



OGMCOAL DNR &lt;ogmcoal@utah.gov&gt;

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## Fwd: FW: Grassy Trail Seismic Monitoring

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**Steve Christensen** <stevechristensen@utah.gov>

Mon, Aug 31, 2015 at 2:23 PM

To: OGMCOAL DNR &lt;ogmcoal@utah.gov&gt;

West Ridge- Seismic Monitoring Reports

----- Forwarded message -----

From: **Madsen, Karin** <kmadsen@coalsource.com>

Date: Mon, Aug 31, 2015 at 9:28 AM

Subject: FW: Grassy Trail Seismic Monitoring

To: "Steve Christensen &lt;stevechristensen@utah.gov&gt; (stevechristensen@utah.gov)" &lt;stevechristensen@utah.gov&gt;

Steve- See attached. 10 PDF files total

*\*Karin Odendahl-Madsen\***Engineering Technician**UtahAmerican Energy Inc.*

435-888-4026

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Karin,

See attached 2011 & 2012 reports (9 pdf files attached), as mentioned in my previous email.

Brad

BRADFORD E. PRICE, P.E.

Principal Geotechnical Engineer

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**From:** Brad Price [mailto:[bprice@rbgengineering.com](mailto:bprice@rbgengineering.com)]

**Sent:** Friday, August 28, 2015 12:24 PM

**To:** Madsen, Karin

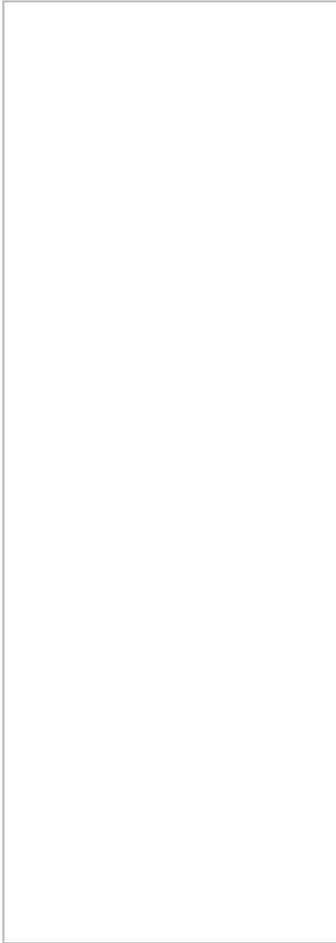
**Cc:** Hibbs, David

**Subject:** Grassy Trail Seismic Monitoring

Karin,

Attached is a pdf copy of the January 2008 to July 2010 Mining-Induced Seismicity Summary Update Report. I will send the 2011 and 2012 monthly seismic reports in a separate email. These go through May 2012. It is possible that Michael has a report for June 2012. He will be back in the office on Monday and I'll have him check. Our understanding was that mining stopped in the middle of June 2012. No monitoring was performed in 2013 or 2014.

Shown below is a list of the email recipients that these reports were sent to.



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**10 attachments**

-  **GrassyTrailMIS UpdateSummaryRptReducedFileSize.09-03-10.pdf**  
3155K
-  **GT sum Dec\_11.pdf**  
494K
-  **GT sum Nov\_11.pdf**  
822K
-  **GT sum Aug\_11.pdf**  
726K
-  **GT sum July\_11.pdf**  
736K
-  **GT sum Feb\_11.pdf**  
383K
-  **GT sum Mar\_11.pdf**  
2529K
-  **GT sum\_Apr-May\_12.pdf**  
669K
-  **GT sum\_Mar\_12.pdf**  
508K
-  **GT sum\_Feb\_12.pdf**  
515K

# MINING-INDUCED SEISMICITY NEAR GRASSY TRAIL DAM AND RESERVOIR

Carbon County, Utah

*Prepared for*



**RB&G**  
ENGINEERING, INC.

JANUARY 2008 TO JULY 2010



September 3, 2010

Dave Shaver  
West Ridge Resources, Inc.  
P.O. Box 910  
East Carbon, UT 84520

Subject: Mining-Induced Seismicity Summary Update Report – January 2008 to July 2010  
Near Grassy Trail Dam and Reservoir

Gentlemen:

A Summary Update Report has been completed for the Mining-Induced Seismicity Study at the Grassy Trail Dam and Reservoir in Carbon County, Utah.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

Michael N. Hansen, P.G.

Bradford E. Price, P.E.

bep/jag

Summary Update Report  
January 2008 – July 2010

**Mining-Induced Seismicity  
Near Grassy Trail Dam  
And Reservoir**

Carbon County, Utah

*Prepared for:  
West Ridge Resources, Inc.*

*September 2010*

RB&G ENGINEERING, INC.

**MINING-INDUCED SEISMICITY  
NEAR GRASSY TRAIL DAM AND RESERVOIR**  
*Carbon County, Utah*

***Summary Update Report January 2008 – July 2010***

**1. INTRODUCTION**

This report summarizes monitoring activities conducted at Grassy Trail Dam and Reservoir primarily between the months of January 2008 and July 2010. The project area is shown on Figure 1. The primary purpose of this study has been to monitor the effects of mining-induced seismicity on the dam and reservoir during and following the mining of Panel 7 in West Ridge Mine, and to evaluate potential effects of mining in Panels 18, 19, and 20 near the north end of the reservoir. The locations of instrumentation used for the monitoring program are shown on Figure 2. This report is an update to the January 2008 Summary Report (Grassy Trail Dam and Reservoir, Mining Induced Seismicity Summary Report January 2008, *RB&G Engineering, January 31, 2008*), which summarized monitoring activities between August 2005 and January 2008. This included the seismic monitoring and ground movements which occurred while mining was at its closest point to the dam in Panel 7 during 2006.

**1.1 Mining Timeline and Proximity to Reservoir**

Figure 3 shows the location of the West Ridge Mine operation relative to Grassy Trail Dam and Reservoir. This figure shows the locations of Panels 6 and 7 on the west side of the reservoir, which were mined in 2005 and 2006. It should be noted that the coal seam mined was 1664 feet vertically below the crest of the dam. The nearest point on Panel 7 was 995 feet horizontally west of the dam's right abutment. Following completion of Panel 7, the mining operation moved to Panel 8, located between 2.7 and 4.7 miles west northwest of the reservoir (north of the previously-mined panels) as shown on Figure 1. The projected areas to be mined in the next two years are shown on Figure 3. From this figure, it appears that future mining will gradually progress in an easterly direction, moving closer to the reservoir. Figure 3 also shows the locations of panels 18, 19, and 20 which are closest to the reservoir and

their projected mining dates as of May 2010. This figure shows a small section west of Panel 18 about 2,700 feet long and 300 feet wide which is proposed to be mined from August through November 2010.

## **2. PRESENTATION OF MONITORING DATA**

Summaries of monitoring data obtained by RB&G Engineering from seismic ground motion instruments, the University of Utah Seismograph Stations (UUSS), and inclinometers are included in the Figure and Table section of this report. Summaries of monitoring data performed by others from piezometers, seepage points, and survey points are presented in the appendix of this report. This section discusses the apparent correlations between the mining operations at West Ridge Mine and the data collected at Grassy Trail Dam and Reservoir.

### **2.1 Ground Motion Monitoring Devices**

The Instantel Minimate geophones have provided monitoring of seismic ground motions at the site since January 2005. The instruments have been sent to the manufacturer for re-calibration several times since their installation. During calibration, one device was always left in operation while the other was being re-calibrated. This was done to ensure that at least one device would be present at the site at all times to provide continuous data during the full duration of the study. Currently one instrument is located on the dam while the other remains on the hillside where it was located during mining of Panel 7.

Tables and graphs summarizing the Minimate data are included in the Figure and Table section of this report. A summary of the number of events per month and the characteristics of the largest event each month since January 2008 is tabulated on Table A-1.

The number of seismic events recorded on the Dam and Hillside per day since January 2008 are plotted on Figure A-1. The number of seismic events per day reported by the UUSS is also plotted on this figure. The figure shows that the dam and hillside seismic units recorded the most daily events during January 2008, with a high of only two events per day. The daily

number of events recorded at the reservoir decreased significantly after January with one event recorded in February, and the last recorded MIS event in December 2008.

In contrast, the maximum number of daily earthquakes recorded by UUSS gradually declined from January through June 2008, from a high of eight events in one day in January to only one event reported during the month July. In August, the number of events began to increase again, fluctuated greatly through December 2008. In January 2009, the number of events began to increase again, reaching as many as 11 events in one day.

During February 2009, a magnitude 2.1 event resulted in mining operations being shut down and then restarted with a panel and barrier method, leaving larger un-mined panels between mined panels. This method resulted in a significant decrease in the number of MIS events, with only twelve events reported from March 2009 to November 2009. Between November 2009 and July 2010 only one event has been reported (April, magnitude 0.1).

It should be noted that during mining in Panel 7 (March 2006), a 2.6 magnitude event was reported along with numerous events greater than magnitude 2.0 up through February 2009. These trends are also illustrated on Figure A-2, which shows events per week rather than events per day. As a comparison with the events from 2006 to 2008, we have included Figures A-1a and A-2a showing the all of the events from January 2006 to July 2010.

Figure A-3 shows the number of events recorded weekly at the reservoir during 2006, as well as the approximate horizontal distance from the mining to the dam at a given time. The number of events detected at the reservoir appears to be a function of the proximity of recent mining. This figure shows that the maximum number of weekly events at the reservoir does not directly coincide with the closest distance to the ongoing mining. Instead, the period of most frequent events lags several weeks behind the period of nearest mining activity. This lag time is likely caused by the tendency of the longwall ceiling to hang up for a period of time while building up stresses sufficient to collapse a portion of the roof.

Lag time is likely also associated with the movement of the landslides in 2006 during the mining of Panel 7. It is our opinion that once the slide started moving, it gained some of its

own momentum and some of the continued movement of the slide in the late summer and fall of 2006 was due to this lag time delay and the time needed for the slide to regain its own stability. It is our opinion that this latter movement was more likely associated with this stability and lag time, and less from the continued mining toward the northern end of Panel 7, which was further away from the dam.

The maximum weekly MIS earthquake event and Peak Ground Acceleration (PGA) values recorded at the reservoir from 2008 to July 2010 are plotted versus time on Figure A-4. The time period during which the greatest acceleration values and the highest number of events (four events) took place were during January and the first week of February 2008. During this time, the maximum PGA value was only 0.0265g. The next and last recorded event was picked up by the Hill Side Unit during the first week of December 2008 with a PGA value of 0.0133g. No MIS event was report by the UUSS for the December event. For comparison, Figure A-4a shows these maximum weekly values from January 2008 to July 2010.

An overview of the seismic activity in the area showing the number of MIS earthquakes reported by the UUSS per month since 2006 to July 2010 is shown on Figure A-5. Figure A-6 shows the earthquake magnitudes for each of these events since January 2006 to July 2010. From these figures, it is apparent that there was a significant decrease in the number of MIS events from October 2006 to March 2007. This corresponds with the move to Panel 8 which had significantly less cover over the mining area. We also see a significant drop in the number of events starting in February 2009 when the mine changed to a panel barrier method of mining. As shown on Figure A-6, there has been a significant change in the magnitudes of the earthquakes after February 2009. Prior to February 2009 the average event magnitude was 1.5. Since February, the largest magnitude events have been 1.4 with an average magnitude of 1.1. This change in number and magnitude of events appears to be related to the changes in mining practices.

## 2.2 Inclinometers

Figure 2 shows the location of each inclinometer. Data from the four inclinometers at the reservoir are compiled in the Figure and Table section of this report. A discussion of data

obtained from each inclinometer is presented below. It should be noted that some of the data prior to 2008 is not included in the following sections and figures. For detailed information prior to 2008, the Grassy Trail Dam and Reservoir, Mining-Induced Seismicity, Summary Report, January 2008 should be referenced.

### *2.2.1 Inclinometer 1*

Inclinometer 1 was installed at the easterly (left) end of the dam in 1998. This inclinometer extends through approximately 48 feet of dam embankment fill and into the foundation to a total depth of about 107 feet. The positive “A” axis of this inclinometer pipe is oriented into the abutment toward the southeast, and the positive “B” axis is oriented downstream to the southwest. Deflection profiles recorded by Inclinometer 1 are shown on Figure B-1. This figure shows that the uppermost 2-foot deflection interval shows substantially greater deflections than the rest of the readings. This observation indicates only that the pipe is not rigidly confined in the soil in the upper few feet, and is not an indicator of significant ground movements.

With the exception of the uppermost point, the deflections recorded along either Inclinometer 1 axis is less than about 0.2 inch. As of July 2010, the magnitudes of the displacements in Inclinometer 1 are small, and do not exhibit a significant tendency toward instability in this area.

### *2.2.2 Inclinometer 2*

Inclinometer 2 was installed near the west (right) end of the dam in 1998. This pipe extends to a total depth of 128 feet, including approximately 120 feet of embankment fill and underlying foundation soil before penetrating about 8 feet into sandstone bedrock. This inclinometer is oriented such that positive movement on the “A” axis indicates movement into the west abutment, and positive movement on the “B” axis is upstream toward the reservoir.

Deflection profiles for the “A” and “B” axes are shown on Figure B-2. Since January 2008 the “A” axis shows less than 0.25 inches of movement. This movement is significantly less than the approximately 3.5 inches of deflection between 2005 and 2008; with the large majority of this deflection having occurred between December 2005 and August 2006. The profiles also show deflection of about 0.5 inch in the negative “B” direction occurring between January 2008 and July 2010. After December 2008 we do not see any new significant movement. Much of the movement is within the error of the instrument. In both cases, the profiles appear to be relatively stable since the end of 2008.

The deflected shape of Inclinator 2 on January 26, 2008 relative to a baseline shape measured on July 20, 2004 is shown in plan view on Figure B-3. The figure shows that the measured deflections are oriented primarily along the dam axis from the west (right) abutment toward the maximum section to the east. The slight “bulging” noted on the “B” axis profile is in the upstream direction. Since no significant movement has occurred between 2008 and July 2010, this information is not included on this figure.

Figure B-4 shows deflections along the “A” axis of Inclinator 2 plotted versus time, beginning in February 2005 up to July 2010. The dates on Figure B-4 can be compared to the dates at which mining occurred closest to the dam. Some lateral deflection (0.4 inch over the 44 to 122-foot depth interval) occurred during Panel 6 mining in 2005. Much of the 2005 deflection occurred during the first half of the year, and measurements after June appear to demonstrate a decreasing rate of deflection. By November 2005, the ongoing deflection appears to be negligible.

As mining commenced in Panel 7, the deflections measured in Inclinator 2 began to increase substantially, with the greatest deflections occurring during and immediately following the period of shortest distance between the mining and the dam. By August 2006, the ongoing deflections were very small. By October 2006 movement became negligible.

There appears to be a very strong correlation between the deflections measured by Inclinator 2 and the proximity of longwall mining. The larger magnitudes of events recorded during Panel 7 mining compared to Panel 6 mining may also contribute to the larger lateral deflections observed during Panel 7 mining.

### 2.2.3 *Inclinometer 3*

Inclinometer 3 was installed in the dam's right (west) abutment in 1998. This pipe extends through about 7 feet of clayey overburden soil, underlain by predominantly mudstone to about 42 feet, and terminates after penetrating about 11 feet into sandstone at a total depth of 53 feet. The positive "A" axis of Inclinometer 3 is oriented predominantly away from the dam and 20 to 25 degrees upstream of the dam axis. The positive "B" axis is oriented predominantly upstream toward the reservoir.

Profiles of deflection measurements recorded at Inclinometer 3 since February 2008 are shown on Figure B-5. The deflection shape shown for the "A" axis and "B" axis shows no significant movement between February 2008 and July 2010.

Figure B-6 is a plan view of the deflection measurements in Inclinometer 3 between 2004 and 2007 and includes the maximum deflection during mining. The predominant plane of back-and-forth lateral deflection is parallel to the dam axis, but an overall movement in the upstream direction is also apparent. Since no significant movement has occurred between 2008 and July 2010 this information is not included on this figure.

Figure B-7 shows the deflection for the various depth intervals plotted versus time. On this figure the trend is very similar to that shown for Inclinometer 2 on Figure B-4. Again, it appears that relatively small lateral ground movements occurred at the abutment during mining of Panel 6 in 2005, followed by larger deflections occurring during Panel 7 mining. As was the case with Inclinometer 2, the rate of deflection at Inclinometer 3 was very small during periods of limited or more distant mining activities, such as November-December 2005 and after August 2006.

The deflections measured at Inclinometer 3 are substantially smaller than those measured at Inclinometer 2; however, it should be noted that the bottom eight feet of Inclinometer 2 appears to be fixed in place, suggesting that the pipe may be anchored in a stationary stratum. By contrast, Inclinometer 3 shows deflections beginning at the deepest measurement interval (51 to 53 feet). This observation suggests that the bottom of the Inclinometer 3 pipe may not be anchored as the Inclinometer 2 pipe appears to be. The 11 foot sandstone unit at the bottom of this inclinometer appears to be moving with the slide. This makes the movement recorded above the bottom only relative to the moving bottom and not to a stationary fixed point. It should be noted that the deflection values recorded only show relative movement between points and do not show absolute deflection values with a true measurement of total side movement and direction of movement.

Since October 2006 to July 2010 Inclinometer 3 has not shown any significant movement.

#### *2.2.4 Inclinometer 4*

Inclinometer 4 was installed in February 2005 on the west rim of the reservoir upstream of the dam. This instrument is located immediately west of the roadway in the lower portion of an apparent slide mass. The pipe extends through approximately 37 feet of soil and penetrates about 30 feet into the underlying bedrock to a total depth of 67 feet. The positive “A” axis for this inclinometer is oriented in an easterly direction toward the reservoir. The positive “B” axis points downstream toward the dam.

Deflection profiles for Inclinometer 4 are shown on Figure B-8. This figure show relative movement compared to a base line reading taken in July, 2007. In July of 2007 Inclinometer 4 (I-4) was run over by a large truck and broken off just below ground level. Repairs were started and put on hold while the road was being widened. The new road cut caused a surficial side which buried I-4. At the time I-4 was not showing signs of movement. In May 2010 the inclinometer was located and dug out, and appears to be functional. Due to the loss of about 2 feet of pipe at the surface, new readings do not

correlate exactly with the previous readings prior to 2007. This may account for the small bulge at 62 feet, as well as the other irregularities in the survey in Figure B-8. The larger displacements shown in the upper 4 feet indicate that the top of the pipe is loose and is moving during the readings.

Taking into account the possible reading error due to the damage, the inclinometer does not show any significant movement since 2007. Some additional repairs are still needed to secure and protect the top of the instrument.

Figure B-9 shows a plan view of the Inclinometer 4 deflection measurements between February 2005 and July 2007. Disregarding the outlying points at depths of 1 and 3 feet, the deflection is predominantly eastward down the slope and into the reservoir, as would be expected.

The deflection of Inclinometer 4 along the “A” axis is plotted versus time on Figure B-10. The same trend observed at Inclinometers 2 and 3 is also apparent at Inclinometer 4. One notable difference is that the deflections attributable to mining of Panel 7 appear to subside several months earlier (around June 2006) at Inclinometer 4, while they continue until about August with slight movement into October 2006 in the west abutment area of the dam.

### 2.3 Piezometers and Observation Wells

The dam has been instrumented with piezometers and observation wells to allow careful monitoring of any changes in pore pressure and seepage behavior. The locations of these instruments are illustrated on Figure 3. East Carbon City is responsible for monitoring the piezometers and observation wells on a regular basis. The monitoring results are uploaded to the States Dam Safety Office web site. This information is available at ([http://nrwrt1.nr.state.ut.us/cgi-bin/damview.exe?Modinfo=Viewdam&DAM\\_NUMBER=UT00126](http://nrwrt1.nr.state.ut.us/cgi-bin/damview.exe?Modinfo=Viewdam&DAM_NUMBER=UT00126)). Figure C-1 in the appendix shows a summary of reservoir levels and piezometer readings between 2008 and 2010. It is our understanding that Piezometer 4 (aka OW-4) located near the maximum section was not read from October 2008 until May 2010 due to a change in

personnel and problems with the lock. We understand that these problems have been resolved and the piezometer is now being read.

A review of the piezometer readings shows an occasional spike on a single piezometer reading. These spikes appear to be errors in data entry since the next reading is back to normal. With exception of the spikes, no substantial or unusual changes in water levels were observed.

## 2.4 Seepage Monitoring Points

Seepage through the dam, foundation, and abutments is collected at three locations, including the toe drain connected to the dam's internal drainage system, a seepage collection system located on the east (left) abutment, and a collection pipe located on the west (right) abutment. The flows from the drains are measured by recording the time to fill a container of known volume with water from each collection point. The clarity of the water has also been recorded during seepage readings. Clear seepage water indicates that the flow is adequately filtered and is not moving material through the dam or foundation. Cloudy seepage water could be a sign of internal erosion, which could lead to a piping-related failure of the structure. It should be noted that no cloudy water has been noted during our site visits. Figure C-2 in the appendix shows the reservoir elevation and seepage at each monitoring location from 2006 through June, 2010. No significant changes in seepage rates have occurred during the monitoring time.

## 2.5 Survey Points

West Ridge Mine contracted with Ware Surveying to provide surveys of points on the dam and the slopes west of the reservoir at various times throughout the monitoring program. We have received updates from Ware Surveying with monthly surveys taken along the dam. According to Ware Surveying, since 2008 little to no significant movement has been reported at the dam. A copy of the survey data is included in the appendix. The locations of the survey points are shown on Figure C-3 of the appendix.

### 3. SUMMARY AND CONCLUSIONS

This section provides a brief summary of the findings of the monitoring data described in the previous section, and presents several conclusions that may be drawn based on this data. It should be noted that mining in the West Ridge Mine continues to occur, along with regular monitoring of impacts at the reservoir site. The current mining is at a much larger distance from the dam than Panels 6 and 7, but the distance between the reservoir and active mining areas is expected to decrease over the next several years. Data collected during this future mining may lead to some refinement of the conclusions presented below.

#### 3.1 Mining-Induced Ground Motions at Grassy Trail Reservoir

The longwall mining operation performed in Panels 6 and 7 resulted in ground motions detected on the hillside west of the dam, as well as on the crest of the dam itself. The recorded mining-induced ground accelerations at the dam were relatively small during mining of Panel 6, and increased substantially during mining of Panel 7. The number of mining-induced events detected by instrumentation at the reservoir also increased substantially during Panel 7 mining. The increase in the number of events and the recorded acceleration levels appears to be strongly connected to the increased proximity of mining. There appears to be a lag of a few weeks up to several months between the time period of closest-proximity mining and the time of maximum mining-induced ground motions at the reservoir. The following table summarizes the number of MIS events starting in 2006.

<b>Year</b>	<b>UUSS MIS / Earthquake events/year</b>	<b>UUSS MIS / Earthquake average events/month</b>
2006	463	38.6
2007	373	31
2008	255	21.3
2009 Jan thru Feb	47	23.5
2009 Feb thru Dec after change in mining	12	1.2
2010 Jan thru July	1	0.083

As shown in the Table above, the average number of events dropped in 2007 and 2008 and was increasing again in the first 2 months of 2009. In later part of February 2009 mining operations were changed to a panel barrier configuration. As shown on the table, the number

of MIS events has dropped significantly since February 2009, when mining practices were changed.

### *3.1.1 Slide Areas on Hillside West of Reservoir*

Grassy Trail Reservoir is located at the junction of the left and right forks of Whitmore Canyon. The dam and reservoir are located on the Colton Formation laid down during the Tertiary Period, Eocene and Paleocene Epochs, about 38 to 56 million years ago. The formation consists of dark-reddish-brown to green beds of mudstone and shaly siltstone interbedded with yellowish to grayish-orange and grayish brown, thin, fine to medium grained quartzose sandstone, with sparse limestone beds. The formation is primarily of alluvial origin with some marginal lacustrine and deltaic deposits (Weiss and others, 1990). Bedrock appears to dip gently to the northeast at an angle of about 7 to 8 degrees.

These mudstone deposits of the Colton Formations are susceptible to sliding and are associated with landslide deposits in the region. While geologic maps of the area show landslide deposits in the region, they do not show any mapped near the dam or in the area near panels 18, 19, and 20. The lack of identified slides on the map, at and near the dam, is likely due to the scale of the mapping and also indicates that other small scale landslides may not be mapped as well.

Inclinometers 2 and 3 have been documenting movement of the landside on the west side of the dam. Significant movement of the west side took place shortly after the dam was constructed and long before current mining operations. MIS movement of this slide started in 2005. Most of the movement took place in 2006, causing about 3.5 inch of inclinometer deflection at the dam. At that time mining came within a horizontal distance of about 1,000 feet of the dam.

Inclinometer 4, located upstream of the dam on the west rim of the reservoir, has shown discrete deflections of up to 0.3 inch at a depth of about 62 feet below the ground surface. These deflections are significantly smaller than those at the dam. Very slight deflections were measured at this depth during mining of Panel 6 in 2005, but the large majority of

this deflection occurred between February and June of 2006, while mining in Panel 7 was closest to the inclinometer. Measurements recorded since June 2006 suggests that this slide area has been relatively stable since that time.

These slides may become more active as future mining activities approach the reservoir and mining-induced ground motions again increase at the site. Due to the changes in mining practices since February 2009, the number of MIS earthquake events has decreased significantly. The magnitude of the MIS earthquake events have also decreased. While MIS hazards still pose a threat to these landslide areas, it appears that, due to decreases in number and magnitude of MIS events, the potential hazards which were seen during the mining of Panel 7 in 2006 have likely also decreased.

It should also be noted that increases in slide movement could occur due to other factors such as above average precipitation and changes in the moisture conditions in the hillside that are entirely unrelated to the mining activities.

#### **4. RECOMMENDATIONS**

It is apparent from the data collected that mining activities in West Ridge Mine have caused mining-induced seismic events, and that ground motions caused by these events are detectable at Grassy Trail Dam and Reservoir. These ground motions have caused some measurable permanent deformations of the ground surface on the hillside west of the reservoir, as well as lateral deformations at the west end of the dam. Despite the recorded deformations, the dam appears to be performing well, and ongoing deformations have been very small to negligible since mining of Panel 7 concluded in the fall of 2006.

The inclinometers suggest that since October 2006 negligible to only very slight deformations (creep) may be ongoing at the dam's west abutment. Continued monitoring of these inclinometers is recommended to verify that the rate of this movement does not increase. Inclinometer #4 was damaged and then buried by a surficial landslide. This slide was triggered by a road cut made to widen the roadway along the west side of the dam.

Regular monitoring of piezometers and seepage collection points is also recommended to verify that the recorded lateral movements do not result in increased seepage and/or internal erosion of the dam. This monitoring is critical to ensure adequate long-term performance of the dam and the safety of people and facilities located downstream.

A meeting was held in May 2010 to discuss the ongoing and future mining operation. As mining continues toward the east, it is gradually approaching closer to the area north of the reservoir. Due to the changes in mining practice to a “Barrier and Panel” configuration after February 2009, MIS events have dropped significantly in number and in magnitude. Based on this decrease, mining of panels # 18, 19 and 20 appears to be significantly safer, relative to dam safety. These areas are now being considered for mining. According to Figure 3, a small portion, about 300 feet wide, along the west side of Panel 18 may begin around in the Fall of 2010.

We recommend that the Minimate seismic monitoring accelerometer located on the hillside west of the dam be relocated to a location north of the dam. The instrument should be placed at a distance about equal to the nearest distance that projected mining is shown at its closest point to the dam. By doing this, we can start gathering new PGA (accelerometer) data relative to the new mining practices. This data can then be compared with data gathered during mining of Panels #6 and #7 in 2005 and 2006.

We recommend the monitoring schedule prepared and discussed in the Grassy Trail Dam and Reservoir, Mining-Induced, Summary Report, January 2008, included as Exhibit E-2 in Appendix E of that report, continue until further notice. A copy of Exhibit E-2 is included in the Appendix of this report. It is anticipated that the parties involved will meet yearly while mining continues, in order to review the monitoring data and update the monitoring schedule as needed. The frequency of monitoring may be increased at any time as dictated by unexpected changes in the monitoring data. We expect that monitoring will increase as mining gets closer to the reservoir.

As noted in Exhibit E-2, we will continue to perform daily reviews of the data on the UUSS web site. If an event of magnitude greater than 3.0 is reported within 5 miles of the dam, thorough site

reconnaissance and readings of the ground motion instruments will be performed within 24 hours. Reading of all other instrumentation (inclinometers and piezometers) will also be performed if any recorded ground acceleration exceeds 0.2g.

## REFERENCES

- Agapito Associates, Inc. (2004), Estimated Impacts to the Grassy Trail Reservoir Due to Longwall Mining, West Ridge Mine, November 2004.
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- RB&G Engineering, Inc. (2008). Grassy Trail Dam and Reservoir, Mining-Induced Seismicity, Summary Report January 2008.



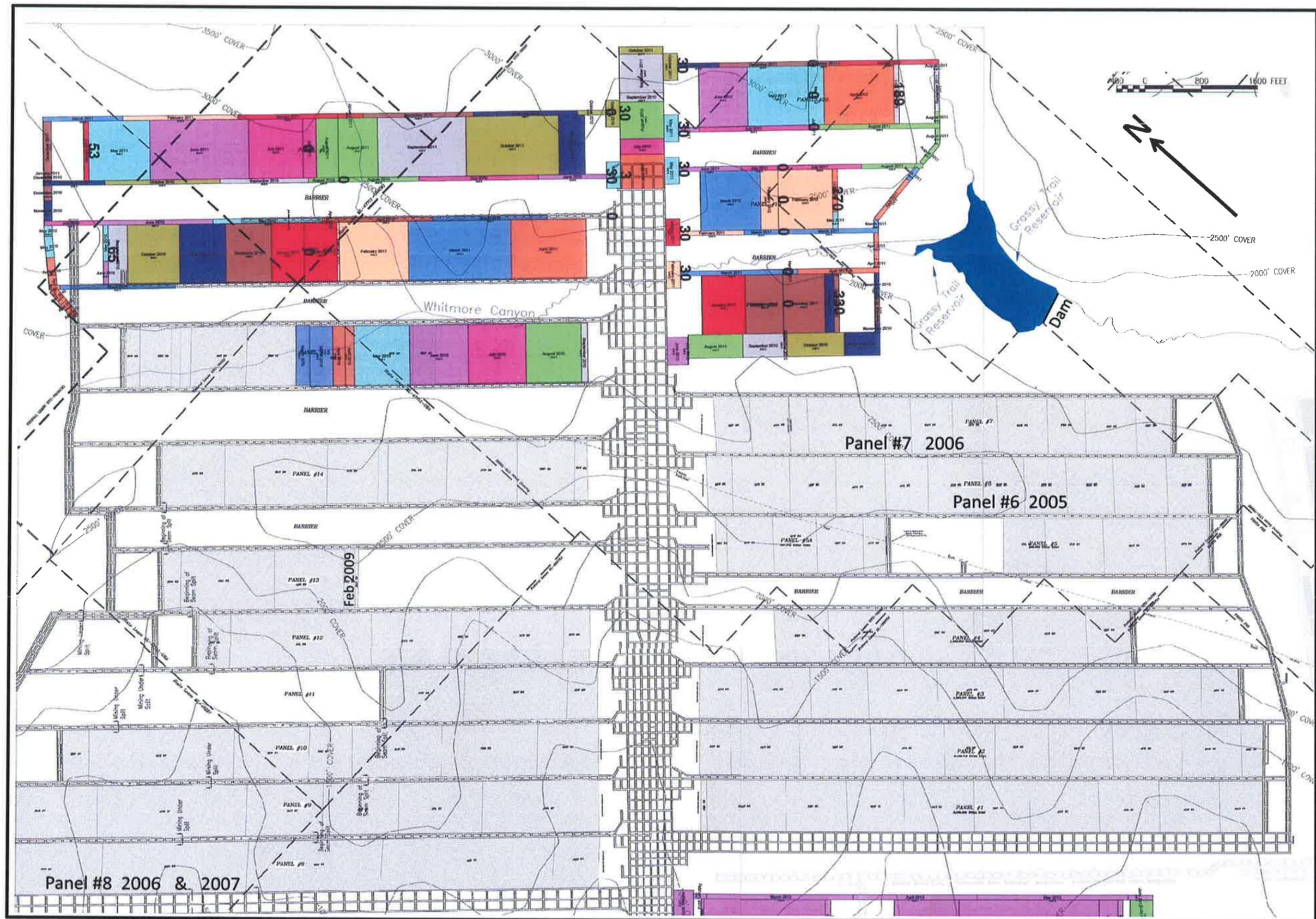


Figure 1  
Project  
Location

West Ridge Mine Project Area  
Grassy Trail Reservoir Mining Induced Seismicity  
Near East Carbon, Carbon County, Utah

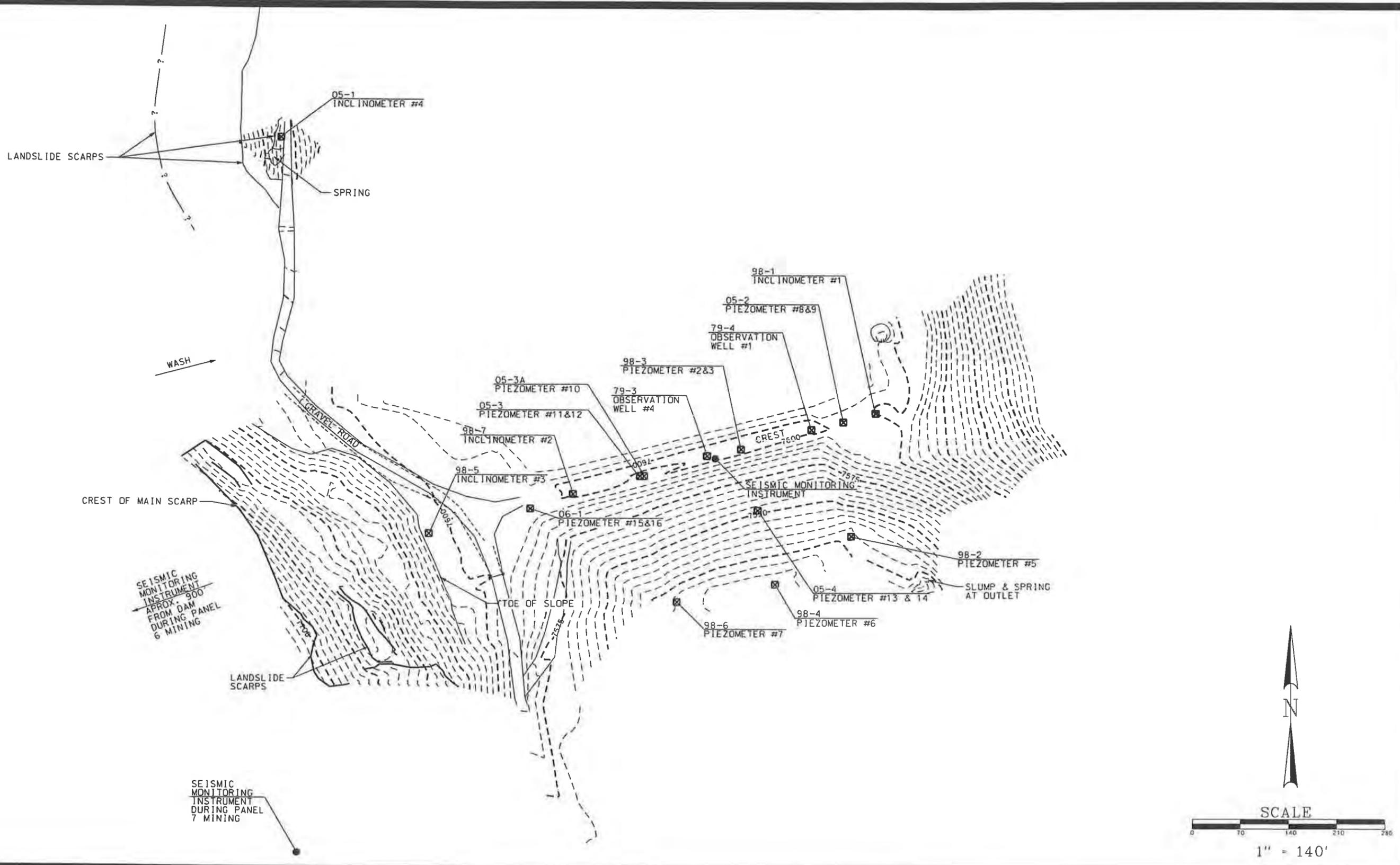


Figure 2

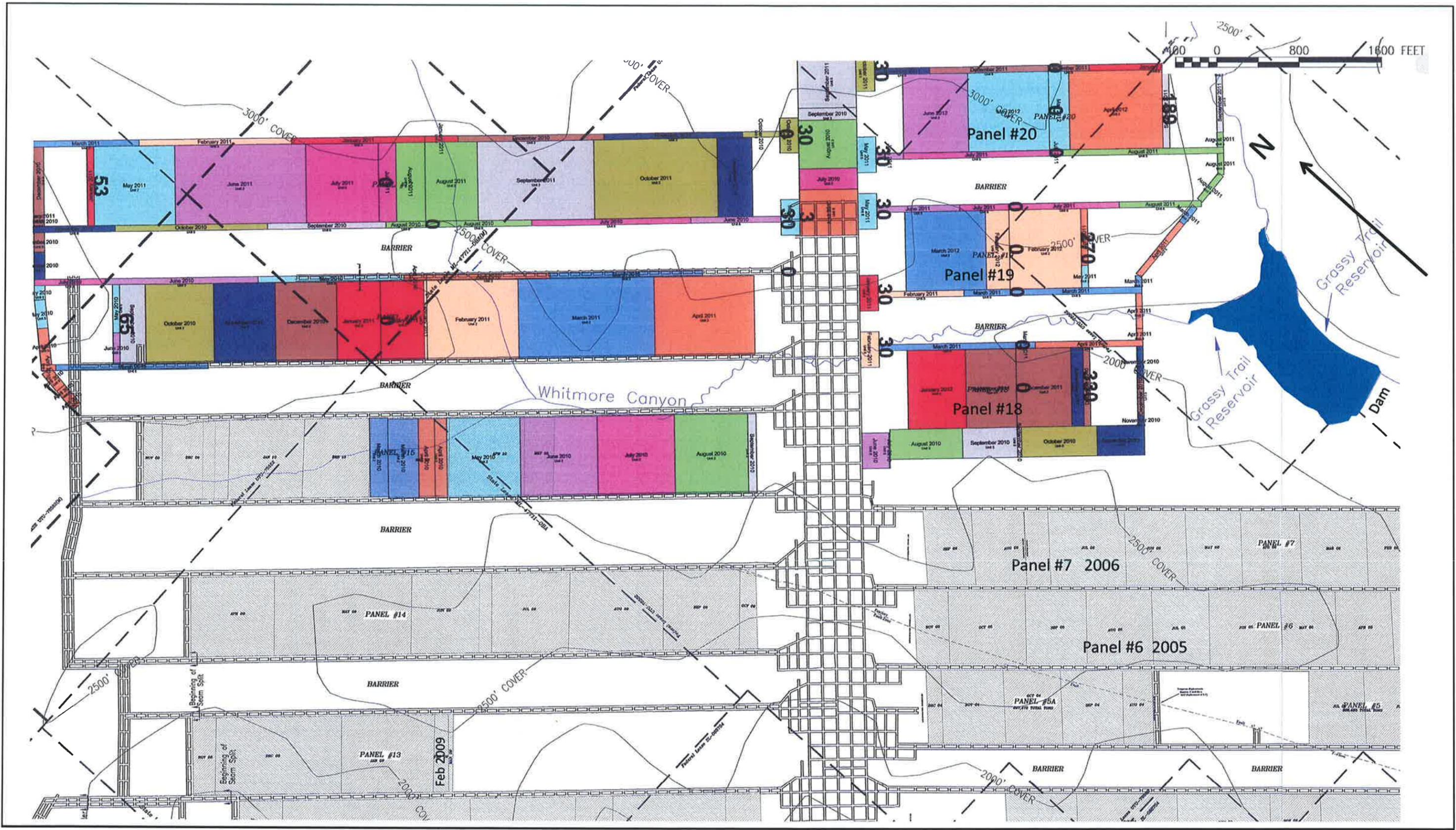


Figure 3  
Project  
Location

West Ridge Mine Project Area with projected Mining Dates  
Grassy Trail Reservoir Mining Induced Seismicity  
Near East Carbon, Carbon County, Utah

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**Ground Motion Monitoring Devices**

**Table A-1**  
**Monthly Summary of Ground Motions**  
**Jan 2008 to July 2010**  
**Grassy Trail Dam**

Month	Device on Dam			Device on Hillside			UUSS Earthquakes	
	No. of Events	Max Per Day	Max Accel. (g)	No. of Events	Max Per Day	Max Accel. (g)	No. of Events	Max Magnitude
Jan 2008	8	1	0.0265	na	removed for repair		45	2.5
Feb 2008	0			1	1	0.0265	23	1.8
Mar 2008	0			0			13	2.0
Apr 2008	0			0			25	2.0
May 2008	0			0			20	2.1
Jun 2008	1	1	0.0265	0			6	1.5
Jul 2008	0			0			1	1.2
Aug 2008	0			0			37	2.1
Sep 2008	0			0			8	1.6
Oct 2008	0			0			32	2.1
Nov 2008	1	1	0.0133	0			8	1.7
Dec 2008	0			0			34	1.8
Jan 2009	0			0			47	2.0
Feb 2009	0			0			3	2.1
Mar 2009	0			0			1	1.4
Apr 2009	0			0			1	1.1
May 2009	0			0			1	1.3
Jun 2009	0			0			2	1.4
Jul 2009	0			0			1	1.2
Aug 2009	0			0			3	1.3
Sep 2009	0			0			1	1.3
Oct 2009	0			0			1	0.6
Nov 2009	0			0			1	1.4
Dec 2009	0			0			0	
Jan 2010	0			0			0	
Feb 2010	0			0			0	
Mar 2010	0			0			1	0.1
Apr 2010	0			0			0	
May 2010	0			0			0	
Jun 2010	0			0			0	
Jul 2010	0			0			0	

Notes: Max. Accel. = Maximum Peak Acceleration Recorded During the Month

### Number of Seismic Events Recorded per Day

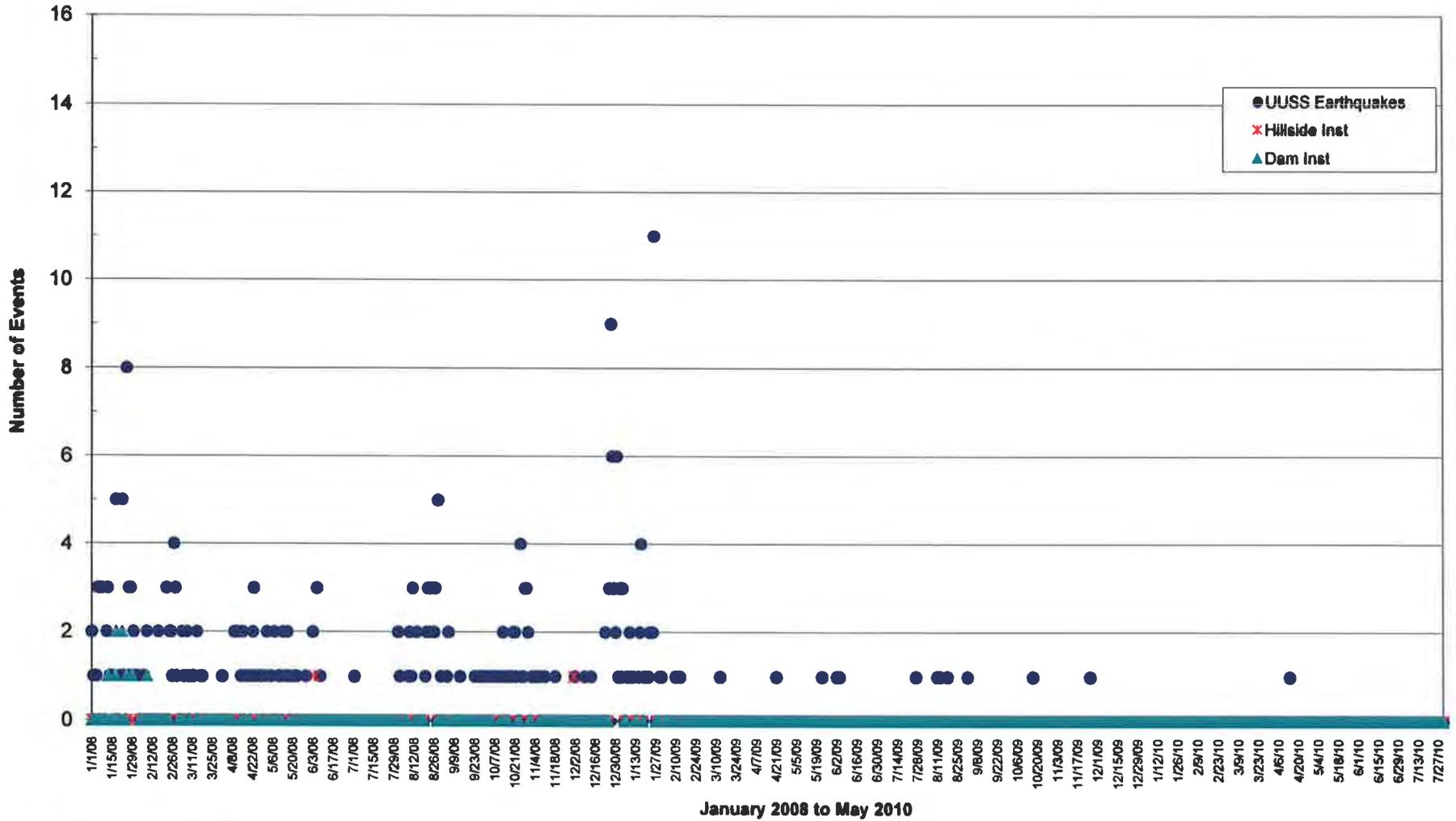


Figure A-1  
**NUMBER OF EVENTS RECORDED PER DAY (SINCE JAN 1 2008)**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH

### Number of Seismic Events Recorded per Day

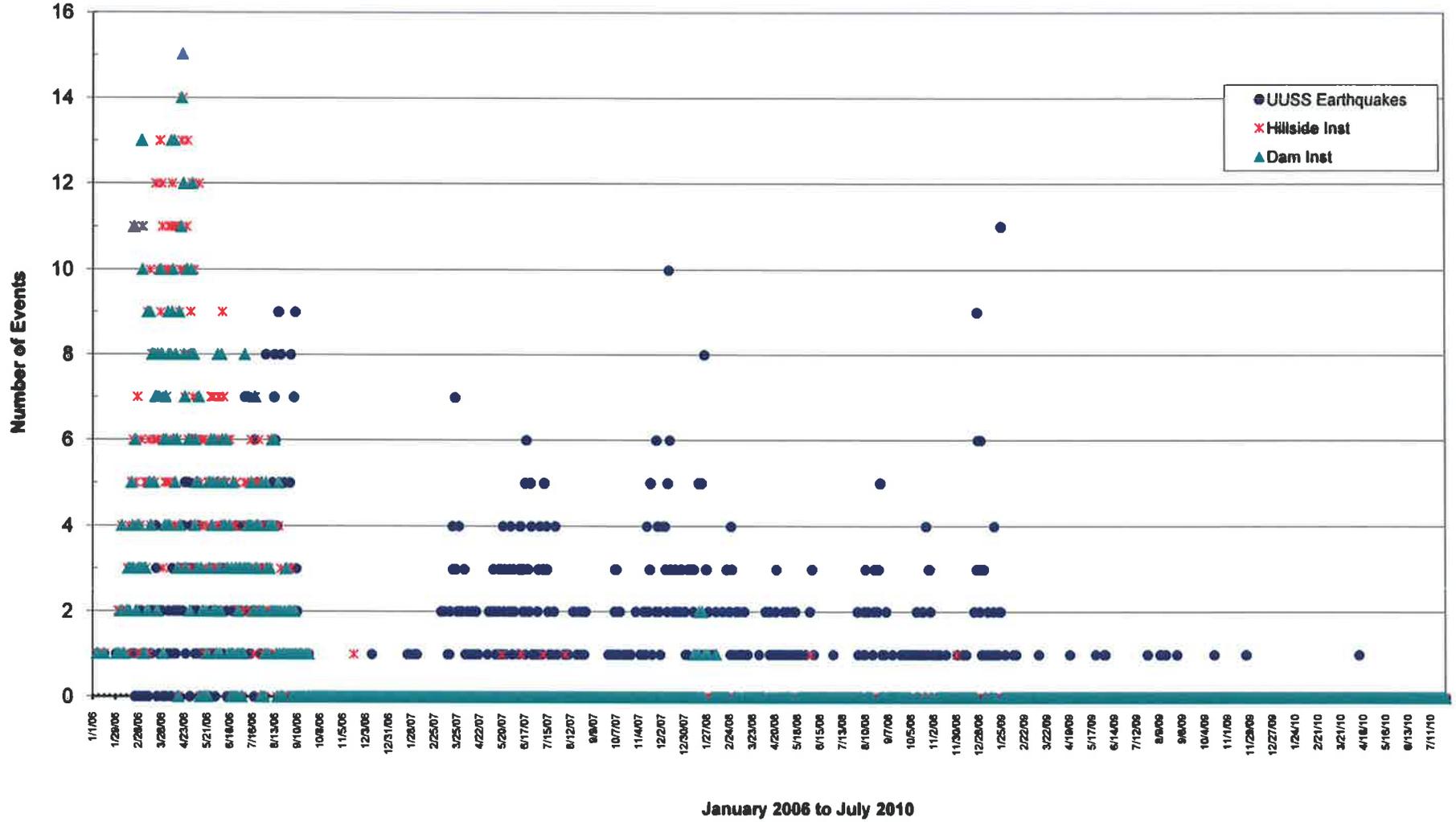


Figure A-1 a  
 NUMBER OF EVENTS RECORDED PER DAY (SINCE JAN 1 2006)  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH

### Seismic Events per Seven day Period

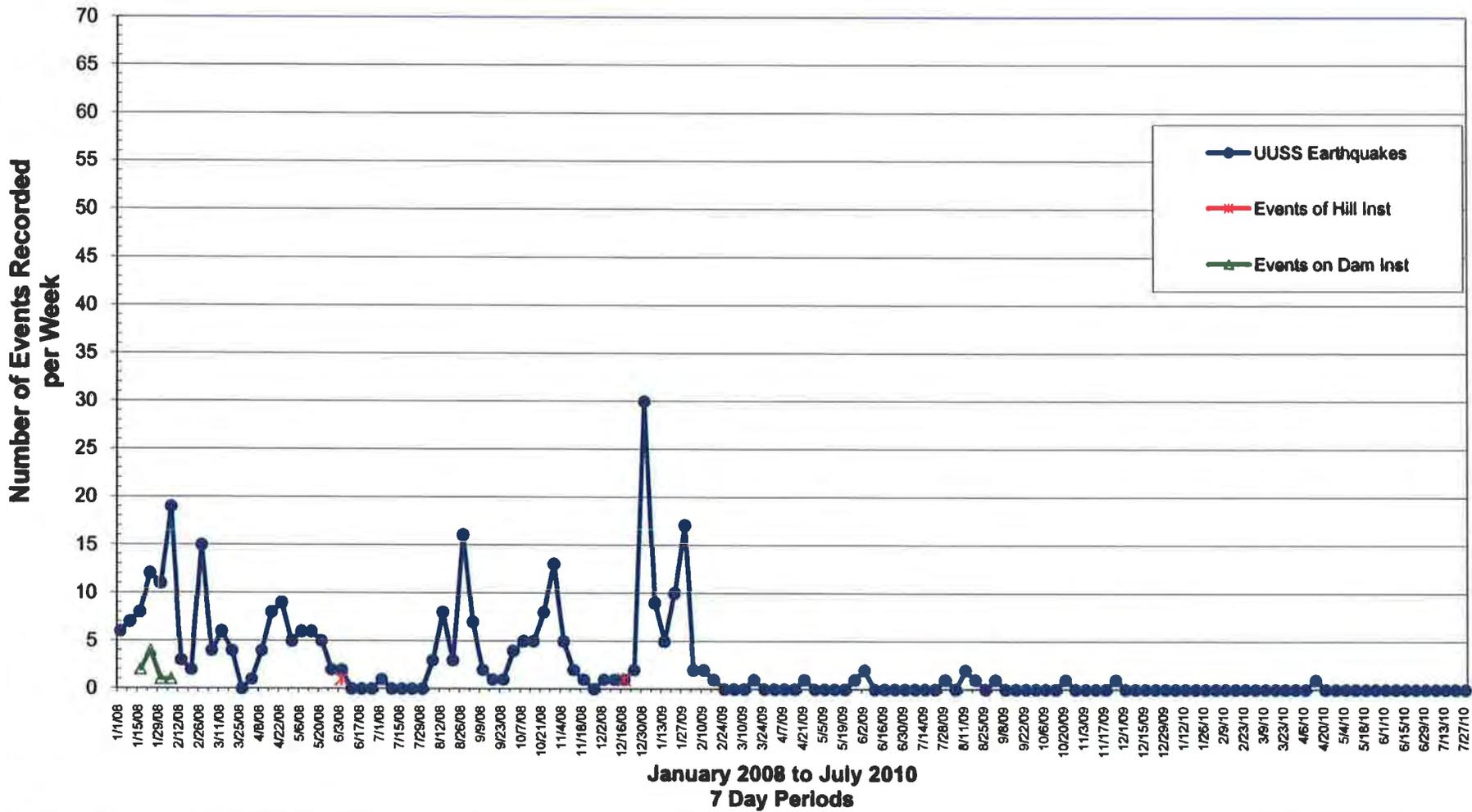


Figure A-2  
**NUMBER OF EVENTS RECORDED PER WEEK (SINCE JAN 1 2008)**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH

### Seismic Events per Seven day Period

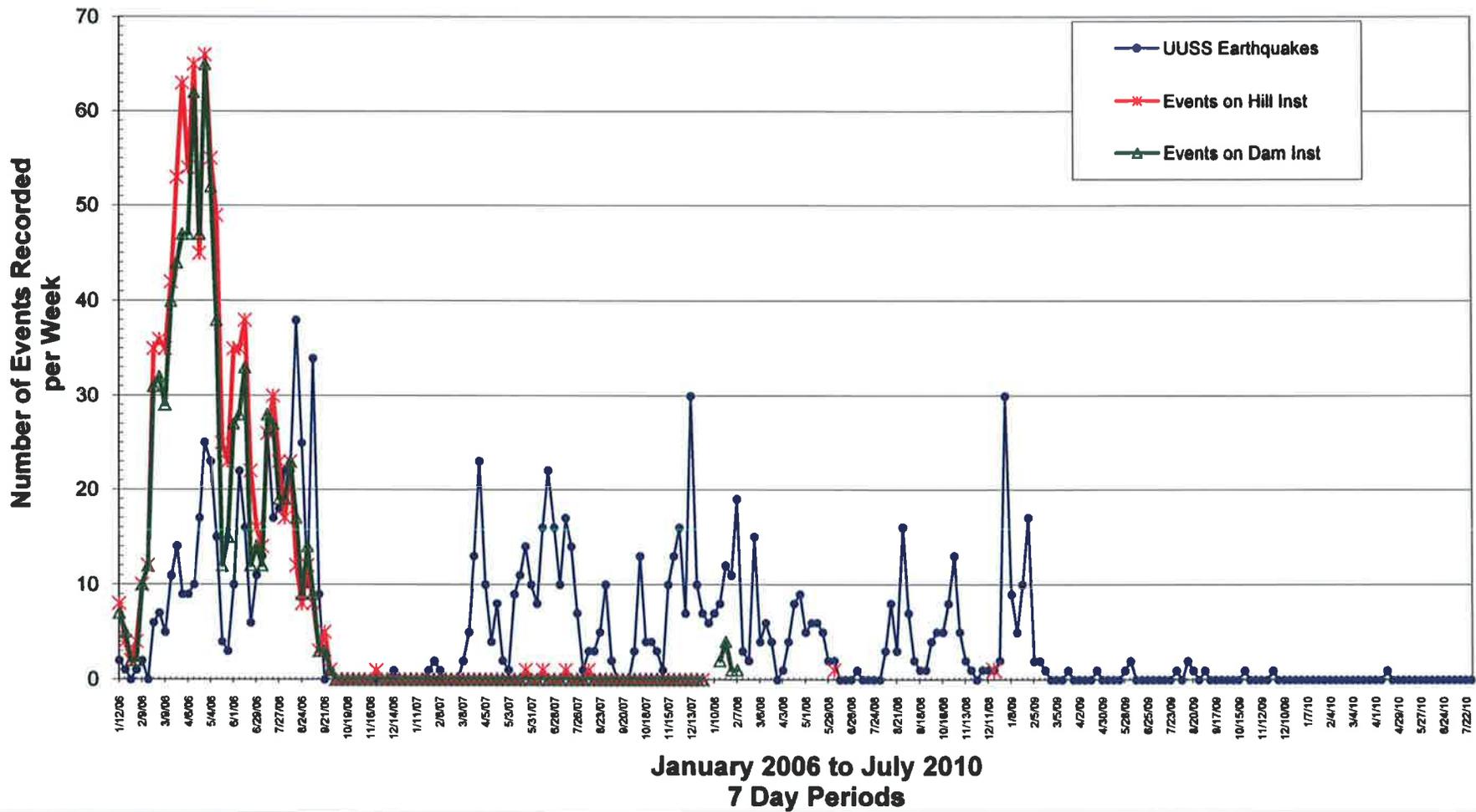


Figure A-2 a  
**NUMBER OF EVENTS RECORDED PER WEEK (SINCE JAN 1 2006)**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH

### Seismic Events per Seven day Period

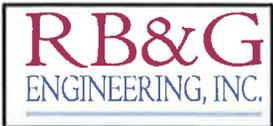
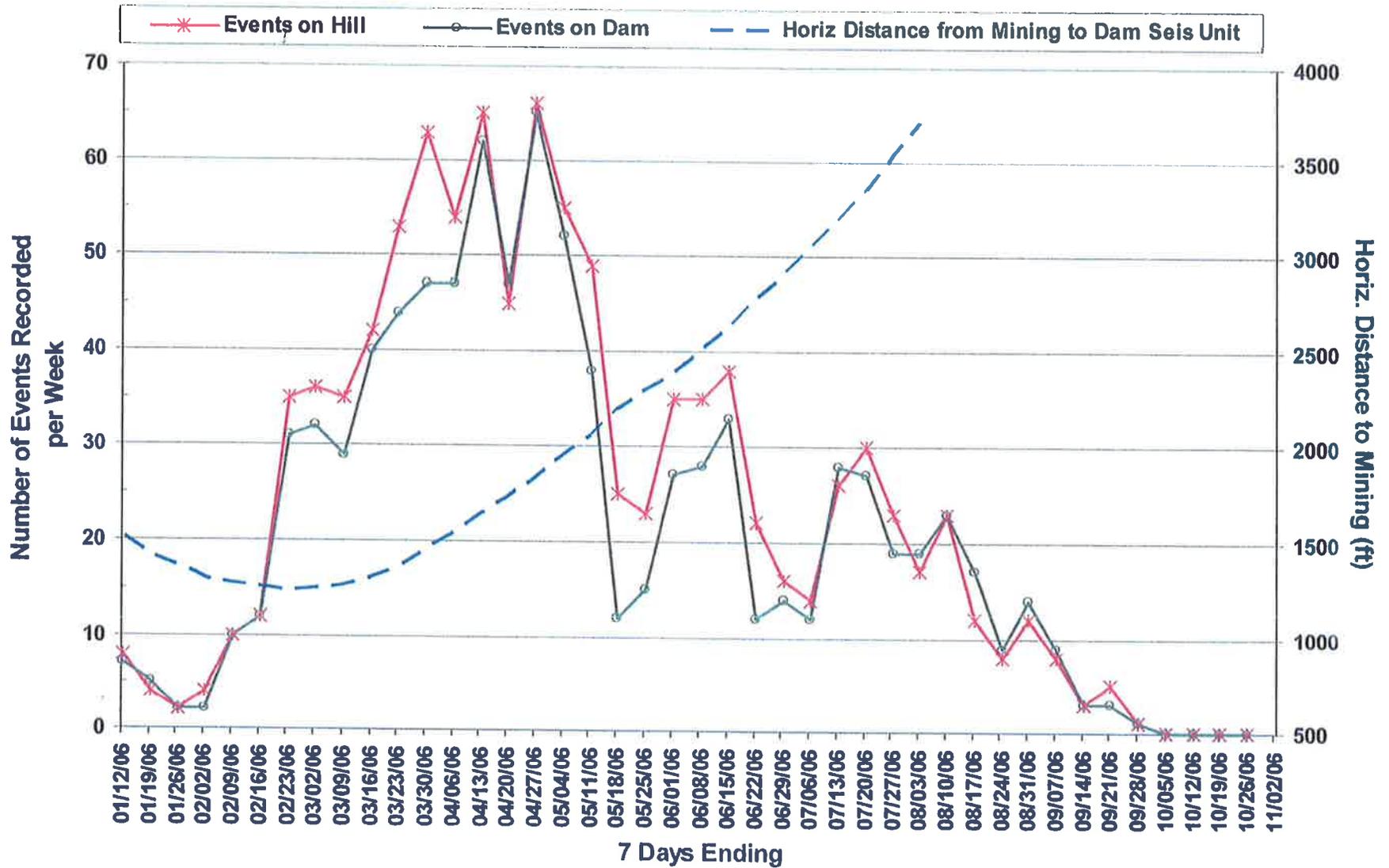
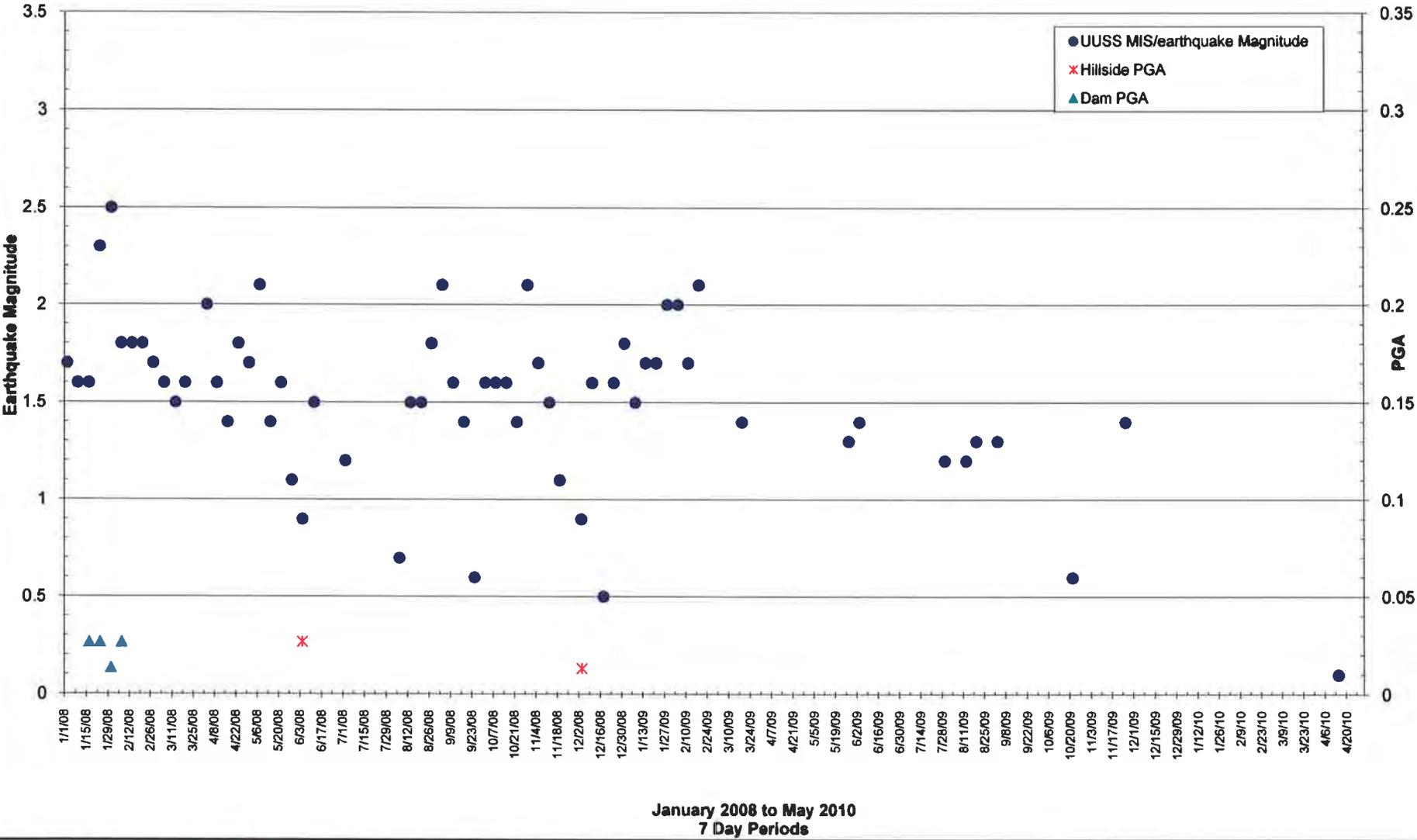


Figure A-3 Events Per Week and Proximity to Mining During 2006  
 Project Grassy Trail Reservoir Mining Induced Seismicity  
 Location Carbon County, Utah

### Maximum MIS/Earthquake Magnitude & PGA Per Seven Day Period



**Figure A-4**  
**PEAK GROUND ACCELERATIONS AND MIS/EARTHQUAKE MAGNITUDES versus TIME**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH

### Maximum MIS/Earthquake Magnitude & PGA Per Seven Day Period

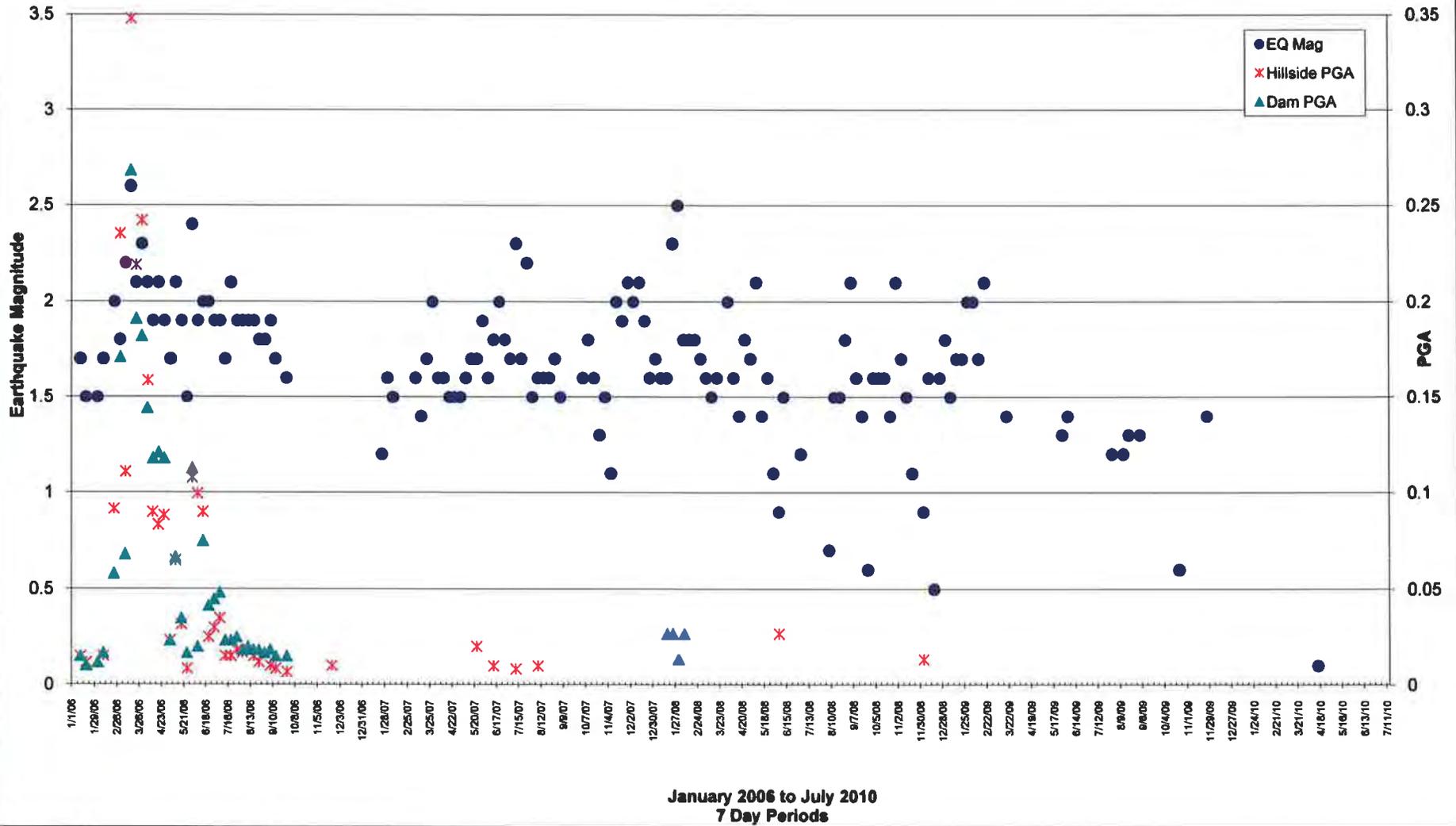
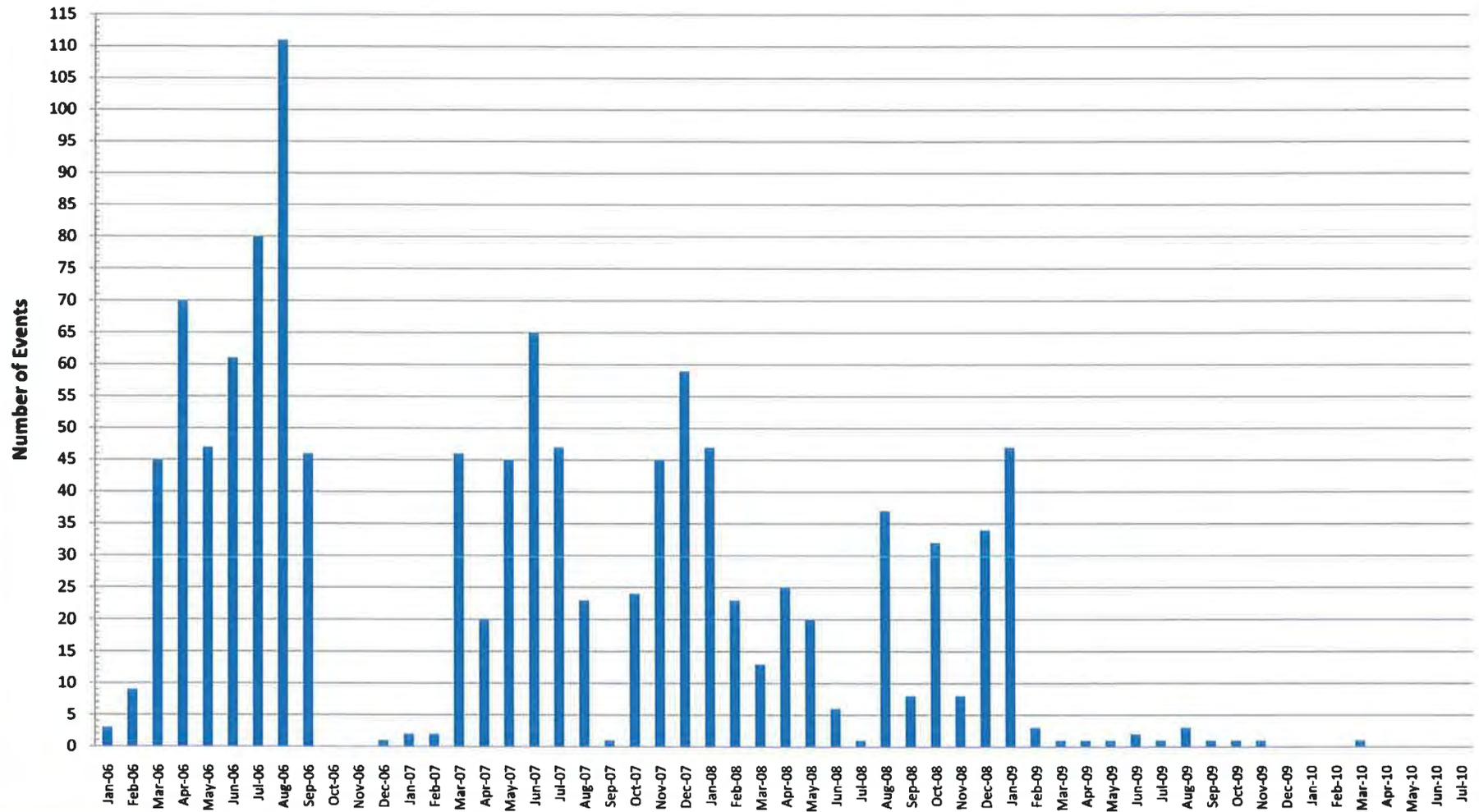


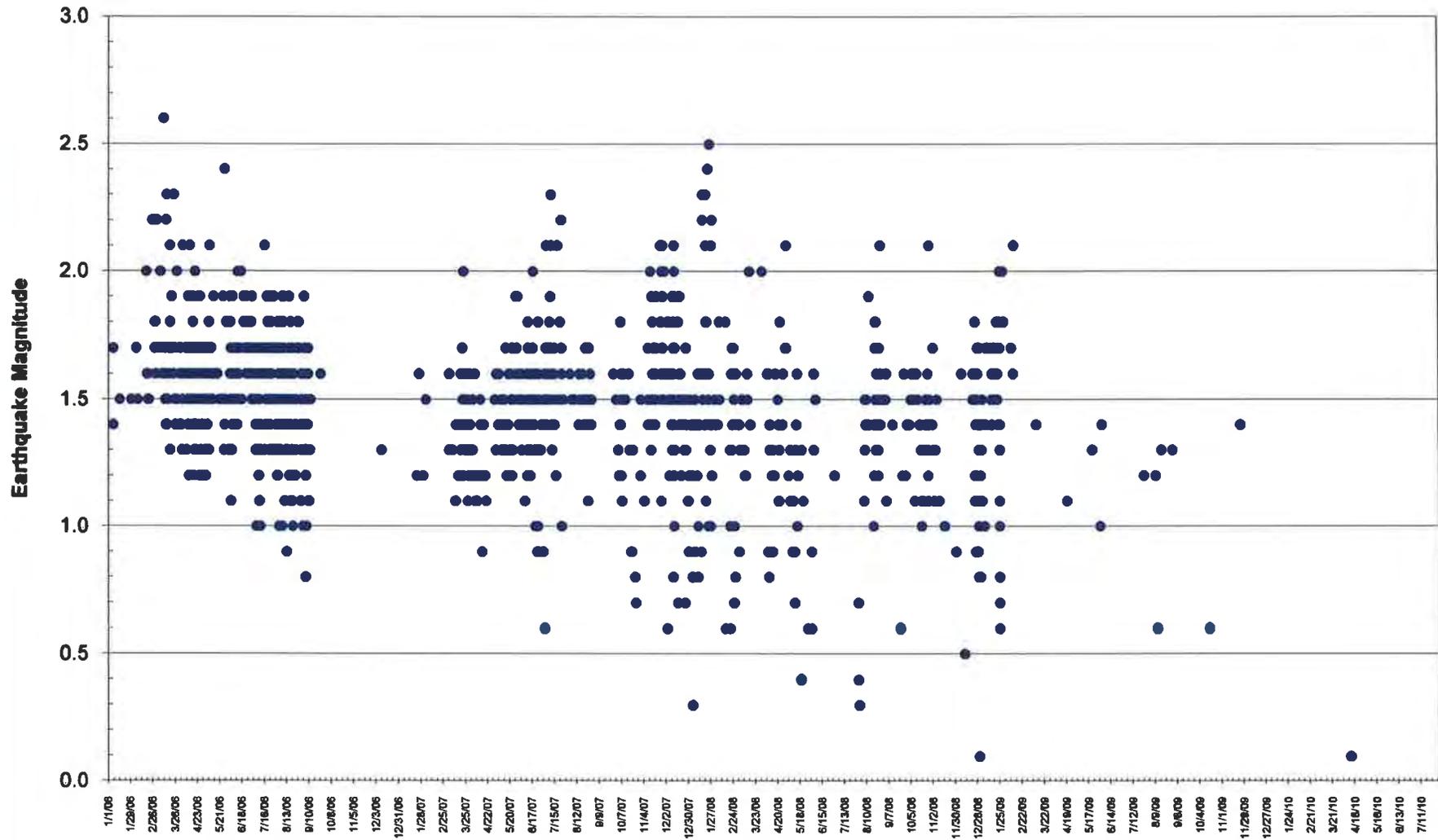
Figure A-4 a  
**PEAK GROUND ACCELERATIONS AND MIS/EARTHQUAKE MAGNITUDES versus TIME**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH

## UUSS Earthquakes per Month West Ridge Mine Near Grassy Trail Dam Jan 2006 - July 2010



**Figure A-5**  
**NUMBER OF UUSS MIS/EARTHQUAKE EVENTS PER MONTH (SINCE JAN 1 2006)**  
**GRASSY TRAIL DAM - CARBON COUNTY, UTAH**

### Daily Earthquake Magnitudes JANUARY 2006 to July 2010

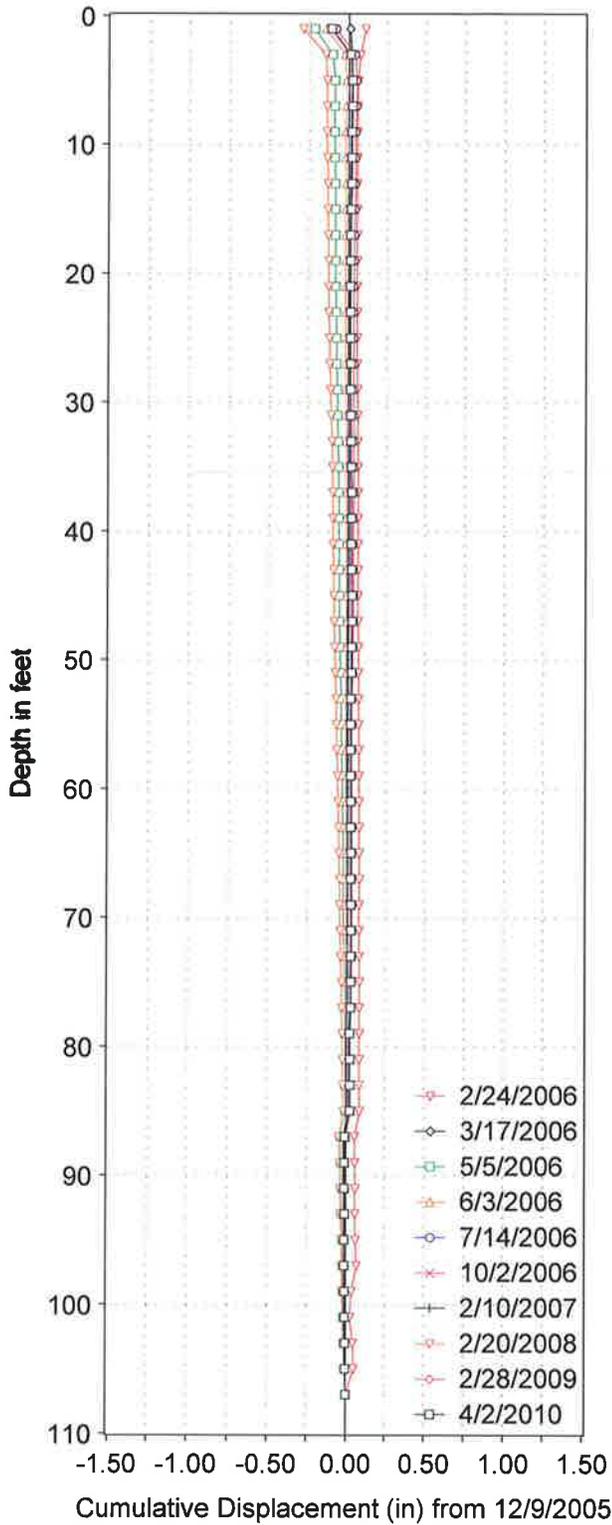


**Figure A-6**  
**Daily Earthquake Magnitudes (SINCE JAN 1 2006)**  
**GRASSY TRAIL DAM - CARBON COUNTY, UTAH**

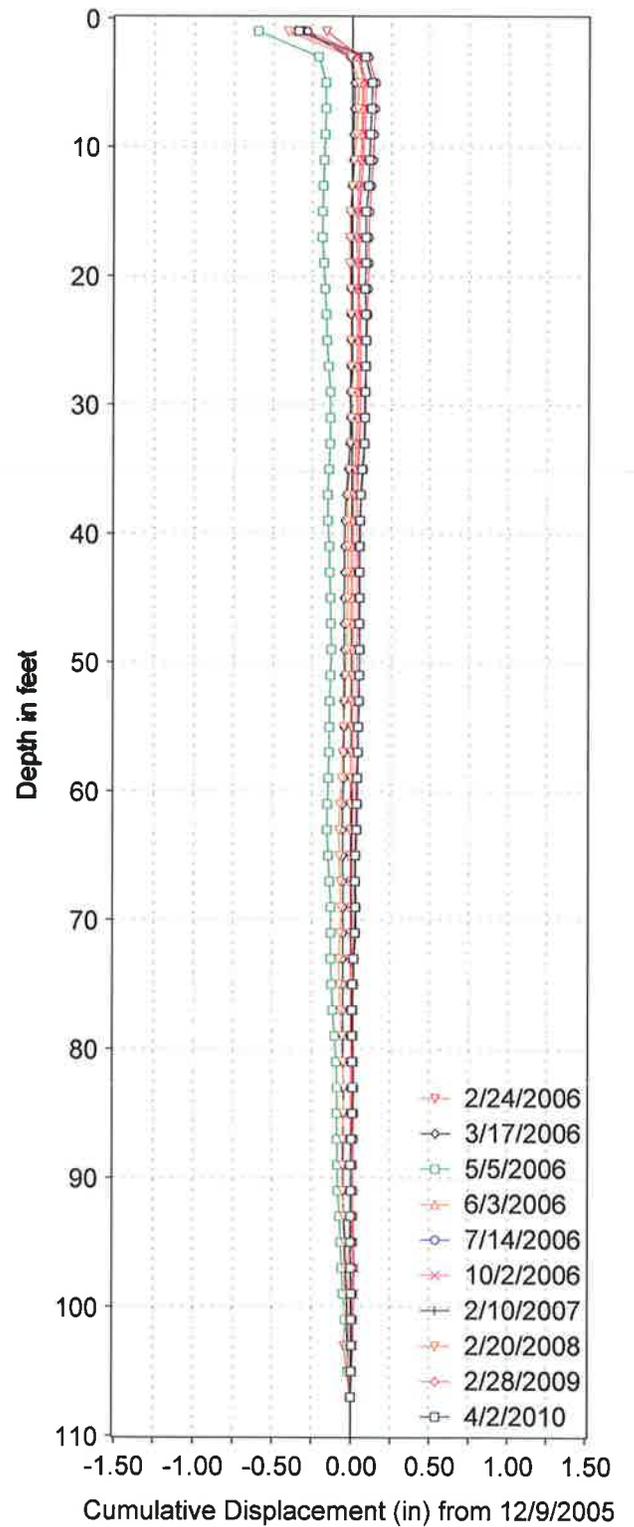
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Inclinometers

GRASSY 1A, A-Axis



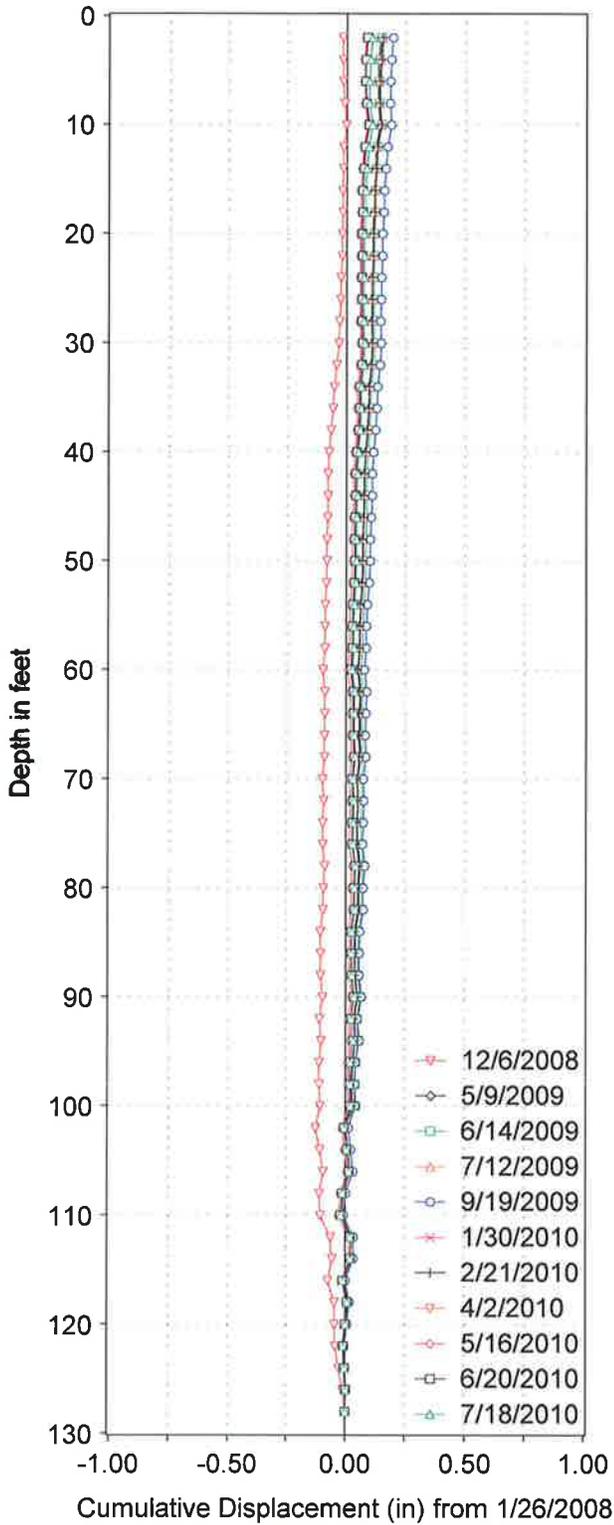
GRASSY 1A, B-Axis



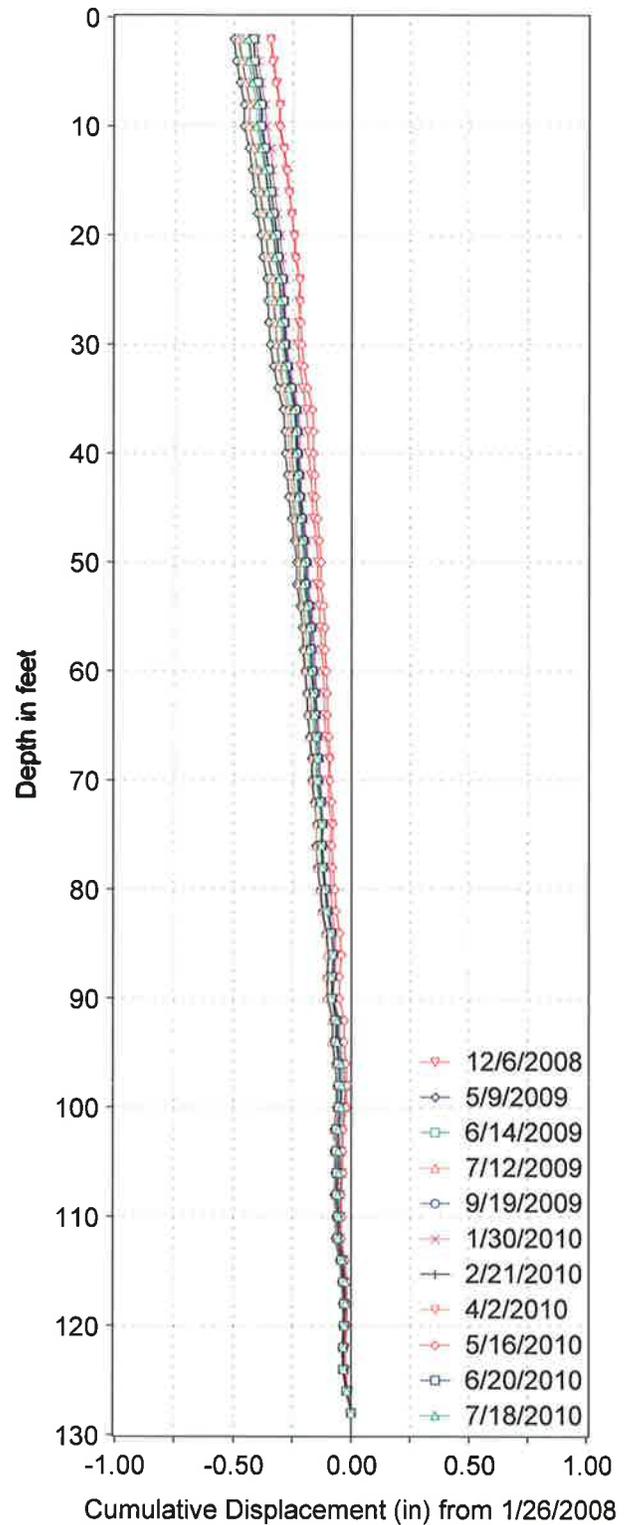
no significant movement observed

Figure B-1  
Inclinometer 1 -Deflection Profiles  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



GRASSY 2A, B-Axis

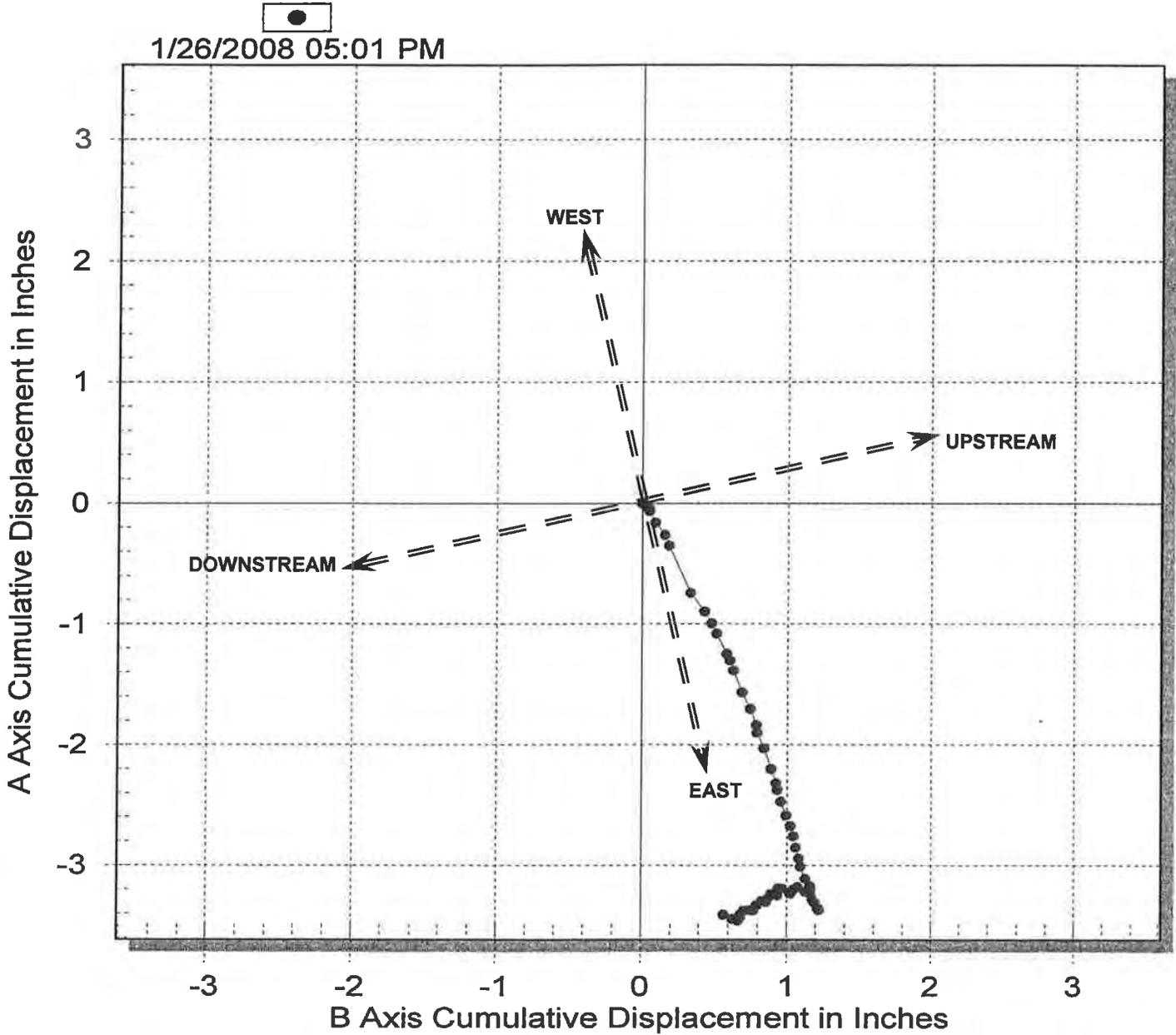


-15 degree skew  
Bias-shift correction

Figure B-2  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY:2A - A Axis vs B Axis

Initial survey: 7/20/2004 09:33 AM



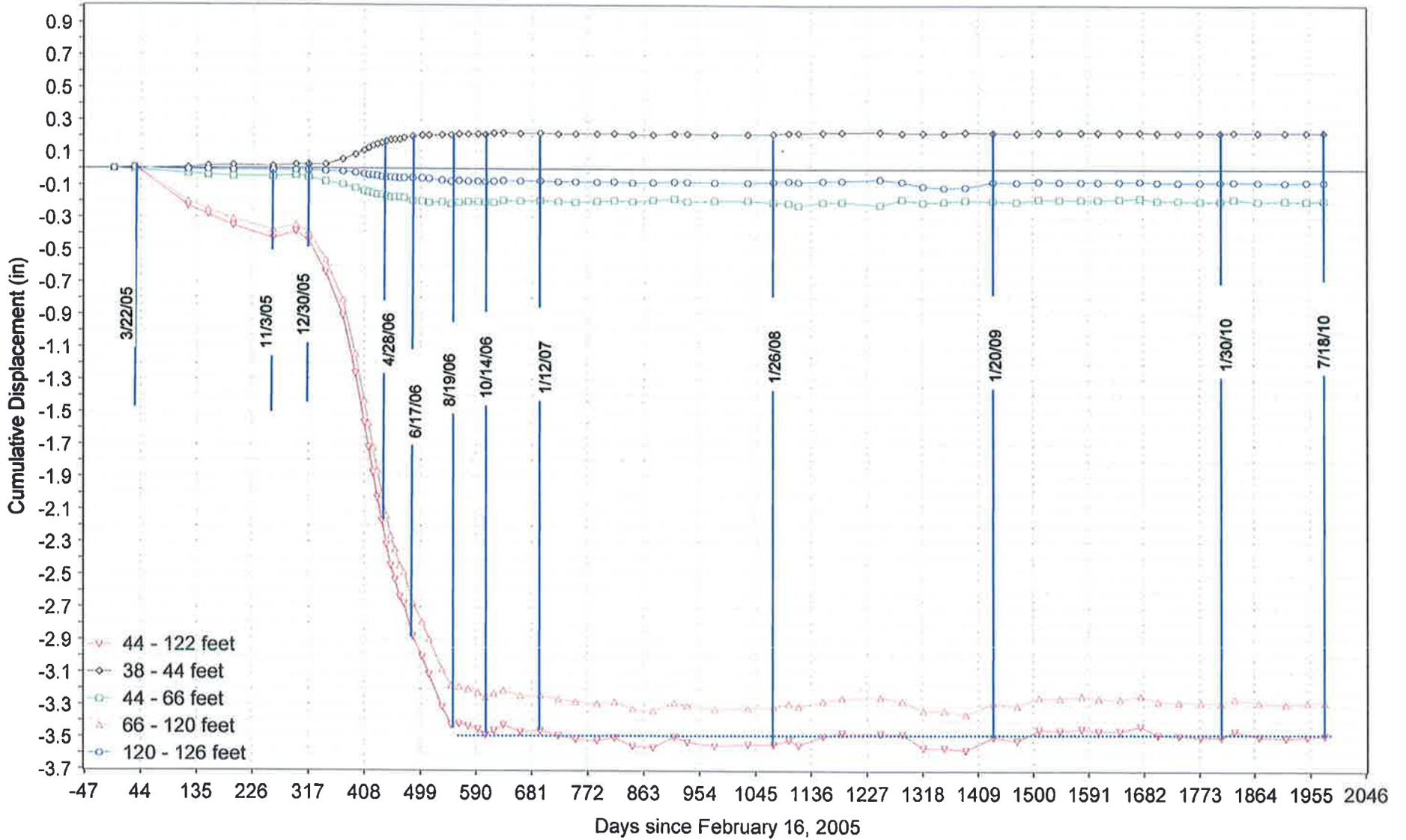
**RB&G  
ENGINEERING  
INC.**

PROVO, UTAH

FIGURE B-3

**INCLINOMETER 2 - PLAN VIEW OF DEFLECTIONS**  
GRASSY TRAIL DAM AND RESERVOIR - CARBON COUNTY, UTAH

GRASSY 2A, A-Axis, -15 degree skew



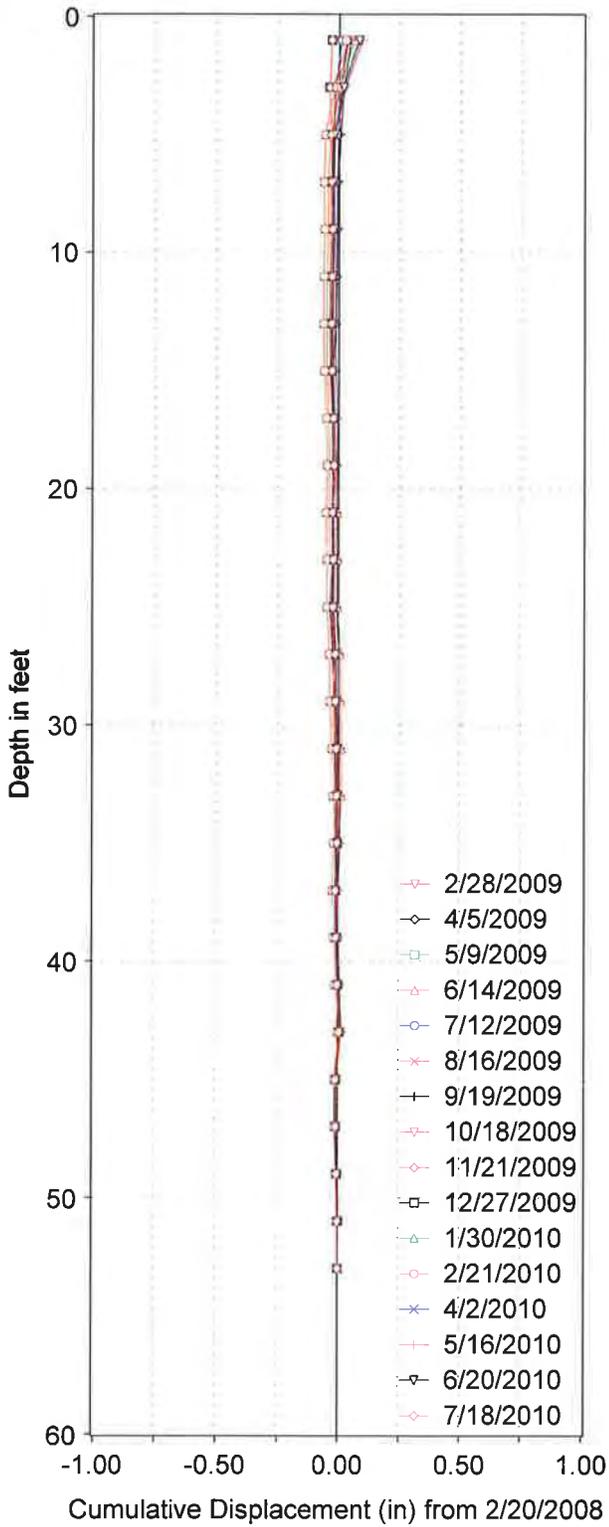
Inclinometer I-2 Located on Dam 7/18/10  
with -15 degree skew



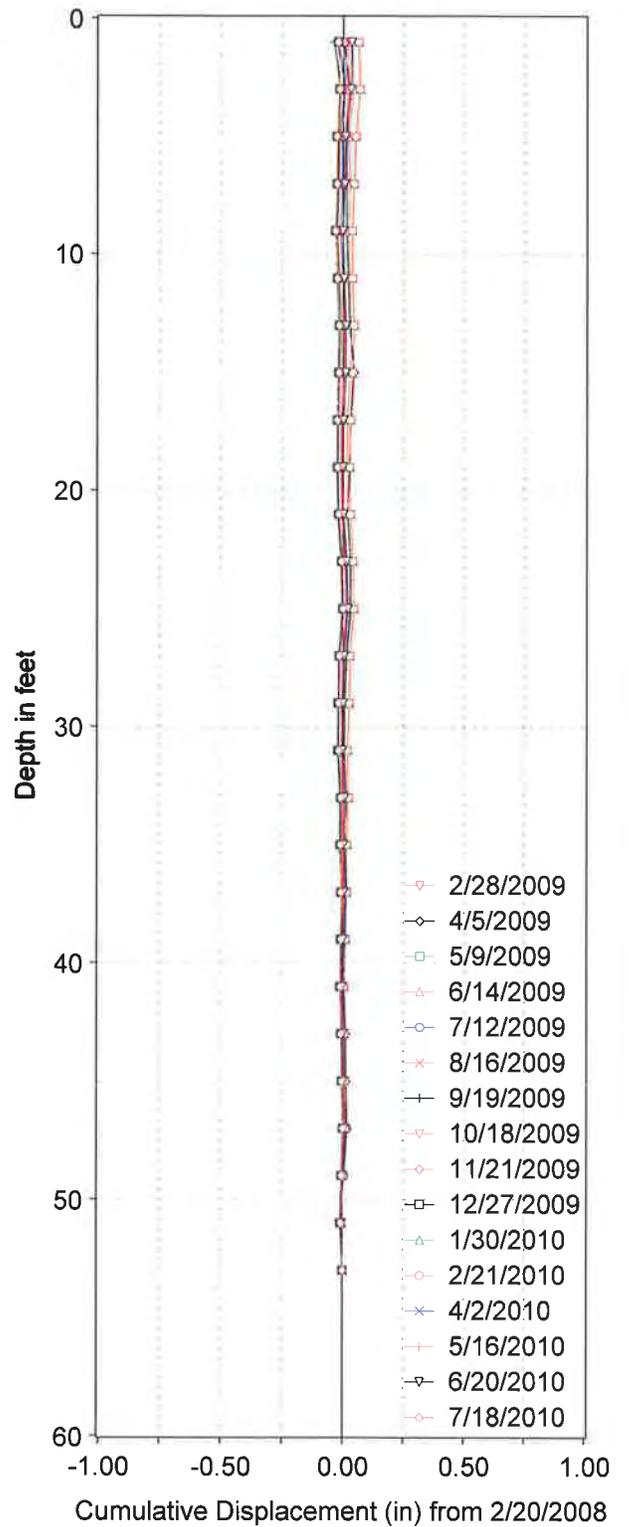
Figure B-4

Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis

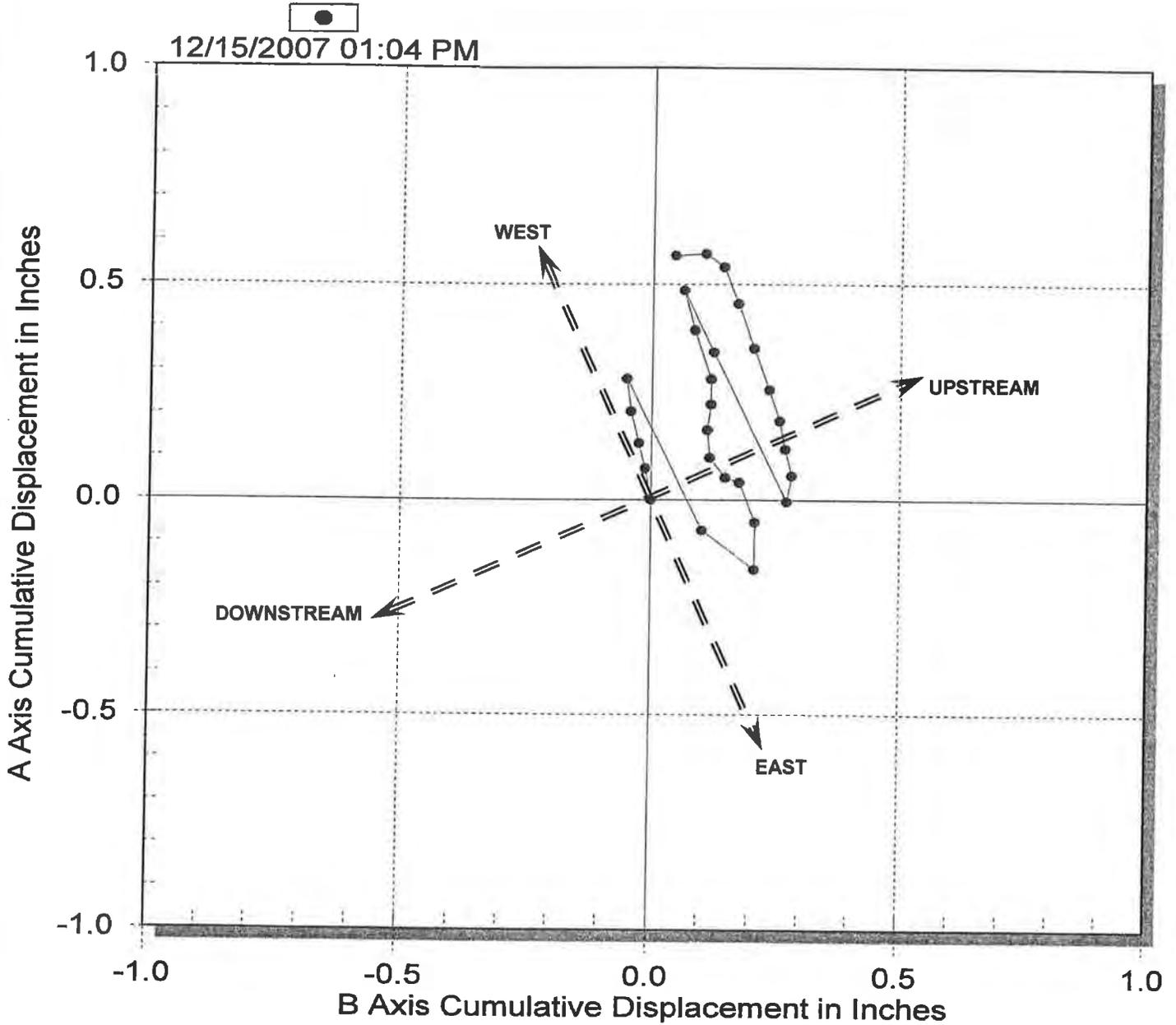


-30 degree skew

Figure B-5  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY:3A - A Axis vs B Axis

Initial survey: 7/20/2004 09:03 AM



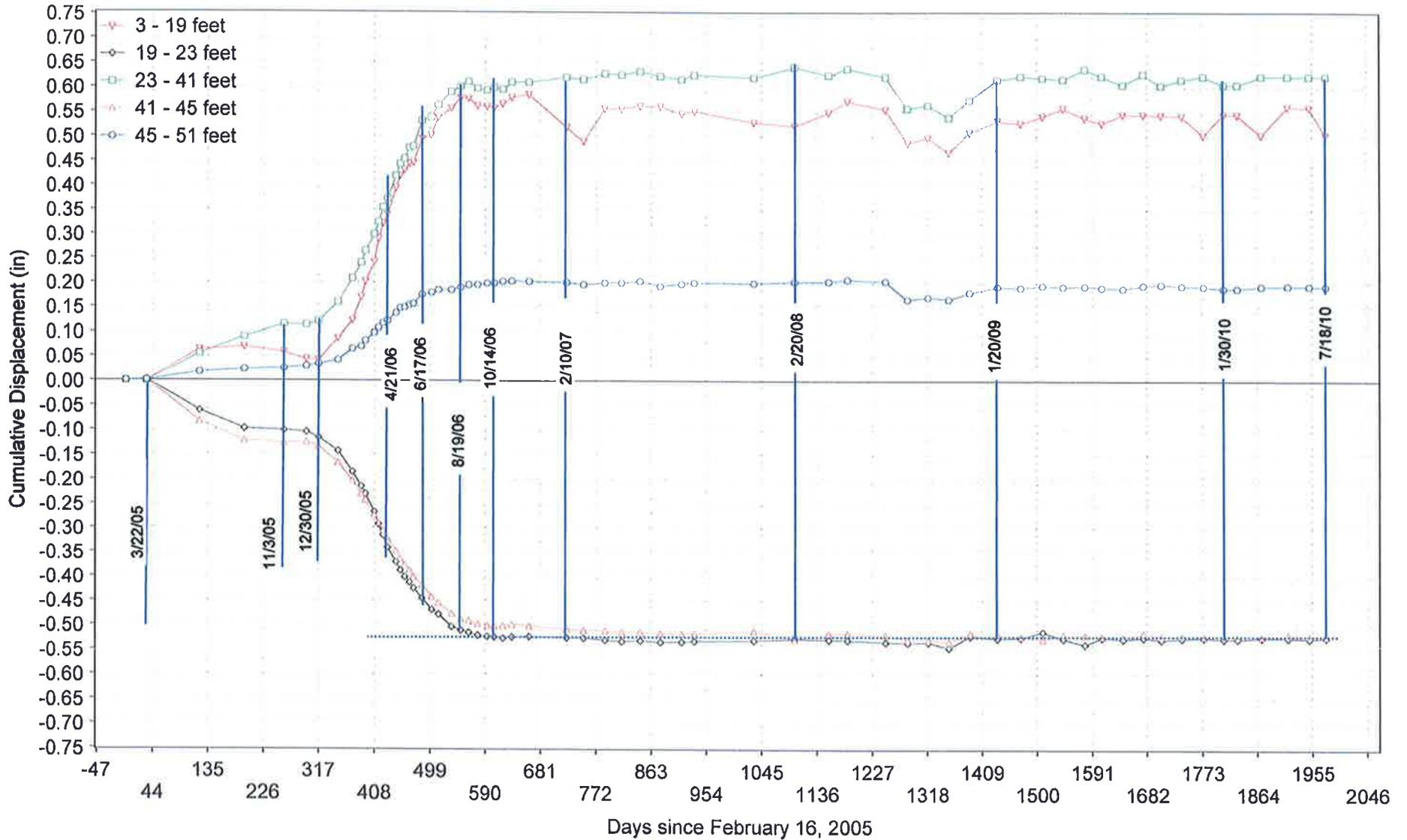
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FIGURE B-6

**INCLINOMETER 3 - PLAN VIEW OF DEFLECTIONS**  
GRASSY TRAIL DAM AND RESERVOIR - CARBON COUNTY, UTAH

### GRASSY 3A, A-Axis



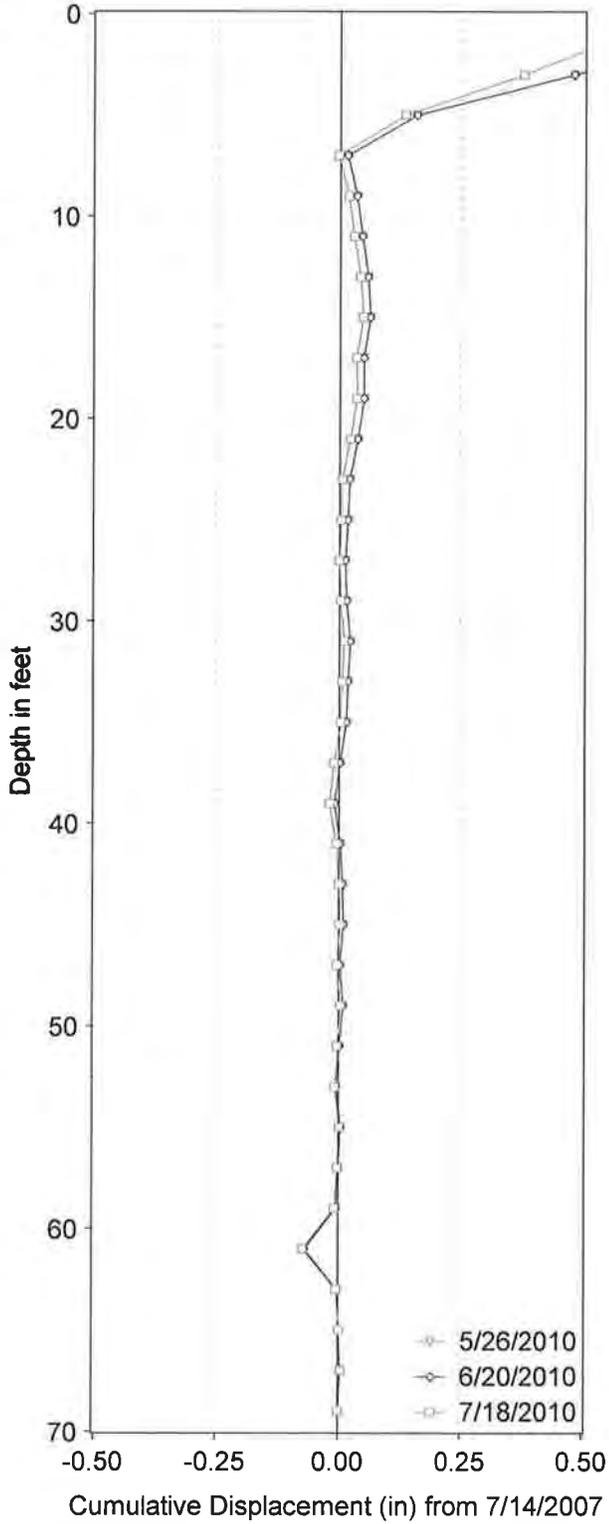
I-3 West/Right Abutment 7/18/10



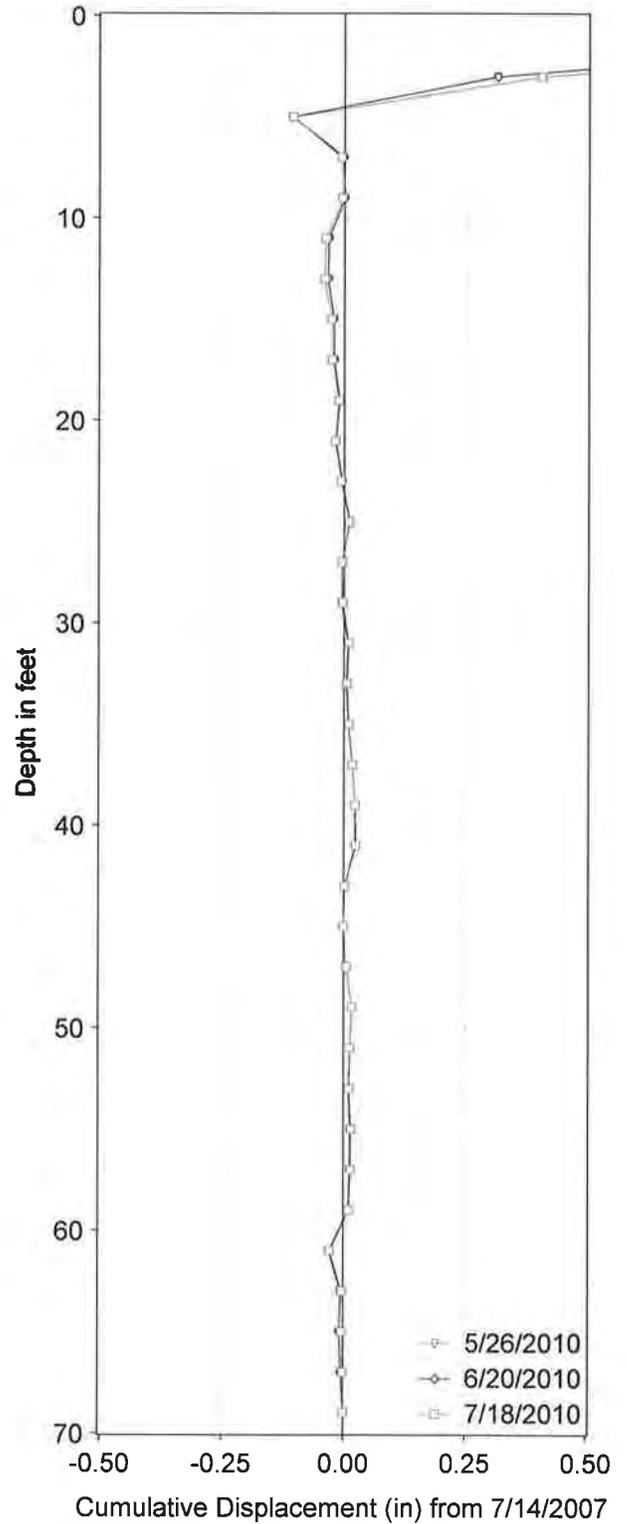
Figure B-7

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

Grassy 4, A-Axis



Grassy 4, B-Axis



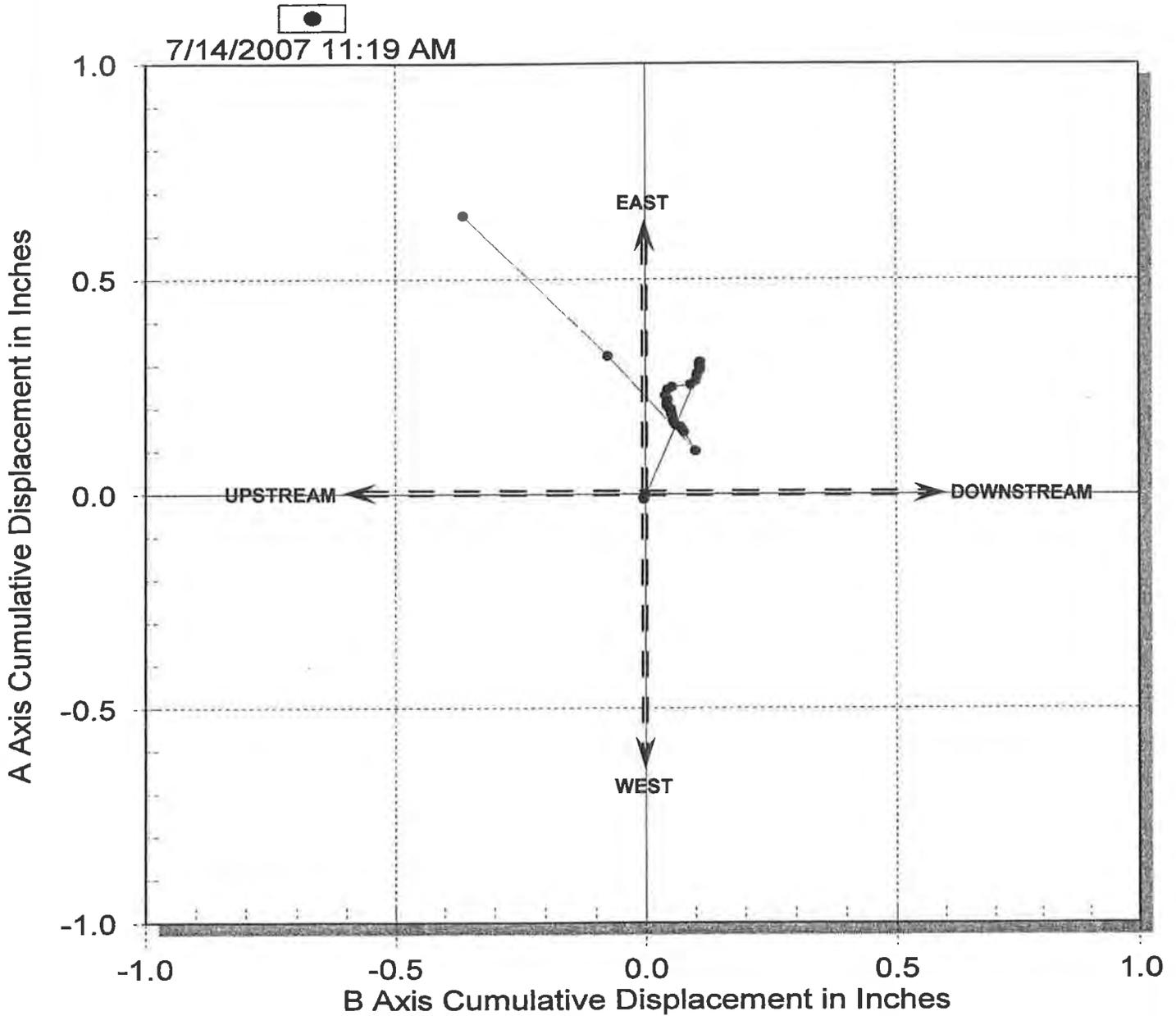
Repairs made 5/26/10 new survey  
may not match true with old surveys

Top few feet are loose

Figure B-8  
Inclinometer 4 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# Grassy:4 - A Axis vs B Axis

Initial survey: 2/16/2005 05:37 PM



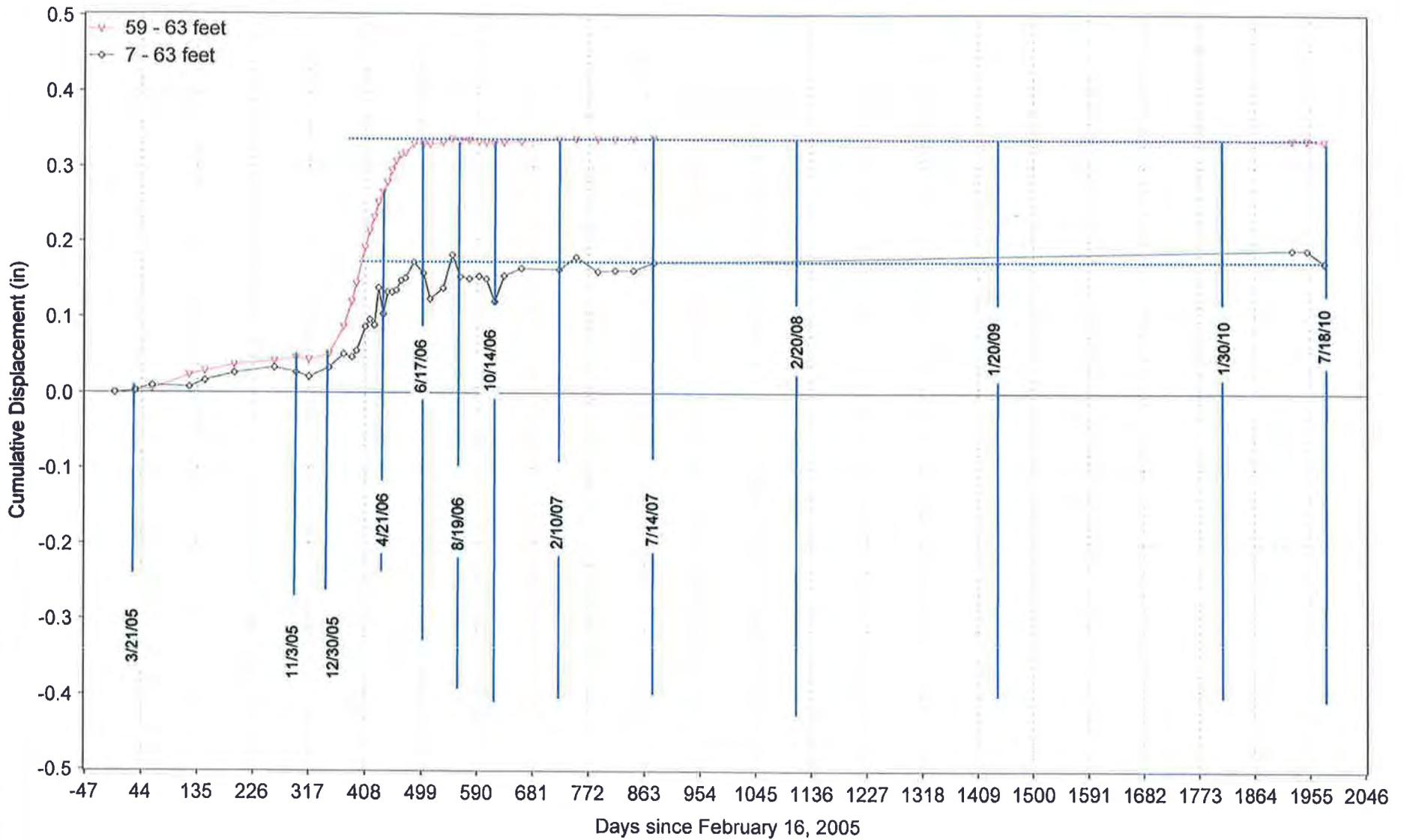
**RB&G  
ENGINEERING  
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FIGURE B-9

**INCLINOMETER 4 - PLAN VIEW OF DEFLECTIONS  
GRASSY TRAIL DAM AND RESERVOIR - CARBON COUNTY, UTAH**

### Grassy 4, A-Axis



Repaired 5/26/10

Reading after may be off from 2005 readings due to repair

7/18/10

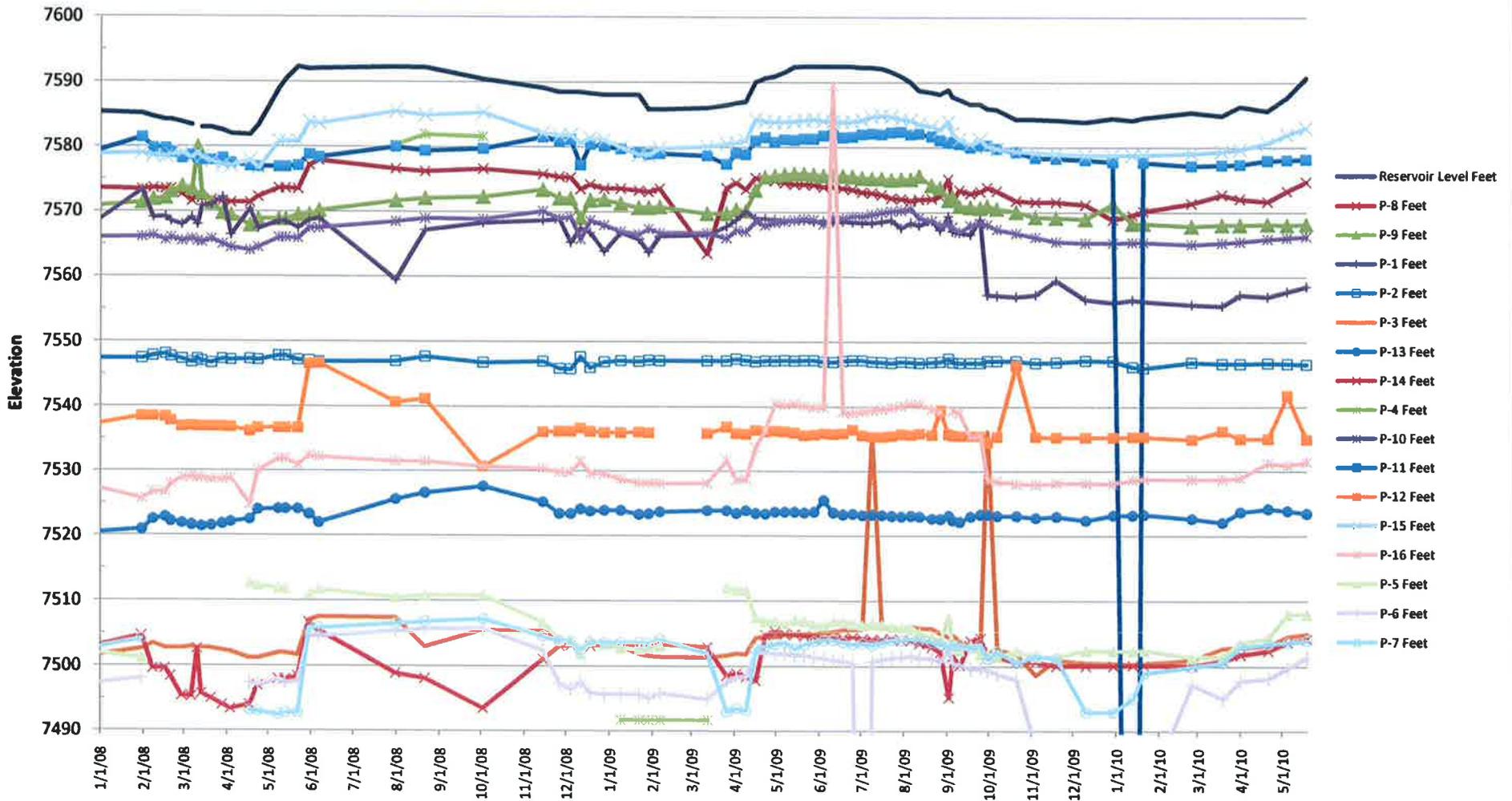


Figure B-10

Inclinometer 4 - Deflection verse Time  
Grassy Trail Dam, Carbon, County, Utah

# Appendix

## Grassy Trail Dam Piezometer Readings

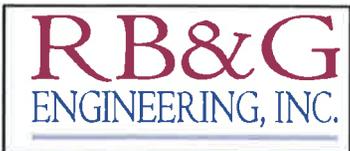


**Figure C-1** Reservoir Elevation and Piezometer Readings

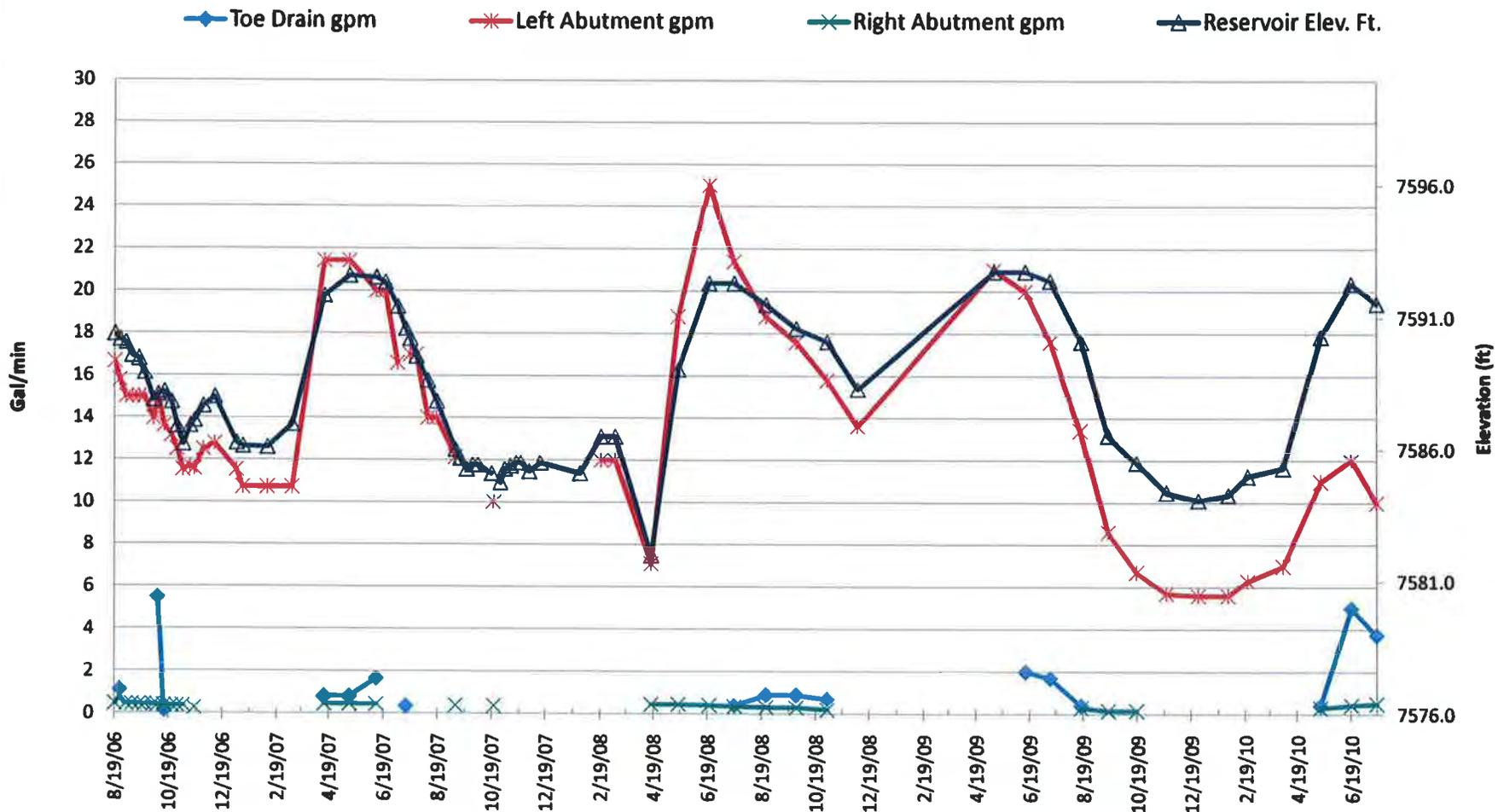
From 1/1/08 to 5/19/10 (data taken from Division of Natural Resources, Water Rights, Dam Safety web site)

GRASSY TRAIL DAM - CARBON COUNTY, UTAH

\* NOTE - spikes are likely errors in data

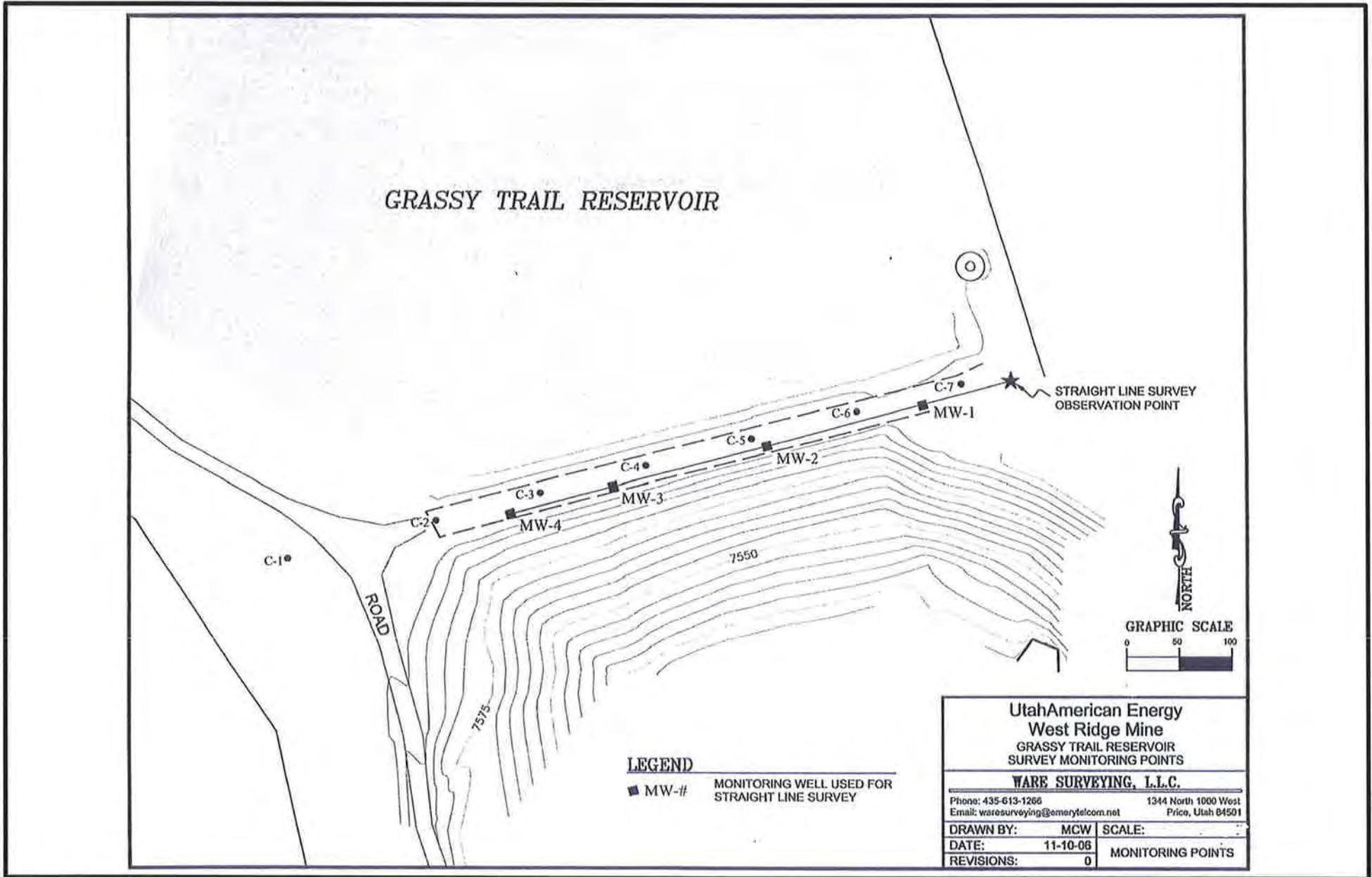


## Grassy Trail Dam Seepage Monitoring



**FIGURE C-2** Seepage Monitoring Readings

**Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 7/18/10  
GRASSY TRAIL DAM - CARBON COUNTY, UTAH**



**Figure C-3**      *Locations of Survey Points on Dam Crest*  
*Project*            *Grassy Trail Reservoir Mining Induced Seismicity*  
*Location*         *Carbon County, Utah*

# UtahAmerican Energy West Ridge Mine

Grassy Trail Reservoir

GPS Survey Data

Anticipated vertical accuracy ~ 0.08'+/-

7/23/2010

STATION	12	13	14	MID	TOE
NORTHING	38,509.85	38,555.42	38,610.87	38,828.21	38,719.59
EASTING	37,047.46	37,064.56	37,099.85	37,580.00	37,664.94
GPS survey date.					
September 2004	7789.87	7771.43	7739.26		
November 2004	7789.84	7771.39	7739.21		
August 2005	7789.75	7771.30	7739.13		
April 2006	7789.46	7771.02	7738.83		
October 2006	7789.39	7770.95	7738.66		
May 2007	7789.45	7771.00	7738.77		
October 2007	7789.45	7771.01	7738.76		
May 2008	7789.57	7771.10	7738.78	7565.52	7515.69
7/13/2008	7789.54	7771.12	7738.82	7565.54	7515.68
8/29/2008	7789.51	7771.08	7738.75	7565.51	7515.63
9/27/2008	7789.49	7771.05	7738.79	7565.52	7515.66
11/24/2008	7789.52	7771.09	7738.76	7565.54	7515.67
3/31/2009	7789.52	7771.07	7738.74	7565.55	7515.65
4/27/2009	7789.50	7771.05	7738.71	7565.53	7515.64
5/29/2009	7789.39	7771.01	7738.72	7565.48	7515.62
6/28/2009	7789.44	7771.08	7738.71	7565.50	7515.63
8/6/2009	7789.49	7771.12	7738.68	7565.49	7515.64
9/9/2009	7789.50	7771.10	7738.67	7565.51	7515.66
10/25/2009	7789.48	7771.11	7738.70	7565.50	7515.67
11/20/2009	7789.49	7771.10	7738.69	7565.49	7515.65
4/15/2010	7789.35	7770.99	7738.80	7565.49	7515.66
5/26/2010	7789.32	7770.91	7738.84	7565.50	7515.66
6/24/2010	7789.36	7770.96	7738.74	7565.46	7515.64
7/22/2010	7789.33	7770.93	7738.75	7565.48	7515.64



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# UtahAmerican Energy

## West Ridge Mine

Grassy Trail Reservoir

Differential Level survey data

7/23/2010

STATION	C-1	C-2	C-3	C-4	C-5	C-6	C-7
NORTHING	38,830.55	38,865.88	38,892.13	38,917.88	38,943.74	38,969.37	38,996.01
EASTING	37,333.20	37,471.64	37,570.28	37,668.82	37,767.40	37,866.16	37,964.74
Differential level survey date.							
07/30/2002 Elevation	7593.49	7590.63	7590.29	7590.67	7590.44	7590.08	7590.08
08/29/2003 Elevation	7593.50	7590.65	7590.31	7590.69	7590.46	7590.08	7590.08
10/27/2004 Elevation	7593.50	7590.62	7590.30	7590.68	7590.45	7590.08	7590.08
08/12/2005 Elevation	7593.52	7590.66	7590.32	7590.69	7590.46	7590.09	7590.08
03/21/2006 Elevation	7593.50	7590.70	7590.30	7590.68	7590.45	7590.09	7590.08
04/14/2006 Elevation	7593.53	7590.73	7590.31	7590.67	7590.44	7590.08	7590.08
05/4/2006 Elevation	7593.54	7590.75	7590.31	7590.66	7590.43	7590.08	7590.08
05/30/2006 Elevation	7593.55	7590.78	7590.31	7590.65	7590.43	7590.07	7590.08
08/11/2006 Elevation	7593.49	7590.79	7590.31	7590.64	7590.43	7590.07	7590.08
09/18/2006 Elevation	7593.51	7590.82	7590.33	7590.66	7590.43	7590.08	7590.08
10/09/2007 Elevation	7593.54	7590.83	7590.33	7590.67	7590.44	7590.08	7590.08
04/28/2008 Elevation	7593.59	7590.84	7590.34	7590.69	7590.45	7590.09	7590.08
05/30/2008 Elevation	7593.56	7590.82	7590.32	7590.65	7590.44	7590.09	7590.08
07/13/2008 Elevation	7593.56	7590.84	7590.33	7590.66	7590.44	7590.08	7590.08
08/29/2008 Elevation	7593.57	7590.83	7590.33	7590.67	7590.44	7590.08	7590.08
09/27/2008 Elevation	7593.56	7590.84	7590.34	7590.68	7590.45	7590.09	7590.08
11/24/2008 Elevation	7593.55	7590.82	7590.32	7590.66	7590.44	7590.08	7590.08
02/23/2009 Elevation	7593.57	7590.83	7590.33	7590.67	7590.45	7590.08	7590.08
03/31/2009 Elevation	7593.57	7590.83	7590.32	7590.67	7590.44	7590.08	7590.08
04/27/2009 Elevation	7593.58	7590.83	7590.33	7590.68	7590.45	7590.08	7590.08
05/29/2009 Elevation	7593.59	7590.84	7590.33	7590.67	7590.44	7590.08	7590.08
06/28/2009 Elevation	7593.57	7590.83	7590.33	7590.67	7590.44	7590.08	7590.08
08/6/2009 Elevation	7593.57	7590.84	7590.33	7590.68	7590.45	7590.08	7590.08
09/9/2009 Elevation	7593.58	7590.84	7590.33	7590.68	7590.45	7590.08	7590.08
10/25/2009 Elevation	7593.56	7590.84	7590.33	7590.68	7590.44	7590.08	7590.08
11/20/2009 Elevation	7593.56	7590.83	7590.32	7590.67	7590.44	7590.08	7590.08
03/05/2010 Elevation	7593.58	7590.84	7590.33	7590.67	7590.45	7590.08	7590.08
04/15/2010 Elevation	7593.60	7590.84	7590.34	7590.68	7590.46	7590.08	7590.08
05/17/2010 Elevation	7593.59	7590.84	7590.33	7590.67	7590.45	7590.08	7590.08
06/24/2010 Elevation	7593.58	7590.84	7590.34	7590.68	7590.45	7590.08	7590.08
07/27/2010 Elevation	7593.56	7590.83	7590.32	7590.68	7590.45	7590.08	7590.08



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# UtahAmerican Energy

## West Ridge Mine

Grassy Trail Reservoir

"Straight line" survey data

7/23/2010

Distance from control point to face of Monitoring Well (MW) in feet									
Date of survey	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	West Mon.	Straight Line Movement
12/14/2006	94.21	141.49	245.90	295.13	394.71	493.96	556.71	na	No
1/31/2007	94.21	141.49	245.90	295.13	394.71	493.96	556.71	na	No
3/1/2007	94.21	141.49	245.90	295.13	394.71	493.96	556.71	na	No
3/29/2007	94.21	141.49	245.90	295.13	394.71	493.95	556.70	na	No
5/30/2007	94.20	141.49	245.89	295.12	394.70	493.94	556.70	na	No
6/5/2007	94.20	141.49	245.89	295.12	394.69	493.94	556.68	na	No
7/2/2007	94.20	141.49	245.89	295.12	394.69	493.94	556.69	na	No
10/9/2007	94.21	141.50	245.90	295.13	394.71	493.95	556.70	na	No
11/10/2007	94.22	141.50	245.90	295.13	394.70	493.95	556.70	na	No
12/27/2007	94.21	141.50	245.91	295.13	394.71	493.95	na	710.95	No
4/28/2008	94.20	141.49	245.90	295.12	394.70	493.95	556.69	710.95	No
5/30/2008	94.20	141.49	245.90	295.12	394.70	493.94	556.69	710.94	No
7/13/2008	94.20	141.49	245.90	295.12	394.70	493.95	556.69	710.94	No
8/29/2008	94.21	141.50	245.90	295.14	394.71	493.96	556.70	710.95	No
9/27/2008	94.21	141.50	245.91	295.14	394.71	493.96	556.70	710.95	No
11/24/2008	94.21	141.51	245.91	295.14	394.71	493.96	556.70	710.95	No
1/26/2009	94.20	141.50	245.91	295.13	394.71	493.96	556.70	710.94	No
2/23/2009	94.20	141.49	245.90	295.13	394.70	493.96	556.69	710.94	No
3/31/2009	94.20	141.50	245.90	295.13	394.71	493.96	556.70	710.95	No
4/27/2009	94.21	141.50	245.90	295.13	394.70	493.95	556.70	710.95	No
5/29/2009	94.20	141.49	245.90	295.12	394.70	493.95	556.69	710.95	No
6/28/2009	94.21	141.51	245.91	295.13	394.71	493.96	556.70	710.95	No
8/6/2009	94.21	141.51	245.91	295.14	394.70	493.96	556.70	710.96	No
9/9/2009	94.22	141.51	245.91	295.14	394.71	493.96	556.70	710.96	No
10/25/2009	94.21	141.51	245.91	295.14	394.71	493.96	556.70	710.96	No
11/20/2009	94.21	141.50	245.90	295.13	394.70	493.95	556.69	710.95	No
3/5/2010	94.21	141.50	245.90	295.13	394.70	493.95	556.69	710.95	No
4/15/2010	94.21	141.50	245.90	295.13	394.70	493.94	556.69	710.94	No
5/17/2010	94.21	141.50	245.90	295.13	394.70	493.95	556.69	710.95	No
6/24/2010	94.21	141.50	245.90	295.13	394.70	493.95	556.69	710.95	No
7/22/2010	94.21	141.50	245.90	295.13	394.70	493.95	556.70	710.95	No
Notes									



**WARE SURVEYING, L.L.C.**

1344 North 1000 West -  
Price, UT 84501  
Office: 435-613-1266





# Memo

**To:** Bret Dixon, Utah Dam Safety  
 Dave Shaver, West Ridge Resources

**From:** Brad Price, Rob Johnson

**Date:** November 14, 2007

**Re:** Updated Monitoring Schedule, Grassy Trail Dam & Reservoir

---

An overview of data obtained in the past year from instrumentation at Grassy Trail Reservoir was presented at a meeting held October 25, 2007. It was noted that very few mining-induced seismic events had been detected near the dam since mining of Panel 7 was completed. Ground movements detected at settlement points and inclinometers in the past year have lessened dramatically; however, it appears that very slight movements may be ongoing. It was determined at the October 25 meeting that the monitoring program should generally continue as it has over the past year; with some slight modifications. The revised monitoring program, to be adopted until further notice, is as follows.

### Accelerometers

Under the present conditions, the accelerometers should be monitored on a monthly basis to ensure that they are working properly and to upload the records of any new events that occur. The hillside instrument requires recalibration at this time. As agreed at the meeting, we will send this instrument to the manufacturer for recalibration at the expense of the mine.

### Inclinometers

Based on discussion at the meeting, and subsequent correspondence/discussion, we (RB&G Engineering) will visit the site to take inclinometer readings one each month until further notice. Inclinometer No. 4, located on the west rim of the reservoir, was damaged by a contractor working for Questar Gas Company. We received a phone call from Tim Blackham of Questar the week of October 29, 2007, who expressed the willingness of Questar and their contractor to pay for and participate in any repairs needed. Repair of this device is currently in progress.

### Piezometers and Drains

The dam's owners (East Carbon City and Sunnyside City) will continue to take responsibility for these items. It was agreed at the meeting that water levels in the piezometers may now be measured every two weeks. Site visits to visually inspect the dam and record drain flows should continue on a weekly basis. Care should be taken to note any new cracking, slumping, seepage, discolored flow from drains, or other irregularities on the dam and surrounding slopes – particularly in the vicinity of the right (west) abutment.

### Survey Points

The survey of points on the dam will continue to be the responsibility of the mine. Surveys will continue to be conducted at monthly intervals. The survey should provide horizontal and vertical coordinates for the monuments at the crest, mid-slope, and toe of the dam. The basis for the survey will be a point located on the left (east) abutment, which is assumed to be stationary based on monitoring performed to date. The survey accuracy should be  $\pm 0.01$  foot vertical and  $\pm 0.02$  foot horizontal.

## EXHIBIT E-2 – PAGE 2 OF 2

### Monitoring of Events Reported by University of Utah Seismic Station (UUSS)

RB&G Engineering will continue to perform daily reviews of the UUSS web site. The threshold criteria used to trigger an immediate site visit will remain in effect. If an event of magnitude greater than 3.0 is reported within 5 miles of the dam, thorough site reconnaissance and reading of accelerometer data will be performed within 24 hours. Reading of all other instrumentation will be performed if any recorded ground acceleration exceeds 0.2g.

Under the anticipated conditions, the proposed schedule of monitoring frequencies and responsibilities is summarized on the table below. The recommended frequency may be changed at any time if instrumentation readings, visual observations, or any other factor indicates that this program is insufficient.

ITEM(S) TO BE MONITORED	MONITORING FREQUENCY	MONITORING RESPONSIBILITY	FREQUENCY OF DATA DISTRIBUTION*
Inclinometers, & Reconnaissance by Geologist/Engineer	Monthly	RB&G Engineering	Monthly
Accelerometers	Monthly	RB&G Engineering	Monthly
Drains & Visual Inspections	Weekly	East Carbon City (forward data to RB&G weekly)	Monthly
Piezometers	Bi-Weekly	East Carbon City	Monthly
Survey Points	Monthly	West Ridge Resources	Monthly
UUSS Website	Daily	RB&G Engineering	Monthly

\*Data to be distributed to those listed below. Any unusual readings or observations to be reported to the group immediately.

DISTRIBUTION LIST – GRASSY TRAIL RESERVOIR MONITORING INFORMATION			
Name	Organization	Telephone	email
** Andrews, Bruce	Sunnyside City	435-888-4444	sunny1@emerytelcom.net
Blake, John	Trust Lands	801-538-5152	jblake@utah.gov
Brinton, Peter	BLM / USO	801-539-4162	Peter_Brinton@blm.gov
** Dean, Dana	DOGM	801-538-5259	danadean@utah.gov
Dixon, Bret	Utah Dam Safety	801-538-7373	bret@dixon@utah.gov
Faddies, Tom	SITLA	801-538-5150	tomfaddies@utah.gov
Falk, Stephen	BLM – Price	435-636-3605	Steve_Falk@blm.gov
Grubaugh-Littig, Pam	DOGM	801-538-5268	pamgrubaughlittig@utah.gov
Hansen, Michael	RB&G Engineering	801-374-5771	mhansen@rbgengineering.com
Hedberg, Wayne	DOGM	801-538-5286	waynehedberg@utah.gov
Hess, Pete	DOGM – Price	435 613-1146 x203	petehess@utah.gov
Houskeeper, Karl	DOGM – Price	435-613-1146 x201	karlhouskeeper@utah.gov
Hudson, Gregg	BLM / USO	801-539-4040	Gregg_Hudson@blm.gov
Kohler, James	BLM / USO	801-539-4037	James_Kohler@blm.gov
** LaFontaine, Orlando	East Carbon City	435-888-6613	ecc@emerytelcom.net
Llewelyn, Jason	Carbon Co. Emerg. Services	435-636-3251	jlllewelyn@co.carbon.ut.us
Marble, Dave	Utah Dam Safety	801-538-7376	davemarble@utah.gov
McKenzie, Jeff	BLM / USO	801-539-4038	Jeff_McKenzie@blm.gov
Perkes, Stan	BLM / USO	801-539-4036	Stan_Perkes@blm.gov
Price, Brad	RB&G Engineering	801-374-5771	bprice@rbgengineering.com
Rigby, Steve	BLM / FS – Price	435-636-3604	steve_rigby@blm.gov
Shaver, Dave	West Ridge Resources	435-888-4017	dshaver@coalsource.com
Stilson, Marc	Water Rights – Price	435-637-1303	marcstilson@utah.gov
Western, Wayne	DOGM	801-538-5263	waynewestern@utah.gov

\*\* Names changed or added since the previous list dated December 4, 2006.

Grassy Trail Dam, Seismic Summary as of February 11, 2011.

For the period from the end of October to February 11, 2011, the UUSS has documented 10 MIS event near the West Ridge Mine area with magnitudes ranging from 0.1 to 1.0. A summary of UUSS (West Ridge Mine) MIS events for the past 20 months are shown below. These recent events are reported as originating between 5 to 6 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1 to 2 miles north and west of the dam. The last 2 events shown on the Table below occurred after the instruments were read on 2/11/11.

MONTH	# MIS events reported by UUSS
December 2008	34
January 2009	47
February Change mining practice to Panel Barrier	2
March	1
April	1
May	1
June	2
July	0
Aug	3
Sept	1
Oct	1
Nov	1
Dec	0
Jan 2010	0
Feb	0
March	0
April	1
May	0
June	0
July	0 Most recent Magnitudes
Aug	1 Mag 1.3
Sept	2 Mag 1.2 & 0.4
Oct	2 Mag 0.1 & 0.9
Nov	0
Dec	0
Jan 2011	2 Mag 0.7& 1.0
Feb as of 2/12/11	6 Mag 0.6, 0.2, 0.2, 0.5, 0.7 & 0.7

No MIS events were recorded on the Dam or Hillside Seismic Units

Inclinometer readings were not taken in January as the Inclinometer was being repaired. Reads were not taken on February 11 due to access problems and not being able to get the instrument up to the dam. Previous months have not shown any notable movement. Reservoir and seepage readings are summarized on the table on the following page.

During this site visits no signs of landslide movement were noted on the hillsides above the reservoir or on the dam.

Michael N. Hansen P.G.  
Engineering Geologist  
RB&G ENGINEERING Inc.

Grassy Trail Dam, Seismic Summary as of February 11, 2011.

For the period from the end of October to February 11, 2011, the UUSS has documented 10 MIS event near the West Ridge Mine area with magnitudes ranging from 0.1 to 1.0. A summary of UUSS (West Ridge Mine) MIS events for the past 20 months are shown below. These recent events are reported as originating between 5 to 6 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1 to 2 miles north and west of the dam. The last 2 events shown on the Table below occurred after the instruments were read on 2/11/11.

MONTH	# MIS events reported by UUSS
December 2008	34
January 2009	47
February Change mining practice to Panel Barrier	2
March	1
April	1
May	1
June	2
July	0
Aug	3
Sept	1
Oct	1
Nov	1
Dec	0
Jan 2010	0
Feb	0
March	0
April	1
May	0
June	0
July	0 Most recent Magnitudes
Aug	1 Mag 1.3
Sept	2 Mag 1.2 & 0.4
Oct	2 Mag 0.1 & 0.9
Nov	0
Dec	0
Jan 2011	2 Mag 0.7& 1.0
Feb as of 2/12/11	6 Mag 0.6, 0.2, 0.2, 0.5, 0.7 & 0.7

No MIS events were recorded on the Dam or Hillside Seismic Units

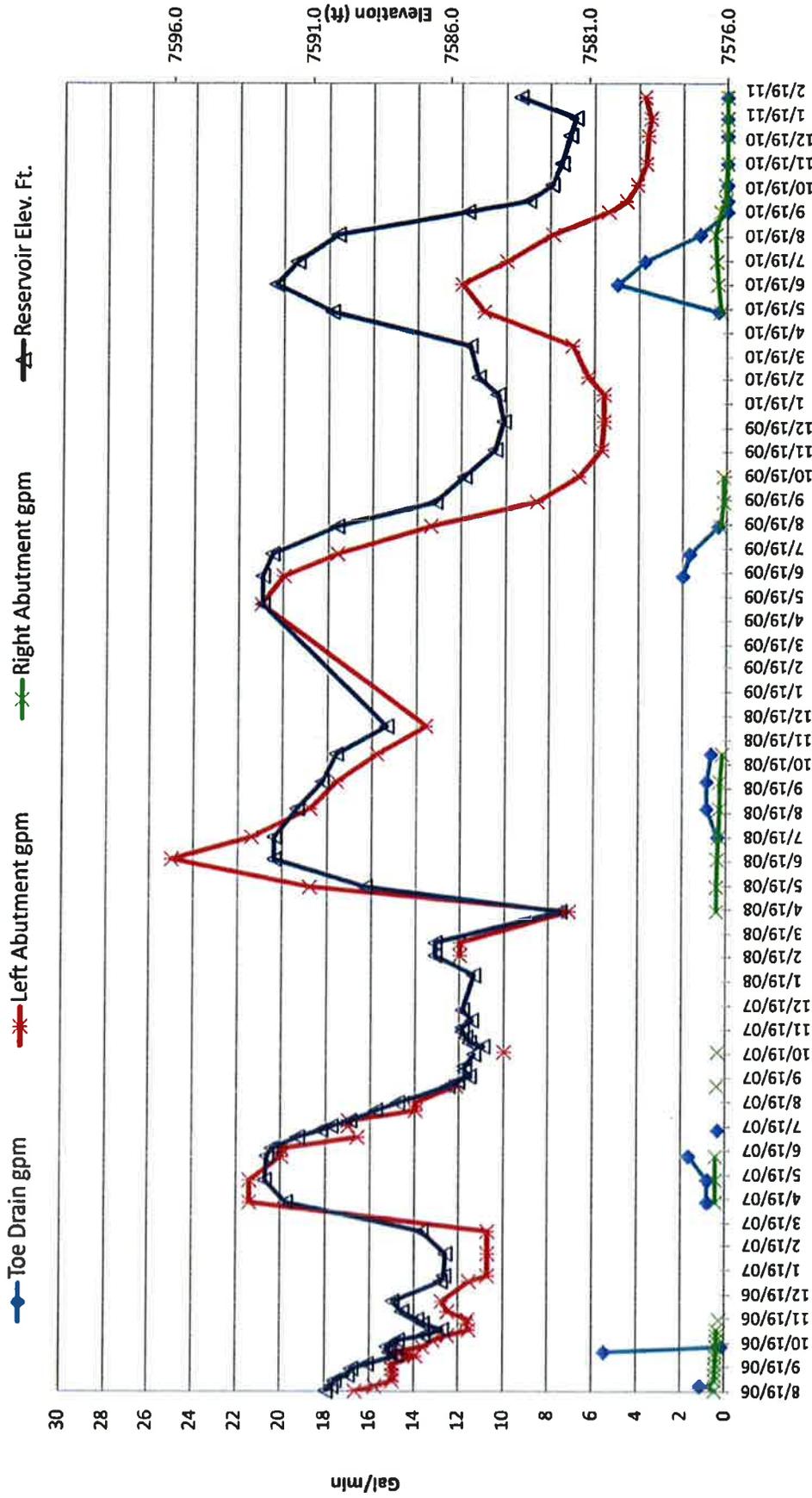
Inclinometer readings were not taken in January as the Inclinometer was being repaired. Reads were not taken on February 11 due to access problems and not being able to get the instrument up to the dam. Previous months have not shown any notable movement. Reservoir and seepage readings are summarized on the table on the following page.

During this site visits no signs of landslide movement were noted on the hillsides above the reservoir or on the dam.

Michael N. Hansen P.G.  
 Engineering Geologist  
 RB&G ENGINEERING Inc.

GRASSY TRAIL DAM SEEPAGE READINGS									
Dam Crest Elevation (ft)		7600.0		Seep1: Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5							
		Seep Location:							
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.00	frozen
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.00	frozen
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.00	frozen
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.00	frozen
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.00	frozen
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.30	Clear
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear
10/3/10	9.3	7583.2		dry		4.6	Clear	0.10	Clear
10/23/10	10.15	7582.4		dry		4.1	Clear	0.10	Clear
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.00	frozen
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.00	frozen
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.00	frozen
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.00	frozen

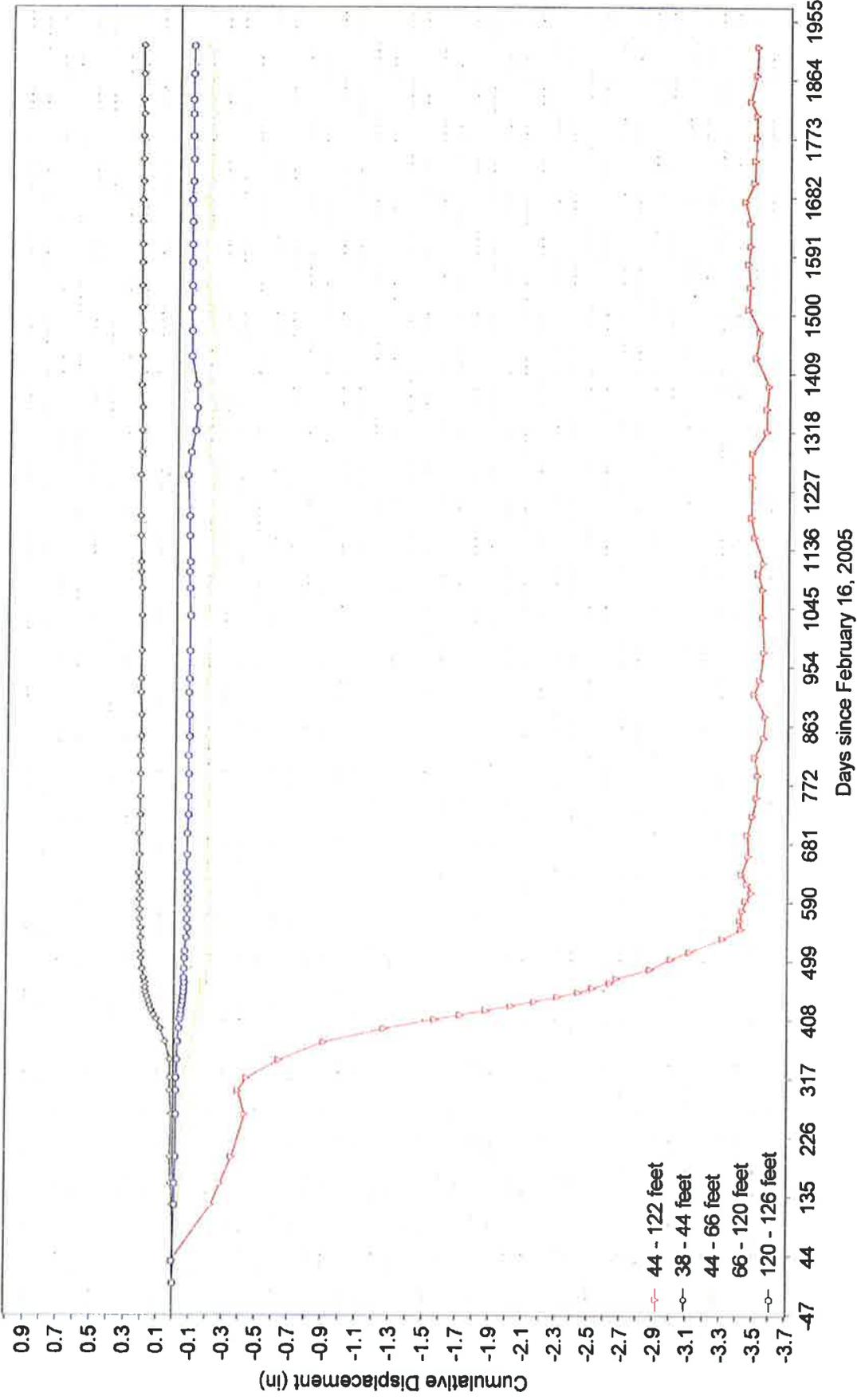
# Grassy Trail Dam Seepage Monitoring



**FIGURE** Seepage Monitoring Readings  
**Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 2/11/11**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH



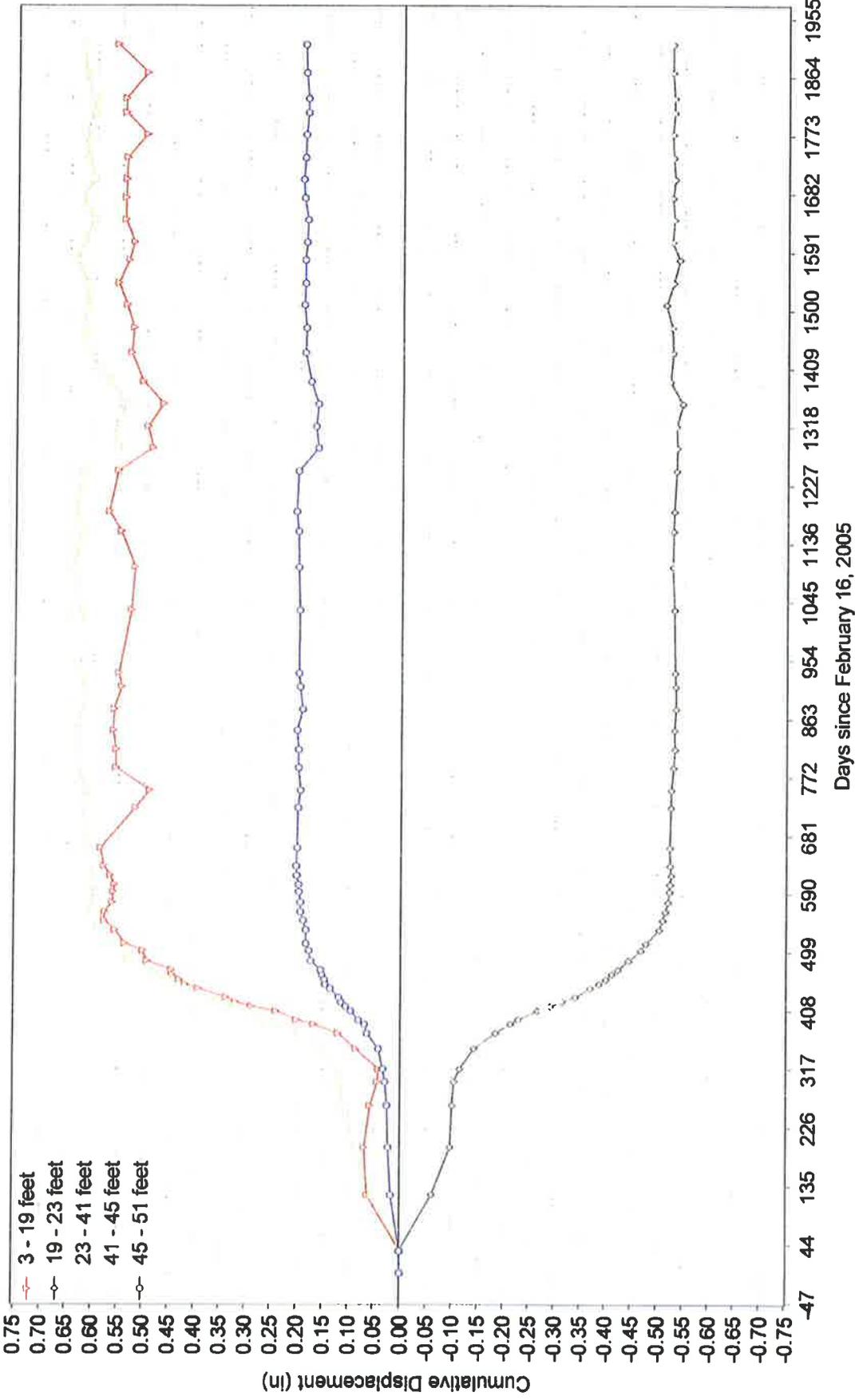
GRASSY 2A, A-Axis, -15 degree skew



Inclinometer I-2 Located on Dam

with -15 degree skew

GRASSY 3A, A-Axis



I-3 West/Right Abutment

Grassy Trail Dam, Seismic Summary as of March 9, 2011.

For the period from the February 11 to March 14, 2011, the UUSS has documented 5 MIS event near the West Ridge Mine area with magnitudes ranging from 0.5 to 1.0. A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 6 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1 to 2 miles north and west of the dam. The event in March, shown on the Table below occurred after the instruments were read on 3/9/11.

MONTH	# MIS events reported by UUSS
December 2008	34
<b>January 2009</b>	47
February <i>Change mining practice to Panel Barrier</i>	2
March	1
April	1
May	1
June	2
July	0
Aug	3
Sept	1
Oct	1
Nov	1
Dec	0
<b>Jan 2010</b>	0
Feb	0
March	0
April	1
May	0
June	0
July	0 Most recent Magnitudes
Aug	1 Mag 1.3
Sept	2 Mag 1.2 & 0.4
Oct	2 Mag 0.1 & 0.9
Nov	0
Dec	0
<b>Jan 2011</b>	2 Mag 0.7& 1.0
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0
March as of 3/14/11	1 Mag 0.8 on 3/14/11

No MIS events were recorded on the Dam or Hillside Seismic instruments.

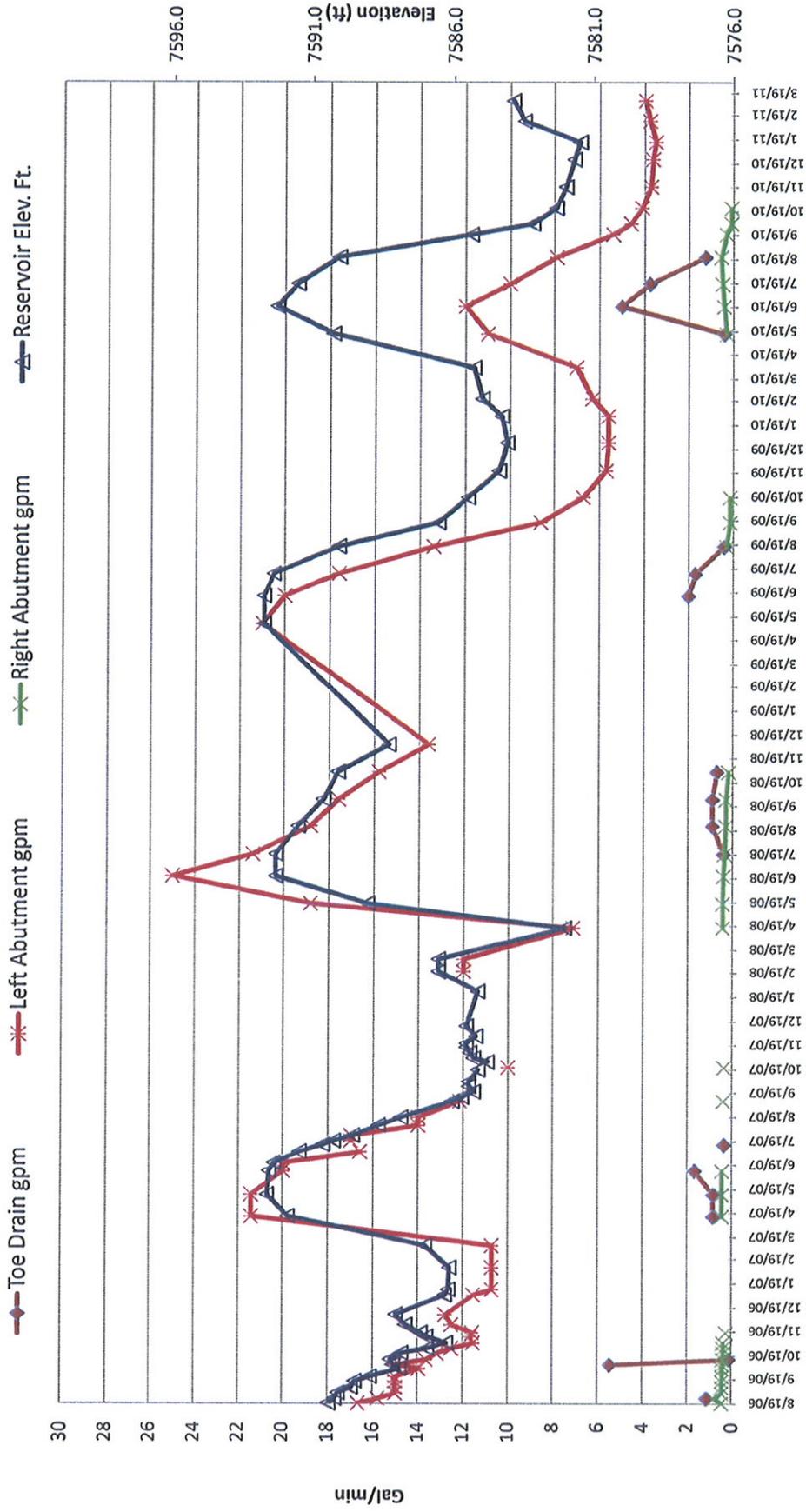
Inclinometer readings were taken in I-2 and I-3. I-4 was buried under 6 feet of snow. Due to the depth of snow, we could not even find the 5 ft. marker that stands up beside the inclinometer to mark its location. Inclinometers readings have not shown any notable movement. Reservoir and seepage readings are summarized in the table on the following page. It should be noted that a blockage has been removed from Piezo # 12 and future readings should be more accurate.

During this site visits no signs of landslide movement were noted on the hillsides above the reservoir or on the dam.

  
Michael N. Hansen P.G.  
Engineering Geologist  
RB&G ENGINEERING Inc.

GRASSY TRAIL DAM SEEPAGE READINGS											
Dam Crest Elevation (ft)		7600.0				Seep 1: Toe Drain		Seep 2: Left Abutment		Seep 3: Right Abutment	
Spillway Elev. (ft)		7592.5						(East Seep)		(West Seep)	
Seep Location:											
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics		
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear		
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen		
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen		
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen		
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen		
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen		
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear		
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear		
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear		
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear		
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear		
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear		
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear		
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen		
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen		
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen		
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen		
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen		

# Grassy Trail Dam Seepage Monitoring



**FIGURE** Seepage Monitoring Readings  
**Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 3/19/11**  
**GRASSY TRAIL DAM - CARBON COUNTY, UTAH**



# Grassy Trail Dam Piezometer Readings

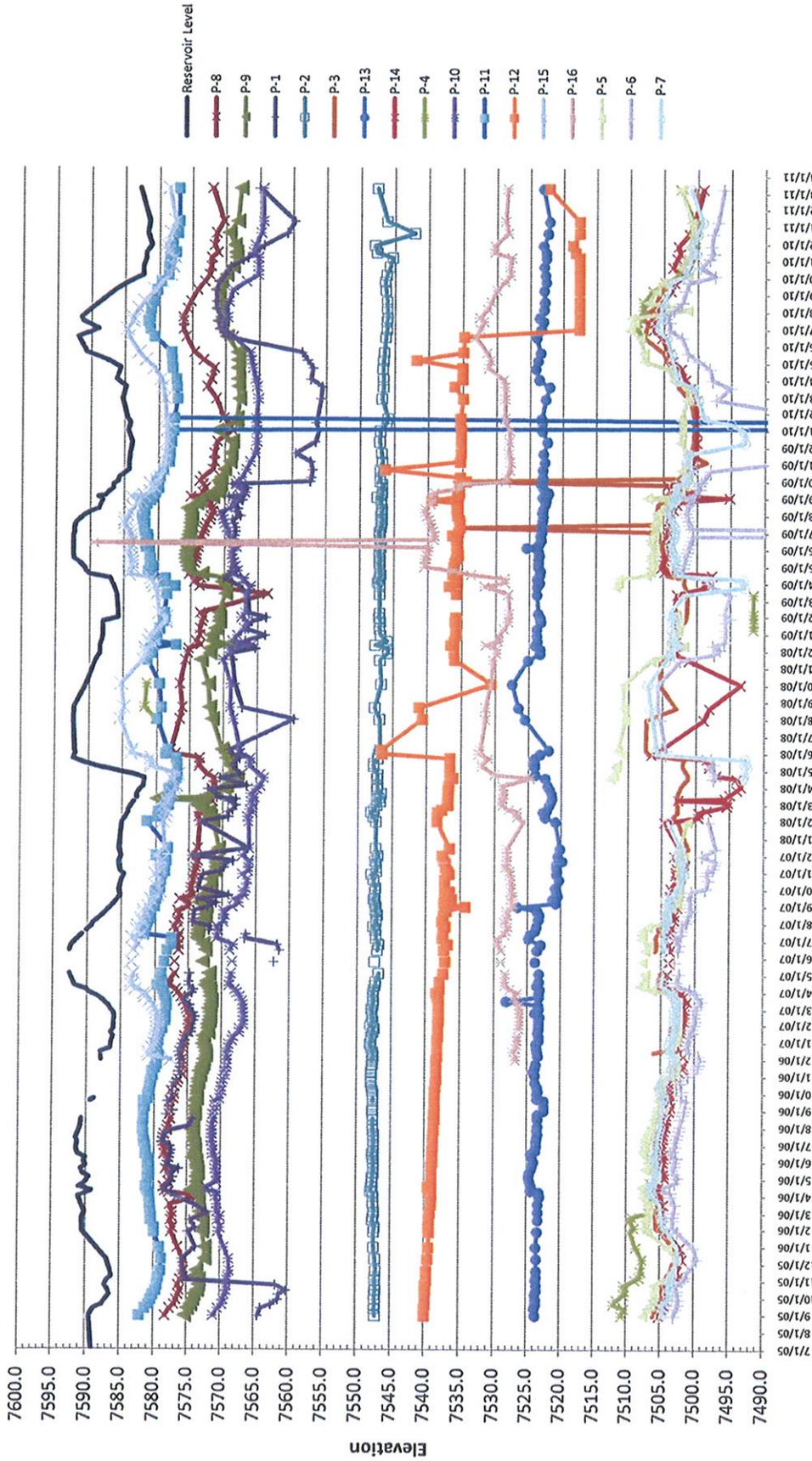


Figure Reservoir Elevation and Piezometer Readings

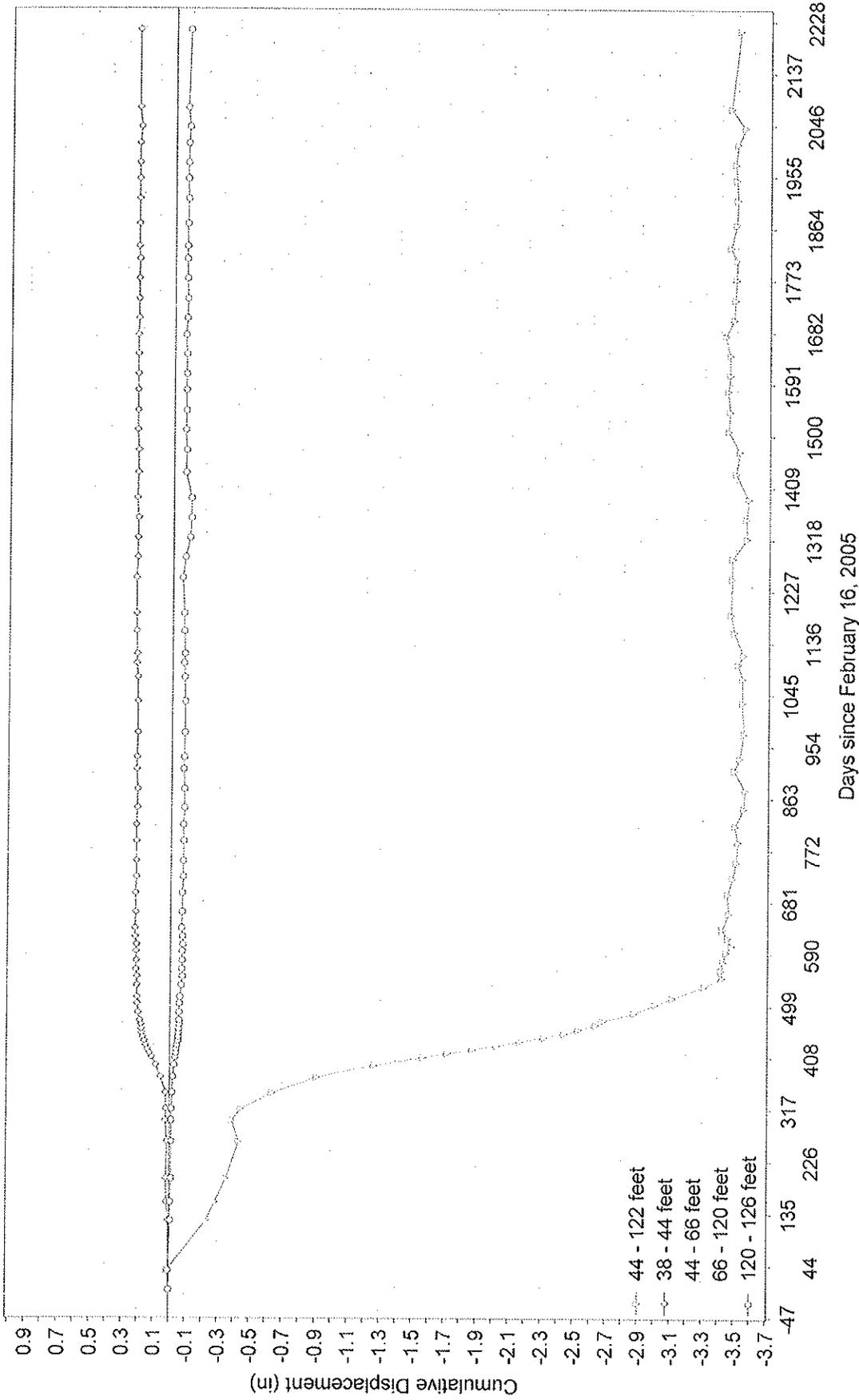
From 8/30/05 to 3/9/11 (some data taken from Division of Natural Resources, Water Rights, Dam Safety web site)

GRASSY TRAIL DAM - CARBON COUNTY, UTAH

\* NOTE - spikes are likely errors in data



GRASSY 2A, A-Axis, -15 degree skew



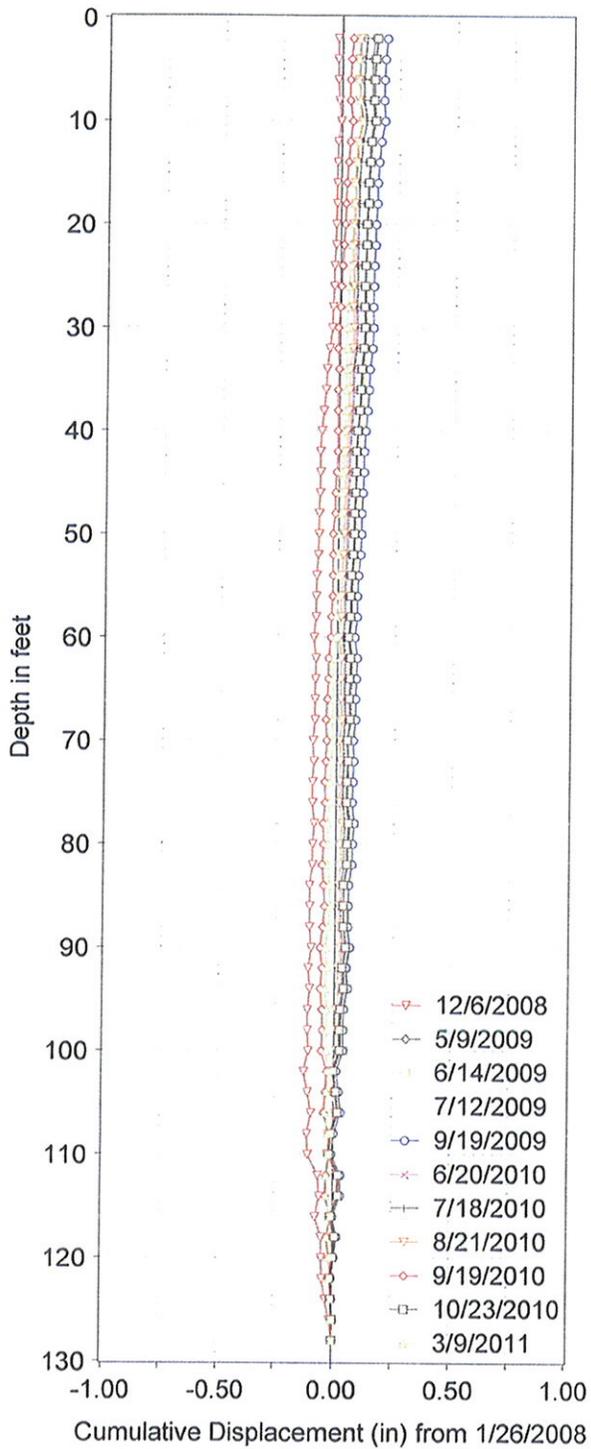
Inclinometer I-2 Located on Dam 3/9/11

with -15 degree skew

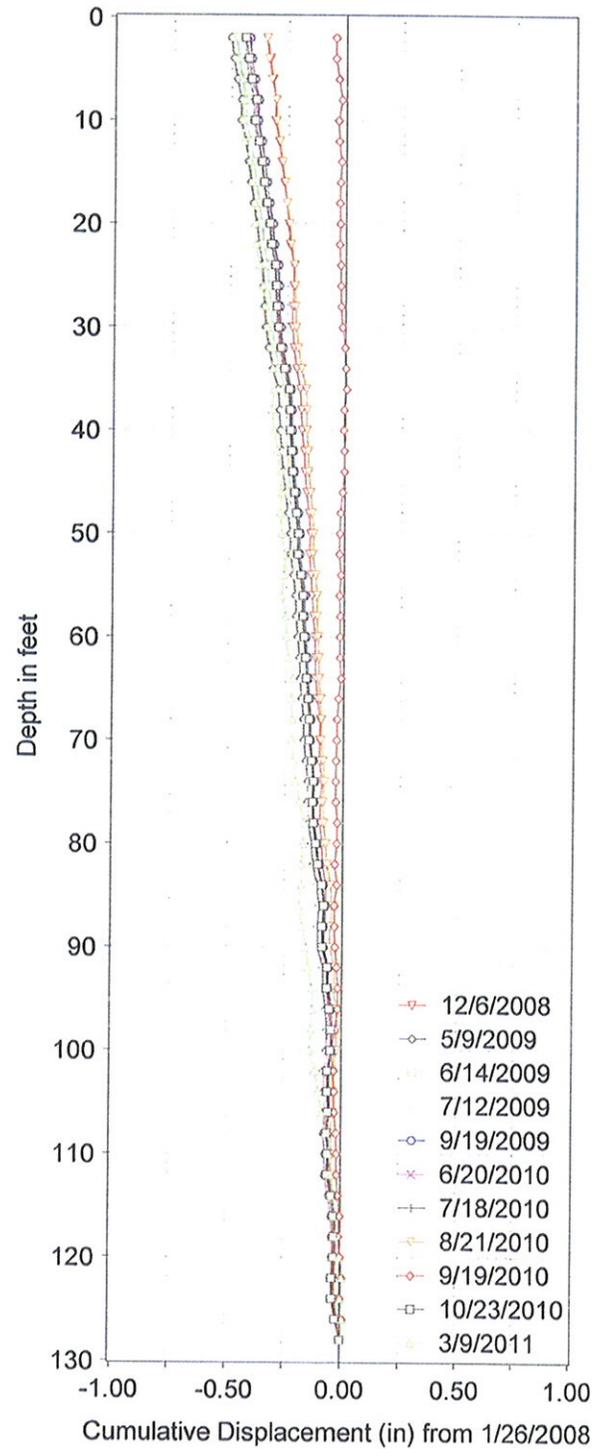
Figure

Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



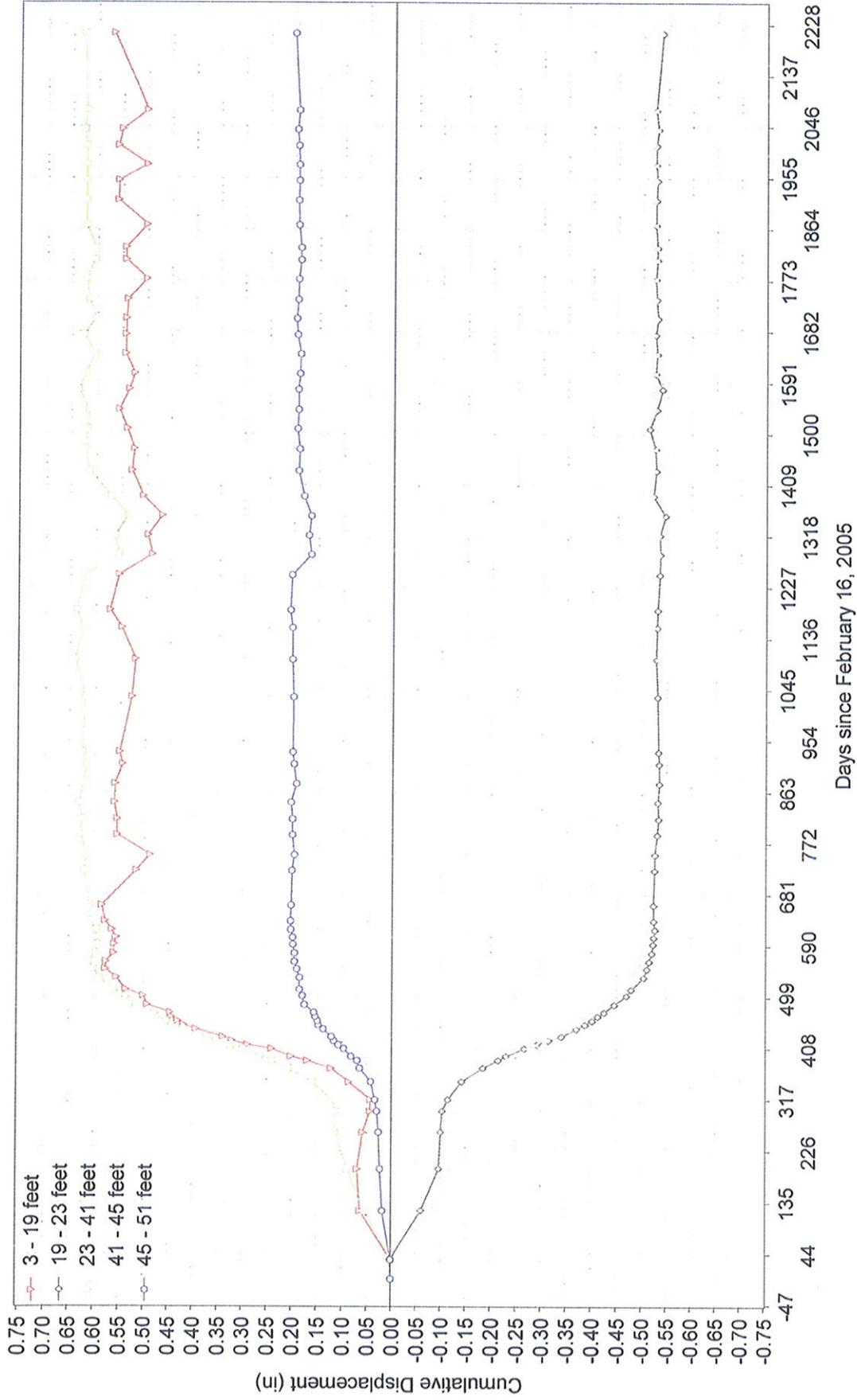
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis

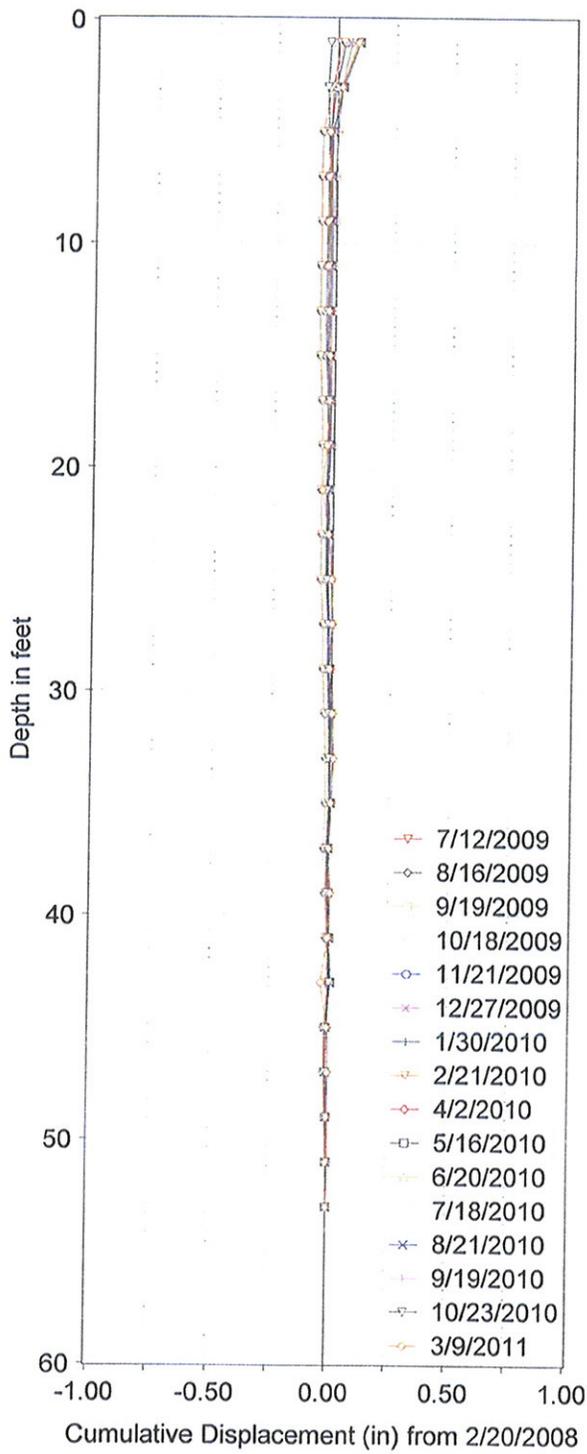


I-3 West/Right Abutment 3/9/11

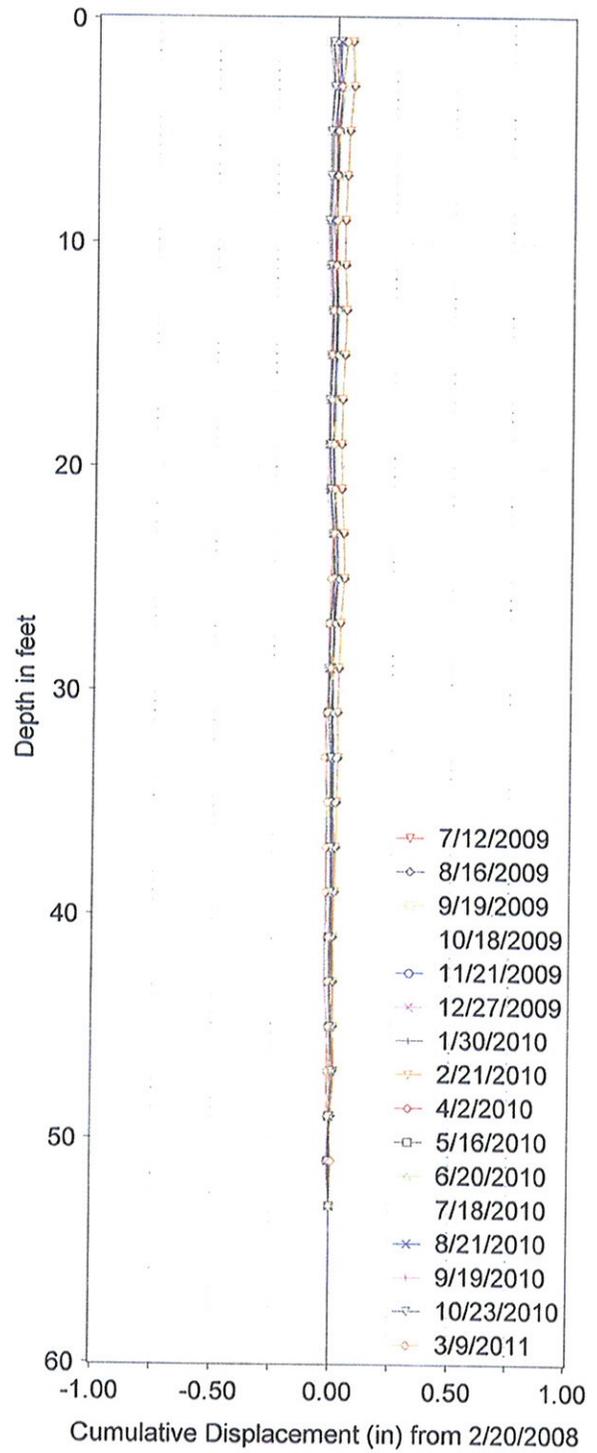
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

Grassy Trail Dam, Seismic Summary as of July 17, 2011.

For the period from the March 14 to July 17, 2011, the UUSS has documented 5 MIS event near the West Ridge Mine area with magnitudes ranging from 0.5 to 1.0. A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst.	Horizontal Distance from Mining to N. Hillside Inst. (ft)
December 2008	34		
<b>January 2009</b>	47		
February <i>Change mining practice to Panel Barrier</i>	2		
March	1		
April	1		
May	1		
June	2		
July	0		
Aug	3		
Sept	1		
Oct	1		
Nov	1		
Dec	0		
<b>Jan 2010</b>	0		
Feb	0		
March	0		
April	1		
May	0		
June	0		
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
<b>Jan 2011</b>	2 Mag 0.7 & 1.0		
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0		
March	4 Mag 1.0, 0.2, 0.8, 0.8		
April	0		
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
July as of 7/14/11	18 events Mag Avg 0.9, Min 0.1, Max 1.9	10	5,130 – 4,180 feet

No MIS events were recorded on the seismic instrument on the Dam. The Hillside instrument was moved further north last year to the mouth of Graveyard Canyon up the Left Fork of Whitmore Canyon. The North Hillside instrument is now closer to the area of active mining and is about 0.88 miles northwest of the dam. As shown on the table above, no seismic events were reported in the area by the University of Utah (UUSS) in April. During May the number of events began to increase, with as many as 36 reported during the June. The overall magnitude of some of the events also appears to have increased. Some events with an earthquake magnitude of 1.4 or greater are been recorded on our North Hillside instrument.

Grassy Trail Dam, Seismic Summary as of July 17, 2011.

For the period from the March 14 to July 17, 2011, the UUSS has documented 5 MIS event near the West Ridge Mine area with magnitudes ranging from 0.5 to 1.0. A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst.	Horizontal Distance from Mining to N. Hillside Inst. (ft)
December 2008	34		
<b>January 2009</b>	47		
February <i>Change mining practice to Panel Barrier</i>	2		
March	1		
April	1		
May	1		
June	2		
July	0		
Aug	3		
Sept	1		
Oct	1		
Nov	1		
Dec	0		
<b>Jan 2010</b>	<b>0</b>		
Feb	0		
March	0		
April	1		
May	0		
June	0		
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
<b>Jan 2011</b>	<b>2 Mag 0.7 &amp; 1.0</b>		
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0		
March	4 Mag 1.0, 0.2, 0.8, 0.8		
April	0		
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
July as of 7/14/11	18 events Mag Avg 0.9, Min 0.1, Max 1.9	10	5,130 – 4,180 feet

No MIS events were recorded on the seismic instrument on the Dam. The Hillside instrument was moved further north last year to the mouth of Graveyard Canyon up the Left Fork of Whitmore Canyon. The North Hillside instrument is now closer to the area of active mining and is about 0.88 miles northwest of the dam. As shown on the table above, no seismic events were reported in the area by the University of Utah (UUSS) in April. During May the number of events began to increase, with as many as 36 reported during the June. The overall magnitude of some of the events also appears to have increased. Some events with an earthquake magnitude of 1.4 or greater are been recorded on our North Hillside instrument.

A Table is attached showing the events recorded on the North Hillside instrument, along with the earthquake magnitudes reported by the UUSS. This Table also shows the recorded triaxle, peak velocity (in/s), acceleration (g), and frequency (Hz) of each event. The largest (MIS) earthquake magnitude reported was 2.0. However, the largest acceleration and velocity recorded was 0.066 g and 0.205 in/s from a 1.9 magnitude event (July 14). A total of 40 events were recorded on the North Hillside instrument with 25 reported as earthquakes by the UUSS.

Inclinometer readings were taken in I-2 and I-3. I-4 was buried under mud from surficial sliding off the hillside. Inclinometers readings have not shown any notable movement.

Since the middle on May to July 17<sup>th</sup> the reservoir has been generally at or overtopping the spillway. The highest reservoir level I recorded was 5.5 inches over the spillway in June. This is the highest water level we have recorded since more detailed monitoring began in 2005.

A chart showing the seepage readings is attached. It may be noted since May 2009, seepage from the left abutment drain appears to be gradually decreasing. The cause for this decrease is not known. We feel that the piezometer readings particularly on the left abutment should be watched closely for any erratic changes.

Reservoir, Piezometer and seepage readings are summarized on the attached graphs.

During this site visits no signs of landslide movement were noted on the hillsides above the dam. It should be noted that due to the wet winter and spring there are a few small slides showing up along the upslope side of the road cut west of the reservoir and a small side above the road cut just north of the reservoir. These slides appear surficial and do not show any movement within the roadway.

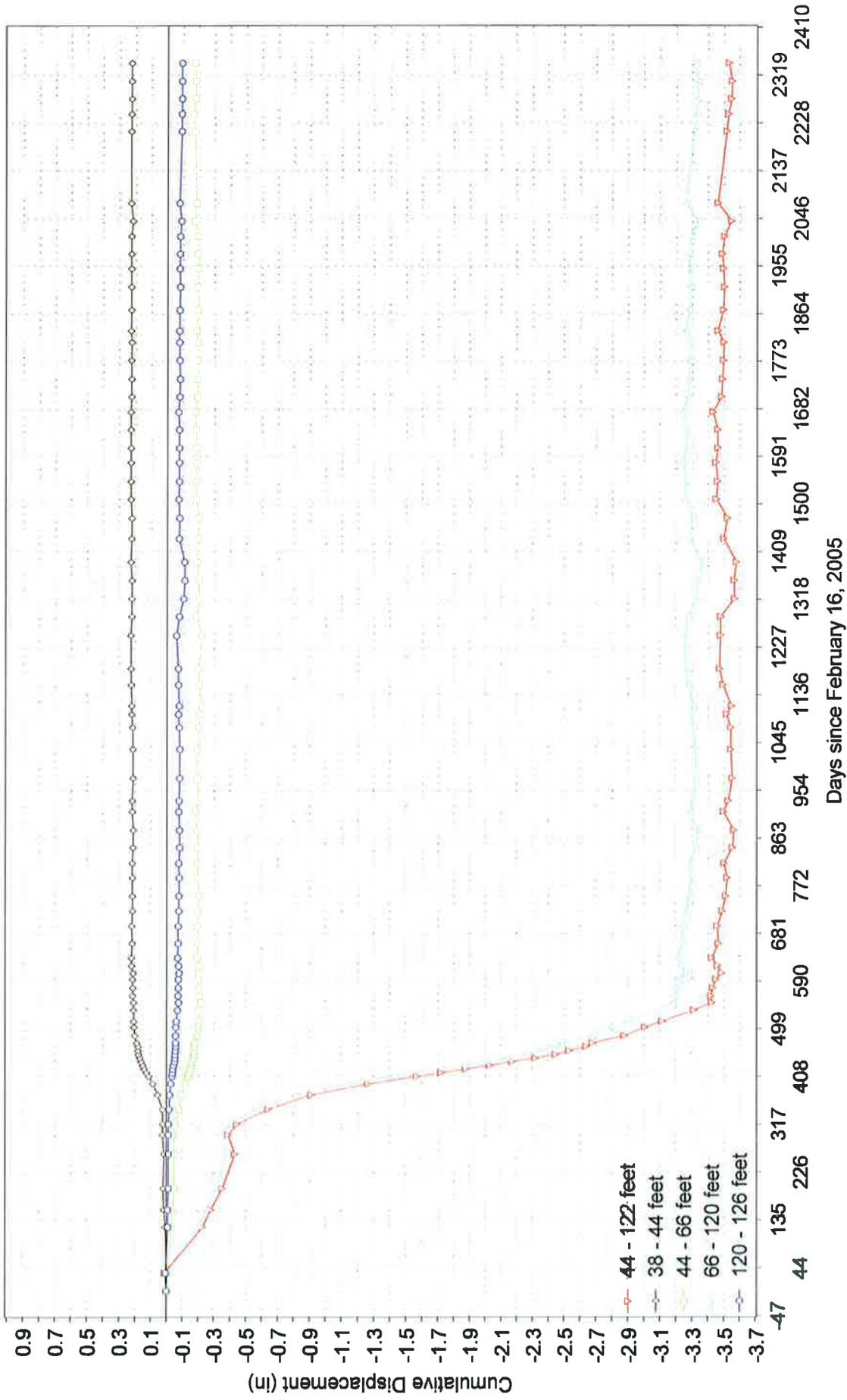
  
Michael N. Hansen P.G.

Engineering Geologist  
RB&G ENGINEERING Inc.

## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0			Seep1:Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5								
Seep Location:										
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	
	Neg = above spillway									
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear	
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen	
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen	
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen	
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen	
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen	
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear	
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear	
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear	
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear	
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear	
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear	
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear	
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen	
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen	
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen	
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen	
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen	
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt	
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear	
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear	
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear	
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear	
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear	
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear	

GRASSY 2A, A-Axis, -15 degree skew



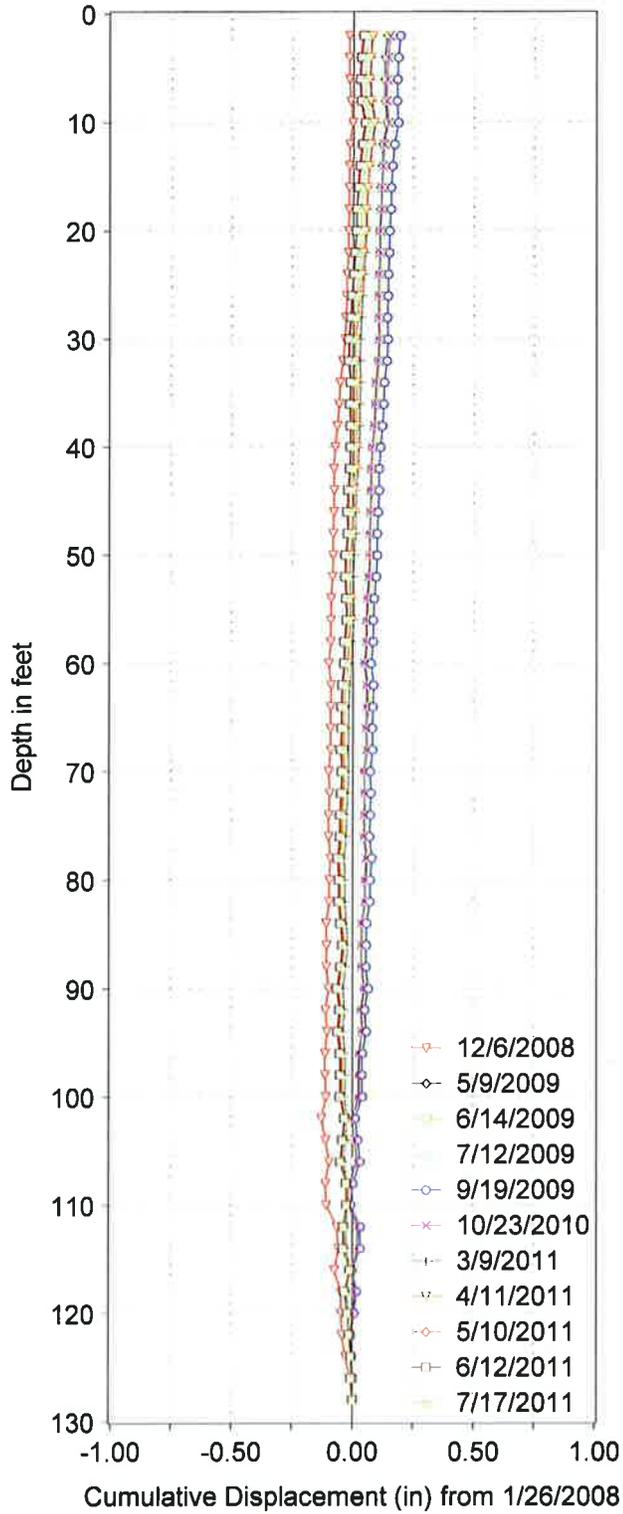
Inclinometer I-2 Located on Dam 7/17/11

with -15 degree skew

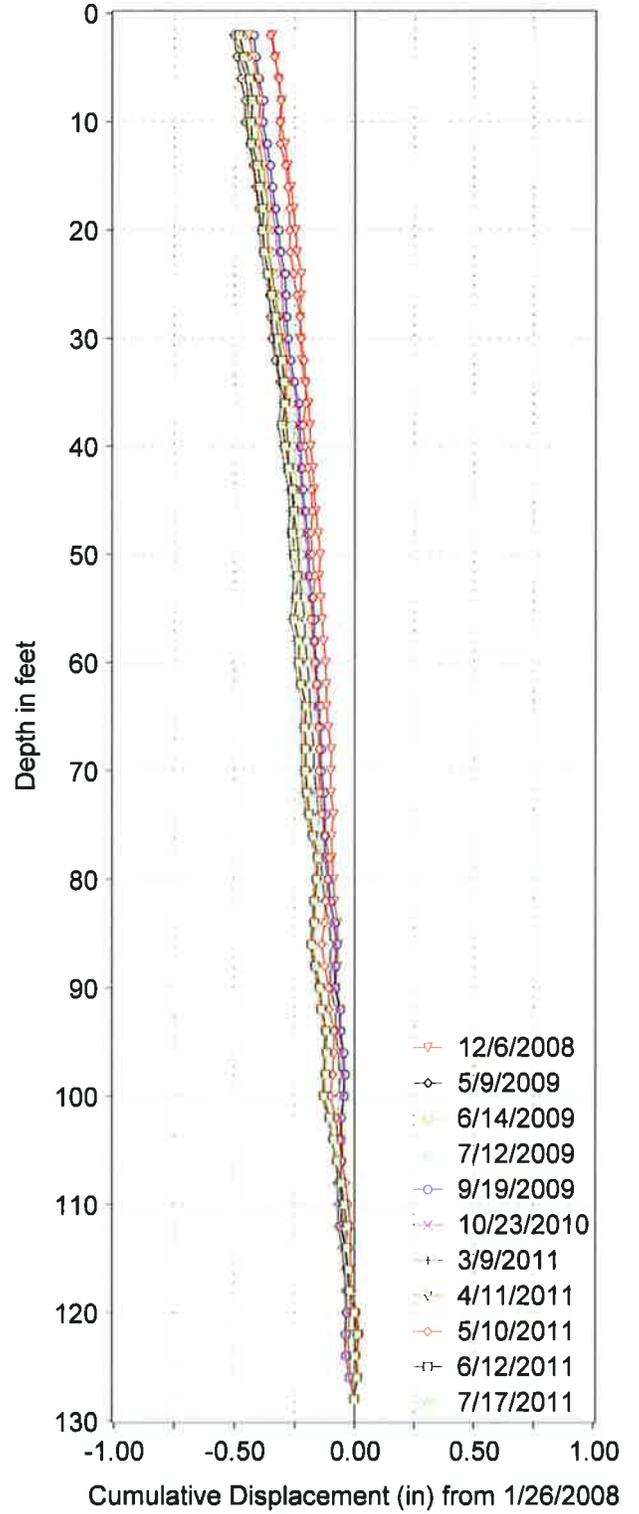
Figure

Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



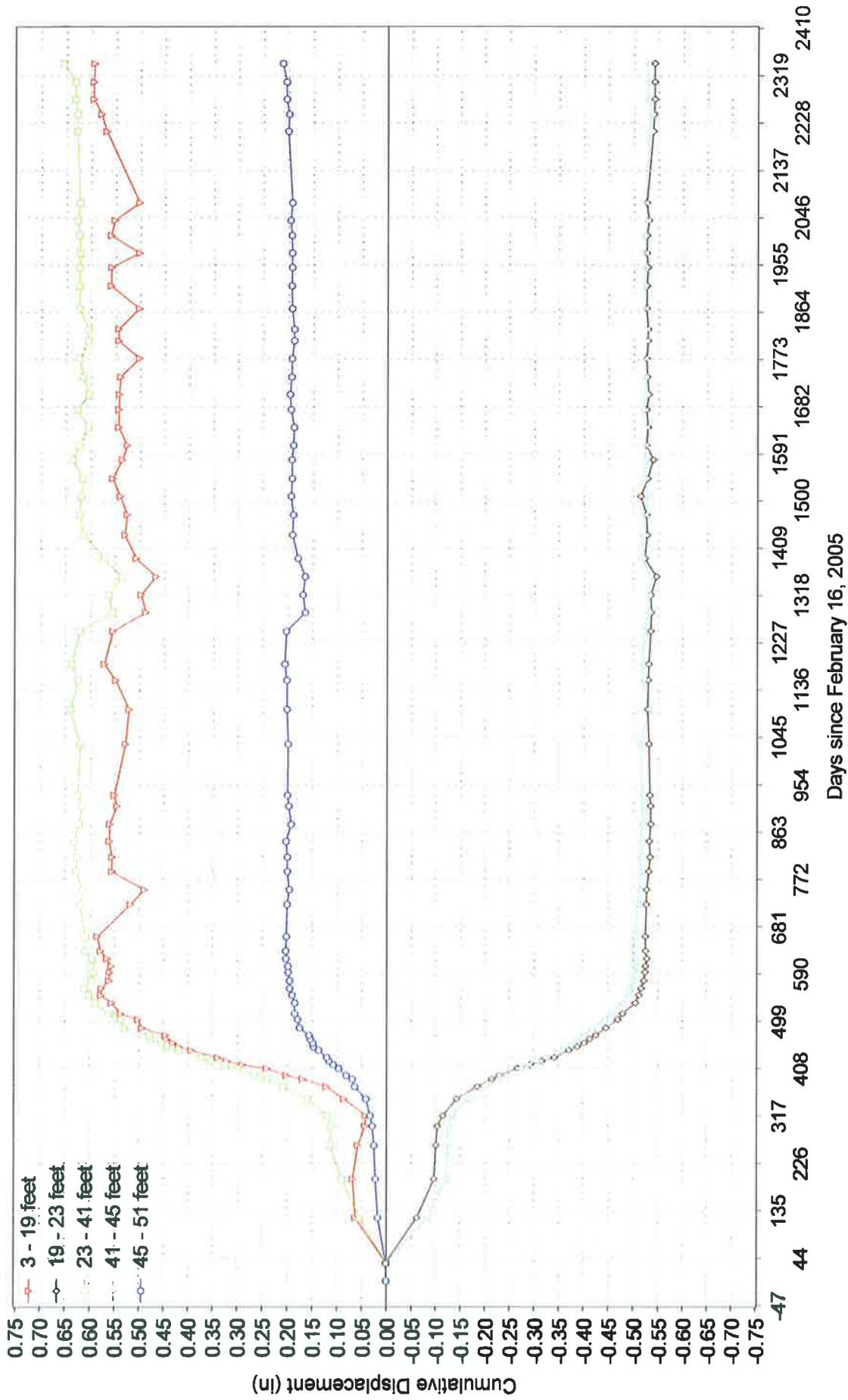
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY 3A, A-Axis

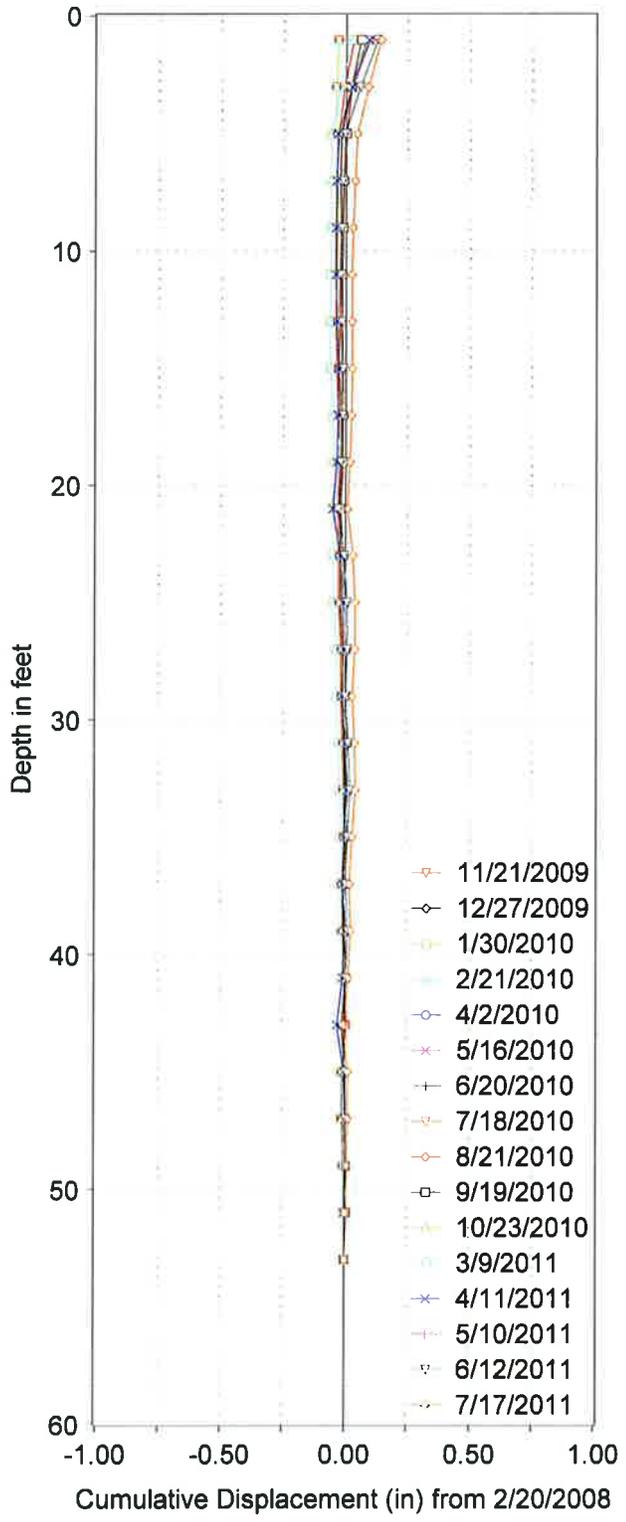


I-3 West/Right Abutment 7/17/11

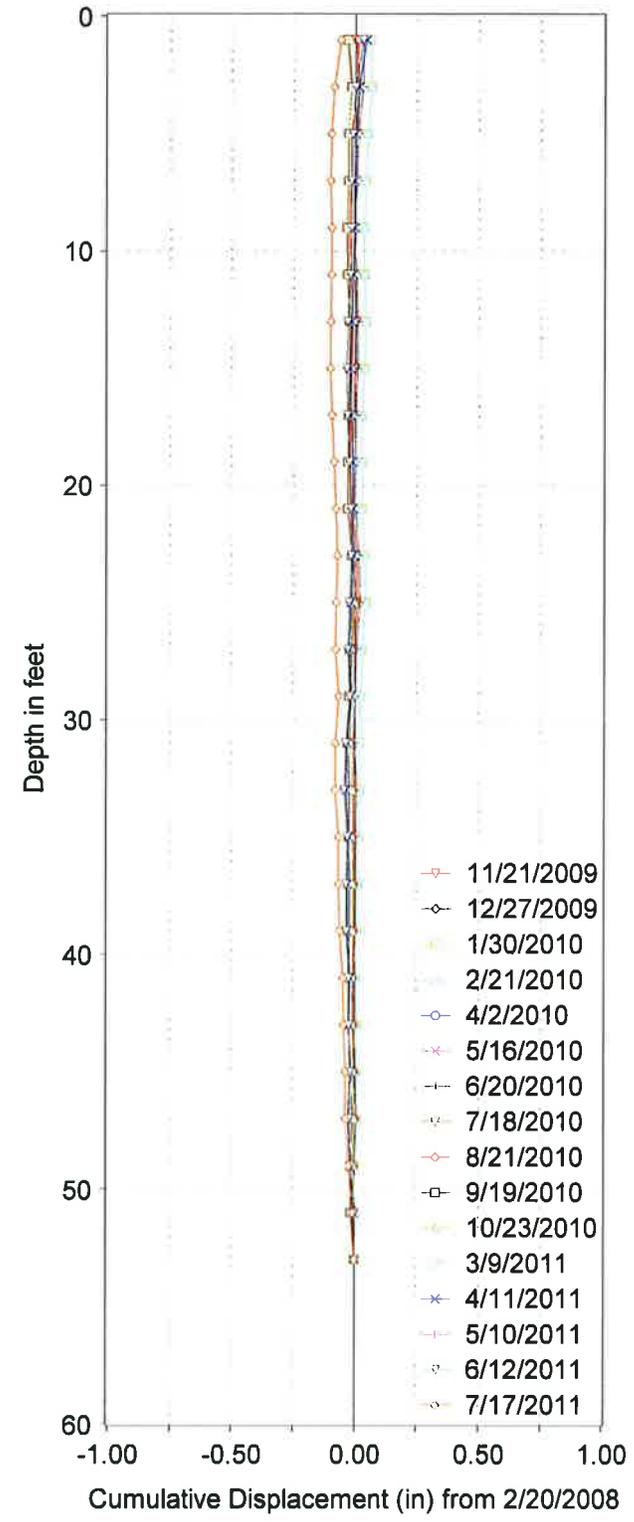
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# Grassy Trail Dam Seepage Monitoring

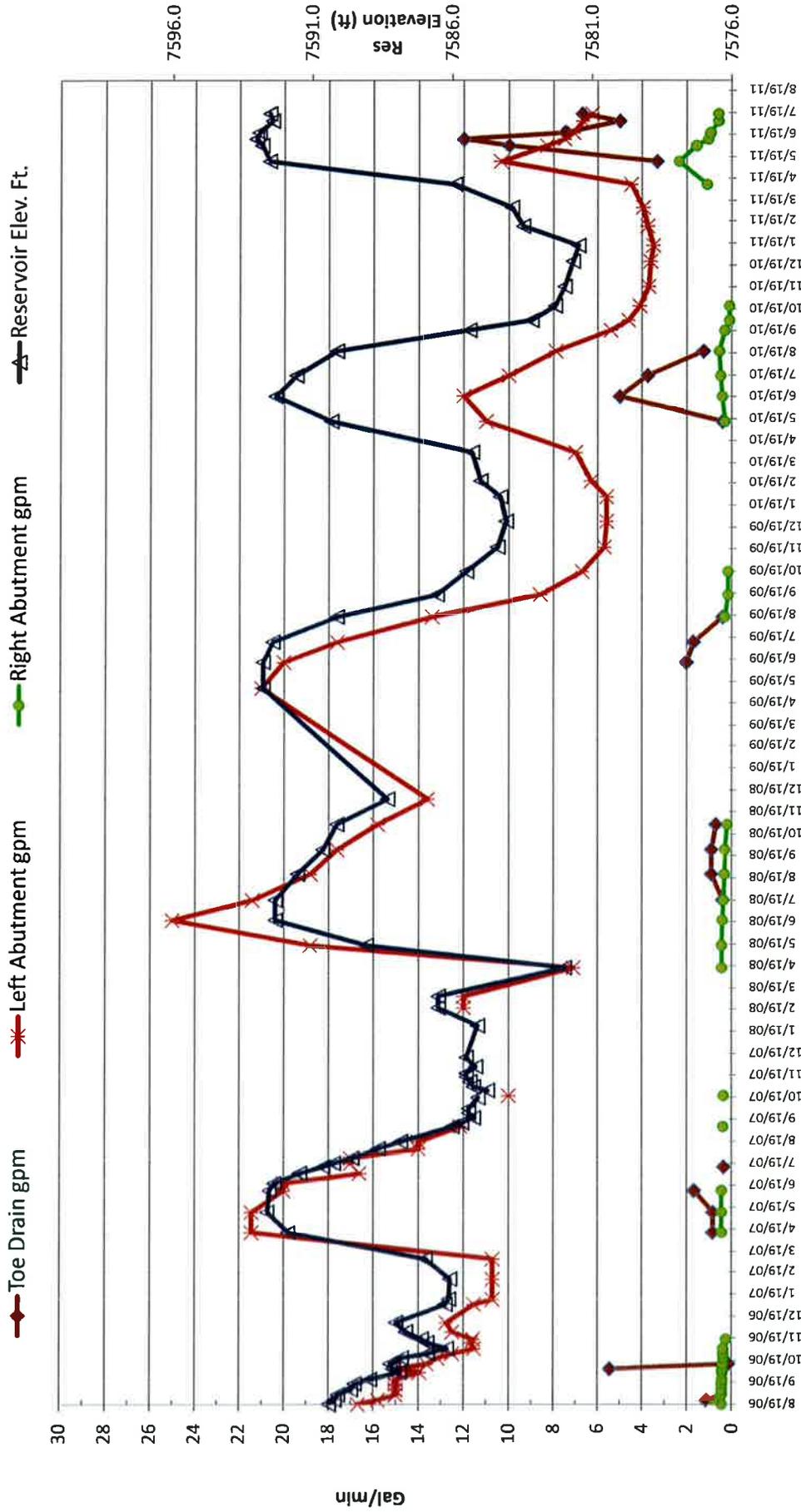
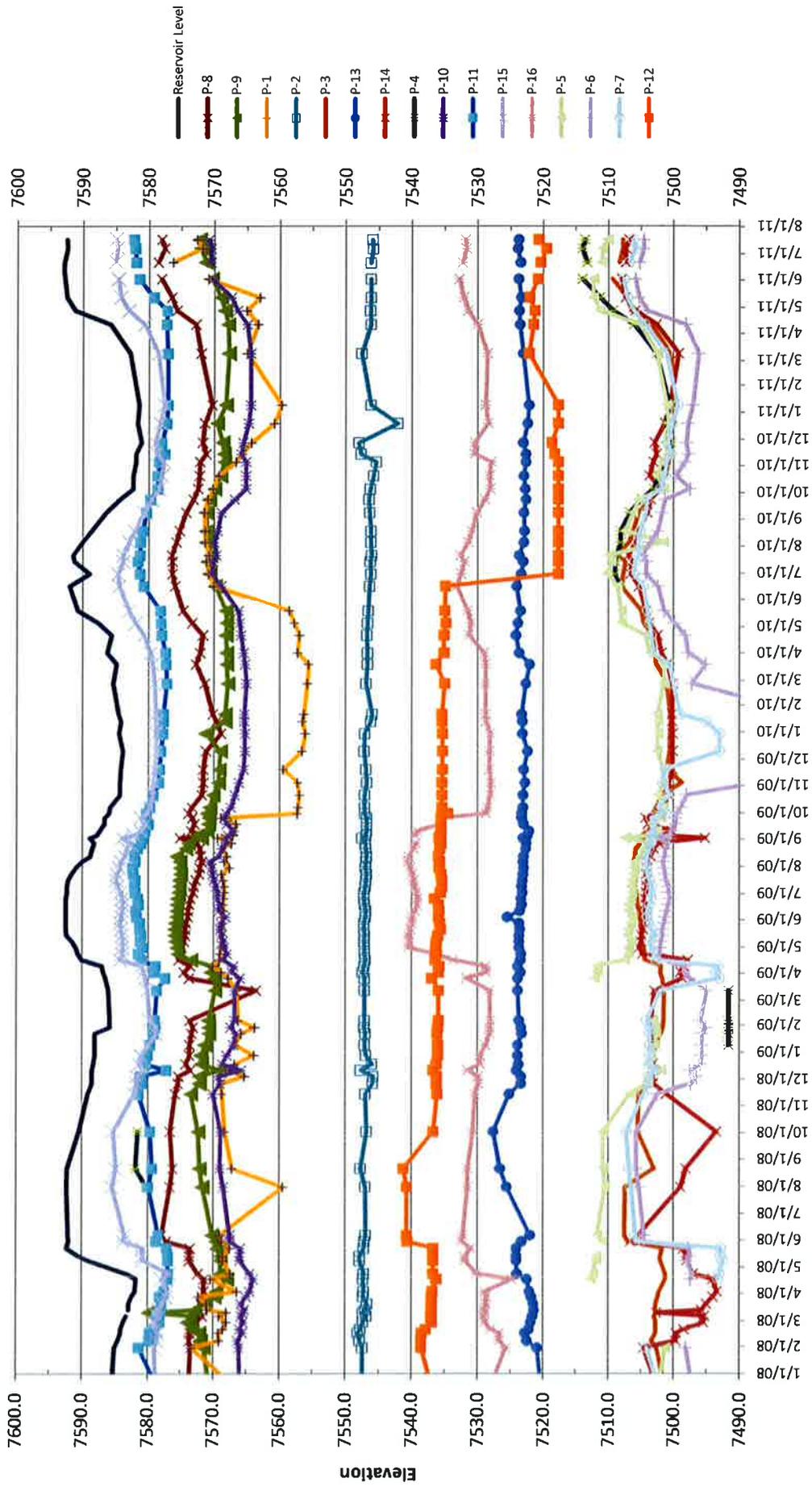


FIGURE Seepage Monitoring Readings

Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 7/17/11  
GRASSY TRAIL DAM - CARBON COUNTY, UTAH



# Grassy Trail Dam Piezometer Readings



**Figure** Reservoir Elevation and Piezometer Readings

From 1/1/08 to 7/17/11 (some data taken from Division of Natural Resources, Water Rights, Dam Safety web site)

GRASSY TRAIL DAM - CARBON COUNTY, UTAH

\* NOTE - spikes are likely errors in data (some very large spikes have been removed)  
**P-12 repaired Jan 2011**

Grassy Trail Dam, Seismic Summary as of August 14, 2011.

For the period from the March 14 to Aug 14, 2011. A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst.	Horizontal Distance from Mining to N. Hillside Inst. (ft)
December 2008	34		
January 2009	47		
February <i>Change mining practice to Panel Barrier</i>	2		
March	1		
April	1		
May	1		
June	2		
July	0		
Aug	3		
Sept	1		
Oct	1		
Nov	1		
Dec	0		
Jan 2010	0		
Feb	0		
March	0		
April	1		
May	0		
June	0		
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
Jan 2011	2 Mag 0.7 & 1.0	0	
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0	0	
March	4 Mag 1.0, 0.2, 0.8, 0.8	0	
April	0	0	
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
July	35 events Mag Avg 0.8, Min 0.0, Max 1.9	10	5,130 – 4,180 feet
Aug as of 8/14/11	16 events Mag Avg 0.3, Min 0.0, Max 1.0	0	

No MIS events were recorded on the seismic instrument on the Dam. The Hillside instrument was moved further north last year to the mouth of Graveyard Canyon up the Left Fork of Whitmore Canyon. The North Hillside instrument is now closer to the area of active mining and is about 0.88 miles northwest of the dam. As shown on the table above, no seismic events were reported in the area by the University of Utah (UUSS) in April. During May the number of events began to increase, with as many as 36 reported during the June. The overall magnitude of some of the events also appears to have increased. Some events with an earthquake magnitude of 1.4 or greater are been recorded on our North Hillside instrument.

Grassy Trail Dam, Seismic Summary as of August 14, 2011.

For the period from the March 14 to Aug 14, 2011. A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst.	Horizontal Distance from Mining to N. Hillside Inst. (ft)
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March	1		
April	1		
May	1		
June	2		
July	0		
Aug	3		
Sept	1		
Oct	1		
Nov	1		
Dec	0		
<b>Jan 2010</b>	<b>0</b>		
Feb	0		
March	0		
April	1		
May	0		
June	0		
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
<b>Jan 2011</b>	2 Mag 0.7 & 1.0	0	
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0	0	
March	4 Mag 1.0, 0.2, 0.8, 0.8	0	
April	0	0	
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
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Aug as of 8/14/11	16 events Mag Avg 0.3, Min 0.0, Max 1.0	0	

No MIS events were recorded on the seismic instrument on the Dam. The Hillside instrument was moved further north last year to the mouth of Graveyard Canyon up the Left Fork of Whitmore Canyon. The North Hillside instrument is now closer to the area of active mining and is about 0.88 miles northwest of the dam. As shown on the table above, no seismic events were reported in the area by the University of Utah (UUSS) in April. During May the number of events began to increase, with as many as 36 reported during the June. The overall magnitude of some of the events also appears to have increased. Some events with an earthquake magnitude of 1.4 or greater are been recorded on our North Hillside instrument.

During the latter part of July and during August Earthquake magnitudes were less than 1.0 and no events were recorded on the Hillside Instruments. A Table is attached showing the events recorded on the North Hillside instrument, along with the earthquake magnitudes reported by the UUSS. This Table also shows the recorded triaxle, peak velocity (in/s), acceleration (g), and frequency (Hz) of each event. The largest (MIS) earthquake magnitude reported was 2.0. However, the largest acceleration and velocity recorded was 0.066 g and 0.205 in/s from a 1.9 magnitude event (July 14). A total of 40 events were recorded on the North Hillside instrument with 25 reported as earthquakes by the UUSS.

Inclinometer readings were taken in I-2 and I-3. I-4 was buried under mud from surficial sliding off the hillside. Inclinometers readings have not shown any notable movement.

Since the middle on May to Aug 14<sup>th</sup> the reservoir has been generally at or overtopping the spillway. The highest reservoir level I recorded was 5.5 inches over the spillway in June. This is the highest water level we have recorded since more detailed monitoring began in 2005.

A chart showing the seepage readings is attached. It may be noted since May 2009, seepage from the left abutment drain appears to be gradually decreasing. The cause for this decrease is not known. We feel that the piezometer readings particularly on the left abutment should be watched closely for any erratic changes.

Reservoir, Piezometer and seepage readings are summarized on the attached graphs.

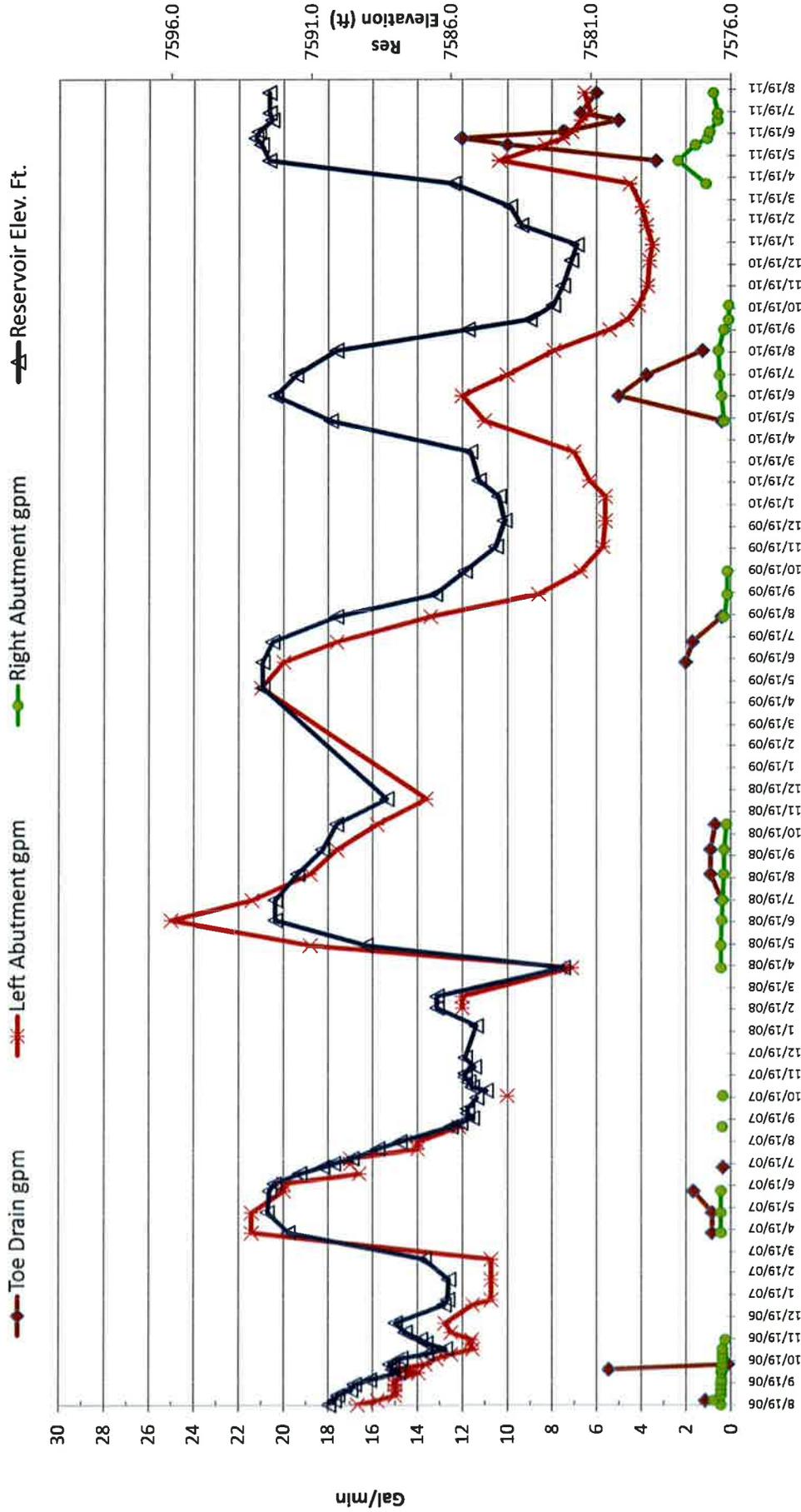
During this site visits no signs of landslide movement were noted on the hillsides above the dam. It should be noted that due to the wet winter and spring there are a few small slides showing up along the upslope side of the road cut west of the reservoir and a small side above the road cut just north of the reservoir. These slides appear surficial and do not show any movement within the roadway.

  
Michael N. Hansen P.G.  
Engineering Geologist  
RB&G ENGINEERING Inc.

## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0		Seep1: Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5							
Seep Location:									
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics
	Neg = above spillway								
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear
8/14/11	-.02	7592.5	1/4" over	6	Clear	6.9	Clear	0.78	Clear

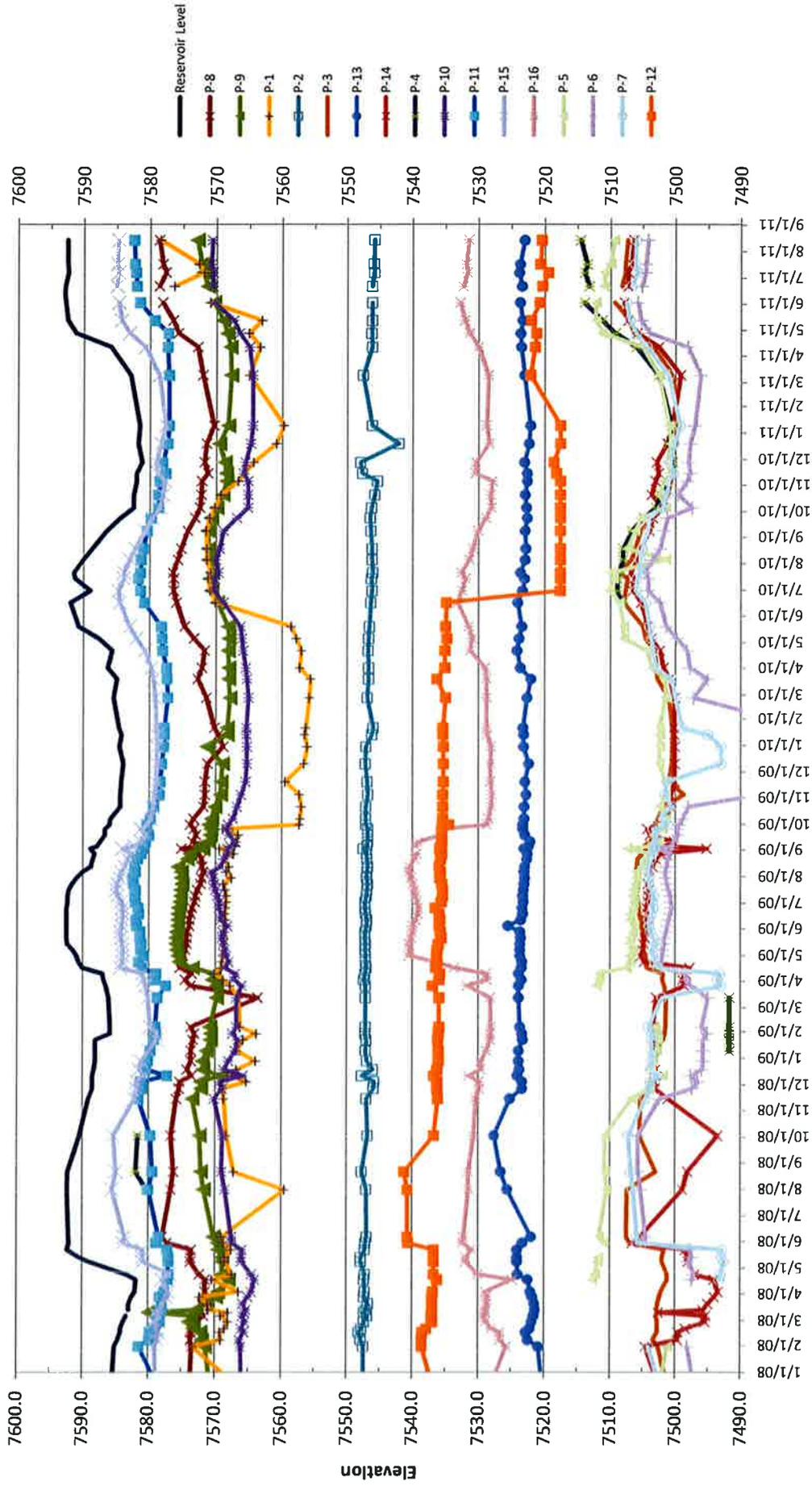
# Grassy Trail Dam Seepage Monitoring



**FIGURE** Seepage Monitoring Readings  
**Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 8/14/11**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH



# Grassy Trail Dam Piezometer Readings



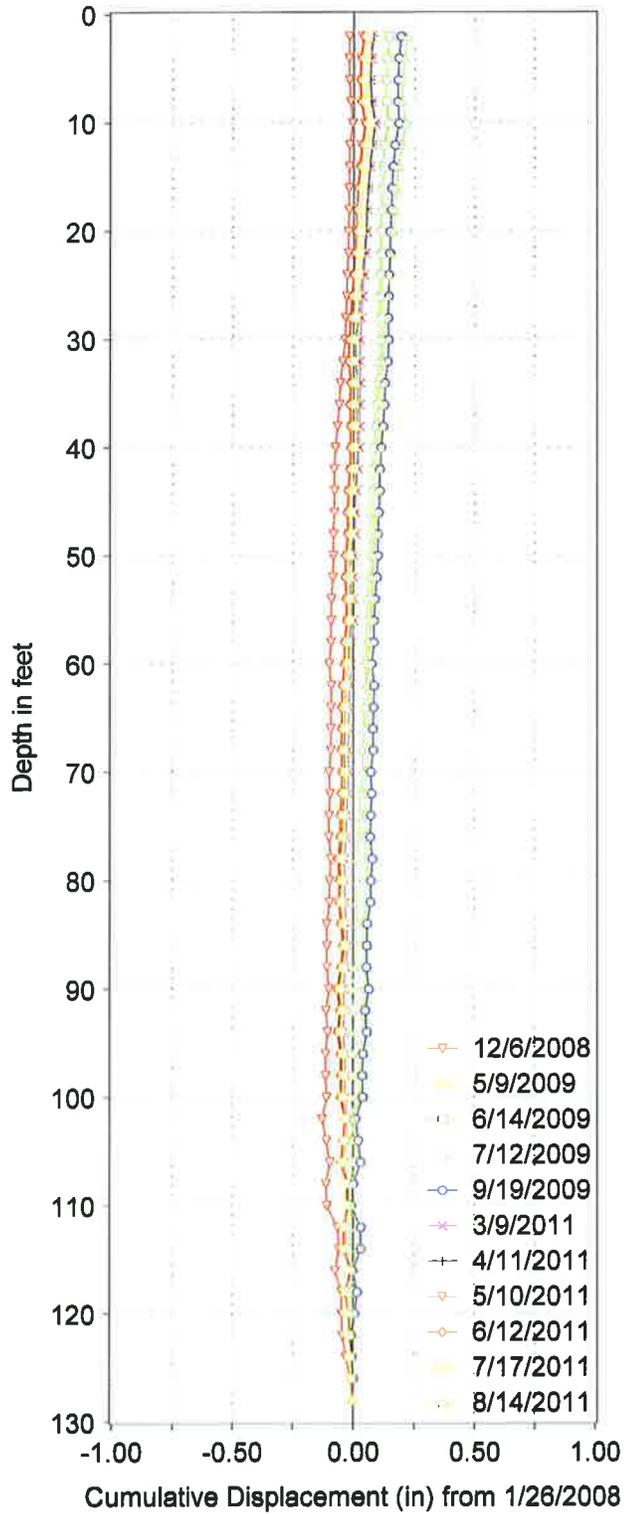
**Figure** Reservoir Elevation and Piezometer Readings

From 1/1/08 to 8/14/11 (some data taken from Division of Natural Resources, Water Rights, Dam Safety web site)

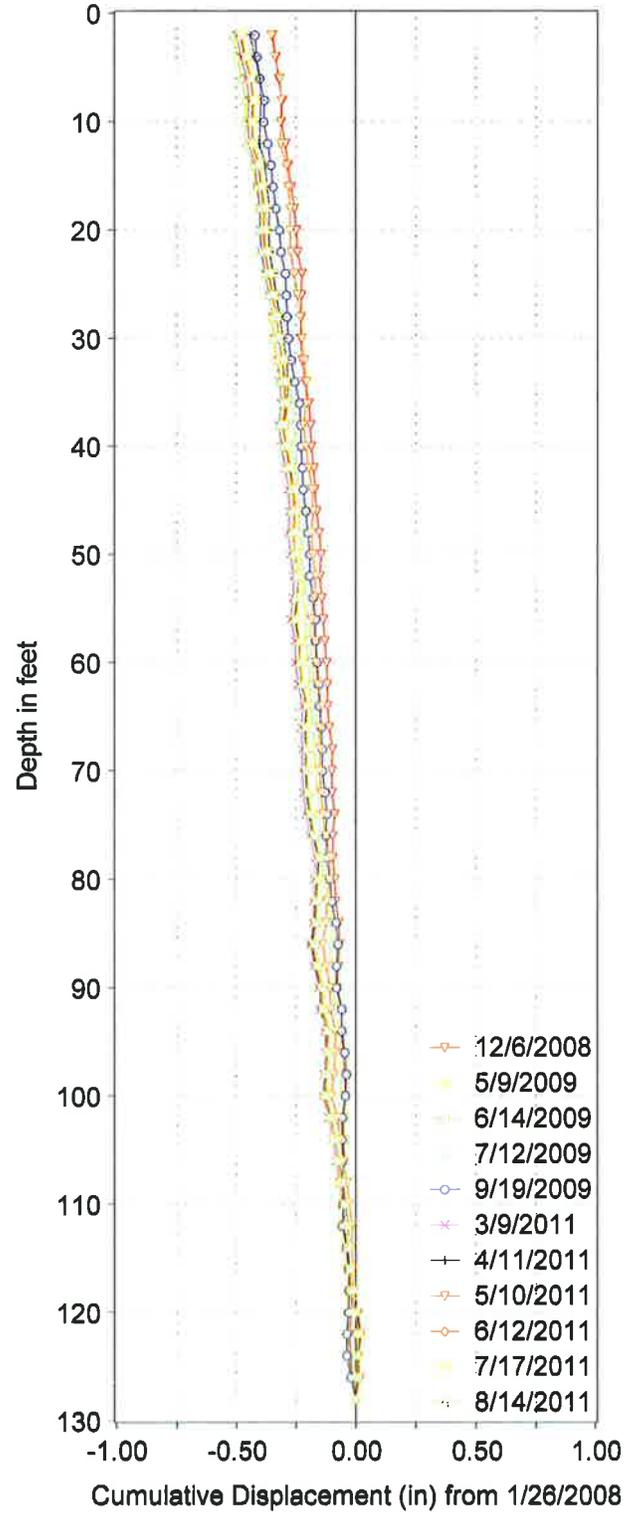
GRASSY TRAIL DAM - CARBON COUNTY, UTAH

\* NOTE - spikes are likely errors in data (some very large spikes have been removed)  
**P-12 repaired Jan 2011**

GRASSY 2A, A-Axis



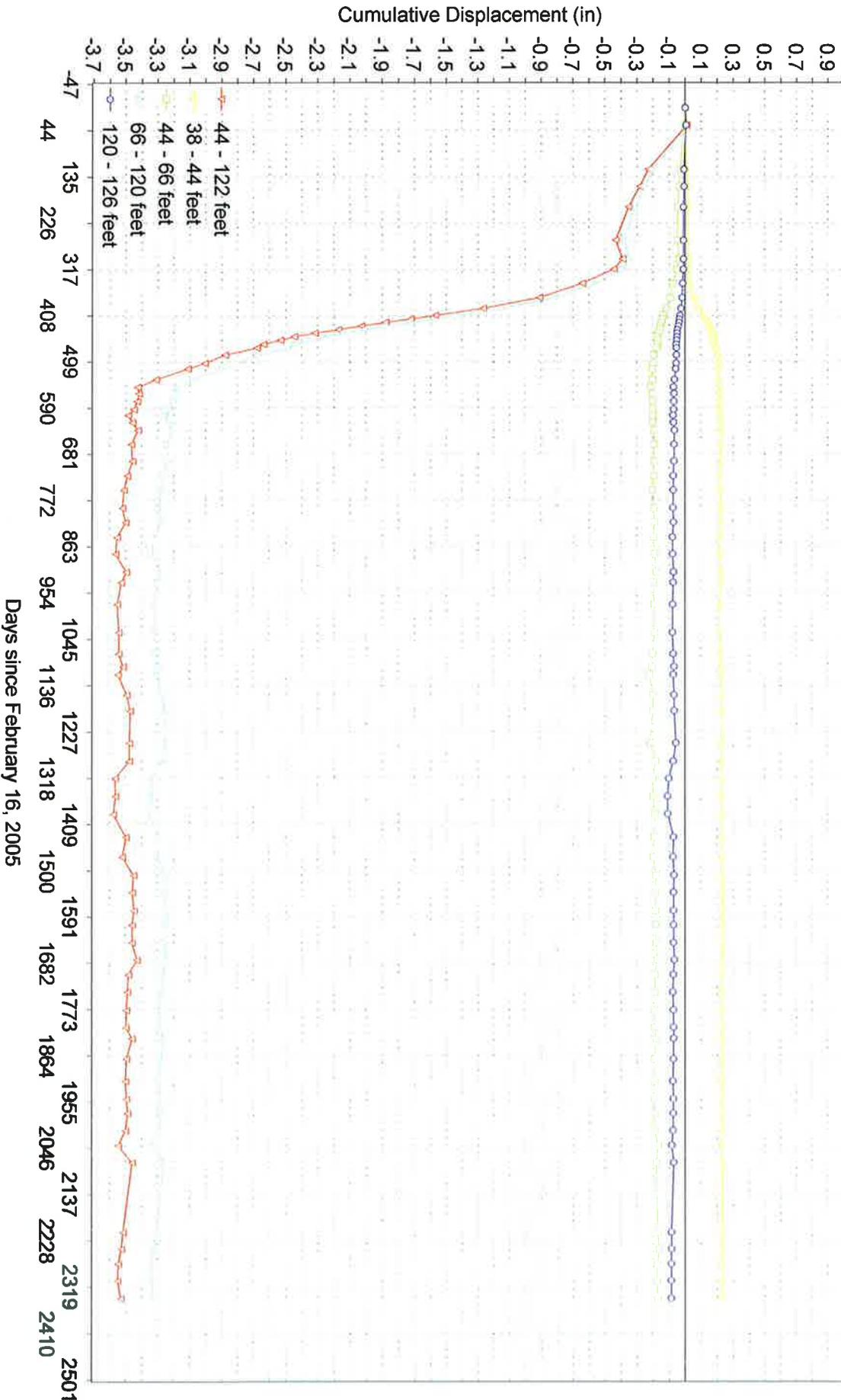
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

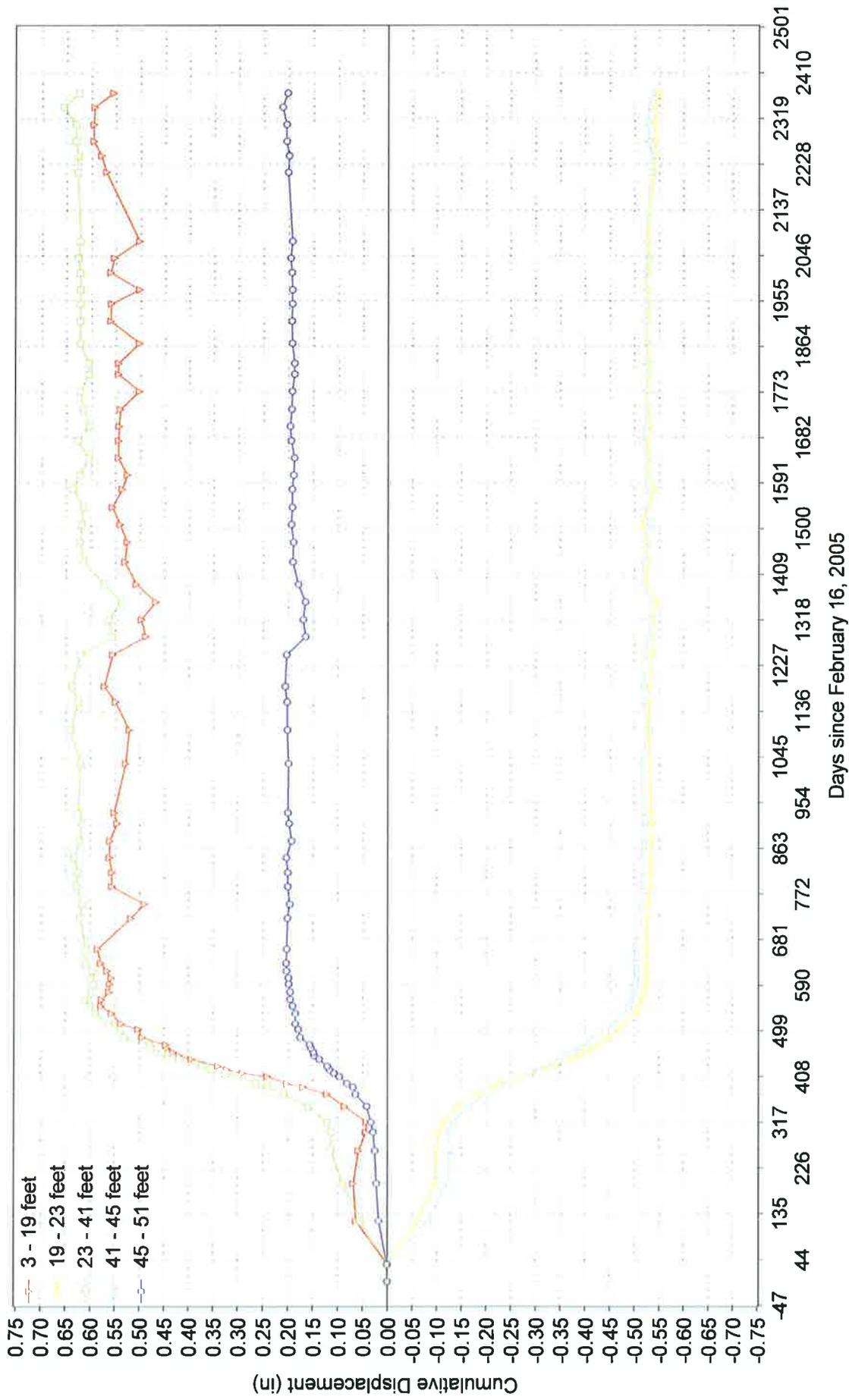
GRASSY 2A, A-Axis, -15 degree skew



Inclinometer I-2 Located on Dam 8/14/11  
with -15 degree skew

Figure  
Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis

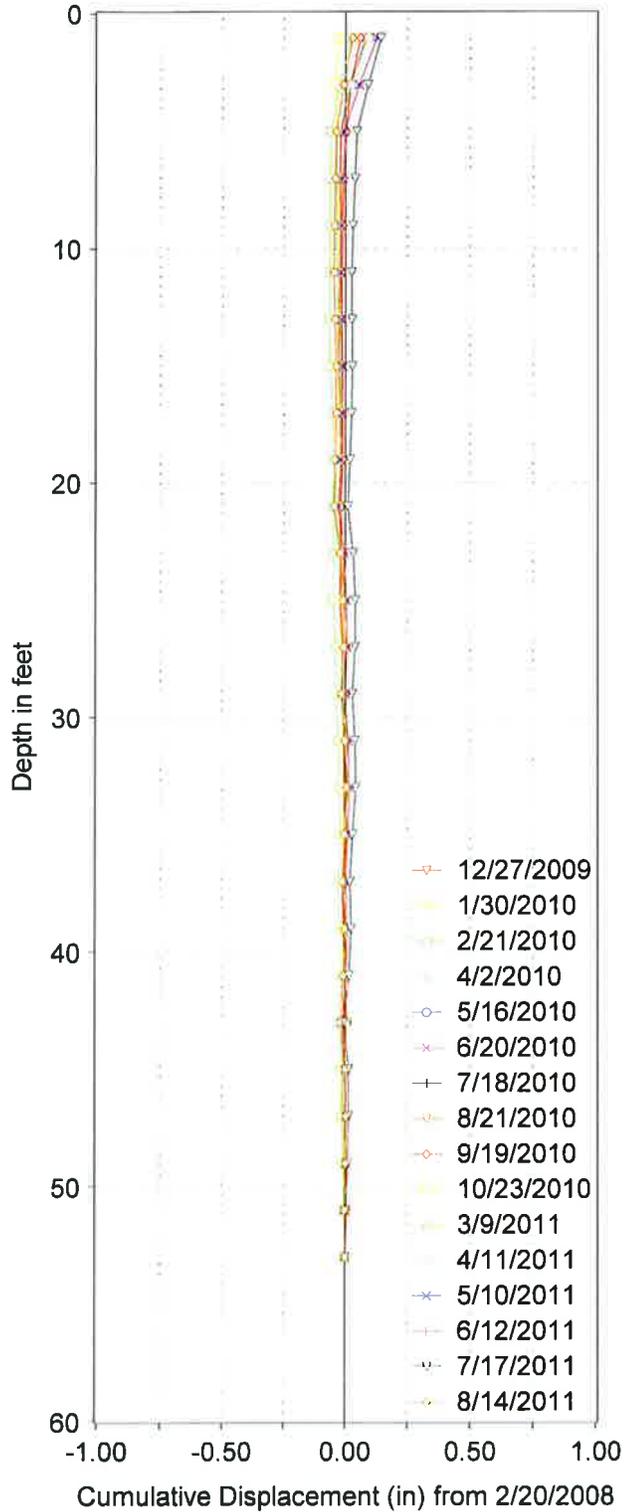


I-3 West/Right Abutment 08/14/11

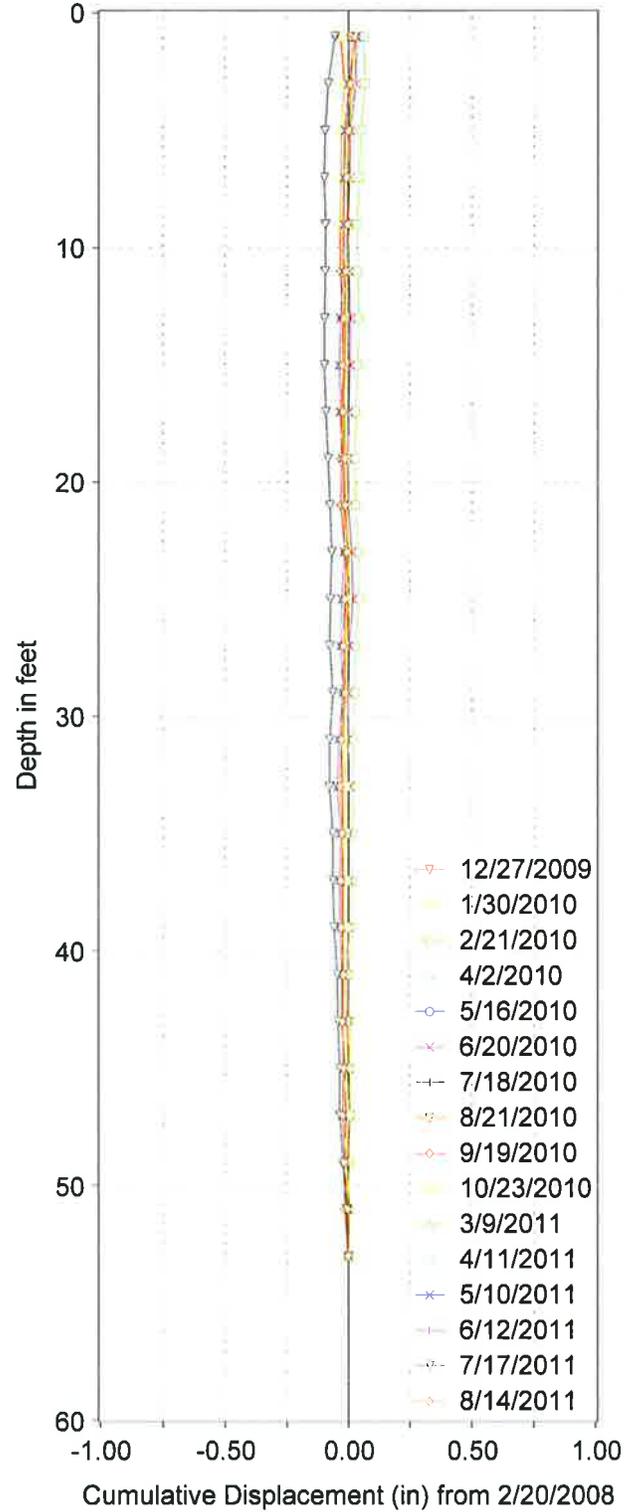
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

Grassy Trail Dam, Seismic Summary as of November 26, 2011.



A summary of UUSS (West Ridge Mine) MIS events for the past 35 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst. & by UUSS (unless noted otherwise) (No events recorded on Dam)	Horizontal Distance from Mining to	
			N. Hillside Inst (ft)	Dam (ft)
December 2008	34			
<b>January 2009</b>	47		N Hillside Inst is ~4,500 ft NW of Dam	
February <i>Change mining practice to Panel Barrier</i>	2			
March	1			
April	1			
May	1			
June	2			
July	0			
Aug	3			
Sept	1			
Oct	1			
Nov	1			
Dec	0			
<b>Jan 2010</b>	<b>0</b>			
Feb	0			
March	0			
April	1			
May	0			
June	0			
July	0	Most recent Magnitudes		
Aug	1	Mag 1.3		
Sept	2	Mag 1.2 & 0.4		
Oct	2	Mag 0.1 & 0.9		
Nov	0			
Dec	0			
<b>Jan 2011</b>	2	Mag 0.7& 1.0		
Feb	8	Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0		
March	4	Mag 1.0, 0.2, 0.8, 0.8	2,050	6,600
April	0		7,000	11,600
May	7	Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	5,800	10,400
June	36 events	Mag Avg 1.2, Min 0, Max 2.0	4,900	9,500
July	35 events	Mag Avg 0.8, Min 0.0, Max 1.9	3,900	8,500
Aug	24 events	Mag Avg 0.3, Min 0.0, Max 1.4	3,100	7,600
Sept	9 events	Mag Avg 1.0, Min 0.3, Max 1.9	2,300	6,900
Oct	24 events	Mag Avg 0.3, Min 0.0, Max 0.5	5,700	10,200
Nov as 11/26/11	35 events	Mag Avg 1.3, Min 0.5, Max 1.	4,900	9,400

No MIS events were recorded on the seismic instrument on the Dam. The Hillside instrument was moved further north last year to the mouth of Graveyard Canyon up the Left Fork of Whitmore Canyon. The North Hillside instrument is now closer to the area of active mining and is about 0.88 miles northwest of the dam. As shown on the table above, no seismic events were reported in the area by the University of Utah (UUSS) in April 2011. During May the number of events began to

increase, with as many as 36 reported during June and 35 events in July and November. The overall magnitude of some of the events also appears to have increased. It appears that only events with an earthquake magnitude of 1.4 or greater have been recorded on the North Hillside instrument. During the latter part of July and during August Earthquake magnitudes were less than 1.0 and no events were recorded on the Hillside Instruments. A Table is attached showing the events recorded on the North Hillside instrument, along with the earthquake magnitudes reported by the UUSS. This Table also shows the recorded triaxle, velocity (in/s), acceleration (g), and frequency (Hz) of each event. The largest (MIS) earthquake magnitude reported was 2.0. However, the largest acceleration and velocity recorded was 0.066 g and 0.205 in/s from a 1.9 magnitude event (July 14). A total of 40 events were recorded on the North Hillside instrument with 25 reported as earthquakes/MIS by the UUSS. A Table summarizing this events between May to November is attached.

Inclinometer readings were taken in I-2 and I-3. I-4 was buried under mud from the sliding of surficial deposits from the slope above the Inclinometer. Inclinometers readings have not shown any notable movement.

Since the middle on May to Aug 14<sup>th</sup> the reservoir has been generally at or overtopping the spillway. The highest reservoir level I recorded was 5.5 inches over the spillway in June. This is the highest water level we have recorded since more detailed monitoring began in 2005.

A chart showing the seepage readings is attached. It may be noted since May 2009, seepage from the left abutment drain appears to be gradually decreasing. The cause for this decrease is not known, but the collector pipe may be plugging off. We feel that the piezometer readings particularly on the left abutment should be watched closely for any erratic changes.

Reservoir and seepage readings are summarized on the attached Table and graphs.

During this site visits no signs of landslide movement were noted on the hillsides above the dam. It should be noted that due to the wet winter and spring there are a few small slides showing up along the upslope side of the road cut west of the reservoir and a small side above the road cut just north of the reservoir. These slides appear surficial and do not show any movement within the roadway.

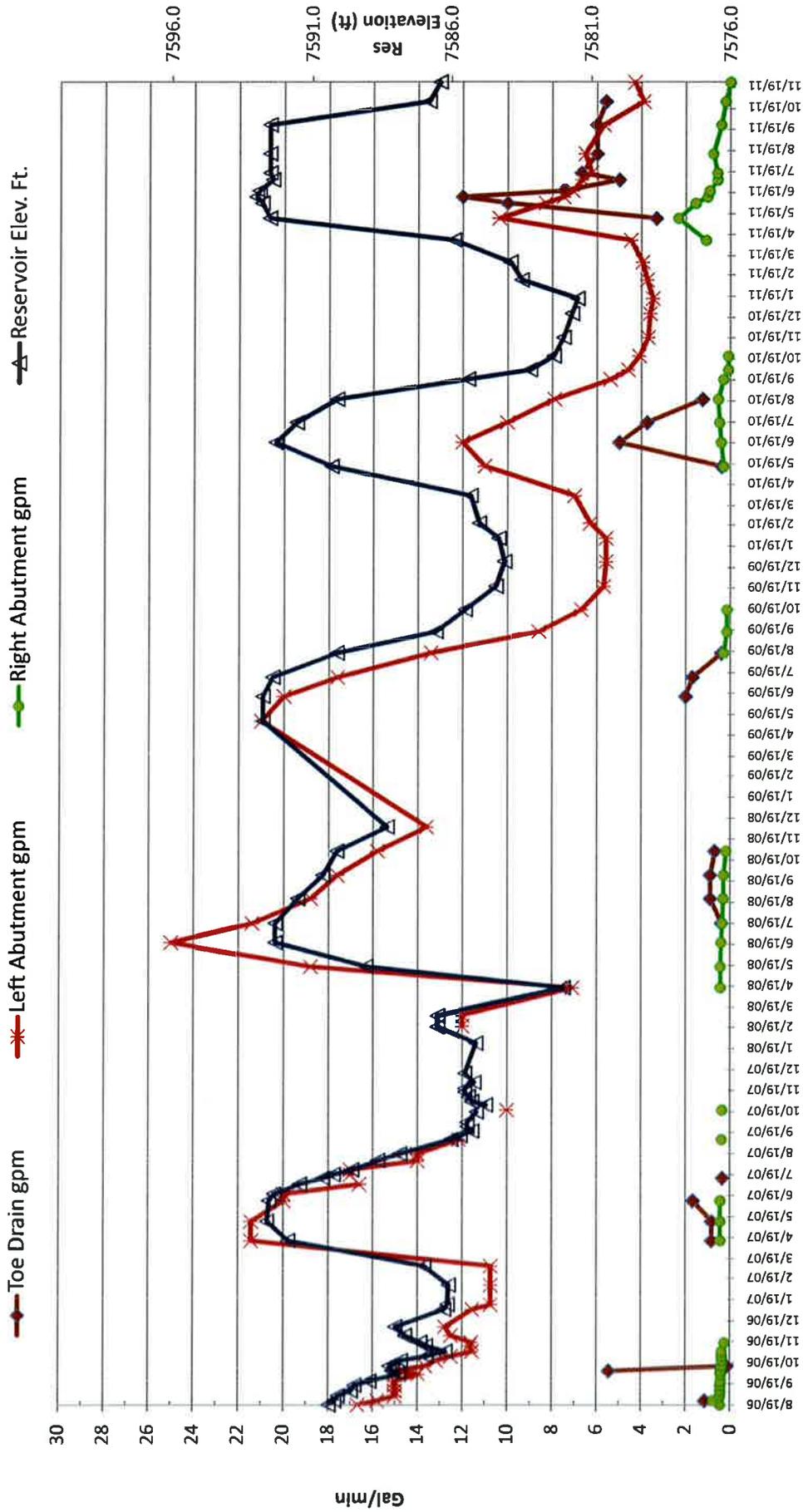
  
Michael N. Hansen P.G.

Engineering Geologist  
RB&G ENGINEERING Inc.

## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0			Seep1: Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5								
Seep Location:										
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	
	Neg = above spillway									
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear	
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen	
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen	
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen	
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen	
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen	
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear	
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear	
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear	
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear	
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear	
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear	
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear	
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen	
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen	
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen	
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen	
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen	
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt	
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear	
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear	
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear	
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear	
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear	
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear	

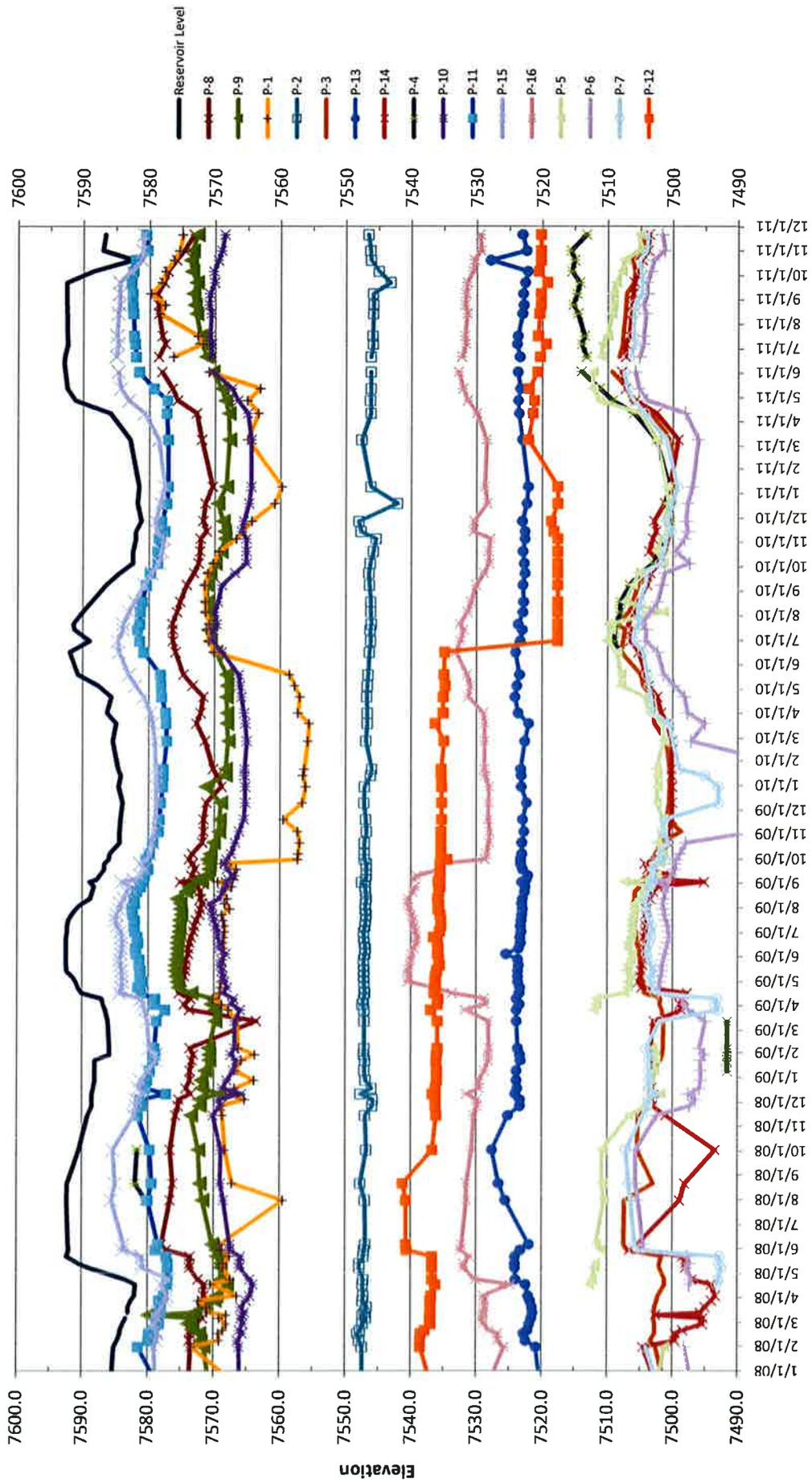
# Grassy Trail Dam Seepage Monitoring



**FIGURE** Seepage Monitoring Readings  
**Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 11/26/11**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH



# Grassy Trail Dam Piezometer Readings



**Figure** Reservoir Elevation and Piezometer Readings

From 1/1/08 to 11/26/11 (some data taken from Division of Natural Resources, Water Rights, Dam Safety web site)

GRASSY TRAIL DAM - CARBON COUNTY, UTAH

\* NOTE - spikes are likely errors in data (some very large spikes have been removed)  
**P-12 repaired Jan 2011**

Grassy Trail Reservoir - May to November 2011 - Period of increased Seismic Activity with accompanying Earthquake Magnitudes

Event Report: List\_May\_Nov 2011

Minimate Accelerometer

Note: none of these events were recorded on the Dam

MIS event Recorded at UUSS

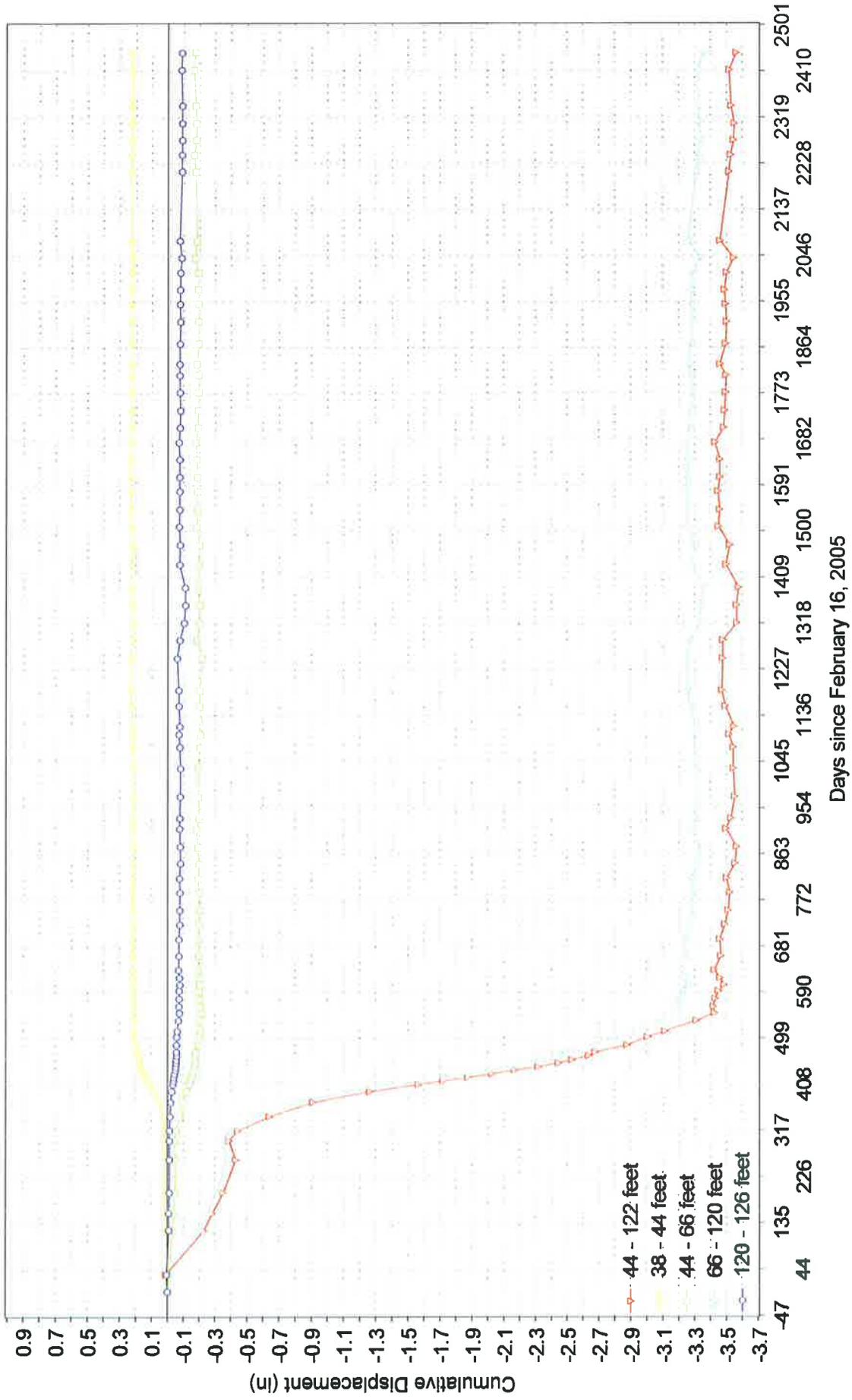
Date	Time	Trigger	Velocity			Acceleration			Frequency			Description	Post Event Note	
			Tran Peak (in/s)	Peak (in/s)	Long Peak (in/s)	Tran Accel (g)	Vert Accel (g)	Long Accel (g)	Tran Freq. Hz.	Vert Freq. Hz.	Long Freq. Hz.			
27-May-11	0:41:20	Long	0.105	0.02	0.07	0.027	0.027	0.027	0.027	14.6	16.5	16.5	N HillSide Inst	EQ Mag 1.5
28-May-11	5:37:02	Long	0.15	0.03	0.085	0.040	0.027	0.027	0.027	12.2	13.5	12.2	N HillSide Inst	EQ Mag 1.7
30-May-11	16:01:23	Tran	0.19	0.04	0.1	0.053	0.027	0.027	0.027	13.8	15.1	12.2	N HillSide Inst	EQ Mag 1.9
4-Jun-11	15:33:55	Tran	0.07	0.035	0.05	0.040	0.027	0.027	0.027	11.9	12.8	15.5	N HillSide Inst	EQ Mag 1.7
12-Jun-11	6:38:39	Long	0.13	0.035	0.085	0.040	0.027	0.027	0.027	13.5	16	14.2	N HillSide Inst	EQ Mag 2.0
13-Jun-11	5:39:54	Long	0.155	0.045	0.125	0.040	0.027	0.027	0.027	12.8	10.9	12.8	N HillSide Inst	EQ Mag 1.8
13-Jun-11	21:05:51	Long	0.12	0.04	0.105	0.040	0.027	0.027	0.027	13.5	10.9	13.5	N HillSide Inst	EQ Mag 1.6
15-Jun-11	20:51:40	Long	0.1	0.04	0.1	0.027	0.027	0.027	0.027	13.8	14.6	14.2	N HillSide Inst	EQ Mag 1.7
16-Jun-11	7:23:44	Long	0.045	0.02	0.045	0.027	0.027	0.027	0.027	14.6	15.1	16	N HillSide Inst	
16-Jun-11	21:20:52	Tran	0.065	0.02	0.035	0.027	0.027	0.027	0.027	16	16.5	16.5	N HillSide Inst	
17-Jun-11	21:00:12	Long	0.06	0.02	0.045	0.027	0.027	0.027	0.027	14.6	16	13.5	N HillSide Inst	EQ Mag 1.4
17-Jun-11	23:58:14	Long	0.13	0.04	0.105	0.040	0.027	0.040	0.040	14.6	15.5	15.1	N HillSide Inst	EQ Mag 1.6
18-Jun-11	11:46:04	Long	0.09	0.03	0.095	0.027	0.013	0.027	0.027	14.6	12.2	14.2	N HillSide Inst	EQ Mag 1.8
19-Jun-11	2:11:17	Long	0.155	0.045	0.15	0.040	0.027	0.040	0.040	13.5	11.1	13.8	N HillSide Inst	EQ Mag 1.7
20-Jun-11	16:57:33	Tran	0.06	0.02	0.055	0.027	0.027	0.027	0.027	16	15.1	16.5	N HillSide Inst	EQ Mag 1.7
20-Jun-11	21:39:53	Tran	0.045	0.015	0.035	0.027	0.013	0.027	0.027	15.5	19	15.1	N HillSide Inst	
21-Jun-11	20:30:14	Long	0.085	0.03	0.095	0.027	0.027	0.027	0.027	14.2	16	13.5	N HillSide Inst	EQ Mag 1.6
22-Jun-11	1:11:46	Long	0.11	0.03	0.095	0.040	0.013	0.027	0.027	15.5	17.7	14.2	N HillSide Inst	
22-Jun-11	1:45:32	Long	0.04	0.015	0.05	0.027	0.013	0.027	0.027	19	36.6	21.3	N HillSide Inst	
22-Jun-11	18:47:13	Long	0.08	0.025	0.07	0.027	0.013	0.027	0.027	14.6	23.3	18.3	N HillSide Inst	EQ Mag 1.6
23-Jun-11	16:36:59	Long	0.08	0.025	0.07	0.040	0.027	0.027	0.027	15.1	21.3	14.6	N HillSide Inst	
25-Jun-11	5:35:46	Long	0.045	0.015	0.05	0.027	0.013	0.027	0.027	18.3	21.3	14.6	N HillSide Inst	
28-Jun-11	1:33:03	Tran	0.055	0.015	0.045	0.027	0.027	0.027	0.027	19.7	28.4	17.7	N HillSide Inst	
28-Jun-11	12:26:30	Long	0.06	0.02	0.055	0.027	0.027	0.027	0.027	18.3	23.3	16.5	N HillSide Inst	
28-Jun-11	23:11:39	Tran	0.055	0.02	0.045	0.027	0.013	0.013	0.013	14.2	17.1	13.1	N HillSide Inst	
29-Jun-11	12:46:39	Tran	0.06	0.02	0.045	0.027	0.013	0.027	0.027	15.5	25.6	18.3	N HillSide Inst	
29-Jun-11	22:15:48	Tran	0.055	0.015	0.055	0.027	0.013	0.027	0.027	19	25.6	16	N HillSide Inst	
30-Jun-11	18:01:06	Long	0.065	0.02	0.07	0.027	0.013	0.027	0.027	17.7	19	16	N HillSide Inst	EQ Mag 1.5
1-Jul-11	7:52:02	Long	0.125	0.035	0.135	0.040	0.013	0.040	0.040	16.5	17.1	15.1	N HillSide Inst	EQ Mag 1.6
1-Jul-11	16:52:17	Long	0.115	0.03	0.13	0.040	0.027	0.040	0.040	15.1	19	15.1	N HillSide Inst	EQ Mag 1.8
2-Jul-11	3:25:38	Long	0.095	0.025	0.095	0.027	0.013	0.027	0.027	16.5	17.7	14.2	N HillSide Inst	EQ Mag 1.7
2-Jul-11	23:18:50	Long	0.11	0.035	0.115	0.040	0.027	0.040	0.040	13.8	19.7	16.5	N HillSide Inst	EQ Mag 1.6
4-Jul-11	5:44:05	Long	0.12	0.035	0.15	0.040	0.027	0.040	0.040	12.8	18.3	13.5	N HillSide Inst	EQ Mag 1.7
5-Jul-11	3:18:00	Tran	0.05	0.015	0.045	0.027	0.013	0.027	0.027	15.1	32	17.7	N HillSide Inst	EQ Mag 1.6
6-Jul-11	6:05:36	Long	0.1	0.025	0.11	0.027	0.027	0.040	0.040	14.2	22.3	16	N HillSide Inst	EQ Mag 1.5
7-Jul-11	1:23:27	Tran	0.05	0.02	0.05	0.027	0.013	0.027	0.027	15.1	26.9	16.5	N HillSide Inst	EQ Mag 1.6
9-Jul-11	23:09:23	Long	0.135	0.03	0.13	0.040	0.027	0.040	0.040	17.1	19.7	15.1	N HillSide Inst	
11-Jul-11	1:28:22	Long	0.065	0.02	0.06	0.027	0.027	0.027	0.027	14.6	24.4	16.5	N HillSide Inst	
12-Jul-11	0:39:42	Long	0.085	0.02	0.08	0.027	0.013	0.027	0.027	15.1	22.3	15.5	N HillSide Inst	EQ Mag 1.4
14-Jul-11	13:02:20	Vert	<b>0.205</b>	<b>0.05</b>	<b>0.19</b>	<b>0.066</b>	<b>0.027</b>	<b>0.053</b>	<b>0.053</b>	13.8	19.7	14.6	N HillSide Inst	EQ Mag 1.9
14-Aug-11	12:04:05	Long	1.52	1.52	2.67	0.066	0.066	0.093	0.093	56.9	46.5	51.2	N HillSide Inst	
2-Sep-11	7:49:07	Tran	1.14	0.254	0.762	0.027	0.027	0.013	0.013	20.5	30.1	22.3	N HillSide Inst	
5-Sep-11	0:11:32	Tran	1.27	0.381	0.889	0.027	0.027	0.013	0.013	20.5	42.7	22.3	N HillSide Inst	
6-Sep-11	5:14:57	Tran	1.4	0.381	0.889	0.027	0.027	0.027	0.027	20.5	30.1	19	N HillSide Inst	
10-Sep-11	9:36:56	Tran	1.27	0.381	0.889	0.027	0.027	0.013	0.013	21.3	24.4	18.3	N HillSide Inst	
11-Sep-11	12:59:09	Tran	1.4	0.381	0.889	0.027	0.027	0.027	0.027	19.7	46.5	17.1	N HillSide Inst	
16-Sep-11	22:35:31	Tran	1.14	0.381	0.889	0.027	0.027	0.013	0.013	17.7	39.4	19	N HillSide Inst	

Grassy Trail Reservoir - May to November 2011 - Period of increased Seismic Activity with accompanying Earthquake Magnitudes

Event Report: List May\_Nov 2011

Date	Time	Trigger	Velocity			Acceleration			Frequency			Description	Post Event Note
			Tran Peak (in/s)	Vert Peak (in/s)	Long Peak (in/s)	Tran Accel (g)	Vert Accel (g)	Long Accel (g)	Tran Freq. Hz.	Vert Freq. Hz.	Long Freq. Hz.		
17-Sep-11	0:12:11	Tran	1.27	0.381	0.635	0.027	0.013	0.013	13.8	19.7	21.3	N HillSide Inst	
17-Sep-11	12:02:16	Tran	1.4	0.381	0.635	0.027	0.013	0.013	15.1	24.4	21.3	N HillSide Inst	
18-Sep-11	1:58:42	Tran	1.27	0.254	0.635	0.027	0.013	0.013	17.7	73.1	18.3	N HillSide Inst	
18-Sep-11	11:36:50	Tran	1.27	0.508	1.14	0.027	0.027	0.027	17.1	34.1	19	N HillSide Inst	
21-Sep-11	16:45:48	Long	1.4	0.508	1.27	0.027	0.013	0.027	18.3	30.1	19.7	N HillSide Inst	
21-Sep-11	21:34:53	Tran	2.16	0.508	1.4	0.040	0.013	0.027	18.3	32	19.7	N HillSide Inst	
23-Sep-11	3:28:59	Tran	1.14	0.381	0.635	0.027	0.013	0.013	17.7	23.3	19	N HillSide Inst	
23-Sep-11	13:07:25	Tran	1.27	0.508	0.889	0.027	0.013	0.027	19	34.1	20.5	N HillSide Inst	
24-Sep-11	0:55:32	Tran	1.78	0.508	1.14	0.027	0.013	0.027	17.7	28.4	18.3	N HillSide Inst	
24-Sep-11	11:01:26	Tran	1.4	0.381	1.02	0.027	0.013	0.013	19	21.3	17.1	N HillSide Inst	
25-Sep-11	1:56:41	Tran	1.4	0.381	0.508	0.013	0.013	0.013	13.5	25.6	17.1	N HillSide Inst	
25-Sep-11	12:30:08	Vert	2.03	1.9	2.03	0.053	0.053	0.053	30.1	46.5	25.6	N HillSide Inst	
26-Sep-11	5:38:49	Tran	1.52	0.381	0.635	0.027	0.013	0.013	14.2	24.4	15.5	N HillSide Inst	
26-Sep-11	13:25:13	Tran	1.9	0.508	1.27	0.027	0.013	0.027	18.3	30.1	19.7	N HillSide Inst	
28-Sep-11	0:35:06	Tran	2.29	0.508	1.78	0.040	0.013	0.027	17.7	39.4	22.3	N HillSide Inst	
28-Sep-11	22:03:35	Tran	1.14	0.254	0.508	0.013	0.013	0.027	16	36.6	20.5	N HillSide Inst	
30-Sep-11	12:04:21	Tran	1.14	0.381	0.508	0.027	0.027	0.027	19	17.1	17.1	N HillSide Inst	
30-Sep-11	15:33:40	Tran	1.4	0.508	1.02	0.027	0.013	0.027	16	26.9	17.7	N HillSide Inst	
1-Oct-11	10:06:54	Tran	1.27	0.381	1.02	0.027	0.027	0.027	19	30.1	20.5	N HillSide Inst	
1-Oct-11	13:28:59	Tran	1.14	0.254	0.635	0.027	0.013	0.027	19	28.4	21.3	N HillSide Inst	
1-Oct-11	17:37:38	Tran	1.52	0.508	0.889	0.027	0.013	0.027	16	25.6	15.5	N HillSide Inst	
2-Oct-11	5:32:02	Tran	1.14	0.381	0.508	0.027	0.013	0.013	16.5	39.4	22.3	N HillSide Inst	
2-Oct-11	10:32:21	Tran	1.65	0.508	1.27	0.027	0.013	0.027	19	26.9	19.7	N HillSide Inst	
2-Oct-11	13:12:41	Tran	1.14	0.254	0.508	0.027	0.027	0.013	17.1	32	22.3	N HillSide Inst	
2-Oct-11	14:45:24	Tran	1.9	0.508	0.889	0.027	0.013	0.013	16	25.6	15.5	N HillSide Inst	
2-Oct-11	17:42:57	Tran	2.03	0.508	0.762	0.027	0.013	0.027	14.6	19.7	16	N HillSide Inst	
29-Oct-11	12:25:48	Vert	0.635	1.14	1.4	0.040	0.080	0.066	85.3	85.3	73.1	N HillSide Inst	
29-Oct-11	13:02:34	Vert	1.78	1.14	1.27	0.040	0.066	0.040	30.1	39.4	36.6	N HillSide Inst	
29-Oct-11	13:03:08	Vert	0.381	1.52	1.52	0.040	0.093	0.066	73.1	85.3	46.5	N HillSide Inst	
31-Oct-11	17:20:40	Tran	1.27	0.254	0.762	0.027	0.013	0.027	17.1	85.3	18.3	N HillSide Inst	
1-Nov-11	18:44:52	Tran	1.14	0.381	0.762	0.027	0.013	0.013	14.6	21.3	13.5	N HillSide Inst	
9-Nov-11	8:35:42	Tran	1.27	0.381	1.02	0.027	0.013	0.027	12.5	34.1	15.5	N HillSide Inst	? EQ Mag 1.6
15-Nov-11	7:09:03	Tran	2.16	0.381	1.27	0.027	0.013	0.027	13.1	39.4	15.1	N HillSide Inst	
Summary of Events with reported Eq magnitudes only													
<b>AVERAGE</b>			0.113	0.032	0.100	0.036	0.023	0.032	14.3	17.1	14.8	<b>AVERAGE 1.7</b>	
<b>MIN</b>			0.050	0.015	0.045	0.027	0.013	0.027	11.9	10.9	12.2	<b>MIN 1.4</b>	
<b>MAX</b>			<b>0.205</b>	<b>0.050</b>	<b>0.190</b>	<b>0.066</b>	<b>0.027</b>	<b>0.053</b>	17.1	32.0	18.3	<b>MAX 2.0</b>	
<b>MODE</b>			0.130	0.030	0.070	0.040	0.027	0.027	14.6	16.0	14.2	<b>MODE 1.7</b>	

GRASSY 2A, A-Axis, -15 degree skew



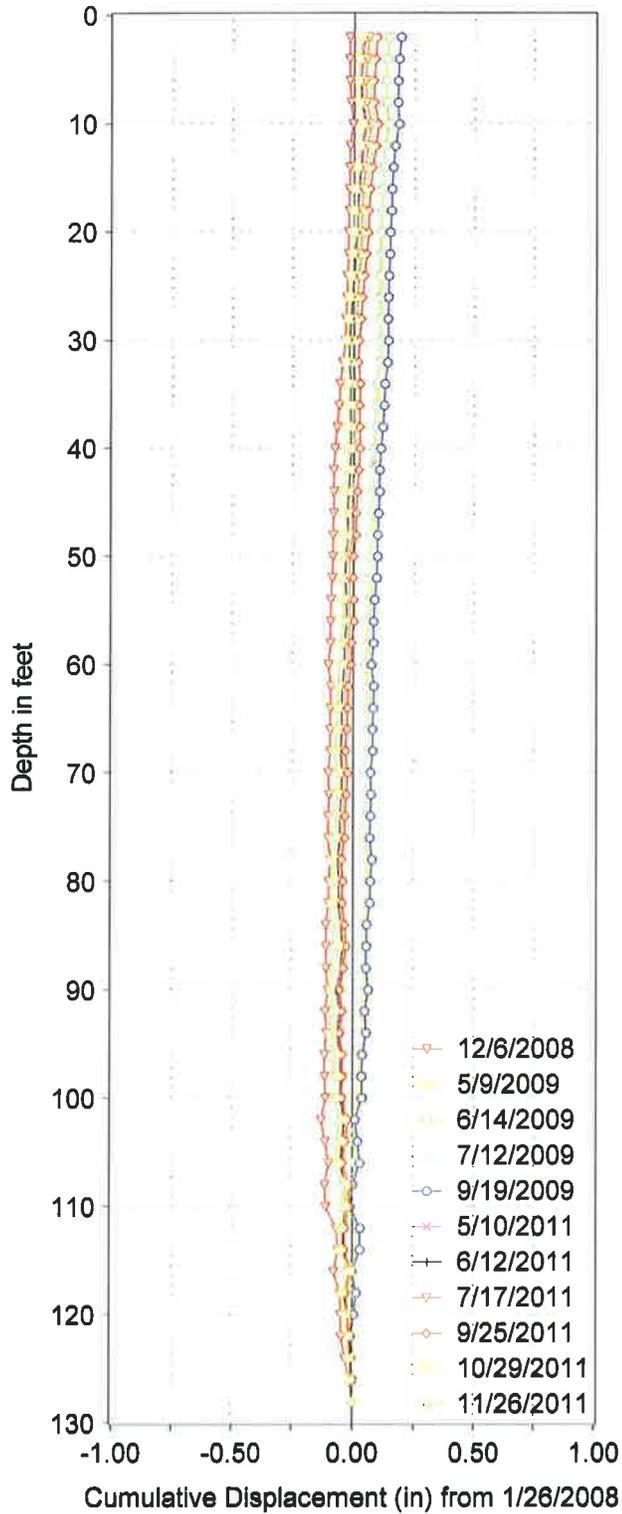
Inclinometer I-2 Located on Dam 11/26/11

with -15 degree skew

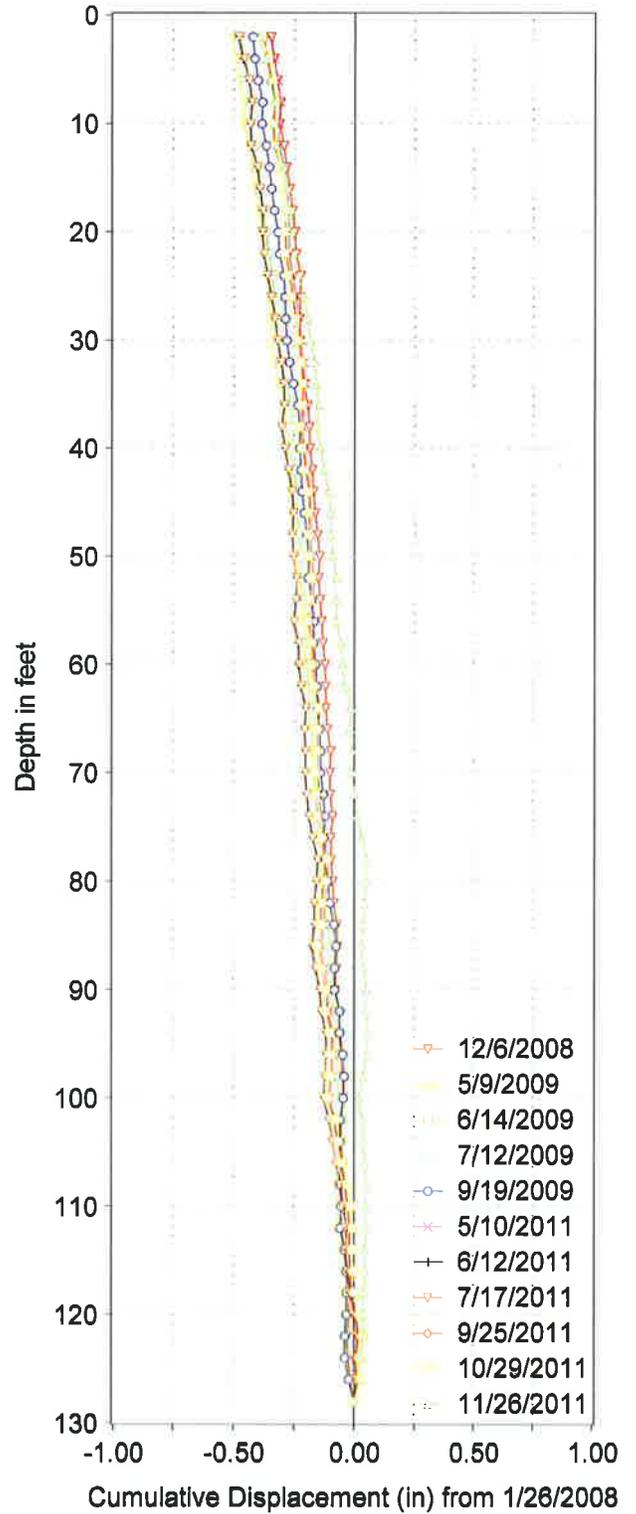
Figure

Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



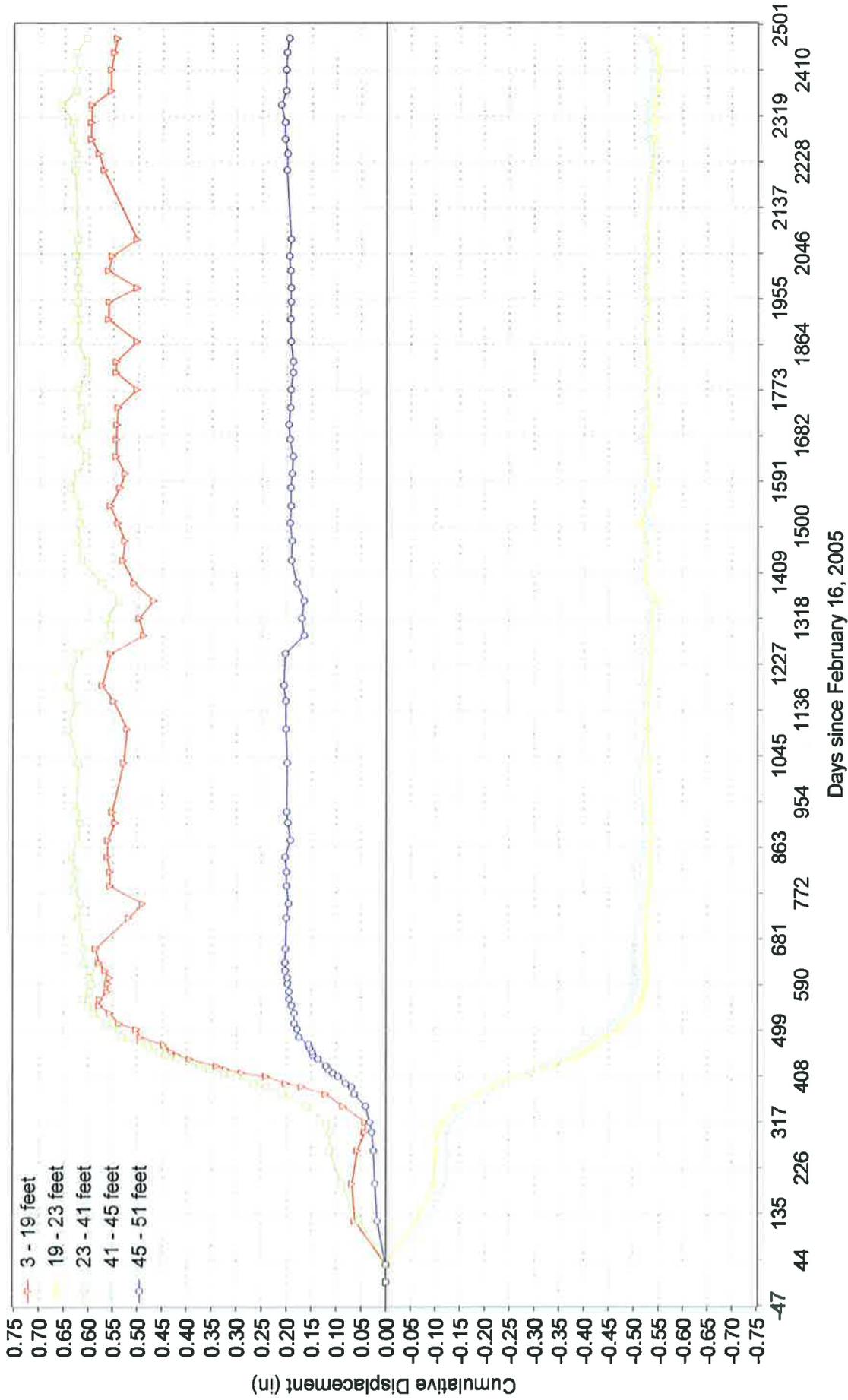
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY 3A, A-Axis

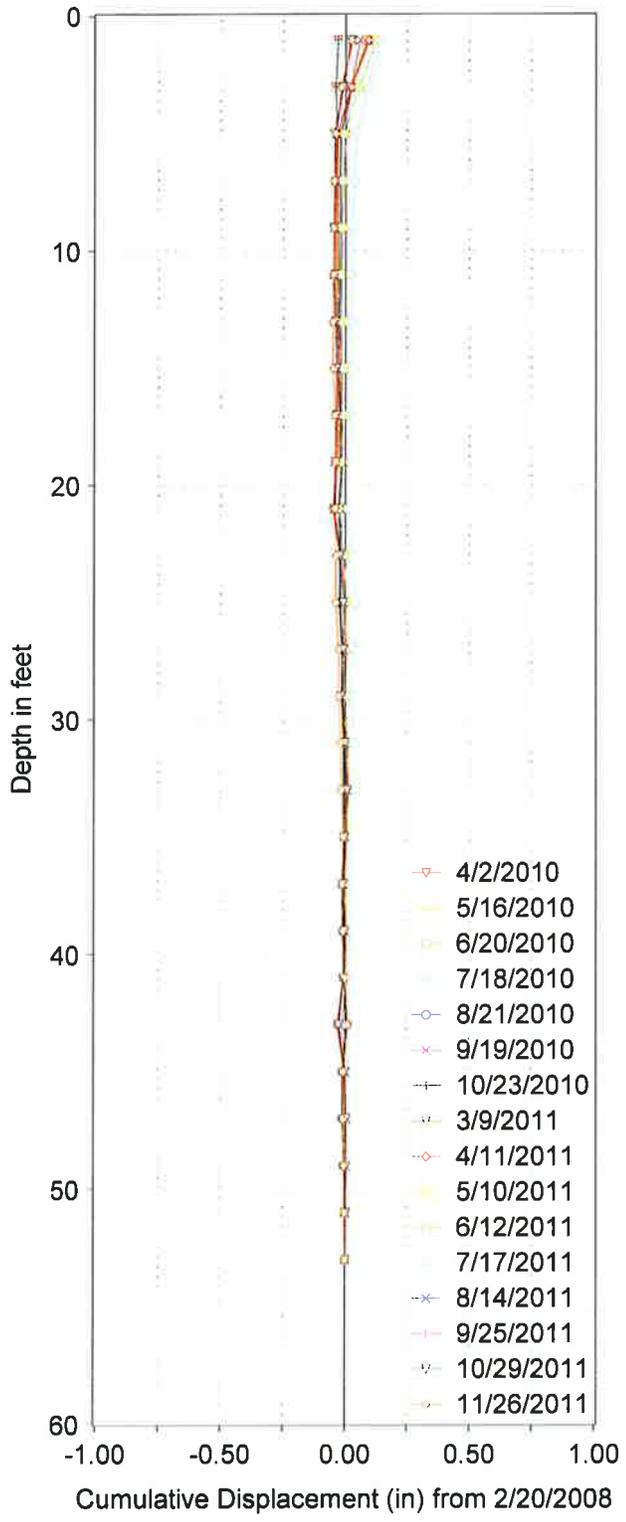


I-3 West/Right Abutment 11/26/11

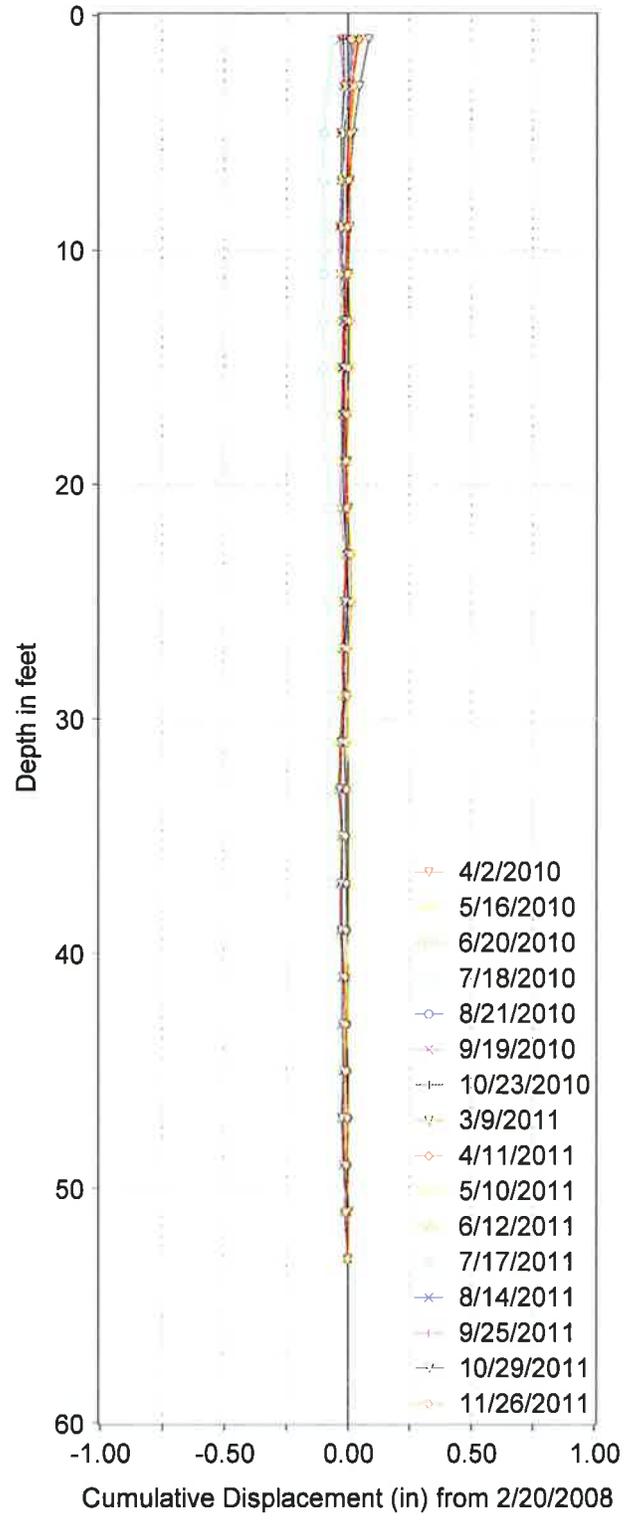
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

A summary of UUSS (West Ridge Mine) MIS events for the past 18 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst. (No events recorded on Dam)	Horizontal Distance from Mining to N. Hillside Inst. (ft)
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
<b>Jan 2011</b>	2 Mag 0.7 & 1.0	0	
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0	0	
March	4 Mag 1.0, 0.2, 0.8, 0.8	0	
April	0	0	
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
July	35 events Mag Avg 0.8, Min 0.0, Max 1.9	10	5,130 – 4,180 feet
Aug	24 events Mag Avg 0.3, Min 0.0, Max 1.4	0	
Sept	9 events Mag Avg 1.0, Min 0.3, Max 1.9		
Oct	24 events Mag Avg 0.3, Min 0.0, Max 0.5	6? events not recorded by UUSS	
Nov	46 events Mag Avg 1.4, Min 0.2, Max 1.9	1	
<b>Dec 2011</b>	35 events Mag Avg 1.2, Min 0.2, Max 1.8	5? events not recorded by UUSS	

Since November 26 there have been 46 Events reported by the UUSS. The maximum magnitude has been 1.9 with an average of 1.2. Some events have been recorded on the Hillside north of the dam which may be MIS event but were not reported by the UUSS as earthquakes/MIS events. No MIS events have been recorded by the seismic instrument on the Dam. It should be noted that none of the events reported by the UUSS were recorded on the Dam or Hillside instruments.

Inclinometer readings were taken in I-2 and I-3. Inclinometers readings have not shown any significant movement.

A chart showing the seepage readings is attached. Reservoir elevation and seepage readings are summarized on the attached Table. During site visits no signs of landslide movement were noted on the hillsides above the dam.

  
 Michael N. Hansen P.G.  
 Engineering Geologist  
 RB&G ENGINEERING Inc.

## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0			Seep1:Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5 <th colspan="2"></th> <th colspan="2"></th> <th colspan="2"></th> <th colspan="2"></th>								
Seep Location:										
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	
	Neg = above spillway									
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear	
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen	
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen	
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen	
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen	
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen	
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear	
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear	
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear	
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear	
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear	
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear	
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear	
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen	
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen	
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen	
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen	
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen	
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt	
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear	
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear	
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear	
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear	
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear	
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear	
8/14/11	-.02	7592.5	1/4" over	6	Clear	6.9	Clear	0.78	Clear	
9/25/11	-.01	7592.5	0.01' over	5.6	Clear	5.7	Clear	0.41	Clear	
10/29/11	5.7	7586.8	Not flowing over	Dry		3.9	Clear	0.22	Clear	
11/26/11	6.1	7586.4		Dry		4.3	Clear	0		
12/31/11	5.1	7587.4	Frozen	Dry		4	Clear	0	Frozen	

# Grassy Trail Dam Seepage Monitoring

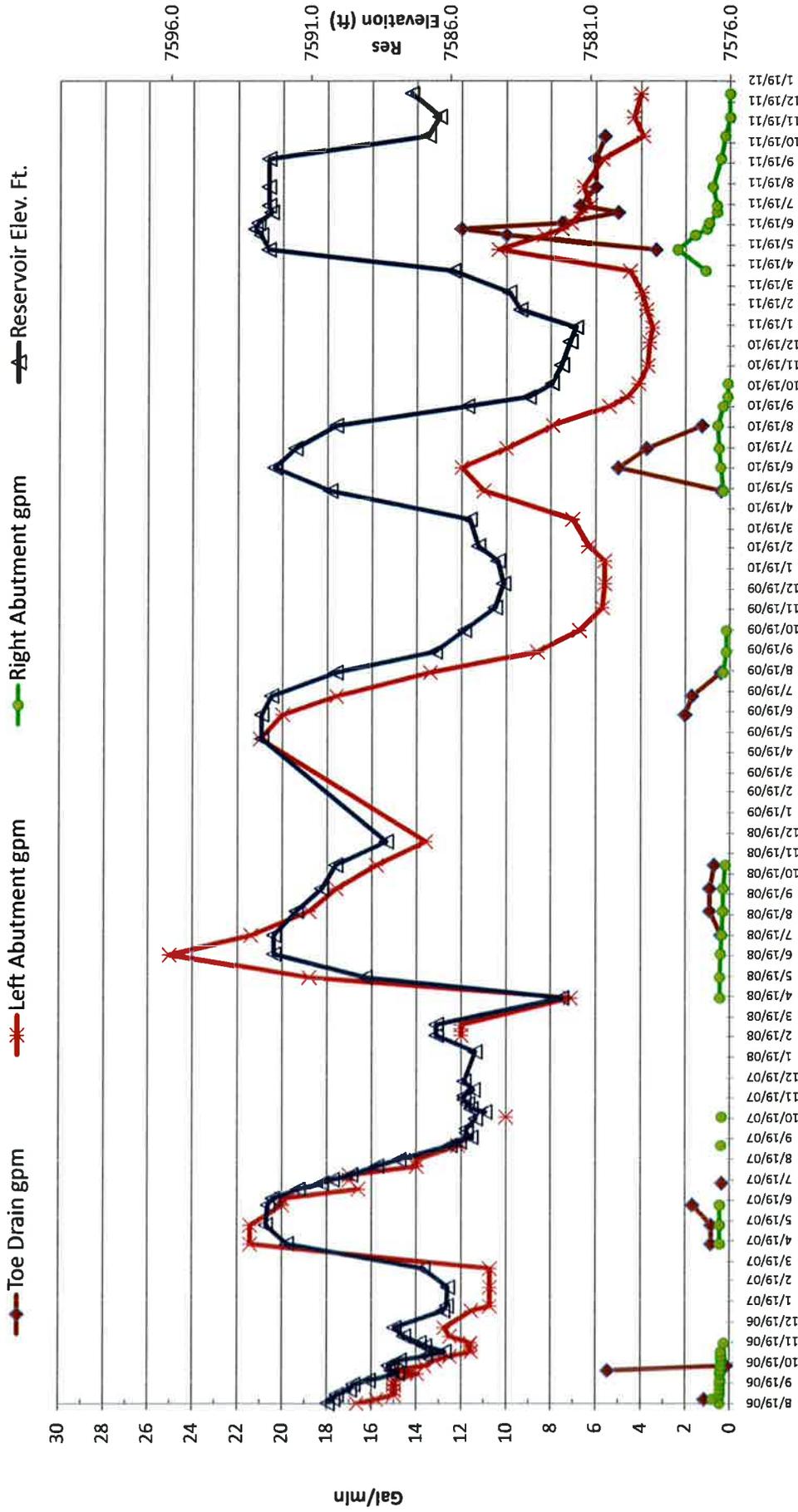
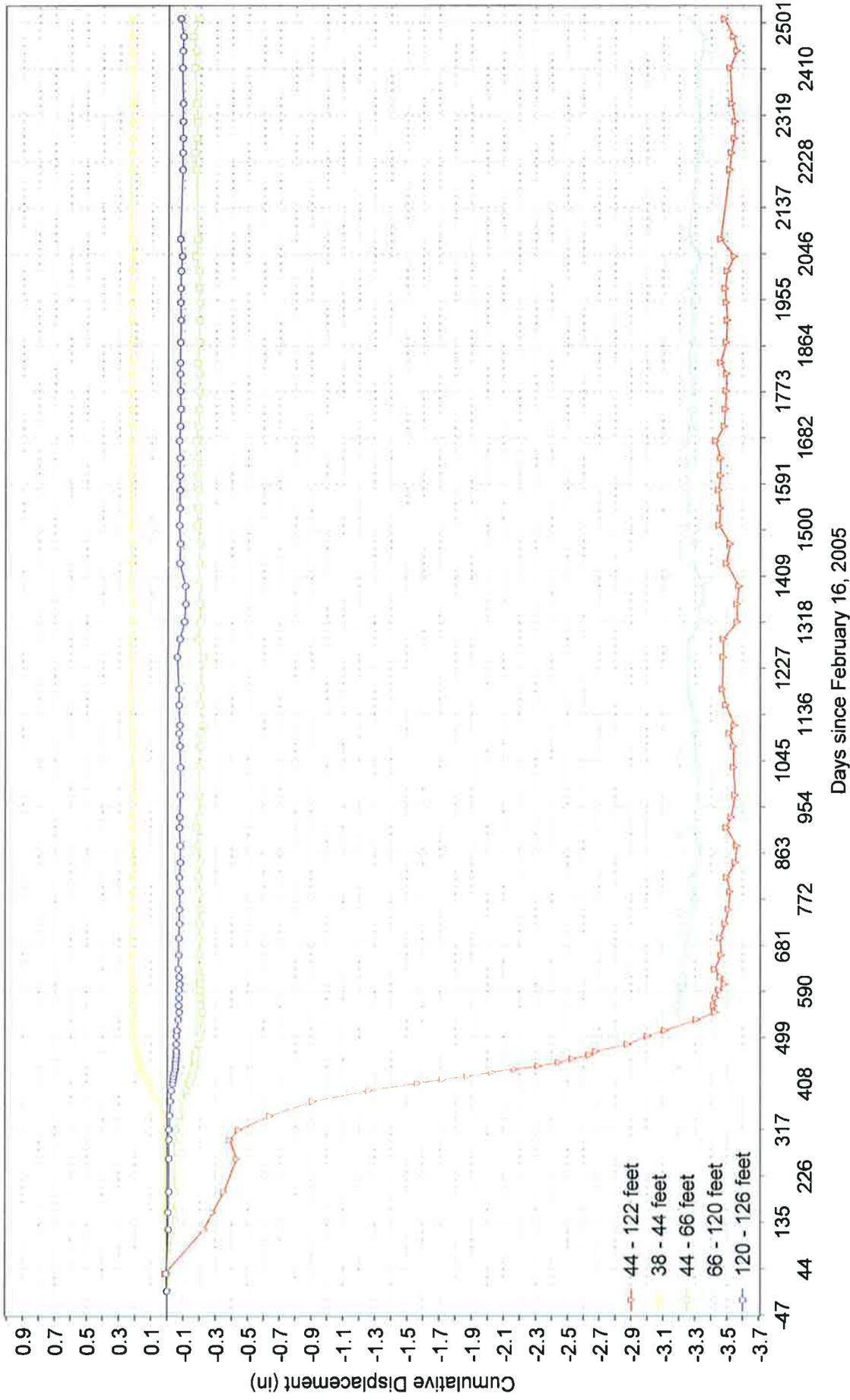


FIGURE Seepage Monitoring Readings

Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 12/31/11  
GRASSY TRAIL DAM - CARBON COUNTY, UTAH



GRASSY 2A, A-Axis, -15 degree skew



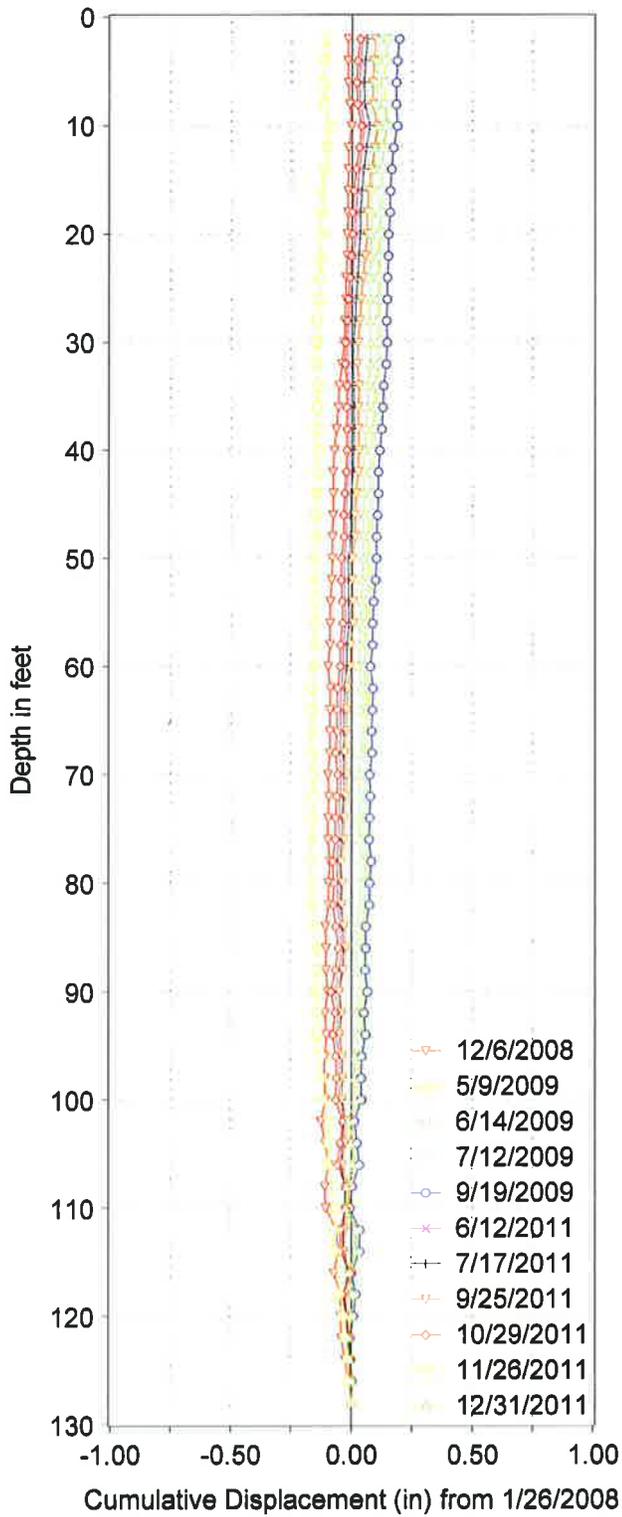
Inclinometer I-2 Located on Dam 12/31/11

with -15 degree skew

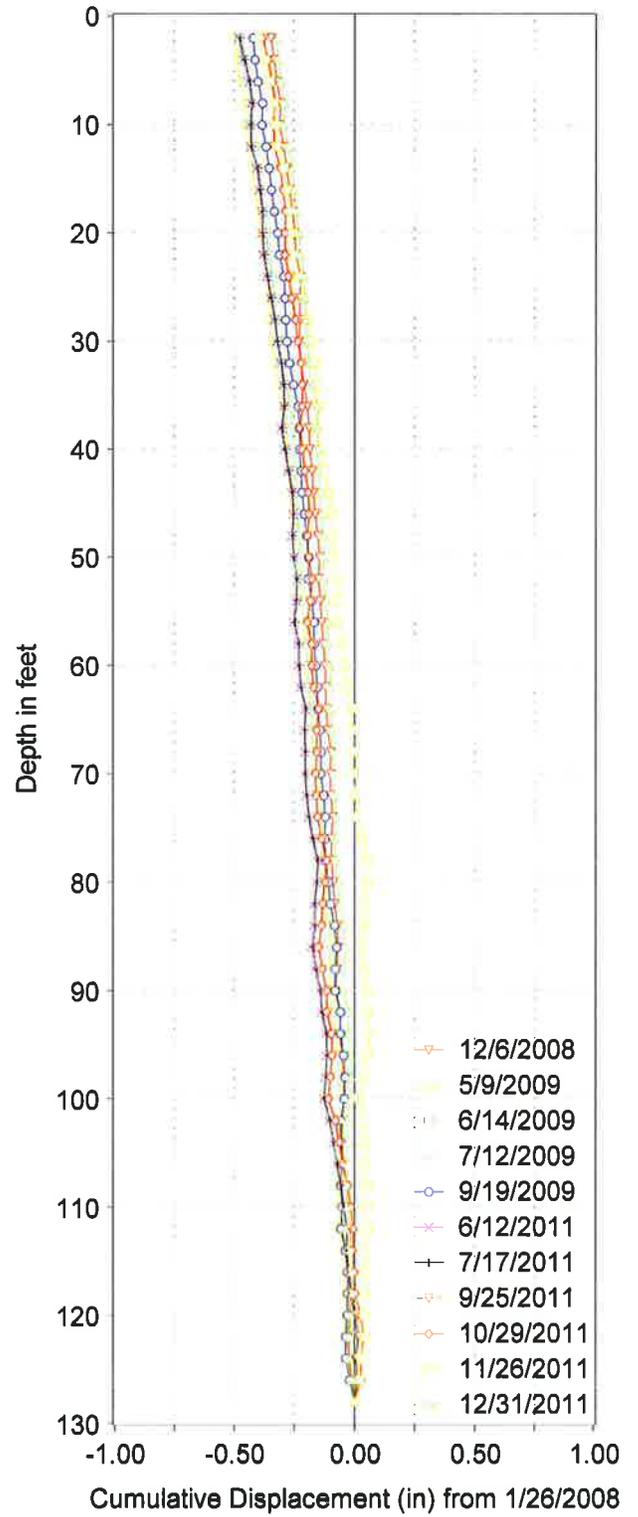
Figure

Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



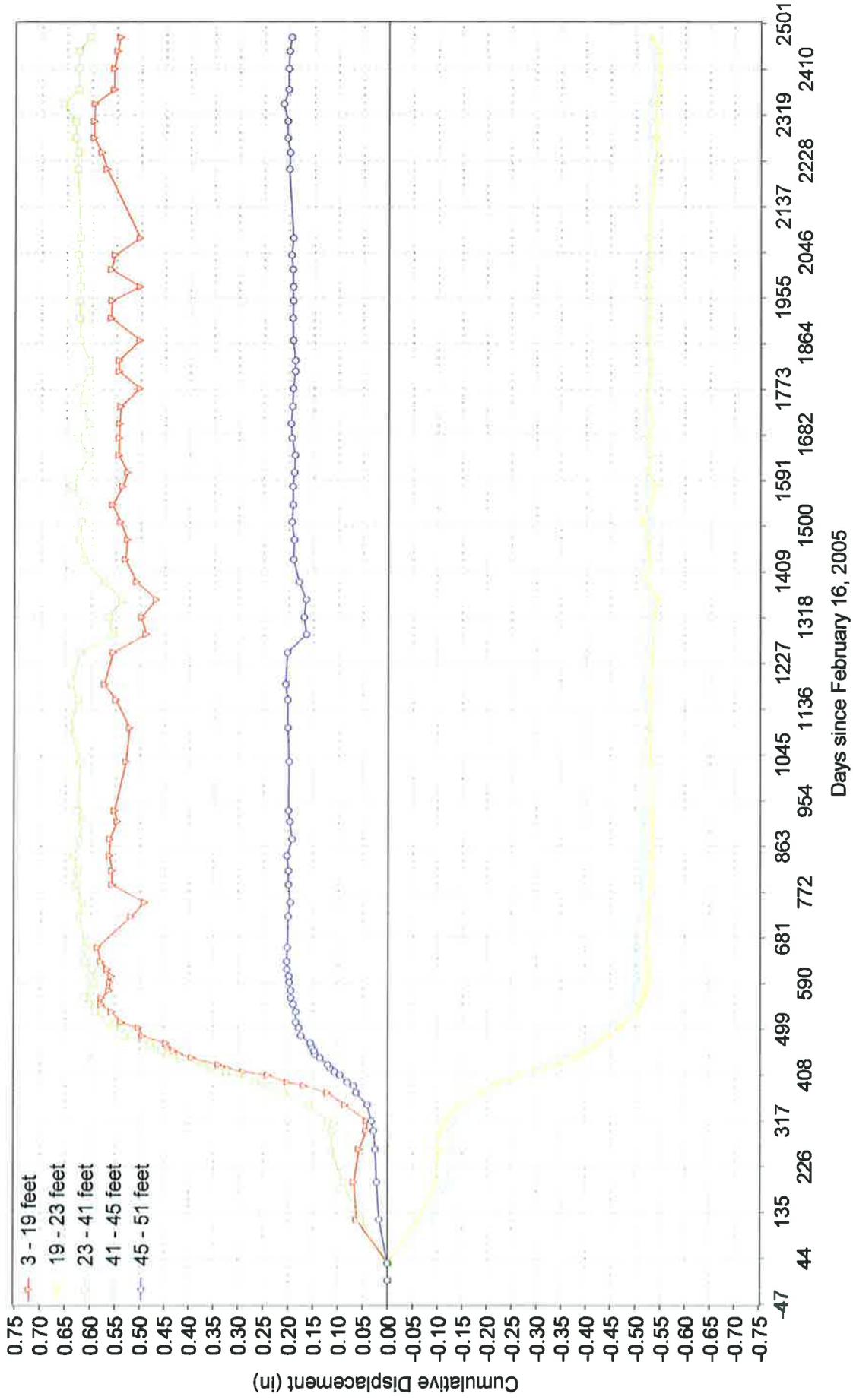
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY 3A, A-Axis

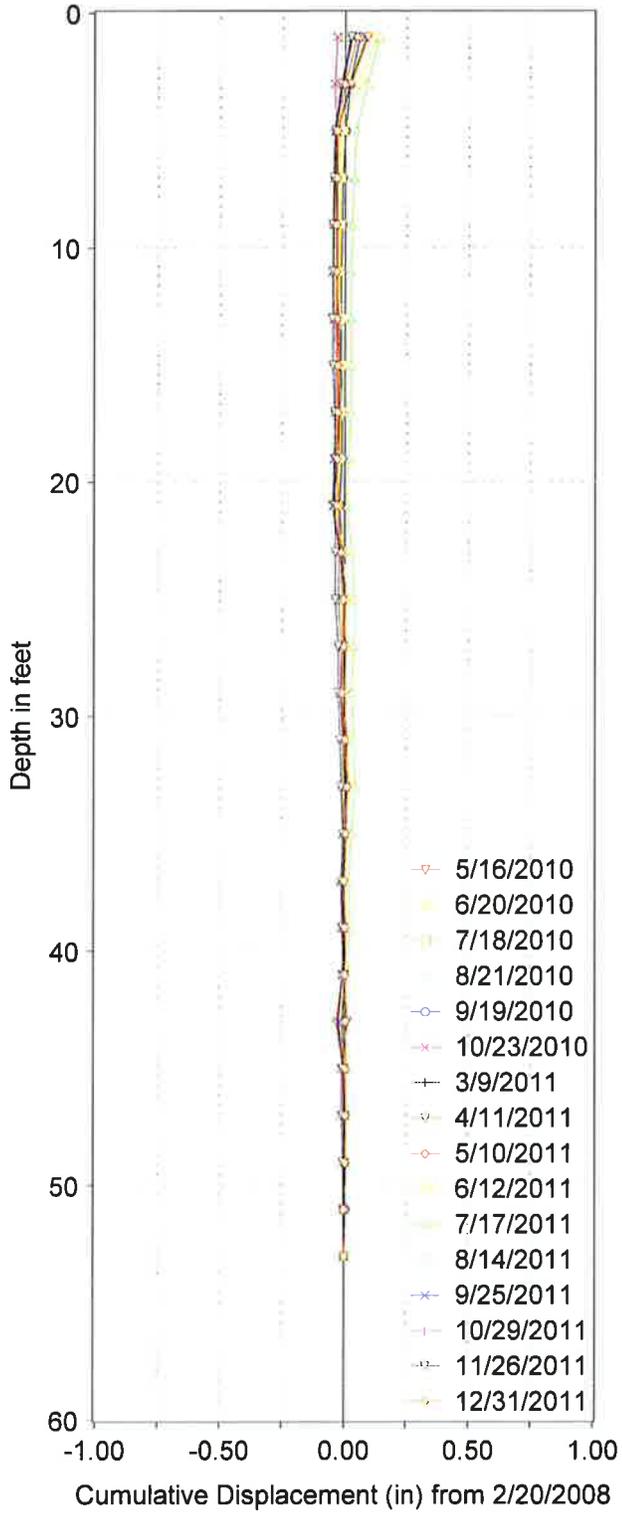


I-3 West/Right Abutment 12/31/11

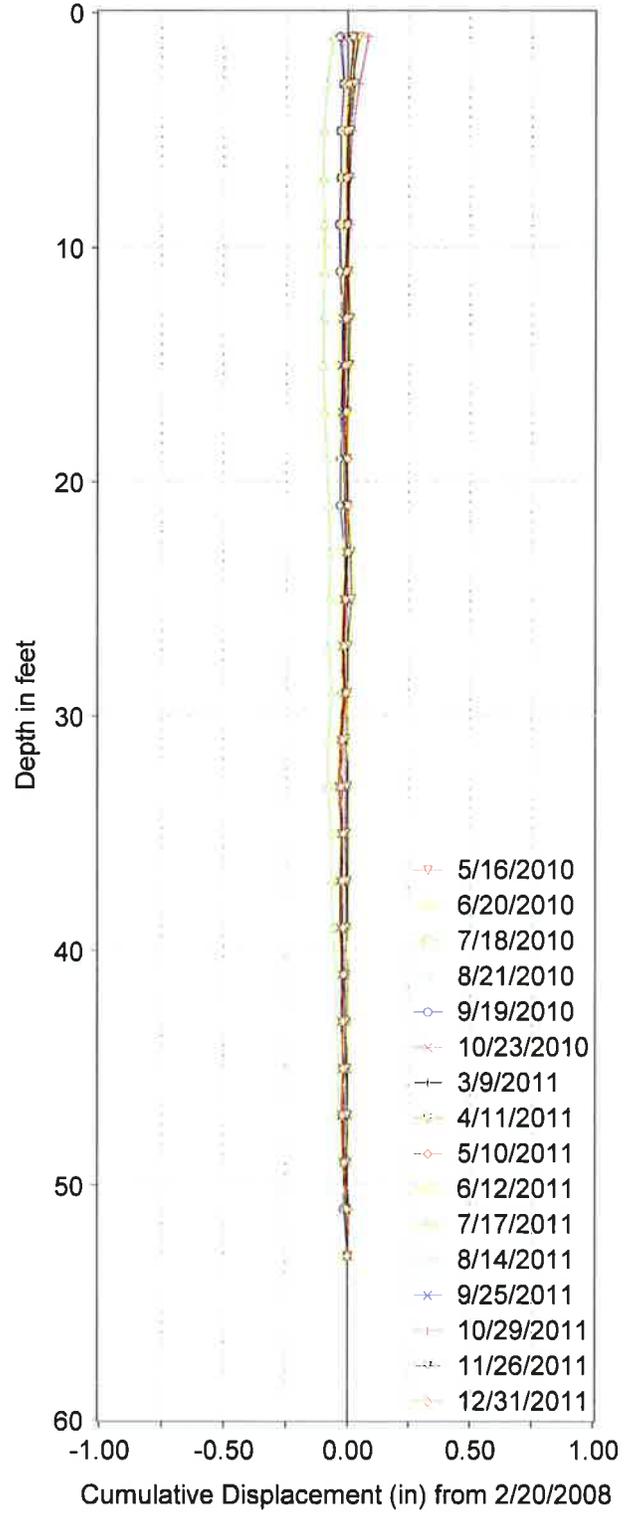
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

A summary of UUSS (West Ridge Mine) MIS events for the past 20 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst. & UUSS (unless noted otherwise) (No events recorded on Dam)	Horizontal Distance from Mining to N. Hillside Inst. (ft)
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
<b>Jan 2011</b>	2 Mag 0.7& 1.0	0	
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0	0	
March	4 Mag 1.0, 0.2, 0.8, 0.8	0	
April	0	0	
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
July	35 events Mag Avg 0.8, Min 0.0, Max 1.9	10	5,130 – 4,180 feet
Aug	24 events Mag Avg 0.3, Min 0.0, Max 1.4	0	
Sept	9 events Mag Avg 1.0, Min 0.3, Max 1.9		
Oct	24 events Mag Avg 0.3, Min 0.0, Max 0.5	6? events not recorded by UUSS	
Nov	46 events Mag Avg 1.4, Min 0.2, Max 1.9	1	
<b>Dec 2011</b>	35 events Mag Avg 1.2, Min 0.2, Max 1.8	5? events not recorded by UUSS	
<b>Jan 2012</b>	15 events Mag Avg 1.0, Min 0.1, Max 1.7		
Feb 26	4 events Mag Avg 1.65, Min 1.6, Max 1.7		

Since the first of the year there have been 19 Events reported by the UUSS. It should be noted that none of the events reported by the UUSS were recorded on the Dam or Hillside instruments.

Inclinometer readings were taken in I-2 and I-3 and show no significant signs of movement.

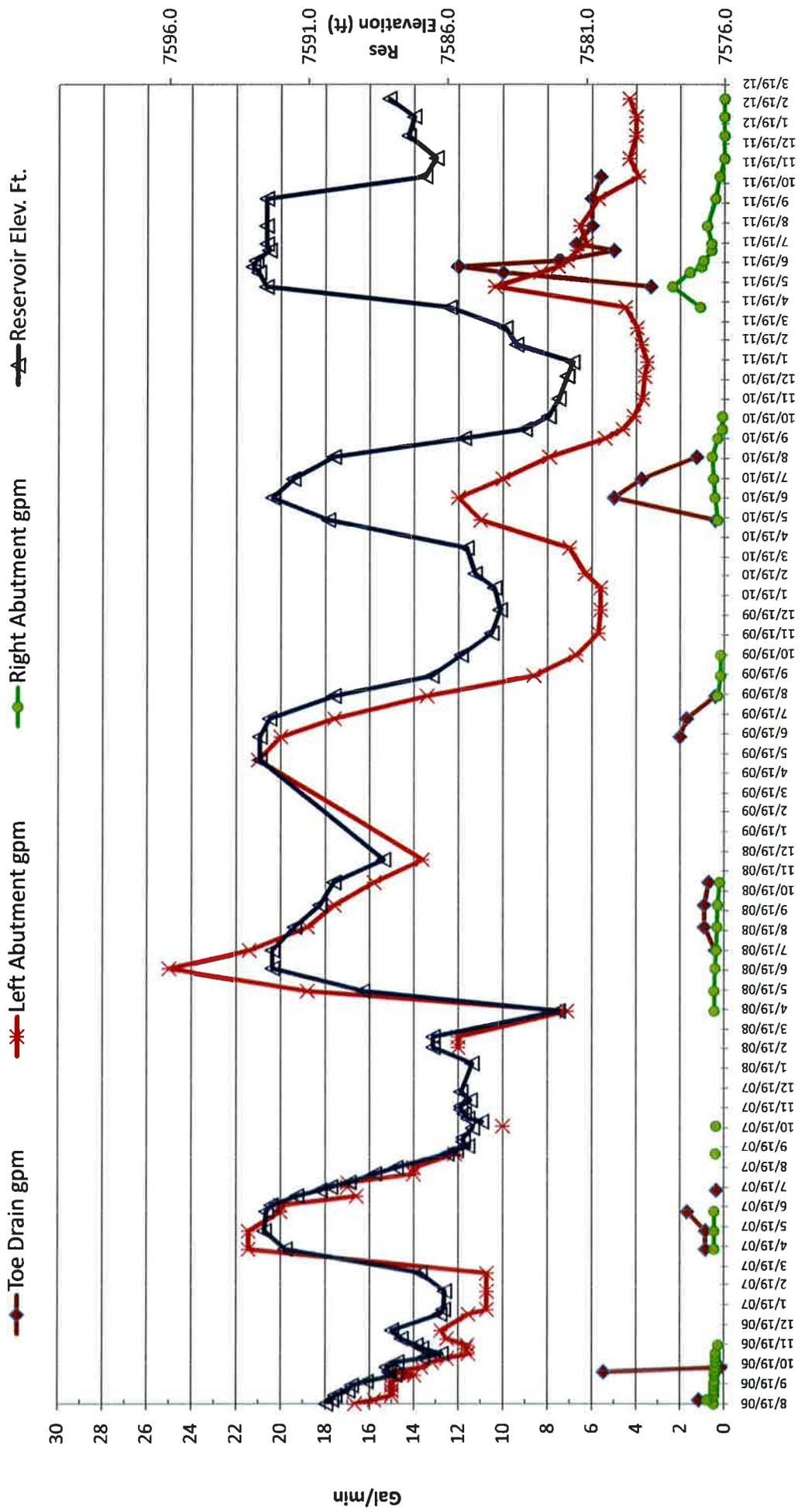
Reservoir elevation and seepage readings are summarized on the attached Table and Chart. Piezometer readings taken by East Carbon City should be available online at the Dam Safety Website. During site visits no signs of significant landslide movement were noted on the hillsides or at the dam.

  
 Michael N. Hansen P.G.  
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 RB&G ENGINEERING Inc.

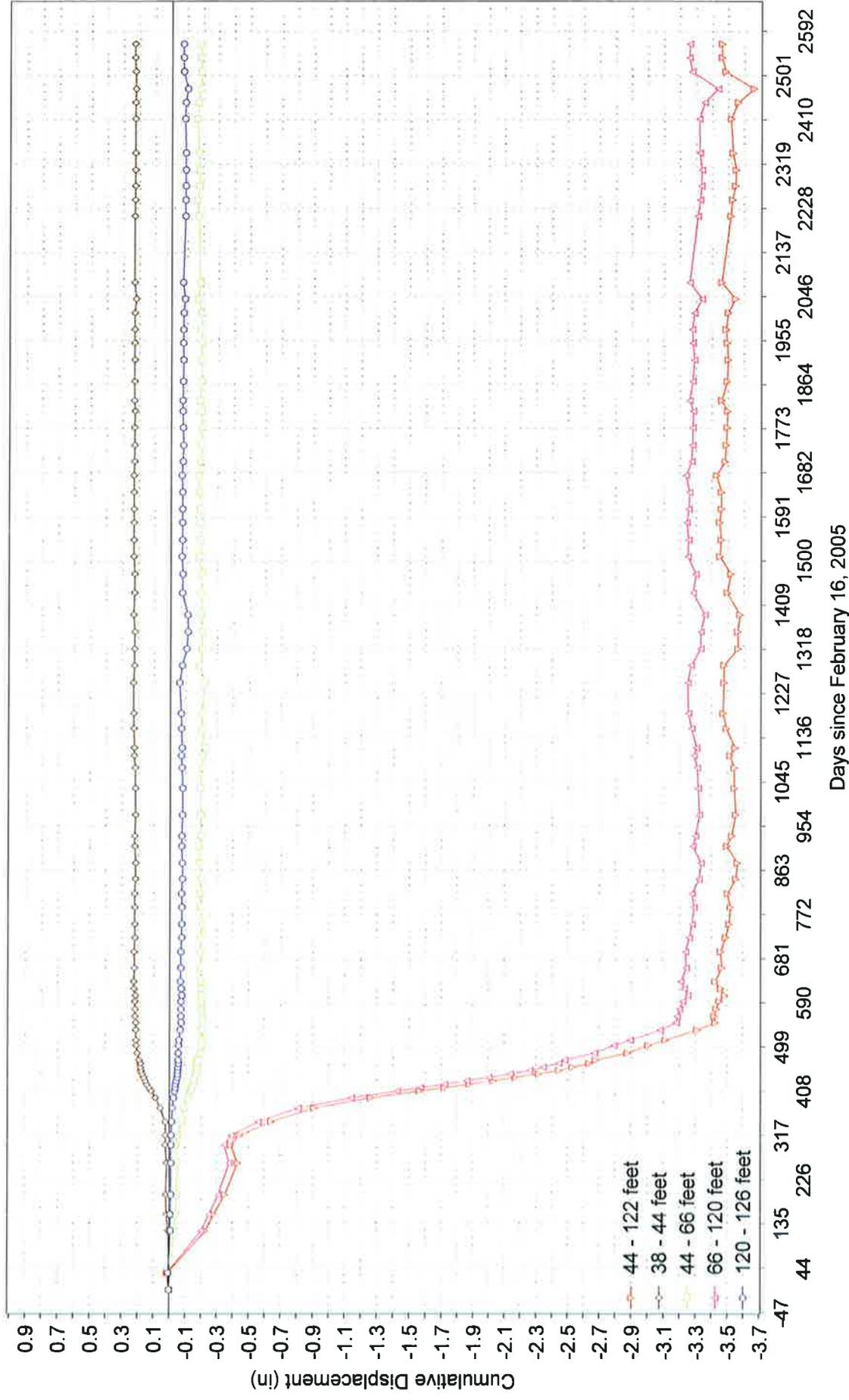
## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0			Seep1: Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5								
Seep Location:										
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	
	Neg = above spillway									
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear	
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen	
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen	
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen	
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen	
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen	
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear	
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear	
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear	
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear	
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear	
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear	
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear	
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen	
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen	
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen	
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen	
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen	
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt	
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear	
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear	
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear	
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear	
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear	
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear	
8/14/11	-.02	7592.5	1/4" over	6	Clear	6.9	Clear	0.78	Clear	
9/25/11	-.01	7592.5	0.01' over	5.6	Clear	5.7	Clear	0.41	Clear	
10/29/11	5.7	7586.8	Not flowing over	Dry		3.9	Clear	0.22	Clear	
11/26/11	6.1	7586.4		Dry		4.3	Clear	0		
12/31/11	5.1	7587.4	Frozen	Dry		4	Clear	0	Frozen	
1/29/12	5.3	7587.2	Frozen	Dry		4	Clear	0	Frozen	
2/26/12	4.4	7588.1	Frozen	Dry		4.3	Clear	0	Frozen	

# Grassy Trail Dam Seepage Monitoring



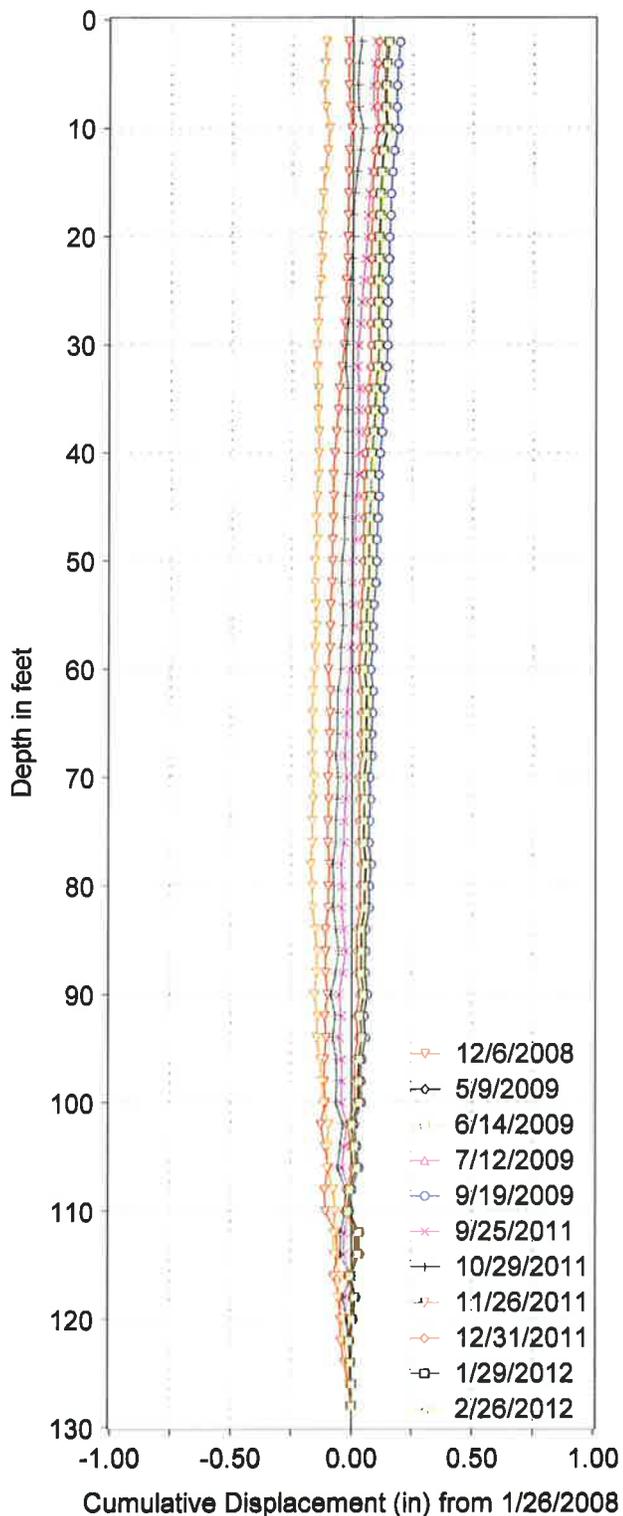
GRASSY 2A, A-Axis, -15 degree skew



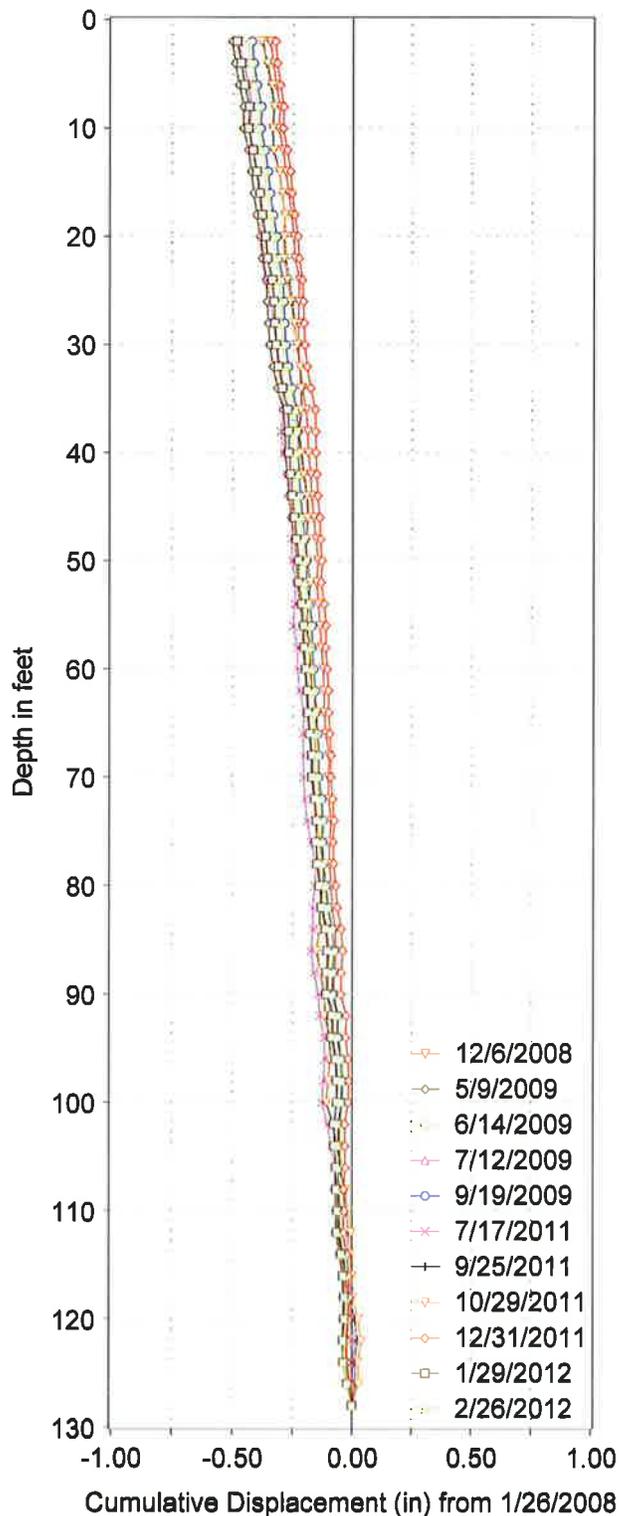
Inclinometer I-2 Located on Dam 02/26/12 with -15 degree skew

Figure  
Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



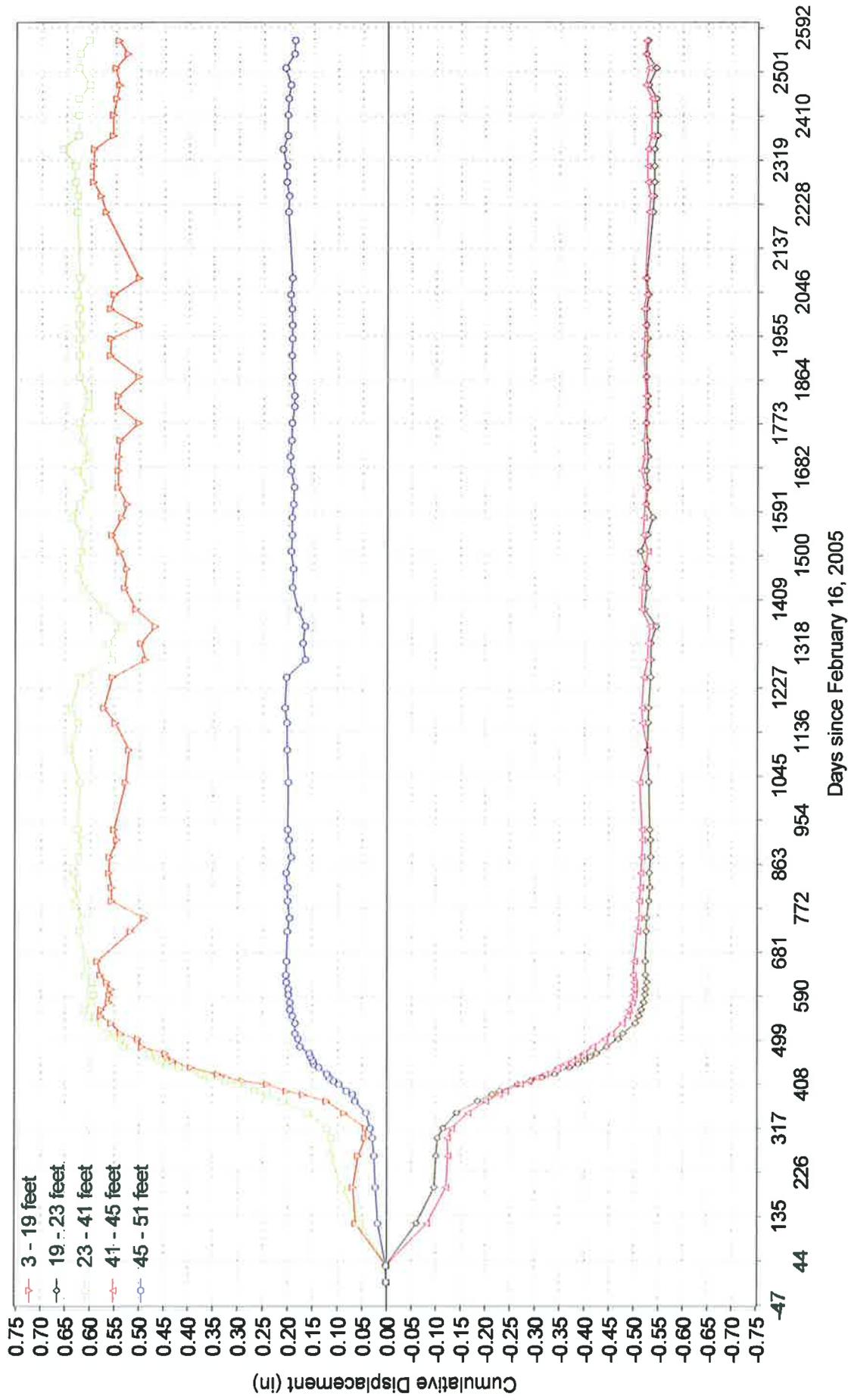
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY 3A, A-Axis

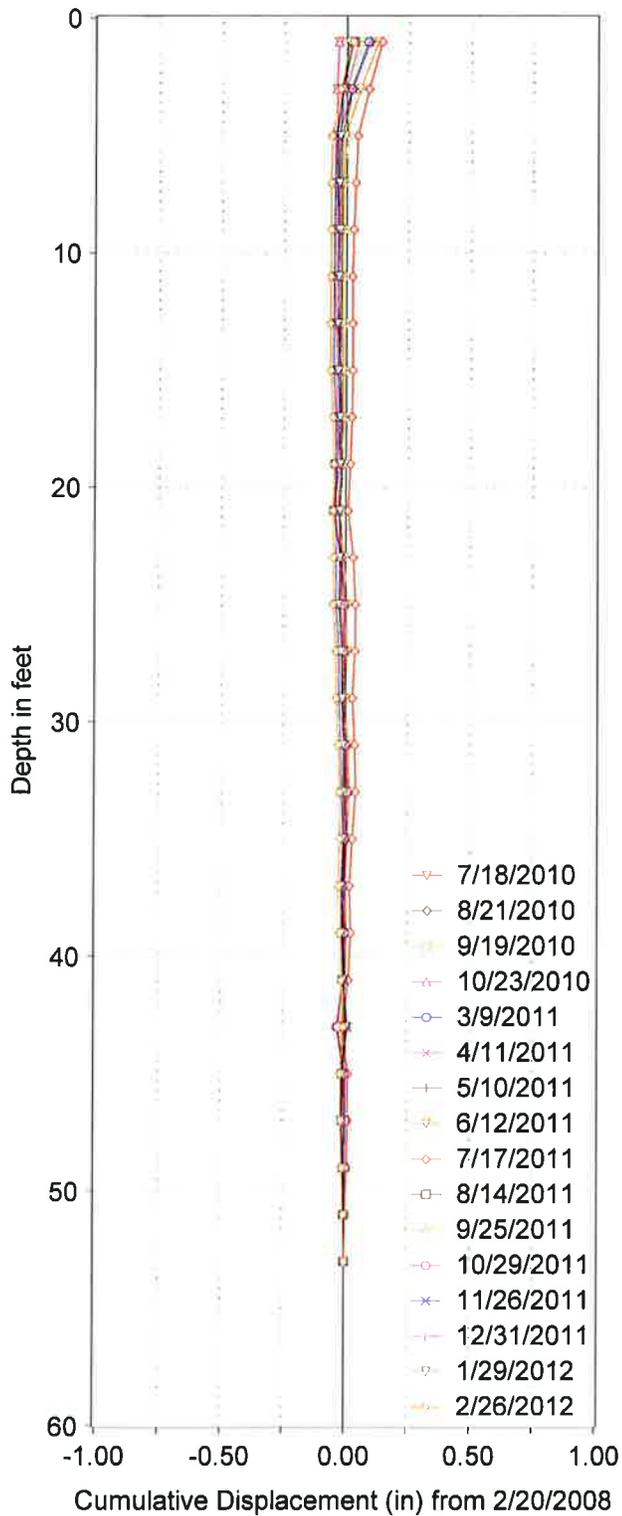


I-3 West/Right Abutment 02/26/12

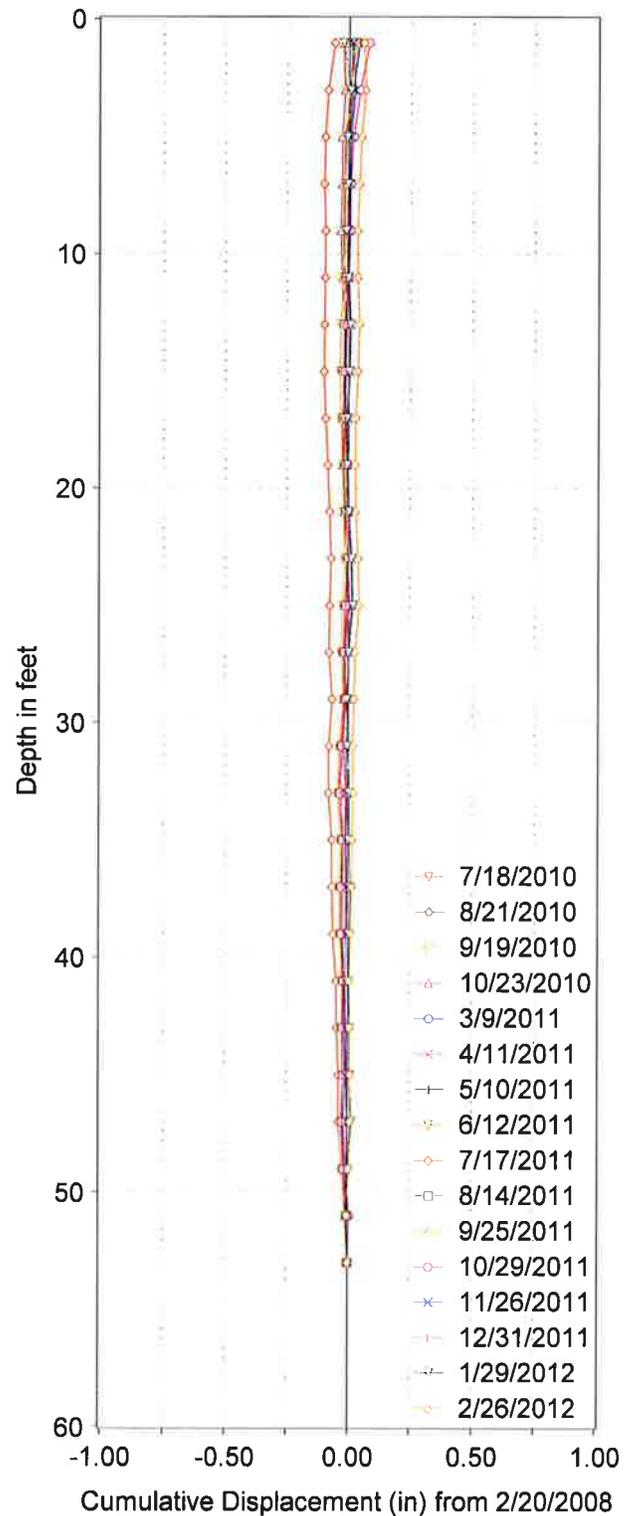
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

Grassy Trail Dam, Seismic Summary for March 31, 2012.



A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 9 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst. & UUSS (unless noted otherwise) (No events recorded on Dam)	Horizontal Distance from Mining to N. Hillside Inst. (ft)
July	0 Most recent Magnitudes		
Aug	1 Mag 1.3		
Sept	2 Mag 1.2 & 0.4		
Oct	2 Mag 0.1 & 0.9		
Nov	0		
Dec	0		
<b>Jan 2011</b>	2 Mag 0.7 & 1.0	0	
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0	0	
March	4 Mag 1.0, 0.2, 0.8, 0.8	0	
April	0	0	
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	8,400 – 5,840 feet
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	6,000 – 4,890 feet
July	35 events Mag Avg 0.8, Min 0.0, Max 1.9	10	5,130 – 4,180 feet
Aug	24 events Mag Avg 0.3, Min 0.0, Max 1.4	0	
Sept	9 events Mag Avg 1.0, Min 0.3, Max 1.9		
Oct	24 events Mag Avg 0.3, Min 0.0, Max 0.5	6? events not recorded by UUSS	
Nov	46 events Mag Avg 1.4, Min 0.2, Max 1.9	1	
<b>Dec 2011</b>	35 events Mag Avg 1.2, Min 0.2, Max 1.8	5? events not recorded by UUSS	
<b>Jan 2012</b>	15 events Mag Avg 1.0, Min 0.1, Max 1.7		
Feb	4 events Mag Avg 1.65, Min 1.6, Max 1.7		
March	8 events Mag Avg 0.8, Min 0.1, Max 1.5		

Since the first of the year there have been 27 events reported by the UUSS. The maximum magnitude has been 1.7 with an average 0.9. Since the first of the year 3 events have been recorded on the Hillside north of the dam which may be MIS events but were not reported by the UUSS as earthquakes or MIS events. While these events did not appear as the typical non-MIS events it is possible that they may have been caused by wind vibration or other low magnitude movement near the instrument. No MIS events have been recorded by the seismic instrument on the Dam. It should be noted that none of the events reported by the UUSS were recorded on the Dam or Hillside instruments.

Inclinometer readings were taken in I-2 and I-3 and show no significant signs of movement.

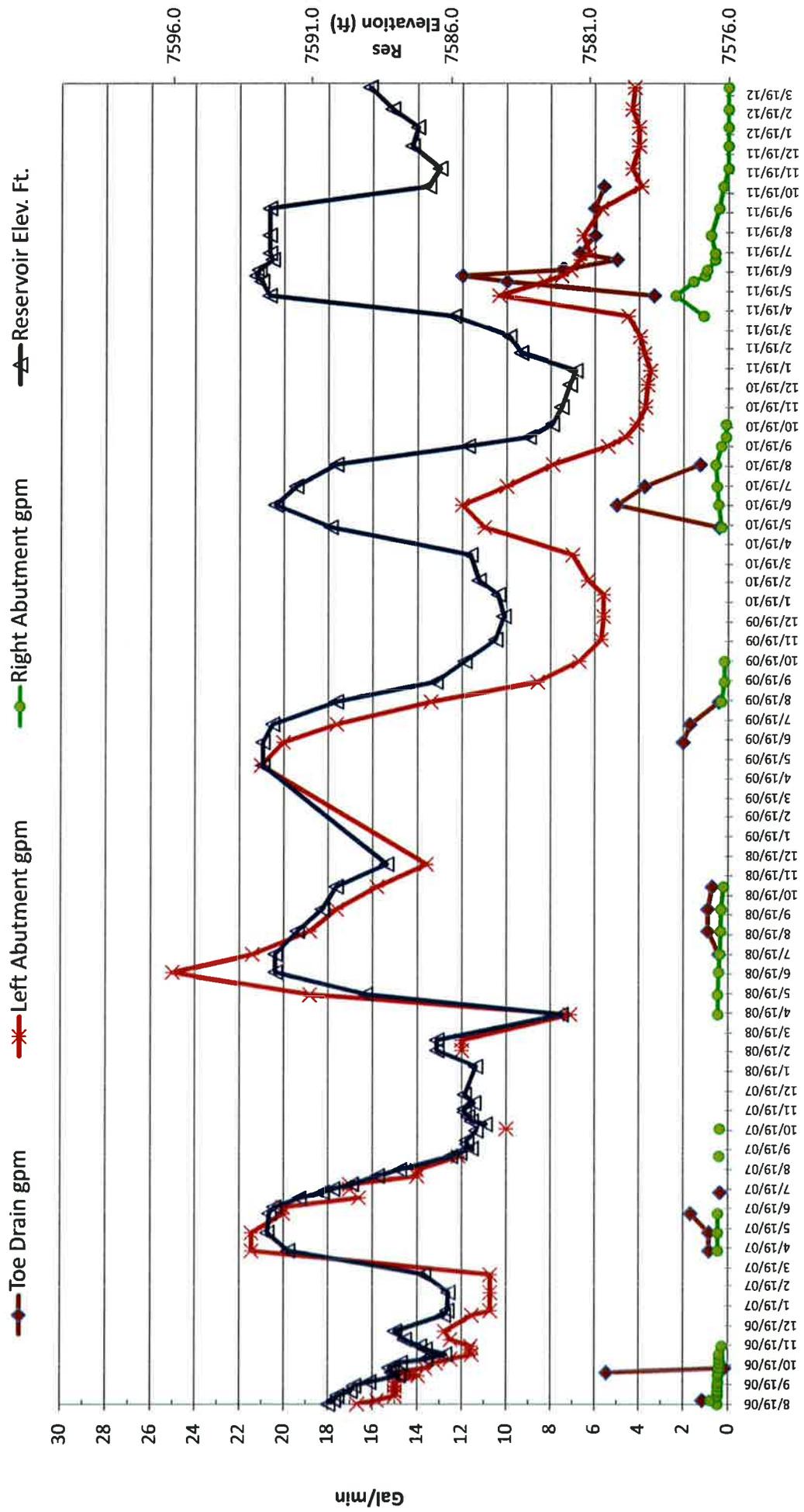
Reservoir elevation and seepage readings are summarized on the attached Table and Chart. Piezometer readings taken by East Carbon City should be available online at the Dam Safety Website. During site visits no signs of significant landslide movement were noted on the hillsides or at the dam.

  
 Michael N. Hansen P.G.  
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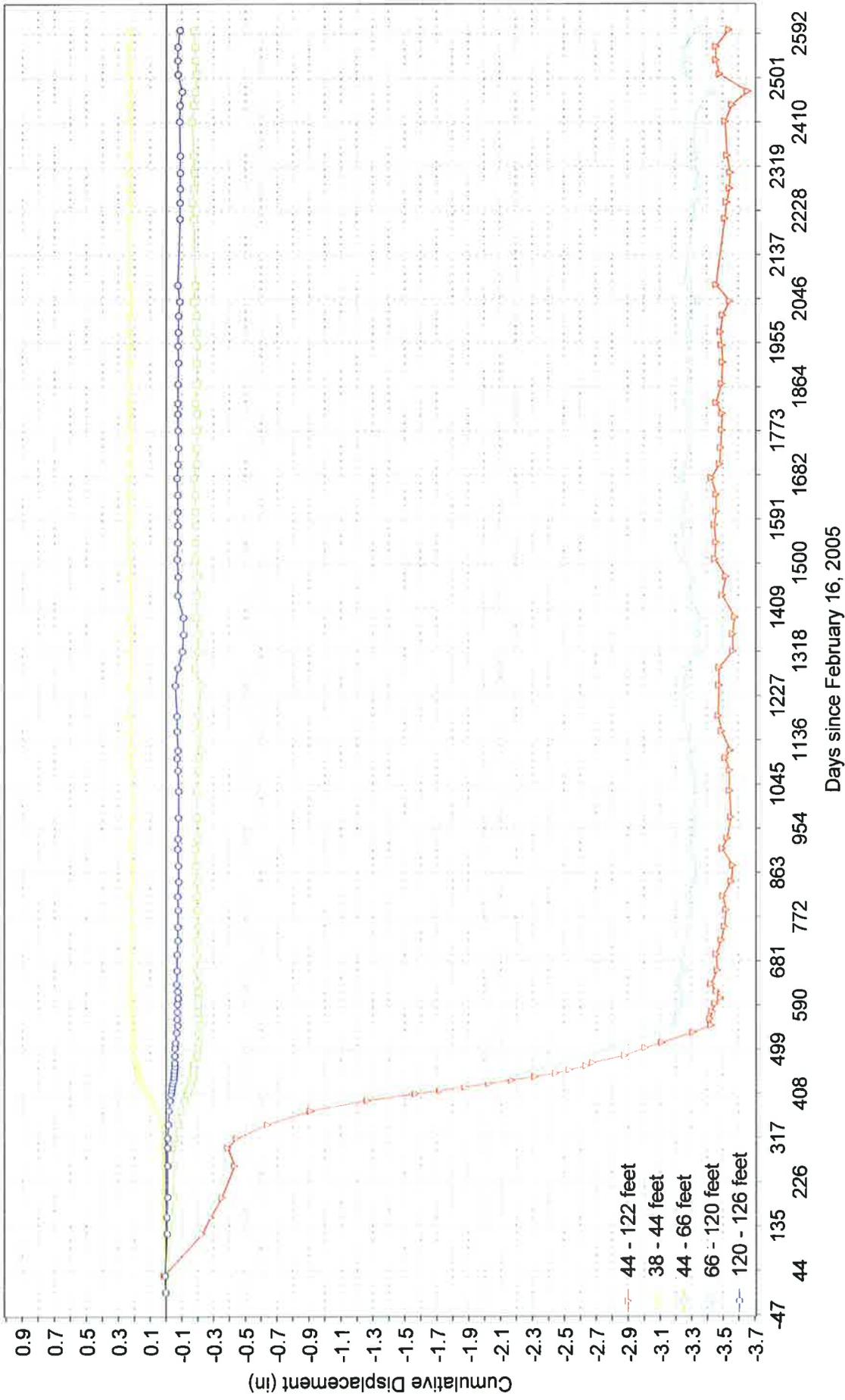
## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0			Seep1: Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5 <th colspan="2"></th> <th colspan="2"></th> <th colspan="2"></th> <th colspan="2"></th>								
Seep Location:										
Date	Reservoir ft Below spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	
	Neg = above spillway									
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear	
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen	
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen	
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen	
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen	
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen	
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear	
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear	
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear	
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear	
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear	
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear	
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear	
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen	
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen	
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen	
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen	
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen	
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt	
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear	
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear	
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear	
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear	
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear	
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear	
8/14/11	-.02	7592.5	1/4" over	6	Clear	6.9	Clear	0.78	Clear	
9/25/11	-.01	7592.5	0.01' over	5.6	Clear	5.7	Clear	0.41	Clear	
10/29/11	5.7	7586.8	Not flowing over	Dry		3.9	Clear	0.22	Clear	
11/26/11	6.1	7586.4		Dry		4.3	Clear	0		
12/31/11	5.1	7587.4	Frozen	Dry		4	Clear	0	Frozen	
1/29/12	5.3	7587.2	Frozen	Dry		4	Clear	0	Frozen	
2/26/12	4.4	7588.1	Frozen	Dry		4.3	Clear	0	Frozen	
3/31/12	3.6	7588.9	ice	damp		4.2	Clear	0	Frozen	

# Grassy Trail Dam Seepage Monitoring



GRASSY 2A, A-Axis, -15 degree skew



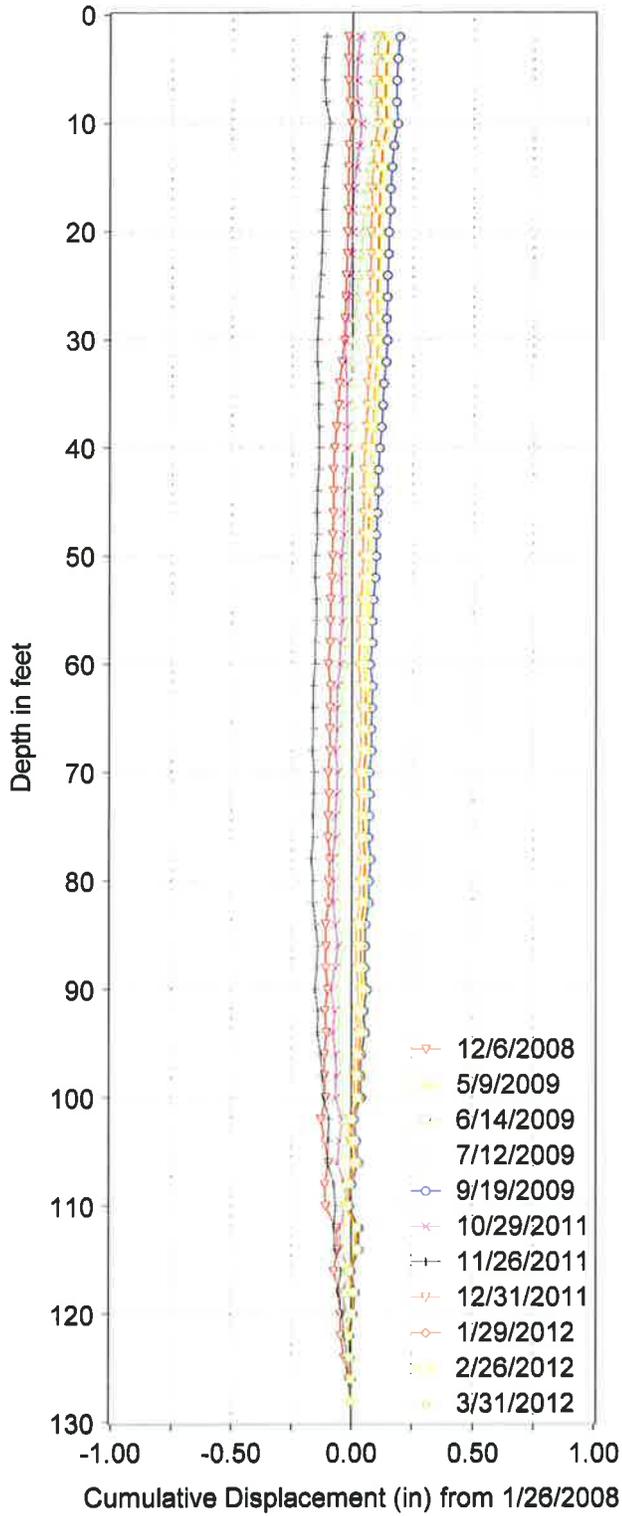
Inclinometer I-2 Located on Dam 03/31/12

with -15 degree skew

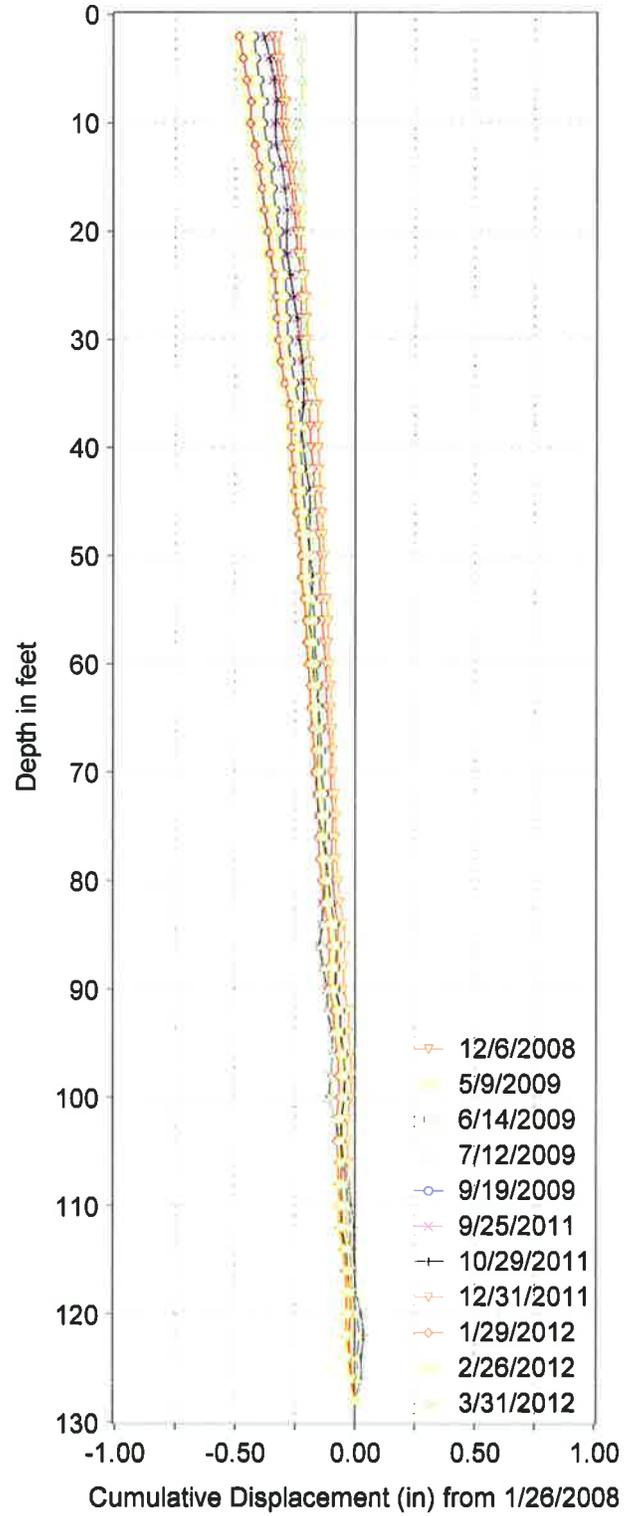
Figure

Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 2A, A-Axis



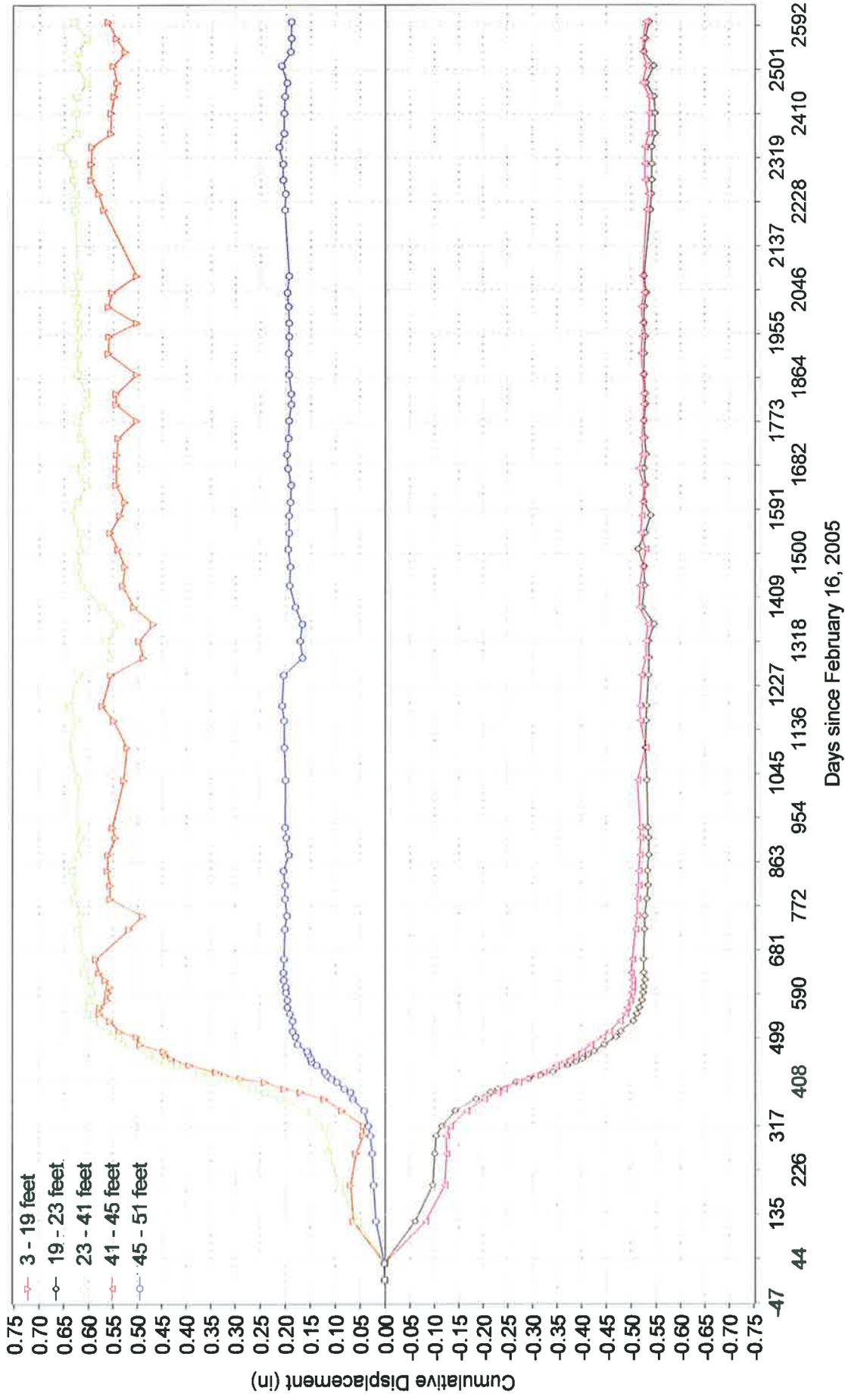
GRASSY 2A, B-Axis



-15 degree skew  
Bias-shift correction

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

# GRASSY 3A, A-Axis

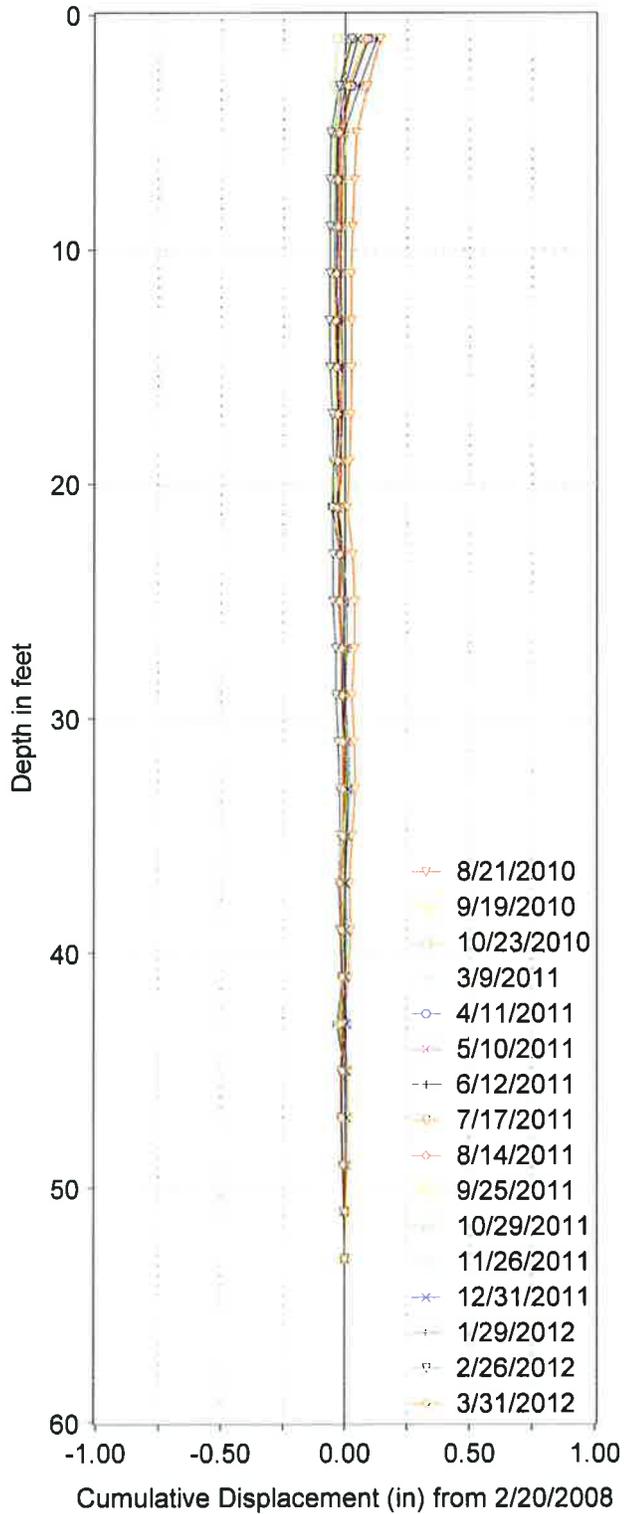


I-3 West/Right Abutment 03/31/12

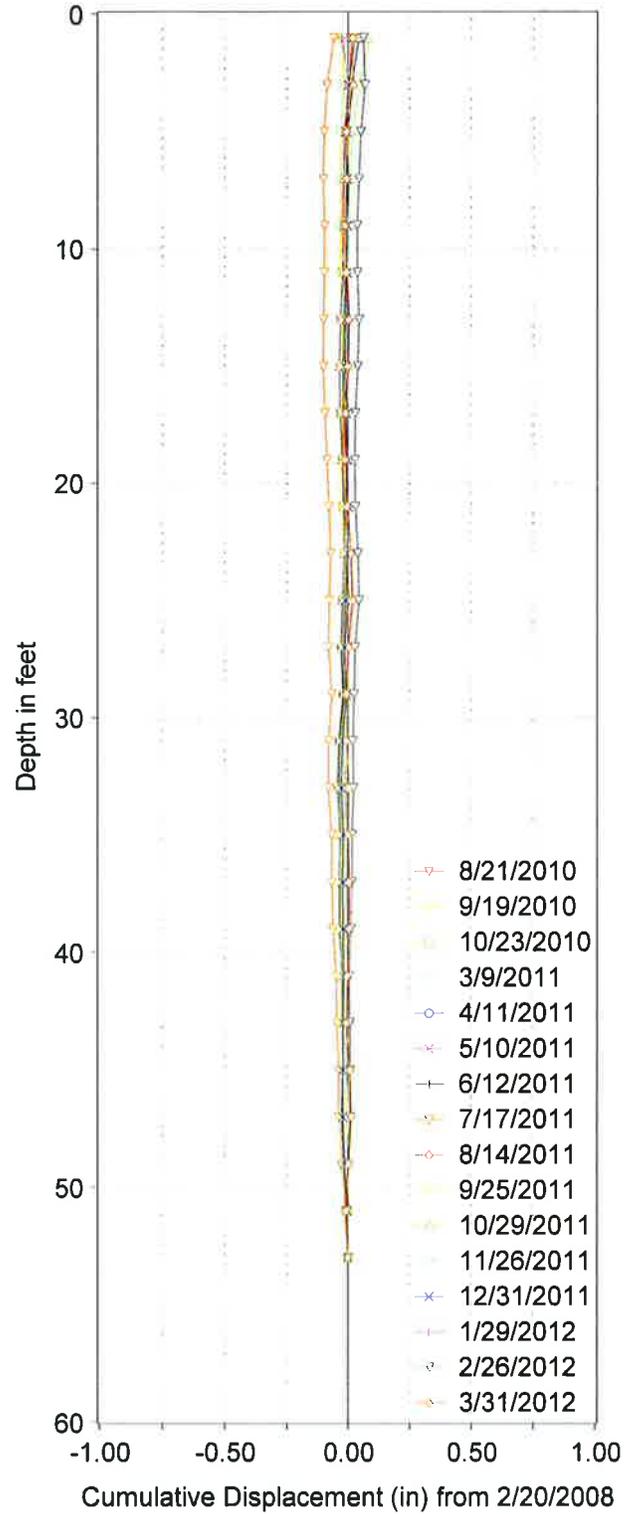
Figure

Inclinometer 3 - Deflections versus Time  
Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
Inclinometer 3 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

Grassy Trail Dam, Seismic Summary for April (May 6), 2012.



A summary of UUSS (West Ridge Mine) MIS events for the past 21 months are shown below. These recent events are reported as originating between 5 to 10 miles north-northwest of Sunnyside and East Carbon, and within a radius of about 1.5 to 4 miles north of the dam.

MONTH	# MIS events reported by UUSS	Events recorded on N Hillside Inst. & by UUSS (unless noted otherwise) (No events recorded on Dam)	Horizontal Distance from Mining to	
			N. Hillside Inst (ft)	Dam (ft)
Aug	1 Mag 1.3		N Hillside Inst is ~4,500 ft NW of Dam	
Sept	2 Mag 1.2 & 0.4			
Oct	2 Mag 0.1 & 0.9			
Nov	0			
Dec	0			
<b>Jan 2011</b>	2 Mag 0.7 & 1.0	0		
Feb	8 Mag 0.6, 0.2, 0.2, 0.5, 0.7, 0.7, 0.7, 1.0	0		
March	4 Mag 1.0, 0.2, 0.8, 0.8	0	2,050	6,600
April	0	0	7,000	11,600
May	7 Mag 0.8, 0.5, 1.1, 0.4, 1.5, 1.7, 1.9	3	5,800	10,400
June	36 events Mag Avg 1.2, Min 0, Max 2.0	12	4,900	9,500
July	35 events Mag Avg 0.8, Min 0.0, Max 1.9	10	3,900	8,500
Aug	24 events Mag Avg 0.3, Min 0.0, Max 1.4	0	3,100	7,600
Sept	9 events Mag Avg 1.0, Min 0.3, Max 1.9		2,300	6,900
Oct	24 events Mag Avg 0.3, Min 0.0, Max 0.5	6? events not recorded by UUSS	5,700	10,200
Nov	46 events Mag Avg 1.4, Min 0.2, Max 1.9	1	4,900	9,400
<b>Dec 2011</b>	35 events Mag Avg 1.2, Min 0.2, Max 1.8	5? events not recorded by UUSS	4,500	8,850
<b>Jan 2012</b>	15 events Mag Avg 1.0, Min 0.1, Max 1.7		4,100	8,500
Feb	4 events Mag Avg 1.65, Min 1.6, Max 1.7		3,900	8,200
March	8 events Mag Avg 0.8, Min 0.1, Max 1.5		3,700 & 2,900	8,000 & 3,800
April	5 events Mag Avg 0.6, Min 0.0, Max 1.6	3? events not recorded by UUSS	2,400	3,900
May 9th 2012	3 events Mag Avg 0.8, Min 0.5, Max 1.1		2,300	4,400

Since the first of the year there have been 35 Events reported by the UUSS. The maximum magnitude was 1.7 with an average of 0.9. Since the first of the year 3 events have been recorded on the Hillside north of the dam which may be MIS events but were not reported by the UUSS as earthquakes or MIS events. While these events do not appear as the typical non-MIS events it is possible that they may have been caused by wind vibration or other low magnitude movement near the instrument. No MIS events have been recorded by the seismic instrument on the Dam. It should be noted that none of the events reported by the UUSS this year were recorded on the Dam or Hillside instruments.

Inclinometer readings were attempted to be taken in I-2 and I-3, but due to mechanical problems with the probe, readings were not obtained. The instrument is being sent for repairs or calibration. No visual signs of movement were noted at the dam.

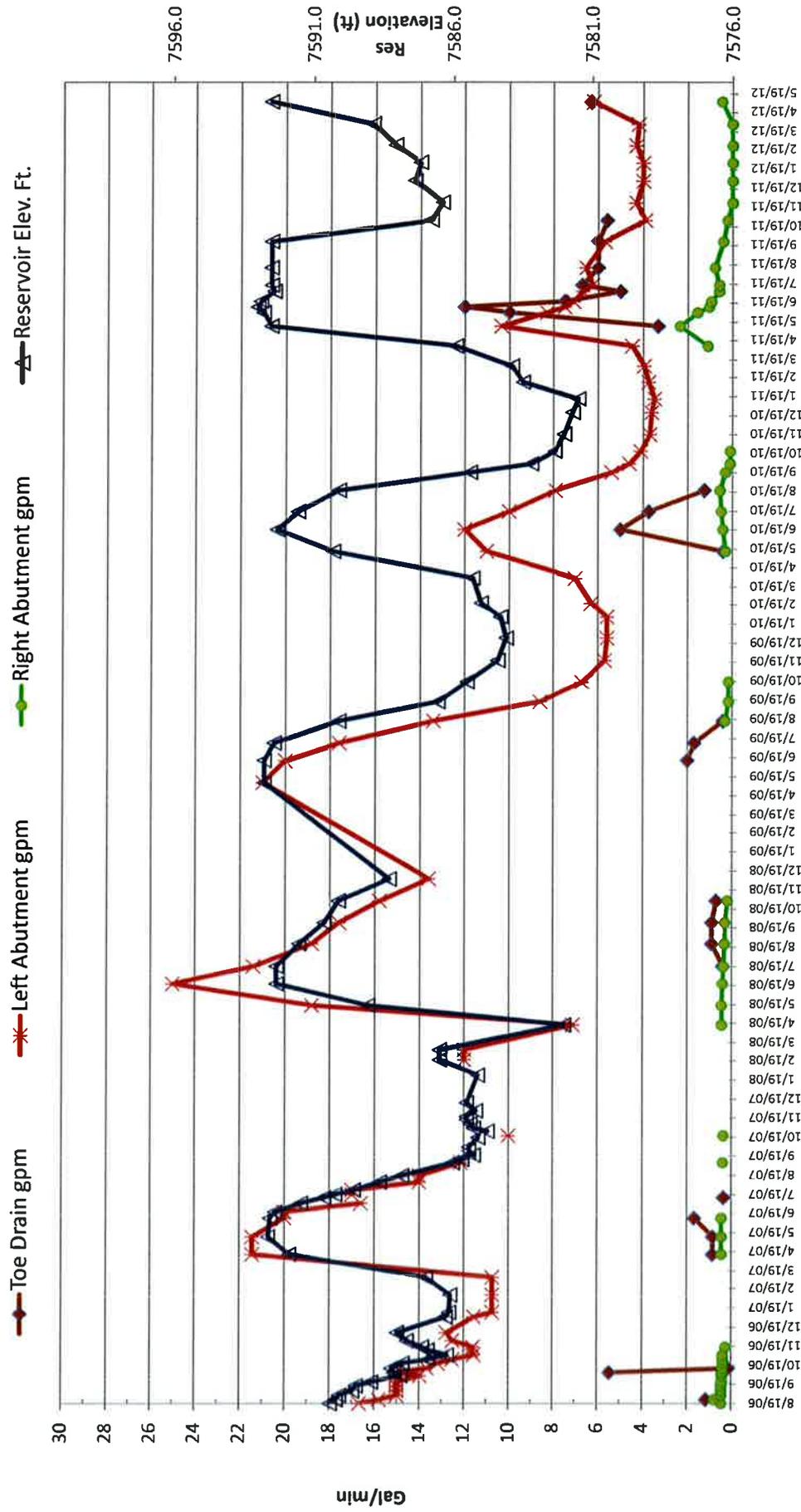
Reservoir elevation, piezometer and seepage readings are summarized on the attached Table and Charts. Piezometer readings taken by East Carbon City should also be available online at the Dam Safety Website. During site visits no signs of significant landslide movement were noted on the hillsides or at the dam.

Michael N. Hansen P.G.  
 Engineering Geologist  
 RB&G ENGINEERING Inc.

## GRASSY TRAIL DAM SEEPAGE READINGS

Dam Crest Elevation (ft)		7600.0			Seep1: Toe Drain		Seep 2: Left Abutment (East Seep)		Seep 3: Right Abutment (West Seep)	
Spillway Elev. (ft)		7592.5 <th colspan="2"></th> <th colspan="2"></th> <th colspan="2"></th> <th colspan="2"></th>								
Seep Location:										
Date	Reservoir ft Below Spillway	Reservoir Elev.	Reservoir Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	GAL/MIN	Water Characteristics	
	Neg = above spillway									
10/18/09	7	7585.5		dry		6.7	Clear	0.16	Clear	
11/21/09	8.1	7584.4	frozen edge	dry		5.7	Clear	0.0	Frozen	
12/27/09	8.4	7584.1	frozen	dry		5.6	Clear	0.0	Frozen	
1/30/09	8.2	7584.3	frozen	dry		5.6	Clear	0.0	Frozen	
2/21/10	7.5	7585.0	frozen	dry		6.3	Clear	0.0	Frozen	
4/2/10	7.2	7585.3	frozen	dry		7.0	Clear	0.0	Frozen	
5/15/10	2.2	7590.3		0.4	Clear	11.0	Clear	0.3	Clear	
6/19/10	0.2	7592.3		5	Clear	12.0	Clear	0.43	Clear	
7/18/10	0.95	7591.6		3.75	Clear	10.0	Clear	0.49	Clear	
8/21/10	2.4	7590.1		1.25	Clear	7.9	Clear	0.55	Clear	
9/19/10	7.1	7585.4		dry		5.4	Clear	0.31	Clear	
10/3/10	9.3	7583.2		dry		4.6	Clear	0.1	Clear	
10/23/10	10.15	7582.4		dry		4.1	Clear	0.1	Clear	
11/19/10	10.5	7582.0	frozen edge	dry		3.7	Clear	0.0	Frozen	
12/24/10	10.8	7581.7	frozen	dry		3.6	Clear	0.0	Frozen	
1/15/11	11	7581.5	frozen	dry		3.5	Clear	0.0	Frozen	
2/11/11	9	7583.5	frozen	dry		3.8	Clear	0.0	Frozen	
3/9/11	8.6	7583.9	frozen	dry		3.9	Clear	0.0	Frozen	
4/10/11	6.6	7585.9	frozen	dry		4.5	Clear	1.10	cloudy, snow melt	
5/12/11	-0.02	7592.5	1/4" over spillway	3.3	Clear	10.3	Clear	2.34	Clear	
6/3/11	-0.3	7592.8	0.3' over spillway	10	Clear	8.3	Clear	1.56	Clear	
6/12/11	-0.46	7593.0	5.5" over spillway	12	Clear	7.5	Clear	1.04	Clear	
6/21/11	-0.4	7592.9	0.4' over spillway	7.5	Clear	7.1	Clear	0.94	Clear	
7/7/11	0.083	7592.4	1" under	5	Clear	6.7	Clear	0.59	Clear	
7/17/11	-0.01	7592.5	0.01' over spillway	6.7	Clear	6.3	Clear	0.59	Clear	
8/14/11	-.02	7592.5	1/4" over	6	Clear	6.9	Clear	0.78	Clear	
9/25/11	-.01	7592.5	0.01' over	5.6	Clear	5.7	Clear	0.41	Clear	
10/29/11	5.7	7586.8	Not flowing over	Dry		3.9	Clear	0.22	Clear	
11/26/11	6.1	7586.4		Dry		4.3	Clear	0		
12/31/11	5.1	7587.4	Frozen	Dry		4	Clear	0	Frozen	
1/29/12	5.3	7587.2	Frozen	Dry		4	Clear	0	Frozen	
2/26/12	4.4	7588.1	Frozen	Dry		4.3	Clear	0	Frozen	
3/31/12	3.6	7588.9	ice	damp		4.2	Clear	0	Frozen	
5/6/12	-.02	7592.5	1/4" over	6.3	Clear	6.2	Clear	0.47	Clear	

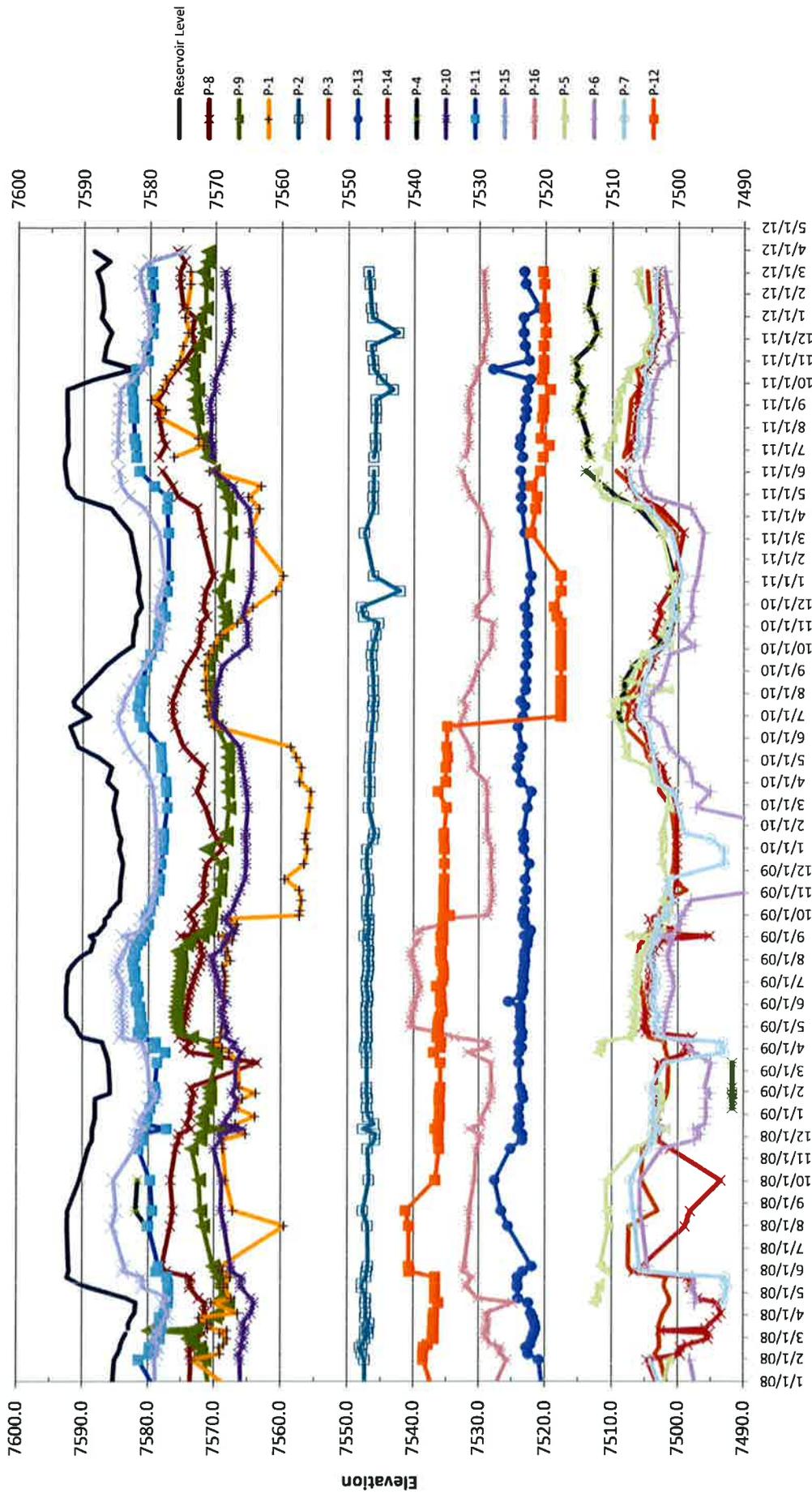
# Grassy Trail Dam Seepage Monitoring



**FIGURE** Seepage Monitoring Readings  
**Seepage Reading and Reservoir Water Levels Versus Time 8/19/06 to 5/6/12**  
 GRASSY TRAIL DAM - CARBON COUNTY, UTAH



# Grassy Trail Dam Piezometer Readings



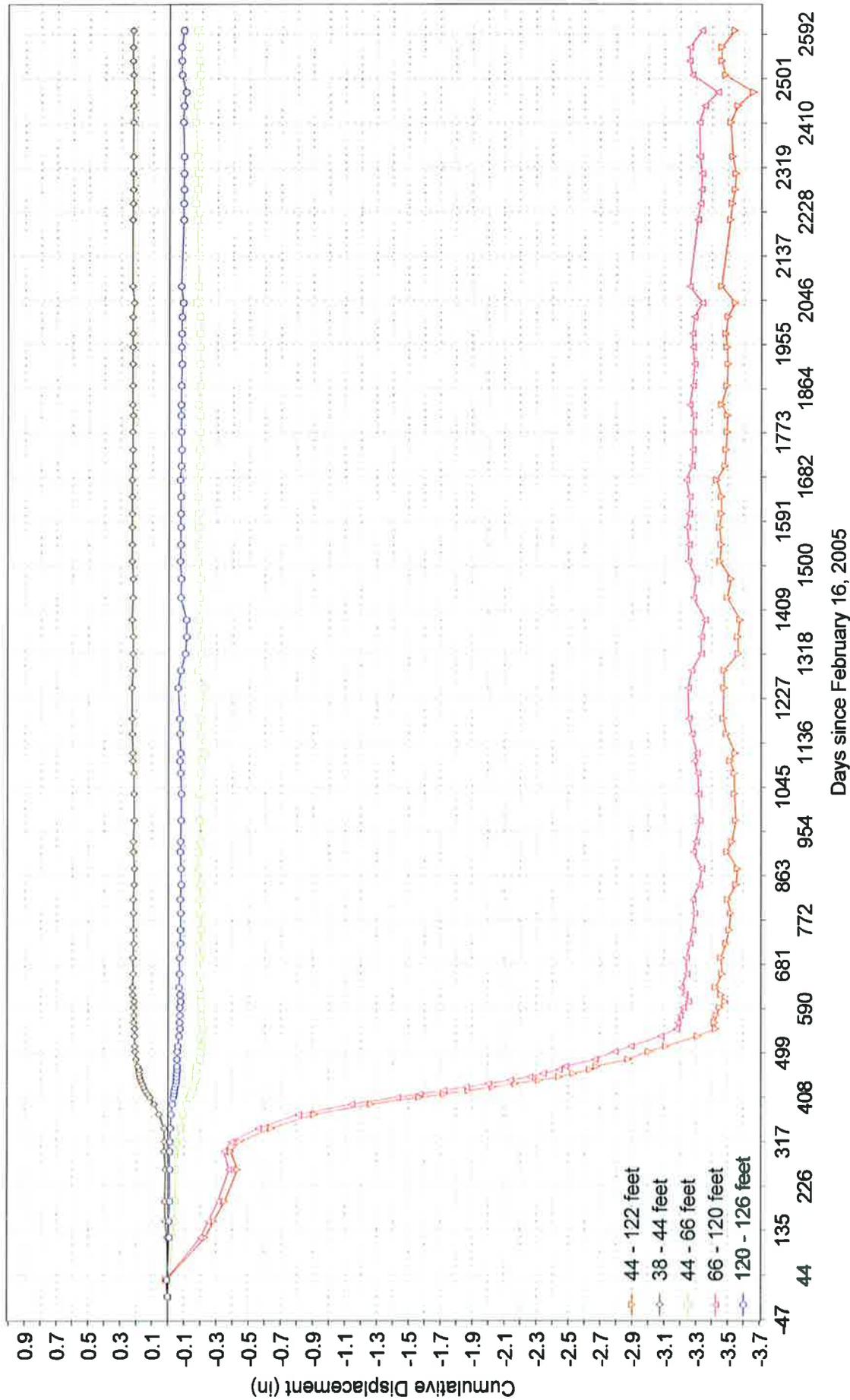
**Figure** Reservoir Elevation and Piezometer Readings

From 1/1/08 to 3/30/12 (some data taken from Division of Natural Resources, Water Rights, Dam Safety web site)

GRASSY TRAIL DAM - CARBON COUNTY, UTAH

\* NOTE - spikes are likely errors in data (some very large spikes have been removed)  
**P-12 repaired Jan 2011**

GRASSY 2A, A-Axis, -15 degree skew



Inclinometer I-2 Located on Dam 03/31/12

with -15 degree skew

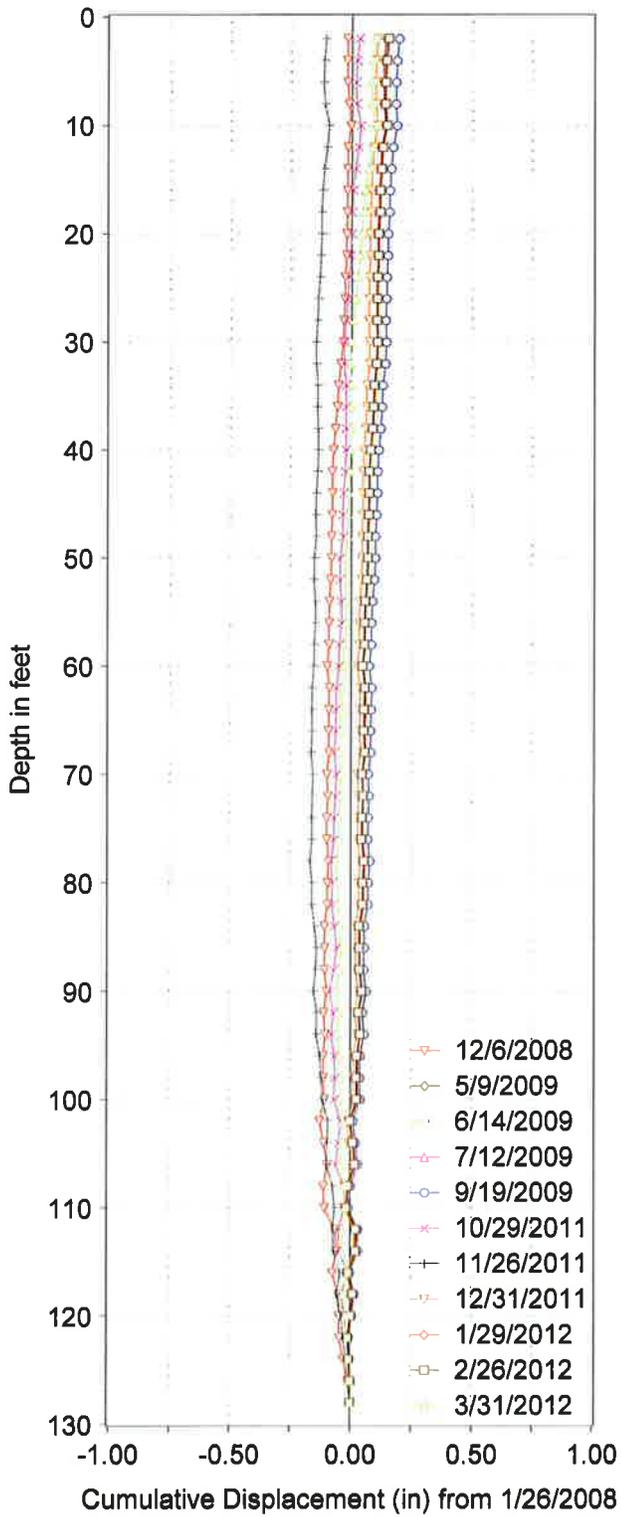
Inclinometer readings for April did not work due to problems with the instrument

Figure

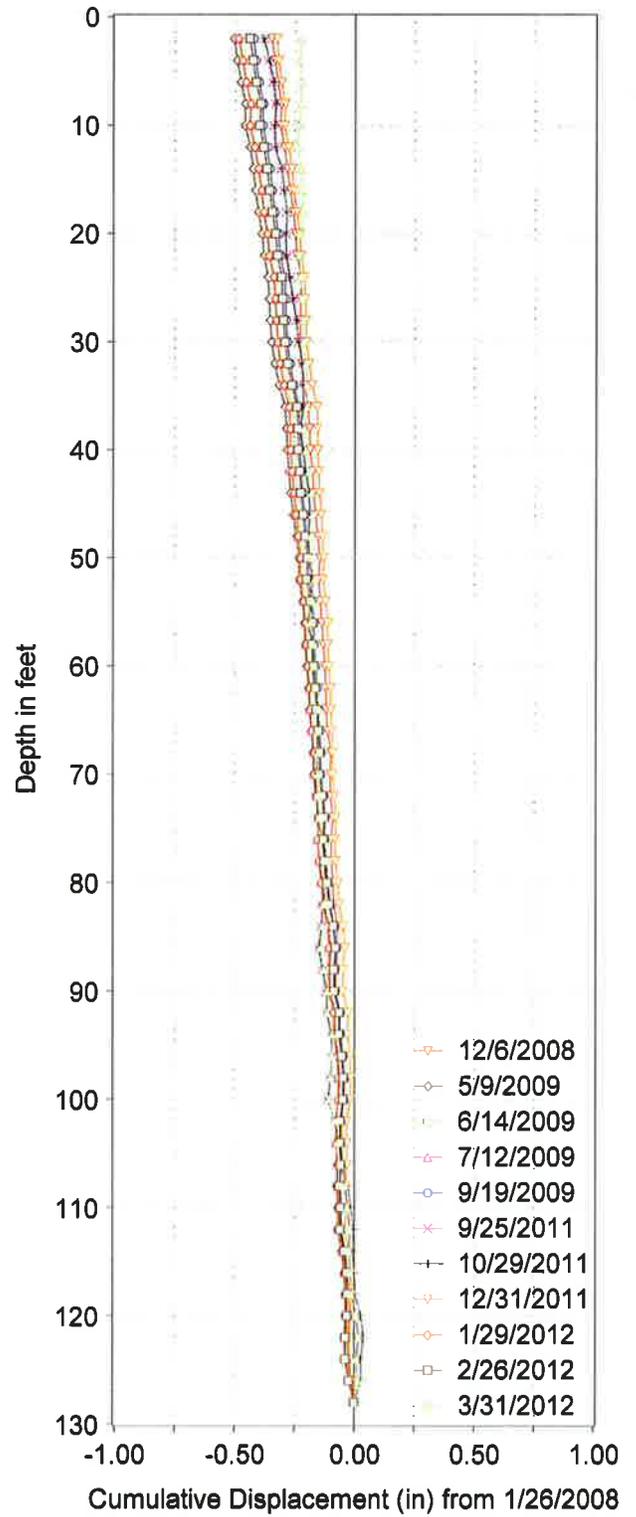
Inclinometer 2 - Deflection versus Time  
Grassy Trail Dam, Carbon County, Utah

Days since February 16, 2005

GRASSY 2A, A-Axis



GRASSY 2A, B-Axis

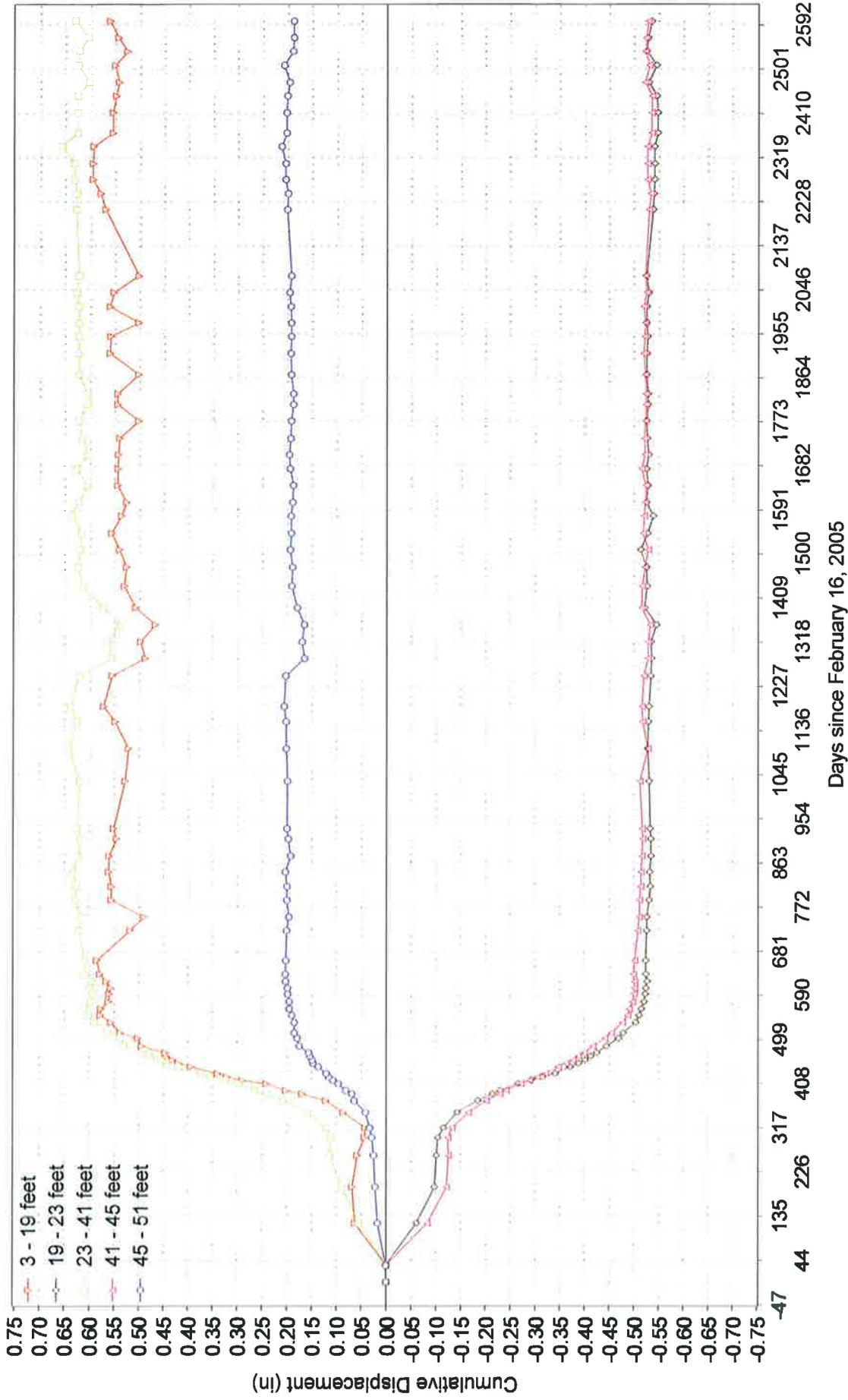


-15 degree skew  
Bias-shift correction

Inc readings for April did not work due to problems with the instrument

Figure  
Inclinometer 2 - Deflection Profile  
Grassy Trail Dam, Carbon County, Utah

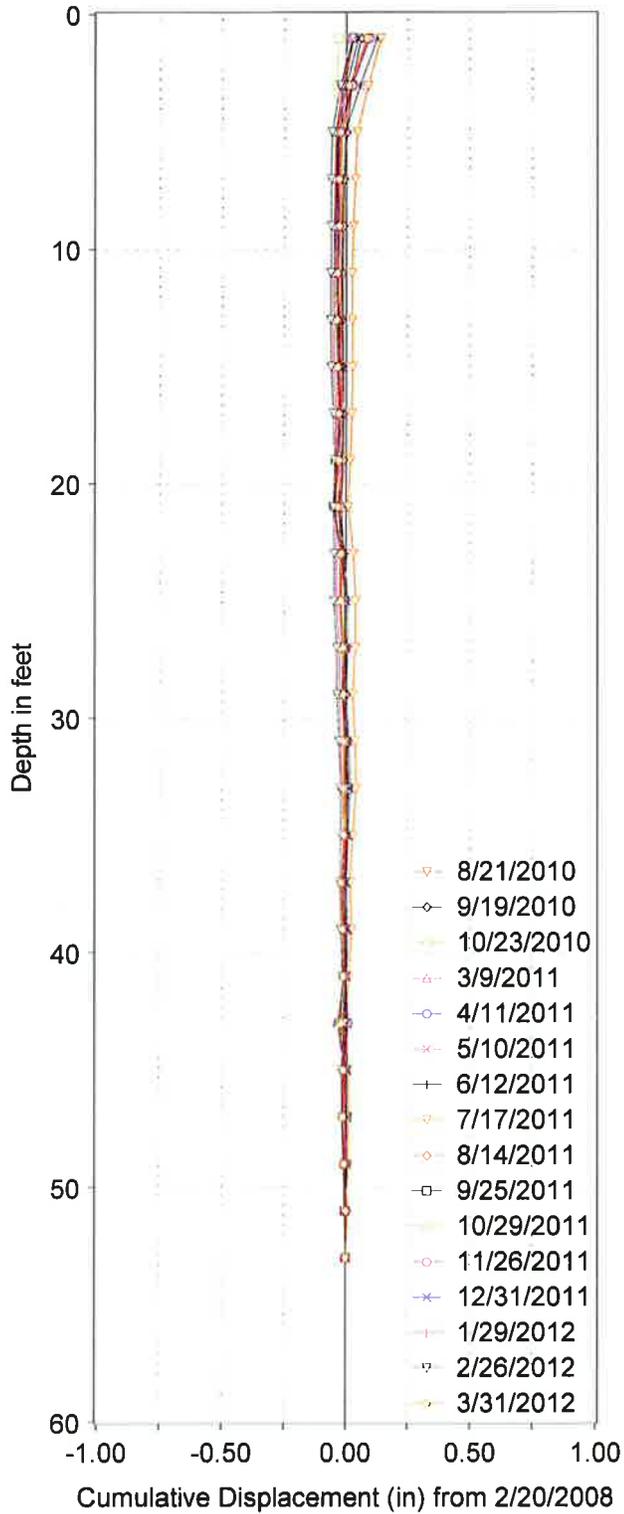
# GRASSY 3A, A-Axis



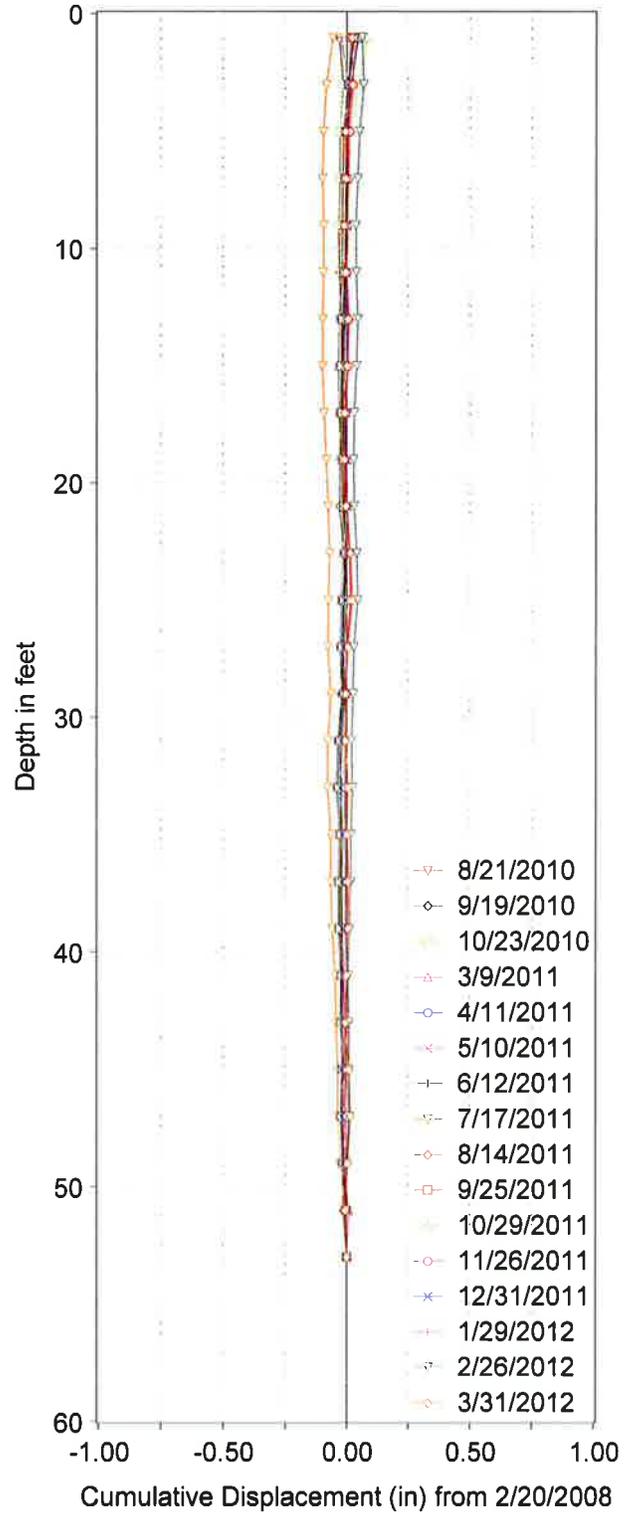
I-3 West/Right Abutment 03/31/12  
 Inclinometer readings for April did not work due to  
 problems with the instrument

Figure  
 Inclinometer 3 - Deflections versus Time  
 Grassy Trail Dam, Carbon County, Utah

GRASSY 3A, A-Axis



GRASSY 3A, B-Axis



-30 degree skew

Figure  
 Inclinator 3 - Deflection Profile  
 Grassy Trail Dam, Carbon County, Utah

Inc readings for April did not work due to problems with the instrument