APPENDIX B. COASTAL INSTRUMENTATION PROCEDURES AND DOCUMENTATION

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1.1 OVERVIEW

Internal landslide movements are typically captured using conventional or in-place inclinometer (IPI) systems - this research used a new inclinometer system: an array of microelectromechanical systems (MEMS) elements used to provide real-time displacement data in a series of vulnerable sites in representative locations along the Oregon Coast. These systems are optimal because they are exceedingly flexible, potentially able to withstand larger deformations than conventional systems, can be placed in more narrow borings, and provide a relatively continuous, three-dimensional profile of boring movement that can be sampled up to a frequency of every 15 minutes. Better yet, these systems can be coupled with traditional vibrating wire (VW) piezometer systems, demonstrating utility in classical landslide monitoring applications. Concurrent to the MEMS/Piezoemeter system was a weather-sealed, battery-solar-powered datalogger system that can be coupled with traditional monitoring sensors, including rain gages and weather stations. A cellular modem is connected to each station and transmits relevant data via cell phone to a File Transfer Protocol (FTP) system on Oregon State University's (OSU's) network every half hour, where it is backed up hourly through automated backup routines managed by OSU's College of Engineering IT support. Additionally, in-situ GNSS sensors (Appendix C) and geophone arrays (Appendix D) were constructed cost-effectively from open-source components and were custom-fabricated to be an exploratory means of observing wave frequencies. These arrays, consisting of three geophones each, provide a potential mechanism for isolating the vibration signatures of waves during storm events versus other potential interference, including highway traffic or wind. These systems of instrumentation will provide physical measurements that will corroborate remotely-sensed observations of landslide movement and coastal bluff erosion for the duration of this project.

1.2 SCOPE OF DOCUMENT

This document contains detailed, specific, standard operating procedures and business rules for systematic data acquisition, storage, processing, analysis to support the potential model development, focused on the in-situ instrumentation. It also includes the drilling bid documents and contract, code for the datalogger, and matlab code for plotting the output files.

1.3 PLANNING

The following work was completed during the planning phase for the instrument installation.

First, Instrumentation locations were selected based on an assessment of (1) potential for movement, (2) representativeness of site for landslide activity and coastal conditions, (3) accessibility for drilling and depth to slide plane, (4) proximity of available site data, (5) equipment functionality including solar power and cellular network reception, and (6) safety. Both Beverly Beach Sites, Arch Cape and Silver Point drill locations were selected behind locations where coastal slumps neighbored ODOT right-of-way and landslide retrogression is expected in coming years. Arizona Inn was selected downslope of the highway with a deep hole to capture a well-documented shear plane that exhibits seasonal movements with retrogressive failure of the sea cliffs below.

After borehole selection, estimates were made regarding the approximate depth to potential shear planes. These approximate depths provided an estimate for (1) drilling costs and (2) MEMS sensor costs, which were directly related to borehole length. Currently, the MEMS systems employed in this study are not modular and must be purchased at the appropriate length beforehand. However, the current systems can be retrieved from a borehole for use elsewhere due to its installation in 1" Inner Diameter Electrical Conduit.

Installation required the purchase of ancillary supplies needed for installation of datalogger stations and MEMS IPIs. In particular, appropriate lengths of 1" ID PVC electrical conduit, PVC conduit epoxy/glue were necessary for MEMS installation. For datalogger/battery/solar panel installation, holes needed to be pre-excavated for post installation, which also required 300-400 pounds of concrete. Each site had two posts – one for a datalogger and the other for a solar panel and battery enclosure.

Lastly, the research team worked with ODOT personnel to prepare the documentation and complete the bidding process for a driller to install the instrumentation. These documents are included at the end of this appendix.

1.4 INSTRUMENTATION INSTALLATION

Instrument installation occurred in four primary stages: 1) configuration of datalogger and SAA in a lab facility, 2) preparation of SAA and piezometers in the field, 3) installation of the SAA in the borehole, and 4) installation of electronics enclosures. The procedure followed for each stage is described in the following paragraphs.

1.4.1 Lab configuration of each datalogger and SAA

Following receipt of the SAA, the first step toward installation was to install the SAASuite and LoggerNet software on a computer. A diagnostic test was then run on each SAA using the SAA232-PC cable to connect to the SAA232 unit. Following instructions in the included SAAF Manual, the diagnostic tests check that the SAA was performing correctly. Once the SAA diagnostic test was complete, then next step was to configure the CR800 datalogger using the same computer and connecting to the datalogger with a Logger-PC (usb to RS232) Cable. Detailed instructions are provided under the *Collecting SAAF Data Using a Datalogger* section of the SAAF Manual.

Before you can remotely connect to a datalogger the RV50 modem must be configured in accordance with the *Campbell Scientific Sierra Wireless AirLink RV50 Quick Deploy Guide* (https://s.campbellsci.com/documents/us/manuals/rv50-quick-deploy-guide.pdf). When connecting the modem to the CR800 datalogger, ensure the white wire is connected to the SW12v port on the CR800. Following configuration of the RV50 modem, the LoggerNet "Setup" tool must be used to create unique connection profiles for each datalogger. Each profile includes the datalogger name, type (CR800Series), IP address for remote connection, and PakBus Address (unique for each datalogger). The PakBus is assigned to a datalogger using the Campbell Scientific Device Configuration Utility program (Separate from LoggerNet) when the datalogger is directly connected to a computer. When directly connected to a datalogger with the Logger-PC cable, the connection type in the profile must be set to "Direct Connect". Once modem configuration is complete, the connection type can be changed to “IP Port” and the appropriate IP Address (static sim card IP) should be entered.

To connect to a datalogger, open the “Connect” tool in LoggerNet and any created datalogger profiles will be displayed in the “Stations” window on the left of the screen. Click on one and hit the “Connect” button. To upload a new CRBasic program, select the “File Control” button and select “Send”, this will allow you to navigate to a new CRBasic program and select it. Sending a new CRBasic program to the datalogger will prompt the user whether they would like to keep or delete data records acquired under the previous program, in most cases select “Keep the existing data”. The “Run Now” and “Run On” Power-up” boxes should be checked as well. If it is the first time a program is being uploaded to the datalogger, the unique SAA_Include*.cr8 file for the connected SAA array needs to be uploaded as well. Guidance for uploading the datalogger code can be found in the Measurand SAAF Manual (http://saaf.measurand.com/home).

1.4.2 Field preparation of the SAA and piezometers

Once in the field, the first step was to test piezometers by connecting them to the AVW200 Analyzer and recording zero readings under saturated, but unsubmerged, conditions. This step may be performed during drilling to save time.

1.4.3 Installation of SAA in borehole

As drilling of the borehole neared completion, then next task was to unroll the SAA and insert it into an assembled 1” Schedule 40 PVC Conduit. This process is detailed in the *Recommended Installation Methods for Vertical to Sub-vertical Installations* section of the SAAF Manual. During placement in the borehole, the drilling rig was used to support the SAA assembly. Based on our experience, the number of personnel needed for placement in the borehole ranged from 3 for boreholes less than 75 feet in length to 5 for boreholes upwards of 200 feet in length.

1.4.4 Installation of electronics enclosures

Electronics enclosures were installed on 2-19/50 inch x 8 foot 16-gauge galvanized metal poles. Poles were installed for both the battery enclosure and the datalogger enclosure, and founded in 20 to 24 inch deep holes shored by concrete. Poles were positioned as close as possible to the borehole, and no more than 15 feet away. Each enclosure was mounted to the pole using the supplied U-clamps.

Table 1. Instrument locations and date of instrument enclosure installation.

Site name	Latitude	Longitude	Borehole Depth	Installation date
Silver Point	45.856018	-123.962563	50 feet	January 23, 2017
Arch Cape	45.798088	-123.967078	160 feet	January 22, 2017
Beverly Beach North	44.730968	-124.057498	50 feet	January 27, 2017
Beverly Beach South	44.725763	-124.058157	50 feet	March 16, 2017

Arizona Inn	42.624147	-124.399302	200 feet	February 9, 2017

Table 2. Serial numbers for components installed at each site.

Site name	Component	Serial number
Silver Point	Enclosure	50053
	SAA	139173
	Modem	LT63740022021028
	Piezometer 1	1626724, 8m deep
	Piezometer 2	1626752, 16m deep
Arch Cape	Enclosure	50052
	SAA	139170
	Modem	LT63720049021028
	Piezometer 1	1629513, 40m deep
	Piezometer 2	1624710, 50m deep
Beverly Beach North	Enclosure	50054
	SAA	139171
	Modem	LT64010077021028
	Piezometer 1	1624169, 8m deep
	Piezometer 2	1622083, 14m deep
Beverly Beach South	Enclosure	50055
	SAA	139172
	Modem	LT63870153021028
	Piezometer 1	1621110, 8m deep
	Piezometer 2	1625985, 14m deep
Arizona Inn	Enclosure	50056
	SAA	139304
	Modem	LT63870151011028
	Piezometer 1	1628639, 42m deep
	Piezometer 2	1629252 60m deep

In addition to the main components, each station included the following equipment:

- (1) Sierra Wireless Airlink RV50 Modem (Manual: https://s.campbellsci.com/documents/us/manuals/rv50.pdf)
- (1) RS232 to USB Cord
- (1) AVW200: 2-Channel Vibrating-Wire Analyzer Module (Manual: https://s.campbellsci.com/documents/us/manuals/avw200.pdf)
- (1) SAA232: MEMS Interface Unit (Manual: http://measurandgeotechnical.com/uploads/products/SpecSheet_SAA232-5_Specification_Model003_61014.pdf)
- (1) Campbell Scientific CR800 Datalogger (Manual: http://www.rap.ucar.edu/projects/winter/instruments/CR800/manual.pdf)
- (2) Geokon 4500 Series Vibrating Wire Piezometers (Manual: http://www.geokon.com/content/manuals/4500_Piezometer.pdf)

- (1) 500mm Segment ShapeAccelArray SAAF MEMS Array (Manual: http://measurandgeotechnical.com/uploads/products/SpecSheet_SAAF_Specification_Model003_70412.pdf)
- (1) MorningStar Sunsaver Solar Regulator
- (1) 12V 100Ah, Deep Cycle, Non-Spillable Battery
- (2) Weatherproofed Enclosures
- (2) Protective Locks
- Multiple packets of Dessicant
- Spool of Copper Wire for Grounding

The following materials were required for SAA installation:

- ¼" Nylon rope (slightly longer than buried length of SAA)
- 1/8" Metal wire rope (25 feet recommended by Measurand Geotechnical)
- 1" or so steel conduit to serve as axle during SAA unrolling (should be around 3-4 feet longer than the width of the SAA reel)
- 2 Saw horses (with notch cut for steel axle to rest)
- PVC Cement and Primer
- 1" PVC Schedule 40 Conduit (enough for buried length of SAA rounded up to the nearest 10 foot increment)
- Hacksaw (for cutting PVC)
- Measurand SAA Install Kit
- Measuring tape
- Wire strippers
- Phillips head screwdriver
- Utility knife

Figure 1 below shows an example setup and explain how the systems are connected (e.g., wiring diagram)

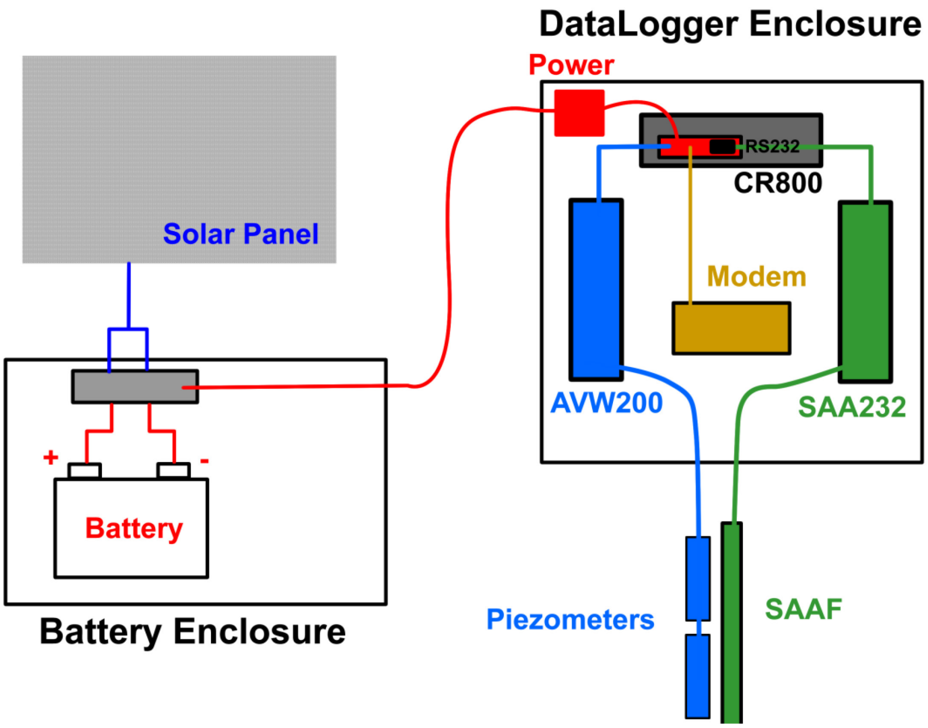

Figure 1. Schematic of the wiring for the MEMS and Piezometer system.

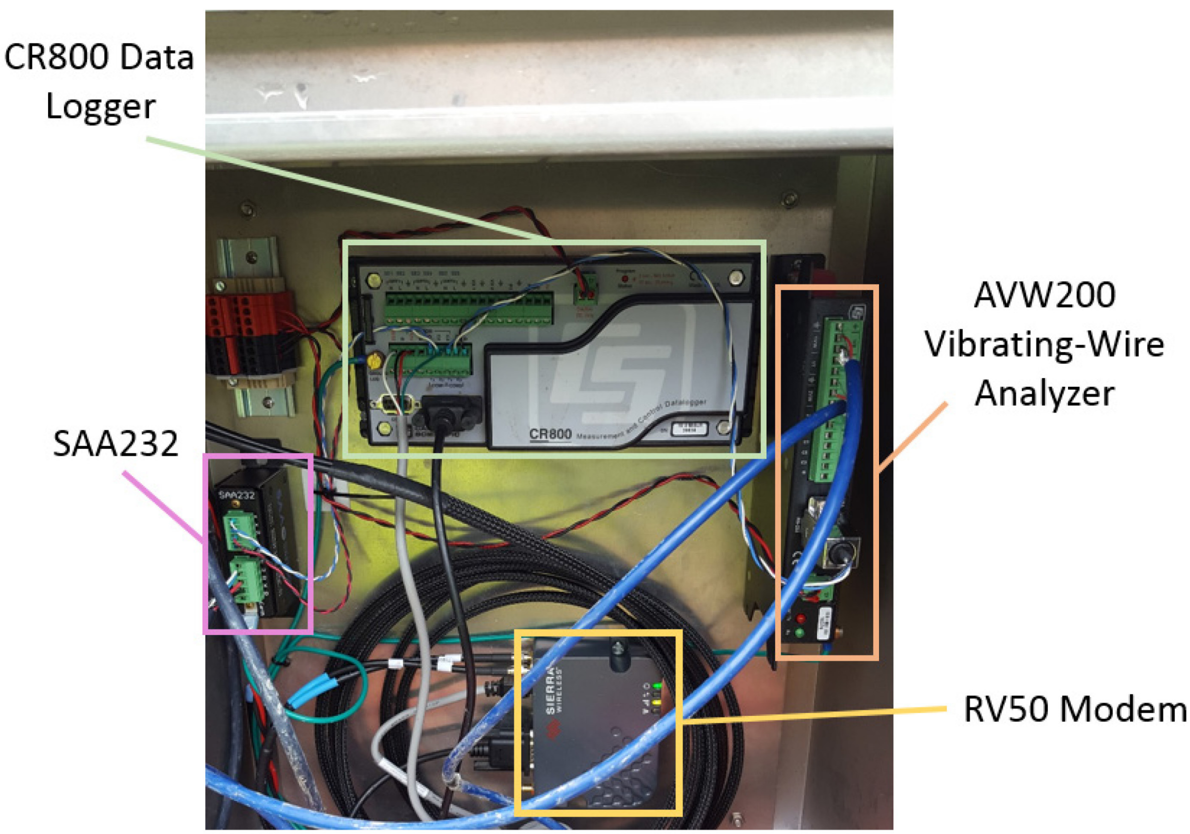

Figure 2. Photograph of components inside each electrical box.

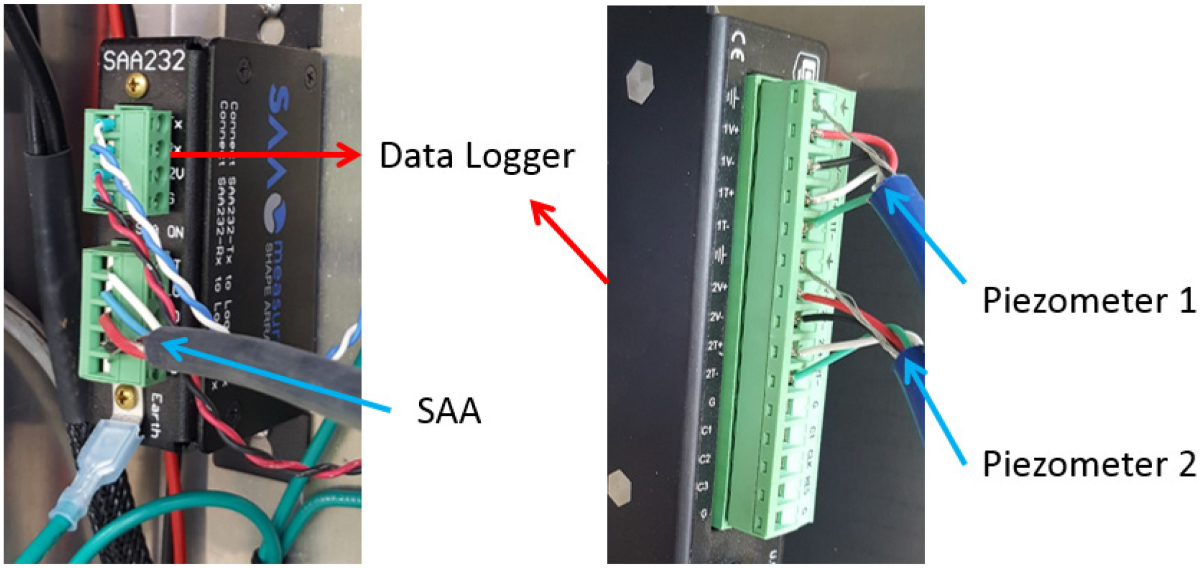

Figure 3. Close-up view of appropriate wire connections for the sensors.

1.5 CUSTOM DATALOGGER CODE

The majority of the datalogger code is auto-generated using the "SAACR_FileGenerator" tool in the SAASuite Software. Two *.CR8 code files will be generated, one contains the code that will be included in the main program for logging the SAA data, and the other is a SAA config file (SAA_Include_V3*.CR8) that will be uploaded to the datalogger as is. *Code must be auto-generated for each individual SAA as they all have unique calibrations*. Guidance for generating the datalogger code can be found in the Measurand SAAF Manual (http://saaf.measurand.com/home). An example of the custom datalogger code is included in the appendix for reference.

To generate the code for logging the Piezometers, use the "Short Cut" tool in LoggerNet and follow the following steps:

- Select New Program
- Datlogger Model = CR800 Series
- Scan Interval 30 minutes
- Under Devices, select the AVW200 folder and select the AVW200 item
- Proceed to the Water folder->Level & Flow and select the Geokon 4500 Series Vibrating Wire Piezometer
- Enter in Calibration constants and initial readings from factory calibration report
- Copy and paste piezometer code into auto-generated SAA logging code. Cross reference the attached example code to see the appropriate location where the piezometer code should be added.

Once the auto-generated SAA and piezometer logging code has been combined, code must be added for connecting and writing to an ftp server. Portions of the example code relevant to writing to an ftp server have been highlighted in yellow. If files are not being properly written to ftp directory and all code appears correct, inquire to COE IT regarding permissions of the ftp directory. A default logging rate of 30 minutes was selected for both the SAA and piezometers. ***The logging rate of the SAA should never exceed a 10 minute interval as it can crash the CR800 datalogger.*** Make sure to include the SW12v initialization code (highlighted green in example code) to ensure the RV50 modem powers on.

It is recommended that the "CRBasic" tool in LoggerNet be used for any modification and/or cutting and pasting of code. All code should be compiled in the CRBasic editor prior to uploading to a live datalogger. If significant changes need to be made to an existing datalogger program, it is recommended that the new code be uploaded to the datalogger in-person as opposed to uploading remotely unless absolutely necessary. If anything goes wrong when uploading new software remotely (e.g., partial upload of new software, code contains bug, etc.) the datalogger will likely freeze, which will require an in-person visit to fix.

1.6 INSTRUMENTATION MAINTENANCE

During each visit to sites (at least biannually), consistent maintenance procedures will be employed. For the data logger enclosure, the following should be performed:

- Check lock for corrosion. If corrosion is superficial, scrape off rust buildup. If excessive, replace lock with dual code/key access. Access code should be set to 8873.
- Check the dessicant for color change/cementation. Replace silica gel dessicant.
- Check hardware for signs of corrosion.
- Check joints for sealant condition. Ensure that silica epoxy is ductile. If brittle, apply new silica epoxy.
- Upload Campbell code updates.
- Power cycle (unplug and plug) power to CR800. This will restart the system and prevent data collection issues. Complete this step around h:15 or h:45 so as to not affect the measurements.

For the battery enclosure, the following should be performed:

- Check lock for corrosion. If corrosion is superficial, scrape off rust buildup. If excessive, replace lock with dual code/key access. Access code should be set to 8873.
- Check the dessicant for color change/cementation. Replace silica gel dessicant.
- Check battery for corrosion.
- Check joints for sealant condition. Ensure that silica epoxy is ductile. If brittle, apply new silica epoxy.
- Replace the battery every two years. (Last replaced 2/2017 when installed new).

For the outer station, the following should be performed:

- Check that grounding wires are in contact with grounding surfaces.
- Check solar panel and wires for condition. Replace system if damage or fatigue apparent.

- Check concrete for condition. If cracked, or pole is leaning, apply readymix to base.
- Verify that all wires are buried\covered appropriately and do not show signs of tearing or chewing by animals.

1.7 PROCESSING

Typical data recorded from each site includes MEMS array outputs, piezometer outputs, and datalogger diagnostics. The FTP site (ftp://landslides@ftp.engr.oregonstate.edu) contains five folders that are backed up hourly on OSU's network. All timestamps for logged data are in **Pacific Standard Time**. Each folder corresponds to a different instrumentation site. The folders are as follows:

- AI: Arizona Inn
- AC: Arch Cape
- BBN: Beverly Beach North
- BBS: Beverly Beach South
- SP: Silver Point
- HSK: Hooskanaden

Within each folder, the following files are updated every half hour from each datalogger station.
DataLogger Diagnostics: XX_LoggerDiag.dat *(XX= Site ID, shown above)*
Data Fields:

- "TIMESTAMP": Time and Date
- "RECORD": Record Number
- "LOGGER_VOLTAGE": Voltage provided to Datalogger
- "LOGGER_TEMPERATURE": Temperature in Datalogger (Celsius)
- "NOT_ENOUGH_POWER": Diagnostic for Insufficient Power

Piezometer Readings: XX_PiezoYYY.dat *(YYY= the Piezometer ID)*
Data Fields:

- "TIMESTAMP": Time and Date
- "RECORD": Record Number
- "BattV": Voltage to Piezometer
- "PTemp_C": Piezometer Temperature (Celsius)
- "Lvl": Piezoemetric Head (m)

ShapeAccelArray Data: XX_SAA_DATA.dat
Data Fields:

- "TIMESTAMP": Time and Date
- "RECORD": Record Number
- "SERIAL_NUMS(1,1)"
- "SAA1_ACC_VALUES(X=1, Y=2,Z=3,N)": X, Y or Z acceleration in segment N
- "SAA1_TEMP_VALUES(N)": Temperature in segment N

A sample of time-dependent output typically contains SAA data that must be processed through SAASuite 2.31, then plotted in Matlab. The free software package provides data output in .MAT form and performed pitch, yaw, and roll corrections from MEMS data. MATLAB outputs include piezometric and inclinometer data. An example from Arizona Inn is as follows:

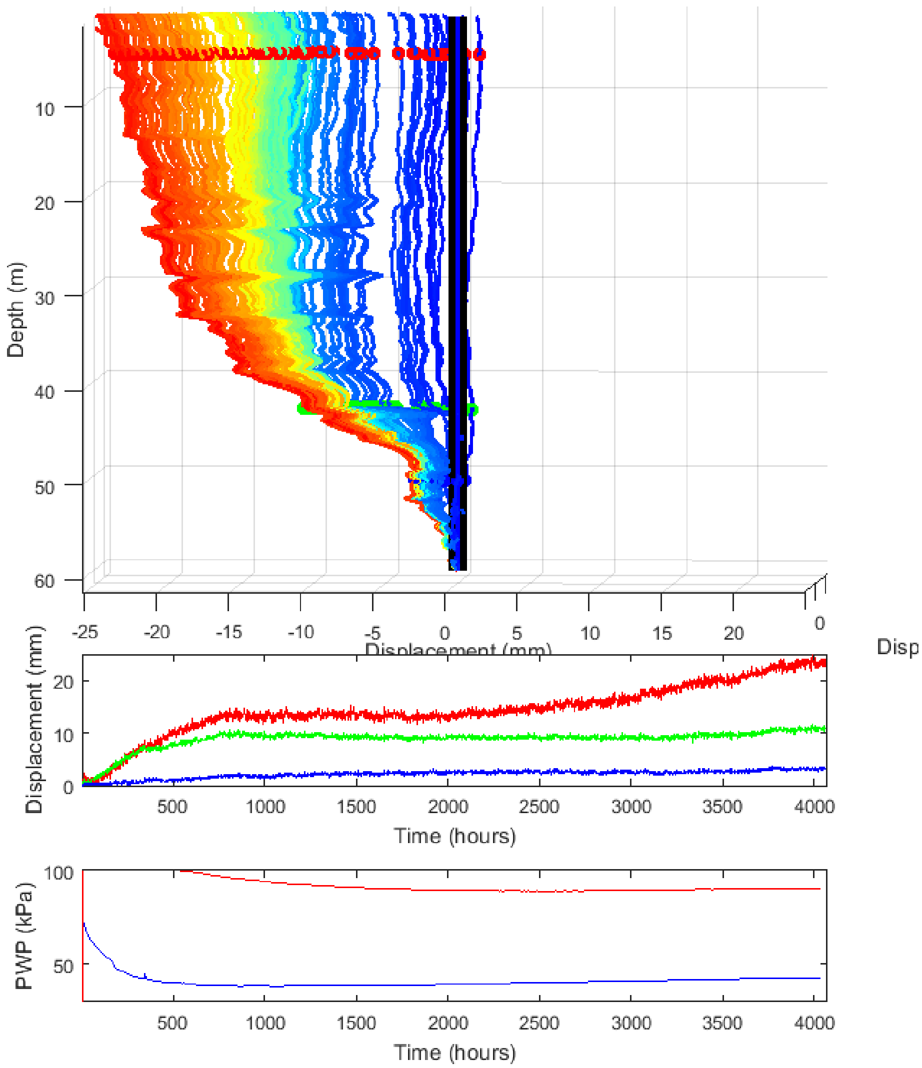

Figure 4. Example Processed output from SAASuite plotted in MATLAB.

1.8 TROUBLESHOOTING

Several issues were encountered during the deployment of the sensors:

- Shortly after installation, the sensor at Arch Cape stopped logging data and was showing voltage spikes. The voltage regulator was replaced, and the system was functional after that.
- In May 2017, the system installed in Arizona Inn stopped logging data. A reboot of the system successfully restored the system. This has worked for numerous systems over the years.

- The sites lost functionality at different dates as follows (failure date in parentheses):
    - Hooskanaden (January 2018), failed from excessive shear.
    - Arizona Inn (February 17, 2019), failed from excessive shear.
    - Spencer Creek South (October 10, 2023), failed from instrument failure.
    - Spencer Creek North (February 3, 2021), failed from excessive shear.
    - Silver Point (April 1, 2021), failed from vandalism.
    - Arch Cape (February 17, 2023), failed from instrument failure.

1.9 SUPPORTING DIGITAL APPENDICES

- Technical Specifications and User Manuals for Instrumentation
    - SAAs
    - Peizos
    - Weather Station
    - Geomote Geophones
    - Modems
    - Campbell Datalogger
- Calibration Documents for the sensors

1.10 EXAMPLE MATLAB CODE

```
clear all

%%%%%EDITABLE%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%Load File
load('A:\leshchib\AI_Working\multi_saa_allcart.mat') %%%File Name and Location // Use sperate working folders.

pwp1raw=importdata('A:\leshchib\AI_Working\AI_Piezo252.dat', ',', 4);
pwp2raw=importdata('A:\leshchib\AI_Working\AI_Piezo639.dat', ',', 4);

%%%Specify Depths and Points of Interest
total_depth=60; %Total Depth of Array, meters
depth_of_interest=110; %Representative of segment number. Example: If 120 0.5m segments, depth_of_interest=120 would be the ground surface (z=0).
depth_of_interest2=35;
depth_of_interest3=20;

%%%Specify Initial Time to Take Readings
time_init=8; %Unitless, should be multiplied by datalogger recording increment. In this case 0.5 hours.
time_inc_actual=0.5; %Actual data collection frequency, hours.
d_ax_lim=30; %scale for X and Y axis.
time_inc_plot=100; %Time increment for plotting, unitless. Example, if 10 units is selected, then it will plot the results of every ten readings.

%%%Plot Viewing
azi=248; %Azimuth for viewing borehole.
elevation=10; %Elevation for viewing borehole.


%%%%%NOT EDITABLE%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
clc
close all
```

```
clear xy_disp

pwp1(:,1)=-9.81*pwp1raw.data(:,13);
pwp2(:,1)=-9.81*pwp2raw.data(:,13);

[time_inc, segments]=size(ArrayCartesian{1,1}.cart_data.x);

depth=total_depth:-0.5:0;

init_x=ArrayCartesian{1,1}.cart_data.x(time_init,:);
init_Y=ArrayCartesian{1,1}.cart_data.y(time_init,:);
init_z=ArrayCartesian{1,1}.cart_data.z(time_init,:);

x_disp=zeros(time_inc, segments);
y_disp=zeros(time_inc, segments);
z_disp=zeros(time_inc, segments);
xy_disp=zeros(time_inc, segments);

x_disp_avg=zeros(time_inc, segments);
y_disp_avg=zeros(time_inc, segments);
z_disp_avg=zeros(time_inc, segments);
xy_disp_avg=zeros(time_inc, segments);

zero_disp_x=zeros(time_inc, segments);
zero_disp_y=zeros(time_inc, segments);

for time_count=time_init:1:time_inc

x_disp(time_count,:)=ArrayCartesian{1,1}.cart_data.x(time_count,:)-ArrayCartesian{1,1}.cart_data.x(time_init,:);
y_disp(time_count,:)=ArrayCartesian{1,1}.cart_data.y(time_count,:)-ArrayCartesian{1,1}.cart_data.y(time_init,:);
z_disp(time_count,:)=ArrayCartesian{1,1}.cart_data.z(time_count,:)-ArrayCartesian{1,1}.cart_data.z(time_init,:);

i=1;

rolling_avg=5;
roll=0;

for avg_count=1:rolling_avg:segments

    x_disp_avg(time_count,avg_count)=mean(x_disp(time_count,(avg_count-roll):avg_count),2);

    depth_avg(1,i)=depth(1,avg_count);
    i=i+1;

        if avg_count>rolling_avg
        roll=rolling_avg;
        else
        roll=roll+1;
        end

end

for segment_count=1:1:segments

xy_disp(time_count,segment_count)=sqrt((x_disp(time_count,segment_count)^2)+(y_disp(time_count,segment_count)^2));

end

end


for time_count=time_init:time_inc_plot:time_inc
```

```
subplot(5,1,[1 3])
set(gcf,'units','points','position',[100,100,500,650])
if time_count==time_init
patch([d_ax_lim -d_ax_lim -d_ax_lim d_ax_lim], [d_ax_lim d_ax_lim -d_ax_lim -d_ax_lim],[0 0 0 0],'FaceColor',[0 0
0],'FaceAlpha',0.1)
hold on
plot3(x_disp(time_init,:),y_disp(time_init,:),depth,'k','LineWidth',10)
hold on
end

t_norm=(time_count-time_init)/(time_inc-time_init);

if t_norm>(2/3)
   t_color=[1 (1-t_norm)/(1/3) 0];
elseif t_norm<(2/3) && t_norm>(1/3)
   t_color=[(t_norm-(1/3))/(1/3) 1 (t_norm-(2/3))/-(1/3)];
elseif t_norm<(1/3)
   t_color=[0 t_norm/(1/3) 1];
else
    t_color=[0 0 1];
end

plot3(x_disp(time_count,:),y_disp(time_count,:),depth,'Color',t_color,'LineWidth',2);
xlim([-d_ax_lim d_ax_lim]);
ylim([-d_ax_lim d_ax_lim]);
view(azi,elevation);
set(gca,'ZDir','Reverse')
grid on
scatter3(x_disp(time_count,(depth_of_interest)),y_disp(time_count,(depth_of_interest)),depth(1,depth_of_interest),50,'filled','r')
hold on
scatter3(x_disp(time_count,(depth_of_interest2)),y_disp(time_count,(depth_of_interest2)),depth(1,depth_of_interest2),50,'filled','
g')
hold on
scatter3(x_disp(time_count,(depth_of_interest3)),y_disp(time_count,(depth_of_interest3)),depth(1,depth_of_interest3),50,'filled','
b')
hold on


xlabel('Displacement (mm)')
ylabel('Displacement (mm)')
zlabel('Depth (m)')
drawnow;
pause(0.01);

subplot(5,1,4)
plot(1:1:time_count,xy_disp(1:time_count,depth_of_interest),'r');
hold on
plot(1:1:time_count,xy_disp(1:time_count,depth_of_interest2),'g');
hold on
plot(1:1:time_count,xy_disp(1:time_count,depth_of_interest3),'b');
hold on
xlim([1 time_inc]);
ylim([0 d_ax_lim]);
xlabel('Time (hours)')
ylabel('Displacement (mm)')

subplot(5,1,5)
plot(1:1:time_count,pwp1(1:time_count,1),'b');
hold on
plot(1:1:time_count,pwp2(1:time_count,1),'r');
hold on
```

```
xlim([1 time_inc]);
ylim([30 100]);
xlabel('Time (hours)')
ylabel('PWP (kPa)')


end

for azi=azi:3:azi+360
subplot(5,1,[1 3])
   view(azi,elevation);
   drawnow
end
```

1.11 DRILLING BID ESTIMATE

ITEM	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	TOTAL PRICE
1	Administration	1	LS	1000	3500
2a	Mobilization - Silver Point	1	LS	3500	3500
2b	Mobilization - Arch Cape	1	LS	3500	3500
2c	Mobilization - BB/SC	1	LS	3500	3500
2d	Mobilization - Arizona Inn	1	LS	14500	14500
3	Drilling (4" HSA)	100	FOOT	90	9000
4	Coring (HQ3)	390	FOOT	90	35100
5	2" SPT Tests/ 3" ModCal	108	EACH	15	1620
6	3" Shelby Tubes	20	EACH	25	500
7	Drums (non-contaminated)	5	EACH	200	1000
8	Drums (contaminated)	1	EACH	200	200
9	Piezometers/Inclinometers	490	FOOT	31.5	15435
10	12" Flush Mounted Completion	5	EACH	650	3250
11	Geotechnical Hole Reports	5	EACH	40	200
12	Stand-By Time	16	HOUR	150	2400
	BID (Items 1-12)				**103370.5**

1.12 Final Drilling Contract

P.O. Box 940
Meridian, ID 83680
PH (208) 888-4790
FAX (208) 888-5712

HAZ TECH Drilling, Inc.

Invoice Number: 13734

Date: 2/15/2017

Sold To: Oregon Department of Transporta
555 13th Street NE, Suite 2
Salem, OR 97301

TIN 82-0455227

Project:
Coastal Landslide Geotechnical Drilling - Oregon Coast

Reference - P.O. No.	Customer No.	Drill Rig	Driller	Terms
CONTRACT# B34785	ODOT2.1	'93 Red BK-81	Chris Peterson	NET30

Description/Comments	Quantity	UOM	Unit Price	Amount
Administration, lump sum	1.00	LS	3,500.00	3,500.00
Mob-Demob - Silver Point Site	1.00	EA	3,500.00	3,500.00
Mob-Demob - Arch Cape Site	1.00	EA	3,500.00	3,500.00
Mob-Demob - BB/SC Site	1.00	EA	3,500.00	3,500.00
Mob-Demob - Arizona Inn Site	1.00	EA	14,500.00	14,500.00
Auger Drilling, per foot	178.00	FT	90.00	16,020.00
Core / Casing Advancer Drilling, per foot	334.00	FT	90.00	30,060.00
SPT's, each	33.00	EA	15.00	495.00
Piezo's / Inclinometers Installed, per foot	512.00	FT	31.50	16,128.00
Geotech Reports, each	5.00	EA	40.00	200.00
Standby, per hour	21.50	HR	150.00	3,225.00
** Project Period of Performance: 1/16/17 - 2/9/17				

Comments: **Please pay from this invoice.**

Remit To:
Haz-Tech Drilling, Inc.
P. O. BOX 940
MERIDIAN, ID 83680

Amount Due : 94,628.00

Invoice

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1.13 EXAMPLE DATALOGGER CRBASIC CODE

```
' ----------------------------------------------------------------------------------------------------------------------------
' Campbell Scientific CR800/850,CR1000,CR3000,CR6,CR300 Datalogger Program for collecting ShapeAccelArray (SAA) Data
' Program Author: Jason Bond, Measurand Inc. (built upon single array program by Murray Simpson) (c) 2016

' Version History:
' 1.0: Initial internal release
' 1.1: 'AVERAGING' added to the PROJECT_INFO file
' 1.2: 'PROGRAM_VERSION_NUM' added to the PROJECT_INFO file
    'Program now contains 2 components to prevent editing of critical code by users: i) SAA_Communicator_Vx_x and ii) SAA_Include_Vx_x
' 1.3  'Pre-sample added to clear sensor values on first read.
    'ScreenObs subroutine added to filter sensor values.
    'Code added to accommodate partial octets at the end of an SAA
' 1.4  'Ability to assign SAAs to any COM port added (instead of requiring sequential use)
    'Ability to use RS232 port to hook up additional SAAs added
' 1.5  'SAA now shutdown and re-powered after a CRC, COM or range error
    'Check for 0 values added to ScreenObs subroutine
    'Dim u,v As Long variables had to be moved outside of ScreenObs subroutine to compile. Problem arose after updating OS on CR1000.
' 1.6   21 Aug 2009:
    'ScreenObs subroutine removed. Now looked after in SAA3D
    'Range Errors removed from SERIAL_ERRORS_FILE
    'Code to accommodate partial octets removed. Now looked after in SAA3D.
' 1.7  'Various changes made in an attempt to improve computation speed. VERSION NOT RELEASED and changes not implemented
    'in subsequent versions due to anticipation of new high resolution SAAs. Historical significance only.
    'a)SetSAAPort added to allow switching of SAA baud
    'b)CRC check removed
    'c) Temperature averaging removed - just one value read in SAA data. GetSAASample modified to allow this.
' 1.8   A) Addition of alarm notification through email/text:
    'a) input of number of masked segments (from the top)
    'b) input of tilt alarm in degrees
    'c) input of email notification parameters
    'd) addition of storage variable for previous readings

    'B) Addition of high resolution SAA data collection capabilities
    'a) public HIGH_RES_SAA As boolean added
    'b) close, open and flush serial port commands added to shut down sequence when data has failed to be acquired.

    'Note: When changing the version number, the Include file reference below must be updated and the VERSION_NUM constant in the include file must be modified
' 1.9   Jan. 27, 2010:
    'uses updated include file: CPU:SAA_Include_V1_9.CRx, corrects bug in collection of high res. data from arrays longer than 8 segments.

    'Note: When changing the version number, the Include file reference below must be updated and the VERSION_NUM constant in the include file must be modified

' 2.3   Uses new include file: CPU:SAA_Include_V2_3.CRx
' 2.4   Capable of acquiring voltage, current, and top segment temperature from SAATop devices integrated into the top of arrays. Uses new include file: CPU:SAA_Include_V2_4.CRx
' 2.5   Nov. 12, 2010: Added acquisition of logger voltage and temperature for diagnostic purposes
' 2.6   Nov. 29, 2010: Added code for using SAA232_5 device for combining up to 5 SAAs on a single serial port
' 2.61  Dec. 07, 2010: Fixed bug in 2.6 for 2nd array data data table
' 2.62  Dec. 13, 2010: Modified to sample some preliminary samples as fast as possible upon power-up before switching to regular scan interval for samples
' 2.63  Mar. 10, 2011: Modified to include array serial numbers in SAA diagnostic files.
' 2.64  Aug. 10, 2011: Modified to use new include file: CPU:SAA_Include_V2_63.CRx
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' 2.65  Aug. 11, 2011: Modified to use new include file: CPU:SAA_Include_V2_64.CRx
' 2.66  Aug. 25, 2011: Modified to provide an error table for each array connected to the data logger.
' 2.67  Sep. 27, 2011: Modified to use new include file: CPU::SAA_Include_V2_66.CRx
' 2.68  Oct. 07, 2011: Modified to use new include file: CPU::SAA_Include_V2_67.CRx, got rid of unused tilt_alarm stuff
' 3.00  Oct. 20, 2011: Simplified, cleaned up code, uses new include file: CPU::SAA_Include_V3_00.CRx.
' 3.01  Dec. 05, 2011: Modified to use new include file: CPU::SAA_Include_V3_01.CRx
' 3.02  Dec. 12, 2011: Modified to use new include file: CPU::SAA_Include_V3_02.CRx
' 3.03  Mar. 05, 2012: Modified to use new include file: CPU::SAA_Include_V3_03.CRx
' 3.04  Aug. 03, 2012: All SAAPZ data is stored in one data table, new include file: CPU::SAA_Include_V3_04.CRx
' 3.05  May 23, 2013: Modified to use new include file: CPU::SAA_Include_V3_05.CRx
' 3.06  Feb 28, 2014: Modified to use new include file: CPU::SAA_Include_V3_06.CRx
' 3.07  Apr. 01, 2014: First version to support PNP: CPU::SAA_Include_V3_07.CRx
' 3.08  June 16, 2014: Modified to use new include file: CPU::SAA_Include_V3_08.CRx
' 3.09  July 14, 2014: Modified to use new include file: CPU::SAA_Include_V3_09.CRx
' 3.10  July 30, 2014: AIA level individual to each SAA, AIA vs non-AIA individual to each SAA
' 3.13  September, 2015: Added support for very long SAAs with multiple SAATops
' 3.14  October, 2016: memory optimizations for CR300 to allow for more than 200 SAA segments

' SAACR_FileGenerator declared Constants
' ---------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<
' Number of preliminary samples to capture
Const NUM_PRELIM_SAMPLES = 5
' Number of SAAs to be monitored
Const NUM_SAAS = 1
' Number of piezometers, must be at least 1, even if no piezometers are used
Const NUM_PIEZOS = 1
' Number of total devices (number of SAAs + SAAPZs)
Const NUM_DEVICES = 1
' Number of PZ strings to be monitored, DEPRECATED (kept for backward compatibility) !!! must be 1 in any case
Const NUM_PIEZO_STRINGS = 1
' Number of raw data samples to average for each measurement
' Samples can range from 100-25500 for AIA capable SAAs (SN > 47100); samples are collected at 400 Hz, thus ~64 seconds are
required for NUM_TO_AVG = 25500
Const SAA1_NUM_TO_AVG = 1000
' Maximum number of octets (8 segment units) of any single SAA being used (must be at least 1, even if no SAA octets are
present, also use 1 if only PNP SAAs are used)
Const MAX_NUM_OCTETS = 1
' Maximum number of PNP segments (single segment units) of any single SAA being used (must be at least 1, even if no PNP
SAAs are present) PNP serial numbers are >= 66000
Const MAX_NUM_PNP_SEGMENTS = 32
' Maximum number of PICS in a single SAA = max( MAX_NUM_OCTETS, MAX_NUM_PNP_SEGMENTS)
Const MAX_NUM_PICS = 32
' Maximum number of magnetometers in a single SAA
Const MAX_NUM_MAGS = 1
' Number of PICs for each SAA (each SAA must have an entry)
Const SAA1_NUM_PICS = 32
' COM port number for each SAA (each SAA must have an entry) COM1=1, COM2=2, COM3=3, COM4=4 for
CR800/CR1000/CR3000
' COMC1=5, COMC3=6, COMU1=7, COMU3=8, COMU5=9, COMU7=10, COMU9=11, COMU11=12 for CR6
Const SAA1_COM_PORT = 1
' COM port number for each Measurand piezometer (if piezometers are used)
Const PIEZO1_COM_PORT = 1
' SAA232-5 port number for each SAA (each SAA must have an entry) 1-5 if SAA232-5 port is being used, otherwise enter 0
Const SAA1_232_5_PORT = 0
' SAA232-5 port number for each Measurand piezometer (if piezometers are used)
' Const PIEZO1_232_5_Port = 0
' Input whether or not SAATop is present or if multiple SAATops are present (0 = not present, N>0 is number of SAATops
present in SAA, typically 1)
' --> Most SAAs built after 2011 should have a SAATop
' --> SAAs of more than 100 meters of length have 2 or more SAATops
Const SAA1_SAATOP = 1
```

```
' >>>>>>>>> END <<<<<<<<<
' -----------------------------------------------------------------------------
' SAACR_FileGenerator declared Constants

' USER declared Constants
' -----------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<

' >>>>>>>>> END <<<<<<<<<
' -----------------------------------------------------------------------------
' USER declared Constants

' Import Include File
Include "CPU:SAA_Include_V3_19_1701041456.CR8"

' SAACR_FileGenerator declared Variables
' -----------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<
' Public ACC, TEMP, and diagnostic variables for each SAA:
' SAA1:
Dim SAA1_ACC_VALUES(MAX_NUM_PNP_SEGMENTS,NUM_SENSORS_PER_PNP) As Float
Dim SAA1_TEMP_VALUES(MAX_NUM_PNP_SEGMENTS) As Float
Dim SAA1_SAATOP_VOLTAGE(SAA1_SAATOP) As Float
Dim SAA1_SAATOP_CURRENT(SAA1_SAATOP) As Float
Dim SAA1_SAATOP_TEMPERATURE(SAA1_SAATOP) As Float
Dim SAA1_SEGS_IN_SECTION(SAA1_SAATOP) As Long

' preliminary loop count
Dim PRELIM_COUNT As Long

Dim i As Long
' >>>>>>>>> END <<<<<<<<<
' -----------------------------------------------------------------------------
' SAACR_FileGenerator declared Variables

' USER declared Variables
' -----------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<

' >>>>>>>>> END <<<<<<<<<
' -----------------------------------------------------------------------------
' USER declared Variables
Public FileCntr = 1
Public FileName As String
'Piezo Variables 'Matt
Public BattV
Public FCLoaded
Public PTemp_C
Public AVWRC
Public VW(6)
Public TT
Public TT0
Public Digits
Public Digits0
Public Lvl
Public ZMode
Public CAvg
Public AVWRC_2
Public VW_2(6)
Public TT_2
Public TT0_2
Public Digits_2
```

```
Public Digits0_2
Public Lvl_2
Public ZMode_2
Public CAvg_2

Alias VW(1)=Freq
Alias VW(2)=Amp
Alias VW(3)=SNRat
Alias VW(4)=NFreq
Alias VW(5)=DRat
Alias VW(6)=TR
Alias VW_2(1)=Freq_2
Alias VW_2(2)=Amp_2
Alias VW_2(3)=SNRat_2
Alias VW_2(4)=NFreq_2
Alias VW_2(5)=DRat_2
Alias VW_2(6)=TR_2

Units BattV=Volts
Units PTemp_C=Deg C
Units TT=deg C
Units TT0=deg C
Units Digits=digits
Units Digits0=digits
Units Lvl=m
Units TT_2=deg C
Units TT0_2=deg C
Units Digits_2=digits
Units Digits0_2=digits
Units Lvl_2=m
Units Freq=Hz
Units Amp=mV RMS
Units NFreq=Hz
Units TR=ohms
Units Freq_2=Hz
Units Amp_2=mV RMS
Units NFreq_2=Hz
Units TR_2=ohms

'Needed for powering modem
Public SW12State As Boolean

'FTP Related Variables
Public FTPResult
Public FLag(2) As Boolean
'Const FTPAddress = "128.193.40.35"
Const FTPAddress = "ftp.engr.oregonstate.edu"
Const UserName="landslides"
Const Password=""

'Piezometer Variable
'Public AVWResult 'Matt DELETE?
'Public VW(NUM_PIEZOS,6) 'Matt DELETE?
' SAACR_FileGenerator declared Data Tables
' --------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<
' Project Descriptor Info
DataTable(PROJECT_INFO,FIRST_SCAN,-1)
	Sample(1,PROGRAM_VERSION_NUM,Float)
	Sample(NUM_SAAS,AVERAGING(),Long)
	Sample(1,PROJECT_NAME,String)
	Sample(1,NUMBER_SAAS,Long)
```

```
		Sample(NUM_SAAS,NUM_PICS_INDEX(),Long)
		Sample(NUM_SAAS*MAX_NUM_PICS,SERIAL_NUMS(),Long)
EndTable

' Serial Port Errors:
DataTable(SERIAL_ERRORS,True,-1)
		Sample(1,SERIAL_NUMS(1,1),Long)
		Sample(NUM_DEVICES,NUM_CRC_ERRORS,Long)
		Sample(NUM_DEVICES,NUM_COM_ERRORS,Long)
EndTable

' Logger Diagnostics:
DataTable(LOGGER_DIAGNOSTICS,True,-1)
		Sample(1,LOGGER_VOLTAGE,Float)
		Sample(1,LOGGER_TEMPERATURE,Float)
		Sample(1,NOT_ENOUGH_POWER,Boolean)
EndTable

' SAA Data Table Values (each SAA requires a data table):
' SAA1:
DataTable(SAA1_DATA,True,-1)
		Sample(1,SERIAL_NUMS(1,1),Long)
		Sample(SAA1_NUM_PICS*NUM_SENSORS_PER_PNP,SAA1_ACC_VALUES(),Float)
		Sample(SAA1_NUM_PICS,SAA1_TEMP_VALUES(),Float)
EndTable


' SAA Diagnostics
DataTable (SAA_DIAGNOSTICS,True,-1)
		Sample(1,SERIAL_NUMS(1,1),Long)
		Sample(SAA1_SAATOP,SAA1_SAATOP_VOLTAGE,Float)
		Sample(SAA1_SAATOP,SAA1_SAATOP_CURRENT,Float)
		Sample(SAA1_SAATOP,SAA1_SAATOP_TEMPERATURE,Float)
EndTable

'Piezo Data Tables
DataTable(Piezo724,True,-1)
		'DataInterval(0,1,Min,10)
		Sample(1,BattV,FP2)
		Sample(1,AVWRC,FP2)
		Sample(1,Freq,FP2)
		Sample(1,Amp,FP2)
		Sample(1,SNRat,FP2)
		Sample(1,NFreq,FP2)
		Sample(1,DRat,FP2)
		Sample(1,TR,FP2)
		Sample(1,TT,FP2)
		Sample(1,Digits,IEEE4)
		Sample(1,Lvl,FP2)
EndTable

DataTable(Piezo752,True,-1)
		'DataInterval(0,1440,Min,10)
		Sample(1,BattV,FP2)
		Sample(1,AVWRC_2,FP2)
		Sample(1,Freq_2,FP2)
		Sample(1,Amp_2,FP2)
		Sample(1,SNRat_2,FP2)
		Sample(1,NFreq_2,FP2)
		Sample(1,DRat_2,FP2)
		Sample(1,TR_2,FP2)
		Sample(1,TT_2,FP2)
```

```
        Sample(1,Digits_2,IEEE4)
        Sample(1,Lvl_2,FP2)
EndTable

'Calibration history table
DataTable(CalHist,NewFieldCal,10)
        SampleFieldCal
EndTable

'DataTable (VW_DATA,True,-1) 'Matt
        'Sample(NUM_PIEZOS*6,VW(),IEEE4)
'EndTable
' >>>>>>>>> END <<<<<<<<<
' ---------------------------------------------------------------------------
' SAACR_FileGenerator declared Data Tables

' USER declared Data Tables
' ---------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<

' >>>>>>>>> END <<<<<<<<<
' ---------------------------------------------------------------------------
' USER declared Data Tables

' SAACR_FileGenerator declared Subroutines
' ---------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<
'
****************************************************************************************************
*****************
' Sub: InitializeDataStructures
' Purpose: initialize all data structures with default value
' Inputs: none
'
****************************************************************************************************
*****************
Sub InitializeDataStructures()

        Dim i,j As Long

        For i = 1 To MAX_NUM_PNP_SEGMENTS
                For j = 1 To NUM_SENSORS_PER_PNP
                        SAA1_ACC_VALUES(i,j) = 0
                Next
                SAA1_TEMP_VALUES(i) = 0
        Next
        For i = 1 To SAA1_SAATOP
                SAA1_SAATOP_VOLTAGE(i) = 0
                SAA1_SAATOP_CURRENT(i) = 0
                SAA1_SAATOP_TEMPERATURE(i) = 0
        Next

EndSub

' ****************************************************************************
' Sub: GetArrayData
' Purpose: gets all of the array data
' Inputs: None
' ****************************************************************************
Sub GetArrayData()
        Call InitializeDataStructures()
```

```
		Dim loop_count As Long
		Dim segment_number As Long

		Call GetLoggerDiagnostics()

		'If logger voltage is below 10.5 V don't take readings from the SAA(s)
		If NOT_ENOUGH_POWER = True Then
			ExitSub
		EndIf

		'add calls to each SAA:
		'--------------------------------------------------------
		'SAA1:
		loop_count=1
		segment_number=1
		Call GetSAATopData(loop_count-
1,SAA1_SAATOP_VOLTAGE(loop_count),SAA1_SAATOP_CURRENT(loop_count),SAA1_SAATOP_TEMPERATURE(lo
op_count),1,segment_number,SAA1_SEGS_IN_SECTION(loop_count))
		Call
GetHighResPNPData(SAA1_ACC_VALUES,SAA1_TEMP_VALUES,1,segment_number,SAA1_SEGS_IN_SECTION(loop_c
ount))
		TurnOffSAA232_5(1)

EndSub
' >>>>>>>>> END <<<<<<<<<
' ----------------------------------------------------------------------------
' SAACR_FileGenerator declared Subroutines

' USER declared Subroutines
' ----------------------------------------------------------------------------
' >>>>>>>>> START <<<<<<<<<
'Sub GetVWData() 'Matt
  'Scan(1,sec,0,1)'need this dummy scan to auto-allocate data tables
    'Get Piezometer Data
    'SerialOpen(COM2,38400,4,0,0)
    'AVW200(AVWResult(),COM2,0,200,VW(1,1),1,1,1,450,6000,2,_60Hz,1,0)
    'AVW200(AVWResult(),COM2,0,200,VW(2,1),2,1,1,450,6000,2,_60Hz,1,0)

  'CallTable VW_DATA
  'SerialClose(COM2)
  'NextScan
'EndSub

' >>>>>>>>> END <<<<<<<<<
' ----------------------------------------------------------------------------
' USER declared SubRoutines

' Main Progam:
' ----------------------------------------------------------------------------
BeginProg
		' SAACR_FileGenerator generated program code
		' ----------------------------------------------------------------------------
		' >>>>>>>>> START <<<<<<<<<
		'PowerCode Matt

		' Project Title
		PROJECT_NAME = "SilverPoint"
		SW12State=True
		SW12 (SW12State)
		NUMBER_SAAS = NUM_SAAS
		AVERAGING(1) = SAA1_NUM_TO_AVG
		PROGRAM_VERSION_NUM = VERSION_NUM
```

```
NOT_ENOUGH_POWER = False

' Serial numbers (each octet) for each SAA:
' ---------------------------------------------------------------------------
' SAA1 - S/N: 139173 -- AIA SAA, PNP SAA
SERIAL_NUMS(1,1) = 139173
SERIAL_NUMS(1,2) = 139652
SERIAL_NUMS(1,3) = 139662
SERIAL_NUMS(1,4) = 139814
SERIAL_NUMS(1,5) = 139682
SERIAL_NUMS(1,6) = 139692
SERIAL_NUMS(1,7) = 139874
SERIAL_NUMS(1,8) = 139884
SERIAL_NUMS(1,9) = 139894
SERIAL_NUMS(1,10) = 139924
SERIAL_NUMS(1,11) = 139914
SERIAL_NUMS(1,12) = 139650
SERIAL_NUMS(1,13) = 139660
SERIAL_NUMS(1,14) = 139670
SERIAL_NUMS(1,15) = 139680
SERIAL_NUMS(1,16) = 139690
SERIAL_NUMS(1,17) = 139560
SERIAL_NUMS(1,18) = 139570
SERIAL_NUMS(1,19) = 139540
SERIAL_NUMS(1,20) = 139547
SERIAL_NUMS(1,21) = 139577
SERIAL_NUMS(1,22) = 139870
SERIAL_NUMS(1,23) = 139880
SERIAL_NUMS(1,24) = 139890
SERIAL_NUMS(1,25) = 139900
SERIAL_NUMS(1,26) = 139910
SERIAL_NUMS(1,27) = 140513
SERIAL_NUMS(1,28) = 140604
SERIAL_NUMS(1,29) = 140594
SERIAL_NUMS(1,30) = 140584
SERIAL_NUMS(1,31) = 140523
SERIAL_NUMS(1,32) = 125951


' Number of segments that belong to each SAATop
' ---------------------------------------------------------------------------
SAA1_SEGS_IN_SECTION(1) = 32

' Number of PICs for each SAA:
' ---------------------------------------------------------------------------
' SAA 1:
NUM_PICS_INDEX(1) = SAA1_NUM_PICS

' COM port assignment for each SAA:
' ---------------------------------------------------------------------------
' SAA1:
COM_PORT(1) = SAA1_COM_PORT
SAA232_5_PORT_INDEX(1) = SAA1_232_5_PORT

' Initialize COM and CRC errors:
' ---------------------------------------------------------------------------
NUM_COM_ERRORS = 0
NUM_CRC_ERRORS = 0

' Initialize SAATOP parameters
' ---------------------------------------------------------------------------
For i=1 To SAA1_SAATOP
```

```
                SAA1_SAATOP_VOLTAGE(i)=0.0
                SAA1_SAATOP_CURRENT(i)=0.0
                SAA1_SAATOP_TEMPERATURE(i)=0.0
        Next i

        ' SAATOP channel of each SAA:
        ' ----------------------------------------------------------------------------
        ' SAA1:
        SAATOP_CHANNEL_INDEX(1) = 0

        FIRST_SCAN = true

        ' USER program initializations
        ' ----------------------------------------------------------------------------
        ' >>>>>>>>> START <<<<<<<<<

        ' >>>>>>>>> END <<<<<<<<<
        ' ----------------------------------------------------------------------------
        ' User program initializations

        ' preliminary scans first
        ' ----------------------------------------------------------------------------
        For PRELIM_COUNT=1 To NUM_PRELIM_SAMPLES
                Scan(1,sec,0,1)
  Call GetArrayData()
                        'fill in project info table:
  CallTable PROJECT_INFO
                        'fill in logger diagnostics table
                        CallTable LOGGER_DIAGNOSTICS
                        'fill in SAA data tables
                        CallTable SAA1_DATA
                        'fill in SAA diagnostics table
                        CallTable SAA_DIAGNOSTICS
                        'record serial errors table:
                        CallTable SERIAL_ERRORS

                        'turn off outputting of project descriptor info after first run
                        FIRST_SCAN = false
                        Delay(0,10,2)
                NextScan
        Next PRELIM_COUNT

        ' SAACR_FileGenerator generated Main Scan Loop
        ' ----------------------------------------------------------------------------
        ' >>>>>>>>> START <<<<<<<<<

Scan(30,min,0,0)
 'Call GetVWData() 'Matt
 Call GetArrayData()
                ' fill in project info table:
                CallTable PROJECT_INFO
                ' fill in logger diagnostics table
                CallTable LOGGER_DIAGNOSTICS
                ' fill in SAA data tables
                CallTable SAA1_DATA
                ' fill in SAA diagnostics table
                CallTable SAA_DIAGNOSTICS
                'fill in serial errors table:
                CallTable SERIAL_ERRORS
        'CallTable Table3
                'CallTable VW_DATA 'Matt
                ' turn off outputting of project descriptor info after first run
```

```
		FIRST_SCAN = false

'Start of Piezo Code
SerialOpen(COM2,38400,4,0,0)
	'Initialize calibration variables for
	'Geokon 4500 Series Vibrating Wire Piezometer calculation 'Lvl'
	'CAvg=1 : Digits0=9731 : TT0=22.8 'Factory
	CAvg=1 : Digits0=9761 : TT0=6.0 'Enter new field zero values here
	'Initialize calibration variables for
	'Geokon 4500 Series Vibrating Wire Piezometer calculation 'Lvl_2'
	'CAvg_2=1 : Digits0_2=9120 : TT0_2=22.1 'Factory
	CAvg_2=1 : Digits0_2=9139 : TT0_2=6.7 'Enter new field zero values here
	'Load the most recent calibration values from the CalHist table
	FCLoaded=LoadFieldCal(True)
	'Main Scan
	'Scan(1,Min,1,0)
		'Default CR800 Datalogger Battery Voltage measurement 'BattV'
		Battery(BattV)
		'Default CR800 Datalogger Wiring Panel Temperature measurement 'PTemp_C'
		PanelTemp(PTemp_C,_60Hz)
		'Geokon 4500 Series Vibrating Wire Piezometer measurement 'Freq'
		AVW200(AVWRC,COM2,0,200,VW(1),1,1,1,1000,4000,1,_60Hz,1,0)
		'Calculate thermistor temperature 'TT'
		TT=1/(1.4051E-3+2.369E-4*LN(TR)+1.019E-7*LN(TR)^3)-273.15
		'Calculate digits 'Digits'
		Digits=Freq^2/1000
		'Calculate water level 'Lvl' (PSI)
		Lvl=(Digits0-Digits)*-0.01586+(TT-TT0)*-0.01081
		'Convert water level 'Lvl' from PSI to m
		Lvl=Lvl*0.70432
		'Zeroing calibration for
		'Geokon 4500 Series Vibrating Wire Piezometer calculations 'Digits' and 'TT'
		FieldCal(4,Digits,1,0,Digits0,ZMode,0,1,CAvg)
		FieldCal(4,TT,1,0,TT0,ZMode,0,1,CAvg)
		'Geokon 4500 Series Vibrating Wire Piezometer measurement 'Freq_2'
		AVW200(AVWRC_2,COM2,0,200,VW_2(1),2,1,1,1000,4000,1,_60Hz,1,0)
		'Calculate thermistor temperature 'TT_2'
		TT_2=1/(1.4051E-3+2.369E-4*LN(TR_2)+1.019E-7*LN(TR_2)^3)-273.15
		'Calculate digits 'Digits_2'
		Digits_2=Freq_2^2/1000
		'Calculate water level 'Lvl_2' (PSI)
		Lvl_2=(Digits0_2-Digits_2)*-0.01675+(TT_2-TT0_2)*-0.0002397
		'Convert water level 'Lvl_2' from PSI to m
		Lvl_2=Lvl_2*0.70432
		'Zeroing calibration for
		'Geokon 4500 Series Vibrating Wire Piezometer calculations 'Digits_2' and 'TT_2'
		FieldCal(4,Digits_2,1,0,Digits0_2,ZMode_2,0,1,CAvg_2)
		FieldCal(4,TT_2,1,0,TT0_2,ZMode_2,0,1,CAvg_2)
		'Call Data Tables and Store Data
		CallTable Piezo724
		CallTable Piezo752
		CallTable CalHist

		' USER program code to execute in Main Scan Loop
		' ---------------------------------------------------------------------------
		' >>>>>>>>> START <<<<<<<<<

		' >>>>>>>>> END <<<<<<<<<
		' ---------------------------------------------------------------------------
		' USER program code to execute in Main Scan Loop
	NextScan
```

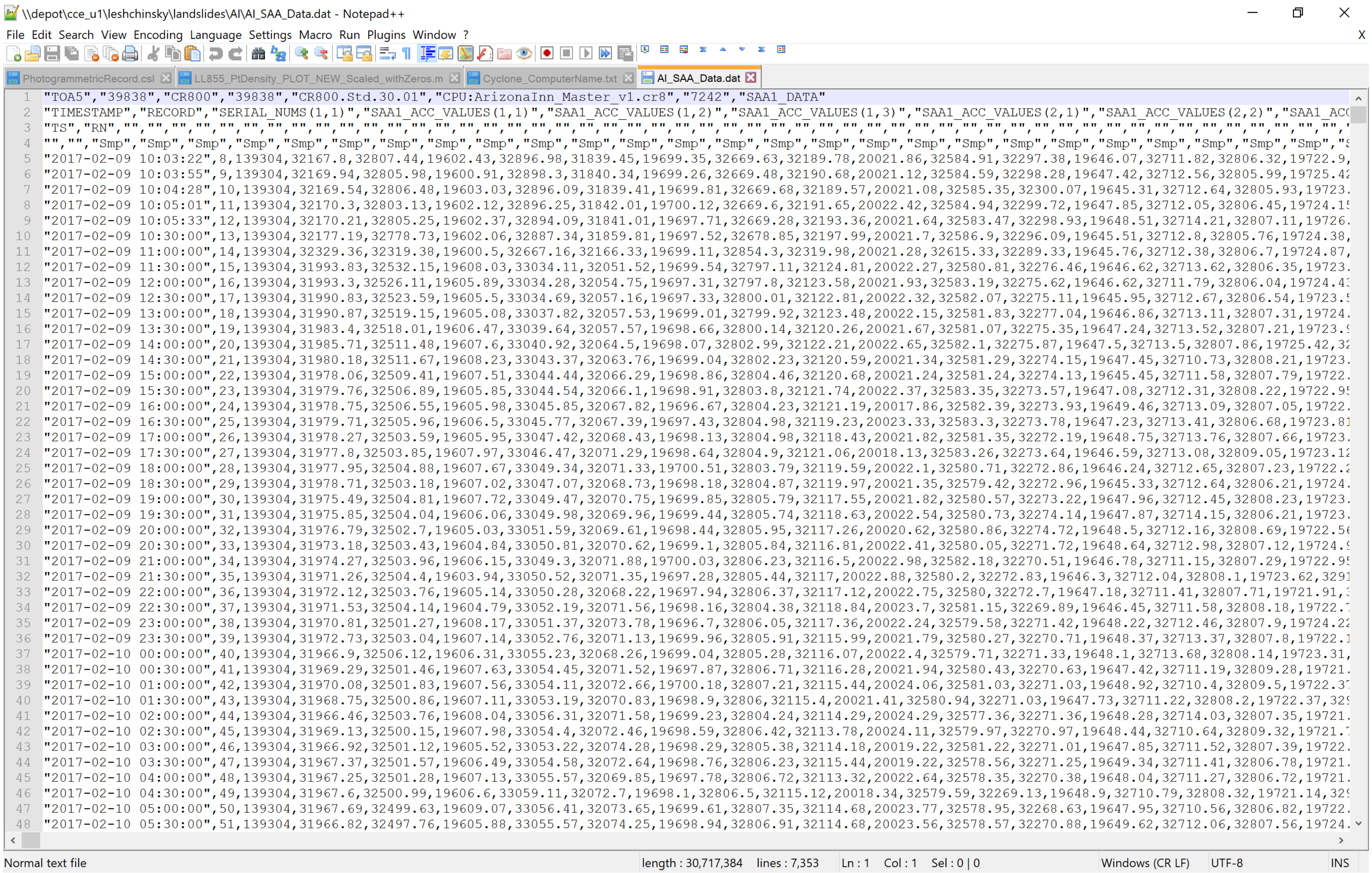
```
		SlowSequence
		Do
		  Delay(1,15,Sec)
   FTPResult=FTPClient(FTPAddress,UserName,Password,"PROJECT_INFO","/SP/SP_ProjectInfo.dat",8,0,30,Min,-1008)

FTPResult=FTPClient(FTPAddress,UserName,Password,"LOGGER_DIAGNOSTICS","/SP/SP_LoggerDiag.dat",8,0,30,Min,-
1008)
		  FTPResult=FTPClient(FTPAddress,UserName,Password,"SAA1_DATA","/SP/SP_SAA_Data.dat",8,0,30,Min,-
1008)

FTPResult=FTPClient(FTPAddress,UserName,Password,"SAA_DIAGNOSTICS","/SP/SP_SAA_Diag.dat",8,0,30,Min,-1008)

FTPResult=FTPClient(FTPAddress,UserName,Password,"SERIAL_ERRORS","/SP/SP_SerialErrors.dat",8,0,30,Min,-1008)
		  FTPResult=FTPClient(FTPAddress,UserName,Password,"Piezo724","/SP/SP_Piezo724.dat",8,0,30,Min,-1008)
		  FTPResult=FTPClient(FTPAddress,UserName,Password,"Piezo752","/SP/SP_Piezo752.dat",8,0,30,Min,-1008)
		Loop
 'FLag(1)=False
		 'EndIf
		'NextScan
		' >>>>>>>>> END <<<<<<<<<
		' ----------------------------------------------------------------------------
		' SAACR_FileGenerator generated Main Scan Loop
EndProg
```

1.14 EXAMPLE SAA DATA LOG



\\depot\cce_u1\leshchinsky\landslides\AI\AI_SAA_Data.dat - Notepad++

File Edit Search View Encoding Language Settings Macro Run Plugins Window ?

PhotogrammetricRecord.csl | LL855_PtDensity_PLOT_NEW_Scaled_withZeros.m | Cyclone_ComputerName.txt | AI_SAA_Data.dat

```
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"TS","RN","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","","",
"","","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp","Smp",
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```

Normal text file | length : 30,717,384 lines : 7,353 | Ln : 1 Col : 1 Sel : 0 | 0 | Windows (CR LF) | UTF-8 | INS

1.15 EXAMPLE PIEZO DATA LOG

\\depot\cce_u1\leshchinsky\landslides\AI\AI_Piezo252.dat - Notepad++

File Edit Search View Encoding Language Settings Macro Run Plugins Window ?

PhotogrammetricRecord.csl | LL855_PtDensity_PLOT_NEW_Scaled_withZeros.m | Cyclone_ComputerName.txt | AI_Piezo252.dat

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"TS","RN","Volts","Deg C","","Hz","mV RMS","","Hz","","ohms","deg C","digits","m"
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