Design Basis Report

Unit Well No. 31

Facility Design

Madison Water Utility
Madison, WI
SEH No. MADWU 129083

November 19, 2014

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November 19, 2014

RE: Unit Well No. 31
Design Basis Report
Facility Design
Madison Water Utility
Madison, WI
SEH No. MADWU 129083

Mr. Adam Wiederhoeft, PE
Madison Water Utility
119 E Olin Avenue
Madison, WI 53713

Dear Mr. Wiederhoeft:

SEH is pleased to provide to you this design basis report which explains the various options for the Unit Well 31, treatment plant, and potable water storage tank. SEH recommends Option 1A: two rectangular backwash tanks housed in the water treatment plant and one separate wire wound ground storage potable water tank. The executive summary highlights the more immediately pertinent portions of this report.

If you have any questions regarding this report, please contact me directly at 715-720-6241.

Sincerely,

Randy Sanford

Randy Sanford, PE
Project Manager

JJB/ak/llb
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Design Basis Report for

Unit Well No. 31
Facility Design

Prepared for:
Madison Water Utility
Madison, Wisconsin

Prepared by:
Short Elliott Hendrickson Inc.
10 North Bridge Street
Chippewa Falls, WI 54729-2550
715.720.6200

I, Randy Sanford, hereby certify that I am a registered Professional Engineer in the State of Wisconsin in accordance with ch. A-E 4, Wis. Adm. Code and that this report has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code.

Randy Sanford 33689 11/18/14
Randy Sanford, PE PE Number Date
Project Manager | Principal

Executive Summary

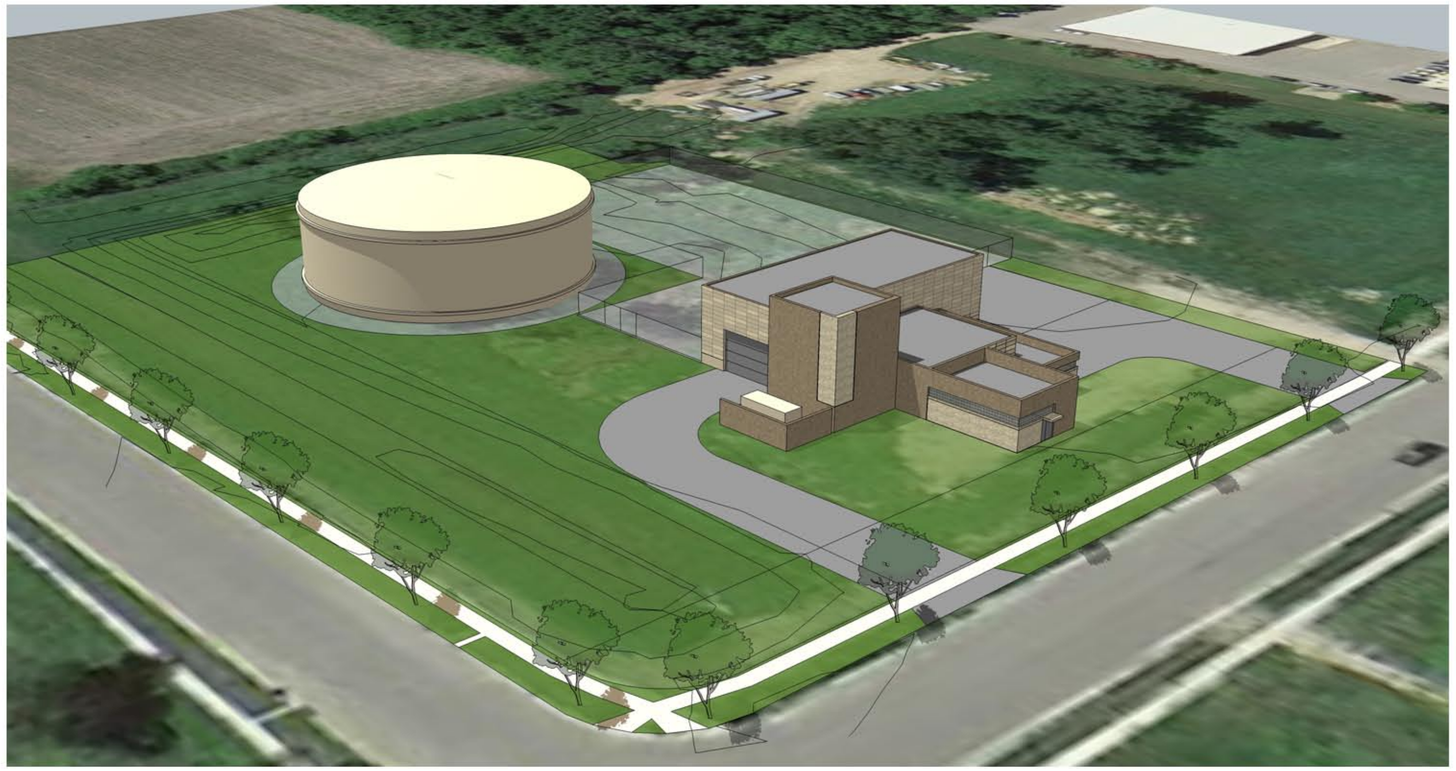
This report discusses the processes and layout options for the proposed Unit Well 31 water treatment plant site. Unit Well 7 and Unit Well 29 were used as a design basis for Unit Well 31 (Well 31). Four options were explored in relationship to a conceptual process flow diagram relative to the treatment plant floor plan layout.

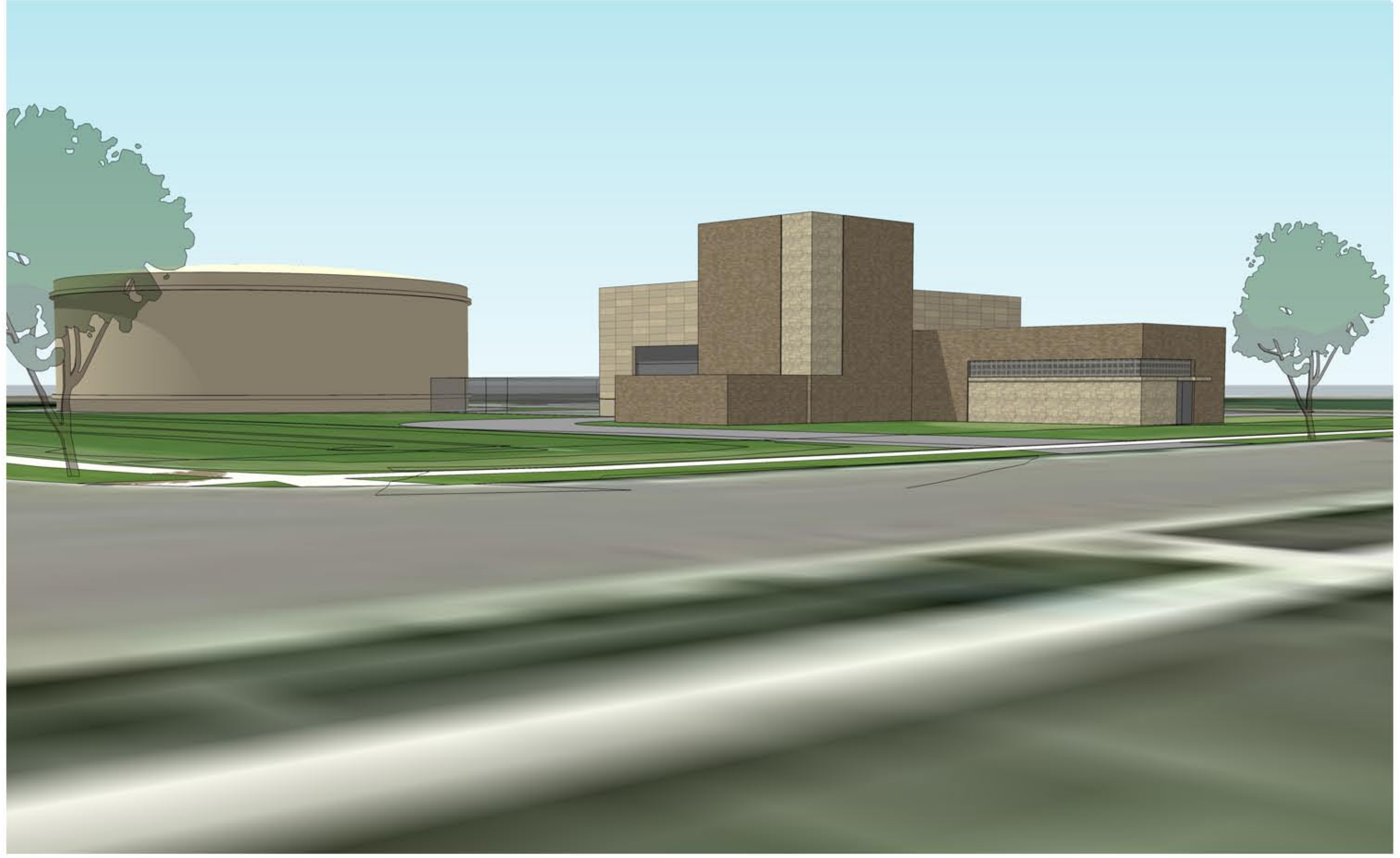
Sixteen vertical pressure filters were used as the basis for design, based on previous utility experiences. Each filter is 4-feet in diameter with a total area of 201 ft^2. Well 31 was waived from requiring a pilot study due to the similar water chemistry with Well 7, so the same design parameters of will be applied to Well 31. The design well pump rate is 2,200 gpm, the filtration rate is 12 gpm/ft^2, and the backwash rate is 30 gpm/ft^2 for seven minutes and a minimum of 100,000 gallons is required for the backwash tank.

Backwash water could be provided either by Well 31 or the distribution system. It is recommended that the utility use the well pump for backwashing similar to the backwashing process at other wells.

Well 31 is expected to require a 340 horsepower (HP) motor. The high lift pumps are each expected to require 180 HP motors. A total of three high lift pumps will be used with two in use at any time and one for redundancy. Two motors at 100 percent speed will pump the firm 3,500 gpm capacity and one motor at a reduced speed will pump the 2,200 gpm plant capacity. The high lift pumps will pump from the potable water tank.

Based on MWU design parameters, industry standard filtration practices, a review of capital costs, maintenance, and life cycle cost analysis it is recommended that MWU move forward with Option 1A as shown below with a total unit well building square footage of 4,052, a 3,900 square foot storage building, two rectangular concrete backwash tanks above grade and one detached 1.5 MG wire-wound cylindrical concrete potable water storage tank. The overall capital costs for this option showed the lowest capital improvement costs at $5.47 Million with the lowest life cycle cost analysis and maintenance. MWU currently has budget $5.7 Million.





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SCHEMATIC IMAGES - OPTION 1A

WELL 31

MADISON WATER UTILITY

11/19/2014

SEH

Potter Lawson

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November 2014

Design Basis Report

Unit Well No. 31

Prepared for Madison Water Utility

1.0 Background of Utility and Existing Needs

The Madison Water Utility (MWU) has been proactive in maintaining and updating its potable water supply, treatment, distribution system, and storage to meet existing and future water needs of the City. In 2008, MWU hired Black & Veatch to produce a comprehensive plan to develop a short-term (through year 2010) and a long-term (through year 2025) plan of improvements needed to correct existing system deficiencies and to serve anticipated growth over the following 20 years.

Highlights of the Black & Veatch report pertaining to Well 31 are listed below:

- In 2025, Average day demands in Pressure Zone 4 (Southeast Zone) are expected to be 1.39 million gallons per day (mgd), maximum day demands are expected to be 2.49 mgd, and peak hour demands are expected to be 3.44 mgd
- The existing Spaanem reservoir at Well 9 has total volume of 3.0 mg and provides 100 percent of the storage for Pressure Zone 4.
- The overflow elevation of the Spaanem reservoir is 1047 feet.
- The highest elevation in Pressure Zone 4 is 955 feet.
- By 2025, a total 2.11 mg of storage is needed in Pressure Zone 4.
- For full build-out, a total of 4.75 mg of storage is needed in Pressure Zone 4.
- A new Well 31 is needed for Pressure Zone 4 to replace Well 10 in order to serve the University of Wisconsin west campus demands.

2.0 Introduction to Project Site

The Madison Water Utility (Utility) is seeking to construct new Unit Well 31 with a water treatment plant. The Utility desires for Unit Well 31 to be designed similarly to Unit Well 7 and Unit Well 29. The Utility provided a basis of design memo dated February 15, 2002 and the most recent plans for Unit Well No. 7 as bid on February 7, 2014. The site will contain the new Well 31, a water treatment plant, and a new ground storage reservoir for potable water to provide water treatment plant equalization and to increase the total storage in Pressure Zone 4.

Madison Water Utility completed construction of Well 31 in 2014. Well 31 is located on the south side of Tradewinds Parkway and provides additional system stability by adding a second water source to the Utility's Pressure Zone 4 in the City's southeast side. The Well 31 site is located approximately 4,500 feet west of Upper Mud Lake (Lake Waubesa) and is southeast of Lake Monona. A map showing the location of the recently drilled Unit Well 31 can be found in Appendix B-1.

3.0 Existing Conditions

3.1 Design Constraints

A Unit Well Design Development memo for Unit Well 7 from 2002 is available in Appendix A-4. For Well 31, the same up front design constraints shall be used.

3.2 Site

The Unit Well 31 site (site) is located on a parcel to the southwest of the intersection of Tradewinds Parkway and Jadon Drive. The nominal ground elevation of the site is 860 feet (Appendix A-1). The 100-year flood plain elevation of the site is 858 feet (Appendix A-2). The site is served by a 10-inch and a 16-inch water main to the north along Tradewinds Parkway (Appendix A-1). The 10-inch main heads west towards South Dutch Mill Road and the 14-inch heads east towards Marsh Road. The site lies within an area of potential wetland indicating soil (WDNR wetland map in Appendix A-1). Future wetland investigations are necessary to define the extent of the impacts. The Genesis Plat Map is provided in Appendix A-3.

A well site investigation report was provided to the Utility by SCS BT Squared in Madison, Wisconsin. Highlights pertaining to the site’s pumping groundwater capacity are listed below:

- The nearest municipal well is the Village of McFarland water supply Well No. 3, at a distance of 7,200 feet. The steady state drawdown predicted by the regional groundwater model in the McFarland No. 3 well at the anticipated pumping rate in proposed Unit Well 31 is approximately 4.5 feet.
- The next closest municipal is City of Monona water supply Well No. 2 at a distance of 10,000 feet, and the third closest well is City of Madison Unit Well 9 at a distance of 11,100 feet. The anticipated steady state drawdown is 2.3 feet in Monona Well No. 2 and 2.6 feet in Madison Unit Well 9.
- The assumed transmissivity in the well site investigation report was 5,400 ft^2/day (40,400 gpd/ft) which produced a Zone of Influence of 6.4 miles with one foot drawdown after 30 days of pumping at the anticipated average day flow of 960 gpm.

3.2.1 Unit Well 31 Construction and Lithology

Unit Well 31 (Well 31) was approved to be drilled in May 2013 and was completed in January 2014 by Municipal Well and Pump. Well 31 was drilled to a depth of 915 feet below ground surface (bgs) using reverse rotary drilling and was cased to a depth of 316 feet using 0.5-inch thick ASTM A53B and neat cement. The cuttings of the borehole showed the geologic profile contains clay to a depth of 110 feet with a layer of sand and cobbles, sand and loose sandstone to a depth of 195 feet, sandstone to a depth of 885 feet, and shaley sandstone to a depth of 915 feet.

Well 31 is cased through unconsolidated deposits, upper bedrock aquifer, and Eau Claire (shale) formation. The well is open to the Mount Simon (sandstone) formation.

3.2.2 Unit Well 31 Water Quality

Iron was measured at 0.24 mg/l and manganese at 11 ug/l. The Utility has a water quality goal for iron of 0.10 mg/l and for manganese of 20 ug/l. The Utility is planning to install a filter to remove iron and manganese from the well water using oxidation and pressure filtration techniques to meet or exceed the Utility's established water quality goal.

The Well 31 water contains some radionuclides, at levels similar to Well 7. Combined radium (226 and 228 isotopes) in Well 31 ranged from 3.2 to 4.2 pCi/L while Well 7 showed a combined radium level of 3.3 pCi/L. Because the water quality and treatment of Well 31 is similar to the quality and treatment of Well 7, the unity equation calculation from Well 7 was used for Well 31 and is included in Appendix H.

For Well 7, discharging waste to the sanitary sewer from our highest filtration loading rate resulted in a unity equation analysis of 0.14. The percent removal efficiency was 0.38. The well was under the limit value of one during the pilot study.

Discrepancies between the sampling and the percent removals are due to the uncertainties in the laboratory measurements. Some samples, particularly Total Uranium Activity, were very close to the Limit of Detection (LOD) listed on the laboratory results.

The letter to request approval for a waiver of a pilot study for Well 31 is in Appendix E. The water quality in Well 31 is very similar to the water quality in Wells 7, 8, and 29. Water quality factors in Well 31, such as excess organic materials and a significant difference in hardness and alkalinity, that could interfere with the operation of a high rate filtration system have not been observed or measured. Due to the fact that MWU has successfully pilot tested waters at Well 7, 8, and 29 using a high rate Pyrolucite media and has successfully operated a Pyrolucite media iron and manganese filter system for over 5 years at Well 29, and given the similar water quality found at Well 31, it is our opinion that chlorine oxidation followed by a high rate Pyrolucite media filter would be successful at Well 31. The Pyrolucite media technology and operational characteristics are very familiar to MWU personnel and have proven historically to remove iron and manganese from other Utility wells.

The attached water quality table in Appendix E provides a comparison of Well 31 water quality and other wells in the Madison Water Utility System for inorganic and radionuclide compounds. Sampling of volatile organic compounds and synthetic organic compounds in Well 31 in 2014 detected only chloromethane at 0.16 ug/L (between limit of detection and limit of quantification).

3.3 Water Distribution System

The proposed site is located in Pressure Zone 4 (Appendix B-1). The overflow elevation of Pressure Zone 4 according to the 2008 Black & Veatch report is 1047 feet. A pressure measurement from 2008 (Appendix B-2) found the static pressure just to the north of the site along Tradewinds Parkway was 76 psi. A flow test from 2008 just to the west at the intersection of Tradewinds Parkway and Galleon Run found the static pressure to be 78 psi and the residual pressure to be 60 psi with a flow of 1,100 gpm.

The design purposes, the high water level of the Unit Well 9 reservoir is assumed to be full with an elevation of 1047 feet. With the reservoir full, the static pressure along Tradewinds Parkway just on the north of the site is approximately 80 psi. A series of flow tests performed on November 12, 2014 showed that the system headloss from the Well 9 reservoir to the Well 31 site is 32 feet at 2,200 gpm and 58 feet at 3,500 gpm. Additional flow tests used as a comparison are shown in Appendix B-2 and the Well 31 site flow test is shown in Appendix B-3.

4.0 Proposed Conditions

A process flow diagram of the proposed water treatment plant is shown in Figure 1. Unit Well 31 will pump raw water to the heads of the pressure filters. Chemical oxidants will be injected far enough before the pressure filters to permit reaction and mixing to occur.

4.1 Well Pump Hydraulics

The static water level in Well 31 was measured at 35 feet bgs. After five days of blasting and test pumping, Municipal Well and Pump measured the finished well pumping water level to be 274 feet below ground surface at a rate of 2,194 gpm on November 8, 2014. The specific capacity was calculated to be 9.18 gpm/ft.

The design pumping rate of Well 31 is 2,200 gpm. Assuming a direct relationship between pumping rate and drawdown and applying the specific capacity from the pumping test (9.18 gpm/ft), the anticipated drawdown at 2,200 gpm is 240 feet, which would have a total depth of 275 feet bgs. The well site investigation report anticipated up to 4.5 of influence between Well 31 and the nearest well (McFarland Well No. 3), and combining 4.5 feet with 275 feet produces a total pumping depth of approximately 280 feet, as shown in Appendix C-1.

A hydraulic profile of Well 31 is shown in Appendix C-1. The well pump motor must be able to fully pump water from the pumping water level, through the drop pipe, through the process piping to the head of the pressure filters, through the pressure filters as they approach full (8 psi maximum pressure differential in operation), and finally through the discharge piping though a pressure sustaining valve to the entrance to the clear well. Separate high lift pumps will pump the water into the distribution system, and separate system will operate the backwash cycle. Headloss calculations for the well pumps are shown in Appendix C-2.

The design condition of the Well 31 pump is 2,200 gpm at 429 feet TDH based on the filter process piping of Well 31 and the Option 1 site layout. Assuming 70 percent pump and motor efficiency, the estimated preliminary motor power is 340 horsepower, as shown in Appendix C-2.

A vertical turbine pump will be used for the well pump. Vertical turbine pumps are widely used and are reliable. SEH recommends the pump be pulled up and inspected every five years and be rehabilitated every 15 to 20 years.

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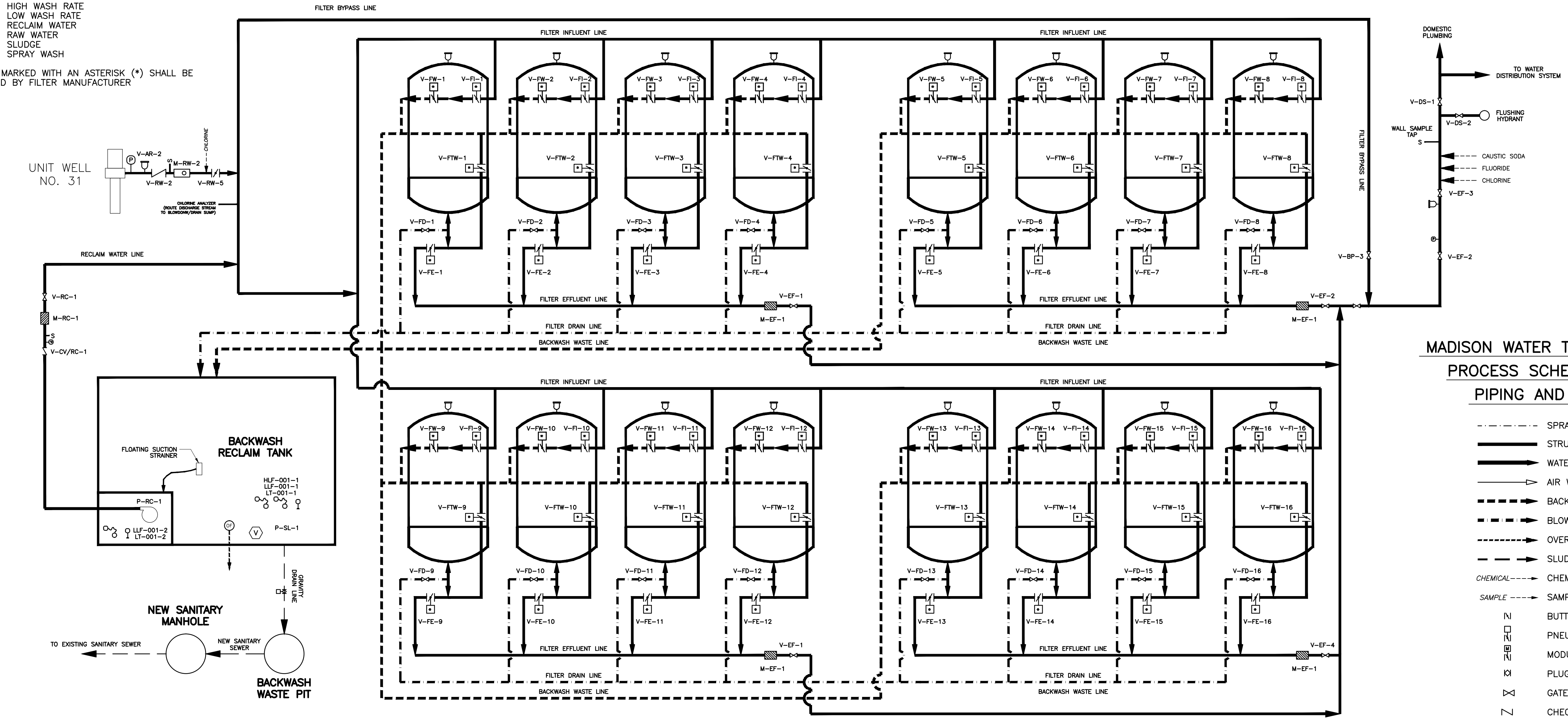
Figure 1: Process Flow Diagram

MADISON WATER TREATMENT PLANT
VALVE AND EQUIPMENT ABBREVIATIONS

FM	FLOWMETER
LT	LEVEL TRANSDUCER
HLF	HIGH LEVEL FLOAT
LLF	LOW LEVEL FLOAT
AE	AERATOR
AR	AIR RELEASE
BD	BLOWDOWN
BL	BLOWER
BP	BYPASS
BW	BACKWASH WASTE VALVE
CV	SWING CHECK VALVE
DCT	DETENTION/CONTACT TANK
DCD	DETENTION/CONTACT DRAIN
DS	DISTRIBUTION SYSTEM
EF	EFFLUENT
FD	FILTER DRAIN VALVE
FE	FILTER EFFLUENT VALVE
FI	FILTER INFLUENT
FTW	FILTER TO WASTE VALVE
FW	FILTER WASTE VALVE
HS	HIGH SERVICE
HW	HIGH WASH RATE
LW	LOW WASH RATE
RC	RECLAIM WATER
RW	RAW WATER
SL	SLUDGE
SW	SPRAY WASH

VALVES MARKED WITH AN ASTERISK (*) SHALL BE SUPPLIED BY FILTER MANUFACTURER



MADISON WATER TREATMENT PLANT
PROCESS SCHEMATIC LEGEND
PIPING AND VALVES

— · — · —	SPRAY WASH LINE
▬▬▬	STRUCTURE
━━━	WATER LINE
——▷	AIR WASH LINE
▬ ▬ ▬▶	BACKWASH WASTE LINE
▬ · ▬ ·▶	BLOWDOWN/DRAIN
- - - -▶	OVERFLOW LINE
— — —▶	SLUDGE/SANITARY SEWER LINE
CHEMICAL ----▶	CHEMICAL FEED POINT
SAMPLE ----▶	SAMPLE TAP LOCATION
N	BUTTERFLY VALVE
⊡	PNEUMATIC VALVE OPERATOR
⊠	MODULATING PNEUMATIC VALVE
⊠	PLUG VALVE
⋈	GATE VALVE
Ν	CHECK VALVE
▨	MAG FLOWMETER
▽	AIR RELEASE VALVE
≡	ORIFICE PLATE
–S	SAMPLE TAP
∿○	FLOAT SWITCH
♀	LEVEL TRANSDUCER
⊕	PRESSURE GAUGE
(OF)	OVERFLOW
–S	SOLENOID VALVE
(V)	TANK VENT

EQUIPMENT

◌	PUMP

10 NORTH BRIDGE ST
CHIPPEWA FALLS, WI 54729
PHONE: 715.720.6200
FAX: 715.720.6300
WATTS: 800.472.5881
www.sehinc.com

2014 UNIT WELL 31 &
WATER TREATMENT PLANT
MADISON WATER UTILITY
MADISON, WISCONSIN

MARK	DATE	DESCRIPTION

REVISIONS

SEH FILE NO. MADWU 129083
PROJECT NO.
ISSUE DATE 11-12-14
DESIGNED BY RJS
DRAWN BY JJB

SHEET TITLE
WATER TREATMENT PLANT
PROCESS SCHEMATIC

SHEET
XX

4.2 Vertical Pressure Filters

An iron and manganese removal pilot study was performed for Unit Wells 7 and 8 and the results were reported in June 2013. For Well 7, a minimum filter area of 184 ft^2 was recommended with a maximum filter loading rate of 12 gpm/ft^2 and a maximum backwash rate of 25 gpm/ft^2 for seven minutes. The design basis of the pressure filters was to closely resemble the pressures filters at Well 7. The Utility has requested a backwash rate of 30 gpm/ft^2, 5 gpm/ft^2 higher than the recommendation from the Well 7 pilot study.

At Unit Well 7, the treatment plant was designed using 16 Atec vertical pressure filters in two groups of eight, each filter with a diameter of four feet and a height of eight feet. The total filter area at Unit Well 7 is approximately 201 ft^2.

Unit Well 31 will utilize these same parameters with the assumption of using forward flow of 25 gpm/ft^2 over 201 ft^2 for seven minutes. Two complete backwash volumes amount to 80,000 gallons.

The pressure vessel requirements are summarized below:

Pressure Vessel Requirements

- Construction of vessel shall be in accordance with the current edition of the ASME code, Section VIII, Division 1 for Non-Fired Pressure Vessels design.
- Vessels shall bear ASME stamp.

Pressure Requirements

- Working pressure: 150 psig
- Hydrostatic test pressure: 195 psig
- Design safety factor shall be 3.5

Materials of Construction

- Number of Vessels: 16
- Tank Diameter: 4 feet, 0 inches

Filter Specifications

- Total filter area: 201 ft^2
- Each filter area: 12.57 ft^2
- Plant flow rate: 2,200 gpm
- Reclaim rate: 10 percent
- Total filtration rate with 10 percent reclaim: 2,420 gpm (12 gpm/ft^2)
- Backwash rate: 377 gpm (30 gpm/ft^2 on one filter)

Process Piping

- Main flow process piping diameter: 12 inches (6.2 fps)
- Backwash flow process piping diameter: 6 inches (3.6 fps)
- Maintain a flow velocity between 2 and 10 feet per second in all process piping if the filter manufactures deems different process piping sizes are necessary.

4.3 Backwash Cycle and Backwash Tank Volume

NR 811 requires the backwash tank be capable of holding two complete backwash cycles for all filters. The backwash tank for Unit Well 31 must also be situated at least two feet above the 100-year flood elevation of 858 feet (Appendix A-2); thus, the floor of the backwash tank must have an elevation of at least 860 feet, which is the existing nominal elevation of the site. Due to the high flood elevation relative to the ground elevation, the backwash tank for Well 31 will have to be constructed fully above ground. Because the backwash water must flow to an elevation higher than the pressure filters, the pressure filters must be backwashed by water only under pressure. No combined air-wash systems can be used, as these system require gravity flow from the filters to the backwash tank.

The backwash process requirements are summarized below:

<u>Backwash Tank Requirements</u>

- Total backwash tank volume: 100,000 gallons minimum (enough for two complete backwash cycles for 7 minutes plus 15 percent volume for sludge)
- Number of tanks: 2
- Volume per tank: 50,000 gallons minimum
- Waste sludge stream: discharge by gravity to sludge pit, to sanitary sewer
- Base elevation: 2-3 feet above floor to allow gravity discharge of sludge to sludge pit

<u>Backwash Cycle Requirements</u>

- Backwash run time: 7 minutes
- Backwash rate: 30 gpm/ft^2
- Backwash water provided by either treated well water or distribution system

The backwash cycle can be operated in one of two ways: 1) utilize distribution system water to backwash the filters with a throttling valve and/or pressure reducing valve or 2) use raw well water to backwash with a throttling valve and/or pressure reducing valve.

A hydraulic profile of the distribution system, pressure filters, and backwash tank is shown in Appendix D-1. Appendix D-1 shows the hydraulic profile if the backwash cycle were operated by the distribution system; during peak hour demands with a full backwash tank, the system would have approximately 70 feet of head to operate the backwash cycle, more than enough head if properly sized process piping is used.

A schematic of the method to backwash using treated water directly from the pressure filters is shown in Appendix D-2. During the normal operation, the raw water line is open and the backwash line is closed to all filters. During the backwash cycle, the raw well water line closes and the backwash line opens on one filters. Using modulating valves, 377 gpm from the treated forward flow line reverses direction towards the tank in the backwash cycle.

Multiple backwash tank styles were considered, but two tank styles were chosen for further consideration: 1) two side-by-side cast-in-place rectangular concrete tanks 12 feet wide by 24 feet long by 24 feet of water depth; 2) two vertical cylindrical tanks 16 feet in diameter and 27 feet of water depth. A single vertical cylindrical tank was ruled out do to the wide foot print, and shorter tank were also ruled our due to foot print. Poly tanks were considered, but poly tanks were not available in volume larger than 10,000 gallons. (Upon the Utility's decision to use 100,000 gallons for the backwash tank after the writing of this report, the cylindrical tanks were no longer considered.)

A tank height of approximately 20 to 30 feet was desired to minimize footprint. The maximum height was set to be 32 feet. Option 1 (Appendix D-3) requires less footprint than Option 2 (Appendix D-4), as Option 1 requires building area of approximately 27 feet by 27 feet, while Option 2 requires approximately 45 feet by 25 feet. Option 2 requires more foot print, because of the recommended 4.5 feet of work space completely around the tank. Option 1, however, is able to be part of the structure of the water treatment plant pumping room building.

4.4 Backwash Reclaim

A backwash reclaim pump will be installed in the backwash tank to reclaim backwash water at a rate of up to 10 percent of plant forward flow. A float skimmer will draw water from the water surface and pump to the head of the pressure filters, upstream of the chemical injection point.

Similar to Well 29 and Well 7, normal operation before reclaim would consist of 10 minutes of pumping to waste and then four to six hours of settling. The total time when the reclaim pump would be operating would be 12 to 15 hours per day, pumping at a rate of four to ten percent of the flow rate of Well 31.

4.5 Backwash Sludge Removal

The concept of the backwash sludge discharge is shown in Appendix M. Appendix M shows the hydraulic profile from the backwash tank to the sanitary sewer. An 8-inch AWWA C900 PVC sanitary sewer pipe is recommended due to the proximately to a municipal well. The sanitary sewer will be pressure rated to AWWA standards. The sludge will drain by gravity from the backwash tank to a pit in the treatment plant, then to a new manhole on the site, then to the sanitary sewer manhole on Tradewinds Parkway.

After the desired volume of water has been reclaimed from the backwash tank, the modulating valve at the base of the backwash tank will open to permit flow from the backwash tank to the receiving sludge pit. An automated pinch valve with a flow meter will control the flow to the sanitary sewer. A series of sprayers will be mounted on the inside-top of the backwash tank to assist sludge flow to the sanitary sewer.

4.6 Potable Water Storage Tank

4.6.1 Volume

To determine the size of the potable water storage tank, the Black & Veatch report was consulted. As Section 1.0 of this report already mentioned, up to 4.75 mg of total storage is needed in Pressure Zone 4, and 2.11 mg is needed by 2025. According to the preliminary potable tank size of 1.5 mg requested by the Utility, the design condition for the proposed ground storage tank will be approximately between year 2035 and full build-out of Pressure Zone 4.

To maintain 20 psi minimum pressure in the system (the minimum pressure at any time during fire flow events) at the highest point in the pressure zone (elevation of 955 feet), the minimum water elevation in the Spaanem reservoir would be 1001 feet, or 45.5 feet down from overflow. The Spaanem reservoir is approximately 71 feet in diameter and contains approximately 30,000 gallons per foot of depth, thus the useful storage in the Spaanem reservoir is 1.36 mg.

4.6.2 Base Elevation

The base elevation of the potable water storage tank shall be 862 feet, two feet above the existing ground elevation of 860 feet. The site shall be graded so that water flows away from the base of the tank.

4.6.3 Construction

The 1.5 mg tank has a volume that sets the design condition of Pressure Zone 4 somewhere between year 2035 and full build-out (see Appendix G). As the Utility expands the water system to meet the City's needs, the storage in Pressure Zone 4 should be reviewed by the Utility as time progresses.

Four options were discussed for the 1.5 mg ground storage potable water tank: 1) a round concrete tank 2) round steel tank 3) a round glass fused steel tank 4) a rectangular concrete tank. Only the rectangular tank option (Potable Tank Option 2 and 2A) would be attached to the water treatment plant. The other options (Potable Tank Options 1 and 1A) would be separate cylindrical tanks not connected to the water treatment plant.

4.7 High Lift Pumps

The Utility desires to have a firm 3,500 gpm pumping capacity from the Well 31 water treatment plant potable water tank. SEH recommends the utility install three high lift service pumps and operate up to two pumps at a time to provide redundancy. Each pump will be able to pump 2,200 gpm alone, and the combination of two pumps will be able to pump 3,500 gpm.

A series of flow tests performed on November 12, 2014 showed that the system headloss from the Well 9 reservoir to the Well 31 site is 32 feet at 2,200 gpm and 58 feet at 3,500 gpm. Combining this field test with the preliminary layouts of the site and the process piping from the Unit Well 7 water treatment plant, preliminary system head curves were produced. From all the anticipated head conditions between the two design flows, the maximum pump motor size is 180 HP, assuming 70 percent efficiency).

The City has request that only split-case pumps be used. Split case pumps shall be used for the high lift pumps. Split case pumps generally have a long useful life, and the Utility recommends the pumps be inspected every five years and be rehabilitated every 15 to 20 years.

4.8 Operational Maintenance

This section summarizes the recommended maintenance with the facilities discussed above.

4.8.1 Potable Water Storage Tank

The maintenance of the proposed potable water storage tank depends on the construction of the tank. The discussion below provides some insight into the maintenance required for each type of tank. NR 811 code requires all potable water storage tanks to be inspected every five years with one drain and float-down inspection no more than every ten years. Life cycle cost analysis are provided in Appendix N to summarize the maintenance and costs associated with each tank type.

4.8.1.1 Cylindrical Steel Tank

Steel tanks are prone to rust and require routine paint inspections. Depending on the paint specification and coating thickness, repainting may be required every 15 to 40 years. Appendix N-1 shows the life cycle costs of a cylindrical steel tank.

4.8.1.2 Wire-Wound Pre-Stressed Cylindrical Concrete Tanks

Concrete tanks generally have little maintenance, other than routine inspections and pitting repairs. Appendix N-2 shows the life cycle costs of a cylindrical wire-wound pre-stressed concrete tank.

4.8.1.3 Cast in Place Cylindrical Concrete Tanks

Concrete tanks generally have little maintenance, other than routine inspections and pitting repairs. Appendix N-3 shows the life cycle costs of a cylindrical cast in place concrete tank.

4.8.1.4 Cast in Place Rectangular Concrete Tank

Concrete tanks generally have little maintenance, other than routine inspections and pitting repairs. Appendix N-4 shows the life cycle costs of a rectangular cast in place concrete tank.

4.8.2 Backwash Tank

4.8.2.1 Cylindrical Stainless Steel Tank

Stainless Steel tanks generally have little maintenance, other than routine inspections and pitting repairs. Appendix O-1 shows the life cycle costs of a cylindrical stainless steel tank. (Because the Utility has chosen to add a factor of safety to the design for a total tank volume of 100,000 gallons, the cylindrical stainless steel tanks are no longer being considered).

4.8.2.2 Cast in Place Rectangular Concrete Tank

Concrete tanks generally have little maintenance, other than routine inspections and pitting repairs. Appendix O-2 shows the life cycle costs of a rectangular cast in place concrete tank.

4.8.3 Unit Well 31 and Pump

Wells over time can clog and deteriorate, causing the expected well capacity to decline. While each well is its own case, typically a well pump should be pulled up every 5 years to examine the pump for wear and deterioration. A well pump may need to be rehabilitated or replaced every 20 years. SEH recommends the Utility trend the pumping rate versus drawdown to determine if well deterioration is occurring.

With high iron and manganese, solids accumulation and bio-fouling is possible in a well, causing the capacity and/or quality to decline. SEH recommends the Utility examine the trends of the raw water quality of Unit Well 31 while the Utility performs routine WDNR sampling.

4.8.4 General Tank Maintenance

The Utility recommends the Utility routinely examine the surface of the tanks for any signs of rust, cracks, or leaks. Such inspections may only be needed every five years. Concrete tanks generally require less maintenance than steel tanks, as steel tanks are prone to rust and require coating. Older concrete tanks may have minor cracks, which can be spot-repaired.

4.8.5 Pressure Filters

The filters will be designed to be as low maintenance as possible. The following recommendations are typical for pressure filters throughout their useful life.

4.8.5.1 Differential Pressure Across Filters

Once per year, the Utility recommends to the monitor the pressure filters between a backwash cycle and compare the results the years before. Trending may help the Utility determine when filter maintenance is required or if SCADA set points may need to be tuned.

4.8.5.2 Filter Breakthrough

Once per year, the Utility recommends the Utility perform a breakthrough analysis of the filters. A break through analysis consists of monitoring the iron and manganese influent and effluent levels every 1-4 hours between two backwashes. The test would help the Utility determine if the backwash cycle is initiating at the proper time or if the filters are permitting excessive iron and manganese to pass through.

4.8.5.3 Filter Media Conservation

Within a month or two after startup, and then once per year after, the Utility recommends the Utility collect a grab sample of the backwash water to examine the amount of filter media in the backwash water. It is typical for media to be lost in the backwash process at a rate of approximately 1 inch per year, and such a routine test would help the Utility prolong the useful life of the filter media.

One every 3-5 years, the Utility recommends a filter be taken offline and have the filter head removed to measure the filter bed. The operator would measure with a yard stick or tape measure from the top of the tank to the media in multiple locations to provide a sense of the amount of filter media remaining in the filter. This process is cumbersome, however, and would require new gaskets on the filter.

4.8.5.4 Media Core Sampling

Periodically, preferably at the same time of the filter bed measurements, the Utility could collect a core sample of the filter media for the media manufacture to test. The manufacturer would examine the media against the original specification. The Utility only recommends this test to be performed if the performance of the filter media has noticeably diminished.

5.0 Facility Recommendations

Based on the existing site conditions and the proposed conditions for the Unit Well 31 water treatment plant, two concepts have been developed based on a detached potable water ground storage facility and an attached potable water ground storage facility. Only the arrangement of the facilities and the style of the tanks varies between the options and not the fundamental design constraints.

5.1.1 Option 1

Option 1 is comprised of a pumping/filtration facility, separate backwash room with steel tanks and chemical feed rooms all located within one building shell. The ground water is pumped to a detached 1.5 million gallon storage tank which could be constructed from one of the four potable water tank options as described above. This facility also includes an attached storage building of a minimum size of 2400 sf. The exterior work would include a dual drive way, paved driveway entrance, two 20-foot sliding gates into a storage yard facility. The storage yard facility will be used to store yard piping such as ductile iron, hydrants, and valves used by the utility. Surrounding the 1.5 million gallon reservoir would be a drivable landscape surface for maintenance type access and security. See a plan view of Unit Well 31 Option 1 and a cost estimate in Appendix I.

5.1.2 Option 1A

Option 1A is generally the same as Option 1 but with a smaller square footage building, comprised of pumping/filtration facility room, and chemical feed rooms, and would consist of a concrete back wash tank all accessible from the pumping/filtration room and located within one building shell. See a plan view of Unit Well 31 Option 1A and a cost estimate in Appendix J.

5.1.3 Option 2

Option 2 would be comprised of a pumping/filtration facility, chemical feed rooms, and a concrete back wash tank all accessible from the pumping/filtration room and located within one building shell. The treated water would be pumped to an attached rectangular 1.5 million gallon storage tank which would be cast in place with a concrete sloped cover. This facility also includes an attached storage building of a minimum size of 2,400 sf facing west. The exterior work would include a dual drive way, paved driveway entrance, a 20-foot sliding gate entrance and one 16-foot sliding gate exit within yard facility. The storage yard facility will be used to store yard piping such as ductile iron, hydrants, and valves used by the utility. Surrounding the entire complex would be an asphaltic surface driveway for building security and maintenance type access. See a plan view of Unit Well 31 Option 2 and a cost estimate in Appendix K.

5.1.4 Option 2A

Option 2A is generally the same as Option 2, comprised of pumping/filtration and would consists of separate backwash room with two steel tanks and chemical feed rooms all located within one building shell with only interior process piping necessary to fill the potable water tank. The attached storage building would be rotated 90 degrees and now faces north maintaining a minimum size of 2,400 sf storage facility. See a plan view of Unit Well 31 Option 2A and a cost estimate in Appendix L.

5.2 Recommended Option

Based on the MWU staff comments, Public Informational Meeting comments and current budgets Option 1A and Options 2 were modified to include a smaller footprint and to provide two interior concrete backwash tanks. The rectangular concrete backwash water ground storage tanks typically have a higher volume versus foot print and the slightly lower maintenance costs as describe in Appendix O. Concrete backwash tanks typically require minimal routine maintenance, and may only require localized repairs with pitting in the concrete as the years pass. See Appendix P for the revised Option 1A and Option 2 building foot print, isometric views, cost estimates.

Based on a review of these revisions it is recommended that Option 1A be constructed with a unit well building square footage of 4,052, a 3,900 square foot storage building two rectangular concrete backwash tanks above grade and one 1.5 MG wire wound cylindrical concrete potable water ground storage tank due to the lower life cycle cost compared to other option.

5.3 General Provisions for Stormwater and Wetlands

For all options, the finished floor elevation of the water treatment plant and all water storage tanks would be 862 feet, two feet above the existing grade of 860 feet and four feet about the flood elevation of 858 feet, to enable stormwater to shed away from structure foundations. All options contain areas for storm water management, and the final site grading will direct water towards the storm water controls as sheet flow whenever possible.

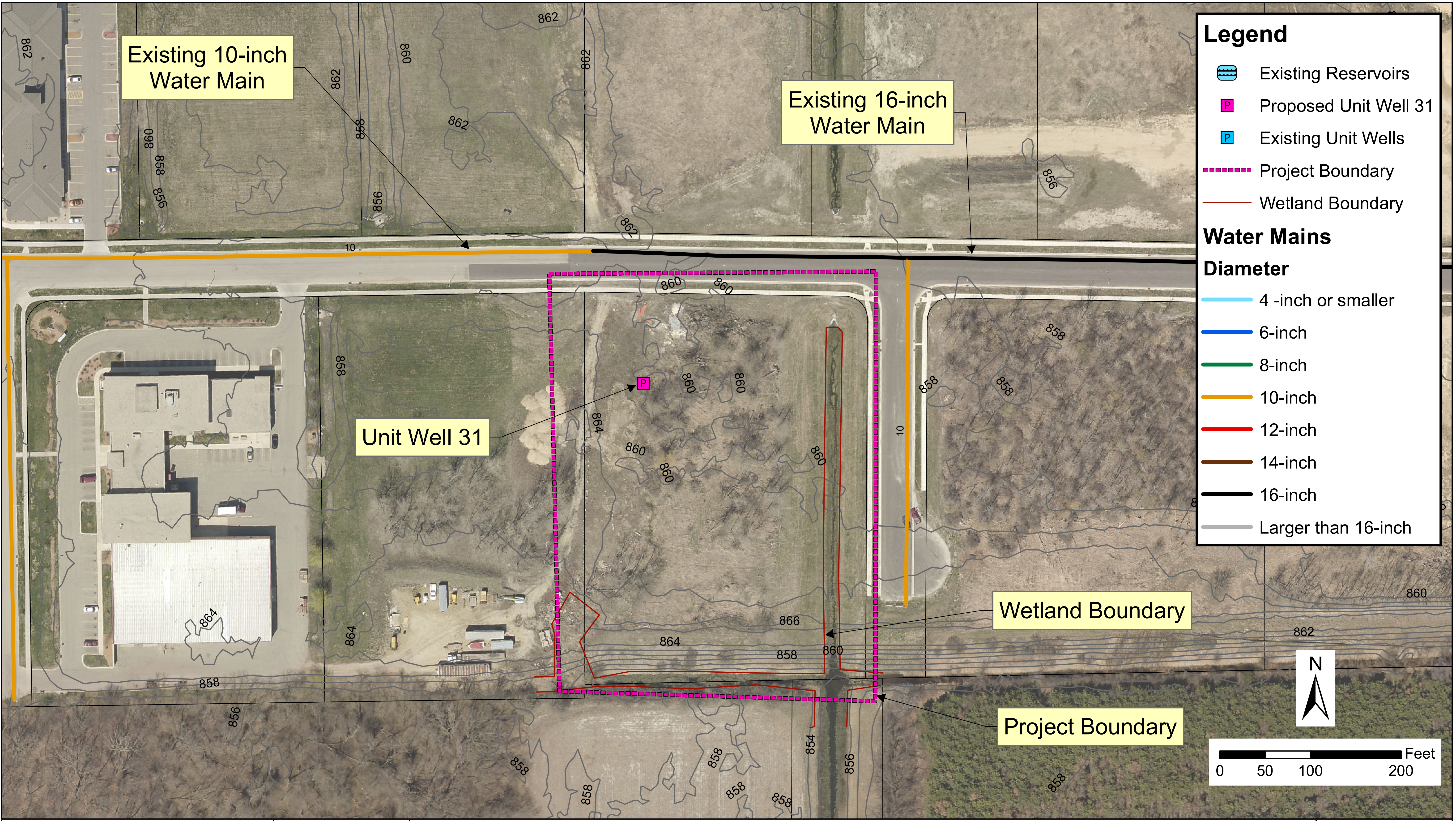
In no option does ground disturbance occur within the delineated wetland on the site. Construction activities will be specified so that the wetland is preserved.

Final stormwater management and erosion control practices will be determined based on the final site design. Stormwater management practices and erosion control practices will be specifically included within final bidding documents and will be specified to abide by the requirements in Appendix A-4, the City’s stormwater management plan, and NR 151.

Appendix A

Site Information

A-1 – Project Site
A-2 – Flood Plain
A-3 – Genesis Plat Map
A-4 – Madison 2002 Design Memo



Path: Q:\KO\M\Madwu\129083\5-final-dsgn\Design Report\Appendix A-1 Project Site.mxd

10 North Bridge Street
Chippewa Falls, WI 54729
PHONE: (715) 720-6200
FAX: (888) 908-8166
TF: (800) 3472-5881
www.sehinc.com

Project: MADWU 129083
Print Date: 11/14/2014

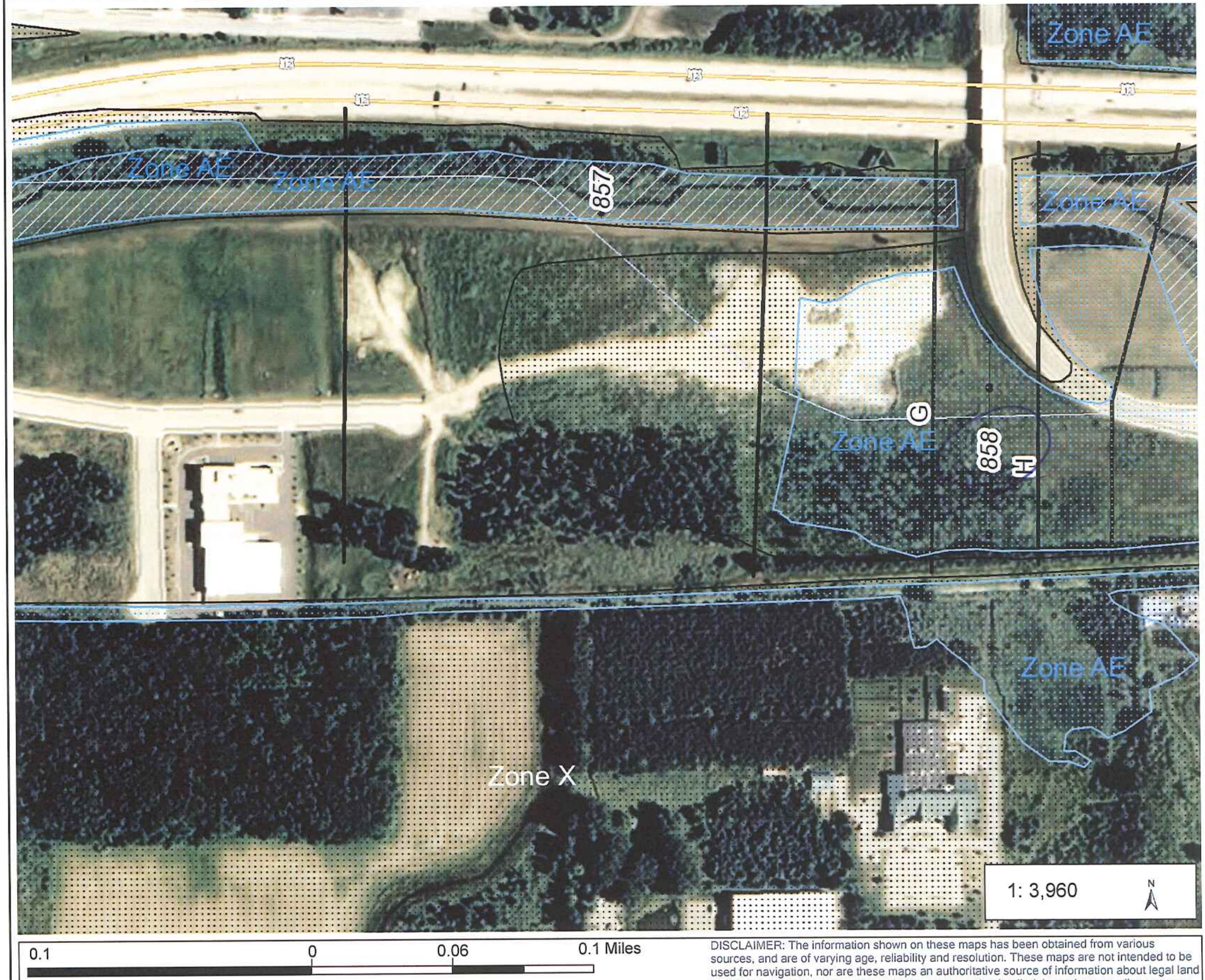
Map by: JJB
Projection: Dane County (US feet)
Source: Madison Water Utility

Project Location in Existing Water System

Unit Well 31
Madison, Wisconsin

Appendix
A-1

Surface Water Data Viewer Map



NAD_1983_HARN_Wisconsin_TM

Legend

- ▨ 1% Annual Chance Flood Haz
- ▦ 0.2% Annual Chance Flood Ha
- — Cross Sections
- Floodway
- ●— Base Flood Elevations
- ☐ FIRM Panel Index
- Rivers and Streams
- ▢ Open Water
- 2008 Air Photos (NAIP)

Flood Plain = 858'

Notes

Proposed Well No. 31

Appendix A-2

FINAL PLAT OF

GENESIS

BEING ALL OF OUTLOT 1, OUTLOT 2, AND OUTLOT 3, OF CERTIFIED SURVEY MAP NO. 12423, VOLUME 77, PAGE 216, LOCATED IN THE NORTHWEST 1/4 OF THE NORTHEAST 1/4 AND THE NORTHEAST 1/4 OF THE NORTHEAST 1/4 OF SECTION 27, TOWNSHIP 7 NORTH, RANGE 10 EAST, CITY OF MADISON, DANE COUNTY, WISCONSIN.

SURVEYOR'S CERTIFICATE

I, JASON L. CANCE, REGISTERED WISCONSIN LAND SURVEYOR, HEREBY CERTIFY:
THAT I HAVE SURVEYED, DIVIDED, AND MAPPED THE PLAT OF GENESIS, BEING ALL OF OUTLOT 1, OUTLOT 2, OUTLOT 3 OF CERTIFIED SURVEY MAP NO. 12423, VOLUME 77, PAGE 216, LOCATED IN THE NORTHEAST 1/4 OF THE NORTHEAST 1/4, AND THE NORTHWEST 1/4 OF THE NORTHEAST 1/4 OF SECTION 27, TOWNSHIP 7 NORTH, RANGE 10 EAST, CITY OF MADISON, COUNTY OF DANE, WISCONSIN.

THAT I HAVE MADE SUCH A SURVEY AT THE DIRECTION OF ALEXANDER LI, MEMBER, GENESIS COMMONS, LLC, OWNER, OF SAID LANDS CONTAINING 34.67 ACRES AND BEING DESCRIBED AS FOLLOWS:
COMMENCING AT THE NORTH 1/4 CORNER OF SAID SECTION 27; THENCE N88°47'45"E 1219.84 FEET ALONG THE NORTH LINE OF THE NORTHEAST 1/4 OF SAID SECTION 27; THENCE S01°12'15"E 503.78 FEET TO THE INTERSECTION OF THE SOUTH RIGHT OF WAY LINE OF USH 12/18 AND THE WESTERLY RIGHT OF WAY LINE OF AGRICULTURE DRIVE BEING THE POINT OF BEGINNING; THENCE S08°45'52"E 82.94 FEET ALONG SAID WESTERLY RIGHT OF WAY; THENCE S23°52'43"E 180.97 FEET ALONG SAID WESTERLY RIGHT OF WAY; THENCE S48°55'28"E 177.77 FEET ALONG SAID WESTERLY RIGHT OF WAY; THENCE S66°08'52"E 169.93 FEET ALONG SAID WESTERLY RIGHT OF WAY; THENCE S80°24'37"E 676.93 FEET ALONG SAID WESTERLY RIGHT OF WAY; THENCE CONTINUING ALONG SAID WESTERLY RIGHT OF WAY BEING THE ARC OF A CURVE TO THE RIGHT HAVING A RADIUS OF 421.39 FEET AND A CHORD BEARING S51°45'34"E 404.09 FEET TO THE SOUTH LINE OF THE NORTH 1/2 OF THE NORTHEAST 1/4 OF SAID SECTION 27; THENCE S88°47'30"W 2589.61 FEET ALONG SAID SOUTH LINE TO THE WEST LINE OF THE NORTHEAST 1/4 OF SAID SECTION 27; THENCE N00°03'24"W 898.56 FEET ALONG SAID WEST LINE TO THE SOUTHERLY RIGHT OF WAY OF USH 12/18; THENCE S86°12'17"E ALONG SAID SOUTHERLY RIGHT OF WAY A DISTANCE OF 196.88 FEET; THENCE CONTINUING ALONG SAID SOUTHERLY RIGHT OF WAY S86°48'49"E 497.61 FEET; THENCE CONTINUING ALONG SAID SOUTHERLY RIGHT OF WAY S88°31'38"E 356.72 FEET; THENCE CONTINUING ALONG SAID SOUTHERLY RIGHTOF WAY N89°26'10"E 179.86 FEET TO THE WESTERLY RIGHT OF WAY OF AGRICULTURE DRIVE ALSO BEING THE POINT OF BEGINNING OF THIS DESCRIPTION.

THAT SUCH PLAT IS A CORRECT REPRESENTATION OF ALL OF THE EXTERIOR BOUNDARIES OF THE LAND SURVEYED AND THE SUBDIVISION THEREOF MADE AND THAT I HAVE FULLY COMPLIED WITH THE PROVISIONS OF CHAPTER 236 OF THE WISCONSIN STATE STATUTES, THE SUBDIVISION REGULATIONS OF THE COUNTY OF DANE, AND THE SUBDIVISION REGULATIONS OF THE CITY OF MADISON, IN SURVEYING, DIVIDING, AND MAPPING THE SAME.

JASON L. CANCE, R.L.S. 2688

WISCONSIN JASON L. CANCE S-2688 CHIPPEWA FALLS WI LAND SURVEYOR

DATED THIS 9TH DAY OF MAY, 2011

OWNER'S CERTIFICATE OF DEDICATION

GENESIS COMMONS, LLC, A CORPORATION DULY ORGANIZED AND EXISTING UNDER AND BY VIRTUE OF THE LAWS OF THE STATE OF WISCONSIN, AS OWNER DOES HEREBY CERTIFIY THAT SAID CORPORATION CAUSED THE LAND DESCRIBED ON THIS PLAT TO BE SURVEYED, DIVIDED, MAPPED, AND DEDICATED AS REPRESENTED ON THIS PLAT.

GENESIS COMMONS, LLC, DOES FURTHER CERTIFY THAT THIS PLAT IS REQUIRED BY S236.10 PR S236.12 TO BE SUBMITTED TO THE FOLLOWING FOR APPROVAL OR OBJECTION:

WISCONSIN DEPARTMENT OF ADMINISTRATION
COMMON COUNCIL OF THE CITY OF MADISON
DANE COUNTY ZONING AND NATURAL RESOURCES COMMITTEE
WISCONSIN DEPARTMENT OF TRANSPORTATION

IN WITNESS WHEREOF, THE SAID GENESIS COMMONS, LLC, HAS CAUSED THESE PRESENTS TO BE SIGNED BY ALEXANDER LI, MEMBER AND COUNTERSIGNED BY HELEN LI, MEMBER AT Madison, WISCONSIN, AND IT CORPORATE SEAL HEREUNTO AFFIXED ON THIS 10th DAY OF June, 2011.

IN THE PRESENCE OF:

Genesis Commons, LLC
CORPORATE NAME

Alexander Li
ALEXANDER LI, MEMBER

COUNTERSIGNED: Helen W Li
HELEN LI, MEMBER

STATE OF WISCONSIN)
Dane COUNTY)SS

PERSONALLY CAME BEFORE ME THIS 10th DAY OF June, 2011, ALEXANDER LI, MEMBER, AND HELEN LI, MEMBER OF THE ABOVE NAMED CORPORATION, TO ME KNOWN TO BE THE PERSONS WHO EXECUTED THE FOREGOING INSTRUMENT, AND TO ME KNOWN TO BE SUCH MEMBERS OF SAID CORPORATION, AND ACKNOWLEDGED THAT THEY EXECUTED THE FOREGOING INSTRUMENT AS SUCH OFFICERS AS THE DEED OF SAID CORPORATION, BY ITS AUTHORITY.

Jeffrey J. Ekola
NOTARY PUBLIC, STATE OF WISCONSIN
Jeffrey J. J. Ekola
(PRINT OR TYPE NAME)

MY COMMISSION EXPIRES August 28, 2011

There are no objections to this plat with respect to Secs. 236.15, 236.16, 236.20 and 236.21(1) and (2), Wis Stats. as provided by s. 236.12, Wis. Stats.

Certified June 9th, 2011

Department of Administration

SEH

CITY COUNCIL CERTIFICATE

RESOLVED THAT THIS PLAT KNOWN AS GENESIS SUBDIVISION LOCATED IN THE CITY OF MADISON, WAS HEREBY APPROVED BY ENACTMENT NUMBER RES-10-00318, FILE ID NUMBER 17823, ADOPTED ON THE 16TH DAY OF APRIL, 2010, AND THAT SAID ENACTMENT FURTHER PROVIDED FOR THE ACCEPTANCE OF THOSE LANDS DEDICATED AND THE RIGHTS CONVEYED BY SAID PLAT TO THE CITY OF MADISON FOR PUBLIC USE.

DATED THIS 13th DAY OF June, 2011

Maribeth Witzel-Behl
MARIBETH WITZEL-BEHL, CITY CLERK
CITY OF MADISON, DANE COUNTY, WISCONSIN

CITY OF MADISON TREASURER'S CERTIFICATE

I, DAVE GAWENDA, BEING DULY APPOINTED, QUALIFIED, AND ACTING TREASURER OF THE CITY OF MADISON, DO HEREBY CERTIFY THAT IN ACCORDANCE WITH THE RECORDS IN MY OFFICE, THERE ARE NO UNPAID TAXES OR UNPAID SPECIAL ASSESSMENTS AS OF THIS 10TH DAY OF JUNE, 2011 ON ANY OF THE LANDS INCLUDED IN THE PLAT OF GENESIS

David M Gawenda
DAVID GAWENDA, CITY TREASURER
CITY OF MADISON, DANE COUNTY, WISCONSIN

DANE COUNTY TREASURER'S CERTIFICATE

I, DAVID J. WORZALA, BEING DULY APPOINTED, QUALIFIED, AND ACTING TREASURER OF THE COUNTY OF DANE, DO HEREBY CERTIFY THAT IN ACCORDANCE WITH THE RECORDS IN MY OFFICE, THERE ARE NO UNPAID TAXES OR UNPAID SPECIAL ASSESSMENTS AS OF THIS 13th DAY OF June, 2011 ON ANY OF THE LANDS INCLUDED IN THE PLAT OF GENESIS

David J Worzala
DAVID J. WORZALA, COUNTY TREASURER
COUNTY OF DANE, WISCONSIN

CONSENT OF CORPORATE MORTGAGEE

JOHNSON BANK, A CORPORATION DULY ORGANIZED AND EXISTING UNDER AND BY VIRTUE OF THE LAWS OF THE STATE OF WISCONSIN, MORTGAGEE OF THE ABOVE DESCRIBED LAND, DOES HEREBY CONSENT TO THE SURVEYING, DIVIDING, MAPPING AND DEDICATING OF THE LAND DESCRIBED ON THIS PLAT, AND DOES HEREBY CONSENT TO THE ABOVE CERTIFICATE OF GENESIS COMMONS, LLC, OWNER.

IN WITNESS WHEREOF, THE SAID JOHNSON BANK HAS CAUSED THESE PRESENTS TO BE SIGNED BY ________, ITS Vice President, AND COUNTERSIGNED BY Kenneth R Dickson, ITS Senior Vice President, AT Johnson Bank, WISCONSIN, AND ITS CORPORATE SEAL TO BE HEREUNTO AFFIXED THIS 10 DAY OF June, 2011.

IN THE PRESENCE OF:

Jaime L Hendrickson

Johnson Bank (CORPORATE SEAL)
CORPORATE NAME

6-10-11
DATE

Kenneth R Dickson 6-10-11
DATE

STATE OF WISCONSIN)
DANE COUNTY)SS

PERSONALLY CAME BEFORE ME THIS 10 DAY OF June, 2011, Paul Manchester, Vice President (TITLE), AND Ken Dickson Vice President (TITLE) OF THE ABOVE NAMED CORPORATION, TO ME KNOWN TO BE SUCH Vice President (TITLE) AND Vice President (TITLE) OF SAID CORPORATION, AND ACKNOWLEDGED THAT THEY EXECUTED THE FOREGOING INSTRUMENT AS SUCH OFFICERS AS THE DEED OF SAID CORPORATION, BY ITS AUTHORITY.

Charles C. Salzwedel
NOTARY PUBLIC, STATE OF WISCONSIN
Charles C. Salzwedel
(PRINT OR TYPE NAME)

MY COMMISSION EXPIRES 5·19·2013

DATE: 2-17-09
REVISION 1: 12-16-09
REVISION 2: 5-9-2011

SHEET 2 OF 3

Randy

Madison Water Utility

David Denig-Chakroff, General Manager

Alan L. Larson – Principal Engineer

523 East Main Street
Madison, Wisconsin 53703
Telephone: 608 266-4653
FAX: 608 266-4426
E-mail: allarson@ci.madison.wi.us

Madison ™

MEMO

Date: February 15, 2002

To: Earl Cheek
Chuck Engelhart
Dennis Cawley
Nancy Quirk

From: Al Larson – Principal Engineer
608-266-4653

Subject: Unit Well Design Development

cc: Doug Grueneberg
Dave Denig-Chakroff

We have selected Strand Associates for the design of Unit Well No. 29. Soon they will be starting work and will be coming to us for direction on what we want and how we want the Unit Well designed. The Request for Qualifications said that we would like Unit Well No. 29 to be designed similar to our other Unit Wells.

To determine what we want/like about our existing Unit Wells we had a meeting and then we toured Unit Wells 15 through 28. Based on that meeting and those tours I offer the following for consideration and discussion.

I. Site Work
    A. The Unit Well site should be relatively flat.
    B. Need between 25,000 and 40,000 or more square feet. Try to be closer to the 40,000 side if at all possible.
    C. Access around the reservoir is important for maintenance purposes.
    D. Exterior landscaping:
        1. Low Maintenance
        2. Provide some screening but don't provide areas that allow hiding.
    E. Need to consider the elevation of the nearest sanitary sewer when locating the pump station and establishing the floor elevation
    F. Should be able to drive up to the chemical feed room with delivery's and have no step to get into the room. No thresholds or ramps if possible.
    G. No tennis courts on top of the reservoir.
    H. No shared functions at all at the facility
    I. Site lighting should be provided; aim it down and away from the neighbors.

J. Provide a flushing hydrant on the site. The flushing hydrant should consider where the chlorinated water is going during flushing. If chlorinated water will end up in a surface water, this is against DNR regulations.

II. Reservoir

A. Reservoir should be between 300,000 and 400,000 gallons depending on the size of the site. Should be large enough to meet the fire demand with the deep well off. (3,000 gpm x 2 hours = 360,000 gallons)
B. Size of the reservoir will depend on the site area available.
C. Piping flexibility to the reservoir. Allow filling of the reservoir from the distribution system under special conditions when the deep well is out.
D. Provide a drain for the reservoir that allows it to be drained to some facility that can accept chlorinated water and cleaned. Storm sewer may not be suitable for draining chlorinated water.

2,200 gpm overflow
can it handle
identify in site plan

III. General Building Features

A. No windows
B. No skylights
C. Glass block for natural light
D. Low maintenance exterior. Minimize paints and other coatings and maximize natural materials like brick and stone
E. Low maintenance interior, minimize wall coverings or paint if at all possible.
F. Ceiling tiles seem to be a constant maintenance problem, they get stained and damaged, don't use them if possible.
G. Use corrosion resistant door materials
H. Keep the exterior electrical panels to a bare minimum.
I. Piping under the slab seems to be a real headache. Need to have the ability to repair or replace the pipe under the slab. We need to consider the materials being used and their longevity.
J. Chuck doesn't like flat roofs. Avoid them if possible.

IV. Deep Well

A. Provide for a meter on the deep well pump discharge
B. Set the deep well location up for routine bailing and/or acidizing of the well.
C. The Deep Well Pump should be near the door
D. Should have a discharge to waste to allow flushing the well without going to the reservoir.
E. Valving on the pump discharge should be avoided if at all possible.
F. Don't use skylights over the well, hatches only. (Security issue)
G. Provide a check valve on the deep well discharge
H. Use a flow switch for positive run confirmation

V. Booster Pumps

A. Continue to use split case centrifugal pumps
B. Provide mechanical seals on the pumps (John Crane or Chesterton)
C. Don't like air operated check valves
D. Use a limit switch on the check valves for pump run confirmation

E. Haven't had a lot of success in using dampened check valves.
F. Provide gate valves on both sides of the pumps
G. Provide a monorail or some other form of lifting for maintenance and removal of the pump and motor.
H. Don't mount the pumps high off the floor, makes them hard to work on.

VI. Piping

A. If a piping pit is required, make it shallow and wide to avoid confined space entry and difficulty in working on the piping.
B. The grating over the piping pit needs to be properly supported with consideration of ease of removal of the grating when needed.
C. Lots of flexibility in the piping should be provided such as:
   1. Pump directly from deep well to the suction side of the booster pumps
   2. Pump directly from the deep well into the distribution system.
D. Piping should be designed with maintenance in mind.
   1. Meters should be easily removed
   2. Pumps should be easily disconnected
   3. Drains should be provided to allow the disposal of water when disassembling pipe.
   4. Instruments or chemical dosing points should be readily accessed.
   5. Sample points should be provided with drains
E.

VOL 59-091A PLATS PAGE 419

Doc# 4770373

FINAL PLAT OF

GENESIS

BEING ALL OF OUTLOT 1, OUTLOT 2, AND OUTLOT 3, OF CERTIFIED SURVEY MAP NO. 12423, VOLUME 77, PAGE 216, LOCATED IN THE NORTHWEST 1/4 OF THE NORTHEAST 1/4 AND THE NORTHEAST 1/4 OF THE NORTHEAST 1/4 OF SECTION 27, TOWNSHIP 7 NORTH, RANGE 10 EAST, CITY OF MADISON, DANE COUNTY, WISCONSIN.

5-9-2011

WISCONSIN
JASON L. CANCE
S-2688
CHIPPEWA FALLS
WI
LAND SURVEYOR

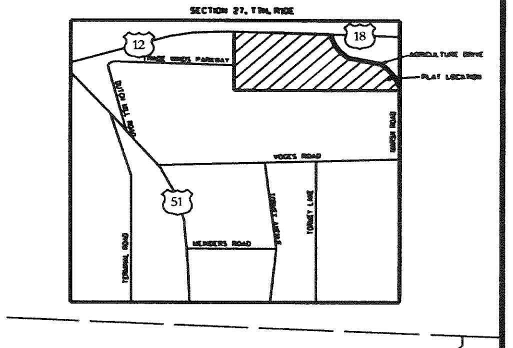
There are no objections to this plat with respect to Secs. 236.15, 236.16, 236.20 and 236.21(1) and (2), Wis Stats. as provided by s. 236.12, Wis. Stats.

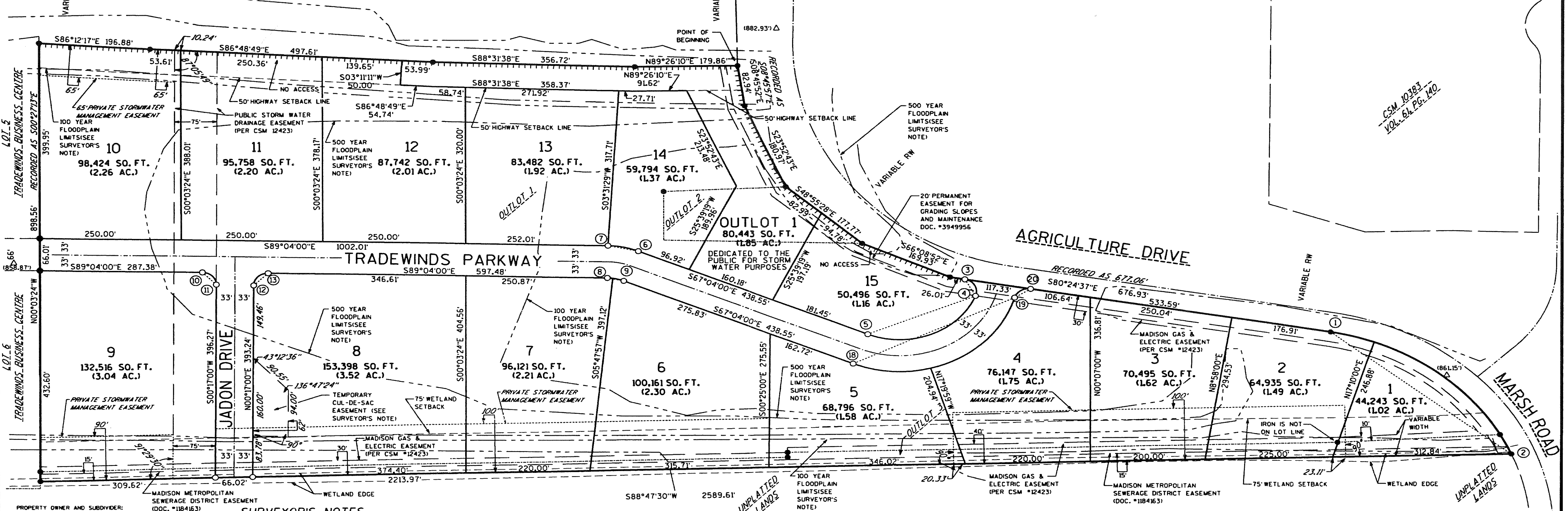
Certified June 9th, 2011

Department of Administration

LOCATION SKETCH

NOT TO SCALE
SECTION 27, T7N, R10E





PROPERTY OWNER AND SUBDIVIDER:
GENESIS COMMONS LLC.
ALEXANDER LI, MEMBER
HELEN LI, MEMBER
411 ORCHARD DRIVE
MADISON, WI 53711
(608) 258-8440

LAND SURVEYOR:
JASON L. CANCE, RLS # 2688
421 FRENETTE DRIVE
CHIPPEWA FALLS, WI 54729
(715) 720-6200

ENGINEER:
RAY POLKINGHORN, PE # 30177
6808 ODANA ROAD
SUITE 200
MADISON, WI 53719
(608) 826-6489

N

BEARINGS REFERENCED TO THE NORTH LINE OF THE NE 1/4 OF SECTION 27, ASSUMED TO BE N88°47'45"E

SCALE
0 100 200

SEH

SURVEYOR'S NOTES

ALL LOTS WITHIN THIS PLAT ARE SUBJECT TO PUBLIC EASEMENTS FOR DRAINAGE PURPOSES WHICH SHALL BE A MINIMUM OF 6 FEET IN WIDTH MEASURED FROM THE PROPERTY LINE TO THE INTERIOR OF EACH LOT EXCEPT THE EASEMENTS SHALL BE 12 FEET IN WIDTH ON THE PERIMETER OF THE PLAT. FOR PURPOSES OF TWO (2) OR MORE LOTS COMBINED FOR A SINGLE DEVELOPMENT SITE, OR WHERE TWO (2) OR MORE LOTS HAVE SHARED DRIVEWAY AGREEMENT, THE PUBLIC EASEMENT FOR DRAINAGE PURPOSES SHALL BE A MINIMUM OF SIX (6) FEET IN WIDTH AND SHALL BE MEASURED ONLY FROM THE EXTERIOR PROPERTY LINES OF THE COMBINED LOTS THAT CREATE A SINGLE DEVELOPMENT SITE, OR HAVE A SHARED DRIVEWAY AGREEMENT, EXCEPT THAT THE EASEMENT SHALL BE 12 FEET IN WIDTH ALONG THE PERIMETER OF THE PLAT. EASEMENTS SHALL NOT BE REQUIRED ON PROPERTY LINES SHARED WITH GREENWAYS OR PUBLIC STREETS. NO BUILDINGS, DRIVEWAYS, OR RETAINING WALLS SHALL BE PLACED IN ANY EASEMENT FOR DRAINAGE PURPOSES. FENCES MAY BE PLACED IN THE EASEMENT ONLY IF THEY DO NOT IMPEDE THE ANTICIPATED FLOW OF WATER.

IN THE EVENT OF A CITY OF MADISON PLAN COMMISSION AND/OR COMMON COUNCIL APPROVED REDIVISION OF A PREVIOUSLY SUBDIVIDED PROPERTY, THE UNDERLYING PUBLIC EASEMENTS FOR DRAINAGE PURPOSES ARE RELEASED AND REPLACED BY THOSE REQUIRED AND CREATED BY THE CURRENT APPROVED SUBDIVISION.

THE INTRA-BLOCK DRAINAGE EASEMENTS SHALL BE GRADED WITH THE CONSTRUCTION OF EACH PRINCIPAL STRUCTURE IN ACCORDANCE WITH THE APPROVED STORM WATER DRAINAGE PLAN ON FILE WITH THE CITY ENGINEER AND THE ZONING ADMINISTRATOR, AS AMENDED IN ACCORDANCE WITH THE MADISON GENERAL ORDINANCES.

NO ACCESS SHALL BE GRANTED ALONG THE WESTERLY RIGHT OF WAY OF AGRICULTURE DRIVE FOR OUTLOT 1 & LOT 15.

NO BUILDING SHALL BE CONSTRUCTED WITH A LOW WINDOW OR DOOR OPENING BELOW ELEVATION 861.00 FEET

BUILDINGS SHALL NOT BE CONSTRUCTED NOR, ELEVATIONS ALTERED WITHIN ALL PRIVATE STORMWATER MANAGEMENT EASEMENTS.

ALL THE LOTS WITHIN THIS SUBDIVISION ARE SUBJECT TO IMPACT FEES THAT ARE DUE AND PAYABLE AT THE ISSUANCE OF BUILDING PERMIT(S).

THIS SUBDIVISION IS LOCATED IN URBAN DESIGN DISTRICT 1 WHICH WILL REQUIRE URBAN DESIGN COMMISSION APPROVAL PRIOR TO THE ISSUANCE OF BUILDING PERMITS FOR INDIVIDUAL LOTS.

FLOOD PLAIN LIMITS WERE DETERMINED FROM FIRM MAP -PANEL 0441G. EARTHWORK IS ACTIVELY BEING PERFORMED AT THIS SITE, THEREFORE THIS MAP MAYBE UNRELIABLE FOR FLOODPLAIN DETERMINATIONS IN THE FUTURE.

THE TEMPORARY CUL-DE-SAC EASEMENT LOCATED ALONG JADON DRIVE IS FOR THE CONSTRUCTION AND MAINTENANCE OF A CUL-DE-SAC. SAID EASEMENT WILL TERMINATE AT THE TIME OF JADON DRIVE'S EXTENSION TO THE SOUTH.

TEMPORARY LIMITED EASEMENTS OVER ALL LOTS WITHIN THIS PLAT SHALL BE GRANTED TO THE CITY OF MADISON FOR THE CONSTRUCTION OF THE PUBLIC IMPROVEMENTS. SAID EASEMENTS SHALL EXPIRE UPON THE COMPLETION OF THE STREETS AND INFRASTRUCTURE IMPROVEMENTS IN AND ADJACENT TO THE PLAT AS CONSTRUCTED BY THE CITY OF MADISON FOR PROJECT NO. 53B2111.

THE SIGNED MOA BETWEEN THE CITY OF MADISON AND THE WISCONSIN DEPARTMENT OF TRANSPORTATION FOR IMPROVEMENTS TO THE INTERSECTION OF USH 51 AND VOGES ROAD / TERMINAL DRIVE, DATED APRIL 27, 2011; AND THE CITY OF MADISON RESOLUTION NUMBER RES-11-00317, LEGISLATIVE FILE ID 21958 SHALL BE RECORDED ALONG WITH THE GENESIS SUBDIVISION PLAT.

SURVEYOR'S NOTES CONT.

PORTIONS OF THE LANDS WITHIN THIS PLAT ARE LOCATED WITHIN THE SPECIAL FLOOD HAZARD AREA, AS SHOWN ON THE FLOOD BOUNDARY AND FLOODWAY MAPS AND THE FLOOD INSURANCE RATE MAPS, BOTH ADOPTED BY THE CITY OF MADISON AS THE OFFICIAL FLOODPLAIN ZONING MAP, DATED AS BEING EFFECTIVE ON JANUARY 2, 2009. PRIOR TO THE ISSUANCE OF ANY BUILDING PERMITS FOR NEW CONSTRUCTION OR DEVELOPMENT, ALL APPLICABLE FLOODPLAIN-RELATED REGULATIONS FOR THE DEVELOPMENT MUST BE SATISFIED.

HIGHWAY SETBACK RESTRICTION

NO IMPROVEMENTS OR STRUCTURES ARE ALLOWED BETWEEN THE RIGHT-OF-WAY LINE AND THE HIGHWAY SETBACK LINE. IMPROVEMENTS AND STRUCTURES INCLUDED BUT ARE NOT LIMITED TO, SIGNS, PARKING AREAS, DRIVEWAYS, WELLS, SEPTIC SYSTEMS, DRAINAGE FACILITIES, BUILDINGS, AND RETAINING WALLS. IT IS EXPRESSLY INTENDED THAT THIS RESTRICTION IS FOR THE BENEFIT OF THE PUBLIC AS PROVIDED IN SECTION 236.293, WISCONSIN STATUTES, AND SHALL BE ENFORCEABLE BY THE WISCONSIN DEPARTMENT OF TRANSPORTATION OR ITS ASSIGNS. CONTACT THE WISCONSIN DEPARTMENT OF TRANSPORTATION FOR MORE INFORMATION. THE PHONE NUMBER MAY BE OBTAINED BY CONTACTING THE COUNTY HIGHWAY DEPARTMENT.

ACCESS RESTRICTION

ALL LOTS AND BLOCKS ARE HEREBY RESTRICTED SO THAT NO OWNER, POSSESSOR, USER, LICENSEE, OR OTHER PERSON MAY HAVE ANY RIGHT OF DIRECT VEHICULAR INGRESS FROM OR EGRESS TO ANY HIGHWAY LYING WITHIN THE RIGHT OF WAY OF U.S.H. 12 / U.S.H. 18; IT IS EXPRESSLY INTENDED THAT THIS RESTRICTION CONSTITUTES A RESTRICTION FOR THE BENEFIT OF THE PUBLIC AS PROVIDED IN S.236.293, STATS., AND SHALL BE ENFORCEABLE BY THE DEPARTMENT OR ITS ASSIGNS. ANY ACCESS SHALL BE ALLOWED ONLY BY SPECIAL EXCEPTION. ANY ACCESS ALLOWED BY SPECIAL EXCEPTION SHALL BY CONFIRMED AND GRANTED THROUGH THE DRIVEWAY PERMITTING PROCESS AND ALL PERMITS ARE REVOCABLE.

ACCESS ON THE EXISTING BELTLINE IS CONTROLLED BY C.A. PROJECT CA04-2(1)

ACCESS IS RESTRICTED BY WISDOT PROJECT F04-2(31)

NOISE RESTRICTION

THE LOTS OF THIS LAND DIVISION MAY EXPERIENCE NOISE AT LEVELS EXCEEDING THE LEVELS IN S. TRANS 405.04, TABLE I. THESE LEVELS ARE BASED ON FEDERAL STANDARDS. THE DEPARTMENT OF TRANSPORTATION IS NOT RESPONSIBLE FOR ABATING NOISE FROM EXISTING STATE TRUNK HIGHWAYS OR CONNECTING HIGHWAYS, IN THE ABSENCE OF ANY INCREASE BY THE DEPARTMENT TO THE HIGHWAYS THROUGH-LANE CAPACITY.

LEGEND

- ■ ...*GOVERNMENT CORNER (AS NOTED)*
- ○ ...*SET 1 1/4 " X 18" IRON REBAR, WEIGHING 4.13 LBS/LIN. FT.*
- ● ...*FOUND 1" O.D. IRON PIPE*
- △ ...*BM (ELEV. NOTED)*

ALL OTHER LOT, AND OUTLOT CORNERS, ARE SET 3/4" X 18" IRON REBAR WEIGHING 1.502 LBS/LIN. FT.

MEASUREMENTS IN ITALICS ARE FOR PRIVATE STORMWATER EASEMENT LOCATIONS AND LOCATION OF TEMPORARY CUL-DE-SAC

DATE: 2-17-09
REVISION 1: 12-16-09
REVISION 2: 5-9-2011

SHEET 1 OF 3

FINAL PLAT OF
GENESIS

BEING ALL OF OUTLOT 1, OUTLOT 2, AND OUTLOT 3, OF CERTIFIED SURVEY MAP NO. 12423, VOLUME 77, PAGE 216, LOCATED IN THE NORTHWEST 1/4 OF THE NORTHEAST 1/4 AND THE NORTHEAST 1/4 OF THE NORTHEAST 1/4 OF SECTION 27, TOWNSHIP 7 NORTH, RANGE 10 EAST, CITY OF MADISON, DANE COUNTY, WISCONSIN.

CONSENT OF CORPORATE MORTGAGEE

MONONA STATE BANK, A CORPORATION DULY ORGANIZED AND EXISTING UNDER AND BY VIRTUE OF THE LAWS OF THE STATE OF WISCONSIN, MORTGAGEE OF THE ABOVE DESCRIBED LAND, DOES HEREBY CONSENT TO THE SURVEYING, DIVIDING, MAPPING AND DEDICATING OF THE LAND DESCRIBED ON THIS PLAT, AND DOES HEREBY CONSENT TO THE ABOVE CERTIFICATE OF GENESIS COMMONS, LLC, OWNER.

IN WITNESS WHEREOF, THE SAID MONONA STATE BANK HAS CAUSED THESE PRESENTS TO BE SIGNED BY TED GUNDERSON, ITS VICE PRESIDENT AND COUNTERSIGNED BY JEFF OLSON, ITS VICE PRESIDENT, AT MONONA, WISCONSIN, AND ITS CORPORATE SEAL TO BE HEREUNTO AFFIXED THIS 10 DAY OF JUNE, 2011.

IN THE PRESENCE OF:

Susan Hoffman

Monona State Bank (CORPORATE SEAL)
CORPORATE NAME

6-10-11
DATE

6-10-11
DATE

STATE OF WISCONSIN)
Dane COUNTY)SS

PERSONALLY CAME BEFORE ME THIS 10 DAY OF June, 2011, Ted Gunderson Vice President (TITLE), AND Jeff Olson Vice President (TITLE) OF THE ABOVE NAMED CORPORATION, TO ME KNOWN TO BE SUCH Vice President (TITLE) AND Vice President (TITLE) OF SAID CORPORATION, AND ACKNOWLEDGED THAT THEY EXECUTED THE FOREGOING INSTRUMENT AS SUCH OFFICERS AS THE DEED OF SAID CORPORATION, BY ITS AUTHORITY.

Ophelia N. Bailly
NOTARY PUBLIC, STATE OF WISCONSIN

Ophelia N Bailly
(PRINT OR TYPE NAME)

MY COMMISSION EXPIRES 1/11/15.

OPHELIA N BAILLY

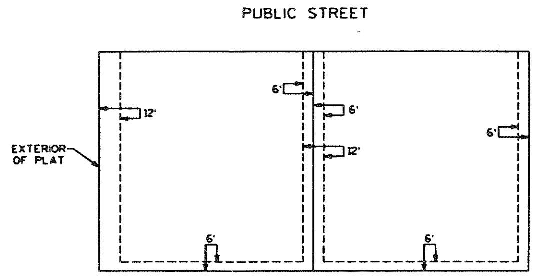
REGISTER OF DEEDS CERTIFICATE

RECEIVED FOR RECORDING THIS 14th DAY OF June, 2011, AT 10:08 O'CLOCK A.M., IN VOLUME 59-091A OF PLATS, ON PAGES 419-421 AS DOCUMENT NO. 4770373

Kristi Chlebowski by Peter Ellestad, deputy
KRISTI CHLEBOWSKI
REGISTER OF DEEDS

TYPICAL EASEMENTS

NOT TO SCALE



CURVE DATA TABLE

CURVE	LOT	RADIUS	CENTRAL ANGLE	LENGTH	CHORD BEARING	CHORD LENGTH	TANGENT FORWARD	TANGENT BACK
1-2		421.39'	57°18'06"	421.44'	S51°45'34"E	404.09'	S23°06'31"E	S80°24'37"E
	1	421.39'	46°22'38"	341.09'	S46°17'50"E	331.86'	S23°06'31"E	S69°29'09"E
	2	421.39'	10°55'28"	80.35'	S74°56'53"E	80.23'	S69°29'09"E	S80°24'37"E
3-4		25.00'	102°10'57"	44.59'	S29°19'08.5"E	38.91'	S21°46'20"W	S80°24'37"E
4-5		144.00'	91°09'40"	229.11'	S67°21'10"W	205.70'	N67°04'00"W	S21°46'20"W
6-7		144.00'	22°00'00"	55.29'	N78°04'00"W	54.95'	N89°04'00"W	N67°04'00"W
8-9		78.00'	22°00'00"	29.95'	S78°04'00"E	29.77'	S67°04'00"E	S89°04'00"E
	6	78.00'	14°53'32"	20.27'	S74°30'46"E	20.22'	S67°04'00"E	S81°57'32"E
	7	78.00'	07°06'28"	9.68'	S85°30'46"E	9.67'	S81°57'32"E	S89°04'00"E
10-11		25.00'	89°21'00"	38.99'	S44°23'30"E	35.15'	S89°04'00"E	S00°17'00"W
12-13		25.00'	90°39'00"	39.55'	N45°36'30"E	35.55'	N00°17'00"E	S89°04'00"E
18-19		210.00'	97°12'34"	356.29'	S64°19'43"W	315.07'	N67°04'00"W	S15°43'26"W
	4	210.00'	59°02'11"	216.38'	N45°14'31.5"E	206.93'	N15°43'26"E	N74°45'37"E
	5	210.00'	38°10'23"	139.91'	S86°09'11.5"E	137.34'	N74°45'37"E	S67°04'00"E
19-20		25.00'	83°51'57"	36.59'	N57°39'25"E	33.41'	S80°24'37"E	N15°43'26"E

SEH

There are no objections to this plat with respect to Secs. 236.15, 236.16, 236.20 and 236.21(1) and (2), Wis Stats. as provided by s. 236.12, Wis. Stats.

Certified June 9th, 2011

Renee M. Pony

Department of Administration

5-9-2011

JASON L. CANCE
S-2688
CHIPPEWA FALLS
WI

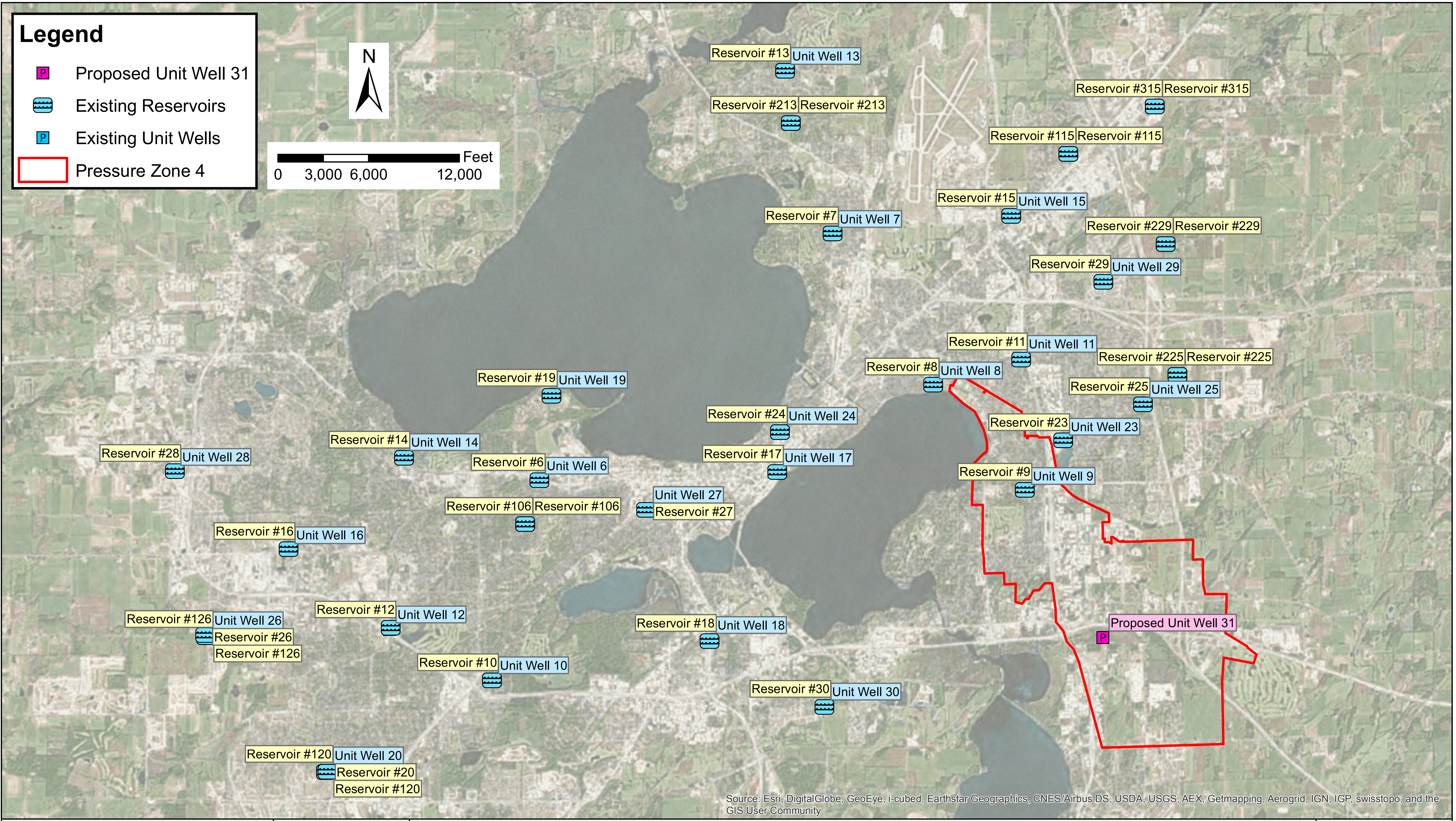
DATE: 2-17-09
REVISION 1: 12-16-09
REVISION 2: 5-9-2011

SHEET 3 OF 3

Appendix B

Distribution System Information

B-1 – Pressure Zones
B-2 – Historical Static Pressures and Flow Tests
B-3 – 2014 Site Flow Tests



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Path: C:\Users\jbohnert\Desktop\Projects\MAdison\Appendix B-1 pressure zone 4.mxd

10 North Bridge Street
Chippewa Falls, WI 54729
PHONE: (715) 720-6200
FAX: (888) 908-8166
TF: (800) 3472-5881
www.sehinc.com

Project: MADWU 129083
Print Date: 10/21/2014

Map by: JJB
Projection: Dane County (US feet)
Source: Madison Water Utility

Project Location in Existing Water System

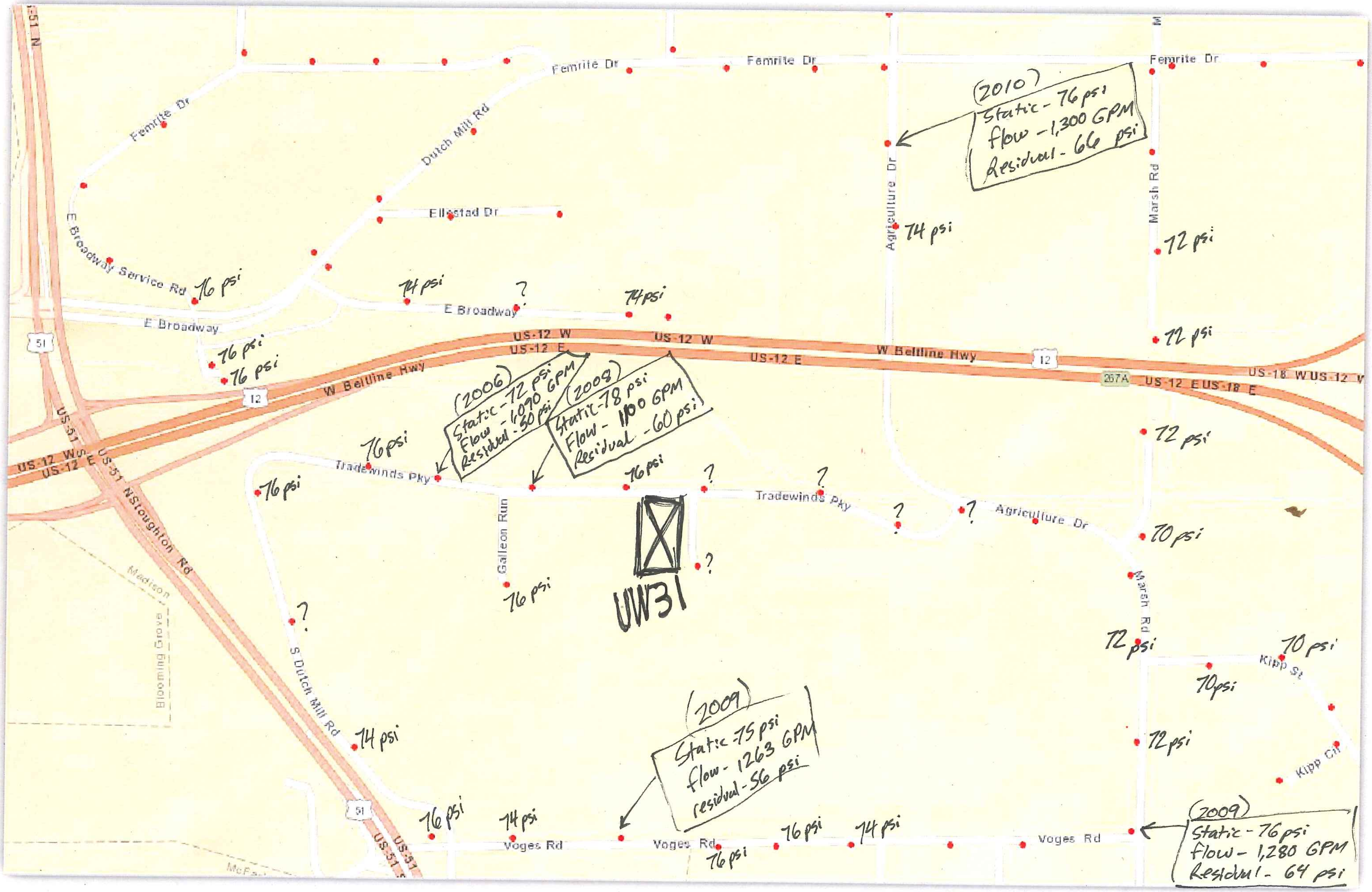
Unit Well 31
Madison, Wisconsin

Appendix
B-1

Appendix B-2

Static Hydrant Pressures & Flow Test Data Near UW31

7/24/14 - ARW



FLOW & PRESSURE TEST

Madison Water Utility
City of Madison, Wisconsin

Test Number: **F-1 (Flow Approximately 1,500 gpm)**

Date: 11-12-2014 **Time:** 10:15 AM **Area of City:**

FLOWING HYDRANT #1

Location: *Tradewinds Parkway & Jadon Drive* Hydrant Number: *6961-1308*

RESIDUAL HYDRANT

Location: *End of Jadon Drive* Hydrant Number: *6962-1309*

Test Hydrant	Flow (gpm)	Static Pressure (psi)	Residual Pressure (psi)	Hydrant No.
Flowing #1: 2 1/2 inch Dia.	1,360	*XXX*	*XXX*	
Residual Hydrant	*XXX*	80 psi	72 psi	

Hydrant Nozzle Size [✓ **2 1/2**] **or 4** inches full-blast, side nozzle

Local Facility Operation - Static Condition

Well 9 Reservoir Level: 94.8 ft *feet from bottom and* *feet below overflow* 99 ft
Well 9: 1718 (into reservoir) *gpm at* *psi discharge*
Well 9 Booster Pump 1 *gpm at* *psi discharge*
Well 9 Booster Pump 2 *gpm at* *psi discharge*
Well 9 Booster Pump 3 *gpm at* *psi discharge*

Local Facility Operation - Flowing Condition

Well 9 Reservoir Level: *feet from bottom and* *feet below overflow*
Well 9: *gpm at* *psi discharge*
Well 9 Booster Pump 1 *gpm at* *psi discharge*
Well 9 Booster Pump 2 *gpm at* *psi discharge*
Well 9 Booster Pump 3 *gpm at* *psi discharge*

Please comment on the operation, flow, setpoint, or pressure on any other equipment or facility in Pressure Zone 4 that might influence this flow test.

- Well 9 Booster pumps are not used.
- Reservoir 9 floats on system to provide gravity service to P.Z. 4
- Well 9 deepwell pump turned-off after start of test ← (off set point is 95.0')

FLOW & PRESSURE TEST

Madison Water Utility
City of Madison, Wisconsin

Test Number: **F-2 (Flow Approximately 2,500 gpm)**

Date: 11-12-2014 **Time:** ≈ 10:25 AM **Area of City:**

FLOWING HYDRANT #1

Location: *Tradewinds Parkway & Jadon Drive* Hydrant Number: *6961-1308*

RESIDUAL HYDRANT

Location: *End of Jadon Drive* Hydrant Number: *6962-1309*

Test Hydrant	**Flow (gpm)**	**Static Pressure (psi)**	**Residual Pressure (psi)**	**Hydrant No.**
Flowing #1: 4½ inch Dia.	2,550	*XXX*	*XXX*	
Residual Hydrant	*XXX*	80 psi	64 psi	

Hydrant Nozzle Size **2 1/2** or [✓ **4** ½] inches throttled to 22 psi for 2,550 gpm

Local Facility Operation - Static Condition

Well 9 Reservoir Level: 94.5 *feet from bottom and* *feet below overflow*
Well 9: off *gpm at* *psi discharge*
Well 9 Booster Pump 1 *gpm at* *psi discharge*
Well 9 Booster Pump 2 *gpm at* *psi discharge*
Well 9 Booster Pump 3 *gpm at* *psi discharge*

Local Facility Operation - Flowing Condition

Well 9 Reservoir Level: *feet from bottom and* *feet below overflow*
Well 9: *gpm at* *psi discharge*
Well 9 Booster Pump 1 *gpm at* *psi discharge*
Well 9 Booster Pump 2 *gpm at* *psi discharge*
Well 9 Booster Pump 3 *gpm at* *psi discharge*

Please comment on the operation, flow, setpoint, or pressure on any other equipment or facility in Pressure Zone 4 that might influence this flow test.

FLOW & PRESSURE TEST

Madison Water Utility

City of Madison, Wisconsin

Test Number: **F-3 (Flow Approximately 3,500 gpm)**

Date: 11-12-2014 **Time:** 10:35 AM **Area of City:**

FLOWING HYDRANT #1

Location: *Tradewinds Parkway & Jadon Drive* Hydrant Number: *6961-1308*

FLOWING HYDRANT #2

Location: *West of Tradewinds Pkwy & Jadon Drive* Hydrant Number: *6861-3*

RESIDUAL HYDRANT

Location: *End of Jadon Drive* Hydrant Number: *6962-1309*

Test Hydrant	**Flow (gpm)**	**Static Pressure (psi)**	**Residual Pressure (psi)**	**Hydrant No.**
Flowing #1: 4½ inch Dia.	3,440	*XXX*	*XXX*	
Flowing #2: 4 inch Dia.	—	*XXX*	*XXX*	—
Residual Hydrant	*XXX*	80 psi	60 psi	

Hydrant Nozzle Size **2 1/2 or [✓ 4 1/2]** inches full-blast - 40psi pitot for 3,440 gpm

Local Facility Operation - Static Condition

Well 9 Reservoir Level:	91.2	*feet from bottom and*		*feet below overflow*
Well 9:	off	*gpm at*		*psi discharge*
Well 9 Booster Pump 1		*gpm at*		*psi discharge*
Well 9 Booster Pump 2		*gpm at*		*psi discharge*
Well 9 Booster Pump 3		*gpm at*		*psi discharge*

Local Facility Operation - Flowing Condition

Well 9 Reservoir Level:		*feet from bottom and*		*feet below overflow*
Well 9:		*gpm at*		*psi discharge*
Well 9 Booster Pump 1		*gpm at*		*psi discharge*
Well 9 Booster Pump 2		*gpm at*		*psi discharge*
Well 9 Booster Pump 3		*gpm at*		*psi discharge*

Please comment on the operation, flow, setpoint, or pressure on any other equipment or facility in Pressure Zone 4 that might influence this flow test.

- note the low reading on reservoir level
- operator noted fluctuating reservoir level readings / pressures as a result of flow tests

FLOW & PRESSURE TEST

Madison Water Utility
City of Madison, Wisconsin

Test Number: **F-4 (Flow Approximately 5,000 gpm)**

Date: 11-12-2014 **Time:** ≈ 10:45 AM **Area of City:**

FLOWING HYDRANT #1

Location: *Tradewinds Parkway & Jadon Drive* Hydrant Number: *6961-1308*

FLOWING HYDRANT #2

Location: *West of Tradewinds Pkwy & Jadon Drive* Hydrant Number: *6861-3*

RESIDUAL HYDRANT

Location: *End of Jadon Drive* Hydrant Number: *6962-1309*

Pitot
30 psi
44 psi

Test Hydrant	**Flow (gpm)**	**Static Pressure (psi)**	**Residual Pressure (psi)**	**Hydrant No.**
Flowing #1: 4½ inch Dia.	2,980 gpm	*XXX*	*XXX*	
Flowing #2: 2~~4~~½" inch Dia.	1,110 gpm	*XXX*	*XXX*	
Residual Hydrant	*XXX*	80 psi	49 psi	

Hydrant Nozzle Size (1) **2 1/2** ~~2~~ (1) **or** **4**½ inches Both full-blast

Local Facility Operation - Static Condition

Well 9 Reservoir Level: 93.9 *feet from bottom and* *feet below overflow*
Well 9: off *gpm at* *psi discharge*
Well 9 Booster Pump 1 *gpm at* *psi discharge*
Well 9 Booster Pump 2 *gpm at* *psi discharge*
Well 9 Booster Pump 3 *gpm at* *psi discharge*

Local Facility Operation - Flowing Condition

Well 9 Reservoir Level: *feet from bottom and* *feet below overflow*
Well 9: *gpm at* *psi discharge*
Well 9 Booster Pump 1 *gpm at* *psi discharge*
Well 9 Booster Pump 2 *gpm at* *psi discharge*
Well 9 Booster Pump 3 *gpm at* *psi discharge*

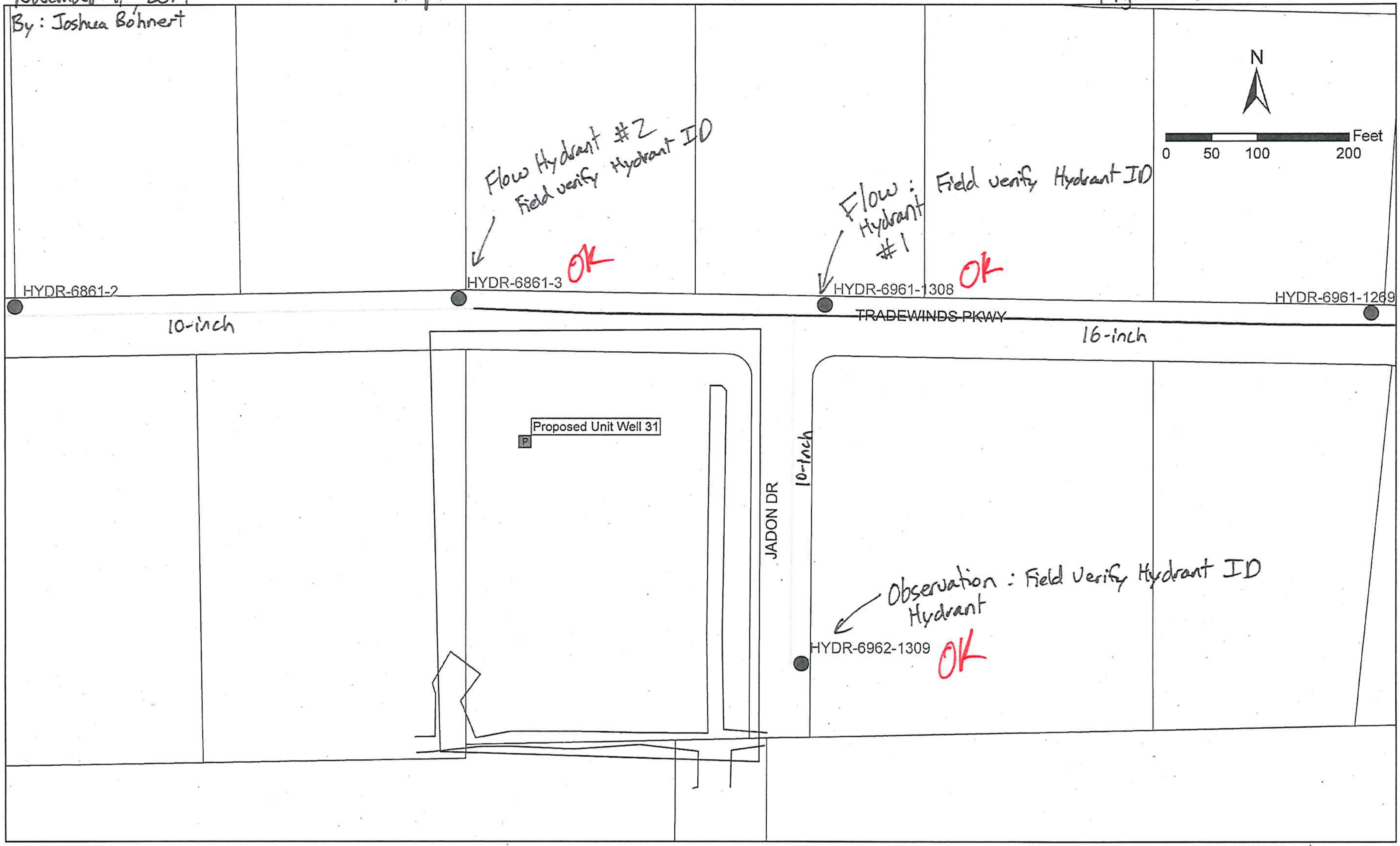
Please comment on the operation, flow, setpoint, or pressure on any other equipment or facility in Pressure Zone 4 that might influence this flow test.

- Did not have 2 large nozzle diffusers - had 2½" diffuser on hydrant #2 -
- May not matter since both at full-blast were flowing at reduced-rates for respective nozzles
- End reading at Reservoir 9 was 92.4-ft
- "On" setpoint for deepwell pump is 90.0-ft

SEH, Inc
November 11, 2014
By: Joshua Böhnert

Proposed Flow Test for Well 31 Site

Figure 1



Appendix C

Well 31 Hydraulics

C-1 – Well 31 Hydraulic Profile
C-2 – Well 31 Hydraulic Calculations
C-3 – Well 31 Specific Capacity

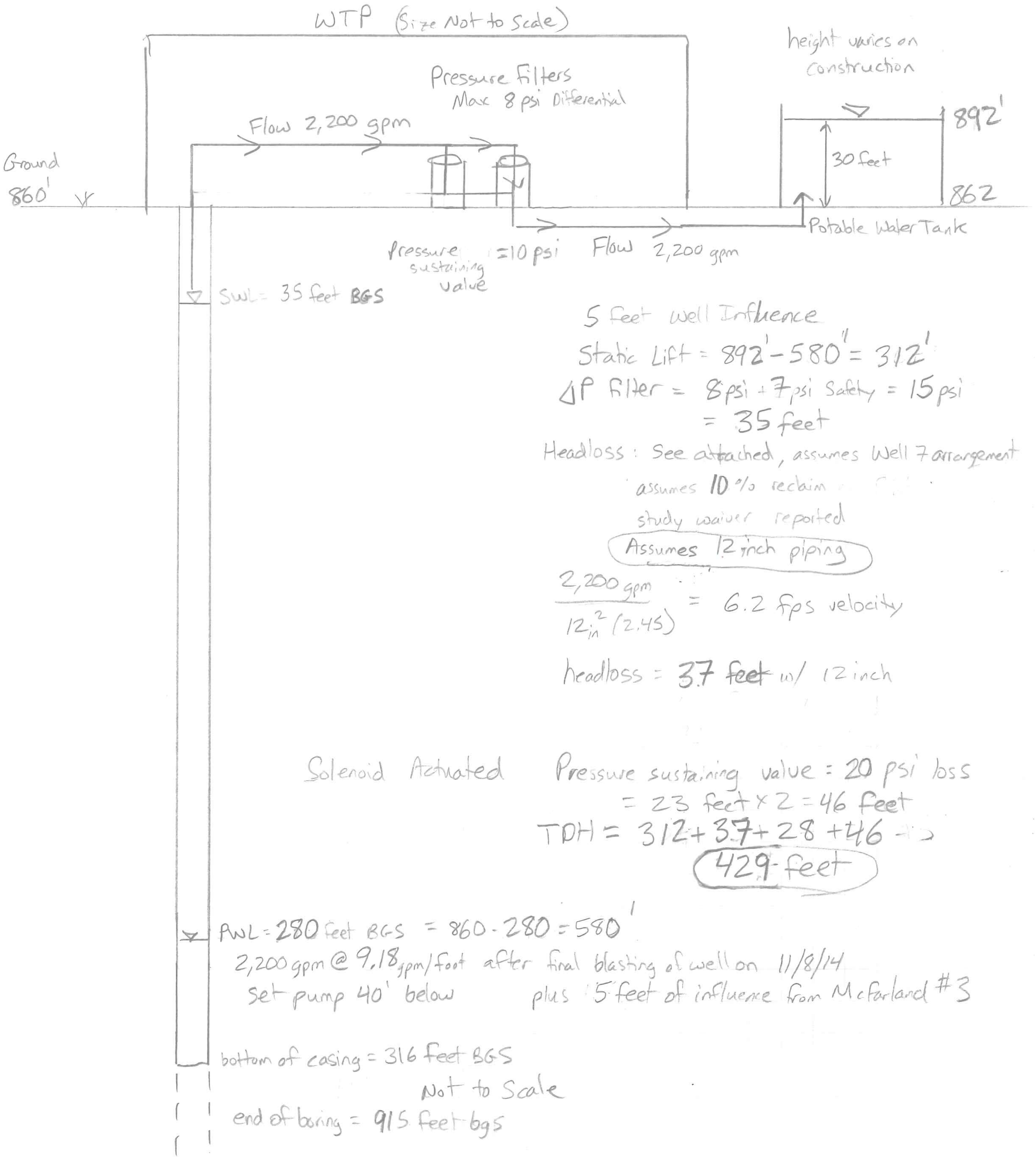
Project: Madison Well 31

Subject: Well 31 pump hydraulics

Date: 11/12/14 By: Joshua Bohnert SEH #: Madwu 129083

Checked by: Date: Office: File #:

Sheet No: Of:



5 feet well Influence

Static Lift = 892' − 580' = 312'

ΔP filter = 8 psi + 7 psi Safety = 15 psi

= 35 feet

Headloss: See attached, assumes Well 7 arrangement

assumes 10% reclaim

study waiver reported

Assumes 12 inch piping

$$\frac{2{,}200 \text{ gpm}}{12_{in}^{2}\,(2.45)} = 6.2 \text{ fps velocity}$$

headloss = 37 feet w/ 12 inch

Solenoid Actuated Pressure sustaining value = 20 psi loss

= 23 feet × 2 = 46 feet

TDH = 312 + 37 + 28 + 46 → 429 feet

PWL = 280 feet BGS = 860 − 280 = 580'

2,200 gpm @ 9.18 gpm/foot after final blasting of well on 11/8/14

set pump 40' below plus 5 feet of influence from McFarland #3

SEH

Madison Water Utility
MADWU 129083
Well 31 WTP
11/19/2014

Well 31 Hydraulics

System Curve

Average Design Flow = 2,200 gpm
Design plus Relclaim = 2,420 gpm
Ground Elevation = 860.0 feet
Static Water Level = 35.0 feet bgs
Specific Capacity = 9.18 gpm/ft
Pumping Water Level = 274.7 ft
Potable Water Tank Height = 30.0 feet ags
Starting Elevation = 585.3 feet
End Elevation = 892.0 feet

Static Lift = 306.7 feet
Darcy-Weisbach Headloss = 37 feet
Pressure Sustaining Valve = 20 psi
Pressure Filter Maximum Differential = 15 psi
Assumed Well Influence = 5 feet

Total Dynamic Head = 429 feet
Assumed Motor/Pump Efficiency = 70%
Motor Power = 341 HP

Madison Water Utility
MADWU 129083
Well 31 WTP
11/19/2014

Well 31 Hydraulics

Fitting Losses

Design Flowrate = *2,200* *gpm*
Design Material = *7* *Concrete, Smooth*
Design roughness = *0.01200* *inches*
Design Temperature = *40* *F*
Design Kinematic Viscosity = *0.0000166* *ft2/sec*

Design pipe diameter, in = 12
Drop Pipe Diameter, in = 12
Pressure Filter Piping, in = 6

Fitting Code	**Size**	**Length of Pipe**	**Description**	**alpha**	**beta**	**Equiv. Length @ actual size**	**Equiv Length @ 12 inches**	**Hazen-Williams Headloss (feet) 130**	Darcy-Weisbach Headloss (feet)
18	12		Ordinary Entrance	1.50	1.00	18	18	0.20	0.30
25	12	275	Straight Pipe	1.00	1.00	275	275	3.02	3.38
25	12	40	Straight Pipe	1.00	1.00	40	40	0.44	0.49
25	12	5	Straight Pipe	1.00	1.00	5	5	0.05	0.06
6	12		Tee - Side out	6.00	0.98	69	69	0.75	1.09
25	12	1	Straight Pipe	1.00	1.00	1	1	0.01	0.01
13	12		Gate Valve - Open	0.59	1.01	7	7	0.08	0.11
9	12		Swing Check Valve	6.62	1.00	79	79	0.87	1.21
13	12		Gate Valve - Open	0.59	1.01	7	7	0.08	0.11
25	12	1	Straight Pipe	1.00	1.00	1	1	0.01	0.01
13	12		Gate Valve - Open	0.59	1.01	7	7	0.08	0.11
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	5	Straight Pipe	1.00	1.00	5	5	0.05	0.06
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	25	Straight Pipe	1.00	1.00	25	25	0.27	0.31
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	30	Straight Pipe	1.00	1.00	30	30	0.33	0.37
13	12		Gate Valve - Open	0.59	1.01	7	7	0.08	0.11
5	12		Tee - Run	1.62	0.98	18	18	0.20	0.29
Merge with 10 % Reclaim, Flow = 2,420 gpm									
6	12		Tee - Side out	6.00	0.98	69	69	0.90	1.32
25	12	8	Straight Pipe	1.00	1.00	8	8	0.10	0.12
Flow Splits in Half, 1,210 gpm									
5	12		Tee - Run	1.62	0.98	18	18	0.07	0.09
25	12	14	Straight Pipe	1.00	1.00	14	14	0.05	0.05
6	12		Tee - Side out	6.00	0.98	69	69	0.25	0.33
13	12		Gate Valve - Open	0.59	1.01	7	7	0.03	0.03
22	12		Sudden Contraction - 1/4	1.20	0.99	14	14	0.05	0.07
Pressure Filter Piping									
25	6	0.5	Straight Pipe	1.00	1.00	1	15	0.05	0.07
6	6		Tee - Side out	6.00	0.98	35	1016	3.69	5.27
Flow Splits in Half, 605 gpm									
3	6		90' Elbow - S.R.	2.70	0.99	16	465	0.47	0.66
25	6	4	Straight Pipe	1.00	1.00	4	117	0.12	0.14
6	6		Tee - Side out	6.00	0.98	35	1016	1.02	1.32
3	6		90' Elbow - S.R.	2.70	0.99	16	465	0.47	0.66
Minus One Filter (-151 gpm), 454 gpm									
5	6		Tee - Run	1.62	0.98	9	274	0.16	0.20
25	6	4	Straight Pipe	1.00	1.00	4	117	0.07	0.08
Minus One Filter (-151 gpm), 303 gpm									
5	6		Tee - Run	1.62	0.98	9	274	0.08	0.09
25	6	4	Straight Pipe	1.00	1.00	4	117	0.03	0.04
Minus One Filter (-151 gpm), 151 gpm									
5	6		Tee - Run	1.62	0.98	9	274	0.02	0.02
25	6	4	Straight Pipe	1.00	1.00	4	117	0.01	0.01

Pressure Filters									
5	6		Tee - Run	1.62	0.98	9	274	0.02	0.02
25	6	4	Straight Pipe	1.00	1.00	4	117	0.01	0.01
Plus One Filter (+151 gpm), 303 gpm									
5	6		Tee - Run	1.62	0.98	9	274	0.08	0.09
25	6	4	Straight Pipe	1.00	1.00	4	117	0.03	0.04
Plus One Filter (+151 gpm), 454 gpm									
5	6		Tee - Run	1.62	0.98	9	274	0.16	0.20
25	6	4	Straight Pipe	1.00	1.00	4	117	0.07	0.08
Plus One Filter (+151 gpm), 605 gpm									
3	6		90' Elbow - S.R.	2.70	0.99	16	465	0.47	0.66
6	6		Tee - Side out	6.00	0.98	35	1016	1.02	1.32
25	6	1	Straight Pipe	1.00	1.00	1	29	0.03	0.04
Flow Recombines, 1,210 gpm									
6	6		Tee - Side out	6.00	0.98	35	1016	3.69	5.27
25	6	0.5	Straight Pipe	1.00	1.00	1	15	0.05	0.07
19	12		Sudden Enlargement - 1/4	2.70	0.99	32	32	0.11	0.16
Plant Piping									
13	12		Gate Valve - Open	0.59	1.01	7	7	0.03	0.03
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.11	0.16
25	12	1	Straight Pipe	1.00	1.00	1	1	0.00	0.00
Flow Recombines and returns to 2,200 gpm									
6	12		Tee - Side out	6.00	0.98	69	69	0.75	1.09
25	12	7	Straight Pipe	1.00	1.00	7	7	0.08	0.09
Pressure Sustaining Valve. Set to 20 psi									
25	12	5	Straight Pipe	1.00	1.00	5	5	0.05	0.06
13	12		Gate Valve - Open	0.59	1.01	7	7	0.08	0.11
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	40	Straight Pipe	1.00	1.00	40	40	0.44	0.49
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	90	Straight Pipe	1.00	1.00	90	90	0.99	1.11
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	85	Straight Pipe	1.00	1.00	85	85	0.93	1.05
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	20	Straight Pipe	1.00	1.00	20	20	0.22	0.25
13	12		Gate Valve - Open	0.59	1.01	7	7	0.08	0.11
25	12	50	Straight Pipe	1.00	1.00	50	50	0.55	0.62
3	12		90' Elbow - S.R.	2.70	0.99	32	32	0.35	0.54
25	12	10	Straight Pipe	1.00	1.00	10	10	0.11	0.12
19	12		Exit	2.70	0.99	32	32	0.35	0.53
Total Equivalent Length						**1813**	**9523**	**Total** **27**	**Total** **37**

Fwd: unit well 31 new pumping results after blasting development.
Randy Sanford to: Joshua Bohnert 11/12/2014 08:59 AM
Cc: Chad Katzenberger

History: This message has been replied to.

Please add information to report !
Thanks.

Randy Sanford
SEH Project Manager

Begin forwarded message:

> From: "Wiederhoeft, Adam" <AWiederhoeft@madisonwater.org>
> To: "'Randy Sanford'" <rsanford@sehinc.com>
> Cc: "Larson, Alan" <ALarson@madisonwater.org>, "Jon Strand " <jstrand@sehinc.com >, "Demorett, Joseph" <jdemorett@madisonwater.org>, "Grande, Joseph" < JGrande@madisonwater.org>
>
> Hi Randy,
>
> Attached are results from the latest Well 31 post-blasting pump test (5-days) – specific capacity of 9.18.
>
> Additionally, the post-blasting water quality field testing indicates that the iron level increased about 30% over what we measured in February – 0.32 mg/L iron. Manganese was not measured. The sample is being further analyzed by the Public Health lab and I'll keep you posted regarding their results.
>
> R,
> Adam
>
> Adam Wiederhoeft, PE
> Madison Water Utility

MUNICIPAL
WELL & PUMP

Test of Well Report

Job #	MT13-252
Customer Name	Madison, City of
Date	11/8/2014

Test Information

Well No:	31	Well Location	Emil Street Service Building			Tested By	Wesley Derksen
Dia. Orifice	10 x 8	Static Level	35 ft	in	Well Depth	915 ft	
Drilled by		Length of Airline		320	Gauge to Ground Level:	ft	in
Pump Set to Disharge Nozzle	320 ft				To Tail Pipe	ft	

Reading No:	Time	Inches on orifice	GPM	Alt. Ga. in Feet	Pumping Level Ft.	Drawdown in Feet	Back Pressure	Specific Capacity	Water Appearance: clear, cloudy, murky muddy, sandy, temp., odor
	6:24 AM Start	53	2,194 0	46.	274.	239.		9.18	Half pencil eraser sand in quart clea
1	6:25 AM		0						Turned off pump
2	6:56 AM		0	200.	120.	85.		0.	
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									

PO Box 311, 1212 Storbeck Drive, Waupun, WI 53963 – Office: 920-324-3400 – Toll-Free: 800-383-7412 – Fax: 920-324-3431
www.municipalwellandpump.com

8/6/13 - 9:29 AM

MUNICIPAL
WELL & PUMP

Test of Well Report

Job # MT13-252

Customer Name Madison, City of

Date 11/4/2014

Test Information

Well No:	31	Well Location	Emil Street Service Building		Tested By	Wesley Derksen
Dia. Orifice	10 x 8	Static Level	40 ft	in	Well Depth	ft
Drilled by		Length of Airline	320		Gauge to Ground Level:	ft in
Pump Set to Disharge Nozzle	320 ft				To Tail Pipe	ft

Reading No:	Time	Inches on orifice	GPM	Alt. Ga. in Feet	Pumping Level Ft.	Drawdown in Feet	Back Pressure	Specific Capacity	Water Appearance: clear, cloudy, murky muddy, sandy, temp., odor
	Start		0	280.	40.	0.		NaN	
1	7:45 AM	14.5	1,147	215.	105.	65.	5	17.65	30 hz fine sand penny size
2	8:10 AM	13	1,086	212.	108.	68.	4	15.97	Cloudy
3	8:29 AM	12	1,044	210.	110.	70.	3	14.91	Half penny sand
4	8:30 AM	23	1,445	185.	135.	95.	5	15.21	35.5 hz Penney sand
5	9:00 AM	21	1,381	180.	140.	100.	5	13.81	Cloudy Penney sand
6	9:40 AM	21	1,381	178.	142.	102.	5	13.54	Half penny
7	9:55 AM	32	1,705	162.	158.	118.	5	14.45	Penny
8	10:24 AM	28	1,594	156.	164.	124.	5	12.85	Half penny
9	11:07 AM	27	1,566	155.	165.	125.	5	12.53	Half penny
10	11:41 AM	36.5	1,820	133.	187.	147.	5	12.38	43.5 hz penny sand
11	12:44 PM	35	1,783	129.	191.	151.	5	11.81	.2 ml sand
12	1:06 PM	43.5	1,987	120.	200.	160.	5	12.42	
13	1:50 PM	43	1,976	113.	207.	167.	5	11.83	.2ml cloudy
14	2:08 PM	51.5	2,162	96.	224.	184.	5	11.75	Cloudy
15	2:41 PM	61	2,353	86.	234.	194.	5	12.13	.2 ml
16	3:00 PM	58	2,295	81.	239.	199.	5	11.53	Cloudy
17	3:37 PM	57	2,275	80.	240.	200.	5	11.38	
18	4:04 PM	13	1,086	180.	140.	100.	5	10.86	Few grains
19									

MUNICIPAL
WELL & PUMP

Test of Well Report

Job #	MT13-252	**Date**	11/5/2014
Customer Name	Madison, City of		

Test Information

Well No:	31	Well Location	Emil Street Service Building			Tested By	Wesley Derksen
Dia. Orifice	10 x8	Static Level	35 ft	in		Well Depth	915 ft
Drilled by		Length of Airline		320		Gauge to Ground Level:	ft	in
Pump Set to Disharge Nozzle	320 ft					To Tail Pipe	ft

Reading No:	Time	Inches on orifice	GPM	Alt. Ga. in Feet	Pumping Level Ft.	Drawdown in Feet	Back Pressure	Specific Capacity	Water Appearance: clear, cloudy, murky muddy, sandy, temp., odor
	7:45 AM Start		0	285.	35.	0.		NaN	
1	8:00 AM	11	999	212.	108.	73.	5	13.68	Cloudy no sand
2	8:42 AM	40	1,906	174.	146.	111.	7	17.17	.1 ml
3	9:12 AM	31	1,678	152.	168.	133.	5	12.62	Cloudy
4	9:18 AM	68	2,485	111.	209.	174.	5	14.28	Clear 50 hz
5	9:44 AM	62.5	2,382	93.	227.	192.	5	12.41	.1 ml
6	10:00 AM	61	2,353	90.	230.	195.	5	12.07	
7	10:33 AM	60	2,334	86.	234.	199.	5	11.73	
8	11:03 AM	59	2,315	84.	236.	201.	5	11.52	
9	11:34 AM	58	2,295	82.	238.	203.	5	11.31	
10	12:00 PM	58	2,295	80.	240.	205.	5	11.2	.1 ml sand
11	12:30 PM	57	2,275	79.	241.	206.	5	11.04	
12	1:00 PM	57	2,275	78.	242.	207.	5	10.99	320 amps
13	1:33 PM	56.5	2,265	77.	243.	208.	5.	10.89	.05 ml sand
14	2:00 PM	56	2,255	76.	244.	209.	5	10.79	
15	2:30 PM	56	2,255	75.	245.	210.	5	10.74	.05 ml sand
16	3:06 PM	55.5	2,245	74.	246.	211.	5	10.64	
17	3:30 PM	55.5	2,245	74.	246.	211.	5	10.64	.05 ml sand
18	4:00 PM	55.5	2,245	73.	247.	212.	5	10.59	.05 ml sand
19									

8/6/13 - 9:29 AM

MUNICIPAL
WELL & PUMP

Test of Well Report

Job # MT13-252

Customer Name Madison, City of

Date 11/6/2014

Test Information

Well No:	31	Well Location	Emil Street Service Building			Tested By	Wesley Derksen
Dia. Orifice	10 x 8	Static Level	35 ft	in		Well Depth	915 ft
Drilled by		Length of Airline		320	Gauge to Ground Level:	ft	in
Pump Set to Disharge Nozzle	320 ft				To Tail Pipe	ft	

Reading No:	Time	Inches on orifice	GPM	Alt. Ga. in Feet	Pumping Level Ft.	Drawdown in Feet	Back Pressure	Specific Capacity	Water Appearance: clear, cloudy, murky muddy, sandy, temp., odor
	Start		0						
1	9:49 AM	49	2,109	70.	250.	215.	5	9.81	
2	10:09 AM	55	2,235	57.	263.	228.	5	9.8	51.8 hz clear .04 ml sand
3	11:25 AM	55.5	2,245	55.	265.	230.	5	9.76	
4	2:09 PM	55	2,235	54.	266.	231.	5	9.68	.03 ml sand in liter of water
5	4:00 PM	55	2,235	53.	267.	232.	5	9.63	240 amps
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									

MUNICIPAL
WELL & PUMP

Test of Well Report

Job # MT13-252

Customer Name Madison, City of

Date 11/7/2014

Test Information

Well No:	31	Well Location	Emil Street Service Building				Tested By	Wesley Derksen
Dia. Orifice	10 x 8	Static Level	35 ft	in		Well Depth	915 ft	
Drilled by			Length of Airline		320	Gauge to Ground Level:	ft	in
Pump Set to Disharge Nozzle		320 ft				To Tail Pipe	ft	

Reading No:	Time	Inches on orifice	GPM	Alt. Ga. in Feet	Pumping Level Ft.	Drawdown in Feet	Back Pressure	Specific Capacity	Water Appearance: clear, cloudy, murky muddy, sandy, temp., odor
	Start		0						
1	7:57 AM	53	2,194	50.	270.	235.	5	9.34	.03 ml sand clear
2	9:30 AM	54.5	2,224	48.	272.	237.	5	9.38	52.1 hz
3	12:31 PM	54	2,214	48.	272.	237.	5	9.34	Pencil eraser size sand in quart
4	2:29 PM	54	2,214	48.	272.	237.	5	9.34	330 amps
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									

Appendix D

Backwash Tank Options

D-1 – Option 1: Rectangular Tanks
D-2 – Option 2: Cylindrical Tanks
D-3 – Option 1: Rectangular Tanks
D-4 – Option 2: Cylindrical Tanks

Project: Madison Well 31 WTP Appendix D-1

Subject: Backwash by System Pressure

Date: 10/23/14 By: Joshua Bohnert SEH #: Madwu 129083

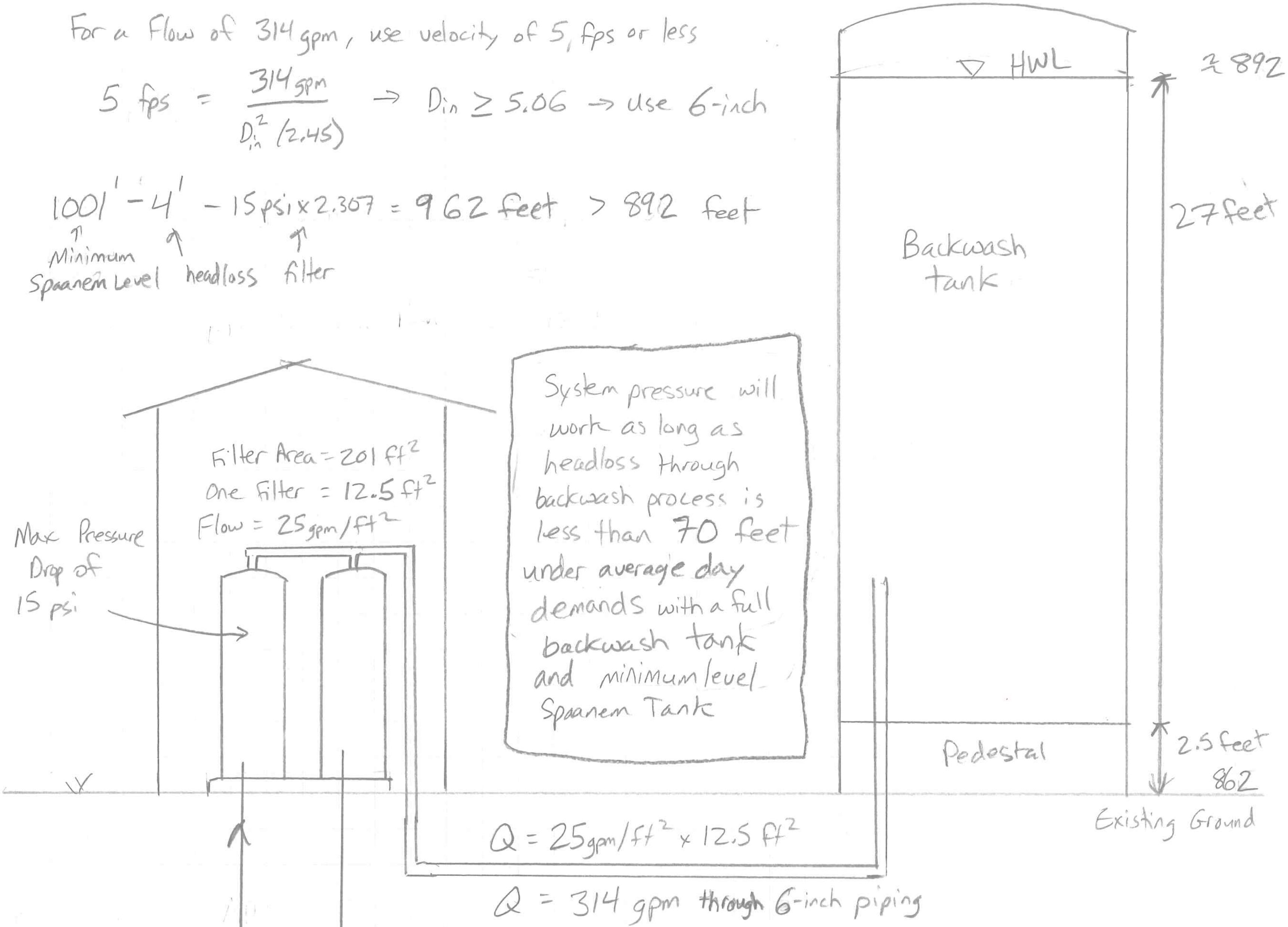
Checked by: Date: Office: File #:

Sheet No: Of:

For a Flow of 314 gpm, use velocity of 5 fps or less

$$5 \text{ fps} = \frac{314 \text{ gpm}}{D_{in}^2 (2.45)} \rightarrow D_{in} \geq 5.06 \rightarrow \text{use 6-inch}$$

$$\underset{\substack{\uparrow \\ \text{Minimum} \\ \text{Spaanem Level}}}{1001'} - \underset{\substack{\uparrow \\ \text{headloss}}}{4'} - \underset{\substack{\uparrow \\ \text{filter}}}{15 \text{ psi} \times 2.307} = 962 \text{ feet} > 892 \text{ feet}$$



System pressure will work as long as headloss through backwash process is less than 70 feet under average day demands with a full backwash tank and minimum level Spaanem Tank

$Q = 25 \text{gpm/ft}^2 \times 12.5 \text{ ft}^2$

$Q = 314$ gpm through 6-inch piping

377 gpm during average day from System, headloss = 4 feet

Appendix D-2

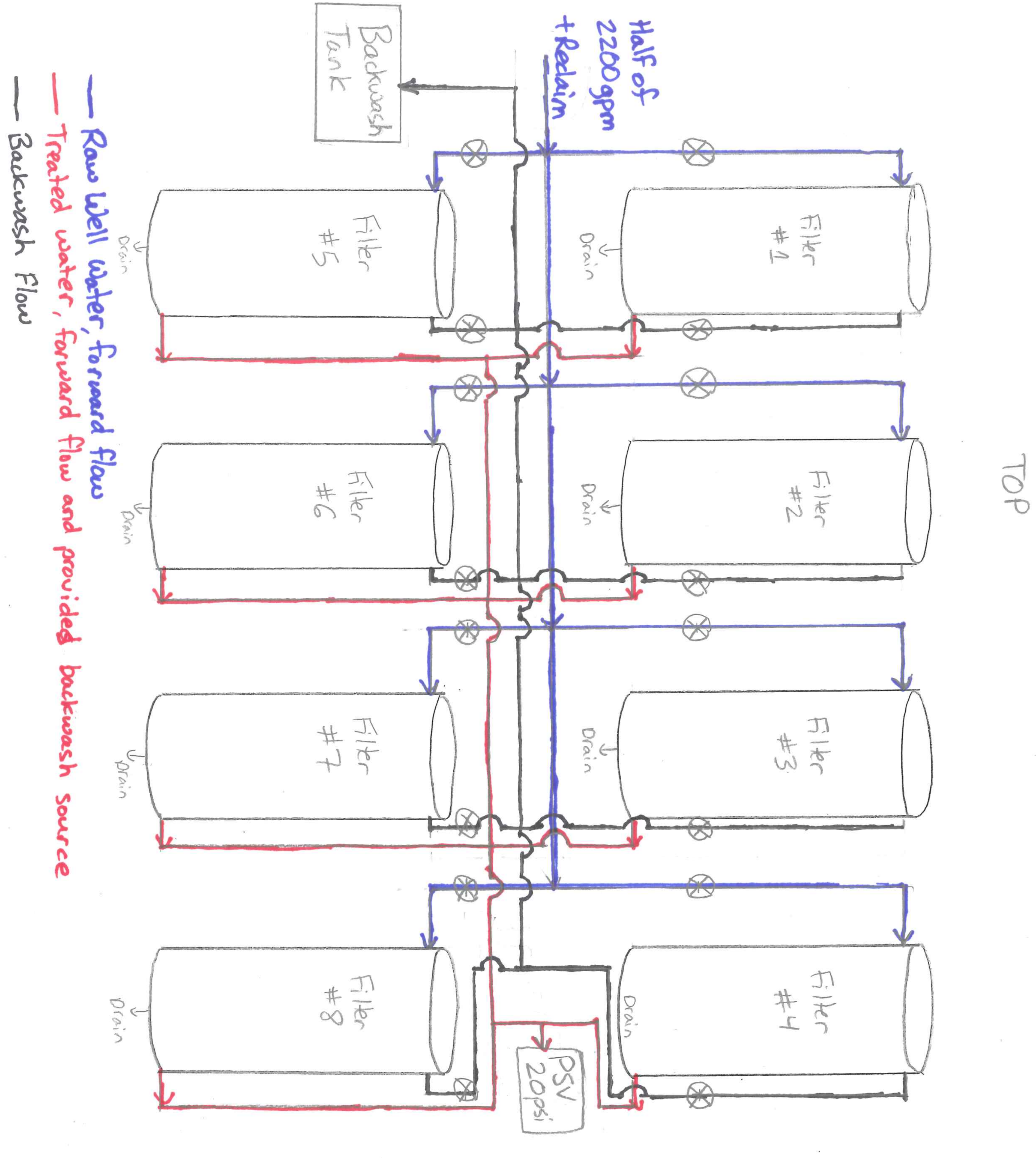
Project: Madison Well 31

Subject: Backwash by treated water

Date: 11/19/14 By: Joshua Rahnert SEH #: Madwu 129083

Checked by: Date: Office: File #:

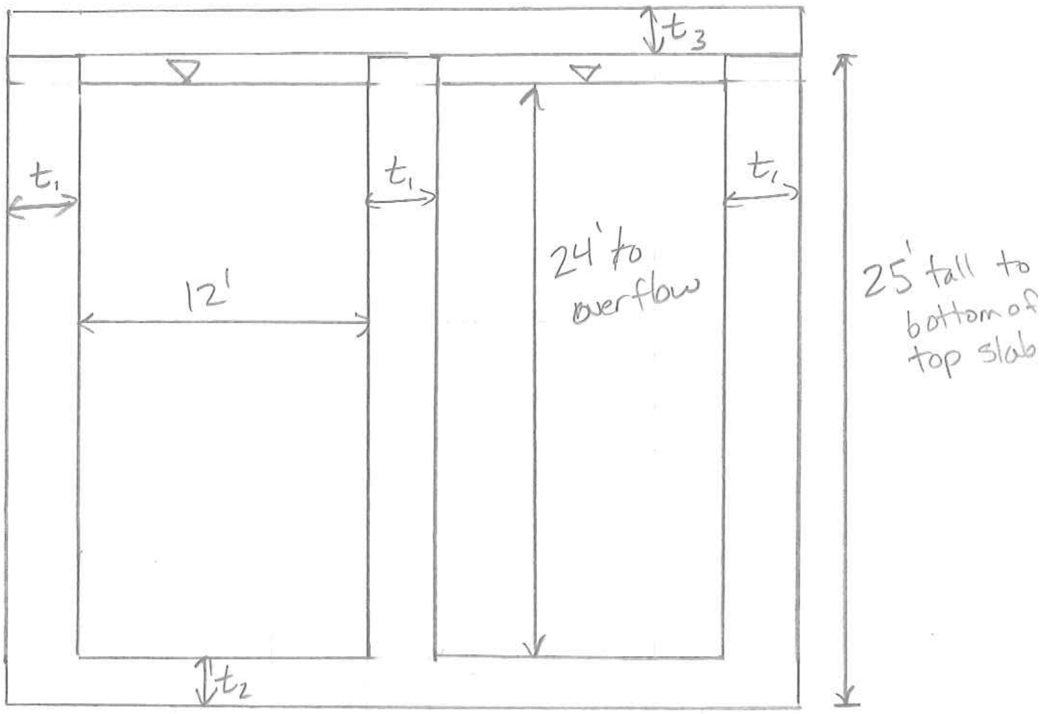
Sheet No: Of:



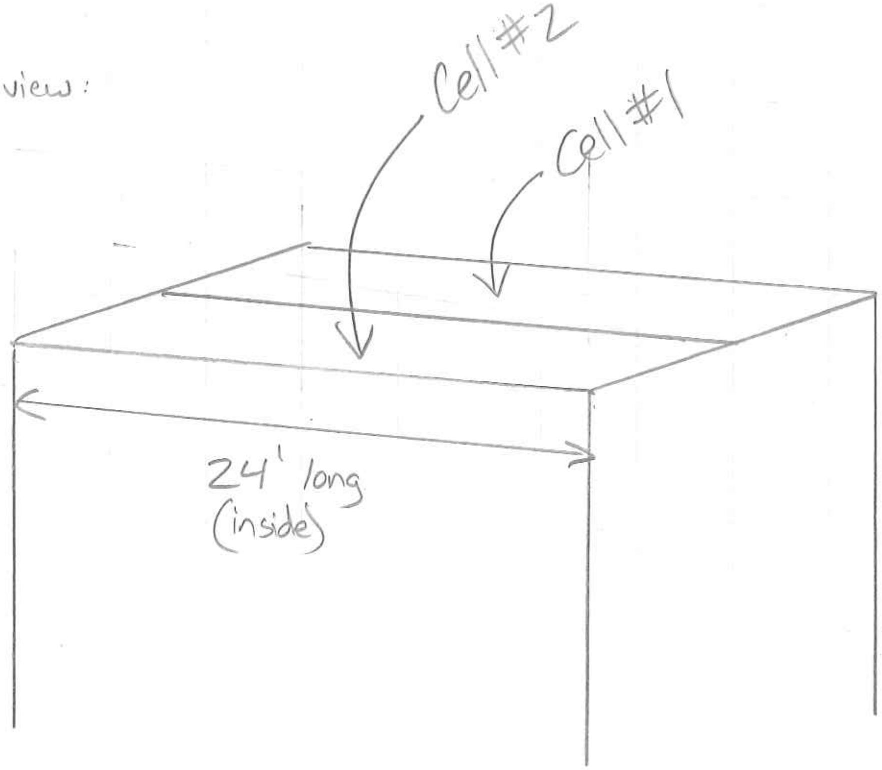
Project: Madison Well 31 WIP
Subject: Backwash tank options
Date: 10/23/14 By: Joshua Bohnert SEH #: Madwu 129083
Checked by: Date: Office: File #:
Sheet No: Of:

Set tank height to overflow 24', with max operating height to 23'9" with one foot freeboard → height = 25 feet + top slab

option 1 : 24'×24'×24' or two 12'×24'×24'



3D view:



SEH

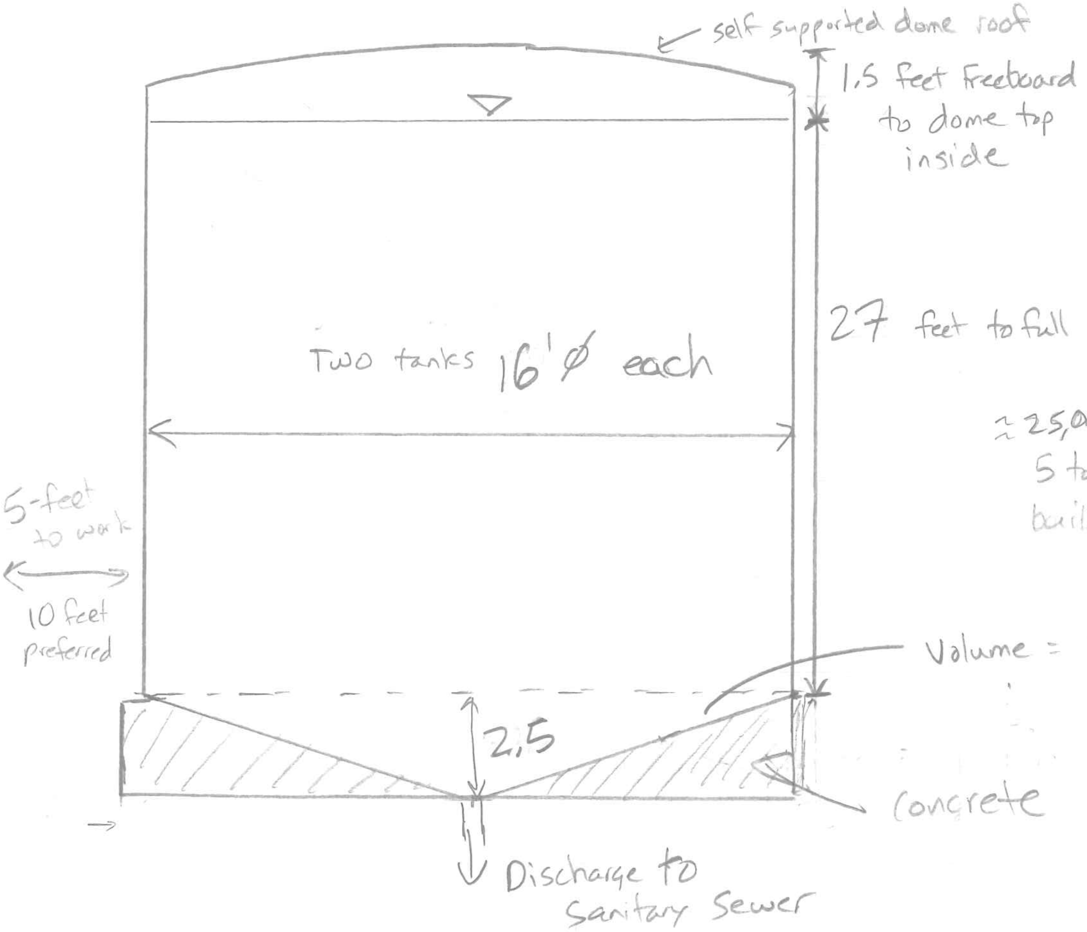
Project: Madison Well 31

Subject: Cylindrical backwash tanks Option #2

Date: 10/23/14 By: Joshua Bohnert SEH #: Madwu 129083

Checked by: Date: Office: File #:

Sheet No: Of:



No higher than 25'
use 20' total height
tank + pedestal

≈ 25,000 lbs of steel (1/4" wall)
5 ton overhead wince
build tank inside

Maintenance costs may double or triple with inside tanks

Someway to sand blast or coat a tank inside, ventilation

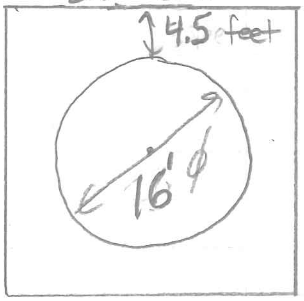
Stainless 304 series → No painting or inspection
2205 duplex stainless ? for corrosive situation

Outside w/ insulation?

Cylindrical tanks are custom built

Footprint *

25'x25'



Appendix E

Pilot Study Waiver

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Water
Utility mwu

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October 17, 2014

RE: Madison Water Utility
Well 31 Request for Pilot Test Waiver
SEH No. MADWU -129083 14.00

Mr. Mark Harder, PE
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

Dear Mr. Harder:

Madison Water Utility (MWU) completed construction of Well 31 in 2014. Well 31 is located on the south side of Tradewinds Parkway and provides additional system stability by adding a second water source to the Utility's Pressure Zone 4 in the City's southeast side. The Well 31 site is located approximately 4,500 feet west of Upper Mud Lake (Lake Waubesa) and is southeast of Lake Monona. A map showing the location of Well 31 is attached.

Well 31 is cased through unconsolidated deposits, upper bedrock aquifer, and Eau Claire (shale) formation. The well is open to the Mount Simon (sandstone) formation.

The production goal of the finished well is 2,100 gpm. Initial drawdown at this flow rate was measured at 250 feet for an estimated specific capacity of 8.4 gpm/ft. The Utility has completed additional development of the well using blasting techniques in the hope of improving the long term specific capacity. Sand is currently being bailed out of the well and development pumping and capacity testing is scheduled for later this fall.

Iron was measured at 0.24 mg/l and manganese at 11 ug/l. The Utility has a water quality goal for iron of 0.10 mg/l and for manganese of 20 ug/l. The Utility is planning to install a filter to remove iron and manganese from the well water using oxidation and pressure filtration techniques to meet the Utility's established water quality goal.

The Utility has two WTP designs (Well 29 and Well 7) which use pyrolusite high rate pressure filters to remove iron and manganese. The Well 29 filters have operated successfully since 2009 consistently removing iron and manganese in the finished water to very low levels. The Pyrolusite media at Well 29 is being used with an effective filter loading rate of 12 gpm/ft^2, a backwash rate of 29 gpm/ft^2 for five minutes, and ultimate filter run times of 21 hours or more with a maximum differential pressure of 8 psi.

Well 29 was successfully pilot tested extensively in 2008 verifying that high rate Pyrolucite filtration in conjunction with chlorine oxidation would effectively remove iron and manganese. Wells 7 and 8 were also successfully pilot tested in 2011 verifying the use of the same process of high rate Pyrolucite filtration following chlorine oxidation. The Well 7 filtration plant was designed based on the 2011 pilot study and is currently under construction. Well 7 will go into full operation in 2015. A filter at Well 8 also using Pyrolucite filters is scheduled for construction in 2017.

The attached water quality table provides a comparison of Well 31 water quality and other wells in the Madison Water Utility System for inorganic and radionuclide compounds. Sampling of volatile organic compounds and synthetic organic compounds in Well 31 in 2014 detected only chloromethane at 0.16 ug/L (between limit of detection and limit of quantification); therefore, VOC and SOC data is not provided with this letter.

The Well 31 water contains some radionuclides, at levels similar to Well 7. Combined radium (-226 and -228 isotopes) in Well 31 ranged from 3.2 to 4.2 pCi/L while Well 7 showed a combined radium level of 3.3 pCi/L. Similar to Well 7, radionuclide discharge will be handled with review of the unity equation upon actual discharges to sanitary sewer.

Referring to the attached water quality table, the water quality in Well 31 is very similar to the water quality in Well's 7, 8, and 29. Water quality factors in Well 31, such as excess organic materials and a significant difference in hardness and alkalinity, that could interfere with the operation of a high rate filtration system have not been observed or measured. Due to the fact that MWU has successfully pilot tested waters at Well 7, 8, and 29 using a high rate Pyrolucite media and has successfully operated a Pyrolucite media iron and manganese filter system for over 5 years at Well 29, and given the similar water quality found at Well 31, it is our opinion that chlorine oxidation followed by a high rate Pyrolucite media filter would be successful at Well 31. The Pyrolucite media technology and operational characteristics are very familiar to MWU personnel and we are confident in its ability to remove iron and manganese from Well 31.

Please consider this our formal request to waive the pilot testing requirement of *Wisconsin Administrative Code* NR 811.44 for Well 31. The attached water quality information on the other wells within the Madison system and our experience with the use of Pyrolucite filters makes this the logical choice for Well 31. Based on previous pilot studies at Wells 7, 8, and 29 and MWU's operational experience at Well 29, we request approval of Pyrolucite media filtration following chlorine oxidation for Well 31 with a filter loading rate of 12 gpm/ft^2, backwash of 29 gpm/ft^2 for 5 minutes, and filter runs of approximately 20 to 24 hours. We also are requesting approval of filter backwash water recycle not to exceed 5% of the total filter loading.

Please contact me here at the Utility, alarson@madisonwater.org or 608.266.4653 or contact either Adam Wiederhoeft, awiederhoeft@madisonwater.org or 608-266-9121 or Randy Sanford of SEH via email, rsanford@sehinc.com, or at 715.456.3225 with any questions or if you need any additional information. We look forward to your favorable review of our request for a pilot test variance.

Sincerely,

MADISON WATER UTILITY

Alan L. Larson, PE, BCEE
Principal Engineer - Water

WISCONSIN
ALAN L.
LARSON
E-34727
MADISON
WIS.
PROFESSIONAL ENGINEER
10/17/14

sw
Attachments
c: Adam Wiederhoeft,PE Madison Water Utility
Randy Sanford, PE, Short Elliot and Hendrickson

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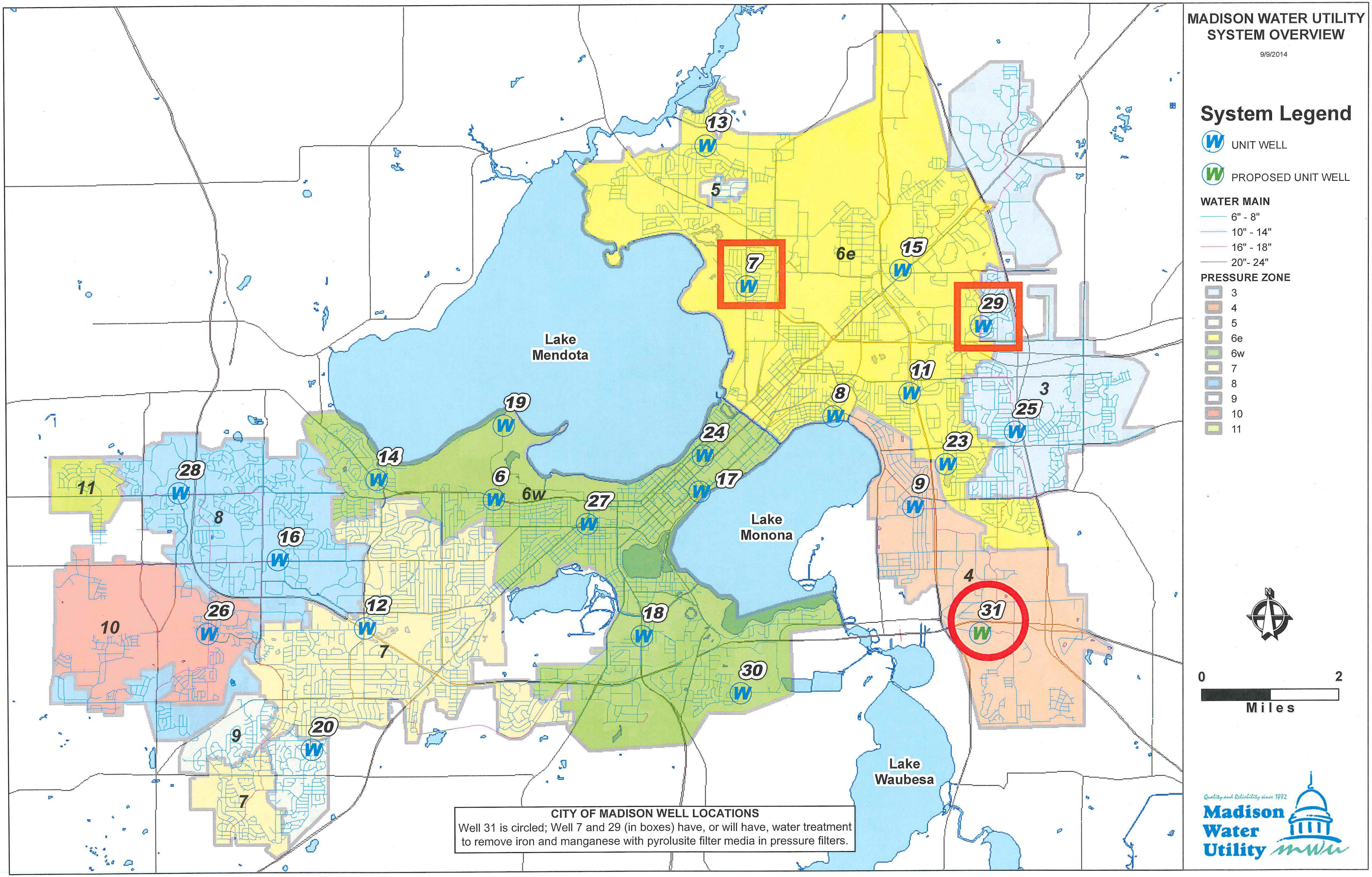


CITY OF MADISON WELL LOCATIONS

Well 31 is circled; Well 7 and 29 (in boxes) have, or will have, water treatment to remove iron and manganese with pyrolusite filter media in pressure filters.

INORGANICS

PARAMETER	UNITS	MCL	Well 31		Well 6	Well 7	Well 8	Well 9	Well 11	Well 12	Well 13	Well 14	Well 15	Well 16	Well 17	Well 18	Well 19	Well 20	Well 23	Well 24	Well 25	Well 26	Well 27	Well 28	Well 29	Well 29	Well 29	Well 30
Sample Date			2/14/14	2/17/14	6/12/13	6/11/13	8/21/13	6/11/13	6/1/13	6/12/13	6/11/13	6/12/13	6/11/13	6/12/13	7/31/13	6/12/13	6/12/13	6/12/13	6/11/13	6/11/13	6/13/13	6/12/13	6/12/13	6/12/13	2012 Deep Well	2012 Booster	6/11/13	6/12/13
Alkalinity (CaCO3)	mg/l		340	342	316	319	302	330	334	280	312	333	314	284	282	273	276	270	353	270	307	280	307	276	315	317	313	261
Aluminum	µg/l		0.79	0.75	0.9	2.2	0.8	0.6	0.9	0.5	0.6	0.6	0.8	0.9	1.4	0.5	0.6	0.6	0.7	0.5	1.2	3.3	0.6	0.4	0.215	0.32	0.5	0.6
Antimony	µg/l	6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	< 0.206	< 0.206	<0.2	<0.2
Arsenic	µg/l	10	<0.2	<0.2	<0.2	0.3	0.4	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	0.3	<0.2	0.3	<0.2	0.7	0.4	<0.2	0.2	0.3	0.3	0.331	< 0.206	0.3	0.4
Barium	µg/l	2000	24	24	23	36	36	28	19	14	34	55	9.6	19	27	15	17	10	66	13	8	20	28	16	53.2	50.7	51	17
Beryllium	µg/l	4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	IO	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	< 0.206	< 0.206	<0.2	<0.2
Cadmium	µg/l	5	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.103	< 0.103	<0.1	<0.1
Calcium	mg/l		63	63	85	76	69	80	77	61	79	99	84	72	72	64	65	57	105	58	62	68	81	64	70.7	69.9	71	59
Chloride	mg/l		2.5	2.5	49	13	22	40	54	2.9	37	106	54	54	47	10	7.1	2.2	95	6.3	3.2	27	39	2.9	3.27	4.23	4.5	5.3
Chromium	µg/l	100	<0.4	<0.4	2.2	<0.4	<0.4	1.2	0.9	0.9	1.7	2.2	0.9	1.3	<0.4	0.6	<0.4	0.8	1.2	<0.4	0.7	1	<0.4	<0.4	0.902	0.983	<0.4	<0.4
Conductivity	µmhos /		625	606	800	679	658	769	846	530	746	1040	806	728	759	566	553	502	1040	533	582	634	753	544	593	590	594	526
Copper	µg/l	1300	< 1.00	< 1.00	13	8.7	3.1	17	3	1.5	29	16	19	1	3.1	0.6	6.5	2	6.4	2.3	2.3	60	2.1	25	9.84	1.32	1.7	3.4
Fluoride	mg/l	4	<0.12	<0.12	0.8	0.7	0.3	0.7	0.8	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.7	0.8	0.9	0.8	0.172	0.74	0.8	0.8
Hardness (CaCO3)	mg/l		346	348	394	372	341	385	386	289	383	461	400	348	370	312	301	285	488	290	332	322	379	301	325	320	328	290
Iron	mg/l		0.24	0.24	<0.01	0.39	0.22	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.1	<0.01	0.19	<0.01	0.07	0.23	0.05	0.07	0.12	0.17	0.37	0.00678	<0.01	0.2
Lead	µg/l	15	0.9	0.5	0.2	0.5	0.1	0.4	0.5	0.2	0.6	<0.1	0.5	<0.1	0.2	0.1	<0.1	0.2	0.2	0.2	0.2	0.4	<0.1	0.2	0.657	< 0.103	<0.1	<0.1
Magnesium	mg/l		46	46	44	44	41	45	47	33	45	52	47	41	46	37	34	35	55	35	43	37	43	34	36	35.4	36	35
Manganese	µg/l		11	11	0.9	27	20	3.8	1	0.4	3.3	0.4	2.3	<0.2	34	3.5	42	3.4	27	27	3.9	26	32	22	84.2	2.63	1.6	13
Mercury	µg/l	2	<0.0206	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	< 0.0206	< 0.0206	<0.02	<0.02
Nickel	µg/l	100	0.6	0.7	1.9	1	1.3	1	1.5	1.2	1	1.4	1.3	1	1.1	0.7	1.2	0.8	2.4	0.6	0.7	2.1	3	1.2	1.26	0.89	1.1	0.6
Nitrogen-Nitrate	mg/l	10	<0.12	<0.12	3	<0.1	<0.1	1.7	2.5	0.9	4.3	3.6	2.2	2.8	<0.1	0.6	<0.1	0.4	4.3	<0.1	0.7	2.2	0.4	<0.1	0.866	0.922	1	<0.1
Nitrogen-Nitrite	mg/l	1	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.08	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	< 0.0400	< 0.0400	<0.04	<0.04
pH (Lab)	s.µ.		7.6	7.6	7.4	7.4	7.7	7.5	7.3	7.5	7.5	7.4	7.6	7.5	7.6	7.5	7.5	7.6	7.4	7.5	7.7	7.5	7.4	7.5	7.63	7.56	7.4	7.4
Selenium	µg/l	50	<0.4	<0.4	1.3	<0.4	<0.4	0.9	0.7	<0.4	1.1	1.1	1	0.5	0.8	<0.4	<0.4	<0.4	1.5	<0.4	0.8	0.5	0.5	<0.4	1.29	1.27	0.6	<0.4
Silver	µg/l		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.563	0.602	<0.2	<0.2
Sodium	mg/l		3.4	3.4	16	6.3	10	15	18	2	14	37	20	19	18	4.9	3.7	2	32	4.8	2.8	11	17	2.1	< 0.206	< 0.206	2.8	3.4
Strontium	µg/l		76	76	70	96	70	71	82	55	79	80	80	62	95	93	94	53	100	71	64	56	92	48	2.89	2.89	77	105
Sulfate	mg/l		9.2	9.2	27	35	17	17	26	10	19	23	31	13	51	17	7.7	8.4	30	14	6.8	13	40	22	7.72	8.22	8.4	19
Thallium	µg/l	2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.3	<0.1	<0.1	0.2	0.2	<0.1	< 0.103	< 0.103	<0.1	<0.1
Total Solids	mg/l		349	346	494	410	374	468	524	304	470	686	522	436	500	320	312	292	696	308	338	374	480	318	342	342	340	298
Zinc	µg/l		31	32	6	5.1	5.3	15	8.2	11	2	2.9	5.6	6.4	7.9	10	2.2	8.6	2.5	3.2	3.3	4.2	4.9	6.5	8.9	8.29	2.1	3.2

RADIONUCLIDES

PARAMETER	UNITS	MCL	Well 31		Well 6	Well 7	Well 8	Well 9	Well 11	Well 12	Well 13	Well 14	Well 15	Well 16	Well 17	Well 18	Well 19	Well 20	Well 23	Well 24	Well 25	Well 26	Well 27	Well 28	Well 29	Well 29	Well 29	Well 30
Sample Date			2/14/14	2/17/14	4/23/14	4/24/14		5/5/14	5/5/14	4/24/14		4/23/14	5/6/14	4/24/14	5/5/14	4/24/14	4/23/14	4/24/14	5/5/14		5/5/14	4/24/14	5/12/14				5/6/14	5/12/14
Gross Alpha	pCi/L	15	6.2	4.4	2.4	4.7		1.4	3.4	0.5			ND	1.6	3.5	3	5.7	3.2	1.9		3.6	3	9.6				3	6.3
Gross Beta	pCi/L	50	--	--	2.9	3.7		3.2	2.9	1.8			ND	0.8	4.7	2.4	8.8	2.9	5.1		2.4	4	5.7				3.1	7.6
Radium-226	pCi/L	--	1.6	2.7	0.29	1.8		1	0.72	0.6			0.35	1	1.6	1.2	2.4	0.7	1		0.91	1.1	2.7				0.68	2.2
Radium-228	pCi/L	--	1.6	1.5	0.23	1.5		0.7	0.25	0.38			0.4	0.5	0.48	1	1.6	0.9	0.4		0.9	0.62	1.8				0.86	0.59
Combined Radium	pCi/L	5	3.2	4.2	0.52	3.3		1.7	1	1			0.75	1.5	2.1	2.2	4	1.6	1.4		1.8	1.7	4.5				1.5	2.8
Uranium	µg/L	30	0	0	--	--		--	--	--			--	--	--	--	--	--	--	--	--	--	--	--			--	--
Uranium	pCi/L	20	--	--	--	--		--	--	--			--	--	--	--	--	--	--	--	--	--	--	--			--	--

Appendix F

High Lift Pump Hydraulic Profile

Project: Madison Well 31

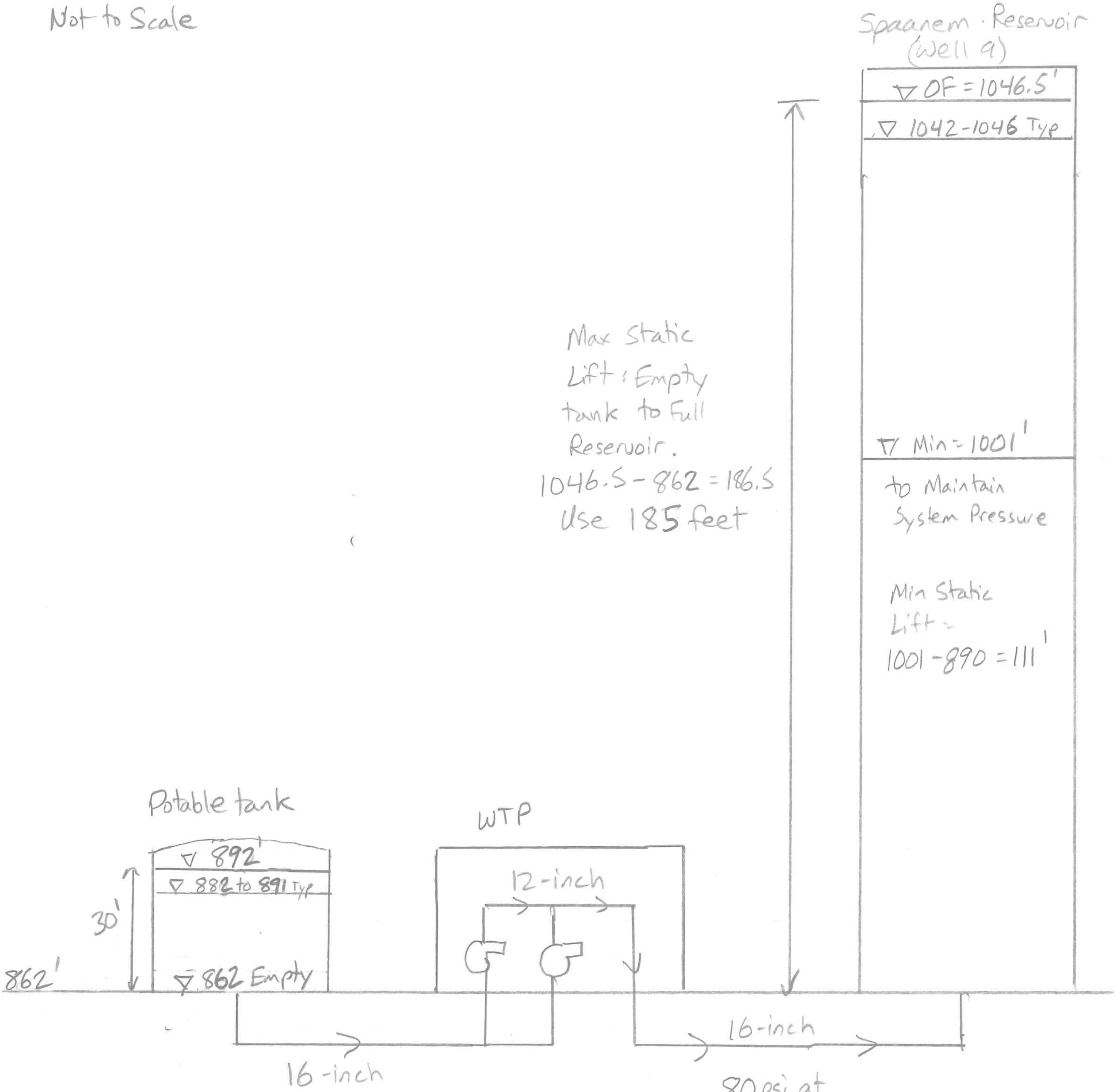
Subject: High lift pump hydraulics

Date: 11/13/14 By: Joshua Bohnert SEH #: Madwu 129083

Checked by: Date: Office: File #:

Sheet No: Of:

Not to Scale



Max Static Lift: Empty tank to Full Reservoir.
1046.5 - 862 = 186.5
Use 185 feet

Min Static Lift = 1001 - 890 = 111'

Height varies based on construction (30 to 32 feet)

Process piping
Δh = 12 feet @ 3500 gpm

80 psi at Site

Headloss to Site:
58 feet @ 3500 gpm
32 feet @ 2200 gpm

Appendix G

Potable Tank Volume Justification

SEH

Project: Madison Well 31 WTP
Subject: Potable water tank storage
Date: 10/29/14 By: Joshua Bohnert SEH #: Madwu 129083
Checked by: Date: Office: File #:
Sheet No: Of:

Volume of Spaanem tank = 3.0 MG
overflow = 1046.5 feet
highest elevation in Pressure Zone for services = 955 feet

Spaanem tank is a ground storage Standpipe of 71.2 feet in diameter → Area = 3981 ft^2 = 29783 gal / foot

Lowest useful level in Spaanem Tank =

955 + 20(2.31) = 1001 feet (45.5 feet down)

Useful Volume = 1.36 MG (29,783 gal/ft x 45.5 feet)

Total Required in Pressure Zone = 2.11 MG to 4.75 MG
2025 to Full buildout

Year 2025 : 2.11 MG − 1.36 MG = 0.75 MG Needed

Full Buildout : 4.75 MG − 1.36 MG = 3.39 MG Needed

Year 2035 : Interpolate 2005 to 2025 projected to 2035

$$\left(\frac{2.11 - 1.68 \text{ MG}}{2025 - 2005}\right) \times 10 \text{ years} = +0.22 \text{ MGD}$$

0.75 MG + 0.22 MG ≈ 1.0 MG

Year 2035 → Approximately 1.0 MG Volume is needed

The Utility has requested for 1.5 MG storage. This additional storage of 1.5 MG should allow the Pressure Zone to develope through 2035, but not to full anticipated development.

4.4 Unit Wells

Table 4-3 provides information on the well capacity, reservoir size, and booster pumping capacity for the 21 unit wells, and three independent deep wells. Well pump capacities provided in Table 4-3 are the listed outputs for the well pump. Booster pump capacities are the sum of the rated design capacities for all boosters on site.

Table 4-3
Unit Well Facility Capacities

Unit Well Identification	Well Capacity (mgd)	Reservoir Size (MG)	Total Booster Capacity (mgd)
3	2.59	0.040	2.30
6	3.46	0.155	3.02
7	3.02	0.135	3.02
8	2.59	0.140	2.38
9(1) (Spaanem)	2.45	3.00	2.88(2)(3)
10	3.17	0.100	2.59
11	2.88	0.150	3.02
12	3.46	0.150	3.02
13	3.17	0.150	2.16
14	3.46	0.150	3.02
15	3.17	0.150	3.02
16	3.46	0.279	5.04
17	2.59	0.375	5.18
18	3.17	0.477	5.47
19	3.02	3.00	8.14
20(1) (Smith)	2.88	4.20	None(2)
23	1.73	0.100	1.73
24	3.02	4.00	9.50
25	3.17	0.325	5.04
26(1) (Highpoint)	3.17	4.00	None(2)
27	3.17	0.315	5.18
28	2.88	0.341	5.04
29	3.17	0.414	6.34
30	3.17	0.400	6.05

(1) Independent Deep Well (Not Unit Well) with Distribution Floating Storage.

(2) Deep Wells 9, 20 and 26 do not require booster pumping to deliver water to the distribution system. These deep wells pump directly to floating storage facilities and water is delivered by gravity to the distribution system.

(3) Booster Station 9 can be used to pump water from Reservoir 9 to the distribution system to allow standpipe to be depleted below normal levels. Typically, Reservoir 9 floats directly on the distribution system and Booster Station 9 is not used.

10 feet lower than if the zone were controlled by a ground-level tank in order to maintain the minimum static pressure with low water level in the tank. For Service Zone 12, which will not have a reservoir to set the hydraulic grade line, the value under the columns headed "Water Surface Elevation" represents the intended hydraulic grade line to be created by closed-end booster pumping. Under the column headed "Serviceable Ground Elevation, Top of Zone" for non-PRV service zones, the values given:

- Represent the highest elevation that should be considered for service
- May be acceptable near storage facilities
- May need to be lowered far from storage facilities if low system pressures occur

The service zone layout criteria presented in Table 5-9, when applied to the MWU service area results in the future service zone layout for the MWU water system as presented in Figure 6-7 in Chapter 6. Based on actual ground elevations from Figure 6-7, Table 5-10 presents expected service conditions within the future service zones.

Table 5-10
Future Service Conditions

	Water Surface Elevation, ft		Actual Ground Elevation, ft		Static Pressure, psi			
					Full Tank		Tank 1/2 Down (1)	
Service Zone	Full Tank	Tank 1/2 Down(1)	Highest GE (2)	Lowest GE	Highest GE	Lowest GE	Highest GE	Lowest GE
123	1,140	1,120	1,038	933	44	90	36	81
4	1,047	1,037	955	850	40	90	36	81
5	1,140	1,120	1,010	933	56	90	48	81
6E	1,080	1,070	988	850	40	100	36	95
6W	1,055	1,045	963	850	40	90	36	84
7	1,171	1,161	1,079	964	40	90	36	85
8	1,200	1,190	1,108	993	40	90	36	85
9	1,245	1,225	1,140	1,038	46	90	37	81
10	1,321	1,301	1,190	1,114	57	90	48	81
11	1,280	1,260	1,170	1,073	48	90	39	81
12	1,140	1,120	1,030	933	48	90	39	81
123 PRV-E	1,140	1,120	933	890	90	108	81	100
123 PRV-W	1,140	1,120	933	880	90	113	81	104
7 PRV-N	1,171	1,161	964	900	90	117	85	113
7 PRV-S	1,171	1,161	964	870	90	130	85	126
8 PRV	1,200	1,190	993	930	90	117	85	113
9 PRV	1,245	1,225	1,038	980	90	115	81	106
10 PRV	1,321	1,301	1,114	1,108	90	92	81	84

(1) Approximately

(2) For non-PRV service zones the highest ground elevation far from storage facilities may need to be lower

Table 5-12
Required Emergency Storage Volume

Service Zone	Equalization Storage Volume, MG					
	2005	2010	2015	2020	2025	Buildout
123	0.70	0.83	0.92	1.03	1.21	4.04
4	0.53	0.57	0.60	0.64	0.70	2.29
5	0.07	0.07	0.07	0.07	0.07	0.08
6E	4.38	4.42	4.47	4.55	4.64	5.28
6W	7.13	7.38	7.67	7.99	8.06	8.26
7	1.88	1.88	1.88	1.89	1.91	1.94
8	1.38	1.53	1.68	1.85	2.01	2.71
9	0.35	0.37	0.38	0.39	0.41	0.45
10	0.13	0.17	0.25	0.33	0.42	0.72
11	0.04	0.07	0.09	0.12	0.16	0.31
12	0.00	0.00	0.00	0.00	0.00	0.07
Total	16.60	17.30	18.01	18.88	19.60	26.15

5.2.3.1.4 Total storage

The required total storage volume is the sum of required equalization, fire and emergency storage volumes defined previously. The required total storage volume for each service zone at each stage of development is presented in Table 5-13.

Table 5-13
Required Total Storage Volume

Service Zone	Equalization Storage Volume, MG					
	2005	2010	2015	2020	2025	Buildout
123	1.50	2.57	2.75	2.98	3.34	7.99
4	1.68	1.75	1.80	1.88	2.11	4.75
5	0.34	0.33	0.33	0.34	0.34	0.34
6E	8.39	7.65	7.72	7.83	7.96	8.87
6W	11.45	11.79	12.18	12.61	12.71	12.98
7	4.32	4.33	4.32	4.34	4.37	4.41
8	3.42	3.66	3.91	4.19	4.45	5.52
9	1.51	1.56	1.58	1.61	1.64	1.72
10	1.01	1.10	1.27	1.46	1.64	2.21
11	0.37	0.45	0.50	0.57	0.65	0.97
12	0.00	0.00	0.00	0.00	0.14	0.34
Total	34.00	35.19	36.37	37.81	39.34	50.11

Table 5-11
Required Equalization Storage Volume

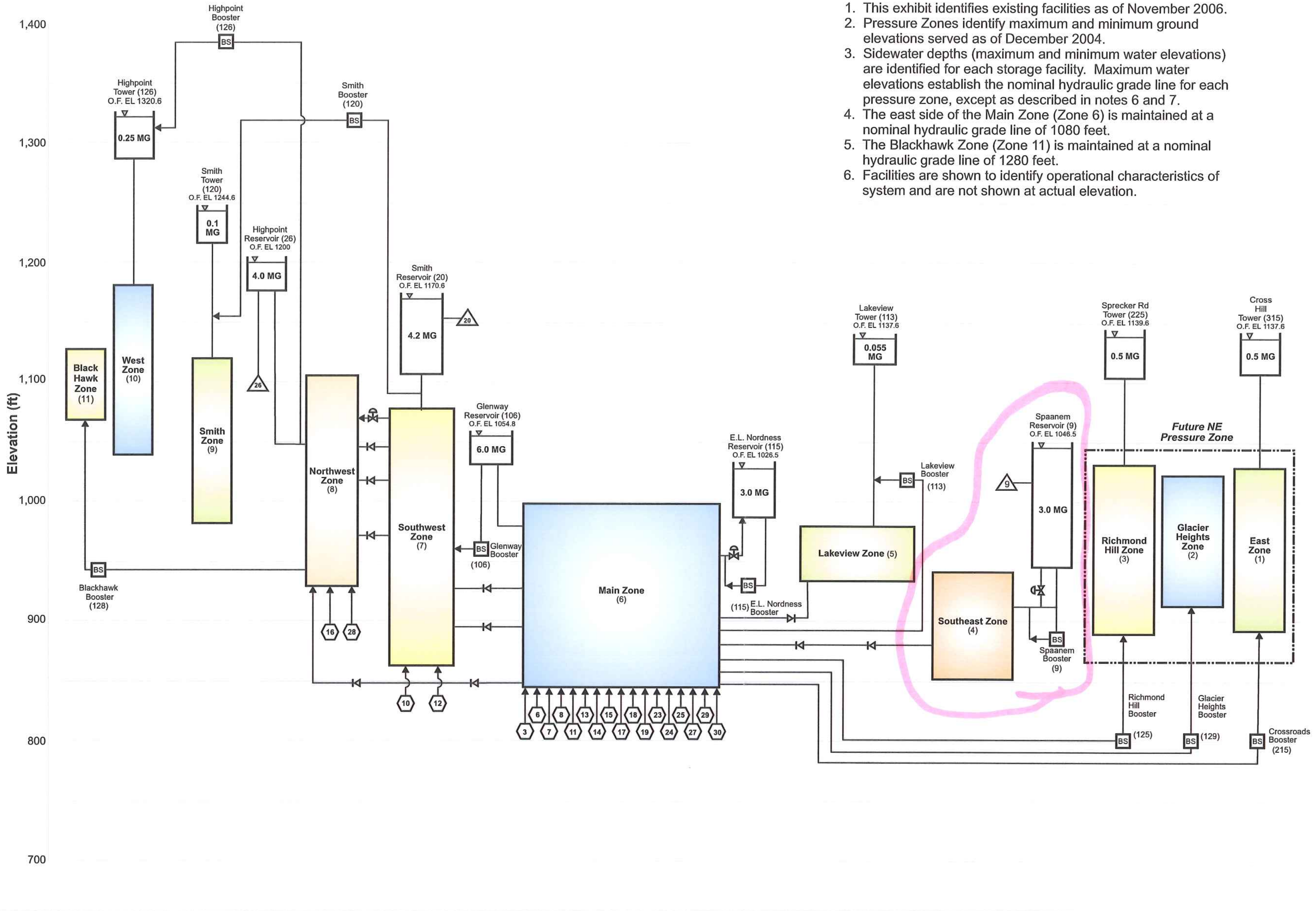
Service Zone	Equalization Storage Volume, MG					
	2005	2010	2015	2020	2025	Buildout
123	0.52	1.11	1.20	1.32	1.50	3.32
4	0.52	0.55	0.57	0.60	0.66	1.70
5	0.14	0.14	0.14	0.14	0.14	0.15
6E	3.03	2.60	2.62	2.65	2.69	2.96
6W	3.69	3.78	3.88	3.99	4.02	4.09
7	1.81	1.82	1.81	1.82	1.83	1.84
8	1.41	1.50	1.61	1.71	1.80	2.18
9	0.53	0.56	0.57	0.58	0.60	0.64
10	0.25	0.30	0.39	0.50	0.59	0.86
11	0.09	0.14	0.17	0.21	0.25	0.42
12	0.00	0.00	0.00	0.00	0.02	0.14
Total	11.99	12.49	12.97	13.54	14.09	18.31

5.2.3.1.2 Fire Storage

The required fire storage volume is based on planned future land use, and therefore remains unchanged at each stage of development. The required fire storage volume for each service zone is presented in Table 5-7.

5.2.3.1.3 Emergency Storage

Provided emergency power is installed at unit wells, the emergency storage volume should be no less than annual average demand for 12 hours. It will be important for the MWU to establish and implement procedures to promptly notify customers of emergency conditions and request they reduce water use to essential household purposes, and to promptly switch supply facilities to emergency power in the event of a power outage. The required emergency storage volume for each service zone at each stage of development is presented in Table 5-12.



Notes.
1. This exhibit identifies existing facilities as of November 2006.
2. Pressure Zones identify maximum and minimum ground elevations served as of December 2004.
3. Sidewater depths (maximum and minimum water elevations) are identified for each storage facility. Maximum water elevations establish the nominal hydraulic grade line for each pressure zone, except as described in notes 6 and 7.
4. The east side of the Main Zone (Zone 6) is maintained at a nominal hydraulic grade line of 1080 feet.
5. The Blackhawk Zone (Zone 11) is maintained at a nominal hydraulic grade line of 1280 feet.
6. Facilities are shown to identify operational characteristics of system and are not shown at actual elevation.

City of Madison, Wisconsin
Water Master Plan
2006

Quality and Reliability since 1882
Madison Water Utility

Legend

- ⋈ Control Valve
- ⧏ Check Valve
- △ Well
- BS Booster Station
- ⬡ Unit Well (All unit wells consist of a deep well, ground storage reservoir, and high-service booster station)

EXISTING SYSTEM SCHEMATIC

BLACK & VEATCH
building a world of difference™

Figure 4-2

P:03896Edwards\138101 Madison WI\10 GIS and Graphics\Existing System Schematic.cdr ADI 11/16/06

Appendix H

Unit Equation

Unity Equation for radioactive materials entering sanitary sewer
Madison, Wisconsin
Column 2 with 36 inches of Pyrolusite
Backwash sampling occurred immediately after Cycle 2

Well No. 31 Based on Well 7

Flux rate =	15	gpm/ft^2
Area of column =	0.35	ft^2
Flow rate =	5.25	gpm

Backwash Cycle	Run Time (hrs)	Gallons Treated
Cycle 1	23	7,245
Cycle 2	**21**	**6,615**
Cycle 3	22	6,930
Total	66	20,790

Backwash Cycle

Flux rate =	22	gpm/ft^2
Run time =	7	minutes
Flow rate =	7.7	gpm
Volume =	53.9	gallons

Well No. 31: Radium-226

Raw Water	1.41	pCi/L
Finished Water	0.11	pCi/L
Backwash Water	35.0	pCi/L

Well No. 31: Radium-228

Raw Water	1.10	pCi/L
Finished Water	0.20	pCi/L
Backwash Water	49.1	pCi/L

Well No. 31: Total Uranium Activity

Raw Water	1.54	pCi/L
Finished Water	3.36	pCi/L
Backwash Water	6.66	pCi/L

Removal Efficiencies

Ra-226	92%
Ra-228	82%
Total Uranium	-118%

Radioactive Loadings Based On Removals

Avg. Ra-226	160	pCi/L
Avg. Ra-228	110	pCi/L
Avg. Total Uranium	-223	pCi/L

Discharges to a Sanitary Sewer Based on Removals

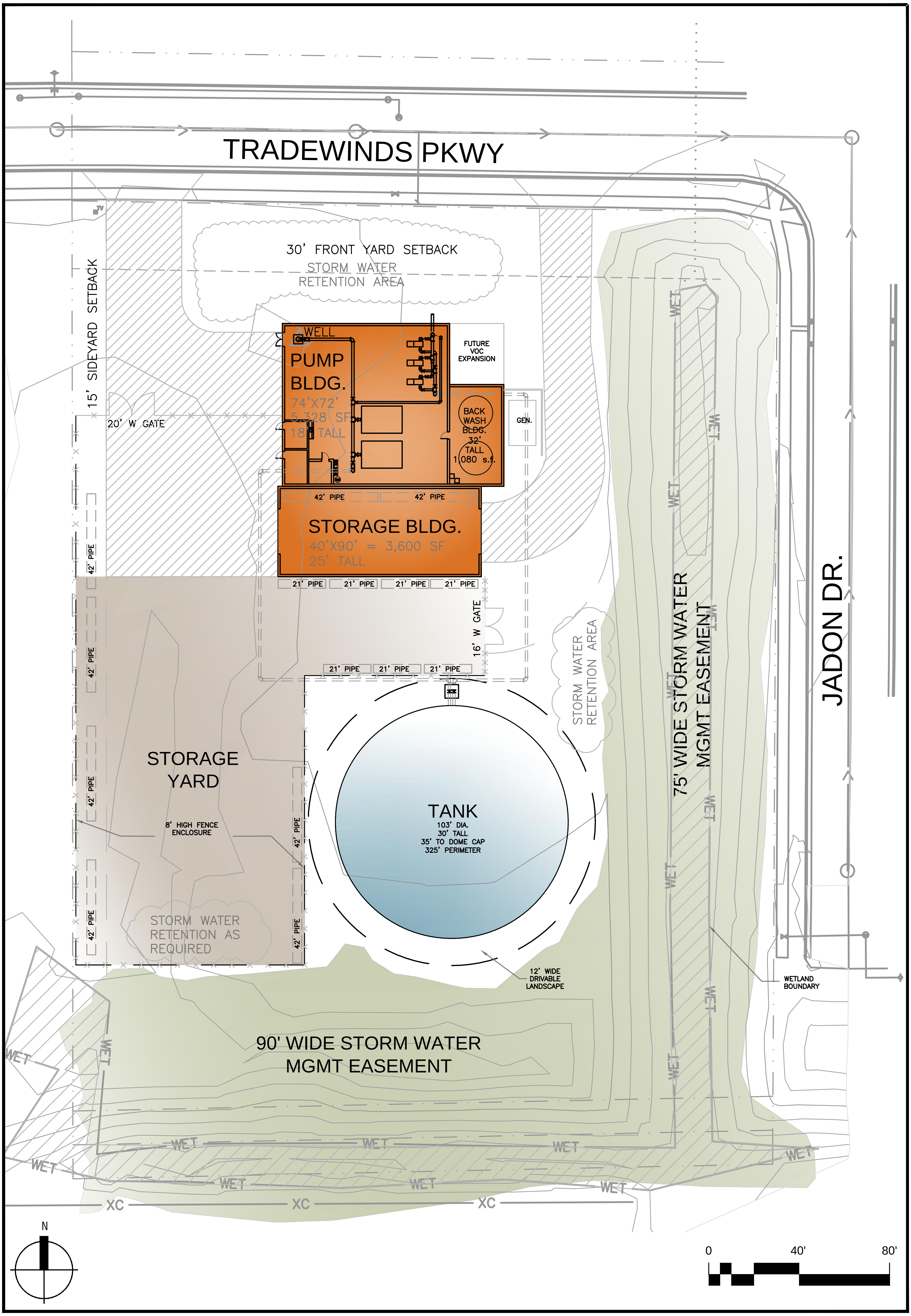
Unity Equation	0.38

Discharges to a Sanitary Sewer Based on Sampling

Unity Equation	0.14	< 1

Appendix I

Option 1 Plan View and Cost Estimate



UNIT WELL 31 - OPTION 1

MADISON WATER UTILITY

11/06/2014

PRELIMINARY CONSTRUCTION COST ESTIMATE
Madison Water Utility (MADWU)
Unit Well 31
Pyrlolusite Filtration & Storage Facility
Option 1

Water Treatment Facility; 31

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
SITE WORK (GRADING, PAVING, LANDSCAPING)	LS	1	$125,000.00	$125,000.00
WATERMAIN	LS	1	$25,000.00	$25,000.00
SANITARY SEWER	LS	1	$10,000.00	$10,000.00
STORM SEWER	LS	1	$40,000.00	$40,000.00
GENERAL BUILDING CONSTRUCTION (WALLS, ROOF, FLOOR, ARCHITECTURAL FINISHES ETC)	SF	6108	$127.00	$775,716.00
MECHANICAL & PLUMBING	LS	1	$75,000.00	$75,000.00
ELECTRICAL (inluding generator)	LS	1	$1,000,000.00	$1,000,000.00
ABOVE GROUND INDOOR BACKWASH PAINTED STEEL TANK (75,000 GAL)	EACH	2	$185,000.00	$370,000.00
BACKWASH TANK CONCRETE PADS	LS	1	$40,000.00	$40,000.00
FILTRATION EQUIPMENT	LS	1	$375,000.00	$375,000.00
PUMPING EQUIPMENT	LS	1	$70,000.00	$70,000.00
WELL PUMP AND MOTOR	LS	1	$150,000.00	$150,000.00
PROCESS PIPING, VALVES ETC.	LS	1	$200,000.00	$200,000.00
CHEMICAL FEED EQUIPMENT	LS	1	$100,000.00	$100,000.00
SCADA/SURVALIENCE Automated Control	LS	1	$485,000.00	$485,000.00
SUBTOTAL				$3,840,720.00
CONTINGENCY - 5%				$192,040.00
TOTAL ESTIMATED WATERMAIN CONSTRUCTION COST				$4,032,760.00

Unit Well 31
Pyrlolusite Filtration & Storage Facility

1.5MG Steel Round Tank

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
1.5 MG wire round tank (15 week construction schedule)	LS	1	$995,000.00	$995,000.00
Special Coatings Treatment (HYDROPHLON, LETTERING, ETC)	SF	9500	$20.00	$190,000.00
Site work MH, Process Piping and Valves	LS	1	$30,000.00	$30,000.00
Mixing System	LS	1	$50,000.00	$50,000.00
Hydrant and Valve	EACH	1	$4,000.00	$4,000.00
EXCAVATION	LS	1	$50,000.00	$50,000.00
SUBTOTAL				$1,319,000.00
TOTAL ESTIMATED COST				$1,319,000.00

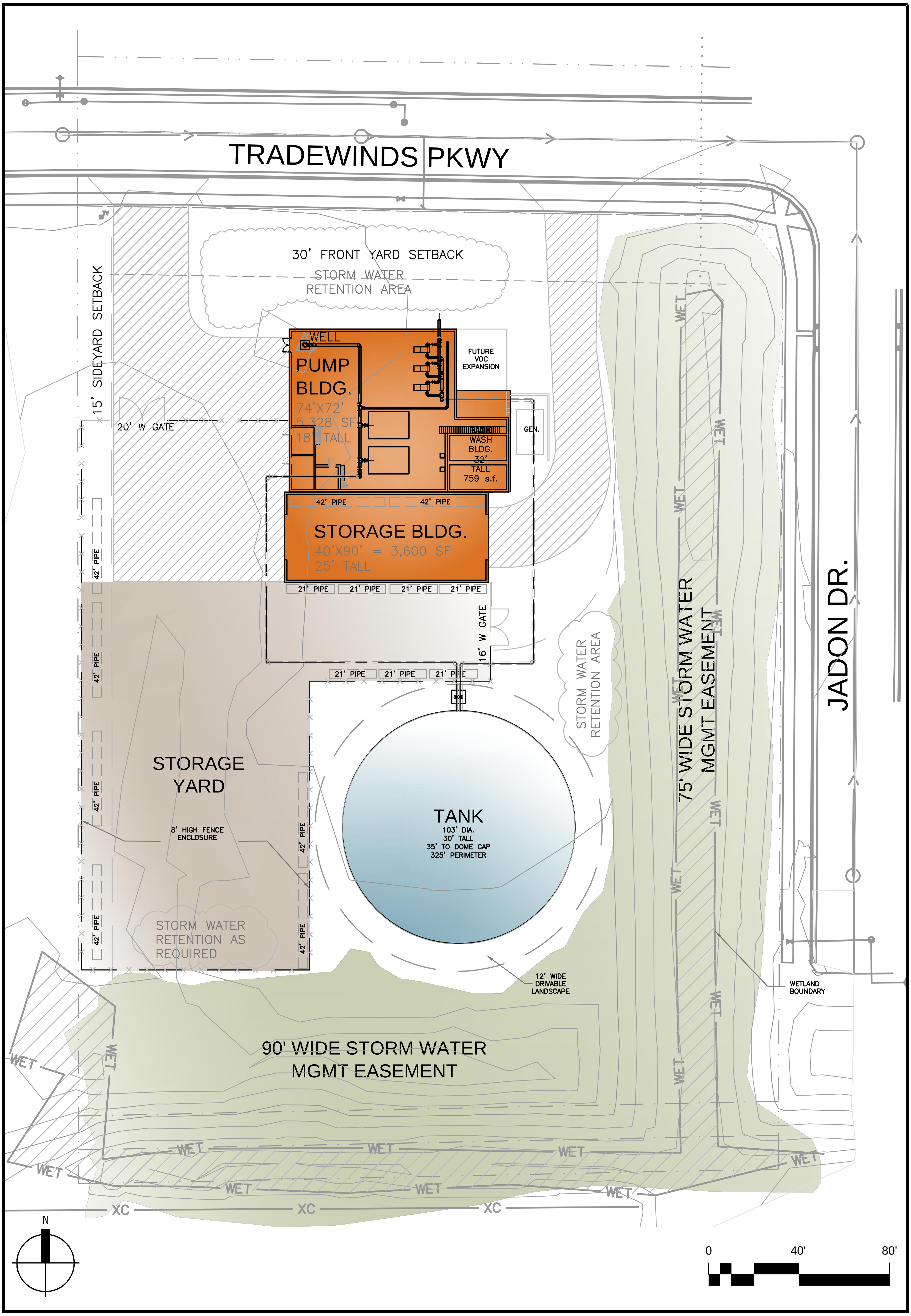
Storage Facility

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
STORAGE FACILITY	SF	3900	$100.00	$390,000.00
SUBTOTAL				$390,000.00
TOTAL ESTIMATED COST				**$390,000.00**

TOTAL ESTIMATED COST	**$5,741,760.00**

Appendix J

Option 1A Plan View and Cost Estimate



UNIT WELL 31 - OPTION 1A

MADISON WATER UTILITY

10/06/2014

PRELIMINARY CONSTRUCTION COST ESTIMATE
Madison Water Utility (MADWU)
Unit Well 31
Pyrlolusite Filtration & Storage Facility
Option 1 A

Water Treatment Facility; 31

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
SITE WORK (GRADING, PAVING, LANDSCAPING)	LS	1	$125,000.00	$125,000.00
WATERMAIN	LS	1	$25,000.00	$25,000.00
SANITARY SEWER	LS	1	$10,000.00	$10,000.00
STORM SEWER	LS	1	$40,000.00	$40,000.00
GENERAL BUILDING CONSTRUCTION (WALLS, ROOF, FLOOR, ARCHITECTURAL FINISHES ETC)	SF	6108	$127.00	$775,716.00
MECHANICAL & PLUMBING	LS	1	$75,000.00	$75,000.00
ELECTRICAL (Exterior Generator & Enclosure)	LS	1	$1,000,000.00	$1,000,000.00
ABOVE GROUND INDOOR BACKWASH TANK (100,000 GAL)	LS	1	$275,000.00	$275,000.00
FILTRATION EQUIPMENT	LS	1	$375,000.00	$375,000.00
PUMPING EQUIPMENT	LS	3	$70,000.00	$210,000.00
WELL PUMP AND MOTOR	LS	1	$150,000.00	$150,000.00
PROCESS PIPING, VALVES, SMALL PUMPS ETC.	LS	1	$200,000.00	$200,000.00
CHEMICAL FEED EQUIPMENT	LS	1	$100,000.00	$100,000.00
SCADA/SURVALIENCE Automated Control	LS	1	$485,000.00	$485,000.00
SUBTOTAL				$3,845,720.00
CONTINGENCY - 5%				$192,290.00
TOTAL ESTIMATED WATERMAIN CONSTRUCTION COST				$4,038,010.00

Unit Well 31
Pyrlolusite Filtration & Storage Facility

1.5MG Wire Round Concrete Tank

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
1.5 MG wire round tank (15 week construction schedule)	LS	1	$995,000.00	$995,000.00
Architecture Treatment (Partial Treatment)	SF	3000	$62.00	$186,000.00
Site work MH, Process Piping and Valves	LS	1	$30,000.00	$30,000.00
Mixing System	LS	1	$50,000.00	$50,000.00
Hydrant and Valve	EACH	1	$4,000.00	$4,000.00
EXCAVATION	LS	1	$50,000.00	$50,000.00
SUBTOTAL				$1,315,000.00
TOTAL ESTIMATED COST				$1,315,000.00

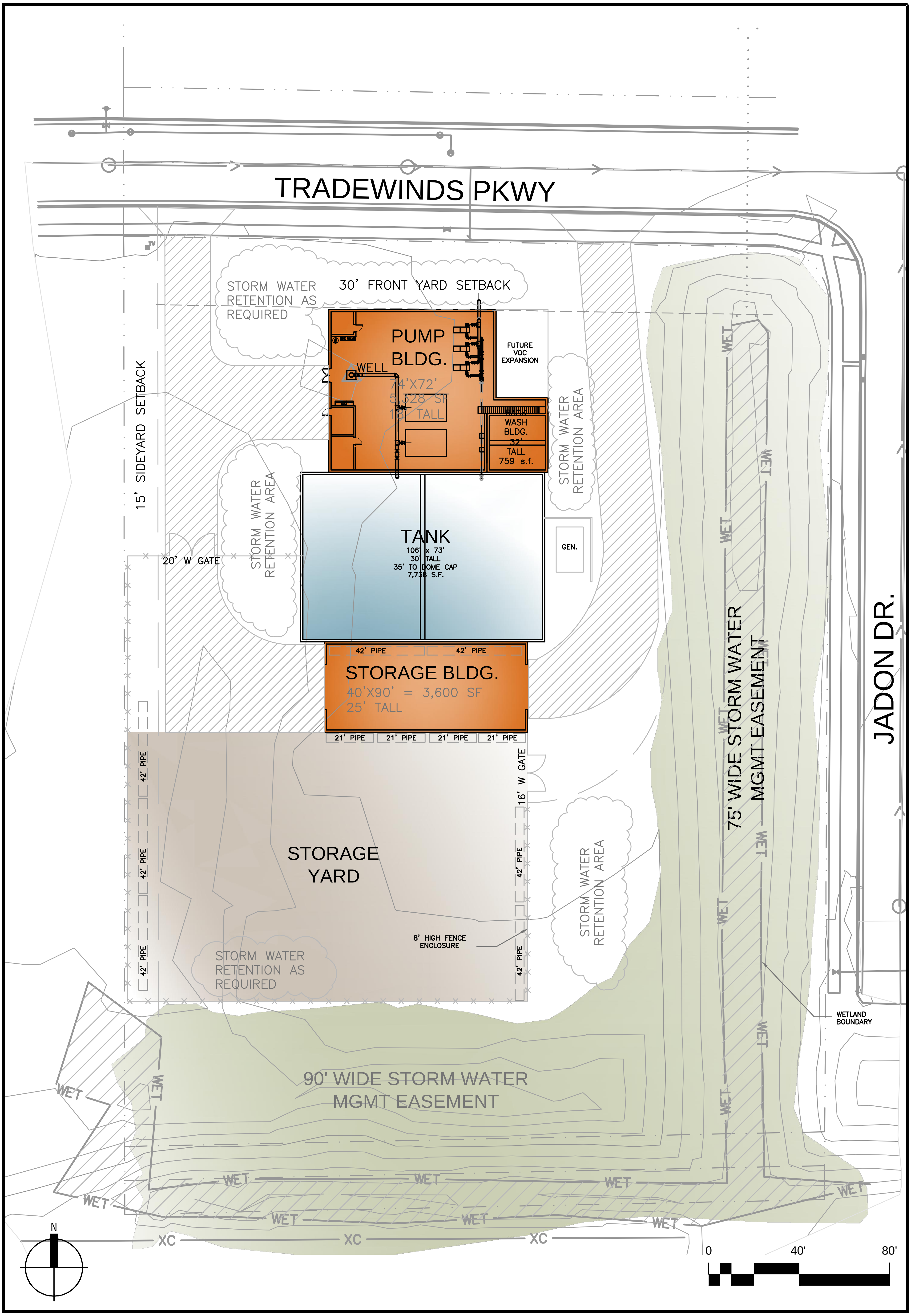
Storage Facility

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
STORAGE FACILITY	SF	3900	$100.00	$390,000.00
SUBTOTAL				$390,000.00
TOTAL ESTIMATED COST				**$390,000.00**

TOTAL ESTIMATED COST	**$5,743,010.00**

Appendix K

Option 2 Plan View and Cost Estimate



UNIT WELL 31 - OPTION 2

MADISON WATER UTILITY

11/06/2014

PRELIMINARY CONSTRUCTION COST ESTIMATE
Madison Water Utility (MADWU)
Unit Well 31: Option 2
Pyrlolusite Filtration & Storage Facility

Water Treatment Facility; 31

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
SITE WORK (GRADING, PAVING, LANDSCAPING)	LS	1	$125,000.00	$125,000.00
WATERMAIN	LS	1	$25,000.00	$25,000.00
SANITARY SEWER	LS	1	$10,000.00	$10,000.00
STORM SEWER	LS	1	$40,000.00	$40,000.00
GENERAL BUILDING CONSTRUCTION (WALLS, ROOF, FLOOR, ARCHITECTURAL FINISHES ETC)	SF	6108	$127.00	$775,716.00
MECHANICAL & PLUMBING	LS	1	$75,000.00	$75,000.00
ELECTRICAL (inluding generator)	LS	1	$1,000,000.00	$1,000,000.00
ABOVE GROUND INDOOR BACKWASH TANK (100,000 GAL)	LS	1	$275,000.00	$275,000.00
FILTRATION EQUIPMENT	LS	1	$375,000.00	$375,000.00
PUMPING EQUIPMENT	LS	3	$70,000.00	$210,000.00
WELL PUMP AND MOTOR	LS	1	$150,000.00	$150,000.00
PROCESS PIPING, VALVES ETC.	LS	1	$200,000.00	$200,000.00
CHEMICAL FEED EQUIPMENT	LS	1	$100,000.00	$100,000.00
SCADA/SURVALIENCE Automated Control	LS	1	$485,000.00	$485,000.00
SUBTOTAL				$3,845,720.00
CONTINGENCY - 5%				$192,290.00
TOTAL ESTIMATED WATERMAIN CONSTRUCTION COST				**$4,038,010.00**

Unit Well 31: Option 2
Pyrlolusite Filtration & Storage Facility

1.5MG Rectangular Concrete

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
1.5 MG Concrete (106-ft x 73-ft x30-ft) with Concrete Cover Max 35-ft	LS	1	$2,500,000.00	$2,500,000.00
Mixing System	LS	1	$50,000.00	$50,000.00
Hydrant and Valve	EACH	1	$4,000.00	$4,000.00
EXCAVATION	LS	1	$25,000.00	$25,000.00
SUBTOTAL				$2,579,000.00
TOTAL ESTIMATED COST				**$2,579,000.00**

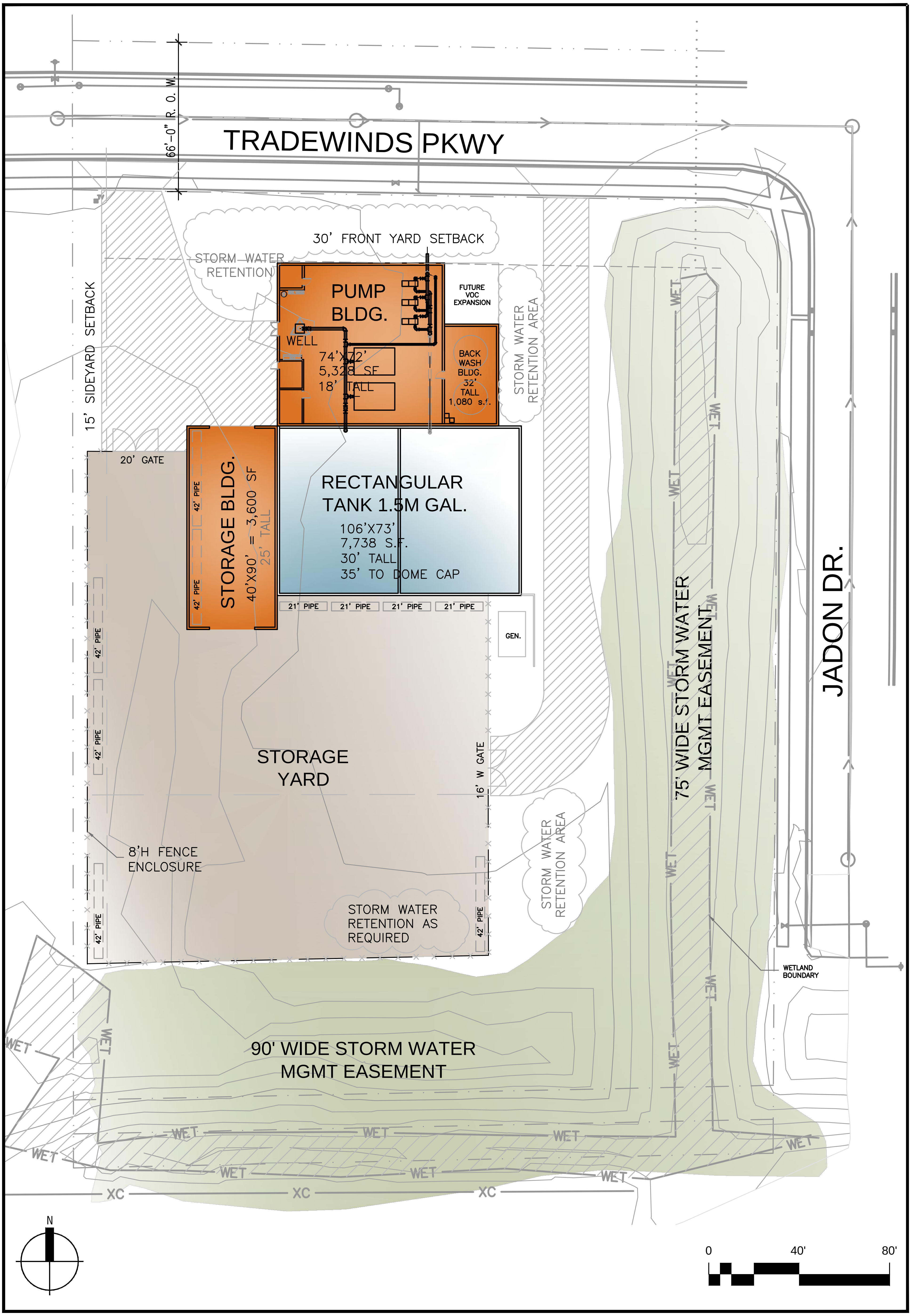
Storage Facility

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
STORAGE FACILITY	SF	3900	$100.00	$390,000.00
SUBTOTAL				$390,000.00
TOTAL ESTIMATED COST				**$390,000.00**

TOTAL ESTIMATED COST	**$7,007,010.00**

Appendix L

Option 2A Plan View and Cost Estimate



Quality and Reliability since 1882
Madison Water Utility
mwu

UNIT WELL 31 - OPTION 2A

MADISON WATER UTILITY

10/06/2014

SEH

Potter Lawson
Success by Design

PRELIMINARY CONSTRUCTION COST ESTIMATE
Madison Water Utility (MADWU)
Unit Well 31: Option 2A
Pyrlolusite Filtration & Storage Facility

Water Treatment Facility; 31

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
SITE WORK (GRADING, PAVING, LANDSCAPING)	LS	1	$125,000.00	$125,000.00
WATERMAIN	LS	1	$25,000.00	$25,000.00
SANITARY SEWER	LS	1	$10,000.00	$10,000.00
STORM SEWER	LS	1	$40,000.00	$40,000.00
GENERAL BUILDING CONSTRUCTION (WALLS, ROOF, FLOOR, ARCHITECTURAL FINISHES ETC)	SF	6108	$127.00	$775,716.00
MECHANICAL & PLUMBING	LS	1	$75,000.00	$75,000.00
ELECTRICAL (inluding generator)	LS	1	$1,000,000.00	$1,000,000.00
ABOVE GROUND INDOOR BACKWASH STEEL TANK (75,000 GAL)	EACH	2	$185,000.00	$370,000.00
BACKWASH TANK CONCRETE PADS	LS	1	$40,000.00	$40,000.00
FILTRATION EQUIPMENT	LS	1	$375,000.00	$375,000.00
PUMPING EQUIPMENT	LS	1	$70,000.00	$70,000.00
WELL PUMP AND MOTOR	LS	1	$150,000.00	$150,000.00
PROCESS PIPING, VALVES ETC.	LS	1	$200,000.00	$200,000.00
CHEMICAL FEED EQUIPMENT	LS	1	$100,000.00	$100,000.00
SCADA/SURVALIENCE Automated Control	LS	1	$485,000.00	$485,000.00
SUBTOTAL				$3,840,720.00
CONTINGENCY - 5%				$192,040.00
TOTAL ESTIMATED WATERMAIN CONSTRUCTION COST				**$4,032,760.00**

Unit Well 31: Option 2A
Pyrlolusite Filtration & Storage Facility

1.5MG Rectangular Concrete

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
1.5 MG Concrete (106-ft x 73-ft x30-ft) with Concrete Cover Max 35-ft	LS	1	$2,500,000.00	$2,500,000.00
Mixing System	LS	1	$50,000.00	$50,000.00
Hydrant and Valve	EACH	1	$4,000.00	$4,000.00
EXCAVATION	LS	1	$25,000.00	$25,000.00
SUBTOTAL				$2,579,000.00
TOTAL ESTIMATED COST				**$2,579,000.00**

Storage Facility

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
STORAGE FACILITY	SF	3900	$100.00	$390,000.00
SUBTOTAL				$390,000.00
TOTAL ESTIMATED COST				**$390,000.00**

TOTAL ESTIMATED COST	**$7,001,760.00**

Appendix M

Sanitary Sewer Profile

Project: Madison Well 31

Subject: Sanitary Sewer from Backwash

Date: 11/14/14 By: Joshua Bohnert SEH #: Madwu 129083

Checked by: Date: Office: File #:

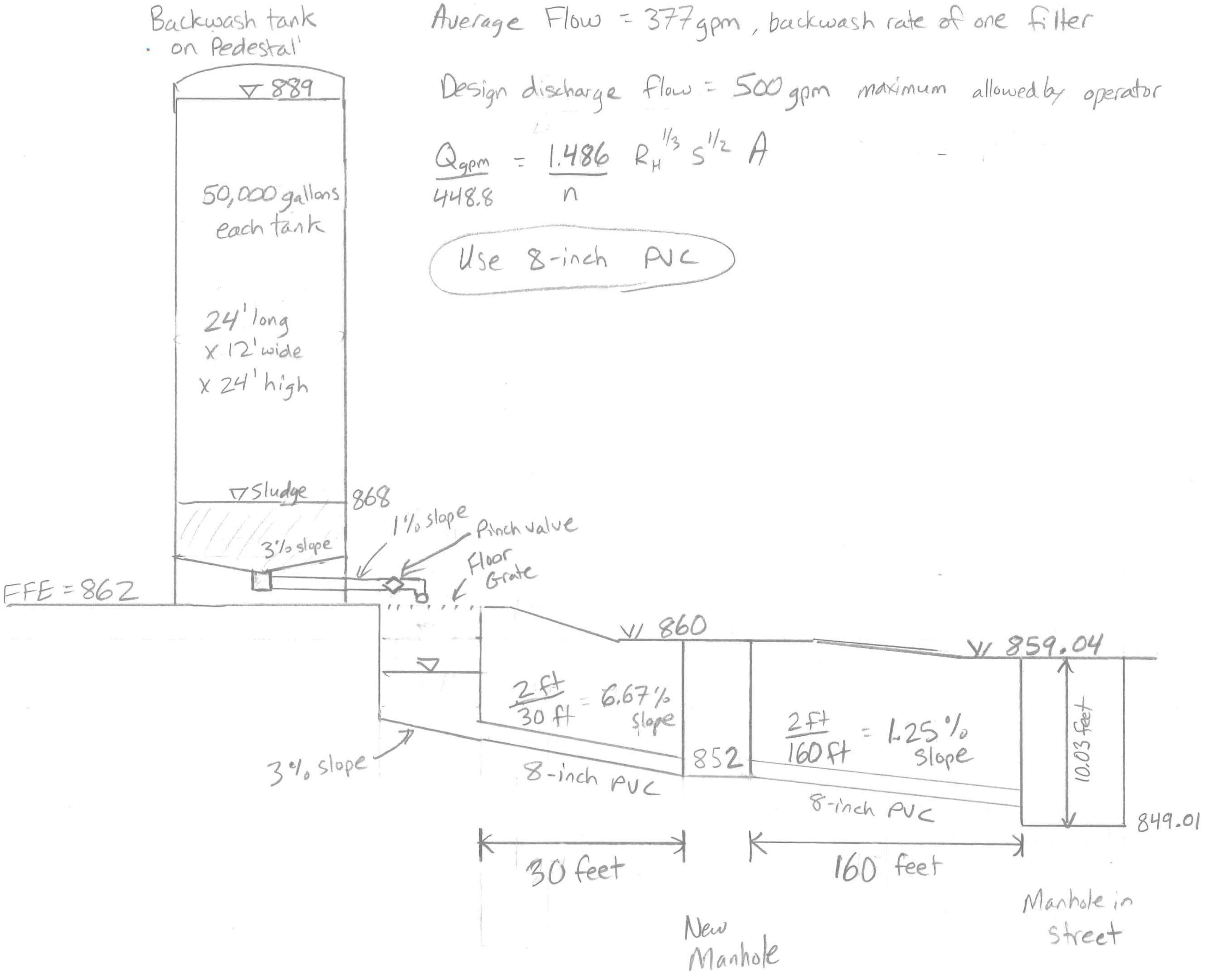
Sheet No: Of:

Average Flow = 377 gpm, backwash rate of one filter

Design discharge flow = 500 gpm maximum allowed by operator

$$\frac{Q_{gpm}}{448.8} = \frac{1.486}{n} R_H^{1/3} S^{1/2} A$$

Use 8-inch PVC



Appendix N

Potable Tank Life Cycle Analyses

N-1 – Steel Cylindrical Potable Tank
N-2 – Wire-Wound Concrete Cylindrical Potable Tank
N-3 – Cast-in-Place Concrete Cylindrical Potable Tank
N-4 – Cast-in-Place Concrete Rectangular Potable Tank

Tank Life Cycle Analysis Worksheet
120-year Present Worth Analysis

1.5 MG Cylindrical Steel Potable Water Ground Storage Tank, 102-foot diameter, 27-foot tall

General Maintenance Costs	Touch Up	Touch Up Cost ($/SF)	Maintenance Repaint Cost ($/SF)	Full Recoat Cost ($/SF)	Wash ($/SF)
Interior Wet	7.5%	11.4		5.84	
Interior Dry	7.5%	10.55	3.03	3.8	0.5
Exterior	7.5%	12.74	5.23	5.99	0.5

Paint Areas	Area (ft^2)			
Interior Wet	8,587	8,811		60,181
Interior Dry	0	0	0	0
Exterior	16,685	19,131	104,716	119,933
Total	25,273	28,000	105,000	180,000
Job Size Update Factor	1.2			

Major Assumptions

Inflation rate of 3.0 %
No Containment Required
ISC-1 Interior Paint, ISC-2 Exterior Paint

Inflation Rate = 3.0%

Year	Capital Costs	Touch Up (7.5 % of Area)	Interior Wet Paint (ICS-2)	Exterior Paint (OCS-4)	Wash	Inspection (NR 810)	Mobilization	Site Restoration	Present Worth	Worth at Year of Expenditure
0	$ 995,000								$ 995,000	$ 995,000
5						$ 4,300			$ 4,300	$ 4,985
10					$ 8,300	$ 4,300			$ 12,600	$ 16,933
15		$ 19,000	$ 60,000			$ 4,300	$ 5,000	$ 3,000	$ 91,300	$ 142,242
20					$ 8,300	$ 4,300			$ 12,600	$ 22,757
25		$ 8,800		$ 105,000	$ -	$ -	$ 5,000	$ 3,000	$ 121,800	$ 255,022
30			$ 60,000		$ 8,300	$ 4,300	$ 5,000	$ 3,000	$ 80,600	$ 195,637
35						$ 4,300			$ 4,300	$ 12,100
40		$ 28,000			$ 8,300	$ 4,300			$ 40,600	$ 132,439
45			$ 60,000			$ 4,300	$ 5,000	$ 3,000	$ 72,300	$ 273,409
50				$ 120,000	$ -	$ -	$ 5,000	$ 3,000	$ 128,000	$ 561,140
55		$ 8,800				$ 4,300			$ 13,100	$ 66,576
60			$ 60,000		$ 8,300	$ 4,300	$ 5,000	$ 3,000	$ 80,600	$ 474,863
65		$ 19,000				$ 4,300			$ 23,300	$ 159,139
70		$ 8,800			$ 8,300	$ 4,300			$ 21,400	$ 169,441
75			$ 60,000	$ 105,000		$ -	$ 5,000	$ 3,000	$ 173,000	$ 1,587,954
80					$ 8,300	$ 4,300			$ 12,600	$ 134,075
85		$ 8,800				$ 4,300			$ 13,100	$ 161,598
90		$ 19,000	$ 60,000		$ 8,300	$ 4,300	$ 5,000	$ 3,000	$ 99,600	$ 1,424,327
95						$ 4,300			$ 4,300	$ 71,286
100	$ 35,000	$ 8,800			$ -	$ -			$ 43,800	$ 841,776

Tank capital costs include the tank, erection, and freight. Engineering and construction of additional site work is extra

Present Cost $ 2,050,000 $ 7,700,000

Q:\KO\M\Madwu\129083\5-final-dsgn\Life Cycle Costs\Potable\[Steel Potable Tank 111414.xlsx]1- 120 yr PW

Tank Life Cycle Analysis Worksheet
120-year Present Worth Analysis

One 1.5 MG Cylindrical Concrete Potable Water Ground Storage Tanks,
103-foot diameter x 35-foot high, Wire Wound

General Maintenance Costs	Wash ($/SF)
Interior Wet	
Interior Dry	0.5
Exterior	0.5

Major Assumptions

Inflation Rate = 3.0%

No Containment Required

Surface Area, Total	Area (ft^2)
Interior Wet	890,971
Interior Dry	0
Exterior	19,658
Total	910,629
Job Size Update Factor	1.2

Year	Capital Costs	Pitting Maintenance	Wash	Inspection (NR 810)	Present Worth	Worth at Year of Expenditure
0	$ 975,000				$ 975,000	$ 975,000
5				$ 4,300	$ 4,300	$ 4,985
10			$ 9,800	$ 4,300	$ 14,100	$ 18,949
15				$ 4,300	$ 4,300	$ 6,699
20		$ 50,000	$ 9,800	$ 4,300	$ 64,100	$ 115,772
25				$ 4,300	$ 4,300	$ 9,003
30			$ 9,800	$ 4,300	$ 14,100	$ 34,224
35				$ 4,300	$ 4,300	$ 12,100
40		$ 50,000	$ 9,800	$ 4,300	$ 64,100	$ 209,097
45				$ 4,300	$ 4,300	$ 16,261
50			$ 9,800	$ 4,300	$ 14,100	$ 61,813
55				$ 4,300	$ 4,300	$ 21,853
60		$ 50,000	$ 9,800	$ 4,300	$ 64,100	$ 377,652
65				$ 4,300	$ 4,300	$ 29,369
70			$ 9,800	$ 4,300	$ 14,100	$ 111,641
75				$ 4,300	$ 4,300	$ 39,469
80		$ 50,000	$ 9,800	$ 4,300	$ 64,100	$ 682,081
85				$ 4,300	$ 4,300	$ 53,044
90			$ 9,800	$ 4,300	$ 14,100	$ 201,637
95				$ 4,300	$ 4,300	$ 71,286
100	$ 35,000				$ 35,000	$ 672,652
Tank capital costs include the tank, erection, and freight. Engineering and construction of additional site work is extra					$ 1,380,000	$ 3,720,000

Q:\KO\M\Madwu\129083\5-final-dsgn\Life Cycle Costs\Potable\[Concrete Cylindrical Wire Wound Potable Tank 111414.xlsx]1- 120 yr PW

Tank Life Cycle Analysis Worksheet

120-year Present Worth Analysis

One 1.5 MG Cylindrical Concrete Potable Water Ground Storage Tanks, 103-foot diameter x 35-foot high, Cast in Place

General Maintenance Costs	Wash ($/SF)
Interior Wet	
Interior Dry	0.5
Exterior	0.5

Major Assumptions

Inflation Rate = 3.0%

No Containment Required

Surface Area, Total	Area (ft^2)
Interior Wet	19,658
Interior Dry	0
Exterior	21,131
Total	40,789
Job Size Update Factor	1.2

Year	Capital Costs	Pitting Maintenance	Wash	Inspection (NR 810)	Present Worth	Worth at Year of Expenditure
0	$ 2,100,000				$ 2,100,000	$ 2,100,000
5				$ 4,300	$ 4,300	$ 4,985
10			$ 10,600	$ 4,300	$ 14,900	$ 20,024
15				$ 4,300	$ 4,300	$ 6,699
20		$ 50,000	$ 10,600	$ 4,300	$ 64,900	$ 117,217
25				$ 4,300	$ 4,300	$ 9,003
30			$ 10,600	$ 4,300	$ 14,900	$ 36,166
35				$ 4,300	$ 4,300	$ 12,100
40		$ 50,000	$ 10,600	$ 4,300	$ 64,900	$ 211,706
45				$ 4,300	$ 4,300	$ 16,261
50			$ 10,600	$ 4,300	$ 14,900	$ 65,320
55				$ 4,300	$ 4,300	$ 21,853
60		$ 50,000	$ 10,600	$ 4,300	$ 64,900	$ 382,365
65				$ 4,300	$ 4,300	$ 29,369
70			$ 10,600	$ 4,300	$ 14,900	$ 117,976
75				$ 4,300	$ 4,300	$ 39,469
80		$ 50,000	$ 10,600	$ 4,300	$ 64,900	$ 690,594
85				$ 4,300	$ 4,300	$ 53,044
90			$ 10,600	$ 4,300	$ 14,900	$ 213,077
95				$ 4,300	$ 4,300	$ 71,286
100	$ 35,000				$ 35,000	$ 672,652
Tank capital costs include the tank, erection, and freight. Engineering and construction of additional site work is extra					$ 2,510,000	$ 4,890,000

Q:\KO\M\Madwu\129083\5-final-dsgn\Life Cycle Costs\Potable\[Concrete Cylindrical Cast in place Potable Tank 111414.xlsx]1- 120 yr PW

Tank Life Cycle Analysis Worksheet

120-year Present Worth Analysis

One 1.5 MG Rectangular Concrete Potable Water Ground Storage Tanks, 106-feet long x 73-feet wide x 35-feet high, Cast in Place

General Maintenance Costs	Wash ($/SF)
Interior Wet	
Interior Dry	0.5
Exterior	0.5

Major Assumptions

Inflation Rate = 3.0%

No Containment Required

Surface Area, Total	Area (ft^2)
Interior Wet	20,268
Interior Dry	7,738
Exterior	20,887
Total	48,893
Job Size Update Factor	1.2

Year	Capital Costs	Pitting Maintenance	Wash	Inspection (NR 810)	Present Worth	Worth at Year of Expenditure
0	$ 2,750,000				$ 2,750,000	$ 2,750,000
5				$ 4,300	$ 4,300	$ 4,985
10			$ 10,400	$ 4,300	$ 14,700	$ 19,756
15				$ 4,300	$ 4,300	$ 6,699
20		$ 50,000	$ 10,400	$ 4,300	$ 64,700	$ 116,855
25				$ 4,300	$ 4,300	$ 9,003
30			$ 10,400	$ 4,300	$ 14,700	$ 35,681
35				$ 4,300	$ 4,300	$ 12,100
40		$ 50,000	$ 10,400	$ 4,300	$ 64,700	$ 211,054
45				$ 4,300	$ 4,300	$ 16,261
50			$ 10,400	$ 4,300	$ 14,700	$ 64,443
55				$ 4,300	$ 4,300	$ 21,853
60		$ 50,000	$ 10,400	$ 4,300	$ 64,700	$ 381,187
65				$ 4,300	$ 4,300	$ 29,369
70			$ 10,400	$ 4,300	$ 14,700	$ 116,392
75				$ 4,300	$ 4,300	$ 39,469
80		$ 50,000	$ 10,400	$ 4,300	$ 64,700	$ 688,466
85				$ 4,300	$ 4,300	$ 53,044
90			$ 10,400	$ 4,300	$ 14,700	$ 210,217
95				$ 4,300	$ 4,300	$ 71,286
100	$ 35,000				$ 35,000	$ 672,652
Tank capital costs include the tank, erection, and freight. Engineering and construction of additional site work is extra					$ 3,160,000	$ 5,530,000

Q:\KO\M\Madwu\129083\5-final-dsgn\Life Cycle Costs\Potable\[Concrete Rectangle Potable Tank 111414.xlsx]1- 120 yr PW

Appendix O

Backwash Tank Life Cycle Analyses

O-1 – Steel Cylindrical Potable Tank
O-2 – Cast-in-Place Concrete Rectangular Potable Tank

Tank Life Cycle Analysis Worksheet

120-year Present Worth Analysis

Two 40,000 gallon Cylindrical Stainless Steel backwash Water Ground Storage Tank, 16-foot diameter, 27-foot tall

General Maintenance Costs	Wash ($/SF)
Interior Wet	
Interior Dry	0.5
Exterior	0.5

Surface Areas, Total	Area (ft^2)
Interior Wet	2,714
Interior Dry	0
Exterior	3,116
Total	5,831
Job Size Update Factor	1.2

Major Assumptions

Inflation Rate = 3.0%

No Containment Required

Year	Capital Costs	Pitting Maintenance	Wash	Inspection (NR 810)	Present Worth	Worth at Year of Expenditure
0	$ 185,000				$ 185,000	$ 185,000
5					$ -	$ -
10			$ 1,600	$ 2,500	$ 4,100	$ 5,510
15					$ -	$ -
20		$ 30,000	$ 1,600	$ 2,500	$ 34,100	$ 61,588
25					$ -	$ -
30			$ 1,600	$ 2,500	$ 4,100	$ 9,952
35					$ -	$ -
40		$ 30,000	$ 1,600	$ 2,500	$ 34,100	$ 111,235
45					$ -	$ -
50			$ 1,600	$ 2,500	$ 4,100	$ 17,974
55					$ -	$ -
60		$ 30,000	$ 1,600	$ 2,500	$ 34,100	$ 200,904
65					$ -	$ -
70			$ 1,600	$ 2,500	$ 4,100	$ 32,463
75					$ -	$ -
80		$ 30,000	$ 1,600	$ 2,500	$ 34,100	$ 362,854
85					$ -	$ -
90			$ 1,600	$ 2,500	$ 4,100	$ 58,632
95					$ -	$ -
100	$ 35,000				$ 35,000	$ 672,652
Tank capital costs include the tank, erection, and freight. Engineering and construction of additional site work is extra					$ 380,000	$ 1,720,000

Q:\KO\M\Madwu\129083\5-final-dsgn\Life Cycle Costs\Backwash\[Steel Backwash Tanks 111414.xlsx]1- 120 yr PW

Tank Life Cycle Analysis Worksheet
120-year Present Worth Analysis

Two 50,000 gallon Rectangular Concrete Backwash Water Ground Storage Tanks, 12-foot wide x 24-foot long x 24-foot high, 18-inch thick walls

General Maintenance Costs	Wash ($/SF)
Interior Wet	
Interior Dry	0.5
Exterior	0.5

Major Assumptions

Inflation Rate = 3.0%

No Containment Required

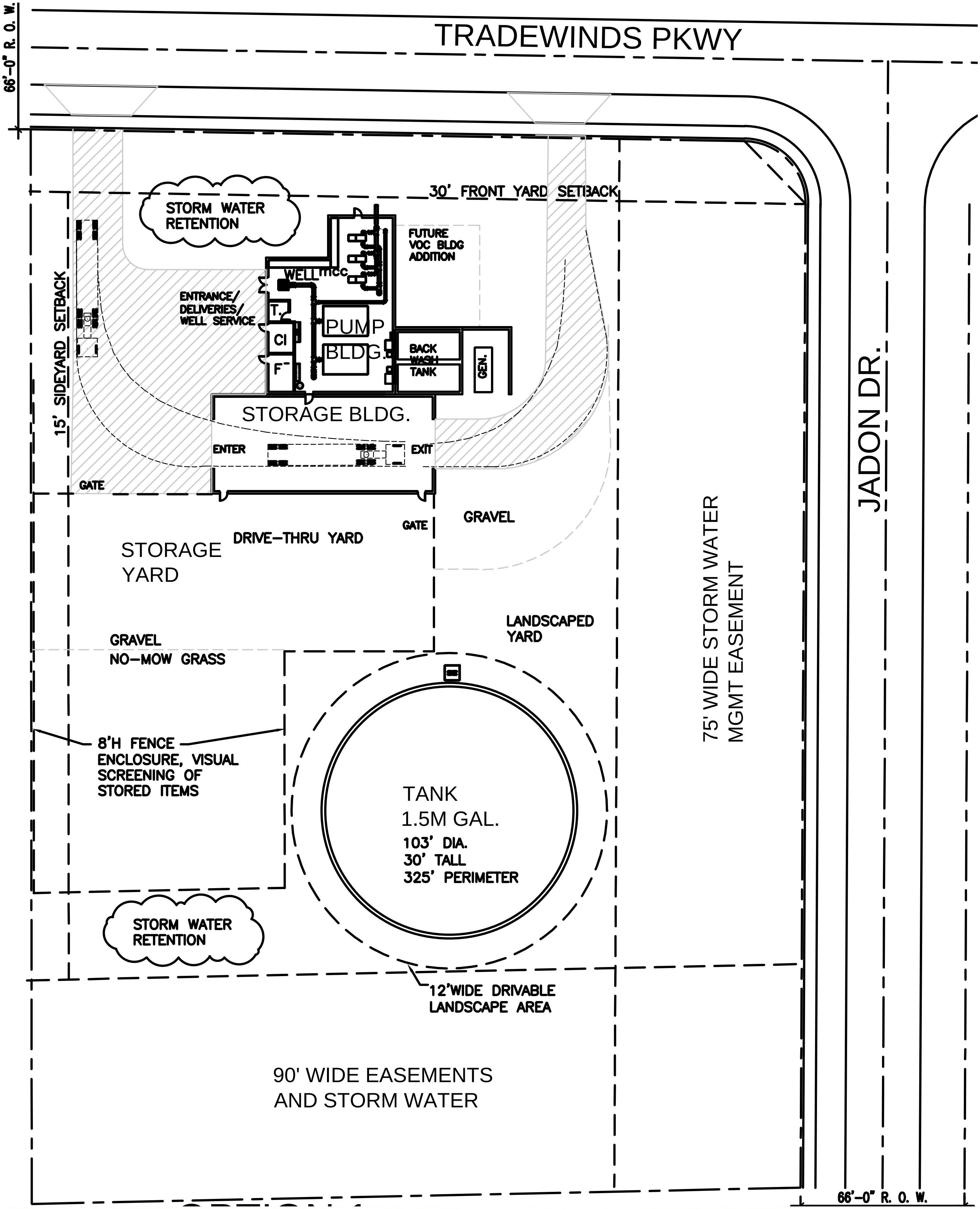
Surface Areas, Total	Area (ft^2)
Interior Wet	5,184
Interior Dry	0
Exterior	2,880
Total	8,064
Job Size Update Factor	1.2

Year	Capital Costs	Pitting Maintenance	Wash	Inspection (NR 810)	Present Worth	Worth at Year of Expenditure
0	$ 220,000				$ 220,000	$ 220,000
5					$ -	$ -
10			$ 1,400	$ 2,500	$ 3,900	$ 5,241
15					$ -	$ -
20		$ 30,000	$ 1,400	$ 2,500	$ 33,900	$ 61,227
25					$ -	$ -
30			$ 1,400	$ 2,500	$ 3,900	$ 9,466
35					$ -	$ -
40		$ 30,000	$ 1,400	$ 2,500	$ 33,900	$ 110,583
45					$ -	$ -
50			$ 1,400	$ 2,500	$ 3,900	$ 17,097
55					$ -	$ -
60		$ 30,000	$ 1,400	$ 2,500	$ 33,900	$ 199,725
65					$ -	$ -
70			$ 1,400	$ 2,500	$ 3,900	$ 30,880
75					$ -	$ -
80		$ 30,000	$ 1,400	$ 2,500	$ 33,900	$ 360,726
85					$ -	$ -
90			$ 1,400	$ 2,500	$ 3,900	$ 55,772
95					$ -	$ -
100	$ 35,000				$ 35,000	$ 672,652
Tank capital costs include the tank, erection, and freight. Engineering and construction of additional site work is extra					$ 410,000	$ 1,740,000

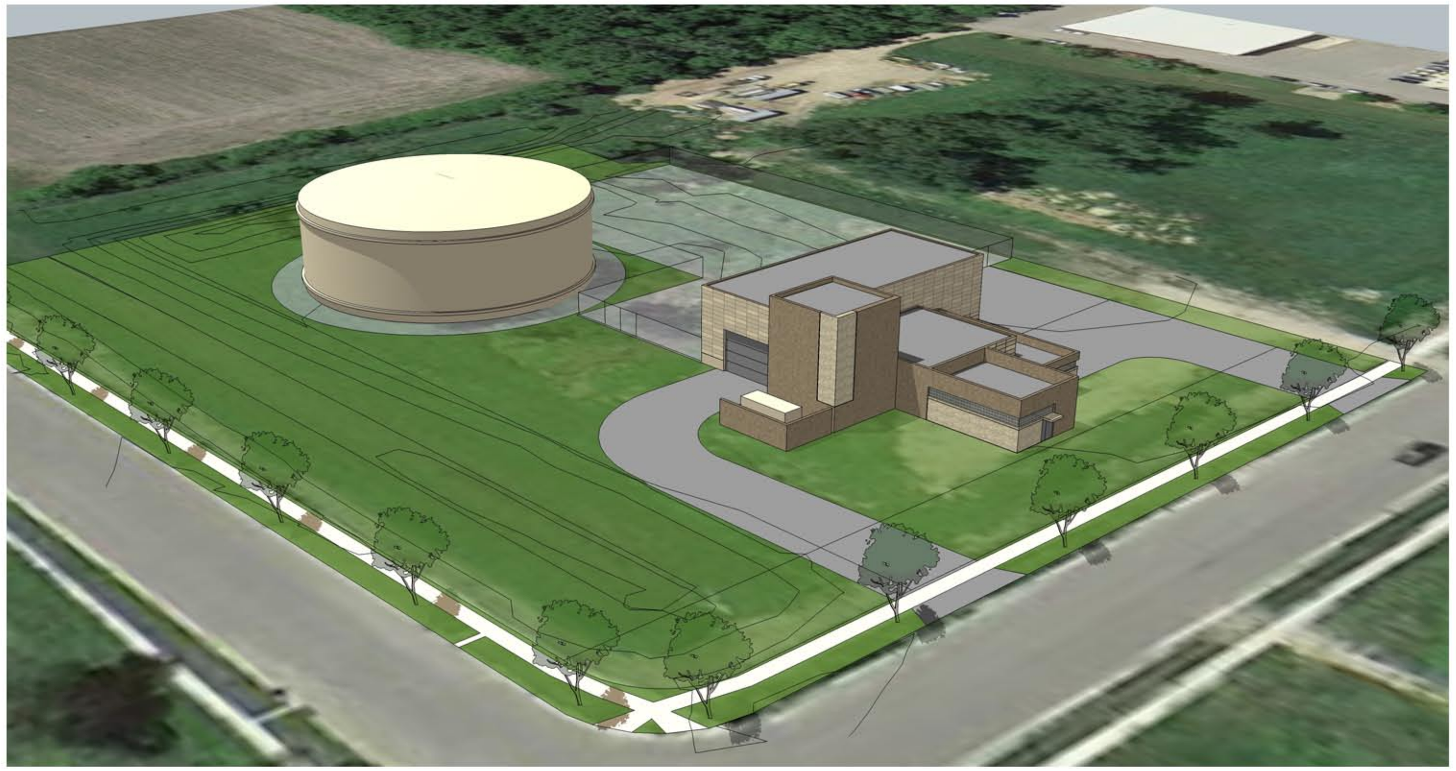
Q:\KO\M\Madwu\129083\5-final-dsgn\Life Cycle Costs\Backwash\[Concrete Backwash Tanks 111414.xlsx]1- 120 yr PW

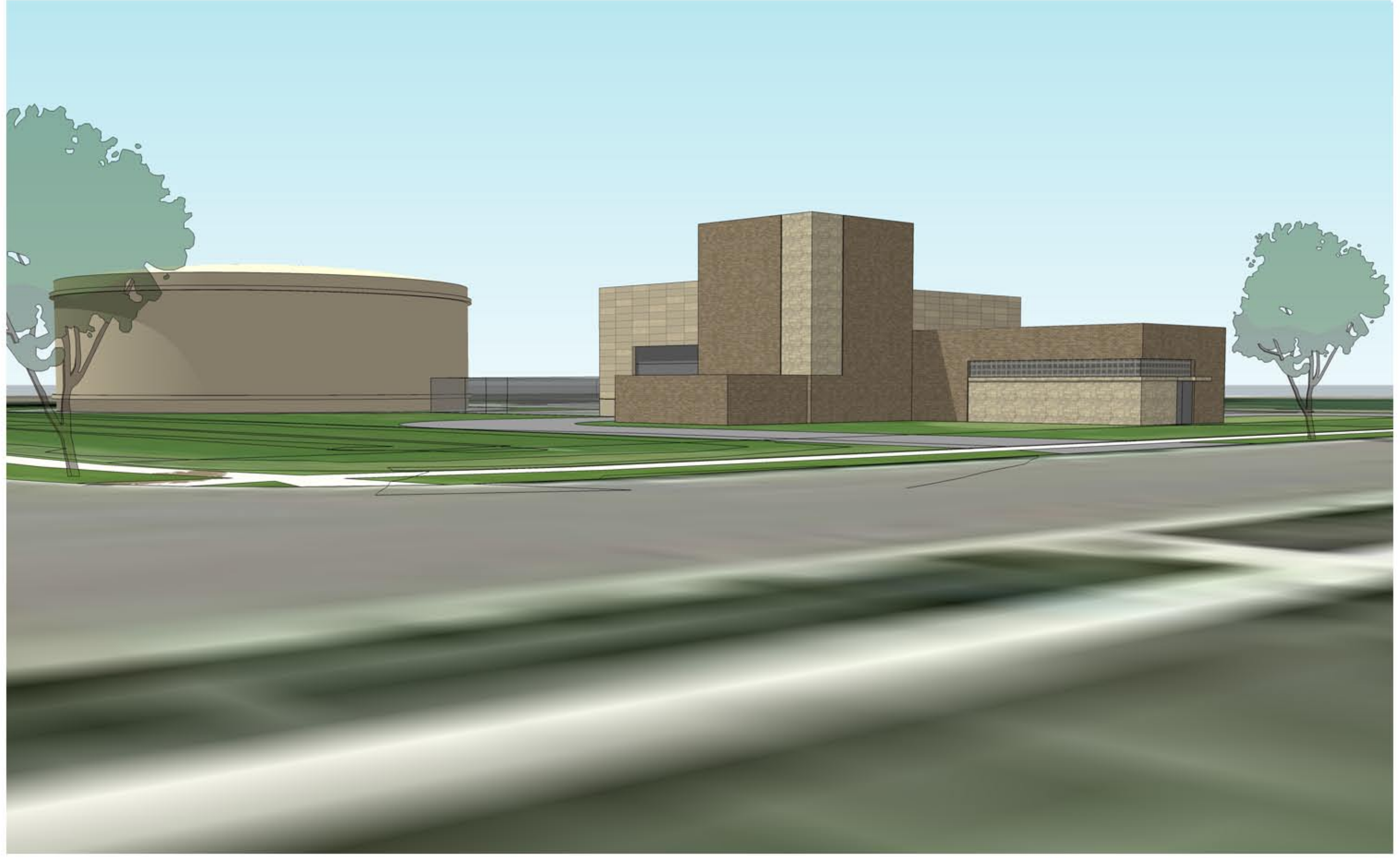
Appendix P

Option 1A and Option 2 Revised



SCHEMATIC IMAGES - OPTION 1A
WELL 31
MADISON WATER UTILITY
11/19/2014





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Madison Water Utility
mwu

SCHEMATIC IMAGES - OPTION 1A

WELL 31
MADISON WATER UTILITY
11/19/2014

SEH

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Success by Design

PRELIMINARY CONSTRUCTION COST ESTIMATE
Madison Water Utility (MADWU)
Unit Well 31
Pyrlolusite Filtration & Storage Facility
OPTION 1A (revised)

Water Treatment Facility; 31

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
SITE WORK (GRADING, PAVING, LANDSCAPING)	LS	1	$125,000.00	$125,000.00
WATERMAIN	LS	1	$25,000.00	$25,000.00
SANITARY SEWER	LS	1	$10,000.00	$10,000.00
STORM SEWER	LS	1	$40,000.00	$40,000.00
GENERAL BUILDING CONSTRUCTION (WALLS, ROOF, FLOOR, ARCHITECTURAL FINISHES ETC)	SF	4052	$127.00	$514,604.00
MECHANICAL & PLUMBING	LS	1	$75,000.00	$75,000.00
ELECTRICAL (Exterior Generator & Enclosure)	LS	1	$1,000,000.00	$1,000,000.00
ABOVE GROUND INDOOR BACKWASH TANK (100,000 GAL)	LS	1	$275,000.00	$275,000.00
FILTRATION EQUIPMENT	LS	1	$375,000.00	$375,000.00
PUMPING EQUIPMENT	LS	3	$70,000.00	$210,000.00
WELL PUMP AND MOTOR	LS	1	$150,000.00	$150,000.00
PROCESS PIPING, VALVES, SMALL PUMPS ETC.	LS	1	$200,000.00	$200,000.00
CHEMICAL FEED EQUIPMENT	LS	1	$100,000.00	$100,000.00
SCADA/SURVALIENCE Automated Control	LS	1	$485,000.00	$485,000.00
SUBTOTAL				$3,584,600.00
CONTINGENCY - 5%				$179,230.00
TOTAL ESTIMATED WATERMAIN CONSTRUCTION COST				$3,763,830.00

Unit Well 31
Pyrlolusite Filtration & Storage Facility

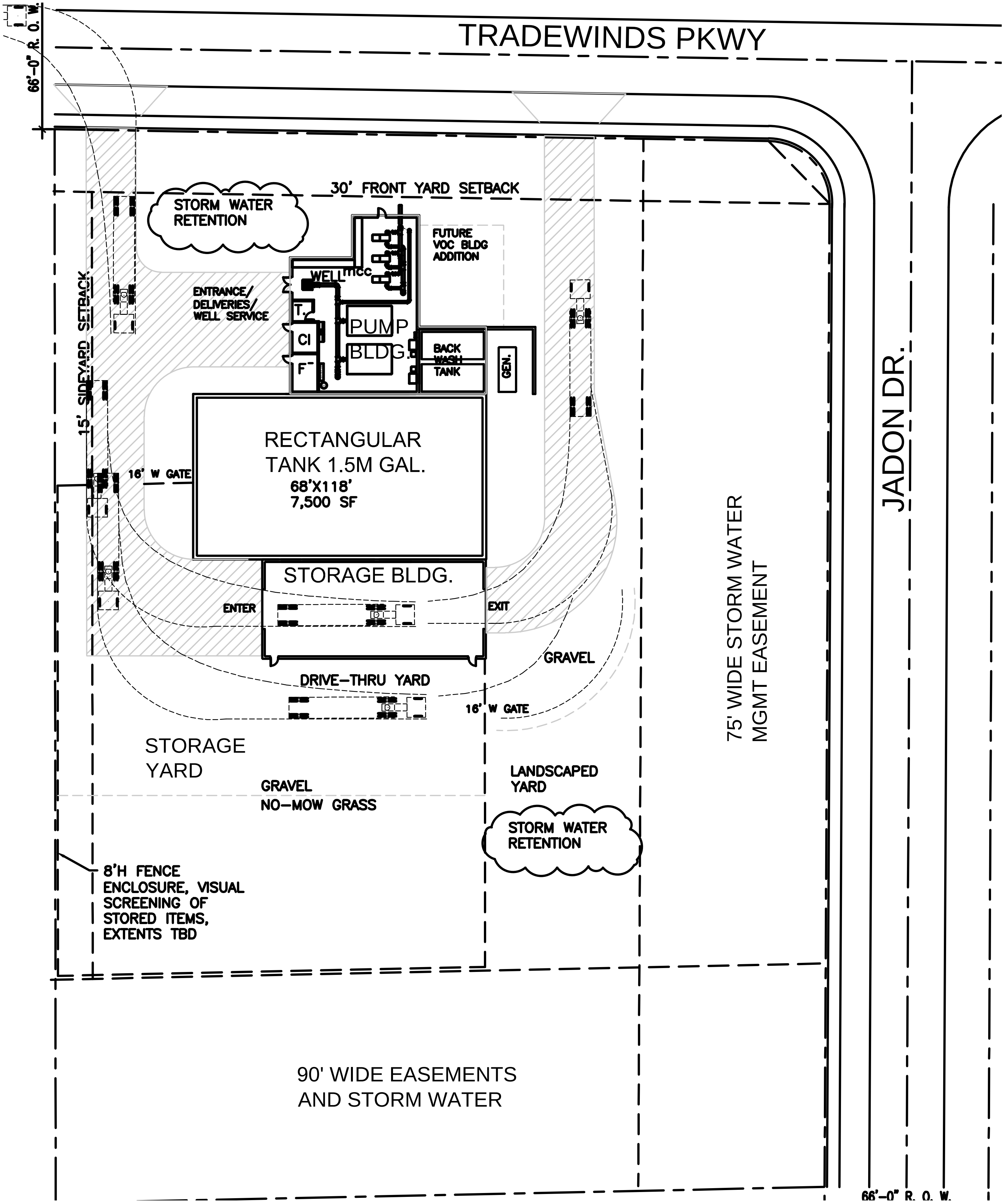
1.5MG Wire Round Concrete Tank

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
1.5 MG wire round tank (15 week construction schedule)	LS	1	$995,000.00	$995,000.00
Architecture Treatment (Partial Treatment)	SF	3000	$62.00	$186,000.00
Site work MH, Process Piping and Valves	LS	1	$30,000.00	$30,000.00
Mixing System	LS	1	$50,000.00	$50,000.00
Hydrant and Valve	EACH	1	$4,000.00	$4,000.00
EXCAVATION	LS	1	$50,000.00	$50,000.00
SUBTOTAL				$1,315,000.00
TOTAL ESTIMATED COST				$1,315,000.00

Storage Facility

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
STORAGE FACILITY	SF	3900	$100.00	$390,000.00
SUBTOTAL				$390,000.00
TOTAL ESTIMATED COST				**$390,000.00**

TOTAL ESTIMATED COST	**$5,468,830.00**



Site Plan BW - OPTION 2
WELL 31
MADISON WATER UTILITY
11/19/2014

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Madison Water Utility

SCHEMATIC IMAGES - OPTION 2
WELL 31
MADISON WATER UTILITY
11/19/2014

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PRELIMINARY CONSTRUCTION COST ESTIMATE
Madison Water Utility (MADWU)
Unit Well 31
Pyrlolusite Filtration & Storage Facility
Option 2 (Revised)

Water Treatment Facility; 31

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
SITE WORK (GRADING, PAVING, LANDSCAPING)	LS	1	$125,000.00	$125,000.00
WATERMAIN	LS	1	$25,000.00	$25,000.00
SANITARY SEWER	LS	1	$10,000.00	$10,000.00
STORM SEWER	LS	1	$40,000.00	$40,000.00
GENERAL BUILDING CONSTRUCTION (WALLS, ROOF, FLOOR, ARCHITECTURAL FINISHES ETC)	SF	4052	$127.00	$514,604.00
MECHANICAL & PLUMBING	LS	1	$75,000.00	$75,000.00
ELECTRICAL (inluding generator)	LS	1	$1,000,000.00	$1,000,000.00
ABOVE GROUND INDOOR BACKWASH TANK (100,000 GAL)	LS	1	$275,000.00	$275,000.00
FILTRATION EQUIPMENT	LS	1	$375,000.00	$375,000.00
PUMPING EQUIPMENT	LS	3	$70,000.00	$210,000.00
WELL PUMP AND MOTOR	LS	1	$150,000.00	$150,000.00
PROCESS PIPING, VALVES ETC.	LS	1	$200,000.00	$200,000.00
CHEMICAL FEED EQUIPMENT	LS	1	$100,000.00	$100,000.00
SCADA/SURVALIENCE Automated Control	LS	1	$485,000.00	$485,000.00
SUBTOTAL				$3,584,600.00
CONTINGENCY - 5%				$179,230.00
TOTAL ESTIMATED WATERMAIN CONSTRUCTION COST				$3,763,830.00

Unit Well 31
Pyrlolusite Filtration & Storage Facility

1.5MG Rectangular Concrete

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
1.5 MG Concrete (106-ft x 73-ft x30-ft) with Concrete Cover Max 35-ft	LS	1	$2,500,000.00	$2,500,000.00
Mixing System	LS	1	$50,000.00	$50,000.00
Hydrant and Valve	EACH	1	$4,000.00	$4,000.00
EXCAVATION	LS	1	$25,000.00	$25,000.00
SUBTOTAL				$2,579,000.00
TOTAL ESTIMATED COST				$2,579,000.00

Storage Facility

ITEM	UNIT	QUANTITY	UNIT PRICE	COST
STORAGE FACILITY	SF	3900	$100.00	$390,000.00
SUBTOTAL				$390,000.00
TOTAL ESTIMATED COST				**$390,000.00**

TOTAL ESTIMATED COST	**$6,732,830.00**