Memorandum

To: Papio-Missouri River Natural Resources District Programs Projects and Operations Subcommittee

From: Paul W. Woodward, PE, Groundwater Management Engineer

Date: July 1, 2019

Re: Review and Recommendation on Amendment to Wellhead Protection Area Plan Interlocal Agreement with City of Tekamah

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The Board approved an Interlocal Agreement with the City of Tekamah in July of 2018 to assist the City in developing a Drinking Water Protection Plan for their community's municipal water supply and Wellhead Protection Area. The agreement was approved under District Policy 17.21 as their WHPA is in a Phase II Groundwater Management Area, see Figure 1. Tekamah applied for and received a Source Water Protection Grant from NDEQ to cover $41,000 of the anticipated $56,000 cost for an enhanced Wellhead Protection Plan, also known as a Drinking Water Protection Plan. Per the agreement, the NRD and Tekamah are responsible for splitting the remaining $15,000, or $7,500 apiece.

Anticipating that nitrate issues being experienced in their municipal wells may require re-abandoning older city wells, the City of Tekamah also applied for a Nebraska Environmental Trust Grant in Sept. 2018 to assist in testing and properly decommissioning these wells. Tekamah received the NET grant in the amount of $40,000 and is requesting that the NRD participate in providing matching funds in the amount of $10,000. Together, $50,000 will cover the scope of work being performed by Groundwater Solutions Group LLC to properly seal 3 previously abandoned wells and install a new well casing seal in Tekamah's water supply well near their fire station.

It is anticipated that properly decommissioning these three wells and installing a new aquifer seal on the City's fire station well will help protect Tekamah's drinking water from shallow, higher nitrate groundwater perched near the ground surface, see Phase 1 Report attached. The enclosed amendment to the interlocal agreement adds language for the District to reimburse the City for $10,000 of their actual expenses, for a total not to exceed District contribution of $17,500.

Management recommends that the Subcommittee recommend to the Board that the General Manager be authorized to execute the proposed First Amendment to the Interlocal Agreement with the City of Tekamah for Wellhead Protection Area Plan cost share, not to exceed $17,500 in District funds, subject to changes deemed necessary by the General Manager and approval as to form by District Legal Counsel.

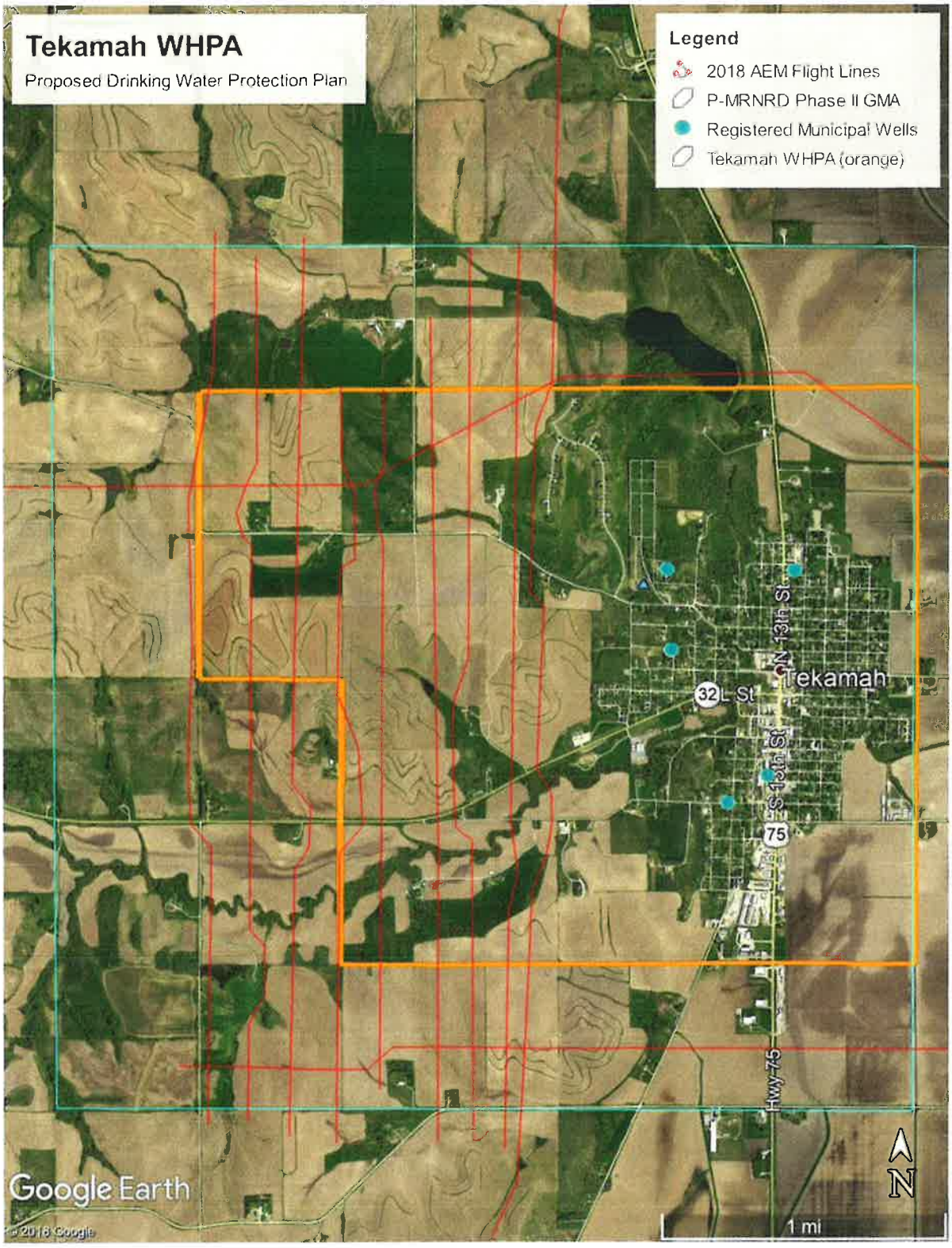
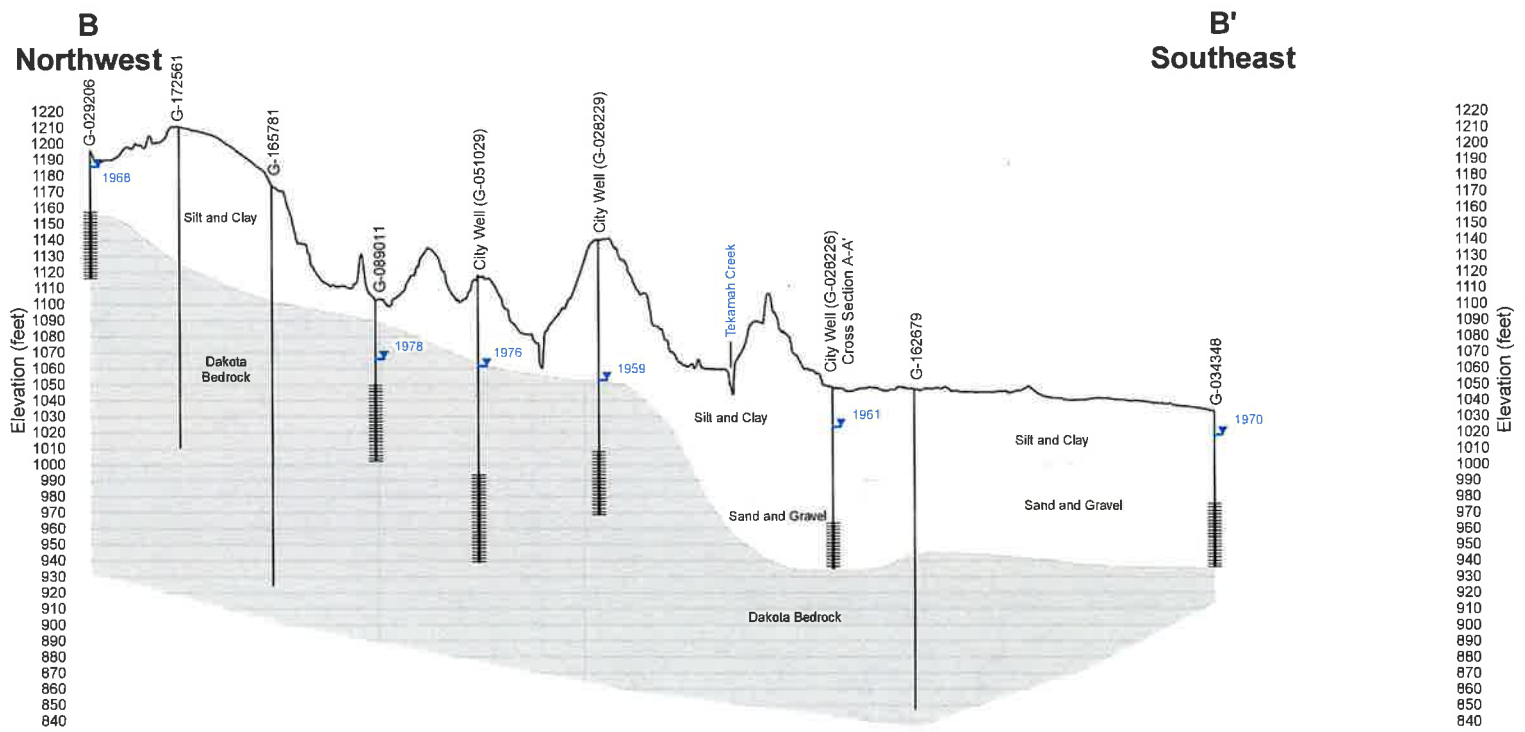


Figure 1 – Map of Tekamah WHPA and Phase II Groundwater Management Area.



1 inch = 1,500 feet horizontal

1 inch = 75 feet vertical (50 scale on engineer's ruler)

G-029206 Unique Nebraska Well Registration Number

Potentiometric Surface (Measured at Installation Date)

Screen

Geologic Contact (all contacts are inferred)

Silt and Clay

Sand and Gravel

Dakota Bedrock

Drawn: 8/30/2018

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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TEKAMAH PHASE II WATER QUALITY MANAGEMENT AREA
AQUIFER ASSESSMENT
TEKAMAH, NEBRASKA

PREPARED FOR

PAPIO-MISSOURI NRD AND JEO

FIGURE 4

HYDROGEOLOGIC CROSS SECTION B-B'

WSP Office, St. Paul, MN | Source: G:\GIS\JEO_Tekamah\mxd\9435-mxd\016 - XSect-B-B'.mxd, 8/30/2018, 12:48:21 PM, NAD 1983 StatePlane Nebraska FIPS 2600 Feet

GROUNDWATER SOLUTIONS GROUP LLC PHASE #1 REPORT- CITY OF TEKAMAH

For Groundwater Protection- Revised Report of Findings of Phase #1- PWS #! G-028226

May 29, 2019

OVERVIEW

Groundwater Solutions Group LLC has signed a contract with the City of Tekamah. This contract is funded by the Nebraska Environmental Trust (NET), the Papio-Missouri River NRD (PMNRD), and the City of Tekamah. The contract has 3 phases of construction. The first phase is the evaluation and discovery phase funded by the PMNRD and the City of Tekamah The 2nd and 3rd phase of the project funding from NET is dependent on acceptance from the Department of Health and Human Services (DHHS) for the enhanced decommissioning of four (4) abandoned public water system wells (ABPWS) and the augmentation of existing PWS #1 G-028226.

Phase #1

Groundwater Solutions Group has conducted the following investigation and evaluation of the site of G-028226, PWS #1.

- Review of existing well log information via Nebraska Department of Natural Resources well registration G-028226.
- Studied historical nitrate results from PWS #1 and four (4) other wells owned by the City of Tekamah.
- Drilled a test hole to depth of 130 feet bgs on site and e-logged that test hole.
- Constructed 2 monitoring wells based on information from the e-log record at depths of 103 feet below grade and 65 feet below grade
- Conducted a downhole video inspection of abandoned PWS well #1.

- Sampled monitoring wells #1 and 2, PWS #1 for thirteen parameter and initial nitrate water quality baselines and static water levels. Sampled abandoned PWS well #1, Monitoring Well #1 and 2, and PWS #1 for nitrates
- Installed data-loggers to determine interactions of well performance.
- Located abandoned PWS wells 1,2, and 3. Abandoned PWS #4 needs to be located and uncovered in Phase #2

Findings of Phase #1

- Registered Public Water Supply Well G-028226 is owned by City of Tekamah and has been identified as being a well that was constructed without adequate environmental seals within the borehole. Historically PWS #1 has had Nitrate results as low as 4.7ppm in March of 2000 and as high as 9.68 in April of 2014.
- The test hole findings indicate 3 zones of water. Zone A indicates a depth of approximately 7- 35 feet, Zone B 60-67 feet and Zone C from 80 to 115 feet below ground surface. Indication from the VSP curve of the e-logging indicate a water quality shift from fresh to "saltier" water at 27 to 35 feet. This is an indication of less desirable water qualities within the borehole at that level. Another shift is indicated from fresh to less desirable is approximately 67 feet to 75 feet adjacent to a clay layer. The VSP curve maintains a neutral line until it reaches approximately 95-103 feet bsg where it indicates a shift to more desirable water quality.

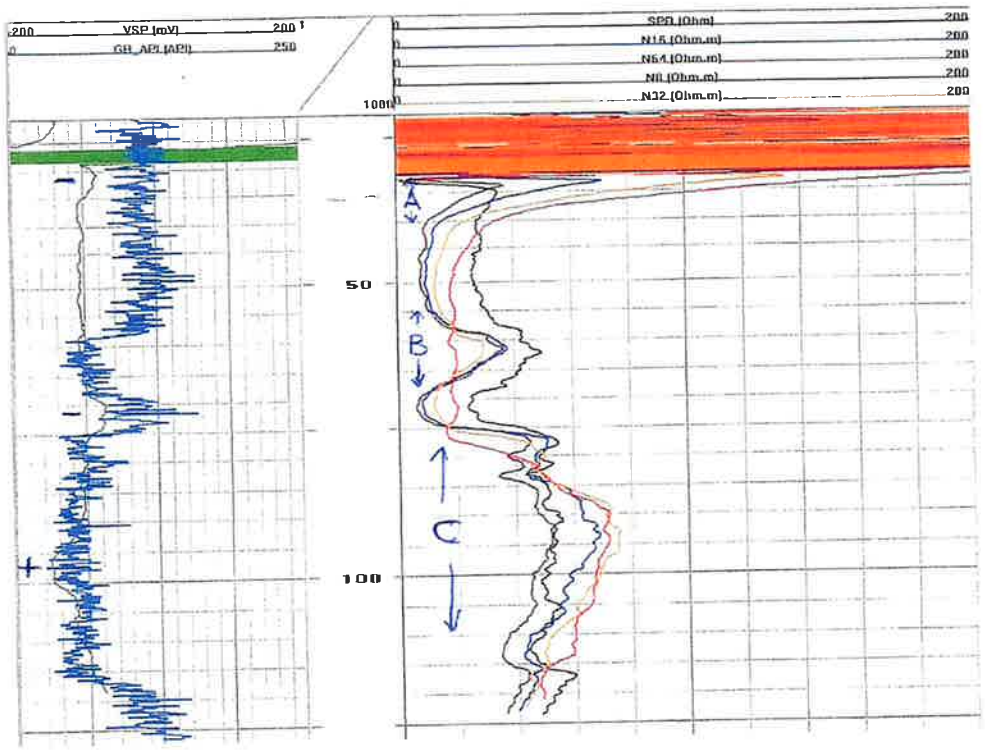
- In short, the e-log indicates three zones of water with dissimilar water quality within each zone.

GEOSPEC DRILLING LLC

E LOG

Name of Well/Borehole: Tekamah 2019-1

Boring Location: 96 degrees, 13', 18.41" W, 41 degrees, 46', 22.30"N
Date Drilled: 4-8-2019 Logged by: Bo Bonn
Time: 15:30 hrs Weather / Temp.: 70 degrees
Bite/Hole Size: 5 inches Total Depth: 130 ft/bgs
Water Level Initial (First Encountered): 27 ft/bgs Water Level final: 27 ft/bgs



TD 130'

○ Baseline Testing- Monitoring Well Placement

- Once the test hole and e-logging were completed, monitoring wells were established in Zone B, and Zone C.
- Monitoring Well, MW# 1 was completed in Zone C to a depth of 103 feet and was screened from 98-103 feet with a 3 inch inside diameter slotted pipe PVC screen. The well casing is 3-inch inside diameter sch. 40 PVC well casing. Static Water level at time of completion was 22 feet bgs. The borehole was gravel packed to a depth of 92 feet bgs. The remaining annular space was grouted with chip bentonite from 92 feet to ground surface.
- MW# 2 was completed in Zone B to a depth of 65 feet and was screened from 60-65 feet with a 3 inch inside diameter slotted pipe PVC screen. The well casing is 3-inch inside diameter sch. 40 PVC well casing. Static Water level at time of completion was 17.1 feet bgs (5 feet higher than MW#1). The borehole was gravel packed to a depth of 58 feet bgs. The remaining annular space was grouted with chip bentonite from 58 feet to ground surface.
- PWS#1 was sampled for the thirteen parameters to establish a water quality baseline. MW#1, MW#2, and PWS#1 were sampled the same day and PWS#1 was running at the time and had been running for several hours.
-

The monitoring wells were developed and sampled for thirteen parameters testing by Midwest Laboratory.

Tekamah Water Quality results

Date April 15, 2019 Midwest Laboratories

Parameter	Sodium ppm	Calcium ppm	Magnesium ppm	pH	Nitrate ppm	Sulfate ppm	Conductivity mmhos/cm	TDS ppm	Hardness gr/gallon	Total Coli MPN/100 ml	Iron ppm	Manganese ppm	Chloride ppm	Fluoride ppm
PWS#1	21	91.6	27.6	7.2	2	60	0.722	469	20	na	0	0.019	13	0.4
MW#1	30.6	94.9	27.6	7.1	0.5	59	0.712	463	20.5	na	0	0.111	19	0.4
MW#2	34.2	191	87.7	6.8	0	330	1.6	1040	49	na	7.6	3.08	148	0.2

Date- May 13, 2019 DHHS lab and Midwest LAb Nitrate only

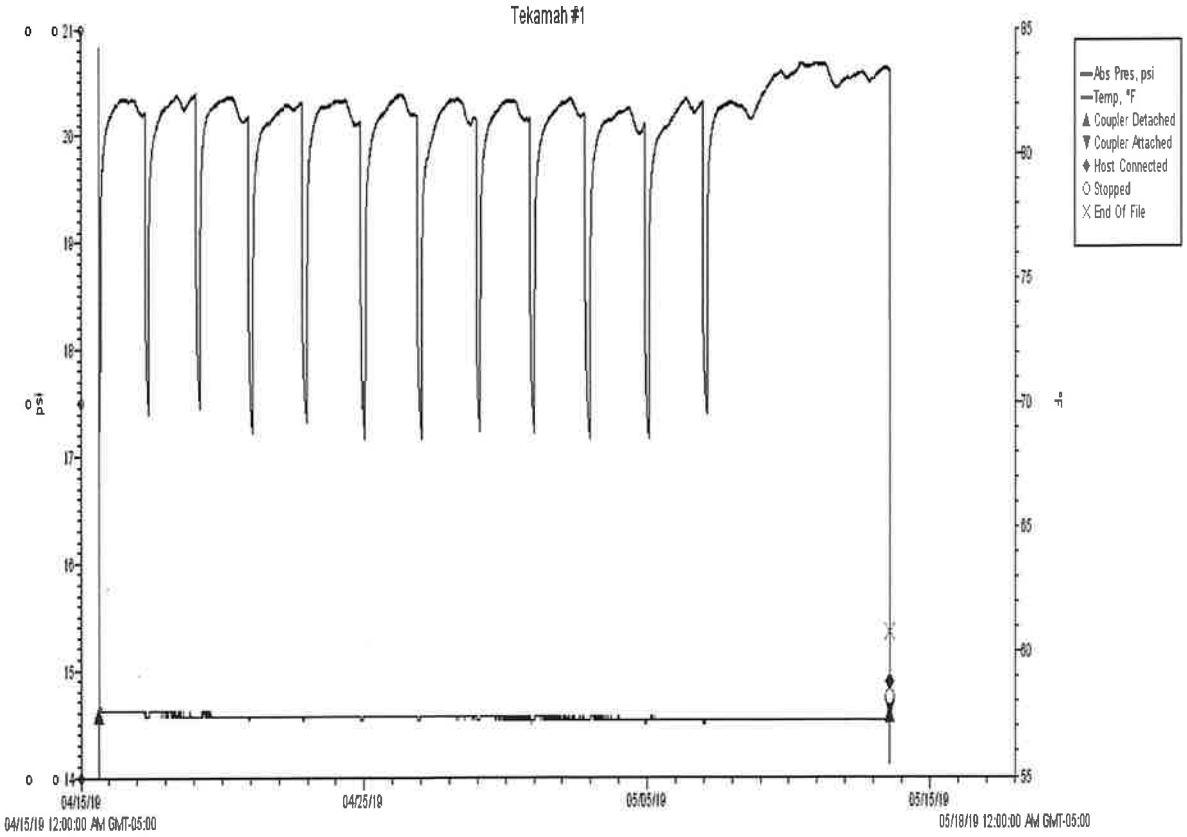
	Midwest Labs				Department of Healt hand Human Services Laboritory				
Well ID	Date	Nitrates	Total Coliform	Comments	Well ID	Date	Nitrate	Total Coliform	Comment
PWS#1	13	7.22	na	Clean sample				na	
MW#1	13	<0.2	na	Clean Sample	MW#1	13	0.221	na	Clean Sample
MW#2	13	<0.2	na	Cloudy sample	MW#2	13	<0.05	na	Slightly Cloudy Sample
ABPSW1	13	15.4	na	Cloudy sample	ABPWS1	13	14.6	na	Cloudy sample

- Nitrate Testing

- PWS #1, MW#1, MW#2, and Abandoned well #1 were all sampled for nitrate concentrations. on May 13, 2019. At the time of sampling PWS #1 was not running and had not been running for several days. Samples were sent to Midwest Laboratories and the Department of Health and Human Service Laboratory for a QA/QC protocol.

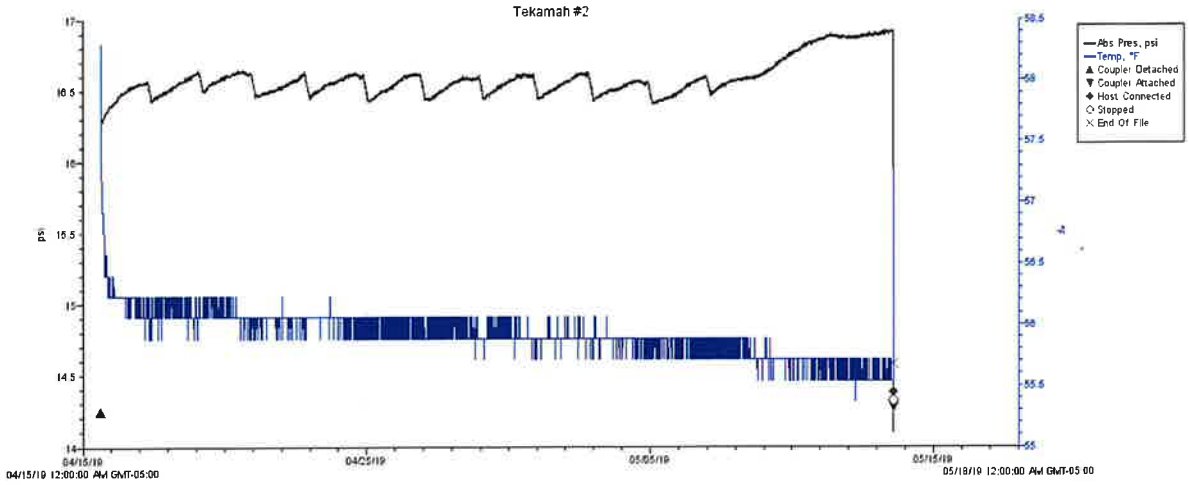
- Data Logging- determining direct influence of PWS #1

- In order to determine if the pumping of PWS #1 had an influence on the monitoring wells and possibly subsequent abandoned PWS wells 1,2,3and 4, dataloggers were installed in MW#1 and MW#2. The loggers were set to record every 5 minutes beginning on April 13, 2019 to May 13, 2019. The findings indicate Monitoring Well #1 reacts immediately in drawdown and recovery to the pumping and idle status of PWS #1. This indicates a direct connection to PWS #1 as both are screened in the production zone of 80-114 feet below grade.



Findings of Monitoring well #2 indicate an immediate response to drawdown when PWS #1 is running but a very delayed and deliberate recovery when PWS #1 is idle.

This indicates zone B is being directly influenced when PWS #1 is running but is being recharged independently at lea



st in part from Zone C possibly through the gravel packed borehole in PWS#1 and/or the abandoned PWS wells #1-4..

- This documents the influence PWS#1 has on the surrounding wells MW#1, MW#2, and ABPWS wells 1,2,3,and 4, and suggests they are hydrologically connected most likely through the gravel packed annulus of PWS#1.
- The static water levels and baseline 13 parameter results illustrate 3 zones do exist. Zone A which is connected to Abandoned PWS well #1 where a static water level of 7.5 feet as documented by the downhole video inspection. The water quality from ABPWS#1 indicated the source of high nitrates (15.4 ppm and 14.6 ppm). This validates the first shift in water quality found on the e-logging record of the test hole.
- Different water levels found in monitoring #2 (17 feet vs 22 feet for MW#1 and 7.5 feet for ABPWS!) indicates a segregated zone of substantially less desirable water quality when compared to Zone C, higher in Iron, TDS, Chlorides, Sodium, Magnesium, Sulfate, Conductivity, Hardness, and Manganese. This supports the second shift in the E-logging record between approximately 67 and 75 feet. Any water quality that is transferred from Zone B to Zone C through the gravel packed annular spaces is most likely being diluted by the overwhelming abundance of water from Zone C.
- Monitoring well #1 completed in the production zone (98-103 feet) has a comparable static water level with PWS #1. Zone C is the major producer with Higher water quality that either Zone A or B.
- Sample results from PWS #1 taken while the pump is running (2.0ppm) indicate the nitrate concentration reduces 250% from when the well sits idle and is sampled on

start-up (7.3ppm). This indicates a point source is the cause of nitrates in PWS #1, more than likely from the gravel packed annulus of PWS#1 intersecting Zone A.

○ Video Inspection of Abandoned PWS #1

On May 13th, 2019 a downhole video inspection of ABPWS #1 was performed. The purpose of this video was to determine if the well casing was structurally stable to withstand enhanced decommission, look for possible holes in the casing that could contribute to point source contamination of PWS #1, determine total depth, length of screened interval, and establish a record of static water level. The finding are as follows;

- Total Depth 90.4 feet from ground surface
- Well casing appears to be structurally sound and viable for enhanced decommissioning
- Static water level is 7.4 feet bgs validating the e-logging record of possible perch water, water sampling confirms nitrate above MCL
- Indication of possible holes as evidenced by corrosion nodules along the casing wall
- Unable to determine length of screen interval due to corrosion.

The Solution

As demonstrated by the data gathered so far, High nitrates exist in an interval from 0 to 41 feet below ground surface. It has also been demonstrated that undesirable water quality exists in Zone B (41-75 feet bgs), and the best production and water quality is within zone C (75-114feet bgs). It is reasonable to expect that if the zone A (0-41 feet bgs) is isolated and Zone B is separated from Zone C by enhanced decommissioning of all four (4) abandoned PWS wells and by augmenting the borehole annulus of PWS #1 G-028226 with approved bentonite grout from 66-75bgs the City could expect to see very low nitrates (0.221ppm to 2.0ppm) on a sustainable basis.

Our Proposal

Enhanced Decommissioning

- Based on the finding above here is the proposal going forward;
- The abandoned 6-inch wells will be cleaned in the areas of grouting and perforation of the casing.
- Perforations will be made at the interval(s) 72-74 feet (lower seal, 50-56 feet (isolate zone b from zone c)
- The screen area will be filled with gravel to within 5 feet of the lower grout interval.
- The lower grout interval will be sealed with a bentonite clay mixed to manufacturer's specification to achieve a 23% active solids content. The grout will be allowed to remain undisturbed for 6 hours.
- The remaining well casing will be filled to within 10 feet of the Zone B and Zone C seal interval chip bentonite grout.
- The well casing will then be perforated adjacent to a clay layer at 50-56 feet with 23% bentonite slurry grout will be placed. The grout interval will sit undisturbed for 6 hours.
- The remaining void of the casing will be filled to within 3 feet of the final grade with neat cement, the top of the casing will be removed, and the upper cap will then be installed according to Title 178 NAC12-012 regulations.
- The well decommissioning notice filed with the DNR will be modified to indicate the enhanced decommissioning used on this well.

WELL BOREHOLE AUGMENTATION

- Pump will be removed and evaluated for wear
- Downhole video of well casing and screened intervals will be performed to determine integrity of well condition
- Well casing and screen will be cleaned by brushing and airlifting to remove debris
- Well will be perforated 69-74 feet bgs to establish separation of Zone C from and l Zone b and Zone A Downhole video inspection will be made to confirm perforation location and condition
- The lower grout interval will be sealed with a bentonite clay mixed to manufacturer's specification to achieve a 23% active solids content. The grout will be allowed to remain undisturbed for 6 hours. The second perforation from 50-56 feet bgs perforation will be grouted with a 23% bentonite active solids content grout. The grout interval will sit undisturbed for 6 hours. The upper interval 20-25 feet will be grouted with neat cement consisting of 5.5 gallons of water per 94-pound bag of Portland cement. Grout will sit undisturbed for 24 hours.
- Downhole video inspection will be performed to validate perforations being sealed
- Well will be airlifted and cleaned of debris and disinfected with 200 PPM disinfectant
- Pump will be re-installed, and test pumped 6 hours for volume capacity

- 13 parameter water samples including total coliform will be taken from PWS well and subsequent monitoring wells to establish a baseline after enhanced decommissioning and well augmentation.

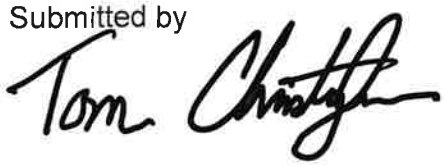
EXPECTED RESULTS

By removing the un-grouted borehole around the abandoned 6- inch wells and the PWS well G-028226 we expect to reduce and eliminate the preferential pathway for contamination to transport to the ground water reservoir. As a result, the nitrate concentrations in water samples of PWS G-028226 should stabilize and reduce. We expect this proposed solution to be of value to the City of Tekamah to assist them in their desire to improve water quality from their PWS water wells and benefit the City by providing the following results:

- Reduction of nitrate concentrations in water samples from the PWS well
- Provide protection of the lower production zone of the aquifer
- Elimination of a potential point sources contamination
- Enhanced protection of the City's groundwater supply

Of the wells being studied at this site, PWS #1 G-028226, MW# 1, MW#2 and Abandoned PWS well #1, only Monitoring Wells #1 and # 2 were properly grouted the entire length of the annulus from just above the screened openings to the surface with bentonite chip grout. This is the same requirement for newly constructed PWS wells in Nebraska since 2009. These are also the only 2 wells in this evaluation with very low nitrate concentrations. This leads to the assumption that once the natural filtration of the subsurface is re-established by enhanced decommissioning of all ABPWS well 1,2,3,and 4 and well annulus augmentation of PWS #1 G-028226, the expected result should mirror very low nitrate concentration documented at this site.

Submitted by



Tom Christopherson-Groundwater Solutions Group

FIRST AMENDMENT TO THE
INTERLOCAL COOPERATION AGREEMENT
Between
THE CITY OF TEKAMAH, NEBRASKA
And
PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT
For
WELLHEAD PROTECTION AREA PLAN COST-SHARE

THIS FIRST AMENDMENT TO INTERLOCAL COOPERATION AGREEMENT (this "**AMENDMENT**") is made by and between the **PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT** (the "**DISTRICT**") and **CITY OF TEKAMAH** (the "**TEKAMAH**") pursuant to the authority provided in the Nebraska Interlocal Cooperation Act (Neb. Rev. Stat. §§13-801, et seq.).

WHEREAS, TEKAMAH and DISTRICT are parties to an Interlocal Cooperation Act Agreement for the Wellhead Protection Area Plan Cost-share dated February 28, 2019 (the "**AGREEMENT**") wherein the DISTRICT agreed to contribute certain funds to assist in the development of a wellhead protection plan for the Tekamah Wellhead Protection Area;

WHEREAS, TEKAMAH retained a professional consultant, Groundwater Solutions Group, LLC (**"PROFESSIONAL CONSULTANT")** to conduct an investigation and evaluation of certain public water system wells within the Tekamah Wellhead Protection Area;

WHEREAS, the PROFESSIONAL CONSULTANT concluded after its investigation that one of TEKAMAH's currently utilized public water supply wells lacks adequate environmental sealing and that certain abandoned public water system wells need to be properly decommissioned;

WHEREAS, the DISTRICT, acknowledging the importance of acting on the PROFESSIONAL CONSULTANT'S conclusions, desires to increase its funding under the AGREEMENT to address the issues identified by the PROFESSIONAL CONSULTANT.

NOW, THEREFORE, for and in consideration of their mutual covenants contained herein and in the AGREEMENT, and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the AGREEMENT is amended as follows:

1. Add Paragraph IV.3 to the AGREEMENT as follows:

DISTRICT agrees to:

3. Reimburse Tekamah up to and not to exceed $10,000 of their total costs associated with the Enhanced Well Decommissioning project.

2. All other terms and conditions of the AGREEMENT shall remain unchanged and are in full force and effect.

IN WITNESS WHEREOF, the parties have duly executed this Amendment, on the dates hereinafter indicated.

[signature page follows]

The TEKAMAH has executed this AMENDMENT on _____, 2019.

THE CITY OF TEKAMAH, NEBRASKA

By _____

Name _____

Title _____

Attest:

_____
City Clerk

The DISTRICT has executed this AMENDMENT on _____, 2019.

PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT
8901 South 154th Street, Omaha, NE 68138-3621

By _____
JOHN WINKLER
General Manager