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## **Appendix B**

### **Groundwater Monitoring Plan**

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# **PROPOSED GROUNDWATER MONITORING PROGRAM**

## **GOLDEN SANDS DAIRY PROJECT AREA**

The Golden Sands Dairy (GSD) project will include the farm production area (GSD Production Area) and approximately 4,660 acres of agricultural fields proposed for conversion from pine plantation (Converted Fields) that will receive commercial and organic nutrient applications through traditional application methods and at some point potentially also via center pivot irrigation equipment. GSD will also utilize 1,800 acres of existing irrigated acres for nutrient applications. This monitoring plan only applies to the Converted Fields, which will receive crop fertilizer for the first time. This proposed groundwater monitoring plan is designed to 1) provide data to document current and future groundwater quality upgradient, beneath and downgradient of the Converted Fields and the GSD Production Area, 2) provide an early warning of potential off-site migration of agricultural chemicals in groundwater, and 3) provide early warning of potential releases from the GSD Production Area. Water-quality changes at the Converted Fields, if any, are expected to occur over decadal intervals<sup>1</sup>, and this monitoring plan was designed to monitor potential long-term water quality changes or to document the absence of such changes. The design of the monitoring plan was influenced by the monitoring program developed by the U.S. Geological Survey to evaluate long-term changes in water quality beneath fields planted in alfalfa and corn in Portage County.<sup>2</sup>

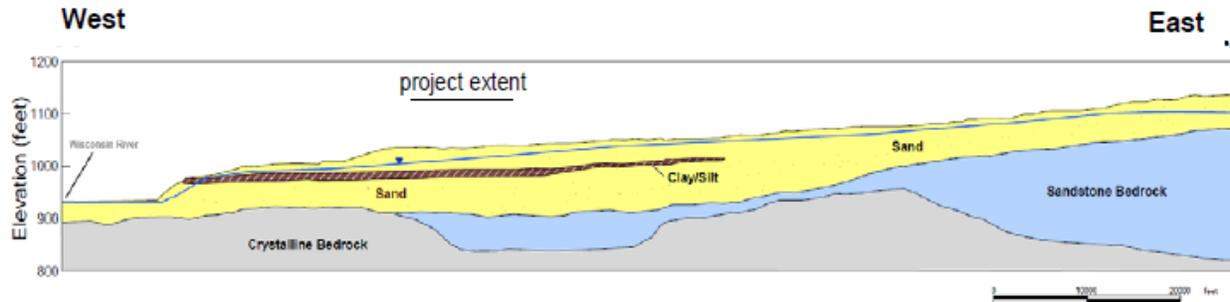
### **Groundwater Conditions**

The GSD Production Area and Converted Fields encompass an area nearly 7 miles west to east and 3 miles north to south, in the southeastern corner of Wood County. The GSD is located in a region with a very productive groundwater aquifer. A schematic hydrologic cross section is shown in the figure below. The main aquifer is a water table aquifer consisting of glacial sands and gravels that are up to 130 feet thick near GSD. The water table is nominally about 20 feet below land surface. Underlying the sands and gravels is an aquifer consisting of Cambrian-aged sandstones of the Mt. Simon Formation that overlies pre-Cambrian aged crystalline bedrock that is not a productive aquifer. The sandstone is reported to be comprised of mainly well-rounded medium grained sand. The sandstone unit generally thickens toward the southeast and is absent to the west of the project area. This region is often referred to as the Central Sands region and/or the Central Sand Plain of Wisconsin.

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<sup>1</sup> Water-quality changes, if any, will occur over an extended period of time because of the large volume of groundwater in storage in the aquifer near GSD. This large volume of groundwater will attenuate (dilute) constituents that leach from the fields.

<sup>2</sup> Saad, D.A., 2007. Agricultural-Related Trends in Groundwater Quality of the Glacial Deposits Aquifer, Central Wisconsin. *Journal of Environmental Quality*, 37:S-209 to S-225.



A silt/clay unit, referred to as the New Rome member, occurs throughout much of the sand plains. This unit consists primarily of silt and clay, which may or may not be rhythmically banded, and is regionally extensive near GSD. The unit, as mapped by Brownell (1986), is about 10 feet thick in the project area and the top of the unit occurs at an elevation of about 950' to the south and west to greater than 1000' above MSL toward the north and west (Brownell, 1986). The unit has been truncated by younger deposits along the Wisconsin River, and the western extent of the unit is defined by previous stands of glacial Lake Wisconsin.

Groundwater flow near GSD is primarily from east to west toward the major streams in the vicinity: Tenmile Creek, Sevenmile Creek and the Wisconsin River. Computed groundwater contours, with arrows showing the general direction of groundwater flow are shown on Figure 1<sup>3</sup>. In the southern and eastern portions of the project area groundwater flow is primarily toward Tenmile Creek, a groundwater fed stream that runs along the southern boundary of the project area. In the northwestern portion of the project area, groundwater flow is primarily toward the lower reaches of Sevenmile Creek which is also primarily a groundwater fed stream. In the west central portion of the project area and the southwestern portion of the project area, groundwater flow is directly toward the Wisconsin River

There are approximately 440 residences within 0.5 miles of the Converted Fields<sup>4</sup>. The identified residences are shown on Figure 1. Approximately 150 residences are located upgradient of the Converted Fields and approximately 290 residences are located downgradient of one or more of the Converted Fields.

## Monitoring Well Locations

The characteristics of the groundwater aquifer beneath the Converted Fields are similar throughout the project area. The soils at all the fields are well drained Plainfield Series sands with minimal slope, and similar cropping patterns are proposed for all fields. Therefore, it is expected that the conversion of these fields from pine plantation to irrigated agriculture will have similar effects, if any, on groundwater quality throughout the project area. Consequently,

<sup>3</sup> The groundwater levels on Figure 1 were calculated with the groundwater model developed to evaluate the effects of pumping from high capacity irrigation and dairy wells associated with the GSD project. The calculated water levels agree closely with a 1988 groundwater contour map of Wood County developed by W.G. Batten of the USGS (Hydrogeology of Wood County, Wisconsin Geologic and Natural History Survey, Information Circular 60, 1989).

<sup>4</sup> The residences were identified based on an analysis of a June 2010 air photo of the area; each identified residence likely has an associated well.

it is not necessary to monitor each of the Converted Fields to understand potential changes in groundwater quality. Rather, it is appropriate to monitor representative fields and the GSD Production Area.

The monitoring plan consists of sixteen monitoring wells in the northwestern part of the project area north of Tenmile Creek and west of Highway 13 to monitor the Converted Fields (eleven wells) and the GSD Production Area (five wells). Water that infiltrates in this area will flow toward and into Sevenmile Creek in the northern part of the area, will flow toward and into the Wisconsin River in the middle part of the area, and will flow toward and into Tenmile Creek in the southern part of this area. The monitoring plan includes five monitoring wells located around the GSD Production Area. As the GSD Production Area is located in the eastern part of the agricultural fields that are proposed for monitoring Converted Fields, the monitoring wells proposed for the GSD Production Area will also provide information to understand long-term water quality changes, if any, from the Converted Fields. The locations of the proposed monitoring wells are shown on Figure 1.

The monitoring wells proposed for the Converted Fields consists of seven monitoring wells screened across the water table and four deeper monitoring wells (piezometers) screened below the New Rome member (depicted on cross section on previous page)<sup>5</sup>. The locations of these proposed wells and groundwater flow paths in the vicinity of the wells are shown on Figure 1. Three of the monitoring wells are located upgradient of the Converted Fields and the purpose of these wells is to quantify the quality of groundwater flowing into the fields from upgradient of the GSD Project (wells F-1s, F-1d, and F-2s). Five water-table monitoring wells, and three deeper wells, are located downgradient of the Converted Fields and upgradient of clusters of residences.

The monitoring system is spatially configured to provide information on potential changes in groundwater quality from upgradient to downgradient of the Converted Fields and to provide data that will serve as a sentinel to potential adverse changes in downgradient residential wells. The distances from the upgradient wells to the downgradient wells range from about two miles to three miles. Sufficient monitoring wells have been proposed to evaluate potential water quality changes along five separate groundwater flow paths that traverse the Converted Fields in this area. With monitoring along five flow paths, sufficient data will be collected to quantify spatial variability in potential water quality effects.

The monitoring wells proposed for the GSD Production Area consist of an upgradient water table monitoring well, three downgradient water-table monitoring wells, and one downgradient deeper monitoring well. The downgradient monitoring wells are located immediately downgradient of the manure and wastewater storage basins and the feed storage pad. The locations of the monitoring wells proposed for the Production Area are shown on both Figures 1 and 2. .

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<sup>5</sup> The water-table monitoring wells will be constructed with 15-foot screens and the deeper monitoring wells will be constructed with 5-foot screens.

## **Well Construction and Completion**

The monitoring wells associated with the Converted Fields will be constructed at least eight months prior to the planned first application of manure on the fields via center pivot irrigation equipment, and the monitoring wells associated with the production area will be constructed within 60 days of completion of construction of the GSD Production Area reviewable facilities. The use of center pivot irrigation for the land application of manure has been met with a fair amount of controversy and we understand that the State via UW Extension is currently studying the practices and that the practice has been banned by a number of local units of government. As such, when this method of application will be used by GSD is undeterminable at this time, particularly given the length of time between this proposal and final project development and manure generation. If manure application via center pivot equipment is pursued, then GSD will follow whatever best management practices or regulatory restrictions that exist at that time and pursue an evaluation of the approval of the irrigation and transfer equipment pursuant to §NR 241.16, Wis. Admin. Code.

Monitoring wells will be constructed of 2-inch schedule 40 PVC. All screens will be 0.001-inch factory cut. Well construction and development will be completed in accordance with the guidance in Ch. NR 141 of the Wisconsin Administrative Code. Upon the completion of well construction, all wells will be surveyed for location, and elevations will be surveyed to within 0.01 foot, Mean Sea Level. In addition, all wells will be tested using the slug- test method for the determination of hydraulic conductivity. Prior to sampling, depths to water will be measured in each well, and wells will be purged of a minimum of 3 casing volumes of water.

## **Monitoring Parameters**

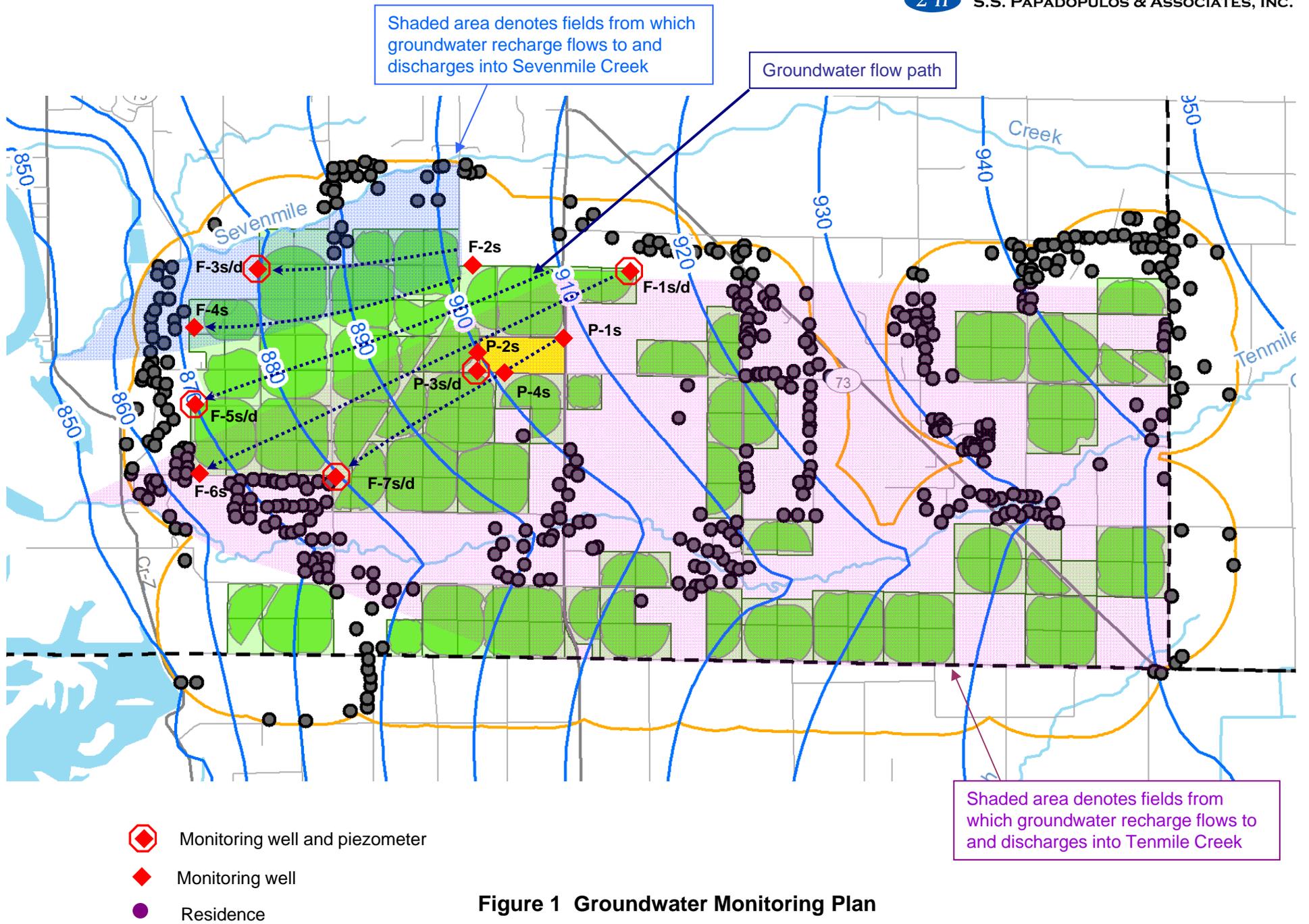
Nitrate and chloride are appropriate parameters to monitor as concerns the application of manure and inorganic fertilizers. These compounds are good indicators because they are abundant in manure and fertilizers, do not readily degrade in the sandy water-table aquifers, and generally migrate in groundwater at the same velocity as the groundwater. Therefore, these will be the primary parameters that will be monitored. In addition, to nitrate (plus nitrite) and chloride, all groundwater samples that are collected will be analyzed in the laboratory for the following parameters:

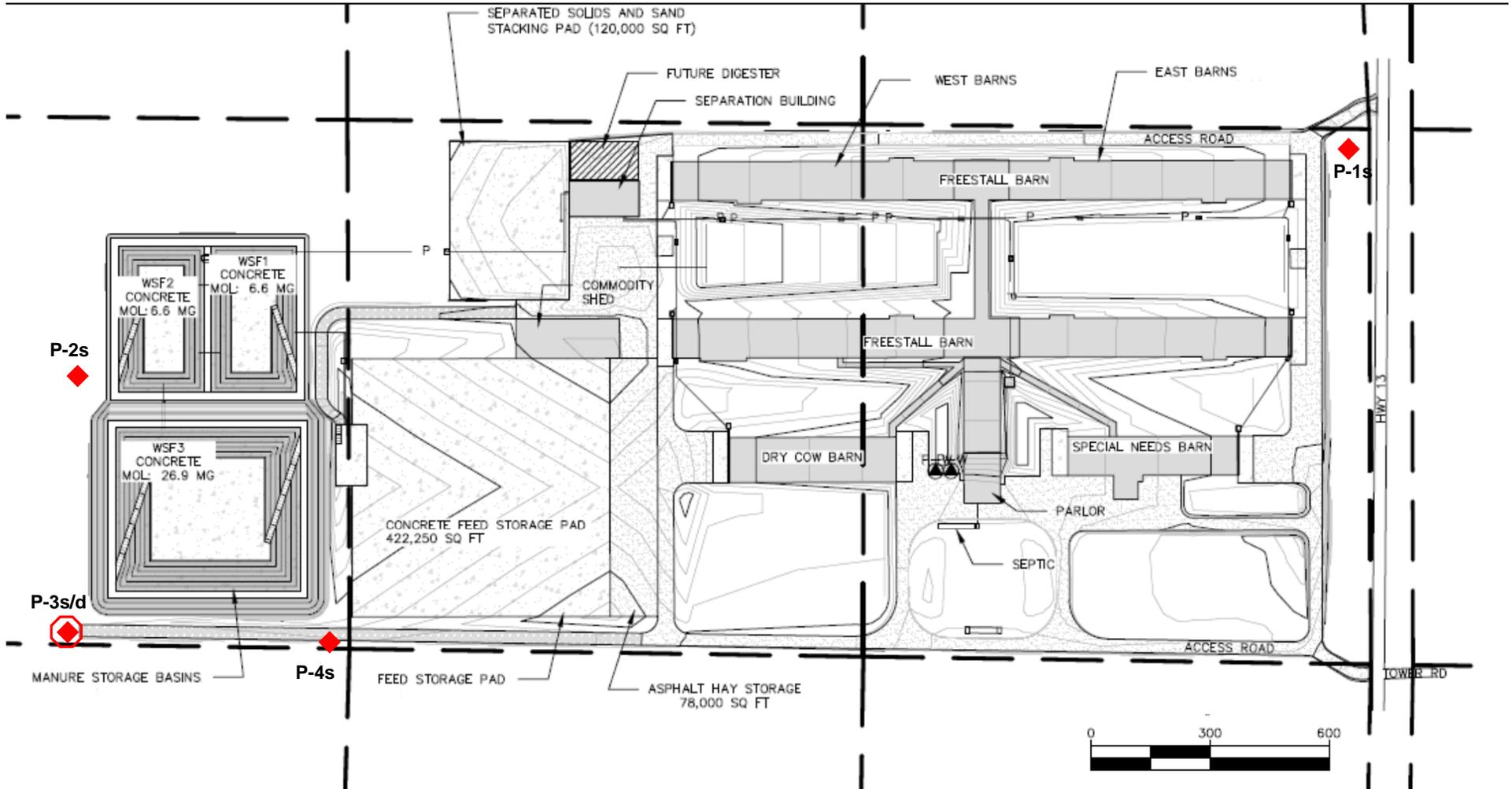
- Coliform
- Total organic nitrogen (Kjeldahl Nitrogen)
- Ammonia
- Total dissolved solids
- Chemical oxygen demand
- pH

In addition, at the time of sample collection, temperature, pH and specific conductivity will be measured, and water levels will be measured.

## **Monitoring Frequency**

Monitoring well sampling will commence within one month of well installation. All monitoring wells will initially be sampled monthly for eight months to establish background conditions. The monitoring wells associated with the GSD Production Area thereafter will be sampled quarterly. All other monitoring wells will be sampled once every fifteen months. Fifteen months is chosen so that in a five-year sampling cycle, each well will be sampled during each of the major seasons, and 15 months is a frequency consistent with potential water-quality changes.





-  Monitoring well and piezometer
-  Monitoring well

Figure 2 Groundwater Monitoring Wells at GSD Production Area