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DEPARTMENT OF JUSTICE

WAR DIVISION

ECONOMIC WARFARE SECTION

REPORT ON

KUNISHIMA WATERWORKS, OSAKA, JAPAN

March 9, 1943

Submitted by: Ernest B. Price
Economic Warfare Section
Department of Justice
Denver, Colorado

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Washington, D. C.

Confidential Report
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Re: Kunishima Waterworks, Osaka, Japan
Submitted by: Ernest B. Price
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KUNISHIMA WATERWORKS, OSAKA, JAPAN

An estimated 70% of the population of the city of Osaka, Japan, is dependent for filtered and pressure water upon the city's single waterworks situated at Kunishima-Machi, Higashi-Yodogawa-Ku. Destruction or serious injury to vital sections of these waterworks would produce the following results, for the period the plant were out of commission:

1. It would deprive 70% of the population of Japan's chief industrial city of filtered water. The importance of this may be judged from the fact that the sewerage of Japan's third largest city, Kyoto, empties into the Yodo River 20 miles upstream from the intake pumps of the Kunishima Waterworks.

2. It would render fire fighting much more difficult through reduction of pressure in the mains. The only gravity reservoir in the city, located on the grounds of Osaka Castle (see separate report No. D-71 of March 10, 1943, on "Osaka Castle Area") has a capacity of only 3,730,000 gals., with a head of but 130 ft. -- only enough to last the city two or three hours. (Per diem consumption of filtered water was 39.7 gals. per capita in 1930.)

3. It would reduce the productive capacity of industrial establishments in Osaka dependent upon city water supply.

GENERAL DESCRIPTION

The city of Osaka stands first in industry, second in population (estimated at 3,321,000, October 1, 1930), and third in area, of the cities of Japan. Its area being only one-third that of Tokyo, whose population was estimated on October 1, 1930, at 6,457,600, Osaka is probably the most highly congested area in all Japan. Osaka's Kunishima Waterworks are located on the right (north) bank of the Yodo River just below the point where the Old Yodo River joins the New Yodo. The entire plant, with the exception of it's water mains and the small pressure-regulator reservoir on the grounds of the Osaka Castle, is concentrated on a single tract of land.

The Osaka Waterworks were first located on this tract when the first Kunishima plant was completed in March 1914. Previous thereto, the city had been supplied with pressure water from a plant located at Sakura-no-Miya, which plant was "abolished" in December 1920. This earlier plant sent water under pressure to the small reservoir located on the grounds of

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the Osaka Castle, from which it was distributed by gravity pressure through 200 miles of mains. Whether this earlier plant could be re-established, were the Kunishima Waterworks put out of commission, is not known, but it seems improbable that it could be used as an effective standby system. In any event, the capacity of the original Kunishima plant was only 53,595,000 gals. per diem, enough to last the 2,750,000 metered water users in 1930 about half a day at the per capita consumption rate of 39.7 gals. per day.

There were two subsequent extensions of the Kunishima Waterworks. The first, completed in March 1922, increased the capacity of the plant to 83,370,000 gals. per diem; the second extension (believed to have been the last), completed in August 1930, increased the capacity of the plant to 127,040,000 gals. per diem.

Since the population of Osaka has undoubtedly greatly increased since 1930, while there is no record of plant expansion since that date, consumption of metered water at present must be close to capacity. With reference to the possibility of a change in source of supply or an extension of the Kunishima Waterworks, the following is quoted from an article which appeared in the Journal, New England Waterworks Association, 1930:

> "The water-works engineer of Osaka told me of his hope to be able to build a new water-works plant at no distant date, taking water from a higher point where it would be free from such pollution. By going far enough a gravity supply could be secured, but that does not seem to be contemplated at present."

Dr. John A. Foote (see "Sources") states that he is quite certain no such plan had been put into effect by April 1, 1941, the date he left Osaka.

Equipment of the Kunishima Waterworks as of August 1930: The equipment of the Kunishima Waterworks as of August 1930 consisted of the following:

3 Intake Towers:

2 oval-shaped brick buildings 6.8 meters (22.10 ft.) by 4.5 meters (14.76 ft.) in diameter, and 15.2 meters (49.85 ft.) high.

2 round brick buildings, each 5.5 meters (18.04 ft.) in diameter and 15.2 meters (49.85 ft.) high.

4 grit chambers:

2 rectangular, reinforced concrete; dimensions: 45.5 meters (149.24 ft.) long by 10.9 meters (35.75 ft.) wide by 3 meters (9.84 ft.) high.

2 "lozenge" pattern, reinforced concrete; dimensions: 39.4 meters (139.23 ft.) long by 12 meters (39.36 ft.) wide, by 4.2 meters (13.77 ft.) high.

2 Intake Pump Stations, reinforced concrete:

1 covering an area of 4680 sq. ft. (dimensions unknown).

1 covering an area of 5350 sq. ft. (dimensions unknown).

13 Intake Pumps, connected directly with motors:

6 centrifugal, each of 100 h.p.; capacity 2100 cu. meters (7738.16 cu. ft.) per hr.; pumping to a height of 8.5 meters (27.88 ft.).

3 centrifugal, each of 150 h.p.; capacity 3000 cu. meters (10,600.7 cu. ft.) per hr.; pumping to a height of 8.5 meters (27.88 ft.).

2 centrifugal, each of 325 h.p.; capacity 4900 cu. meters (173,144+ cu. ft.); pumping to a height of 12.2 meters (40.016 ft.).

2 centrifugal, each of 250 h.p.; capacity 3750 cu. meters (132,508+ cu. ft.) pumping to a height of 12.2 meters (40.016 ft.).

6 Intake Mains:

1 cast iron, diameter 1140mm. (3.74 ft.).

1 reinforced concrete, diameter 1070mm. (3.51 ft.)

2 wooden, diameter 1070 mm. (3.51 ft.)

1 cast iron, diameter 1220 mm. (4.002 ft.)

3 Sulphuric Almina Solution Chambers:

1 wooden two-story building covering an area of 15 tsubo (59.30 sq. yds.).

2 wooden two-story buildings each covering an area of 12.5 tsubo (49.42 sq. yds.).

10 Settling Reservoirs:

7 stone-walled, concrete; dimensions of each: 102 meters (334.56 ft.) by 78 meters (255.84 ft.) by 3.2 meters (10.49 ft.), and each having a capacity of 23,160 cu. meters (814,491+ cu. ft.).

3 reinforced concrete reservoirs, similar measurements, but each having a capacity of 25,160 cu. meters (889,045+ cu. ft.).

24 Filter Beds:

14 tile-faced concrete, each 73 meters (239.44 ft.) by 73 meters (239.44 ft.), and each with a capacity of 25,440 cu. meters (898,939+ cu. ft.) per diem.

10 reinforced concrete, same measurements and capacity.

6 Clean Water Reservoirs:

4 rectangular concrete; dimensions: 84 meters (275.52 ft.) by 71 meters (232.88 ft.) with a depth of 3 meters (9.84 ft.), and a capacity of 16,000 cu. meters (565,371 cu. ft.) each

2 reinforced concrete; dimensions: 73 by 71 meters (239.44 by 232,88 ft.) with a depth of 3 meters (9.84 ft.), and a capacity of 15,000 cu. meters (530,035+ cu. ft.).

2 Mixing Chambers for Rapid Filter System:

Reinforced concrete; dimensions: 58 meters (190.24 ft.) by 3.4 meters (11.152 ft.) by 5.2 meters (17.05 ft.).

3 Settling Reservoirs for Rapid Filter System:

3 reservoirs of reinforced concrete; dimensions: 80.2 meters by 16.2 meters (263.05 by 53.33 ft.) and having a depth of 5 meters (16.4 ft.) each.

12 rapid filter beds of reinforced concrete; dimensions: 11 meters by 8.5 meters (36.08 by 27.88 ft.), having a depth of 3 meters (9.84 ft.) each. At the filter speed fixed at 120 meters (393.6 ft.) per diem, the capacity of each bed is 9600 cu. meters (339,222+ cu. ft.) per diem.

One Rapid Filter System Shed:

One-story reinforced concrete building, the ground space occupying 183.9 tsubo (726.08 sq. yds.).

Rapid Filter System Main Building:

1 three-story, reinforced concrete building with a basement, the ground space extending to 80.5 tsubo (318.27 sq. yds.), the floor space extending to 356 tsubo (140.75 sq. yds.). The basement is for the storage of sulphuric almina and other things, ground floor for the office, second floor for apparatus of solving sulphuric almina, and the research office inspection of the quality of water, and the third floor for washing tank.

Three Chlorination Houses:

2 wooden buildings occupying the ground space of 3 tsubo (11.86 sq. yds.) each.

1 wooden building occupying the ground space of 4 tsubo (15.81 sq. yds.).

Seven chlorination apparatus:

No. 1 room equipped with two apparatus having a maximum capacity of chlorination amounting to 50 kilograms each a day, one of them being a reserve;

No. 2 room equipped with three aparatus, two of which having a maximum capacity of 72 kilograms each a day, and the remaining one having a maximum capacity of 32 kilograms a day;

No. 3 room equipped with two apparatus having a maximum capacity of 73 kilograms each a day.

Two Service Pump Stations:

1 brick building occupying a ground space of 604 tsubo (2388.03 sq. yds.).

1 reinforced concrete building extending to 267 tsubo (1055.63 sq. yds.).

21 Service Pumps (directly connected to electric motors):

3 centrifugal pumps directly connected with electric motors, the capacity of the motor being 280 h.p., revolution 1200 per min., pumping capacity 760 cu. meters (26,855+ cu. ft.) per hr., and capacity of pumping water to a height of 61 meters (200 ft.).

12 centrifugal pumps, the capacity of motor being 300 h.p., 1200 r.p.m., pumping capacity 1010 cu. meters (35,335 cu. ft.) per hr., with the capacity of pumping water to a height of 55 meters (180 ft.).

6 centrifugal pumps connected with steam turbines, the capacity of the turbine being 1390 h.p., 7500 r.p.m., pumping revolution 680 per minute, pumping capacity 5580 cu. meters (197,173+ cu. ft.) per hr., and with the capacity of pumping water to a height of 55 meters (180 ft.).

1 Electric Power Receiving and Transformation Station. A brick building occupying a ground space of 81.9 tsubo (323.79 sq. yds.).

Equipment for Receiving and Transformation:

Station No. 1: 4 500 k.v.a. single phase transformer, one of these being a reserve transformer; 6 25 k.v.a. single phase transformer; 4 100 k.v.a. single phase transformer.

Station No. 2: 3 2000 k.v.a. single phase transformer, one being a reserve; 4 750 k.v.a. single phase transformer, one being a reserve; 6 25 k.v.a. single phase transformer.

Power Generation Plant. A brick building occupying a ground space of 121.2 tsubo (479.19 sq. yds.).

Equipment of the power plant:

Main generator, 3 triple vertical closed type directly connected with steam engine, with a capacity of 180 k.w. per hr. each.

Auxiliary generator, 2 double vertical closed type directly connected with steam engines, with a capacity of 60 k.w. per hr. each.

Boiler station - a brick building occupying a ground floor of 521.7 tsubo (2060.63 sq. yds.) consisting of the boiler room, coal economizing room, blower rooms; 2 chimneys having a top diameter of 2.73 meters (8.95 ft.) and a height of 24.2 meters (79.4 ft.) each.

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Steam boilers and additional equipment:

12 super-heated steam boilers with heating area of 262 sq. meters (3343.12 sq. ft.) each, and heater's area of 81 sq. meters (1033.56 sq. ft.) each.

4 saturation steam boilers with heating area extending to 262 sq. meters (3343.12 sq. ft.) each.

1 unit of coal conveyer.

4 units of coal economizers.

4 blowers.

1 unit of aerial coal conveyer with a capacity of 20,000 k.g. per hr.

Distribution mains:

"No. 1 service pump station: western main, diameter 1070 mm., goes across the New Yodo River, reaches Honjamachi, goes across the Aji River, passes the Hanazono bridge, and arrive at the harbor; central main, diameter 990 mm., goes across the New Yodo River underneath the river bed, reaches Umeda, goes across the Dojima River, and the Tosabori River, and runs along the Nishi-Yokobori River to Saiwaicho; Horie main, diameter 1070 mm., goes across the New Yodo River underneath the river bed, reaches Nakatsu, runs along the Dojima-Ohashi (bridge), and arrives at Sakuragawa-machi; Tamatsukuri main, diameter 990 mm., goes across the New Yodo River underneath the river bed, reaches Toyosakicho, goes along the Miyakojima bridge, passes through Tamatsukuri, and ends at the western gate of the Tennoji temple; Castle clean water reservoir main, diameter 660 mm., goes across the New Yodo River underneath the river bed, runs along the Miyakojima bridge, and reaches the clean water reservoir within the Osaka castle site.

"No. 2 service station: eastern main, diameter 1070 mm., goes across the New Yodo River, reaches Nagaramachi, arrives at Tenjinbashi Rokuchome, runs to south along Temmabashi street, reaches the west gate of the Tennoji Temple, and then goes still further south to Abeno way; northern main, diameter 990 mm., reaches Tenjinbashi Rokuchome same as the eastern main, but from there it goes to Deiri bridge via Ukitamachi and the Osaka station, then it goes to Sakurajima-machi via the Asahi bridge, Kishima-machi and Shimaya-machi." (Far Eastern Review, August 1930 (v.26), article by Eisaburo Kusano.)

Additional Details of Equipment

Pumping Engines: An article in The Engineering Record of May 11, 1907 (v.25 no. 19) describes the pumping engines then in service at the plant as being "triple expansion pumping engines of the Worthington type" pumping "to the distributing reservoir at Osaka Castle against a total head of about 130 feet."

The Osaka Castle reservoir: While the above-mentioned article implies that in 1907 the reservoir at Osaka Castle served as an actual distributing reservoir and furnished by gravity the pressure in the mains, a later article in the Far Eastern Review of August 1930 (v. 26) by a

Mr. Eisaburo Kusano makes it clear that with the later equipment, added in 1930, pressure on the mains is maintained by the pumping station itself pumping against the Osaka Castle reservoir, which thus serves only as a pressure regulator reservoir and as a small reserve against emergencies. Mr. John Burgess, City Office Engineer for the Board of Water Commissioners, Denver, Colorado, agreed with this view pointing out that the indicated capacity of the Osaka Castle reservoir -- 3,750,000 gals. -- would last the city only about two or three hours, were it the only source of supply. In other words, were the Kunishima plant put out of commission, the city would have a reserve supply of filtered water under pressure of from only two to three hours.

The rapid sand filter plant: An article by Mr. Harold E. Babbitt, Professor of Sanitary Engineering, Unitversity of Illinois (present address: 204 Engineering Hall, Urbana, Illinois) on "Water Supply and Sewerage of Large Japanese Cities," in the Engineers News Record of May 1, 1930 (v. 104) refers to this rapid sand filter plant as having been constructed by the Pittsburgh Filter Company.

Locations and Identification

To serve as a guide to the location and identification of vital sections of the Kunishima Waterworks, three sketches and reproductions of two photographs are attached.

Exhibit A is a sketch made from a map dated 1931 in Japanese, showing the principal water mains as described in the preceding section of this report.

Exhibit B is an aerial photograph of the Kunishima Waterworks, taken presumably about 1930. This is reproduced from the Far Eastern Review of August 1930. It affords confirmation of the locations given on the Exhibit A map.

Exhibit C is based on United States War Department Map Collection, Map no. 4393 of Osaka City (G24 - 1941 - 20). The purpose of this exhibit is to give aerial distances and bearings of the two most vital points of the waterworks plant in relation to Osaka Castle, the highest point and principal landmark in Osaka, on the grounds of which is situated the pressure regulator reservoir.

Exhibits D and E are reproductions of photographs printed in the Far Eastern Review of August 1930.

In the opinion of Mr. John Burgess, City Office Engineer of the Board of Water Commissioners, Denver, Colorado, the most vital parts of the Kunishima plant, in order of importance, are (numbers correspond to those given on the exhibits):

1 and 3. The intake towers and intake pumping station. If all intake pipes and intake pumping stations could be knocked out, the entire plant would be out of commission in a few hours through lack of supply of raw water. The intakes and the intake pumping station which supply the sedimentation reservoirs and slow sand filter beds are shown in Exhibits A, B, and C. Mr. Burgess believes, however, that the rapid filter plant must have its own intake farther down the stream, although this can not be located on any map; hence, the next most vital point to hit would be:

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2. The rapid filter plant itself (see also Exhibit D). Next in importance would be:

7. The central pumping station which services the mains, pumping against the pressure regulator reservoir in the Osaka Castle grounds (see also Exhibit B). Next in importance would be:

8. The exposed mains as they cross the Yodo, Tosobori, and other rivers. None of these is shown on any map, but they are positively identified and located by Dr. John A. Foote (see "Sources"). The one carried across the Tosobori River, by a bridge, is shown in the photograph (Exhibit E).

9. Pressure regulator reservoir on grounds of Osaka Castle.

The above constitute the indicated targets for precision bombing. Pattern bombing on the rest of the Kunishima plant would be likely to dislocate some of the sedimentation, slow filtration, and clear water reservoirs, and similar bombing along the direct air route from the Waterworks to Osaka Castle might well destroy important distributing mains.

(Note: Strategic objectives in the Osaka Castle area are covered by a separate report bearing that title.)

Sources

Dr. John A. Foote, 495 Downing Street, Denver, Colorado, now with the American Baptist Home Missionary Society, Baptist Headquarters, Colorado Building, Denver, Colorado, was a missionary in Japan from September 1912 to April 1, 1941, under the American Baptist Foreign Missionary Society. From April 1913 to April 1, 1941, the date of his final departure from Japan, his headquarters were in Osaka. His address at the time of his departure was 58 Moto Imasoto, Minsmidori, Itchome, Higashi-Yodogawa Ku, Osaka, which is not far from the Waterworks.

His missionary activities made him intimately familier with the city of Osaka.

Dr. Foote impresses one as being unusually alert and as having a retentive memory. He says that "traveling about" on foot, bicycle, or automobile was a hobby of his. He of course handles the Japanese language fluently, both spoken and written.

Dr. Foote was able to sketch from memory with remarkable accuracy, before seeing a map, locations and features subsequently identified by maps or photographs.

Mr. John Burgess, City Office Engineer of the Board of Water Commissioners, Denver, Colorado.

The Engineering Record, May 11, 1907 (v. 25, no. 19).

Far Eastern Review, August 1930 (v. 26), article by Eisaburo Kusano.*

*(Note: Pages 3 - 7 contain description of waterworks equipment. Figures in the metric system were taken from this source, and conversions into American measures are indicated in parentheses. These conversions were calculated roughly in this office and may not be exact.)

Engineers News Record, May 1, 1930 (v. 104), article entitled "Water Supply and Sewerage of Large Japanese Cities," by Harold E. Babbitt, Professor of Sanitary Engineering, University of Illinois.

Journal, New England Waterworks Association, 1930.