**Annual Report to the City of Austin Balcones Canyonlands Preserve, 2010**

**Geotechnical cores and associated Piezometers pertinent to the Jollyville Transmission Main (JTM)**

## Abstract

Prior to the construction of the Jollyville water transmission line, data is being collected in order to properly characterize the subsurface conditions along the JTM alignment below the BCP. In 2010, five (5) borings were drilled to obtain samples of bedrock, field testing was conducted that included downhole televiewer imaging and packer testing at each location, piezometers were installed in a subset of the boring locations, pump tests conducted at one site, groundwater elevations obtained from the piezometers, and general site reconnaissance activities conducted. Characterization of the subsurface conditions along the JTM alignment below the BCP will continue throughout the project, so specific conclusions may change over time as additional data becomes available. However, it appears from the characterizations completed to date that construction of a tunnel under the BCP is viable in a manner that can be protective of BCP environmental resources. Specific details remain to be determined on how best to accomplish this task.

## Problem

The problem being evaluated is the proper characterization of subsurface conditions along the JTM alignment below the BCP. The objectives of the investigations performed to evaluate the subsurface characteristics included:

- Further identify the geologic units, solution features, faulting, joint characteristics, etc. and their extent along the tunnel alignment.
- Further identify top of rock and depth of weathering along the tunnel alignment.
- Characterize the intact rock and rock mass properties of each geologic unit including strength, hardness, abrasiveness, slake propensity, geologic structure and all other geologic, geotechnical and engineering factors that may control borability and constructability.
- Characterize the contacts between geologic units.
- Characterize the hydrogeology along the tunnel alignment.
- Determine the corrosivity of the soil and groundwater.
- Determine the characteristics of the geology and hydrogeology to adequately protect environmental resources that may be present above the tunnel in the BCP.

## Materials and methods

Five borings were drilled with HQ-3 rock coring equipment to obtain samples of bedrock to characterize ground conditions for tunnel design and construction. Boring depths ranged from 170 to 210 feet. Two of the borings (JT-105 and JT-106) were angled at 20$^{o}$ from vertical; the other three borings were drilled vertically. A summary of the borings is included in the following table, and the locations are shown in the Attachment A.

| Boring | Depth | Orientation | Piezometer |
|---|---|---|---|
| JT-105 | 191 ft | Inclined 20° from Vertical Oriented S60°W | No |
| JT-106 | 186 ft | Inclined 20° from Vertical Oriented North | No |
| JT-107 | 209 ft | Vertical | Yes |
| JT-108 | 185 ft | Vertical | Yes |
| B-2B | 170 ft | Vertical | Yes |



The borings were drilled with a truck mounted rig similar to the one pictured to the right (in the process of drilling an angled boring). All vehicles (excluding the drill rig) that entered the BCP had 4-wheel drive, and the 4-wheel drive mechanism was engaged continuously while in the BCP.

The following restrictions were enforced during the drilling process:

- The only drilling fluids allowed were plain water or biodegradable polymer, such as EZ Mud.
- All water for drilling came from the approved location on the Colorado River.
- All drilling fluids and cuttings were contained, containerized, and transported offsite to an appropriate disposal site.
- Surface casing was installed if circulation was reduced to less than 50%, or if a void of 12 inches or more was encountered. In either case, casing was advanced at least one foot past the water loss zone or void prior to continuing coring.
- Trash was hauled out at the end of each shift.

Field testing included downhole televiewer imaging and packer testing. Downhole televiewer imaging consisted of lowering an instrument down the borehole that was capable of imaging the sidewalls of the boring either acoustically or optically.

Packer testing was done to calculate the permeability of the rock to determine an estimate of water inflow potential into the tunnel during construction before the final liner is installed. Packer tests consisted of lowering inflatable packers into the borehole, inflating them to seal off a section of borehole, and then pressurizing the water within the sealed off section while measuring the pressure and water flow. The tests were run at predetermined pressure levels, but were never allowed to exceed the overburden pressure, so no rupture occurred. All water introduced into the borehole was sourced from the Colorado River.

Piezometers were installed in borings JT-107, JT-108, and B2-B. This included putting 2 inch diameter PVC down the borehole, a sand filter, bentonite seal, and cement-bentonite grout. At the surface, the PVC casing was installed flush with the ground surface with a protective steel box. *Although the piezometers originally installed at these locations met the technical requirements of State regulations, due to licensing issues, the City requested that new piezometers be installed adjacent to those already in place. These piezometers were reinstalled in 2010 as well.*

Pump tests were conducted on the cluster of piezometers at JT-107 to observe the local groundwater "response" (drawdown).

In addition, the Environmental Commissioning Consultant Team members from INTERA and Glenrose Engineering accessed the BCP during 2010 for site reconnaissance, evaluating geological and hydrogeological conditions, viewing environmental features such as springs, seeps and creeks; and for collecting groundwater elevations from vibrating wire (VW) piezometers.

## Results

The results of the geologic boring activities were the production of geologic cores, which have been logged, reviewed by professional geoscientists and geologists, and are currently being utilized to determine the most appropriate depth and lithology in which to construct the tunnel. Documentation of these cores can be found in the Black & Veatch *Draft Basis of Design Report*, *Appendix A*, dated October 2010.

The pump test data collected at JT-107 produced information that is being used to help develop a conceptual groundwater model and contribute to the general body of scientific knowledge associated with groundwater resources related to the BCP. That data can be found in the Black & Veatch *Draft Groundwater Assessment Report*, dated November 30, 2010.

A copy of the Environmental Commissioning Consultant Team's most recent report on the groundwater elevation data is included as Attachment B.

## Conclusions

Characterization of the subsurface conditions along the JTM alignment below the BCP will continue throughout the project, so specific conclusions may change over time as additional data becomes available. However, it appears from the characterizations completed to date that construction of a tunnel under the BCP is viable in a manner that can be protective of BCP environmental resources, but specific details remain to be determined on how best to accomplish this task.

**Attachment A**
**Map of Geologic Borings and Piezometers**

DRAFT

JT-127
JT-126
JT-125-A
JT-124-A
JT-123
JT-104-A
JT-122
JT-121
JT-120-A
JT-119
JT-118
JT-117
JT-116-A
JT-108-A
JT-107S-A
JT-107D-A
JT-107PZ-A
JT-107ITW-A
Lanier Well
JT-106
JT-105
Old WPT4 Well
Bowman Well
Borehole Well
JT-103-A
Powerline Spring
Windmill Well
Ribelin Spring 2 (Lower Ribelin)
JT-115
JT-114
JT-113
JT-102
JT-101-A
JT-110-A
JT-109
JT-100
JT-111
JT-112
F-23
F-27

PiezoPlan.mxd J.Steurer 7/26/10

# City of Austin, Texas

## Water Treatment Plant 4

Jollyville Transmission Main

DRAFT

July 26, 2010

**LEGEND**

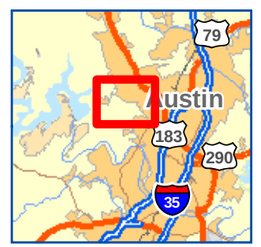
- Monitoring Springs
- Water Wells
- Planned Piezometer
- Existing Piezometer
- Existing Borehole
- Proposed Retrieval Shaft
- Proposed Working Shaft
- Current Proposed Alignment
- Infrastructure Corridor
- Reservoir and WTP 4
- Old WTP 4 Site
- BCP
- Potential Future BCP
- Creeks
- Water
- City of Austin Parks
- Parcels

N
W E
S

0 1,250 2,500

Feet

1 inch = 2,500 feet




# Piezometers Plan

BLACK & VEATCH
Building a world of difference.

Data source: BV, City of Austin, CAPCOG, ESRI

**Attachment B**
**Groundwater Elevation Data from Vibrating Wire Piezometer Installations at the WTP4 Site Area**

# Groundwater Elevation Data from Vibrating Wire Piezometer Installations at the WTP4 Site Area

## Data Summary: June 30, 2010

The following information is a summary of the available data regarding groundwater elevations near the WTP4 site based on vibrating wire piezometer measurements. This data summary includes information collected by INTERA during a monitoring event on June 15, 2010. INTERA is submitting the information at this time because of its relevance and utility for the ongoing groundwater assessment.

### Background on Piezometer Installations and Equipment

Vibrating wire (VW) piezometers (Geokon Model 4500 Series) were installed in 2007 in six boreholes northwest (denoted B-4A, B-5, and B-8A) and northeast (B-8, B-9, and B-10) of the WTP4 site (see Figure 1). Installation and location information are published in Fugro (2008). The VW piezometer instrument utilizes a stainless steel diaphragm connected to a vibrating wire element. Through a cable connection to ground surface, a pulse of varying frequency is applied to two coils located near the wire element. Changing pressures on the element cause it to deflect with this deflection measured as a change in tension and frequency of vibration of the wire element. The instrument is calibrated before installation in the borehole. The instruments were installed in a sand sock around the instrument at selected depths and were typically grouted above and below the instrument depth locations and/or to the ground surface. Thus, the instruments are providing data for calculation of a groundwater elevation representative of a short vertical interval (i.e., less than 1 ft). Frequency and temperature readings are taken at ground surface using a data recorder (Slope Indicator VW Data Recorder 52613500) that provides the excitation, signal conditioning, and readout of the instrument. Laboratory-derived calibration constants are used in a polynomial equation to calculate pressure head from the instrument frequency reading. Groundwater elevation is calculated as the sum of pressure head and elevation of the instrument in the borehole.

Installations in an individual borehole at the site include from one to four VW piezometers installed at isolated intervals in the same borehole. Instruments in four of the boreholes (B-8A, B-8, B-9, and B-10) were monitored multiple times in 2007 only. Instruments in two of the boreholes (B-4A and B-5) were monitored multiple times in 2007, once in 2008, and twice in 2009.

## Recent VW Piezometer Monitoring – June 15, 2010

INTERA obtained frequency and temperature readings from B-4A, B-5, B-8, B-9, and B-10 on June 15, 2010. The instruments in these boreholes appeared to be functioning properly with the exception of the thermistor at the deepest instrument at B-10. The failed thermistor is not critical since the calculation of groundwater elevation is not using a temperature correction (note: the exclusion of a temperature correction is consistent with data reporting previously conducted by Fugro).

B-8A no longer exists at its designated location and it is assumed that it has either been destroyed or plugged and abandoned. Thus, B-8A with instruments at two depths in the Glen Rose provided readings to calculate groundwater elevations for a period in 2007 only. The historical information is provided herein as it may be useful for the groundwater assessment.

B-4A and B-5 are located adjacent to Oasis Bluff Drive. Adding combination locks to these wells is planned for the July 2010 round of monitoring for these VW piezometers in order to restrict access and reduce opportunity for damage or loss of instrument cables from vandalism. The labeling on the instrument cables at B-8, B-9, and B-10 consists of markings on ragged duct tape. The labeling will be refurbished during the July VW piezometer monitoring round.

The calculated groundwater readings from B-4A, B-5, B-8, B-9, and B-10 from data collected on June 15, 2010 are consistent with prior readings taken starting in April 2007. Table 1 summarizes the groundwater elevation data determined from readings in the VW piezometers for the period of record from April 2007 to June 2010.

## Summary of Data from the VW Piezometers

The data from these instruments provide baseline groundwater elevation monitoring data starting in 2007. They will also continue to provide measurements of groundwater elevation for from two to four depths at four of the installation locations (B-5, B-8, B-9, and B-10), thus allowing calculation of vertical gradients.

The recorded data is summarized in Table 1 and shown graphically in Figures 2 to 7. Measurements were taken at B-4A and B-5 during 2007, 2008, 2009 and 2010 (Figures 2 and 3). B-4A and B-5 monitor one and two depths, respectively in the Glen Rose Formation at locations between Lake Travis and the Raw Water Pump Station site. Groundwater elevations at B-4A and B-5, located about 2,400 and 1,000 ft, respectively, from the shoreline of Lake Travis show a direct correlation with rising and falling water levels in Lake Travis (Figures 8 and 9). The data from B-4A and B-5 may potentially be used as transient calibration targets for the groundwater model.

Measurements were taken in B-8, B-9, and B-10 in 2007 with no additional measurements until June 15, 2010 (Figures 5, 6, and 7). The uppermost monitor interval in B-8, B-9, and B-10 is at a depth logged as Edwards/Walnut Formations (i.e., near interface between these two formations). B-8, B-9, and B-10 also monitor two, three and two depths, respectively in the Glen Rose Formation. Groundwater elevations in B-8, B-9, and B-10 appear to be relatively consistent (stable); however, the period of record is just five months in 2007 and once in June 2010. B-8, B-9 and B-10 are located within about 200 ft of each other and at ground surface are on a relative topographic high (ground surface elevation from 973 to 994 ft MSL) above Bull Creek. They may provide useful calibration targets for groundwater elevations at the Edwards/Walnut Formations contact and at multiple depths in the Glen Rose Formation at a location in the Bull Creek watershed representative of a surface topographic high.

An example of the setup for data collection is shown in the photograph in Figure 10 for the B-9 VW piezometer. Continued monthly monitoring at the five vibrating wire peizometer locations will provide valuable baseline data.

## References

Fugro, 2008. Geotechnical Data Report, City of Austin, Water Treatment Plant No. 4, Austin, TX. Report to TCB Inc. from Fugro Consultants Inc., Report No. 1001-3571, February 2008.

**Table 1 Summary of Groundwater Elevations from the Vibrating Wire Piezometers**

| Piezometer | B-4A | B-5 | B-5 | B-8A | B-8A | B-8 | B-8 | B-8 | B-9 | B-9 | B-9 | B-9 | B-10 | B-10 | B-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pressure Transducer Elevation (ft MSL) | 484.5 | 652.9 | 492.9 | 599.1 | 474.1 | 929.7 | 699.7 | 479.7 | 930.1 | 662.1 | 600.1 | 474.1 | 916.5 | 636.5 | 461.5 |
| DATE | Groundwater Elevation (ft) | | | | | | | | | | | | | | |
| 4/2/2007 | 599.5 | 675.9 | 595.7 | 675.2 | 555.7 | 935.4 | 762.2 | 632.8 | n.r. | * | 679.3 | 527.3 | 935.9 | 692.3 | 523.3 |
| 4/25/2007 | 598.0 | 676.7 | 600.4 | 674.4 | 550.0 | 937.8 | 761.3 | 630.2 | 940.9 | 665.6 | 679.0 | 526.5 | 935.9 | 691.9 | 522.8 |
| 5/13/2007 | 598.7 | 677.1 | 603.1 | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. |
| 5/20/2007 | n.r. | n.r. | n.r. | 675.0 | 548.7 | 938.5 | 760.9 | 628.5 | 942.1 | 668.0 | 678.9 | 526.3 | 935.3 | 692.0 | 522.4 |
| 6/4/2007 | 599.8 | 678.6 | 606.8 | 675.9 | 548.3 | 938.8 | 760.8 | 628.0 | 942.7 | 671.2 | 678.8 | 526.2 | 937.3 | 691.8 | 522.3 |
| 6/11/2007 | 600.3 | 679.1 | 608.0 | 676.0 | 547.9 | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. |
| 6/18/2007 | 600.3 | 679.5 | 608.8 | 676.5 | 547.7 | 939.1 | 760.6 | 627.3 | 943.5 | 674.2 | 678.8 | 526.0 | 937.1 | 691.7 | 522.1 |
| 6/28/2007 | 601.1 | 680.0 | 609.9 | 677.0 | 547.6 | 939.1 | 760.7 | 627.1 | 943.9 | 675.5 | 678.9 | 526.1 | 937.4 | 693.5 | 521.9 |
| 7/5/2007 | 601.7 | 681.1 | 613.4 | 677.6 | 547.6 | 939.3 | 760.8 | 627.2 | 944.2 | 676.6 | 678.9 | 526.0 | 938.4 | 691.8 | 521.9 |
| 7/13/2007 | 602.3 | 682.4 | 615.6 | 677.9 | 547.4 | 939.4 | 760.7 | 626.6 | 944.5 | 677.2 | 678.9 | 525.9 | 939.2 | 691.8 | 521.9 |
| 7/18/2007 | 603.1 | 682.7 | 615.5 | 678.4 | 547.5 | 939.4 | 760.9 | 626.6 | 944.7 | 677.4 | 679.0 | 525.9 | 939.3 | 691.8 | 521.8 |
| 7/24/2007 | 603.5 | 682.4 | 615.2 | 678.7 | 547.5 | 939.3 | 760.8 | 626.4 | 944.7 | 678.4 | 679.0 | 525.8 | 939.6 | 691.8 | 521.8 |
| 8/1/2007 | 604.3 | 681.9 | 615.7 | 679.4 | 547.4 | 939.2 | 760.9 | 626.2 | 944.7 | 678.7 | 679.0 | 525.8 | 940.3 | 691.8 | 521.7 |
| 8/8/2007 | 604.7 | 681.8 | 616.3 | 679.9 | 547.4 | 939.1 | 760.9 | 626.0 | 944.7 | 678.8 | 679.1 | 525.8 | 941.1 | 691.9 | 521.7 |
| 8/21/2007 | 605.7 | 681.7 | 617.0 | 680.9 | 547.4 | 938.8 | 761.0 | 625.8 | 944.7 | 679.1 | 679.1 | 525.7 | 942.0 | 691.9 | 521.6 |
| 9/5/2007 | 606.5 | 681.8 | 616.7 | 681.8 | 547.4 | 938.6 | 761.1 | 625.4 | 944.5 | 679.3 | 679.2 | 525.6 | 941.8 | 692.0 | 521.5 |
| 9/19/2008 | 599.4 | 675.2 | 583.9 | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. |
| 1/9/2009 | 593.2 | 673.5 | 582.1 | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. |
| 9/16/2009 | 578.1 | 671.0 | 558.9 | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. | n.r. |
| 6/15/2010 | 593.4 | 678.3 | 604.0 | n.r. | n.r. | 938.4 | 762.2 | 619.5 | 944.4 | 681.6 | 674.4 | 523.5 | 941.9 | 689.4 | 518.9 |

* Disqualified because frequency reading is outside calibration range and would indicate a negative pressure head

n.r. No readings

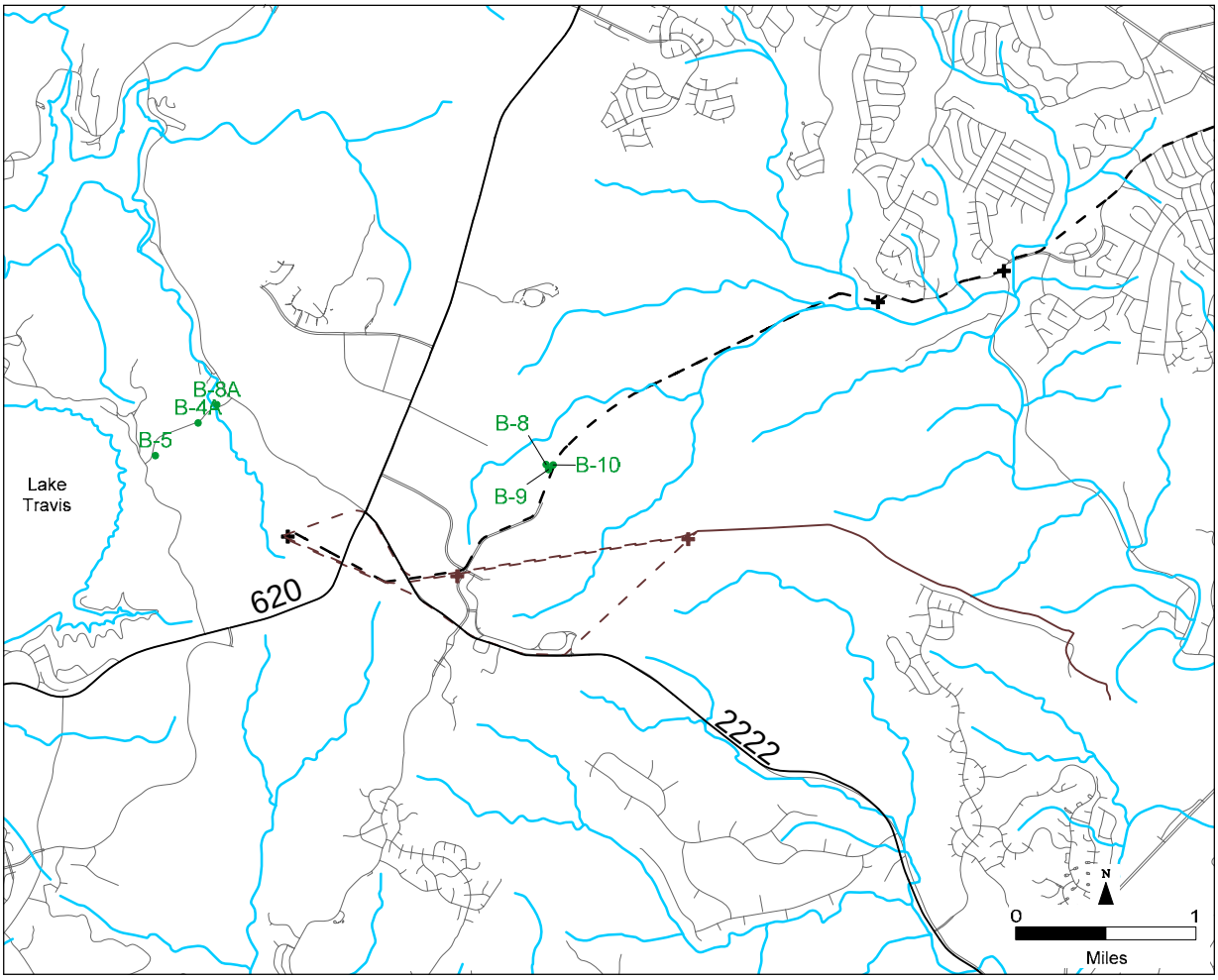
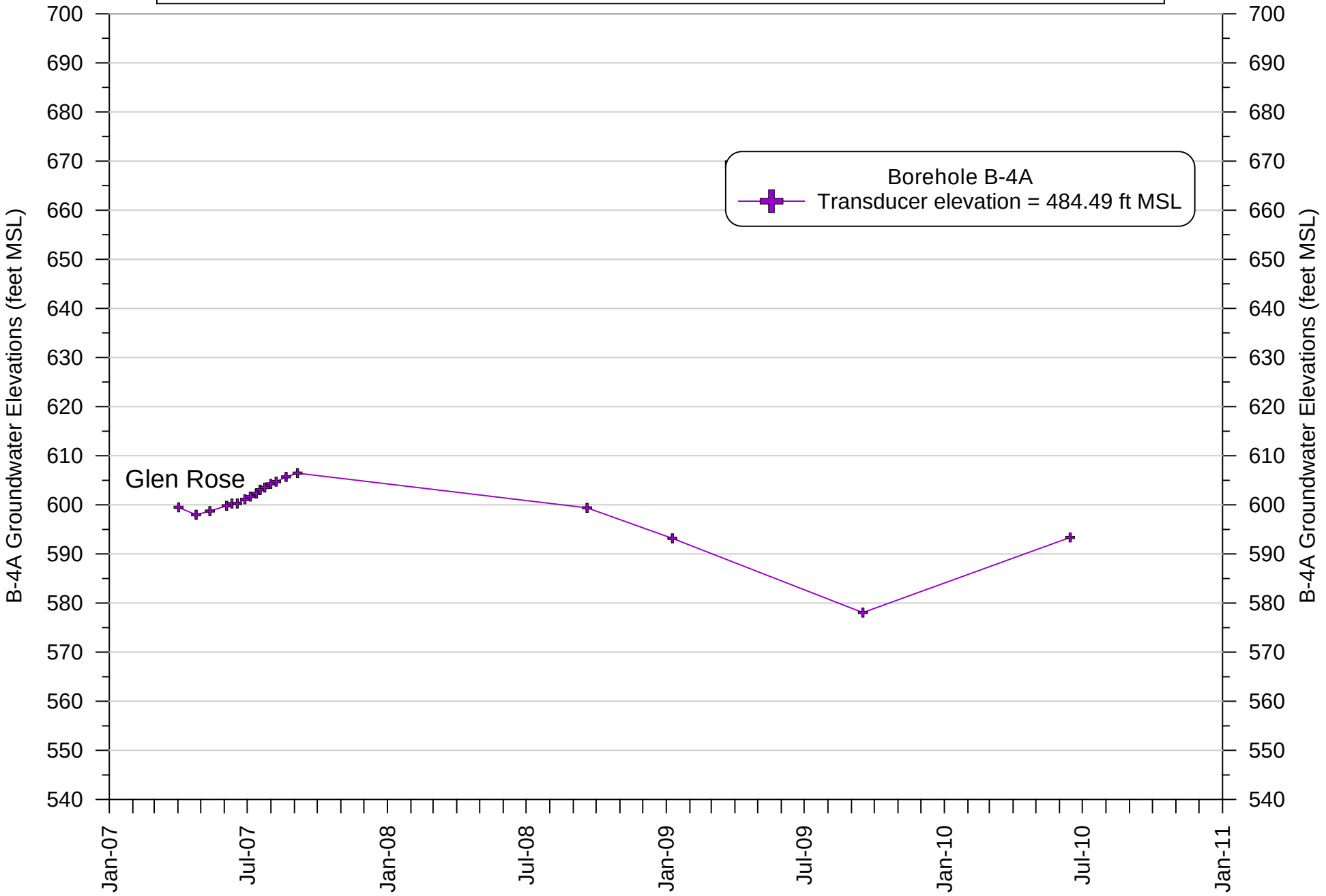



**Figure 1 Location of Vibrating Wire Piezometers**

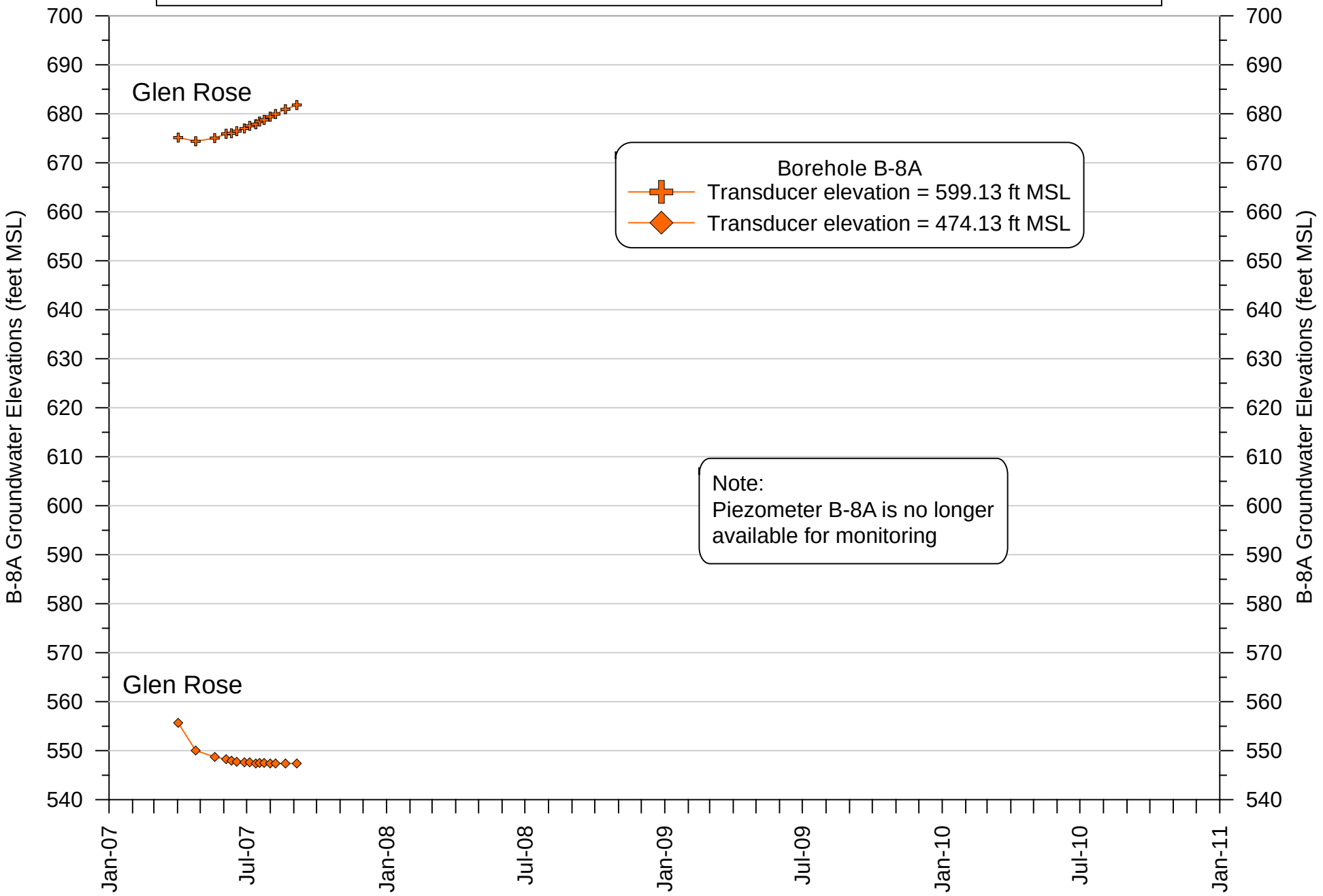
# Figure 2 Vibrating Wire Piezometer Groundwater Elevation Measurement for B-4A



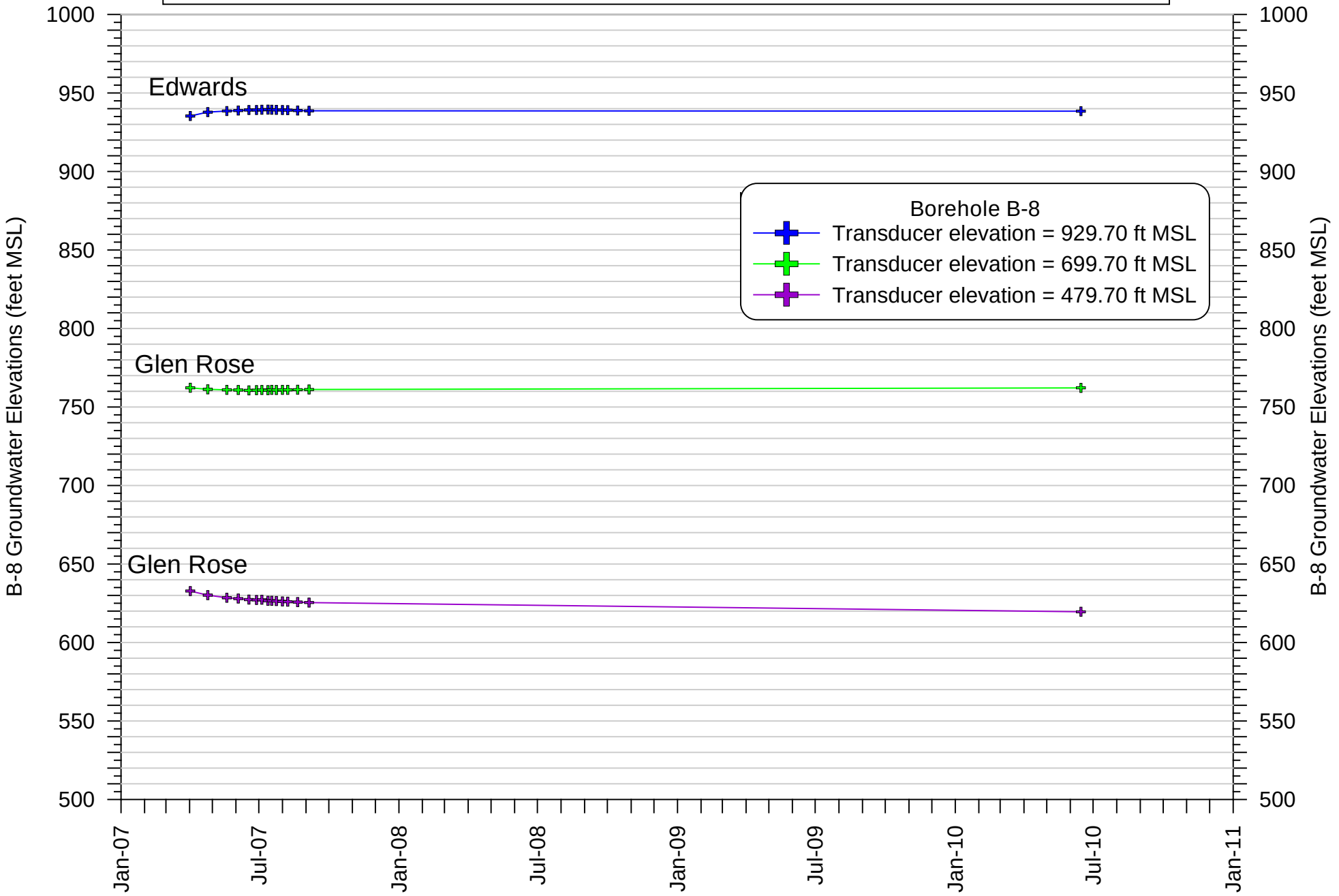
# Figure 3 Vibrating Wire Piezometer Groundwater Elevation Measurement for B-5



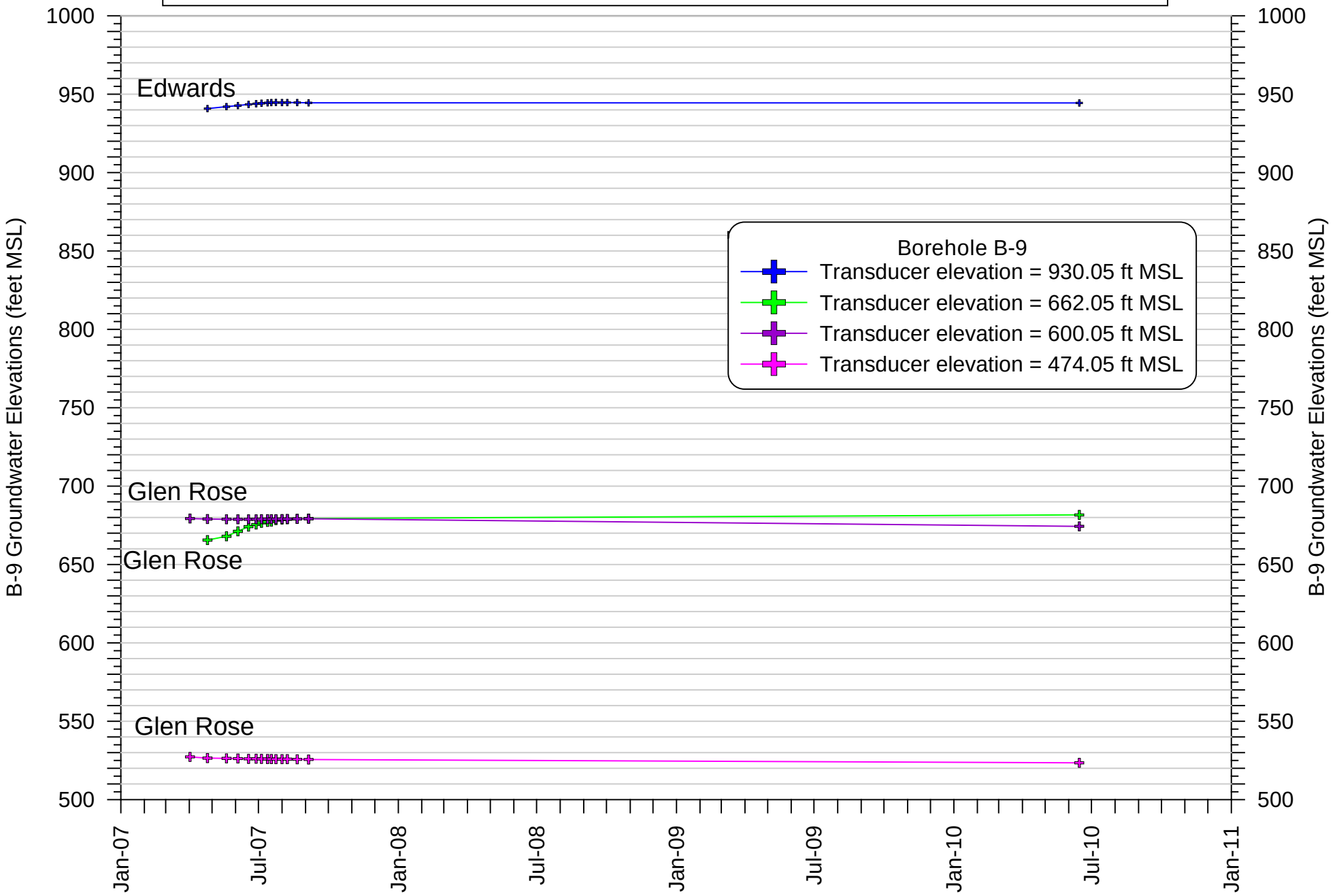
# Figure 4 Vibrating Wire Piezometer Groundwater Elevation Measurement for B-8A



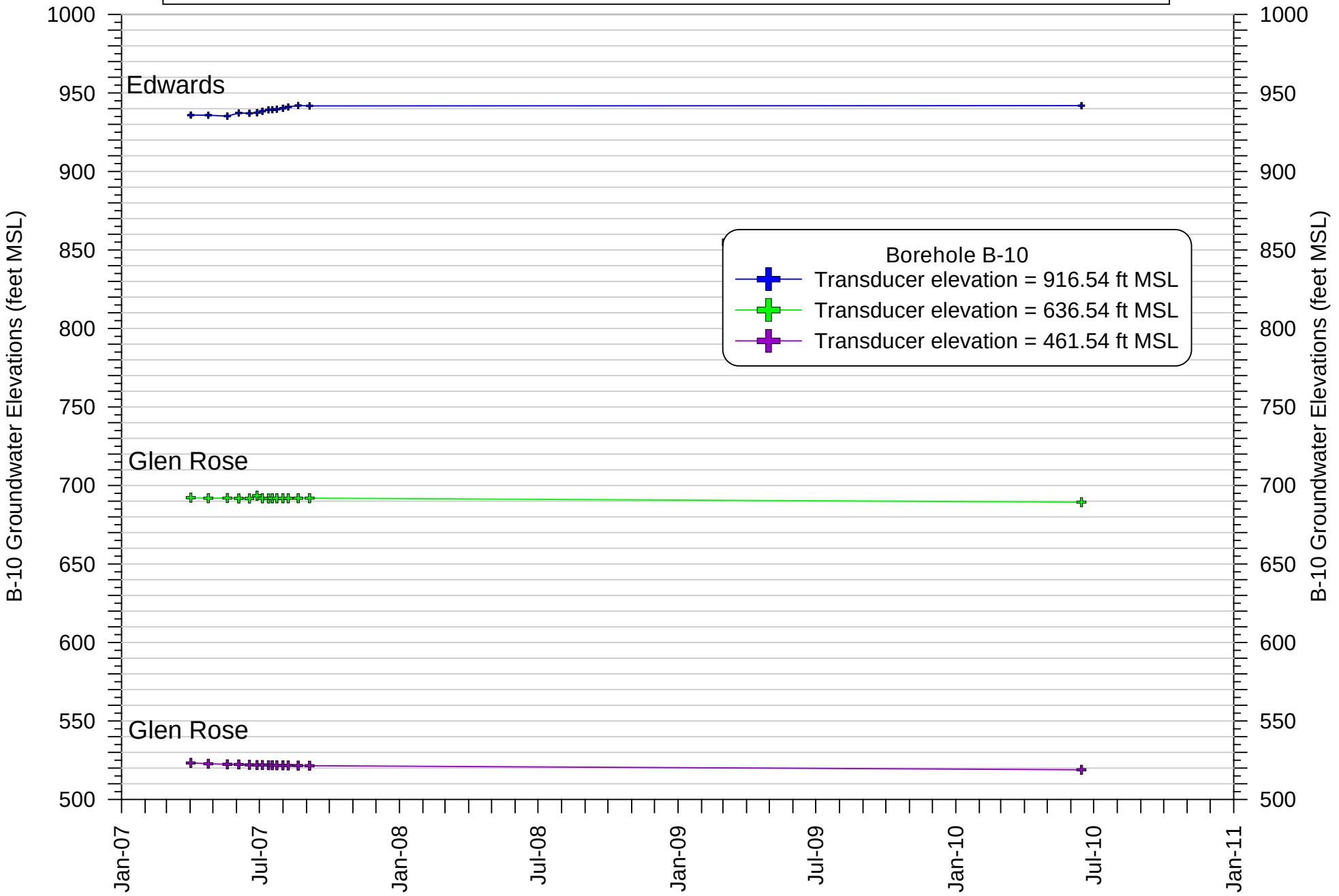
# Figure 5 Vibrating Wire Piezometer Groundwater Elevation Measurements for B-8



# Figure 6 Vibrating Wire Piezometer Groundwater Elevation Measurements for B-9



# Figure 7 Vibrating Wire Piezometer Groundwater Elevation Measurements for B-10



# Figure 8 Average Monthly Water Level for Lake Travis

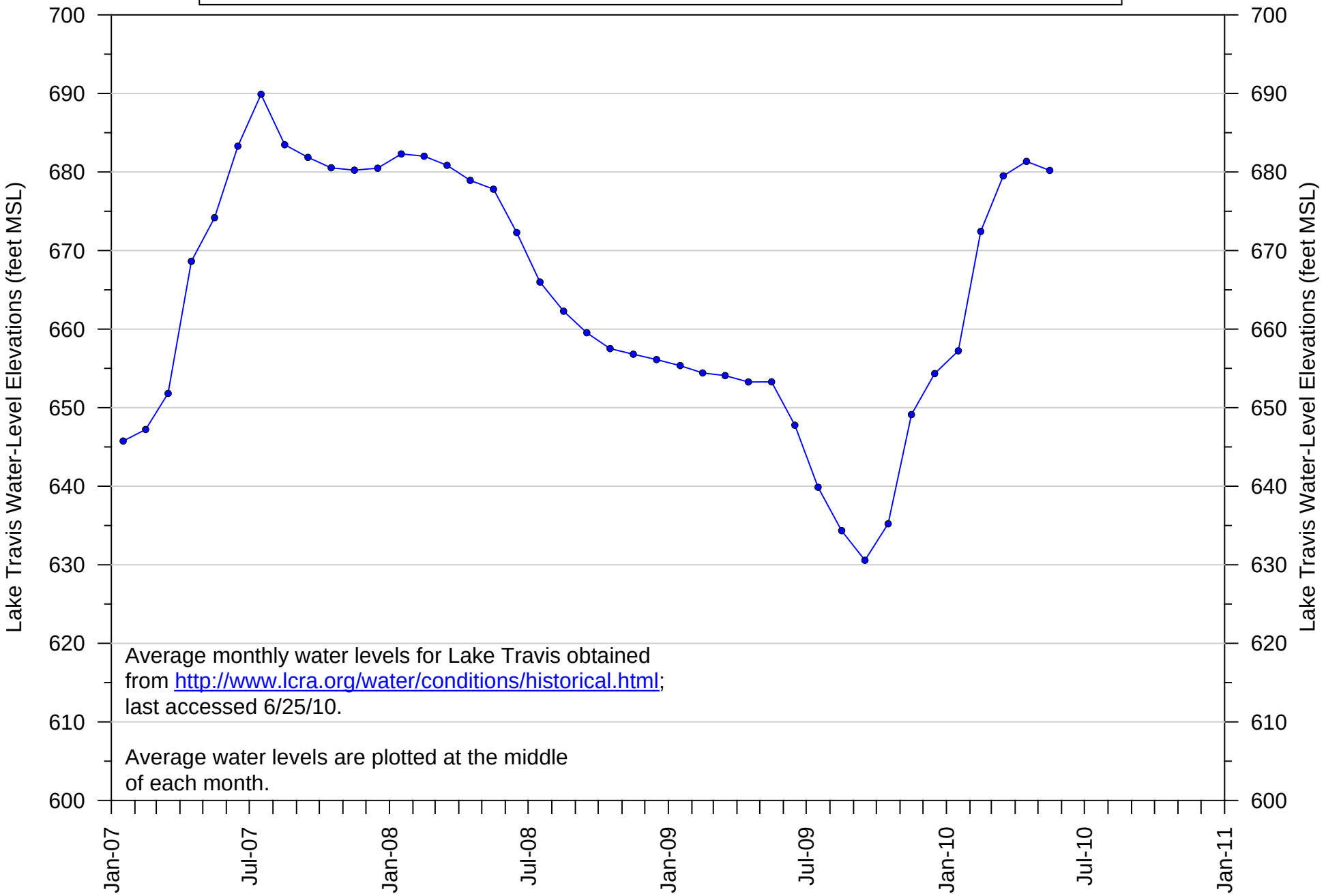


Figure 9 Vibrating Wire Piezometer Groundwater Elevation Measurements (B-4A, B-5, and B-8A) Plotted with Lake Travis Monthly-Average Water Levels

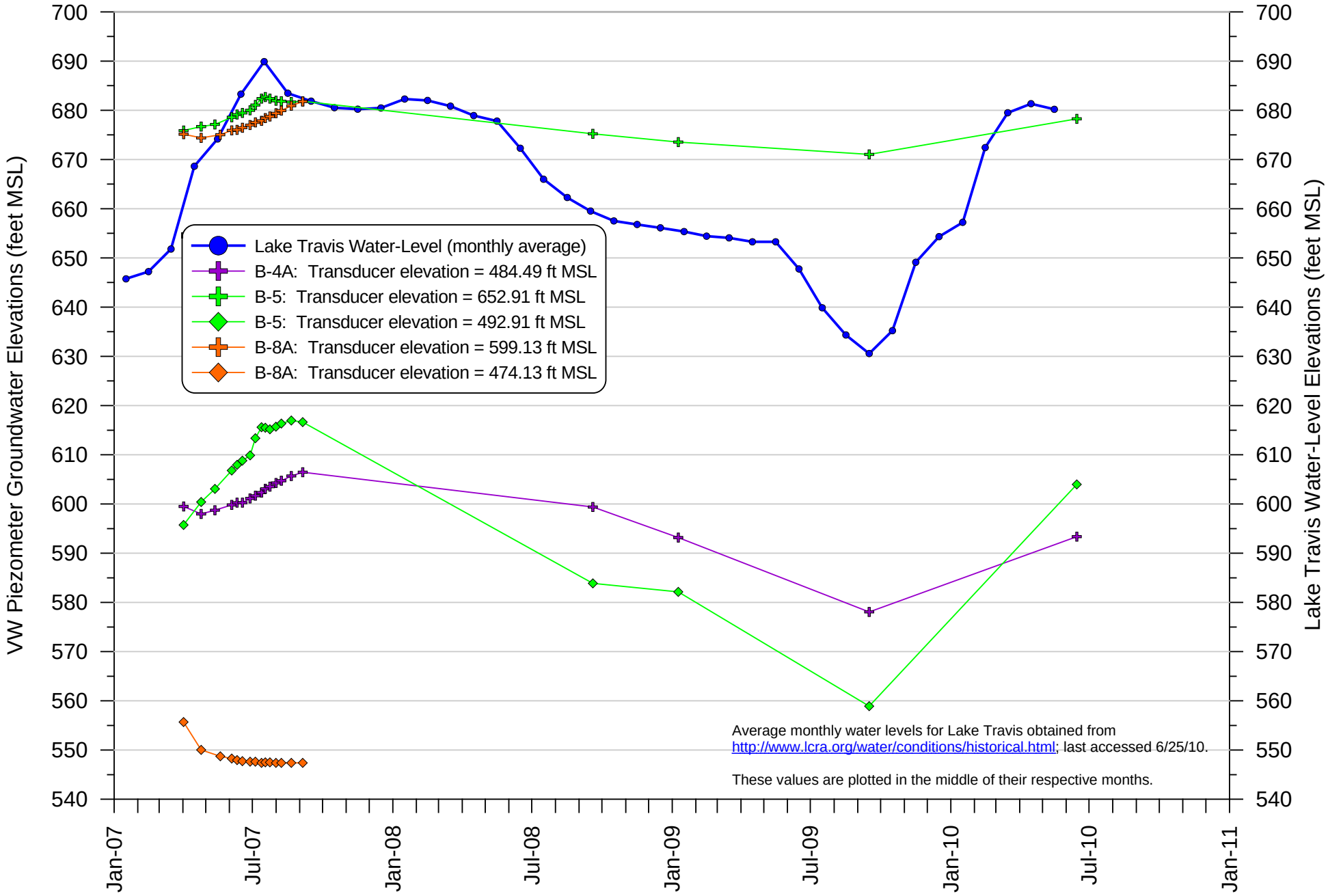





Figure 10 Photograph of the B-9 Installation Showing Cable from One of the Downhole Instruments Connected to the Data Recorder