M E M O R A N D U M

ATTN: Mr. Tim McCumber, WCMC Town Administrator & Clerk – Treasurer Town of Merrimac	**DATE:** September 28, 2015
COMPANY: Kunkel Engineering Group/Geo-Logic Associates	**PROJECT NO.:** 2015-K019
FROM: Sarah Battelle, CHG	
SUBJECT: Evaluation of Proposed Well Location for Town of Merrimac	
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Kunkel Engineering Group/Geo-Logic Associates (KEG/GLA) was contracted by the Town of Merrimac to perform an evaluation in the selection of a primary and backup well to serve the Merrimac Sanitary District (District). As part of this scope of work, KEG/GLA reviewed the Revised Alternative Feasibility Study, Groundwater Remedial Strategy, Badger Army Ammunition Plant (December 2011) prepared for the United States Army and the Well Site Investigation Report (December 2012), prepared by MSA Professional Services of Baraboo, Wisconsin. The objective of the review was to provide recommendations for siting of a primary and backup well to be constructed as part of groundwater remedial actions to address groundwater contamination resulting from the Badger Army Ammunitions Plant (BAAP).

BACKGROUND

As a result of production and waste disposal operations associated with the production of munitions for World War II, the BAAP, located within Sumpter and Merrimac Townships of Sauk County, has impacted soil and groundwater. In response to the discovery of these impacts, numerous studies have been conducted and remedial actions taken by the Army. There are three contaminant plumes emanating from the BAAP: the southern Propellant Burning Ground (PBG) plume, the Central Plume, and the northern Deterrent Burning Ground (DBG) plume. Groundwater from the PBG and DBG plumes are impacted by dinitrotoluene (DNT) and chlorinated solvents. Groundwater in the Central Plume area is impacted by DNT. Based on monitoring well data collected in wells on the BAAP and surrounding areas, groundwater and the associated contaminant plumes flow from the contaminant source areas in a south-southeasterly direction toward the Wisconsin River and the Merrimac and Sumpter Township areas. Although the highest contaminant concentrations are measured in wells primarily on BAAP, the contaminant plumes extend beyond the BAAP boundary, and particularly the PBG plume, which extends south toward Sumpter, and Prairie du Sac further south. Because many

of the surrounding communities rely on private groundwater wells for their water supply, there is a potential health risk if the contaminants from the BAAP enter the water supply.

The Revised Alternative Feasibility Study (AFS) recommends the construction of a public water system drawing water from wells located outside of the contaminant plumes and their flow paths. Using select wells to provide municipal water is expected to provide a safe, reliable source of water to the community including well owners located downgradient of the BAAP that may be affected by the migration of the contaminant plumes. Private potable (drinking water) supply wells would be abandoned by the Army (eliminating the exposure risk from ingestion of potentially impacted groundwater) and the drinking water source would be replaced by connection to public water supply. Over time, BAAP expects that the contaminants will degrade naturally, however, groundwater monitoring would continue in select wells to assess the conditions of each of the three groundwater contaminant plumes, and document that they have stabilized or receded.

To implement the proposed remedial action, the affected communities would form a water district for the development and long-term management of the public water system. The public water supply would include the construction of two groundwater production wells, to be located east of the BAAP and outside of limits of the contaminant plumes. The wells would be constructed within the deeper Mount Simon sandstone formation and processed through water storage and treatment facilities before entering the water distribution system. The following sections describe the results of a well test investigation performed to assess possible water supply well locations for the public water system.

Well Investigation

MSA Professionals of Baraboo, Wisconsin performed an evaluation of four possible well locations by drilling four test borings (Figure 2). Two confirmatory Test Well locations were recommended to be constructed and tested to verify the feasibility of constructing two final wells as the groundwater source for a public water system. The selected test borings were located outside and upgradient of the documented BAAP contaminant plumes. Each test boring was drilled through the Mount Simon formation, encountered at a depth of about 190 to 240 feet below ground surface (bgs) and terminating at depths of about 455 to 530 feet. The Mount Simon formation consisted of an upper layer of cemented dolomite and shale with some sand layers, over a predominant sandstone. Each boring was cased into the Mount Simon Formation with the remainder of the boring left open to its total depth for testing. Following drilling, the test borings were pumped to evaluate their production capabilities, and were also sampled to assess the water quality at each location. Of the four test borings, three (Test Borings #1, #3, and #4) were considered viable well locations, with the best water quality was identified at Test Boring #4. The fourth boring (Test Boring #2) encountered elevated iron (1.95 mg/L), well above the secondary drinking water standard for iron of 0.3 mg/L, and exhibited lower relative production. It should be noted that water quality samples from Test Borings #1

and #3 also contained elevated iron (0.772 and 0.377 mg/L, respectively) and water from these wells would require additional treatment to remove iron.

The pumping tests included pumping at a rate of 55 gallons per minute (gpm) within the Mt. Simon sandstone for two hours at Test Boring #1 with no reported drawdown. The other two viable test borings were each pumped at about 100 gpm over a period of 72 hours. Test Boring #3 exhibited drawdown of nine feet before stabilizing for the duration of the test, while Test Boring #4 exhibited a maximum drawdown of 25 feet. Additionally, the pumping test results suggest that the upper Mt. Simon formation (shale and dolomite above the sandstone), is acting as an aquitard to separate the Mt. Simon sandstone aquifer from shallower unconsolidated sand and gravel aquifer above.

MSA conducted a record search for potential contaminant sources within one mile of the three viable well locations (viable Test Borings #1, #3 and #4 correspond to Test Well locations A, B and C) (See attached Figures 1 and 2). Potential contaminant sources included spill sites, solid waste sites, leaking underground storage tanks (USTs), and existing fuel storage tanks (above and below ground). Results indicated all spills had received "closed" status from the Wisconsin Department of Natural Resources (DNR) or Department of Agriculture, Trade, and Consumer Protection (ATCP), and were located downgradient of the proposed well locations. MSA reports that there were no solid waste sites, leaking UST, or existing fuel storage tanks with one half mile of the proposed well locations. A search of known septic tanks within 400 feet of each well location was also conducted (the required distance between a production well and a septic system). There are septic systems and publicly owned treatment works (POTWs) in the vicinity of each of the Test Well locations, however, there were no septic systems within the required 400 feet of the three proposed Test Well locations. Test Well B is located adjacent to the Eagle Point and Foster's Shore developments. This area is zoned for single- family homes, each with its own private septic system that would result in septic systems within 400 feet of the Test Well B. The proposed District is requesting a variance to allow septic tanks within 100 feet of Test Well B if development of a final well in this location occurs.

Results of the Well Investigation (MSA, 2012) conclude that the locations identified as Test Wells A and C are the most viable locations. Test Well B's location in a residential development area is considered a viable location and could be used if results of either Test Well sites A or C are unsatisfactory.

SUMMARY AND CONCLUSIONS

KEG/GLA conducted a review of the Revised AFS prepared for the BAAP and the Well Investigation Report prepared for the proposed District to evaluate a primary and backup well to serve the District. Based on our review of the Revised AFS, KEG/GLA believes that the proposed remedy to construct a Public Water System outside of the groundwater contaminant plumes from the BAAP and into the underlying Mt. Simon sandstone is the best long-term solution for the Town of Merrimac and the surrounding communities to be incorporated into

the District. The upper portion of the well will be cased and sealed to isolate the producing zone from the overlying shallow aquifer that has been impacted by DNT and chlorinated solvents from the BAAP. The following benefits will be realized by the public water system:

- Provides the best opportunity for long-term protection of the health of the community;
- Provides the ability to monitor water quality at one point source and ensure a consistent safe water source rather than multiple private wells with unregulated water quality;
- If contamination is identified, allows for treatment to be implemented at one well rather than multiple wells.
- Reduces the risk of private wells being drilled within the groundwater contaminant plume; and
- Reduced the potential for changes in the aquifer and plume configuration that could occur from pumping of multiple wells at different pumping rates.

KEG/GLA also concurs with the conclusions presented by MSA to drill and construct Test Wells at locations A and C to verify the feasibility of constructing two final wells at these locations as groundwater sources for the proposed public water system. If a priority is assigned to these wells, Test Well C would be rated first with the best water quality and its location, which is the furthest east and furthest from the groundwater contaminant plumes. It is located 200 feet southeast of the intersection of Highway 78 and Mattson Road. Constant rate pumping at this well location yielded about 100 gpm, though the Mt. Simon sandstone may be thinner at this location (around 50 feet).

Test Well A, located on agricultural land at the intersection of Goette Road and Highway 78, is also viable, but may require iron removal if similar water quality is encountered to that in the adjacent Test Boring (#1). Additionally, the test boring was only tested over a period of 2 hours at a rate of 55 gpm. Typically, a constant rate test of at least 72 hours is recommended to evaluate the hydraulic properties and its production capabilities as was performed at the other viable test borings. Because the actual production rate is uncertain at this location, Test Well A would be considered the backup test well location.

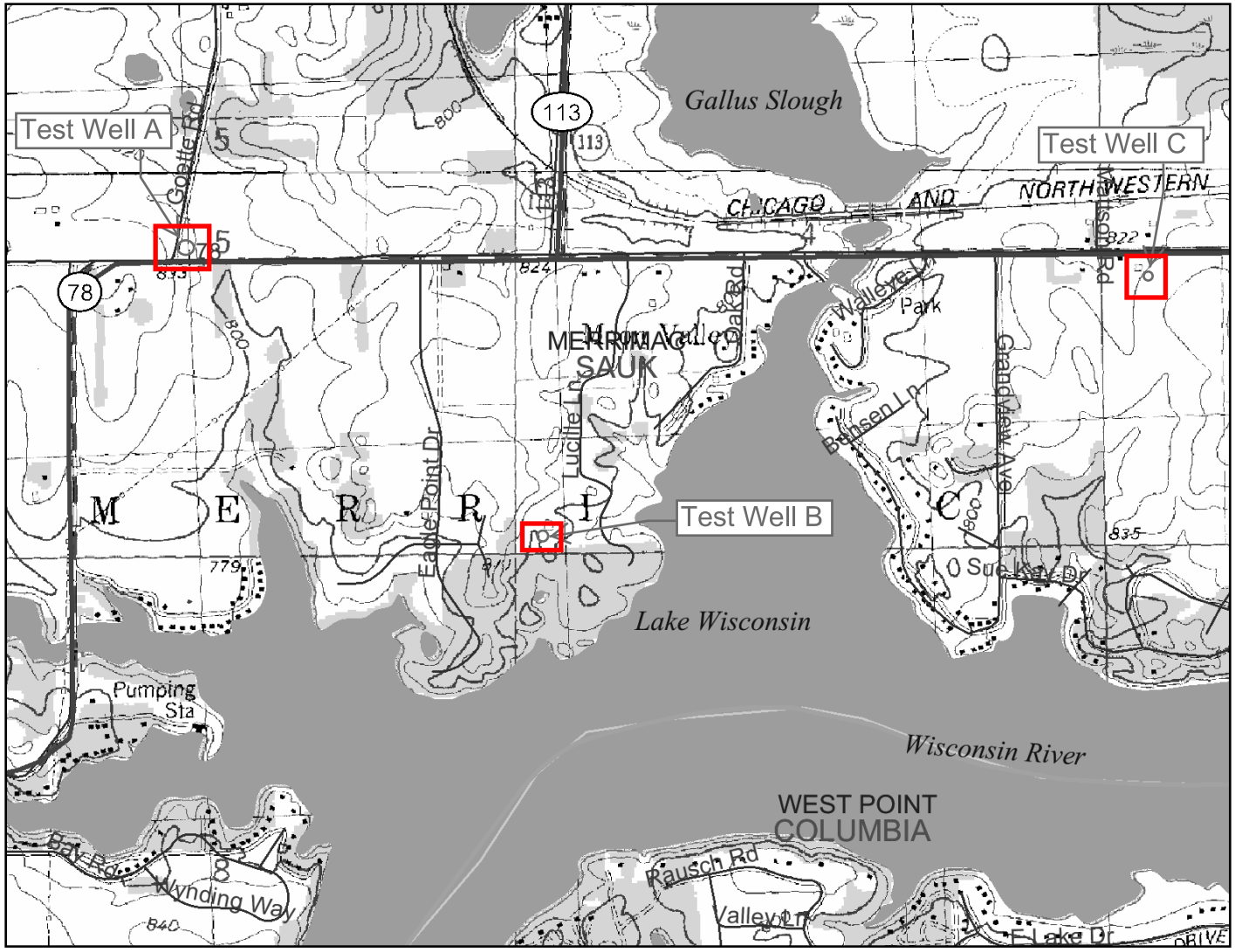
Test Well B, to be located within the Eagle Point/Foster's Shore expansion area on Lucille Lane, is also viable, but is not preferred because of its location within a single-family housing development, the potential for iron treatment if similar water quality is encountered to the test boring, and the future presence of septic systems within 100 feet of the final well, though isolation of the production zone from the upper groundwater is proposed. It is noted that based on the test boring results, this location could produce at the highest potential production rate.

MSA has recommended that each test well be thoroughly tested and KEG/GLA concurs. The testing program should include long-term pumping tests with a series of monitoring wells constructed into the upper and Mt. Simon sandstone aquifers to evaluate aquifer pumping test data as part of the assessment of long-term groundwater available to the community. The

aquifer analysis should consider groundwater demand at full build-out in accordance with each community's general plan, the quantity of groundwater in storage, the long-term constant production rate, well drawdown, aquifer hydraulic properties, the zone of influence and the calculated depletion of groundwater within the aquifer over time. It may also be advantageous to model the septic intercept risk to consider the long-term impact to the production zone, should the well seal fail. Water quality testing must include all standard water quality analytical tests, including radiochemistry testing for radium 226 and 228, which may be emitted from the shale units above the producing aquifer. Following testing, the final well design must be developed to ensure isolation of the producing zone from the overlying unconsolidated sand and gravel aquifer and casing of gamma ray emitting shales (resulting in increased radium in groundwater).

In closing, KEG/GLA believes that the remedial alternative proposed by the BAAP to construct a public water system outside of the BAAP groundwater contaminant plumes and into the underlying deeper Mt. Simon sandstone is the best long-term solution for the Town of Merrimac and the surrounding communities. In verifying the location for the final production well, Test Well C is the recommended primary well location based on the water quality data and its location furthest from the contaminant plume migration path. Test Well A is believed to be the better backup production well location (over Test Well B), though some iron removal may be required. A production well located in the vicinity of Test Well B is ranked third, since it would be located within a single-family housing development where septic systems could be in use within 100 feet of the well resulting in an additional potential contaminant risk, in addition to the potential for iron removal treatment that may be required.

USGS Location Map



Legend

Major Highways
- Interstate
- State Highway
- U.S. Highways

County Roads

Local Roads

24K County Boundaries

Civil Towns
- Civil Town

24K Open Water

24K Rivers and Shorelines
- Intermittent
- Fluctuating
- Perennial

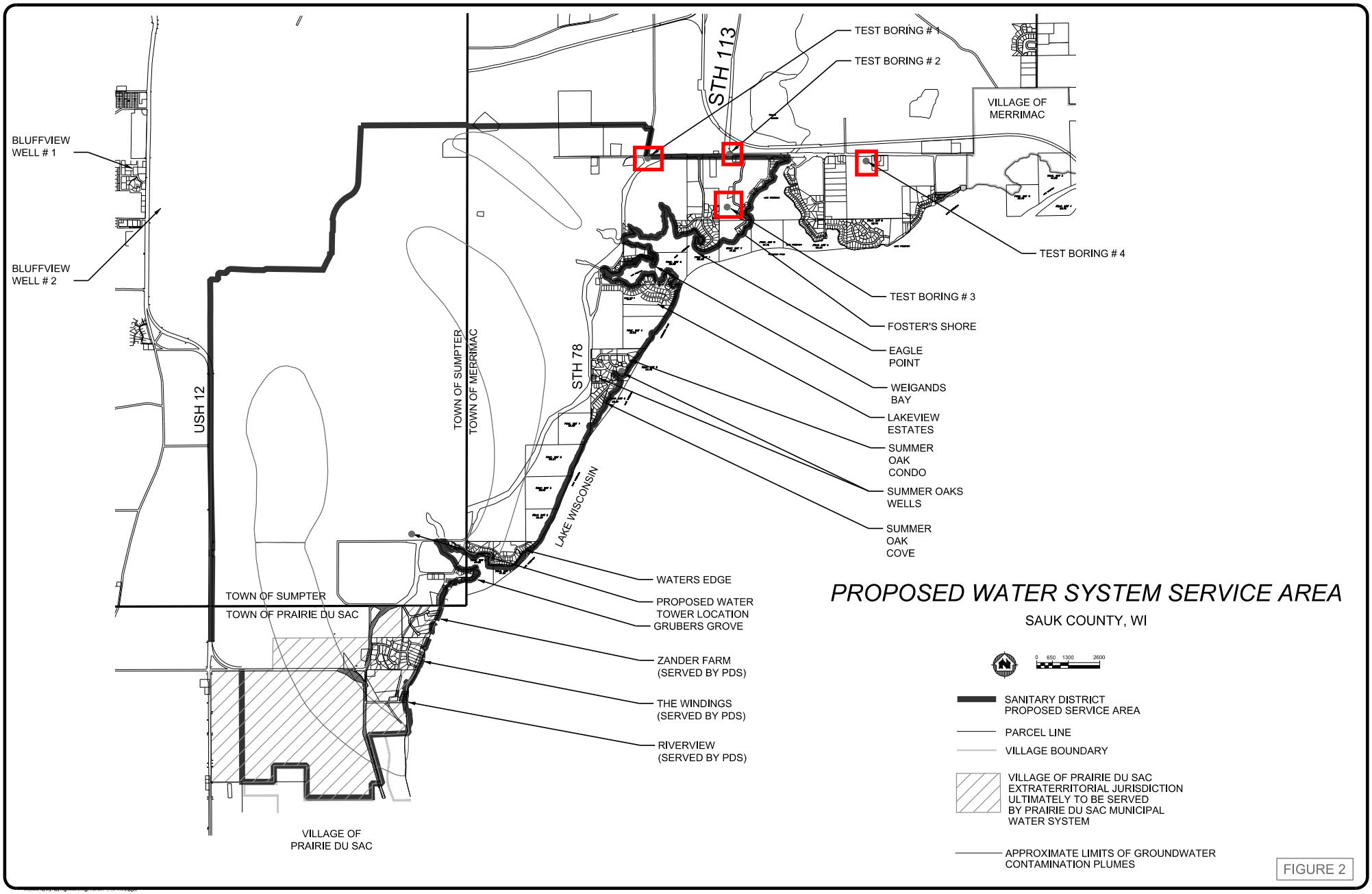
Cities and Villages
- Village
- City

N

Scale: 1:17,999

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

FIGURE 1


BLUFFVIEW WELL # 1
BLUFFVIEW WELL # 2
USH 12
STH 113
STH 78
TOWN OF SUMPTER
TOWN OF MERRIMAC
TOWN OF SUMPTER
TOWN OF PRAIRIE DU SAC
VILLAGE OF PRAIRIE DU SAC
VILLAGE OF MERRIMAC
LAKE WISCONSIN
TEST BORING # 1
TEST BORING # 2
TEST BORING # 3
TEST BORING # 4
FOSTER'S SHORE
EAGLE POINT
WEIGANDS BAY
LAKEVIEW ESTATES
SUMMER OAK CONDO
SUMMER OAKS WELLS
SUMMER OAK COVE
WATERS EDGE
PROPOSED WATER TOWER LOCATION
GRUBERS GROVE
ZANDER FARM (SERVED BY PDS)
THE WINDINGS (SERVED BY PDS)
RIVERVIEW (SERVED BY PDS)
PROPOSED WATER SYSTEM SERVICE AREA
SAUK COUNTY, WI
0 650 1300 2600
SANITARY DISTRICT PROPOSED SERVICE AREA
PARCEL LINE
VILLAGE BOUNDARY
VILLAGE OF PRAIRIE DU SAC EXTRATERRITORIAL JURISDICTION ULTIMATELY TO BE SERVED BY PRAIRIE DU SAC MUNICIPAL WATER SYSTEM
APPROXIMATE LIMITS OF GROUNDWATER CONTAMINATION PLUMES
FIGURE 2