

## LoCAL Deliverable 1.4

### Baseline data from Barredo

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<b>WP number</b>	<b>WP 1</b>
<b>Partner responsible</b>	<b>UoG</b>





Research & Innovation  
Research Fund for Coal and Steel

# LOCAL

Low-Carbon After-Life (LoCAL): sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks



## Deliverable 1.4

### Baseline data from Barredo

The follow data was initially proposed for month 18. The sampling schedule was delayed to allow for a synchronised programme across all European partner sites (UK and Bytom). A 12 month sampling regime will be carried out across all project sites. The following table represents analysis from the first 6 months of sampling at Barredo, Spain.

<b>Abbreviation:</b>	<b>Name:</b>	<b>Description:</b>
SP1	Sampling point N°1	Water from pump at 100m depth
SP2	Sampling point N°2	Water from pump at 200m depth
SP3	Sampling point N°3	Water at the exit of the shell and tube heat exchanger (Hospital)
SP4	Sampling point N°4	Water at the exit of the plate heat exchanger (University)
SP5	Sampling point N°5	Water at the entrance of the plate heat exchanger (University)

Key for Barredo system sampling site locations for chemical analyses.

		Barredo		SP3 H	SP4 I	SP5 J	
		SP1 A	SP2 B				
<b>Multiprobe</b>	No rest	T [°C]	22.6	23.3	19.5	19.14	22.9
	After 5 min rest	ORP (mV) Eh	13.4	15.3	7.3	11.1	16.4
		Ph	6.31	6.17	6.47	6.37	6.38
		Dissolved oxygen [ppm] [mg/L]	2.21	2.43	1.63	0.08	2.03
		Electrical conductivity [µS/cm]	2886	2943	2875	2888	2832
		TDS	1443	1545	1438	1444	1416
		Salinity	1.5	1.61	1.5	1.51	1.47

Barredo field physiochemistry for 19/01/2015 campaign.

			Barredo		SP3 H	SP4 I	SP5 J
			A 100 (SP1)	B 200 (SP2)			
Lab measurements (Spain)	Filtered samples	Mn (ppb)	317	299	309	324	315
		Fe (ppb)	1896	2631	1819	2339	1922
	Unfiltered samples	Mn (mg/L)	0.4	0.3	0.4	0.4	0.4
		Fe (mg/L)	3.1	3.3	2.9	5	23
	Major anions and cations [mg/L]	Li <sup>+</sup>	0.15	0.16	0.15	0.16	0.16
		Na <sup>+</sup>	534.43	583.46	539.99	541.96	542.73
		NH <sub>4</sub> <sup>+</sup>	0	0	0	0	0
		K <sup>+</sup>	7.93	7.30	7.28	7.41	7.22
		Ca <sup>+2</sup>	123.12	117.23	124.36	124.34	123.76
		Mg <sup>+2</sup>	63.27	62.13	64.19	63.80	63.51
		F <sup>-</sup>	0.77	0.78	0.79	0.76	0.79
		Cl <sup>-</sup>	16.17	16.52	16.18	16.19	16.20
		NO <sup>-2</sup>	0	0	0	0	0
		Br <sup>-</sup>	0	0	0	2.23	0
		NO <sup>-3</sup>	0	0	0	0	0
		PO <sub>4</sub> <sup>-3</sup>	0	0	0	0	0
	SO <sub>4</sub> <sup>-2</sup>	685.74	721.99	686.29	689.10	689.28	
	TC (mg/L)	240.65	232.75	238.90	232.20	230.45	
	IC (mg/L)	230.55	222.20	230.25	223.20	223.70	
	TDC (mg/L)	10.10	10.57	8.68	8.99	6.73	
CARBONATES (mg/L)	0	0	0	0	0		
BICARBONATES (mg/L)	1158.76	1218.10	1153.17	1159.68	1155.23		
ALKALINITY (mg/L)	1158.76	1218.10	1153.17	1159.68	1155.23		

Barredo lab measurements for 19/01/2015 campaign.

# Low Carbon After Life: sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks

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		Barredo			Figaredo D	River Turón (close to source) E	Mariana F	SP3 H	SP4 I	SP5 J	River Turón (close to Figaredo) K	
		100 (SP1) A	200 (SP2) B	4 Pumps ON C								
Multiprobe	No rest	T [°C]	22.93	23.1	22.97	22.2	13	14.75	24.9	22.85	22.81	19
	After 5 min rest	ORP (mV) Eh	-44.9	-39.8	-51.2	-49.4	10	13.01	-62.2	-58.6	-52	24
		Ph	8.02	8.01	8.36	8.13	8.19	8.16	7.96	8.07	8.36	8.06
		Dissolved oxygen [ppm] [mg/L]	1.52	1.52	2.26	2.92	4.08	3.92	2.05	0.39	2.68	5.33
		Electrical conductivity [µS/cm]	2419	2415	2436	2354	528	1118	2450	2415	2417	1246
		TDS	1210	1207	1218	1177	264	559	1225	1207	1209	623
		Salinity	1.24	1.24	1.25	1.21	0.26	0.56	1.26	1.24	1.24	0.63
Alkalinity test	Alkalinity [mmol/l]	17.4	24.9	17.6	16.8	5.2	7.7	17.7	18.8	17.6	8.6	
	Alkalinity [mg/l]	1061.4	1518.9	1073.6	1024.8	317.2	469.7	1079.7	1146.8	1073.6	524.6	
Sulfide test	Sulfides [mg/L]	0.1	0.1	0	0.1	0	0	0.1	0.1	0	0	

Barredo field physiochemistry for 24/06/2015 campaign.

# Low Carbon After Life: sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks

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			Barredo			Figaredo D	River Turón E	Mariana F	SP3 H	SP4 I	SP5 J	River Turón (close to Figaredo) K
			A 100 (SP1)	B 200 (SP2)	C 4 Pumps ON							
Lab measurements (Spain)	Filtered samples	Mn (ppb)	437.1	423.3	433.5	598.1	0.3	37.2	434.2	457.7	438.4	281.2
		Fe (ppb)	5058.1	4429.2	4059.1	4520.2	<0.60	133.4	4389.7	4659.4	4538.6	2106.2
	Unfiltered samples	Mn (mg/L)	0.5	0.7	0.5	0.6	0	0	0.5	0.5	0.5	0.3
		Fe (mg/L)	1.1	4.3	3.3	3.1	0.1	0	2.9	4	3.3	0.1
	Major anions and cations (mg/L)	Li <sup>+</sup>	-	0.14	0.14	-	-	-	0.15	0.17	0.14	-
		Na <sup>+</sup>	393.37	423.80	404.95	366.44	27.67	42.73	409.96	517.38	421.75	75.37
		NH <sub>4</sub> <sup>+</sup>	-	-	-	-	0.61	-	-	-	-	0.91
		K <sup>+</sup>	6.68	6.79	6.79	6.27	2.89	3.11	8.81	7.86	7.26	5.02
		Ca <sup>+2</sup>	144.25	129.86	144.09	152.75	65.51	155.76	156.38	143.78	138.09	131.49
		Mg <sup>+2</sup>	68.96	68.77	72.97	70.76	17.61	45.21	72.34	63.20	71.81	59.83
		F <sup>-</sup>	0.42	0.53	0.64	0.44	0.13	0.12	1.09	0.29	0.43	0.23
		CL <sup>-</sup>	13.31	13.13	13.54	13.88	6.26	8.19	15.40	14.72	15.39	22.43
		NO <sup>-2</sup>	-	-	-	-	-	3.69	-	-	-	-
		Br <sup>-</sup>	-	-	-	-	-	-	-	-	-	-
		NO <sup>-3</sup>	-	-	-	-	3.10	1.03	0.62	-	0.36	3.58
		PO <sub>4</sub> <sup>-3</sup>	-	-	-	-	0.18	-	-	-	-	-
	SO <sub>4</sub> <sup>-2</sup>	657.08	665.91	661.86	646.29	66.26	280.76	696.11	653.70	662.43	631.35	
	TC (mg/L)	193.7	181.2	184.6	186.8	54.7	88.8	197.2	190.1	125.7	70.4	
	IC (mg/L)	191.7	180.8	184.1	185.6	50.1	85.8	193.5	189.5	123.3	66.3	
	TOC (mg/L)	2.0	0.4	0.5	1.2	4.5	3.0	3.7	0.6	2.3	4.1	
CARBONATES (mg/L)	-	-	-	-	-	-	-	-	-	-		
BICARBONATES (mg/L)	969.70	972.34	963.09	941.69	259.34	414.46	970.28	972.90	962.95	472.86		
ALKALINITY (mg/L)	969.70	972.34	963.09	941.69	259.34	414.46	970.28	972.90	962.95	472.86		

Barredo lab measurements for 24/06/2015 campaign.

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		Barredo			Figaredo D	River Turón (close to source) E	Mariana F	SP3 H	SP4 I	SP5 J	River Turón (close to Figaredo) K
		100 (SP1) A	200 (SP2) B	4 Pumps ON C							
Multiprobe	No rest	T [°C]	22.03	23.06	21.69	21.46	14.79	14.6	Intalación parada, no se tomo muestra debido a que el agua llevaba estancada cerca de 2 meses por lo que no es representativa	18.46	
	After 5 min rest	ORP (mV) Eh	-36.4	-40.52	-32.16	-46.2	52.5	3.21		53.5	
		Ph	8.4	8.19	7.95	7.64	8.31	7.76		8.15	
		Dissolved oxygen [ppm] [mg/L]	3.21	2.97	3.46	3.06	6.98	4.51		6.02	
		Electrical conductivity [µS/cm]	2300	2348	2315	2300	469	1125		1649	
		TDS	1150	1174	1157	1150	235	562		824	
		Salinity	1.18	1.21	1.19	1.18	0.23	0.56		0.84	
Alkalinity test	Alkalinity [mmol/l]	16.8	16.1	16.2	16.7	4.3	7.6	11.0			
	Alkalinity [mg/l]	1024.8	982.1	988.2	1018.7	262.3	463.6	671			
Sulfide test	Sulfides [mg/L]	0	0	0	0.1	0	0	0			

Barredo field physiochemistry for 01/09/2015 campaign.

# Low Carbon After Life: sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks

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			Barredo			Figaredo D	River Turón E	Mariana F	SP3 H	SP4 I	SP5 J	River Turón (close to Figaredo) K
			A 100 (SP1)	B 200 (SP2)	C 4 Pumps ON							
Lab measurements (Spain)	Filtered samples	Mn (ppb)	0.5	0.4	0.5	0.6	0.0	0.0				0.3
		Fe (ppb)	3.7	3.4	3.4	2.6	0.0	0.7				0.1
	Unfiltered samples	Mn (mg/L)	0.6	0.5	0.6	0.7	0.3	0.1				0.5
		Fe (mg/L)	4.7	3.9	19	3.7	0	2.6				2.5
	Major anions and cations (mg/L)	Li <sup>+</sup>	0.10	0.14	0.13	0.12	-	-				-
		Na <sup>+</sup>	391.91	403.51	395.90	412.93	31.28	40.33				205.78
		NH <sub>4</sub> <sup>+</sup>	-	-	-	-	0.79	-				-
		K <sup>+</sup>	7.22	7.57	7.49	6.67	3.79	3.36				7.18
		Ca <sup>+2</sup>	138.17	141.63	144.25	140.80	56.63	155.20				117.97
		Mg <sup>+2</sup>	68.43	73.09	71.42	67.16	14.43	46.01				54.20
		F <sup>-</sup>	0.40	0.48	0.44	0.47	0.14	0.14				0.23
		CL <sup>-</sup>	12.92	13.42	13.05	14.57	10.36	9.20				9.57
		NO <sup>-2</sup>	-	-	-	-	-	-				-
		Br <sup>-</sup>	-	0.53	-	-	-	-				-
		NO <sup>-3</sup>	-	-	-	-	1.77	1.12				1.35
		PO <sub>4</sub> <sup>-3</sup>	-	-	-	-	-	-				-
	SO <sub>4</sub> <sup>-2</sup>	598.60	634.46	620.51	607.49	50.57	267.62				385.21	
	TC (mg/L)	196.50	189.90	198.70	194.30	54.70	91.84				123.50	
	IC (mg/L)	193.30	185.55	195.45	189.10	47.37	87.43				119.65	
	TOC (mg/L)	3.20	4.35	3.25	5.20	7.33	4.41				3.85	
CARBONATES (mg/L)	-	-	-	-	-	-				-		
BICARBONATES (mg/L)	961.37	976.04	970.46	996.63	245.27	440.60				654.85		
ALKALINITY (mg/L)	961.37	976.04	970.46	996.63	245.27	440.60				654.85		

Barredo lab measurements for 01/09/2015 campaign.



# Low Carbon After Life: sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks

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Water origin	Sampling name	Description	Considerations
Mine water from Barredo shaft	A	Pump place at circa 100 m depth	
	B	Pump place at circa 200 m depth	
	C	The four pumps working at the same time (3pumps 100m depth+1pump 200m depth)	Some times it is not posible to sample under this conditions
Mine water from Figaredo shaft	D	Pump placed at circa 100m depth	(Barredo and Figaredo have hydraulic conexions) Figaredo wellhead is placed in an upper horizon than Barredo, so in dry periods can occur that there is not enoth water for pump Figaredo
Mariana adit	F	Not pumped, sample taken directly from the adit	Before it was connected with Barredo, now the conection has been sealed
Turón river	E	Sample taken close to the source of the river	Turón river infiltrates in Figaredo workings
	K	Sample taken after downstream to Figaredo workings	
Rainwater Oviedo		Taken directly from the roof of the Mines School	A picture of the homemade vessel to the water collection can be seen at the right hand

**Key for Barredo system sampling site locations for isotopic analyses.**

Description	Sample	$\delta^{18}\text{O}_{\text{VSMOW}}$ (‰)	$\delta^2\text{D}_{\text{VSMOW}}$ (‰)
Rainwater Oviedo	Jul 15 (1)	-1.9	-11
	Jul 15 (2)	-1.9	-12
	aug 15	-2.0	-13.6
	Nov-15	-2.5	-19
Jun-15	A (1)	-7.4	-45
	A (2)	-7.4	-43
	B (1)	-7.4	-43
	B (2)	-7.4	-45
	C (1)	-7.6	-46
	C (2)	-7.3	-45
	D (1)	-7.4	-47
	D (2)	-7.6	-46
	E (1)	-7.6	-45
	E (2)	-7.8	-43
	F (1)	-7.2	-43
	F (2)	-7.2	-42
	K (1)	-7.5	-46
	K (2)	-7.3	-43
Sep-15	A (1)	-7.2	-45
	A (2)	-7.0	-43
	B (1)	-7.4	-45
	B (2)	-7.3	-45
	C (1)	-7.3	-46
	C (2)	-7.5	-46
	D (1)	-7.5	-48
	D (2)	-7.6	-48
	E (1)	-7.2	-42
	E (2)	-7.1	-41
	F (1)	-7.0	-43
	F (2)	-7.3	-42
	K (1)	-7.7	-46
	K (2)	-7.6	-45
Nov-15	A (1)	-7.3	-47
	A (2)	-7.3	-46
	B (1)	-7.5	-47
	B (2)	-7.3	-46
	E (1)	-7.5	-44
	E (2)	-7.5	-44
	F (1)	-7.2	-41
	F (2)	-7.1	-42
	K (1)	-7.7	-47
	K (2)	-7.5	-47

Baseline isotopic data from Barredo.