Replace or Repair Potable Bore Holes?

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Abstract

Riverina Water operate a number of Bores for potable water use varying in output from 1litre per second to 150litres per second and varying in age from mid 1960 to current date.
As these bore start to age a decision has got to be made what is to be done with an ageing bore. This paper is based on some field experiences that Riverina Water has come across.

Introduction
Riverina Water is a regional water supply authority, based at Wagga Wagga in southern New South Wales, covering the local government areas of Wagga Wagga City Council, Lockhart Shire, Urana Shire and Greater Hume Shire Councils and only supplies potable water to the above local government areas.

What sort of failures have we experienced with bores?

There have been a number of different types of failures within our bore fields starting with the usual pump & motor failures, blocked screens and casing failures. Some of the pump & motor failures have been as a result of blocked screens and casing failures.

Good recording keeping of the water table, kilolitre output of pumps and spot flow readings (litres per second), hour counter readings, amps are essential tools in monitoring the on going health of a bore including setting up a spread sheet or database to calculate the continuous performance of the pump.

As our bores are based in old river or creek valleys which are made up of various layers of clay and gravels which act as a natural filter medium and does not have the ability to be backwashed by mechanical means or as the head loss increases within these natural filters, one of the first signs of bore hole problems has generally been a loss of output of a particular bore.

This is generally picked up by a filtration plant operator who will report that they are unable to maintain output from a particular bore pump. With this report an initial investigation from available computer records and log sheets may show a decline in the water level over the bore pump when it is operating and returning to normal Static Water Level (SWL) when the bore pump stops. As a general rule when it gets to this point output litre per second (l/sec.) start to decline which corresponds to what our operator has reported?

If the above does not appear to be happening we then start a more thorough procedure of testing the pump and motor checking amps, power supply performance to manufactures curves and specifications which may lead to the need to start maintenance procedures.

Another possible cause of this decline in output could be from other bores which are tapped into the same aquifer and this may lead to more detailed investigation of the bore fields operation as a whole which is currently being undertaken by the Dept. of Natural Resources. Some of these bores, even though they are licenced bores are outside of Riverina Waters control.

Riverina Water has a routine maintenance schedule of approximately 4 year intervals, currently we are in the process of changing this to hours run, and we remove each pump, motor and column for inspection. As part of this process in the last 10 years we have also included a camera inspection of the actual bore hole which has enabled Riverina Water to make a more informed decision on the life of the particular bore hole and condition of the casing and screen.

Once the pump, motor and column have been removed from the borehole a camera inspection is immediately undertaken to assist us in making informed decisions. This will give us a visual record of the condition of the bore casing and screen. To assist in this inspection quite often you may have to repeat the process of lowering the camera to get an initial look the condition the bore is currently in. To assist the camera getting a better view at the condition of the bore casing and screen after the first inspection you may have to do some light brushing to remove any build up so as the actual condition of the casing and screen is revealed (I will talk about brushing a little later)

In this section I will address some of the problems which we have found when looking at the screens and methods which we have found successful to overcome blocked screens and a couple of things to avoid.

With screens one of the main areas that have come to our attention is the length of actual screening. When the bore was originally drilled the screens where designed to give a maximum continuous output i.e. a bore was designed to maintain 200l/sec with minimum drawn down. In practice we do not draw this volume of water i.e. 120l/sec. so you have an excess of screening. This has the effect that because we are not drawing water through the screens at maximum velocity to effectively clean the screen the part of the screen in which the greatest velocity is coming through is kept clean and the remainder of the screen has very little flow coming through so growth or buildup starts to develop and over a period of time when the high flow area start to block as in a conventional filter, the lower screens cannot operate as they are already blocked with buildup, in operations we have the long term effect of a blocked filter which requires a backwash.

The next part of the operation is how do you backwash a natural filter and where do you send the waste backwash water.

A solution we have come up with is to use a product called ClearBore which is a chemical that can come in granular form or more recently liquid. The liquid form saves a lot of mixing, handling and dissolving problems. The ClearBore penetrates the screen areas to soften up any hard material and as we surge the bore we are able to force the ClearBore out further into the screens and any loose material will be drawn in through the screens and end up in the sump of the borehole. To discharge the ClearBore if the pH is around 7.00 you are able to discharge the remaining waste material out onto a paddock.

Before commencing the ClearBore procedure you have to do some calculations as to diameter of bore, length of bore casing, length of screen and diameter of screen.

The ClearBore is generally pumped into the bore using a high pressure pump and hose, which you then proceed to lower into the borehole and constantly monitor the position of the outlet of the high pressure hose. When you reach the screen area you will slow the rate at which you are lowering the hose or increase the dosing rate for the screen and then return to previous rate

of lowering when you pass out of the screen until you come to another level of screening. Some bores can have 1, 2 or 3 levels of screens.

On completion of the injection process we surge the bore generally using compressed air. An alternative method is if it is possible to put a drilling rig over the hole which is easier to control the surging process you surge for a period of time and then leave the ClearBore for a minimum of 24hours before starting to remove the ClearBore.

Quite often wire brushing was used to loosen the calcium or other hard scale build up but this led to possible damage to casing or the screens so this practice has not been continued but softer brush type brooms have been developed.

Up until 2 years ago to remove the ClearBore Riverina Water used to lower a submersible pump on a hose down the bore hole to remove the remaining ClearBore and debris. The closest we could go to the bottom of the borehole was governed by the length of the motor and quiet often the pump inlet would become blocked with rubbish which meant we had to stop the process, remove the pump and clear the inlet hoping that we haven't done to much damage to the pump and then repeat the process of lowering the pump etc. again. We then removed this pump and did another camera inspection to see the result of the work.

Our current practice is to now use an air lifting technique which involves the use of a large compressor (size) and a venturi which is attached to a hose and lowered to the bottom of the bore hole by using a crane and rotary drill rods. This method is a lot more flexible and easier to position where you are drawing the rubbish from the bore hole.

After this process is completed we do another camera inspection which now allows us to have a real close look at the condition of the screen and casing and enable us to make more positive decision on how much possible life is left in the bore hole instead of waiting for the more dramatic stage of screen or casing failure and allows for the next phase of do I have to replace the bore hole or can the existing bore hole be saved.

Problems with Brushing of boreholes and solutions.

In the early days of borehole inspection generally wire brushing was the means used to remove scale and build up from the casing and screens. This generally involved making up some type of wire brush using steel wire cable cut with oxy and sandwiched between steel plates. This was then lowered down the borehole on a cable attached to a drilling rig or cable winch and lowered and raised in a surging action. The wire brush quite often actually caused a break in the bore casing with the gravel pack entering the borehole. At this point you can only say a few choice magic words but this will not fix the problem that has been created.

In more recent times we are now using a softer bristle type brush to overcome the problems of damaging the bore casing or the screens, while they do not remove the solid buildup like wire brushing or scraping, the combination of the softer brush and ClearBore work extremely well.

The area of failure which I will discuss is casing failure.

We have experienced a number of different types of failure with bore casing. Up to recently all of our casings are made of mild steel and welded together at about 6metre lengths. This involves sometimes just butting lengths of pipe together and running a run of weld around

them, more recently the drillers started to weld a collar around the join to give them more strength and less chance of failure at the join in the casing.

Another area of concern was that to raise and lower the casing the drillers used to blow 2 holes in the top of each length to allow them to use chains to raise and lower the casing into position and then re weld the pieces that had been cut out back into position after they had attached the next length of casing into position which has proved to been another major point of failure.

Another cause of failure is a pump attached to the pump discharge column not having enough clearance between the casing and the diameter of the pump and with the vibration of the pump rubs against the bore casing and eventually wears holes in the casing. Generally the first sign of this problem is when the gravel pack start to turn up in the main or aeration towers and by this time we have a major problem on our hand which in the past generally led to a new bore having to be drilled. This meant not only just drilling a new hole but having to change discharge pipe work, power supply location and possibly a new structure to accommodate the new infrastructure plus sealing of the existing bore hole.

Cause of failures has been many and varied some have even caused by ourselves during maintenance. A lot of these failures were before we had camera inspection.

We now have to make the big decision repair the existing bore hole or replace the bore hole.

About 7years ago some of our bores where starting to get to the end of their life, water tables where unable to be maintained, pumps / motors where constantly failing, screens where blocked, ClearBore was not around and you had to use some pretty nasty type chemicals to try and clean the casing, and then the disposal of the chemicals generally meant you had to dig large holes at the bore site to enable you to remove the diluted chemical. Stainless steel tubing was something you only dreamed about due to cost of the material and the problems of specialist welding techniques.

After a number of camera inspections and trialing of different methods to improve the performance the decision was made that the bores had to be abandoned which creates another problem of having to seal them to prevent them from contaminating the new bore or possibly the whole bore field

Up to 5 years ago if you had originally drilled a large enough bore hole you may have been able to insert this original casing with another smaller diameter column and then try and seal it at the bottom by using rubber rings or a “K” packer. If you where successful in sealing this we then had to buy a new pump with a smaller outside diameter and possibly a smaller output. An example of this is the original hole has a 500mm nominal diameter casing and pump was 400mm outside diameter and pumped at 150l/sec after inserting the new casing you may end up having a 450mm nominal diameter sleeve down with a pump of 350mm outside diameter. It could also mean having to change the discharge column of the pump. This process was carried by Riverina Waters’s staff of engineers, fitters and welders under guidance of the Department of Natural Resources

In more recent time Riverina Water, with the help of AGE Development from Western Australia have started to reline our existing bores using stainless steel casing. Generally we

have found that the screens are in good conditions. Using the example from above the original hole has a 500mm nominal diameter casing and pump was 400mm outside diameter and pumped at 150l/sec after inserting the new casing you may end up having a 490mm nominal diameter sleeve and still be able to use the existing pump motor and column.

Before relining you have to go through all the above steps of camera inspections, brushing and cleaning the existing casing before starting the insertion process. The new casing has a section of bonded rubber attached to the outside of the stainless steel tube, you start to lower this first section and add the extra lengths after lowering the previous lengths, each section is welded together after careful preparation of the ends. When the full length of casing has been lowered a camera inspection is made to ensure that the new casing is in the correct position before moving onto the next step which is to expand the new casing to seal against the old steel casing, this is done by inserting a dolly which can be hydraulically expanded from the surface to force the new stainless steel column to seal against the old steel casing. In some of our borehole it has been necessary to swage the full length of the stainless steel lining to give us a bit more clearance for us to use an existing pump and motor but generally it is on necessary to expand (swage) the column in a couple of places.

The next step that Riverina Water is moving into is the riser less or no discharge column. This makes use of the new stainless steel casing becoming the discharge column. It involves using a submersible pump and motor and a “Inflatable Packer” to form the seal between the suction side of the pump and the discharge column.

We are still evaluating the long term of this system but have currently got 6 in different sized boreholes. The big cost saving as we see it is the cost of not having discharge column which has to be purchased and then maintained which from our experience is one of the major cost and failure items when maintaining a bore pump.

Another saving which we are trying to evaluate by using the riser less system the pump and motor are held rigid in the bore casing which should stop damage to the pump and motor from vibration of hanging on lengths of steel column which can move around, this will stop any chance of the pump, motor or column from damaging the new stainless steel casing again because everything is held rigid.

In the last few years we have now changed to using stainless steel for all bore casing and Johnson screening. The columns are still welded together which requires the welders to be more skilled to carry out this type of work and stainless steel bands are used when joining the columns. No holes are cut into the casing.

Since changing to the stainless steel lining method we have only had to drill 2 new replacement boreholes. The reason that the existing boreholes could not be reused was that the where 150mm nominal diameter and by the time we lined them we could not get a pump, motor and cables inside the new casing. Our current practice now when drilling small boreholes, we are generally using 200mm nominal diameter stainless steel casing, which hopefully will allow us in the future to carry out any repairs, inspection and cleaning process without having to drill new boreholes.

In summing up

Riverina Water is of the opinion that it is going to be more cost effective to reline and maintain our existing boreholes than to have to drill new hole.

You do not have to build new infrastructure with all the additional cost of licences, permits etc which are required today, yes you may have to modify some existing fittings, switchboards, starters etc. and you do not have the extra job of having to seal the old borehole

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