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Agency Name: Minnesota Pollution Control Agency

Title: Minnesota Pollution Control Agency's Statewide Water Quality Data in the National Groundwater Monitoring Network

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Overview of Work

The Minnesota Pollution Control Agency (MPCA) is a state agency that monitors environmental quality, offers technical and financial assistance, and enforces environmental regulations. The MPCA routinely monitors the state's groundwater to determine the kinds of pollution present, identify any emerging pollution trends, and evaluate whether any types of pollution controls are necessary. As part of its routine ambient groundwater monitoring activities, the MPCA currently samples a network about 270 wells across the state in three principal aquifers of national interest: 1) sand and gravel aquifers of glacial origin, 2) the Cambrian-Ordovician Aquifer System, and 3) the Upper Carbonate Aquifer. Most the agency's network wells are installed in the sand and gravel aquifers of glacial origin, and all of them are scheduled for annual sampling and tested for over 100 constituents in both the field and laboratory.

For this project, the MPCA planned to install five new Cambrian-Ordovician monitoring wells to its monitoring network. These additional wells were needed because the agency's ambient groundwater quality network currently has less than the recommended number of monitoring wells, and most of the sampled wells are not evenly distributed throughout the aquifer but are located in the Minneapolis-St. Paul metropolitan area. Furthermore, four of the Cambrian-Ordovician wells originally included in the NGWMN from the MPCA's ambient monitoring network can no longer be accessed by the MPCA for sampling as a result of property transfers.

Description of the MPCA's Existing Water-Quality Network

The MPCA's Ambient Groundwater Monitoring Network (Figure 1) was put in place in 2004 to evaluate groundwater quality conditions in Minnesota and provide information on any changes in water quality. This monitoring is required by the state's Groundwater Protection Act which charges the MPCA to evaluate the presence and distribution of non-agricultural chemicals in the groundwater, such as solvents and metals. To meet its monitoring objectives, the MPCA's Ambient Groundwater Monitoring Network primarily samples shallow wells that underlie the urban parts of the state, where non-agricultural chemicals most likely are used and disposed. The wells sampled by the network typically are installed in the sand and gravel aquifer of glacial origin, the Upper Carbonate Aquifer, and Cambrian-Ordovician Aquifer systems (Table 1). The network wells are not evenly distributed throughout these aquifers but are concentrated in the parts of them that are vulnerable to contamination. Aquifers that are not expected to contain human-caused pollution, such as the state's deep aquifers, typically are not sampled by this monitoring network.

There are two components to the MPCA's Ambient Groundwater Monitoring Network. Most of network wells intersect the water table of the surficial sand and gravel aquifers and serve as an early warning system. The remainder of the network primarily monitors the Cambrian-Ordovician Aquifer system and deep parts of the sand and gravel aquifers, although it does contain a couple of wells that are installed in the Upper Carbonate

Aquifer. Most of the sampled Cambrian-Ordovician aquifer system wells are installed in the Prairie du Chien-Jordan aquifer because of its considerable use for public and domestic water supplies.

The early warning system wells in the MPCA's groundwater network are used to discern the effect of various urban land uses on groundwater quality and provide information on emerging trends. These wells are distributed among four different land use settings: 1) sewered residential, 2) residential areas that use subsurface sewage treatment systems (SSTS) for wastewater disposal, 3) commercial or industrial, and 4) undeveloped. The data collected in the undeveloped areas, which mainly are forested areas in the Northern Minnesota, provides a baseline to assess the extent of any pollution from all other land use settings. Most of the wells in the early warning system component of the network contain young water that was recently recharged into the groundwater. The results of testing to determine the age of the water extracted from the wells in the early warning network has found that it is less than one year old in over 80% of the tested wells.

The early warning system component of the MPCA's network initially was developed in 2004. To save costs, existing shallow monitoring wells were used. Most of these were constructed as part of the MPCA's ambient groundwater monitoring activities during the 1990s, US Geological Survey (USGS) projects, or the USGS's National Water-Quality Assessment. However, the existing wells were not located in all of the settings of interest to the MPCA, and monitoring wells needed to be installed to fill this gap. This occurred primarily from 2010-2016 and approximately 150 monitoring wells were installed for this network during this period.

The remainder of the wells in the MPCA's network are used to assess water-quality conditions at depth in places that are vulnerable to contamination. Most of the Cambrian-Ordovician Aquifer System wells are located in the eastern Twin Cities Metropolitan Area (TCMA). The deep sand and gravel aquifer wells sampled by the network are located throughout the state.

Table 1. Number of wells monitored by the MPCA's Groundwater Monitoring Network by U.S. Geological Survey Principal Aquifer

Principal Aquifer	Number of Sites Monitored
Surficial Aquifer System	198
Cambrian-Ordovician Aquifer System	38
Upper Carbonate Aquifer	5
Cretaceous Aquifer	0
Crystalline-Rock Aquifer	0

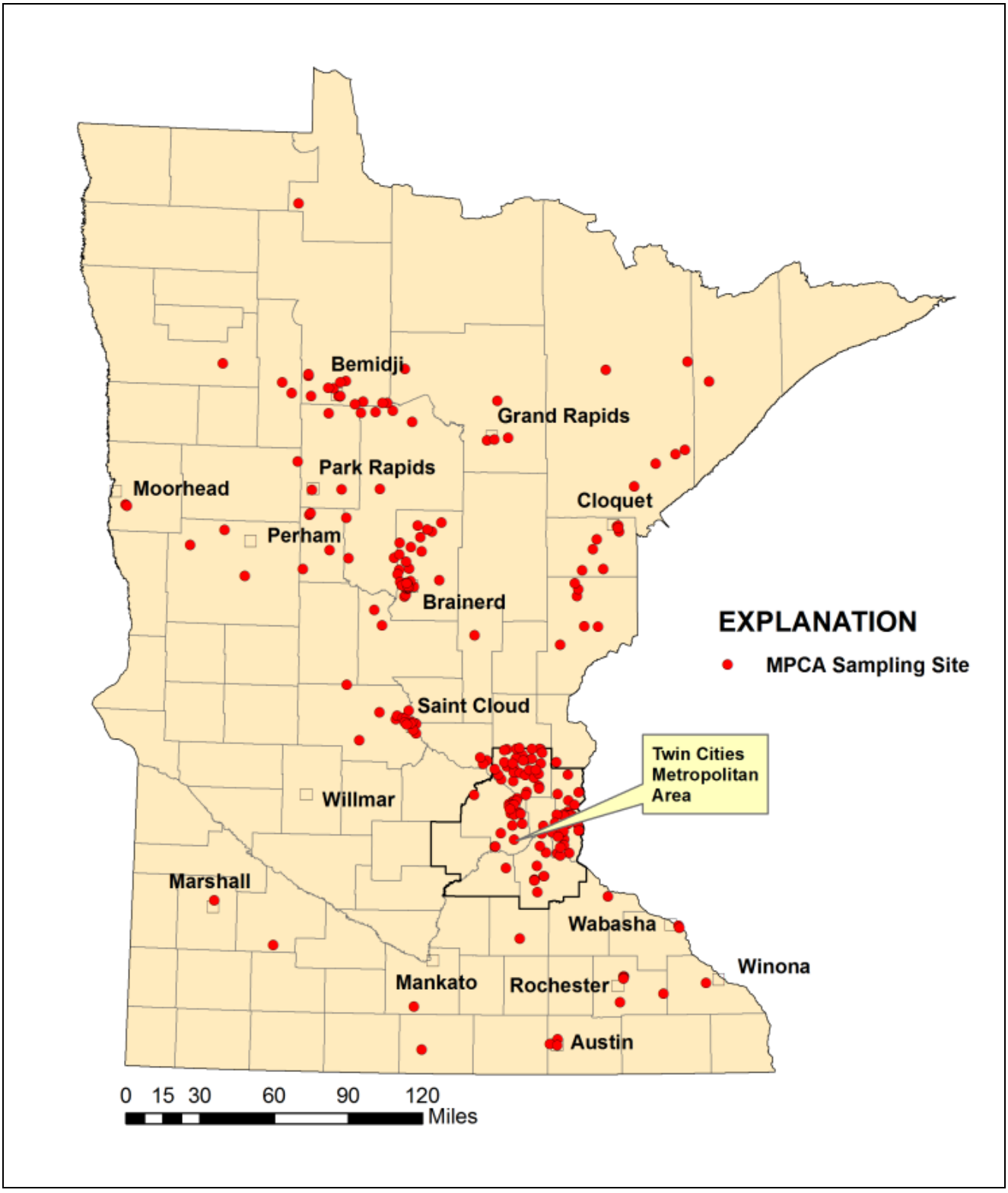

Figure 1. The MPCA's Ambient Groundwater Monitoring Network, 2016.

Secure Access to Well Sites

For this project, the upper part of the Prairie du Chien-Jordan aquifer was targeted for well installation. In Minnesota, several aquifers comprise the Cambrian-Ordovician system, including the Galena, St. Peter, Prairie du Chien-Jordan, Tunnel City/Wonewoc, and the Mount Simon-Hinckley. The Prairie du Chien was targeted for groundwater quality monitoring for two reasons. First, the Prairie du Chien is an important aquifer for water supplies in the seven-county Minneapolis-St. Paul metropolitan area and Southeastern Minnesota. Water use data collected by the Minnesota Department of Natural Resources showed this aquifer supplied over 85 percent water supply for domestic, commercial, industrial, and public users in 2023. Second, there are many places where this aquifer is close to the land surface and covered with permeable unconsolidated deposits which makes it naturally vulnerable to contamination.

Publicly owned lands were targeted for well installations. The decision to focus on properties owned by local, state, and federal governments for groundwater quality monitoring sites was based on experience installing approximately 150 monitoring wells for the MPCA's ambient groundwater quality monitoring network from 2010-2015. As part of this past project, many owners of privately-owned properties were contacted regarding well installations, but in most cases, voluntary access was not secured to install wells on the private lands. In contrast, the city, county, and other state and federal agencies were more willing to partner with MPCA to expand its ambient groundwater quality monitoring network. The Minnesota State Statutes permits the Pollution Control Agency to conduct monitoring where known contaminant releases have occurred (Minnesota Statutes, Chapter 115B), and it is the duty of the property owner to cooperate with the agency. However, in the specific case of ambient groundwater quality monitoring, it is not known (or even likely) that any contamination by chemicals legally classified as a hazardous substance has happened. Subsequently, there is no legal obligation for the property owner to cooperate with the MPCA on ambient groundwater quality monitoring, and all access agreements for installation of these monitoring sites are voluntary.

Well drilling locations were selected using a multi-step process. First, a computer desktop exercise was undertaken to identify several potential sites in each targeted city using available spatial data. Next, all potential sites were visited in the field to ensure that they were suitable for well drilling and water sampling collection. Then, the potential sampling sites were prioritized, and the property owner was contacted to obtain permission to install a monitoring well. Finally, after verbal permission was given, formal access agreements were signed with each property owner prior to well installation.

Several sets of spatial data were used to identify areas for potential monitoring sites. A dataset representing the boundaries of the cities and townships in the state were available from the Minnesota Department of Transportation. Geologic information was obtained from county atlases that were prepared by the Minnesota Geological Survey and Minnesota Department of Natural Resources. In the State of Minnesota, these two agencies have worked together for several decades to produce county geologic atlases, which describe the

geology and groundwater resources of the county. These atlases were available for all counties in this project area and have two parts: 1) part A, which is the geologic description of the county and 2) part B, which describes the county's hydrogeology. The bedrock and surficial geology data from Part A were in this project used to delineate areas in each community where the Prairie du Chien-Jordan was the first bedrock and was expected to be vulnerable to contamination. Aerial photography information and land ownership information was available from the Minnesota Geospatial Information office. These two datasets were used to confirm the property targeted for well installation was in an urban area and owned by a public entity.

The following process was used to identify several potential groundwater monitoring sites in each city. First, the bedrock geology and city boundary information were overlain to identify the areas in each city where the Prairie du Chien-Jordan was the first bedrock aquifer. Next, the surficial geology data was then used to further refine the potential groundwater monitoring sites to locations where the Prairie du Chien-Jordan was both the first bedrock aquifer and the overlying unconsolidated sediments were comprised of sand or gravel, which would readily allow water and any associated contaminants to reach the aquifer. After this step was completed, aerial photographs were used to locate places that were large enough for well drilling and would be accessible for water quality sampling, and the land ownership information was used to confirm that the property was owned by local or state government.

Field visits were made to each of the sites identified in the office prior to contacting the property owner about a voluntary access agreement for a monitoring well site. Each site was examined to determine if the site: 1) could accommodate a mud or air rotary drilling rig, 2) there were no overhead utilities or tree branches that would obstruct the drilling operation, and 3) had suitable place to park a sampling vehicle. A photographic log also was taken of each site during the visit. The potential sites in each targeted city were subsequently prioritized before the property owner was contacted regarding voluntary access to install a monitoring well.

Formal access agreements and verbal commitments were granted to install wells at most of the identified sites. In 2021, access agreements for monitoring well installations were signed to install monitoring wells in a city park in Cannon Falls and on public land in the City of Zumbrota. Verbal agreements were in place to install monitoring wells on property owned by the City of Plainview and property owned by the Minnesota Department of Natural Resources in Lewiston.

Install and Develop Monitoring Wells

Contractors on the state's Statewide Drilling Services contract were used to install wells for this project. This contract currently has nine different well drilling companies under contract for a variety of services, and there are several companies on it who can drill bedrock aquifer wells. On this contract, the well installation prices

also vary among the vendors. When trying to secure a driller for this project, attempts were made in the first years of the project to secure the most cost-effective contractor.

The first attempt to install wells for this project was made in October/November 2021, and a purchase order was created with one of the contractors to install the wells in Cannon Falls and Zumbrota. This drilling activity had to be postponed about one week before the scheduled well installation date due to an issue with a right-of-way permit fee. When the access agreement to install the well at the Cannon Falls site was initially discussed and signed, it was not known that the city would also request that the MPCA apply for a subsequent right-of-way permit. MPCA legal staff has maintained that the State of Minnesota is exempt from paying these permit fees, and the agency will not allow programs to use any funds for these. An attempt to get the right-of-way permit fee waived was not successful, so the Cannon Falls wells could not be installed at the location secured by the first access agreement. As a result of this issue, the drilling campaign for the Cannon Falls and Zumbrota sites was aborted because the drilling contractor based their cost for this work on mobilizing from their location approximately 2-3 hours away to install both monitoring wells during the same drilling event.

A second attempt was made to install the Cannon Falls and Zumbrota monitoring wells in 2022 after an access agreement was signed with the Minnesota Department of Transportation for an alternate monitoring well site in the City of Cannon Falls. The alternate groundwater quality monitoring site was located near a state-owned truck facility in an industrial part of the city. A purchase order was again made with a contractor on the State of Minnesota's well drilling contract to install the monitoring well at the new location in Cannon Falls and Zumbrota. Unfortunately, the contractor was not able schedule the well installations. During this time, the state was experiencing drought conditions, and this made it more difficult to schedule monitoring well drilling because there was a large demand for well drilling work, especially irrigation well activities. In addition, it also was reported that there were issues procuring well drilling supplies due to supply-chain issues related to the COVID-19 pandemic.

The Cannon Falls and Zumbrota wells were installed in the November 2024. Both wells were drilled using a truck-mounted Mayhew 1400 mud rotary rig by Steffl Drilling and Pump (State of Minnesota drilling license number 1551). Prior to well installation, all the underground utilities within 25 feet of the proposed site were professionally located and marked. At each site, boreholes were advanced through the unconsolidated sand, gravel, or clay deposits using an auger bit until the limestone was encountered. When the borehole was advanced to the limestone/dolomite, a roller cone bit was used to drill through the bedrock. To expedite the drilling process, a small roller cone bit was first used to drill through the limestone. The borehole was then enlarged using progressively larger roller cone bits to reach the final borehole diameter of 6.25 inches. It was very apparent when the limestone was encountered due to the difference in hardness between the limestone/dolomite and the overlying unconsolidated deposits and the presence of limestone fragments in the drill cuttings. Mud rotary circulation was lost during the drilling of both wells, which is fairly common in

this part of Minnesota according to the licensed driller. At the Zumbrota site, mud rotary circulation was lost at 23 feet due to the presence of gravel.

After the borehole was completed, each well was installed using stainless steel casing and screen and was flushed with clean water to remove the drilling mud used during the installation process (Figures 2 and 3). The Minnesota well code requires stainless steel well casing and screen since each well was deeper than 50 feet. Well screens were installed into the first 20 feet of the bedrock aquifer. However, due to the lack of circulation in the Zumbrota well, the bottom 5 feet of sediment in the borehole could not be removed during drilling, and the screen was installed in the 55-75 foot depth interval. The joints on the well casing were threaded. Before the sand pack was installed, each newly-constructed well was flushed to remove the drilling mud from the borehole by pumping clean water from the rig down the well. This was done prior to well completion. Water was flushed repeatedly down the well until it was clear. After the well was sufficiently purged, the screened interval of the well was backfilled with red flint sand. A one-foot-long plug of bentonite chips was placed above the sand pack, and the rest of the borehole (up to the land surface) was backfilled with Portland cement.

The remaining wells were not installed at the other locations mainly due to cost. The lowest cost well drillers were initially considered for well installation for this project, and purchase orders were obtained with them in 2021 and 2022. However, these were not the contractors that were ultimately available to do the work, and this left less funds to install the remaining monitoring wells. There also was an issue at the proposed site in Plainview, which prevented the planned well installation from moving forward.

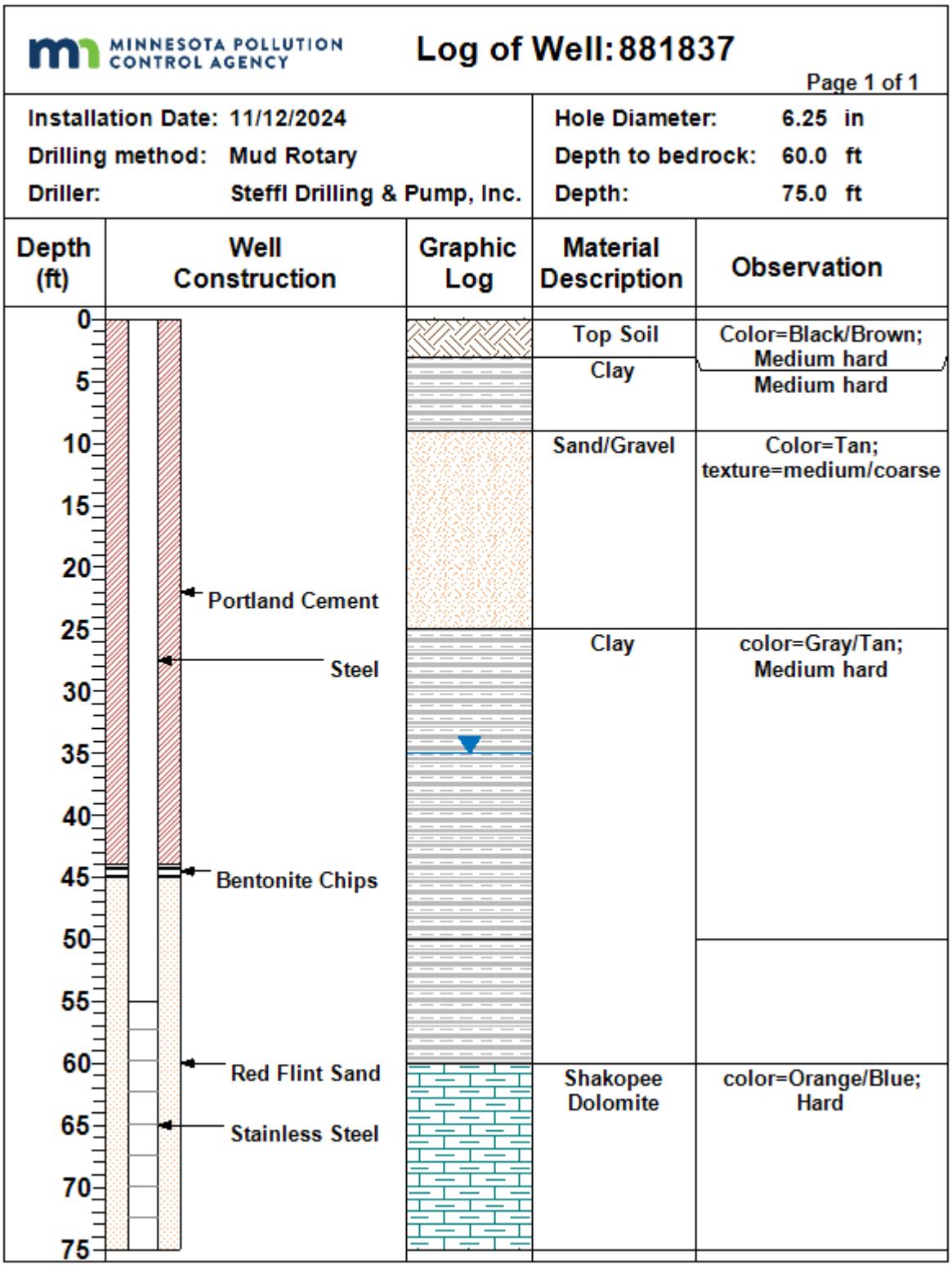

Figure 1. Drilling log for well installed in the City of Zumbrota, Minnesota.

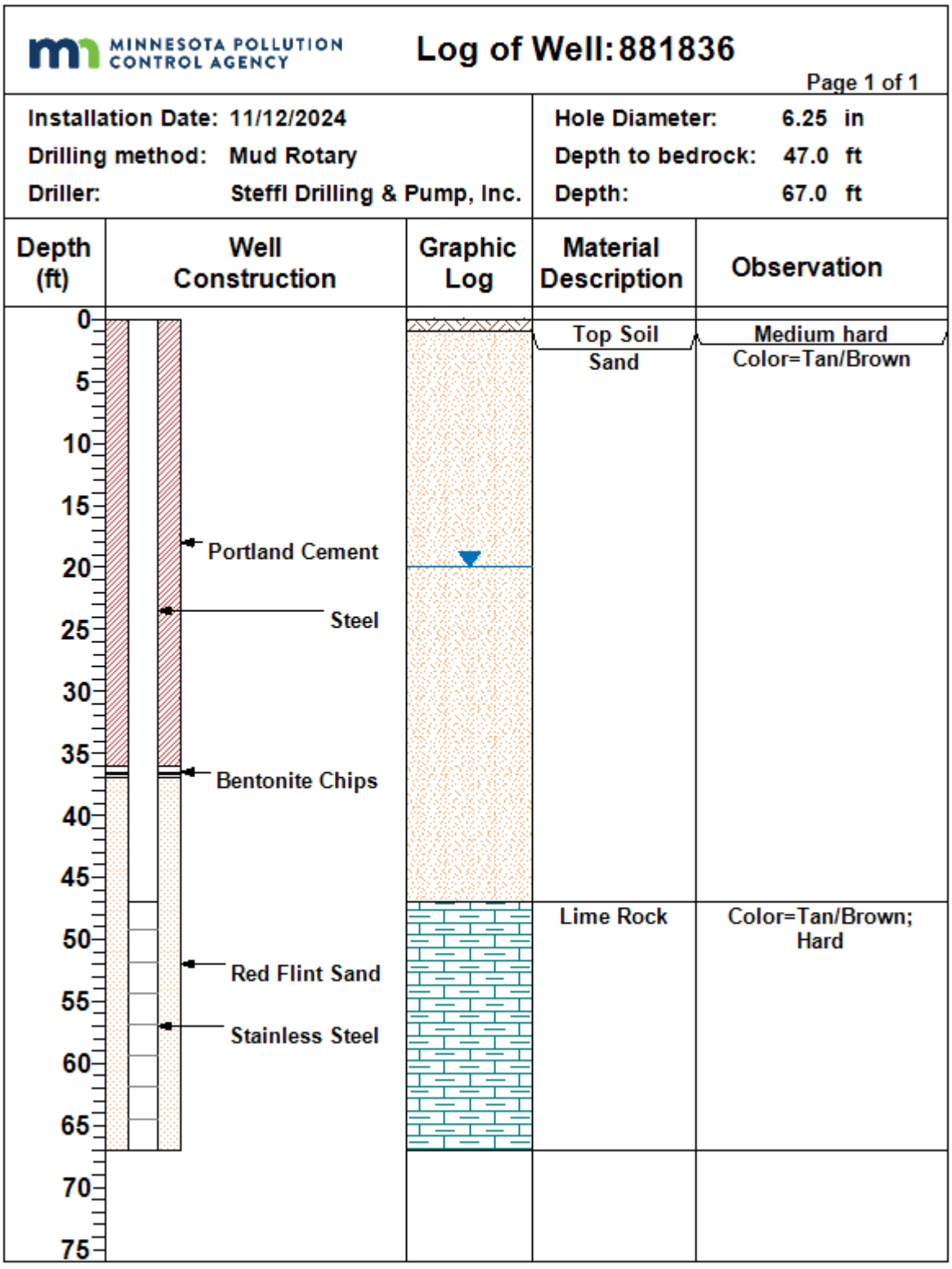

Figure 2. Drilling log for the well installed in the City of Cannon Falls, Minnesota.