Measures pertaining to the fish inside the port at the Fukushima Daiichi Nuclear Power Station

＜Reference Material＞
June 26, 2023
TEPCO Holdings
Fukushima Daiichi D&D Engineering Company

- To prevent fish containing high cesium concentrations from escaping outside of the port, TEPCO has been implementing multilayered measures pertaining to the fish inside the port which include improving the environment of the port, catching the fish in addition to keeping them in place, and monitoring the port.
- In addition to existing measures, the following measures will be implemented going forward.

① Measures to improve the environment of the port such as removing rubble and paving will be implemented in a planned manner to reduce the cesium concentration of seawater within the Units 1-4 intake open channel to less than 1 Bq/L. To deal with the sand deposits, a silt fence will be installed at the discharge outlet of K discharge channel and the sediment deposition will be sampled to gather information to consider the measures.

② Measures to catch the fish and prevent them from leaving that area by the use of gill nets, and others have been strengthened in light of the suspension of black rockfish shipment in February, 2022. In addition, the net to prevent the fish from leaving at the East sea wall will be replaced with nets made of strong and corrosion-resistant polyester monofilament nets and steel pipe piles (main installation). The new net will be extended to surround the Units 1-4 intake open channel. Other measures at the port entrance to prevent the fish from leaving such as measures using underwater sound will continue to be considered.

③ The cesium concentration of seawater in the port and the status of the fish will continue to be monitored.

＜Announced on September 27, 2022 (updated on June 5, 2023) only in Japanese＞

- Among the additional measures mentioned above, design, procurement and other preparations to start “the main installation work for the net to prevent the fish from leaving at the East sea wall” has been completed and preparations are underway so that construction can begin in July with the goal of operation by the end of 2023.
- In response to the sampling results of the sediment deposition in the Units 1-4 intake open channel as well as the detection of the high cesium concentration in the black rockfish caught on May 18 in the Units 1-4 intake open channel, surveys and measures pertaining to the fish inside the port will be strengthened further. A survey will be conducted of the cesium concentration of seawater gathered near the seafloor in the Units 1-4 intake open channel, the seabed soil in the Units 1-4 intake open channel will be covered again, the mesh size will be made finer of the main installation net to prevent fish from leaving at the Units 1-4 intake open channel exit, and the environmental improvement for the entire port will be considered.
- We will continue to work on measures pertaining to the fish inside the port including the environmental improvement in the port.

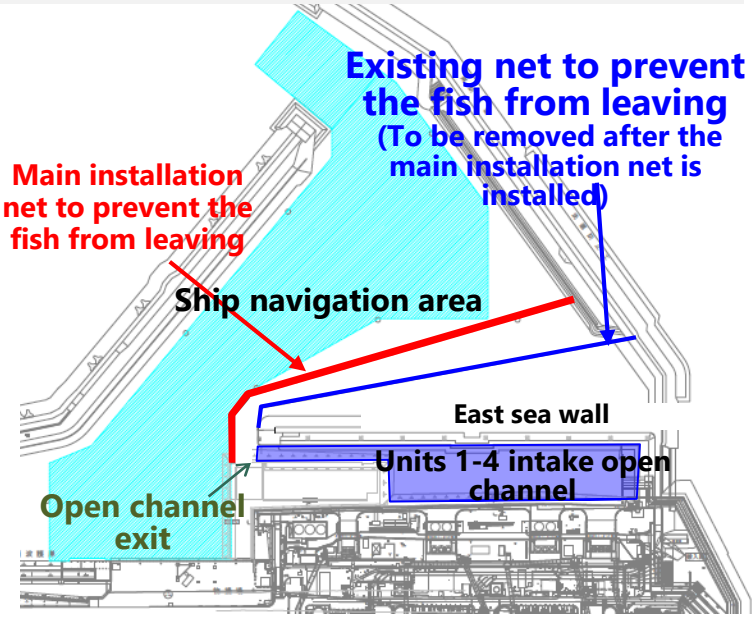
1. Main installation work for the net to prevent the fish from leaving at the East sea wall

TEPCO

- The net to prevent fish from leaving installed near East sea wall will be main installation by replacing with a permanent net made of steel pipe piles and strong and corrosion-resistant polyester monofilament nets, and extended to surround the Units 1-4 intake open channel exit to strengthen the measure to prevent fish from leaving from around the Unit 1-4 intake open channel. (The existing net to prevent the fish from leaving will be removed.)
  - The net to prevent the fish from leaving will encompass an area as large as possible surrounding the Units 1-4 intake open channel exit while also ensuring that ships can pass safely through the port. The net will cover the full water depth in the area from the seafloor to sea level, and will be made with a small mesh size of around 4 cm.
  - Because the net function can degrade due to various aging phenomena including corrosion due to seawater, damage in high waves, and sinking due to adhesion of marine organisms, it will be made with steel pipe piles and high durability netting.
  - **Preparations are ongoing so that construction can begin in July. We aim to begin operation by the end of this year.**
  - During construction, the current net to prevent the fish from leaving will be left in its place and other measures to prevent the fish from leaving such as maintaining the gill net at the port entrance and adding additional cage net near the sea wall will be implemented.

Table 1. Details of the main installation work fot the net to prevent the fish from leaving at the East sea wall

Work overview	Type of work
①Steel pipe pile placement Pile diameter 1,000mm Length 18.0m×6 piles ②Steel pipe pile placement Pile diameter 900mm Length 17.3m×20 piles	Pile driving with a piling ship
③Installation of guiderails for the high durability nets 54 locations	Underwater welding by diving work
④Attachment of wires for high durability nets Length 20m×27 sections between piles	Lifting work with crane barge
⑤Attachment of high durability nets Width 20m× Height 9m×27 nets	Lifting work with crane barge and diving work performed simultaneously



※See the following slides for details of the net construction work

Diagram 1 Area where the net to prevent the fish from leaving will be installed

【Reference】Main installation net to prevent the fish from leaving (Placement of the steel pipe piles/installation parameters of the high durability nets)

【Placement of the steel pipe piles (Diagram 2)】

- Piles with a diameter of 1000 mm will be used for Area 1 where heavily affected by wave power from outside of the port, and piles with a diameter of 900 mm will be used for Area 2 that is less affected by wave power.

【Installation parameters of the high durability net (Diagram 3)】

- The net will rise above sea level by 1 m.
- The gap between the high durability nets and the steel pipe piles will be 3 cm, smaller than the net mesh size.
- The skirt of the net that will brush the seafloor will prevent any rock fish from escaping.

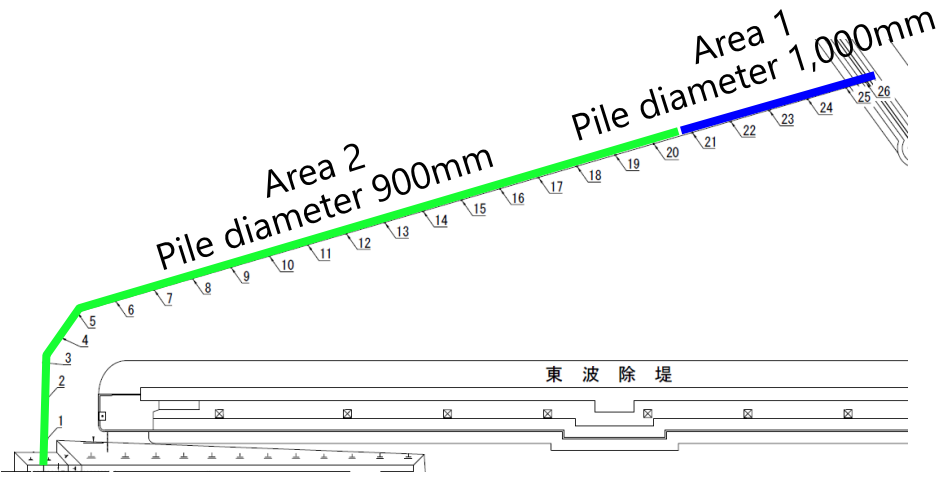


Diagram 2 Placement of the steel pipe piles

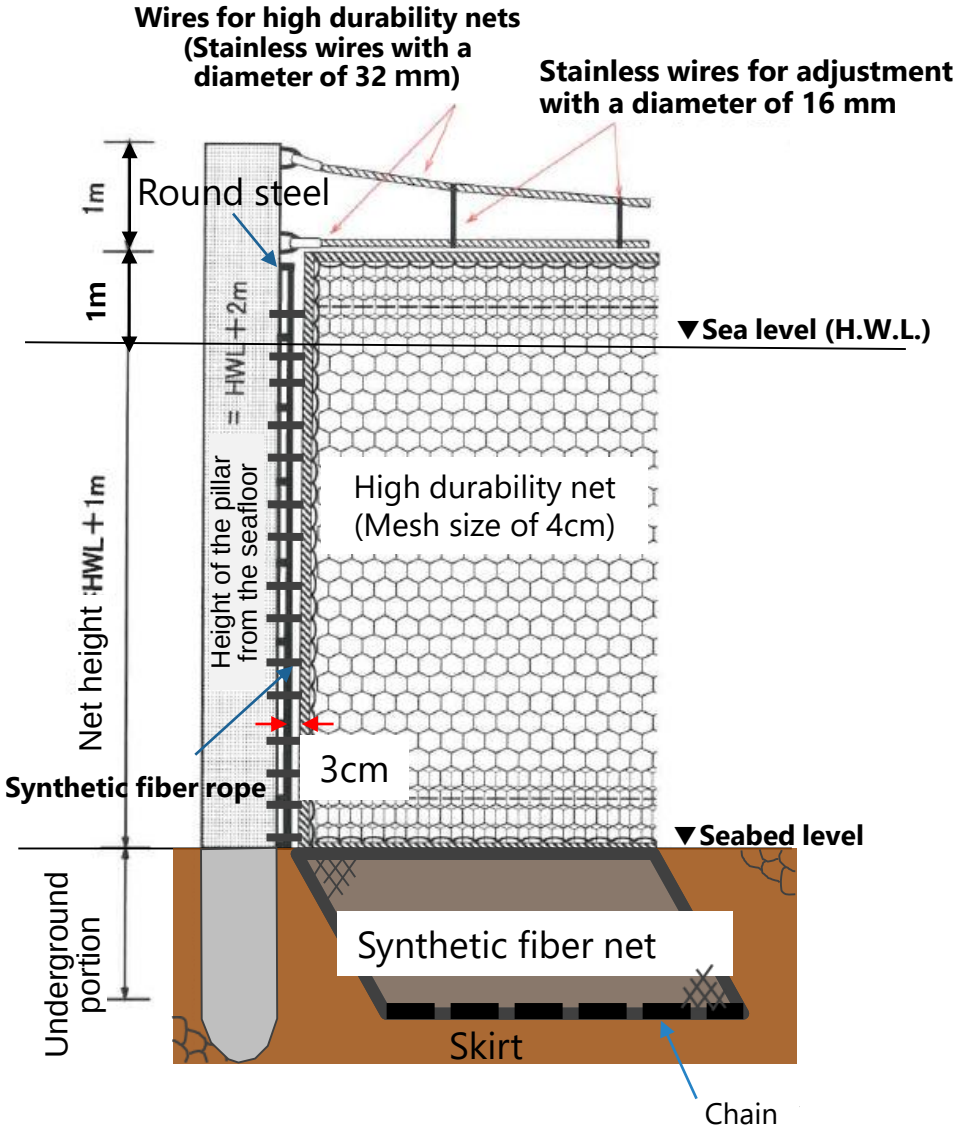


Diagram 3 Net installation

【Reference】Main installation net to prevent the fish from leaving (Placement of steel pipe piles/attachment of high durability nets)

【Placement of steel pipe piles】

- Steel pipe piles that will be the support for the high durability nets will be placed in front of the Eastern wave breaker at 20 m intervals using 50-ton piling ships
- To prevent the seawater from getting more cloudy during construction, steel pipe piles will be equipped with a lid designed to prevent increases in seawater turbidity.
- Once the steel pipe piles are in place, the attachment guiderails for the high durability nets will be welded on by divers.

【Attachment of high durability nets】

- Wires for attaching high durability nets will be lifted with a 250-ton crane barge and installed between the steel pipe piles.
- High durability nets will be lifted with a crane barge and bound to the wires and piles by a diver.
- During the construction work , gill nets keep placed at the port entrance and basket nets will be added near the breakwater.

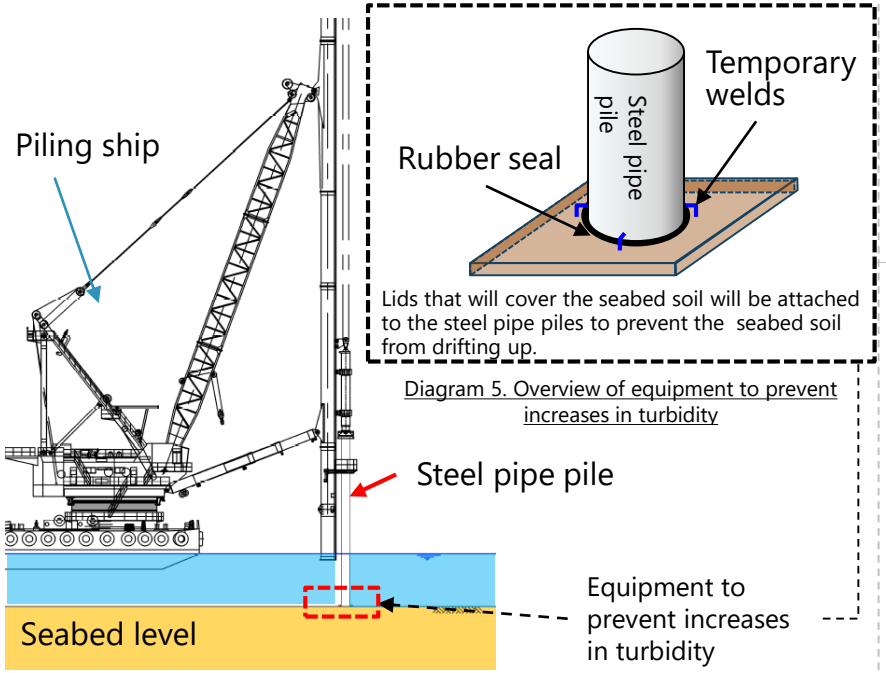


Diagram 5. Overview of equipment to prevent increases in turbidity

Diagram 4. Steel pipe pile driving method

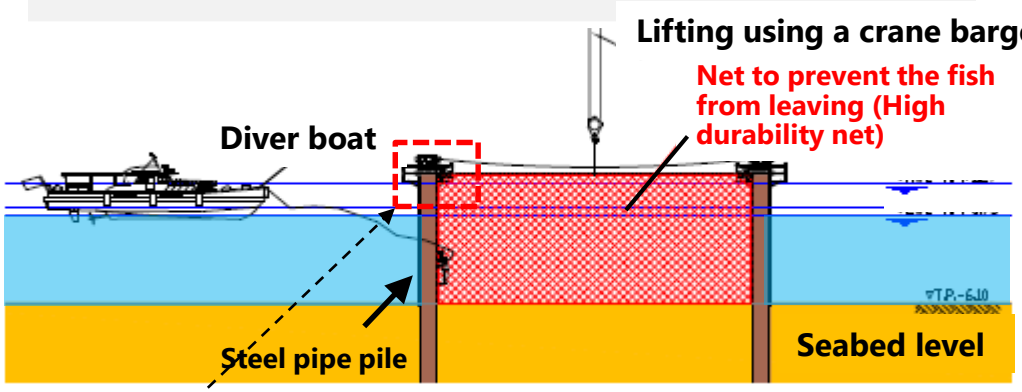


Diagram 6. High durability net attachment method

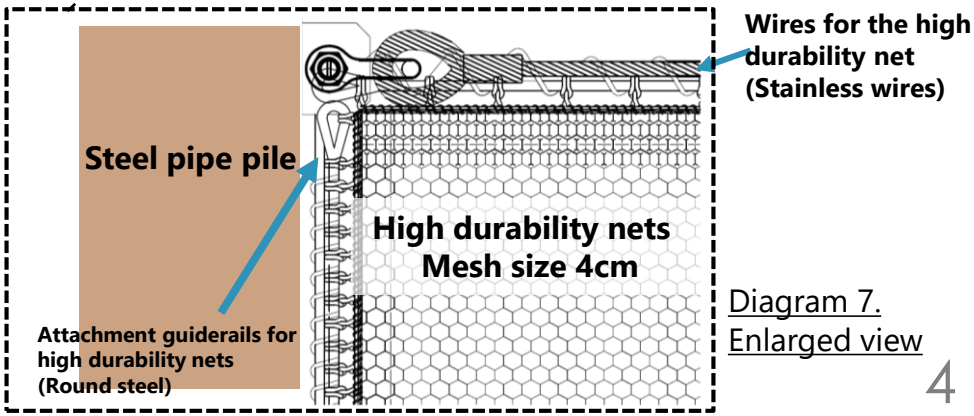


Diagram 7. Enlarged view

2-1. Survey of seawater concentration near the seafloor in the Units 1-4 intake open channel

- A high Cesium-137 concentration of 18,000 Bq/kg was observed in a black rockfish caught on May 18 at the Units 1-4 intake open channel.
- According to the daily seawater sampling on the south side of the Units 1-4 intake open channel, the average of concentration Cesium-137 in seawater near the sea surface in FY2022 was about 5 Bq/L, its concentration is difficult to explain based on the knowledge that the cesium concentration factor in fish is 100 ((Bq/kg)/(Bq/L)).
- As the cesium concentration of the seabed soil in the open channel was found to exceed one-hundred thousand Bq/kg, the cesium concentration of the seawater near the seafloor and containing in the seabed soil (interstitial water) could be higher than that of the seawater at sea level taken in the seawater sampling. Taking this into account, **the cesium concentration in the seawater near the seafloor, seabed soil, and seawater in the seabed soil near where the black rockfish was caught will also be surveyed.**

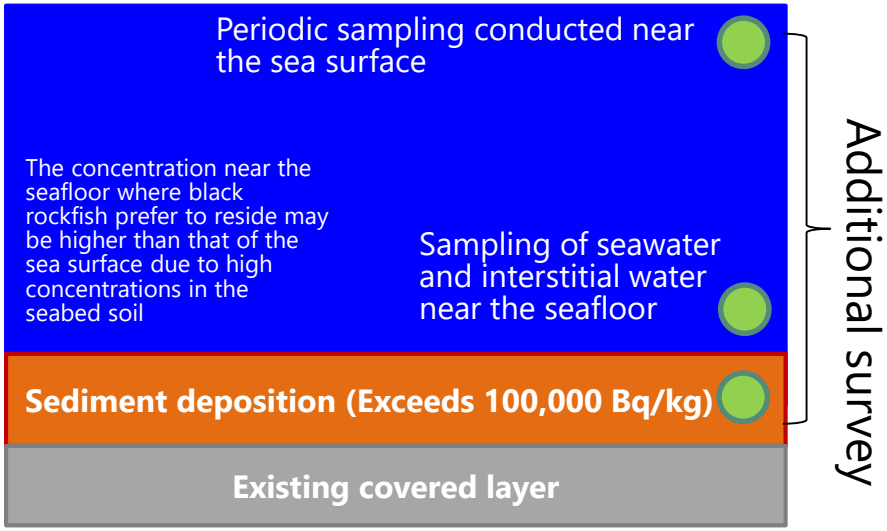


Diagram 1. Cross section of the open channel

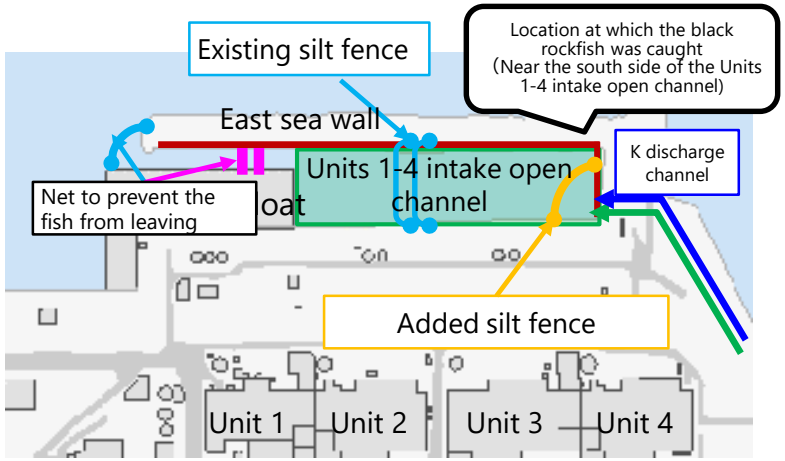


Diagram 2. Location where the black rockfish was caught (survey location)

2-2. Recover of the seabed soil in the Units 1-4 intake open channel

- In January 2023, the seabed soil in the Units 1-4 intake open channel was sampled and analyzed. Results showed that the cesium concentration of the sediment deposition in the open channel was high (Announced on April 27, 2023 only in Japanese).
- Following these results, as we were studying countermeasures against sediment deposition, as shown in 2-1, high cesium concentration were detected in a black rockfish caught in the Units 1-4 intake open channel.
- **Measures against sediment deposition will be quickly implemented,** along with investing the cause of the high cesium concentration detected in the black rockfish.
- **Specifically, the seabed soil will be covered again. This is much less likely to damage the cover placed in 2012 compared to dredging and can be performed quickly.**
- Because sand will continue to flow into the open channel from the discharge channel especially during rain, there will be discussions of reducing the flow of sand from the discharge channel and dredging after the seabed soil is recovered.

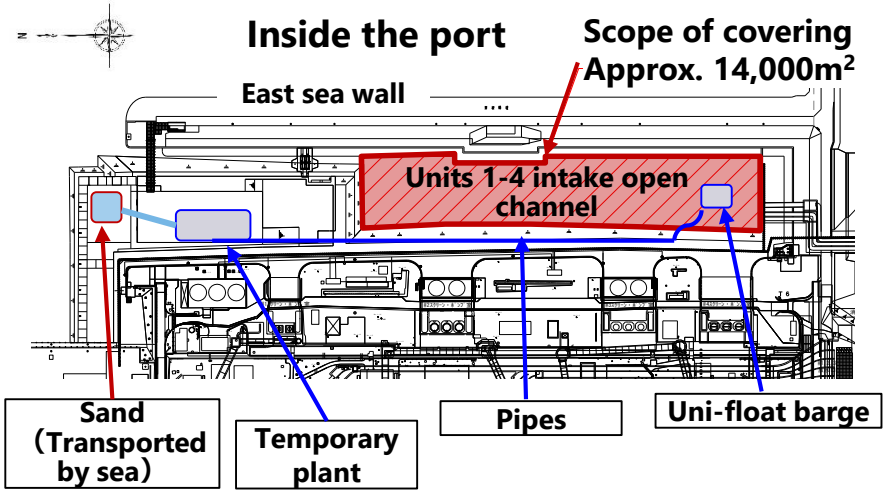


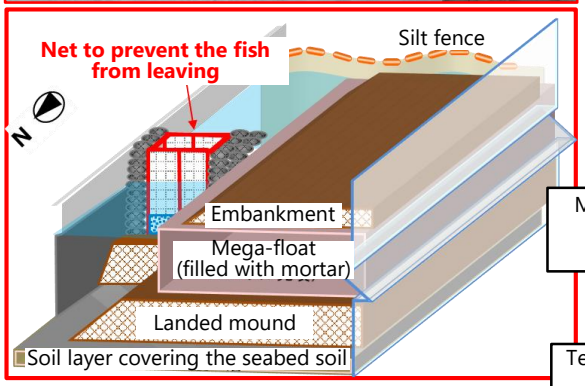
Diagram 1. Seabed soil covering work plan

Before covering the seabed soil using cement based material, sand mixed with seawater will be scattered from a uni-float barge to prevent the sand from lifting.

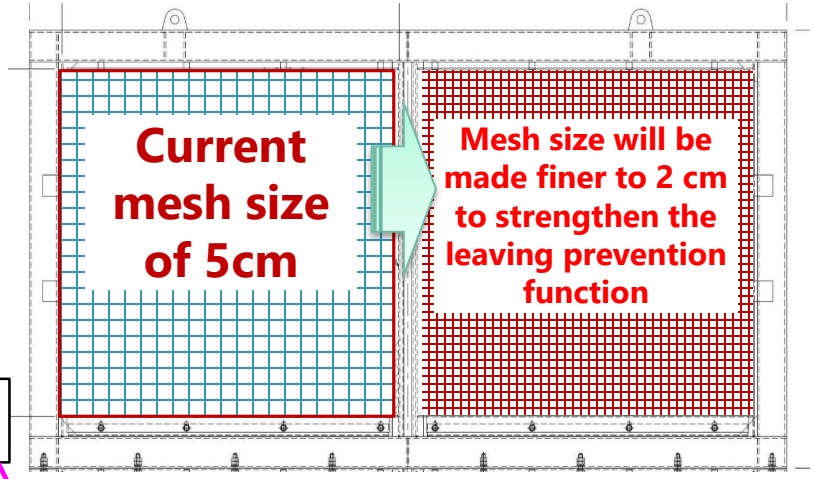
Diagram 2. Covering using a uni-float barge (sand covering/soil covering)

2-3. Fining the mesh of the main installation net to prevent the fish from leaving at the Units 1-4 intake open channel exit

- As a measure to prevent the fish from leaving, a main installation metal net to prevent the fish from leaving with a mesh size of 5cm has been installed at the Units 1-4 intake open channel exit in October, 2021.
- With these measures, we believe that fish with a height and width exceeding 5 cm, such as the black rockfish caught on May 18, will not escape outside the open channel, but **as an additional measure, the mesh size will be made finer to strengthen the function of preventing fish from leaving.**



Main installation net to prevent the fish from leaving (Mesh size of 5 cm)



Front view of the main installation net to prevent the fish from leaving

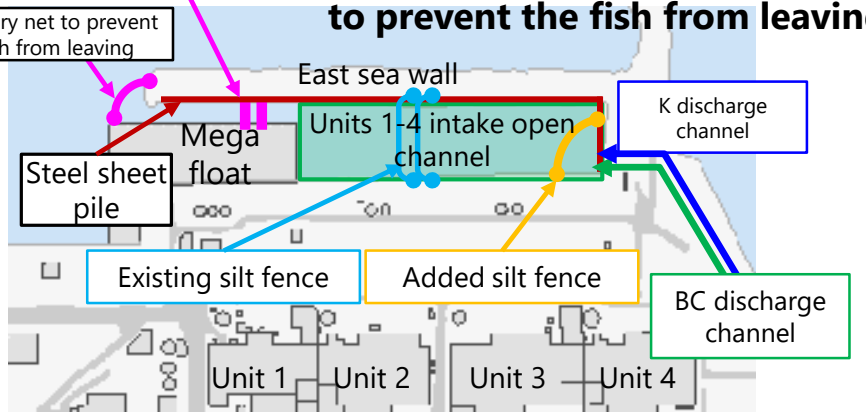


Diagram 1. Measures to prevent the fish from leaving installed at the Units 1 through 4 open intake channel exit

2-4. Discussions on the environmental improvement for the entire port (Surveys and measures against the sediment deposition)

- Surveys have been already conducted of the sediment deposition in the Units 5 and 6 intake open channel and the Units 1-4 intake open channel.
- **In light of the findings regarding state of the Units 1-4 intake open channel,** the original plan to sample the sediment deposition across the port **will be enhanced to sampling of the seawater of sea surface, middle and seafloor in addition to the sediment deposition to analyze cesium concentration.**
- The need for additional surveys and measures will be considered if high cesium concentrations are observed at any of the sampling locations.
- The Units 5 and 6 intake open channel is currently being dredged to remove the sand deposits. The current monitoring schedule for this open channel will remain for the time being.

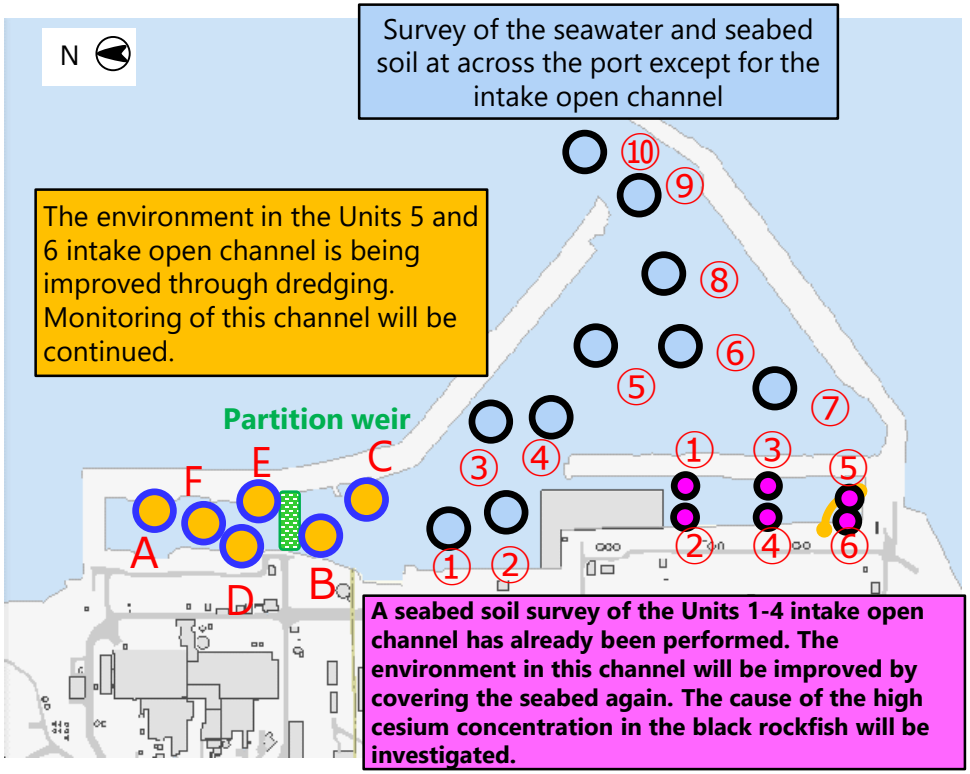


Diagram 1. Diagram of the survey locations

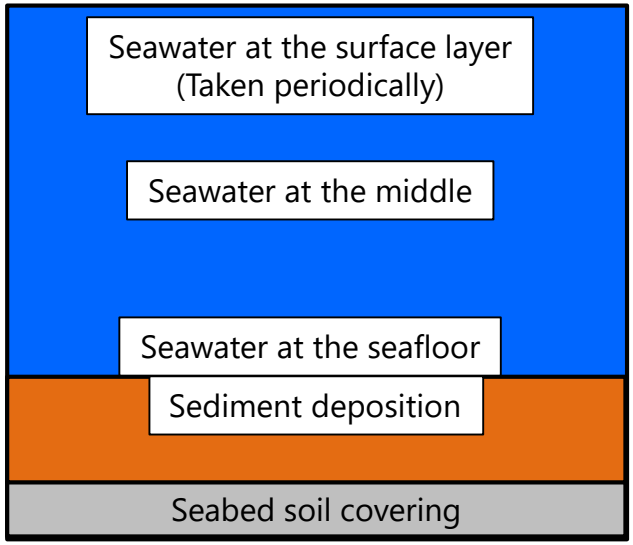
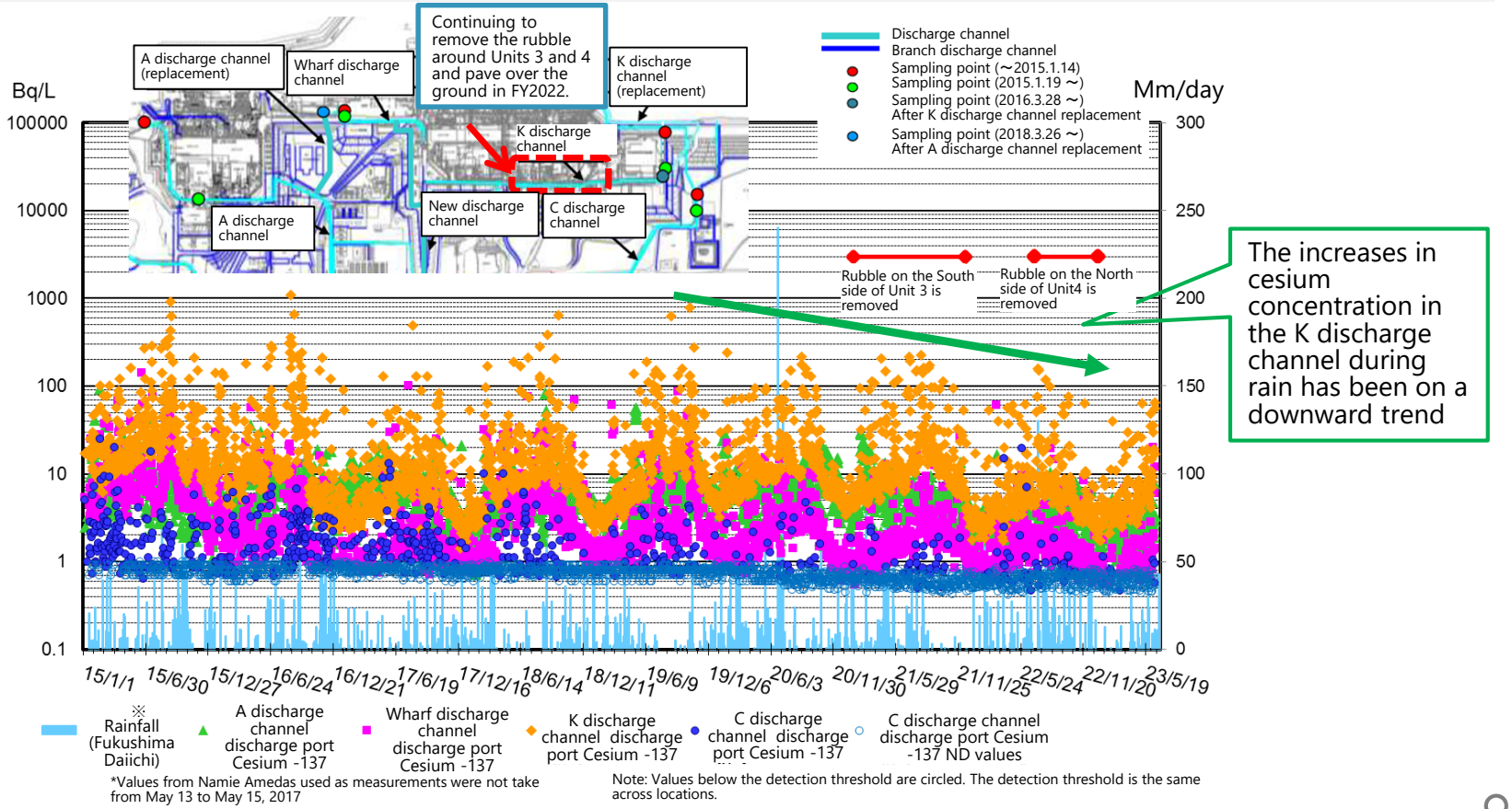


Diagram 2. Survey methods across the port except for the Units 1-4 intake open channel and the Unit 5 and 6 intake open channel (subject to sampling)

2-5. Discussions on the environment improvement for the entire port (Improvement of the water quality in the K discharge channel)

- Measures to reduce the amount of cesium that flows into the port from the K discharge channel continue to be implemented as part of the environmental improvement in the port measures. As a result, increases in cesium concentration during rain has been on a downward trend.
- Progress continues to be made in these measures in FY2023, for example, through removing the rubble around the Unit 3 turbine building shed and paving over the west side of the Unit 3.
- **With the aim of reducing the cesium concentration of seawater in the Units 1-4 intake open channel will be below 1 Bq/L, we will work to reduce the concentration in K discharge channel by considering to move up the schedule for the rubble removal from around Units 1-4 and paving the ground, and implement measures to reduce the outflow of sand.**



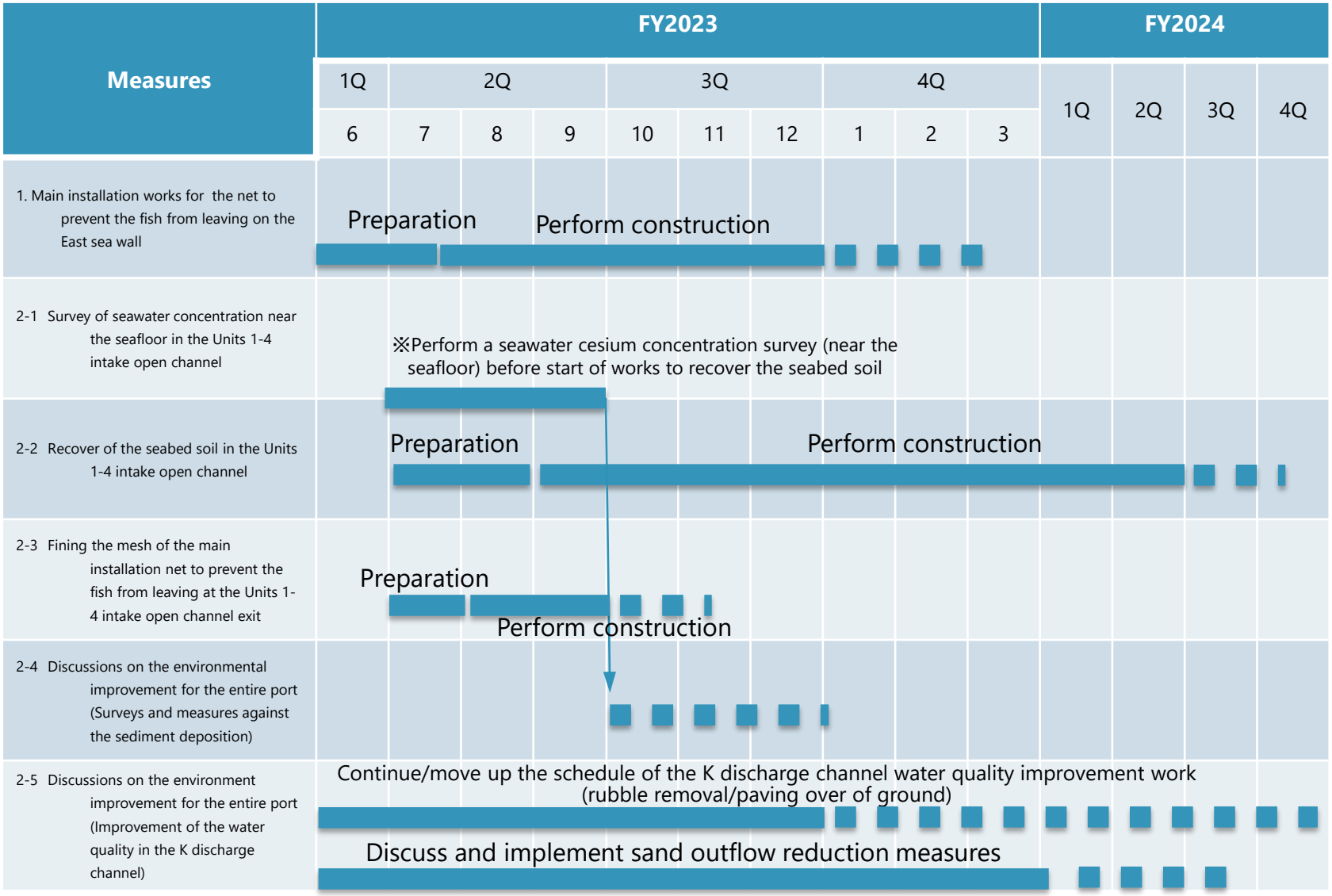
*Values from Namie Amedas used as measurements were not take from May 13 to May 15, 2017

Note: Values below the detection threshold are circled. The detection threshold is the same across locations.

Diagram 1. Cesium 137 concentration in the discharge channel

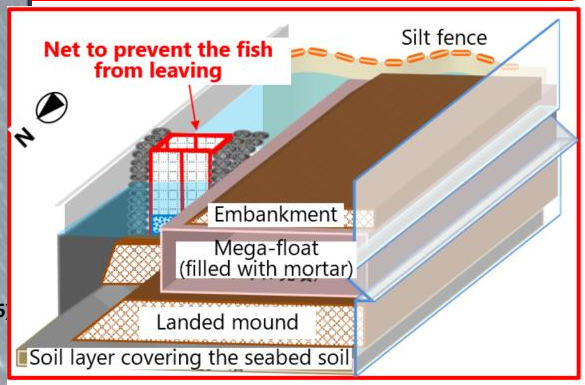
3. The schedule

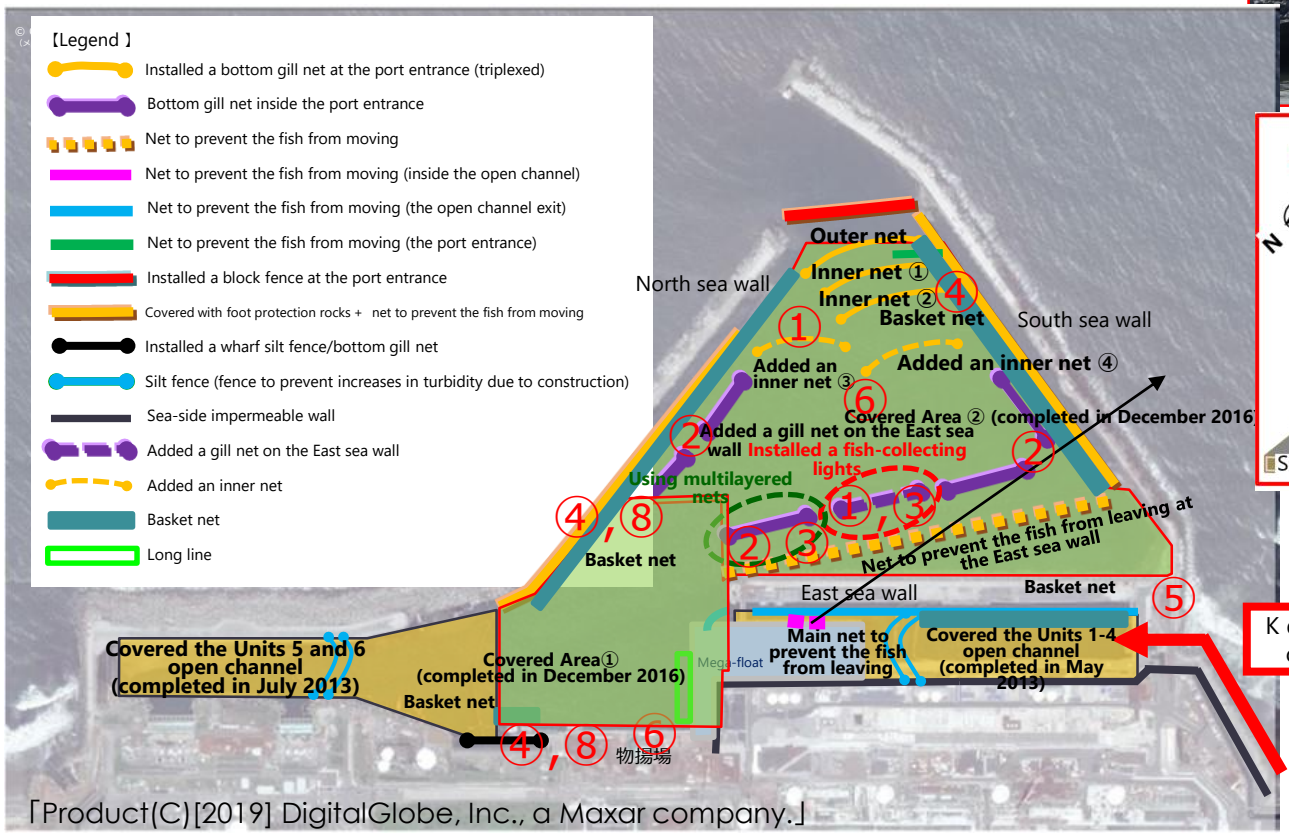
- Main installation works for the net to prevent the fish from leaving on the East sea wall will be prioritized. At the same time, measures to address the sediment deposition in the Units 1-4 intake open channel and the investigation of the high cesium concentration observed in the black rockfish will be carried out.



【Reference】Measures to catch the fish in the port (status of gill nets)

- Additional multilayered measures have been implemented to catch the fish in the port and prevent the fish in the port from leaving. As a result of these measures, the number of specimens caught and analyzed has increased significantly from 88 in FY2021 to 415 in FY2022.
  - ① Added inner net ③ and a gill net near the East sea wall (2022/2/21～)
  - ② Increased the number of times the gill net was deployed in the port (from two times a week to three times a week) (2022/3/1～)
  - ③ Installed multiple nets and fish-collecting lights in some gill nets on a trial basis (Changed up the location periodically) (2022/4/22～)
  - ④ Installed basket nets near the wharf in the port and near the North and South sea wall (2022/5/12,19～)
  - ⑤ Installed basket nets in the Units 1-4 open intake channel (2022/5/26～)
  - ⑥ Added additional inner nets ④. Started long lining on a trail basis（2022/7/20,28～）
  - ⑦ Added additional cage nets to catch black rockfish in their spawning season (2023/3/30～)





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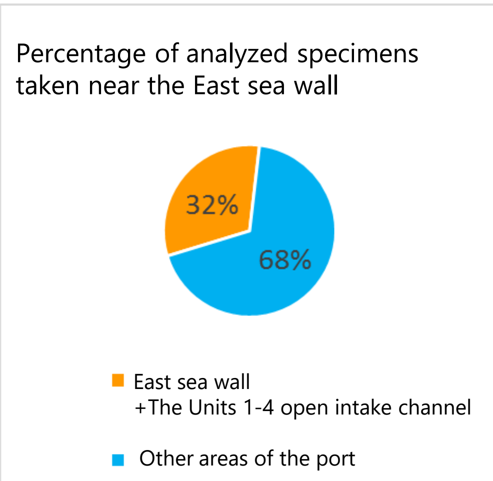
The open channel for Units 1 through 4 is a closed off area, sandwiched by the seawall and the Eastern wave breaker, with the exit to the port blocked by the mega-float. The main net to prevent fish from escaping was installed at the exit to the port in October 2021 and a steel sheet pile was installed at the Eastern wave breaker.

【Reference】State of fish catching inside the power station port

- Following increased efforts to catch the fish in the port implemented in February 2022 and onward, the number of specimens caught and analyzed has increased significantly from 88 in FY2021 to 415 in FY2022. The number of specimens analyzed with cesium concentrations exceeding 100 Bq/L has also increased accordingly.
- The trend of a higher number of fish with a cesium concentration exceeding 100 Bq/kg coming from near the East sea wall and the Units 1-4 intake open channel continued from FY2021 to FY2022. In particular, the cesium concentration of all of the fish caught inside the Units 1-4 intake open channel exceeded 100 Bq/L.
- We will continue to strengthen our efforts to catch fish by improving upon catching methods and adding nets.



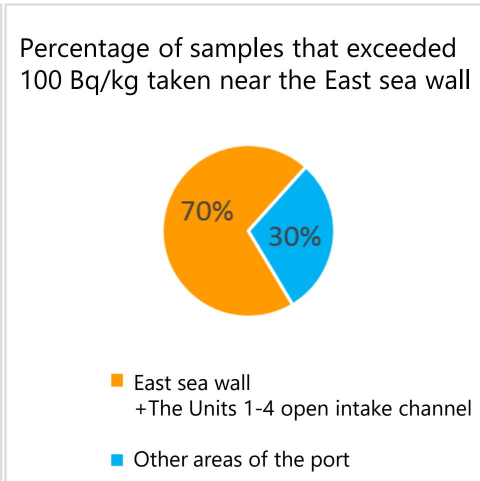


Diagram Percentage of specimens taken and specimens exceeding 100 Bq/L taken around the East sea wall

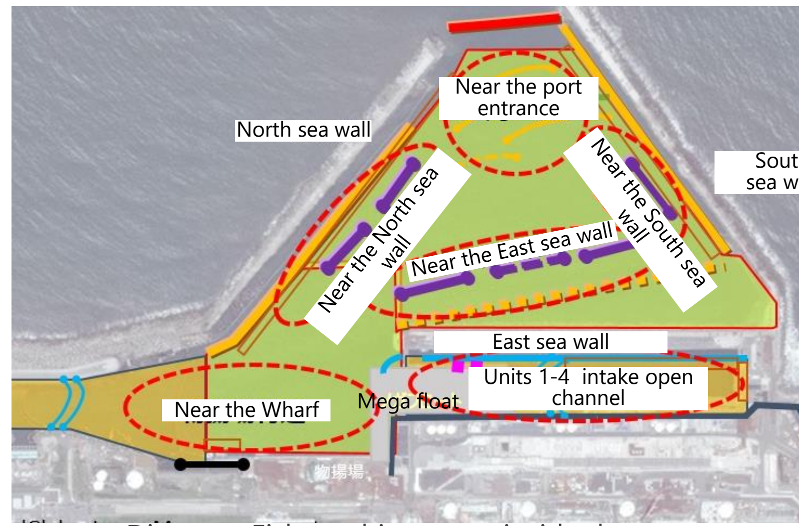


Diagram: Fish catching areas inside the port

Table Number of specimens analyzed for each area and the number of specimens that exceeded 100 Bq/L

Fish catching area	Total			FY2019			FY2020			FY2021			FY2022		
	Number of samples analyzed	Number of samples that exceeded 100 Bq/kg	Percentage of fish samples with cesium concentrations that exceeded 100 Bq/kg	Number of samples analyzed	Number of samples that exceeded 100 Bq/kg	Percentage of fish samples with cesium concentrations that exceeded 100 Bq/kg	Number of samples analyzed	Number of samples that exceeded 100 Bq/kg	Percentage of fish samples with cesium concentrations that exceeded 100 Bq/kg	Number of samples analyzed	Number of samples that exceeded 100 Bq/kg	Percentage of fish samples with cesium concentrations that exceeded 100 Bq/kg	Number of samples analyzed	Number of samples that exceeded 100 Bq/kg	Percentage of fish samples with cesium concentrations that exceeded 100 Bq/kg
Near the port entrance	176	6	3%	49	3	6%	7	0	0%	12	0	0%	108	3	3%
Near the Southern breakwater	64	2	3%	11	1	9%	9	0	0%	9	1	11%	35	0	0%
Near the Northern breakwater	199	8	4%	13	0	0%	11	0	0%	41	0	0%	134	8	6%
Near the Eastern wave breaker	192	25	13%	42	5	12%	8	1	13%	23	5	22%	119	14	12%
Open intake channel for Units 1 through 4	21	13	62%	9	1	11%							12	12	100%
Near the wharf	26	4	15%	13	2	15%	3	1	33%	3	1	33%	7	0	0%
Total	678	58	9%	137	12	9%	38	2	5%	88	7	8%	415	37	9%
Near the East seawall* of the Units 1-4 intake open channel	31%	66%		37%	50%		21%	50%		26%	71%		32%	70%	
Other areas inside the port	69%	34%		63%	50%		79%	50%		74%	29%		68%	30%	