Part B: Monitoring Program Implementation and Report

8 Monitoring Program – Implementation

Table 7 below summaries the required frequency operational monitoring detailed in Section 5.4 of the WCMP

Table 7: Annual Operational Monitoring Program

What to be monitored		Frequency
Soils	- Complete (Laboratory)	Annually
	- pH (Laboratory)	Six monthly
	- pH (Field with laboratory confirmation at 10% of samples)	Quarterly
Sediments	- Complete (Laboratory)	Annually
	- pH (Laboratory)	Quarterly
	- pH (Field with laboratory confirmation at 10% of samples)	Six monthly
Surface Waters	- Complete (Laboratory)	Six monthly
Visual	- Basins - Engineering controls - Gallery (800m Range) - Lime treatment process - Safety and signage	Annually
	- Range perimeter - Vegetation health	Six monthly

Table 8 below presents the annual monitoring program prepared to meet requirements detailed within section 5.4 the WCMP.

Table 8: Monitoring Program Schedule

Quarter	Activities	See Report Section
1	Field Sampling – pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health	Part B this Report
2	Six Monthly Monitoring pH in Primary and Secondary Impact Areas • Soils • Sediments Six Monthly Monitoring • Surface Waters	Not included in this report
3	Field Sampling – pH in Primary and Secondary Impact Areas • Soils	Not included in this report

	• Sediments Six Monthly Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health Annual Visual Inspection of Range perimeter for shot loss.	
4	Annual Monitoring • Soil • Surface Waters • Sediments	Not included in this report

Summaries of each sampling event are provided in the following sections. Laboratory results for monitoring events are provided within Appendixes;

- **Appendix 1: Quarter 1 Laboratory Results**

9 Monitoring Program – Quarter 1

A samplings exercise was undertaken 3rd November 2020 in accordance with Section 8.
A summary of the sampling event is given below.

Summary of sampling event

Table 9: Quarter 1 Sampling Event

Aspect	See Report Section
Field Sampling • Soil pH in Primary and Secondary Impact Areas • Sediments Additional following recommendations from previous sampling • Field sampling of surface waters is also included to support monitoring within other Quarters • Ammonia as N - If water is present within the drainage line at rear of 800m stop butt	9.1
Six Monthly Visual Inspections • WQ Basins • Engineering Controls • Lime Treatment Process • Safety and Signage • Vegetation Health	9.2

9.1 Field Sampling (pH) Soil, Sediments and Surface Waters

The results from the QTR1 sampling exercise are provided for each range following.
Results outside the target criteria are indicated in RED.

Results are discussed at Section 9.3.1 following.

9.1.1 Results – pH Soils, Sediments and Surface Waters 50m range

Table 10: Soils Sediment and Surface Waters 50m range

Date 3/11/20		
Sample ID	**Location 50 Meter range**	**pH- (Field in Water)**
101	Range 1 – floor (soil)	8.1
	Lab pH	8.2
102	Range 2 - floor (gravel)	8.1
103	Range 3 - floor (gravel)	7.9
	Lab pH	9.2
104	Range 4 - floor (gravel)	7.8

Date 3/11/20		
Sample ID	**Location 50 Meter range**	**pH- (Field in Water)**
105	Bushland off Range – rear of main butt	7.5
	Lab pH	5.3
106	Bushland off Range – west of range	7.5
107	Bushland off Range - north off car park	7.4
108	Face of Butt- Bullet catcher	7.3
109	Face of Butt- Bullet catcher	7.4
110	Face of Butt- Bullet catcher	7.1
111	Face of butt – above bullet catcher	7.6
112	Face of butt – above bullet catcher	7.7
113	Within 10m in front of bullet catcher range	7.7
114	Within 10m in front of bullet catcher range	7.6
115	Within 10m in front of bullet catcher range	7.4
116	Sediment Basin off 50m	7.1
117	Water Basin off 50m	6.9
	Lab pH	7.6
118	Water from WQT Pipe (from 50m range)	6.8
	Lab pH	7.2

9.1.2 Results – Soils, Sediments and Surface Water 500m range

Table 11: Soils Sediment and Surface Waters 500m range

Sample ID	Location	pH (Field in Water)
201	Target bay 1 (0-50m)	7.5
202	Target bay 2 (50-100m)	7.1
203	Target bay 3 (100-150m)	7.4
204	Target bay 4 (150-200m)	7.2
205	Target Bay 5 (200-300m)	7.0
206	Target Bay 6 (300-385m)	7.0
207	Target Bay 7 (385-500m)	6.7

Sample ID	Location	pH (Field in Water)
208	Additional (Target Bay) (385-500m)	7.0
209	Additional (Target Bay) (100-150m)	7.0
210	Additional (Target Bay) (300-385m)	7.4
211	1 Bushland - North	7.0
212	2 Bushland – West 1	6.8
213	3 Bushland – West 2	6.9
214	4 Bushland – East	6.8
215	5 Bushland - South	6.5
216	1 Main Butt West	6.5
217	2 Main Butt Central	6.7
218	3 Main Butt East	6.9
219	Int Mound 1 – 50m	6.8
	Lab pH	6.2
220	Int Mound 2- 100m	7.2
221	Int Mound 3 -150m	7.4
222	Int Mound 4 – 200m	7.4
223	Int Mound 5 – 300m	7.6
224	Int Mound 6 – 385m	7.5
225	1 10m in front of Main butt West	7.2
226	2 10m in front of Main butt Central	7.2
227	3 10m in front of Main butt East	7.1
	Lab pH	6.2
228	10 m in front of Int Mound 1 -50m	7.2
229	10 m in front of Int Mound 2 -100m	7.0
230	10 m in front of Int Mound 3 -150m	7.4
231	10 m in front of Int Mound 4 – 200m	7.5
232	10 m in front of Int Mound 5 – 300m	7.5
	Lab pH	8.6
	Lab pH (duplicate)	8.6

Sample ID	Location	pH (Field in Water)
233	10 m in front of Int Mound 6 – 385m	7.2
250	Water Basin – Car Park	6.9
	Lab pH	7.0
251	Sediment – Basin 4 car park	6.9
252	Water Basin 1 (Range 2)	7.0
		6.9
253	Sediment Basin 1 (Range 2)	6.9
	Lab pH	8.2
254	Water – basin 500 east	6.9
	Lab pH	7.3
255	Sediment basin 500 east	7.1
256	Water Basin 500 West	7.1
	Lab pH	7.9
257	Sediment basin 500 east	7.1
258	Water – below basin 200	7.0
	Lab pH	6.4
259	Sediment below basin 200	6.9
260	Water below basin 500 east	NA
261	Sediment below basin 500 east	6.9

9.1.3 Results – Soils, Sediments and Surface Waters 800m range

Table 12: Soils Sediment and Surface Waters 500m range

Sample ID	Location	pH (Field in Water)
001	Bullet catcher 1	8.8
002	Bullet catcher 7	8.5
003	Butt- non shot area – top of butt above target box 3	8.2
004	Butt – non shot – between target box – between 4-5	8.3
005	Butt under bullet catcher 4	8.2

Sample ID	Location		pH (Field in Water)
006	Butt under bullet catcher 5		8.1
007	Mantlet – west		7.8
008	Mantlet- central		7.7
	Lab		5.9
009	Mantlet - east		7.8
010	Area in front of Mantlet - west		7.8
011	Area in front of Mantlet - central		7.3
012	Area in front of Mantlet - east		7.7
013	Bench in front of Butt - west		7.9
014	Bench in front of Butt - central		7.7
	Lab pH		8.1
015	Bench in front of Butt - east		7.8
016	Rear of Butt		7.2
017	Area over store room		7.6
018	Stormwater outlet culvert upper		7.3
019	Stormwater outlet culvert lower		7.0
020	Rear channel outlet – lower		7.0
021	Rear channel outlet - upper		6.8
022	Sediment in Galley		7.7
	Lab pH		8.2
023	Sediment in 800m basin		6.8
024	Water 800m basin		7.0
	Lab pH		6.4
	Lab pH duplicate		6.3
025	Water – rear drain		6.2
	Lab pH		6.3
	Ammonia as N in water The relevant threshold levels are given below		0.34 mg/L
	• ANZECC 2000 PFWS/NEPM 2013 GIL	0.9 mg/L	
	• ANZECC 2000 RWQG	10mg/L	

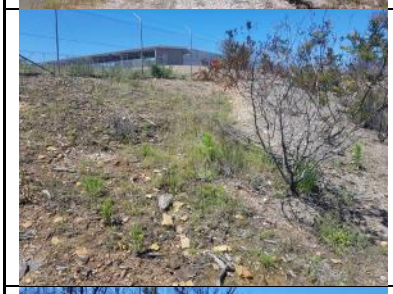
9.2 Six Monthly Visual Inspections

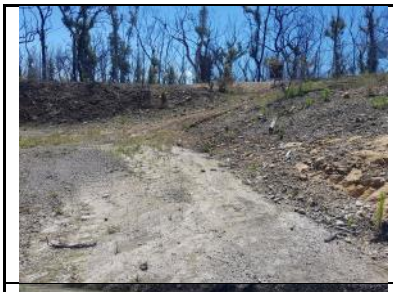
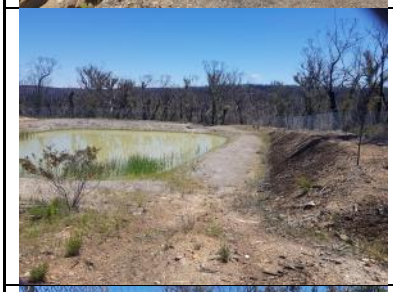
The observations from the QTR1 visual inspection are provided for each range following.

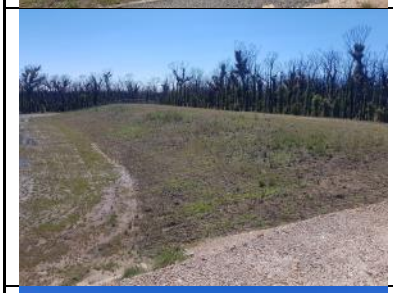
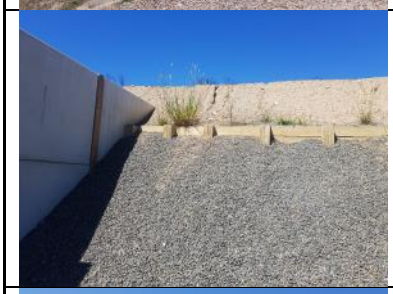
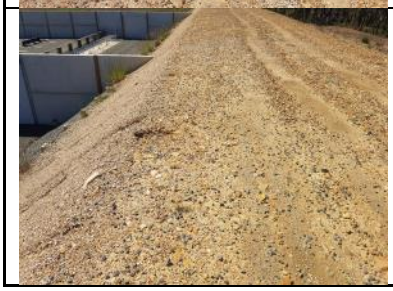
Results are discussed at Sections 8.2.1- 8.2.4 following.

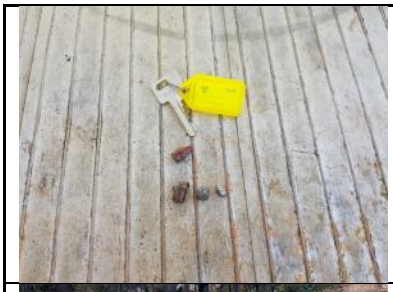
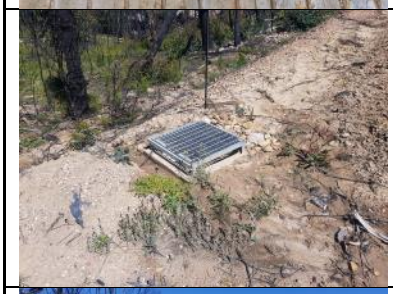
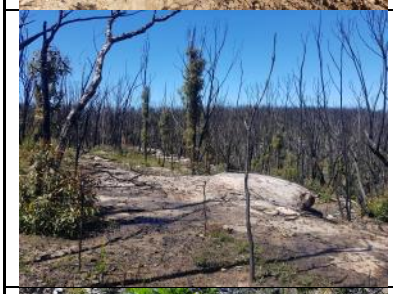
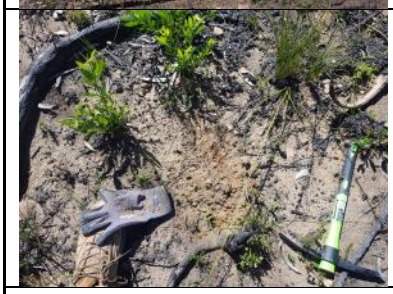
9.2.1 50m range

Table 13: Visual Inspection, 50m Range and Surrounds

Basins	
Basin 5 (at 50m range)	
	• Basin full • Note scour near entrance – discussed further
	• Scour over batter at entrance to basin enclosure • Water directed by surface water swale to entrance track to basin • Scour leads down access track to spread at bench and then down batter at basin **Suggest a formalise drain will be required in this location to arrest further scour – rock over fabric**
	
	

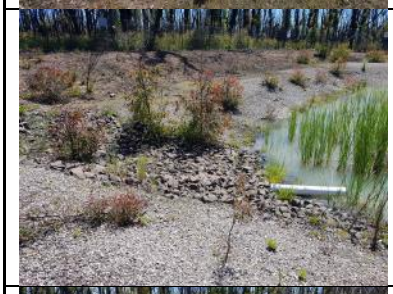
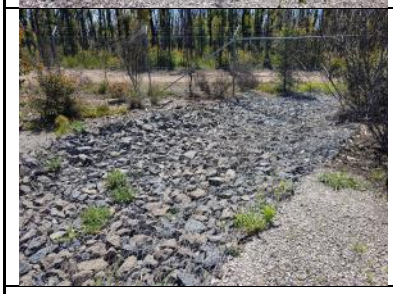
<table>
<tr><td>  </td><td rowspan="2"></td></tr>
<tr><td>  </td></tr>
<tr><td>  </td><td>• Water flowing from water treatment process / pits exiting low flow pipe to basin</td></tr>
<tr><td> 
  </td><td>• Spillway and outlet area stable</td></tr>
<tr><td colspan="2">Vegetation Health/Surface cover</td></tr>
<tr><td>  </td><td>• Grave surfaces weed free</td></tr>
</table>

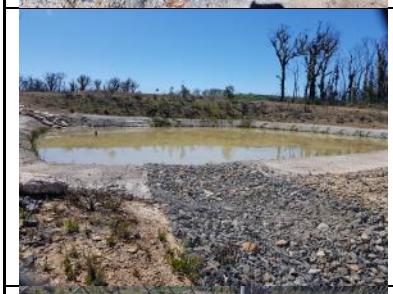
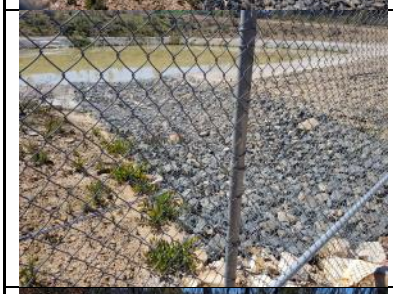
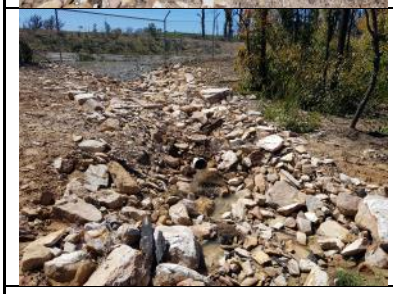
 	Range/Bay 1 • Water pooling in central area • Not riling over batter of butt to South western side
	Mound SE of Range/Bay1 • Vegetation patchy – surface generally stable • Some sediment localised loss
  	**Top of Stop butt at 500m** • Some riling at front of batter • Occurs where water is pooling on top of butt formation and overflows over face **Rework of top of the mound formation will be required to prevent surface water passing over the batters of the stop butt.**

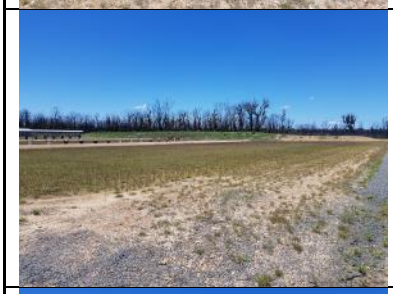
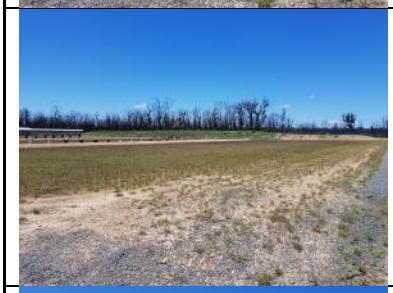
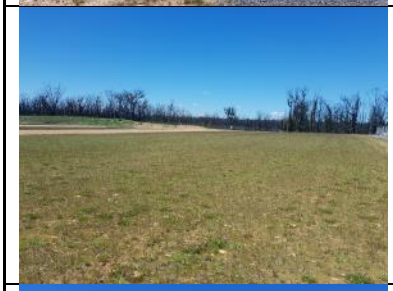
	• Bullet fragments within stop butt area above bullet catchers
	• Pit at South East corner of 50m stop butt • Pit is full of sediment and being bypassed **Modification of this outlet area may be required.**
	• Drain to stormwater pit bare • Minor sediment loss evident **Further stabilization of the back of the mound will be required to reduce the sediment load to the drainage outlets.**
 	• Bushland external to 50m range • Natural regeneration commencing – limited ground covers • Very little cover of surface • Root material beginning to be evident in surface soils/topsoils
Engineering controls: Lime treatment Process • The lime treatment process is a closed sealed unit. • Inspection of the unit is not possible This item has been removed from sampling program. Servicing or inspection by a qualified technician may be recommended by monitoring outcomes.	
Engineering controls: Road Infrastructure and Drainage • Road Infrastructure and Drainage for the 50m range is addressed within Section 8.2.2	
Safety and Signage • Safety and signage for the 50m range is addressed within Section 8.2.2	

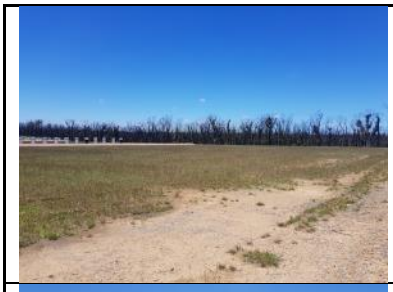
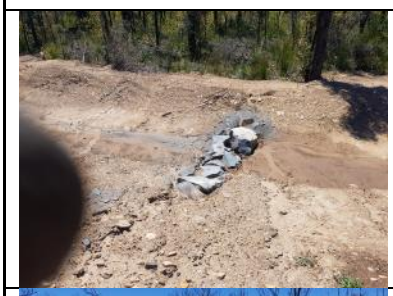
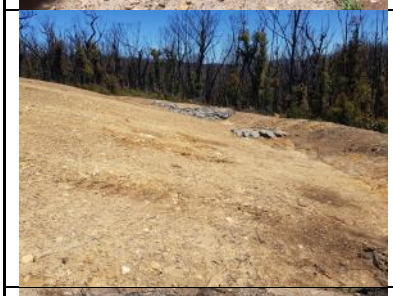
9.2.2 500m range:

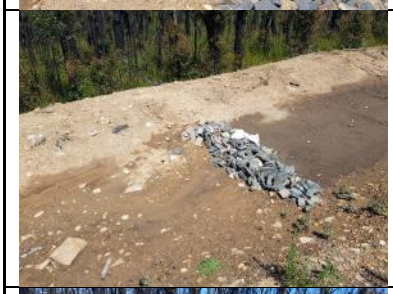
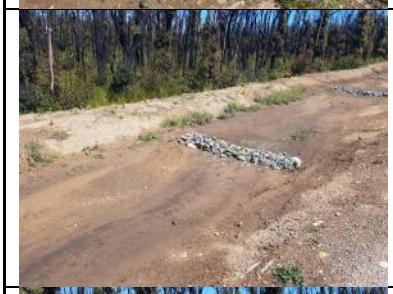
Table 14: Visual Inspection, 500m Range and Surrounds

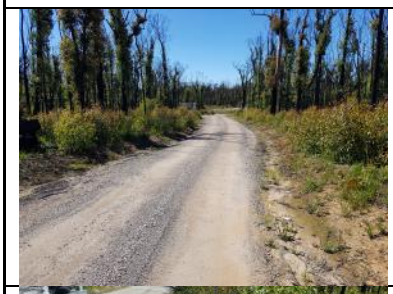
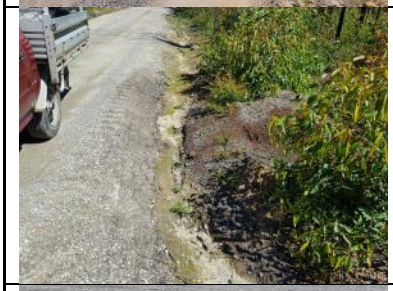
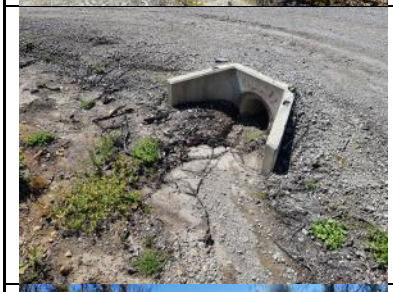
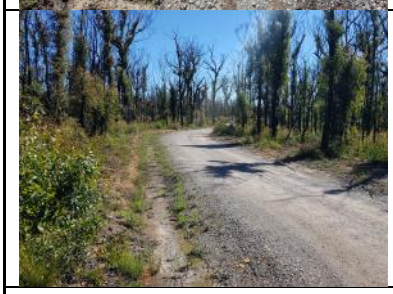
Basins	
Basin 2 (500m west)	
  	• Basin is full to trickle/low flow level • Inlet and out let areas to basin are stable
Basin 3 (500m east)	
 	• Basin is full to trickle/low flow level • Significant re work has been undertaken at the main (Southern) inlet of the basin with placement of rock • Water is passing out the side of the inlet control and is Leading to scour adjacent to the inlet **It is likely that re work of the inlet structure will be required**

<table>
<tr><td>  </td><td></td></tr>
<tr><td> 
  </td><td>• The outlet control is stable</td></tr>
<tr><td>  </td><td>• The area below the outlet is stable</td></tr>
<tr><td>  </td><td>• Trickle/low flow outlet from Basin
• Area below outlet stable – rock lined
• Pipe appears to be shortened following fire damage</td></tr>
<tr><td colspan="2">Vegetation Health Surface Cover
General comment to vegetation on 500m range
• No significant erosion evident
• Significant percentage of surface cover provided by moss and lichens and weeds
• In several bays drainage is an issue – this will limit plant growth in the heavy or compacted soils
• Absence of real topsoil is a limitation in long term. Also very low organic matter
• Further works will be required if grass cover of greater than 70% is required eg – address topsoil organic matter and issues and address drainage issues</td></tr>
</table>

	**Shooting Point 0m to Intermediate mound 50m** • Vegetation cover 50-70% • Nil erosion evident • Minor ponding over central area and at rear of targets
	**Intermediate mound 50m to intermediate mound 100m** • Vegetation cover >70% • Nil erosion evident • Significant ponding over central area
	**Intermediate mound 100m to intermediate mound 150m** • Vegetation cover >70% • Nil erosion evident • Note that the slumping to landscape mound has been repaired and re landscaped
	**Intermediate mound 150m to intermediate mound 200m** • Vegetation cover <70% • Nil erosion evident • Significant moss cover to provide surface cover
	**Intermediate mound 200m to intermediate mound 300m** • Vegetation cover >50% • Patchy • Nil erosion evident • Poor drainage at rear of target
	**Intermediate mound 300m to intermediate mound 385m** • Vegetation cover >70% + • Nil erosion evident • Very mossy

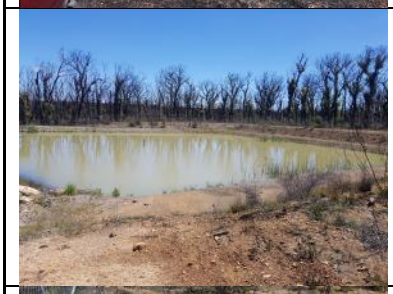
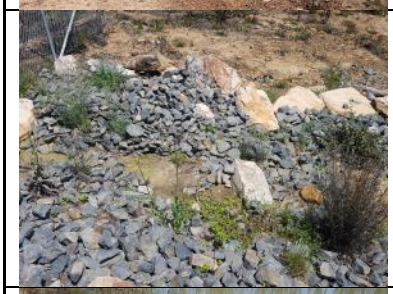
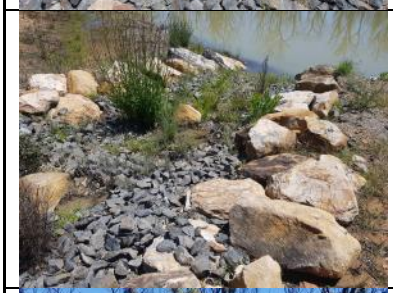
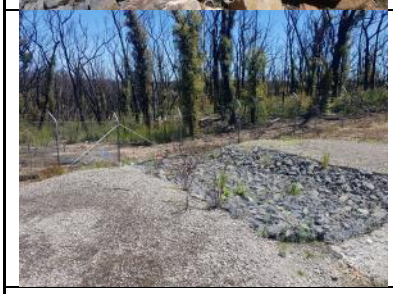
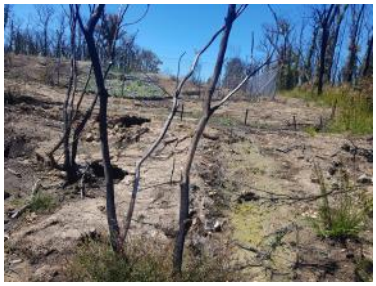
	**Intermediate mound 385m to 500m Butt** • Vegetation cover ~30% bare with 50-70% cover over rest of surface • Nil erosion evident
 	**New lay-down area located to north of basin2** • Gravel surface • 4 shipping containers placed to replace storage lost in fire
No photo	• Swale drains western side of 500m west – grassed up and stable
 	• Swale drain leading to south west corner of 500m stop butt • Invert of drainage swales bare with some scour/sediment loss evident • New rock check dams installed • rock size too large & no fabric installed causing water to be focused through with scour underneath **Recommend intermix smaller rock (75mm-150mm) into gaps of existing structures plus some smaller rock (diameter 25mm)**
	**Stormwater pit located at rear western corner of stop butt** • pit function reinstated following fire damage • surrounds of pit protected with rockwork

<table>
<tr><td>  </td><td>Rock inlet to stormwater pit located western corner at rear of butt
Sediment from drainage swale accumulating in rock work</td></tr>
<tr><td>  </td><td rowspan="2">New rock work at inlet to Basin 3 (500m East)</td></tr>
<tr><td>  </td></tr>
<tr><td>  </td><td rowspan="3">Swale drains at 500m east
Installed rock checks with diameter 75-100mm
Some without fabric
Some with poor shape and outflanked on eastern side and will lead to failure</td></tr>
<tr><td>  </td></tr>
<tr><td>  </td></tr>
</table>

<table>
<tr><td>  </td><td>Top of Stop butt at 500m
• Some riling at front of batter
• Occurs where water is pooling on top of butt formation and overflows over face</td></tr>
<tr><td colspan="2">Engineering controls: Road Infrastructure and Drainage</td></tr>
<tr><td> 
  </td><td>• All road areas are stable
• Some minor erosion within invert of table drains</td></tr>
<tr><td> 
  </td><td>• Some sediment deposition within table drains and at culverts
Maintenance of these area should be scheduled</td></tr>
<tr><td colspan="2">Safety and signage</td></tr>
<tr><td>  </td><td>• Safety direction signage in place</td></tr>
</table>

9.2.3 Other Basins

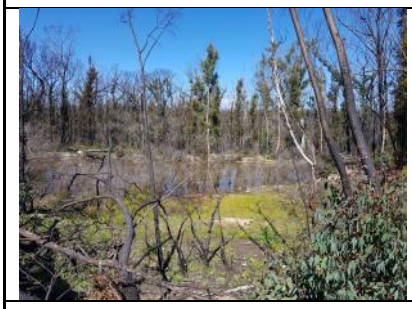
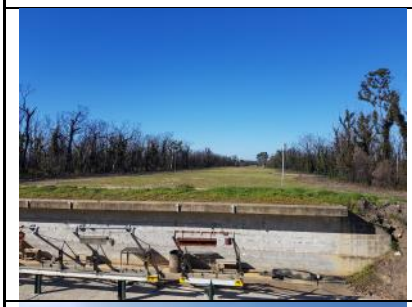
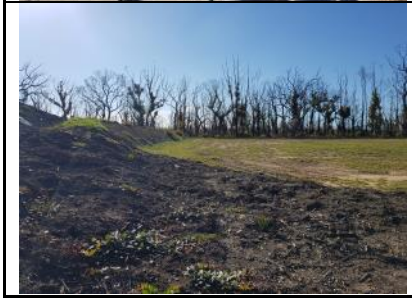
Table 15: Visual Inspection, Other Basins

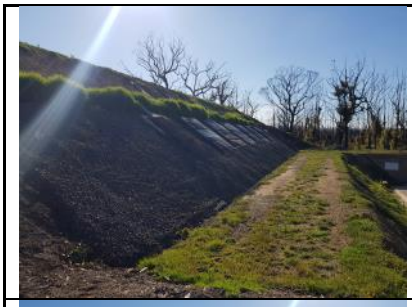
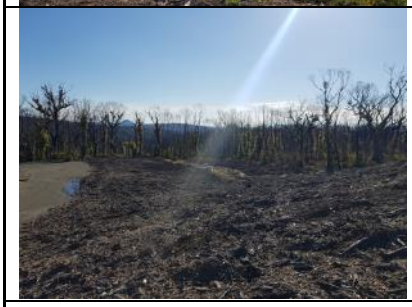
Basin 1 (at future 200m range)	
	• Surrounds to basin are stable • Basin is full to low flow outlet pipe
	
	• Rock work at the invert has been moved by flows • Geotextile has been exposed **Additional works may be required in this area**
	
	• Outlet control/spillway is stable
	• "erosion" or movement of material below basin outlet evident • Loss of burnt mulch material with limited progress into underlying strata • This area to be monitored for natural regeneration following fire **This area may require further works and plantings, monitor for natural stabilisation and progress of erosion**

Basin 4 (at car park)	
	• Basin inlet and outlet stable • Basin full of reeds

9.2.4 800m range

Table 16: Visual Inspection 800m Range and Surrounds

Basin 7 (800m Range)	
	**Basin 7/Bushland Pond** • Basin partially full of ponding water
Vegetation Health	
	**Vegetative health 0-100m from target** • First 6-10m veg cover more patchy (see below) • Rest of range grass cover good
	**Vegetative health first 6-10m from Mantlet** • 50-70% cover with patchy bare areas

	**Vegetative health – bench in-front of stop but and bullet catchers**
	**Vegetative health rear of stop butt** • Vegetation establishing within channel • Mulched area still leaching water following rainfall • Organic sheen evident on surface of water
Concrete Galley	
	• Sediment, debris and blue metal (~25mm) accumulating over surface of concrete gallery
Engineering controls: Road Infrastructure and Drainage	
	**Roads and Access tracks** • Range still not in use • Access track in good condition • Leaf litter and debris over surface
	**Safety and signage** • **New fencing and signage provided at the entrance**
Engineering controls: Lime treatment Process • The lime treatment process is a closed sealed unit. • Inspection of the unit is not possible This item should be removed from the sampling program. Servicing or inspection by a qualified technician may be recommended by monitoring outcomes.	

	Lime treatment process sealed and intact

9.3 Discussion of results

9.3.1 Field Sampling (pH) Soil, Sediments and Surface Water

The following samples returned pH values outside the target range of pH 6.5-8.5;
Discussions of results is included following each observation.
Recommended actions are provided in bold.

Table 17: pH Discussion of Results

Sample ID	Location	pH (Field)
50m Range		
103	Soil/Gravel - Range floor – Range 4	7.9
	Lab pH	9.2
	Sample 103 returned a field pH within the target range of 6.5-8.5 but a laboratory pH of 9.2. • This elevated pH does not seem to have impacted on the pH of water within Basin 5. • This pH is not consistent with other gravels tested at the range • No specific action is recommended	
105	Soil - Bushland off Range – rear of main butt	7.5
	Lab pH	5.3
	Sample 105 returned a field pH within the target range of 6.5-8.5 but a laboratory pH of 5.3. • This sample is from a bushland area where a lower pH is to be expected • No action is recommended	
500m Range		
219	Soil - Intermediate Mound 1 – 50m	6.8
	Lab pH	6.2
	Sample 219 returned a field within the target range of 6.5-8.5 but a laboratory pH of 6.2. • This location has returned a pH outside the target range in the past. • Treatment with lime in this area has been recommended in the previous annual report. • **This ongoing treatment will be confirmed with range management.**	

Sample ID	Location	pH (Field)
227	Soil - 10m in front of Main butt East	7.1
	Lab pH	6.2
	Sample 227 returned a field within the target range of 6.5-8.5 but a laboratory pH of 6.2. • This location has returned a laboratory pH within the target range in the previous quarter. • No specific action is recommended.	
232	Soil - 10 m in front of Intermediate Mound 5 – (300m)	7.5
	Lab pH	8.6
	Lab pH (duplicate)	8.6
	Sample 232 returned a field within the target range of 6.5-8.5 but a laboratory pH of 8.6. • This location has returned a laboratory pH within the target range in the previous quarter. • No specific action is recommended	
258	Surface Water- Creek below Basin 1 200	7.0
	Lab pH	6.4
	Sample 258 returned a field pH within the target range of 6.5-8.5 but a laboratory pH of 6.4. • This sample is from a bushland area where a lower pH is to be expected • No action is recommended	
800m Range		
008	Soil - Mantlet- central	7.7
	Lab	5.9
	Sample 008 returned a field within the target range of 6.5-8.5 but a laboratory pH of 5.9. • This location has returned a laboratory pH within the target range in the previous quarter. • No specific action is recommended	
024	Surface Water – Basin 7 (800m)	7.0
	Lab pH	6.4
	Lab pH duplicate	6.3
	Sample 024 returned a field pH within the target range of 6.5-8.5 but a laboratory pH of 6.3 & 6.4. • This sample is from a bushland area where a lower pH is to be expected • No specific action is recommended	
025	Surface Water – Drainage channel at rear of 800m stop butt	6.2

Sample ID	Location	pH (Field)
	Lab pH	6.3
	Sample 025 returned a field pH of 6.2 outside within the target range of 6.5-8.5 and a laboratory pH of 6.2 & 6.3. • This sample is from a bushland area where a lower pH is to be expected • No specific action is recommended	

9.3.2 Visual Inspections: Water Quality Basins

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 18: Discussion of Observations Water Quality Basins

Item	Location	Observation and Comment
1.	Basin 1	Rock work at the inlet to the basin has been moved by in-flows. Geotextile has been exposed **Additional works may be required in this area to reinstate rock works. The rock material used should be well graded hard rock.**
2.	Outlet area below Basin 1	"Erosion" or movement of material below the basin outlet is evident. This loss is of burnt mulch material with limited progress into underlying soil strata. This area to be monitored for natural regeneration following fire. **This area may require further works and plantings, monitor for natural stabilisation and progression of erosion.**
3.	Basin 2 (500m west)	Inlets and outlet areas are stable. No issues evident or required action.
4.	Basin 3 (500m east)	Significant re work has been undertaken at the main (Southern) inlet of the basin with placement of rock. Water is passing out the side of the inlet control and is Leading to scour adjacent to the inlet. **It is likely that re work of the inlet structure will be required. It is recommended that any re work include shaping of the inlet channel to create a defined inflow and is lined with geotextile.** **The rock used should consist of well graded angular material.**
5.	Basin 4 (car park)	Inlets and outlet areas are stable. No issues or required action is evident.
6.	Basin 5 (50m)	Scour is evident over batter at entrance to basin enclosure. Water is directed by surface water swale towards entrance track to basin. Scour leads down access track to spread at bench and then down batter at basin leading to scour. **Suggest a formalise drain will be required in this location to arrest further scour – rock over fabric**
7.	Basin 6	This basin has not been constructed.
8.	Basin 7 (800m range)	Inlets and outlet areas are stable.

		No issues or required action is evident.

9.3.3 Visual Inspections: Lime treatment Process

Visual inspection of the lime treatment process was not possible as this infrastructure is sealed and not readily accessible. It is recommended that this item be removed from the sampling program for future monitoring events. Servicing or inspection by a qualified technician may be identified as required by future monitoring results.

9.3.4 Visual Inspections: Road Infrastructure and Drainage

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 19: Discussion of Observations Road Infrastructure

Item	Location	Observation and Comment
1.	50/500m	Some sediment deposition is evident within table drains and at culverts. **Works in these areas to clear the sediment should be scheduled within normal maintenance program.**
2.	800m	No issues or required action is evident.

9.3.5 Visual Inspections: Signage

Directional and safety signage was in place across all areas.
Signage was provided at basin enclosures indicating that the water is not suitable for firefighting purposes.

9.3.6 Visual Inspections: Vegetation health - Range areas

Significant portions of the range areas heavily grazed with localised bare areas.

No significant sediment loss was observed from Range areas or surrounds. The existing surface soil material is generally poor however seems to be resistant to erosion.

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 20: Discussion of Observations, Vegetation Health

Item	Location	Observation and Comment
1.	Range 1 – 50m range	Localised pooling is occurring in the middle of the range. This pooling is impacting establishment of surface cover. Erosion is not evident over the surface
2.	Various – 500m range	Localised pooling is occurring in several locations within the 500m range. This pooling is impacting establishment of surface cover. Erosion is not evident over the surface

9.3.7 Visual Inspections: Other Engineering Controls and Structures

The following table summarises observations and recommended actions from Section 9.2. Recommended actions are provided in bold.

Table 21: Discussion of Observations, Other Engineering Controls and Structures

Item	Location	Observation and Comment
1.	Stop butt – 500m range	Some riling at front of batter occurring where water is pooling on top of butt formation and overflows over face **Rework of top of the mound formation will be required to prevent surface water passing over the batters of the stop butt.**
2.	Pit at South East corner of 50m stop butt	Pit is full of sediment and being bypassed **Modification of this outlet area may be required depending on existing stormwater arrangement** **E.g. additional control to prevent pit becoming blocked or otherwise replace with a stable surface level outlet and spreader.**
3.	Drain at rear of 50m stop butt	The Drainage swale leading to the SE stormwater pit is bare with sediment loss evident **Further stabilization of the back of the mound will be required to reduce the sediment load to the drainage outlets.**
4.	Swale drain leading to south west corner of 500m stop butt	The invert of drainage swales bare with some scour/sediment loss evident. New rock check dams have been installed. It is noted that the rock size too large with no fabric installed causing water to be focused through with scour underneath **It is recommended intermix smaller rock (75mm-150mm) into gaps of existing structures plus some smaller rock (diameter 25mm).** **Works to revegetate the invert of the channels should be considered to reduce generation of sediment.**
5.	Western corner at rear of 500m butt	Sediment from drainage swale is accumulating in rock work at the inlet to the stormwater pit. **Revegetation / stabilisation works are required at the rear of the batter and invert of the swale to reduce sediment generation.**
6.	Face of stop butt at 500m	Some riling at front of batter occurring where water is pooling on top of butt formation and overflows over face. **Rework of top of the mound formation will be required to prevent surface water passing over the batters of the stop butt.**

9.4 Recommendations

The following recommendations are made subsequent to the first quarter monitoring event;

9.4.1 Management Actions

The following management actions are presented summarised from section 9.3;

1. Investigate works to improve/ reinstate inlet controls at Basin 1 and Basin 3.

2. Investigate works to provide an additional inlet at the access track to Basin 5.
3. Include clearing of sediment from drainage and culverts within the road network to the 50m and 500m ranges.
4. Investigate works to re shape top of stop butt mounds at the 50 and 500m ranges
5. Investigate works to improve stabilisation/vegetation rear of the stop butt mounds at the 50 and 500m ranges and associated drainage
6. Investigate works to improve check measures (as required) at the swale drains at the Eastern side of the 500m range and South Eastern corner of the 500m range.
7. Investigate works to maintain / improve drainage outlet at the southern corner at rear of 50m range.
8. Confirm treatment of the 50m intermediate mound at 500m range per recommendations from 2020 Annual Monitoring Report.

   Investigate treatment of the 50m intermediate mound at the 500m range to correct observed low pH (assume pH~5.5). Note that placement of ground limestone may provide a longer term effect but should be confirmed with the range manager as appropriate.

9.4.2 Follow up Monitoring

No specific follow up monitoring is recommended.

9.4.3 Changes to Sampling Program

No changes to scheduled monitoring/s program is recommended.

10 References

Southern Highlands Regional Shooting Complex, Water Cycle Management Plan (ErSed Sept 2018)

National Environment Protection (Assessment of Site Contamination) Measure (NEPM), National Environment Protection Council (2013).

National Environment Protection (Assessment of Site Contamination) Measure (NEPM), Schedule B1 Guideline on Investigation Levels for Soil and Groundwater, National Environment Protection Council (2011).

Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council (October 2000).

Guidelines for Consultants Reporting on Contaminated Sites, NSW Office of Environment and Heritage (2011).

Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd edition), NSW Department of Environment and Conservation (2006).

Best Management Practices for Lead at Outdoor Shooting Ranges, United States Environmental Protection Agency (2005).

Southern Highlands Regional Shooting Complex Civil Works Plans
Drawings C-SC-202-253 (Arcadis Australia Pacific Pty Limited, 2015)