

APPENDIX 14C

DREDGE PLUME MODELLING ASSESSMENT



Dredge Plume Modelling

Dredging sediment plume dispersion over existing
and proposed port configurations

(Design July 2026)

Report prepared for MBIE

August 2026

Document History

Versions

Version	Revision Date	Summary	Reviewed by
0.1	21/07/2026	Initial document created	Montaño
0.2	03/08/2026	Draft for internal review	Montaño

Distribution

Version	Date	Distribution
1.0	07/08/2026	FINAL - MBIE Project team

Document ID: P0678 - 09

Authors

Berthot A., Montano M., Beamsley, B.

Contributors

Watson H.

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1.Introduction

Northport is a deep-water commercial port strategically situated at Marsden Point near Whangārei in Northland, New Zealand (Figure 1-1).

The Ministry of Business, Innovation and Employment (MBIE) seeks approvals pursuant to the Fast-track Approvals Act 2024 for a shipyard and drydock facility (Northland Shipyard and Drydock Facility, NSDF) abutting the western side of the existing Northport facility at Marsden Point. The project includes a reclamation, vessel haul-out system, and associated wharf structures, dredging and supporting infrastructure.

Key components of the project include:

1. Reclamation of approximately 9.5 hectares
2. A `cutout` to the reclamation where a vessel haul out system is to be located, being either a floating drydock, a shiplift or other lifting mechanism
3. Construction of a piled wharf structure to accommodate vessels either temporarily (before/after haul-out), or for extended periods where works not requiring haul out can be undertaken
4. Capital and maintenance dredging associated with construction and ongoing operation of the marine maintenance operations facility, including a berth pocket and a vessel turning basin to provide for safe navigation.
5. Fixed plan and buildings to accommodate marine maintenance activities and materials
6. Sufficient working and laydown areas for maintenance operations, including the ability to transfer vessels to hardstand
7. Access to and around the marine maintenance operations facility including a landside area for staff carparking
8. Public access around the edge of the reclamation to a public fishing platform.

MetOcean Solutions (MOS, a division of the Meteorological Service of New Zealand) has undertaken a number of earlier numerical hydrodynamic and morphological modelling simulations and dredged plume dispersion simulations related to operations and expansion of Northport, with results presented in MOS reports P0367-01 to P0367-06 (MetOcean Solutions, 2018a, 2018b, 2018c, 2018d, 2018e, 2018f), in 2021 reports P0519-01 to P0519-03 (MetOcean Solutions, 2021a, 2021b, 2021c) and in 2022 reports P0519-10 to P0519-13 (MetOcean Solutions, 2023, 2022a, 2022b).

The two proposed designs are the proposed shipyard and drydock facility (Design West) and the proposed shipyard and drydock facility AND recently consented Eastern



Reclamation (Design East and West). Both include dredging and reclamation areas and a piled wharf (see Figure 1-2 and Figure 1-3).

This technical report examines the characterisation of the dispersion of sediment plumes associated with the proposed dredging associated with the proposed shipyard and drydock facility, based on the update of the hydrodynamic models of the existing and proposed port configurations (MetOcean Solutions, 2026a).

The structure of this report is as follows. Section 1 presents a summary of previous study undertaken at the site and the datasets used in the study. Section 2 describes the methodology and model setup. In Section 3, results of dredged sediment plume modelling from both Existing and the two proposed bathymetry layouts are presented. Section 4 provides a summary of this report. A list of references is given in the last section of the document.

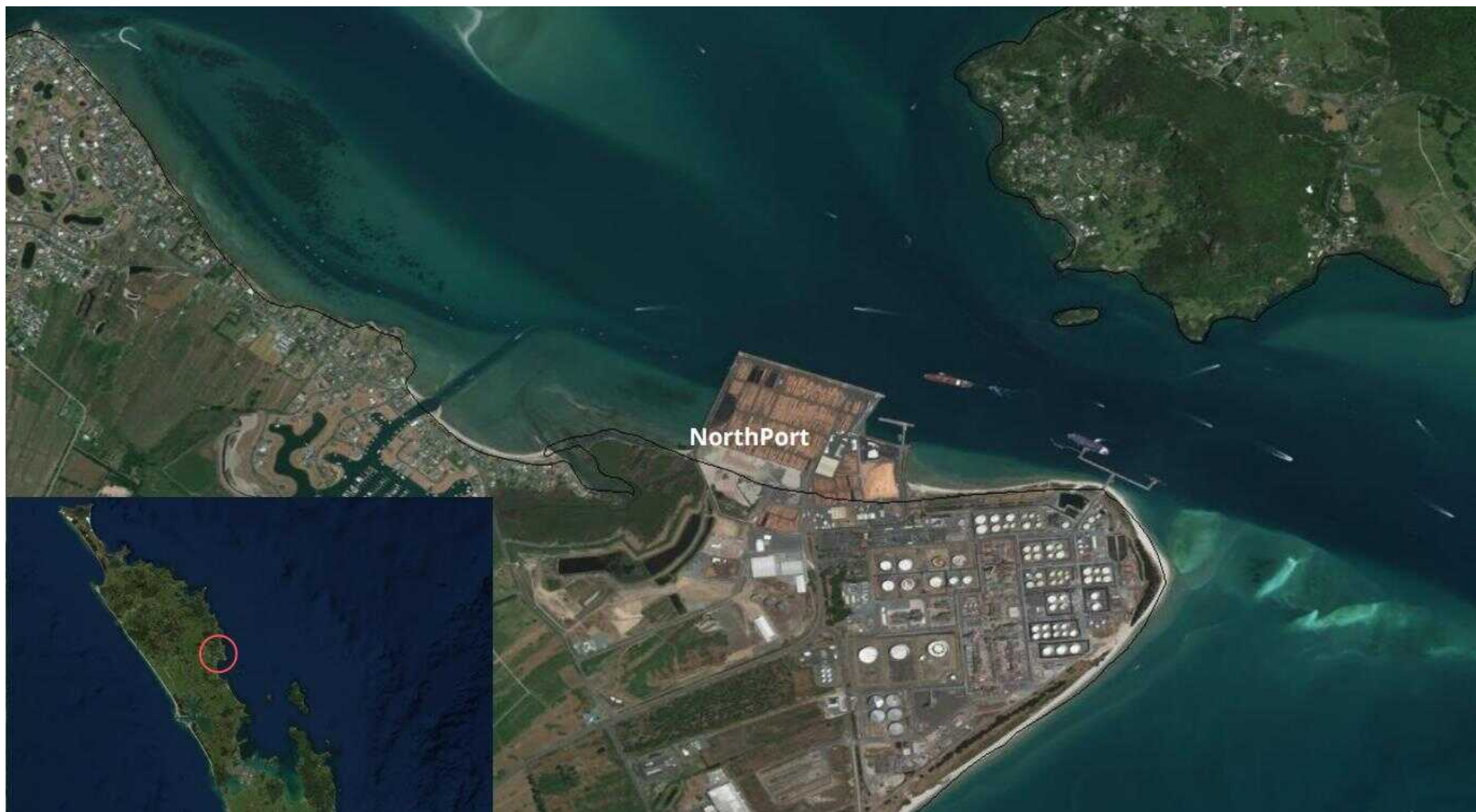


Figure 1-1 Location of Northport within Whangārei Harbour.



Figure 1-2 Concept drawing for the July 2026 design proposed area to be dredged and reclaimed for Design West.

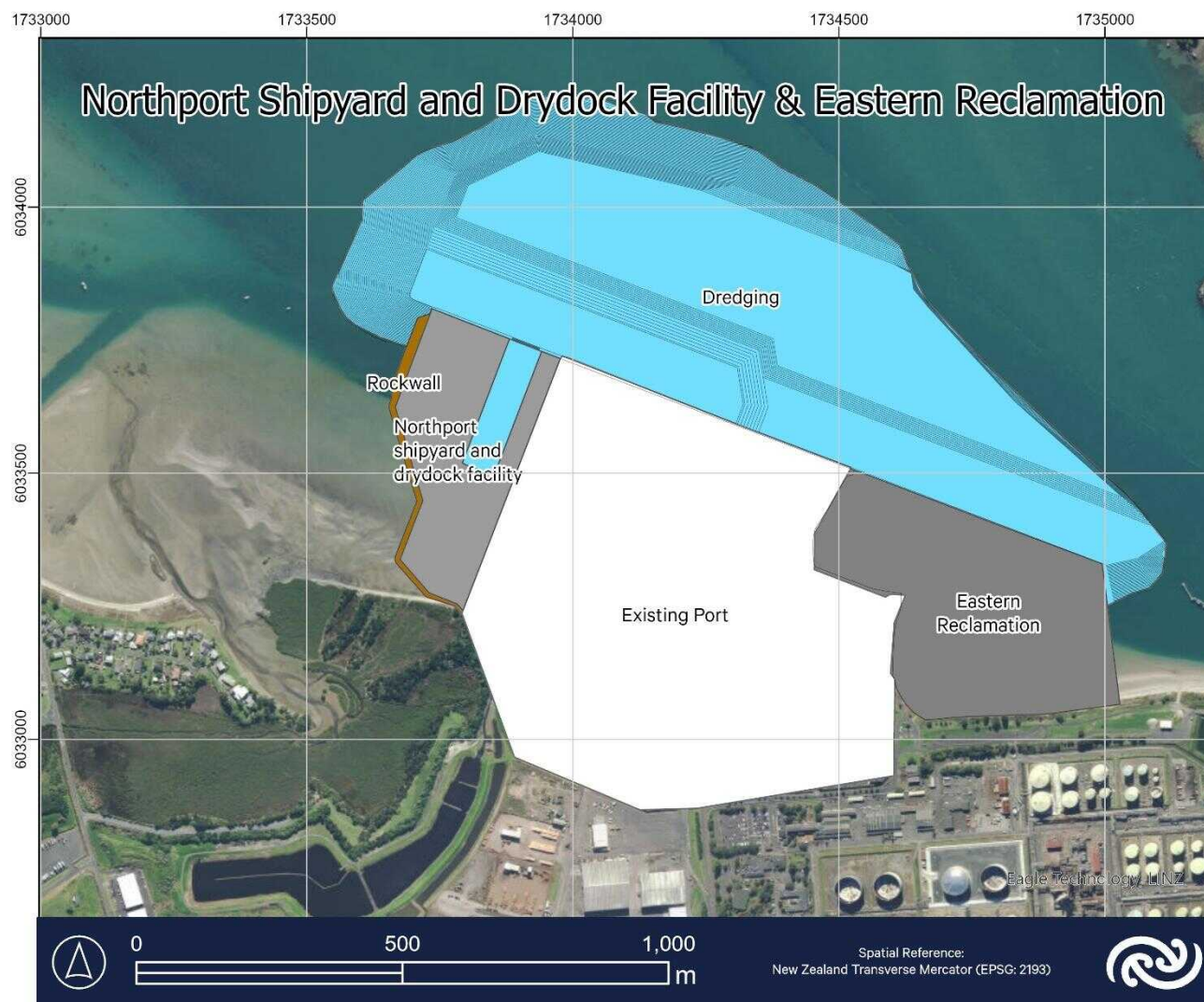


Figure 1-3 Concept drawing for the July 2026 design proposed area to be dredged and reclaimed for Design East and West.

2. Methodology

2.1 Approach

Over the last 15 years, MetOcean Solutions has undertaken several modelling studies of the Whangārei Harbour. The characterisation of the physical environment of the Whangārei Harbour and the establishment of wave, current and sediment dynamics numerical models began in 2015-2016 with the Refining New Zealand (RNZ) proposed deepening of the shipping channel to Marsden Point Refinery (MetOcean Solutions, 2016).

An actual release of sediment in the oceanic environment is a process that is finite in time (i.e. occurring at a specific time, over a finite period) and inherently non-deterministic (i.e. controlled by a range of random and unpredictable variables such as currents and turbulences). Since future ocean conditions and exact timing of the dredging works are unknown, it is not possible to predict the actual outcomes of a release before an event occurs. However, the probability of future oceanic conditions can be assessed from the historical conditions, thereby allowing statistical characterisation of the spatial dispersion of the suspended sediment plume patterns.

In the present study, dredging operations were simulated over a 1-month period for three different configurations:

- 1) the existing bathymetry (Existing),
- 2) the Eastern reclamation and NSDF (Design East and West), and
- 3) the NSDF (Design West).

A range of dredging locations (Figure 2-1 and Figure 2-2) and dredging methods were considered to assess the dispersion characteristics of the generated plumes. Dredge dewatering, the process of separating water from the solid material dredged, may be concurrent with or separate from the actual dredging within the reclamation enclosure. A dredge dewatering technical report is provided in Appendix C (MetOcean Solutions, 2026b)

2.2 Hydrodynamics

Details on the hydrodynamic model used to prepare the hydrodynamic dataset input for this dredged sediment plume modelling are provided in MetOcean Solutions (2026a).



2.3 Dredging Scenarios

It is expected that dredging operations will be undertaken using either a Backhoe Dredger (BHD), a Cutter Section Dredge (CSD) or a TSHD (Trailing Suction Hopper Dredge), depending on the location within the dredge area and the contractors the undertake the work.

For both the BHD and CSD options, the dredging vessels were assumed to operate continuously 24 hours a day, 7 days a week. The simulations were reproduced at 3 different sites (Figure 2-1, Table 2-1). For the TSHD we assumed 3 different dredge operation cycles depending on the area and based on the previously modelled TSHD operations (MetOcean Solutions, 2018e). The simulations were reproduced at 7 different sites (Figure 2-2) and were undertaken with both the existing and the dredged bathymetry to assess the dispersion of the plume as the dredging work progresses and the hydrodynamic changes with the deepening of the bathymetry locally. The month-long simulations at the different sites also allow capturing a wide Dredge Plume Modelling range of tidal and residual flows, and their spatial variability within the area to be dredged.

Table 2-1 Positions and depth of release sites of the dredging operation simulations for CSD and BHD methods. Depths are relative to mean sea level.

Site	Longitude	Latitude	Existing Depth (m)	Proposed Depth (m)
S1	174.4804	-35.8306	6.7	16.1
S2	174.4811	-35.8292	9.5	14.6
S3	174.4834	-35.8301	11.9	14.8
S4	174.4834	-35.8287	10.5	13.4

Table 2-2 Positions, cycle duration and depth of release sites of the dredging operation simulations for TSHD methods. Depths are relative to mean sea level.

Site	Longitude (°)	Latitude (°)	Depth (m)		Cycle duration (min)		
			Existing	Proposed	Infilling with no overflow	Infilling with overflow	Standby between infilling
S1	174.4829	-35.8284	10.5	19.6	12	51	152
S2	174.4808	-35.8303	8.4	16.1	12	51	152
S3	174.4850	-35.8317	15.1	16.1	12	113	100



S4	174.4874	-35.8293	14.1	19.6	12	113	100
S5	174.4892	-35.8329	17.0	17.6	12	59	142
S6	174.4910	-35.8319	16.5	19.6	12	59	142
S7	174.4937	-35.8343	16.2	17.6	12	59	142



Northport — CSD / BHD / Dewatering Sites

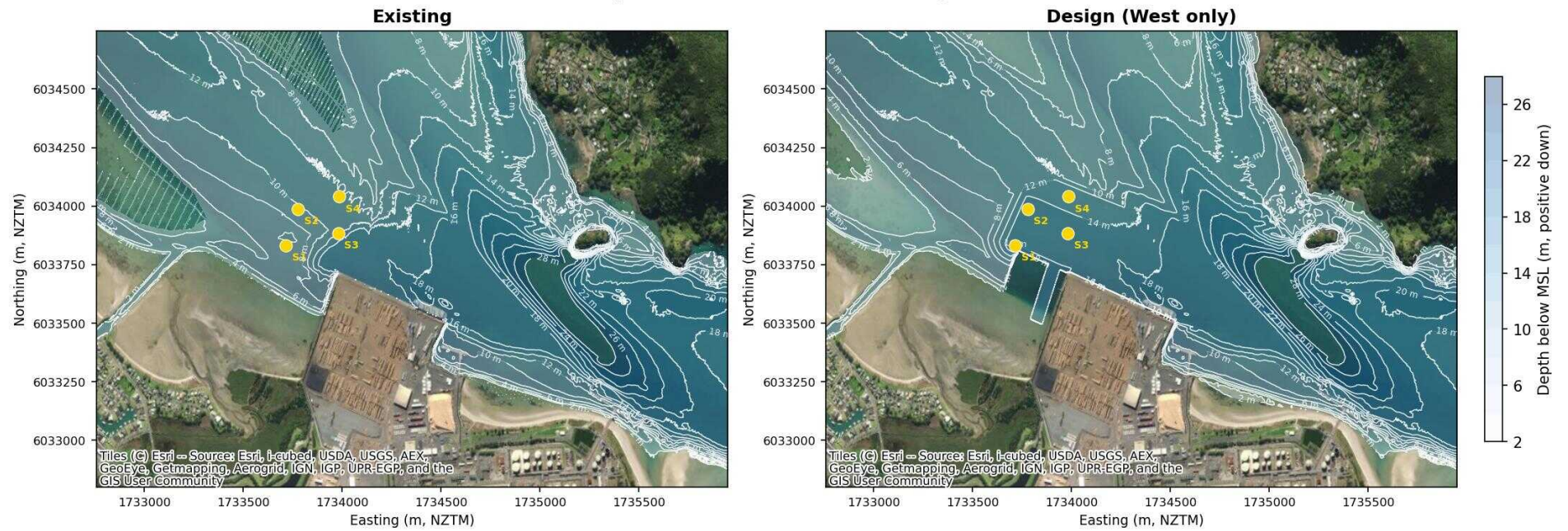


Figure 2-1 Release sites considered for the sediment dredging using CSD and BHD methods and the Existing (left) and proposed NSDF bathymetric contour around Northport.

Northport — TSHD Dredging Sites

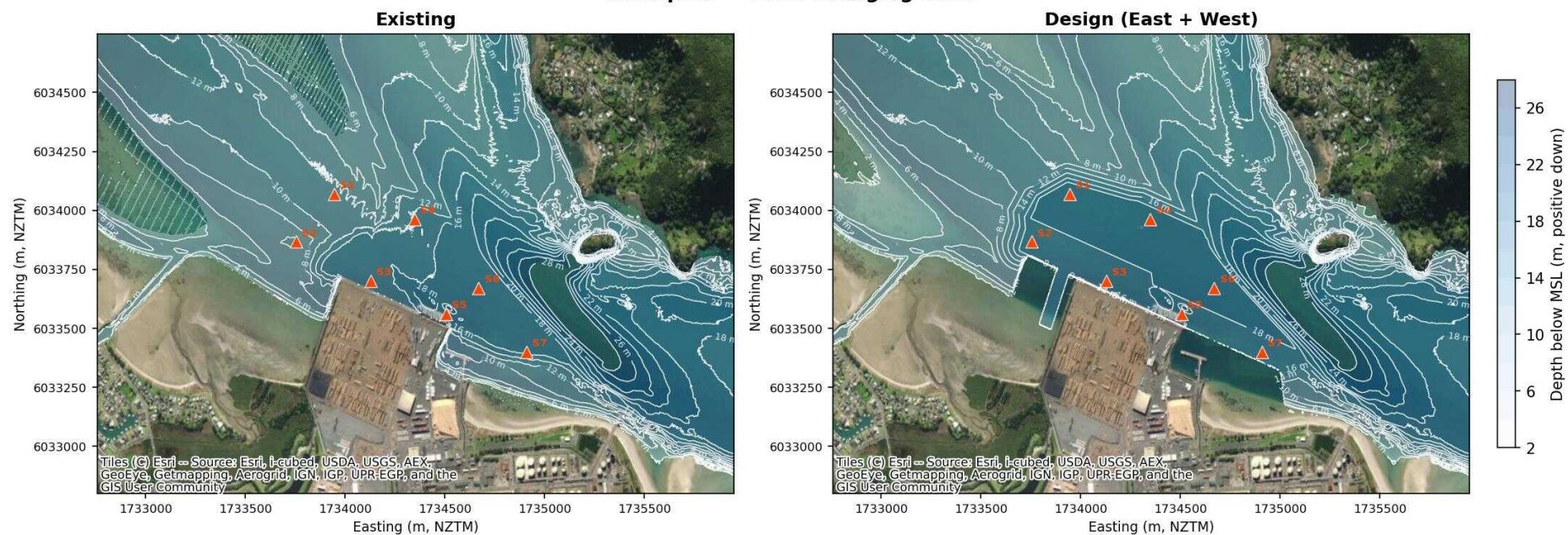


Figure 2-2 Release sites considered for the sediment dredging using TSHD methods and the Existing (left) and the proposed combined Eastern Reclamation and NSDF bathymetric contour around Northport.

2.3.1 Sediment Distribution

Two representative sediment distributions were assumed in the sediment plume modelling: a **silty sand**, and a **sandy silt** (Table 2-3 and Table 2-4).

The values for the four different sediment classes used were obtained from a previous report (MetOcean Solutions, 2018e), and remain appropriate. The coarse sand and gravel classes were not included in the simulation due to their fast settling and very low proportion.

Table 2-3 Sediment distribution for the silty sand and associated settling velocities.

Silty sand	Medium sand (0.2-0.6 mm)	Fine Sand (0.6-0.2 mm)	Silt (2-60 µm)	Clay (<2 µm)
Representative d50 [µm]	450	130	22.8	2
Proportion (%)	25	60	9	5
Settling velocity [m s⁻¹]	51.7e-3	9.2e-3	0.33e-3	0.2e-3

Table 2-4 Sediment distribution for the sandy silt and associated settling velocities.

Sandy silt	Medium sand (0.2-0.6 mm)	Fine Sand (0.6-0.2 mm)	Silt (2-60 µm)	Clay (<2 µm)
Representative d50 [µm]	450	130	22.8	2
Proportion (%)	3	48	31	17
Settling velocity [m s⁻¹]	51.7e-3	9.2e-3	0.33e-3	0.2e-3

2.3.2 Dredging source terms

The processes by which sediment is released and suspended in the water column during dredging operations vary with the type of dredger used. Consequently, the different dredging methods result in different source terms for the dispersion modelling.

Backhoe dredging consists of mechanically removing seabed sediment using a backhoe mounted on a barge (Figure 2-3). The principal sources of sediment suspension when using a BHD are:



- Near seabed disturbance when loading the bucket, and
- Through the water column as the bucket is lifted to the barge.

Cutter section dredging works by breaking up and mixing the sediment with water via a rotating cutter head. The key source of sediment suspension when using a CSD is:

- Near seabed disturbance from the rotating cutter head as shown in Figure 2-4.

During the TSHD dredging phase (see Figure 2-5), sediment is sucked into the vessel hopper using a drag head and a fraction of the sediment disturbed by the drag head is suspended in the water column. Sediment suspension is also expected due to the action of propeller wash. These two sources of sediment suspension are identified as Sources 1 and 3 in Figure 2-5, and are:

- Drag head source: bottom 3 meters of water column.
- Propeller wash source: bottom 3 meters of the water column.
- Surface loss source: surface 3 meters of water column.

After the initial hopper infilling, the actual content of the hopper is a sediment/water mixture which is typically ~20% solids by volume (Spearman et al., 2007). To maximise the amount of sediment in the hopper the dredging and pumping process can be continued, which results in the hopper “overflowing” and thereby releasing some sediment in the water column. This phase will be referred to as “overflow phase” and is shown as the Source “2” in Figure 2-5.

The overflow load consists of a highly concentrated mixture of sediment and water and the bulk behaviour of that sediment mixture may become dominant over the individual particle settling processes (Winterwerp, J.C., 2002); depending on water depth and current shear within the receiving environment.

In the present simulations, this overflow phase was modelled considering two sources of sediment to the passive plume:

- Suspension of sediment de-entrained from the dynamic plume descent uniformly release within the entire water column.
- Passive plume generated following the dynamic plume impact: release within a cylinder of 2 m height and 60 m radius on the seabed.

The magnitude of the various source terms was defined using methods described by Becker et al., (2015), such that source term magnitudes are based on the *expected* dredger production rate which is the amount of *in-situ* sediment removed per unit of time ($\text{m}^3 \text{s}^{-1}$)



(Table 2-5). Depending on the dredging methodology, fraction(s) of that production rate are transferred into the passive sediment plume that will be then advected and dispersed by ambient currents. The different source terms, release depths and fraction of production rate are provided in Table 2-6 and

Table 2-7 for the BHD, CSD and TSHD dredgers and were defined based on consultation with Northport and dredging contractors during MetOcean Solutions (2018e).

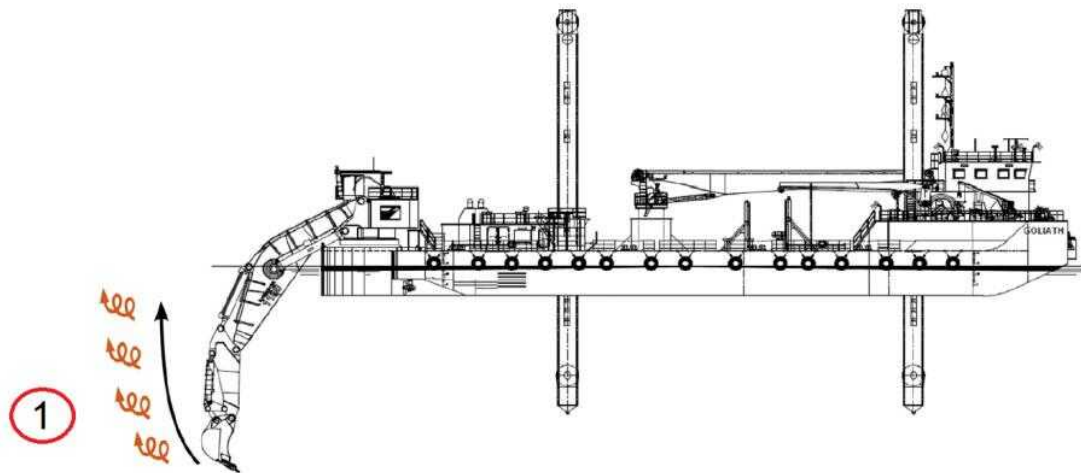


Figure 2-3 Sediment suspension sources of a Backhoe Dredger (from Becker J. et al., 2015)

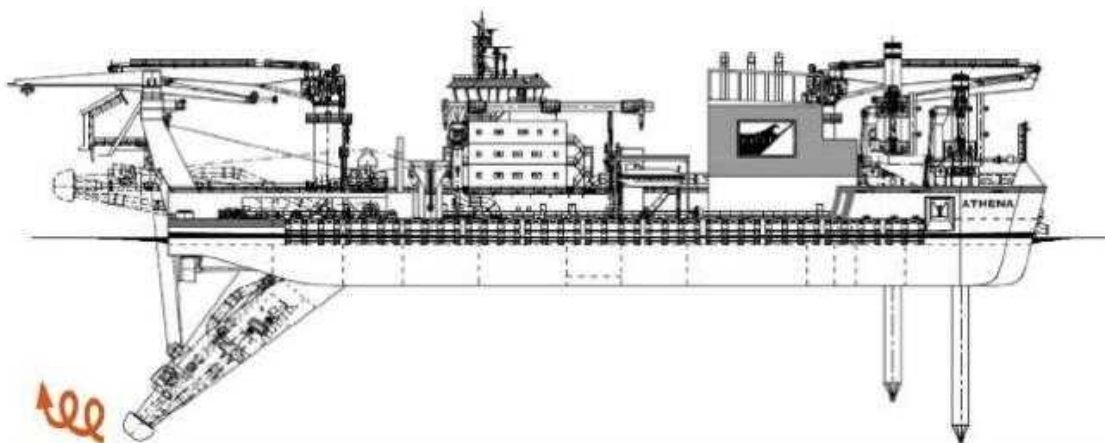


Figure 2-4 Source of a dredge plume for a Cutter Suction Dredger (after Becker J. et al., 2015)

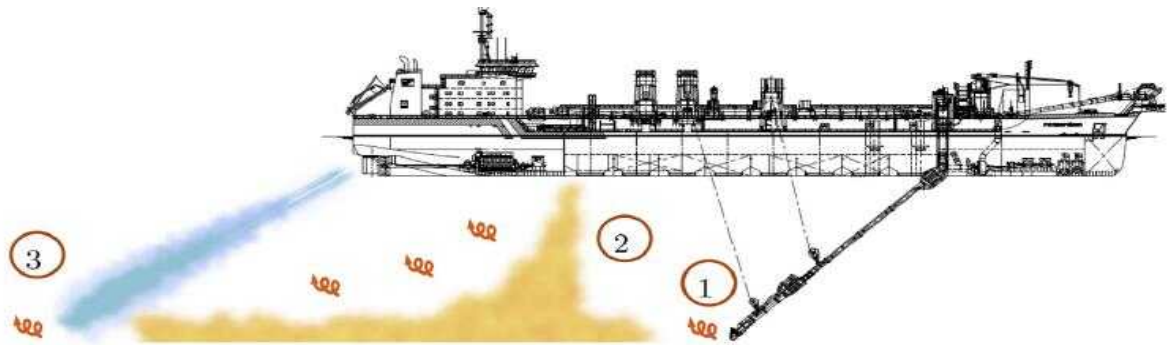


Figure 2-5 Sediment suspension sources of a dredge plume for a Trailing Suction Hopper Dredger: 1-Drag Head, 2-Overflow, including de-entrainment during plume descent through the water column and density current on the seabed, 3-Propeller wash (from (Becker J. et al., 2015))

Table 2-5 Representative ranges for (empirical) source term fractions (from (Becker J. et al., 2015)).

Plume source	Symbol	Fraction
Draghead	σ_d	0–0.03
Overflow ratio	R_o	0–1
In-hopper settlement	f_{sett}	0–1
In-matrix fixation	f_{trap}	0.01–0.05
Overflow	σ_o	0–0.2
Cutterhead	σ_c	0.01–0.05
Bucket drip	σ_b	0–0.04
Bottom door (hydraulic)	σ_p	0–0.1
Bottom door (mechanic)	σ_p	0.0–0.05

Table 2-6 Summary of all source terms for each dredging method.

	Release depth	Radius (m)	Fraction of production rate
BHD			
Bucket – near bed disturbance	Bottom 2 m	10	0.04
Bucket Losses de-entrainment	Water Column	25	0.04
CSD			
Cutterhead disturbance	Bottom 3 m	10	0.05
TSHD			
Overflow (sediment de-entrained during descent)	Water Column	20	0.2
Overflow (density current at the bottom)	Bottom 2 m	60	0.8
Propeller wash	Bottom 2 m	20	0.03
Drag head disturbance	Bottom 2 m	20	0.03
Surface sediment losses	Surface	20	0.01

Table 2-7 Magnitude of source terms for the different dredging methods.

Dredging method	Production Rate ($\text{m}^3 \text{s}^{-1}$)	Dry Volumic Mass (kg m^{-3})	Production Rate (kg s^{-1})
BHD	0.138	1600.00	218.59
CSD	0.44	1600.00	696.96
TSHD	0.19-0.37*	1600.00	306.67-581.42

* For the TSHD dredge we are considering that each site has a different dredging cycle length (see Table 2-2), therefore it has a different production rate. However, the daily production rate is of 9200 m^3 .

2.4 Sediment Plume Modelling

2.4.1 OpenDrift Model description

The sediment plume scenarios were simulated using the trajectory modelling framework OpenDrift (Dagestad et al., 2018). OpenDrift is an open-source python-based framework for Lagrangian particle tracking developed by the Norwegian Meteorological Institute. The framework is highly modular and can be used for any type of drift calculations in the ocean or atmosphere (i.e., search and rescue, larval drift, plastic drift, hydrocarbon advection).



The simulations were undertaken using the SedimentDrift module. This module incorporates key sediment-associated parameters such as settling velocity and critical shear stress for resuspension.

The dispersion modelling consists of a trajectory tracking scheme applied to discrete particles in time and space-varying 3D oceanic currents.

$$\frac{dx_p}{dt} = \tilde{u}(x, y, z, t) + u_t$$

$$\frac{dy_p}{dt} = \tilde{v}(x, y, z, t) + v_t$$

$$\frac{dz_p}{dt} = w_t + w_s$$

(2.1 a,b,c)

Where x_p, y_p, z_p are particle 3D coordinates, $\tilde{u}_{(x,y,z,t)}, \tilde{v}_{(x,y,z,t)}$ are horizontal ocean currents, u_t, v_t, w_t are the diffusion components representing turbulent motions and w_s is the settling velocity.

In the horizontal plane, particles were advected by ocean currents using a 4th order Runge-Kutta tracking scheme, a numerical analysis method that approximates the curve of the function f between two points by a 4th degree polynomial. Moreover, particles are subject to additional displacement by horizontal diffusion.

In the OpenDrift framework, the horizontal diffusion is included by applying an uncertainty to the horizontal current magnitudes. The magnitude of the current uncertainty was estimated using the general diffusion equation (2.2).

$$\int_t^{t+\Delta t} u_t \cdot dt = \sqrt{2 \cdot k_{u,v} \cdot \Delta t} \cdot \theta(-1,1)$$

(2.2)

Where $\theta(-1,1)$ is a random number from a uniform distribution between -1 and 1; Δt is the time step of the model in seconds and $k_{u,v}$ is the horizontal eddy diffusivity coefficient in m^2s^{-1} .

In the vertical dimension, particles are subject to both vertical settling (w_s) and diffusive displacement (w_t) due to vertical turbulence through the water column. In OpenDrift, the vertical mixing process is parameterised using a random walk based numerical scheme similar to equation (2.2) when using a constant vertical diffusion coefficient k_z (Visser, 1997).



In the modelling of dispersion, the horizontal and vertical diffusion account for mixing and diffusion caused by sub grid scale processes of higher resolution than the computational grid, that are not explicitly resolved by the hydrodynamic model (i.e., eddies).

In the present study, since high resolution flows are available (Section 2.2) the amount of added diffusion is expected to be limited. A generic horizontal coefficient of $0.1 \text{ m}^2\text{s}^{-1}$ was applied which is consistent with a length scale of order 20-40 m (i.e. approximate grid resolution). The spatial scales of the vertical turbulence in the water column are one or several orders of magnitude smaller than the horizontal ones. The vertical diffusion coefficient was set to a value of $0.01 \text{ m}^2\text{s}^{-1}$.

2.4.2 Particle release

Depending on the scenarios modelled (i.e., TSHD, CSD or BHD) particles were released according to source terms of Table 2-6 and Table 2-7

Individual simulations were undertaken for each sediment class (Table 2-3, Table 2-4) and results were then combined to obtain the total Suspended Sediment Concentration (SCC) plume and deposition fields. The total number of particles released per simulation and per sediment class, was of the order $\sim 100,000$ for CSD and BHD and $\sim 200,000$ for TSHD simulations. This amounts to a total of 400,000 and 800,000 particles when combining the 4 different sediment classes. Additionally, the model timestep was set at 60 seconds for medium and fine sand and 300 seconds for clay and silt.

2.4.3 Post-processing

The total SSC and cumulative deposition fields were reconstructed with a grid cell resolution of 25 m. Suspended sediment concentration were computed at three levels in the water column, i.e. surface, mid depth and near-bed.

Gridded fields of TSS and deposition were reconstructed from the particle clouds using a kernel density estimator (Silverman, 1986). In the kernel density approach, individual particles are assumed to represent the centre of mass of a “cloud”; the density profile of the cloud is described by the *kernel function*, while the spreading of the particle’s equivalent mass is defined by the *bandwidths* associated with a given particle or receptor (Bellasio, R., et al., 2017; Vitali et al., 2006). These two components are then used to derive a *particle density field*, also referred to as a *probability density function*. Here, the kernel density estimation is undertaken following the approach proposed by Botev, et al. (2010). The proposed method uses an adaptive kernel density estimation method based on the smoothing properties of linear diffusion processes. The key idea is to view the kernel from



which the estimator is constructed as the transition density of a diffusion process (Botev, Z. I et al., 2010).

Based on the spatial distribution of particles at a given time, defined by their positions (X_{part}, Y_{part}) , we can calculate the probability density function, $PDF(x,y)$ derived from the *kernel density estimator* describing the density of particles throughout the domain. The spatial integration of the *probability density function* $PDF(x,y)$ over the entire domain equals one.

The $PDF(x,y)$ values can be converted to particle density when multiplied by the total number of particles in the domain i.e. with units (particles m^{-2}). The particle density can in turn be converted to mass density, or mass distribution, based on the equivalent mass carried by individual particles i.e. with units (kg m^{-2}). Mass concentration (i.e. Suspended Sediment Concentration, SSC) is obtained by dividing the mass density by the correct vertical depth band i.e. with units (kg m^{-3} or mg L^{-1}). Statistics were derived from the obtained time-varying TSS fields. The report presents the 50th percentile (i.e. median) and 90th percentile TSS at each level in the water column.

A similar approach is followed for estimating the depositional thickness. The probability density function of the deposited particles is computed and converted to a (dry) sediment mass density field in (mass m^{-2}). The sediment mass is converted to a volume using its dry volumetric mass (assumed to be 1600 kg m^{-3}) which effectively yields a deposition thickness in metres i.e. ($m^3.m^{-2} = m$).

The newly deposited sediment is expected to be less compact than *in-situ* sediment due to incorporation of water between deposited grains. A bulking coefficient of 1.5 was applied to predicted deposition thicknesses. This means 1 m^3 of dredged *in-situ* sediment would create a 1.5 m^3 deposition volume.



3.Results

Dispersion of dredging plumes within the harbour were simulated for a wide range of scenarios including:

- 3 Different dredging operations (BHD, CSD and TSHD, Figure 2-1, Figure 2-2)
- 4 Sites for BHD and CSD and 7 sites for TSHD
- 3 Different bathymetries
 - 1) The existing bathymetry,
 - 2) the combined Eastern Reclamation and NSDF, and
 - 3) the NSDF
- 2 combinations of sediments Sandy silts versus Silty Sands.

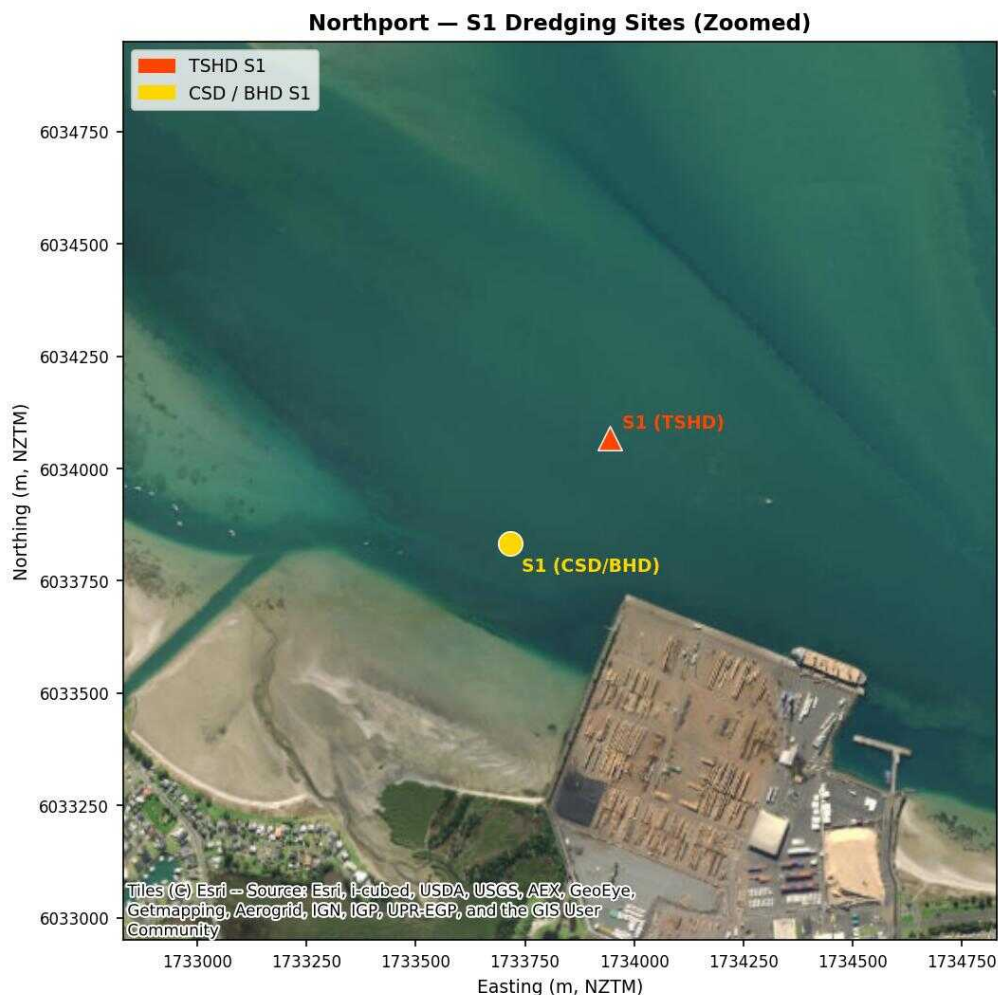


Figure 3-1 Location of Sites S1 for the TSHD, CSD and BHD dredging methods.

3.1 Sediment plumes from Dredging methods

Main features from the results are described below. All corresponding mean, 50th percentile, and 90th percentile TSS maps, as well as final cumulative deposition fields, are provided in Appendix A (MetOcean Solutions, 2026c) as digital image files for all the sites. It is important to note that due to the intermittent nature of TSHD dredging cycles (see Table 2-2) the 50th percentile maps may appear blank. To fulfil the 50th percentile, the conditions must be met at least 50% of the time. The TSS threshold exceedance figures (Section 3.2) confirm that high concentrations only persist in the regions near the source. In this report, we provide the results for Site 1 across the three dredging operations (Figure 3-1).

The various modelling results are shown below in Figures 3-1 – 3-25.



S1



Figure 3-2 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

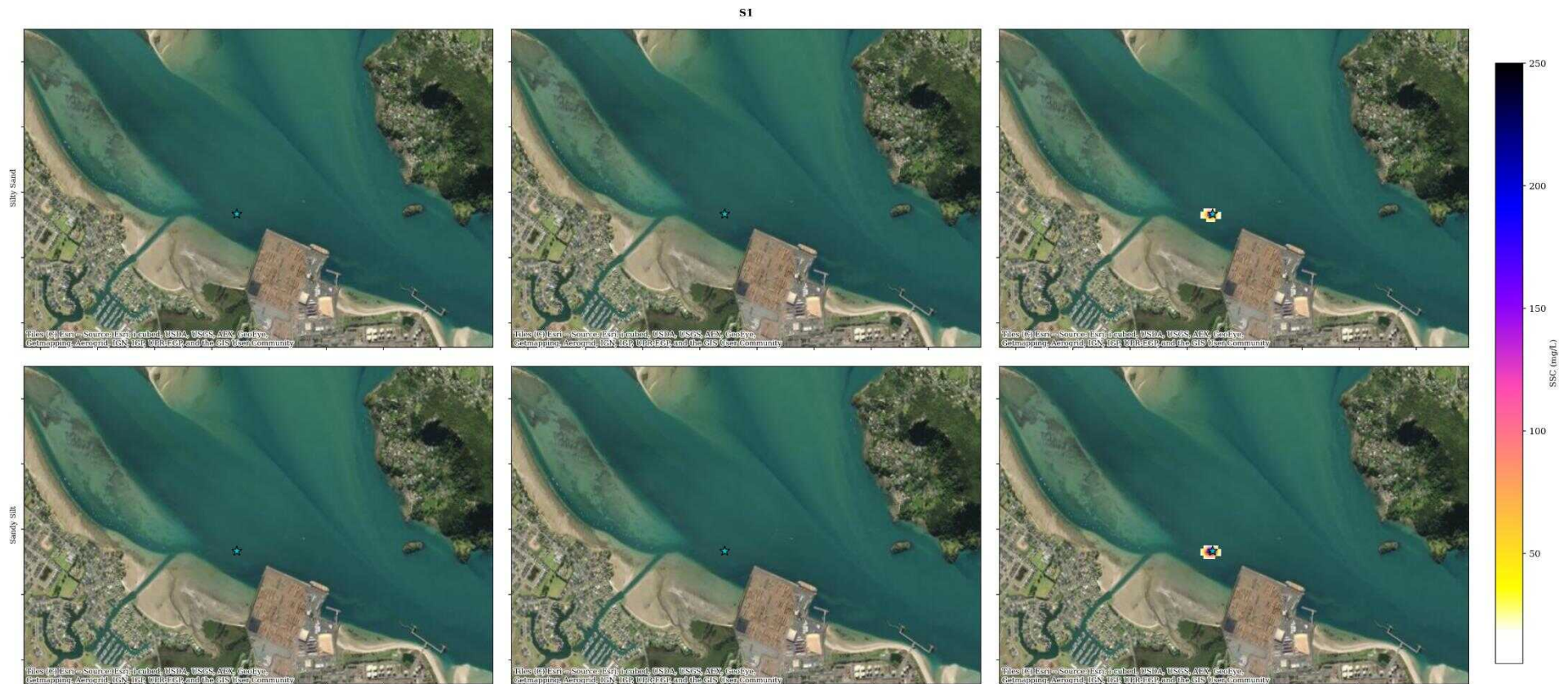


Figure 3-3 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

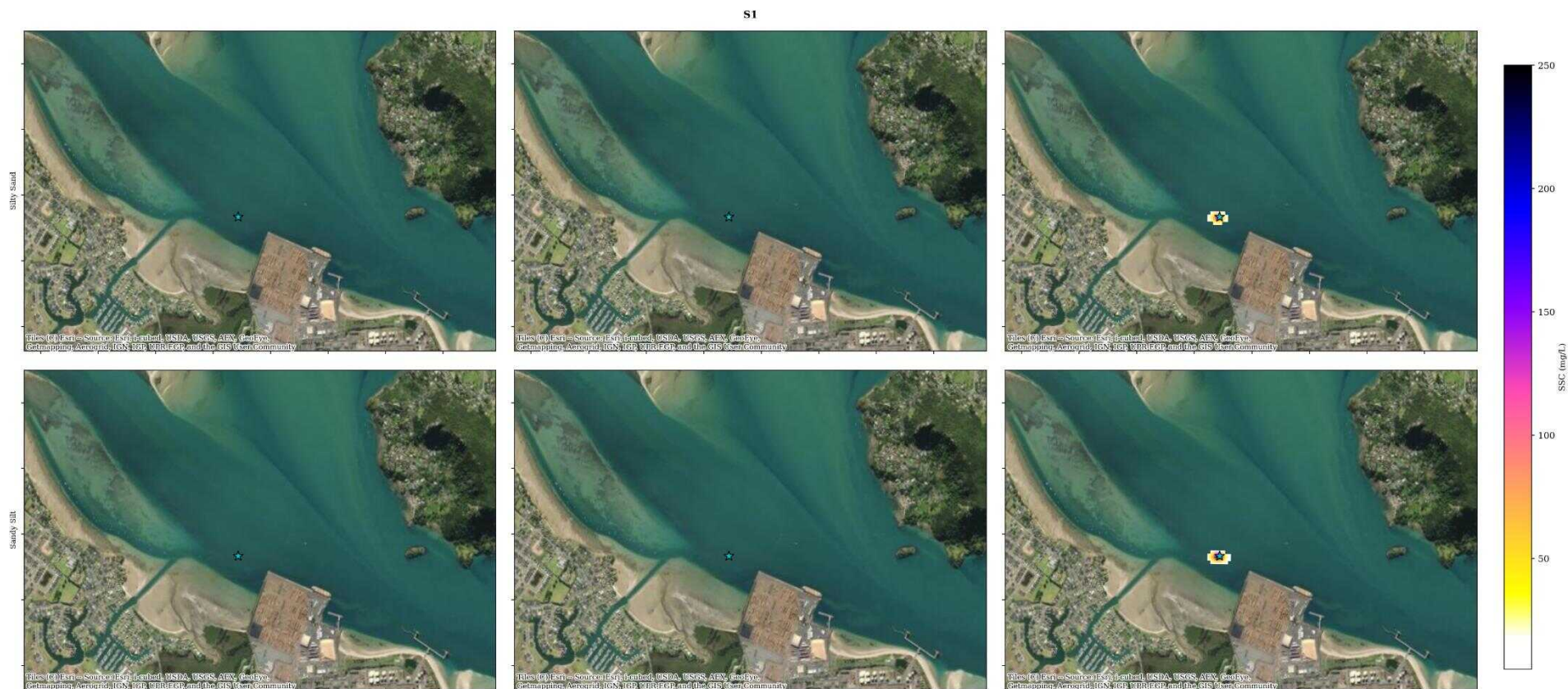
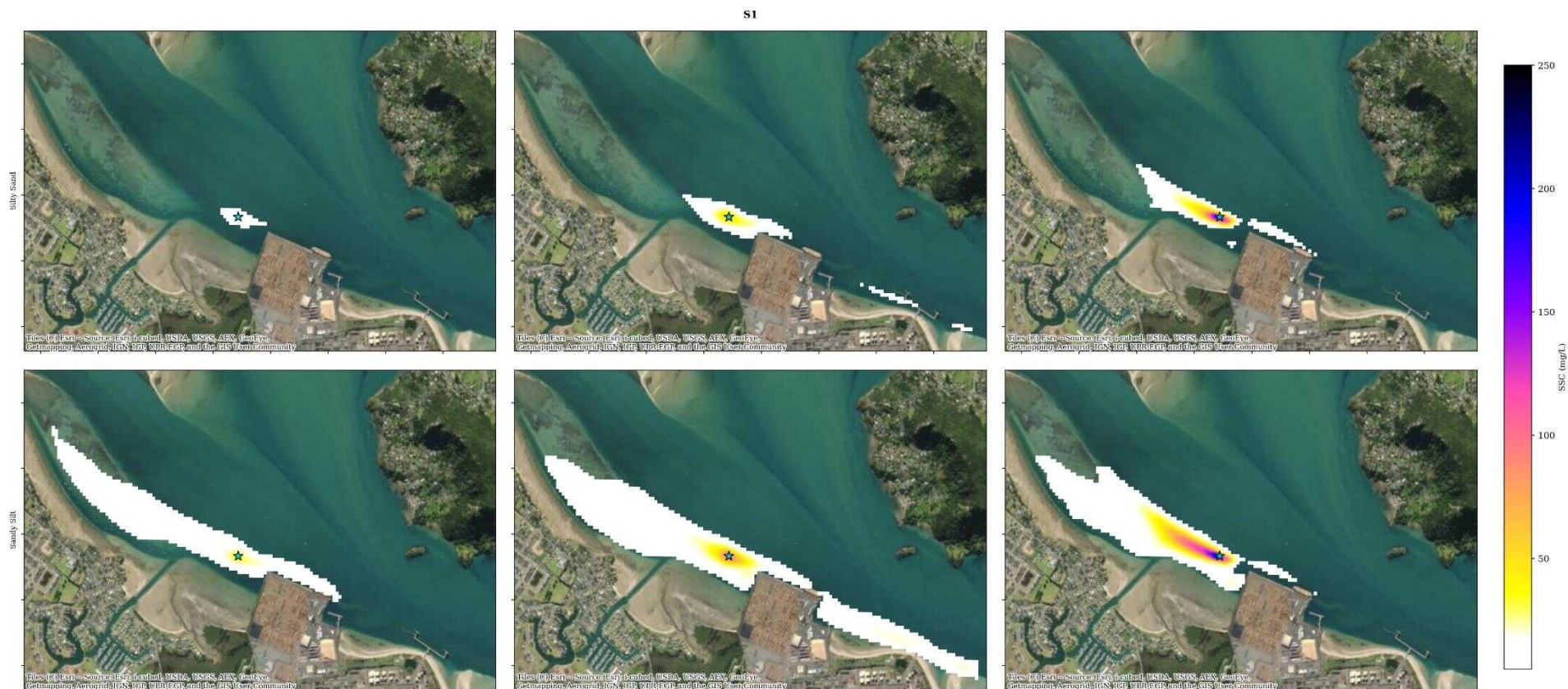
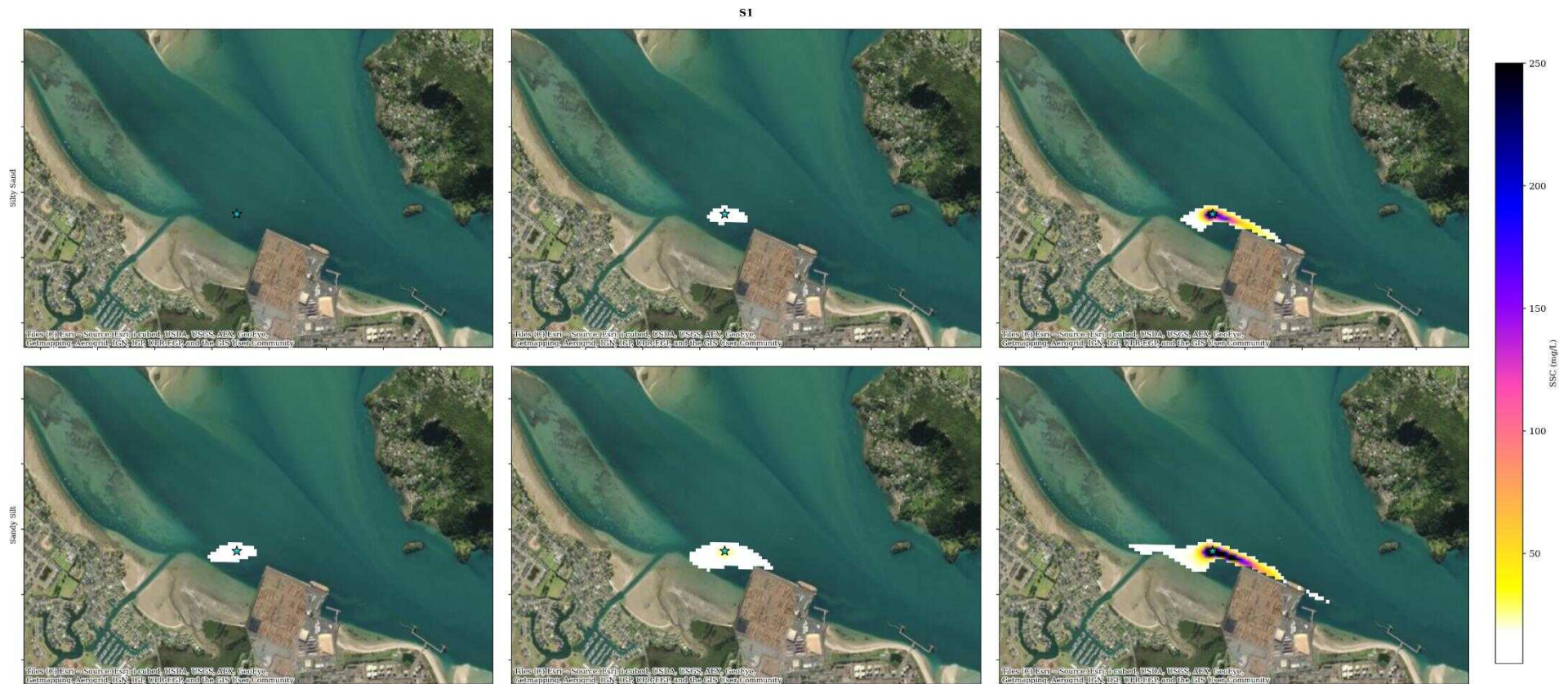
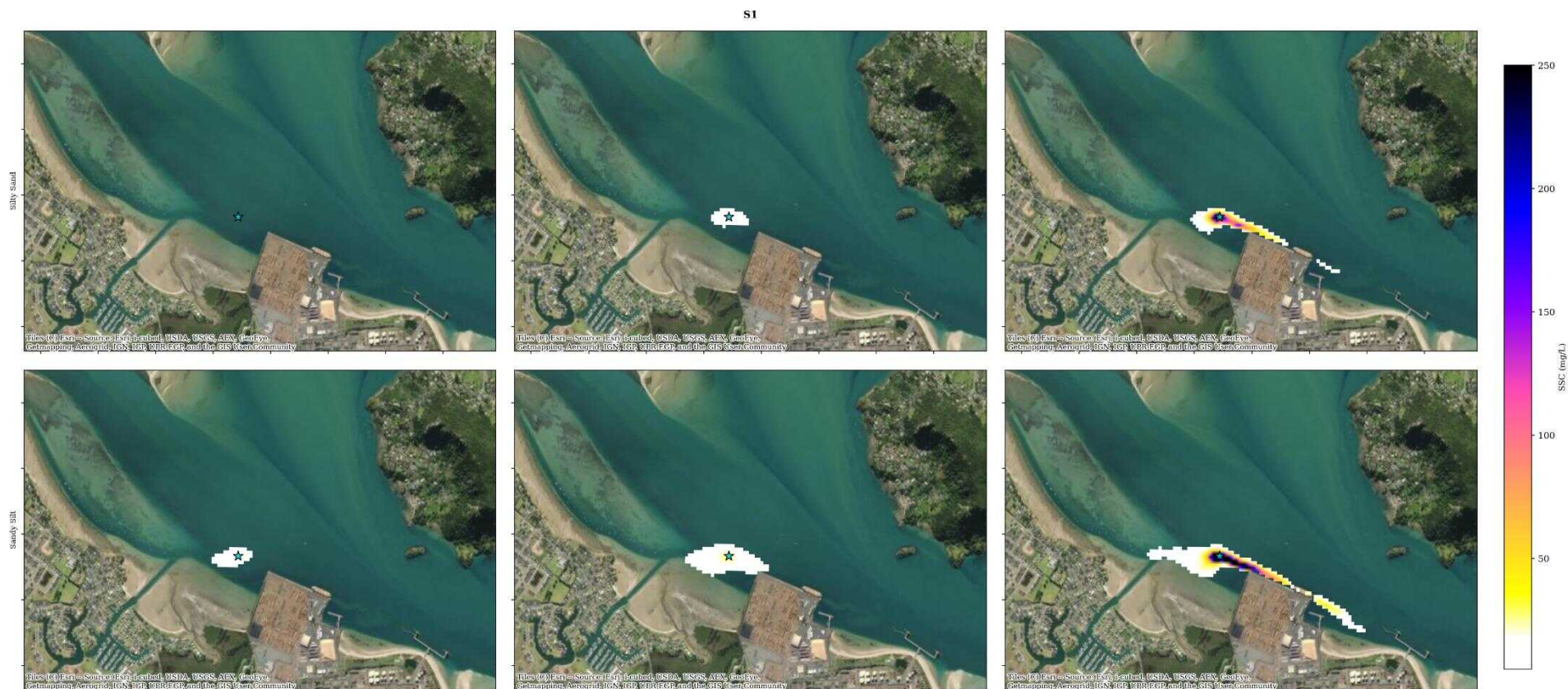


Figure 3-4 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .







S1

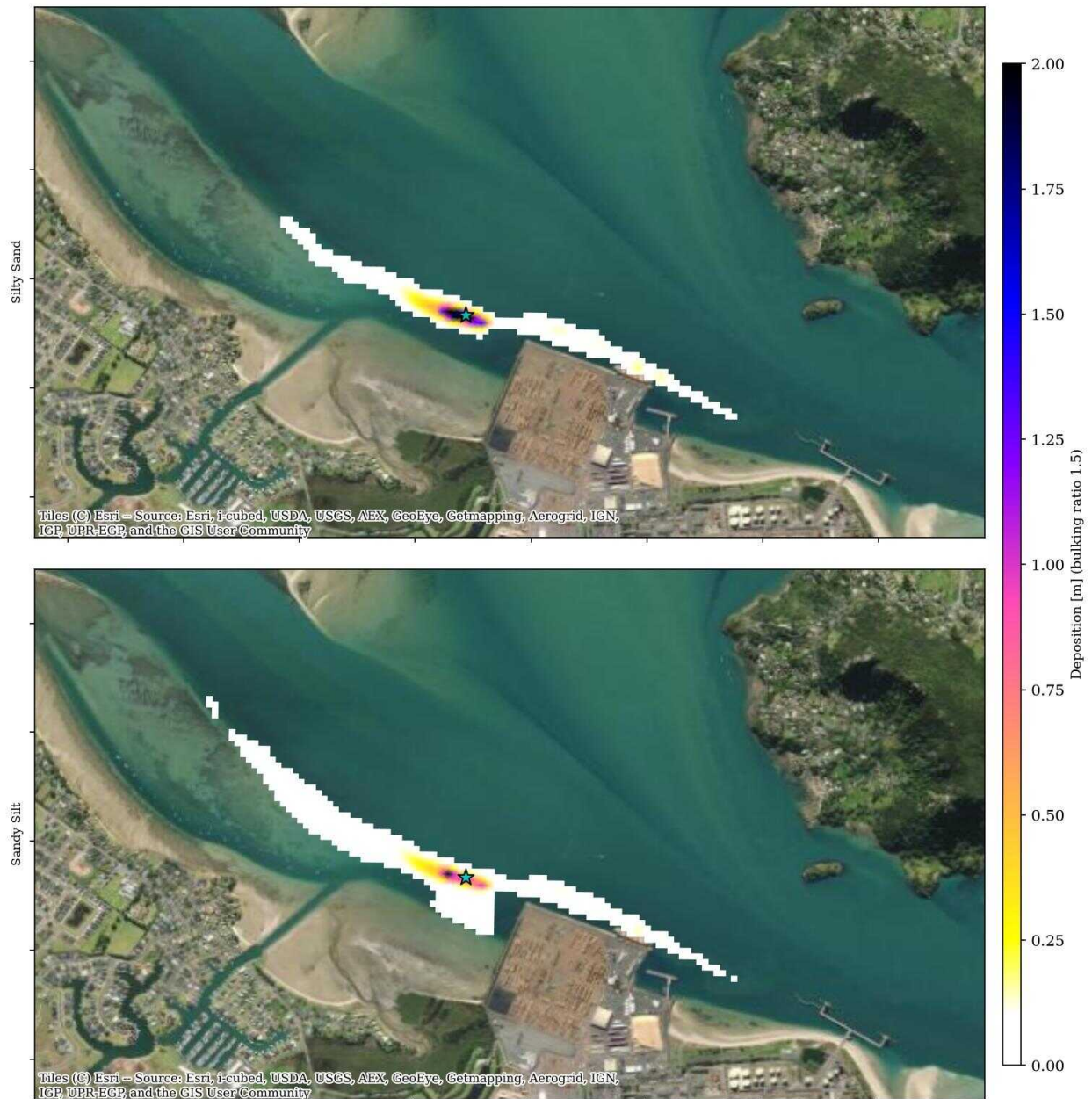


Figure 3-8 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

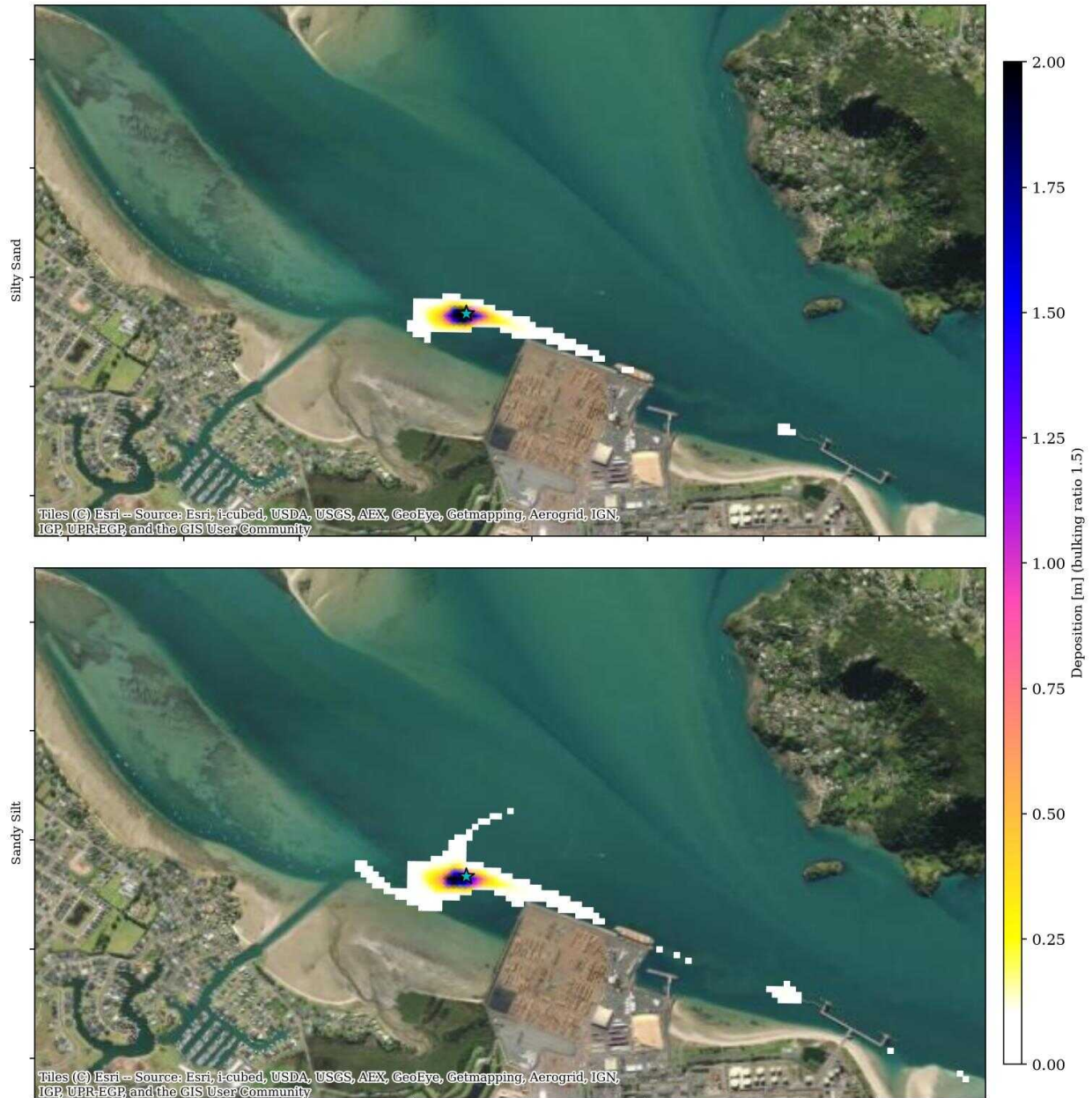


Figure 3-9 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

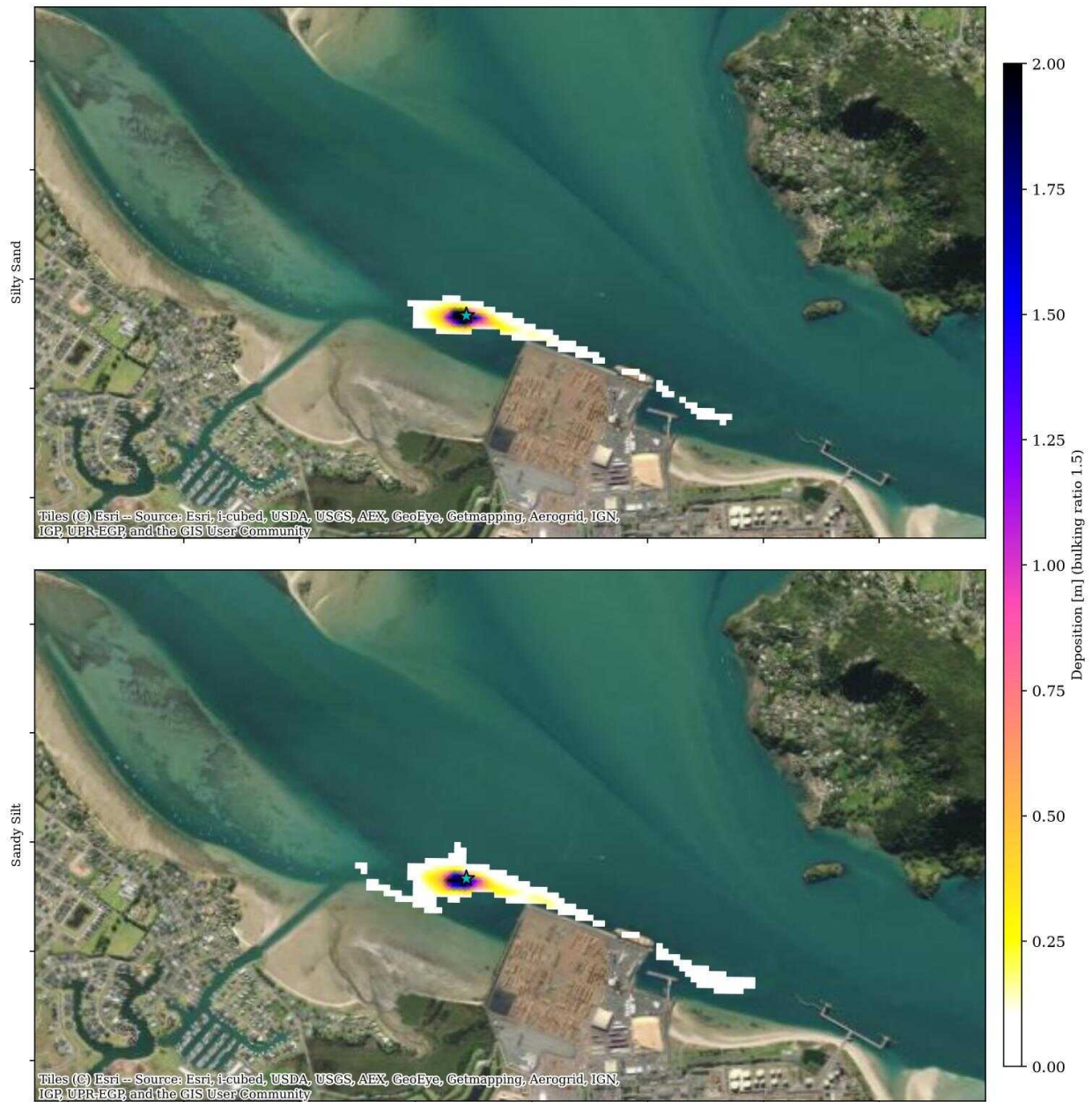
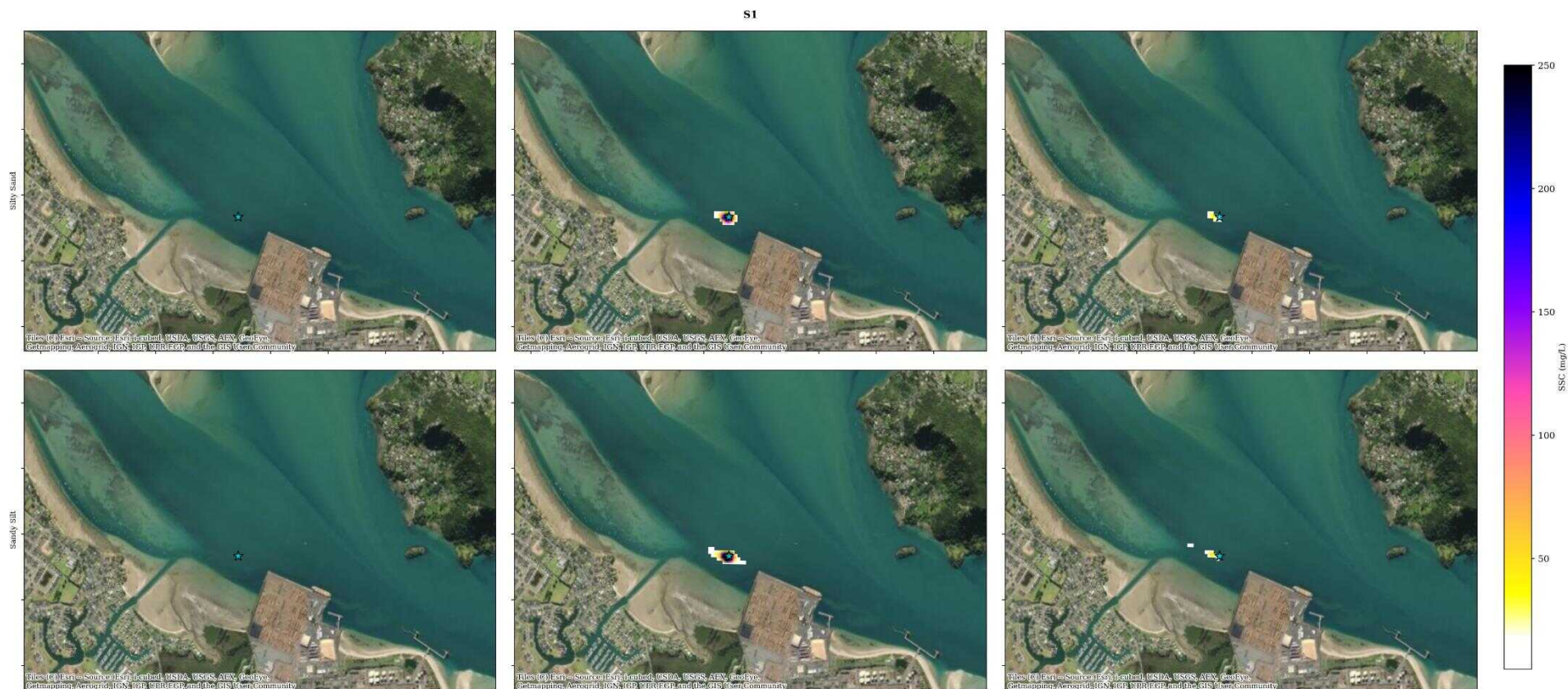


Figure 3-10 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.



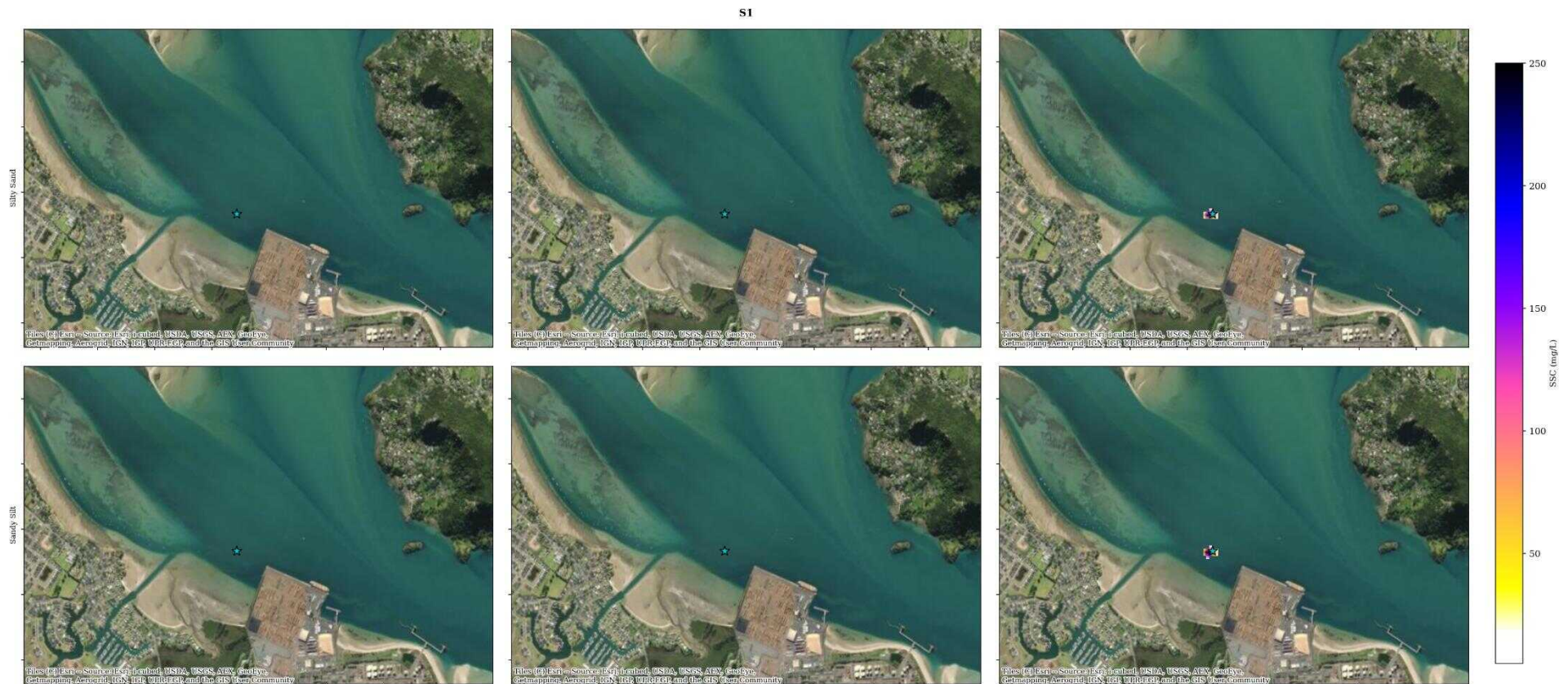


Figure 3-12 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

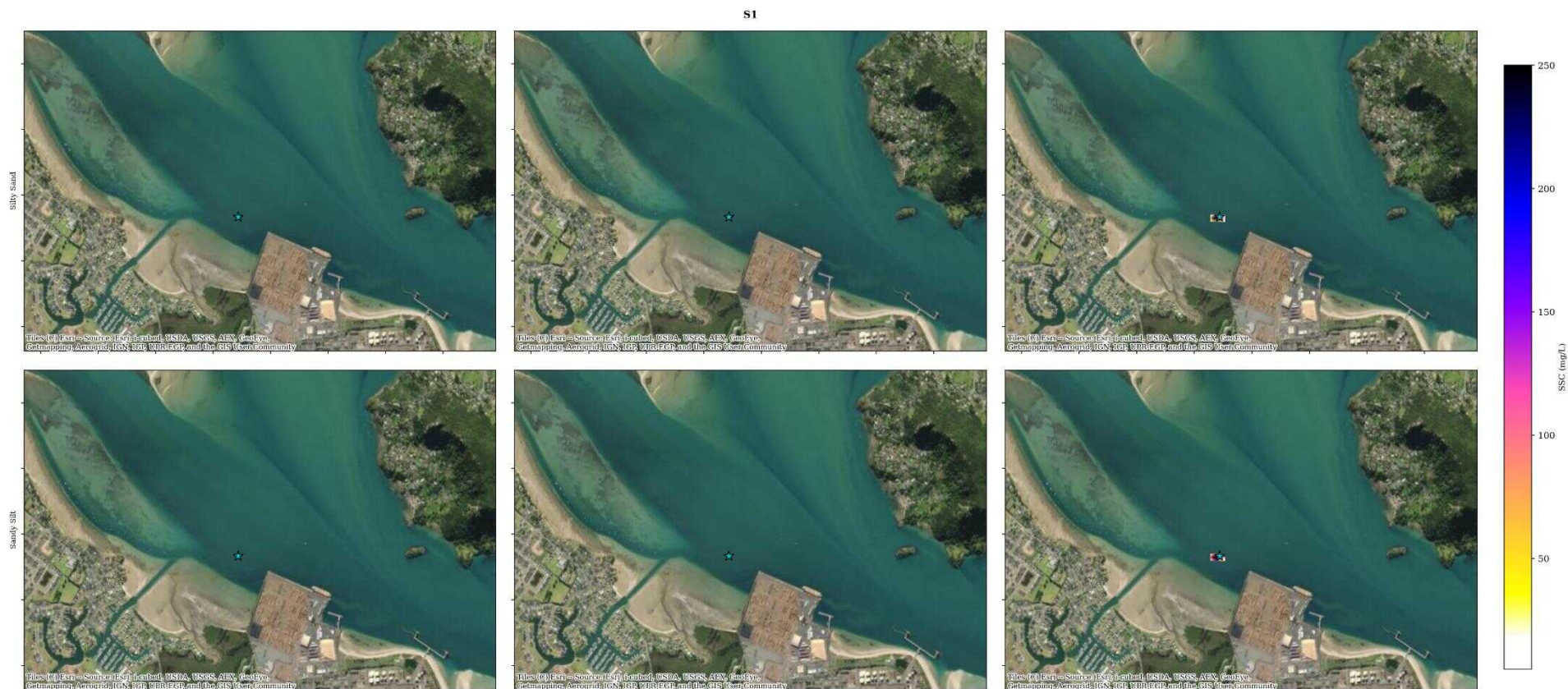
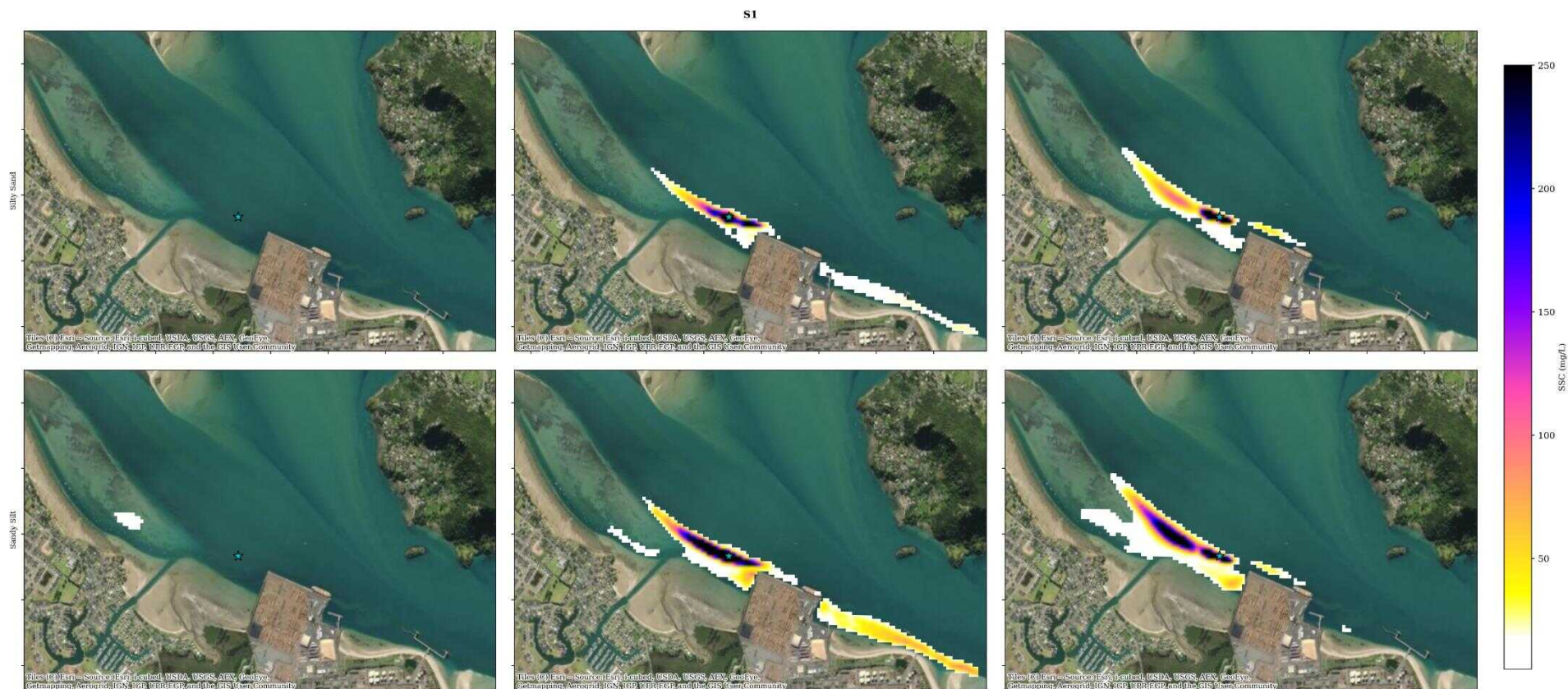
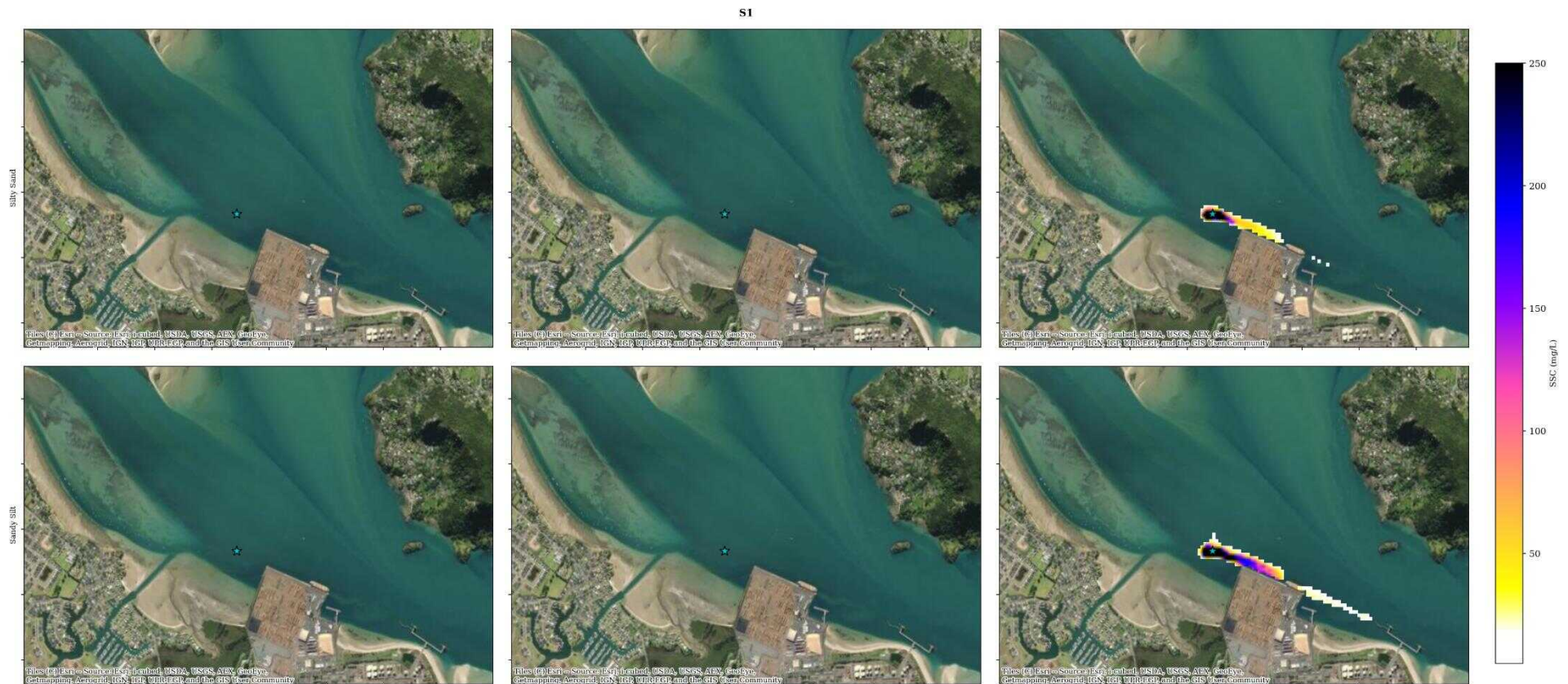


Figure 3-13 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .





S1

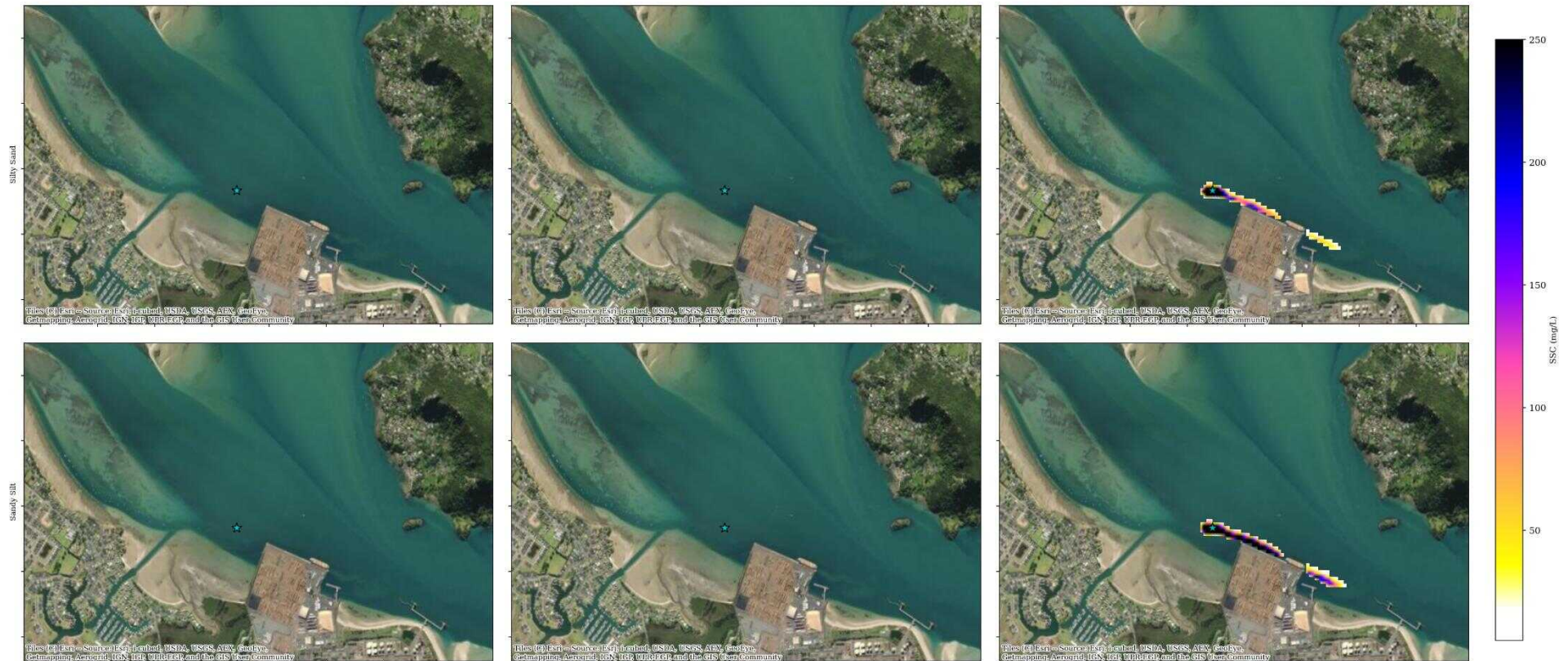


Figure 3-16 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S1

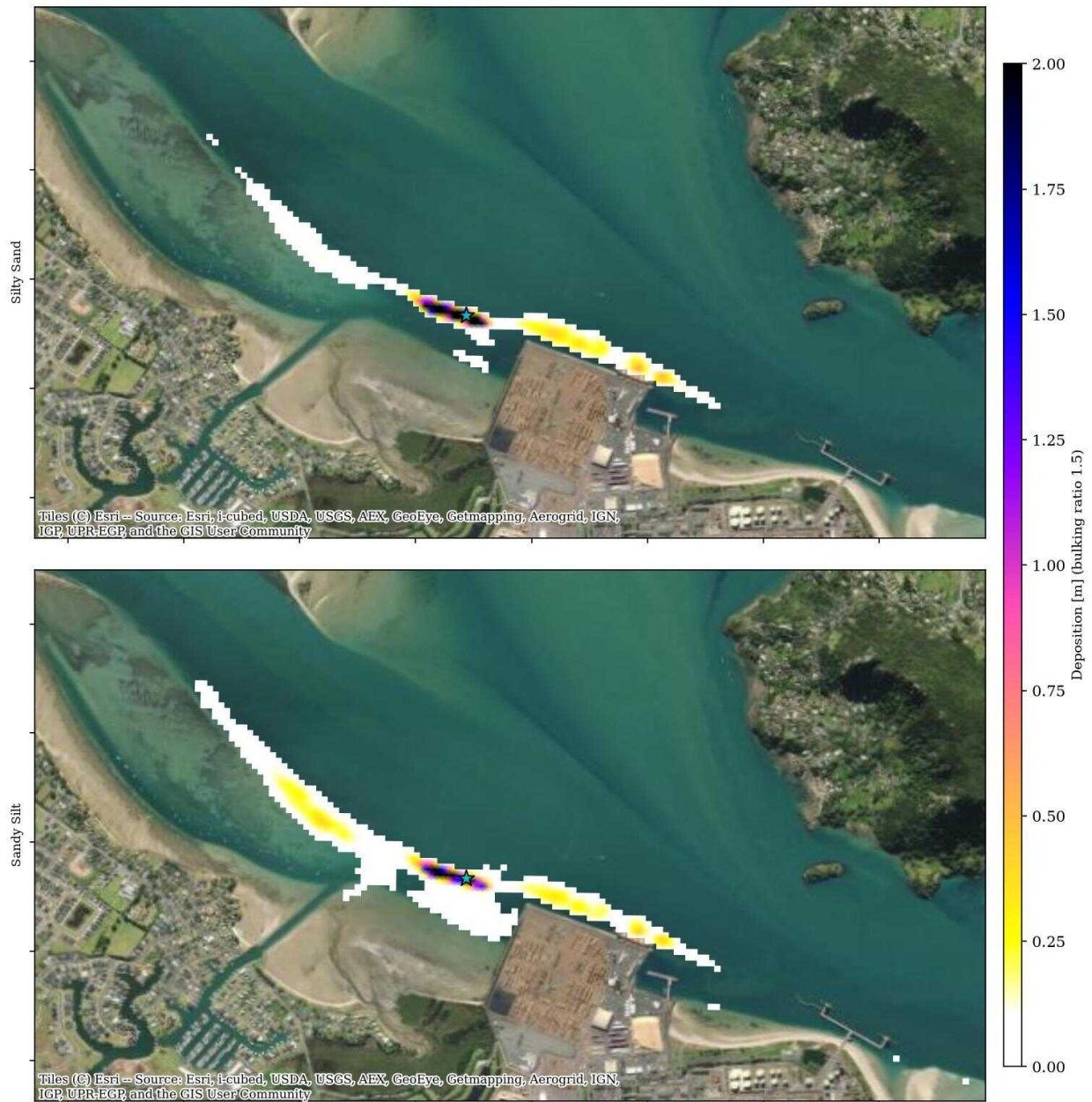


Figure 3-17 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

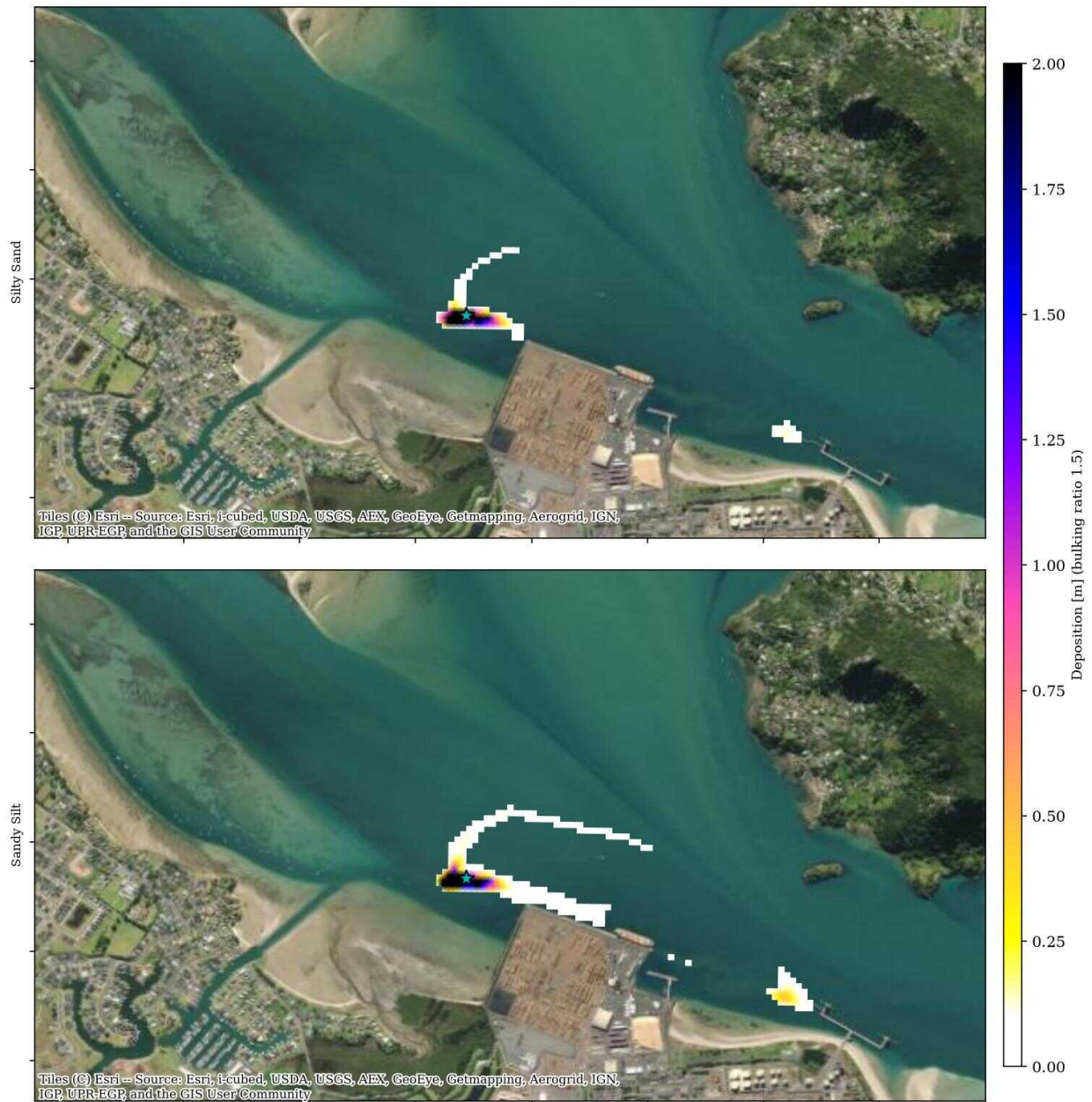


Figure 3-18 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

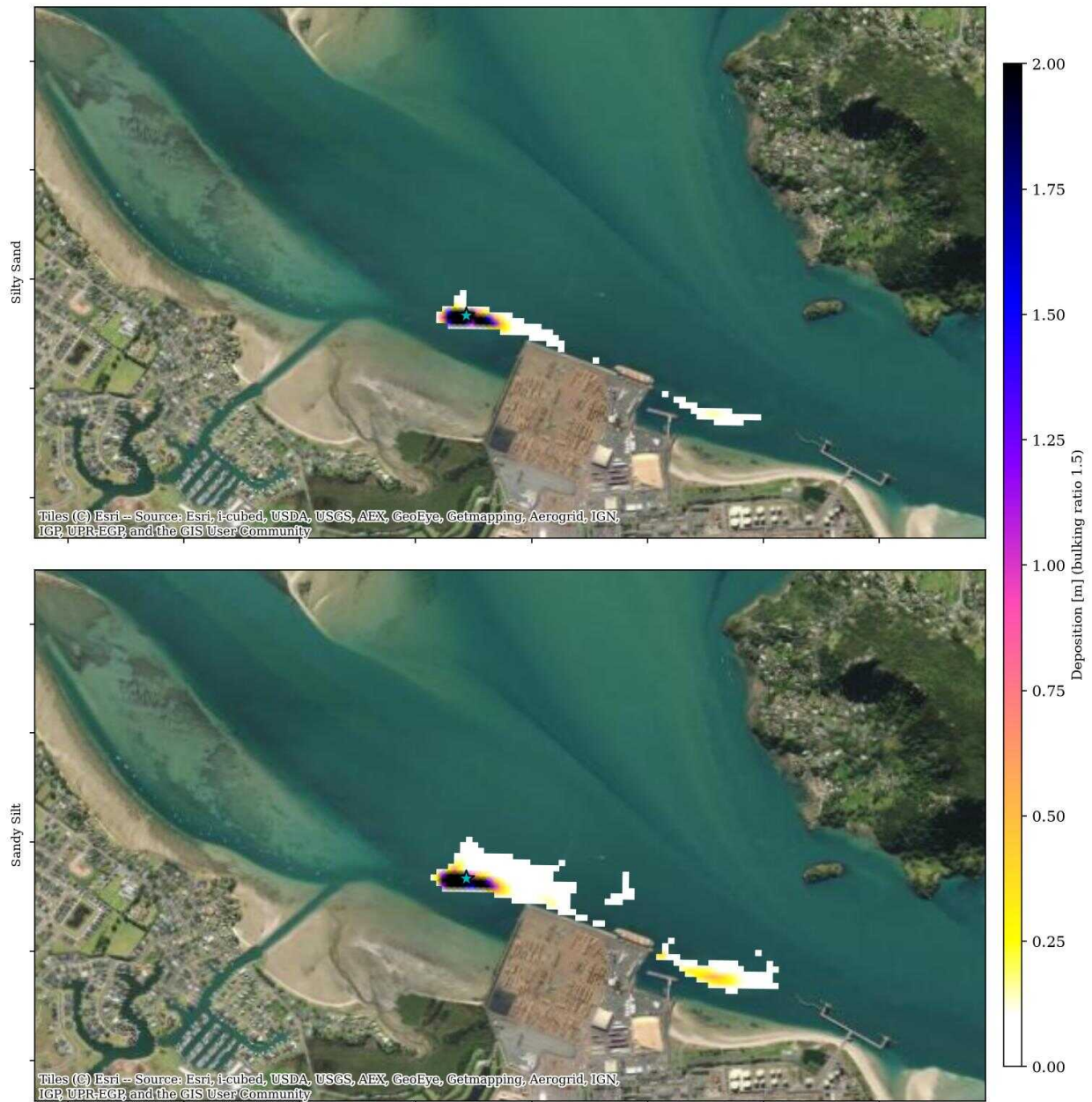
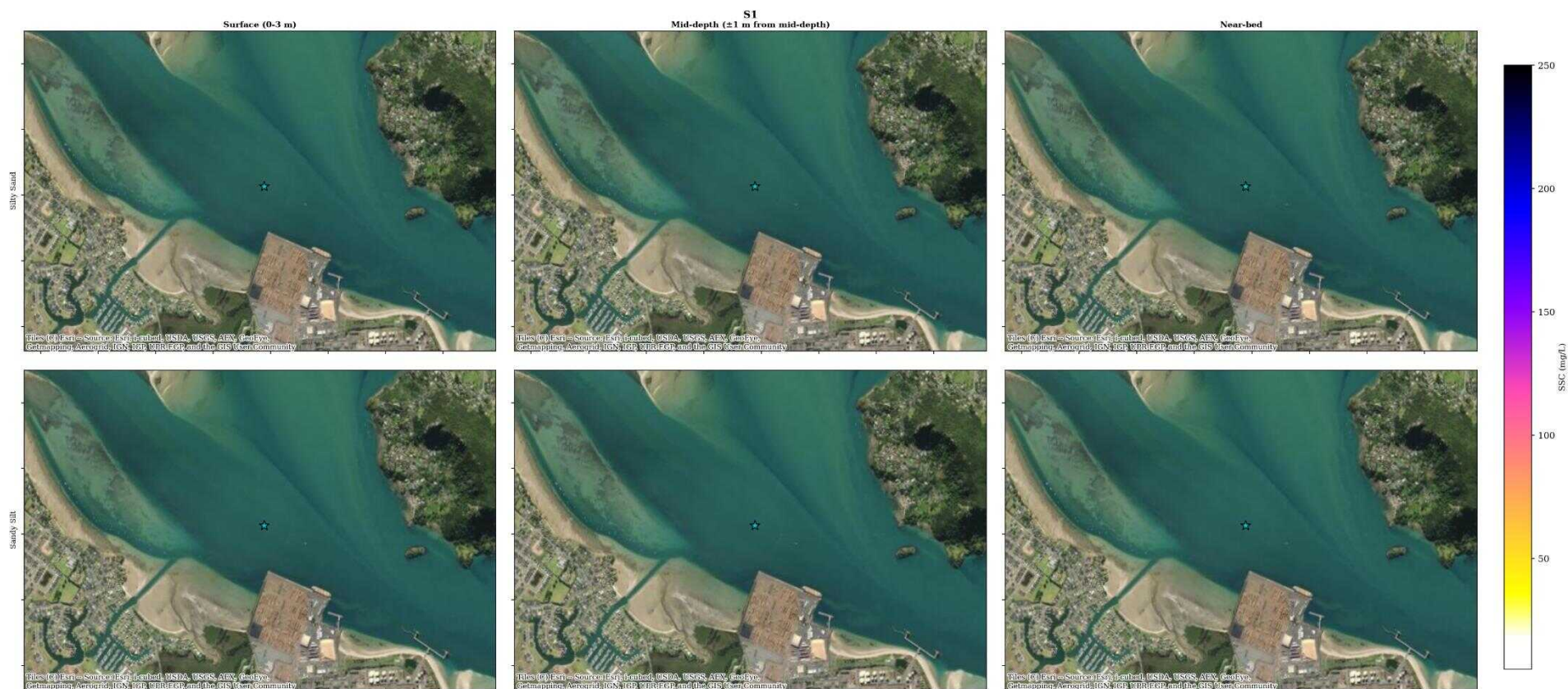


Figure 3-19 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.



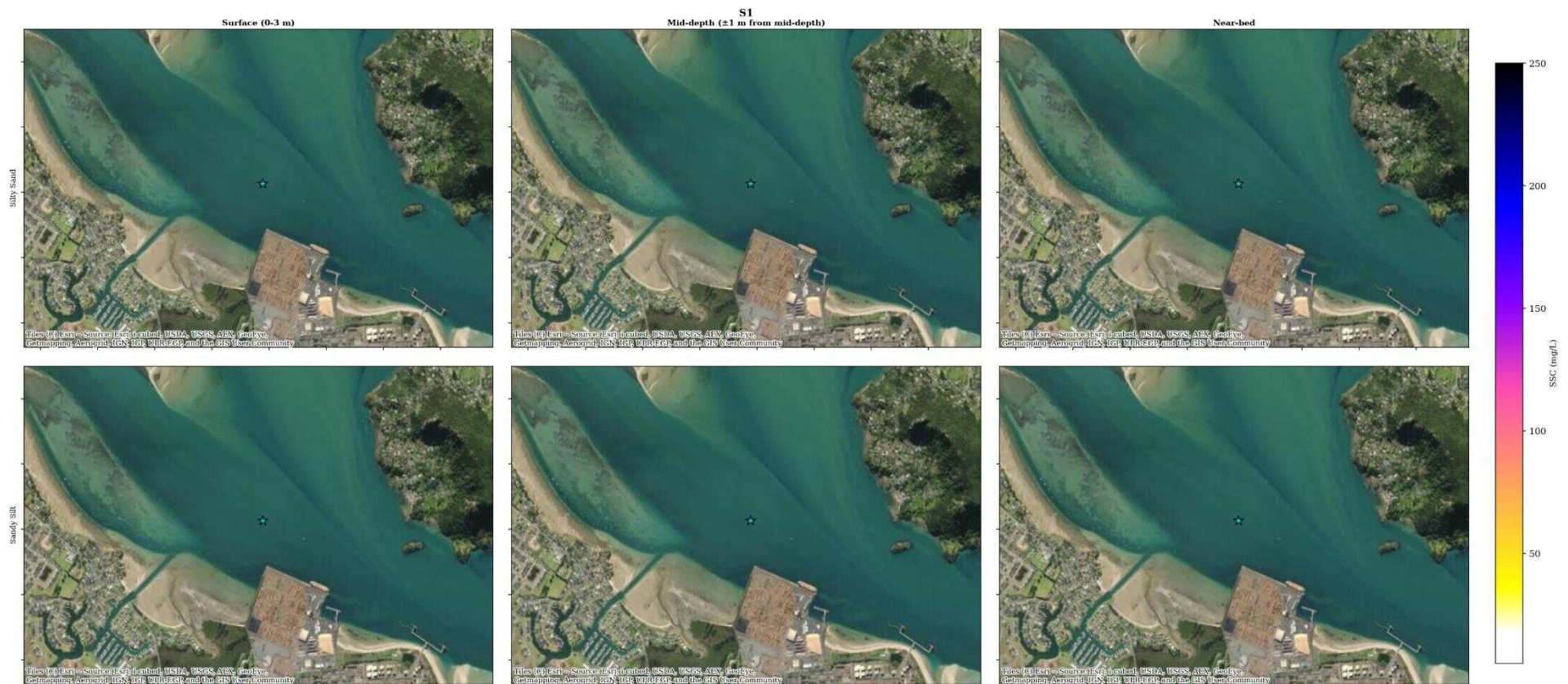


Figure 3-21 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. TSS were masked below 5 mg L^{-1} .

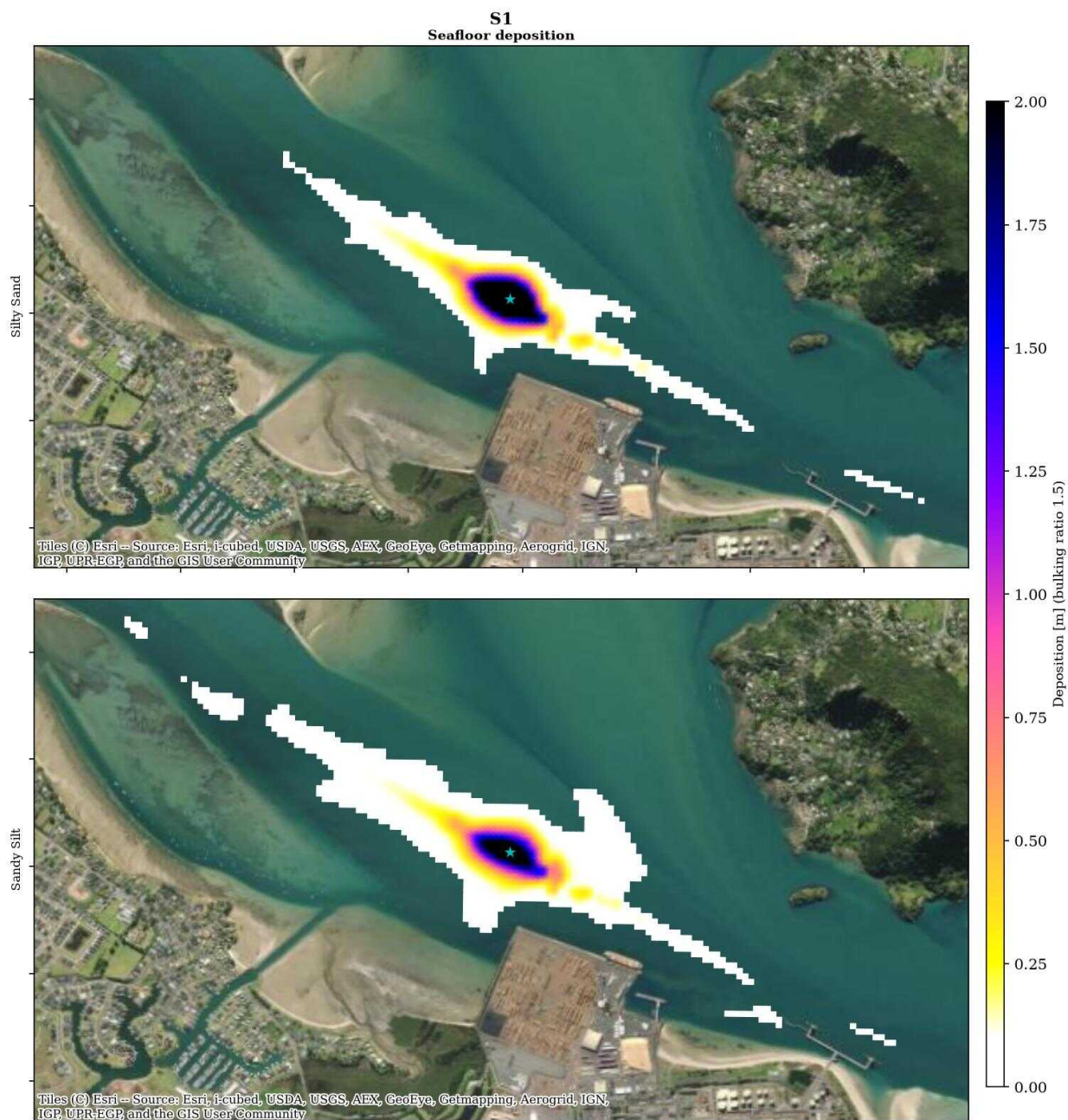


Figure 3-24 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 5 mm.

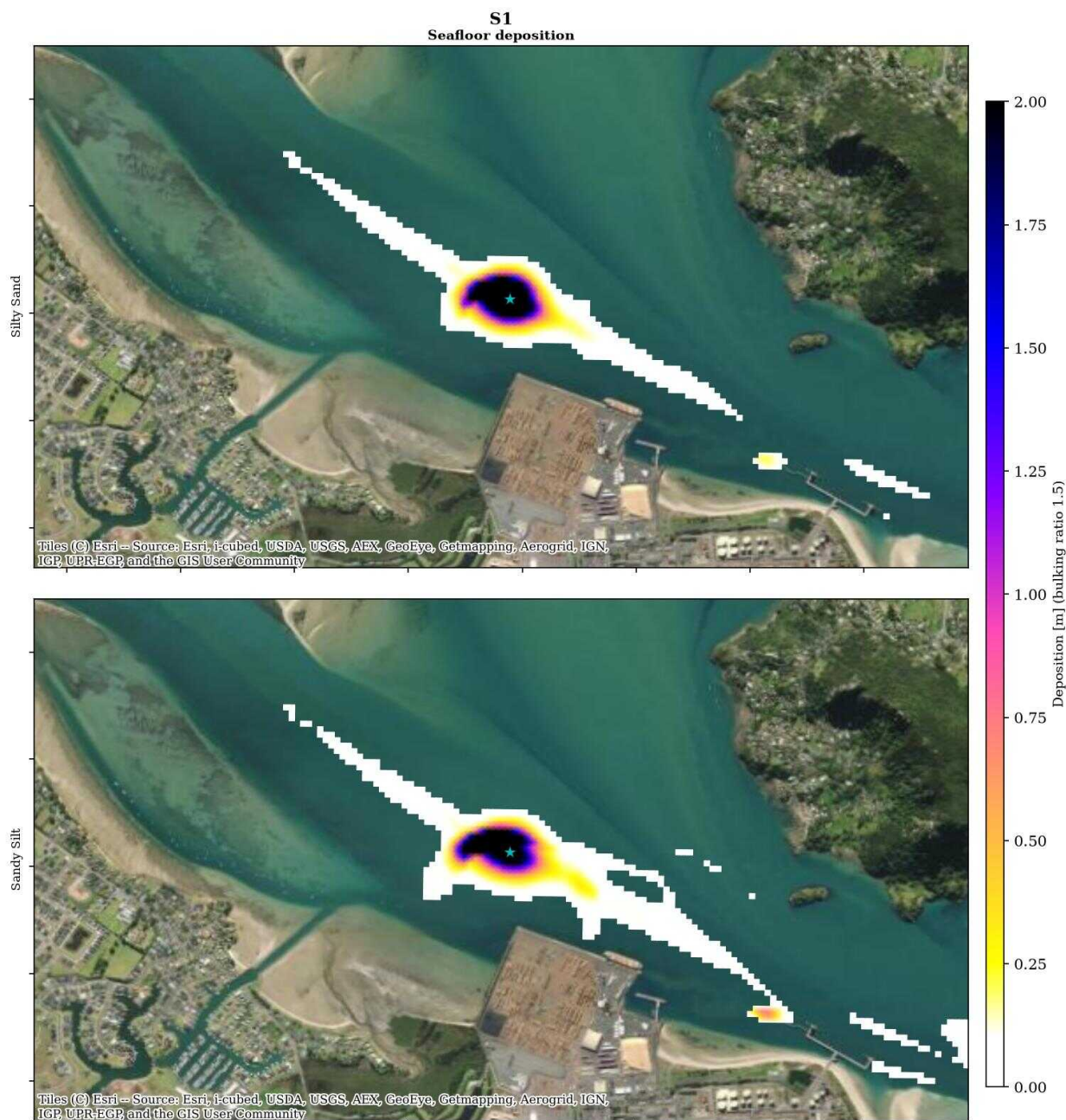


Figure 3-25 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 5 mm.

In general, dredge dispersion and deposition footprints follow a clear northwest-southeast-axis. Sediment plumes tend to have a more westward extension under existing bathymetry. However, with the proposed designs, the plumes tend to be contained within the dredged region or extend eastwards. These patterns are particularly evident in the 90th percentile spatial maps and sediment deposition maps for BHD (Figure 3-5 - Figure 3-10) and CSD (Figure 3-14 - Figure 3-19) dredging methods. For the TSHD dredging

method, a westward extension remains, though it is reduced under the proposed designs (Figure 3-22- Figure 3-25). Because some of the TSHD dredging are more exposed to the channel hydrodynamics, sediment plume footprints extend slightly further than those from the less exposed, lower energy sites located closer to the port.

The dredge plume footprints are more extensive for the sandy silt scenario relative to the silty sand scenario due to the larger fraction of slow-settling sediment, which can travel further away from the release location. Conversely, the silty sand plumes are typically more concentrated near the source, as the larger fractions of fast-settling material remains in the immediate vicinity of the release site.

Overall, the highest TSS levels for the BHD, CSD and TSHD methods are found near the seabed. However, there are instances where BHD dredging results in larger TSS levels within the mid-depth layers. This is due to the vertical motions of the bucket through the water column and the associated source terms applied in the simulation.

The 50th percentile TSS maps illustrate the TSS levels that are exceeded 50% of the time. To evaluate the highest potential TSS levels within the harbour during a one-month dredging operations, maps of the 90th percentile TSS are provided. The 90th percentile values represent concentrations exceeded only 10% of the time, capturing conservative exposure scenarios.

Moreover, we present cumulative deposition maps. These maps illustrate where sediment resulting from the dredging operations finally deposits. It is important to note that these maps assume the accumulated deposition after one month of continuous dredging at the designated sites. In practice, the dredger will move through the berth pocket to be dredged and, depending on production rate and volume to be removed, operations may not require a full month to complete. Consequently, the spatial extent and the magnitude of the deposition maps should be interpreted as relative, conservative indicators. The cumulative deposition footprints obtained from the simulations takes into consideration the capacity of sediments to be resuspended. However, it is possible that localised accumulation areas could develop in regions of low flow increasing deposition thickness in those specific zones where resuspension conditions (critical shear stress values) can be rarely meet. Overall, the deposition maps can be considered relatively conservative because subsequent sediment resuspension and further ambient dispersion is possible, which would potentially reduce the initial deposition thickness over time.



3.2 TSS Threshold exceedance

In an ecological assessment context, it is useful to precisely quantify the percentage of time that specific TSS thresholds are exceeded. Spatial maps quantifying the exceedance percentages for the 2, 5 and 10 mg L⁻¹ are provided from Figure 3-26 to Figure 3-31. Additional figures for other bathymetries and sites are provided in Appendix B (MetOcean Solutions, 2026d). This section focuses exclusively on the results for the proposed Eastern Reclamation and NSDF bathymetry across all three dredging methods and both sediment types (silty sands and sandy silts).

The higher exceedance values near the source are expected due to the continuous release of material. Generally, the highest exceedance percentages occur throughout the channel region, where tidal currents confine and advect most of the sediment plumes. The sandy silt scenario has higher percentages relative to the silty sand simulations. This is due to the larger fraction of slow-settling sediment within the sandy silt's simulations.



S1 — Sandy Silt Proposed East West

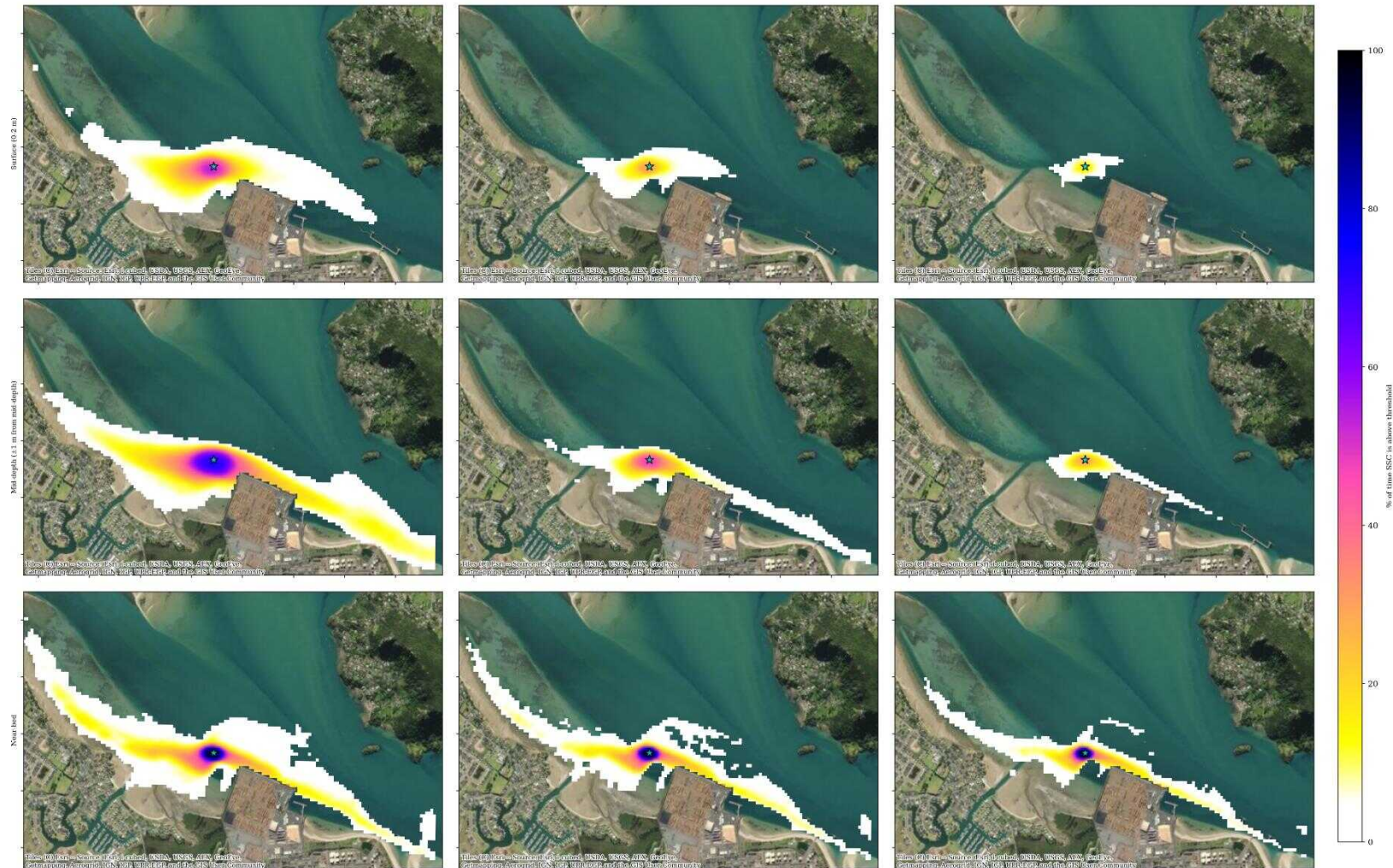


Figure 3-26 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 – Silty Sand Proposed East West

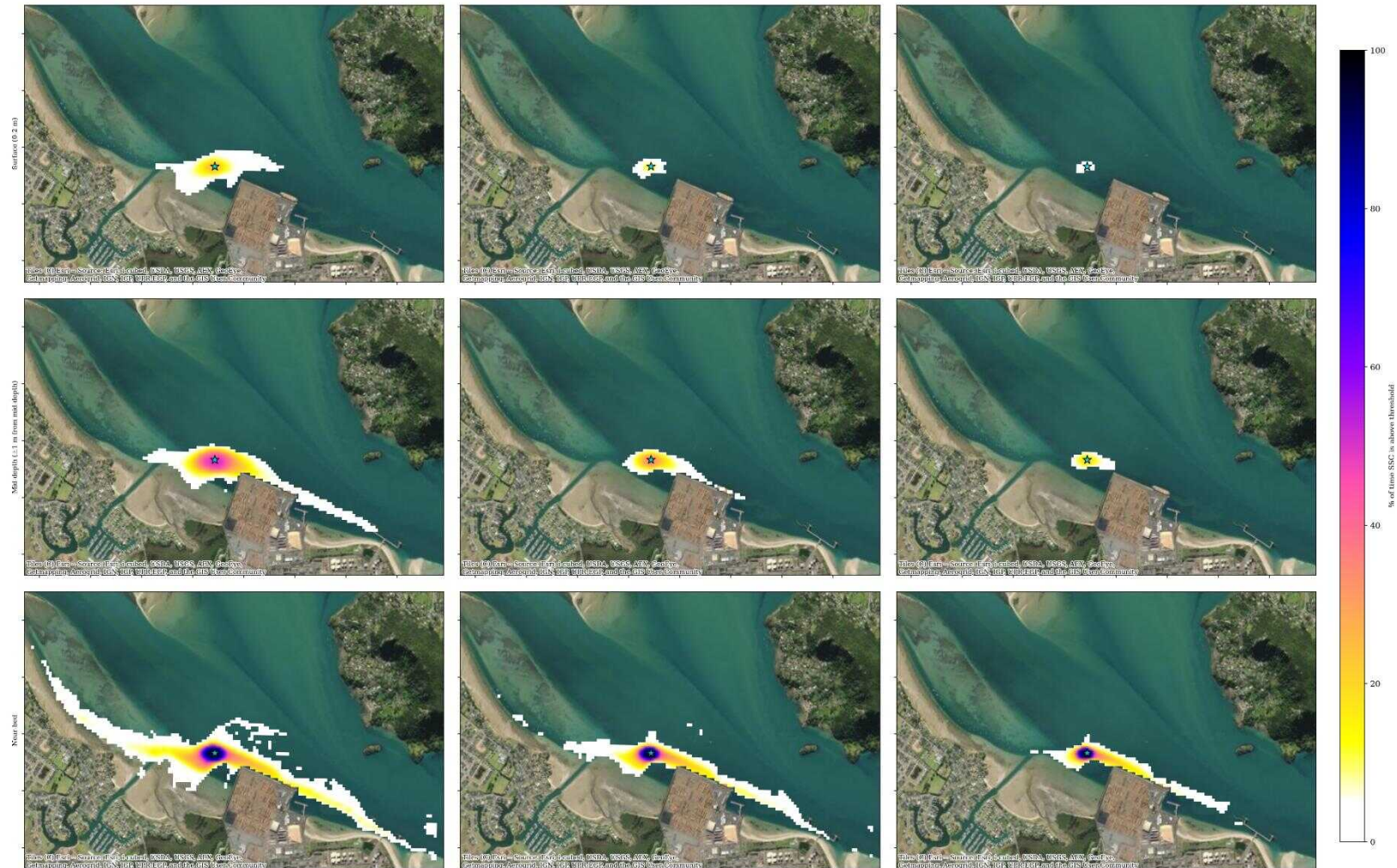


Figure 3-27 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S1 – Sandy Silt Proposed East West

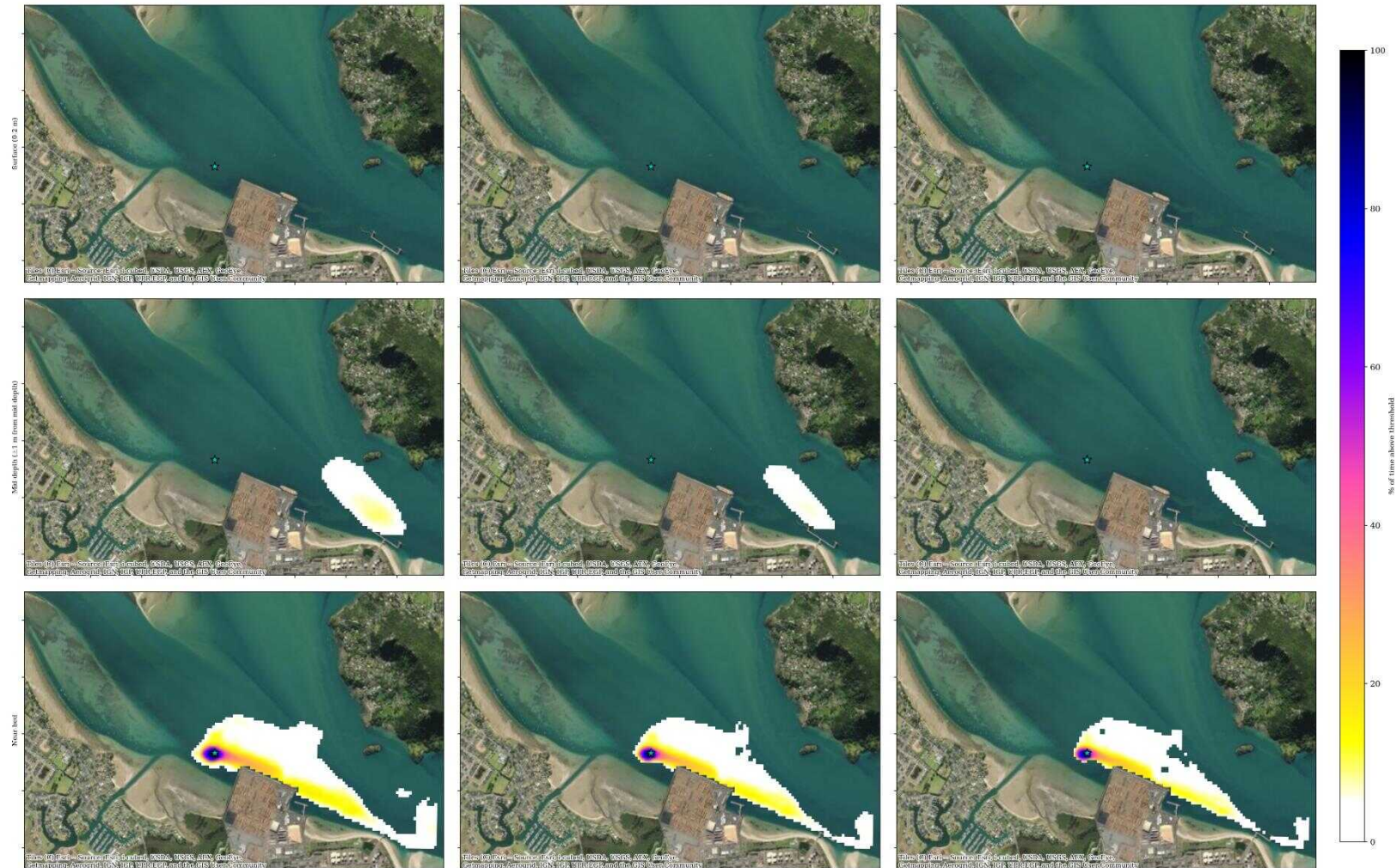


Figure 3-28 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**.. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 – Silty Sand Proposed East West

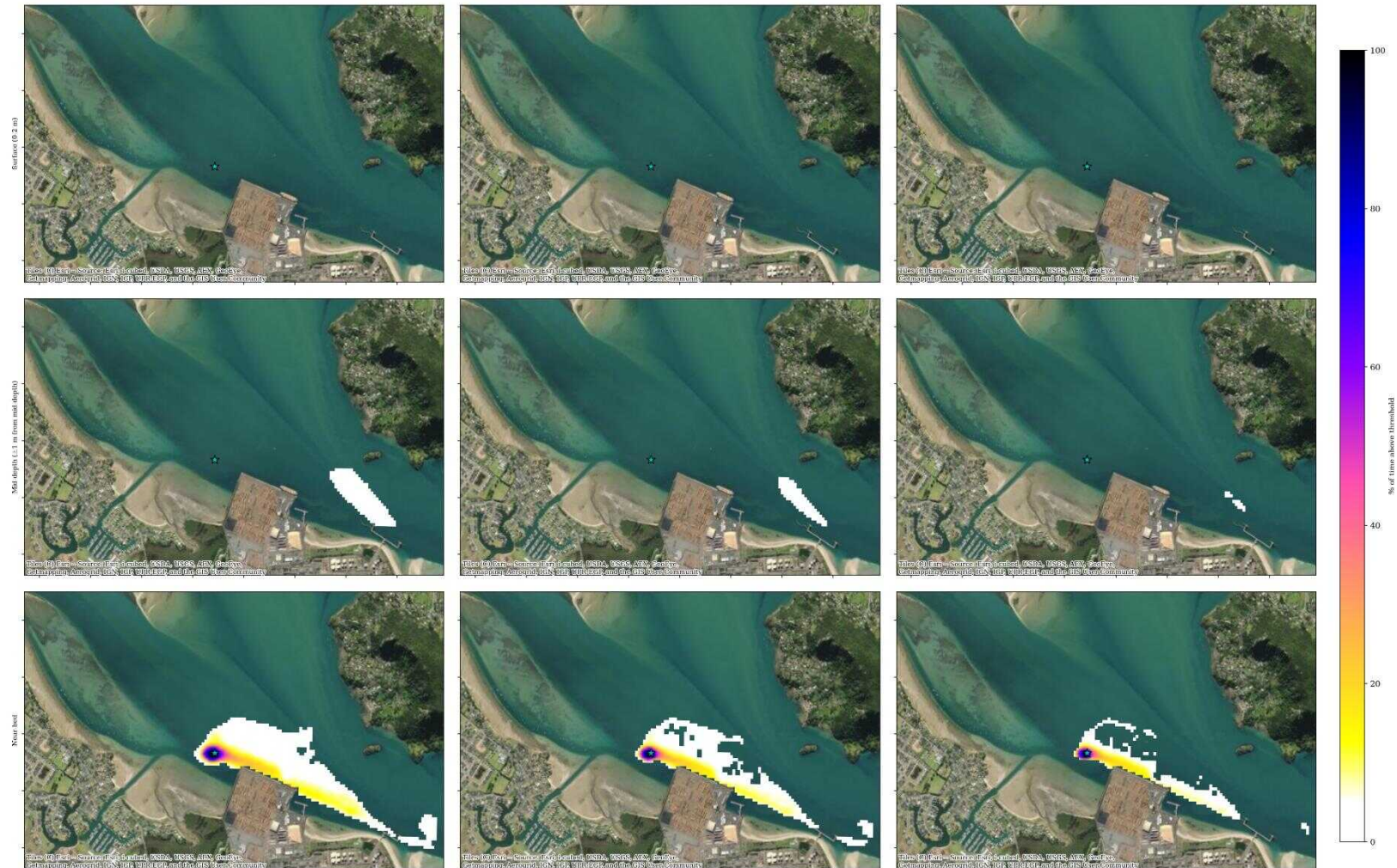
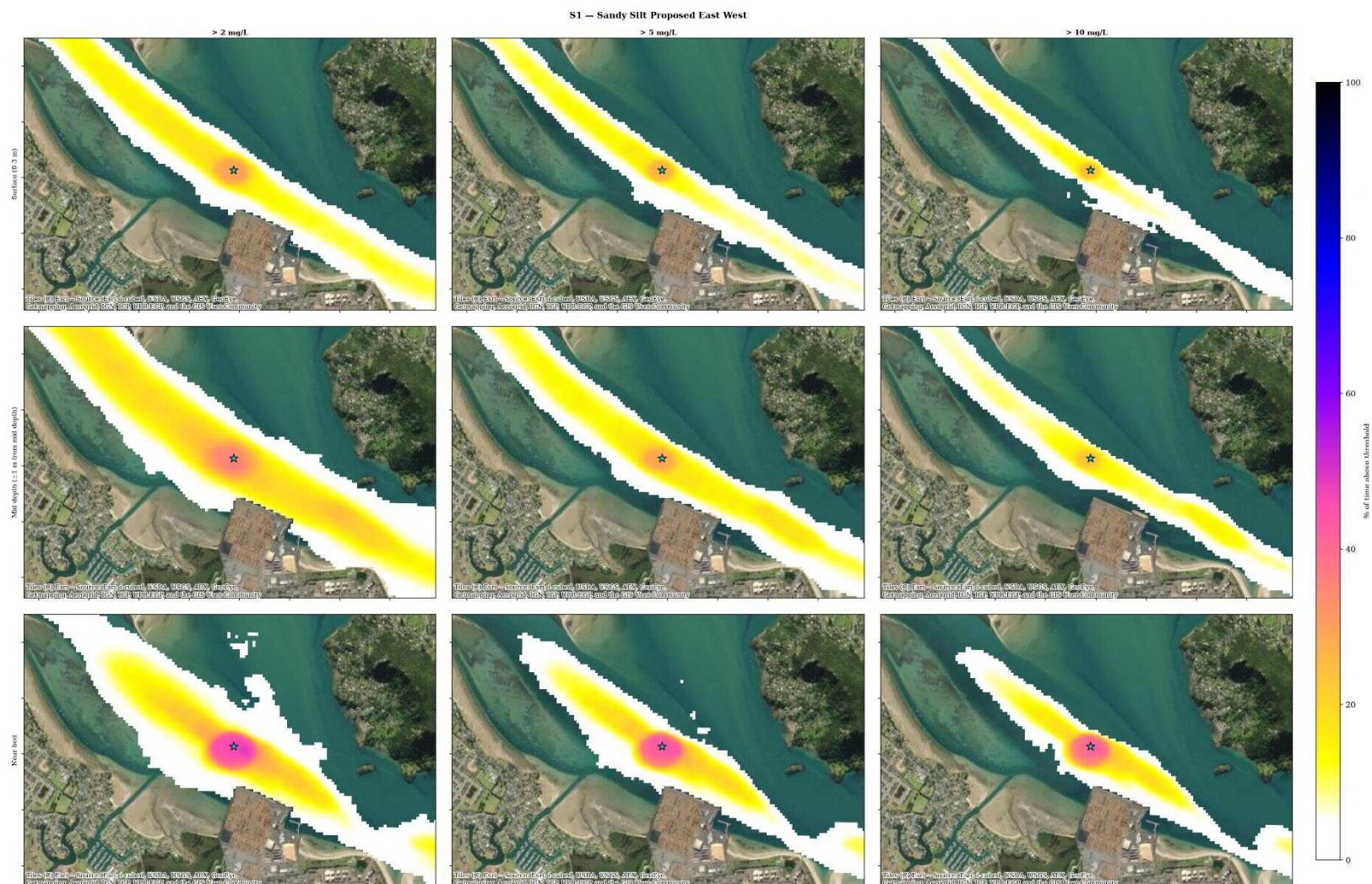
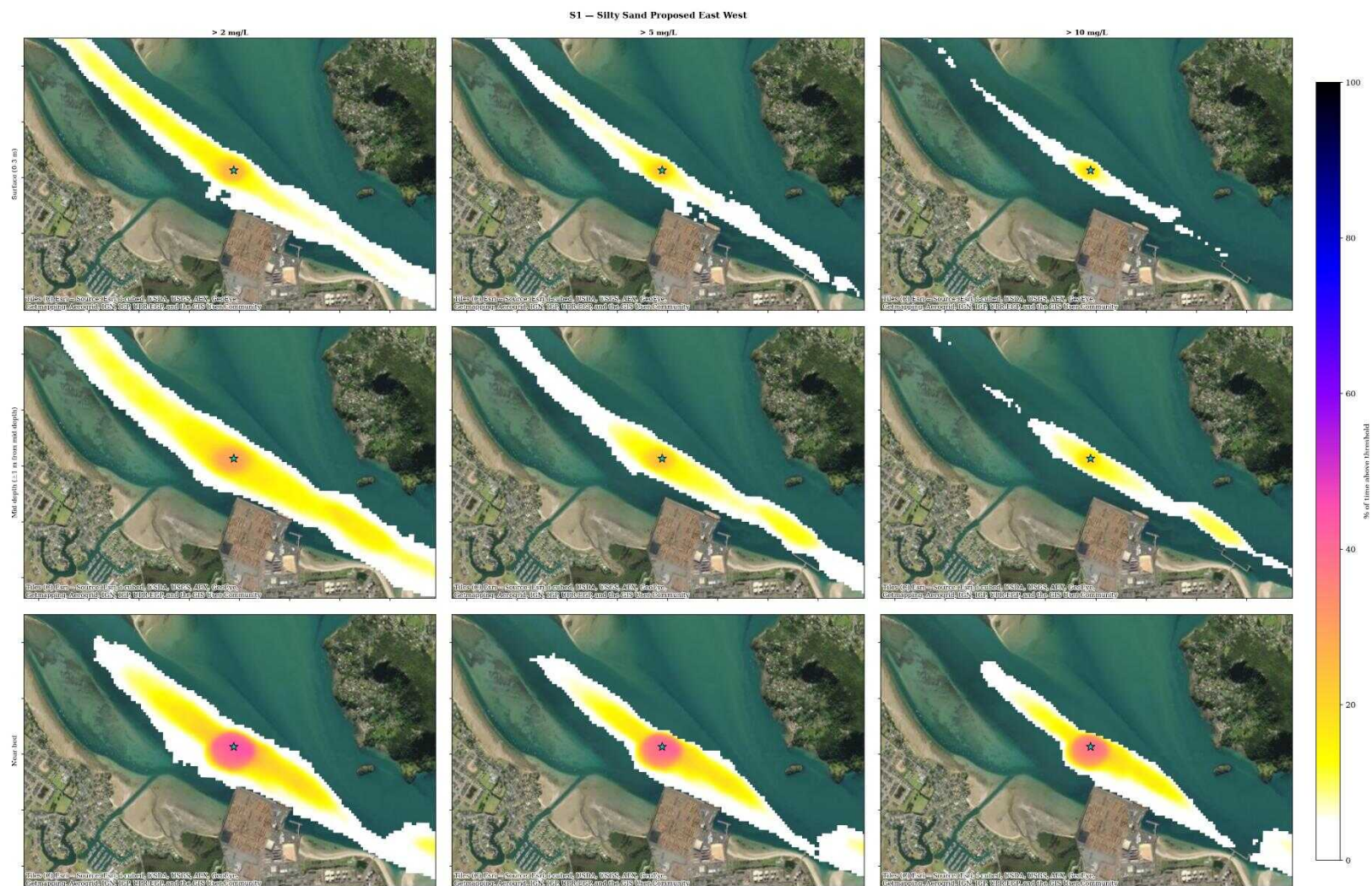


Figure 3-29 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.





4. Summary

A series of one-month-long simulations were conducted to simulate the dispersion and deposition of dredging plumes within the harbour. The simulation evaluated three dredging methods (BHD, CSD and TSHD) across multiple sites and three bathymetric configurations (Existing, combined Eastern Reclamation and NSDF and only NSDF) and two sediment types (Sandy silt and silty sand).

Results in this report are framed using distinct statistical and operational metrics such as 50th percentile and 90th percentile TSS maps and cumulative deposition maps that illustrate the sediment plume and final seabed footprint. All modelled scenarios assume one month of continuous dredging at a single fixed location. Because active dredging operations move dynamically through the berth pocket, and may complete works in less than a month, the plume dimensions and deposition magnitudes should be interpreted as relatively conservative indicators.

Based on the evaluated scenarios, the key findings are as follows:

- Plume dispersion and deposition footprints generally align along a distinct northwest-southeast axis. Under existing bathymetric conditions, plumes extend further westward. However, the proposed structural designs have a tendency to confine sediment plumes within the dredged footprints or redirect their transport eastward, suggesting that as the dredging process advances the plume extension will be reduced.
- TSHD has a higher exposure to channel hydrodynamics, therefore certain sites exhibit a greater plume transport
- BHD and CSD plumes show a more pronounced eastward shift under the proposed designs.
- Plume dimensions are impacted by the grain-size distribution and settling velocities. The sandy silt scenario has a more extensive, widespread plume due to a higher fraction of slow-settling sediments that remain suspended in the water column for a longer period.
- For all three dredging methods, the highest TSS concentrations occur near the seabed.
- Exceedance durations for the 2, 5 and 10 mg L⁻¹ TSS thresholds are highest within the channel region, where tidal currents restrict and advect the sediment plumes.



5. References

- Becker J., van Eekelen E., van Wiechen J., de Lange W., Damsma T., Smolders T., van Koningsveld M., 2015. Estimating source terms for far field dredge plume modelling. *Journal of Environmental Management* 149, 282–293.
- Bellasio, R., Bianconi, R., Mosca, S., Zannetti, P., 2017. Formulation of the Lagrangian particle model LAPMOD and its evaluation against Kincaid SF6 and SO2 datasets. *Atmospheric Environment* 163, 87–98.
- Botev, Z. I., Grotowski, J. F., Kroese, D.P., 2010. Kernel density estimation via diffusion. *Annals of Statistics* 38, 2916–2957.
- Dagestad, K.-F., Röhrs, J., Breivik, Ø., Ådlandsvik, B., 2018. OpenDrift v1.0: a generic framework for trajectory modelling. *Geoscientific Model Development* 11, 1405–1420. <https://doi.org/10.5194/gmd-11-1405-2018>
- MetOcean Solutions, 2026a. Hydrodynamic Modelling 2026 Update - Effects of Proposed Reclamation and Dredging Layout on Hydrodynamics (Report prepared for MBIE No. Report P0678-01).
- MetOcean Solutions, 2026b. Dredging sediment plume dispersion over existing and proposed port configurations. Dewatering simulations. Appendix C (Report prepared for MBIE No. Report P0678-09 Appendix C).
- MetOcean Solutions, 2026c. Dredging sediment plume dispersion over existing and proposed port configurations. Sediment Plumes and Deposition plots. Appendix A (Report prepared for MBIE No. Report P0678-09 Appendix A).
- MetOcean Solutions, 2026d. Dredging sediment plume dispersion over existing and proposed port configurations. Exceedance plots. Design July 2026. Appendix B (Report prepared for MBIE No. Report P0678-09 Appendix B).
- MetOcean Solutions, 2023. Hydrodynamic Modelling Additional Output Locations - Effects of Proposed Reclamation and Dredging Layout on Hydrodynamics (Report prepared for Northport No. Report P0519-13).
- MetOcean Solutions, 2022a. Hydrodynamic Modelling Update - Effects of Proposed Reclamation and Dredging Layout on Hydrodynamics (Report prepared for Northport No. Report P0519-10).
- MetOcean Solutions, 2022b. Morphodynamic Modelling for the Northport Environment. Modelling Update . Predicted morphological response to proposed eastern land reclamation (Report prepared for Northport No. Report P0519-11).
- MetOcean Solutions, 2021a. Hydrodynamic Modelling - Effect of Proposed Reclamation Layouts on Hydrodynamics (Report prepared for Northport No. Report P0519-01).
- MetOcean Solutions, 2021b. Morphodynamic Modelling for the Northport Environment. Modelling Update . Predicted morphological response to proposed capital dredging and land reclamation (Report prepared for Northport No. Report P0519-02).



- MetOcean Solutions, 2021c. Dredge Plume Modelling . Dredging sediment plume dispersion over existing and proposed port configurations (Report prepared for Northport No. Report P0519-03).
- MetOcean Solutions, 2018a. Morphodynamic Evolution Modelling for the Northport Environment - Predicted morphological response to proposed capital dredging and land reclamation (Report prepared for Northport No. Report P0367-03).
- MetOcean Solutions, 2018b. Morphodynamic Evolution Modelling for the Northport Environment - Morphological model calibration (Report prepared for Northport No. Report P0367-01 Rev B).
- MetOcean Solutions, 2018c. Morphodynamic Evolution Modelling for the Northport Environment - Five year morphological prediction of the swinging basin morphological response (Report prepared for Northport No. Report P0367-05).
- MetOcean Solutions, 2018d. Northport Dredging Project - Dredging Plume Modelling (Report prepared for Northport No. Report P0367-01).
- MetOcean Solutions, 2018e. Dredging Plumes for NorthPort Environment (Report prepared for Northport No. Report P0367-04).
- MetOcean Solutions, 2018f. Hydrodynamic Modelling - Methodology, Validation and Simulations (Report prepared for Northport No. Report P0367-02).
- MetOcean Solutions, 2016. Characterisation of the physical environment at the Whangarei Harbour entrance and establishment of numerical models of wave, current and sediment dynamics (Report prepared for Refining New Zealand No. Crude Freight Shipping Project Whangarei Harbour).
- Silverman, B.W., 1986. Density Estimation for Statistics and Data Analysis, Chapman and Hall Ltd. ed. London.
- Spearman, J., Bray, R.N., Land, J., Burt, T.N., Mead, C.T., Scott, D., 2007. Plume dispersion modelling using dynamic representation of trailer dredger source terms, in: J.P.-Y. Maa, L.P.S. and D.H.S. (Ed.), Proceedings in Marine Science, Estuarine and Coastal Fine Sediments Dynamics Interco 2003. Elsevier, pp. 417-448.
- Visser, A., 1997. Using random walk models to simulate the vertical distribution of particles in a turbulent water column. Marine Ecology - Progress Series 158, 275-281. <https://doi.org/10.3354/meps158275>
- Vitali, L., Monforti, F., Bellasio, R., Bianconi, R., Sachero, V., Mosca, S., Zanini, G., 2006. Validation of a Lagrangian dispersion model implementing different kernel methods for density reconstruction. Atmospheric Environment 40, 8020-8033.
- Winterwerp, J.C., 2002. Near-field behavior of dredging spill in shallow water. Journal of Waterway Port Coastal and Ocean Engineering 128, 96-98.





Dredge Plume Modelling

Dredging sediment plume dispersion over existing
and proposed port configurations

(Design July 2026)

Appendix A

Report prepared for MBIE
August 2026

Document History

Versions

Version	Revision Date	Summary	Reviewed by
0.1	21/07/2026	Initial document created	Montaño
0.2	03/08/2026	Draft for internal review	Montaño

Distribution

Version	Date	Distribution
1.0	07/08/2026	FINAL -MBIE Project team

Document ID: P0678 – 09 – Appendix A

Authors

Montaño M.

Contributors

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continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.75

Figure 55 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.76

Figure 56 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.77

Figure 57 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.78

Figure 58 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.79

Figure 59 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.80

Figure 60 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel.



The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.81

Figure 61 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.82

Figure 62 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.83

Figure 63 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.84

Figure 64 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.85

Figure 65 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 5**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.86

Figure 66 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 5**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge



continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.87

Figure 67 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 5**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.88

Figure 68 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 5**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.89

Figure 69 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.90

Figure 70 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.91

Figure 71 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.92

Figure 72 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel.



The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.93

Figure 73 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 7**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.94

Figure 74 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 7**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.95

Figure 75 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 7**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.96

Figure 76 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 7**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.97

Figure 77 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.98

Figure 78 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.99

Figure 79 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand



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Figure 97 Final cumulative sediment deposition thickness (m) for CSD dredging at site 3 , over the proposed NSDF bathymetry . Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.	118
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Figure 105 Final cumulative sediment deposition thickness (m) for TSHD dredging at site 3 , over the existing bathymetry . Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.	126



- Figure 106 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 127
- Figure 107 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 128
- Figure 108 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 129
- Figure 109 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 5**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 130
- Figure 110 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 5**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 131
- Figure 111 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 132
- Figure 112 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 6**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 133
- Figure 113 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 7**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 134
- Figure 114 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 7**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm. 135

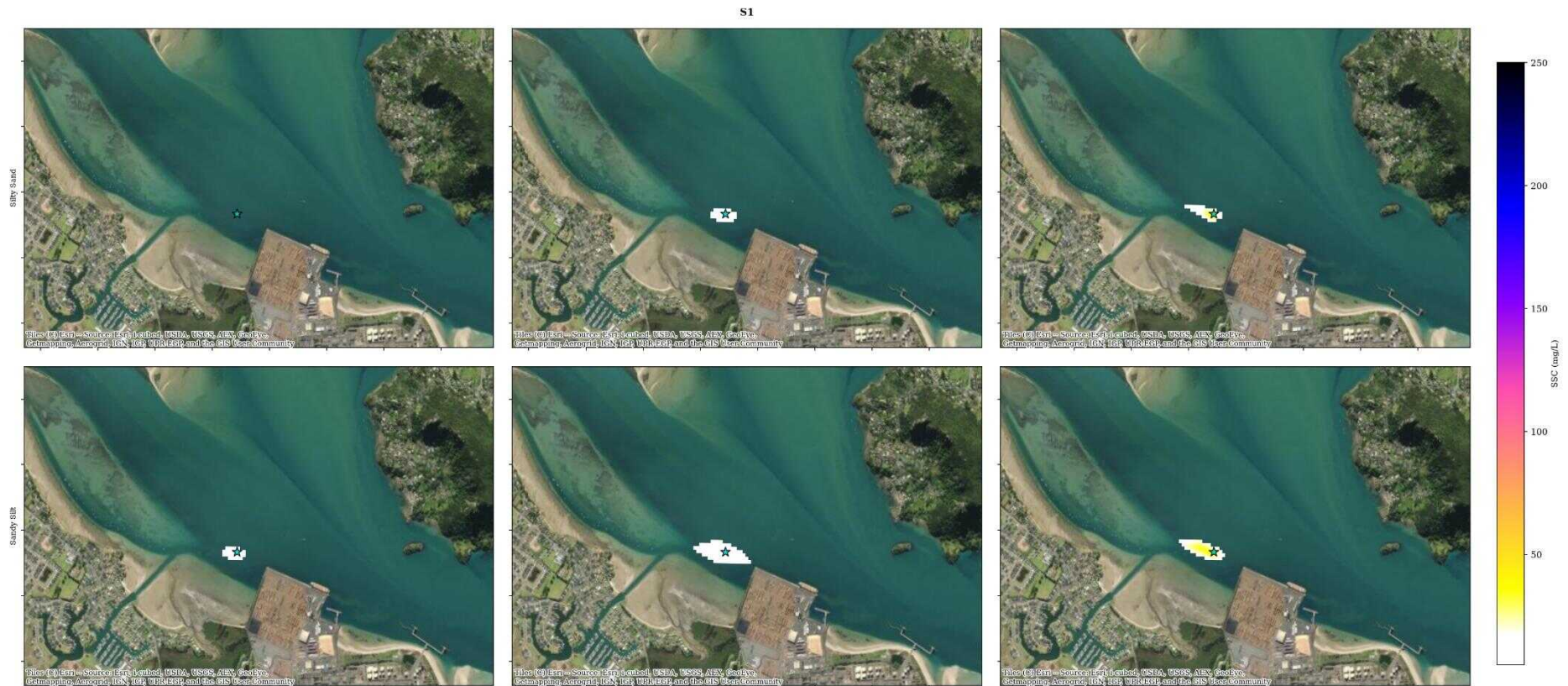




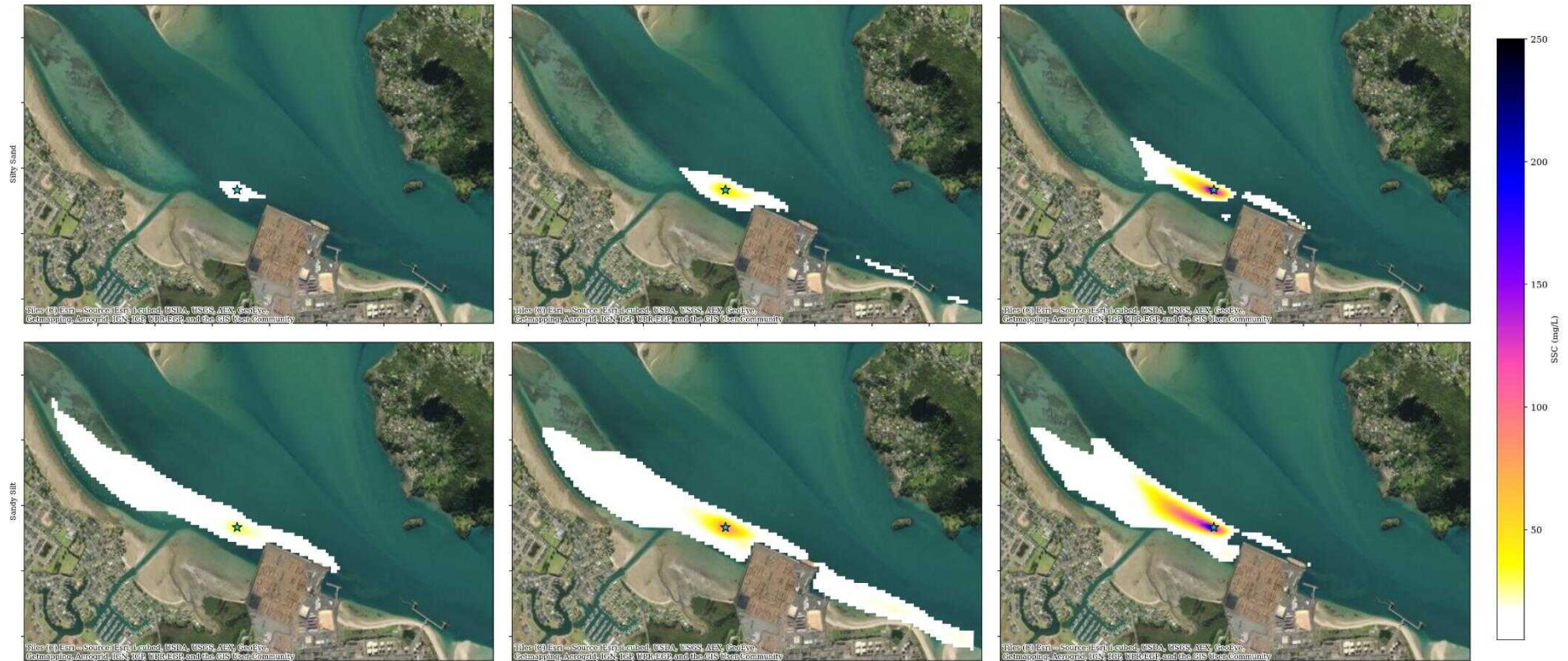
Appendix A: Additional Figures



BHD sediment plumes



S1



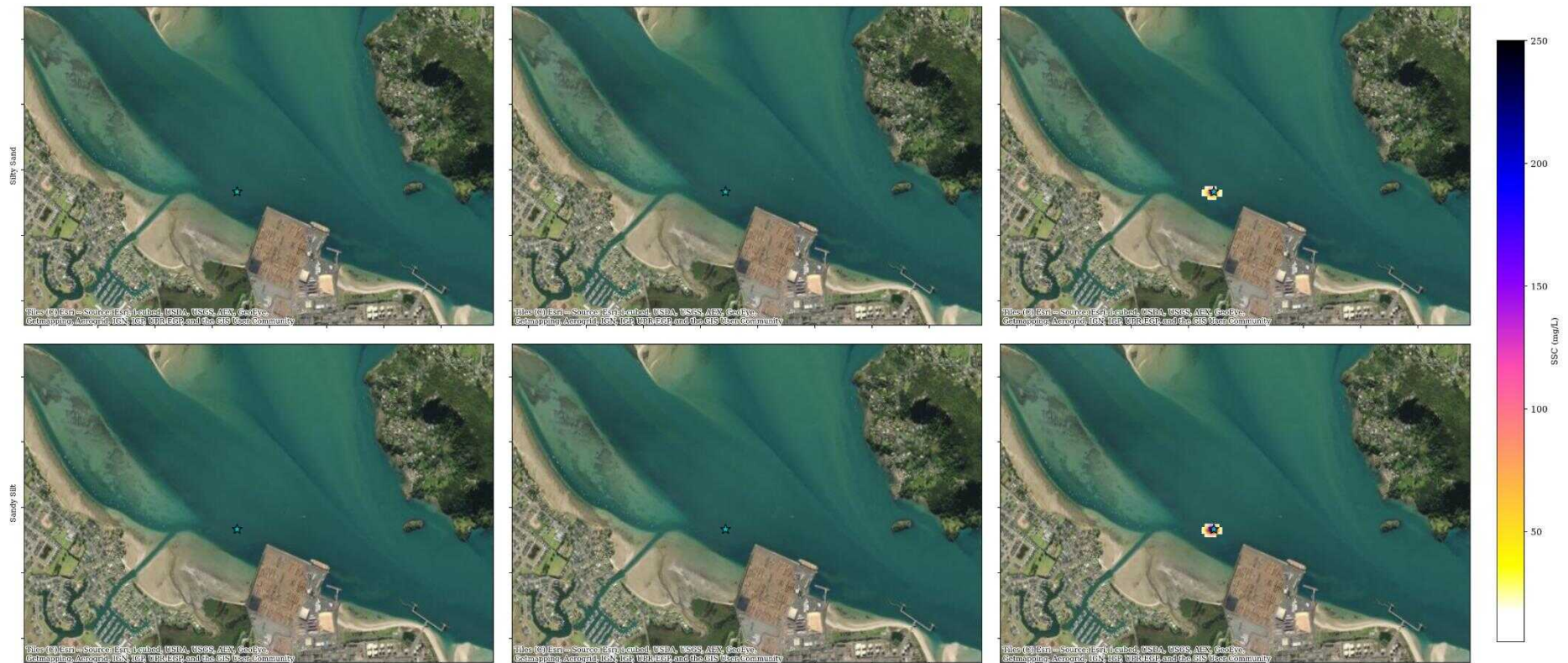
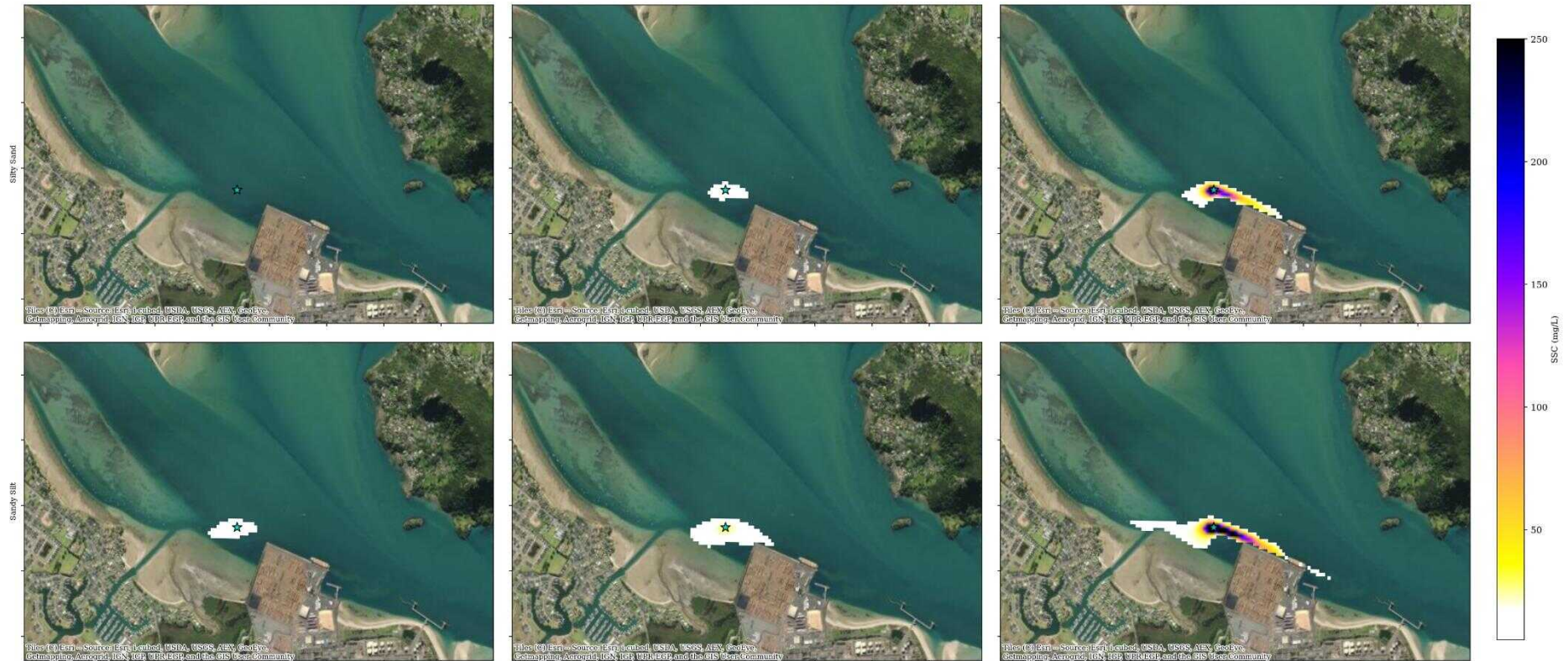


Figure 3 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S1



S1

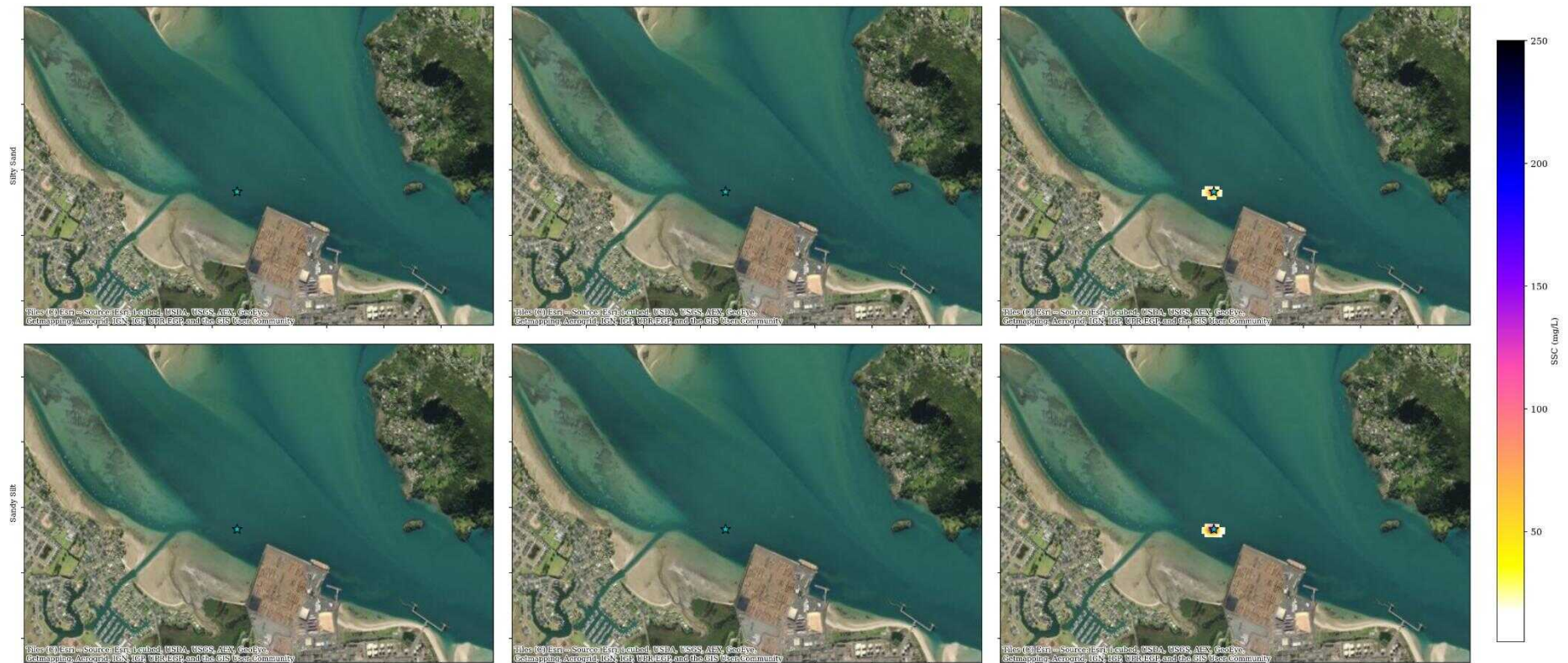


Figure 5 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1}

S1



Figure 6 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1}

S2

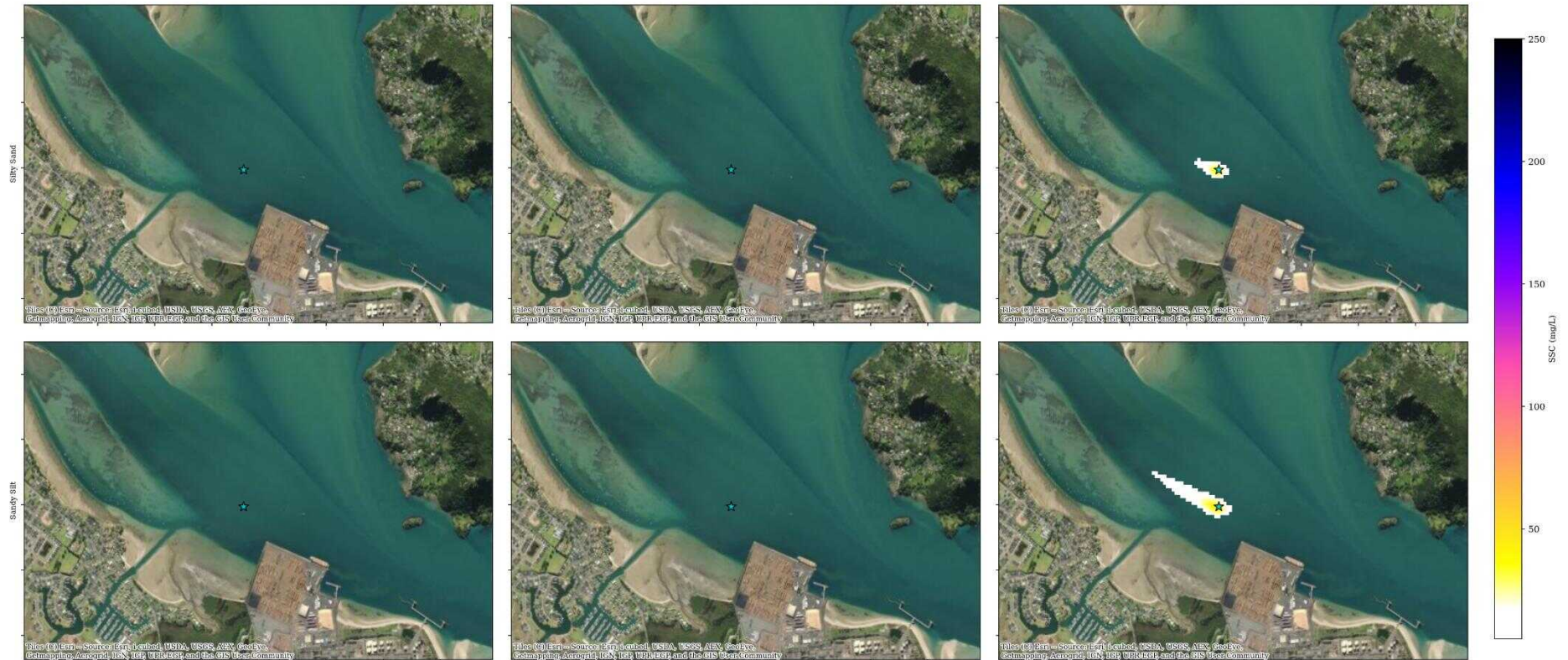
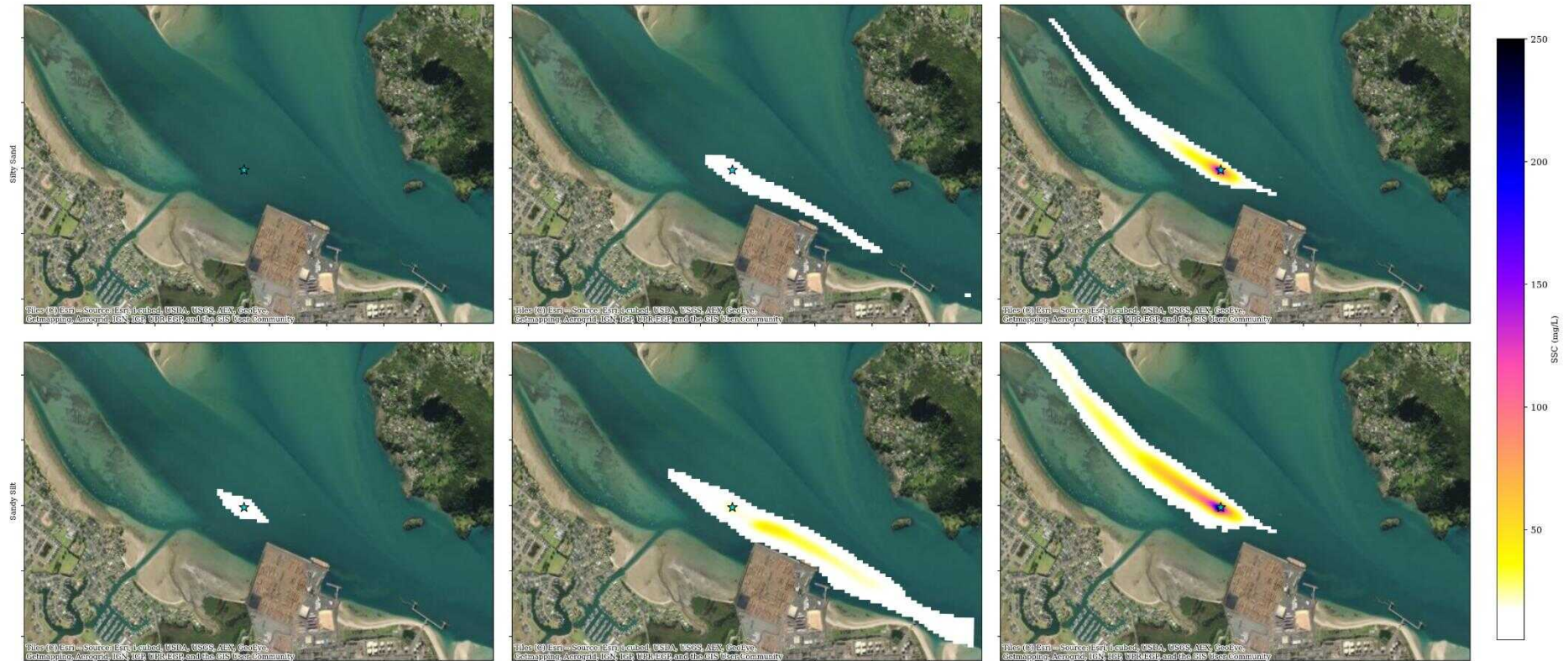


Figure 7 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S2



S2

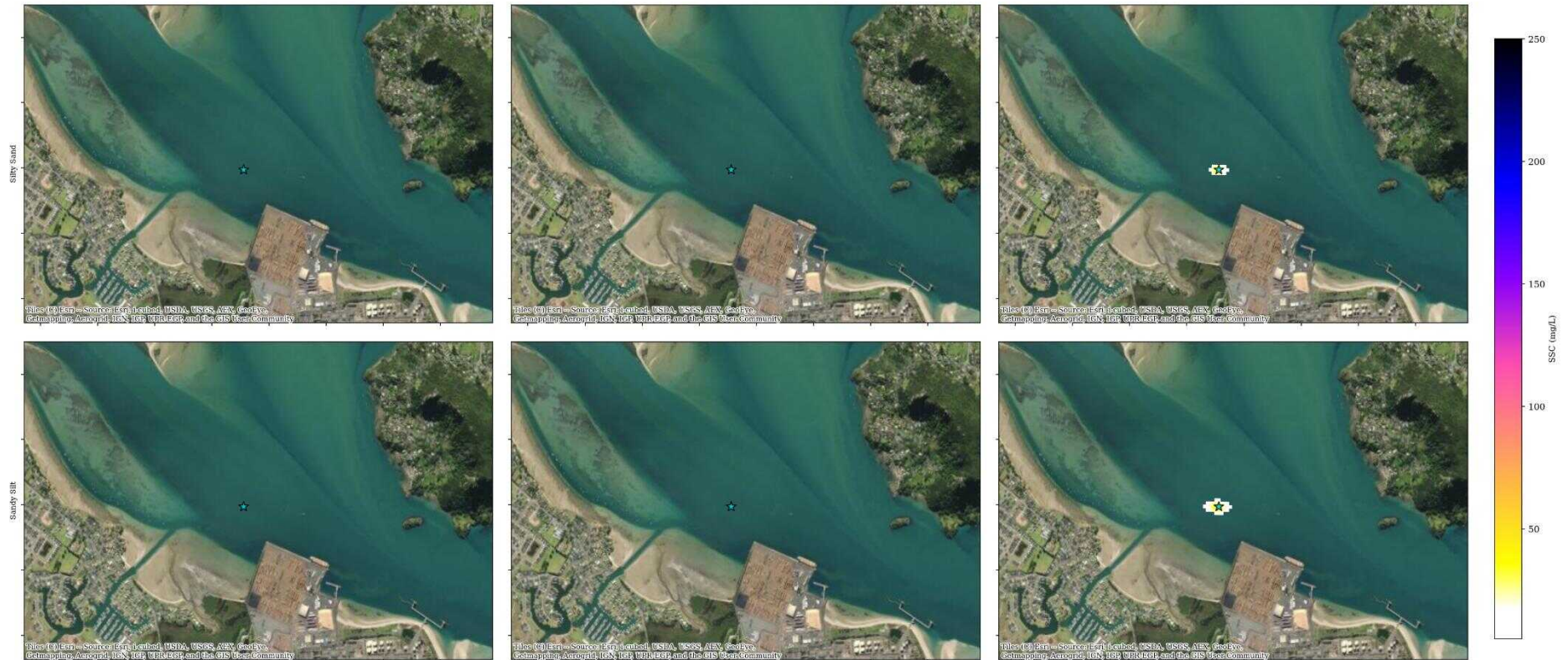
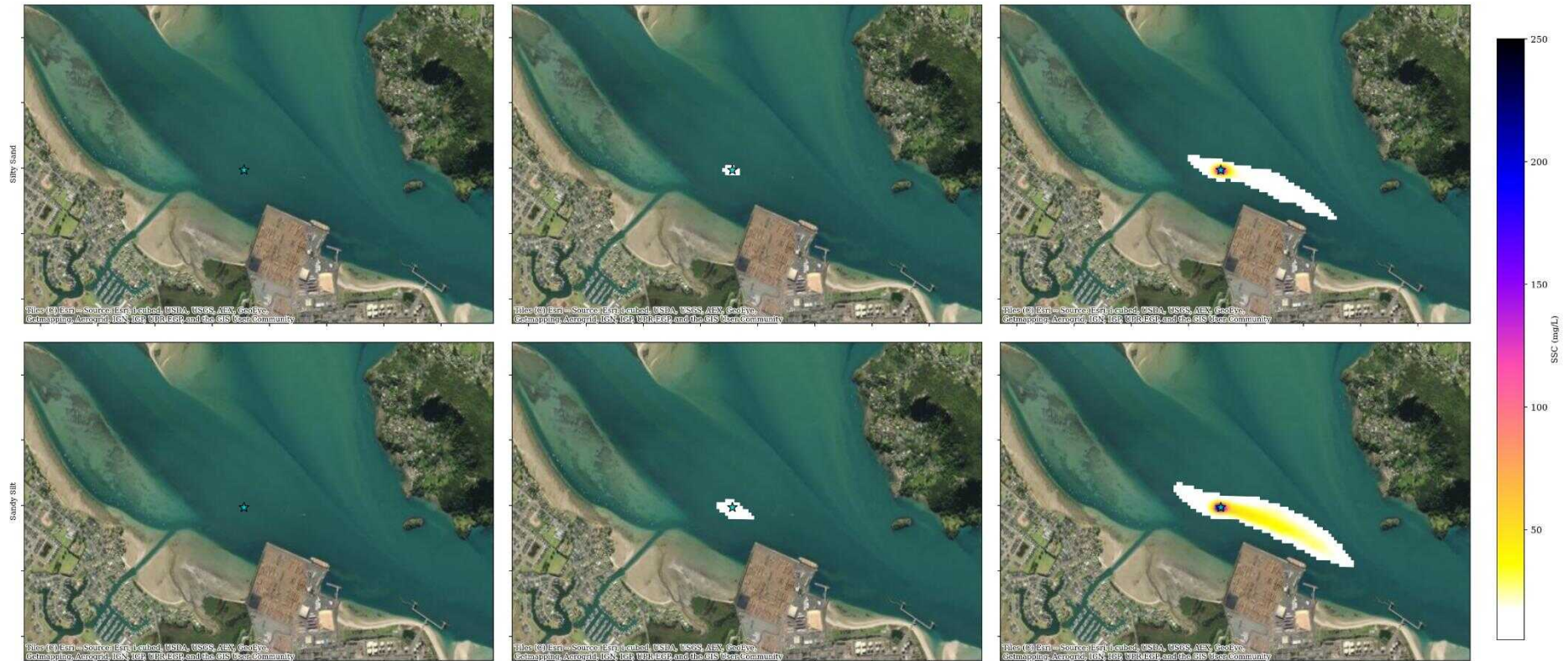


Figure 9 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S2



S2

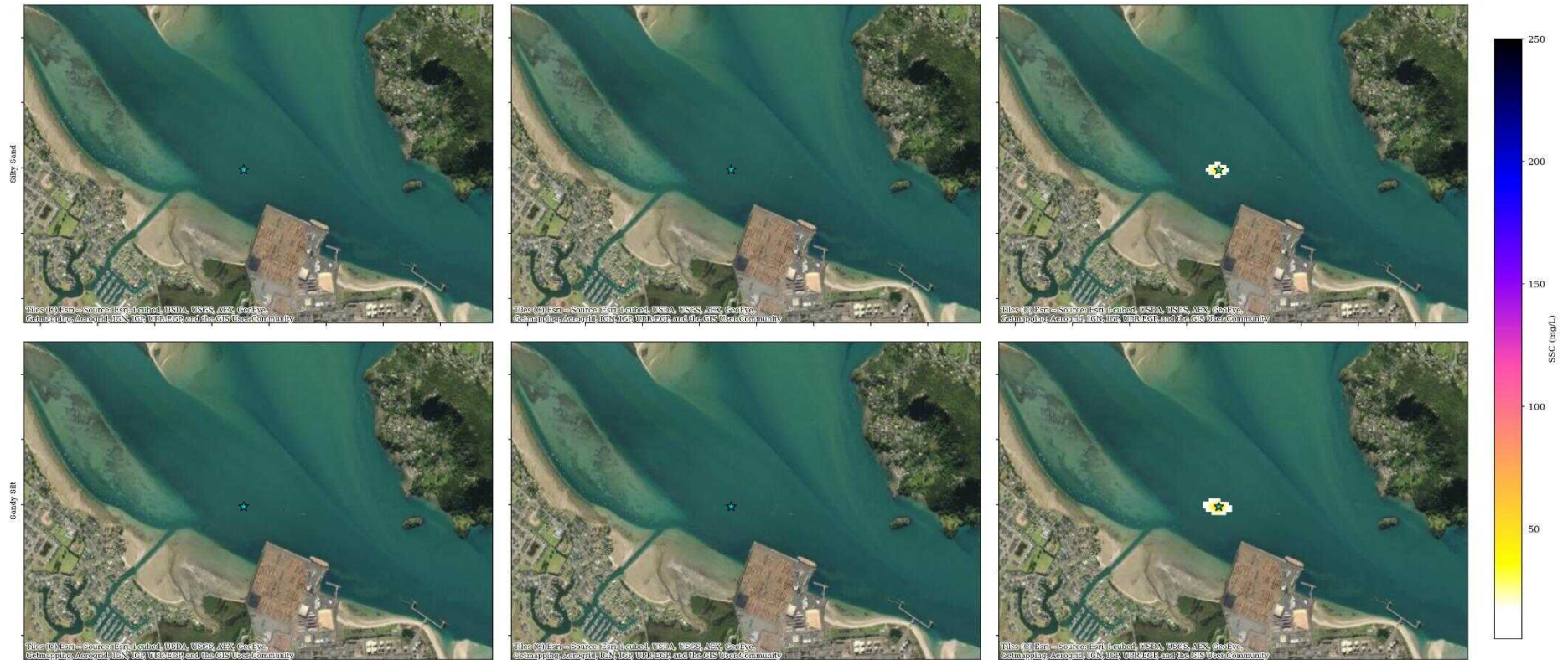


Figure 11 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹

S2

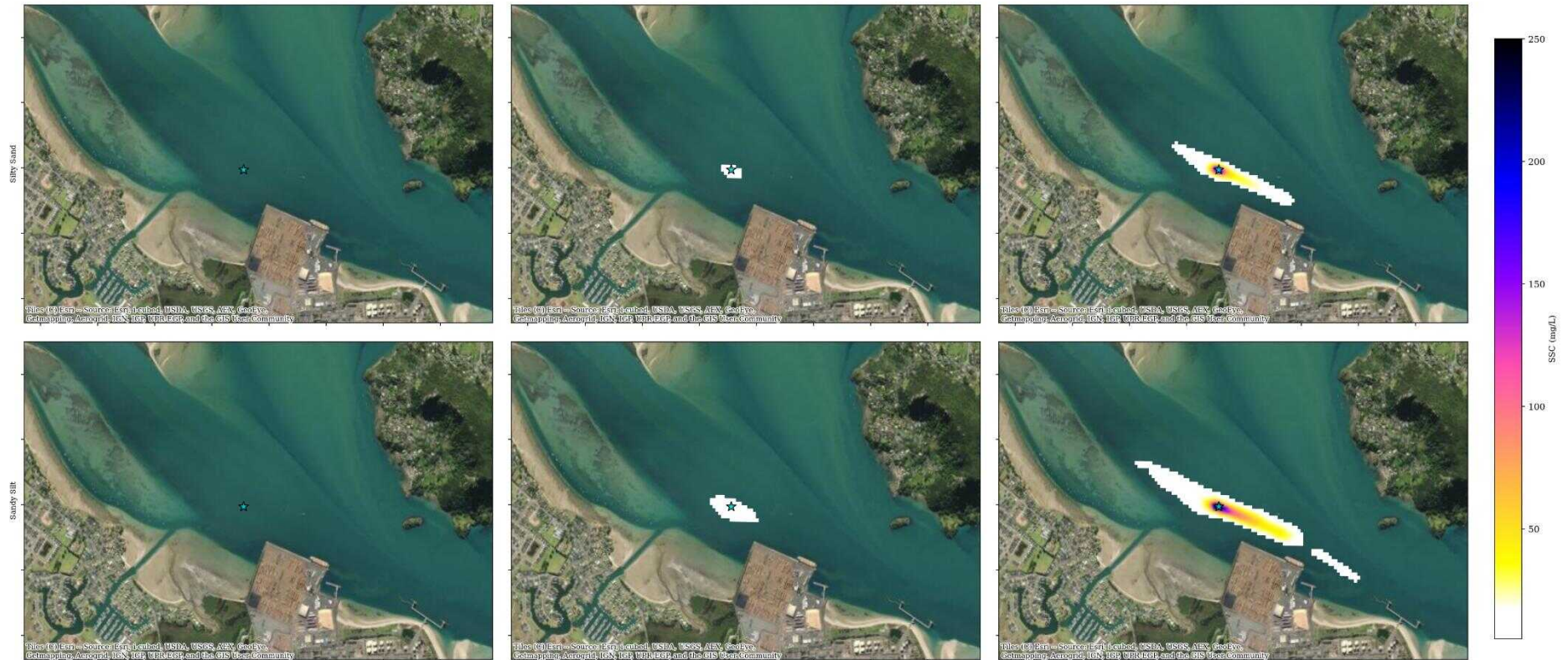
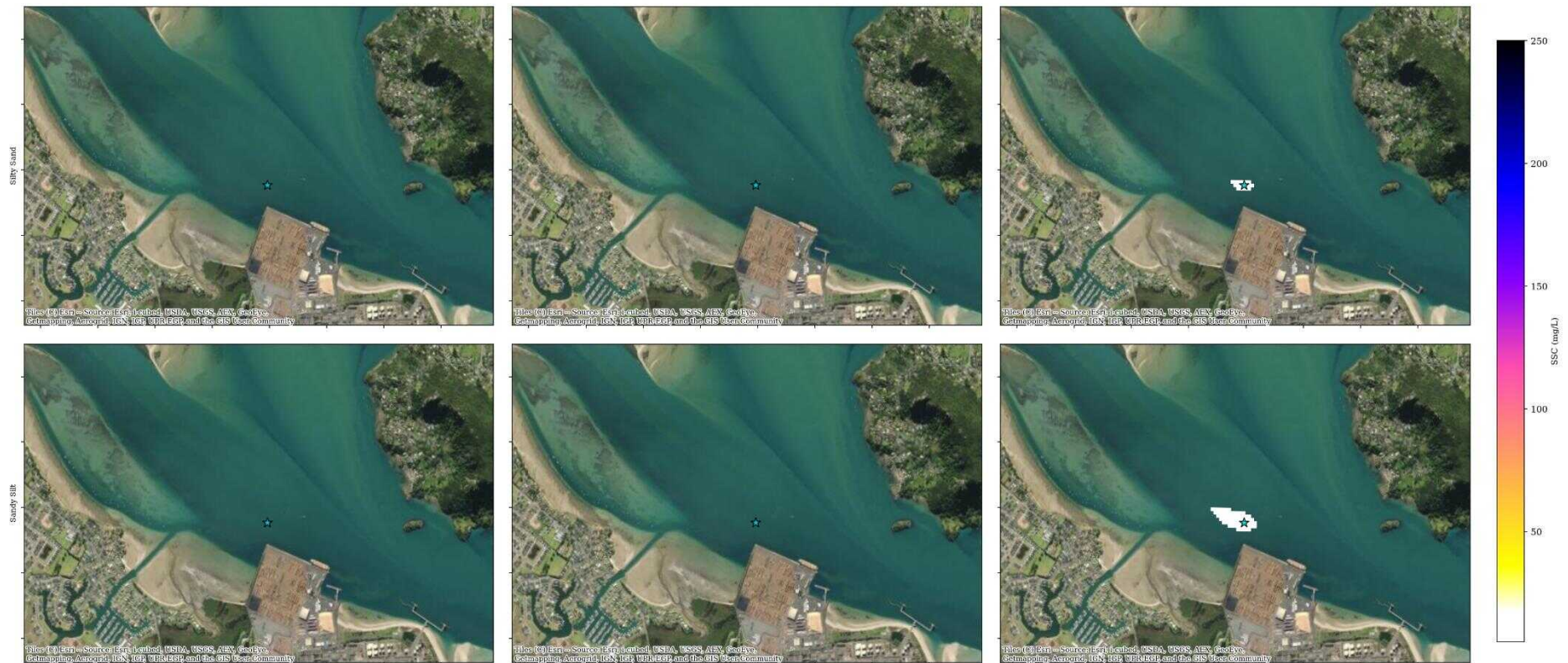


Figure 12 90th percentile of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1}



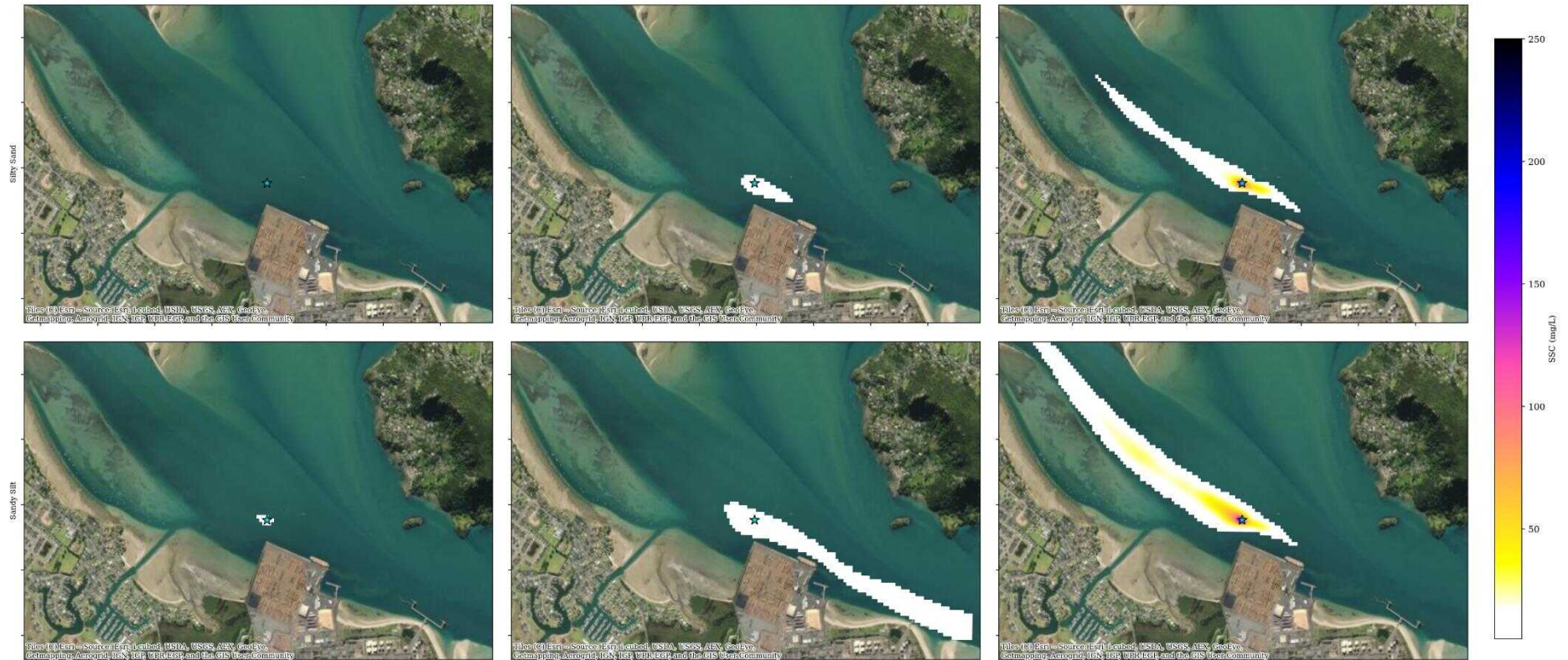


Figure 14 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

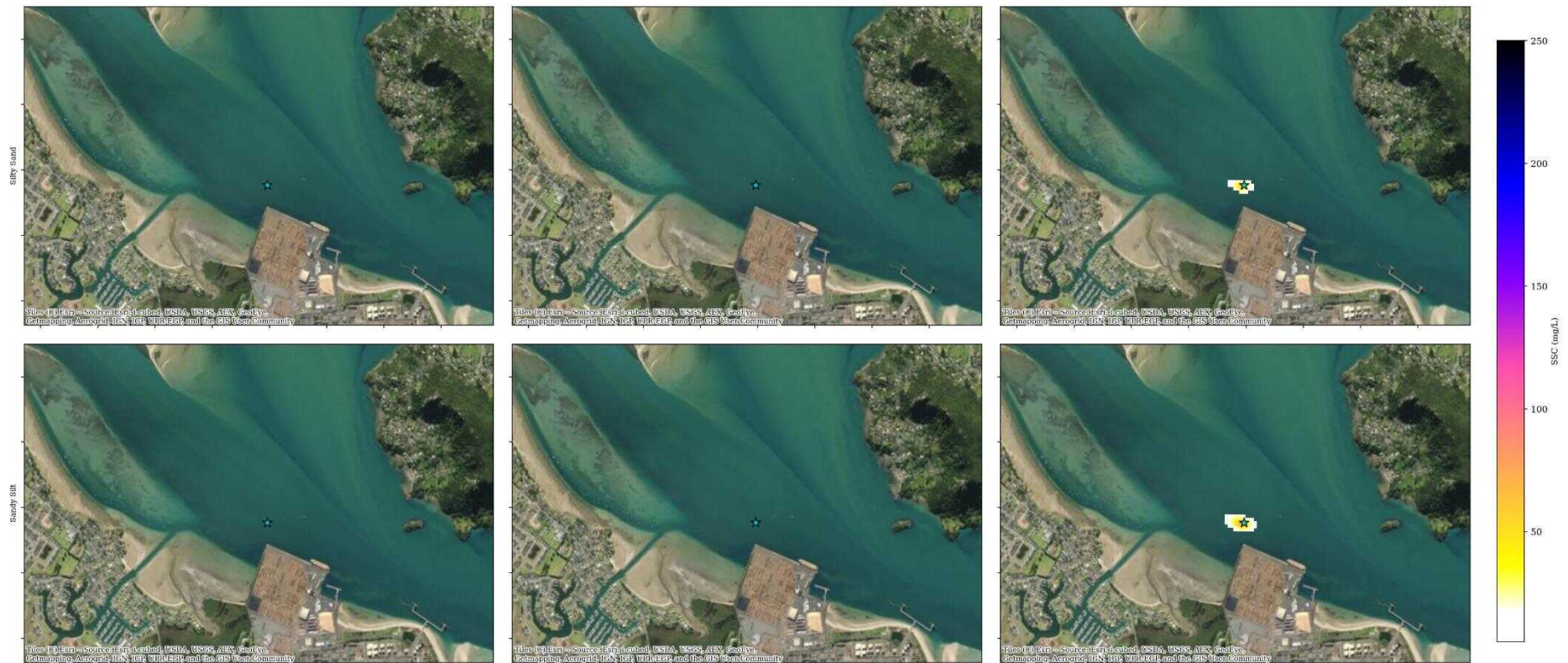


Figure 15 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

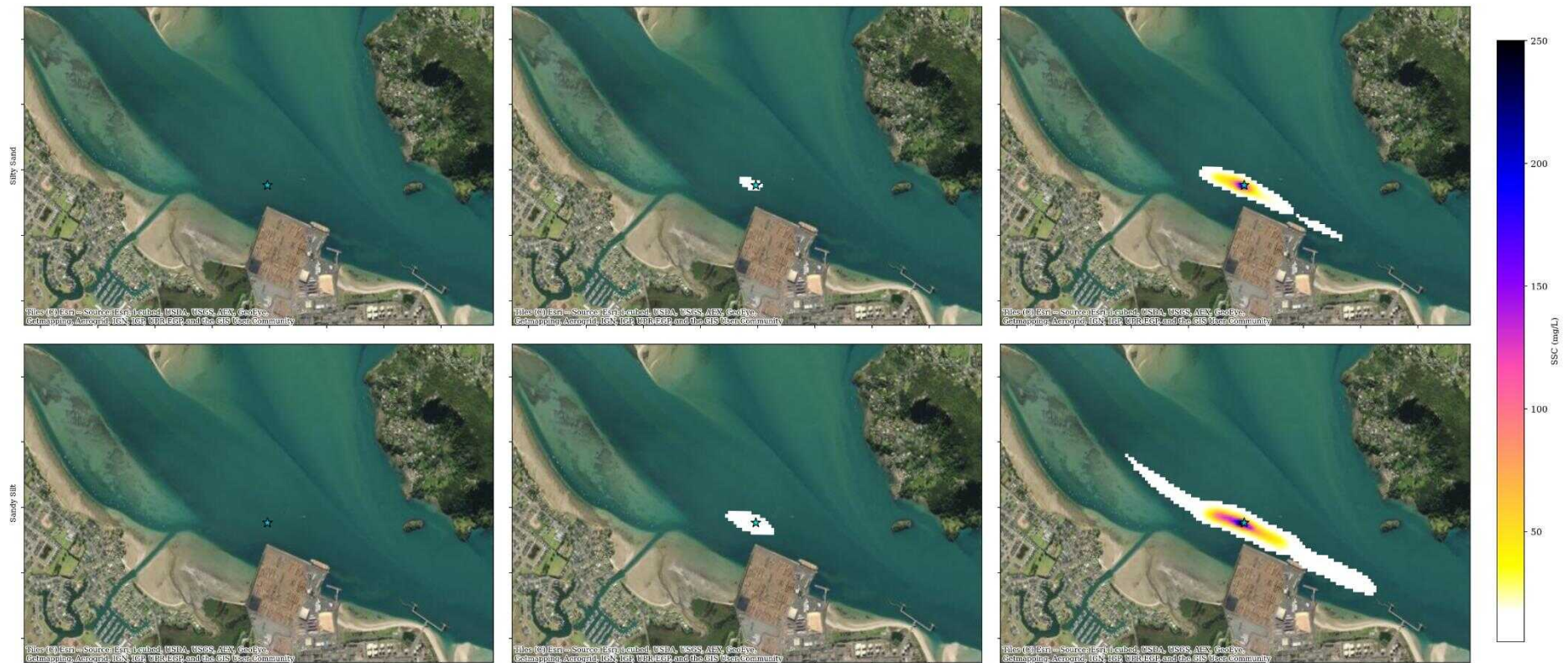


Figure 16 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

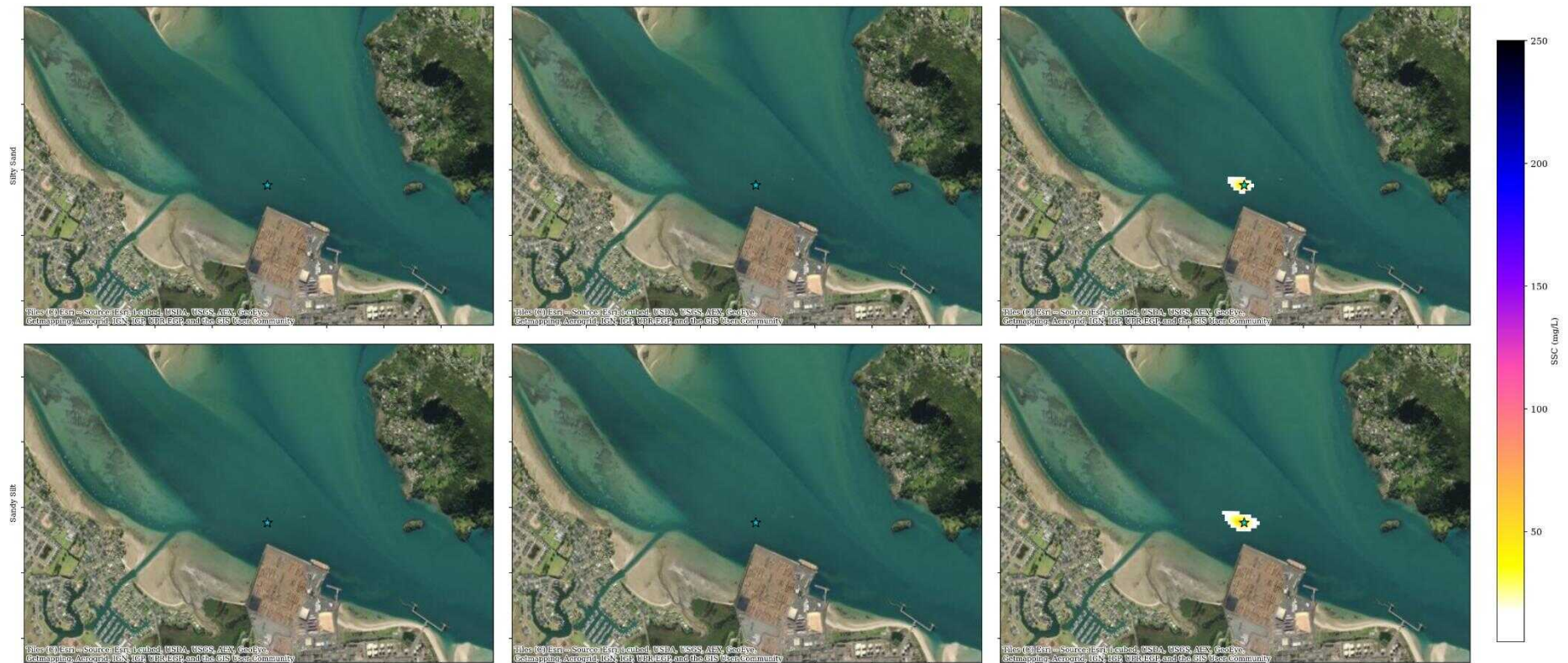




Figure 18 90th percentile of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹

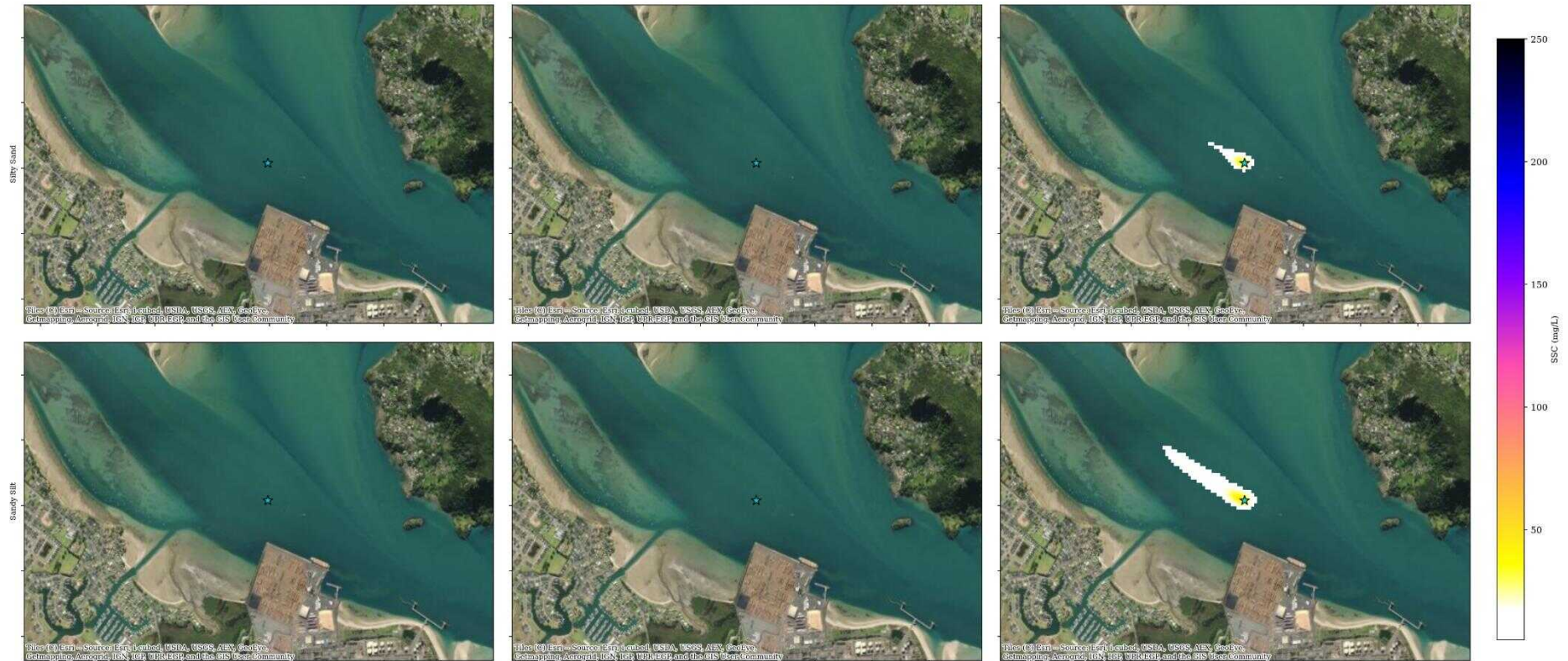
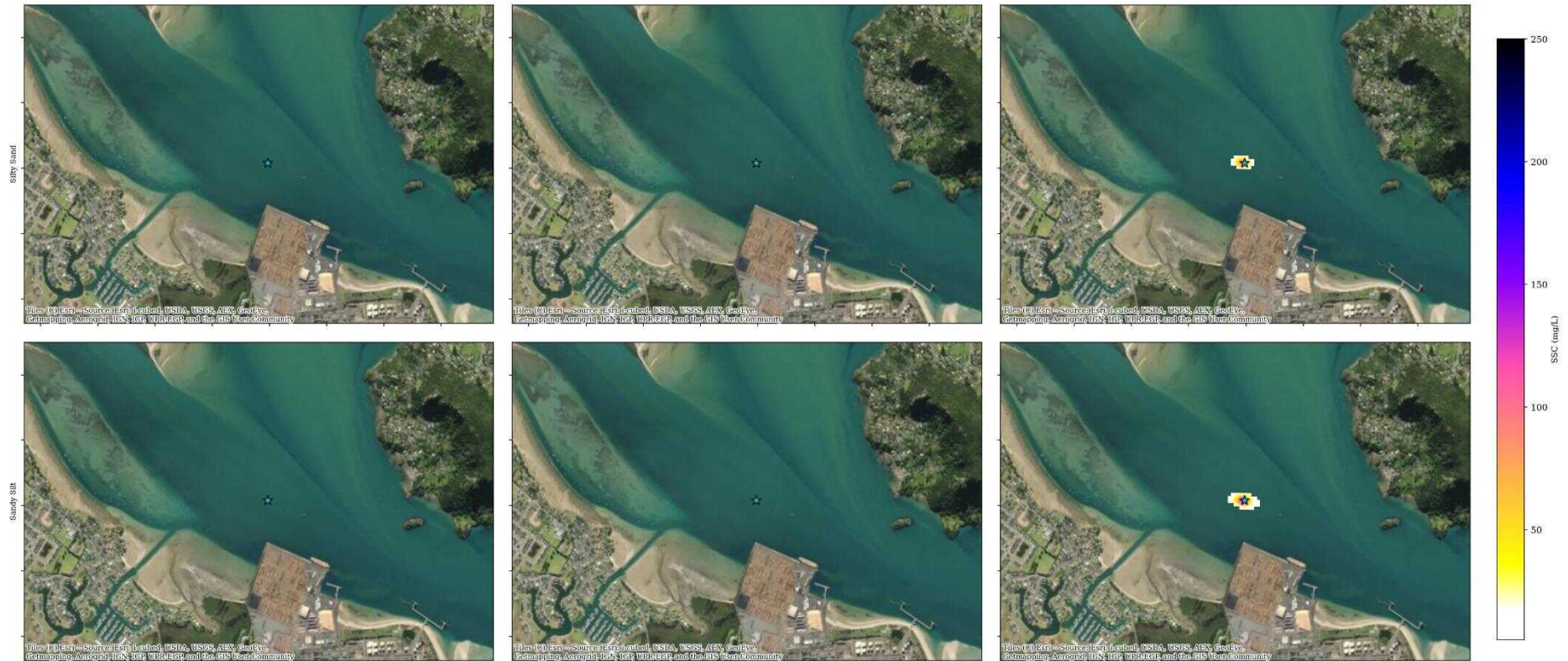
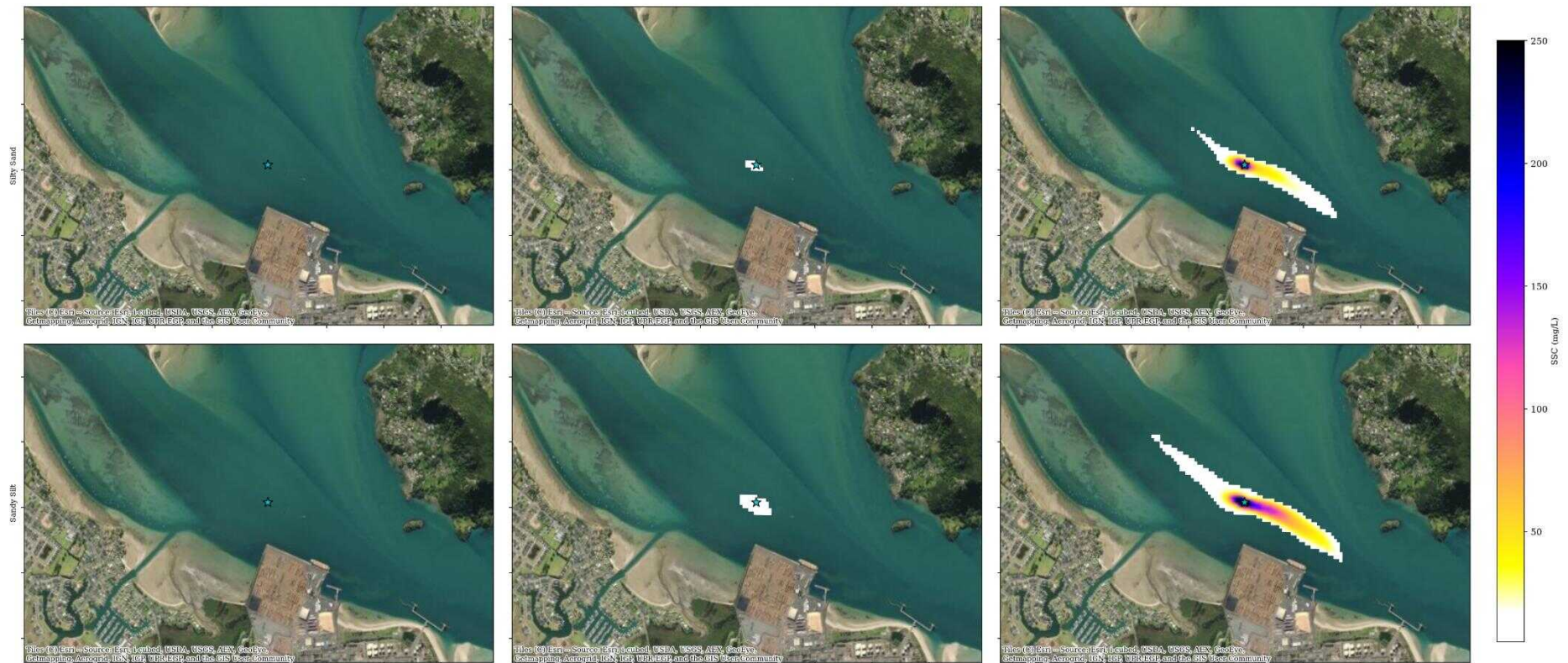
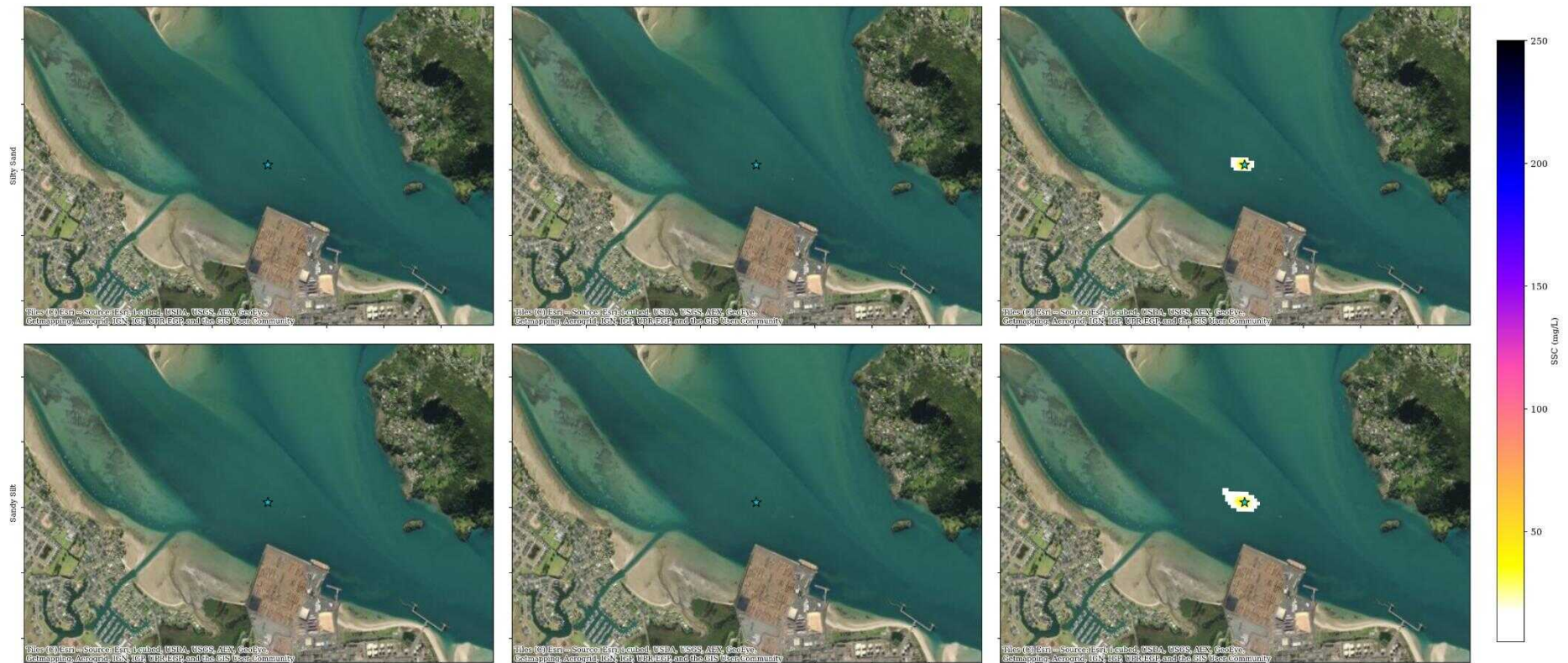


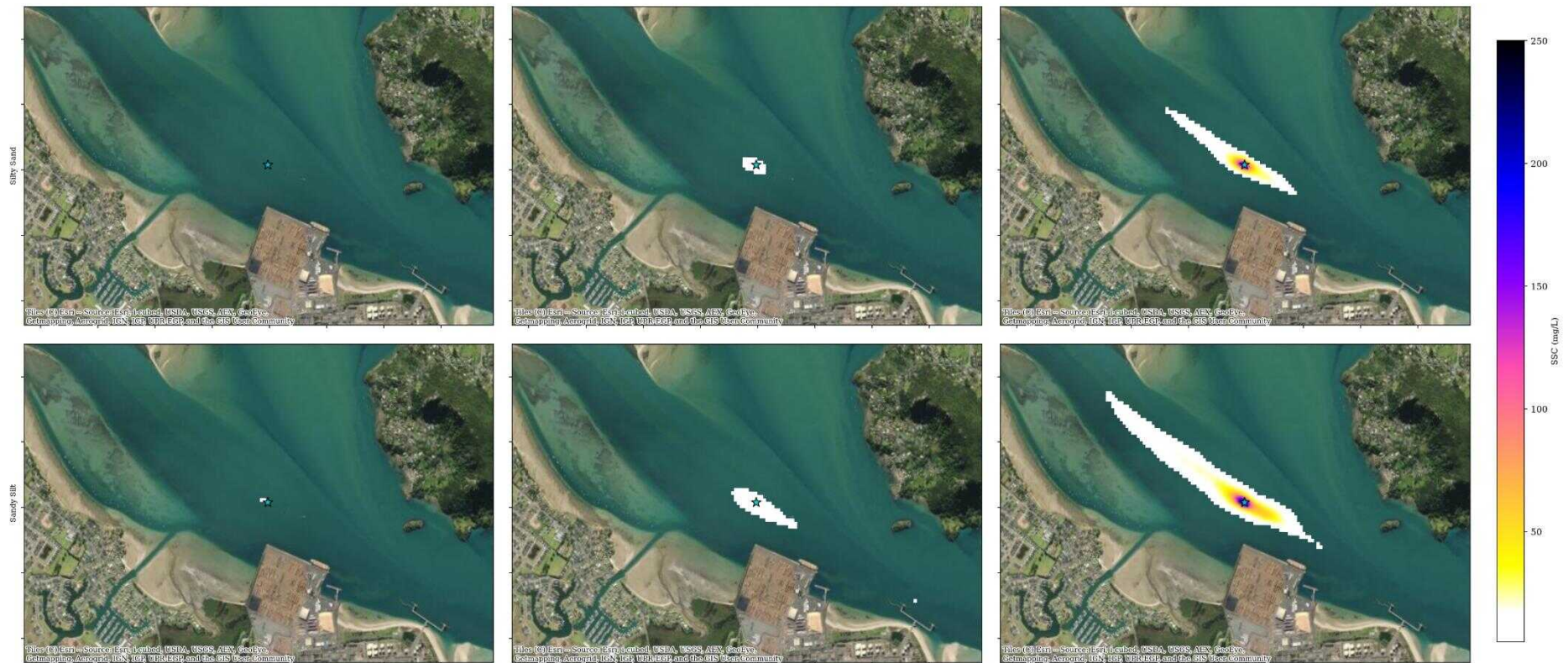
Figure 19 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **BHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.



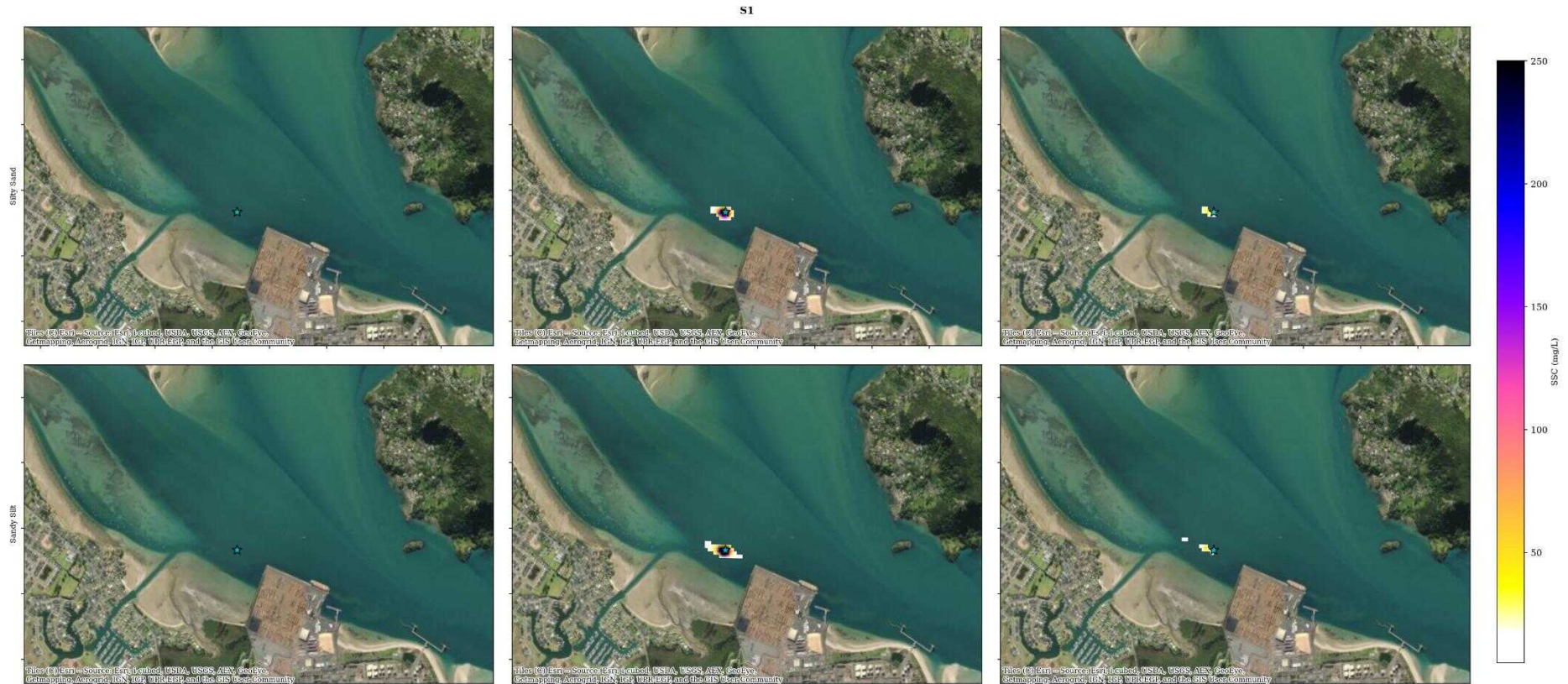




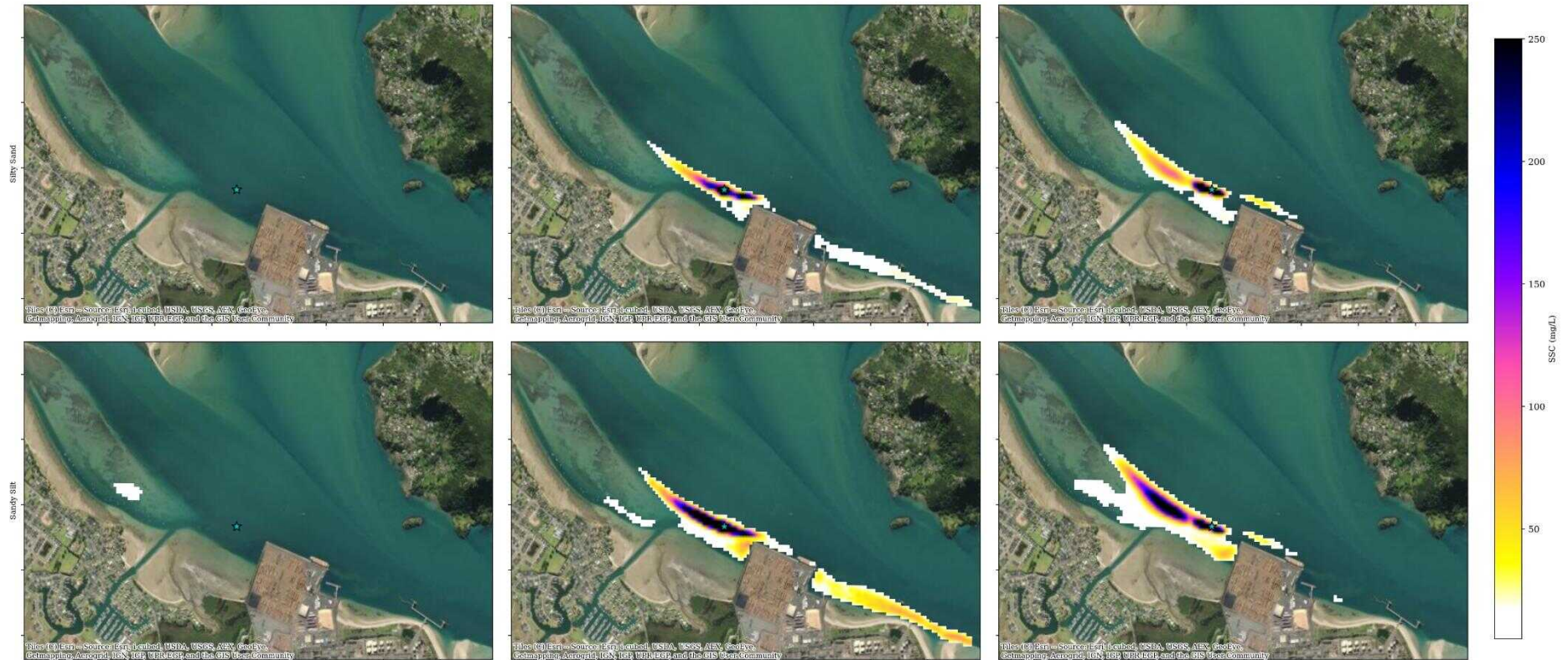




CSD sediment plumes



S1



S1

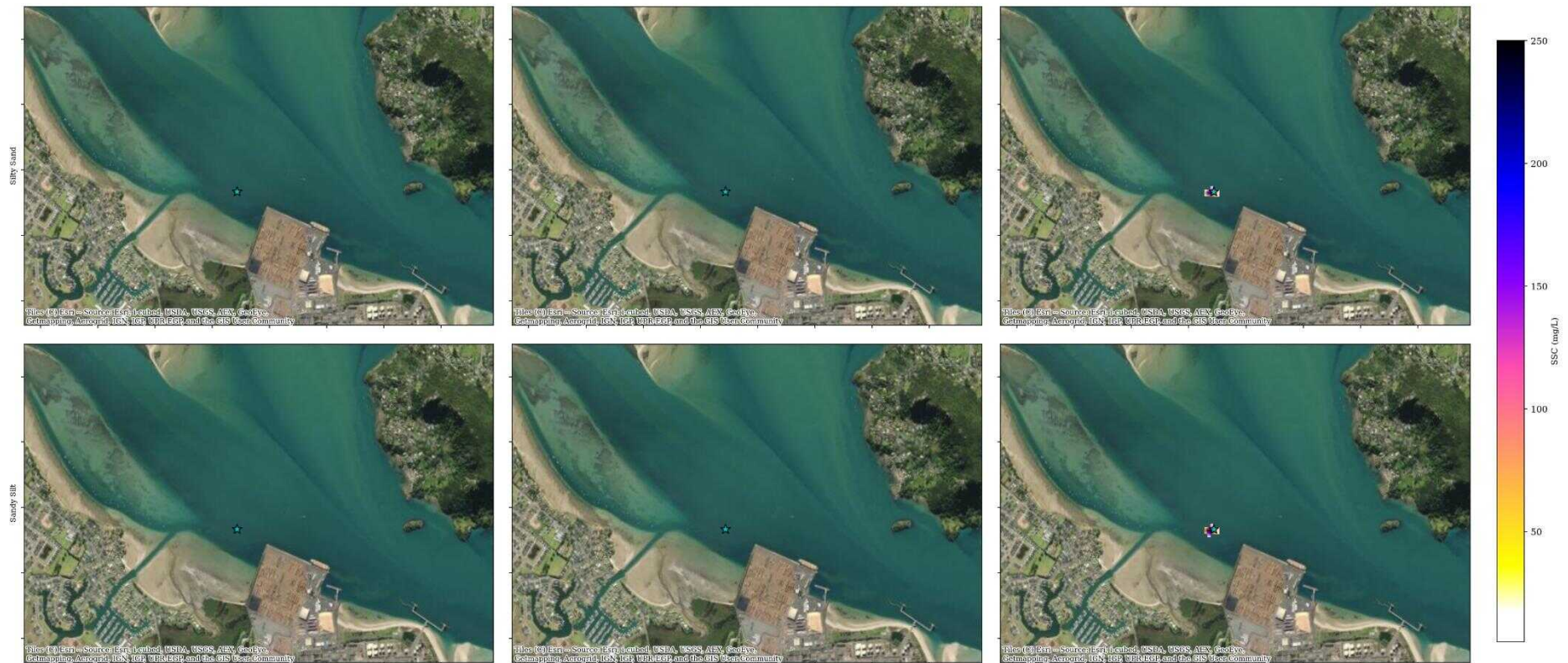


Figure 27 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

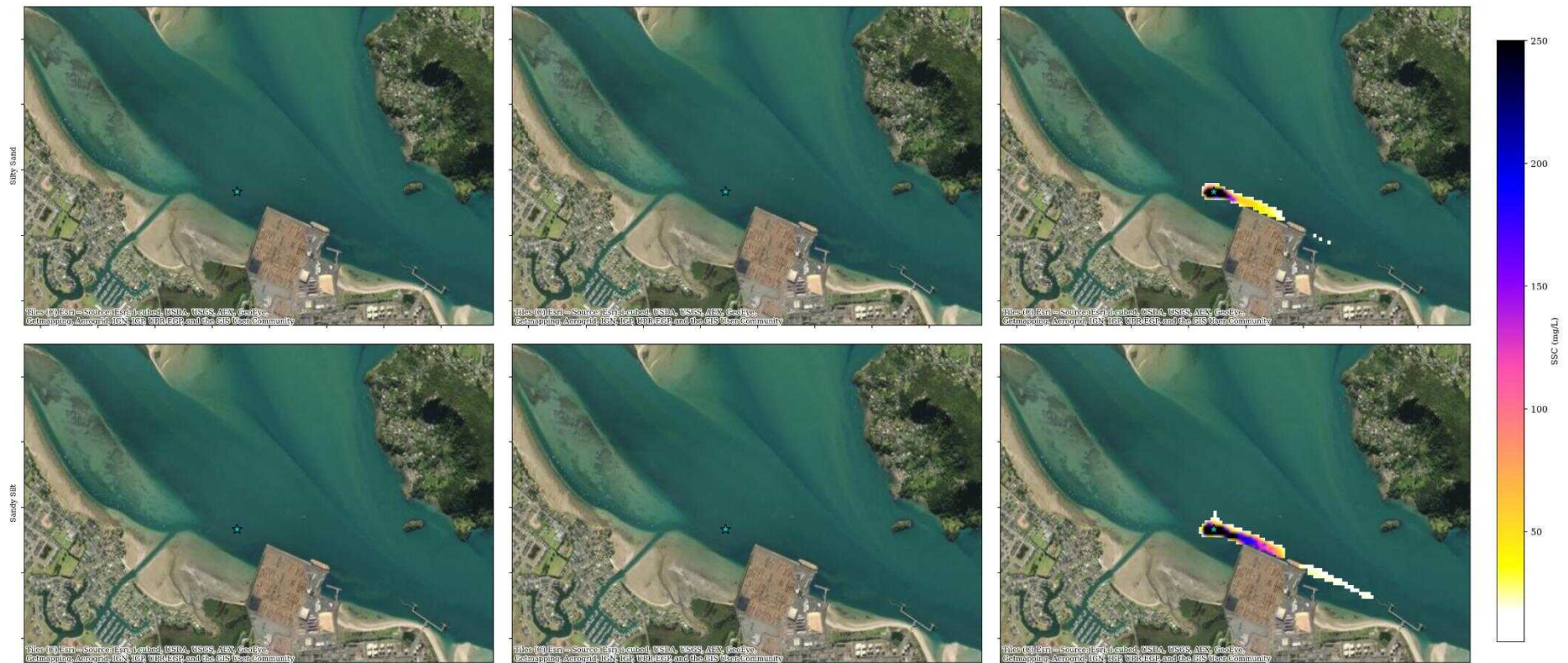


Figure 28 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S1

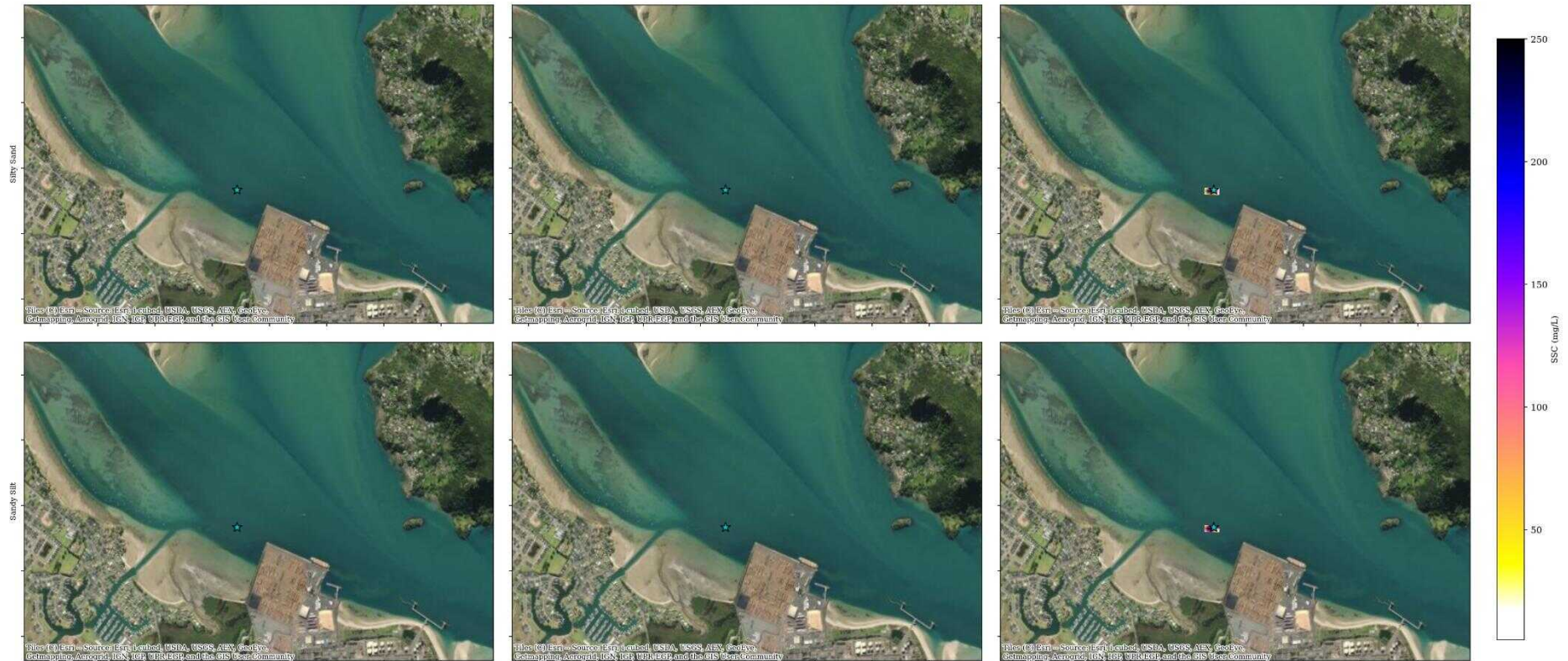
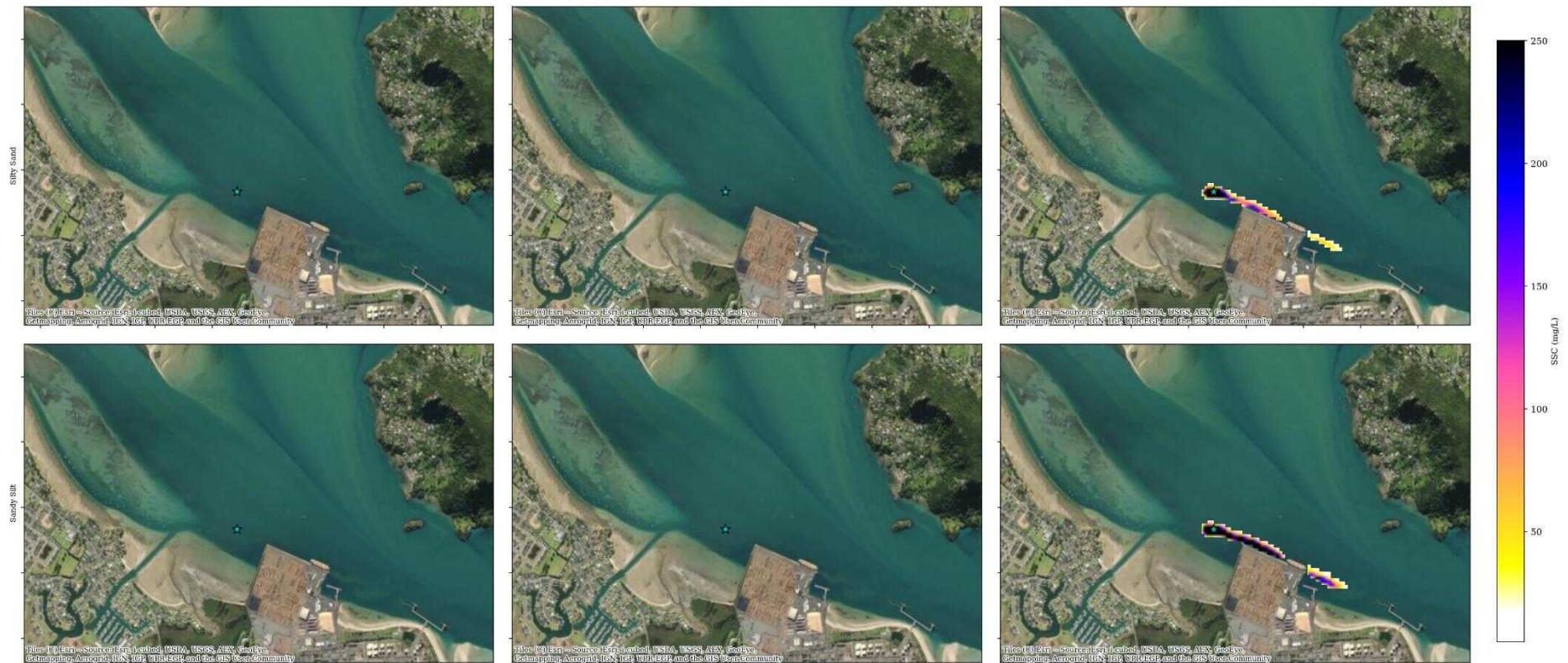


Figure 29 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1}



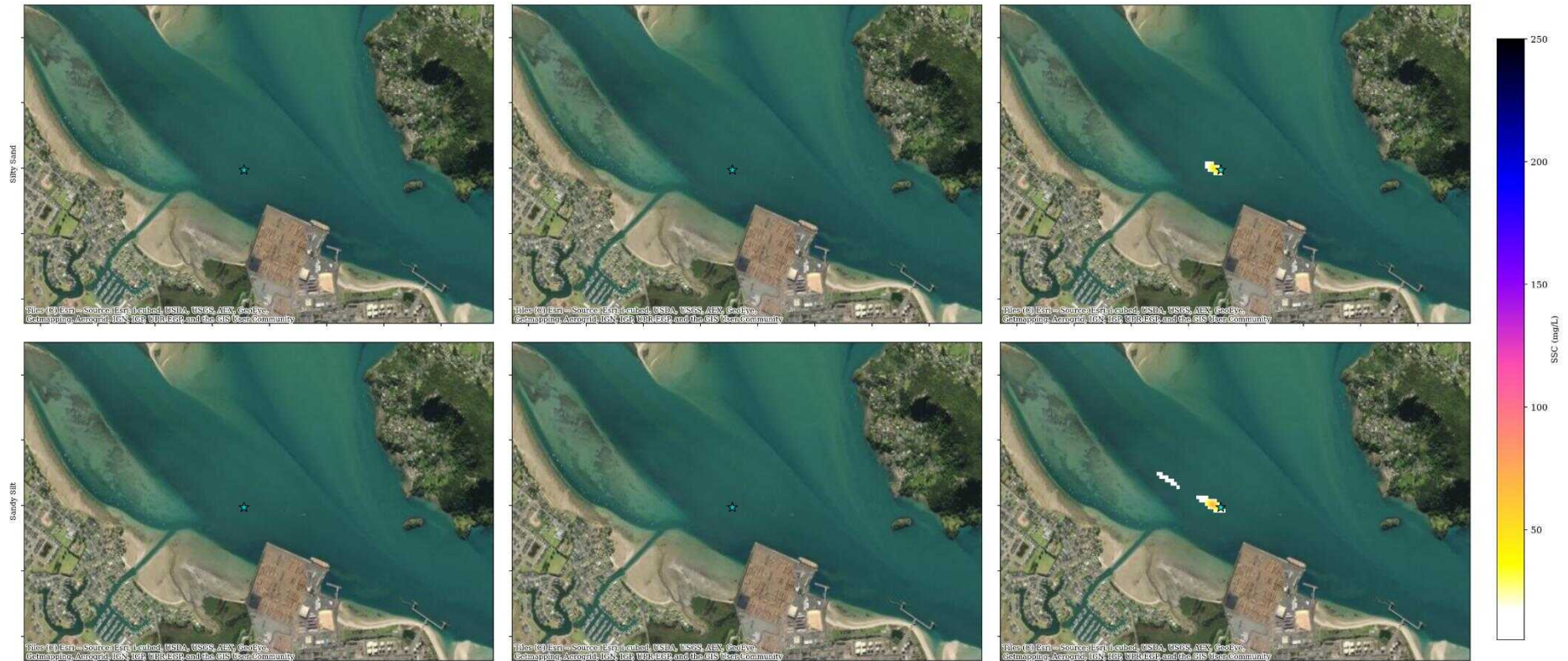


Figure 31 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S2

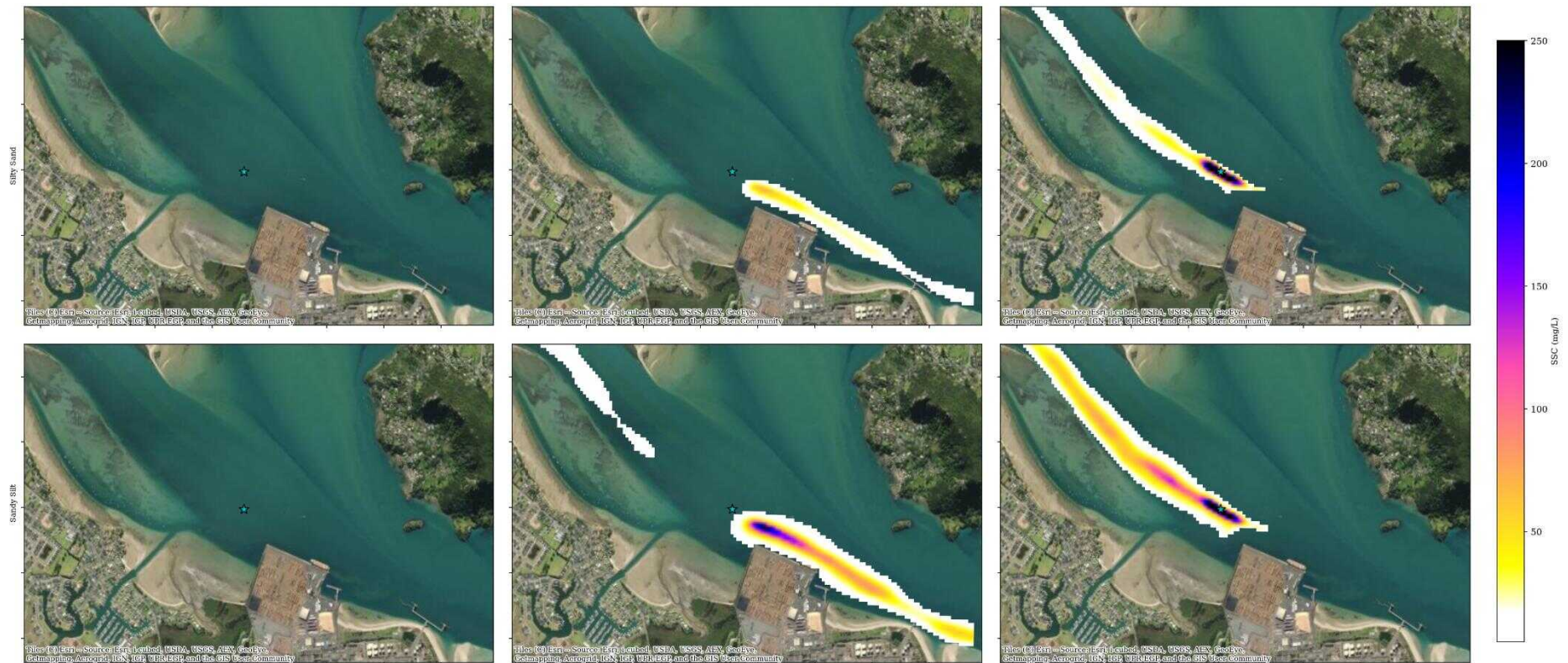


Figure 32 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

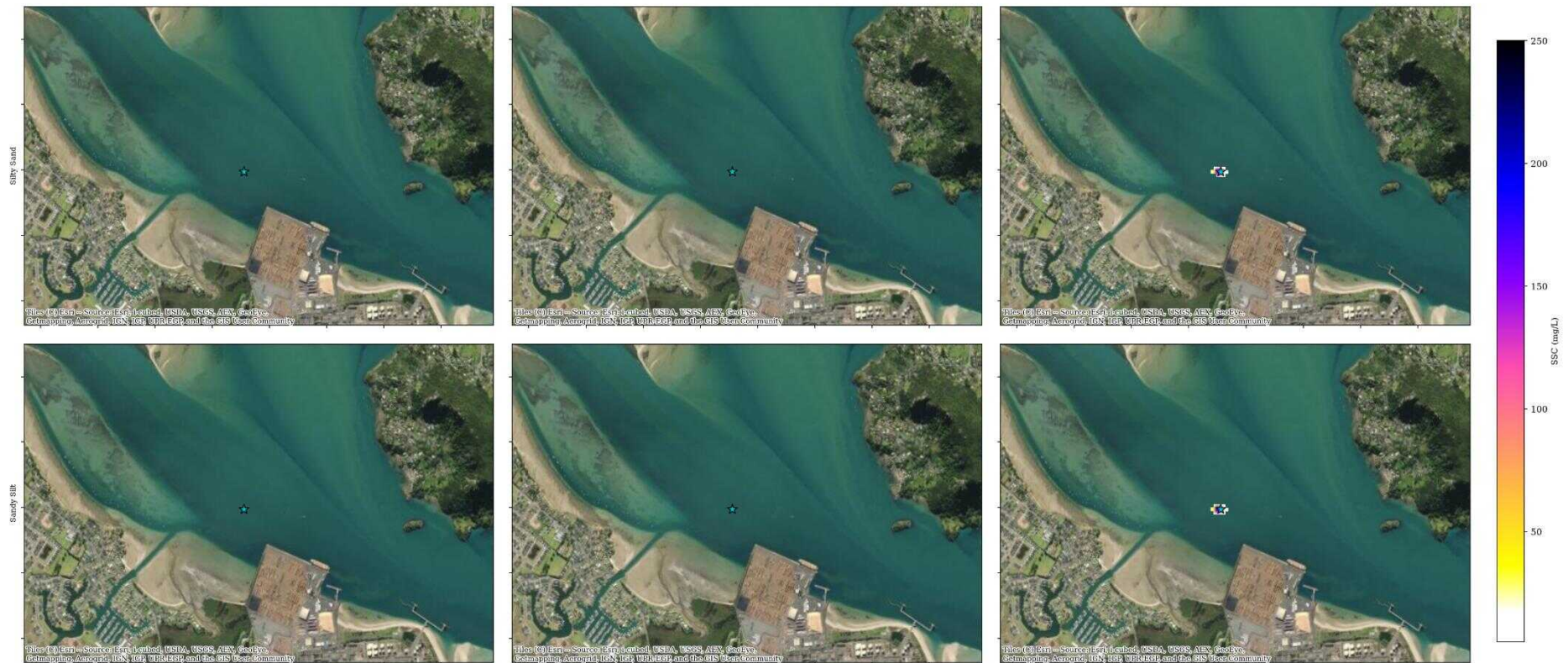


Figure 33 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

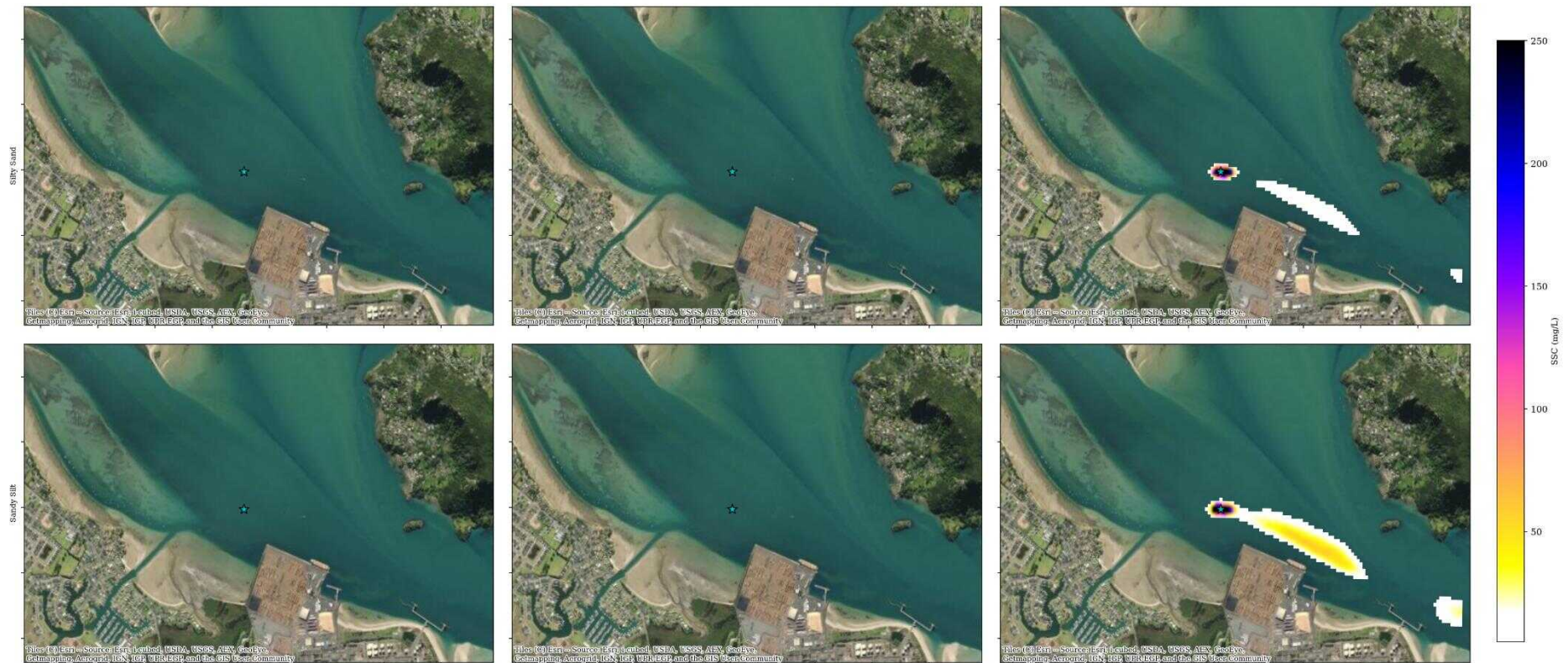


Figure 34 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

S2

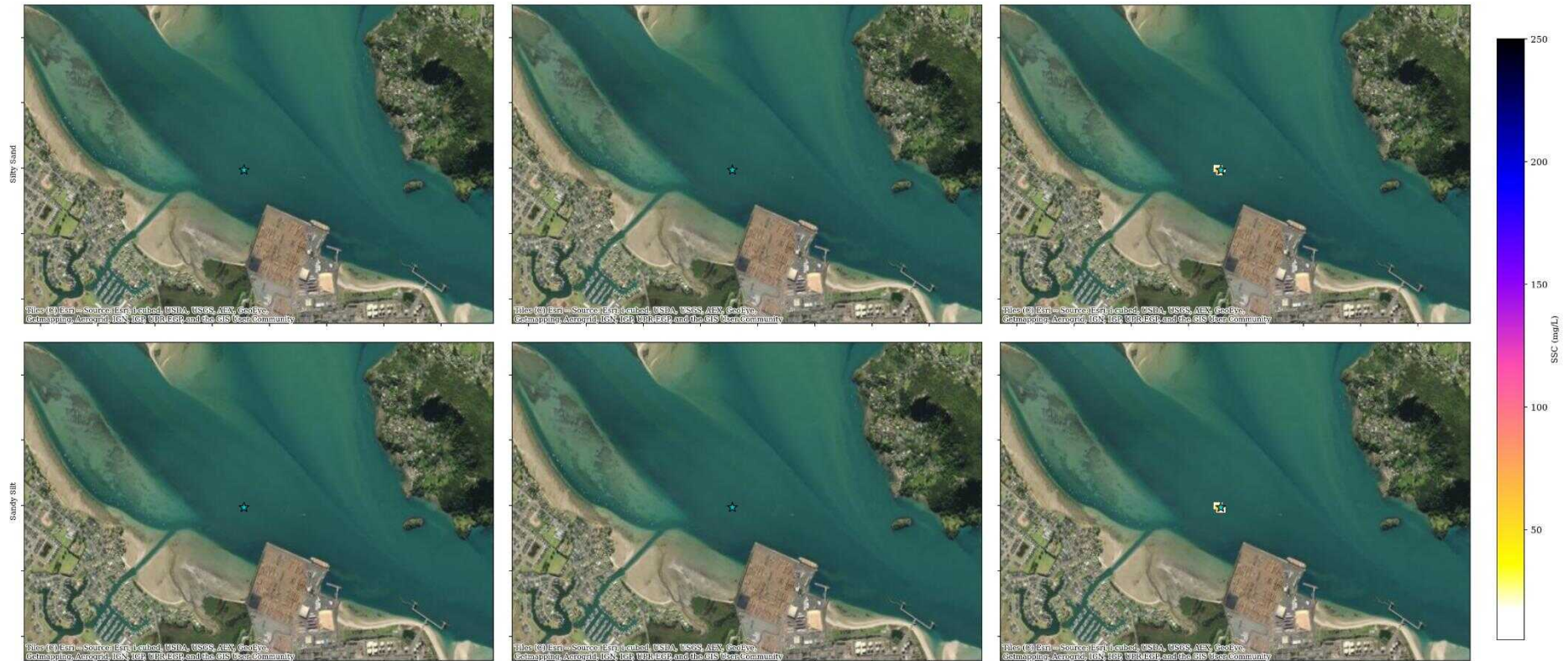




Figure 36 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1}

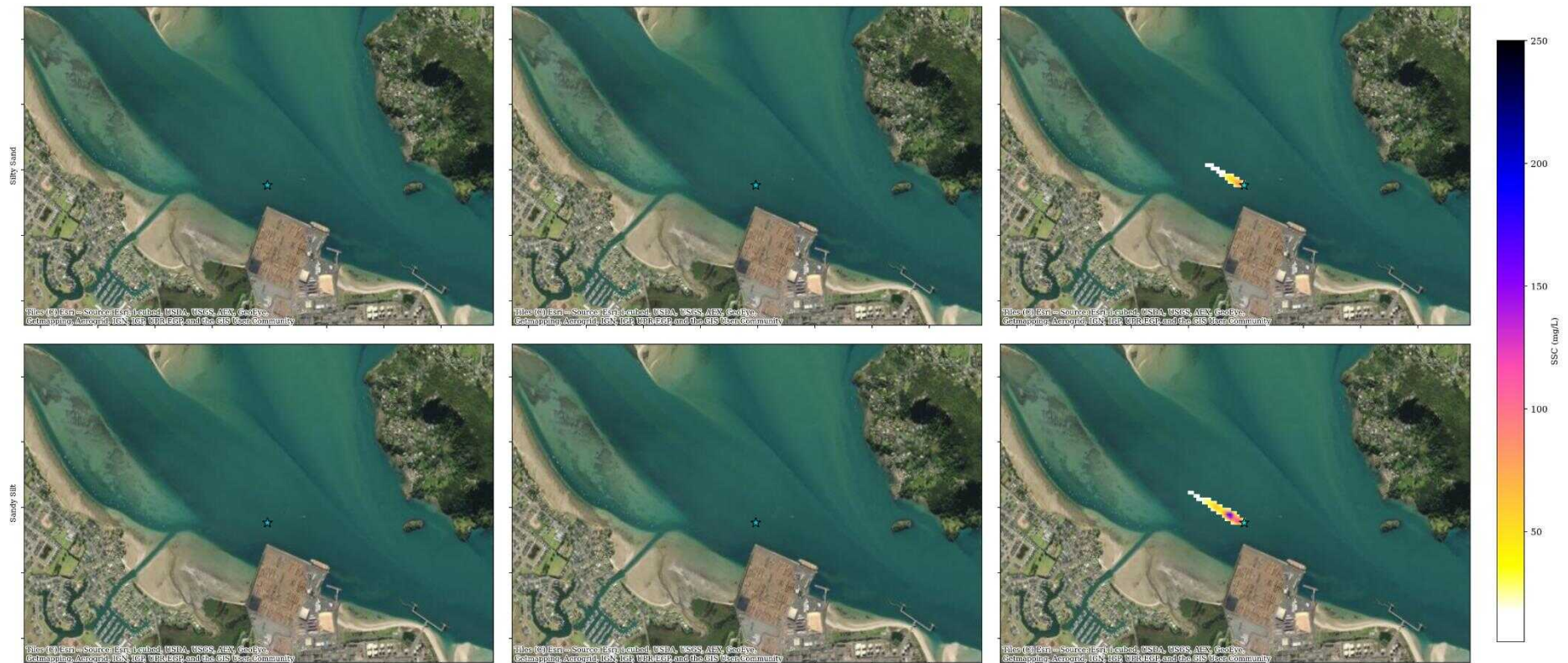


Figure 37 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

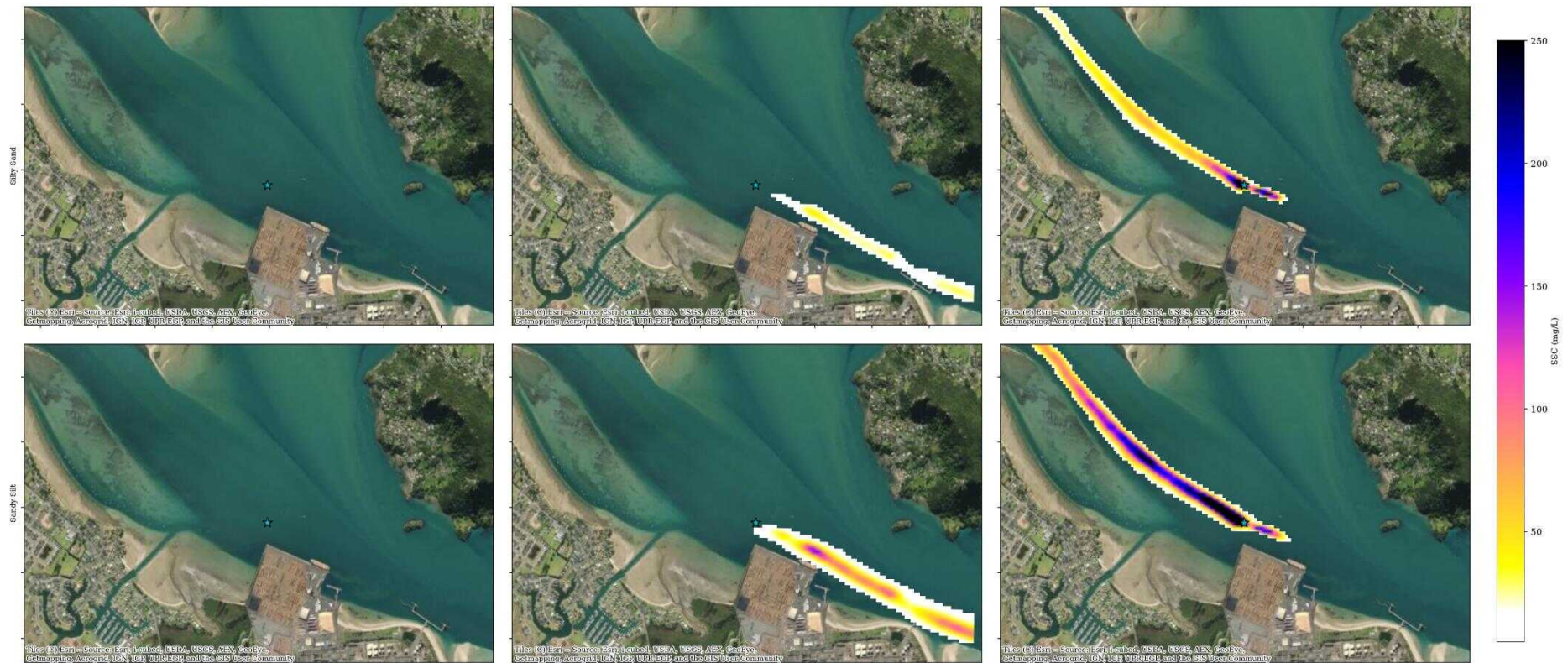


Figure 38 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

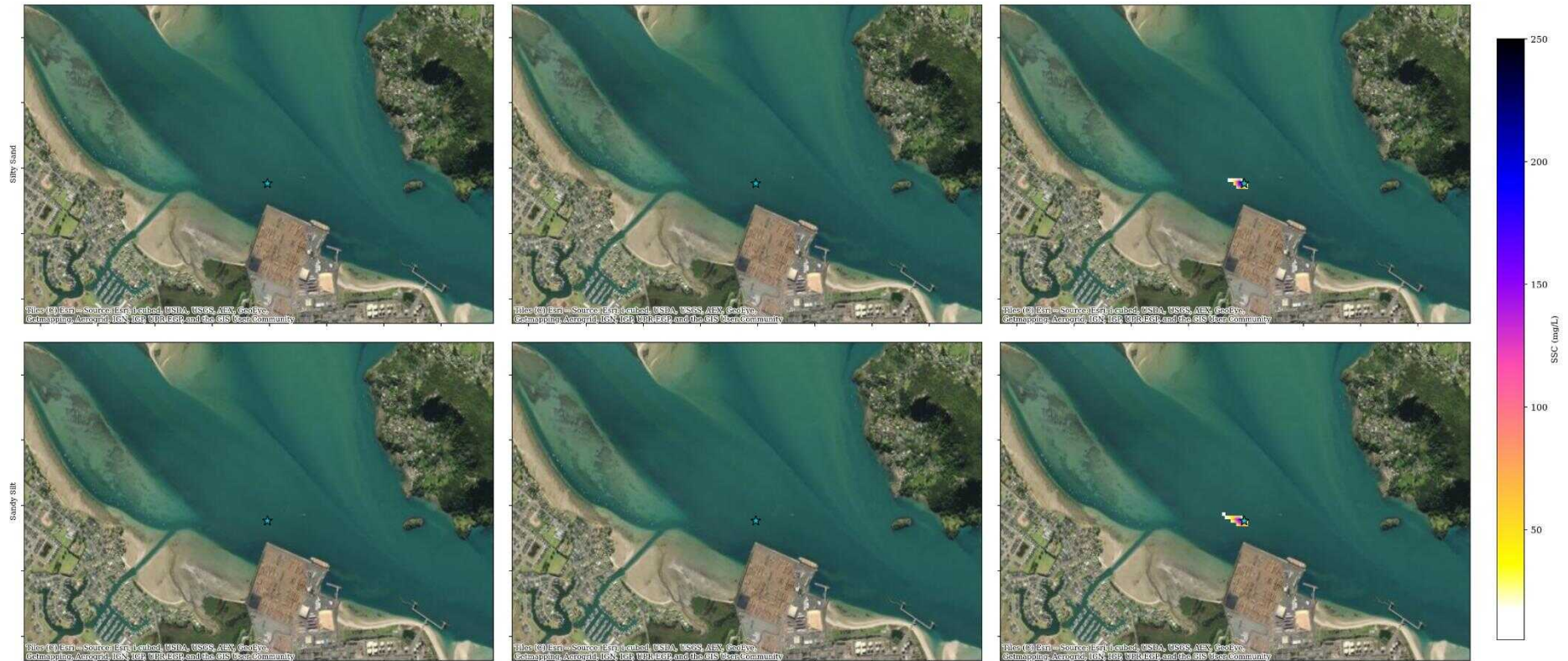


Figure 39 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

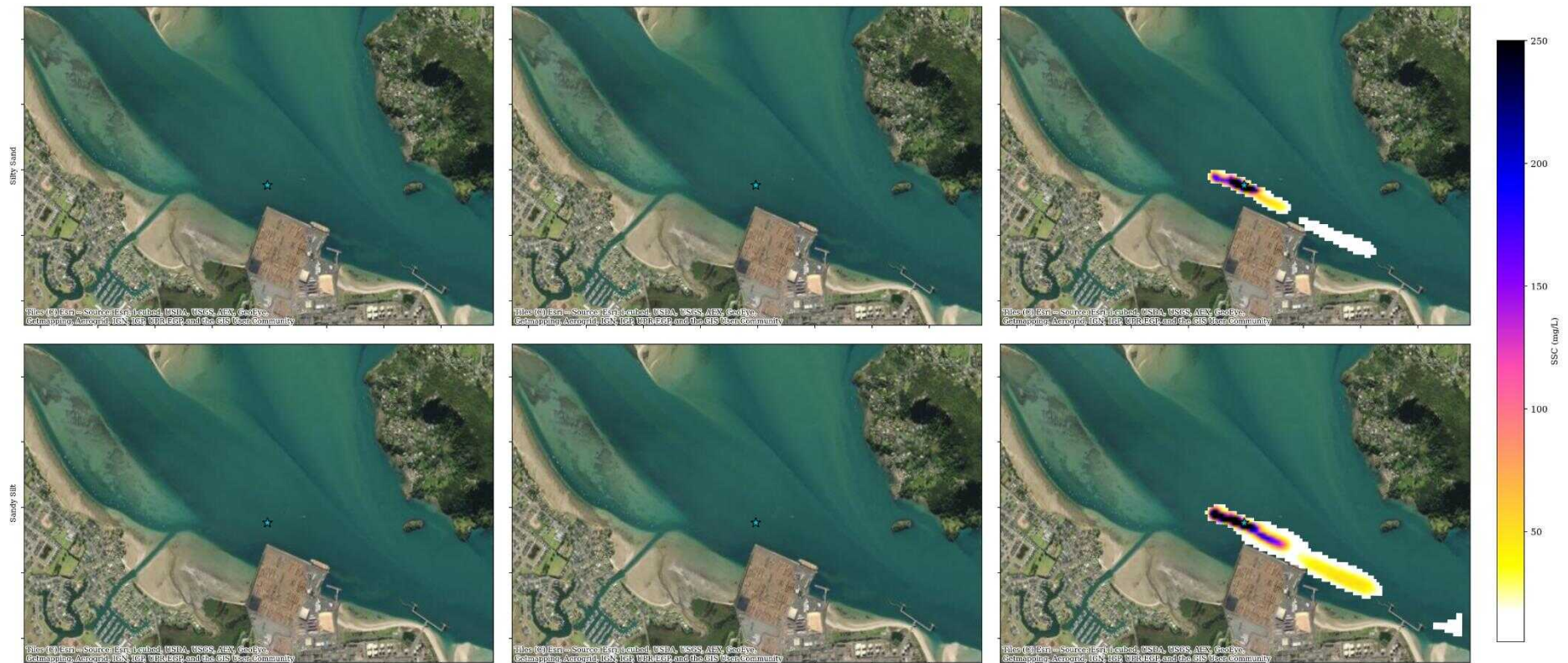


Figure 40 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

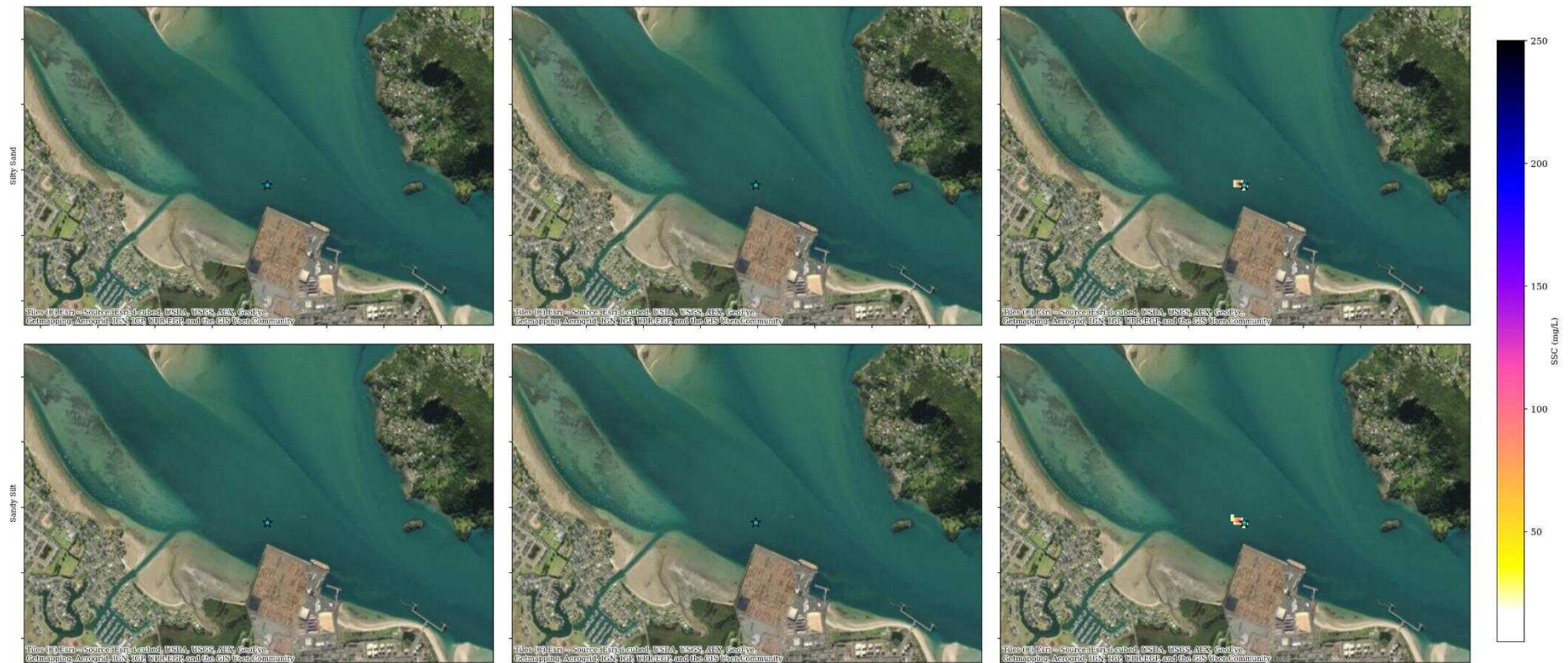
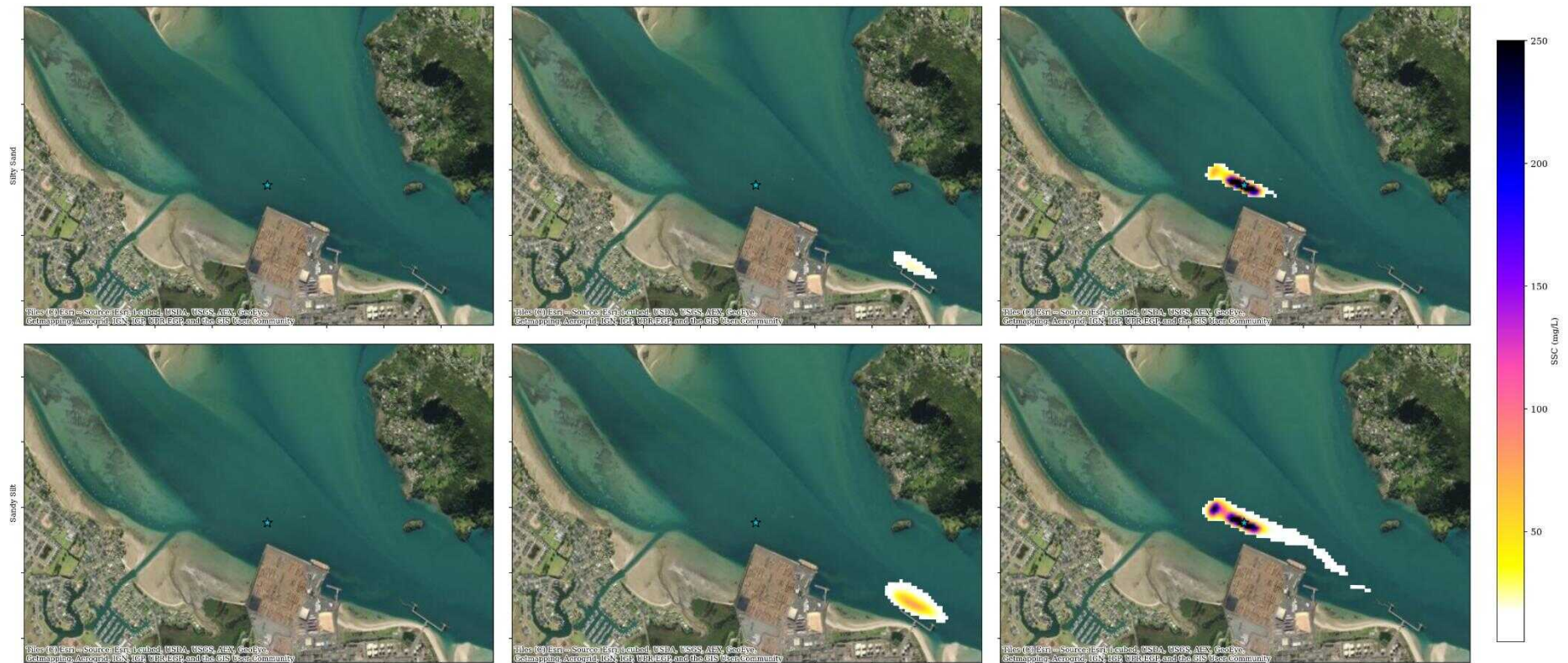


Figure 41 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹



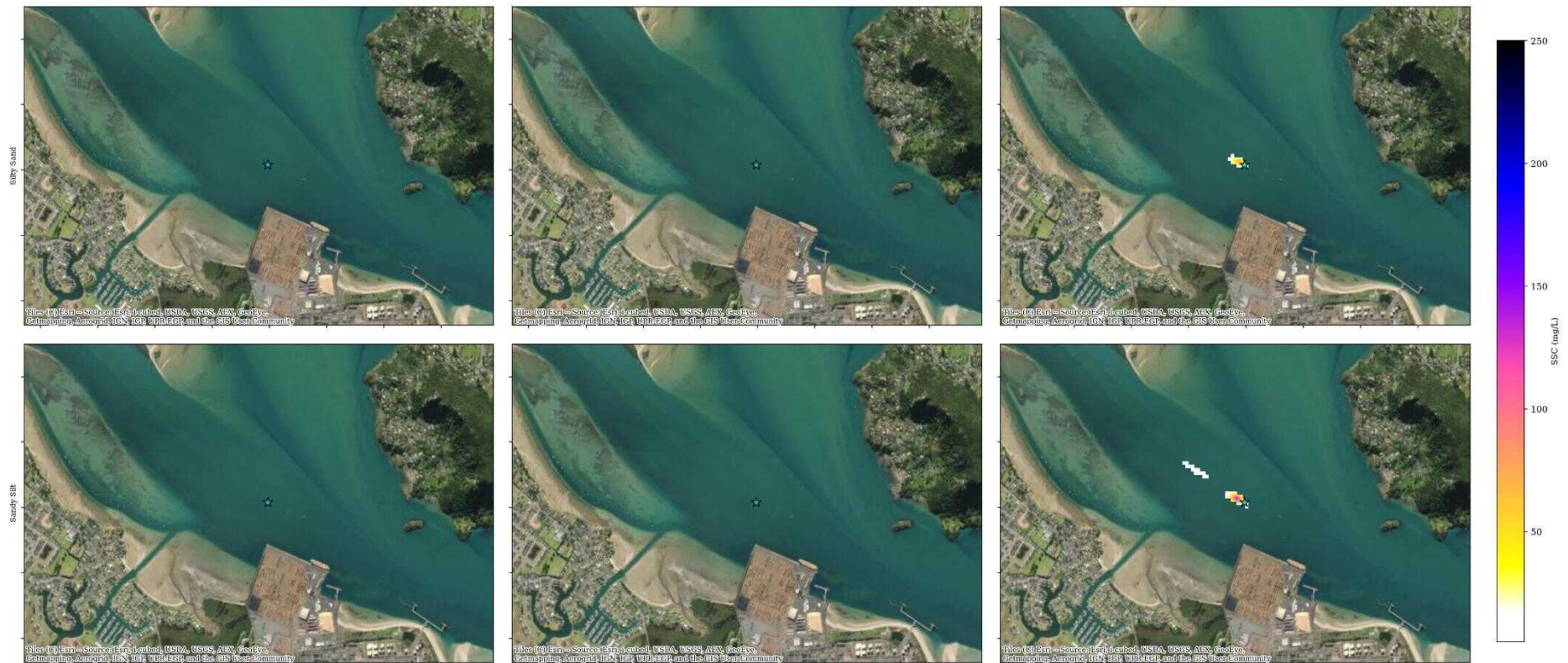


Figure 43 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

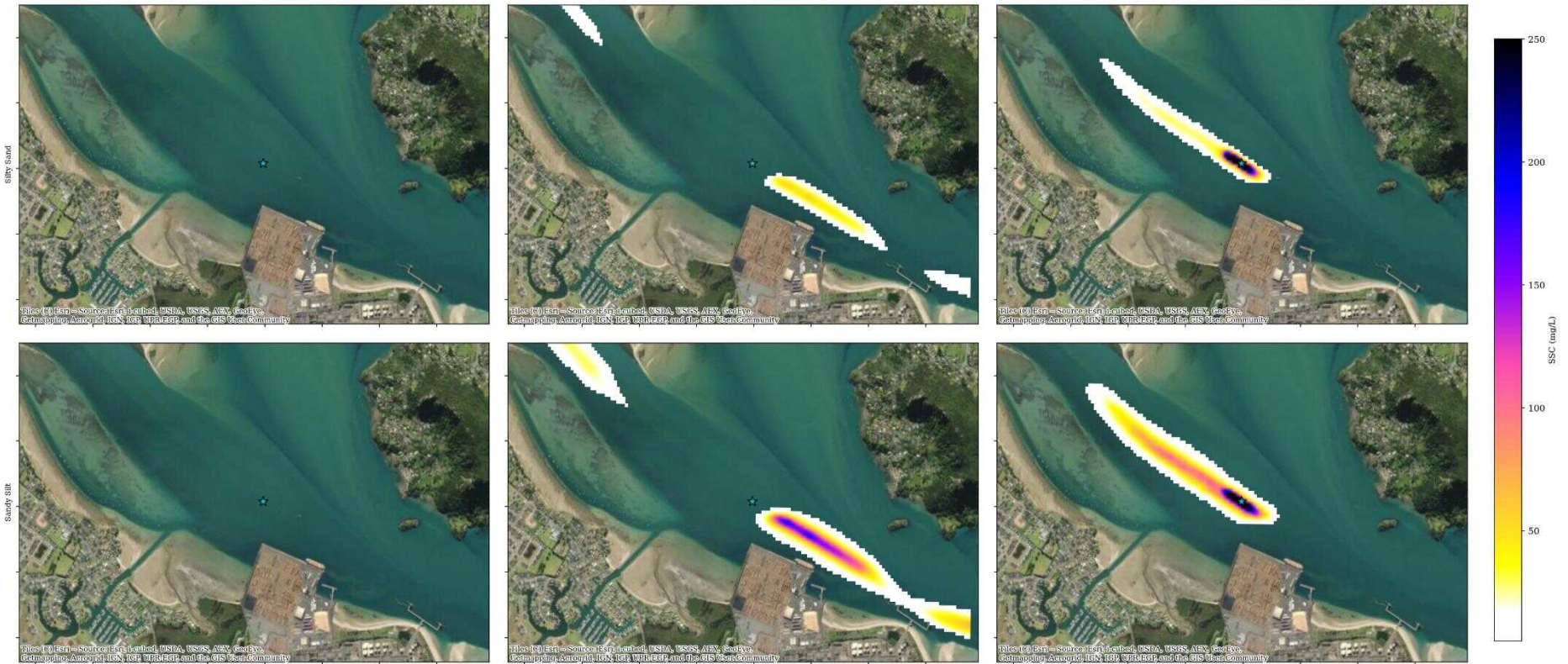


Figure 44 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

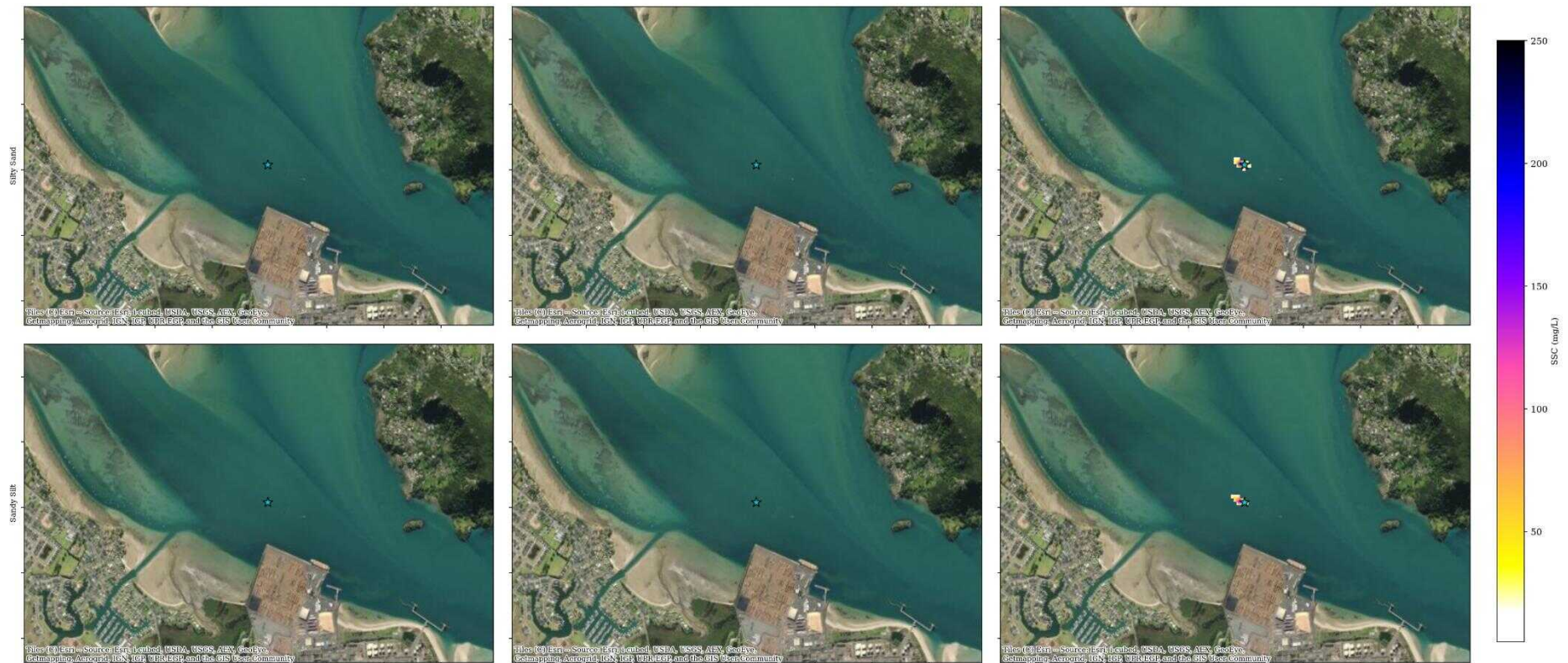


Figure 45 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

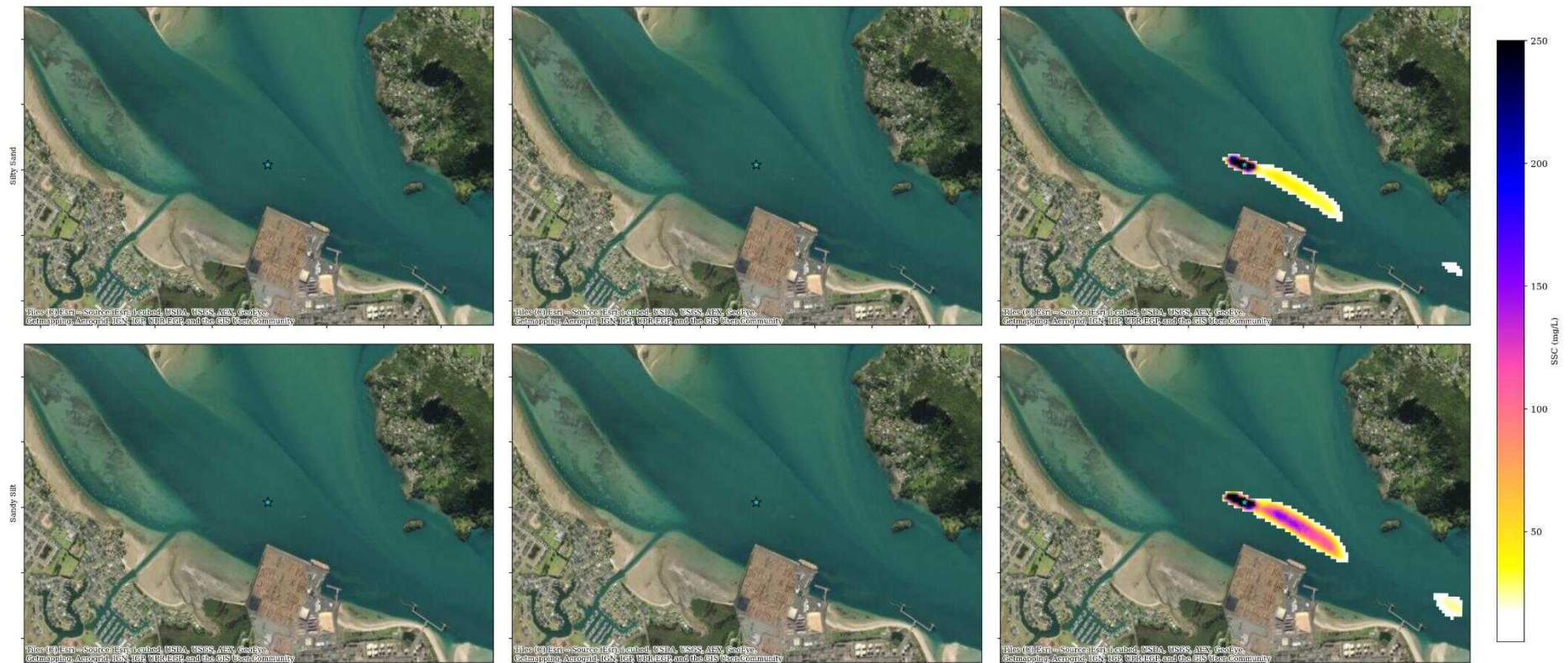


Figure 46 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

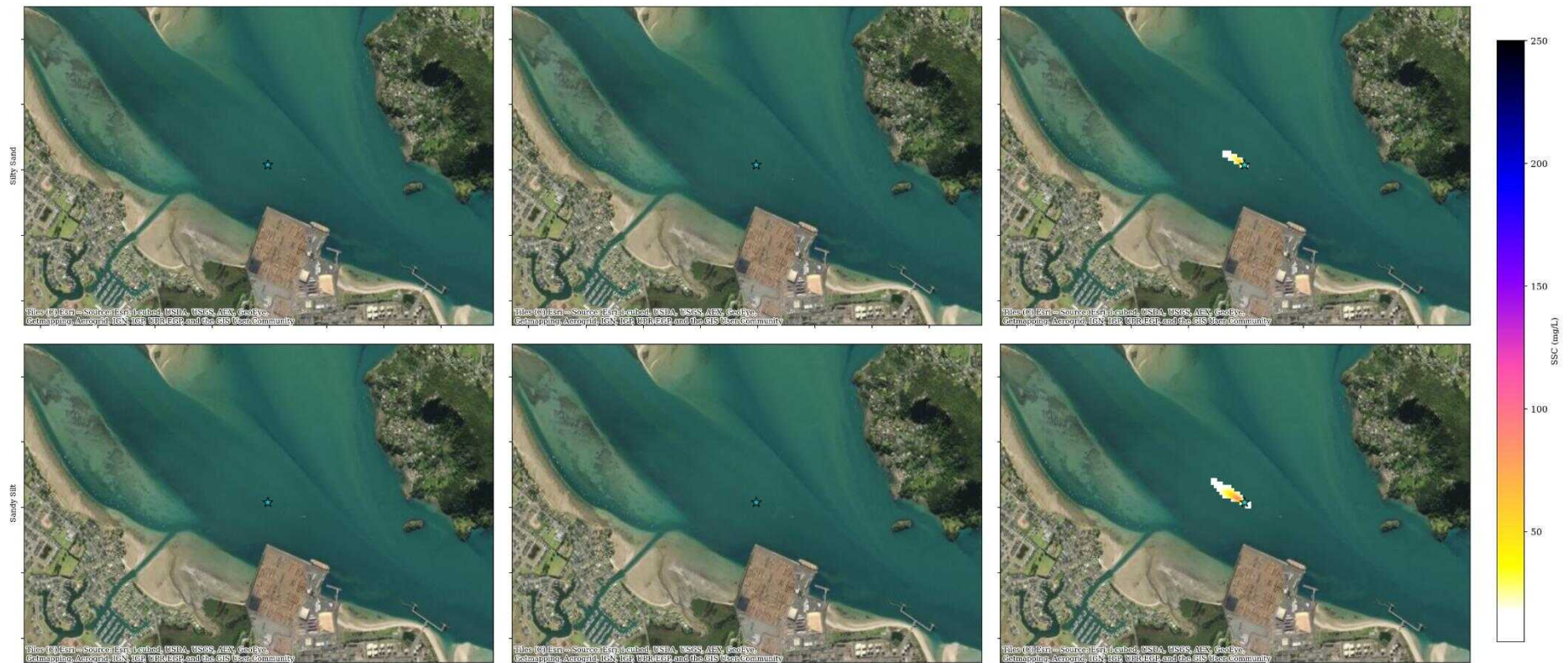
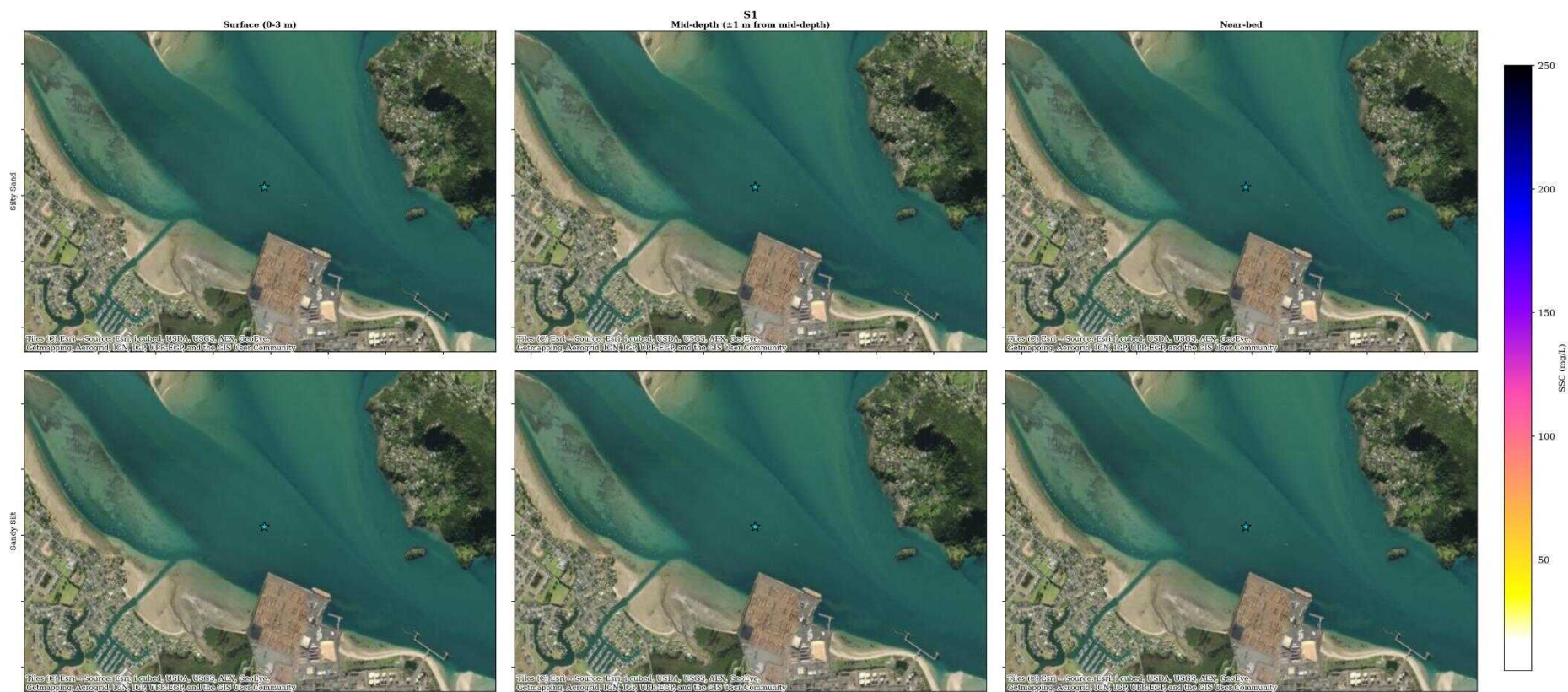


Figure 47 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **CSD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹



TSHD sediment plumes



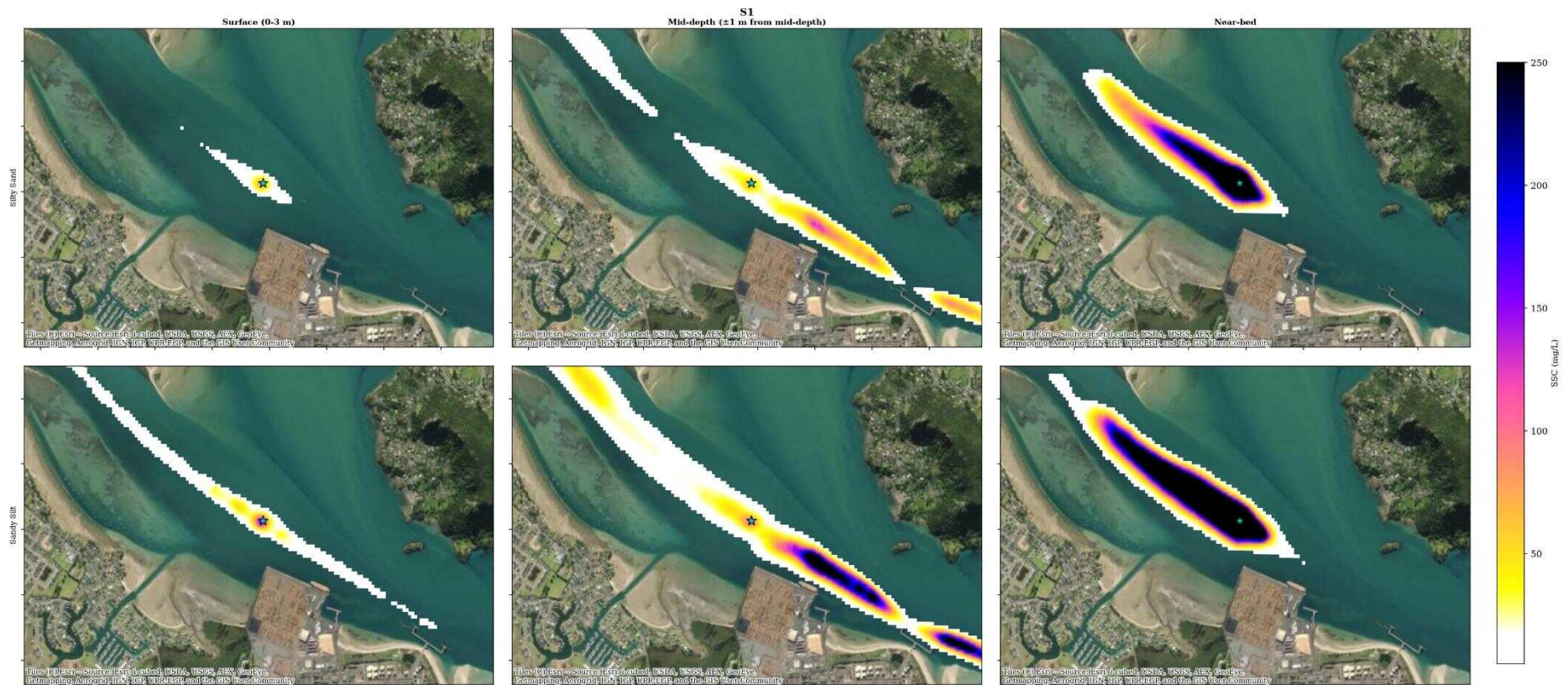


Figure 50 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .





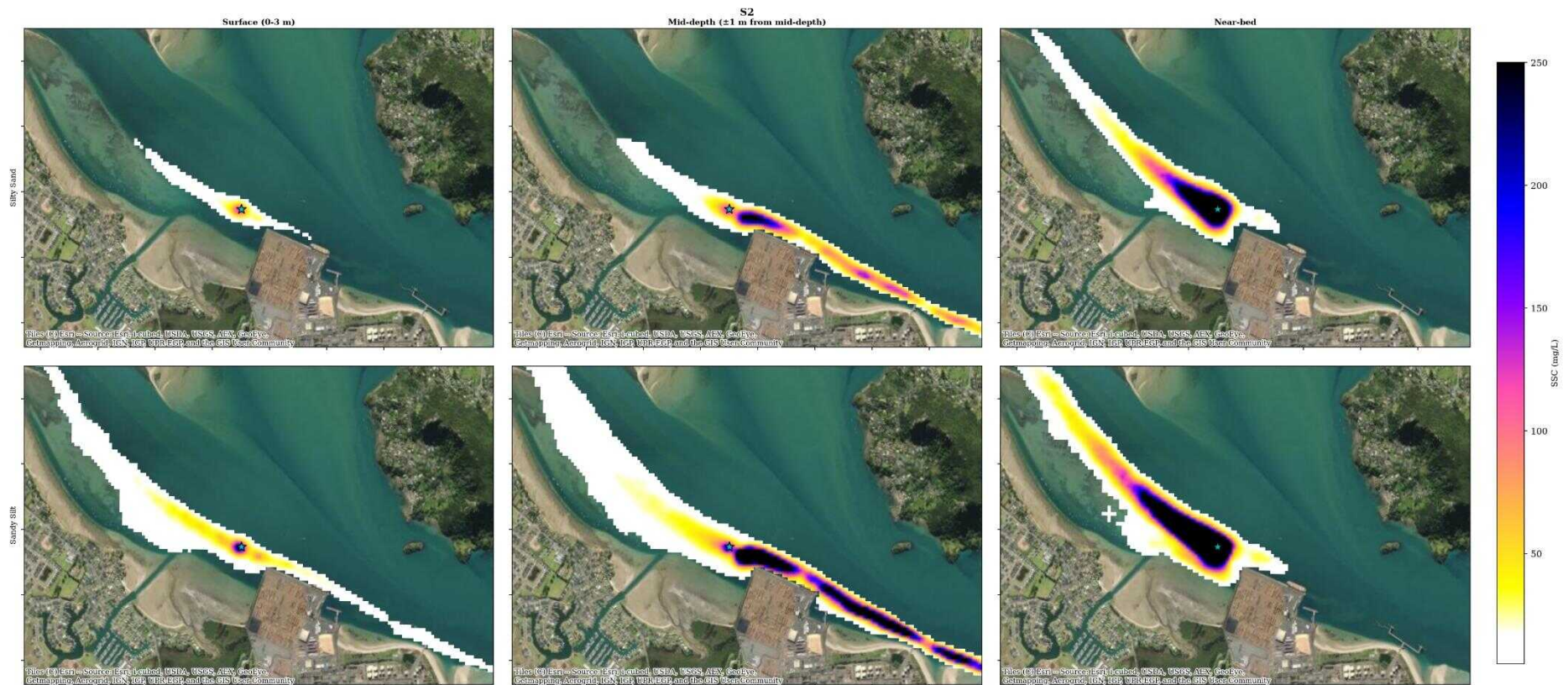


Figure 54 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.



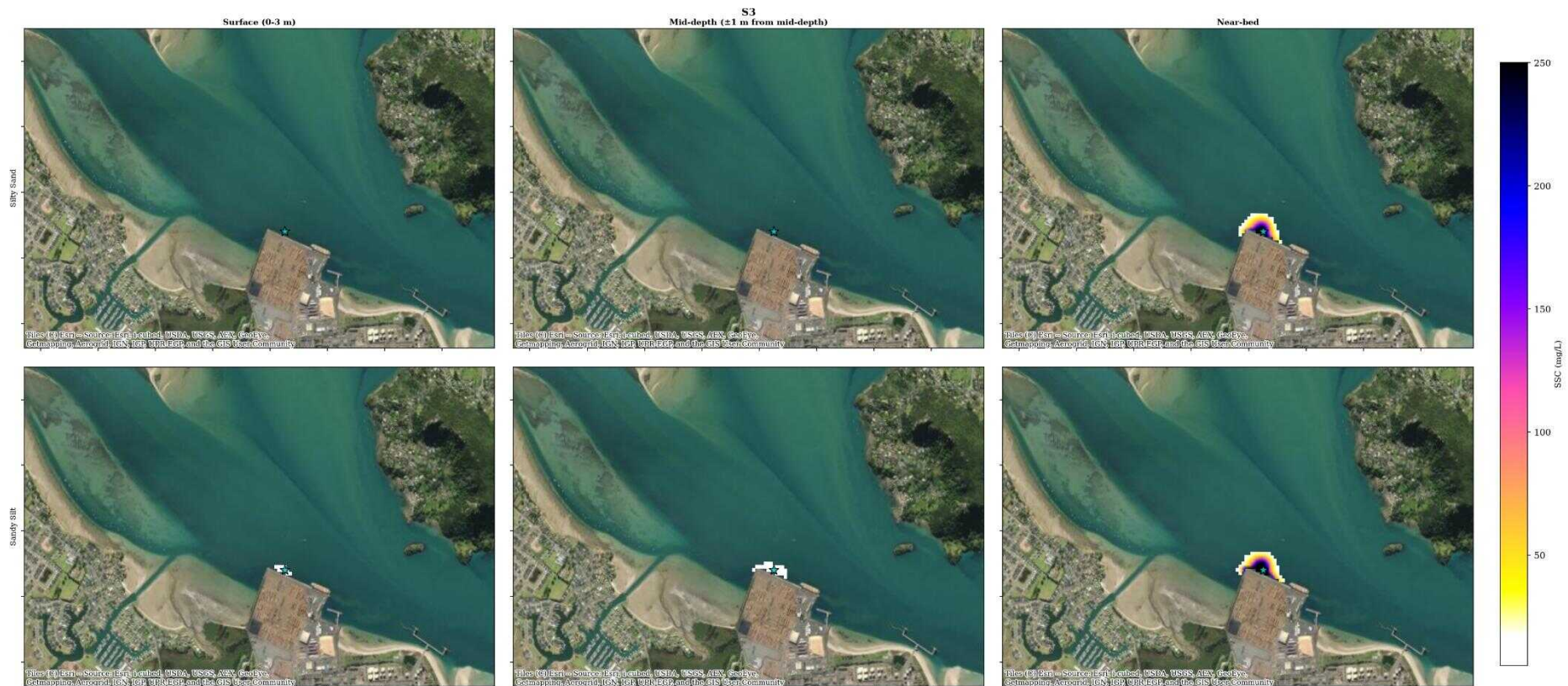


Figure 57 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

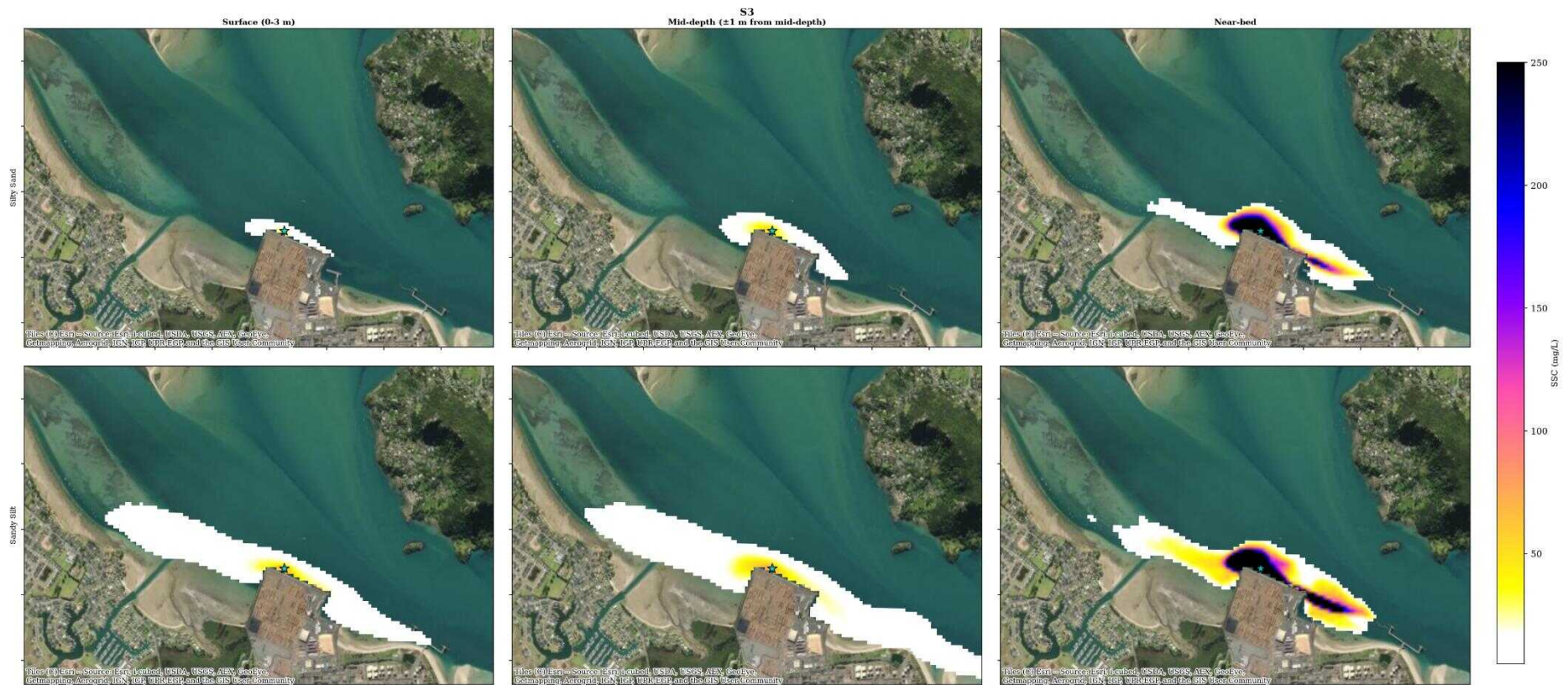


Figure 58 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.



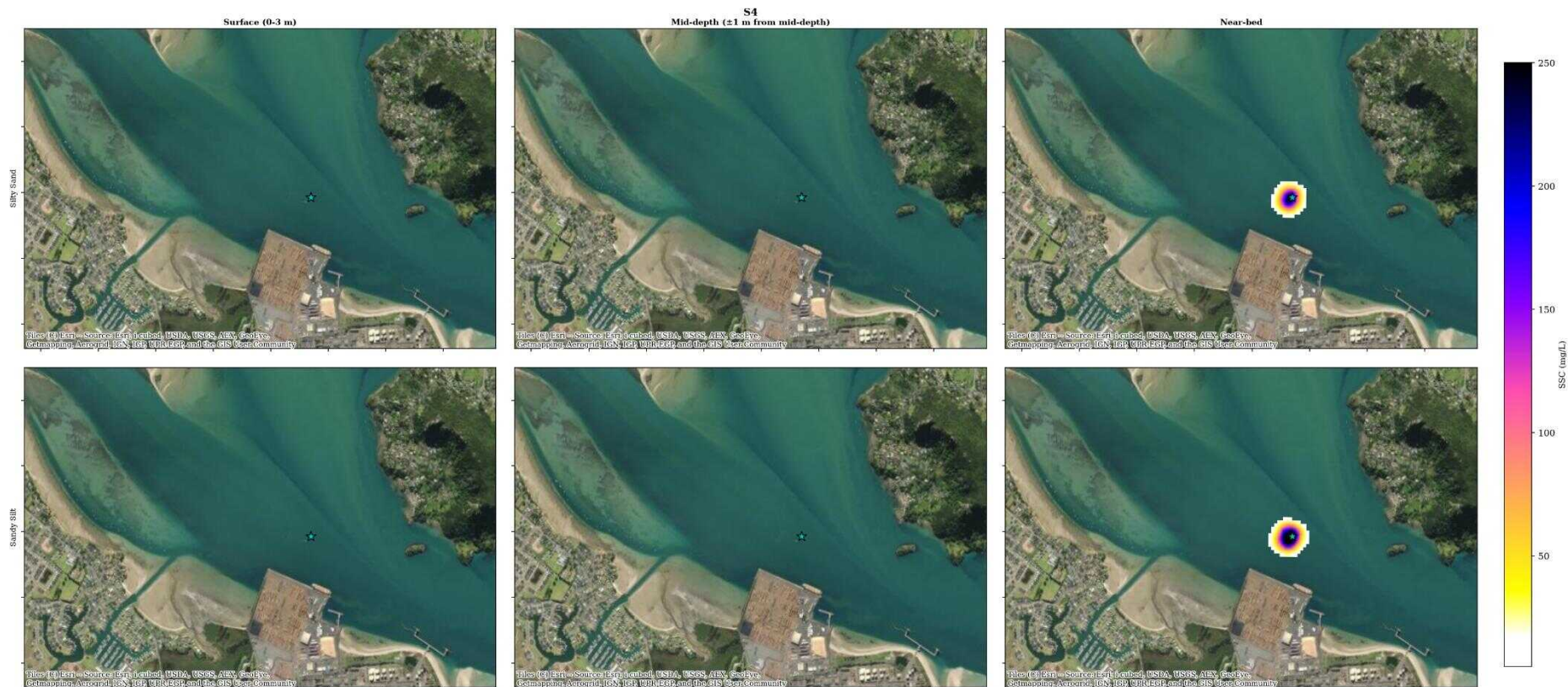


Figure 61 **50th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.

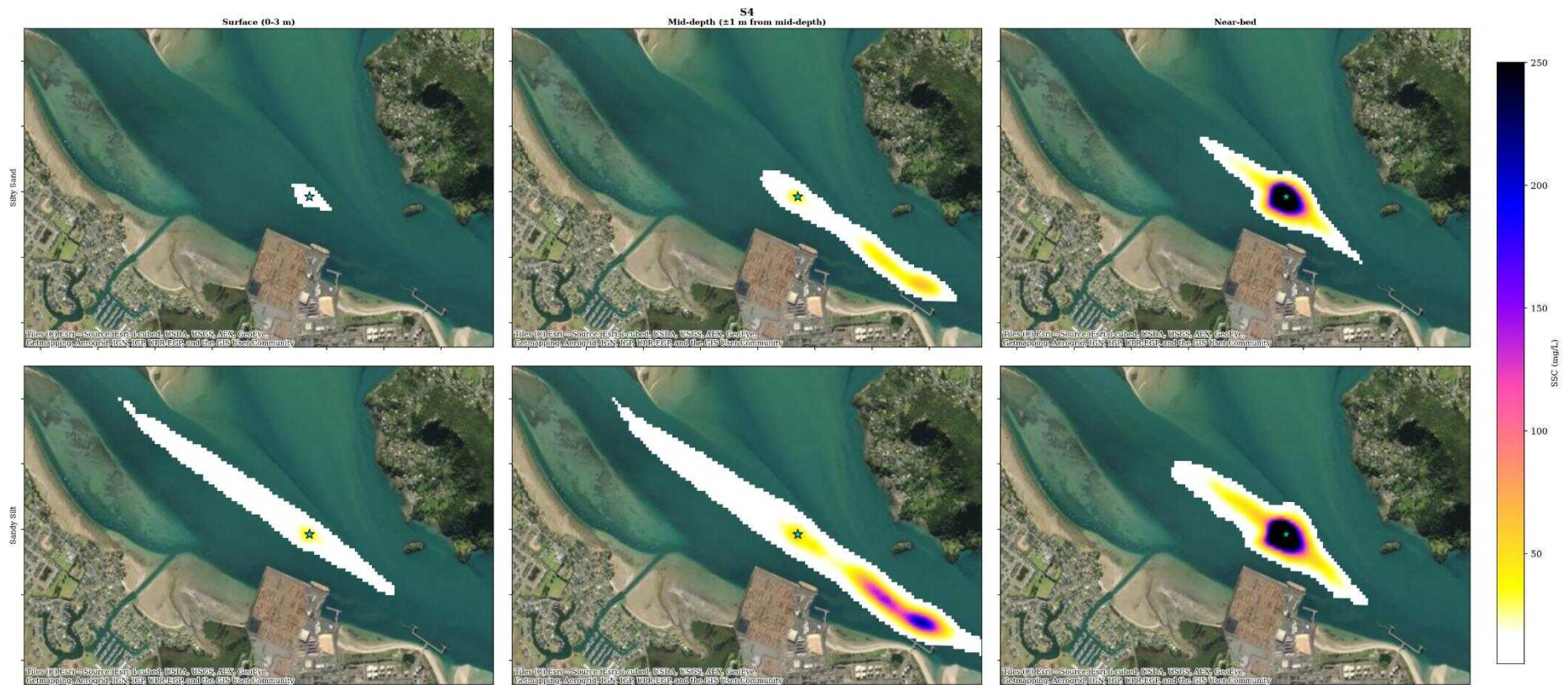
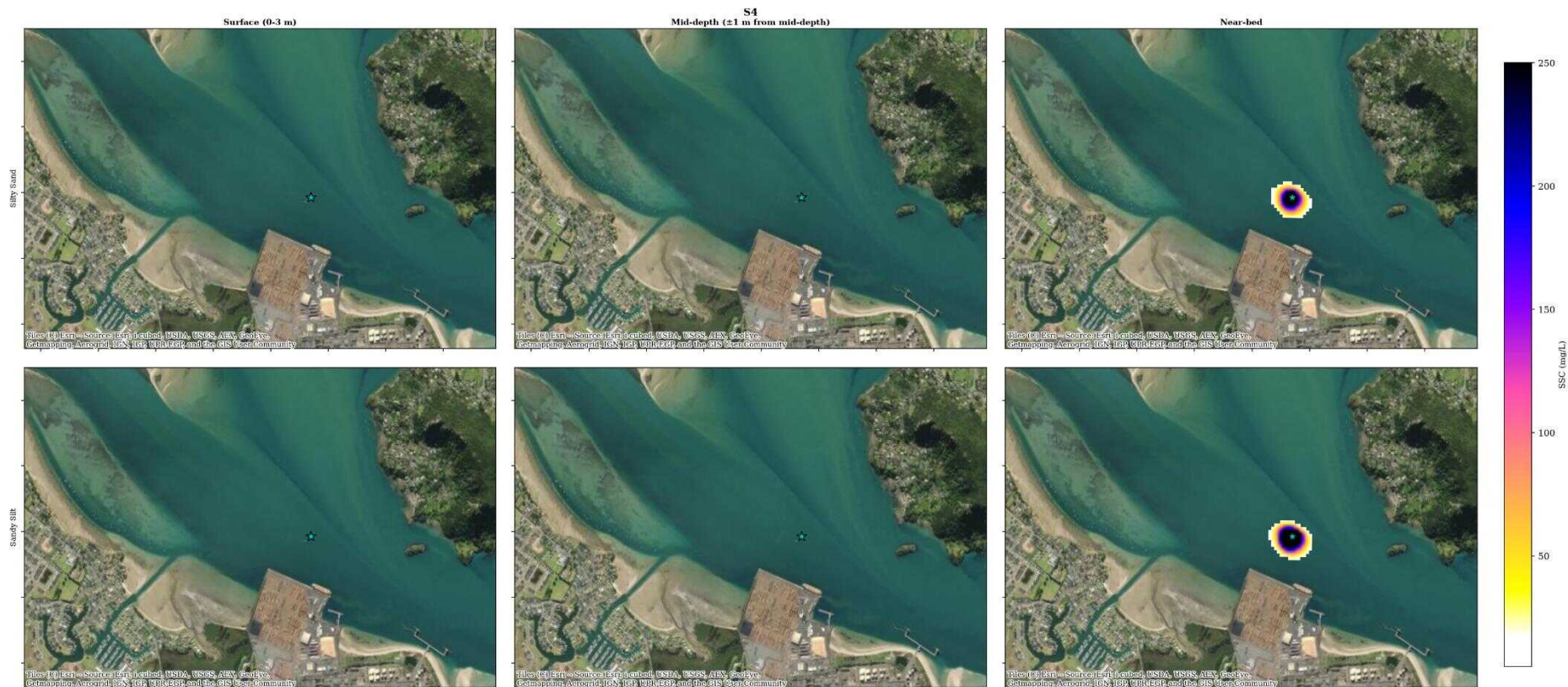
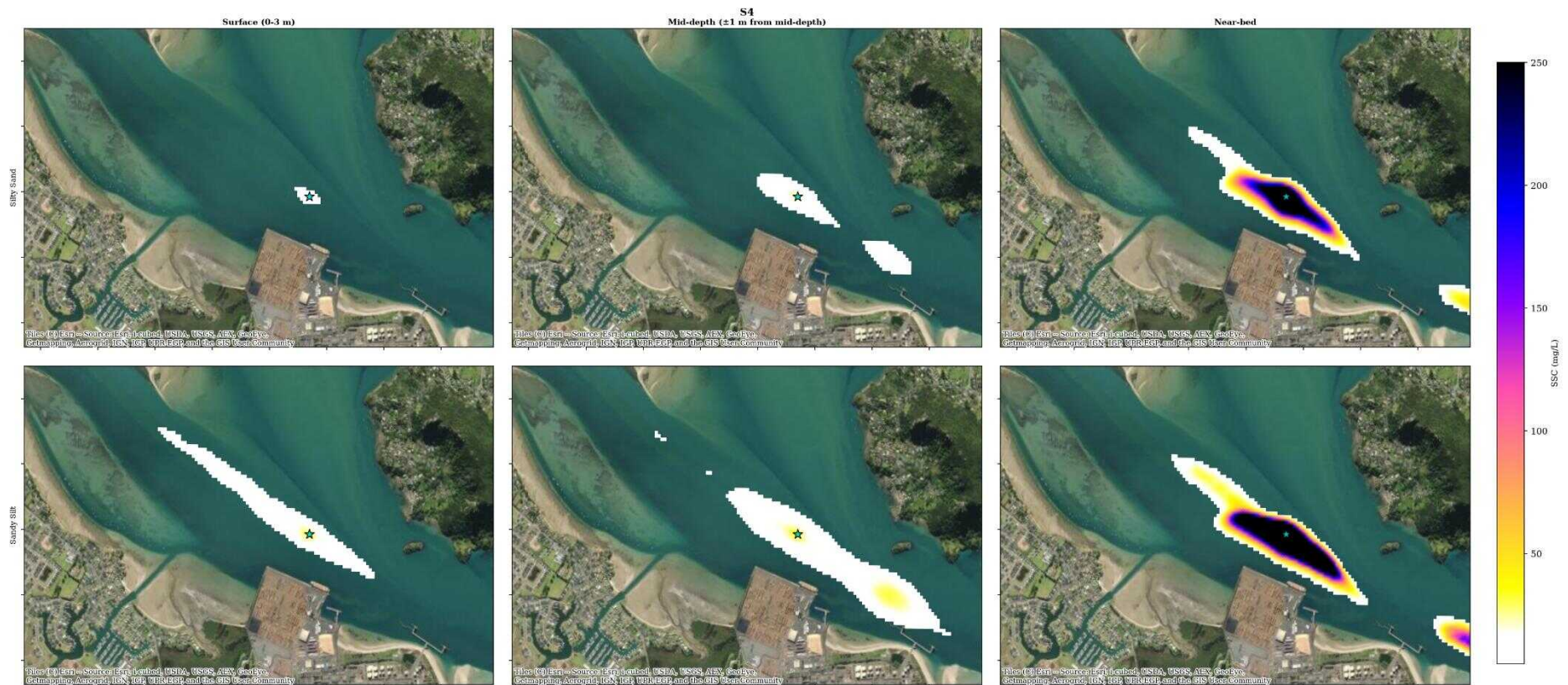


Figure 62 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .







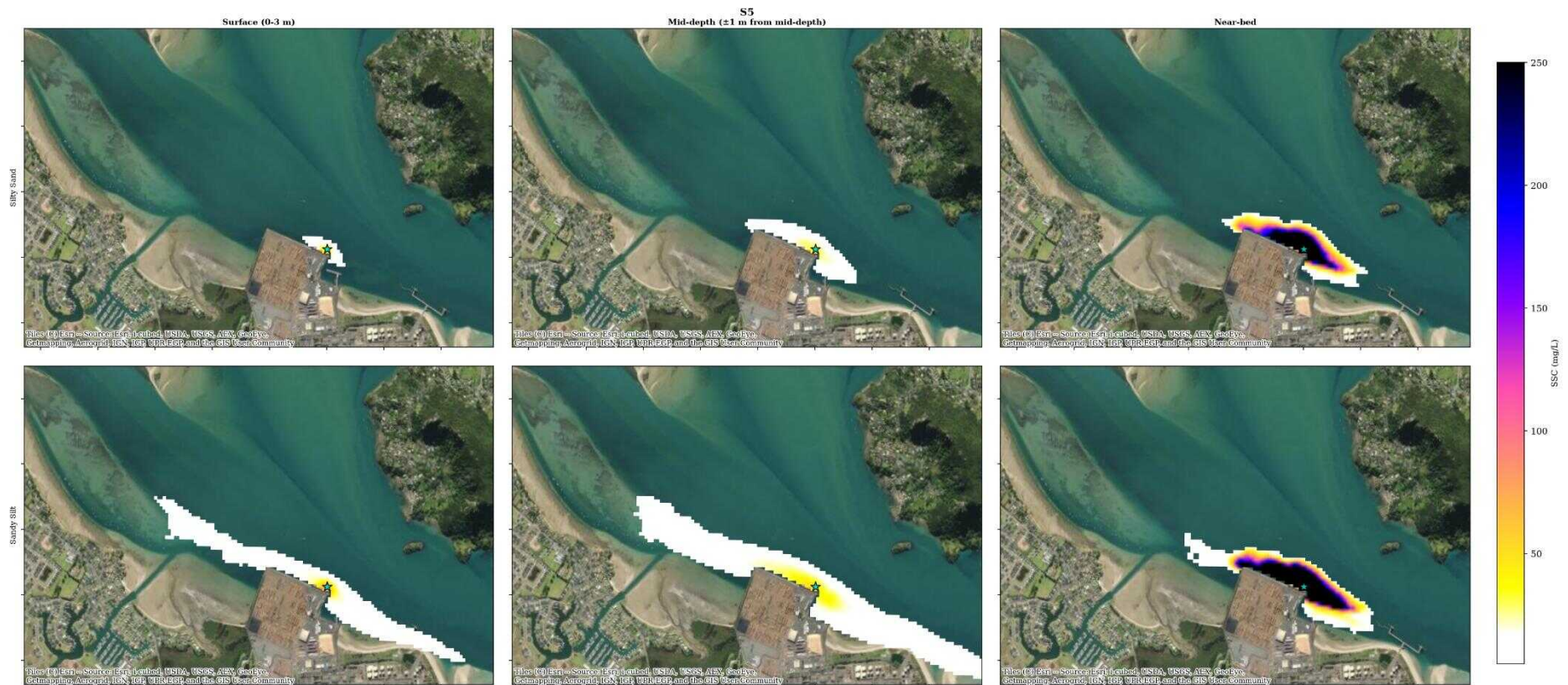


Figure 66 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 5**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.





Figure 69 **50th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

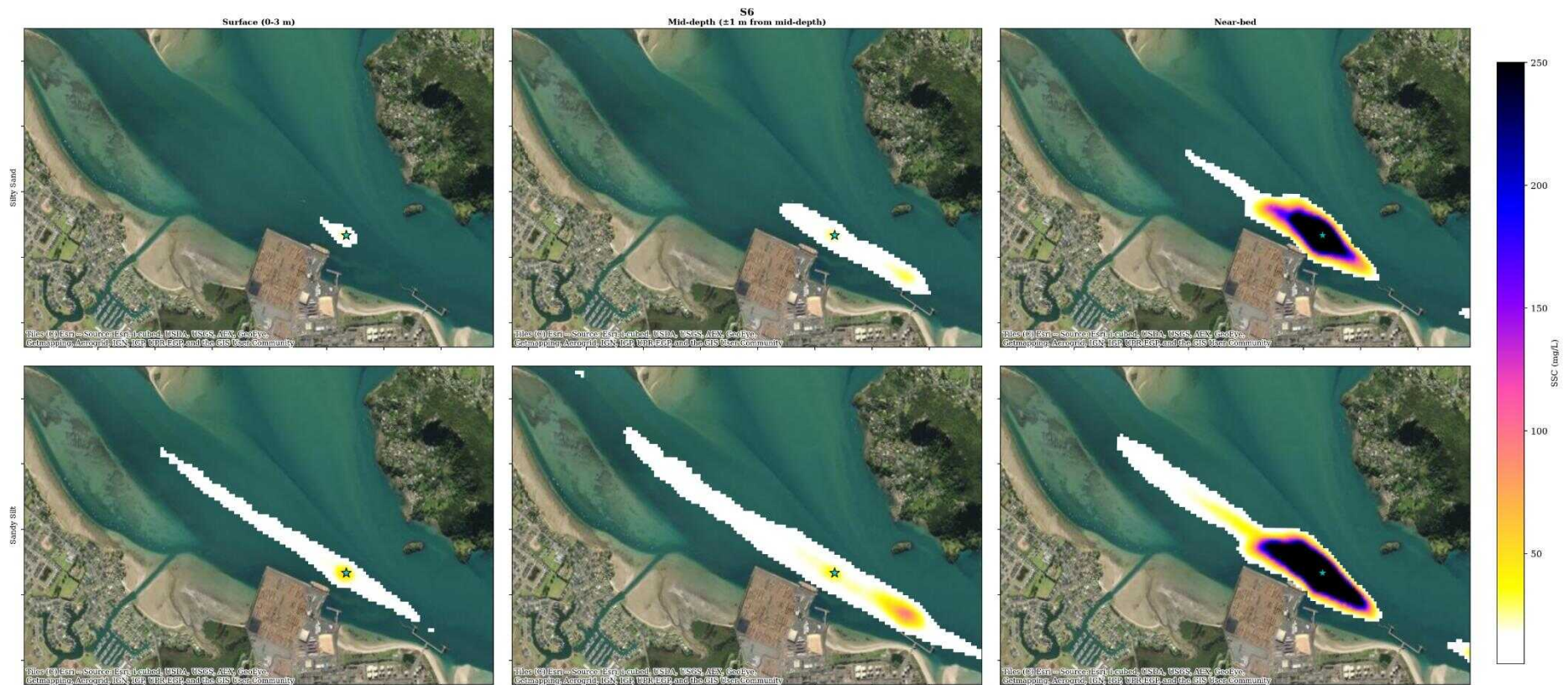


Figure 70 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.



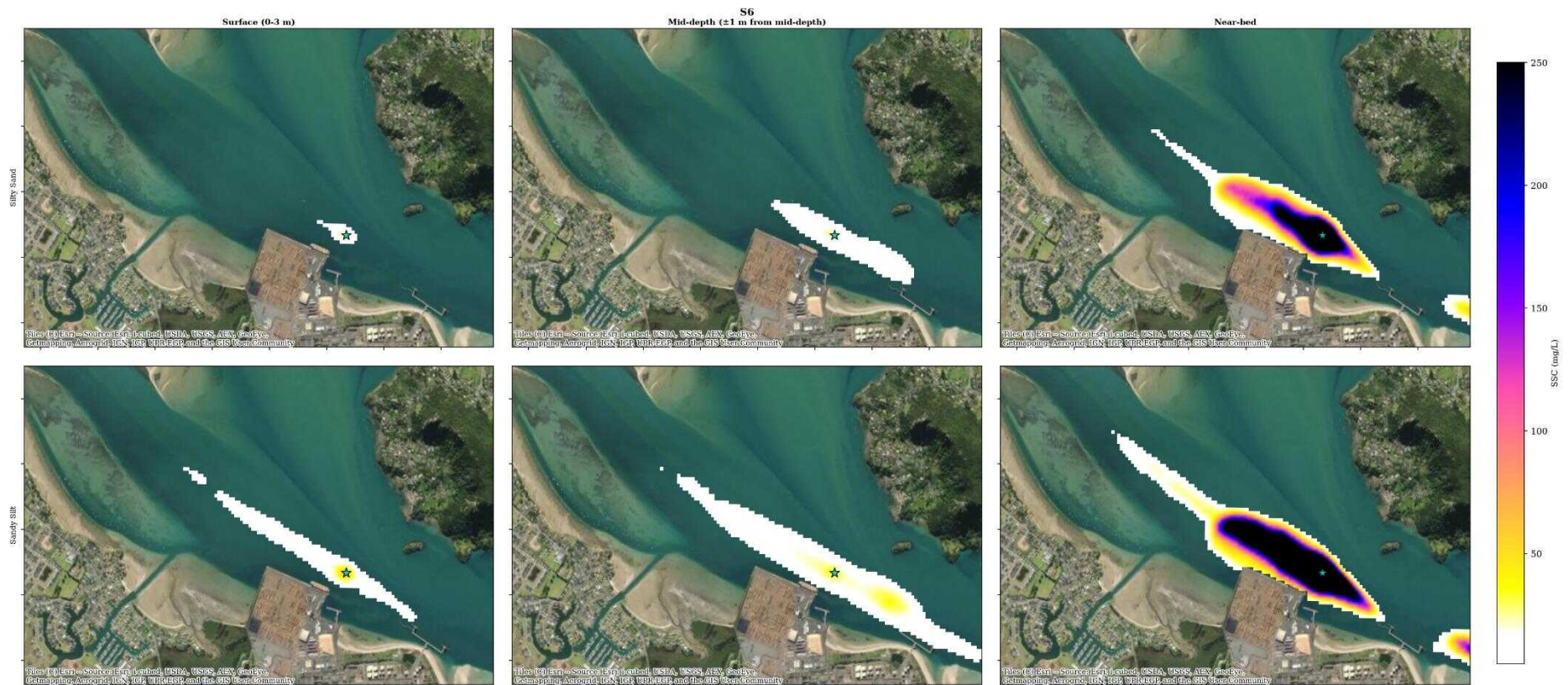


Figure 72 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 6**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .



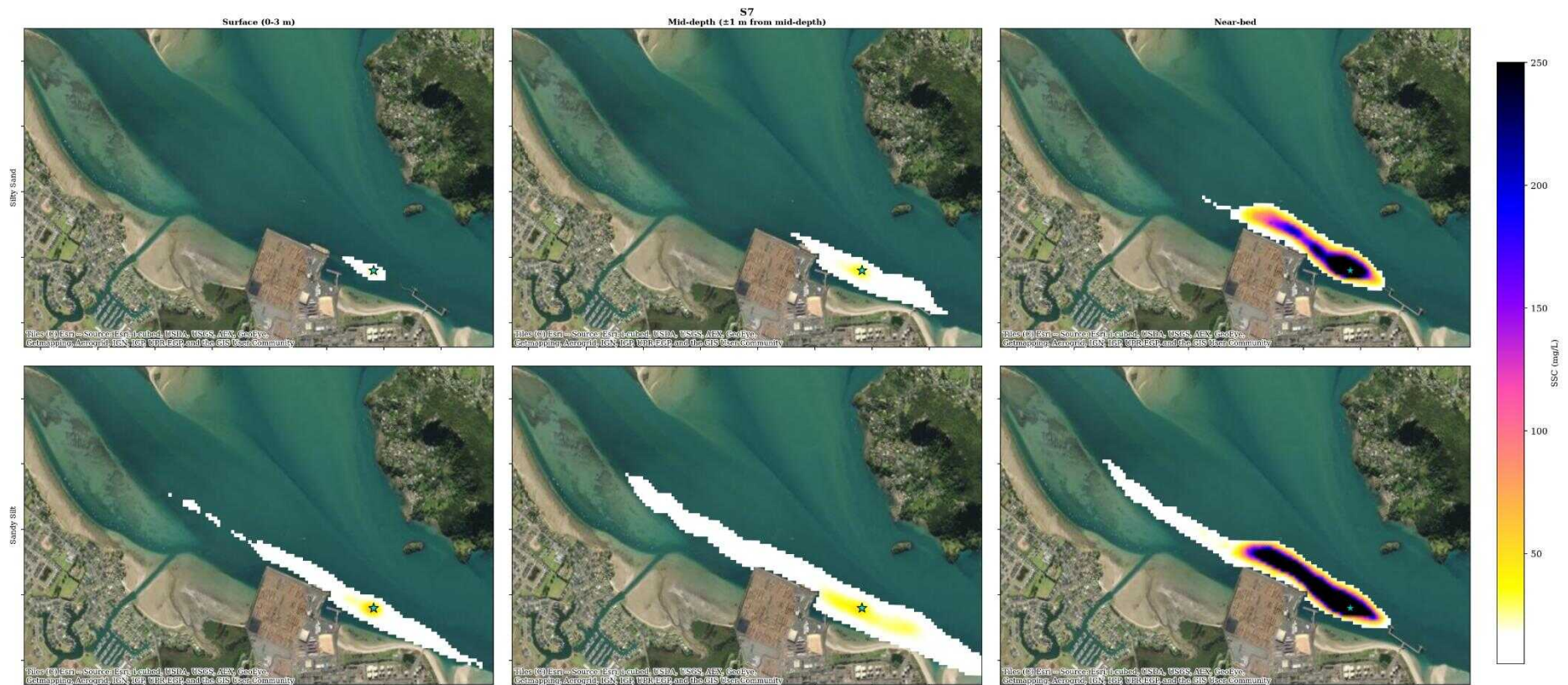


Figure 74 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 7**, over the **existing bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L⁻¹.



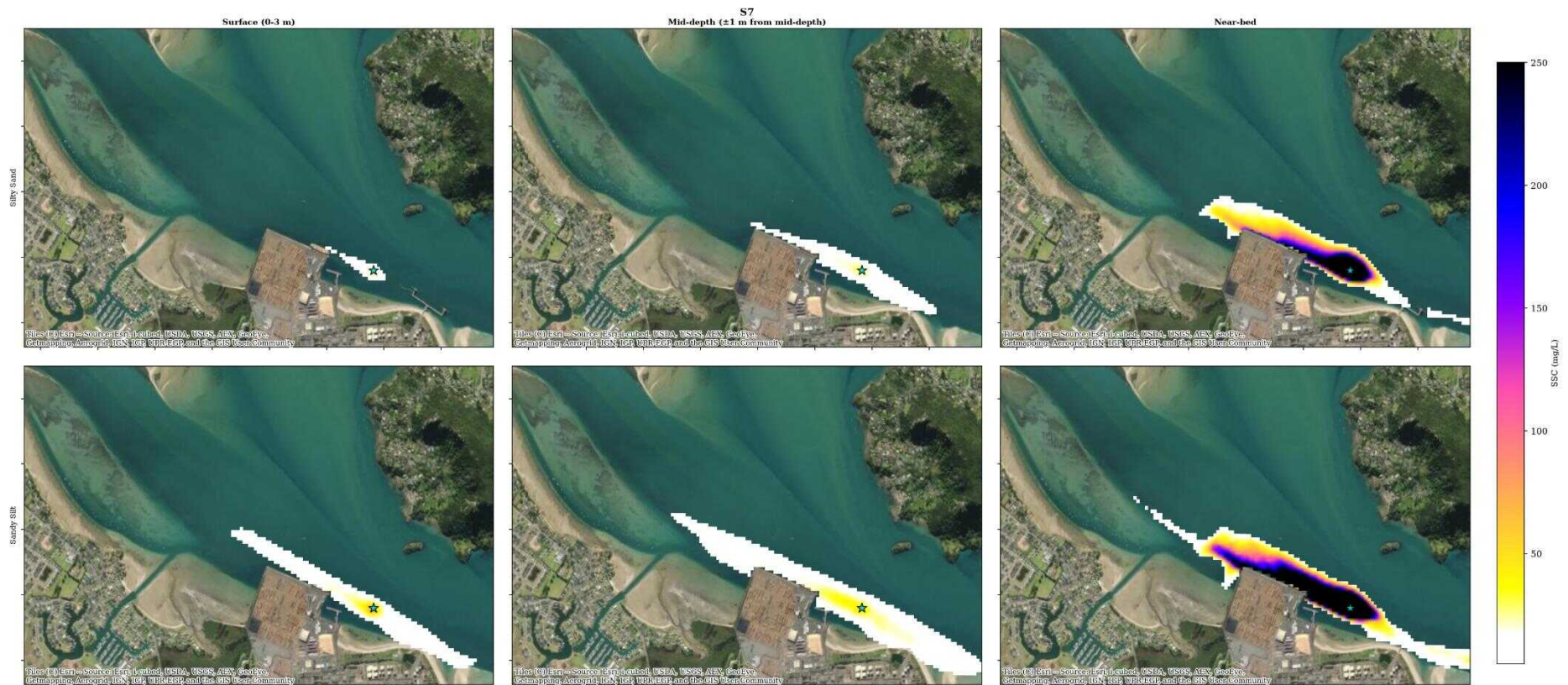


Figure 76 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **TSHD** dredging at **site 7**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. The dredger is assumed to dredge continuously over the 1-month simulation period. TSS were masked below 5 mg L^{-1} .

BHD Sediment deposition

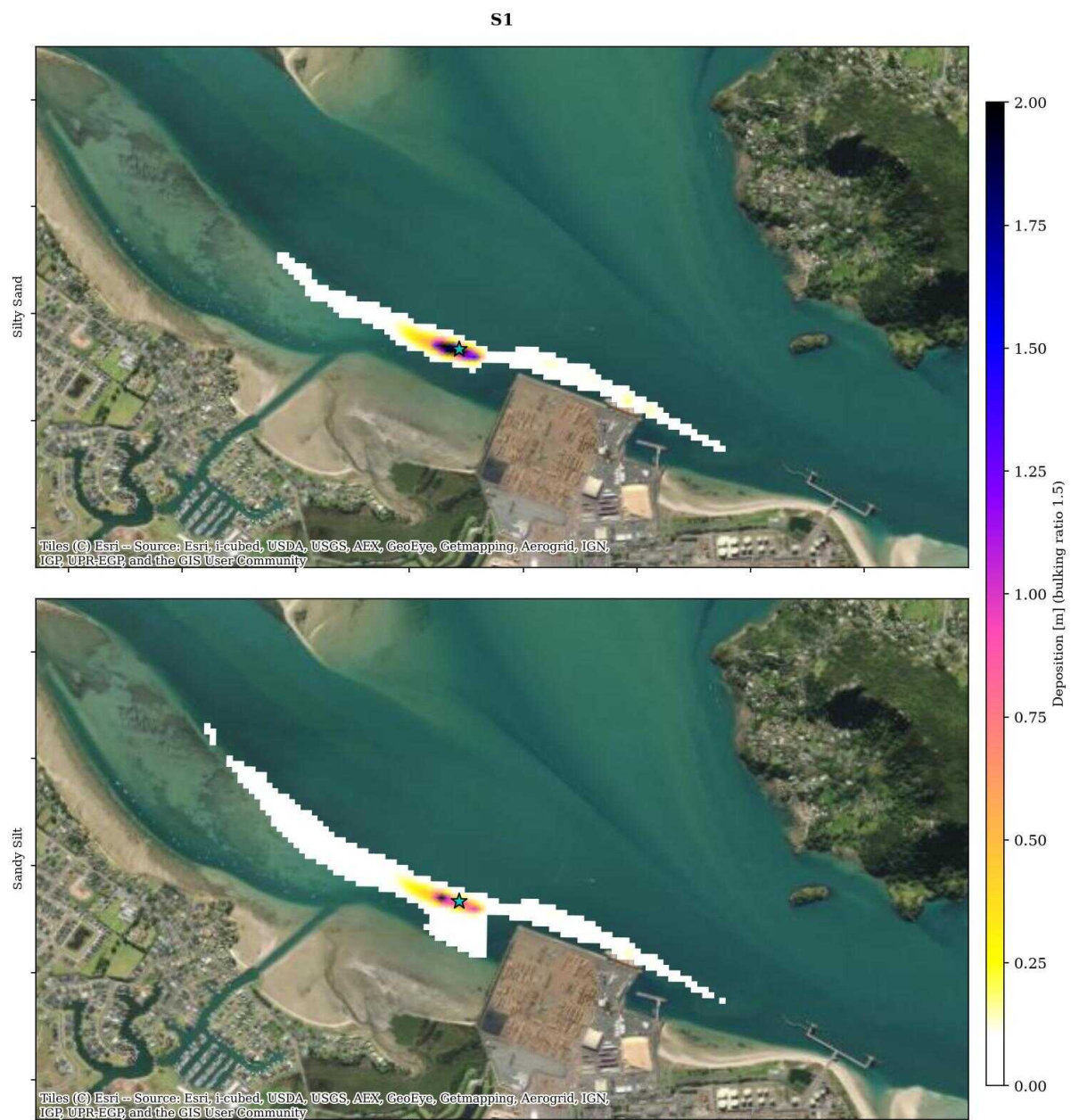


Figure 77 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

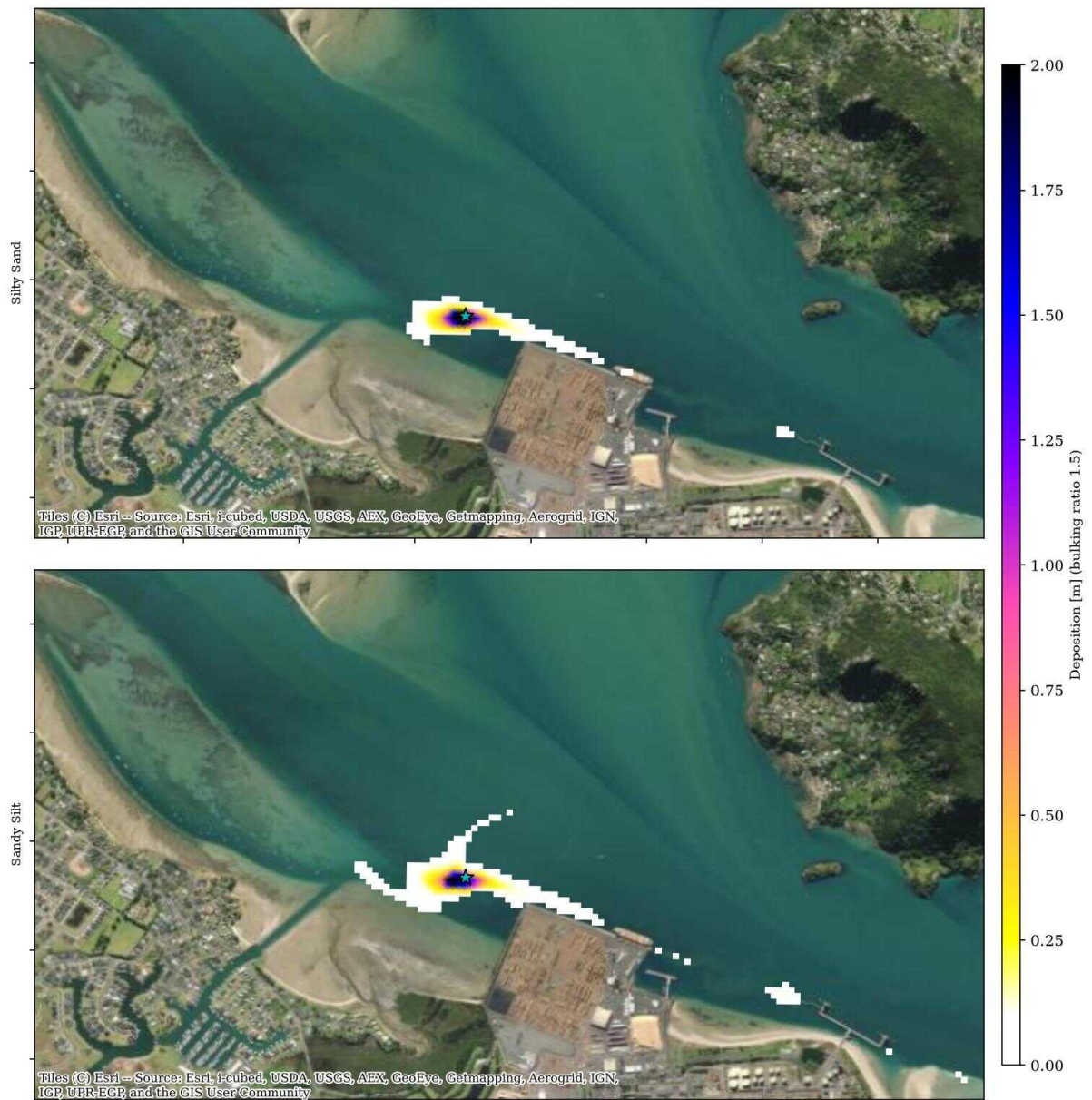


Figure 78 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

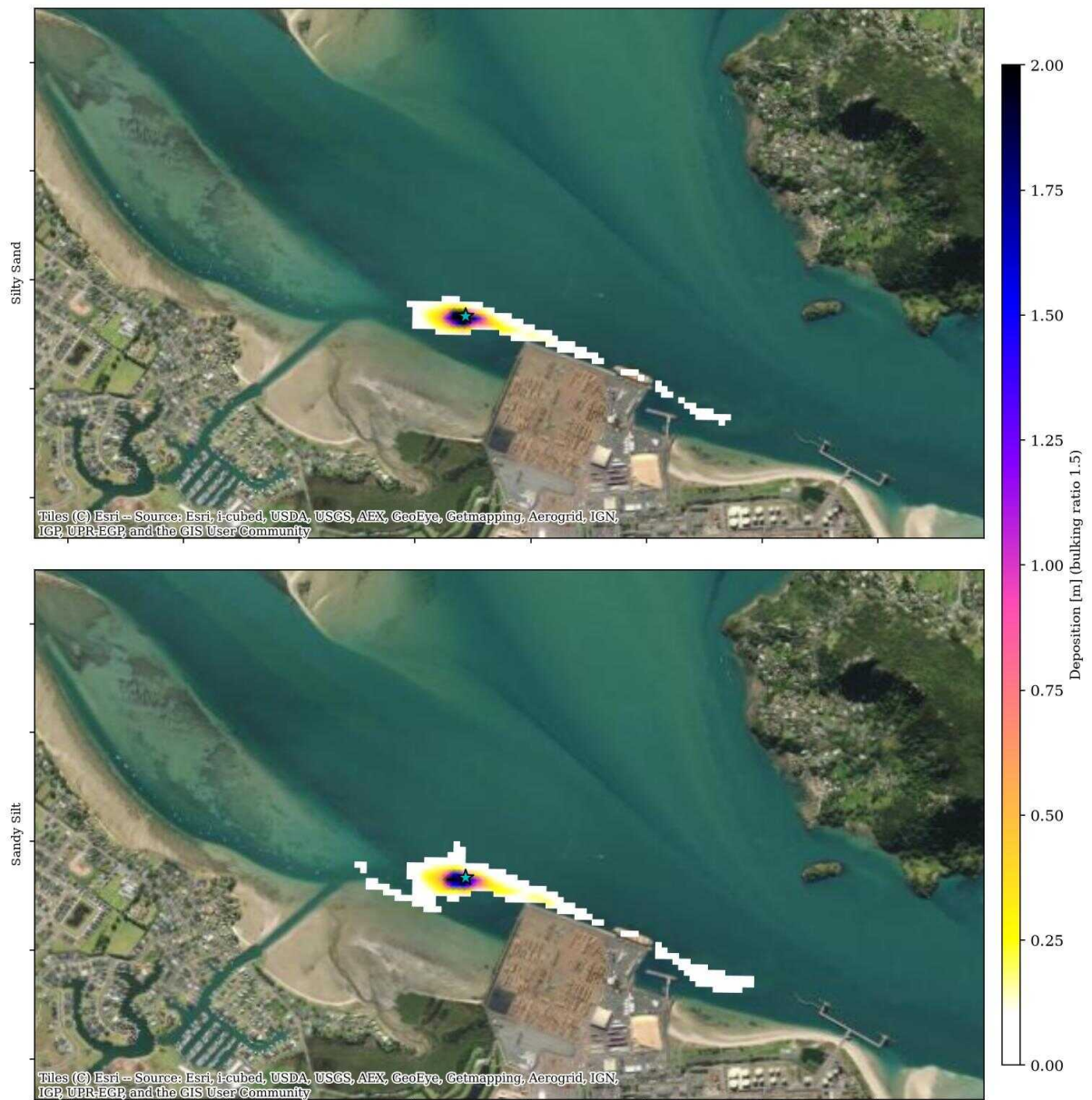


Figure 79 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S2

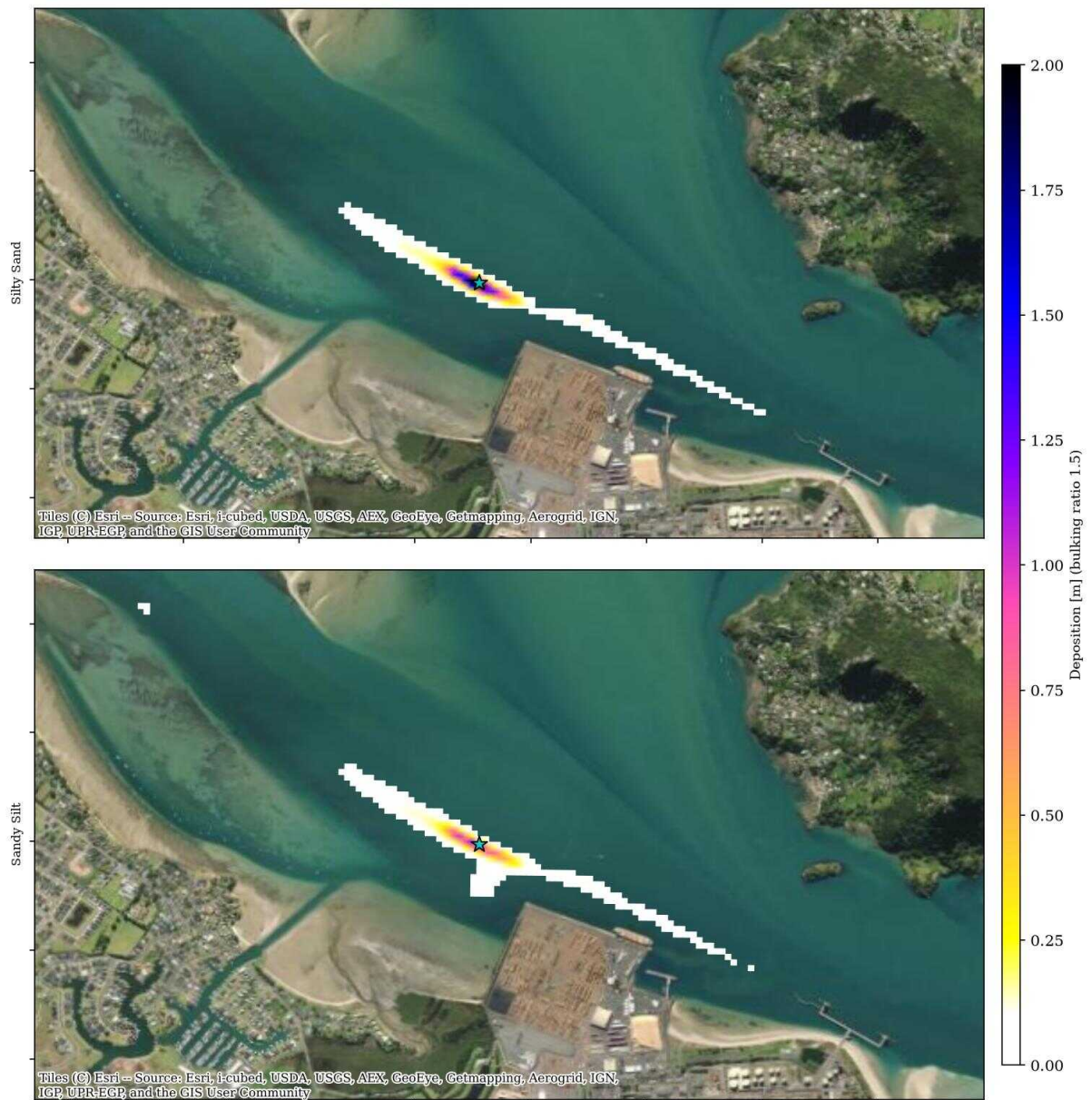


Figure 80 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S2

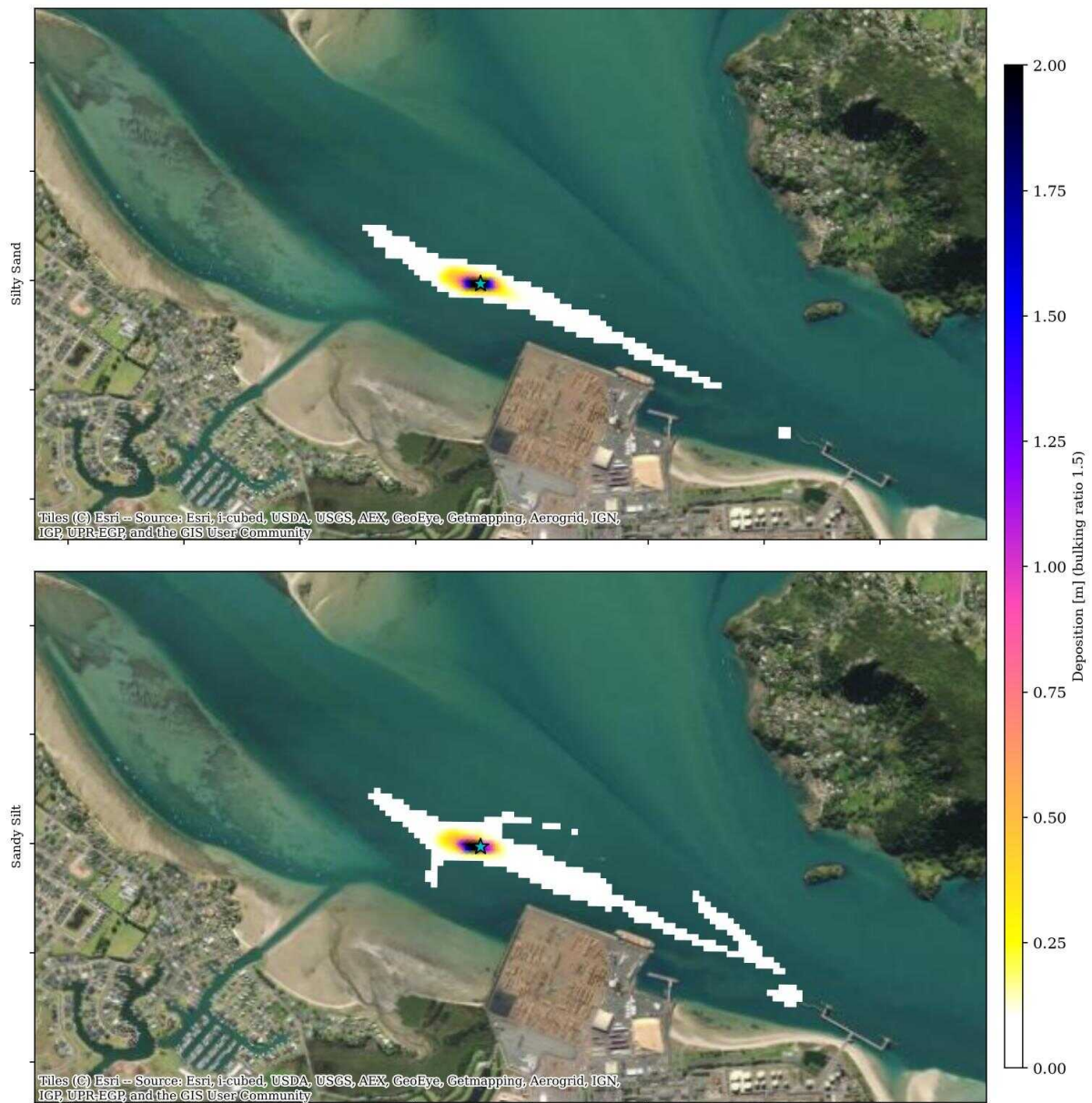


Figure 81 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S2

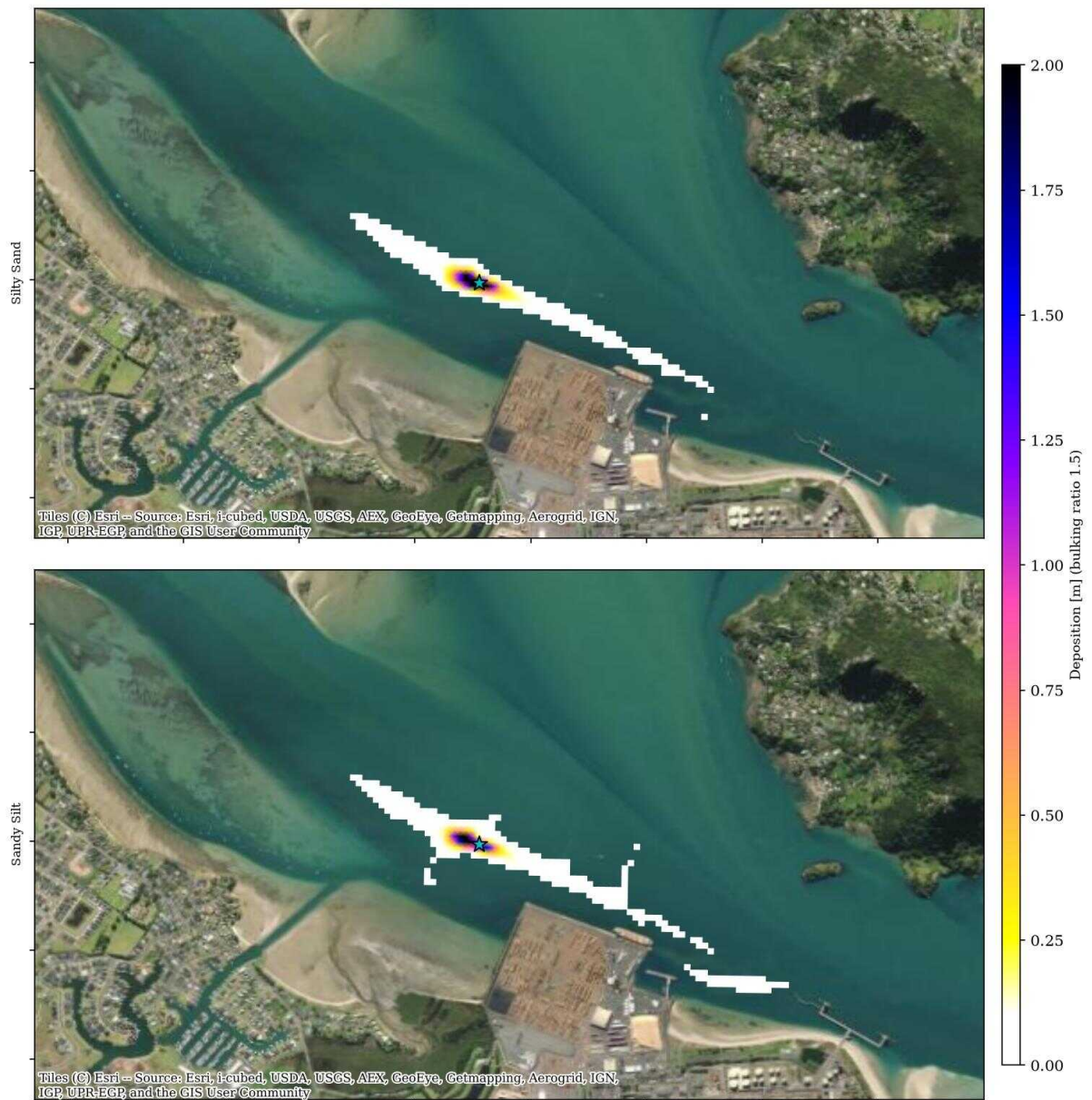


Figure 82 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

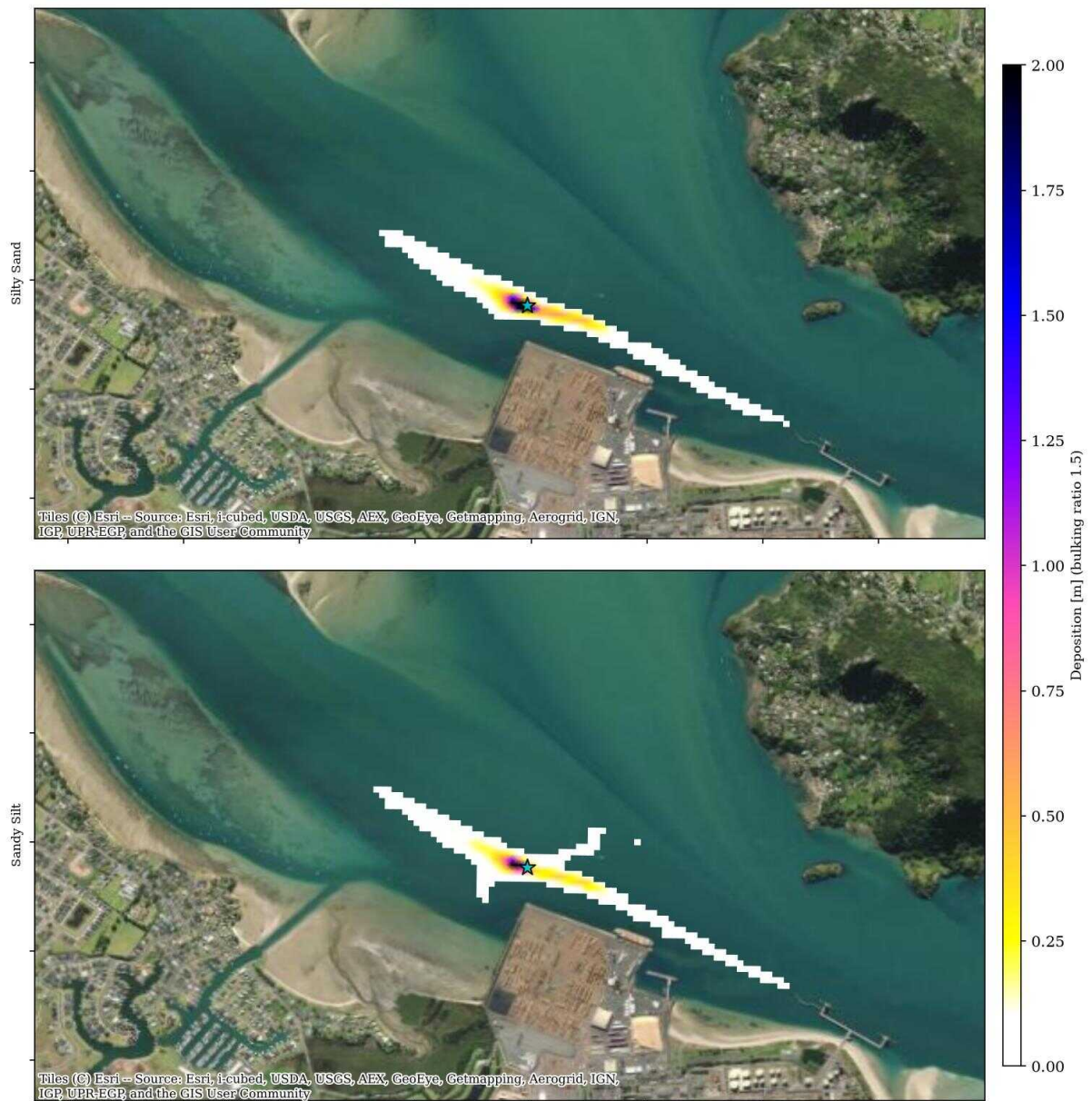


Figure 83 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

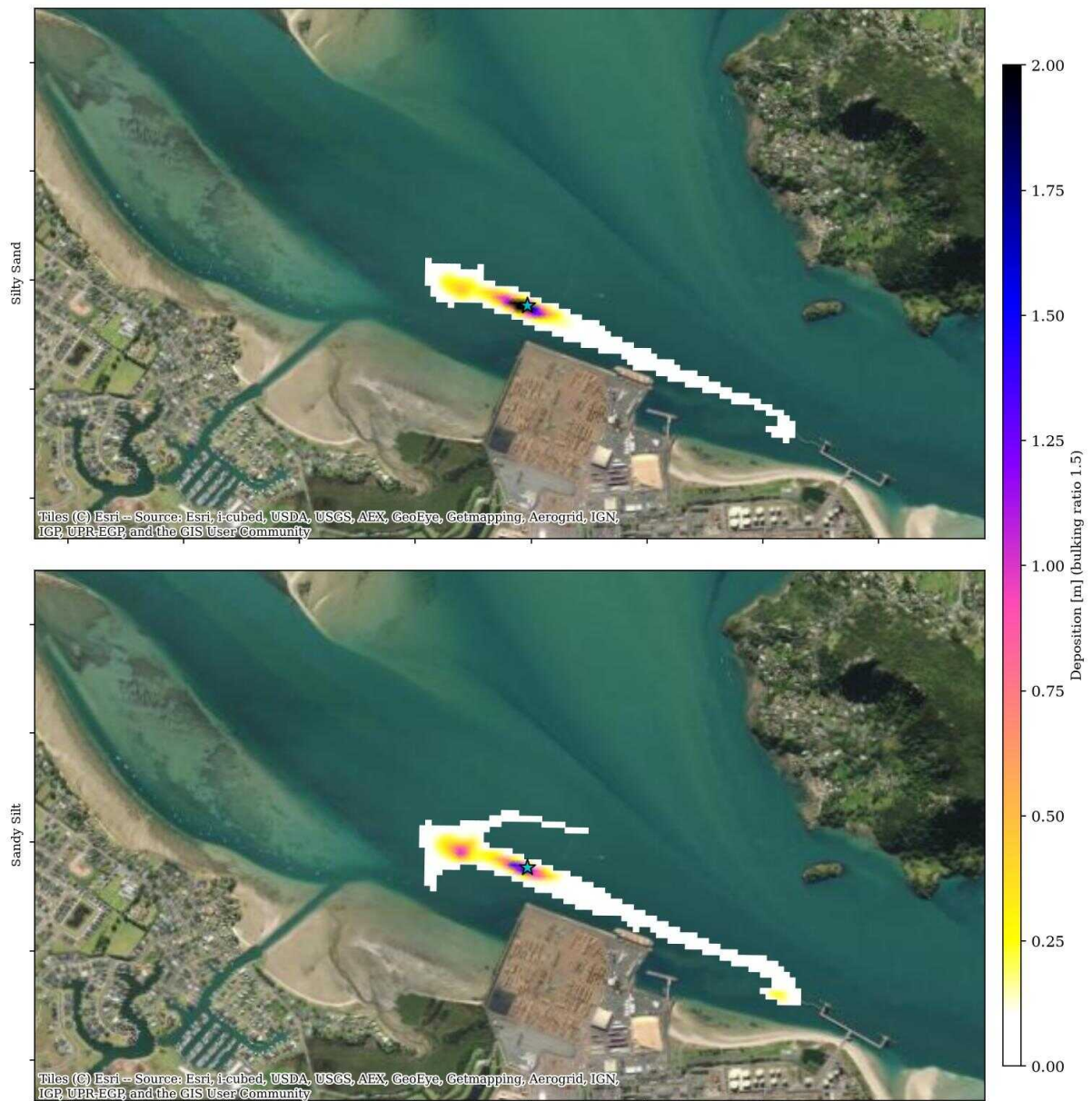


Figure 84 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

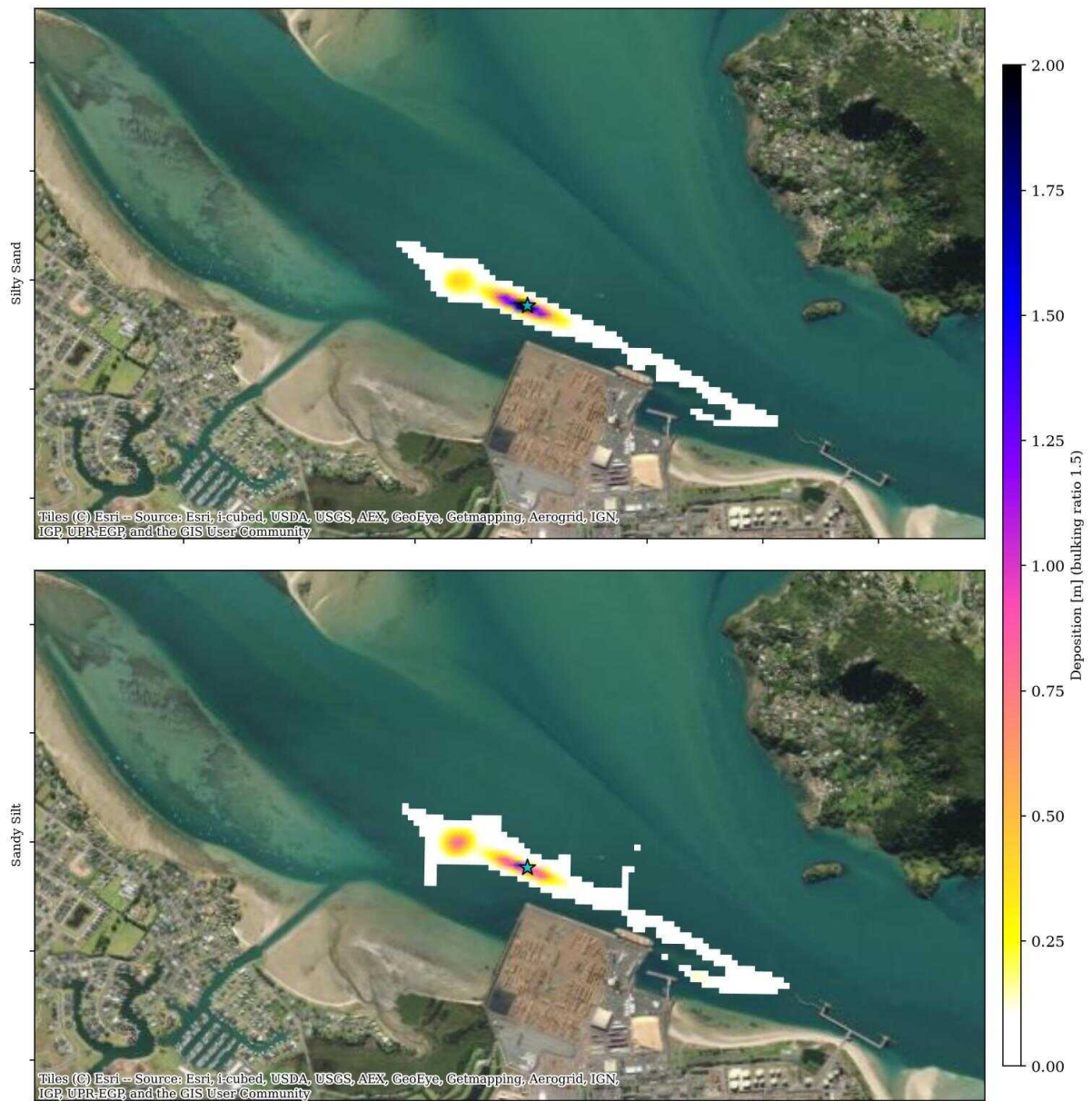


Figure 85 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S4

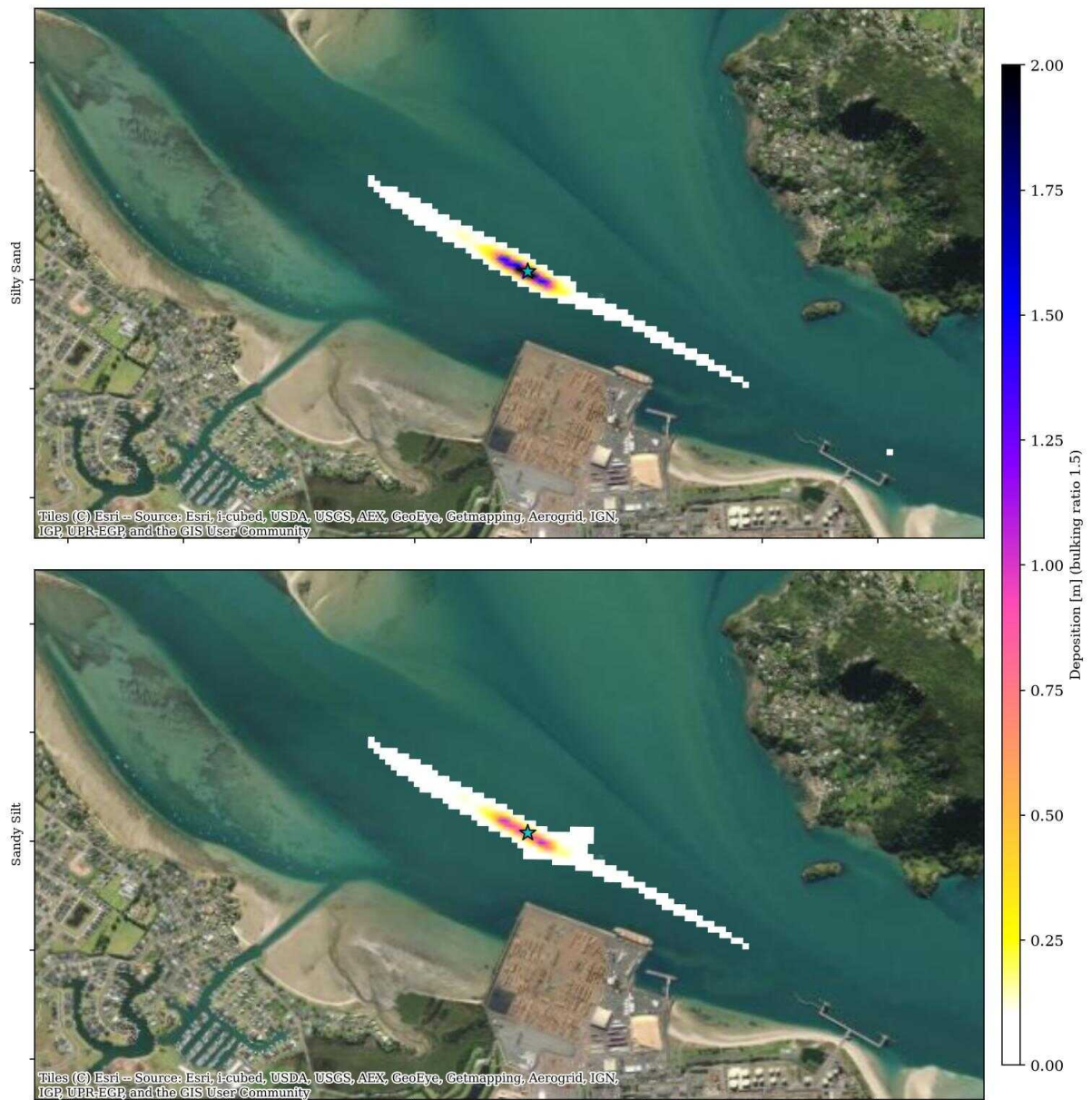


Figure 86 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S4

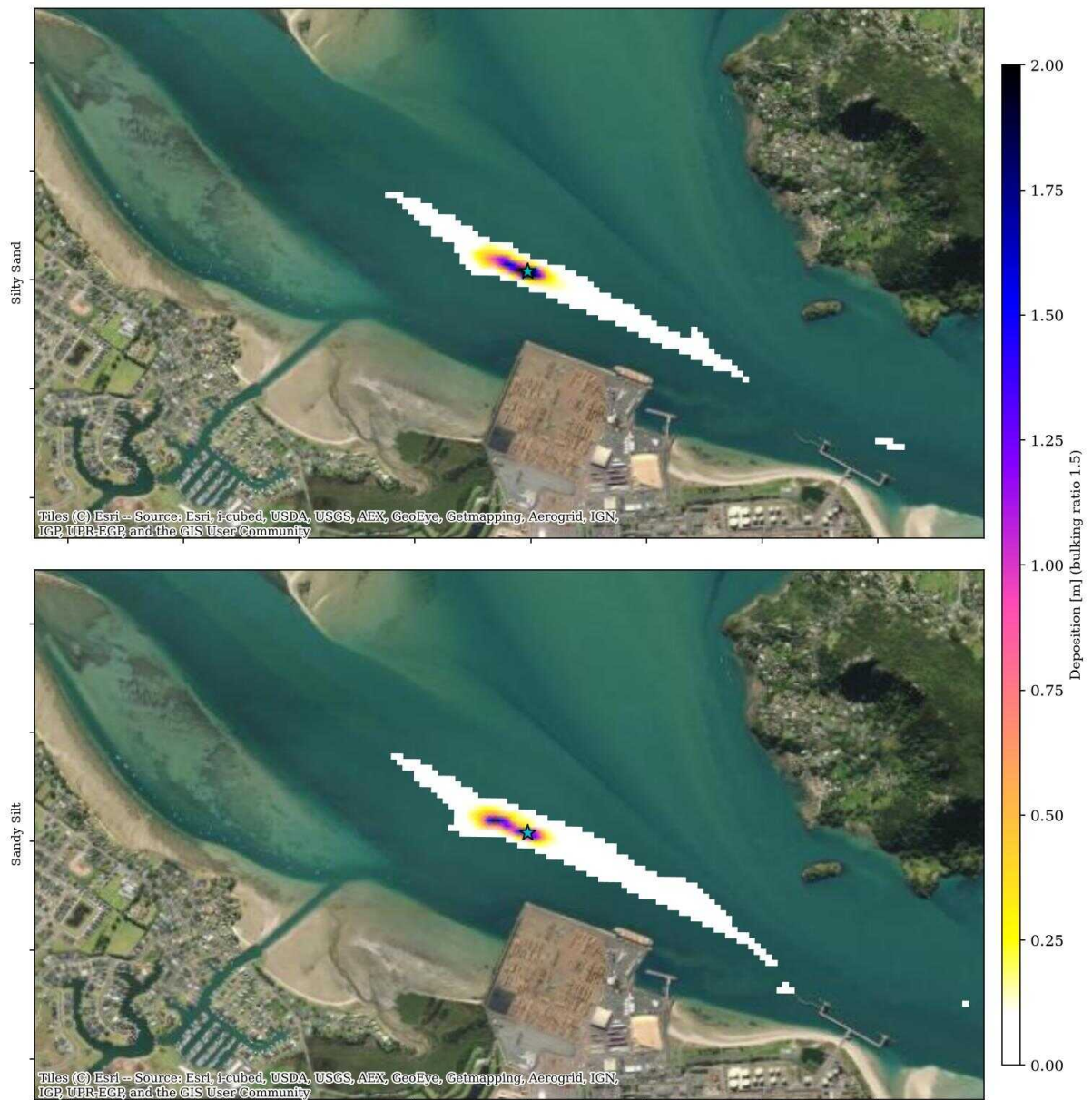


Figure 87 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S4

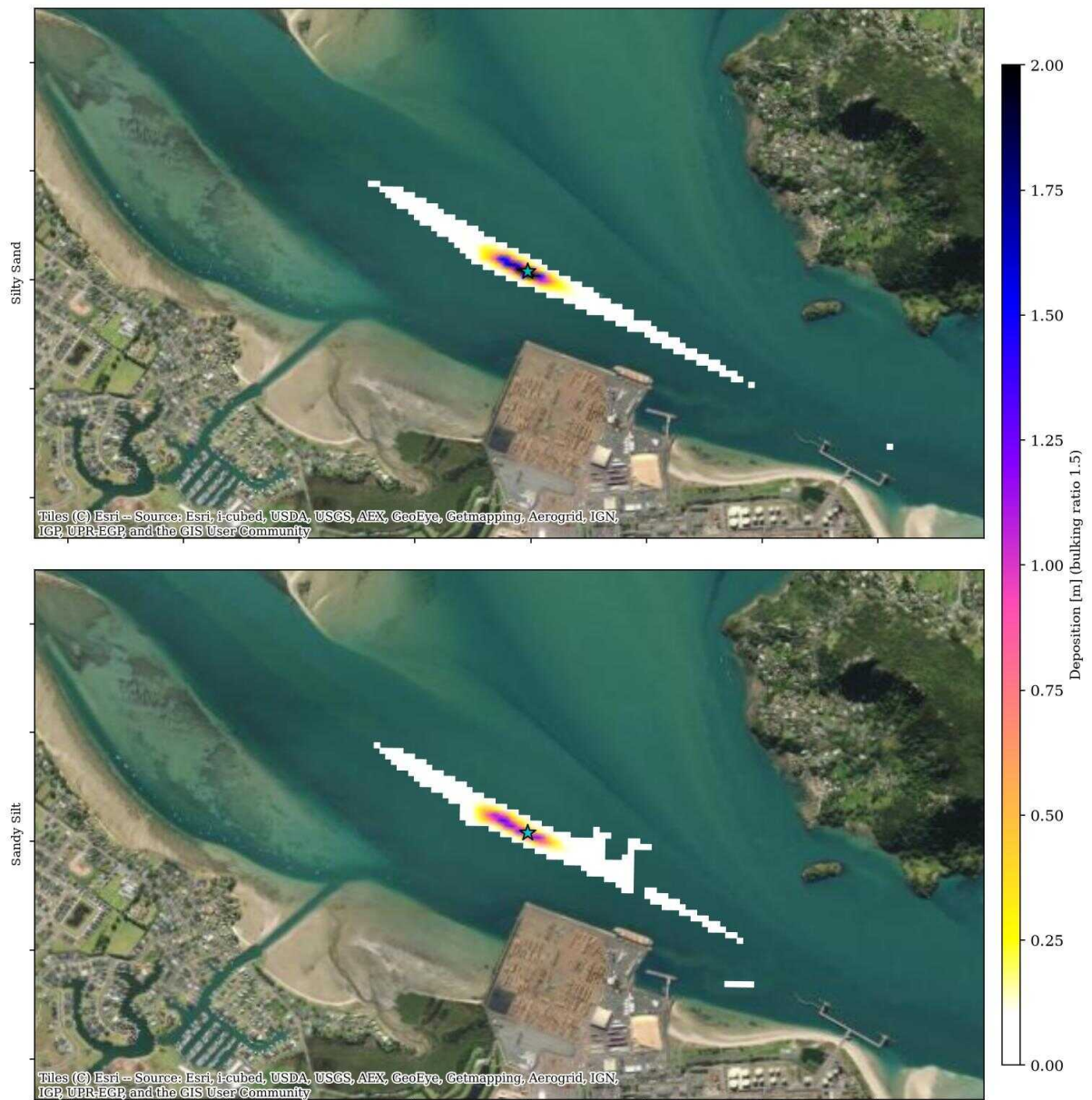


Figure 88 Final cumulative **sediment deposition thickness (m)** for **BHD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

CSD Sediment deposition

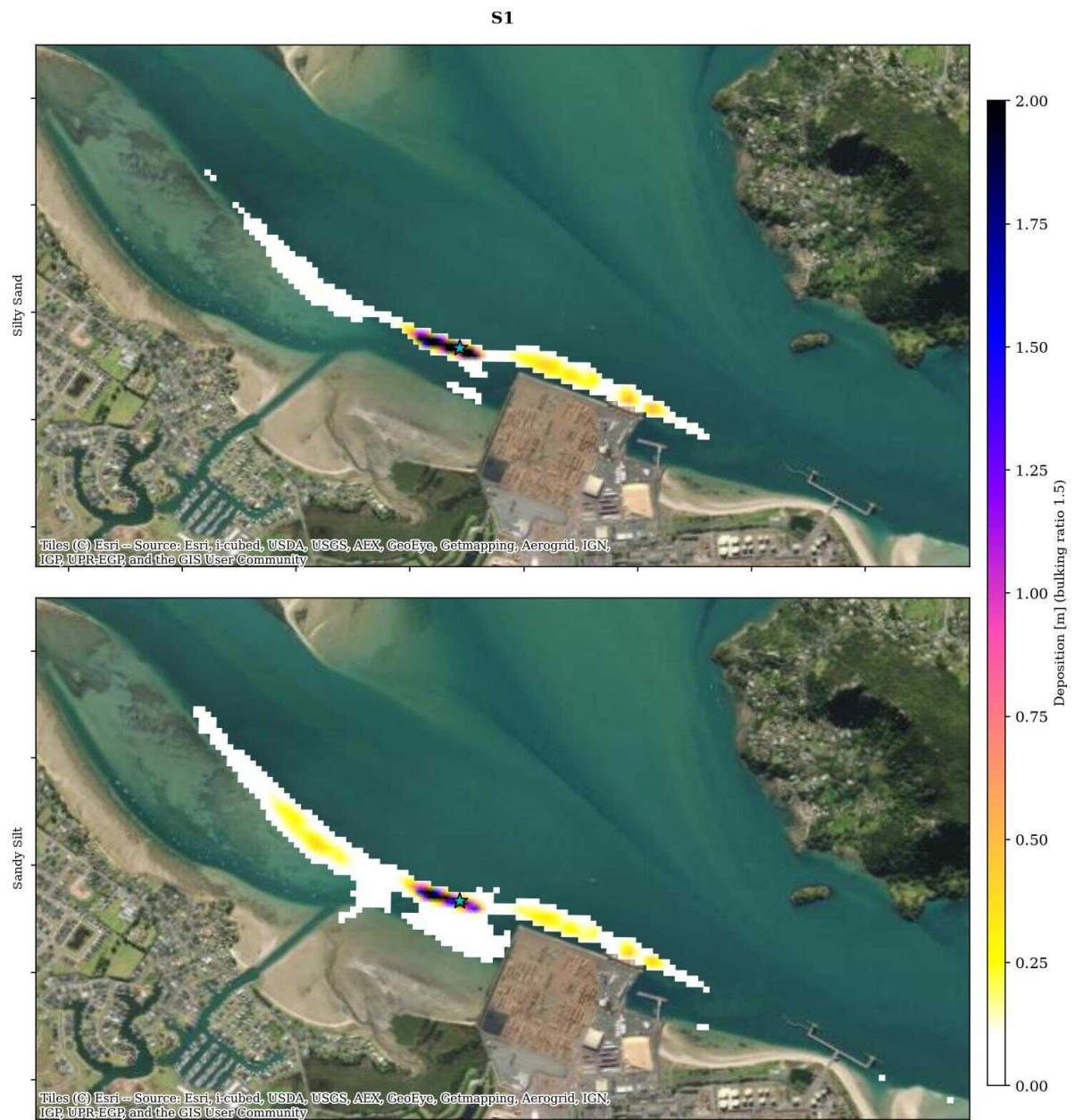


Figure 89 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

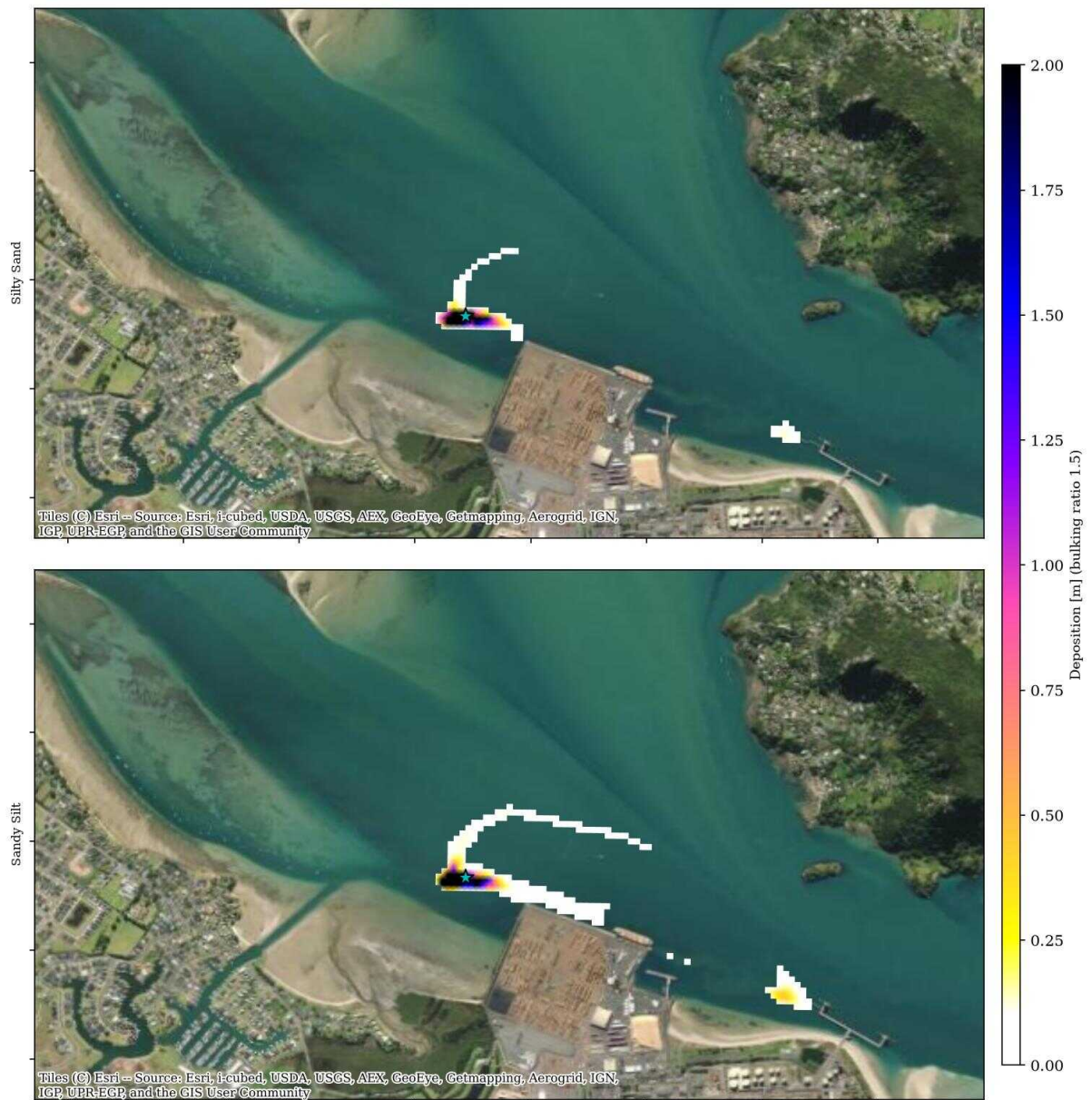


Figure 90 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S1

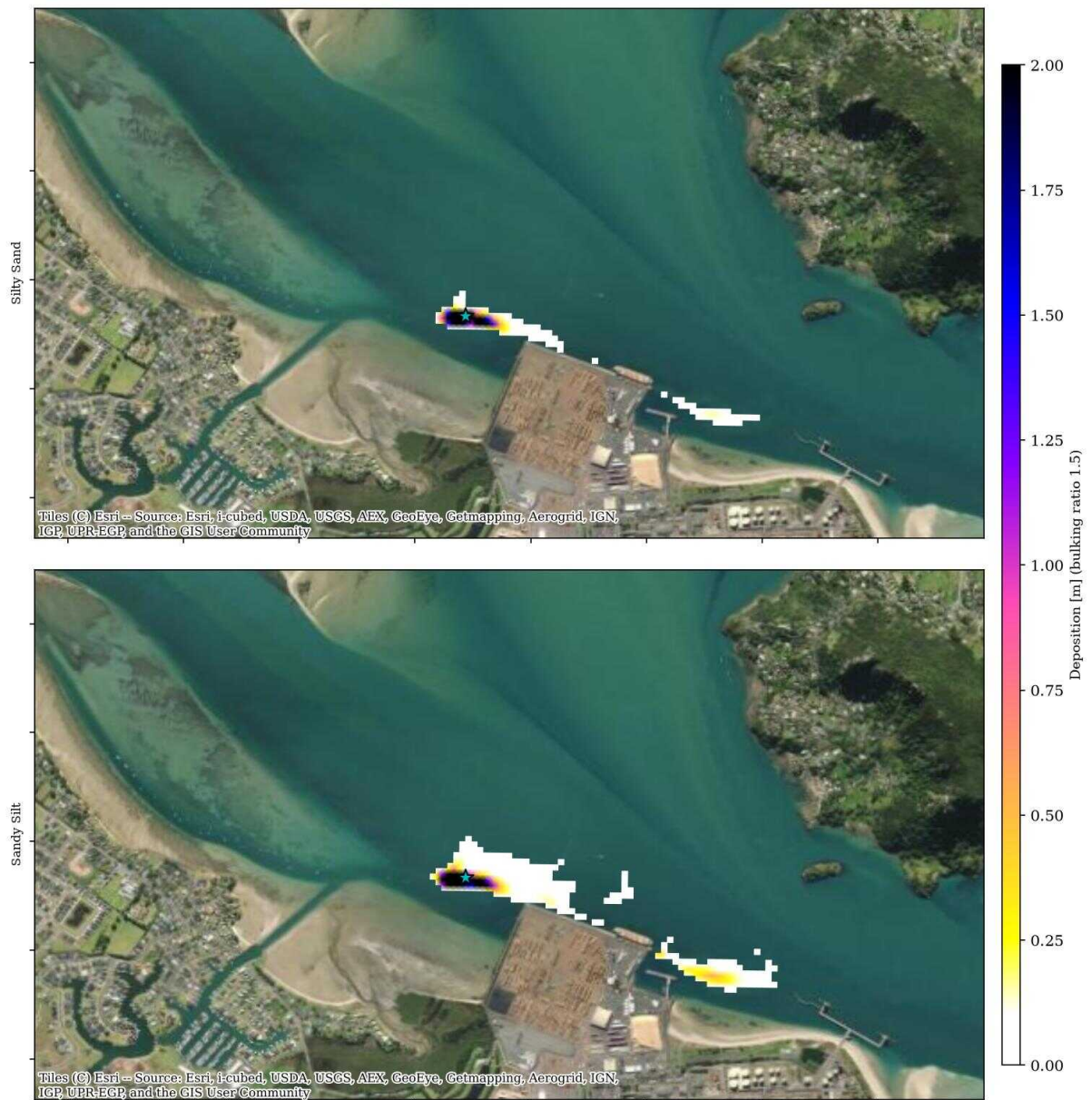


Figure 91 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S2

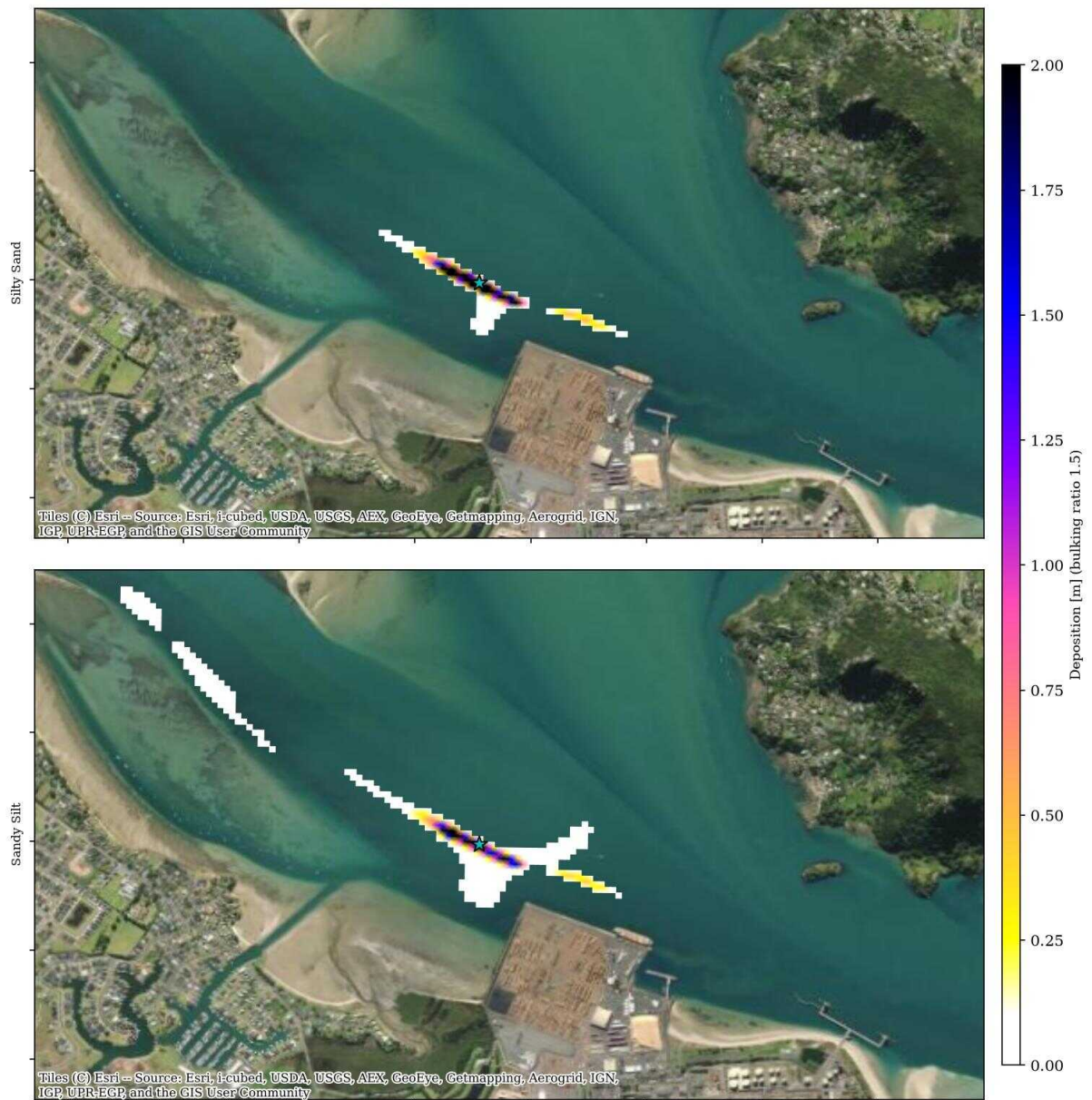


Figure 92 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S2

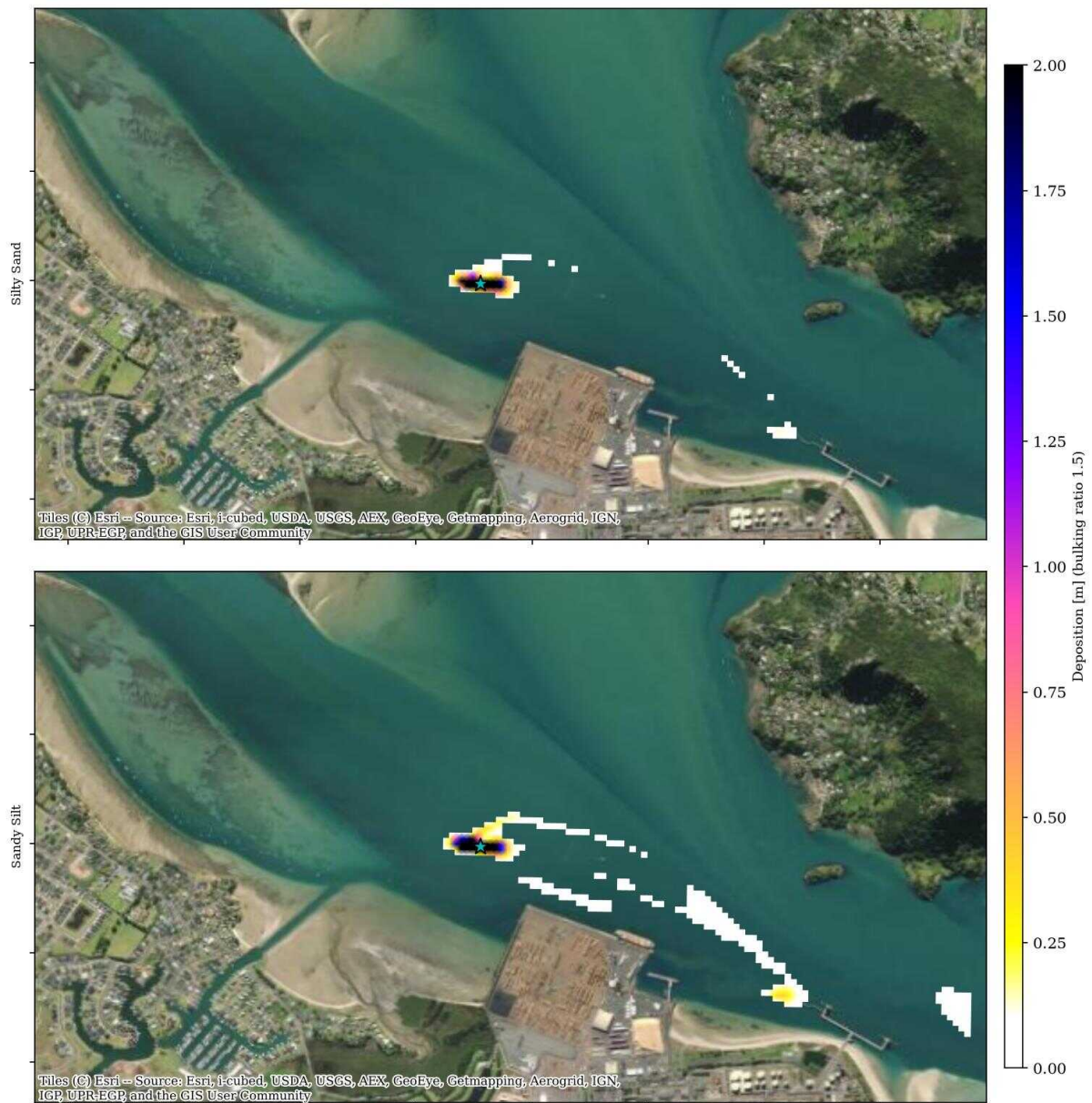


Figure 93 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S2

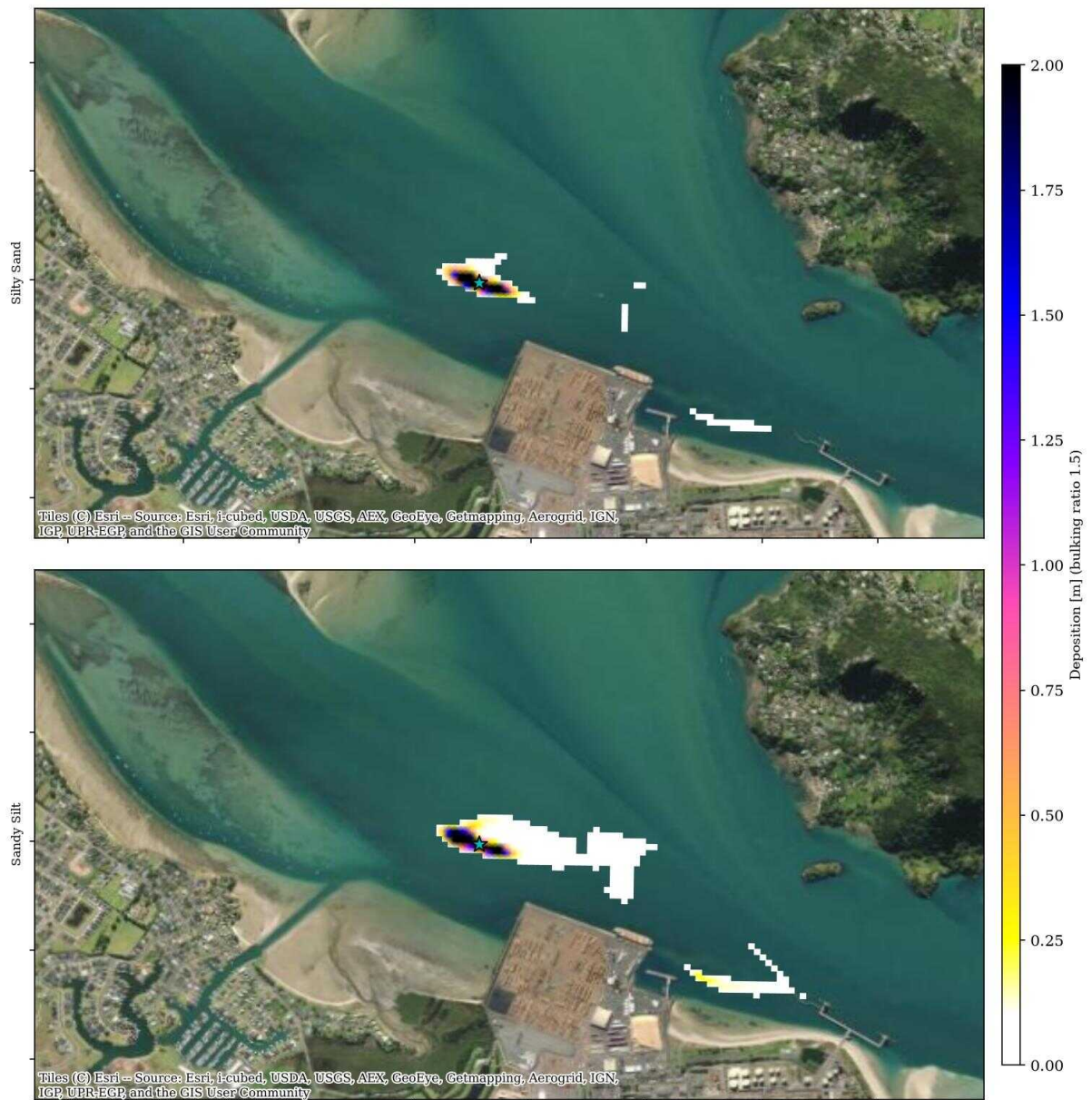


Figure 94 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

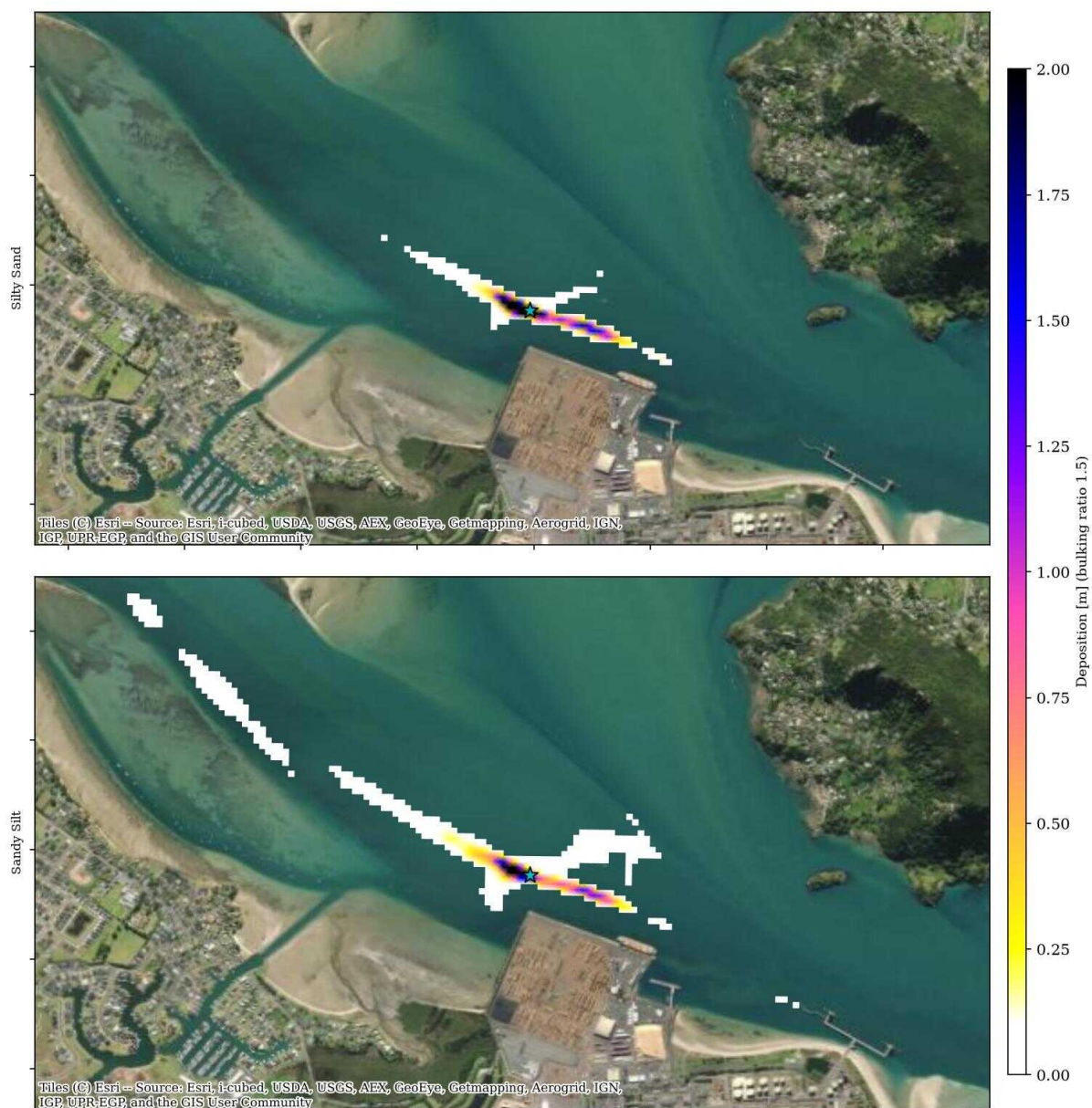


Figure 95 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

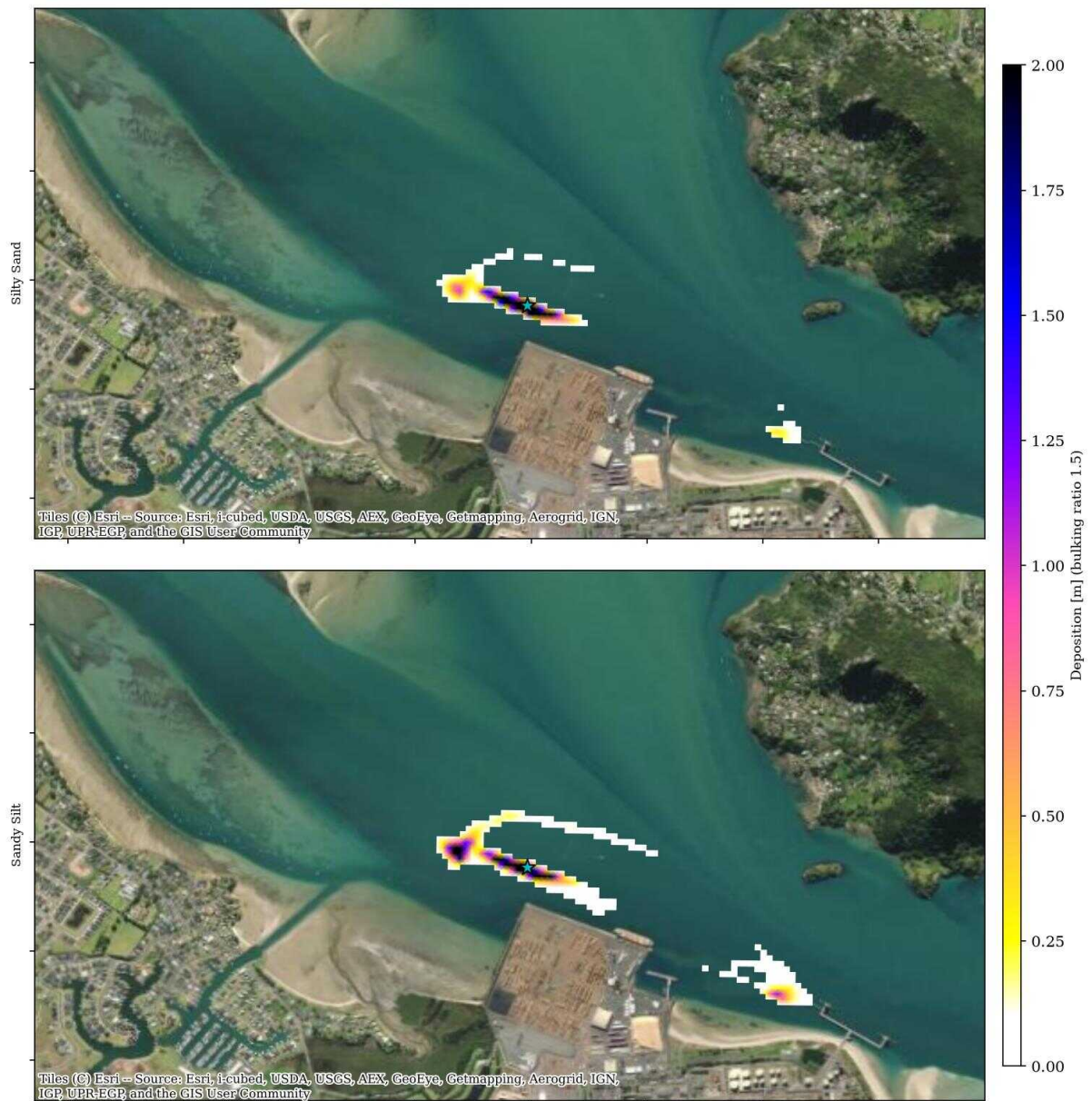


Figure 96 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

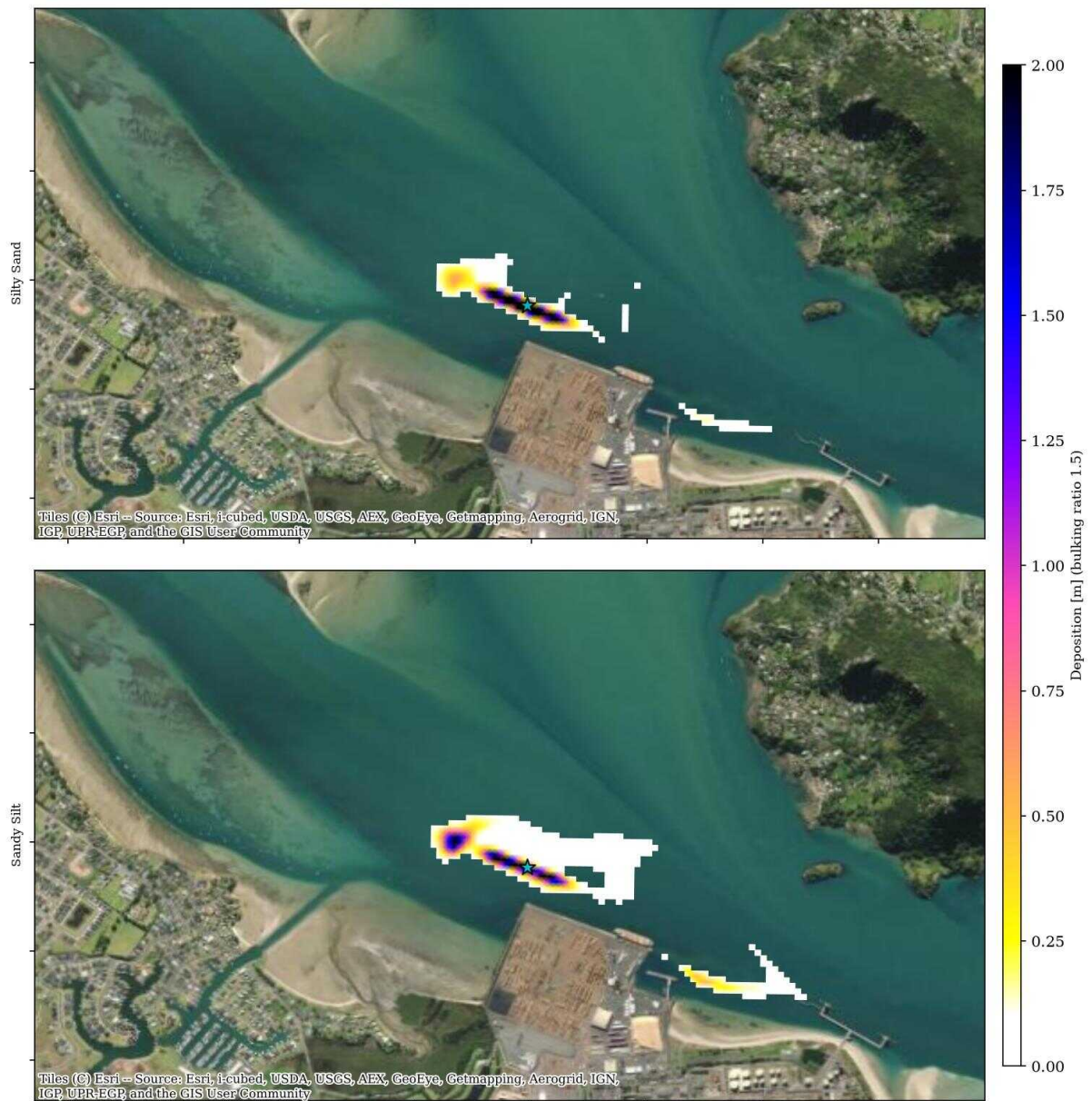


Figure 97 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S4

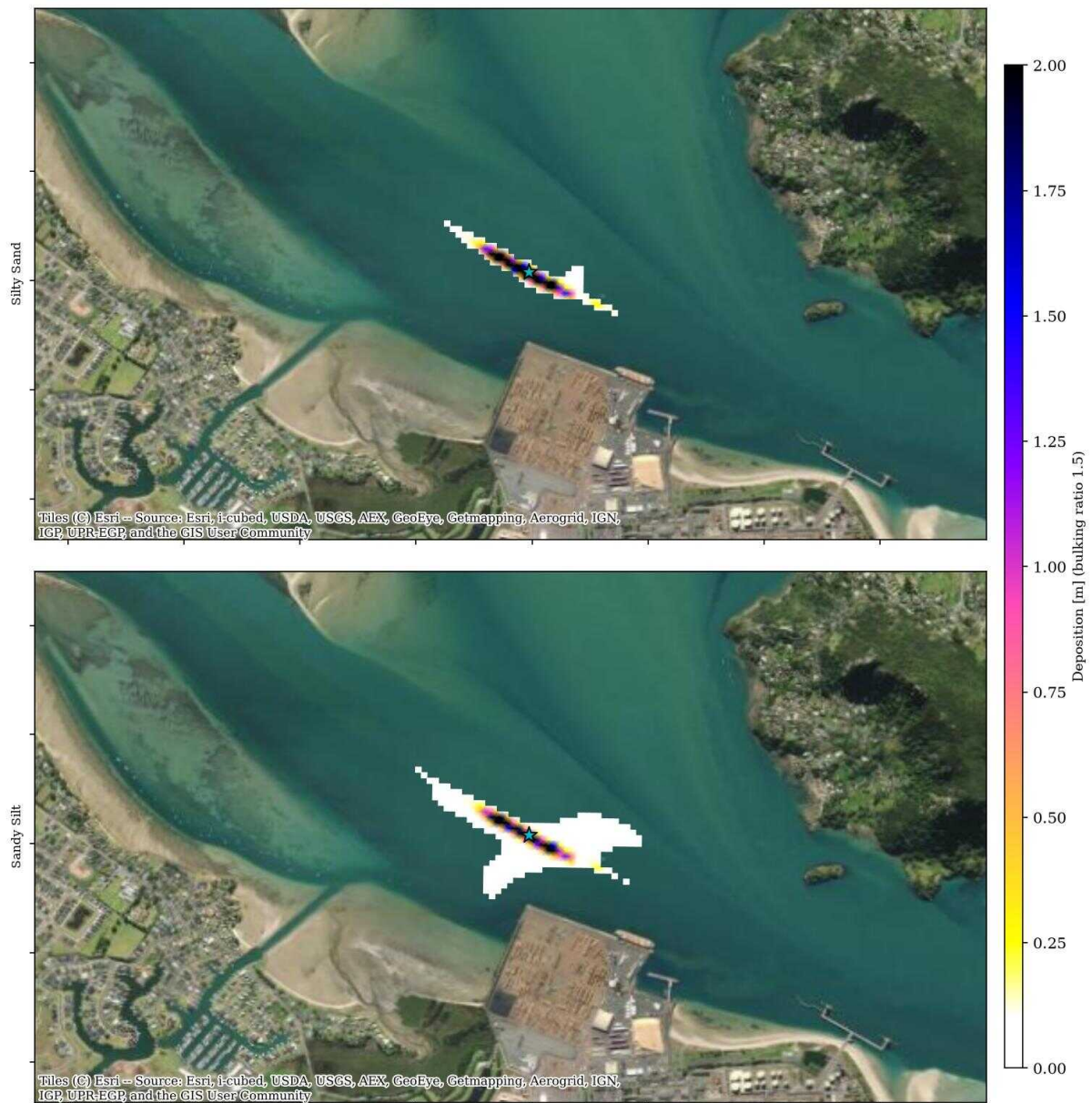


Figure 98 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S4

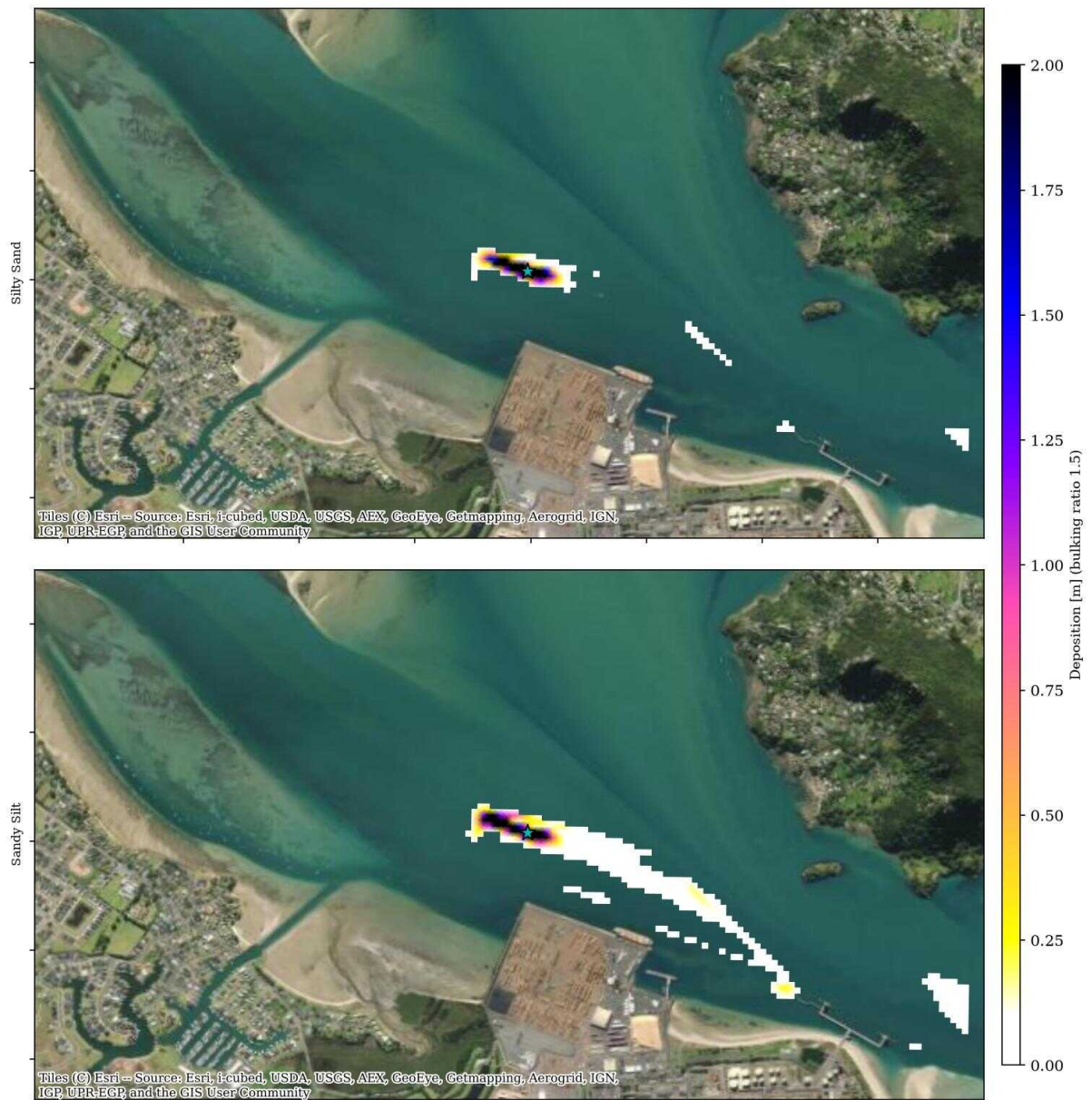


Figure 99 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

S4

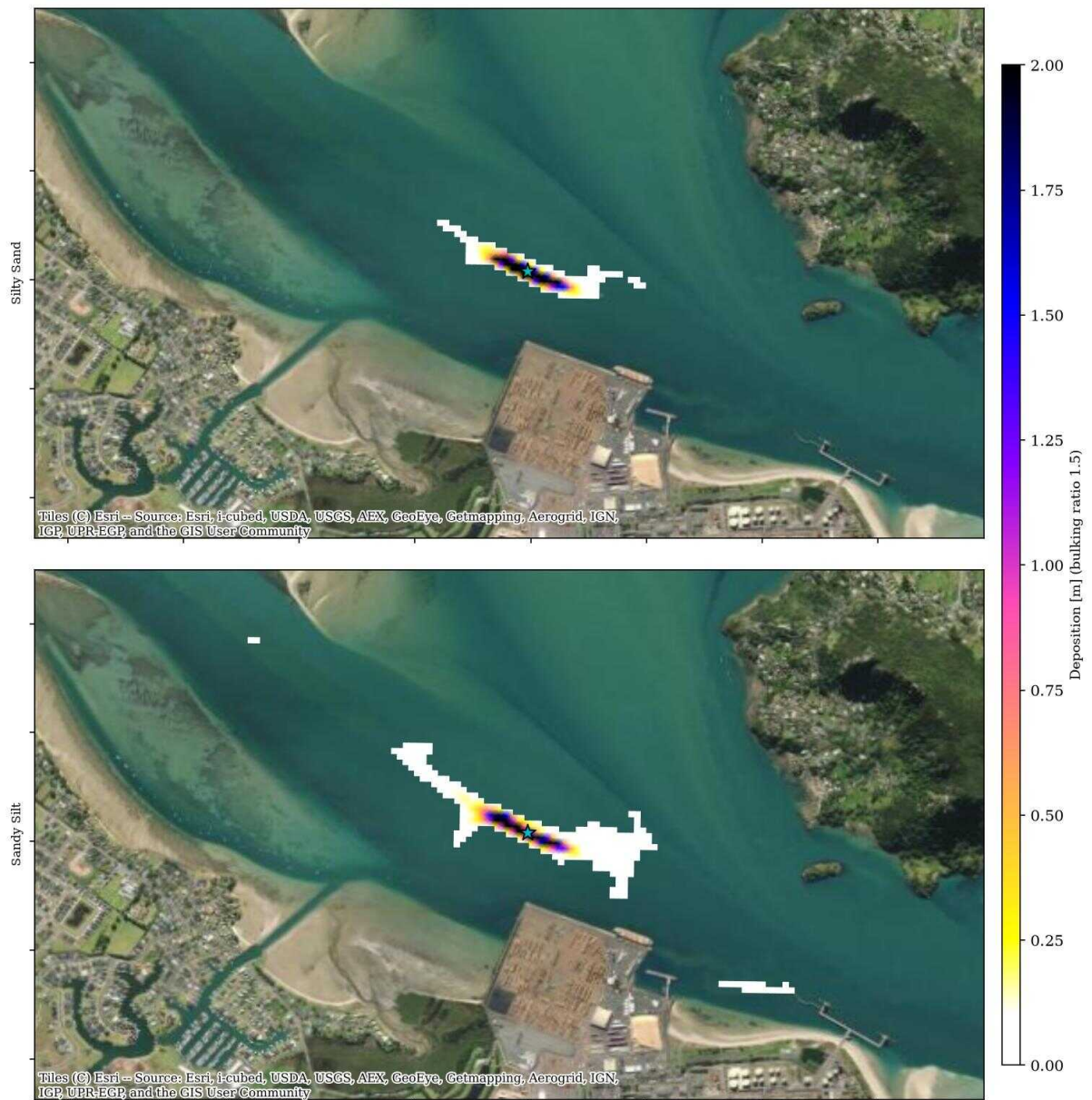


Figure 100 Final cumulative **sediment deposition thickness (m)** for **CSD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

TSHD Sediment deposition

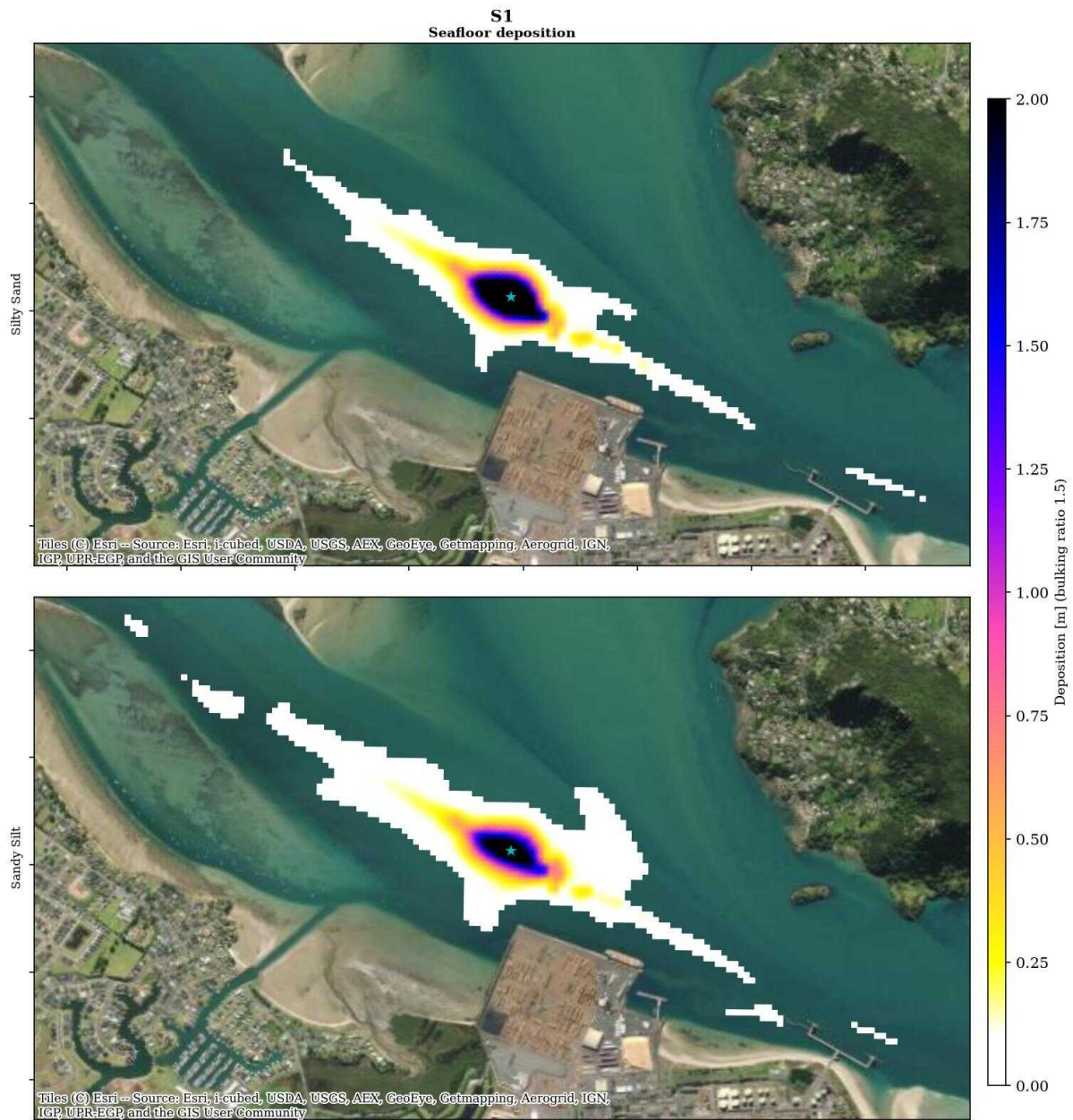


Figure 101 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

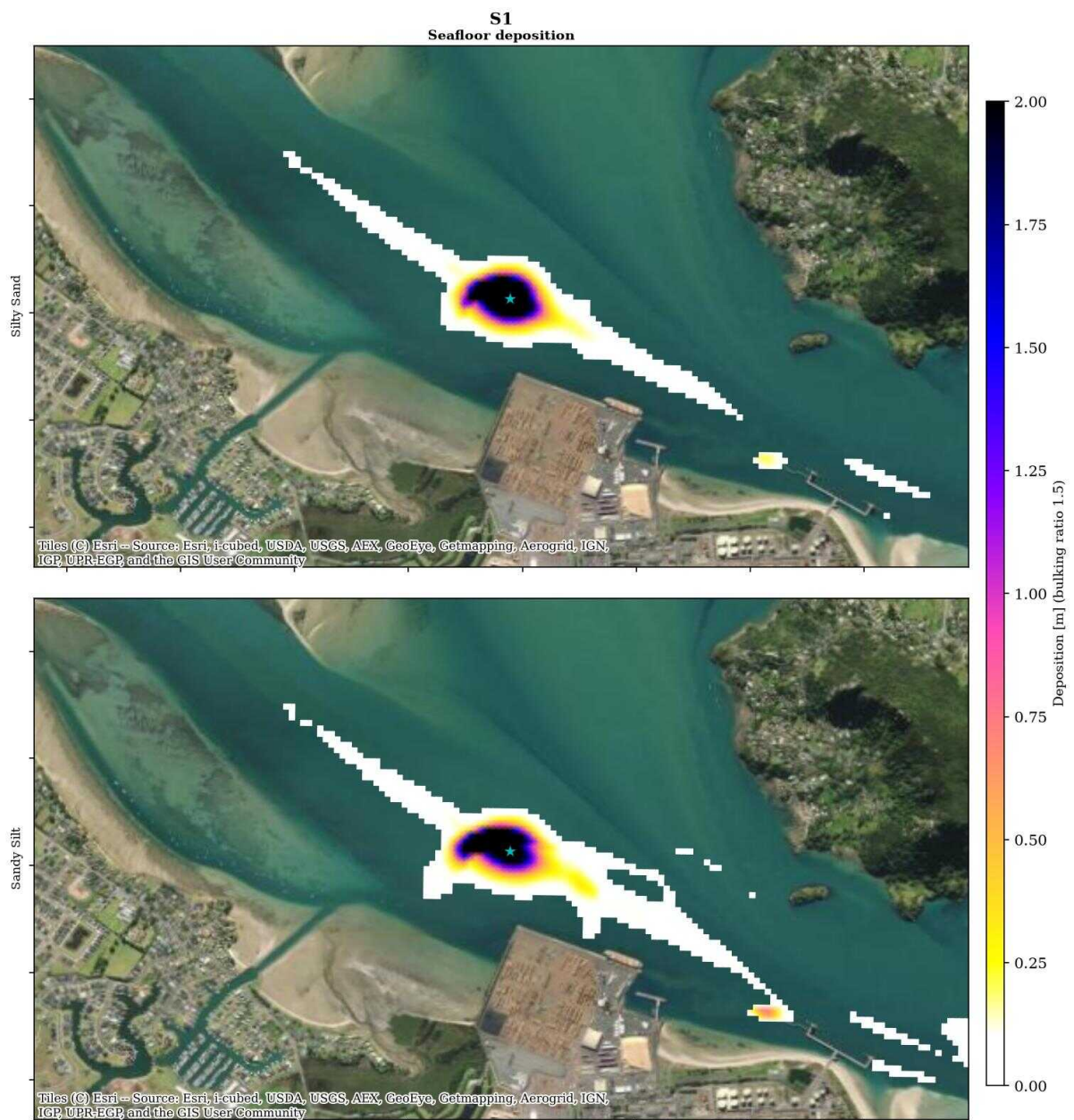


Figure 102 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

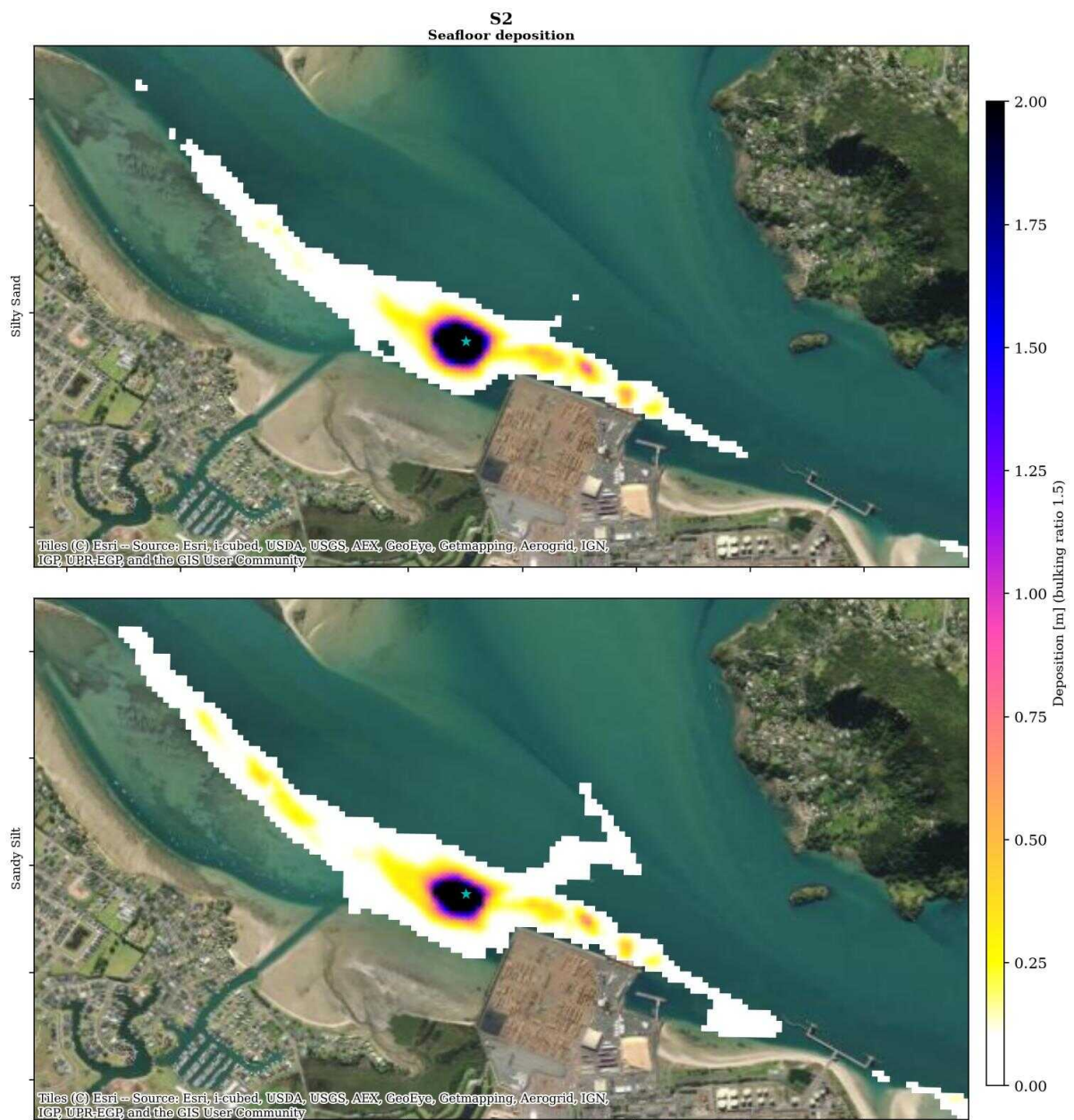


Figure 103 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

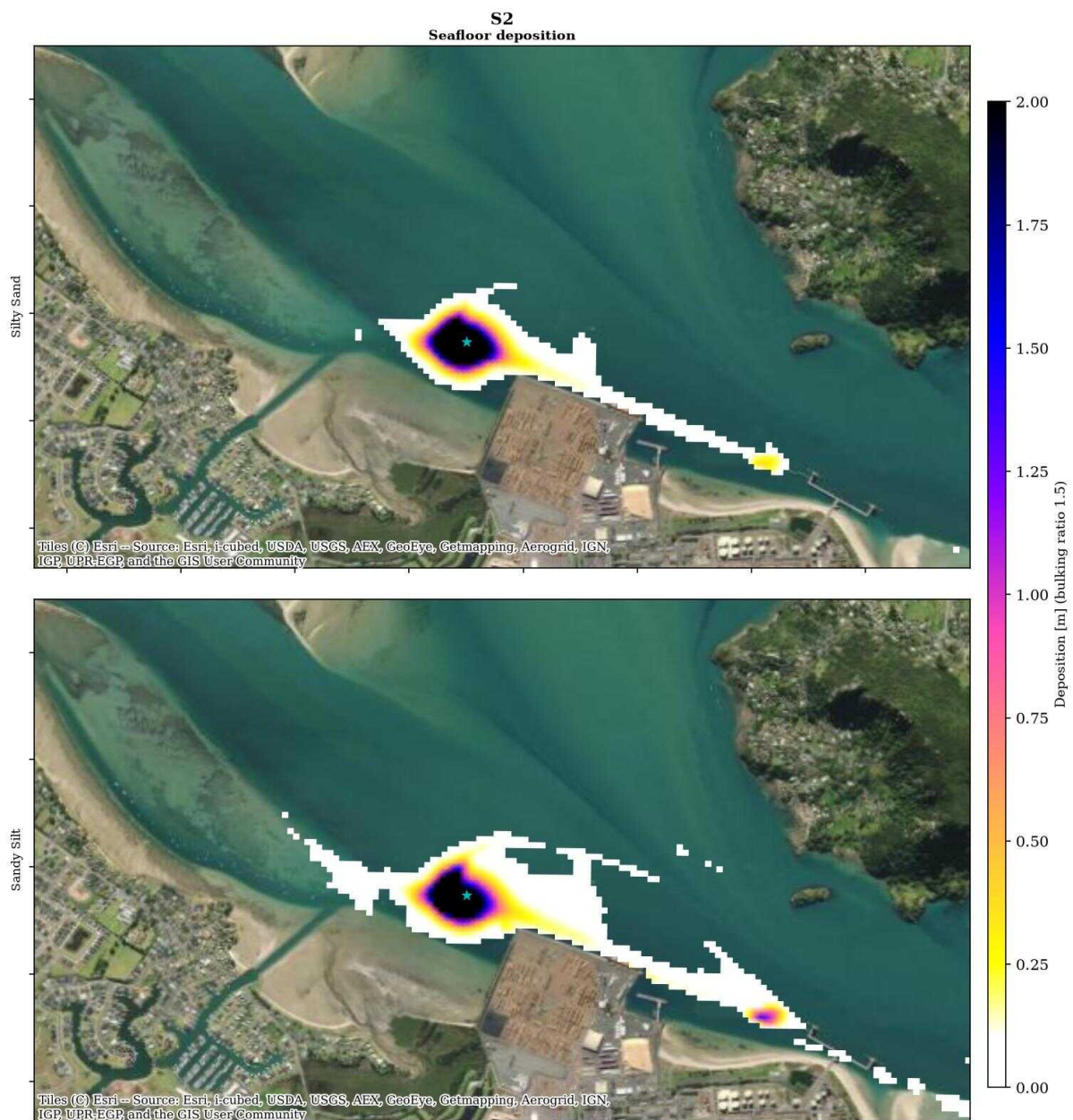


Figure 104 Final cumulative **sediment deposition thickness (m)** for **TSHD dredging at site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

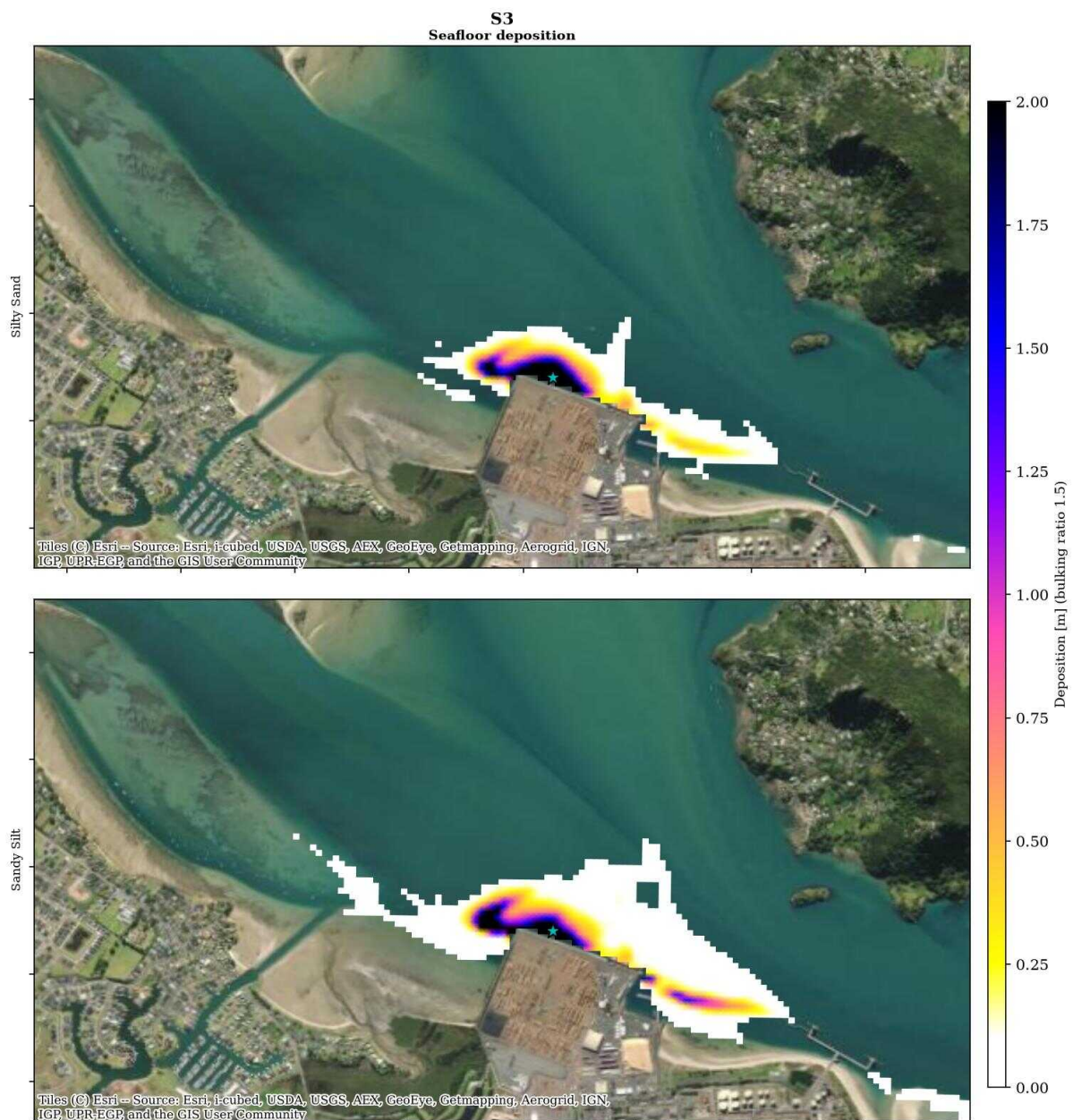


Figure 105 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

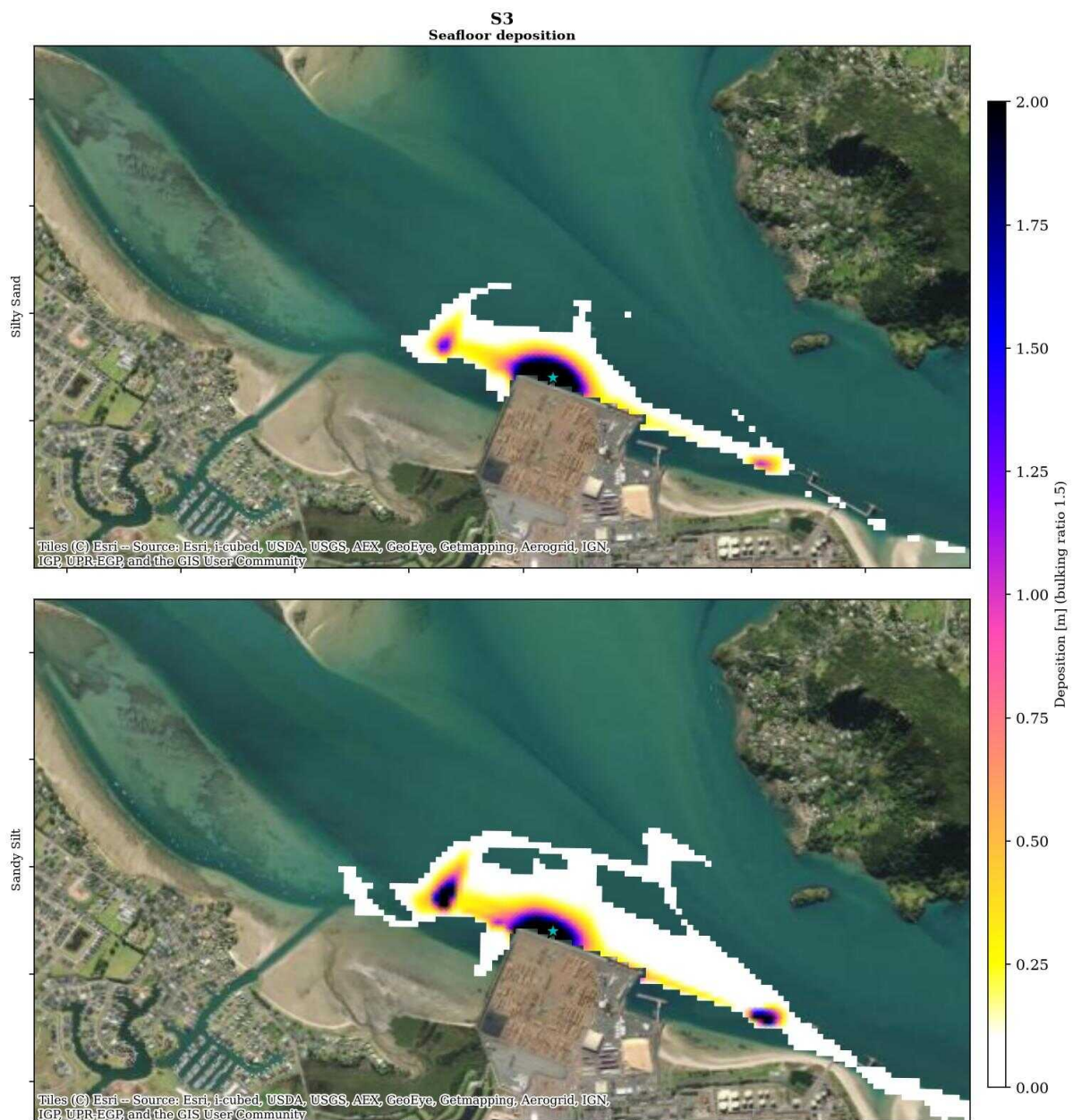


Figure 106 Final cumulative **sediment deposition thickness (m)** for **TSHD dredging at site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

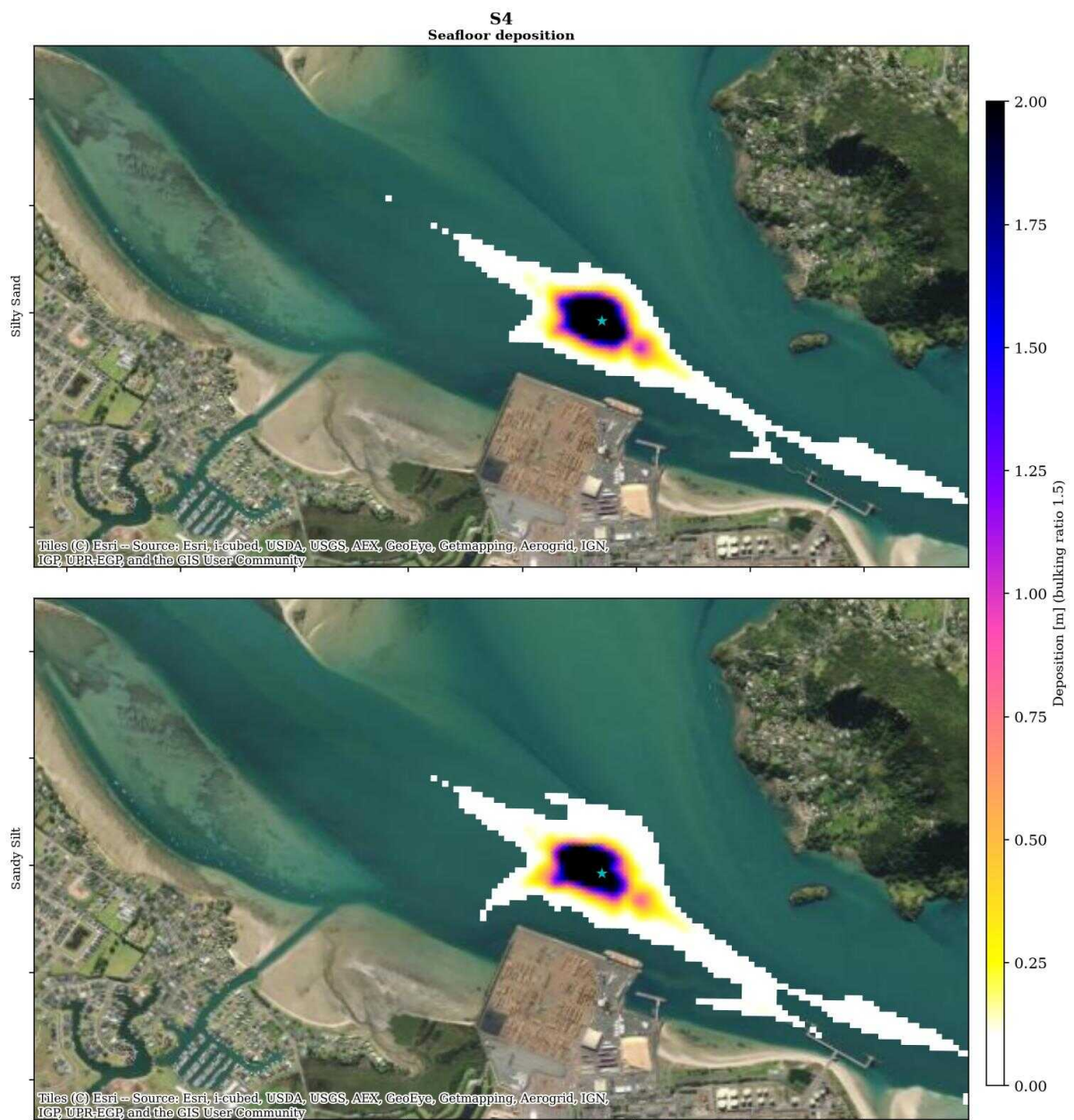


Figure 107 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

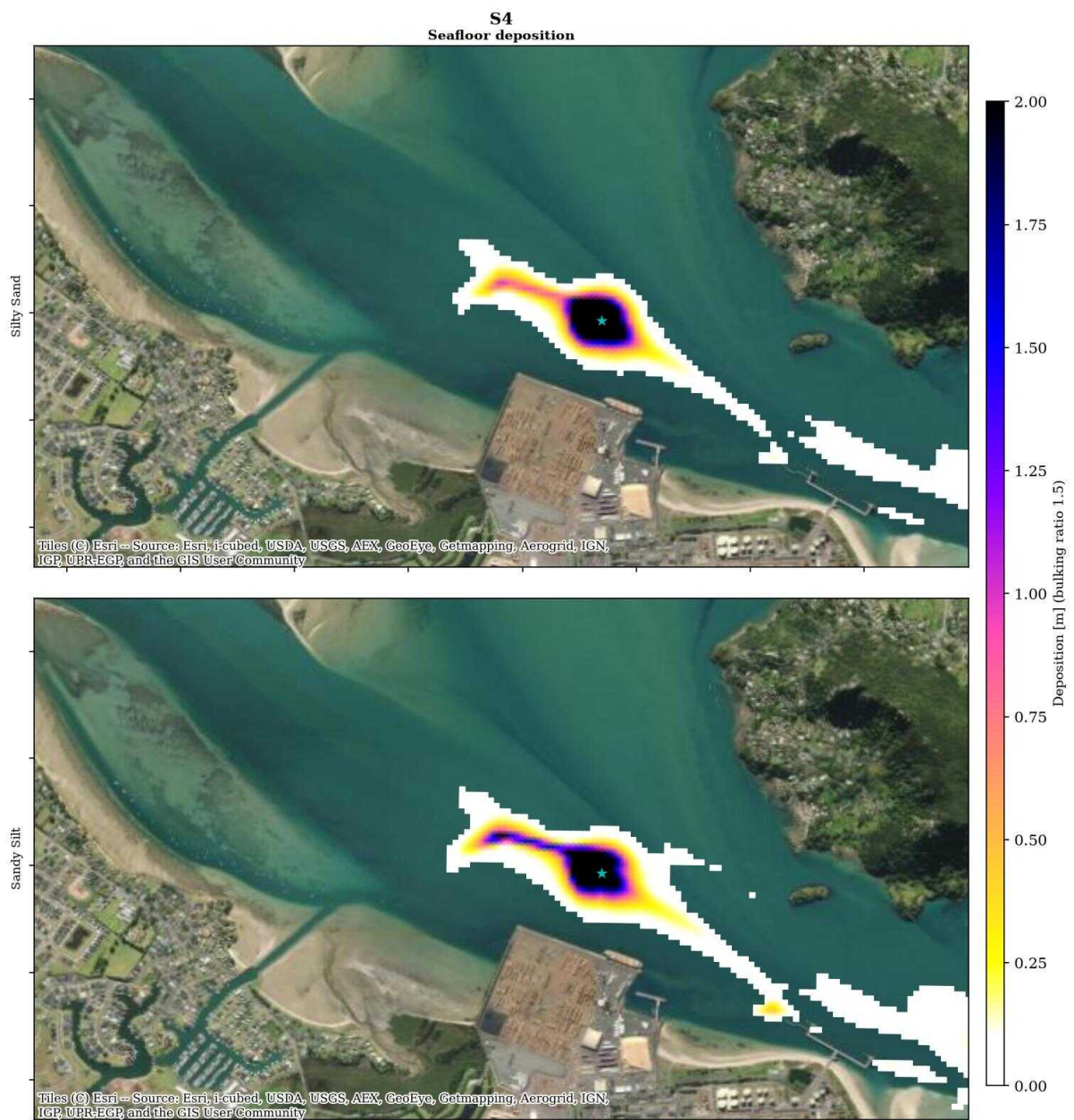


Figure 108 Final cumulative **sediment deposition thickness (m)** for **TSHD dredging at site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

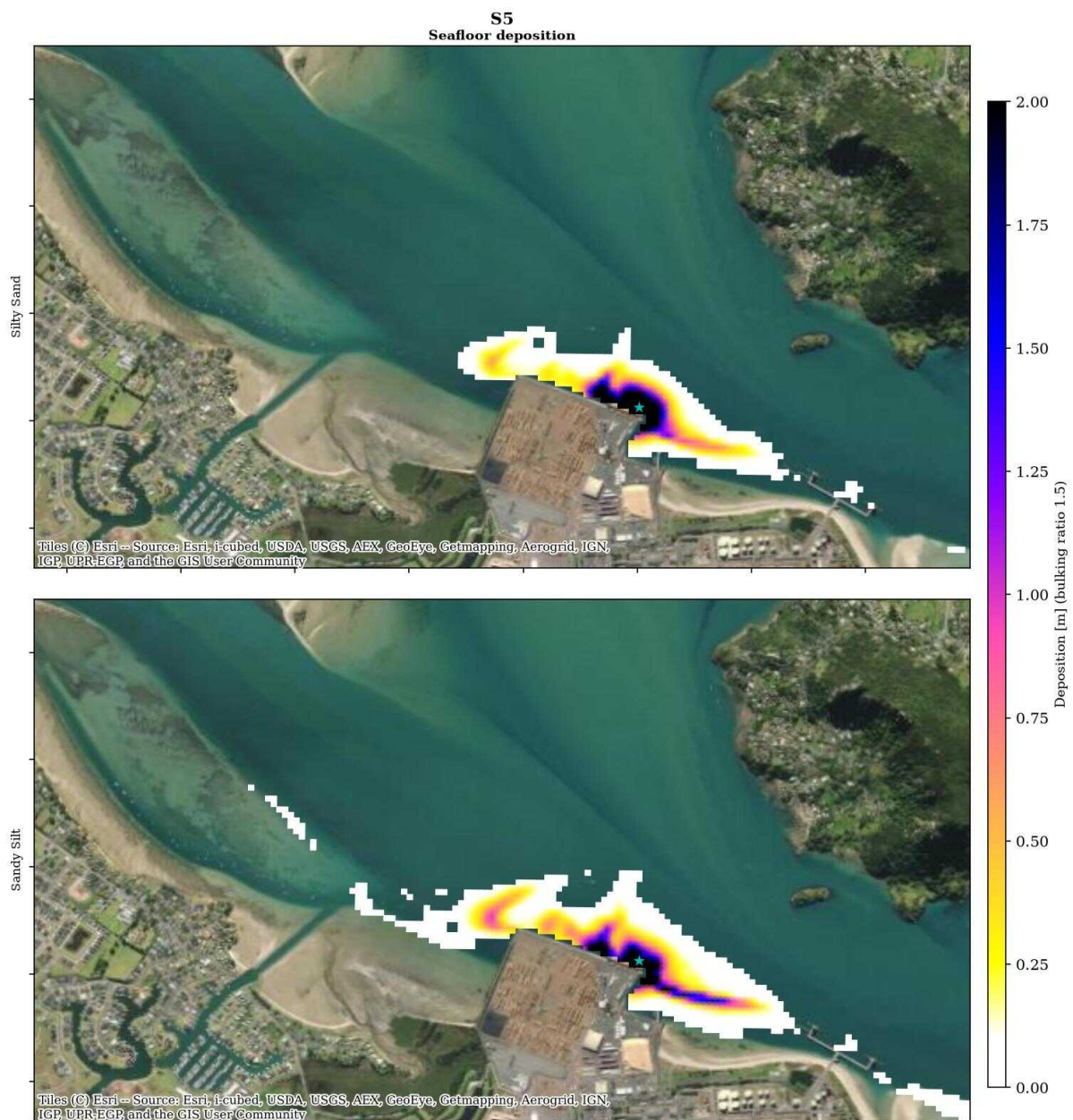


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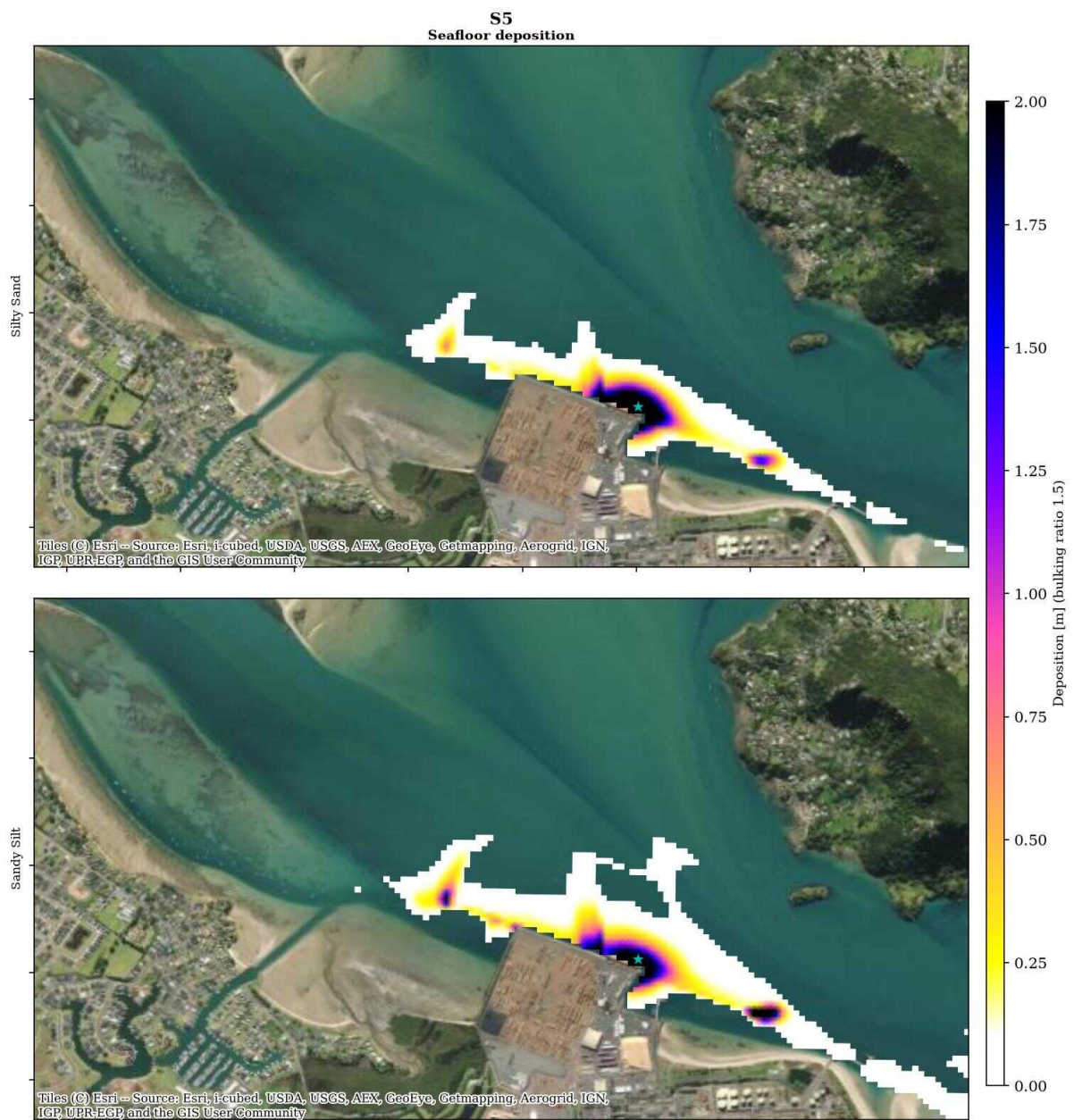


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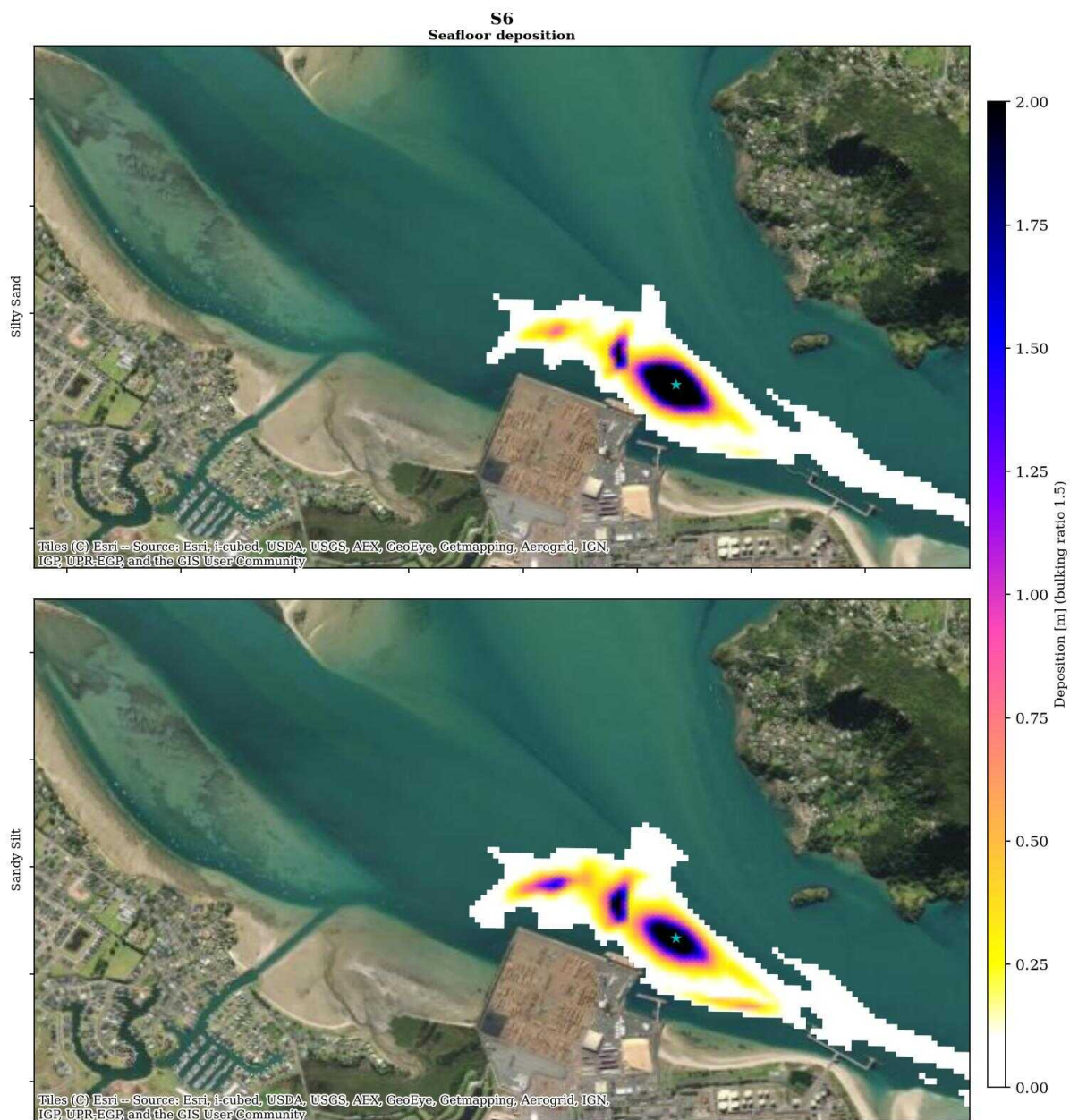


Figure 111 Final cumulative **sediment deposition thickness (m)** for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the silty sand on the top panel and sandy silt on the bottom panel. Deposition thickness was masked below 1 mm.

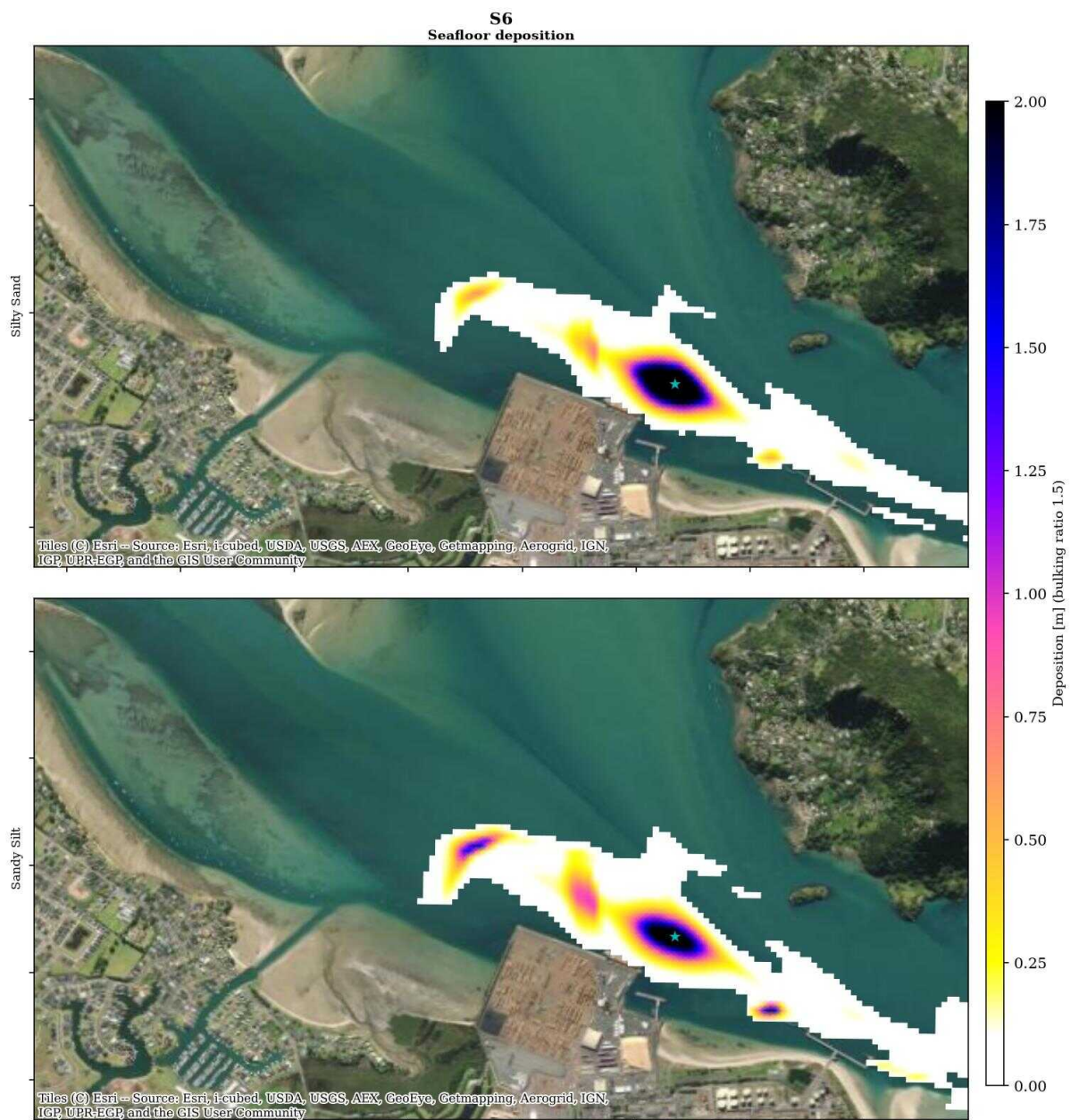


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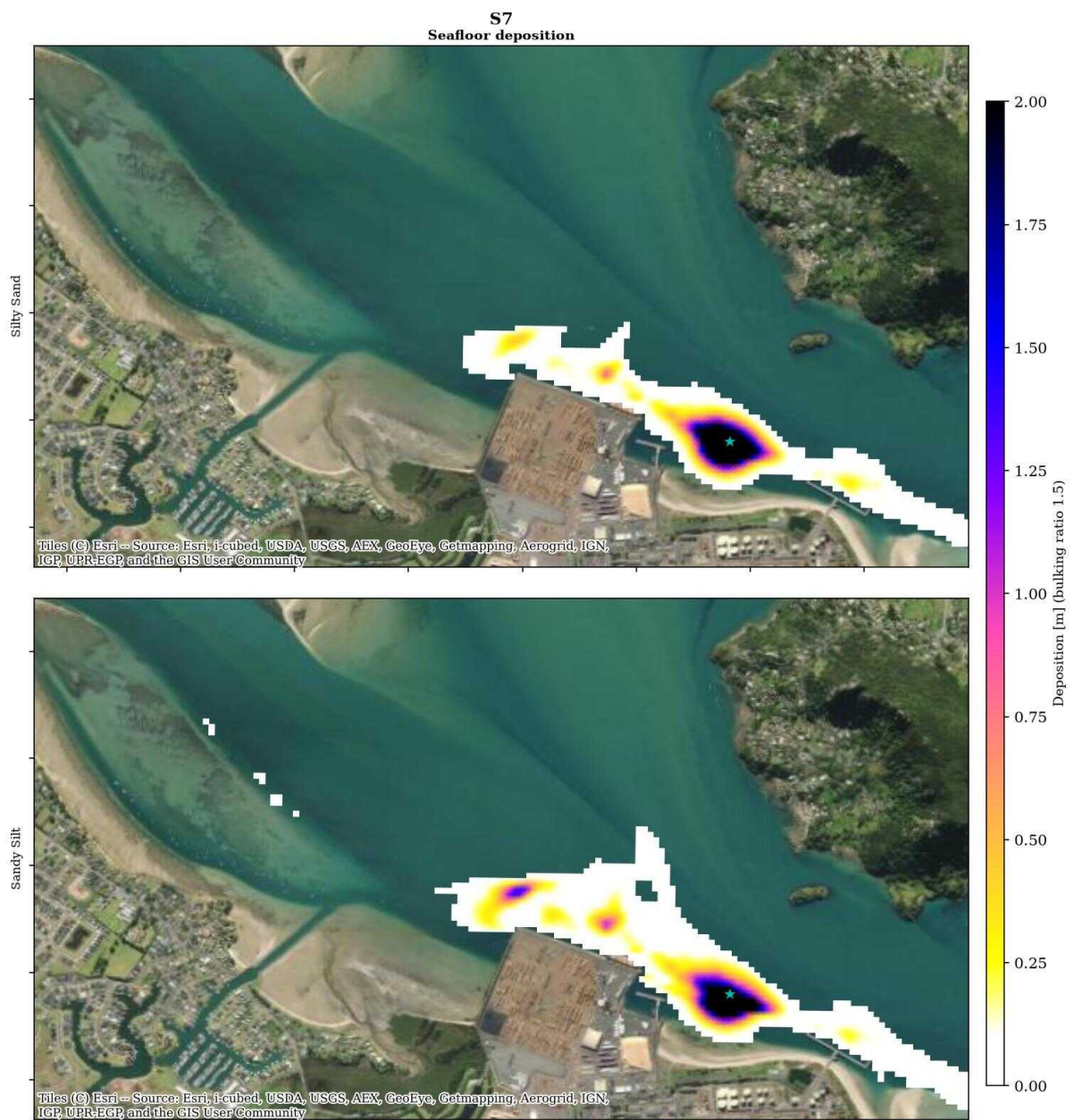


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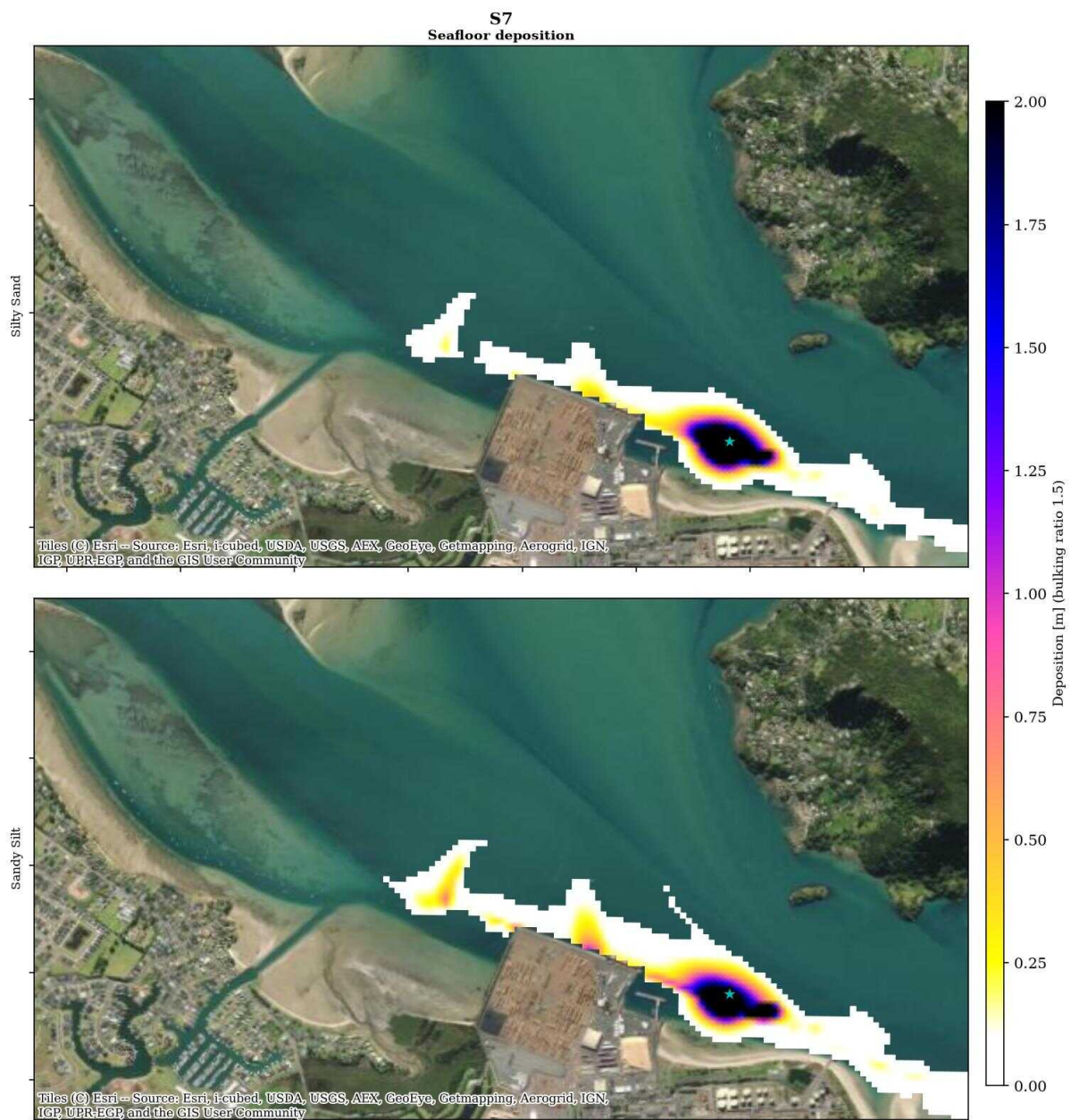


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Dredge Plume Modelling

Dredging sediment plume dispersion over existing
and proposed port configurations

Exceedance plots

(Design July 2026)

Appendix B
August 2026

Document History

Versions

Version	Revision Date	Summary	Reviewed by
0.1	21/07/2026	Initial document created	Montaño
0.2	03/08/2026	Draft for internal review	Montaño

Distribution

Version	Date	Distribution
1.0	07/08/2026	FINAL - MBIE Project team

Document ID: P0678 – 09 – Appendix B

Authors

Montaño M.

Contributors

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Figure 62	Percentage of time total suspended sediment concentrations (mg L^{-1}) are above thresholds of 2, 5, and 10 mg L^{-1} (left to right), at surface, mid water and nearbed levels (top to bottom) for TSHD dredging at site 4 , over the existing bathymetry . Results are shown for the silty sand . Results were masked below 1%.	76
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	Eastern Reclamation and NSDF bathymetry. Results are shown for the sandy silt . Results were masked below 1%.	77
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	bathymetry. Results are shown for the silty sand . Results were masked below 1%.	84
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Figure 72	Percentage of time total suspended sediment concentrations (mg L^{-1}) are above thresholds of 2, 5, and 10 mg L^{-1} (left to right), at surface, mid water and nearbed levels (top to bottom) for TSHD dredging at site 6 , over the proposed Eastern Reclamation and NSDF bathymetry . Results are shown for the silty sand . Results were masked below 1%.	86
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Appendix B: Additional Figures



BHD exceedance plots

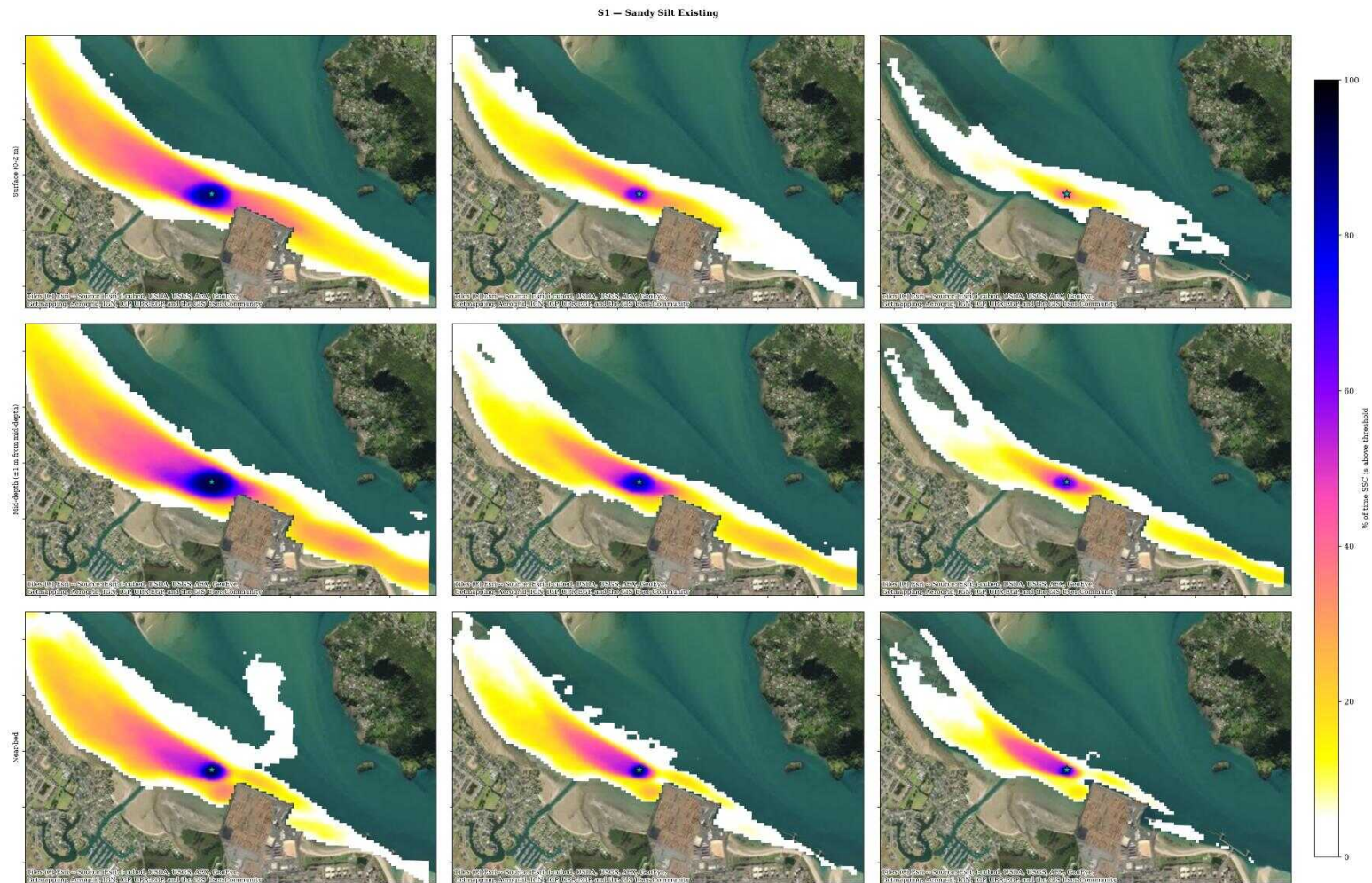


Figure 1 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 – Silty Sand Existing



Figure 2 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S1 — Sandy Silt Proposed East West



Figure 3 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 — Silty Sand Proposed East West

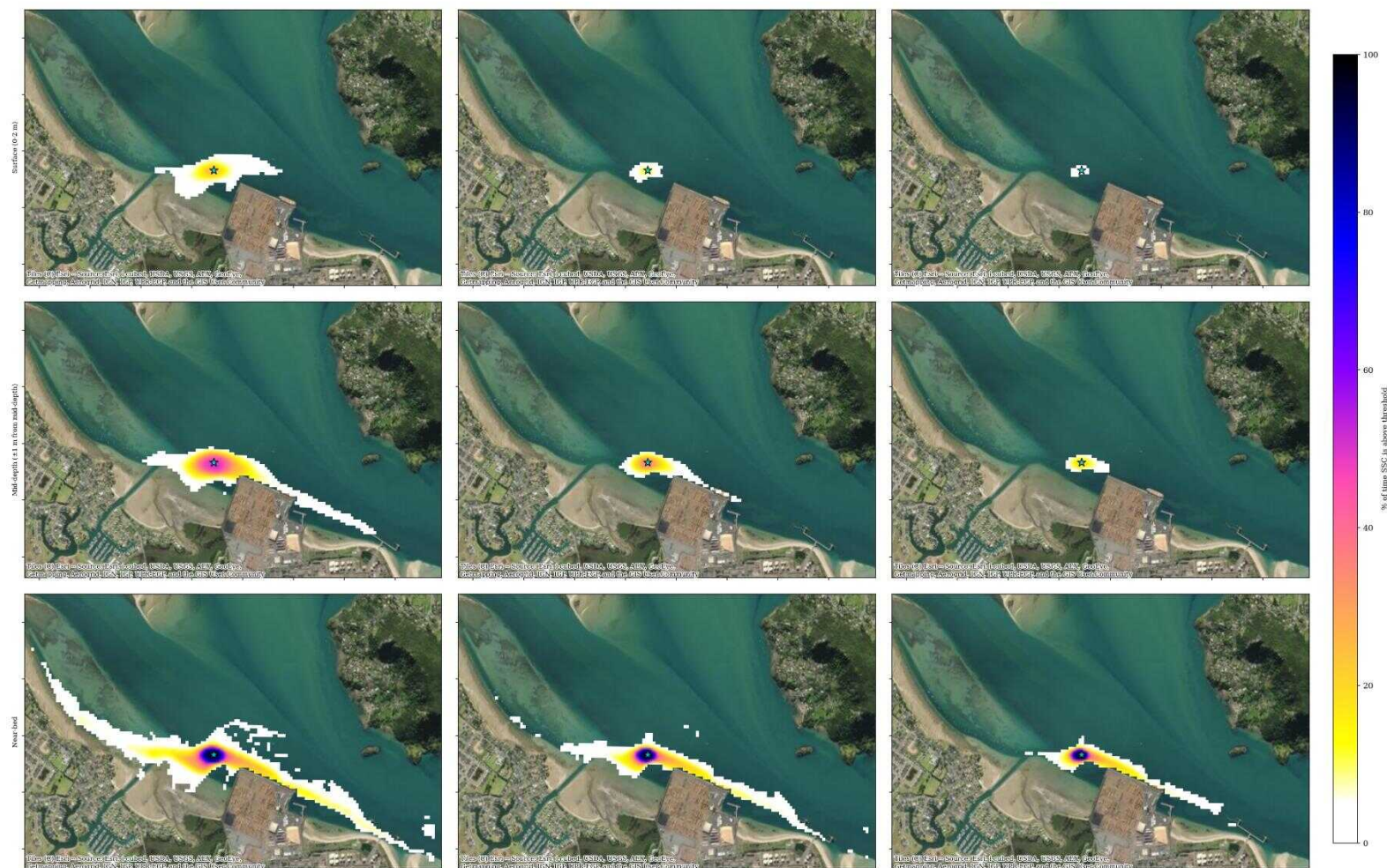


Figure 4 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S1 — Sandy Silt Proposed West Only

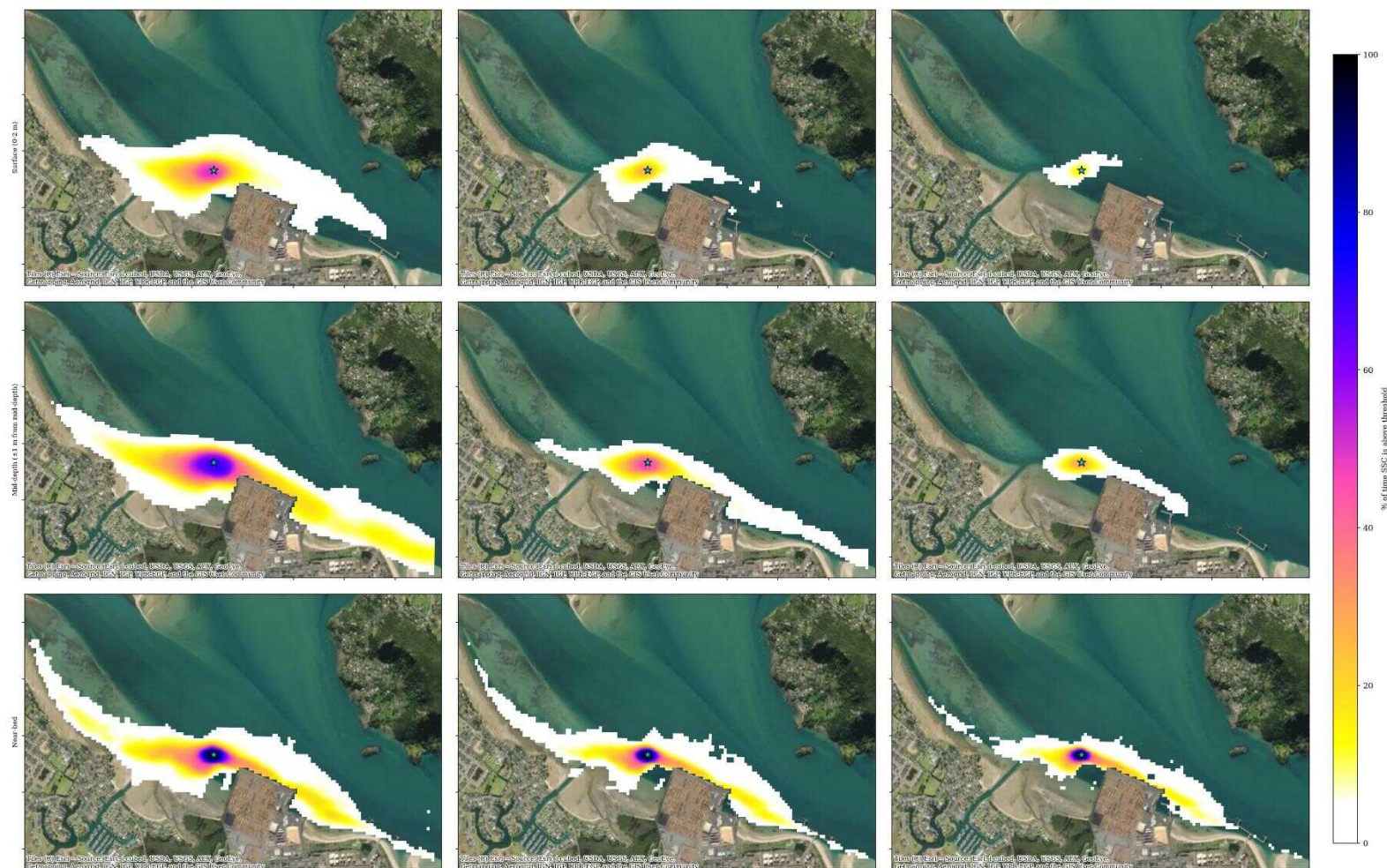


Figure 5 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 — Silty Sand Proposed West Only

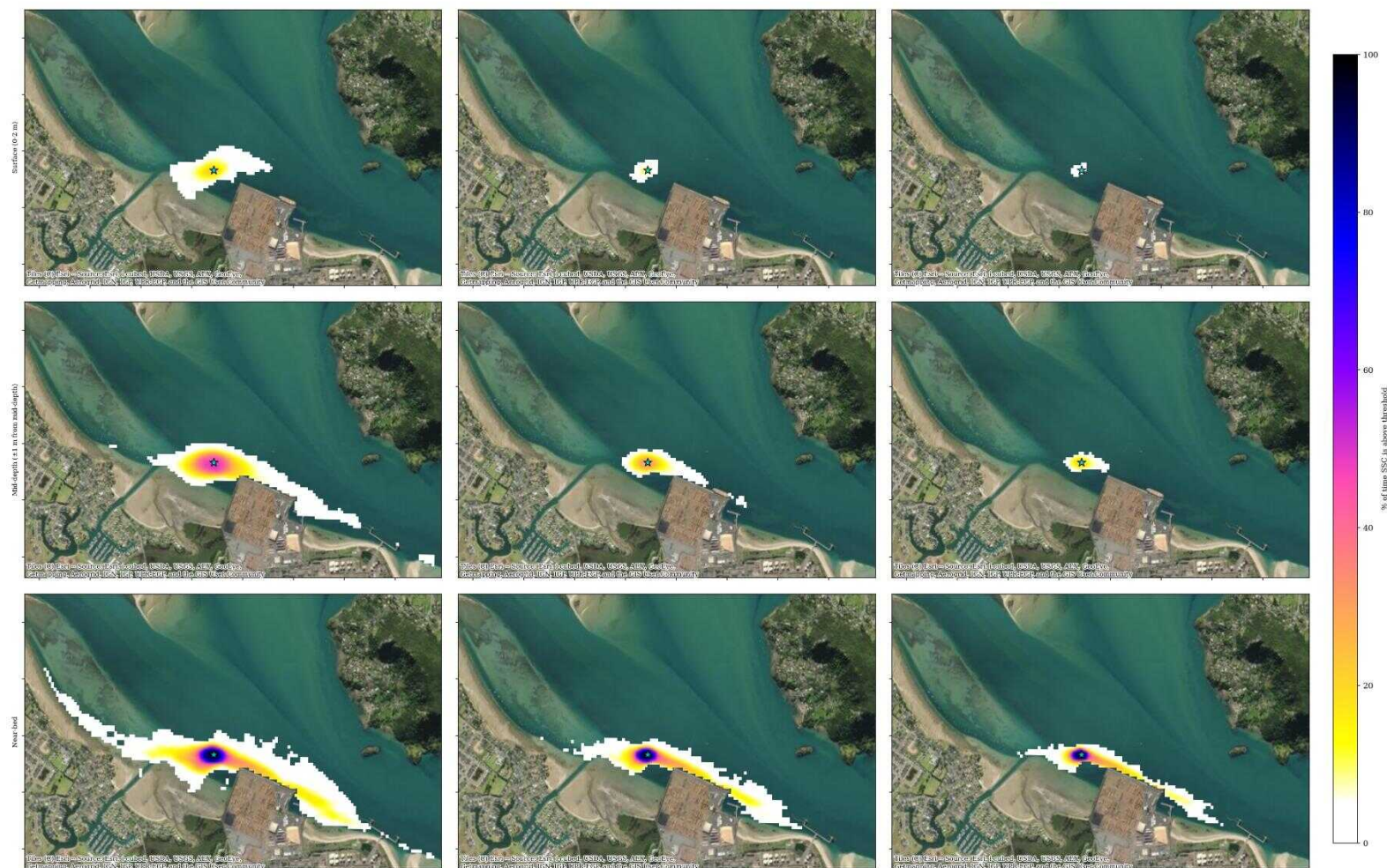


Figure 6 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S2 — Sandy Silt Existing

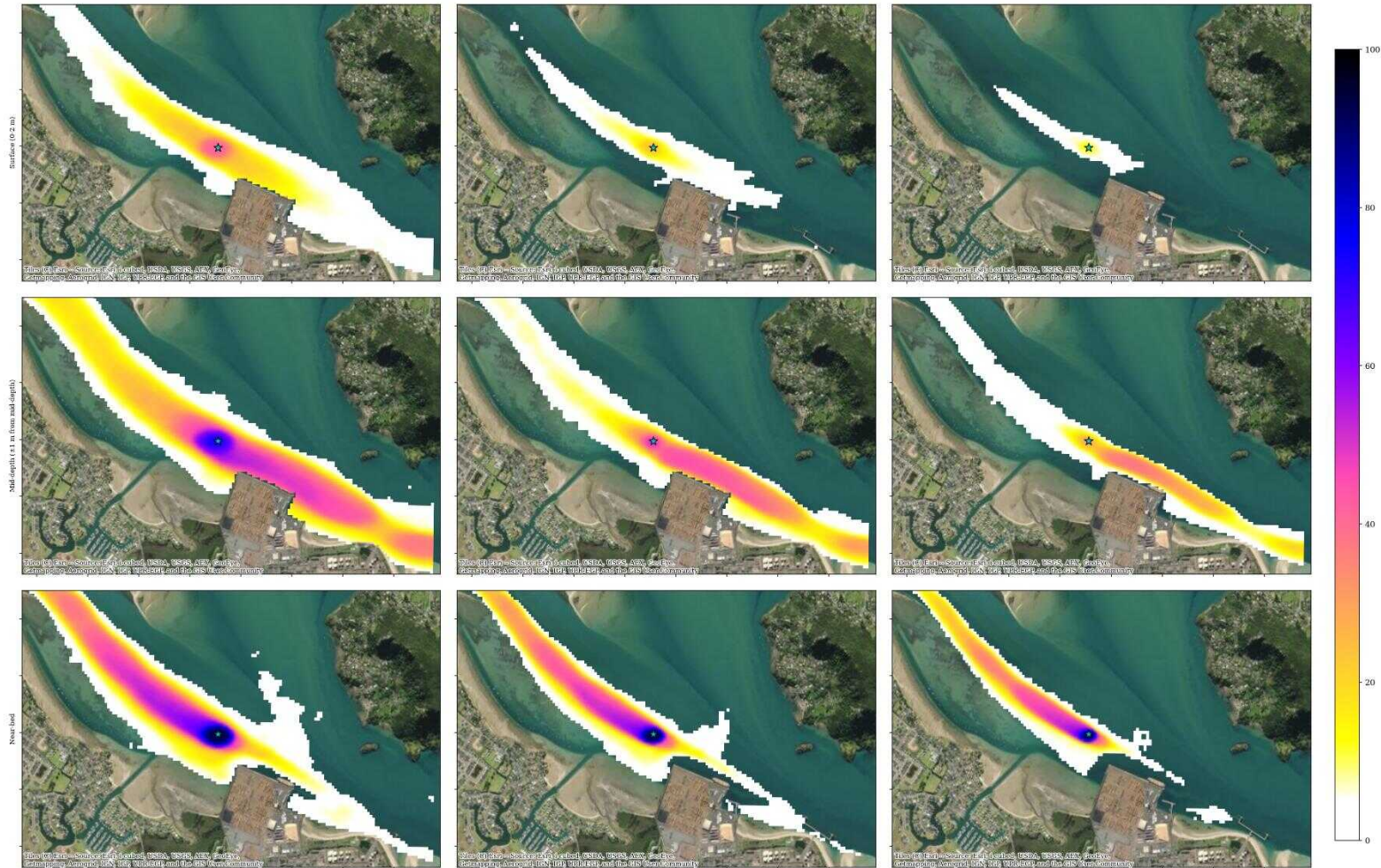


Figure 7 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S2 — Silty Sand Existing



Figure 8 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S2 — Sandy Silt Proposed East West

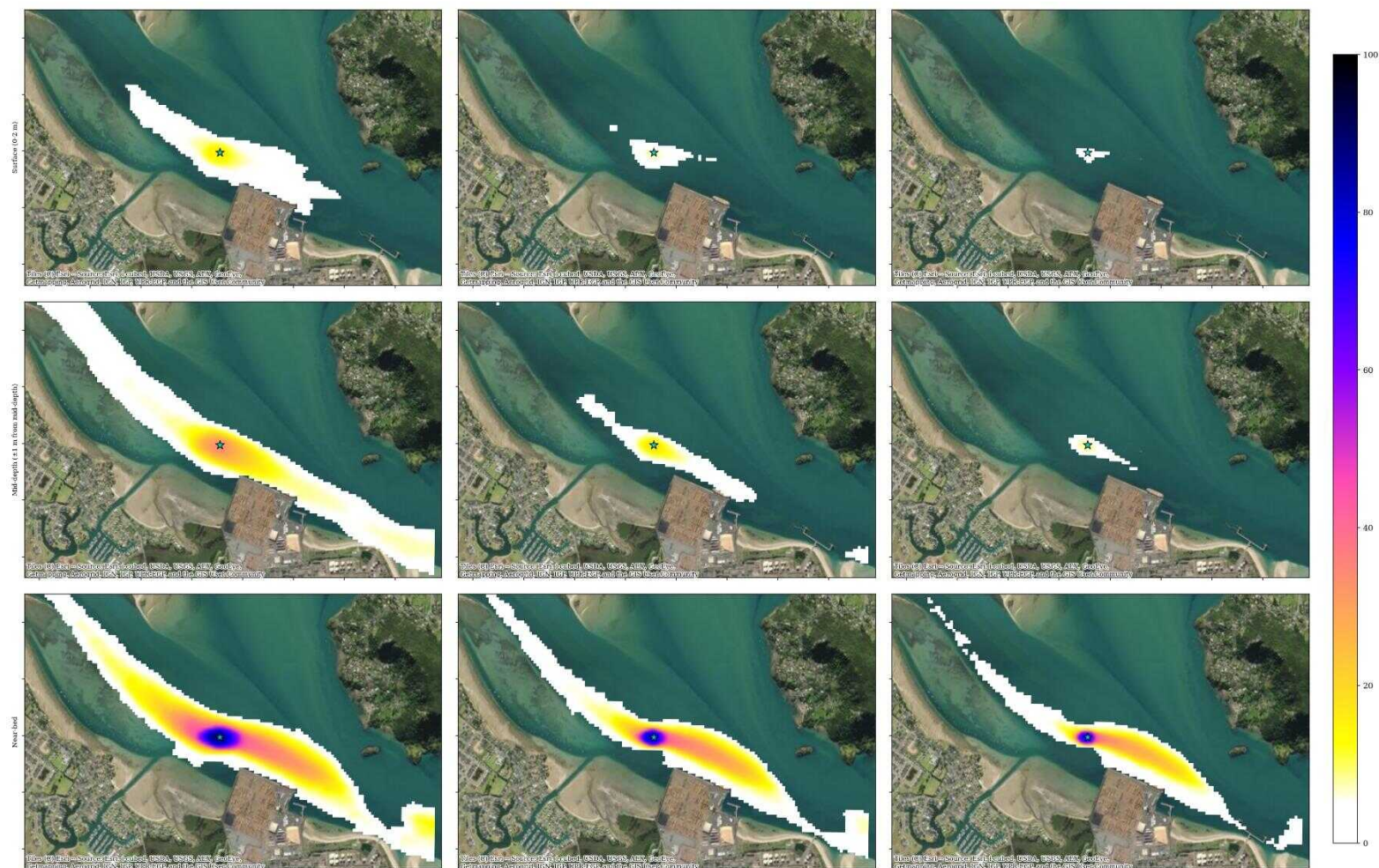


Figure 9 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S2 — Silty Sand Proposed East West



Figure 10 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S2 — Sandy Silt Proposed West Only

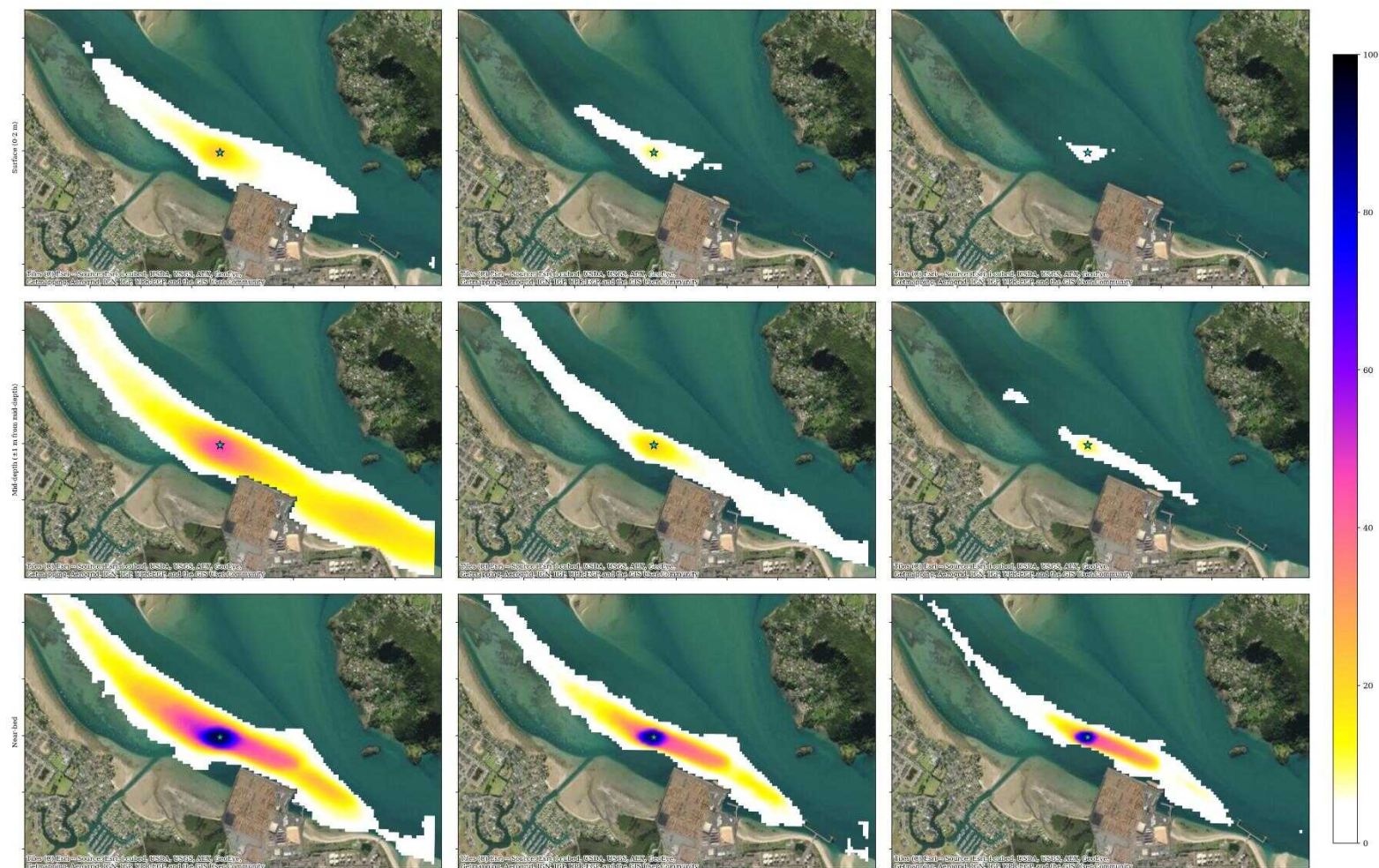


Figure 11 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S2 — Silty Sand Proposed West Only



Figure 12 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S3 — Sandy Silt Existing

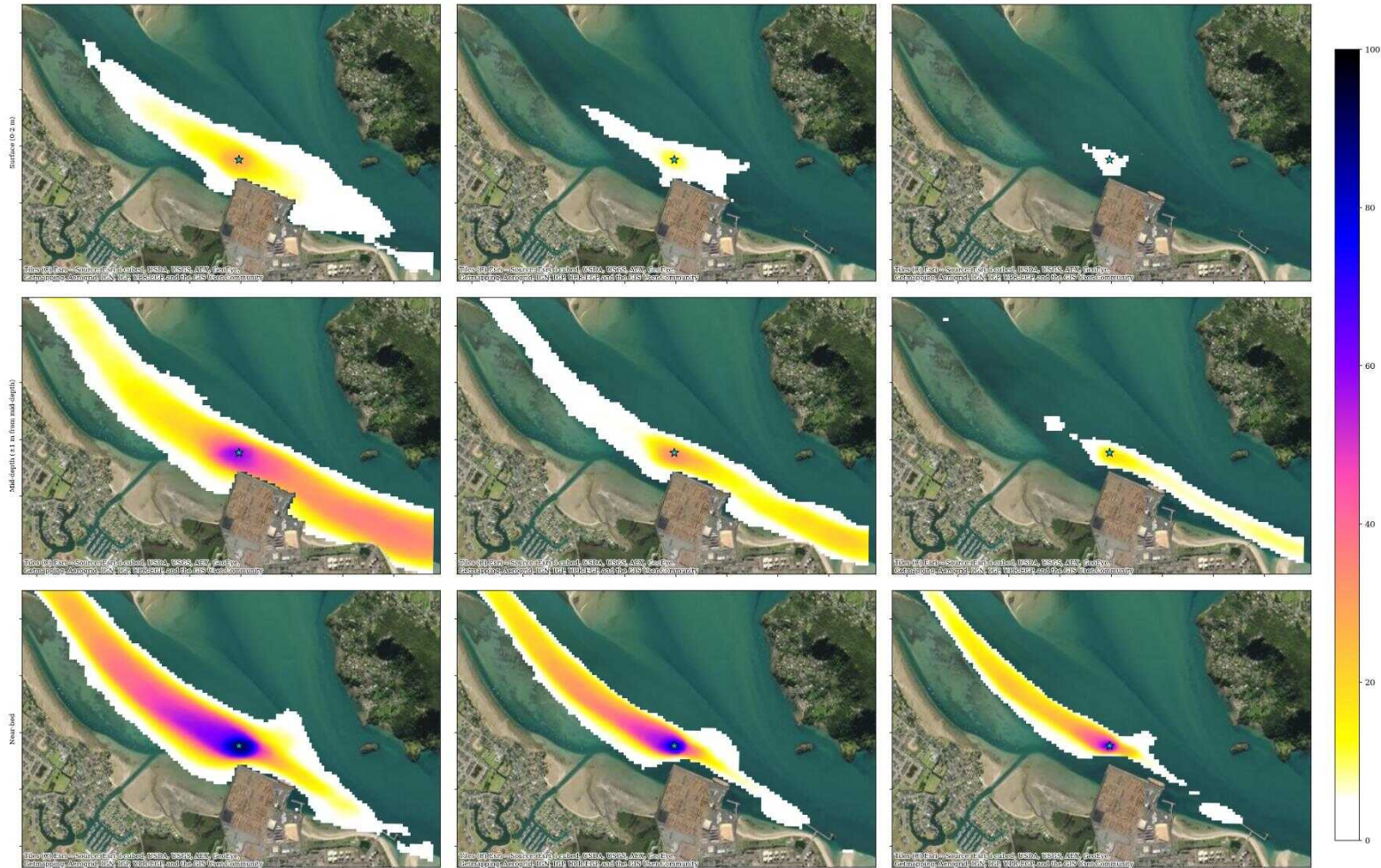


Figure 13 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S3 – Silty Sand Existing

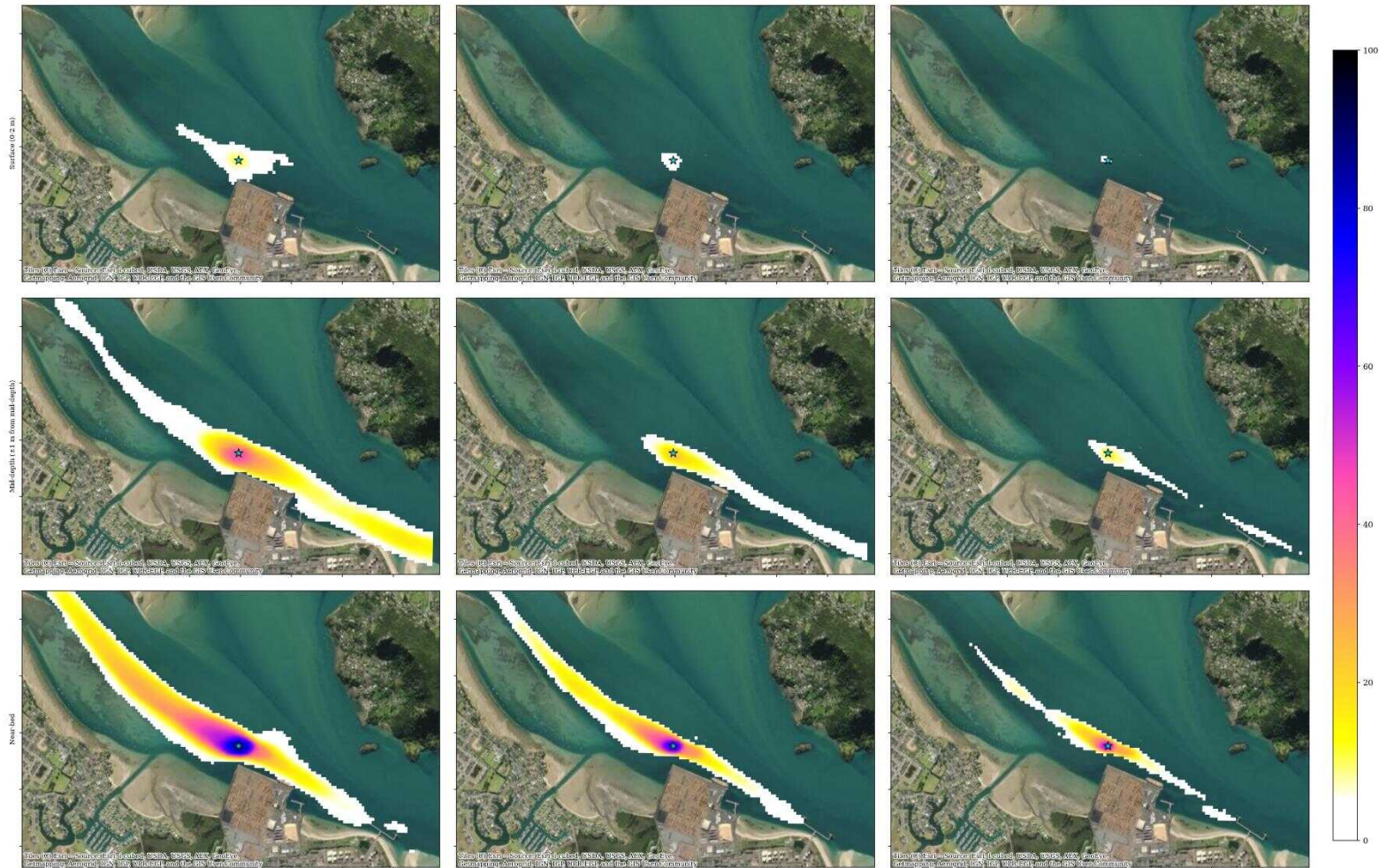


Figure 14 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S3 — Sandy Silt Proposed East West



Figure 15 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S3 — Silty Sand Proposed East West



Figure 16 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S3 — Sandy Silt Proposed West Only

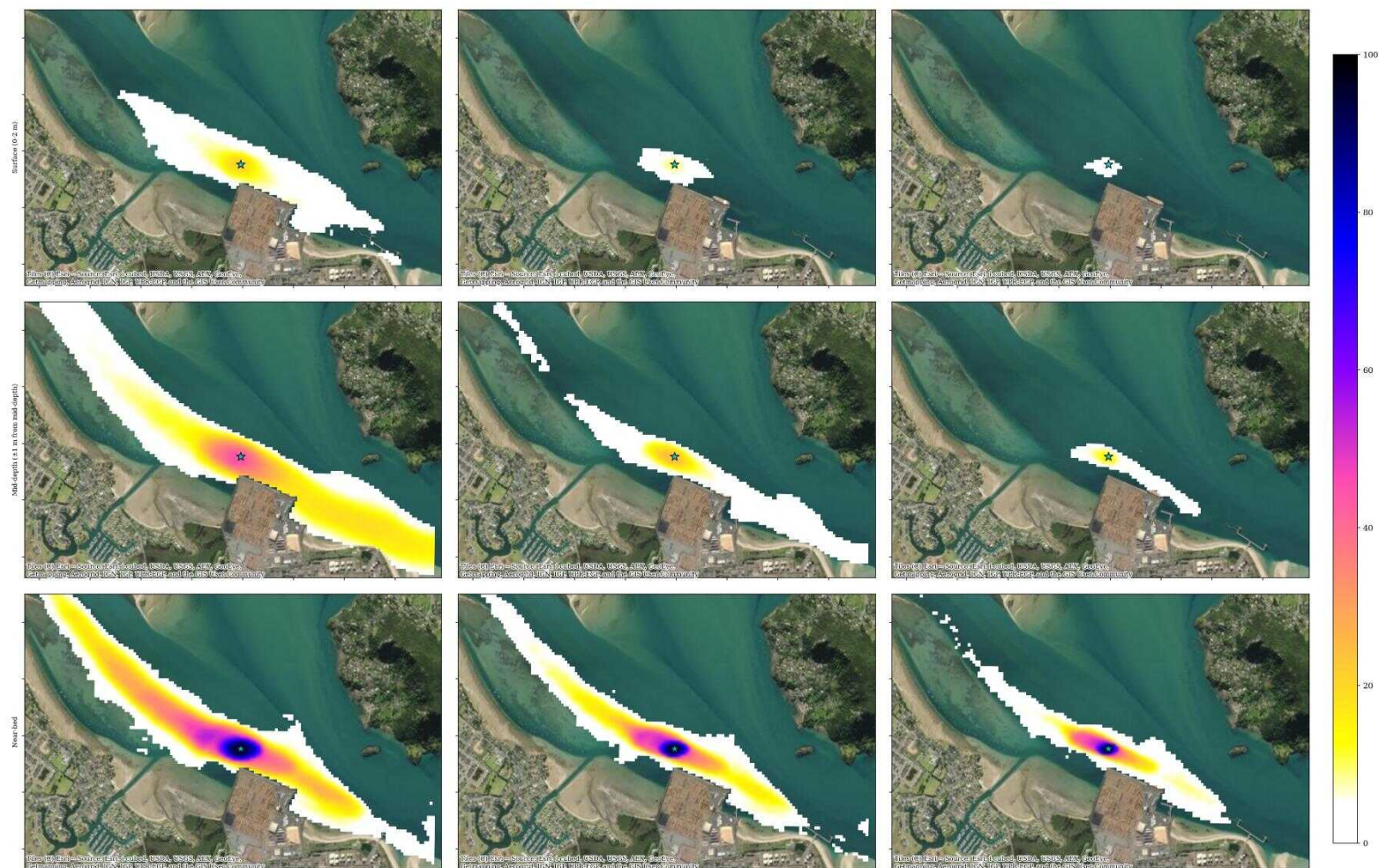


Figure 17 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S3 — Silty Sand Proposed West Only



Figure 18 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S4 — Sandy Silt Existing

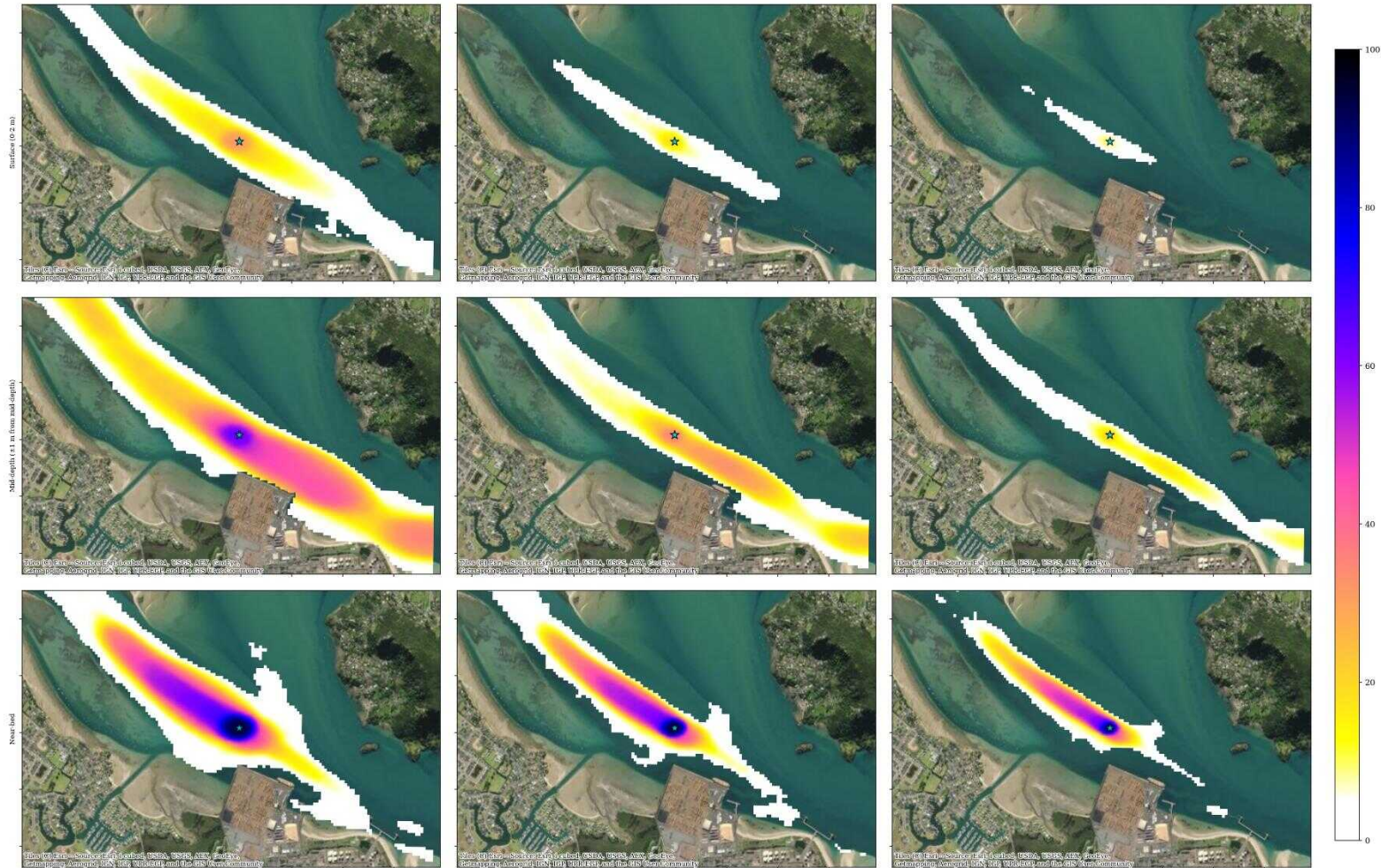


Figure 19 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S4 — Silty Sand Existing



Figure 20 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S4 — Sandy Silt Proposed East West

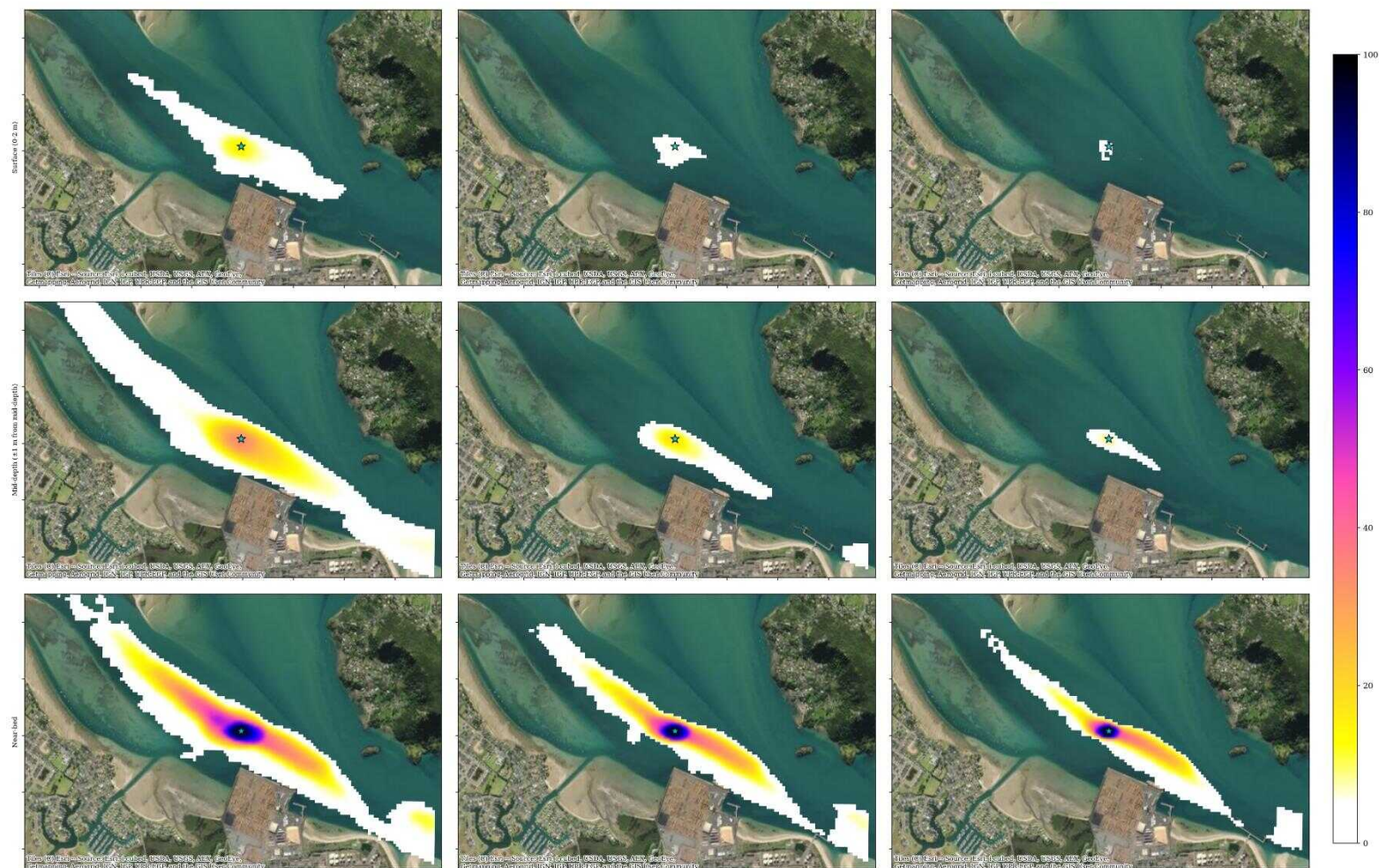


Figure 21 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S4 — Silty Sand Proposed East West

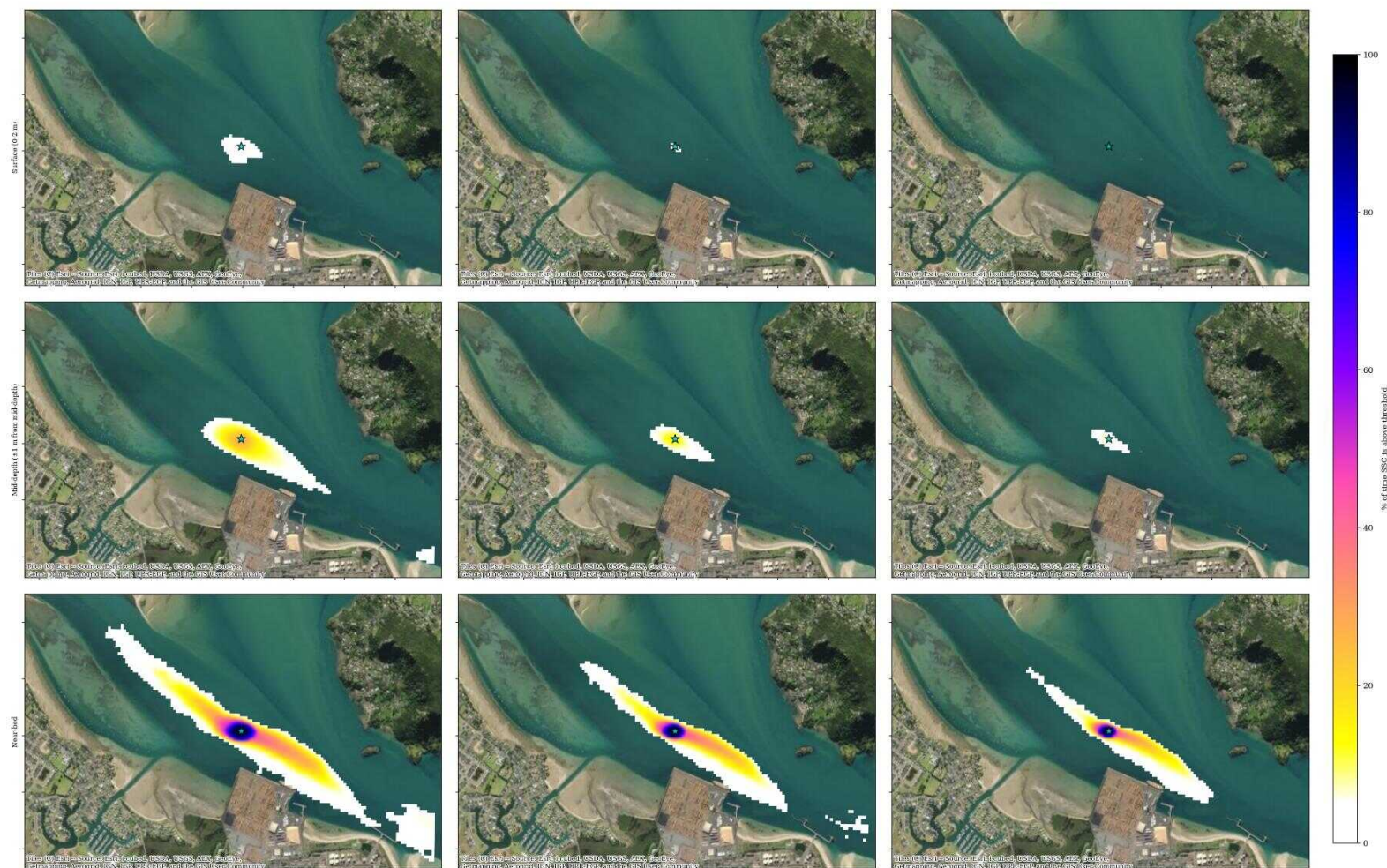


Figure 22 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S4 — Sandy Silt Proposed West Only

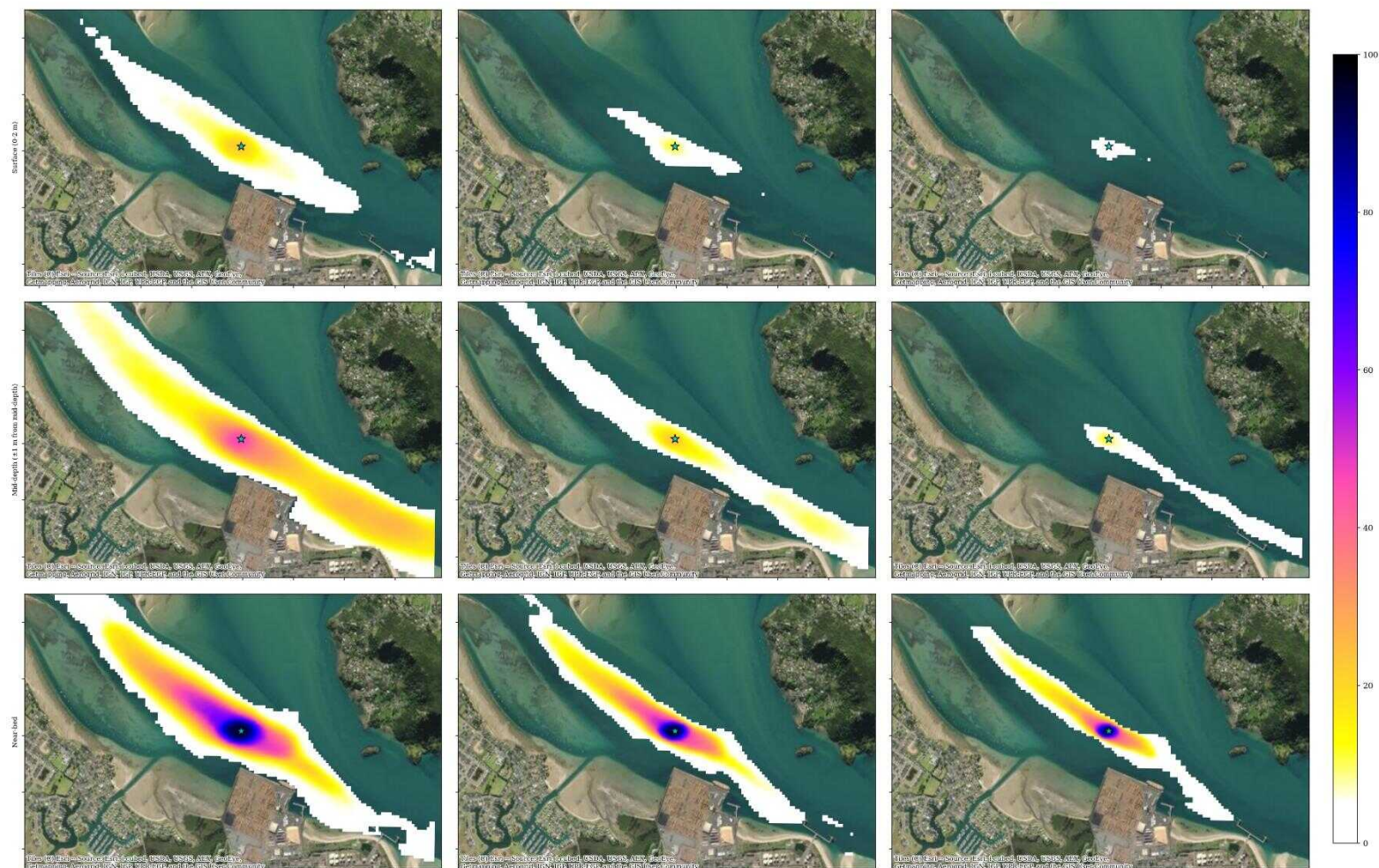


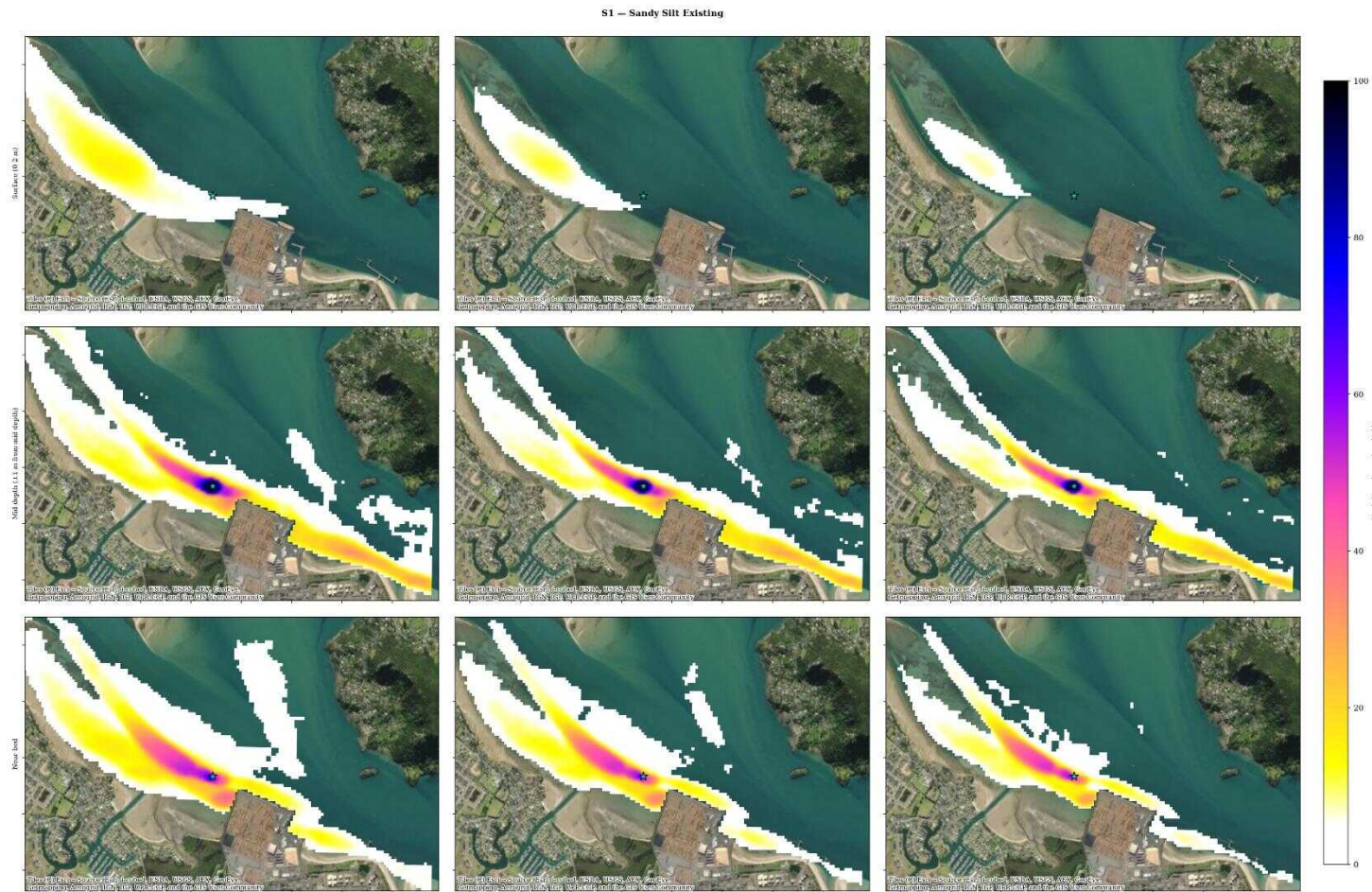
Figure 23 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S4 — Silty Sand Proposed West Only



Figure 24 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **BHD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

CSD exceedance plots



S1 — Silty Sand Existing

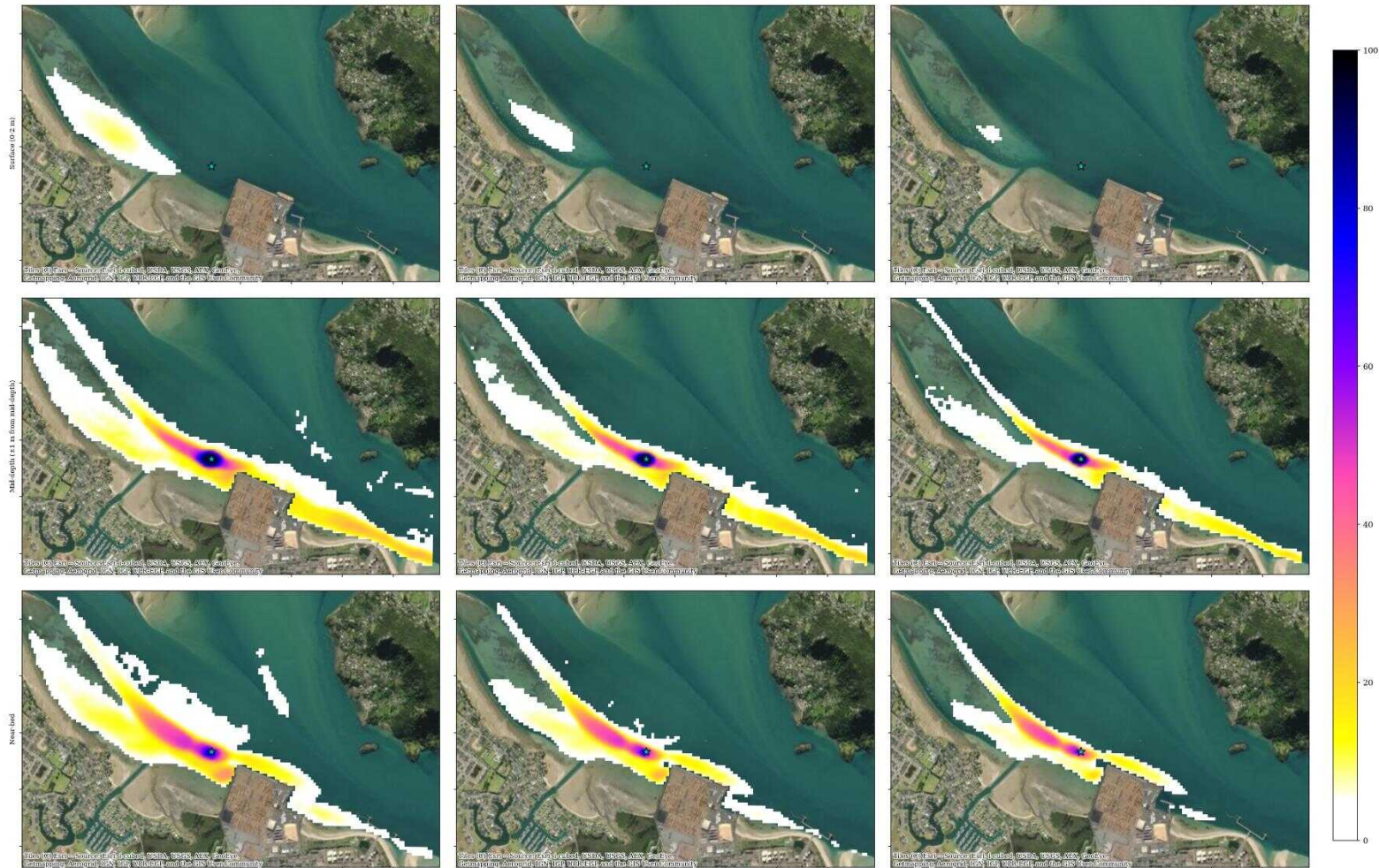


Figure 26 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 1**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S1 — Sandy Silt Proposed East West



Figure 27 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 — Silty Sand Proposed East West

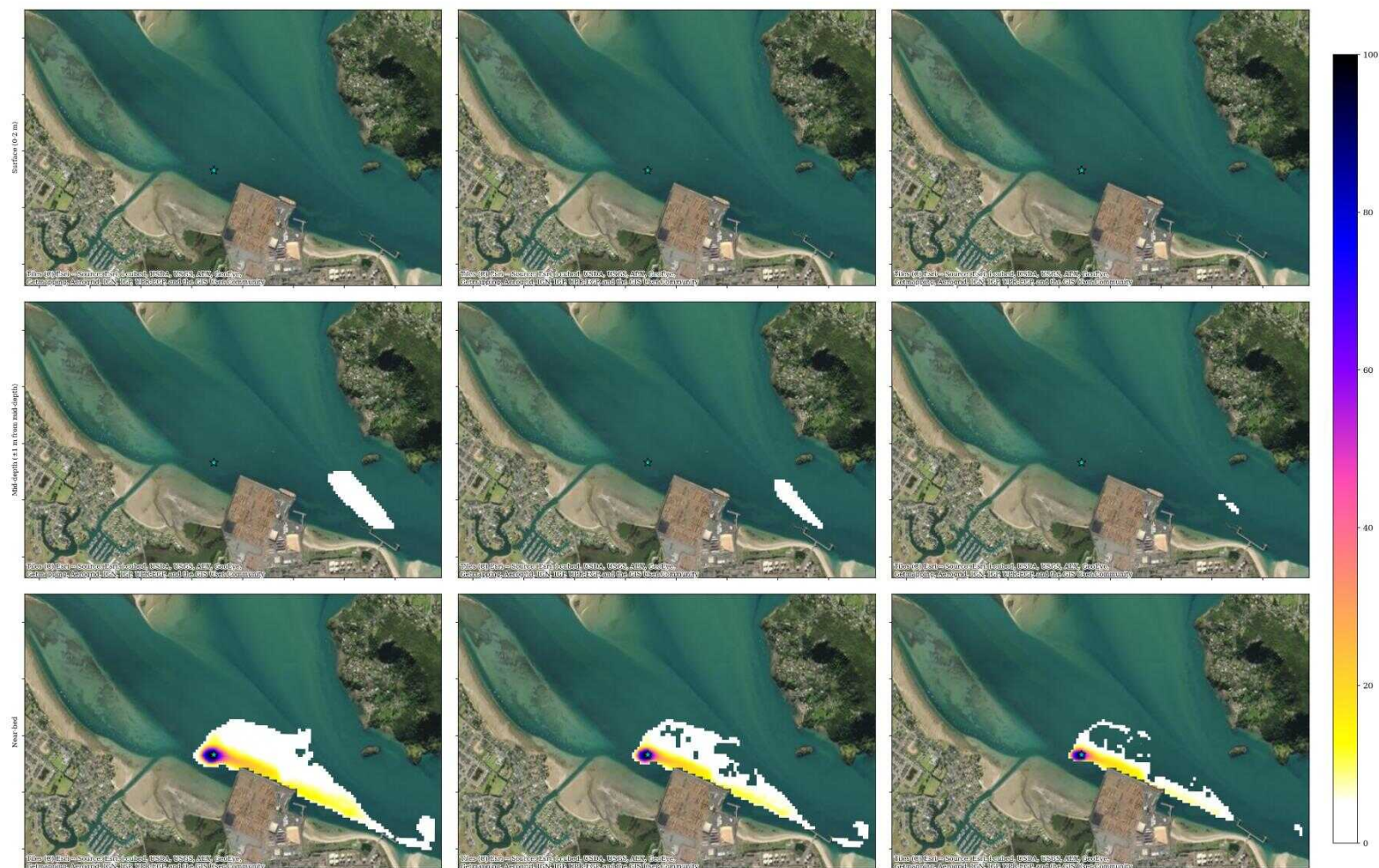


Figure 28 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 1**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S1 — Sandy Silt Proposed West Only

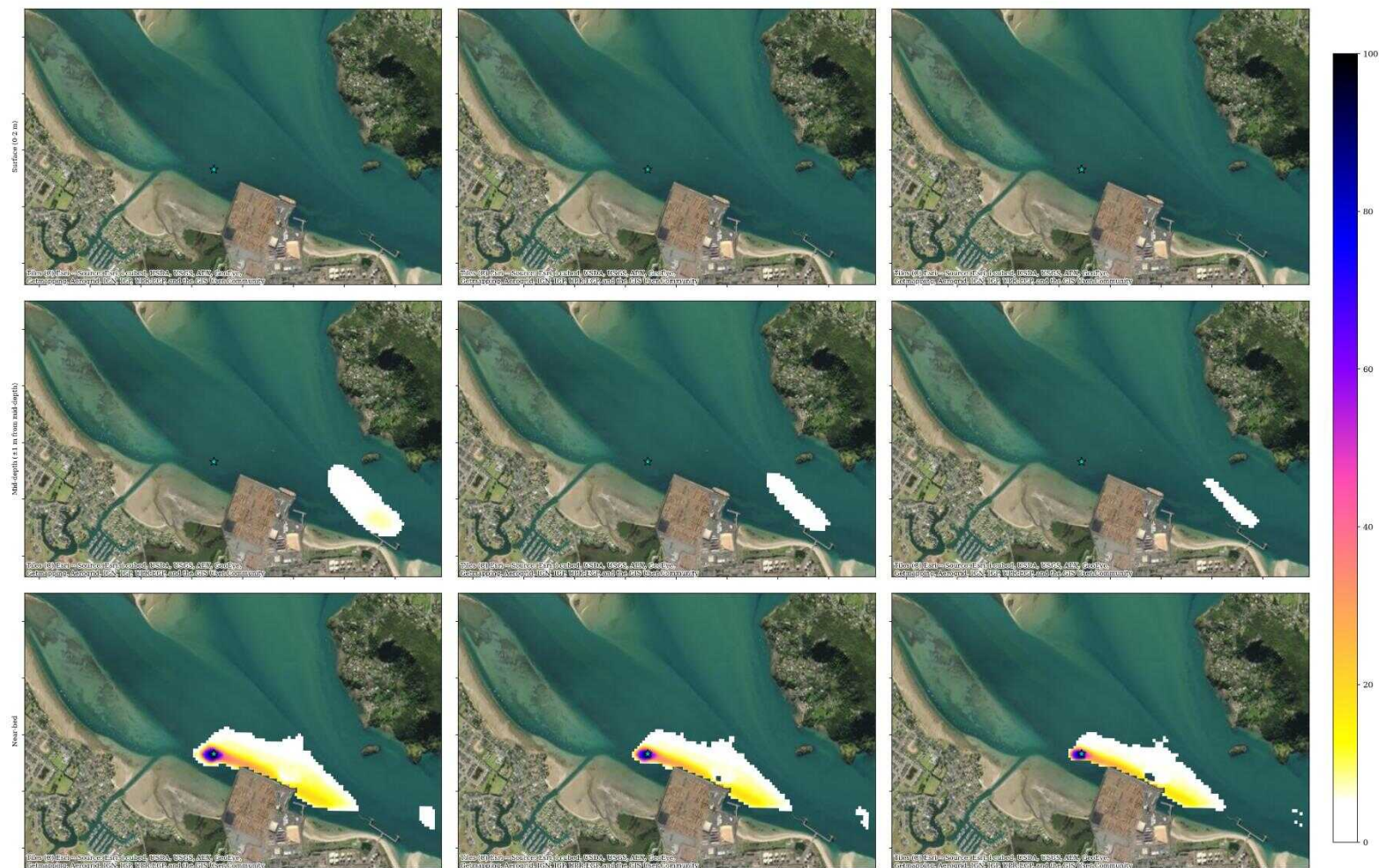


Figure 29 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S1 — Silty Sand Proposed West Only



Figure 30 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 1**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S2 — Sandy Silt Existing

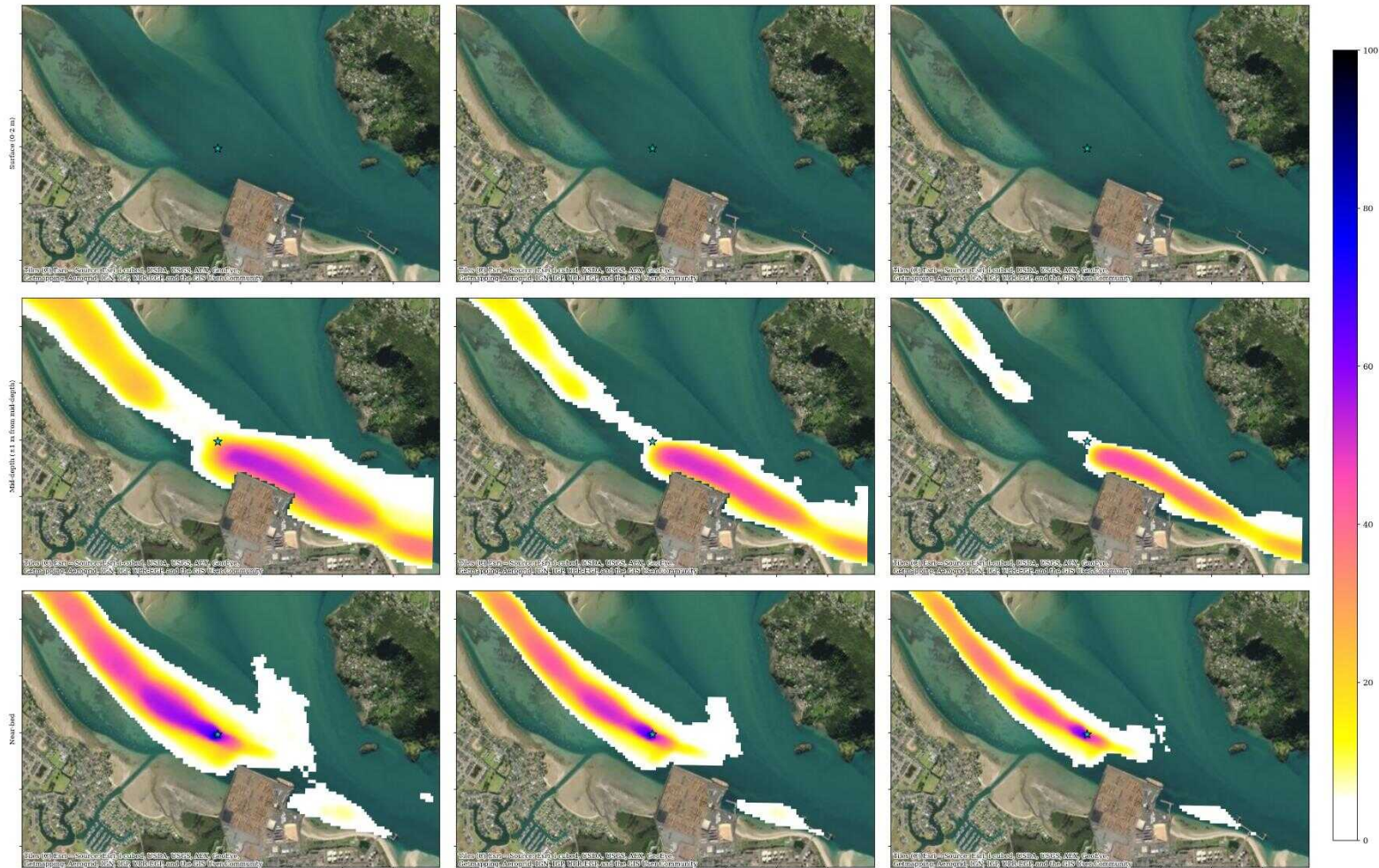


Figure 31 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 2**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S2 – Silty Sand Existing

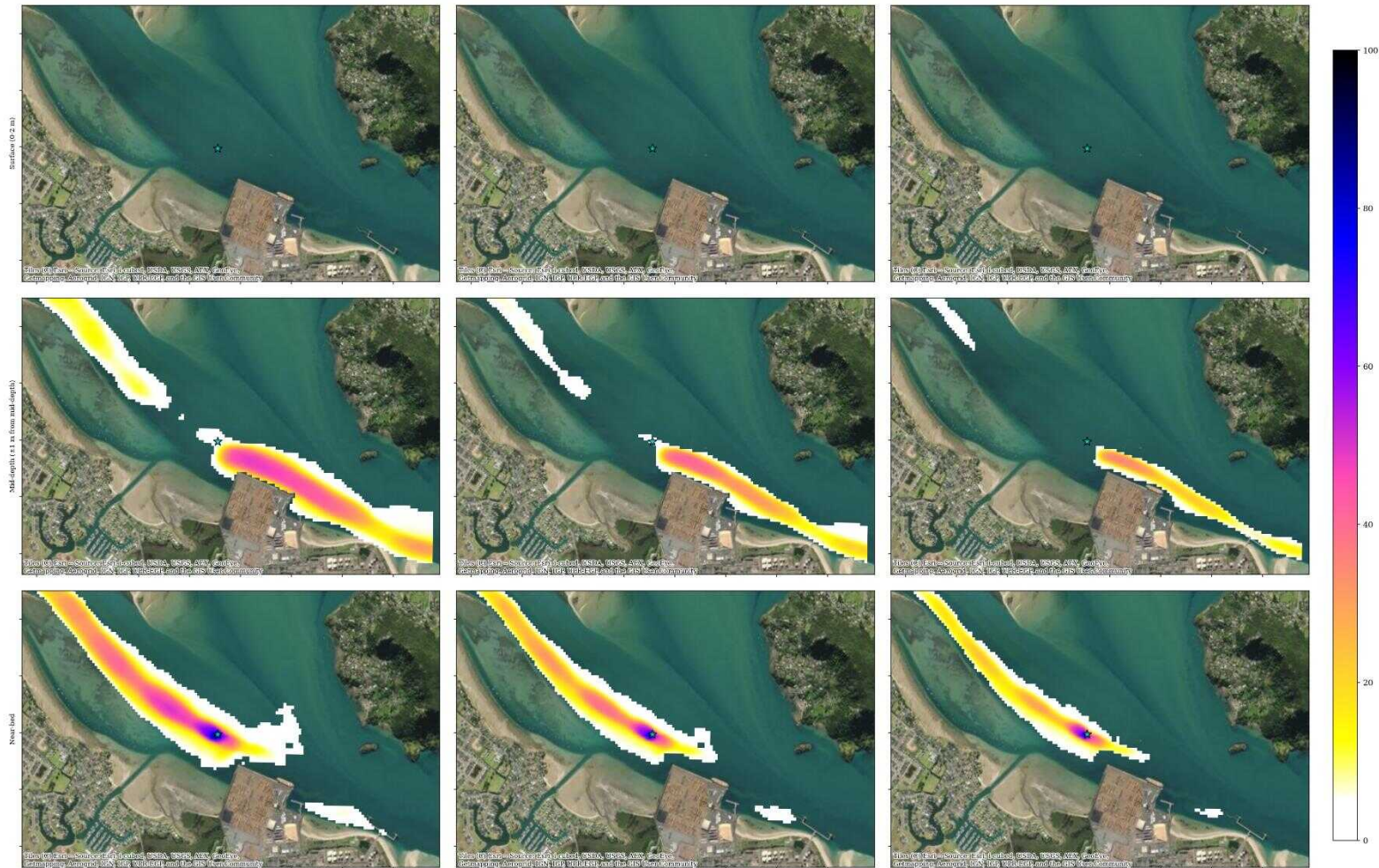


Figure 32 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 2**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S2 — Sandy Silt Proposed East West



Figure 33 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S2 — Silty Sand Proposed East West



Figure 34 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S2 — Sandy Silt Proposed West Only

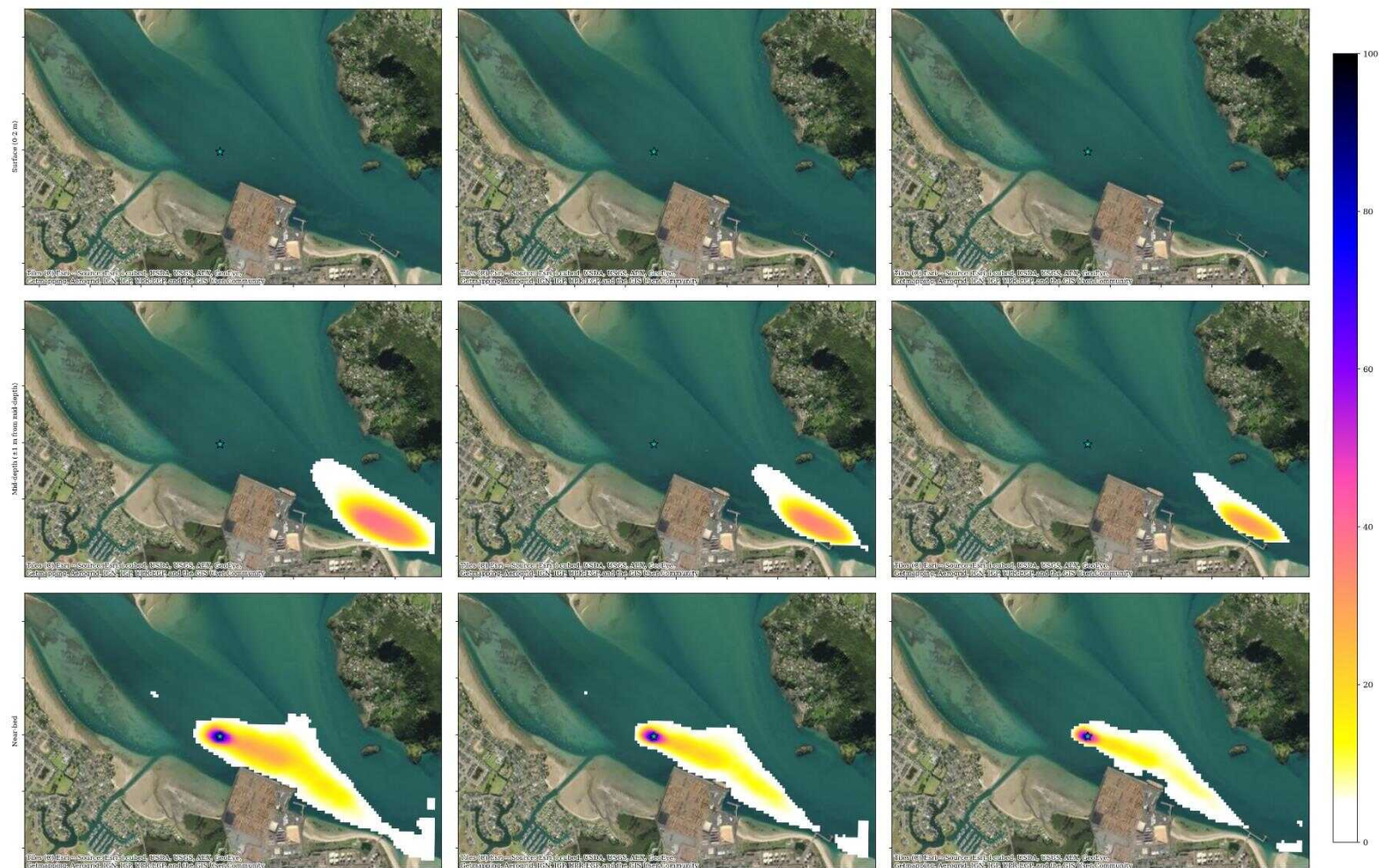


Figure 35 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S2 — Silty Sand Proposed West Only

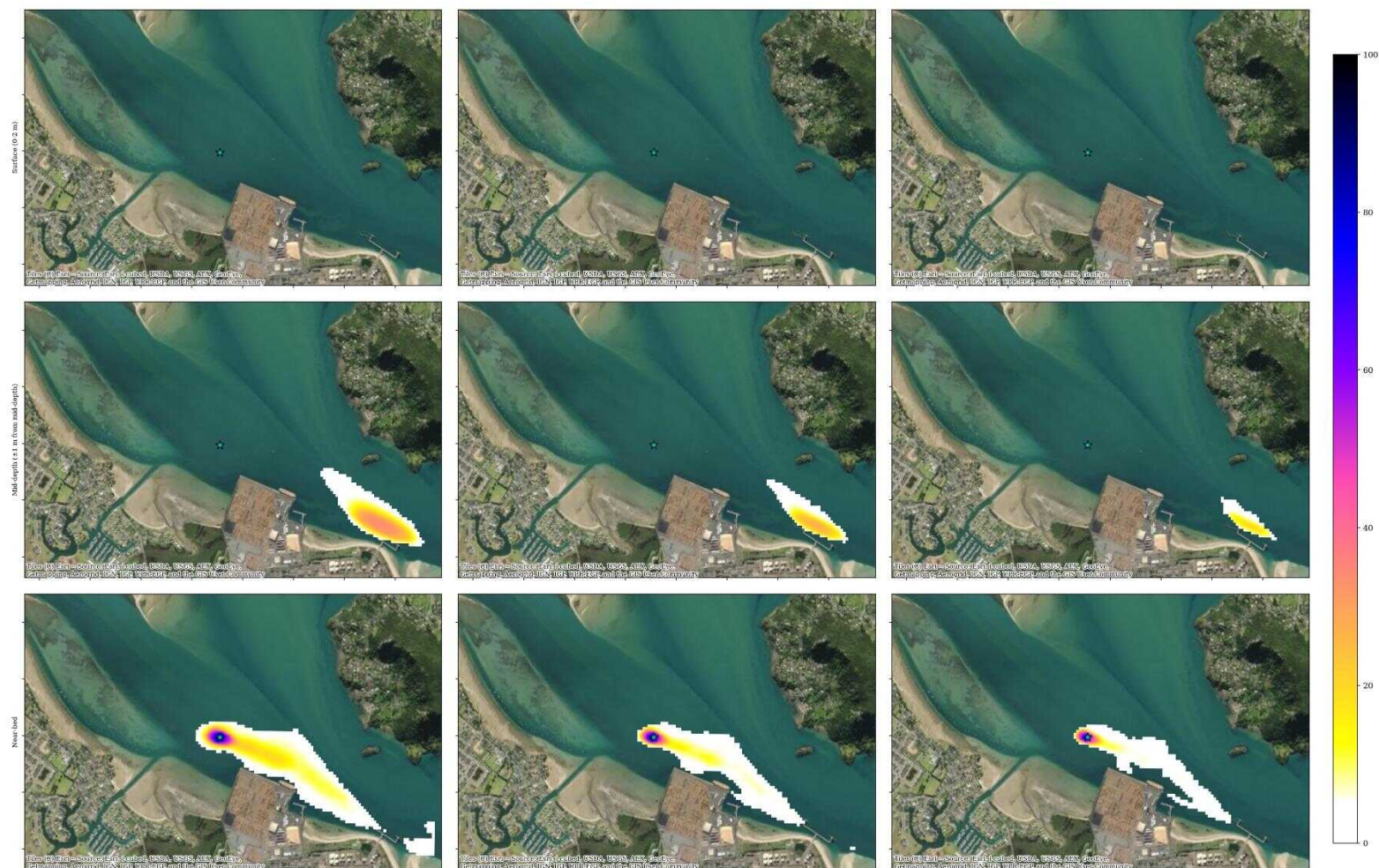
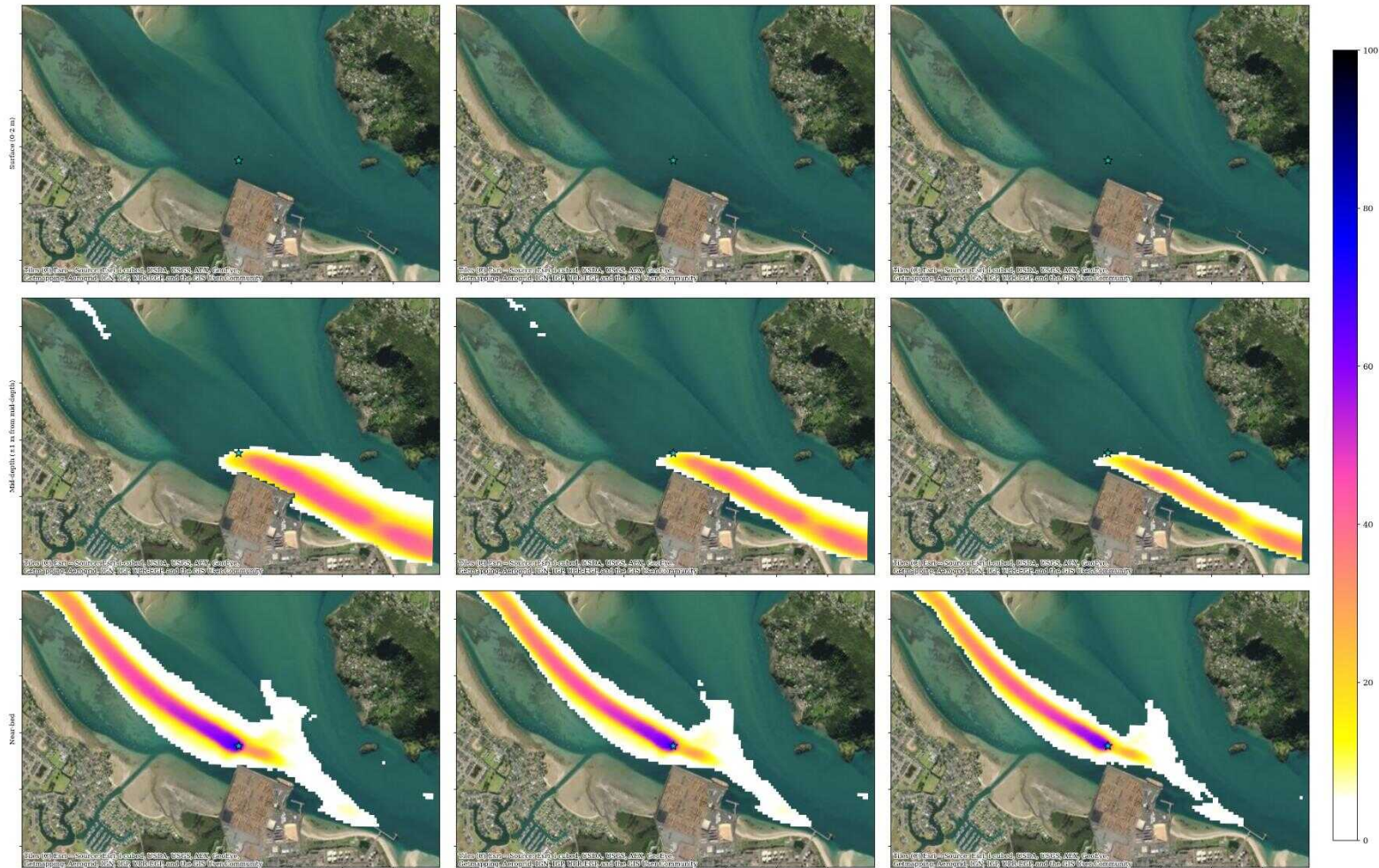


Figure 36 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 2**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S3 – Sandy Silt Existing



S3 – Silty Sand Existing

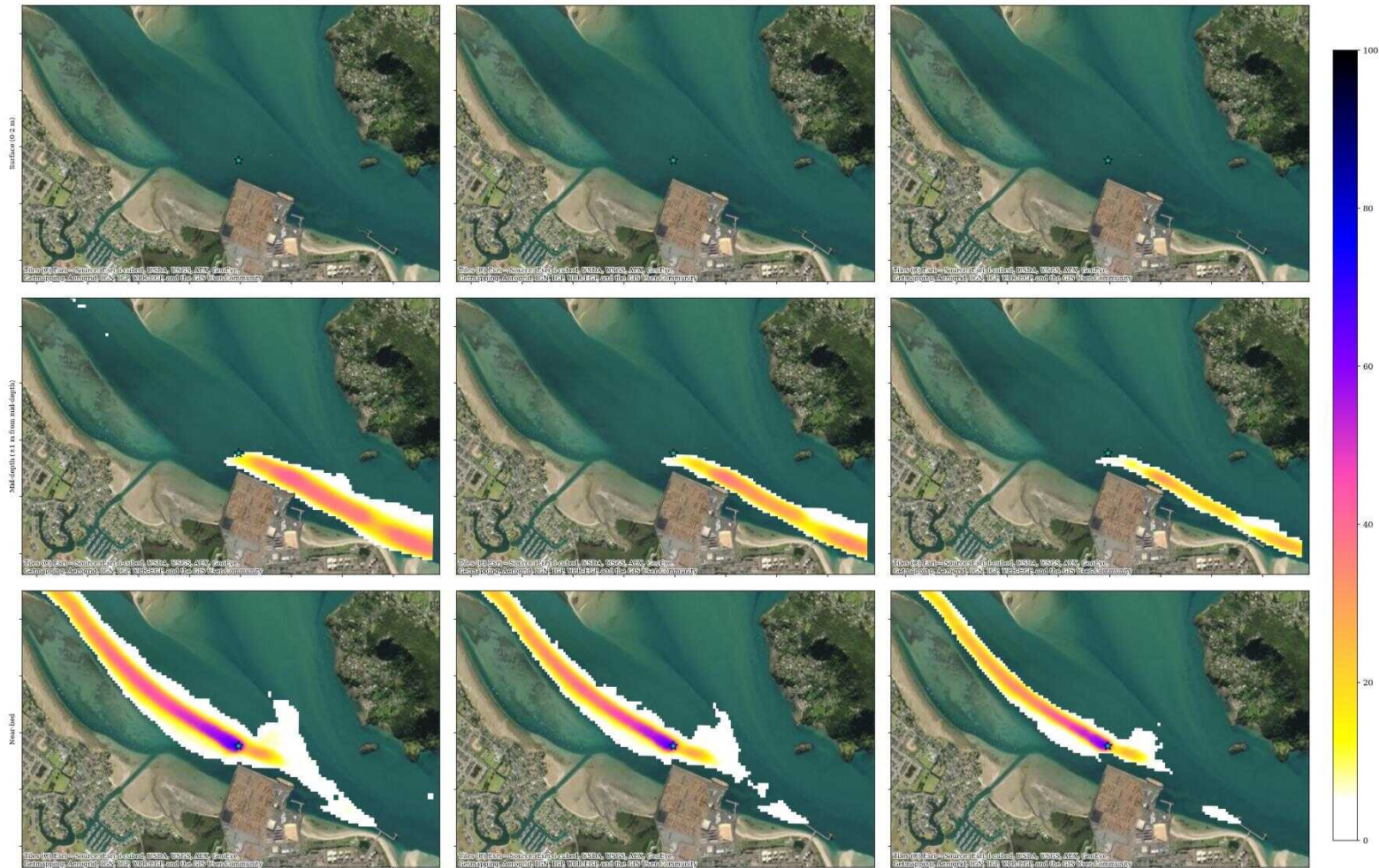


Figure 38 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 3**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S3 — Sandy Silt Proposed East West

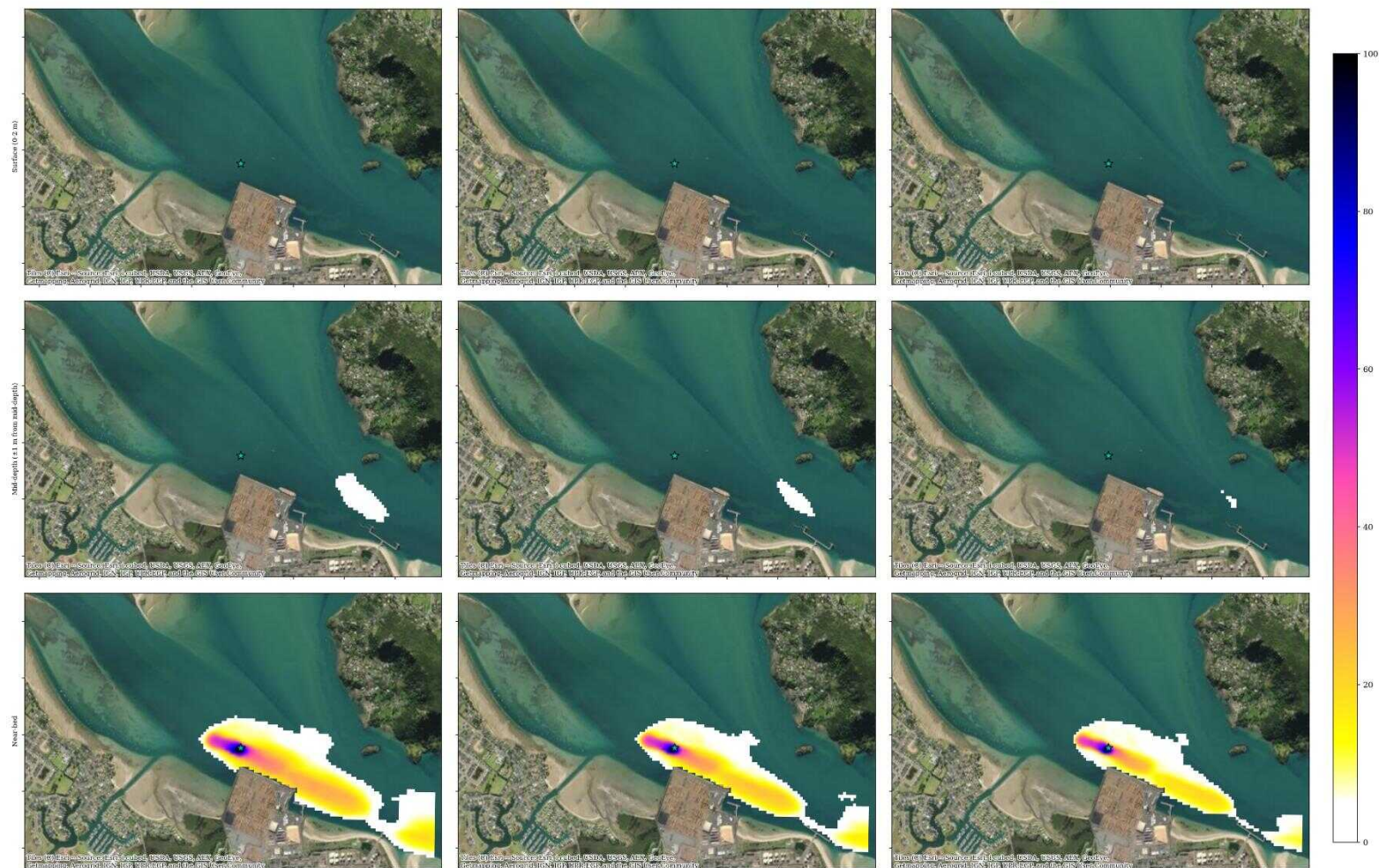


Figure 39 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S3 — Silty Sand Proposed East West



Figure 40 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S3 — Sandy Silt Proposed West Only

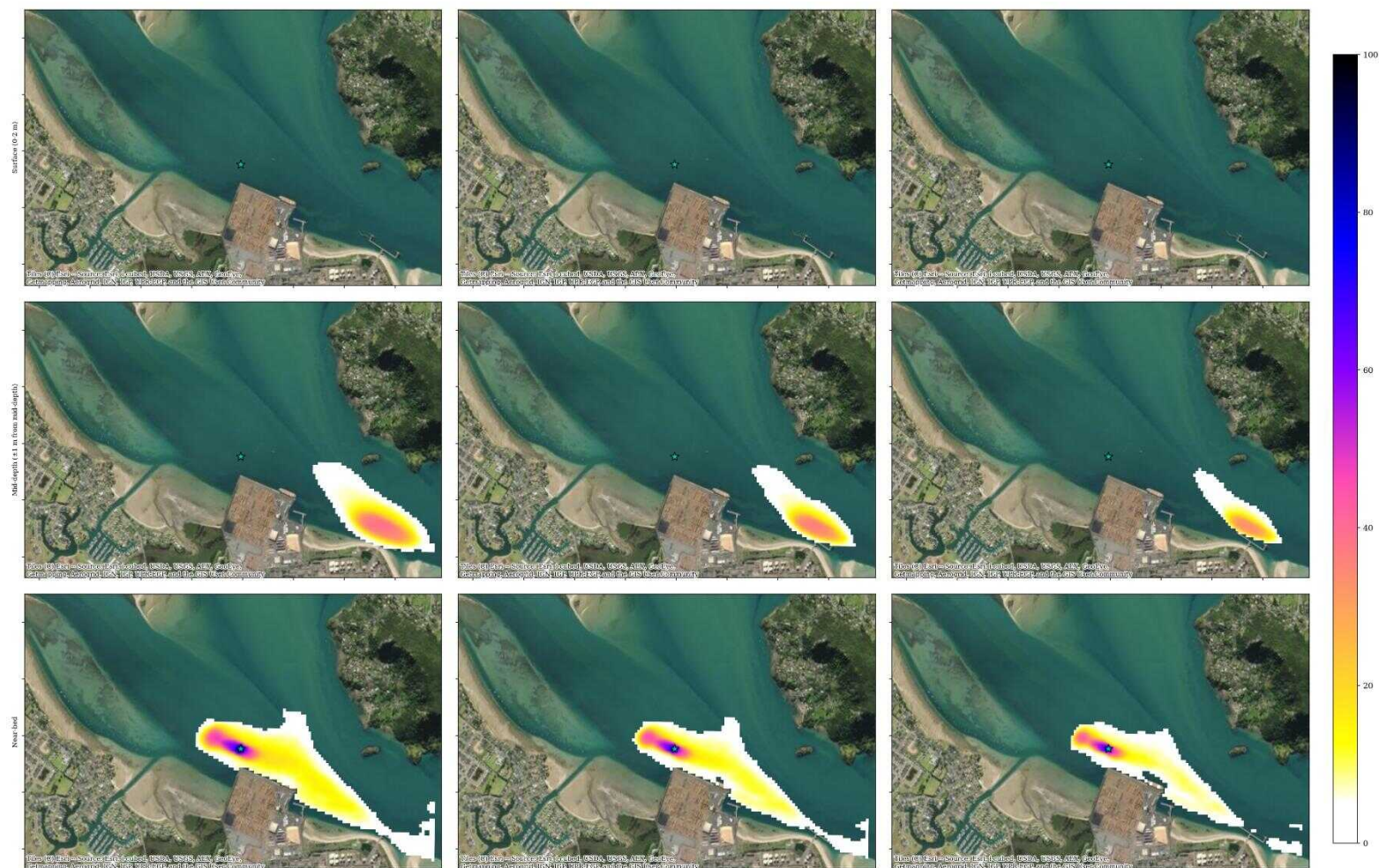


Figure 41 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S3 — Silty Sand Proposed West Only

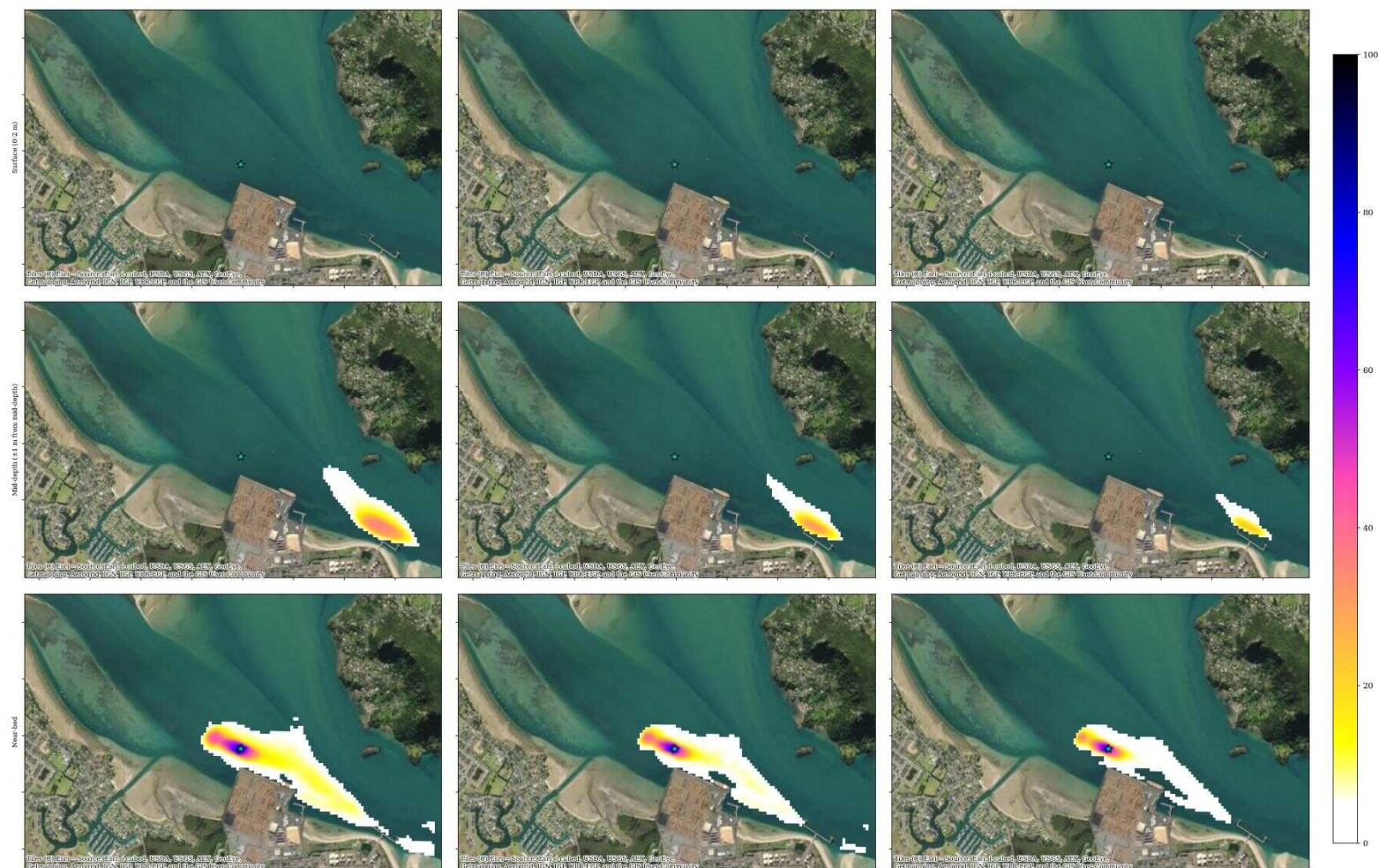


Figure 42 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹** (left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 3**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S4 — Sandy Silt Existing

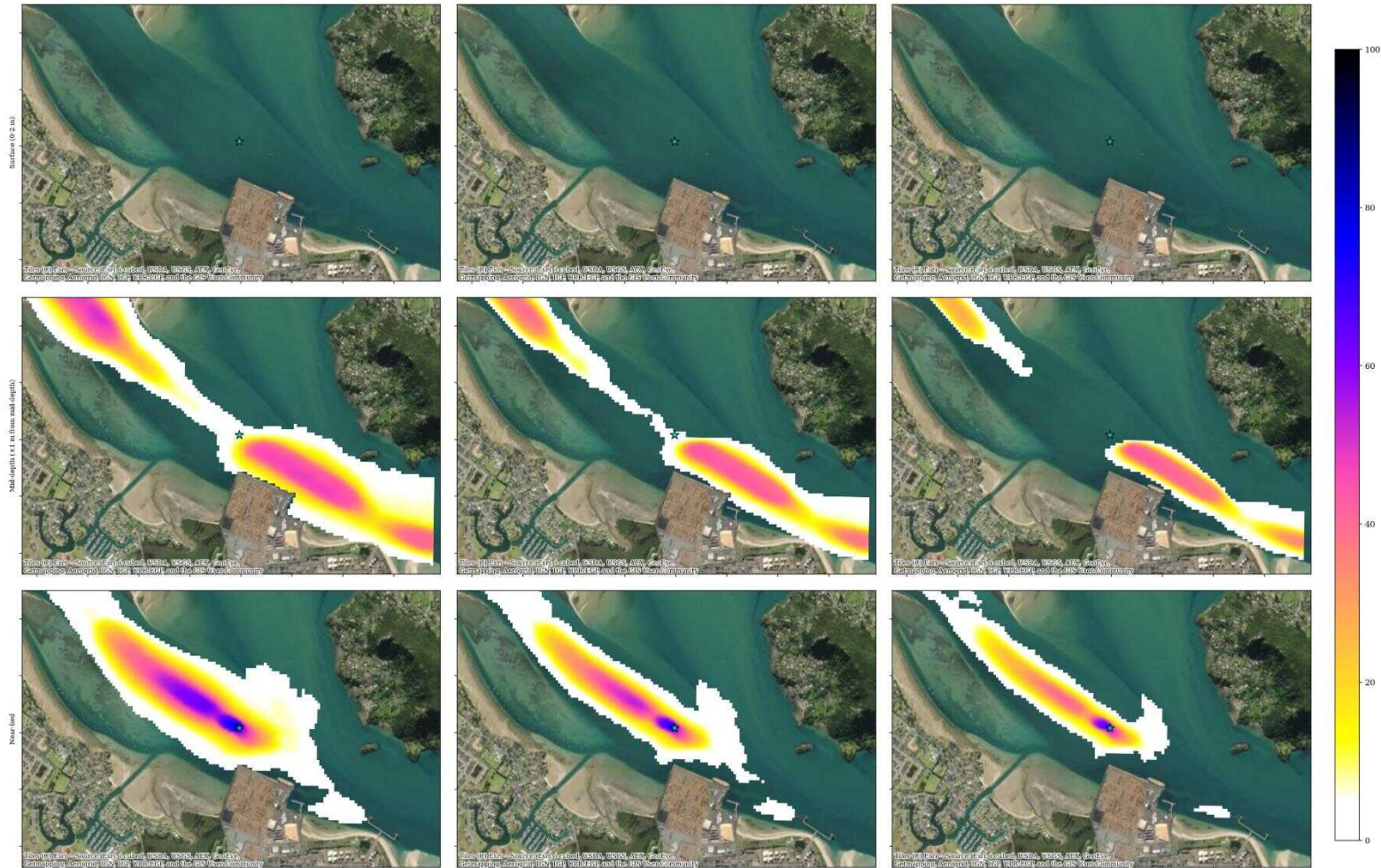


Figure 43 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 4**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S4 – Silty Sand Existing

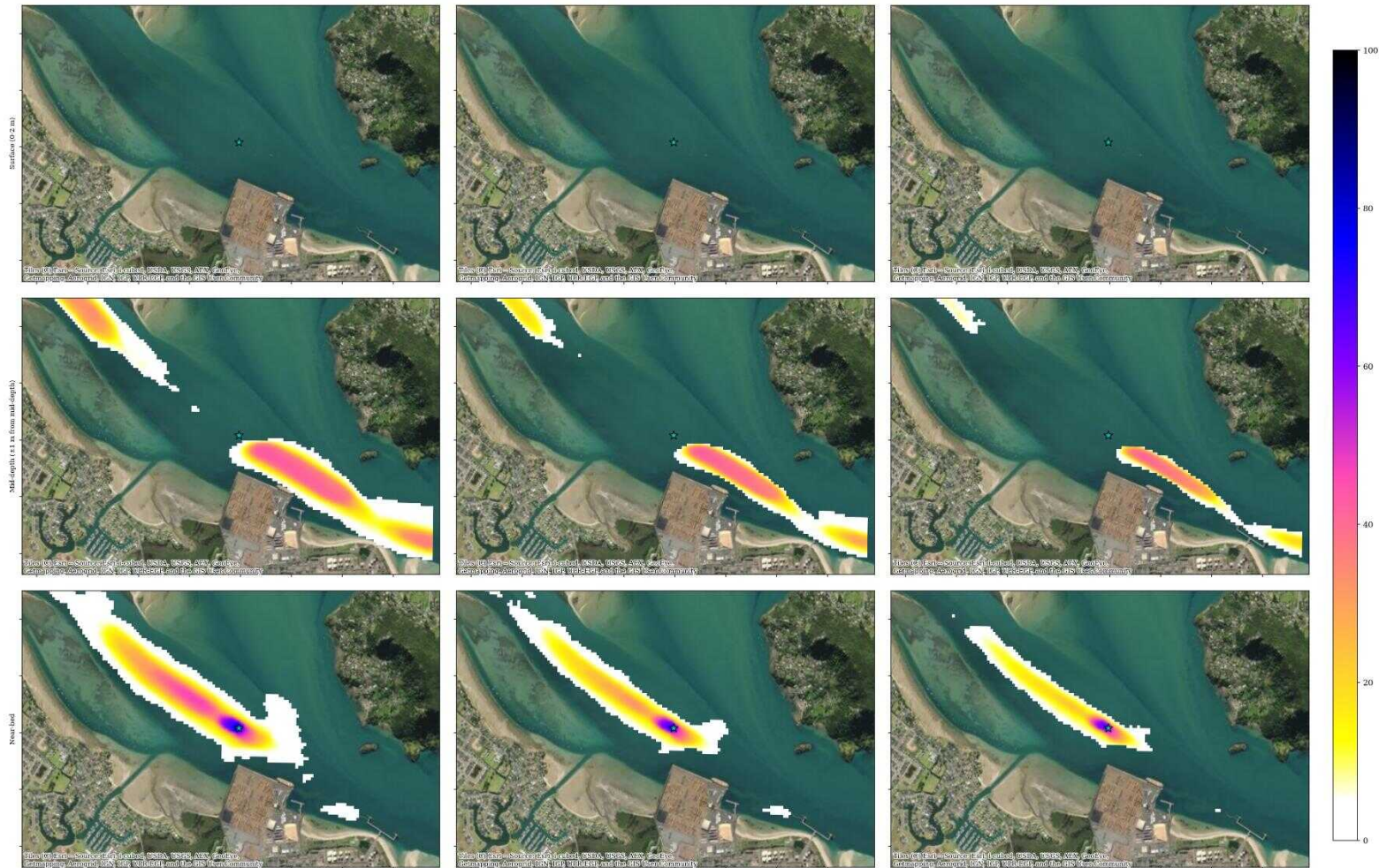


Figure 44 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD dredging at site 4**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S4 — Sandy Silt Proposed East West



Figure 45 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S4 — Silty Sand Proposed East West



Figure 46 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

S4 — Sandy Silt Proposed West Only

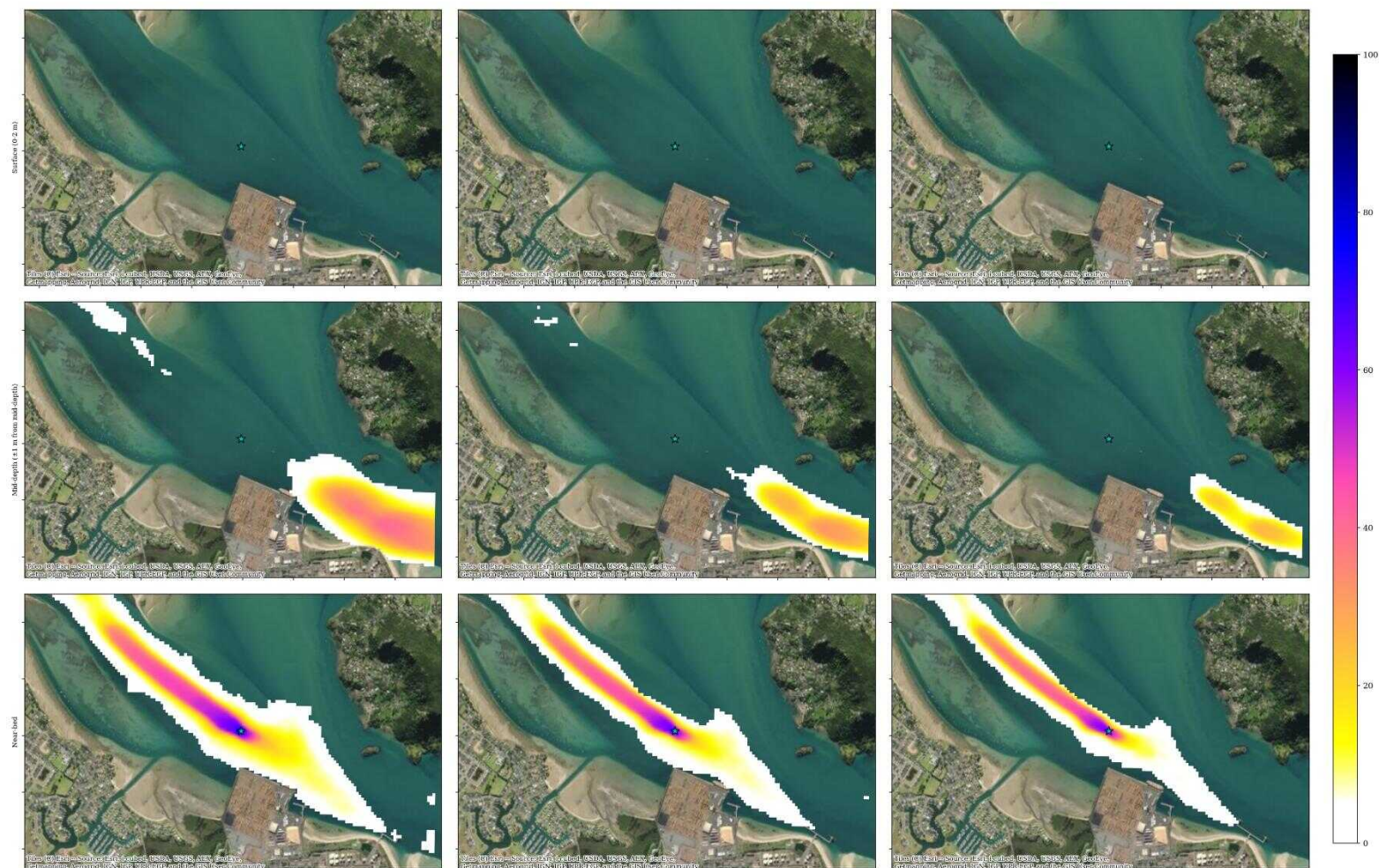


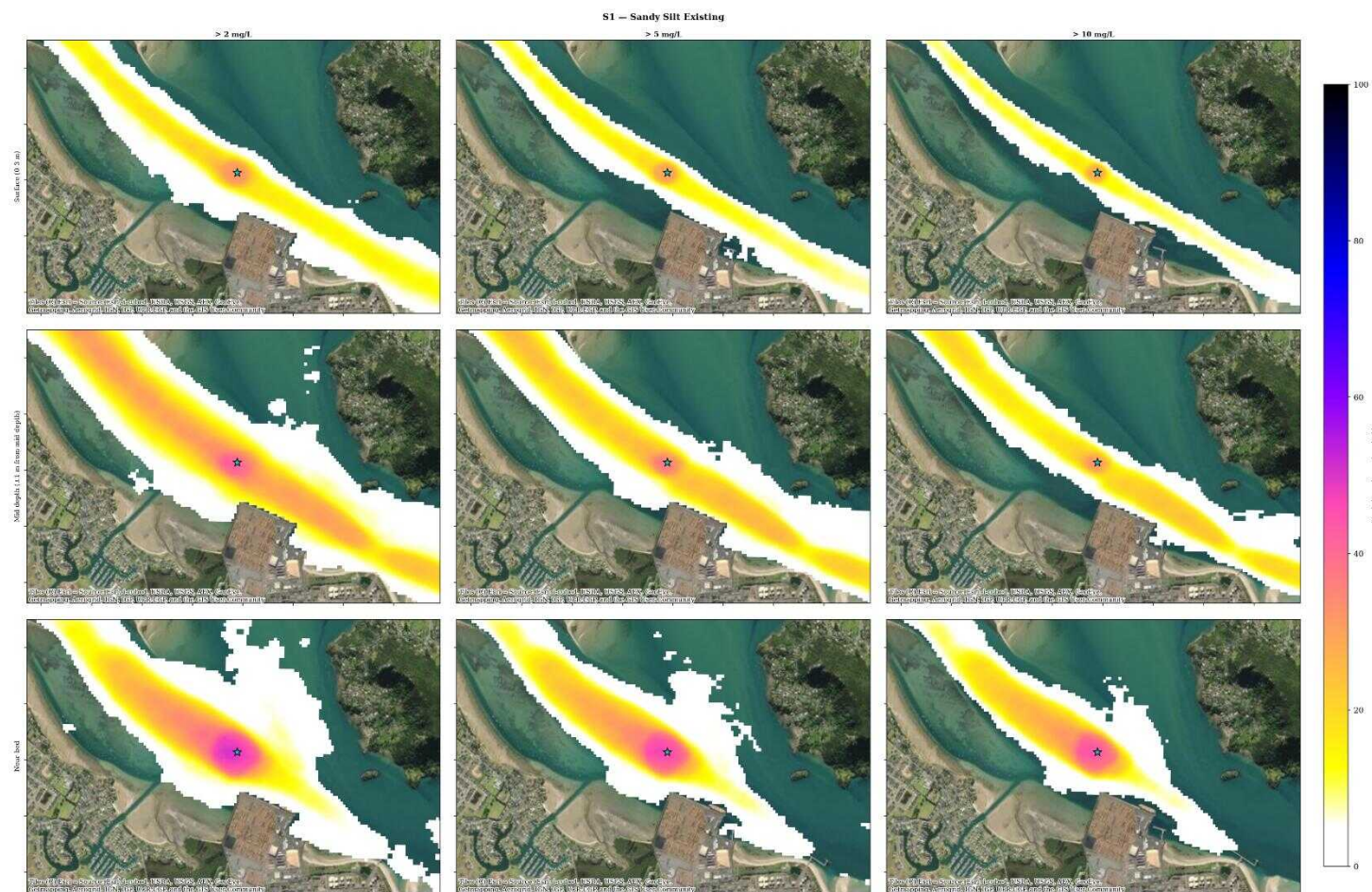
Figure 47 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

S4 — Silty Sand Proposed West Only



Figure 48 **Percentage of time** total suspended sediment concentrations (mg L⁻¹) are above thresholds of **2, 5, and 10 mg L⁻¹**(left to right), at surface, mid water and nearbed levels (top to bottom) for **CSD** dredging at **site 4**, over the **proposed NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

TSHD exceedance plots



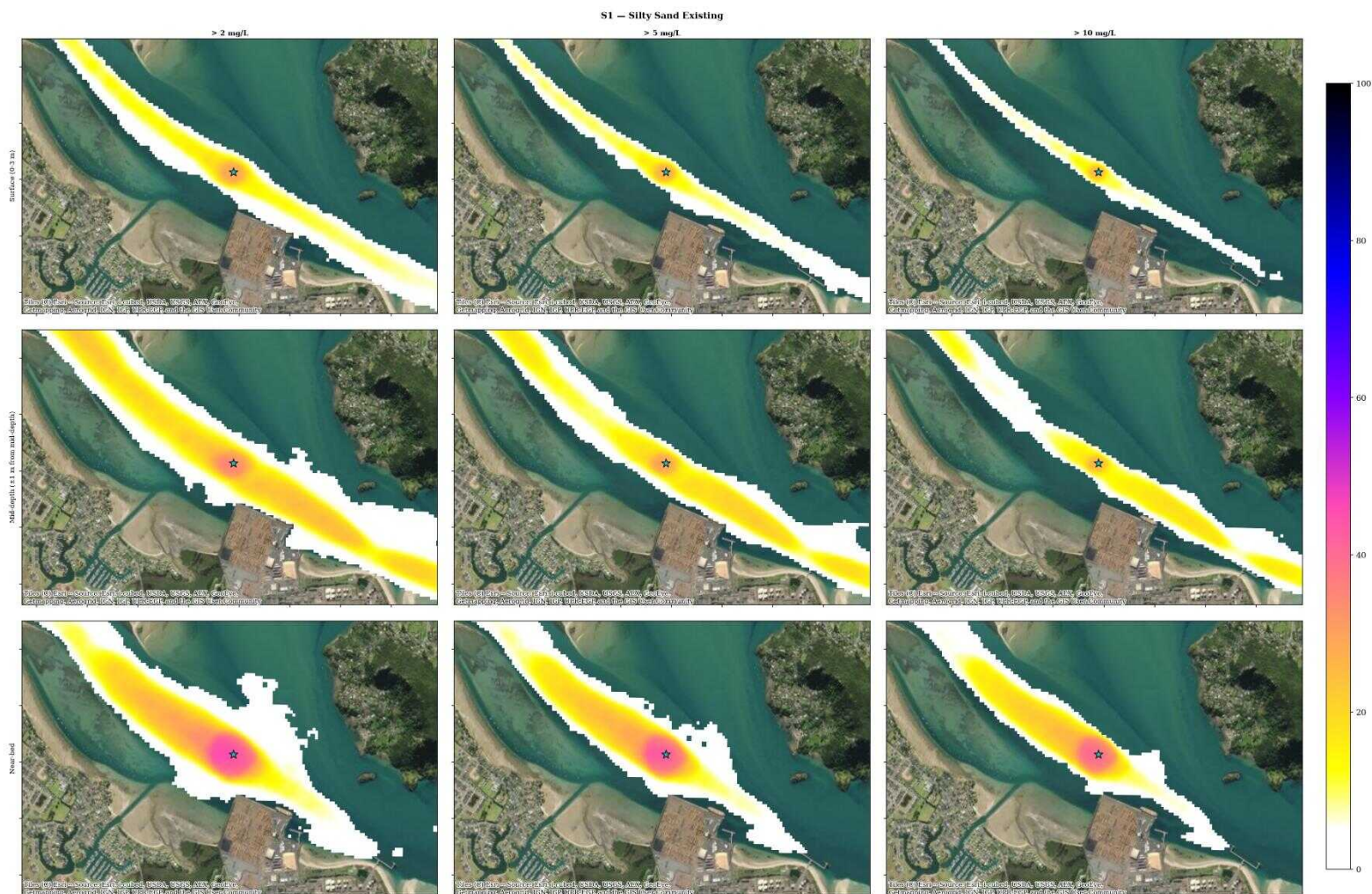
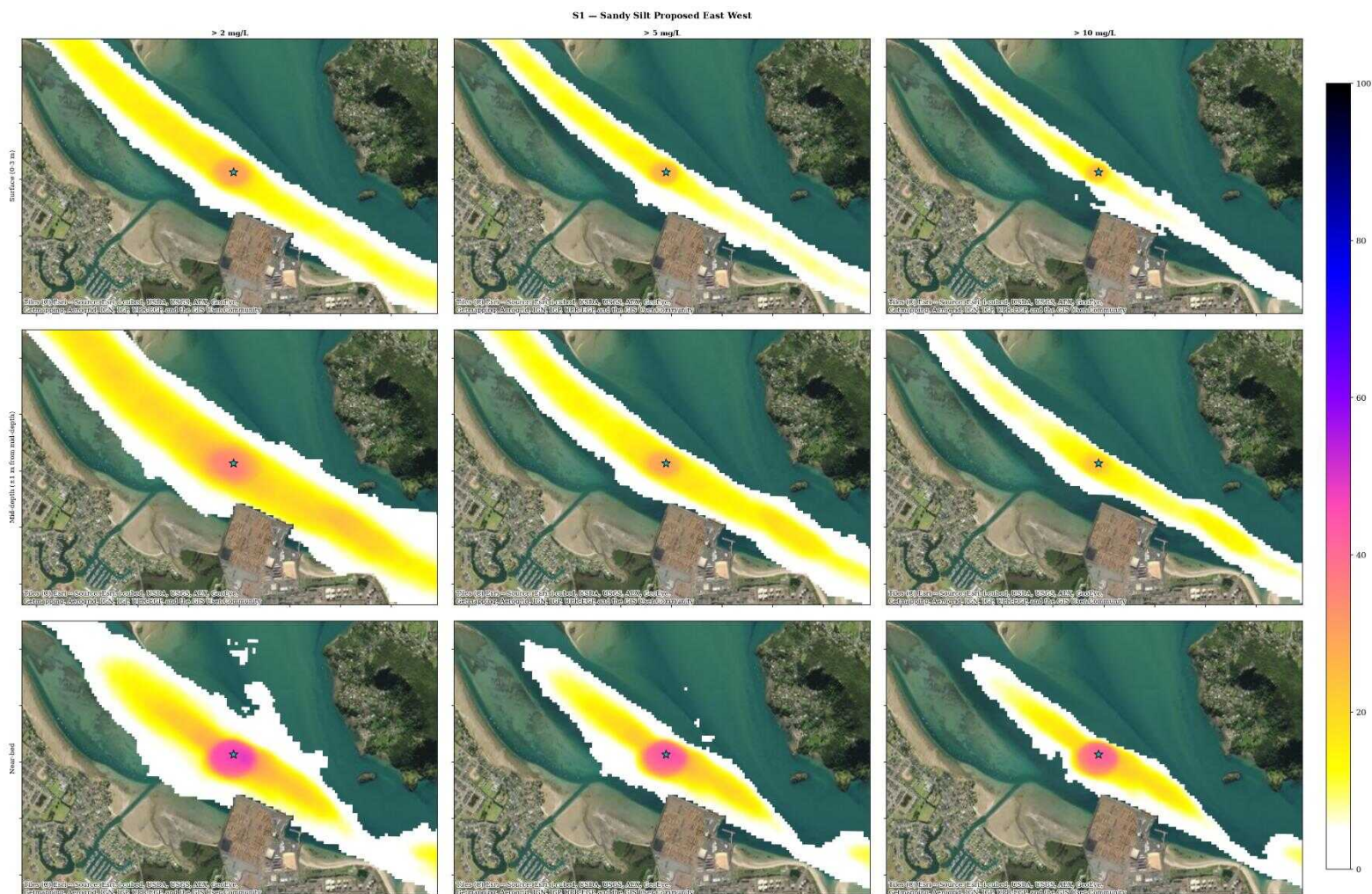
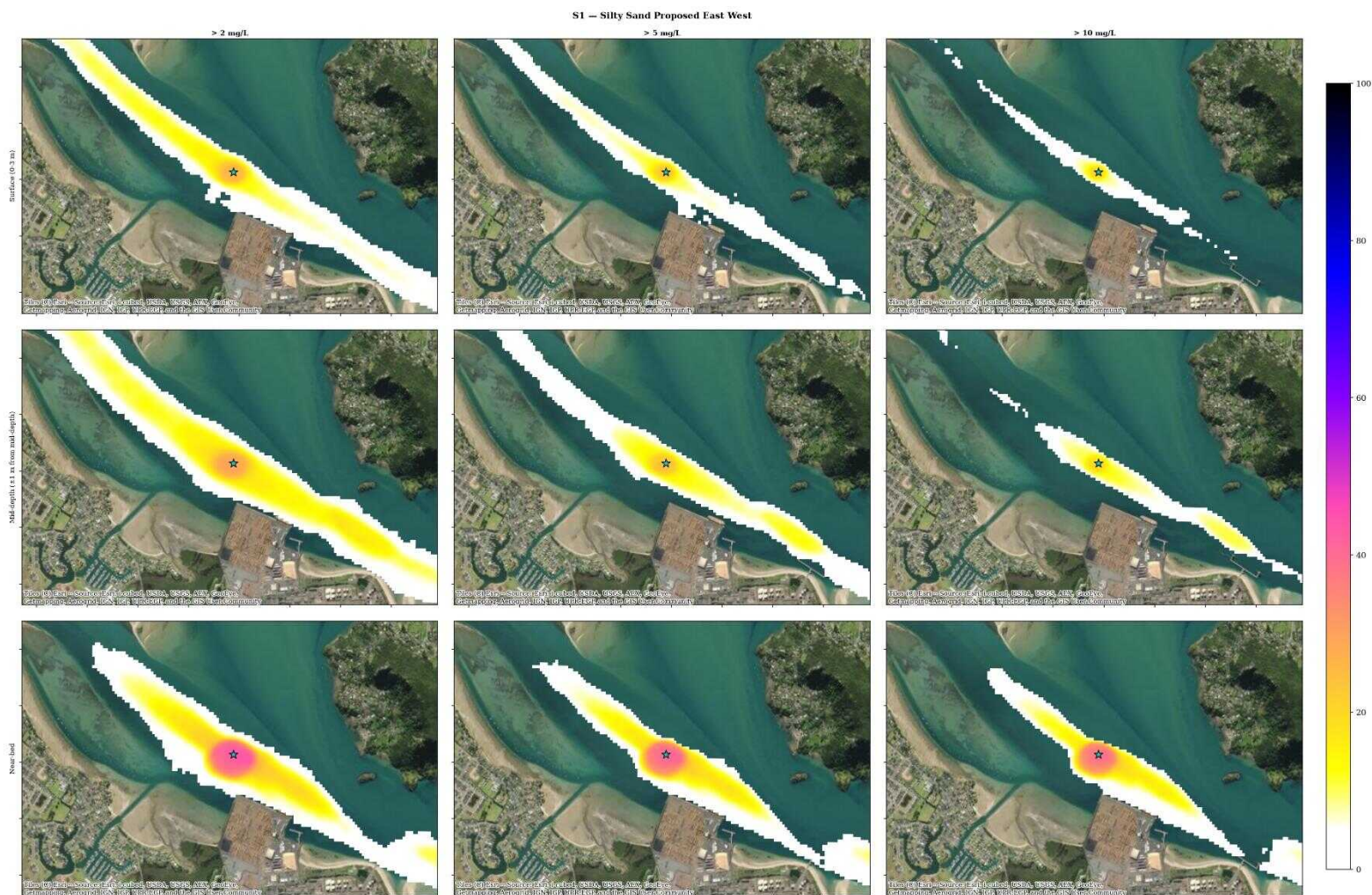


Figure 50 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 1**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.





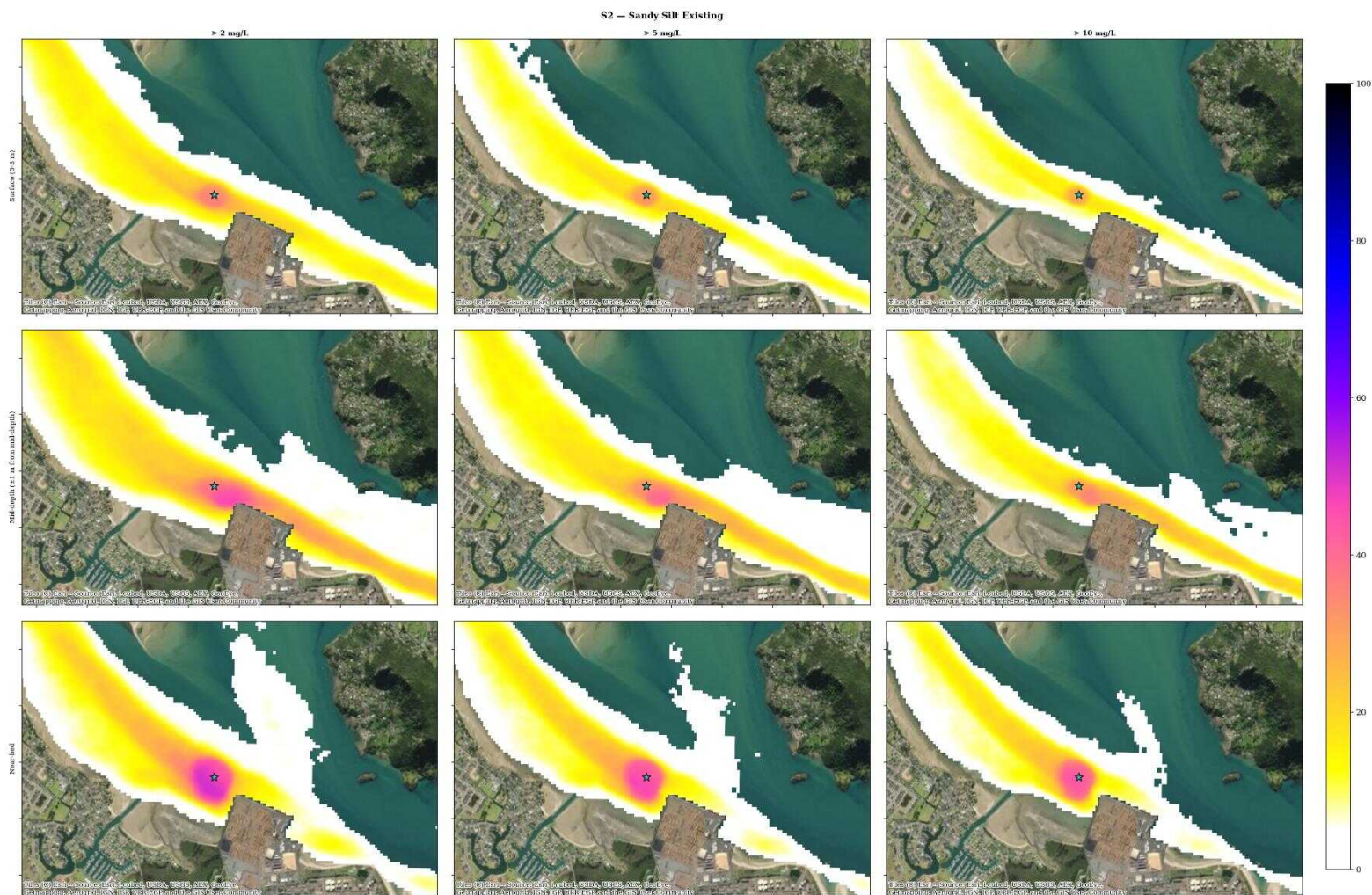


Figure 53 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

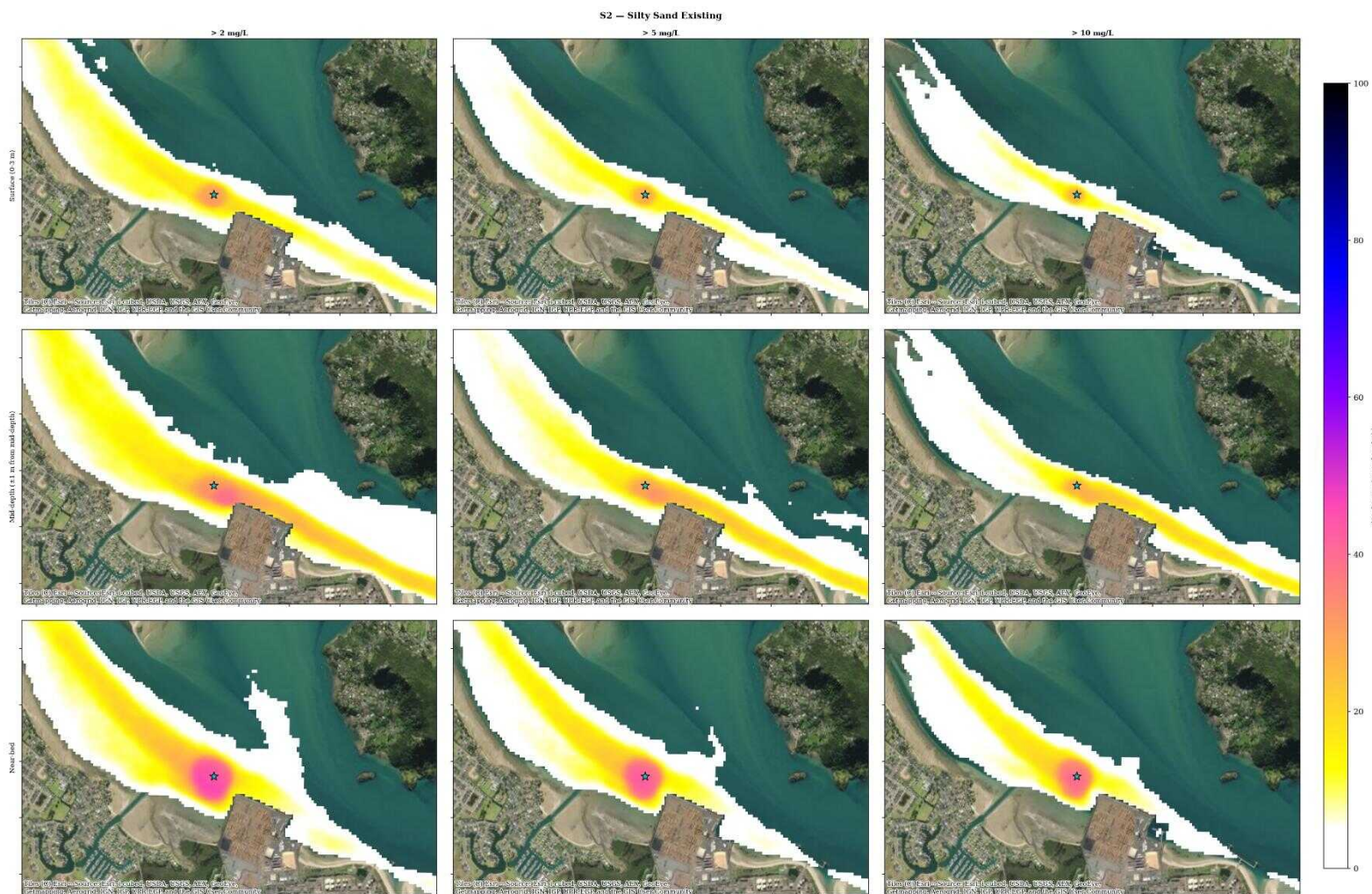
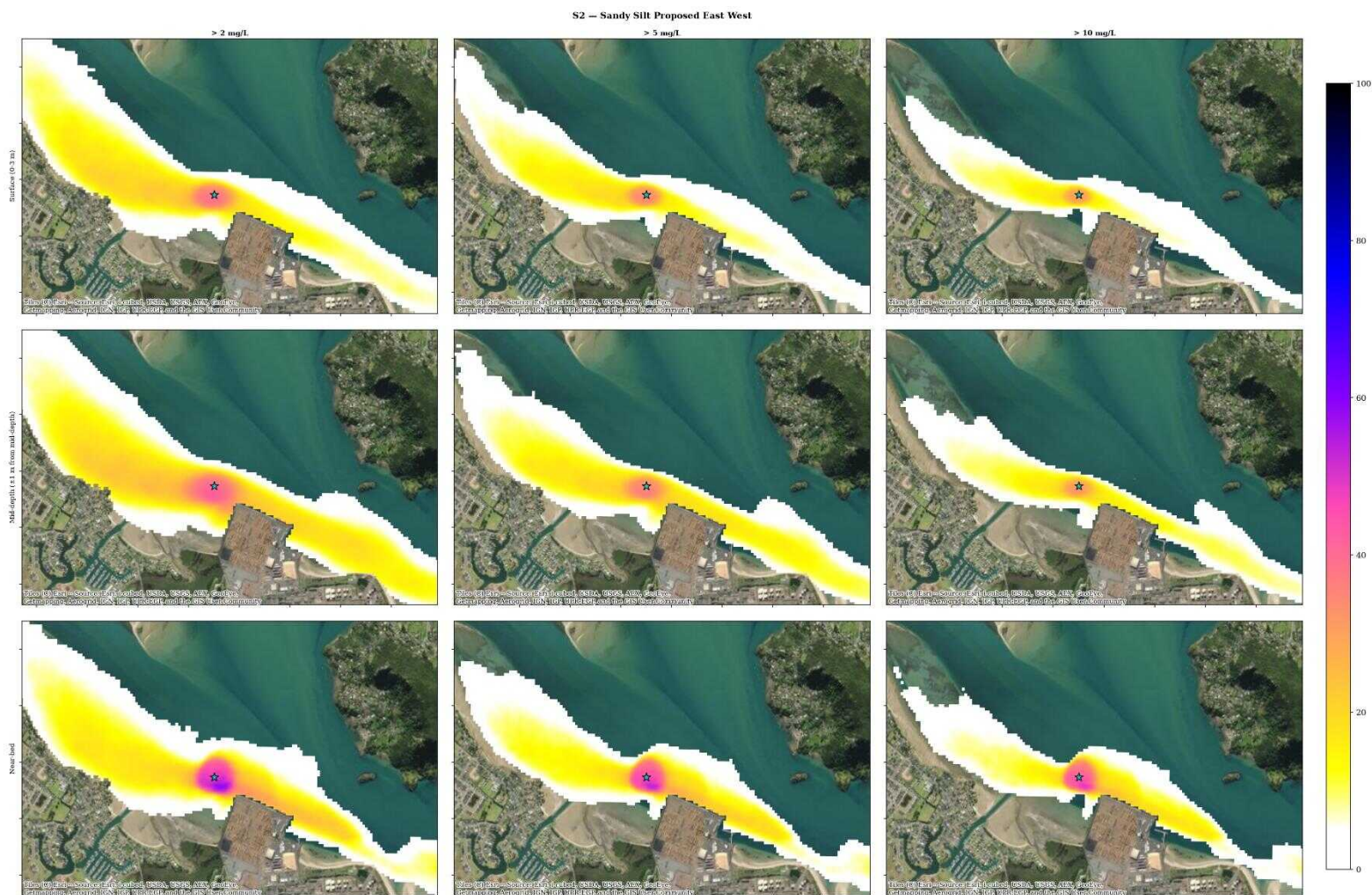


Figure 54 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 2**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.



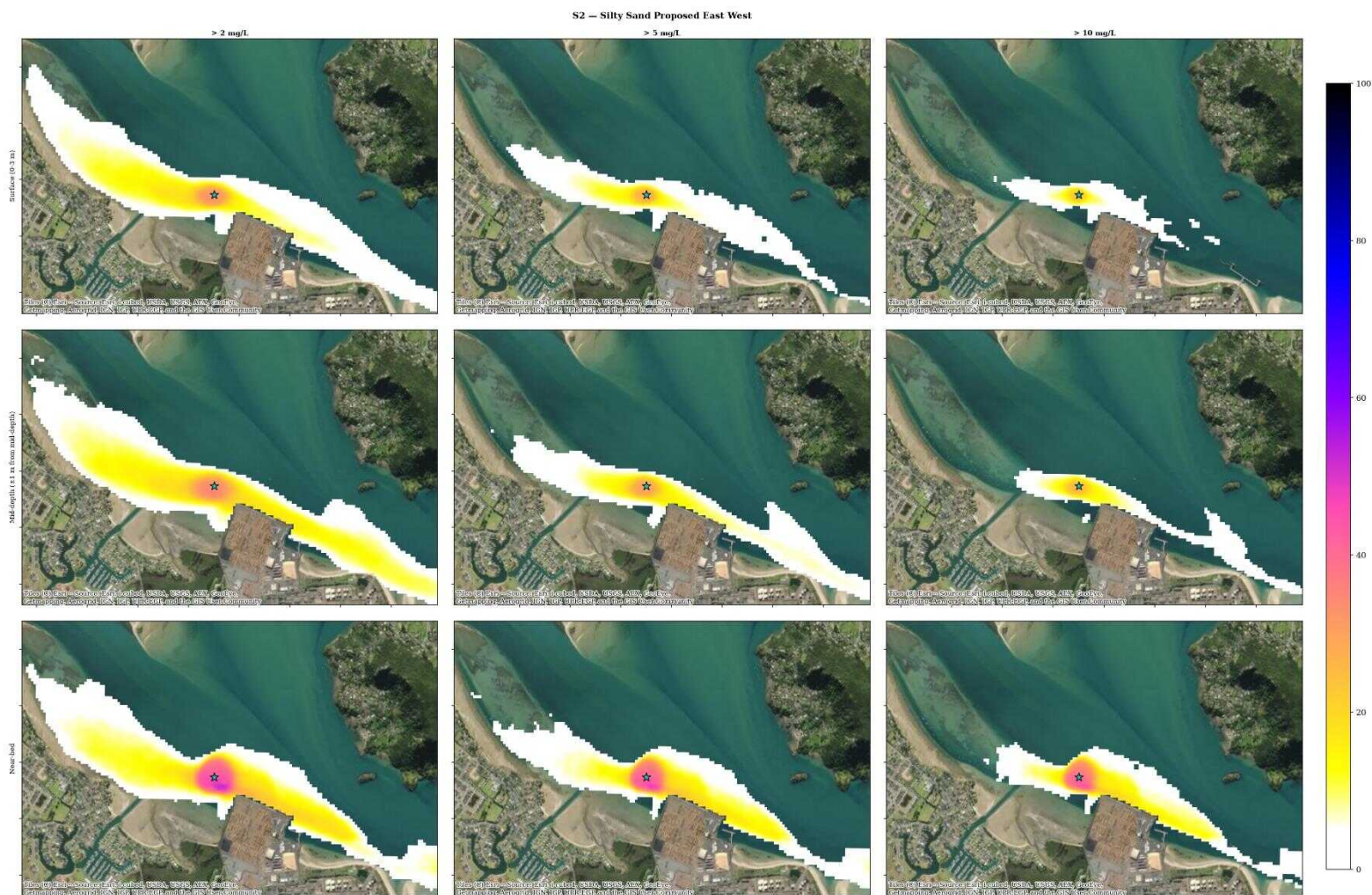


Figure 56 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD dredging at site 2**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

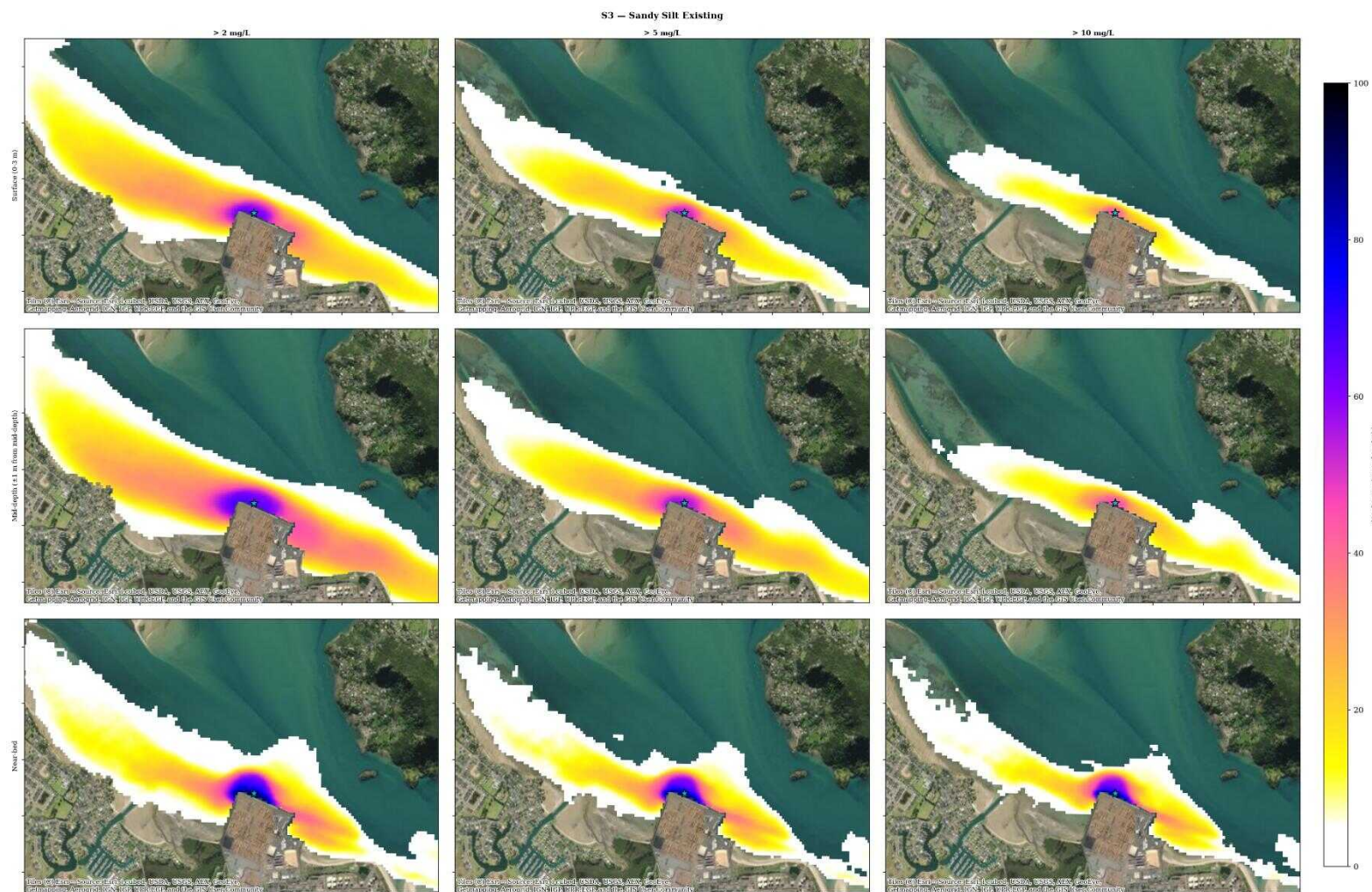


Figure 57 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

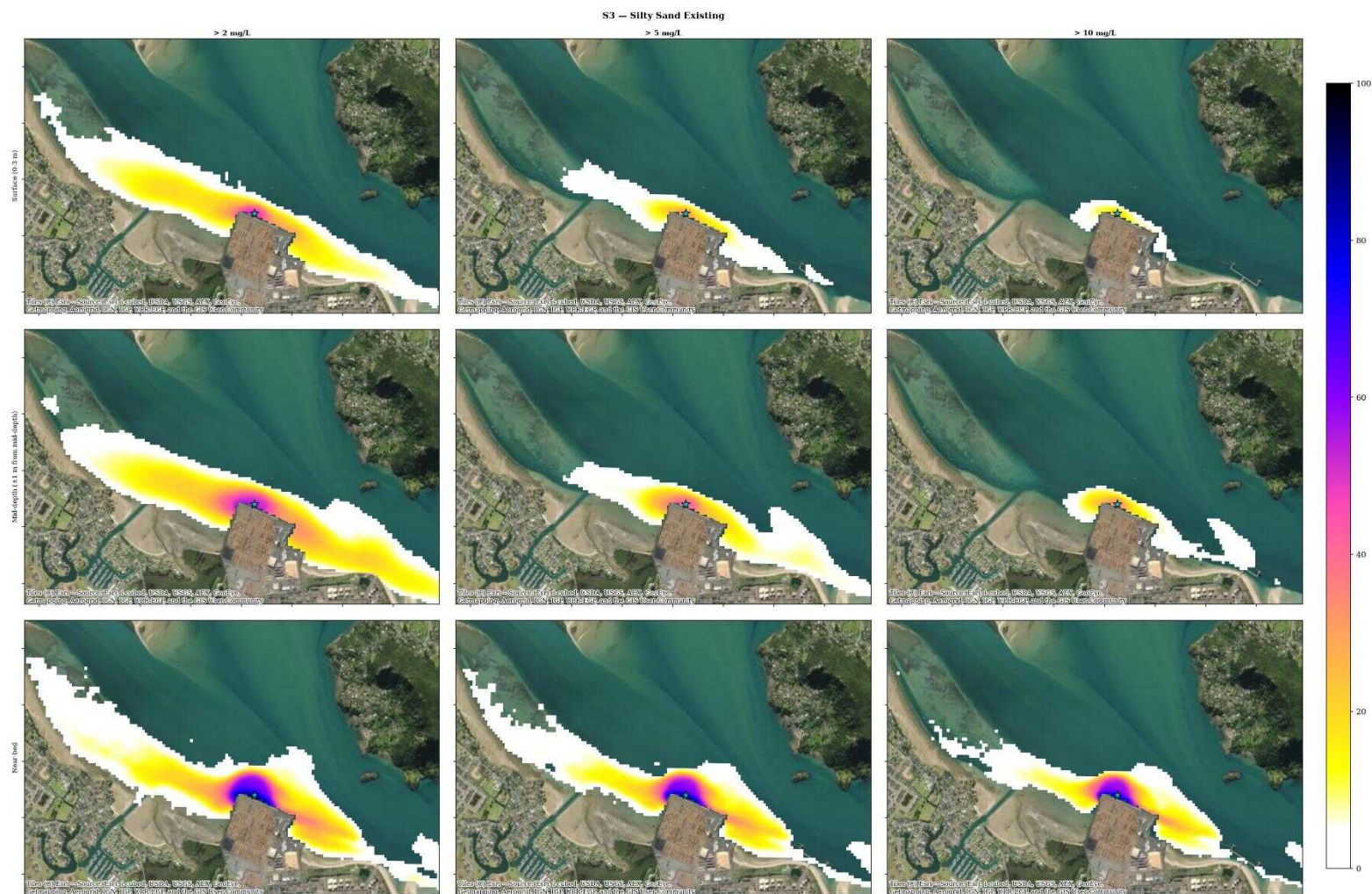


Figure 58 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 3**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

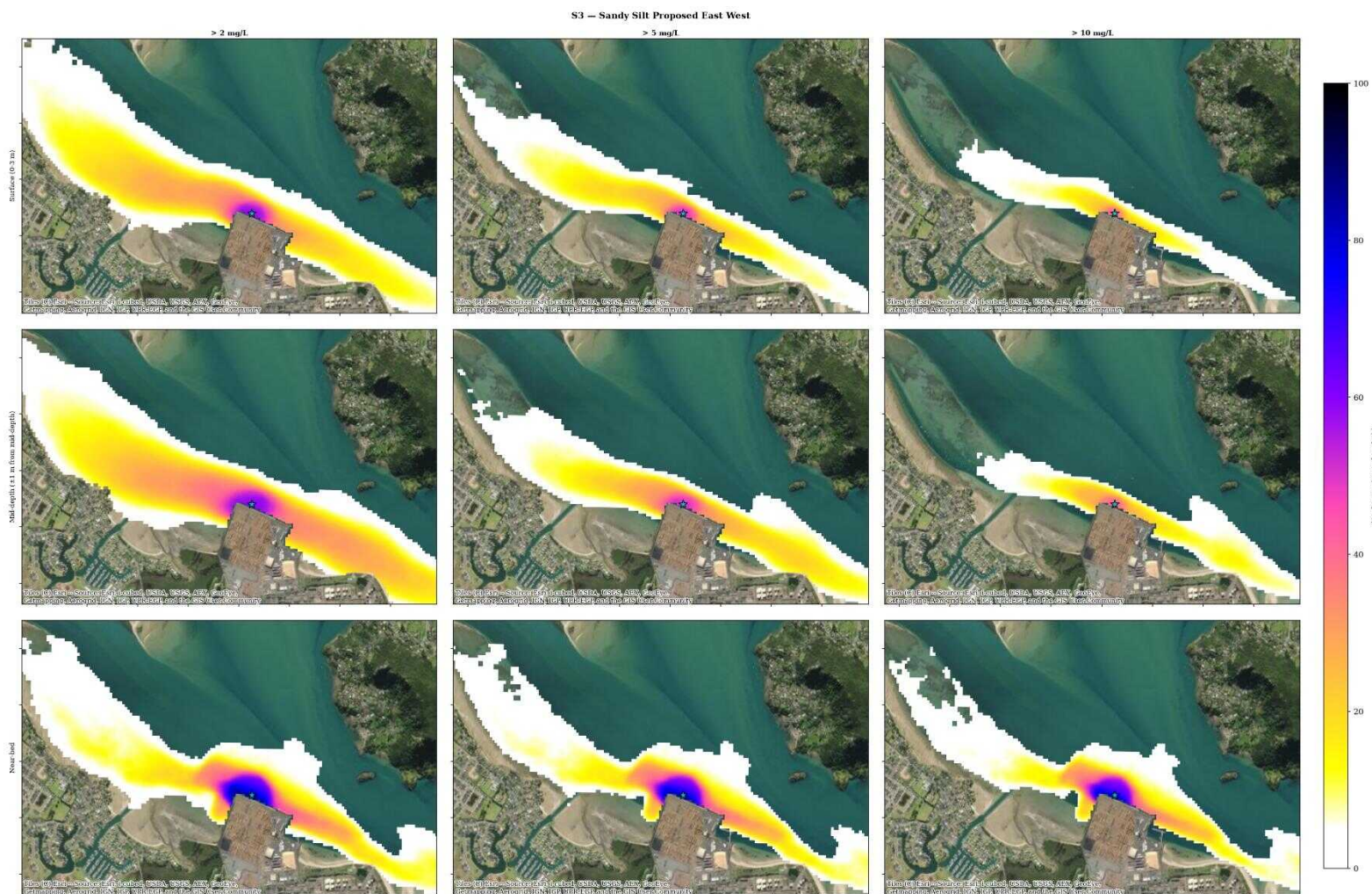
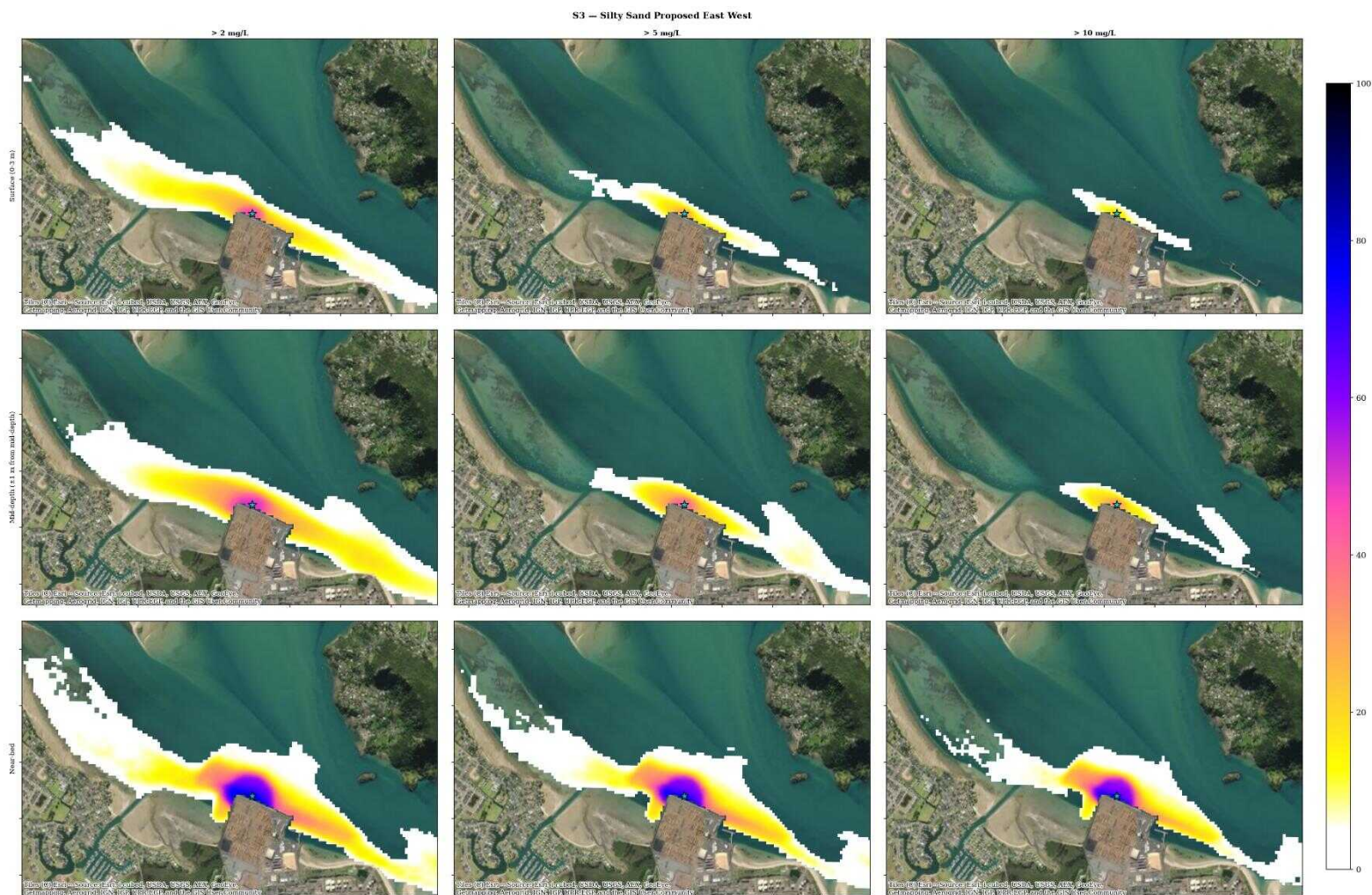
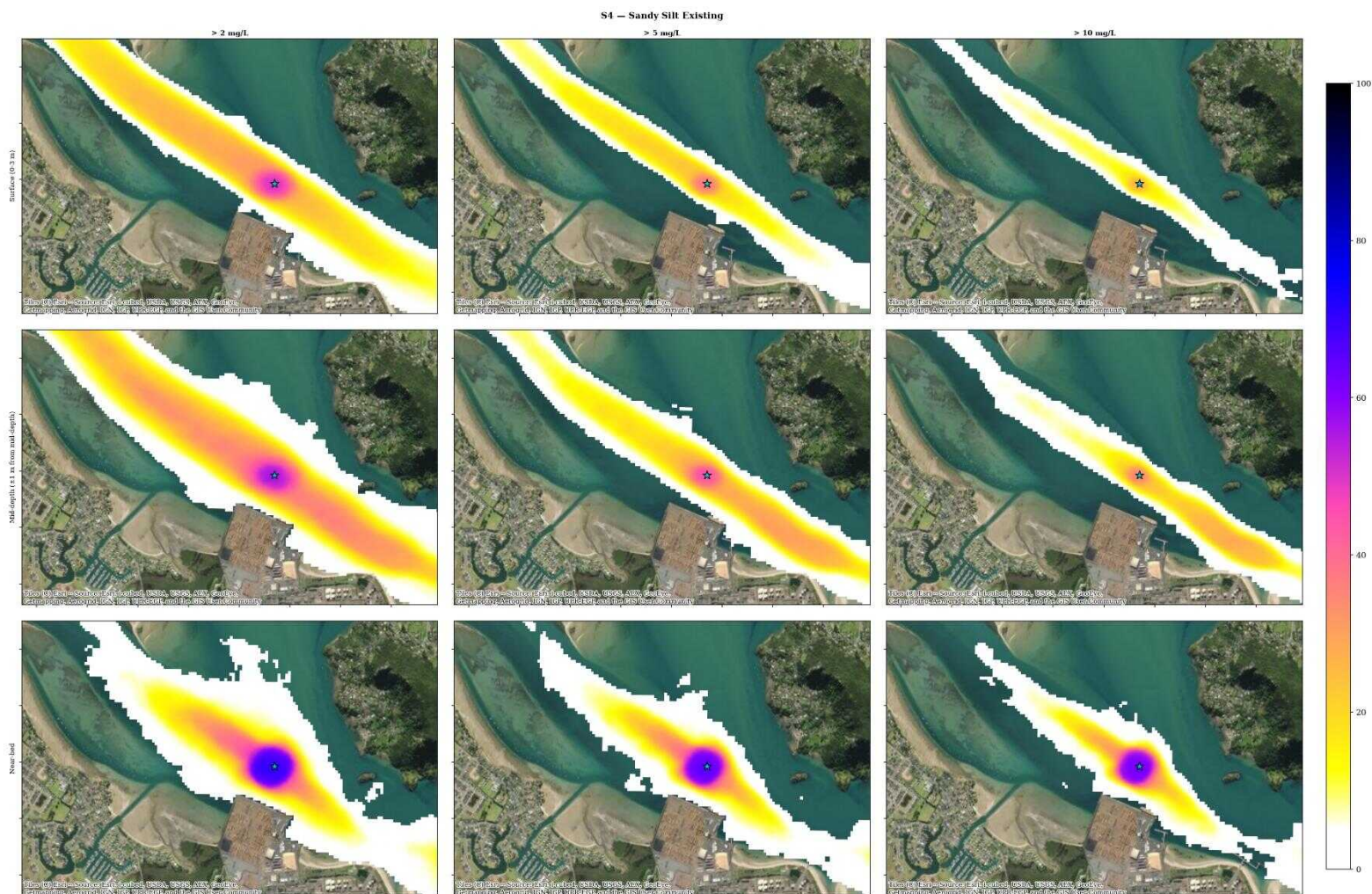


Figure 59 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 3**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.





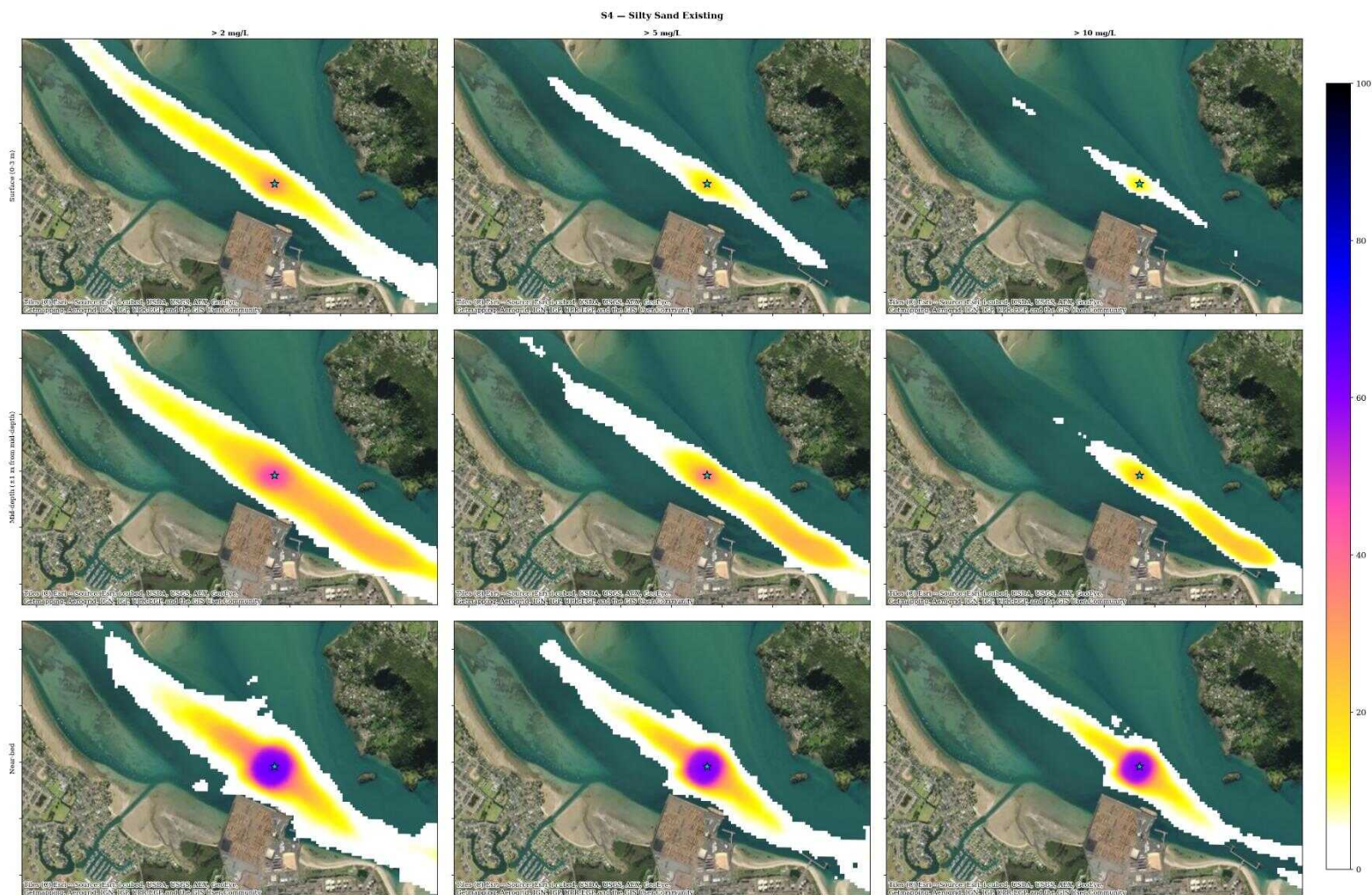


Figure 62 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 4**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

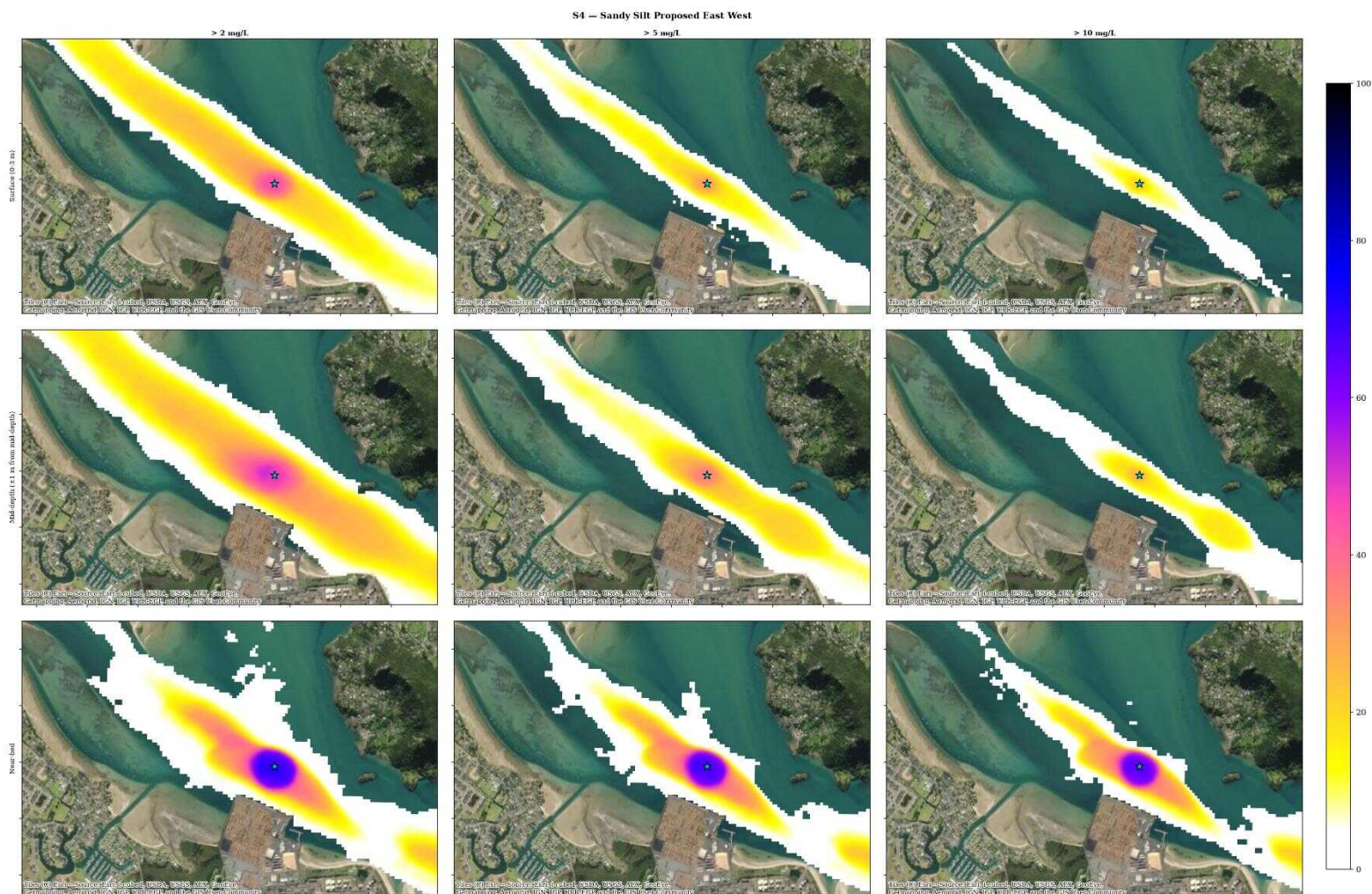
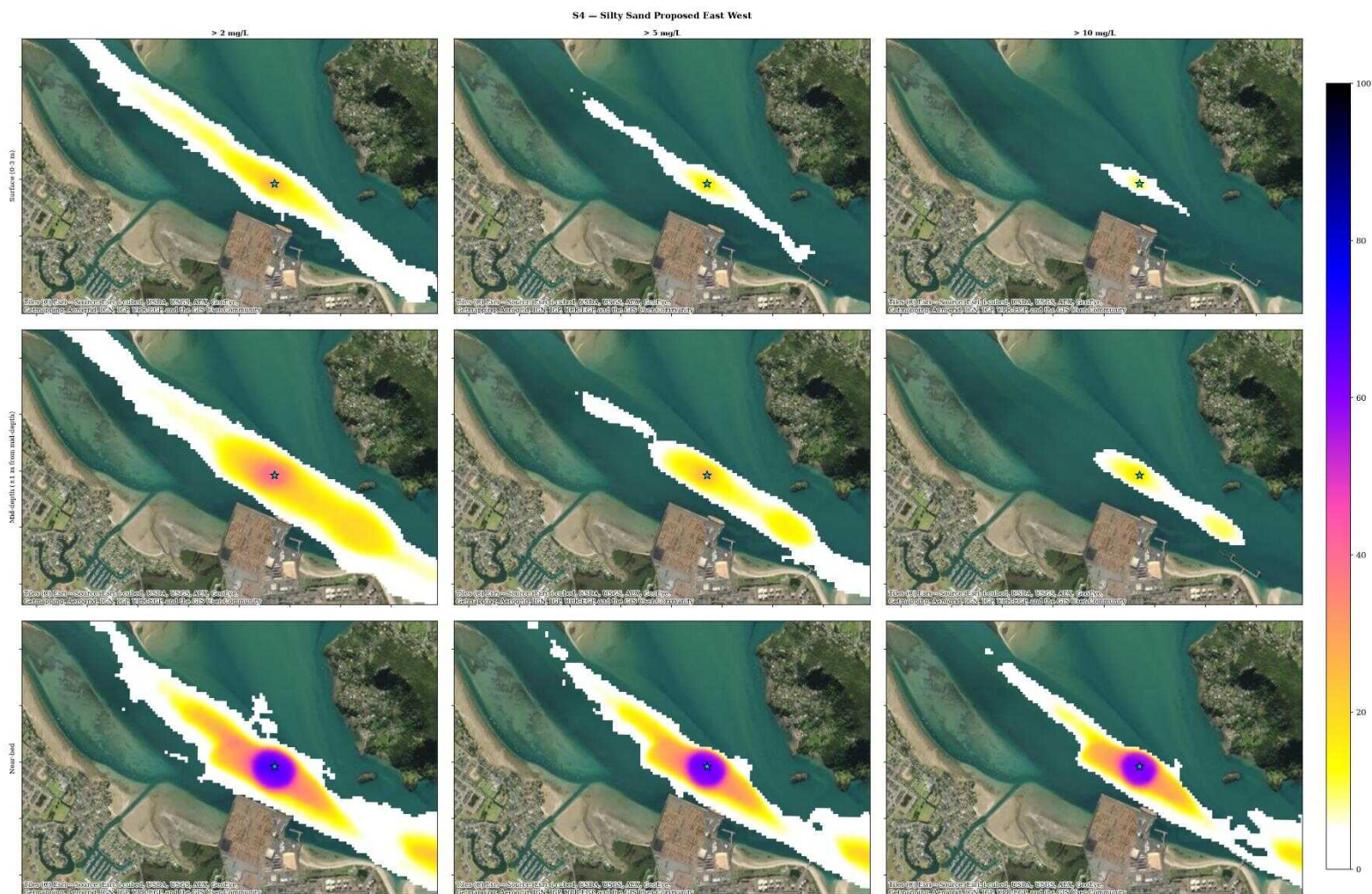


Figure 63 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 4**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.



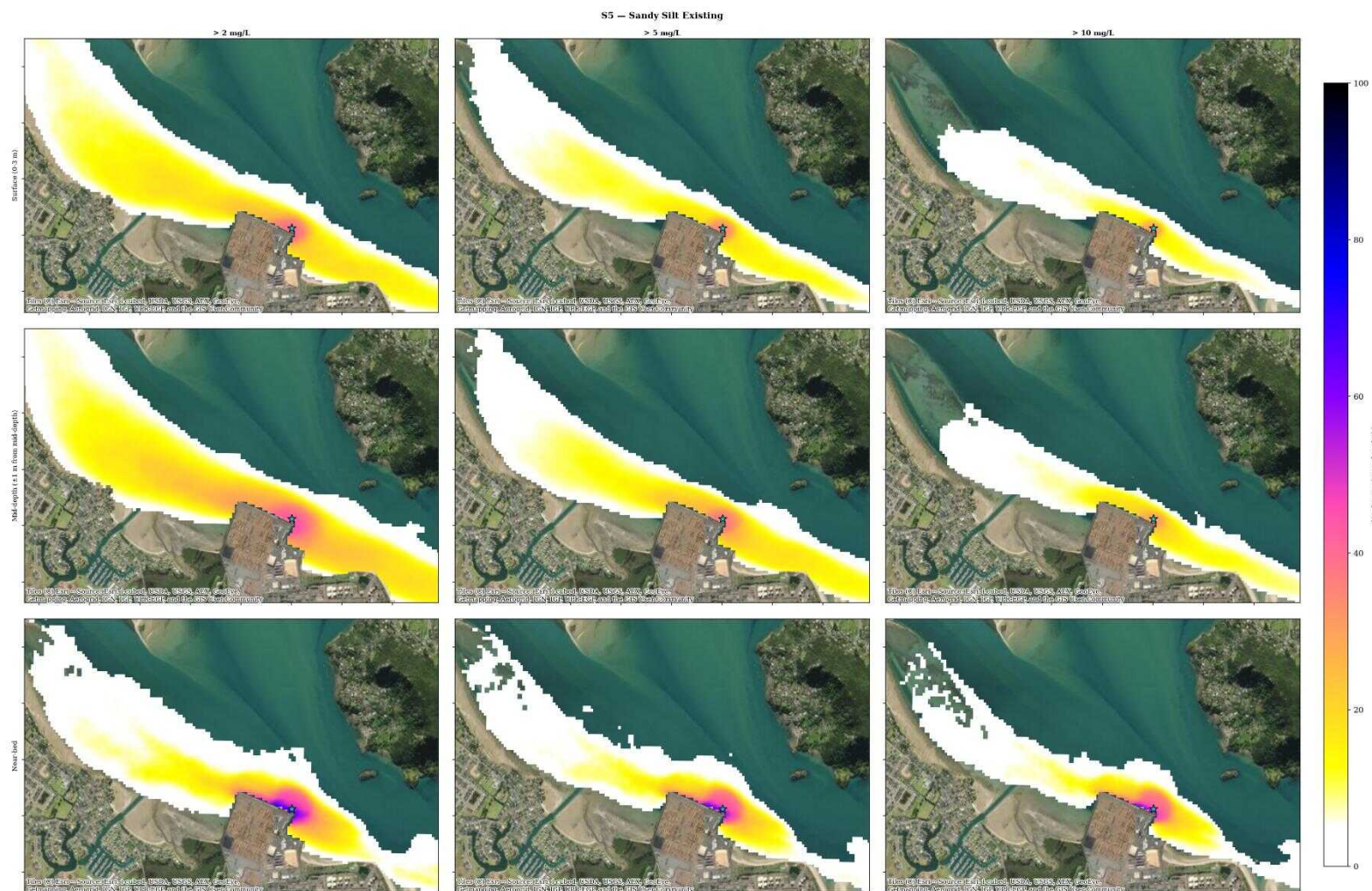


Figure 65 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 5**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

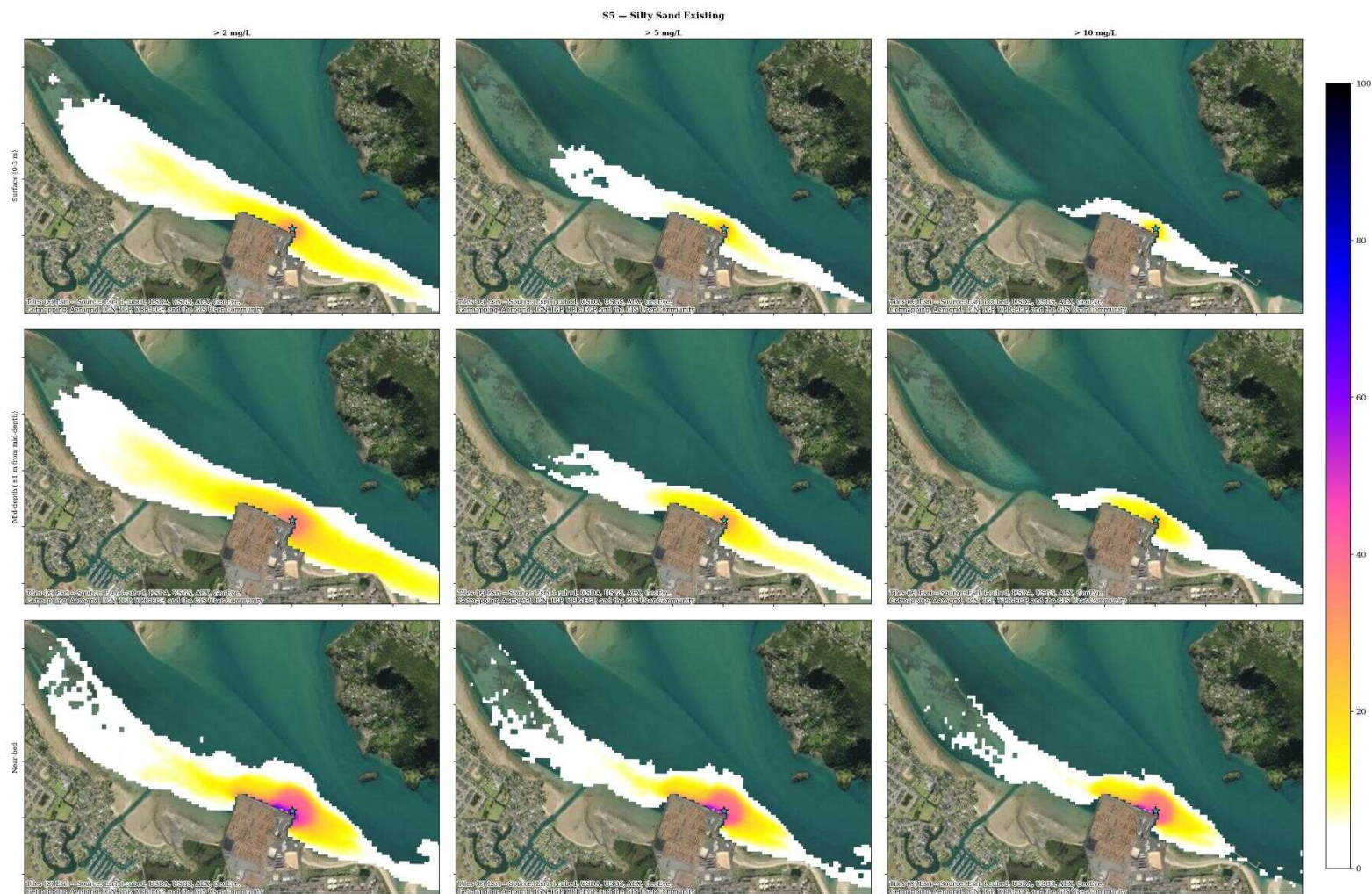
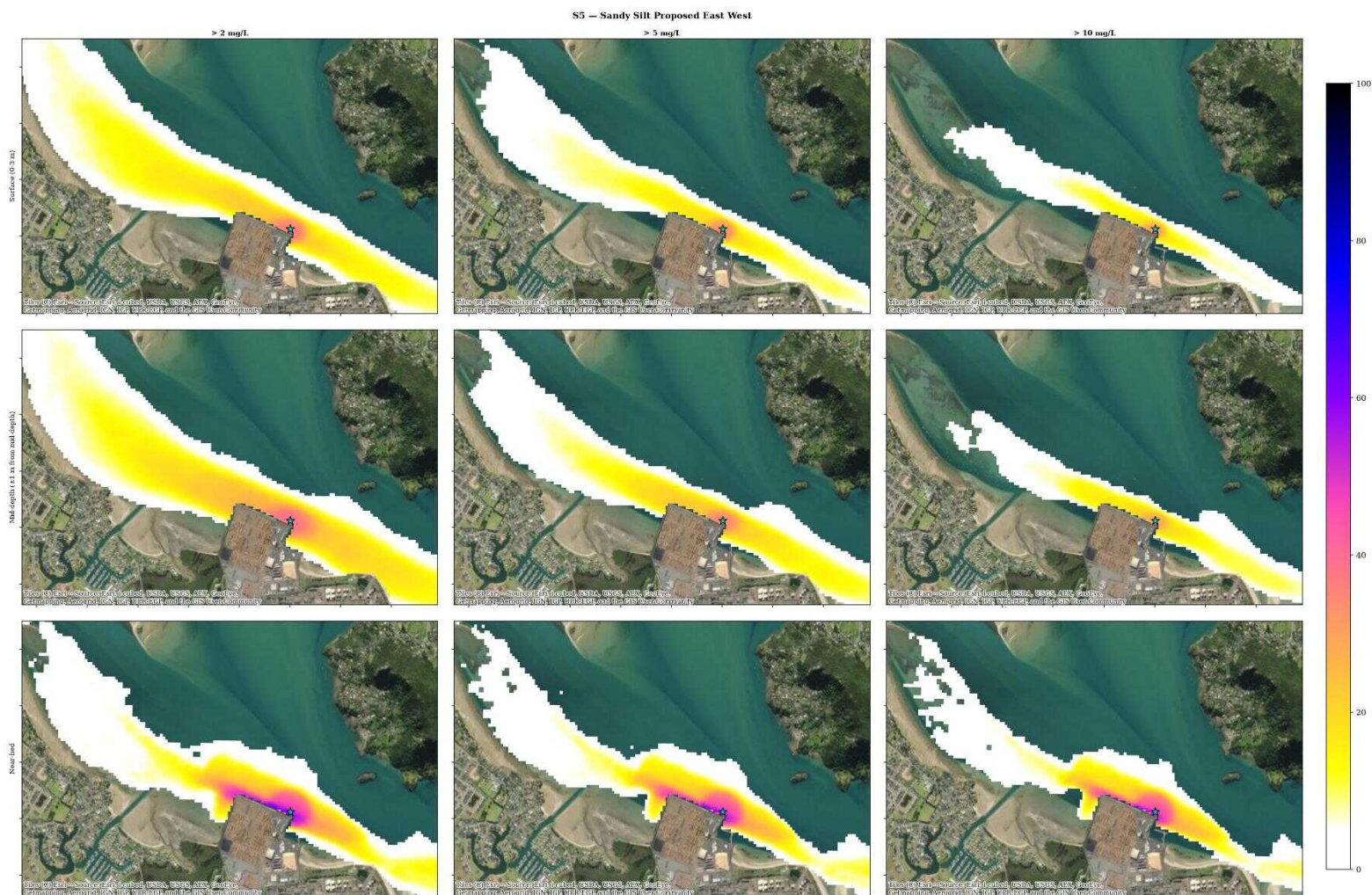
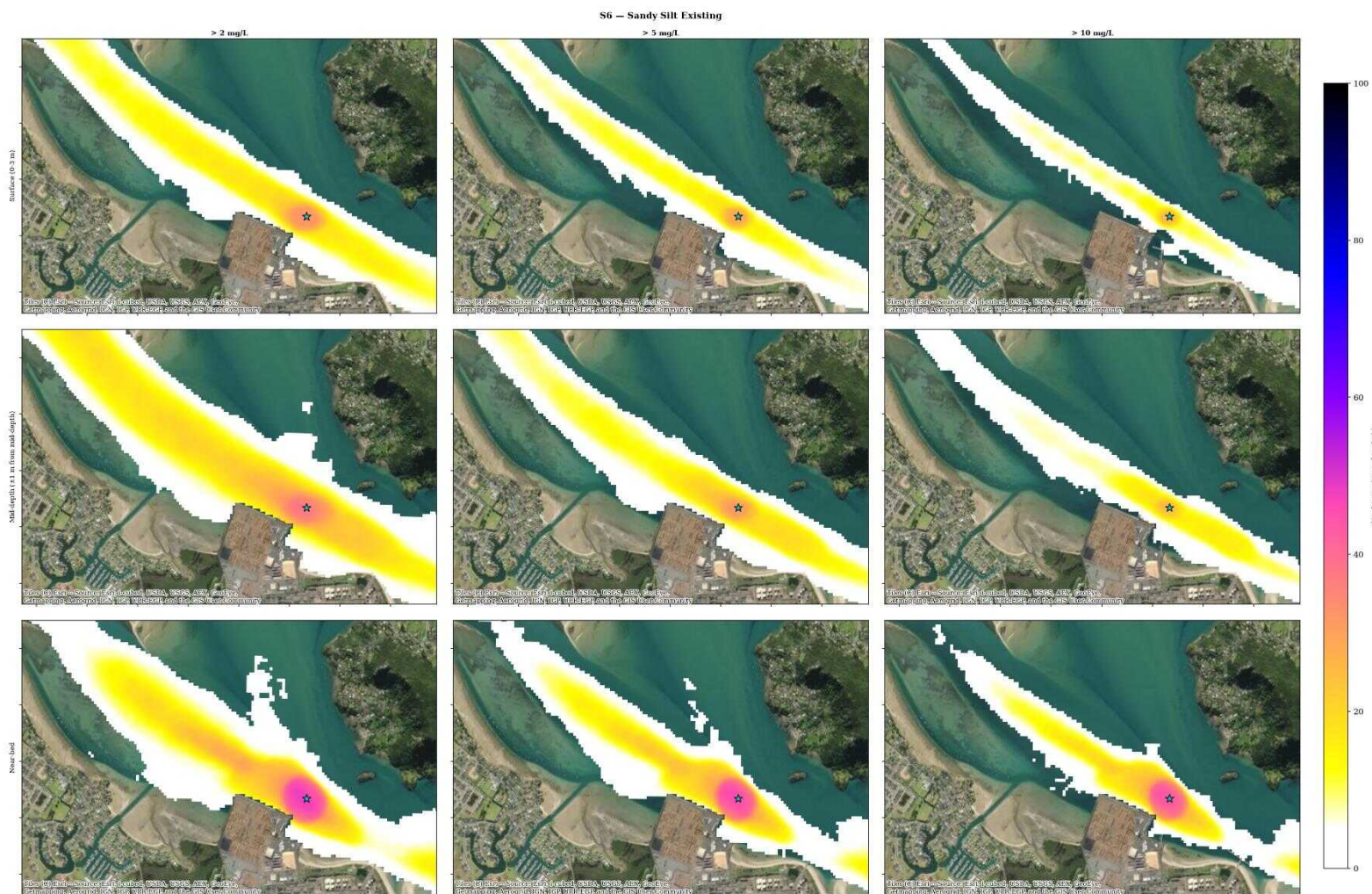


Figure 66 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 5**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.





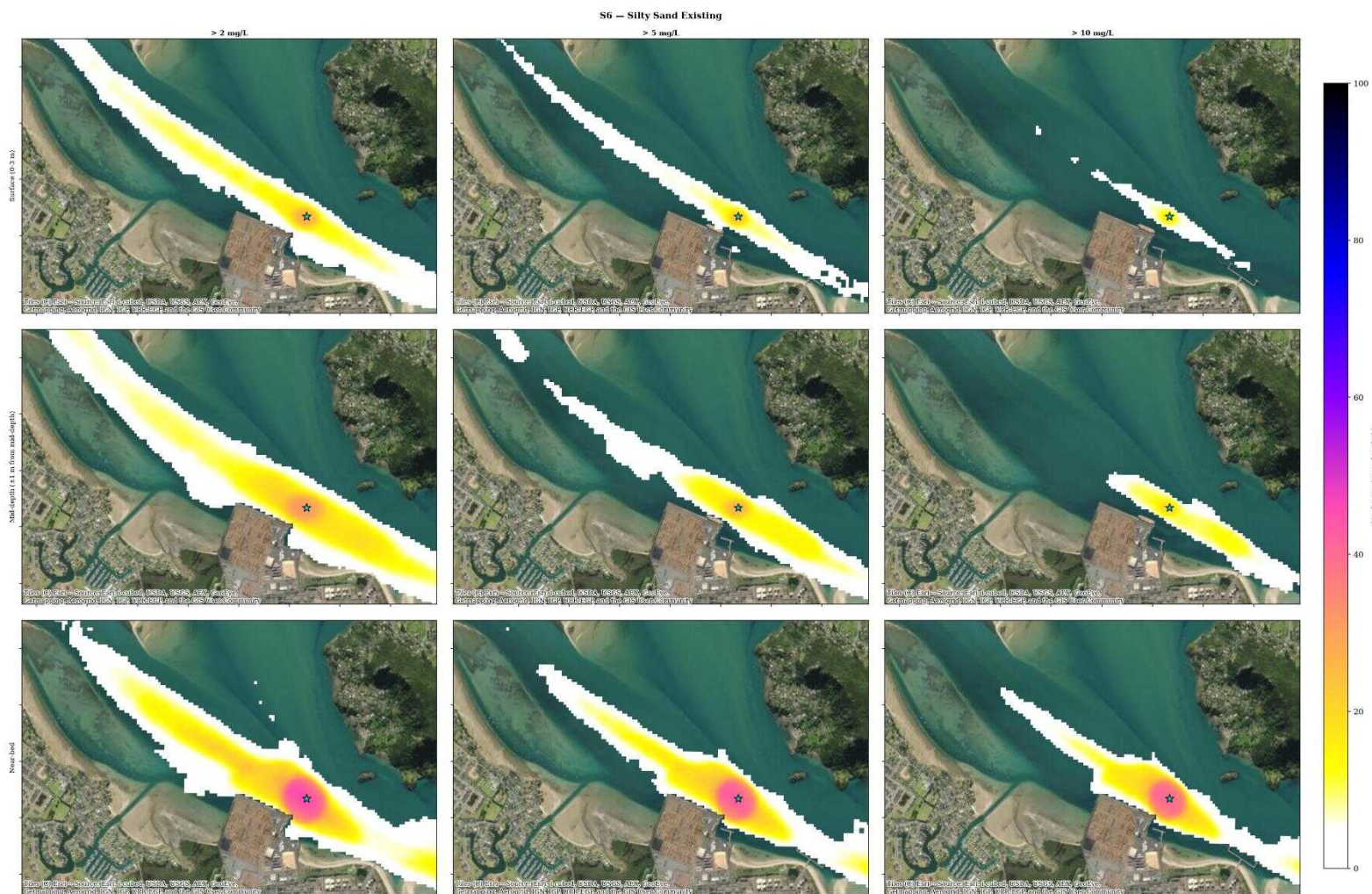
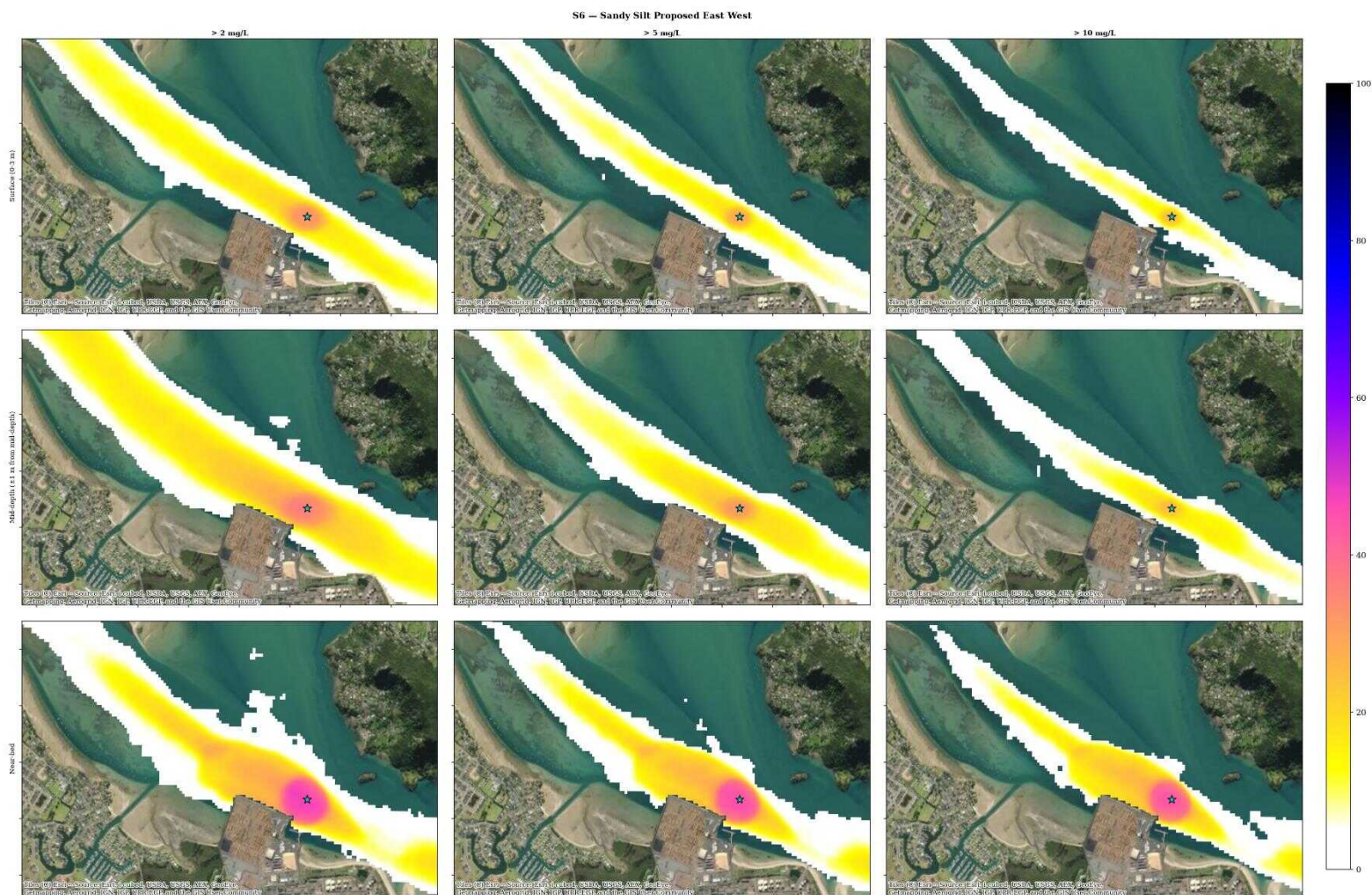
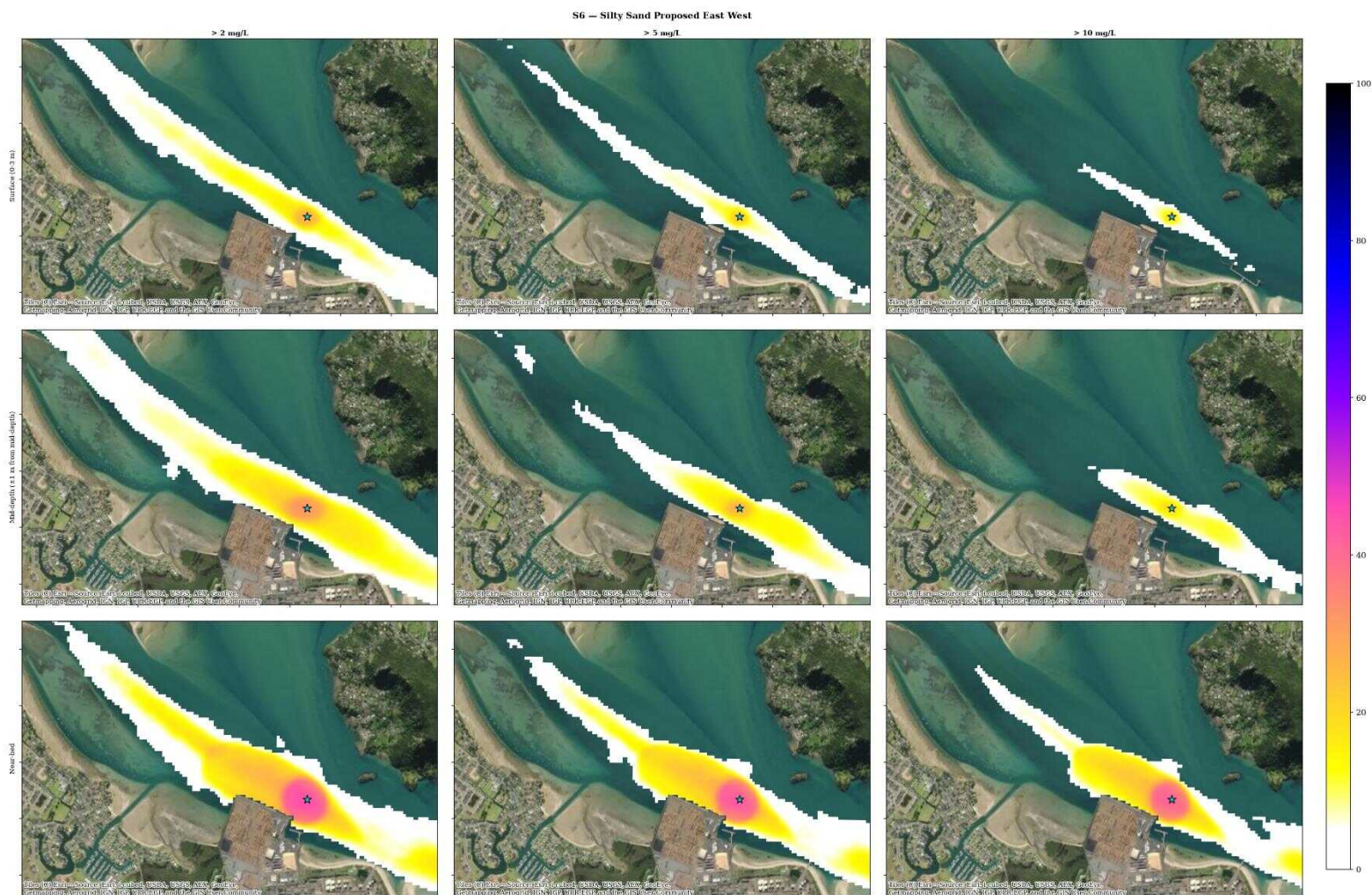


Figure 70 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 6**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.





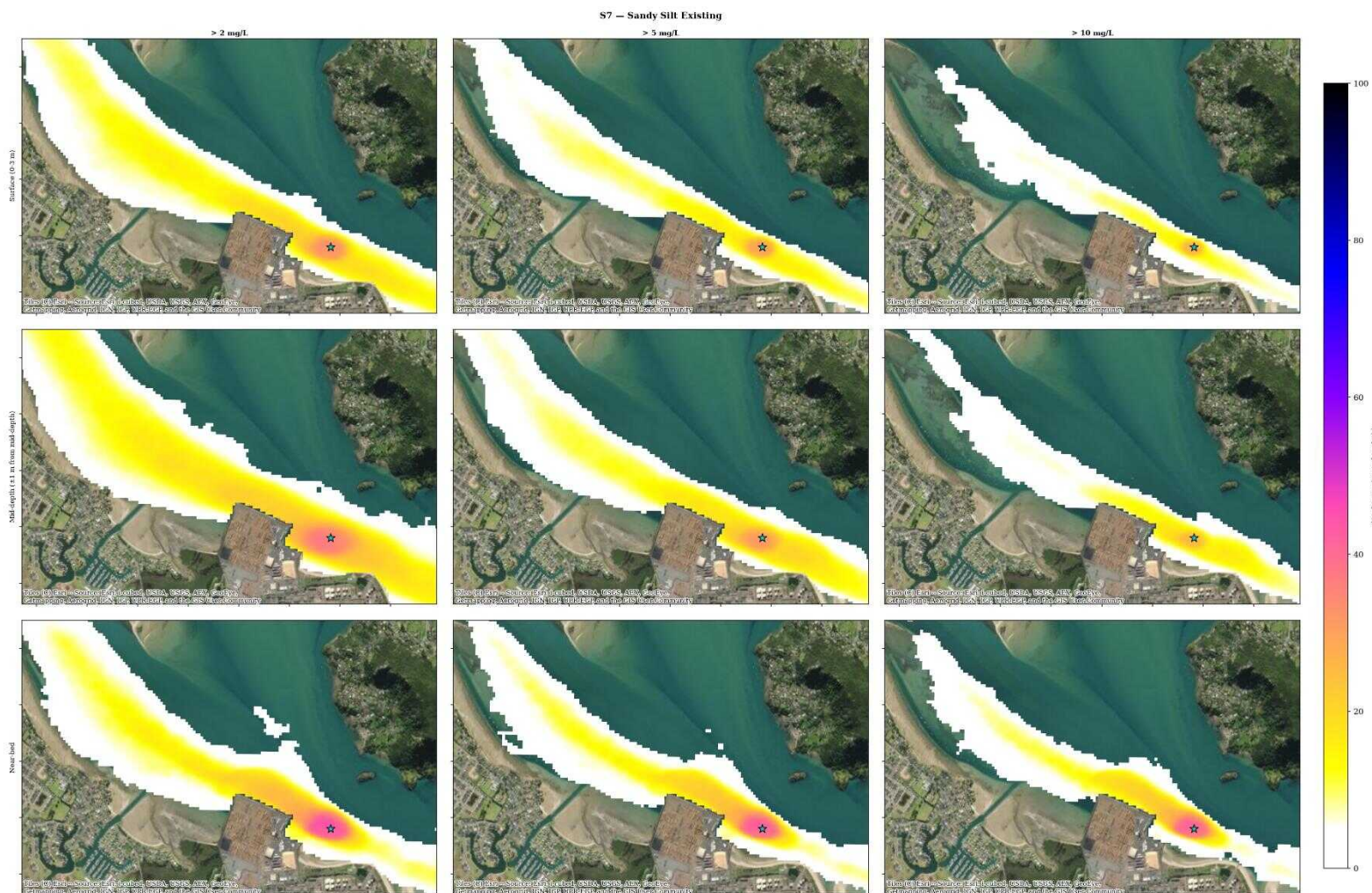


Figure 73 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 7**, over the **existing bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.

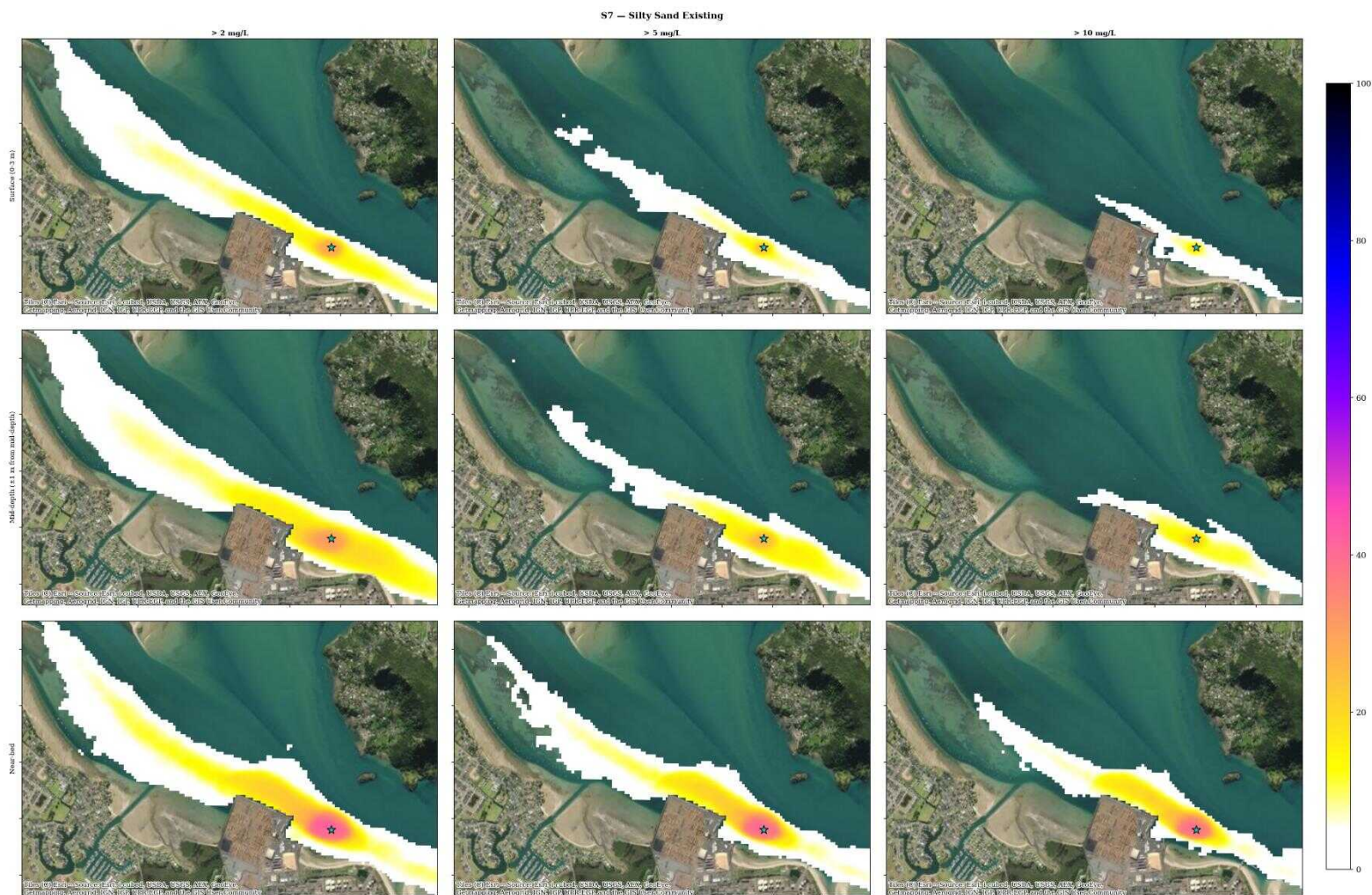


Figure 74 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 7**, over the **existing bathymetry**. Results are shown for the **silty sand**. Results were masked below 1%.

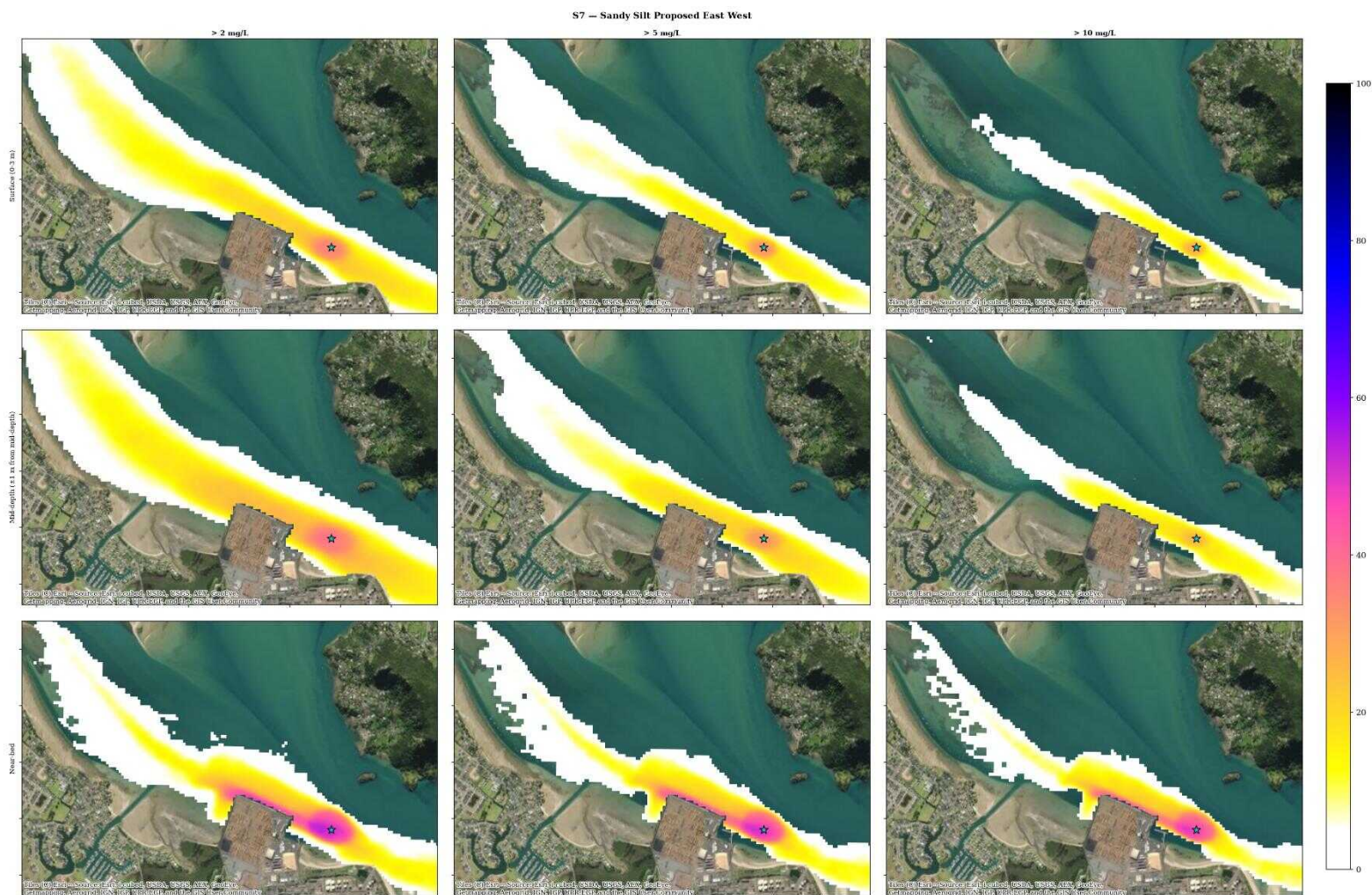


Figure 75 **Percentage of time** total suspended sediment concentrations (mg L^{-1}) are above thresholds of **2, 5, and 10 mg L^{-1}** (left to right), at surface, mid water and nearbed levels (top to bottom) for **TSHD** dredging at **site 7**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the **sandy silt**. Results were masked below 1%.





Dredge Plume Modelling

Dredging sediment plume dispersion over existing
and proposed port configurations

Dewatering simulations

Appendix C

Report prepared for MBIE

August 2026

Document History

Versions

Version	Revision Date	Summary	Reviewed by
0.1	05/08/2026	Initial document created	Montaño
0.2	07/08/2026	Draft for review	Beamsley

Distribution

Version	Date	Distribution
1.0	07/08/2026	FINAL - MBIE Project team

Document ID: P0678 – 09 – Appendix C

Authors

Montaño M.

Contributors

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Appendix C: Dewatering simulations

Northport is a deep-water commercial port strategically situated at Marsden Point near Whangārei in Northland, New Zealand (Figure 1-1).

The Ministry of Business, Innovation and Employment (MBIE) seeks approvals pursuant to the Fast-track Approvals Act 2024 for a shipyard and drydock facility (Northport Shipyard and Drydock Facility, NSDF) abutting the western side of the existing Northport facility at Marsden Point. The project includes a reclamation, vessel haul-out system, and associated wharf structures, dredging and supporting infrastructure.

In this appendix we describe the dredge dewatering simulations that forms part of the dredge sediment plume dispersion activities (See MOS report P0678-09, MetOcean Solutions 2026). The dewatering was simulated over a 1-month period for three different configurations:

- 1) the existing bathymetry (Existing),
- 2) the Eastern reclamation and NSDF (Design East and West), and
- 3) the NSDF (Design West).

The dewatering simulations were undertaken using an earlier design for the reclamation region and proposed dredged area (Figure 1-1, Figure 1-2), which in the immediate area of discharge is near identical to the existing configuration being considered. As such, there are no significant changes to the plume dispersion dynamics expected.





Figure 1-1 Concept drawing for the proposed area to be dredged and reclaimed for Design West.

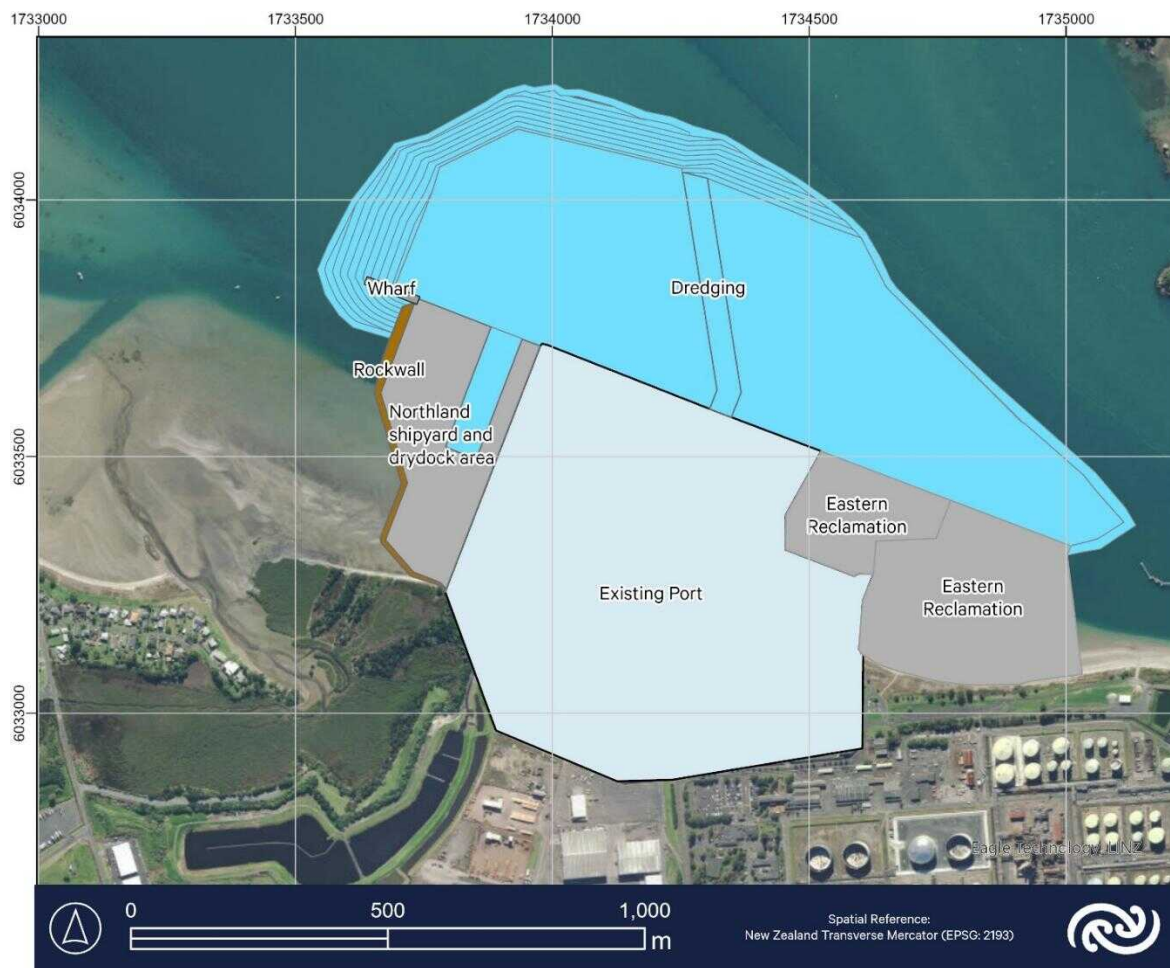


Figure 1-2 Concept drawing for the proposed area to be dredged and reclaimed for Design East and West.

1.Introduction

Dredge dewatering is the process of separating water from the solid material dredged. The dredged material may be used for the reclamation, in which case the dredged slurry will be discharged within the reclamation bund, and decanting will occur with sediment settling within the reclamation enclosure and returning water will be released through a pipe located near the seabed at the corner of the existing quay (see Figure 1-1 and Table 1-1). This dewatering process may be concurrent with or separate from the actual dredging.

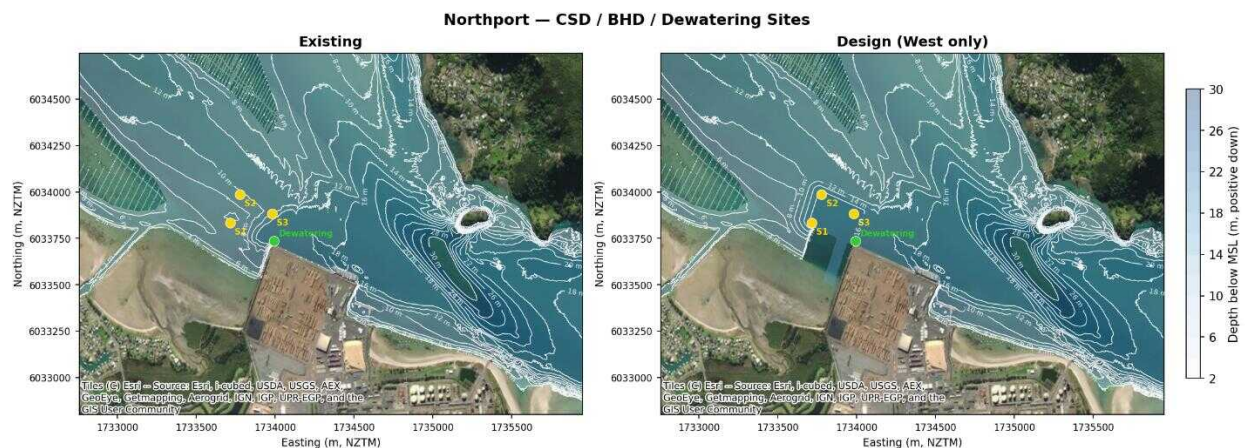


Figure 1-1 Release sites considered for the sediment dredging using CSD and BHD methods and the Existing (left) and proposed NSDF bathymetric contour around Northport.

Table 1-1 Positions and depth of release sites of the dewatering simulations. Depths are relative to mean sea level

Site	Longitude	Latitude	Existing Depth (m)	Proposed Depth (m)
Dewatering	174.4835	-35.8314	15.5	16.0

Table 1-2 Summary of source terms and scaling fractions simulated during dewatering simulations.

Source	Release depth	Radius (m)	Fraction of production rate
Pipe discharge	2 m above seabed	10	1

Table 1-3 Magnitude of source terms for the Dewatering

Dewatering	Magnitude
Pump rate ($\text{m}^3 \text{hr}^{-1}$)	1000
TSS in slurry for silty sand (mg L^{-1})	100
TSS in slurry for sandy silt (mg L^{-1})	500
Dry volumic mass (kg m^3)	1600

TSS=Total Suspended Sediment



2.Methodology

2.1 Dewatering Plume Modelling

The dewatering plume scenarios were simulated using the trajectory modelling framework OpenDrift (Dagestad et al. 2018). For more information see Report P0678-09 (MetOcean Solutions 2026).

2.1.1 Particle release

Dewatering particles were released according to source terms of Table 1-3.

Individual simulations were undertaken for silt and clay sediment and results were then combined to obtain the total Suspended Sediment Concentration (SCC) plume. The total number of particles released per simulation and per sediment class, was of the order ~100,000 for Dewatering. This amounts to a total of 200,000 particles when combining the 2 different sediment classes. Additionally, the model timestep was set at 300 seconds for clay and silt.



3.Results

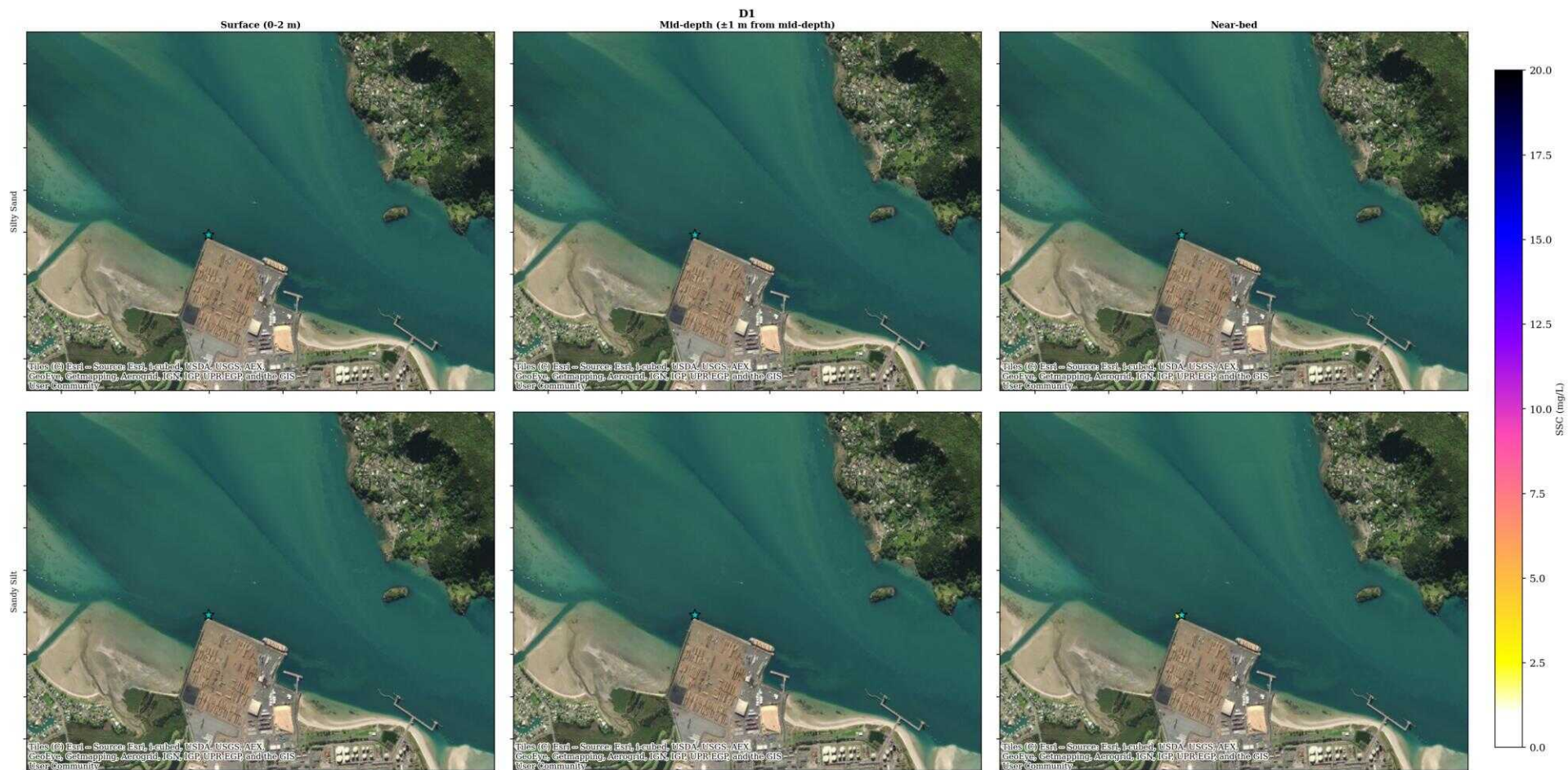
3.1 Dewatering Sediment Plume

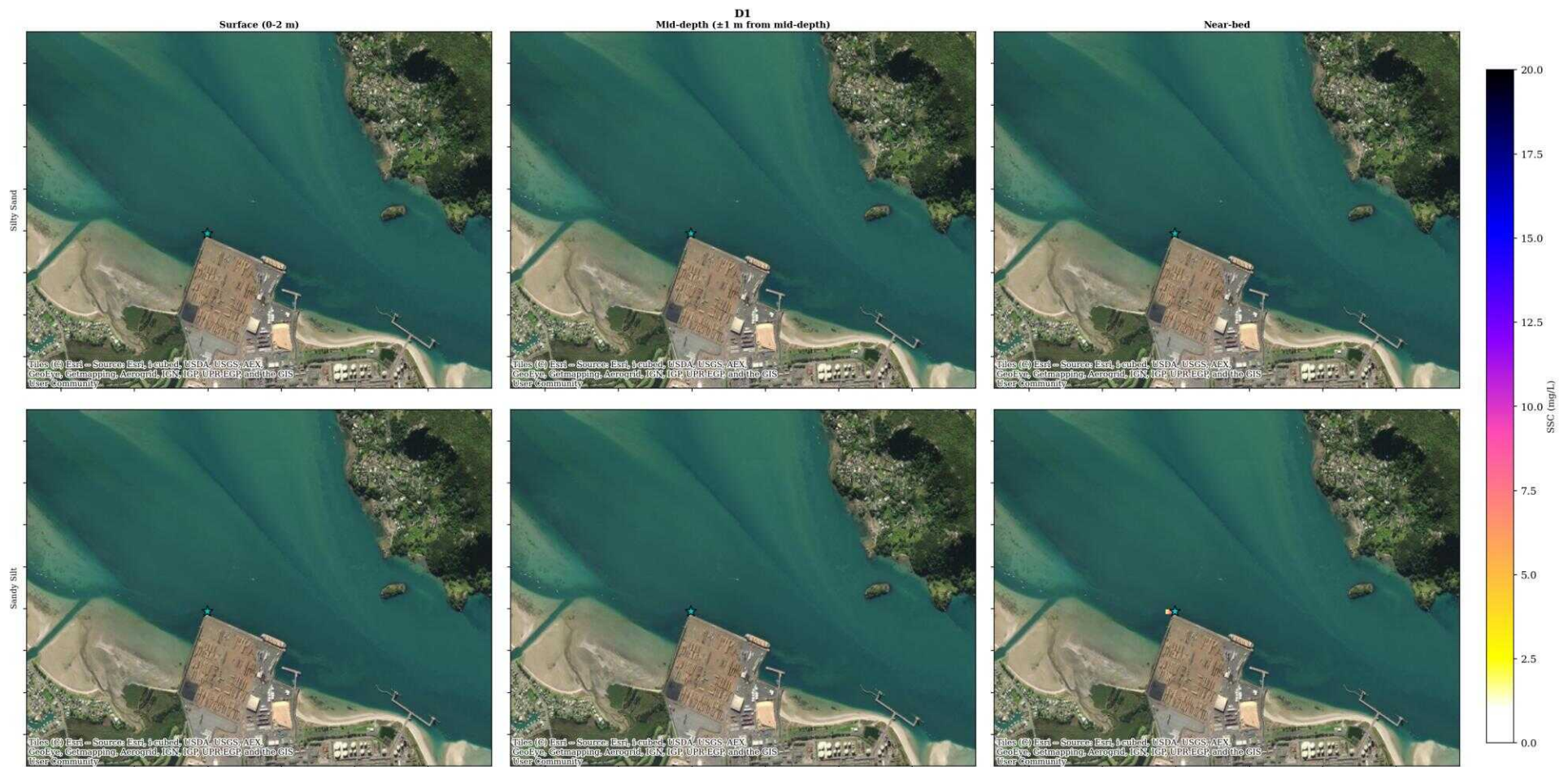
It is likely that the majority of the dredged material will be used for the reclamation. The corresponding sources terms for dewatering are significantly smaller than the dredging methods production rates (Table 1-3). As expected, the resulting 50th percentile TSS plumes exhibit low TSS levels, that are confined in the nearbed layer (Figure 3-1-Figure 3-3). The 90th percentile shows a slightly more extensive near-bed sediment plume (Figure 3-4 to Figure 3-6). However, relative to the CSD and BHD releases, the sediment plume extends eastward regardless of the bathymetry configuration, remaining concentrated around the port.

Modelled scenarios assume one month of continuous dewatering discharging at a fixed location. The key findings based on the figures are as follows:

- The highest TSS concentrations occur near the seabed.
- Dewatering plumes exhibit a persistent eastward trajectory and stay concentrated around the port area regardless of the bathymetry layout.







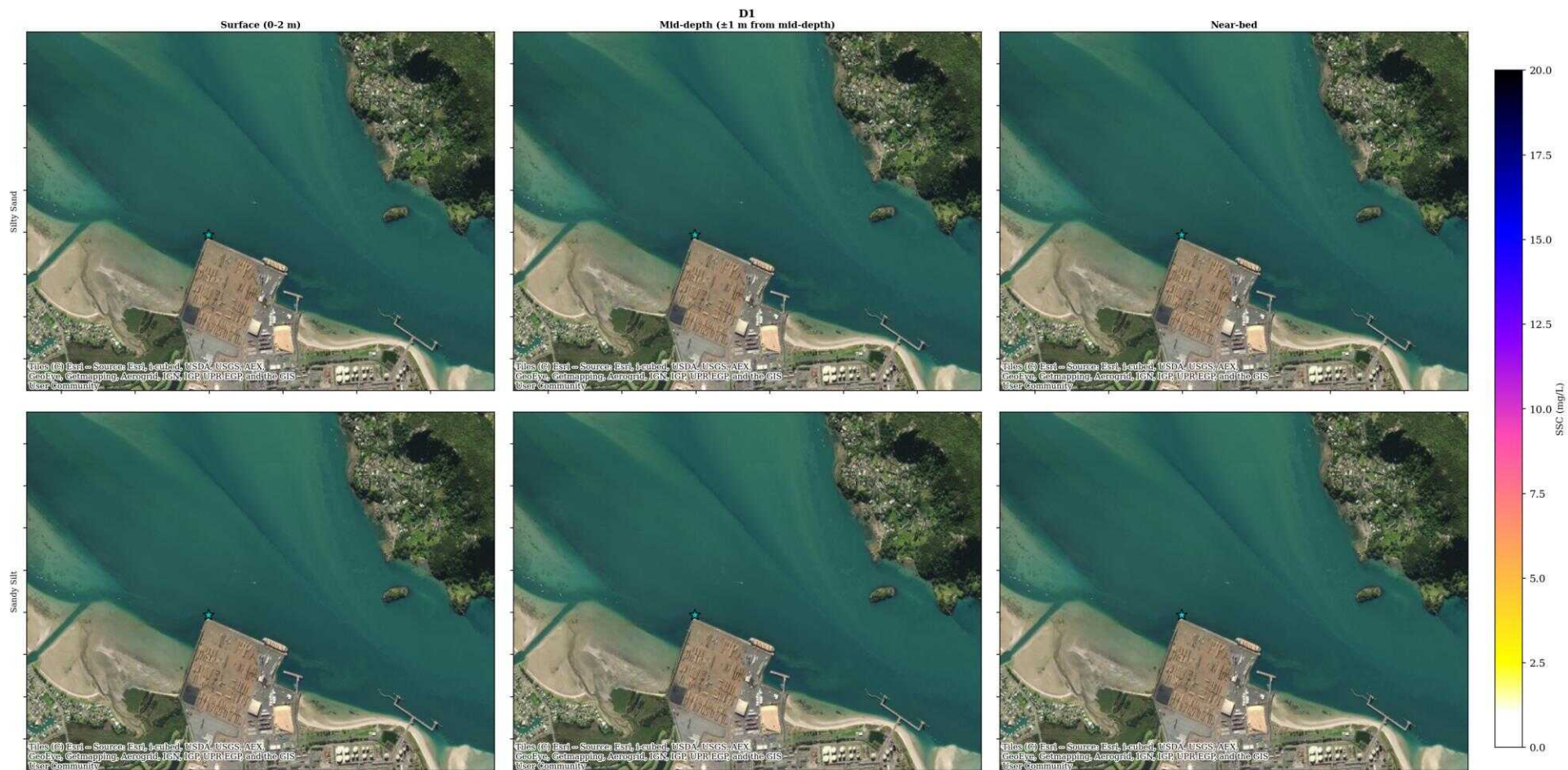
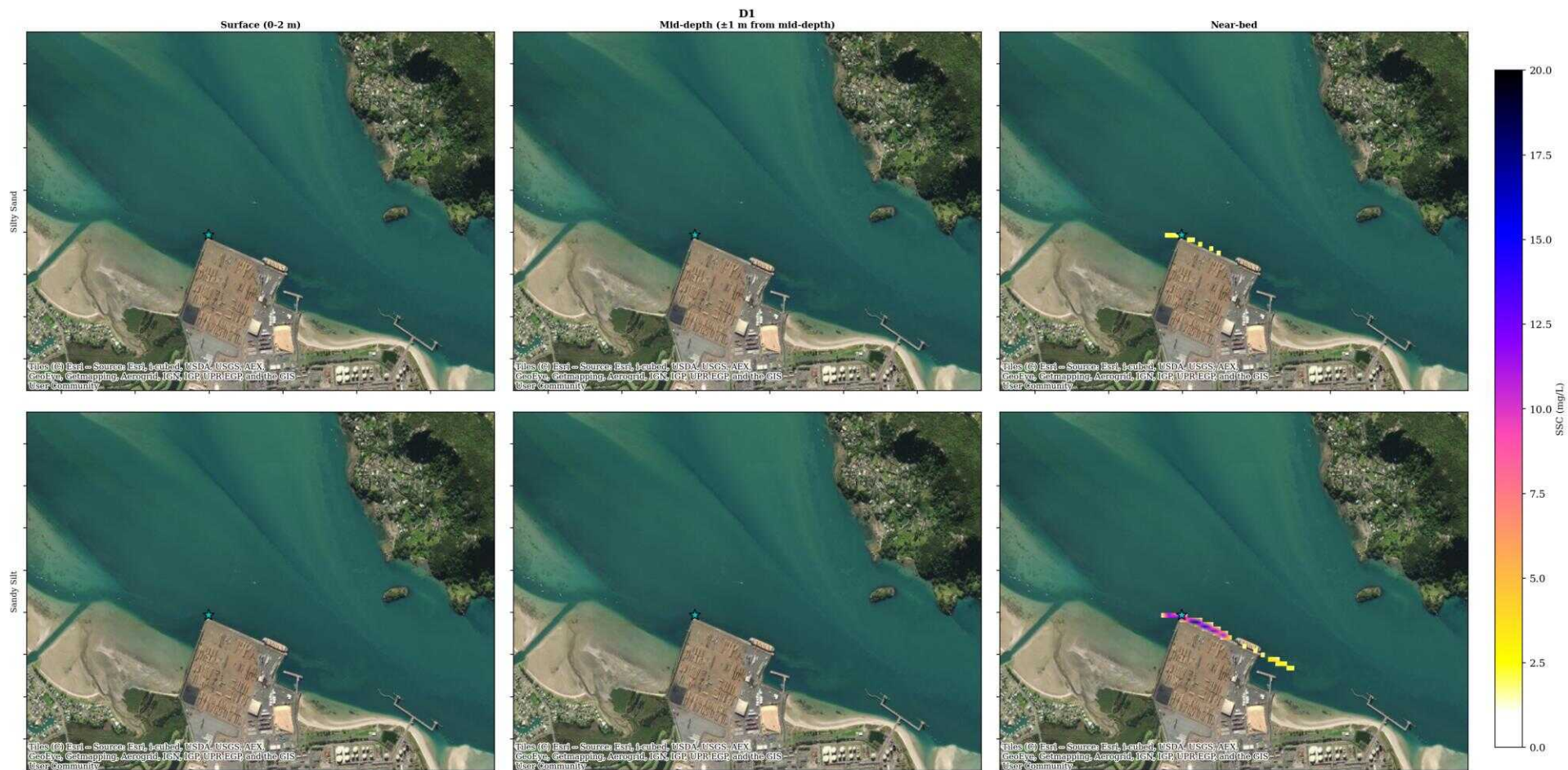


Figure 3-3 **50th percentile** total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for **dewatering site**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. TSS were masked below 1 mg L^{-1} .



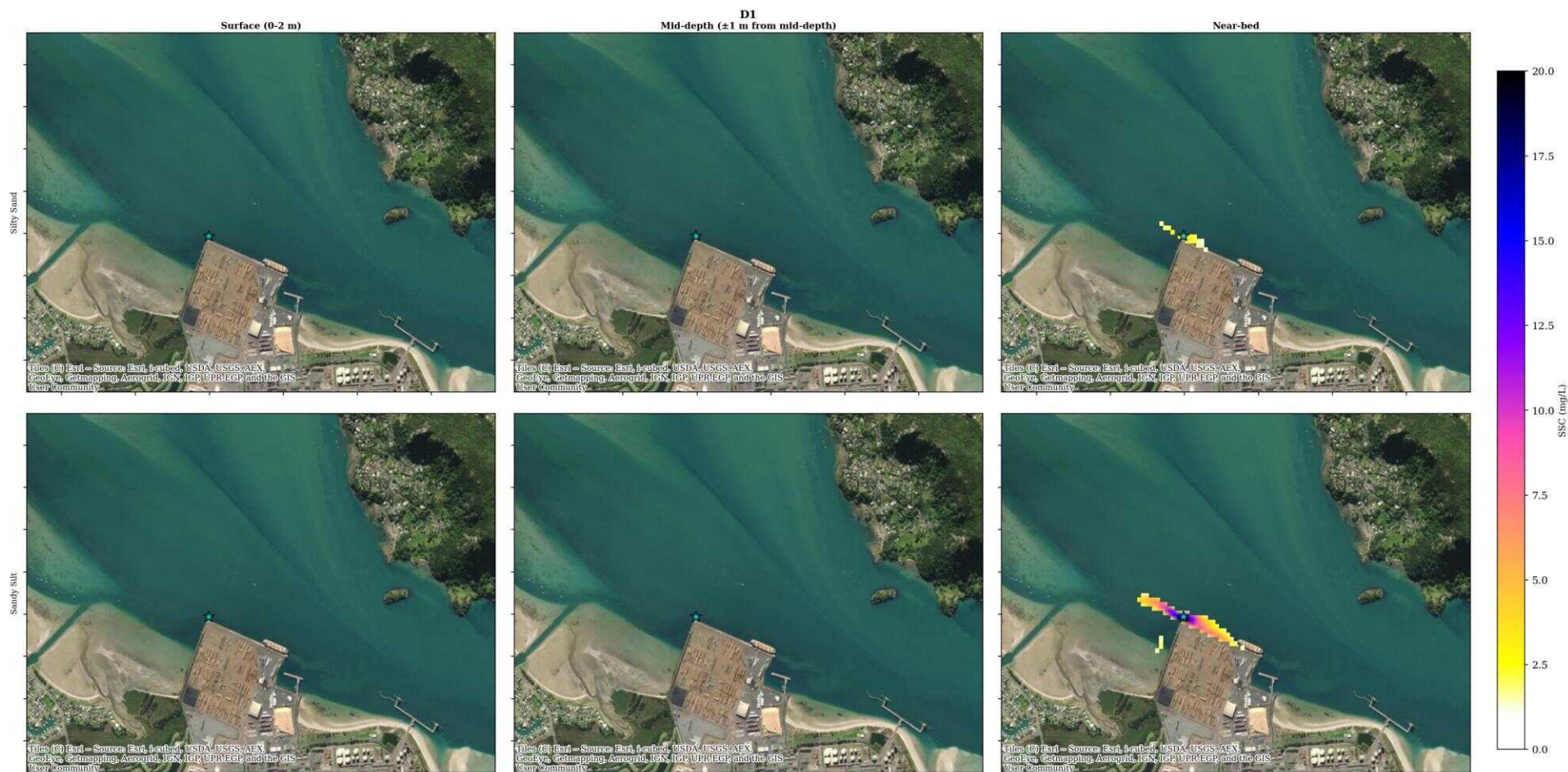


Figure 3-5 **90th percentile** of total suspended sediment concentrations (mg L^{-1}) at surface, mid water and nearbed levels (from left to right) for the **dewatering site**, over the **proposed Eastern Reclamation and NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. TSS were masked below 1 mg L^{-1} .

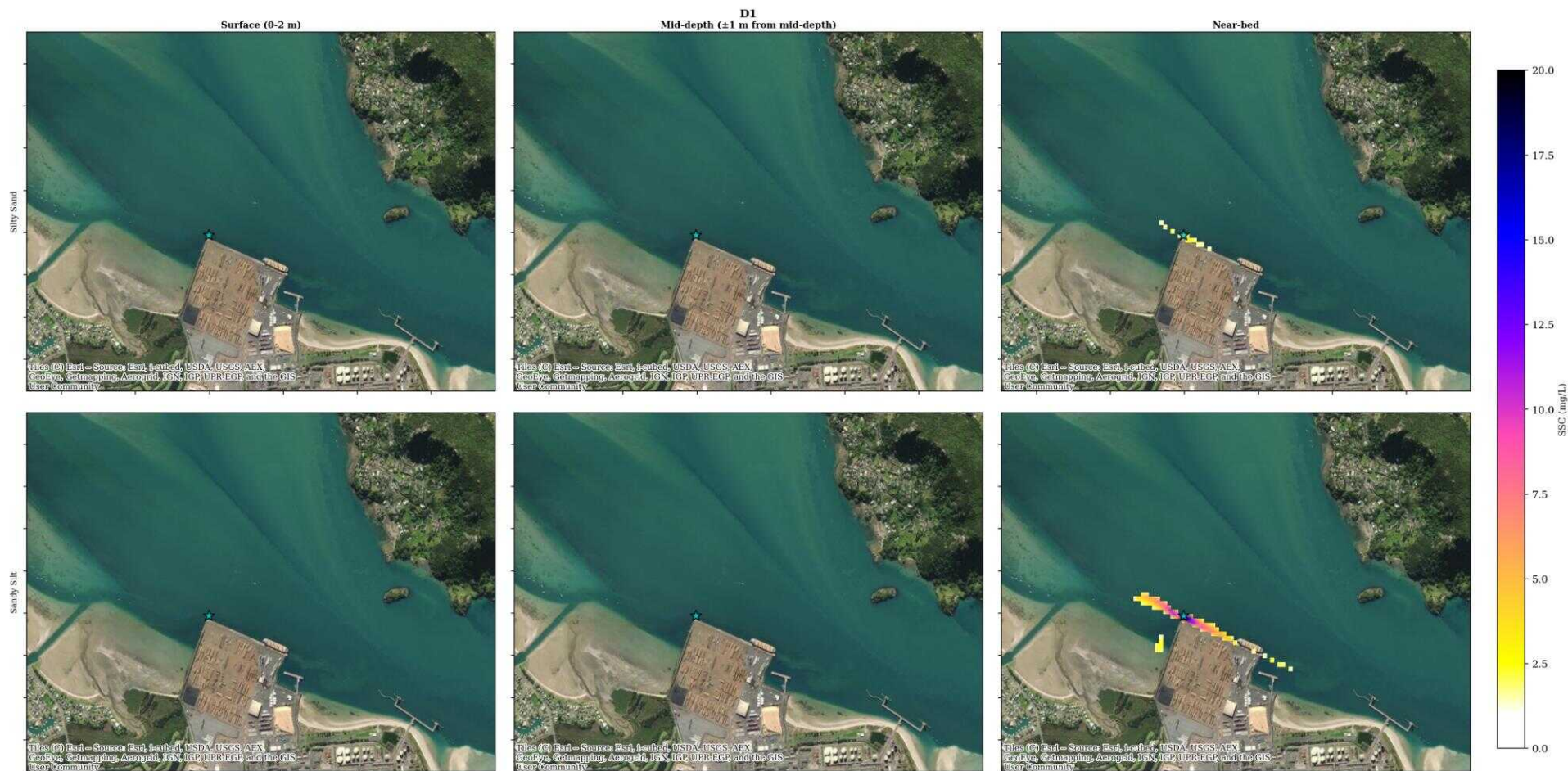


Figure 3-6 **90th percentile** of total suspended sediment concentrations (mg L⁻¹) at surface, mid water and nearbed levels (from left to right) for the **dewatering site**, over the **proposed NSDF bathymetry**. Results are shown for the silty sand on the top panels and sandy silt on the bottom panel. TSS were masked below 1 mg L⁻¹.

4. References

- Dagestad, K.-F., J. Röhrs, Ø. Breivik, and B. Ådlandsvik. 2018. "OpenDrift v1.0: A Generic Framework for Trajectory Modelling." *Geoscientific Model Development* 11(4): 1405–20. doi:10.5194/gmd-11-1405-2018.
- MetOcean Solutions. 2026. *Dredging Sediment Plume Dispersion over Existing and Proposed Port Configurations. (Design July 2026).* . Report prepared for MBIE.

