

Axial loads at the drilled pier end of the tiebeams continue to follow the seasonal trends. In the past, the magnitude of the loads appeared to be increasing each year. This year, the loads are similar to what was observed in 2013 except for Tiebeams 1 and 26. Compared to 2013 the axial load is somewhat greater in Tiebeam 1 and lower in Tiebeam 26. Overall for the past four years, the axial loads appear to be increasing in all tiebeams except Tiebeam 26 where the load appears to be decreasing. However, the poor data for 2015 for Tiebeams 1 and 26 make it difficult to clearly see the trends. Due to a gauge failure, strong axis bending moments for Tiebeam 12 are omitted from the plot.

Strong axis bending moments at the drilled pier end of the tiebeams appear to be lower than a year ago except for Tiebeam 14 which appears to be about the same as last year. For the past four years the strong axis bending moments appear to be decreasing in Tiebeams 1 and 26 and remaining about the same in Tiebeams 13 and 14.

Weak axis bending moments in Tiebeams 1, 12, and 26, decreased compared to last year although the change for Tiebeam 26 is probably due the loss of data from one of the gauges. The weak axis bending moment stayed about the same in Tiebeam 14.

Drilled Piers

The profile plots for both instrumented piers suggest a general increase in axial load and bending moment over most of the length of the piers this quarter. This however is due to the timing of the readings since we are comparing the quarterly average to the annual running average and the October quarter readings are at or near the high or low point of the seasonal variations.

Plots of the axial load versus time continue to show a gradual increase in axial load in both shafts at all depths. The seasonal variations are apparent in the plots for the individual gauges. This year we had some erratic data recorded for the gauges at 84 feet in Pier 1. This affects both the axial load and bending moment plots but the data does not appear to indicate a significant change from past trends at this depth.

Bending moments in Pier 1 are changing most at the shallow and deep ends of the pier with moments decreasing over time at 29, 35.5, 64, and 114 feet, and increasing at 22.5 feet and above and at 74, 84, and 134 feet. Bending moments remain relatively constant at 42, 47, and 74 feet. A similar trend occurs in Pier 9 where the bending moments remain relatively constant between 30 and 50 feet and are increasing at all other depths.

AGGREGATE STOCKPILES

We observed and photographed the aggregate stockpiles on October 23, 2015. The photos are Figures 4 and 5 which are included in Appendix A. Only a small pile of aggregate closest to the right-of-way fence remains. This pile has been virtually unchanged since January 2014. The pile is about 8 feet high and covers only a small area of the property.

This completes the October 2015 annual report for the CUY-90-15.24 Slope Monitoring Project, ODOT PID 96504.

Report prepared by:

Brendan P. Lieske, E.I.
Staff Engineer

Report reviewed by:

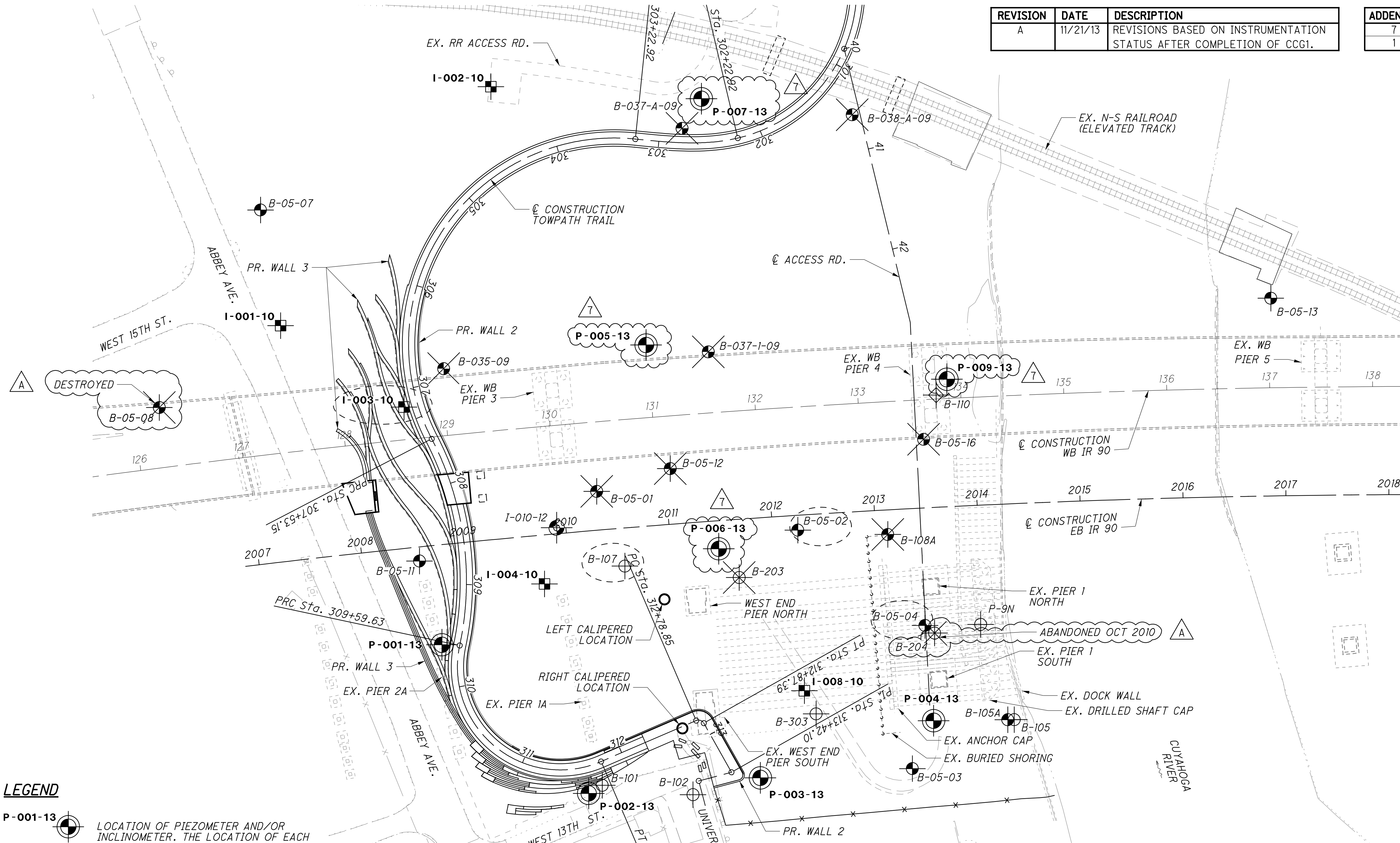
Alan J. Esser, P.E., D.GE
Chief Consultant

APPENDIX A

ARRANGEMENT OF INSTRUMENTATION

REVISION	DATE	DESCRIPTION
A	11/21/13	REVISIONS BASED ON INSTRUMENTATION STATUS AFTER COMPLETION OF CCG1.

ADDENDUM	DATE
7	8/2/13
1	4/16/13



LEGEND

P-001-13 — LOCATION OF PIEZOMETER AND/OR INCLINOMETER. THE LOCATION OF EACH INCLINOMETER IS WITHIN 5 FEET OF THE LOCATION OF THE PIEZOMETER.

B-05-01 — LOCATION OF INCLINOMETER/PIEZOMETER INSTALLED BY BBCM IN 2006 (B-05-01 THROUGH B-05-04, B-05-07, B-05-08, B-05-11 THROUGH B-05-13, AND B-05-16). THESE INSTRUMENTS ARE NOT AFFECTED BY THE GRADING AND REMAIN IN SERVICE.

B-105A — LOCATION OF REPLACEMENT INCLINOMETER INSTALLED BY BBCM IN 2006 (B-105A AND B-108A).

B-101 — LOCATION OF INCLINOMETER AND/OR PIEZOMETER INSTALLED BY BBCM BETWEEN 1994 AND 1999 (B-101, B-102, B-105, B-107, B-203, B-204, B-303, AND P-9N).

B-110 — LOCATION OF INCLINOMETER AT B-110, WHICH WAS DESTROYED BY EXCAVATION ACTIVITIES IN MARCH, 2006

I-010-12 — LOCATION OF INCLINOMETER INSTALLED DURING PIER 3 CONSTRUCTION, 2012

I-001-10 — (7) LOCATION OF EXISTING INCLINOMETER AND/OR PIEZOMETER (I-001-10 THROUGH I-004-10 & I-008-10 AND P-001-10 THROUGH P-004-10 & P-008-10 INSTALLED AS PART OF THE CCG1 CONTRACT). THE LOCATION OF EACH PIEZOMETER IS WITHIN 5 FEET OF THE LOCATION OF THE INCLINOMETER. DEVELOPER IS RESPONSIBLE FOR THE REPLACEMENT INSTRUMENTATION, IF DAMAGED. (NOT USED: I-005-10 THROUGH I-007-10 & I-009-10 AND P-005-10 THROUGH P-007-10 & P-009-10).

LOCATION OF ABANDONED/DESTROYED INCLINOMETER AND/OR PIEZOMETER (B-05-01, B-05-12, B-05-16, B-035-0-09, B-037-I-09, AND B-037-A-09, B-038-A-09, B-107, B-108A, B-203, B-204, B-05-08) (A)

INCLINOMETER AND/OR PIEZOMETER TO BE REPLACED. THE FUTURE INSTALLATION WILL HAVE THE SAME DESIGNATION PRECEDED BY LETTER 'A' (B-05-02, B-05-04, B-107, I-003-10)

NOTE:
THE DEVELOPER NEEDS TO PROTECT ALL THE INSTRUMENTS AND REPLACE ANY IF DAMAGED, PER SCOPE REQUIREMENTS.

0 25 50 100
HORIZONTAL SCALE IN FEET

DRAWN CDS CHECKED JN

INSTRUMENTATION PLAN
CUYAHOGA RIVER WEST BANK

CUY-90-14.90

1/4

61/93

P:\82119\geotechnical\sheets\82119ZP410 Addendum 7 - Revision A.dgn 11/21/2013 8:08:35 AM csteck

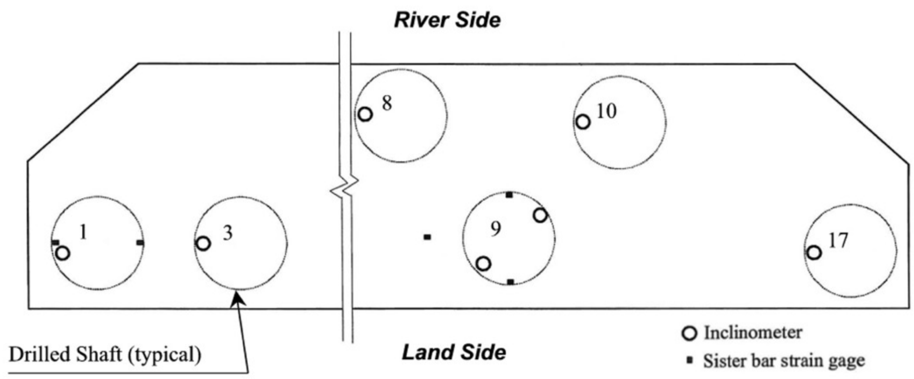


Figure 2. Pier cap with the location of inclinometers and strain gauges.

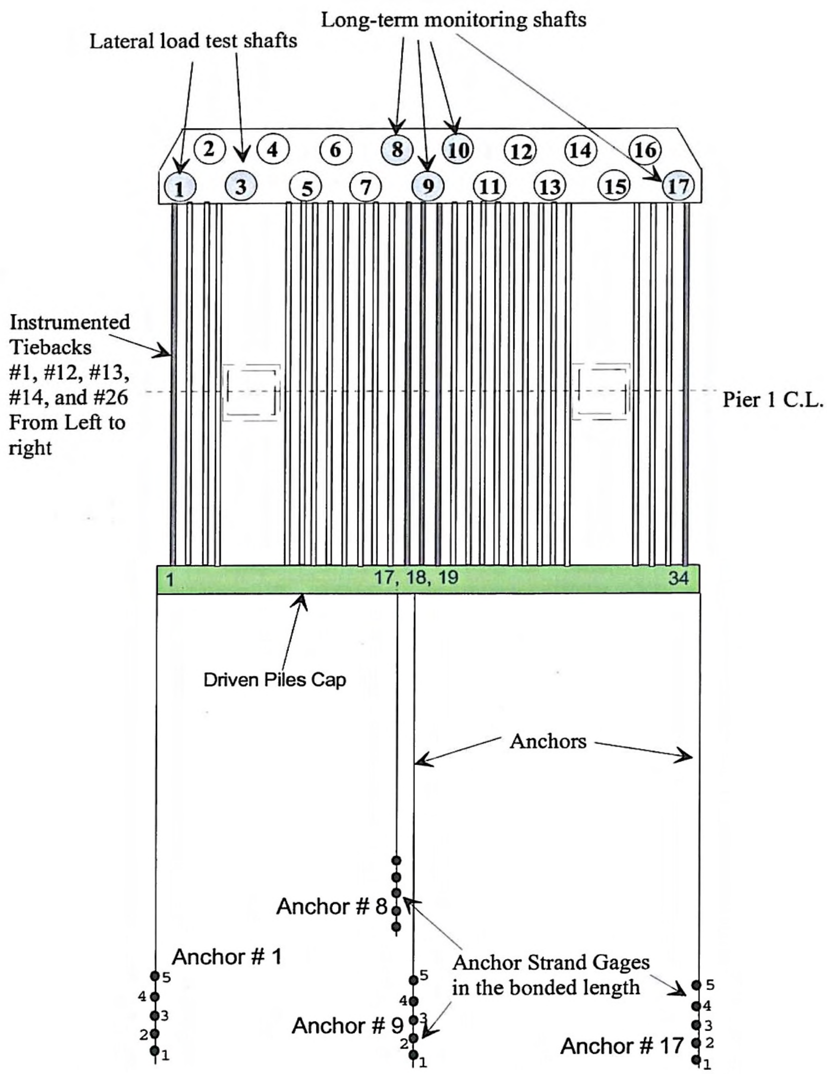


Figure 3. Plan of the stabilization system showing the locations of the instrumented foundation elements.

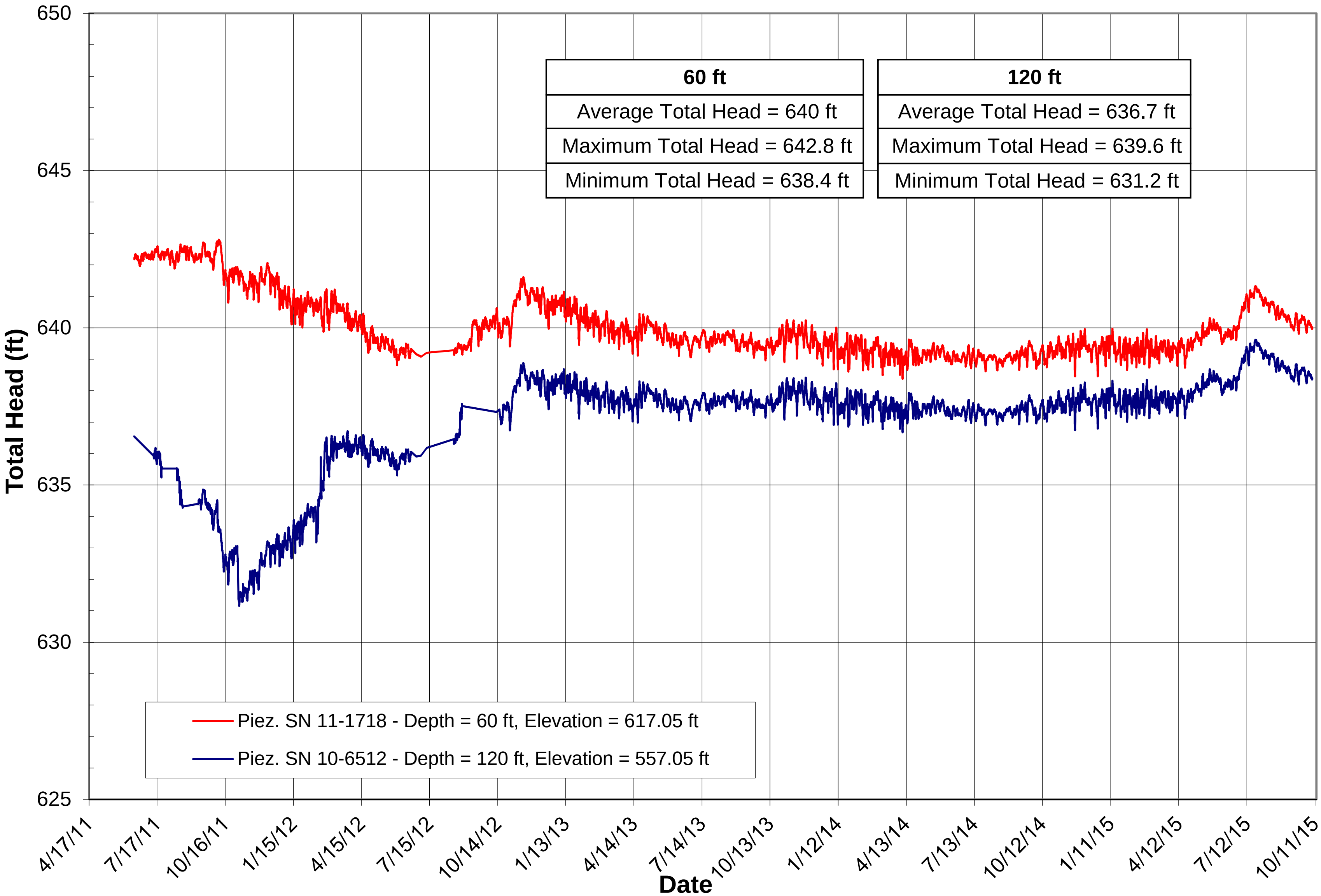
Figure 4. Aggregate stockpile east of the ODOT right-of-way (October 23, 2015)

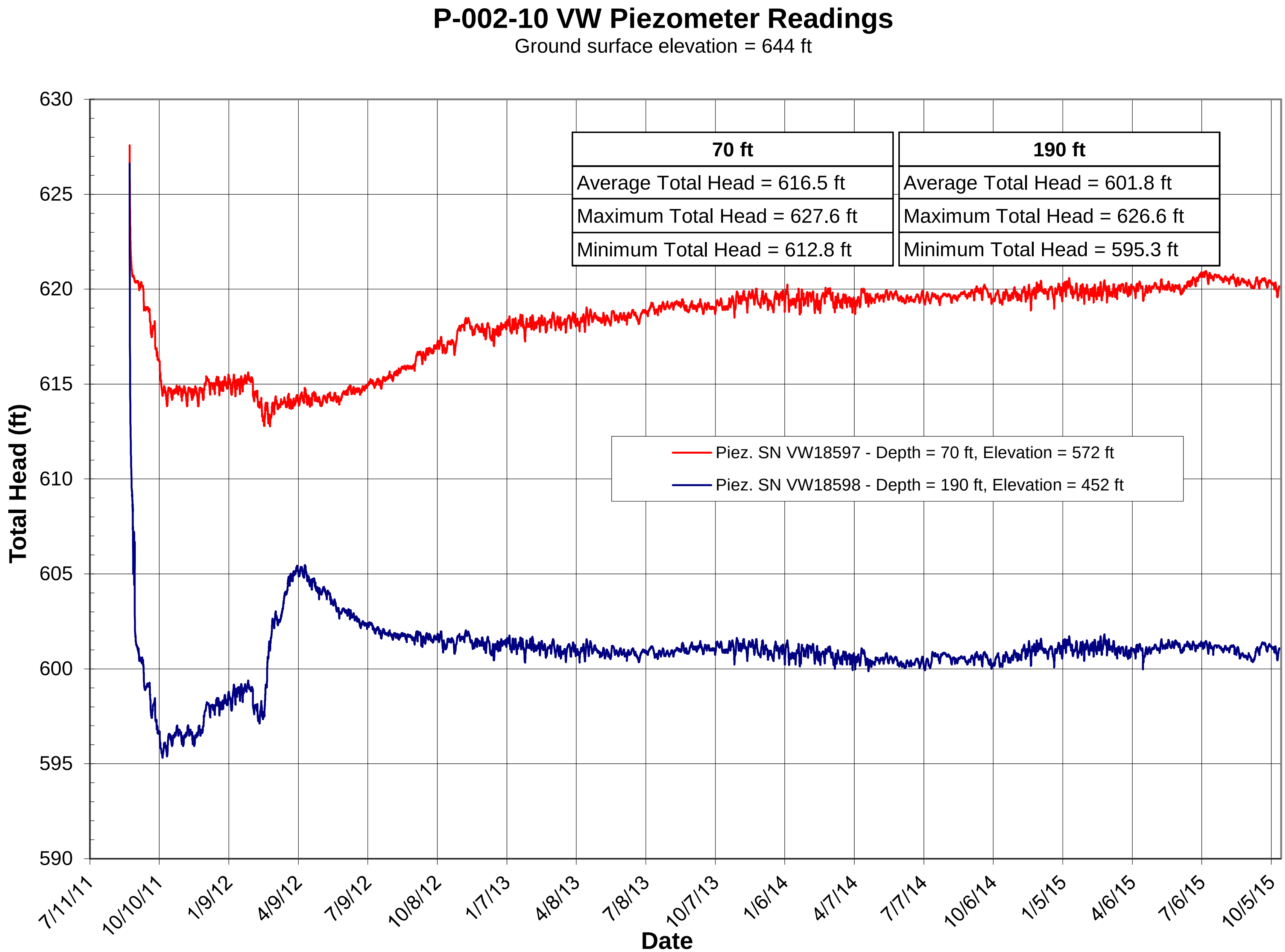
Figure 5. Aggregate stockpile near ODOT's east right-of-way fence (October 23, 2015)

APPENDIX B
PLOTS OF INSTRUMENT READINGS
DISCUSSED IN THE REPORT

P-001-10 VW Piezometer Readings

Ground surface elevation = 677.05 ft




P-002-10 VW Piezometer Readings
Ground surface elevation = 644 ft
70 ft
Average Total Head = 616.5 ft
Maximum Total Head = 627.6 ft
Minimum Total Head = 612.8 ft
190 ft
Average Total Head = 601.8 ft
Maximum Total Head = 626.6 ft
Minimum Total Head = 595.3 ft
Piez. SN VW18597 - Depth = 70 ft, Elevation = 572 ft
Piez. SN VW18598 - Depth = 190 ft, Elevation = 452 ft
Total Head (ft)
630
625
620
615
610
605
600
595
590
Date
7/11/11
10/10/11
1/9/12
4/9/12
7/9/12
10/8/12
1/7/13
4/8/13
7/8/13
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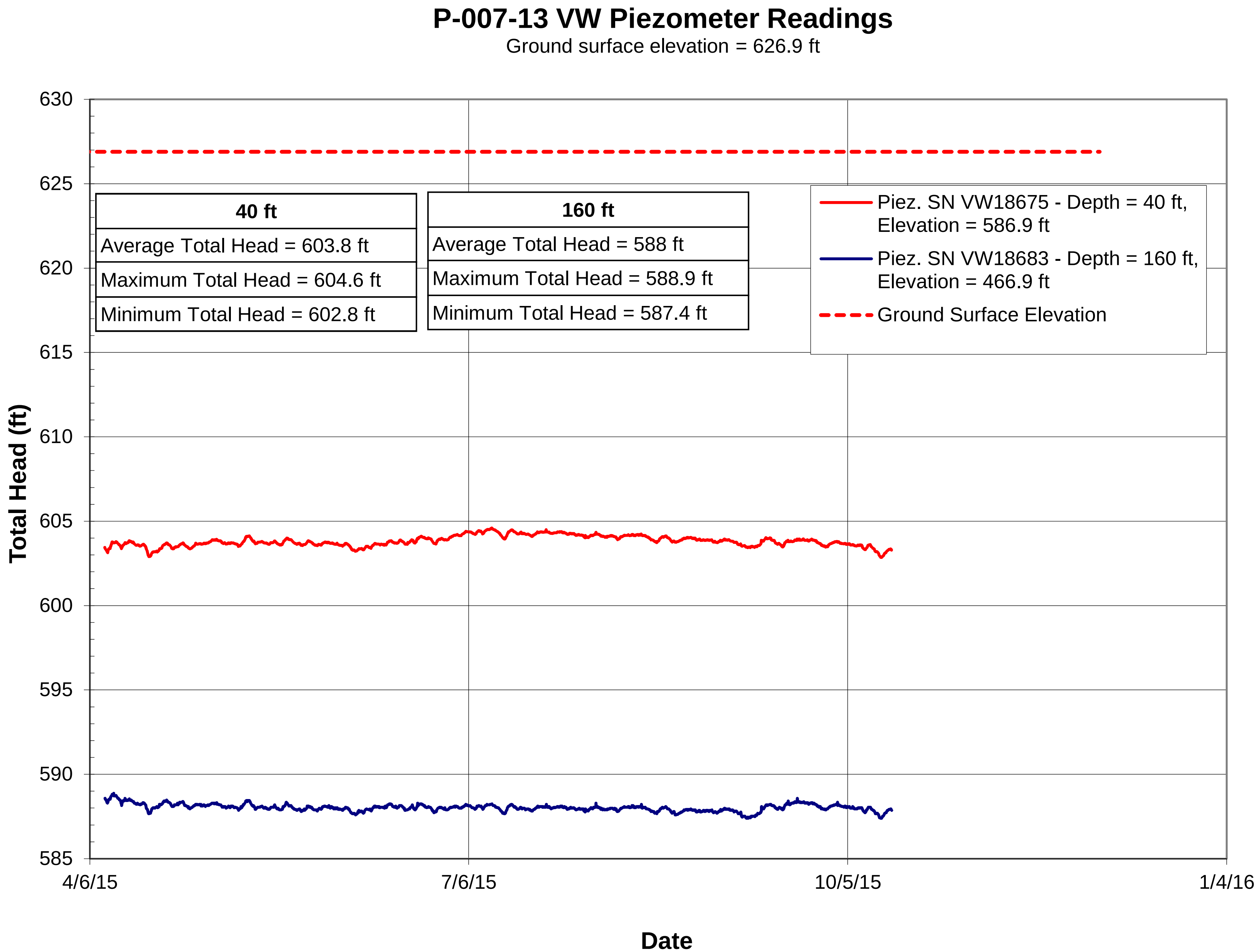
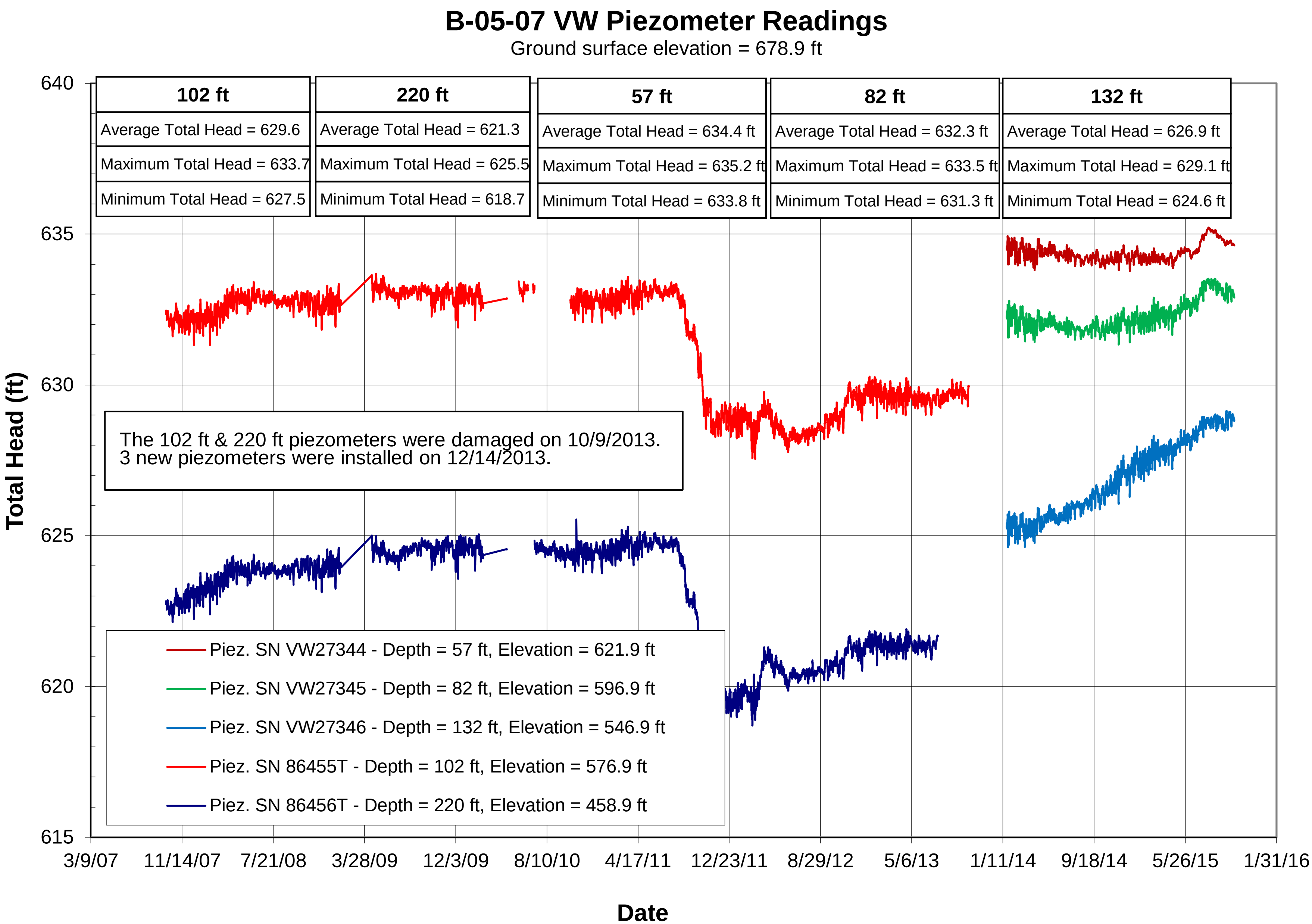
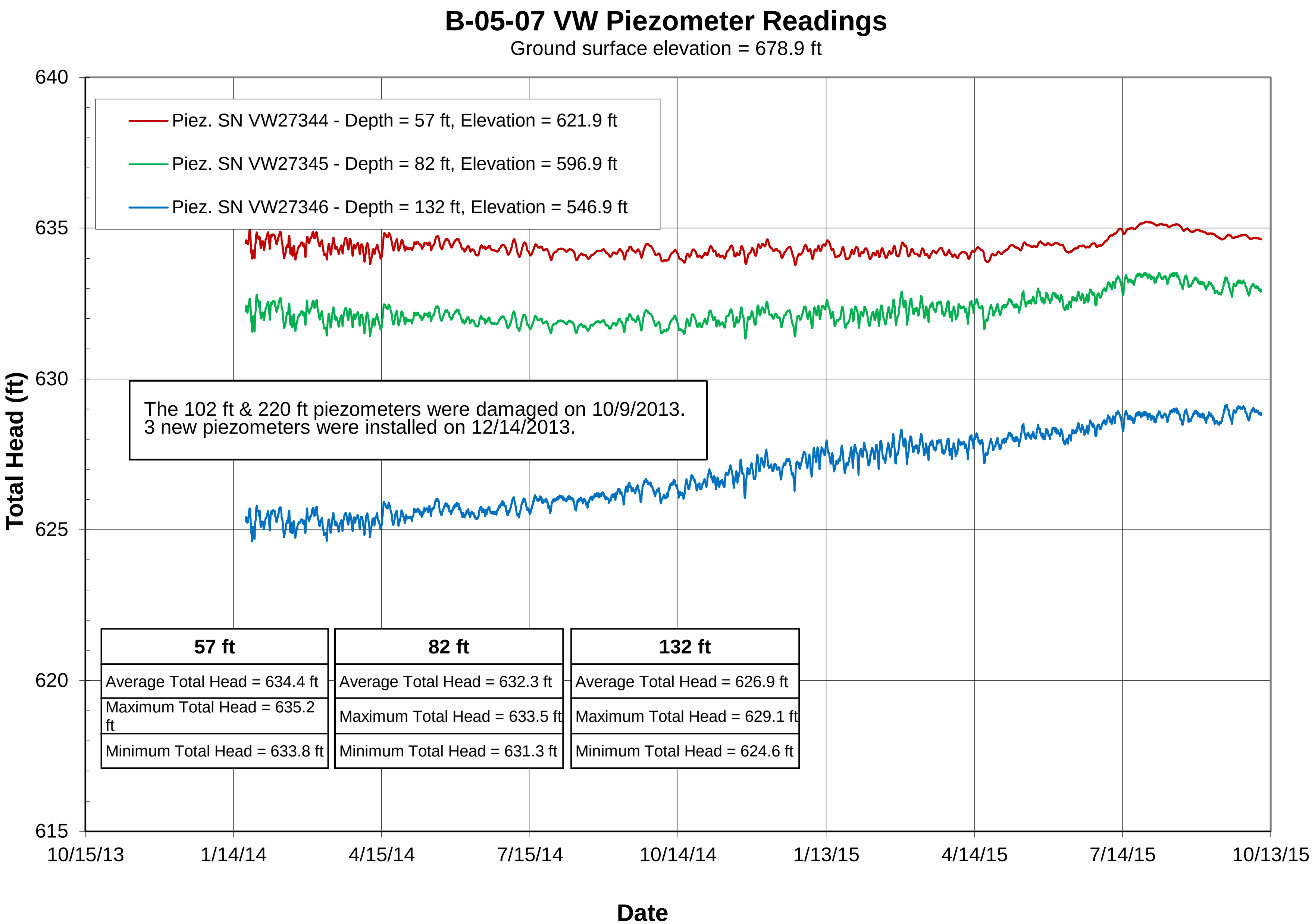
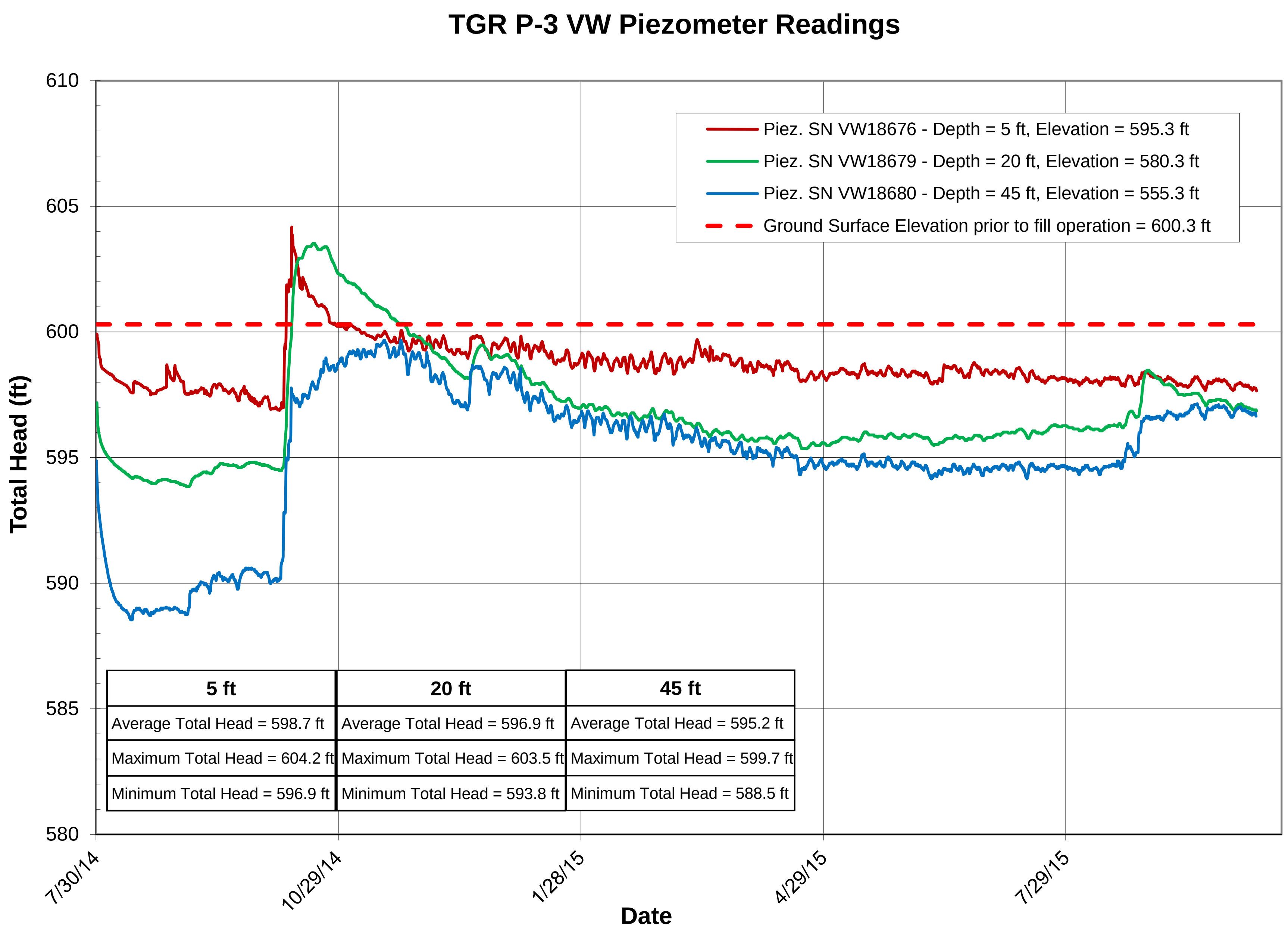
4/6/15
7/6/15
10/5/15


P-007-13 VW Piezometer Readings
Ground surface elevation = 626.9 ft
40 ft
Average Total Head = 603.8 ft
Maximum Total Head = 604.6 ft
Minimum Total Head = 602.8 ft
160 ft
Average Total Head = 588 ft
Maximum Total Head = 588.9 ft
Minimum Total Head = 587.4 ft
Piez. SN VW18675 - Depth = 40 ft, Elevation = 586.9 ft
Piez. SN VW18683 - Depth = 160 ft, Elevation = 466.9 ft
Ground Surface Elevation
Total Head (ft)
630
625
620
615
610
605
600
595
590
585
4/6/15
7/6/15
10/5/15
1/4/16
Date



B-05-07 VW Piezometer Readings
Ground surface elevation = 678.9 ft
102 ft
Average Total Head = 629.6
Maximum Total Head = 633.7
Minimum Total Head = 627.5
220 ft
Average Total Head = 621.3
Maximum Total Head = 625.5
Minimum Total Head = 618.7
57 ft
Average Total Head = 634.4 ft
Maximum Total Head = 635.2 ft
Minimum Total Head = 633.8 ft
82 ft
Average Total Head = 632.3 ft
Maximum Total Head = 633.5 ft
Minimum Total Head = 631.3 ft
132 ft
Average Total Head = 626.9 ft
Maximum Total Head = 629.1 ft
Minimum Total Head = 624.6 ft
The 102 ft & 220 ft piezometers were damaged on 10/9/2013.
3 new piezometers were installed on 12/14/2013.
Piez. SN VW27344 - Depth = 57 ft, Elevation = 621.9 ft
Piez. SN VW27345 - Depth = 82 ft, Elevation = 596.9 ft
Piez. SN VW27346 - Depth = 132 ft, Elevation = 546.9 ft
Piez. SN 86455T - Depth = 102 ft, Elevation = 576.9 ft
Piez. SN 86456T - Depth = 220 ft, Elevation = 458.9 ft
Total Head (ft)
640
635
630
625
620
615
3/9/07
11/14/07
7/21/08
3/28/09
12/3/09
8/10/10
4/17/11
12/23/11
8/29/12
5/6/13
1/11/14
9/18/14
5/26/15
1/31/16
Date


B-05-07 VW Piezometer Readings
Ground surface elevation = 678.9 ft
Piez. SN VW27344 - Depth = 57 ft, Elevation = 621.9 ft
Piez. SN VW27345 - Depth = 82 ft, Elevation = 596.9 ft
Piez. SN VW27346 - Depth = 132 ft, Elevation = 546.9 ft
The 102 ft & 220 ft piezometers were damaged on 10/9/2013.
3 new piezometers were installed on 12/14/2013.
57 ft
Average Total Head = 634.4 ft
Maximum Total Head = 635.2 ft
Minimum Total Head = 633.8 ft
82 ft
Average Total Head = 632.3 ft
Maximum Total Head = 633.5 ft
Minimum Total Head = 631.3 ft
132 ft
Average Total Head = 626.9 ft
Maximum Total Head = 629.1 ft
Minimum Total Head = 624.6 ft
Total Head (ft)
640
635
630
625
620
615
10/15/13
1/14/14
4/15/14
7/15/14
10/14/14
1/13/15
4/14/15
7/14/15
10/13/15
Date


TGR P-3 VW Piezometer Readings
610
605
600
595
590
585
580
Total Head (ft)
Piez. SN VW18676 - Depth = 5 ft, Elevation = 595.3 ft
Piez. SN VW18679 - Depth = 20 ft, Elevation = 580.3 ft
Piez. SN VW18680 - Depth = 45 ft, Elevation = 555.3 ft
Ground Surface Elevation prior to fill operation = 600.3 ft
5 ft
Average Total Head = 598.7 ft
Maximum Total Head = 604.2 ft
Minimum Total Head = 596.9 ft
20 ft
Average Total Head = 596.9 ft
Maximum Total Head = 603.5 ft
Minimum Total Head = 593.8 ft
45 ft
Average Total Head = 595.2 ft
Maximum Total Head = 599.7 ft
Minimum Total Head = 588.5 ft
7/30/14
10/29/14
1/28/15
4/29/15
7/29/15
Date

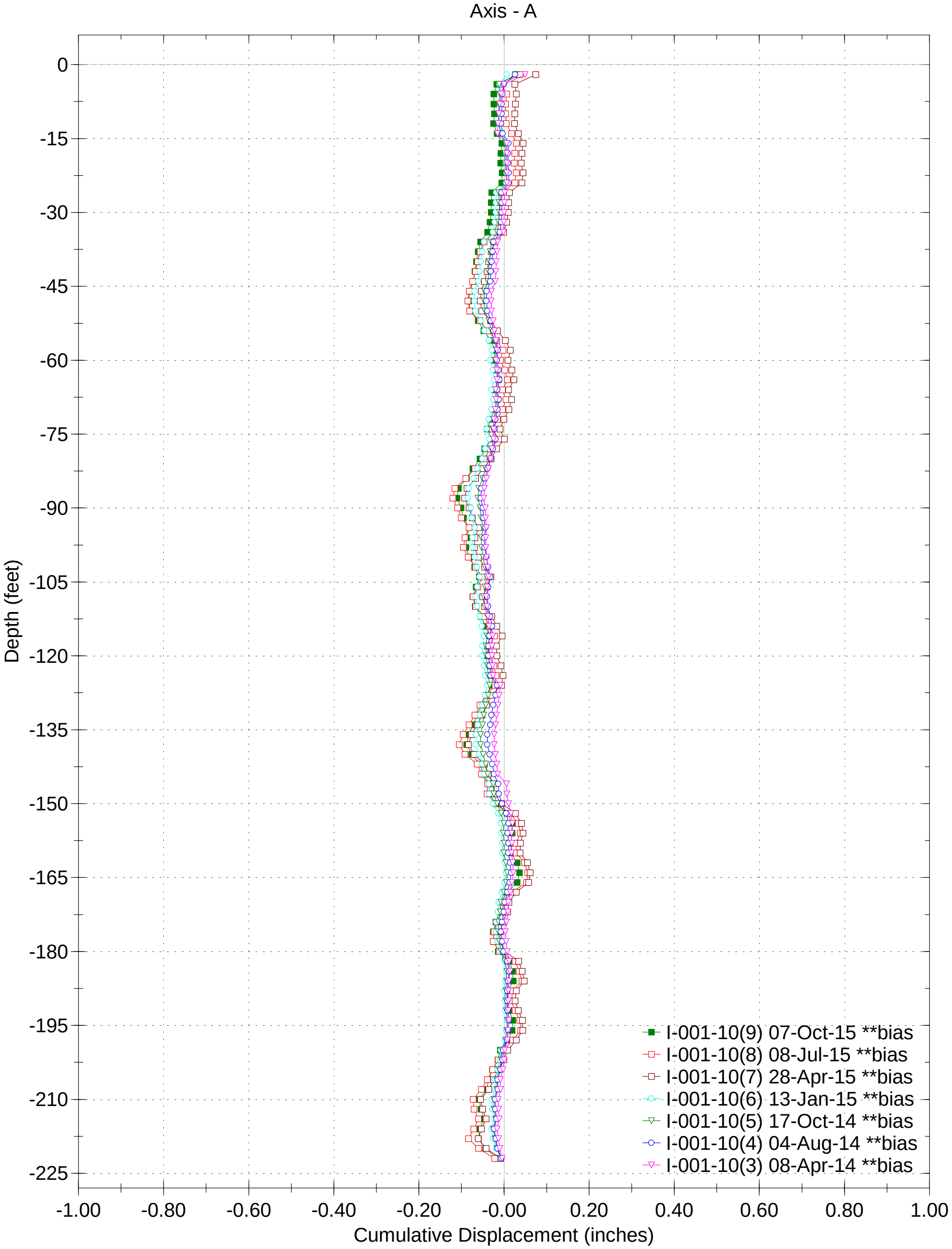
RST Instruments Ltd.

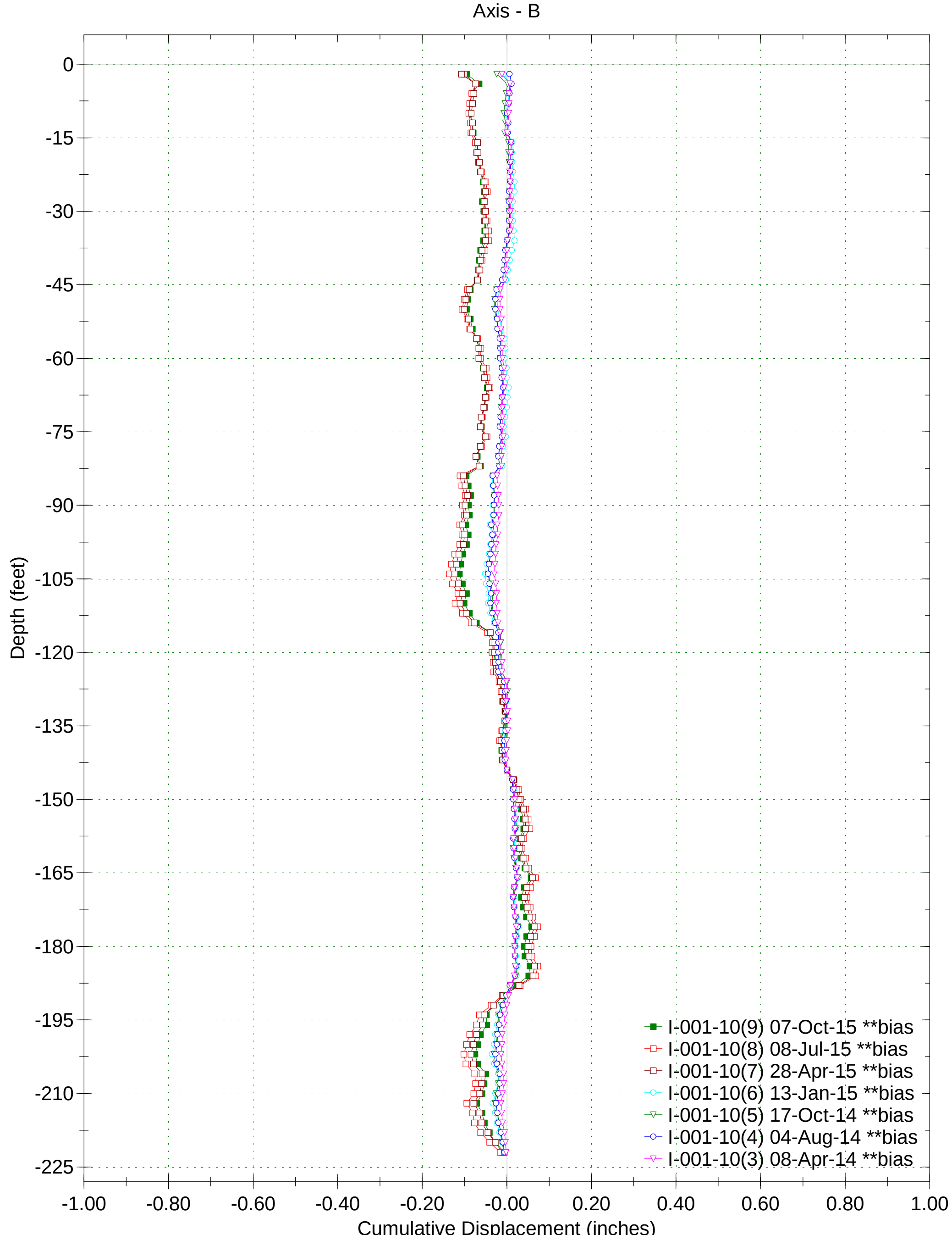
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : I-001-10
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing : 663346.19
Easting : 2189917.266
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 222.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 10 07:36
Applied Azimuth : 0.0 degrees





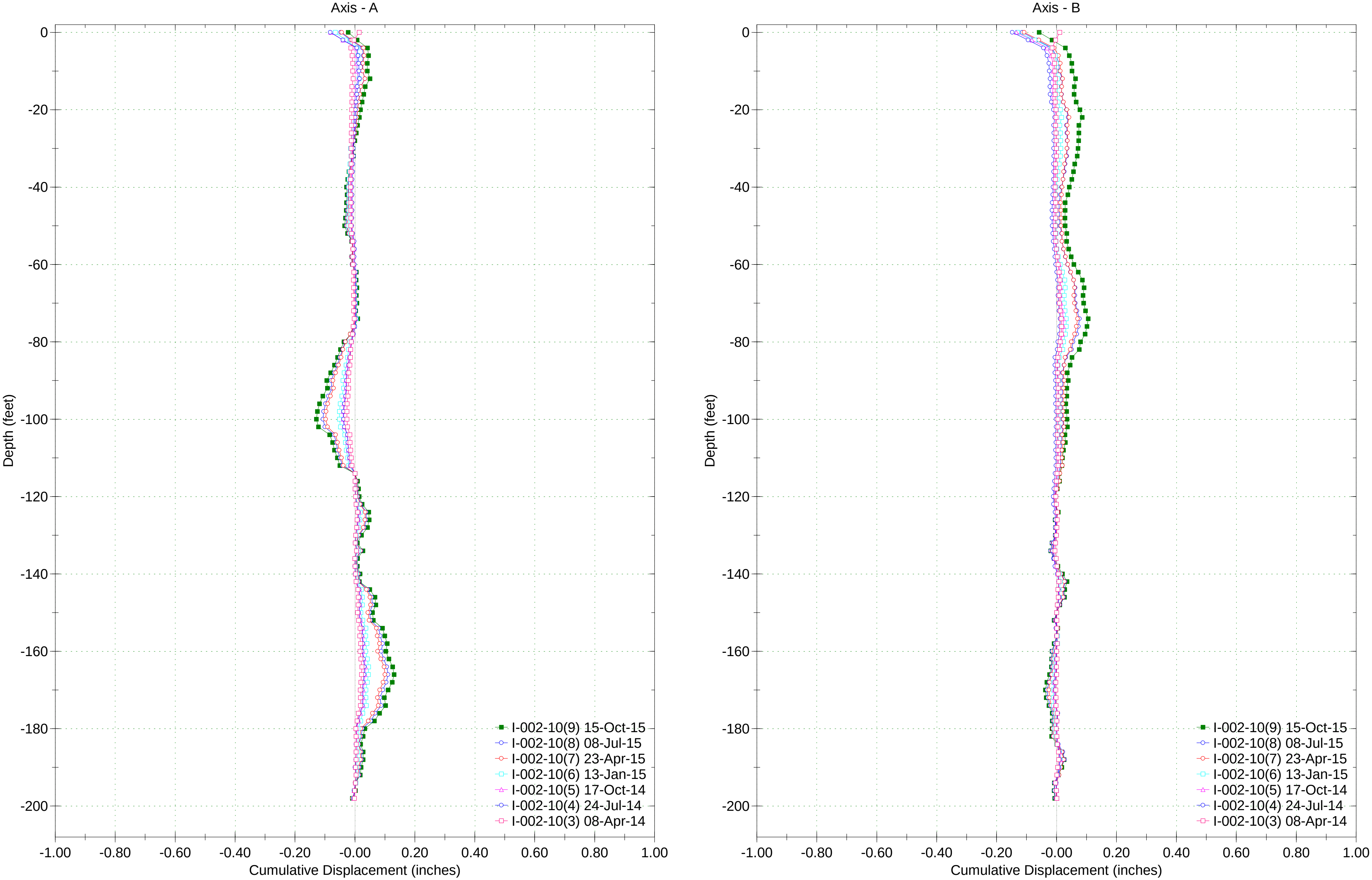
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : I-002-10
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing : 663622.262
Easting : 2189778.413
Collar :

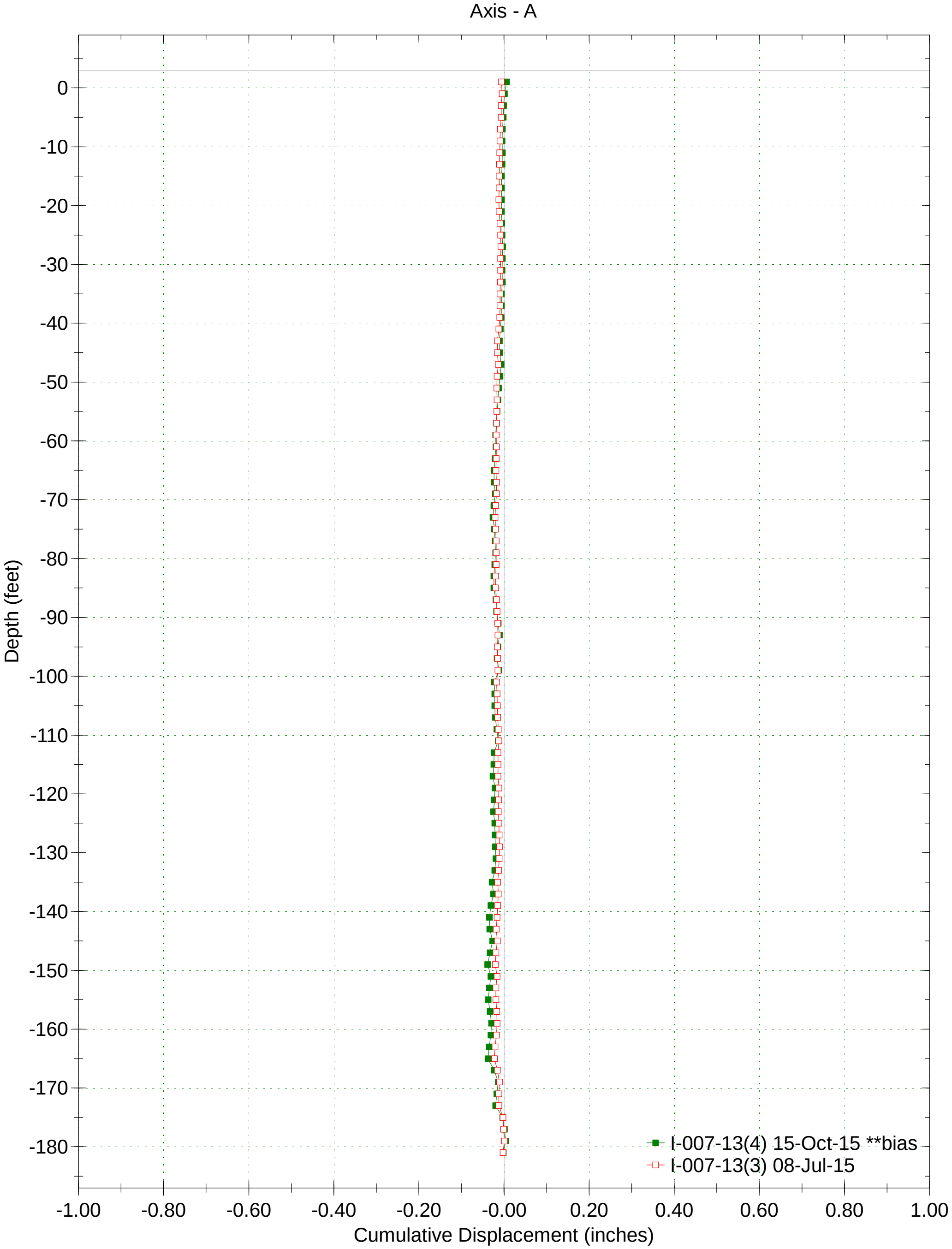
Spiral Correction : N/A
Collar Elevation : 2.0 feet
Borehole Total Depth : 200.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 09 09:59
Applied Azimuth : 0.0 degrees

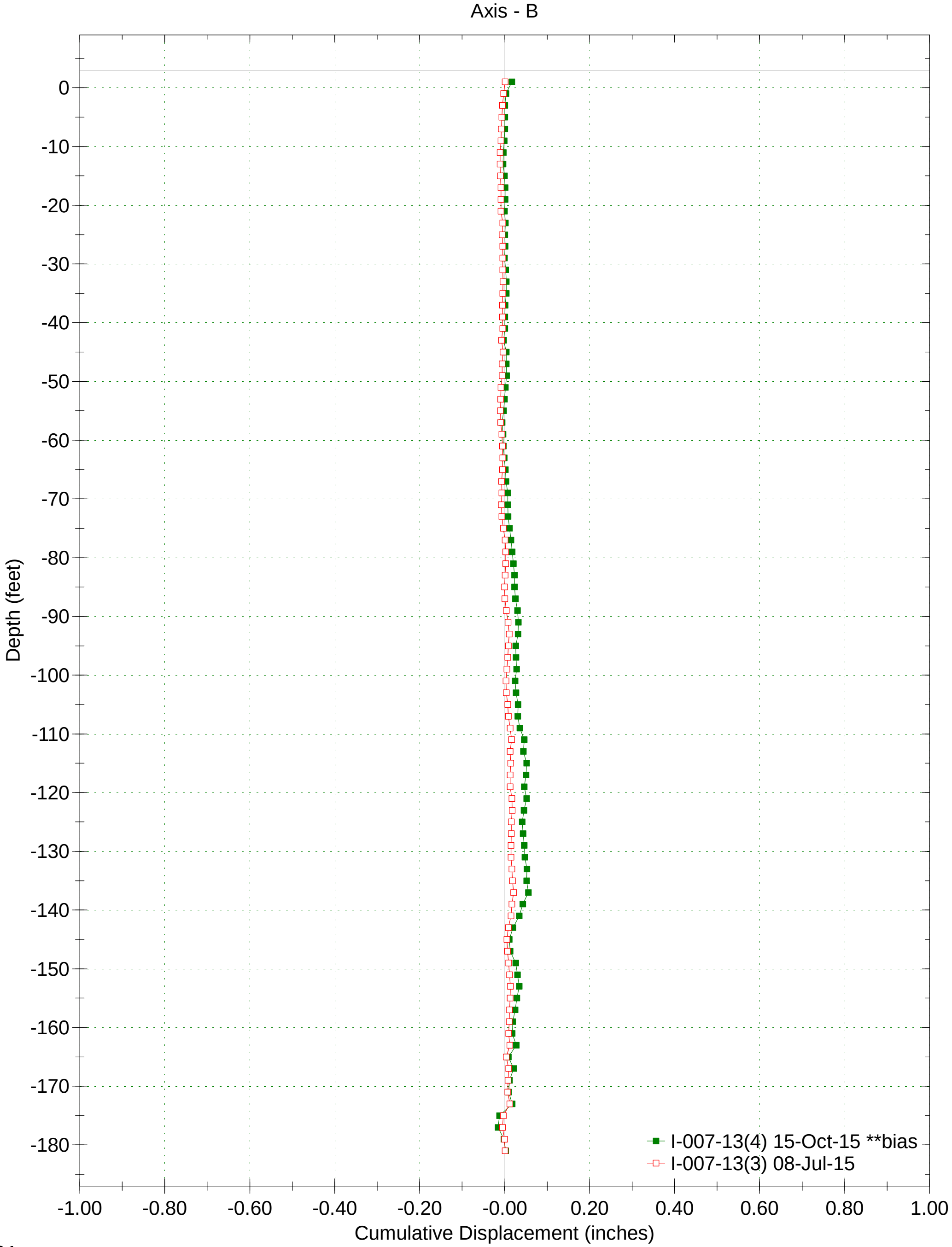


RST Instruments Ltd. | CUMULATIVE DISPLACEMENT | Inclinalysis v. 2.47.5

Borehole : I-007-13
Project : CUY-90-15-24
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 3.0 feet
Borehole Total Depth : 184.0 feet
A+ Groove Azimuth :
Base Reading : 2015 Apr 28 15:31
Applied Azimuth : 0.0 degrees





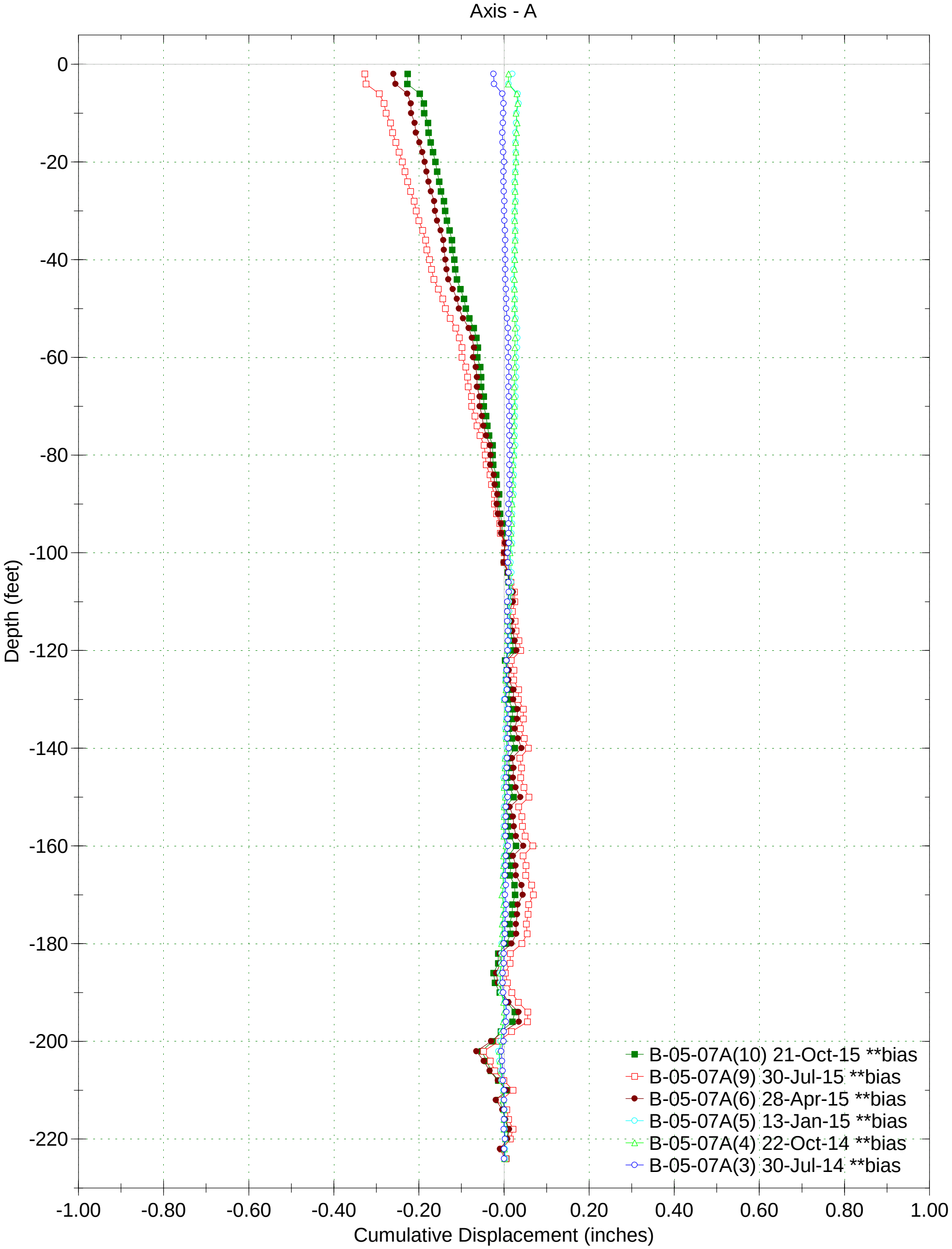
RST Instruments Ltd.

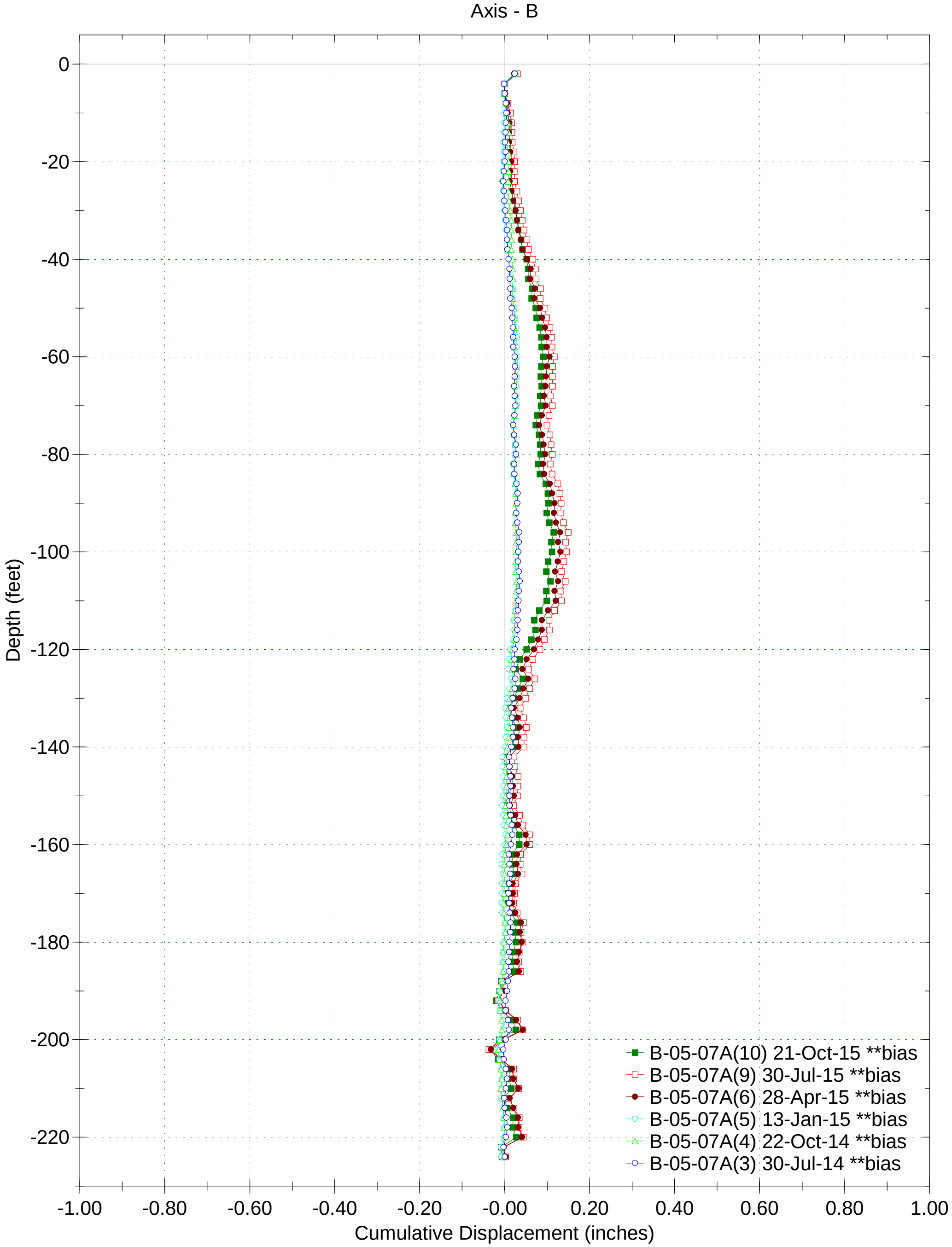
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : B-05-07A
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing : 663369.991
Easting : 2189805.799
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 224.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Apr 11 09:50
Applied Azimuth : 0.0 degrees





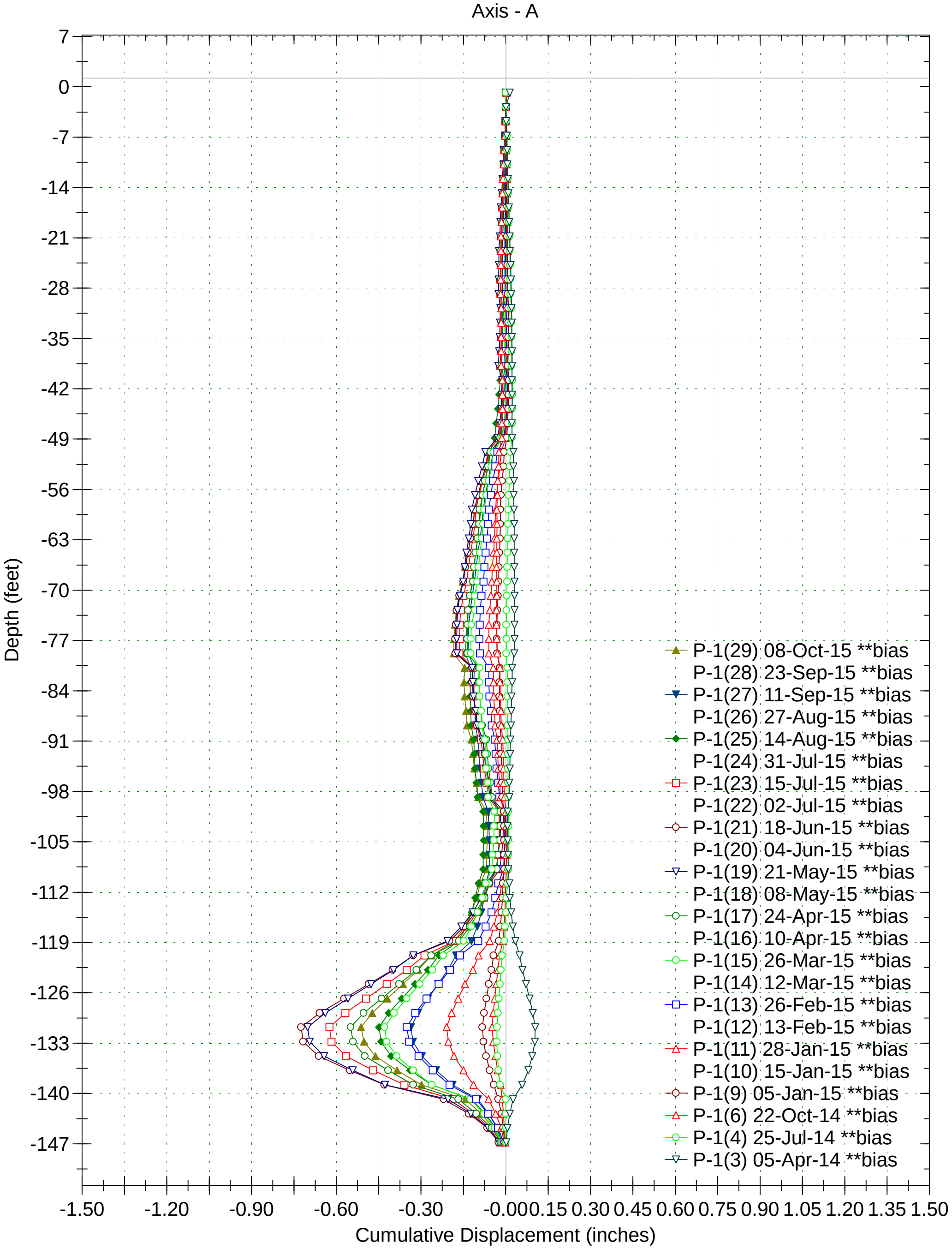
RST Instruments Ltd.

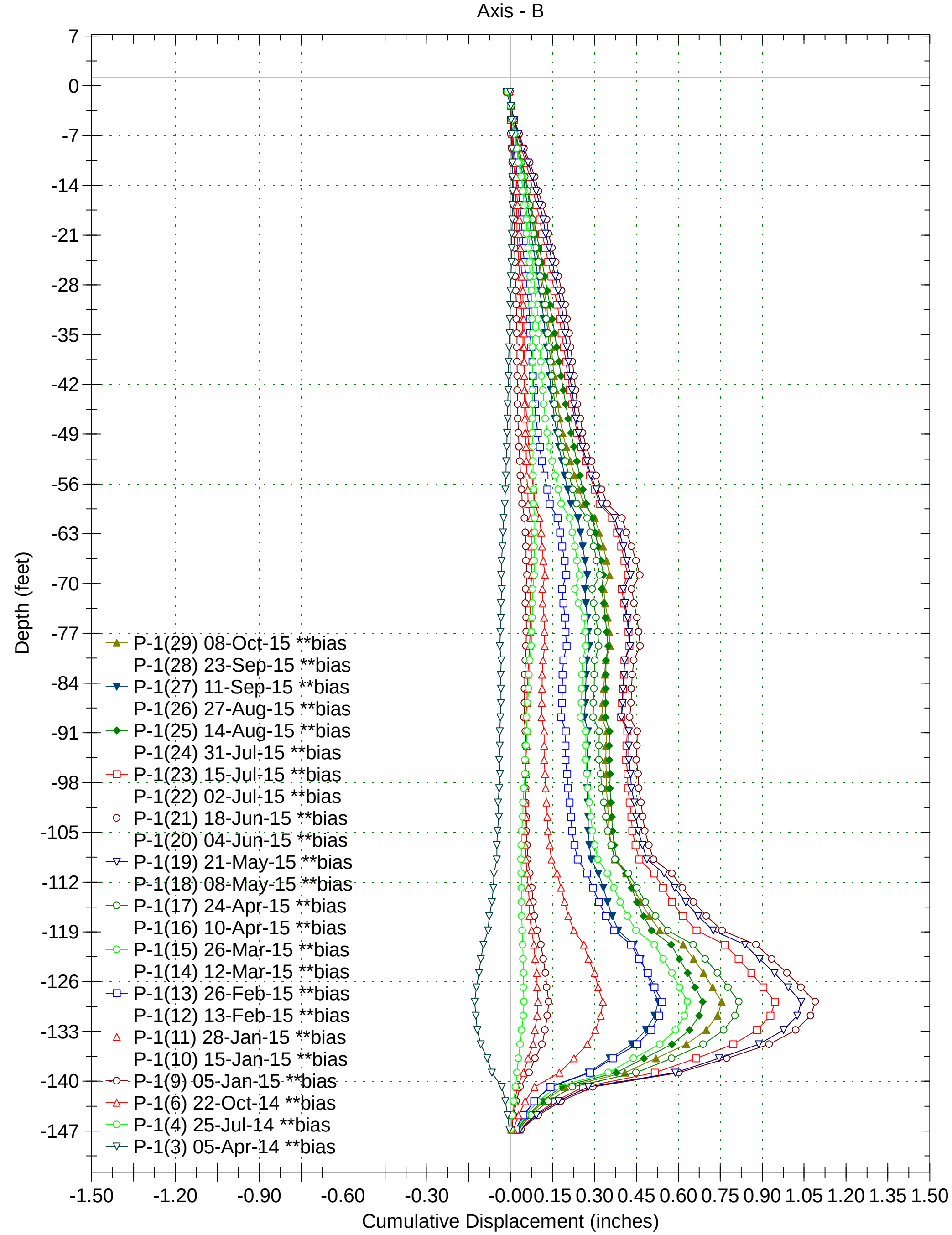
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

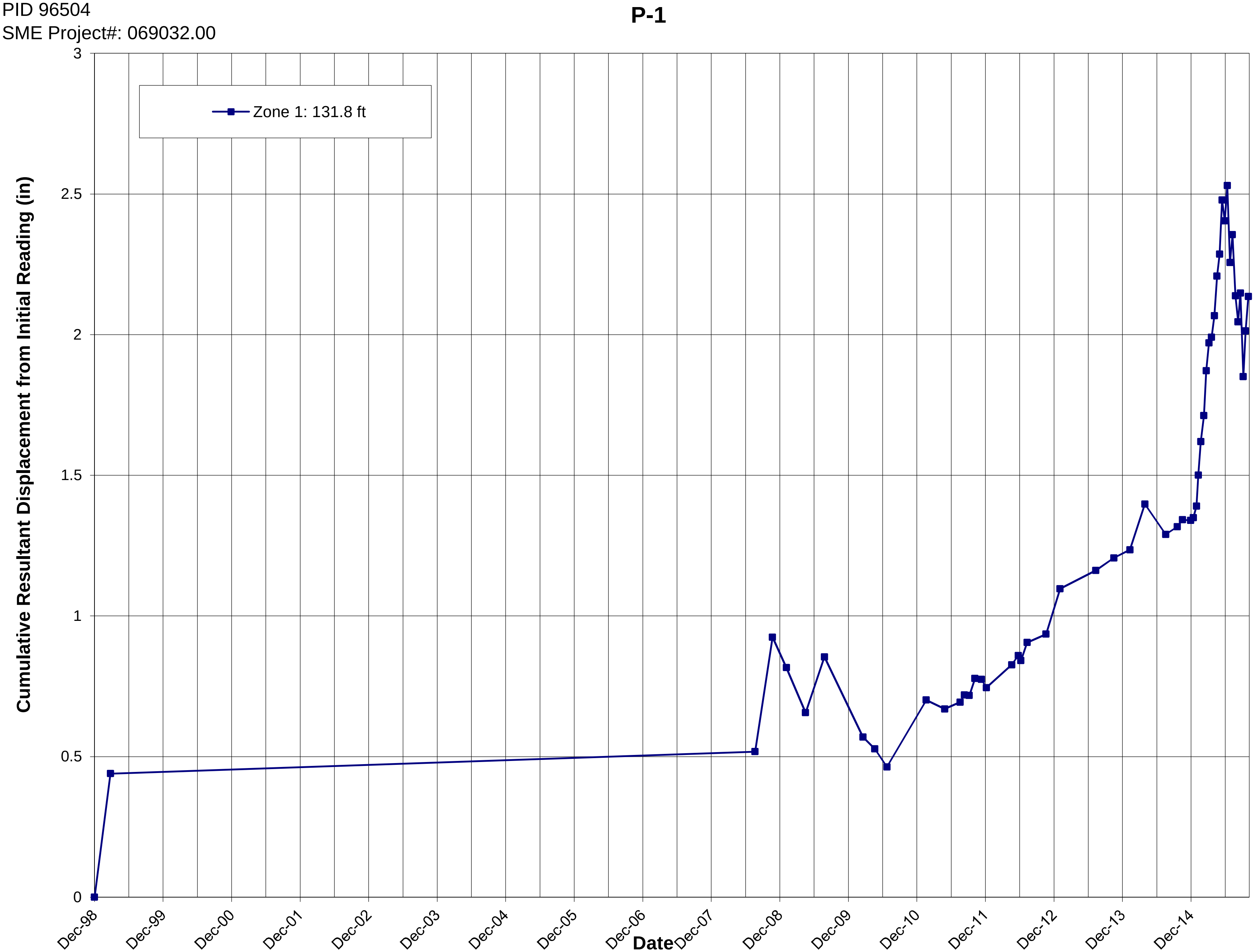
Borehole : P-1
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 22 10:47
Applied Azimuth : 0.0 degrees





CUY-90-15.24
PID 96504
SME Project#: 069032.00



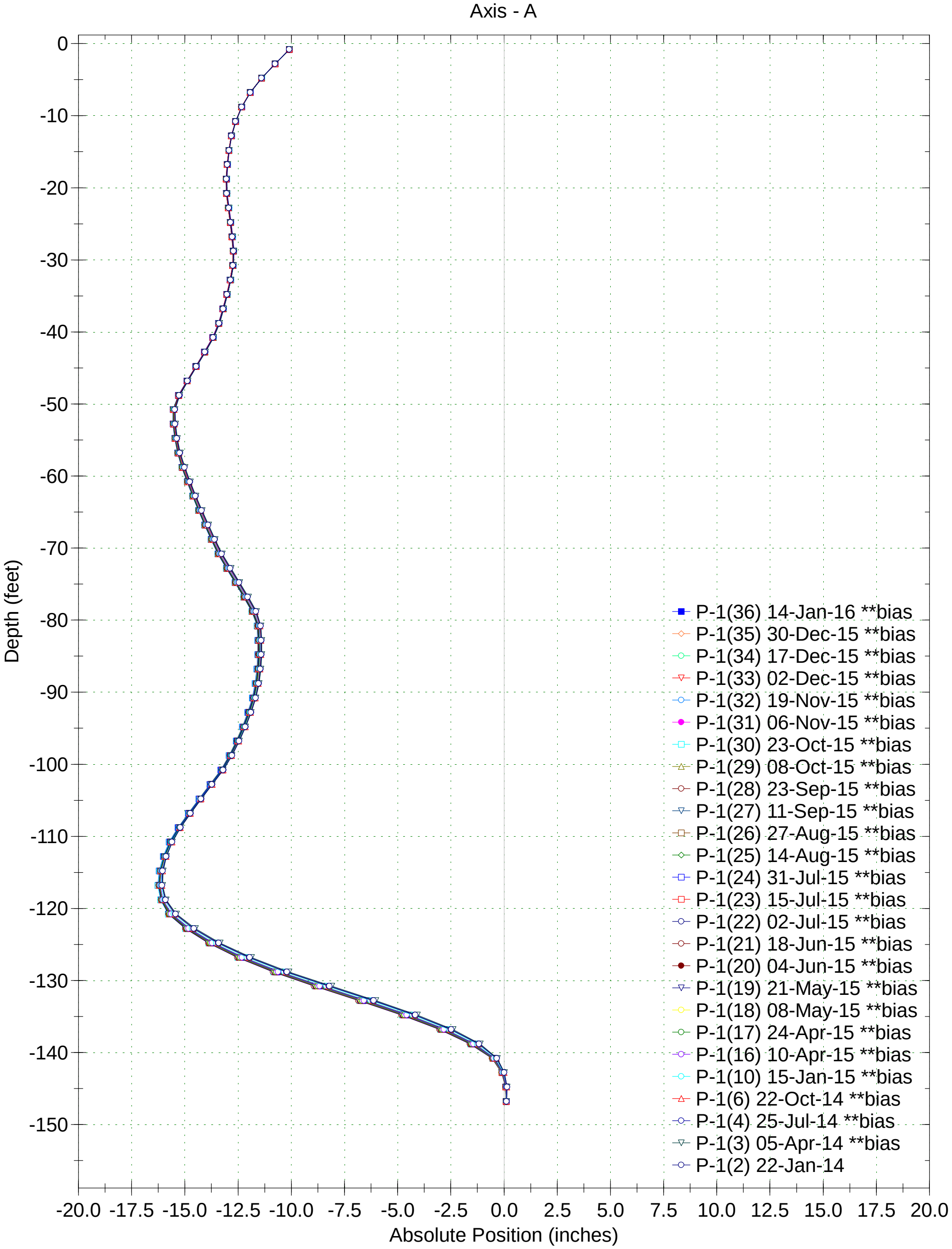
RST Instruments Ltd.

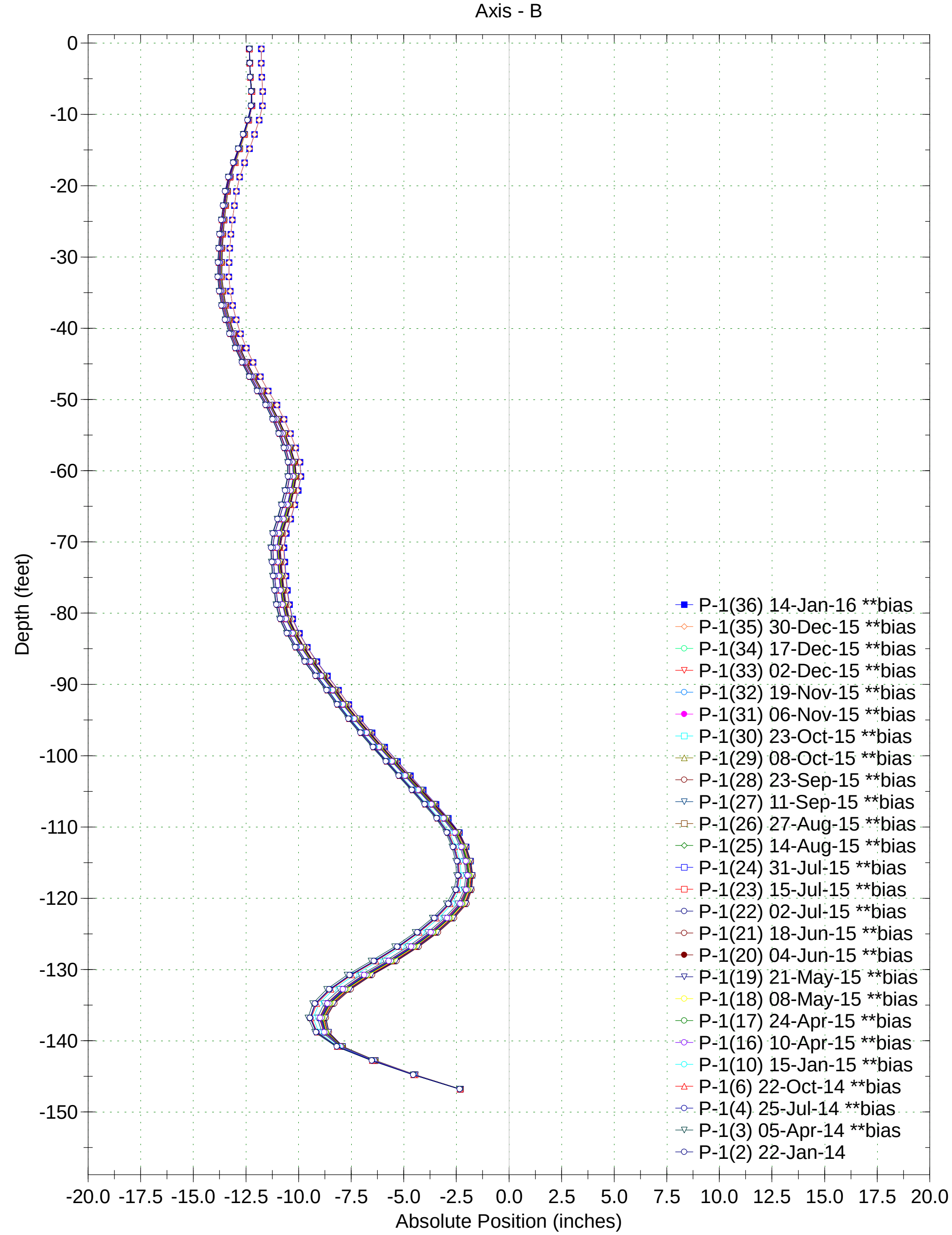
ABSOLUTE POSITION

Inclinalysis v. 2.47.5

Borehole : P-1
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 22 10:47
Applied Azimuth : 0.0 degrees





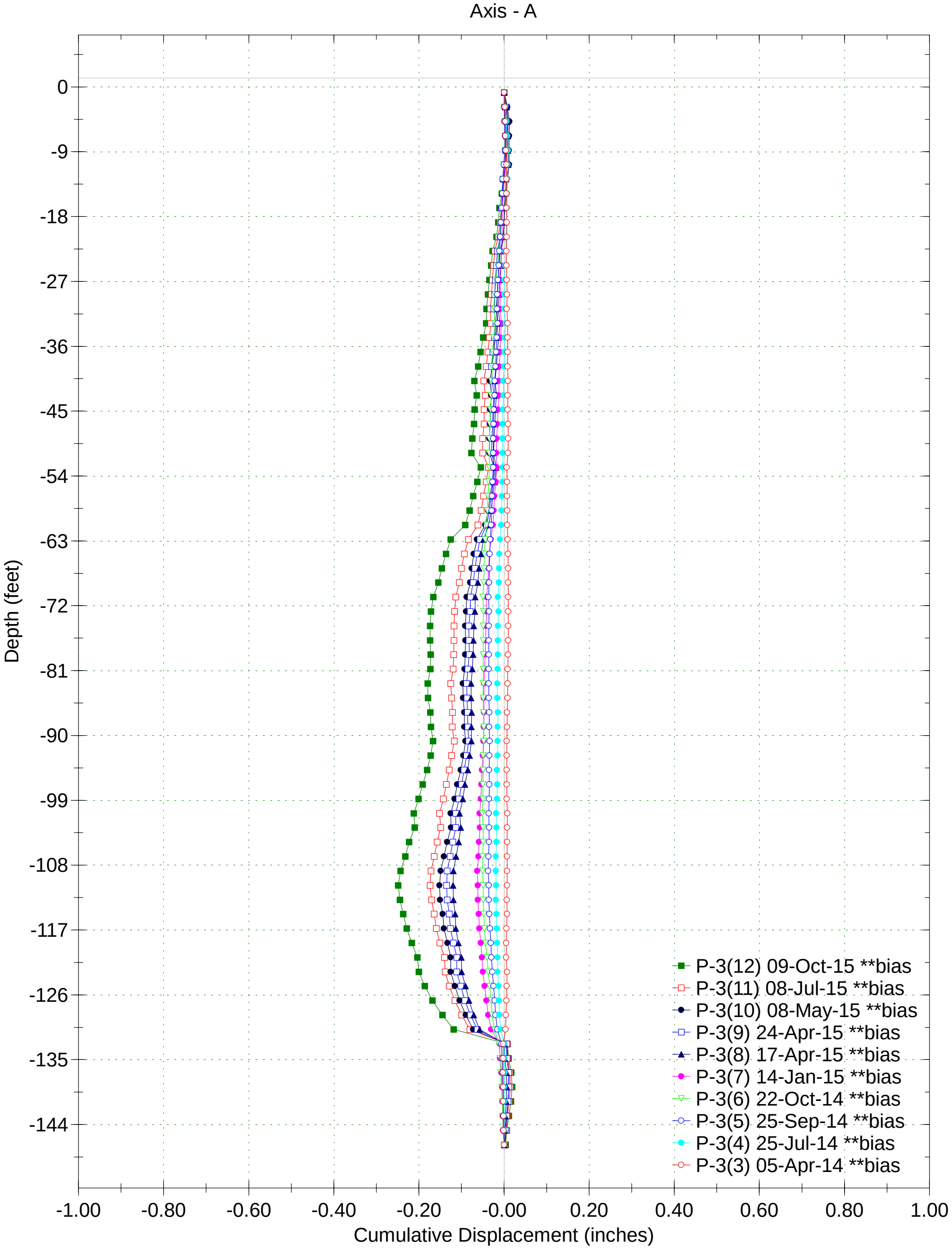
RST Instruments Ltd.

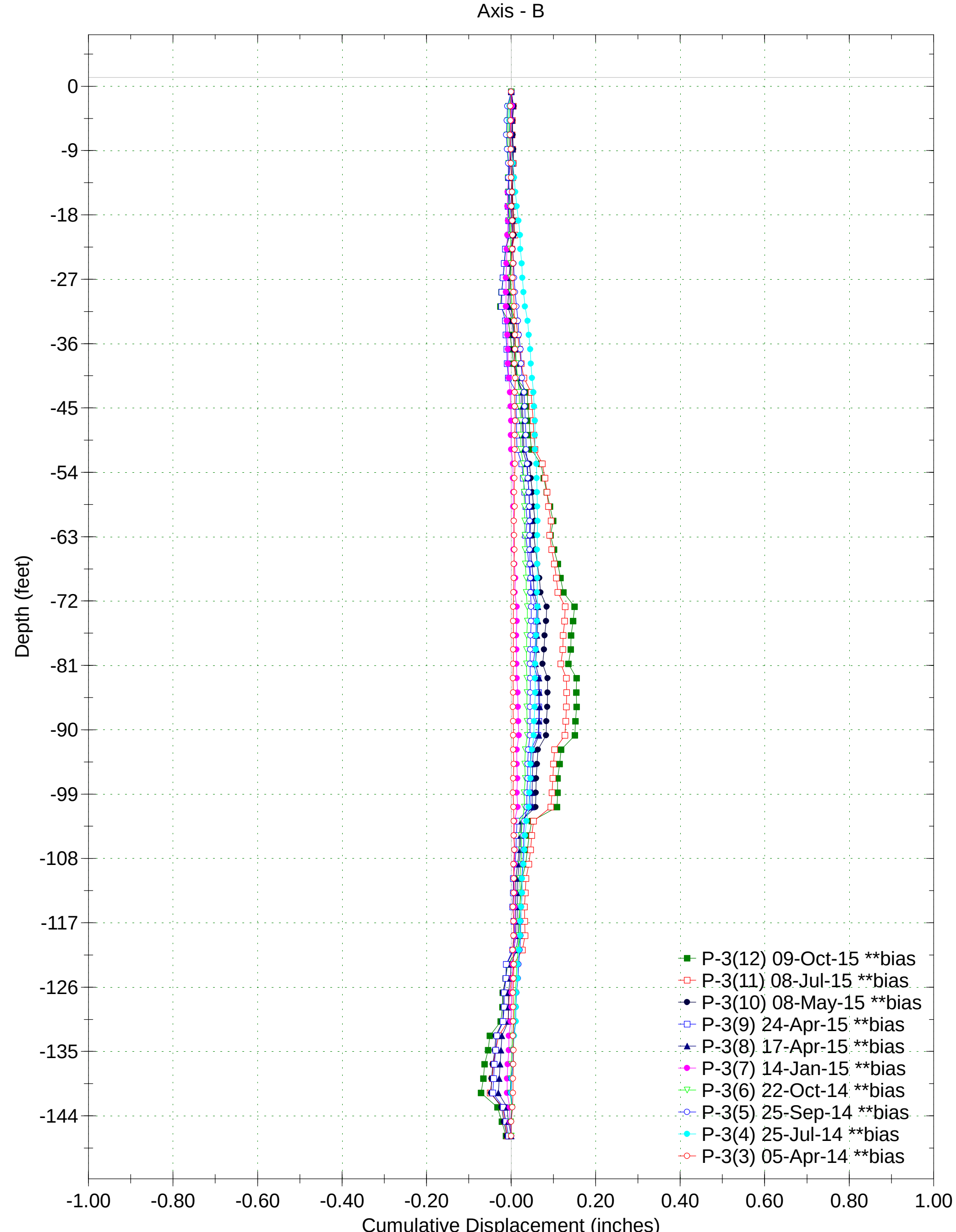
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : P-3
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 21 10:48
Applied Azimuth : 0.0 degrees





RST Instruments Ltd.

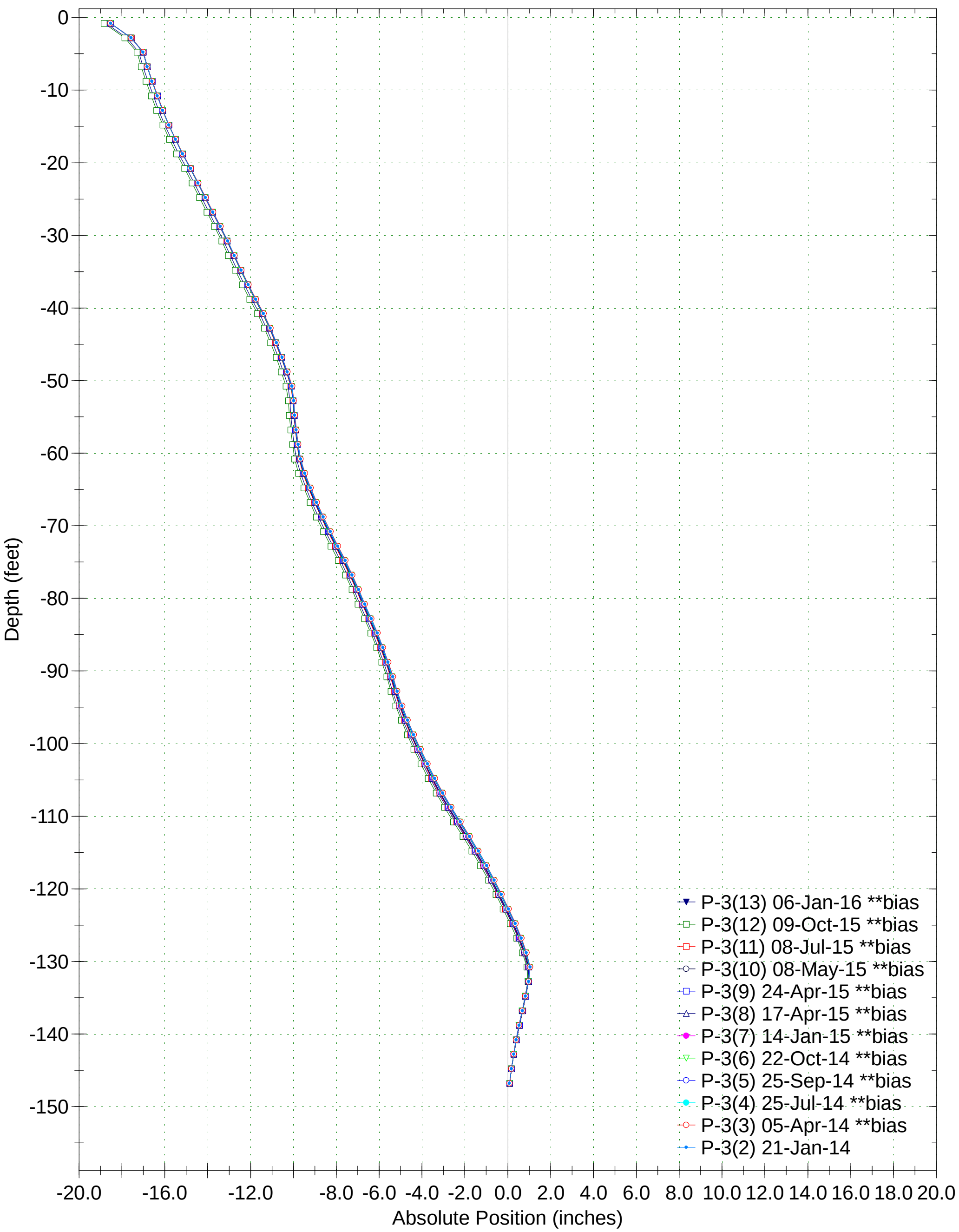
ABSOLUTE POSITION

Inclinalysis v. 2.47.5

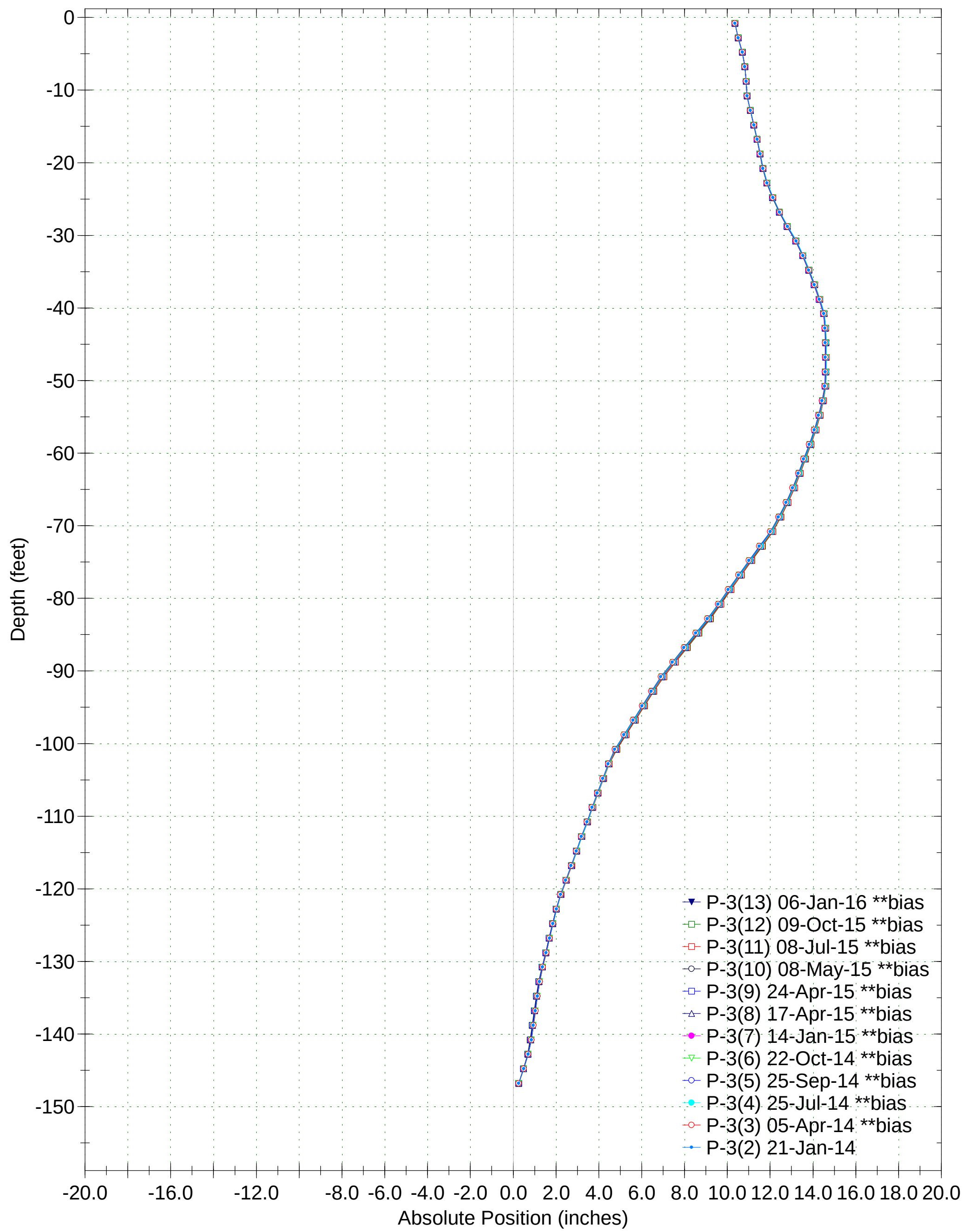
Borehole : P-3
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 21 10:48
Applied Azimuth : 0.0 degrees

Axis - A



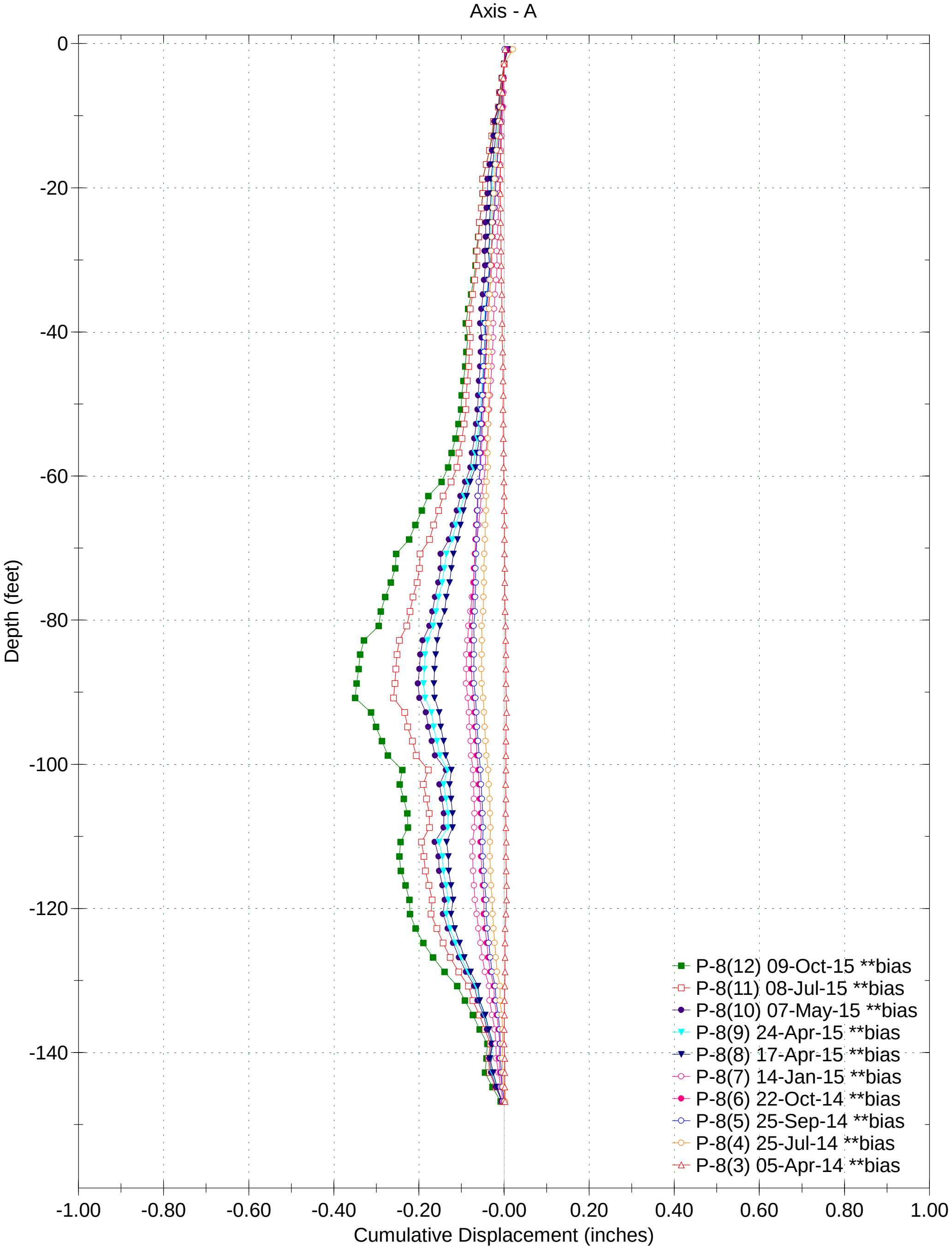
Axis - B

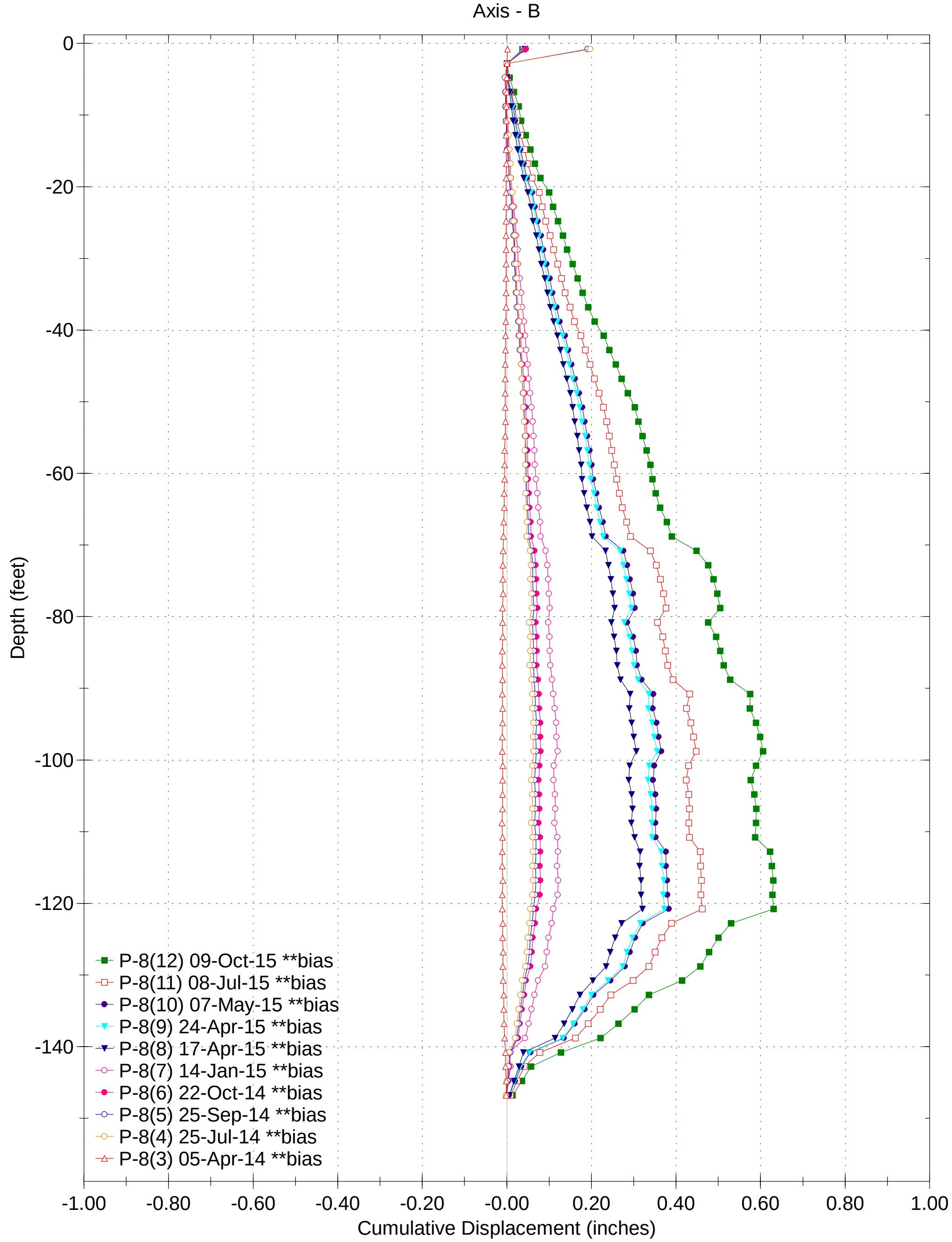


RST Instruments Ltd. | CUMULATIVE DISPLACEMENT | Inclinalysis v. 2.47.5

Borehole : P-8
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 16 10:23
Applied Azimuth : 0.0 degrees

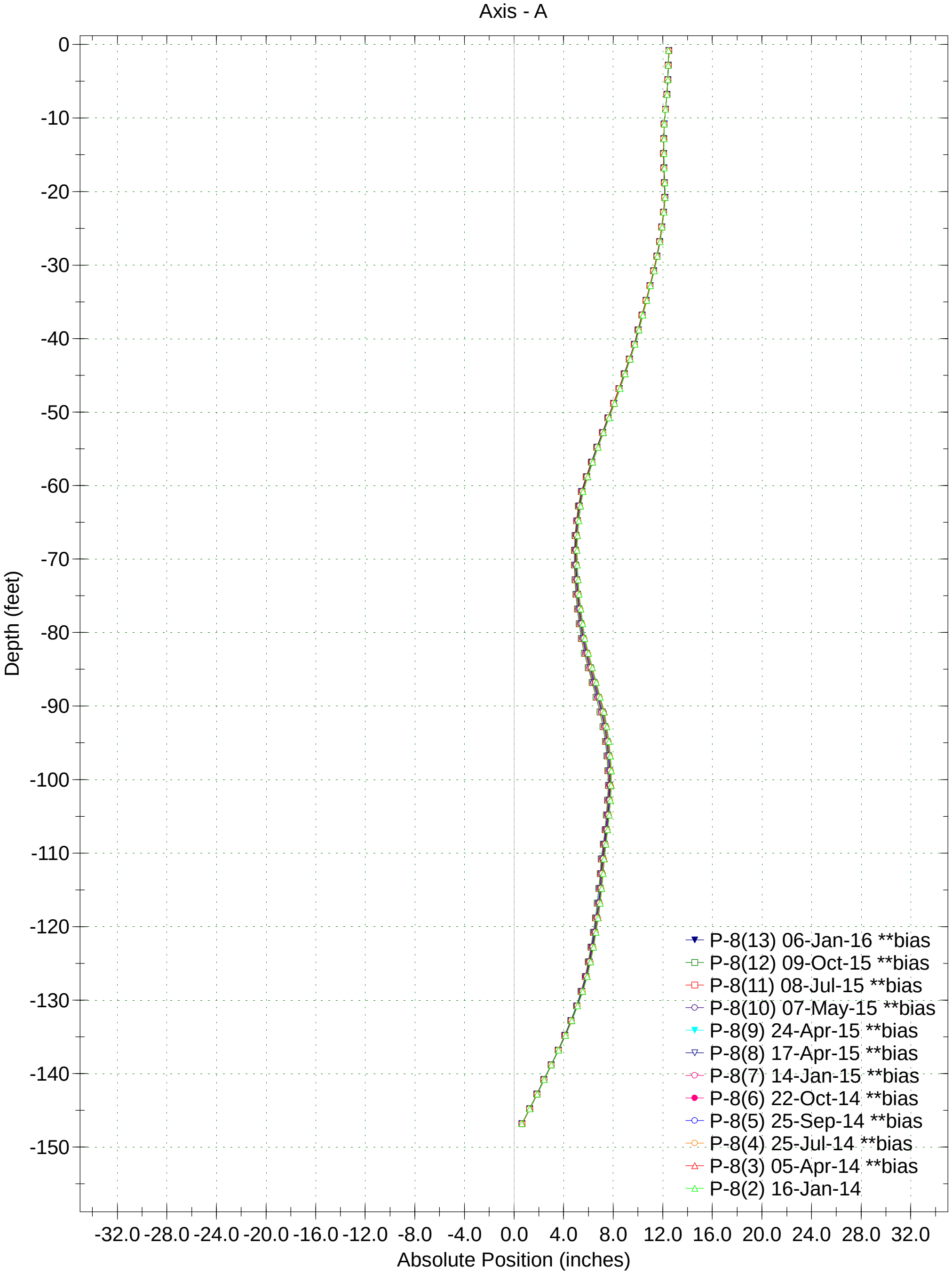


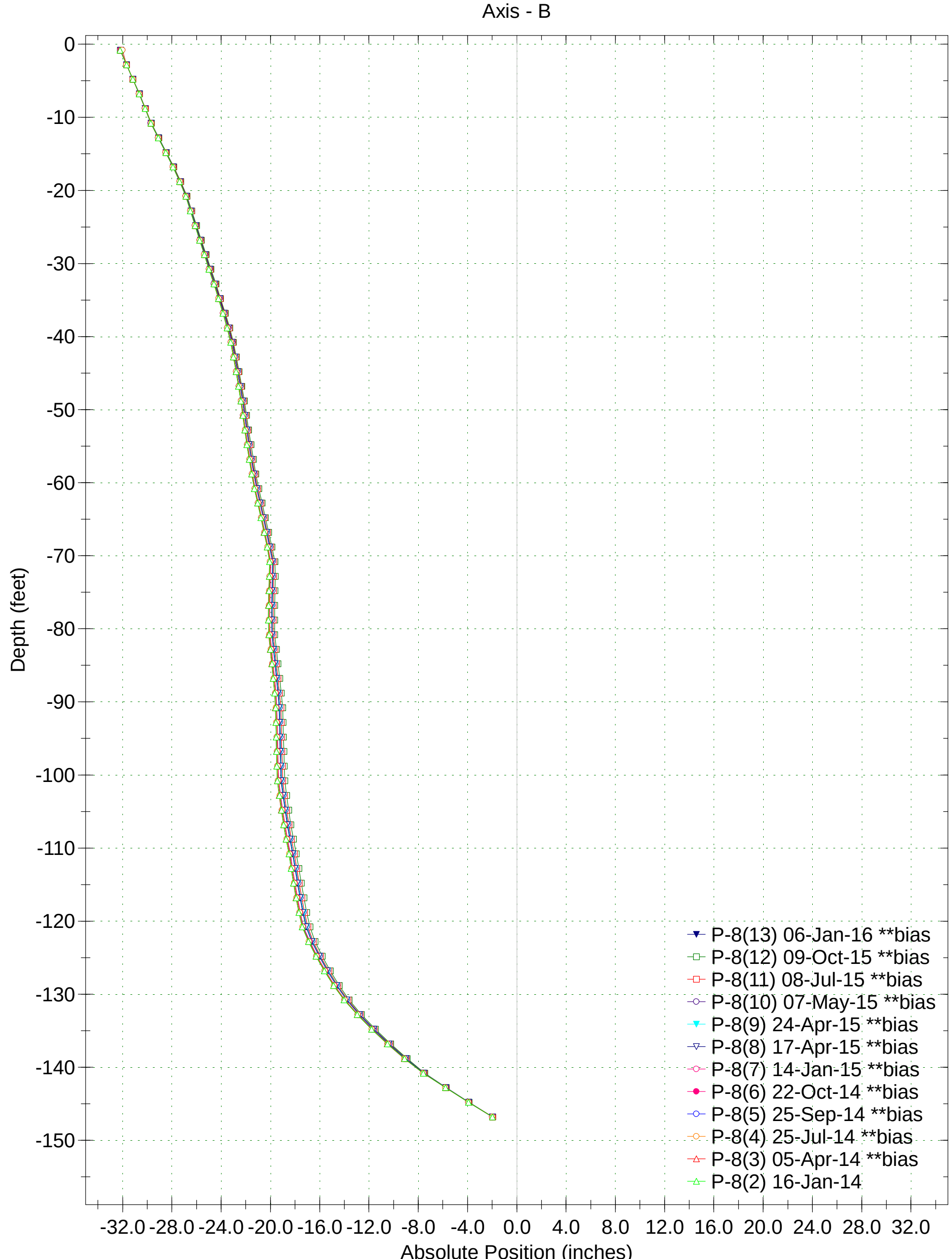


RST Instruments Ltd. | ABSOLUTE POSITION | Inclinalysis v. 2.47.5

Borehole : P-8
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 16 10:23
Applied Azimuth : 0.0 degrees





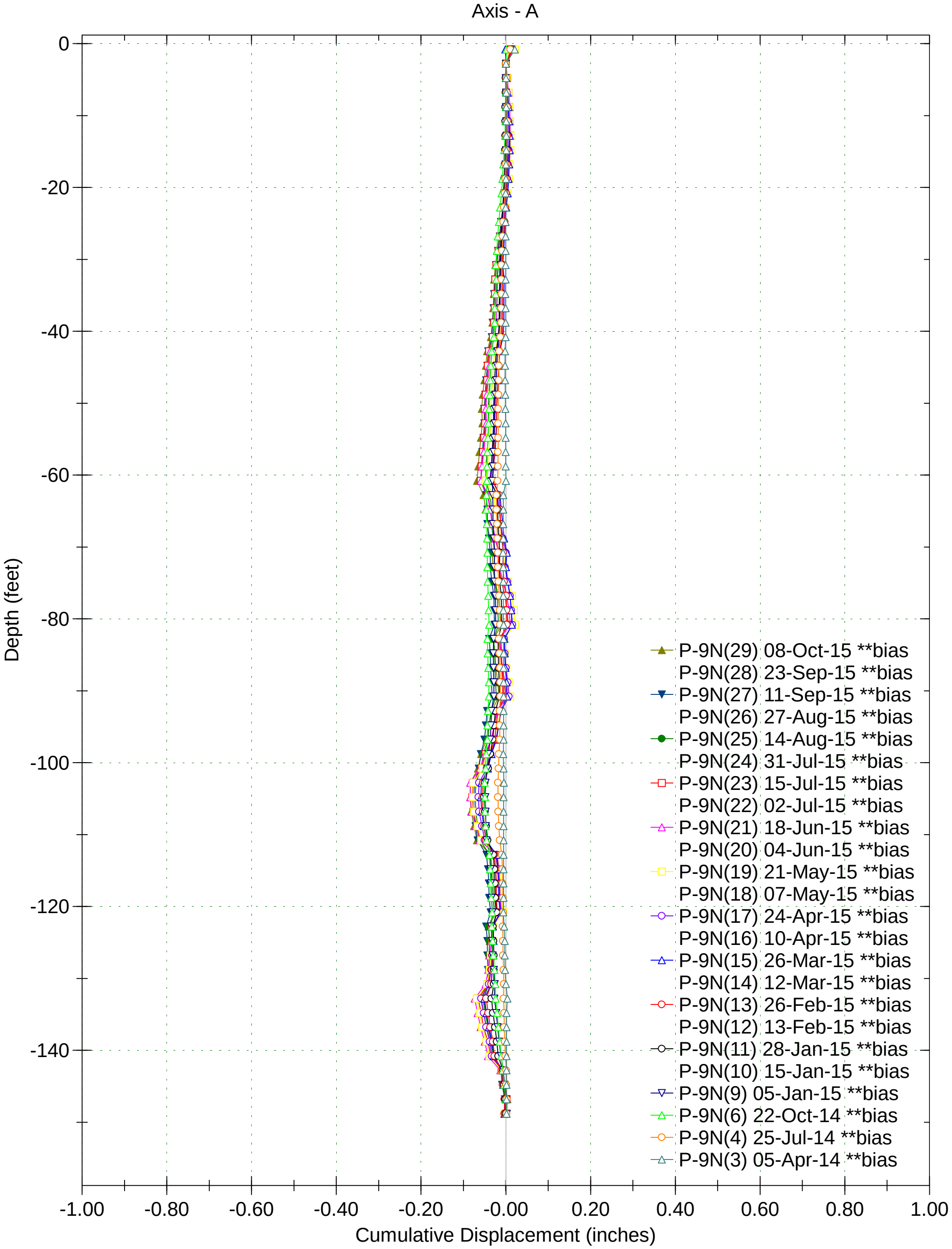
RST Instruments Ltd.

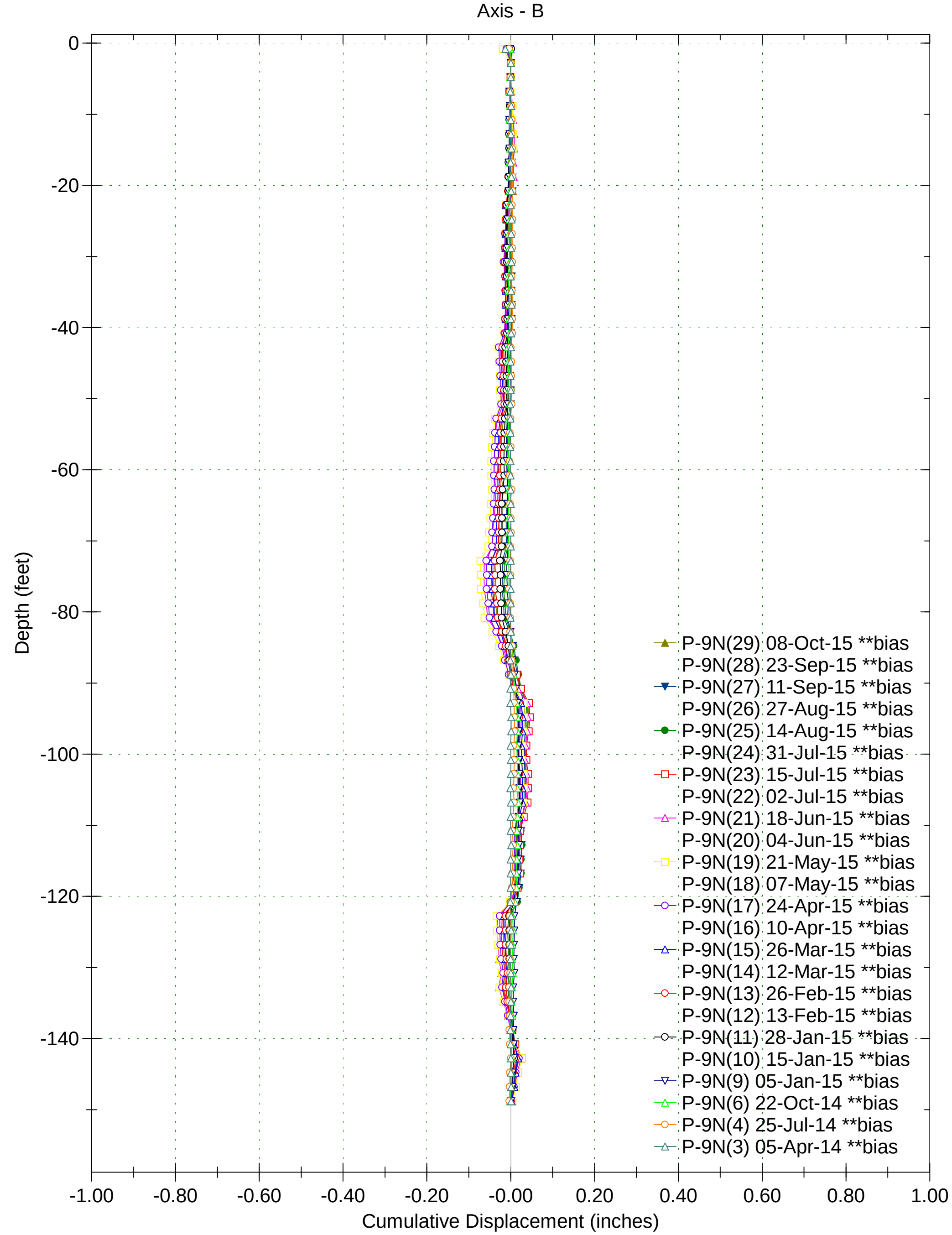
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : P-9N
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 150.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 16 09:28
Applied Azimuth : 0.0 degrees

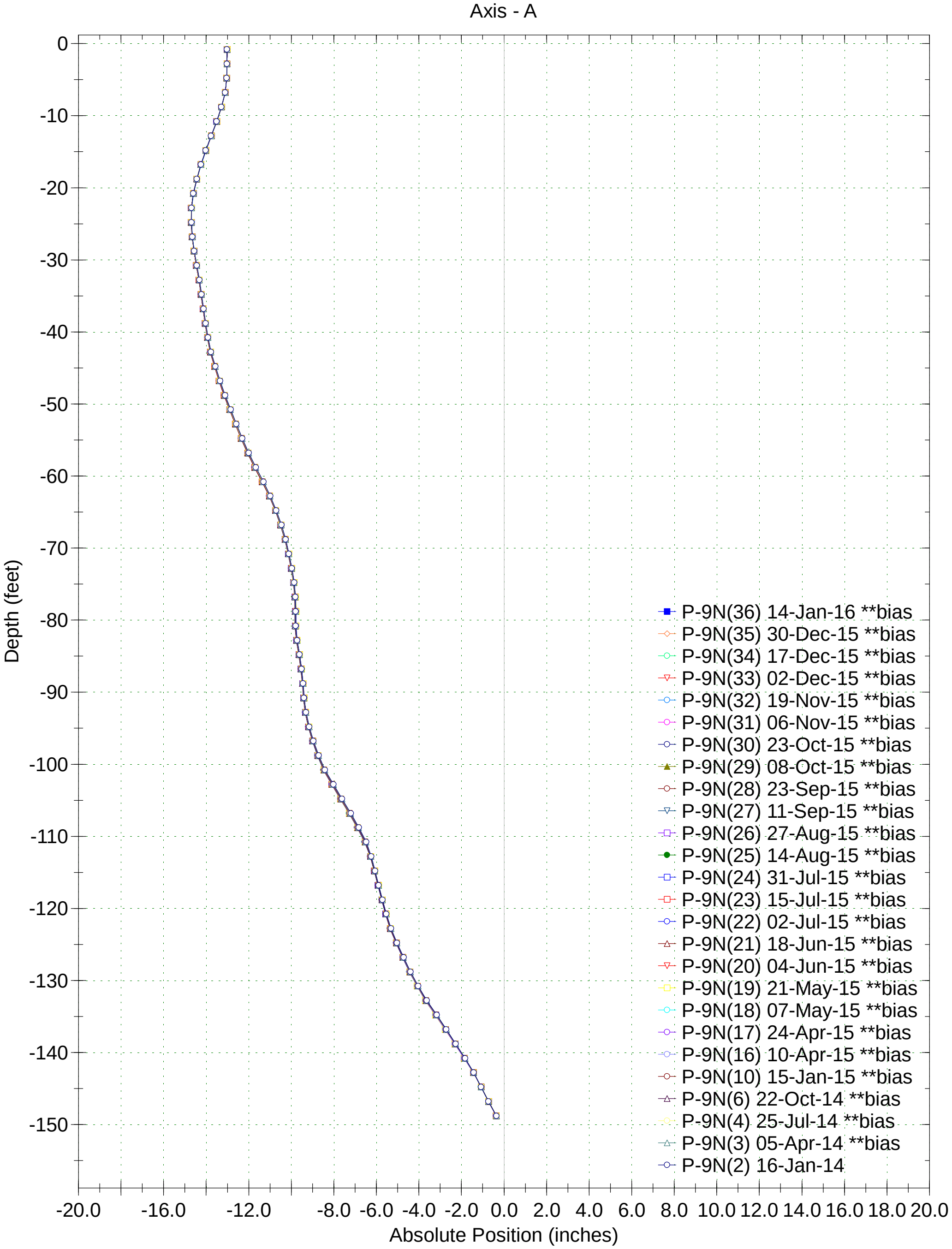


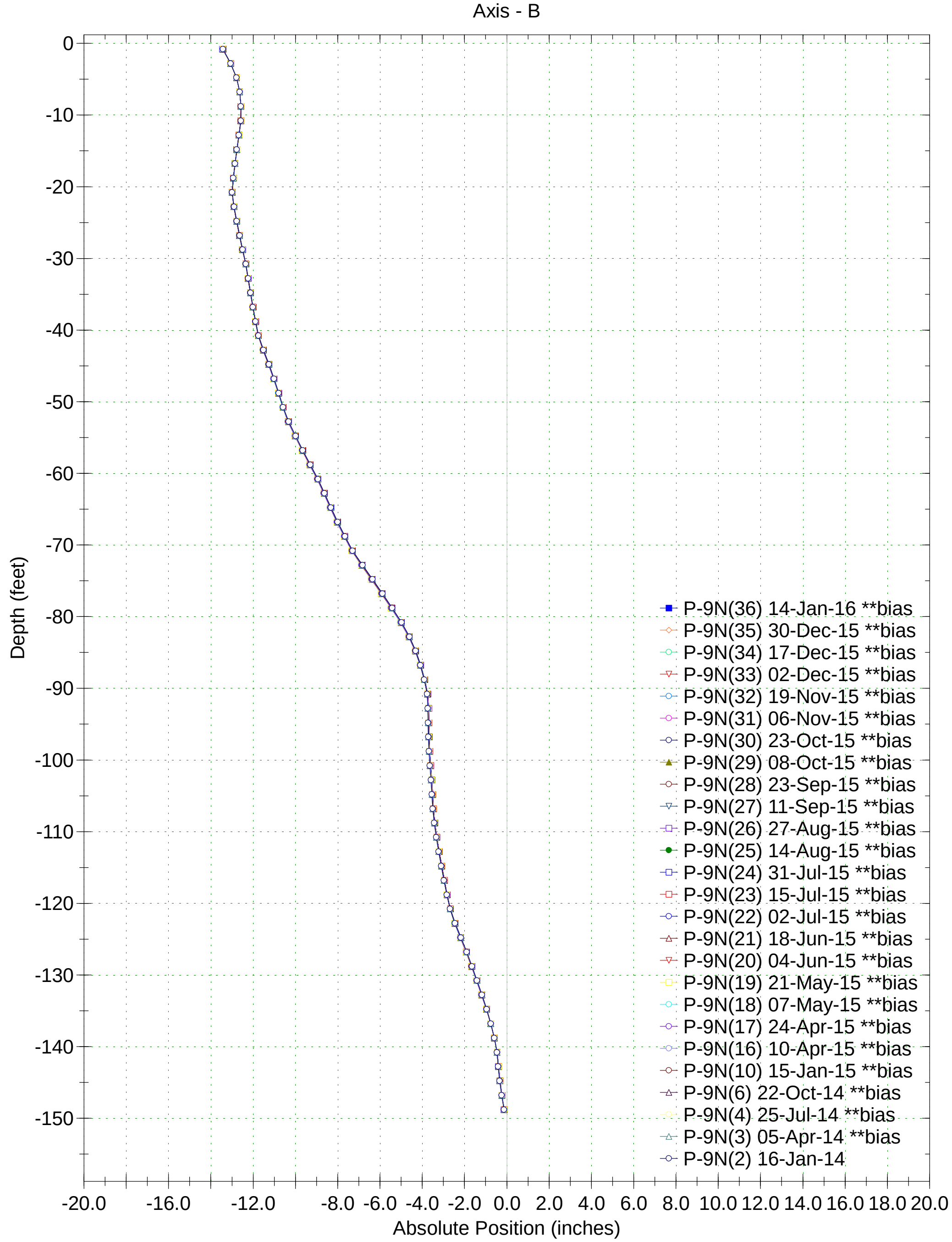


RST Instruments Ltd. | ABSOLUTE POSITION | Inclinalysis v. 2.47.5

Borehole : P-9N
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 150.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 16 09:28
Applied Azimuth : 0.0 degrees





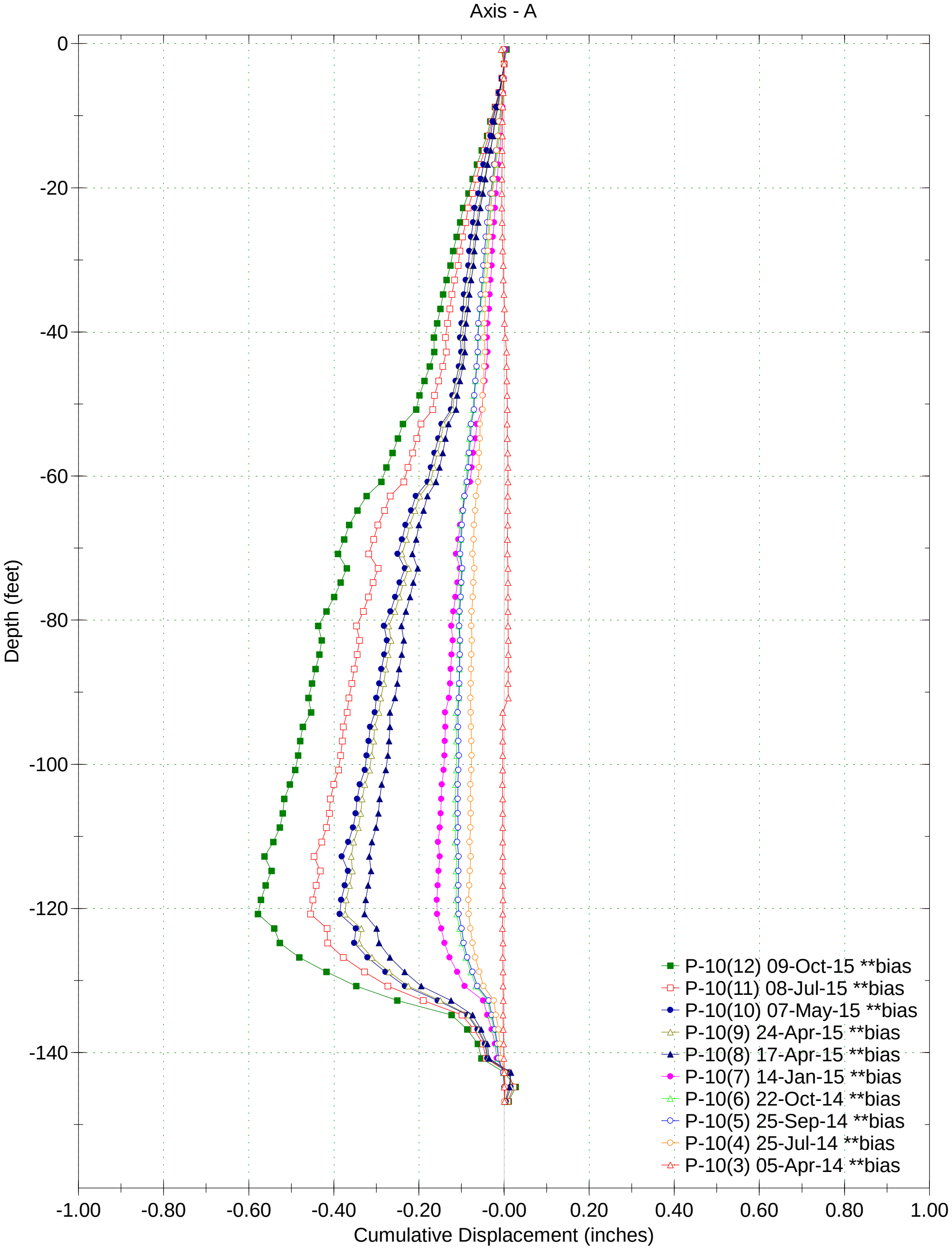
RST Instruments Ltd.

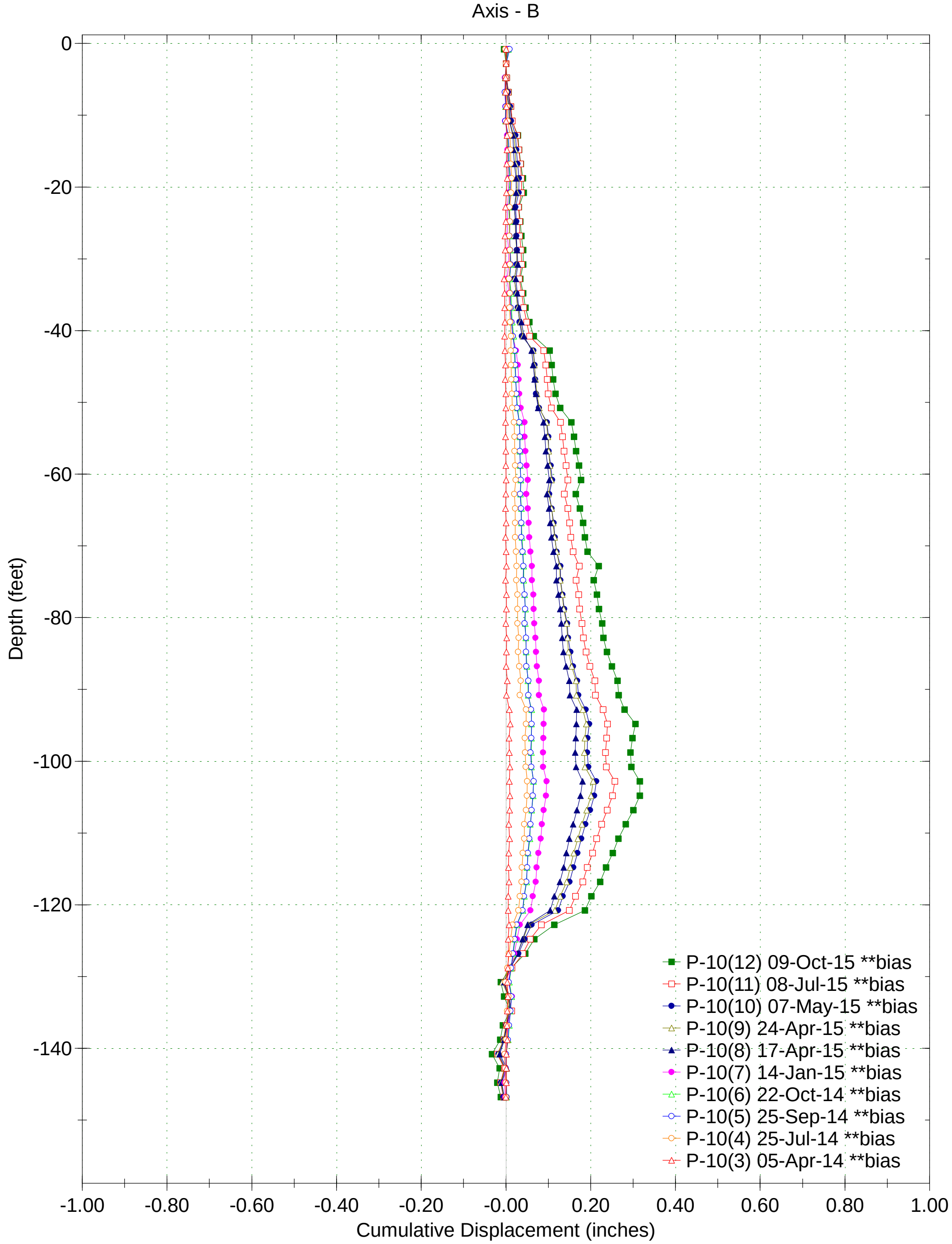
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : P-10
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 16 06:45
Applied Azimuth : 0.0 degrees





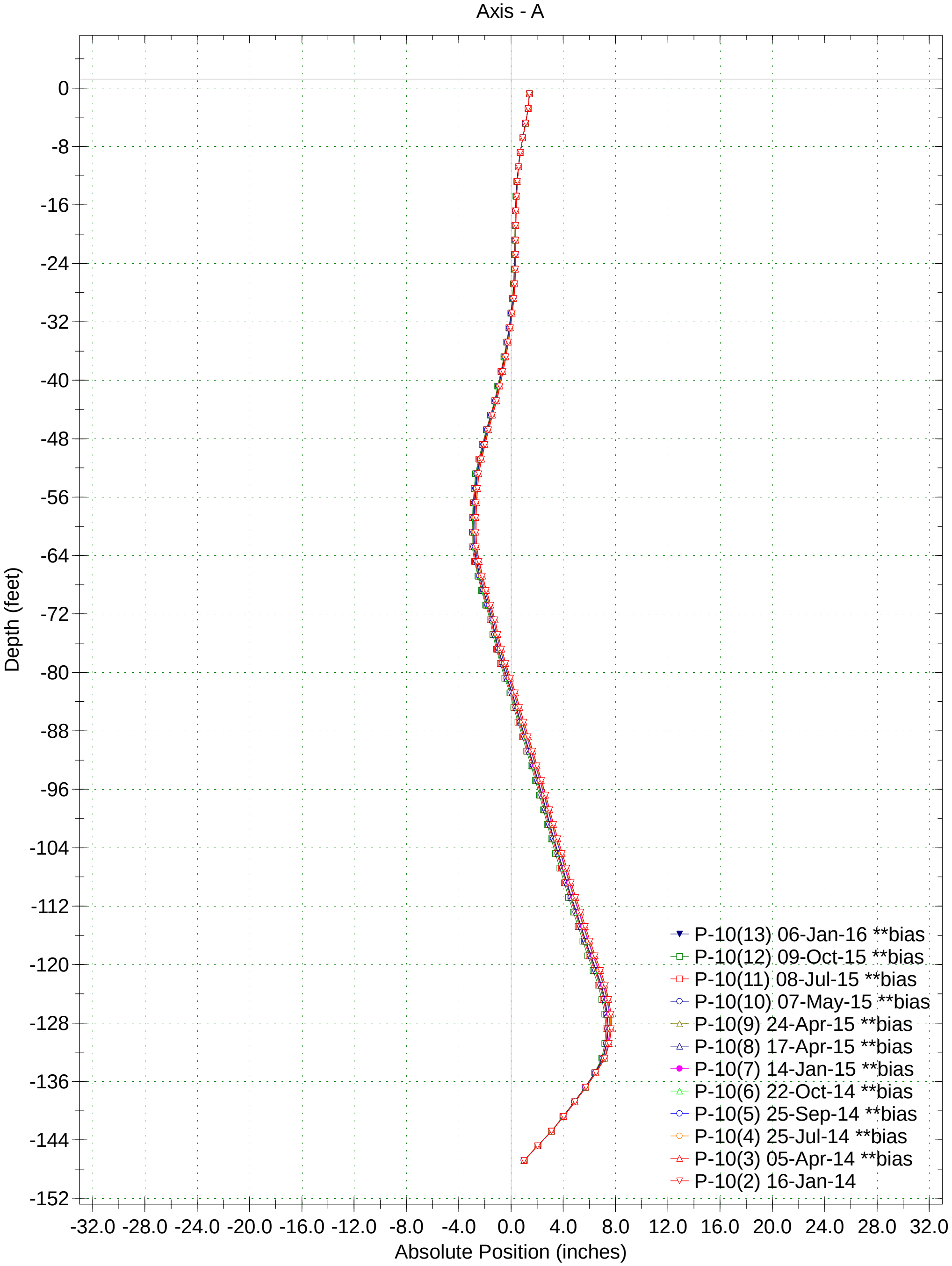
RST Instruments Ltd.

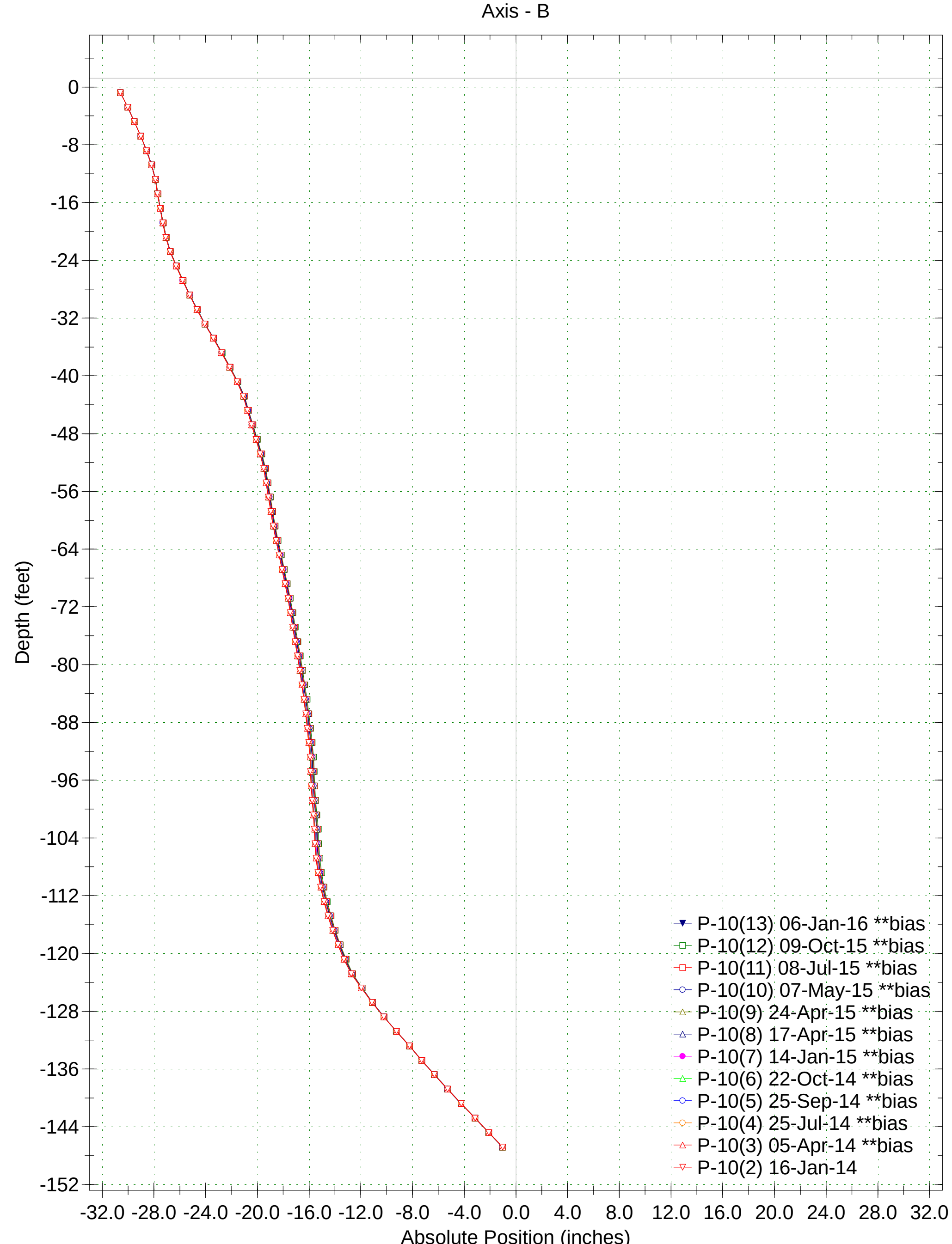
ABSOLUTE POSITION

Inclinalysis v. 2.47.5

Borehole : P-10
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 16 06:45
Applied Azimuth : 0.0 degrees





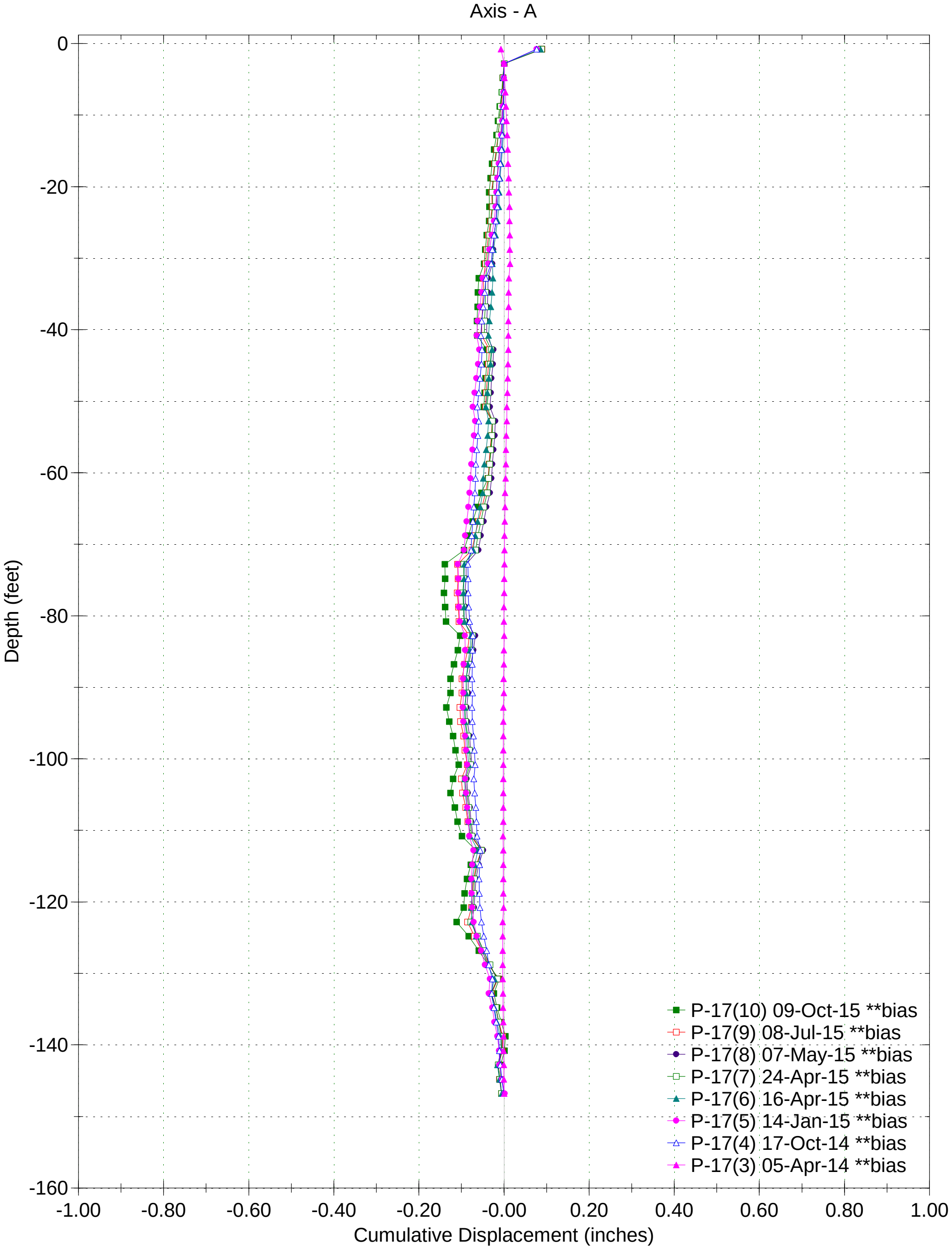
RST Instruments Ltd.

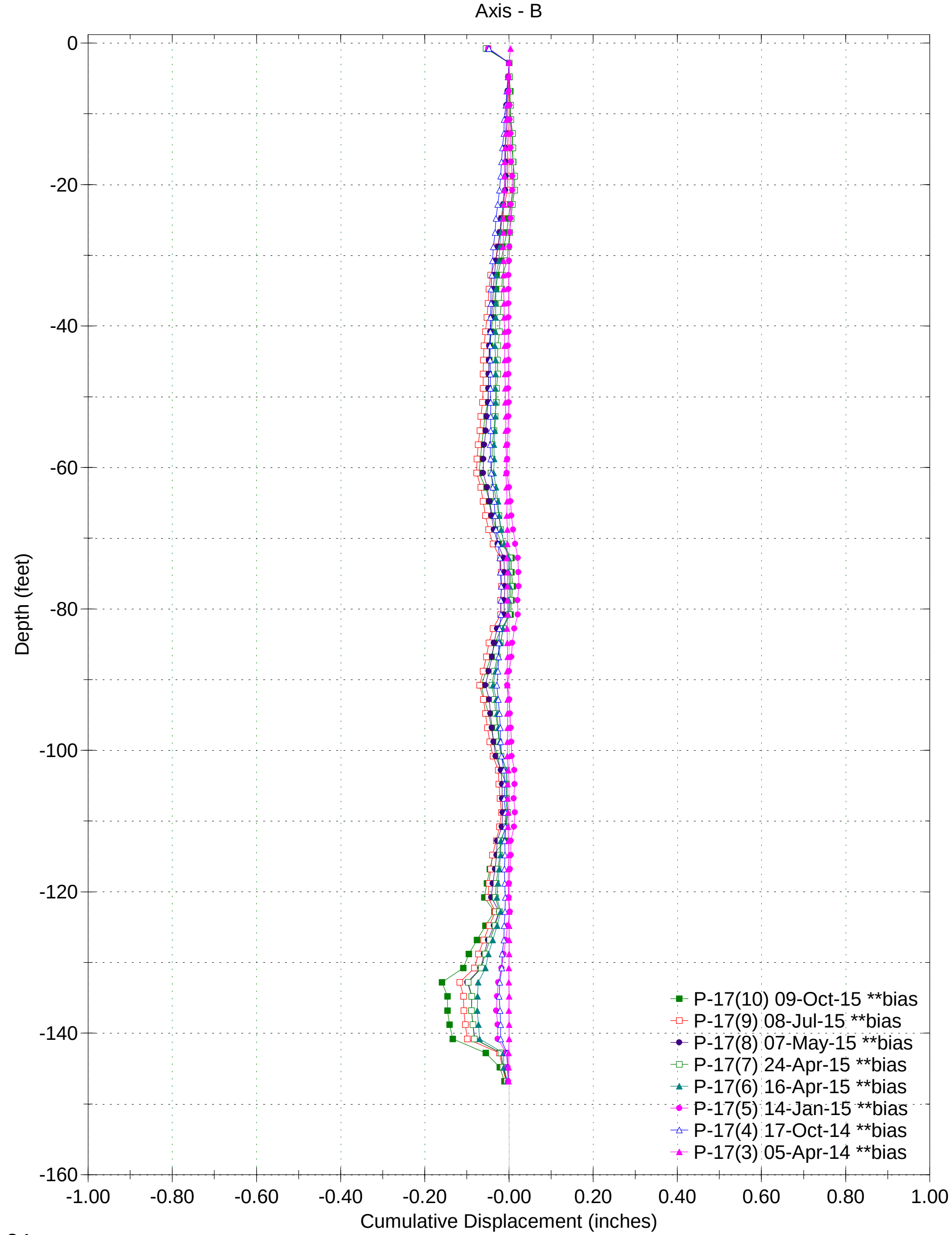
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : P-17
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 15 12:02
Applied Azimuth : 0.0 degrees





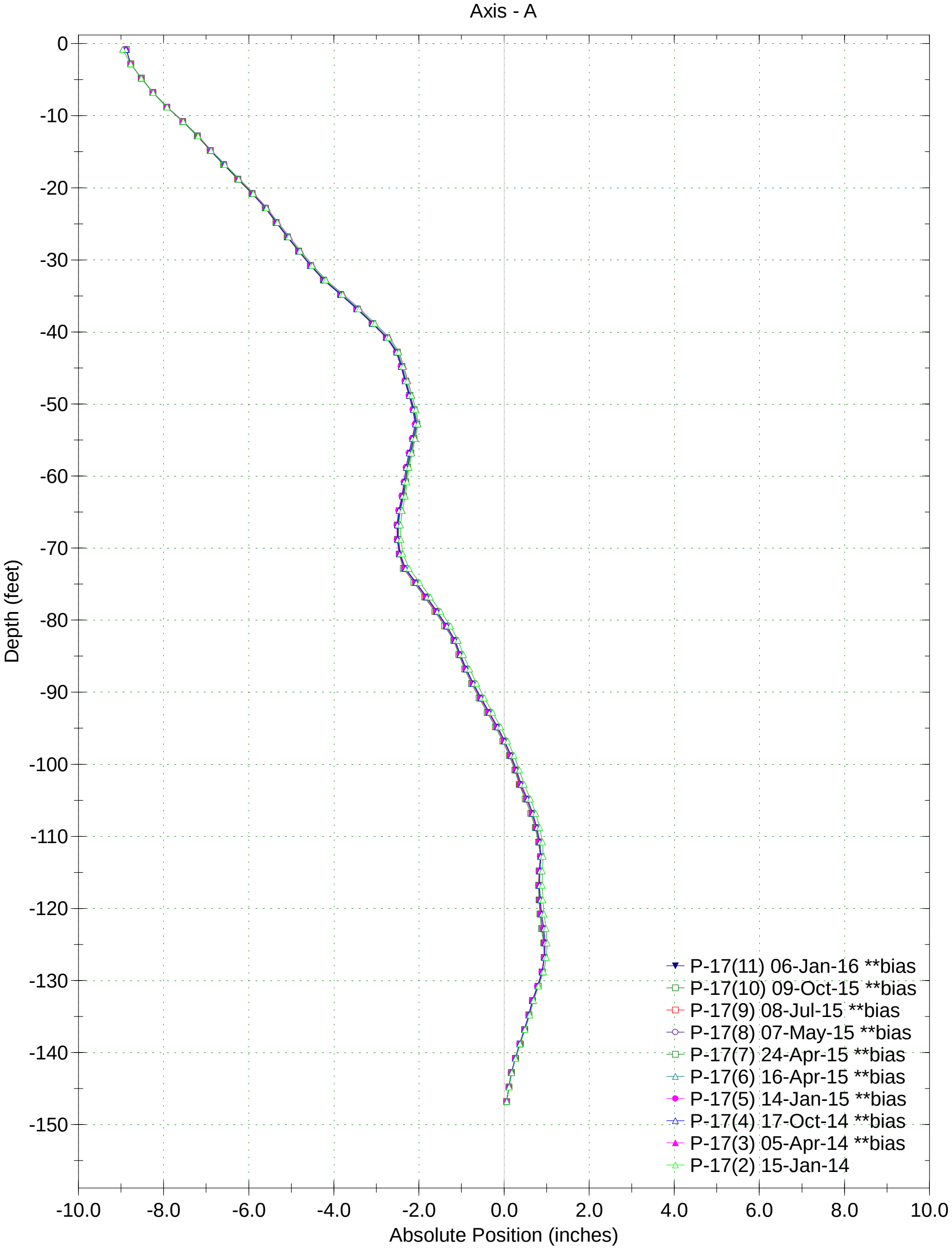
RST Instruments Ltd.

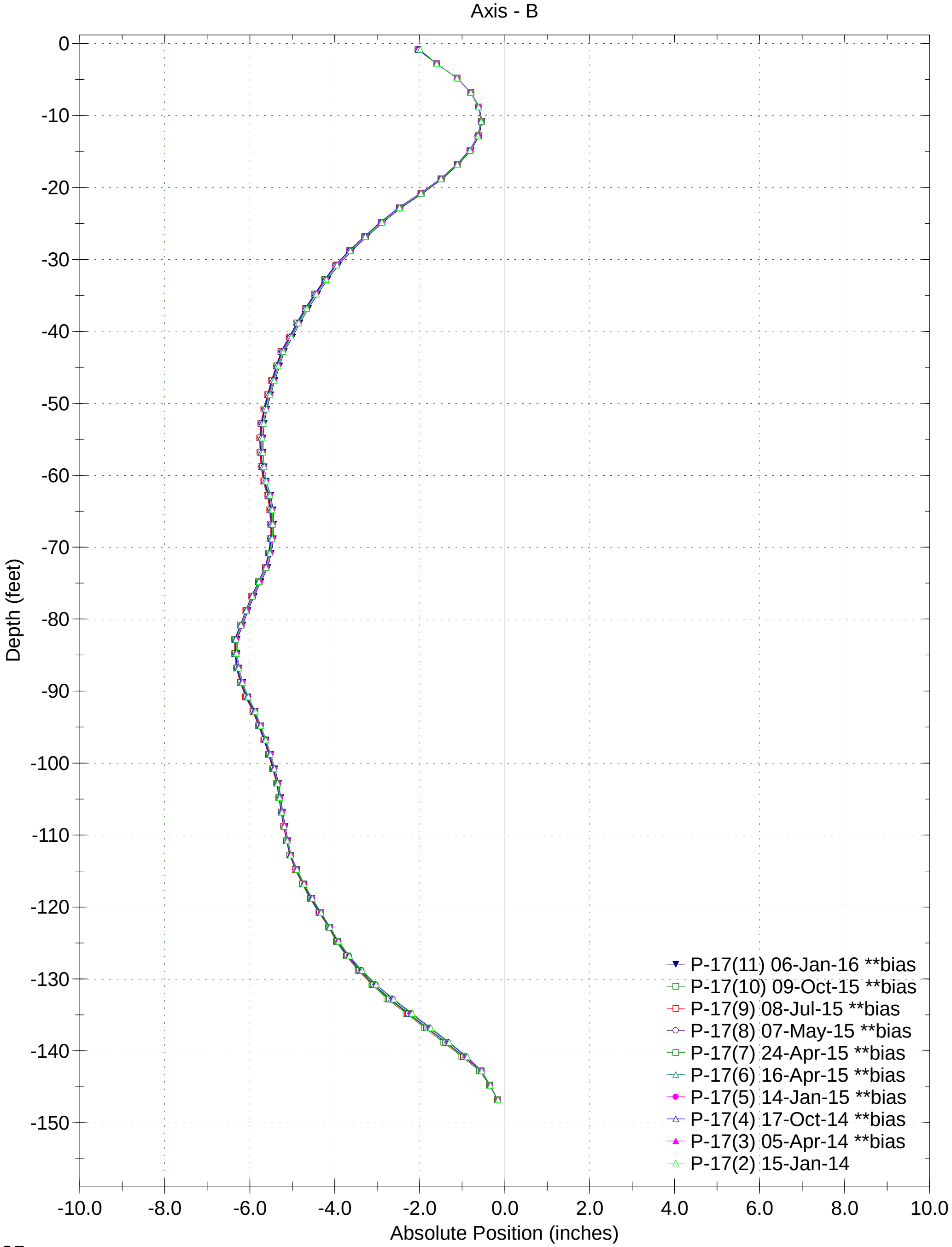
ABSOLUTE POSITION

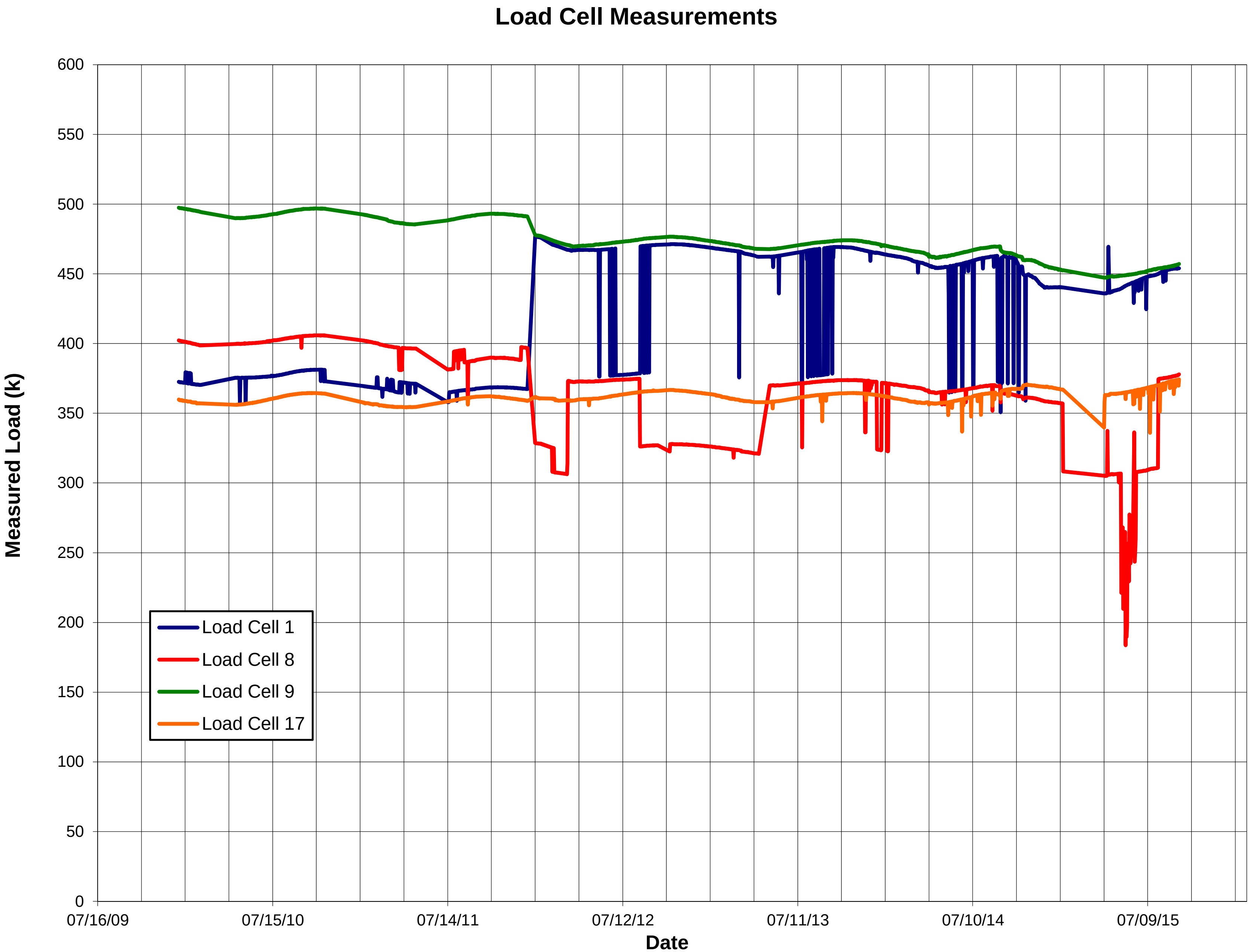
Inclinalysis v. 2.47.5

Borehole : P-17
Project : CUY-90-15-24
Location : Cleveland, Ohio
Northing :
Easting :
Collar :

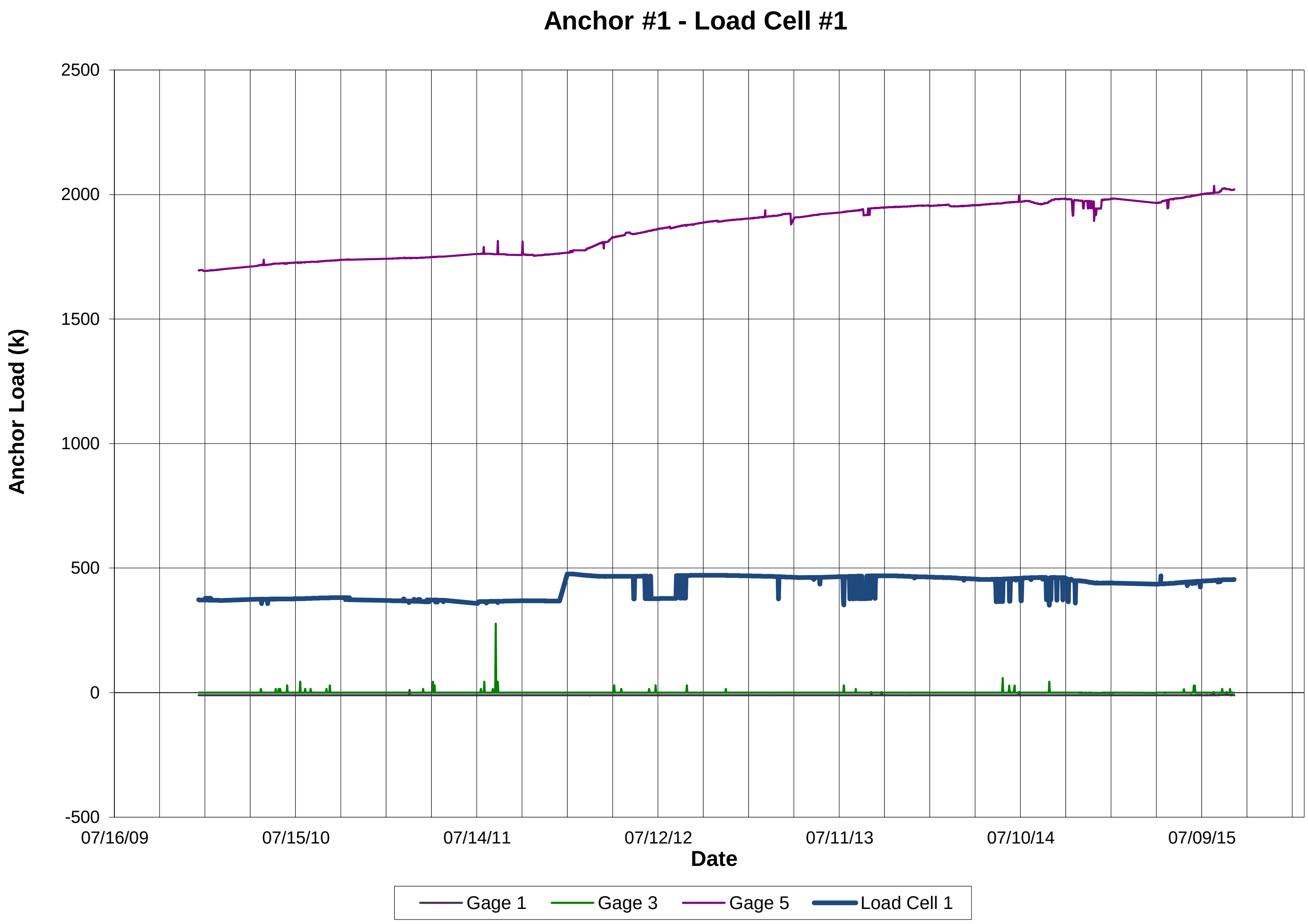
Spiral Correction : N/A
Collar Elevation : 1.2 feet
Borehole Total Depth : 148.0 feet
A+ Groove Azimuth :
Base Reading : 2014 Jan 15 12:02
Applied Azimuth : 0.0 degrees





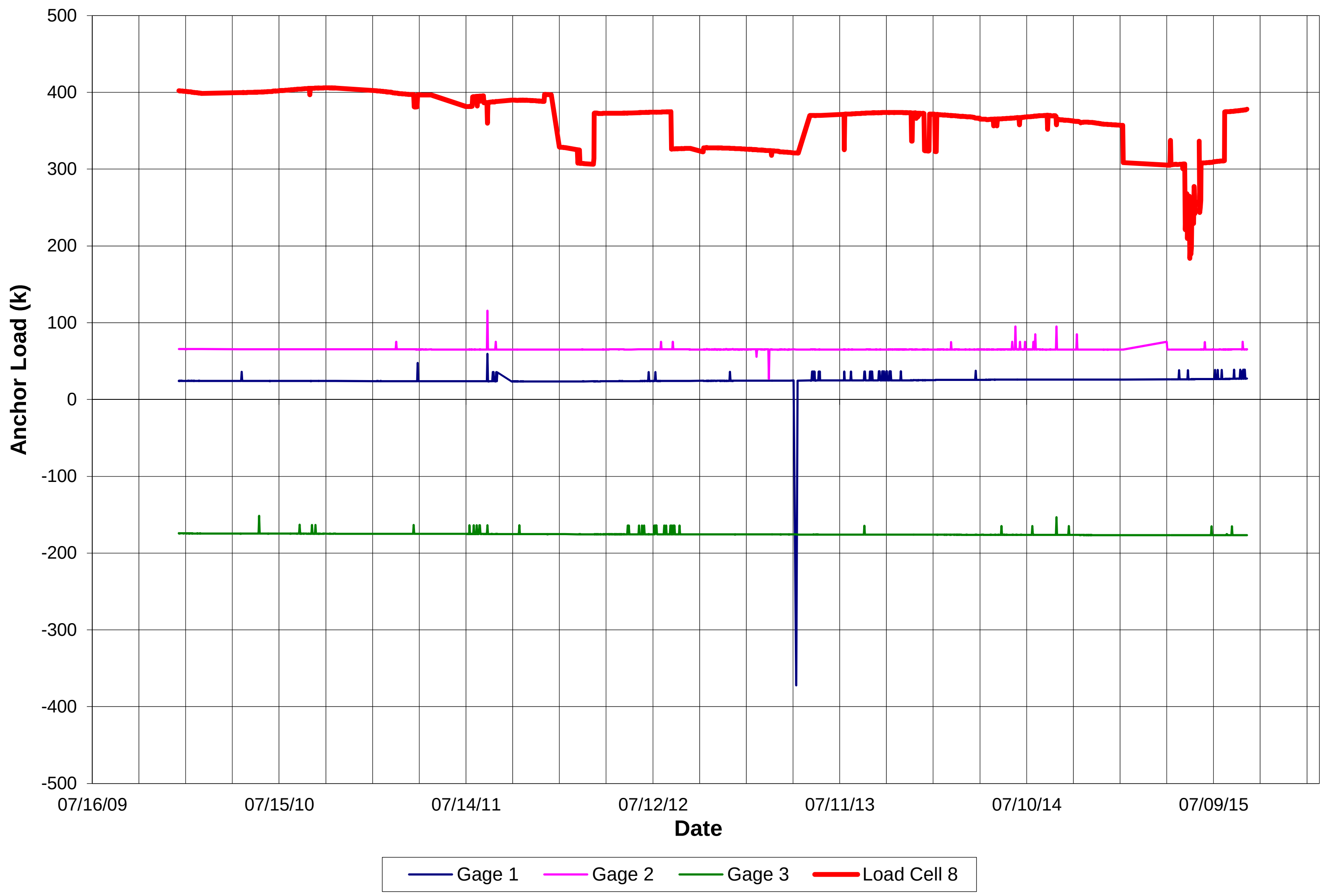


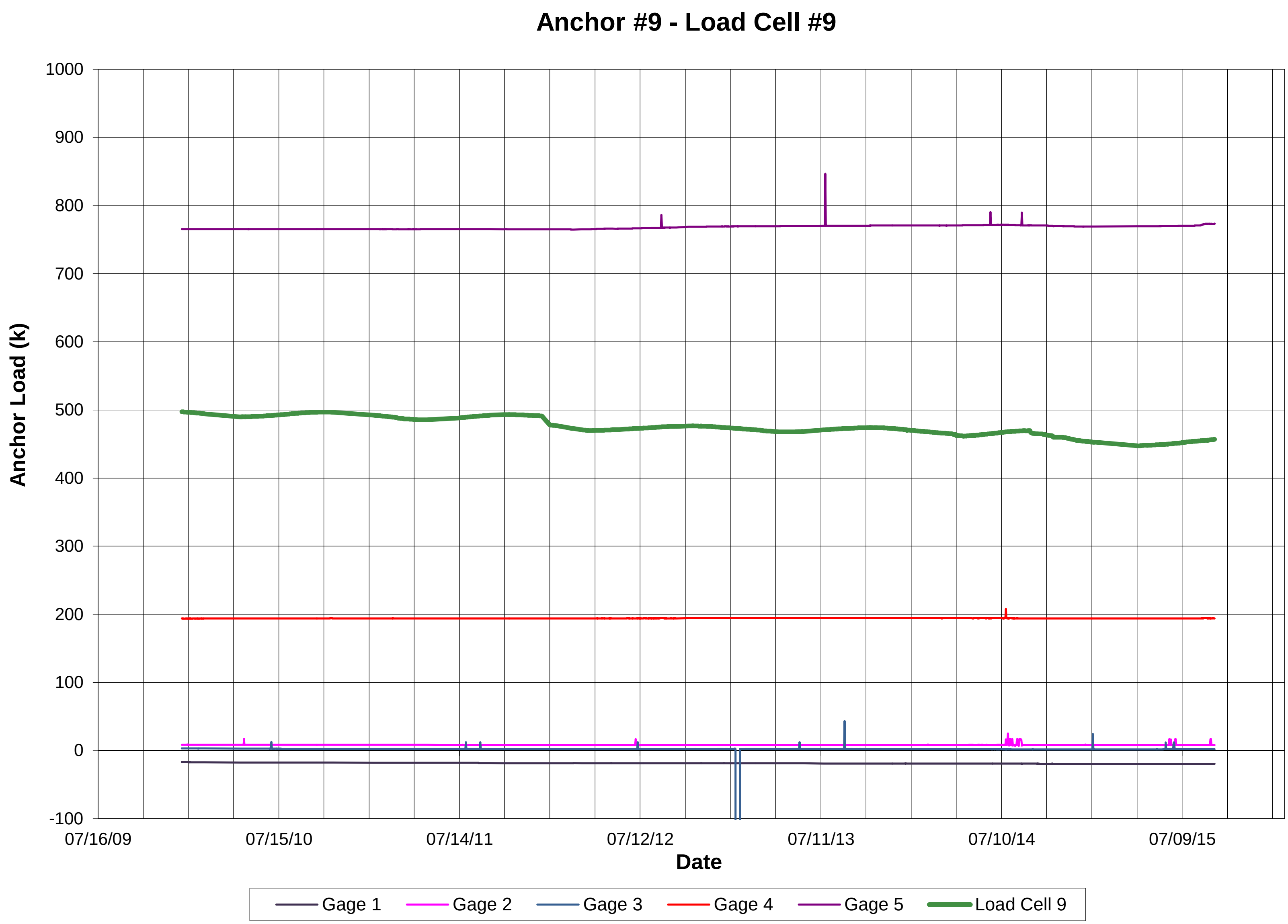
Load Cell Measurements
600
550
500
450
400
350
300
250
200
150
100
50
0
Measured Load (k)
07/16/09
07/15/10
07/14/11
07/12/12
07/11/13
07/10/14
07/09/15
Date
Load Cell 1
Load Cell 8
Load Cell 9
Load Cell 17



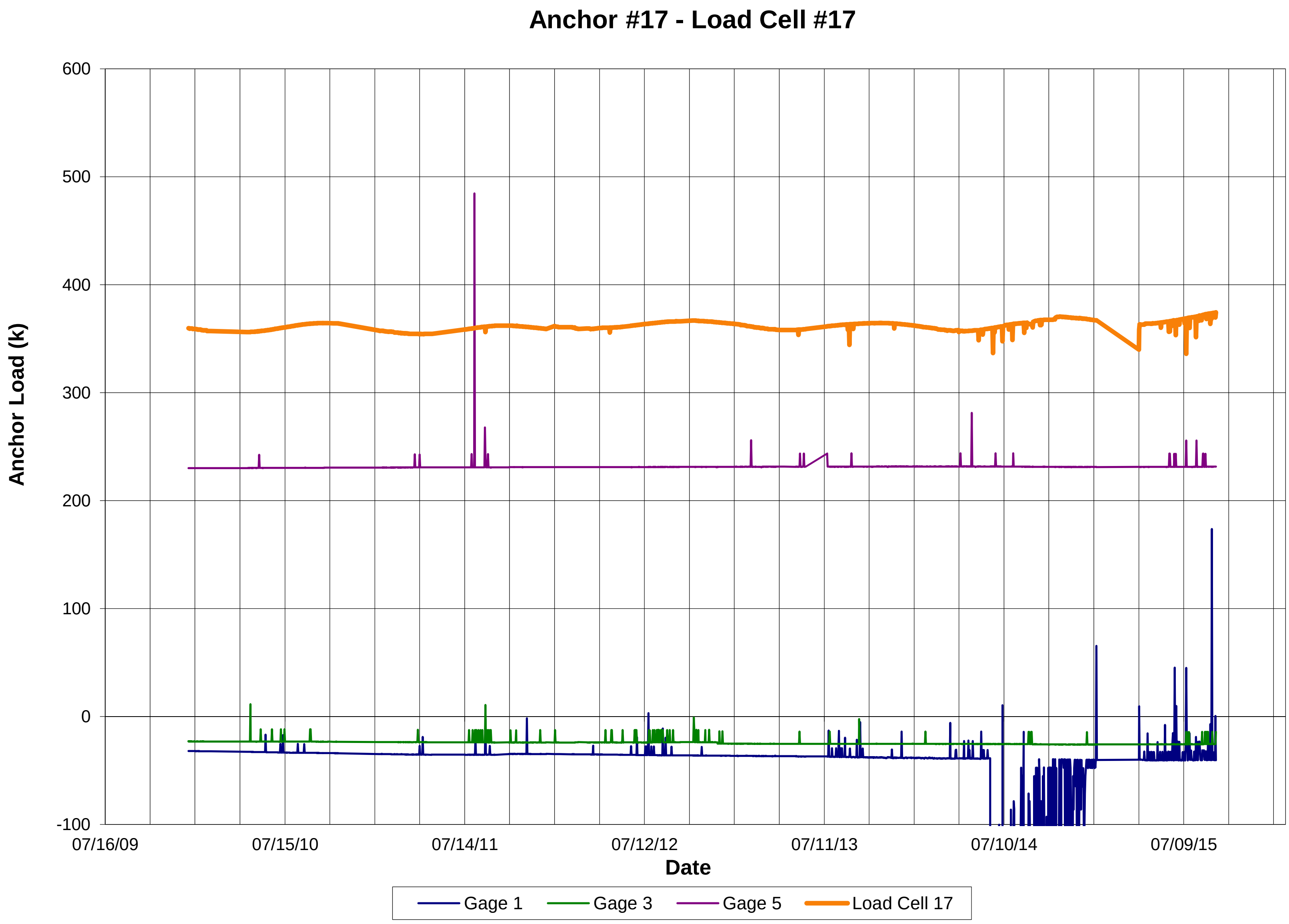
Anchor #1 - Load Cell #1
Anchor Load (k)
2500
2000
1500
1000
500
0
-500
07/16/09
07/15/10
07/14/11
07/12/12
07/11/13
07/10/14
07/09/15
Date
Gage 1
Gage 3
Gage 5
Load Cell 1

Anchor #8 - Load Cell #8



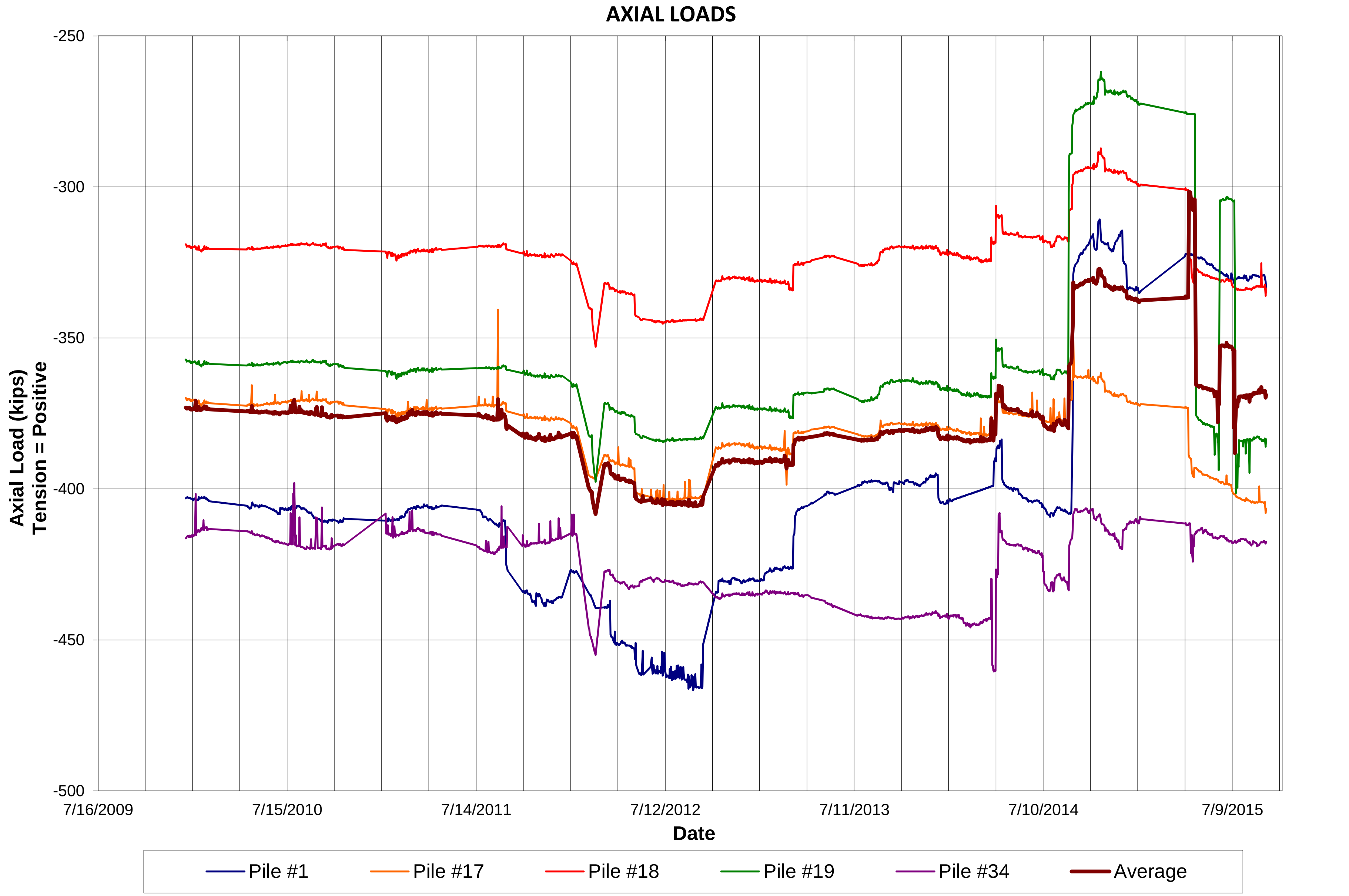


Anchor #9 - Load Cell #9
Anchor Load (k)
1000
900
800
700
600
500
400
300
200
100
0
-100
07/16/09
07/15/10
07/14/11
07/12/12
07/11/13
07/10/14
07/09/15
Date
Gage 1
Gage 2
Gage 3
Gage 4
Gage 5
Load Cell 9



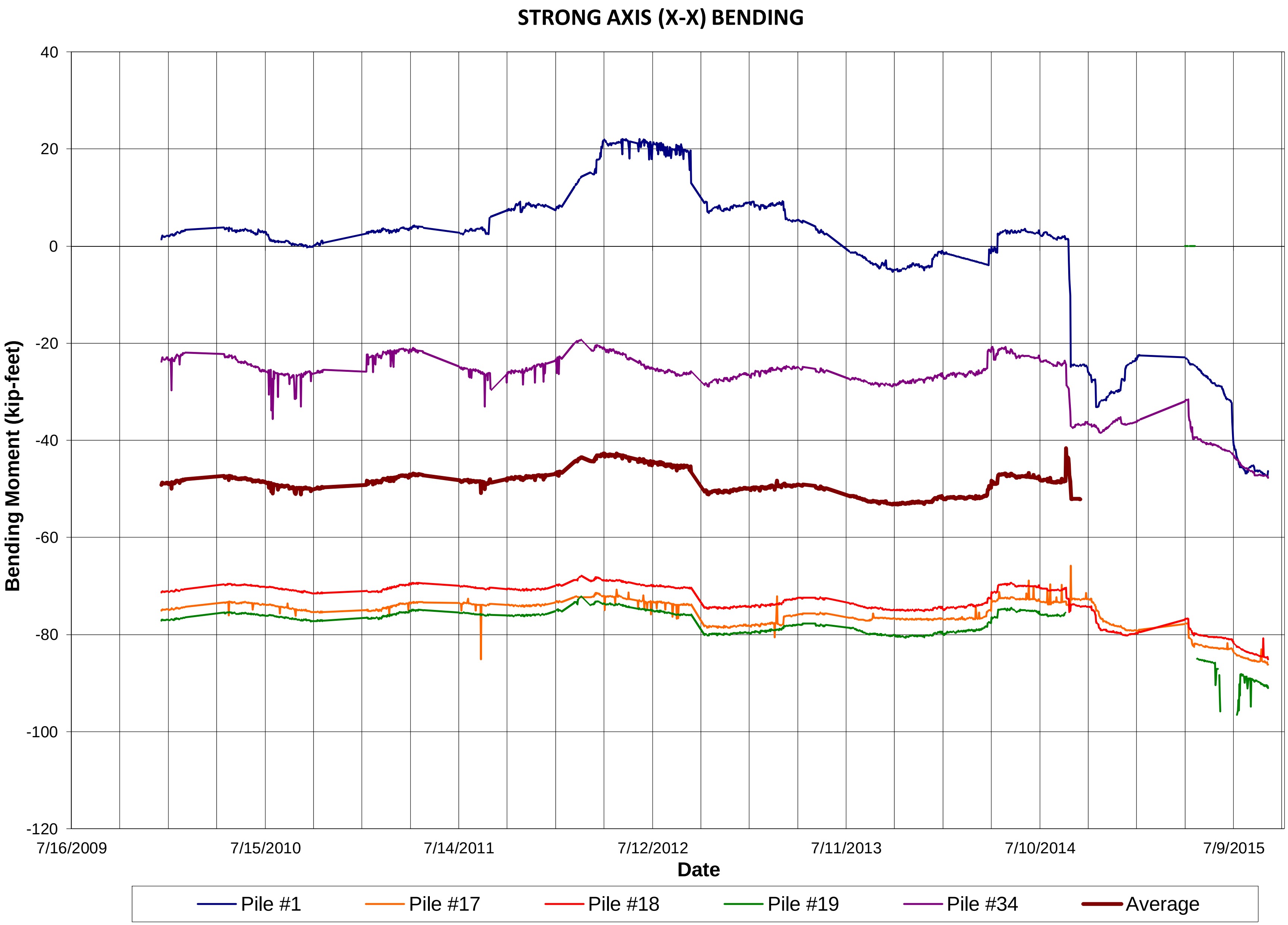
Anchor #17 - Load Cell #17
Anchor Load (k)
600
500
400
300
200
100
0
-100
07/16/09
07/15/10
07/14/11
07/12/12
07/11/13
07/10/14
07/09/15
Date
Gage 1
Gage 3
Gage 5
Load Cell 17

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



Driven Piles

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



Driven Piles

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
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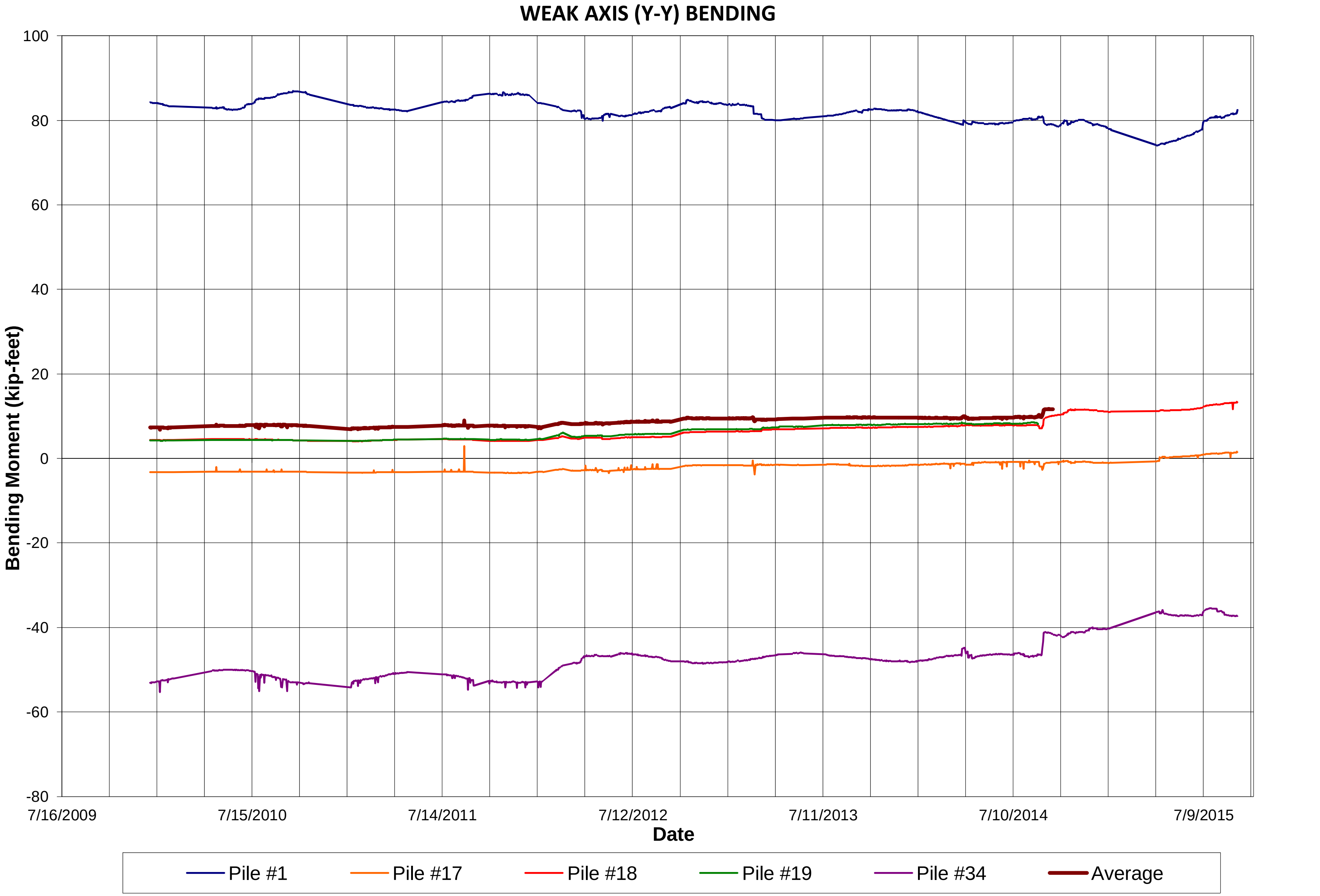
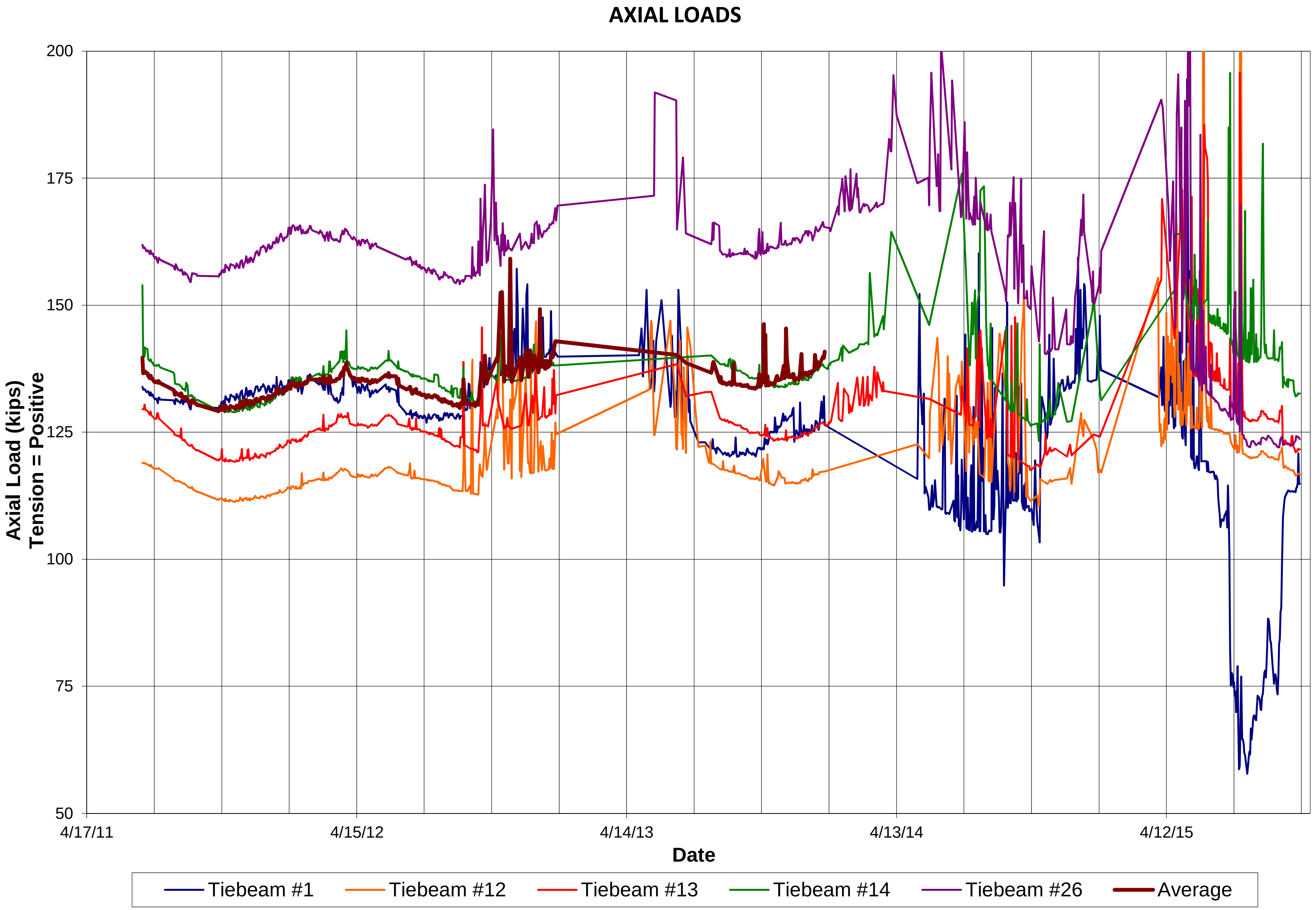


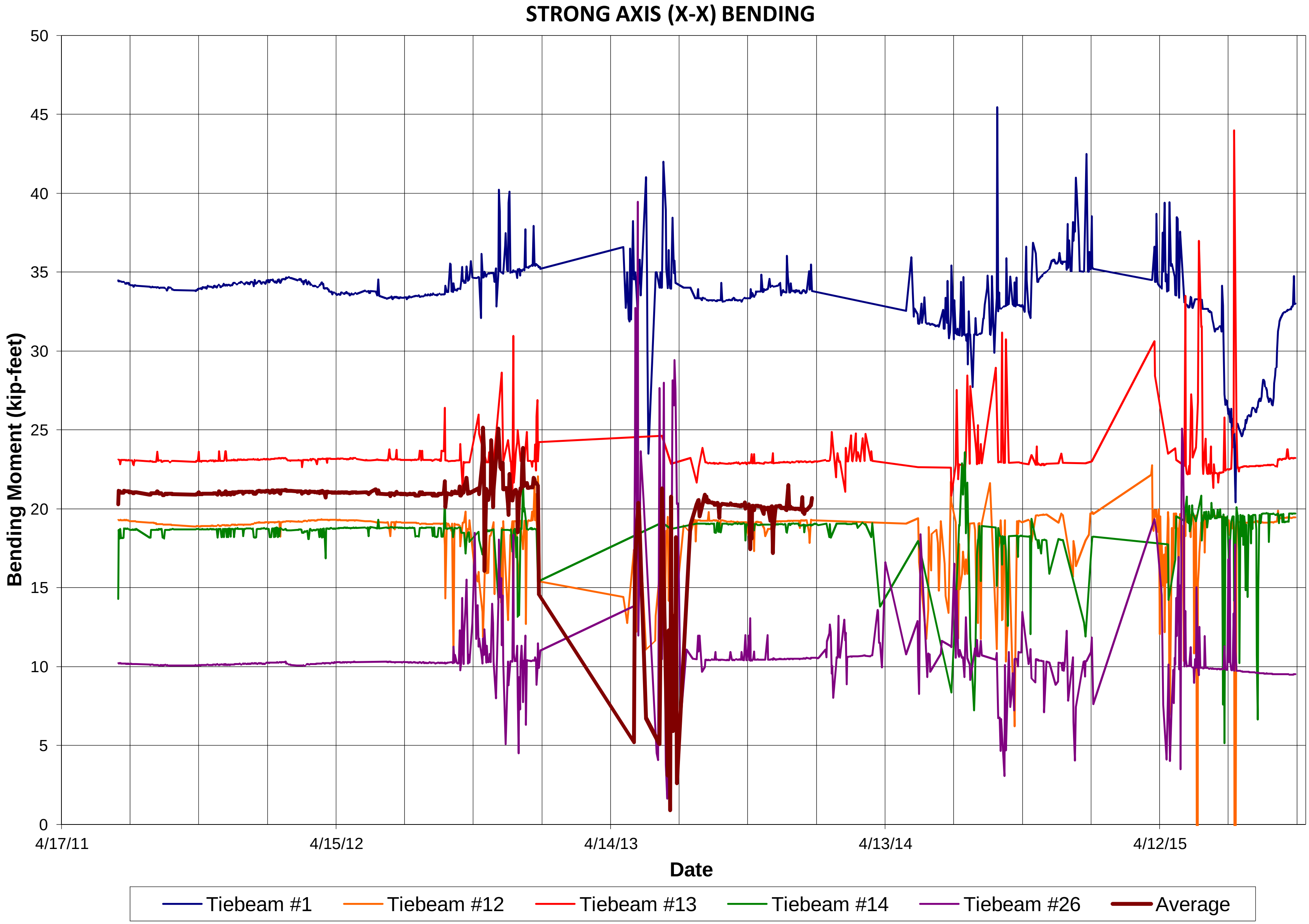
Driven Piles

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



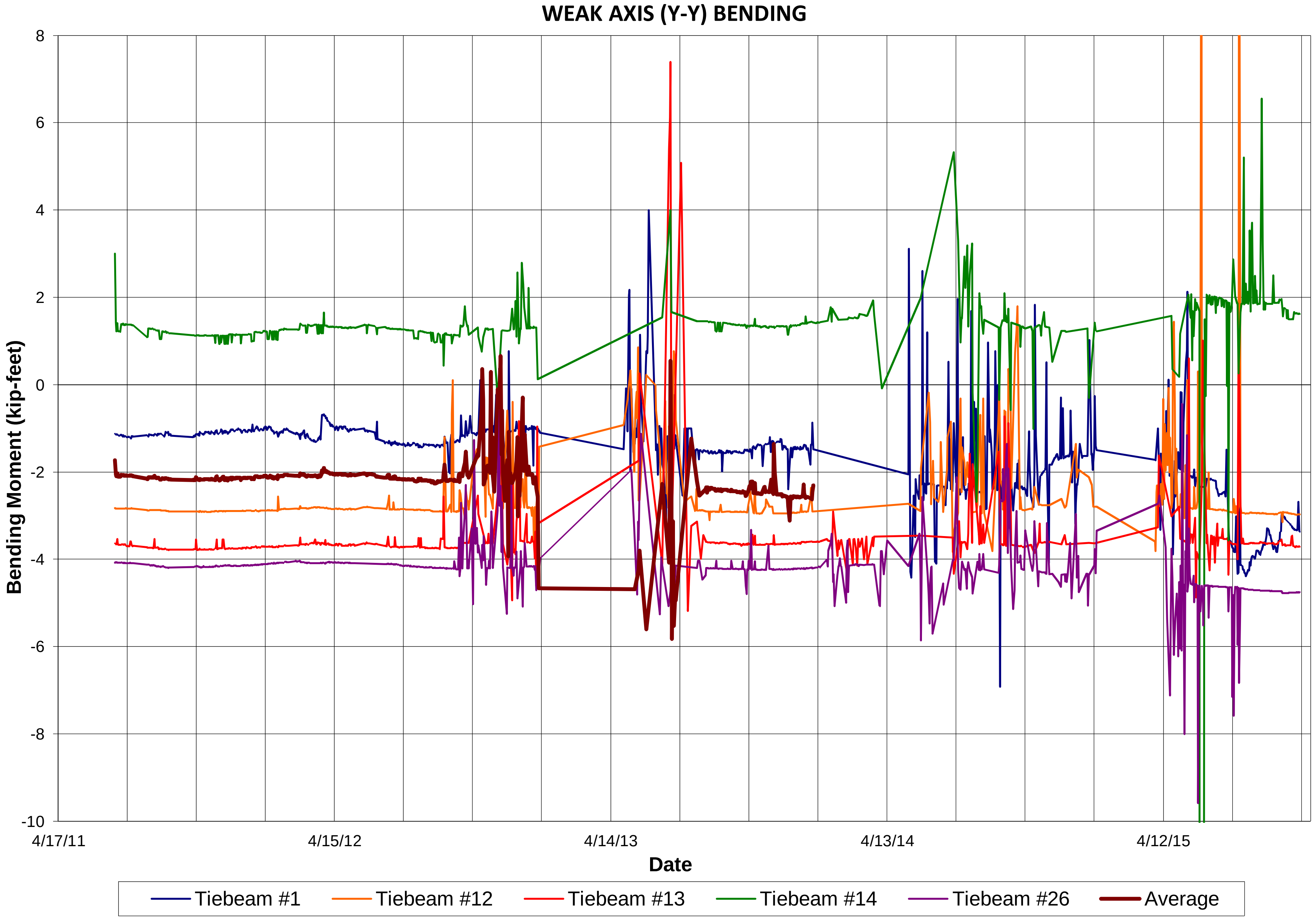
Tiebeams - Anchor Side

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



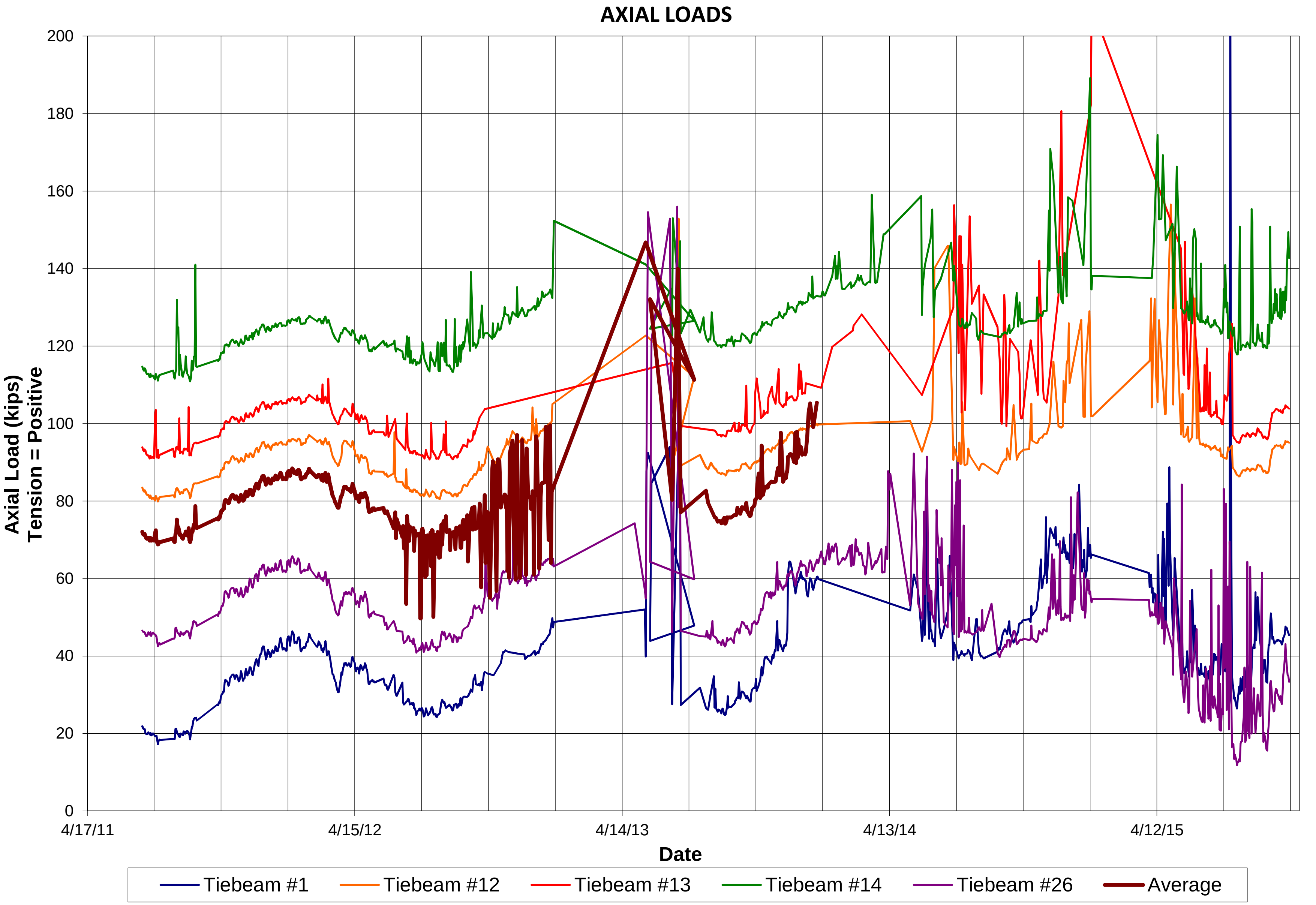
Tiebeams - Anchor Side

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



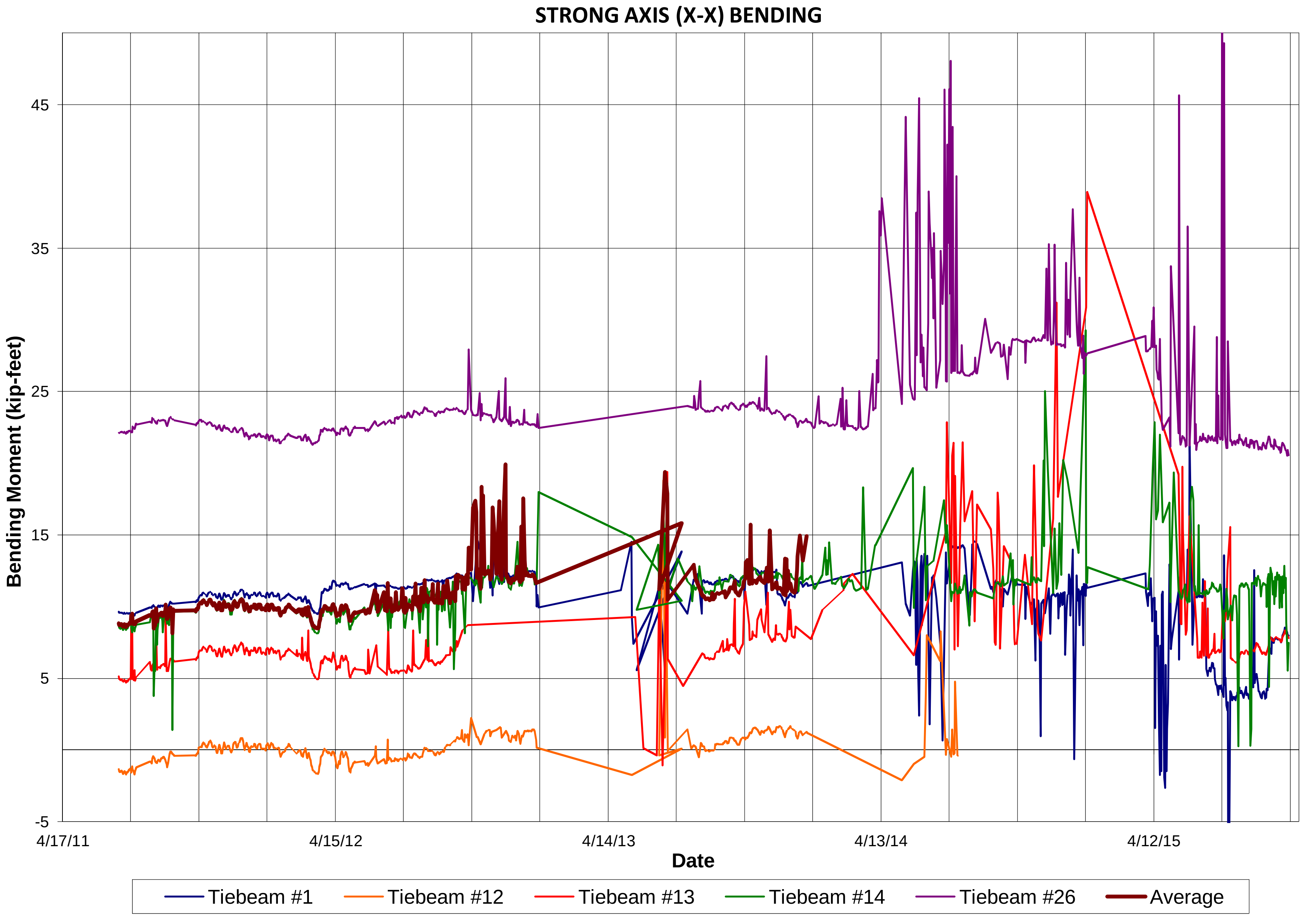
Tiebeams - Anchor Side

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



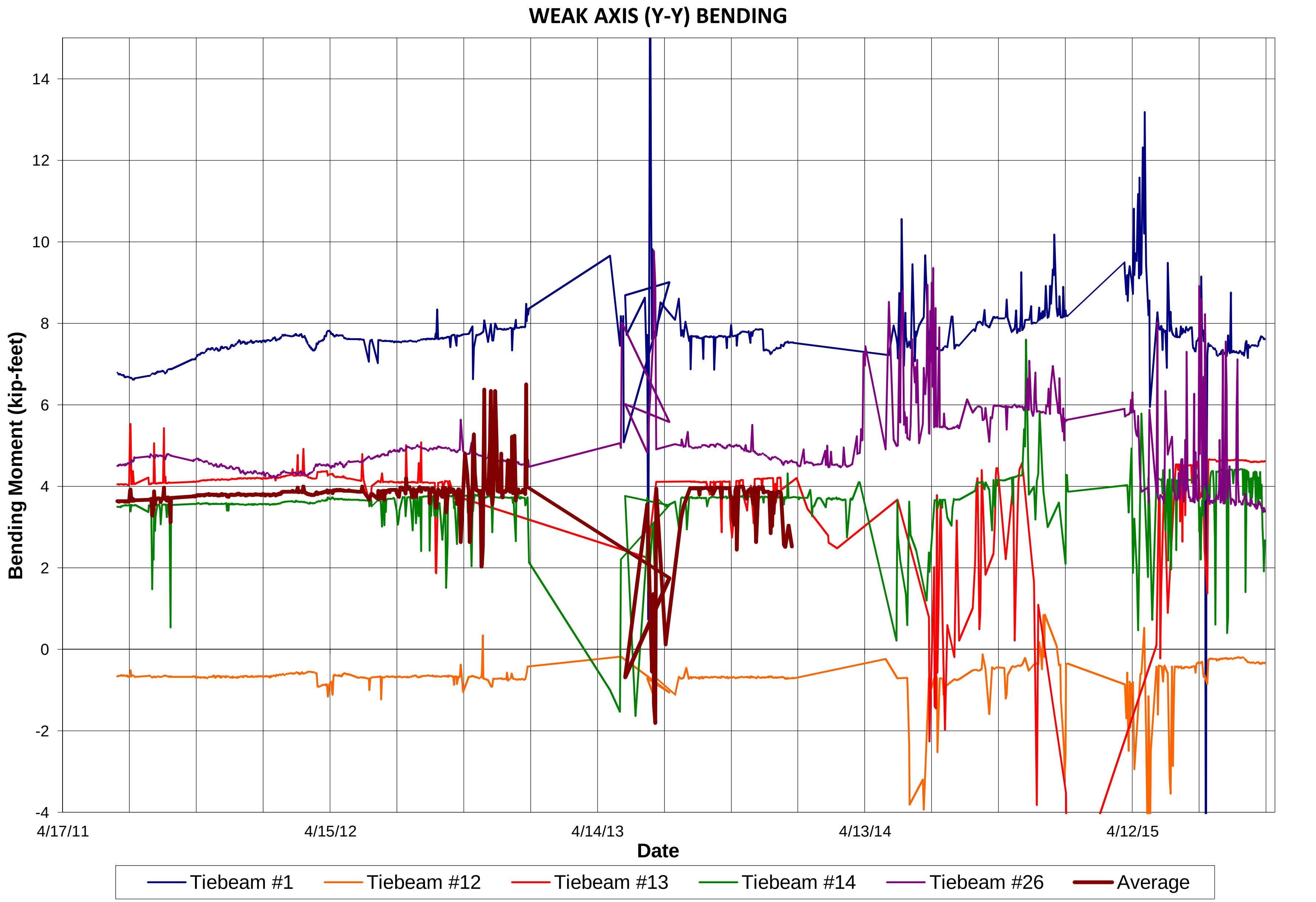
Tiebeams - Drilled Pier Side

CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00



Tiebeams - Drilled Pier Side

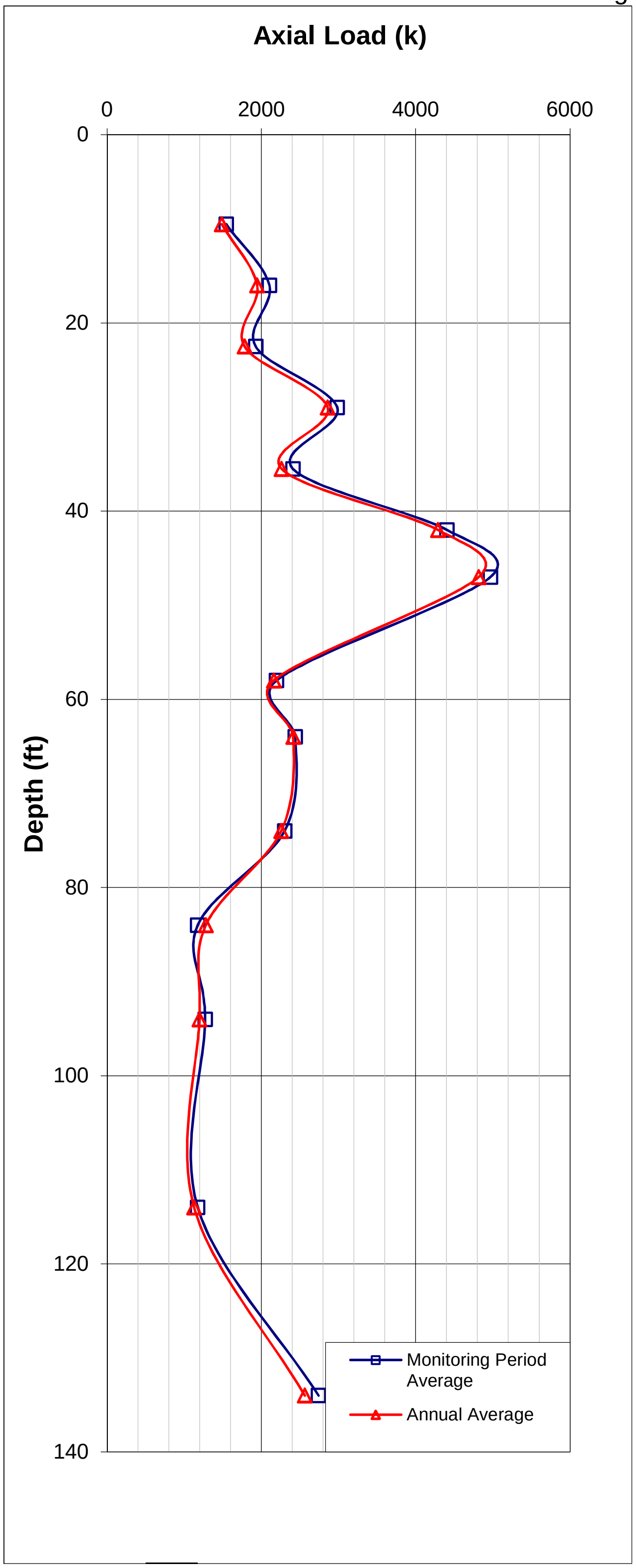
CUY-90-15.24 Slope Monitoring
Cleveland, Ohio
PID 96504
SME#: 069032.00

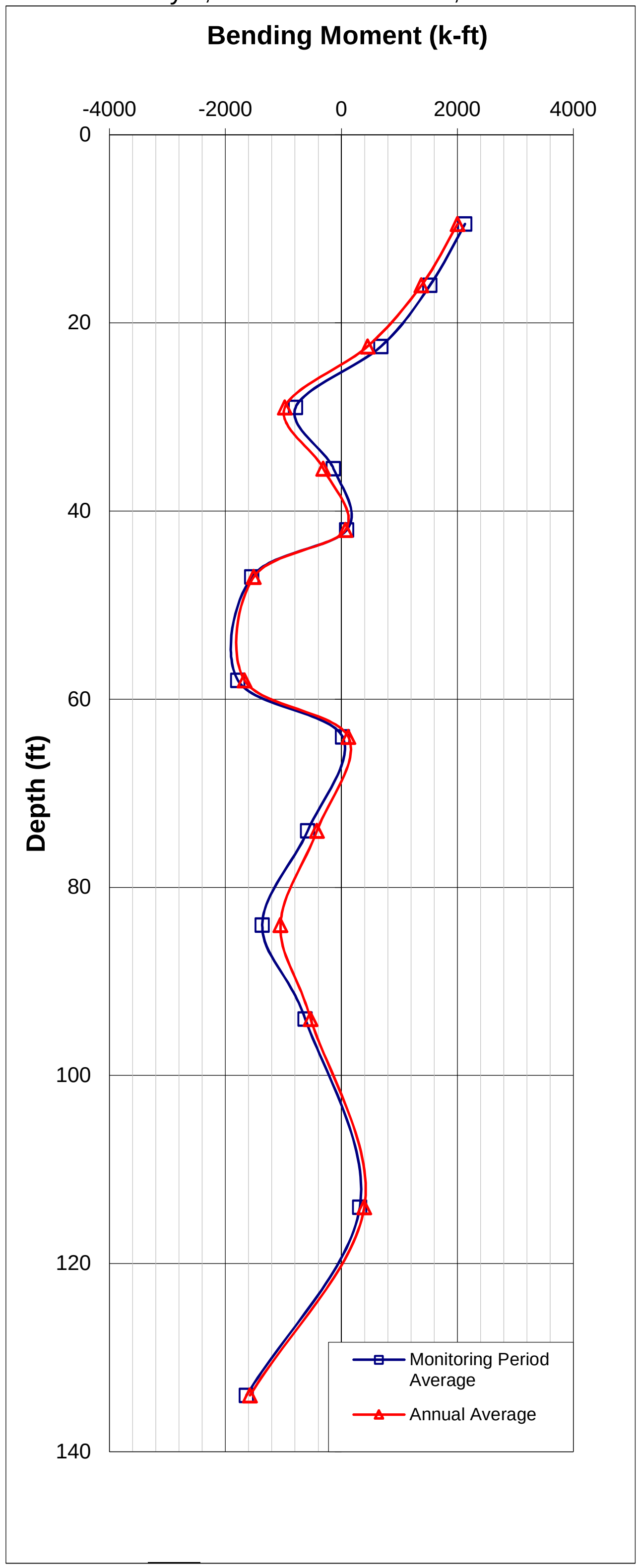


Tiebeams - Drilled Pier Side

CUY-90-15.24 Slope Monitoring
PID 96504
Cleveland, Ohio
SME#: 069032.00

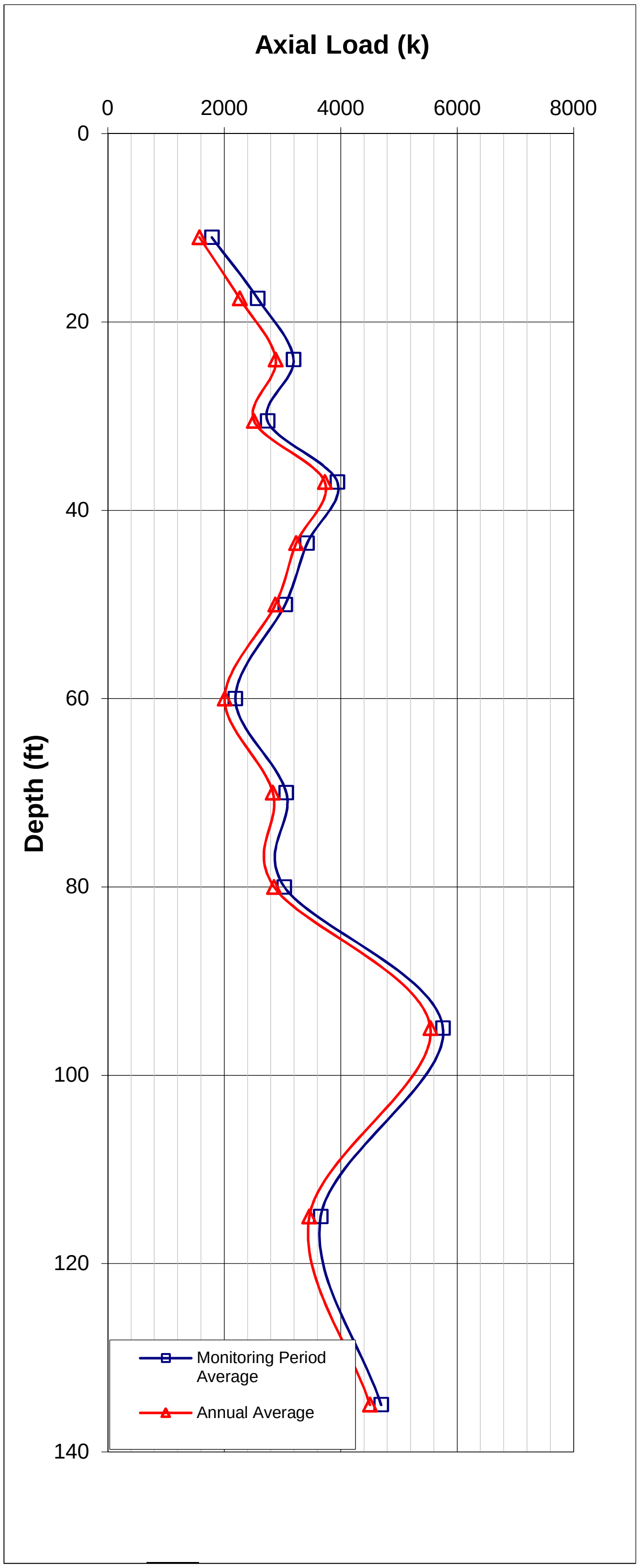
Drilled Shaft #1
(Weak Axis Bending)
Average for Period: July 9, 2015 thru October 9, 2015

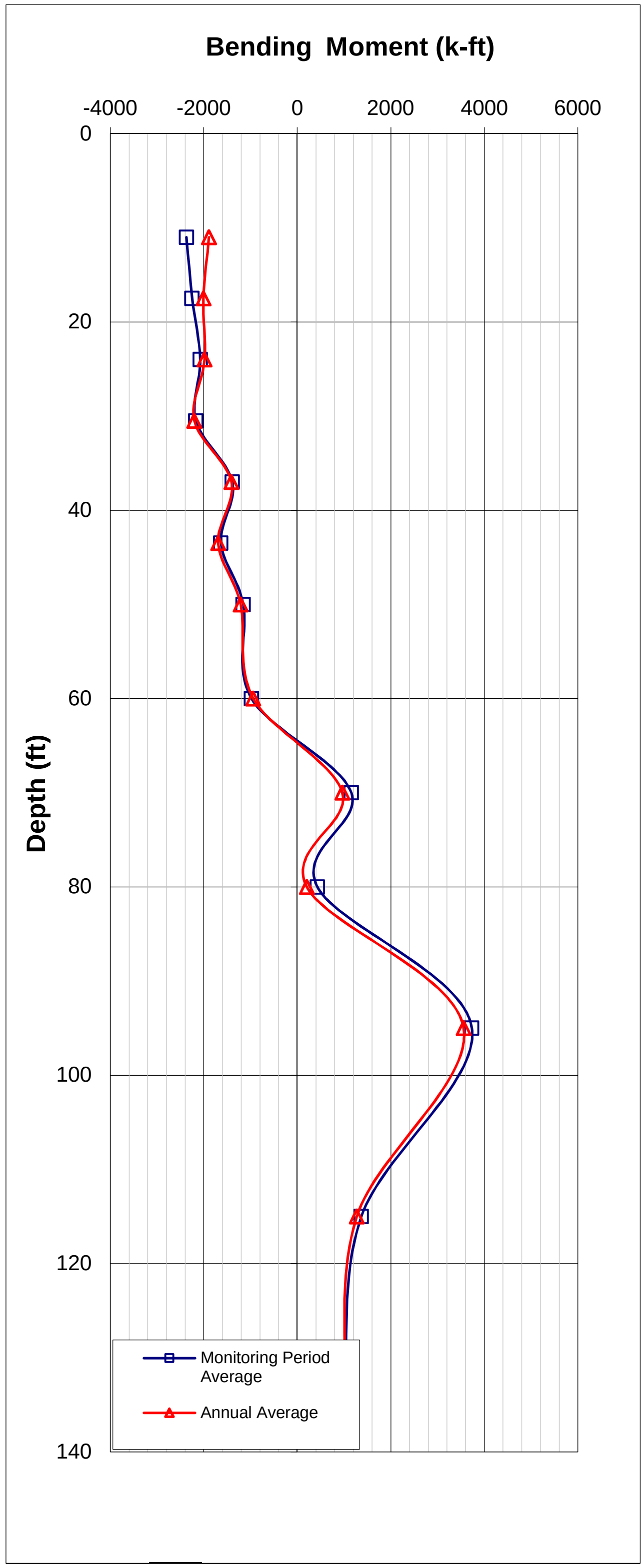


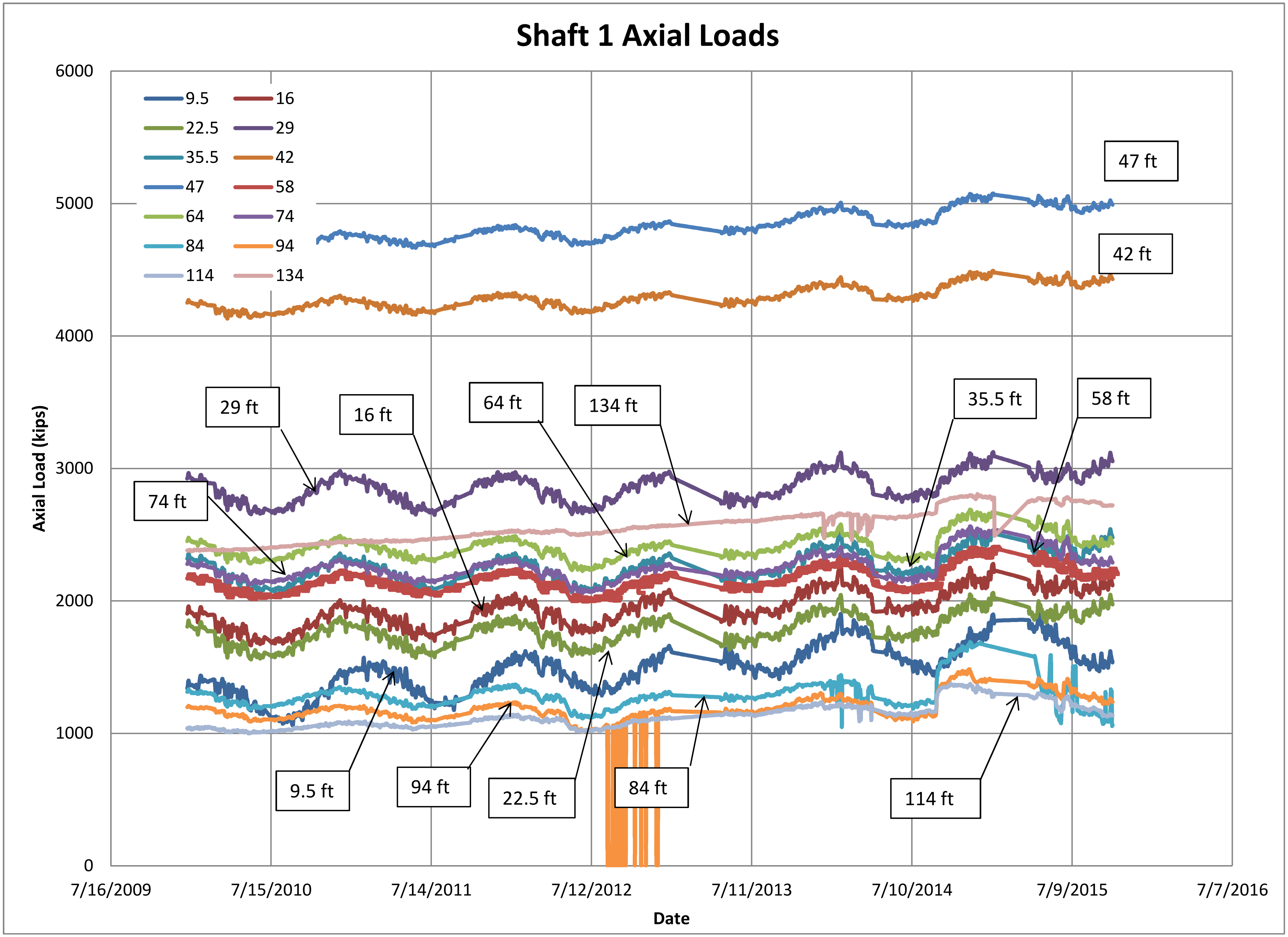


CUY-90-15.24 Slope Monitoring
PID 76117
Cleveland, Ohio
EDP #09305G

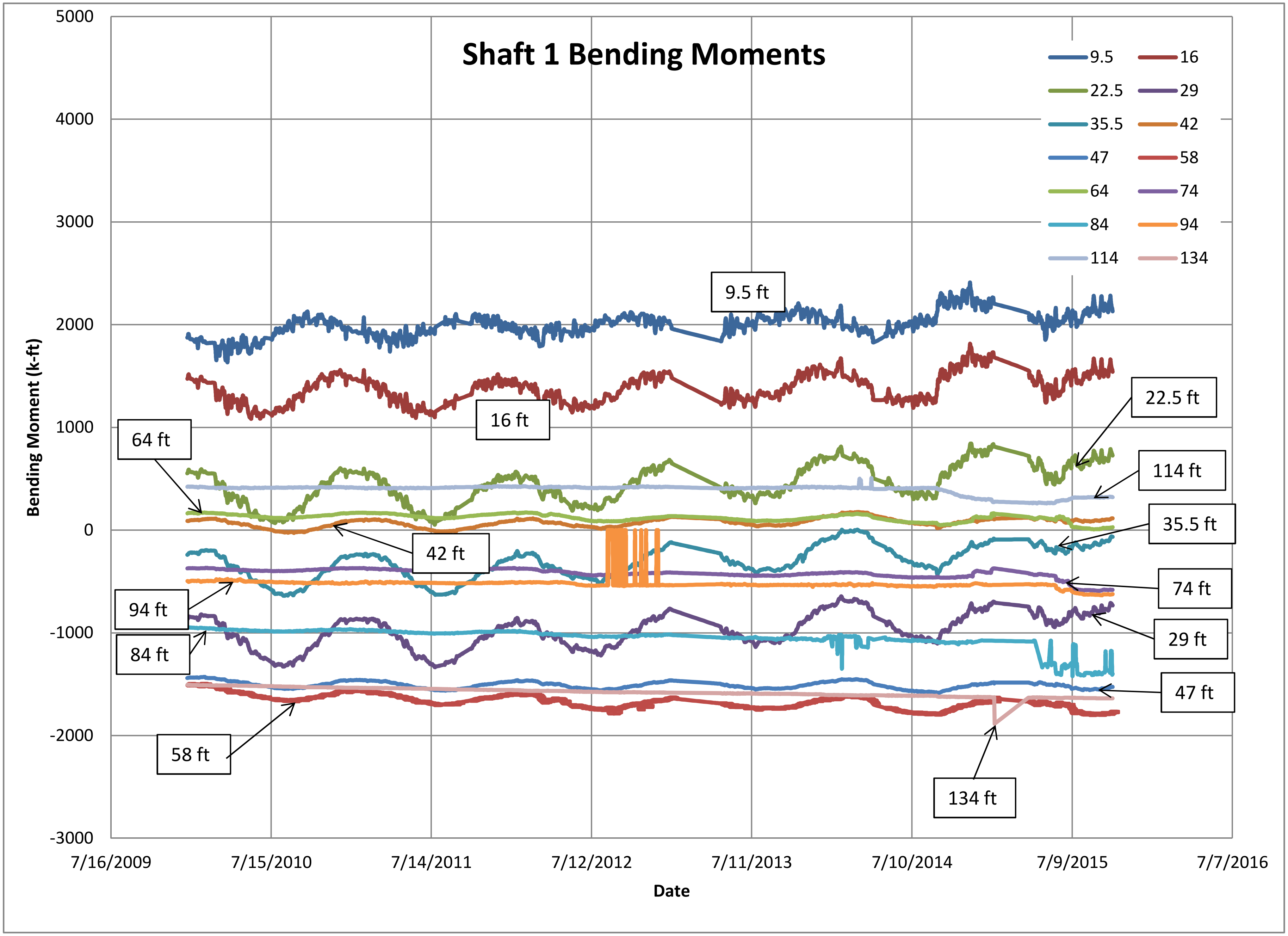
Drilled Shaft #9
Strong Axis Bending
Average for Period: July 9, 2015 thru October 9, 2015



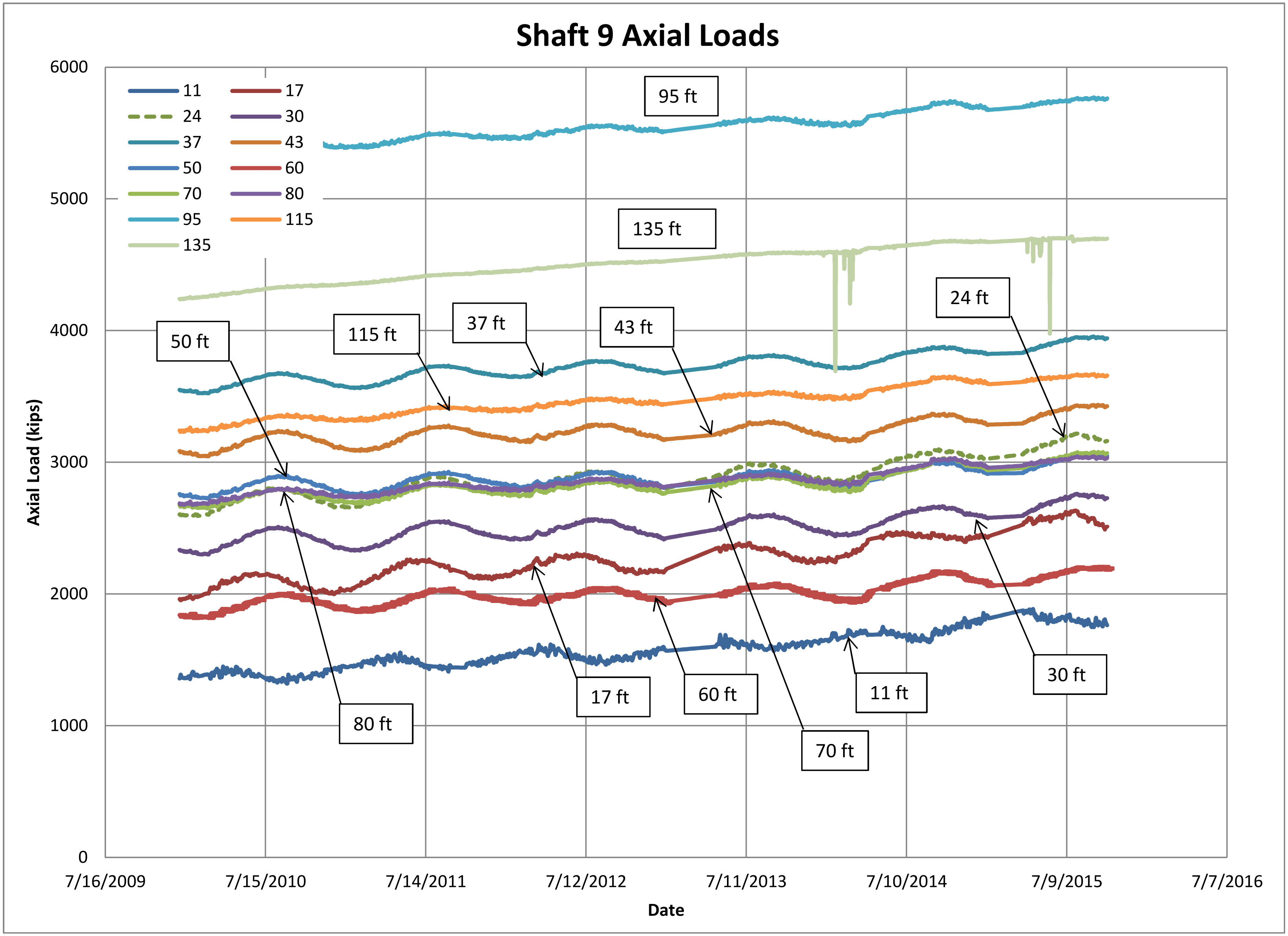


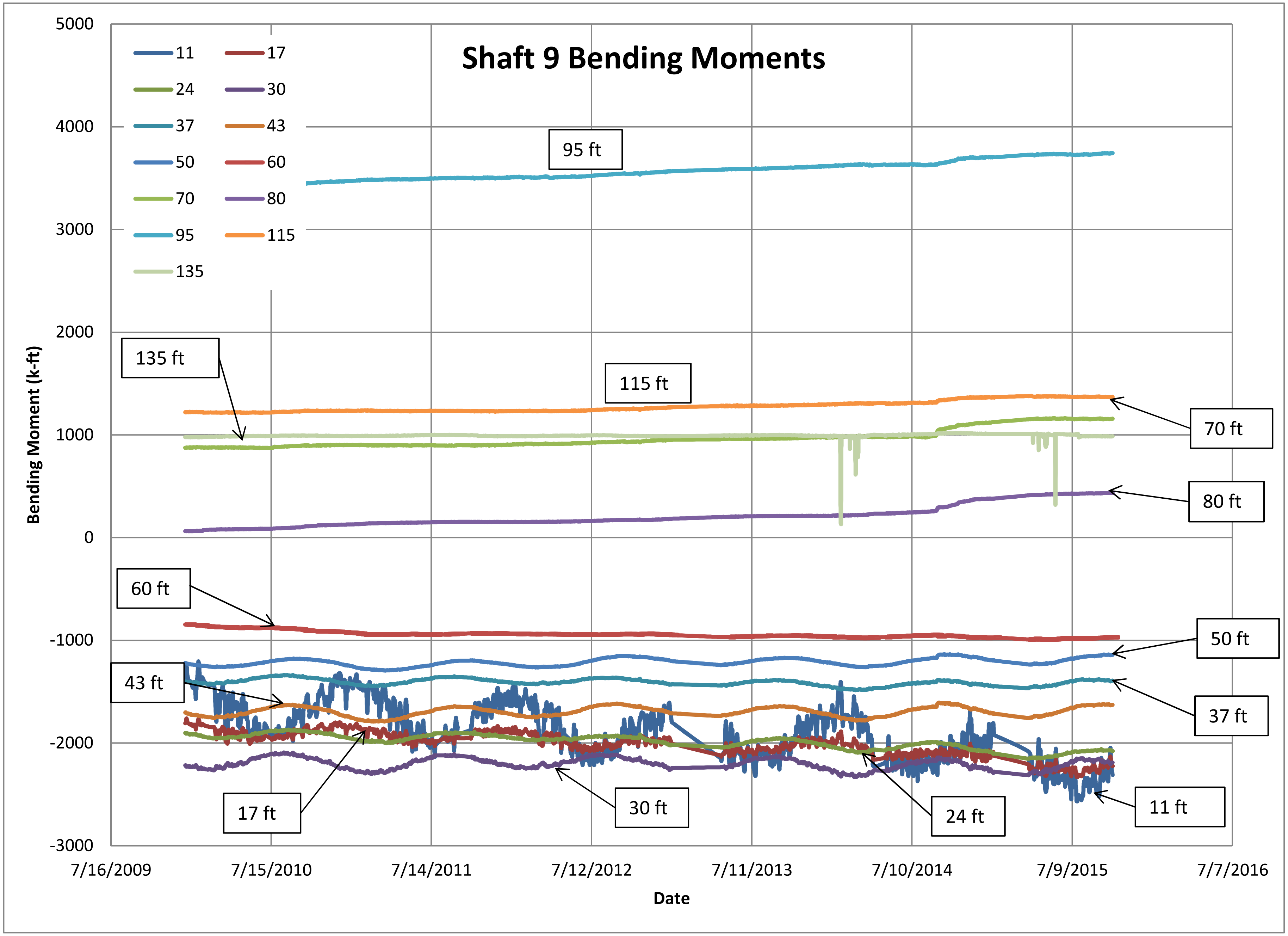


Shaft 1 Axial Loads
Axial Load (kips)
6000
5000
4000
3000
2000
1000
0
7/16/2009
7/15/2010
7/14/2011
7/12/2012
7/11/2013
7/10/2014
7/9/2015
7/7/2016
Date
9.5
16
22.5
29
35.5
42
47
58
64
74
84
94
114
134
47 ft
42 ft
29 ft
16 ft
64 ft
134 ft
35.5 ft
58 ft
74 ft
9.5 ft
94 ft
22.5 ft
84 ft
114 ft



Shaft 1 Bending Moments
9.5
16
22.5
29
35.5
42
47
58
64
74
84
94
114
134
9.5 ft
16 ft
64 ft
22.5 ft
114 ft
35.5 ft
42 ft
94 ft
74 ft
84 ft
29 ft
47 ft
58 ft
134 ft
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
Bending Moment (k-ft)
7/16/2009
7/15/2010
7/14/2011
7/12/2012
7/11/2013
7/10/2014
7/9/2015
7/7/2016
Date


Shaft 9 Axial Loads
Axial Load (kips)
Date
6000
5000
4000
3000
2000
1000
0
7/16/2009
7/15/2010
7/14/2011
7/12/2012
7/11/2013
7/10/2014
7/9/2015
7/7/2016
11
17
24
30
37
43
50
60
70
80
95
115
135
95 ft
135 ft
24 ft
50 ft
115 ft
37 ft
43 ft
80 ft
17 ft
60 ft
70 ft
11 ft
30 ft



Shaft 9 Bending Moments
11
17
24
30
37
43
50
60
70
80
95
115
135
95 ft
135 ft
115 ft
70 ft
80 ft
60 ft
50 ft
43 ft
37 ft
17 ft
30 ft
24 ft
11 ft
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
Bending Moment (k-ft)
7/16/2009
7/15/2010
7/14/2011
7/12/2012
7/11/2013
7/10/2014
7/9/2015
7/7/2016
Date