

**University of Stuttgart**  
Germany



# Analytische Qualitätssicherung Baden-Württemberg

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Proficiency Test 12/23  
BOD<sub>5</sub> in waste water

Final report

provided by  
AQS Baden-Württemberg at  
Institute for Sanitary Engineering, Water Quality and Solid Waste Management,  
University of Stuttgart  
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on behalf of the Ministry of the Environment, Climate Protection  
and the Energy Sector Baden-Württemberg

Stuttgart, in February 2024

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<b>Version of the report</b>	1	

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## 1. General

This PT was provided by AQS Baden-Württemberg in the framework of the nation-wide conducted waste water PT scheme in Germany. This PT scheme is based on the requirements of the German Working Group on water issues of the Federal States and the Federal Government (LAWA), which fixed the way of doing PTs in the regulated environmental sector in its AQS-leaflet A-3 for the analysis of water, waste water and sludge. These PTs are conducted together with several PT providers nationwide in Germany in a harmonised way.

The PT was executed and evaluated according to the requirements of DIN 38402-A45 and ISO/TS 20612.

## 2. PT design

Each participant received the following samples:

- 3 sample for the determination of BOD<sub>5</sub> in 3 x 2 1000-ml-glass bottles with skrew cap. Preservation by autoclaving. Because of autoclaving, there was no need to cool the samples.

12 different concentration levels/batches were produced. The concentration levels were randomly allocated to the participants. It was ensured that each participant received one concentration level from their concentration level 1–4, 5-8 and 9-12.

## 3. Sample preparation

The samples for the above mentioned parameters were based on a real waste water matrix. The waste water was filtered by using 5 µm and 1 µm filter cartridges to eliminate particles. To reduce germs, the waste water was irradiated with ultraviolet light and pasteurised at 80°C in a stainless steel vessel overnight. During pasteurisation, the waste water was aerated with a mixture composed of carbon dioxide and nitrogen to prevent calcium carbonate precipitation.

The waste water was spiked with stock solutions. The concentrations covered waste water relevant ranges.

## 4. Sample distribution

The samples were dispatched on 28 August 2023 by express service (GoExpress).

## 5. Analytical methods

The participants were restricted to use one analytical method according to the actual requirements of the “Technical Module Water” from the German Working group on water issues of the Federal States and the Federal Government (LAWA) as well as to the “Waste water regulations” in Germany.

<b>Parameter</b>	<b>Method according to the actual issue of the module water and the German waste water regulation</b>
BOD <sub>5</sub>	DIN EN 1899-1: 1998-05 (H51) DIN EN ISO 5815-1: 2020-11 (H50)

Laboratories outside of Germany were free to choose an analytical method.

The samples had to be analysed in duplicate over the complete method (sample preparation and measurement). The participants were asked to submit the results as average values in mg/l with three significant digits.

A lower limit of quantification of 3 mg/l had to be achieved in the PT.

## 6. Submission of the results

The deadline for the submission of results was on 15 September 2023. Results submitted after the deadline were not accepted.

## 7. Basic principle of evaluation and assessment

The basic principle of the evaluation and assessment of the PTs from AQS Baden-Württemberg are described in the document „Evaluation of the PTs and information for the report“, which can be downloaded from [www.aqsbw.de/pdf/ausw\\_berichte\\_v1\\_en.pdf](http://www.aqsbw.de/pdf/ausw_berichte_v1_en.pdf).

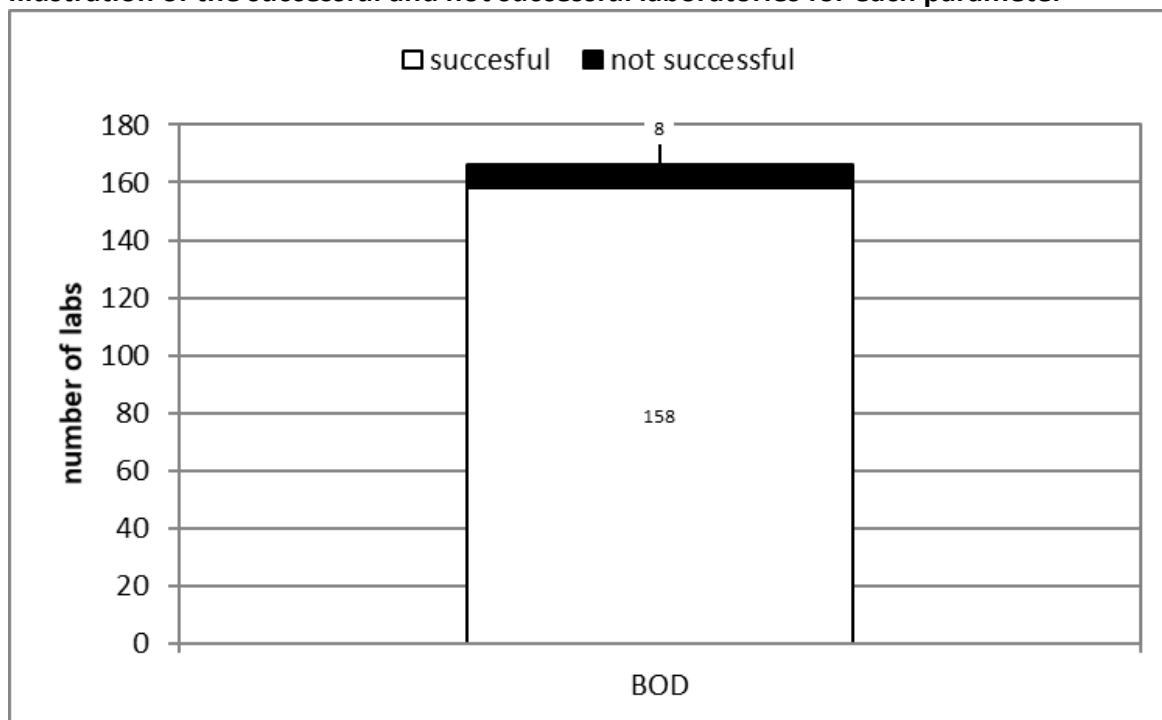
This PT was evaluated as follows:

<b>Assigned value <math>x_{pt}</math>:</b>	Consensus value (Hampel estimator)						
<b>Standard deviation for proficiency assessment <math>\sigma_{pt}</math>:</b>	Q method Variance function						
<b>Upper limit of <math>\sigma_{pt}</math>:</b>	20 %						
<b>Lower limit of <math>\sigma_{pt}</math>:</b>	10 %						
<b>Assessment:</b>	$z_U$ -Score						
<b>Classification of the single results:</b>	<table style="border: none;"> <tr> <td style="padding-right: 20px;"><math> z_U  \leq 2,0</math></td> <td>successful</td> </tr> <tr> <td><math>2,0 &lt;  z_U  &lt; 3,0</math></td> <td>questionable</td> </tr> <tr> <td><math> z_U  \geq 3,0</math></td> <td>unsatisfactory</td> </tr> </table>	$ z_U  \leq 2,0$	successful	$2,0 <  z_U  < 3,0$	questionable	$ z_U  \geq 3,0$	unsatisfactory
$ z_U  \leq 2,0$	successful						
$2,0 <  z_U  < 3,0$	questionable						
$ z_U  \geq 3,0$	unsatisfactory						
<b>Parameter assessment:</b>	A parameter was assessed as successful, if more than half of the values were correctly determined (2 out of 3 values are within the tolerance limits).						

## 8. Evaluation

<b>Number of participants:</b>	168 2 labs reported no results
<b>Number of reported values</b>	498
<b>Number of accepted values:</b>	466 (93,6 %)

### Illustration of the successful and not successful laboratories for each parameter



## 9. Explanation for the appendices

The explanations for the appendices can be found in the document „Evaluation of the PTs and information for the report“ which can be downloaded from [www.agsbw.de/pdf/ausw\\_berichte\\_v1\\_en.pdf](http://www.agsbw.de/pdf/ausw_berichte_v1_en.pdf).

## 10. Measurement uncertainty

### General:

Number of labs with valid values	166
Number of labs with valid values and reported measurement uncertainties	111 (66,9 %)
Number of valid values	498
Number of valid values with measurement uncertainties	333 (66,9 %)

**Measurement uncertainties against the accreditation status**

Accreditation status of the values	Number of values	Number of values with measurement uncertainty
accredited	360	273 (75,8 %)
not accredited	69	21 (30,4 %)
not specified	69	39 (56,5 %)

**Interpretation of the reported measurement uncertainties:**

If measurement uncertainties are underestimated values assessed as “satisfactory” in the PT ( $|z_U| \leq 2$ ), will have a large  $\zeta$ -score.  $|\zeta| > 2$  means that the “own” requirements (defined in terms of estimated uncertainty) are not fulfilled.

<b>Number of values with reported measurement uncertainty having a <math> z_U  \leq 2,0</math></b>	313
<b>Number of values with a magnitude of <math>\zeta</math>-scores <math>&gt; 2</math></b> The own requirements of the laboratory are not fulfilled and the estimation of the measurement uncertainty is too low	25 (8 %)

**11. Traceable reference values**

The explanations about traceable reference values can be found in the document „Evaluation of the PTs and information for the report“, which can be downloaded from [www.aqsbw.de/pdf/ausw\\_berichte\\_v1\\_en.pdf](http://www.aqsbw.de/pdf/ausw_berichte_v1_en.pdf).

**12. Internet**

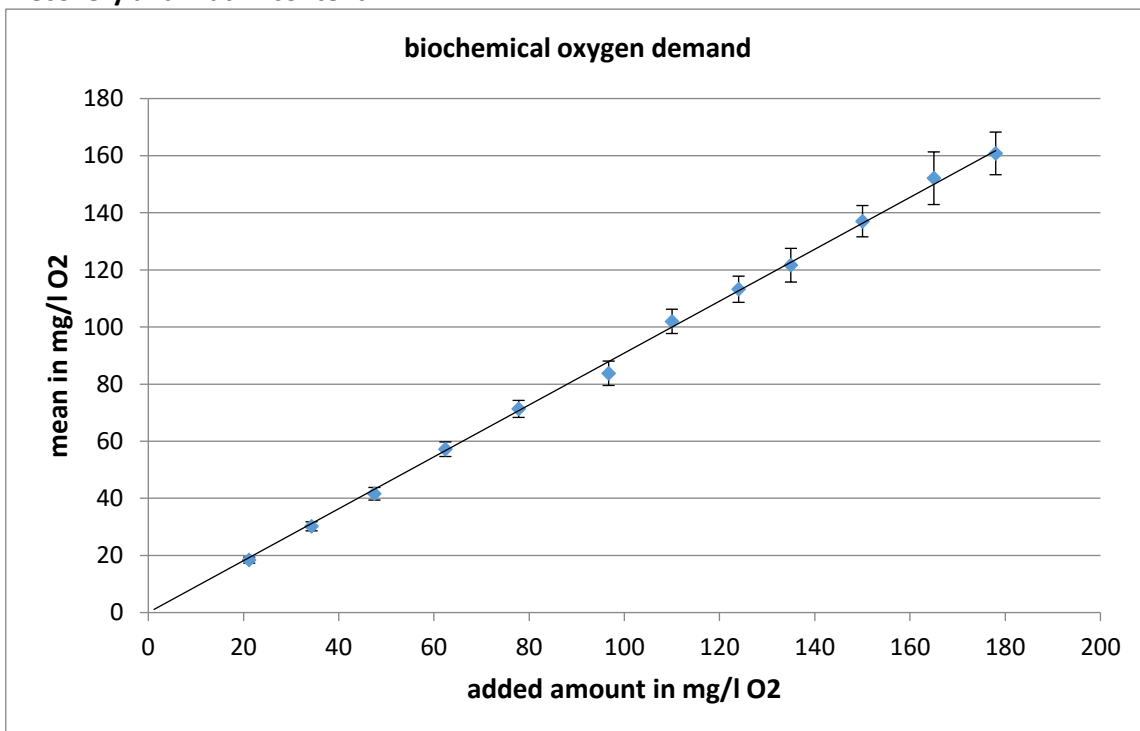
The report is available on the following webpage: [www.aqsbw.de/pdf/288/report\\_288.pdf](http://www.aqsbw.de/pdf/288/report_288.pdf)



# biochemical oxygen demand

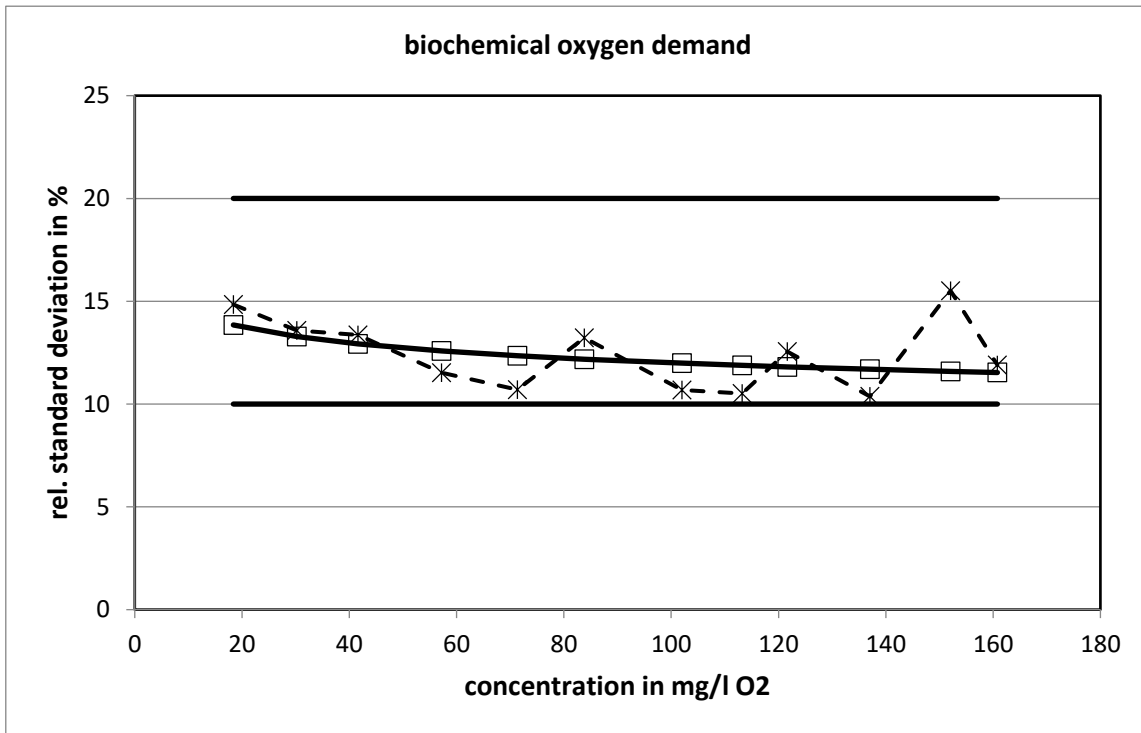
level	assigned value [mg/l O <sub>2</sub> ]	expanded uncertainty of the assigned value [%]	standard deviation, calculated using robust statistics [mg/l O <sub>2</sub> ]	standard deviation from variance function [mg/l O <sub>2</sub> ]	standard deviation for proficiency assessment [mg/l O <sub>2</sub> ]	standard deviation for proficiency assessment [%]	upper tolerance limit [mg/l O <sub>2</sub> ]	lower tolerance limit [mg/l O <sub>2</sub> ]	upper tolerance limit [%]	lower tolerance limit [%]	number of results	out below	out above	out [%]
1	18,38	5,72	2,727	2,545	2,545	13,85	23,87	13,59	29,89	-26,03	42	2	2	9,5
2	30,19	5,24	4,103	4,010	4,010	13,28	38,82	22,64	28,56	-25,02	42	2	2	9,5
3	41,60	5,28	5,561	5,377	5,377	12,93	53,15	31,46	27,74	-24,39	40	3	0	7,5
4	57,19	4,45	6,593	7,197	7,197	12,58	72,61	43,60	26,95	-23,78	42	0	2	4,8
5	71,31	4,18	7,635	8,808	8,808	12,35	90,16	54,65	26,42	-23,36	41	1	0	2,4
6	83,80	5,10	11,08	10,21	10,21	12,18	105,6	64,48	26,04	-23,06	42	0	3	7,1
7	102,0	4,17	10,90	12,22	12,22	11,98	128,1	78,83	25,58	-22,70	41	1	1	4,9
8	113,2	4,05	11,90	13,45	13,45	11,88	141,9	87,73	25,34	-22,51	42	1	0	2,4
9	121,6	4,84	15,26	14,36	14,36	11,81	152,3	94,42	25,18	-22,38	42	1	0	2,4
10	137,1	4,00	14,22	16,02	16,02	11,69	171,2	106,7	24,91	-22,17	42	2	1	7,1
11	152,1	6,05	23,59	17,62	17,62	11,59	189,6	118,7	24,68	-21,98	41	5	1	14,6
12	160,8	4,65	19,14	18,55	18,55	11,53	200,3	125,6	24,55	-21,89	41	2	0	4,9
sum											498	20	12	6,4

## Recovery and matrix content

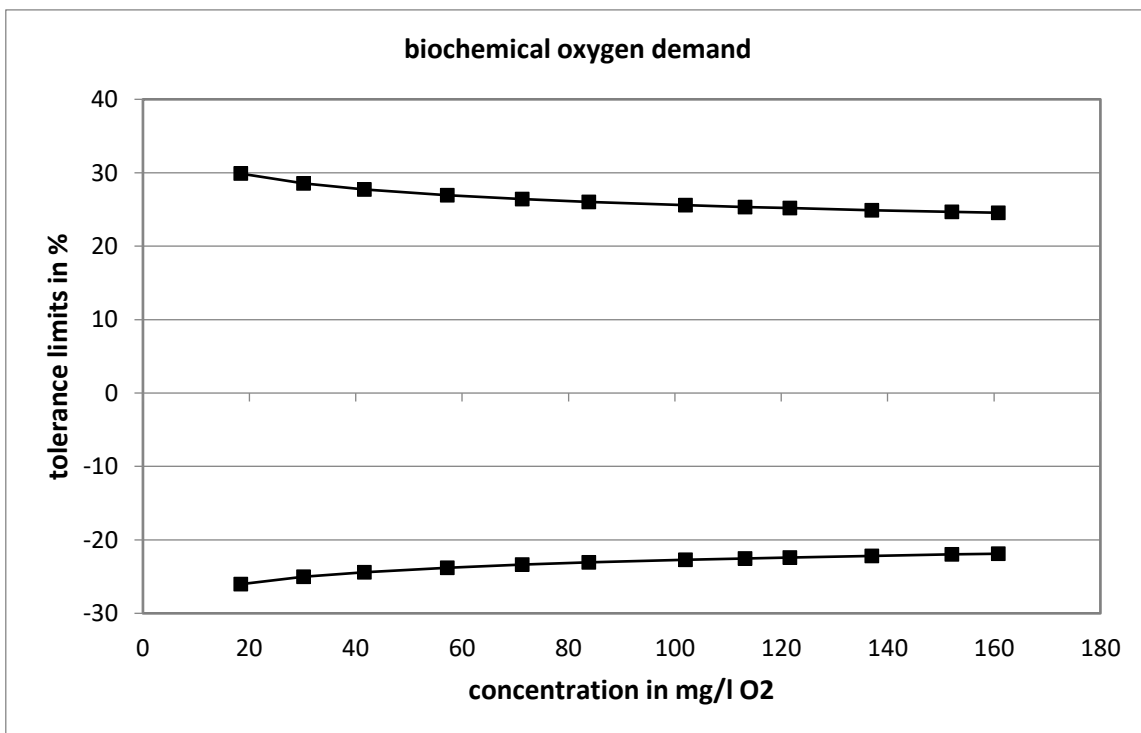


Slope of the regression: 0,919; average recovery rate: 91,9 %  
 The matrix content was 0 mg/l O<sub>2</sub>

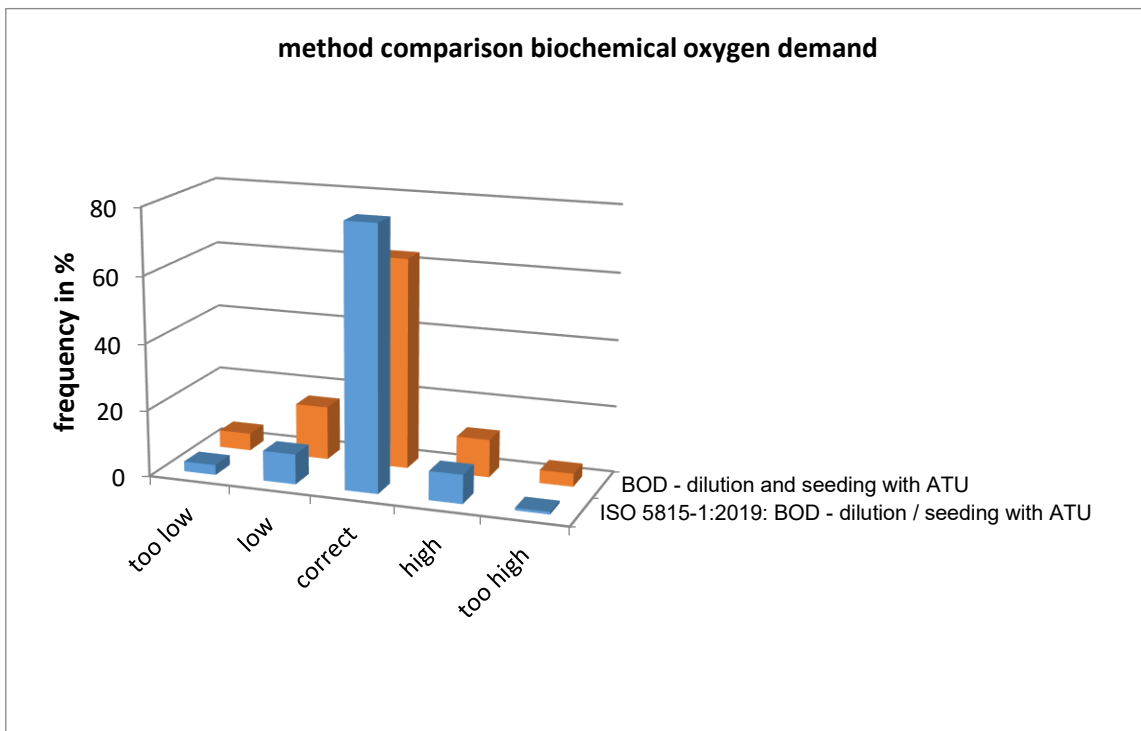
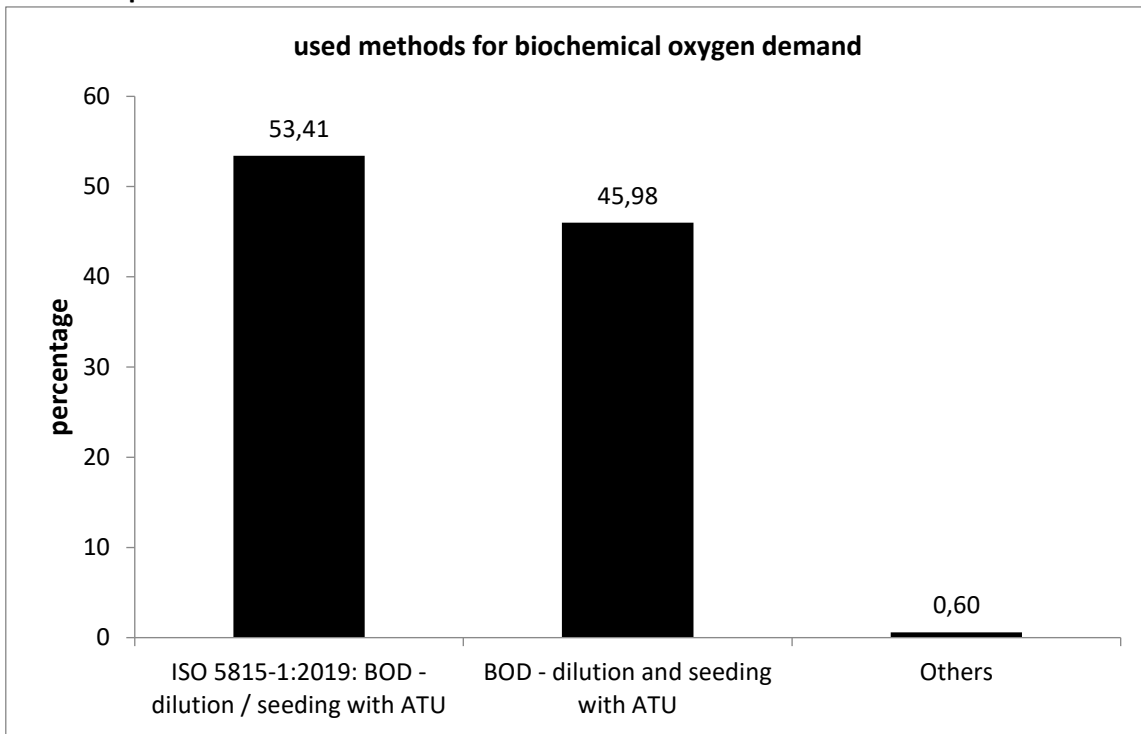
Relative standard deviation and tolerance limits



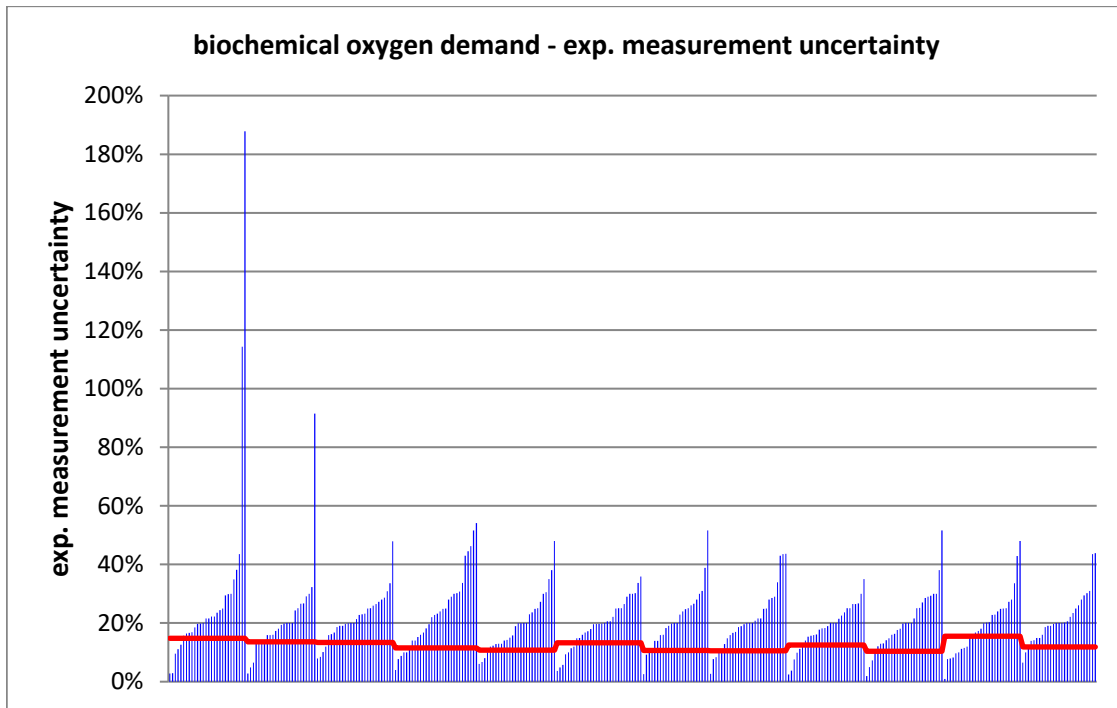
The relative standard deviations calculated with the variance function did not reach the limits.



Method specific evaluation



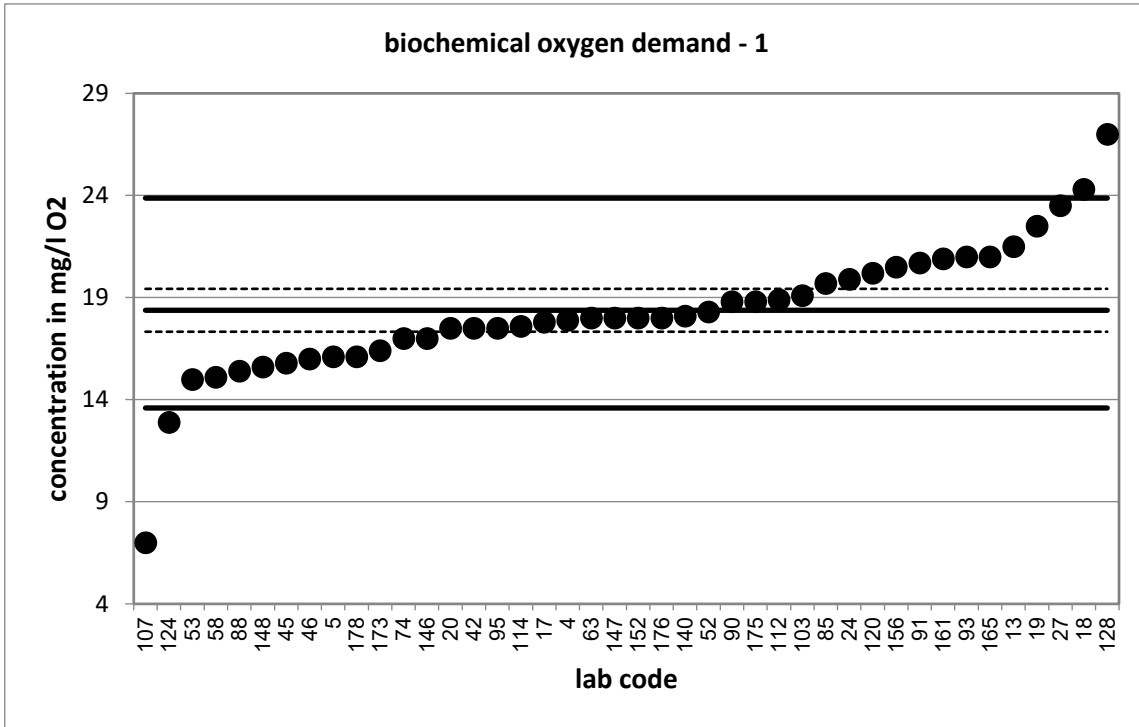
The values determined with ISO 5815-1 showed the closest statistical distribution.



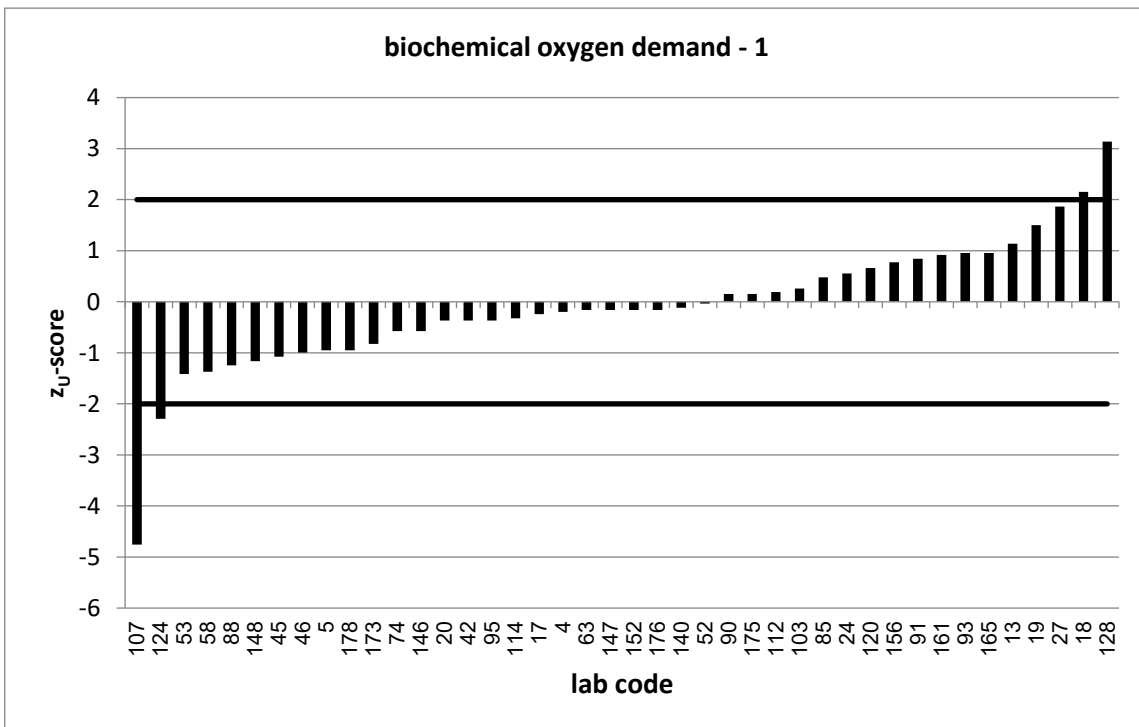
BOD5		biochemical oxygen demand - 1			
assigned value [mg/l O2]*		18,38 ± 1,05			
upper tolerance limit [mg/l O2]		23,87			
lower tolerance limit [mg/l O2]		13,59			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
4	17,9			-0,2	s
5	16,1	3,22	-1,3	-1,0	s
13	21,5	4,64	1,3	1,1	s
17	17,8	3	-0,4	-0,2	s
18	24,3	2,7	4,1	2,2	q
19	22,5	8,6	1,0	1,5	s
20	17,5	20	-0,1	-0,4	s
24	19,9			0,6	s
27	23,5			1,9	s
42	17,5	2,75	-0,6	-0,4	s
45	15,8	2	-2,3	-1,1	s
46	16			-1,0	s
52	18,3	7,97	0,0	0,0	s
53	15			-1,4	s
58	15,1	3	-2,1	-1,4	s
63	18	4	-0,2	-0,2	s
74	17	5	-0,5	-0,6	s
85	19,7	37	0,1	0,5	s
88	15,4			-1,2	s
90	18,8	3,7	0,2	0,2	s
91	20,7	0,59	3,8	0,8	s
93	21	2	2,3	1,0	s
95	17,5			-0,4	s
103	19,1			0,3	s
107	7			-4,8	u
112	18,9			0,2	s
114	17,6	2,9	-0,5	-0,3	s
120	20,2			0,7	s
124	12,9			-2,3	q
128	27	5	3,4	3,1	u
140	18,1	5,4	-0,1	-0,1	s
146	17	4	-0,7	-0,6	s
147	18	4	-0,2	-0,2	s
148	15,6	3,36	-1,6	-1,2	s
152	18	0,5	-0,7	-0,2	s
156	20,5	5	0,8	0,8	s
161	20,9	6,27	0,8	0,9	s
165	21	5,25	1,0	1,0	s
173	16,4			-0,8	s
175	18,8			0,2	s
176	18	3	-0,2	-0,2	s
178	16,1	5,62	-0,8	-1,0	s

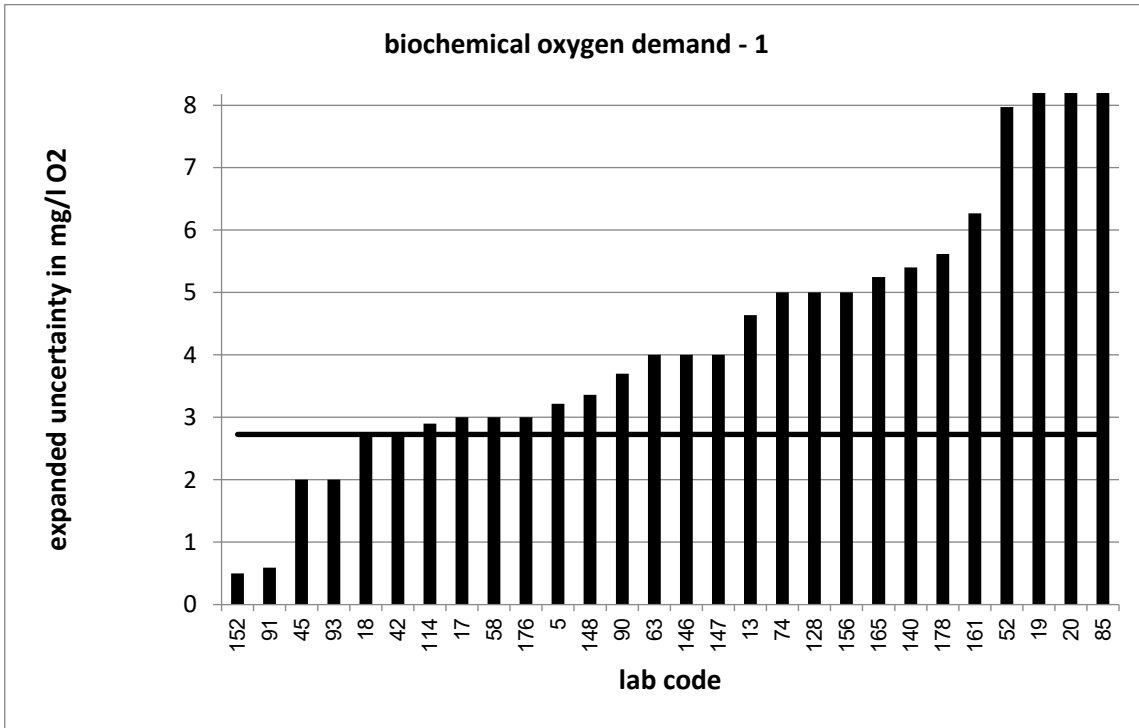
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor  $k=2$  corresponding to a confidence level of about 95%

\*\* s = satisfactory, q = questionable, u = unsatisfactory

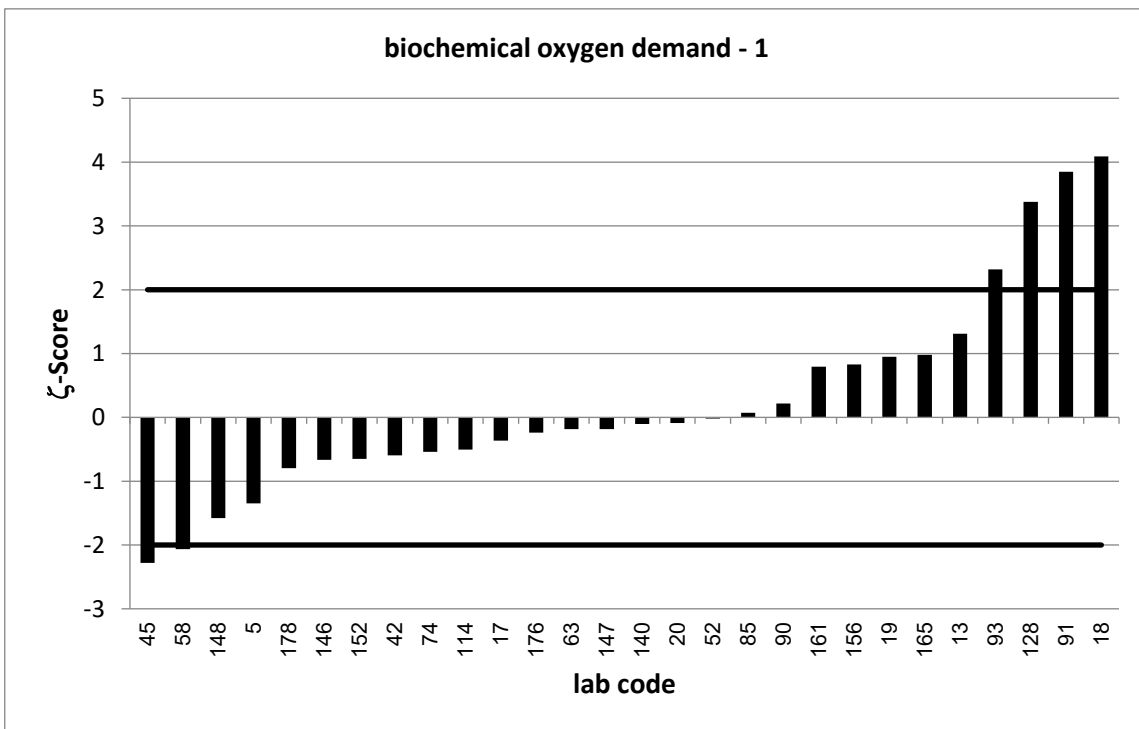


Strongly deviating values are not shown in the diagram.





Strongly deviating values are not correctly shown in the diagram.

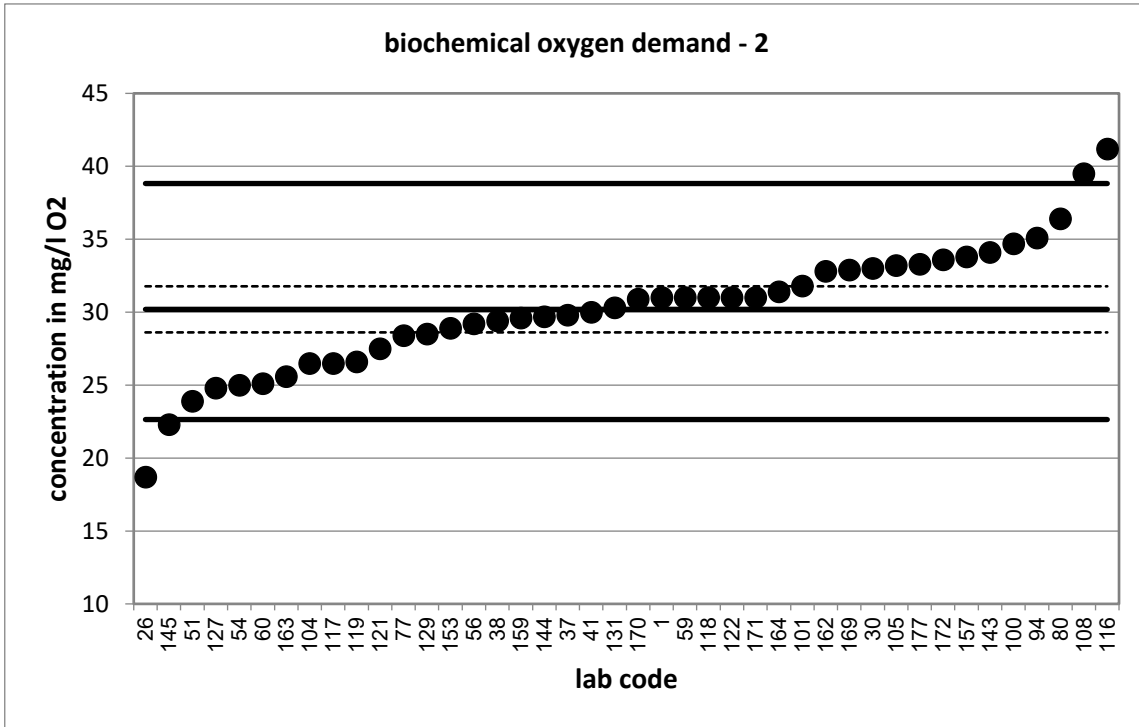


BOD5		biochemical oxygen demand - 2			
assigned value [mg/l O2]*		30,19 ± 1,58			
upper tolerance limit [mg/l O2]		38,82			
lower tolerance limit [mg/l O2]		22,64			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
1	31	6,2	0,3	0,2	s
26	18,7	5	-4,4	-3,0	u
30	33	4,6	1,2	0,7	s
37	29,8	3,88	-0,2	-0,1	s
38	29,4	5,9	-0,3	-0,2	s
41	30			-0,1	s
51	23,9			-1,7	s
54	25			-1,4	s
56	29,2			-0,3	s
59	31	6	0,3	0,2	s
60	25,1			-1,3	s
77	28,4			-0,5	s
80	36,4	1,02	6,6	1,4	s
94	35,1			1,1	s
100	34,7	5,55	1,6	1,0	s
101	31,8	4,13	0,7	0,4	s
104	26,5			-1,0	s
105	33,2			0,7	s
108	39,5			2,2	q
116	41,2	10	2,2	2,6	q
117	26,5	1,3	-3,6	-1,0	s
118	31	2	0,6	0,2	s
119	26,6	4,8	-1,4	-1,0	s
121	27,5	6,9	-0,8	-0,7	s
122	31	10	0,2	0,2	s
127	24,8			-1,4	s
129	28,5			-0,4	s
131	30,3	6	0,0	0,0	s
143	34,1	5,41	1,4	0,9	s
144	29,7			-0,1	s
145	22,3	6,5	-2,4	-2,1	q
153	28,9			-0,3	s
157	33,8			0,8	s
159	29,6	4,2	-0,3	-0,2	s
162	32,8	30	0,2	0,6	s
163	25,6	4,43	-2,0	-1,2	s
164	31,4	8,36	0,3	0,3	s
169	32,9	6,58	0,8	0,6	s
170	30,9	4,9	0,3	0,2	s
171	31	9,3	0,2	0,2	s
172	33,6			0,8	s
177	33,3			0,7	s

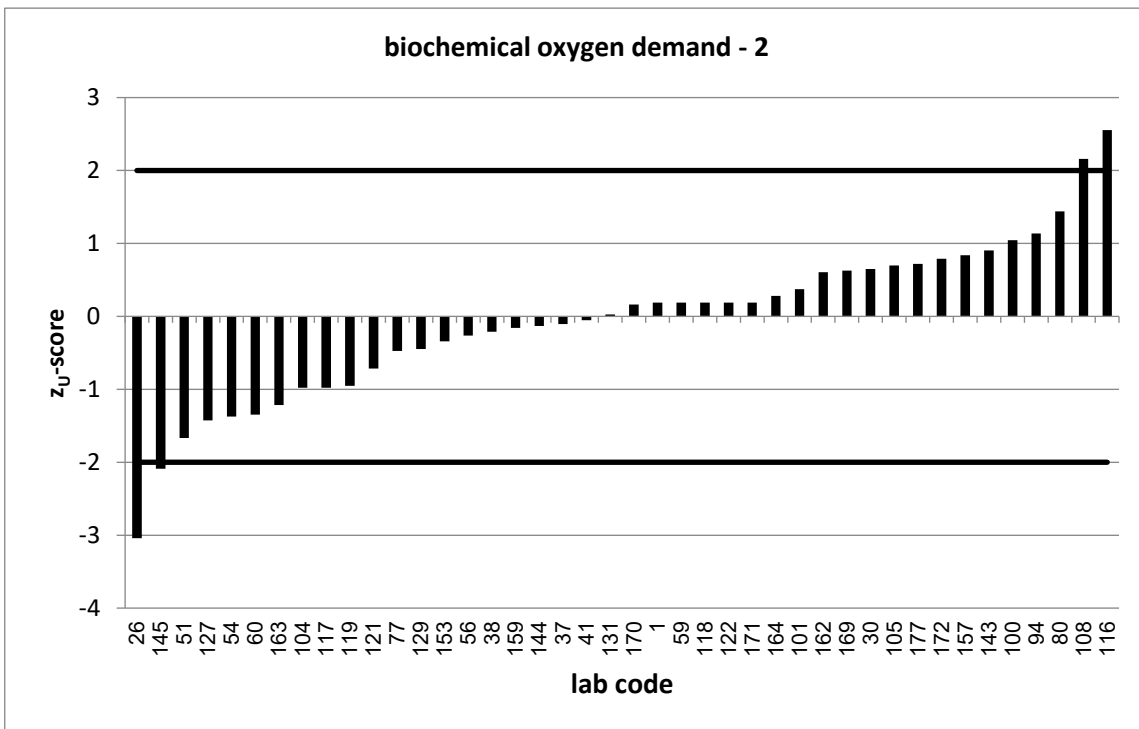
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor k=2 corresponding to a confidence level of about 95%

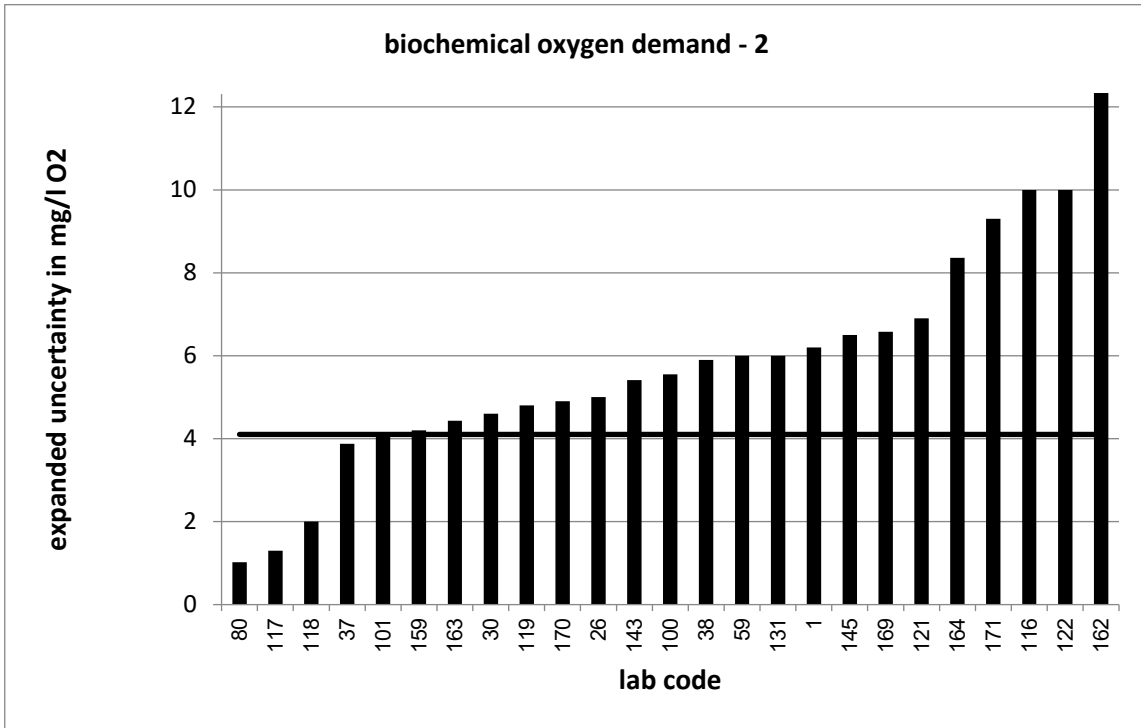
\*\* s = satisfactory, q = questionable, u = unsatisfactory



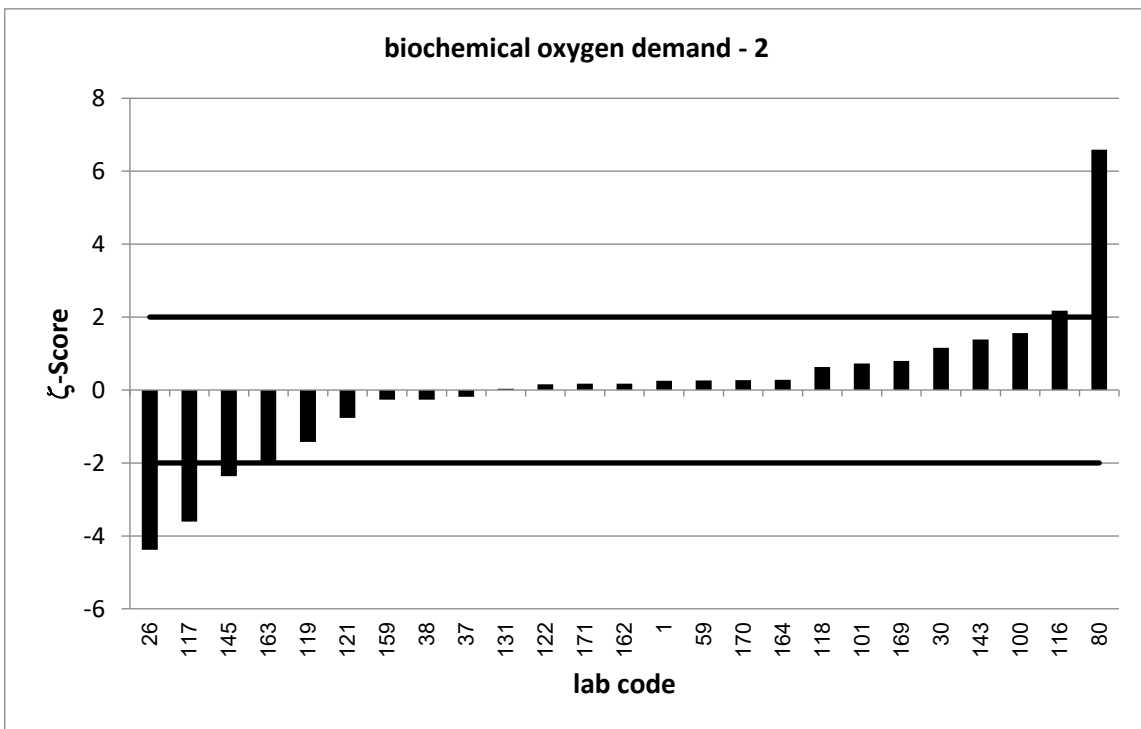


Strongly deviating values are not shown in the diagram.





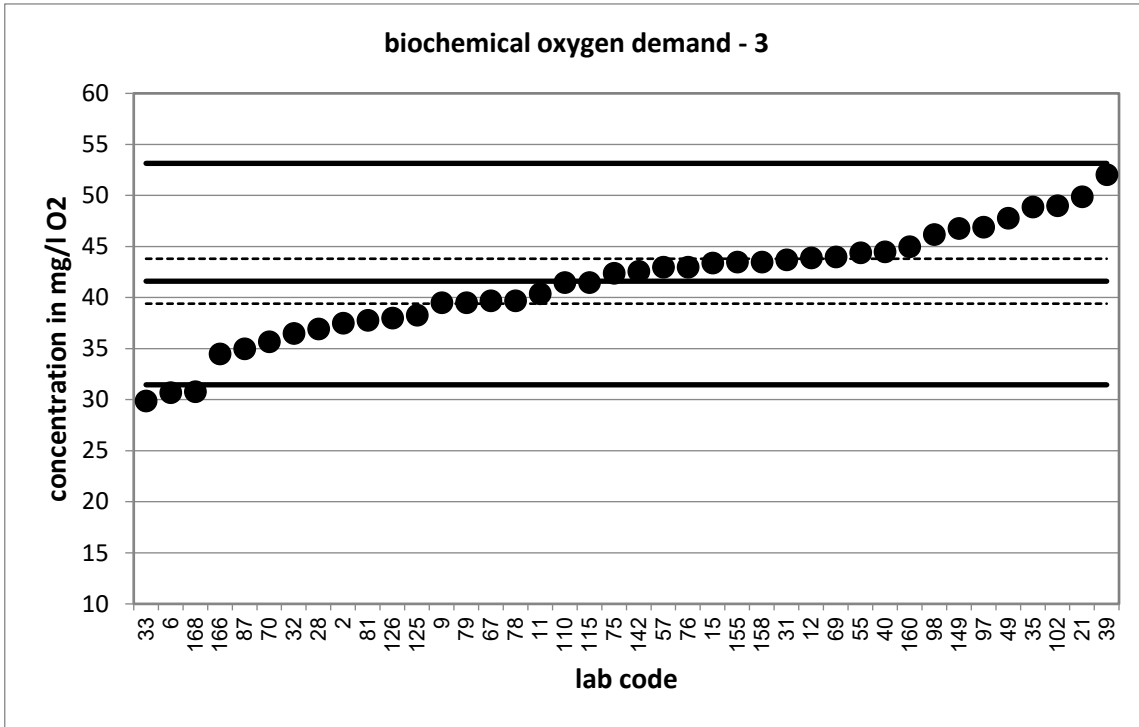
Strongly deviating values are not correctly shown in the diagram.



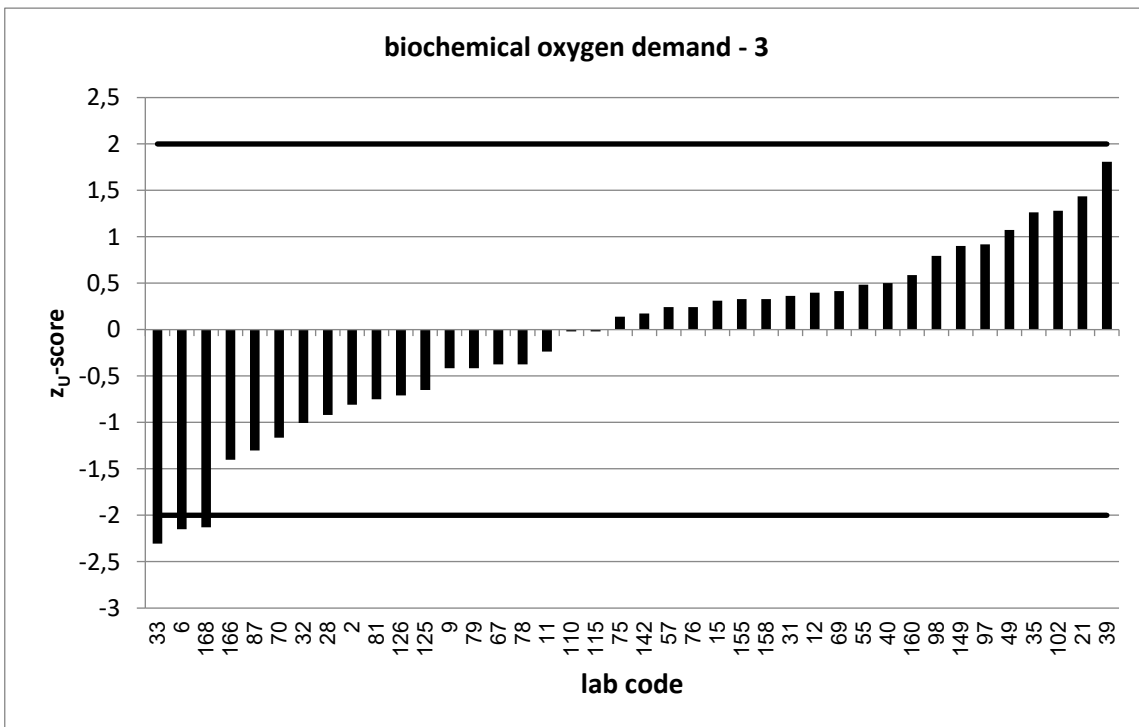
BOD5		biochemical oxygen demand - 3			
assigned value [mg/l O2]*		41,6 ± 2,2			
upper tolerance limit [mg/l O2]		53,15			
lower tolerance limit [mg/l O2]		31,46			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
2	37,5	6,97	-1,1	-0,8	s
6	30,7			-2,1	q
9	39,5			-0,4	s
11	40,4			-0,2	s
12	43,9	10	0,4	0,4	s
15	43,4	5,21	0,6	0,3	s
21	49,9			1,4	s
28	36,94	6	-1,5	-0,9	s
31	43,7			0,4	s
32	36,5	3,7	-2,4	-1,0	s
33	29,9			-2,3	q
35	48,9	13,7	1,1	1,3	s
39	52,04			1,8	s
40	44,5	7,07	0,8	0,5	s
49	47,8	13	0,9	1,1	s
55	44,4	8,44	0,6	0,5	s
57	43			0,2	s
67	39,7	9,12	-0,4	-0,4	s
69	44	7,37	0,6	0,4	s
70	35,7	12	-1,0	-1,2	s
75	42,4	13,1	0,1	0,1	s
76	43	10	0,3	0,2	s
78	39,7	10,3	-0,4	-0,4	s
79	39,5	7,9	-0,5	-0,4	s
81	37,8	18,1	-0,4	-0,7	s
87	35	9,27	-1,4	-1,3	s
97	46,9	10	1,0	0,9	s
98	46,2	11,6	0,8	0,8	s
102	49	9,8	1,5	1,3	s
110	41,5	3,5	-0,1	0,0	s
115	41,5	11,9	0,0	0,0	s
125	38,3	7,28	-0,9	-0,7	s
126	38	7,5	-0,9	-0,7	s
142	42,6	8,5	0,2	0,2	s
149	46,8	3,7	2,4	0,9	s
155	43,5			0,3	s
158	43,5			0,3	s
160	45			0,6	s
166	34,5			-1,4	s
168	30,8	7,7	-2,7	-2,1	q

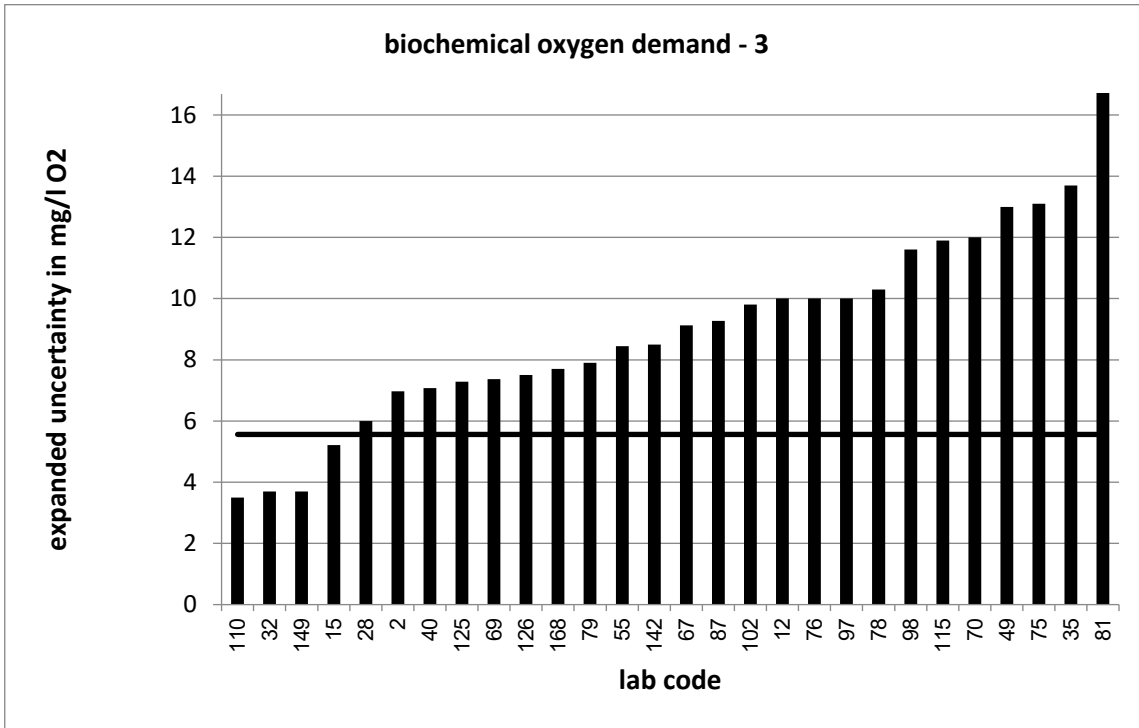
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\*\* s = satisfactory, q = questionable, u = unsatisfactory

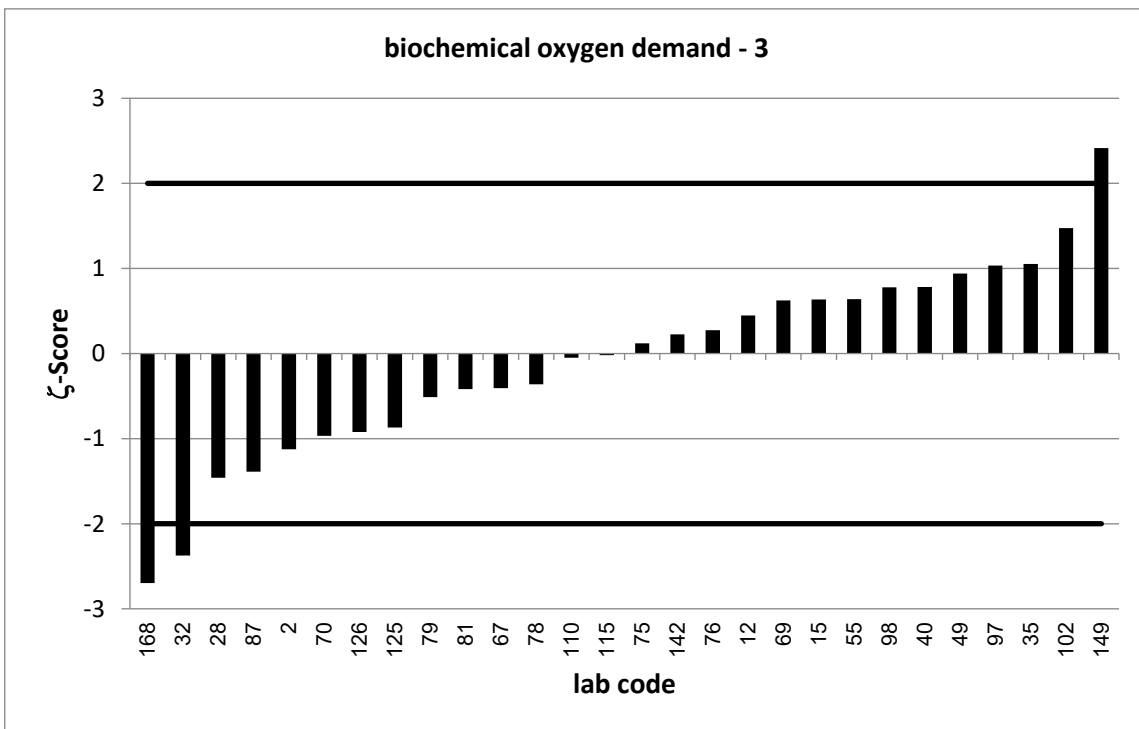


Strongly deviating values are not shown in the diagram.





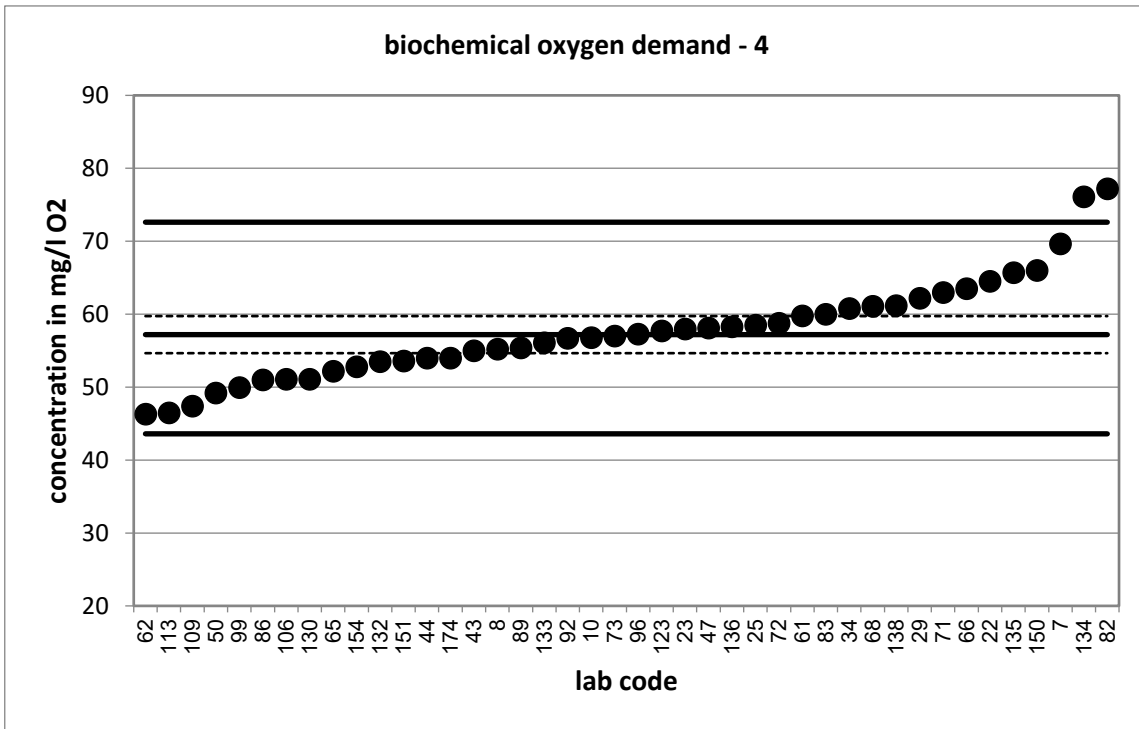
Strongly deviating values are not correctly shown in the diagram.



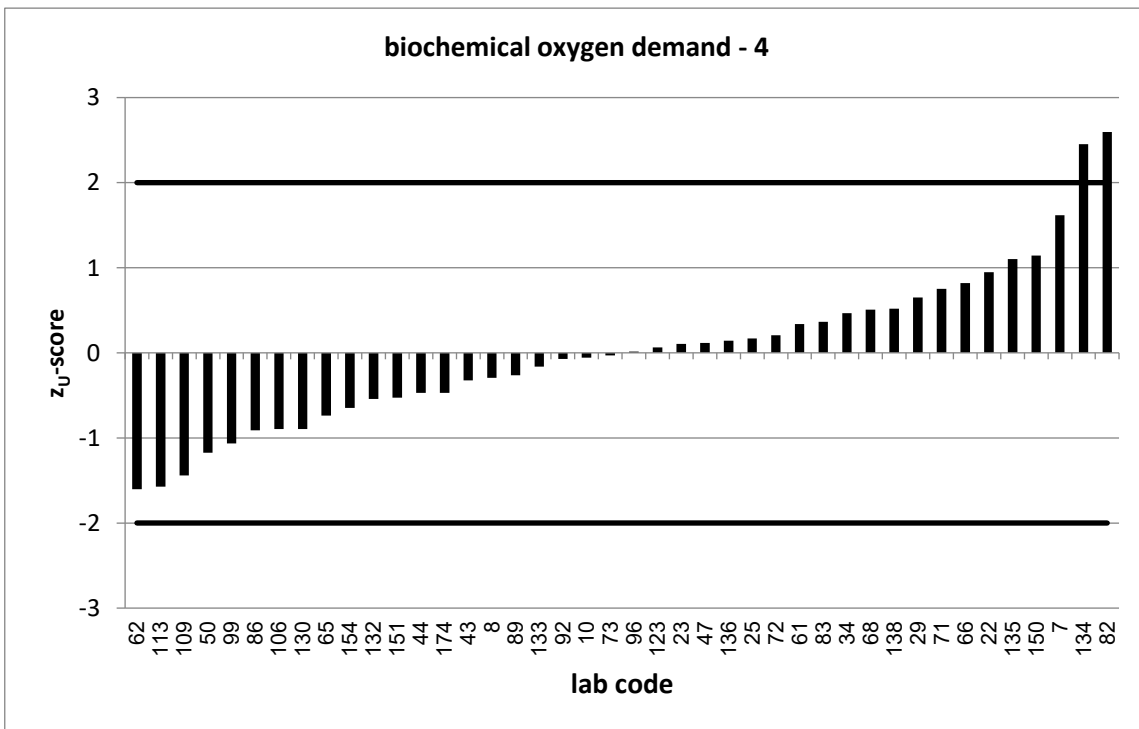
BOD5		biochemical oxygen demand - 4			
assigned value [mg/l O2]*		57,19 ± 2,54			
upper tolerance limit [mg/l O2]		72,61			
lower tolerance limit [mg/l O2]		43,6			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
7	69,675	31	0,8	1,6	s
8	55,2	16,7	-0,2	-0,3	s
10	56,8	30,72	0,0	-0,1	s
22	64,5	15	1,0	0,9	s
23	58	9,3	0,2	0,1	s
25	58,5			0,2	s
29	62,2	8,7	1,1	0,6	s
34	60,8	15,14	0,5	0,5	s
43	55	5,5	-0,7	-0,3	s
44	54	25	-0,3	-0,5	s
47	58,1	2,33	0,5	0,1	s
50	49,2	25,4	-0,6	-1,2	s
61	59,8	4,6	1,0	0,3	s
62	46,3	13,9	-1,5	-1,6	s
65	52,19	11,51	-0,8	-0,7	s
66	63,5	7,62	1,6	0,8	s
68	61,1			0,5	s
71	63			0,8	s
72	58,79			0,2	s
73	57	8,66	0,0	0,0	s
82	77,2	21,6	1,8	2,6	q
83	60			0,4	s
86	51	10	-1,2	-0,9	s
89	55,4	9,26	-0,4	-0,3	s
92	56,7	5	-0,2	-0,1	s
96	57,3			0,0	s
99	49,95	4,99	-2,6	-1,1	s
106	51,1			-0,9	s
109	47,4			-1,4	s
113	46,5	11,6	-1,8	-1,6	s
123	57,7			0,1	s
130	51,1	21,99	-0,6	-0,9	s
132	53,5	15,5	-0,5	-0,5	s
133	56,1	18,9	-0,1	-0,2	s
134	76,1			2,5	q
135	65,7	9,2	1,8	1,1	s
136	58,3	14	0,2	0,1	s
138	61,2			0,5	s
150	66	12	1,4	1,1	s
151	53,6	16,5	-0,4	-0,5	s
154	52,8	12	-0,7	-0,6	s
174	54			-0,5	s

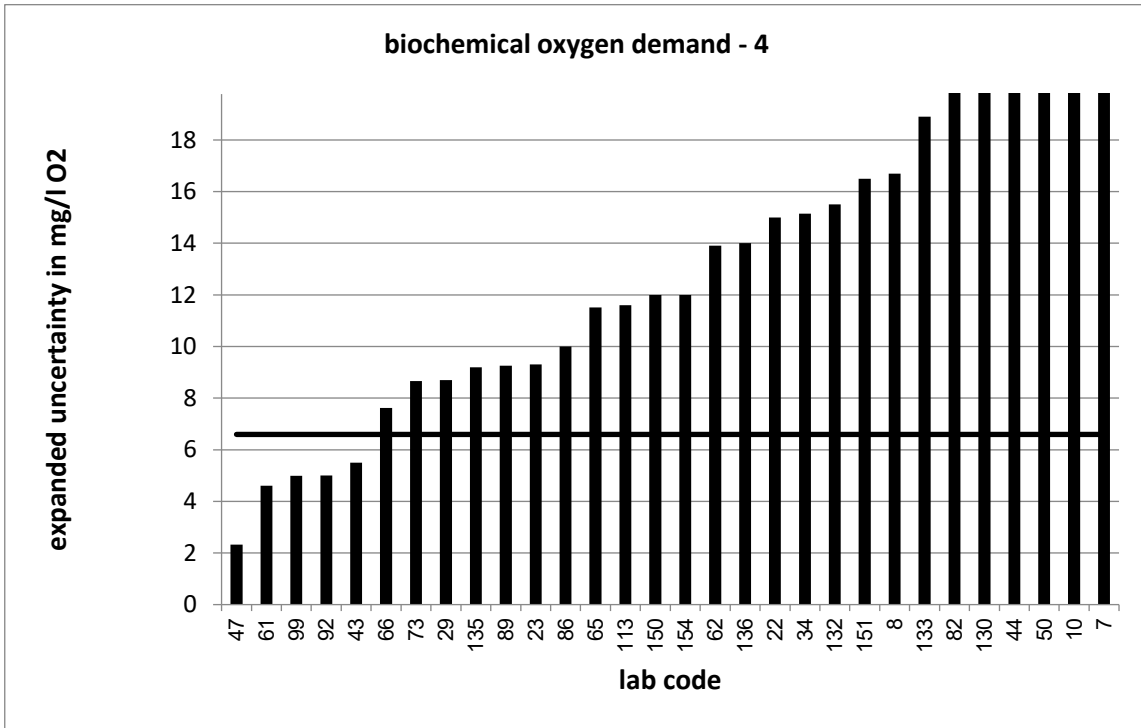
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor k=2 corresponding to a confidence level of about 95%

\*\* s = satisfactory, q = questionable, u = unsatisfactory

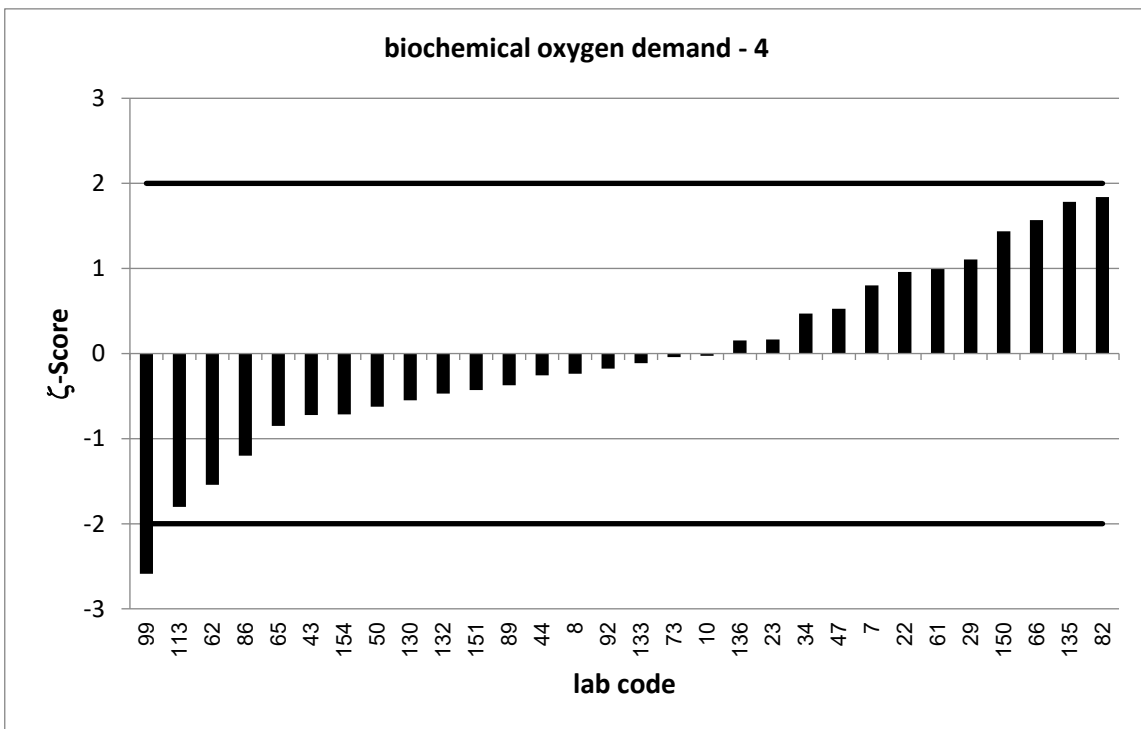


Strongly deviating values are not shown in the diagram.





Strongly deviating values are not correctly shown in the diagram.

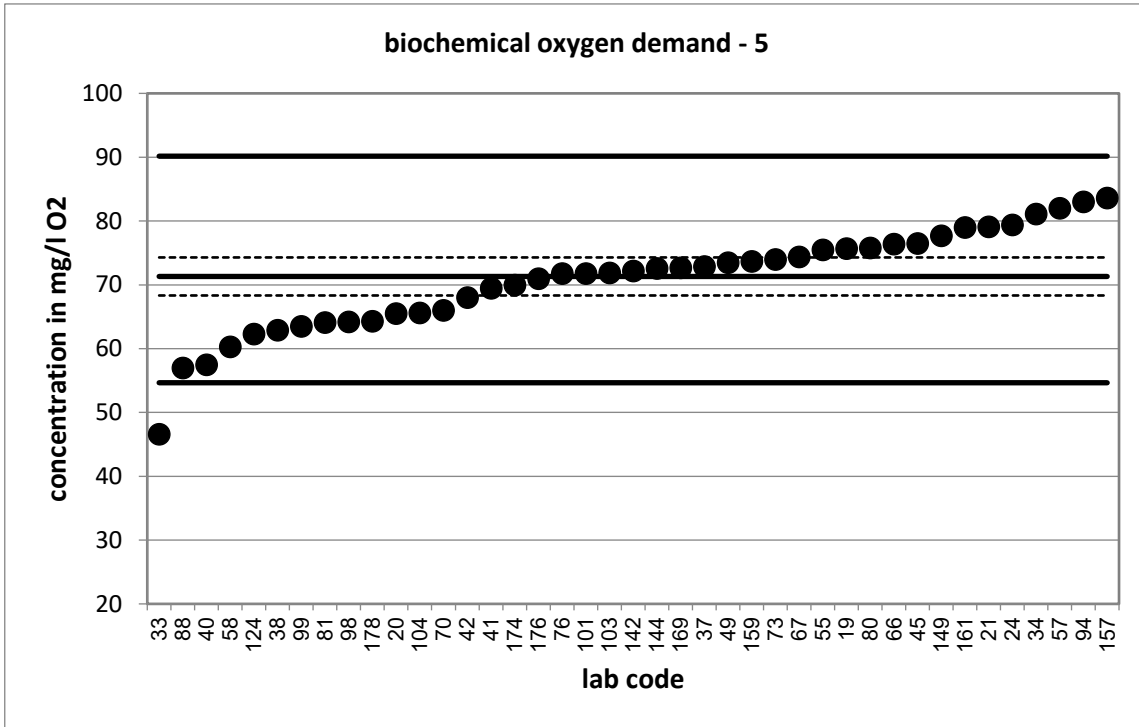




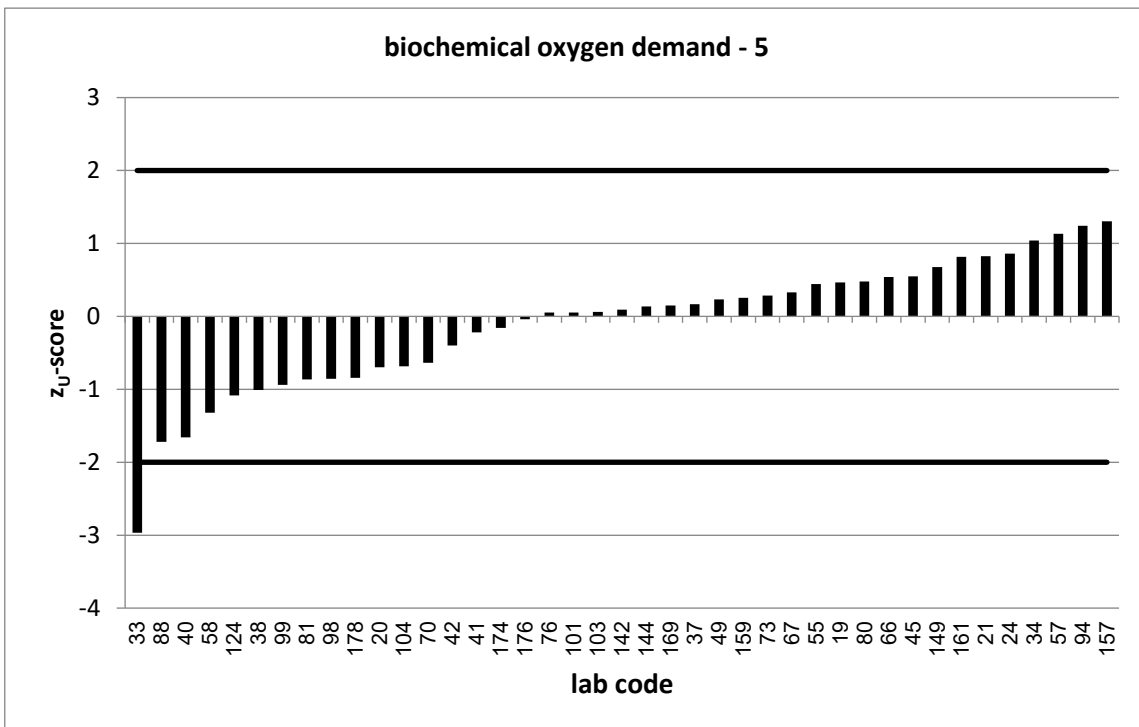
BOD5		biochemical oxygen demand - 5			
assigned value [mg/l O2]*		71,31 ± 2,98			
upper tolerance limit [mg/l O2]		90,16			
lower tolerance limit [mg/l O2]		54,65			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
19	75,7	28,8	0,3	0,5	s
20	65,5	20	-0,6	-0,7	s
21	79,1			0,8	s
24	79,4			0,9	s
33	46,6			-3,0	u
34	81,12	20,2	1,0	1,0	s
37	72,9	9,47	0,3	0,2	s
38	62,9	12,6	-1,3	-1,0	s
40	57,5	7,07	-3,6	-1,7	s
41	69,5			-0,2	s
42	68	10,7	-0,6	-0,4	s
45	76,5	9,8	1,0	0,6	s
49	73,5	20	0,2	0,2	s
55	75,5	14,3	0,6	0,4	s
57	82			1,1	s
58	60,3	12,1	-1,8	-1,3	s
66	76,4	9,17	1,1	0,5	s
67	74,4	17,1	0,4	0,3	s
70	66	4	-2,1	-0,6	s
73	74	11,1	0,5	0,3	s
76	71,8	17	0,1	0,1	s
80	75,8	5,09	1,5	0,5	s
81	64,1	30,8	-0,5	-0,9	s
88	57			-1,7	s
94	83			1,2	s
98	64,2	16,1	-0,9	-0,9	s
99	63,5	6,35	-2,2	-0,9	s
101	71,8	9,33	0,1	0,1	s
103	71,9			0,1	s
104	65,6			-0,7	s
124	62,3			-1,1	s
142	72,2	14,4	0,1	0,1	s
144	72,6			0,1	s
149	77,7	6,2	1,9	0,7	s
157	83,6			1,3	s
159	73,7	10,5	0,4	0,3	s
161	79	23,7	0,6	0,8	s
169	72,7	14,5	0,2	0,1	s
174	70			-0,2	s
176	71	10	-0,1	0,0	s
178	64,3	22,5	-0,6	-0,8	s

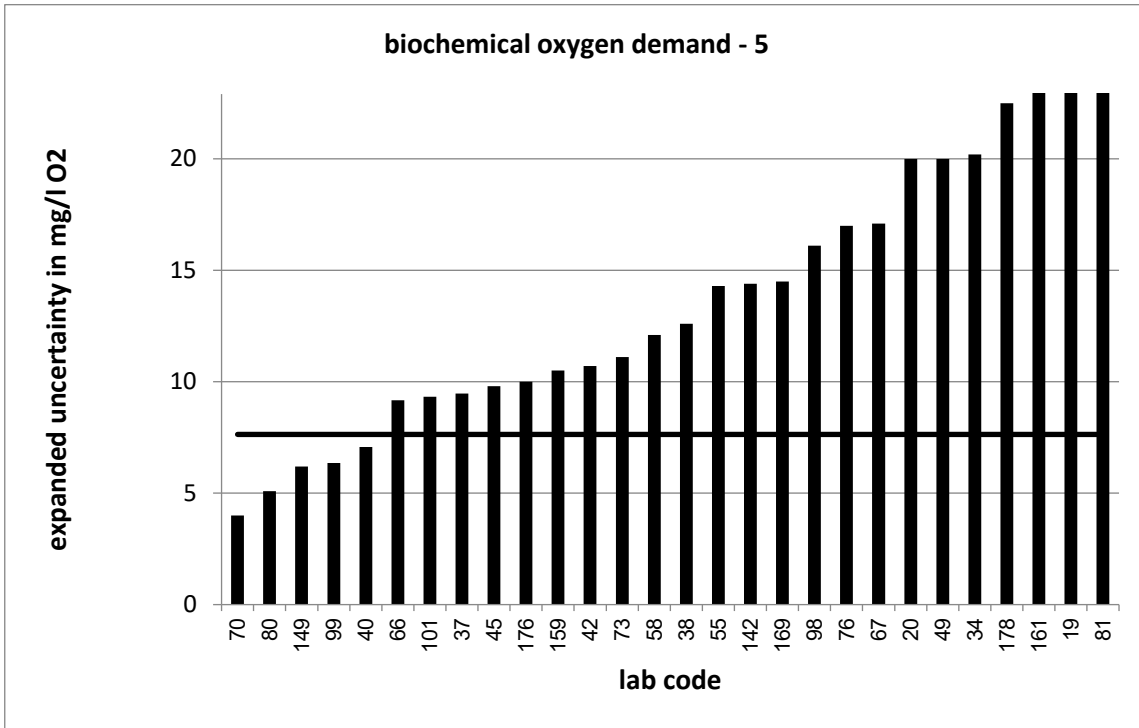
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor  $k=2$  corresponding to a confidence level of about 95%

\*\* s = satisfactory, q = questionable, u = unsatisfactory

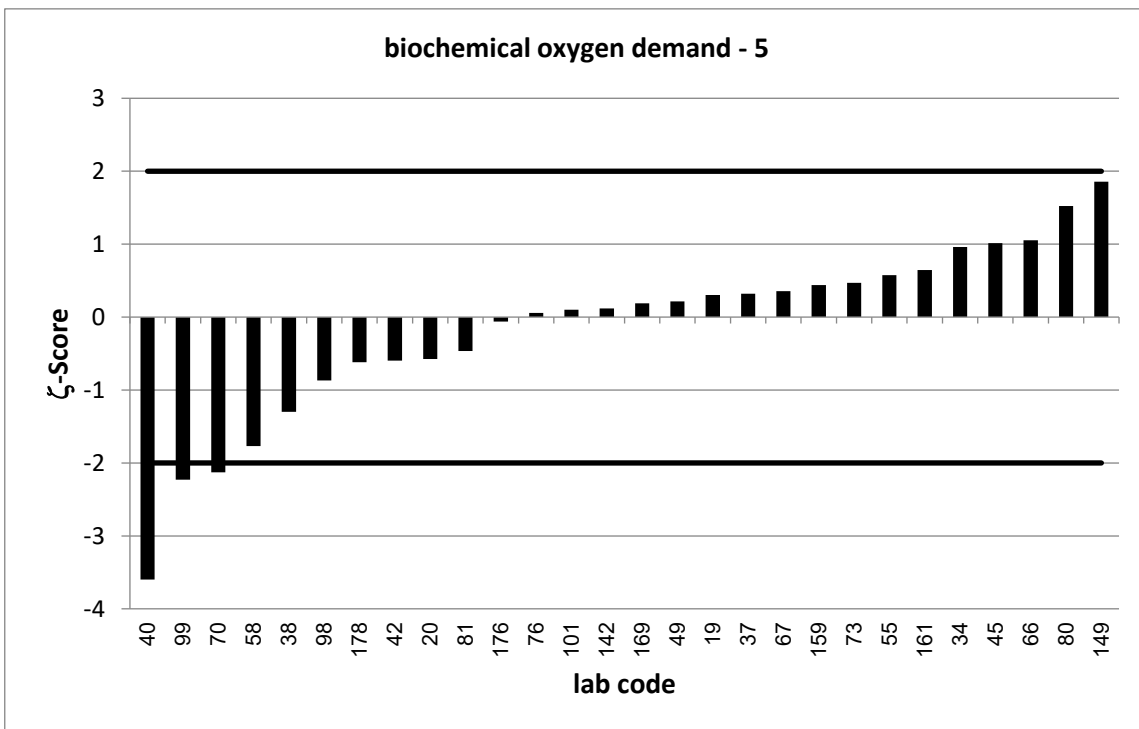


Strongly deviating values are not shown in the diagram.





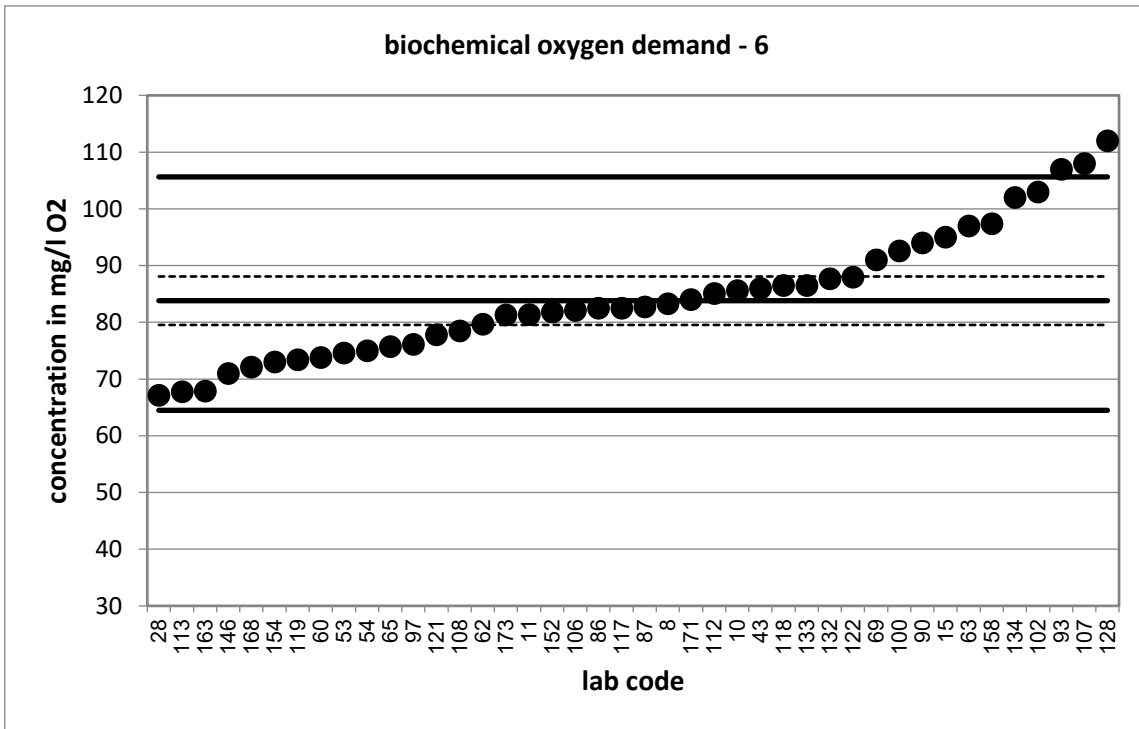
Strongly deviating values are not correctly shown in the diagram.



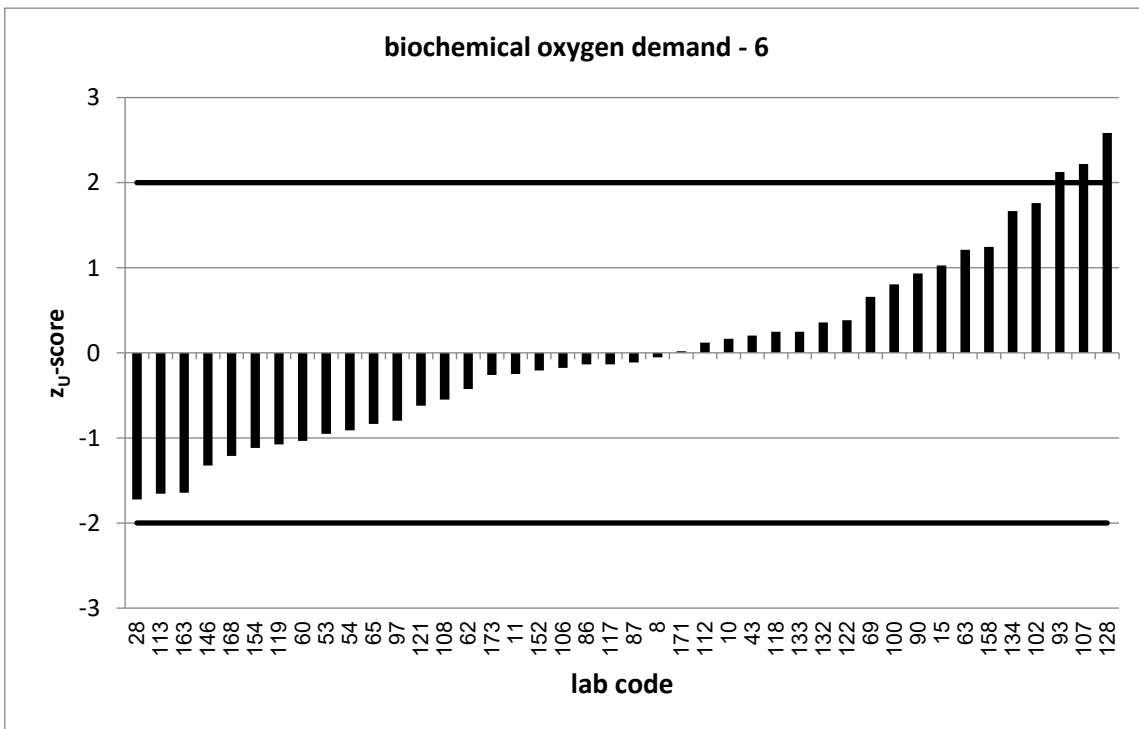
BOD5		biochemical oxygen demand - 6			
assigned value [mg/l O2]*		83,8 ± 4,27			
upper tolerance limit [mg/l O2]		105,6			
lower tolerance limit [mg/l O2]		64,48			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
8	83,3	25,2	0,0	-0,1	s
10	85,6	30,72	0,1	0,2	s
11	81,4			-0,2	s
15	95	11,4	1,8	1,0	s
28	67,15	10	-3,1	-1,7	s
43	86	8,6	0,5	0,2	s
53	74,6			-1,0	s
54	75			-0,9	s
60	73,8			-1,0	s
62	79,7	23,9	-0,3	-0,4	s
63	97	20	1,3	1,2	s
65	75,75	16,73	-0,9	-0,8	s
69	91	15,24	0,9	0,7	s
86	82,5	17	-0,1	-0,1	s
87	82,7	21,9	-0,1	-0,1	s
90	94	18,6	1,1	0,9	s
93	107	10	4,3	2,1	q
97	76,1	15	-1,0	-0,8	s
100	92,6	14,8	1,1	0,8	s
102	103	20,6	1,8	1,8	s
106	82,1			-0,2	s
107	108			2,2	q
108	78,5			-0,5	s
112	85,1			0,1	s
113	67,8	17	-1,8	-1,7	s
117	82,5	4,04	-0,4	-0,1	s
118	86,5	5	0,8	0,2	s
119	73,4	13,2	-1,5	-1,1	s
121	77,8	19,5	-0,6	-0,6	s
122	88	10	0,8	0,4	s
128	112	22	2,5	2,6	q
132	87,7	25,4	0,3	0,4	s
133	86,5	29,1	0,2	0,2	s
134	102			1,7	s
146	71	14	-1,7	-1,3	s
152	81,8	3	-0,8	-0,2	s
154	73	10,8	-1,9	-1,1	s
158	97,4			1,2	s
163	67,9	11,7	-2,6	-1,6	s
168	72,1	18	-1,3	-1,2	s
171	84	25,2	0,0	0,0	s
173	81,3			-0,3	s

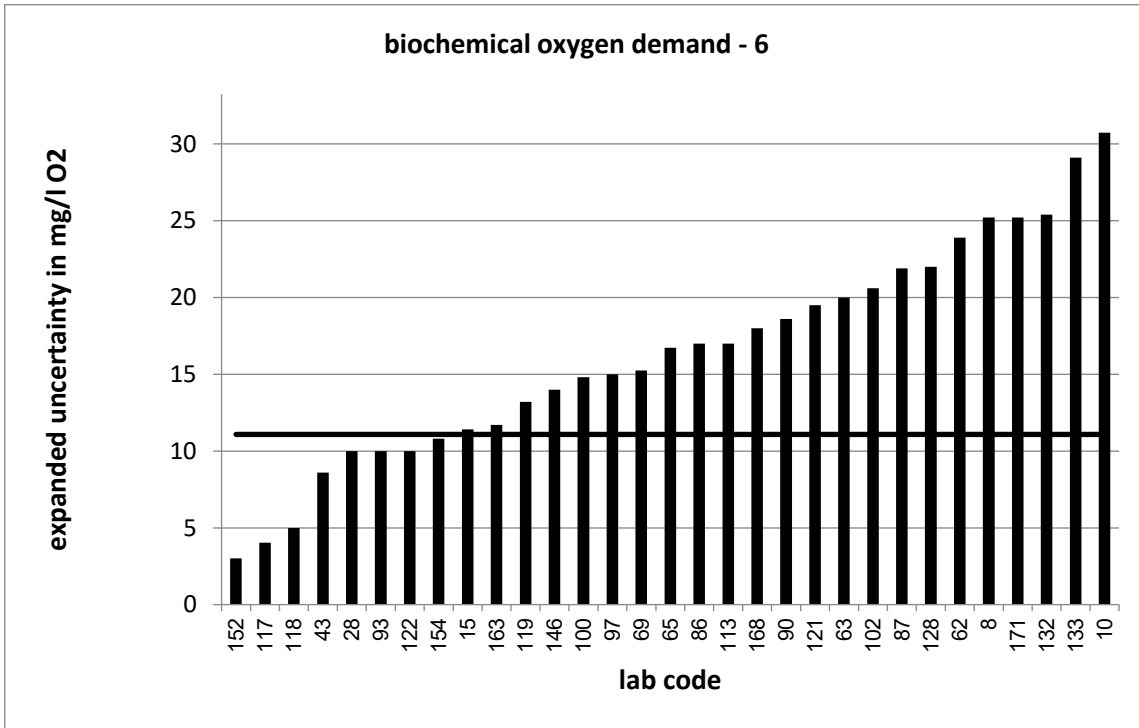
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor k=2 corresponding to a confidence level of about 95%

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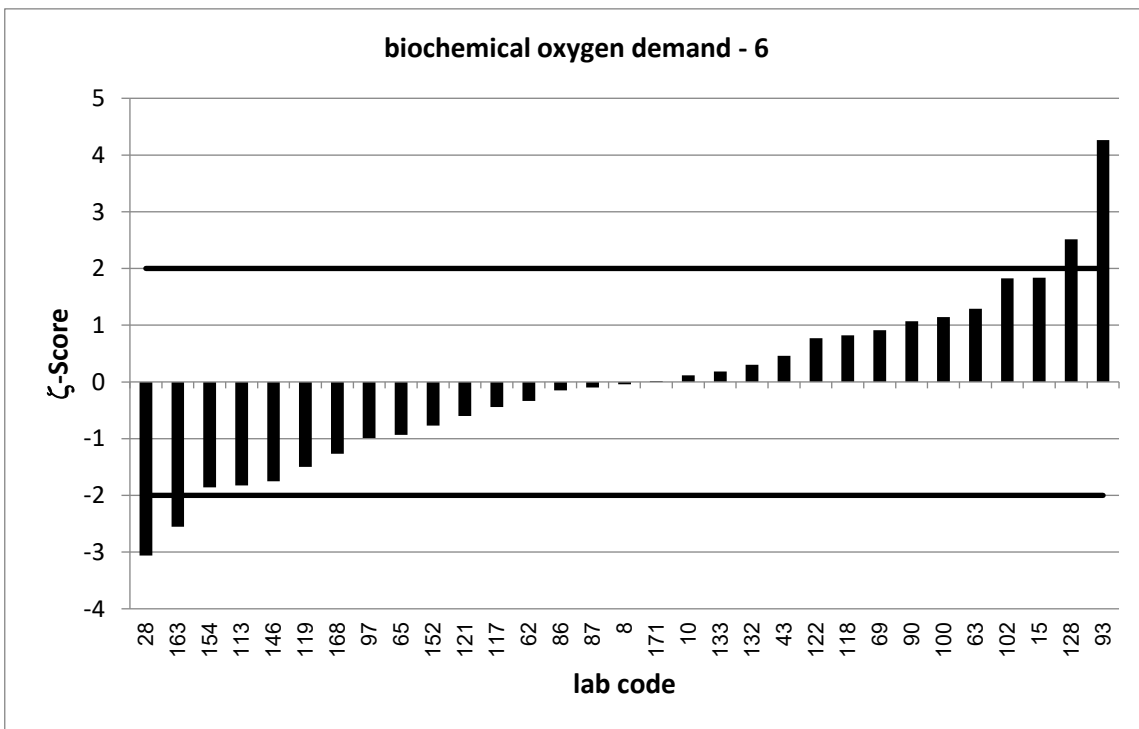


Strongly deviating values are not shown in the diagram.





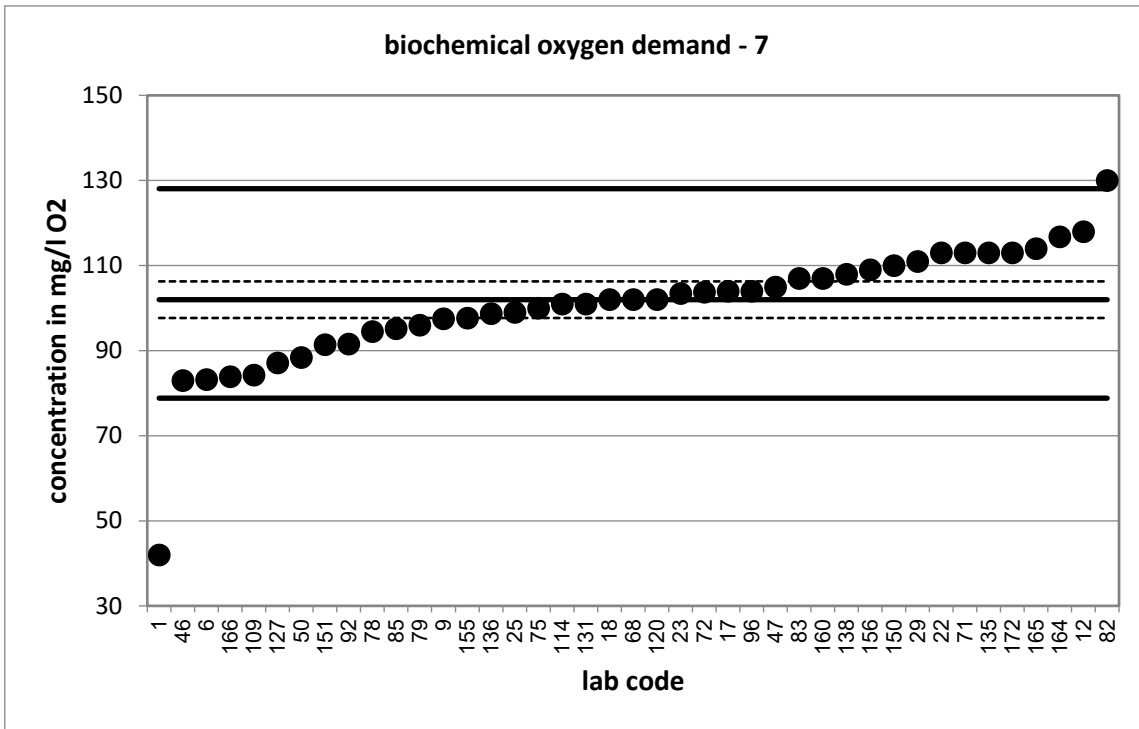
Strongly deviating values are not correctly shown in the diagram.



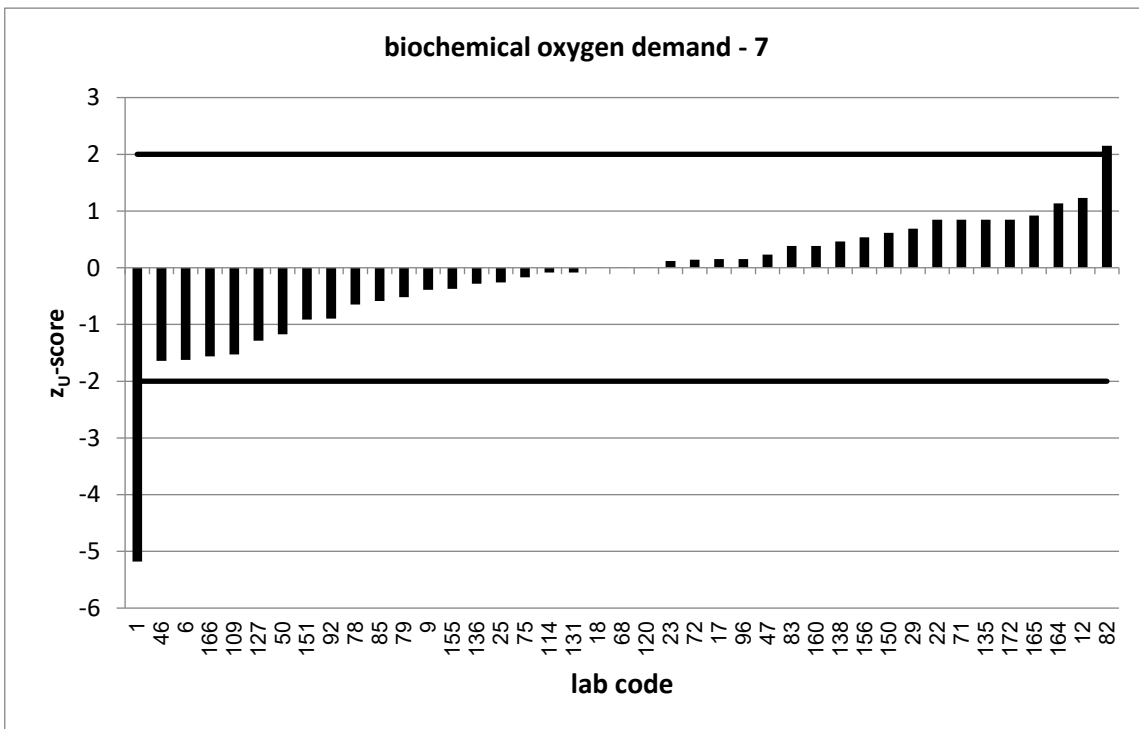
BOD5		biochemical oxygen demand - 7			
assigned value [mg/l O2]*		102 ± 4,3			
upper tolerance limit [mg/l O2]		128,1			
lower tolerance limit [mg/l O2]		78,83			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
1	42	8,4	-12,7	-5,2	u
6	83,2			-1,6	s
9	97,5			-0,4	s
12	118	27	1,2	1,2	s
17	104	19	0,2	0,2	s
18	102	11,4	0,0	0,0	s
22	113	28	0,8	0,8	s
23	103,5	16,6	0,2	0,1	s
25	99			-0,3	s
29	111	15,5	1,1	0,7	s
46	83			-1,6	s
47	105	2,65	1,2	0,2	s
50	88,4	45,6	-0,6	-1,2	s
68	102			0,0	s
71	113			0,8	s
72	103,8			0,1	s
75	100	31	-0,1	-0,2	s
78	94,5	24,6	-0,6	-0,6	s
79	96	19,2	-0,6	-0,5	s
82	130	36,4	1,5	2,1	q
83	107			0,4	s
85	95,2	37	-0,4	-0,6	s
92	91,6	10	-1,9	-0,9	s
96	104			0,2	s
109	84,3			-1,5	s
114	101	16	-0,1	-0,1	s
120	102			0,0	s
127	87,1			-1,3	s
131	101	20	-0,1	-0,1	s
135	113	15,7	1,4	0,8	s
136	98,7	23,7	-0,3	-0,3	s
138	108			0,5	s
150	110	21	0,7	0,6	s
151	91,4	27,4	-0,8	-0,9	s
155	97,7			-0,4	s
156	109	10	1,3	0,5	s
160	107			0,4	s
164	116,8	31,1	0,9	1,1	s
165	114	28,6	0,8	0,9	s
166	83,9			-1,6	s
172	113			0,8	s

\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor k=2 corresponding to a confidence level of about 95%

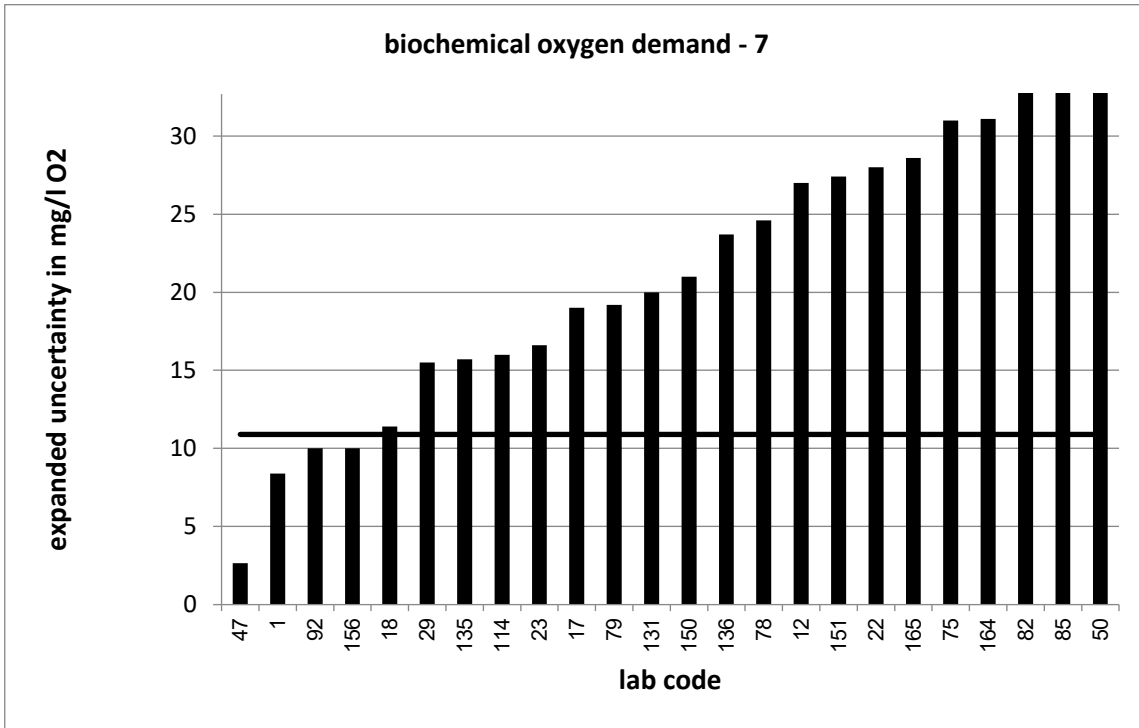
\*\* s = satisfactory, q = questionable, u = unsatisfactory



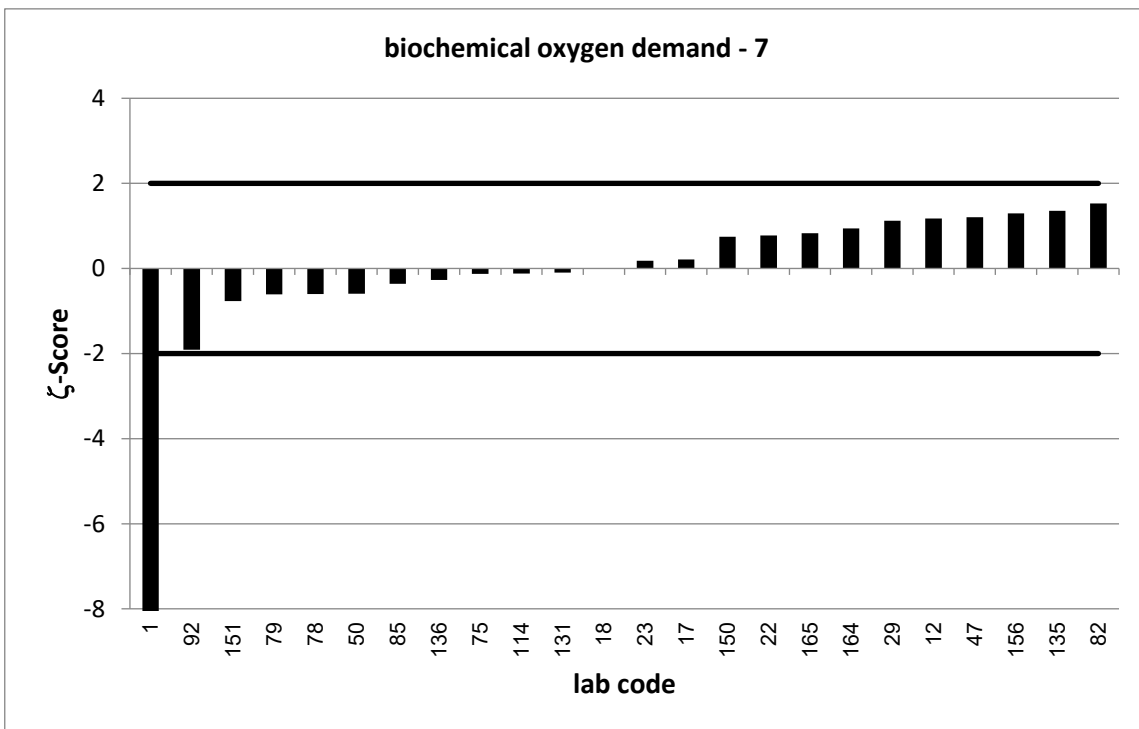
Strongly deviating values are not shown in the diagram.







Strongly deviating values are not correctly shown in the diagram.

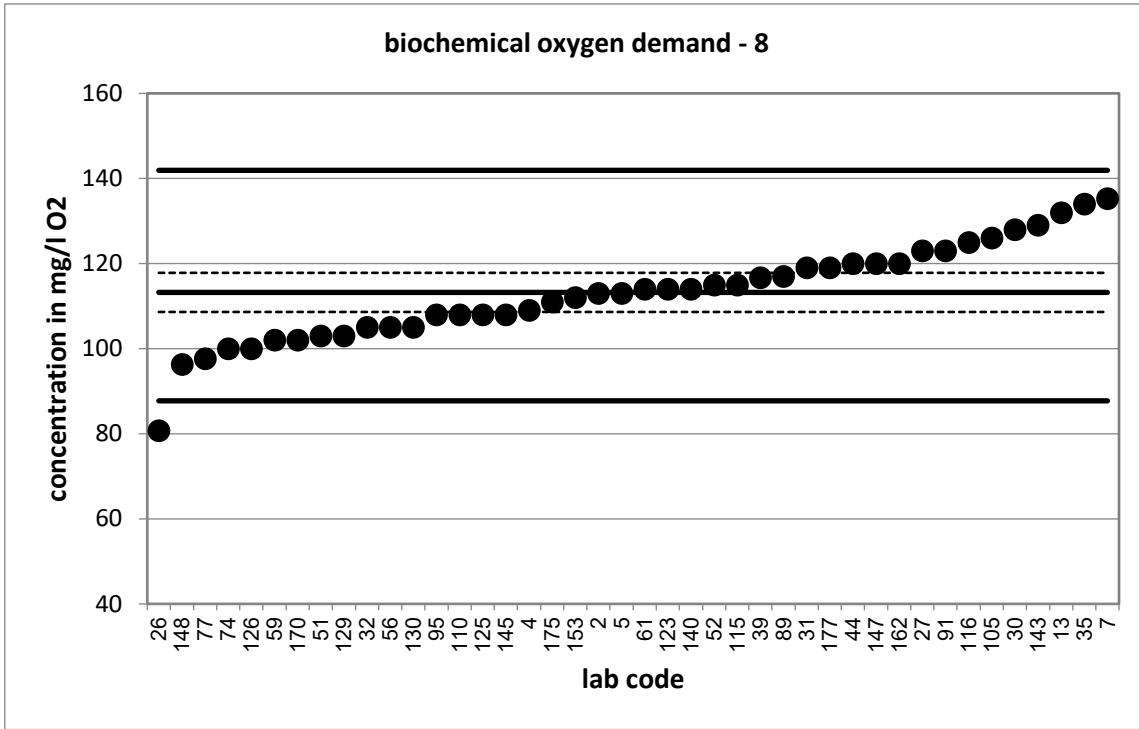


Strongly deviating values are not correctly shown in the diagram.

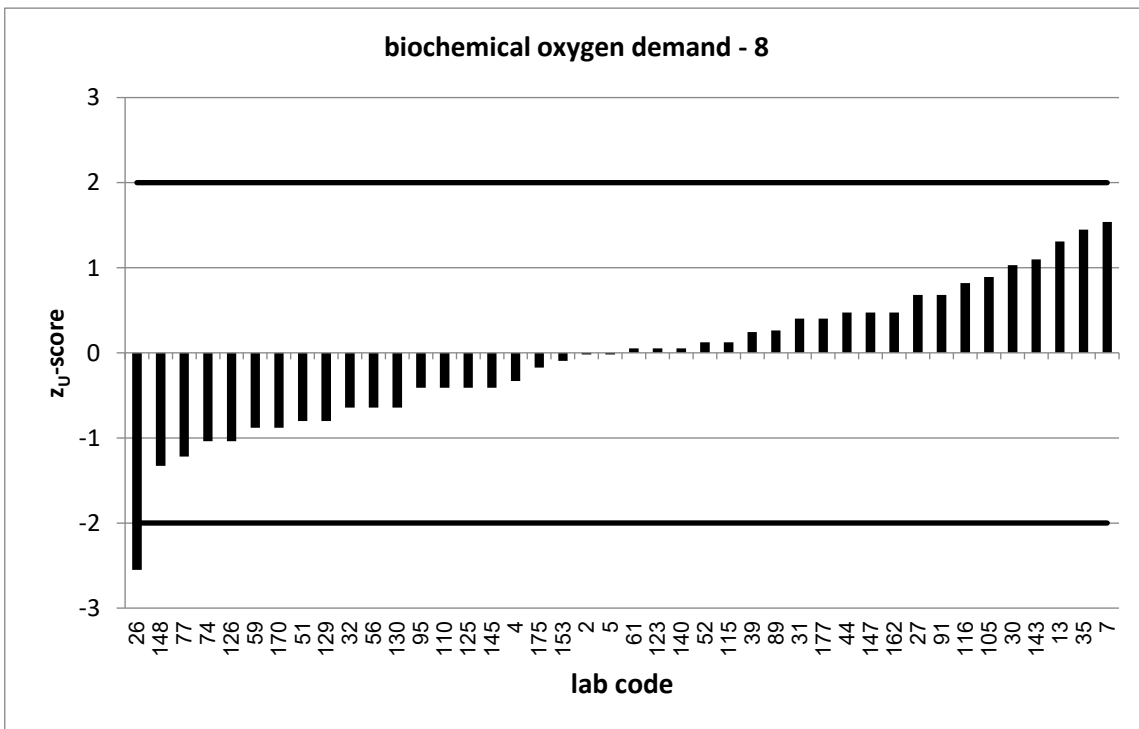
BOD5		biochemical oxygen demand - 8			
assigned value [mg/l O2]*		113,2 ± 4,6			
upper tolerance limit [mg/l O2]		141,9			
lower tolerance limit [mg/l O2]		87,73			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
2	113	21	0,0	0,0	s
4	109			-0,3	s
5	113	22,6	0,0	0,0	s
7	135,3	59	0,7	1,5	s
13	132	28,5	1,3	1,3	s
26	80,7	8	-7,1	-2,6	q
27	123			0,7	s
30	128	19	1,5	1,0	s
31	119			0,4	s
32	105	10,7	-1,4	-0,6	s
35	134	37,5	1,1	1,4	s
39	116,7			0,2	s
44	120	25	0,5	0,5	s
51	103			-0,8	s
52	115	50,1	0,1	0,1	s
56	105			-0,6	s
59	102	20	-1,1	-0,9	s
61	114	8,8	0,2	0,1	s
74	100	29	-0,9	-1,0	s
77	97,7			-1,2	s
89	117	19,5	0,4	0,3	s
91	123	3,25	3,5	0,7	s
95	108			-0,4	s
105	126			0,9	s
110	108	9	-1,0	-0,4	s
115	115	32,9	0,1	0,1	s
116	125	31	0,8	0,8	s
123	114			0,1	s
125	108	20,5	-0,5	-0,4	s
126	100	20	-1,3	-1,0	s
129	103			-0,8	s
130	105	45,08	-0,4	-0,6	s
140	114	38,7	0,0	0,1	s
143	129	20,5	1,5	1,1	s
145	108	13,9	-0,7	-0,4	s
147	120	24	0,6	0,5	s
148	96,3	20,8	-1,6	-1,3	s
153	112			-0,1	s
162	120	30	0,4	0,5	s
170	102	17,3	-1,3	-0,9	s
175	111			-0,2	s
177	119			0,4	s

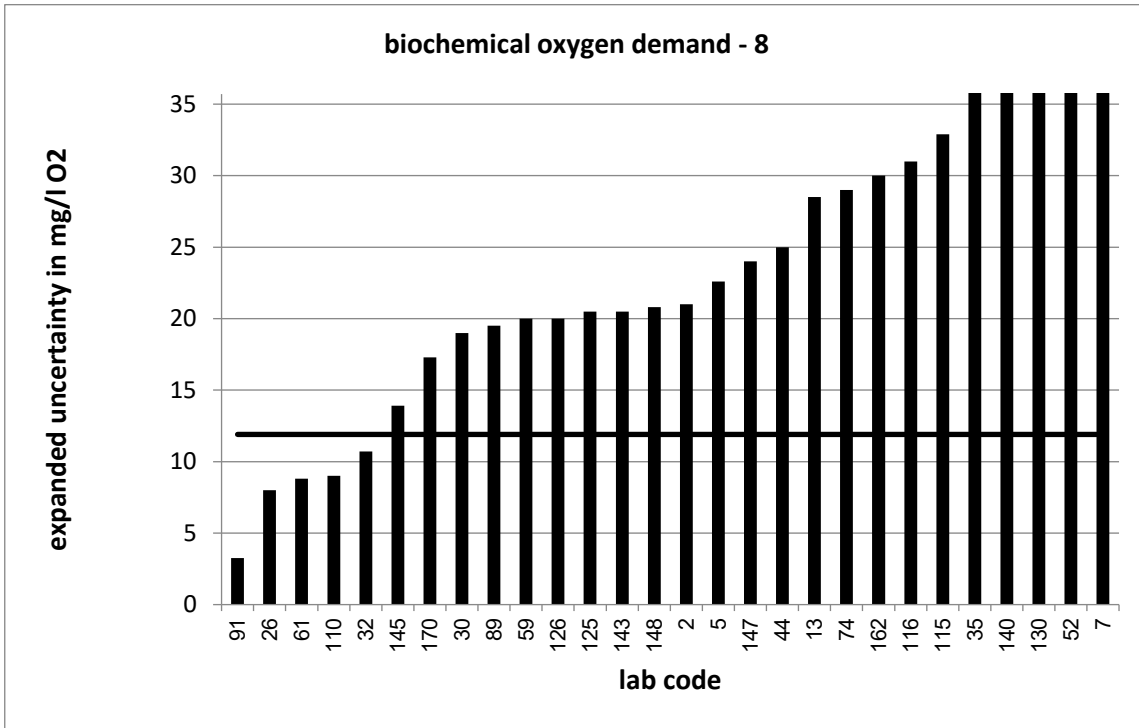
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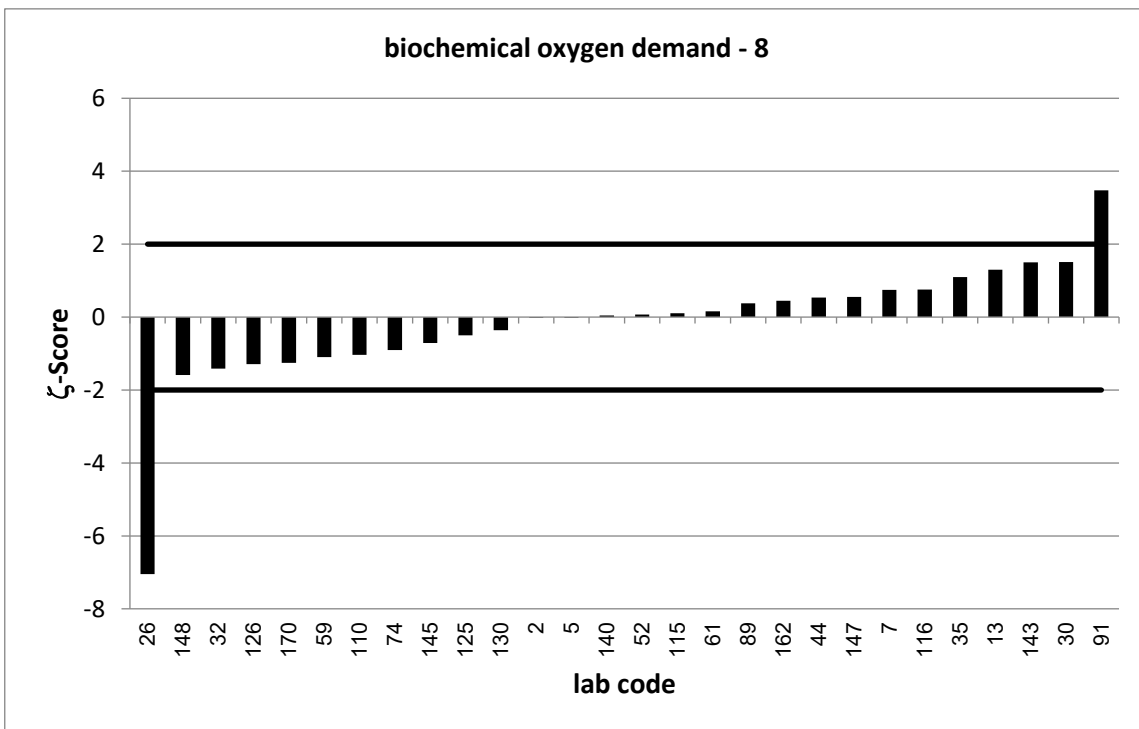


Strongly deviating values are not shown in the diagram.





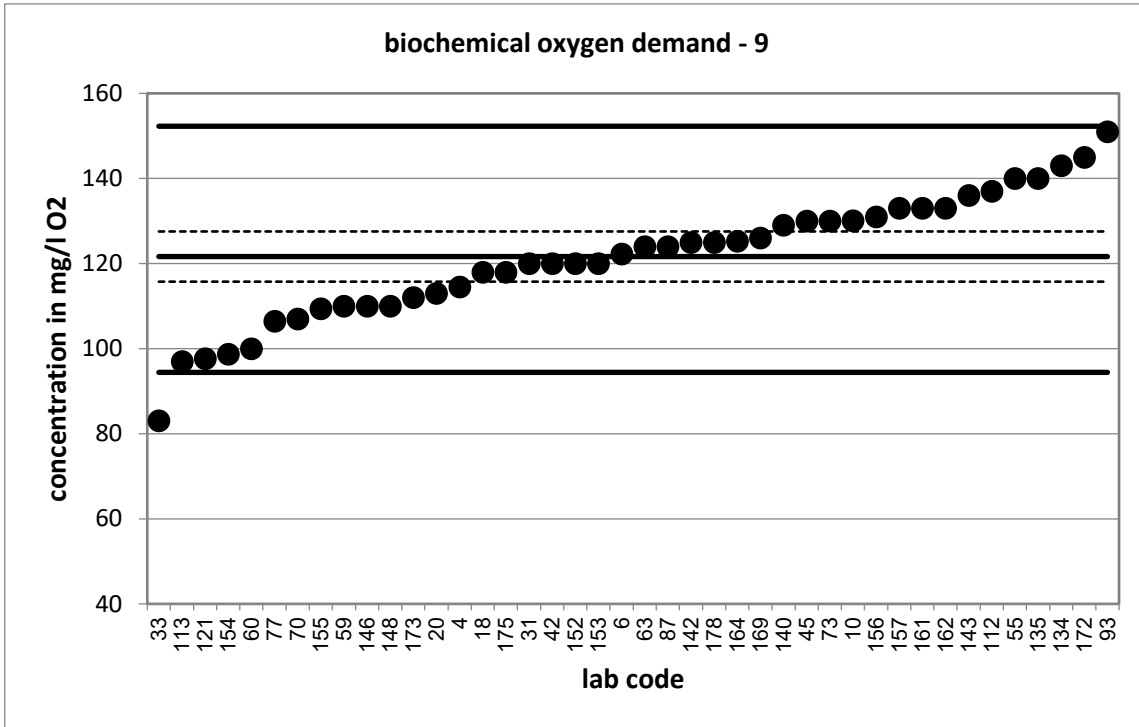
Strongly deviating values are not correctly shown in the diagram.



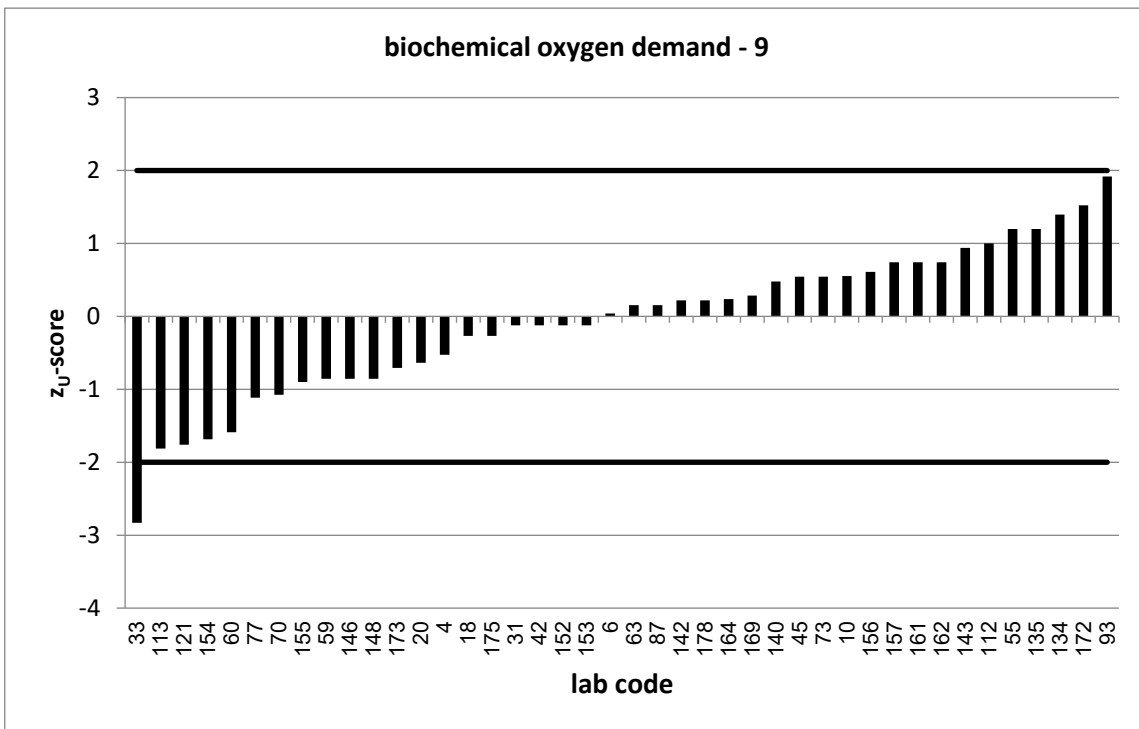
BOD5		biochemical oxygen demand - 9			
assigned value [mg/l O2]*		121,6 ± 5,9			
upper tolerance limit [mg/l O2]		152,3			
lower tolerance limit [mg/l O2]		94,42			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
4	114,5			-0,5	s
6	122,25			0,0	s
10	130,1	30,72	0,5	0,6	s
18	118	13,2	-0,5	-0,3	s
20	113	20	-0,8	-0,6	s
31	120			-0,1	s
33	83,1			-2,8	q
42	120	18,8	-0,2	-0,1	s
45	130	16,6	0,9	0,5	s
55	140	26,6	1,3	1,2	s
59	110	20	-1,1	-0,9	s
60	100			-1,6	s
63	124	20	0,2	0,2	s
70	107	4	-4,1	-1,1	s
73	130	20	0,8	0,5	s
77	106,5			-1,1	s
87	124	32,9	0,1	0,2	s
93	151	15	3,6	1,9	s
112	137			1,0	s
113	97	24,3	-2,0	-1,8	s
121	97,7	24,5	-1,9	-1,8	s
134	143			1,4	s
135	140	19,6	1,8	1,2	s
140	129	34,2	0,4	0,5	s
142	125	25,1	0,3	0,2	s
143	136	21,6	1,3	0,9	s
146	110	22	-1,0	-0,9	s
148	110	23,6	-1,0	-0,9	s
152	120	3	-0,5	-0,1	s
153	120			-0,1	s
154	98,7	18,1	-2,4	-1,7	s
155	109,4			-0,9	s
156	131	10	1,6	0,6	s
157	133			0,7	s
161	133	39,9	0,6	0,7	s
162	133	30	0,7	0,7	s
164	125,3	33,4	0,2	0,2	s
169	126	25,2	0,3	0,3	s
172	145			1,5	s
173	112			-0,7	s
175	118			-0,3	s
178	125	43,7	0,2	0,2	s

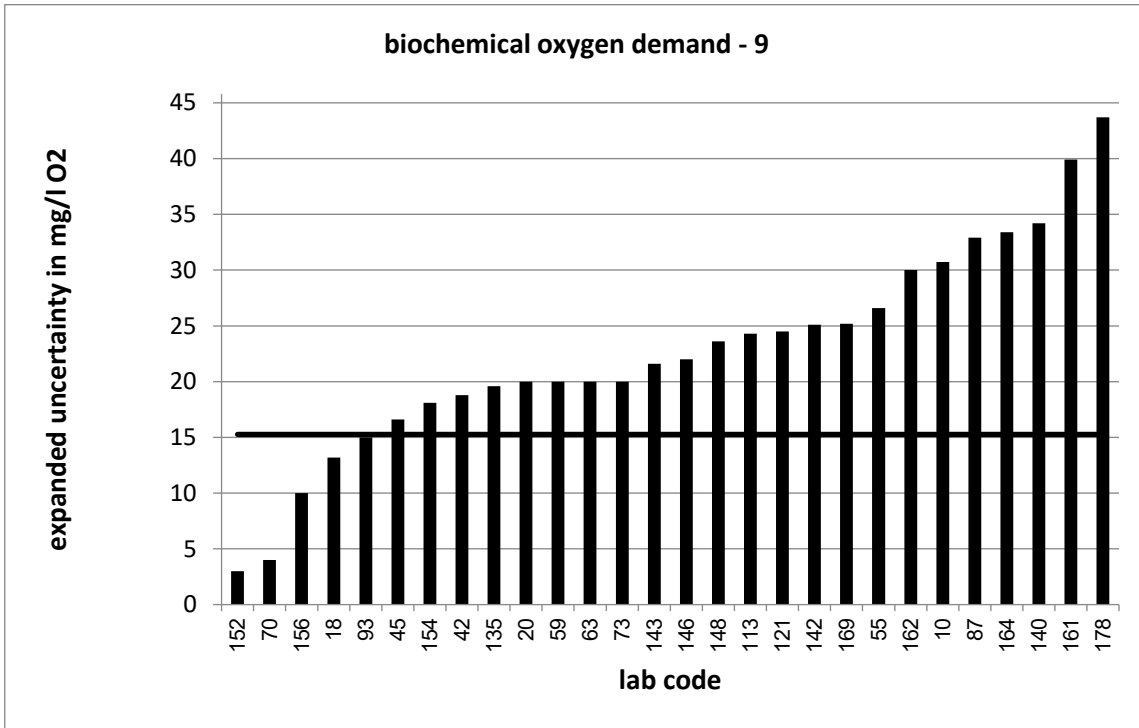
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor k=2 corresponding to a confidence level of about 95%

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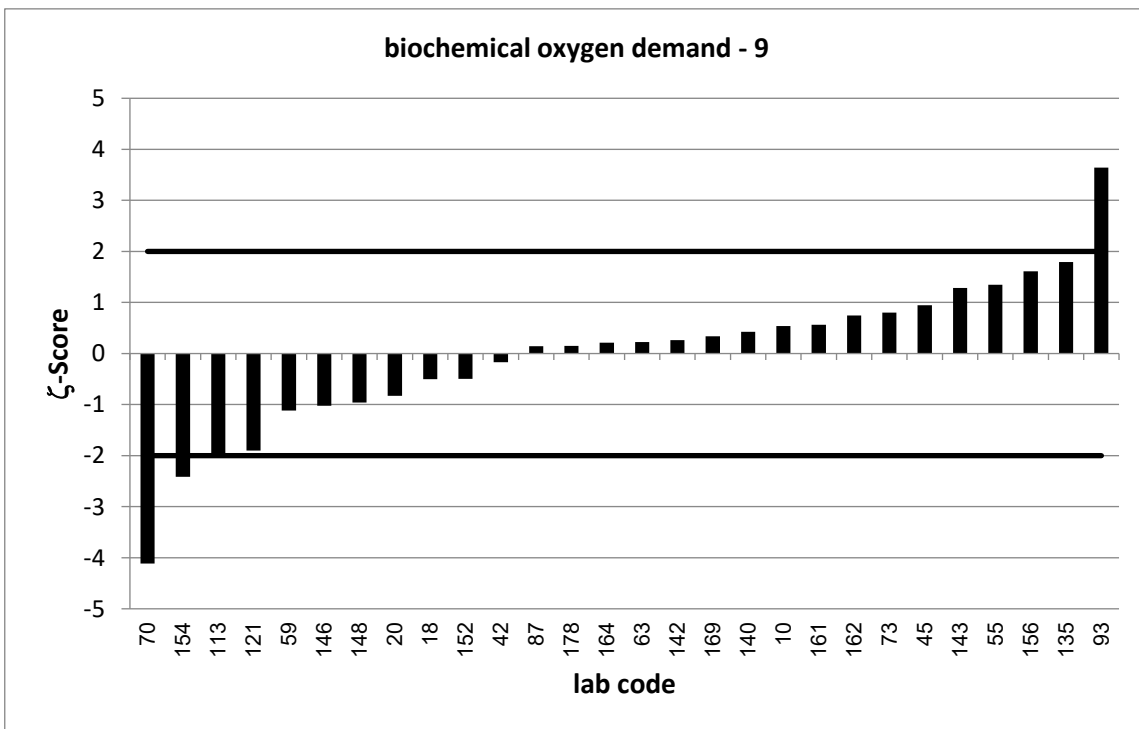


Strongly deviating values are not shown in the diagram.





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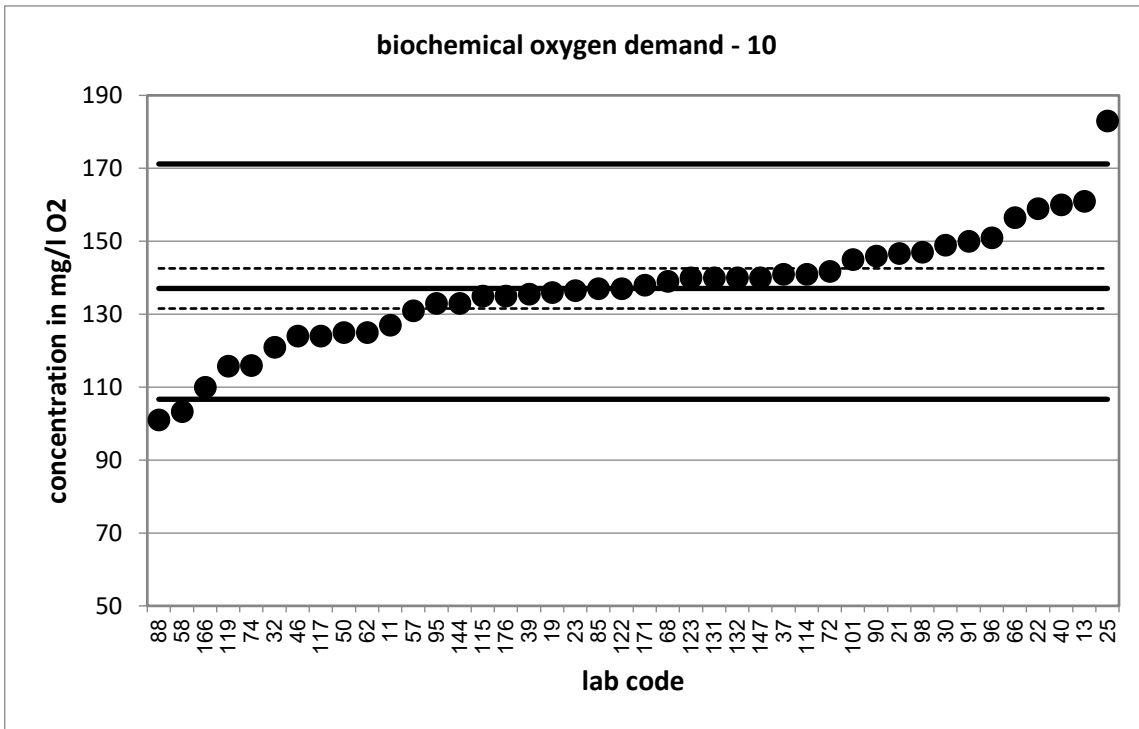


BOD5		biochemical oxygen demand - 10			
assigned value [mg/l O2]*		137,1 ± 5,5			
upper tolerance limit [mg/l O2]		171,2			
lower tolerance limit [mg/l O2]		106,7			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
11	127			-0,7	s
13	161	34,8	1,4	1,4	s
19	136	51,7	0,0	-0,1	s
21	146,7			0,6	s
22	159	40	1,1	1,3	s
23	136,5	21,8	0,0	0,0	s
25	183			2,7	q
30	149	21	1,1	0,7	s
32	121	12,4	-2,4	-1,1	s
37	141	18,3	0,4	0,2	s
39	135,5			-0,1	s
40	160	28,3	1,6	1,3	s
46	124			-0,9	s
50	125	64,5	-0,4	-0,8	s
57	131			-0,4	s
58	103,3	20,7	-3,2	-2,2	q
62	125	37,5	-0,6	-0,8	s
66	156,5	18,8	2,0	1,1	s
68	139			0,1	s
72	141,8			0,3	s
74	116	34	-1,2	-1,4	s
85	137	37	0,0	0,0	s
88	101			-2,4	q
90	146	28,9	0,6	0,5	s
91	150	2,86	4,2	0,8	s
95	133			-0,3	s
96	151			0,8	s
98	147	36,8	0,5	0,6	s
101	145	18,9	0,8	0,5	s
114	141	23	0,3	0,2	s
115	135	38,6	-0,1	-0,1	s
117	124	6,1	-3,2	-0,9	s
119	115,8	20,9	-2,0	-1,4	s
122	137	10	0,0	0,0	s
123	140			0,2	s
131	140	28	0,2	0,2	s
132	140	40,6	0,1	0,2	s
144	133			-0,3	s
147	140	28	0,2	0,2	s
166	110			-1,8	s
171	138	41,4	0,0	0,1	s
176	135	20	-0,2	-0,1	s

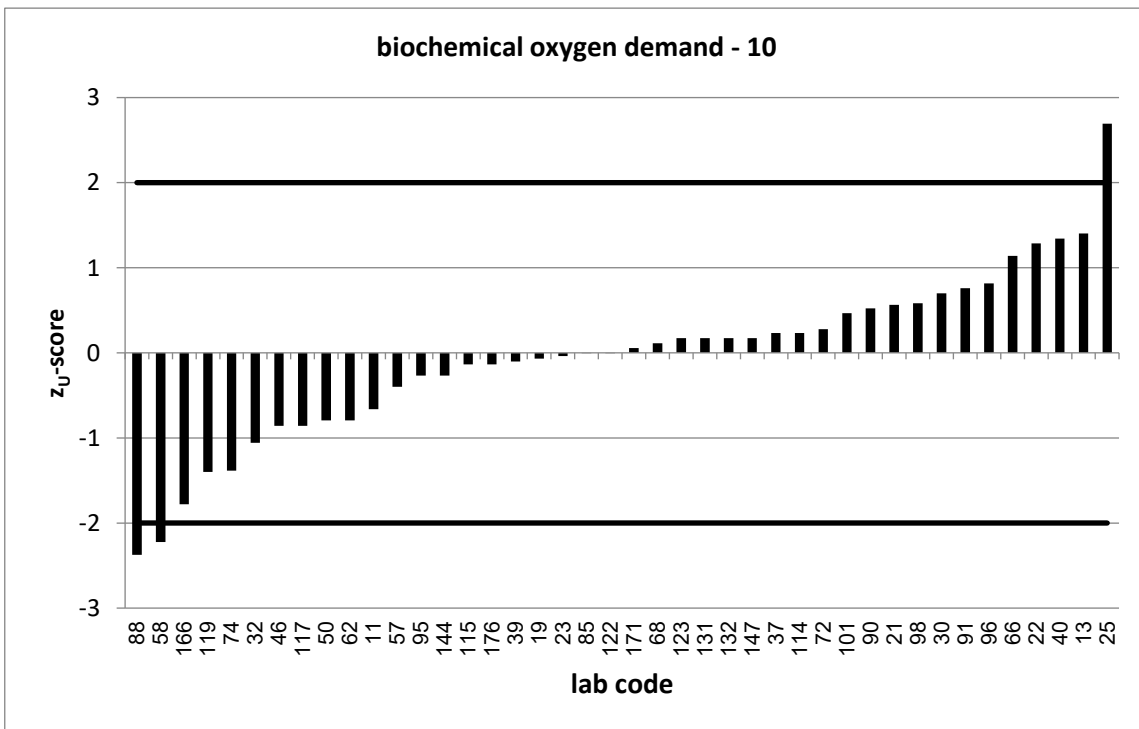
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor k=2 corresponding to a confidence level of about 95%

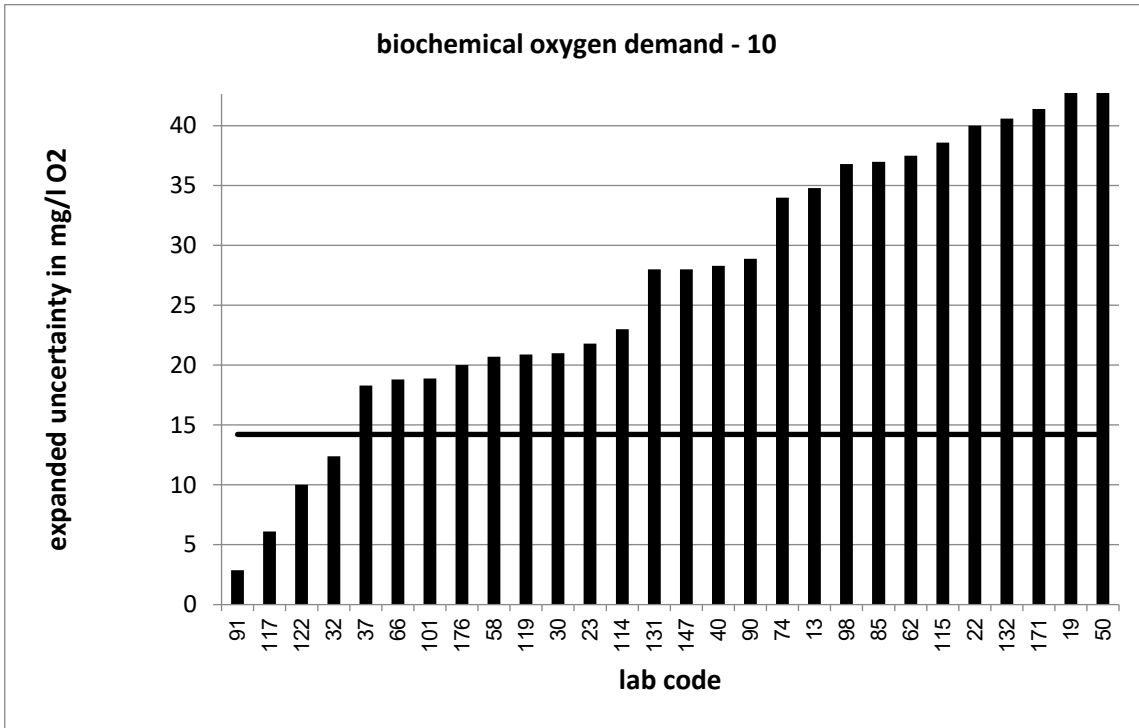
\*\* s = satisfactory, q = questionable, u = unsatisfactory



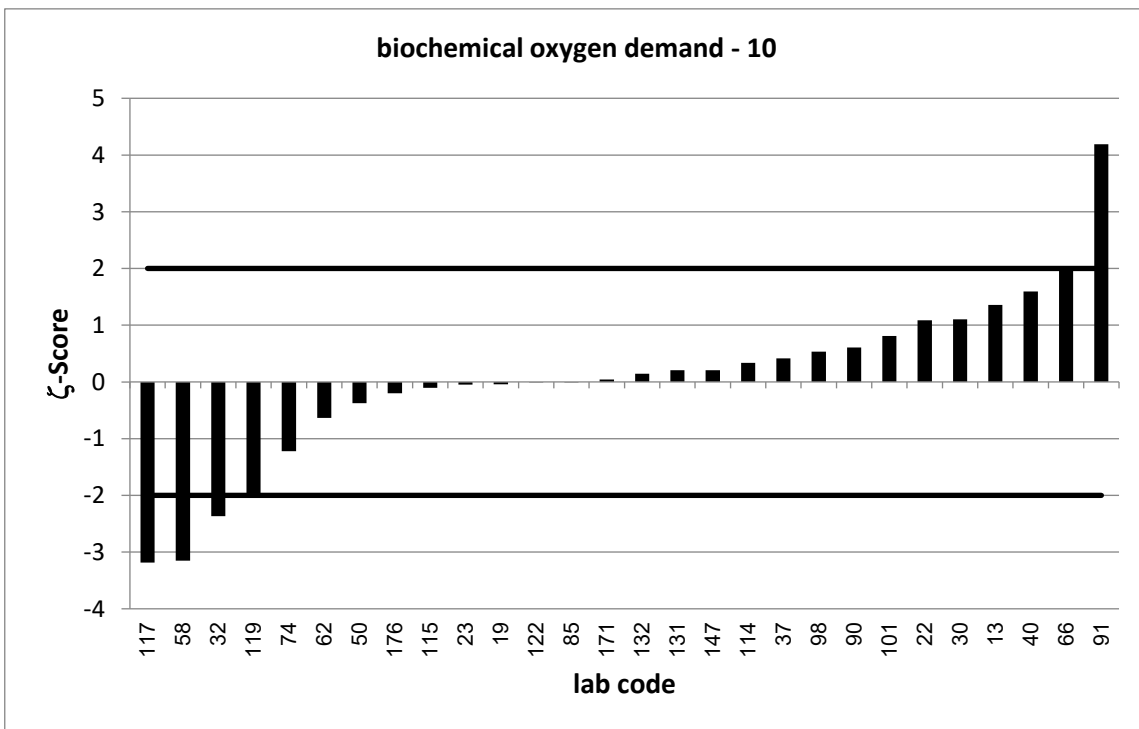


Strongly deviating values are not shown in the diagram.





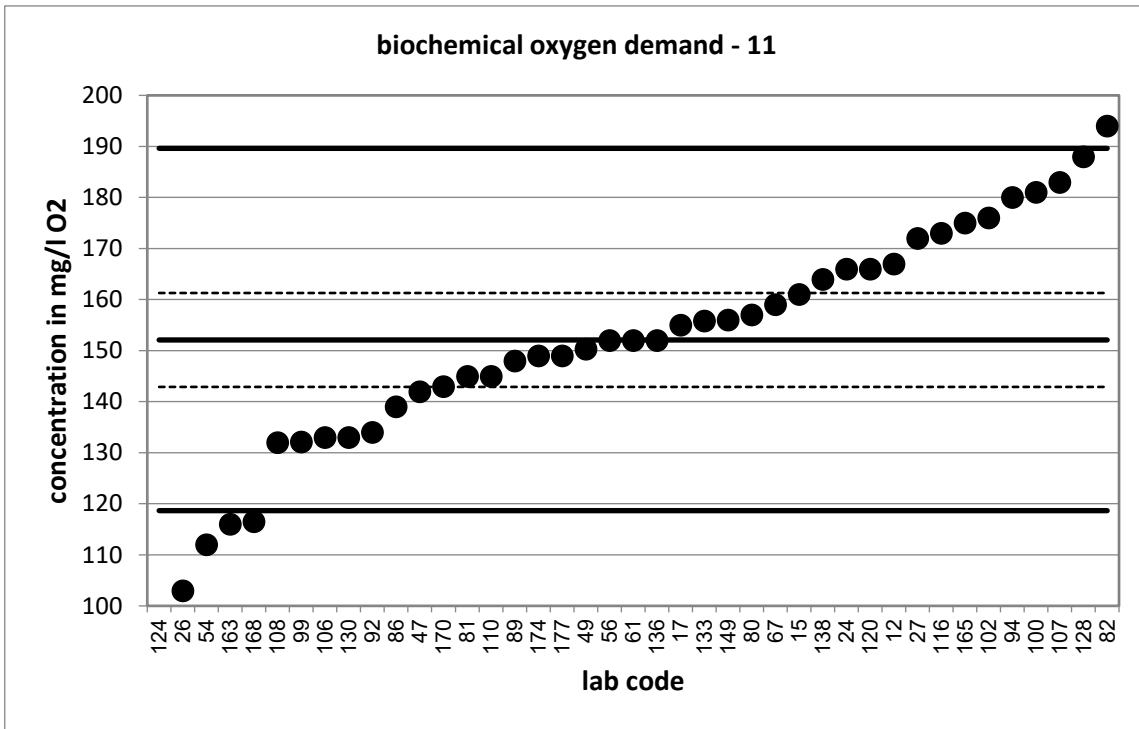
Strongly deviating values are not correctly shown in the diagram.



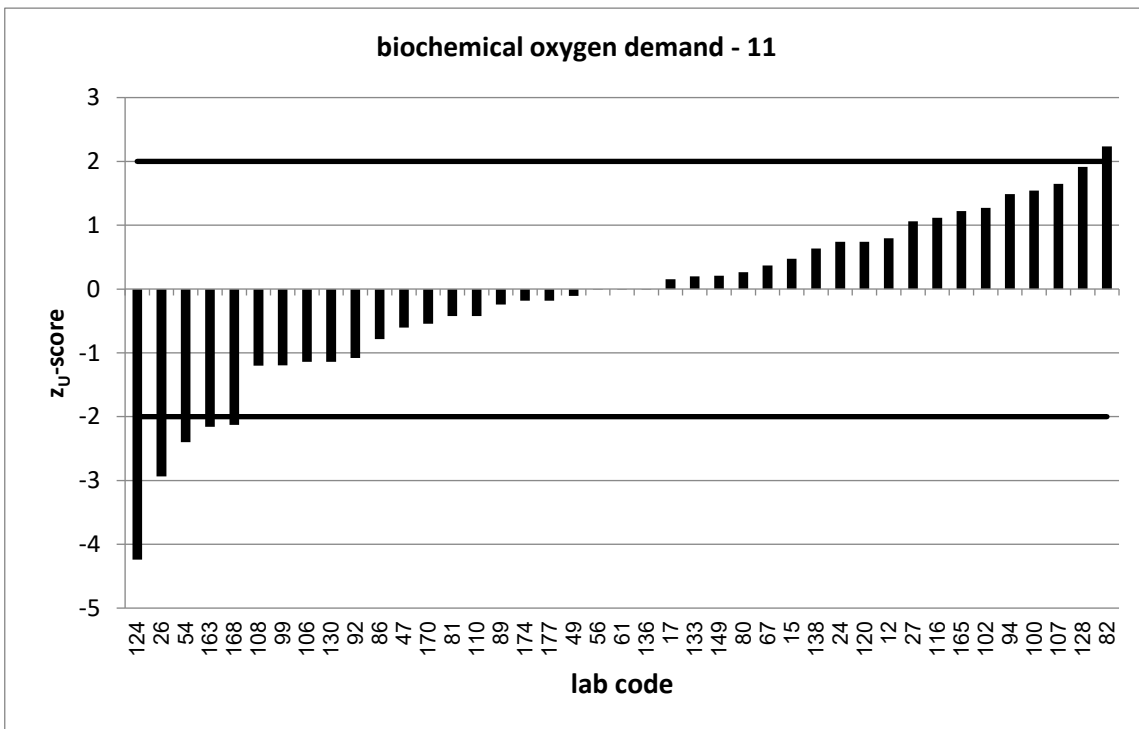
BOD5		biochemical oxygen demand - 11			
assigned value [mg/l O2]*		152,1 ± 9,2			
upper tolerance limit [mg/l O2]		189,6			
lower tolerance limit [mg/l O2]		118,7			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
12	167	38	0,8	0,8	s
15	161	19,3	0,8	0,5	s
17	155	28	0,2	0,2	s
24	166			0,7	s
26	103	10	-7,2	-2,9	q
27	172			1,1	s
47	142	1,24	-2,2	-0,6	s
49	150,3	40,9	-0,1	-0,1	s
54	112			-2,4	q
56	152			0,0	s
61	152	12	0,0	0,0	s
67	159	36,4	0,4	0,4	s
80	157	18,1	0,5	0,3	s
81	145	69,6	-0,2	-0,4	s
82	194	54,3	1,5	2,2	q
86	139	28	-0,9	-0,8	s
89	148	24,8	-0,3	-0,2	s
92	134	15	-2,1	-1,1	s
94	180			1,5	s
99	132,1	13,21	-2,5	-1,2	s
100	181	29	1,9	1,5	s
102	176	35,1	1,3	1,3	s
106	133			-1,1	s
107	183			1,6	s
108	132			-1,2	s
110	145	12	-0,9	-0,4	s
116	173	43	1,0	1,1	s
120	166			0,7	s
124	81,2			-4,2	u
128	188	38	1,8	1,9	s
130	133	56,98	-0,7	-1,1	s
133	155,8	52,4	0,1	0,2	s
136	152	36,5	0,0	0,0	s
138	164			0,6	s
149	156	12	0,5	0,2	s
163	116	20,06	-3,3	-2,2	q
165	175	43,8	1,0	1,2	s
168	116,5	29,1	-2,3	-2,1	q
170	143	22,9	-0,7	-0,5	s
174	149			-0,2	s
177	149			-0,2	s

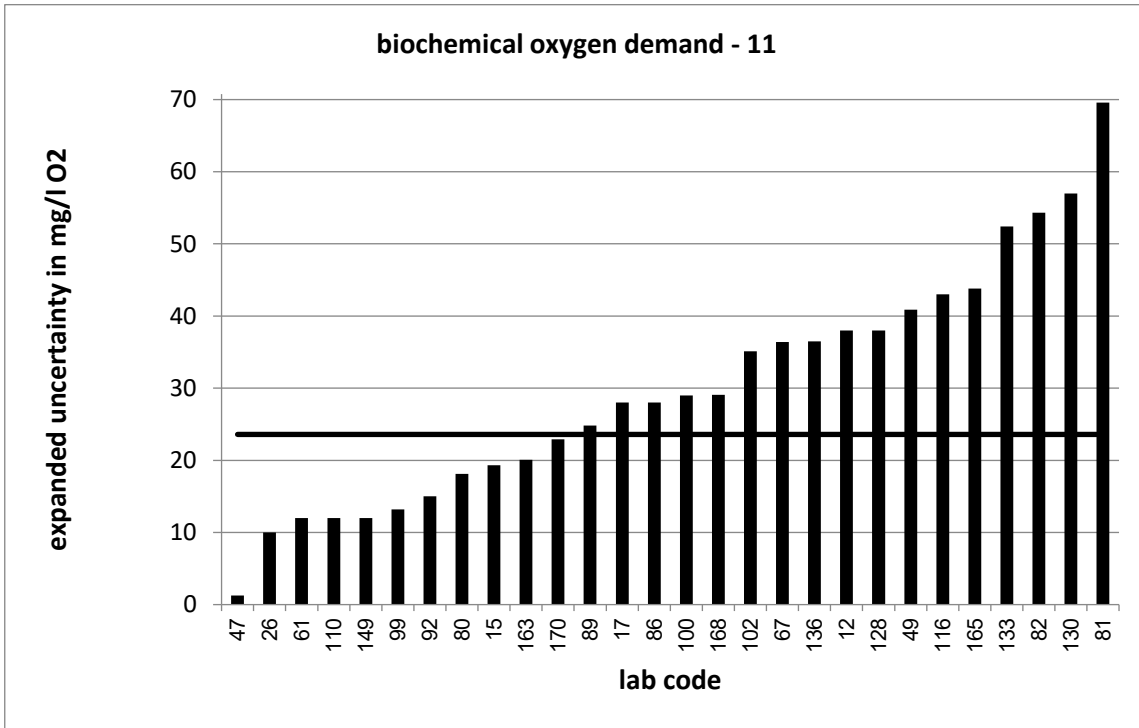
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor  $k=2$  corresponding to a confidence level of about 95%

\*\* s = satisfactory, q = questionable, u = unsatisfactory

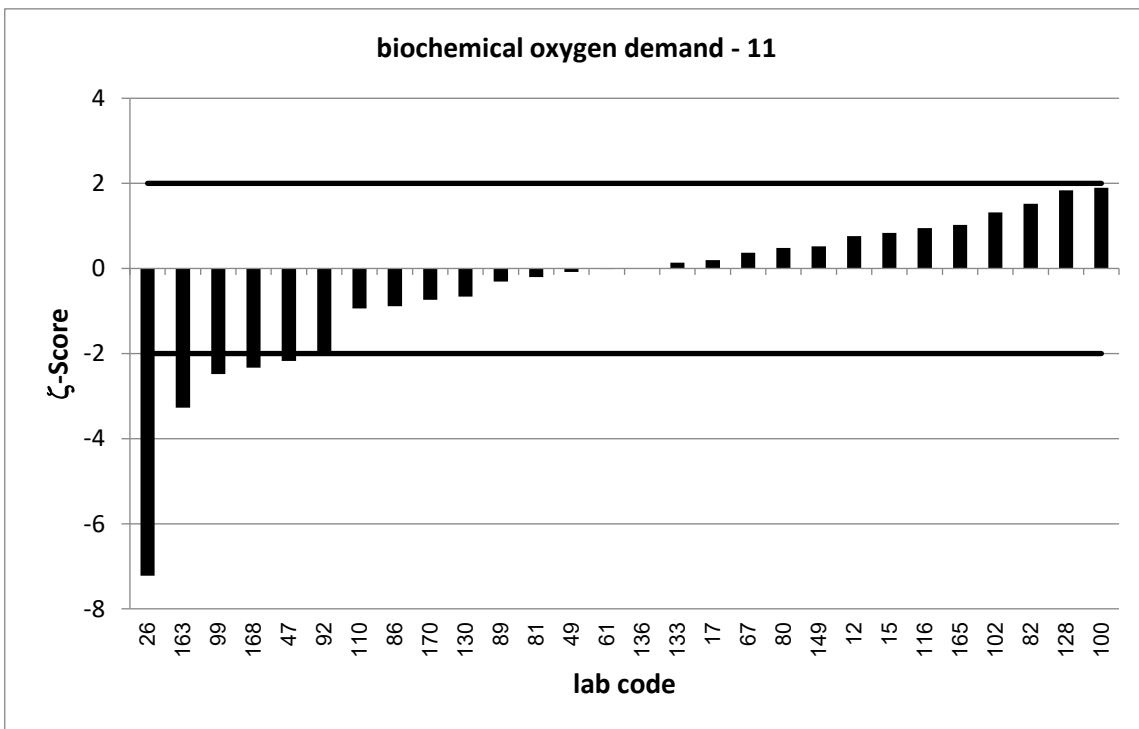


Strongly deviating values are not shown in the diagram.





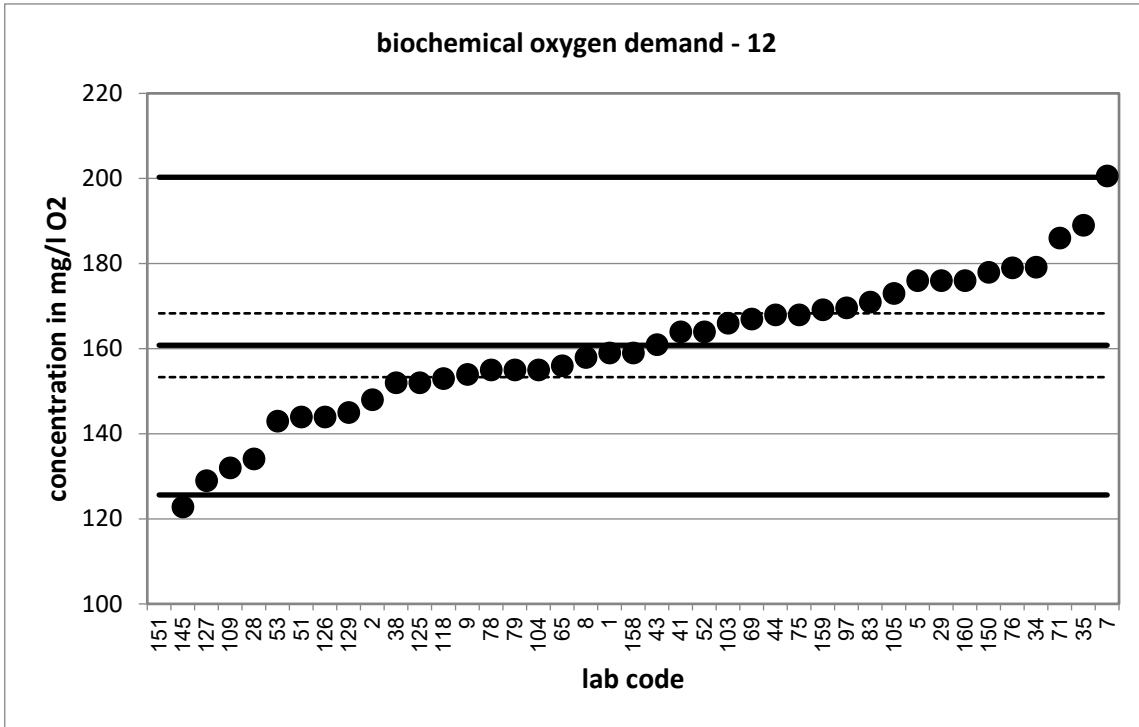
Strongly deviating values are not correctly shown in the diagram.



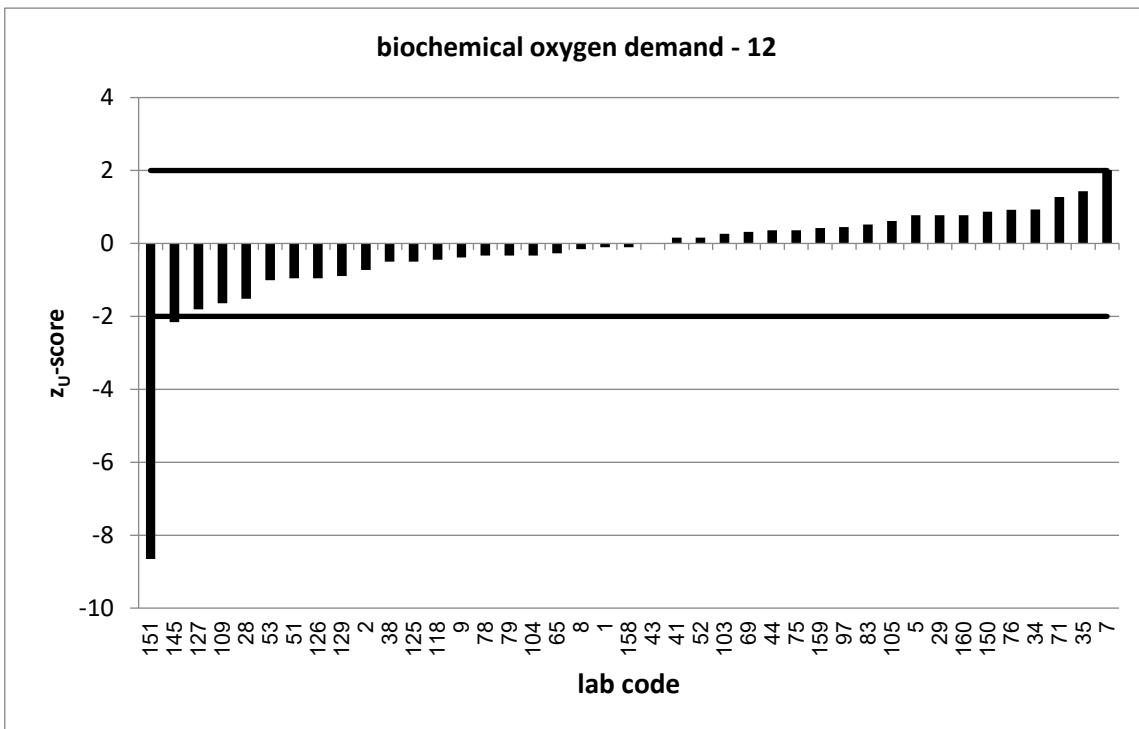
BOD5		biochemical oxygen demand - 12			
assigned value [mg/l O2]*		160,8 ± 7,5			
upper tolerance limit [mg/l O2]		200,3			
lower tolerance limit [mg/l O2]		125,6			
lab code	result [mg/l O2]	±	z-score	Z <sub>U</sub> -score	assessm.**
1	159	31,8	-0,1	-0,1	s
2	148	27,5	-0,9	-0,7	s
5	176	35,2	0,8	0,8	s
7	200,59	88	0,9	2,0	s
8	158	47,8	-0,1	-0,2	s
9	154			-0,4	s
28	134,15	20	-2,5	-1,5	s
29	176	24,6	1,2	0,8	s
34	179,18	44,62	0,8	0,9	s
35	189	52,9	1,1	1,4	s
38	152	30	-0,6	-0,5	s
41	164			0,2	s
43	161	16,1	0,0	0,0	s
44	168	25	0,6	0,4	s
51	144			-1,0	s
52	164	71,4	0,1	0,2	s
53	143			-1,0	s
65	156,04	34,46	-0,3	-0,3	s
69	167	26,8	0,4	0,3	s
71	186			1,3	s
75	168	52,1	0,3	0,4	s
76	179	42	0,9	0,9	s
78	155	40,3	-0,3	-0,3	s
79	155	31	-0,4	-0,3	s
83	171			0,5	s
97	169,6	35	0,5	0,4	s
103	166			0,3	s
104	155			-0,3	s
105	173			0,6	s
109	132			-1,6	s
118	153	10	-1,2	-0,4	s
125	152	28,9	-0,6	-0,5	s
126	144	29	-1,1	-1,0	s
127	129			-1,8	s
129	145			-0,9	s
145	122,8	14,8	-4,6	-2,2	q
150	178	34	1,0	0,9	s
151	8,5	2,5	-38,7	-8,7	u
158	159			-0,1	s
159	169,2	24	0,7	0,4	s
160	176			0,8	s

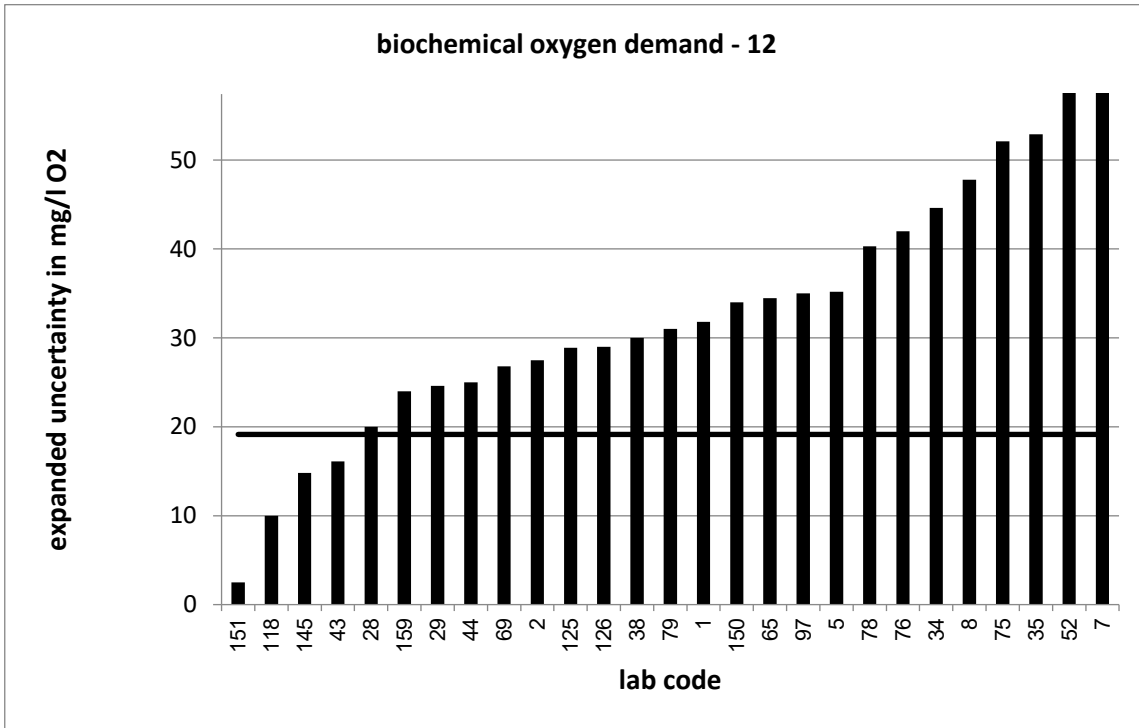
\* The stated uncertainty of the assigned value is the expanded uncertainty with a coverage factor  $k=2$  corresponding to a confidence level of about 95%

\*\* s = satisfactory, q = questionable, u = unsatisfactory

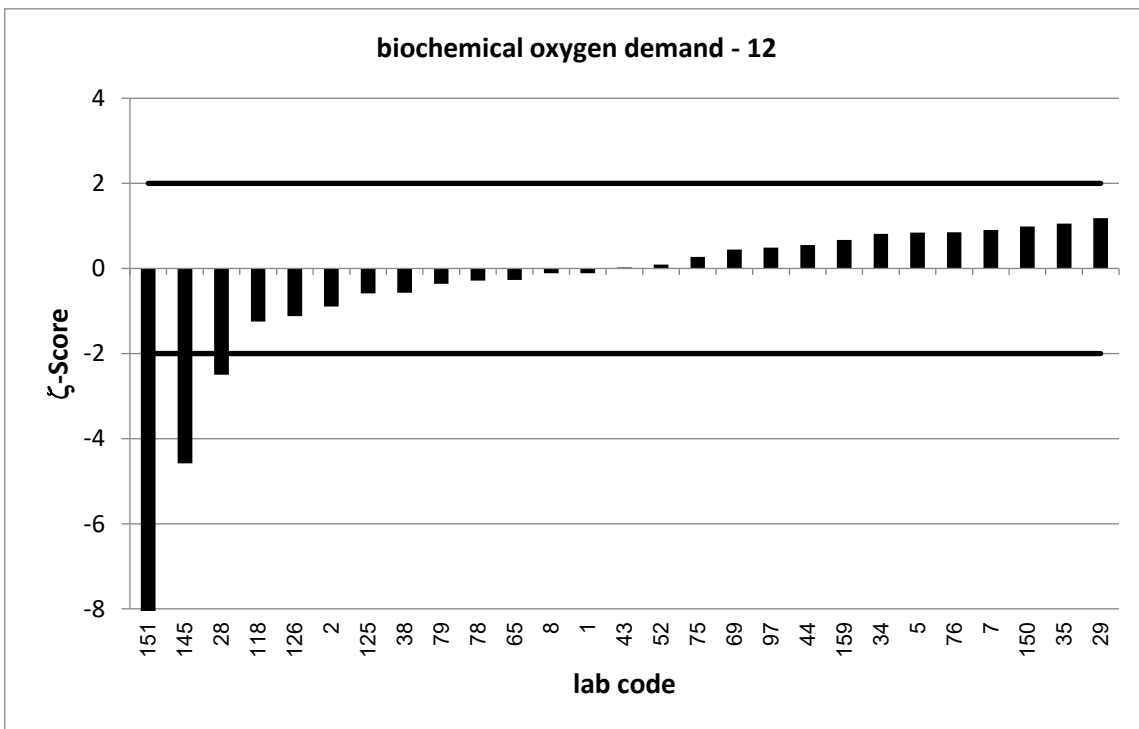


Strongly deviating values are not shown in the diagram.





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