## Appendix: supplementary data (SD)

Section 1 provides information on the average sedimentological and geochemical analysis of the aquifer material conducted by TNO in 2018. Section 2 provides supplementary figures on the monitored infiltration period one, section 3 likewise for period two. Section 4 lists the analytical results on recharge water quality. Section 5 provides photographs taken at the ASTR site in Breezand. Section 6 presents additional micrographs on sampled points discussed in section 2.5. Section 7 provides the analytical results on the well rehabilitation samples including the sedimentological analysis and XRD analysis results. Lastly, section 8 provides additional submersible camera shots of the injection wells.

## Section 1: TNO lithological site survey

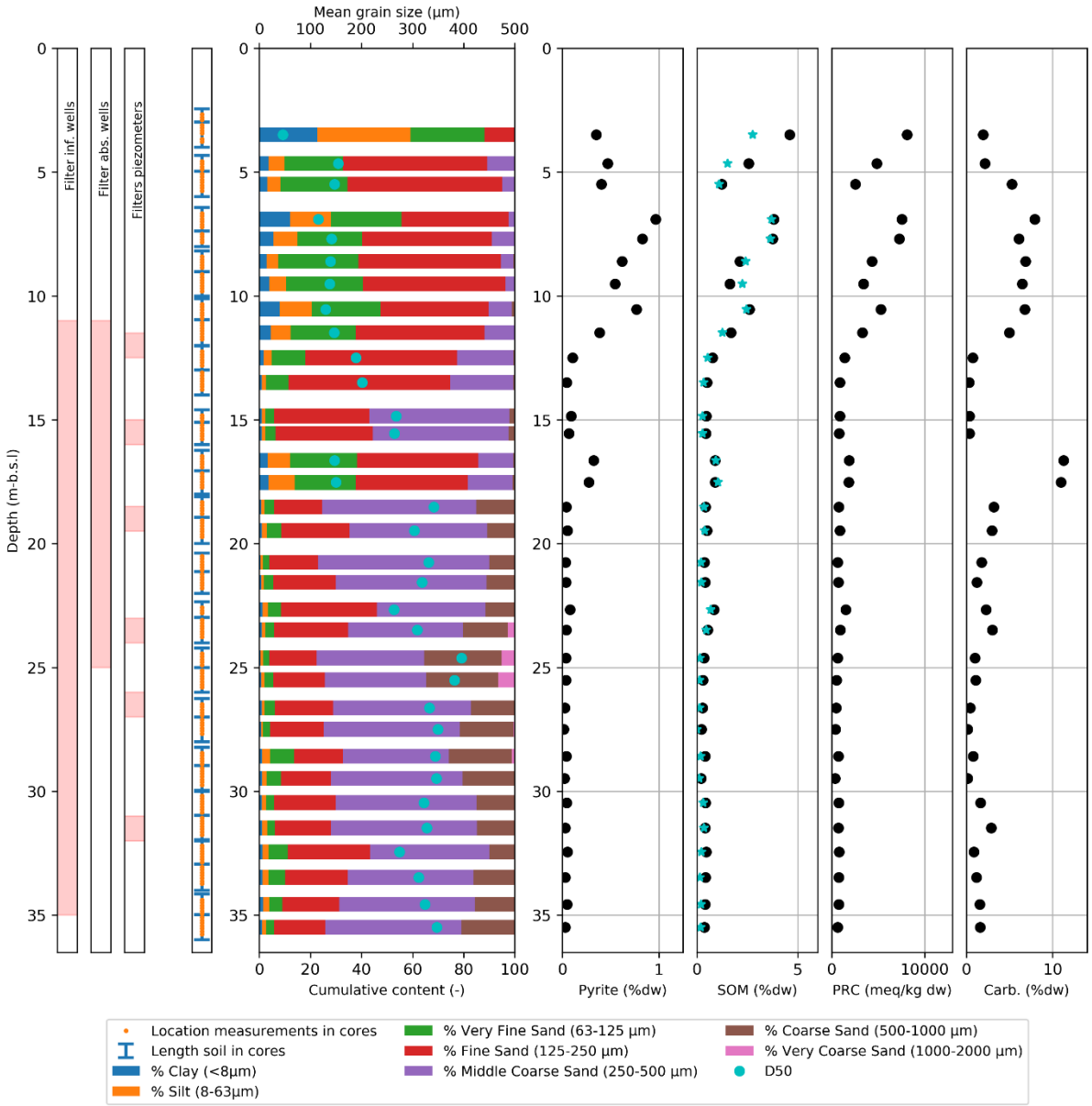



*Figure 1.1: Average sedimentological and geochemical analysis on the aquifer matrix in Breezand. Adopted from E. Kruisdijk.*

## TNO - Geological Survey of the Netherlands

B14B0993

| | |
|---|---|
| Soort boring | : Matig diepe boring derden |
| Coordinaatsysteem | : Rijksdriehoeksmeting |
| X-coordinaat (m) | : 116969 |
| Y-coordinaat (m) | : 544722 |
| Locatiebepaling | : Geschat, methode onbekend |
| Referentievlak | : Normaal Amsterdams Peil |
| Maaiveld (cm) | : 0 |
| Datum boring | : 11-2-2019 |
| Eigenaar | : Emiel Kruisdijk TU-Delft |
| Vertrouwelijkheid | : Vertrouwelijk |
| Geheim tot | : 31-12-2022 |

### Boormethode

| Diepte (cm) | Omschrijving |
|---|---|
| 0 - 200 | Trilboring, boordiameter (mm): 40 |
| 200 - 3565 | Trilboring, boordiameter (mm): 100 |

### Lithologie

| | |
|---|---|
| Org. beschrijver lithologie | : TNO |
| Beschrijver lithologie | : Nico Janssen |
| Beschreven sediment | : Nat en droog sediment |
| Datum boorbeschrijving | : 11-4-2019 |
| Norm mediaanklasse | : NEN 5104 |
| Hulpmiddel beschrijving | : Vergelijkingsmicroscoop, Binoculair |

| Diepte (cm) | Grondsoort | Omschrijving | %Lu | | %Za | | %Os | |
|---|---|---|---|---|---|---|---|---|
| | | | M63 | | %Si | | %Gr | Ca |
| 0 - 33 | zand | zand, zwak siltig, matig humeus, grijs-bruin, 2.5y 5/2, Zand: matig fijn, matig kleine spreiding, matig afgerond, spoor roze korrels, spoor witte korrels, spoor zwarte korrels, spoor bont materiaal, spoor wortels, spoor houtresten, Schelpen: spoor schelpmateriaal, spoor schelpgruis, spoor hele schelpen, spoor Hydrobiidae, weinig fijne detritus | 170 | 0 | 1 | 99 | 0 | 5 | 2 |
| 33 - 66 | zand | zand, zwak siltig, matig humeus, grijs, 5y 5/1, Zand: matig fijn, matig kleine spreiding, matig afgerond, spoor roze korrels, spoor witte korrels, spoor bont materiaal, spoor houtresten, spoor wortels, Schelpen: spoor schelpmateriaal, spoor schelpgruis, spoor glimmer, spoor grove korrels, veel fijne detritus, houtskool | 170 | 0 | 1 | 99 | 0 | 5 | 2 |
| 66 - 100 | zand | zand, zwak siltig, zwak humeus, licht-grijs, 5y 6/2, Zand: matig fijn, matig grote spreiding, matig afgerond, weinig grijze korrels, spoor witte korrels, spoor zwarte korrels, spoor bont materiaal, spoor worteiresten, Schelpen: spoor schelpmateriaal, spoor schelpgruis, spoor hele schelpen, spoor juveniel, spoor Hydrobiidae, spoor Euspira sp., spoor glimmer, spoor glauconiet, spoor zee-egelstekels, spoor fijne detritus, spoor insluitsels zand | 180 | 0 | 1 | 99 | 0 | 1 | 2 |
| 100 - 125 | zand | zand, zwak siltig, zwak humeus, licht-grijs, 5y 6/1, Zand: zeer fijn, matig kleine spreiding, matig afgerond, spoor witte korrels, weinig zwarte korrels, spoor bont materiaal, Schelpen: spoor schelpmateriaal, spoor schelpgruis, spoor glimmer, spoor glauconiet, spoor detritus, spoor detrituslagen | 140 | 0 | 4 | 96 | 0 | 2 | 3 |
| 125 - 150 | leem | leem, sterk zandig, grijs, 5y 6/1, Zand: matig fijn, zeer grote spreiding, matig afgerond, spoor grijze korrels, spoor witte korrels, spoor zwarte korrels, spoor bont materiaal, spoor plantenresten, Schelpen: weinig schelpmateriaal, spoor doubletten, spoor schelpgruis, spoor hele schelpen, spoor juveniel, veel Hydrobiidae, spoor glimmer, spoor glauconiet, spoor detritus | 150 | 0 | 60 | 40 | 0 | 0 | 3 |
| 150 - 175 | zand | zand, zwak siltig, licht-grijs, 5y 7/1, Zand: matig fijn, matig grote spreiding, matig afgerond, spoor witte korrels, weinig grijze korrels, spoor zwarte korrels, spoor bont materiaal, Schelpen: spoor schelpmateriaal, spoor schelpgruis, spoor Gastropoda, spoor glimmer, spoor glauconiet | 180 | 0 | 1 | 99 | 0 | 0 | 2 |



*Figure 1.2: Lithological characteristics until 175 cm below ground level (BGL).*

| Diepte (cm) | Grondsoort | Omschrijving | M63 | %Lu | %Sl | %Za | %Gr | %Os | Ca |
|---|---|---|---|---|---|---|---|---|---|
| 175 - 200 | zand | zand, zwak siltig, licht-grijs, 5y 7/1, Zand: matig fijn, matig grote spreiding, matig afgerond, weinig grijze korrels, spoor witte korrels, spoor zwarte korrels, spoor bont materiaal, Schelpen: weinig schelpmateriaal, weinig schelpgruis, spoor schelpfragmenten, spoor Hydrobiidae, spoor glimmer, spoor glauconiet, weinig zee-egelstekels, spoor detritus, Opm.: foram1 | 180 | 0 | 4 | 96 | 0 | 0 | 3 |
| 200 - 217 | zand | zand, zwak siltig, grijs, 5y 6/1, Zand: matig fijn, matig grote spreiding, matig afgerond, weinig grijze korrels, spoor witte korrels, spoor bont materiaal, Schelpen: spoor schelpmateriaal, spoor schelpresten, spoor glimmer, spoor zee-egelstekels, weinig insluitsels zand, basis scherp, Opm.: INZ is UFZ 100mu | 150 | 0 | 1 | 99 | 0 | 0 | 2 |
| 217 - 218 | zand | zand, zwak siltig, donker-grijs, 5y 4/1, Zand: uiterst fijn, zeer kleine spreiding, matig afgerond, weinig grijze korrels, spoor witte korrels, spoor bont materiaal, spoor glauconiet, spoor grove korrels, weinig insluitsels klei, basis scherp | 100 | 0 | 4 | 96 | 0 | 0 | 3 |
| 218 - 233 | veen | veen, mineraalarm, bruin, 10yr 2/1, Veen: matig amorf, zeggeveen, veel plantenresten, veel riet, veel zegge, veel wortelresten, basis geleidelijk | | 0 | 0 | 0 | 0 | 100 | 1 |
| 233 - 257 | klei | klei, zwak siltig, matig humeus, bruin, 2.5y 4/1, weinig plantenresten, weinig riet, weinig zegge, veel wortelresten, basis diffuus | | 100 | 0 | 0 | 0 | 10 | 1 |
| 257 - 288 | klei | klei, zwak siltig, zwak humeus, grijs, 5y 4/1, spoor plantenresten, spoor zegge, spoor wortels | | 100 | 0 | 0 | 0 | 4 | 1 |
| 288 - 316 | klei | klei, zwak siltig, zwak humeus, grijs, 5y 4/1, spoor plantenresten, spoor riet, spoor wortels, spoor glimmer, spoor detritus | | 96 | 4 | 0 | 0 | 4 | 1 |
| 316 - 348 | klei | klei, zwak siltig, zwak humeus, grijs, 5y 4/1, spoor plantenresten, spoor wortels, spoor glimmer, cm-gelaagdheid, zwak gelaagd, Opm.: GCM is Zs3 | | 96 | 4 | 0 | 0 | 2 | 1 |
| 348 - 400 | geen monster | geen monster | | | | | | | |
| 400 - 420 | | basis scherp, Opm.: verstoord; sediment vergelijkbaar met interval 200-216cm | | | | | | | |
| 420 - 439 | zand | zand, matig siltig, zwak humeus, grijs, 5y 4/1, Zand: uiterst fijn, zeer kleine spreiding, matig afgerond, spoor bont materiaal, spoor plantenresten, spoor wortels, weinig glimmer, spoor detritus, cm-gelaagdheid, weinig gelaagd, weinig leemlagen, spoor kleilagen, basis diffuus, Opm.: WOS1 in topdeel | 80 | 1 | 15 | 84 | 0 | 1 | 1 |
| 439 - 456 | zand | zand, matig siltig, grijs-bruin, 5y 6/1, Zand: uiterst fijn, matig kleine spreiding, matig afgerond, spoor grijze korrels, spoor witte korrels, spoor bont materiaal, weinig glimmer, spoor glauconiet, spoor insluitsels detritus, spoor insluitsels klei, Opm.: verstoord? | 100 | | | | | | 1 |
| 456 - 491 | zand | zand, zwak siltig, zwak humeus, donker-grijs, 5y 4/1, Zand: uiterst fijn, matig kleine spreiding, matig afgerond, spoor bont materiaal, weinig grijze korrels, spoor witte korrels, spoor zwarte korrels, weinig glimmer, spoor glauconiet, spoor detritus, spoor insluitsels zand, weinig gelaagd, basis diffuus | 100 | 0 | 1 | 99 | 0 | 1 | 3 |
| 491 - 507 | zand | zand, zwak siltig, zwak humeus, licht-grijs, 5y 6/1, Zand: uiterst fijn, zeer kleine spreiding, matig afgerond, weinig grijze korrels, spoor witte korrels, spoor zwarte korrels, spoor bont materiaal, weinig glimmer, spoor grove korrels, spoor detritus, spoor insluitsels klei, spoor insluitsels leem, basis diffuus, Opm.: foram1 | 90 | 1 | 4 | 95 | 0 | 1 | 3 |
| 507 - 556 | zand | zand, matig siltig, zwak humeus, licht-grijs, 5y 6/1, Zand: uiterst fijn, matig kleine spreiding, matig afgerond, weinig grijze korrels, spoor witte korrels, spoor zwarte korrels, spoor bont materiaal, weinig glimmer, spoor glauconiet, spoor grove korrels, spoor detritus, spoor insluitsels klei, weinig gelaagd, spoor detrituslagen, weinig leemlagen, Opm.: licht verstoord | 100 | 0 | 12 | 88 | 0 | 2 | 3 |
| 556 - 600 | geen monster | geen monster | | | | | | | |
| 600 - 608 | | Opm.: verstoord; eventueel behorende bij 507-556cm | | | | | | | |



*Figure 1.3: Lithological characteristics until 608 cm BGL.*

## Section 2: Infiltration period One

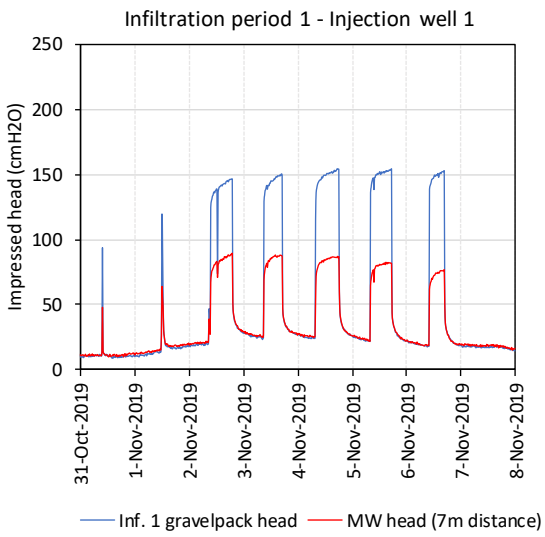



*Figure 2.1a: The head in the injection well one gravelpack piezometer and the abstraction well gravelpack piezometer (dedicated monitoring well) for infiltration period one.*

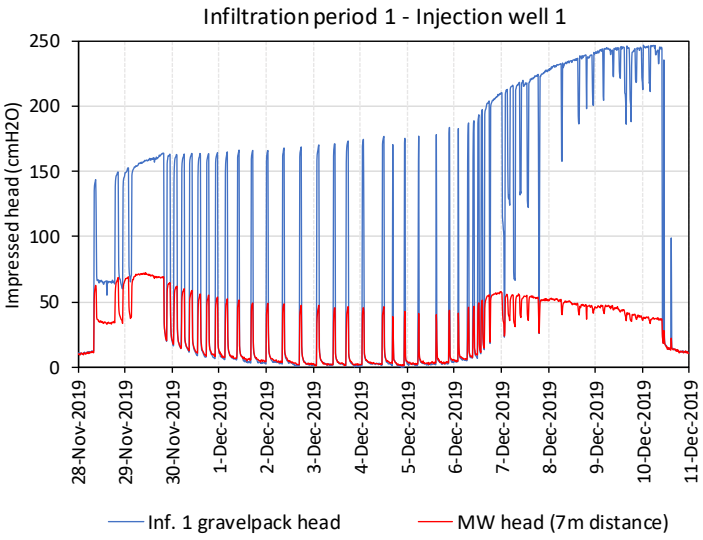



*Figure 2.1b: Ditto for infiltration period one after the 21-day standstill.*

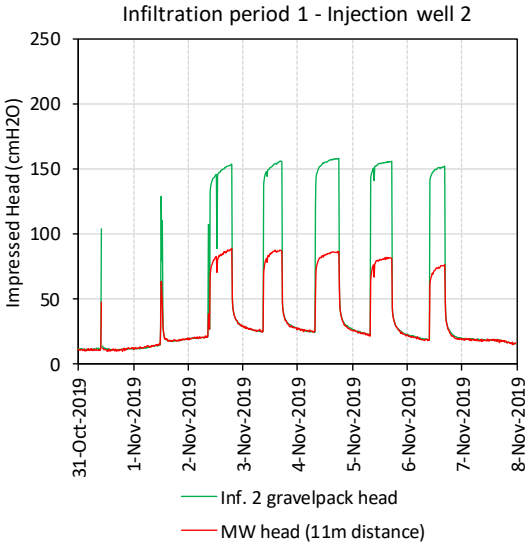



*Figure 2.2a: The head in the injection well two gravelpack piezometer and the abstraction well gravelpack piezometer (dedicated monitoring well) for infiltration period one.*

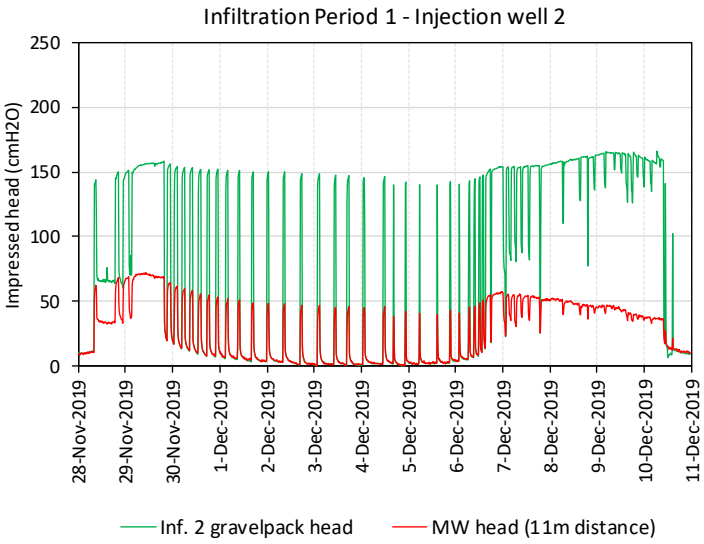



*Figure 2.2b: Ditto for infiltration period one.*

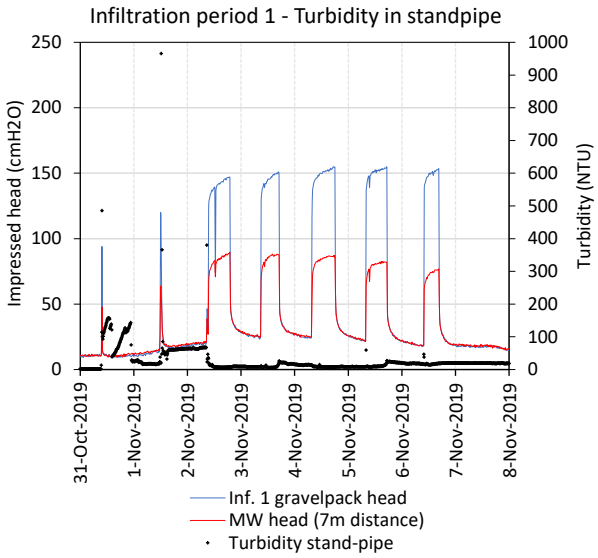



*Figure 2.3a: The turbidity in the standpipe at the first few days of ASTR operation. Turbidity peaks up to 500 and 1000 NTU are noticed on 30-Oct-2019 and 1-Nov-2019, respectively.*

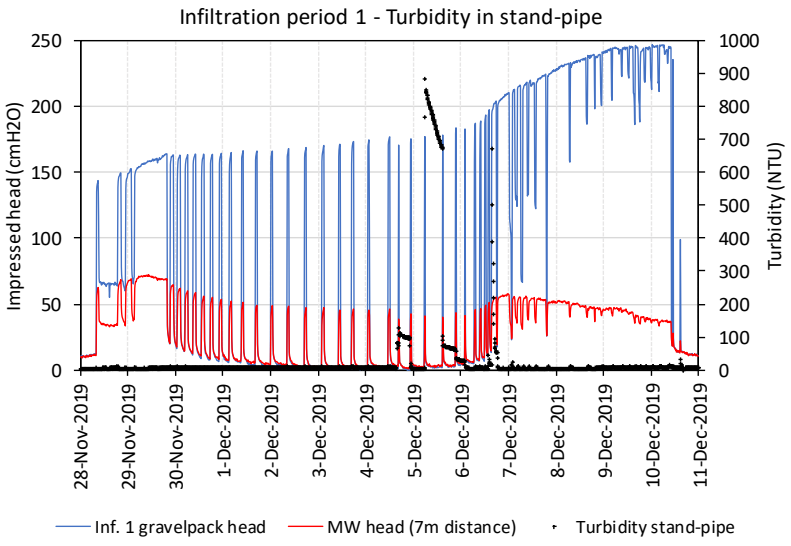



*Figure 2.3b: The turbidity in the standpipe showing the remarkable turbid event reaching 900 NTU on 5-Dec-2019.*

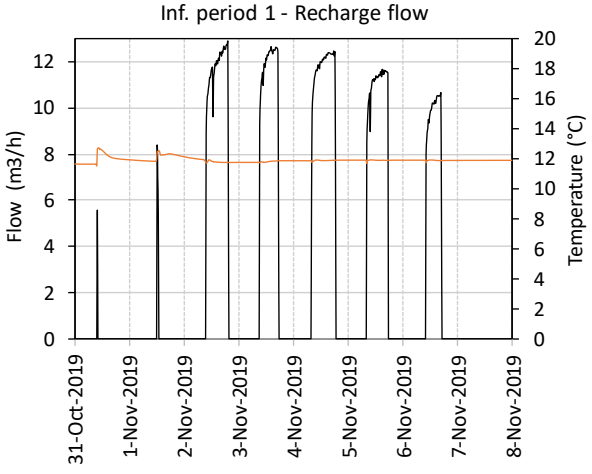



*Figure 2.4a: Recharge rate ($m^3/h$) for infiltration period one*

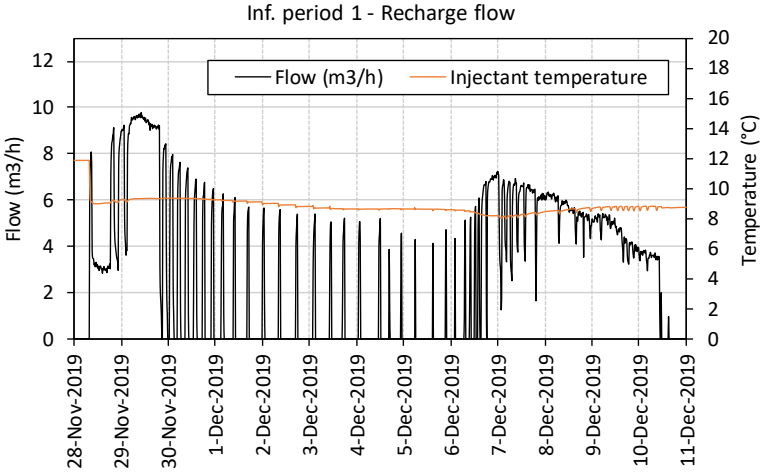



*Figure 2.4b: Recharge rate ($m^3/h$) for infiltration period one*

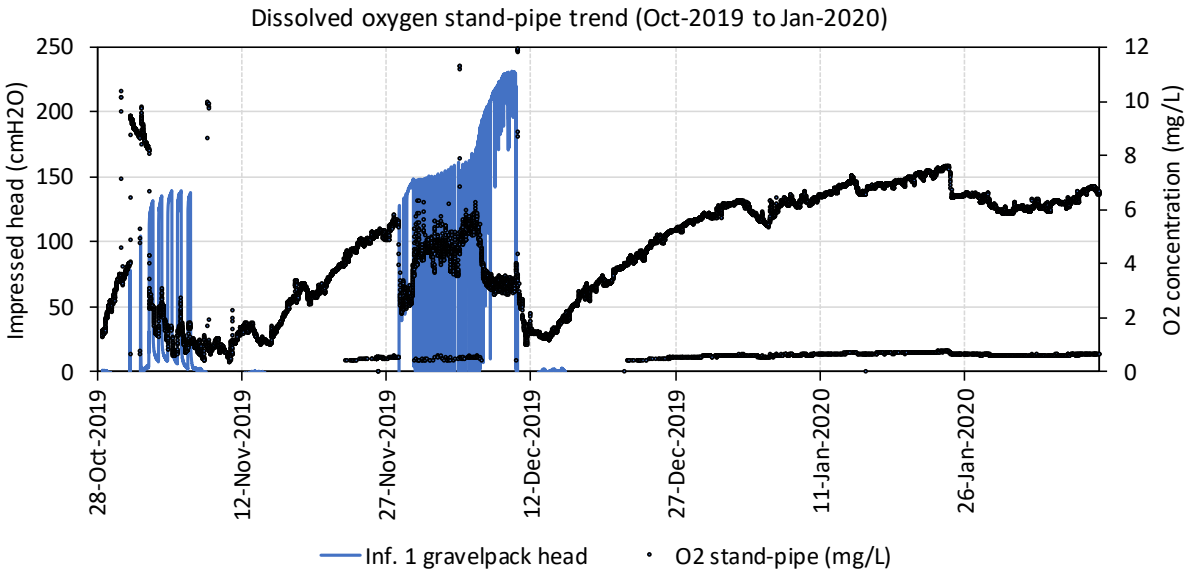



*Figure 2.5: The dissolved oxygen in the standpipe shown over a larger time extent. The blue lines show the first infiltration period, indicating a rise in dissolved oxygen content within the stagnant water of the standpipe during standstill due to atmospheric oxygen diffusion.*

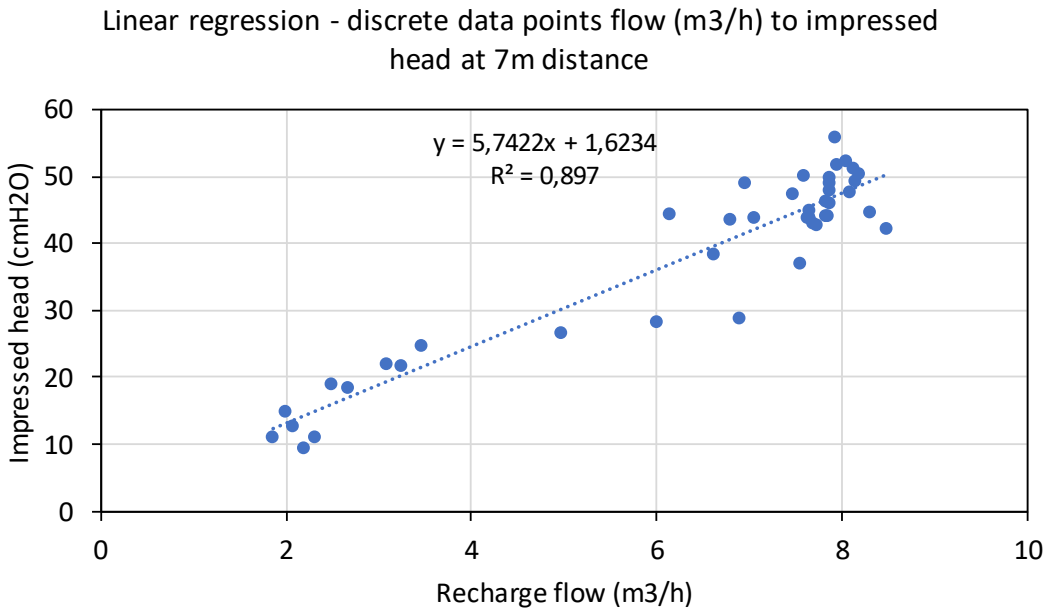



*Figure 2.6: Linear regression of head rise to recharge flow during infiltration. The regression constant is used to derive the recharge flow during infiltration period one. N = 46.*

## Section 3: Infiltration Period Two

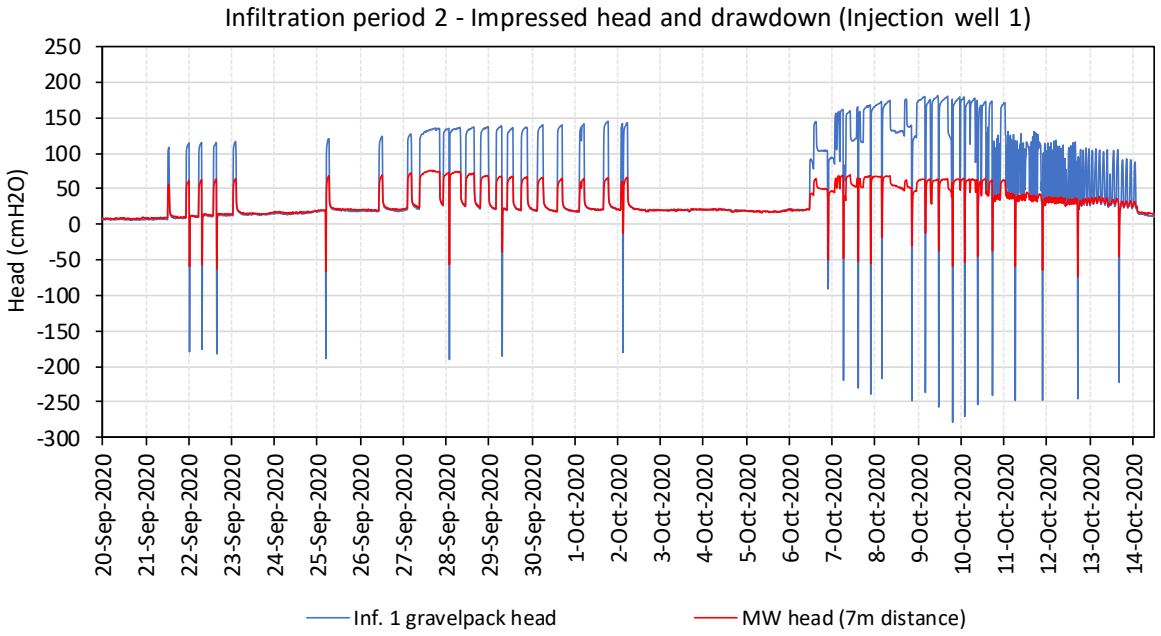



*Figure 3.1: The impressed head rise and drawdown by the automated backflush system during infiltration period two for injection well one. Notice the increase in drawdown with successive backflush events suggesting resistance increase on the borehole wall.*

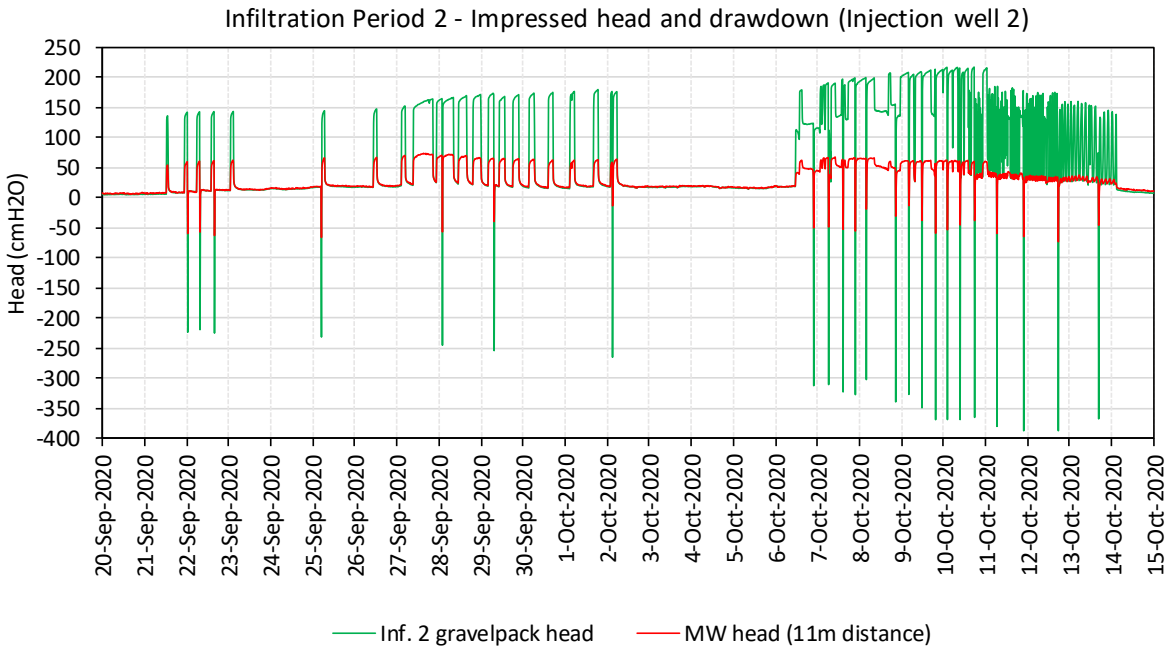



*Figure 3.2: The impressed head rise and drawdown by the automated backflush system during infiltration period two for injection well one.*

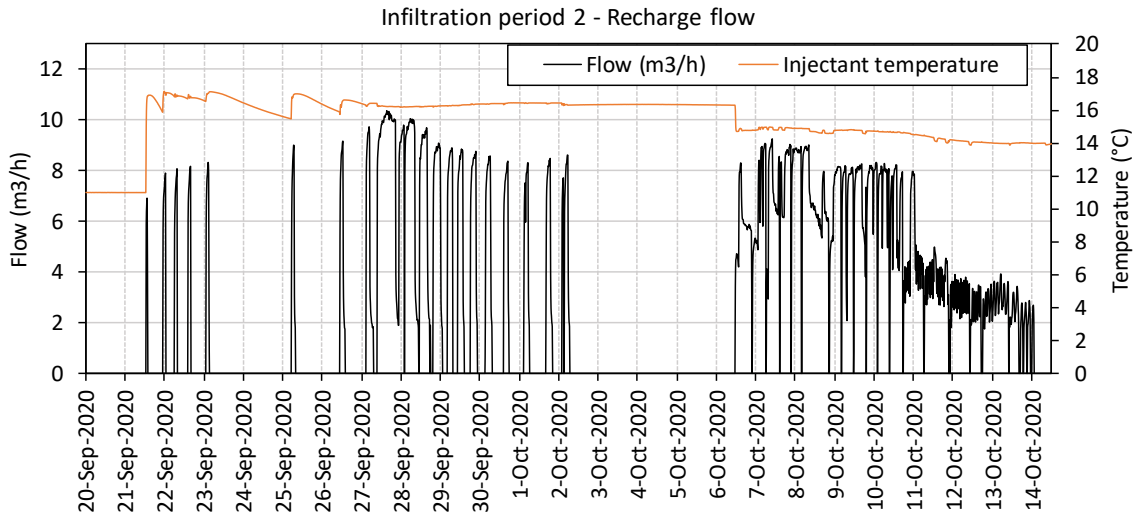



*Figure 3.3: Recharge flow (m³/h) during infiltration period two*

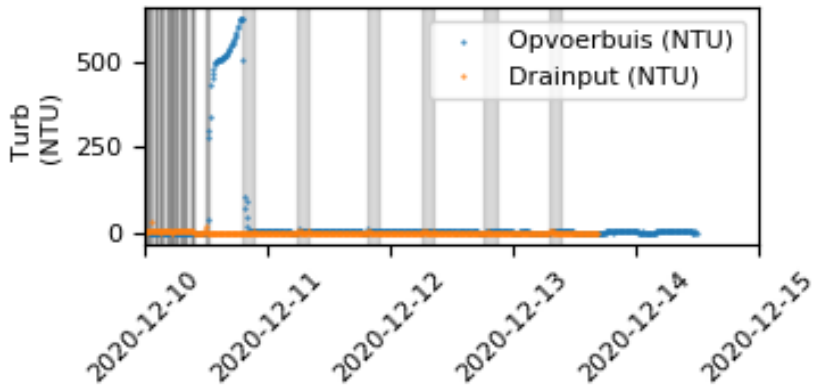



*Figure 3.4: Simultaneous turbidity reading between the drain reservoir ('drainput') and the standpipe ('opvoerbuis'). Notice the significant difference on December 10th, 2020. The drain reservoir showed turbidity readings of approximately 5 NTU while the turbidity in the standpipe reached 600 NTU.*

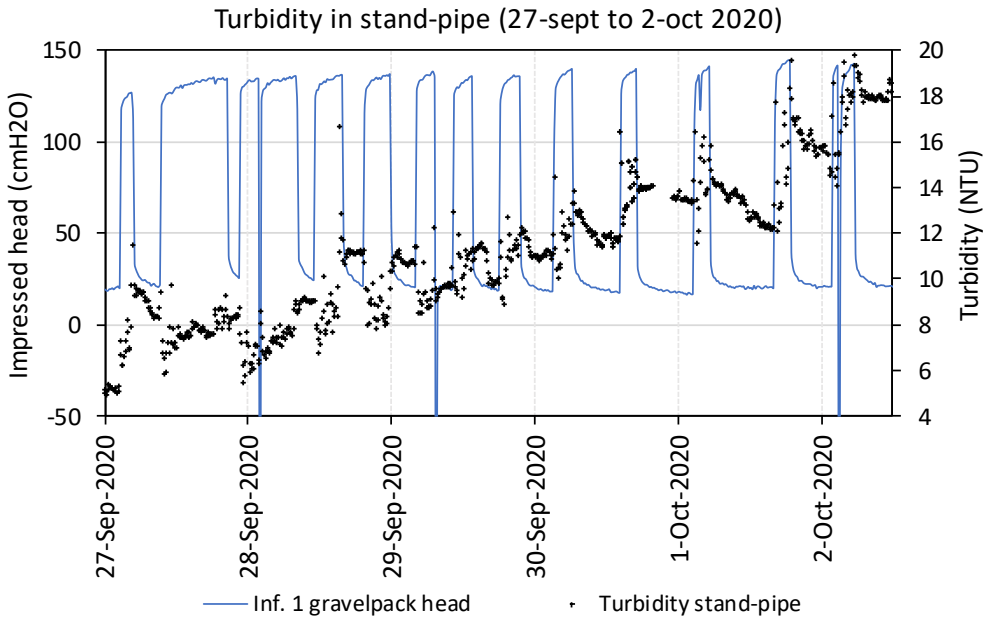



*Figure 3.5: Typical trend of turbidity in the standpipe during short injection runs.*

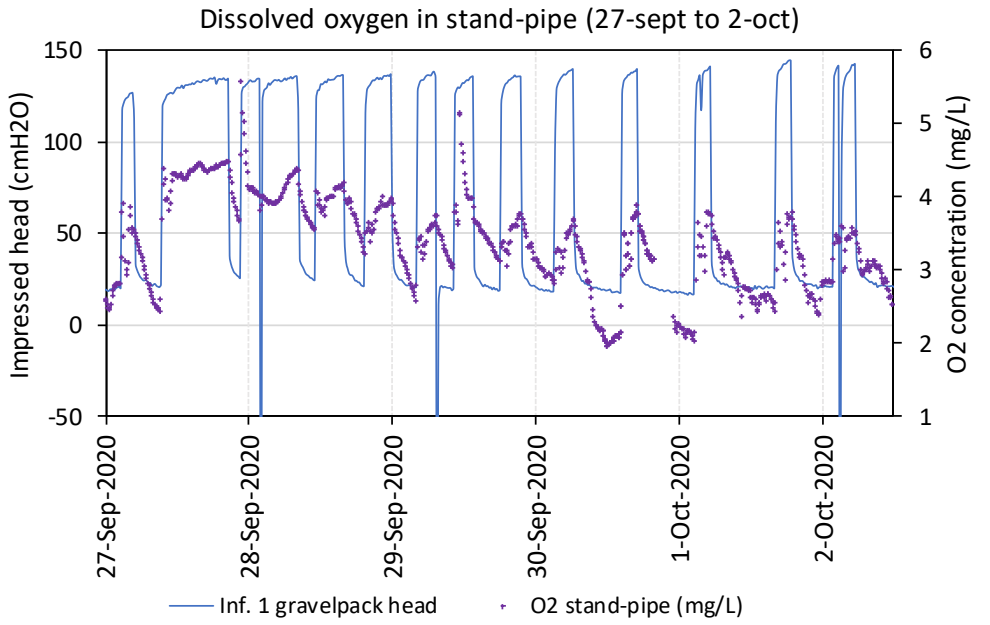



*Figure 3.6: Typical trend of dissolved oxygen in the standpipe during short injection runs.*

## Section 4: Infiltration Water Quality

| Sample Information | Unit | Range (min/max) (n=19) | Average (n=19) |
|---|---|---|---|
| pH | - | 6.98 - 8.20 (n=12) | 7.25 |
| $EC_{25}$ | µS/cm | 829 – 1193 (n=9) | 1019 |
| Bicarbonate ($HCO_3^-$) | mg/L | 414 – 441 (n=3) | 424 |
| Sulphate ($SO_4^{2-}$) | mg/L | 117 - 351 | 223 |
| Phosphate ($PO_4^{3-}$) | mg/L | 1.9 - 18.3 | 11.3 |
| Nitrate ($NO_3^-$) | mg/L | 6.1 – 49.9 | 23.7 |
| Nitrite ($NO_2^-$) | mg/L | <0.1 | <0.1 |
| Fluoride ($F^-$) | mg/L | 0.36 – 0.47 | 0.42 |
| Bromide ($Br^-$) | mg/L | 0.20 – 0.28 | 0.23 |
| Chloride ($Cl^-$) | mg/L | 107 – 222 | 151 |
| Sodium ($Na^+$) | mg/L | 71 - 107 | 91 |
| Calcium ($Ca^{2+}$) | mg/L | 152 - 244 | 191 |
| Magnesium ($Mg^{2+}$) | mg/L | 25 - 40 | 33 |
| Potassium ($K^+$) | mg/L | 50 - 74 | 60 |
| Iron ($Fe^{2+}$) | mg/L | 0.07 – 1.56 | 0.20 |
| Manganese ($Mn^{2+}$) | mg/L | 0.28 – 0.73 | 0.44 |
| Boron ($B^{3+}$) | mg/L | 0.20 – 0.28 | 0.23 |
| Strontium ($Sr^{2+}$) | mg/L | 0.60 – 0.96 | 0.75 |
| ***PHREEQC modelled (n=3)*** | | | |
| Assumed temperature | °C | 8.0 | |
| Assumed $O_2$ | mg/L | 5.0 | |
| Ferrihydrite | - | 2.83 - 2.99 | |
| Calcite | - | 0.78 - 1.17 | |
| Hydroxyapatite | - | 6.68 - 8.49 | |
| Rhodochrosite | - | 0.33 - 0.84 | |
| Ionic balance (IB) | % | -1.6 to -5.2 | |

## Section 5: Images shot at the ASTR site

*Figure 5.1: Metallic sheen on stagnant water within the standpipe taken November 25th, 2020 after a 41-day standstill.*


*Figure 5.2: Metallic sheen on stagnant water within the standpipe taken November 25th, 2020 after a 41-day standstill.*

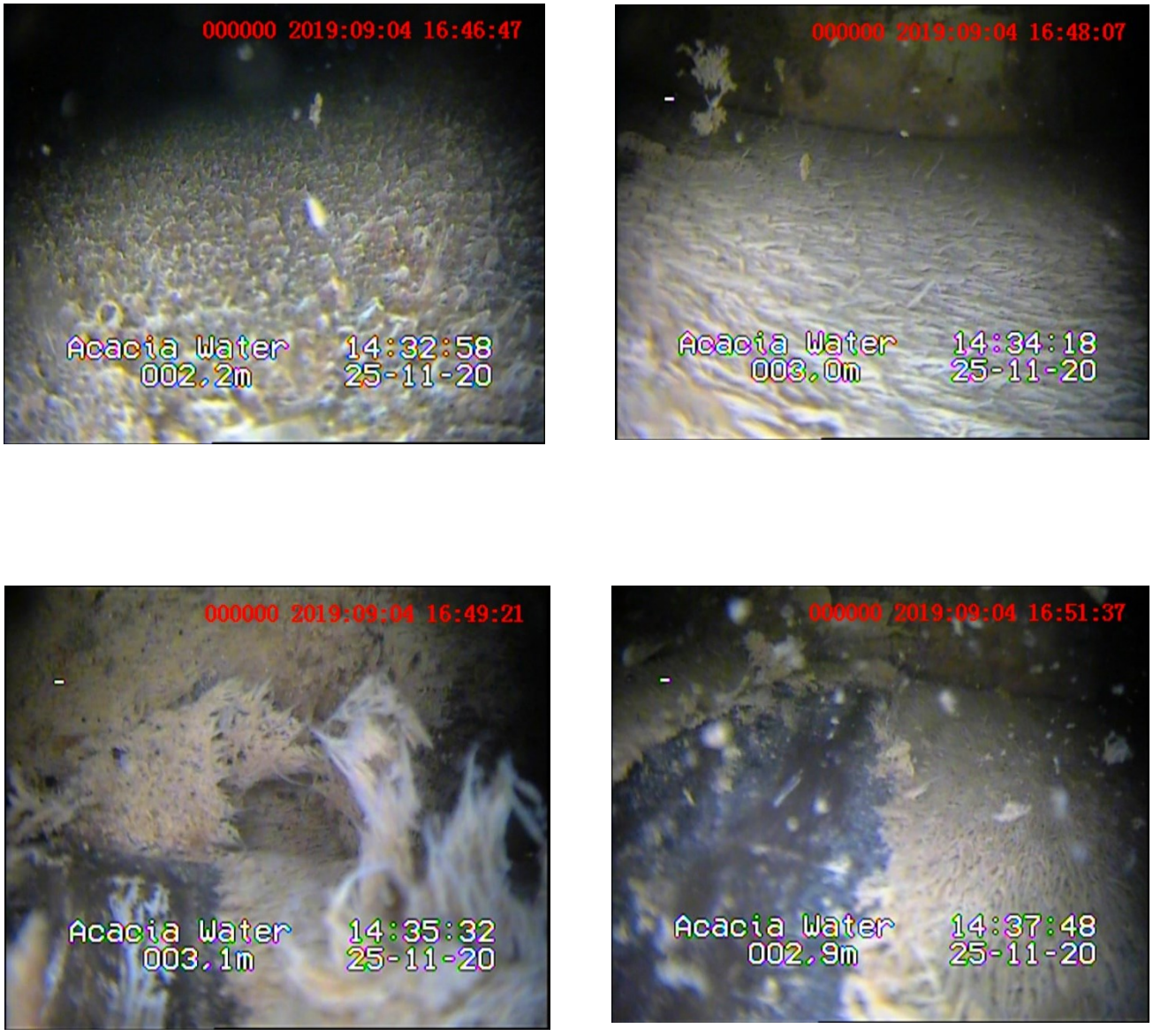



*Figure 5.3: Several shots of the conditions within the standpipe taken November 25th, 2020 after a 41-day standstill. A thick mat of microbial deposits covered the pipe interior and seemed to thicken with depth. The image below shows the standpipe material colour.*

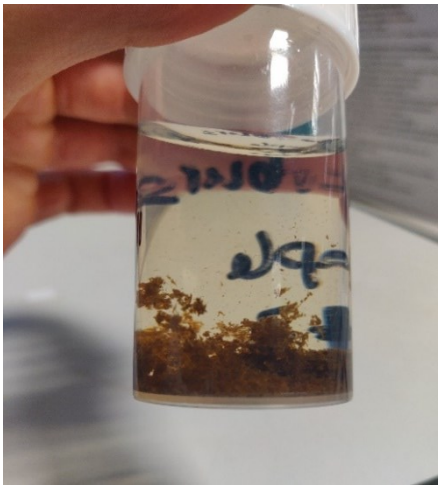


*Figure 5.4: Images taken on top of the container, showing the top of the standpipe in contact with atmospheric oxygen and the interior (right).*

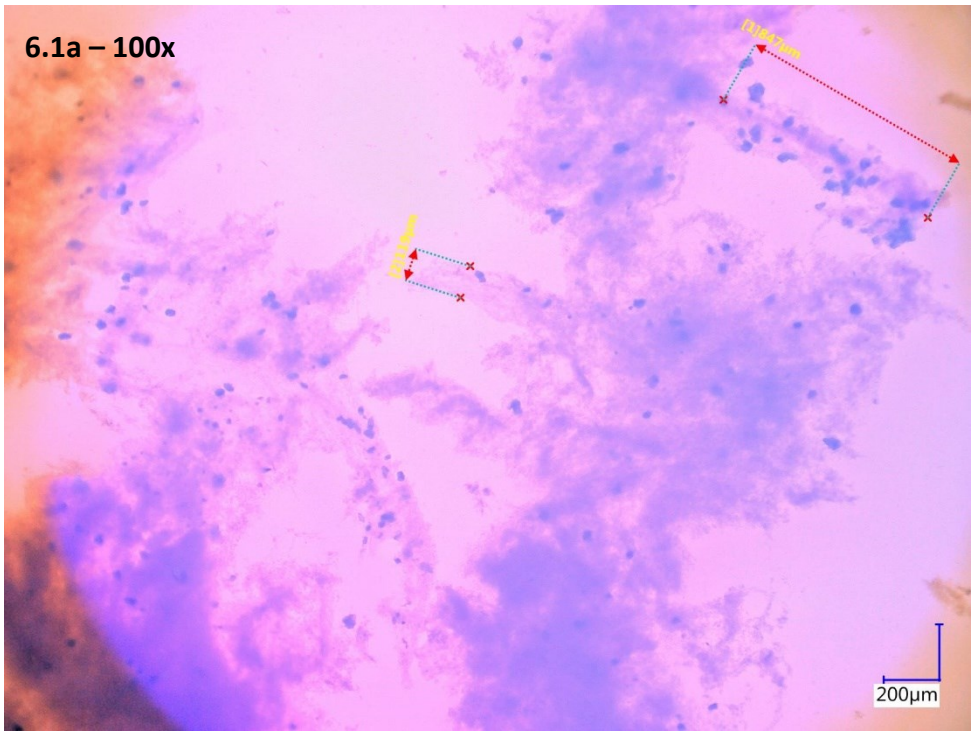

*Figure 5.5: Camera shot of the conditions within the main tile outlet discharging tile drainage water to the drain reservoir. A mat of microbial deposits similar to that in the standpipe (fig. 5.3) is seen.*

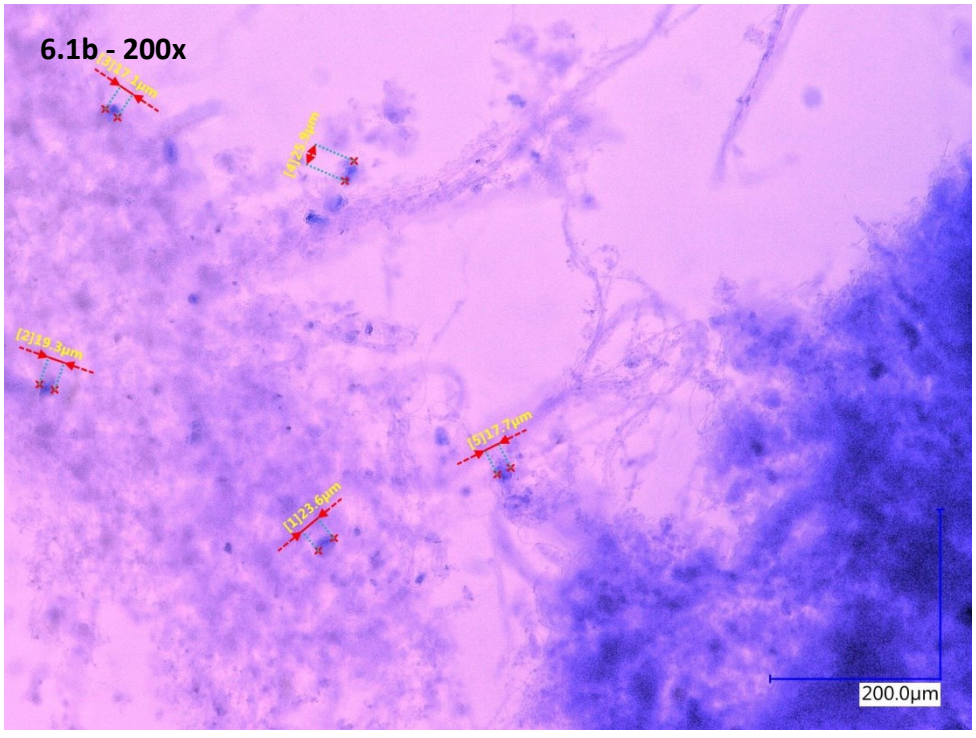
*Figure 5.6: Image taken of the disc-filters after the head is removed. The filter is covered in brown slimy material. Shot taken November 25th, 2020 after a 41-day standstill.*

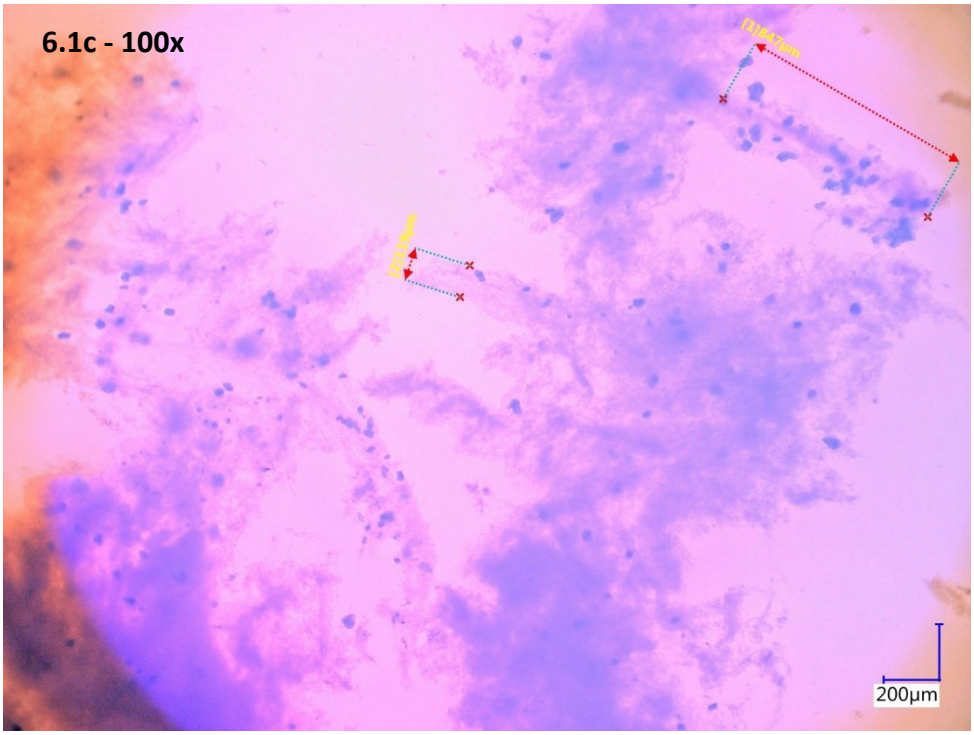
*Figure 5.7: The automated backflush pump removed prior to the well rehabilitation on November 25th, 2020. A thin layer of brown glutenous material is discerned suggesting iron oxides.*

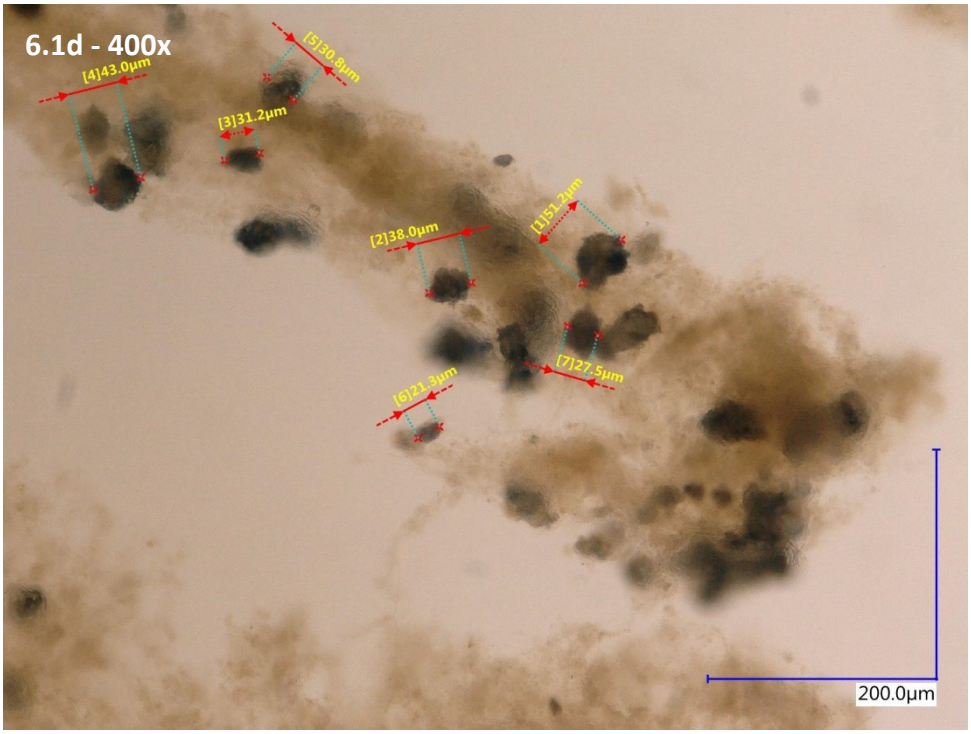
## Section 6: Micrographs (digital light microscope)

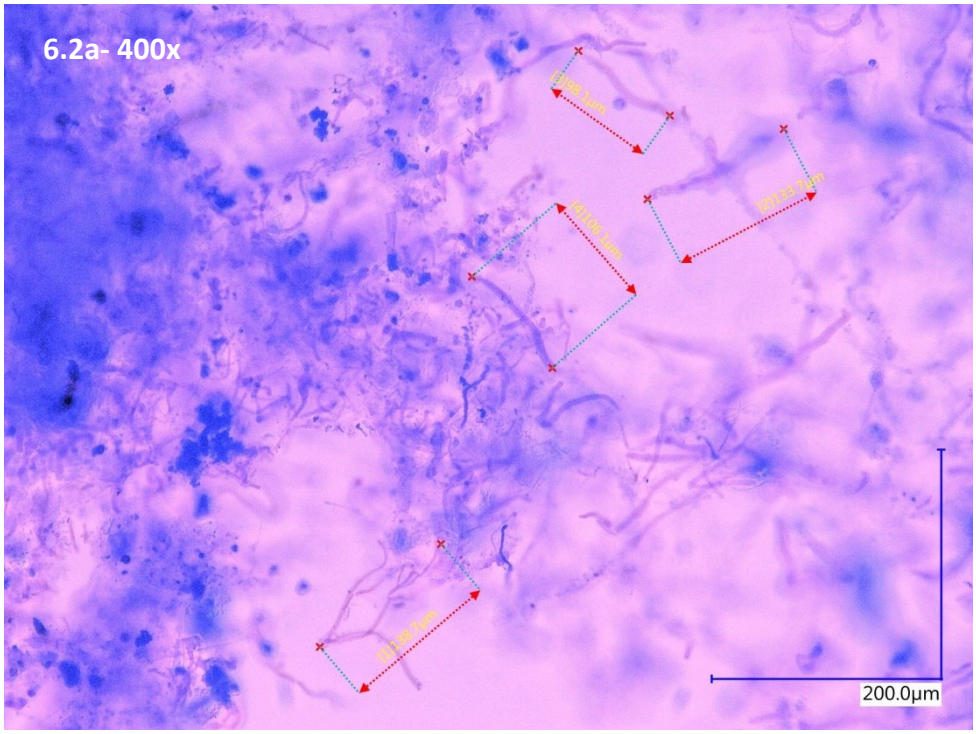
Figures 6.1 correspond to micrographs taken of disc-filtrate material (S2). Figures 6.2 correspond to micrographs taken of material removed from the standpipe (S3). Figures 6.3 correspond to the material removed during the well rehabilitation on November 25th, 2020 (S1.2). Figures 6.4 correspond to material removed during the well rehabilitation between 2nd and 4th February 2020 (S1.1).

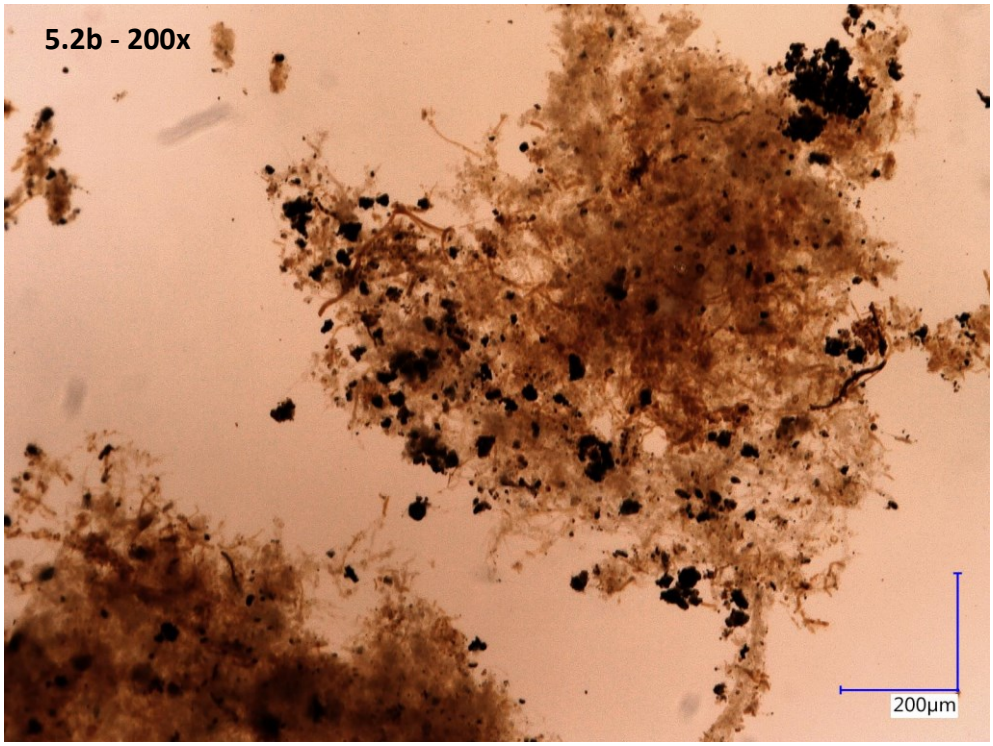


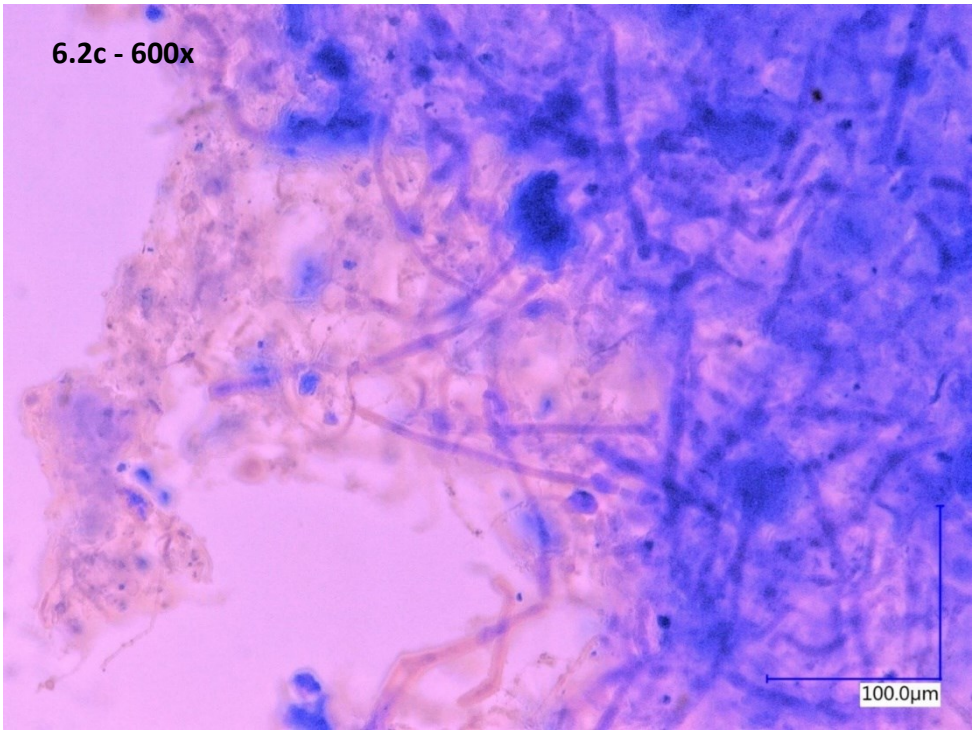



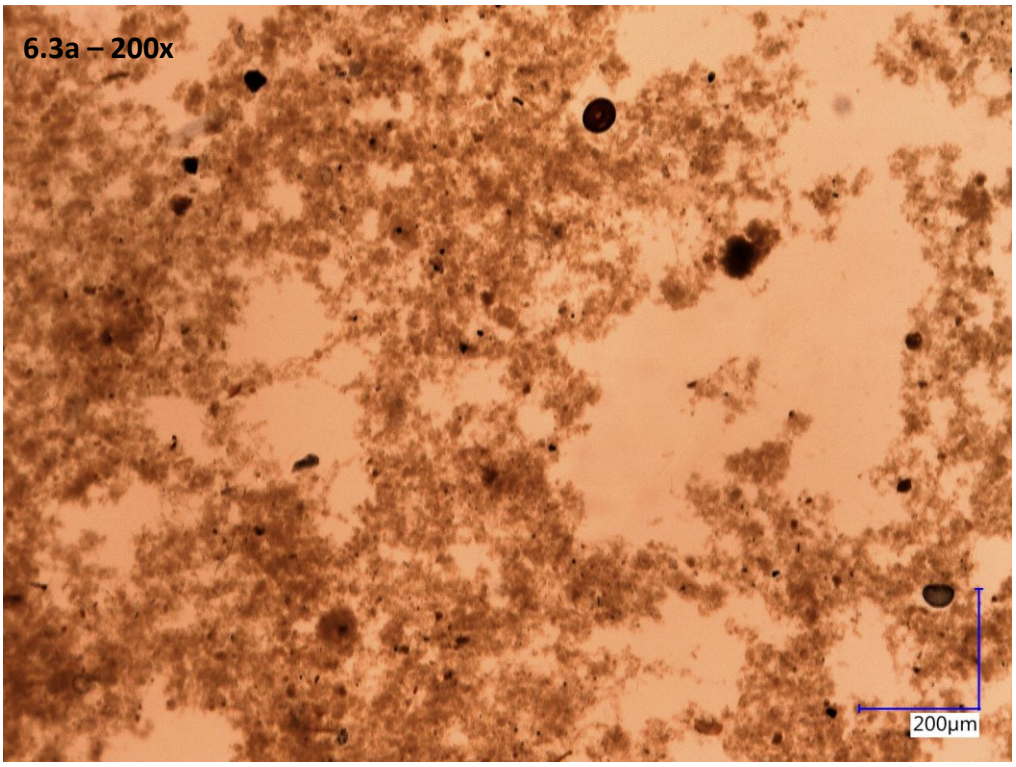

6.1c - 100x
200µm

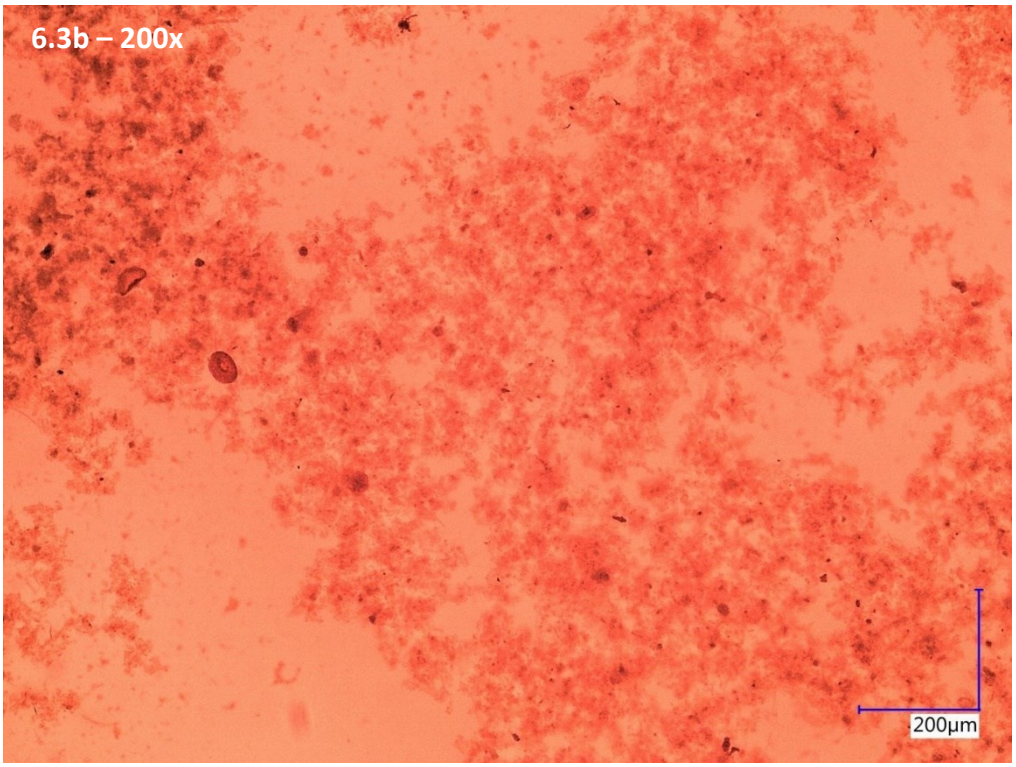

6.1d - 400x
[4]43.0µm
[5]30.8µm
[3]31.2µm
[2]38.0µm
[1]51.2µm
[7]27.5µm
[6]21.3µm
200.0µm

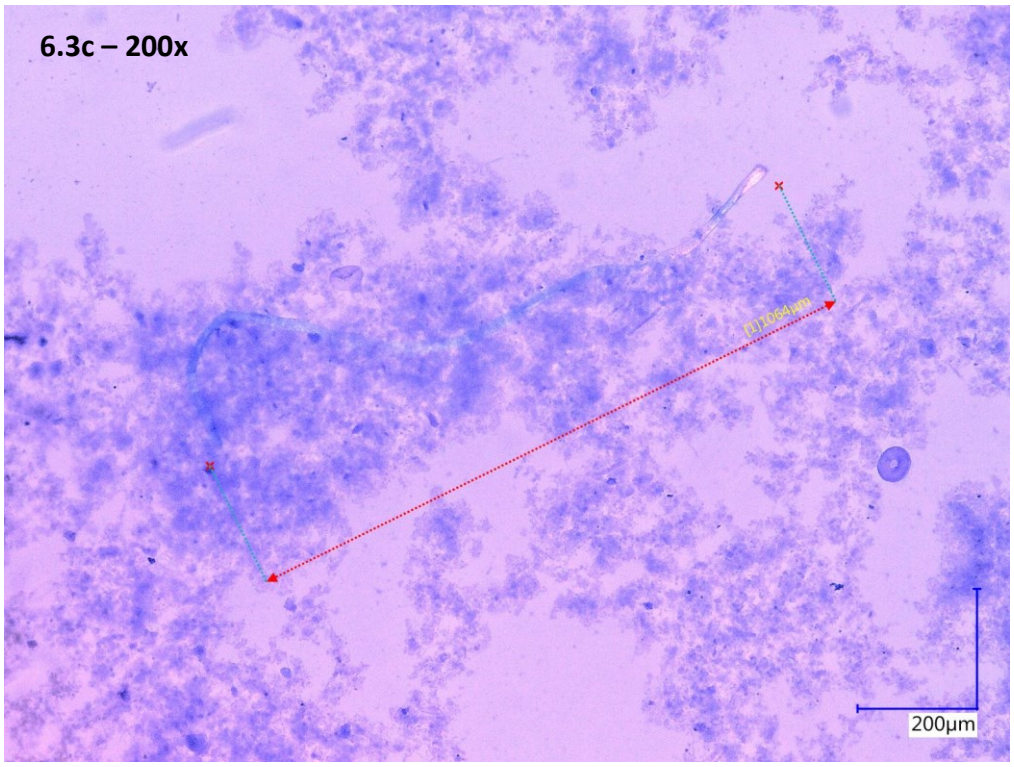

6.2a- 400x
200.0µm

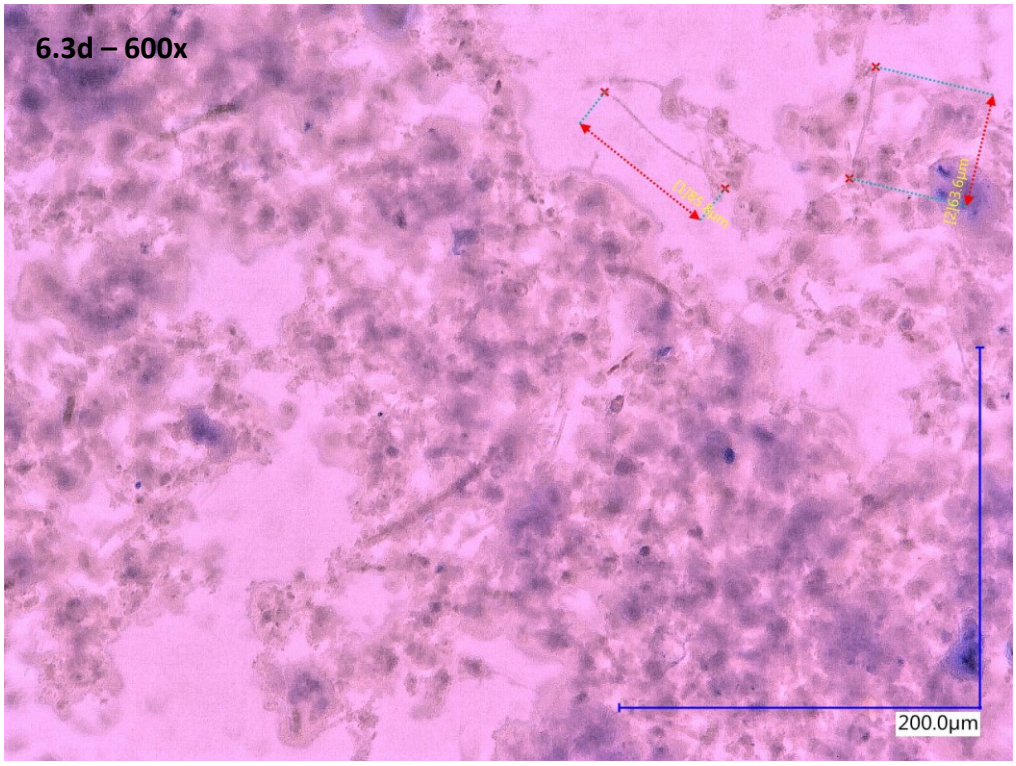

5.2b - 200x
200µm

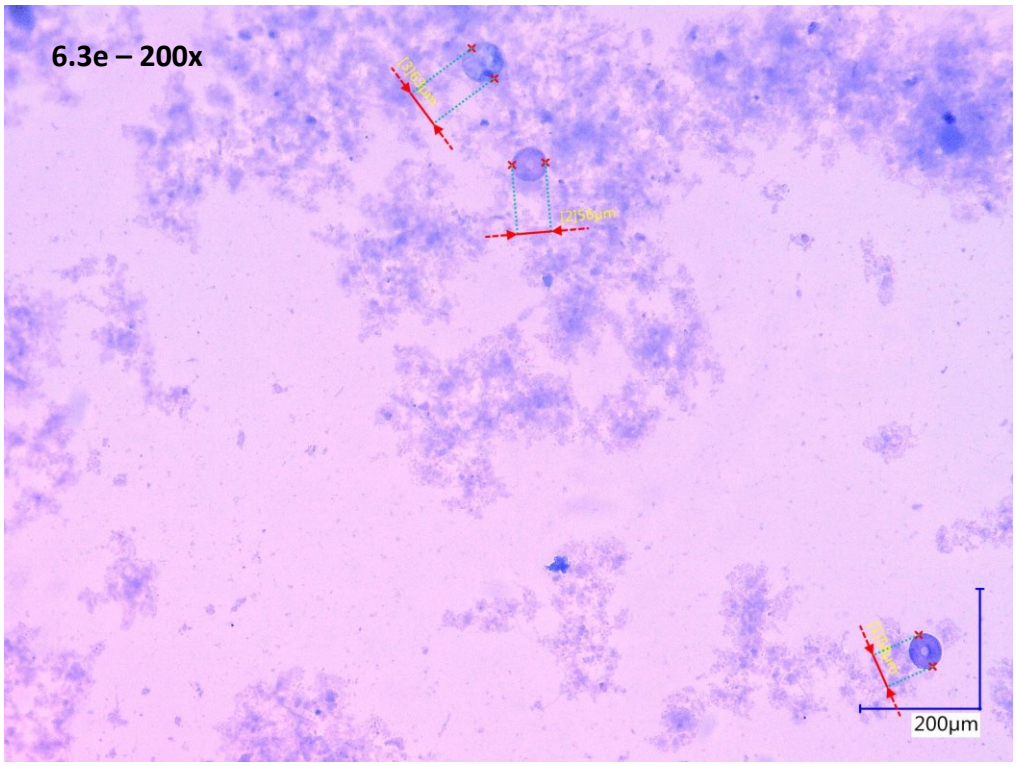

6.2c - 600x
100.0µm

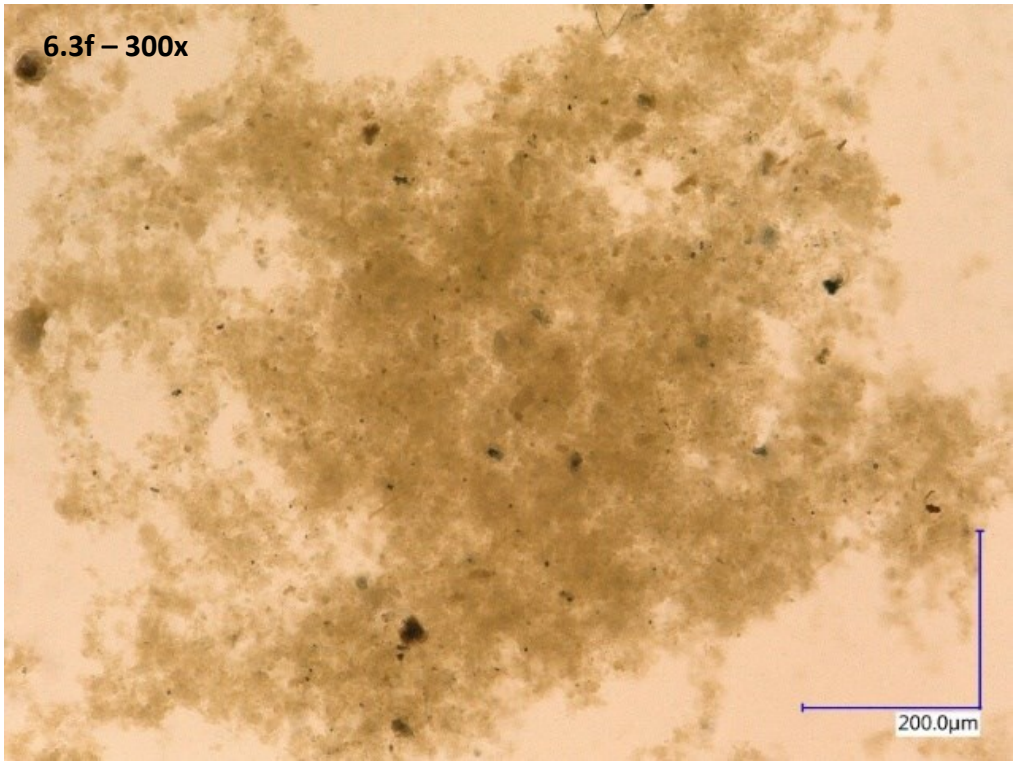

6.3a – 200x
200µm


6.3b – 200x
200µm

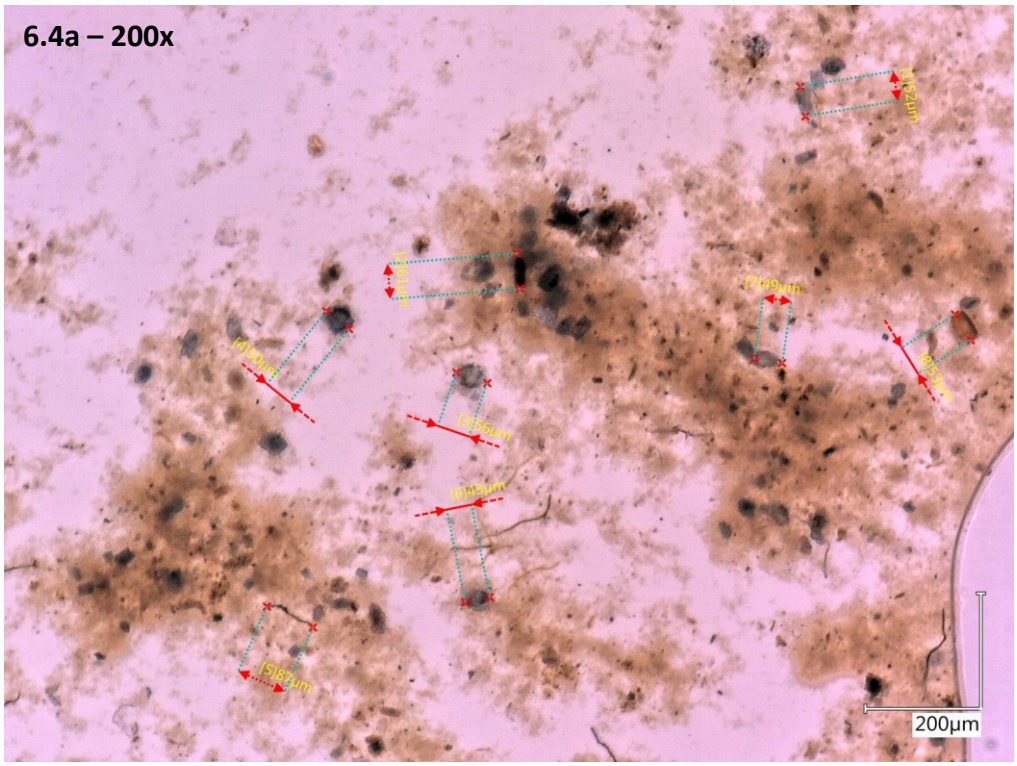

6.3c – 200x
200µm


6.3d – 600x
200.0µm

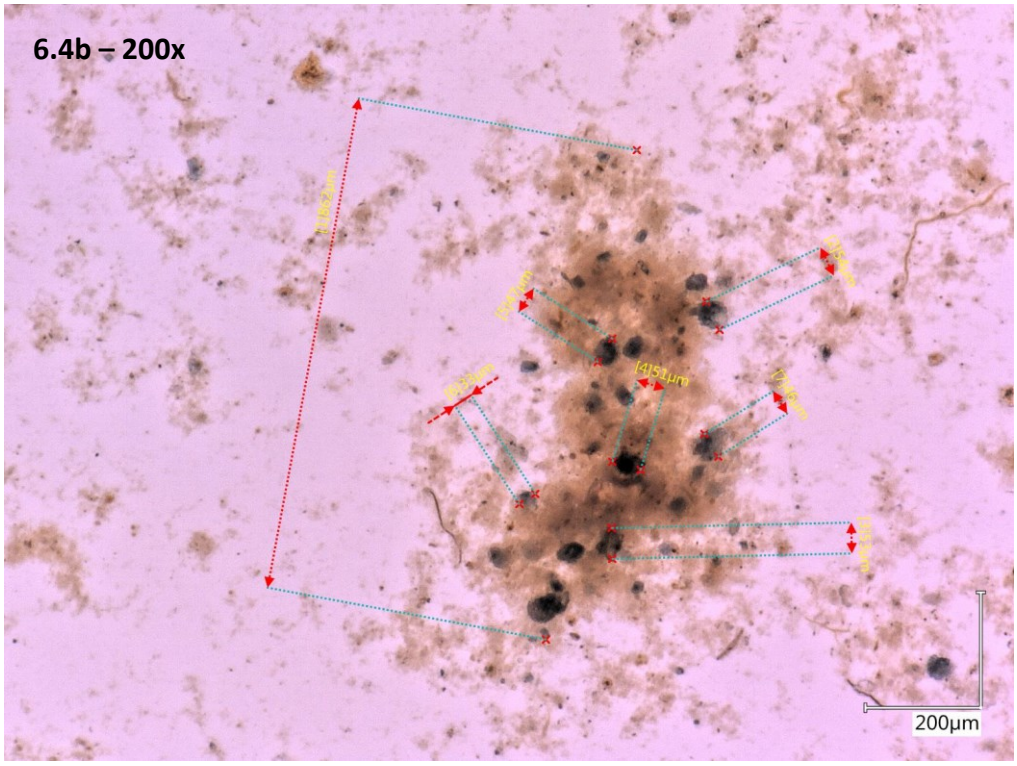

6.3e – 200x
200µm

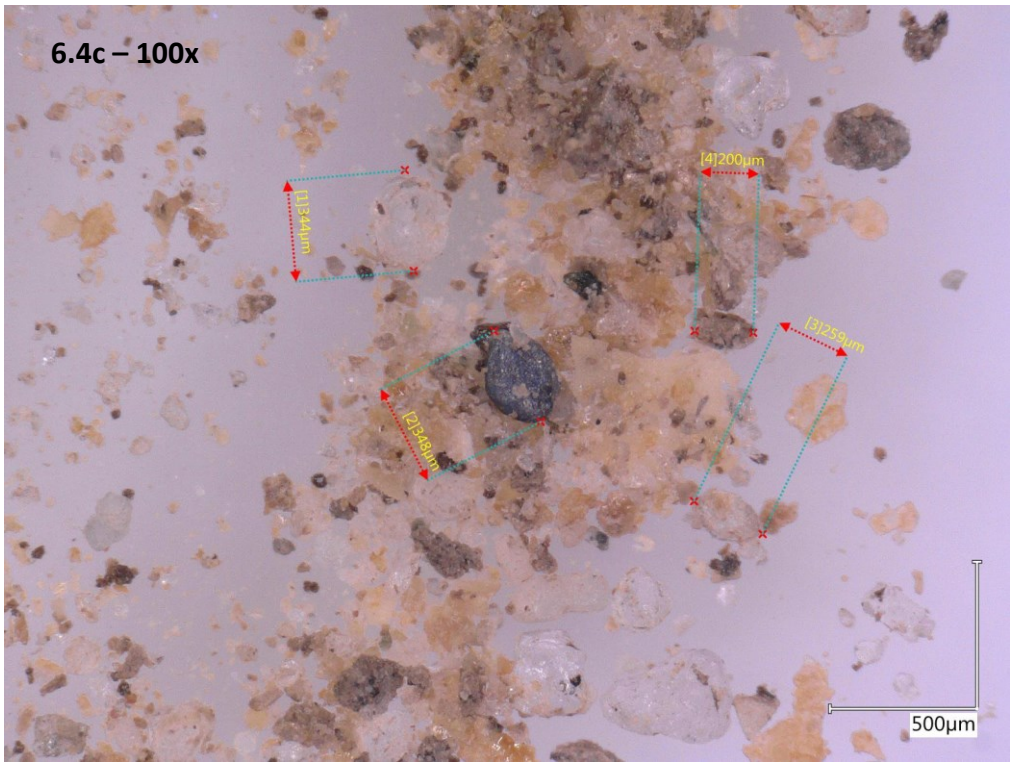

6.3f – 300x
200.0µm

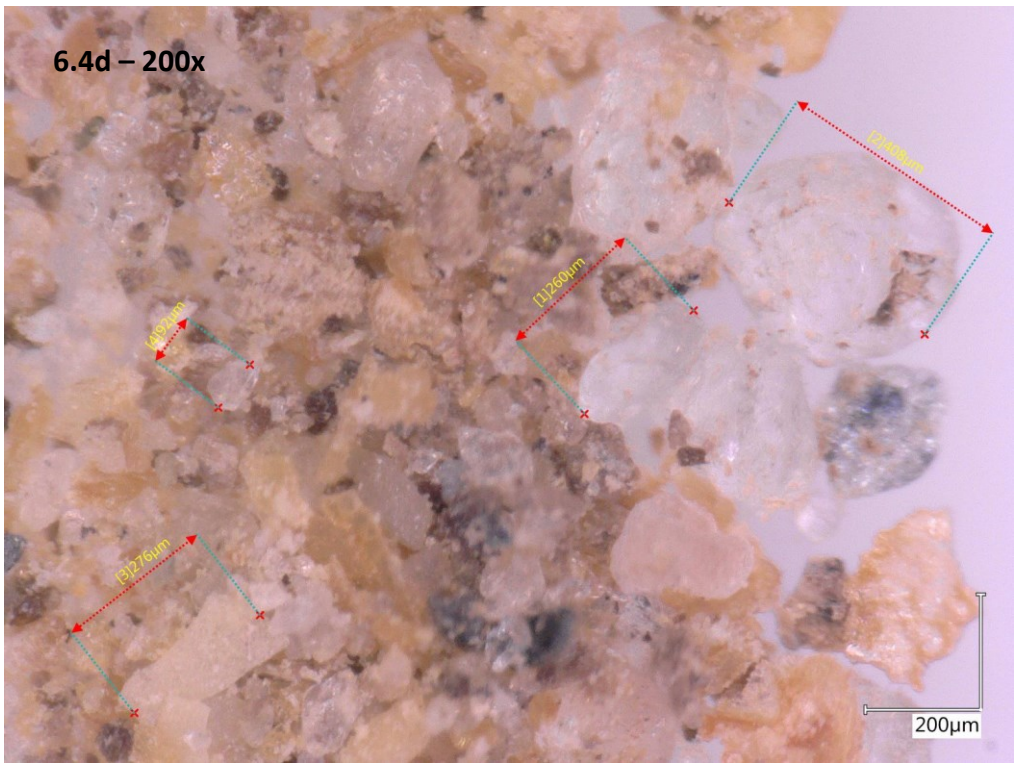
**6.4a – 200x**




**6.4b – 200x**




6.4c – 100x
[1]344µm
[4]200µm
[3]259µm
[2]348µm
500µm


6.4d – 200x
[1]260µm
[4]192µm
[3]276µm
200µm

## Section 7: Well Rehabilitation Sample Analysis

*Table 7.1: Analytical results on the chemical constituents of digested clogging material taken during the well rehabilitation between February 2nd and 4th, 2020.*

| **Well Regeneration – Suspended Material During Backflush (Solid-fraction data)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Information | | | Material | Constituents | | | | | |
| | | Standing well = 0.3m³ | **TSS removed** | **$C_{ORG}$** | **S** | **Fe** | **Ca** | **P** | Elemental Sum |
| **Cycle** | Sample no. | Standing well fraction evacuated/well screen sample location | mg | ppm | ppm | ppm | ppm | ppm | % |
| **Infiltration Well 1** | | | | | | | | | |
| **Initial backflush** | 1 | 90L | 717 | 166,889 | 44,802 | 104,503 | 44,547 | 71,166 | 43 |
| | 2 | 450L | 836 | 118,834 | 42,630 | 82,964 | 49,260 | 56,846 | 35 |
| | 3 | 720L | 702 | 113,175 | 42,528 | 153,764 | 44,477 | 89,681 | 44 |
| | 4 | 1440L | 296 | 110,332 | 44,683 | 243,956 | 37,772 | 134,745 | 57 |
| **Mechanical Cleaning (jetting)** | 1 | above filter | 2,327 | 19,865 | 40,655 | 27,514 | 0 | 13,834 | 10 |
| | 2 | top filter | 3,688 | 22,629 | 63,283 | 25,153 | 3,223 | 14,154 | 13 |
| | 3 | middle filter | 66,948 | 11,383 | 46,075 | 3,429 | 10,060 | 1,913 | 7 |
| | 4 | ¾ filter | 2,840 | 51,619 | 55,301 | 57,791 | 13,638 | 33,082 | 21 |
| | 5 | bottom filter | 22,926 | 16,789 | 59,074 | 19,512 | 35,352 | 6,105 | 14 |
| **Post backflush** | 1 | 300L | 997 | 43,783 | 54,150 | 53,422 | 34,936 | 27,301 | 21 |
| | 2 | 1260L | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Infiltration Well 2** | | | | | | | | | |
| **Initial backflush** | 1 | 90L | 353 | 193,007 | 121,005 | 134,120 | 36,838 | 97,100 | 58 |
| | 2 | 450L | 436 | 193,006 | 107,510 | 154,749 | 40,800 | 107,361 | 60 |
| | 3 | 720L | 287 | 110,610 | 81,745 | 331,773 | 41,183 | 150,218 | 72 |
| **Jetting** | 1 | ¼ filter | 1,620 | 40,305 | 59,254 | 60,254 | 8,120 | 33,263 | 20 |
| **Post backflush** | 1 | 90L | 731 | 93,972 | 49,622 | 145,928 | 29,721 | 89,710 | 41 |

| Well Regeneration - Sample fluid-fraction data (anions) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample information | | | Laboratory analysis | | | | | Anions | | | | | | | |
| | | standing well = 270 L | **pH** | **$EC_{25}$** | **T** | **Turbidity** | **DOC** | **$HCO_3^-$** | **$SO_4^{2-}$** | **$PO_4^{3-}$** | **$NO_3^-$** | **$NO_2^-$** | **$F^-$** | **$Br^-$** | **$Cl^-$** |
| **Cycle** | Sample no. | Approximate pumped volume/well screen sample location | - | µS/cm | °C | NTU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **Pumping test (initial)** | 1 | 90L | 7.27 | 1489 | 11.6 | 8.40 | 47.9 | 620.41 | 166.11 | 36.43 | 1.09 | 4.63 | 0.42 | 0.37 | 122.41 |
| | 2 | 450L | 7.27 | 1513 | 11.5 | 11.90 | 49.1 | 651.03 | 166.93 | 38.01 | 0.48 | 4.43 | 0.43 | 0.37 | 122.45 |
| | 3 | 720L | 7.19 | 1412 | 11.4 | 2.45 | 28.3 | 475.95 | 193.85 | 18.39 | 1.05 | 2.48 | 0.38 | 0.33 | 121.75 |
| | 4 | 1440L | 7.17 | 1365 | 11.4 | 1.88 | 23.1 | 455.14 | 203.64 | 8.73 | 1.31 | 1.65 | 0.37 | 0.33 | 121.43 |
| **Mechanical cleaning (jetting)** | 1 | above filter | 7.17 | 1353 | 11.9 | 1.34 | 21.7 | 410.35 | 207.09 | 7.75 | 3.49 | 0.76 | 0.38 | 0.32 | 121.93 |
| | 2 | top filter | 7.18 | 1360 | 11.6 | 3.16 | 21.2 | 414.64 | 205.86 | 7.88 | 5.63 | 0.29 | 0.38 | 0.32 | 121.32 |
| | 3 | middle filter | 7.23 | 1348 | 11.8 | 2.74 | 20.4 | 421.76 | 207.31 | 6.43 | 4.35 | 0.38 | 0.38 | 0.32 | 121.20 |
| | 4 | 3/4 filter | 7.29 | 1401 | 11.8 | 2.60 | 20.7 | 429.82 | 206.38 | 6.17 | 4.14 | 0.22 | 0.38 | 0.32 | 120.42 |
| | 5 | bottom filter | 7.31 | 1391 | 11.5 | 2.34 | 19.7 | 484.74 | 202.70 | 4.37 | 3.45 | 0.35 | 0.41 | 0.32 | 122.46 |
| **Pumping test (post)** | 1 | 300L | 7.51 | 1370 | 11.7 | 2.57 | 20.9 | 434.05 | 201.41 | 6.89 | 3.69 | 0.00 | 0.42 | 0.32 | 122.67 |
| | 2 | 1260L | 7.36 | 1371 | 12.1 | 1.55 | 20.0 | 425.78 | 200.66 | 4.90 | 4.21 | 0.00 | 0.39 | 0.32 | 121.78 |
| **Pumping test (initial)** | 1 | 90L | 7.28 | 1508 | 11.6 | 11.20 | 49.7 | 640.44 | 136.23 | 35.16 | 11.79 | 0.00 | 0.42 | 0.37 | 120.76 |
| | 2 | 450L | 7.21 | 1498 | 11.8 | 7.98 | 47.2 | 631.40 | 171.43 | 32.81 | 3.45 | 7.52 | 0.41 | 0.32 | 120.29 |
| | 3 | 1440L | 7.02 | 1357 | 11.8 | 1.42 | 24.2 | 409.83 | 209.37 | 7.55 | 9.71 | 0.22 | 0.36 | 0.32 | 120.08 |
| **Jetting** | 1 | 1/4 filter | 7.38 | 1357 | 11.8 | 1.33 | 21.7 | 417.79 | 208.31 | 7.35 | 6.70 | 0.00 | 0.38 | 0.33 | 120.50 |
| **Pumping test (post)** | 1 | 90L | 7.36 | 1356 | 11.6 | 1.95 | 24.4 | 447.05 | 208.80 | 12.1 | 5.98 | 0.00 | 0.39 | 0.33 | 120.29 |

*ults (anion elements) on the hydrochemical properties of samples taken during*
*ween February 2nd and 4th, 2020.*

**Well Regeneration - Sample fluid-fraction data (cations)**

| Sample information | | | Laboratory analysis | | | | | Major Cations | | | | | | Minor Cations | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | standing well = 270 L | pH | $EC_{25}$ | T | Turbidity | DOC | $Na^{+}$ | $Ca^{2+}$ | P | S | $Mg^{2+}$ | $K^{+}$ | $Fe^{2+}$ | $Mn^{2+}$ | $As^{3+}$ | $Cu^{2+}$ | $Zn^{2+}$ | $Ni^{2+}$ | $Sr^{2+}$ |
| Cycle | Sample no. | Approximate pumped volume/well screen sample location | - | µS/cm | °C | NTU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Pumping test (initial) | 1 | 90L | 7.27 | 1489 | 11.6 | 8.40 | 47.9 | 80.80 | 216.74 | 15.98 | 76.55 | 30.26 | 52.86 | 3018.71 | 546.61 | 34.83 | 4.28 | 12.11 | 1876.96 | 1079.86 |
| | 2 | 450L | 7.27 | 1513 | 11.5 | 11.90 | 49.1 | 81.22 | 225.89 | 16.98 | 75.78 | 30.55 | 52.36 | 3588.64 | 356.07 | 40.99 | 4.19 | 9.51 | 1866.82 | 1135.53 |
| | 3 | 720L | 7.19 | 1412 | 11.4 | 2.45 | 28.3 | 79.23 | 183.53 | 6.90 | 88.58 | 29.77 | 49.34 | 149.54 | 441.26 | 23.26 | 2.71 | 6.90 | 1882.85 | 783.51 |
| | 4 | 1440L | 7.17 | 1365 | 11.4 | 1.88 | 23.1 | 80.42 | 179.56 | 3.34 | 94.16 | 29.88 | 50.30 | 46.73 | 473.38 | 11.53 | 2.84 | 6.50 | 1896.26 | 685.22 |
| Mechanical cleaning (jetting) | 1 | above filter | 7.17 | 1353 | 11.9 | 1.34 | 21.7 | 78.33 | 170.07 | 2.89 | 90.55 | 29.44 | 49.95 | 34.19 | 465.97 | 10.43 | 15.92 | 19.85 | 1870.98 | 647.45 |
| | 2 | top filter | 7.18 | 1360 | 11.6 | 3.16 | 21.2 | 79.61 | 170.24 | 2.89 | 91.73 | 29.41 | 49.99 | 35.16 | 447.37 | 12.03 | 16.70 | 15.55 | 1859.97 | 651.86 |
| | 3 | middle filter | 7.23 | 1348 | 11.8 | 2.74 | 20.4 | 80.16 | 171.81 | 2.44 | 96.07 | 29.63 | 51.14 | 35.43 | 514.48 | 10.03 | 34.10 | 61.79 | 1856.58 | 641.39 |
| | 4 | 3/4 filter | 7.29 | 1401 | 11.8 | 2.60 | 20.7 | 80.33 | 173.49 | 2.33 | 93.70 | 29.56 | 49.82 | 35.12 | 452.54 | 9.25 | 10.57 | 11.17 | 1857.99 | 634.18 |
| | 5 | bottom filter | 7.31 | 1391 | 11.5 | 2.34 | 19.7 | 86.90 | 180.85 | 1.81 | 103.55 | 32.08 | 55.51 | 27.03 | 511.52 | 10.12 | 5.21 | 9.54 | - | 647.20 |
| Pumping test (post) | 1 | 300L | 7.51 | 1370 | 11.7 | 2.57 | 20.9 | 80.39 | 173.54 | 2.65 | 92.46 | 29.76 | 51.01 | 32.21 | 468.51 | 9.46 | 4.78 | 7.63 | 1888.73 | 628.79 |
| | 2 | 1260L | 7.36 | 1371 | 12.1 | 1.55 | 20.0 | 79.48 | 171.51 | 1.85 | 90.97 | 29.47 | 51.11 | 27.13 | 485.66 | 9.66 | 2.62 | 7.32 | 1868.72 | 614.57 |
| Pumping test (initial) | 1 | 90L | 7.28 | 1508 | 11.6 | 11.20 | 49.7 | 79.60 | 215.96 | 15.76 | 64.14 | 29.34 | 54.41 | 3917.34 | 664.77 | 45.86 | 6.23 | 21.64 | 1851.34 | 1071.46 |
| | 2 | 450L | 7.21 | 1498 | 11.8 | 7.98 | 47.2 | 81.79 | 221.75 | 14.17 | 82.57 | 29.90 | 53.00 | 2620.47 | 244.33 | 41.29 | 3.63 | 7.80 | 1867.01 | 1135.57 |
| | 3 | 1440L | 7.02 | 1357 | 11.8 | 1.42 | 24.2 | 79.31 | 171.21 | 2.80 | 91.23 | 29.27 | 48.55 | 41.62 | 385.87 | 11.79 | 1.48 | 6.26 | 1862.69 | 672.37 |
| Jetting | 1 | 1/4 filter | 7.38 | 1357 | 11.8 | 1.33 | 21.7 | 78.98 | 172.81 | 2.73 | 94.33 | 29.32 | 49.58 | 28.84 | 211.34 | 13.62 | 14.24 | 13.95 | 1854.52 | 635.01 |
| Pumping test (post) | 1 | 90L | 7.36 | 1356 | 11.6 | 1.95 | 24.4 | 80.18 | 180.44 | 4.50 | 95.24 | 29.67 | 49.90 | 42.22 | 311.33 | 13.68 | 6.73 | 6.95 | 1866.32 | 673.62 |

*ytical results (cation elements) on the hydrochemical properties of samples taken during*
*ation between February 2nd and 4th, 2020.*

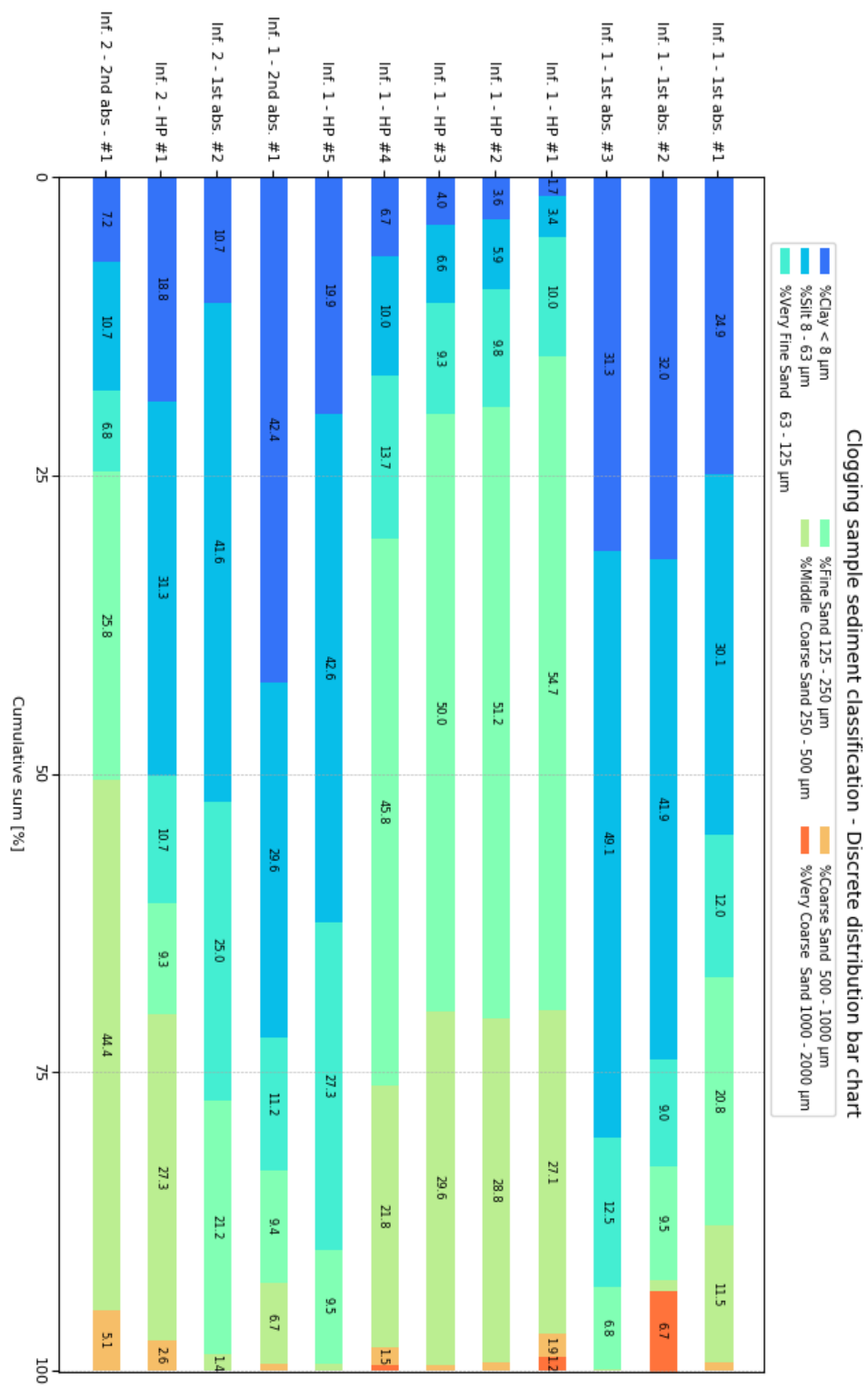
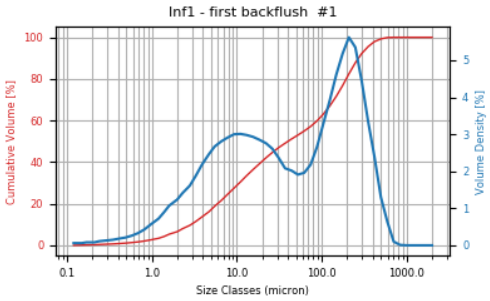
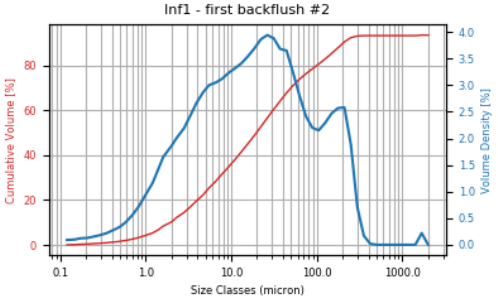
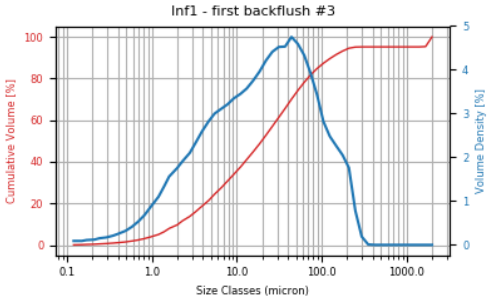
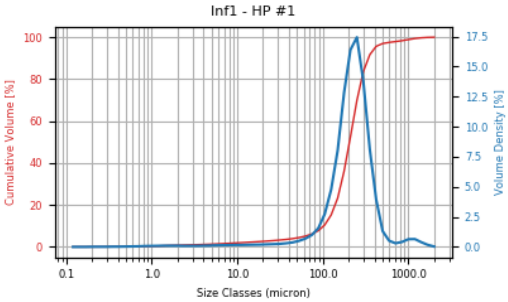


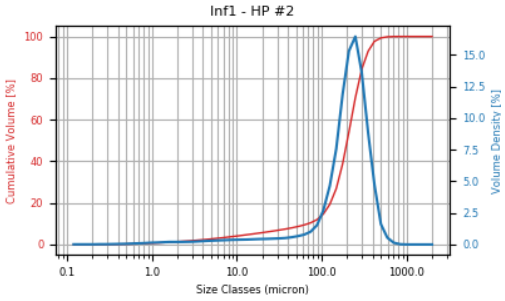

*Figure 7.2: Sediment classification on regeneration samples.*

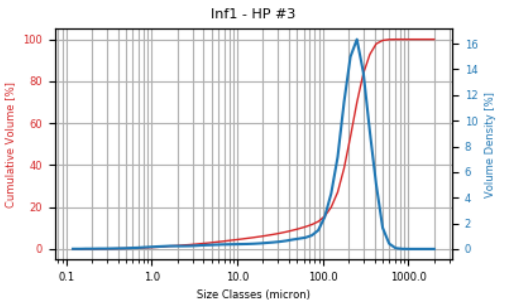

Inf1 - first backflush #1
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

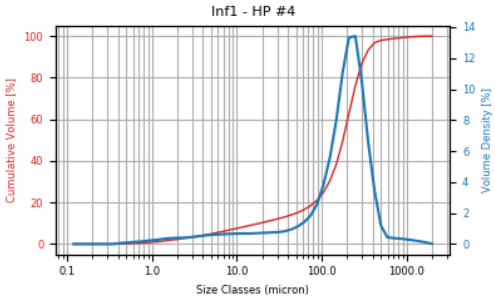

Inf1 - first backflush #2
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

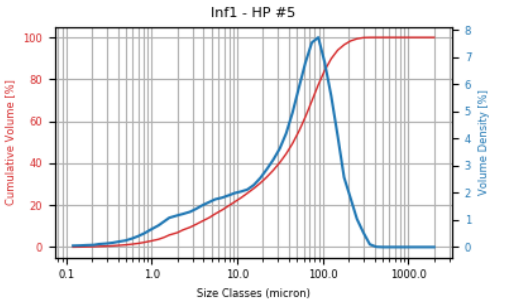

Inf1 - first backflush #3
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

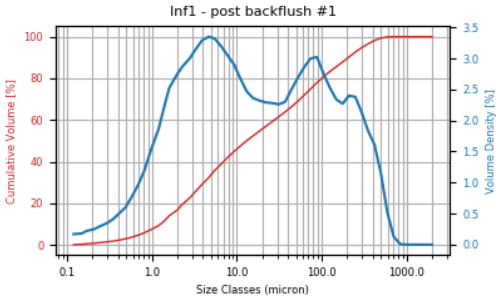

Inf1 - HP #1
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

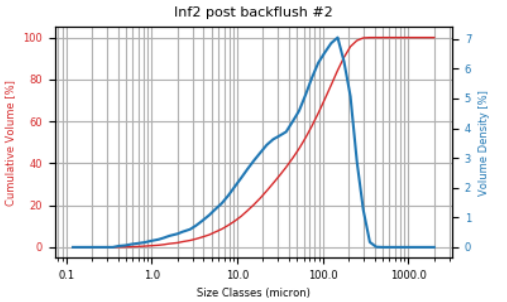

Inf1 - HP #2
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

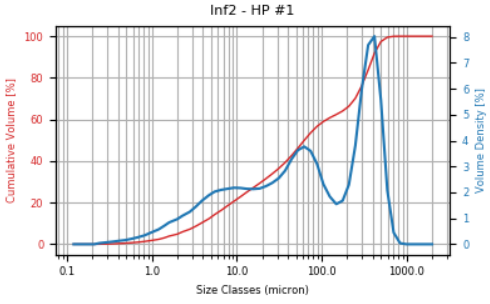

Inf1 - HP #3
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

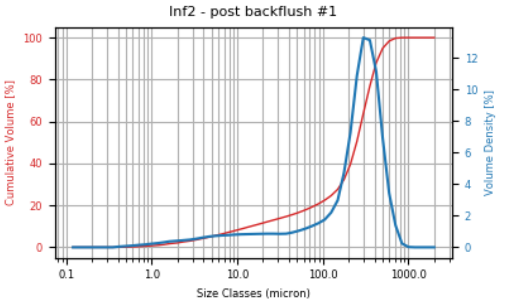

Inf1 - HP #4
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)


Inf1 - HP #5
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)


Inf1 - post backflush #1
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)


Inf2 post backflush #2
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)


Inf2 - HP #1
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)


Inf2 - post backflush #1
Cumulative Volume [%]
Volume Density [%]
Size Classes (micron)

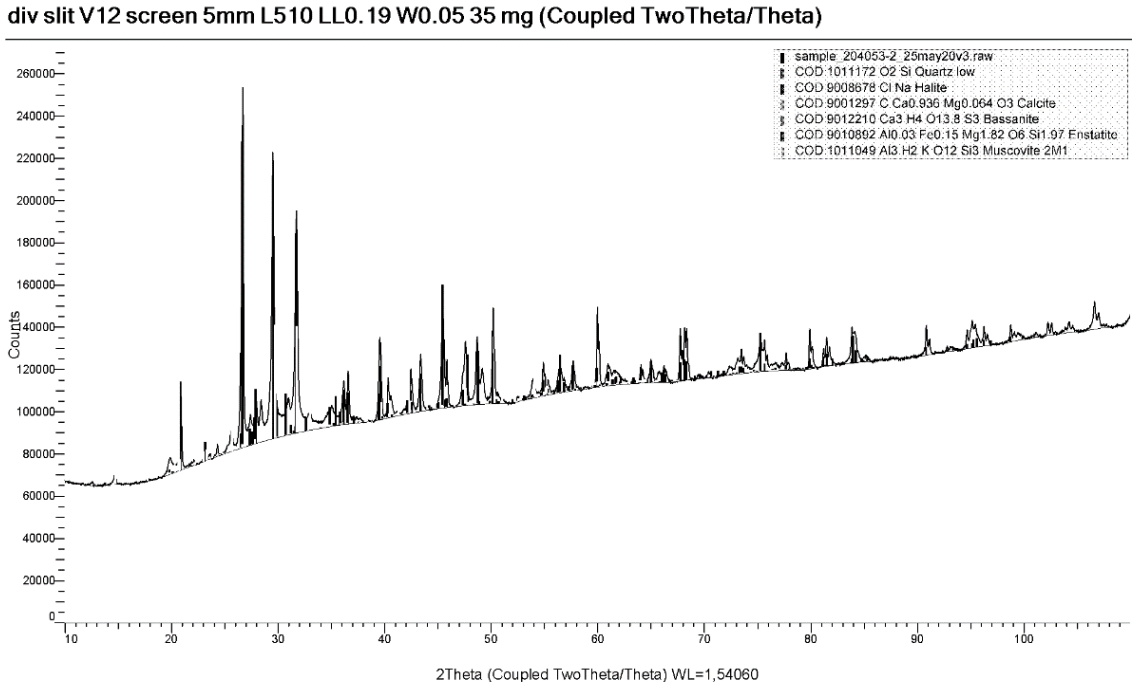



*Figure 7.4: XRD analysis on the second backflush sample from the first backflush procedure during the well rehabilitation between February 2nd and 4th, 2020.*

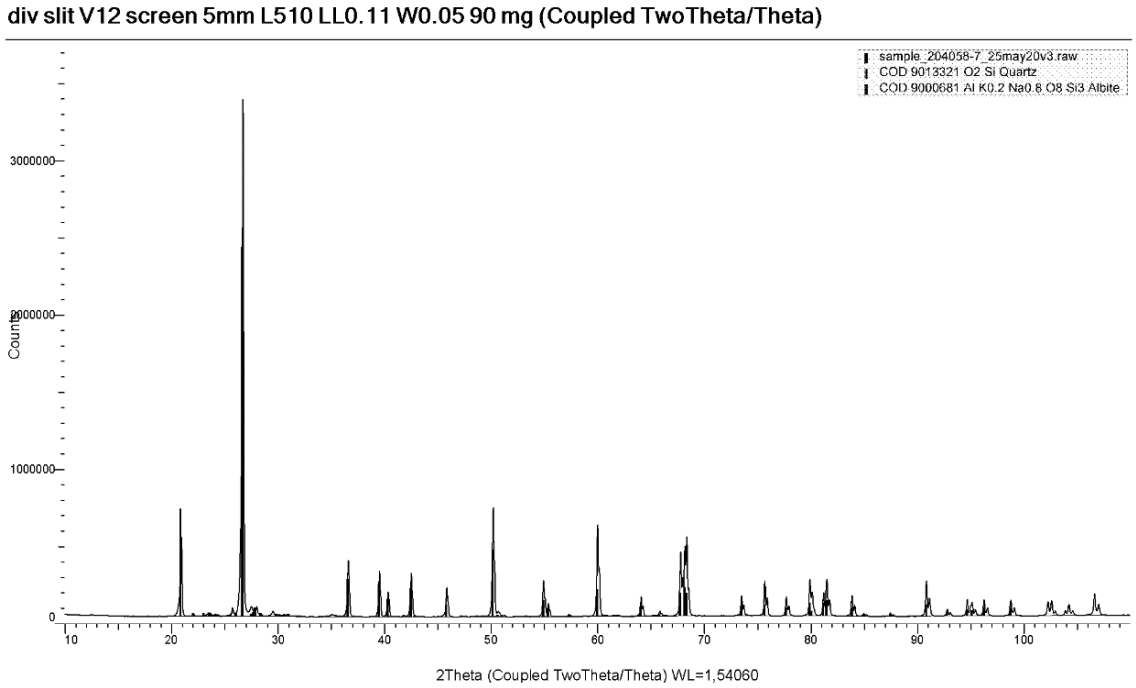



*Figure 7.5: XRD analysis on the third sample taken during the mechanical cleaning procedure during the well rehabilitation between February 2nd and 4th, 2020.*

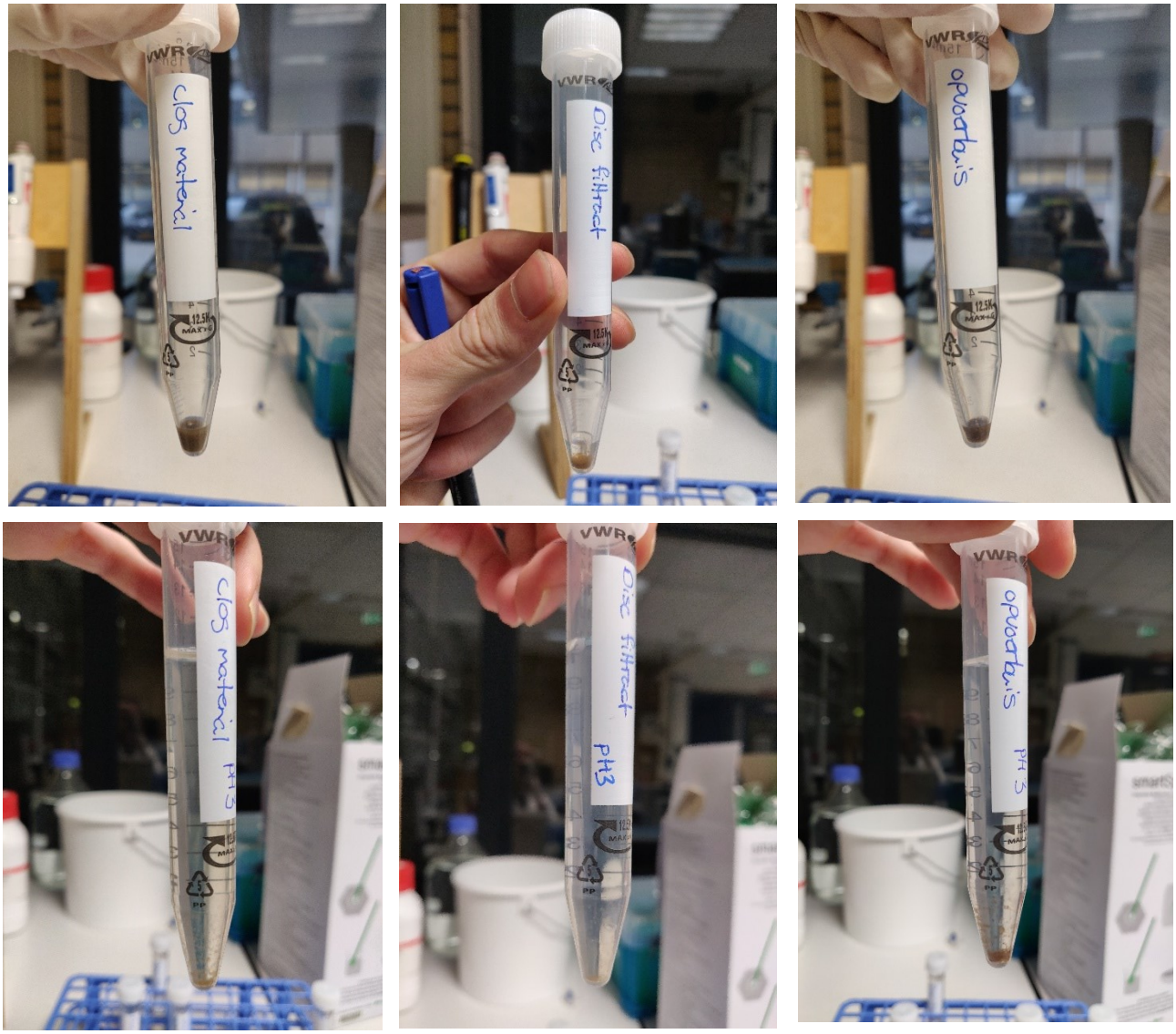



*Figure 7.6: Simple acidification test with 1% HNO3 to investigate the presence of metal-oxides in removed suspended material from the well rehabilitation on November 25th, 2020 (left column, top before acidification, bottom after acidification). Middle column corresponds to the material removed from the disc filters and the right column corresponds to material removed from the standpipe interior.*

## Section 8: Submersible camera inspection injection wells


*Figure 8.1: Large biofilm depicted near the middle filter screen shot after the first clogging event from infiltration period one.*

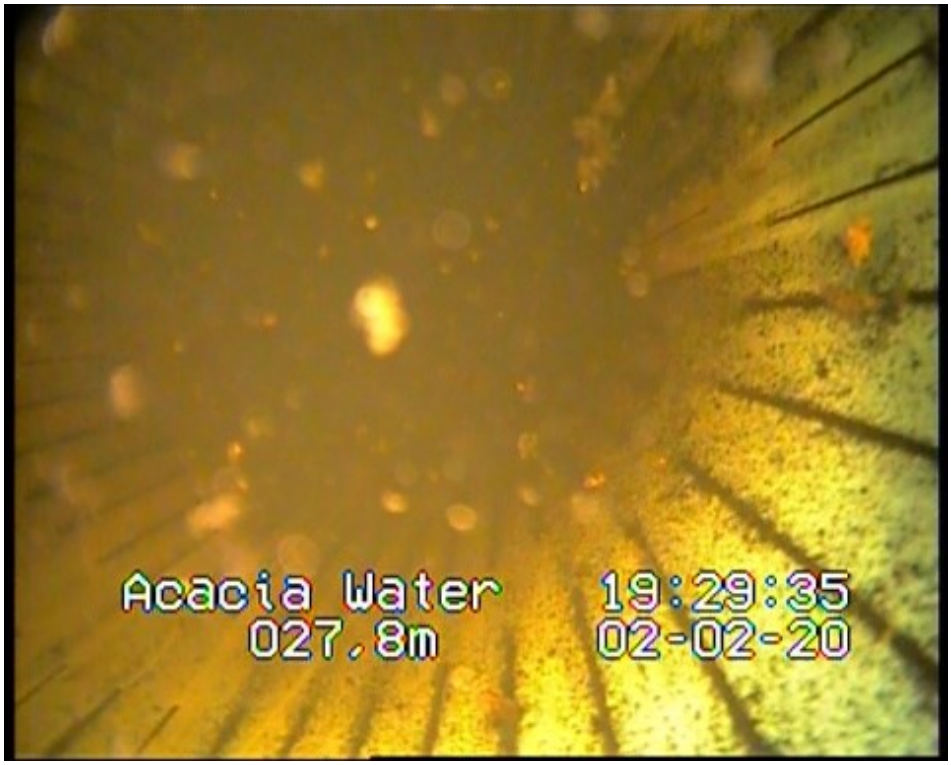



*Figure 8.2: Dark material (organic) within filter slots with staining on the well interior.*

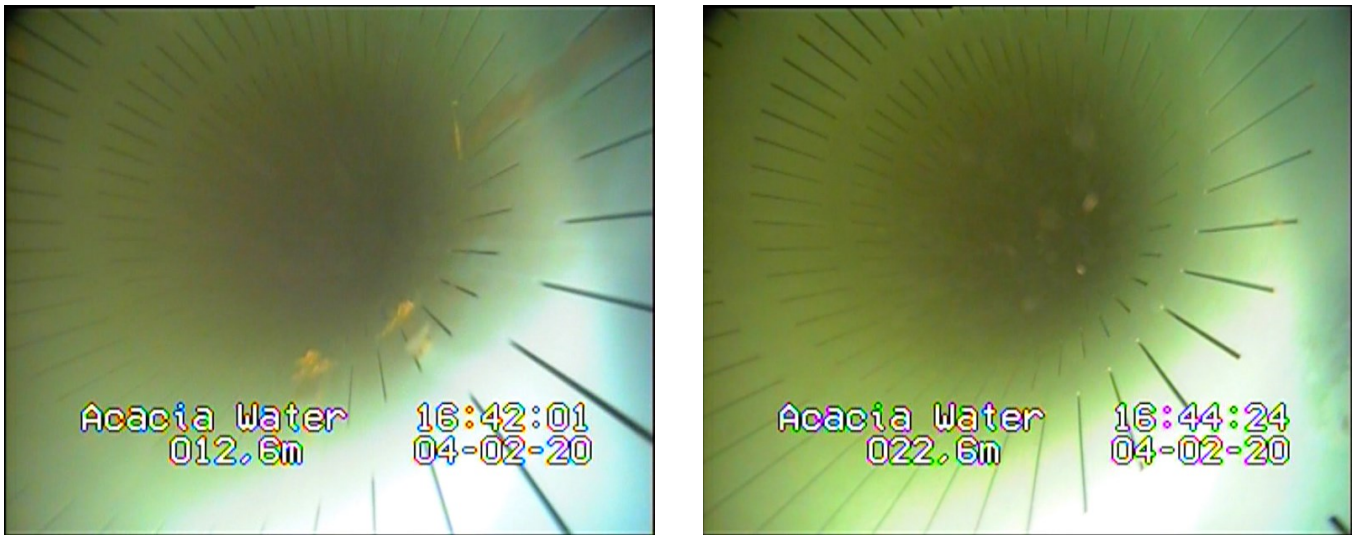



*Figure 8.3: Very clean filter slots and well interior after the well rehabilitation between February 2nd and 4th, 2020.*

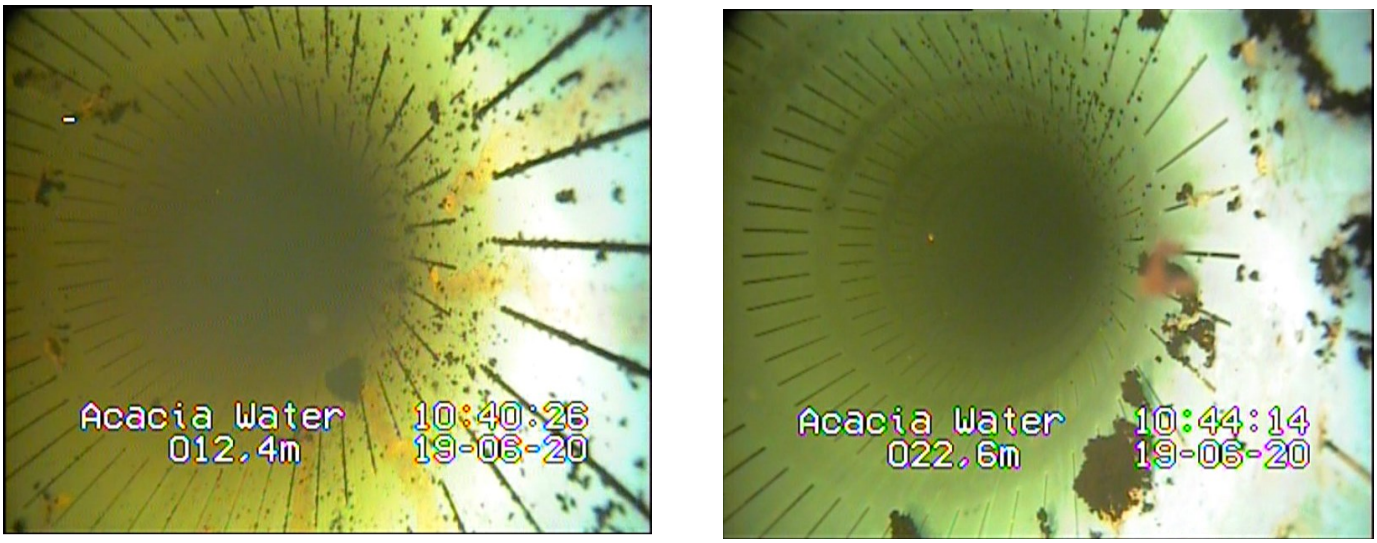



*Figure 8.4.: In-well inspection on June 19th, 2020 after a standstill period of 141 days since the well rehabilitation. Images are taken at the same horizons as figure 8.3. Dark material has filled the slots during shutdown likely relating to microbial growth*