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The Marathon Dam: Collaboration of American & Greek engineers

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Abstract

Built by an American contractor, Ulen and Company, on behalf of the Greek State, the Marathon Dam, one of the largest European constructions and the world's only marble dam when erected in October 1929, was by no means just a US product. Greek engineers proved to be a worthy ally to the Ulen engineering staff, unfolding specific skills and demonstrating qualities in which their American counterparts seemed to be lacking. By "reading" the Marathon Dam as an example of cooperation between a technologically advanced nation and one located on what is conventionally regarded as the edge of the developed world at the time, the authors would like to encourage research into technological systems in the design and building of which nations and geographical areas that historians used to "scorn" were involved. They are convinced that new insights and substantial reappraisals will emerge once scholars take seriously the many components of an increasingly interconnected world involved in technological development and its heritage.

Introduction

September 1922 was a dreadful month in the history of Modern Greece, a rather young Nation, at least as measured by the standards of the Old Continent, since she gained her independence as late as in 1832, after a national upheaval against the Ottoman Empire, and the intervention of the Great Powers – Great Britain, France, and Russia – of the time (Gallant 2001). The Greek army had just experienced a series of critical defeats by the Turks led by Mustapha Kemal Atatürk, the father of Modern Turkey. Smyrna was burning, and panic-stricken mobs of people belonging to the then affluent and populous Greek community of the city were running to the waterfront, hoping to escape violence and death by being conveyed to one of the ships lying in the harbor. The destruction of Smyrna was the last act of a war that had started ten years earlier, and was waged, apart from Greece and Turkey, by most of the Balkan countries.

If the military defeat of 1922 resulted for Greece in the definitive loss of the territories that her army had temporarily conquered in Asia Minor, it didn't prevent her from eventually succeeding in doubling her population and size during the decade 1912-1922. The 1922 catastrophe even increased the human potentialities of the country by about 1,200,000 new citizens, forced, following the population exchange agreement between Greece and Turkey of January 30, 1923, to leave the land of their ancestors in Asia Minor and Eastern Thrace, and to settle in within the new frontiers of the Greek State as they were redesigned according to the Treaty of Lausanne signed by the two countries on July 23, 1923.

Most of these new Greeks were installed in regions that had belonged to the Ottoman Empire before the 1912-1922 war. But some other territories that had been part of the Greek State since its creation in 1832 were also deeply affected by the influx of so many people in such a short span of time. Between 1923 and 1928, the population of Athens and its environs, the city of Piraeus included, critically surged after the arrival of around 300,000 new people (Geniki Statistiki Ypiresia Ellados, 1931, p. 48-49). This sudden increase in the number of inhabitants of the two cities led to a dramatic deterioration of their urban landscape. The existing infrastructures now proved to be totally inadequate for serving the needs of the inhabitants, old and new. Especially, water consumption literally collapsed. In 1920, the available (average) quantity of water in Athens was equal to thirty liters per day per inhabitant (Istoriko Archeio Dimou Athinaion, 1921), needless to say a poor achievement for a European capital in the early decades of the 20th century. But the worst was still to come. In the years following the arrival and settlement of Greeks expelled from Turkey, water consumption dropped to 10 liters per day per inhabitant (Gausmann, 1932), that is the average amount a Parisian was provided by his municipality on a daily basis around 1800 (Bocquet *et al*., 2008, p. 1824). Obviously, new public works were necessary in order to supply the region of Athens with a decent quantity of the "precious liquid".

On December 22, 1924, the Greek government signed a contract with the American engineering corporation Ulen & Company, and its economic ally in Greece, the "Bank of Athens" (Eleftheron Vima, 1924). Some months later, on April 4, 1925, and after a series of discussions within the National Parliament and the public sphere, the agreement became a law of the Greek State (Efimeris Kyverniseos, 1925). Among the key components, and probably the most important one, of the projected water supply system was a dam located near the historic Marathon battlefield (Figure 1). It was not by chance that among the different options for supplying Athens and its environs with water: ---i.e., carry water into the city from remote springs, create a water storage system nearby…---, the dam solution was eventually adopted. Indeed, in the 1920s, all conditions were ripe for the construction of a water storage system at the site of Marathon.

[INSERT FIGURE1]

The long path to the Marathon Dam

In 1834, the year it became the capital of the newly founded Greek Kingdom, Athens was a small town of 14,000-odd inhabitants, completely devoid of any modern infrastructure. At the time, Athens dwellers got their water from the handful public fountains and the numerous private wells in the city (Chatzis, 2007; Chatzis and Mavrogonatou, 2010; Chatzis and Mavrogonatou, forthcoming). For many years, serious shortage of the "precious liquid" was a permanent feature of everyday life in the Greek capital. In the second half of the 1840s, the (re)discovery of the aqueduct built by the Roman Emperor Hadrian (76-138) and his successor (Leigh, 1999), and the subsequent works carried out by the municipality, in a rather piecemeal and intermittent way as they solely depended on the limited financial resources of the city, significantly upgraded the water supply conditions of Athens, especially during the 1870-1890 period. But despite this improvement, at the end of the 19th century the "water issue" was still to be resolved for the inhabitants of Athens. Given the chronic paucity of municipality's financial inputs, the central state decided to interfere in local affairs. Charilaos Trikoupis (1832-1896), the modernizing Prime Minister who dominated the political stage of his country over the 1880-1895 period, turned to Edouard-Marie Quellennec (1856-1927), a French State engineer and a member of the famous "Ponts et Chaussées" corps (Bridge and Roads Corps) (Chatzis, 2009), and asked him to deal with the water question. Quellennec was at that time in Greece along with a team of French engineers and other technicians as a technical expert invited by the national government to help it with the design and the implementation of the most ambitious program of Public Works the Greek state had ever envisioned, and partially implemented, since its foundation (Chatzis, 2004). Indeed, in 1889, Quellennec produced a draft in which he proposed to carry into the region of Athens water from the springs of Stymphale located in Peloponnese. Based on this first comprehensive treatment of the water issue, the government of Trikoupis prepared a bill in May 1890. While the latter didn't succeed in becoming a law of the State, it nevertheless launched a series of debates within the engineering community, and stimulated it to seek ways for ameliorating Quellennec's work on the one hand, to devise alternative solutions to the water problem of Athens and its surroundings, on the other hand.

The dam solution loomed on Athens' horizon a short time after Quellennec's study first appeared. In the late 1890s, Rosseels, the then Belgian Consul General in the Greek Capital, drew up a proposal in which the first reference to a (future) dam at the site of Marathon can be found (Ministère des Affaires Etrangères, 1900). But during the 1890s and the first decade of the 20th century, the water storage option was given a cold welcome in Greece. Quellennec himself wasn't favorable to Rosseel's proposal (Quellennec 1899). Georges Bechmann (1848-1927), a fellow of Quellennec who had gained a worldwide reputation as chief engineer of the Paris Water Department, when invited by the Greek government as a technical adviser, also opposed the project in 1900 (Bechmann, 1900, p. 64-65). Twelve years later, another European engineer, K. Kinzer from Austria, also working on behalf of the Greek State, expressed in his turn the same aversion to the dam solution (Kinzer, 1912, p. 4-6). Several eminent and highly influential members of the Greek engineering community of the day also criticized the water storage solution, which was now put forward, especially during the 1902-1906 period, by an increasing number of engineers and engineering firms as the cheapest solution to the "water problem" for Athens (Kalantzopoulos, 1964, p. 23-31). Thus, in 1899, Petros Protopapadakis (1858-1922), a former student of the "Ecole Polytechnique" and "Ecole des Mines" in Paris, in a conference organized by the Greek Polytechnical Association – i.e., the first professional organization of Greek engineers –, pleaded the case for spring waters, and expressed strong doubts about dams, the construction of which was, in his opinion, subjected to many technical problems (Protopapadakis, 1899). In 1907, in a paper published in the Greek engineering journal "Archimidis", Anastasios Soulis (1836-1918), a graduate of the French "Ecole des Ponts et Chaussées" and a Professor at the Polytechnic School of Athens, also gave a negative assessment to the water storage solution (Soulis, 1907). It is worth noting that it was Soulis who, in his 1884 manual entitled "Hydraulics" produced the first lengthy presentation of the "state-of-the practice" in the domain of water storage techniques in Greek (Soulis, 1884, p. 356-395). Obviously, as most of the 19th century Greek engineers were steeped in the French engineering tradition (Assimacopoulou *et al*., 2009; Assimacopoulou and Chatzis, 2003), they were following their counterparts in France in their predominant preference for spring waters as the best way for providing cities with the "precious liquid". This option was especially illustrated by "Hausmannian" Paris (Bocquet *et al*., 2008), which by the end of the 19th century had been transformed into an icon of the modern city, and was enjoying the status of a template concerning urban infrastructures (Harvey, 2003).

But the future is not necessarily a repetition of the past. From the 1910s on, Greek engineers started modifying their views on the respective pros and cons of remote spring waters and water storage systems for providing cities with water. As a result, the "dam solution" was gaining more and more adherents among them. This shift in attitude didn't happen haphazardly. Indeed, from the late 19th century on, a steadily increasing number of practitioners throughout the world resorted to storage techniques for supplying cities with water. Without a doubt, the US was in the vanguard of the movement, especially thanks to the foundation of two institutions: the Bureau of Reclamation (1902) and the Tennessee Valley Authority (1933). After importing to their fatherland the groundbreaking work by French "Ponts et Chaussées" engineers Joseph-Augustin Torterue de Sazilly (1812-1852) and Emile Delocre (1828-1909), who developed mathematically based methods of gravity dam design in the 1850s, American engineers, from the 1880s on, cultivated extensively the art of this kind of structures (Billington *et al*. 2005; Smith, 1971; Schnitter, 1994; Kollgaard and Chadwick, 1988). In 1888, Edward Wegmann published "The design and construction of masonry dams", one of the first, and extremely popular, manuals entirely dedicated to this kind of structure worldwide (Wegmann, 1888; 1918). At the turn of the century one of the highest dams of the time, the “New Croton” Dam (built in 1898-1906, 91 m high) was erected near New York, and within the years following its completion, two other dams symbolized the preeminence of the New Continent in this domain of Public Works: the arch (no gravity) “Shoshone” Dam (1905-1909, 100 m high) and the gravity “Elephant Butte” Dam (1912-1916, 91 m high). The development of large water storages system around the world -- even in France, one could number seventy “large” dams, i.e., higher than 15 meters, in 1919 (Bordes, 2010, p. 75) -- led to the creation of the “International Commission on Large Dams” in July 1928. By progressively embracing the dam solution, Greek engineers were merely keeping up with the views of their counterparts abroad.

The first comprehensive study of the artificial lake and the related dam at the site of Marathon was produced by the American firm “Ford, Bacon and Davis” at the end of the 1910s (Ford, Bacon and Davis, 1920; Archibald, 1921; Genidounias, 1923; Mpotsaris, 1925). Invited by the recently founded “Bank of Piraeus”, which, alongside other banks and industrial companies of the time, was entertaining fond hopes for a concession of the (future) water supply system of Athens, a team of thirty American men, placed under the supervision of Walter Spear, a graduate from the Massachusetts Institute of Technology and the then chief engineer at the Board of Water Supply of the New York City (Speer, 1922), was dispatched in Greece in 1920, and “were in the field from March until September with forty or fifty Greek assistants. All survey work was done by stadia. Experienced rod men and instrument men were almost impossible to get, but a large part of the drafting was done by local men. They proved to be good workmen, but very slow, and the English characters bothered them when it came to lettering a plan” (Archibald, 1921, p. 465). This cosmopolitan team “did an unbelievable amount of excellent work and within about a year produced an exhaustive study of the various problems presented and reached conclusions, which, with certain modifications due to unpredictable changes, should form the basis for all future work on these projects (Gausmann, 1940, p. 79)”, in the words of R. Gausmann, the General manager of Ulen for the Marathon dam (*infra*). The technical and financial elements of the study were presented to the Greek government in October 1920, but the 1920-1922 war against Turkey prevented the project from coming into fruition.

Immediately after the hostilities between the two countries were definitively brought to a close, a team of Greek State engineers once more came to grips with the question of supplying Athens and Piraeus with water. The “task force” squad, which was headed by Theologos Genidounias (1871-1938) and comprised two other engineers, Petros Loprestis and Argyrios Koumousis, reported the results of their study in January 1923 (Genidounias, 1923). After a detailed examination of all the proposals produced so far, they followed in “Ford, Bacon and Davis” company’s footsteps, and suggested the construction of a water storage system in Marathon. In several respects, the composition of the team was a microcosm of the community of engineers in Greece in the 1920s (Antoniou, 2006; Antoniou *et al*., 2007). As in the 19th century, the latter showed strong cosmopolitan strains, as it was composed of a great number of graduates of engineering institutions in Europe -- in the meantime France ceased to be the main destination and was superseded in this role by German speaking countries and Italy –, graduates who often had also gained professional experience abroad. For instance, Genidounias was a graduate of the famous Polytechnic School of Zurich, and worked for a long while outside the borders of his fatherland. His baptism of fire as a young engineer took place in Asia Minor, where he was employed by the company involved in the building of the railway line connecting EsciSehir and Ikonio. In 1897, he returned to Switzerland, and specialized in hydraulic works and the use of reinforced concrete (the “Hennebique” system). From 1905 to 1919, Genidounias served the Egyptian government, and as a high civil servant at the Ministry of Public Works, he played a key part in the development of several large programs of public works aiming to harness and to exploit the water resources of the Nile. Once back in Greece, in 1919, he was assigned a position at the "Water Works Department" (WWD), set up in 1917 within the Ministry of Transportation, founded, in turn, three years earlier by the first government of the liberal Eleftherios Venizelos (1864-1936), the politician who stamped inter-war Greece with his modernizing zeal (Personal Folder of Genidounias; Tsatsos, 1938; Gausmann, 1940, p. 59-61). Within the WWD, Genidounias thoroughly examined the different proposals concerning the "water issue" of Athens that had been produced since Rosseel's contribution, and steadily defended the "dam solution" at the site of Marathon (Genidounias, 1922). Petros Loprestis (1870-1941) graduated from "R. Scuola d'Ingegneria di Padova" in 1893. After serving as a municipal engineer on the island of Corfu, he moved to the Greek Capital, and from 1919 on, he worked for the central government at the Ministry of Transportation. He even managed WWD from 1931-1932. An author of many publications on urban hydraulics, he actively participated in the design and implementation of nearly all the large hydraulic works programs in Greece during the 1920s and the 1930s (Kitsikis, 1934, p. 190; Anonymous, 1941). Argyrios Koumousis, the youngest member of the team, was a former pupil of the "Technische Hochschule" in Munich, from which he graduated as a civil engineer in 1915 (Kitsikis, 1934, p. 161).

The study by Genidounias and his two fellows proved to be instrumental in the adoption of the Marathon dam as the best solution for the supply of Athens and Piraeus with water. Apart from a small minority, whose members persisted in defending the option based on the transportation into Athens and its environs of spring waters from Peloponnesus (*supra*), Greek engineers were now massively voting for the "dam solution" in Marathon (X, 1923; Ta

Chronika, 1923; 1925). The same year in which Genidounias and his team at WWD published their study, in an article that appeared in “Archimidis”, Alexandros Sinos, a professor of hydraulics at the Polytechnic School of Athens, informed the community of Greek engineers about the advantages of the water storage systems (Sinos, 1923), a subject that continued to be a matter of interest for Greek engineers in the 1930s (Floris, 1933; 1936). At the same time, politicians (Mpotsaris 1925, p. 575), physicians (Kalantzopoulos, 1964, p. 59) and the press (Ta Chronika, 1923) were frequently referring to the many examples of cities in the US as well as in Europe that had already successfully adopted water storage techniques, and were trying to convince the inhabitants of Athens and Piraeus that water from artificial lakes could be as tasty and healthy as spring water.

The construction of the dam

In the early 1920s, the “dam solution” in Marathon was very popular among Greek engineers and politicians. The massive arrival (at) and the subsequent settlement of successive tides of Greeks from Asia Minor and Eastern Thrace in the region of Athens functioned as a catalyst, compelling the Greek governments of the time to take action and materialize the plan. Given the technical experience American companies had gained in this domain since the end of the 19th century, and the growing presence of American capitalism in inter-war Europe (Bonin and de Goey, 2009; Bairoch, 1997), it is not by chance that the two firms that made a tender both had American nationality (Cassimatis, 1988). As we have already said in the Introduction, the race was eventually won by Ulen & Company, which, in the opinion of the Greek Embassy in Washington and part of the press at least, surpassed its competitor MacArthur Brothers Co in international reputation and financial stamina (Efimeris ton syzitiseon tis D΄ en Athinais Syntaktikis ton Ellinon Synelefseos, 1925, p. 553 ; Empros, 1928).

Under the terms of the contract, Ulen and the Bank of Athens granted the Greek State a loan of ten million dollars over twenty years and half, to be used for the construction of a modern water network, capable of meeting the increasing needs of the cities of Athens and Piraeus. In order to service such a loan and to cover the running costs of the projected network, the Greek state imposed upon the owners of all city buildings that would be supplied by the new water system a specific tax during the building process, and after the completion of the network, a compulsory subscription. According to the agreement, the State would also hand out concession of the network over twenty-two years after its completion to a company to be set up. In addition to loaning the Greek State, Ulen was designated as the contractor of the project, and was entrusted with the tasks of the design and building of the water supply system to come; for these services, the American firm would receive the total payment of 1,200,000 dollars (Efimeris Kyverniseos, 1925).

Judging from the track-record of the firm, the choice of Ulen as contractor seems sound. Founded in 1897, the company soon became member of the small group of first-rate American corporations specialized in large Public Works programs. Indeed, before being interested in the Greek market, the company had already carried out more than a hundred water supply and sewage programs in the US and South America. Among them was the building of the longest underground aqueduct of the time, and probably the flagship of the firm's achievements: designed as part of the water supply system for New York City, the "Shandaken Tunnel" was 29 kilometers long, and its quick completion in 1923 was immediately hailed as a technical breakthrough. Besides designing and building urban hydraulics works, Ulen was also involved in the sectors of railways, harbor works, and hydroelectric power plants. It even worked on behalf of Ford Corporation, and built plants for the giant of the automotive industry (Ethnos, 1925).

For its first contract in Greece, Ulen mobilized the large stock of experience it had accumulated so far. Being part of the class of concrete gravity dams, the Marathon construction was 285 m long, 54 m high, and varied in thickness from 4.5 m at the top to 48 m at the bottom, while it had a circular shape with a 400 m radius (Gausmann, 1934) (Figure 2). Less impressive, to be sure, than the then largest water storage systems in the US, the Greek product of the American company was nevertheless a sizeable dam, and one of the biggest European constructions of the time. It could match, for example, the highest French dam in the 1920s, the "Furens Dam": built in 1862-1866, this legendary masonry construction near Saint-Etienne had a maximum height of 56 m. In one respect at least, the Marathon Dam was, and probably still is, even unique around the world, since it was entirely paneled externally on both sides with Pentelic marble, the building material that the Parthenon was made of (Figure 3). This feature of the construction --- to be sure, a hint of the region's glorious past (Kaika, 2006) --- didn't pass unnoticed. Not later than November 1929, the "Popular Science Monthly" hailed "The World's only Marble Dam" (Anonymous, 1929a), and did so the "New Reclamation Era" (Anonymous, 1929b), and more recently the "New Scientist and Science Journal" (White, 1971, p. 481).

[INSERT FIGURES 2 & 3]

The building site opened its doors in October 1926 (Figures 4 and 5), and three years later, in October 1929, the dam had been totally erected with success. It cost 2,120,000 dollars, contained over 156,000 m^3 of concrete, and its completion mobilized 900 people a day on the average (Gausmann, 1934). Organizing efficiently the work of many workers gathered in a limited place was one of the thorniest problems for engineers after the rise of the big corporation at the turn of the 20^{th} century (Porter, 2006).

[INSERT FIGURES 4 & 5]

In the 1920s, the rationalization of work, that is the effort at increasing the output of labor and machinery thanks to a series of strategies -- such as separating the conception from the execution of work, breaking down the work into simple operations, “objectifying” and measuring tasks carried out by machines and laborers, stimulating worker’s productivity with financial incentives…-- was already a fully-fledged area of engineering practice and research, symbolized by a series of neologisms, such as “Taylorism”, “Fordism”, or “Scientific Management” (Rabinback, 1992, Chatzis, 2008). Being already familiar with the rationalization of work movement, probably while involved in the construction of factories for the Ford Motor company, Ulen’s staff didn’t hesitate to mobilize “Scientific management” techniques on the dam building site in Greece (Figure 6). Indeed, the various operations were sorted out on the basis of their difficulty of execution, while the working people employed at the site, engineers and foremen included, were assigned specific tasks according to their qualifications – and their gender (Figure 7) --, and they were paid accordingly. Specialized Ulen staff proceeded to the evaluation of the time needed for the different construction tasks and operations, and used such times to stimulate the work effort provided by the operators through a system of financial incentives and bonuses (Loprestis, 1928; Tsalikis, 1927, p. 196). Though “Scientific Management” was not a *terra incognita* for the Greek engineers, who first heard about Taylor and “Taylorism” as early as 1916 in the columns of the journal “Viomichaniki kai VIotechniki Epetheorisis”, very few applications of such techniques eventually took place in inter-war Greece (Antoniou *et al*., 2007, p. 245-250). The Marathon Dam was one of these scarce applications. It even turned out, in the opinion of the witnesses of the time at least, to be a successful one. Indeed, it seems that the Greek workers at the building site were not opposed to being subjected to such techniques (Tsalikis, 1927, p. 196).

[INSERT FIGURES 6 & 7]

To deal with the construction of the Marathon dam, Ulen dispatched a part of its engineering staff to Greece. As the General Manager of the project in Athens, R Gausmann, put it, given the lack of experience of Greek engineers in the management of large public works programs, “it could not be expected that foreign capital, or in fact Greek capital either, would be willing to risk money on important projects, entirely under Greek direction” (Gausmann, 1940, p. 40). But even so**,** to a significant extent the construction of the dam was a Greek adventure as well. Several Greek engineers were, indeed, involved in the design and building of the structure. They proved to be helpful, even indispensable, to their American counterparts, especially thanks to their mathematical and scientific skills. To his amazement, for Gausmann the Greek engineer proved to be able to “produce formulae with the same facility that the magician produces rabbits from a borrowed hat”, and, in doing so, “he dazzles the poor American with his mathematics and his reasoning, which are both faultless” (Gausmann, 1940, p. 99). In this respect, he contrasts with the American engineer. To quote Gausmann once more, the latter demonstrates in his practice a series of qualities that make him an efficient practical man, since “ he has (…) been brought up to realize that there are usually more than one acceptable ways of obtaining the desired results, and that the main thing is not to spend too much valuable time, trying to determine beforehand which is absolutely the best way of doing a job, but to select a method, which is known by past experience to be adequate and which will produce good results, and then to go ahead and push it through as quickly and as cheaply as possible” (Gausmann, 1940, p. 99). But, at the same time, Gausmann noted wistfully, “the American engineer is never quite certain about formulae, nor how much they should be trusted. If he can find some way to measure and weigh and experiment, even on a small scale, he feels more certain of his results” (Gausmann, 1940, p. 99). These national specificities concerning mathematics and theoretical sciences and their use for engineering purposes stemmed, in part at least, from the differences between the education Greek and American engineers used to receive at that time. Indeed, despite the fact that by the end of 19th century the leaders of the American engineering community accepted formal educational training as the best means for entering the field, it was only after the arrival of a number of European-born or European educated engineers in the US in the wake of World War I that the engineering schools in the USA started emphasizing higher mathematics and abstract scientific knowledge in their curricula (Seely, 2004, p. 53 & 65). Greek engineers, in contrast, had had a strong theoretical background since the foundation of the Greek State. When Modern Greece lacked sufficient engineering educational infrastructures, they used to study abroad, enrolling in schools that were often leaders in building bridges between scientific knowledge and engineering: indeed, some of the best French engineering institutions during the 19th century, and their German and Italian counterparts in the first decades of the 20th century were frequently visited by young Greeks wishing to become an engineer. Little by little, this theoretical tradition in engineering education also took root in Greece; as a result, engineers graduated from the Polytechnic School of Athens after the 1890s were also offered a curriculum placing strong emphasis upon scientific and mathematical fundamentals (Antoniou, 2006; Antoniou *et al*., 2007, p. 254-250).

Some of the Greek engineers who impressed Gausmann with their mathematical skills and "faultless" reasoning were hired by the American firm, and even worked in positions of responsibility. Thus Aristopahnis Tsalikis was employed by Ulen from 1925-29 as one of the right-hand men of the American chief engineer Keayes. Tsalikis graduated from the Civil Engineering Department of the "Technische Hoschschule" in Munich in 1903, and started his professional career working for the large corporation "Siemens-Halske" in the building of the subway in Hamburg. His second employer was another German company, "Lenz", in Berlin. There, Tsalikis was involved in several railways and hydraulic works as chief engineer. In

1917, the year he moved back to Greece, he was assigned a position of responsibility at WWD within the Ministry of Transportation. After working for Ulen, he was appointed General Director of the Technical Works Department within the Ministry for Agriculture (Kitsikis, 1934, p. 358).

But the most important Greek actor participating in the Marathon venture was of a "collective" nature: the group of Greek engineers within the Ministry of Transportation who were responsible for controlling and overseeing the design and building process on behalf of the Greek State. Let us close this section by mentioning a specific contribution of a member of this group to the success of the operation. We have already referred to Loprestis, one of the proponents of the Marathon Dam solution as the best means to supply Athens and its surroundings with water (*supra*). During the construction of the dam, Loprestis suggested the use of volcanic ash, known as "Santorin earth"-- from the name of a Greek volcanic island-- for enhancing the strength and the hydraulic properties (the imperviousness) of the concrete, i.e., the material the dam was made of. Loprestis's idea appealed to the Ulen staff, who asked the person responsible for the "Laboratory of Strength of Materials" at the Polytechnic School of Athens to undertake a series of experiments, after the completion of which the idea first put forward by the Greek engineer was endorsed by the Americans, and turned into reality (Tsalikis, 1927).

Conclusion

The Marathon Dam was dedicated in October 1929, and it is still operational**.** Built by an American contractor on behalf of the Greek State, this technological artifact was by no means the mechanical application of know-how elaborated in the USA and simply transferred without the slightest alteration to Greece. As we have seen, the Marathon dam bears the stamp of the Greek engineering community as well. First of all, it was the late outcome of a particularly lengthy public debate in Greece, which started in the 1890s and in which many Greek engineers took part. The decisive study that suggested that the storage system was the best solution for supplying Athens with water was also probably produced by a team of Greek state engineers working at the Water Works Department within the Ministry of Transportation. But even after the Greek State turned to a foreign company for the final design and the building of the dam, the Greek engineering community continued to be fully involved in the venture. Greek engineers proved, indeed, to be a worthy partner for the Ulen engineering staff in several respects, exhibiting specific skills and demonstrating qualities in which their American counterparts seemed to be lacking.

The Marathon Dam can thus be read as an example of cooperation, to be sure an unsymmetrical one but a real cooperation all the same, between a technologically advanced nation and one located on what is conventionally regarded as the edge of the developed world of the time. In this respect, the case of the Marathon Dam questions a series of views and practices that have dominated the writing of the history of technology until recently. Indeed, many historians serving the field have focused on a handful of nations, deemed the sole interesting actors participating in the race for technological innovation. In turn, this almost exclusive focus on a very small number of nations, considered uncritically to be the only ones that deserve the attention of scholars, to the detriment of the supposedly “uninteresting” multitude, has led to a conception of technological transfer as a bipolar and mono-faceted process that comprises an active “transmitter” and a passive “receptor”, and involves no significant transformation. Does the case studied here stand as unique? In the light of a series of recent works by historians of science and technology, the answer seems to be a rather firm “no” (Saraiva, 2009; Raj, 2007; Krige, 2006). We would like thus to encourage researchers to carry out investigations into other technological systems, the design and building of which involved nations and geographical areas that researchers traditionally ignored. We are convinced that new insights and substantial reappraisals will emerge after scholars introduce in the picture of the technological development and its heritage the contributions of the many components of an increasingly, thanks to the action of technology among other forces, interconnected world.

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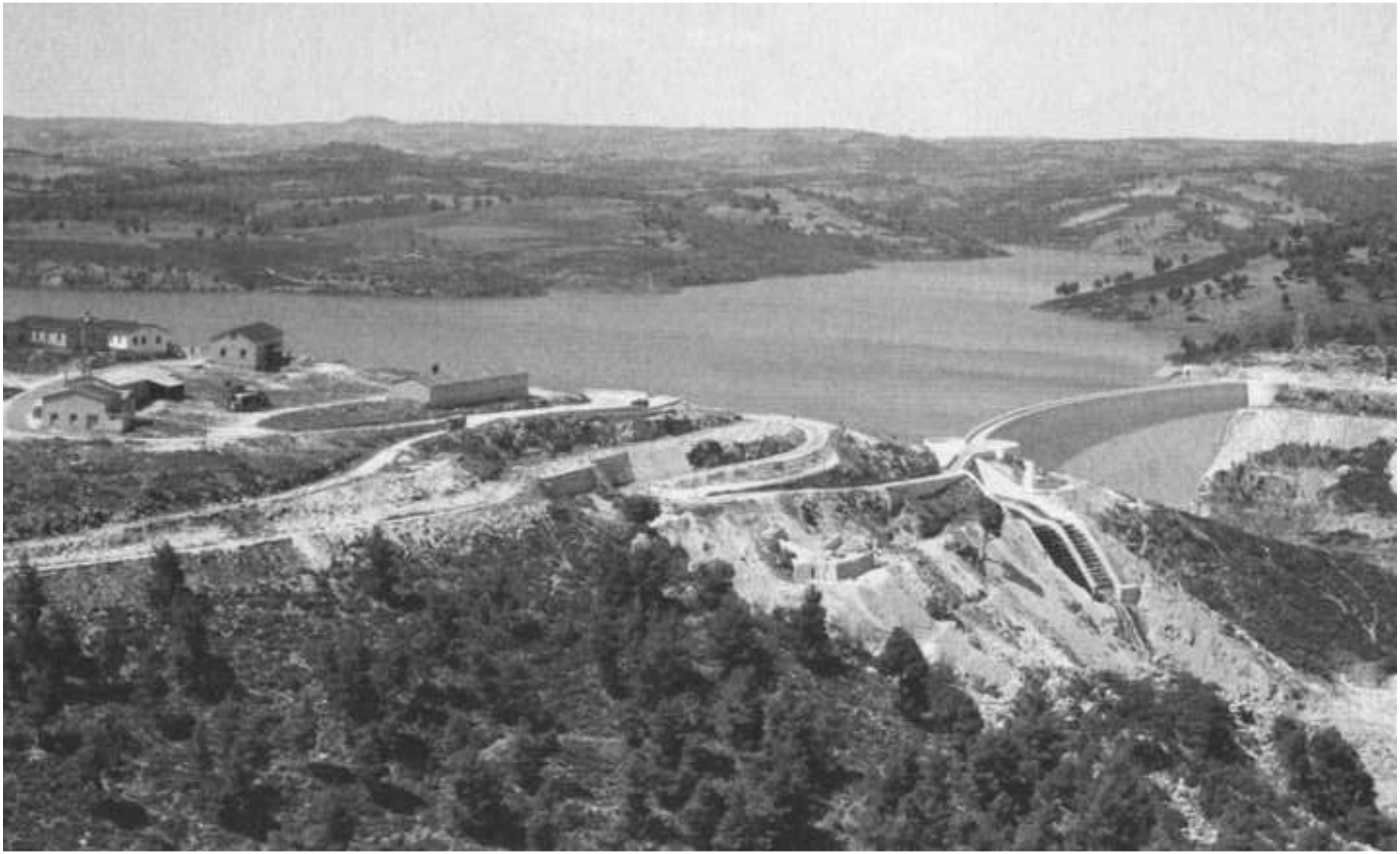

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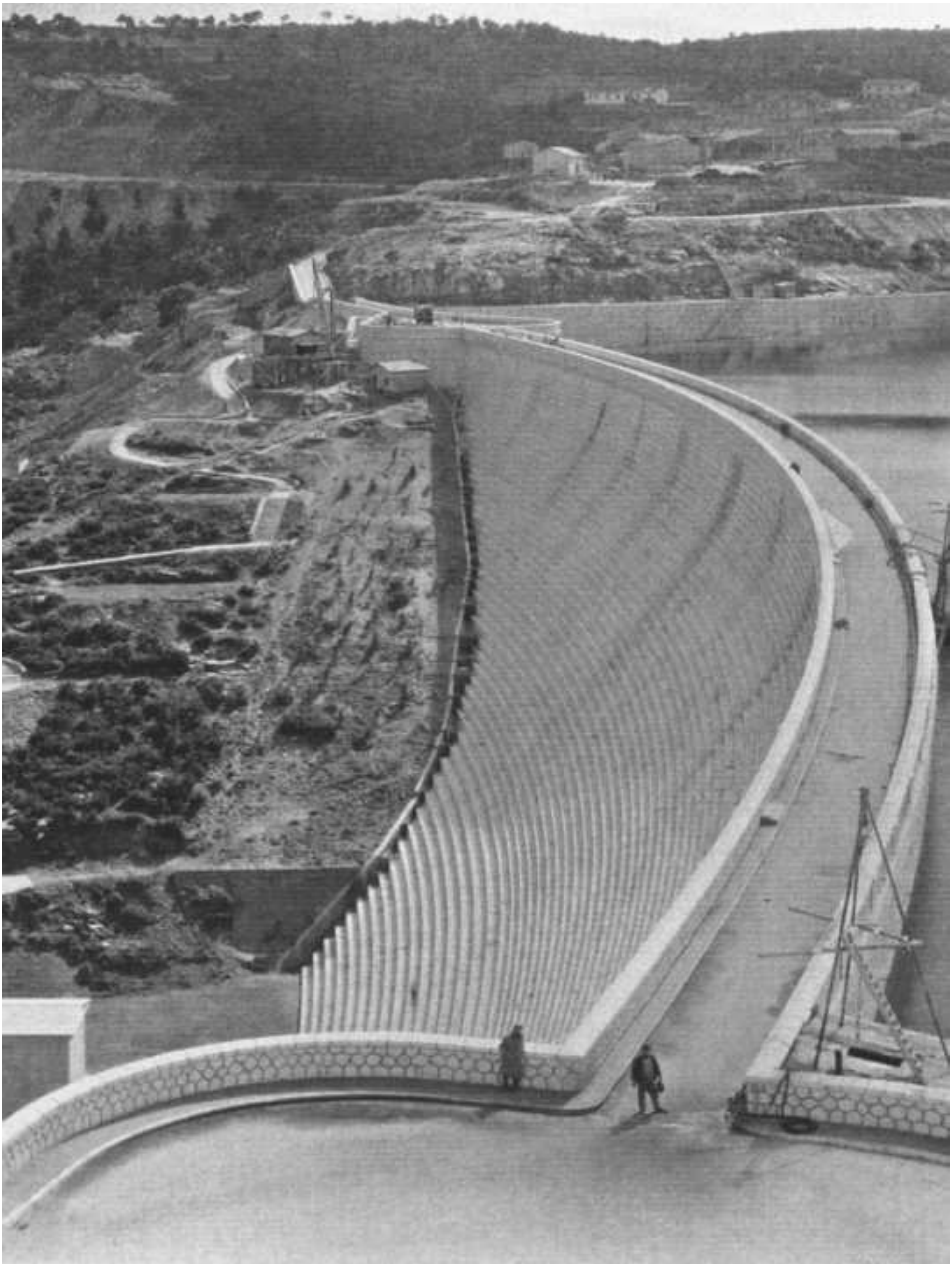

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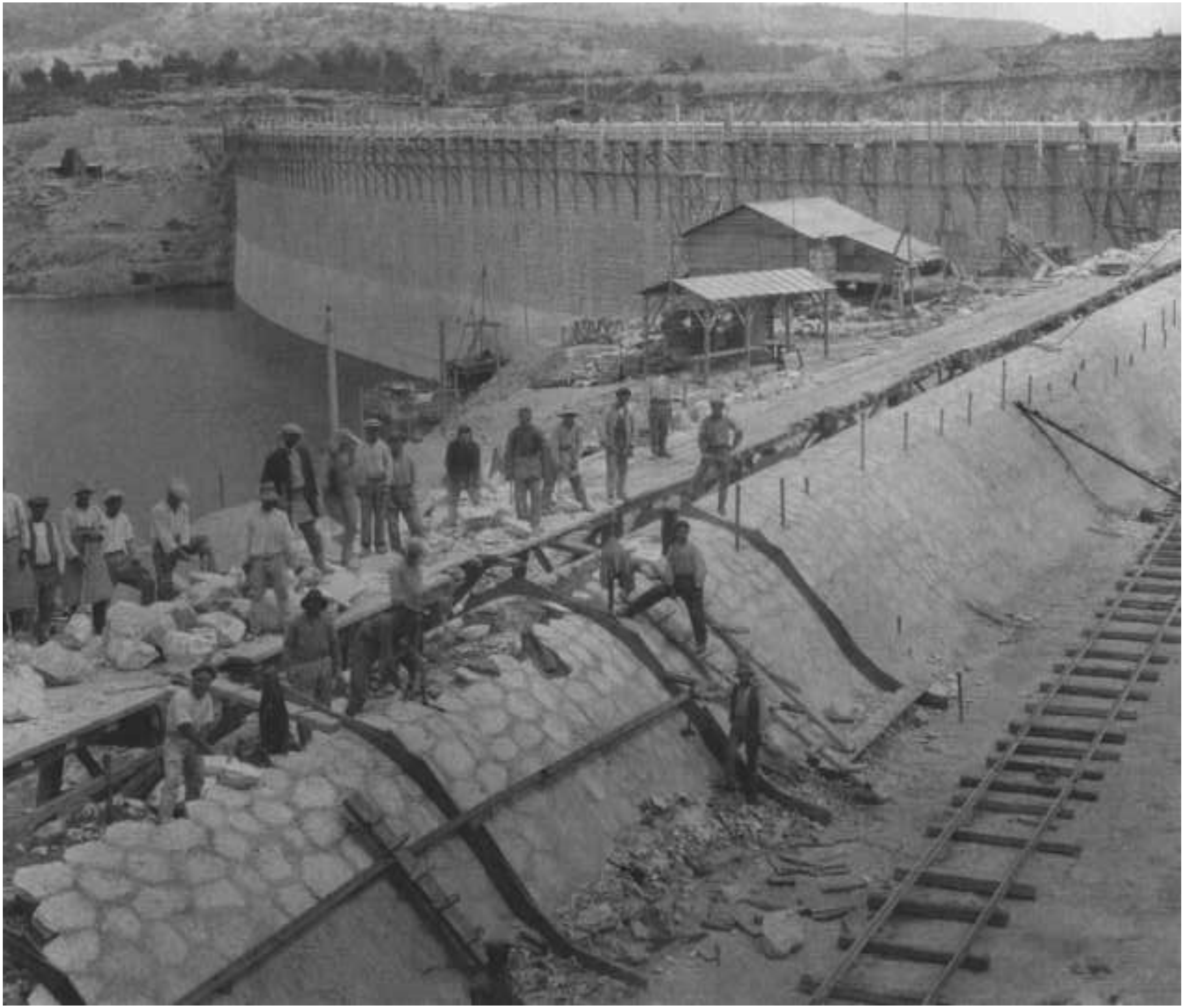

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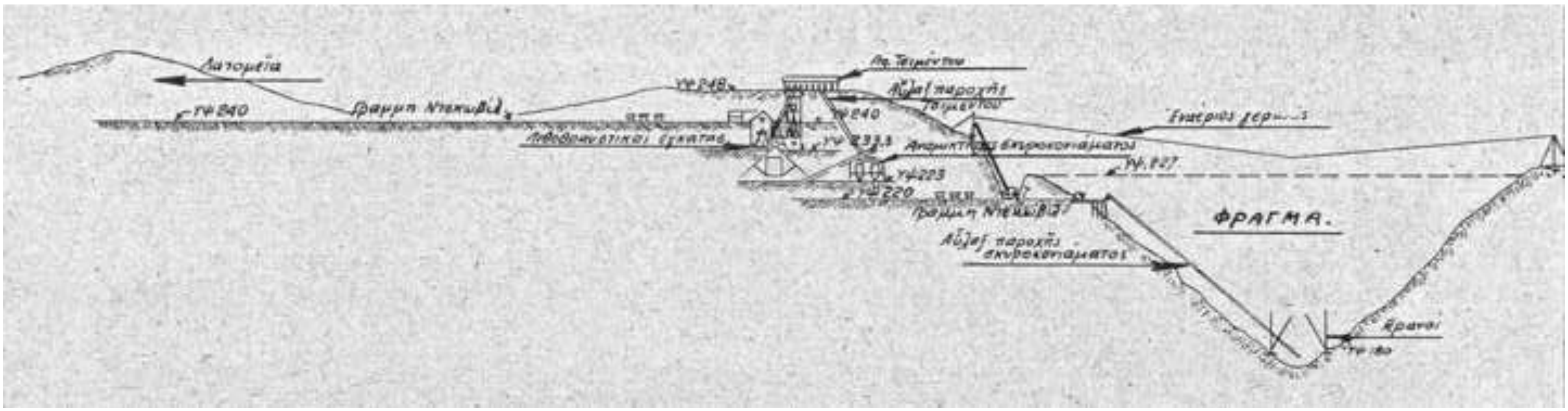

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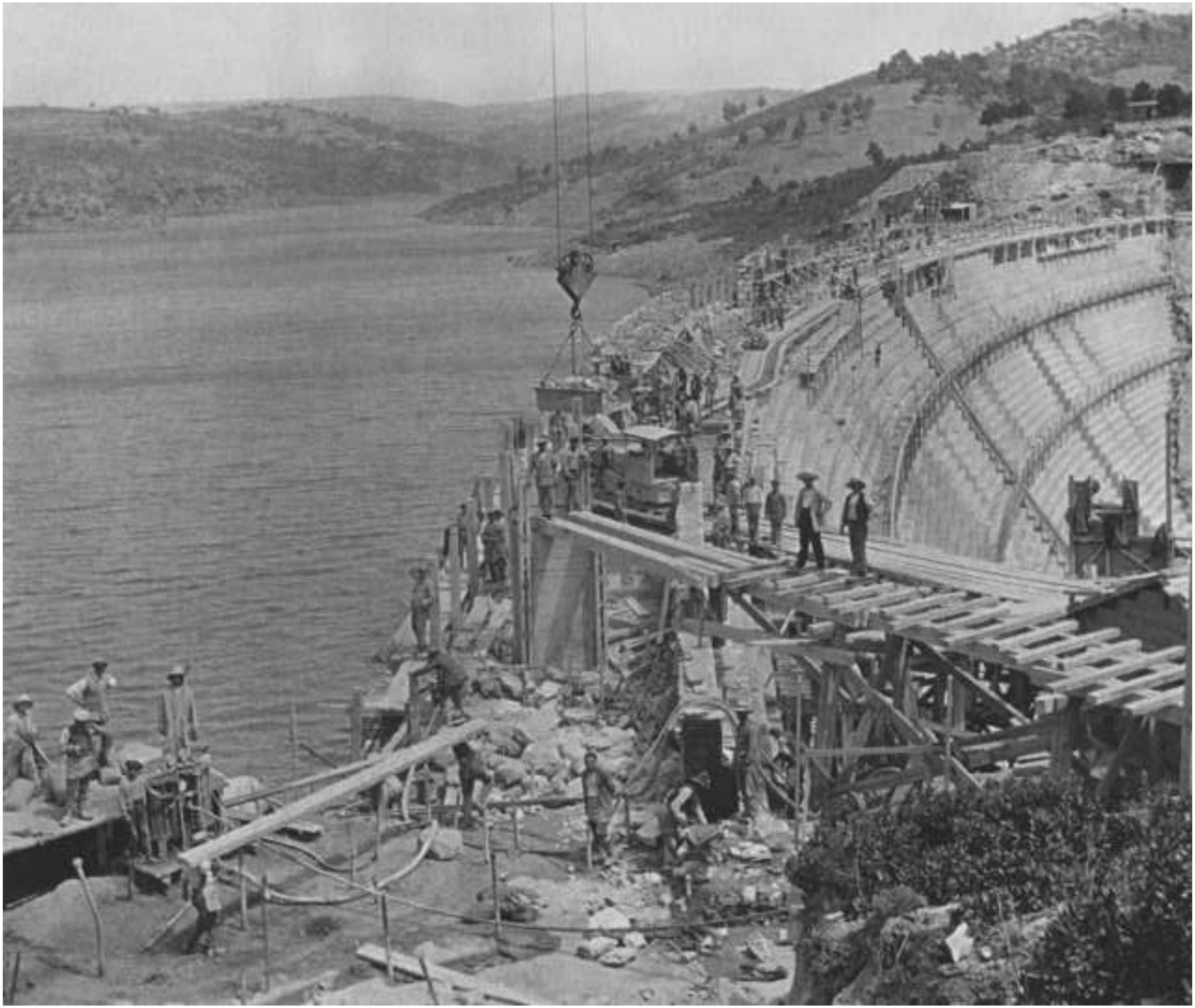

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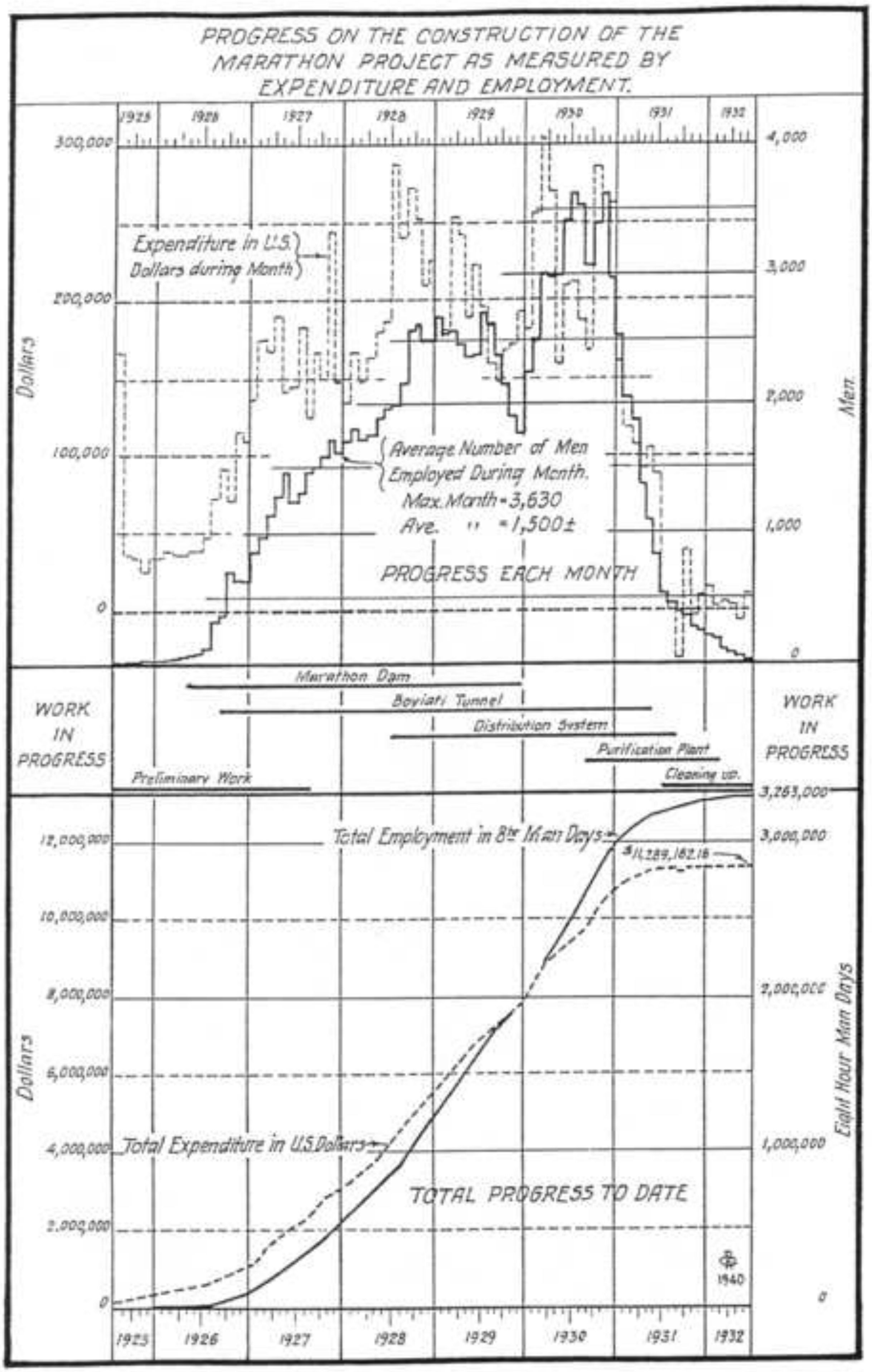
PROGRESS ON THE CONSTRUCTION OF THE MARATHON PROJECT AS MEASURED BY EXPENDITURE AND EMPLOYMENT.
1925
1926
1927
1928
1929
1930
1931
1932
300,000
200,000
100,000
0
Dollars
4,000
3,000
2,000
1,000
0
Men
Expenditure in U.S. Dollars during Month
Average Number of Men Employed During Month.
Max. Month = 3,630
Ave. " = 1,500±
PROGRESS EACH MONTH
WORK IN PROGRESS
Marathon Dam
Boyiati Tunnel
Distribution System
Purification Plant
Preliminary Work
Cleaning up.
WORK IN PROGRESS
3,283,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Dollars
3,000,000
2,000,000
1,000,000
0
Eight Hour Man Days
Total Employment in 8 Hr. Man Days
$11,289,182.16
Total Expenditure in U.S. Dollars
TOTAL PROGRESS TO DATE
1940
1925
1926
1927
1928
1929
1930
1931
1932

Figure
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