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Hihi WWTP Activated Sludge Reactor

25 November 2019

CONFIDENTIAL

Structural Condition Assessment

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Document History and Status

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1	2019-11-14	Isabelle M.	Thomas Lewis	-	-
2	2019-11-18	Isabelle M	Andrew Springer	Eros Foschieri	Final

Revision Details

Revision	Details
1	Comment on report and findings
2	Comment on scope an overall intended use of the report

Contents

Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Far North District Council ('**Client**') in relation to structural condition assessment of the Hihi WWTP Activate Sludge Reactor ('**Purpose**') and in accordance with the offer of service dated 30 October 2019. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

This report is a high-level commentary based solely on issues observed from visual inspections of the tank and previous experience with similar structures. No detailed analysis has been completed at this stage.

1 Background

An inspection by Fraser Thomas in 2014 (attached in Appendix A) found significant damage to the large aeration tank at Hihi wastewater Hihi WWTP Activated Sludge Reactor located at Marchant Road, as shown below. This report included the following observations:

- The internal dividing wall had partially collapsed
- Flaking of the tank waterproofing and,
- Exterior cracking.

In October 2019 WSP was commissioned by Far North District Council (FNDC) to carry out an inspection to confirm the previously observed issues and assess any further damage that has arisen. This assessment was to include:

1 An external assessment looking for visible issues, including:

- Displacement of deformation of any structural elements
- Checking for cracks on the outside wall of the tank
- Staining or discolouration
- The state of ground to assess any saturation, saddened soil
- Ground settlement

2 An internal assessment of issues visible from the top of the tank, checking the inner walls of the tank, dividing wall and general condition of assets.

3 The preparation of a brief report that includes a description of the condition of each critical element, with photos and recommendations.

2 Inspection

Two inspections of the reservoir were carried out by Isabelle Mander (WSP Graduate Engineer)..

The first inspection was conducted on the internal conditions with the tank drained on the 31st of October 2019. The interior of the tank was observed from the tank's external railing. The site conditions were overcast, following rain the previous day.

The second inspection of the external condition with the tank full took place on the 5th of November 2019. The conditions on site were hot and clear, in a dry weather period.

The specific defects, recommended actions and approximate maintenance intervention timeframes are shown in the table below. In some cases, further investigations have been recommended before maintenance begins to identify damage that could not be assessed visually.

During both inspections the maintenance operator was present at all times.

3 Site observations

3.1 Access

The access from Marchant Road is by a sealed single vehicle crossing, onto a gravel pad with room for manoeuvring. Both the access and the pad were in good condition and no defects were noted.

3.2 External Structure

Several cracks along the construction joints were observed, and one section was noted as being wet. This section was approximately 50mm long and covered in mould. Some vertical cracking was also observed, in addition to calcification and mould growth around the cracks. Other than the section noted no wet patches were found. The wall should be water-blasted to clear mould so cracks can more easily be recorded.

No signs of the base failing were observed. The connection between the base and the rest of the tank is secure, with no signs of cracks, calcification or wet patches. The ground surrounding the reservoir was stable and showed no signs of settlement.

3.3 Internal Structure

3.3.1 Dividing Wall

A section of the internal dividing wall was noted to have collapsed in the Fraser Thomas report. The internal assessment revealed this to still be true, in addition to further degradation of the wall. Cracking on the western side of the wall suggests this section will fail in a similar manner if left. Scour also affects this wall and the outline of steel reinforcing can be seen. Due to this lack of support the wall is bowing and has been observed to sway while the tank is running. The wall should be removed or replaced to avoid further damage.

3.3.2 Perimeter Wall

Minor spalling of concrete. Exposed reinforcement

3.3.3 Base Slab

An internal assessment of the base could not be made as sediment within the tank covered the floor.

3.4 Fixtures

There is minor damage to the tank's fixtures. Several have begun to rust and should be replaced to prevent further damage. Three defunct clamps should be removed and the holes sealed. In addition, five of the vertical aeration pipes had fallen into the tank and should be removed.

3.5 Inspection Photos

A full set of photos from both inspections is provided in Appendix B.

Item	Defect or Issue	Recommended Action
External Structure		
1.1	Cracking around the two construction joints around 75% of tank	Sika approved contractor to seal the cracks with Sikadur 31

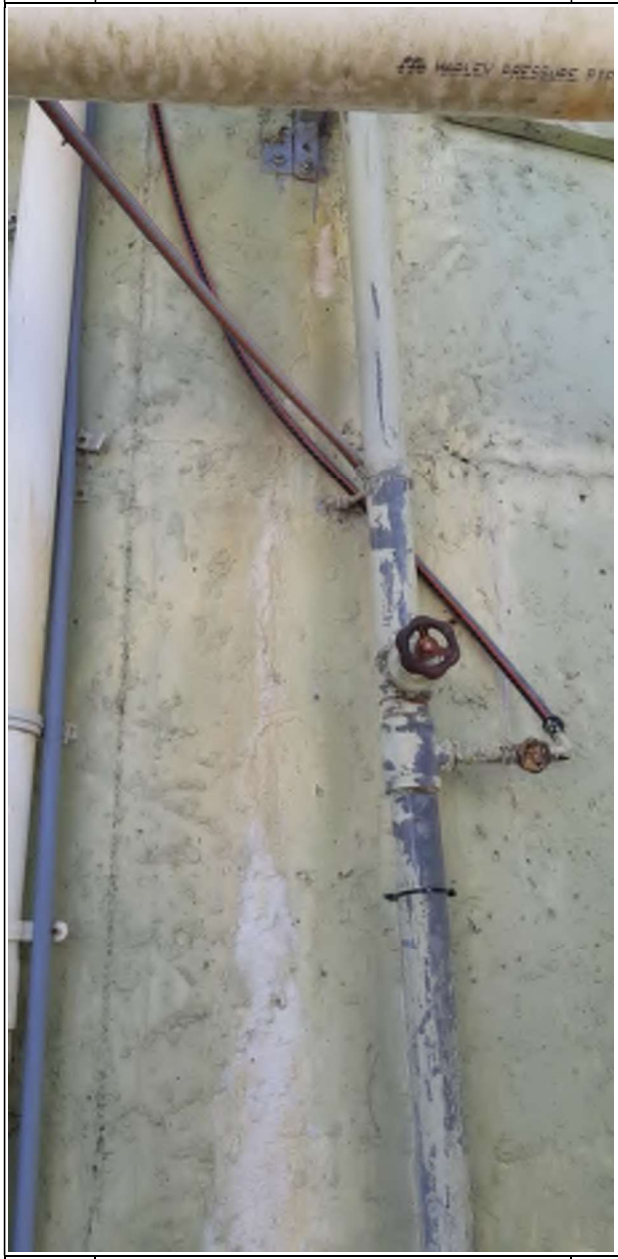
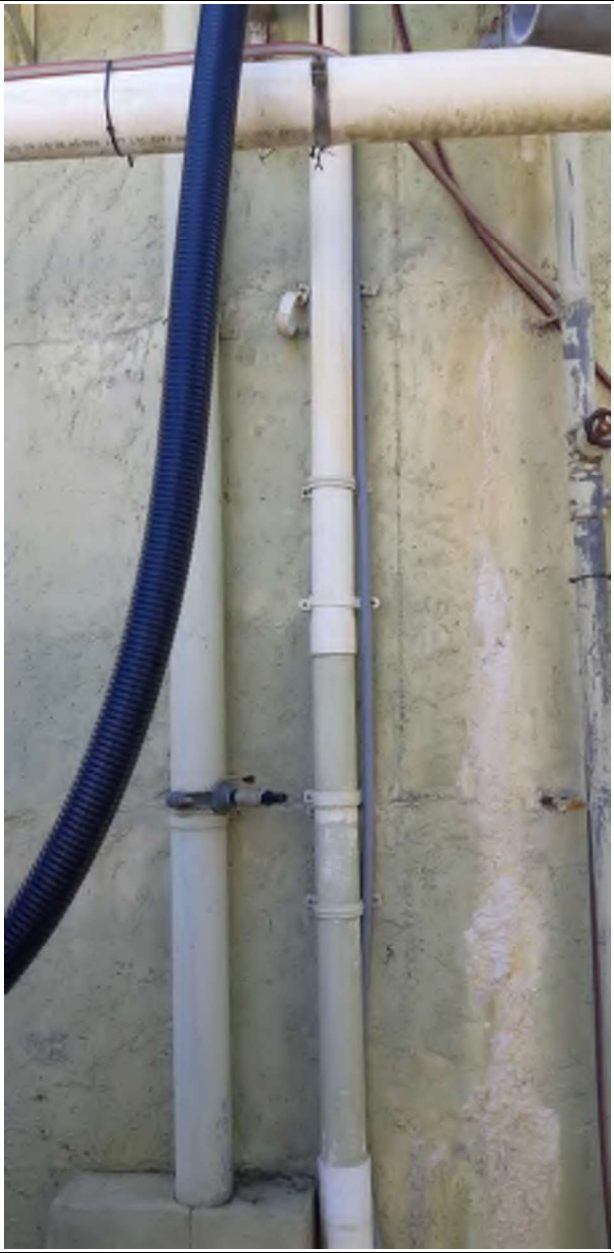
1.2	A 50mm moist crack covered in mould on the north side of the tank that runs along the lower construction joint	Clean out crack and repair with sika monotop

1.3	7 m of vertical cracks in various locations around the tank	Sika approved contractor to seal the cracks with Sikadur 31

 		
1.4	Exposed reinforcing is visible inside the tank	Remove laitance and repair with sika monotop
		
1.5	Scour inside the tank and wear of tank waterproofing	Re-apply waterproofing with a product from an approved supplier
		
1.6	Moss and mould may be obscuring the extent of cracks	High pressure water blast walls of the reservoir to remove all vegetation, debris and laitance

Internal Dividing Wall		
2.1	The wall is showing several signs of failure: The eastern segment has collapsed The western segment is showing significant cracking The wall has been eroded and the outline of reinforcing can be seen The wall has been noted to sway when the tank is running	Repair or replace the internal dividing wall.

Fixtures		
3.1	Obsolete Brackets	Remove and seal holes with appropriate mortar

3.2	Rust on external brackets, valves and bolts	Replace with stainless steel fixtures
	 	
3.3	Rust and mould underneath external walkways	Clean element and record rate of corrosion

		
3.4	Several defunct pipes have fallen into the tank and remain there	Remove the defunct pipes and replace as needed
		
Other		
4.1	Sediment build-up inside the tank which limits the capacity of the tank and prevented a full inspection of the base	Remove sediment and drain tank to conduct a full inspection of the base; In the future perform regular maintenance to prevent build-up

4 Risks / Remedial Works

Based on the observations made on site, and drawing on previous experience of similar structures, we would expect failure to occur in certain elements, as described below.

4.1 Internal Dividing Wall

The internal dividing wall has already experienced partial failure. It can be expected to fail completely as further deterioration occurs over time, or during a significant seismic event.

The internal wall is not considered to be a structural element; therefore, its failure will not result in loss of contents or progressive failure of the tank.

The serviceability of the tank may however be affected, with the dividing wall no longer performing its original function.

4.1.1 Remedial Works

While not essential to the structural stability of the tank, a full replacement of the internal wall would be advisable to maintain full function. Advice from a process specialist should be sought before undertaking this.

4.2 Perimeter Wall

The perimeter wall is a critical structural element, and minor signs of cracking are already present. There is also a limited area of damp which indicates some water egress.

The cracks observed will propagate over time, resulting in minor leaking, initially noticeable as further damp present on the external surface. This may also occur suddenly if a significant seismic event occurs.

If cracking does worsen to the point of water egress, then there will be a small rate of loss of contents. This may be repaired immediately, otherwise the rate of water egress will increase exponentially until the internal water level reaches the level of the cracking.

4.2.1 Remedial Works

Further investigation would be required to confirm, but we would expect:

- *Full repair of all cracks/spalling, to prevent worsening. This can be expected to cost between $40k to $80k, taking around 2 weeks to complete.*
- *Detailed Seismic Analysis to check the structural capacity is sufficient to withstand the expected earthquake loading. A design fee for this can be provided, but we would expect it to be around $8k - $10k, taking around 2 weeks to complete.*

4.3 Base Slab

The base slab is also a critical structural element, but has not yet been observed, due to presence of debris.

It is common to see minor leakage in a base slab of this age, especially around any penetrations (inlet, outlet, scour etc). While this loss of contents is very limited and does not tend to be compounded by seismic actions, it is a very serious concern as it can lead to effectively scouring the fill from beneath the tank. If this is not prevented in time, then the structure will be undermined and become destabilised once the foundation is compromised, leading to structural failure and loss of contents.

4.3.1 *Remedial Works*

As leaks in a base slab can be very difficult to locate, even when cleaned, it is common practise to construct a new overlay slab, approx. 200mm thick to provide confidence in a watertight base element with a 50+ year design life.

This would be expected to cost approximately $100k, taking around 3 weeks to construct.

4.4 Wall – Base Connection

While not easily observable on site, a common failure experienced by tanks of this age is a lack of structural connection between the base slab and perimeter wall.

If these two are not connected then they may separate when an earthquake causes uplift of the wall, resulting in loss of contents.

4.4.1 *Remedial Works*

There are several methods of preventing this failure:

- *Construct a new reinforced concrete nib at the base of the wall, providing a connection to the wall and base, expected to cost approximately $100k, taking around 3 weeks to construct.*
- *Install a new overlay base slab which is fixed to the perimeter wall. This also provides a new base slab, preventing leaking as described above. This would be expected to cost approximately $100k, taking around 3 weeks to construct.*

4.5 Service Life

4.5.1 *Seismic*

We have not carried out a full structural assessment of the structure. However, based on previous experience of similar structures and accounting for the defects observed we would expect the following:

- *The structure would remain standing after a significant seismic event, but;*
- *The structure would experience significant additional cracking, resulting in loss of contents*

Therefore, the structure is not expected to remain functioning after a significant seismic event unless repairs are carried out.

4.5.2 *Durability*

If no repairs are carried out, then all cracking and spalling of concrete will propagate to the point where egress of stored water becomes unacceptable. This would be expected within 10 years.

If repairs are carried out and appropriate maintenance is continued, the service life may be perpetuated for 50 years or more. However, the maintenance costs of repairing an ageing structure like this will increase as time goes on, with more regular inspections and maintenance schedules required.

5 Conclusion

We recommend the following actions:

- The tank should be cleared of sediment and the base examined.
- The internal dividing wall should be removed or repaired, with advice from a process specialist.
- All cracks should be sealed appropriately.
- Regular maintenance and structural inspections of the existing tank should occur to monitor the deterioration of the reservoir.
- A Detailed Seismic Assessment of the tank should be carried out to determine the percentage compliance with the National Building Standard. This may include reinforcement scanning and more detailed investigations.