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MEMORANDUM

TO: Mayor Dave Cieslewicz
Larry D. Nelson, City Engineer
George E. Meyer, Water Commissioner
Paul Nehm, Director of Operations & Maintenance

FROM: David Denig-Chakroff, General Manager

DATE: June 12, 2007

RE: Well 16 Investigation Report of June 8, 2007

Thank you for furnishing me with the Well 16 Investigation Report, which I received late yesterday afternoon. I appreciate the work of the Team, and share its interest to fully assess events surrounding the failed chlorinator, and I am committed to continue efforts to improve both the quality and reliability of services provided by myself and my staff. Please consider these comments regarding the findings and recommendation of the Investigation Team.

Findings.

1. The Investigation Team considered a related event involving a chlorine feed valve malfunction at Well 8 as part of its overall review. To clarify the facts surrounding that incident: there was no "erroneous test of the water in the reservoir rather than in the well." The initial test of the water in the reservoir was accurate and satisfactory. Due to an apparent lack of awareness of chlorine in the well, the well water was not tested. The well and booster pumps were started, and the chlorine levels were tested following 20 minutes of operation. High chlorine levels were identified after 20 minutes of operation, resulting in an immediate shut down of the unit well. The problem did not persist "until the following day."

2. Mechanical failures at Wells 29, 8 and 16 bear some similarity in that equipment and communication breakdowns occurred at each. However, I respectfully suggest that the details of each situation differed substantially, and it is exactly these differences that challenge us when drafting "*standard* operating procedures."

3. "Written comprehensive standard operating procedures for Rounders and Operators" were not developed by January 31, 2007. This did not occur for lack of effort, and it does not mean that standard procedures were not developed and issued. A single set of answers to the diverse nature of potential problems is not easily attained. The development of procedures is, and must be, a dynamic and ongoing process that responds to changes and situations that develop without warning, and must involve the employees who have decades of experience in these areas.

4. Efforts to develop standards have not been "deferred" because of the lack of the filling of the Water Supply Engineer position. With the assistance of the principal engineer (and more recently the temporary water supply supervisor), we have prepared and circulated operating procedures in email and memo format to employees at all levels to offer uniform responses to anticipated or commonly seen problems, and to supply custom directives for unpredictable events. To a degree, the lack of applicants for the position of Water Supply Engineer (posted three times) has slowed the completion of the SOP efforts, but it has by no means been "deferred."

Recommendations.

The Investigation Team has made excellent recommendations. Some are in process, and others I welcome and will do my best to implement. For example:

1. The performance of our employees must be improved. Most are experienced and have received both formal and on the job training. The consistency of their response, however, both in the work performed and in documentation and communication, has been, at times, unsatisfactory. I agree that this is a priority. This needs to be accomplished through additional ongoing training in both technical aspects, as well as procedural aspects (documentation, communication, etc.) of their jobs. We are making significant progress in both these areas.

2. Two types of chlorine analyzers and a hand-held instrument are used for measuring chlorine levels at wells. All of this equipment is state-of-the-art and is considered to be the best available technology. Each type of equipment has different ranges of accuracy. It has been reported that analyzers with probes may be more susceptible to inaccuracies when exposed to very hard water. For this reason, we watch them closely and maintain them monthly, or sooner if their accuracy begins to slip. To avoid recurrent problems, we are working with the manufacturers of all this equipment and checking their accuracy and recalibrating frequently. We have also initiated a plan to test and compare each type of equipment in a controlled setting in order to better evaluate the equipment and better understand the limitations of each.

3. The Utility has been working on the design of a new SCADA system for some time. We have never considered that the new system will resolve all the issues related to these incidents. Many safety and advanced operating features, however, are being designed into the new system. When the new system is ready for implementation, there will not be a "time period between the two systems (that) represents a period of additional risk." The "move from the old to the new SCADA system" will not provide an opportunity "to review how the water supply system operates in a manual mode." The new system will be started while the old system continues to operate. Both systems will operate side by side while facilities are systematically transferred from the old system to the new one. This tandem operation of the two systems is likely to last for six months or more, and there will never be a period when the water system is not covered by one SCADA system or the other.

4. The Water Utility has a "supervisor on call" system, with each supervisor being charged with on call responsibility. To date, we have operated with a "tree system." If the first supervisor called is not available, a call goes to the next in hierarchy. This system could be improved, however, and I agree that rotating an assignment of a particular supervisor to be "on call" after hours is a better approach. We will implement this change and establish a schedule to identify specific on call supervisors within the next month.

Finally, I believe it critically important that I participate fully in the assessment and response to any well failures or problems with water quality. I would like to schedule a meeting with the investigation team (or with those members who are available) in the next week to discuss their findings and recommendations. I will be prepared to discuss these issues further at the June 19 Board Meeting. I am at your immediate disposal for discussion as well.

Thank you.



David Denig-Chakroff
General Manager



Public Works

Well 16 Chlorine Failure Incident Attachment A

Well 29 Chlorine/Fluoride Failure Incident Investigation Report

October 27, 2006

Executive Summary

The failure of chlorine and fluoride feed equipment at Well 29 did not create a significant risk to public health nor did it violate any State regulations. However, it violated the Utility's own policy for chlorinating and fluoridating its drinking water. The facts that the unit well contains equipment not used at any other site, was on standby status, was operating in the middle of the night, and was operating for only four hours twice a week significantly contributed to the failure of safeguards in place to prevent such an incident. The incident revealed vulnerabilities in the Utility's operating systems, however, that could have serious consequences under other circumstances. These vulnerabilities include electronic equipment issues, outdated and inefficient work order and documentation processes, inadequate training for staff, and the need for more and better communication. A Corrective Action Plan for addressing these issues is outlined at the end of this report.

Incident Description

Late on the afternoon of October 5, 2006, the Water Utility Principal Engineer informed the General Manager that Unit Well 29 was being shut down for the winter and that he had discovered that chlorine and fluoride had not been fed at the well since late August. The General Manager, Principal Engineer and Water Quality Manager immediately began looking into the situation.

Well 29 had been on standby status during this time, meaning it was operating for only about 4 hours, twice a week, in the middle of the night, for a total of about 8 hours per week. The well had operated nine times while the chlorine and fluoride feed equipment was dysfunctional.

In May 2006, Well 29 had been placed on standby status in order to minimize the use of the well, which produces elevated levels of manganese. It was being operated in the middle of the night in order to minimize discolored water occurrences at customers' taps in the service area. Whenever Unit Well 29 was not operating (95% of the time), the area was being served by wells with proper chlorine and fluoride feed rates. Ten routine distribution system samples taken in the Well 29 service area during this period showed appropriate levels of chlorine residual in the drinking water and all bacteriological samples showed no bacterial contamination.

The General Manager contacted Wisconsin Department of Natural Resources on October 6, 2006, to determine if any regulations had been violated due to the lack of chlorine or fluoride feed at the well. Public drinking water from ground water sources are not required to be chlorinated or fluoridated in Wisconsin, thus no state regulations had been violated, according to DNR officials. However, the incident violated the Utility's own policy for chlorinating and fluoridating its drinking water.

The General Manager also contacted the Mayor and the Director of Public Health for Madison and Dane County. The public health director said the health risk associated with the incident appeared to be very minimal. A review of public health records for the prior month showed no increase in gastrointestinal illnesses that could be attributed to consumption of non-chlorinated water.

The Mayor requested a formal investigation into the incident by the Water Utility General Manager, the Utility Water Quality Manager, and the City Engineer on October 6, 2006. The formal investigation was initiated on Saturday, October 7, 2006, with a visit by the investigation team to the unit well and a discussion onsite with the Waterworks Operator I on duty that day. Subsequently, records were reviewed and additional interviews were conducted. Discussions or interviews were held with eleven Utility employees regarding the incident.

Well Operation/Maintenance Procedure and Information Compilation

Every unit well in Madison's water system is visited each day by a Waterworks Operator I (commonly referred to as a "Rounder"). If the well is not operating and has not operated since the last visit, the Rounder inspects the unit and the grounds to ensure that everything is in proper order.

If the well is operating, the Rounder records various readings and measurements on a daily report sheet for the well. Among the instrument readings taken by the Rounder, are (1) the weight (in pounds) of chlorine cylinders, (2) the volume (in gallons, as a function of tank weight) of fluoride, (3) the chlorine feed rate, and (4) the chlorine residual as water enters the distribution system (from a chlorine analyzer unit). Among the measurements physically taken by the Rounder are the chlorine residual as the water enters the distribution system (a backup to the chlorine analyzer reading) and the fluoride level as the water enters the distribution system.

If the well is not operating when the Rounder visits, but has operated since the last visit, the Rounder records the weight of chlorine cylinders and the volume of fluoride. None of the other readings or measurements listed above can be taken when the well is not operating.

For any well that is operating or has operated since his last visit, the Rounder brings the daily report sheet for that well into the office after his "rounds" and turns them in to the Operator II, who is the Utility's 24-hour operator on duty. The Operator II reviews the daily reports and calculates chlorine and fluoride use, based on the reduction of weight of chlorine cylinders and the decrease in volume of fluoride over the past 24 hour period (if the well is running regularly) or from the previous time the well was operated (if the well is on standby or otherwise runs intermittently). The Operator II makes the calculations on the daily report sheet, transfers the calculated information onto a summary cover sheet for all wells for the day, and enters the data on a pumpage report spreadsheet. He also enters some of the data into an automated program in the Supervisory Control and Data Acquisition (SCADA) system.

The SCADA system also electronically collects and records some information directly from the unit wells. The SCADA system, among other information, continually collects and records the following: (1) the weight of chlorine cylinders, (2) the volume of fluoride, and (3) the chlorine residual as indicated by the chlorine analyzer. If the chlorine residual is low at any well, a visible warning signal appears on the SCADA computer screen for that well.

If a Rounder finds something at a unit well, through observation or analysis of data, that requires maintenance, he notifies the Operator II. If the matter requires immediate attention, he will call the

Operator II from the unit well. If the matter does not require immediate attention, he will make a note on the daily report or talk to the Operator II at the end of his rounds. When the Operator II becomes aware of a need for maintenance, he writes up a work order form and sends the form to the Maintenance Supervisor for action.

The Maintenance Supervisor makes assignments of work orders received from operators to his maintenance staff. When a Maintenance Worker completes a work order, he writes a summary of the work completed on the form and returns it to the Supervisor, who reviews the work, and forwards the completed work order back to the Operator as a record that the work was completed. If a Maintenance Worker determines that a situation cannot be immediately resolved and that a unit well should not be operated until the situation is resolved, he is instructed to shut off power to the pump so the unit cannot be operated until the maintenance work is completed.

Unit Well 29 also has an automated alarm system with the capability of triggering audible alarms in the unit well when certain conditions exist. This system also has the capability of automatically shutting the well down when certain conditions exist, including the failure of chlorine feed equipment.

Investigation Team Findings

On or about August 24, 2006, a deep-well flow meter at Unit Well No. 29 failed. There were thunderstorms and lightning strikes in the area on August 24 and 25, which may have caused a power surge that disabled the meter. No other electronic systems at the well were impacted by these storms. The first time that Well 29 operated after the meter failed was August 29, 2006.

The function of the failed meter was to measure water flow from the deep well and to regulate the addition of chlorine and fluoride into the system based on the amount of water flow. No other wells in the Madison system are set up like this unit and no others are equipped with a meter on the deep well. Well 29 is the only well in the system with a variable frequency drive (VFD) deep well pump. The VFD motor was installed to provide for gradual start-up of the pump in order to avoid a surge upon start-up, which causes pumpage of unacceptable amounts of sand from the well, which could damage equipment and increase system maintenance costs. The VFD pump also saves energy and electrical costs of operation.

For all other wells in the system, deep well pumps are not metered, they operate at a single speed and pump at a constant flow rate, and chemical feed equipment introduces chlorine and fluoride at a constant rate. For Well 29, where the VFD pump provides varying flow rates over time, chlorine and fluoride feed rates must vary accordingly and fluctuate with the speed of the pump. The regulation of chlorine and fluoride feed rates is accomplished by linking the deep-well meter, which measures the flow rate from the well, to the chlorine and fluoride feed equipment. A signal from the meter adjusts the feed rates based on the amount of flow at any given time. It was this flow meter that failed on or about August 24, effectively stopping the flow of chlorine and fluoride into the system when the pump operated. Rounders were not routinely recording the deep-well meter readings at Well 29, and thus did not note the meter failure.

The first three times Well 29 operated following the failure of the meter-chemical-feed system (August 29, September 1, and September 5), no Rounders or Operators raised any concern or took any action to verify the lack of chemical use or to notify Maintenance of equipment failure. Three different Rounders and Operators had been on duty on these three occasions and in a position to review records that would have indicated a lack of chlorine and fluoride use at the well. Operators explained that, since Well 29 was being operated for so few hours each time it was run, that the apparent lack of chemical usage could be

the result of faulty readings, data entry errors, or scale tolerances for such short duration of pumping. They said their normal procedure in this situation would be to note chemical use the next time the well ran to see if there was a pattern. The Water Utility Principal Engineer also reviewed the daily records on these days and did not notice the negligible chemical use at Well 29. This duty would normally be conducted by a Water Supply Engineer, a position that is currently vacant.

The fourth time the well ran, on September 11, 2006, a Rounder inspecting the site during the day, when the well was not operating, noticed that chlorine or fluoride use was negligible when the well ran the night before. He made a note on the daily report sheet for the well, stating, "chemical usage seems low." The Operator II who would have reviewed this record on September 11 said he would have written a work order for this, but no work order could be found.

Well 29 operated on September 15, September 19 and September 22, without Rounders, Operators, or the engineer raising questions about chemical usage at the well.

On September 27, a Rounder on duty again wrote a note on the daily report sheet for the well, which said, "chemical usage??". This sheet was turned into the Operator II on duty, and that Operator issued a work order for Maintenance to check out the problem. Maintenance personnel visited the well and determined that the meter was not working or sending a signal to the chemical feed equipment. Maintenance personnel did not shut off power to the pump. They did relay their findings to the Operator II on duty who made a note in the daily log that the well should not be operated until the equipment was fixed. That Operator does not specifically remember if he also posted a memo to that effect. Two other Operators said a memo was posted, but no such memo was found.

On October 4, 2006, the Principal Engineer questioned an Operator II as to why Well 29 had not been operated for a week. The Operator II did not know the reason and could find no memo indicating that it should not be operated. The Principal Engineer directed that it be operated that night, that message was transmitted to the Operator on duty that evening, and the well was operated.

On October 5, as Unit Well 29 was being prepared for shut down for the winter, the Maintenance Supervisor informed the Principal Engineer that the water in the reservoir had no chlorine residual. The Principal Engineer directed that the water in the reservoir should not be put into the distribution system, but rather, should be drained to waste. He began looking at well records, realized the chlorine and fluoride equipment had not been working for weeks, and immediately informed the General Manager.

Safeguards and their Applicability to this Incident

The Utility has multiple safeguards in place to maintain designated chlorine and fluoride levels in its drinking water. For various reasons, most of those safeguards failed in this incident. Safeguards in place at Well 29 are as follows:

- Chlorine analyzers at the wells measure chlorine levels of water being pumped to the distribution system and transmit the data to the SCADA system when the unit well is operating.

Chlorine analyzers have needed frequent adjustment, especially at Well 29, because elevated levels of manganese and iron in the water impact the accuracy of the instrument. Consequently, Operators do not have confidence in the chlorine analyzers and do not give much credence to the data they provide through the SCADA system or to the alarms that

indicate low chlorine levels based solely on that data.

- Chlorine residual information from the chlorine analyzers is also recorded by Rounders on their daily record sheet if the well is operating.

Chlorine analyzers were not operating when Rounders visited Well 29 because the unit well was operated in the middle of the night and was not pumping at the times they were conducting their rounds.

- As a backup to the chlorine analyzer data, Rounders take a water sample and measure chlorine residual of water pumped into the distribution system at the unit well. They also measure fluoride level in the water if the unit well is operating

Neither of these measurements were taken at Well 29 because the unit well was operated in the middle of the night and was not pumping when the Rounders visited the site.

- An automated system at Well 29 monitors various parameters, including chlorine and fluoride feed equipment operation and can sound an alarm or shut the unit well down if the equipment fails.

The alarms on this automated system had been disabled. The investigation team could not determine when, why or by whom the alarms had been turned off.

- The same automated system includes a feature that is designed to ensure that some chemicals would be added to the system even in the event of a deep-well meter failure. The system provides for input of a minimum setting that would cause the equipment to feed chemicals at a pre-established minimum level, even if the meter were reading no flow.

The "minimum" setting in the system was entered as zero, thus effectively deactivating the minimum chemical feed feature. It is likely this feature was never activated upon start-up of the unit well in 2005

- Quantities of chemicals used at a unit well are recorded by Rounders and reviewed by Operators and their Supervisor. This information is also collected and compiled in the SCADA system.

Operators erroneously concluded on several occasions that the apparent negligible chemical usage at the well was the result of minimal hours of operation, faulty readings, data entry errors, or scale tolerances for short-duration pumping. The Principal Engineer reviewing the daily reports did not notice the lack of chemical use. Operators rely on the data collected by Rounders, rather than that being sent to the SCADA system directly from the unit well.

- Chlorine and Fluoride levels are measured in the distribution system.

These measurements, taken during the day, when Well 29 was not operating, continued to accurately show appropriate levels of chlorine and fluoride in the distribution system.

The fact that this well has new and unique equipment, was on standby status, was operating in the middle of the night, and was operating for only four hours twice a week significantly contributed to the failure of safeguards in place to prevent such an incident.

Work Order System and Communication

The work order system used by Operators to order maintenance at unit wells is outdated and inefficient and does not provide sufficient "paper trail" to be able to accurately track a work order from inception to closure. Operators do not keep a copy of work orders at the time they are issued. They only keep a copy when the work order is returned to them after the work is completed. Consequently, it is possible for a work order to be lost without any documentation of it ever having been issued. Work order forms also lack sufficient information to be able to accurately determine who acts on them at each stage of the process and the date and time each action on a work order takes place.

Communication systems in place for communicating important well operation information between Rounders and Operators, between Operators on different shifts, and between Operators and their Supervisor need improvement. Communication problems are exacerbated by the fact that Rounders, Operators and Supervisors work different shifts and may not see one another face-to-face for days at a time. Rounders rely on hand-written notes on daily report sheets or on verbal communications with Operators on duty. Operators rely on a daily hand-written log and on posted memos to relay important information to Operators on subsequent shifts. There is too much reliance on Rounders, Operators and Supervisors to check various sources for information, rather than one central location.

Corrective Action Plan

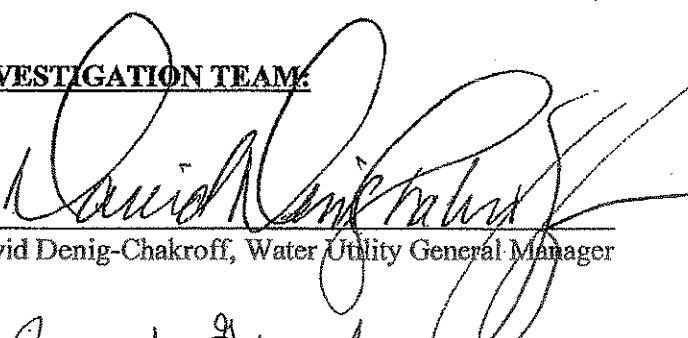
As a result of this investigation, the following actions will be taken:

- Chlorine analyzers at wells will continue to be checked and adjusted monthly by Maintenance personnel, and whenever Rounders or Operators report a problem or discrepancy. All chlorine analyzer units will be assessed in terms of their ability to maintain accuracy. If the accuracy of any are found to be impacted by manganese or other minerals in the water, a different type of analyzer will be installed that can maintain accuracy. For all wells operating this winter, the chlorine analyzer assessment and/or replacement will be completed by December 31, 2006. For all wells not currently in operation, the assessment and/or replacement will be completed by July 1, 2007. Responsible employee: Maintenance Supervisor.
- Effective immediately, for any well operated on standby or intermittently for more than a week, an operating schedule and/or Rounder's schedule will be established such that a Rounder will visit the well when it is operating and collect operating data at the well at least once for every 24 hours of operating time. Responsible employees: Principal Engineer/Water Supply Engineer.

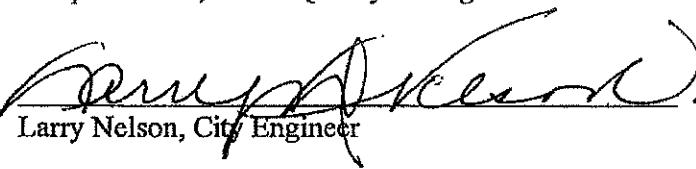
- By November 30, 2006, security will be programmed into the automated systems at wells to prevent anyone, except specified supervisory personnel and the Electronics Maintenance Technician, to modify alarm and failure response settings. The Electronics Maintenance Technician will be assigned the specific duty to check unit well alarms on a monthly basis and to verify that they are activated and operational. Responsible employee: Principal Engineer.
- Training will be provided to Operators, Rounders, Maintenance personnel, and the Electronics Maintenance Technician on new automated systems and new equipment at unit wells by February 31, 2007. Training updates will be provided annually or more frequently if needed. Operators will be assigned to "rounds" at least quarterly in order to keep them current and practiced in onsite well operations. Responsible employee: Principal Engineer/Water Supply Engineer.
- By December 31, 2006, the daily well report sheet used by Rounders will be reviewed, revised and updated and a daily unit well checklist will be developed, based on the recommendations of an employee committee with Rounder, Operator, Maintenance Worker, and supervisory representatives. The report sheet and checklist will be reviewed and updated as needed annually. Responsible employee: Principal Engineer
- By December 31, 2006, a weekly operational report for Operators and Rounders will be developed, which will provide comprehensive system status information, specifications and parameters for measurements and readings at wells, and other information needed by Operators and Rounders in order to effectively and efficiently operate the system during the week. The report will be provided for reference with the daily checklist as each Rounder begins his shift. Responsible employee: Principal Engineer.
- Effective immediately, Operators will be required to provide a system status report at the end of each shift to the Operator coming on duty for the next shift. In addition, by December 31, 2006, an automated well operation daily log system will be developed to consolidate the documentation and communication of well operation information at one source for Rounders, Operators, Supervisors and Maintenance Personnel. In addition to the shift-change status report, Operators and Supervisors will be trained on the automated system and directed to check this source of information at the beginning of each shift or as needed for reference during the shift. Responsible employee: Principal Engineer
- Written, comprehensive, standard operating procedures for Rounders and Operators will be developed, by January 31, 2007, based on the recommendations of an employee committee with Rounder, Operator, Maintenance Worker, and supervisory representatives. The standard operating procedures will be reviewed and updated as needed annually. Responsible employee: Principal Engineer/Water Supply Engineer.
- By November 30, 2006, software and/or hardware will be installed that will provide Operators with a separate computer screen dedicated for the "display view" component of the SCADA system so that the data in that system can be easily viewed at all times. Chemical usage data compiled in "display view" will be reviewed by Operators and checked against the same data collected and submitted by Rounders. The "display view" system will be programmed such that a visible alarm or warning is triggered on the screen if the data show inappropriate chlorine or fluoride use for the amount of operating time at any well. Responsible employee: Principal Engineer.

- An interim, automated work order system will be implemented by October 31, 2006. The Utility will participate with other City agencies in the ongoing solicitation, review, selection and purchase of a permanent work order/inventory software package that meets its needs. Responsible employee: Principal Engineer/General Manager.
- Effective immediately, Supervisors of maintenance and operating personnel will clarify with their staff the appropriate justifications and process for shutting a well down and cutting power to a well, including the personnel with that authority and responsibility and the communication requirements for taking such action. In the event of an emergency with a potential affect on public health or safety, maintenance and operating staff will continue to have this responsibility and authority if prior communication with a supervisor is not practical or expedient. Responsible employees: Principal Engineer and Maintenance Supervisor.
- By October 31, 2006, the position description and other paperwork will be submitted to Human Resources needed to post, advertise for, and hire the vacant Water Supply Engineer. Responsible employee: Principal Engineer.
- By October 31, 2006, the Utility's Strategic Planning Initiative consultants will have facilitated a work session with employees representing the Water Supply, Engineering, Maintenance, Meter Shop, and Distribution sections to review maintenance best practices and to work to tailor those practices to the current and future needs of the Utility with the goal of initiating implementation of those practices immediately and achieving full implementation in 2007. Responsible employee: General Manager.
- The Water Utility General Manager will report to the Mayor on the progress of this corrective action plan on a monthly basis through December 31, 2006, and quarterly thereafter or as requested.

INVESTIGATION TEAM:


David Denig-Chakroff, Water Utility General Manager


Joseph Grande, Water Quality Manager


Larry Nelson, City Engineer

16 Chiching St.
Incident
Attachment B

Madison Water Utility Operations Tasks/Assignments per UW 29 Investigation

Madison Water Utility Operations Tasks/Assignments per UW 29 Investigation

Well 16 Chlorine Failure Incident Investigation Report

June 8, 2007

Incident Description.

The following summary is based on the interview notes by supervisors of employees who were involved in this incident and the records of the Water Utility regarding Well 16 on April 20, 2007.

The Water Utility operates a well and reservoir at 6706 Mineral Point Road. On Friday, April 20, 2007, an Operator 1, termed "Rounder", and a Maintenance Mechanic were at the site. The Rounder reported to Maintenance Mechanic that the chlorinator was not working. The Rounder took a chlorine residual of 0.22 mg/l at approximately 10:20 am. He reported that the chlorine analyzer was reading 0.21 mg/l and noted on the report "feed set stuck at 10# (maxed out) unable to lower it". The Rounder informed the Maintenance Mechanic and left the site. The Rounder recalls talking to the Operator 2 when he arrived at the Water Utility about the chlorinator ("rotometer") issue.

The Maintenance Mechanic adjusted and raised and lowered the BB in the rotometer. He then contacted his Leadworker and asked if he should change the tube to 25#. The Leadworker told him to wait until the following Monday and check with the Maintenance Supervisor. The Maintenance Mechanic did not inform the Operator 2.

Based upon the report from the Rounder received at 1:00 pm that the rotometer was stuck, the Operator 2 ran the calculations for chlorine use and determined that adequate chlorine was being used and that assumed that the rotometer was sticking. He then prepared a work order and assumed that the Maintenance Mechanic would have called him if there was a problem.

However, the chlorinator had malfunctioned and the water from the well was not being chlorinated. The chlorine level began to fall at 10:00 am and continued to fall through the day. The chlorine cylinder weight indicated no chlorine use after 11:00 am on April 20, 2007.

The SCADA system automatically issued a warning that the water was being under-chlorinated but the warning did not result in action by the Operators on two shifts at the Operation Center at the Water Utility Office. Well 16 was not turned off until lower demand negated the need for pumping, which was at 8:40 pm, Saturday.

On Saturday, April 21, 2007, Operator 2 Henderson, based on the SCADA data determined that the reservoir had been under-chlorinated. Henderson contacted Principal Engineer Larson, who directed that the well be taken out of service. Henderson prepared Job Order 604.

On Sunday, April 22, 2007, Operator 2 Guderyon determined that Well 16 needed to be placed in service. He called a Maintenance Mechanic Paul into work. The Maintenance Mechanic repaired the chlorinator, wasted one-half the reservoir to the storm sewer. With the chlorine residual raised to 0.25 mg/l, the well was placed back in service at 10:00 am, Sunday.

Investigation Charge.

Mayor Cieslewicz requested George Meyer, Water Board Member, Paul Nehm, Madison Metropolitan Sewerage District Plant Engineer and Larry Nelson, City Engineer to review the Well 16 Incident and report their findings to the Mayor and Water Board.

Related Incidents.

The Water Utility has sustained several failures regarding the addition of chlorine to the public water supply. Those failures have resulted in media reports that are generally negative and induced concern on the part of the public and elected officials for the public water supply.

Past incidents include:

- A low chlorine failure at Well 29, which was operated on an intermittent basis. The event occurred on or about August 23, 2006 and was not discovered until October 5, 2006. A variable flow meter failed, which regulated chlorine feed into the well water.

The Operator 1 reported low chlorine use on two separate occasions before action was taken to correct the issue. The alarm was found to have been disabled and the Operations Center did not detect the problem.

An investigation was undertaken and a detailed report with findings and recommendations was issued on October 27, 2007. That report, entitled Well 29 Chlorine/Fluoride Failure Incident Investigative Report, is attached and made a part of this report.

- On March 27, 2007, a chlorine feed valve malfunctioned and about 25 pounds of chlorine flowed into the well of Well 8. The well was restarted based upon an erroneous test of the water in the reservoir rather than the well. The Operations Center did not respond to the high chlorine warnings and the problem was not discovered until the following day.

Furthermore, the incident was not disclosed to the public until the press contacted the Principal Engineer, presumably on a tip from employees.

On May 27 at 7:02 pm, Operator 2 Allen reported to his supervisor that he had shut down Well 7 because the chlorine level was below the established limit of 0.14. Operator 1 Green reported to the site and determined that a chlorine tank had been replaced but not turned on. The reservoir was drained and placed back in service. In this incident, an error, not a mechanical failure, had occurred but was rectified without a compromise to the public water supply system.

Investigation Team Findings.

The Well 16 incident of April 20, 2007 has great similarity to the incidents at Well 29, and Well 8. In each incident, a mechanical failure occurred and the impact of that failure was not fully understood by the Maintenance employees and the Operation Center for a period of time. Furthermore, pertinent information that could result in a quicker understanding the incident was not communicated between employees. In each of these cases, the final result did not pose a risk to public health. But, the confidence of the public in its Water Utility was diminished.

The Well 29 Chlorine/Fluoride Failure Incident Investigative Report, Attachment A, is still a current document and a number of its recommendations have not been implemented as scheduled. Specifically, the report recommended that "written, comprehensive, standard operating procedures for Rounders and Operators will be developed by January 31, 2007."

A summary of the report's recommendations and current progress are attached to this report as Attachment B.

The development of the standard operating procedures were delayed by the lack of the filling of the Water Supply Engineer and a lack of time on the part of the Principal Engineer. The position has been advertised but an acceptable candidate has not been found. The position is currently rated as an Engineer 3, Group 18, Range 10. Given the incidents sustained since the Well 29 incident, this important project should not have been deferred.

Given the requirements of the SCADA system and the need to have ability to continually train a number of employees in the Water Supply Section, the Water Utility should revisit the job requirements of this position.

On May 25, 2007, the Engineering Operations Manager was temporarily assigned to assist the Water Supply Section pending the retention of a Water Supply Engineer.

As a result of the Well 16 incident and following the direction of the Mayor on May 8, 2007, the Water Utility Manager has prepared a draft SOP (Standing Operating Procedure) for Chlorine Levels. This procedure will be presented to the Board of Water Commissioners on June 19, 2007. That procedure will serve several purposes:

- It is a procedural document for the employees and supervisors of the Water Utility and it will remove the individual preferences or hesitation on the part of employees and supervisors;
- It is a policy document by the Water Board defining the limits of chlorination; and,
- It will provide a written reference point to the public as to the "specification" for chlorine in the public water supply.

The adoption of the SOP will require a rigorous training program for all maintenance employees, operators, and supervisors. Monthly problems and drills need to be implemented. However, the adoption of this SOP represents but a chapter of the "Written, comprehensive, standard operating procedures for Rounders and Operators..." envisioned in the Well 29 Chlorine/Fluoride Failure Incident Investigative Report.

A review of the interviews of the employees after this incident indicates that the employees are concerned about high chlorine levels. They are less concerned about low chlorine levels and they do not trust the chlorine analyzers. There is reliance on the calculations of the chlorine used, however, and the Well 16 incident is an example. Reliance on calculations of chlorine used is looking back to what happened previously. It does not discern a failure that is in progress.

The failure of the chlorine analyzers remains a concern. Further review of the maintenance schedule and the failure rate needs to be undertaken including available documentation of the preventive maintenance (PM) program. The Well 29 Report tasked the monthly checking of the chlorine analyzers. Given the continued problems of operating at chlorine levels close to the detection limits of available equipment and the high mineral content of Madison's water, which contributes to equipment failure, the Water Utility and the Water Board need to consider embarking on a program to upgrade the chlorine analyzers and the maintenance frequency of the analyzers. Given the limitations on equipment, this should be considered a research and development program.

The current SCADA system is to be replaced by the Water Utility. It would be a serious mistake to consider the development and installation of a new SCADA system as the resolution of issues manifested by these incidents. Rather, that time period between the two systems represents a

period of additional risk to the operation. However, the move from the old to the new SCADA system represents a perfect opportunity to review how the water supply system operates in a manual mode and to institute those procedures and tasks into the new system. The SOP for the water supply operations is an important part in the development of the new SCADA system.

The Water Utility does not have a "Supervisor On-Call". Given the potential for equipment failure and the need to manage a 24-hour, 365-day a year operation, the Water Utility should establish a supervisor on call capability employing at least 6 but not more than 8 supervisors, including Managers, to a weekly on-call shift. A side benefit would be the cross training of supervisors in the various aspects of Water Utility operations.

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