REPORT

Tonkin+Taylor

Manukau Harbour Port Feasibility Study

Fieldwork - Final Technical Working Paper

Prepared for Ministry of Transport | Te Manatū Waka Prepared by Tonkin & Taylor Ltd Date June 2024 Job Number 1018198-FR v1.0





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1 Introduction

Te Manatū Waka / the New Zealand Ministry of Transport has appointed Tonkin & Taylor Ltd and their subconsultants (Royal HaskoningDHV, MetOcean Solutions, Pacific Marine Management, the University of Auckland, Discovery Marine Limited, and RMA Science) to undertake a feasibility study to understand whether it would be technically possible to locate a port in the Manukau Harbour from a navigation and operational reliability perspective.

The Manukau Harbour has previously been identified as a potential port location, however there are unanswered questions around the technical feasibility of this given the complex and dynamic nature of the harbour entrance along with other factors associated with greenfield port development. This is an engineering study, and environmental, social, and economic factors are not part of the current scope of work.

1.1 Purpose of the document

This report has been prepared by Tonkin & Taylor Ltd and provides a summary of fieldwork and associated factual reporting undertaken in conjunction with the Manukau Harbour Port Feasibility study.

2 Fieldwork overview

A wide range of fieldwork data collection was undertaken to support this study which is summarised in Figure 2-1 and Table 2-1. More detailed information is included in the sections that follow.



Figure 2-1: Overview of field investigations (extent of bathymetric survey shown separately in Figure 3-1)

Table 2-1: Fieldwork data collection overview

Ľ	5 Data			Deployment/survey details			
Sectic	collection	Data use	Completed scope	Deployment/survey 1	Deployment/survey 2	Deployment/survey 3	deployment
	Provide a contemporary		Inner harbour single beam echosounder	25/05/23 - 27/05/23			3 days
2.1	Dathumatru	surface of the seafloor over	Open coast single beam echosounder	08/06/23 - 11/06/23			4 days
3.1	ватнутнетту	numerical models and for the navigation channel design	Pressure transducer dipping to fill data gaps from the vessel soundings	26/06/2023			1 day
			Bed mounted ADCP in the inner harbour used to measure currents but can also retrieve water level	24/03/2023 - 25/03/2023	13/04/2023 - 10/06/2023		60 days
3.2	Water levels	Calibration/verification data	Pressure transducer deployed at Waiuku	24/03/2023 - 17/07/2023			3 months
			Pressure transducer deployed at Karaka	Equipment missing	1/07/2023 - 17/07/2023		2 weeks
			Pressure transducer deployed at Cornwallis	24/03/2023 - 18/07/2023			3 months
		Calibration (varification data	Wave buoy deployed offshore	24/03/2023 - 28/03/2023	13/04/2023 - 21/05/2023	10/06/2023 - 3/08/2023	2 months
3 3	Wayes	for the numerical modelling	Inner harbour wave buoy deployed in the inner harbour	24/03/2023 -13/04/2023	25/05/23 - 1/11/23		5 months
5.5	Waves	Characterise wave breaking across the bar and general observation	Fixed camera located on South Head observing the harbour entrance	29/03/2023 - 1/11/23			7 months
	3.4 Currents Calibration/verification data for the numerical modelling	Bed mounted ADCP	24/03/2023 - 25/03/2023			2 days	
3.4		Boat mounted ADCP in the harbour entrance collecting hourly measurements for 13 hrs over a spring tide	28/03/2023			1 day	
			5 x drifter deployments on incoming and outgoing tides	10/06/2023 - 12/06/2023			1 day
		Input to numerical modelling	57 particle size distribution tests	24/03/2023 - 25/03/2023	25/05/2023		n/a
	and dredge assumptions	15 sediment density tests	24/03/2023 - 25/03/2023	25/05/2023		n/a	
3.5	Sediment Visual to support physical testing		Macrophotography of sediment samples	24/03/2023 - 25/03/2023	25/05/2023		n/a
		Input to dredge assumptions	Contaminant testing of 6 sediment samples	26/05/2023			n/a
3.6	Suspended sediment	To validate sediment transport modelling parameters	Water column sampling device deployed on the open coast to measure sediment flux using catch device	1/11/2023			1 day

3 Fieldwork components

3.1 Bathymetry

Discovery Marine Ltd (DML) was engaged to undertake hydrographic survey using a single beam echo sounder across the study area. This information was collected to enable the development of a bathymetric model that reflects present day conditions, primarily for the purposes of hydrodynamic modelling, navigation channel design and dredge volume calculations.

Survey of the inner Harbour was undertaken using a 7.7 m alloy vessel, mounted with a single beam echo sounder in late May 2023, and outer Harbour over the bar in early June 2023 during calm conditions. Extents for the survey are shown in Figure 3-1. The DML report that documents this work is included in Appendix A.



Figure 3-1: Coloured lines indicate the path of the single beam echo sounder survey. Black dots show where point measurement using a pressure transducer dipped from a helicopter have been undertaken to supplement the surveyed area.

Wave breaking in shallow water prevented survey of some areas by boat. To infill these areas, helicopter dipping with a pressure transducer was undertaken in spot locations on 26 June 2023. The methodology for this is shown in Figure 3-2, pictures taken during deployment are provided in Figure 3-3 and the flight path shown in Figure 3-4.



2. Lower device to bed until slack develops in line and hover for 3 min.

 Lift and move to next location

Figure 3-2: Helicopter dipping.



Figure 3-3: Helicopter dipping. Top left = pilot hovering helicopter in fixed position. Top right = pendulum weighted enclosure containing pressure sensors. Lower image = float positioned approximately midway along line (top half slack out of view beneath the helicopter) to serve as a visual aid for the pilot whilst hovering during the dip duration.



Figure 3-4: Image shows helicopter moving from one location to the next, periodically reducing altitude and hovering in position while water levels were measured. Note an additional flight was undertaken to measure depths on the south bank.

Depths were calculated by time-averaging water levels recorded at a frequency of 8 Hz for the duration of the dip, not less than two minutes. Depths were derived from pressure measurements using a hydrostatic equation, assuming a density of saltwater of 1.03 g/cm³ and an atmospheric pressure of 10.1324 dbar. Example output data is shown in Figure 3-5.



Figure 3-5: Example of pressure transducer data.

Water depths were measured using the pressure transducers at the location of a control point (NZTM long 1729580.109, lat 5895207.099) previously surveyed by DML at -6.8 m CD Onehunga, to reduce water depth measurements to bed-level measurements. Control point measurements were undertaken on three occasions to characterise tidal water level change over the duration of the dipping measurements (Figure 3-6). Corrected depths are also therefore in m CD Onehunga. The accuracy of control point measurements was assessed by comparing changes in water levels between control point dip measurements and measurements of water level change at the Paratutae gauge (refer Appendix A). This indicates an accuracy of measurement in the order of +/- 0.1 m.

Linearly interpolated corrections for tide applied to dip measurements between control point dips differ from changes in the true tidal waveform. The resulting potential exists for overestimation of water depth up to 0.1 m. The horizontal accuracy of the onboard Cabri G2 GPS has been taken as +/-10 m. Placement of the pressure transducer is located within +/-20 m of the hover location. Overall horizontal accuracy is therefore taken as +/-30 m.

An overall error in bathymetric measurement by helicopter dipping is therefore estimated to be +0.2 m to -0.1m.



Figure 3-6: Errors associated with bathymetric dipping.

Accuracy of dipping measurements has been assessed by comparing the relative change in water levels at the control point location, to water level changes measured at Paratutae Island.

3.2 Water levels

Pressure transducers were deployed in three locations around the perimeter of the harbour at the locations shown in Figure 3-7 to ensure a range of locations to validate and calibrate a hydrodynamic model. Water level measurements were undertaken at 1 minute time intervals and deployed for up to a 3-month duration. Vertical datum calibration will be undertaken through the deduction of Mean Sea Level. Additionally, the level of instrumentation relative to adjacent structures has been documented as part of the installation.

Waiuku and Cornwallis measurements were undertaken in NZ Daylight Time (NZDT, UTC+13), and Karaka in NZ Standard Time (NZST, UTC+12). Sample output data is provided in Appendix B.

Mid-way through the deployment period the pressure transducer in Karaka was removed from the site through unknown circumstances. A second pressure transducer was deployed between 1 July and 17 July in a similar position.



Figure 3-7: Water level measurement – deployment locations.

3.3 Waves

3.3.1 Wave buoys

Wave buoys were deployed outside the Manukau Bar in 30 m of water for six months, and inside the Manukau Harbour in 10 m of water for three months as shown in Figure 3-8.



Figure 3-8: Locations of wave buoys and fixed camera observing wave breaking over the Bar.

Both wave buoys were connected to a catenary mooring system as per the manufacturer's specifications. This involved an anchored mooring leading up to a large float (left float in Figure 3-9) connected to a secondary float that isolates the wave buoy (right float in Figure 3-9) at the end of this system from tension in the mooring line.



Figure 3-9: Catenary mooring system for the wave buoys.

An Obscape OBS-Buoy 400 was deployed at the offshore location to measure both swell and wind waves. A SofarOcean Spotter buoy was deployed at the inner harbour location to characterise wind waves generated within the Manukau Harbour. Both buoys had a fixed sampling interval of 30 minutes. Example data outputs are provided in Figure 3-10 for the harbour buoy and Figure 3-11 for the offshore buoy, also presented in Appendix C.



Figure 3-10: Sample of data collected from the harbour wave buoy between 13 and 14 June 2023.

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Figure 3-11: Sample of data collected from the offshore wave buoy between 21 June and 11 July 2023.

Various independent validation studies have been undertaken on the equipment used for this deployment and this information is summarised in Table 3-1.

Bulk wave	Root mean square error			
parameters	Offshore buoy	Harbour buoy		
Wave Height	0.1 m (H _{m0})	0.1 m (H _{sig})		
Peak Period	1.3 sec	1.7 sec		
Mean Direction	19 deg	22 deg		

Equipment failure of the offshore wave buoy on two occasions required several additional redeployments which required settled weather conditions, resulting in data not being measured during these times.

During higher energy wave conditions, particularly when wave heights exceeded 4 m, measurements appeared 'spiky' and considered questionably high. These measurements are considered to be an overestimation of wave conditions at this time (i.e. biased high) due to the catenary mooring becoming fully extended, which reduced the ability of the mooring lines to dampen restraint between mooring ballast and the wave buoy. Care needs to be taken for model calibration when considering large wave heights in field data.

3.3.2 Fixed camera

As shown in Figure 3-12 the fixed camera was installed close to the lighthouse on South Head. Images were taken each second for the first 15 minutes of every hour. Pixel resolution in images measured 3904 W x 2200 H.



Figure 3-12: Still camera placement location on South Head.

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On 10 July 2023 the GPS track of a boat encircling the Manukau Bar was recorded and select way points recorded (shown indacatively as red dots in Figure 3-13) for later use in the georeferencing of still images.



Figure 3-13: Georeferencing of still imagery.

3.4 Currents

3.4.1 Bed mounted ADCP

A bed mounted ADCP was deployed in two subtidal locations as shown in Figure 3-14.



Figure 3-14: Current measurement locations.

A bed mounted ADCP was initially deployed in the centre of the channel entrance for a period of 24 hours at a depth of approximately 15m. Multibeam in this area detected large sandy bed forms that exceeded the height of the equipment raising the possibility this equipment would be buried. Part way through the brief deployment, it appears the instrument was buried. Velocity measurements ceased at this time and a tilt in the device of around 5 degrees was detected. Following reversal of tidal currents, tilt measurements indicated the device re-levelled and current measurements resumed. Current measurements from this initial deployment are provided in Table 3-2. The instrument detects the height of water above it and uses that information to split the water column above into three equal depth layers. Data collected for the duration that the ADCP was buried is not considered in Table 3-2 results.

This instrument was then relocated further inside the harbour to an area with more benign bed load transport (refer Figure 3-14 identified as 'Relocated ADCP'). After this device was relocated, data corruption midway through a month long deployment period resulted in this information becoming unusable.

		Upper	Middle	Lower	Unit	
Speed	Mean	1.26	1.17	1.02	m/s	Тор
	Max	2.09	1.98	1.73	m/s	Middle
	Min	0.09	0.08	0.10	m/s	Lower
	Std. dev	0.55	0.50	0.42	m/s	

Table 3-2:	Current measurement statistics from ADPC deployment in channel entrance
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3.4.2 Boat mounted ADCP

A boat mounted ADCP was used on 23 March 2023 to measure currents along the transect shown in Figure 3-15. Transects were repeated with a RDI workhorse owned by the Port of Auckland on a 1-hour frequency over the duration of a spring tidal cycle (between approximately 7am and 9pm NZDT). The transects were carried out across the channel off Manukau Heads. The first four transects were located between -37.0326775; 174.53151433 and -37.045933; 174.54171467. The remaining 26 transects were located between -37.03046133; 174.5378965 and -37.044628; 174.54938867. The two sets of survey were approximately 600 m apart. Example output data from this is shown in Figure 3-16. Further information is included in Appendix A.



Figure 3-15: ADCP transect location.



Figure 3-16: Example of ADCP transect data during the ebb tide showing current speed through the water column.

The survey team lost data from a few of the transects so returned at the end of the day to plug the gaps of the hourly transects they had missed.

3.4.3 Drifter deployment

Initially dye studies in conjunction with aerial survey were considered to improve understanding of currents around the harbour entrance, and over the bar. However, following peer review it was suggested that tracking drifters would be a useful exercise to gain an insight into the flows in and out of the harbour to help verify the numerical model outputs, so this approach was adopted.

A series of 5 drifters were designed and built to measure currents between the Manukau Harbour entrance and the bar. The main body of the drifter was designed to extend 1.3 m below the water surface and move with surface currents, a GPS tracker was attached to the tip of a mast (refer Figure 3-17). Three drifters were released on 10 June 2023 on the incoming tide, with two placed in the northern channel, and one in the southern channel. Two additional drifters were then introduced upstream of the initial three to measure outgoing current speeds (refer Figure 3-18). Time series measurements were undertaken at a fixed frequency of approximately 30 seconds. The release location and tracks are shown in Figure 3-19. GPS units used were Oyster 3 from Digital Matter and have a stated positional accuracy of 10 m. Consecutive GPS locations could only be recorded until drifters had travelled more than 20 m from their previous position. GPS measurements were recorded in WGS84 (projection) as decimal degrees to 9 significant figures for latitude and 10 significant figures for longitude (i.e. precision less than 1 m). The inferred time-averaged speed between consecutive GPS positions was smoothed using a 20-window moving mean (i.e. 10 minute period) and a gaussian blur to account for positional inaccuracies to ensure drifter speeds were more representative of the true drifter movement, based on independent vessel track and observations during deployment.

None of the drifters re-entered the harbour, and only information within the first 24 hours of this deployment was used. Wind conditions at the time of deployment were very light (variable, less than 5 knots), meaning negligible effects of wind on drifter movement. Offshore swell was small on this day (significant wave heights less than 1 m).



3.5

Figure 3-17: Drifters used to measure surface currents.



Figure 3-18: Timing of drifter deployment.





Figure 3-19: Drifter release area and tracks.

3.5 Sediment

3.5.1 Sampling

Sediment samples were collected in 57 locations indicated in Figure 3-20. In a number of locations sufficient quantity of sample was obtained to enable a solid density test.



Figure 3-20: Sediment sampling locations.

Sampling was undertaken using a Van Veen grab sampler (Figure 3-21). This involves lowering the sampler to the seafloor on a rope. As the sampler makes contact with the seabed it unweights the lowering line resulting in the release of a split pin and the closure of the jaws capturing a sample that can then be hauled back to the surface.



Figure 3-21: Van Veen grab sampler.

In some instances, samples could not be retrieved, likely due to dense materials at the bed resulting in the jaws not penetrating, particularly in the upper reaches of the Papakura Channel. In other instances, retrieved samples contained a mix of both sand and coarse shell, possibly meaning the bed was primarily comprised of sand, with a layer of overlying shell.

A laboratory sub-sample was selected by hand from the larger mass within the sampler at each test location. By observation efforts were made to select material that was representative within the

sampler, however some small differences could occur between multiple sub-samples of the same retrieved mass. The significance of these differences are minimised to an extent overall by collecting and testing clusters of multiple samples through the study area.

When a sampler is lifted out of the water it contains a sieve in the top from which water is drained before opening the jaws. In the process of raising the sampler through the water column some material could be lost through this sieve, particularly fine material when the sampler is agitated. Care was taken when lifting the sampler to raise it smoothly hand over hand.

Upon reaching the surface, care is required not to shake the sampler and suspend sediments that could then make their way out through the metal sieve as the sample is drained over the side of the boat. By observation this loss appears to be very small in comparison to the overall sample mass. Fine silt would likely make up the larger portion of any potential loss however, overall, this loss is not expected to be significant.

3.5.2 Laboratory testing

The following laboratory testing was undertaken for the purposes of determining physical parameters of bed sediment for modelling and dredge assumptions:

- 57 particle size distributions were undertaken by the University of Waikato using laser diffraction on 50-gram sub-samples, sieved down to 63 micron prior to processing. Refer to Figure 3-20 for locations and Figure 3-22 and Figure 3-23 for median grain size results.
- 15 density tests were undertaken on 50-gram sub-samples by the University of Waikato, to provide information that broadly characterises the range of bed sediment materials recovered. Refer to Figure 3-24 for locations and results.
- 6 environmental tests on 250-gram sub-samples were undertaken by Hills Laboratory (refer Figure 3-25 for locations). This information was gathered to inform environmental constraints regarding the potential disposal or reuse (i.e. reclamation) of dredged material discussed in the associated dredging report TWP06. The following environmental tests were undertaken:
 - Heavy metals screen level As, Cd, Cr, Cu, Ni, Pb, Zn.
 - Organochlorine Pesticides UltraTrace in Soil.
 - Polycyclic Aromatic Hydrocarbons Screening in Solids.
 - Total Recoverable digestion.
 - Total Recoverable Mercury.
 - Total Organic Carbon.

Field test results with photographs and laboratory reports provided in Appendix E.

Outside the harbour entrance a large variation in grain size distribution was observed. In areas close the main channels grain sizes were larger (typically D_{50} = 300 to 500 microns). Further away from these channels grain sizes became smaller (typically D_{50} =150 to 300 microns).



Figure 3-22: Median grain sizes (microns) from sampling outside the harbour entrance (Black line indicates concept channel alignment).

Moving up inside the harbour median grain sizes reduced, typically becoming less than 200 microns. In the base of channels this material became silty in places (less than 63 micron). Rare coarse loose shell deposits were encountered over some of this material. Outside of the channels in shallower depths, material reverted to a fine sand.



Figure 3-23: Median grain sizes (microns) from T+T (2023) sampling inside the harbour. Black line indicates the concept channel alignment.



Figure 3-24: Density (g/cm³) results from select sampling locations.



Figure 3-25: Environmental test locations (note that these samples were also tested for particle size distribution and density).

Due to the range of bed sediments recovered, all samples were photographed to assist with the assessment of sediment transport and coastal morphodynamics (example in Figure 3-26). Photographs were taken to provide additional context regarding the makeup of this material and its origins.



Figure 3-26: Macrophotography of sediment samples.

The laboratory testing was undertaken by third party laboratories following their own in-house quality assurance procedures. For the environmental testing the samples were kept refrigerated and there was a chain of custody to ensure that no samples were tampered with.

3.6 Suspended sediment

The modelling approach allows for the two-dimensional (2D) representation of sediment transport. To build confidence in the sediment transport model schema and parameters, a sediment catch device was developed to measure suspended sediment. Suspended sediment monitoring was initially proposed during high energy events using a helicopter in the same manner as bathymetric dipping. During bathymetric dipping it was difficult for the pilot to maintain a steady hover over breaking waves despite the calm conditions at that time. For health and safety reasons it was decided not to proceed with sediment sampling over a large sea state. Instead, a sediment sampler was developed for deployment by boat in comparatively calmer conditions.

As tidal current flowed through this sampler, suspended sediment in the current was filtered out and collected. After retrieval, the weight of collected material was measured. The speed of the tidal current passing through the sampler was inferred from a drag tilt sensor, located next to the sampler (Figure 3-27 and Figure 3-28). Measurements of speed are taken as an average over the distance between the seabed and the mouth of the sampler.



Figure 3-27: Schematic indicating deployment of catch device.



Figure 3-28 Catch device function

Deployment of the catch device was undertaken on 1 November 2023 at 0930 hrs NZST midincoming tide, on the southern side of the south-west channel at NZTM 1729580.109 E, 5895207.099 N. The sea state offshore from the bar was considered calm, with significant wave heights less than 1 m. The device was suspended 1 m above the seabed for a period of 6 minutes during an early stage of the flood tide. The sampler collected 180 grams using a 100-micron cloth filter over this duration. An average current speed of 1.4 m/s was recorded at this time. How this information is related to the modelling results is discussed in the Numerical Modelling Report TWP03b.

Testing of the device was through deployment in a number of comparatively safer coastal settings featuring a range of current speeds, wave conditions, water depths and sediment types. The stability of the device and function of the filter, including deployment and retrieval was observed by a diver on these occasions. Tests indicated the potential for sample loss during collection due to orbital velocities from shoaling waves and wave breaking. This limited deployment to calmer areas/deeper water conditions in the tidal channel.

4 Applicability

This report has been prepared for the exclusive use of our client Ministry of Transport | Te Manatū Waka, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

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REPORT OF SURVEY

Bathymetric Survey of Manukau Harbour

Auckland, New Zealand

REPORT PREPARED FOR:





REPORT PREPARED BY:



Surveyed by: Surveyor in Charge: Vessels: Survey dates: Report date: Report version: Discovery Marine Ltd. W. Roest, NZCHS, MNZ SRL *Tupaia, MNZ 142238* 23 to 24 March 2023, 25 to 26 May 2023, 09 to 12 June 2023 20 June 2023 1.0



1. EXECUTIVE SUMMARY

Discovery Marine Ltd (DML) was contracted by Tonkin + Taylor (T&T) on behalf of the Ministry of Transport to conduct a bathymetric survey of the Manukau Harbour entrance and main channels. In addition, a vessel mounted Acoustic Doppler Current Profiler (ADCP) survey was undertaken over a 13hr spring tide cycle along with deployment of seabed mounted gauges and sediment samples to aid with the Port feasibility study.

The survey was planned to be conducted in multiple phases as weather conditions and tide allowed. To complete the survey, 3 phases were required as follows:

- **Phase 1** 23 to 24 March 2023. An ADCP survey over a 13-hour spring tide was undertaken in the vicinity of Middle Deep channel, between South Head and Beacon Point. T&T's seabed mounted ADCP and wave buoys deployed, and sediment samples taken at given locations.
- **Phase 2** 25 to 26 May 2023. Inner Harbour bathymetric survey using Single Beam Echosounder (SBES) of Papakura channel, from opposite the LPG Terminal to near Mako Point. Sediment samples were collected at specified locations.
- **Phase 3** 09 to 12 June 2023. Bathymetric survey of the Manukau bar prioritising the harbour entrances (South West and South channel) using SBES. Completion of the survey from Middle Deep channel to Huia Bank.



Figure 1Figure 1 depicts the approximate survey area and phases of the survey operations.

Figure 1: Manukau Survey Area



2. WEATHER AND SEA CONDITIONS

Phase 1: Day 1 weather conditions were favourable for working inside the harbour entrance. However, strong ebb tide currents and slight SW wind caused turbulent water near South Head requiring the ADCP survey line to be relocated 200m further east after the first pass. On Day 2, moderate sea conditions were experienced on the Manukau bar during the flood tide and short cresting 1m waves whilst transiting the South channel.

Phase 2: Good weather and calm sea conditions were experienced for the inner harbour survey.

Phase 3: Weather predictions proved accurate with a sustained high-pressure system over the west coast. Initial sea conditions were variable 10 knot E wind with a consistent chop that wasn't always comfortable but manageable. Near the end of the survey sea conditions deteriorated as the wind intensified gusting 30 knots and swung to the SW. This caused a washing machine effect in the South West entrance and restricted sounding over the North and South Bank. Data acquisition continued in the more sheltered waters of South entrance and inner harbour.

3. SURVEY PLATFORMS AND EQUIPMENT

3.1 SURVEY VESSEL TUPAIA

DML used their 7.7m Senator survey vessel *Tupaia* for this project as it offered a safe working platform for the Manukau bar, having an enclosed cabin, twin outboards and a shallow draught. The vessel is an inshore survey boat fitted with a modern survey suite comprising GNSS positioning systems, motion sensor and high frequency digital SBES. The survey equipment is fully calibrated and all offsets between sensors are known. All survey data is logged directly into a hydrographic software package, QPS Qinsy. The vessel is operated under Maritime New Zealand MOSS.



Figure 2 Survey Vessel, Tupaia





Figure 3: Helms Survey and Navigation Screens onboard Tupaia

Name	Тираіа	
MNZ number	142238	
Owner	Discovery Marine Limited	
Туре	Senator 770	
Year Built	2019	
	Length: 7.7m	
Dimensions	Beam: 2.49m	
	Draught: 0.7m	
Propulsion	Twin Mercury 150HP 4 stroke outboard engines	
Survey Class	MNZ Survey for 8 Pax – Inshore Waters, (within 12nm) and Enclosed Waters	
H&S Considerations	Operates under the direction of the vessel skipper and within MNZ MOSS requirements, MBES and SVP deployment and recovery SOP.	

Table 1: Specifications of Survey Vessel Tupaia



3.2 POSITIONING SYSTEM AND ATTITUDE CORRECTION

An Applanix POSMV Wavemaster II (POSMV) provided position, attitude, and heave data for this survey.

Key Components:	POSMV Wavemaster II	
Position Accuracy:	Horizontal: <0.1m (95%), Vertical: <0.1m (95%) (G4+)	
Roll and Pitch Accuracy:	0.02°	
Heading Accuracy:	0.03°	
True Heave Accuracy:	0.02m or 2%	
Position Aiding	G4+ correction	

Table 2: Tupaia Positioning System Details

3.3 SINGLEBEAM ECHO SOUNDER (SBES)

A Tritech PA500 SBES was fitted to *Tupaia* and measured the bathymetric depth data.

Table 3: Tritech PA500 Details

Single beam Echo Sounder:	Tritech PA500 SBES
Sonar Operating Frequency:	500khz @ 10Hz
Swath Opening Angle:	6°
Rated Accuracy	+/- 1cm

3.4 SPEED OF SOUND SENSOR

An AML SVP was used to measure the sound velocity, pressure and temperature through the water column at various locations during the survey.

Table 4: AML 3 LGR Details

Speed of sound sensor:	AML 3 LGR (sound velocity, pressure, temperature sensor)
Resolution:	0.01m/s
Precision:	0.01m/s

4. SURVEY CONTROL & POSITIONING

4.1 HORIZONTAL DATUM

The horizontal datum and projections parameters that the survey is referenced to are provided in Table 5.

Datum:	New Zealand Geodetic Datum 2000 (NZGD2000) Reference Ellipsoid: GRS80
Projection:	New Zealand Transverse Mercator 2000 (NZTM2000)

Table 5: Horizontal Datum and Projection



4.2 VERTICAL DATUM

The vertical datum that the survey is referenced to is provided in Table 6

Datum:	Chart Datum Onehunga
Datum Description:	5.593m below LINZ mark B.M. CC 65 (code ADLT)

4.3 CONNECTION TO DATUM

The survey was connected to datum using tide stations at Onehunga (Auckland Council) and Paratutae Island (LINZ). A transfer of sounding datum (TSOD) was undertaken between the Onehunga tide gauge and the Paratutae tide gauge to establish the height of tide above datum.

5. CONDUCT OF SURVEY

5.1 PHASE 1

Phase 1 was conducted between 23 March and 24 March 2023.

The Acoustic Doppler Current Profiler (ADCP) survey required repeat transits by the survey vessel across the narrow harbour entrance, over 13-hour observation period during spring tides. This provides current data at its highest expected velocity. Day 1 (23 March) provided the opportunity with improving sea conditions and spring tides to complete the survey. The team experienced turbulent and potentially hazardous sea conditions across the initial route provided by the client (shown red, Figure 4) so a decision was made on the water to relocate the transect approximately 200m further east (shown blue, Figure 4) in more favourable water. During the day, sediment samples were taken at a location within proximity to the ADCP route.

The survey was completed to the full extent of the requirements and the ADCP results given to the client for analysis by a 3rd party.

Day 2 (24 March) was allocated for the deployment of the client's two wave bouys and additional sediment samples at given locations. The morning flood tide period allowed for transiting the Manukau bar via the South Channel in cresting 1m waves. A trip report was lodged with Coast Guard prior to and returning from crossing the bar. The outer bar wave buoy was deployed, and sediment samples taken at convenient locations. Sediment sample locations were logged and provided to the client.

On returning to the harbour, the second wave buoy was deployed and further sediment samples taken.

Some exploratory and ad hoc seabed mapping was undertaken on Day 1 using DML's Multibeam Echosounder (MBES) in the vicinity of the seabed mounted ADCP. The real time results indicated the presence of significant sand waves in area where the ADCP was deployed. There were then concerns the strong current and sand wave movements could possibly bury the ADCP and a decision was made by T&T to recover it and reconsider the deployment location.





Figure 4: Phase 1 ADCP Transect



Figure 5: ADCP surface buoy in strong tidal current



Figure 6: MBES image of sand waves near ADCP



5.2 PHASE 2

Phase 2 was conducted between 25 May and 26 May 2023.

The goal for Phase 2 was to maximise the high tide water levels and complete SBES data capture and sediment samples over the shallow banks of the Papakura channel.

Priority was given to the collection of sediment samples at specified locations. Samples were refrigerated until they could be delivered to Hill Laboratories. Guidelines for sample collection (provided by the client) were adhered to and involved disinfecting the Van Veen grab and the use of plastic sheets and disposal gloves for each sample. This ensured there was no cross contamination.



Figure 7: Sediment sampling with Van Veen grab

The bathymetric survey of Papakura channel and surrounding shallows achieved good results and coverage. The extent of survey spanned from opposite the LPG Terminal to Mako Point, see Figure 8.




Figure 8: Phase 2 Bathymetric survey coverage

5.3 PHASE 3

Phase 3 was conducted between 9 June and 12 June 2023.

9 June - With a promising marine weather forecast, intentions were to survey the remaining harbour channel while awaiting the sea conditions to improve and allow surveying of the Manukau bar and outer harbour survey area.

After a few hours SBES surveying in sheltered water and waiting for the tide to flood, the South Channel Harbour Entrance became navigable. A trip report was lodged with Coast Guard (CH18) and a 30-minute bar watch commenced. Surveying of the Manukau bar started by following predetermined runlines over the priority area, South West channel. This worked well and depth measurements were recorded from beyond the Pilot Limit, up over the shoal bank and back into deeper water of Middle Deep. Minimum depths experienced over the entrance shoal were 4 - 5m. At the end of day, the priority area with denser survey line spacing was near complete. Maui dolphin were observed in the channel and made brief approaches to the vessel on a few occasions. These sightings were reported on the Department of Conservation website.

10 June - Good sea conditions and a continuous Coast Guard bar watch, allowed for a full day surveying on the Manukau bar.

11 June – With deteriorating conditions predicted (gusting 30knt SW), focus was on finishing the middle deep channel first and then South channel. This was achieved however marginal conditions along the edges of Middle Deep restricted survey efforts from progressing far into the shallows of the North and South Bank. The calmer water of South channel allowed for extended coverage. As



predicted the conditions became unworkable in the entrance so the survey progressed inside South Head.

12 June – The final area of survey (Huia Bank) was completed in the morning and the afternoon spent demobilising and driving back to Tauranga.



Figure 9: Phase 3 Bathymetric survey coverage

5.4 ON SITE VERIFICATION AND ACCURACY CHECKS

The following calibrations, checks and verifications were conducted on site.

- Vessel positions provided by the POSMV were compared with an independent positioning system on the chart plotter for verification.
- A bar check was conducted with the SBES to confirm offsets and correct sounder operation.
- Comparisons of overlapping depth data surveyed at different times/day, the differences observed and confirmed within expected tolerances.
- Measurements of sound velocity were conducted daily and at changes of tide or location. Measurements ranged between 1,504 to 1,513 m/s.



6. DATA POST PROCESSING

Once the field work was complete, all data was transferred to DML's office IT environment for post processing.

6.1 SBES

SBES bathymetric data was processed and validated using Qimera with any spurious soundings cleaned from the dataset using 3D point editing. Depths were reduced to be in terms with Chart Datum Onehunga by using tidal data recorded at Onehunga and Paratutae Island. Data for the Onehunga gauge was accessed through the Auckland Council data portal. Data for the Paratutae tide gauge was accessed via the LINZ website.

A transfer of sounding datum (TSOD) was undertaken to establish CD at the Paratute Gauge, from the existing Standard Port of Onehunga. After reducing the Paratuate tidal data to CD, tidal curves for both locations were compared, and several anomalies noted, especially at the Paratutae gauge where spurious data was regularly evident. Spurious data from both tide files was removed where possible or smoothed in the final tide file used for reduction to CD.

The survey area was split into two tidal reduction blocks by a line joining Puponga Point in the north to Mako Point in the south. SBES data to the east was reduced on Onehunga gauge data and SBES data to the west, including the outer harbour area was reduced on Paratutae gauge data.



Figure 10: Tidal Reduction Blocks

Generally, where cross lines overlap other data inside the harbour there is good agreement between lines run at different times and different states of tide. In the outer harbour area however, there



appears to be an offset between the mainlines and cross lines running along the contour on the seaward side of the bar. The offset is in the order of 0.5m in some places. The exact cause of this difference is unknown although we suspect it is the tide and current flow in the outer harbour area, on the seaward side of the bar differing to that recorded at the Paratutae tide gauge.

6.2 EXPORT AND DELIVERY

The SBES data from Phase 2 and 3 was combined into a single SBES data set and exported as an XYZ ASCII XYZ file.

7. ESTIMATED DEPTH ACCURACY

The accuracy of SBES bathymetry depths for this survey is assessed as +/-0.15m (Hz and Vz) inside the harbour and +/-0.35m outside the harbour as determined by average crossline checks, position checks, and inspection of overlapping data.

Accuracy of soundings is within the LINZ-1 TVU hydrographic survey specification.

8. DIFFICULTIES ENCOUNTERED

All equipment operated well, weather was fine and sea conditions were manageable. Boat launching and recovery was done at the Waiau Pa boat ramp. It was advantageous to become Boat club members to have the use of the security gate-controlled boat parking and launching facilities. Other local boat ramps were visited but ease of launching depended on tide levels, and they didn't have pontoons.

Tide data from the Onehunga tide gauge was initially supplied by Auckland Council for the wrong sensor. A query was raised with the Council and the correct data was eventually supplied. Data for the Paratutae tide gauge, accessed from the LINZ website is noisy and required the removal of spurious data and eventual interpolation/smoothing to establish a final tide curve.

9. PERSONNEL

The personnel involved in this project including their role and qualifications are tabulated below.

Name	Qualifications	Role	
Declan Stubbing	BSurv, CPHS1	Project Manager	
Wade Roest	NZCHS, MNZ SRL	Surveyor in Charge	
Jimmy Van der Pauw	BSurv, CPHS1	Phase 1 - Hydrographic Surveyor	
Dirk Immenga	MNZ Commercial Launchmaster	Phase 1 - Skipper	
Cam Low	MNZ SRL	Phase 2 & 3 - Skipper	
Marc Tecofsky	MNZ Coastal/Offshore	Phase 2 - Alt Skipper	
Josh Fowden	MNZ Commercial Launchmaster	Phase 3 - Skipper	

Table 7: Survey Personnel



10.COMMENTS & RESULTS

The SBES bathymetric survey completed all objectives within specification. Successful coverage of the Manukau bar and harbour was achieved within the weather and tidal constraints.

Sea bed sediment samples were collected as requested and sent for analysis.



Figure 11: Papakura Channel, Manukau Harbour



11.RETENTION OF DATA

DML will retain copies of the project deliverables, including source data files, on its servers for a period of 12 months from completion of the project. The data will then be archived to a digital medium and retained for 7 years. After the initial 12-month period client requests to access and supply project data will incur a fee.

DML wishes to thank the T&T for the opportunity to undertake this project and looks forward to working together again in the future.

For Discovery Marine Ltd

Authored by	Wade Rail	Date: 16 June 2023	
	Wade Roest (NZCHS, MNZ SRL)	Hydrographic Surveyor	
Approved by	DA 17	Date: 20 June 2023	
	Declan Stubbing (BSurv, CPHS1)	Chief Executive Officer	

Digital Data pack:

- A. Report of Survey (.pdf)
- B. Survey Data: All points, 2m and 5m Grid



APPENDIX A – METADATA

Survey Company	Discovery Marine Ltd			
Project Name	Manukau Harbour Bathymetry Survey			
Project Number	2255			
Location	Clarks Beacl	n, Auckland		
Client	Tonkin + Ta	ylor		
Contract Number	-			
Survey Dates	Phase 1: 23-	-24/03/2023 Phase 2: 25-26/05/2023 Phase 3: 09-1	2/06/2023	
Surveyor In Charge	D. Stubbing	/ W. Roest		
Field Personnel	W. Roest, D	. Stubbing, J. VDP, D. Immenga, C. Low, M. Tecofsky. J. Fo	wden	
Office Personnel	D. Stubbing	, W. Roest		
Horizontal Datum and Project	Projection NZTM2000			
Vertical Datum		Chart Datum Onehunga. Elevations supplied as heights positive above datum, negative below datum.		
Water Level Reduction	Tide	Tide Stations: Onehunga and Paratutae Island		
Origin of Coordinates and Levels		Chart Datum Onehunga being 5.593m below LINZ mark B.M. CC 65 (code ADLT)		
Survey Vessel	MV Tupaia			
Positioning System	Applanix POSMV Wavemaster II. G4+ correction			
Sonar System	Tritech PA500, 500kHZ			
Acquisition Software	QPS Qinsy			
Processing and Delivery Software		QPS Qimera		
Data Collected	SBES Bathymetry			
Coverage Achieved	Transects w	Transects with crosslines		
Accuracy Standard Achieved	Yes			
Bathymetric Gridded Surface Method		Average		
Bathymetric Gridded Surface Resolution				
Seafloor backscatter file type		NA		
File Format		ASCII XYZ		
Data Custodian Contact Details		Declan@dmlsurveys.co.nz		



Figure Appendix B.1: Water depths measured by pressure transducers (Top = Waiuku, Middle = Cornwallis, Bottom = Karaka)





Figure Appendix C.1: Wave rose showing Hsig. and Peak period for harbour wave buoy for five month deployment from May through November 2023.



Figure Appendix C.2: Wave rose showing Hsig. and Peak period for offshore wave buoy for two month deployment from June through July 2023

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Mission

This section contains basic mission information, including information about the instrument used in this deployment mission, a location map and basic data statistics from the mission. All times are referenced to the local time of the device used to configure the Eco. All depths are referenced to the water surface

General info

Deployment/File Name: Eco38_20230323094724				
Operator: Peter Quilter				
Full Deployment Date Range: 23/03/2023, 9:47:31 am to: 24/03/2023, 7:57:31 pm				
ID	Eco_0038	Firmware	8008.4	
Samples	411	Interval (minutes)	5	
Salinity	Salt water	35 ppt		
Latitude	-37.036148	Longitude	174.560608	
Magnetic declination	20.2222			
Average direction	195.6 deg	Average speed	1.15 m/s	
Max Depth Below Surface	17.14 m			
Upper layer depth	8.67 m			
Middle layer depth	11.50 m			
Lower layer depth	14.32 m			
User id	CCAA9622-A3B4-42DD-8E45-DCF58FF1FB28			
Data id	144D9F43-B5F1-4ADB-A0AB-FF52F18578B3			
Created	24/03/2023, 8:11:11 pm			
Processor version	1.0.22.0			
Processed	24/03/2023, 8:25:44 pm			

Statistics (for Report Date Range only)

		Upper	Middle	Lower	Unit
Speed	Mean	1.26	1.17	1.02	m/s
	Max	2.09	1.98	1.73	m/s
	Min	0.09	0.08	0.10	m/s
	Std. dev	0.55	0.50	0.42	m/s
	Mean	Max	Min	Std. dev	Unit
Temperature	20.7	28.2	19.9	1.5	°C
Pressure	12.6	17.1	0.0	6.2	m
Tilt	9.3	73.9	1.2	15.1	deg

Location

Deployment location: Latitute -37.036148 and Longitude 174.560608.



Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

Figures

Polar Scatter Plots

These plots show the current speed and direction in a polar coordinate graph (North at the top, 0°) for each of the three depth layers. Data is shown for the Report Date Range. The numbers on the outside of the graph indicate the direction the current is flowing towards for that layer. For example, if a dot is plotted along the 40° line, then it indicates current flowing towards the Northeast. The distance away from the center of the graph indicates how fast the current is flowing: the closer to the center, the slower the water is moving.



Histogram of Speed

These plots indicate the distribution of current speed for each of the three depth layers. The graph is generated by first taking the current speed data from the Report Date Range and dividing it into intervals of equal size. Then, the number of samples (i.e. an individual measurement interval) in each interval is counted. The numbers on the bottom (X-axis) indicate the speed intervals. The numbers on the left (Y-axis) indicate the number of samples in each interval. For example, if the highest bar on the graph is from the 0.3-0.4 m/s range, then that means that the current speed in this range happens more often than any other speed in the Report Date Range.





5

0



Histogram of Direction

These plots indicate the distribution of current direction for each of the three depth layers. The graph is generated by first taking the current direction data from the Report Date Range and dividing it into ranges of equal size. Then, the number of samples (i.e. an individual measurement interval) in each range is counted. The numbers on the bottom (X-axis) indicate the direction ranges. The numbers on the left (Y-axis) indicate the number of samples in each range. For example, if the highest bar on the graph is from the 90-120° range, then that means that the current direction in this range happens more often than any other direction during the Report Date Range.





deg

Speed/Direction Occurence Frequency

These plots combine the speed and direction histograms to show the occurrence frequency of current speed and direction for each of the three depth layers in a cartesian coordinate graph. Data is shown for the Report Date Range. The numbers on the left (Y-axis) indicate the current's speed while the numbers along the lower (X-axis) indicate the direction the current is flowing towards. The color of each block inside the graph indicates the occurrence frequency of that particular speed/ direction combination, scaled by the color bar on the bottom. For example, if the block with the darkest color is the intersection of 270° and 0.3 m/s, then that means that the currents are moving at this speed and direction more often than any other speed/direction.



0 2 4 6 8 10 12 14 16 18 20 22 24

Direction and Maximum Speed

Similar to the Polar Scatter plots, these plots show the current speed and direction in a polar coordinate graph (North at the top; 0°) for each of the three depth layers. However, here only the maximum current speed, and its corresponding direction, are shown. The data are plotted as bars extending from the center of the graph. For example, if the longest bar (the one extending the farthest from the center of the graph) is at 270°, then that means the highest current speed was measured along this direction for this particular depth layer.





Direction and Mean Speed

Similar to the Polar Scatter plots, these plots show the current speed and direction in a polar coordinate graph (North at the top; 0°) for each of the three depth layers. However, here only the mean current speed, and its corresponding direction, are shown. The data are plotted as bars extending from the center of the graph. For example, if the longest bar (the one extending the farthest from the center of the graph) is at 180°, then that means the mean (average) current speed was measured along this direction for this particular depth layer.



Direction and Flow

These plots show the average volume of water per day (flow) over the cross sectional area of the acoustic cone above the instrument. Data has units of m³/m²/day (cubic meter per square meter per day). The data are plotted as bars extending from the center of the graph. For example, if the longest bar (the one extending the farthest from the center of the graph) is at 320°, and the distance from the center of the graph is along the 10,000 inner circle, that means that an average of 10,000 m3 of water per day flows across the acoustic cone of the instrument for that particular depth layer.



Enviroment

Three plots provide details about the environment over time (i.e. a time-series). These include: water temperature, water pressure (depth) and instrument tilt angle. Data is shown for the Report Date Range. The number on the bottom (X-axis) indicate the date/time while the numbers of the left (Y-axis) indicate the respective data value.





Sampling location plan - Bar Area (west)





Sampling location plan - Central Area





Sampling location plan - Upper harbour Area (east)



Sample photographs
1.02.JPG

1.04.JPG



1.01.JPG





1.06.JPG

1.08.JPG



1.05.JPG





1.10.JPG

1.12.JPG



1.09.JPG



7 8

6

Distance (mm)



1.14.JPG

1.16.JPG



1.13.JPG





1.18.JPG



1.17.JPG





2.04.JPG

2.06.JPG



2.03.JPG





2.08.JPG

3.01.JPG



2.07.JPG





Distance (mm)



(m) ourging Distance (mm)

3.03.JPG

3.05.JPG



3.02.JPG





3.07.JPG



3.06.JPG





4.02.JPG

4.04.JPG



4.01.JPG





4.06.JPG



4.05.JPG





5 10 15 20 25 30 Distance (mm)



1 2 3 4 5 6 7 8 5 10 Distance (mm)



Distance (mm)



5.02.JPG

5.05.JPG



5.01.JPG





5.07.JPG





5.06.JPG





Non-Routine, Experiment. Job: 3289872



Job Number	3289872	Client Reference:	Manukau	Port
Client	Tonkin & Taylor		Contact:	Hayley Jones
Description	Photos of Density samples	for client		
Analyst	Gina McNamara	Date:	21/06/202	23

Scope:

Take photos of each sample for client, so a visual comparison can be made for each sample and it's density result.

Methodology:

As each sample is measured for density, a separate portion is placed on a foil tray and photographed.

Results:



Sample 5.10 - 3289872.1 - contains bivalve shellfish, mud and sand



Sample 5.11 - 3289872.2 - contains pieces of shell, and mud

Appendix No.2 - Density sample photos for 3289872 - Page 2 of 3

Non-Routine, Experiment. Job: 3289872





Sample 5.12 - 3289872.3- contains a lot of large univalve shells, periwinkles, pieces of shell and mud



Sample 5.09 - 3289872.4 – contains a lot of small univalve shells, periwinkles, pieces of shell and mud



Sample 5.13 - 3289872.5 - contains pieces of shell, find sand, mud and free water

Appendix No.2 - Density sample photos for 3289872 - Page 3 of 3

Non-Routine, Experiment. Job: 3289872





Sample 5.08 - 3289872.6 – contains small pieces of shell, fine sand and mud

Particle Size Distribution (PSD) testing

PSD sampling results summary

																																								Laser	Weighted
Sample Name	0.05	0.06	0.12 0.3	24 0.49	0.98	3 2	3.9	7.8 15	.6 31	37 4	4 53 63	3 74 8	3 105	125	149	177	210	250 30	00 350	420	500	590	710 840	1000	1190	1410	1680	2000 238	30 2830	3360	Dx (10)	Dx (50)	Dx (90)	D [4,3]	D [3,2]	Kurtosis	Skew	Mode	Span	Obscuratio	Residual Residua
1.01 SC1	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.2	2 1.3 4.8	3 12.3	23.5	38.3	54.3	69.4 8	81.8 90	.7 94.9	96.8	97.2	97.2	97.2 97.2	97.3	97.7	98.2	98.8	99.3 99	.6 99.9	100.0	101.0	169.0	295.0	222.0	159.0	44.5	6.2	166.0	1.2	16.0	0.2 0.3
1.02 SC2	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.1	0.8 3.	5 10.1	20.9	36.0	52.9	69.5 8	3.2 93	.1 97.8	99.7	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	105.0	172.0	280.0	184.0	160.0	0.6	0.8	173.0	1.0	12.1	0.2 0.2
1.03 SC3	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.1	2 1.5	5.5	14.8	29.1	46.9 6	6.1 83	.0 93.0	98.7	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	138.0	216.0	333.0	226.0	203.0	-0.1	0.6	218.0	0.9	15.9	0.4 0.4
1.04 SC4	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	3 2.5	8.0	19.2	35.1	53.4	1.4 86	.3 94.4	98.7	99.9	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	130.0	204.0	319.0	216.0	192.0	0.5	0.8	204.0	0.9	17.0	0.4 0.4
1.05 SC5	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0		0.2	1.4	5.5	13.8	26.2 4	3.1 62	.1 /6.8	89.6	97.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	166.0	267.0	423.0	282.0	250.0	-0.1	0.6	2/1.0	1.0	13.7	0.6 0.6
1.06 506	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	0.0 0.0 0.0		0.3	1./	5.7	13.0	23.5	67.4 53	.1 05.9	/8.5	87.4	92.9	96.1 97.5	98.1	98.5	98.8	99.2	99.5 99	.8 99.9	100.0	167.0	289.0	537.0	343.0	269.0	32.8	4.7	280.0	1.3	14.5	0.3 0.4
1.07 507	0.0	0.0	0.0 0	.0 0.0		0.0	0.0	0.0 0	0.0	0.0 0.	0 0.0 0.0			0.0	0.5	2.8	0.0	27 38	.2 33.1	/3.0	87.3	95.3	70.4 00.0	100.0	100.0	100.0	100.0	100.0 100	0 100.0	100.0	213.0	334.U E21.0	523.U 940.0	304.0	310.0	0.0	0.8	534.0	1.0	23.1	0.3 0.4
1.00.500	0.0	0.0	0.0 0	0 0.0		0.0	0.0	0.0 0	0.0	0.0 0.				0.0	0.0	2.6	10.1	2.7 0	1 567	7/ 0	40.0	02.4	00 2 100 0	100.0	100.0	100.0	100.0	100.0 100	0 100.0	100.0	200.0	220.0	516.0	249.0	210.0	-0.1	0.0	220.0	0.0	10.1	0.0 0.0
1.09.309	0.0	0.0	0.0 0	0 0.0			0.0	0.0 0	0 0.0	0.0 0.				0.0	0.7	0.0	0.0	0.4 2	2 60	1/4.0	27.2	12.0	50.8 7/1.8	87.1	05.2	00.0	100.0	100.0 100	0 100.0	100.0	207.0	6/1.0	1060.0	684.0	50/ 0	0.2	0.7	6/3.0	1.0	13.0	0.7 0.7
1.10.5010	0.0	0.0	0.0 0	0 0.0		0.0	0.0	0.0 0	0 0.0	0.0 0.				0.0	1.3	3.8	8.5	6.3 27	4 38 6	53.1	66.7	78.0	87.7 93.8	97.5	99.2	99.9	100.0	100.0 100	0 100.0	100.0	218.0	404.0	749.0	451.0	363.0	1.8	1.2	404.0	1.0	12.4	0.7 0.7
1.17.5011	0.0	0.0	0.0 0	0 00	0.0	0.0	0.0	0.0 0	0 0.0	0.0 0.			0.0	0.2	0.0	0.2	1.3	5.9 15	8 28 6	47.8	66.4	81.3	92.2 97.5	99.6	100.0	100.0	100.0	100.0 100	0 100.0	100.0	275.0	429.0	675.0	456.0	405.0	0.8	0.9	426.0	0.9	13.1	0.0 0.5
1.13 SC12	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	0 0.0 0.0	0.0 0.0	0.3	1.9	6.6	15.3	28.1 4	4.8 63	4 77.6	89.9	97.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	162.0	263.0	421.0	278.0	245.0	-0.1	0.6	267.0	1.0	14.5	0.3 0.3
1.14 SC13	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	0.0	0.0	0.0	0.0	0.3	2.1 7	.2 15.1	29.5	46.6	63.5	80.0 91.2	98.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	319.0	517.0	823.0	546.0	482.0	-0.2	0.6	523.0	1.0	16.4	0.5 0.5
1.15 M.Heads																													-												
outer Bar #1	0.0	0.0	0.0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.1 0.9	3.9	10.1	20.8	34.8	50.6	6.3 80	.2 88.7	94.2	96.5	97.0	97.1 97.1	97.2	97.7	98.3	98.9	99.4 99	.7 99.9	100.0	125.0	209.0	363.0	262.0	196.0	39.7	5.8	206.0	1.1	17.9	0.3 0.3
1.16																				1																					
Manukau	0.0	0.0	0.0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	0.0	0.4	1.9	5.4	11.5	1.7 35	.4 48.7	64.6	78.0	88.0	95.1 98.6	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	202.0	355.0	618.0	386.0	324.0	0.5	0.9	358.0	1.2	15.3	0.4 0.4
1.17 M.Heads																																									
Inner Bar #3	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	0.3	1.5	5.5	12.9	23.9	8.7 55	.6 69.3	82.4	91.4	96.6	99.1 99.9	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	167.0	283.0	484.0	307.0	262.0	1.2	1.0	280.0	1.1	17.0	0.3 0.3
1.18 M.Heads																																									
Inner Bar #4	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	0.0	0.0	0.0	0.1	0.9	4.5 12	.8 24.0	41.9	60.4	76.5	89.5 96.7	99.8	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	285.0	453.0	717.0	479.0	426.0	0.0	0.7	454.0	1.0	16.9	0.4 0.5
2.01 52	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0		0.4	2.0	6.5	14.6	26.5 4	2.0 59	.5 /3.4	86.1	94.2	98.3	99.8 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	163.0	2/2.0	450.0	292.0	252.0	0.7	0.9	2/3.0	1.1	13.5	0.3 0.4
2.02 2-300E	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	0.0 0.0 0.0		0.0	0.2	1.3	4.4	10.2 4	0.1 33	.9 47.5	03.8	11.8	88.2	95.5 99.1	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	209.0	360.0	614.U	388.0	330.0	0.3	0.8	363.0	1.1	13.4	0.4 0.4
2.03 2-300 1	0.0	0.0	0.0 0	0 0.0		0.0	0.0	0.0 0	0.0	0.0 0.	0 0.0 0.0			2.0	1.4	0.Z	12.0	0.0 27	2 25 /	/4.4	56.0	94.7	74.5 91.7	97.6	02.1	05.2	07.5	00.0 100	5 00.0	100.0	199.0	323.0 451.0	1000.0	540.0	270.0	0.7	2.0	323.0	2.0	12.7	0.4 0.4
2.04 2-0003	0.0	0.0	0.0 0	0 0.0			0.0	0.0 0	0 0.0	0.0 0.			0.0	2.0	4.2	12.0	25.1	1.7 60	1 74 8	97.6	05.3	03.2	00 0 100 0	100.0	100.0	100.0	100.0	70.0 77 100.0 100	0 100 0	100.0	168.0	271.0	/130.0	200.0	254.0	0.7	2.0	270.0	1.0	14.7	0.4 0.4
2.06 \$2-300\$	0.0	0.0	0.0 0	0 00	0.0	0.0	0.0	0.0 0	0 0.0	0.0 0.	0 00 00		0.1	0.0	0.5	1.9	5.0	1.0 20	4 30 6	45.0	59.4	72.4	84.3 92.3	97.4	99.7	100.0	100.0	100.0 100	0 100.0	100.0	244.0	446.0	795.0	487.0	401.0	0.3	0.8	454.0	1.0	8.3	0.4 0.4
2.07 SS14	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	0.0	0.0	0.1	0.9	3.5	0.2 21	.9 35.3	53.8	71.0	84.5	94.3 99.1	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	249.0	405.0	646.0	428.0	378.0	0.0	0.7	409.0	1.0	13.4	0.4 0.4
2.08 SS15	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.1 0	.3 0.6	0.7 0.	.7 0.7 0.7	7 0.7 0.1	7 1.3	3.1	7.3	14.2	23.5	35.4 48	.6 59.4	70.5	78.9	84.8	89.1 91.6	93.4	94.8	96.0	97.2	98.2 99	.1 99.6	100.0	161.0	306.0	747.0	424.0	248.0	14.1	3.4	280.0	1.9	21.3	0.3 0.3
2.09 SS16	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.0	0.0	0.0	0.0	0.1	0.8	3.2 8	.2 14.9	26.4	39.8	53.6	68.4 79.8	88.7	94.6	98.1	99.7	100.0 100	.0 100.0	100.0	315.0	565.0	1030.0	627.0	514.0	1.0	1.1	559.0	1.3	9.5	0.5 0.5
3.01 SS17	0.0	0.0	0.0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.	1 1.1	5.2	15.4	31.6	51.5	1.6 87	.7 95.8	99.4	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	138.0	207.0	309.0	217.0	198.0	0.1	0.7	208.0	0.8	14.9	0.4 0.5
3.02 SS18	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.	1 1.0	4.5	13.3	27.5	45.6 6	5.2 82	.7 92.9	98.7	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	142.0	218.0	334.0	229.0	206.0	-0.1	0.6	220.0	0.9	18.2	0.5 0.6
3.03 SS19	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.1	2 1.9	7.0	18.5	35.4	55.3	4.5 89	.6 97.1	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	132.0	201.0	302.0	210.0	191.0	-0.2	0.6	202.0	0.8	18.4	0.5 0.5
3.04 SS20	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.1	3 2.5	8.7	21.7	39.7	60.0	8.3 91	.8 97.9	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	128.0	193.0	291.0	202.0	184.0	-0.1	0.6	194.0	0.8	18.8	0.6 0.6
3.05 \$\$21	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.0 0	.0 0.0	0.0 0.	.0 0.0 0.0	0.0 0.1	2 1.8	6.6	17.0	32.5	51.0 6	9.8 85	.6 94.4	99.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	134.0	208.0	322.0	219.0	197.0	0.0	0.7	209.0	0.9	15.6	0.5 0.5
3.06 \$\$22	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.0	0.2 0	./ 1.0	1.0 1.	0 1.0 1.0		1 2.2	5.9	15.1	29.0	4/.9 0	07.4 84	.2 93.8	98.9	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	137.0	214.0	327.0	223.0	1/3.0	0.2	0.4	216.0	0.9	14.3	0.3 0.3
3.07 3323	0.0	0.0	0.0 0	0 0.0		0.0	0.0	1.0 0	5 5 0	6.6 7	2 70 0.0		1 1.4	0.4 1/1 1	14.0	28.8	40.7 0	00.9 83	4 495	98.7	56.0	50.0	62.0 66.0	60.7	74.1	70.0	94.4	90.7 04	5 07 0	00.7	138.0	210.0	2020.0	762.0	204.0	-0.1	0.0	219.0	5.2	6.2	0.4 0.4
3.00 5524	0.0	0.0	0.0 0	0 0.0	0.0	0.0	0.0	0.0 0	2 03	0.0 7.	3 03 03	2 03 0	5 1.5	5.1	11.3	20.0	30.4	16 52	2 59 5	65.6	69.7	72.6	75.7 78.6	82.0	85.6	89.1	92.4	95.2 97	5 990	99.9	145.0	288.0	1480.0	564.0	261.0	3.8	2.0	231.0	4.6	10.2	0.5 0.5
4 01 1A	0.0	0.0	0.0 0	0 00) 12	27	6.0	11 7 17	9 24 0	25.4 26	8 28 1 29 4		38.3	44.3	51.9	60.2	68.4	5 9 82	3 86.5	89.9	92.3	94.2	96.0 97.4	98.7	99.5	99.9	100.0	100.0 100	0 100 0	100.0	6.5	143.0	423.0	191.0	16.1	6.8	2.0	177.0	2.9	25.7	0.3 0.2
4.02 1B	0.0	0.0	0.0 0	.0 0.1	3.9	9 8.6	17.7	32.7 49	.6 65.5	69.3 72.	9 76.3 79.1	81.4 83.	5 85.6	87.6	89.6	91.7	93.8	5.7 97	.5 98.7	99.6	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	2.3	15.9	154.0	48.9	5.8	7.0	2.6	9.9	9.5	15.2	0.7 0.4
4.03 1C	0.0	0.0	0.0 0	.0 0.0) 1.3	3 3.0	6.3	11.7 17	.4 23.3	24.8 26.	1 27.4 28.5	5 29.8 31.9	35.3	40.1	46.6	54.0	61.8 6	9.2 75	.9 80.5	84.4	87.3	89.6	91.9 93.8	95.6	97.0	98.2	98.9	99.4 99	.8 99.9	100.0	6.4	162.0	610.0	254.0	15.6	13.0	3.1	192.0	3.7	24.5	0.3 0.2
4.04 1D	0.0	0.0	0.0 0	.0 0.0	1.8	3 4.0	8.4	15.6 23	.9 32.7	34.9 36.	.9 38.9 40.8	3 42.9 46.0	50.5	56.3	63.4	70.8	78.0 8	34.2 89	.1 92.1	94.2	95.5	96.4	97.4 98.3	99.1	99.6	99.9	100.0	100.0 100	.0 100.0	100.0	4.7	103.0	312.0	145.0	11.7	12.2	3.0	167.0	3.0	22.1	0.4 0.2
4.05 1 E																						She	elly																		
4.06 1F	0.0	0.0	0.0 0	.0 0.0	0.0	0.0	0.8	2.3 4	.0 5.6	5.7 5.	.7 5.7 5.7	7 5.9 7.0	0 10.9	18.8	31.6	47.1	62.9	6.2 85	.7 90.0	91.8	92.1	92.1	92.2 92.8	93.9	95.3	96.7	97.9	98.8 99	.5 99.8	100.0	102.0	182.0	350.0	279.0	77.0	17.3	3.9	180.0	1.4	12.9	0.4 0.4
4.07 1G	0.0	0.0	0.0 0	.0 0.0	0.1	1 0.2	1.2	3.0 5	.1 7.2	7.7 8.	.0 8.1 8.1	8.3 9.1	1 11.4	15.4	21.8	29.7	38.7 4	8.0 57	.0 63.5	69.6	74.2	77.8	81.3 84.2	87.2	89.9	92.5	94.8	96.7 98	.3 99.3	99.9	95.9	260.0	1190.0	467.0	64.9	6.0	2.4	216.0	4.2	22.2	0.3 0.3
4.08 1H	0.0	0.0	0.0 0	.0 0.0) 1.1	1 2.5	5.6	11.5 18	.2 25.0	26.7 28.	.0 29.0 29.7	7 30.5 32.2	2 35.9	41.9	50.9	61.7	73.0 8	3.5 91	.9 96.7	99.4	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	6.7	147.0	286.0	144.0	16.4	-0.7	0.3	189.0	1.9	17.2	0.4 0.3
5.01 2A	0.0	0.0	0.0 0	.0 0.0	2.6	5.6	11.3	20.7 30	.9 42.2	45.5 48.	.9 52.4 55.5	58.4 61.	65.8	/0.8	//.0	83.6	90.1 9	95.3 98	.8 100.0	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	3.5	46./	210.0	81.8	8./	-0.2	0.9	1/1.0	4.4	20.2	1.4 1.3
5.02 2B	0.0	0.0	0.0 0	.0 0.0	2.9	0.4	13.1	24.1 30	.0 48.7	52.0 50.	7 01.2 05.2	2 68.7 72	/ /5.5	/8.8	82.4	80.2	90.0	3.7 96	.8 98.7	99.8	100.0	45.4	F2 F (0.0	100.0	74.0	100.0	100.0	01.5 05	.0 100.0	00.0	3.0	32.9	210.0	/1.3	7.0	2.1	1.0	47.5	0.3	17.8	0.5 0.2
5.03.20	0.0	0.0	0.0 0	.0 0.0	0.2	0.3	1.1	∠.0 4 10.0 20	0 /0./	1.2 1.	7 10 6 51	9.0 9.4	+ 9.9	10.6	11.0	13.1	10.1	7.7 ZI	.0 25.9	04 4	38.5 07.0	43.4	00.4 00.7	00.0	100.0	81.U	öö./	71.0 95 100.0 100	0 100 0	99.8	2 4	000.U	1090.0	049.U	/4.3 0 E	1.U 6.1	1.2	102.0	2.7	20.1	0.5 0.4
5.04 2D	0.0	0.0	0.0 0	0 0.0	2.0) 22	5.2	10.6 17	0 40.1	43.0 45. 24.8 24	3 277 200	30.0 31	5 2/1 0	04.Z	42.2	10.0 48.1	54.7	14 49	0 720	77.9	97.9 81.9	90.7 85.2	88.7 01.4	99.9	0.001	97.0	98.0	99.5 00	8 100.0	100.0	3.0	30.0 186.0	207.U 762.0	207.0	9.0 17.0	7.6	2.1	216.0	4.9	20.0	0.4 0.3
5.06.2E	0.0	0.0	0.0 0	0 0.0	1.0) 2.3	4.9	9.6 15	3 21 /	27.0 20.	9 24 6 25 1	26.0 28	37.0	40.5	51.4	64.0	76.7 9	7.6 05	5 99 2	100.0	100.0	100.0	100.0 100.0	100.0	100.4	100.0	100.0	100.0 100	0 100.0	100.0	8.2	146.0	262.0	141.0	18.6	-0.8	0.1	179.0	17	21.7	0.5 0.2
5.07 2G	0.0	0.0	0.0 0	.0 0.0	1.6	3 4.3	9.1	17.0 26	.5 37.8	41.1 44	2 47.4 50.2	2 52.8 55.8	3 59.6	64.1	69.8	75.9	82.2	8.0 92	.9 96.0	98.3	99.4	99.9	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	4.3	62.3	268.0	106.0	10.7	1.3	1.3	183.0	4.2	18.0	0.4 0.3
5.08	0.0	0.0	0.0 0	.0 0.0) 1.4	1 3.0	6.2	11.4 17	.0 23.7	25.6 27.	4 29.1 30.6	32.5 35.	5 40.7	48.2	58.2	69.3	80.1 8	9.3 96	.0 99.2	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	6.6	129.0	254.0	128.0	15.3		-		<u> </u>		
5.09	0.0	0.0	0.0 0	.0 0.0	2.3	3 5.1	10.7	20.2 30	.8 41.4	44.3 47.	2 50.4 53.6	56.7 60.	64.9	69.6	74.7	79.6	84.2 8	8.0 91	.2 93.1	94.7	95.9	96.8	97.8 98.6	99.3	99.8	100.0	100.0	100.0 100	.0 100.0	100.0	3.7	51.8	279.0	116.0	9.3						
5.1	0.0	0.0	0.0 0	.0 0.0	0.0	0.2	1.3	3.2 5	.0 7.1	7.5 7.	.5 7.5 7.5	7.5 7.	7 9.6	15.3	28.4	47.4	68.4 8	35.9 97	.0 94.7	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	108.0	181.0	263.0	179.0	60.5				N	٨	
5.11	0.0	0.0	0.0	.0 0.0	1.6	5 3.6	7.6	14.3 21	.3 28.4	29.8 31.	.3 32.8 34.6	37.0 41.0	47.2	55.2	65.0	75.1	84.4	91.7 96	.9 95.9	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	5.1	112.0	238.0	115.0	12.8				IN.	л	
5.12	0.0	0.0	0.0 0	.0 0.0	2.1	4.8	10.3	19.4 29	.2 38.7	41.2 43.	.6 46.2 48.6	5 51.1 54.4	4 58.8	64.2	70.6	77.5	84.1	0.0 94	.7 97.4	99.1	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	3.8	69.0	250.0	102.0	9.8						
5.13	0.0	0.0	0.0 0	.0 0.0	1.0	2.2	4.8	9.4 14	.5 20.4	21.9 23.	.2 24.5 26.1	28.4 32.0	39.6	49.0	60.6	72.5	83.3	1.7 97	.3 99.7	100.0	100.0	100.0	100.0 100.0	100.0	100.0	100.0	100.0	100.0 100	.0 100.0	100.0	8.4	127.0	239.0	127.0	18.8						



Measurem	nent Details				Meas	urement Detai	ls			
	Sam	ple Name 1.	01 SC1				Analysis Date Ti	ne 13/06/202	23 12:08:10 PM	
	SOP	File Name Se	ediment.msop			Mea	asurement Date Ti	ne 13/06/202	23 12:08:10 PM	
	La	b Number 2	023133/1				Result Sou	r ce Measuren	nent	
	Opera	tor Name ro	dgers							
Analysis					Resul	t				
	Part	icle Name Se	ediment				Concentrati	on 0.3582 %		
	Particle Refrac	tive Index 1.	500				Sp	an 1.151		
	Particle Absorp	tion Index 0.	200				Uniform	ity 0.570		
	Dispers	ant Name W	ater				Specific Surface A	ea 37.78 m²/	kg	
	Dispersant Refrac	tive Index 1.	330				D [3	,2] 159 μm		
	Scatter	i ng Model M	ie				D [4	,3] 222 μm		
	Analy	vsis Model G	eneral Purpose				Dv (1	l 0) 101 μm		
	Weighte	d Residual 0.	24 %				Dv (5	50) 169 μm		
	Laser Ol	oscuration 15	5.99 %				Dv (9	90) 295 μm		
							Dv (9	95) 351 μm		
						Ve	olume Below (31) µ	um 0.00 %		
Frequency	(compatible)									
15	1								L	
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Volume Density (
0-	· · · · · · ·						,,,,,,			
0.	01	0.1	1.0)	10.0		100.0	1,0	0.00	10,000.0
				[141] 1.01	Size Classes (µ SC1-13/06/2023 12:0	m) B:10 PM				
Result										
Size (µn	n) % Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	
0.050	0.00	7.80	0.00	88.0	4.79	350	94.91	1410	98.22	
0.060	0.00	15.6	0.00	105	12.28	420	96.76	1680	98.77	
0.12	0.00	31.0	0.00	125	23.49	500	97.15	2000	99.26	

0.0000	0.00	15.0	0.00	105	12.20	420	50.70	1000	50.77	
0.120	0.00	31.0	0.00	125	23.49	500	97.15	2000	99.26	
0.240	0.00	37.0	0.00	149	38.34	590	97.17	2380	99.63	
0.490	0.00	44.0	0.00	177	54.28	710	97.17	2830	99.86	
0.980	0.00	53.0	0.00	210	69.43	840	97.18	3360	99.98	
2.00	0.00	63.0	0.18	250	81.78	1000	97.34			
3.90	0.00	74.0	1.27	300	90.66	1190	97.72			



Malvern Instruments



Measure	ement Details					Measur	ement Details				
	Sam	ple Name 1.02 SC	2				Ana	lysis Date Tin	1e 13/06/2023 1	12:19:39 PM	
	SOP	File Name Sedime	ent.msop				Measurer	nent Date Tin	ne 13/06/2023 1	12:19:39 PM	
	La	b Number 20231	33/2					Result Sour	ce Measuremen	ıt	
	Opera	ator Name rodger	S								
	•										
Analysis		tala Na wa Castina				Result		.	0.000.0/		
	Part De stiele De for	icie Name Sedime	ent					Concentratio	on 0.2689 %		
	Particle Refrac							Spa Line: Communit	an 1.019		
	Particle Absorp						C		ty 0.312		
	Dispers	sant Name water					Speci	nic Surface Are	ea 37.42 m ⁻ /kg		
	Dispersant Refrac							D [3,	2] 160 μm		
	Scatter	Ing Model Mie						D [4,	3] 184 μm		
	Analy	vsis Model Genera	il Purpose					Dv (1	0) 105 μm		
	Weighte	d Residual 0.21 %						Dv (5	0) 172 μm		
	Laser O	bscuration 12.14 9	6					Dv (9	υ) 280 μm		
								Dv (9)	5) 315 μm		
							Volume	Below (31) μ	m 0.00 %		
Frequen	cy (compatible)										
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				[1/2] 1 02	Size Clas	ses (µm)	9 DM				
				[1-12] 1.02	JCE 13,00,202	10 12.10.0	5 1 101				
Result											
Size (µ	um) % Volume Under	Size (µm) % V	olume Under	Size (µm)	% Volume l	Jnder	Size (µm) % Vo	olume Under	Size (µm) %	Volume Under	
0.0	500 0.00	7.80	0.00	88.0		3.51	350	97.76	1410	100.00	
0.00	0.00	15.6	0.00	105		10.13	420	99.65	1680	100.00	
0.1	0.00	31.0	0.00	125		20.85	500	99.99	2000	100.00	
0.2	240 0.00	37.0	0.00	149		35.97	590	100.00	2380	100.00	
0.4	490 0.00	44.0	0.00	177		52.89	710	100.00	2830	100.00	



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63.0

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0.76

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69.45

83.21

93.11

840

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1190

100.00

3360

100.00

100.00



Measureme	nt Details				Ν	Measurer	ment Details				
	Sam	ple Name 1.0)3 SC3					Analysis Date Tin	ne 13/06/202	3 4:01:12 PM	
	SOP	File Name Se	diment.msop				Meas	surement Date Tin	ne 13/06/202	3 4:01:12 PM	
	Lal	b Number 20)23133/3					Result Sour	ce Measurem	ient	
	Opera	tor Name roo	dgers								
	•		5								
Analysis					R	Result					
	Part	icle Name Se	diment					Concentratio	on 0.4555 %		
	Particle Refrac	tive Index 1.5	500					Spa	an 0.904		
	Particle Absorpt	tion Index 0.2	200					Uniformi	ty 0.276		
	Dispers	ant Name Wa	ater				S	pecific Surface Ar	ea 29.54 m²/l	kg	
	Dispersant Refrac	tive Index 1.3	30					D [3,	2] 203 μm		
	Scatteri	i ng Model Mi	e					D [4,	3] 226 μm		
	Analy	vsis Model Ge	neral Purpose					Dv (1	0) 138 μm		
	Weightee	d Residual 0.3	85 %					Dv (5	0) 216 μm		
	Laser Ob	oscuration 15	.88 %					Dv (9	0) 333 μm		
								Dv (9	5) 369 μm		
							Vol	ume Below (31) µ	m 0.00 %		
Frequency (compatible)										
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					Size Class	es (µm)					
				[143] 1.03	SC3-13/06/2023	3 4:01:12 PI	М				
Recult											
Size (um)	% Volume Under	Size (µm)	% Volume Under	Size (um)	% Volume U	nder	Size (um)	% Volume Under	Size (um)	% Volume Under	
0.0500	0.00	7.80	0.00	88.0		0.16	350	93.01	1410	100.00	
0.0600	0.00	15.6	0.00	105		1.48	420	98.70	1680	100.00	
0.120	0.00	31.0	0.00	125		5.50	500	100.00	2000	100.00	
0.240	0.00	37.0	0.00	149	1	14.75	590	100.00	2380	100.00	
0.490	0.00	44.0	0.00	177	2	29.05	710	100.00	2830	100.00	
0.980	0.00	53.0	0.00	210	4	16.94	840	100.00	3360	100.00	
2.00	0.00	63.0	0.00	250	6	6.06	1000	100.00			
3.90	0.00	74.0	0.00	300	8	33.03	1190	100.00			



Malvern Instruments



Measureme	nt Details					Measur	ement Details	5			
	Sam	ple Name 1.04 SC	4					Analysis Date Tin	ne 13/06/202	3 4:07:40 PM	
	SOP	File Name Sedime	ent.msop				Meas	surement Date Tin	ne 13/06/202	3 4:07:40 PM	
	Lal	b Number 20231	33/4					Result Sour	ce Measurem	ient	
	Opera	tor Name rodger	S								
Analysis						Result					
	Part	icle Name Sedime	ent					Concentratio	on 0.4632 %		
	Particle Refrac	tive Index 1.500						Spa	n 0.930		
	Particle Absorpt	tion Index 0.200						Uniformi	ty 0.287		
	Dispers	ant Name Water					S	pecific Surface Are	a 31.22 m²/l	۲q	
	Dispersant Refract	tive Index 1.330						D [3,	2] 192 μm		
	Scatteri	i ng Model Mie						D [4,	3] 216 μm		
	Analy	rsis Model Genera	l Purpose					Dv (1	0) 130 μm		
	Weighted	d Residual 0.39 %						Dv (5	0) 204 μm		
	Laser Ob	oscuration 16.96 9	6					Dv (9	0) 319 μm		
								Dv (9	5) 356 μm		
							Vo	lume Below (31) μ	m 0.00 %		
Frequency (compatible)										
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0.01		0.1	1.0		10	0.0		100.0	1,00	0.0	10,000.0
				— [144] 1.04	Size Class SC4-13/06/202	ses (µm) 3 4:07:40	PM				
Pocul+											
Size (um)	% Volume Under	Size (um) % V	olume Under	Size (um)	% Volume I	Inder	Size (um)	% Volume Under	Size (um)	% Volume Under	
0.0500		7.80		88 0	, s volume c	0.33	3120 (μ11)	94 42	1410	100.00	
0.0600	0.00	15.6	0.00	105		2.45	420	98.66	1680	100.00	
0.120	0.00	31.0	0.00	125		8.00	500	99.86	2000	100.00	
0.240	0.00	37.0	0.00	149		19.22	590	100.00	2380	100.00	
0.490	0.00	44.0	0.00	177		35.05	710	100.00	2830	100.00	
0.980	0.00	53.0	0.00	210		53.41	840	100.00	3360	100.00	
2 00	0.00	63.0	0.00	250		71 43	1000	100.00			



3.90

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Malvern Instruments



Measureme	nt Details					Measur	ement Details				
	Sam	ple Name 1.05 SC	5				A	Analysis Date Tim	e 14/06/202	3 8:20:57 AM	
	SOP	File Name Sedime	nt.msop				Measu	rement Date Tim	e 14/06/202	3 8:20:57 AM	
	Lal	b Number 20231	33/5					Result Sourc	e Measurem	nent	
	Opera	tor Name rodger	5								
Analysis						Result					
7 mary 515	Part	icle Name Sedime	nt			Result		Concentratio	n 0.4746 %		
	Particle Refrac	tive Index 1.500						Spa	n 0.962		
	Particle Absorpt	tion Index 0.200						Uniformit	v 0.294		
	Dispers	ant Name Water					Spe	ecific Surface Are	a 24.04 m²/l	kg	
	Dispersant Refrac	tive Index 1.330					•	D [3,2	2] 250 µm	5	
	Scatteri	i ng Model Mie						D [4,3	3] 282 μm		
	Analy	rsis Model Genera	l Purpose					Dv (10) 166 μm		
	Weighted	d Residual 0.55 %						Dv (50)) 267 μm		
	Laser Ob	oscuration 13.67 %	, >					Dv (90)) 423 µm		
								Dv (95	5) 470 μm		
							Volu	me Below (31) μr	n 0.00 %		
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0.01		0.1	1.0		10 Size Clear	.0		100.0	1,00	0.0	10,000.0
				[145] 1.05	SC5-14/06/202	3 8:20:57	AM				
Result											
Size (µm)	% Volume Under	Size (µm) % V	olume Under	Size (µm)	% Volume L	Inder	Size (µm) %	Volume Under	Size (µm)	% Volume Under	
0.0500	0.00	7.80	0.00	88.0		0.00	350	76.79	1410	100.00	
0.0600	0.00	15.6	0.00	105		0.17	420	89.63	1680	100.00	
0.120	0.00	31.0	0.00	125		1.37	500	97.01	2000	100.00	
0.240	0.00	37.0	0.00	149		5.53	590	99.99	2380	100.00	
0.490	0.00	44.0	0.00	177		13.75	710	100.00	2830	100.00	
2 00	0.00	53.U 63.0	0.00	210 250		20.24 43 12	840 1000	100.00	3360	100.00	



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Malvern Instruments



Measureme	ent Details				Mea	surement Detail	s			
	Sam	nle Name 10	06 506				Analysis Date Tin	ne 14/06/202	23 8·26·23 AM	
	SOP	File Name Se	diment mson			Mea	surement Date Tin	ne 14/06/202	23 8·26·23 AM	
	Ja	h Number 20	123133/6			inco	Result Sour	ne Measurem	hent	
	Opera	tor Name roo	daers				Result Sour		lent	
	Opera		ugers							
Analysis					Resu	ılt				
	Part	i cle Name Se	diment				Concentratio	on 0.5449 %		
	Particle Refrac	tive Index 1.5	500				Spa	an 1.278		
	Particle Absorpt	tion Index 0.2	200				Uniformi	ty 0.453		
	Dispers	ant Name Wa	ater			5	Specific Surface Are	ea 22.31 m²/	kg	
	Dispersant Refrac	tive Index 1.3	330				D [3,	2] 269 μm		
	Scatteri	ing Model Mi	e				D [4,	3] 343 μm		
	Analy	/sis Model Ge	eneral Purpose				Dv (1	0) 167 μm		
	Weighte	d Residual 0.3	34 %				Dv (5	0) 289 μm		
	Laser Ob	oscuration 14	.50 %				Dv (9	0) 537 μm		
							Dv (9	5) 656 μm		
						Vo	olume Below (31) μ	m 0.00 %		
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				[146] 1.06	Size Classes (j SC6-14/06/2023 8:20	um) 5:23 AM				
Result										
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Unde	r Size (μm)	% Volume Under	Size (µm)	% Volume Under	
0.0500	0.00	7.80	0.00	88.0	0.0	1 350	65.91	1410	98.83	
0.0600	0.00	15.6	0.00	105	0.3	420	78.47	1680	99.21	
0.120	0.00	31.0	0.00	125	1.7	U 500	87.37	2000	99.54	
0.240	0.00	37.0	0.00	149	5.7	2 590	92.88	2380	99.79	
0.490	0.00	110	0.00	177	12.0	0 710		2020	00.04	
0 000	0.00	44.0	0.00	177	12.9 22 E	9 710	96.05	2830	99.94 100.00	



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weasureme					Iviea	surement Detail	5	4.4.10.6.10.00		
	Sam	ple Name 1.0)7 SC7				Analysis Date Tin	ne 14/06/202	23 8:33:55 AM	
	SOP	File Name Se	diment.msop			Mea	surement Date Tin	ne 14/06/202	23 8:33:55 AM	
	Lal	b Number 20	023133/7				Result Sour	ce Measurem	nent	
	Opera	tor Name ro	dgers							
Analysis					Resu	lt				
	Part	icle Name Se	diment				Concentratio	on 1.0704 %		
	Particle Refrac	tive Index 1.5	500				Sp	an 0.921		
	Particle Absorpt	tion Index 0.2	200				Uniformi	itv 0.284		
	Dispers	ant Name Wa	ater			9	Specific Surface Ar	ea 18.97 m²/l	ka	
	Dispersant Refrac	tive Index 13	330			_	D [3	21 316 um		
	Scatteri	ina Model Mi					D [4	31 354 µm		
	Analy	rsis Model Ga	neral Purnose				יין ש Dv (1	0) 215 µm		
	Weighter						Dv (1	0) 224 µm		
	veighted		00 0/				DV (5	ο 522		
	Laser Of	oscuration 23	.08 %				DV (9	ο) 523 μm		
								5) 584 μm		
						Vo	olume Below (31) µ	m 0.00 %		
Frequency (compatible)									
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0.01		0.1	1.0)	10.0		100.0	1,00	0.0	10,000.0
				— [147] 1.07	Size Classes (µ SC7-14/06/2023 8:33	im) 3:55 AM				
Result										
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Unde	r Size (μm)	% Volume Under	Size (µm)	% Volume Under	
0.0500	0.00	7.80	0.00	88.0	0.0	350	55.07	1410	100.00	
0.0600	0.00	15.6	0.00	105	0.0	420	73.64	1680	100.00	
0.120	0.00	31.0	0.00	125	0.0	500	87.28	2000	100.00	
0.240	0.00	37.0	0.00	149	0.4	7 590	95.30	2380	100.00	
0.490	0.00	44.0	0.00	177	2.8	3 710	98.94	2830	100.00	
0.980	0.00	53.0	0.00	210	8.7	6 840	99.90	3360	100.00	
2.00	0.00	63.0	0.00	250	20.72	2 1000	100.00			
3.90	0.00	74.0	0.00	300	38.1	9 1190	100.00			



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Measureme	nt Details				Me	asurement Detail	S			
	Sam	ple Name 1.0	08 SC8				Analysis Date Tir	ne 16/06/202	23 8:34:21 AM	
	SOP	File Name Se	diment.msop			Mea	surement Date Tir	ne 16/06/202	23 8:34:21 AM	
	Lal	b Number 20)23133/8				Result Sour	ce Measurem	nent	
	Opera	tor Name ro	dgers							
	•		5							
Analysis					Res	sult				
	Part	i cle Name Se	diment				Concentration	on 1.2344 %		
	Particle Refrac	tive Index 1.5	500				Sp	an 1.009		
	Particle Absorpt	tion Index 0.2	200				Uniform	ity 0.310		
	Dispers	ant Name Wa	ater			5	Specific Surface Ar	ea 12.45 m²/l	kg	
	Dispersant Refrac	tive Index 1.3	30				D [3,	,2] 482 μm		
	Scatteri	ng Model Mi	e				D [4,	, 3] 551 μm		
	Analy	sis Model Ge	neral Purpose				Dv (1	0) 314 μm		
	Weightee	d Residual 0.6	51 %				Dv (5	i0) 521 μm		
	Laser Ob	oscuration 18	.06 %				Dv (9	0) 840 μm		
							Dv (9	93 7 μm		
						Va	lume Below (31) µ	um 0.00 %		
Frequency (compatible)									
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					Size Classes	(μm)				
				[148] 1.08	SC8-16/06/2023 8:	34:21 AM				
Result										
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Und	ler Size (µm)	% Volume Under	Size (µm)	% Volume Under	
0.0500	0.00	7.80	0.00	88.0	0.0	00 350	15.83	1410	100.00	
0.0600	0.00	15.6	0.00	105	0.	00 420	29.74	1680	100.00	
0.120	0.00	31.0	0.00	125	0.0	00 500	46.01	2000	100.00	
0.240	0.00	37.0	0.00	149	0.	00 590	62.35	2380	100.00	
0.490	0.00	44.0	0.00	177	0.	05 710	78.62	2830	100.00	
0.980	0.00	53.0	0.00	210	0.	51 840	90.00	3360	100.00	
2.00	0.00	63.0	0.00	250	2.	70 1000	97.24			
3.90	0.00	74.0	0.00	300	8.	02 1190	99.81			



Malvern Instruments



Measureme	nt Details				Ν	Measure	ement Detail	S			
	Sam	ple Name 1.0	9 SC9					Analysis Date Ti	me 16/06/202	23 8:41:52 AM	
	SOP	File Name Seo	diment.msop				Mea	surement Date Ti	me 16/06/202	23 8:41:52 AM	
	La	b Number 20						Result Sou	r ce Measuren	nent	
	Opera	itor Name roo	dgers								
Analysis	_ .				F	Result		.			
	Part	icle Name Sec	diment					Concentrat	ion 0.8236 %		
	Particle Refrac	tive Index 1.5	00					S	pan 0.931		
	Particle Absorp	tion Index 0.2	.00					Uniform	11ty 0.285	1	
	Dispers	ant Name wa	ater				3	Specific Surface A	rea 19.35 m ⁻ /	кд	
	Dispersant Refrac	tive index 1.3	30					D[:	3,2] 310 μm		
	Scatter	ng wodel Mi	e noral Durnoco					D [4	4,3] 348 μm		
	Analy	A Desidual 0.2						DV (ΓΟ) 209 μm		
	weighted		4 % 61 %					DV (οο) 529 μm		
	Laser Or	Scuration 10.	.01 /6					DV (95) 578 µm		
							Vo	UV (μm 0.00 %		
							•0	June Delow (51)	µ 11 0.00 70		
Frequency (compatible)										
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0.01		0.1	1.0		Size Class	o es (μm)		100.0	1,0	50.0	10,000.0
				[149] 1.09	SC9-16/06/2023	8:41:52	AM				
Pocult											
Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume U	nder	Size (um)	% Volume Under	Size (um)	% Volume Under	
0.0500	0.00	7 80	0.00	88.0	Jo volume O	0.00	350	56 71	1410	100.00	
0.0600	0.00	15.6	0.00	105		0.00	420	74.76	1680	100.00	
0.120	0.00	31.0	0.00	125		0.02	500	87.97	2000	100.00	
0.240	0.00	37.0	0.00	149		0.71	590	95.76	2380	100.00	
0.490	0.00	44.0	0.00	177		3.58	710	99.34	2830	100.00	
0.980	0.00	53.0	0.00	210	1	0.14	840	100.00	3360	100.00	
2.00	0.00	63.0	0.00	250	2	22.57	1000	100.00			



3.90

0.00

74.0

0.00

300

40.11

1190

Malvern Instruments



Measureme	ent Details					Measur	ement Details							
	Sam	ple Name 1.1	0 SC10					Analysis Date Tim	ne 16/06/202	3 8:49:02 AM				
	SOP	File Name Sec	diment.msop				Measu	irement Date Tin	ne 16/06/202	3 8:49:02 AM				
	Lal	b Number 20	23133/10					Result Sour	ce Measurem	nent				
	Opera	tor Name roo	lgers											
Analusia						Desult								
Analysis	Dent	ala Nama Ca	d'			Result		Companya	- 11420.0/					
	Part Deutiele Defue	icie Name See	alment											
		tive index 1.5	00			Span 1.048								
		ant Name Wa	00			Specific Surface Area 10.10 m^2/kg								
	Dispers	tivo Indox 13	30			Specific Surface Area 10.10 m ^e /kg								
	Scatteri	ing Model Mi	50					D [3,	2] 594 µm					
	Analysis Model General Purpose							D [4,3] 684 µm						
Weighted Residual 0.69 %							Dv (10) 385 μm							
Laser Obscuration 13.91 %								Dv (9)	0) 1060 um					
	Laser Obscuration 13.91 %							Dv (9	5) 1180 µm					
							Volu	ime Below (31) u	m 0.00 %					
Frequency (compatible)													
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0.01		0.1	1.0		Size Clas	ises (μm)		100.0	1,00		10,000.0			
				[150] 1.10	SC10-16/06/20)23 8:49:0	2 AM							
Result														
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume L	Jnder	Size (µm) %	6 Volume Under	Size (µm)	% Volume Under				
0.0500	0.00	7.80	0.00	88.0		0.00	350	5.95	1410	99.44				
0.0600	0.00	15.6	0.00	105		0.00	420	14.75	1680	100.00				
0.120	0.00	31.0	0.00	125		0.00	500	27.19	2000	100.00				
0.240	0.00	37.0	0.00	149		0.00	590	41.97	2380	100.00				
0.490	0.00	44.0	0.00	177		0.00	710	59.83	2830	100.00				
0.980	0.00	53.0	0.00	210		0.00	840	74.81	3360	100.00				
2.00	0.00	63.0	0.00	250		0.39	1000	87.08						



3.90

0.00

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Malvern Instruments



Measureme	ent Details					Measurement Details						
	Sam	ple Name 1.1	1 SC11					Analysis Date Tin	ne 16/06/202	3 8:57:32 AM		
	SOP	File Name Sec	diment.msop				Meas	urement Date Tin	ne 16/06/202	3 8:57:32 AM		
	Lal	b Number 20	23133/11					Result Sour	ce Measurem	nent		
	Opera	tor Name roo	lgers									
			-									
Analysis						Result						
	Part	icle Name Sec	diment			Concentration 0.6168 %						
	Particle Refrac	tive Index 1.5	00			Span 1.313						
	Particle Absorpt	tion Index 0.2	00									
	Dispers	ant Name Wa	iter			Specific Surface Area 16.53 m ² /kg						
	Dispersant Refrac	tive Index 1.3	30			D [3,2] 363 μm						
	Scatteri	ing Model Mie	e			D [4,3] 451 μm						
	Analy	vsis Model Ge	neral Purpose			Dv (10) 218 μm						
Weighted Residual 0.30 %								Dv (5	0) 404 μm			
	Laser Ob				Dv (9	0) 749 μm						
					Dv (9	5) 880 μm						
							Volu	ume Below (31) μ	m 0.00 %			
Frequency (compatible)											
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				[151] 1.11	SC11-16/06/20	i23 8:57:3	2 AM					
Result												
Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume L	Inder	Size (um)	% Volume Under	Size (um)	% Volume Under		
0.0500	0.00	7.80	0.00	88.0		0.00	350	38.61	1410	99.85		
0.0600	0.00	15.6	0.00	105		0.00	420	53.12	1680	100.00		
0.120	0.00	31.0	0.00	125		0.20	500	66.67	2000	100.00		
0.240	0.00	37.0	0.00	149		1.27	590	78.03	2380	100.00		
0.490	0.00	44.0	0.00	177		3.84	710	87.68	2830	100.00		
0.980	0.00	53.0	0.00	210		8.47	840	93.78	3360	100.00		
2.00	0.00	63.0	0.00	250		16.30	1000	97.45				



3.90

0.00

74.0

0.00

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						Mangurament Dataila						
Measurement De	tails				M	easurement Deta	ils					
	Samp	ole Name 1.1	2 SC11				Analysis Date Tir	ne 16/06/202	3 9:04:31 AM			
	SOP F	ile Name Sec	diment.msop			Me	asurement Date Tir	ne 16/06/202	3 9:04:31 AM			
	Lab	Number 20	23133/12				Result Sour	ce Measurem	nent			
	Operat	or Name roo	lgers									
Analysis					Re	esult						
	Partie	:le Name Sec	diment				Concentrati	on 0.7319 %				
Р	article Refracti	ive Index 1.5	00			Span 0.935						
Pa	rticle Absorpti	on Index 0.2	00			Uniformity 0.288						
-	Dispersa	nt Name Wa	iter			Specific Surface Area 14.80 m ² /kg						
Disp	ersant Refract	ive Index 1.3	30			D [3.21 405 um						
	Scatterin	a Model Mi	6				D [4	. 31 456 um				
	Analys	is Model Ge	neral Purpose			μ (4,5) 400 μm						
	Weighted	Residual 0.4	4 %				 Dv (5	i0) 429 um				
	Laser Ob	scuration 13.	08 %				(- Dv (9	0) 675 um				
							_ v (9)5) 757 um				
						v	olume Below (31) µ	um 0.00 %				
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0.01		0.1	1.0)	10.0		100.0	1,00	0.0	10,000.0		
				[152] 1 12	Size Classe	s (µm)						
				[132] 1.12	3011-10/00/2023	5.04.51 AW						
Result												
Size (µm) % V	olume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Un	der Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0	C	0.00 350	28.62	1410	100.00			
0.0600	0.00	15.6	0.00	105	C	0.00 420	47.77	1680	100.00			
0.120	0.00	31.0	0.00	125	C	0.00 500	66.35	2000	100.00			
0.240	0.00	37.0	0.00	149	C	0.00 590	81.31	2380	100.00			
0.490	0.00	44.0	0.00	177	C).15 710	92.19	2830	100.00			
0.980	0.00	53.0	0.00	210	1	1.30 840	97.54	3360	100.00			
2.00	0.00	63.0	0.00	250	5	5.90 1000	99.58					
3.90	0.00	74.0	0.00	300	15	5.79 1190	99.97					









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Massurama	nt Details				Ma	Measurement Details						
weasureme	fit Details	nla Nama 11	4 5 6 1 2		IVIC	easurement Detai	Analysis Data Tir	na 16/06/202	0.10.40 AM			
	Sam	pie Name 1.1	4 5013				Analysis Date Tir	ne 16/06/202	3 9:18:48 AlVI			
	SOP	File Name Se	diment.msop			IVIea	surement Date Tir	ne 16/06/202	23 9:18:48 AM			
	Lal	b Number 20)23133/14				Result Sour	ce Measurem	ient			
	Opera	tor Name roo	dgers									
Analysis					Re	sult						
,	Part	icle Name Se	diment				Concentratio	on 1.1084 %				
	Particle Refrac	tive Index 1.5	500			Span 0.975						
	Particle Absorpt	tion Index 0.2	200			Uniformity 0.297						
	Dispers	ant Name Wa	ater			Specific Surface Area 12.44 m ² /kg						
	Dispersant Refrac	tive Index 1.3	30			D [3,2] 482 um						
	Scatteri	ng Model Mi	e				D [4	, 3] 546 μm				
	Analy	sis Model Ge	neral Purpose				Dv (1	0) 319 μm				
	Weighter	d Residual 0.4	18 %				Dv (5	6) 517 um				
	Laser Ob	scuration 16	.36 %				() Dv (9	0) 823 um				
							Dv (9	5) 915 µm				
						Ve	blume Below (31) µ	Im 0.00 %				
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					Size Classes	(μm)						
				[154] 1.14	SC13-16/06/2023	9:18:48 AM						
Result												
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Und	der Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0	0	.00 350	15.09	1410	100.00			
0.0600	0.00	15.6	0.00	105	0.	.00 420	29.54	1680	100.00			
0.120	0.00	31.0	0.00	125	0	.00 500	46.55	2000	100.00			
0.240	0.00	37.0	0.00	149	0	.00 590	63.50	2380	100.00			
0.490	0.00	44.0	0.00	177	0.	.00 710	80.01	2830	100.00			
0.980	0.00	53.0	0.00	210	0	.27 840	91.19	3360	100.00			
2.00	0.00	63.0	0.00	250	2	.13 1000	97.99					
3.90	0.00	74.0	0.00	300	7.	.20 1190	99.99					







0.0500	0.00	7.80	0.00	88.0	0.90	350	88.67	1410	98.28	
0.0600	0.00	15.6	0.00	105	3.92	420	94.17	1680	98.90	
0.120	0.00	31.0	0.00	125	10.10	500	96.45	2000	99.39	
0.240	0.00	37.0	0.00	149	20.79	590	97.04	2380	99.73	
0.490	0.00	44.0	0.00	177	34.79	710	97.07	2830	99.91	
0.980	0.00	53.0	0.00	210	50.57	840	97.08	3360	99.99	
2.00	0.00	63.0	0.00	250	66.34	1000	97.24			
3.90	0.00	74.0	0.08	300	80.19	1190	97.68			







0.0600	0.00	15.6	0.00	105	0.04	420	64.56	1680	100.00	
0.120	0.00	31.0	0.00	125	0.36	500	78.03	2000	100.00	
0.240	0.00	37.0	0.00	149	1.86	590	88.04	2380	100.00	
0.490	0.00	44.0	0.00	177	5.35	710	95.07	2830	100.00	
0.980	0.00	53.0	0.00	210	11.54	840	98.61	3360	100.00	
2.00	0.00	63.0	0.00	250	21.66	1000	100.00			
3.90	0.00	74.0	0.00	300	35.42	1190	100.00			





Measurem	ent Details					Measur	ement Detail	ls					
	Sam	ple Name 1.	167 M.Heads Inner I	Bar #3				Analysis Date Ti	me 16/06/202	23 9:41:41 AM			
	SOP	File Name Se	diment.msop				Mea	asurement Date Ti	me 16/06/202	23 9:41:41 AM			
	Lal	Number 2	023133/17					Result Sou	rce Measuren	nent			
	Opera	tor Name ro	dgers										
Analysis						Result							
	Part	i cle Name Se	diment					Concentrat	i on 0.6293 %				
	Particle Refrac	tive Index 1.	500			Span 1.122							
	Particle Absorpt	ion Index 0.2	200			Uniformity 0.346							
	Dispers	ant Name W	ater			Specific Surface Area 22.90 m²/kg							
	Dispersant Refrac	tive Index 1.	330			D [3 2] 262 µm							
	Scattering Model Mie						D [4,3] 307 um						
	Analysis Model General Purpose							- Dv (10) 167 μm				
	Weighted				Dv (50) 283 μm							
	Laser Ob				Dv (90) 484 μm							
					Dv (95) 557 μm							
						Volume Below (31) μm 0.00 %							
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				9:41:41 A	M	.i Dai #3-	10/00/2023						
Result													
Size (µm) % Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume l	Jnder	Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0		0.01	350	69.25	1410	100.00			
0.0600	0.00	15.6	0.00	105		0.25	420	82.40	1680	100.00			

0.0000	0.00	15.0	0.00	105	0.25	420	02.40	1000	100.00	
0.120	0.00	31.0	0.00	125	1.52	500	91.41	2000	100.00	
0.240	0.00	37.0	0.00	149	5.47	590	96.60	2380	100.00	
0.490	0.00	44.0	0.00	177	12.91	710	99.10	2830	100.00	
0.980	0.00	53.0	0.00	210	23.94	840	99.88	3360	100.00	
2.00	0.00	63.0	0.00	250	38.73	1000	100.00			
3.90	0.00	74.0	0.00	300	55.58	1190	100.00			







0.0500	0.00	7.80	0.00	88.0	0.00	350	24.03	1410	100.00	
0.0600	0.00	15.6	0.00	105	0.00	420	41.92	1680	100.00	
0.120	0.00	31.0	0.00	125	0.00	500	60.42	2000	100.00	
0.240	0.00	37.0	0.00	149	0.00	590	76.48	2380	100.00	
0.490	0.00	44.0	0.00	177	0.10	710	89.47	2830	100.00	
0.980	0.00	53.0	0.00	210	0.91	840	96.69	3360	100.00	
2.00	0.00	63.0	0.00	250	4.52	1000	99.84			
3.90	0.00	74.0	0.00	300	12.78	1190	100.00			




Measureme	ent Details				Measu	rement Detail	5					
	Sam	ple Name 2.0	1 S2				Analysis Date Tin	ne 16/06/202	23 9:55:36 AM			
	SOP	File Name Sed	diment.msop			Mea	surement Date Tin	ne 16/06/202	23 9:55:36 AM			
	La	b Number 20					Result Sour	ce Measurem	nent			
	Opera	tor Name roo	dgers									
	•		5									
Analysis					Result							
	Part	icle Name Se	diment				Concentratio	on 0.4737 %				
	Particle Refrac	tive Index 1.5	00				Spa	an 1.055				
	Particle Absorp	tion Index 0.2	.00			Uniformity 0.329						
	Dispers	ant Name Wa	iter			S	pecific Surface Ar	ea 23.83 m²/l	kg			
	Dispersant Refrac	tive Index 1.3	30				D [3,	2] 252 μm				
	Scatteri	ng Model Mi	e				D [4,	3] 292 μm				
	Analy	sis Model Ge	neral Purpose				Dv (1	0) 163 μm				
	Weighte	d Residual 0.3	3%			Dv (50) 272 μm						
	Laser Ob	oscuration 13.	.54 %			Dv (90) 450 μm						
						Dv (95) 510 μm						
						Vo	lume Below (31) μ	. m 0.00 %				
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				11501 2 01	Size Classes (µm)						
				[159] 2.01	52-16/06/2023 9:55:36	AM						
Result												
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0	0.02	350	73.38	1410	100.00			
0.0600	0.00	15.6	0.00	105	0.39	420	86.13	1680	100.00			
0.120	0.00	31.0	0.00	125	1.97	500	94.23	2000	100.00			
0.240	0.00	37.0	0.00	149	6.47	590	98.31	2380	100.00			
0.490	0.00	44.0	0.00	177	14.62	710	99.75	2830	100.00			
0.980	0.00	53.0	0.00	210	26.45	840	99.99	3360	100.00			
1 2.00	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	~~ ~	~ ~ ~ ~	050	10.01	1000	100.00					



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Measureme	ent Details				Me	easuremer	nt Details					
	Sam	ple Name 2.02	2-300E				Ana	alysis Date Tim	ne 16/06/2023 1	0:02:44 AM		
	SOP	File Name Sed	iment.msop				Measure	, ment Date Tim	ne 16/06/2023 1	0:02:44 AM		
	Lal	b Number 202	23133/20					Result Source	e Measurement	t		
	Opera	tor Name rode	gers									
	•											
Analysis					Re	sult						
	Part	icle Name Sed	iment					Concentratio	on 0.6126 %			
	Particle Refrac	tive Index 1.50	0					Spa	n 1.124			
	Particle Absorpt	tion Index 0.20	0					Uniformi	ty 0.345			
	Dispers	ant Name Wat	er				Speci	fic Surface Are	ea 18.18 m²/kg			
	Dispersant Refrac	tive Index 1.33	0					D [3,2	2] 330 μm			
	Scatteri	i ng Model Mie						D [4,	3] 388 μm			
	Analy	rsis Model Gen	eral Purpose					Dv (1	0) 209 µm			
	Weighted	d Residual 0.39	%			Dv (50) 360 μm						
	Laser Ob	oscuration 13.4	0 %			Dv (90) 614 μm						
			Dv (95) 698 μm									
			Volume Below (31) μm 0.00 %									
	cy (compatible)											
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				[160] 2.02	2-300E-16/06/202	3 10:02:44 A	M					
Result												
Size (µm)	% Volume Under	Size (µm) %	6 Volume Under	Size (µm)	% Volume Und	der Siz	ze (µm) % V	olume Under	Size (µm) %	Volume Under		
0.0500	0.00	7.80	0.00	88.0	0.	.00	350	47.45	1410	100.00		
0.0600	0.00	15.6	0.00	105	0	.00	420	63.83	1680	100.00		
0.120	0.00	31.0	0.00	125	0.	.16	500	77.83	2000	100.00		
0.240	0.00	37.0	0.00	149	1.	.3] 20	590	88.24	2380	100.00		
0.490	0.00	44.U	0.00	1//	4	.58 17	710	95.52	2830	100.00		
0.980	0.00	53.0	0.00	210	10	.17	840	99.11	3360	100.00		



2.00

3.90

0.00

0.00

63.0

74.0

0.00

0.00

250

300

20.08

33.89

1000

1190

100.00

Malvern Instruments



Measu	urem	ent Details					Measurement Details							
		Sam	ple Name 2.03 2	-300W				Ana	alysis Date Tim	ne 16/06/2023	10:09:31 AM			
		SOP	File Name Sedim	ent.msop				Measure	ment Date Tim	ne 16/06/2023	10:09:31 AM			
		Lal	b Number 20231	33/21					Result Source	e Measuremer	nt			
		Opera	tor Name rodge	S										
							D 11							
Analys	SIS						Result							
		Part	icle Name Sedim	ent			Concentration 0.7421 %							
		Particle Refrac	tive Index 1.500				Span 1.012							
		Particle Absorpt	ion Index 0.200											
		Dispers	ant Name Water					Speci	fic Surface Are	ea 19.74 m²/kg				
		Dispersant Refrac	tive Index 1.330						D [3,2	2] 304 μm				
		Scatteri	ng Model Mie						D [4,3	3] 348 μm				
		Analy	sis Model Generation	al Purpose					Dv (10	0) 199 μm				
		Weightee	d Residual 0.35 %				Dv (50) 325 µm							
		Laser Ob	scuration 17.24	%			Dv (90) 528 μm							
							Dv (95) 597 μm							
								Volume	e Below (31) μι	m 0.00 %				
Freque	ency	(compatible)												
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					(1(1) 2 02	Size Clas	sses (µm)	00.21 444						
					[161] 2.03	2-30000-16/06	5/2023 10	09:31 AM						
Result														
Size	(μm) % Volume Under	Size (µm) % \	olume Under	Size (µm)	% Volume	Under	Size (µm) % Vo	olume Under	Size (µm) %	6 Volume Under			
0	.050	0.00	7.80	0.00	88.0		0.00	350	57.51	1410	100.00			
0	.060	0.00	15.6	0.00	105		0.00	420	74.38	1680	100.00			
	0.12	0.00	31.0	0.00	125		0.14	500	86.96	2000	100.00			
	0.24	0.00	37.0	0.00	149		1.40	590	94.70	2380	100.00			
	0.49	0.00	44.0	0.00	177		5.15	710	98.60	2830	100.00			



0.980

2.00

3.90

53.0

63.0

74.0

0.00

0.00

0.00

210

250

300

0.00

0.00

0.00

12.52

25.08

41.94

840

1000

1190

100.00

3360

99.81

100.00



Measurem	ent Details				Meas	Measurement Details						
	Sam	ple Name 2.0	04 2-600S				Analysis Date Tin	ne 16/06/202	3 10:35:00 AM			
	SOP F	ile Name Se	diment.msop			Mea	surement Date Tin	ne 16/06/202	3 10:35:00 AM			
	Lab	Number 20	023133/21				Result Sour	ce Measurem	nent			
	Opera	tor Name ro	dgers									
Analysis					Resu	t						
Anarysis	Parti	cle Name Se	diment		Titest		Concentratio	on 0.7015 %				
	Particle Refract	tive Index 1	500				Sn	an 1983				
	Particle Absorpt	ion Index 02	200				Uniformi	ity 0.624				
	Dispers	ant Name W	ater			ç	Specific Surface Ar	ea 16.23 m ² /l	ka			
	Dispersant Refract	tive Index 13	330			-	D I3	21 370 um				
	Scatteri	na Model Mi	ie				D [4	31 567 um				
	Analy	sis Model Ge	aneral Purnose				יי, Dv (1	0) 193 µm				
	Weighted	Residual 03	39 %				Dv (1	() 451 um				
	l acor Oh	scuration 12	67 %				Dv (9	0) 1090 um				
	Laser Ob	scuration	.07 70			Dv (90) 1090 μm Dv (95) 1380 μm						
						Dv (95) 1380 μm Volume Below (31) μm 0.00 %						
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				[162] 2.04	Size Classes (µ 2-600S-16/06/2023 1	m) 0:35:00 AM						
				,								
Result												
Size (um) % Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under			
0.0500		7 80	0.00	88.0	0.18	350	35.41	1410	95 32			
0.0600	0.00	15.6	0.00	105	0.76	420	45.82	1680	97.49			
0.120	0.00	31.0	0.00	125	1.96	500	55.96	2000	98.79			
0.240	0.00	37.0	0.00	149	4.23	590	65.23	2380	99.52			
0.490	0.00	44.0	0.00	177	7.68	710	74.48	2830	99.84			
0.980	0.00	53.0	0.00	210	12.43	840	81.67	3360	99.98			
2.00	0.00	63.0	0.00	250	18.98	1000	87.63					
3.90	0.00	74.0	0.00	300	27.33	1190	92.11					



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Measureme	nt Details					Measure	ement Details	S				
	Sam	ple Name 2.05	52-600W					Analysis Date Tir	ne 16/06/202	3 10:42:09 AM		
	SOP	File Name Sed	iment.msop				Mea	surement Date Tir	ne 16/06/202	3 10:42:09 AM		
	La	b Number 202	23133/23					Result Sour	ce Measurem	ient		
	Opera	tor Name rode	aers									
			5									
Analysis						Result						
	Part	icle Name Sed	iment					Concentration	on 0.5214 %			
	Particle Refrac	tive Index 1.50	00					Sp	an 0.998			
	Particle Absorpt	tion Index 0.20	00					Uniform	i ty 0.309			
	Dispers	ant Name Wat	er				S	pecific Surface Ar	ea 23.58 m²/l	kg		
	Dispersant Refrac	tive Index 1.33	80			D [3,2] 254 μm						
	Scatteri	ng Model Mie						D [4,	, 3] 290 μm			
	Analy	sis Model Gen	eral Purpose					Dv (1	0) 168 μm			
	Weightee	d Residual 0.35	5 %					Dv (5	ί0) 271 μm			
	Laser Ob	oscuration 14.6	55 %			Dv (90) 439 μm						
						Dv (95) 496 μm						
							Vo	lume Below (31) µ	u m 0.00 %			
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0.01		0.1	1.0		Size Class	ses (μm)		100.0	1,00	50.0	10,000.0	
				[163] 2.05	2-600W-16/06/	/2023 10:4	12:09 AM					
Result												
Size (µm)	% Volume Under	Size (µm) 9	% Volume Under	Size (µm)	% Volume L	Jnder	Size (µm)	% Volume Under	Size (µm)	% Volume Under		
0.0500	0.00	7.80	0.00	88.0		0.00	350	74.84	1410	100.00		
0.0600	0.00	15.6	0.00	105		0.12	420	87.60	1680	100.00		
0.120	0.00	31.0	0.00	125		1.10	500	95.25	2000	100.00		
0.240	0.00	37.0	0.00	149		4.95	590	98.80	2380	100.00		
0.490	0.00	44.0	0.00	177		12.86	710	99.87	2830	100.00		
0.980	0.00	53.0	0.00	210	:	25.11	840	100.00	3360	100.00		
2.00	0.00	63.0	0.00	250		41.73	1000	100.00				



3.90

0.00

74.0

0.00

300

60.36

1190

Malvern Instruments



Measuren	nent Details					Measurement Details						
	Sam	ple Name 2.06 S	2-300S				An	alysis Date Tin	ne 16/06/2023	10:50:47 AM		
	SOP	File Name Sedim	ent.msop				Measure	ement Date Tin	ne 16/06/2023	10:50:47 AM		
	La	b Number 20231	33/24					Result Sour	ce Measureme	ent		
	Opera	itor Name rodge	rs									
Analysis						Result						
	Part	icle Name Sedim	ent					Concentratio	on 0.4484 %			
	Particle Refrac	tive Index 1.500						Spa	an 1.235			
	Particle Absorpt	tion Index 0.200					_	Uniformi	ty 0.379			
	Dispers	ant Name Water					Spec	ific Surface Are	ea 14.98 m²/kg]		
	Dispersant Refrac	tive Index 1.330						D [3,	2] 401 μm			
	Scatteri	ng Model Mie						D [4,	3] 487 μm			
	Analy	vsis Model Gener	al Purpose			Dv (10) 244 μm Dv (50) 446 μm						
	Weighte	d Residual 0.35 %)			Dv (50) 446 μm						
	Laser Obscuration 8.32 %						Dv (90) 795 μm					
								Dv (9	5) 911 μm			
							Volum	e Below (31) μ	m 0.00 %			
Frequency	y (compatible)											
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				[164] 2.06	52-3005-16/0	6/2023 10	:50:47 AM					
Pocul+												
Sizo (up	n) % Volume Under	Size (um) %	/olume Under	Size (um)	% Volumo	Under	Size (um) %	/olume Under	Size (um)	% Volume Under		
0.050		- 512e (μΠ) % (- 7 00		οο ο	70 VOlume	0.00	250	20 62	1/10	100.00		
0.050		7.00 15.6	0.00	00.U 105		0.00	350 420	20.02 45.02	1410	100.00		
0.000	20 0.00	31.0	0.00	125		0.04	500	59.44	2000	100.00		
0.24	10 0.00	37.0	0.00	149		0.50	590	72.40	2380	100.00		



0.490

0.980

2.00

3.90

0.00

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0.00

44.0

53.0

63.0

74.0

0.00

0.00

0.00

0.00

177

210

250

300

1.94

5.02

11.02

20.35

710

840

1000

1190

84.30

92.33

97.44

99.66

2830

3360

100.00

Malvern Instruments

99.05

100.00

100.00

3360



Measu	urem	ent Details					Measurement Details						
		Sam	ple Name 2.07 S	S14				Ana	alysis Date Tim	e 16/06/2023	3 10:57:43 AM		
		SOP	File Name Sedim	ient.msop				Measure	ment Date Tim	e 16/06/2023	3 10:57:43 AM		
		Lal	b Number 2023	133/25					Result Source	e Measureme	ent		
		Opera	tor Name rodge	rs									
Analys	SIS	–					Result			0.0070.0/			
		Part	icle Name Sedim	ient					Concentratio	on 0.6978 %			
		Particle Refrac	tive Index 1.500						Spa	n 0.981			
		Particle Absorpt	tion Index 0.200						Uniformit	ty 0.301			
		Dispers	ant Name Water					Speci	fic Surface Are	a 15.89 m²/k	g		
		Dispersant Refrac	tive Index 1.330						D [3,2	2] 378 μm			
		Scatteri	ng Model Mie						D [4,3	3] 428 μm			
		Analy	sis Model Gener	al Purpose					Dv (10	0) 249 µm			
		Weighted	d Residual 0.35 %	ó					Dv (50	0) 405 µm			
		Laser Ob	oscuration 13.36	%			Dv (90) 646 μm						
									Dv (9	5) 723 μm			
								Volume	e Below (31) μ	m 0.00 %			
Freque	ency	icy (compatible)											
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					(165) 2.07	Size Clas	ses (µm)	42 414					
					[165] 2.07	5514-16/06/20)23 10:57:	43 AM					
Result													
Size	e (μm) % Volume Under	Size (µm) %	Volume Under	Size (µm)	% Volume l	Jnder	Size (µm) % V	olume Under	Size (µm)	% Volume Under		
0	.050	0.00	7.80	0.00	88.0		0.00	350	35.31	1410	100.00		
0	.060	0.00	15.6	0.00	105		0.00	420	53.76	1680	100.00		
	0.12	0.00	31.0	0.00	125		0.00	500	70.96	2000	100.00		
	0.24	0.00	37.0	0.00	149		0.07	590	84.54	2380	100.00		
	0.49	0.00	44.0	0.00	177		0.87	710	94.31	2830	100.00		



0.980

2.00

3.90

0.00

0.00

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53.0

63.0

74.0

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0.00

0.00

210

250

300

3.50

10.20

21.89

840

1000

1190

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Measureme	nt Details				Ν	Measure	ement Details	5				
	Sam	ple Name 2.08	3 SS15					Analysis Date Tir	ne 16/06/202	23 11:04:47 AM		
	SOP	File Name Sed	liment.msop				Mea	surement Date Tir	ne 16/06/202	23 11:04:47 AM		
	Lal	b Number 202	23133/26					Result Sour	ce Measurem	nent		
	Opera	tor Name rod	gers									
Analysis					F	20cult						
Analysis	Dart	icle Name Sod	limont			(esuit		Concontratio	on 0.7649 %			
	Particle Refrac	tive Index 150						Concentration	n 1913			
	Particlo Absorpt	tion Index 0.20						Uniformi	h 0.696			
	Dispers	ant Name Wat	ter				s	necific Surface Ar	cy 0.050 ca 24.23 m ² /	ka		
	Dispersant Refrac	tive Index 133	30						21 248 µm	ng l		
	Scatteri	ina Model Mie	50 5					D [4	3] 424 µm			
	Analy	rsis Model Ger	Deral Purnose					ן בי, Dv (1	0) 161 µm			
	Weighter	d Residual 0 33	3 %					Dv (5	0) 306 µm			
	Laser Of	scuration 21	34 %			Dv (90) 300 μm						
						Dv (90) 747 μm Dv (95) 1220 μm						
							Vo	lume Below (31) u	m 0.64 %			
Frequency (compatible)											
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0.01		0.1	1.0		Size Class	o es (μm)		100.0	1,00	50.0	10,000.0	
				[166] 2.08	SS15-16/06/202	23 11:04:4	17 AM					
Result												
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume U	nder	Size (µm)	% Volume Under	Size (µm)	% Volume Under		
0.0500	0.00	7.80	0.14	88.0		0.73	350	59.42	1410	96.02		
0.0600	0.00	15.6	0.26	105		1.28	420	70.47	1680	97.20		
0.120	0.00	31.0	0.64	125		3.07	500	78.90	2000	98.24		
0.240	0.00	37.0	0.70	149		7.29	590	84.80	2380	99.09		
0.490	0.00	44.0	0.70	177	1	4.17	710	89.07	2830	99.64		
0.980	0.00	53.0	0.70	210	2	23.53	840	91.64	3360	99.95		
2.00	0.00	63.0	0.70	250	3	35.35	1000	93.43				



3.90

0.00

74.0

0.70

300

48.58

1190



Measureme	nt Details				Meas	urement Detail	s					
	Sam	ple Name 2.0	9 SS16				Analysis Date Tir	ne 16/06/202	23 11:11:50 AM			
	SOP	File Name Se	diment.msop			Mea	surement Date Tir	ne 16/06/202	3 11:11:50 AM			
	Lal	b Number 20)23133/27				Result Sour	ce Measurem	nent			
	Opera	tor Name roo	dgers									
			5-5-									
Analysis					Result	t						
	Part	i cle Name Se	diment				Concentration	on 0.6581 %				
	Particle Refrac	tive Index 1.5	00			Span 1.272						
	Particle Absorpt	tion Index 0.2	200			Uniformity 0.390						
	Dispers	ant Name Wa	ater			Specific Surface Area 11.68 m²/kg						
	Dispersant Refrac	tive Index 1.3	30			D [3,2] 514 μm						
	Scatteri	ng Model Mi	e			D [4,3] 627 μm						
	Analy	rsis Model Ge	neral Purpose			Dv (10) 315 μm						
	Weightee	d Residual 0.4	9 %			Dv (50) 565 μm						
	Laser Ob	oscuration 9.4	9 %			Dv (90) 1030 μm						
						Dv (95) 1210 μm						
						Vo	lume Below (31) µ	m 0.00 %				
Frequency (compatible)											
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					Size Classes (µr	m)						
				[167] 2.09	SS16-16/06/2023 11:1	1:50 AM						
Pocul+												
Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under			
0.0500	0.00	7 80		88 0	0.00	350	14 92	1410	98.07			
0.0600	0.00	15.6	0.00	105	0.00	420	26.44	1680	99.71			
0.120	0.00	31.0	0.00	125	0.00	500	39.84	2000	100.00			
0.240	0.00	37.0	0.00	149	0.00	590	53.63	2380	100.00			
0.490	0.00	44.0	0.00	177	0.13	710	68.35	2830	100.00			
0.980	0.00	53.0	0.00	210	0.84	840	79.81	3360	100.00			
2.00	0.00	63.0	0.00	250	3.21	1000	88.74					
3.90	0.00	74.0	0.00	300	8.17	1190	94.60					



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Measurement Details					Measurement Details						
San	nple Name 3.01 SS	17				Ana	alysis Date Tim	e 16/06/2023 11	:49:00 AM		
SOP	File Name Sedime	nt.msop				Measurer	ment Date Tim	e 16/06/2023 11	:49:00 AM		
La	b Number 202313	3/28					Result Source	e Measurement			
Oper	ator Name rodgers										
Analysis					Result						
Par	ticle Name Sedime	nt			Result		Concentratio	n 0.4138 %			
Particle Refra	tive Index 1 500	iii.					Sna	n 0.829			
Particle Absorr	tion Index 0.200				Uniformity 0.257						
Disper	sant Name Water				Specific Surface Area 30.37 m ² /kg						
Dispersant Refra	tive Index 1330				D [3,2] 198 μm						
Scatter	ina Model Mie				D [4,3] 217 μm						
Anal	vsis Model General	Purpose					– [.,, Dv (1(0) 138 µm			
Weighte	d Residual 043 %	. aipose			Dv (50) 207 μm						
Laser O	bscuration 14.91 %				Dv (90) 309 um						
					Dv (90) 309 μm Dv (95) 344 μm						
							e Below (31) μι	m 0.00 %			
	iency (compatible)										
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			[168] 3.01	SIZE Class SS17-16/06/20	ses (µm) 23 11:49:0	0 AM					
Result											
Size (µm) % Volume Under	Size (µm) % Vo	lume Under	Size (µm)	% Volume L	Inder	Size (µm) % Vo	olume Under	Size (µm) % V	olume Under		
0.0500 0.00	7.80	0.00	88.0		0.07	350	95.84	1410	100.00		
0.0600 0.00	15.6	0.00	105		1.14	420	99.39	1680	100.00		
0.120 0.00	31.0	0.00	125		5.15	500	100.00	2000	100.00		
0.240 0.00	37.0	0.00	149		15.36	590	100.00	2380	100.00		
0.490 0.00	44.U 52 0	0.00	1//	-	51.50	7 IU 840	100.00	2030	100.00		
0.120 0.00 0.240 0.00 0.490 0.00 0.980 0.00	31.0 37.0 44.0 53.0	0.00 0.00 0.00	125 149 177 210		5.15 15.36 31.56 51.54	500 590 710 840	100.00 100.00 100.00 100.00	2000 2380 2830 3360	100.00 100.00 100.00 100.00		



2.00

3.90

0.00

0.00

63.0

74.0

0.00

0.00

250

300

71.59

87.68

1000

1190

100.00

Malvern Instruments



Moscuromo	nt Dotails					Moosure	omont Dotail	c					
weasureme		. I. N	2 6610			weasure	ement Detail		10/00/200				
	Sam	pie Name 3.0	12 55 18					Analysis Date Til	ne 16/06/202	3 11:56:06 AM			
	SOP	File Name Se	diment.msop				Mea	surement Date Tir	ne 16/06/202	3 11:56:06 AM			
	La	b Number 20)23133/29					Result Sour	ce Measurem	ient			
	Opera	tor Name roo	dgers										
Analysis						Result							
	Part	icle Name Se	diment					Concentrati	on 0.5360 %				
	Particle Refrac	tive Index 1.5	500					Sp	an 0.881				
	Particle Absorp	tion Index 0.2	200					Uniform	ity 0.269				
	Dispers	ant Name Wa	ater				9	Specific Surface Ar	ea 29.07 m ² /	ka			
	Dispersant Refrac	tive Index 13	30					D [3	21 206 um	5			
	Scatteri	i na Model Mi	P					– [- D [4	31 229 µm				
	Analy	rsis Model Ge	eneral Purnose					Dv (1	0) 142 µm				
	Woighton					Dv (50) 218 μm							
	Weighted		16.0/			Dv (50) 218 μm							
	Laser Of	Scuration 10	.10 %			Dv (90) 334 μm Dv (95) 370 μm							
									3 70 μm				
							Vo	lume Below (31) p	Im 0.00 %				
Frequency (compatible)												
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0.01		0.1	1.0		Size Class	ses (µm)		100.0	1,00		10,000.0		
				[169] 3.02	SS18-16/06/20	23 11:56:0	16 AM						
Result													
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume L	Jnder	Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0		0.05	350	92.89	1410	100.00			
0.0600	0.00	15.6	0.00	105		0.99	420	98.68	1680	100.00			
0.120	0.00	31.0	0.00	125		4.48	500	100.00	2000	100.00			
0.240	0.00	37.0	0.00	149		13.28	590	100.00	2380	100.00			
0.490	0.00	44.0	0.00	177	:	27.46	710	100.00	2830	100.00			
0.980	0.00	53.0	0.00	210		45.60	840	100.00	3360	100.00			
2.00	0.00	63.0	0.00	250		65.21	1000	100.00					



3.90

0.00

74.0

0.00

300

82.65

1190

Malvern Instruments



Meas	urem	ent Details					Measurement Details						
		Sam	ple Name 3.0	03 SS19				Ana	lysis Date Tin	ne 16/06/2023	3 12:02:42 PM		
		SOP	File Name Se	ediment.msop				Measurer	nent Date Tin	ne 16/06/2023	3 12:02:42 PM		
		La	b Number 2	023133/30					Result Sour	ce Measureme	ent		
		Opera	tor Name ro	odgers									
Analy	sis						Result						
		Part	i cle Name Se	ediment					Concentratio	on 0.5033 %			
		Particle Refrac	tive Index 1.	500					Spa	an 0.845			
		Particle Absorpt	tion Index 0.2	200			Uniformity 0.256						
		Dispers	ant Name W	'ater				Specif	fic Surface Are	ea 31.48 m²/k	g		
		Dispersant Refrac	tive Index 1.3	330					D [3,	2] 191 μm			
		Scatteri	ng Model M	ie					D [4,	3] 210 μm			
		Analy	sis Model Ge	eneral Purpose					Dv (1	0) 132 μm			
		Weighte	d Residual 0.4	46 %			Dv (50) 201 μm						
		Laser Ob	scuration 18	3.42 %			Dv (90) 302 μm						
							Dv (90) 302 μm Dv (95) 333 μm						
								Volume	e Below (31) μ	m 0.00 %			
Frequ	uency (compatible)												
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					[170] 3.03	SS19-16/06/20	123 12:02:4	12 PM					
Result	t .												
Size	- e (μm՝	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume l	Jnder	Size (µm) % Vo	olume Under	Size (µm)	% Volume Under		
0	0.0500	0.00	7.80	0.00	88.0		0.19	350	97.13	1410	100.00		
0	0.0600	0.00	15.6	0.00	105		1.88	420	99.99	1680	100.00		
	0.120	0.00	31.0	0.00	125		7.03	500	100.00	2000	100.00		
	0.240	0.00	37.0	0.00	149		18.49	590	100.00	2380	100.00		
	0 4 90	0.00	44 0	0.00	177		35 39	710	100 00	2830	100.00		



0.980

2.00

3.90

0.00

0.00

0.00

53.0

63.0

74.0

0.00

0.00

0.00

210

250

300

55.29

74.51

89.61

840

1000

1190

100.00

100.00

100.00

3360

Malvern Instruments



Measurement Details Sample Name 3.04 SS20							Measurement Details								
	Sample Name 3.04 SS20 SOP File Name Sediment.msop							A	nalysis Da	te Tin	ne 16/06/2023	3 12:42:54 PM			
		SOP	File Name Sedim	nent.msop				Measur	rement Da	te Tin	ne 16/06/2023	3 12:42:54 PM			
		La	b Number 2023	133/31					Resul	Sour	ce Measureme	ent			
		Opera	tor Name rodge	ers											
Analys	is						Result								
		Part	icle Name Sedim	nent					Conce	ntratio	on 0.4969 %				
		Particle Refrac	tive Index 1.500				Span 0.846								
		Particle Absorpt	tion Index 0.200												
		Dispers	ant Name Water	r			Specific Surface Area 32.66 m ² /kg								
		Dispersant Refrac	tive Index 1.330							D [3,	2] 184 μm				
		Scatteri	ng Model Mie							D [4,	3] 202 μm				
		Analy	rsis Model Gener	ral Purpose			Dv (10) 128 μm								
	Weighted Residual 0.55 % Laser Obscuration 18.81 %							Dv (50) 193 μm							
	Laser Obscuration 18.81 %						Dv (90) 291 μm								
							Dv (95) 321 μm								
								Volun	ne Below	(31) μ	m 0.00 %				
Freque	requency (compatible)														
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					[171] 3.04	Size Clas SS20-16/06/20	ses (µm))23 12:42:	54 PM							
Result															
Size	(µm)	% Volume Under	Size (µm) %	Volume Under	Size (µm)	% Volume I	Jnder	Size (µm) %	Volume U	nder	Size (µm)	% Volume Under			
0.	0500	0.00	7.80	0.00	88.0		0.29	350	ç	7.94	1410	100.00			
0.	0600	0.00	15.6	0.00	105		2.51	420	9	9.99	1680	100.00			
	0.120	0.00	31.0	0.00	125		8.74	500	10	0.00	2000	100.00			
	0.240	0.00	37.0	0.00	149		21.66	590	10	0.00	2380	100.00			
1 0	J.490	0.00	44.0	0.00	177		39.72	710	10	0.00	2830	100.00			



0.980

2.00

3.90

0.00

0.00

0.00

53.0

63.0

74.0

0.00

0.00

0.00

210

250

300

59.95

78.30

91.78

840

1000

1190

100.00

100.00

100.00

3360

Malvern Instruments



Maagurama	nt Dataila					Maagura	mont Dotail							
weasureme			- CC04			weasure	ment Detail	s	100000					
	Sam	ple Name 3.0	15 5521					Analysis Date Tir	ne 16/06/202	23 12:49:47 PM				
	SOP	File Name Se	diment.msop				Mea	surement Date Tir	ne 16/06/202	23 12:49:47 PM				
	La	b Number 20)23133/32					Result Sour	ce Measurem	nent				
	Opera	tor Name roo	dgers											
Analysis					I	Result								
	Part	icle Name Se	diment					Concentration	on 0.4318 %					
	Particle Refrac	tive Index 1.5	500			Span 0.904								
	Particle Absorp	tion Index 0.2	200			Uniformity 0.277								
	Dispers	ant Name Wa	ater			Specific Surface Area 30.51 m ² /kg								
	Dispersant Refrac	tive Index 13	30			D [3,2] 197 μm								
	Scatteri	i na Model Mi	P					D [4	31 219 µm					
	Analy		Dv (10) 134 μm											
	Woighton		Dv (50) 208 µm											
	Weighted Residual 0.46 % Laser Obscuration 15.58 %						Dv (50) 208 μm							
	Laser Obscuration 15.58 %						Dv (90) 322 μm							
							Dv (95) 356 μm Volume Below (31) μm 0.00 %							
							vo	iume Below (31) h	l m 0.00 %					
Frequency (compatible)													
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0.01		0.11			Size Class	ses (µm)		100.0	1,00		10,000.0			
				[172] 3.05	SS21-16/06/202	23 12:49:4	7 PM							
Result														
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume U	Inder	Size (µm)	% Volume Under	Size (µm)	% Volume Under				
0.0500	0.00	7.80	0.00	88.0		0.19	350	94.40	1410	100.00				
0.0600	0.00	15.6	0.00	105		1.82	420	99.01	1680	100.00				
0.120	0.00	31.0	0.00	125		6.58	500	100.00	2000	100.00				
0.240	0.00	37.0	0.00	149		17.01	590	100.00	2380	100.00				
0.490	0.00	44.0	0.00	177	3	32.45	710	100.00	2830	100.00				
0.980	0.980 0.00 53.0 0.00 210					50.99	840	100.00	3360	100.00				
2.00	0.00	63.0	0.00	250	6	69.77	1000	100.00						



3.90

0.00

74.0

0.00

300

85.60

1190

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Measureme	nt Details					Measure	ment Detail	c							
weasureme	Som	nlo Namo 20	6 5522			ivieasure		Analysis Data Ti	no 16/06/202	2 12-56-40 DM					
	Sam	File Name So	dimont mean				Maa	Analysis Date Th	ne 16/06/202	2 12:50:40 PM					
	306						Ivied	Basult Com		.5 12.30.40 FIM					
	La	b Number 20	123133/33					Result Soul	ce measurem	ient					
	Opera	itor Name roo	dgers												
Analysis						Result									
	Part	icle Name Se	diment					Concentrati	on 0.3448 %						
	Particle Refrac	tive Index 1.5	500					Sp	an 0.891						
	Particle Absorpt	tion Index 0.2	200			Uniformity 0.277									
	Dispers	ant Name Wa	ater			Specific Surface Area 34.72 m ² /kg									
	Dispersant Refrac	tive Index 1.3	330			D [3,2] 173 μm									
	Scattering Model Mie Analysis Model General Purpose							D [4,3] 223 μm							
	Analysis Model General Purpose							Dv (10) 137 μm							
	Weighte		Dv (50) 214 μm												
	Laser Of		Dv (30) 214 µm												
				Dv (95) 327 µm											
						Volume Below (31) μm 0.97 %									
							•0		un 0.57 70						
Frequency (compatible)														
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0.01		0.1	1.0		10	.0		100.0	1,00	0.0	10,000.0				
					Size Class	ses (µm)									
				[173] 3.06	SS22-16/06/20	23 12:56:40	D PM								
Result															
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume L	Inder	Size (µm)	% Volume Under	Size (µm)	% Volume Under					
0.0500	0.00	7.80	0.19	88.0		1.06	350	93.79	1410	100.00					
0.0600	0.00	15.6	0.72	105		2.15	420	98.90	1680	100.00					
0.120	0.00	31.0	0.97	125		5.88	500	100.00	2000	100.00					
0.240	0.00	37.0	0.97	149		15.05	590	100.00	2380	100.00					
0.490	0.00	44.0	0.97	177	i	29.60	710	100.00	2830	100.00					
0.980	0.980 0.00 53.0 0.97 210					47.93	840	100.00	3360	100.00					
2.00	0.00	63.0	0.97	250		67.35	1000	100.00							



3.90

0.00

74.0

0.97

300

84.22

1190



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Measureme					ivieasu	rement Details	s	4.6.10.6.10.0.0				
	Sam	ple Name 3.0	07 SS23				Analysis Date Tin	ne 16/06/202	23 1:52:16 PM			
	SOP	File Name Se	diment.msop			Mea	surement Date Tin	ne 16/06/202	23 1:52:16 PM			
	La	b Number 20	023133/34				Result Sour	ce Measurem	nent			
	Opera	tor Name ro	dgers									
Analysis					Result							
	Part	icle Name Se	diment				Concentratio	on 0.4520 %				
	Particle Refrac	tive Index 1.5	500				Spa	an 0.900				
	Particle Absorpt	tion Index 0.2	200				Uniformi	ty 0.275				
	Dispers	ant Name Wa	ater			S	pecific Surface Ar	ea 29.46 m²/l	kg			
	Dispersant Refrac	tive Index 1.3	330				D [3,	2] 204 μm				
	Scatteri	i ng Model Mi				D [4,	3] 227 μm					
	Analy	isis Model Ge				Dv (1	0) 138 μm					
	Weighte	d Residual 0.3	37 %				Dv (5	0) 216 μm				
	Laser Ob	oscuration 15	.74 %			Dv (90) 333 μm						
						Dv (95) 369 μm						
						Volume Below (31) μm 0.00 %						
Frequency	(compatible)											
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0.0	1	0.1	1.0)	10.0		100.0	1,00	0.0	10,000.0		
				[174] 2.07	Size Classes (µm)							
				[174] 3.07	5523-16/06/2023 1:52:1	0 PIVI						
Result												
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0	0.13	350	93.02	1410	100.00			
0.0600	0.00	15.6	0.00	105	1.39	420	98.71	1680	100.00			
0.120	0.00	31.0	0.00	125	5.35	500	100.00	2000	100.00			
0.240	0.00	37.0	0.00	149	14.55	590	100.00	2380	100.00			
0.490			0.00	177	20.01	710	100 00		100.00			
	0.00	44.0	0.00	1//	28.81	710	100.00	2830	100.00			
0.980	0.00	44.0 53.0	0.00	210	46.71	710 840	100.00	3360	100.00			



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Measurement Details			Measu	rement Details							
Si	ample Name 3.08 SS24			Ana	alysis Date Tim	e 16/06/2023 2:0	1:27 PM				
sc	• OP File Name Sediment.mso	qc		Measurer	nent Date Tim	e 16/06/2023 2:0	1:27 PM				
	Lab Number 2023133/35				Result Source	e Measurement					
Op	erator Name rodgers										
•	5										
Analysis			Result								
Pa	article Name Sediment				Concentratio	n 0.0796 %					
Particle Refr	ractive Index 1.500				Spa	n 5.215					
Particle Abso	rption Index 0.200			Uniformity 1.576							
Dispe	ersant Name Water			Specific Surface Area 60.61 m ² /kg							
Dispersant Refr	ractive Index 1.330			D [3,2] 99.0 μm							
Scatt	ering Model Mie			D [4,3] 763 μm							
An	alysis Model General Purpe	ose			Dv (10	0) 89.9 µm					
Weigh	ted Residual 0.48 %			Dv (50) 370 μm							
Laser	Obscuration 6.19 %			Dv (90) 2020 μm							
				Dv (95) 2440 μm							
				Volume Below (31) μm 5.87 %							
Frequency (compatible)											
	1	1	1		1						
© 4			10.0 Size Classes (μm) 8 SS24-16/06/2023 2:01:2	т т т т т т т т т 10 27 рм		1,000.0		00.0			
Recult											
Size (um) % Volume Unde	er Size (um) % Volume	Under Size (um)	% Volume Under	Size (um) % V	olume Under	Size (um) % V	olume Under				
	0 780	1.76 88.0	0 82	350	<u>48</u> <u>4</u> 0	1410	79.00				
0.0600 0.0	0 15.6	3.49 105	11.47	420	53.27	1680	84.43				
0.120 0.0	0 31.0	5.87 125	14.11	500	56.93	2000	89.74				
0.240 0.0	0 37.0	6.60 149	18.25	590	59.85	2380	94.45				
0.490 0.0	0 44.0	7.27 177	23.61	710	62.95	2830	97.81				
0.980 0.0	0 53.0	7.91 210	29.86	840	66.01	3360	99.69				



2.00

3.90

0.00

0.55

63.0

74.0

8.43

8.96

250

300

36.66

43.44

1000

1190

69.73

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Measurement Details Sample Name 3.09 SS25						Measurement Details							
	Sam	ple Name 3.0	9 SS25					Analysis Date Tir	ne 16/06/202	23 2:08:35 PM			
	SOP	File Name Se	diment.msop				Mea	surement Date Tir	ne 16/06/202	23 2:08:35 PM			
	La	b Number 20)23133/36					Result Sour	ce Measuren	nent			
	Opera	tor Name roo	dgers										
						N							
Analysis	Davit	iala Nama Ca	diment		ĸ	Kesult		Componentiati	am 0 2001 0/				
	Particle Pofrac	tive Index 1 F				Snan 4 622							
	Particle Abcorn	tion Index 0.2	200					Juniform	all 4.022				
						Specific Surface Area 22.98 m ² /kg							
	Dispers		ater				2	Specific Surface Ar	ea 22.98 m ⁻ /	кд			
	Dispersant Refrac	tive index 1.3	30					D [3	, 2] 261 μm				
	Scatter	ng Model Mi	e					D [4	, 3] 564 μm				
	Analy	rsis Model Ge	eneral Purpose					Dv (1	0) 145 μm				
	Weighte	d Residual 0.4	17 %					Dv (5	i0) 288 μm				
	Laser Ob	.87 %				Dv (90) 1480 μm							
							Dv (9	1980 μm					
						Vo	lume Below (31) µ	Im 0.33 %					
Frequency (compatible)												
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10	requency (compatible)							\wedge					
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				[1701 0.00	Size Class	es (μm)	DM						
				[176] 3.05	5525-16/06/202	3 2:08:35	PIM						
Result													
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume U	nder	Size (µm)	% Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	0.00	88.0		0.57	350	59.46	1410	89.09			
0.0600	0.00	15.6	0.17	105		1.91	420	65.58	1680	92.36			
0.120	0.00	31.0	0.33	125		5.13	500	69.68	2000	95.17			
0.240	0.00	37.0	0.33	149	1	1.34	590	72.63	2380	97.46			
0.490	0.00	44.0	0.33	177	2	20.04	710	75.65	2830	99.01			
0.980	0.980 0.00 53.0 0.33 210					0.42	840	78.62	3360	99.86			
2.00	0.00	63.0	0.33	250	4	1.55	1000	82.04					



3.90

0.00

74.0

0.33

300

52.15

1190



Measureme	Measurement Details Sample Name 4.01 1A					Moasur	omont Dotail	c						
wiedsurenne	Som		Ivieasui		Analysis Da	to Tir	na 16/06/20	00 0·1E·2E	DM					
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	La	tor Nama ra	023133/30					Resul	L SOUI		nent			
	Opera		lugers											
Analysis				Result										
	Part				Conce	ntrati	on 0.0642 %							
	Particle Refrac	tive Index 1.	500						Sp	an 2.911				
	Particle Absorp	tion Index 0.	200					Un	iformi	i ty 0.957				
	Dispers	ant Name W	/ater				9	Specific Surfa	ice Ar	ea 373.8 m²/	kg			
	Dispersant Refractive Index 1.330 Scattering Model Mie								D [3,	, 2] 16.1 μm				
	Scattering Model Mie Analysis Model General Purpose								D [4,	, 3] 191 μm				
	Analysis Model General Purpose Weighted Residual 0.31 %								Dv (1	0) 6.45 μm				
	Weighted Residual 0.31 % Laser Obscuration 25.71 %								Dv (5	0) 143 μm				
	Laser Obscuration 25.71 %						Dv (90) 423 μm							
							Dv (95) 642 μm							
							Va	lume Below	(31) µ	im 23.96 %				
Frequency	(compatible)													
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				[177] / 04	Size Clas	sses (µm)	264							
				[177] 4.01	IA-10/00/202	25 2:15:35								
Result														
Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume	Under	Size (um)	% Volume II	nder	Size (um)	% Volum	e Under		
0.0500	0.00	7 80	11 72	88.0		33.90	350	۶	6.46	1410		99.93		
0.0600	0.00	15.6	17 94	105		38 30	420	6	9.88	1680		100.00		

0.0500	0.00	7.80	11.72	88.0	33.90	350	86.46	1410	99.93	
0.0600	0.00	15.6	17.94	105	38.30	420	89.88	1680	100.00	
0.120	0.00	31.0	23.96	125	44.25	500	92.30	2000	100.00	
0.240	0.00	37.0	25.43	149	51.87	590	94.16	2380	100.00	
0.490	0.00	44.0	26.75	177	60.18	710	95.96	2830	100.00	
0.980	1.18	53.0	28.08	210	68.44	840	97.42	3360	100.00	
2.00	2.67	63.0	29.44	250	75.94	1000	98.65			
3.90	5.97	74.0	31.13	300	82.34	1190	99.49			







Size (µm)	% Volume Under									
0.0500	0.00	7.80	32.71	88.0	83.54	350	98.70	1410	100.00	
0.0600	0.00	15.6	49.55	105	85.57	420	99.56	1680	100.00	
0.120	0.00	31.0	65.50	125	87.56	500	99.95	2000	100.00	
0.240	0.00	37.0	69.34	149	89.61	590	100.00	2380	100.00	
0.490	0.05	44.0	72.87	177	91.69	710	100.00	2830	100.00	
0.980	3.90	53.0	76.31	210	93.76	840	100.00	3360	100.00	
2.00	8.64	63.0	79.09	250	95.74	1000	100.00			
3.90	17.69	74.0	81.37	300	97.53	1190	100.00			





Measurer	nent Details				Measu	rement Details							
	Sam	ple Name 4.03	1C			An	alysis Date Tin	ne 16/06/2023	2:30:07 PM				
	SOP	File Name Sedi	ment.msop			Measure	ment Date Tin	ne 16/06/2023	2:30:07 PM				
	Lal	b Number 202	3133/39				Result Sour	ce Measureme	ent				
	Opera	tor Name rodg	jers										
Analysis					Result								
	Part	icle Name Sedi	ment				Concentratio	on 0.0597 %					
	Particle Refrac	tive Index 1.50	0				Spa	an 3.730					
	Particle Absorpt	tion Index 0.200	0				Uniformi	ty 1.194					
	Dispers	ant Name Wate	er			Spec	ific Surface Are	ea 383.7 m²/kg	g				
	Dispersant Refrac	tive Index 1.330	0				D [3,	2] 15.6 μm					
	Scatteri	ng Model Mie					D [4,	3] 254 μm					
	Analy	sis Model Gene	eral Purpose				Dv (1	0) 6.40 μm					
	Weighted	d Residual 0.32	%			Dv (50) 162 μm							
	Laser Ob			Dv (90) 610 μm									
					Dv (95) 944 μm								
						Volum	e Below (31) μ	m 23.31 %					
Frequenc	v (compatible)												
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					Size Classes (µm)								
				[179] 4.03	1C-16/06/2023 2:30:07	PM							
Rocul+													
Size (ur	n) % Volume Under	Size (µm) %	Volume Under	Size (µm)	% Volume Under	Size (µm) % V	olume Under	Size (µm)	% Volume Under				
0.050	0.00	7.80	11.66	88.0	31.86	350	80.46	1410	98.15				
0.060	0.00	15.6	17.42	105	35.26	420	84.42	1680	98.92				
0.12	20 0.00	31.0	23.31	125	40.06	500	87.32	2000	99.42				

0.0000	0.00	15.0	17.42	103	55.20	420	04.42	1000	90.92	
0.120	0.00	31.0	23.31	125	40.06	500	87.32	2000	99.42	
0.240	0.00	37.0	24.80	149	46.57	590	89.59	2380	99.75	
0.490	0.00	44.0	26.12	177	54.02	710	91.85	2830	99.94	
0.980	1.34	53.0	27.37	210	61.79	840	93.77	3360	100.00	
2.00	2.95	63.0	28.50	250	69.24	1000	95.56			
3.90	6.27	74.0	29.78	300	75.92	1190	97.04			





Measureme	ent Details					Measur	ement Details								
	Sam	ple Name 4.0	4 1D				An	alysis Date Tim	e 16/06/202	3 2:44:15 PM					
	SOP	File Name Sec	diment.msop				Measure	ment Date Tim	e 16/06/202	3 2:44:15 PM					
	Lal	Number 20	23133/40					Result Sourc	e Measurem	nent					
	Opera	tor Name roo	lgers												
Analysis						Result									
	Part	i cle Name Seo	diment					Concentratio	n 0.0396 %						
	Particle Refrac	tive Index 1.5	00					Spa	n 2.970						
	Particle Absorpt	ion Index 0.2	00					Uniformit	y 1.117						
	Dispers	ant Name Wa	iter				Spec	ific Surface Are	a 513.0 m²/k	kg					
	Dispersant Refractive Index 1.330 Scattering Model Mie							D [3,2	!] 11.7 μm						
	Scattering Model Mie Analysis Model General Purpose							D [4,3] 145 μm						
	Analysis Model General Purpose Weighted Residual 0.36 %						Dv (10) 4.65 μm								
	Weighted Residual 0.36 % Laser Obscuration 22.11 %						Dv (50) 103 μm								
	Laser Obscuration 22.11 %							Dv (90)) 312 μm						
	Laser Obscuration 22.11 %						Dv (95) 465 μm								
							Volum	e Below (31) μr	n 32.66 %						
Frequency	(compatible)														
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				[100] 4.04	Size Clas	ses (µm)									
				[180] 4.04	1D-16/06/202	3 2:44:15 1	M								
Result															
Size (µm)) % Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume	Under	Size (µm) % V	/olume Under	Size (µm)	% Volume Under					
0.0500	0.00	7.80	15.62	88.0		45.97	350	92.06	1410	99.90					
0.0600	0.00	15.6	23.88	105		50.47	420	94.16	1680	100.00					
0.120	0.120 0.00 31.0 32.66 125						500	95.48	2000	100.00					
0.240	0.00	27.0	24 07	140		62.25	E00	06.42	2200	100.00					

0.120	0.00	31.0	32.66	125	56.25	500	95.48	2000	100.00	
0.240	0.00	37.0	34.87	149	63.35	590	96.43	2380	100.00	
0.490	0.00	44.0	36.87	177	70.82	710	97.42	2830	100.00	
0.980	1.77	53.0	38.87	210	78.01	840	98.29	3360	100.00	
2.00	3.98	63.0	40.77	250	84.19	1000	99.06			
3.90	8.38	74.0	42.88	300	89.14	1190	99.60			



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Measurem	ent Details				Meas	urement Details							
	Sam	ple Name 4.06 1F					Analysis Date Tim	ne 16/06/2023 2:5	52:18 PM				
	SOP	File Name Sedime	ent.msop			Meas	urement Date Tim	ne 16/06/2023 2:5	2:18 PM				
	Lal	b Number 20231	33/41				Result Source	ce Measurement					
	Opera	tor Name rodger	S										
Analysis					Resul	t							
	Part	icle Name Sedime	ent				Concentratio	on 0.1347 %					
	Particle Refrac	tive Index 1.500					Spa	in 1.359					
	Particle Absorpt	tion Index 0.200					Uniformi	ty 0.841					
	Dispers	ant Name Water				Sp	pecific Surface Are	a 77.89 m²/kg					
	Dispersant Refrac	tive Index 1.330					D [3,2	2] 77.0 μm					
	Scatteri	ng Model Mie					D [4,	3] 279 μm					
	Analy	sis Model Genera	l Purpose				Dv (1	0) 102 μm					
	Weighted	d Residual 0.38 %				Dv (50) 182 μm							
	Laser Ob	scuration 12.94 %	6			Dv (50) 182 μm Dv (90) 350 μm							
							Dv (9	5) 1150 μm					
						Volu	ume Below (31) µ	m 5.61 %					
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Frequency	(compatible)	1											
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0.0		0.1	1.0	— [181] 4.06	Size Classes (μ 1F-16/06/2023 2:52:1	m) 8 PM	100.0	1,000.0	10,000.0				
Result													
Size (µm	n) % Volume Under	Size (µm) % V	olume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm) % V	olume Under				
0.050	0 0.00	7.80	2.26	88.0	6.97	350	90.00	1410	96.70				
0.060	0 0.00	15.6	3.97	105	10.94	420	91.75	1680	97.92				
0.12	0 0.00	31.0	5.61	125	18.80	500	92.09	2000	98.84				
0.24	0.00	37.0	5.72	149	31.62	590	92.11	2380	99.46				
0.49	0.00	44.0 53.0	5.72	210	47.13 62 91	710 840	92.23	2830 3360	99.81 99.98				



2.00

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weasurenie		. I. N	7.10		Iviedsu	rement Details		10,000,000	2 2.00.2C PM				
	Sam	ple Name 4.0	7 1G				Analysis Date Tin	ne 16/06/202	23 3:00:26 PM				
	SOP	File Name Sec	diment.msop			Mea	surement Date Tin	ne 16/06/202	23 3:00:26 PM				
	La	b Number 20	23133/42				Result Sour	ce Measurem	ient				
	Opera	tor Name roo	lgers										
Analysis					Result								
	Part	icle Name Sec	diment				Concentratio	on 0.2095 %					
	Particle Refrac	tive Index 1.5	00			Span 4.229							
	Particle Absorpt	tion Index 0.2	00			Uniformity 1.223							
	Dispers	ant Name Wa	iter			Specific Surface Area 92.44 m ² /kg							
	Dispersant Refract	tive Index 13	30			D [3,2] 64.9 µm							
	Scatteri	na Model Mi	2			D [4,3] 467 um							
	Analy	rsis Model Ga	neral Purnose			Dv (10) 95.9 μm							
	Weighted Residual 0.30 % Laser Obscuration 22.21 %						Dv (10) 95.9 μm Dv (50) 260 μm						
					Dv (50) 260 μm Dv (90) 1190 μm								
	Laser OL		21 /0			Dv (90) 1190 μm Dv (95) 1710 μm							
						Vo	DV (9 Jume Below (31) u	m 720%					
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					Size Classes (µm)		.,					
				[182] 4.07	1G-16/06/2023 3:00:26	PM							
Result	% Volume Under	Sizo (um)	% Volume Under	Size (um)	% Volumo Under	Size (um)	% Volume Under	Size (um)	% Volume Under				
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0.0500	0.00	7.8U 15 G	5.UT 5.10	۵۵.U ۱۵۶	9.12 11 /1	32U 320	03.47 60 5 5	1410 1620	92.40 Q1 77				
0.0000	0.00	31.0	7 20	105	15.43	420 500	74 18	2000	96.72				
0.120	0.00	37.0	7.20	149	21 76	500	77.80	2380	98.29				
0.490	0.00	44.0	7.96	177	29.73	710	81.28	2830	99.34				
0.980	0.13	53.0	8.08	210	38.69	840	84.23	3360	99.91				
2.00	0.18	63.0	8.08	250	48.01	1000	87.16	5550					
3.90	1.15	74.0	8.25	300	56.97	1190	89.94						



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Measureme	ent Details				Meas	urement Details							
	Sam	ple Name 4.08	1H			Analysis Date Time 16/06/2023 3:08:45 PM Measurement Date Time 16/06/2023 3:08:45 PM							
	SOP	File Name Sedi	iment.msop			Measu	urement Date Tin	ne 16/06/2023 3	3:08:45 PM				
	Lal	b Number 202	3133/43				Result Sour	ce Measuremen	nt				
	Opera	tor Name rode	gers										
Analysis					Resul	t							
	Part	icle Name Sed	iment				Concentratio	on 0.0415 %					
	Particle Refrac	tive Index 1.50	0			Span 1.905							
	Particle Absorpt	tion Index 0.20	0			Uniformity 0.598							
	Dispers	ant Name Wat	er			Specific Surface Area 365.0 m ² /kg							
	Dispersant Refract	tive Index 1.33	0			D [3,2] 16.4 μm							
	Scatteri	ng Model Mie				D [4,3] 144 μm							
	Analy	isis Model Gen	eral Purpose			Dv (10) 6.70 μm							
	Weighted	d Residual 0.40	%			Dv (50) 147 μm							
	Laser Ob				Dv (9	0) 286 μm							
				Dv (9	5) 330 μm								
				Volu	ume Below (31) µ	m 24.98 %							
Frequency	requency (compatible)												
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0.0	1	0.1	1.0		10.0		100.0	1,000.0)	10,000.0			
				[183] 4.08	Size Classes (µ1	m) 15 PM							
				[100] 100									
Result													
Size (µm)) % Volume Under	Size (µm) %	6 Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm) %	Volume Under				
0.0500	0.00	7.80	11.45	88.0	32.16	350	96.68	1410	100.00				
0.0600	0.00	15.6	18.16	105	35.85	420	99.37	1680	100.00				
0.120	0.00	31.0	24.98	125	41.90	500	100.00	2000	100.00				
0.240	0.00	37.U 11 0	20.05 28.01	149 177	50.93 61 71	590 710	100.00	238U 2830	100.00				
0.980) 1.11	53.0	29.04	210	73.03	840	100.00	3360	100.00				



2.00

3.90

2.49

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63.0

74.0

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100.00



Measureme	ent Details					Measur	ement Details	i					
	Sam	ple Name 5.0	1 2A					Analysis Date	Time 19/06/20	23 3:44:19 PM			
	SOP	File Name Sec	liment.msop				Meas	urement Date	Time 19/06/20	23 3:44:19 PM			
	La	b Number 20	23133/44					Result Se	ource Measurer	nent			
	Opera	ator Name roo	lgers										
Analysis						Result							
	Part	icle Name Sec	diment					Concentr	ation 0.0269 %				
	Particle Refrac	tive Index 1.5	00						Span 4.414				
	Particle Absorp	tion Index 0.2	00					Unifo	r mity 1.430				
	Dispers	ant Name Wa	ter				Sp	pecific Surface	Area 688.8 m ² /	′kg			
	Dispersant Refrac	tive Index 1.3	30			D [3,2] 8.71 μm							
	Scatter	ing Model Mie	2			D [4,3] 81.8 μm							
	Analy	/sis Model Ge	neral Purpose			Dv (10) 3.46 μm							
	Weighte				Dv	r (50) 46.7 μm							
	Laser Ol				D	r (90) 210 μm							
							D	r (95) 247 μm					
							Vol	ume Below (31) μm 42.15 %				
Frequency	(compatible)												
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				[184] 5.01	Size Clas 2A-19/06/202	ses (µm) 3 3:44:19	РМ						
Result													
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume	Under	Size (µm)	% Volume Und	er Size (µm)	% Volume Un	der		
0.0500	0.00	7.80	20.65	88.0		61.71	350	99.9	1410	100	0.00		
0.0600	0.00	15.6	30.90	105		65.83	420	100.0	1680	100	0.00		
0.120	0.00	31.0	42.15	125		70.83	500	100.0	2000	100	.00		

0.120	0.00	31.0	42.15	125	70.83	500	100.00	2000	100.00	
0.240	0.00	37.0	45.52	149	76.99	590	100.00	2380	100.00	
0.490	0.04	44.0	48.85	177	83.62	710	100.00	2830	100.00	
0.980	2.56	53.0	52.36	210	90.05	840	100.00	3360	100.00	
2.00	5.57	63.0	55.47	250	95.28	1000	100.00			
3.90	11.31	74.0	58.36	300	98.77	1190	100.00			







Size (µm)	% Volume Under									
0.0500	0.00	7.80	24.10	88.0	72.16	350	98.67	1410	100.00	
0.0600	0.00	15.6	36.01	105	75.51	420	99.75	1680	100.00	
0.120	0.00	31.0	48.70	125	78.83	500	100.00	2000	100.00	
0.240	0.00	37.0	52.64	149	82.40	590	100.00	2380	100.00	
0.490	0.03	44.0	56.70	177	86.16	710	100.00	2830	100.00	
0.980	2.85	53.0	61.15	210	90.02	840	100.00	3360	100.00	
2.00	6.38	63.0	65.16	250	93.69	1000	100.00			
3.90	13.13	74.0	68.67	300	96.82	1190	100.00			



Malvern Instruments



Measureme	nt Details				Me	easurement Deta	ils					
Wedstarenie	Sam	nlo Namo 50	13.20		Analysis Date Time 19/06/2023 3:59:25 PM Measurement Date Time 19/06/2023 3:59:25 PM							
	SOP	File Name So	dimont moon			Мо	analysis Date Til	ne 19/06/202	22 2.50.25 DM			
		h Number 20	122122///6			IVIE	Posult Sour					
	Onora		daora				Result Sou		ient			
	Opera		ugers									
Analysis					Re	sult						
	Part	i cle Name Se	diment				Concentrati	on 0.2777 %				
	Particle Refrac	tive Index 1.5	500			Span 2.710						
	Particle Absorpt	tion Index 0.2	200			Uniformity 0.801						
	Dispers	ant Name Wa	ater			Specific Surface Area 80.77 m ² /kg						
	Dispersant Refrac	tive Index 1.3	330			D [3,2] 74.3 μm						
	Scatteri	ng Model Mi	e			D [4,3] 849 μm						
	Analy	sis Model Ge	neral Purpose			Dv (10) 107 μm						
	Weighted	d Residual 0.4	15 %			Dv (50) 656 μm						
	Laser Ob	scuration 25	.05 %			Dv (90) 1890 μm						
							Dv (9	95) 2320 μm				
						v	olume Below (31) J	ım 6.67 %				
Fraguanay	requency (compatible)											
	quency (compatible)						1		1	1		
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0.01		0.1	1.0		IU.U Size Classes	(um)	100.0	1,00	JU.U	10,000.0		
				[186] 5.03	2C-19/06/2023 3:5	59:25 PM						
Pocult												
Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Ling	der Size (um)	% Volume Under	Size (um)	% Volume Under			
0.0500		7 QO	2 K1	2020 (μΠ) 22 0			25 00	1/10	Ω1 ∩1			
0.0500	0.00	15.6	4 58	105	9.	.94 420	31 87	1680	86.66			
0.120	0.00	31.0	6.67	125	10	.61 500	38.46	2000	91.54			
0.240	0.00	37.0	7.21	149	11	.62 590	45.35	2380	95.56			
0.490	0.00	44.0	7.71	177	13	.06 710	53.47	2830	98.27			
0.980	0.18	53.0	8.22	210	15	.05 840	60.82	3360	99.76			
2.00	0.30	63.0	8.65	250	17.	.90 1000	68.13					



3.90

1.09

74.0

9.03

300

21.79

1190



Measureme	nt Details				Mea	surement Detail	ls					
	Sam	ple Name 5.	04 2D			Analysis Date Time 19/06/2023 4:06:35 PM Measurement Date Time 19/06/2023 4:06:35 PM						
	SOP	File Name Se	diment.msop			Mea	asurement Date Tin	ne 19/06/202	23 4:06:35 PM			
	La	b Number 2	023133/47				Result Sour	ce Measuren	nent			
	Opera	tor Name ro	dgers									
Analysis					Resu	lt						
	Part	icle Name Se	diment				Concentratio	on 0.0433 %				
	Particle Refrac	tive Index 1.	500				Spa	an 4.892				
	Particle Absorp	tion Index 0.	200				Uniformi	ty 1.670				
	Dispers	ant Name W	ater			9	Specific Surface Are	ea 630.2 m²/	kg			
	Dispersant Refrac	tive Index 1.	330				D [3,	2] 9.52 μm				
	Scatter	i ng Model M	ie			D [4,3] 114 μm						
	Analy	sis Model G	eneral Purpose			Dv (10) 3.59 μm						
	Weighte	d Residual 0.	43 %			Dv (10) 5.59 μm Dv (50) 58.0 μm						
	Laser Ol	oscuration 28	8.75 %			Dv (50) 58.0 μm Dv (90) 287 μm						
						Dv (90) 287 μm Dv (95) 373 μm						
						Va	olume Below (31) μ	m 40.11 %				
Frequency (compatible)											
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					Size Classes (µ	m)		.,				
				[187] 5.04	2D-19/06/2023 4:06:	35 PM						
Decult												
Kesult	% Volume Under	Size (up)	% Volumo Lador	Size (upp)	% Volume Linda		% Volume Lader	Size (up)	% Volumo Lindor			
								Size (µm)				
0.0500	0.00	1.80	19.88 20.76	88.U	56.54	+ 350 1 420	94.08	1410	100.00			
0.0000	0.00	31.0	29.70 40.11	105	64 18	3 500	90.44	2000	100.00			

0.0000	0.00	15.0	25.10	105	00.01	120	50.11	1000	100.00
0.120	0.00	31.0	40.11	125	64.18	500	97.86	2000	100.00
0.240	0.00	37.0	42.95	149	69.32	590	98.73	2380	100.00
0.490	0.00	44.0	45.73	177	74.98	710	99.35	2830	100.00
0.980	1.99	53.0	48.63	210	80.79	840	99.73	3360	100.00
2.00	5.13	63.0	51.24	250	86.26	1000	99.94		
3.90	10.93	74.0	53.69	300	91.03	1190	100.00		





Measureme	ent Details					Measur	ement Details						
	Sam	ple Name 5.0)5 2E				Α	nalysis Date Tin	ne 19/06/202	23 4:13:52 PM			
	SOP	File Name Se	diment.msop				Measur	ement Date Tin	ne 19/06/202	23 4:13:52 PM			
	La	b Number 2	023133/48					Result Sour	ce Measuren	nent			
	Opera	tor Name ro	dgers										
Analysis						Result							
	Part	icle Name Se	diment					Concentratio	on 0.0678 %				
	Particle Refrac	tive Index 1.	500					Spa	an 4.056				
	Particle Absorpt	tion Index 0.2	200					Uniformi	i ty 1.239				
	Dispers	ant Name W	ater				Spe	cific Surface Ar	ea 336.0 m²/	kg			
	Dispersant Refrac	tive Index 1.3	330				-	D [3,	2] 17.9 μm	-			
	Scatteri	i ng Model M	ie					D [4,	3] 297 μm				
	Analy	vsis Model Ge	eneral Purpose					Dv (1	0) 7.30 μm				
	Weighte	d Residual 0.3	31 %					Dv (5	0) 186 μm				
	Laser Ob	oscuration 24	.67 %			Dv (90) 763 μm							
							Dv (95) 1050 μm						
							Volur	ne Below (31) µ	m 23.22 %				
Frequency (compatible)												
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				[188] 5.05	Size Class 2E-19/06/2023	ses (µm) 4:13:52 P	М						
Result													
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume l	Jnder	Size (µm) %	Volume Under	Size (µm)	% Volume Under			
0.0500	0.00	7.80	10.59	88.0		31.59	350	72.89	1410	97.94			

Size (µm)	% Volume Under									
0.0500	0.00	7.80	10.59	88.0	31.59	350	72.89	1410	97.94	
0.0600	0.00	15.6	16.98	105	33.98	420	77.76	1680	98.92	
0.120	0.00	31.0	23.22	125	37.40	500	81.78	2000	99.49	
0.240	0.00	37.0	24.81	149	42.25	590	85.20	2380	99.81	
0.490	0.00	44.0	26.27	177	48.14	710	88.70	2830	99.96	
0.980	1.02	53.0	27.68	210	54.65	840	91.64	3360	100.00	
2.00	2.33	63.0	28.87	250	61.41	1000	94.30			
3.90	5.21	74.0	30.02	300	67.98	1190	96.41			



Malvern Instruments



Measurem	nent Details					Measure	ement Details						
Sample Name 5.06 2F							Analysis Date Time 19/06/2023 4:20:58 PM						
SOP File Name Sediment.msop							Measurement Date Time 19/06/2023 4:20:58 PM						
	Lal				Result Source	e Measurem	ent						
Operator Name rodgers													
Analysis						Result							
	Part	i cle Name Sedi	ment			Concentration 0.0611 %							
	Particle Refrac	tive Index 1.50	0					Spa	n 1.738				
	Particle Absorpt	ion Index 0.20	0					Uniformit	ty 0.519				
	Dispers	ant Name Wate	er				Speci	fic Surface Are	a 322.4 m²/k	g			
	Dispersant Refract	tive Index 1.33	0					D [3,2	2] 18.6 μm				
	Scatteri	ng Model Mie						D [4,3	3] 141 μm				
	Analy	sis Model Gene	eral Purpose					Dv (10	0) 8.17 μm				
	Weighted	Residual 0.48	%					Dv (50	0) 146 µm				
	Laser Ob	scuration 21.6	5 %					Dv (90	0) 262 μm				
								Dv (9	5) 296 μm				
							Volume	e Below (31) μι	m 21.44 %				
Frequency	/ (compatible)												
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				[189] 5.06	Size Class 2F-19/06/2023	ses (µm) 4:20:58 Pl	м						
				-									
Result													
Size (µn	n) % Volume Under	Size (µm) %	Volume Under	Size (µm)	% Volume U	Inder	Size (µm) % Vo	olume Under	Size (µm)	% Volume Under			
0.050	0.00	7.80	9.63	88.0		28.18	350	99.18	1410	100.00			
0.060	0.00	15.6	15.32	105	3	32.92	420	100.00	1680	100.00			
0.12	0.00	31.0	21.44	125	4	40.49	500	100.00	2000	100.00			
0.24	0.00	37.0	22.83	149	:	51.41	590	100.00	2380	100.00			
0.49	0.00	44.0	23.88	177	(64.00	710	100.00	2830	100.00			



0.980

2.00

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63.0

74.0

24.61

25.13

25.98

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300

76.69

87.56

95.49

840

1000

1190

100.00

100.00

100.00

3360



Measurement Details	Measurement Details					
Sample Name 5.07 2G	Analysis Date Time 19/06/2023 4:28:51 PM					
SOP File Name Sediment.msop	Measurement Date Time 19/06/2023 4:28:51 PM					
Lab Number 2023133/49	Result Source Measurement					
Operator Name rodgers						
Analysis	Result					
Particle Name Sediment	Concentration 0.0286 %					
Particle Refractive Index 1.500	Span 4.229					
Particle Absorption Index 0.200	Uniformity 1.398					
Dispersant Name Water	Specific Surface Area 561.6 m²/kg					
Dispersant Refractive Index 1.330	D [3,2] 10.7 μm					
Scattering Model Mie	D [4,3] 106 μm					
Analysis Model General Purpose	Dv (10) 4.27 μm					
Weighted Residual 0.42 %	Dv (50) 62.3 μm					
Laser Obscuration 18.03 %	Dv (90) 268 μm					
	Dv (95) 331 μm					
	Volume Below (31) μm 37.82 %					
Frequency (compatible)						
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Result						
Size (μm) % Volume Under Size (μm) % Volume Under Size (μm) % Volum	e Under Size (μm) % Volume Under Size (μm) % Volume Under					

% Volume Under	Size (µm)								
100.00	1410	96.03	350	55.82	88.0	17.03	7.80	0.00	0.0500
100.00	1680	98.28	420	59.58	105	26.54	15.6	0.00	0.0600
100.00	2000	99.43	500	64.14	125	37.82	31.0	0.00	0.120
100.00	2380	99.90	590	69.75	149	41.05	37.0	0.00	0.240
100.00	2830	100.00	710	75.91	177	44.18	44.0	0.00	0.490
100.00	3360	100.00	840	82.15	210	47.38	53.0	1.84	0.980
		100.00	1000	87.95	250	50.18	63.0	4.34	2.00
		100.00	1190	92.92	300	52.78	74.0	9.11	3.90



Malvern Instruments



Measureme	Measurement Details					Measurement Details						
Sample Name 5.08 3289872.6						Analysis Date Time 20/06/2023 11:55:55 AM						
SOP File Name Sediment.msop							Measurement Date Time 20/06/2023 11:55:55 AM					
	Lal	Number 2023	139/6			Result Source Measurement						
Operator Name rodgers												
Analysis						Decult						
Analysis	Dort	icle Name Sodim	oot			Result		Conc	ontratio	m 0.0E91.9/		
	Particlo Pofrac	tive Index 1 500	lent					Conc	Sna	10.0301 /		
	Particle Absorpt	tion Index 0.200								• 0 508		
		ant Name Water					c.	nocific Sur		19 0.330	(a)	
	Dispers						S	pecific Sur		a 592.7 m /*	(y	
	Dispersant Refract								D [3,	2] 15.3 μm		
	Scatteri	ng Model Mie							D [4,	3] 128 μm		
	Analy	sis Model Gener	ral Purpose						Dv (1	0) 6.58 μm		
	Weighted	d Residual 0.38 %	6						Dv (5	0) 129 μm		
	Laser Ob	scuration 24.36	%						Dv (9	0) 254 μm		
									Dv (9	5) 291 μm		
							Vol	ume Belov	/ (31) μ	m 23.65 %		
Frequency (compatible)											
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				[1770] 22	Size Clas	ses (µm)						
				[1770] 52	09072.0-20/00/7	2023 11.3	5.55 AIVI					
Result												
Size (µm)	% Volume Under	Size (µm) %	Volume Under	Size (µm)	% Volume l	Jnder	Size (µm)	% Volume	Jnder	Size (µm)	% Volume Under	
0.0500	0.00	7.80	11.38	88.0		35.51	350		99.16	1410	100.00	
0.0600	0.00	15.6	16.96	105		40.71	420	1	00.00	1680	100.00	
0.120	0.00	31.0	23.65	125		48.17	500	1	00.00	2000	100.00	
0.240	0.00	37.0	25.61	149		58.17	590	1	00.00	2380	100.00	
0.490	0.00	44.0	27.40	177		69.25	710	1	00.00	2830	100.00	
0.980	1.40	53.0	29.10	210		80.12	840	1	00.00	3360	100.00	
2.00	2.99	63.0	30.64	250		89.27	1000	1	00.00			



3.90

6.17

74.0

32.45

300

95.97

1190



Measurement Details	Measurement Details					
Sample Name 5.09 3289872.4	Analysis Date Time 20/06/2023 11:21:31 AM Measurement Date Time 20/06/2023 11:21:31 AM					
SOP File Name Sediment.msop						
Lab Number 2023139/4	Result Source Measurement					
Operator Name rodgers						
Analysis	Result					
Particle Name Sediment	Concentration 0.0310 %					
Particle Refractive Index 1.500	Span 5.308					
Particle Absorption Index 0.200	Uniformity 1.929					
Dispersant Name Water	Specific Surface Area 647.7 m ² /kg					
Dispersant Refractive Index 1.330	D [3,2] 9.26 μm					
Scattering Model Mie	D [4,3] 116 μm					
Analysis Model General Purpose	Dv (10) 3.67 μm					
Weighted Residual 0.41 %	Dv (50) 51.8 μm					
Laser Obscuration 21.88 %	Dv (90) 279 μm					
	Dv (95) 437 μm					
	Volume Below (31) μm 41.43 %					
Frequency (compatible)						
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Size (µm) % volume under Size (µm) % volume under Size (µm) %	% volume under size (μm) % volume under size (μm) % volume under					

Size (µm)	% Volume Under									
0.0500	0.00	7.80	20.19	88.0	60.49	350	93.12	1410	99.98	
0.0600	0.00	15.6	30.84	105	64.86	420	94.72	1680	100.00	
0.120	0.00	31.0	41.43	125	69.62	500	95.88	2000	100.00	
0.240	0.00	37.0	44.32	149	74.70	590	96.83	2380	100.00	
0.490	0.00	44.0	47.21	177	79.63	710	97.81	2830	100.00	
0.980	2.25	53.0	50.41	210	84.16	840	98.63	3360	100.00	
2.00	5.05	63.0	53.56	250	88.01	1000	99.31			
3.90	10.67	74.0	56.71	300	91.15	1190	99.76			



Malvern Instruments



Measureme	nt Details	ails					Measurement Details				
Sample Name 5.10 3289872.1						Analysis Date Time 20/06/2023 10:57:30 AM					
	SOP	File Name Sed	liment.msop			Measurement Date Time 20/06/2023 10:57:30 AM					
	Lal	b Number 202	23139/1				Result Sour	ce Measurem	nent		
	Opera	tor Name rod	gers								
Analysis						t					
	Part	i cle Name Sed	liment				Concentratio	on 0.1119 %			
	Particle Refrac	tive Index 1.50	00				Spa	an 0.861			
	Particle Absorpt	tion Index 0.20	00				Uniformi	ity 0.287			
	Dispers	ant Name Wa	ter			S	Specific Surface Ar	ea 99.19 m²/l	kg		
	Dispersant Refract	tive Index 1.33	30				D [3,	, 2] 60.5 μm			
	Scatteri	ng Model Mie	9				D [4,	, 3] 179 μm			
	Analy	sis Model Ger	neral Purpose				Dv (1	0) 108 μm			
	Weighted	d Residual 0.63	3 %				Dv (5	i 0) 181 μm			
	Laser Ob	scuration 13.6	66 %				Dv (9	0) 263 μm			
							Dv (9	5) 287 μm			
						Vo	lume Below (31) µ	m 7.13 %			
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Frequency (compatible)						1			1	
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0.01		0.1	1.0		Size Classes (μι	n)	100.0	1,00	50.0	0,000.0	
				[1765] 328	39872.1-20/06/2023 10):57:30 AM					
Decult											
Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under	Size (um)	% Volume Under		
0.0500	0.00	7 80	3 24	88 0	7 74	350	99.93	1410	100.00		
0.0600	0.00	15.6	4.99	105	9.55	420	100.00	1680	100.00		
0.120	0.00	31.0	7.13	125	15.30	500	100.00	2000	100.00		
0.240	0.00	37.0	7.45	149	28.41	590	100.00	2380	100.00		
0.490	0.00	44.0	7.54	177	47.38	710	100.00	2830	100.00		
0.980	0.00	53.0	7.54	210	68.39	840	100.00	3360	100.00		
2.00	0.21	63.0	7.54	250	85.94	1000	100.00				
3.90	1.34	74.0	7.54	300	96.97	1190	100.00				



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Measurement Details Measurement Details	Measurement Details					
Sample Name 5.11 3289872.2 Analysis Date Time 20/06/2023 11:0	Analysis Date Time 20/06/2023 11:05:42 AM					
SOP File Name Sediment.msop Measurement Date Time 20/06/2023 11:0	Measurement Date Time 20/06/2023 11:05:42 AM					
Lab Number 2023139/2 Result Source Measurement						
Operator Name rodgers						
Analysis Result						
Particle Name Sediment Concentration 0.0588 %						
Particle Refractive Index 1.500 Span 2.072						
Particle Absorption Index 0.200 Uniformity 0.670						
Dispersant Name Water Specific Surface Area 468.3 m ² /kg						
Dispersant Refractive Index 1.330 D [3,2] 12.8 µm						
Scattering Model Mie D [4,3] 115 μm						
Analysis ModelGeneral PurposeDv (10) 5.11 μm						
Weighted Residual 0.36 % Dv (50) 112 μm						
Laser Obscuration 28.67 % Dv (90) 238 μm						
Dv (95) 277 μm						
Volume Below (31) μm 28.14 %						
Frequency (compatible)						
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[1766] 3289872.2-20/06/2023 11:05:42 AM						
Result						
Size (µm) % Volume Under Size (µm) % Vo	olume Under					
0.0500 0.00 7.80 14.27 88.0 40.98 350 99.20 1410	100.00					
0.0600 0.00 15.6 21.30 105 47.16 420 100.00 1680	100.00					
0.120 0.00 31.0 28.14 125 55.21 500 100.00 2000	100.00					
0.240 0.00 37.0 29.78 149 65.01 590 100.00 2380	100.00					
0.450 0.00 44.0 31.26 1/7 75.08 710 100.00 2830 0.080 1.62 52.0 22.82 210 94.27 940 100.00 2260	100.00					
2 00 3 59 63 0 34 61 250 91 73 1000 100.00 3360	100.00					



3.90

7.60

74.0

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300

96.86

1190
Analysis - Under

Malvern Instruments



Measurement Details					М	Measurement Details					
Sample Name 5.12 3289872.3						Analysis Date Time 20/06/2023 11:14:18 AM					
SOP File Name Sediment.msop						Measurement Date Time 20/06/2023 11:14:18 AM					
Lab Number 2023139/3								Result Sour	ce Measurem	nent	
Operator Name rodgers											
Analysis					Re	Result					
	Part	icle Name Sec	diment			Concentration 0.0250 %					
	Particle Refrac	tive Index 1.5	00			Span 3.567					
	Particle Absorpt	tion Index 0.2	00			Uniformity 1.200					
	Dispers	ant Name Wa	iter				Speci	ific Surface Ar	ea 614.7 m²/	kg	
	Dispersant Refrac	tive Index 1.3	30					D [3,	, 2] 9.76 μm		
	Scatteri	ing Model Mi	e					D [4,	, 3] 102 μm		
	Analy	/sis Model Ge	neral Purpose					Dv (1	0) 3.80 μm		
	Weighte	d Residual 0.4	6 %					Dv (5	0) 69.0 μm		
	Laser Ob	oscuration 17.	26 %					Dv (9	0) 250 μm		
								Dv (9	5) 304 μm		
							Volum	e Below (31) µ	1 m 38.70 %		
Frequency	(compatible)										
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Size Classes (μm) — [1767] 3289872.3-20/06/2023 11:14:18 AM											
Result											
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Un	der Size ((μm) % V	olume Under	Size (µm)	% Volume Under	
0.0500	0.00	7.80	19.40	88.0	54	.44	350	97.44	1410	100.00	
0.0600	0.00	15.6	29.20	105	58	.80	420	99.14	1680	100.00	
0.120	0.00	31.0	38.70	125	64	.16	500	99.83	2000	100.00	
0.240	0.00	37.0	41.20	149	70	.63	590	100.00	2380	100.00	

0.00

2.09

4.79

10.29

44.0

53.0

63.0

74.0

43.61

46.17

48.61

51.13

177

210

250

300

0.490

0.980

2.00

3.90

77.47

84.14

89.99

94.72

710

840

1000

1190

100.00

100.00

100.00

100.00

2830

3360

100.00

100.00

Density test results

Density Test result register

Sample Name	Particle Den	sitv a/cm3
earripre Harrie	1.01	3.55
	1.09	3.02
	1.14	2.77
	1.18	2.82
	2.03	2.94
	3.03	2.94
	4.01	2.71
	4.04	2.72
	5.02	2.64
	5.03	2.69
	5.09	1.49
	5.10	1.89
	5.11	1.59
	5.12	1.45
	5.13	1.64

Particle density measured using the Density Bottle (Small pyknometer) Method

Environmental test results



R J Hill Laboratories Limited 28 Duke Street Frankton 3204 Private Bag 3205 Hamilton 3240 New Zealand

Lab No:

6 **0508 HILL LAB** (44 555 22) 64 7 858 2000 mail@hill-labs.co.nz www.hill-labs.co.nz

3289872

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SPv5

Certificate of Analysis

Tonkin & Taylor

Client:

Contact:	Hayley Jones	5		Da	te Received:	30-May-2023		
	C/- Tonkin &	Taylor		Da	te Reported:	23-Jun-2023		
	PO Box 317	•		Qu	iote No:	124087		
	Tauranga 31	40		Or	der No:	Manukau Por	t	
	_			Cli	ent Reference:	Manukau Por	t	
					bmitted Bv:	Havley Jones	•	
Sample T	une: Sediment				,			
Sample Ty	ype. Sediment	Sample Name:	5 10 - Site 1	5 11 - Site 2	5 12 - Site 3	5.09 - Site 4	5 13 - Site 5	
	、	Sample Name.	25-May-2023 12:45 pm	25-May-2023 1:45 pm	25-May-2023 1:00 pm	25-May-2023 1:05 pm	25-May-2023 1:15 pm	
		Lab Number:	3289872.1	3289872.2	3289872.3	3289872.4	3289872.5	
Individual Te	ests							
Dry Matter		g/100g as rcvd	76	64	58	63	67	
Particle size	analysis* [‡]		See attached report	See attached report	See attached report	See attached report	See attached report	
Density*		g/mL at 20°C	1.89	1.59	1.45	1.49	1.64	
Total Recove	erable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	
Total Organi	c Carbon*	g/100g dry wt	0.11	0.42	0.65	0.45	0.35	
Heavy metals	s screen level As,	,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recove	erable Arsenic	mg/kg dry wt	< 2	8	10	12	11	
Total Recove	erable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	
Total Recove	erable Chromium	mg/kg dry wt	3	12	13	14	15	
Total Recove	erable Copper	mg/kg dry wt	< 2	4	4	4	5	
Total Recove	erable Lead	mg/kg dry wt	1.6	6.0	7.6	8.0	8.8	
Total Recove	erable Nickel	mg/kg dry wt	< 2	6	6	7	7	
Total Recove	erable Zinc	mg/kg dry wt	13	40	45	51	48	
Organochlor	ine Pesticides Ultr	raTrace in Soil						
Aldrin		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
alpha-BHC		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
beta-BHC		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
delta-BHC		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
gamma-BHC	C (Lindane)	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
cis-Chlordan	ie	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
trans-Chlord	ane	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
2,4'-DDD		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
4,4'-DDD		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
2,4'-DDE		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
4,4'-DDE		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
2,4'-DDT		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
4,4'-DDT		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Total DDT Is	somers	mg/kg dry wt	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	
Dieldrin		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Endosulfan I		mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007	
Endosulfan I	I	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Endosulfan s	sulphate	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Endrin		mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007	
Endrin aldeh	yde	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Endrin keton	e	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Heptachlor		mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	



Heptachlor

CCREDITED FSTING LABORATO

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Sediment							
Sa	mple Name:	Site 1 25-May-2023 12:45 pm	Site 2 25-May-2023 1:45 pm	Site 3 25-May-2023 1:00 pm	Site 4 25-May-2023 1:05 pm	Site 5 25-May-2023 1:15 pm	
L	ab Number:	3289872.1	3289872.2	3289872.3	3289872.4	3289872.5	
Organochlorine Pesticides UltraT	race in Soil						
Heptachlor epoxide	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004	
Hexachlorobenzene	mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007	
Methoxychlor	mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007	
Polycyclic Aromatic Hydrocarbon	s Screening in S	olids*					
Total of Reported PAHs in Soil	mg/kg dry wt	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	
1-Methylnaphthalene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
2-Methylnaphthalene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Acenaphthylene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Acenaphthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Anthracene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Benzo[a]anthracene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	< 0.031	< 0.037	< 0.041	< 0.038	< 0.036	
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	< 0.031	< 0.036	< 0.041	< 0.038	< 0.035	
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Benzo[e]pyrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Benzo[k]fluoranthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Chrysene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Fluoranthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Fluorene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Naphthalene	mg/kg dry wt	< 0.07	< 0.08	< 0.09	< 0.08	< 0.08	
Perylene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Phenanthrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Pyrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015	
Sa	mple Name:		Site	6 25-May-2023 1:2	5 pm		
L	ab Number:			3289872.6			
Individual Tests							
Dry Matter	g/100g as rcvd			74			
Particle size analysis* [‡]				See attached report			
Density*	g/mL at 20°C			1.82			
Total Recoverable Mercury	mg/kg dry wt			< 0.10			
Total Organic Carbon*	g/100g dry wt			0.30			
Heavy metals screen level As,Co	d,Cr,Cu,Ni,Pb,Zn	I					
Total Recoverable Arsenic	mg/kg dry wt			8			
Total Recoverable Cadmium	mg/kg dry wt			< 0.10			
Total Recoverable Chromium	mg/kg dry wt			13			
Total Recoverable Copper	mg/kg dry wt			3			
Total Recoverable Lead	mg/kg dry wt			4.7			
Total Recoverable Nickel	mg/kg dry wt			6			
Total Recoverable Zinc	mg/kg dry wt			38			
Organochlorine Pesticides UltraTrace in Soil							
Aldrin	mg/kg dry wt			< 0.0004			
alpha-BHC	mg/kg dry wt			< 0.0004			
beta-BHC	mg/kg dry wt			< 0.0004			
delta-BHC	mg/kg dry wt			< 0.0004			
gamma-BHC (Lindane)	mg/kg dry wt			< 0.0004			
cis-Chlordane	mg/kg dry wt			< 0.0004			
trans-Chlordane	mg/kg dry wt			< 0.0004			

Sample Type: Sediment		
Sar	nple Name:	Site 6 25-May-2023 1:25 pm
L	ab Number:	3289872.6
Organochlorine Pesticides UltraTi	race in Soil	
2,4'-DDD	mg/kg dry wt	< 0.0004
4,4'-DDD	mg/kg dry wt	< 0.0004
2,4'-DDE	mg/kg dry wt	< 0.0004
4,4'-DDE	mg/kg dry wt	< 0.0004
2,4'-DDT	mg/kg dry wt	< 0.0004
4,4'-DDT	mg/kg dry wt	< 0.0004
Total DDT Isomers	mg/kg dry wt	< 0.003
Dieldrin	mg/kg dry wt	< 0.0004
Endosulfan I	mg/kg dry wt	< 0.0007
Endosulfan II	mg/kg dry wt	< 0.0004
Endosulfan sulphate	mg/kg dry wt	< 0.0004
Endrin	mg/kg dry wt	< 0.0007
Endrin aldehyde	mg/kg dry wt	< 0.0004
Endrin ketone	mg/kg dry wt	< 0.0004
Heptachlor	mg/kg dry wt	< 0.0004
Heptachlor epoxide	mg/kg dry wt	< 0.0004
Hexachlorobenzene	mg/kg dry wt	< 0.0007
Methoxychlor	mg/kg dry wt	< 0.0007
Polycyclic Aromatic Hydrocarbons	Screening in S	Solids*
Total of Reported PAHs in Soil	ma/ka drv wt	< 0.4
1-Methylnaphthalene	mg/kg dry wt	< 0.013
2-Methylnaphthalene	mg/kg dry wt	< 0.013
Acenaphthylene	mg/kg dry wt	< 0.013
Acenaphthene	ma/ka drv wt	< 0.013
Anthracene	mg/kg dry wt	< 0.013
Benzo[a]anthracene	mg/kg dry wt	< 0.013
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.013
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	< 0.032
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	< 0.032
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.013
Benzo[e]pyrene	mg/kg dry wt	< 0.013
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.013
Benzo[k]fluoranthene	mg/kg dry wt	< 0.013
Chrysene	mg/kg dry wt	< 0.013
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.013
Fluoranthene	mg/kg dry wt	< 0.013
Fluorene	mg/kg dry wt	< 0.013
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.013
Naphthalene	mg/kg dry wt	< 0.07
Perylene	mg/kg dry wt	< 0.013
Phenanthrene	mg/kg dry wt	< 0.013
Pyrene	mg/kg dry wt	< 0.013

Analyst's Comments

[‡] Analysis subcontracted to an external provider. Refer to the Summary of Methods section for more details.

Appendix No.1 - Waikato University Report

Appendix No.2 - Density sample photos for 3289872

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Sediment								
Test	Method Description	Default Detection Limit	Sample No					
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6					
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	1-6					
Sample preparation by Non Routine section*	Sample preparation as per test requirement.	-	1-6					
Soil Prep Dry for Organics,Trace*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6					
Heavy metals screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1-6					
Organochlorine Pesticides UltraTrace in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.0002 - 0.003 mg/kg dry wt	1-6					
Polycyclic Aromatic Hydrocarbons Screening in Solids*	Sonication extraction, GC-MS/MS analysis. Tested on as received sample. In-house based on US EPA 8270.	0.010 - 0.05 mg/kg dry wt	1-6					
Dry Matter	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry), gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-6					
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-6					
Particle size analysis*	Malvern Laser Sizer particle size analysis from 0.05 microns to 3.4 mm. Samples are measured in volume %. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-6					
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1-6					
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-6					
Total Organic Carbon*	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1-6					

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 30-May-2023 and 23-Jun-2023. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

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Kim Harrison MSc Client Services Manager - Environmental

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