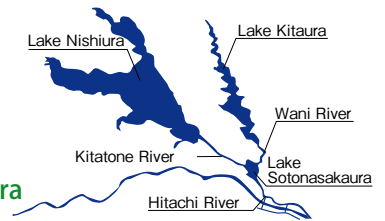


Outline of Lake Kasumigaura



History of Lake Kasumigaura

Lake Kasumigaura is located about 60km away from Tokyo and in the southeastern part of Ibaraki Prefecture. It is the second largest freshwater lake in Japan.

Lake Kasumigaura was a part of the Pacific Ocean with downstream area of Tone River, Lake Inbanuma and Lake Teganuma about 6,000 years ago. Later, sediment supplied from Tone River has separated these lakes from the ocean and made Lake Kasumigaura what it is today.

Hydrological/meteorological characteristics

The Lake Kasumigaura basin area belongs to East Japan Type climatic zone. In winter, north-west seasonal winds called "Tsukuba Oroshi" tend to blow down from Mt. Tsukuba and sunny days tend to last, and there is limited amount of rainfall. In summer, south-east seasonal winds blow up from the ocean and they bring relatively large amount of rainfall. There are few regional differences in the temperature in this basin area except for the mountain areas and annual mean temperature is around 13 degrees Celsius. Average annual rainfall is 1,257mm, comparatively smaller than national average of 1,700mm.

Characteristics of the lake

The surrounding area of Lake Kasumigaura is low-lying and ill drained. Therefore, this area has struggled with repeated floods. In addition, since this area is located close to the sea and subject to the sea tide, this area has also struggled with the severe salt damages and droughts. Especially, the floods in 1938 and 1941, and the salt damages extended to approx.1,140 ha in 1958 which arose from the severe drought caused significant damages in this area.

In terms of the water quality, as the lake has an extended basin area and its depth is rather shallow, it is subject to water pollution or eutrophication.

Socio-economic aspect of the basin

The Lake Kasumigaura basin area extends over 24 municipalities in Ibaraki, Chiba and Tochigi prefectures and its basin area coverage is equivalent to just about one third of total area of Ibaraki Prefecture, i.e. 2,157km², and its population reached approx. 960,000.

The basin area was mainly developed for farmland and rice growing, lotus root growing and hog raising, etc. are its major lines of businesses.

Agriculture in this basin has been promoted since Edo Period. But as the agricultural lands developed in this basin are basically located in the low-lying area, farmers have struggled with the floods for long years.

After the World War II, to meet the socio-economic development in Japan, new rice fields were developed along the lake by reclamation to increase food production. Nowadays, the downstream area of the lake is one of the richest grain-yielding areas in Kanto Plain.

When it comes to the industrial aspect, along with the high economic growth started from the latter half of 1950s, development of Kashima Coastal Industrial Zone, construction of Tsukuba Academic City and construction of Joban Expressway and Higashikanto Expressway stimulated the urbanization in this area. As a result, the total value of industrial shipment increased and reached 5.6 trillion yen according to the Ibaraki Prefectural Statistics Yearbook 2013.

Outline of Lake Kasumigaura

Lake	
Total space	Approx. 220km ² Lake Nishiura 168.2km ² , Lake Kitaura 35.0km ² , Hitachitone River & others 15.3km ²
Total coastal line length	250km Lake Nishiura 121.4km, Lake Kitaura 63.9km, Hitachitone River 64.6km
Total capacity	Approx. 850 mil. m ³ at the time of Y.P.+1.0m
Max. depth	7m Average depth 4m
Water exchange	Approx. 200 days

Basin	
Basin area	2,157km ² Approx. 1/3 of Total Ibaraki Pref. (6,097km ²)
Total # of municipality	24 Ibaraki Pref.(17 cities, 4 towns, 1 village), Chiba Pref. (1 city), Tochigi Pref. (1 town)
# of municipalities surrounding the Lake	13 Ibaraki Pref.(10 cities, 1town, 1village), Chiba Pref. (1 city)
Annual mean rainfall	1,244mm Annual average rainfall in the basin (1996-2015)

*In this chart, three lakes respectively named "Lake Nishiura", "Lake Kitaura" and "Lake Sotonasakaura" and three rivers named "Hitachi River", "Kitatone River" and "Wani River" all combined make up "Lake Kasumigaura".

Flood in Jun-Jul 1938 Y.P.+3.34m (Downflow flooding)

-The total amount of rainfall in the Lake Kasumigaura basin area caused by the typhoon reached 400-500mm.

-The total amount of rainfall in the mountain area of the Tone River system was 100-200mm.

-Downflow flooding occurred

As the cross section of Hitachitone River was small, inundation in the area around Lake Kasumigaura continued for dozens of days.

-Damages

The inundated area totaled approx. 2,145km² in the entire Tone River system. Damages to the agricultural production in the Lake Kasumigaura basin area reached 13.6 million yen (equivalent to the present value of 20 billion yen.)

Flood in Jul 1941 Y.P.+2.90m (Backflow flooding)

-Rainfall caused by the seasonal rain front and typhoon (more than 300mm of rainfall in the Kinu River and Watarase River basins, which are located in the mid-stream area of Tone River basin)

-Rainfall in the Lake Kasumigaura basin was relatively small as opposed to the mid-stream area of Tone River.

-Backflow flooding occurred.

The backflow from Tone River flowed into Lake Kasumigaura and caused the flood damages shown below.

-Damages

Inundated houses in Tsuchiura exceeded 1000.

Inundated houses in Hokota exceeded 200.

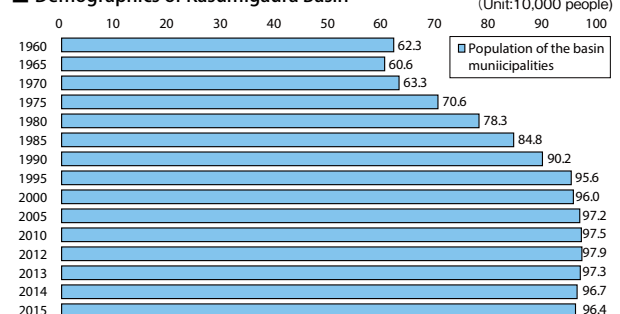
The 2,000 ha of farmland was totally submerged around Kitaura, and a wide range of farmland around Nishiura was also submerged.

Salt damages on the agriculture

Year	Damaged space (ha)	Damage amount (K yen)	Remarks
1957	315	4,161	Salt damage (in May) in Kamisu Village
1958	1,139	32,265	Salt damage(Jun-Aug) Kashima, Namekata, Inashiki-Gun
1960	365	8,847	Salt damage(Jul) Kashima, Namekata, Inashiki-Gun
1961	118	1,866	Salt damage(Jul) Kashima, Namekata, Inashiki-Gun
1962	74	2,467	Salt damage, Kashima, Namekata, Inashiki-Gun
1963	372	9,133	Salt damage, Kashima, Namekata, Inashiki-Gun
1964	124	1,648	Salt damage, Kashima, Namekata, Nanbu Region
1966	50	1,636	Salt damage, Kashima, Namekata, Nanbu Region
1967	595	10,120	Salt damage, Kashima, Namekata, Nanbu, Seibu Region
1973	14	—	Salt damage in Aug in Okinosu Hitachi River basin
1974	496	—	Salt damage (in May-Sep) in Kitaura, Hitachi River basin

*The amount is calculated based on the value of 1975 year.

Demographics of Kasumigaura Basin





Management and Operation

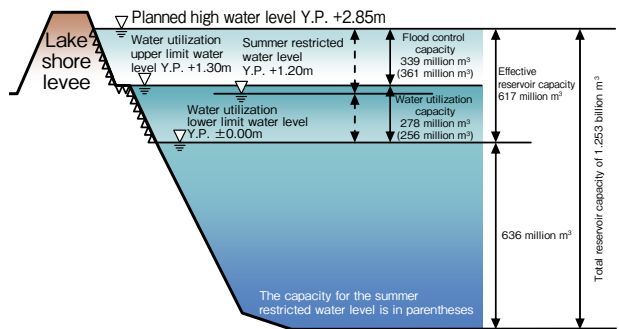
Water Level of Lake Kasumigaura Before Starting Management

Lake Kasumigaura is near the sea, and the water level is affected by the tide. Since the width of Hitachi Tone River that was located at the exit of Lake Kasumigaura used to be narrow, it is ill drained at the time of flooding, and subject to the water level of Tone River, so that the water level of Lake Kasumigaura had been changing largely and constantly. In particular, the flood in June 1938 recorded water level of Y.P. +3.34m due to the inadequate discharge capacity of Hitachi Tone River. In addition, the flood of 1941 recorded water level of Y.P. +2.90m as the flood water from Tone River reversely flowed into Lake Kasumigaura. Since 1948, Ministry of Construction had dredged to broaden the width of Hitachi Tone River, and the drainage capacity improved and the average water level lowered, but that prompted salt water intrusion from the sea and caused salt damage. In 1963, the Hitachi River Sluice Gate was constructed at the confluence point of Tone River and Hitachi Tone River and the sluice gate came to be operated when water level of Tone River increased or during the spring tide. However, except for these times, the water level naturally fluctuated due to rain and the tides. Since 1975, the Hitachi River Sluice Gate has started to maintain the water level at the request of Ibaraki Prefecture and Chiba Prefecture for the purpose of water utilization. As a result, the water level came to be kept comparatively stable from roughly Y.P. +0.9m to Y.P. +1.3m except during flood or drought.

Water Level Management of Lake Kasumigaura

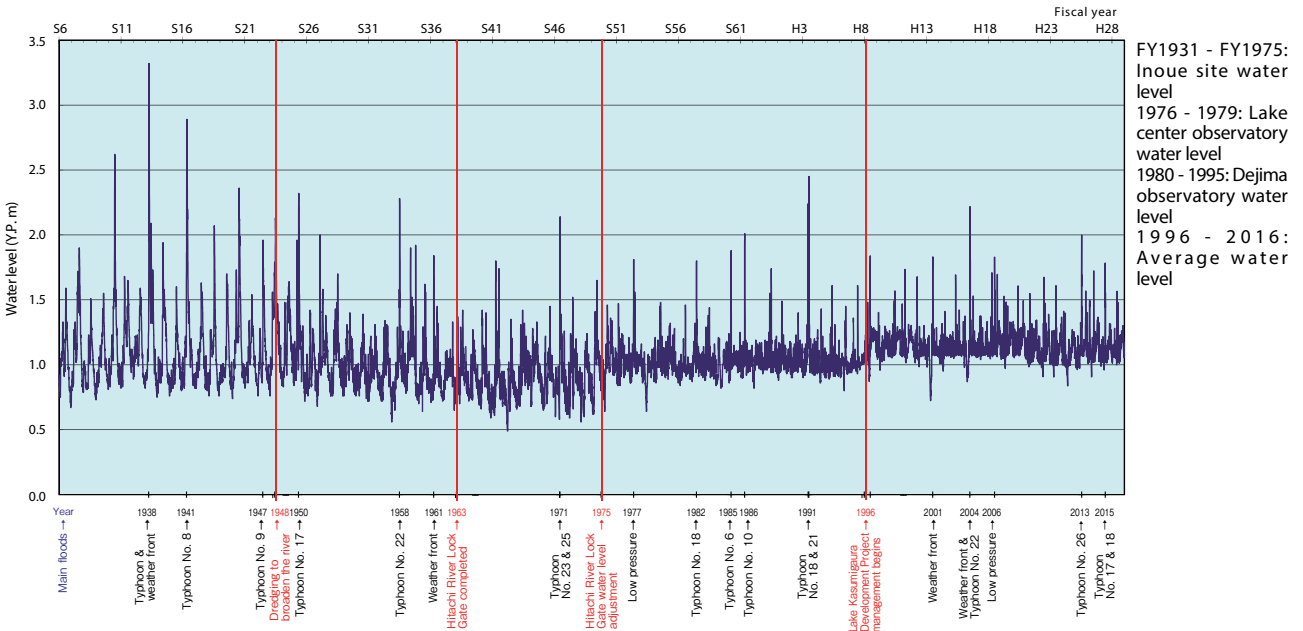
From April 1996, water level management was started to achieve the purpose of the Lake Kasumigaura Development Project, that is, flood control and water utilization. Normally, the maximum water level for water utilization is Y.P. +1.3m, but considering the surrounding environment of Lake Kasumigaura, it is mainly kept around Y.P. +1.1m from April to mid-October which is the growing, flowering and fruiting season of plants such as common reeds. In order to prepare for water use during the irrigation period from mid-March, water level is managed with a target of Y.P. +1.3m from mid-November to the end of February. These water level adjustments are done by operating the Hitachi River Sluice Gate.

Lake Kasumigaura Water Volume Distribution Diagram

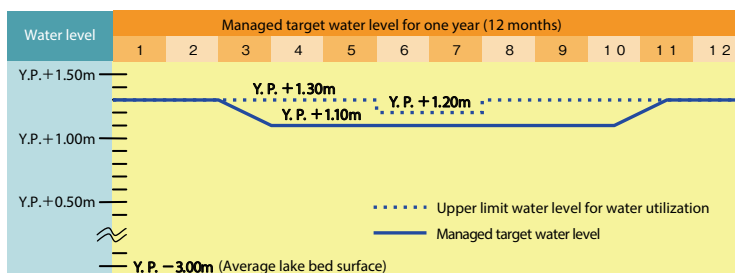


(Note) Y.P.: For the river improvement reference point of the Tone River water system, Y.P. ±0m corresponds to -0.84m for the water level in the middle of Tokyo Bay (above sea level reference point).

Existing Water Level Change Diagram (FY1931 - FY2012)



Managed Target Water Level of the Lake Kasumigaura Development Project



Note: "Upper limit water level for water utilization" is the upper limit water level set for water use, and when it comes to implementation, depending on such things as water usage and rainfall conditions, the water level will be lower than this level. Even if the water level is low, the water level will not be raised by causing a reverse flow through operating the Hitachi River Lock Gate.

○Overview of Management and Operation

The Hitachi River Sluice Gate is operated in order to adjust the water level of Lake Kasumigaura.

To supply water to Tokyo metropolitan area and Chiba Prefecture, water is conveyed from Lake Kasumigaura to the Tone River via the Tone River Link Canal.

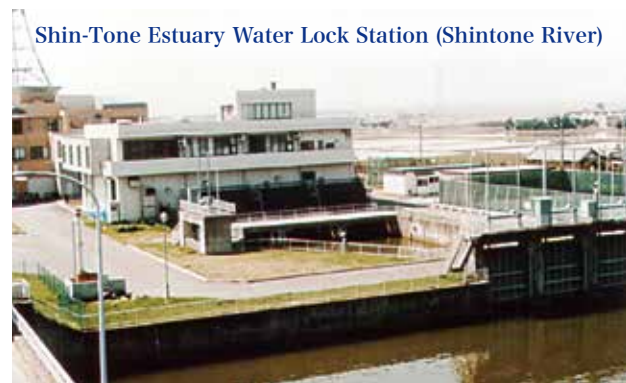
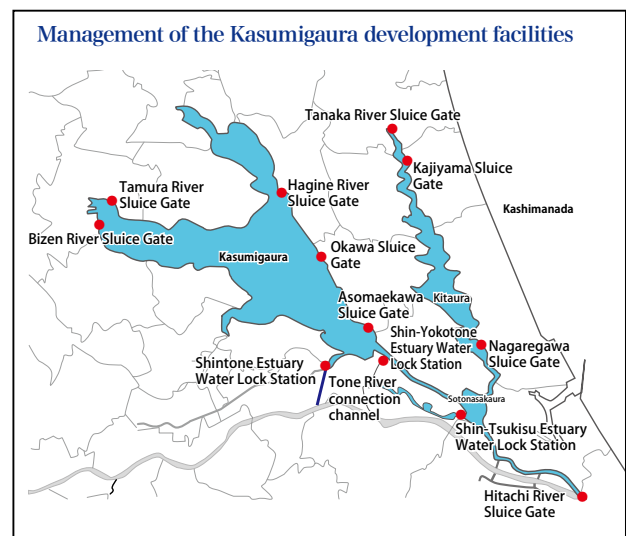
Sluice gates and pumps along Yokotone River, Shin-Tone River and Yodaura River are operated as necessary so that the water level fluctuation of Lake Kasumigaura may not affect the water level of these rivers.

Even if the water level drops to the lower limit of Y.P. +0.0m due to drought, accumulated sediment along waterways and in front of sluice pipes is dredged so as not to hinder the navigation of boats and pumping. In addition, by spreading the dredged sediment along the lake shore to create a foreshore as a method for handling the dredged sediment, it can be expected to reduce processing costs and regenerate the base for lake shore vegetation that will improve the environment around the lake.

In addition, operation and maintenance of the lake

shore levee constructed by the Lake Kasumigaura Development Project, inspection and maintenance of sluice gates, pumping stations and observation facilities, and environmental surveys are done.

With regards to the Hitachi River Sluice Gate, Tone River Link Canal, Shin-Yokotone Lock Station, and facilities related to lake shore levee and water management information system, Japan Water Agency entrusts management and operation of these facilities to the Kasumigaura River Office of Ministry of Land, Infrastructure, Transport and Tourism to manage the lake unitarily.



Natural Environment of Lake Kasumigaura

○Natural environment of Lake Kasumigaura

Along the coast of Lake Kasumigaura, there are widespread communities of wetland plants such as carex dispalata and reeds as well as emerging plants such as Manchurian wild rice, and floating leaves plants such as water fringe and water caltrops, etc. The vegetation survey conducted from 1996 through 2010 confirmed that there were about 350 to 450 species of vegetation in the area. All those plants formed the basis of nesting grounds of waterfowls and spawning grounds of fish and other water creatures in and around the lake.



Japanese marsh warbler Japanese reed bunting great reed warbler

As to the birds observed on and around Lake Kasumigaura, on-site surveys in and after 1996 showed that there were about 70 to 90 species of birds. Among them were migrating birds such as whooper swans and bean geese which were passing the winter and intermediate egrets and Von Schrenck's bitterns which were passing summer for breeding. Precious species such as Northern goshawks, white wagtails, Japanese marsh warblers, and Japanese reed buntings, etc. were also observed throughout the year. In addition to those plants and birds, many mammals, insects, fishes, and benthic animals were found. From that, it could be said that Lake Kasumigaura and its surroundings retain precious natural environment.

Myoginohana is a huge marshland of approx. 52 ha and is located on the southwestern part of Lake Kasumigaura (Lake Nishiura). This area has a huge community of wetland plants, the largest in Kasumigaura Area. The communities of reeds, Manchurian wild rice, and common cattails in this large area were designated as Specific Plant Community by Ministry of the Environment under the Second Natural Environment Conservation Basic Survey conducted in 1978 because the nature of marshland is well-retained and worth to be conserved. In this reed field, many great reed warblers are living, which are well found in all the areas surrounding the lake. For Japanese marsh warblers, this place is very important for wintering and breeding. Breeding of Japanese reed buntings are also observed here. As Myoginohana is abundant in nature, it is used for the venue to conserve wetland plants and to learn the environment of Lake Kasumigaura, after building an observation hut and nature trails for observation of plants and birds.

○Environmental measures in the Lake Kasumigaura Development Project

When implementing Lake Kasumigaura Development Project, various measures were taken in consideration of the conservation of nature and landscape of the lake. As for Myoginohana area, the maximum efforts were made to change the current situation as little as possible to conserve precious reed communities and other vegetation as well as the birds living or staying in the marshland.



Myoginohana (Ukishima, Inashiki City, Ibaraki Pref.)

* "Hana" literally means nose in Japanese. As this marshland sticks out to the lake like a nose, it is called the nose of Myogi area.

To prevent disorderly entries into Myoginohana marshland area and conserve the widespread reed communities there, walking trails, boardwalks, observation decks and an observation hut were built on a part of the land as the places for closer contact with nature.



Wild bird observation deck



Wild bird observation hut



Water Quality of Lake Kasumigaura

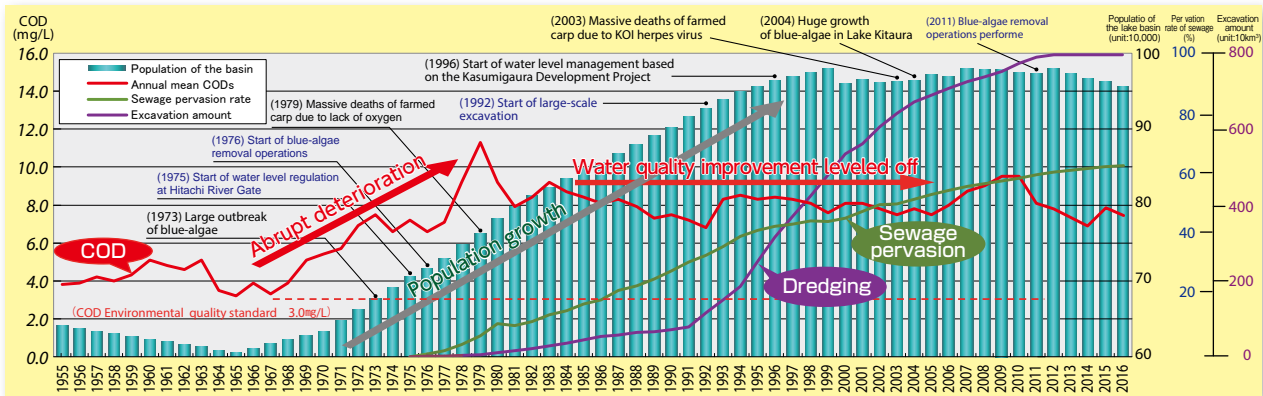
○Current status of water quality

Lake Kasumigaura has a wide basin area which includes 56 inflowing rivers. Since Lake Kasumigaura is shallow considering its large surface area and has a huge stagnant water area, it is susceptible to deterioration of water quality caused by eutrophication. The sign of deterioration have been observed since olden times.

Especially after World War II, along with the high economic growth, deterioration of water quality became quite noticeable, and in the latter half of the 1960s to early 1970s the parametric value of COD showed 7mg/L or more, and in 1979 it showed a high value of 11.3mg/L and it caused large outbreak of phytoplankton (blue-algae) in the summer. But since the 1990s, thanks to a conversion of a dominant species of phytoplankton, the frequency of outbreak of blue-green algae has been decreased.

Although various water quality conservation measures have been taken after that, parametric value of COD in 2012 showed 7.7mg/L, which far exceeded the environmental standard value. It indicates that deterioration of water quality is still continuing presently.

■ Secular change of various factors in Lake Kasumigaura basin



Note) The dredged amount described here shows the one conducted by Kasumigaura River Office of MLIT.

○Water quality conservation measures

Lake Kasumigaura was categorized into “Lake and marsh type A” of Environmental Standard on water pollution in 1972 and “Lake and marsh type III (for the time being type IV)” in 1986.

Aiming at improving and conserving the water quality of Lake Kasumigaura, various plans and programs have been implemented so far. In 1982, Ibaraki Prefectural Government implemented “the regulation on prevention of eutrophication in Lake Kasumigaura, Ibaraki Prefecture” and in parallel, they formulated “the basic plan for prevention of eutrophication in Lake Kasumigaura”. In 1985, Lake Kasumigaura was appointed one of the lakes under the Act on Special Measures concerning Water Quality Conservation of Lakes and Marshes. Following this act, Ibaraki, Chiba and Tochigi prefectures formulated “the water quality conservation plan of Lake Kasumigaura” and started comprehensive water clean-up measures to cover the lake and its basin based on this plan.

The 7th stage of Lake and Marsh Water Quality Conservation Plan from fiscal 2016 through fiscal 2020, which was formulated in March 2017, set forth the target water quality values for COD, total nitrogen and total phosphorus for the steady water quality improvement in Lake Kasumigaura. This plan also targets the realization of “swimming in Lake Kasumigaura” and “playing in the river” in the long term. To that end, during the 8th stage of the plan and after, the plan aims to achieve water quality with an average value of between 5mg/L and 5.5mg/L for COD in the entire region as soon as possible.

○Water quality monitoring stations

For Lake Kasumigaura, a total of 10 water quality monitoring stations are installed, i.e. 4 stations for Lake Nishiura region, 3 stations for Lake Kitaura, and 3 stations for Hitachitone River to conduct constant monitoring of water quality. In addition, periodical water quality inspection is conducted at 16 spots within the lake region for general items, living environment items and eutrophication-related items, and so on.

■ Environmental Quality Standards for Water Pollution (Lake and marsh type A)

	pH	COD	SS	DO	E. Coli. number	Applicability of the utilization purpose
Type A	6.5 or more 8.5 or less	3mg/L or less	5mg/L or less	7.5mg/L or more	1,000 MPN 100mL or less	Drinking water 2nd/3rd grade Aquatic 2nd grade Water bathing Industrial Water Irrigation water Environmental Conservation

■ Environmental Quality Standards for Water Pollution (Lake and marsh type III)

	Total nitrogen	Total phosphorus	Applicability of the utilization purpose
Type III	0.4mg/L or less	0.03mg/L or less	Drinking water 3rd grade, Aquatic 2 and 3 types, industrial water, irrigational water, environmental conservation
Type IV	0.6mg/L or less	0.05mg/L or less	Aquatic 2 and 3 types, Industrial water, irrigational water, and environmental conservation

■ Outline of the 7th Stage Lake and Marsh Water Quality Conservation Plan in Lake Kasumigaura

Planning Period	Fiscal 2016 to Fiscal 2020
Target water quality	Target quality in FY 2020: (annual mean) COD7.4mg/L, total nitrogen 1.0mg/L, total phosphorus 0.083mg/L
Water quality Conservation measures	Conservation measures for domestic wastewater, wastewater from factories and offices, the livestock industry, farmland, fisheries in general, net fish farming, the lake interior and the natural environment including green lands surrounding the lake
Other measures	Raising awareness and increasing knowledge among local residents, initiatives triggered by the holding of the World Lake and Marsh Conference, understanding the water quality of Lake Kasumigaura and its feeder rivers, promoting research through coordination with the Ibaraki Kasumigaura Environmental Science Center and other related organizations, improving the promotion of planning through cooperation and collaboration with the relevant people, implementing measures against blue-green algae and monitoring radioactive materials in Lake Kasumigaura’s water environment.

History of Lake Kasumigaura Development Project

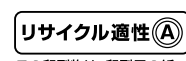
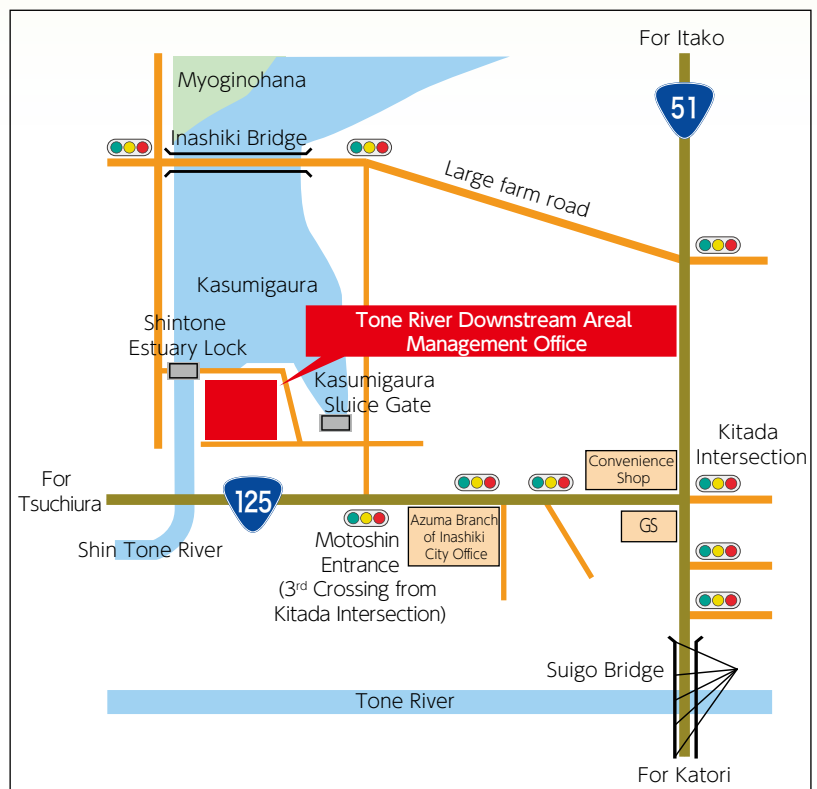
- 1 Apr, 1968 Survey for the project implementation plan started.
- 7 Jul, 1970 Lake Kasumigaura Development Project was added to Water Resources Development Basic Plan for Tone River System as a new project due to its overall revision (Aug, 1972).
- 22 Mar, 1971 The Minister of MOC (Ministry of Construction) directed the project implementation policy.
- 27 Mar, 1971 Project implementation plan was granted.
- 31 Mar, 1971 Responsibility for Lake Kasumigaura Development Project was transferred from MOC to WARDEC (= Water Resources Development Public Corporation) and WARDEC bulletined the start of construction works.
WARDEC established Lake Kasumigaura Development Construction Office (in Tonegawa Estuary Barrage Construction Office).
- 4 Oct, 1971 Lake Kasumigaura Development Construction Office was moved to Itako Town, Namegata Gun, Ibaraki Pref. (Currently Itako City)
- 1 Jun, 1975 Lake Kasumigaura Development Construction Office was reorganized to Lake Kasumigaura Development Construction Department.
- 28 Mar, 1995 Water Resources Development Basic Plan was revised.
- 1 Apr, 1995 Lake Kasumigaura Development Construction Department was moved to the current office (Inashiki City, Ibaraki Pref.)
- 6 Nov, 1995 The Minister of MOC instructed the implementation policy (4th amendment).
- 5 Mar, 1996 Project implementation plan was granted. (4th amendment)
- 21 Mar, 1996 The Minister of MOC instructed the Facility Management Policy on Lake Kasumigaura Development Facilities.
- 29 Mar, 1996 Facility Management Regulations on Lake Kasumigaura Development Facilities were granted.
- 1 Apr, 1996 Lake Kasumigaura Development Integrated Operation and Maintenance Office was established and started its operation.
- 22 Jan, 2003 The Minister of Ministry of Land, Infrastructure, Transportation and Tourism (=MLIT) instructed Facility Management Policy (amended) on Lake Kasumigaura Development Facility.
- 12 Mar, 2003 Facility Management Regulations (amended) on Lake Kasumigaura Development Facilities was granted.
- 1 Oct, 2003 Incorporated Administrative Agency Japan Water Agency (=JWA) was established. (WARDEC was disbanded.)
- 28 Mar, 2005 Facility Management Regulations on Lake Kasumigaura Development Facilities was partially amended.
- 1 Apr, 2005 Lake Kasumigaura Development Integrated Operations and Maintenance Office and Tonegawa Estuary Barrage Operation and Maintenance Office were integrated into Tonegawa Karyu Integrated Operation and Maintenance Office.
- 11 Mar, 2011 The Great East Japan Earthquake (M9.0, Seismic intensity of 6+ in JMA scale was observed in peripheral area) occurred and some parts of the lake shore levee were severely damaged due to liquefaction of soil. (Disaster restoration work completed in March 2013.)



Tone River Downstream Areal Management Office

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<http://www.water.go.jp/kanto/kasumiga/>

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(Made in August 2018)