

Date: April 24, 2018
To: Nikki Gilmore, Chief Administrative Officer
From: Jeff Westlake, Superintendent of Public Works
Subject: Water Treatment and Soda Ash Project

PURPOSE

This report is to provide an update on the operations of the Soda Ash dosing system and results of the first optimization phase.

BACKGROUND

In June of 2016, the Village of Pemberton undertook a water sampling program to determine the best course of action to mitigate the corrosion of metallic plumbing systems and fixtures. The results indicated an immediate need to adjust the pH and alkalinity of the well water which is considered slightly acidic.

As a result, Village Engineers proposed treatment options and subsequently prepared design drawings for tendering the construction of a water conditioning plant which would use Sodium Carbonate (Soda Ash) to increase the pH and Alkalinity of Pemberton's well water. Depending on the impacts of Soda Ash, additional consideration was given to also adding Clear Hib 5 an orthophosphate.

The project is now complete and the Village Water Conditioning Plant, located in Pioneer Park and formally referred to as the well-house, has been operational since June, 2017. The Plant was initially run at a lower pH set point during the commissioning phase to establish solution concentrations, test the equipment and controls and to carefully assess the chemical reactions with Pemberton's well water. A significant effort went into establishing the ratio of soda ash to water mixture as at concentrations greater than 10%, there is potential for the solution to freeze within the injection line. The plant is currently operating at an 8% solution of Sodium Carbonate to water.

In October 2017, the Village entered into the first optimization phase whereby the Plant was setup to achieve a target pH of 7 at the injection point and maintain an alkalinity between 40 and 80mg/L CaCO₃. Although the initial optimisation phase was proposed to run at a higher pH value, the alkalinity target was achieved and stable and therefore the Village, in consultation with Village Engineers, opted to run the first phase at a pH set point of 7. At this set point, an average pH value of 7.20 has been observed in weekly water sample testing from eight (8) locations throughout the distribution system.

On February 21st and 22nd 2018, the Village set out to assess the influence Soda Ash (Sodium Carbonate) has had in mitigating corrosion in residential plumbing systems in Optimization Phase 1. In this regard, nine (9) residential locations evenly distributed throughout the distribution system were selected for sampling of which 90% of the 2018 samples were taken at locations previously sampled in 2016.

For the Optimization Phase 1 sampling program, two separate samples were taken over two days. Sample 1 was taken using a 1L container, first draw from a faucet that had not run for at least six (6) hrs. The following day, a second sample was taken using a 120mL container using the same first draw technique as the first sample. The one (1) litre sample size container was used to conform to the Federal standards for sampling for corrosion while the second 120mL container was used as a control to relate to the samples taken in 2016.

In 2016, 55% of the samples collected from the nine (9) locations, tested above the MAC (Maximum Acceptable Concentration). Out of the nine (9), 120mL and nine (9), 1L samples collected in 2018, zero exceeded the MAC for lead. A summary of the results can be seen in the chart attached (**Appendix A**) as well as the weekly pH and Alkalinity correlation (**Appendix B**).

DISCUSSION & COMMENTS

Staff has been very pleased with the results to date and the progress that has been made in addressing the adjustment in the pH balance in the water.

Going forward the System will operate under the existing conditions, setting a target pH of seven (7) with a corresponding Alkalinity target of between 40 and 80mg/L CaCO₃. Operations will continue to monitor pH and Alkalinity weekly at eight (8) sample stations within the distribution system. As well, testing will be conducted daily at the Water Conditioning Plant, in order to maintain the corrosion inhibiting properties currently observed.

Despite the upgrades to the System and the improvement to the water quality, the Village and Vancouver Coastal Health Authority encourage residents to always flush their lines until the water runs cold particularly after a prolonged period in which the taps have not been run.

COMMUNICATIONS

The Operations and Development Services Department has been working with the Communication Coordinator to regularly update the Village's website and eNews with current information related to Operations. This Report will be made available on the Water Conditioning Project page on the Village's website.

LEGAL CONSIDERATIONS

There are no legal considerations as this report is being presented for information purposes.

IMPACT ON BUDGET & STAFFING

The Operations Division operates on the approved annual municipal budget, Provincial grants and where applicable cost recovery as per the Development Procedures Bylaw No. 725, 2013. The Water Treatment Project was completed with funding through the Community Amenity Gas Tax Fund and our Municipal Water Reserves. No other funding was required, either under increased taxation or increased user fees to complete this project.

INTERDEPARTMENTAL IMPACT & APPROVAL

There are no interdepartmental impacts or approval required at this time.

IMPACT ON THE REGION OR NEIGHBOURING JURISDICTIONS

The Village of Pemberton provides water services to the Pemberton North Water System (PNWS). Any upgrades and or changes to the Village's water system impacts the water provided to PNWS; therefore, the significant improvements in pH and Alkalinity have similar positive results in that area. A copy of this report will be forwarded to the SLRD for their information.

ALTERNATIVE OPTIONS

There are no alternative options for consideration.

POTENTIAL GOVERNANCE CONSIDERATIONS

The services provided by the Operations Division meet with Strategic Priority One: Economic Vitality by supporting a diversified economy; Strategic Priority Two: Good Governance by being open and accountable and fiscally responsible; Strategic Priority Three: Excellence in Service by ensuring that the Village continues to deliver the highest quality of municipal services within the scope of our resources; and finally, Strategic Priority Four: Social Responsibility by supporting the creation of a strong and vibrant community.

RECOMMENDATIONS

THAT the Water Treatment and Soda Ash Project Update report be received for information.

Submitted by:	Jeff Westlake, Public Works Superintendent
CAO Approval by:	Nikki Gilmore, Chief Administrative Officer

Attachments:

- Appendix A: Comparative Metals Testing
- Appendix B: Village of Pemberton Water Sampling Program for 2017 and 2018 to date

APPENDIX A
Comparative Metals Testing

Comparative Metals Testing
2016 - 2018

Location					Benchlands	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	60.2	52.2	269
Total Iron	ug/L		300	<10	<10	30
Total Lead	ug/L	10		0.38	1.17	19
T. Manganese	ug/L		50	<1	<1	7

Location					Pemberton North	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	41.6	116	1470
Total Iron	ug/L		300	<10	16	125
Total Lead	ug/L	10		0.6	1.77	1.06
T. Manganese	ug/L		50	<1	2	6.8

Location					Creekside	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	116	554	1890
Total Iron	ug/L		300	<10	<10	53
Total Lead	ug/L	10		1.19	1.56	2.9
T. Manganese	ug/L		50	<1.0	<1.0	20

Location					Alder	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	70.1	156	719
Total Iron	ug/L		300	<10	15	31
Total Lead	ug/L	10		0.76	2.63	63
T. Manganese	ug/L		50	<1.0	2.3	11

Location					The Glen	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	12.9	35.9	536
Total Iron	ug/L		300	<10	<10	34
Total Lead	ug/L	10		0.56	2.02	48
T. Manganese	ug/L		50	<1.0	<1.0	16.9

Location					Prospect North	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	45.7	116	1660
Total Iron	ug/L		300	<10	16	73
Total Lead	ug/L	10		0.52	1.77	55.4
T. Manganese	ug/L		50	<1.0	2.0	26

Location					Pioneer/Peaks	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	47.4	217	431
Total Iron	ug/L		300	13	<10	49
Total Lead	ug/L	10		0.88	2.14	4.19
T. Manganese	ug/L		50	1.0	<1.0	16

different unit same area

Location					Town Centre	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	1550	782	4630
Total Iron	ug/L		300	14	<10	197
Total Lead	ug/L	10		0.79	0.65	6.45
T. Manganese	ug/L		50	11.8	6.6	68.4

Location					Poplar	
Container size				1L	120ml	120ml
Total Metals	Units	MAC	AO	Feb 22/18	Feb 21/18	Feb 17/16
Total Copper	ug/L		1000	518	725	4500
Total Iron	ug/L		300	<10	<10	56
Total Lead	ug/L	10		3.59	4.07	39
T. Manganese	ug/L		50	2.2	1.8	34

APPENDIX B
2017
Water Samples

Village of Pemberton Water Sampling Program

Location	Date	CL2	PH	Alkalinity	Notes
Health Centre	6/5/2017	0.30	6.2	26	
Village Office	6/5/2017	0.25	6.2	19	No pH adjustment
Collins	6/5/2017	0.43	6.2	18	was carried out
Plateau	6/5/2017	0.35	6.2	24	during this week
Urdal	6/5/2017	0.37	6.2	13	
Oak	6/5/2017	0.41	6.2	19	
Farm	6/5/2017	0.40	6.2	13	
meadows	6/5/2017	0.39	6.1	7	
		0.36	6.2	17.38	Weekly Average
Health Centre	6/12/2017	0.36	6.8	43	
Village Office	6/12/2017	0.31	6.8	50	
Collins	6/12/2017	0.39	6.8	48	
Plateau	6/12/2017	0.37	6.9	41	well 3
Urdal	6/12/2017	0.38	6.9	50	
Oak	6/12/2017	0.38	6.7	38	
Farm	6/12/2017	0.32	6.8	42	
meadows	6/12/2017	0.37	6.9	25	
		0.36	6.8	42.13	Weekly Average
Health Centre	6/19/2017	0.26	7.0	41	
Village Office	6/19/2017	0.32	7.0	75	
Collins	6/19/2017	0.40	7.0	56	
Plateau	6/19/2017	0.32	7.0	60	well 3
Urdal	6/19/2017	0.36	7.0	59	
Oak	6/19/2017	0.34	7.1	55	
Farm	6/19/2017	0.36	7.1	41	
meadows	6/19/2017	0.35	7.1	56	
		0.34	7.0	55.38	Weekly Average
Health Centre	6/26/2017	0.38	7.1	26	
Village Office	6/26/2017	0.28	7.1	24	
Collins	6/26/2017	0.30	7.7	46	
Plateau	6/26/2017	0.34	7.6	32	well 3
Urdal	6/26/2017	0.36	7.3	25	
Oak	6/26/2017	0.31	7.7	46	
Farm	6/26/2017	0.36	7.4	38	
meadows	6/26/2017	0.35	7.2	36	
		0.34	7.4	34.13	Weekly Average
Health Centre	7/4/2017	0.52	6.5	33	
Village Office	7/4/2017	0.33	6.3	27	
Collins	7/4/2017	0.40	6.4	37	
Plateau	7/4/2017	0.35	6.3	32	well 3
Urdal	7/4/2017	0.37	6.5	46	

Oak	7/4/2017	0.41	6.5	43	
Farm	7/4/2017	0.39	6.5	29	
meadows	7/4/2017	0.38	6.4	30	
		0.39	6.4	34.63	Weekly Average
Health Centre	7/10/2017	0.26	7.1	32	
Village Office	7/10/2017	0.26	7.1	45	
Collins	7/10/2017	0.38	7.0	51	well 3
Plateau	7/10/2017	0.33	6.9	37	
Urdal	7/10/2017	0.32	6.8	44	
Oak	7/10/2017	0.38	6.9	54	
Farm	7/10/2017	0.36	7.1	40	
meadows	7/10/2017	0.34	7.0	41	
		0.33	7.0	43	Weekly Average
Health Centre	7/18/2017	0.30	6.6	36	
Village Office	7/18/2017	0.29	6.4	42	
Collins	7/18/2017	0.40	6.8	46	
Plateau	7/18/2017	0.29	7.1	38	well 3
Urdal	7/18/2017	0.31	6.8	35	
Oak	7/18/2017	0.32	7.2	29	
Farm	7/18/2017	0.32	6.7	32	
meadows	7/18/2017	0.30	6.8	42	
		0.32	6.8	38	Weekly Average
Health Centre	7/25/2017	0.26	6.1	29	
Village Office	7/25/2017	0.19	6.2	20	
Collins	7/25/2017	0.37	6.2	25	
Plateau	7/25/2017	0.29	6.2	28	res drained and refilled
Urdal	7/25/2017	0.31	6.2	23	2 pumps running soda ash
Oak	7/25/2017	0.31	6.1	19	diluted
Farm	7/25/2017	0.37	6.2	22	
meadows	7/25/2017	0.29	6.2	29	
		0.30	6.2	24	Weekly Average
Health Centre	8/1/2017	0.31	6.7	35	
Village Office	8/1/2017	0.22	6.7	26	
Collins	8/1/2017	0.40	6.7	58	
Plateau	8/1/2017	0.32	6.7	33	well 3
Urdal	8/1/2017	0.38	6.7	39	
Oak	8/1/2017	0.38	6.7	37	
Farm	8/1/2017	0.37	6.7	53	
meadows	8/1/2017	0.37	6.7	51	
		0.34	6.7	42	Weekly Average
Health Centre	8/8/2017	0.29	6.4	29	
Village Office	8/8/2017	0.23	6.4	46	

Collins	8/8/2017	0.36	6.5	35	Well 3
Plateau	8/8/2017	0.31	6.5	46	
Urdal	8/8/2017	0.32	6.3	44	
Oak	8/8/2017	0.35	6.3	36	
Farm	8/8/2017	0.32	6.4	34	
meadows	8/8/2017	0.33	6.4	44	
		0.31	6.4	39	Weekly Average
Health Centre	8/15/2017	0.23	6.6	31	
Village Office	8/15/2017	0.20	6.7	20	soda ash system down
Collins	8/15/2017	0.33	6.7	24	over the weekend
Plateau	8/15/2017	0.23	6.5	30	well 2 running due to a fault
Urdal	8/15/2017	0.26	6.6	23	
Oak	8/15/2017	0.33	6.6	22	
Farm	8/15/2017	0.29	6.6	23	
meadows	8/15/2017	0.28	6.6	18	
		0.27	6.6	24	Weekly Average
Health Centre	8/21/2017	0.27	6.6	24	
Village Office	8/21/2017	0.19	6.6	30	
Collins	8/21/2017	0.35	6.6	29	
Plateau	8/21/2017	0.26	6.6	29	
Urdal	8/21/2017	0.33	6.7	33	
Oak	8/21/2017	0.33	6.6	22	
Farm	8/21/2017	0.32	6.7	29	
meadows	8/21/2017	0.31	6.7	27	
		0.30	6.6	28	Weekly Average
Health Centre	8/28/2017	0.28	6.4	23	
Village Office	8/28/2017	0.23	6.6	26	
Collins	8/28/2017	0.38	6.4	26	
Plateau	8/28/2017	0.30	6.6	31	
Urdal	8/28/2017	0.30	6.4	28	
Oak	8/28/2017	0.32	6.4	25	
Farm	8/28/2017	0.30	6.4	25	
meadows	8/28/2017	0.30	6.4	29	
		0.30	6.4	27	Weekly Average
Health Centre	9/5/2017	0.28	6.6	28	
Village Office	9/5/2017	0.23	6.5	24	
Collins	9/5/2017	0.38	6.5	30	
Plateau	9/5/2017	0.30	6.4	38	
Urdal	9/5/2017	0.30	6.6	24	
Oak	9/5/2017	0.32	6.6	43	
Farm	9/5/2017	0.30	6.6	26	
meadows	9/5/2017	0.30	6.5	27	
		0.30	6.5	30	Weekly Average

Health Centre	9/11/2017	0.20	6.6	26	
Village Office	9/11/2017	0.29	6.9	30	
Collins	9/11/2017	0.29	6.9	27	
Plateau	9/11/2017	0.26	6.8	29	
Urdal	9/11/2017	0.29	6.9	30	
Oak	9/11/2017	0.32	6.8	30	
Farm	9/11/2017	0.27	6.9	24	
meadows	9/11/2017	0.26	6.9	38	
		0.27	6.8	29	Weekly Average
Health Centre	9/20/2017	0.23	6.7	26	
Village Office	9/20/2017	0.35	6.4	27	
Collins	9/20/2017	0.33	6.6	26	
Plateau	9/20/2017	0.24	6.7	28	
Urdal	9/20/2017	0.24	6.8	26	
Oak	9/20/2017	0.33	6.8	22	
Farm	9/20/2017	0.27	6.7	21	
meadows	9/20/2017	0.20	6.7	28	
		0.27	6.7	26	Weekly Average
Health Centre	9/25/2017	0.24	6.4	25	
Village Office	9/25/2017	0.25	6.5	28	
Collins	9/25/2017	0.33	6.4	25	
Plateau	9/25/2017	0.29	6.4	25	
Urdal	9/25/2017	0.24	6.5	26	
Oak	9/25/2017	0.33	6.5	25	
Farm	9/25/2017	0.27	6.3	25	
meadows	9/25/2017	0.20	6.4	28	
		0.27	6.4	26	Weekly Average
Health Centre	10/2/2017	0.24	6.9	25	
Village Office	10/2/2017	0.23	6.9	27	
Collins	10/2/2017	0.32	6.9	30	
Plateau	10/2/2017	0.26	6.6	29	
Urdal	10/2/2017	0.25	6.7	25	
Oak	10/2/2017	0.31	6.8	26	
Farm	10/2/2017	0.28	6.7	30	
meadows	10/2/2017	0.25	6.7	34	
		0.27	6.8	28.25	Weekly Average
Health Centre	10/16/2017	0.25	6.4	50	
Village Office	10/16/2017	0.21	6.3	55	
Collins	10/16/2017	0.30	6.3	52	
Plateau	10/16/2017	0.26	6.3	53	
Urdal	10/16/2017	0.32	6.4	62	
Oak	10/16/2017	0.27	6.6	49	

Farm	10/16/2017	0.26	6.4	48	
meadows	10/16/2017	0.25	6.3	53	
		0.27	6.4	52.75	Weekly Average
Health Centre	10/23/2017	0.27	7.0	54	
Village Office	10/23/2017	0.20	6.9	59	
Collins	10/23/2017	0.32	7.0	55	
Plateau	10/23/2017	0.26	7.0	55	New pumps installed
Urdal	10/23/2017	0.26	6.7	56	
Oak	10/23/2017	0.29	6.9	58	
Farm	10/23/2017	0.23	7.0	59	
meadows	10/23/2017	0.27	6.7	58	
		0.26	6.9	57	
Health Centre	6/11/2017	0.28	7.4	61	
Village Office	6/11/2017	0.21	7.4	61	
Collins	6/11/2017				frozen
Plateau	6/11/2017	0.28	7.7	50	
Urdal	6/11/2017				frozen
Oak	6/11/2017	0.27	7.6	58	
Farm	6/11/2017				frozen
meadows	6/11/2017				frozen
		0.26	7.5	58	
Health Centre	14/11/2017	0.33	7.0	50	
Village Office	14/11/2017	0.30	7.0	60	
Collins	14/11/2017	0.35	7.0	57	
Plateau	14/11/2017	0.33	7.0	54	
Urdal	14/11/2017	0.31	7.0	53	
Oak	14/11/2017	0.34	7.0	53	
Farm	14/11/2017	0.31	7.0	57	
meadows	14/11/2017	0.29	7.0	50	
		0.32	7.0	54	
Health Centre	21/11/2017	0.25	7.3	62	
Village Office	21/11/2017	0.20	7.3	74	
Collins	21/11/2017	0.28	7.3	59	
Plateau	21/11/2017	0.30	7.3	52	
Urdal	21/11/2017	0.19	7.3	68	
Oak	21/11/2017	0.27	7.3	62	
Farm	21/11/2017	0.23	7.3	59	
meadows	21/11/2017	0.28	7.3	57	
		0.25	7.3	62	
Health Centre	28/11/2017	0.23	7.4	71	
Village Office	28/11/2017	0.22	7.3	58	
Collins	28/11/2017	0.34	7.3	49	

Plateau	28/11/2017	0.29	7.4	55	
Urdal	28/11/2017	0.29	7.3	53	
Oak	28/11/2017	0.29	7.3	67	
Farm	28/11/2017	0.27	7.3	56	
meadows	28/11/2017	0.29	7.4	54	
		0.28	7.3	58	
Health Centre	5/12/2017	0.26	7.1	56	
Village Office	5/12/2017	0.26	7.0	47	
Collins	5/12/2017				frozen
Plateau	5/12/2017	0.30	7.1	53	
Urdal	5/12/2017				frozen
Oak	5/12/2017	0.33	7.0	50	
Farm	5/12/2017				frozen
meadows	5/12/2017				frozen
		0.29	7.1	52	
Health Centre	11/12/2017	0.30	7.4	49	
Village Office	11/12/2017	0.24	7.4	50	
Collins	11/12/2017				frozen
Plateau	11/12/2017	0.31	7.4	56	
Urdal	11/12/2017				frozen
Oak	11/12/2017	0.34	7.4	54	
Farm	11/12/2017				frozen
meadows	11/12/2017				frozen
		0.30	7.4	52	
Health Centre	18/12/2017	0.27	7.4	55	
Village Office	18/12/2017	0.25	7.4	59	
Collins	18/12/2017	0.34	7.2	53	
Plateau	18/12/2017	0.33	7.4	55	
Urdal	18/12/2017	0.33	7.5	56	
Oak	18/12/2017	0.36	7.5	53	
Farm	18/12/2017	0.30	7.4	56	
meadows	18/12/2017	0.33	7.4	55	
		0.31	7.4	55	
Health Centre	27/12/2017				
Village Office	27/12/2017				
Collins	27/12/2017				
Plateau	27/12/2017	0.35	6.7	40	
Urdal	27/12/2017				
Oak	27/12/2017	0.38	6.8	39	
Farm	27/12/2017				
meadows	27/12/2017				
		0.37	6.7	40	

2018
Water Sampling To Date

Village of Pemberton Water Sampling Program

Location	Date	CL2	PH	Alkalinity	Notes
Health Centre	3/1/2018	0.31	7.6	44	
Village Office	3/1/2018	0.19	7.6	49	
Collins	3/1/2018				frozen
Plateau	3/1/2018	0.29	7.6	50	
Urdal	3/1/2018				frozen
Oak	3/1/2018	0.34	7.6	44	
Farm	3/1/2018				frozen
meadows	3/1/2018				frozen
		0.28	7.6	47	
Health Centre	8/1/2018	0.28	7.1	41	
Village Office	8/1/2018	0.35	7.1	50	
Collins	8/1/2018	0.40	7.1	49	
Plateau	8/1/2018	0.37	7.1	44	
Urdal	8/1/2018				flooded
Oak	8/1/2018	0.40	7.0	50	
Farm	8/1/2018	0.33	7.1	50	
meadows	8/1/2018	0.36	7.0	45	
		0.36	7.1	47	
Health Centre	16/1/2018	0.37	7.1	40	
Village Office	16/1/2018	0.30	7.2	49	
Collins	16/1/2018	0.37	7.1	49	
Plateau	16/1/2018	0.34	7.1	45	
Urdal	16/1/2018	0.30	7.1	39	
Oak	16/1/2018	0.36	7.1	40	
Farm	16/1/2018	0.21	7.1	45	
meadows	16/1/2018				frozen
		0.32	7.1	44	
Health Centre	22/1/2018	0.32	7.1	42	
Village Office	22/1/2018	0.28	7.2	41	
Collins	22/1/2018	0.31	7.1	45	
Plateau	22/1/2018	0.30	7.1	47	
Urdal	22/1/2018	0.31	7.1	37	
Oak	22/1/2018	0.31	7.1	42	
Farm	22/1/2018	0.27	7.1	41	
meadows	22/1/2018	0.27	7.2	44	
		0.30	7.1	42	
Health Centre	30/1/2018	0.32	7.0	54	
Village Office	30/1/2018	0.27	7.0	48	
Collins	30/1/2018	0.34	7.0	53	
Plateau	30/1/2018	0.32	7.0	51	
Urdal	30/1/2018				flooded

Oak	30/1/2018	0.31	7.0	56	
Farm	30/1/2018	0.29	7.0	45	
meadows	30/1/2018	0.34	7.0	50	
		0.31	7.0	51	
Health Centre	5/2/2018	0.29	7.2	44	
Village Office	5/2/2018	0.26	7.2	45	
Collins	5/2/2018	0.36	7.2	47	
Plateau	5/2/2018	0.36	7.2	44	
Urdal	5/2/2018				flooded
Oak	5/2/2018	0.36	7.2	47	
Farm	5/2/2018	0.35	7.2	43	
meadows	5/2/2018	0.35	7.2	45	
		0.33	7.2	45	
Health Centre	13/2/2018	0.32	7.5	55	
Village Office	13/2/2018	0.32	7.7	46	
Collins	13/2/2018				frozen
Plateau	13/2/2018	0.32	7.3	47	
Urdal	13/2/2018				frozen
Oak	13/2/2018	0.32	7.7	48	
Farm	13/2/2018				frozen
meadows	13/2/2018				frozen
		0.32	7.5	49	
Health Centre	20/2/2018	0.32	7.2	45	
Village Office	20/2/2018	0.31	7.2	48	
Collins	20/2/2018				frozen
Plateau	20/2/2018	0.33	7.2	50	
Urdal	20/2/2018				frozen
Oak	20/2/2018	0.36	7.2	51	
Farm	20/2/2018				frozen
meadows	20/2/2018				frozen
		0.33	7.2		
Health Centre	27/2/2018	0.34	7.2	43	
Village Office	27/2/2018	0.22	7.2	49	
Collins	27/2/2018	0.33	7.2	46	
Plateau	27/2/2018	0.34	7.2	51	
Urdal	27/2/2018				frozen
Oak	27/2/2018	0.33	7.2	44	
Farm	27/2/2018	0.31	7.2	49	
meadows	27/2/2018				frozen
		0.31	7.2	47	
Health Centre	5/3/2018	0.29	7.0	54	
Village Office	5/3/2018	0.32	7.0	53	

Collins	5/3/2018	0.37	7.0	51	
Plateau	5/3/2018	0.31	7.0	52	
Urdal	5/3/2018				flooded
Oak	5/3/2018	0.35	7.0	47	
Farm	5/3/2018	0.33	7.0	52	
meadows	5/3/2018				
		0.33	7.0	52	
Health Centre	5/20/2018	0.31	6.9	47	
Village Office	5/20/2018	0.32	7.0	48	
Collins	5/20/2018	0.35	7.0	48	
Plateau	5/20/2018	0.31	7.0	50	
Urdal	5/20/2018				flooded
Oak	5/20/2018	0.33	7.0	44	
Farm	5/20/2018	0.31	7.0	48	
meadows	5/20/2018	0.31	7.0	43	
		0.32	7.0	47	

Health Centre	5/26/2018	0.30	7.1	40	
Village Office	5/26/2018	0.28	6.9	35	
Collins	5/26/2018	0.32	7.1	40	
Plateau	5/26/2018	0.33	6.9	37	
Urdal	5/26/2018	0.30	7.1	40	
Oak	5/26/2018	0.31	7.2	40	
Farm	5/26/2018	0.31	7.3	43	
meadows	5/26/2018	0.25	6.9	39	
		0.30	7.1	39	
Health Centre	6/3/2018	0.29	6.9	51	
Village Office	6/3/2018	0.26	6.9	51	
Collins	6/3/2018	0.37	6.9	46	
Plateau	6/3/2018	0.32	6.9	46	
Urdal	6/3/2018	0.35	6.9	48	
Oak	6/3/2018	0.35	6.9	46	
Farm	6/3/2018	0.33	6.9	41	
meadows	6/3/2018	0.30	6.9	51	
		0.32	6.9	48	
Health Centre	6/9/2018	0.31	0.0	55	
Village Office	6/9/2018	0.23	0.0	47	
Collins	6/9/2018	0.36	0.0	49	pH analyzer faulty
Plateau	6/9/2018	0.34	0.0	44	
Urdal	6/9/2018	0.35	0.0	53	
Oak	6/9/2018	0.35	0.0	49	
Farm	6/9/2018	0.33	0.0	46	
meadows	6/9/2018	0.32	0.0	50	

		0.32	0.0	49	
Health Centre	6/16/2018	0.28	7.2	54	
Village Office	6/16/2018	0.32	7.3	57	
Collins	6/16/2018	0.35	7.2	49	
Plateau	6/16/2018	0.33	7.2	50	
Urdal	6/16/2018	0.36	7.2	50	
Oak	6/16/2018	0.34	7.2	54	
Farm	6/16/2018	0.33	7.2	50	
meadows	6/16/2018	0.35	7.2	43	
		0.33	7.2	51	