

Exhibit A  
Overview of Data Collection Methodology and Equipment:  
*Streambed-Pumping Study*

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*Water & Environmental Systems Technology, Inc.*

**1. Purpose of Project**

The project sponsors propose a new study to determine the effect of groundwater pumping on the South Platte River and particularly to examine the function, and even the existence, of a low-permeability stream bed layer in a stream. Issues revolving around the science of groundwater resources are of critical importance in the semi-arid American West and we wish to conduct a study on the river to provide insight into the field. The results of the study will be presented as at least a case study in an academic journal as well as be used as a practical application in groundwater engineering courses taught at Colorado State University. The City of Littleton's South Platte Park provides an ideal venue for the study, as there are four high capacity pumping wells (operated by Centennial Water & Sanitation) within a few hundred feet of the river. The study will be conducted from September 2016 to April 2017 by Dr. Ryan Bailey and Luke Flores from Colorado State University as well as having the technical and financial assistance of Dr. Catherine Kraeger-Rovey of Water & Environmental Systems Technology, Inc. The results of the study will serve as the basis of Mr. Flores' Master's thesis. The project is funded through both a 1-year \$50,000 grant from the Colorado Water Conservation Board and a \$50,000 funding contribution by Dr. Kraeger-Rovey.

**2. Study Area**

The study area is the South Platte River corridor between the C-470 and W. Mineral Ave. crossings (Figure 1) in the city of Littleton's South Suburban Park. The equipment and instruments needed for the study are five nested monitoring well sites that includes 11 monitoring wells and data loggers to measure groundwater levels in the aquifer, two acoustic Doppler current profilers (ADCP) to measure flow rates in the river (one upstream and one downstream), and a staff gage to measure water levels in the river at the river bank.



Figure 1. Map of study area, showing location of 4 pumping wells and the location of streamflow measurements.

### 3. Measuring Streamflow in the South Platte River

Streamflow in the South Platte River will be measured upstream and downstream of the pumped area, to determine how much river water seeps into the aquifer, or how much water is gained by the river from the aquifer, pending the results of the study. Measuring streamflow will be performed using two ADCPs, which uses sonar to measure water velocity. CSU already owns the ACPS. One will be positioned at the upstream end, and the other at the downstream end (see blue dots in Figure 1). The ADCP is placed inside a small boat and pulled slowly across the cross section of the river using a rope and pulley system (tied to T-posts hammered into the bank on either side of the river) to get velocity readings. See the figures below.



Figure 2. Acoustic Doppler Current Profiler used to measure streamflow in a river.

## 4. Monitoring Wells

### 4.1 Locations

Monitoring wells will be installed to measure the drawdown of the water table created by the 4 high-capacity pumping wells. The water levels in the wells will also be compared to the water level in the river from the data provided from the staff gage. The proposed locations of the monitoring wells are shown in Figure 3. A list of the site:

- Two sites (A, B) on the bank of the river that will be installed using a Geoprobe 7822DT.
- Two sites (C, D) at the mid-point between the pumping wells and river
- One site (E) on the opposite side of the river, to determine if the groundwater on the west side is affected by the pumping

For sites A and B three nested monitoring wells of differing depths (3, 6, and 12 ft.) will be installed. Sites C and D, two nested monitoring wells at approximately 12 and 20 ft.

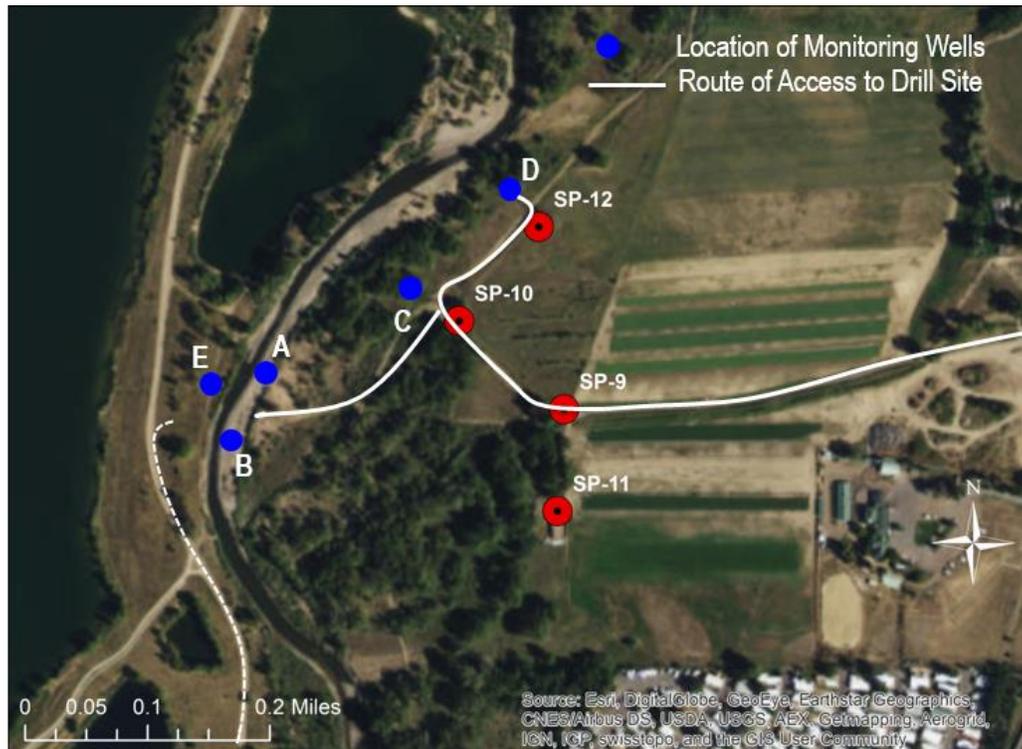


Figure 3. Location of Monitoring Wells

### 4.2 Design and Installation

The general design of each monitoring well is shown at the end of the proposal, according to standards imposed by the Division of Water Resources (CCR 402-2: *Rules and Regulations for Water Well Construction, Pump Installation, Cistern Installation, and Monitoring and Observation Well Construction*). 2-inch schedule 40 PVC will be used. A sand filter pack will be

placed around the perforated PVC pipe in the lower section of the borehole, overlain by bentonite and a small surface concrete seal. The top of the well will be level with the ground surface. There will be a lock on the cap.

The monitoring wells at locations A and B will be installed using a 4” hollow-stem auger with a Geoprobe 7822DT. The rig weighs approximately 8000 lb. and rides on a track rig to minimize disturbances to the park landscape. See Figure 4. As stated above, locations A and B will have a nest of wells drilled at depths of 3, 6, and 12 ft. Location E will also be drilled with the Geoprobe 7822DT but only to a depth of 6 ft.

The monitoring wells at locations C and D will be installed using a 4” hollow-stem auger and rubber wheeled drill rig operated by Drilling Engineering, Inc. (see Figure 5). These wells will be drilled to a depth of 12 ft. and 20 ft. The access route to these three locations is shown in Figure 3 above. Driving on grass will be kept to a minimum. There may be slight damage to the grass due to the weight of the drill rig.

The exact dates of installation of the monitoring wells will be closely coordinated with the city of Littleton and the South Suburban Parks and Recreation District and designed to minimize disruptions to the park and the impact upon the local environment.

Any nearby underground pipes and cables will be located and marked using the Colorado 811 locator service. CSU accepts responsibility for this process and any damage that might occur. Permitting for each well will be accomplished using the Monitoring/ Observation Water Well Permit Application (Form GWS-46).



**Figure 4. Geoprobe 7822DT**



**Figure 5. Drilling Engineering, Inc. Drill Rig**

### **4.3 Measuring Water Levels**

Water table levels will be measured at 15-minute intervals using HOBO Onset Data Loggers (left in Figure 6), with one data logger for each well. The data logger will be placed near the bottom of each monitoring well. For data download, the data logger is removed from the well and connected to a laptop using an optic USB base station (right in Figure 6). The pumping tests are planned to be performed during winter low-flow conditions in the South Platte River beginning as soon as October or early November and proceeding through late February or early March. There will be several pumping tests performed during this period to ensure accurate and reliable results. Vehicles will not be necessary to obtain data after initial installation.



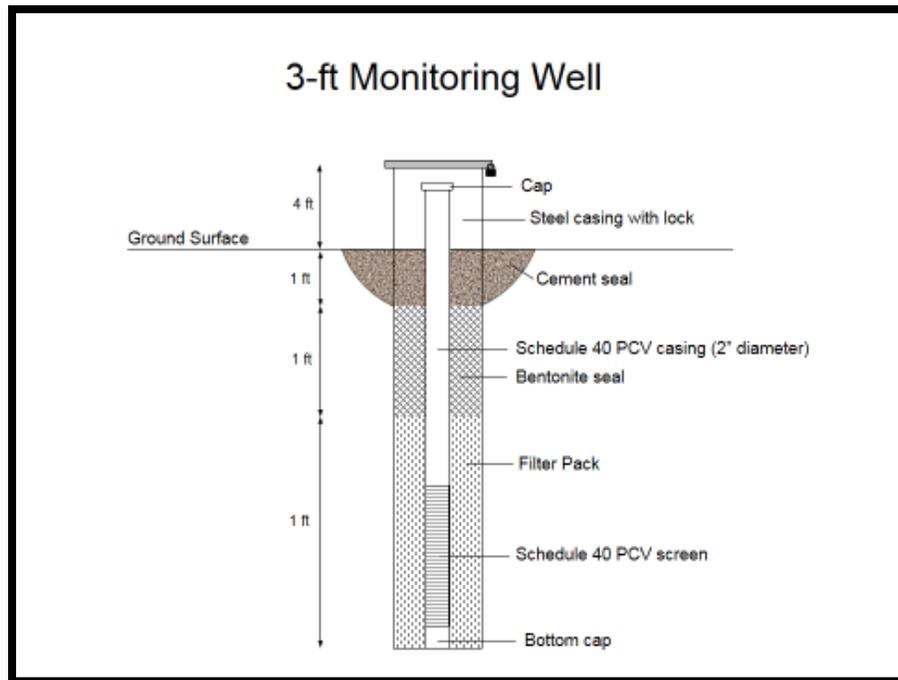
**Figure 6. Left: HOBO Water level data logger (Part #U20L-01) Right: Optic USB Base Station to connect the data logger to a laptop for downloading water level data.**

#### 4.4 Removal

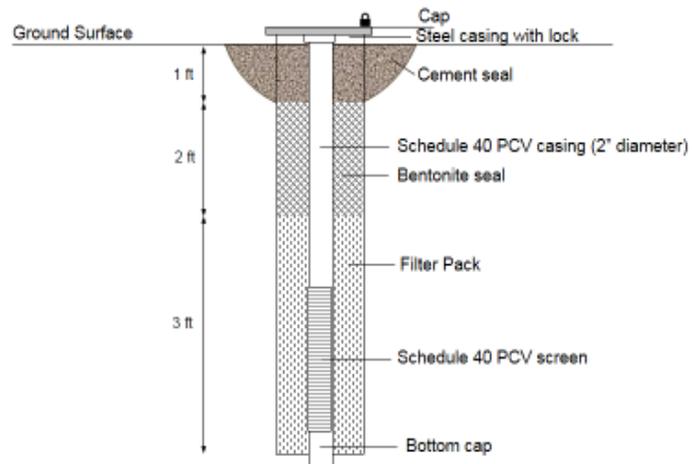
Once the necessary data are collected for the study, the wells will be abandoned in accordance with state regulations (*GWS-09: Well Abandonment Form*). The top 2-3 feet of each monitoring well will be removed and then capped and then buried again with dirt. A vehicle or rig will not be necessary to remove the wells. The removal of the top part of each well and subsequent burial ensures that each well casing will never be unearthed through a natural process or influence the park in any meaningful way. Dr. Bailey and Luke Flores can also be responsible for planting new vegetation atop the dirt.

All results and subsequent articles, papers, and theses will be shared with the city of Littleton and South Suburban Parks and the Recreation District. We are very grateful for the cooperation of the entire city for allowing us to conduct our study in South Suburban Park and look forward to working with them throughout the entire process.

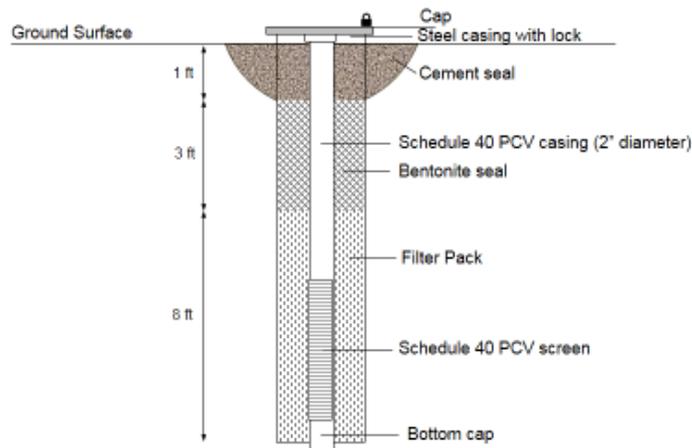
#### 4.5 Well Schematics for sites A, B



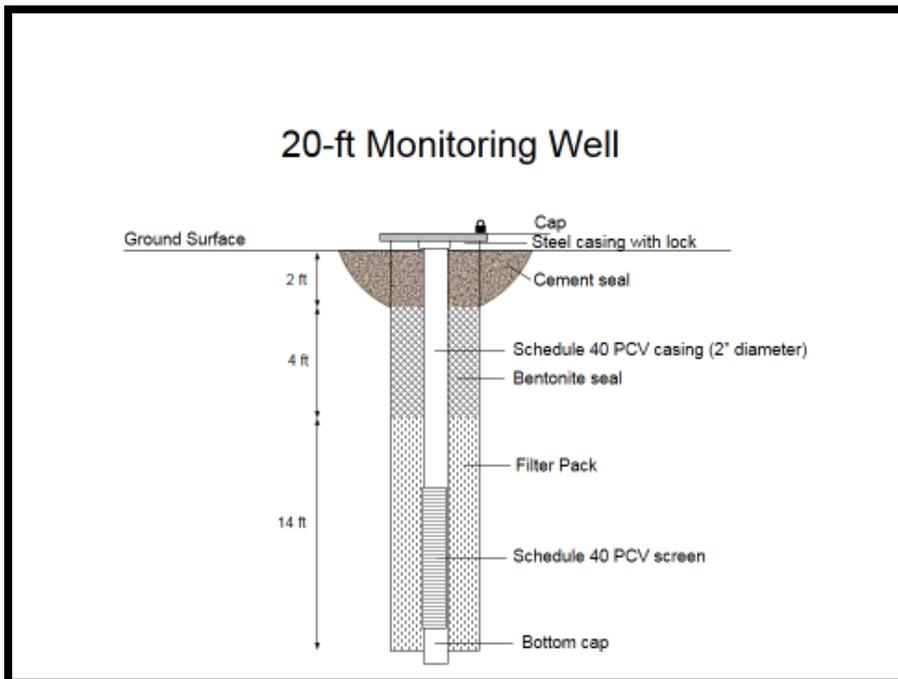
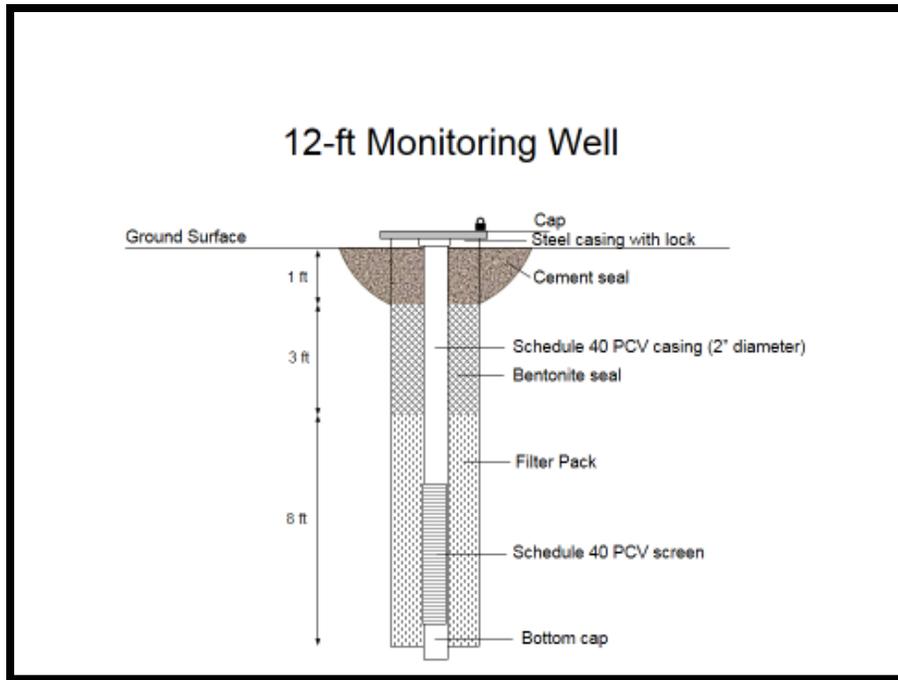
## 6-ft Monitoring Well



## 12-ft Monitoring Well



## 4.6 Well Schematics for sites C, D



## 4.7 Well Schematics for site E

