# Hydrogeologic Assessment of Potential Impacts of Meramec Ash Ponds on Local Groundwater and Surface Water

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Prepared for

Union Electric Company,

Meramec Plant

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# 1. INTRODUCTION

Union Electric (UE) is currently reviewing management options for the fly ash ponds at the UE Meramec Power Plant. As part of the review, UE has asked CH2M HILL to collate available site investigation data (see references) and perform a critical assessment of the local hydrogeological impacts, particularly to groundwater, potentially resulting from current and historic ash pond operations. The hydrogeological information will support UE in its ongoing dialogue with the Missouri Department of Natural Resources regarding future ash management strategies.

The analytical data compiled in the study was provided to CH2M HILL by UE; it represents the results of earlier investigations by other parties. The interpretations of site hydrogeology were based on this information, familiarity with the regional geology, and CH2M HILL's experience with similar environmental settings.

# 2. SITE GEOLOGY

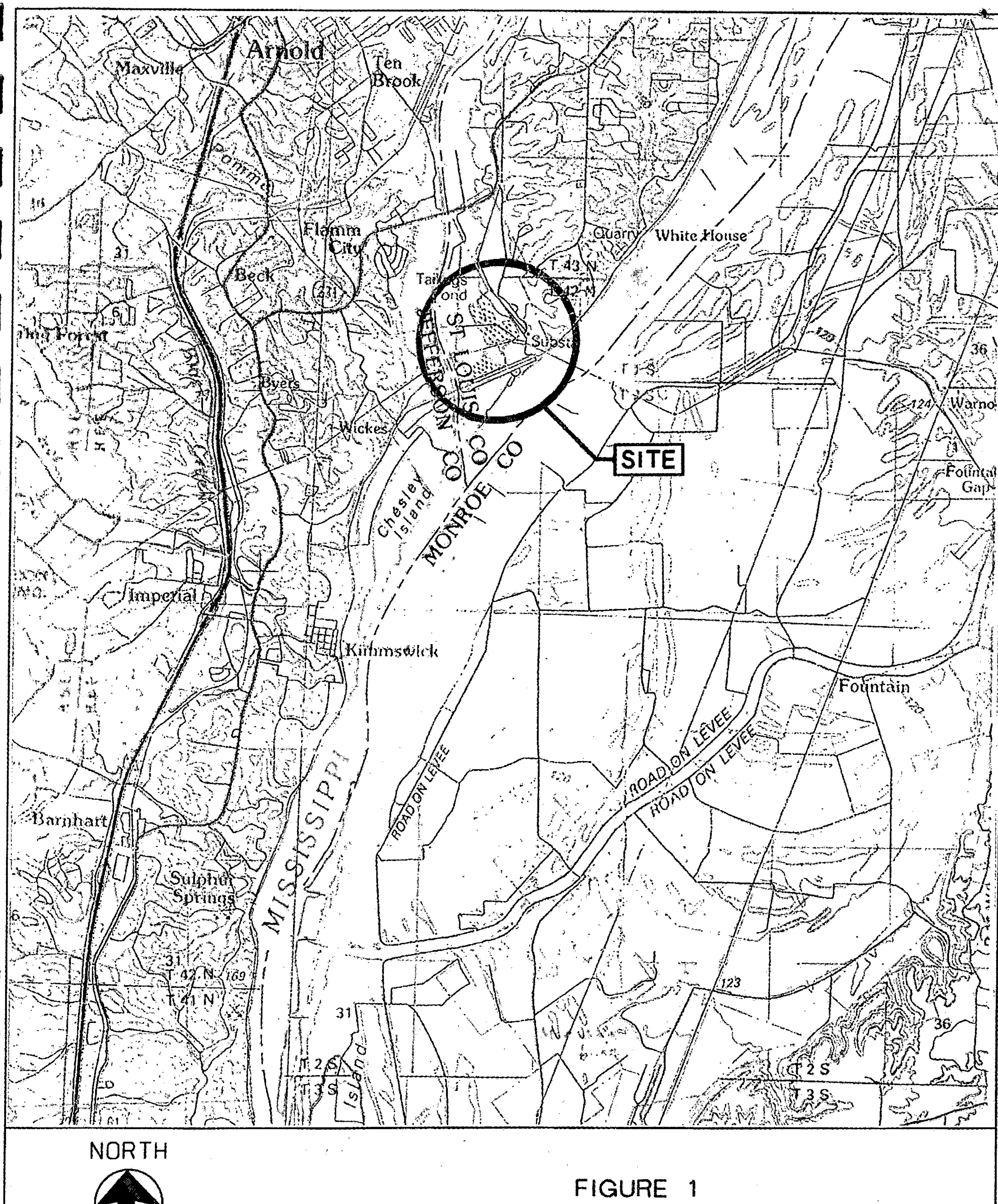
## 2.1 Site Description

The UE Meramec Plant is located in the far southeast corner of St. Louis County near the confluence of the Meramec and Mississippi Rivers. The plant lies on flat floodplain land at an elevation of between 410-420 feet above Mean Sea Level (MSL), directly east of the Meramec River and west of the Mississippi River. The Meramec River enters the Mississippi River just downstream, to the south of the property. To the north and west of the site, the land is hilly and mostly wooded. Figure 1 shows the site location.

The ash ponds are situated south of the power plant and cover about 110 acres. The fly ash has been stored onsite in unlined ponds for over 40 years. The site subsurface was initially described during pre-construction geotechnical investigations conducted by Stone and Webster Engineering Company in 1949. The boring logs from the investigation were reviewed as part of this study.

In addition, ash pond 489 has been investigated several times in the past and provides a valuable model for the current study. It is the southernmost ash pond and represents the downgradient boundary of the facility. Two abandoned and three active groundwater monitoring wells are installed along the lower edges of the pond parallel to the two rivers. Two background monitoring wells are located east and north of the ash pond area. Also, CH2M HILL has been monitoring groundwater levels at ash pond 490 as part of an alternative closure cap feasibility study. Data from both sites are used in this study.

Figure 2 shows the site plan and monitoring well locations. It also shows the W-E section line used to depict the conceptual site model.




## FIGURE 1

# SITE LOCATION MAP

UNION ELECTRIC MERAMEC PLANT
ST. LOUIS CO., MISSOURI

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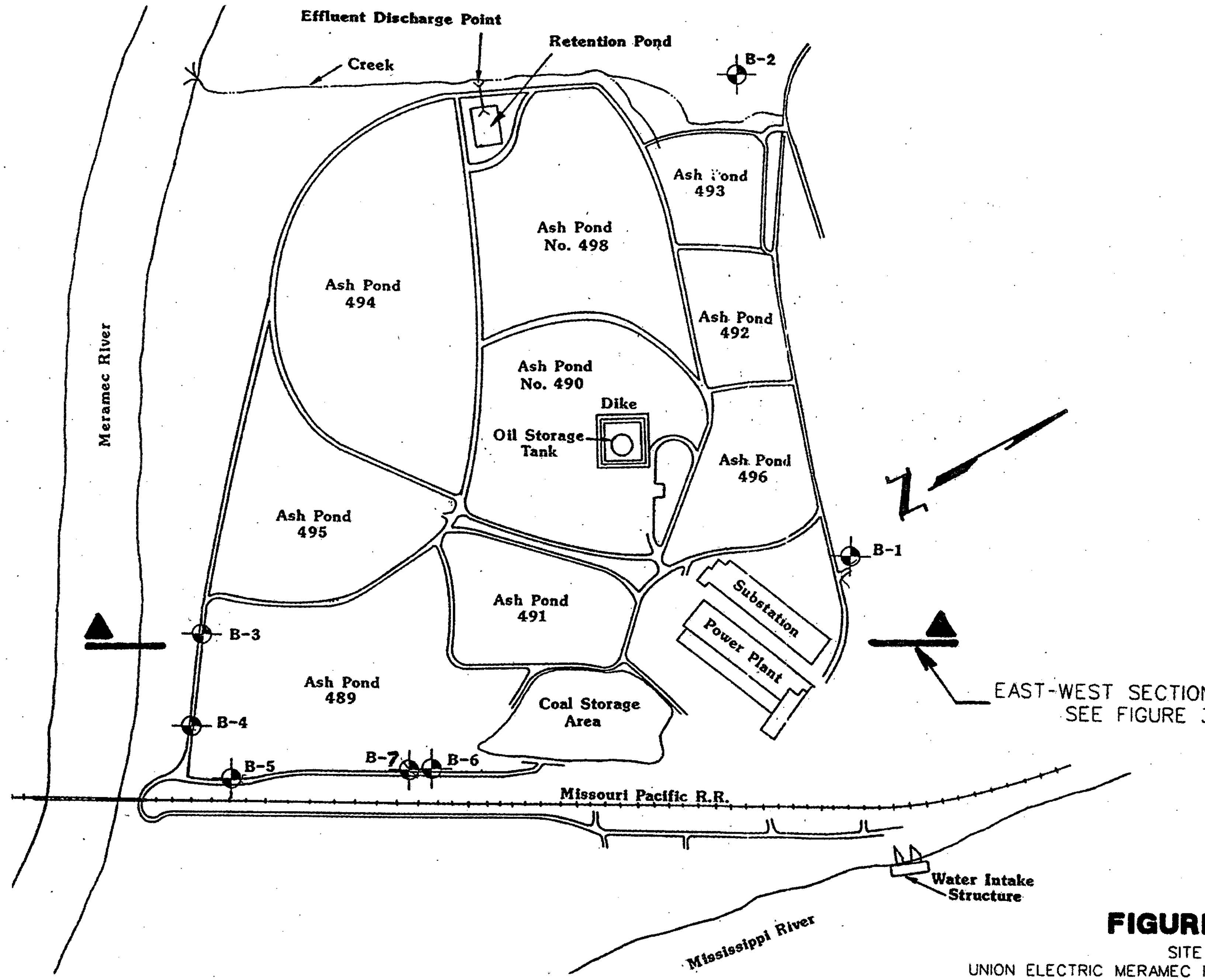


**FIGURE 2**
SITE PLAN
UNION ELECTRIC MERAMEC PLANT
ST. LOUIS COUNTY, MISSOURI

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## 2.2 Surface and Subsurface Soils

The present site grade is as much as 20 feet above the original ground surface that is indicated by historic engineering drawings (Stone and Webster, 1949). As part of the plant construction project, the original grade was increased by using imported silty clay fill. Reportedly, the ash ponds were made by excavating onsite silts and clays and using the material as construction fill beneath the plant and also for the ash pond berms. In general, the site soils under the fill materials are typical floodplain deposits, comprising interbedded clay, silt, sand, and gravel. The alluvium tends to become coarser-grained with increasing depth and proximity to the river channels. These varied sedimentary deposits were excavated to about 10 feet below original grade to form the ash ponds. The pond bottoms were apparently several feet above the average elevation of the water table.

Details of the soil stratigraphy at pond 489 are provided by the drilling logs of the monitoring wells, particularly wells MW4, MW5, and MW6 (Woodward-Clyde Consultants, 1988). Subsurface information for the remainder of the site was obtained from geotechnical logs completed during the original geotechnical site investigation prior to plant construction (Stone and Webster, 1949). A conceptual site model has been developed using this information and is shown in Figure 3 as a generalized W-E cross-section.

As shown in Figure 3, the site stratigraphy changes eastward from the Meramec River. The west part of the site near the river is underlain primarily by silts and sands. In contrast, sands are poorly represented in the east, and fine silts and clay underlie this part of the property. A thick sequence of silts east of the plant suggests a former deeply-incised alluvial valley. In general, pond ash fill or construction fill extends about 20 to 25 feet below the current site grade (nominally 420 ft. MSL). The fill is underlain by alluvial clayey silt and fine silty sand deposits typically 20 to 40 feet thick (except at the east edge of the site where fine material extends almost to bedrock). As depth increases, the sands in the west part of the site become coarser-grained and gravelly, with less fines. About 90 feet below grade (approximately 320 ft. MSL) a very stiff, blue-gray, high plastic clay is encountered. The clay is estimated to be about 5 to 10 feet thick in the west but increases to 60 to 70 feet thick at locations beneath the plant. Limestone bedrock is present at depths of about 105-115 feet. A coarse sand and gravel bed, up to 10 feet thick, exists between the limestone and the gray clay. The sand and gravel also contains limestone and shale fragments and may represent a highly weathered bedrock surface.

## 2.3 Bedrock

According to geotechnical reports for the site (Shannon and Wilson, 1979), the limestone beneath the alluvium and clay belongs to the Warsaw formation of the Meramecian series and is upper Mississippian in age. The formation comprises shales and fine-grained shaley limestones, and is fossiliferous. The numerous boring logs from the pre-construction investigation confirm the presence of shale and limestone bedrock beneath the site.

The bedrock surface slopes gently to the southeast although the regional dip is typically to the northeast. This is because, structurally, the site lies within a lithographic trough or syncline (Missouri Geological Survey, 1974). Synclines can often act as traps for mineralized groundwater, a situation that is discussed further in section 3.2.2 below.

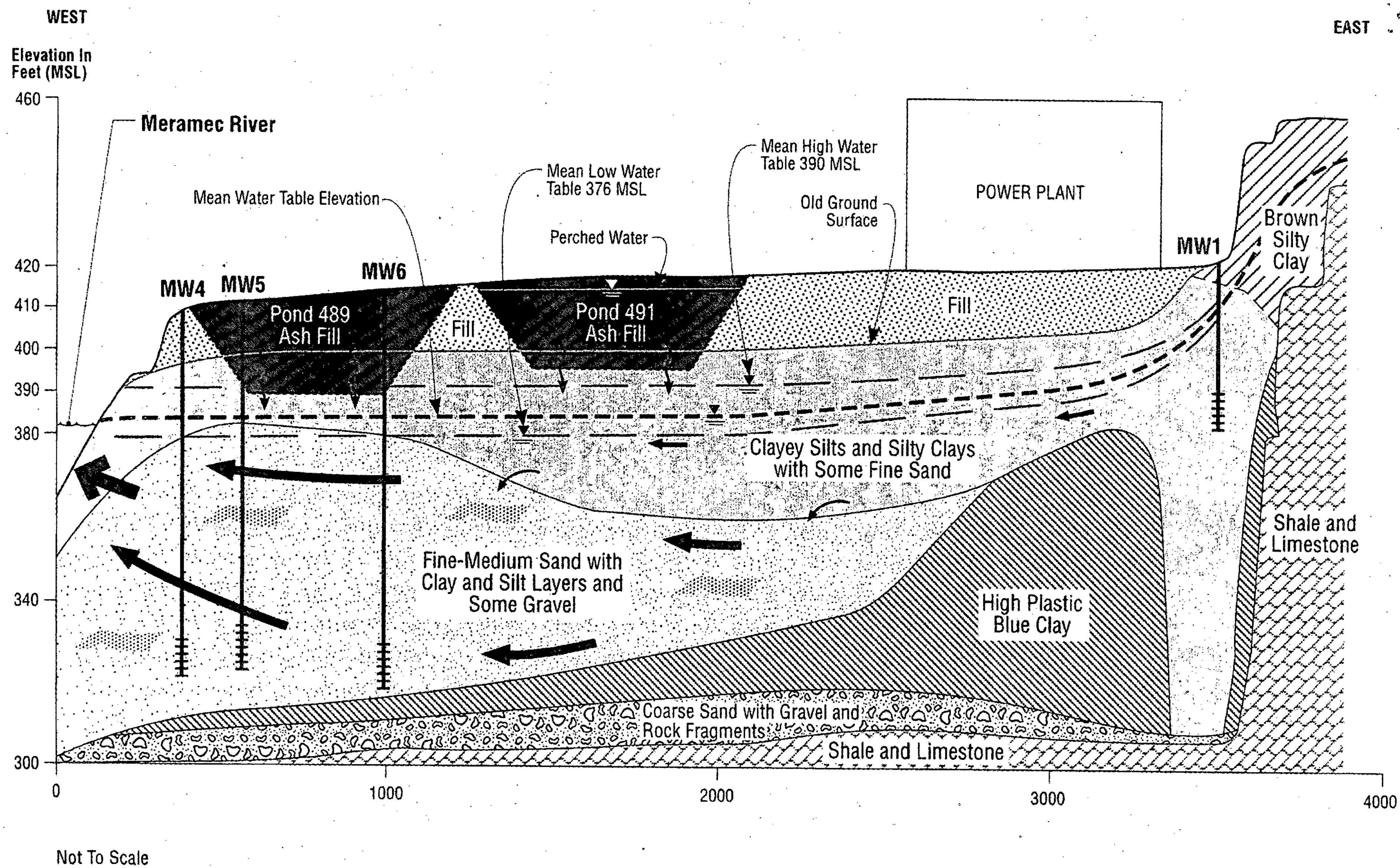


FIGURE 3
**Conceptual Site Model**
Union Electric Meramec Plant, St. Louis County, MO

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E143874.SR.ZZ Cross-Section 12-3-97 mjl

# 3. SITE HYDROLOGY

## 3.1 Surface Water

The Meramec and Mississippi Rivers are the dominant surface water features near the UE site. The Mississippi River controls the flow of the Meramec River causing the latter to back-up during flood stage. The mean discharge of the Mississippi River is 188, 300 cubic feet per second (cfs); the mean discharge of the Meramec River is 3,244 cfs. The averages are based on river years 1933 to 1996 (USGS, 1996). Typically, the river stage ranges between elevations of 376 ft. MSL to 390 ft. MSL (U.S. Army Corps of Engineers). The nearest river gage is at Water's Point, 2 miles downriver on the Mississippi. The mean river stage here is 380.8 ft. MSL (averaged between 1900 and 1994). According to the US Army Corps of Engineers (personal communication with R.J. Dieckmann, St. Louis District) the Mississippi River gradient, locally, is about one-half foot per mile. Therefore, the mean river stage at the UE plant is about 382 ft. MSL (several feet below the ash ponds).

In addition, a small creek north of the site runs west into the Meramec River. The creek receives water from the retention pond located north of ash pond 498. Rainwater that does not infiltrate surface soils in the area of the ash ponds will pass offsite via the retention pond and creek.

## 3.2 Groundwater

### 3.2.1 Alluvial Aquifers

Site-specific groundwater information was obtained from five monitoring wells installed in January, 1988 and from shallow piezometers installed in pond 490. Depth to groundwater in the area of ash pond 489 is indicated by monitoring wells MW4, MW5, and MW6. These wells are between 90 feet and 101 feet deep with screened intervals near the base of the alluvium. Wells MW1 and MW2 are hydraulically upgradient of the ash pond and are 41 feet and 56 feet deep, respectively. Over the past several years, UE has monitored the depth to water in the five wells and also recorded the corresponding Mississippi River stage. This data is provided in Appendix 1 and summarized in Table 4 below.

Data show that the water levels in the downgradient wells MW4, MW5, and MW6 closely reflect the recorded river stage. The groundwater depth in MW1, however, is typically about 30 feet higher than the ash pond wells; at MW2, the depth to water is some 20 feet higher than the ash pond wells. Also, the response of water levels in MW1 and MW2 to changes in river stage is less apparent. These differences can be accounted for by considering the relative distances of the wells from the rivers and the accompanying changes in lithology. Wells MW1 and MW2 are located several thousand feet away from the rivers, on the edge of the floodplain and near the base of the adjacent hills. In addition, they are completed to shallower depths in finer-grained, less transmissive sediments and as a result tend to respond more slowly to elevation changes in the local water table.

### 3.2.2 Bedrock Aquifers

There is little detailed information about the bedrock aquifers directly beneath the site. A previous geotechnical investigation by Shannon and Wilson (1979) collected 10-feet long, rock core samples from five borings located near the power plant. However, no monitoring wells were installed in bedrock.

Groundwater aquifers in the St. Louis region have been described and classified by the Missouri Geological Survey in a 1974 report. According to the survey, the Mississippian bedrock underlying southeastern St. Louis County yields groundwater with high dissolved solids content and rich in sodium-chloride. The mineralized water is believed to represent saline connate water trapped by the synclinal structure that runs through the site. Natural flushing of groundwater occurs slowly in synclinal areas and tends to result in water resources of poor quality. The report concludes that bedrock aquifers in the region of the site are "not favorable" for well development because of poor yields and concentrations of dissolved solids and sodium chloride that often exceed relevant drinking water standards.

### 3.2.3 Drinking Water Aquifers

The UE Meramec site does not overlie any currently-used drinking water aquifers. Neither the alluvial aquifer nor the bedrock aquifer beneath and downgradient of the site are used for drinking water. St. Louis County Water withdraws its supply directly from the Meramec, Missouri, or Mississippi Rivers at locations upgradient of the site (personal communication, St. Louis County Water Co.). A search of records for wells within one mile of the UE facility was performed by contacting the MDNR, Division of Geology and Land Survey. Locally, there are no groundwater extraction wells downgradient from the site, between the facility and either the Meramec or Mississippi Rivers. The nearest state-registered wells are located west of the Meramec River, along Highway 61. Future use of the bedrock aquifers is not considered a likelihood, all but precluded by the intrinsically saline quality of the groundwaters and the abundant availability of surface water.

## 3.3 Hydrogeologic Parameters

Detailed laboratory analyses of the hydrogeological properties of the site sediments and bedrock are not readily available. Nonetheless, some general characteristics of the site stratigraphy can be interpreted to help describe groundwater movement. Figure 3 is a W-E cross-section of the plant location that depicts the position of the water table across the site. Perched water table conditions are present in several of the ash ponds, as indicated by piezometers in the pond 490 tree plot and water levels observed recently in pond 491.

The hydraulic gradient at the site slopes south and east toward the adjacent major rivers. The situation is implied by the large (~ 30 feet) difference in head between the groundwater levels measured at wells MW1 and MW2, and those measured at wells MW4, MW5, and MW6. The downgradient wells are about 3,000 feet from MW1. Groundwater flow is thus toward the rivers at an approximate average hydraulic gradient of 0.01 ft/ft. However, the number and distribution of wells onsite do not provide adequate information to describe in three dimensions the water-table surface of the alluvial aquifer, or the potentiometric surface of the uppermost underlying bedrock aquifer.

The hydraulic conductivity of the ash deposits and the underlying sediments has not been analyzed but can be reasonably estimated from details of the soil stratigraphy. CH2M HILL has tested coal fly ash at other similar sites and determined the hydraulic conductivity to range between about $10^{-5}$ and $10^{-6}$ cm/s, values that correspond to silt. Coarser sands and gravels have hydraulic conductivities several orders-of-magnitude higher than finer silts and clays, from $10^{-1}$ to $10^{-3}$ cm/s.

Referring to Figure 3, it is apparent that the upper sediments are generally less permeable than the sediments below. This means that the groundwater flux in the ash, silts and silty sands will be significantly less than in the sands and gravels. Nonetheless, both sedimentary horizons will tend to be at least twice as permeable as the underlying shaley limestone. Hydraulic conductivity is also direction-dependent. In the absence of vertical cracks, average horizontal conductivity is typically several orders-of-magnitude larger than vertical conductivity, especially in interbedded alluvial deposits. Table 1 shows the relationship of sedimentary grain size to hydraulic conductivity (Freeze and Cherry, 1979).

## 3.4 Aquifer Sequence and Relationship

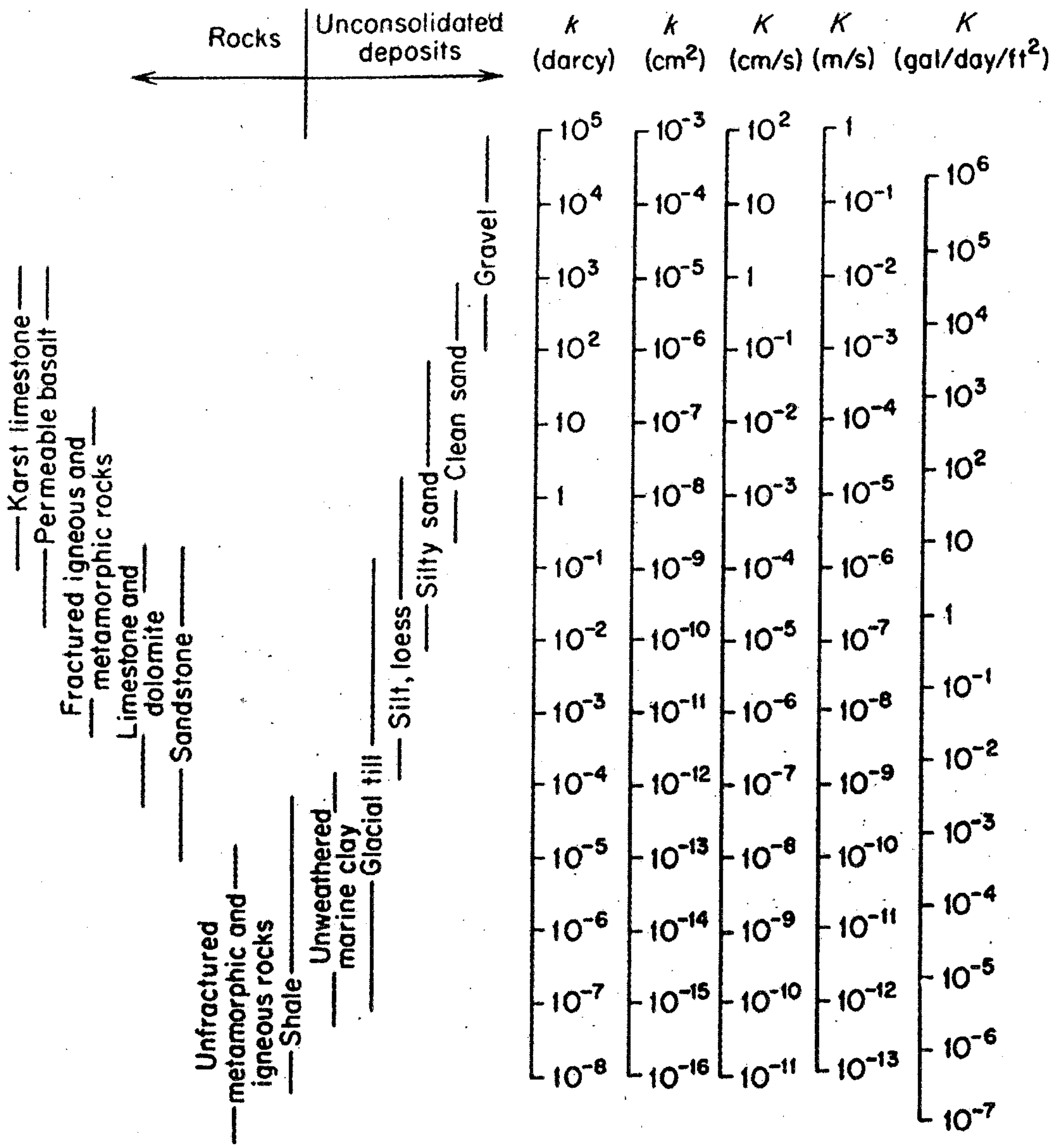
Figure 3 is a schematic representation of a vertical cross-section west-to-east through the site. The ground surface is at an elevation of between 410 feet MSL and 420 feet MSL. The ponded fly-ash is estimated to be 25-feet thick and lies on top of several feet of fine-grained clayey silts, silts, and fine silty sands. Beneath the west part of the site, the fine-grained sediments quickly grade into coarser sands and gravels. At about an elevation of 320 ft. MSL, a 5 to 10 feet thick layer of hard blue clay occurs, underlain by a nominal 10-feet thick bed of coarse sand, gravel, and rock fragments. The sand and gravel rest on top of shaley limestone bedrock at an approximate elevation of 305 ft. MSL. The east part of the site is predominantly underlain by fine-grained sediments. The sand and gravel zone appears to pinch out below the plant and is not recorded in logs for borings east of the plant.

The water table is shown corresponding to the mean elevation of 382 ft. MSL but can rise during high water to levels within the ash pond deposits. Based on data recorded by the U.S. Army Corps of Engineers 2 miles south of the facility, the mean high water stage at the site is approximately eight feet above normal (i.e. ~ 390 ft. MSL), and the mean low water stage is about six feet below normal (i.e. ~376 ft. MSL).

Under normal or low flow river stages, groundwater from the site flows to the rivers. The rivers act as boundary conditions for the alluvial groundwater onsite, preventing the groundwater from discharging elsewhere locally. Under flood conditions, the rivers act as groundwater divides, containing the site groundwater until the hydraulic gradient toward the river is restored as floodwater recedes. The specific interaction between the ash pond deposits and the alluvial groundwater is discussed below.

# TABLE 1

## Common Range of Values of Hydraulic Conductivity



# 4. ASH POND EFFECTS ON GROUNDWATER

## 4.1 Ash - Groundwater Hydraulic Relationship

Under average river conditions, the water table at the site is several feet below the ash pond bottoms. However, perched water conditions often occur within the ponds when the inflow of water from the plant or rainfall exceeds the infiltration capacity of the ponds and the discharge from the retention basin.

Because of the low permeability of the fly ash, the vertical flux of water moving through the ash under gravity is significantly less than the horizontal flux of groundwater through the alluvium, particularly the upper sand and gravel zone. In addition, the interbedded nature of alluvial deposits exerts a strong anisotropy on the flow system causing horizontal conductivity to be orders-of-magnitude larger than vertical conductivity (Freeze and Cherry, 1979). In other words, relatively small quantities of slowly percolating water from the ash ponds will be influenced by the larger volume and predominantly horizontal component of groundwater flow in the upper sands and gravels, and will thus preferentially move laterally toward the rivers not vertically toward the underlying bedrock.

## 4.2 Ash Composition

As mentioned above, the ash ponds at the Meramec facility have been in existence for over 40 years. The ash from pond 489 was sampled and analyzed by UE in 1994 to determine its composition and to assess the leaching potential of the various chemical constituents of the ash. The samples were composited from three pond horizons: lower, middle, and upper.

The ash sample results were compared to background soil samples from two facility locations and also to average values determined for typical Missouri soils by the Geochemical Survey of Missouri (as referenced by UE in its September 22, 1994 report to the MDNR). Calcium (Ca), sodium (Na), arsenic (As), and boron (B), were found in the composite ash samples at levels above twice the site background concentration. Table 2 shows the composition of the fly-ash and local background soil samples as represented by the total soils analysis data.

Two standard leaching tests were performed on the ash samples: U.S. EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP); and ASTM Method D-3987. The former test uses a buffered organic acid solution (pH 4.98) as the extraction fluid. The ASTM method uses neutral-pH water as the extraction fluid. Table 3 presents the results of the TCLP and ASTM leaching tests.

Onsite and background TCLP results for barium (Ba), cadmium (Cd), manganese (Mn), and lead (Pb) were above state surface water and groundwater standards. Onsite and background TCLP results for arsenic (As), mercury (Hg), and selenium (Se) exceeded state surface water standards.

# TABLE 2
## Total Soils Analysis

| Parameters: | Total analysis, without extraction, of: | | | | | |
|---|---|---|---|---|---|---|
| | Pond 489 Ash Composites: | | | | On-site Soils: | |
| | Lower | Middle | Upper | Mean | River Bank | Bluff Base |
| Conventional - | | | | | | |
| Calcium | 19,890 | 18,450 | 10,970 | 16,437 | 4,130 | 1,860 |
| Iron | 16,610 | 10,590 | 10,530 | 12,577 | 21,300 | 8,299 |
| Magnesium | 1,877 | 1,511 | 1,449 | 1,612 | 3,138 | 1,902 |
| Sodium | 623 | 366 | 776 | 588 | 79.4 | 71.3 |
| Toxic metals - | | | | | | |
| Arsenic | 51 | 19 | 103 | 58 | 13 | 7 |
| Barium | 221.2 | 204.2 | 219.1 | 214.8 | 427.2 | 125.2 |
| Boron | 573.1 | 663.9 | 276.7 | 504.6 | 89.9 | 46.8 |
| Cadmium | 2.74 | 2.72 | 2.03 | 2.50 | 2.26 | 1.11 |
| Chromium | 39.04 | 36.48 | 32.80 | 36.11 | 18.87 | 13.37 |
| Cobalt | 10.8 | 7.5 | 11.1 | 9.8 | 14.8 | 9.2 |
| Copper | 32.75 | 20.68 | 42.30 | 31.91 | 34.16 | 9.90 |
| Manganese | 212.3 | 205.0 | 152.0 | 189.8 | 809.3 | 518.0 |
| Mercury | <2 | <2 | <2 | <2 | <2 | <2 |
| Lead | 44 | 23 | 78 | 48 | 239 | 18 |
| Selenium | <1 | <1 | <1 | <1 | <1 | <1 |
| Silver | 0.152 | 0.091 | 0.241 | 0.161 | 0.213 | 0.052 |
| Zinc | 164.7 | 156.5 | 154.1 | 158.4 | 133.9 | 49.7 |

All units are ug/g (ppm)

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# TABLE 3

## TCLP and ASTM Analysis of Ash

| Parameters: | | TCLP extract analysis of: Pond 489 Ash Composites: Lower | Middle | Upper | Mean | On-site Soils: River Bank | Bluff Base | ASTM extract analysis of: Pond 489 Ash Composites: Lower | Middle | Upper | Mean | On-site Soils: River Bank | Bluff Base | Off-Site Soils: N.Tele. Road | S.Tele. Road |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conventional -** | | | | | | | | | | | | | | | |
| Ammonia | | | | | | | | 0.05 | 0.01 | 0.6 | 0.22 | 0.05 | 0.03 | 0.13 | 0.23 |
| Calcium | Run 1 | 790 | 910 | 514 | 738 | 105 | 47.4 | 46 | 44.6 | 30.5 | 40.36667 | 6.4 | 0.9 | 0.7 | 3.5 |
| | Run 2 | 660 | 810 | 350 | 607 | 61 | 39.4 | 58.8 | 57.4 | 31.8 | 49.33333 | 7.3 | 1.7 | | |
| Chemical Oxygen Demand | | | | | | | | 2 | 3 | 71 | 25 | 17 | 16 | 40 | 65 |
| Chloride | | | | | | | | 0.8 | 1.3 | 1.2 | 1.1 | 0.8 | 0.8 | 1.3 | 2.3 |
| Flouride | | | | | | | | 0.2 | 0.2 | 0.8 | 0.4 | 0.3 | 0.3 | 0.23 | 0.35 |
| Iron | Run 1 | 0.04 | 0.04 | 0.06 | 0.046667 | 0.21 | 0.08 | 0.02 | <0.02 | 0.04 | 0.03 | 2.58 | 1.73 | 2.4 | 2.9 |
| | Run 2 | 0.04 | 0.05 | 0.03 | 0.04 | 0.04 | 0.06 | 0.04 | 0.02 | <0.02 | 0.027 | 3.96 | 4.3 | | |
| Magnesium | Run 1 | 13.4 | 10 | 12 | 11.8 | 23 | 9 | 0.57 | 0.53 | 1.5 | 0.866667 | 2.35 | 0.47 | 0.47 | 2 |
| | Run 2 | 10.9 | 8 | 10.1 | 9.666667 | 16.4 | 8 | 0.7 | 0.5 | 1.4 | 0.866667 | 3 | 1 | | |
| Nitrate/nitrite Nitrogen | | | | | | | | 0.02 | 0.01 | 0.05 | 0.026667 | 0.5 | 0.07 | 0.03 | 0.11 |
| pH | | | | | | | | 10.24 | 10.35 | 9.48 | 10.02333 | 8.74 | 8.72 | 5.44 | 6.57 |
| Specific Conductance | | | | | | | | 298 | 291 | 227 | 272 | 85.3 | 26.9 | 47 | 60 |
| Sodium | | | | | | | | 1.83 | 1.5 | 2.04 | 1.79 | 5.62 | 3.24 | | |
| Sulfate | | | | | | | | 92 | 72 | 68 | 77 | 28 | 20 | 26 | 24 |
| Total Dissolved Solids | | | | | | | | 248 | 231 | 186 | 222 | 134 | 67 | 123 | 170 |
| Total Phosphate | | | | | | | | <0.01 | 0.01 | 0.09 | 0.04 | 0.02 | 0.02 | 0.19 | 0.23 |
| **Toxic metals -** | | | | | | | | | | | | | | | |
| Arsenic | Run 1 | 0.010 | 0.008 | 0.012 | 0.010 | 0.005 | 0.005 | 0.056 | 0.015 | 0.180 | 0.084 | 0.002 | 0.004 | <.005 | <.005 |
| | Run 2 | 0.015 | 0.016 | 0.042 | 0.024 | 0.013 | 0.014 | 0.033 | 0.015 | 0.085 | 0.044 | 0.006 | 0.005 | | |
| Barium | Run 1 | 4 | 3 | 7 | 5 | 16 | 11 | 0.02 | 0.02 | 0.03 | 0.023333 | 1.33 | 0.57 | 0.53 | 0.66 |
| | Run 2 | 1 | 2 | 5 | 3 | 4 | 5 | 0.19 | 0.21 | 0.12 | 0.173333 | 0.89 | 0.57 | | |
| Boron | Run 1 | | | | | | | 6.06 | 6.24 | 4.07 | 5.456667 | 0.27 | <0.2 | 0.15 | 0.13 |
| | Run 2 | | | | | | | | | | | | | | |
| Cadmium | Run 1 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.02 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <.005 | <.005 |
| | Run 2 | 0.006 | 0.004 | 0.009 | 0.006 | 0.006 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | | |
| Chromium | Run 1 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.005 | 0.004 | 0.006 | 0.005 | 0.003 | 0.002 | <.005 | <.005 |
| | Run 2 | 0.049 | 0.075 | 0.009 | <0.05 | 0.002 | 0.002 | 0.005 | 0.007 | 0.005 | 0.006 | 0.014 | 0.013 | | |
| Cobalt | Run 1 | | | | | | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <.05 | <.05 |
| | Run 2 | | | | | | | | | | | | | | |
| Copper | Run 1 | 0.02 | 0.03 | 0.02 | 0.023333 | 0.01 | 0.01 | 0.002 | <0.001 | 0.002 | 0.002 | 0.008 | 0.006 | 0.005 | 0.013 |
| | Run 2 | 0.009 | 0.007 | 0.020 | 0.012 | 0.012 | 0.010 | 0.002 | 0.002 | 0.002 | 0.002 | 0.009 | 0.007 | | |
| Manganese | Run 1 | 1.8 | 1.2 | 2.1 | 1.7 | 1.5 | 0.5 | <0.001 | <0.001 | 0.002 | 0.002 | 0.020 | 0.022 | 0.010 | 0.040 |
| | Run 2 | 1.2 | 0.68 | 1.5 | 1.126667 | 1.4 | 0.82 | <0.001 | <0.001 | <0.001 | <0.001 | 0.035 | 0.071 | | |
| Mercury | Run 1 | 0.0001 | 0.0001 | 0.0002 | 0.0001 | 0.0002 | 0.0004 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <.001 | <.001 |
| | Run 2 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Lead | Run 1 | 0.4 | 0.33 | 0.27 | 0.333333 | 0.33 | 0.27 | <0.001 | <0.001 | <0.001 | <0.001 | 0.012 | 0.003 | <.005 | 0.016 |
| | Run 2 | <0.01 | <0.01 | <0.01 | <0.01 | 0.054 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.031 | <0.01 | | |
| Selenium | Run 1 | 0.017 | 0.013 | 0.019 | 0.016 | 0.007 | 0.004 | 0.002 | <0.001 | 0.028 | 0.015 | 0.002 | 0.004 | <.005 | <.005 |
| | Run 2 | 0.005 | 0.011 | 0.014 | 0.010 | 0.004 | 0.005 | <0.001 | <0.001 | 0.040 | 0.014 | <0.001 | <0.001 | | |
| Silver | Run 1 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <.005 | <.005 |
| | Run 2 | 0.006 | 0.009 | 0.004 | 0.006333 | 0.003 | 0.003 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Zinc | Run 1 | 0.2 | 0.36 | 0.1 | 0.22 | 0.3 | 0.23 | 0.02 | 0.01 | 0.01 | 0.013333 | 0.11 | 0.06 | 0.04 | 0.04 |
| | Run 2 | 0.2 | 0.14 | 0.4 | 0.246667 | 0.94 | 0.88 | 0.02 | 0.02 | 0.02 | 0.02 | 0.06 | 0.05 | | |

All units for extractable analysis are mg/l, except pH (std units) and Specific Conductance (umhos/cm)

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Corresponding ASTM results for Cd, Mn, and Pb did not show concentrations in excess of applicable standards, with the exception of one background sample from the river bank analyzed for lead. ASTM results for Hg in onsite and background samples were higher than surface water standards. ASTM data for As and boron (B) in onsite samples exceeded groundwater standards (boron also was above irrigation water quality standards). The ASTM data for Se exceeded the aquatic life quality criterion.

## 4.3 Ash Pond Groundwater

Monitoring wells MW4, MW5, and MW6 monitor groundwater quality at the downgradient edge of ash pond 489. Wells MW1 and MW2 monitor the quality of groundwater hydraulically upgradient of the ash ponds, to the west and north. Groundwater samples have been collected and analyzed by UE for a variety of water quality indicators. Table 4 summarizes the data, presenting average constituent concentrations for results from 20 sampling events conducted during recent years (except for silver (Ag), boron (B), cobalt (Co), lead (Pb), and manganese (Mn), which were analyzed only twice). The data gives dissolved and total concentrations for the constituents; the dissolved concentration data is considered more representative of groundwater conditions and is discussed below.

Comparison of upgradient well data with downgradient well data shows an increase in the concentrations of some constituents at downgradient wells. The parameters conductivity, total hardness, and total dissolved solids show increases as do the individual constituents chloride (Cl), sulfate ($SO_4$), calcium (Ca), sodium (Na), and magnesium (Mg). These data are consistent with the characteristics of the local alluvial groundwater which is notable for its unusually high salt content caused by the influence of mineralized connate water and local trough-like geological structure (Missouri Geological Survey, 1974).

The majority of metals analyzed do not show significant changes in concentration between upgradient wells and downgradient wells, particularly Co, Hg, Pb, and Se. Concentrations of Ag, As, B, Cd, Cr and Cu are higher in one or more of the downgradient wells; however, only boron has elevated concentrations in all three downgradient wells. Importantly, with the exception of B, Fe, and Mn, the majority of averaged metal concentrations in groundwater samples do not exceed groundwater standards.

The occurrence of boron in the downgradient wells represents the influence of the ash ponds. Average concentrations range between 7 and 13 parts per million (ppm). The groundwater criterion for B is 2 ppm. However, the standard is intended to be protective of citrus crops, and therefore is not appropriate or relevant to the Meramec site.

Iron was detected in the upgradient well MW2 at a concentration of 27 ppm. Concentrations of Fe were lower in the downgradient wells, but still above the state standard of 0.3 ppm. Manganese was detected in the upgradient well MW2 at a mean concentration of 8,465 parts per billion (ppb). In downgradient wells the concentrations were lower, averaging between 399-1179 ppb. The groundwater standard for Mn is 50 ppb. The Missouri Geological Survey has reported that alluvial groundwater from Meramec River alluvium "contains significant quantities of iron and manganese." Over half the samples referenced showed Fe and Mn concentrations above 750 ppb, with a maximum Fe value of 21 ppm and a maximum Mn value of 4,600 ppb reported (Missouri Geological Survey, 1974). Also, site background soil samples were found to contain Fe and Mn

# TABLE 4

**MERAMEC PLANT: UPGRADIENT VS. DOWNGRADIENT GROUNDWATER MONITORING RESULTS**

AVERAGE VALUES*

| Well Number | Temp. Deg. C | pH | Cond um MHOS | Total Hardness mg/l | Cl mg/l | SO4 mg/l | F mg/l | TDS mg/l | Ca Dis. mg/l | Na Dis. mg/l | Mg Dis. mg/l | Ag** Dis. ug/l | Ag** Tot. ug/l | As Dis. ug/l | As Tot. ug/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upgradient | | | | | | | | | | | | | | | |
| 1 | 15.0 | 6.75 | 767 | 388 | 9.5 | 61.8 | 0.23 | 476 | 97 | **17** | 40 | 0.63 | **0.63** | 1.9 | **3.0** |
| 2 | 13.9 | **6.66** | **613** | **223** | **7.8** | **7.9** | **0.22** | **351** | **70** | 18 | **16** | 0.63 | 0.63 | 13.5 | 13.9 |
| Downgradient | | | | | | | | | | | | | | | |
| 4 | 14.9 | 7.28 | 1058 | 476 | 35.9 | 249.6 | **0.38** | 718 | 142 | 39 | 32 | 0.63 | 0.63 | 8.2 | 11.0 |
| 5 | 15.7 | **7.39** | 936 | 457 | 48.9 | 148.1 | 0.37 | 602 | 130 | 39 | 20 | 0.63 | 1.05 | 3.3 | 3.9 |
| 6 | 15.6 | 7.01 | **2187** | **1786** | **117.7** | **891.4** | 0.32 | **1853** | **361** | **56** | **72** | 1.75 | **1.60** | 9.7 | **11.4** |

| Well Number | Ba Dis. ug/l | Ba Tot. ug/l | B** Dis. mg/l | B** Tot. mg/l | Cd Dis. ug/l | Cd Tot. ug/l | Co** Dis. mg/l | Co** Tot. mg/l | Cr Dis. ug/l | Cr Tot. ug/l | Cu Dis. ug/l | Cu Tot. ug/l | Pb** Dis. ug/l | Pb** Tot. ug/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upgradient | | | | | | | | | | | | | | |
| 1 | 248 | 242 | 0.04 | **0.04** | 1.2 | **1.4** | 0.025 | 0.025 | 1.9 | 3.8 | 1.8 | 6.1 | 1.1 | 3.7 |
| 2 | 506 | 478 | 0.06 | 0.16 | 0.9 | 1.5 | 0.025 | 0.025 | 5.2 | 1.7 | 1.5 | **4.6** | 0.8 | 3.6 |
| Downgradient | | | | | | | | | | | | | | |
| 4 | 242 | 225 | 7.03 | 7.09 | 1.4 | 1.3 | 0.025 | 0.025 | 1.4 | 1.3 | 1.4 | 5.1 | 0.8 | 1.3 |
| 5 | 211 | 206 | 6.88 | 7.67 | 1.2 | 1.6 | 0.025 | 0.025 | 5.3 | 10.7 | 5.3 | **8.2** | 0.8 | 1.5 |
| 6 | 113 | 124 | 11.12 | **13.18** | 1.9 | **2.1** | 0.025 | 0.025 | 3.2 | 3.6 | 4.0 | 7.3 | 0.8 | 1.3 |

| Well Number | Mn** Dis. ug/l | Mn** Tot. ug/l | Hg Dis. ug/l | Hg Tot. ug/l | Zn Dis. ug/l | Zn Tot. ug/l | Fe Dis. mg/l | Fe Tot. mg/l | Se Dis. ug/l | Se Tot. ug/l | Well Water Level | River Water Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upgradient | | | | | | | | | | | | |
| 1 | 577 | **621** | 0.8 | 1.5 | 15 | 26 | 0.8 | 2.9 | 2.4 | 2.5 | 411.78 | 378.82 |
| 2 | 8465 | 4383 | 0.9 | 0.9 | 13 | 19 | 27.0 | 26.9 | 2.3 | 2.4 | 400.97 | 378.22 |
| Downgradient | | | | | | | | | | | | |
| 4 | 399 | 382 | 0.7 | 0.8 | 11 | 19 | 5.1 | 5.3 | 2.3 | 2.5 | 378.40 | 378.22 |
| 5 | 404 | 422 | 0.7 | 0.8 | 17 | 21 | 4.2 | 4.4 | 2.3 | 2.4 | 379.02 | 378.22 |
| 6 | 1179 | **1246** | 0.8 | 0.8 | 12 | 25 | 18.3 | 19.2 | 2.3 | 2.4 | 378.02 | 378.22 |

* Parameters which values increase significantly downstream vs. upstream are indicated by Shading/Bold type.

** Only two sets of data were taken for these parameters. All other parameters were sampled a total of 20 times.

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concentrations two and three times those measured in the ash (see Table 2). It appears, therefore, that the concentrations of iron and manganese in the site environment are consistent with background conditions and not related to ash pond operations.

The three downgradient monitoring wells are screened near the base of the alluvium, the interval in which alluvial groundwater production wells normally would be completed Therefore, groundwater samples from these wells represent the potential groundwater exposure pathway. Based on the leaching test data, only modest attenuation of ash leachate concentrations would be required to meet applicable water quality criteria. Given the small vertical water flux from the low permeability ash relative to the much higher lateral groundwater flux in the coarser alluvial sands, significant dilution-attenuation is likely occurring.

## 4.4 Impact of Ash Ponds on Groundwater Quality

Based on the data made available to CH2M HILL and summarized in the above tables, it appears that the ash ponds do not have a significant influence on local groundwater quality. Table 5 presents site data that exceed Missouri State Water Quality Criteria. The TCLP and ASTM data are maximum values. The groundwater data are mean values derived from multiple groundwater sampling events. The background data represent either groundwater samples from upgradient wells MWI or MW2; or leaching test results from onsite background soil samples taken from a river bank or from the base of a bluff.

The TCLP test results show the potential for As, Cd, Mn, Pb, and Se to be mobilized from the ash under acidic conditions; the ASTM results suggest that As, B and Se could mobilize under more alkaline conditions. The pH of Meramec River and Mississippi River alluvial groundwater is alkaline (between 7.7 and 8.1), a reflection of the mineralized nature of the local groundwater (Missouri Geological Survey, 1974). According to plant personnel, the pH of ash water entering the ponds is between 9.5 and 10.5. As a result of these conditions, the site environment is naturally reducing and alkaline.

Concentrations of arsenic and boron in the ash are above background. Therefore, it is not unreasonable to expect increased concentrations of As and B in groundwater samples from downgradient wells in alluvial sediments (as compared with upgradient wells located nearer the back of the floodplain). The fact that As and B values in the downgradient wells do not exceed water quality criteria - despite being present in the ash above background concentrations - attests to the low availability and mobility of these elements to alluvial groundwater at the site and the effects of natural dilution-attenuation processes.

Because of the alkaline environment, metals such as Cd, Pb, and Mn would be more resistant to leaching. For example, although Pb is present in the ash at concentrations above background, increased levels of Pb in downgradient monitoring wells is not likely. The absence of metals (with the exception of Mn, as discussed above) in groundwater samples at concentrations above applicable state standards demonstrates the relative geochemical stability of the ash ponds at the site, and their lack of impact on groundwater quality.

## Table 5
## Summary of Analytical Data That Exceed Water Quality Criteria

| | Missouri State Water Quality Criteria (ppb) | | | | Analytical Data Exceeding State Criteria (ppb) | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Aquatic Life | Drinking | Irrigation | Groundwater | TCLP | ASTM | Groundwater | Background |
| As | 20 | 50 | 100 | 50 | 42 | 180 | NE | NE |
| Ba | NC | 2000 | NC | 2000 | 7000 | NE | NE | NE |
| B | NC | NC | 2000 | 2000 | NT | 6060 | 11,120 | 16,000T |
| Cd | NC | 5 | NC | 5 | 40 | NE | NE | NE, 30T |
| Cr | NC | 100 | 100 | 100 | NE | NE | NE | NE |
| Co | NC | NC | NC | 1000 | NT | NE | NE | NE |
| Fe | 1000 | 300 | NC | 300 | NE | NE | 18,300 | 27,000G |
| Cu | NC | 1300 | 500 | 1300 | NE | NE | NE | NE |
| Mn | NC | 50 | NC | 50 | 2100 | NE | 1246 | 8465G, 1500T |
| Hg | 0.5 | 2 | NC | 2 | 1 | 1 | 0.8 | 0.9G, 1T, 1A |
| Pb | NC | 15 | NC | 15 | 400 | NE | NE | 330T, 31A |
| Se | 5 | 50 | NC | 50 | 19 | 28 | NE | 7T |
| Ag | NC | 50 | NC | 50 | NE | NE | NE | NE |
| Zn | NC | 5000 | NC | 5000 | NE | NE | NE | NE |
| Cl | NC | 250 | NC | NC | NT | 1300 | NE | 800A |

Note: NC = no criterion; NT = no test; NE = no exceedance; G = groundwater background value; T = TCLP background value; A = ASTM background value. Also: groundwater data are mean values; TCLP and ASTM data are maximum values; the aquatic life water quality criterion for Hg is for chronic exposure.

Neither mercury nor selenium was detected in the ash Total Analysis (see Table 2) and neither element showed a significant difference in concentration between upgradient and downgradient wells. Their presence in leaching extracts, therefore, is not a useful indicator of ash pond effects upon groundwater and does not appear to be representative of the naturally reducing and alkaline site conditions.

# 5. Risk Characterization

Risk characterization generally involves developing a conceptual site model, identifying chemicals of concern, identifying complete exposure pathways, and assessing resultant health and environmental risk. The present study has condensed the approach to focus upon ash pond effects on groundwater and surface water. The effects, if any, are controlled by the physical characteristics of the groundwater flow regime and the physicochemical aspects of the ash deposits.

## 5.1 Conceptual Site Model

The conceptual site model shows that groundwater flux under the ash ponds exhibits a marked anisotropy and is controlled in large part by the proximity of the Meramec and Mississippi Rivers.

Under normal conditions, groundwater from the site moves in a predominantly horizontal direction and discharges to the nearby rivers. Percolating water from the ash ponds is unlikely to migrate vertically to the underlying bedrock given the strong horizontal flow patterns typical in interbedded alluvial sediments. Deeper groundwater, stored in underlying shale and limestone bedrock, typically exists under confined conditions; that is, the hydraulic gradient is upward. Thus, alluvial groundwater would be fed by the bedrock groundwater as it moved upward into the unconsolidated river sediments through old wells or fissures in the bedrock. Given these conditions, leachate potentially generated within the ash will not migrate downward into bedrock aquifers but will rather discharge to the rivers.

## 5.2 Potential Chemicals of Concern

Previous environmental site investigations have resulted in an analytical data base that describes the chemical make-up of the ash, the chemicals present in ash leachate, and the quality of groundwater upgradient and downgradient of the ash ponds. For this study, potential chemicals of concern were those constituents that occurred in the ash at concentrations more than twice above background; or were present in test leachates or groundwater samples above water quality standards.

For the UE Meramec site, seven metals - arsenic (As), boron (B), cadmium (Cd), manganese (Mn), mercury (Hg), lead (Pb), and selenium (Se) - present in the ash were considered potential chemicals of concern. The occurrence of these metals at the site has been discussed above (see Section 4 and Table 5). The data indicate that many of the chemicals found in the site environment are in fact consistent with the local hydrogeological setting and are not necessarily the consequence of ash pond operations. For example, both surface water and groundwater in southeast St. Louis County are abnormally high in dissolved solids, particularly calcium and manganese, resulting in an unusually alkaline environment at the site (Missouri Geological Survey, 1974).

Other metals that are present above background levels in the ash, or in laboratory test leachates produced from the ash, are not found at significant concentrations in downgradient groundwater samples. This indicates that metals in the ash are relatively immobile, and are not being leached at a significant rate or in significant concentrations to adversely impact groundwater quality.

## 5.3 Complete Exposure Pathways

Because of the nature of operations at the UE Meramec facility, the public has restricted access to the site. In addition, the surrounding land use is low-density with no agriculture or residential communities downgradient of the facility. Because of these factors, the primary exposure pathway of concern at the site is exposure to contaminated drinking water.

A complete exposure pathway requires a contaminant source (ash pond); a mechanism of release (leaching); a transport medium (groundwater); and a point of exposure (drinking water). Exposure to groundwater is not a complete pathway at the site, however, because:

- with the exception of B, Fe, and Mn, alluvial groundwater does not show concentrations of ash pond constituents above drinking water standards
- the groundwater standard for B is intended to be protective of citrus crops and, therefore, is not appropriate for the current situation
- local alluvial groundwater exceeds water quality criteria for chloride, manganese and iron (Missouri Geological Survey, 1974)
- alluvial groundwater discharges to surface water (rivers) not to bedrock aquifers
- existing bedrock aquifers locally produce highly mineralized, saline water that is of poor quality and not suitable for drinking
- bedrock groundwater typically flows up into alluvial sediments
- neither alluvial nor bedrock groundwater is used for public drinking water supplies - St. Louis County Water draws its supplies directly from the rivers upstream of the plant

## 5.4 Risk Assessment Conclusions

Using the information provided, and based on knowledge of the local hydrogeology, there appears to be no significant impacts to groundwater from the existing ash ponds. Furthermore, potential risks associated with exposure to drinking water derived from alluvial or bedrock aquifers are not salient because groundwater in the vicinity of the site is not suitable for current or future use as a potable water supply because of its highly mineralized nature. It follows, therefore, that the discharge of groundwater under the site to the Mississippi River and Meramec River does not cause adverse impacts on the local surface water quality.

In conclusion, based upon the data provided by UE, there appears to be no significant health or environmental risks associated with potential exposure to groundwater or surface water affected by ash pond operations at the UE Meramec site.

# Appendix 1
# Meramec Plant Quarterly Groundwater Monitoring Data

MERAMEC PLANT QUARTERLY GROUND WATER MONITORING DATA

SAMPLE FIELD

| Well Number | Temp. Deg. C | pH | Cond um MHOS | Total Hardness mg/l | Cl mg/l | SO4 mg/l | F mg/l | TDS mg/l | Ca Dis. mg/l | Na Dis. mg/l | Mg Dis. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.1 | 6.39 | 853 | | 8.9 | 55.0 | 0.12 | 525 | 100 | 18 | 41 |
| 1 | 15.5 | 6.60 | 855 | | 9.3 | 56.6 | 0.20 | 444 | 102 | 3 | 39 |
| 1 | 15.0 | 6.76 | 813 | | 8.9 | 61.9 | 0.19 | 492 | 100 | 12 | 41 |
| 1 | 15.2 | 6.85 | 760 | | 9.7 | 60.3 | 0.32 | 429 | 101 | 5 | 41 |
| 1 | 14.1 | 6.74 | 750 | | 10.0 | 63.7 | 0.22 | 483 | 99 | 19 | 41 |
| 1 | 15.5 | 6.42 | 645 | | 10.6 | 65.2 | 0.22 | 461 | 97 | 27 | 40 |
| 1 | 13.7 | 6.60 | 750 | | 8.7 | 58.4 | 0.23 | 454 | 97 | 23 | 42 |
| 1 | 13.2 | 6.51 | 794 | | 7.4 | 61.7 | 0.18 | 425 | 89 | 21 | 38 |
| 1 | 13.4 | 6.79 | 645 | | 8.7 | 55.2 | 0.30 | 501 | 99 | 15 | 43 |
| 1 | 13.7 | 6.81 | 720 | | 12.2 | 59.5 | 0.34 | 468 | 96 | 16 | 40 |
| 1 | 15.2 | 6.84 | 760 | | 10.2 | 65.0 | 0.22 | 454 | 97 | 5 | 43 |
| 1 | 17.1 | 6.95 | 755 | | 9.2 | 74.0 | 0.20 | 492 | 109 | 20 | 40 |
| 1 | 18.0 | 6.58 | 760 | | 8.9 | 62.6 | 0.20 | 504 | 99 | 19 | 42 |
| 1 | | | | | | | | | | | |
| 1 | 16.5 | 6.82 | 828 | | 5.1 | 61.0 | 0.23 | 491 | 102 | 26 | 39 |
| 1 | 17.0 | 6.69 | 715 | | 8.2 | 57.0 | 0.19 | 458 | 97 | 54 | 40 |
| 1 | 15.0 | 6.70 | 780 | | 11.5 | 67.5 | 0.23 | 507 | 85 | 13 | 36 |
| 1 | 14.0 | 6.71 | 850 | | 11.0 | 66.0 | 0.28 | 472 | 95 | 0.5 | 41 |
| 1 | 15.0 | 6.78 | 740 | 359 | 9.9 | 72.3 | 0.75 | 492 | 76 | 12 | 41 |
| 1 | 16.0 | 7.00 | 730 | 416 | 12.3 | 69.0 | 0.28 | 450 | 107 | 9 | 36 |
| 2 | 14.3 | 6.40 | 631 | | 6.9 | 9.0 | 0.16 | 383 | 72 | 18 | 16 |
| 2 | 14.7 | 6.41 | 645 | | 8.5 | 13.9 | 0.20 | 387 | 80 | 5 | 17 |
| 2 | 14.3 | 6.52 | 705 | | 7.9 | 10.7 | 0.20 | 369 | 76 | 17 | 17 |
| 2 | 14.2 | 6.54 | 662 | | 5.6 | 3.1 | 0.25 | 331 | 60 | 12 | 16 |
| 2 | 13.3 | 6.42 | 631 | | 8.8 | 8.6 | 0.21 | 379 | 76 | 20 | 16 |
| 2 | 12.2 | 6.65 | 588 | | 9.6 | 12.9 | 0.29 | 418 | 80 | 18 | 32 |
| 2 | 13.4 | 6.52 | 556 | | 9.2 | 2.8 | 0.22 | 395 | 71 | 23 | 13 |
| 2 | 12.6 | 6.68 | 798 | | 4.4 | 5.3 | 0.17 | 297 | 60 | 22 | 11 |
| 2 | 12.3 | 6.77 | 530 | | 7.2 | 5.0 | 0.28 | 307 | 63 | 18 | 13 |
| 2 | 12.5 | 6.60 | 505 | | 9.2 | 5.0 | 0.28 | 329 | 60 | 19 | 11 |
| 2 | 14.0 | 6.84 | 510 | | 6.9 | 5.0 | 0.25 | 308 | 67 | 5 | 13 |
| 2 | 15.8 | 6.74 | 495 | | 7.5 | 13.3 | 0.21 | 348 | 74 | 26 | 14 |
| 2 | 15.0 | 6.71 | 565 | | 2.5 | 7.6 | 0.20 | 263 | 71 | 16 | 16 |
| 2 | 10.0 | 6.60 | 640 | | 8.8 | 7.4 | 0.18 | 324 | 71 | 13 | 16 |
| 2 | 14.5 | 6.82 | 510 | | 1.3 | 8.0 | 0.23 | 319 | 63 | 40 | 14 |
| 2 | 16.5 | 6.58 | 650 | | 6.3 | 1.0 | 0.22 | 317 | 71 | 43 | 17 |
| 2 | 15.5 | 6.50 | 677 | | 9.3 | 9.3 | 0.19 | 389 | 61 | 15 | 15 |
| 2 | 13.8 | 6.48 | 656 | | 10.0 | 8.0 | 0.24 | 361 | 72 | 0.5 | 14 |
| 2 | 14.5 | 6.62 | 612 | 194 | 7.7 | 8.6 | 0.24 | 329 | 53 | 17 | 15 |
| 2 | 15.5 | 6.80 | 680 | 251 | 11.2 | 5.6 | 0.26 | 374 | 79 | 13 | 13 |
| 4 | 15.2 | 7.15 | 1235 | | 38.2 | 239 | 0.29 | 810 | 145 | 42 | 37 |
| 4 | 15.2 | 7.29 | 1271 | | 29.3 | 400 | 0.33 | 883 | 171 | 36 | 37 |
| 4 | 14.8 | 7.25 | 1178 | | 26.6 | 278 | 0.35 | 864 | 168 | 44 | 39 |
| 4 | 14.6 | 7.41 | 1132 | | 29.1 | 356 | 0.37 | 814 | 167 | 38 | 37 |
| 4 | 14.1 | 7.15 | 1116 | | 28.6 | 361 | 0.40 | 845 | 158 | 41 | 38 |
| 4 | 13.9 | 7.04 | 1046 | | 29.9 | 340 | 0.38 | 797 | 141 | 43 | 35 |
| 4 | 13.9 | 7.24 | 1008 | | 35.2 | 225 | 0.42 | 720 | 133 | 48 | 31 |
| 4 | 13.7 | 7.32 | 1100 | | 37.9 | 191 | 0.36 | 610 | 121 | 42 | 31 |
| 4 | 13.7 | 7.35 | 910 | | 42.9 | 127 | 0.50 | 575 | 120 | 37 | 26 |
| 4 | 14.1 | 7.39 | 845 | | 34.9 | 205 | 0.43 | 655 | 135 | 27 | 29 |
| 4 | 15.1 | 7.45 | 875 | | 44.3 | 121 | 0.46 | 593 | 122 | 24 | 29 |
| 4 | 17.3 | 7.45 | 915 | | 43.2 | 145 | 0.42 | 625 | 129 | 44 | 27 |
| 4 | 16.0 | 7.34 | 922 | | 40.0 | 195 | 0.41 | 735 | 134 | 40 | 29 |
| 4 | 11.0 | 7.10 | 1100 | | 40.2 | 255 | 0.40 | 759 | 145 | 35 | 36 |
| 4 | 15.5 | 7.34 | 1200 | | 36.2 | 267 | 0.30 | 743 | 152 | 57 | 31 |
| 4 | 17.5 | 7.19 | 1020 | | 39.9 | 194 | 0.32 | 699 | 146 | 76 | 31 |
| 4 | 16.0 | 7.16 | 1010 | | 9.0 | 180 | 0.35 | 785 | 127 | 33 | 31 |
| 4 | 14.0 | 6.94 | 995 | | 48.0 | 196 | 0.32 | 689 | 135 | 15 | 31 |
| 4 | 17.4 | 7.47 | 1070 | 403 | 45.0 | 210 | 0.33 | 753 | 109 | 17 | 31 |
| 4 | 15.8 | 7.50 | 1210 | 519 | 33.0 | 369 | 0.42 | 422 | 172 | 28 | 29 |
| 5 | 16.3 | 7.50 | 1401 | | 36.1 | 573 | 0.29 | 1138 | 229 | 38 | 26 |
| 5 | 15.2 | 7.35 | 1265 | | 37.0 | 393 | 0.29 | 849 | 185 | 39 | 23 |
| 5 | 15.6 | 7.45 | 958 | | 49.1 | 131 | 0.43 | 577 | 133 | 42 | 18 |
| 5 | 15.7 | 7.35 | 833 | | 53.5 | 52.4 | 0.45 | 465 | 121 | 30 | 16 |
| 5 | 15.1 | 7.45 | 831 | | 53.4 | 40.3 | 0.47 | 471 | 112 | 36 | 15 |
| 5 | 11.9 | 7.18 | 774 | | 53.9 | 44.4 | 0.46 | 466 | 105 | 45 | 15 |
| 5 | 11.3 | 7.32 | 783 | | 54.1 | 21.2 | 0.40 | 469 | 103 | 47 | 18 |
| 5 | 14.5 | 7.50 | 840 | | 50.8 | 8.4 | 0.37 | 413 | 99 | 57 | 17 |
| 5 | 14.8 | 7.40 | 765 | | 32.7 | 12.4 | 0.41 | 412 | 96 | 36 | 19 |
| 5 | 14.9 | 7.45 | 740 | | 51.8 | 15.2 | 0.46 | 475 | 95 | 25 | 17 |
| 5 | 15.5 | 7.17 | 985 | | 45.4 | 273 | 0.44 | 494 | 153 | 21 | 22 |
| 5 | 17.5 | 7.40 | 775 | | 49.1 | 117.3 | 0.41 | 572 | 136 | 41 | 22 |
| 5 | 17.0 | 7.34 | 888 | | 46.8 | 159.7 | 0.36 | 690 | 129 | 42 | 25 |
| 5 | 13.5 | 7.21 | 1030 | | 41.9 | 147.0 | 0.34 | 587 | 126 | 33 | 22 |
| 5 | 16.0 | 7.50 | 750 | | 46.7 | 16 | 0.29 | 418 | 93 | 45 | 24 |
| 5 | 15.0 | 7.44 | 720 | | 47.9 | 1 | 0.23 | 412 | 92 | 75 | 21 |
| 5 | 17.0 | 7.35 | 860 | | 53.5 | 81.5 | 0.29 | 573 | 103 | 35 | 21 |
| 5 | 15.0 | 7.06 | 1022 | | 53.0 | 242 | 0.29 | 667 | 143 | 18 | 24 |
| 5 | 16.5 | 7.64 | 1010 | 291 | 48.0 | 207 | 0.32 | 702 | 123 | 19 | 21 |
| 5 | 16.0 | 7.30 | 1260 | 419 | 50.0 | 136 | 0.28 | 1047 | 213 | 31 | 21 |
| 6 | 15.5 | 7.28 | 2440 | | 79.4 | 1169 | 0.26 | 2119 | 443 | 55 | 62 |
| 6 | 15.3 | 7.10 | 2390 | | 75.5 | 1041 | 0.30 | 2007 | 544 | 20 | 186 |
| 6 | 15.2 | 7.14 | 2090 | | 77.0 | 1061 | 0.30 | 1951 | 404 | 59 | 64 |
| 6 | 15.6 | 7.01 | 1920 | | 81.2 | 933 | 0.33 | 1871 | 398 | 51 | 67 |
| 6 | 14.8 | 7.30 | 1916 | | 59.5 | 937 | 0.33 | 1751 | 371 | 54 | 66 |
| 6 | 13.9 | 6.93 | 1771 | | 109.9 | 863 | 0.41 | 1666 | 308 | 70 | 62 |
| 6 | 14.2 | 6.95 | 1708 | | 86.3 | 812 | 0.32 | 1710 | 304 | 60 | 68 |
| 6 | 14.6 | 7.09 | 1843 | | 92.1 | 729 | 0.30 | 1513 | 261 | 53 | 61 |
| 6 | 14.7 | 7.01 | 1995 | | 119.2 | 587 | 0.40 | 1435 | 401 | 47 | 66 |
| 6 | 14.8 | 7.03 | 1660 | | 120.0 | 665 | 0.40 | 1611 | 306 | 42 | 64 |
| 6 | 15.4 | 7.05 | 2420 | | 119.2 | 872 | 0.36 | 1803 | 344 | 57 | 76 |
| 6 | 17.5 | 6.45 | 2100 | | 149.6 | 862 | 0.27 | 1876 | 384 | 46 | 70 |
| 6 | 14.8 | 7.01 | 1750 | | 128.7 | 642 | 0.30 | 1752 | 261 | 39 | 72 |
| 6 | 16.8 | 6.78 | 2000 | | 130.0 | 892 | 0.32 | 1552 | 299 | 46 | 64 |
| 6 | 17.5 | 6.93 | 2030 | | 135.1 | 930 | 0.25 | 1528 | 290 | 43 | 74 |
| 6 | 15.0 | 7.02 | 1950 | | 132.9 | 665 | 0.23 | 1524 | 283 | 45 | 73 |
| 6 | 12.3 | 6.93 | 2520 | | 137.0 | 1232 | 0.28 | 2403 | 71 | 46 | 7 |
| 6 | 15.0 | 6.60 | 3020 | | 146.0 | 1081 | 0.28 | 1955 | 368 | 44 | 72 |
| 6 | 16.4 | 7.09 | 2560 | 1779 | 130.8 | 1351 | 0.27 | 2498 | 382 | 52 | 102 |
| 6 | 16.0 | 7.00 | 2560 | 1792 | 128.0 | 1069 | 0.34 | 2324 | 410 | 47 | 65 |

| Well Number | Ag Dis. ug/l | Ag Tot. ug/l | As Dis. ug/l | As Tot. ug/l | Ba Dis. ug/l | Ba Tot. ug/l | B Dis. mg/l | B Tot. mg/l | Cd Dis. ug/l | Cd Tot. ug/l | Co Dis. mg/l | Co Tot. mg/l | Cr Dis. ug/l | Cr Tot. ug/l | Cu Dis. ug/l | Cu Tot. ug/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 7.8 | 20.5 | 354 | 482 | | | 1.2 | 2.8 | | | 8 | 15 | 6.5 | 8 |
| 1 | | | 1.5 | 4.6 | 199 | 267 | | | 1.0 | 2.0 | | | 4 | 7 | 1 | 1 |
| 1 | | | 1.5 | 1.5 | 235 | 244 | | | 1.9 | 1.5 | | | 2 | 5 | 1 | 6.4 |
| 1 | | | 1.5 | 1.5 | 267 | 303 | | | 1.0 | 0.5 | | | 1 | 4 | 1 | 3 |
| 1 | | | 1.5 | 1.5 | 218 | 241 | | | 3.1 | 4.1 | | | 3 | 3 | 1 | 7.4 |
| 1 | | | 1.5 | 1.5 | 169 | 187 | | | 2.3 | 2.2 | | | 4 | 5 | 1 | 7 |
| 1 | | | 1.5 | 1.5 | 201 | 241 | | | 1.7 | 1.6 | | | 1 | 1 | 1 | 3 |
| 1 | | | 1.5 | 1.5 | 231 | 251 | | | 2.0 | 2.6 | | | 2 | 3 | 1 | 5.1 |
| 1 | | | 1.5 | 1.5 | 174 | 195 | | | 2.5 | 0.5 | | | 1 | 1 | 3 | 4.6 |
| 1 | | | 4 | 4 | 210 | 196 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 6 |
| 1 | | | 1.5 | 1.5 | 175 | 196 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 9 |
| 1 | | | 1.5 | 1.5 | 206 | 227 | | | 0.5 | 0.5 | | | 2 | 4 | 1 | 5.9 |
| 1 | | | 1.5 | 1.5 | 181 | 180 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 9 |
| 1 | | | | | | | | | | | | | | | | |
| 1 | | | 1.5 | 3 | 264 | 278 | | | 0.5 | 1.0 | | | 1 | 1 | 1 | 2 |
| 1 | | | 1.5 | 1.5 | 203 | 185 | | | 1.2 | 1.2 | | | 1 | 14 | 1 | 13 |
| 1 | | | 1.5 | 1.5 | 348 | 158 | | | 0.5 | 2.0 | | | 1 | 1 | 0.5 | 0.5 |
| 1 | | | 0.5 | 3 | 292 | 275 | | | 0.5 | 0.5 | | | 1 | 5 | 0.5 | 9 |
| 1 | 0.25 | 0.25 | 1 | | 296 | | 0.050 | 0.050 | 0.5 | | 0.025 | 0.025 | 0.5 | 1 | 6.8 | |
| 1 | 1 | 1 | 1.5 | 1.5 | 420 | 400 | 0.025 | 0.025 | 0.5 | 0.5 | 0.025 | 0.025 | 1 | 1 | 5.7 | 9.9 |
| 2 | | | 13.8 | 19.9 | 603 | 582 | | | 0.5 | 2.2 | | | 1 | 1 | 1 | 3.7 |
| 2 | | | 5.8 | 15.1 | 575 | 531 | | | 1.0 | 1.4 | | | 3 | 1 | 1 | 1 |
| 2 | | | 7.7 | 9.4 | 571 | 508 | | | 0.5 | 1.0 | | | 3 | 2 | 1 | 6.5 |
| 2 | | | 24 | 33 | 574 | 564 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 3 |
| 2 | | | 6 | 6 | 588 | 559 | | | 3.4 | 3.0 | | | 1 | 1 | 1 | 2.4 |
| 2 | | | 6.6 | 10.7 | 440 | 413 | | | 2.0 | 2.4 | | | 2 | 2 | 1 | 6 |
| 2 | | | 5.1 | 5.1 | 524 | 526 | | | 1.1 | 1.4 | | | 1 | 1 | 1 | 1.5 |
| 2 | | | 4 | 4 | 386 | 383 | | | 1.8 | 2.4 | | | 3 | 2 | 1 | 4.7 |
| 2 | | | 5 | 3.1 | 410 | 792 | | | 2.1 | 0.5 | | | 1 | 1 | 3.4 | 4.2 |
| 2 | | | 10 | 10 | 386 | 382 | | | 0.5 | 2.1 | | | 1 | 1 | 1 | 10 |
| 2 | | | 2 | 7 | 361 | 346 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 12 |
| 2 | | | 6.4 | 3.9 | 399 | 461 | | | 0.5 | 0.5 | | | 2 | 2 | 1 | 1 |
| 2 | | | 1.5 | 1.5 | 403 | 419 | | | 0.5 | 0.5 | | | 1 | 1 | 5 | 7 |
| 2 | | | 122 | 95 | 485 | 560 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 1 |
| 2 | | | 14 | 16 | 391 | 382 | | | 0.5 | 0.5 | | | 1 | 2 | 1 | 2 |
| 2 | | | 5 | 3 | 404 | 432 | | | 0.5 | 6.0 | | | 1 | 3 | 1 | 6 |
| 2 | | | 6 | 6 | 964 | 442 | | | 0.5 | 0.5 | | | 77 | 5 | 1 | 2.5 |
| 2 | | | 4 | 6 | 342 | 502 | | | 0.5 | 0.5 | | | 0.8 | 4 | 0.5 | 8 |
| 2 | 0.25 | 0.25 | 4.5 | | 529 | | 0.053 | 0.241 | 0.5 | | 0.025 | 0.025 | 0.5 | | 0.5 | |
| 2 | 1 | 1 | 6 | 1.5 | 680 | 620 | 0.077 | 0.079 | 0.5 | 0.5 | 0.025 | 0.025 | 1 | 1 | 12 | 2 |
| 4 | | | 8.3 | 15.7 | 249 | 261 | | | 1.3 | 1.3 | | | 1 | 1 | 1 | 5.6 |
| 4 | | | 6.4 | 10.7 | 215 | 204 | | | 1.8 | 1.7 | | | 1 | 1 | 2.1 | 1 |
| 4 | | | 6.9 | 8.5 | 237 | 244 | | | 1.5 | 1.6 | | | 3 | 2 | 1 | 8 |
| 4 | | | 12 | 15 | 302 | 314 | | | 1.7 | 1.3 | | | 1 | 1 | 1 | 2.9 |
| 4 | | | 6 | 7 | 226 | 296 | | | 4.0 | 3.0 | | | 1 | 1 | 1 | 3.1 |
| 4 | | | 6.9 | 10.6 | 188 | 176 | | | 3.0 | 3.0 | | | 3 | 4 | 1 | 9 |
| 4 | | | 6.2 | 3.8 | 209 | 211 | | | 2.4 | 2.2 | | | 3 | 1 | 1 | 1.5 |
| 4 | | | 4.5 | 5.5 | 187 | 161 | | | 3.0 | 3.3 | | | 2 | 2 | 1 | 5.5 |
| 4 | | | 10 | 4.9 | 153 | 156 | | | 2.1 | 0.5 | | | 1 | 1 | 1 | 5.8 |
| 4 | | | 10 | 10 | 185 | 186 | | | 0.5 | 0.5 | | | 1 | 1 | 3 | 10 |
| 4 | | | 6 | 8 | 155 | 147 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 7 |
| 4 | | | 7.5 | 13.2 | 171 | 194 | | | 0.5 | 0.5 | | | 1 | 2 | 1 | 1 |
| 4 | | | 1.5 | 1.5 | 149 | 150 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 6 |
| 4 | | | 27 | 41 | 378 | 385 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 1 |
| 4 | | | 12 | 14 | 252 | 266 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 13 |
| 4 | | | 6 | 6 | 216 | 222 | | | 0.5 | 0.8 | | | 1 | 2 | 1 | 6 |
| 4 | | | 8 | 6 | 500 | 98 | | | 0.5 | 0.5 | | | 1 | 1 | 2 | 1.1 |
| 4 | | | 5 | 9 | 171 | 168 | | | 0.5 | 0.5 | | | 1 | 0.5 | 0.5 | 3 |
| 4 | 0.25 | 0.25 | 5.2 | | 198 | | 5.70 | 5.82 | 1.6 | | 0.025 | 0.025 | 1 | | 0.8 | |
| 4 | 1 | 1 | 9 | 13 | 503 | 450 | 5.25 | 5.36 | 0.5 | 0.5 | 0.025 | 0.025 | 1 | 1 | 7.6 | 8.3 |
| 5 | | | 4.2 | 7.5 | 246 | 226 | | | 1.5 | 6.0 | | | 1 | 2 | 1 | 7.1 |
| 5 | | | 1.5 | 4.3 | 143 | 180 | | | 1.8 | 1.6 | | | 1 | 1 | 2.2 | 4 |
| 5 | | | 1.5 | 3.2 | 125 | 129 | | | 1.1 | 1.4 | | | 3 | 3 | 1 | 5.2 |
| 5 | | | 3.3 | 4.5 | 135 | 135 | | | 1.4 | 1.1 | | | 1 | 1 | 1 | 4.1 |
| 5 | | | 1.5 | 1.5 | 115 | 117 | | | 3.9 | 3.0 | | | 1 | 1 | 1 | 2.5 |
| 5 | | | 1.5 | 1.5 | 118 | 233 | | | 2.0 | 2.0 | | | 1 | 1 | 1 | 6 |
| 5 | | | 1.5 | 1.5 | 143 | 145 | | | 1.8 | 2.1 | | | 1 | 3 | 1 | 2.9 |
| 5 | | | 1.5 | 1.5 | 151 | 161 | | | 1.9 | 2.7 | | | 1 | 2 | 1 | 5 |
| 5 | | | 1.5 | 1 | 156 | 152 | | | 3.4 | 0.5 | | | 1 | 1 | 4 | 4.1 |
| 5 | | | 6 | 6 | 166 | 185 | | | 0.5 | 0.5 | | | 1 | 2 | 2.1 | 6 |
| 5 | | | 1.5 | 1.5 | 251 | 224 | | | 0.5 | 0.5 | | | 1 | 1 | 3 | 10 |
| 5 | | | 1.5 | 1.5 | 702 | 304 | | | 1.2 | 0.5 | | | 1 | 1 | 1 | 1 |
| 5 | | | 1.5 | 1.5 | 154 | 166 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 1 |
| 5 | | | 10 | 17.5 | 319 | 325 | | | 0.5 | 1.2 | | | 1 | 1 | 3 | 18 |
| 5 | | | 1.5 | 1.5 | 172 | 174 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 4 |
| 5 | | | 1.5 | 1.5 | 166 | 188 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 6 |
| 5 | | | 1.5 | 1.5 | 444 | 121 | | | 1.5 | 2.0 | | | 84 | 177 | 73 | 14 |
| 5 | | | 0.5 | 2 | 143 | 214 | | | 0.5 | 0.5 | | | 0.5 | 2 | 2 | 35 |
| 5 | 0.25 | 1.1 | 0.5 | | 225 | | 4.67 | 5.60 | 0.5 | | 0.025 | 0.025 | 0.5 | | 0.5 | |
| 5 | 1 | 1 | 12 | 14 | 580 | 510 | 5.08 | 5.74 | 0.5 | 0.5 | 0.025 | 0.025 | 1 | 1 | 4.6 | 7 |
| 6 | | | 10.5 | 13.3 | 125 | 140 | | | 3.0 | 2.2 | | | 1 | 2 | 3.7 | 6.6 |
| 6 | | | 6.7 | 11.6 | 78 | 80 | | | 2.6 | 3.0 | | | 1 | 1 | 1.4 | 7 |
| 6 | | | 8 | 8.5 | 115 | 120 | | | 2.3 | 2.9 | | | 1 | 1 | 4.9 | 8.1 |
| 6 | | | 21 | 19 | 124 | 131 | | | 3.4 | 3.3 | | | 1 | 1 | 2.8 | 4.8 |
| 6 | | | 6 | 6 | 65 | 131 | | | 5.6 | 2.1 | | | 1 | 1 | 2 | 3.1 |
| 6 | | | 7.3 | 11 | 64 | 152 | | | 4.0 | 5.3 | | | 1 | 2 | 1 | 3 |
| 6 | | | 4.3 | 1.5 | 75 | 86 | | | 3.8 | 7.8 | | | 1 | 3 | 1 | 4 |
| 6 | | | 2 | 3 | 53 | 86 | | | 5.1 | 6.0 | | | 1 | 1 | 2.4 | 4 |
| 6 | | | 7 | 2.9 | 85 | 120 | | | 1.7 | 0.5 | | | 1 | 2 | 2 | 8.2 |
| 6 | | | 9.5 | 9.5 | 81 | 70 | | | 0.5 | 1.4 | | | 1 | 2 | 8.5 | 4.8 |
| 6 | | | 3 | 4 | 92 | 78 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 5.5 |
| 6 | | | 4.6 | 7.6 | 120 | 147 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 15 |
| 6 | | | 1.5 | 1.5 | 55 | 56 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 6 |
| 6 | | | 9 | 8.7 | 165 | 204 | | | 0.5 | 0.5 | | | 1 | 1 | 1 | 6 |
| 6 | | | 13 | 16 | 98 | 95 | | | 0.5 | 0.5 | | | 1 | 2 | 5 | 14 |
| 6 | | | 5 | 5 | 95 | 102 | | | 0.5 | 1.0 | | | 1 | 1 | 3 | 9 |
| 6 | | | 4 | 4 | 74 | 72 | | | 0.5 | 0.5 | | | 1 | 5 | 2 | 9 |
| 6 | | | 5 | 4 | 26 | 45 | | | 0.5 | 0.5 | | | 20 | 25 | 15 | 14 |
| 6 | 1.5 | 1.2 | 2.6 | | 24 | | 13.70 | 17.20 | 0.5 | | 0.025 | 0.025 | 0.5 | 0.5 | 2 | |
| 6 | 2 | 2 | 14 | 17 | 341 | 410 | 9.54 | 9.35 | 0.5 | 0.5 | 0.025 | 0.025 | 1 | 1 | 9.5 | 10 |

| Well Number | Pb Dis. ug/l | Pb Tot. ug/l | Mn Dis. ug/l | Mn Tot. ug/l | Hg Dis. ug/l | Hg Tot. ug/l | Zn Dis. ug/l | Zn Tot. ug/l | Fe Dis. mg/l | Fe Tot. mg/l | Se Dis. ug/l | Se Tot. ug/l | Well Water Level | River Water Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 1.0 | 1.0 | 50 | 60 | 10.6 | 18.1 | 2.5 | 2.5 | 410.63 | 369.46 |
| 1 | | | | | 1.0 | 1.0 | 10 | 20 | 0.25 | 1.5 | 2.5 | 2.5 | 408.31 | 369.36 |
| 1 | | | | | 1.0 | 1.0 | 10 | 30 | 0.25 | 4.9 | 2.5 | 2.5 | 409.92 | 370.18 |
| 1 | | | | | 1.0 | 1.0 | 20 | 30 | 0.25 | 2.2 | 2.5 | 2.5 | 409.69 | 371.74 |
| 1 | | | | | 1.0 | 15.1 | 10 | 50 | 0.50 | 2.3 | 2.5 | 2.5 | 409.05 | 370.11 |
| 1 | | | | | 1.0 | 1.0 | 10 | 10 | 0.25 | 1.8 | 2.5 | 2.5 | 411.39 | 372.38 |
| 1 | | | | | 0.5 | 0.5 | 10 | 10 | 0.25 | 1.5 | 2.5 | 2.5 | 412.37 | 371.68 |
| 1 | | | | | 0.5 | 0.5 | 10 | 20 | 0.25 | 1.6 | 2.5 | 2.5 | 411.96 | 370.08 |
| 1 | | | | | 0.5 | 0.5 | 10 | 10 | 0.25 | 1.7 | 2.5 | 2.5 | 413.16 | 380.68 |
| 1 | | | | | 0.5 | 0.5 | 10 | 40 | 0.25 | 2.6 | 2.5 | 2.5 | 412.61 | 379.85 |
| 1 | | | | | 0.5 | 0.8 | 10 | 10 | 0.25 | 1.9 | 2.5 | 2.5 | 411.89 | 374.43 |
| 1 | | | | | 1.2 | 1.5 | 10 | 20 | 0.25 | 2.0 | 2.5 | 2.5 | 411.22 | 372.53 |
| 1 | | | | | 2.3 | 0.5 | 10 | 20 | 0.25 | 1.4 | 2.5 | 2.5 | 410.57 | 382.11 |
| 1 | | | | | | | | | | | | | | |
| 1 | | | | | 0.5 | 0.5 | 10 | 30 | 0.25 | 1.4 | 2.5 | 5 | 411.39 | 394.78 |
| 1 | | | | | 0.5 | 0.5 | 10 | 30 | 0.25 | 1.5 | 2.5 | 2.5 | 414.34 | 396.33 |
| 1 | | | | | 0.5 | 0.5 | 10 | 30 | 0.10 | 1.7 | 5 | 2.5 | 412.84 | 394.17 |
| 1 | | | | | 0.5 | 0.5 | 30 | 30 | 0.13 | 2.8 | 0.5 | 0.5 | 414.06 | 380.23 |
| 1 | 1.2 | 6.3 | 708 | 741 | 0.25 | | 97 | | 0.06 | | 1 | | 412.35 | 378.15 |
| 1 | 1 | 1 | 445 | 501 | 0.5 | 0.5 | 20 | 10 | 0.20 | 1.3 | 2.5 | 2.5 | 413.87 | 399.28 |
| 2 | | | | | 1.0 | 1.0 | 10 | 10 | 23.6 | 23.1 | 2.5 | 2.5 | 399.41 | 349.46 |
| 2 | | | | | 1.0 | 1.0 | 20 | 30 | 27.3 | 28.5 | 2.5 | 2.5 | 399.16 | 349.34 |
| 2 | | | | | 1.0 | 1.0 | 10 | 10 | 25.5 | 23.0 | 2.5 | 2.5 | 398.55 | 370.18 |
| 2 | | | | | 1.0 | 1.0 | 30 | 40 | 26.7 | 28.9 | 2.5 | 2.5 | 398.53 | 371.74 |
| 2 | | | | | 1.0 | 1.0 | 10 | 30 | 25.2 | 25.7 | 2.5 | 2.5 | 398.44 | 370.14 |
| 2 | | | | | 1.0 | 1.0 | 10 | 10 | 30.2 | 26.9 | 2.5 | 2.5 | 400.19 | 372.38 |
| 2 | | | | | 0.5 | 0.5 | 10 | 10 | 28.2 | 28.5 | 2.5 | 2.5 | 400.59 | 371.68 |
| 2 | | | | | 0.5 | 0.5 | 10 | 60 | 22.4 | 23.2 | 2.5 | 2.5 | 400.37 | 370.08 |
| 2 | | | | | 0.5 | 0.5 | 10 | 10 | 23.4 | 22.3 | 2.5 | 2.5 | 401.54 | 350.68 |
| 2 | | | | | 0.5 | 0.5 | 10 | 10 | 33.0 | 25.3 | 2.5 | 2.5 | 402.41 | 379.85 |
| 2 | | | | | 4.3 | 1.7 | 10 | 10 | 21.4 | 22.4 | 2.5 | 2.5 | 400.30 | 374.43 |
| 2 | | | | | 1.1 | 1.5 | 10 | 20 | 25.6 | 25.9 | 2.5 | 2.5 | 397.97 | 372.53 |
| 2 | | | | | 1.4 | 0.5 | 10 | 10 | 26.0 | 27.2 | 2.5 | 2.5 | 401.90 | 382.15 |
| 2 | | | | | 0.5 | 2.0 | 10 | 10 | 27.3 | 26.6 | 2.5 | 2.5 | 399.71 | 366.74 |
| 2 | | | | | 0.5 | 0.5 | 10 | 10 | 25.3 | 25.5 | 2.5 | 2.5 | 402.17 | 394.78 |
| 2 | | | | | 0.5 | 0.5 | 10 | 20 | 26.5 | 25.7 | 2.5 | 2.5 | 401.38 | 396.33 |
| 2 | | | | | 0.5 | 0.5 | 10 | 20 | 34.8 | 30.9 | 1.5 | 2.5 | 403.00 | 394.18 |
| 2 | | | | | 0.5 | 0.5 | 10 | 20 | 34.4 | 32.0 | 0.5 | 0.5 | 401.12 | 380.23 |
| 2 | 0.5 | 6.1 | 9440 | 693 | 0.75 | | 20 | | 29.9 | | 1 | | 401.78 | 378.15 |
| 2 | 1 | 1 | 7190 | 8070 | 0.5 | 0.5 | 30 | 10 | 31.2 | 34.0 | 2.5 | 2.5 | 405.22 | 399.28 |
| 4 | | | | | 1.0 | 1.0 | 10 | 10 | 5.6 | 5.5 | 2.5 | 2.5 | 371.28 | 369.48 |
| 4 | | | | | 1.0 | 1.0 | 10 | 10 | 5.8 | 5.1 | 2.5 | 2.5 | 370.67 | 369.26 |
| 4 | | | | | 1.0 | 1.0 | 10 | 10 | 5.4 | 5.8 | 2.5 | 2.5 | 370.48 | 370.16 |
| 4 | | | | | 1.0 | 1.0 | 20 | 20 | 5.2 | 6.1 | 2.5 | 2.5 | 371.28 | 371.74 |
| 4 | | | | | 1.0 | 1.0 | 10 | 40 | 5.7 | 5.5 | 2.5 | 2.5 | 370.46 | 370.14 |
| 4 | | | | | 1.0 | 1.0 | 10 | 10 | 5.9 | 5.9 | 2.5 | 2.5 | 373.73 | 372.36 |
| 4 | | | | | 0.5 | 0.5 | 10 | 10 | 6.2 | 5.3 | 2.5 | 2.5 | 372.66 | 371.68 |
| 4 | | | | | 0.5 | 0.5 | 10 | 50 | 5.0 | 4.6 | 2.5 | 2.5 | 371.14 | 370.08 |
| 4 | | | | | 0.5 | 0.5 | 10 | 10 | 4.2 | 4.1 | 2.5 | 2.5 | 278.63 | 380.68 |
| 4 | | | | | 0.5 | 0.5 | 10 | 10 | 4.1 | 5.5 | 2.5 | 2.5 | 380.08 | 379.85 |
| 4 | | | | | 1.0 | 0.5 | 10 | 10 | 4.6 | 5.1 | 2.5 | 2.5 | 374.47 | 374.43 |
| 4 | | | | | 1.3 | 1.8 | 10 | 10 | 4.3 | 4.4 | 2.5 | 2.5 | 374.22 | 372.53 |
| 4 | | | | | 0.5 | 0.5 | 10 | 10 | 4.2 | 4.4 | 2.5 | 2.5 | 381.73 | 382.13 |
| 4 | | | | | 0.5 | 1.0 | 10 | 10 | 5.5 | 5.5 | 2.5 | 2.5 | 358.63 | 366.74 |
| 4 | | | | | 0.5 | 0.5 | 10 | 30 | 6.0 | 5.4 | 2.5 | 5 | 392.72 | 394.78 |
| 4 | | | | | 0.5 | 0.5 | 10 | 30 | 5.0 | 5.0 | 2.5 | 2.5 | 394.28 | 396.33 |
| 4 | | | | | 0.5 | 0.5 | 10 | 20 | 5.3 | 5.4 | 1.5 | 2.5 | 393.51 | 374.18 |
| 4 | | | | | 0.5 | 0.5 | 10 | 30 | 4.5 | 5.3 | 0.5 | 0.5 | 376.22 | 380.23 |
| 4 | 0.5 | 1.6 | 382 | 379 | 0.75 | | 10 | | 5.0 | | 1 | | 379.17 | 378.15 |
| 4 | 1 | 1 | 436 | 435 | 0.5 | 0.5 | 10 | 30 | 5.3 | 6.1 | 2.5 | 2.5 | 398.67 | 399.28 |
| 5 | | | | | 1.0 | 1.0 | 10 | 20 | 7.6 | 7.7 | 2.5 | 2.5 | 371.89 | 369.48 |
| 5 | | | | | 1.0 | 1.0 | 140 | 10 | 6.5 | 6.3 | 2.5 | 2.5 | 371.16 | 369.36 |
| 5 | | | | | 1.0 | 1.0 | 10 | 30 | 4.3 | 5.1 | 2.5 | 2.5 | 370.99 | 370.18 |
| 5 | | | | | 1.0 | 1.0 | 10 | 20 | 3.9 | 4.6 | 2.5 | 2.5 | 371.78 | 371.74 |
| 5 | | | | | 1.0 | 1.0 | 10 | 50 | 3.9 | 4.0 | 2.5 | 2.5 | 370.95 | 370.14 |
| 5 | | | | | 1.0 | 1.0 | 10 | 10 | 3.6 | 4.0 | 2.5 | 2.5 | 374.41 | 372.35 |
| 5 | | | | | 1.0 | 1.0 | 10 | 10 | 3.8 | 3.6 | 2.5 | 2.5 | 373.25 | 371.68 |
| 5 | | | | | 0.5 | 0.5 | 10 | 10 | 3.5 | 3.1 | 2.5 | 2.5 | 371.68 | 370.08 |
| 5 | | | | | 0.5 | 0.5 | 10 | 10 | 3.4 | 3.5 | 2.5 | 2.5 | 379.98 | 380.68 |
| 5 | | | | | 0.5 | 0.5 | 10 | 10 | 2.8 | 3.8 | 2.5 | 2.5 | 390.26 | 379.85 |
| 5 | | | | | 0.5 | 0.5 | 10 | 10 | 5.3 | 5.2 | 2.5 | 2.5 | 374.94 | 374.43 |
| 5 | | | | | 0.5 | 0.5 | 10 | 10 | 3.6 | 4.3 | 2.5 | 2.5 | 375.09 | 372.53 |
| 5 | | | | | 1.4 | 1.4 | 10 | 10 | 3.9 | 4.0 | 2.5 | 2.5 | 382.35 | 382.13 |
| 5 | | | | | 0.5 | 0.5 | 10 | 10 | 4.2 | 4.1 | 2.5 | 2.5 | 369.12 | 366.74 |
| 5 | | | | | 0.5 | 2.0 | 10 | 10 | 3.0 | 3.0 | 2.5 | 2.5 | 393.14 | 394.75 |
| 5 | | | | | 1.0 | 0.5 | 10 | 30 | 2.8 | 2.8 | 2.5 | 2.5 | 398.52 | 396.33 |
| 5 | | | | | 0.5 | 0.5 | 10 | 30 | 3.6 | 4.0 | 2.5 | 2.5 | 394.24 | 394.18 |
| 5 | | | | | 0.5 | 0.5 | 10 | 20 | 4.2 | 5.0 | 0.5 | 0.5 | 378.55 | 380.23 |
| 5 | 0.5 | 1.9 | 318 | 314 | 0.5 | | 20 | | 4.2 | | 1 | | 379.91 | 378.15 |
| 5 | 1 | 1 | 200 | 330 | 0.5 | 0.5 | 10 | 20 | 5.8 | 6.6 | 2.5 | 2.5 | 399.21 | 399.28 |
| 6 | | | | | 1.0 | 1.0 | 10 | 10 | 8.4 | 16.9 | 2.5 | 2.5 | 370.38 | 369.48 |
| 6 | | | | | 1.0 | 1.0 | 20 | 10 | 16.8 | 19.2 | 2.5 | 2.5 | 369.62 | 369.36 |
| 6 | | | | | 1.0 | 1.0 | 20 | 10 | 17.2 | 19.9 | 2.5 | 2.5 | 369.73 | 370.16 |
| 6 | | | | | 1.0 | 1.0 | 20 | 10 | 19.5 | 19.4 | 2.5 | 2.5 | 373.61 | 371.74 |
| 6 | | | | | 1.0 | 1.0 | 10 | 10 | 18.2 | 18.0 | 2.5 | 2.5 | 369.77 | 370.14 |
| 6 | | | | | 1.0 | 1.0 | 10 | 10 | 18.8 | 17.7 | 2.5 | 2.5 | 373.29 | 372.38 |
| 6 | | | | | 1.0 | 1.0 | 10 | 10 | 18.3 | 17.7 | 2.5 | 2.5 | 371.89 | 371.68 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 16.7 | 18.4 | 2.5 | 2.5 | 371.26 | 370.08 |
| 6 | | | | | 0.5 | 0.5 | 10 | 30 | 17.4 | 10.7 | 2.5 | 2.5 | 377.84 | 380.68 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 14.9 | 21.3 | 2.5 | 2.5 | 379.20 | 379.85 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 19.5 | 20.6 | 2.5 | 2.5 | 373.81 | 374.43 |
| 6 | | | | | 1.3 | 1.1 | 10 | 20 | 17.7 | 17.7 | 2.5 | 2.5 | 374.07 | 372.53 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 18.6 | 16.7 | 2.5 | 2.5 | 382.77 | 382.13 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 18.0 | 22.2 | 2.5 | 2.5 | 368.92 | 366.74 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 16.3 | 19.2 | 2.5 | 2.5 | 391.99 | 394.78 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 18.3 | 18.9 | 2.5 | 2.5 | 395.88 | 396.33 |
| 6 | | | | | 0.5 | 2.0 | 10 | 10 | 28.4 | 23.0 | 1.5 | 2.5 | 394.14 | 394.18 |
| 6 | | | | | 0.5 | 0.5 | 10 | 10 | 21.0 | 20.3 | 0.5 | 0.5 | 377.41 | 380.23 |
| 6 | 0.5 | 1.6 | 1182 | 1298 | 0.25 | | 20 | | 24.0 | | 1 | | 379.12 | 378.15 |
| 6 | 1 | 1 | 1176 | 1201 | 0.5 | 0.5 | 10 | 50 | 20.3 | 22.2 | 2.5 | 2.5 | 399.06 | 399.28 |