Borehole Logs - Golder 2005

REPORT OF BOREHOLE: BH2

SHEET: 1 OF 2

CLIENT:	Landcom	COORDS: 301003.46 m E 6239818.33 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 7/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.00 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M-H	Water Level 29/2/05	0		BH2/1 DS 0.00-0.10 m R = 0A PID = 3.6 ppm			CI CH	FILL; Silty CLAY, medium to high plasticity, brown orange, trace fine angular gravel, trace roots	D	St-VSt	Gattic Cover Concrete Bentonite
				0.55	BH2/2 SPT 0.10-0.55 m 7,7,8 N = 15 R = 0A PID = 2.1 ppm				Red brown mottle from 0.55m		VSt-H	
			1		BH2/3 SPT 0.55-0.95 m 7,15,17/100mm, refusal R = 0A PID = 3.2 ppm				SHALE, extremely weathered, extremely low strength, with clay bands	D-M		
				1.55								
	H		2	2.10	BH2/4 SPT 1.10-1.55 m 8,14,21 N = 35 R = 0A PID = 3.8 ppm				Pale grey shale gravel cuttings from 2.1m			1.5mm Graded Sand Class 18 uPVC 0.5mm
			3	3.65								
									For Continuation Refer to Sheet 2			
			4									
			5									
			6									
			7									
			8									Piezometer Details to Scale
			9									
			10									

REPORT OF BOREHOLE: BH2

SHEET: 2 OF 2

CLIENT:	Landcom	COORDS: 301003.46 m E 6239818.33 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 7/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.00 m	CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (0.03 EL, 0.1 VL, 0.3 L, 1 M, 3 H, 10 VH, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
					3.65		Continuation of Sheet 1				
					3.75		NO CORE 3.65 - 3.75m				
NMLC				4			SHALE, orange brown and grey, with pale grey clay seams/zones, fractured	DW		3.75-4.00m: Bx6, St, Sm, Sn (Fe) 3.80m: DS, silty clay, 25mm 3.86m: DS, silty clay, 4mm 3.90m: DS, silty clay, 20mm	
					4.25						
		92	0 (12)		4.37		Dark grey with occasional orange brown, friable	EW-DW		4.10-4.20m: fractured around vertical joint 4.20m: J, 90°, Pl, Sm, Sn, Fe	
							4.37-4.53m: highly fractured, with clay, possible sheared zone				
					4.70		4.70-4.95m: highly fractured, trace clay, possible sheared zone				
				5				DW		5.00-5.36m: Bx15, 0-5°, St, Sm, Cn & Sn (Fe)	
					5.35		SILTSTONE, dark grey, with occasional brown gravel sized inclusions	DW-SW		5.39m: Drilling break 5.60m: B, 5°, Un, Sm, Cn 5.61m: B, 0-10°, Un, Sm, Cn	
				6							
					6.30		Interbedded SILTSTONE / SANDSTONE, dark grey and grey, sandstone is fine grained			6.14m: J, 30°, St, Sm, Cn 6.27m: J, 20°, St, Sm, Sn, Fe 6.31m: B, 0°, St, Sm, Sn, Fe 6.34-6.36m: fractured along bedding, 5-10°, Sn (Fe)	
		90	43 (84)		6.73		6.73-7.05m: fractured	DW		6.42m: J, 45°, Un-St, Ro, Sn, Fe 6.51m: B, 0-10°, St, Ro, Sn, Fe 6.56m: B, 0-10°, St, Ro, Sn, Fe	
				7	7.05		SILTSTONE, dark grey	SW			
					7.70					7.54m: J, 30-40°, St, Ro, Cn, fractured 7.70m: Possible J, 90°, Un-St, Sm, Cn	
							NO CORE 7.70-8.00m				
				8	8.00		END OF BOREHOLE @ 8.00 m				
				9							
				10							

REPORT OF BOREHOLE: BH249

SHEET: 1 OF 1

CLIENT: Landcom
PROJECT: Contamination Investigation
LOCATION: Zouch Road, Edmondson Park
JOB NO: 04623119

COORDS: 301594 m E 6239558 m N 56 MGA94
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 100mm mm HOLE DEPTH: 8.00 m

DRILL RIG: Gemco 210B
DRILLER: Drilltest
LOGGED: GJF DATE: 10/2/05
CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADT	M-H	Groundwater Not Encountered	0	0.10	DS 0.00-0.10 m R = 0A PID = 4.1 ppm SPT 0.10-0.55 m			ML	SILT, low plasticity, brown	D	L	TOPSOIL
								CL CI	CLAY, low to medium plasticity, brown red	M	F-St	RESIDUAL
				0.60	R = 0A PID = 3.4 ppm SPT 0.60-1.05 m			CH	CLAY, high plasticity, red grey, trace of fine shale gravel	M	VSt	
			1	1.00	R = 0A PID = 2.7 ppm SPT 1.10-1.55 m				As above but grey mottled red with fine to medium shale gravel		H	
				1.60	R = 0A PID = 3.1 ppm				Inferred SHALE, extremely to distinctly weathered, low strength, grey black with interbedded clay seams			SHALE BEDROCK
STRATA PACK			2									
			3									
			4									
			5	5.00					Dark grey, trace of iron stained zones, occasional medium ironstone inclusions (distinctly weathered)			
			6									
			7	7.00					Inferred Interbedded SHALE and SANDSTONE, grey, distinctly weathered, medium strength sandstone is fine grained, grey.			
			8	8.00					END OF BOREHOLE @ 8.00 m			
			9									
			10									

REPORT OF BOREHOLE: BH291

SHEET: 1 OF 2

CLIENT:	Landcom	COORDS: 301974.25 m E 6239501.97 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 8/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.15 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M	Water Level 24/2/05	0		BH291/1 DS 0.00-0.10 m R = 0A PID = 3.1 ppm			ML	SILT, low plasticity, brown, with clay, trace fine angular and rounded gravel, trace roots	M	L	Gattic Cover Concrete Bentonite
				0.35					TOPSOIL			
					BH291/2 SPT 0.10-0.55 m 2,2,3 N = 5			CI CH	Silty CLAY, medium to high plasticity, red brown mottle, with roots, with fine subrounded gravel	M	F St	
				0.90								
			1	1.05	PP = 100, 150, 110 kPa R = 0A PID = 3.4 ppm			GP	Clayey GRAVEL / Gravelly CLAY, red, orange and grey, gravel is fine and medium, clay is high plasticity	M	St	
					BH291/3 SPT 0.60-1.05 m 3,8,10 N = 18 PP = 420 kPa R = 0A PID = 3.6 ppm			CH CI CH	Silty CLAY with ironstone gravel layers, medium to high plasticity, grey and red brown, ironstone is fine to coarse, angular	M	VSt	1.5mm Graded Sand Class 18 uPVC 0.5mm
			2		BH291/4 SPT 1.10-1.55 m 5,9,11 N = 20 PP = 350, 360 kPa R = 0A PID = 3.0 ppm							
				2.60					For Continuation Refer to Sheet 2			
			3									
			4									
			5									
			6									
			7									
			8									Piezometer Details to Scale
			9									
			10									

REPORT OF BOREHOLE: BH291

SHEET: 2 OF 2

CLIENT: Landcom
PROJECT: Contamination Investigation
LOCATION: Zouch Road, Edmondson Park
JOB NO: 04623119

COORDS: 301974.25 m E 6239501.97 m N 56 MGA94
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 100mm mm HOLE DEPTH: 8.15 m

DRILL RIG: Gemco 210B
DRILLER: Drilltest
LOGGED: RS DATE: 8/2/05
CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2	2.60		Continuation of Sheet 1				
		83	0 (5)	3			Silty CLAY, medium to high plasticity, pale grey, with ironstone gravel bands and iron stained sandstone layers, generally firm to stiff	EW		3.30m: PP=220kPa 3.60m: PP=110kPa	
					3.73						
				4	4.10		Sandy Silty CLAY, medium plasticity, grey, with occasional orange brown staining 3.77-3.85m: low strength iron stained sandstone layer				
					4.30		NO CORE 4.10 - 4.30m				
		82	30 (50)		4.60		SANDSTONE, medium grained, brown with black inclusions 4.60-4.75m: fractured with clay, with ironstone gravel	DW		4.47m: B, 0-5°, Un, Ro, Sn, Fe	
				5	4.94		SILTSTONE, dark grey, with occasional brown staining			4.81m: DS, 30mm 4.95-5.00m: fractured 5.05-5.10m: fractured, possibly drilling induced in lower strength rock	
					5.20		NO CORE 5.20 - 5.40m				
					5.40		SILTSTONE, dark grey, occasional orange brown, with fractured and weathered zones	DW			
				6	6.00		6.00-6.60m: fractured, friable, possible sheared zone	EW-DW		5.60m: J, 90°, St, Sm, Cn, fractured 5.61-5.65m: possible shear zone, highly fractured 5.69m: J, 45°, Pl, Sm, Cn 5.70m: DS, silty clay with VL strength friable black rock, 100mm 5.86m: DS, silty clay, 60mm	
		93	35 (50)					DW		6.69m: DS, silty clay, 10mm	
				7				SW		6.82m: DS, silty clay, 10mm 6.86-6.91m: fractured, friable, very low strength	
					7.50			DW		7.22m: B, 5-10°, St, Sm, Cn 7.32m: DS, 80mm, friable 7.48m: J, 20°, Pl, Sm, Sn-Vr 7.54m: B, 0-10°, St, Sm, Sn, Fe	
					8.00		SANDSTONE, fine grained, dark grey and orange brown	SW			
				8	8.15		(Hole strata packed 8.00 to 8.15m)			7.92m: DS, 3mm	
							END OF BOREHOLE @ 8.15 m				
				9							
				10							

NMLC
STRATA PACK

GAP6_0-BETA.GLB CORED BOREHOLE J:\04PROJ\101-150\041E89~1\LOGS_BOREHOLES.GPJ GAP6_0-BETA.GDT 10/08/2005 8:56:17 AM

REPORT OF BOREHOLE: BH521

SHEET: 1 OF 2

CLIENT:	Landcom	COORDS: 300912.66 m E 6239736.05 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 11/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.60 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M	Water Level 24/2/05	0	0.45	BH521/1 DS 0.00-0.10 m R = 0A PID = 2.9 ppm				Silty CLAY, medium plasticity, brown, with roots, zones of Clayey SILT, trace coarse sand and fine gravel, black, subangular POSSIBLE FILL / REWORKED TOPSOIL	M	F St	Gattic Cover Concrete Bentonite
			1	1.30	BH521/2 SPT 0.15-0.60 m 3,7,7 N = 14 R = 0A PID = 4.2 ppm			CI CH	Silty CLAY, medium to high plasticity, orange brown mottle, with fine gravel, rounded to angular, trace roots, with firm zones RESIDUAL	M	F-St	
				1.60	BH521/3 SPT 0.65-1.10 m 4,6,6 N = 12 PP = 200 kPa R = 0A PID = 3.8 ppm			CH	High plasticity, red brown, trace grey, tending sandy			
			2	2.50	BH521/4 SPT 1.15-1.60 m 3,5,8 N = 13 PP = 180 kPa R = 0A PID = 4.1 ppm			CI	Sandy Silty CLAY, medium plasticity, grey and orange brown, with ironstone gravel RESIDUAL	M	St-VSt	1.5mm Graded Sand Class 18 uPVC 0.5mm
					BH521/5 SPT 1.60-2.05 m 6,9,11 N = 20 R = 0A PID = 3.6 ppm				For Continuation Refer to Sheet 2			
			3									
			4									
			5									
			6									
			7									
			8									Piezometer Details to Scale
			9									
			10									

REPORT OF BOREHOLE: BH521

SHEET: 2 OF 2

CLIENT:	Landcom	COORDS: 300912.66 m E 6239736.05 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 11/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.60 m	CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK				0							
				1							
				2	2.50		Continuation of Sheet 1				
				3			Inferred SHALE, extremely weathered				
				4	4.60		Increased resistance from 4.6m				
				5							
				6							
				7							
				8	8.60		END OF BOREHOLE @ 8.60 m				
				9							
				10							

GAP6_0-BETA.GLB CORED BOREHOLE J:\04PROJ\101-150\041E89~1\LOGS_BOREHOLES.GPJ GAP6_0-BETA.GDT 10/08/2005 8:56:20 AM

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F02a
RL2

REPORT OF BOREHOLE: BH558

SHEET: 1 OF 2

CLIENT:	Landcom	COORDS: 301189.5 m E 6239431 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 11/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.60 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M-H	Water Level 24/2/05	0	0.10	BH558/1 DS 0.00-0.10 m R = 0A PID = 2.7 ppm			ML	Clayey SILT, brown, with fine gravel, trace fine sand, trace roots TOPSOIL	D	L	Gattic Cover Concrete Bentonite
				0.55	BH558/2 SPT 0.15-0.60 m 3,7,9 N = 16 R = 0A PID = 3.9 ppm			ML	Sandy SILT, pale brown, sand with fine, with fine gravel ALLUVIAL	D-M	MD	
			1	1.10	BH558/3 SPT 0.65-0.95 m 8,19, HB refusal R = 0A PID = 3.4 ppm			CI CH	Silty CLAY, medium to high plasticity, red orange brown, with extremely weathered iron stained zones, trace black coarse rounded sand, trace roots RESIDUAL	D-M	H	
				2.00	BH558/4 SPT 1.10-1.40 m 12,24, HB refusal R = 0A PID = 3.4 ppm			CI CH	Sandy Silty CLAY, medium to high plasiticity, grey and brown, with ironstone gravel, fine to coarse, sand is fine, trace roots, trace black organics RESIDUAL	D	H	
			2						For Continuation Refer to Sheet 2			1.5mm Graded Sand Class 18 uPVC 0.5mm Piezometer Details to Scale
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

REPORT OF BOREHOLE: BH558

SHEET: 2 OF 2

CLIENT: Landcom
PROJECT: Contamination Investigation
LOCATION: Zouch Road, Edmondson Park
JOB NO: 04623119

COORDS: 301189.5 m E 6239431 m N 56 MGA94
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 100mm mm HOLE DEPTH: 8.60 m

DRILL RIG: Gemco 210B
DRILLER: Drilltest
LOGGED: RS DATE: 11/2/05
CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK				0							
				1							
				2	2.00		Continuation of Sheet 1				
							Cuttings: pale grey clay and ironstone				
				3							
				4	4.30		Increased resistance from 4.3m, probable shale				
				5							
				6							
				7							
				8	8.60		END OF BOREHOLE @ 8.60 m				
				9							
				10							

REPORT OF BOREHOLE: BH608

SHEET: 1 OF 3

CLIENT:	Landcom	COORDS: 301282.5 m E 6239214.9 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 11/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 15.70 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M-H		0		BH608/1 DS 0.00-0.10 m R = 0A PID = 6.3 ppm			CI	Silty CLAY, medium plasticity, brown mottled orange, trace coarse black sand, friable RESIDUAL	D	H	Gattic Cover 0.0 - 0.1m Concrete 0.1 - 0.2m
				0.65	BH608/2 SPT 0.15-0.60 m 9,13,14 N = 27 R = 0A PID = 2.9 ppm				Red and grey, with ironstone gravel, with fine angular black gravel			Bentonite 0.2 - 6.0m
			1	1.45	BH608/3 SPT 0.65-1.10 m 8,12,15 N = 27 R = 0A PID = 3.4 ppm				Becoming extremely weathered shale, with medium strength from 1.50-1.60m	D-M		
			2	2.50	BH608/4 SPT 1.15-1.60 m 5,10,19 N = 29 R = 0A PID = 3.8 ppm				For Continuation Refer to Sheet 2			1.5mm Graded Sand 6.0 - 15.7m Class 18 uPVC 0.5mm 6.7 - 15.7m
			3									
			4									
			5									
			6									
			7									
			8									
			9									Piezometer Details Not To Scale
			10									

REPORT OF BOREHOLE: BH608

SHEET: 2 OF 3

CLIENT:	Landcom	COORDS: 301282.5 m E 6239214.9 m N 56 MGA94	DRILL RIG: Gemco 210B		
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest		
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS	DATE:	11/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 15.70 m	CHECKED: CPM	DATE:	4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK				0							
				1							
				2							
					2.50		Continuation of Sheet 1				
				3			Inferred Interbedded SHALE and SANDSTONE, grey, sandstone is fine grained				
				4							
				5							
					5.80						
				6			5.80-6.30m: Inferred high strength sandstone band				
				7							
				8							
				9							
				10							

REPORT OF BOREHOLE: BH608

SHEET: 3 OF 3

CLIENT:	Landcom	COORDS: 301282.5 m E 6239214.9 m N 56 MGA94		DRILL RIG: Gemco 210B	
PROJECT:	Contamination Investigation	SURFACE RL: m	DATUM: AHD	DRILLER: Drilltest	
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°		LOGGED: RS	DATE: 11/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm	HOLE DEPTH: 15.70 m	CHECKED: CPM	DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK	Water Level 24/2/05			10			Inferred Interbedded SHALE and SANDSTONE, grey, sandstone is fine grained				
				11							
				12							
				13							
				14							
				15							
					15.70						
				16			END OF BOREHOLE @ 15.70 m				
				17							
				18							
				19							
				20							

REPORT OF BOREHOLE: BH614

SHEET: 1 OF 1

CLIENT:	Landcom	COORDS: 301582 m E 6239197 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: GJF DATE: 10/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.00 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADT	M	Groundwater Not Encountered	0	0.20	DS 0.00-0.20 m R = 0A PID = 1.9 ppm SPT 0.10-0.55 m R = 0A PID = 2.6 ppm SPT 0.60-1.05 m R = 0A PID = 3.8 ppm SPT 1.10-1.55 m R = 0A PID = 4.1 ppm			ML	Clayey SILT, low plasticity, brown	D-M	L	TOPSOIL
								CI	CLAY, medium plasticity, red, trace of fine shale gravel	M	St	RESIDUAL
			1	0.80				CH	CLAY, high plasticity, grey red with fine to medium shale gravel	M	VSt-H	
				1.30					As above but Shaley CLAY, grey brown			
				1.60					Inferred SHALE, extremely to distinctly weathered, low strength with clay bandings, grey brown			SHALE BEDROCK
STRATA PACK			2									
			3									
			4									
				4.80					As above but with iron stained zones of varying strength and resistance			
			5									
			6									
				6.40					Inferred Interbedded SHALE and SANDSTONE, distinctly weathered, low strength, grey, sandstone is fine to medium grained			
			7									
			8	8.00					END OF BOREHOLE @ 8.00 m			
			9									
			10									

REPORT OF BOREHOLE: BH640

SHEET: 1 OF 3

CLIENT:	Landcom	COORDS: 302028.5 m E 6239121.1 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 9/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 15.60 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M		0	0.10	BH640/1 DS 0.00-0.10 m R = 0A PID = 1.9 ppm			CH	Silty Gravelly CLAY, medium plasticity, gravel is coarse, dry FILL - access road	D	VSt	Gattic Cover 0.0 - 0.1m Concrete 0.1 - 0.2m
				0.65	BH640/2 SPT 0.15-0.60 m 5,7,7 N = 14 R = 0A PID = 2.6 ppm				Silty CLAY, high plasticity, red and brown, trace fine gravel, trace roots RESIDUAL			
	H		1	0.90	BH640/3 SPT 0.65-1.00 m 7,13,19/100mm, refusal R = 0A PID = 3.8 ppm				SHALE, grey with orange brown zones, extremely weathered, extremely low to very low strength, friable BEDROCK TC-bit refusal at 2.30m 0.90-1.00m: low to medium strength zone			Bentonite 0.2 - 6.0m
			2	2.30	BH640/1 DS 1.40-1.50 m R = 0A PID = 4.1 ppm				For Continuation Refer to Sheet 2			1.5mm Graded Sand 6.0 - 15.6m Class 18 uPVC 0.5mm 6.6 - 15.6m
			3									
			4									
			5									
			6									
			7									
			8									
			9									Piezometer Details Not To Scale
			10									

REPORT OF BOREHOLE: BH640

SHEET: 2 OF 3

CLIENT: Landcom
PROJECT: Contamination Investigation
LOCATION: Zouch Road, Edmondson Park
JOB NO: 04623119

COORDS: 302028.5 m E 6239121.1 m N 56 MGA94
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 100mm mm HOLE DEPTH: 15.60 m

DRILL RIG: Gemco 210B
DRILLER: Drilltest
LOGGED: RS DATE: 9/2/05
CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK				0							
				1							
				2	2.30		Continuation of Sheet 1				
				3			Cuttings: SHALE, grey, friable (coarse sand size cuttings, angular, inferred very low to low strength				
				4	4.00		Dark grey, inferred medium strength				
				5	5.00		With carbonaceous zones? black cuttings				
				6	6.50		Increased resistance from 6.5m, resistance increasing with depth				
				7	7.00		Inferred interbedded SANDSTONE and SHALE, sandstone is fine grained, grey, inferred medium to high strength				
				8							
				9							
				10							

REPORT OF BOREHOLE: BH640

SHEET: 3 OF 3

CLIENT: Landcom
PROJECT: Contamination Investigation
LOCATION: Zouch Road, Edmondson Park
JOB NO: 04623119

COORDS: 302028.5 m E 6239121.1 m N 56 MGA94
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 100mm mm HOLE DEPTH: 15.60 m

DRILL RIG: Gemco 210B
DRILLER: Drilltest
LOGGED: RS DATE: 9/2/05
CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK	Water Level 24/2/05			10			Inferred interbedded SANDSTONE and SHALE, sandstone is fine grained, grey, inferred medium to high strength				
				11	11.00		Inferred SANDSTONE, fine grained, grey, inferred high strength				
				12							
				13							
				14							
				15	15.60						
				16			END OF BOREHOLE @ 15.60 m				
				17							
				18							
				19							
				20							

REPORT OF BOREHOLE: BH650

SHEET: 1 OF 1

CLIENT:	Landcom	COORDS: 301626.23 m E 6239093.1 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: GJF DATE: 10/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 8.00 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADT	M	Groundwater Not Encountered	0	0.10	DS 0.00-0.10 m R = 0A PID = 2.8 ppm SPT 0.10-0.55 m R = 0A PID = 3.2 ppm SPT 0.60-1.05 m R = 0A PID = 3.0 ppm SPT 1.10-1.55 m R = 0A PID = 4.0 ppm SPT 1.55-1.90 m R = 0A PID = 3.6 ppm			ML	SILT, low plasticity, brown	D	L	TOPSOIL
								CI	CLAY, medium plasticity, red brown, trace of fine ironstone gravel	D-M	St	RESIDUAL
				0.60				CI CH	CLAY, medium to high plasticity, grey red	M	St-VSt	
			1	1.20				CH	Gravelly CLAY, high plasticity, grey mottled yellow with fine to medium angular shale gravels	M	H	
			2	2.20					Inferred SHALE, extremely weathered, extremely low strength, grey with ironstone banding and clay seams			SHALE BEDROCK
STRATA PACK			3									
			4									
			5									
				5.60					As above with ironstone banding			
			6									
			7	7.20					Inferred Interbedded SHALE and SANDSTONE, distinctly weathered, low strength, grey, sandstone is fine to medium grained			
			8	8.00					END OF BOREHOLE @ 8.00 m			
			9									
			10									

REPORT OF BOREHOLE: BH675

SHEET: 1 OF 3

CLIENT:	Landcom	COORDS: 301470 m E 6239003 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 8/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 15.60 m	CHECKED: CPM DATE: 4/8/05

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADT	M		0	0.10	BH675/1 DS 0.00-0.10 m R = 0A PID = 2.8 ppm			ML CI CH	SILT, brown, trace fine angular gravel TOPSOIL Silty CLAY, medium to high plasticity, red brown grey mottle, with roots, with extremely weathered ironstone gravel RESIDUAL	D M	L-MD St VSt	Gattic Cover 0.0 - 0.1m Concrete 0.1 - 0.2m Bentonite 0.2 - 6.0m
				0.65	BH675/2 SPT 0.15-0.60 m 4,5,5 N = 10 R = 0A PID = 3.4 ppm							
			1	0.80	BH675/3 SPT 0.65-1.10 m 5,7,11 N = 18 PP = 360 kPa R = 0A PID = 2.6 ppm				From 0.65m: Less roots, with ironstone gravel, medium subrounded to angular From 0.8m: Increasing fine angular ironstone gravel with depth			
	H		2	2.55	BH675/4 SPT 1.15-1.60 m 6,11,17 N = 28 PP = 480 kPa R = 0A PID = 1.9 ppm				For Continuation Refer to Sheet 2			1.5mm Graded Sand 6.0 - 15.6m Class 18 uPVC 0.5mm 6.6 - 15.6m Piezometer Details Not To Scale
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

REPORT OF BOREHOLE: BH675

SHEET: 2 OF 3

CLIENT:	Landcom	COORDS: 301470 m E 6239003 m N 56 MGA94	DRILL RIG: Gemco 210B
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILLER: Drilltest
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	LOGGED: RS DATE: 8/2/05
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 15.60 m	CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2	2.55		Continuation of Sheet 1				
NMLC		86	30 (10)	3			SHALE, pale grey, friable, with red ironstone gravel layers, ironstone is low to high strength, fractured due to drilling and handling	EW			
				4						3.79m: Possible J, 15-25°, St, Sm, ironstone gravel fragments	
		91	30 (10)	5							
				6	6.35						
		100	30 (55)	7			Dark grey, trace iron stained zones, occasional medium ironstone gravel inclusion, generally fractured around ironstone inclusions due to drilling	DW		6.85m: J, 45°, Pl, Sm, Cn 6.93m: J, 30°, Un, Sm, Cn 7.04-7.10m: fractured, handling/driling break	
					7.45					7.31m: J, 15°, Un, Sl, Cn 7.34m: J, 15°, Pl, Sl, Cn	
STRATA PACK				8			Inferred Interbedded SHALE and SANDSTONE, grey, sandstone is fine grained				
				9							
				10							

REPORT OF BOREHOLE: BH675

CLIENT:	Landcom	COORDS: 301470 m E 6239003 m N 56 MGA94	SHEET: 3 OF 3
PROJECT:	Contamination Investigation	SURFACE RL: m DATUM: AHD	DRILL RIG: Gemco 210B
LOCATION:	Zouch Road, Edmondson Park	INCLINATION: -90°	DRILLER: Drilltest
JOB NO:	04623119	HOLE DIA: 100mm mm HOLE DEPTH: 15.60 m	LOGGED: RS DATE: 8/2/05
			CHECKED: CPM DATE: 4/8/05

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (meters)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
STRATA PACK	Water Level 24/2/05			10			Inferred Interbedded SHALE and SANDSTONE, grey, sandstone is fine grained				
				11							
				12							
				13							
				14							
				15	15.60						
				16			END OF BOREHOLE @ 15.60 m				
				17							
				18							
				19							
				20							

APPENDIX D

Remediation Action Plan (RAP) and including Environmental Management Plan (EMP) - Landcom Site

9 September 2010

LANDCOM PROJECT 12619 - ZOUCH ROAD, EDMONDSON PARK, NSW

REMEDIATION ACTION PLAN

Submitted to:
Landcom
Level 2, 230 Church Street
Parramatta, NSW

REPORT

A world of capabilities delivered locally

Report Number. 107623047-001-R-Rev1

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Golder Associates

Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery
Landcom	David Schofields	Rev0	26 August 2010	electronic
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Landcom	David Schofields	Rev1	9 September 2010	electronic
Environ	Graeme Nyland	Rev1	9 September 2010	electronic
Golder	Glen Fuller	Rev1	9 September 2010	File

Executive Summary

Golder Associates Pty Ltd (Golder) was retained by Landcom to prepare a Remediation Action Plan (RAP) for the proposed development of the Site located at Zouch Road, Edmondson Park, NSW (herein referred to as the Site and shown in Figure 1).

The Site has an area of about 94.0 ha, was purchased by Landcom in about 1990 and formed part of the former Defence owned Ingleburn Military Precinct between 1940 and 1990. The Site was used predominantly as an infantry training area and included a rifle range, grenade ranges, weapons pits and obstacle courses.

The Site has been zoned specifically for the proposed development under the Liverpool City Council LEP outlining various land uses as shown in Figure 2. Zoning for the Concept Plan approval are generally consistent with the zoning detailed within this RAP. For the purpose of this RAP Golder have identified these areas as:

- Rural-Residential Zone West (RRZW);
- Residential Zone North of Rail Alignment (RZNRA) which includes recreational areas and town centre; Rail Corridor (RC); and
- Conservation Zone (Regional Park) South of Rail Alignment (CZSRA)

There have been several unexploded ordnance (UXO) investigations to establish the military history of the Site and assess the presence / absence of UXO and small arms ammunition (SAA).

A Detailed Site Investigation (DSI) carried out in 2005 by Golder included the excavation of 759 sample locations, collection of soil and groundwater samples, analysis of selected soil and groundwater samples for potential contaminants of concern and limited UXO remediation was carried out within the former grenade ranges.

Based on the results of the DSI and the proposed development of the Site, remediation and validation works are required to render the Site suitable for the proposed end land use. Remediation and or management works will generally consist of the following:

- A visual site inspection and removal of all military associated objects such as concertina wire, training pits, former structures / concrete slabs, general rubbish, scrap metal and asbestos containing materials;
- Clearance of vegetation within proposed residential areas to facilitate a 100% UXO search and removal of small arms ammunition (SAA). Vegetation clearance will generally involve the removal of vegetation to near surface level including trees earmarked for removal as part of the proposed development;
- A visual inspection and removal of observed SAA within conservation zones and implementation of a Site Management Plan (SMP). Subject to approval limited vegetation clearance (slashing of grasslands) may be carried out to facilitate the visual search and removal of SAA from these areas;
- Remediation / management of lead particulate impacted material associated with the former rifle range stop butt. Remedial works will involve the excavation/re-engineering of lead particulate impacted material, placement within a centralised location (encapsulation structure) and placement of a cap to minimise surface water infiltration and limit access to material by the public. The encapsulation structure will require ongoing management in accordance with a Site Management Plan (SMP);
- Asbestos Containing Material (ACM) identified will be relocated to the lead particulate re-engineered area for burial within a designated area in the encapsulation structure and implementation of a Site Management Plan (SMP);
- Waste material (vegetation and building demolition within the north western corner of the Site) will be excavated and disposed off site subject to further assessment during remediation works; and

- PAH impacted material identified at TP599 will be excavated, transported and disposed off site in accordance with NSW DECC Waste Classification Guidelines.

Abbreviations / Glossary

ACM	Asbestos containing material
ANZECC	Australian & New Zealand Environment & Conservation Council
B(a)P	Benzo(a)pyrene (a PAH Compound)
BTEX	Benzene, toluene, ethylbenzene, xylene
Contact	A metallic object of military firearm origin, greater than 25mm in length
C_6-C_9	Light hydrocarbon chain groups (for example petrol)
C_{10}-C_{14}	Medium hydrocarbon chain groups (for example kerosene)
C_{15}-C_{28}	Heavy hydrocarbon chain groups (for example diesel)
C_{29}-C_{36}	Heavy Hydrocarbon chain groups (for example, lube oil)
DECCW	Department of Environment, Climate Change and Water (formerly NSW EPA, NSW DECC and NSW Water)
DSI	Detailed Site Investigation
EPA	Environment Protection Authority
Golder	Golder Associates Pty Ltd
<1, <100	Less than the PQL, that is, less than 1 or 100 units
LOQ	Limit of quantitation (also see LOR or PQL) – of chemical concentrations attainable
Low Density Residential	Refers to residential properties with gardens and accessible soil, including single family dwellings, townhouses, villas, children's daycare centres, pre-schools and primary schools.
mg/kg	Milligrams per kilogram (or part per million)- equal to
mg/L	Milligrams per litre (or part per million)
ND	Not detected above the LOQ or PQL
NHMRC	National Health & Medical Research Council
PAH	Polycyclic aromatic hydrocarbon
% RPD	Relative percent difference
PID	Photoionisation detector
ppb	Part per billion
ppm	Part per million
PQL	Practical quantitation limit (of chemical concentration)
RAP	Remediation Action Plan
SAA	Small arms ammunition
TPH	Total petroleum hydrocarbons

TRH	Total recoverable hydrocarbons
µg/L	Micrograms per litre (or part per billion)
µS/cm	MicroSiemens per centimetre a measure of conductivity and salinity
UCL	Upper confidence limit of data set
UXO	Unexploded ordnance
VHC	Volatile halogenated compounds
VOC	Volatile organic compounds

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APPENDIX C
Draft Interim Advice #4 (Environ 2005b)

APPENDIX D
Summary of Exceedances

APPENDIX E
Environmental Management Plan (EMP) Proposed Remediation Works

1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) were engaged by Landcom to prepare this Remediation Action Plan (RAP) for the property located at Zouch Road, Edmondson Park, NSW (herein referred to as the "Site"). A Site Locality Plan including Lot/DP details is presented as Figure 1 (Appendix A).

The RAP has been prepared in general accordance with the NSW EPA Guidelines for Consultants Reporting on Contaminated Sites (EPA 1997), NSW EPA Site Auditor Guidelines (DEC 2006) and the NSW DECC Waste Classification Guidelines (DECC 2009).

Golder previously prepare an RAP (Golder 2006) for the proposed development of the Site which was conceptual at the time as the Larger Edmondson park Land Release was subject to rezoning applications being considered by relevant regulatory agencies. This RAP has been developed based on the current proposed development and supersedes the previously prepared Golder 2006 document.

This RAP has also been prepared by Golder to accompany a Concept Plan Application under Part 3A of the Environmental Planning & Assessment Act, 1979 (EP&A Act) and a proposal for State Significant Site listing under Schedule 3 of State Environmental Planning Policy Major Development 2005 (SEPP Major Development) in relation to the former Ingleburn Army Base and certain adjoining lands within the Edmondson Park Release Area of the South West Growth Centre (referred to herein as 'Edmondson Park South').

1.1 Background

A brief summary of background information is provided as follows:

- The Site has an area of about 94 hectares (ha) and formerly formed part of the Ingleburn military precinct from about 1940 to 1990. During this period the Site was primarily used as an infantry training area including rifle range and grenade ranges;
- Landcom acquired the Site from the Department of Defence in the early 1990s;
- There have been three unexploded ordnance (UXO) investigations carried out at the Site to identify historical military use of the site and site assessment of potential UXO within higher risk areas. These investigations are further discussed in Section 3.1;
- A NSW EPA Accredited Contaminated Land Site Auditor (SA), Mr Graeme Nyland of Environ Pty Ltd was engaged by Landcom to provide an independent assessment of the investigations and an opinion with respect to the suitability of the Site to be developed for residential landuse;
- A Detailed Site Investigation (DSI) was carried out by Golder in 2005 (Golder 2005). The DSI included a soil and groundwater sampling and analysis program and limited UXO remediation within former grenade ranges located within the eastern and north eastern corners of the Site. This report, findings and recommendations are further summarised in Section 3.2;
- Subsequently a Remediation Action Plan (Golder 2006) was prepared for the then conceptual development of the Site being considered by stakeholders and regulatory agencies including local government authorities (Council). The RAP was reviewed by the SA and an interim advice issued indicating that the Site could be made suitable for the proposed development subject to the implementation of the RAP and SA recommendations;
- Landcom and other stakeholders (land owners and regulatory agencies) within the larger Edmondson Park Land Release Area applied to Liverpool and Campbelltown City Councils and were successful in 2006 in obtaining rezoning of the areas for residential land use, rail corridor, conservation areas and commercial land uses. The approved Edmondson Park Zoning Plan is presented as Figure 2;

- The NSW Government approved the proposed South West Rail Link corridor which divides the Site in half from the south eastern corner to the north western corner of the Site;
- Based on the approved zoning boundaries the conceptual development included within the previously prepared RAP (Golder 2006) was modified to accommodate conservation agreements and the final rail corridor. Landcom proposes to submit a development application for the Site and proposed remediation works to Liverpool Council in mid to late 2010;

1.2 Objective

The aims of the RAP are to:

- Set remediation goals that shall ensure the Site will be suitable for residential, commercial and open space land use, and will pose no unacceptable risk to human health or the environment;
- Evaluate the range of remediation options available to address the existing site contamination, and thereby reduce risks to acceptable levels;
- Document the various safeguards required to complete the remediation work in a safe, environmentally friendly manner; and
- Identify the necessary approvals and licenses required by regulatory authorities in order to enable the remediation works to proceed.

2.0 SITE CHARACTERISATION

2.1 Site Description / Identification

The Site is within the Edmondson Park Release Area, which was initially rezoned by an amendment to Liverpool local Environmental Plan 1997 (Amendment No.83) in March 2006 and subsequently amended by Liverpool Local Environmental Plan (Amendment No. 114) in May 2008. The Site is legally identified as Lots 1, 2, 7 & 8 in Deposited Plan (DP) 1127652. At the time of the DSI the Site was identified as Lot 1 in DP807460 and Lot 2 in DP 807461 and is currently zoned as follows:

- R1 General Residential
- R5 Rural Residential
- B2 – Local Centre
- SP2 Infrastructure (Railway)
- RE1 – Public Recreation
- E1 – National Parks and Nature Reserves

The Concept Plan is generally consistent with the existing zones, but will seek to rezone part of the R1 General Residential zone to SP2 Infrastructure (Educational Establishment), rezone the B2 – Local Centre zone to B4 – Mixed Use zone, and rezone the R5 Rural Residential zone to E4 – Environmental Living.

The development of Site will consist of four distinct zones (refer to Figure 4) identified as the following:

- Rural-Residential Zone West (RRZW) which will consist of up to 14 rural residential lots with a minimum lot size of 4000m^2 and within a total area of around 8.3 ha located along the western boundary of the Site.;
- Residential Zone North of Rail Alignment (RZNRA) which has an area of about 43 ha and will largely consists of R1 General Residential zone, a school, public open space and Mixed Use development in the town centre zone. The development of this area will be progressive with the Town Centre area and school site developed first followed by the remaining residential areas;
- Rail Corridor (RC) has an area of about 6.4 ha, which transects the site from the south eastern corner to the north western corner of the Site. The rail corridor is approximately 60m wide and will be developed by the Transport Construction Authority (TCA) for the South West Rail Link. This corridor also includes a small wedge of land between the proposed town centre and regional park (refer to site ownership plan); and
- Conservation Zone (Regional Park) South of Rail Alignment (CZSRA) which has an area about 36 ha and will form part of the Edmondson Regional Park.

The development of the conservation area is part of a conservation agreement (CA) entered into between the Australian Government and NSW Government in 2009 (CA 2009).

The South West Rail Corridor extends from the south eastern corner to the north western corner of the Site and is currently being remediated and developed by the Transport Construction Authority (TCA) which has approval under State Environmental Planning Policy (SEPP).

Golder Associates environmental staff carried out a site walk as part of the DSI and recent site visit (March 2010). The Site observations and site features (shown in Figure 3) are discussed in detail in the DSI report (Golder 2005), and have been summarised in the following Section.

2.2 Current Site Conditions

The Site is currently fenced with a cyclone wire mesh fencing along the western boundary and parts of the northern boundary, a wire fence constructed from star pickets and wire along the northern, eastern and southern boundaries.

It is understood that the Site has historically had an ongoing security issues with illegal dumping of general waste, spoil and abandoned vehicles occurring on the Site. There were no signs of illegal dumping or significant changes of site conditions observed since the DSI was completed and during the March 2010 Site walkover.

Currently access is via a gate from Zouch Road located adjacent to the south-western corner of the Site. There is an unsealed track that extends from the access gate around the perimeter of the Site with several tracks transecting the Site. The access tracks are generally grassed and it is understood that they are maintained by a contractor to provide a firebreak between heavily vegetated areas of the Site.

The Site contains several heavily vegetated areas on the northern, eastern, southern, western and central parts of the Site, understood to contain an endangered species of Cumberland Land Snail. Snail shells were observed in the general areas in and around the heavily vegetated areas.

The Site is littered with remnants of Military objects used primarily for infantry training such as training pits, star pickets with barbed wire fencing, concertina wire, concrete slabs (former structures / buildings), trenches and small arms ammunition.

The area on the central / western part of the Site is heavily vegetated with a concertina wire compound located within the western part. General rubbish such as whitegoods, scrap metal and vehicle parts were observed within the western part of the compound. About 30 rolls of concertina wire were observed within the south eastern part of the compound. Pieces of concertina wire / barbed wire and steel star pickets were observed on the ground surface level. Weapons training pits were also observed within the area, however, were relatively shallow.

An area located within the north-western corner of the Site contains stockpiles of what appears to be a mixture of soil, vegetation and building rubble. This area has been previously identified by Milsearch and PB as the Waste Disposal Area West. At the time of the Site visit the stockpiles were well vegetated with grass with building rubble visible on the surface and between stockpiles. To the north of the fill area Cabramatta Creek runs across the north-western corner of the Site. The Site perimeter track runs along the eastern boundary of the area and is at a slight elevation (between 1.0 to 1.5m) above the surrounding area. A steel pipe was observed within the perimeter track and allows surface water runoff to transect the track and drain towards Cabramatta Creek.

The area immediately east of the waste disposal / fill area is heavily vegetated and contains relics of infantry training within the area such as training pits, concertina wire, star pickets and .303 and plastic blank small arms ammunition (SAA). The military objects observed within the area have been presented in Figure 3.

An open trench of about 1.5-2.0m depth was observed adjacent to the northern boundary (Figure 3). The trench was observed to contain scrap metal, concertina wire and some building waste such as bricks and whitegoods. Immediately to west of the trench was a stockpile of soil (SP5) about 30m^3 placed along the top of the excavation. We understand the area was used as an armoured assault training area with the trench excavated as an obstacle for tanks and armoured vehicles. Based on the history of the Site and the close proximity of living quarters it is unlikely that actual armoured vehicles and tanks were used on the Site. Based on a visual assessment the stockpiled material appears to have resulted from the excavation of the trench. A small stockpile was observed east of the trench and stockpiled soil and was similar in appearance to the larger stockpile (SP6).

An area west of the armoured assault training area was observed to contain a series of six concertina wire obstacles about 20-30m in length running south to north (Figure 3).

The area between the perimeter access track along the northern boundary and the heavily vegetated area generally consisted of tall dry grass with pockets of medium to dense vegetation. Training pits were observed within the area with several observed to be either filled with water or contained steel star pickets and sheet metal. SAA (blanks) was observed sporadically across the area.

The Site currently contains three dams (Dam 1, 2 & 3) located on the eastern, western and southern parts of the Site respectively. Surface water runoff is directed across the Site generally along naturally formed drainage depressions and a small creek, which transects the eastern part of the Site.

Several areas on the northern, southern and western part of the Site were observed to contain concrete slabs associated with former structures. The slabs were generally in good condition with no staining observed. The concrete slabs were located using a hand held GPS and are identified in Figure 2.

A Command Post was located on the central / northern part of the site and is surrounded by star pickets and barbed wire (refer Figure 3). The Command Post consists of an excavation about 2.0m deep with sheet metal walls. At the time of the investigation the excavation was full of water.

A former rifle range was observed on the western / southern part of the Site (refer to Figure 3). A stop butt was observed on the northern part of the area and is oriented west to east. We understand firing was orientated north to south towards the former military camp. No obvious target areas were observed within the stop butt that would indicate concentrated areas of lead particulate. Lead particulate and fragments of .303 small arms ammunition were visible on the surface of the area. We understand that the rifle range was previously oriented in a west to east direction and include 5 miniature rifle ranges, which were reoriented in the 1970s to its current layout. Lead particulates were also observed at the main entrance and perimeter track in the north-western corner of the Site.

Coal Stockpiles were observed at two locations on the Site with the first located on the central part of the Site (about 200m^3) and the second at the south-eastern corner of the Site (about 150m^3). We understand the coal was used on the adjoining military camp.

The ground surface level within an area adjacent to the large coal stockpile located on the central part of the Site was observed to undulating and disturbed. We understand that this area contains three burial trenches identified during previous investigations as the Board of Survey Disposal Pits. We understand that the trenches contain buried waste such as scrap metal, concrete, building demolition and disused office equipment (filing cabinets etc). Immediately south of this area an open trench was observed with scrap metal, whitegoods, asbestos sheeting and general rubbish.

Asbestos Containing Material (ACM) was observed in several parts of the Site. The main area where ACMs were observed was in the vicinity of the former rifle range located on the central part of the Site. The Asbestos observed within this area was generally a fragmented piece of bonded asbestos sheeting associated with roofing or sheeting scattered sporadically across the area. Asbestos pipes were observed stockpiled on the eastern part of the Site. The areas were ACMs were observed were mapped using a hand held GPS and are presented in Figure 3.

The former grenade ranges (REM 1 to REM3) and additional areas (REM 4 and REM 5) identified were remediated (for unexploded ordnance (UXO)) during the DSI (Golder 2005) are currently well vegetated and appear to be unchanged since the limited remediation and investigation works were completed.

The Site currently contains several areas of blackberry infestation. These areas are generally located along the drainage and creek alignments on the eastern and western part of the Site. The blackberry infestations were previously treated, however, have re-established within the areas previously infested.

Several stockpiles of soil other than small mounds of dirt within the vicinity of training pits were observed across the Site. The stockpiles were generally heavily vegetated with grass. The stockpiles were located using a hand held GPS and are presented in Figure 3.

2.3 Surrounding Land Use

The Site is located within a semi rural / residential area of Edmondson Park. The Site is accessible only from Zouch Road located on the south western corner of the Site. The Site is irregular shaped with the surrounding landuse as follows:

- A series of semi rural / residential properties are located to the north of the Site and consist of grazing areas for cattle, goats and horses, a chicken farm and residential dwellings, beyond which is Jardine Drive;
- Semi rural properties to the east consisting of grazing land for cattle, goats and horses, beyond which is Croatia Avenue;
- Former Ingleburn Military Establishment (Camp) located to the south of the Site, with residential dwellings located adjacent to the south-eastern corner of the Site. We understand that these dwellings were used as the Army Married Quarters and currently are being used as low cost accommodation;
- Zouch Road adjacent to the south western corner of the site; and
- Residential properties adjacent to the western boundary of the Site, beyond which is Culverston Avenue.

3.0 SUMMARY OF INVESTIGATION REPORTS AT THE SITE

3.1 Background Investigation Reports

The Site is located within a semi rural area of Edmondson Park, NSW and has an area of about 94ha. A Site Locality Plan is presented as Figure 1. The site was purchased in the early 1990's by Landcom. The site was previously used as a training area for infantry purposes and as a result the site is variably contaminated with UXO. Previous investigations have identified ancillary activities at the site which have resulted in asbestos (from demolition of military buildings), building rubble, unwanted stores and vehicle parts buried in trenches / stockpiles and possible in existing dams.

Previous assessments at the site have involved UXO investigations. Further investigation was required to assess the significance of the UXO contamination on soil and groundwater, and to assess non-UXO contamination of the site to determine the suitability of the site for rezoning. It was proposed that the site zoning be changed from rural zone to approximately 50% residential and 50% conservation.

An accredited EPA Site Auditor (SA), Mr Graeme Nyland (Environ Pty Ltd) was appointed to ensure compliance with statutory requirements in relation to the contamination assessment and remediation of the site.

Previous UXO investigation reports of the Site include:

- A Stage 1 Preliminary Contamination Investigation – Zouch Road Ingleburn 92ha Site dated September 2000 prepared by Milsearch Pty Ltd;
- A Stage 2 Munitions Contamination Investigations dated 21 January – 6 April 2002 prepared by Milsearch Pty Ltd; and
- A Stage 2 Munitions Contamination Investigations Additional Investigations dated 2003 prepared by Milsearch Pty Ltd.

Subsequently in 2004 Parsons Brinckerhoff Pty Ltd were commissioned by Landcom to prepare a Sampling Analysis and Quality Plan (SAQP) (PB 2004) for review and approval by the Appointed NSW EPA accredited Site Auditor Mr. Graeme Nyland. The SAQP was approved in August 2004 and the subsequent scope of work issued for tender.

3.2 Detailed Site Investigation Report

Golder Associates completed a Detailed Site Investigation (DSI) of the Site in August 2005 (Golder 2005). The purpose of the investigation was to assess the Site in terms of suitability for the end land uses proposed as residential and open space (conservation) in the context of the proposed site redevelopment. The investigation targeted potential ground contamination associated with past site use as a Former Infantry Training Area and in accordance with the Site Auditor approved Sampling Analysis and Quality Plan (PB 2004).

The Site formed part of the Edmondson Park Release Area and was subject to a rezoning proposal to Liverpool and Campbelltown City Councils.

The preliminary development planning of the Site comprises of a proposed rail line transecting the Site from the south-eastern corner to the north-western corner of the Site, approximately 38 Ha of Conservation Zone, riparian protection park south of the proposed rail alignment and approximately 47 Ha of development including elements of a town centre with residential districts within the northern and south western parts of the Site and a residential zone of about 8 Ha with limited development and clearing of vegetation in the north western corner of the site.

3.2.1 Conclusions and Recommendations of the DSI Report

The conclusions of the DSI regarding the subsurface conditions at the Site were reported as follows:

- The use of the site for residential and conservation land uses is considered acceptable subject to the implementation of the recommendations made below and the limitations discussed in the DSI report;
- A Remediation Action Plan be prepared in accordance with the NSW EPA (now DECCW) Guidelines;
- The site should be subject to a visual site inspection and removal of all military associated objects such as concertina wire, training pits, former structures / concrete slabs, general rubbish, scrap metal and asbestos piping;
- Determination of the most appropriate remedial strategies for Small Arms Ammunition, Asbestos Containing Material, and lead particulate impacted material were provided in the DSI report, and are discussed further at later stages of this report; and
- PAH impacted material identified at TP599 should be excavated, transported and disposed off site in accordance with the then current NSW EPA Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-liquid Wastes (EPA 1999).

3.3 Remediation Action Plan (RAP) – Golder 2005

On completion of the DSI, Golder prepared a RAP for review by the NSW EPA accredited SA and regulatory authorities. The RAP was prepared based on the proposed re-development of the Site for mixed residential, conservation and rural residential land uses.

Remediation works required to render the Site suitable for the proposed end land use generally consist of the following:

- A visual site inspection and removal of all military associated objects such as concertina wire, training pits, former structures / concrete slabs, general rubbish, scrap metal and asbestos piping;
- Clearance of vegetation within proposed residential areas to facilitate a 100% UXO search and removal of SAA. Vegetation clearance will generally involve the removal of vegetation to near surface level including trees earmarked for removal as part of the proposed development;
- A visual inspection and removal of observed SAA within conservation zones. Subject to approval limited vegetation clearance (slashing of grasslands) may be carried out to facilitate the visual search and removal of SAA from these areas;
- Remediation / management of lead particulate impacted material associated with the former rifle range stop butt. Remedial works will involve the excavation/re-engineering of lead particulate impacted material, placement within a centralised location and placement of a cap to minimise surface water infiltration and limit access to material by the public;,
- Asbestos containing material (ACM) identified will be relocated to the lead particulate re-engineered area for burial within a designated area;
- Waste material (vegetation and building demolition within the north western corner of the Site will be excavated and disposed off site subject to further assessment during remediation works; and
- PAH impacted material identified at TP599 will be excavated, transported and disposed off site in accordance with NSW DECC *Waste Classification Guidelines.*

3.4 Site Auditor, Interim Advice – Environ

As previously noted, Mr Graeme Nyland of Environ was engaged as the NSW EPA Accredited Site Auditor (SA) to provide an independent review of whether the land is suitable for the intended end land use, i.e. an Audit under Section 47 (1)(b) (iia) of the NSW Contaminated Land Management Act 1997 (the CLM Act).

The Audit has included thus far a review of

- The Initial UXO investigations carried out by Milsearch (Initial Advice and Interim Advice #2) in 2003;
- Sampling analysis quality plan (SAQP) prepared by Parsons Brinkerhoff (PB), Australia in 2004;
- Detailed site Investigation and Limited UXO Remediation carried out by Golder in 2005 (Draft Interim Advice #3); and
- Review of remediation action plan (RAP) prepared by Golder in 2005 (Draft Interim Advice #4).

The following provides brief summary of conclusions and recommendations presented in Draft Interim Advice #3 and Draft Interim Advice #4.

Draft Interim Advice #3, 8 September 2005 (Appendix B)

The SA carried out a review of the DSI report prepared by Golder and provided an Interim Advice with respect to its suitability in accordance with NSW DECCW Guidelines and conclusions made.

The Auditor considered that "*the investigations documented by Milsearch and Golder's reports have been adequate to identify the major contamination issues at the site for the purposes of remediation planning. Golder as identified seven AOC's requiring remedial action and the Auditor concurs with these items, with comments as noted in Section 11.2. Preparation of a RAP is now required to address these items.*"

Draft Interim Advice #4, 21 October 2005 (Appendix C)

The SA carryout a review of the Draft "Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW" dated October 2005 and provided comments and suggested amendments relating to the RAP and its adequacy for the proposed remediation works.

The SA concluded "*Overall, it is considered that the remediation approach recommended by Golder is appropriate. Section 3.2 and 3.3 include recommendations for changes to the RAP. Contamination issues raised within the previous Interim Advice letters have been addressed by the RAP. Of critical importance will be the successful implementation of SMPs for ongoing site management in certain areas of the Site.*"

The Auditor noted the requirement for the preparation of an Environmental Management Plan (EMP) to be developed for the proposed remediation works to control environmental impacts during remediation works.

Note: The recommendations made by the SA (Draft Interim Advice #4) have been incorporated into this RAP. In addition an EMP and Site Management Plan (SMP) for the proposed Conservation Zone have also been prepared and should be read in conjunction with this document.

4.0 GEOLOGICAL SETTING

4.1 Topography

According to the 1:25 000 Liverpool Topography Map 9030-ill-S (1983) the Site is at an elevation of between 50m AHD to 70m AHD, with the highest point of the site located in the south-western corner of the Site. An approximate central ridgeline extends from the south-western corner of the Site across to the north-eastern part of the Site, with the landform sloping away from this ridgeline east and northwest.

Additionally, site investigations and the previous Milsearch Stage 1 Report indicate that the topography is gently undulating, with two prominent features:

- A low ridgeline originating from the low ground in the north west corner and rising parallel to the northern perimeter to a high point located on the northern boundary; and
- A small hill in the southeast portion of the Site, which gradually falls away to the northeast.

Much of the undulating terrain ranged between 2 and 3 degrees in slope, with steeper slopes in the drainage line areas and areas of disturbance.

The nearest surface water body to the Site (other than the drainage channels and small creek that transverse e the Site) is Cabramatta Creek to the west to northwest of the Site, which flows southwest to northeast. The Site currently contains one small watercourse (creek) which transects the southeast portion of the site, flowing in a south easterly direction. The watercourse is made up of a series of small ponded areas, which fill during periods of wet weather. The site currently contains three dams (Dam 1, 2 & 3) located on the eastern, western and southern portions of the site respectively. At the time of the Site work Dam 1 and 2 contained small amounts of water and Dam 3 was dry. The dam wall of Dam 3 was observed to have been breached with a small trench excavated. Other minor drainage channels / depressions in the northern and western parts of the site direct surface runoff towards the Dams and eventually drain into the creek.

Bunbury Curran Creek is approximately 2.3km to the south east of the Site and intersects the Georges River approximately 5km east of the Site.

4.2 Geology and Hydrogeology

According to the Penrith Geological Series Sheet 9030 Edition 1 (1991), the Site is located on an area of Bringelly Shale of the Wianamatta Group, comprised of shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff. Weathered, sandy Bringelly Shale was observed in the southwest corner of the Site. To the west and east of the Site, Quaternary deposits of medium grained sand, clay and silt deposits are present.

The Penrith Soil Landscape Series Sheet 9030 (1989) indicates the soil landscape to be gently undulating, rising on Wianamatta Group Shales. Soils are shallow to moderately deep (<1.0m), hard setting with mottled texture, generally red and brown podzolic soils occur on crests grading to yellow on lower slopes and drainage lines.

Perched groundwater is expected to occur in the various alluvial deposits, more specifically near main drainage lines and dams, and is likely to flow in the direction of slope. Regional groundwater, however, is expected to be present in the cracks and fissures within the bedrock and is expected to flow to the east towards the Georges River, though Cabramatta Creek may locally influence groundwater beneath the western portion of the site.

The groundwater quality from the Ashfield Shale typically indicates high salinity, where as the groundwater from the underlying Hawkesbury Sandstone typically has low salinity (1,000mg/L). Where the Ashfield Shale overlies the Hawkesbury Sandstone, the groundwater in the sandstone is often decreased quality due to infiltration for the overlying shale derived waters (1:100,000 Geology Sheet).

Based on the standing water levels within the seven monitoring wells on site the groundwater contours were interpreted and are presented in the DSI report (Golder 2005). The groundwater contours indicate that the groundwater within the Shale / Sandstone Bedrock and flows in two directions from the ridgeline to the north western and south eastern direction.

4.3 Acid Sulfate Soils Risk Maps

A review of the 1:25,000 Liverpool Acid Sulfate Soil Risk Map (9030S2, June 1995), indicates that the site is located in an area of no known occurrence of acid sulfate soils, therefore land management and development activities are not likely to be affected by acid sulfate soil material.

5.0 HISTORICAL INFORMATION

5.1 Sources of Historical Information

Historical information on the Site and the surrounding properties was obtained following the review of various sources of information including:

- Title search documents;
- Aerial photographs;
- Liverpool Local Government records; and
- Groundwater bore information search through the Department of Infrastructure Planning and Natural Resources.

The historical information on the Site and surrounding properties has been previously described and detailed in the Detailed Contamination Investigation (DSI) Report (Golder 2005).

5.2 Summary of Site History

Based on the information obtained from Liverpool City Council and documents from a Land and Property information search as reported in DSI Report (Golder 2005), the site is currently owned by the New South Wales Land & Housing Corporation.

Information on the owners / occupiers of the site was obtained from records held by the Land Titles Office. Based on this review, the site appears to have been part of a parcel of land that formed part of a Crown Grant to Mr. Henry Kitchen in 1819.

The land was then transferred to a Mr. Charles Throbs in 1821 who in turn leased the site to a Mr. Matthew Sewell between 1863 and the late 1800's. The Site was then sold to Mrs Annie Sheppard. A portion of the Site was then sold to a Mr Harold Alfred Swane in 1945.

The Commonwealth of Australia purchased both properties that form the Site in 1953 and subsequently on sold the Site to the New South Wales Land & Housing Corporation in 1990.

Aerial photographs were obtained from the Department of Land and Water Conservation and are presented in Golder 2005. Based on our review of the aerial photographs, issues of environmental concern and a broad indication of their significance are provided below.

- The 1956 aerial photograph shows what appears to be the Miniature Rifle Range located on the south western portion of the Site. A drainage line is apparent from the Miniature Rifle Range to the north towards a dam / holding pond. Disturbance is apparent in the surface conditions of the central / eastern part of the Site (the grenade throwing bay and impact zone).
- The 1961 aerial photograph shows what appear to be three dams located on the eastern, southern and western parts of the Site. There is an area of disturbance located north of the Miniature Rifle Range.
- The 1978 aerial photograph shows that the Site appears similar expect that the miniature rifle range has been reconfigured to one large range (stop butt) configured to fire in a southerly direction.
- The 1986 aerial photograph shows the rifle range similar to the current configuration / shape. An area of disturbance is visible on the central part of the Site, which appears to consist of three trenches excavated from west to east (disposal trenches). An area of disturbance is also noted on the north western part of the Site.
- The Site appears similar to the current shape and status. There are what appear to be areas of vegetation clearing (10m transects) across areas of the Site. There is heavy vegetation on the

northern, eastern, southern western and central parts of the Site. The rifle range area is visible as is the disposal trench area on the central part of the Site.

Aerial photographs (of years 1947, 1956, 1961, 1965, 1970, 1978, 1986, 1991, 1994, 1998, and 2002) showing the Sites development are included in Golder 2005.

6.0 CURRENT DEVELOPMENT PROPOSAL

The Site forms part of the Edmondson Park Release Area and was rezoned by an amendment to Liverpool local Environmental Plan 1997 (Amendment No.83).

The Land was previously zoned under Liverpool Local Environmental Plan 1997 and was predominantly rural land. The land was zoned Rural (1e) future urban, rural 1(c) Environment Protection and the Department of Defence owned land was Special Use 5(a) Military.

The land is currently zoned for a combination of urban purposes, residential, commercial, open space and special use zones. A map showing the existing zonings is presented in Appendix A.

The development of Site will consist of four distinct zones (refer to Figure 4) identified as the following:

- **Rural-Residential Zone West (RRZW)** which will consist of up to 14 rural residential lots with a minimum lot size of 4000m^2 and within a total area of around 8.3 ha located along the western boundary of the Site;
- **Residential Zone North of Rail Alignment (RZNRA)** which has an area of about 43 ha and will largely consists of R1 General Residential zone, a school, public open space and Mixed Use development in the town centre zone. The development of this area will be progressive with the Town Centre area and school site developed first followed by the remaining residential areas;
- **Rail Corridor (RC)** has an area of about 6.4 ha, which transects the site from the south eastern corner to the north western corner of the Site. The rail corridor is approximately 60m wide and will be developed by the Transport Construction Authority (TCA) for the South West Rail Link. This corridor also includes a small wedge of land between the proposed town centre and regional park (refer to site ownership plan); and
- **Conservation Zone (Regional Park)** South of Rail Alignment (CZSRA) which has an area about 36 ha and will form part of the Edmondson Regional Park.

The development of the conservation area is part of a conservation agreement (CA) entered into between the Australian Government and NSW Government in 2009.

6.1 Preliminary Development Schedule

The development of the Site will be progressive with the current development schedule generally as follows:

Stage 1 works will consist of:

- The development of the area known as RRWZ;
- Commencement of filling works associated with the area proposed to be occupied by the proposed Town Centre;
- Excavation of lead particulate material from the access roadway along the northern boundary of the proposed low density RZNRA prior to the construction of the South West Rail Corridor; and
- Construction works associated (by other) within the proposed rail corridor.

Stage 2 works will consist of the progressive development of the RZNRA and Town Centre Area.

Stage 3 works will consist of the establishment of the conservation zone and appropriate management protocols.

7.0 SITE CHARACTERISATION

Based on previous investigations and historical information the activities of potential environmental concern were identified as follows.

Table 1: Activities of Potential Environmental Concern

Activity	Area	Contaminants of Concern
Live grenade throwing and rocket propelled grenades (81mm mortars)	Grenade Range	UXO and grenade explosion residues
Miniature (small arms) firing range	Firing range stop butts Roadway where engineered stop butt material was placed Dam 3	Lead particulate and other heavy metals
Possible munitions disposal	Dams 1, 2 and 3	UXO
Waste disposal in trenches	Three burial trenches NE of miniature rifle range Possible additional unknown locations	Unknown, could include heavy metals, petroleum hydrocarbon, pesticides, asbestos, household chemicals
Waste disposal in piles including building rubble	Extreme north west corner of the Site 100m north east of entrance gate South of miniature firing range Two piles on crest of hill north of miniature firing range Potential locations across entire site	Unknown, could include heavy metals, petroleum hydrocarbon, pesticides, asbestos, household chemicals
In-ground structures used for infantry minor tactical training	Known slit trench locations Underground command posts Possible additional unknown locations	Physical objects such as star pickets and corrugated iron Unknown, possible heavy metals (significant contamination would not be expected with this type of material, removal would be desirable for aesthetic purposes)
Infantry minor tactical training	Entire Site, especially near slit trenches	Expended SAA, small percentage of live (unexpended) SAA
Pest and weed control	Entire Site	Pesticides, herbicides, arsenic, mercury
Runoff of contaminants	All waterways on site	Lead particulate primarily Pesticides, herbicides, arsenic, mercury
Building products and treatments	Former buildings and central part of site including rifle range and waste disposal area	Pesticides, asbestos, lead
Storage and distribution of coal	Coal Stockpile	Coal dust Possible PAHs, phenols (significant contamination would not be expected with unburnt coal, however constituent compound shall be tested in underlying soils)
Practice obstacles	Numerous locations	Barbed wire physical hazard

Activity	Area	Contaminants of Concern
Car body disposal and burning	Numerous locations	PAHs, heavy metals, petroleum hydrocarbons
Car body disposal, surface dumping and practice obstacles	Numerous locations	Physical objects including cars and barbed wire Unknown, possible PAHs, heavy metals, petroleum hydrocarbons (significant contamination would not be expected with these types of surface dumping, removal would be desirable for aesthetic purposes)

7.1 Contaminants of Concern

Based on the results of the review of historical information, previous investigations, the SAQP (PB 2004), Site Auditor comments and site inspection, a number of historical and current land uses are considered to have potential to impact soil and/or groundwater within the Site.

The potential contaminants of concern on this Site include:

- Potential UXO;
- Expended and live small arms ammunition (blanks) and grenade explosion residues (including bi-products such as nitrates and phosphates);
- Lead particulate and other heavy metals (arsenic, cadmium, copper, nickel, zinc and mercury);
- Petroleum hydrocarbons (including total petroleum hydrocarbons, benzene, toluene, ethyl benzene, xylenes and polycyclic aromatic hydrocarbons);
- Phenols (in the vicinity of coal stockpiles and residual coal);
- Pesticides and herbicides;
- Asbestos; and
- Unknowns, such as various households type chemicals.

Many of the contaminants of concern are likely to be limited to specific areas as detailed below:

- Grenade Range – UXO and grenade explosion residues;
- Firing range stop butts – lead particulate and other heavy metals;
- Roadways (where excess stop butt material was placed during re-engineering of rifle range) – lead particulate;
- Board of Survey Disposal Trenches (central part of the Site) and potential additional unknown locations – unknown, however, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos and household chemicals;
- Waste disposal piles (including building rubble)– unknown, however, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos and household chemicals;

- Underground command posts and unknown slit trenches – physical objects such as star pickets and corrugated iron, possibly heavy metals;
- Stockpiled Soil across the Site - unknown, however, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos and household chemicals
- Entire Site (Pest Control) – pesticides, herbicides, arsenic, mercury;
- Former Buildings – Pesticides, metals and asbestos;
- Coal Stockpiles – coal Dust, PAHs and phenols;
- Car body disposal / general rubbish – PAHs, heavy metals and petroleum hydrocarbons; and
- Entire Site – expended SAA, with a small percentage of live SAA (including blanks).

8.0 RESULTS AND FINDINGS OF PREVIOUS ASSESSMENT

A Sampling Analysis and Quality Plan (SAQP) was developed by Parsons Brinkerhoff (PB 2004) after a review of available information and consultation with the Site Auditor. The sampling plan consisted of the following three strategies across parts of the Site:

- Proposed Residential Areas were sampled on a 32m grid based pattern;
- Proposed Conservation Area was sampled on a 50m grid based pattern; and
- Judgmental sampling locations were targeted in areas identified as potential higher risk.

Golder Associates implemented a soil sampling program, carried out at 763 sampling locations and consisting test pits, hand auger holes or boreholes between 24 January 2004 and 3 March 2005.

Seven of the ten boreholes were converted to groundwater monitoring wells. Groundwater samples were collected from each of the seven monitoring wells as well as three water samples collected from testpits excavated within the Board of Survey Disposal Pits.

Selected soil and groundwater samples were analysed for the identified contaminants of concern detailed in the DSI report (Golder 2005). The Laboratory Analysis Summary Tables presented in the DSI report have been modified based on the proposed new development and are presented in Appendix D.

It should be noted that the boundaries of the proposed residential and conservation zones have been modified base on the proposed development which has resulted in the sampling frequencies within the proposed Rural – Residential Zone being a combination of sampling points across both a 32m and 50m grid. The variation from the original sampling and investigation rationale (i.e. 32m grid within residential areas) is not considered to be significant given the lack of contamination identified across the larger Site.

The following Sections provide a brief summary of the works and laboratory analysis carried out within the proposed development areas identified in Section 6.0.

8.1 Proposed Rural Residential Zone West (RRZW)

The proposed Rural-Residential Zone West has an area of approximately 8.3ha. The area largely consists of open grasslands with a scattering of small to medium size trees, access roadways, stockpiles of soil and waste material.

A total of 78 sampling points were excavated within the proposed RRZW with selected samples analysed for the contaminants of concern identified in Section 7.1. The majority of laboratory analysis results were below laboratory detection limits and the adopted Site criteria (Residential – NEPM A)

Lead particulate impacted material has been identified within the south western corner, north eastern boundary shared with the rifle range and northern part of the RRZW. The depth of impacted material was observed to range between 0.2m to 0.8m below ground level.

A waste disposal area is present within the north western corner of the area and consists of building demolition, soil and organic matter.

There are several stockpiles within the southern part of the area. These stockpiles were observed to be predominately clean soil.

Based on the results of the contamination investigation within the Residential Areas RRZW, the area is considered suitable for redevelopment as Residential landuse; subject to the recommendations within Section 24 (DSI Report) and further detailed in Section 11.0 relating to lead particulate impacted material, military objects and SAA being adopted.

8.2 Proposed Residential Zone North Rail Alignment (RZNRA)

The proposed Residential Zone North Rail Alignment (RZNRA) has an area of approximately 43ha. The area consists of open grasslands, Cumberland Woodlands and former army infantry training infrastructure such as training pits, obstacles and grenade ranges.

A total of 435 sampling locations were excavated within the proposed Residential Zone North Rail Alignment (RZNRA). Selected samples were analysed for selected contaminants of concern. The results of the laboratory analysis were below the adopted on site criteria (Residential – NEPM A) for all samples except for the following:

- One Sample BH249/3 (0.6-1.05m) exceeded the phytotoxicity criteria of 20 mg/kg (As) with a concentration of 28 mg/kg, however was well below the NEHF (A) criteria of 100 mg/kg;
- The concentrations of total chromium exceeded the phytotoxicity criteria of 1 mg/kg (Cr (VI), however all concentrations were below the NEHF (A) criteria. Given the relatively low concentrations of total chromium, the results are not considered significant. However, five samples were analysed for Chromium VI with all results below laboratory detection limits and the adopted criteria;
- The reported concentration of zinc exceeded the phytotoxicity criteria of 200 mg/kg in three samples (HA140/1, TP469/1 and TP471/2) and were 470, 720 and 810 mg/kg respectively, but were well below the NEHF (A) levels of 7,000 mg/kg; and
- SP6/1 reported the presence of chrysotile asbestos.

Bonded asbestos piping was observed near sampling location No.TP348. General waste associated with military activities such as concertina wire, SAA, star pickets, sheet metal and domestic waste (whitegoods) were observed across several areas of the site as well as in open trenches located on the northern and eastern part of the Site.

Based on the results of the contamination investigation within the Residential Areas RZNRA, the area is suitable for redevelopment as Residential landuse, subject to the recommendations within Section 24 of the DSI relating to lead particulate material, asbestos containing materials, Military objects and SAA being adopted.

8.3 Rail Corridor (RC)

Rail Corridor (RC) has an area of about 6.4 ha. The area consists of a mixture of open grasslands, Cumberland Woodlands and former army infantry training infrastructure such as training pits, obstacles, grenade range and former building structures.

A total of 55 sampling locations were excavated within the proposed Rail Corridor (RC). Selected samples were analysed for selected contaminants of concern. The results of the laboratory analysis were below the adopted on site criteria (Residential – NEPM A) which is conservative given the end land use could be regarded as commercial / industrial.

Lead particulate impacted material was identified within the north part of the RC (north western corner of the Site). The lead particulate impacted material existing within the near surface material used to construct the access roadway and ranges in depths between 0.5 to 0.8m bgl.

Based on the results of the investigation within the proposed Rail Corridor area is considered suitable for redevelopment for Special Land Use (Rail Infrastructure), providing the recommendations within Section 24 of the DSI relating to the lead particulate impacted material and military objects, UXO and SAA are implemented.

Remediation works where required within the RC are being undertaken by TCA as approved under the south west rail Part 3A approval process.

8.4 Conservation Zone

The proposed Conservation Zone South Rail Alignment (CZSRA) is about 36ha in size and encompasses the central and southern parts of the Site. The area consists of a mixture of open grasslands, Cumberland Woodlands and former army infantry training infrastructure such as training pits, obstacles, grenade range, rifle range, disposal trenches and former building structures.

A total of 195 sampling locations were excavated within the proposed CZSRA. Selected samples were analysed for selected contaminants of concern. The results of the laboratory analysis were below the adopted on site criteria for all samples except for the following:

- One Sample HA AS9/1 (0.0-0.1m) exceeded the phytotoxicity criteria of 20 mg/kg (As) with a concentration of 24 mg/kg, however was below the NEHF (E) criteria of 200 mg/kg;
- One Sample TP723/1 (0.0-0.1m) exceeded the phytotoxicity criteria of 3 mg/kg (Cd) with a concentration of 4 mg/kg, however was below the NEHF (E) criteria of 40 mg/kg;
- Eight samples exceeded the exceeded the phytotoxicity criteria of 100 mg/kg (Cu) with a concentrations raging from 110 mg/kg to 410 mg/kg, however was below the NEHF (E) criteria of 2000 mg/kg;
- The concentrations of total chromium exceeded the phytotoxicity criteria of 1 mg/kg (Cr (VI) in all samples, however all concentrations were below the NEHF (E) criteria. Given the relatively low concentrations of total chromium, the results are not considered significant. However, 5 samples were analysed for chromium VI, with all results being below laboratory detection limits and the adopted criteria;
- The reported concentration of zinc exceeded the phytotoxicity criteria of 200 mg/kg in two samples TP704/3 (1.0-0.1m) and TP723/1 (0.0-0.1m) and were 410 mg/kg and 910 mg/kg, but were well below the NEHF (E) criteria of 14,000 mg/kg;
- The reported concentration of lead exceeded the phytotoxicity criteria and open space criteria of 600mg/kg in five samples as follows;
  - Sample TP642/2 (0.1-0.3m) had a reported concentration of 620mg/kg;
  - Sample TP646/1 (0.0-0.1m) had a reported concentration of 1578mg/kg;
  - Sample TP691/4 (2.5-2.7m) had a reported concentration of 1187mg/kg;
  - Sample TP693/1 (0.0-0.2m) had a reported concentration of 1283mg/kg; and
  - Sample TP713/3 (0.3-0.5m) had a reported concentration of 760mg/kg.
- TP599/1 (0.0-0.1m) which had a reported concentration of 5.6 mg/kg benzo(a)pyrene and 43 mg/kg total PAHs and exceeds the criteria of 2 mg/kg benzo(a)pyrene and 40 mg/kg total PAHs;
- Chrysotile asbestos was detected in two soil samples (HA AS3/2, HA AS5/2);
- Chrysotile & amosite asbestos was detected in five board samples (HA AS11/1,HA AS4/1,HA AS5/1, HA AS8/1 & TP723/4); and
- Chrysotile Asbestos was detected in four board samples (HA AS1/1, HA AS2/1, HA AS3/1, HA AS6/1).

Four of the five exceeding samples for lead were collected from the lead particulate material located within the former rifle range. A total of eighty-six samples were collected from the lead particulate material with the calculated 95% UCL (upper confidence level) of 118 mg/kg.

Seven samples were analysed for Toxicity Characteristic Leachate Potential (TCLP) in acidic, saline and deionised water conditions. The results were generally below laboratory detection limits except for lead and

zinc. There are currently no on -site criteria for TCLP, but based on the 95% UCL concentration for lead of 118 mg/kg the material would be classified as General Solid Waste for the purpose of off site disposal. (DECC 2009).

Lead particulate material was observed within the former rifle range, main entrance and access track located within the north western corner and northern boundary of the Site. Based on the information provided in previous reports, the lead particulate material is distributed over an area of about 45,000m^2. Based on the results of this investigation the depths of lead particulate material ranged between 0.1m to 4.5m with an average thickness of about 0.8m. The estimated volume of lead particulate impacted material has been assessed to be approximately 35,000m^3. The lead particulate generally consisted of lead fragments and bullet fragments between 5mm to 10mm in size.

Fragmented pieces of bonded asbestos sheeting was observed on the surface over an area of approximately 25,500m^2 within the rifle range extending to the waste disposal trenches located on the central part of the Site. The area was mapped using a hand held GPS and is shown in Figure 2. The quantity of impacted material has been estimated at about 2,500m^3.

Three Waste Disposal Trenches (Board of Survey Waste Disposal Pits) were investigated by the excavation of testpits through the waste. The buried waste generally consisted of building demolition, scrap metal, plastic, wire and pieces of asbestos sheeting (predominantly within the eastern parts of the trenches). A clay-capping layer of between 0.1m to 0.7m thickness was observed.

Based on the results of the investigation the proposed Conservation area is considered suitable for redevelopment for Open Space Land Use, providing the recommendations within Section 24 (DSI Report) relating to the lead particulate and asbestos impacted material and military objects, UXO and SAA are implemented.

8.5 Groundwater (Entire Site)

Ten boreholes were drilled using a truck mounted drill rig to initial depths of 8.0m. On completion of the ten locations five were dry; subsequently three selected boreholes (BH608, BH640 and BH675) were extended to about 15.0m. On completion of the drilling program seven of the ten locations were observed to have standing water levels of between 46.15 to 54.8m AHD. The remaining three locations were dry on completion.

Monitoring wells were installed and developed in accordance with the SAQP (PB 2004). Subsequently the wells were purged by removing four times the well volume and allowed to recharge over a 24hr period prior to sampling. Indicators parameters were measured in the field during purging and are presented in the DSI report (Golder 2005). Samples were analysed for the contaminants of concern as outlined in PB 2004.

In addition to the samples collected from the seven monitoring wells an additional sample from the perched water within the three Board of Survey Disposal Trenches was collected. Samples were analysed for the same contaminants of concern total for the groundwater samples.

The results of laboratory analysis were below the ANZECC 2000 water quality guidelines in all samples except for some exceedance for selected heavy metals as follows:

- One sample (BH2) exceeded the ANZECC 2000 groundwater guidelines for arsenic of 0,024mg/L with a concentration of 0.12 mg/L;
- All samples exceeded the ANZECC 2000 water quality guidelines of 0.0002mg/L for chromium VI with concentrations for total chromium ranging from 0.008 to 0.012mg/L;
- Three samples (BH294, BH521 and BH608) exceeded the ANZECC 2000 water quality guidelines of 0.0014mg/L for copper with concentrations of 0.003, 0.002 and 0.004mg/L respectively;

- Six samples (BH2, BH294, BH521, BH608, BH640 and BH675) exceeded the ANZECC 2000 water quality guidelines of 0.0034mg/L for lead with concentrations ranging from 0.004mg/L (BH2) to 0.012mg/L (BH675);
- Three samples (BH558, BH640, BH675) exceeded the ANZECC 2000 water guidelines of 0.011 for nickel with concentrations of 0.16, 0.19 and 0.022 respectively; and
- One sample (BH608) exceeded the ANZECC 2000 water quality guidelines of 0.008mg/L for zinc.

The exceeding concentrations of heavy metals in both upgradient and down gradient groundwater monitoring wells indicates that the heavy metals present in the groundwater is largely indicative of the general water quality within the area and not derived as a result of Site activities. Background concentrations of heavy metals are generally known to be elevated within the Wianamatta Group. We consider that the results obtained are within the range typical of Wianamatta Group bedrock and residual soil aquifer.

Seven groundwater and three perched water samples were analysed for PAHs. The reported concentrations were below laboratory detection limits in all samples. However the laboratory detection limits were above the ANZECC 2000 low reliability criteria for benzo(a)pyrene and anthracene. Considering the majority of PAH results in soil were below laboratory detection limits and the appropriate on site landuse criteria it is unlikely that PAHs would impact adversely on the groundwater quality.

8.6 UXO Remediation of REM 1 to REM7

Bactec, under the project management of Golder completed a 100% search and remediation of seven areas identified as REM 1 to REM7. REM 1 to REM 5 were potential UXO areas identified during previous investigations, with REM 6 & REM 7 identified during this investigation.

All areas were subject to a 100% search and remediation of UXO. No live UXO were identified during the remediation, however, nine practice 81mm mortars (REM6) and one training anti tank mine (REM7) were identified during the search of sampling sites.

Bactec, cited in the DSI, have provided clearance certification for the seven areas identified above and these are shown on Figure 6 of the DSI report.

Based on the results of the remediation, there is a low risk that inert UXO items may remain on the Site in the remediated areas. It is important to note that no live UXO have been identified on the Site during this investigation. A review of site history and previous investigations concluded that live ordnance were not commonly used on this site. Therefore the risk of any live UXO remaining on the Site is considered low though not negligible.

8.7 UXO Clearance Investigation

763 contamination investigation sampling sites, consisting of an area of about 2m x 2m were cleared as part of the soil sampling program. A general UXO search was conducted at and between sampling points. Contacts encountered between sampling sites and within the search area were further investigated.

Contacts were generally with the majority of site containing nil contacts. Contacts generally consisted of:

- Scrap metal and sheet metal;
- Steel star pickets;
- Concertina wire or barbed wire; and

- SAA, metal clips and plastic blanks.

During the search of sampling locations contacts between sites were generally consistent with those encountered within the sampling sites except for two locations where a practice 81mm mortar was identified near sampling site 580 (REM6) and a practice anti tank mine (REM7) was located near sampling site TP549. The areas were added to the previously identified UXO remediation areas and a 100% UXO search carried out.

8.8 Metallic Anomalies

As agreed with the Site Auditor a visual inspection was carried out in the areas where metallic anomalies were previously identified with the site observations summarised as follows:

- The larger areas of metallic anomalies were located within the Cumberland Woodlands on the northern, north western, southern and western parts of the Site;
- The areas were generally heavily vegetated; and
- The metallic anomalies appear to coincide with areas of concentrated military activities, such as training pits, concertina wire, former structures, SAA and military obstacles.

A general UXO sweep was carried out using a metal detector generally along the grid system established between sampling points. Contacts were irregularly along the limited search area and where encountered were investigated. No UXO were identified during the general sweep with contacts generally consisting of star pickets, barbed wire, SAA and metal clips.

8.9 Small Arms Ammunition (SAA)

Expended SAA was observed between sampling sites and more generally concentrated within the areas formerly designated as primary infantry training areas. The Site was largely heavily vegetated with grass and woodlands at the time of the investigation, which hindered access.

Considering the quantities of SAA encountered during this investigation it would appear that the estimated average density of expended SAA blanks of 702 contacts /ha across the Site suggested by Milsearch (2002) is appropriate, given the SAA encountered during this investigation.

Based on visual assessment the SAA is concentrated within areas identified as primary-training areas (training pits, military obstacles) located within the northern, south eastern, southern and western parts of the Site. The quantity of SAA based on a review of the previous investigation and current investigation may range from 50 to 2500 contacts / ha (with an average of approximately 700 contacts / ha) within these concentrated areas. The quantity of SAA within the areas outside the primary training areas may range between 5 to 500 contacts / ha (with an average of approximately 250 contacts / ha).

We have discussed our investigation findings with BACTEC (UXO Consultant) and consider that 5 -10% of all SAA used at the site may remain live. We believe this is more realistic than the 2% estimated by Milsearch (2003). There is a risk of non discharged blanks across the site that would have resulted from clearing blockages and replacing magazines during infantry training. Even though current investigations did not encounter un-spent blank ammunition during our investigation, Milsearch (2002) did encounter several live SAA blanks.

Live SAA have not been found during these investigations. No guidance is provided in NSW DECCW guidelines, however indications are that a zero tolerance is adopted for SAA on residential sites. The presence of spent SAA represents a low risk on this site to human health and the environment, though this risk is not negligible. The remedial strategy for this site should incorporate measures to remediate or account for SAA conditions at the site.

9.0 BASIS FOR REMEDIATION ASSESSMENT CRITERIA

9.1 Vested Responsibilities

The primary technical responsibility for the regulatory management of contaminated sites in NSW is held by the Department of Environmental Climate Change and Water (DECCW, formerly the NSW DECC and NSW EPA). This responsibility is vested in the DECCW by the provisions of numerous NSW Acts and Regulations, as well as through various NSW government policies, guidelines and undertakings. In particular, the *Contaminated Land Management Act 1997* (CLM, 1997) specifically addresses the management of contaminated land and establishes a process for investigating and (where possible) remediating contaminated land which represents significant risk of harm to human health of the environment.

The CLM Act provides for the accreditation of auditors to ensure appropriate standards of managing contaminated land. The accreditation and responsibilities of a site auditor are detailed in the *Guidelines for the NSW Site Auditor Scheme* (NSW DEC 2006). In auditing a site, the auditor is required under the CLM Act to have due regard to the guidelines endorsed by the DECCW.

The adopted Assessment Criteria for Soils is presented in below.

Table 2: Assessment Criteria - Soils

	Threshold Concentrations for Soils		
Contaminant	**Residential with Accessible Soils (mg/kg)[1]**	**Parks and Open Space (mg/kg) [2]**	**Provisional Phytotoxicity Criteria (mg/kg)[3]**
Heavy Metals			
Arsenic	100	200	20
Cadmium	20	40	3
Chromium (III / VI)	120,000 / 100	240,000 / 200	400 / 1
Copper	1000	2,000	100
Mercury	15	30	1
Nickel	600	600	60
Lead	300	600	600
Zinc	7,000	14,000	200
Total Petroleum Hydrocarbons			
$C_6 – C_9$	65 [4]	65 [4]	-
$C_{10} – C_{36}$	1,000 [4]	1,000 [4]	-
$>C_{16} – C_{35}$ (Aromatic)	90	180	-
$>C_{16} – C_{35}$ (Aliphatics)	5,600	11,200	-
$> C_{35}$ (Aliphatics)	56,000	112,000	-
Monocyclic Aromatic Hydrocarbons			
Benzene	1 [4]	1 [4]	-
Toluene	1.4 [4]	1.4 [4]	-
Ethylbenzene	3.1 [4]	3.1 [4]	-
Total Xylene	14 [4]	14 [4]	-
Polycyclic Aromatic Hydrocarbons			
Total	20	40	-
Benzo(a)pyrene	1	2	-
Polychlorinated biphenyls	10	20	-
Phenols (Total)	8,500	17,000	-

	Threshold Concentrations for Soils		
OC Pesticides			
Aldrin + Dieldrin	10	20	-
Heptachlor	10	20	-
Chlordane	50	100	-
DDT + DDD + DDE	200	400	-
Asbestos	No respirable fibres in surface soil		

Notes:

1. Assessment Criteria based on the NSW EPA Guidelines for the NSW Site Auditor Scheme (2006) – NEHF A / Column 1
2. Assessment Criteria based on the NSW EPA Guidelines for the NSW Site Auditor Scheme (2006) – NEHF E / Column 3
3. Assessment Criteria based on the NSW EPA Guidelines for the NSW Site Auditor Scheme (2006) – Provisional Phytotoxicity Criteria;
4. Assessment Criteria based on the NSW EPA Guidelines for Assessing Service Station Sites (1994).

9.2 Review of Similar UXO/ SAA Sites

To provide recommendations regarding the Remedial measures for the site, it is appropriate to assess the remedial strategies adopted at similar sites elsewhere in NSW, Australia and internationally.

There are currently no published criteria for live UXO and SAA in NSW or Australia. In 1987 the Auditor General tabled a report in Federal Parliament expressing concerns with the policy and departmental procedures of the Department of Defence (Defence) in relation to:

- The identification and recording of UXO;
- Its policy for dealing with affected areas; and
- The procedures for clearing contaminated land.

In response to the Auditor General's comments Defence issued the "Commonwealth Policy on the Management of Land Affected by Unexploded Ordnance" (November 1990). However this document did not resolve the issues of procedures for technical search and remediation guidelines to authorities outside Defence.

The "Protocol for the Health Risk Assessment and Management of Contaminated Sites" (1991) and the "Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites" (ANZECC 1992) jointly created a language and a procedural framework on which to formulate suitable assessment processes and management strategies for all forms of contamination, including UXO. However neither document addresses UXO directly and consequently the assessment and remediation of UXO / SAA in NSW have been addressed on a site specific basis since that time.

Previous experience has shown that the NSW DECCW has adopted a zero tolerance approach to UXO / SAA in residential areas. Research carried out on international guidance on live UXO remediation indicates that there is no consensus approach. In the US, the approach adopted is a site specific assessment, though zero tolerance is recommended. It is therefore concluded that a zero tolerance approach to live UXO / SAA should be adopted in the remediation of proposed residential areas of this site, as this is a conservative remedial strategy. The methodology of removing UXO / SAA is not covered in Australian guidance, and therefore the methodology options will be discussed later within the remedial strategy.

The redevelopment of sites with UXO / SAA for residential purposes involves the removal of all SAA from the Site. The mechanism by which, this occurs is either by remediation prior to development or by a condition on

the Site Audit Statement, which requires that SAA remediation (removal) be undertaken prior to development of individual residential blocks.

Golder has completed a review of available information and provides the following points:

- There is currently no specific guidance provided by NSW DECCW regarding the remediation of sites with UXO or SAA. The remediation of such sites has typically been agreed with local council, DECCW and appointed Site Auditors on a case by case basis;
- There have been no other similar developments within Australia for low density residential developments and more specifically in NSW where SAA have been present, that have been allowed to proceed until the SAA has been remediated (i.e. removed). That is the local council and DECCW have adopted a zero tolerance on the presence of SAA blanks or otherwise. This is the case more notably for the Delfin Lendlease development at St Marys (a former Department of Defence site);

  There is currently a proposed development of former Department of Defence land known as Stockton Rifle Range, Popplewell Road Fern Bay NSW. The Site is proposed to be developed for mixed land uses including low density Residential. Based on a review of a Site Audit Statement prepared by Dr Ian Swain of Sinclair Knight Mertz (SKM), Dr Swain considered that the Site could be made suitable subject to the implementation of the RAP prepared which included the removal of UXO;
- There have been similar developments in the USA and UK where former rifle ranges (including ammunition dumps) were redeveloped for residential and commercial use. However, public domain information indicates that the sites tend to be assessed on a site specific basis and that the sites were cleared of UXO / SAA prior to each development proceeding. The methodology of such clean up has varied and is there does not appear to be an accepted universal methodology due to the variety of UXO / SAA encountered and the variability of the sites in which they are found;
- Golder have been involved with the redevelopment of a site at Williamstown (Victoria) which was developed as low density residential, subject to a Site Audit condition made by the Site Auditor that each lot required a 100% UXO search and removal of the SAA prior to the construction of the residential developments.

10.0 REMEDIATION OPTION SELECTION RATIONALE

10.1 Remedial Goals

The Site is to be redeveloped for residential and open space (conservation) landuse. The remediation goal for the Site is to:

- Complete remediation and validation works such that the land is rendered suitable for the proposed residential and open space (conservation) landuses;
- Verify that there are no unacceptable off-site impacts at the Site during or following remediation; and
- Ensure that the remediation works are conducted safely so as to protect on-site workers, and the public.

10.2 Decision Making Rationale

The appropriate remedial strategy for the site should ensure that the remediation goals be achieved. However, there are likely to be different options for the remediation of the AOC's, each of which may be feasible. It will therefore be necessary to identify the preferred remediation strategy which provides the most efficient remediation. To achieve this, a decision making process is required to enable differentiation of different options. Therefore the following factors have been adopted to assess the relative merits of potential remedial options:

- Technical feasibility;
- Environmental impact;
- Relative cost benefit; and
- Ongoing maintenance requirements

From assessment of these issues, qualitative comparative analysis will be carried out. This is undertaken using the following decision making matrix:

	Decision Making Rating		
Decision Making Parameters	***High Rating***	***Medium Rating***	***Low Rating***
Technical Feasibility	Technically feasible remediation resulting in fit for purpose site suitability	Technically feasible remediation, requiring additional remedial supplementary measures or constraints on landuse	Not technically feasible for remediation of contaminant hazard
Environmental Impact	Creates minimal environmental impact both on site and offsite (flora, fauna, waste, life cycle impacts, sustainability impacts)	Creates adverse environmental impact either on site or offsite (flora, fauna, waste, life cycle impacts or sustainability impacts)	Creates adverse environmental impacts on site and offsite (flora, fauna, waste, life cycle impacts and sustainability impacts)
Relative Cost Benefit	Least expensive capital cost (or within 20% of the least expensive technically feasible option)	Intermediate capital cost	Most expensive capital cost (or within 20% of the highest technically feasible option)
Ongoing Maintenance	No maintenance required	Maintenance required, no ongoing environmental capital cost, not requiring expert environmental consultancy input	Maintenance required, ongoing environmental capital costs incurred, expert environmental consultancy required

It is important to note that in discussion of remedial strategy, there may be some decisions which are made on the basis of a single parameter. For example, if there is a single technically feasible option for a particular area of concern, then the other factors (such as environmental impact, relative cost benefit and ongoing maintenance) are irrelevant to the selection of remedial strategy. Consequently not all of these parameters need be assessed in each instance. However where multiple parameter decision are required, the above table will be used as the appropriate guidance.

It is also noted that the proposed location of the rail alignment could change during the development planning stages (i.e. prior to development site preparation). However it is understood that the rail alignment would only move to the north, and not encroach within the currently proposed open space parkland area. Therefore the remedial solutions indicated within this RAP represent conservative remedial options as they will be based upon a more conservative landuse (residential) remedial criteria than that required of open space parkland.

Technical Feasibility

The most critical issue in the remedial strategy is that the technique be technically feasible. Unless the remedial strategy provides definitive remediation, it is of limited value, and will create environmental risk both during remediation and on an ongoing basis in the future. The technical feasibility assessment must enable that the remediation goals are met. The feasibility should be based on present technology and provide proven remedial success on similar issues.

Environmental Impact

The remedial strategy should be integrated with the ongoing environmental management requirements of the site. The intended use of the site is for residential and open space/ conservation landuse. The remedial strategy should not compromise the current or the ongoing environment. Consequently, the existing environment in the proposed open space area should be maintained to the extent practical. It is acknowledged that the environment in the proposed residential area will be impacted by the development, however the remediation activities in this area should complement the proposed development activities.

For a remedial strategy to be appropriate, it should also incorporate the principals of the *Waste Avoidance and Resource Recovery Act 2001* (WARR). The WARR documents the NSW DECCW waste management hierarchy and reinforces waste avoidance as the primary goal in resource management. Disposal to landfill is regarded as the least favourable strategy. The most favourable strategy is resource recovery, including re-use, reprocessing or energy production. Accordingly, in the case of the site, disposal to landfill should be avoided if this is compatible with the other selection criteria (technical feasibility, relative cost benefit and ongoing maintenance requirements).

Another object of the WARR act is to ‘assist in the objectives of the Protection of the Environment Operations Act, 1997’ (PoEO). The main objective of the PoEO is to reduce risk to the human health and prevent the degradation of the environment.

Relative Cost Benefit

The remedial options should be assessed in terms of the qualitative costs which are likely to be incurred. These costs are not quantified within this document, but are assessed in relative terms to determine most expensive and least expensive remedial options. The cost benefit assessment will also take account of ongoing maintenance costs, in addition to initial capital costs.

Ongoing Maintenance Requirements

Ongoing maintenance required as part of the remedial strategy should be minimised. However it is acknowledged that in certain instances it may be preferred to accept some ongoing maintenance if this provides benefits to the other selection criteria.

10.3 Remediation Criteria

As stated in the Auditor approved SAQP (PB 2004) to assess the significance of contamination detected in the soil and groundwater during the investigation, it is necessary to define the concentrations to be used for comparison. Golder understands that the proposed land use is comprised of a combination of low density residential landuse, low density residential landuse with special conservation zoning, and open space parkland (conservation area).

In accordance with the recommendations of the Auditor Guidelines and Section 105 of the CLM Act, the analytical results for soil samples collected during the previous investigation conducted at the Site have been evaluated against the following guidelines:

- National Environmental Protection Council (NEPC), *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) 1999, Schedule B(1) Table 5-A, Guideline on the Investigation Levels for Soil and Groundwater;
- NSW Department of Conservation (NSW DEC) 2006), *Guidelines for the NSW Site Auditor Scheme 2nd Edition*; and
- NSW Environment Protection Authority (NSW EPA) (1994), *Guidelines for Assessing Service Station Sites*, December 1994.

NEPM

The NEPM is published by the National Environment Protection Council and presents a nationally consistent policy framework for site contamination assessments. The purpose of the NEPM is to establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, land owners, developers and industry. Schedule B (1) of the Measure provides Guidelines on the Investigation Levels for Soil.

The NEPM defines an Investigation Level as the concentration of a contaminant above which further appropriate investigation and evaluation will be required (ANZECC / NHMRC Guidelines 1992).

The Investigation Levels considered are health based (HILs). We have used the HIL Setting A for proposed residential areas and HIL Setting E for proposed open space areas (conservation zone) for interpretation of the results in this DSI investigation, and are proposed for the remedial and validation works. The selection of these levels is based on the present and potential future use of the Site. These guidelines are the same as the NSW DEC Auditor's guidelines and endorsed by the DECCW for use in NSW.

NSW EPA Service Station Guidelines,

Currently there are no nationally endorsed criteria for the assessment of petroleum hydrocarbons. Therefore we have adopted the NSW EPA's Service Station Guidelines as a screening criteria for TPH and BTEX.

The Service Station Guidelines specify "Threshold Concentrations for Sensitive Land Use- Soils" for C_6-C_9 and C_{10}-C_{36} fractions, benzene, toluene, ethyl-benzene, total xylenes (BTEX).

As documented within Section 9.2, there are no accepted criteria for UXO and SAA remediation in NSW. The remedial approach will be to remove UXO and SAA from the site in a fit for purpose based remedial strategy, which adopts a conservative approach consistent with guidance from NSW DEC on contamination assessment and remediation.

11.0 REMEDIATION AREAS OF CONCERN (AOC)

The DSI report (Golder 2005) has identified from the site history and results of the site investigation, the following Areas of Concern (AOC's), currently considered to apply to the Site:

- AOC1 - Military Items (concertina wire, obstacle course, etc.);
- AOC2 - UXO and SAA (Residential, Commercial and Special Use Areas);
- AOC3 - UXO and SAA (Conservation Areas);
- AOC4 - Lead impacted soils;
- AOC 5 - Asbestos containing materials;
- AOC6 - PAH contaminated soil; and
- AOC7 - Waste disposal pits

11.1 Military Items (AoC1)

General waste associated with military activities such as concertina wire, SAA, star pickets, sheet metal and domestic (white goods) were observed across several areas of the proposed Residential Zone North Rail Alignment (RZNRA) as well as in open trenches located on the northern and eastern part of the Site.

Three Waste Disposal Trenches (Board of Survey Waste Disposal Pits) were identified on the central portion of the Site. The trenches were about 3.5m deep, consisting of buried waste including building demolition, scrap metal, plastic, wire and pieces of asbestos sheeting (predominantly within the eastern parts of the trenches). A clay capping layer of between 0.1 m to 1.0 m thickness was observed.

A waste disposal area in the north west corner of the Site was identified in the DSI report. The volume of fill in this area is anticipated to be approximately 750m^3.

Stockpiles of clean fill material were identified in the DSI report across the entire Site.

11.2 Small Arms Ammunition in Residential Area (AoC2) and Conservation Area (AoC3)

Expended SAA was observed between sampling sites and more generally concentrated within the areas formerly designated as primary infantry training areas. Based on visual assessment the SAA is concentrated within areas identified as primary training areas (training pits, military obstacles) located within the northern, south eastern, southern and western parts of the Site. The quantity of SAA based on a review of the previous investigation and current investigation may range from 50 to 2500 contacts / ha (with an average of approximately 700 contacts / ha) within these concentrated areas. The quantity within the areas outside the primary training areas may range between 5 to 500 contacts / ha (with an average of approximately 250 contacts / ha).

11.3 Lead Particulate Material (AoC4)

Lead particulate associated with the former rifle range was observed adjacent to the main entrance and the eastern boundary of the proposed Residential Zone South West Corner (RZSWC).

Five sampling locations were identified in the Conservation Zone which exceeded the phytotoxicity criteria and open space criteria for lead [samples TP642/2 (0.1-0.3m), TP626/1 (0.0-0.1m), TP691/4 (2.5-2.7m), TP693/1 (0.0-0.2m) and TP713/1 (0.3-0.5m)].

Lead particulate material was observed within the former rifle range, main entrance and access track located within the north western corner and northern boundary of the Site. Based on the information provided in previous reports the lead particulate material is distributed over an area of about 45,000 m^2. Based on the

results of this investigation the depths of lead particulate material ranged between 0.1 – 0.45m. The estimated volume of lead particulate impacted material has been assessed to be about 35,000 m^3. The lead particulate generally consisted of lead fragments and bullet fragments between 5mm to 10mm in size.

11.4 Asbestos Containing Material (AoC5)

Bonded asbestos piping was observed near sampling location No 348. Fragmented pieces of bonded asbestos sheeting were observed on the surface over an area of about 25,500 m^2 within the rifle range extending to the waste disposal trenches located on the central part of the Site. This area has been mapped using a hand held GPS unit, and has been included in Figure 2 of this report. The quantity of impacted material has been estimated at about 2,500 m^3.

Chrysotile asbestos was detected in three samples (SP6/1, HA AS3/2, and HAAS5/2).

Chrysotile & amosite asbestos was detected in four samples in the Conservation Area (HA AS11/1, HA AS5/1, HA AS8/1, and TP723/4).

11.5 PAH Impacted Material (AoC6)

TP599/1 (0.0-0.1m) located in the Conservation Zone reported a concentration of benzo[a]pyrene of 5.6 mg/kg, and total PAHs of 43 mg/kg, which exceeded the adopted criteria of 2 mg/kg and 40 mg/kg respectively.

11.6 Buried Waste – Board of Survey Disposal Pits (AoC7)

Buried waste material was identified in three burial trenches (Board of Survey Disposal Pits) consisting of building demolition, scrap metal, machine parts, furniture, filing cabinets and asbestos containing fibro sheeting.

11.7 Other Issues

11.7.1 Stockpiled Material

Stockpiled material was identified across the Site during the DSI report. The stockpiles varied in size, and were reportedly clean fill material and topsoil with the exception of SP13, and the material located in the waste disposal area in the north western corner of the Site.

11.7.2 Blackberries

Areas within the Site were identified in the DSI as containing substantial blackberry infestations. As Blackberry is a noxious weed, and slashing of these shrubs is prohibited, and these areas were not able to be investigated for UXO and SAA. It is recommended that the areas of blackberry infestation be suitably cleared and investigated prior to undertaking of remedial works. This area comprises approximately 1.3 hectares and the distribution of these areas is shown on Figure 2. If it is not possible to investigate these areas prior to remedial works, then a conservative approach should be adopted which assumes UXO and SAA clearance is required in these areas.

11.7.3 Potential Live Rounds

The site was occupied as a rural area prior to becoming part of the defence land in 1940. Documentation reviewed by others as part of previous investigations identified that the ammunition used at the Site during military exercises were “blank rounds”. No documentation of live firing exercises was recorded other than within the rifle range area. It is unlikely that live fire exercises (external to the rifle range) were conducted on the Site due to the close proximity to living quarters, and the requirement for a 2.5km boundary for live rounds to be used. However, it cannot be guaranteed that the use of live ammunition has never occurred at the Site, and that the potential of live rounds being present onsite does not exist. Former land owners, community members and off duty soldiers with access to the land may have used live rounds at the Site over the sites history.

12.0 DISCUSSION OF REMEDIAL OPTIONS

The options discussed in this section have been identified based on technical feasibility, a qualitative assessment, and their impacts on the environment, the community, ongoing risk at the Site, and ongoing maintenance and management of the Site.

12.1 Military and General Waste (AoC1)

The Military items other than UXO and SAA and general surface waste was observed across a wide area at the site and contains a variety of surficial waste materials including concertina wire, metal training obstacles and former military structures such as training pits.

12.1.1 Preferred Remedial Option AoC1

Due to the variety of the materials and their surficial nature, the most efficient remedial option would be to collect the materials, and dispose of this offsite. It is not technically feasible to treat these materials (such as concertina wire and metal objects) on the site, and consequently the principal determinant in the remedial selection is the technical feasibility. Assessment of issues of environmental impact and relative cost benefit would be little relevance for such a relatively small volume of material. Additionally, the disposal of this material offsite would not require ongoing maintenance of these materials on the site. Therefore offsite disposal of this material is the preferred remedial option.

Table 3: Summary of Remediation Selection Rating Criteria – AOC1

	Technical feasibility	**Environmental impact**	**Relative cost benefit**	**Ongoing maintenance**
Soil Treatment	Low	High	Low	High
On Site Re-Engineering and Sealing	High	Medium	High	Medium
Offsite Disposal	High	Medium	High	High

The location of the areas observed to contain military and general wastes (AoC1) are shown on Figure 3.

Prior to the commencement of any other remedial works, a technical specification for the work should be formulated. Then the site is to be subjected to a visual inspection and removal of all military associated objects such as concertina wire, training pits, former structures / concrete slabs, general rubbish, scrap metal and asbestos piping. This activity is to be completed by a suitably qualified sub-contractor. If any asbestos containing material is found during the clean up process, it is to be removed in accordance with NSW WorkCover requirements.

As this option involves the removal of these materials from the site, no contingency measures are necessary as the materials are suitable for offsite disposal. If additional material is encountered during remedial or site clearance works, the same methodology provided herein should be applied. The excavated pits may require backfill with either imported fill or re-engineered soils from elsewhere on the site. The replacement soils should be suitable for the proposed landuse of the Site (i.e. either DECCW approved residential or open space criteria, as appropriate).

Stockpiles have been tested during the DSI and can be disposed offsite. Stockpile materials could alternatively be re-used on site provided that they have been tested (at frequency specified in Section 14.0) and demonstrated as suitable for use on the site appropriate to the proposed landuse.

Stockpiles of coal have been encountered in the area of the small arms firing range and in the east corner of the site (CZSRA). The coal is not considered as a waste as it has considerable resource value, and is not

considered as a contaminant as it is a naturally occurring rock material. The coal shall be removed from the site, and the base of the former stockpiles validated by visual assessment.

Alternative remedial options may be considered and could be adopted, but only following liaison and agreement with Landcom and the Site Auditor.

12.2 UXO and SAA in Residential Areas (AoC2) and Conservation Area (AoC3)

The remediation of UXO and SAA in the proposed residential areas and conservation area involves the incorporation of a complete clearance and visual clearance in lower risk areas, as this is understood to represent the policy adopted within Australia and international for similar sites. However the methodology of the UXO/SAA clearance is not stipulated in either Australian or international guidance. Therefore there are a range of possible methodologies which could be considered for the site. However, only the options which enable complete clearance suitable to provide a site fit for purpose (i.e. suitable for the proposed land use) have been considered here. Consequently the discussion of risk based UXO / SAA clearance has not been considered within low density residential areas, as these involve the statistical evaluation of UXO / SAA to be left on site, which would not meet with the remediation goals adopted for this project.

The principal constraint in the implementation of complete UXO / SAA clearance at this site is the requirement for vegetative reduction necessary to enable complete access with UXO detection equipment. It is understood that complete vegetative clearance in the conservation zone would be counter-productive, in that it would destroy the Cumberland Woodland which is the primary element of conservation in the proposed parkland. Consequently, we have provided three options for UXO / SAA clearance which are technically feasible, but which have varying degree of environmental impact and ongoing maintenance.

Proposed Strategies

Based on the review of previous investigations and current investigation the proposed strategies for Small Arms Ammunition and associated risks to Landcom are as follows;

Option 1 – Adopt Zero Tolerance of SAA within Proposed Residential Areas and Removal of Visual SAA and Military Objects from Conservation Areas

Description of Task	Remediation Risks	Residual Risks Following Remediation Implementation
Task One Approval of Option One by Site Auditor and Local Authorities	Risk that Site Auditor and Local Authorities will not agree with proposed strategy within the conservation areas.	Possible Site Audit Condition within conservation area, subject to NPWS, DECCW and local government agreement
Task Two Visual inspection and removal of military objects such as concertina wire, star pickets, training pits, general rubbish, site obstacles	Potential harm to Site visitors and trespassers. Aesthetic appearance of the Site.	Low – medium risk of UXO / SAA being present in the conservation area
Task Three Vegetation Reduction Residential Areas Only	NPWS will be required to approve the vegetation reduction of Cumberland Woodlands. We understand NPWS has given in principal agreement to clear areas within Residential Zones	If approved by NPWS there is the potential for complaints and objections by local residents and local Councils.
Task Four Complete Search and remediation of UXO / SAA within Residential Areas	Areas exceeding 250 items/ha not able to be assessed with clear certainty, therefore quantity of areas requiring search and remediation not clear.	UXO / SAA risk removed from low density residential areas (i.e. low risk). Where vegetation reduction has not been completed as within conservation areas UXO / SAA may be encountered if vegetation is disturbed at a later date.
Task Five Visual Search and remediation of observed UXO / SAA – Conservation Zone	Potential harm to Site visitors and trespassers. Aesthetic appearance of the Site.	UXO / SAA may be encountered during disturbance within conservation area after remediation
Task Six Certification and Sign off by Site Auditor	Auditor may impose Site Audit Conditions on conservation zone.	Subject to Site Audit Conditions and notices issued by DECCW and local authorities within conservation zone.
Option Evaluation Criteria		Technical feasibility – High rating Environmental impact – Medium rating Relative cost benefit – High rating, Ongoing maintenance – Medium rating

Option 2 – Adopt Zero Tolerance of SAA within the Site.

Description of Task	Remediation Risks	Residual Risks Following Remediation Implementation
Task One Approval of Option Two by Site Auditor and Local Authorities	Most conservative strategy, most likely to be accepted by regulators based on UXO / SAA considerations	SAA Risk removed from Site (i.e. low risk)
Task Two Visual inspection and removal of military objects such as concertina wire, star pickets, training pits, general rubbish, site obstacles	Potential harm to Site Visitors and trespassers. Aesthetic appearance of the Site.	Low risk of SAA being present on the Site
Task Three Vegetation reduction across all areas	NPWS will be required to approve the vegetation reduction of Cumberland Woodlands. Major uncertainty with approval by for vegetative reduction within Conservation Zone due to environmental impact.	If approved by NPWS the is the potential for complaints and objections by local residents and local councils.
Task Four 100 % search and remediation of UXO / SAA	Low – medium risk of UXO / SAA being present on the Site	UXO / SAA Risk removed from Site (i.e. low risk)
Task Five Certification and sign off by Site Auditor	Auditor may impose Site Audit conditions.	UXO / SAA Risk removed from Site (i.e. low risk) Unlikely that Site Audit conditions regarding SAA will be imposed
Option Evaluation Criteria		Technical feasibility – High rating Environmental Impact – Low rating Relative cost benefit – Medium rating Ongoing maintenance – High rating

***Option 3*– Adopt a Zero Tolerance of SAA within Proposed Residential Areas, removal of visual military objects and clear areas of SAA when and as required in the Conservation Area**

Description of Task	Remediation Risks	Residual Risks Following Remediation Implementation
Task One Approval of Option 3 by Site Auditor and Local Authorities	Risk that Site Auditor and Local Authorities will not agree with proposed strategy. Potential extensive delays justifying option to stakeholders	UXO / SAA Risk removed from Site (i.e. low risk) in residential areas, however risk of conservation areas remaining uncleared for a longer period of time
Task Two Visual inspection and removal of military objects such as concertina wire, star pickets, training pits, general rubbish, site obstacles – Residential zone	Potential harm to Site visitors and trespassers. Aesthetic appearance of the Site.	Low – medium risk of SAA being present on the Site
Task Three Vegetation Reduction Across Residential Areas Only	NPWS will be required to approve of vegetation reduction of Cumberland Woodlands. We understand NPWS has given in principal agreement to clear areas within Residential Zones	Potential for complaints and objections by local residents and local councils.
Task Four Complete Search and remediation of UXO / SAA within Residential Areas.	Low – medium risk of SAA being present on the Site	UXO / SAA Risk removed from low density residential areas (i.e. low risk). Where vegetation reduction has not been completed as within conservation areas UXO / SAA may be encountered if vegetation is disturbed at a later date.
Task Five Certification and sign off of Residential Areas by Site Auditor	Auditor may impose Site Audit Condition.	UXO / SAA Risk removed from Site (i.e. low risk)
Task Six Visual inspection and removal of military objects such as concertina wire, star pickets, training pits, general rubbish, site obstacles – Conservation zone, as required	Potential harm to Site visitors and trespassers. Aesthetic appearance of the Site.	Low – medium risk of UXO / SAA being present on the Site
Task Seven Clearance of areas of Conservation zone of UXO / SAA with a complete search, as required	Low – medium risk of UXO / SAA being present on the Site	Although it has been assessed as a low risk, until the task is completed there may still be potential for live SAA located Conservation Areas.
Task Eight Certification and sign off of Conservation Areas by Site Auditor	Auditor may impose Site Audit conditions.	UXO / SAA Risk removed from Site (i.e. low risk)
Option Evaluation Criteria		Technical feasibility – High rating Environmental impact – Low rating Relative cost benefit – Medium rating Ongoing maintenance – Medium rating

12.2.1 Preferred Remedial Option AoC2 and AoC3

The preferred remedial solution for the UXO / SAA is controlled by the environmental impact issue. The complete clearance of UXO / SAA over the entire site area would involve vegetation clearance. This would negate the purpose of providing an open space / conservation area and consequently complete vegetative clearance within this area is not possible. For this reason alone**, Option 1** is the preferred option (i.e. complete clearance within the residential areas and visual clearance within the conservation area). This option is also the higher rating in terms of relative cost benefit.

Table 4: Summary of Remediation Selection Ratings – AOC 2 and AOC 3

	Technical feasibility	**Environmental impact**	**Relative cost benefit**	**Ongoing maintenance**
Option 1	High	Medium	High	Medium
Option 2	High	Low (Limiting Factor – option unacceptable)	Medium	High
Option 3	High	Low (Limiting Factor – option unacceptable)	Medium	Medium

This option provides a workable remedial strategy with low risk of ongoing Site Audit Condition commitments within residential areas, providing a residential site clear of SAA. This option does not involve the destruction of Cumberland Woodland in the conservation zone. Consequently, this option is preferred on the basis of technical feasibility, cost benefit and environmental impact.

This preferred option does require some limited ongoing maintenance issues, and does allow for some residual risk (which is discussed in Section 12.11), though this is judged to be low.

The technical specification for the UXO / SAA remedial project should require that only contractors suitably approved for such clearance work by Department of Defence shall be considered.

12.2.2 Methodology for Preferred Remedial Option AoC2and AOC3

Considering our review of available information, current investigation results it is likely that the Local Council, DECCW and Site Auditor will require justification that the SAA can remain on the Site. The preferred strategy at this point would be to recommend Option 1, on the basis that it meets the requirements of technical feasibility and environmental impact. The issues of ongoing maintenance are discussed within the section on Residual Risk (refer to Section 12.11). The key elements of the remedial strategy include the following:

1. Remediate the site of all surface military objects such as concertina wire, star pickets, training pits, scrap materials, obstacles, etc from all areas of the site by visual inspection;

2. Conduct a complete shallow search of the low density residential areas after vegetation clearance using a Minelab F3 Detector (or similar). The search will be carried out within 100m x 100m grid, and these grids will be used for validation (as described below). On completion of remediation a UXO/SAA clearance certificate will be issued for low density residential areas; and

3. Conduct a visual walk over on a grid based pattern to remove visual SAA within the Conservation Zone (a 100% search would require destruction of the Cumberland woodland habitat and is unlikely to gain approval). As vegetation cannot be cleared, the visual search will be conducted to the extent practicable).

4. Undertake validation of 100m x 100m grids. This will involve a 10% check of both complete and visual UXO/SAA clearance. If the validation checks encounter UXO/SAA, then the 100m x 100m grid square clearance shall be repeated.

Alternative remedial options may be considered and could be adopted, but only following liaison and agreement with Landcom and the Site Auditor.

Prior to implementing the UXO / SAA remediation strategy, a technical specification for the work should be prepared. Subsequent to commencement of remedial works, a visual inspection will be carried out across the site and removal of military objects such as concertina wire, star pickets, training pits, general rubbish and site obstacles would be required. Subsequently the methodology used within Residential Areas and Conservation Areas will be implemented, as follows:

Residential Areas (AoC2)

After the visual inspection and removal of military objects other than SAA, residential areas will undergo vegetation reduction, following the issue of a Section 91 permit by NPWS. The vegetation within each area will be reduced to a height of not more than 0.1m in height to enable a metal detector search to be conducted.

The area will then be subjected to a shallow metal detector search to locate and remediate all SAA and UXO within the area. As the ordnance used on the site did not have a significant penetrating capability and therefore shallow search using metal detectors is the recommended search technique. The penetration depth of the metal detector is a minimum of 300 mm. and would be suitable for the SAA and ordnance items expected to be encountered on these sites. The metal detector search will be carried out using the following methodology:

- The areas will be divided into workable blocks (100m x 100m) and the boundaries positions marked by differential GPS;
- Two 2-man teams will be utilized to search each block using Minelab F3 Detectors (or similar) with a line spacing of 1 metre;
- All targets identified during the search to be investigated, documented and removed;
- In the event of any live ordnance found would be marked in accordance with the (UXO) Standard Operating Procedures. The relevant Department of Defence personnel and the client would be advised of any UXO finds for the appropriate action or removal of such items. The UXO Site Manager would stay with the UXO until the item is handed over to the appropriate authorities;
- All Free From Explosive (FFE) and Explosive Ordnance Waste (EOW) located in the sampling areas would be certified, stowed securely near the site for removal from the site appropriately disposed;
- Validation of the search will be carried out by 10% search of individual 100m x 100m blocks. Where UXO / SAA contacts are encountered during validation, the original search of the 100m x 100m block shall be repeated; and
- Preparation of a report detailing the methodology, results, validation and certification of the residential areas being free of SAA and UXO.

Conservation Zone (AoC3)

After the visual inspection and removal of military objects other than UXO / SAA the conservation area will undergo a visual search and limited UXO/SAA remediation. The methodology to be used for the visual search and limited UXO/SAA remediation will consist of:

- The areas will be divided into workable blocks and the boundaries positions marked with the DGPS. The area will be subsequently divided further into lanes of about 5 to 10m wide (dependent on team size);
- Four to six man teams will walk shoulder to shoulder (about 0.5m spacing between each man) the length of the search area;
- All visually encountered UXO / SAA will be collected, stockpiled and disposed of to an appropriate landfill;
- Any live ordnance encountered will be managed in accordance with standard operating procedures;
- Validation of visual searches are by means of 10% validation check of 100m x 100m blocks. UXO / SAA contacts encountered during the 10% validation will require the repeating of the original search of the 100m x 100m block; and
- Preparation of a report detailing the methodology, results, validation and certification that the conservation area is free of visual UXO / SAA.

Alternative methodologies, meeting the design intent, must be agreed with the environmental consultant and the Site Auditor.

As a complete SAA search requiring vegetation reduction of environmentally sensitive areas is not proposed as part of this methodology and as such SAA could remain within the subsurface profile. Subsequently a site management plan would be required to manage any ground disturbance within the area and to make stakeholders aware of potential for UXO / SAA at the site and would likely include UXO clearance prior to future ground penetration.

12.3 Lead Impacted Material and Asbestos Containing Material (AoC4 and AoC5)

Based on the results of the DSI investigation in relation to the lead particulate material, the 95% UCL is below the onsite criteria, however, the TCLP testing indicates potential for lead to be leached and therefore poses a low risk of future impact on the surrounding soil and groundwater.

ACMs were identified over several parts of the Site. The ACM was predominantly fractured pieces of fibro sheeting located on the surface of the central / southern part of the Site and within the Board of Survey Burial Pits. ACM pipes were observed on the eastern part of the site with a stockpile of soil identified with asbestos fibres on the northern part of the site.

Soil treatment (for example by soil washing) has been considered, however this option does not meet the design criteria in terms of technical feasibility of relative cost benefit. Soil washing involves the separation of contaminants from clean soil. The lead particulate impacted soil at this Site is within a matrix of high plasticity clay, and the lead particulate is fine grained. This would not allow the efficient separation of lead from the soil, and would result in soil requiring either offsite disposal of on-site containment. Consequently, soil washing would also additionally incur the costs associated with the alternative options described below. For these reasons the assessment of soil treatment for these materials has not been further assessed.

The following options to manage the lead particulate material and fragmented asbestos pieces on the site are as follows:

AoC4 /5 Option One – Reengineering existing material and construction of sealing layer (Cap and Contain)

The purpose of this option is to contain these materials on the site in a specially constructed sealed area. The sealed layer will preclude access to the soil / fill within the sealed layer and prevent (or largely preclude) infiltration and recharge to the contained materials. It is noted that the materials intended to be contained are not likely to leach under Site conditions, and would consequently have a low risk of affecting groundwater within the area beneath the sealed layer.

The cap and contain system proposed herein is intended to comply with NSW DEC "Guidelines for the Assessment of On-Site Containment of Contaminated Soil (ANZECC 1999). The primary objective of these guidelines is to protect the health and safety of human and environmental receptors, minimise the need for ongoing management and support the best use of available waste treatment and disposal facilities and other public resources. This option will include the following tasks:

- Preparation of Technical Contract Specifications and approval by regulatory authorities. This will require a detailed survey of the existing topography and specific geotechnical investigations (test pits) to enable final design;
- Preparation of a level area within the existing rifle range to accept ACM;
- Carryout and emu pick of ACM fragments identified within the area, placement in suitable containers (i.e. plastic bags appropriately labelled) and placement within prepared area. The ACM material identified within the Board of Survey Burial Pits (AoC7) would also be excavated at this time and placed within the prepared area;
- Remove the vegetation within the area identified as the former rifle range and lead particulate area after approval by regulatory and local authorities;
- Re-engineer (re-shape) the western part of the lead particulate impacted material (former rifle range) to match existing areas;
- Re-locate the lead particulate material from the access tracks located on the western and northern parts of the site to the former rifle range area;
- Construct a sealing layer of 0.4m thickness of clay over the ACM and lead particulate impacted material. This layer should include a marker layer (such as a brightly coloured geotextile – uPVC or HDPE) to indicate to site users location of the top of the sealing layer. The NSW EPA Environmental Guidelines for Solid Waste Landfills specifies that a suitable barrier between subsurface strata and groundwater (to contain landfill leachate) is a modified soil liner of permeability less than 10^{-9} m/s. However the purpose of this sealed layer is to provide a physical barrier between site users and the contained materials, and therefore a clay layer meeting onsite open space criteria would be sufficient to achieve this requirement. Clays with varying characteristics (preferably derived from the area of the proposed site) could be considered following approval by Environmental Consultant and Site Auditor;
- Spread a layer of topsoil (nominally 100mm thickness) across the area. This area can subsequently be seeded with native grasses, however deep rooting plants should not be planted above this sealed layer;
- Construction Quality Assurance (CQA) documentation and as-built drawings (based on detailed survey) shall be provided to validate the placement of the sealing layers; and
- Prepare a remediation report and site management plan (SMP) to be implemented to control future ground penetration within the area. Appropriate signage should be included within the SMP and placed at the Site area to inform site users of limitations on land use.

This option provides a fit for purpose remedial strategy to manage the potential aesthetic issues and impacts from water percolating through the lead-impacted material and minimize impact of ACM on the environment.

The location of the sealed contained area is proposed in Figure 6. This area at the south-west of the conservation zone is the area of the former rifle range stop butt. The area is undulating and includes the majority of the lead particulate material, and is adjacent to the area of surficial ACM. The undulations in this area would minimise the engineering and construction required to provide a sealed area. Therefore this strategy involves the use of an already disturbed area and allows this area to be rehabilitated as well as providing an area for deposition of lead and ACM impacted soils.

This option would require some vegetative clearance of the area to enable the engineered sealed area to be constructed. This may require the application for a Section 91 permit from the NPWS.

In terms of remedial selection parameters, this option would be of high rating for technical feasibility, high rating for environmental impact (as it improves an area already disturbed by construction of former rifle range stop butt), high rating for relative cost benefit and medium rating for ongoing maintenance (this is further discussed in Section 12.12).

AoC4 /5 Option Two – Excavation and disposal of ACM and lead particulate material

This option will include the following tasks:

- Preparation of Technical Contract Specifications and approval by regulatory authorities;
- Removal of vegetation within the area identified as the former rifle range and lead particulate area after approval by regulatory and local authorities;
- Collect ACM by emu pick, transport and disposal to a suitable landfill in accordance with WorkCover and DECCW guidelines;
- Excavate lead, transport and disposal to a suitable landfill of impacted material in accordance with the Waste Classification Guidelines (DECC 2009);
- Validation of the impacted areas; and
- Preparation of a validation report for sign off by Site Appointed Auditor.

This option would be the more conservative approach, provide the least risk to Landcom and would be the more expensive of the options. This work should be carried out in conjunction with a Department of Defence approved UXO / SAA contractor.

Based on the above remedial approaches there will be a requirement for some vegetative clearance to enable placement of a separation layer. Such vegetation removal may require the involvement of a suitably trained arborist.

In terms of remedial selection parameters, this option would be of high rating for technical feasibility, medium rating for environmental impact (as it would still require the rehabilitation of the stop butt area, which has already been disturbed by historical landuse), low rating for relative cost benefit and medium rating for ongoing maintenance (this is further discussed in 12.12).

12.3.1 Preferred Remedial Option AoC4 and AoC5

The remediation selection criteria adopted in Section 10.0 have been evaluated for the options considered, and these are summarised in the table below:

Table 5: Summary of Remediation Selection Rating - AOC4 and AOC5

	Technical feasibility	Environmental impact	Relative cost benefit	Ongoing maintenance
Option 1 - On Site Re-Engineering and Sealing	High	Medium	High	Medium
Option 2 - Offsite Disposal	High	Low	Low	High
Additional Option Considered - Soil Treatment	Low (Limiting factor – option unacceptable)	High	Low	High

The preferred option is Option 1 (re-engineering and sealing of the material on site). Option 1 enables the construction of an area to contain these materials within an area which is already impacted with lead particulate (in the vicinity of the former rifle range). Option 1 does not involve the transportation of material from this Site to another. This option is technically feasible and based on existing information, will not require ongoing groundwater monitoring adjacent to the engineered sealed material. This option is also believed to have a more sustainable impact than transporting and disposing such a large volume of material elsewhere. This option is also favoured from a relative cost benefit perspective, as it is estimated to cost less than half of the cost of Option 2.

This sealed area should not include the erection of structures on the capped area that may result in the risk of harm to human health or the environment.

A “Concept Design” for the capped area is provided in Section 13.0. Alternative designs, meeting the design intent, must be agreed with the environmental consultant and Site Auditor.

The precise location and technical specification of the sealed layer should be selected in conjunction with DECCW, Landcom and the Site Auditor prior to the remediation works.

It is noted that there will be some ongoing maintenance issues associated with this proposed approach, and these will be further discussed in Section 12.11 (residual risk), and Section 12.12 (ongoing maintenance).

12.4 Preferred Remedial Option (AoC6)

PAH impacted material identified at TP599 (AOC 6) should be excavated, transported and disposed off site in accordance with the Waste Classification Guidelines (DECC 2009). This approach is preferred as the volume of material small, and it is cost effective to remove this volume to an appropriate offsite facility. This option is technically feasible (the alternative of on-site treatment would involve trials for alternative treatment techniques which would not be justified by such a small volume of material) and has little environmental impact given the size of the affected area. This is summarised in the table below:

Table 6: Summary of Remediation Selection Ratings - AoC6

	Technical feasibility	Environmental impact	Relative cost benefit	Ongoing maintenance
Soil Treatment	Low	High	Low	High
On Site Re-Engineering and Sealing	High	Medium	High	Medium
Offsite Disposal	High	Medium	High	High

Remediation of the PAH impacted material identified at TP599 will include the following tasks:

- Delineation of the extent of the impacted material, and assessment of possible source of the impact (if possible);
- Preparation of technical specification for the works;
- Removal of the contaminated soil by mechanical extraction;
- Classification of the excavated soils required to be disposed off site to licensed landfill; and
- Validation sampling of the soil remaining on site after remediation is completed.

12.5 Board of Survey Burial Pits (AoC7)

ACM's were identified as fractured sheeting within the Board of Survey Burial Pits. In addition building demolition, scrap metal, machine parts and furniture were also identified within the pits. Currently there is between 0.4 to 1.0m of capping material consisting of gravely CLAY.

The following options have been identified as potential remedial strategies to manage the buried waste material:

AOC7 - Option One– Cap and Cover

The tasks associated with this option would involve;

- Preparation of Technical Specifications, appropriate plans and approval by regulatory authorities;
- Removal of vegetation within the area after approval by regulatory and local authorities;
- Placement of a warning layer of geotextile or similar material to alert potential users of the Site to the presence of the material;
- Construct a sealing layer of 1.0m thickness over the ACM and placement of suitable; markers on the surface to alert potential users of the Site;
- Spread a layer of topsoil across the area and seed with native grasses (deep rooting plants should not be planted above this sealed layer); and
- Prepare a remediation report and site management plan to be implemented to control future ground penetration within the area.

AOC7 - Option Two – Excavation and relocation to Engineered Area (Encapsulation Structure)

The tasks associated with this option would involve;

- Preparation of Civil Contract Specifications, appropriate plans and approval by regulatory authorities;
- Removal of vegetation within the area after approval by regulatory and local authorities;
- Excavate ACM and waste material and relocate to a prepared are within the proposed engineered cell located within the former rifle range area on the western / central part of the Site;
- Validation of impacted area after excavation;
- Placement of a warning layer of geotextile or similar material to alert potential users of the site to the presence of the material;
- Spread a layer of topsoil across the area and seed with native grasses (deep rooting plants should not be planted above this sealed layer). Install surface markers alerting potential Site users; and
- Prepare a remediation report and site management plan to be implemented to manage future ground penetration within the area.

AOC7 - Option Three – Excavation and Removal from Site

The tasks associated with this option would involve:

- Preparation of Civil Contract Specifications, appropriate plans and approval by regulatory authorities;
- Removal of vegetation within the area after approval by regulatory and local authorities;
- Excavate ACM and waste material, transport and disposal to a suitable landfill in accordance with WorkCover and DECCW guidelines;
- Validation of the impacted areas; and
- Preparation of a validation report for sign off by the appointed Site Auditor.

This option would be the more conservative approach, provide the least risk to Landcom and would be the most expensive of the three options.

12.5.1 Preferred Approach for Buried Waste Material

The buried waste material within the trench is varyingly contaminated with either ACM or building demolition and other various extraneous materials (i.e. man made materials, as opposed to soils). The preferred remedial strategy is to excavate the waste materials, sort (oversize & metallic materials) where appropriate and feasible and relocation within the proposed encapsulation structure located within the former rifle range (Remediation strategy AoC7/2).

This option is consistent with the strategies proposed to remediate similar materials encountered to the west and provides a technically feasible, environmentally acceptable solution. This option provides a minimal cost benefit compared to disposal off site and reduces the size of the impacted area for ongoing maintenance of these materials on the site. This is summarised in the table below:

Table 7: Summary of Remediation Selection Ratings - AoC7

	Technical feasibility	Environmental impact	Relative cost benefit	Ongoing maintenance
Option One - Cap and Cover	High	Medium	Medium	Medium
Option Two - On Site Re-Engineering and Sealing)	High	Medium	Medium	High
Option Three - Offsite Disposal	High	Medium	Low	High

The location of the areas observed to contain military and general wastes (AoC7) are shown on Figure 5.

Prior to the commencement of any other remedial works, the site is to be subjected to a visual inspection, and removal of all military associated objects such as concertina wire, training pits, former structures / concrete slabs, general rubbish, scrap metal and asbestos piping. This activity is to be carried out by a suitable AS1 licensed contractor, in accordance with NSW DECCW and NSW WorkCover requirements.

Surfaced water retained within excavations shall be disposed offsite in accordance with NSW DECCW guidance on liquid waste disposal guidelines, to enable appropriate backfill. Alternatively, where demonstrably suitable, the water may be re-used on site.

Alternative methodologies for remediation of AOC 7, meeting the design intent, must be agreed with the environmental consultant and the Site Auditor.

12.6 Preferred Remedial Option for Stockpile and Waste Material

Stockpile material present in the Waste Disposal West zone was reported in the DSI to contain organic matter, and building demolition material. The volume of material represented by the Waste Disposal West zone is not enough to suffice the implementation of a screen to remove the building waste from this material. Stockpile SP6 was identified as containing an asbestos fibre during the DSI.

Due to the nature and volume of the waste and stockpile material described above, it is recommended that this material be sampled in accordance with the *Sampling Design Guidelines* (EPA 1995) and disposed offsite at a licensed facility. Stockpiles which are excavated to either offsite facilities or onsite engineered sealed area, should be validated in accordance with the requirements of Section 14.0. The rationale for the remediation option selection is based on that described in Section 10.0 and summarised in the table below.

Table 8: Table : Summary of Remediation Selection Ratings - Stockpiles and Waste Material

	Technical feasibility	Environmental impact	Relative cost benefit	Ongoing maintenance
Soil Treatment	Low	High	Low	High
On Site Re-Engineering and Sealing	High	Medium	High	Medium
Offsite Disposal	High	Medium	High	High

The remaining stockpiles present onsite contain clean fill material and topsoil. These stockpiles can be used for backfilling the training pits present at the Site. Additionally, the stockpiles generated during the investigation of the grenade range area can be levelled and re-spread across this portion of the Site.

12.7 Blackberry Clearance

During remedial works the area of blackberries present onsite (shown on Figure 3), comprising approximately 1.3 Hectares, are to be removed by a suitable qualified arborist. On completion of their removal, a 100% UXO and small arms ammunition (SAA) search of the newly accessible areas is to be undertaken. It is noted that the contamination assessments in these areas have been covered within the DSI report, and the contamination assessment within the overall site has met with the design intent in this regard. It is additionally noted that subject to the progress of the development, the blackberry coverage may increase, effecting the cost associated with their removal. In this instance the full area of blackberry infestation at the time should be assessed for UXO / SAA.

12.8 Waste Classification Program

All soil excavated for offsite disposal will be classified in accordance with the NSW DECC *Waste Classification Guidelines* (2009).

- The sampling frequency of soil to be disposed of will be between one sample per 50 m^3 and one per 100 m^3, and where relevant, may be supplemented with the results of the in-situ sampling carried out.
- Collection of samples of the residual soils in the excavation followed by laboratory analysis to characterise these soils as discussed in Section 10.3.
- Minimise adverse impact of contaminated soil in the excavation area on human health and the environment by implementing health, safety and environmental safeguards; contaminated soil handling, management and offsite transportation protocols, and monitoring procedures.

12.9 Groundwater

Groundwater is to be assessed at the Site before and after remediation to ensure no impacts occur from the remedial works at the Site for the parameters and criteria as assessed as part of the DSI (Golder 2005). Based on existing groundwater quality data it is not anticipated that groundwater will require treatment, remedial action or long term ongoing monitoring.

12.10 Coal Stockpiled Material

Although coal stockpiled material is not considered to be adversely affected by COC, the preferred management strategy for this material would be to dispose off site possibly to an industry or community benefactor (such as the rail museum near Camden) for reuse.

The coal may be disposed off site after further characterisation and in accordance with the Natural Immobilisation Approval Number 1999/05 for Coal and Ash impacted material.

A secondary approach could involve the dispersal of coal material within the conservation area subject to agreement with NPWS and SA.

12.11 Residual Risk

The objective of the remediation at the Zouch Road Site, is the removal of the remnants of Small Arms Ammunition (SAA) and potential Unexploded Ordnance (UXO) within proposed residential areas and conduct a visual clearance of contacts within proposed conservation zone. For the purposes of the remediation, a contact is defined as a metal fragment of military firearm origin greater than 25mm in length.

The preferred remedial option involves visual clearance of UXO and SAA in the conservation zone. The complete clearance of this area would not be possible without vegetation clearance within this area of Cumberland Woodland. The proposed remedial clearance would be carried out by a team of trained UXO consultants, and therefore it is considered that there is a low, but negligible, risk of live UXO / SAA remaining at the site following this remedial exercise. The presence of live UXO / SAA has not been found during the DSI.

The assessment of the residual risk is a combination of the likelihood of UXO / SAA being found at the site following the proposed remediation, and the potential consequence of such a discovery. The tables below provide a rationale for the assessment of residual risk.

UXO / SAA Likelihood Levels

Level	Description	Probability	Description Regarding Category of UXO / SAA
5	Almost certain	>0.8	Has been observed on Site and is almost certain to be present
4	Likely	0.5-0.8	Is likely to be present based on the site history
3	Possible	0.1-0.5	It is possible that UXO / SAA is present
2	Unlikely	0.04 – 0.1	It is unlikely that UXO / SAA will be present, but not impossible
1	Rare	<0.04	It is highly unlikely that UXO / SAA will be present and the likelihood of the category is probably no different from that at non-military land

The significance of the UXO / SAA is dependent on the type of material used at the site. The ranking of consequence will depend on the particular situation that applies to the site and is as follows:

Level	Descriptor	Impact on Site Workers and Users	Impact on Public	Cost to Remedy
5	Catastrophic	Multiple fatalities, large number of injuries	Public exposed to a life threatening hazard	>$10 Million
4	Major	Single fatality or serious non-recoverable injury; or several major injuries	Public exposed to a hazard that could cause injuries	$0.5 – 10 Million
3	Moderate	A number of safety incidents requiring treatment by a physician	Public exposed to a hazard that could cause minor injuries	$0.05-0.5 Million
2	Minor	A number of safety incidents requiring treatment by a qualified first aid person	Exposure of public to a hazard that does not cause injury	$0.005-0.05 Million

Level	Descriptor	Impact on Site Workers and Users	Impact on Public	Cost to Remedy
1	Insignificant	Minor safety incidents only	Negligible impact on public	<$0.005 Million

The risk can then be estimated for each land use at the site by the following equation:

Risk = likelihood x consequence

The resulting number will be in the range 1-25. The higher the value, the higher the risk and the lower the likelihood that the land will be suitable for its proposed use. The risk ranking which is similar to those adopted by Defence on other projects within Australia, is summarised in the table below, together with the audit response that would typically apply. It can be noted that as the risk increases, the greater the likelihood is that the land is only suitable for it proposed use with management controls with respect to future activities on the site. The extreme case is that the site is not suitable for the proposed use.

Risk Level	Descriptor	Indicative Land Use
16 – 25	Extreme	Land not suitable for proposed use, imminent risk of harm
9 – 15.9	High	Land not suitable for use unless conditions are applied to control the activities at the site
4 – 8.9	Medium	Land may be suitable for use, consider whether conditions are required to control activities at the site
1 – 3.9	Low	Land suitable for use without conditions

In the case of the residential land at the site, the UXO / SAA remediation will involve complete clearance. Therefore the likelihood of encountering UXO / SAA is “unlikely” and the consequence is “minor” (given that no live UXO or SAA have been encountered in investigations to date). The risk is therefore low to medium, and therefore the land would be considered suitable for residential use.

In the conservation area, the UXO / SAA clearance will be a clearance using visual techniques due to the vegetative cover constraining the clearances in this area. Therefore the likelihood of encountering items is “possible” and the consequence is “minor”, indicating a medium risk. This would indicate the land to be suitable for open space use. A Site Management Plan (SMP) is required and should include some details to advise landowners / maintenance personnel whether precautions are required and what must be done in the event that an item were to be found. This may include assessment of provisions to be made in construction of new paths or access within areas of previously dense vegetation.

12.12 Ongoing Maintenance Issues

The preferred remedial option provided for the Site involves the complete clearance of UXO / SAA in proposed residential areas, with clearance of visual UXO / SAA in the conservation area, the excavation and emplacement of ACM and lead particulate material within an encapsulation structure, the offsite removal of PAH impacted soils and the offsite removal of stockpiled waste materials to appropriate facilities.

Ongoing maintenance will be required for the encapsulation structure for the ACM and lead particulate material. This material will be sealed at depth to prevent site users from accessing this material. I t is therefore imperative that the integrity of the sealed layer be retained after construction. This will require erection of notices around the encapsulation structure, informing site users (including maintenance staff) that excavation of soil in this area is not permitted. The area can be grassed, but cannot be planted with deep rooting plants which could penetrate the sealing layer.

Site services should not be installed within or through this area, as this may affect the sealing layer and could lead to exposure of the sealed materials. Similarly erection of structures should be avoided above the sealed area. This will require a planning instrument (such as a notice on the 149 Certificate) to notify future users of the presence of this material at depth and the restrictions on excavation in this area.

On the basis of the proposed remediation, ongoing management of the Site in regard to the asbestos material present on site will be required. This will be in the form of a Site Management Plan (SMP), which will details limitations and restrictions to any subsurface works in areas where Asbestos and Lead Particulate Material have been capped and covered.

12.13 Proposed Remedial Schedule

The proposed development will be staged to allow the progressive development of the Site in conjunction with relevant adjoining land owners as follows:

- Stage 1 – Development of the Rural Residential Zone West (RRZW), Stage 1 Area and Town Centre Area within Residential Zone North of Rail Alignment (RZNRA). It is envisaged that the Rail Corridor will also be developed at about this time by TIDC;
- Stage 2 – Development of the remaining RZNRA; and
- Stage 3 – Remediation of the Conservation Zone including construction and capping of engineered area and visual UXO/SAA clearance.

A Site Audit Statement will be required to be prepared for the individual areas on completion of remedial works.

The timing and scheduling of the individual stages is subject to approvals and discussions with relevant approval bodies (Council, NSW DECCW and NPWS).

13.0 CAPPED AREA (ENCAPSULATION STRUCTURE) - CONCEPT DESIGN

As discussed in Section 12.3 the preferred remedial strategy to manage / remediate the lead particulate material and asbestos containing materials identified is cap and contain the impacted materials within a centralised area (encapsulation structure) with ongoing site management. The cap and containment of these materials is considered to provide a remedial solution which manages the impacted material on the Site with little ongoing risk to human health and the environment.

As part of this RAP a concept design has been prepared to:

- Demonstrate that the volume of impacted material can be accommodated within the available area;
- Provide minimum design and construction details for approval/comment by the Site Auditor; and
- Facilitate discussion with National Parks and Wildlife Services (NPWS) who will ultimately be responsible for the ongoing site management of this area.

The following Sections provide the location of the proposed capped area, rationale and design input parameters used to prepare this concept design and preliminary construction methodology.

13.1 Proposed Location of Capped Area (Encapsulation Structure)

The proposed capped area will be constructed within the area currently occupied by the rifle range stop butt and former miniature rifle range as shown in Figure 6. This location has been chosen based on the following rationale:

- The majority of lead particulate impacted material is located within this general area;
- The area has been substantially disturbed and therefore requires minimal vegetation clearance of sensitive habitats;
- The geology consists of medium to high plastic clays to a depth of about 3.0 metres overlying shale bedrock. Groundwater within the area observed to be at depths greater than 15.0m below ground level (bgl); and
- The proposed area is located along the top of an existing ridgeline, therefore limiting the area of surface water infiltration.

13.2 Design Input and Considerations

In preparing this concept design the following design parameters and considerations have been made.

- The distance from the proposed rural residential area to the capped area shall be a minimum of 20m;
- The volume of lead particulate impacted material is estimated to be as follows:
  - Former Rifle Range Area and immediate surrounds – 25,000m^3; and
  - Access roads south western corner and north western part of the Site – 8,000m^3 to 9,000m^3;
- The volume of ACM impacted material has been estimated to be as follows:
  - Burial Pits – 800m^3 to 900m^3; and
  - Surface ACM present over rifle range area and immediate surrounds – 100m^3 to 200m^3; and
  - Other ACM impacted areas – 20m^3 to 50m^3.

- The capped area has been limited to a maximum height of 77.0m AHD;
- Batters shall not exceed a gradient of 2:1m (horizontal:vertical);
- The existing natural landform should be used where possible to complement the design, manage future surface water run-off and limit ongoing management requirements; and
- Clearance of vegetation shall be limited to the lead particulate impacted area identified.

13.3 Proposed Design and Minimum Construction Requirements

Based on the design inputs and considerations presented above, a concept design was prepared and is shown in Figures 6 to 10. The design generally consists of:

- Lead particulate material bring reshaped to blend into the existing natural topography and with consideration of the adjoining sensitive habitat (Cumberland Woodland areas);
- A burial pit excavated in the area shown after the removal of surface particulate and ACM fibro pieces. Excavated natural material will be stockpiled for use as capping material;
- ACM collected from the rifle range area, existing burial pits located to the east of the rifle range and other identified areas will be placed within the newly constructed pit;
- On completion of the placement of the ACM a 200mm cover of lead particulate material will be placed and compacted. A warning layer consisting of a geofabric or equivalent will placed over the burial pit area. At such time filling works using lead particulate material will continue until the final impacted material surface level is achieved. The cover to be present above the ACM burial pit shall be a minimum of 1.0m and may consist of lead particulate material, clay cap and a growing medium.
- Capping material consisting of natural high plasticity clay similar to material encountered at the Site will be placed and compacted to a minimum depth of 0.4m. Clay capping material should have a permeability coefficient of no less than $1x10^{-9}$ m/sec. Material should be placed at or near optimum moisture content and achieve a compaction of at least 98% Standard Maximum Dry Density (SMDD);
- A minimum 0.2m depth growing medium shall be placed across the capped area. The growing medium shall consist of topsoil preferably sourced from the Site. Topsoil material sourced from off site should be in accordance with NPWS requirements and be approved prior to delivery to Site; and
- The capped area shall be re-vegetated with shallow rooted shrubs and grasses native to the Site or approved by NPWS. A rehabilitation plan should be prepared by a suitably qualified ecologist and approved by NPWS.

Surface water management will consist of the installation of deceleration points and appropriate erosion controls during the Site rehabilitation. A surface water management plan should be prepared as part of the final design.

On completion of capping works appropriate signage shall be erected to direct across the capped area to identify future uses to the appropriate authority (NPWS or NSW DECCW) prior to intrusive works being carried out within the area.

Based on the concept design presented in Figure 7C, the volume of material that can be accommodated within the area shown is estimated to be about 45,000m^3 including the clay cap and growing medium. There is the potential to increase the volume of material by another 3,000m^3 to 5,000m^3 with this area without increasing the height or capped area footprint through the increased gradient of batters from approximately 4:1 (H:V) as currently designed for most of the area to 2:1 (H:V) if required.

13.4 Preliminary Construction Methodology

The construction of the capped area will be staged to coincide with the development of the Site. The preliminary construction methodology will generally be as follows:

- Mobilisation of remediation and UXO clearance contractors;
- A complete UXO search will be carried by an approved UXO consultant prior to any intrusive works or heavy machine being used in the area. Contacts should be investigated in accordance with Section 12.2;
- Collection of ACM fibro sheeting fragments from the surface area of the rifle range and immediate surrounds. ACM and ACM impacted near surface soil shall be stockpiled and covered within appropriate environmental controls including signage in accordance with NSW WorkCover requirements. All works will be required to be carried out under the supervision of a AS1 Licensed contractor;
- Excavation of lead particulate impacted material from the RRZW and RZNRA and stockpile within the proposed capped area footprint;
- Establish remediated zone between the proposed capped area and RRZW (i.e. 20m zone between capped area and RRZW boundary);
- Construction of boundary fencing between RRZW and Conservation Zone and installation of appropriate signage;
- Vegetation clearance across lead particulate impacted area. Vegetation will be slashed and collected for assessment for use as mulch on the Site by the environmental consultant. No vegetation or organic material should be placed within the capped area without the consent of the SA and relevant stakeholders. The incorporation of vegetation should be avoided where possible to eliminate the generation of potential explosive gases such as methane and settlement potential across the capped area;
- Lead particulate material within the proposed burial pit area and including the area immediately upgradient (i.e. area to the east) should be excavated and material placed within the capped area footprint;
- Excavation of proposed ACM burial pit and stockpiling of VENM within the validated area to the east;
- Excavation of existing Board of Survey burial pits and ACM material for re-encapsulation within the newly constructed pit. All works to be carried out by an AS1 licensed contractor. Dust monitoring to be performed in accordance with NSW WorkCover and NSW DECCW requirements;
- Placement of initial cover material (burial pit) and installation of warning layer over ACM burial pit area;
- Excavation of lead particulate material from rifle range surrounds, transport and shape capped area as per final design;
- After validation and inspection of remediated areas the capped area will be capped with at least 0.4m of clay VENM sourced from the Site or approved off site material;
- Placement of growing medium and implementation of rehabilitation plan; and
- Installation of appropriate signage alerting people to contact a designated authority prior to intrusive works in accordance with the Site Management Plan.

14.0 PROPOSED VALIDATION PROGRAM

14.1 Validation Sampling

Validation is required to ensure that remediation works have been conducted in accordance with the protocols established for the project in this RAP.

The soil remediation criteria described in Section 10.3 will be applied during the validation works to selected soils for which are to remain on the Site.

The data obtained from the Validation Program shall be statistically analysed to ensure that the upper 95% confidence limit of the arithmetic average concentration of the analytes of concern is below the relevant clean up criteria. Should individual samples exceed the criteria, the domain over which a 95% UCL will be applied shall be discussed with the Auditor.

Statistical analysis will not be undertaken when comparing data against environmental-based criteria (i.e. phytotoxicity-based criteria).

Generally, if an excavation validation sample fails a clean-up criterion, further excavation and subsequent validation of the affected area will be required.

Validation testing will be applied as follows:

UXO and SAA

After the remediation works have been completed, an additional 10% validation sweep of the areas will be completed for the presence of UXO and SAA. T his methodology is to be undertaken for either visual or complete search methodologies.

The proposed methodology to validate each remediation sub area (approximately 1.0 ha cells) would be as follows:

- On completion of UXO / SAA remediation the UXO Site Manager will undertake an independent and supplemental 10% search (validation check). The validation check will be carried out using the methodologies presented in Section 11.0 (for residential and conservation areas)
- Upon finding nil contacts during the 10% search, the validation of the SAA will be considered complete.
- If contacts are discovered, then the sub area should be repeated, using the appropriate search methodology for the proposed land use i.e. complete search for proposed residential areas or visual search for proposed conservation areas; and
- A report shall be compiled documenting the validation approach and methodology.

As identified in Section 12.11the objective of the remediation is to remove remnants of SAA and UXO. For the purposes of the remediation, a contact is defined as a metal fragment of military firearm origin and is greater than 25mm in length.

Asbestos and Lead Particulate Material

Remediated lead particulate areas external to the capped area footprint will be inspected for the visual presence of lead particulate. Soil validation samples will be collected from the walls and base of excavations on a 10m grid and submitted to a NATA accredited laboratory for analysis of lead and asbestos.

Areas affected by re-engineering and re-location of lead particulate material and asbestos containing material will be capped with a 0.4 m thick sealing separation layer. A detailed survey by a registered surveyor will be carried out after the placement of ACM and re-shaping of the lead particulate impacted material. In addition a survey will be carried out after the placement of the clay cap to confirm the minimum thickness of the cap across the area is greater than the minimum requirement i.e. 0.4m.

Imported Fill / Fill Sourced from the Site

Fill material will be required to backfill weapons pits and remediation excavation across the Site. The majority of backfill material will be sourced from virgin excavated natural material (VENM) and clean stockpiled soil material. Prior to Site material being used to backfill excavations, a review of laboratory data collected during the DSI will be carried out to assess the concentrations of potential COC. In addition to the historical data a check testing program consisting of 1 sample per 250m^3 will be collected for laboratory analysis. Laboratory analysis will consist of TPH, BTEX, PAHs, Metals and OCPs.

Imported fill to be used at the Site for the purposes of backfilling and/or creating a capping / sealing layer will be sourced from an appropriate location, and will be subjected to additional confirmation sampling as per the requirements of the NSW *EPA Sampling Design Guidelines*, or as agreed to be the Site Auditor. Material will be VENM or excavated natural material (ENM) in accordance with NSW DECCW Waste Classification Guidelines and will be analysed for a selection of heavy metals, TPH, BTEX, PAHs and OCPs.

PAH Impacted Area – AOC7

Prior to excavation works further delineation sampling is required to assess the extent of PAH impacted material within this area. Delineation sampling will consist of either test pits or boreholes on a 5 to 10m grid. Soil samples will be collected at near surface and at intervals of depth to a maximum depth of 1.0m bgl. Selected soil samples will be analysed for TPH and PAH.

After the excavation, further characterisation and disposal of PAH impacted material to a suitably licensed landfill facility the resultant excavation will subject to a visual inspection and collection of validation samples from the walls and base of the excavation across a 5.0m grid.

Soil samples will be submitted to a NATA accredited testing laboratory for analysis of TPH and PAH.

The resultant excavation will be backfilled with validated VENM won from the Site or validated imported material.

Stockpiled Material

Stockpiled material (building waste material, ACM impacted and coal) identified across the Site will be excavated, further assessed for potential re-use on Site or disposal off site.

After the stockpiles have been removed, a visual inspection will be carried out and observations recorded. Where ACM or obvious contamination is observed soil samples will be collected from the footprint of the former stockpile area and submitted to a NATA accredited laboratory for analysis. Samples will be analysed for the COC identified most likely to be selected heavy metals and organic compounds TPH, BTEX and PAHs).

A minimum of one sample will be collected from each impacted stockpile footprint for analysis.

14.2 Validation Criteria

The validation criteria selected for the remediation project shall be conservative, so as to permit residential and open space landuse.

In summary, the validation thresholds adopted shall comprise two data sets:

1) Environmental Investigation Thresholds; and

2) Health-Based Investigation Levels.

Environmental Investigation Thresholds have been established with the purpose of protecting the environment and in particular, plants. Health-based investigation levels are based on the NEHF Health-based Soil Investigation Levels (HILs), which are endorsed by the DECCW.

Soils have been successfully validated if:

- All validation samples report concentrations below the validation criteria; or

- (for HILs only) the 95% UCL on the arithmetic average contaminant concentration for each contaminant within a particular area is below the respective validation criterion. The following conditions must also be met:
  - No single sample contains an analyte concentration greater than 2.5 times the relevant criteria; and
  - The data set upon which the UCL is calculated must be statistically valid (i.e. sufficient data must be available to calculate a meaningful UCL figure).

14.3 Validation Reporting

On completion of the works, a Remediation / Validation Report detailing the works carried out will be prepared, and submitted to the Auditor for review. The report will be structured in general accordance with the *Guidelines for the NSW Site Auditor Scheme*, and shall document:

- Any variations to the strategy undertaken during the implementation of the remedial works;
- Results of environmental monitoring undertaken during the course of the remedial works;
- Details of any environmental incidents occurring during the course of the remedial works and the actions undertaken in response to these incidents; and
- Other information as appropriate.

The report will serve to document the remediation works for future reference by Landcom and any other relevant parties with an interest in the Site.

15.0 MANAGEMENT PLAN REQUIREMENTS

The implementation of health and safety and environmental control issues onsite are the responsibility of the Site contractor and project managers during the remediation works. The implementation of environmental control measures required as part of ongoing maintenance will be the responsibility of the future landowner (which is understood to be NPWS/DECCW within the open space area).

Prior to the commencement of remedial activities onsite, the following documents are to be prepared and approved by DECCW, the appointed Site Auditor, and Landcom:

- Environmental Management Plan (Appendix E);
- Site Management Plan (incorporating Landcom requirements);and
- Construction Management Plan

Additionally, contractors working at the Site are required to prepare a Site Specific Health and Safety Plan for their works.

Aspects of the management plans should include as a minimum the following:

15.1 Hazard Evaluation

Potential Contaminants of Concern

From the Site information currently available, the main contaminants expected to be present onsite have been provided previously in Section 7.1.

Responsibilities

Contractors performing work activities are expected to meet all applicable Commonwealth and State requirements for worker health and safety issues. They are responsible for supervising their employees, enforcing they own OH&SP, and maintaining applicable worker health and safety conditions.

The Site Foreman or the project managers may stop a contractor's operation, which presents an imminent hazard to worker health and safety.

15.2 Environmental Control Measures

Contractors performing work activities are expected to meet all applicable Commonwealth and State requirements for environmental issues. They are responsible for supervising their employees, enforcing their own environmental management plan, and maintaining working conditions so as to minimise impact on the environment.

The Site Foreman or the project managers may stop a contractors operation, which presents an imminent hazard to the environment.

Environmental control measure required to be implemented on Site include dust control, silt fences, and covering loads leaving the Site. Specific details are to be incorporated into the Environmental Management Plan.

15.3 Personal Protective Equipment

Personal protective equipment on the Site shall consist of Level D protection. These are to be listed in Site Specific Health and Safety Plan.

15.4 Standard Safe Work Practices

All personnel on Site are required to follow the Standard Safe Work Practices including requirements for induction, eating and drinking and visitors. These are to be incorporated into the Site Specific Health and Safety Plan.

15.5 Decontamination

The contaminants of concern are not expected to pose an immediate threat to life or health if inhaled or when in contact with unprotected skin. However, in the event of physical injury or other serious medical concerns, immediate first-aid is to be administered in lieu of further decontamination efforts. Additional requirements that shall be conducted upon leaving the Site are found in the Environmental Management Plan.

15.6 Emergency Response

The Site Foreman and nominated safety personnel will evacuate personnel and summon outside assistance from appropriate response agencies. Other responsibilities are found in the Site Specific Health and Safety Plan.

15.7 Public Safety

All work areas will be controlled in a manner to prevent the public entering the Site. This will reduce public access to soil during construction.

15.8 Site Management Plan - Conservation Area

It is understood that a Site Management Plan (SMP) is required for the conservation area to manage ongoing risks to human health and the environment. This will include the mechanisms to manage the Site over the long term. This SMP will require the inclusion of the key elements of the maintenance issues which will result from this RAP. Consequently the SMP will require input from a suitably qualified environmental consultant to provide guidance on the following issues:

- Summary of site conditions;
- Land title notifications (of sealed containment and UXO / SAA issues);
- Record of construction details associated with the sealed containment area;
- Constraints on landuse with respect to UXO / SAA;
- Constraints on landuse with respect to the capped containment area;
- Ongoing maintenance checks (nature and frequency);
- Contingency measures to be adopted if contamination (including UXO / SAA) is encountered;
- Discussion of residual risks at the Site;
- Environmental controls and procedures to be adopted when excavating at the Site;
- General site maintenance.

The SMP should be compiled prior to the commencement of the remediation works, and will require liaison with Landcom, DECCW and the Site Auditor.

16.0 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

16.1 Data Quality Objectives

The data quality objectives for the field work, sampling and analysis will consist of the following:

- The sampling program should meet with the objectives of characterising the residual soils after the removal of contaminated materials;
- The Laboratory Limits of Reporting (LORs) will be targeted to be below the adopted criteria;
- Field duplicates will be collected and analysed at a minimum frequency of 10% of field samples. The Relative Percentage Differences (RPDs) will be targeted to be below 50%;
- Field wash blanks will be collected, where relevant and analysed to provide evidence that no cross-contamination had occurred during field sampling;
- Laboratory spikes, controls and surrogates are targeted to be within 70% and 130% to demonstrate the reliability of the laboratory results reported; and
- Laboratory duplicates will be targeted to have RPD values less than 30%.

16.2 Field Quality Control

Standard QA/QC procedures will be adopted during the entire remediation process including those for sample collection, management and handling. Specific requirements will include the use of laboratory prepared jars and containers, decontamination of sampling equipment between locations, collection of an appropriate number of quality control samples, preservation of samples in ice chests and transport to laboratories under chain of custody documentation. Calibration of all field measuring equipment such as a PID will be carried out at an appropriate frequency which will not be less than once a day when in use. All calibration results will be documented in a log book, dated and signed by the person who calibrated the equipment.

16.3 Field Quality Control Samples

Field quality control (QC) samples will comprise:

- Field split duplicates: Individual samples will be split in the field and placed in two separate containers. One sample will be sent to the primary laboratory and the duplicate sent to an independent check laboratory and
- Blind duplicates: Both the primary and duplicate samples generated in the field will be sent to the same laboratory however, the duplicate sample will be blind coded.

The frequency of duplicate samples analysed will be a minimum of 10% field samples.

16.4 Laboratory Quality Control

Laboratory analysis will be conducted in accordance with the standard test methods outlined in Schedule B(3) of the NEPM (1999) for soils or equivalent modified methods supported by adequate quality control. The laboratories will be registered by NATA for all the test methods used on this project.

The practical quantitation limits (PQLs) will be set at a level below the relevant assessment criteria.

Laboratory quality control samples will typically include:

- Laboratory duplicate samples;

- Spiked samples;
- Certified reference standards;
- Surrogate standards/spikes; and
- Laboratory blanks.

16.5 Completeness

The completeness of the sampling and analysis program will be calculated as a percentage of samples with acceptable results to the total number of samples scheduled for analysis. The targeted completeness will be 95%.

17.0 LICENSES AND APPROVALS

The contractors and all other agencies involved in the remediation should ensure that the remediation work is carried out in accordance with licenses, approvals and other specific regulatory requirements applicable for the various aspects of work involved.

17.1 SEPP 55

The State Environmental Planning Policy 55 (SEPP 55) – Remediation of Land, is a document produced by the Department of Urban Affairs and Planning & Planning NSW) to establish 'best practice' for managing land contamination through the planning and development process.

Investigations carried out at the Site identified past activities on the Site that had caused contamination, to a degree that parts of the Site required remediation. The SEPP 55 Guidelines state that the objectives of a Stage 2 Detailed Site Investigation are to define the nature, extent and degree of contamination, to assess potential risk posed by contaminants to health and the environment, and to obtain sufficient information to develop a remedial action plan (RAP). We consider the objectives of the Initial Site Investigation and the Detailed Site Investigations have been met.

The objective of the Remedial Action Plan (RAP) is to set objectives and to document the process to remediate the Site and answer the following questions:

- Can the Site be appropriately remediated?
- Is the remediation proposed practical?
- Are the proposed cleanup criteria appropriate for the proposed future use?
- Are the proposed Health and Safety environmental management, community relations and contingency plans acceptable? and
- Is a site audit necessary?

We consider that the Remediation Action Plan (RAP) shows that the Site can be remediated for the proposed residential and open space land use, that the remediation proposed is practical and that the proposed cleanup criteria are appropriate for this use. We also consider that the health and safety, community relations and contingency plan are acceptable (as contained in the Appendices of this report).

The scope of remediation works proposed are considered to be Category 2 remediation under SEPP 55, however, the presence of threatened species on the Site automatically elevate the remediation works to Category 1 under SEPP 55.

Accordingly Category 1 remediation works require Part 3A planning approval as a class of development specified under Schedule 1 of SEPP Major Development, which will be addressed by the Part 3a Concept Plan Approval.

17.2 Ongoing Planning Issues

The provision of an on-site capped containment area creates constraints to some land uses in this area and will be managed through the implementation of a Site Management Plan. The capped area should not be excavated as this will expose contained material. This will require that future landowners are made aware of this situation to ensure that the capped or contained area is protected from any unintentional or uncontrolled disturbance that could breach the integrity of the physical barrier. This may involve notation or covenant on the property title or notation on a certificate issued under s. 149(5) of the Environmental Planning and Assessment Act (1979), or relevant sections (Section 88B notice on land titles) of the Contaminated Land Management Act (1997). It is understood that this area will become NPWS land and that NPWS will then

become responsible for the maintenance of this area. The SMP should be made available to the personnel responsible for this maintenance in the future.

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We would be pleased to answer any questions about this important information

Report Signature Page

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