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MEMORANDUM

Date: September 25, 2025

To: Tom Terry, City Administrator
Corey Schweich, Public Works Director
State of Minnesota Departments of Natural Resources and Health

From: Rich Revering, PE, City Engineer

Subject: Water Quality Complaints Investigation Findings

BMI No. 24X.134964.000

BACKGROUND

The City of Elko New Market (City) conducted a four-week pump test of the Prairie du Chien/Jordan aquifer in the months of November and December 2023. This is the aquifer from which the City obtains its water supply. The test was conducted as required by the Minnesota Department of Natural Resources (DNR) in accordance with a plan approved by DNR staff. In May of 2024, the City began receiving reports from private domestic well owners in the Elko New Market area of notable quality degradation of the water coming into their homes from their wells. Most suspected a link between the City's aquifer pump test and the reduced water quality. Most reported their water had returned to normal after the episode described in the complaints.

These reports led to the inclusion of a Water Quality Complaints Response Plan as a condition to the City's 2024 Water Appropriation Permit Amendment. The Response Plan is focused on sampling various wells in the area at different amounts of City withdrawal from the aquifer to see if there is a connection between City usage and aquifer water quality for certain constituents. Actions to comply with the Response Plan have begun and will continue based on City usage level triggers until complete. In addition to the Response Plan requirements, staff was asked by the City Council to investigate the complaints based on other information it might determine to be informative and report to the Council its findings. Other than obtaining and reporting final Response Plan sampling data, this investigation is complete.

There are several reasons the City wished to determine a cause for the complaints:

- To determine if health risks were posed
- To determine if the phenomenon is likely to recur as City usage increases over time
- To inform how the City might site and/or operate future and existing wells to minimize the chances and/or magnitude of recurrences
- To see if finding the cause might lead to information private domestic well owners can use to operate and/or maintain their wells to minimize recurrence or prevent/reduce fouling of their systems if there is a recurrence.

- To see if finding the cause of the complaints might inform requirements of future aquifer pump tests in Elko New Market or elsewhere
- To determine if restitution to private domestic well owners was indicated, and, if so, how restitution might be determined.

The evidence from the staff investigation indicates that sustained drawdown and/or recovery of water levels in domestic wells during the City's pump test facilitated the release from inside the wells' casings of existing (and normal) buildup of material into the water columns where it was captured by the pumps and delivered into the homes in amounts notably above normal.

This memo describes the methods and data gathered to reach this conclusion. It also reviews other theories considered and why they were rejected as causes of the poor water quality. This memo does not cover whether restitution is recommended or how it might be determined. A separate memo will be provided related to compensation.

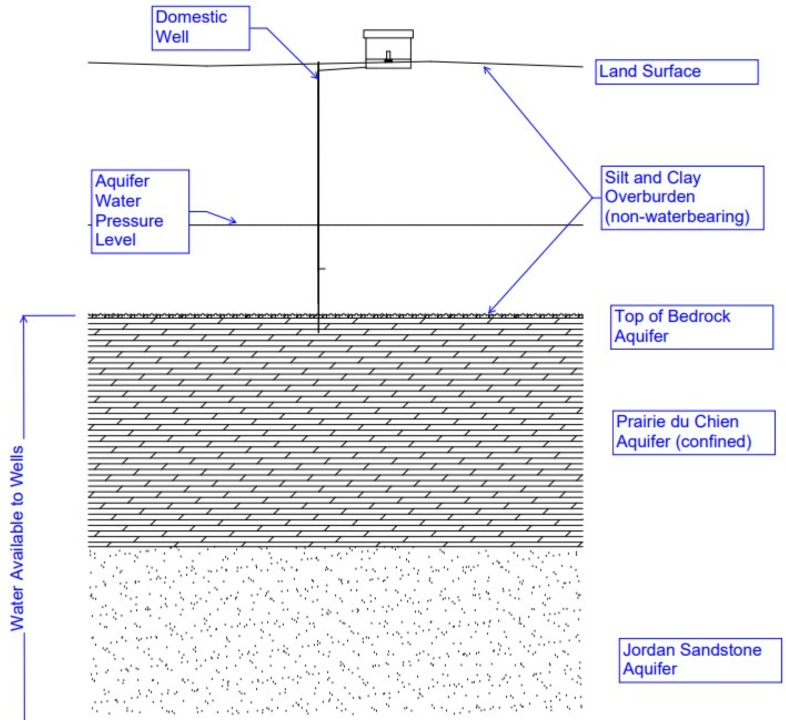
The Minnesota Departments of Natural Resources (DNR) and Health (MDOH) were provided a copy of the draft of this memo for review and comment. The DNR offered commentary that can be summarized as cautioning that the information in the memo may be missing nuance, but it supports the conclusion in the memo. DOH commentary implies that its staff feels more data is needed, but also that its focus is on possible long-term chemistry changes. No DOH commentary was offered on the explanation for this singular event.

DISCUSSION

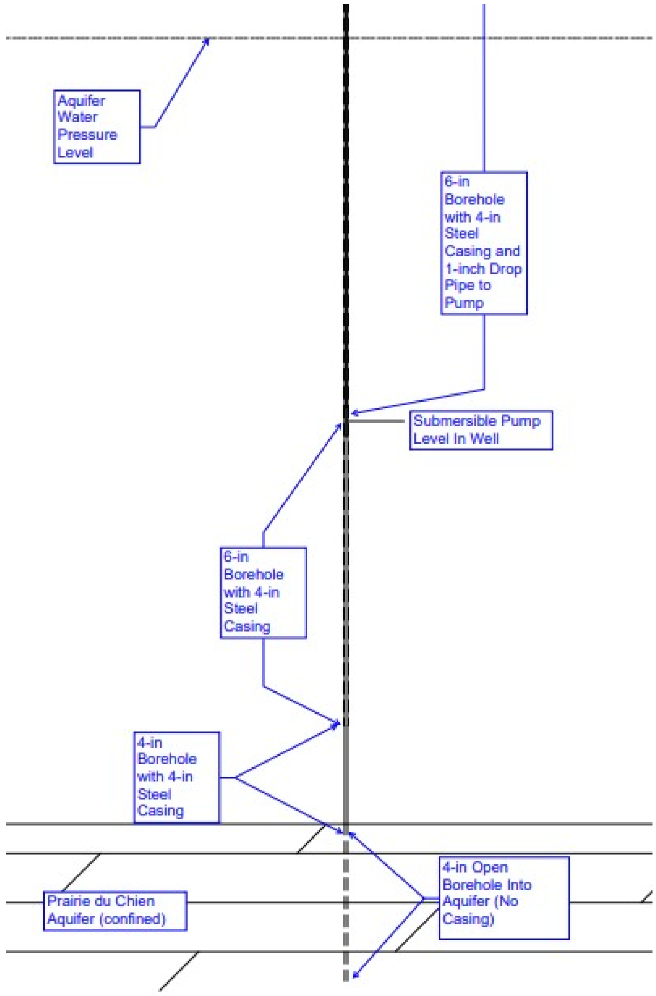
The Council is advised that the purpose of this memo is focused on explaining the cause of the water quality issues observed by some private well owners during the City's aquifer pump test. No conclusions are intended to be made regarding long-term trends in water quality in the aquifer due to City pumping, and none should be inferred. Staff acknowledges that the aquifer/private well/city well system is complex. This memo does not attempt to fully capture that complexity – its audience will consist mostly of persons that are not trained in hydrogeology, water chemistry, or well construction. Accordingly, the graphics and information present herein are intended instead to illustrate concepts that will aid understanding of what happened, rather than relate specific details of drawdown amounts versus time, or aquifer materials, strata thicknesses, or other system data. Some standard industry terms are not used in favor of terms that may make more intuitive sense to the intended audience.

<u>Background Information on Private Domestic versus City Wells and Interference</u>

The following graphic illustrates typical domestic well construction for a bedrock well in the Elko New Market Area. It is based on an actual well in the dataset for this investigation and is drawn to relative scale. Note the two-story house to help illustrate scale:

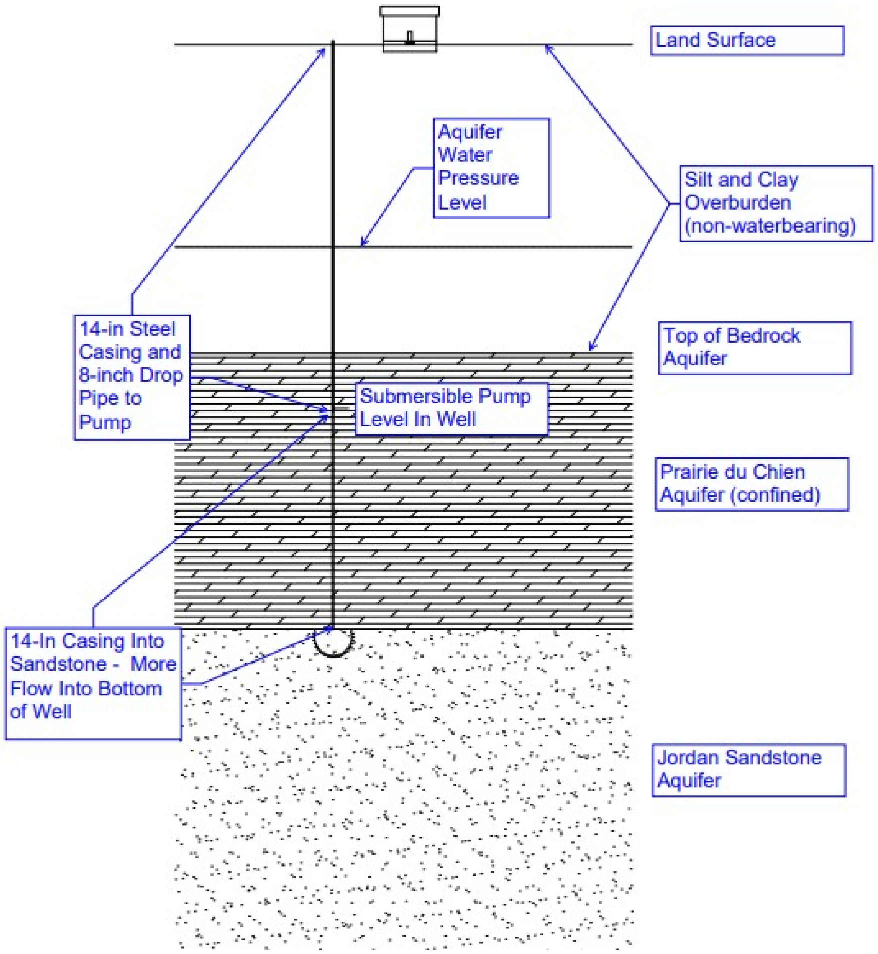


To better see what is happening in the space between the aquifer water pressure level (commonly referred to as "static water level") and the top of the aquifer, the next figure zooms in on that zone:

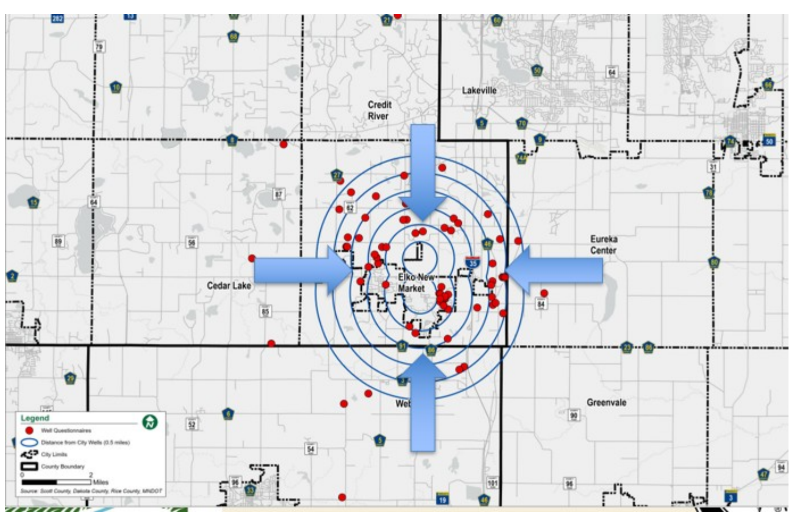


The aquifers in the Elko New Market area are confined aquifers, meaning the water in them is under pressure. Note that the aquifer water pressure level represents how high the water level rises in the well once the aquifer is penetrated. To illustrate the concept, one might imagine juice rising in the straw when you lightly squeeze a juice box. It is not the water level that would be observed if an excavation were made to that depth; there is little free water above the aquifer layers. Because the pressurized aquifer water rises in a well that reaches the aquifer, the well pump only needs to be set below the aquifer water pressure level. Most drillers choose a pump depth that puts the pump about 30 feet below the pressure level. Water pressure levels have remained relatively constant since records became available but do vary with geography.

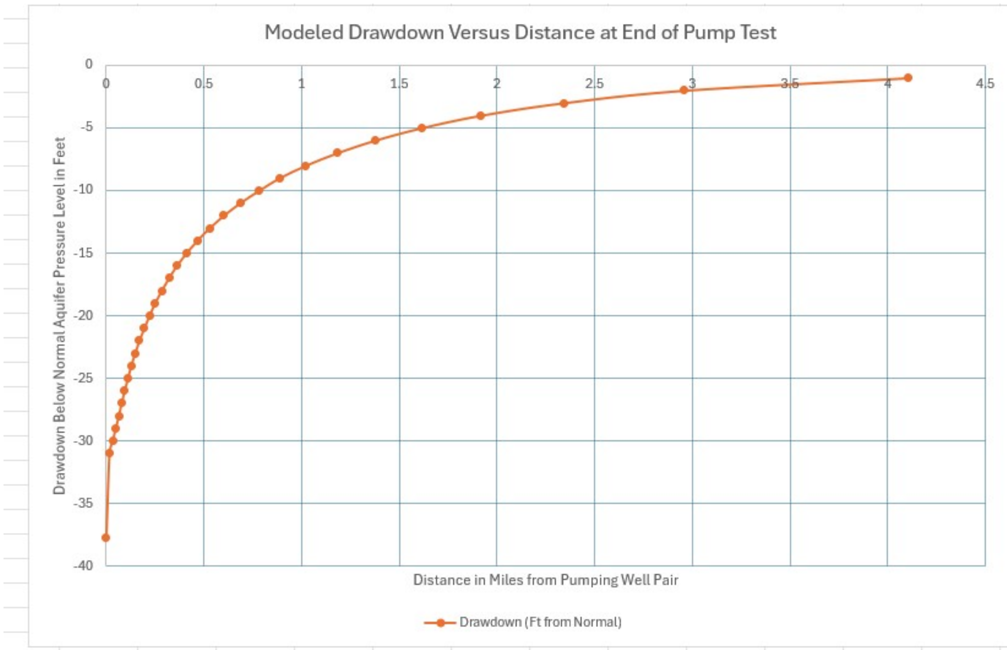
The following figure shows a typical City well, with the same imaginary 2-story home for scale. Compared to domestic wells, City wells are bigger in diameter and deeper, typically penetrating through the Prairie du Chien and into the top of the Jordan. The Jordan is sandstone rather than fractured rock, so a cavity can be developed to increase the availability of free water into the well. The sandstone is also more transmissive, so a greater volume of water can move towards the well with less drawdown (explained below) of the aquifer pressure level. Note also that the City pumps are set deeper in the well to accommodate the greater drawdown created by the higher relative pumping rate.



The following map illustrates the effect of City pumping on water in the aquifer. It imagines two wells are pumping at the same time. The blue arrows simply show that water is moving towards the wells from all directions. The oblong concentric rings are ½ mile offsets from the wells.

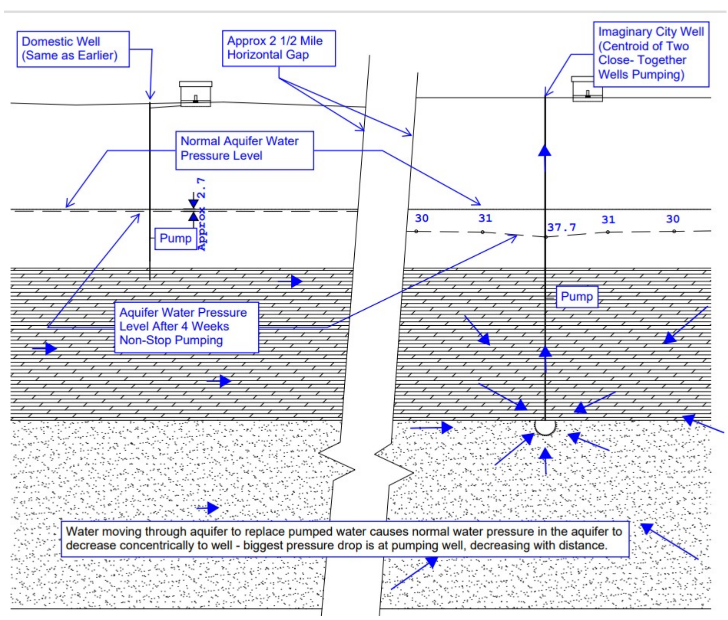


The change from normal water pressure level to a water pressure level caused during pumping is called drawdown. The modeled (not measured) aquifer pressure level versus distance from the centroid of the two wells from the preceding map while pumping is shown on the following chart. This is for illustrative purposes. Actual drawdown during the aquifer pump test or for any future pumping at a given location will depend on the amount and duration of the pumping activity, which wells are pumping, and local variation in aquifer pressure level and aquifer characteristics.



The chart shows drawdown at the centroid of the pumping well pair of 37.7 feet and a drawdown of 5 feet at wells a little over a 1 ½ miles away, for example.

Superimposing predicted drawdowns onto the well profiles results in the following graphic:



The dashed line below the normal aquifer pressure level line illustrates predicted drawdown, to scale. The numbers show predicted drawdown, in feet. The pump positions in the respective wells are called out.

For this scenario, the domestic well pump is still below the aquifer pressure level drop caused by City pumping. If drawdown goes below a domestic well pump position due to City pumping (imagine a domestic well very close to a City well), it is called ***interference***. Water in the domestic well would be below the pump and couldn't be reached unless the pump was placed deeper in the well.

Lowering pump depth in the existing well is a common and effective remedy for bedrock wells when interference occurs or is predicted based on planned City pumping changes.

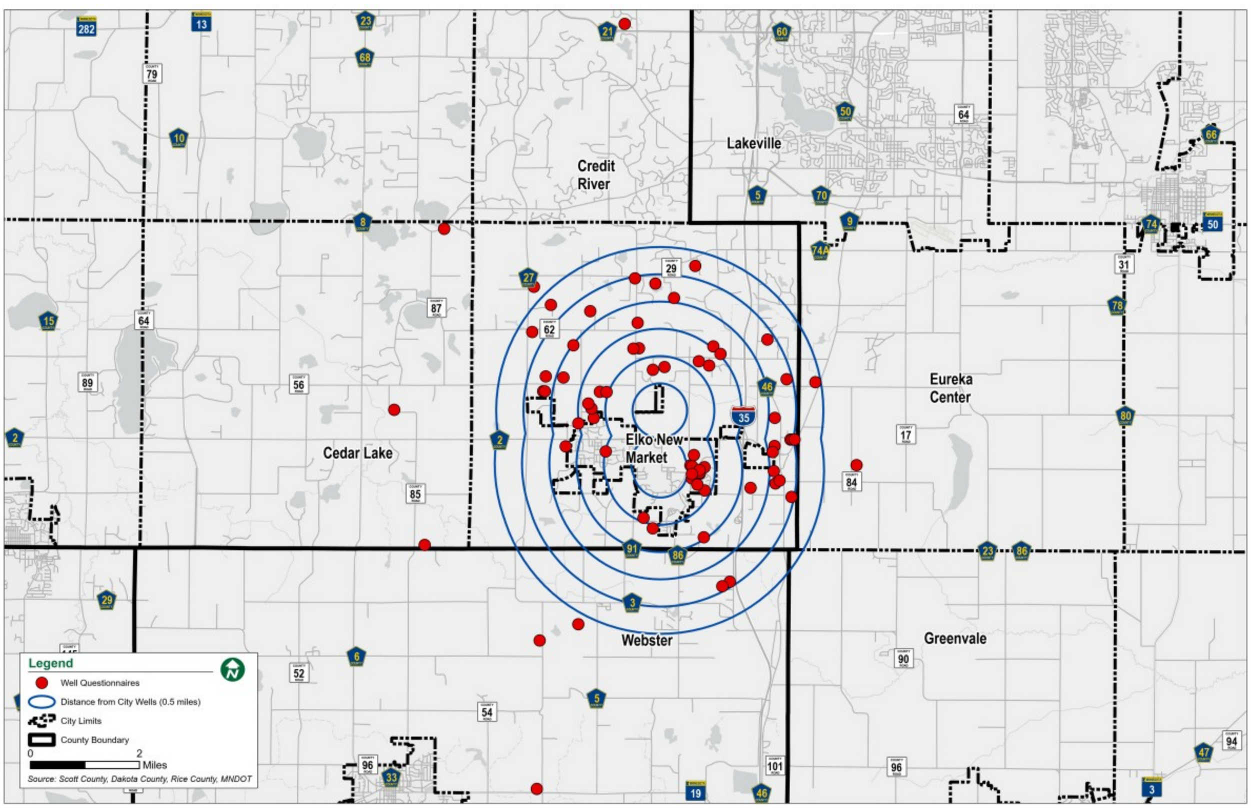
Actions Taken to Investigate Cause of Water Quality Complaints from the City's Aquifer Test

1. Questionnaires and Well Log Review

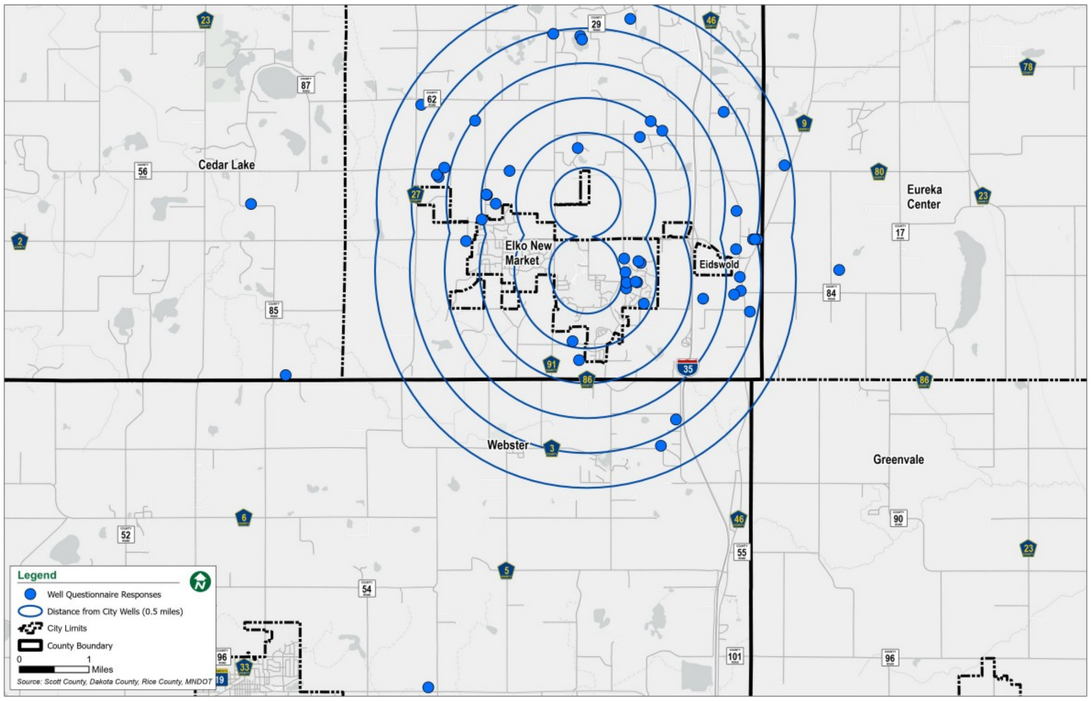
Staff devised and mailed questionnaires to 68 well owners that reported water quality concerns and received 45 responses. A blank copy of the Water Quality questionnaire is attached for reference.

Maps are provided to show the general spatial distribution of complaints and responses.

68 Questionnaires were sent out. The well locations are represented by red dots:

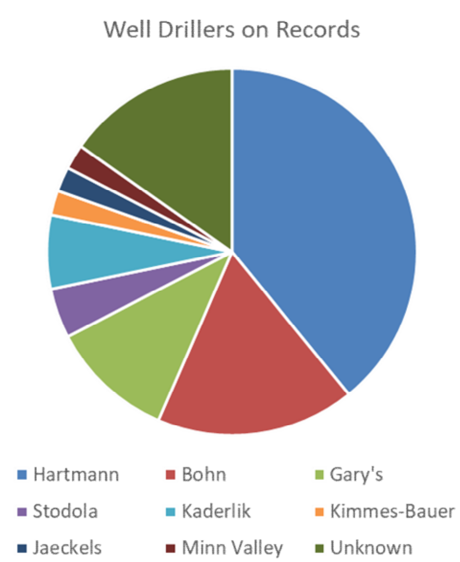


Staff received 45 responses. Response locations are represented by blue dots:



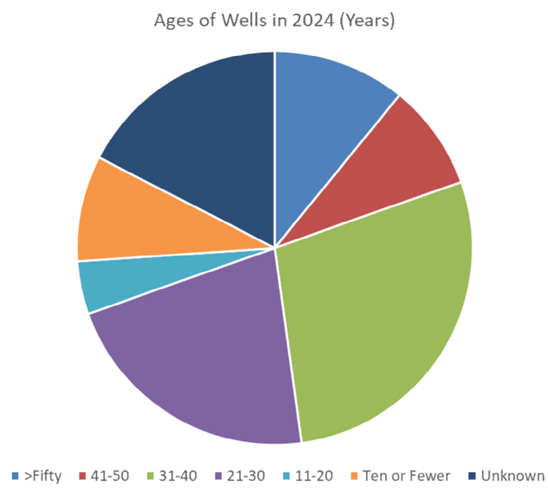
The City was provided by respondents or found well logs for 32 wells of 45. No well information is available for 13 wells. All wells with logs were found to be “bedrock” wells as described earlier. This means they’re obtaining water from the same aquifer as the City. This was expected, as access to shallower sand and gravel aquifers is known to be limited in this area.

The following chart shows who drilled the wells based on well logs and questionnaire responses:



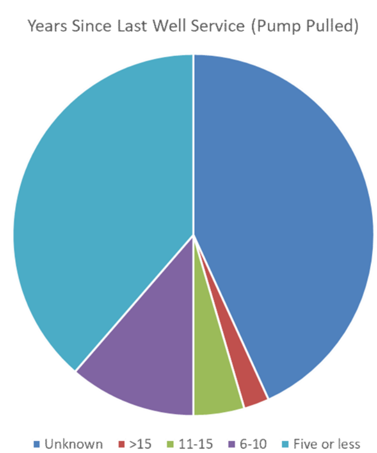
Staff found during this investigation and in seeking well data for other needs that drillers can be a valuable source of information. They often have records not available elsewhere, either from when they drilled a well, or, more commonly, when they serviced one. Their observations of typical well conditions in the area also proved informative, as will be discussed later.

The next chart shows the age of wells:



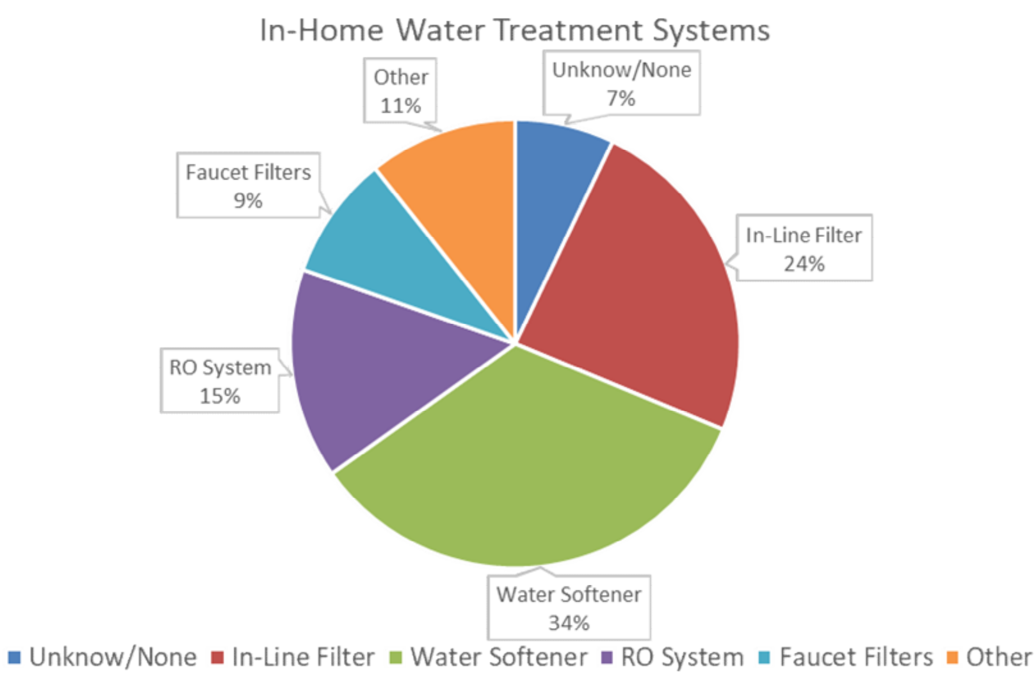
Examination of the chart reveals that two-thirds of known wells are less than 40 years old. This is an indication that the well depths and casings were constructed to a similar standard and are generally in good condition.

The questionnaire asked if the owner knew when the well was last serviced. Servicing a well usually means pulling the drop pipe and pump to check condition and replace components deteriorated due to accumulation in the drop pipe, rusted segments of drop pipe, or pump problems. Over half of respondents that had information on service have had their pumps pulled in the last 15 years. This comports with statements from Hartmann that drop pipes should be inspected every 10 to 15 years. The pipes corrode and can leak or break. Minerals accumulate inside the drop pipe, reducing its ability to deliver water to the home and making the pump work harder. See the image of a segment of drop pipe below.

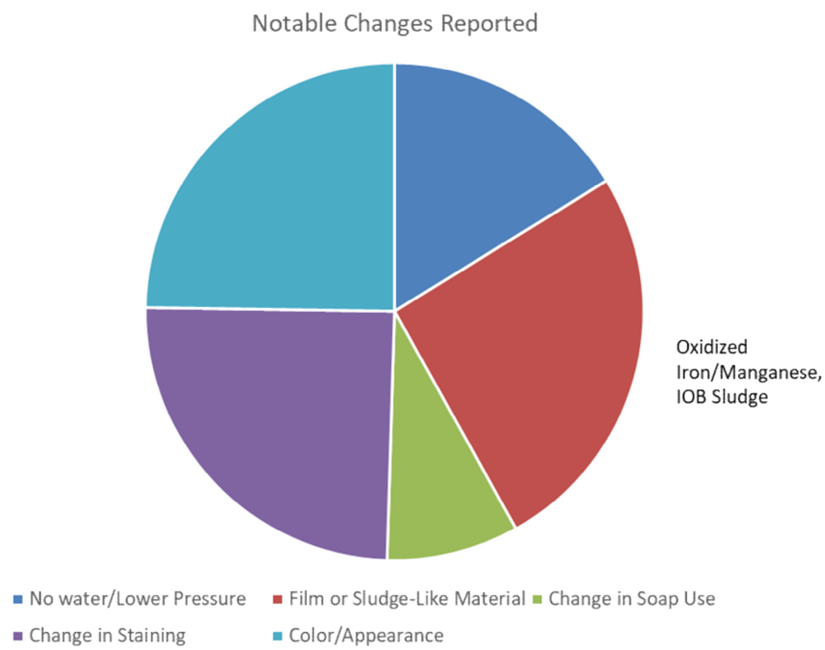


Mineral Accumulation in Drop Pipe

The following chart shows the various types of in-home water treatment systems used in the homes surveyed. Many have more than one system. An in-line filter might be the first system incoming water enters. This will remove larger particles before it enters the water softener for removal of hardness. Some homes also have systems that remove iron and manganese, or faucet filters with activated charcoal for taste and odor control. Dealing with iron, manganese, and hardness is typical for water from the aquifers in this area.



The next chart quantifies the types of notable changes reported during the pump test. Most respondents reported multiple issues.



The issues reported are linked. The sludge-like material would block filters or foul softener media, restricting flow through the system and resulting in no water or low pressure at the tap. The material that broke through any treatment system would discolor the water at the tap and contribute to staining of fixtures. Multiple respondents reported a need to change filters more frequently during the water quality episode. It was concluded the complaints were all based on the same phenomenon. The same material the homeowners were accustomed to dealing with on a regular basis in small amounts came into the home in larger amounts during the pump test.

Clogged Filter

The questionnaire asked about specific dates and times the episode was first noticed and how long it lasted. The intent was to compare this information with phases of the pump test. Investigators hoped to determine if it was during initial drawdown, at what level of drawdown, after some period of sustained drawdown, or during or after recovery of aquifer water pressure level. Responses regarding first notice were generally non-specific and wide-ranging. Two reported December 1, 2023, others were less specific or simply said "during the pump test." Some reported time periods before or after the pump test was completed. Most respondents indicated the water returned to normal within a few days, though some indicated it was still happening when they completed the questionnaires several months after the pump test was completed. Information could not be gleaned from the responses that might have revealed a trend in episode timing relative to the phase of the test.

2. Sampling of Area Wells

The City coordinated sampling at 19 wells per Water Quality Response Plan requirements of its 2024 Groundwater Appropriation Permit Amendment issued by the DNR. There are two more rounds of sampling at the same wells required. The earliest anticipated completion would be the Fall of 2025.

Results from 15 sample sites are currently available, and were reviewed for potential insights into the cause of the water quality complaints.

The Plan requires a full purge of standing water in wells prior to sampling to ensure water fresh from aquifer is sampled; however, the City also sampled water from the wells pre-purge for dissolved iron and dissolved manganese to see if there were meaningful differences.

The only constituent with a health limit found to be exceeded in any well was dissolved manganese (9 of 15 locations). The pre-purge (standing well water) dissolved manganese range was <5 to 415 micrograms per liter. 100 is the health limit. The post-purge (fresh from aquifer) value range was 36 to 430 micrograms per liter.

Pre to Post dissolved manganese increased in 6 wells by between 6 and 322 micrograms/liter. The average increase was 116. An increase means there is less dissolved manganese in well water and/or piping than in aquifer water, indicating it can change form in the well or piping and come out of solution. No sampling was performed to look for differences between water standing in piping versus water in the well.

Pre to Post dissolved manganese concentration went down in 9 wells by 1 to 40 micrograms per liter. The average decrease was 14. While this would indicate the opposite of increasing levels, it should be noted the average change was much smaller.

Pre to Post dissolved iron increased in 10 wells by between 313 and 3,665 micrograms/liter. The average was 1,456. Pre to Post dissolved iron went down in 5 wells by between 720 to 4830 micrograms per liter. The average was 3,026. Iron increased in every well where manganese increased from well to aquifer water. Most samples showed less dissolved iron in the well than in the aquifer water, indicating it can change form from soluble to insoluble in the well or piping.

The sampling crew had no control or knowledge of well usage prior to their arrival – low change wells may have already been full of "fresher" water from recent well use. The sample results are inconclusive on their own due to variability in the results and unknown usage prior to sampling. Sampling does indicate that iron and manganese can change form from dissolved to insoluble and vice versa as water resides in the well or in piping.

Only 6 of 15 samples showed less dissolved manganese in the well than in the aquifer, but the degree of change was significant compared to the opposite condition. Sampling results appear to support the potential for iron and manganese to change form and build up inside the well casing, but more data would be required to confirm this and the mechanism(s) behind the changes. A water scientist consulted suspects microbial processes rather than chemical processes for manganese based on typical pH levels in groundwater. The presence of Iron Oxidizing Bacteria (IOB) was tested at two wells. One well was not in the sample set but was selected based on the nature of the complaint received (orange film), and one was selected at random from other wells being sampled. IOB (not harmful) was found at both wells where it was sampled for. IOB will develop a visible slime layer where present. Anyone who has peered inside a sump pump system that's been in place for a while has seen what this looks like. IOB can convert dissolved iron and manganese to insoluble forms. These forms include the reddish and/or black build up most private domestic well owners are familiar with.

Hardness wasn't measured pre and post purge, however, visual observations at pulled wells indicate hardness also contributes to buildup in wells and pipes. The layer of white in the earlier photo of a drop pipe shows what hardness scale looks like.

3. Conferral with Experts and Pump Pulls

This section paraphrases remarks from the various experts spoken with over the course of the investigation. The remarks were not based on a formal interview or testimony, but on conversations about what might have happened, or about a certain possibility, or even during arranging other work related to the investigation such as sampling or lowering a pump.

- RH Renner – *Contractor for the most recent new Elko New Market City well and redevelopment of existing wells. Seasoned well contractor. Past President of the Minnesota Well Drillers Association.*

  Roger Renner was invited to meet with staff shortly after the reports of water quality issues possibly related to the pump test started coming in. After briefing him on the pump test and the nature of the complaints, Roger stated it sounded like biofilm from normally occurring iron-oxidizing bacteria was drying and coming loose inside the private well casings due to the continuous and sustained drawdown and getting sucked up into the pumps.

- Hartmann Well Company – *Hartmann Well out of New Prague is a family-owned and operated well company that drills and services private domestic wells. Its service area is extensive, however, it has drilled and/or serviced many of the wells in the Elko New Market area. The City contracted with Hartmann to pull one pump (Pump Pull 1) for staff's benefit in seeing first-hand how a domestic well is put together and what type of material might be collecting on the drop pipe and pump. They were also contracted to pull the pump at a resident's home that was complaining of low water pressure (Pump Pull 2). Staff elected to have that pump lowered while it was open rather than potentially need to pull it a second time only to lower it.*

  Pump Pull 1 – When asked how the crew knew where the water level was without measuring, the crew replied they could tell by looking at the drop pipe and counting the number of fixed segments they had pulled. When they reached those segments there was clearly a change. The pipes at that point were either rust colored on the outside or whitish on the outside. A call with one of Hartmann's owners provided details. Above the water level, the pipe will look like normal, zinc-coated (galvanized) pipe. This part of the pipe is never submerged. The rusty section is where water levels fluctuate due to pumping at that well or influence from a nearby larger well. This part of the pipe is wet, but frequently exposed to air, so surface rust forms. The top of the rusty zone is the normal aquifer water pressure level. Below the rusty (fluctuation) zone the drop pipe is usually white due to scale from hardness in the water. The pipe is always wet in this zone, but the water is moving up and down from drawdown. Examination of the interior of the pulled drop pipe showed a black, slimy build up, so Public Works kept a sample from one of the pipe segments the well owner elected to have replaced while the pump was pulled. A photo of this material after it dried was included earlier in this memo.

Pump Pull 2 – It was decided to add a length of drop pipe and electrical wire to lower this pump while the well was open for inspection. This did create a complication for the contractor since they hadn't been advised they'd be lowering the pump before coming to the site. This contractor will always bring an air compressor and special tooling to scrub the interior of the well casing in the zone they'll be lowering through and to (normally about 20 feet). The purpose of this is to remove and flush out buildup inside the well casing so that it doesn't become dislodged by the pump or drop pipe scraping the walls as the previously unused area of the well is entered. The material can get sucked up by the pump and damage it if they don't clean that area first. Hartmann did secure the equipment needed that same day and complete the lowering. Their statement that cleaning is a matter of routine was supportive of the theory that natural built-up material in the well casings was the source of the material for the water quality complaints.

It was observed for both pump pulls that the well contractor thoroughly flushes the wells before reconnecting to the piping into the home. Disturbance from the pump pulling activity stirs up water in the well (not the aquifer), resulting in a black colored discharge until that water is replaced by clean water from the aquifer.

- LRE – *LRE is an engineering firm that specializes in hydrogeology (water in the ground). Its Minnesota staff supported the City with the aquifer pump test design and helped conduct it. They provided information in this report related to modeled drawdown, helped select sampling sites, and consulted on various other issues related to the area aquifers and groundwater movement.*

  Figures are not included in this summary, but stakeholders may find it interesting to know that groundwater in the aquifers in the Elko New Market area is not static, and the aquifer pressure level varies by geography. LRE provided figures showing the extents of the aquifer and that pressure level declines as you move away from Elko New Market towards the Minnesota and Mississippi Rivers. This means the groundwater is flowing toward and discharging to these rivers through seepage. The velocity of flow is estimated to be only a handful of inches per day around Elko New Market, but it indicates the aquifer should be imagined more as an underground river than as a lake.

- Braun Intertec – *Braun Intertec was hired by the City to collect and coordinate analysis of the samples the City is required to do as a condition of its 2024 Appropriation Permit Amendment.*

  One phone discussion with Braun staff included Jim Florey, who is a microbiologist that has done work with water wells. They were being asked about the potential for IOB to be typical in these types of wells. He explained that microorganisms in the environment don't necessarily choose where they exist, but rather that the environment chooses them. In other words, if an environment is conducive to its survival, the organism, IOB in this case, will eventually be found there. It would be reasonable to expect that since available well information indicates they are similar in construction, the internal environments would also be similar and that the presence of IOB would not be unexpected.

- Bolton & Menk, Inc (Water chemistry expert) – *Herman Dharmarajah, PhD, is an engineer in charge of designing water and wastewater treatment systems.*

Herman was on a call where the potential mechanism behind the oxidation of iron and manganese in wells from dissolved to insoluble forms was being discussed. He was questioned if exposure to oxygen at the top of the standing water in the well would facilitate the change. He responded it was unlikely for manganese because the pH conditions would be wrong. He stated he thought the manganese changes were due to microbial action. This would form a black-colored precipitate. Iron would oxidize with exposure to oxygen in that environment. Iron would form an orange or brown colored residue.

4. Theories Reviewed and Rejected

Various stakeholders early in the process expressed different theories for what might have happened:

- "Stirred up the Aquifer"
- "Drew lower-quality water toward the wells"
- "This is normal in domestic wells"

"Stirred up the Aquifer"

This assertion was interpreted to mean that possibly the water moving toward City wells during the pump test agitated material in or at the bottom of area wells such that it was resuspended in the water column and drawn in by the pumps.

This was examined by estimating flow velocities in the aquifer at various distances from a City pumping well to see if they would have been adequate to move any particulates. Estimates of the velocity of natural flow in the aquifer towards area rivers were also obtained. The induced and natural flow velocities toward City pumps or towards the river at private wells in the area are in the range of 2 to 20 inches per day.

The induced flow velocities in the aquifer immediately around the bottom of a private domestic well are over 20,000 inches per day - three orders of magnitude greater than that caused by City pumping. In other words, use of the private well would be far more likely to "stir up" any material settled in the bottom of a well. Pump test stirring of the aquifer is rejected as a plausible or likely cause.

"Drew lower-quality water toward the wells"

This assertion was interpreted to mean that possibly the water moving toward City wells during the pump test drew a plume of lesser quality water towards domestic wells.

The review is similar to that of the "stirring up" theory since velocity is distance/time and distance is velocity X time.

Water in the aquifer at the nearest private wells to City wells would have moved less than 50 feet during the entire pump test at the velocities estimated above. Water travel distance would have been about the same as ongoing natural movement towards the rivers at the average distance of the complaints from City wells. It is improbable that there happened to be a plume of bad water that close to 68 well sites dispersed in all directions and separated over several miles or that natural movement over the years had not already moved such a plume to any of the wells. Moving plumes of bad water is rejected as a plausible or likely cause.

"This is normal in domestic wells"

There is evidence that mineral deposits do find their way from the wells into the homes on a routine basis; however, it was clear from complaints and the questionnaire responses that the amounts reported were different from and higher than what private domestic well owners are accustomed to managing. It should be noted that many of the well owners with complaints were not aware of the City's pump test or even whom to report problems to yet noticed changes significant enough to find a contact and report the issue to the DNR. Explaining the episode away as "normal" was deemed to be an incomplete response.

CONCLUSION

The evidence is summarized as follows:

- While the amount of drawdown in private domestic wells varied by distance from the City's pumping wells, drawdown did occur in these wells on a continuous and sustained basis for several weeks during the aquifer test, creating a differing condition from normal City pumping operations.
- Statements from water well professionals indicates a build up of naturally occurring minerals occurs over time inside well casings such that it needs to be managed to prevent damage to the well pump when they are lowering a pump from its current position inside a well or that they've seen it on components pulled out of wells and believe it is susceptible to sloughing if in a non-submerged condition for a period of time. It was not possible to sample or photograph this material in situ since it is located a hundred or more feet below grade inside a small diameter well casing and is submerged below the normal water pressure level of the aquifer.
- Questionnaire responses describing the material and the fact that most wells returned to normal after the episode support the drying and sloughing of mineral material that was then captured by the pump and delivered to the home's plumbing system. Once the material was pumped out of the well, the water began to clear up.
- Sampling before and after flushing of wells demonstrates that iron and manganese can change form as water from the aquifer resides in the well.
- Sampling confirms that iron, manganese, and hardness are prevalent in well water in the area. Manganese was the only constituent related to the complaints found in the wells sampled that exceeded State health standards, though one site did show Arsenic over these standards. Arsenic is colorless and tasteless and is not believed to be a contributing factor to the complaints.
- The two wells sampled for IOB tested positive for this microorganism, indicating it may be a factor in the breakdown of dissolved iron and manganese to insoluble forms and the formation of the slime or grease-like material reported in some of the responses. The sample size was small; however, this finding is consistent with experienced contractor observations, water chemistry in a well, the descriptions in some of the complaints, and the common environment in these wells. This bacterium is not harmful to human health but can create a nuisance.
- No alternative source was identified for the reported material. The interior of the well casings would have been the only location affected by City pumping where evidence exists for the presence of accumulations. The interior of the drop pipes and plumbing systems does contain this material; however, those surfaces remained wet and experienced no change in pressure or flow velocity during the pump test.

- Three alternative theories were reviewed and rejected because the required flow velocities to support them were not induced by City pumping or denial with no basis of dozens of reports of the event would be required. No additional theories were identified.

It is concluded based on this evidence that biofilm and/or mineral buildup inside the well casings was exposed to air for up to several weeks during drawdown at the private wells affected. The exposure and/or rising water as aquifer pressure levels recovered facilitated the release of the exposed material from the well casing. After being released into the water column, the material was drawn into the well pump and delivered to the plumbing system in the connected home. The material may have been flakes or clumps that were churned to a slurry by the pump which was then captured by filters or treatment equipment in the home. Incomplete removal by home treatment would have resulted in color, odor and taste changes by the user. Once the material was removed by home treatment and/or flushed through the system the user's water returned to normal. Failure to return to normal as reported by some users might be explained by residual material in the home's plumbing system. No other explanation for not returning to normal has been identified.

RECURRENCE POTENTIAL

Based on the findings regarding the source of the material, it is expected that mineral deposits will continue to build up inside the private domestic well casings in the area, regardless of City pumping activity. Accordingly, under the right conditions, the water quality episode reported could recur.

Recurrence would not be expected from normal City usage, even as withdrawals increase due to growth in demand. City pumps are not normally run continuously for weeks at a time, so the levels and duration of drawdown experienced during the pump test are not expected. In addition, when City pumps cycle on and off during normal operation, the aquifer water pressure level can recover between cycles. Since lack of submergence for a sustained period appeared to cause the material release, that condition would not recur with normal operations. It should be noted that as City growth continues, the cumulative effect of multiple City wells cycling on and off could eventually mimic the drawdown of a single or pair of pumps running continuously. However, the drawdowns in area wells would be incremental rather than sudden, so the material release would be gradual and in small amounts – over months or years – rather than sudden and in large amounts, as happened during the 2023 aquifer test.

Recurrence would be expected if the City were to conduct another aquifer test or run a pump or pumps continuously for several weeks for some other reason. It is recommended for any future continuous pumping events that the City take the following steps to prevent and reduce water quality impacts on area wells:

1. Notify well owners in the Elko New Market area by mail and social media of the scheduled dates of the pumping and recovery period, when foreseeable.

2. Advise well owners to closely monitor their filters and/or run outdoor spigots for a few minutes each morning before regular use during the planned pumping period, watching for the presence of excess mineral material in the water. If noted, thoroughly flush the well using one or more outdoor hydrants or hose bibbs until the water runs clear before using water inside the house.

3. Advise well owners to contact a well contractor and the City if water fails to run clear after at least 30 minutes of flushing and not to use the water until the well is examined.

Periodic flushing is a recommended maintenance practice for private domestic wells even if no water quality problems are happening. Flushing twice a year for 20 to 30 minutes can remove any loose material in the well casing, drop pipe and service piping and reduce buildup on filters. Ideally, the flushing would be done at a yard hydrant or outside hose bibb that is connected to the home's plumbing before any in-home treatment occurs. Most homes are plumbed in this way based on standard practice. If unsure, a plumber can quickly tell by examination if hose bibbs are plumbed correctly and make corrections or add a bibb if needed. Running two or more outside taps at the same time will improve flushing performance.

Homeowners that do not have inline filters at the head of their in-home treatment systems may wish to have one installed. These filters will protect more sensitive treatment equipment from even small amounts of particles and sludges. Homeowners using these systems report the filters capture material and require occasional filter replacement or cleaning even under normal circumstances.