Measures to make Horikawa River Limpid

Implementation by Nagoya City

Sep.3rd 2016

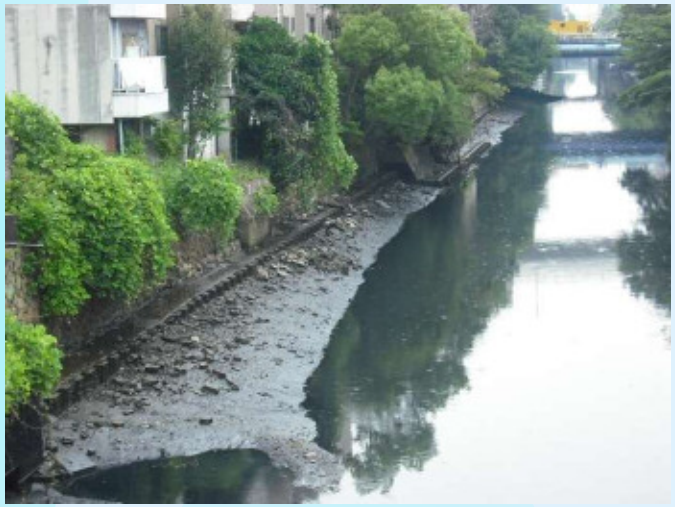
Greenification & PublicWorks Bureau
River Plannning Div.
Waterworks and Sewerage Bureau
Sewerage Plannning Div.

Points of the Report

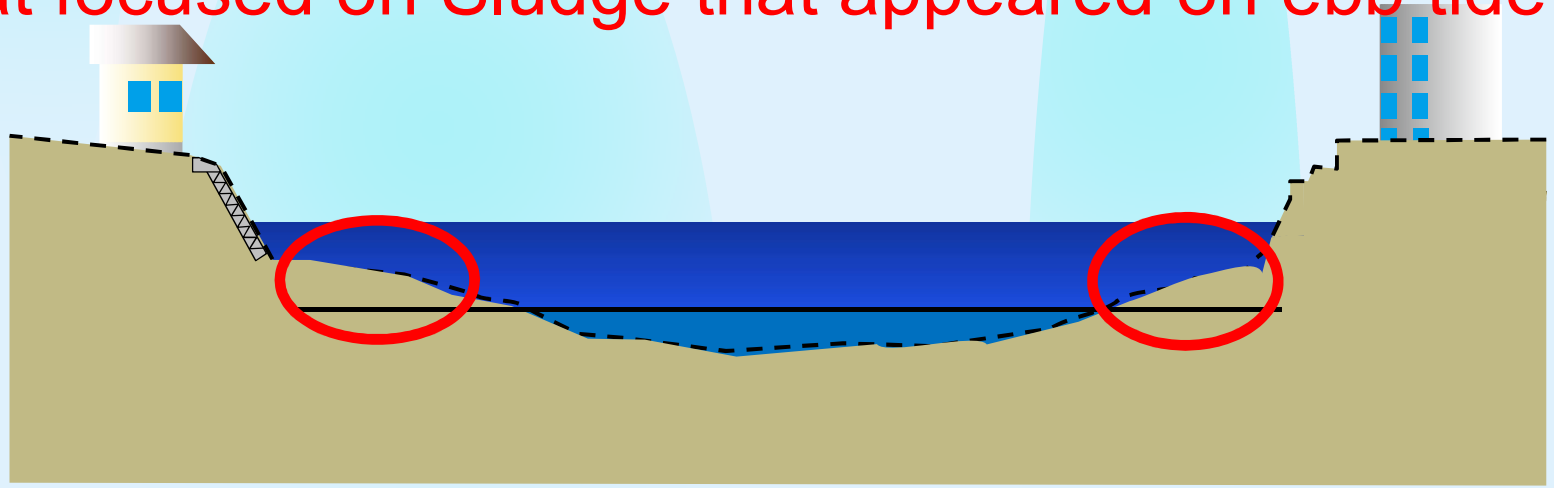
- Clarification experiments by covering sand
  - ・Monitoring survey result
- Sludge will be removed near the pier of Naya Bridge
- Utilization of shallow ground water
  - ・Starting to use the well of upstream of Nakaido Bridge (Mar. 2016)
  - ・Planning to survey new well（Water supply will start by Mar.2017）
- Making shallows and deeps
  - ・At downstream of Ruriko Bridge（Feb, 2016）
  - ・At downstream of Meoto Bridge（by Mar, 2017）
- Pollutants removal / inflow reduction
  - ・Horikawa Ugan Rain-water Reservoir for pollution control
    （Cumulative stored water volume in fy2015）

Clarification Experiments by Covering Sand

Sludge appearing from riverbed on the ebb tide.

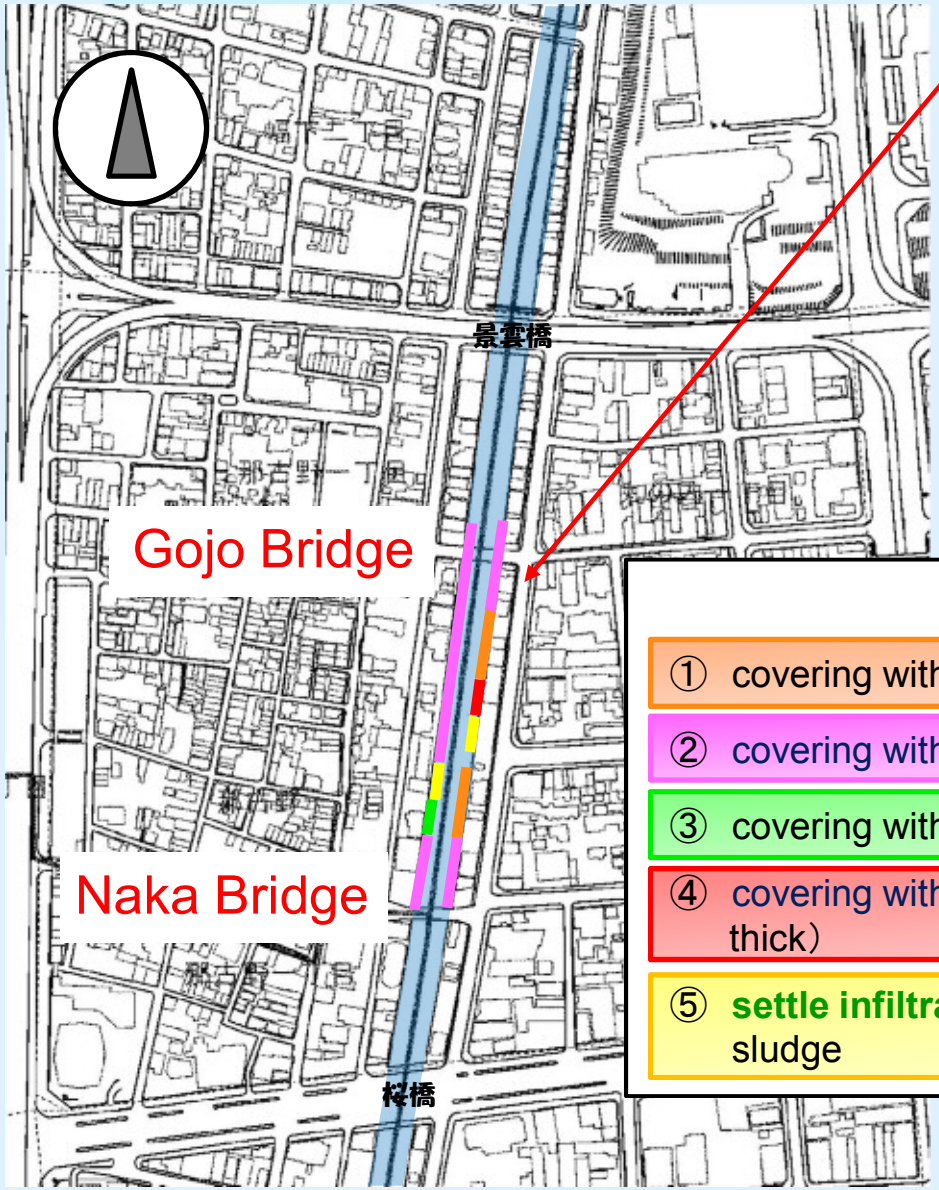


We implemented several clarification experiments that focused on Sludge that appeared on ebb tide.



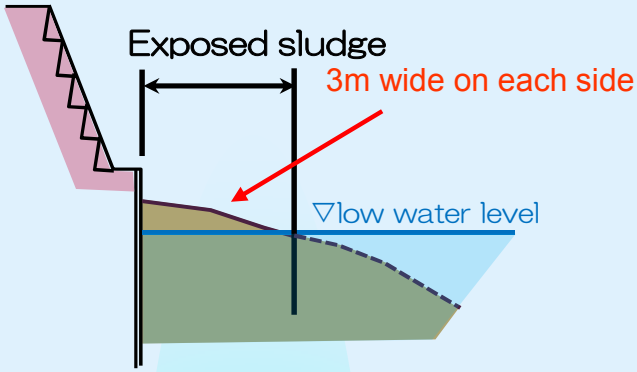
Outline of Clarification Experiments

■ Location



about 300m long

(600m on both sides)



【Five case】

① covering with **sand**（30cm thick）

② covering with **coal ash**（30cm thick）

③ covering with **sand**（30cm thick）after removing sludge（30cm thick）

④ covering with **coal ash**（30cm thick）after removing sludge（30cm thick）

⑤ **settle infiltrators**（coal ash pillar, 40cm high, 1m interval）inside sludge

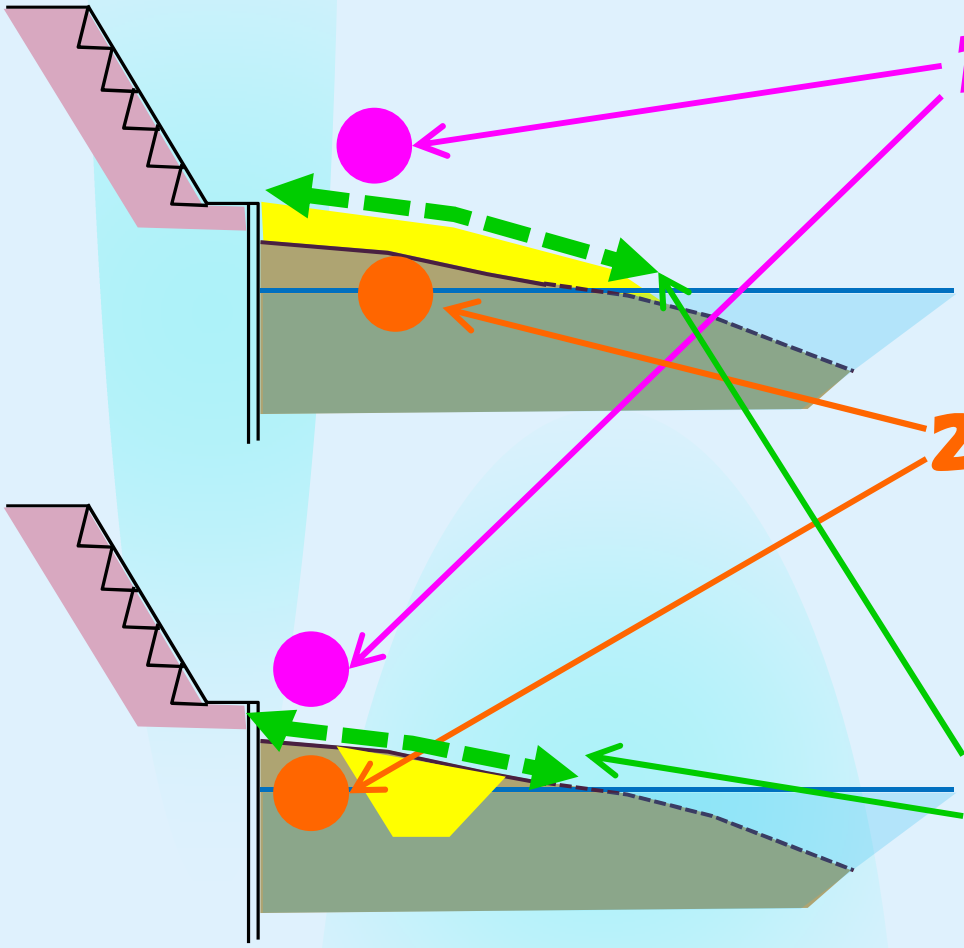
Construction of the experiment site

from Jan.16 to Jan.23

Machines set on a float
constructed the experiment site.

Situation of Clarification Experiments by Covering Sand

Monitoring Survey



1. Smell survey point
above covering sand, etc.
(above bottom sediment at permeating facility)

2. Bottom sediment survey point
below covering sand, etc.
(around purifying material at permeating facility)

3. Benthos survey point
surface of covering sand, etc.

Monitoring Survey Result (bottom sediment and smell)

Survey was conducted during low tide in spring tide

- pre-survey (before construction) Aug. 25,26 2014
- post-survey (after construction) 1st : Jul. 31 2015　2nd : Jul. 4, 5 2015

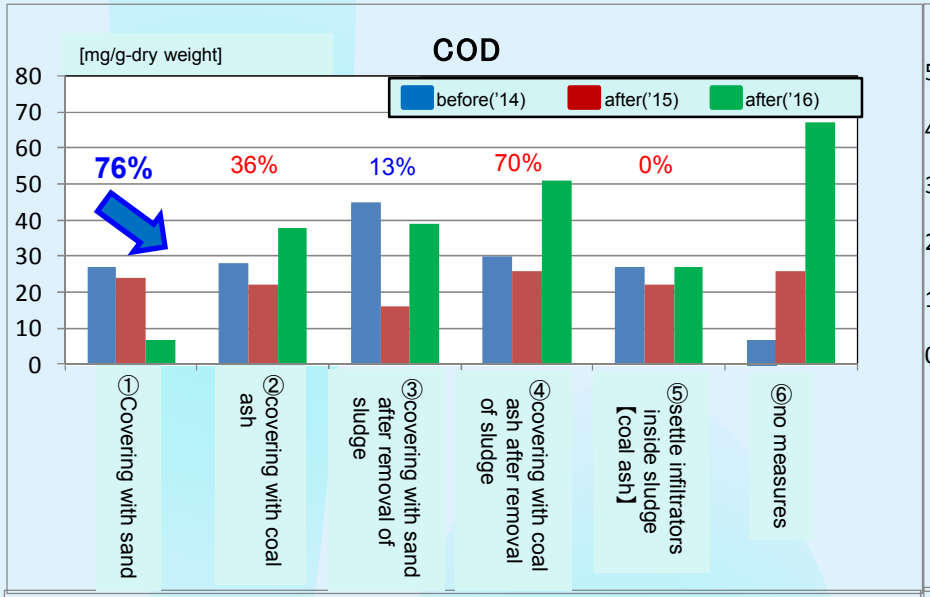
	point	① covering with sand			② covering with coal ash			③ covering with sand after removal of sludge			④ covering with coal ash after removal of sludge			⑤ settle infiltrators inside sludge【coal ash】			No measures		
	date	before	after		before	after		before	after		before	after		before	after		before	after	
		2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
	temp.(℃)	28.4	34.7	34.0	30.2	33.2	29.0	28.2	34.4	30	30.2	34.3	33.0	30.2	33.4	31.5	30.0	35.1	32
	water temp.(℃)	25.7	26.8	25.0	25.7	26.8	24.5	26.0	26.6	24.8	26.3	26.8	35.5	25.7	26.8	24.5	27.2	26.9	24.5
	mud temp.(℃)	26.3	24.6	25.0	26.3	27.0	23.0	26.0	26.4	22.5	25.8	24.3	30.9	26.5	25.4	21.0	26.0	28.6	28.0
	color	black-gray	black	dark-gray	black-gray	black	black	black	black	black	black-gray	black	black	black-gray	black	dark-gray	black-gray	black	black
	soil	silt mixed with sand and stone	clay	mud mixed with sand	silt mixed with sand	silt mixed with clay	silt mixed with clay	silt mixed with sand	clay	clay mixed with sand	silt mixed with sand	silt mixed with clay	clay	silt mixed with clay	clay	clay mixed with stone	sand mixed with silt	clay	clay
	odor	weak H2S	weak H2S	weak oil	H2S	weak oil	weak oil	strong H2S	weak oil	weak oil	H2S	weak H2S	weak oil	H2S	weak oil	weak oil	H2S	weak oil	weak oil
bottom sediment	pH	7.9	6.6	8.0	7.8	6.7	8.2	7.8	6.4	7.8	7.5	6.5	7.9	7.6	6.5	8.1	8.2	6.6	7.5
	COD(mg/g-dry)	27	24	6.5	28	22	38	45	16	39	30	26	51	27	22	27	7	26	67
	T-N(mg/g-dry)	1.6	1.8	0.44	2.7	1.6	4.3	4.2	2.1	3.1	2.7	2.5	3.1	2.3	1.6	1.7	0.5	2.2	4.0
	T-P(mg/g-dry)	1.9	1.9	0.27	2.1	1.1	2.3	4.1	1.3	1.5	3.2	1.7	1.6	1.6	1.4	0.98	0.24	1.8	3.80
	T-C(%)	2.4	3.0	0.9	6.8	3.4	8.0	9.5	3.1	6.2	5.1	5.2	3.9	6.2	3.9	3.4	0.3	3.8	6.4
	free sulfar(mg/g-dry)	0.36	0.25	0.04	0.71	0.44	0.71	1.1	0.34	0.14	0.24	0.90	0.24	1.1	0.35	0.03	0.13	0.71	0.90
	sulfar(mg/g-dry)	8.9	14	4	4.8	12	13	9.2	3.7	9.7	8.5	11	6.4	9.7	6.5	4.2	2.8	12.0	20.0
	ORP(mV)	-200	-87	-315	-240	12	-297	-210	40	-336	-290	-46	-358	-240	3	-318	-270	-177	-333
	ignition loss(%)	6.0	6.3	1.4	13.5	6.7	13.8	13.5	7.4	11.2	9.4	12.2	11.4	14.2	8.3	7.8	1.5	8.0	13.3
	loose on drying(%)	32.4	42.1	22.6	51.1	32.7	49.6	46.9	40.0	42.0	43.7	47.3	43	48.8	38.6	37.0	20.8	51.5	56.2
	H2S(mg/kg-dry)	<0.1	<0.1	<0.1	230	<0.1	<0.1	370	<0.1	<0.1	0.1	<0.1	<0.1	32	<0.1	<0.1	140	<0.1	<0.1
odor	H2S(ppm)	<0.0005	0.0006	0.014	0.0013	0.0034	0.023	0.0018	0.010	0.180	<0.0005	0.14	0.04	<0.0005	0.0025	0.047	<0.0005	0.0029	0.0068

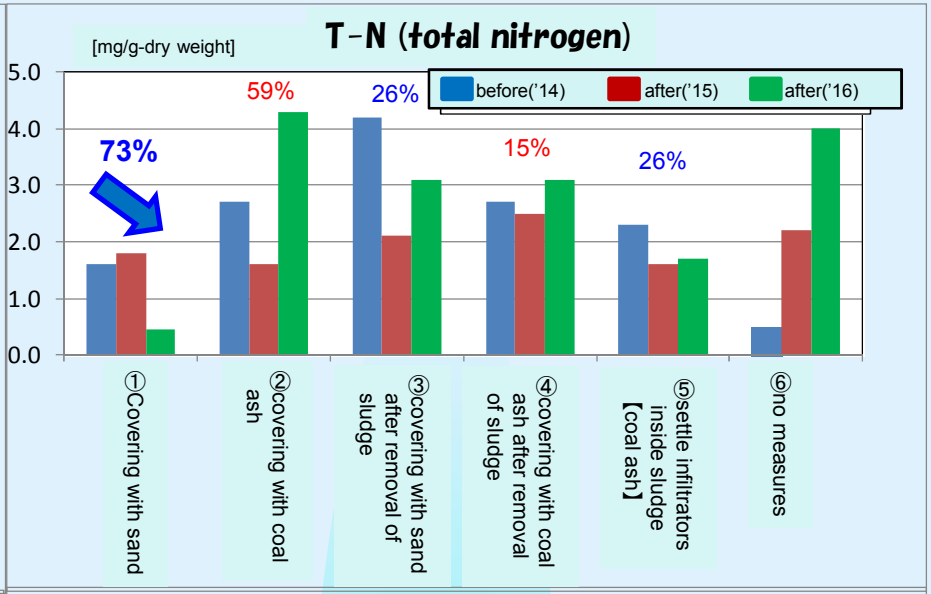
Monitoring Survey Result (bottom sediment)

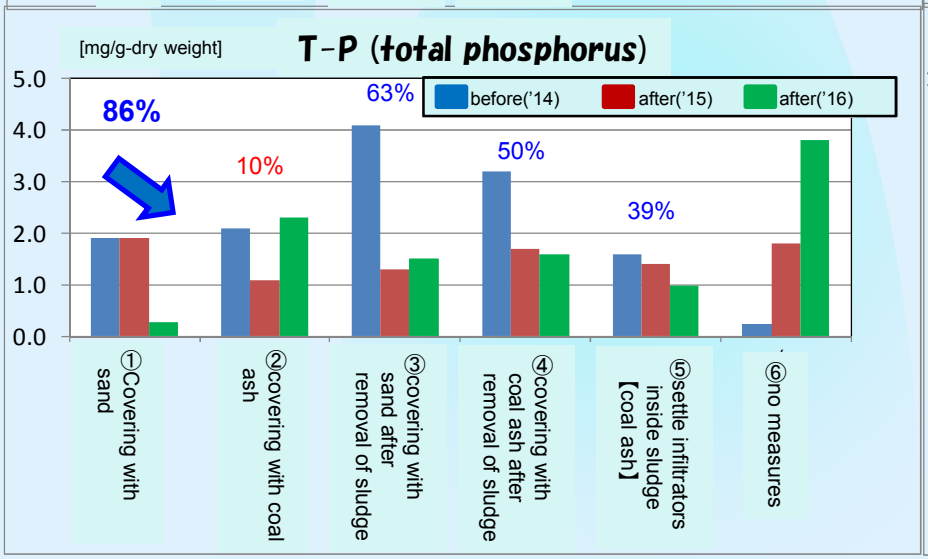
More than 70% improved

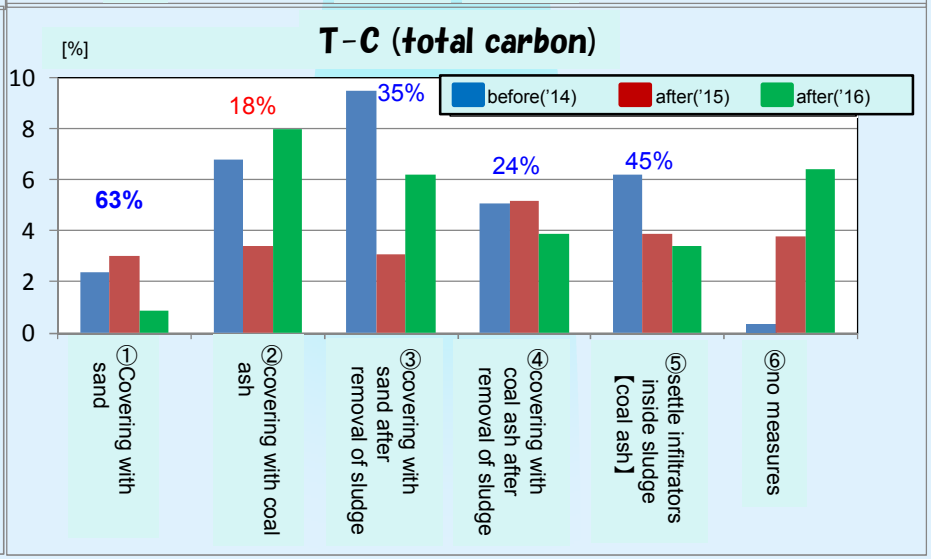
- pre-survey (before construction)
  Aug. 25,26 2014
- post-survey (after construction)
  1st : Jul. 31 2015　2nd : Jul. 4, 5 2015

Blue#: improved　Red#: not improved







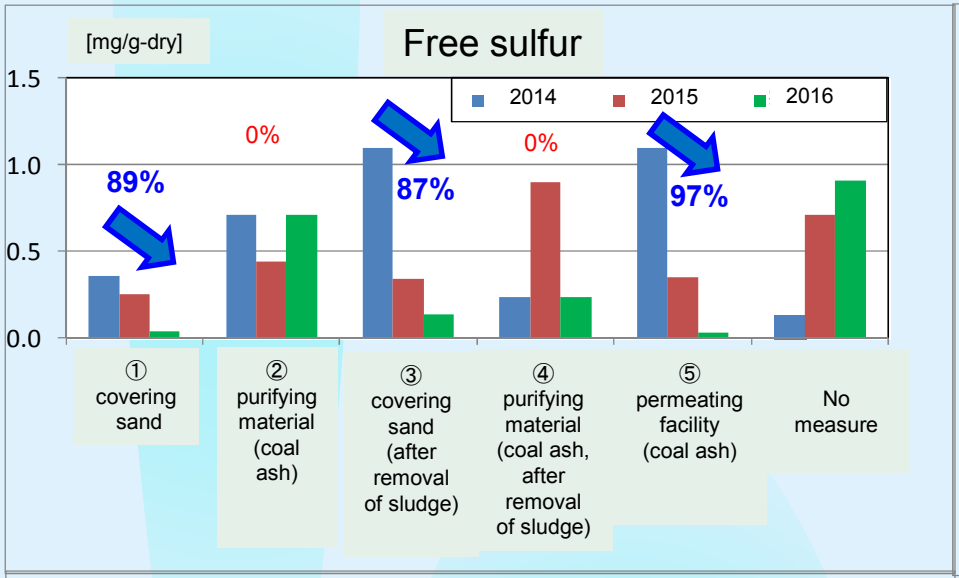


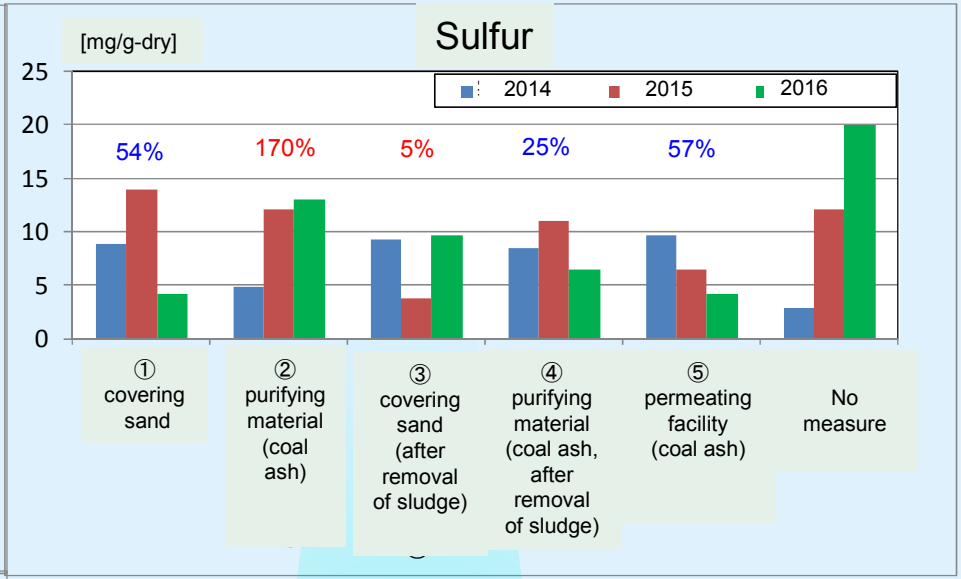
Monitoring Survey（Sulfur）

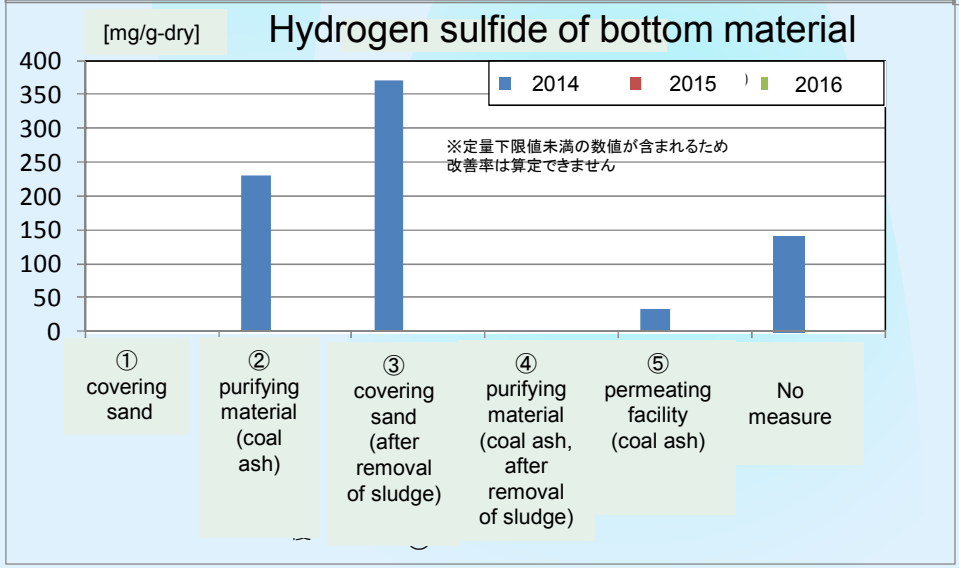
Improved more than 70%

- survey in advance　Aug. 25th, 26th 2014
- survey after the event (First)　Jul.31st 2015
- survey after the event (Second)　Jul.4th, 5th 2016

Brue：Improvement　Red：No improvement







- The value of COD, and Nutrient salts are improved
- The free sulfur was improved after ①Covered by sand, ③ Covered by sand after removal of sludge, ⑤Percolation facility
- Hydrogen sulfide of bottom material was improved in all area

Monitoring Survey(benthic organism)

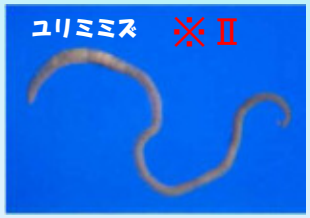
- survey in advance　Aug. 25th, 26th 2014
- survey after the event (First)　Jul.31st 2015
- survey after the event (Second)　Jul.4th, 5th 2016

○Result of measurement survey

Division	Omen・tum	Ordinal	Family	Japanese name	2014	2015			2016		
					Gojo bridge	①	②	⑤	①	②	⑤
Annelida	Earthworm	イトミミズ目	ミズミミズ科	エラミミズ ※Ⅰ						●	●
				ウチワミミズ属					●		
				ユリミミズ ※Ⅱ						●	●
				ユリミミズ属			●	●			
				トガリミズミミズ属	●						
				イトミミズ亜科	●	●	○	○	●	○	○
	Leech	吻蛭目	ヒラタビル科	ハバヒロビル属			●				
				ヌマビル ※Ⅲ						●	
		ハエ目(双翅目)	チョウバエ科	オオチョウバエ						●	
				ホシチョウバエ					●		
				ユスリカ属					●	●	
	The number of the kind of the living things				2	1	2	1	4	5	2

※● includes ○. So we don't count ○

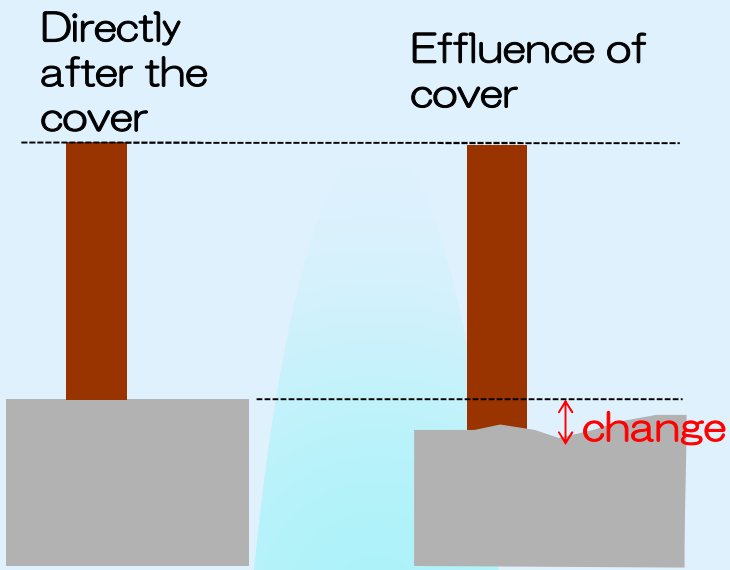
①Covered by sand, ②Covered by coal ash,
⑤Percolation facility



・The kind of living things was increased in all area
・We can expect the diversification of living things.

Monitoring Survey(effluence of cover)

○Survey of the effluence of covered
by the alteration of the tide level

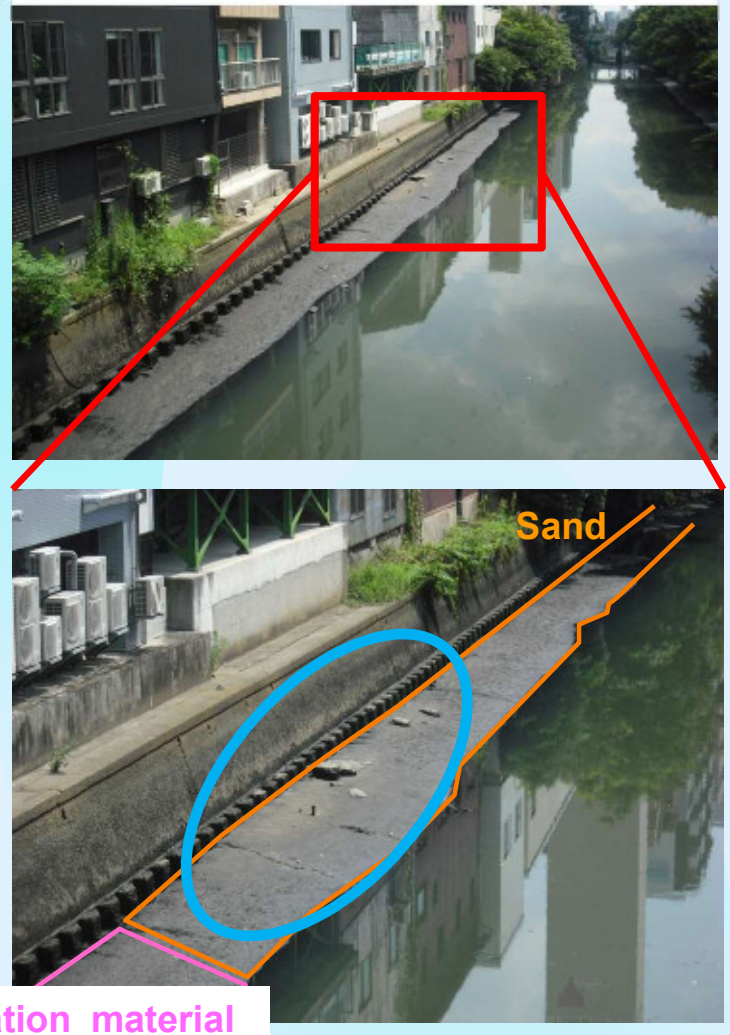


	Change(average)
The area covered with coal ash	-4.1cm
The area covered with sand	-1.0cm

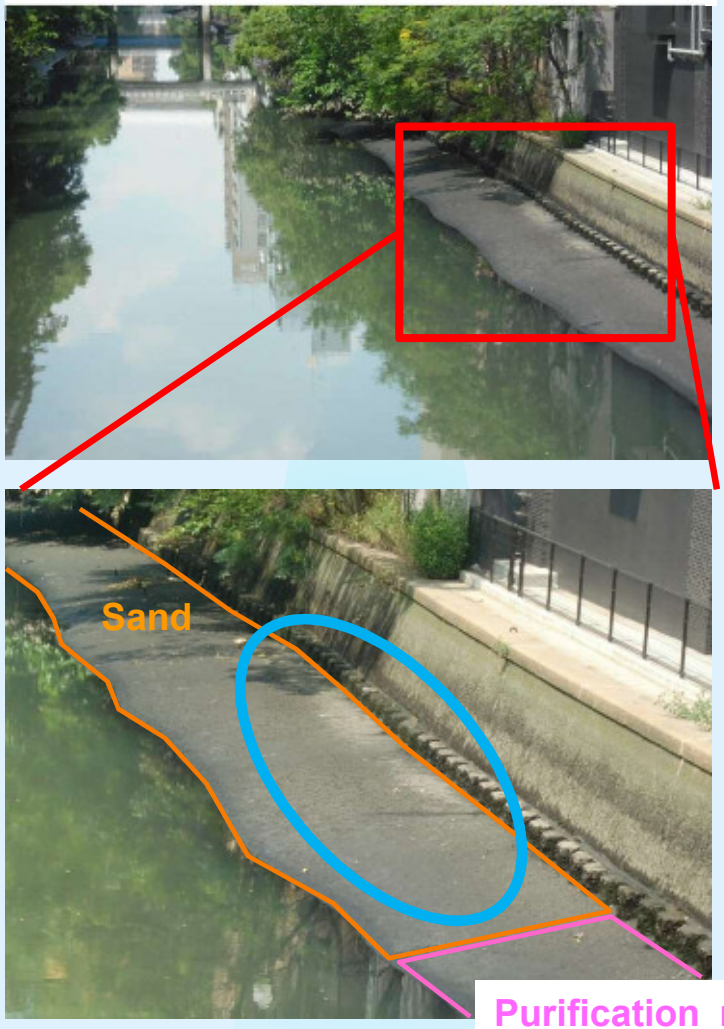
※17 months after the cover

Monitoring Survey (Difference in bank levels)

Gojyo Bridge, downstream, left bank



Naka Bridge, upstream, right bank



Good condition sand could be confirmed at higher bank level.

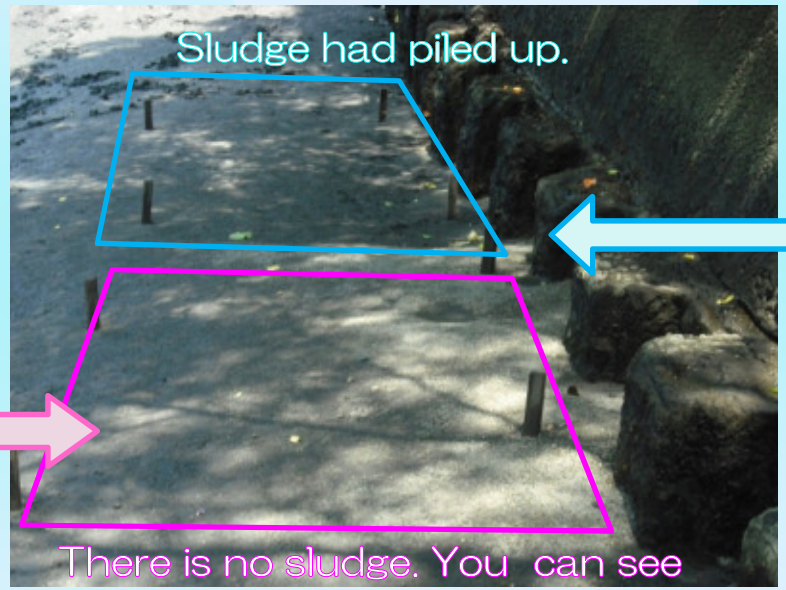
Monitoring Survey (Difference in slopes)

Check sedimentary sludge

Sludge at steeper slope could hardly be piled up.

Steeper slope (15%)

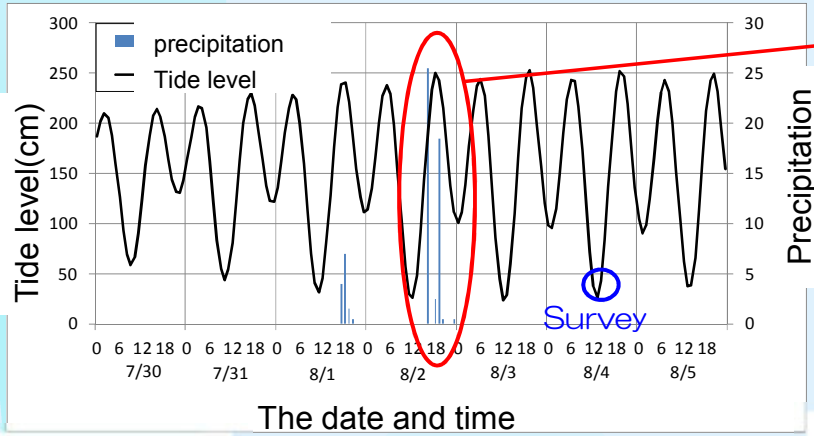
Gentler slope (5%)



Monitoring Survey

Sludge condition before and after flood

Change of sludge condition caused by heavy rain on Aug. 2nd

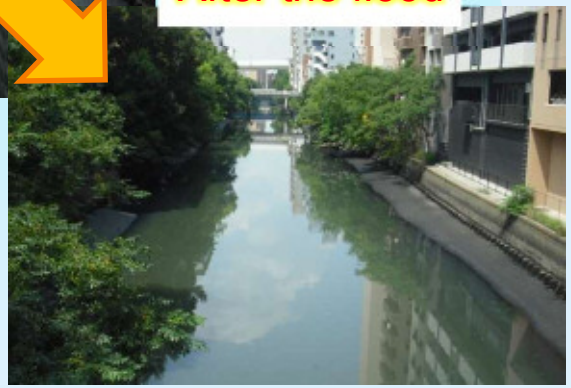


Rain condition Aug. 2nd 16:00 – 20:00
max 25.5mm/hour
Sum 47.5mm

Sludge on the covering sand was washed away.
Covered area kept good condition.

Before the flood

After the flood



Before the flood

After the flood

Monitoring Survey　conclusion

Covering material

- Sand improvement rate is high at the result of bottom survey.
- Sand is hard to flow out.

Covering figure and so on

-There is slight sludge at highly covered bank.

-There is slight sludge at steeper slope.

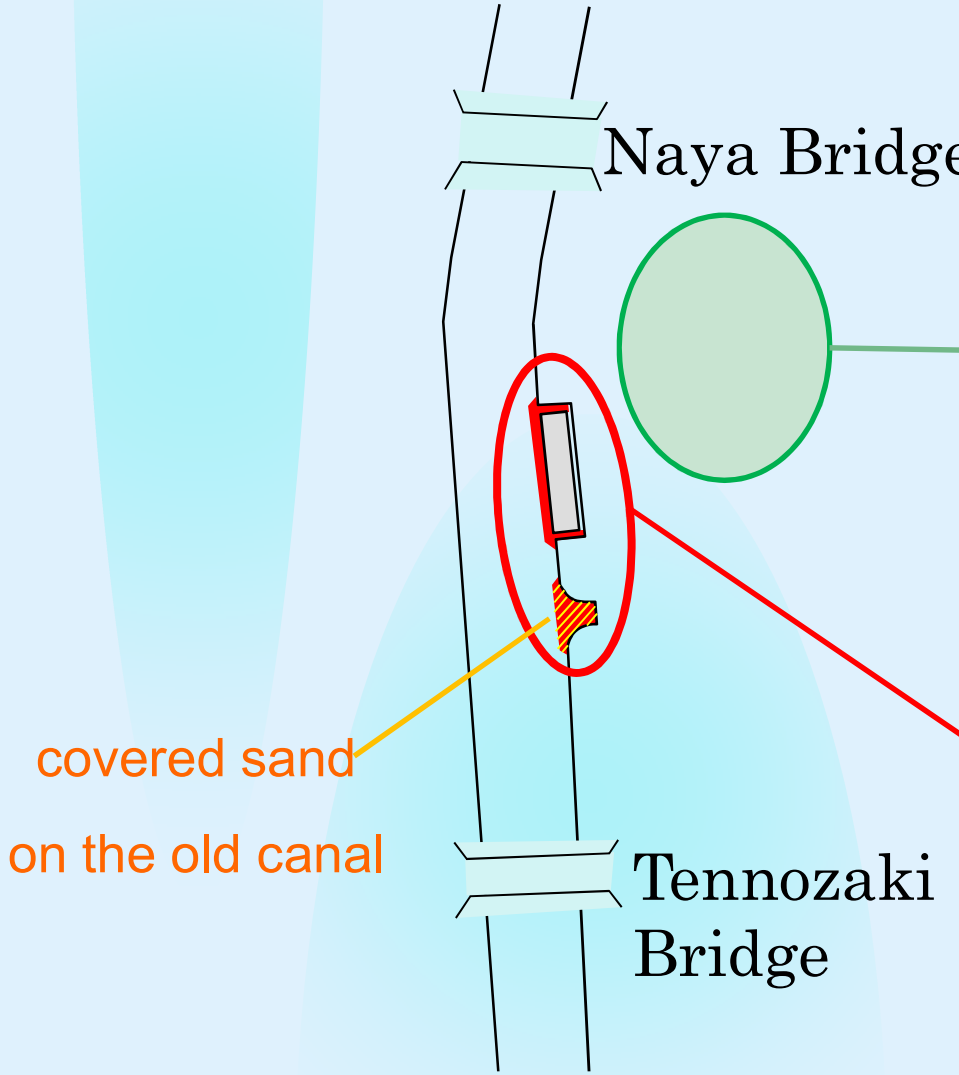
Etc.

Biodiversity by sand covering is expected.

Covered area keeps some good level by rain.

Removal of Sludge in Naya Bridge area

Redevelopment project of
Naya Bridge east urban district
(completion scheduled in 2017)



removal of sludge
near the dock and the old canal
about 250m^3 (scheduled volume)

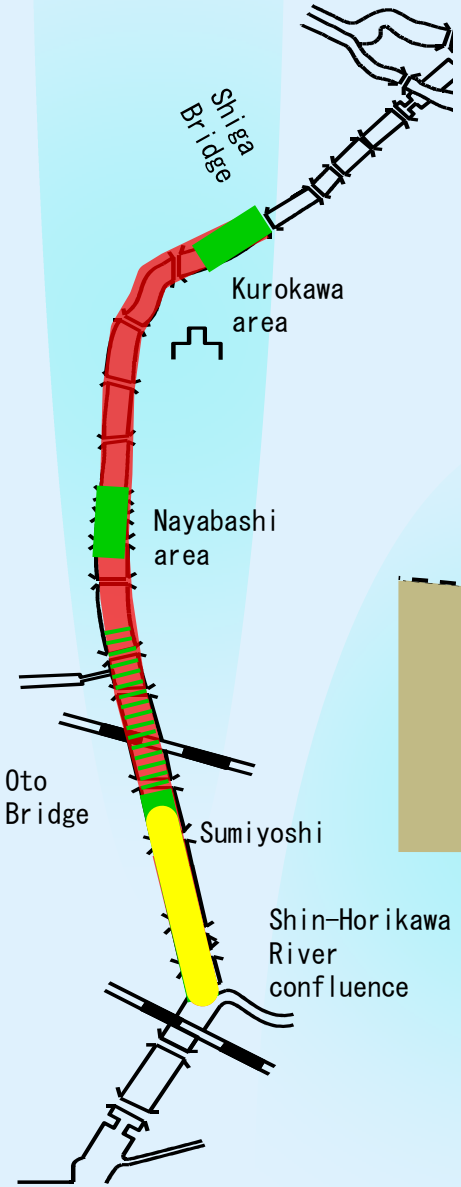
Making additional water sources

◆Use of shallow ground water in the upstream area

★: scheduled survey point in 2016 (downstream from Tabata Bridge)

Improvement of water quality

◆Removal of sludge

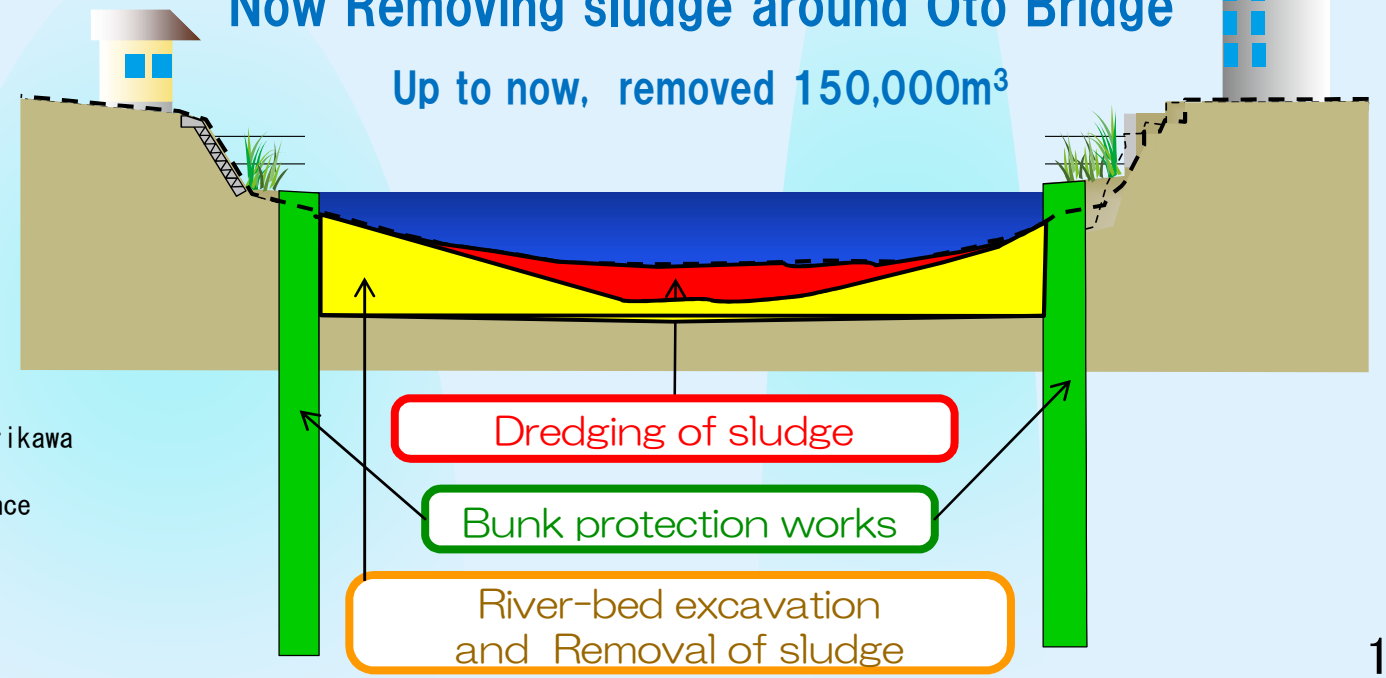


- Removal of sludge on water route from Shiga Bridge to Shin-Horikawa River confluence(1994～2007)
- Removal of sludge and river bed excavation at the same time implemented from downstream

About 700m³ removed in 2015

Now Removing sludge around Oto Bridge

Up to now, removed 150,000m³



Improvement of water quality

◆ Making shallows and deeps

Setting wooden piles and ripraps generates variable stream on the river for enforcing river's self-purification function with growth of plants.

fish spawning and plants' seed ashore

change of stream

Improvement of water quality

Installed in 2010
(Meoto Bridge～Kurokawa No.1 Bridge)

Installed in 2012
(Downstream of Kurokawa No.2 Bridge)

Installed in 2013
(Upstream of Kurokawa No.2 Bridge)

Installed in 2015
(Downstream of Ruriko Bridge)

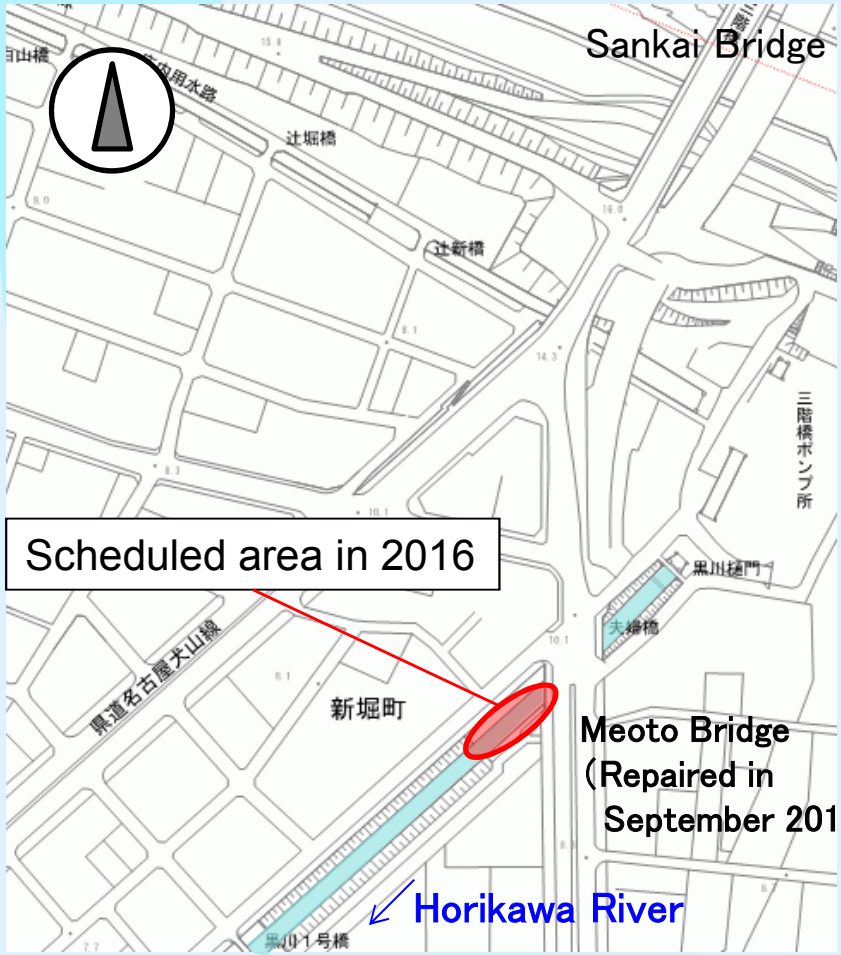
Some of the creatures
seen in the upstream of Horikawa River

◆ Improvement

- Variety and amount of fish have increased.
- Benthos have increased.
- Plants have grow up more.

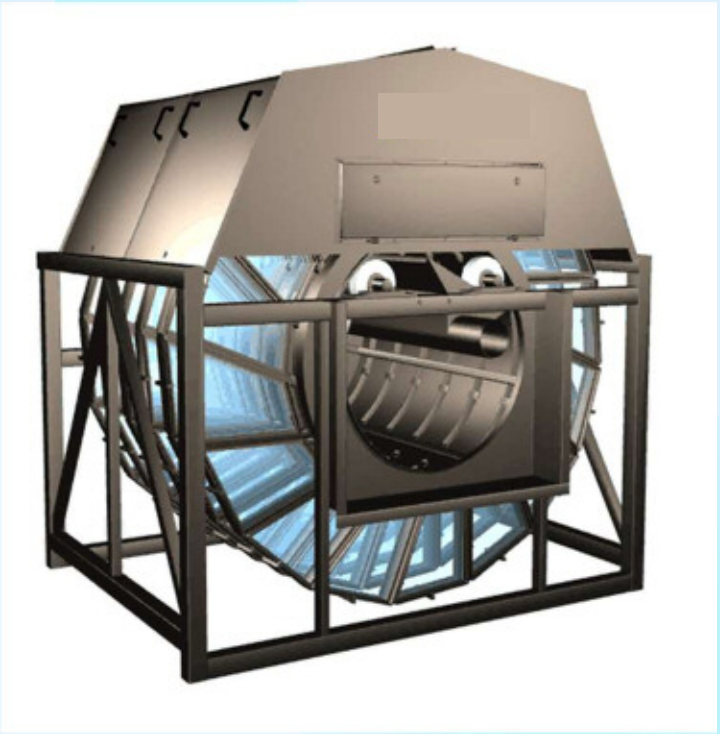
Improvement of water quality

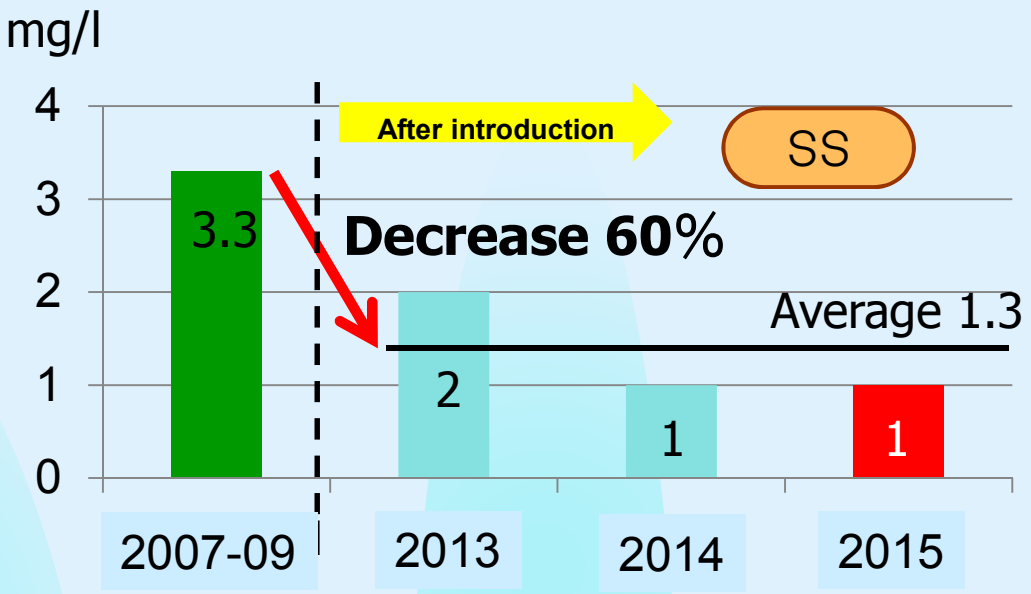
- Making shallows and deeps
  In 2016, scheduled to work at downstream of Meoto Bridge.



Removal and reduction of inflow of pollutants

◆Advanced water treatment at the Meijo Water Treatment Center (From May 2010)





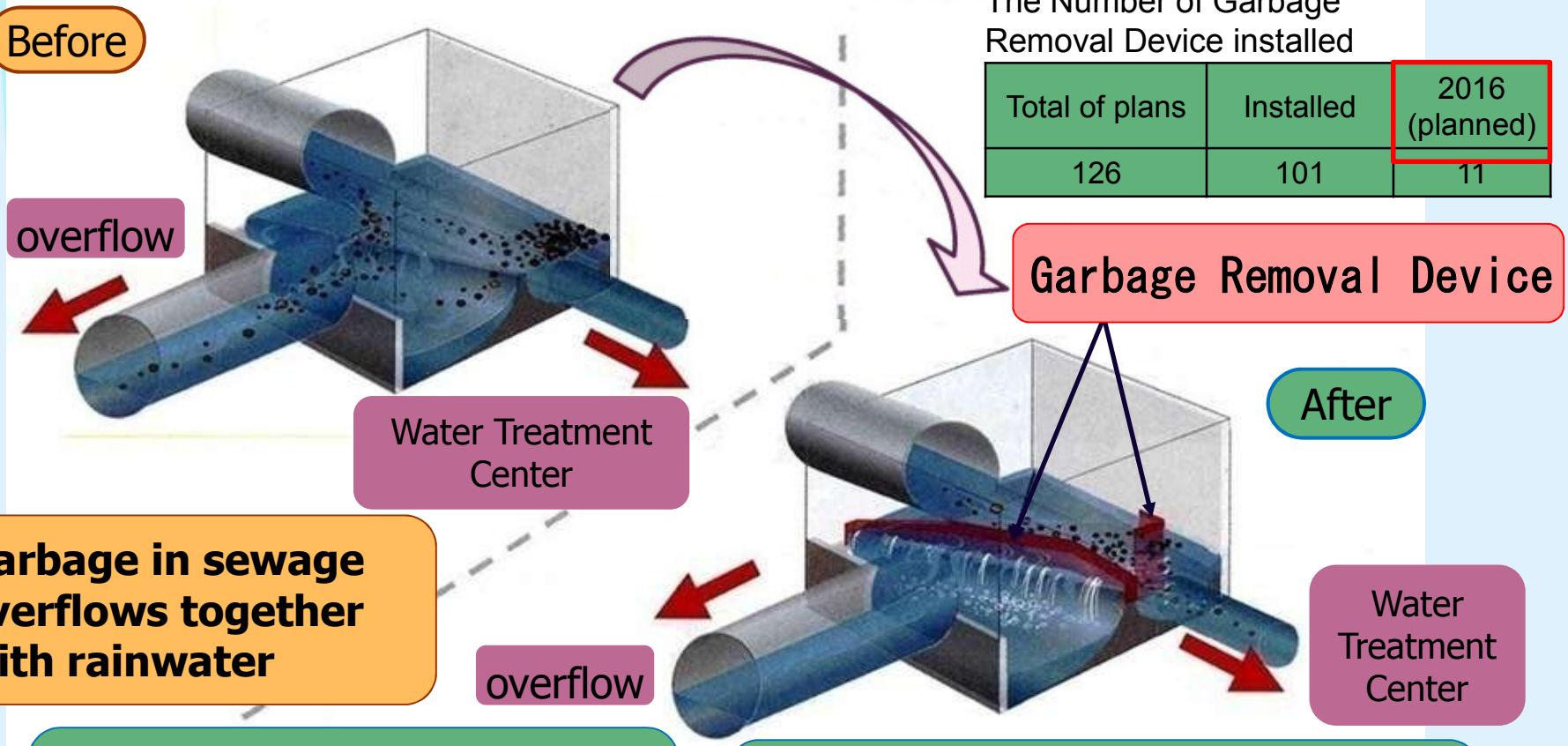
Filter out more minute Suspeded Solids(SS) in treated water by filteration devices

Removal and reduction of inflow of pollutants

◆Improvement of combined sewer system （Installation of Garbage Removal Device）

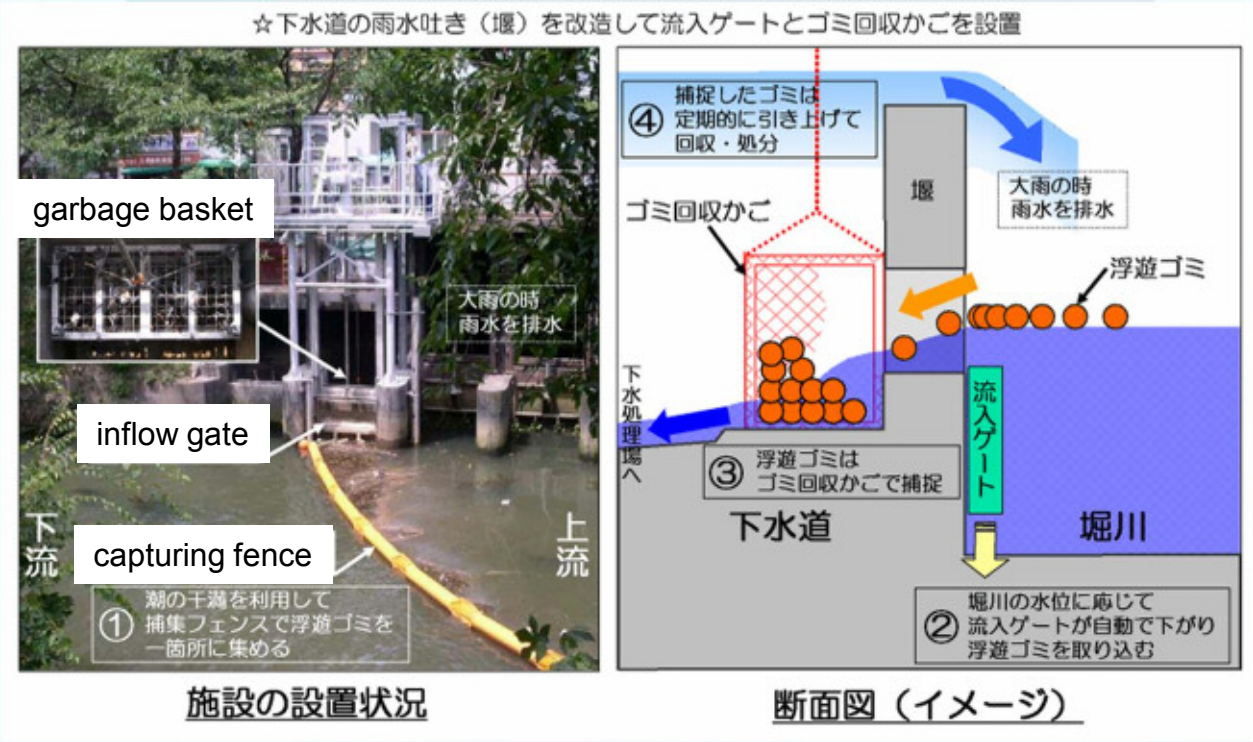
The Number of Garbage Removal Device installed

Total of plans	Installed	2016 (planned)
126	101	11



Removal and reduction of inflow of pollutants

◆Garbage catcher（Near Johoku Bridge） since 2006



Result of collection in 2012	1.1 t
in 2013	0.8 t
in 2014	0.7 t
in 2015	1.4 t

Additional Water Resource

◆Utilization of Reclaimed Wastewater （Excluding winter）

Conducting reclaimed wastewater treated by membrane filtration at the Moriyama Water Treatment Center

○Water Supply:　Up to 4,000㎥/day（0.046㎥/s）

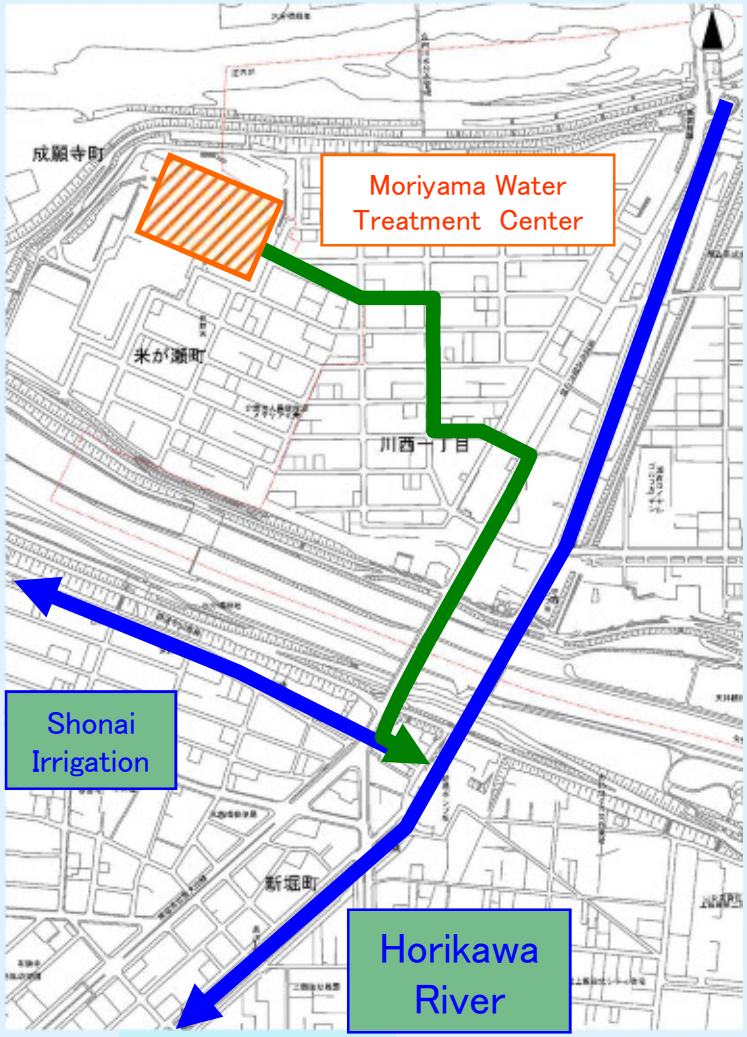
Flat membrane unit in aerobic tank

（400 sheets × 12units）

Upper stage membrane case （200 cartridges inside）

Lower stage membrane case （200 cartridges inside）

Flat membrane unit



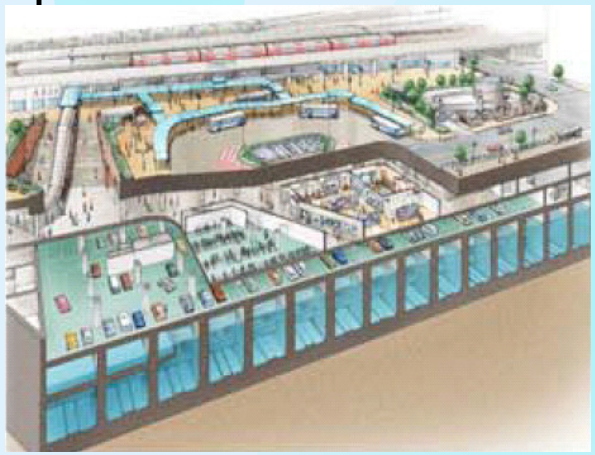
※Water conveyance period is generally irrigation seasons (from April to October) (except the period for Shonai irrigation channel （from November to March）

Removal and reduction of inflow of pollutants

◆Control of combined sewer overflow (rainwater storage facility)

Construct rainwater storage facilities to reduce pollution load for Horikawa River in rainy weather by storing high polluted first flush rainwater temporarily.

Ozone Stormwater Reservoir for pollution control



Started operation in 2006
(12,000m^3)

Horikawa Ugan Rain-water Resevoir for pollution control

Started operation in 2010
(13,000m^3)

Horikawa Sagan Rain-water Resevoir for pollution control

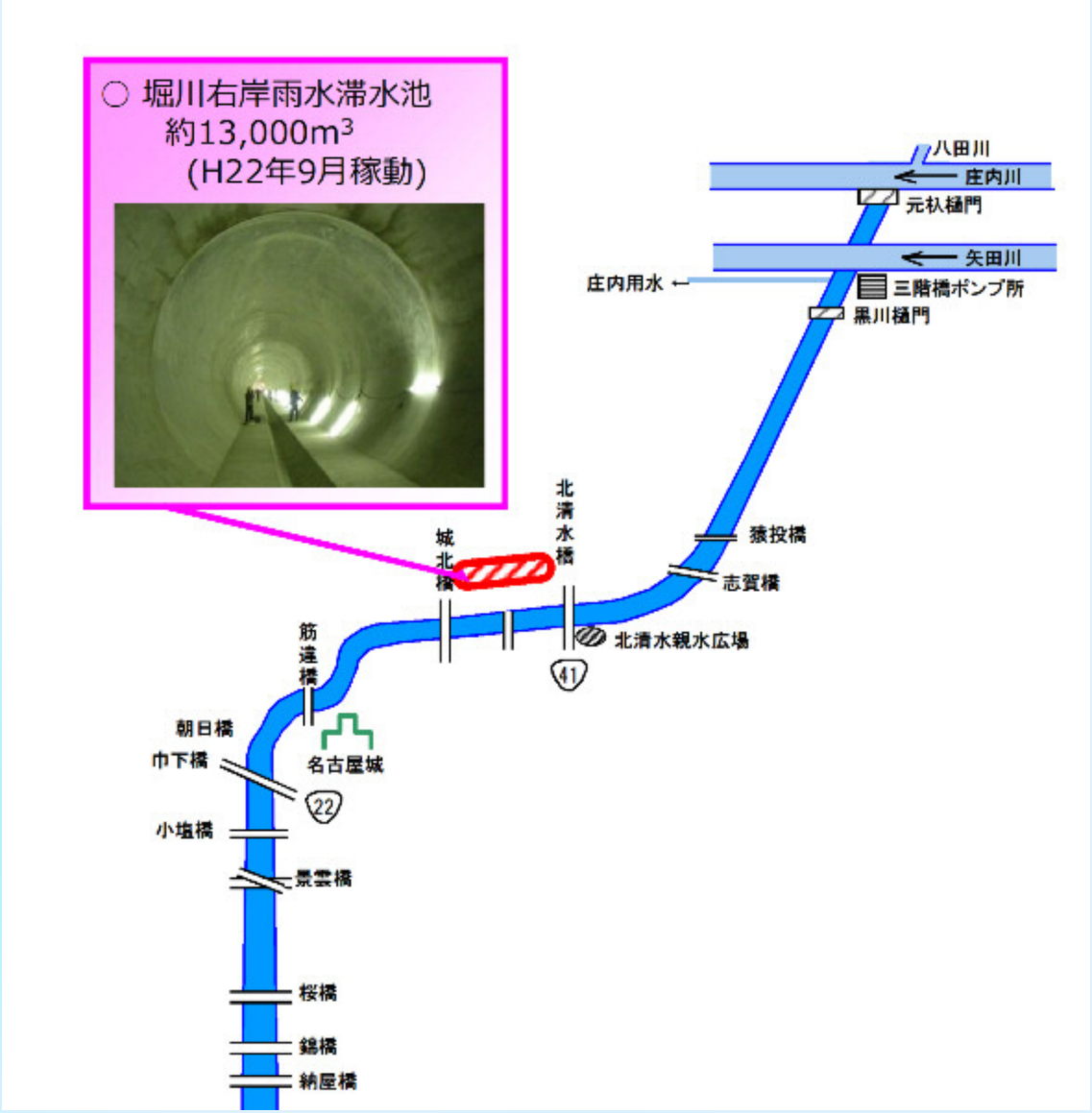
Scheduled to start operation in 2018
(14,000m^3)

Removal and reduction of inflow of pollutants

◆Horikawa Ugan Rain-water Resevoir for pollution control

- Started operation in September 2010
- About 13,000㎥

Cumulative stored water volume in fy 2015
About 680,000㎥



Thank you for your attention.