INVESTIGATION REPORT

RAW SEWAGE DISCHARGE TO THE RED RIVER

CITY OF WINNIPEG

NORTHEND SEWAGE TREATMENT PLANT

January 2003

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Summary

As a result of an incident at the North End Sewage Treatment Plant at about 1:30 PM on September 16, 2002, Manitoba Conservation was notified by the City of Winnipeg that raw sewage was being discharged to the Red River. This was a direct result of the main lift pumps in the dry wells being inoperable due to flooding of the dry wells. Raw sewage would continue to be discharged to the Red River until such time that the dry wells could be placed back in operation.

Manitoba Conservation conducted an investigation, which consisted of sampling the Red River, observing remedial work at the North End Sewage Plant and interviewing City of Winnipeg staff regarding the incident. From the information gathered from the interview process and the observation of the remedial work, Manitoba Conservation has concluded that the direct cause of the raw sewage being discharged to the Red River was due to the fact that the pumps in the dry wells became flooded resulting in the inability to pump sewage through the treatment plant.

The cause of the flooding of the dry wells was the removal of a pump inspection plate prior to the pump (i.e. MP5) being hydraulically isolated. Factors that contributed to the failure to determine that the pump was hydraulically isolated were the malfunctioning of the pump drainage system and the suction gate valve and a lack of accurate information on the operation of the suction gate valve. Once the dry wells flooded there was no mechanism in place too effectively pass the sewage through the treatment plant. This resulted in raw sewage being diverted to the Red River until the liftstation pumps could be placed back online.

It is recommended that the dry wells be physically isolated from each other, pump drainage systems upgraded, control mechanisms improved and operation practices changed.

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Introduction

On September 16, 2002 at about 1:30 PM an incident occurred at the North End Sewage Treatment Plant resulting in the influent dry well pumps located in the main building being taken out of service due to flooding. This in turn resulted in the necessity of raw sewage being discharged to the Red River, to prevent sewage from backing up into the collection system and flooding residential basements and businesses. Manitoba Conservation was notified by telephone and E-mail at approximately 3 PM on September 16. Manitoba Conservation attended morning briefing sessions arranged by The City of Winnipeg to appraise interested parties of the progress at the North End Sewage Treatment Plant. Some handout notes were distributed at these sessions and briefing notes were E-mailed to concerned parties, copies attached as Appendix 1. Manitoba Conservation began an investigation, which included monitoring of the Red River, observing the removal of the suction gate valve and later included interviewing City of Winnipeg employees. This report is a summary of the investigation.

Background

This was not the first major occurrence of raw sewage being discharged to the Red River as a result of flooding the dry wells at the North End Sewage Treatment Plant. In 1965 a similar event occurred where raw sewage was discharged to the Red River as a result of flooding of the dry wells at the North End Sewage Treatment Plant. On the 1965 occurrence, two work crews were performing maintenance on related equipment at the same time in different locations. One work crew had disassembled one of the intake lift pumps after hydraulically isolating the pump by closing the suction gate valve. The second crew was working on an electrical panel, which controlled the suction gate valve associated with the same pump. The suction gate valve at that time was a hydraulically actuated valve with a pre-set normally open position. When the electrical crew working on the panel removed a circuit breaker, the suction gate valve was automatically opened with no mechanism for it to be closed, resulting in flooding of the dry wells and subsequent discharge of raw sewage to the Red River.

Interviews

Interviews were conducted with a number of City staff involved with the operation of the North End Sewage Treatment Plant, as part of the investigation. The personnel interviewed included: the sewage treatment plant operator responsible for the main lift pumps at the time of the incident, the Supervisor of Operations for the plant, and the Manager of Wastewater Services.

Discussion

Raw sewage entering the North End Sewage Treatment Plant collects in a stilling well. From there it flows via two headers, which supply six pumps located in three interconnected dry wells, with two pumps per well. The six pumps provide the hydraulic lift to allow sewage to flow through the treatment plant. A suction gate valve is located between each pump and the header to isolate flow from the header to the pump thereby allowing maintenance of the equipment in the dry well. The valve must be closed for any work associated with access to the internal workings of the pump, thus effectively hydraulically isolating the stilling well from the dry well. The pump is equipped with a drainage piping system and a shut-off valve to allow draining of the downstream portion of the suction gate valve, the reducer located between the intake suction gate valve, the pump and a portion of the discharge header. Due to clogging problems associated with the drainage piping system, the normal practice in the plant is to partially remove a number of bolts on an inspection plate, thus draining the sewage contained in the piping downstream of the suction gate valve. Raw sewage is allowed to drain to the floor area around the partially loosened inspection plate until drainage has ceased. Once flow had ceased from the inspection plate, work on the equipment located in the dry well would commence. This would allow the removal of the inspection plate and the work crew could proceed to complete the required maintenance work. This procedure has been in effect for at least ten years or more. As long as the valve between the header of the stilling well and the appropriate pump is fully closed, staff believed this method posed no risk. According to the personnel interviewed, it never occurred to plant staff or management to replace the drainage piping system, which had been designed by professional engineers as part of the overall plant design, with a proper system that would work effectively.

Maintenance on major equipment at the North End Sewage Treatment Plant is co-ordinated through a system of work orders. The City of Winnipeg supplied work orders, relative to the main lift pump, identified as MP5, to Manitoba Conservation. Of those work orders supplied, three stand out, which may be associated with problems involving the suction gate valve. The first being work order # 1444, created on October 24, 1994, where comments are made with reference to MP5 that it "sounds like a piece of metal is in discharge line". The work order indicates that this was checked and found to be “OK”. The second is work order # 11188, created on May 14, 2001. The work order comments say, " please check limit switch on MP 5 does not show it is closed (suction gate valve)". This work order was completed on July 9, 2001 and closed on July 12, 2001. The third occurrence is work order # 12455, created on June 6, 2002. Comments on this work order read "suction valve will not close on MP5". The work order does not indicate a completed date or a closed date.

Plant operators change work areas on a six month rotation, to allow familiarity with the entire plant. Such a rotation occurred in July. At this time, it was decided that another attempt to complete maintenance work on MP5 would be conducted. In order to do such work, the suction gate valve associated with MP5 would have to be effectively closed.

The crew assigned to the area associated with MP5 was requested to attempt to isolate MP5 and perform some much-needed maintenance. As indicated earlier the previous operators indicated on work order # 12455 that the suction value on MP5 would not close.

A Rotork valve actuator is used to control the operations of the suction gate valve. It is an electrical device attached to the valve, which allows remote operation of the valve. It also makes opening and closing the valve less time consuming. Also attached to the valve mechanism is a manual crank wheel. The wheel can also be used to open, close, or snug up the valve to ensure the valve is fully seated or is at it's limits of travel. Attached to the Rotork actuator is a position indicator, which shows the relative position of the valve. During the investigation, it was observed that the position indicator showed the valve in a partially open position. During the interview with the operator, Manitoba Conservation had been told that the position indicator did not indicate the continuous position of the valve, it simply indicated that the valve plate was open, closed, or in travel mode. The City was requested to confirm the position indicator operation while the unit was in the City's repair shop. The City indicated it could not comply with the request as the device had been submerged in sewage and would not likely be placed back into service.

When the valve is in the full open position, the valve stem extends a considerable distance up through the Rotork control device. As the valve is closing the valve stem retracts into the Rotork actuator device. Manitoba Conservation was advised by both the operator and the plant supervisor that they believed that the valve was in the fully closed position when the valve stem was recessed 3 – 4 inches below the top of the Rotork actuator. This was the case with the other valve in the same dry well, although the other valve was not of identical construction. Information obtained after the incident indicated that the valve stem must be recessed approximately 14 inches below the top of the Rotork actuator to be in the fully closed position

The adopted procedure to drain the downstream portion of the suction gate valve, the reducer located between the intake suction gate valve, the pump and a portion of the discharge header was followed, however the flow continued through the inspection port. A plan was developed based on staff discussion and consensus, to allow the valve to plug with sewage solids over a period of time. The staff thought the valve was very close to being fully closed as the manual crank wheel was at the point of refusal and could no longer be turned to close the valve, but flow continued to come from the inspection plate. Staff would allow the flow to continue through the inspection port in the beginning of the week and close the port over the weekend. This procedure which was started in late August was implemented for a period of about three weeks. During the third week the flow from the inspection port gradually ceased. At this point, staff thought the valve had sealed itself, the inspection plate could be fully removed and the routine maintenance work could be performed on MP5. It was at the time the last few bolts were being removed that the inspection plate released. The inspection plate blew off, thrusting the

operator across the dry well. All attempts by the operator to replace the inspection plate failed due in part to the weight of the plate (i.e. approximately 37 kilograms) coupled with the tremendous flow of raw sewage rushing out of the inspection plate port. By this time the liquid level, according to the operator, was rising rapidly in the dry wells which are all interconnected. The operators immediately realised the risk of potential electrical shock from the high voltage electrical motors and proceeded to shut off the power to all the pumps. This in effect prevented the raw sewage from entering the sewage treatment plant. To prevent sewage from backing into residences and businesses, raw sewage was diverted to the Red River.

The City of Winnipeg under took a Water Quality-monitoring program from Dunkirk Bridge (upstream of the outfalls) to Netley Creek, downstream of Selkirk, to monitor the effects of the raw sewage being discharged to the Red River. Booms were also placed at the outfalls to minimize the spread of floating debris downstream of the outfalls. These measures were maintained until a few days after the pumps in the dry well were back on line and discharge of raw sewage to the river had ceased. An interim report was supplied to Manitoba Conservation dated October 25, 2002, which details the incident and the follow-up activities of the City of Winnipeg (Appendix 1).

Prior to the removal of the suction gate valve, divers inspected the valve via the intake header of the stilling well. They determined that the valve was open approximately 30 centimetres (12 inches). This would account for the trouble maintenance crews were having in attempting to stop the flow through the inspection plate. In essence when the crew did manage to stop the flow through the inspection plate, the flow was not stopped at the valve as they had assumed, but at the inspection plate itself. Consequently when the bolts were loosened and the blockage at the inspection plate was freed, the raw sewage flowed with the full force of the 3.3 meters (11 feet) of head pressure. For this reason it was impossible for the operator to replace the inspection plate once it had been completely removed.

The interior of the valve body is supposed to have four valve guides, a 36 cm (14 inch) section on the top and a 107 centimetre (42 inch) section on the bottom, on both sides of the bonnet.

Photographs taken of the interior of the suction gate valve indicate the upper valve guide bar is absent and has moved to the lower portion of the valve body as shown in photos 511 and 516 respectively. The missing portion is 107 centimetres (42 inches) in length. The valve guides allow the valve plate to travel vertically and provide lateral support to the valve plate thereby preventing the valve plate from twisting or becoming misaligned. It is suspected that as a result of the missing guide the valve plate became misaligned, causing the valve plate to jam against the short valve guide now located in the lower part of the valve body and thereby preventing full closure of the valve plate. Coincidentally the valve was open a distance approximately equal to that of the length of the short valve guide.

Photo 511
Top Bonnet of suction gate valve. Left side of interior of bonnet shows valve guide bar is missing.

Photo 516
The upper valve guide bar, which is missing from the valve bonnet, as shown in Photo 511, is now positioned in the lower section of the valve body as shown in the above photo.

Conclusions

1. The discharge of raw sewage resulted from the flooding of the dry wells, which prevented the continued operation of the sewage treatment plant.
2. The flooding of the dry wells resulted from the removal of a pump inspection plate, when the pump was not hydraulically isolated.
3. The piped drainage system for the pumps is unreliable and has not worked satisfactorily for many years. Action should have been taken to replace the current system with one that works properly.
4. The inspection plate should not be used to determine if the pump assembly is hydraulically isolated and it should not be used for draining the system.
5. Plant operators were not aware of the position of the valve stem on the suction gate valve when the valve was in the fully closed position.

6. The suction gate valve had been identified as having problems closing. At the time the Rotork unit indicated that the valve was not fully closed and there was no other positive information indicating that the valve was closed, the decision should have been made to have divers visually inspect the suction gate valve. This would have indicated the degree to which the valve was open and appropriate corrective action could be taken, thus preventing discharge of raw sewage to the Red River.

Recommendations

1. The dry wells should be physically isolated from each other. A safe, secure manual escape route for plant staff should be provided in each dry well.
2. A functional pump drainage system with control valves should be designed, constructed and maintained on all major lift pumps.
3. A system should be designed, constructed and maintained to provide a positive check that a pump assembly has been hydraulically isolation after its suction gate valve has been closed, while maintaining hydraulic control in the pump assembly.
4. A monitoring device should be installed and maintained on all valve actuators, which will accurately indicate the relative position of the valve plate.
5. All major valves should be equipped with devices to ensure that staff can visually determine the position of the valve stems in the fully closed position.
6. All problems with major valves should be investigated by removing from service and making necessary repairs.
7. A program should be developed to exercise all valves on a routine basis to ensure proper functioning.

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