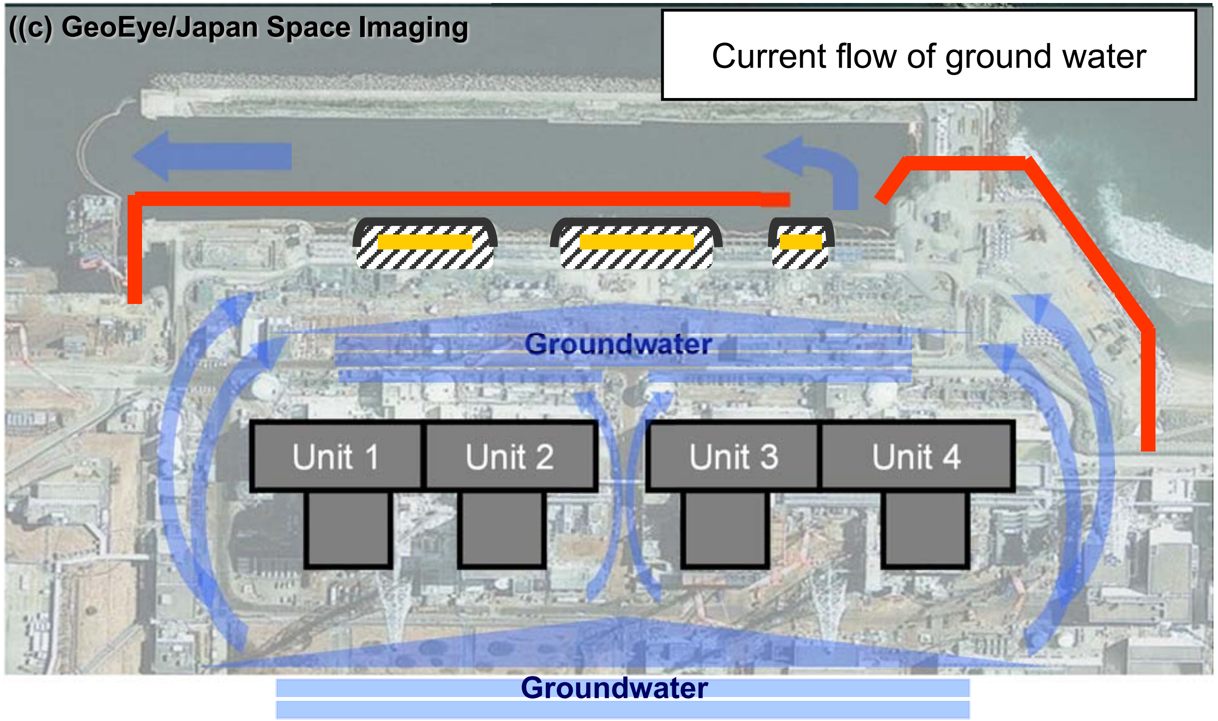
Efforts to ensure ocean protection
- Subdrain operations and Seaside impermeable wall closing -

September 2, 2015

Tokyo Electric Power Company

Current groundwater conditions

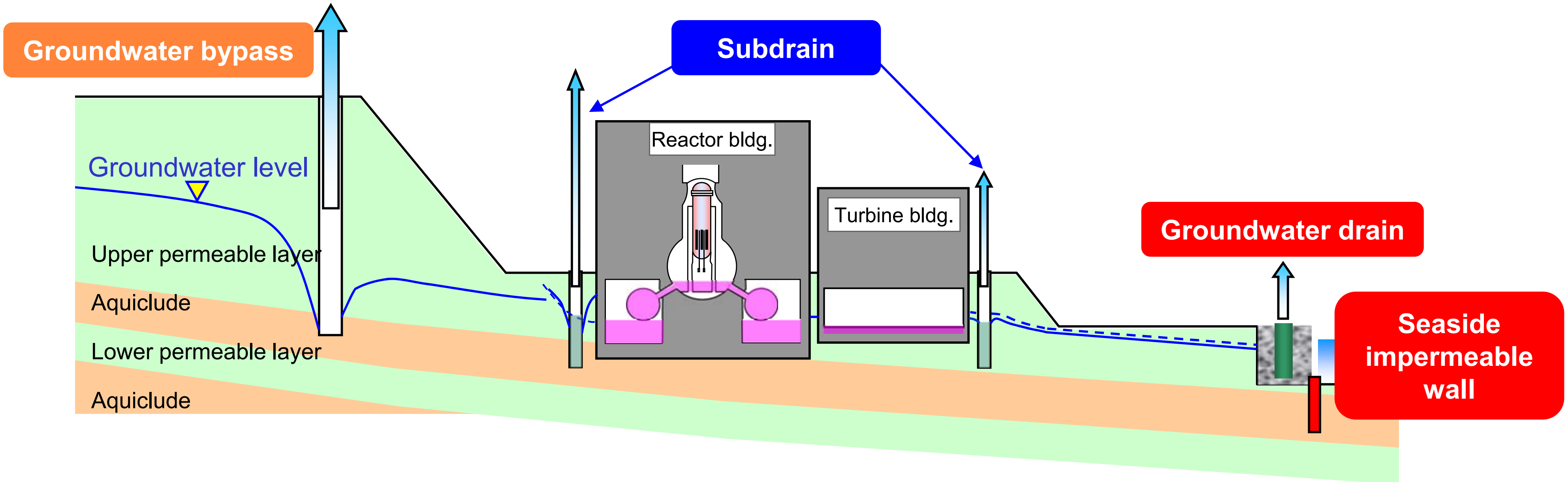
- Groundwater around the reactor buildings flows from the landside to the seaside. The water is confirmed to contain radioactive materials by mixing with rainwater after contact with contaminated debris left on the ground due to the accident.
- The radioactive material concentration of the groundwater is much lower than that of the highly contaminated water accumulated in the reactor buildings. The water level of the contaminated water inside the buildings is kept lower than that of the surrounding groundwater, which prevents the water from flowing outside of the buildings. Therefore, the contaminated water in the buildings theoretically does not mix with the groundwater flowing around the buildings.



* Reference (Page 20)

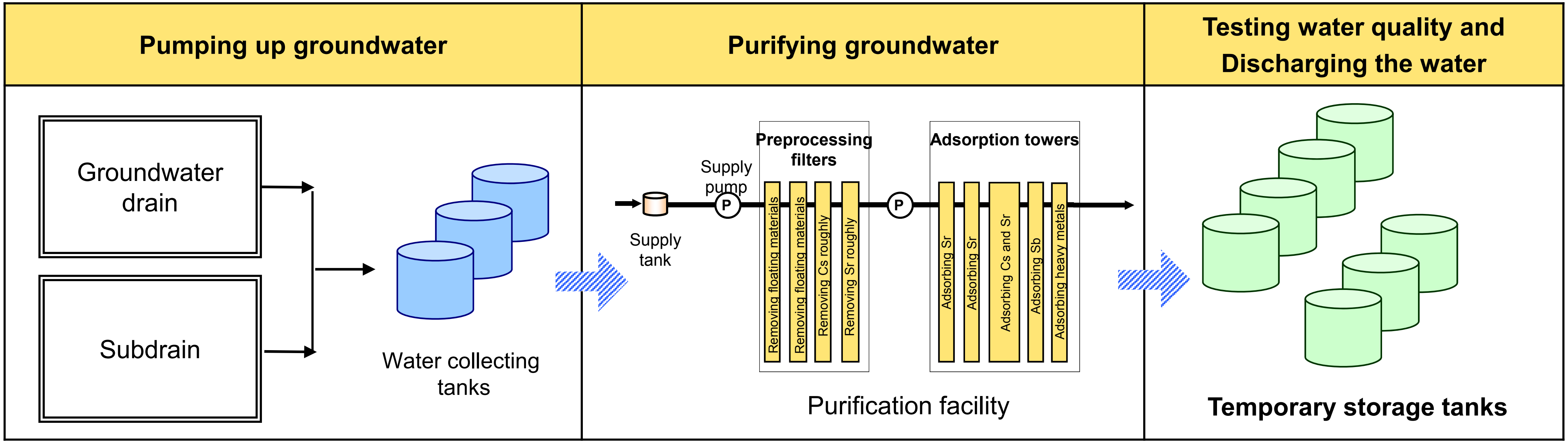
Pumping up groundwater by groundwater drain and subdrain systems

- The wells built on the bank protection (groundwater drain) pumps up groundwater flowing to the sea.
- The amount of groundwater flowing to the sea is also reduced by using the wells near the buildings and located upper-stream than groundwater (subdrain).
- Pumping up by subdrain greatly reduces the amount of groundwater flowing into the reactor buildings, which consequently causes to reduce the volume of highly contaminated water stored on the premises; as a result, contributing to reduce the risks to spread the contamination to the port.



Purifying the pumped up groundwater and testing the system stability

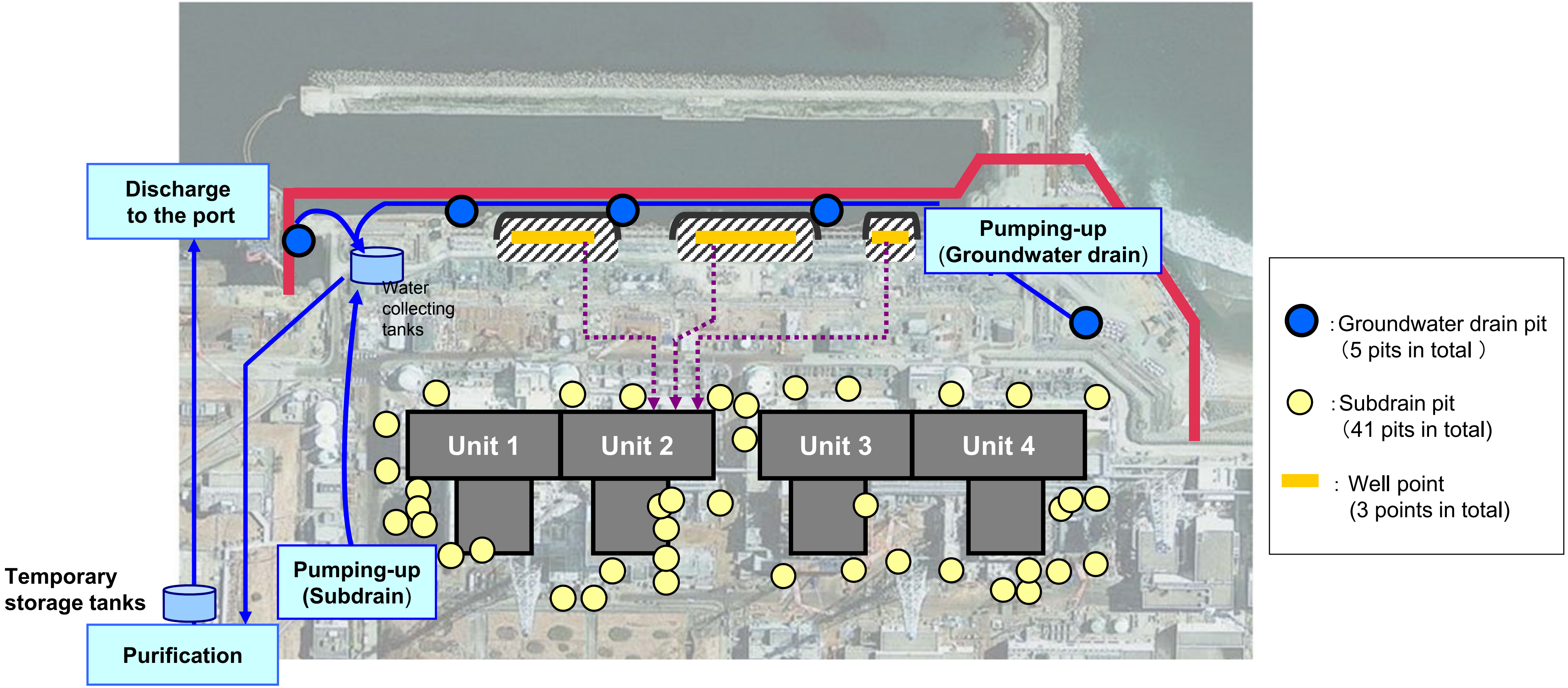
- The pumped up groundwater is purified by a specialized facility capable of reducing radioactive material concentrations from one-thousandth up to one ten-thousandth.
- Because the pumped up groundwater contains much lower radioactive material concentrations than the accumulated water inside the buildings, the specialized purification facility is consisted of simple structures and has less risks of being out of order.
- Water purification and transfer systems are confirmed to perform stably by the functional test to actually purify the pumped up groundwater.



Discharging the purified groundwater

●The purified groundwater is planned to be discharged inside the port after confirming it satisfies more stringent water quality standards than the one set for the groundwater bypass.

●In terms of the discharge, it is necessary to gain the understanding of the relevant government agencies and the fishing communities by explaining them about the operations.



Closing the seaside impermeable wall

- The seaside impermeable wall is planed to be closed after water purification and transfer systems are confirmed to work stably.
- The seaside impermeable wall is installed deeper than the lower permeable layer (30m deep in the ground).
- The seaside impermeable wall surrounding the bank protection of Units 1 to 4 can hold back groundwater flowing from the site to the port; consequently, the ocean will be further protected from contamination.

Fundamental policies for subdrain and groundwater drain operations

1. Fundamental policies

(1) As for water to discharge, more stringent upper limit of radioactive concentration is set than that of groundwater bypass.

Nuclide	Cesium 134	Cesium 137	Gross β	Tritium
Becquerel/liter	1	1	3 (1)*	1,500

* confirmed that the value is less than 1 Becquerel/liter by monitoring approx. once every 10 days.

(2) The effects of subdrain and groundwater drain are maximized.

(3) Water other than from subdrain and groundwater drain is not mixed. (Dilution is not conducted)

2. Handling different kinds of nuclides

(1) Cesium and Gross β (Strontium 90 etc.)

If the monitoring results surpass the upper limit of radioactive concentration in the temporary storage tanks, the water is purified again through the purifying facility and the purification is repeated until the results fall below the limit.

In addition, analyses of Cesium 134, Cesium137 and Gross β are conducted in the relay tanks and water collecting tanks at appropriate intervals in order to prevent the need for re-purification.

(2) Tritium

If the monitoring results surpass the upper limit of radioactive concentration in the temporary storage tanks, the water is not discharged to the ocean but transferred to the tanks on the premises.

While monitoring and analyzing each water collecting tank, in case of exceeding the upper limit of radioactive concentration, the water is not transferred to the purification facility but transferred and stored to the tanks on the premises, which prevents high level concentration in the temporary storage tanks.

Water quality analysis of subdrain and groundwater drain

《Water stored in the temporary storage tanks（After purification）》

Every discharge （analysis before discharge）	**TEPCO and a third-party organization** （MITSUBISHI NUCLEAR FUEL CO., LTD. or KAKEN Inc. etc.）*1	✓ Analysis by a lower detection limit than for upper limit of radioactive concentration.
Approx. once every 10 days (once within 10 days)	**TEPCO and a third-party organization** （MITSUBISHI NUCLEAR FUEL CO., LTD. or KAKEN Inc. etc.）*1	✓ Gross β is analyzed with below a lower detection limit. (less than 1 Becquerel/liter)
Once per month （the first purification amount every month）*3	**TEPCO and a third-party organization** （Japan Chemical Analysis Center and KAKEN Inc. ）*1 **Government organization** （Japan Atomic Energy Agency）	✓ Increased number of nuclides are analyzed in detail with lower detection limit value rather than analyzing discharged water each time. [Unit：Becquerel/liter] （Cesium 134: Approx. 0.01, Cesium 137: Approx. 0.01, Strontium 90: Approx. 0.01 Gross β: Approx. 1, Gross α: Approx. 4, Tritium: Approx. 1～10）
Once per month （Weighted average sample of discharged water in a month）	**TEPCO and a third-party organization** （Japan Chemical Analysis Center and KAKEN Inc. ）	✓ The total discharged number of Becquerel is calculated (by weighted average sample.) The accuracy of analysis is the same as the first purification amount every month.

《Upper limit of radioactive concentration》 【Unit：Becquerel/liter】

Cesium 134	Cesium 137	Gross β	Tritium
1	1	3	1,500

（For Reference 1: Regulatory Notification Limit ）

Cesium 134	Cesium 137	Strontium 90	Tritium
60	90	30	60,000

（For Reference 2: WHO Drinking Water Quality Guideline）

Cesium 134	Cesium 137	Strontium 90	Tritium
10	10	10	10,000

《Water stored in the water collecting tanks（Before transferred to subdrain purification facility）》

Each tank （Analyzed before transferred to subdrain purification facility）	**TEPCO**	✓ Confirmed that the radioactive concentration is less than the upper limit of 1,500 Becquerel/liter by Tritium monitoring analysis.*2 ✓ Monitored for any rapid changes of Cesium 134 and 137 (at the same time of Tritium analysis.)
Once per week	**TEPCO**	✓ Gross β is analyzed to understand purifying functions of the purification facility.

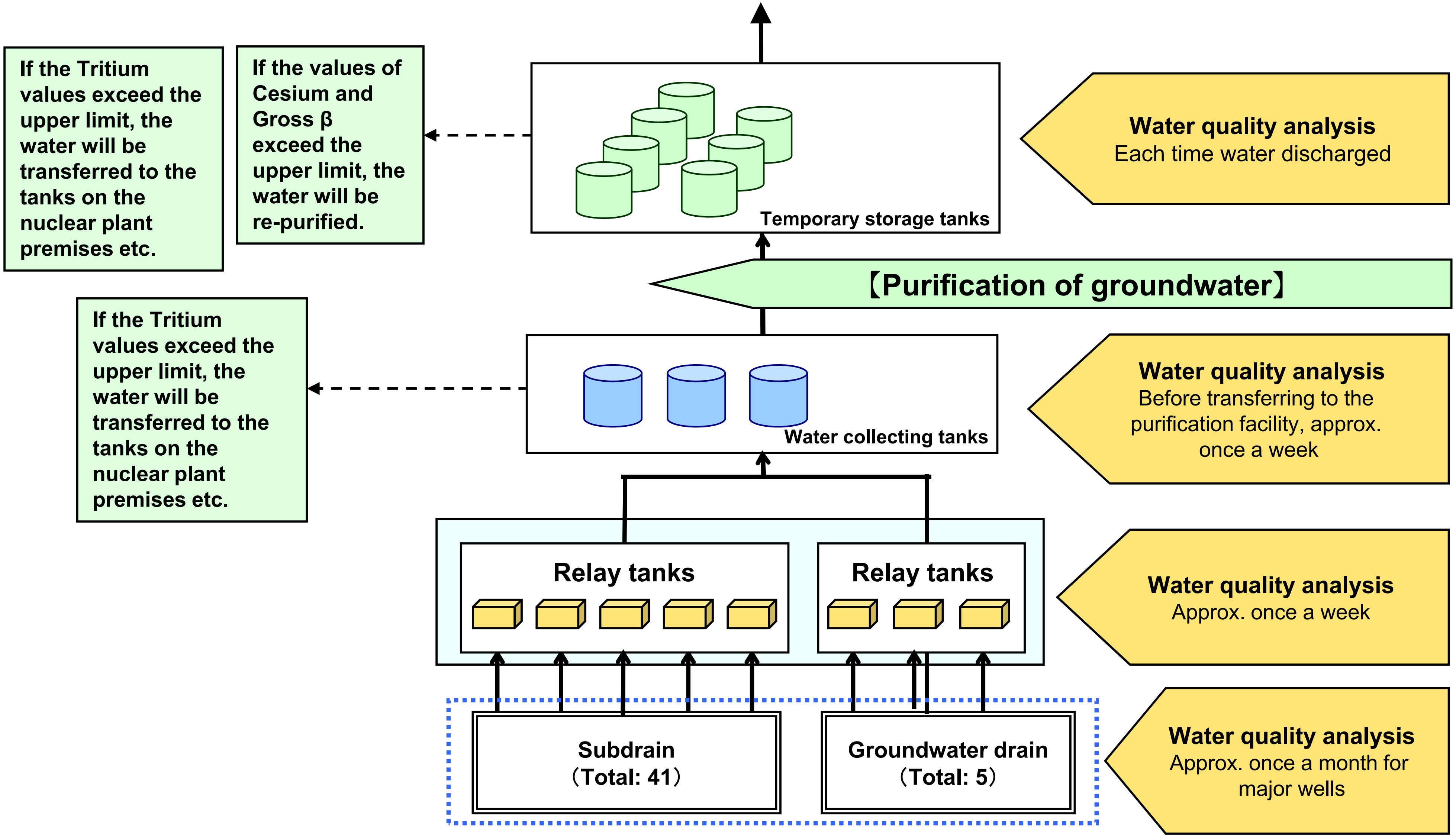
《Water stored in the relay tanks（Before transferred to the water collecting tanks）》

Once per week (8 relay tanks analyzed every week)	**TEPCO**	✓ From monitoring and analysis of Tritium, trend monitoring is conducted so that there are no effects to the Tritium concentration in the water collecting tanks. ✓ Trend monitoring is conducted for Cesium 134, 137 and Gross β.

*1 MITSUBISHI NUCLEAR FUEL CO., LTD., or KAKEN Inc. and Japan Chemical Analysis Center are analytical institutions having no capital ties with TEPCO and also conduct additional analyses as necessary other than above.
*2 Tritium monitoring analysis is a method to understand in a short time period the approximate concentration of Tritium which takes approx. 6 hours to calculate while for normal analysis it takes about one and a half days to calculate.
*3 Sampling is conducted (obtained as analytical samples) at the beginning of each month.

Water quality control method for subdrain and groundwater drain

The water is discharged after confirmation that the monitoring results do not surpass the upper limit of radioactive concentration.



Water quality monitoring results of temporary storage tanks

Latest result
（as of September 2nd, 2015）

Radiation analysis is conducted for purified water stored in temporary storage tanks and the results confirm to surpass the upper limit of radioactive concentration.

Unit: Becquerel/liter

	Temporary storage tank A		Temporary storage tank B		Upper limit of radioactive concentration	Regulatory Notification Limit *2	WHO Drinking Water Quality Guideline
	TEPCO	Third-party organization	TEPCO	Third-party organization	—	–	—
Sampling Date	August 19, 2015		August 19, 2015		—	—	—
Volume of water in storage [m3]	1,020		990		—	—	—
Cs-134	ND(0.55)	ND(0.43)	ND(0.74)	ND(0.39)	1	60	10
Cs-137	ND(0.58)	ND(0.62)	ND(0.78)	ND(0.57)	1	90	10
Other γ nuclides	ND	ND	ND	ND	Not detectable	—	—
Gross β	ND(0.85)	ND(0.47)	ND(0.83)	ND(0.49)	3(1)*1	—	—
H-3	460	430	330	390	1,500	60,000	10,000

	Temporary storage tank E		Temporary storage tank F		Upper limit of radioactive concentration	Regulatory Notification Limit *2	WHO Drinking Water Quality Guideline
	TEPCO	Third-party organization	TEPCO	Third-party organization	—	—	—
Sampling Date	August 20, 2015		August 20, 2015		—	—	—
Volume of water in storage [m3]	1,030		970		—	—	—
Cs-134	ND(0.61)	ND(0.53)	ND(0.59)	ND(0.47)	1	60	10
Cs-137	ND(0.76)	ND(0.57)	ND(0.58)	ND(0.59)	1	90	10
Other γ nuclides	ND	ND	ND	ND	Not detectable	—	—
Gross β	ND(0.94)	ND(0.50)	ND(0.85)	ND(0.49)	3(1)*1	—	—
H-3	550	600	400	480	1,500	60,000	10,000

The numerical values in the brackets indicate detection limits.

***1 The detection limit for gross β (Strontium 90 is in gross β）is lowered to 1 Bq/L to conduct analysis once every 10 days monitoring.**

***2 Regulatory Notification Limit: "Notification for Dose Equivalent Limits on the Basis of the Ministerial Ordinance for Commercial Power Reactors" appendix 2, section 6th**

Water quality result list of Subdrain and groundwater drain

Latest result
(as of Sep. 2nd, 2015)

Unit: Becquerel/liter

	Unit	Pit	Cesium 134	Cesium 137	Gross β	Tritium	Sampling date
Existing subdrain pits	Unit 1	1	13	62	79	16,000	2015 08/24
		2	ND(9.8)	17	ND(16)	210	2015 08/24
		8	180	820	1,100	130	2015 08/13
		9	65	340	450	350	2015 08/13
	Unit 2	18	2,000	8,800	10,000	1,300	2015 08/12
		19	1,500	6,900	8,900	1,300	2015 08/12
		20	ND(11)	24	41	1,900	2015 08/12
		21	21	93	100	1,100	2015 08/12
		22	13	52	240	520	2015 08/12
		23	12	62	87	550	2015 08/24
		24	25	110	190	200	2015 08/24
		25	32	110	200	130	2015 08/24
		26	89	350	500	ND(130)	2015 08/24
		27	71	280	480	ND(130)	2015 08/24
	Unit 3	31	22	75	120	180	2015 08/24
		32	ND(12)	ND(18)	18	ND(130)	2015 08/24
		33	ND(12)	31	32	380	2015 08/24
		34	74	310	430	550	2015 08/24
		40	310	1,200	1,800	ND(130)	2015 08/13
	Unit 4	45	ND(8.3)	ND(15)	ND(18)	ND(130)	2015 08/12
		51	ND(9.4)	ND(16)	ND(18)	660	2015 08/12
		52	ND(8.9)	ND(15)	ND(18)	ND(130)	2015 08/12

	Unit	Pit	Cesium 134	Cesium 137	Gross β	Tritium	Sampling date
Existing subdrain pits	Unit 4	53	ND(9.3)	ND(18)	ND(11)	ND(130)	2015 08/25
		55	ND(10)	ND(16)	ND(11)	ND(130)	2015 08/25
		56	ND(10)	ND(18)	26	190	2015 08/25
		58	ND(11)	25	35	130	2015 08/25
		59	ND(10)	ND(18)	38	770	2015 08/25
Newly installed subdrain pits	Unit 1	201	ND(9.8)	ND(16)	ND(11)	ND(130)	2015 08/25
		202	ND(11)	ND(18)	ND(11)	ND(130)	2015 08/25
		203	ND(9.4)	ND(16)	ND(13)	ND(130)	2015 08/13
		204	ND(12)	ND(19)	74	ND(130)	2015 08/13
		205	ND(12)	ND(16)	21	320	2015 08/13
		206	ND(11)	ND(18)	37	ND(130)	2015 08/13
	Unit 2	207	ND(10)	ND(16)	ND(18)	ND(130)	2015 08/12
		208	ND(9.2)	ND(15)	ND(18)	ND(130)	2015 08/12
	Unit 3	209	ND(10)	ND(16)	ND(13)	350	2015 08/13
		210	ND(11)	ND(18)	43	ND(130)	2015 08/13
		211	21	75	190	ND(130)	2015 08/13
	Unit 4	212	ND(9.7)	ND(16)	ND(18)	ND(130)	2015 08/12
		213	ND(9.0)	ND(15)	ND(18)	160	2015 08/12
		214	ND(9.4)	ND(16)	ND(18)	8,500	2015 08/12
		215	ND(11)	ND(14)	ND(18)	ND(130)	2015 08/12
Groundwater drain pits		A	ND(0.94)	1.7	4,300	3,800	2015 8/17
		B	2.3	7.3	4,300	4,400	2015 8/17
		C	9.9	37	7,100	16,000	2015 8/17
		D	9.4	33	1,400	2,600	2015 8/17
		E	ND(0.89)	2.6	ND(14)	250	2015 8/17

●"ND" indicates less than the detection limit and the numerical values in the brackets indicate detection limits.
●No.1 operation is excluded.
●No. 201 to No. 215 and N1 to N15 are identical.（subject reviewed）

Outline of Measures to Protect the Ocean

Outline of measures to protect the ocean

Urgent measures

-Preventing outflow to the port ①Ground improvements/ pumping groundwater/ paving in the contaminated area
<Leakage prevention> <Contaminant isolation>

-Removing contamination source ②Removing highly contaminated water from trenches <Contaminant removal>

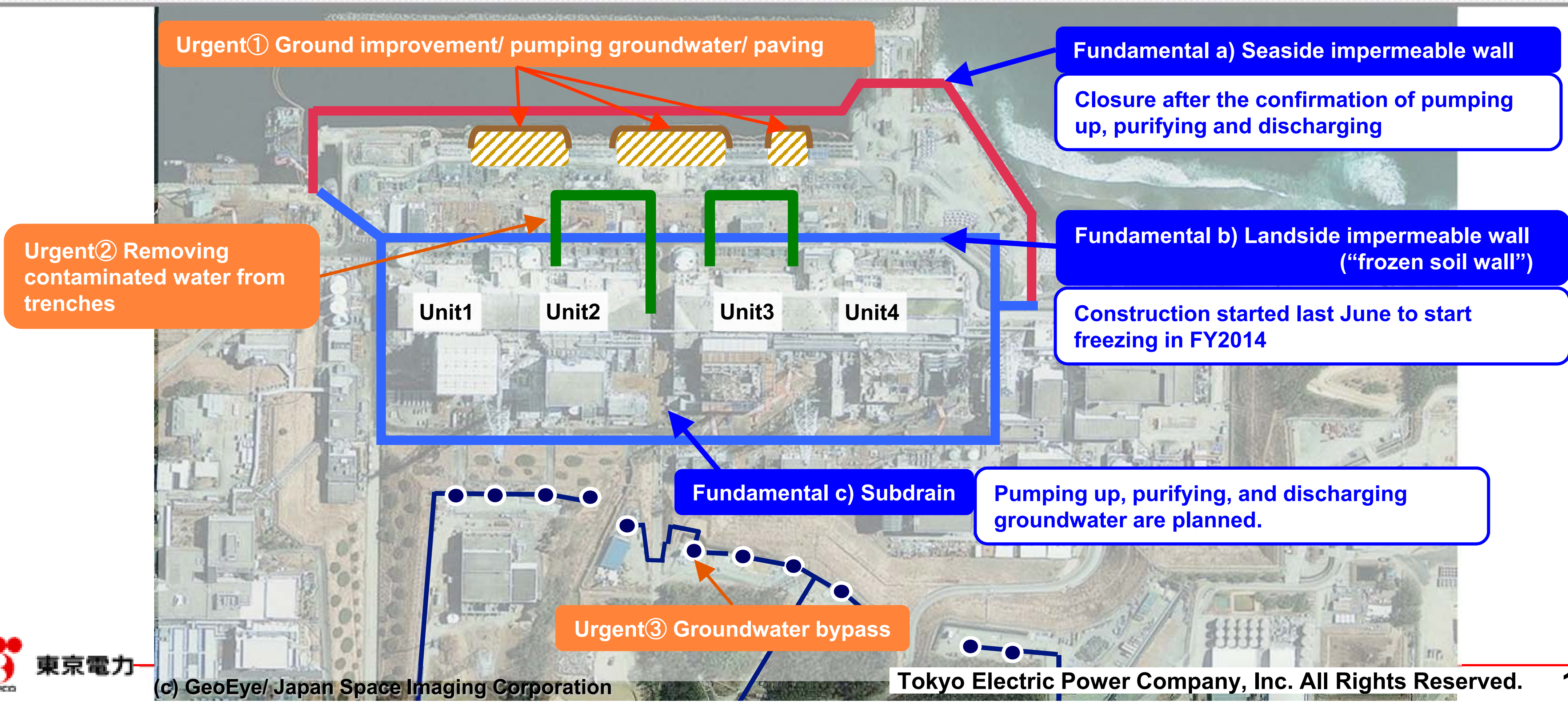
-Controlling increase of contaminated water ③Pumping up groundwater on the landside of the buildings
(groundwater bypass) <Contaminant isolation>

Fundamental measures

-Stopping outflow to the sea **a) installing seaside impermeable wall** <Leakage prevention>

-Controlling increase of contaminated water & Preventing outflow to the port
b) installing landside impermeable wall ("frozen soil wall") < Contaminant isolation>

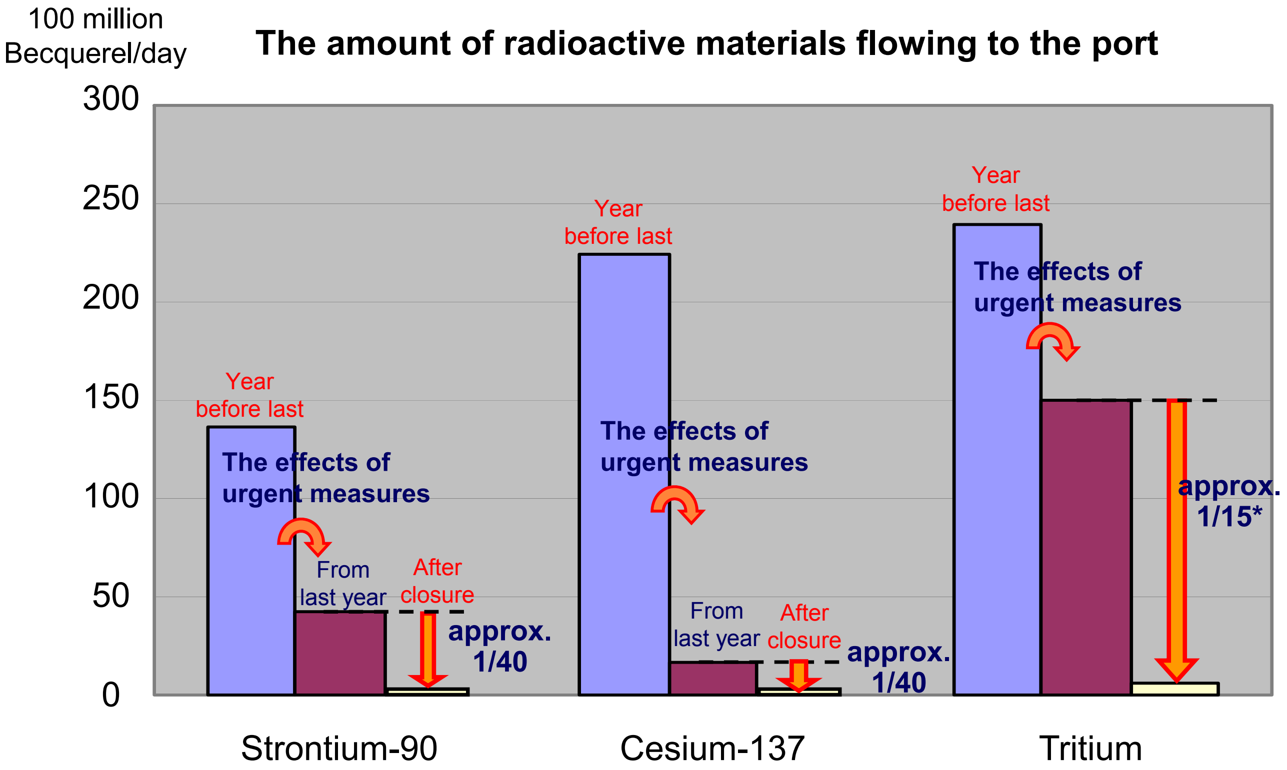
-Controlling groundwater inflow to the reactor buildings etc. **c) pumping up groundwater by Subdrain**
<Contaminant isolation>



Effects of Pumping up and Redirecting Groundwater

The effects of purifying and discharging the pumped up groundwater

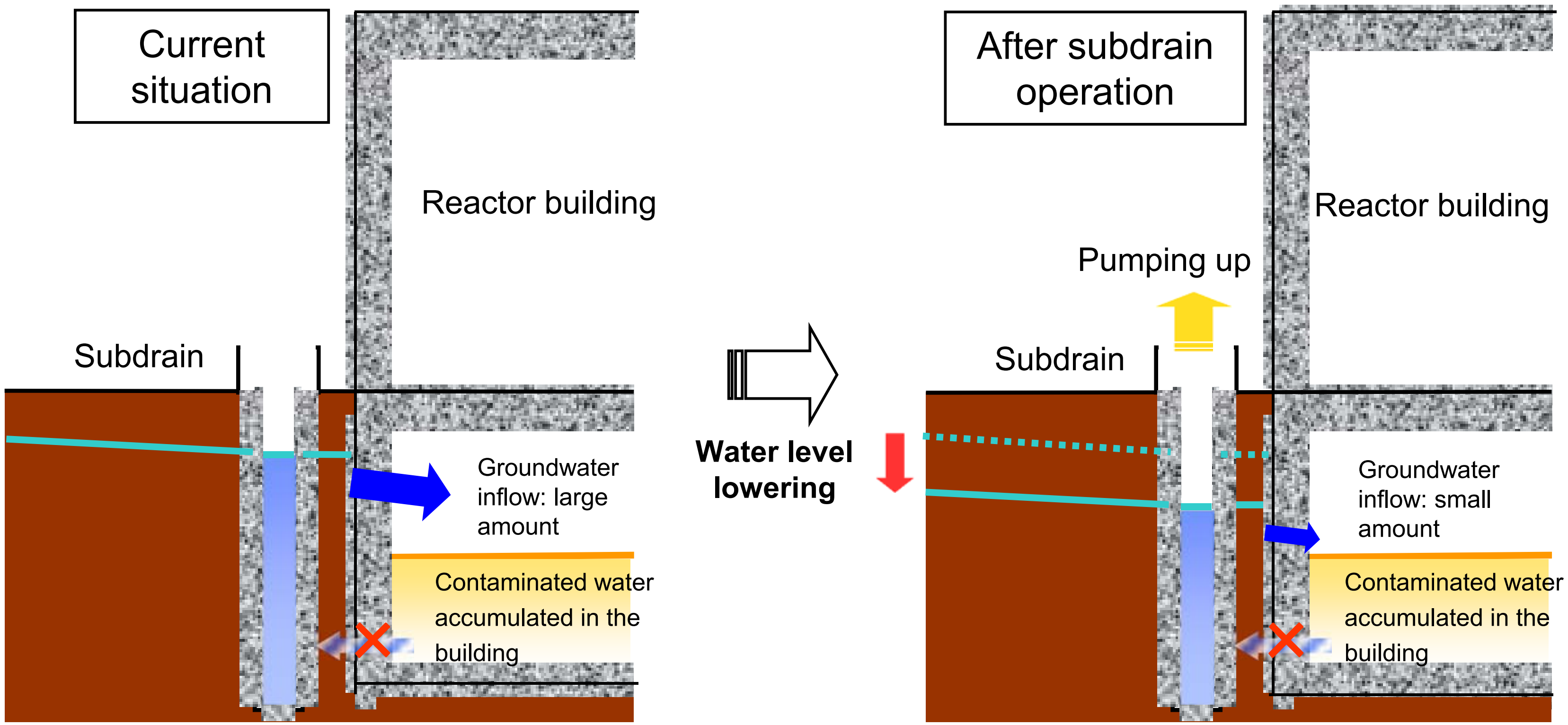
- The implementation of urgent measures such as ground improvements and well points has been controlling the amount of radioactive materials flowing into the port.
- The amount of radioactive materials can be reduced by pumping up, purifying, and discharging groundwater flowing into the port and also by closing the seaside impermeable wall.
- After closure of the seaside impermeable wall, water quality in the port is expected to be further improved.
- The seaside impermeable wall can further prevent marine pollution in case of contaminated water leakage in each mid-and-long term decommissioning project.



*The amount of radioactive materials flowing into the port is subject to change since it is evaluated estimating the water quality and the flow volume of groundwater.

Effects of pumping up groundwater by subdrain

- The subdrain operation can lower the groundwater level around the reactor buildings. Especially on the landside of the buildings, the water level difference between groundwater level around the buildings and the contaminated water level inside the buildings is confirmed to be approximately 4 to 5 meters. Pumping up groundwater by subdrain is estimated to reduce the inflow volume to 150m³/day from currently 300m³/day. The reduction of groundwater inflow leads to lower the amount of highly contaminated water retained on the premises.

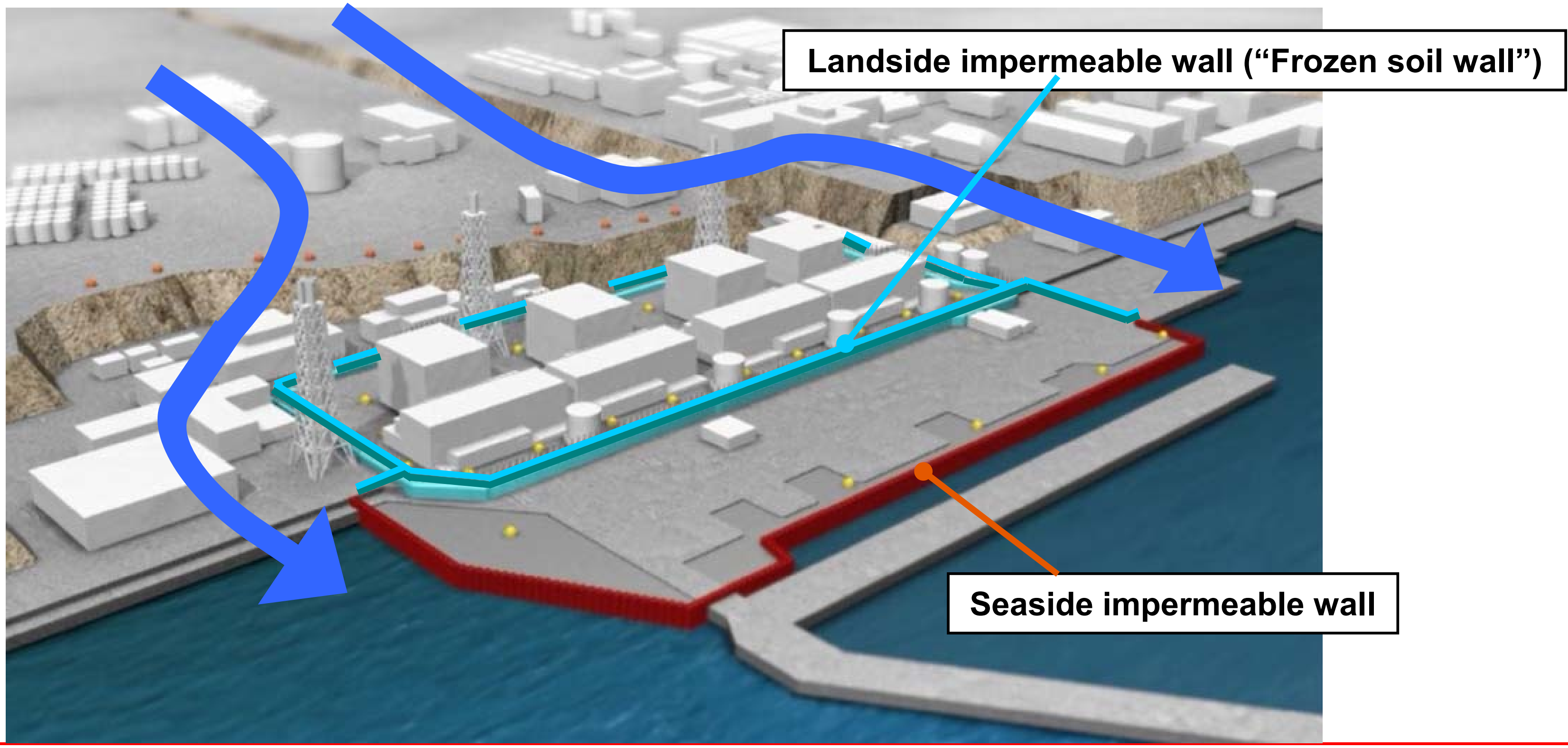


Inflow volume into the building: approx. 300m³ /day

Inflow volume into the building: approx. 150m³ reduced/ day

Groundwater after installation of the landside impermeable wall ("Frozen soil wall")

- As a drastic measure for water management, installing the landside impermeable wall around the Unit 1 to 4 is planned as well as pumping up groundwater by subdrain and closing the landside impermeable wall. The construction started in June 2014 and the freezing is expected to start within FY2014.
- Currently, the groundwater that flows from upstream around Unit 1 to 4 is widely diverted by the landside impermeable wall and flows into the ocean without being contaminated around the buildings.
- The inflow of groundwater around Unit 1 to 4 is significantly controlled after the installation of landside impermeable wall, so that the amount of groundwater pumped up is lowered.



Testing the Purification System Stability

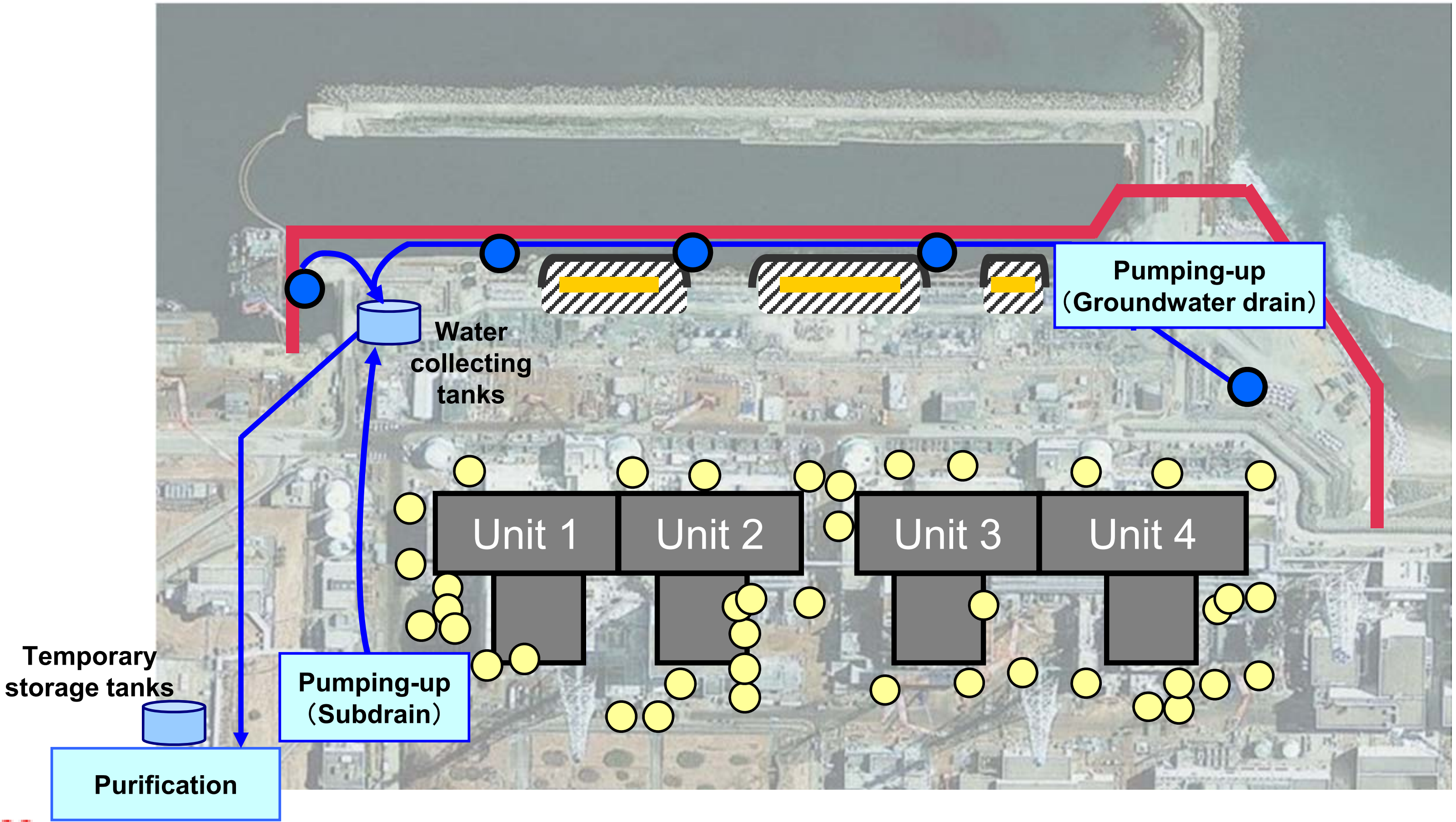
Testing the purification system stability

- The system stability has been tested for four months, from July 2014 to November 2014, by pumping up a total of approx. 4,000m^3 of groundwater.

	Subdrain pit	Water collecting tank	Purification facility (Adsorption tower)	Temporary storage tank
【STEP1】 Passing-water operation test			<July 10> Passing-water operation by filtrated water（Approx. 2 hours, 50m^3）	
【STEP2】 Purification performance test	<Aug. 14 to Aug. 16> Pumping up groundwater ▶	Collecting groundwater ▶	Purifying groundwater 1^{st} time（Approx. 300m^3） <Aug. 20> ▶	Storing groundwater
【STEP3.1】 Continuous circulation test			<Sept. 5 to Sept. 11> Continuous circulation by groundwater (8 hours × 7 days)	
【STEP3.2】 System operation test	Pumping up groundwater ▶ <from Sept. 16>	Collecting groundwater ▶	Purifying groundwater ▶ 2^{nd} time (Approx. 700m^3): <Sept. 26 to Sept. 27> 3^{rd} time (Approx. 1,000m^3): <Oct. 17 to Oct. 18> 4^{th} time (Approx. 1,000m^3): <Oct. 26 to Pct. 27> 5^{th} time (Approx. 1,000m^3): <Nov. 4 to Nov. 5>	Storing groundwater

STEP3.2 Continuous circulation test

- The operation test similar to a full-scale operation was implemented using the pumped up groundwater in 4 temporary storage tanks (4,000m^3 in total).
  - ✓ The purification facility was confirmed to work stably by pumping up the amount of groundwater that can be stored in the temporary water storage tanks using the subdrain and groundwater drain.
  - ✓ The system stability was confirmed through the continuous operation tests.



Groundwater drain pit
（in front of the Unit 1 intake）

Purifying the pumped up groundwater

- The facilities to collect, purify, and transfer groundwater were confirmed to operate as planned.
- The purification facility was confirmed to purify the water to a level better than the concentration limit set by TEPCO.

Unit: Becquerel/liter

	Water quality after purification 1st test*1 Approx. 300m^3	**Water quality after purification** 2nd test Approx. 700m^3	**Water quality after purification** 3rd test*2 Approx. 1,000m^3	**Water quality after purification** 4th test Approx. 1,000m^3	**Water quality after purification** 5th test*3 Approx. 1,000m^3	TEPCO's upper limit of radioactive concentration for Subdrain and Groundwater drain	[Reference] WHO drinking water guideline
Cesium 134	**Less than measurable limit (<0.54)**	**Less than measurable limit (<0.71)**	**Less than measurable limit (<0.46)**	**Less than measurable limit (<0.53)**	**Less than measurable limit (<0.62)**	**1**	10
Cesium 137	**Less than measurable limit (<0.46)**	**Less than measurable limit (<0.58)**	**Less than measurable limit (<0.62)**	**Less than measurable limit (<0.77)**	**Less than measurable limit (<0.68)**	**1**	10
Gross β	**Less than measurable limit (<0.83)**	**Less than measurable limit (<0.80)**	**Less than measurable limit (<0.88)**	**0.93**	**Less than measurable limit (<0.88)**	**3(1)*4**	10 (Strontium 90)
Tritium	**670**	**620**	**520**	**450**	**360**	**1,500**	10,000

*1 A third-party organization confirmed the values were better than the concentration limit set by TEPCO.
(Cesium 134: below measurable limit(<0.43), Cesium 137: below measurable limit(<0.52), Gross β: below measurable limit(<0.31), Tritium: 610)
*2 A third-party organization confirmed the values were better than the concentration limit set by TEPCO.
(Cesium 134: below measurable limit(<0.48), Cesium 137: below measurable limit(<0.42), Gross β: below measurable limit(<0.32), Tritium: 530)
*3 A third-party organization confirmed the values were better than the concentration limit set by TEPCO.
(Cesium 134: below measurable limit(<0.50), Cesium 137:below measurable limit(<0.43), Gross β: below measurable limit(<0.33), Tritium: 350)
*4 The value was confirmed to be below 1 Becquerel/liter from monitoring once every 10 days.

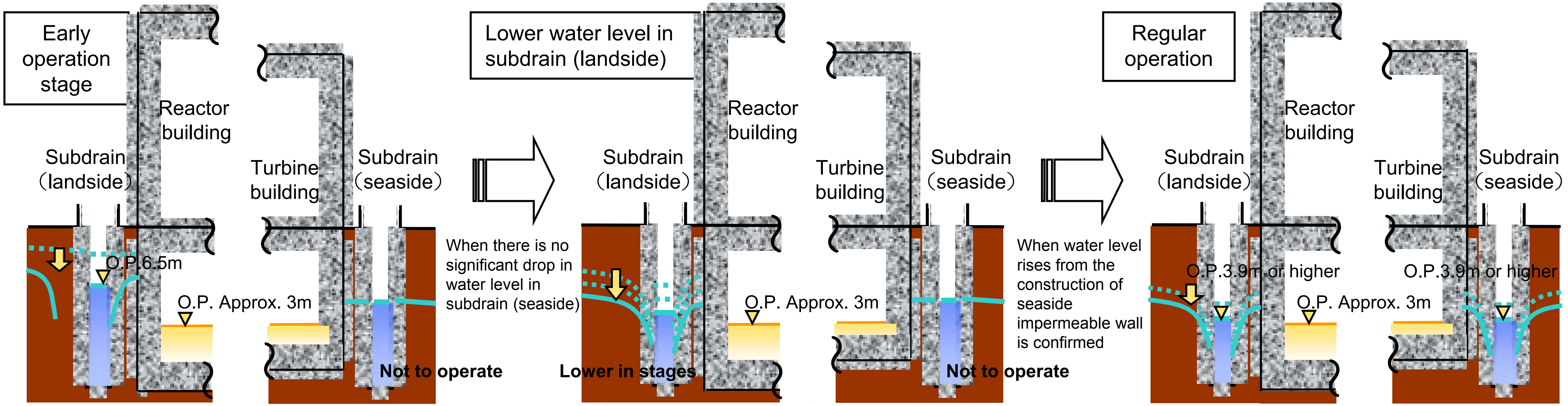
Facility design of subdrain water treatment facilities

- The amounts of pumped up groundwater are estimated approx. 50m^3 - 100m^3 /day for groundwater drain and approx. 500m^3 - 700m^3 /day for subdrain.
- The capacity to handle groundwater is increased for the pumps to pump up groundwater, the treatment capacity of the purification facility to purify groundwater, and the tanks to store groundwater.

	Pumping up groundwater		Purifying groundwater	Testing water quality and discharging water
Operation process	 Subdrain pit  Groundwater drain pit	 Water collecting tank	 Purification facility	 Temporary storage tank
Equipment capacity	Pumping up capacity	Water storage capacity	Treatment capacity	Water storage capacity
	<Groundwater drain> **Approx. 800m^3/day** (The amount to pump up: 50m^3～100m^3) <Subdrain> **Approx.1,800m^3/day** (The amount to pump up: 500m^3～700m^3)	**Approx. 3,000m^3 (Approx. 1,000m^3×3 tanks)**	Approx. 1,200m^3/day	**Approx. 7,000m^3 （Approx. 1,000m^3×7 tanks）**

Ensuring safety of subdrain operations

- The water level of subdrain located on the landside of the reactor buildings will be lowered in stages while not significantly affecting the water level of subdrain on the seaside.
- Subdrain on the seaside will not be put into operation until confirmation of the rising water level has been made of subdrain on the landside by constructing seaside impermeable wall. The pump stop position (L value) is set to O.P. 6.5m for subdrain on the landside and the change in water level of subdrain on the seaside will be checked for a set period of time (about a week). At that time, if we find that there is no significant drawdown in subdrain on the seaside, that there is enough of a water level difference between subdrain and accumulated water in the reactor buildings and that the amount of accumulated water can be received at the transfer point, then we can determine that there is no risk of outflowing accumulated water and turn the setting down. Afterward, we will continue to turn the setting down in stages while confirming that there is no risk of outflowing accumulated water in the buildings.
- After confirming the rising water level of subdrain on the seaside from the construction of the seaside impermeable wall, the pump stop position (L value) of subdrain on both landside and seaside near the buildings is set to O.P. 3.9m as the lowest limit. We will operate the subdrain while confirming the change in water levels.



Subdrain (landside)	O.P.6.5m
Subdrain (seaside)	Not to operate

Subdrain (landside)	Lower in stages
Subdrain (seaside)	Not to operate

Subdrain (landside)	O.P.3.9m or higher
Subdrain (seaside)	O.P.3.9m or higher