

RESERVOIR INSPECTIONS TO PROTECT AND PRESERVE WATER QUALITY



Paper Presented by:

Jillian Busch

Author:

Jillian Busch, *Scientific Officer,*

Data Based Solutions P/L



*8th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
PCYC in Orange,
1 to 3 April, 2014*

RESERVOIR INSPECTIONS TO PROTECT AND PRESERVE WATER QUALITY

Jillian Busch, *Scientific Officer*, Data Based Solutions Pty Ltd

ABSTRACT

Storage reservoirs play a key role in delivering safe drinking water to the consumers. A regular inspection program is essential to determine any hazards or risks to this important product. With a focus to preserve and protect water quality, a thorough external inspection of the tank and surrounds can give operational staff valuable clues towards identifying any contamination issues. This paper is about the stepped inspection process and evidence gathering exercise that will indicate the most commonly found contamination areas of a water tank.

1.0 INTRODUCTION

The need for a thorough inspection program is fundamental to Drinking Water Management Plans. To properly manage and maintain drinking water, risks at the tank site need to be identified early before developing into incidents. A process should be followed to identify all potential risks. Although operational staff regularly attend sites and conduct routine monitoring, most 'in depth' inspections seem to be left to external contractors on a cyclic basis when reservoir cleaning operations occur. In between the more thorough inspections and cleanings, contamination points can develop for a number of reasons – including storm damage, structural failures or just a general lack of maintenance. Therefore the drinking water can be at risk from the surrounds, birds or vermin.

Understanding the inherent risks associated with the design or construction materials of a storage tank, will assist with an understanding of the how the storage tank functions, and how it may impact on water quality and disinfection levels within the distribution system.

Conducting regular inspections and being alert to the contamination evidence may prevent failed water quality results which in turn could lead to a boil water notice under the advice of local health authorities.

The following key evidence points have been chosen to take operational staff through a stepped process when conducting an inspection, starting at the overall appearance of the site and then looking for the water quality hazards around and within storages.

2.0 DISCUSSION

The key to conducting a thorough inspection of a tank is to follow a stepped process. This reduces the risk of missing key evidence and enables the majority of issues to be detected.

Relying primarily on visual observations, the main areas to be carefully examined are:

1. The site compound and surrounding environs
2. The tank structural design, materials used and its age
3. The roof, platform, entry hatch areas and associated fixtures
4. Looking at internal features such as the water line and exposed ladder areas.

2.1 The Site

The tank site and surrounds are the first stage of evidence gathering. If the area is well maintained and looked after, then there is a chance that issues would have been identified and reported or rectified by operational staff. A remote tank with long grass, overhanging trees and damaged fences would have an increased likelihood of water quality and personal safety issues being present, purely because there hasn't been the 'eyes' onsite to identify them.

Walking around the site gives information on compound fence effectiveness for keeping out unauthorised persons (Figure 1&2). Can the security of the site be compromised by the overhanging trees, how far up the tank does the graffiti go, or can the security system on the external ladder be bypassed by determined persons? How many other 'users' have access to the site? This information gauges how much non-controlled activity occurs on site.



Figure 1: *Security breach evidence*



Figure 2: *Vandal activity evidence*

During the walk around, it is also a time to look for any evidence of birds roosting or accessing the reservoir, by observing faecal accumulation or staining on the wall base or upper tank external areas. Bird presence should also be observed and time taken to watch any flight activity near platforms, ventilation or eave areas.

Other site area observations include the presence of debris or 'bits' on the ground that have come from the tank structure itself – roofing screws, dislodged rotating vents, roof sheet flashings, gutter sections etc. This type of evidence will alert the inspector to any storm damage that may have occurred or a 'lack of regular maintenance' on the roof areas.

2.2 The Tank

For the tank, potential contamination issues can be identified without the operator even having to leave the ground. Upper wall features such as inlets and overflows may have ineffective sealing or fixture points. Vent panels with coarse mesh could allow the entry of small birds or vermin, and dust and leaf debris. Overhanging trees can damage roofs, leave significant debris requiring excessive maintenance and provide a path for both vandals and mammals to access the roof area. Significant graffiti on the walls indicates regular unauthorised access to the site and care must be taken to identify and eliminate potential roof access points.



Figure 3: *Overhanging tree hazard*



Figure 4: *Vents and gutter defective*

2.3 Roof Area

The above two points could be looked at as having a medium risk to the water as the evidence leads to potential contamination sources. When the roof area is not sealed, the risk becomes significant as there is now direct access to the drinking water.

The following questions should be asked when looking at a roof area:

- Is the roof area secure?
- Are there missing sheets or ridge cappings that would allow drainage or vermin entry to the tank?
- How much debris has accumulated on the roof and where does the drainage go - this is important on concrete roof structures, which often rely on flexible joints for sealing.
- Are the gutters clear, draining away and not back flowing into the tank?
- Do roof mounted structures such as telemetry, vents or cathodic protection have unsealed covers or fixing points that allow drainage into the tank?

Observe the presence of other fixtures such as davits, antennas, solar panels or telemetry boxes, which all offer roosting areas for birds and the subsequent accumulation of faecal material which can blow or drain into the stored water. Checking to see that the roof vents are secure and that rotating vents are working and are not seized in a way that vermin or birds can enter the internal areas of the tank.



Figure 5: *Faecal debris & unsealed platform*



Figure 6: *Unsealed gutter joint*

Other not so obvious contamination points can occur under ridge caps, sheeting joints or where debris accumulates and can be blown back into the tank (Figure 5). Areas that rely on sealant to protect the joint or edges of roof sheeting will need regular maintenance to reseal and freshen up the application area. UV exposure, constant flexing and subtle movement of the joints can create unsealed areas in a few short years (Figure 6).

2.4 Entry Hatch & Platform

The sealing of the entry hatch and platform area is critical to prevent contamination ingress. As there is usually hand railing (a fantastic perch for birds!), davits and antenna, this area of the roof is most likely to accumulate faecal matter. Combine this with a poor sealing hatch and you have an elevated risk of contaminated water.

The entry hatch cover should be securely locked and made with a continuous raised edge to protect against any direct drainage, ponding or debris build up (Figure 7). Hatches have often been compromised by OH&S standards such as ladder stiles protruding through the cover and front edges removed to eliminate trip hazards. These both create water entry points and a significant water quality risk (Figure 8). Entry hatches (or any other roof and platform covers) should be made of strong material that cannot be compromised or forced open by vandal activity on the roof area, and they must be secure against any prevailing wind or storm events.

Small holes, localised corrosion, and unsealed areas on the platform may be all that is needed for storm water to backflow into a reservoir. Even holes which appear raised may be a contamination point when debris causes the water to pond at a deeper level than anticipated.

As most inspections are conducted in dry weather conditions, look for evidence of ‘dirt puddles’ that can indicate where water is pooling rather than draining away.



Figure 7: *Entry hatch unsealed*



Figure 8: *Ponding & entry hatch unsealed*

When a platform is installed on the top of a roof, water will pond upstream of the platform, when there is limited or no dedicated drainage. Ultimately, the silicon seals will degrade and no longer hold the water out. Similarly, if the platform is underneath the roof and doesn't slope away, then ponded water can flow back into the reservoir. Most platforms have kick plates around the edges and once again OH&S has taken precedence and helped to create ponded areas of debris and contaminated water. Kick rails need to be lifted up higher than normal to allow for effective drainage off the platform and away from the entry hatch area.

2.5 Inside the Tank

Opening the hatch and looking inside can quickly verify if contamination has been entering the tank. The presence of any floating debris such as dust, feathers, leaf litter or straw material on the surface or around the high water mark (Figure 9&10), can indicate external materials are entering the tank. Other floating debris observed could be from construction materials that have become dislodged (eg. insulating tape or sealing foams).

If any evidence is found, further investigation is then needed to determine the source and possible entry points.

Places to look for the evidence of faecal matter are anywhere a bird could roost or vermin could run - on the ladder, wall ledges, roof framing or internal pipe structures.



Figure 9: *Bird debris on high water line*



Figure 10: *Roof drainage sediment*

Other evidence indicating that there are unsealed areas include light spots on the water (indicating holes in the roof or walls) and water stains on walls or beams (indicating water leakage).

A bucket of water test is a simple way to confirm drainage entry points. This is easily performed by pouring a bucket of water around the area under suspicion eg. platform or entry hatch, , and observing if water drips back into the tank. (Figure 11&12) The bucket of water test is also recommended after any maintenance works to confirm that there is effective sealing present.

Major concerns such as corroded rafters and purlins, or rotting framing timbers may indicate that the roof is vulnerable to a structural failure and potential future access points for contamination. The evidence could also be subtle – a mud trail along a wood beam could show termites have compromised the structure.

2.6 Under the Water

Observing (where the clarity of the water allows) the depth or depositing patterns of sediments can help identify where they are coming in from. Does the pattern indicate failing roof seals or ineffective drainage? If there is leaf litter present, then this is most likely coming from the vents or roof edge areas. Debris around the inlet may have entered the tank from an upstream source while corrosion deposits may be coming from the roof structure, ladder or pipework. Any corroded material or excessive sediment levels within the tank will be adding to the disinfection demand of the drinking water.



Figure 11: *Bucket of water test*



Figure 12: *Infiltration evidence*

The sediment patterns can also indicate the mixing cycles of the tank. If there is a clear path from the inlet to the outlet, then the body of the water is most likely not mixing and the fresh incoming water is short circuiting to the outlet. If there is a swirling pattern with sediment profiles formed around posts etc, then the contained water is at least circulating within the tank.

The presence of wall sediments below the water line, indicate that the tank water levels are not being cycled enough or there are low disinfection levels and possibly stagnated water present. These wall sediments will cause a water quality event if the tank volume is lowered below the 'normal level' and then refilled, resulting in the re-suspension of the sediments.

2.7 Commonality

Once an issue has been identified, it shouldn't just be rectified and forgotten. More often than not, there will be multiple tanks in a network with a similar design. This is where commonality arises and can be used to predict future problems. Questions which should be asked include:

- Is there another roof/platform/entry hatch the same?
- Are there tanks with the same manufacturer?
- Are there tanks of the same age?

Early identification is the best defence against potential contamination issues.

3.0 CONCLUSION

Following a stepped process to conduct a thorough site and tank inspection is the best way to identify potential risks to the quality of drinking water. A methodical approach reduces the likelihood of missing key risks. By knowing what evidence to look for and where it may be is also crucial to uncovering issues. When a defect is identified, don't just fix the single incidence – consider where else it may be found within your network. But most importantly, make thorough site inspections routine – early identification can eliminate potential problems quickly, thus maintaining a quality product for your customers.