Work Plan: Vertical Seismic Array Deployment at TA-16, Wellbore R-25c

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Scope of work

This work plan describes the deployment of seismic sensing and recording equipment in Wellbore R-25c at TA-16 for the purpose of acquiring critical new data required to better quantify seismic hazards affecting LANL facilities.

Justification of need

The Los Alamos Seismic Network (LASN) continuously monitors local earthquake activity in the Los Alamos area in support of LANL's Seismic Hazards program. Seismic monitoring of LANL facilities is a requirement of DOE Order 420.1B (Facility Safety). This can only be satisfied through reliable 24/7 operation of LASN remote earthquake ground-motion monitoring instrumentation, which currently consists of an array of 7 sensitive-motion field stations. This is adequate for characterizing local earthquake activity near LANL, but the spatial coverage is severely limited, only one station uses modern broadband digital equipment, and there is no deep wellbore monitoring capability. Network expansion and upgrades are critical to improving LASN's ability to satisfy the DOE Order. Of these critical tasks, deploying a vertical seismic array in an appropriate deep wellbore on LANL property has the highest priority. This enhanced capability will provide unique data required to accurately characterize local site response and expected ground motion that LANL facilities would experience in the event of a significant nearby earthquake. The importance of this proposed activity to LANL's Facilities Safety cannot be over-emphasized. The new capability will also greatly improve our understanding of earthquake activity for the entire northern New Mexico region, as LASN is the only network operating in this seismically active area.

Wellbore selection

A total of four LANL wellbores were considered for deployment of the seismic array before selecting R-25C. In addition, a well in Los Alamos townsite was assessed. The important criteria were: 1) the well needs to sample both Bandelier tuff members (Tshirige and Otowi) and penetrate at least as deeply as the Puye formation, 2) the ground surface must be on a mesa top as opposed to in a canyon, 3) the well must be available on a semi-permanent basis and the installation must not interfere with ongoing groundwater monitoring operations, and 4) the nearby infrastructure must be reasonably quiet seismically and our deployment must not interfere with ongoing Technical Area activities or construction. R-25c is the only well that meets all of these requirements. In particular, criterion 3 is met ideally because water level data from R-25c indicate the monitoring well has been dry since it was completed in 2008 and it is not anticipated that it will show saturation in the near future. In addition, the location of the well at TA-16 happens to lie on a perfect azimuth for our existing data telemetry system at TA-03, SM-40.

Work plan overview

The plan is to install two seismic sensors and associated power, recording and telemetry equipment at TA-16, Wellbore R-25c (see Figs. 1 and 2 for location and Fig. 3 for current as-built well diagram). One sensor will be deployed at the bottom of the wellbore casing at a depth of 1080 feet and the other sensor will be installed at the surface near the wellhead. In addition, a drop pipe and gage tube will be installed to allow monitoring of the water level near the bottom of the well. Personnel and equipment from LANL/ADEP will support the wellbore deployment to ensure the well is not damaged. EES-17 personnel will install the surface equipment. The two sensors are connected to a seismic digitizer/recorder and the data are then RF telemetered to the LASN central recording facility at TA-03, building SM-40, room S10. Surface installation will involve securing the recorder, radio and power system in an appropriate

weatherproof, secure enclosure that can be locked if necessary. Additionally, a short (6 to 8 feet) mast will be erected for mounting an RF antenna and solar panel. After all equipment is installed and connected, EES-17 personnel will spend several days testing and calibrating the system. Once system functionality is confirmed, the equipment will run unattended, requiring only occasional site visits (2-4 per year) for maintenance. The long-term plan is for this station to be a permanent addition to LASN. The deployment will follow procedures to ensure that the existing well completion will be functionally unaltered and available for groundwater monitoring, if necessary.

Description of downhole sensor, wireline and acoustic coupling material

The downhole sensor is a Kinemetrics, Inc. Hyposensor force balance accelerometer (FBA) that detects 3 components of seismic ground motion (vertical, N/S and E/W). The sensor is contained in a 316 stainless steel housing 3 inches OD and 1.5 feet long with the bottom 1 to 2 inches being conical (Fig. 4). It is connected to a 1200-foot length of wireline cable that is 0.75 inches OD and has yellow footage markers every 50 feet that are 1 inch OD (Fig. 5). The cable/FBA connector is watertight and made of 316 stainless steel with a coupling ring made of marine grade corrosion resistant brass (Fig. 4). The cable sheath, connector molding and footage markers are made of thermoplastic polyurethane elastomer (Estane 58863 TPU). The FBA package is installed with two Teflon centralizers that are 4 inches OD (Fig. 6) and attached at the top and bottom of the stainless steel housing. The FBA will sit at the bottom-center of the wellbore (1080 feet) and is surrounded by a uniform mixture of 3-mm and 5-mm diameter soda-lime glass beads for acoustic coupling to the wellbore casing. The total length of glass-bead fill is roughly 2 feet.

Deployment plan details

Figure 7 shows a schematic diagram of the planned as-built configuration of the equipment and materials to be installed in R-25c. A 1-inch ID steel drop pipe will be installed with a 40-foot length of 316 stainless steel tubing attached to the bottom. The wireline cable and a 1-inch ID schedule 80 flush-joint threaded PVC gage tube will be strapped to the drop pipe as it is being lowered into the well. During deployment, the FBA package will hang 4 to 5 feet below the bottom of the drop pipe and gage tube. When the FBA reaches the bottom of the wellbore casing, the glass beads will be delivered to the top of the package through a separate tremie tube system that will be removed after the beads are in place. The drop pipe and gage tube will then be lowered an additional 1 to 2 feet to provide adequate slack in the wireline cable. The entire downhole assembly will then be hung from a steel landing plate with the drop pipe bearing all of the weight on a final steel coupling at the top of the pipe and seated on the landing plate. The steel drop pipe and PVC gage tube will be capped at the bottom with perforations around the OD to allow water to enter. The drop pipe will have a pressure transducer installed at the bottom to be used for continuous monitoring of the water level in the sump below the screen. The PVC gage tube will be used for occasional true-water-level measurements without needing to remove the pressure transducer from the drop pipe. The FBA package and glass beads should displace the existing ~4 ft of water in the bottom of the sump upward to where the transducers in the drop pipe and gage tube can monitor the sump water. If for some reason there is not adequate water in the sump, some deionized water could potentially be added to the sump water (residual potable water used during development and testing after the installation of R-25c) to provide sufficient water for monitoring.

The installation is designed to allow the FBA package, glass beads, drop pipe and gage tube to be easily removed from the well to allow for sampling, in the unlikely event that groundwater is detected in the well. In addition, no alteration of or damage to the existing wellbore completion will occur as a result of the deployment. Material Data Safety Sheets (MSDS) for all equipment and materials to be installed in the wellbore are available for examination on request. Equipment rinsate blanks are planned to be collected from the cable, connector, FBA housing, beads, and PVC tubing before installation in the well.

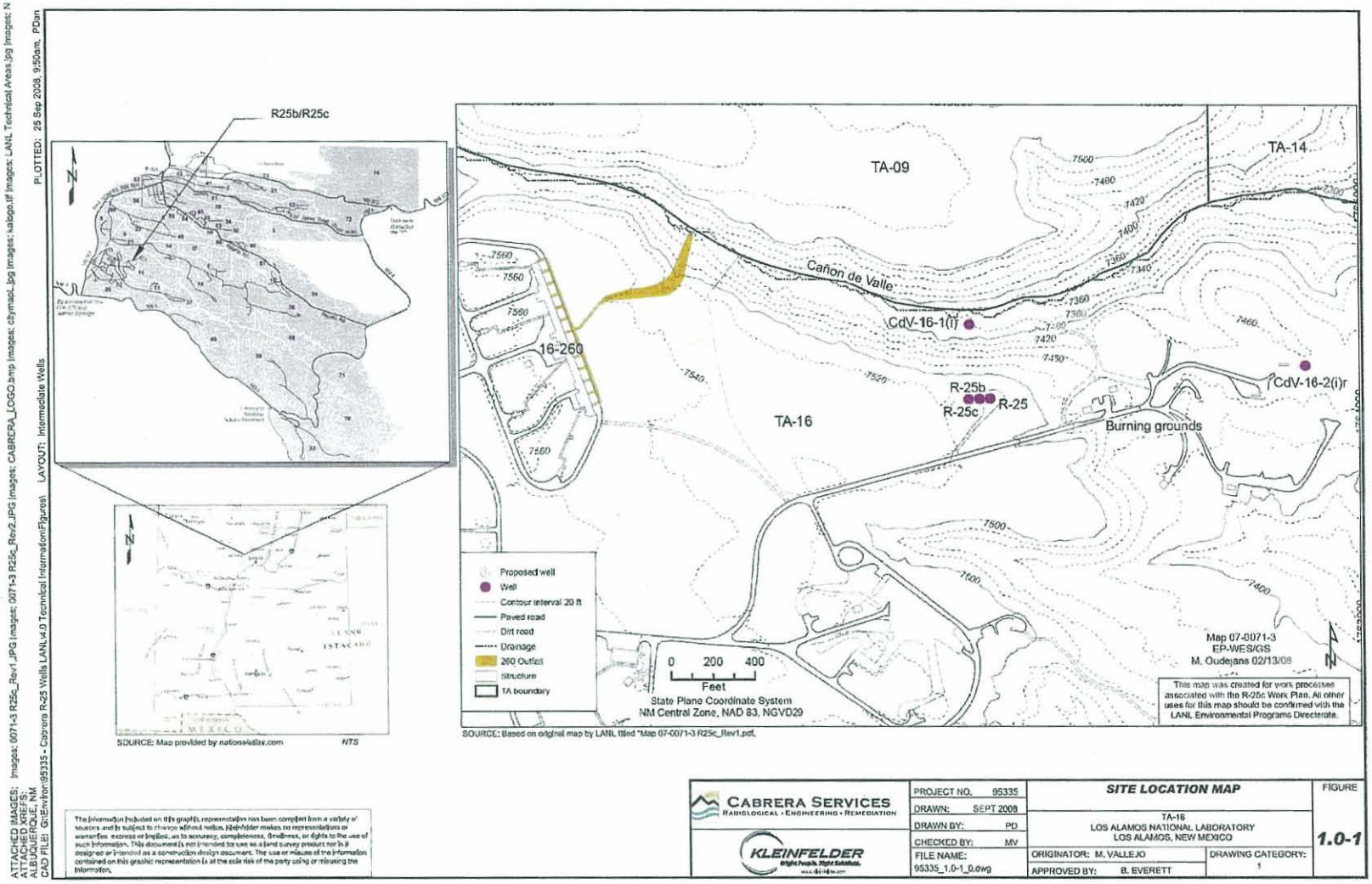


Figure 1. Site Location Map

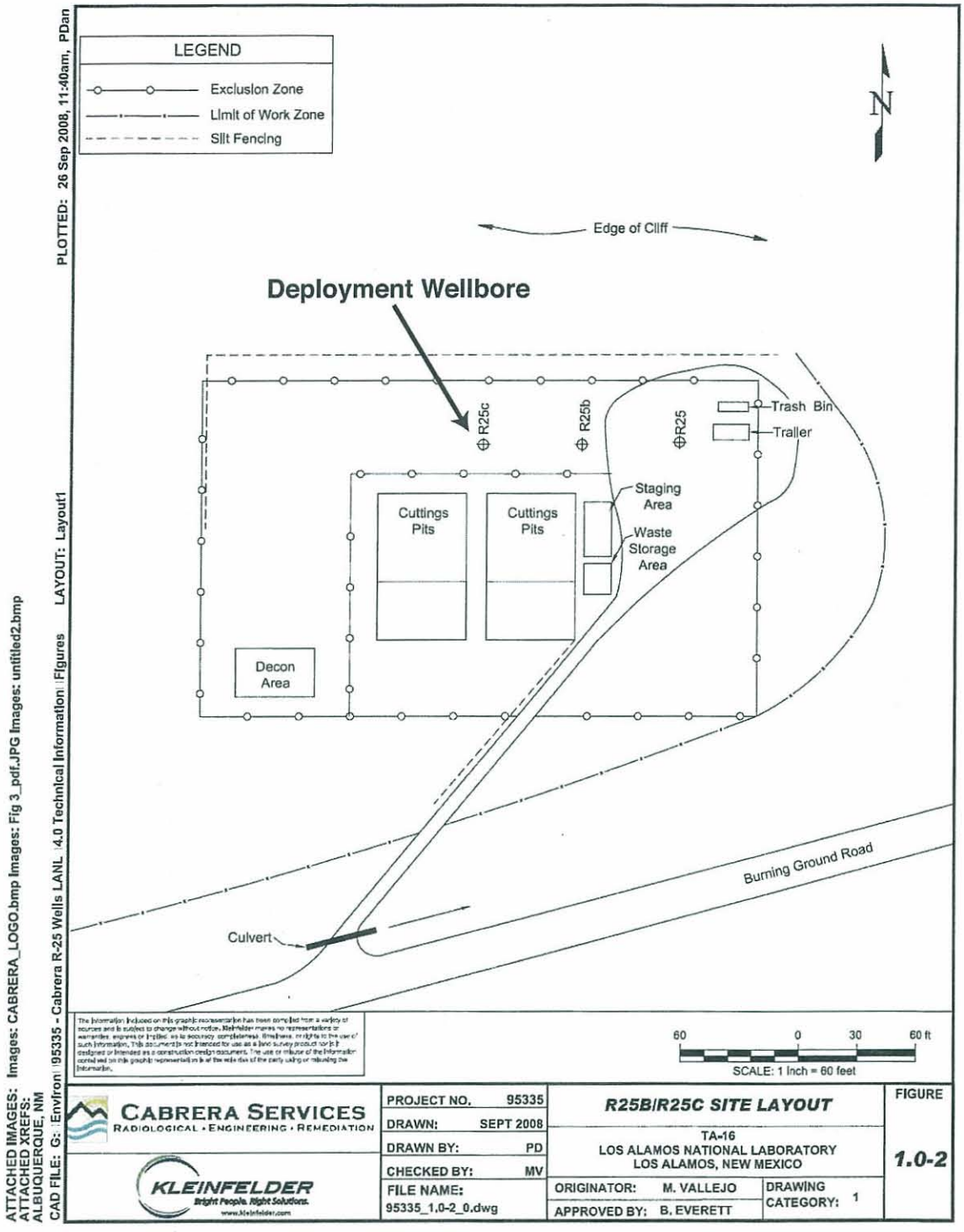


Figure 2. Site Layout

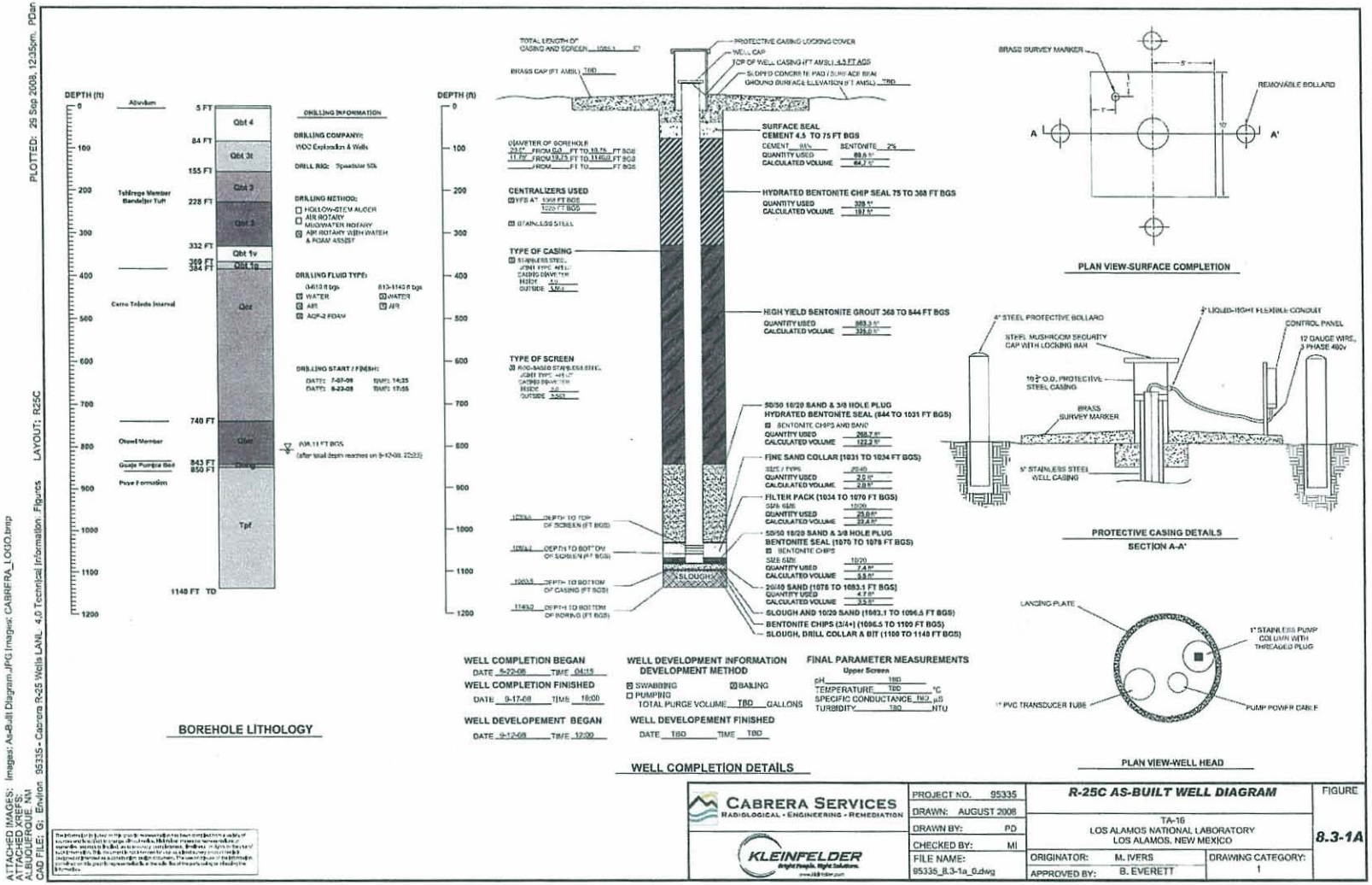


Figure 3. R-25c As-Built Well Diagram



Figure 4. FBA package mounted on cable



Figure 5. Polurethane-sheathed cable and footage markers



Figure 6. Teflon centralizers with SS screws

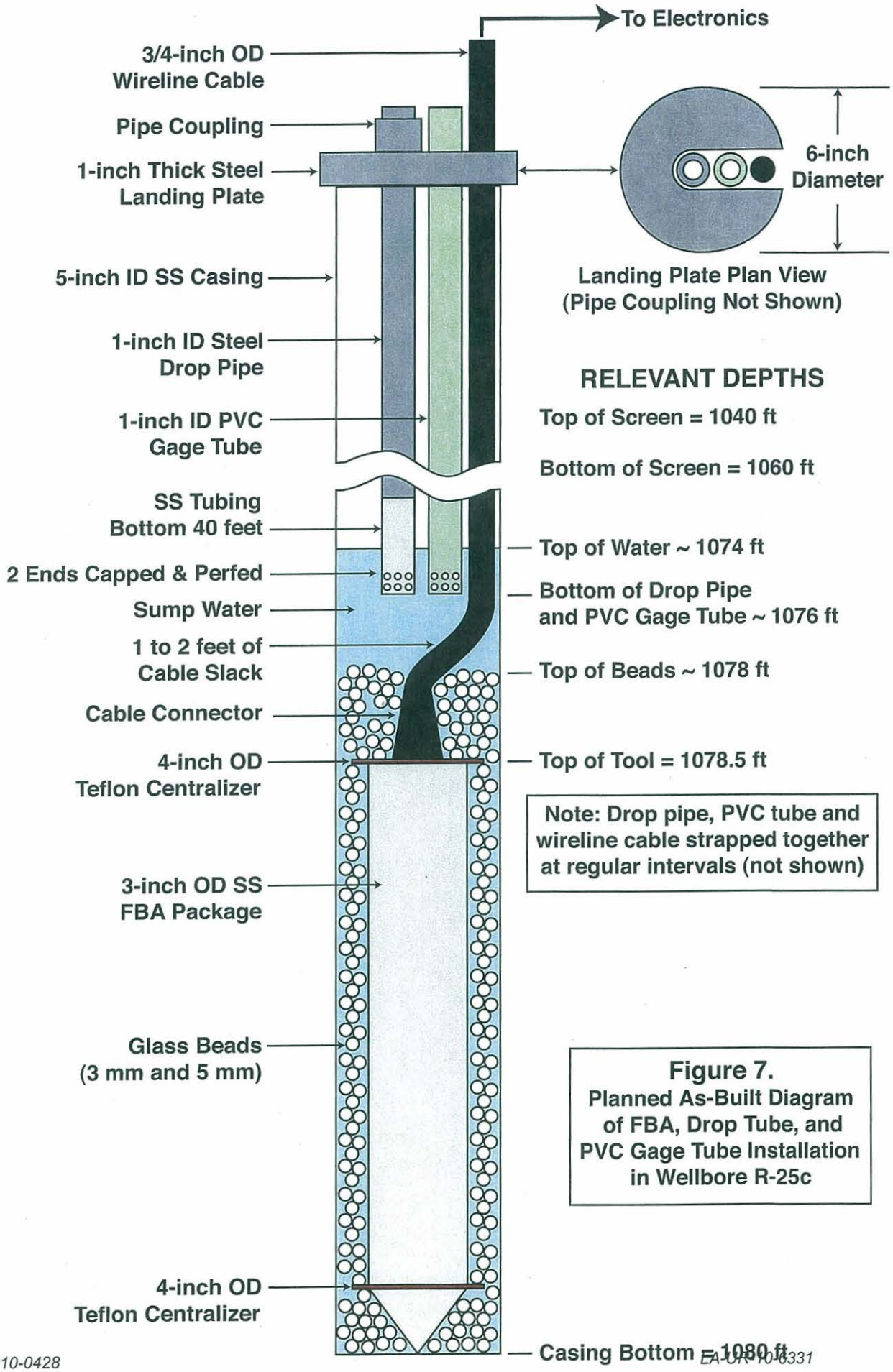


Figure 7.
Planned As-Built Diagram of FBA, Drop Tube, and PVC Gage Tube Installation in Wellbore R-25c