Borax Works

HISTORIC STRUCTURES REPORT

EAGLE BORAX WORKS
HARMONY BORAX WORKS
DEATH VALLEY NATIONAL MONUMENT
CALIFORNIA

HISTORIC STRUCTURES REPORT

Prepared by

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Western Service Center
Office of History and Historic Architecture
National Park Service
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PREFACE

Perhaps the most significant historical activity that occurred in Death Valley was the mining and processing of borax; certainly it is the best known. Death Valley National Monument possesses the sites of two borax plants, and the purpose of this report, which satisfies NSPS-B-6, 6 and 6A, has been to study the history of the borax industry in Death Valley and study the remains of these plants so as to form a basis for the interpretation of the industry and for determining the extent of preservation of these plants.

Research has been as exhaustive as material presently available will permit, and it is doubtful that much more documentary material will emerge. Virtually no company records of either operation have apparently survived, for a check with Harmony's descendant company, U.S. Borax and Chemical Corporation, failed to turn up any except those on display at the Borax Museum, Furnace Creek Ranch in Death Valley. Efforts to locate the papers of William Coleman and F. M. "Borax" Smith were fruitless. Apparently some Coleman materials have survived the years, for mention is made of a set of papers in James Scherer, Lion of the Vigilantes, but there is no hint as to location.

Hopefully somewhere there resides information specifically related to Eagle and Harmony which will provide the needed data on the technology of borax making but after all avenues in this direction have been exhausted, research will have to center on other plants using similar extracting techniques.

In the course of research on this project it became abundantly clear that a good, accurate history of the borax industry in the United States is sorely needed, especially if the Park is to interpret this most significant story. This study should trace the rise of borax refining in the United States, give histories of the individual plants and companies, and discuss the marketing and tariff problems the product encountered. Many of these activities had a direct bearing upon Harmony, and this information will bring into clearer focus the true significance of Harmony.

This report has been a joint undertaking between Historical Architect Robert Simmonds and Historian Russ Holland, both of the Office of History and Historic Architecture, Western Service Center. Architect Simmonds prepared the Architectural Data and Administrative Data sections, while Historian Holland prepared the History Data section. The two collaborated on the other portions of the report.

A number of people have been most helpful in the preparation of this report. I want to express especial gratitude to Horace Albright who searched his files and loaned me material he had on the borax industry. Gene Smith, head of the Lands Department of U. S. Borax and Chemical Corporation is Los Angeles, was most helpful in providing information, particularly on land owerships. Joe V. Kern, Manager of Public Relations for U.S. Boarax, opened the company's collection of historical photographs, a number of which were most useful. I am also grateful to the staff of Death Valley National Monument for their help while conducting research at the park. Superintendent Robert Murphy, Chief Park Naturalist Peter Sanchez, and seasonal Park Naturalist Dorothy Shally should especially be mentioned. Russ Johnson of the Chalfant Press in Bishop was particularly helpful in locating useful material and in making available to me earlyday volumes of the Inyo Independent. Mrs. Mary Cavitt, Librarian of the Inyo County Library in Independence, was invaluable in locating pertinent material in the library and county records in the courthouse.

Thanks should also be expressed to Mary Shipman, of the Office of History and Historic Architecture, Eastern Service Center, who typed this report.

F. Ross Holland, Jr.

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A. Basic Findings

1. Summary of Historical Data

Two of the oldest borax plants in Death Valley were Eagle, located near Bennett's Well, and Harmony, situated at the mouth of Furnace Creek. Eagle, under the guidance of Isadore Daunet, went into operation in 1882. A small and simple plant, it produced about 130 tons of borax in its first 15 months. Daunet experienced financial and marital problems and killed himself in 1884. Shortly afterwards Eagle Borax Works went out of business, and over the years the processing plant gradually disappeared until today it is represented by little more than two mounds of earth and a sheet of metal.

Harmony Borax Works had a longer life. Borax was found in its vicinity in 1881, and W. T. Coleman, a prominent San Francisco businessman, set up a borax plant and began producing in late 1883 or early 1884. During summer months, when the weather was so hot that the processing water in the crystallizing vats would not cool down enough to permit the suspended borax to crystallize, Coleman moved his work force to the Amargosa borax plant near present day Tecopa, California.

Perhaps the best known event associated with Harmony is the use of the large mule teams and double wagons to haul borax to the railhead. Shortly after Harmony went into operation J. W. S. Perry was instructed to devise an efficient method to haul the borax to the railhead. The result was the large wooden wagons and accompanying water wagon, which, with a team of twenty mules, became the symbol of borax. These teams began operation at Harmony and did not reach fame until after the demise of that borax plant. The evidence indicates, during the years Harmony operated, that 18 mules usually pulled the wagons laden with borax to the railhead at Mojave.

Harmony went out of operation in 1889 when Coleman's financial empire collapsed. Acquired by Frank M. "Borax" Smith, the plant never resumed the boiling of cottonballs, and in time became part of the borax reserves of Pacific Coast Borax Company and its successors.

Time and the weather have taken their toll on the old works. Although much of the operation has disappeared, there nevertheless are good remains, far more than at Eagle.

2. Summary of Architectural Data

Photographic evidence indicates that the Eagle works was a simple and elementary method of processing, and the Harmony works was a more complex and refined method of processing.

The Eagle works contained at least one, possibly two, rock shelters apparently to house employees, while the Harmony works contained a large collection of structures other than the plant itself.

The support structures were similarly functional and straightforward in design, since they were a part of a purely industrial and manufacturing undertaking.

3. Present Conditions

The existing works are both in a state of advanced deterioration caused by the natural elements and the pilfering by man. Only a small percentage of the original equipment remains. These items were probably considered expendable or too costly to move and reuse.

The adobe building walls and stone retaining walls of the Harmony plant remain in a deteriorating condition, and only remnants of the wooden sections of this plant can be presently found. Remnants of the adobe walls of two of the Harmony village structures remain.

4. Potentialities

The Eagle and Harmony Borax Works offer the interpretive opportunity to display the pioneer beginnings of borax mining and processing in the United States which is so closely related to Death Valley. The Harmony works due to its scale of operation, its proximity to the Furnace Creek area, the quality of its remains, and its association with "Twenty Mule Team Borax" becomes the more important site of the two and, of course, would be the place to tell this story.

5. Additional Research Needed

Research to date has not uncovered the necessary technical data to reconstruct the precise processing techniques employed at either plant. Therefore, the actual processing method is left to speculation, based on evidence given herein of other, and similar, plants. Engineering and mineralogical research would need to be undertaken by respective professionals if a factual and descriptive reconstruction of the processing

method and subsequent plant layout and operation are to become known.

B. Recommendations:

1. Ruins at plants be stabilized and protected from further deterioration. A description for emergency stabilization is presented in the Architectural Section under the heading of Proposed Construction Activity.

2. Following emergency stabilization, comprehensive archaeological research be undertaken at the Harmony works to attempt to determine the physical layout of both the plant and the supporting company townsite. Limited archeological research be carried out at the Eagle site to investigate known ruins. This would be in addition to the preliminary archeological testing now under contract and to be completed in FY 72, and would require additional funding, PCP & PSP programming.

3. Further technical research on the process of the manufacture of borax at both Eagle and Harmony Borax Works be undertaken to ensure that factual interpretation can be accomplished. [See Item 3 of Section A, "Additional Research Needed."]

4. Restoration of the Harmony Site should be accomplished after completion of emergency stabilization, comprehensive archeological research, and research on the process of borax manufacture noted above. This restoration would re-establish historic grades, roads, trails and outline the plant and town site. Obliteration of non-historic site features would be accomplished at this time. Also, a permanent surfaced access road and parking area would be designed and constructed outside the historic zone. This phase will require separate road and trail funding, PCP & PSP programming, and would combine H & MA and EP & D design services.

5. It is believed that visitor interest in the history of borax in Death Valley will increase; consequently, the recommendations presented in items 2, 3 and 4 should be instigated by program funding in the near future so that the full story of this intriguing history of borax mining and processing can be accurately told to the visitor.

C. Suggestions:

Should any restoration/reconstruction and/or interpretive features be desired in the future at the Harmony works, then further technical research outlined in item 3 will be requisite. If the above statement is accepted, then the

following limited restoration/reconstruction is suggested: (1) the chainlink fence be removed from its present location because of its objectionable and restrictive appearance; (2) a new protective fence be installed to encompass the entire plant area which would be less objectionable visually; (3) the barn-like structure visible in Illustration No. 7 be reconstructed and used for interpretive display and as an on-site interpretive exhibit; (4) the ruins should be stabilized but not reconstructed, but rather a scale model of the plant, company townsite and important landscape features be built and housed in the barn-like structure to convey to the visitor the full extent of the Harmony Borax Works' development and operation. The approach stated in the last suggestion would be less costly than full restoration-reconstruction and could still accomplish the presentation of a factual interpretive message.

II. Administrative Data

A. Name and Number of Structure

1. Harmony Borax Works, no number.

2. Eagle Borax Works, no number.

B. Proposed Use

Both borax works will serve as on site interpretive features of the early Borax industry in Death Valley.

C. Provisions for Operating the Structures

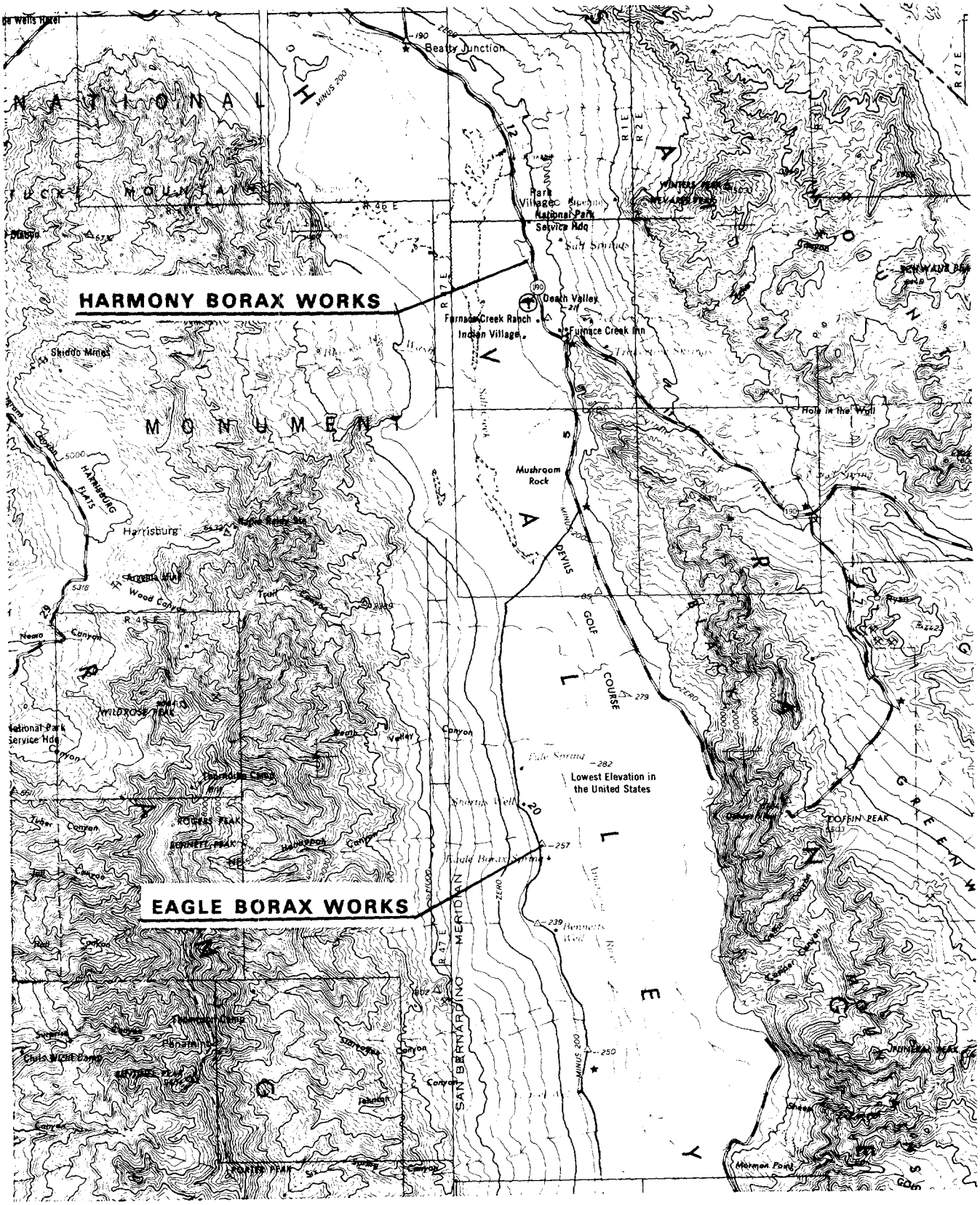
The sites will continue to be operated as self-guiding. Use of the Harmony site for guided tours can easily be accomplished, but the Eagle site is quite remote, creating transportation problems. Methods of operating and interpreting these sites should remain flexible to the staff to account for the variable interest levels of the visitor to the Death Valley Borax mining history.

D. Estimate of Proposed Construction Activity

1. Stone rubble retaining wall stabilization at Harmony Borax	$3,400
2. Stone foundation stabilization at Eagle Borax	500
3. Obliterate paths in the tailings area at Harmony	2,600
4. Temporary road and parking area adjustments at Harmony and Eagle Borax Works	1,100
5. Tamarisk removal and site restoration at Eagle - Three months	
1st Year -- 75% Removal FY '72	27,000
2nd Year -- 25% Completion FY '73. . . .	15,000
(NOTE: Extreme weather conditions in the valley floor limit construction to the months of April and May in FY '72 with project completion in September in FY '73.)	
NET CONSTRUCTION COST. . . .	$49,600
Plans, surveys	7,400
Supervision.	6,000
Contingencies.	9,400
GRAND TOTAL	$72,400

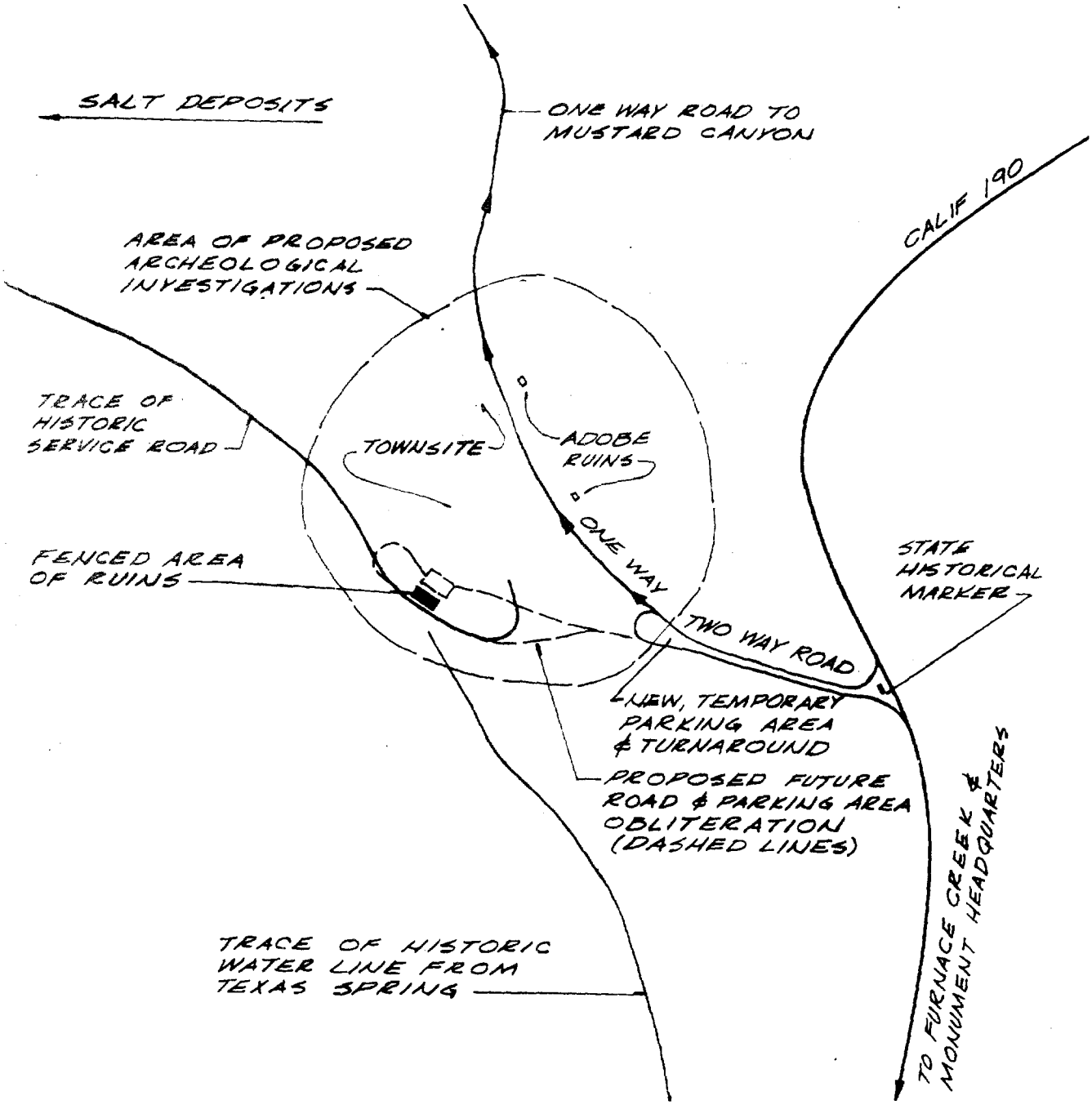
[Note: This estimate is based on cost figures as of June 1971 and should be revised as required to adjust to the variables of economic conditions at the time of construction.

Approval of this report by the Director of the Region constitutes approval of this estimate and the Project Construction Proposal (P.C.P.).]



DEATH VALLEY 7

Scale 1:250,000

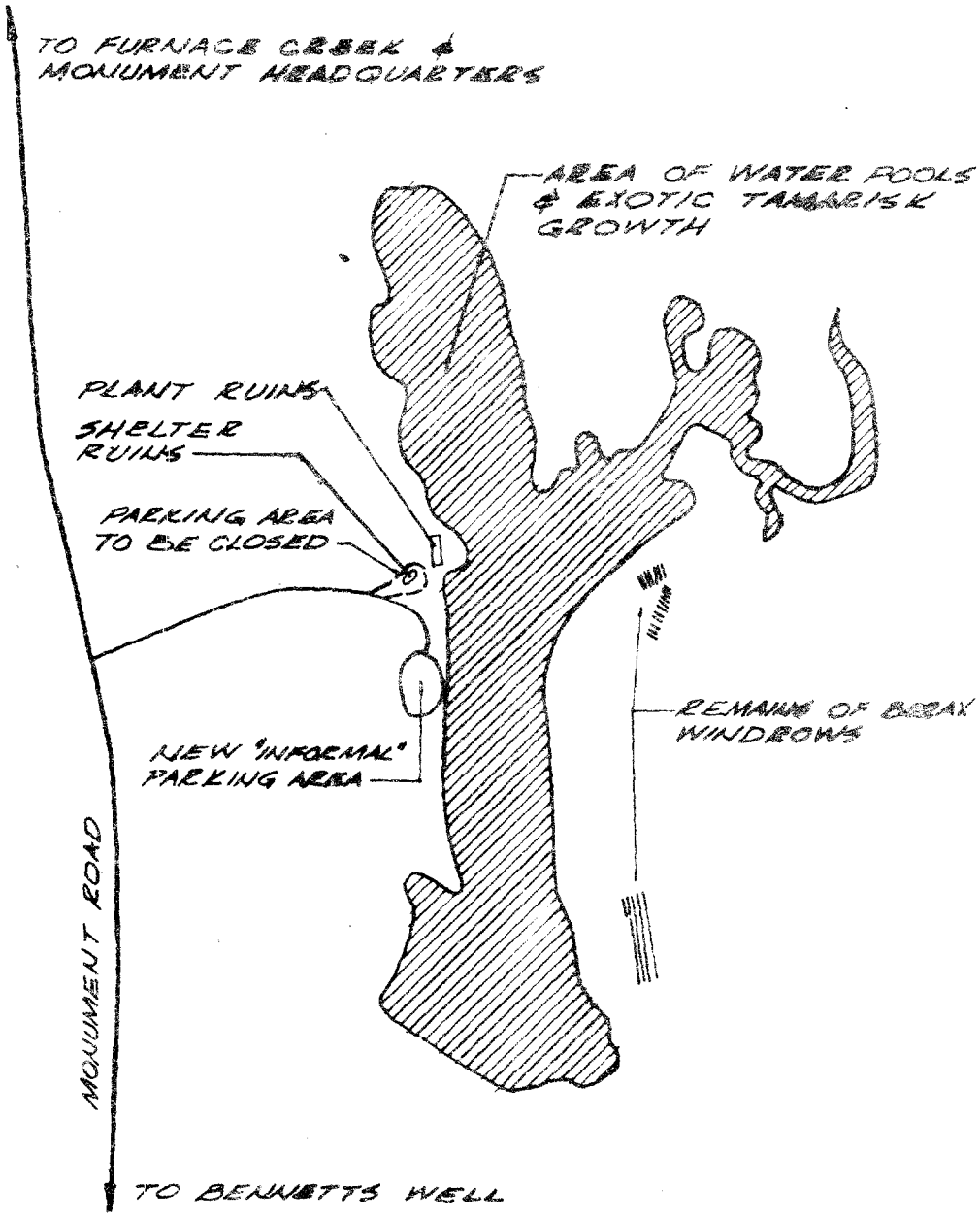


SITE PLAN

NO SCALE

NORTH

HARMONY BORAX WORKS



SITE PLAN

NO SCALE

NORTH

EAGLE BORAX WORKS

III. History Data

Introduction

Of all the visions Death Valley conjures up in the popular mind none stands out more vividly than the making of borax and the hauling of it by the 20-mule team. For years advertising men--through the media of still pictures, radio, and television--have created this vision and built it up all out of proportion to its historical significance--an illusion, interestingly enough, that had its genesis in the fertile brain of Stephen T. Mather when he was in charge of sales promotion for Pacific Coast Borax Company. Later Mather became the founder and first director of the National Park Service.(1)

Probably no one did more to publicize borax and Death Valley than Mather. Through both his advertising endeavors and his encouragement of John R. Spears, who subsequently wrote Illustrated Sketches of Death Valley, a highly successful popular account of Death Valley and the borax activities there, Mather's efforts have kept an enduring spotlight focused on Death Valley. Some may consider Death Valley Scotty the valley's chief public relations man, but it has to be remembered that Scotty was promoting himself, not Death Valley, and from his effusions Death Valley as a geographical entity comes through in distorted and fragmented pieces.

The 20-mule team, the picturesque symbol of the borax industry supposedly had its beginning at Harmony Borax Works, the remains of which are very much in evidence today despite the fact that over eighty years have passed since the plant produced its last vat of borax. Nevertheless the borax industry thrives today, larger than ever with its advertising symbol still the 20-mule team.

Harmony Borax Works was not the first such plant, in the world, in the United States, or, for that matter, in Death

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1. Robert Shankland, Steve Mather of the National Parks (New York: Alfred A. Knopf, 1951), pp. 27-28; Horace M. Albright, "For a Young Man, a Reluctant Trip to Columbus Marsh," Pioneer (Employee magazine of the U.S. Borax and Chemical Co.), Sept. 1963, p. 22.

Valley, but in an indirect way it was the birth place of the 20-mule team symbol, and, moreover, it was a good example of a typical marsh borax operation. Furthermore, it is today a collection of the best preserved remains of a borax operation within the National Park System, and as a result is worthy of preservation and development as an interpretive instrument.

The Beginnings of Borax

Marco Polo introduced borax to Europe when he returned from China with a pouch of tincal - a crude borax. It turned out to be a precious commodity for it was the only substance metal workers found that permitted them to solder gold.(2) Subsequently other deposits were discovered in northern Italy in the mid 18th century and in Tibet at least by the latter part of the same century.(3)

Despite the finding of further deposits in Chile in 1836, borax remained a scarce item that brought a handsome price. The United States had to import what it used, and by the middle of the 19th century on drug store shelves borax brought, reportedly, 25¢ per ounce. But by 1864, the price of borax had dropped to 35¢ per pound.(4) Since it was a precious item, American business interests in time began to think that surely this country contained deposits of borax.

Dr. John A. Veatch in 1855 went in search of the mineral, and a year later discovered at Clear Lake in Lake County, California, the substance he had been seeking. Determining the deposit to be worthy of development, Veatch and a group of San Francisco business men formed the Borax Company of California. Eight years passed before actual exploitation of the find began, but from 1864 to 1868 this area was the principal supplier of borax for the United States market. The techniques of production this company used were rather crude and wasteful, but these people did produce about 300 tons of refined borax annually, and it brought an average of 25 cents

2. John H. Effelinck, "Once Worth More Than Gold: Early Story of Borax," The Mineralogist, v.V.#8 (August 1937), p. 5.

3. Ruth C. Woodman, The Story of the Pacific Coast Borax Co. (Los Angeles: Ward Ritchie Press, 1951), pp. 3-5.

4. W. A. Chalfant, Death Valley: The Facts (Stanford University Press, c1936), p. 127; California State Mining Bureau, Fourth Annual Report of the State Mineralogist for the Year ending May 15, 1884 (Sacramento: James L. Ayes, Supt. of State Printing, 1884), p. 93.

per pound on the San Francisco market.(5)

Another find nearby continued to fill the needs of home consumption for the next three years, until 1871 when marsh borate operations began in Nevada at Columbus Marsh and Salt Wells. The following year F. M. Smith -- to become known as Borax Smith -- discovered the Teels Marsh borate field -- the richest specimens of cottonball borate discovered up to that time.(6) At about the same time the borax plant at Columbus Marsh went into service, and John W. Searles began setting up borax operations at Searles Lake, California.(7)

These were all marsh operations, utilizing tincal and cottonball, a type of ulexite which was found on the surface of the ground where lakes had once been. The technique of extracting the pure borax was simple. Cottonball borate was scooped and shoveled off the ground and hauled to the plant and dumped in vats of boiling water. After the ore dissolved the solution was run into cooling vats where the refined borax crystallized around rods or plates dangling in the water. Sometimes the sides of the zinc vats were all the surface provided for the borax to crystallize on. The solidified borax was broken from these surfaces, placed in bags, and hauled to the railhead for transshipment to San Francisco where it was refined into commercial form.

The advent of these new operations had an immediate effect upon quantity and price. In 1872 the United States produced 140 tons of borax which sold for $640 per ton; a year later this country manufactured 1000 tons, but by then the price had dropped to $496 per ton.(8)

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5. San Francisco Mining and Scientific Press, May 31, 1884; Woodman, The Pacific Coast Borax Co., p. 6; Esselink, "Once Worth More than Gold," pp. 6, 21-24. The first discovery of borate in the United States reportedly occurred at Tuscan Springs in Tehama County, Jan. 8, 1856, some nine months before Veatch's discovery at Clear Lake. See Fourth Annual Report of the State Mineralogist, p. 91. Marius R. Campbell, "Reconnaissance of the Borax Deposits of Death Valley and Mojave Desert," United States Geological Survey Bulletin No. 200 (Washington: G.P.O., 1902) p. 7.

6. Woodman, the Pacific Coast Borax Co., pp. 10-11.

7. Ibid., p. 11; Vincent H. O'Donnell, "History of Boarx," ms in files of Stauffer Chemical Co., San Francisco, p. 5.

8. O'Donnell, "History of Borax," pp. 4, 6, 21.

Discovery of Borax in Death Valley

It would appear that borate was first noticed in Death Valley at least as early as 1873. In that year the Inyo Independent reported:

> Extensive deposits [of borate] have recently been found and located at two or three different points in Death Valley, some 70 miles, and more, south of Gold Mountain. There it is said to lie on the ground from one inch to a foot in depth, but containing a large percentage of borate of lime and other impurities.

One of these deposits, the newspaper went on, was located near where the "49 immigrants [the Bennett-Arcane party] abandoned their wagons which were subsequently burned by the Indians." The finding of these deposits did not bring about a boom stampede; the newspaper noted that development possibilities were doubtful due to the impure state of the borate, the distance from transportation, and the inhospitable land and climate.(9)

Isidore Daunet would have agreed with this assessment, for seven years later he and several companions attempted to cross Death Valley in the summer and became stranded. Two of the stronger travellers, one of whom was Daunet, departed to seek help, and when they returned with friendly Indians, the rescue party found three of those left behind dead from dehydration; at one point Daunet saved himself from the same fate by killing one of his animals and drinking its blood. On this adventure Daunet noticed the presence of borate in Death Valley, but he did not seriously consider developing the site until after the news of Aaron Winters' sale of the Furnace Creek find to W. T. Coleman had reverberated through Death Valley and environs.

Eagle Borax Works

Daunet, as one would judge by his name, was a Frenchman, who migrated to this country in 1860 at the age of ten. He

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9. Inyo Independent, May 10, 1873.

came to San Francisco and remained there until 1863 when he became a prospector. He had been prospecting in the Panamints when he and his six companions had made the unwise attempt to cross Death Valley in mid-summer in 1880.(10) Despite this flirtation with death, Daunet was not intimidated by the hazards of the then infamous valley, and in 1882 he entered into partnership with J. M. McDonald, M. Harmon, and C. C. Blanch to work the borate fields just north of Bennetts Well. He hauled in the necessary machinery and equipment and set up operation, utilizing water from a nearby spring. Their first shipment, by wagon to the railhead at Daggett, of crudely refined borax consisted of 37 tons and brought but eight cents a pound, although one San Francisco authority considered it "about equal to the best refined article." But their technique apparently improved, and by the end of 1883 the partners had shipped a total of 260,000 pounds of borax, subsequent shipments of which had brought 10 cents and higher per pound.(11)

The Eagle Borax claim consisted of 320 acres valued at $800, composed of 16 claims of 20 acres each.(12) Improvements on the land were valued at $1000 in 1883 and $1,150 the following year.(13)

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10. John R. Spears, Illustrated Sketches of Death Valley and Other Borax Deserts of the Pacific Coast (Chicago: Rand, McNally & Co., 1892), p. 51-52; San Francisco Morning Call, May 30, 1884.

11. Ibid., p. 52; Henry G. Hanks, "Report on the Borax Deposits of California and Nevada," in California State Mining Bureau, Third Annual Report, Part 2 (Sacramento: James J. Ayers, 1883), pp. 36-37; San Francisco Mining and Scientific Press, June 30, 1883.

12. Inyo County Tax Assessment Rolls, 1883, p. 40 in Inyo County Courthouse; San Francisco Mining and Scientific Press, June 30, 1883. Spears, p. 52 wrongly says the acreage totalled 260 acres, and Hanks, p. 36, likewise inaccurate, gives the claim at 270 acres.

13. Inyo County Tax Assessment Rolls, 1884, p. 31, in Inyo County Courthouse.

Daunet and his associates used the usual method for refining the crude cottonball into borax. The cottonball was dumped into a large vat and dissolved in boiling water. The liquid afterwards was conducted into huge cooling vats where the borax crystalized. The residue was then poured off and the resultant borax made ready for shipment by wagon to the railhead. The state mineralogist reported that the product was hauled to Calico Station (Daggett) by way of Panamint Valley, Willow and Granite Spring, Black Ranch and Grapevine.(14)

Ed Stiles in later years said that he hauled the first load of borax from Eagle in the fall of 1882. According to him he worked at the time as a freighter for Jim McLaughlin in southern Nevada. The freighting business had dropped off to nothing because of the arrival of the railroad, and McLaughlin looked elsewhere for employment of his teams. He entered into a contract with one of the agents for the operation to haul the refined borax to the railhead, and, accordingly, instructed Stiles to take a 12-mule team and two wagons, one in tow, to the Death Valley site. Stiles' first load for Eagle, which was that plant's initial shipment, consisted of six tons of borax, the first such hauled out of Death Valley, or so Stiles contends. It took Stiles eleven days to get to the railhead at Daggett. His wagons carried water which were replenished at springs along the way. Stiles said he halued four of five loads for the Eagle company before McLaughlin sold his wagons to W. T. Coleman.(15)

Little survives on the operation of the Eagle works. From the evidence available, however, it appears that the operation was small, unsuccessful, and short-lived. If one can believe Stiles, the plant probably went into operation by early autumn, 1882, for he said he hauled the first load in the fall of that year. Moreover, The Engineering and Mining Journal, which was usually a little slow in getting its news, reported on December 2, 1882, that 10 men were at Eagle "getting out borax and preparing it for shipment."

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14. Hanks, "Report on the Borax Deposits of California and Nevada," p. 37. Hanks indicates that the cottonball around Eagle works was of good quality because, he says, there was little residue after the boiling process.

15. Ed Stiles, "Saga of the Twenty-Mule Team," Westways, v. 31, no. 12 (Dec. 1939), p. 8. Whatever Stiles says must be accepted with caution. See discussion on the 20-mule team , Supra.

The nearest newspaper, the Inyo Independent, reported in January 1883 that Eagle was then producing and shipping borax.(16) Stiles reported but three men working at the plant, which indicates that he arrived at the plant near the beginning of its operation, for by December seven others had been added. Stiles probably saw Blanch, who was plant superintendent, McDonald, and Harmon.

Daunet, who was president of the borax company, was in San Francisco, where on October 1, 1882, he married Clotilde Gerraud, a French-Canadian grass-widow. Daunet did not learn about her previous marriage until after the ceremony, and this discovery required considerable mental adjustment on his part.

For a while Daunet's business and personal life went well. The plant in Death Valley continued to produce, and in May 1884, just before the roof fell in, reportedly employed 11 men who made enough borax to keep "three large teams steadily employed" transporting the product to the railhead. The plant operated continuously, except for the summer months when, so the partners found, the weather was too hot to permit crystallization of the borax in the cooling vats. Daunet during the summer also found the region to be more than he could take, which was a good excuse for him to remain in San Francisco with his bride and handle company business at that end.

Unfortunately, business troubles began to pile up for Daunet, and as his financial standing deteriorated, so did his marriage. Quarrels between Isidore and Clotilde increased in frequency and vehemence, and in May 1884, shortly after Daunet had been swindled out of $11,000 by two men, Clotilde left the bed and board of her husband and filed for divorce. Not long afterwards, just as Daunet returned from a trip to Death Valley, she had divorce papers served on her beleagured husband. This final act, coming on top of the swindle, was more than Daunet, who hoped for a reconciliation, could take, and going to his room at 535 Post Street, he sat down in front of a mirror and wrote a 12-page "note" addressed "To the Public" in which he rambled on about events that brought him to his present frame of mind, the departure of his wife being the crowning cause. He then wrapped a white cloth around his head and with his pistol put a bullet into the right side of his brain. He was buried from the Masonic Temple at Montgomery

16. Inyo Independent, Jan. 20, 1883; Engineering and Mining Journal, v. 34 (July-Dec. 1882), Dec. 2, 1882.

and Post Streets in San Francisco on May 30, 1884.

With the death of Daunet the business quickly folded and in time the property was sold. The land and property lay idle until 1901 when it was relocated as a mining claim and a few months later conveyed to U.S. Borax Company who held the site in their reserve borate lands until sold to Borax Consolidated Ltd. in 1922. In 1956 the land was transferred to Death Valley Hotel Company and later conveyed to the National Park Service.(17)

Daunet's venture was not a successful one, for many reasons. By the time he and his partners entered the business, marsh borate extractions were becoming marginal operations. In order for them to be profitable there had to be certain reasonably favorable factors, not the least of which was transportation. It was expensive hauling the crystallized borax to the railhead and also expensive bringing supplies into Death Valley. Hanks, the State Mineralogist, said in 1883:

> One of the greatest difficulties in winning borax in Death Valley is the trouble of bringing in supplies. To each supply wagon an equally large one must follow filled with barrels of water for the animals, and it takes some twenty days to make the trip from San Bernardino. This difficulty will be greatly lessened when the railroad is completed.(18)

It is one thing if the borax operator is shipping his product to a railhead and bringing his supplies from the same place on the return journey, but it is an entirely different kettle of expenses if he is shipping his borax to one railhead and bringing his supplies from another, as Daunet and his partners were having to do.

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17. Ibid., Spears, Illustrated Sketches of Death Valley, p. 54; Hanks, "Report on the Borax Deposits of Nevada and California," p. 33; San Francisco Mining and Scientific Press; May 10, 1884; Property Record, Death Valley Hotel Co., in records at U.S. Borax and Chemical Co., Los Angeles; San Francisco Chronicle, May 30, 1884; San Francisco Morning Call, May 30, 1884.
Of the three surviving partners only Myron Harmon left any record. In 1892, according to Spears, p. 54, he was operating a restaurant in Daggett. Later he became an official of the quick-silver mines at New Almaden. See W. A. Chalfant, Death Valley: The Facts (Stanford: Stanford University Press, c1936), p. 123.

18. Hanks, "Report on the Borax Deposits of California and Nevada," p. 36.

Physical Appearance of Eagle Borax Works

Little information survives on the physical layout, structures, and equipment of Eagle Borax Works, but the information available today indicates that the complex was a typical marsh-type operation; that is, there was a furnace and tank to heat the water that dissolved the crude borax, and cooling vats into which the liquid borax was poured for crystallization.

The best contemporary description of the operation was made by Henry G. Hanks in 1883, and it was but a brief one:

> The works consist of an iron pan twenty-two by five feet deep. The fuel is mesquet [sic] wood, of which there is an abundant supply for the present. Fires are built under the pan in which the solutions are made. There are twelve one thousand-gallon tanks of No. 16 galvanized sheet iron, cylindrical in form, with wider bottoms, into which the solutions are run to crystalize."(19)

Two photographs in subsequent years show the remains of Eagle Borax Works and afford some details of the plant. From the pictures of the remains it appears that the borax plant consisted of little more than a simple furnace heating the tank of hot water and the cooling vats. Stonework was just adequate to serve as a foundation and support for the furnace, tank, and vats. No enclosure is shown, nor are any associated buildings, such as quarters, barns, and corrals, shown.

The simpleness of the works is further indicated by the tax evaluation. In 1883 the county tax assessor valued the improvements at $1,000, and the following year he increased it to $1,150. During the same year he valued the improvements at Harmony Borax Works at $2,100 in 1883 and at $3,000 in 1884.(20)

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19. Hanks, "Report on the Borax Deposits of California and Nevada," p. 37. Another source reports the boiling tank as being "twenty feet long, three feet wide, and two deep." At the same time it confirms the twelve galvanized iron crystallizing vats and says in addition to mesquite the boiler used "nut pine" from the Panamints. See San Francisco Mining and Scientific Press, June 30, 1883.

20. Inyo County, Tax Assessment Rolls, 1883, pp. 40 and 191; Tax Assessment Rolls, 1884, pp. 40 and 150, both in Inyo County Courthouse.

The two photographs above are Illustrations Nos. 1 and 4 in this report. No. 4 was taken in 1891 and shows the back of the elevation works, and No. 1 was made around 1909 and shows the front elevation. From what little comparison is permitted, it would appear that the plant had not changed greatly in the seventeen year interval.

The 1891 photograph shows what appears to be a pile of rocks or stones. Perhaps this pile is actually the remains of a wall (it is difficult to ascertain because of the angle of the picture) of the quarters used by Daunet when he was at the works. Spears reported in 1892, "'The old rock-house in which he [Daunet] lived in Death Valley with the well and tools for gathering borax may still be seen much as he left them . . .'"(21)

Discovery of Borax at Harmony

Although Eagle was the first borax making plant in Death Valley, it was the claim near Furnace creek that spurred the interest in working the borate deposits of Death Valley.

The initial figure generally given credit for stirring interest in the marsh borate deposits of the Valley is Aaron Winters, a rancher of sorts who had settled east of Death Valley in Ash Meadow, where he and his wife Rosie, "a comely, delicate Spanish-American woman with frail health and little fitted for privations of the desert," lived in a hut.(22) The story of the prospector who told Winters how to test for borax, the subsequent journey Winters and his wife made to Furnace Creek in Death Valley, and the successful test for borax is well known. Indeed, the statement, "She burns green, Rosie. By God we're rich," is the punch line to one of the most enduring romantic legends of Death Valley. There is some evidence, however, to doubt that it happened that way. As the story goes Winters learned from an itinerant prospector that sulphuric acid and alcohol were needed to test for borax. The sulphuric acid is poured on the ore and it dissolves away the salt, leaving the weaker borax. After that the

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21. Quoted in Benjamin Levy, "Death Valley National Monument: Historical Background Study," National Park Service, Division of History, April 15, 1969, p. 124.

22. Spears, Illustrated Sketches of Death Valley, pp.56-57.

tester pours on a small quantity of alcohol and ignites it. If borax is present, the flame will be green.

No one has really explained satisfactorily where Winters obtained the sulphuric acid and alcohol, or, indeed, where he could have obtained them. He, according to all accounts, heard the story at his home, and afterwards with his wife journeyed from here and across the desert to the vicinity of Furnace Creek where they conducted their famous test. Where could he have acquired the two chemicals needed for the test? There was no town or store between the two sites, or within a reasonable radius of either place.(23)

After determining that borax indeed existed where he thought, Winters returned to his home and wrote W. T. Coleman, a San Francisco businessmen, of his discovery. Coleman was interested and dispatched a representative to investigate Winters' story. Determining that Winters spoke factually, the representatives, reportedly William Robertson and Rudolph Neuschwander gave Winters a check for $20,000, a fortune of gigantic proportions to this man of meagre circumstances. Winters used part of the money to buy a ranch at Pahrump Oasis in Nevada.(24)

Winters made his discovery in 1881, for in the fall of that year the Death Valley Salt and Borax Mining District was formed and Coleman and a number of his employees began filing borate claims. Winters did not leave the area of his discovery immediately, but rather remained at Camp Winters "3/4 of a mile north of the mouth of Furnace Creek." He served as first Recorder of the mining district and

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23. San Francisco Mining and Scientific Press, Aug. 5, 1882, carries an interesting article by Hanks saying that the green lands looked for in the test for boracic acid are very difficult to see with the naked eye, and that a spectroscope was needed. This condition apparently did not apply to the cottonball in the vicinity of Harmony. Modern day tests by Park employees using Winters' technique shows that the burning borate gives a distinct green flame.
That Winters had sulphuric acid cannot be eliminated as a possibility. Superintendent Bob Murphy informs me that wagon freighters sometimes carried oil of vitriol to treat calluses on their animals.

24. Spears, Illustrated Sketch of Death Valley, p. 60; James A.B. Scherer, The Lion of the Vigilantes; William T. Coleman and the Life of Old San Francisco (Indianapolis: Bobbo-Merill, c. 1939), p. 302.

remained in this capacity until February 21, 1882, when he resigned.(25)

In late 1881 and early 1882 various combinations of people in groups of seven or eight began staking out borate claims, usually 160 acres in size, the maximum the mining district laws allowed. Laws governing the filing of borax claims at that time stipulated that borate lands were to be patented in the same manner as placer mines. Since the mining act of May 2, 1872, was the law, no claim by a single individual could be larger than 20 acres, and an association of people could not file a location greater in size than 160 acres. Some of the names such as W. T. Coleman's, appear on several mining claims. F.M. "Borax" Smith's name also appears on claims in the Furnace Creek area, indicating that he was in business with Coleman at this early stage of borax development in Death Valley.(26) The other names were probably Coleman's employees, and Coleman was using the names to get around the mining laws which, as indicated above, restricted numbers and sizes of claims. Early in the game Coleman began acquiring under his own name some of these group claims. By the end of

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25. Ledger, Death Valley Mining District, 1881-1886, in Borax Museum, Furnace Creek Ranch, Death Valley, Calif., pp. 2-3.

26. Ibid., pp. 2-112. Henry M. Copp. United States Mineral Lands Governing Their Occupancy and Disposal (Washington: Published by Editor, 1882), pp. 52, 100, 145. The exact role of "Borax" Smith in Coleman's operations can not be ascertained with the present evidence available. But that he was involved with Coleman in the making of borax in Death Valley, there seems little doubt. The previously cited mining district records certainly indicate it, and an early day wagoneer, Ed Stiles, if his story is reliable, says that "Borax" Smith was the one who hired him to haul for Harmony Borax Works. Moreover, he states categorically that Smith was Coleman's partner. See Ed Stiles, "Saga of the Twenty-Mule Team," Westways, v. 31, no. 12 (Dec. 1939), p. 8. Spears, p. 26, says Coleman and Smith were partners at Harmony.

1882 Coleman apparently owned outright most, if not all, of these claims.(27)

Establishing Harmony Borax Works

According to Hanks, Coleman organized the Greenland Salt and Borax Mining Company to operate the borax plant at the mouth of Furnace Creek.(28) This Company apparently was a temporary organization, perhaps quickly set up to get things going. At any rate the name is not mentioned in the Inyo County tax records nor in the property records of the descendant company, the present day U.S. Borax and Chemical Co. The name Greenland, incidentally, was the one Coleman gave to the nearby farming operation that later became known as Furnace Creek Ranch.(29)

Little is known about the beginning of actual borax production at the Harmony works. In 1883 Hanks reported that Coleman had made a settlement at the mouth of Furnace Creek and he and Smith were "engaged in putting up works [in Death Valley] on a ridge quite elevated." The slowness in moving into the Furnace Creek area was apparently due to Coleman first setting up the Amargosa works near the present day Tecopa, California, for Hanks reported at the same time that the works there already had 80 crystalling tanks and that it expected to begin production soon.(30)

The fact that the Amargosa works was built before Harmony under-cuts the popular belief that Coleman built Amargosa after he found that the heat was too great in Death Valley to make borax in the summer months since the water wouldn't cool and the borax would therefore not crystallize. The fact that one could not make borax in the summer in Death Valley was aapparently not a discovery of Coleman's, but rather of the operators of Eagle Borax Works, for the state geologist in the

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27. Ibid; Ancient Lake No. 1, Ancient Lake No. 6, and Winters properties, all in Property Records, Death Valley Hotel Co., files of U.S. Borax & Chemical Co., Los Angeles. Coleman's first sole acquisition was made Dec. 23, 1881.

28. Hanks, "Report on the Borax Deposits of California and Nevada," p. 36.

29. Chalfant, Death Valley: The Facts, p. 140.

30. Hanks, "Report on the Borax Deposits of California and Nevada," pp. 36-37.

1883 annual report, the one that said Coleman was then setting up his works in Death Valley, stated, the Eagle "Company has made the experience that it is next to impossible to manufacture borax during the hottest season, as the solutions will not cool down to a temperature at which crystallization takes place."(31) Coleman's purpose in setting up Amargosa may indeed have been for the purpose of having summer employment for the Harmony workers, but if so, he was profiting by someone else's discovery, not his own.

According to Spears, the borax plant at Furnace Creek went into operation in 1883 under the Greenland Company name, although the Inyo County tax records for 1883 listed the operation simply as W. T. Coleman Borax Works.(32) But the following year Coleman reorganized his borax activities in Death Valley into three companies: the Meridian Borax Mining Company, the Harmony Borax Mining Company, and the Henry Clay Mining Company. The surviving records leave one in total confusion about these companies. It appears that the Harmony Company managed the borax works at Furnace Creek, at least at first. Henry Clay apparently embraced the Amargosa Works operation. The Meridian Company, usually cited as the administrator of the Amargosa plant, was apparently a borax land holding company. This latter contention is supported by the county tax records which for the years 1884, 1886, 1887, 1889, and 1890 show improvements on that company's property valued at various times as $600 and $500 with no machinery listed, whereas Harmony and Henry Clay have improvements valued during these years in the vicinity of $2,500 each with machinery valued at $1,500 for Henry Clay and $2,500 at Harmony. Moreover, the tax records give the location of land for Harmony as being in Township 28, for Henry Clay as being in Townships 21 and 28,

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31. Ibid., p. 37.

32. Inyo County Tax Assessment Rolls, 1883, p. 191. The belief that Harmony began operation in 1883 is further supported by a newspaper article in October 1884 which stated that Coleman was "putting in works to crystallize a much larger quantity of refined borax than formerly." At the time, incidentally, Coleman was closing down Amargosa for the season and moving his work force to Harmony. See San Francisco Mining and Scientific Press, Oct. 25, 1884.

and Meridian in Townships 26 and 27.(33) The Amargosa works was near present-day Tecopa in Township 21.(34)

What company operated which works is further confused by the papers Coleman filed when he went bankrupt in 1888. He listed his three principal borax companies as Harmony, Meridian, and California Chemical Works. The latter outfit was a refinery plant in Alameda "where products of [Harmony and Meridian] were worked up."(35)

Harmony consisted of the land and works, including the ranch, in Death Valley and embraced the borate lands and the borax works at Furnace Creek. Meridian consisted of the Amargosa works.

It is generally asserted that Harmony was set up in 1882. There is evidence, however, to indicate that the plant was not erected until the following year. As previously mentioned Hanks' report for 1883 said that the plant at Amargosa was just being completed and that Harmony was in the process of being put up and had not yet produced any borax. The Inyo County Newspaper reported in January 1883 that Coleman was then hauling machinery in for the Amargosa plant.(36) Probably it went into operation shortly after the summer of 1883. By May 1884 it was in full operation and according to a newspaper account employed 40 men who produced three tons of borax per day.(37)

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33. Inyo County Tax Assessment Rolls, 1884, pp. 150-51; 1886, p. 123; 1887, pp. 83, 122; 1888, pp. 65, 98; 1889, p. 76; 1890, pp. 132, 192.

34. Ibid.; Hanks, "Report on the Borax Deposits of California and Nevada," p. 37.

35. The Engineering and Mining Journal, May 18, 1888; The San Francisco Mining and Scientific Press, June 2, 1888.

36. Hanks, "Report on the Borax Deposit of Death Valley," pp. 36-37; Inyo Independent, Jan. 20, 1883.

37. Phillip W. Powell, "Death Valley," ms in Library of Death Valley National Monument, p. 79. Spears says that during its operating years Harmony usually employed 40 people. See Spears, Illustrated Sketches of Death Valley, p. 28.

The Operation at Harmony

A typical borax plant employed a variety of people, including engineers, blacksmiths, teamsters, coopers, boilermen, watchmen, and Chinese and caucasian laborers. Pay ranged from $5.00 per day for blacksmiths to $1.25 per day for laborers, and each received room and board. Chinese laborers also received $1.25 per day, but they had to board themselves. The white collar workers, such as clerks, foremen, and agents, received $100 to $125 per month.(38)

At Harmony the gathering of the cottonball was done principally by the Chinese laborers who shoveled the raw ore from the surface of the ground and used sleds, push carts, and wagons to transport the borate to the processing plant.(38a)

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38. California State Mining Bureau, Fourth Annual Report of the State Mineralogist for the year ending May 15, 1884 (Sacramento: James J. Ayres, 1884), p. 93.

This report gives general wages paid at California borax works as follows:

blacksmith	$5.00 per day
blacksmith helper	3.00 per day
engineer	4.00 per day
teamster	3.25 per day
cooper	3.25 per day
boilerman	2.31 per day
watchman	2.31 per day
laborer	1.25 per day
cook	50.00 per month

As well as the above positions the San Francisco Mining and Scientific Press, Feb. 9, 1884, listed also:

clerk at mine	$125 per month
agent at RR station	100 per month
firemen (Chinese)	50 per month
swampers or helpers	1.95 per day
fuel teamster	3.25 per day

It cost the borax companies $1.00 to board each white man.

38a. Not far from the Harmony plant are windrows which have been labelled borax gardens. The windrows, as well as similar ones at Eagle Borax Works, are not associated with the active days of the borax works, but rather were created during the period 1905-1910 when the Pacific Coast Borax Co. was doing assessment work connected with claim patenting. See note entitled "Borax Gardens" in Fact File, Death Valley National Monument.

Local Indians and some whites gathered mesquite, and possibly other desert plants to be used as fuel for the furnace that heated the water that dissolved the raw product.

In an effort to remain in operation as deep into the summer season as possible, the works at Harmony wrapped the cooling vats with some sort of cloth so that water could be played on them to assist in lowering the temperature. Photographs of the works show the vats with these wrappings.

The Twenty Mule Team

Getting the finished product to market from the bowels of Death Valley was a difficult, but not impossible, task. After the borax crystallized it was removed from the vats and broken off the rods. It was then left to dry, after which it was put into sacks. The sacks, incidentally, were made at the California State Prison, and Coleman paid $80 or $85 per thousand for them.(39) The full bags were then stacked onto wagons that carried them to the railhead at Mojave. The sacking operation probably occurred in the wooden shed located just in front of the vats and from here the bags were loaded into wagons for transportation to Mojave.

In the beginning these wagons were the ordinary type used in desert hauling and employed eight to twelve horses. At first the borax was hauled by contract teamsters. Reportedly Charles Bennett of Pahrump, Nevada, was the first contractor to haul borax from Harmony.(40)

John Spears, who visited Death Valley just a few years after Harmony ceased operation, and who talked to participants, states that contract hauling did not last long, just a year. Coleman felt that it would be cheaper for the borax works to do its own hauling, and he instructed J.W.S. Perry, a trained druggist and the timekeeper at his borax office in Mojave, to

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39. Ledger, Coleman Daybook, 1884-1887, pp. 44-48 Borax Museum, Furnace Creek Ranch, Death Valley, California.

40. Chalfant, Death Valley: The Facts, p. 41. Spears, Illustrated Sketches of Death Valley, pp. 84-86, is apparently the source for Chalfant's statement on Bennett. According to T. S. Palmer, ed., Place Names of the Death Valley Region in California and Nevada (Mimeograph copy in Library of Death Valley National Monument), p. 95, Texas Springs, the main source of water for Harmony Borax Works, was named for Charles "Texas" Bennett.

devise wagons and lay out a route to get the borax to the railhead.(41)

Spears, and every other writer who wrote about borax and Death Valley, says Perry proceeded to gather all the information he could on west coast wagons used to haul heavy loads and began to devise a wagon that could carry 10 tons. When he completed his design he turned his plans over to J. T. Delameter, of Mohave, who assembled ten wagons, each costing $900. Perry designed well and Delameter built commensurately, for in five years of constant use no wagon broke down.

The best description of the wagon has been given by Spears who saw two of them still in service when he visited Death Valley in the early 1890s. He said:

> "The hind wheel was seven feet in diameter, and its tire was eight inches wide and an inch thick. The forward wheel was five feet in diameter, with a tire like that on the rear wheel. The hubs were eighteen inches in diameter by twenty-two inches long. The spokes were made of split oak, 5 1/2 inches wide at the butt, and four inches wide at the point. The felloes were made double, each

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41. John William Samuel Perry was born in Shelbyville, Mo., on September 4, 1848, and came to California at an early age. He attended the California College of Pharmacy in San Francisco from which he graduated around 1879. While employed at Wenzel Drug Store in San Francisco he met W.T. Coleman who offered him a job, apparently at Mojave.

In 1882 Perry married Alice Olmstead of Eureka, California, and right afterwards the newlyweds journeyed to Mojave or Death Valley. One writer, after an interview with his daughter, says that Perry became Superintendent at Harmony and set up the plant there. There is, however, no other evidence to support this contention. Indeed, contemporary newspaper accounts state that R. Neuschwander was Superintendent at Harmony. (See San Francisco Mining and Scientific Press, May 10, 1884.)

Perry continued to work in the borax business, and after F. M. Smith took over Coleman's borax interests, Perry worked for Smith, becoming in time Superintendent of the operation at Borate. He died in 1898. See L. Burr Belden, "Bride Decides to Make Home at Death Valley," and "Daughters Tell Perry's Part in 20 Mule Borax," in San Barnardino Sun-Telegram, January 21 and February 5, 1961; Pearl L. Perry to [Superintendent Granville B. Liles], [Los Angeles], cJune 5, 1961, in files of Death Valley National Monument.

> piece being four by four inches large in cross-section, and the two being edge-bolted together. The forward axle-trees were made 3 1/2 inches square. The wagon beds were sixteen feet long, four feet wide, and six feet deep. The tread of the wagon--the width across the wheels--was six feet. Each wagon weighted 7,600 pounds, and the cost of the lot was about $9,000. . ."(42)

> "In building the desert freight wagon, the front wagon receives a tongue of ordinary length, while from the rear axle projects a little wrought-iron tongue about three feet long. The second wagon has a tongue, say six feet long, with a stout vertical ring on the end of it, which, when the two wagons are coupled together, slides over the three-foot tail of the front wagon. Then to hold the two wagons together a stout chain runs from the front axle of one to the front axle of the other.

The bringing into being of the twenty mule team is fraught with vagueness and contradictory evidence. Spears, who is the generally accepted basic authority on Death Valley's borax operations, said Perry developed 20-mule teams at Coleman's Death Valley borax works to pull the wagons to the railhead. Certainly the idea of a 20-mule team was not revolutionary. A 20-mule team pulling three wagons existed, at least in concept, several years before Perry began work on the project. A stretch of a 20-mule team hitched to three wagons was used in 1876 to illustrate a fanciful drawing of the Smith Brothers refinery in Album of American Manufactures.(43) On the other hand, popular accounts say that the Superintendent of the Amargosa works noticed that one of the young teamsters, Ed Stiles, was hauling twice as much with his twelve mules as a fellow driver pulled with his eight-mule team. In contemplating this peculiar fact, the Superintendent wondered how much could be hauled if the two teams were put together. Accordingly Stiles stretched out his team and then hooked up the eight additional mules in front of them. He then attached the other wagon to is own and added a water wagon, thus bringing into being the traditional twenty mule team and its paraphenalia.(44)

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42. Spears, Illustrated Sketches of Death Valley, pp. 86-89, 92; Harry P. Gower to Bill R. Morse, March 1, 1890, in files of U. S. Borax and Chemical Co., Los Angeles.

43. See Ruth C. Woodman, The Story of the Pacific Coast Borax Co. (Los Angeles: Ward Ritchie Press, 1951), p. 13, for a copy of the picture.

44. See Woodman, The Story of the Pacific Coast Borax Co., p. 20 as an example of this version of the story.

The latter story varies here and there in details in the various accounts, but it generally hovers close to the above rendition. These recitations apparently are based on the reminiscenses of Ed Stiles who gave out interviews in the 1930s. Books written about Death Valley prior to these interviews don't mention Stiles or his version of the story.(45)

In one of the interviews in 1939 Stiles said that one day he hitched onto his front wagon a new wagon that had just been brought in. He then attached a smaller third wagon that carried water and feed. He hitched his twelve mules to these vehicles, and then added eight more animals, thus bringing into being the first twenty mule team. This event, he said, occurred at the Amargosa works, and he hauled the first load of borax with the twenty mule team from there. He drove these twenty mule teams for two and a half years, carrying borax from both Amargosa and Harmony to the railhead.(46)

Evidence uncovered in the course of the research for this report casts a cloud over this generally accepted story. The 20-mule team apparently had an even less significant role than previously believed. The evidence reasonably conclusively indicates that Coleman's Death Valley borax works did not use a 20-mule team, but rather an 18-mule team. Other than Spears, no contemporary account refers to 20-mule teams at Harmony or Amargosa. References exist, however, to 18-mule teams at Harmony. There are those who may counter that Spears and others report that although referred to as 20-mule teams, actually the

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45. Spears, Illustrated Sketches of Death Valley (1892) and Chalfant, Death Valley: The Facts (1930), two of the more accurate books on Death Valley history do not mention Stiles. Of course, absolute accuracy has never been a criteria of the written history of Death Valley. If a writer on the history of Death Valley gets within 100 miles and ten years of an an event, his book or article merits special commendation for truth.

46. Ed Stiles, "Saga of the Twenty-Mule Team," Westways, v. 30, no. 12 (Dec. 1939) pp. 8-9. L. Burr Belden, "Daughter tells Perry's Part in 20 Mule Borax," San Bernardino Sun-Telegram, Jan. 22, 1961, gives an account of the first use of the 20-mule team based on an interview Stiles gave to the San Bernardino newspaper in the 1930s. This version varies in detail from the above account. Belden has Harmony, not Amargosa, as the setting, and says that Stiles hitched his 12 mules and the eight mules of another teamster to his wagon which had coupled to it the smaller eight-mule wagon. The third venicle used for water was not introduced until the second twenty mule team came with the stouter, custom made wagons.

Although this evidence does cast a deep shadow of doubt over Stiles' story of his being a key figure in the development of the 20-mule team, it does not mortally wound Spears as a source. Spears' book has long been spoken of with great reverence and held as the basic work on Death Valley's borax activity, and Spears did interview the participants in this work. But in view of these apparent errors, Spears should be used with some caution until more historical research is done that will form a background to permit a more accurate assessment of his book. At the same time it should be mentioned, and kept in mind that Spears enjoys some status as a historian. His history of the United States Navy, for example, is considered, by those qualified to judge, as one of the better books on the subject.

The Route to the Railhead

Perry is also given credit for laying out the route to Mojave that the 20-mule teams followed.(49) This route went from Furnace Creek, across Devils Golf Course and down the west side of Death Valley. The road then veered up the wash to Wingate Pass and then down into the south end of Panamint Valley. From on to Lone Willow Springs, Granite Wells, and westward to Blackwater Well. The road continued on to Cuddyback Lake and Desert Well to the Mojave-Owens Road into Mojave.(50) Chinese laborers, supervised by Charles Bennett, built the road. It was no easy task for they had to use mauls to flatten the hardened incrustations in the Devils Golf Course so as to have a reasonably smooth road. Overnight stops were placed at regular intervals along the 164 mile route. As much as possible the borax company attempted to place these stops at or near springs, but only a few of these existed along the route; so, the Company utilized wagons

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In his book Spears said that the picture on a borax box of "two wagons drawn by a string of mules that stretched out apparently for half a mile over a boundless plain" had renewed his interest in following Mather's urging that he visit Death Valley and write sketches about it. See Spears, Illustrated Sketches of Death Valley, p. 7.

49. There is conflict on the railhead the 20-Mule teams journeyed to. Stiles, "Saga of the Twenty-Mule Team," p. 9, says Daggett, while Spears, Illustrated Sketches of Death Valley, pp. 86-87, says Mojave. The weight of evidence is on the side of Mojave.

50. Harry P. Gower to Bill R. Morse, March 1, 1960, in files of U. S. Borax and Chemical Co., Los Angeles.

teams consisted of 18 mules and two horses, the latter two animals, known as wheelers, were temperamentally better suited than mules to being hitched directly to the wagon, and consequently they were technically 18-mule teams. But this contention is easily countered by at least one statement that refers to Coleman's five teams as consisting of 18 animals each and a photograph in 1885 which is labelled "20-mule team at Harmony" (Illustration No. 7 shows, when one takes the time to count, only 18 animals pulling the wagons. Other companies in the vicinity such as the Carlton Borax company as late as 1889 used 18-mule teams to haul their borax. One could safely bet that were it known that 20 mules in a team were more efficient, the borax people would have quickly added the extra animals.(47) Of course, there is the possibility that the general rule was to employ 18 mules in pulling the wagons, but on occasion, due perhaps to the use of small sized mules, or more rigorous weather conditions the drivers hitched up 20 mules to the wagons.

The evidence indicates that during the time Spears visited Death Valley 20-mule teams indeed hauled borax (he took photographs of the teams and wagons), but only two teams were in operation. Perhaps Spears conveniently extended backward in time the use of 20 mules to haul borax to strengthen the significance of the 20-mule team concept for his friend Mather who had evolved the idea of the 20-mule team as an advertising symbol. Certainly "20-mule team" rolls off the tongue more smoothly than "18 mule team." One cannot rule out the possibility although it doesn't seem likely, that the 20-mule team was wholly an advertising gimmick and that the 20-mule teams in use when Spears visited Death Valley were there to give substance to the slogan and to permit Spears to take photographs for his book.(48)

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47. San Francisco Mining and Scientific Press, May 10, 1884, April 7, 1888; Jan. 26, 1889; The Engineering and Mining Journal, Feb. 9, 1889. Illustration No. 7, supra. The April 7, 1888 report also says that the Company operated five 18-mule teams, which supports Spears' statement that Perry had 10 wagons made.

48. In doubting the existence of the 20-mule team, one should not lose sight of the remarkable wagons Perry designed. They were the real element of significance in getting the borax to the railhead; the question of whether 18- or 20-mule teams were used as motive power is important only because it was an advertising symbol.

with 500 gallon iron tanks for dry camps.(51) These water wagons were not a constant appendage, for Spears states they "were towed by the teams from the springs to the dry camps, and from the dry camps back to the springs to be filled again when empty."

At each stop the Company built two to four wooden storage "boxes" that held four bales of hay and six bags of barley as feed for the animals. On the way to the borax works the drivers placed the store of hay and grain at the station, and on the return trip to Mojave the mules consumed the food. The mules ate the grain from troughs placed in the front of the wagon between the wheels, and dined on the hay which was scattered on the ground.

Thievery and vandalism at these stations, Spears says, was a problem. Desert tramps and prospectors--he made no distinction between the two--stole hay and grain from these stations, destroyed water pipes leading from springs, and left valves open on the water wagons. The company did not attenpt to arrest or prosecute these vandals, believing they "were all in league together" and the arrest of one would result in greater damage to their property by his brothers.

The 18-mule team stretched out in front of the huge freight wagons nearly 100 feet. A single line called a jerk line, ran from the nigh lead mule down the left side of the team to the driver who some times rode on the wagon and other times on the left mule nearest the wagon, depending upon personal preference. The driver sent his signals down this

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51. Spears, Illustrated Sketches of Death Valley has the best and most thorough account of the 20-mule team operation, and the ensuing discussion of the topic is based on his rendition.

An attempt to gain further information on the mule team hauling was made in May 1971 when this writer visited the Kern County Courthouse in Bakersfield, California. Since the railhead of Mojave was in Kern County and since the Inyo County tax records did not reflect the large number of mules required for the hauling for any of the three companies, it was felt that the mules and wagons were taxed in Kern County. Unfortunately, the trip to Bakersfield was fruitless; these early records have been lost or misplaced, to the consternation not only of this writer, but also several Kern County historians who have recently been seeking them.

line to the lead mule. To assist him in getting his message to the mules he had a whip to crack over their heads and a box containing pebbles which he used to pepper out-of-reach recalcitrant mules.

A flip of the jerk line, a crack of the whip, and a mighty, gravelly "Git up there you *!!*?*??&!*!," that screeched across the desert like the caw of a maddened crow, and the animals leaned into their collars and another load of borax began lumbering on its way to the railhead. The 30 tons of equipment and product rolled down Death Valley across the Devils Golf Course, up the grade to Wingate Pass and down the other side to Mojave. It was a tedious, grueling task for driver and swamper, and at the end of the journey it undoubtedly took mighty potent whiskey to rid their mouths of the alkalai taste.

The 18-mule-later 20-mule-teams and their wagons continued in use as long as Harmony and the Amargosa plant operated, but when these two works ceased producing borax the wagons went out of service. In the early 1890s a couple of the outfits were reactivated, and if the 20-mule teams were actually used, it was during this period. Off and on at various Pacific Coast Borax Co. plants in the general area of Death Valley, such as at Borate and the Lila C. works, the large teams and wagons served until around 1907 when the railroads reached the borax plants themselves.(52)

The Physical Layout at Harmony

Harmony borax plant was a larger and more complex operation than Eagle. Although there are fragments of documentary evidence on the physical layout of Harmony, our principal information comes from photographs of the place. But none of this evidence gives much data about size and distances, and most unfortunately we don't have a map or plat of this plant.

Water for the operation was obtained from Texas Spring, about three miles from the plant, and it was piped, presumably

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52. Smith attempted in 1894 to introduce a mechanical vehicle, or engine, and two ore cars to haul the borax to the railhead. Known as Old Dinah, this engine required extensive and constant repairs to keep it operating, and at the end of a year was taken out of service to be replaced by the more reliable 20-mule team. Today it is on display at the Furnace Creek Ranch. See Woodman, The Story of the Pacific Coast Borax Co., pp. 27-28.

by gravity, to water storage tanks on the rise back of the boiler. Thereafter it was all downhill. From the storage tanks the water was piped to the boiling tanks where the crude borax was dissolved.

This solution of borax was then piped to the cooling vats--reportedly there were 57 vats, each with 1800 gallons capacity, at Harmony--where the borax crystallized on zinc rods or plates suspended in them. The vats at Harmony were wrapped with some sort of cloth so that their exterior could be wet down to assist in lowering the temperature of the borax solution when the weather got hot.

Near the dissolving tanks was a track on which a small ore car ran. Perhaps this vehicle was used to carry the settlings of the borax solution back to the boiler pan for recycling to remove all the borax from the ore.

A wooden barn-like structure had been erected just in front of the crystallizing vats. Probably it was here that the borax was stored to await shipment to the railhead.

About a half mile from the plant was a collection of adobe structures that consisted of living quarters, office, and cooking and dining facilities for the men who worked at Harmony. Very little evidence on these structures survives today. So little is left of the structures that it is impossible to guess at their use.

The above discussion is but a fragmentary picture of the Harmony plant, but unfortunately documentary evidence about this plant and its operation does not survive. Consequently, to understand the plant and fill in those gaps of knowledge that the documentary and iconographic evidence leave, we have to turn to information about similar plants.

In 1882 a reporter described Borax Smith's new Fish Lake Valley plant near Candelaria, Nevada. From what we know of the Harmony plant, the Fish Lake operation was apparently similar. The description is worth quoting in full for it helps us to understand Harmony better:

> The site selected for the works is on the western marsh and under the side of the hill, high enough to allow a grade sufficient for the handling of the solution from the time the crude borax is first landed on the dump. The crude is shoveled up into winrows on the marsh and

allowed to remain for a time, that the moisture might leave it, decreasing the weight in the matter of hauling. It is then loaded into a wagon and taken to the dump.

The side of the hill has been excavated for the building of a stone wall, done in mason work, which is about 15 ft. high and 150 ft. long. The dump has an easy approach from two sides, and is level enough on the top for the easy handling of all the material taken there. A new building covers the boiler and pumping room, in which is a tubular boiler 16 ft. in length and 54 inches in diameter. There are two steam pumps in position, one of which has a six-inch cylinder, and is used for the purpose of pumping water from the well for washing the tanks and sprinkling, as well as fire purposes. This well is 22x12 ft. in size and 18 ft. deep. The other pump has a four-inch cylinder, and is used for feeding the boiler and for conveying water to crystalizers. An immense network of steam pipes, of sizes varying from half an inch to four inches in diameter, runs about the pumps and boiler to the dissolving tanks. It is estimated that about 1,500 ft. of steam pipe have been put into the places required. Right under the stone wall are six immense iron dissolving tanks, each of which is nine feet in diameter by seven in depth. The tops of these are covered with a platform made of two-inch plank, in which openings are made for filling the tanks. A system of steam pipe extends all over the bottom of each tank, and about every four inches the pipe is perforated for the escape of steam. A quantity of the crude borax is dumped into one or more of the tanks, and about three feet of water added. This fills the tank to within two feet of the top, when the steam is turned on and the mixture receives a thorough boiling.

The Crystallizers.

It is then allowed to settle 10 or 12 hours, and is then drawn off from the top of the solution by a syphon into the crystalizer, located on a platform about 30 ft. below. There are 45

crystallizers now in use, and more will be added when necessary. Each of these is lined with galvanized iron, upon the surface of which the borax precipitates itself and is easily removed. The solution remaining in the dissolving tanks is then given a second boiling drawn off again, as above described. The mud and remainder of the borax is then turned into a system of mud tanks, which occupy a position immediately below the first line of tanks, and if found to contain a large enough percentage of borax it is shoveled into a car and run along a track to a Hinckley elevator, which lands it on the top again, whence it goes into the dissolving tanks. After the crude borax has been worked over and over, until but little remains, the tailings are removed to a reservoir made in the ground, just below the last line of crystalizers.

This reservoir is 50 ft. square, and two and one-half feet deep, and here the tailings are allowed to remain and undergo the natural changes, the same as when first taken from the marsh. Car tracks run between the lines of mud and the crystallizing tanks, and into the drying and storage building. This building is 64 ft. long by 24 in width on the ground floor, and is intended for storing and drying. a second story has been added to it, which runs the entire length, but is only half as wide. In this are placed the superintendent's office and a sleeping-room for the employes, of whom there will be about 20 when everything is in full operation. There is a good-sized boarding house and blacksmith shop close at hand, and a corral 100 ft. square has been built near by, with a good-sized barn within the inclosure. It is calculated that there will be 40 to 50 tons of borax manufactured per month. This has a market value of $200 per ton, from which it can easily be estimated that the institution involves a financial proposition of no small proportions.(53)

The Manufacture of Borax

A further understanding of Harmony and its layout can be gained by a discussion of the method by which borax was extracted from the ore. By the time Harmony and Amargosa

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53. San Francisco Mining and Scientific Press, Sept. 2, 1882.

went into operation the technique of extracting the commercial borax from the ore was well known. It was not a complex process, but it was time-consuming. Essentially, the borate ore was placed in a large open water-filled tank and as the water was heated, usually by steam, and the mixture stirred by hand the borax dissolved. An 1892 account says that at this first step carbonate of soda was mixed with the cottonball borax, apparently as a flux to get rid of such impurities as carbonate of lime.(54) This borax solution was poured off into vats where the water cooled and the borax crystallized either on the sides of the vats or on plates or rods suspended in these containers. The residue water was re-cycled through the process. The crystallized borax was removed from the tanks, broken into chunks, and sacked immediately or stored in a building where it was later bagged for shipment to the railhead.

About the time Harmony folded a couple of enterprising and optimistic men opened a borax plant in the nearby Saline Valley. Though smaller than Harmony, this plant operated much the same way, judging from the account of a local newspaperman. He was reported as saying:

> . . . the new company has 18 crystallizing tanks, each of a capacity of 1,000 gallons. Three tanks are emptied each day, and the yield from these is about two tons of borax. In the very warm weather the yield might not reach that amount, as the borax does not crystallize so well as in cool weather. The crude material is first boiled, the boiler having a capacity equal to three of the crystallizing tanks, and the solution is then run into them and allowed to stand six days. The borax accumulates on the sides of the tanks, which are made of zinc, and on plates of the same metal suspended in the liquid. Seven of these plates are used in each tank. The borax is put in sacks direct from the tanks, and is ready for shipment.(55)

It is interesting to compare this passage with one of the few descriptions of Harmony, which the Deputy Assessor of Inyo County reported as having "57 crystallizing tanks holding

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54. Engineering and Mining Journal, Sept. 10, 1892.

55. Engineering and Mining Journal, Aug. 17, 1889. A similar account of this works can be found in San Francisco Mining and Scientific Press, June 15, 1889.

1800 gallons each, and 8 receiving tanks, 2000 gallons each. The borax remains in the crystallizers from 10 to 14 days, when it is ready for sacking."(56)

A more detailed account has survived of the San Bernardino Borax Mining Company, J. S. Searles' operation, which began in the mid-1870s and was located not far from Harmony. For its day Searles' borax was considered quite good, bringing one cent a pound more on the market than did Nevada borax. The California State Mineralogist reported:

> There are five steam boiling tanks, each with a capacity of 7,000 gallons; the impure, natural borax is shoveled into the boiling tanks, and the soluble matter dissolved by heat communicated through a wet steam coil, of one and a quarter inch iron pipe. The boiling tanks are made of three-inch Oregon cedar, seven feet deep, and ten and a half feet square on the bottom. They are not lined. When the solutions are brought to the proper strength (16° to 30° Beaumé, according to the character of the material), they are drawn off, while still hot, into crystallizing vats lined with galvanized iron. There are thirty of these vats, which are cylindrical. The borax taken from the crystallizers, after the first operation, is called "concentrated," and is not wholly pure. While the solutions are cooling, the mud is sluiced out of the boiling tanks, after which they are again filled, and the operation goes on continuously.
>
> In due time the crystals are taken from the crystallizers and returned to the boiling tanks, a portion of which are kept for this special work. Clean water is pumped in and the steam turned on. When solution is effected, and the liquor has the density of 18°, the liquors are run into square crystallizers, which are also lined with galvanized iron, and the solution made to cool slowly, although the climate is so warm that outside protection is unnecessary. Every precaution is observed that there may be no disturbance during crystallization. The result is "refined borax" of a very superior quality.

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56. San Francisco Mining and Scientific Press, April 7, 1888.

The mother liquors are returned to the the boiling tanks, and used again and again for the first solutions, until they become so foul as to yield crystals of foreign salts, when they are allowed to go to waste. Of the square crystallizers there are nine, six of which are forty-eight feet long, and three, thirty feet long. All of them are four feet deep and four and a half feet wide.

All liquors are returned to the boiling tanks by a steam syphon pump. Water is brought seven and a half miles in inch and a quarter iron pipes for the steam boilers and for drinking; but water for the solutions is derived from fourteen wells, each of which is fifty-five feet deep. These wells are artesian, the water rising three feet above the surface. The entire steam power is derived from one steam boiler, 42 inches in diameter, with 32 flues. Covers to the boiling tanks are made of Oregon pine. There is a rough wooden building over the boiling tanks, but none over any other of the works. The solutions are drawn off by means of an iron pipe, which passes up through the bottom of the tank, and is connected with a shorter length, to which it is joined by a common elbow, loose enough to turn easily. The jointed pipe is lowered gradually at the proper time, drawing the hot solution from the surface. This is a simple and convenient appliance, the use of which greatly facilitates the operation. It is very much like one to be described in the mention of Teel's Marsh works in Nevada.

A large evaporating trough of wood has lately been added to the plant, which is lined with galvanized iron, and is used in connection with open cuts or trenches in the ground, to concentrate by the sun's heat the foul mother liquors. This trough or tank has a capacity of 10,000 gallons. In it the last portion of borax crystallizes out.

Fifty men and thirty-five animals are employed at these works. All the fuel is obtained from the marsh, being wholly sage brush and grease wood, which grow near by in great abundance. This fuel is gathered in wagons and thrown into the furnace under the boiler with pitchforks. In this work fourteen mules are continually employed.(57)

57. California State Mining Bureau, Third Annual Report of the State Mineralogist for the Year Ending June 1, 1883 (Sacramento: James J. Ayers, 1883), pp. 27-28.

Further insight into borax manufacture is gained from a description of the Teels Marsh operation in Esmeralda County, Nevada:

> The method employed by Smith Brothers for the production of borax from the crude material is by solution, separation of mechanical impurities by settling, and crystallization. The result is concentrated borax. When this is recrystallized, it is known as refined borax. The deposit is known as crude borax, specimens of which may be seen in the State Museum, numbered 3380 and 3381. It occurs as a superficial stratum, varying from half an inch to eighteen inches in thickness. This is raked into windrows, shoveled into wagons, and hauled to the borax works, situated on a small hill near by. The heat required for solution is obtained from two twenty-four-inch steam boilers, which are supplied with water by a Cameron & Douglas steam pump. There are nine boiling tanks, of boiler iron, eight feet in diameter and seven feet deep. From the boilers the steam is conducted to the boiling tanks through two-inch iron pipes to a wet coil of a peculiar form--shown in figure 9--a vertical pipe, carrying the steam to the center of the coil (if this is a proper term), which is pierced full of small holes, through which the steam escapes into the solution.
>
> The operation is commenced by filling the boiling tanks one third to one half full of water, according to the quality of the crude material, as learned by experience. When the water is boiling hot, the crude borax is shoveled in until the solution has a density equal to 20° to 30° Beaume's hydrometer. The hot solution is allowed to stand over night, the steam being turned off. In the morning the solution, now free from sand and other mechinical impurity, is run off into crystallizers of No. 14 galvanized sheet iron. These vessels are square, seven feet at the bottom and six feet at the top. They are provided with covers of No. 16 galvanized sheet iron. As the solution cools, crystals of borax form in these crystallizers in crusts varying from half an inch to four inches in thickness. As soon as the boiling tanks are discharged, the mud is sluiced out; they are then pumped partly full of water for the next operation. When crystals cease to form in the crystallizers the mother liquor is

drawn off, and the crystals removed from the sides and bottom, and returned to the clean boiling tanks in which they are redissolved and allowed to stand for a time undisturbed, as in the first operation, when the solutions are drawn again into the crystallizers. The result is concentrated borax. The mother liquors from both operations are run off into shallow pans of wood, covering half an acre, in which solar evaporation takes place, salts containing some borax crystallize out, after which the very impure mother liquor is allowed to go to waste. The plan of calcining to remove organic matter has never been practiced, although it should be.

The hot liquors are drawn from the surface in the boiling tanks by an ingenious device, which consists of a goose-neck of three-inch iron pipe connected with a common flexible hose of the same diameter. The joints are common elbows and nipples. A three-inch pipe passes up through the bottom of each boiling tank near one side. The boiling tanks are set in a row, fifteen feet above the crystallizers; the pipe rises a few inches above the bottom, to allow for the settling mud. On the end of this pipe a common elbow is loosely screwed; in this is screwed a nipple, another elbow, and a length of pipe nearly as long as the bottom of the tank. This long pipe turns freely, and can be elevated or depressed at pleasure, and extends obliquely to the surface of the fluid. The elbows are all loose, being only screwed hand tight. When it is required to draw off the liquors, the end of the pipe is depressed, until the opening is just below the surface. The solution flows down through the pipe without disturbing the sediment. By means of the hose, the liquors are conveyed to either of the crystallizers at pleasure.(58)

Some phases of borax manufacture not mentioned in the two above accounts are illumined in the brief description of the Nevada Salt

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58. California State Mining Bureau, Third Annual Report, 1883, pp. 46-48.

and Borax Company's Rhodes Marsh plant, also in Esmeralda County, Nevada:

> The work of producing borax out of such excellent material is very simple. Indeed, the borax is already there and only requires dissolving from the adulterating mud and recrystallizing.
>
> At the railroad station, on the western portion of the marsh, the company has its works, consisting of a warehouse, an engine and boiler-house, four boiler-tanks (7x8), twenty-four crystallizing tanks, waste tanks, etc.
>
> The company has also a salt mill in the warehouse for grinding table salt.
>
> The attention of the company will be confined, for a decade at least, to the manufacture of borax from the native borate of soda. To do this, the top crust to the depth of six inches is shoveled into cars, taken to the works, and dumped into the boiling tanks, which are partly filled with water from a well strongly impregnated with borax. The tanks are then boiled by steam from the boilers until the borate of soda is all dissolved, when it is allowed to settle. The water containing the solution is then decanted into the crystallizing tanks, which are of galvanized iron, with sheets of the same material suspended in them. Here the borax crystals form on the sides and on the plates to the depth of about two inches. The water is then run off into the waste reservoir and saved, for it still contains some borax. The borax crystals are knocked off and shoveled up. This constitutes the "crude borax" of commerce, really worth more than the "refined," because it contains an excess of boracic acid. This is now redissolved and mixed with carbonate of soda, to reduce it to the standard. At 18° Beaume it is again decanted into crystallizing tanks, where "refined borax" is finally formed.
>
> The capacity of these is calculated for fifty tons per month and for some time they have been producing at fully that rate.(59)

The End of Harmony

Harmony and Amargosa in the meanwhile continued to produce borax from the cottonball, but from the very beginning discoveries had been made that assured the demise of these two plants. In late 1882 and 1883 deposits of borax, richer types than the cottonball variety at Harmony and Amargosa, were discovered at such places as Calico and Monte Blanco. The quartz-like ore at Calico was named colemanite in honor of W. T. Coleman. But nothing was done at first to develop these places, mainly because colemanite required different and more sophisticated techniques. Moreover, the rather depressed condition of the borax market in the first half of the 1880s probably influenced greatly the reluctance to gamble on a new ore. By the mid-1880s Coleman had begun to develop Calico. However, before he could get the plant into operation tragedy struck in the form of financial disaster.

One of the greater shocks San Francisco has received over the years was to hear that the upright and respected W. T. Coleman was bankrupt. Long honored by San Franciscans because of his role as leader of the vigilantes during that city's turbulent early years and under serious consideration for nomination for President of the United States by one of the major parties, Coleman had over extended himself and had been caught short.

In May 1888 the huge empire that Coleman had created crumpled into a formless mass. The operation began sputtering publicly, although not recognized at the time, the preceding April when the borax refining plant at West End in Alameda announced plans to close. Coleman said at the time that the plant would resume operation at the end of summer.(60) Not long afterwards the Harmony plant in Death Valley also ceased operations. Many felt the closing was only temporary, and locally rumors spread around the first of the following year that Harmony would soon be back boiling the cottonballs.(61)

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60. San Francisco Mining and Scientific Press, April 28, 1888.

61. San Francisco Mining and Scientific Press, January 26, February 2, 1889; The Engineering and Mining Journal, February 9, 1889. The exact date of the shutting down of Harmony is not known. Obviously it was, however, some time in May or June. In any event, the plant would have closed normally on July 1 for the summer months. A newspaper report on February 2, said the plant had been closed most of 1888. Consequently, one can safely assume that the plant did not fire up again after the end of the summer idle period.

By April, though, pessimism had set in, and a newspaper reported that "Coleman's big borax works in Death Valley . . . has only one sweltering individual to guard its collapsed greatness." By September someone suggested running a railroad down Death Valley to "make the enormous borax works of Death Valley, now idle, profitable to work."(62)

Meanwhile, Coleman's three principal borax companies were assigned on May 9, 1888 to A. L. Tubbs. The accountants and lawyers then began sorting out the wreckage in an attempt to salvage from Coleman's former holdings as much dollar value as possible to pay off creditors. An early report filed by Coleman revealed that his Harmony company had assets of $732,170.49 and liabilities totalling $213,972.52; the Meridian company's assets were $657,832.03 and liabilities of $171,842.65; and the California Chemical Company boasted assets of $208,541.18 and liabilities of $161,500.(63) But it soon became apparent that the assets of Coleman's companies generally had been greatly over estimated, and in July Coleman was soliciting creditors to settle for 40¢ on each dollar of indebtedness. By December reports spread that most of Coleman's creditors had agreed to the proposition.(64) Coleman was a man of great integrity and personal honor, and though not legally bound to do so, paid off all his debts in full before he died in 1893.(65)

Borax Smith Becomes Owner

Francis Marion Smith acquired Coleman's borax interests in Death Valley, including the lands and improvements of Harmony, Meridian, and Henry Clay companies. Reportedly he purchased the property in May of 1890 for $400,000; at any rate, Smith owned the businesses by the end of the year for he paid the taxes on all three companies in December of that year.(66)

62. San Francisco Mining and Scientific Press, April 6, September 14, 1889.

63. The Engineering and Mining Journal, May 12, June 2, 1888; San Francisco Mining and Scientific Press, June 2, 1888.

64. The Engineering and Mining Journal, July 28, December 8, 1888.

65. Scherer, Lion of the Vigilantes, pp. 309-310.

66. The Engineering and Mining Journal, May 3, 1890; Inyo County Tax Assessment Rolls, 1890, pp. 132, 192, Inyo County Courthouse.

Smith in 1887 had reorganized his borax holdings in Nevada under the name of Pacific Borax Salt and Soda Company. With the acquisition of the three companies in Death Valley, the Chetco borax mine in Oregon, the Calico mine, and Coleman's West End refinery in Alameda he reorganized once again, this time under the name Pacific Coast Borax Company.(67)

Smith let the borate lands at Furnace Creek lie in reserve, and apparently made no effort to work the cottonball at Harmony. He concentrated his effort on the richer colemanite ore at Calico. At least by November 1890 the Calico mine was in operation producing 12 tons of ore a day. J.W.S. Perry was superintendent of the works, and he had the crude borax transported to the railhead at Daggett via a 14-mule team.(68) Later production must have increased, for, according to Spears, Perry found it necessary to use two 20-mule teams to haul the borax to Daggett.(69)

Production never resumed at Harmony, and like Eagle, the plant stood silent through the years, and time, the elements, and vandals slowly eroded the plant and its buildings until today Harmony can be considered at best a shadow--and a poorly defined one at that--of its former greatness.

Although Harmony did not resume operations, borax production in the Death Valley region continued, with companies extracting the product from different type ores with more sophisticated techniques. After Harmony the plant at Calico, which processed colemanite ore, came to the fore, and in later years it was followed by such places as Lila C., Monte Blanco, and Ryan, all honored names in the history of borax production. Today the plant at Boron is a prime producer of borax in the area. Clear Lake, Teels Marsh, Columbus Marsh, Searles Lake, Calico, Lila C., Ryan, Boron and many other sites march across the pages of the borax story, but of the many only two--Eagle and Harmony--are today in public ownership and commemorate this important industry.

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67. The Engineering and Mining Journal, July 2, 1887; David T. Day, Mineral Resources of the United States, Calendar Years 1889 and 1890, U.S. Geological Survey (Washington: G.P.O., 1892), pp. 503-504.

68. San Francisco Mining and Scientific Press, November 29, 1890.

69. Spears, Illustrated Sketches of Death Valley, p. 90.

IV. Architectural Data

A. Record Drawings of Existing Conditions:

There is too little evidence of the Eagle or Harmony works left on the site to warrant the time required for measured drawings. The extant ruins have been recorded in HABS field notebooks for future use, if warranted. Also extensive photo coverage has been accomplished to adequately support future measured drawings.

B. Photographs of Existing Conditions:

See Appendix.

C. Detailed Description of Fabric, Materials, and Construction:

Eagle Borax Works.

The site of this works is a level plain on the west side of the valley floor. Adjacent to the plant was an extensive system of water pools, now nearly dry, from which the water supply was drawn. There is no evidence that trees existed at the site during the historic period. Illustration No. 5 shows the works as it appears in 1971 in contrast to the same view in illustration No. 4 (circa 1891). The encroachment into and takeover of the water pools by the exotic Tamarisk tree completely alters the historic appearance.

The basic building materials were stone and earth embankments. All that remains of the stone shelter is a low mound of rock covered with wind-deposited sand. The stone and earth foundations for the dissolving tank and crystallizing tanks remain today in a badly eroded condition.

The crystallizing tanks have long since disappeared but they were reported to have been constructed of 16 gauge galvanized metal. Illustration No. 1 shows the works with five such tanks directly east of the dissolving tank. It appears from this picture that the tanks were 4 to 5 feet high truncated cones with a base diameter equal to their height, and a top diameter 2/3 of that dimension. The tanks were formed by two rows of taper cut sheets of metal riveted together.

The dissolving tank was constructed of 1/2" iron plates riveted together to form a rectangular tank 20'-0" long and 3'-6" wide x 2'-6" deep containing approximately 1212

gallons (full).

Two parallel stone foundations supported the dissolving tank about 20" off the ground or the hearth to create a 20'-0" long firebox with the chimney stack at the south end. The stone was extended up along the sides of the tank forming retaining walls to keep the tank from bulging or breaking open under the heavy pressure of a full tank of water which would have weighed 10,920 pounds or 5 1/2 tons (full). The tank was internally braced with diagonal tie rods. The stack (now missing) was probably constructed of riveted sheet metal. Its height was above seven to eight feet.

The fire was introduced at the open, north end of the firebox and traveled southward to exhaust up the stack.

Midway along the east side of the tank, a large diameter pin was built into the tank. This may have been a pivot point for a hoisting arm. Just 24 feet west of the boiler is a depression 3 feet to 6 feet deep and rectangular in shape 12 feet wide by 35 feet long, probably the tailings reservoir.

All that remains today of the plant facility is the eroding foundation, the base for the stack and the bottom plate of the dissolving tanks.

Immediately east of the plant and water pools was the area of borax harvesting. Remaining evidence of borax gardens, resulting from patent work in the early 1900s, are still visible. (See History Section.)

Probably the harvest method was to plow the areas of the salt marsh containing borax ore into 2-3 foot high windrows or to build a series of mounds of the material. This piling up of the ore would have permitted the moisture to drain out, thus reducing the ore's weight before it was transported to the dissolving tank.

Excellent examples of these mounds and windrows remain and are easily discernable at a distance, depending upon the sun's angle and resulting shadow pattern. These ruins are quite fragile during the wet or winter season which is also the heavy visitation period, for they became very soft, spongy, and unstable under the weight of foot traffic. Quite the opposite occurs during the extremely hot, dry summer season, for the salts crystallize into hard, sharp, knife-like ridges which can cut into the soles of one's shoes. See Illustration No. 6.

Harmony Borax Works

This plant is located a few miles north of the present visitor center at Furnace Creek and just off California state highway

190. The site is on the north slope of an alluvial fan extending westward into the valley floor toward Salt Creek and the salt marsh from which the Borax was harvested.

Harmony Borax was extensive in size and complexity when compared with the Eagle operation. Water was piped overland to the site from Texas Spring some three miles or more away. Directly north of the plant the company housed employees and support facilities in adobe and wood structures, of which two adobe walled ruins remain today; time and weather have reduced the others to mounds on the plain.

The plant was carved into the hillside with the water storage tanks located at the high point to allow for gravity flow into the plant itself.

The processing operation at Harmony appears to be quite similar to the Pacific Borax Works at Fish Lake Valley described in the History section, with the exception of the water supply. Photographic evidence indicates that the Harmony plant layout was similar though the production capacity was less.

Therefore, rather than attempt to reconstruct the plant from what fragmentary evidence is available, "let the photographs speak for themselves," and this report will concentrate on the known physical evidence remaining and its stabilization. [See Illustrations Nos. 7, 8, 9, 10, and 11]

Erected prior to NPS ownership, a chain link fence protects the extant ruins and, at the same time, permits viewing of them by the visitor.

This fence will remain intact until such time that restoration/reconstruction or a definite interpretive program requires a change.

The plant was constructed upon terraces of levels of varying heights each supported by cut sandstone, or stone rubble retaining walls, or framed wood platforms. The remaining portions of these walls and platforms show signs of weakness and the need for stabilization. This deterioration has been caused by natural weather erosion, by removal of the plant equipment and reusable building materials, and by the removal of the stone rubble from the retaining walls for the construction of the foundation walls of the chain link fence addition.

A long service road climbed up the hill from the salt marsh on the west and the wash on the east, thus allowing for a continuous flow of wagons carrying the unprocessed borax ore directly to the plant parallel to this road. Immediately adjacent to the road are

two partially buried iron dissolving tanks placed end to end [illegible] 25'-0" (±) in length, with their tops exposed 8" and 16" respectively above the road grade. The tanks are constructed of 3/8" sheet iron riveted together to form a tank 24'-10" x 5'-9" inside. The easternmost tank has a concave bottom with a maximum depth of 31 1/2" and a minimum depth of 24" at the sides, while the other tank has a flat bottom to a depth of 27" and a curved side edge with a 6" radius. The long sides of the tanks are reinforced with an angle 3 1/2" x 3 1/2" x 3/8" riveted to the sideand topped with a 4" x 8" wood timber bolted to the angle. The narrow ends are reinforced in the same manner with one exception; the easternmost tank is raised 8" above the other tank and uses on the west end a 1/2" bent plate 3 1/4" x 8 1/4" in lieu of the wood timber. The easternmost tank has 5 1/4" diameter drain hole in the bottom but the western tank has none in the bottom but has a 3 1/2" diameter drain opening in the end with a 1 1/2" invert elevation. The tanks are supported on a sand and gravel fill held in place by a stone retaining wall on the downhill side and by a wood retaining wall of one 4 x 8 and one 2 x 8 on the upper side.

Directly east of and on a level 7'0" lower than the dissolving tanks, a structure, 20' 8" x 27' 6", was built to house the boiler and other unknown plant operations. The 20'-8" long south wall of this structure was built on top of the retaining wall which extends along the entire plant and which also supports the dissolving tanks. The boiler and its foundation is situated parallel to this wall. The other three walls of the structure were constructed a few feet north of the boiler and enclosed an area 13'-6" x 20'-8", leaving a 14'-0" open section of wall on the east and west. This opening allowed for natural air ventilation across the boiler.

The walls, which bear directly upon a stone foundation are constructed of adobe blocks whose widths are 12", 16", 18" and 20" depending upon position in the wall. The block height is 6" throughout, but the lengths, vary from 6" to 16". The walls have been worn by wind and moisture erosion but appear to be sound structurally since the adobe contains a considerable amount of sand and gravel, creating a very hard and solid block. Some collapse of the tops of the south, west and north walls has occurred, probably before the addition of the fence protection. No rebuilding or stabilization of these walls appears to be required at this time.

Framed openings were located in the walls as follows: a door in the east wall, two windows in the north wall, one window in the west wall, and two rectangular slots, one vertical and the other horizontal, in the west wall. These slots may have been used for the passage of belts, cables, or pipes.

A combined roof system covered the entire structure: a gable roof over the boiler area and a shed roof which began near the midpoint of the north roof slope and spanned the balance of the building. The roof was constructed of rafter framing, sheathing, and shingles, all of wood, and corrugated metal roofing. Interestingly,

photographic evidence indicates these roofs were added sometime after the plant went into operation.

The boiler is encased on three sides in a walled structure 9'-0" x 18'-6" long open on the east or front face. The walls are primarily cut of sandstone masonry 2'-0" thick, rising to a height of approximately 7'-0". The balance of the wall height apparently was constructed entirely of adobe block since traces of that type block remain. The space between this wall and the cylindrical boiler was laid up with fire brick to the top of the sandstone and fitted to the boiler. Sand acting as an insulating cover started at this point and extended above the top of the boiler about 12" to 15". The walls of the structure were reinforced from expanding with three sets of wood staves and 3/4" tie rods. Beneath the boiler two fire boxes were constructed. The front-facing firebox was made of firebrick with an upward-sloping back wall to the center of the boiler. It was equipped with the usual iron grate and cleanout. The rear firebox, also lined with firebrick, was located at the back of the boiler with a cast iron access door on the north or side wall. No cleanout or grate area existed. The rear firebox appears to have had an auxiliary function, for little soot staining or ash remains. The boiler front was encased in a cast iron panel bearing two name plates. One side or one half the front panel is missing (photo evidence in the park photo file), but the remaining panel contains the manufacturer's name plate, "Fulton Iron Works., Hinckley, Spiers & Hayes., San Francisco."

East of the boiler room is a narrow level area for a distance of about 175 feet which served as a wood storage area and ash dump. On the west end of the plant is the tailings area over 100 feet in length.

Below the boiler and dissolving tanks level two tiers of metal tanks housed in wood were supported on stone and wood platforms of which only remnants remain today. These tanks may have performed the function of the mud tanks referred to in the description of the Fish Lake Valley operation.

The next level below contained several long rows of crystalizing tanks with truncated cone shapes and a large wood barn-like building approximately 30 x 60 feet in size. A shallow wash was partially covered with fill from the grading of this area during construction of the plant and the wooden building. The latter structure straddled this wash on wood posts.

A dugout structure was located on the easternmost end of this level. No trace of this appears today but Illustration No. 9 shows the dugout roof.

A rail track for ore cars ran from the tailing area parallel to the two dissolving tanks eastward toward the boiler room where it

turns on a wood platform westward and runs downhill to the next lower level of the two tiers of tanks. Thence it again turns eastward on this level and alongside the first row of crystallizing tanks. The track worked its way back and forth on each side of the rows of crystallizing tanks and supposedly terminated within the wood barn-like building where the storage and bagging operation would have taken place. [See Illustrations Nos. 10 and 11.]

The present parking area and road system has obscured most of the remnants of the foundations of the barn, the crystallizing tanks, the rail tracks, and the service road. Archeological probing of this area will be needed to precisely locate these features.

D. Proposed Construction Activity

Eagle Borax Works

1. Remove the exotic tamarisk growth from the area and restore the indigenous vegetation.

2. Restore the water pools after the above item has been completed.

3. Archeological investigations presently contracted are to be completed in FY '72, and will aid materially in determining the full extent of needed stabilization.

4. Relocate the "informal" parking area out of the immediate and known historic remains.

5. Preserve borax windrows by establishing viewing areas for interpreting them from a distance, but discouraging walking on or among them.

Harmony Borax Works

1. Archeological investigations presently contracted for are to be completed in FY '72, and will aid materially in determining the full extent of needed stabilization and development. This report will be concerned with the immediate emergency stabilization.

2. Stabilize the existing stone rubble retaining walls and rebuild those sections where they have collapsed.

3. Eliminate man-made trails through the tailings area and restore the damaged sections of the tailings.

4. Eliminate vehicle traffic from the existing loop road and parking area at the Harmony Plant by closing the road at its junction with the one way Mustard Canyon Road. Construct a temporary parking area and a turnaround at this junction to provide direct access to State Highway 190 to avoid forcing all return traffic through Mustard Canyon.

V Appendix

Form 10-411
(July 1965)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

PROJECT CONSTRUCTION PROPOSAL

DISTRIBUTION OF COPIES	
NO.	TO

1. STATEMENT OF MANAGEMENT'S REQUIREMENTS, PROPOSED WORK, AND ITS RELATIONSHIP TO OTHER FACETS OF THE PARK PROGRAM. *(Provide detail data for "Management Information" on Form 10-411a, Supplemental Sheet and attach.)*

Emergency stabilization of stone rubble retaining walls and obliteration of path in the tailings area at Harmony Borax Works. Stone foundation stabilization at Eagne Eagle Works.

Temporary road and parking area adjustments at Harmony and Eagle Borax Works.

2. ADVANCE REQUIREMENTS DATA

LAND STATUS	MASTER PLAN NO.	APPROVAL DATE
U.S. Government Owned	Pending	

PCP NUMBERS OF PREVIOUSLY COMPLETE PORTIONS	INTERRELATED & DEPENDENT PROJECT PCP NUMBERS

INTERPRETIVE PROSPECTUS APPROVAL DATA	DATE

WATER RIGHT NEEDS & STATUS

RESEARCH NEEDS & STATUS

OTHER

3. RECOMMENDED BY SUPERINTENDENT *(Signature & Date)*	4. APPROVED BY REGIONAL DIRECTOR *(Signature & Date)*

5. LOCATION WITHIN AREA OR TERMINI
Eagle Borax Works & Harmony Borax Works

6. BLDG. OR RT.# AND SEC.

7. REGION: Western

8. PARK: Death Valley National Monument

9. PROJECT
Emergency Stabilization of Harmony & Eagle Borax Works

Inyo *(County)*

California *(State)*

10. PCP INDEX NO.
M-

CLASS ☐ (A) – Estimate based on working Drawings
CLASS ☐ (B) – Estimate based on preliminary plans
CLASS ☒ (C) – Estimate based on similar facilities in other parks

P.S. & S. by
BPR ☐ NPS ☒

ESTIMATE

ITEM	QUANTITY	COST
1. Stone Rubble Retaining Wall Stabilization @ Harmony Borax	JOB	$ 3,400
2. Stone Foundation Stabilization @ Eagle Borax	JOB	500
3. Obliterate Paths in the Tailings Area @ Harmony	JOB	2,600
4. Temporary Road and Parking Area Adjustments @ Harmony & Eagle Borax Works	JOB	1,100
5. Tamarisk Removal and Site Restoration @ Eagle – 3 months	JOB	
1st Year 75% Removal - FY '72	JOB	27,000
2nd Year 25% Completion - FY '73		15,000
		$ 49,600

NOTE: This estimate is based on June 1971 cost figures.

RESEARCH ESTIMATE APPROVED:

(Asst. Director, Resource Studies) (Date)

CONSTRUCTION ESTIMATE APPROVED:

(Design Office Chief) (Date)

INTERPRETIVE ESTIMATE APPROVED:

(Asst. Regional Director, Operations) (Date)

ESTIMATE TOTALS	$ 49,600
RESEARCH	49,600
Construction	13,400
Plans, Surveys, and Supervision	9,400
Contingencies	72,400
CONSTRUCTION SUB TOTAL	
INTERPRETIVE SUB TOTAL (100%)	
GRAND TOTAL	72,400

USA DC 66-25 27

ILLUSTRATIONS

Illustration No. 1

View of the Eagle Borax Works looking toward the west. This view, taken about 1909, indicates that only five crystallizing tanks were used. Note the presence of marsh grass. After removal of the Tamarisk growth, the indigenous grass should be restored to the area. (Photo # DEVA 3502)

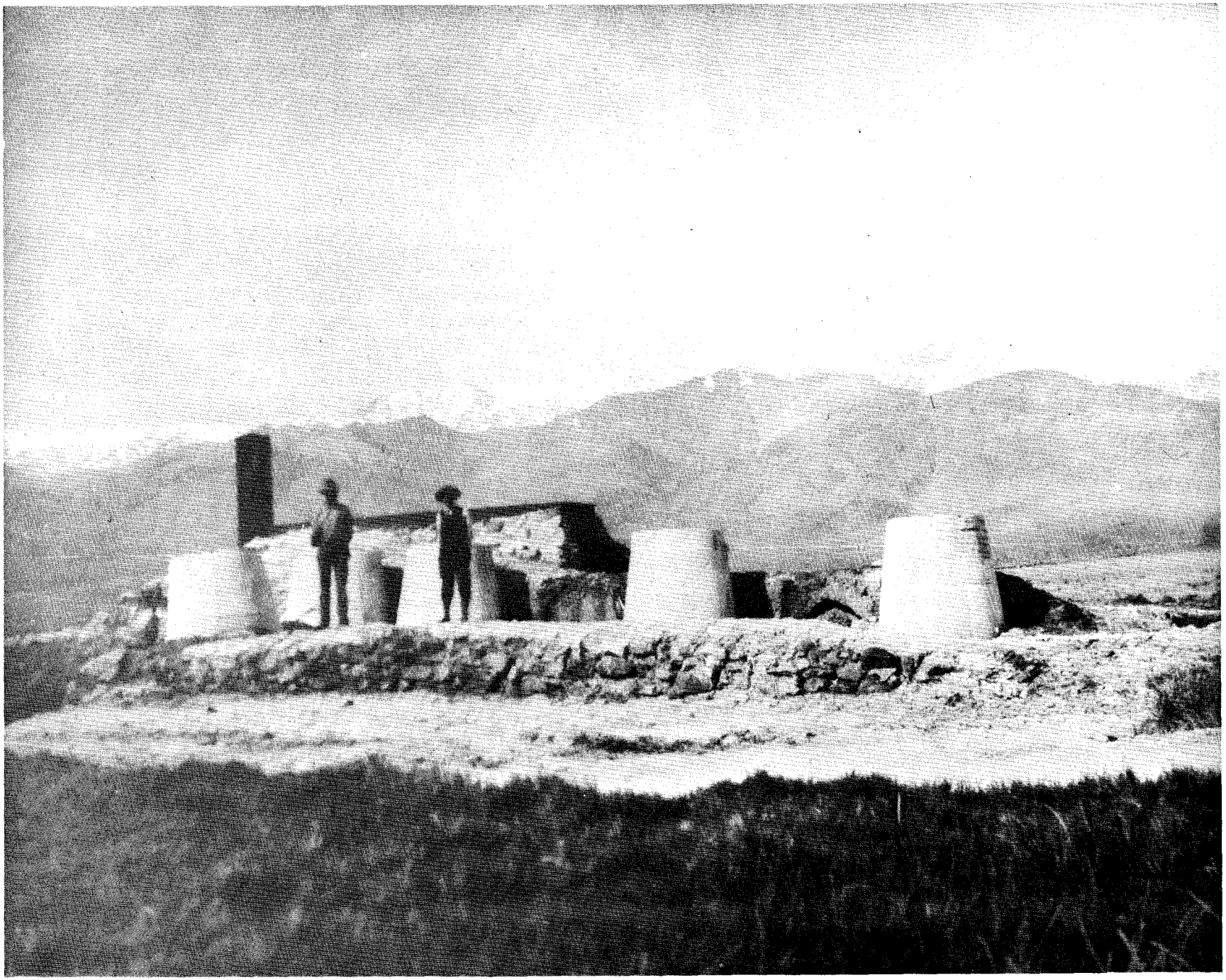


Illustration No. 2

Detail view of the dissolving tank and flue at Eagle Borax Works in 1954 before it disappeared. A description of the tank is included in the Architectural Section. (Photo # DEVA 1706)

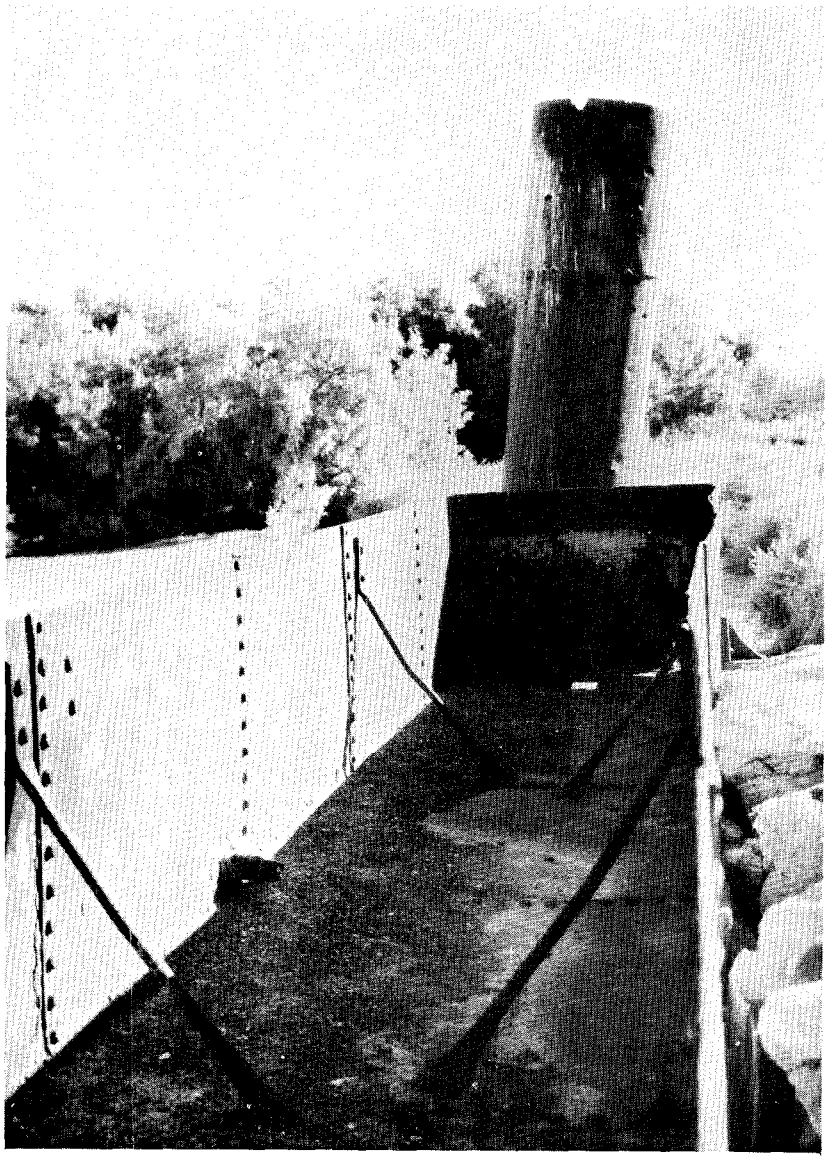


Illustration No. 3

View of fire box and support for dissolving tank today. (WSC Photo, 1971)

Illustration No. 4

Eagle Borax Works circa 1891, looking east across the valley floor. Note the absence of Tamarisk trees, the construction of the rock shelter, and the tailings. Photo courtesy of U.S. Borax and Chemical Corporation.

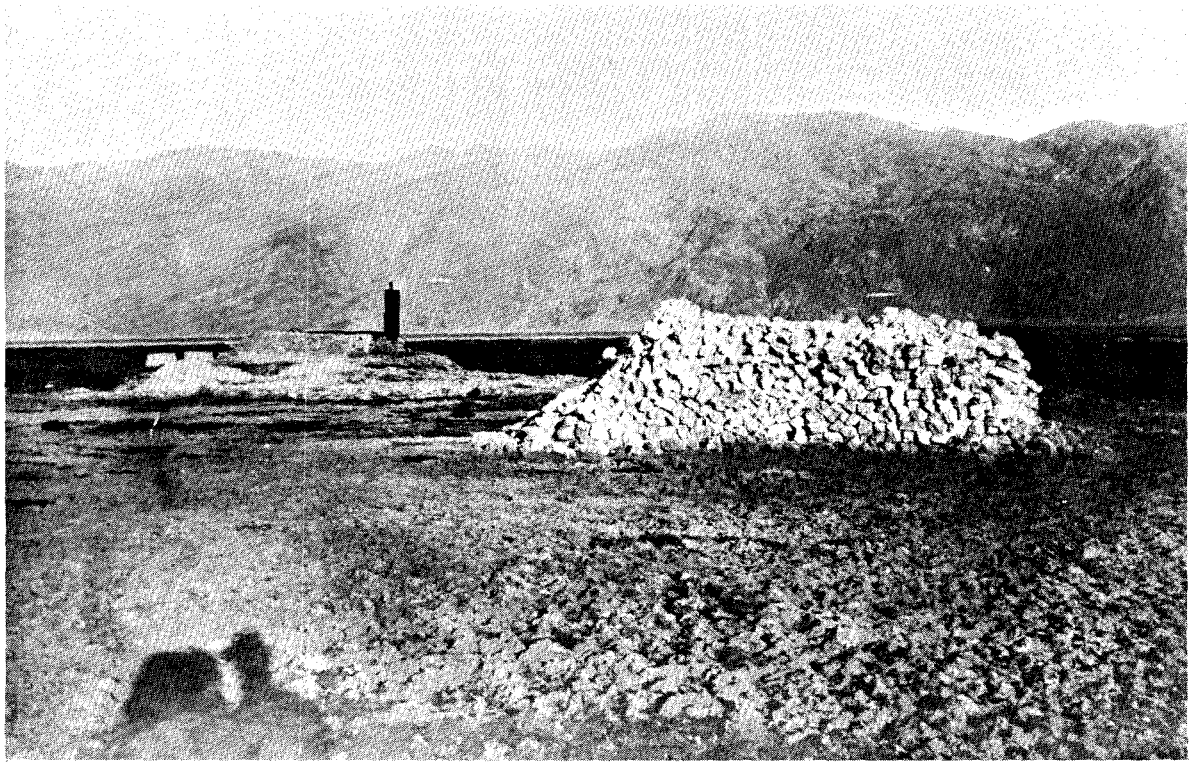
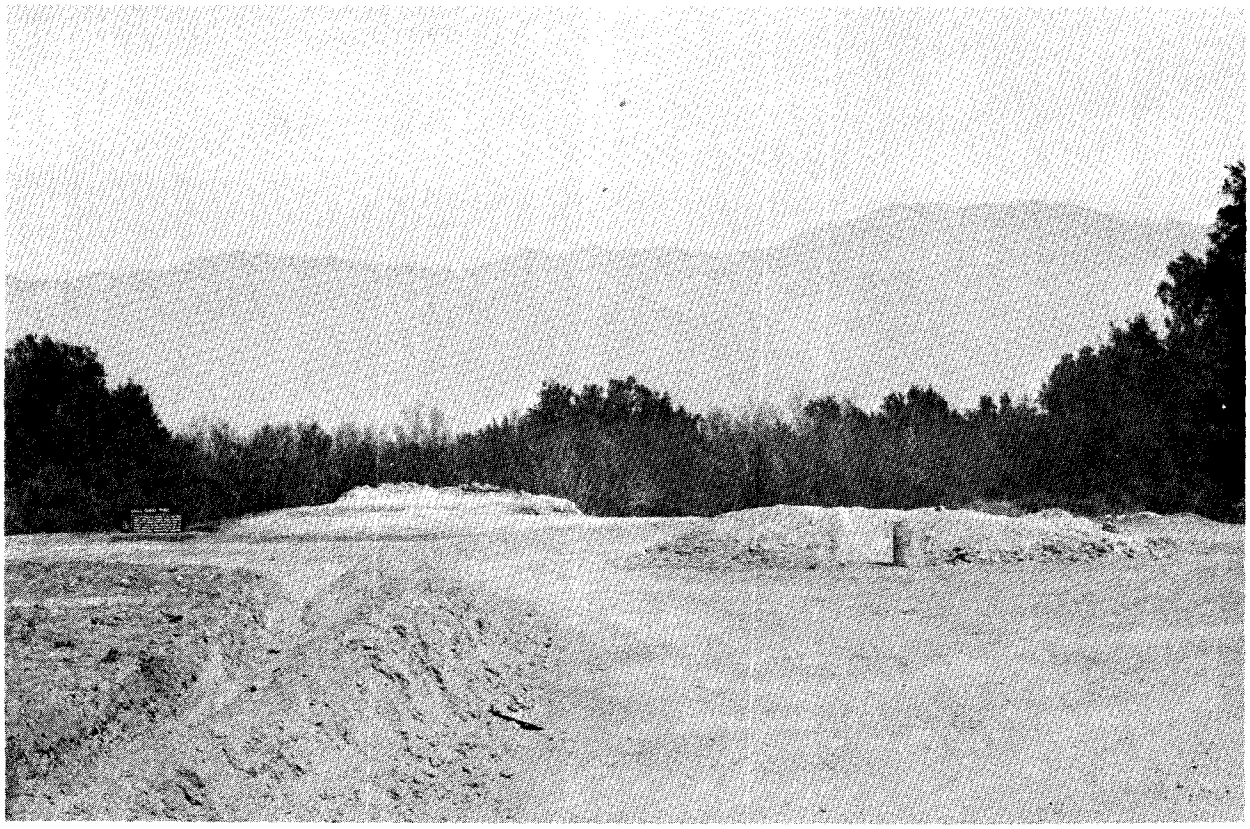


Illustration No. 5

Photograph taken from the approximate position as the one in Illustration No. to indicate the amount of deterioration that has occurred through the years. Note the frowth of exotic Tamarisk and the position of the road and parking area. The road and parking area are to be moved to the right (off the photo) and out of the historic area. The trees are to be removed under the Soil and Moisture Program. (WSC photo, 1971)

Illustration No. 6

View of the borax windrows at Eagle Borax Works. (WSC photo, 1971)



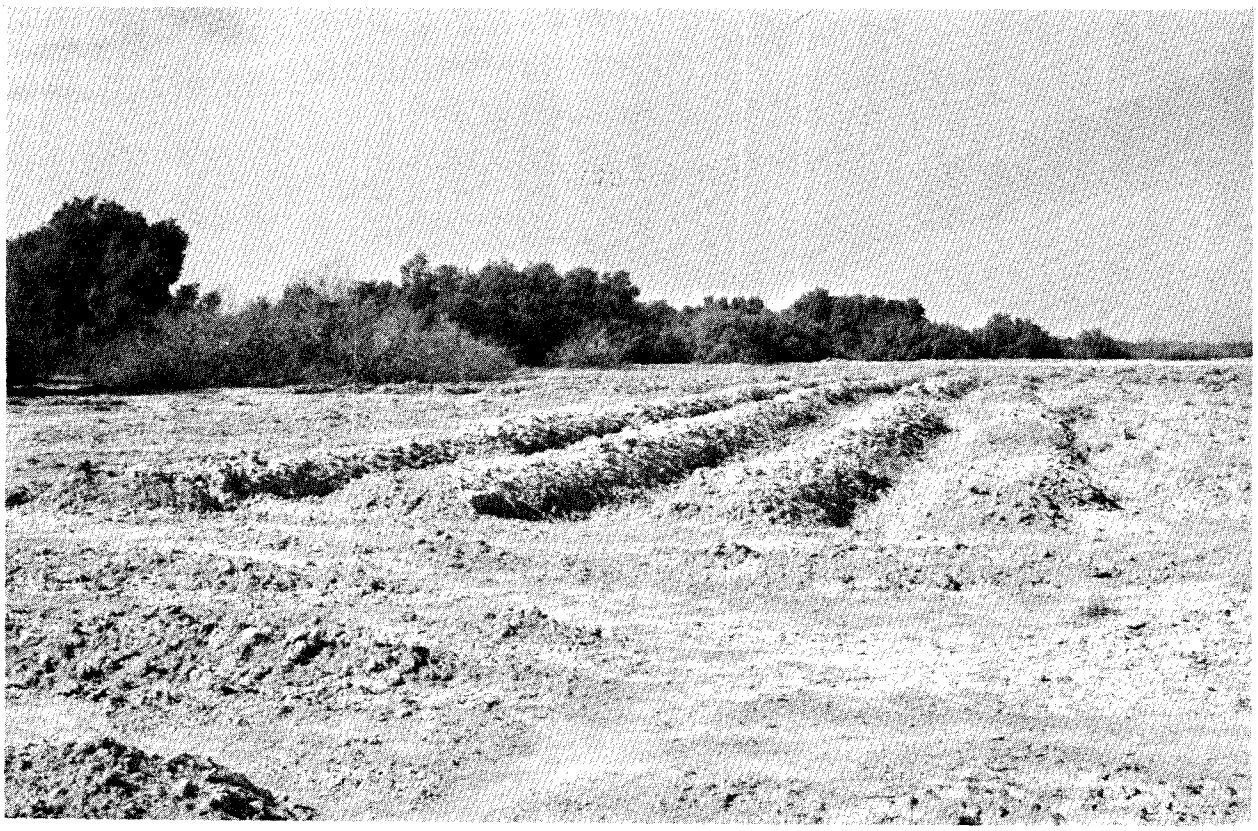
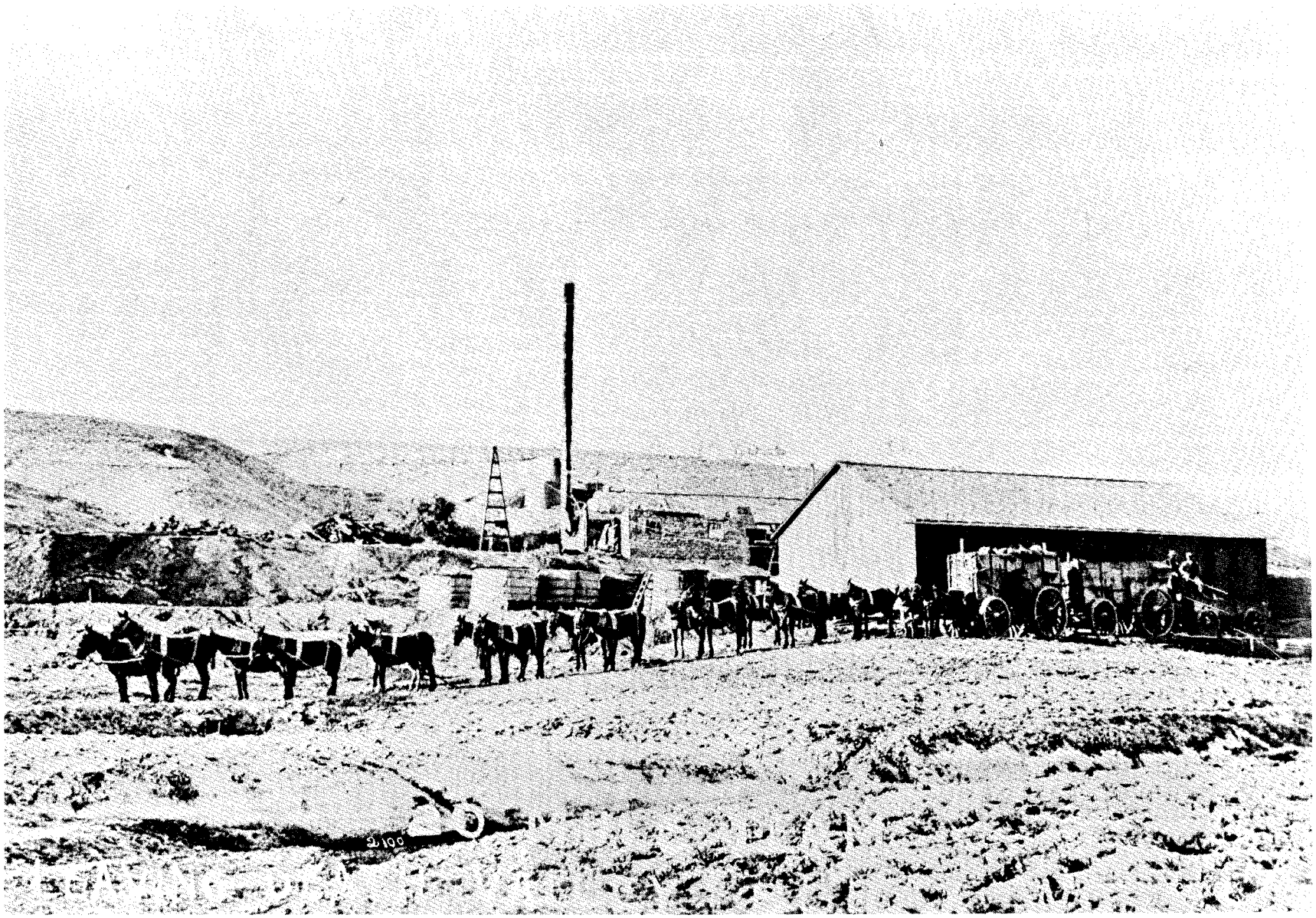


Illustration No. 7

Circa 1885 detail view of the wood barn-like structure and loading of borax for shipment. Although plainly labelled 20-mule team, a count shows the team to consist of only 18 animals. Photo courtesy of U.S. Borax and Chemical Corporation.



A twenty mule team at the Harmony Borax Works about 1885

Public Relations Department
United States Borax & Chemical Corporation

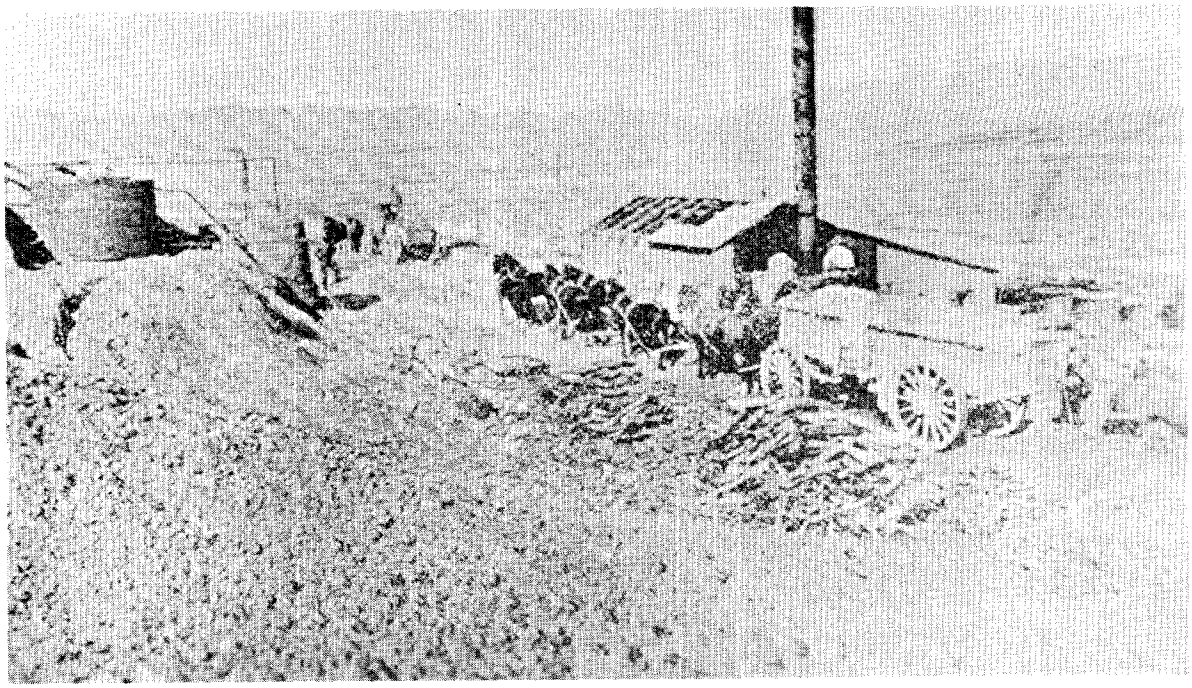
3075 Wilshire Boulevard
Los Angeles, California

Illustration No. 8

Circa 1886 view of borax ore being transported to the dissolving tanks at plant. Note the water tanks and the fuel wood storage area. Photo courtesy of U.S. Borax and Chemical Corporation.

Illustration No. 9

The Harmony plant in 1892. This view is the most complete picture of the works available today. The plant had been out of operation four years at this time. Photo courtesy U.S. Borax and Chemical Corporation.



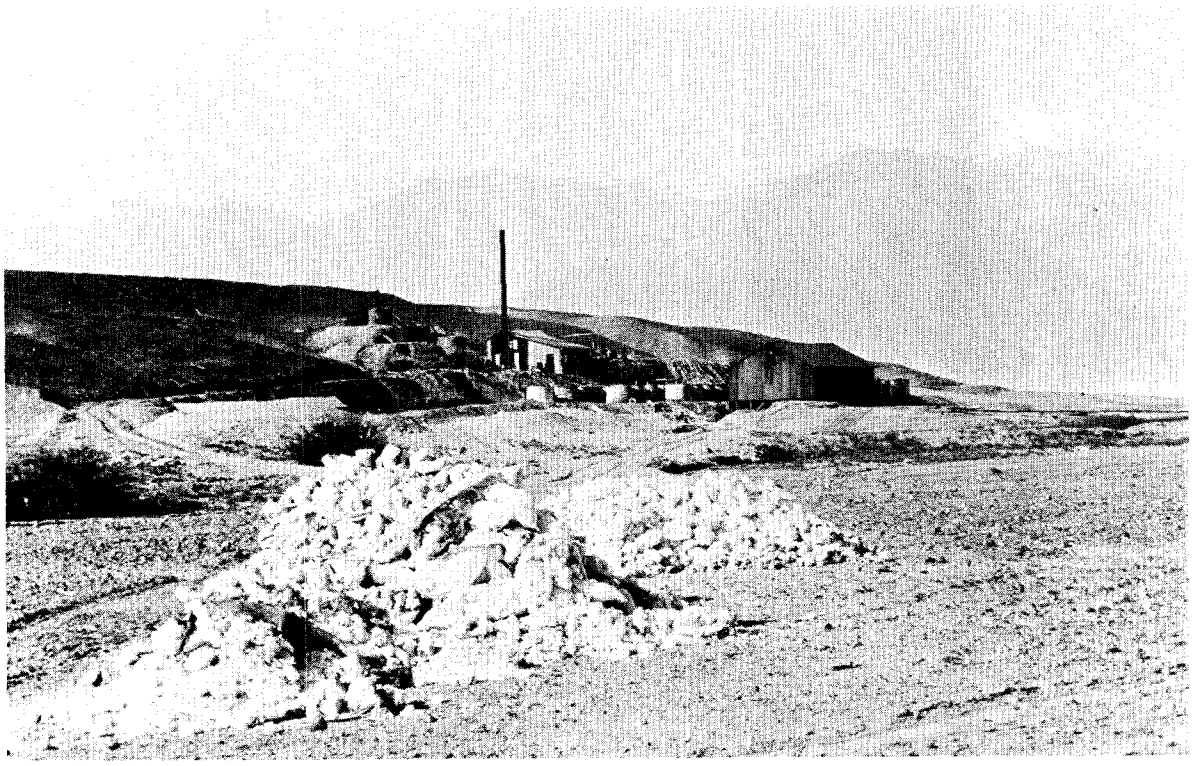


Illustration No. 10

The Harmony plant about 1900. Abandoned works looking east. Photo in files of Death Valley National Monument.

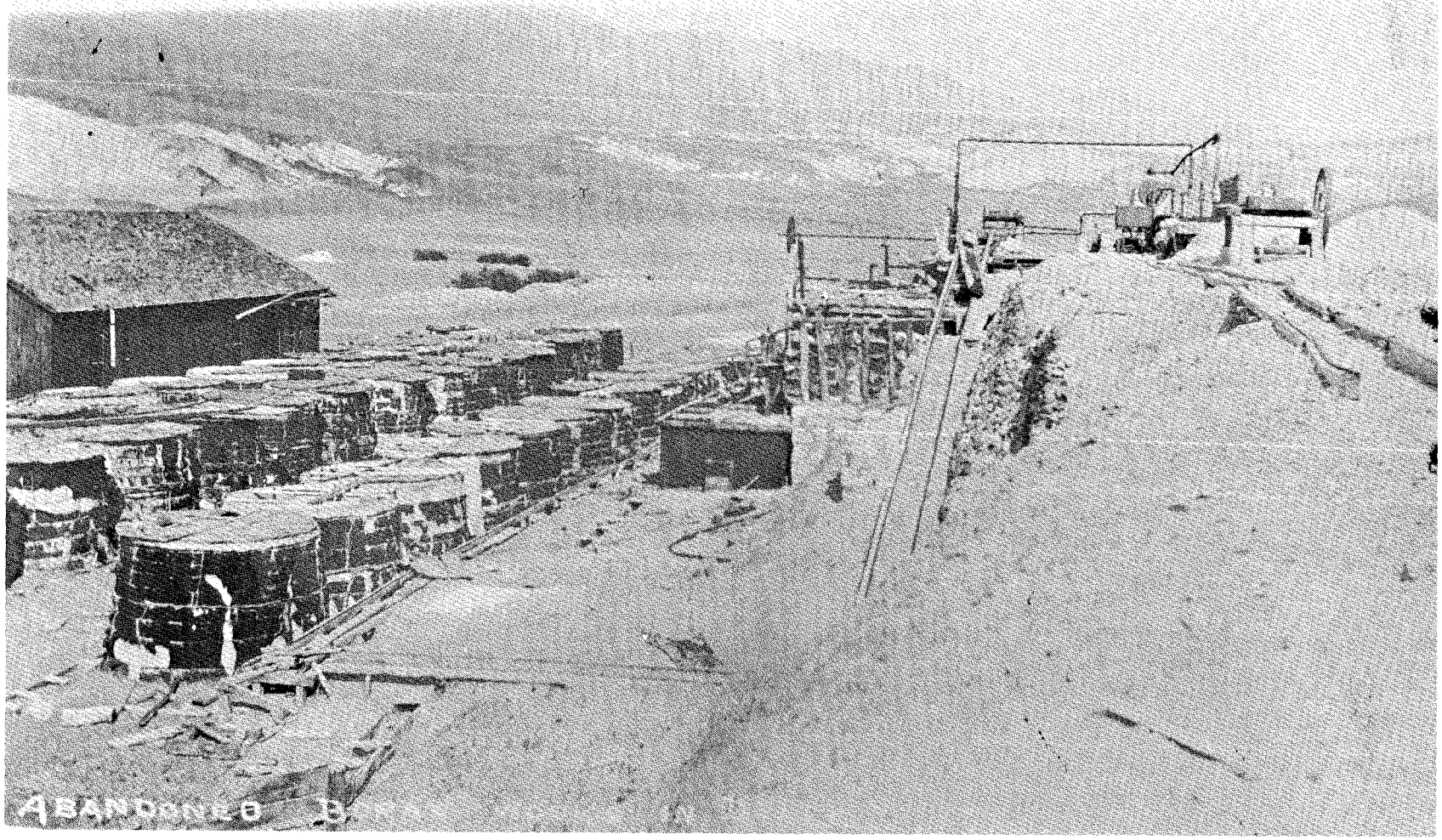

ABANDONED

Illustration No. 11

The Harmony plant about 1900. Abandoned works looking south from the area of the crystallizing tanks. Note felt padding on crystallizing tanks. Photo in files of Death Valley National Monument.

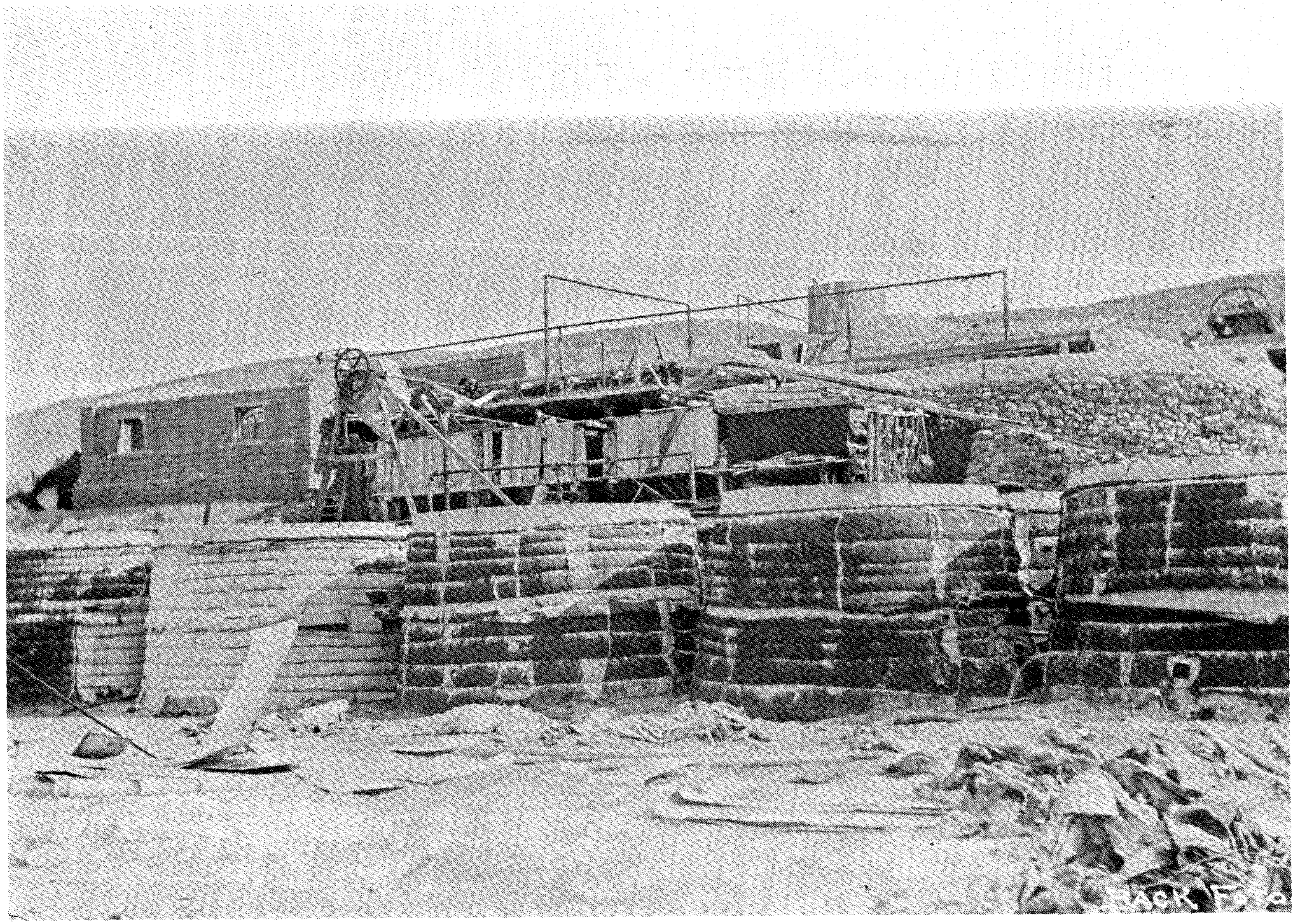

BACK FOTO

Illustration No. 12

CCC work near the Harmony plant in the 1930's. The workers were manufacturing adobe block for the park maintenance buildings. Photo in files of Death Valley National Monument. (Photo # DEVA 723)

Illustration No. 13

Similar view to Illustrations No. 9 and 12 showing the conditions in 1971. (WSC Photo, 1971)

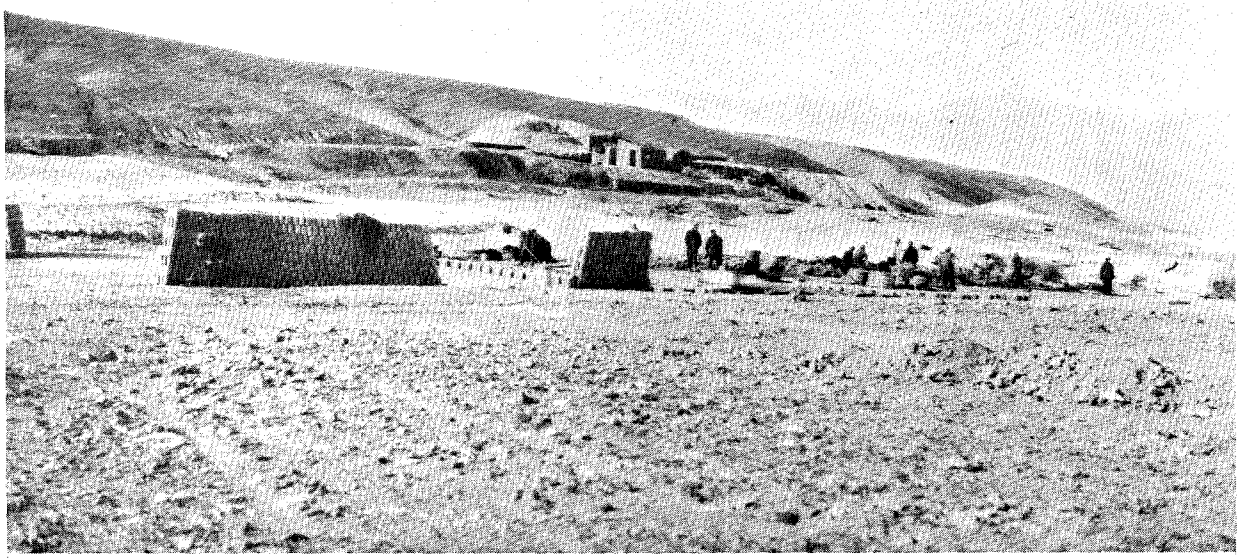


Illustration No. 14

View from within the building ruins to the west showing the dissolving tanks, their foundations, a portion of the remaining wood platform. Note lower right corner of the photo, typical example of the adobe wall construction, no precise size of block or masonry pattern. (WSC Photo, 1971)

Illustration No. 15

View of stone rubble retaining walls to be stabilized. (WSC Photo, 1971)

Illustration No. 16

Front view of the boiler and its supporting structure.
(WSC Photo, 1971)

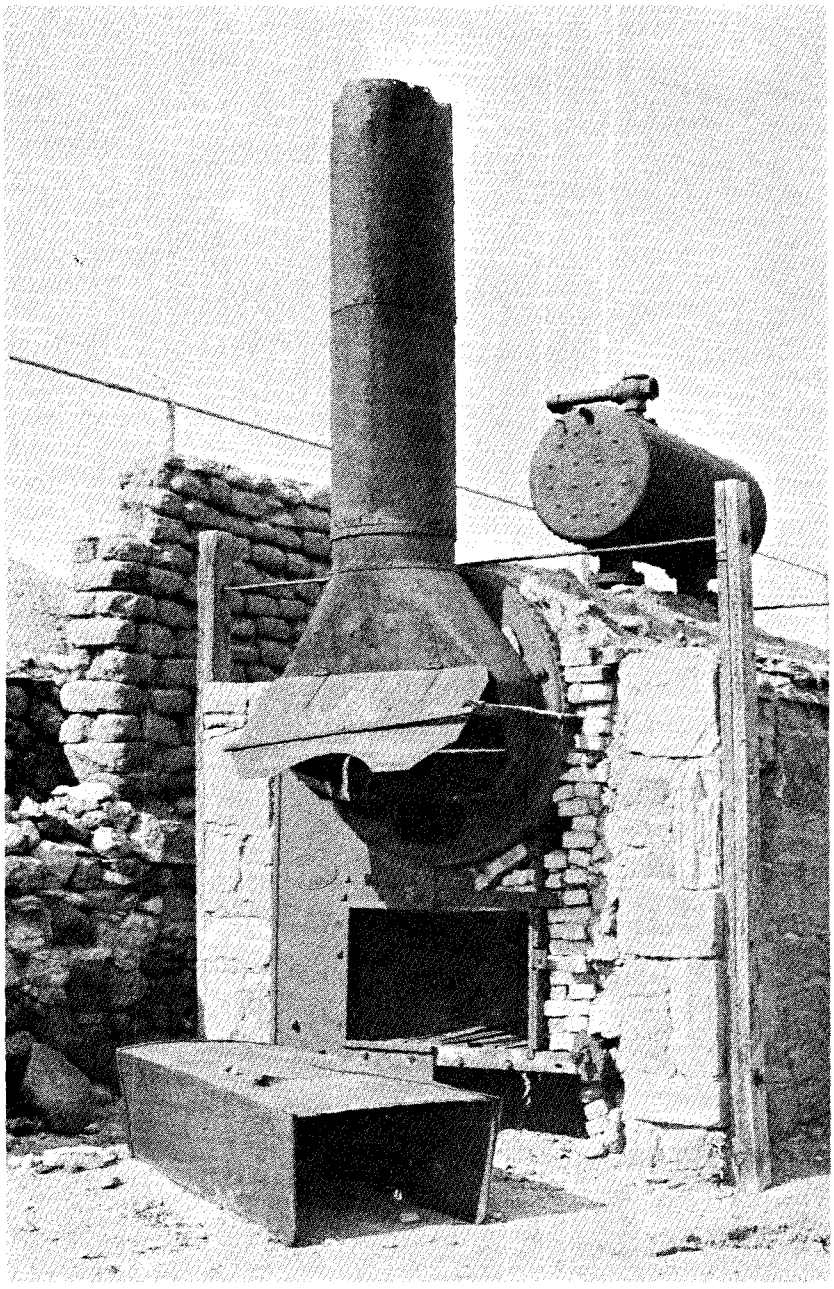
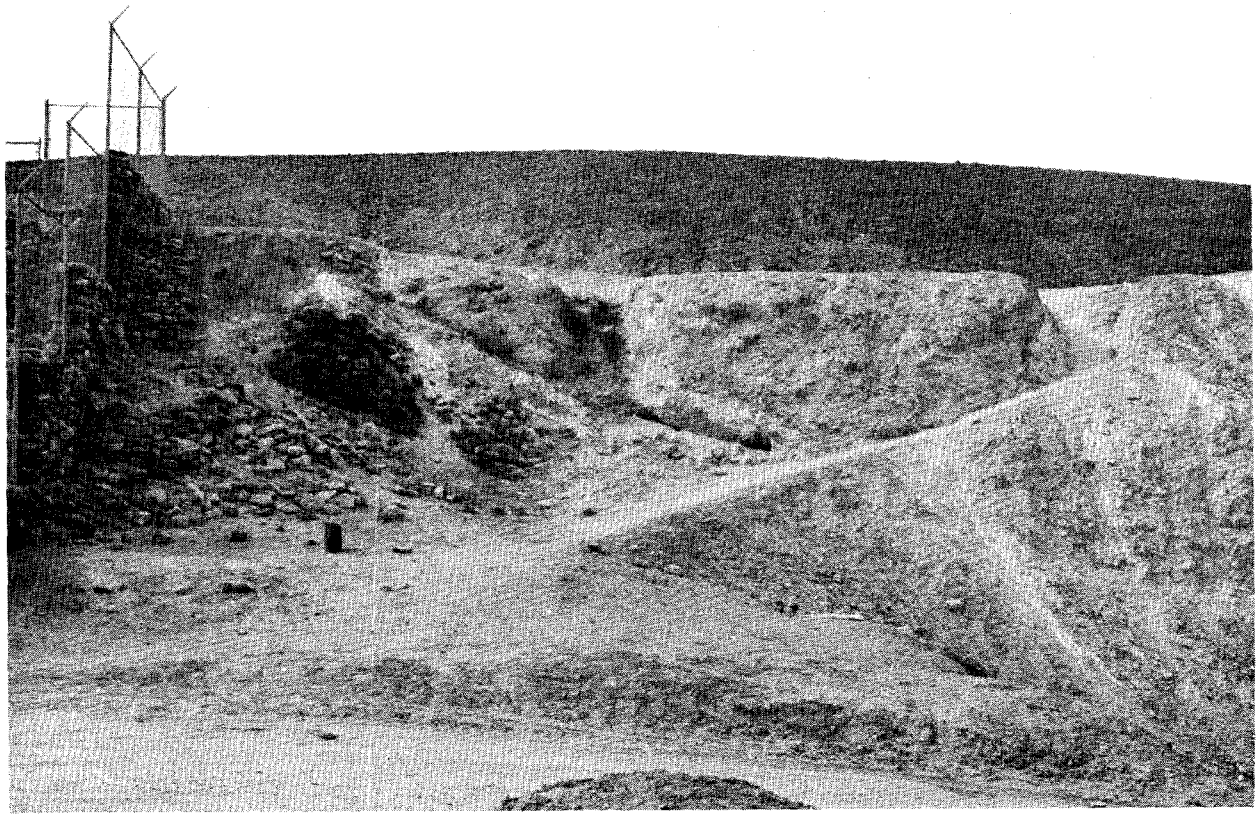


Illustration No. 17

View of the tailings and stone rubble retaining walls to be stabilized. (WSC Photo, 1971)

Illustration No. 18

Approaching Harmony Borax Works from Mustard Canyon in 1892. Note company village to the left. Photo courtesy of U.S. Borax and Chemical Corporation.



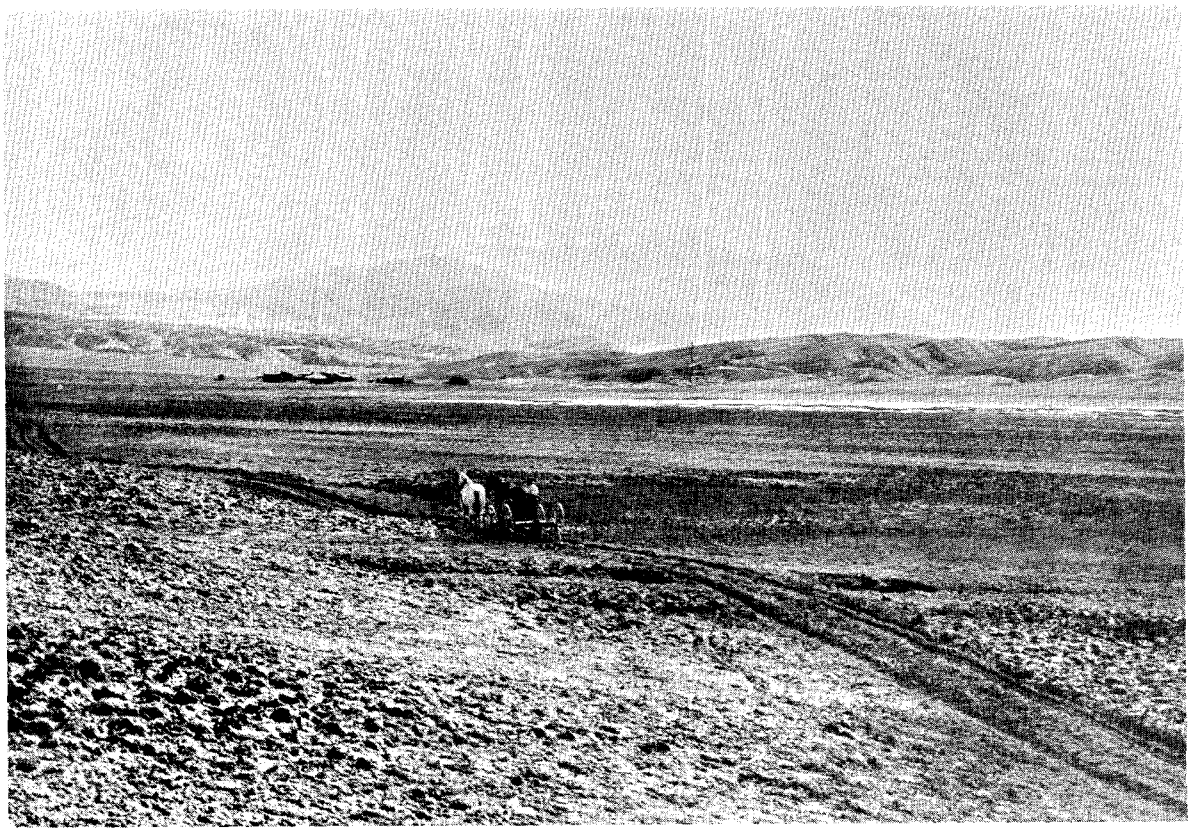


Illustration No. 19

Aerial view of the Harmony Borax Works and ruins of the company townsite. Loop road and parking area to be obliterated. Note evidence of historic road traces and the location of the water line to Texas Spring (line on the hillside disappearing off the photo on the left side). (WSC Photo, 1971)

Illustration No. 20

Village structures in 1892 at the Amargosa Borax Works, Harmony's sister plant. Photo courtesy of U.S. Borax and Chemical Corporation.

Illustration No. 21

Village structures in 1892 at Amargosa Borax Works, Harmony's sister plant which was located near present day Tecopa, California. Photo courtesy U.S. Borax and Chemical Corporation.

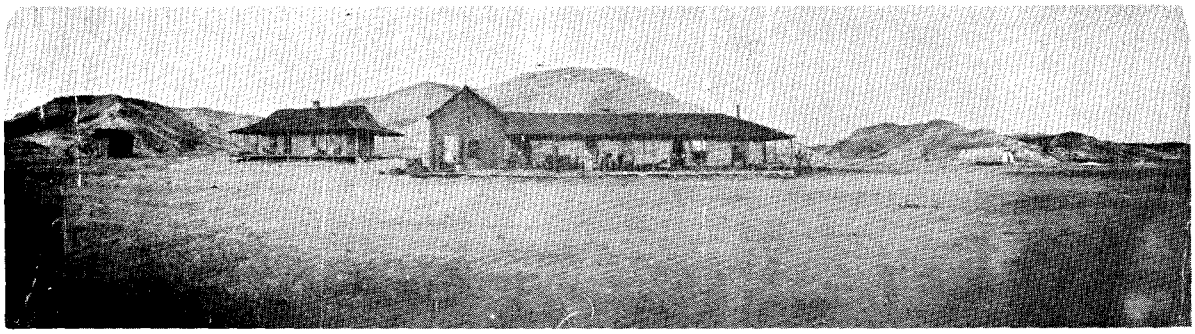
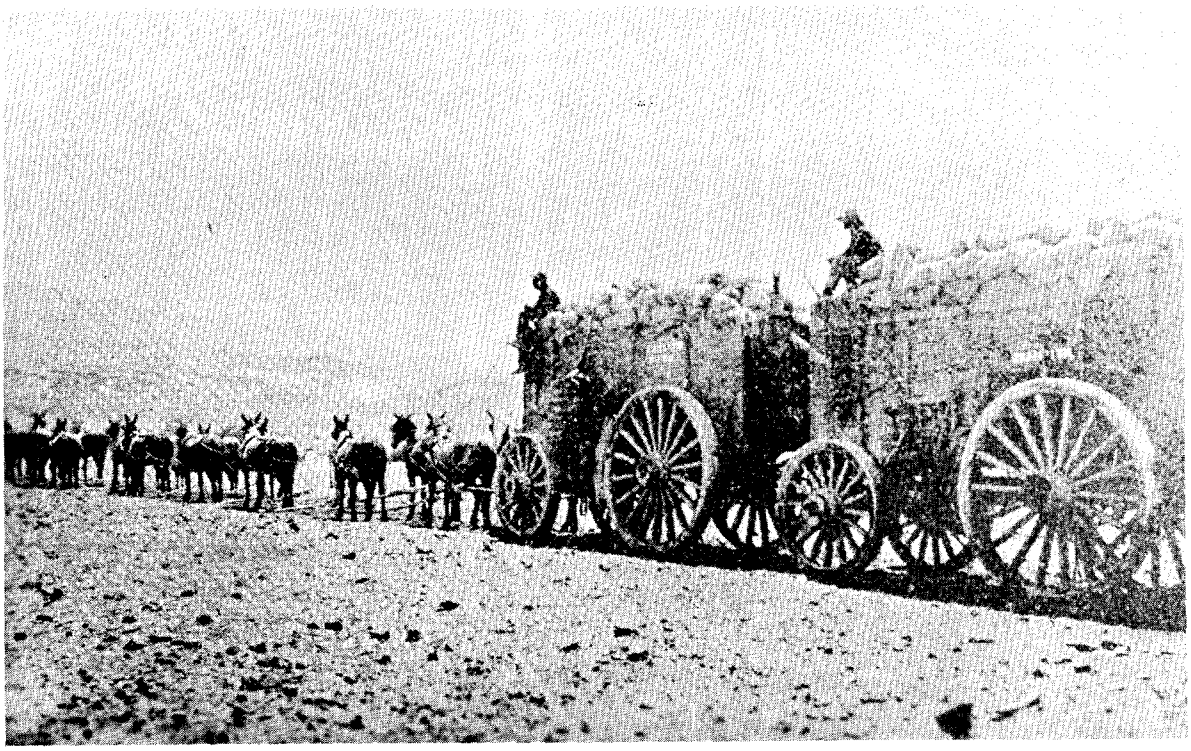


Illustration No. 22

Load of borax going from Harmony to the railhead in 1886.
Photo courtesy of U.S. Borax and Chemical Corporation.

Illustration No. 23

Driver and swamper in front of loaded borax wagon, 1886.
Photo courtesy of U.S. Borax and Chemical Corporation.



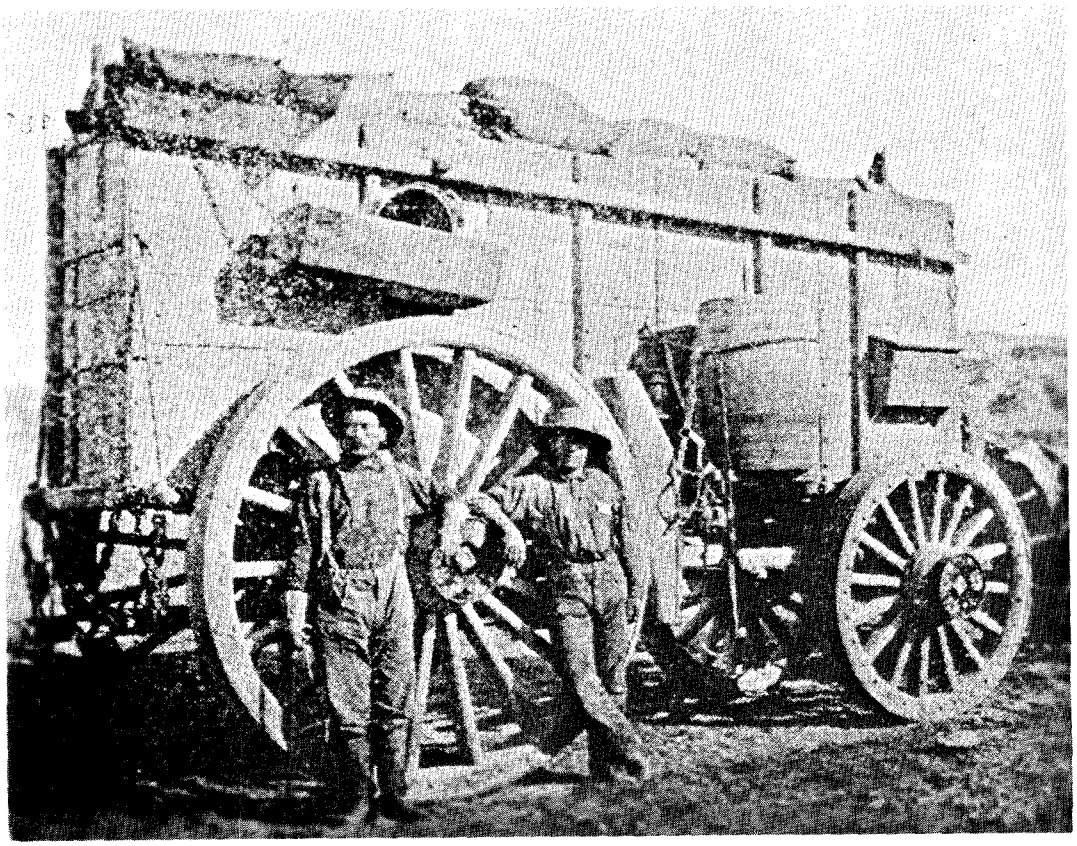
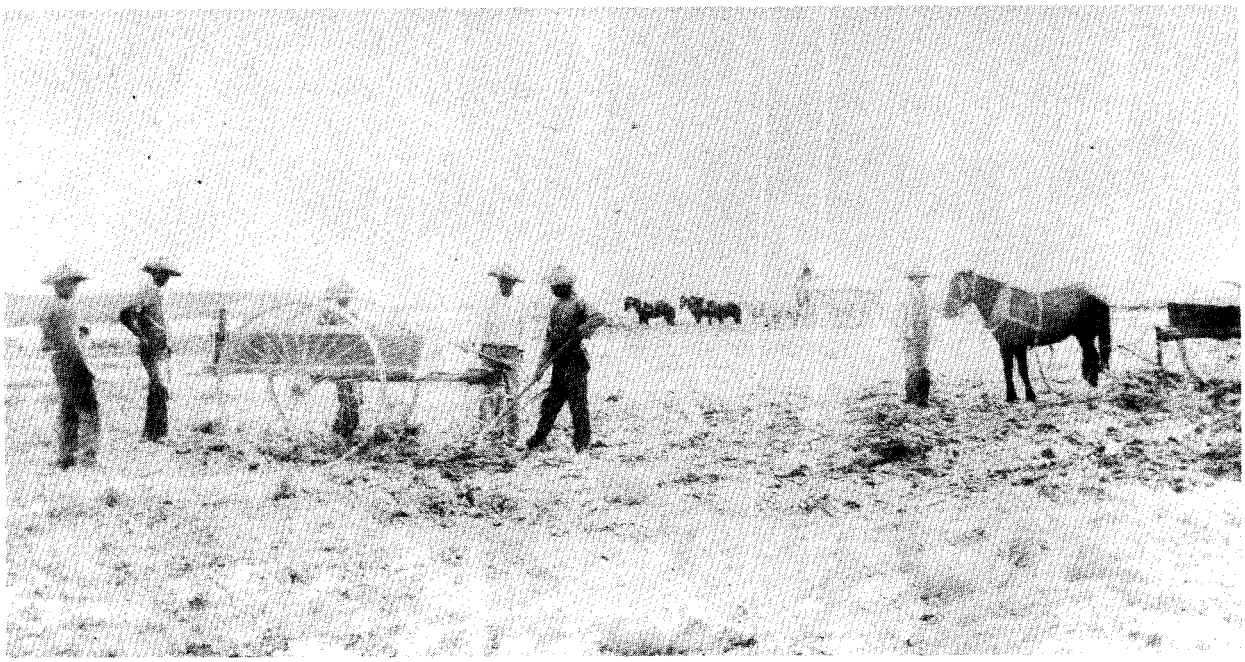


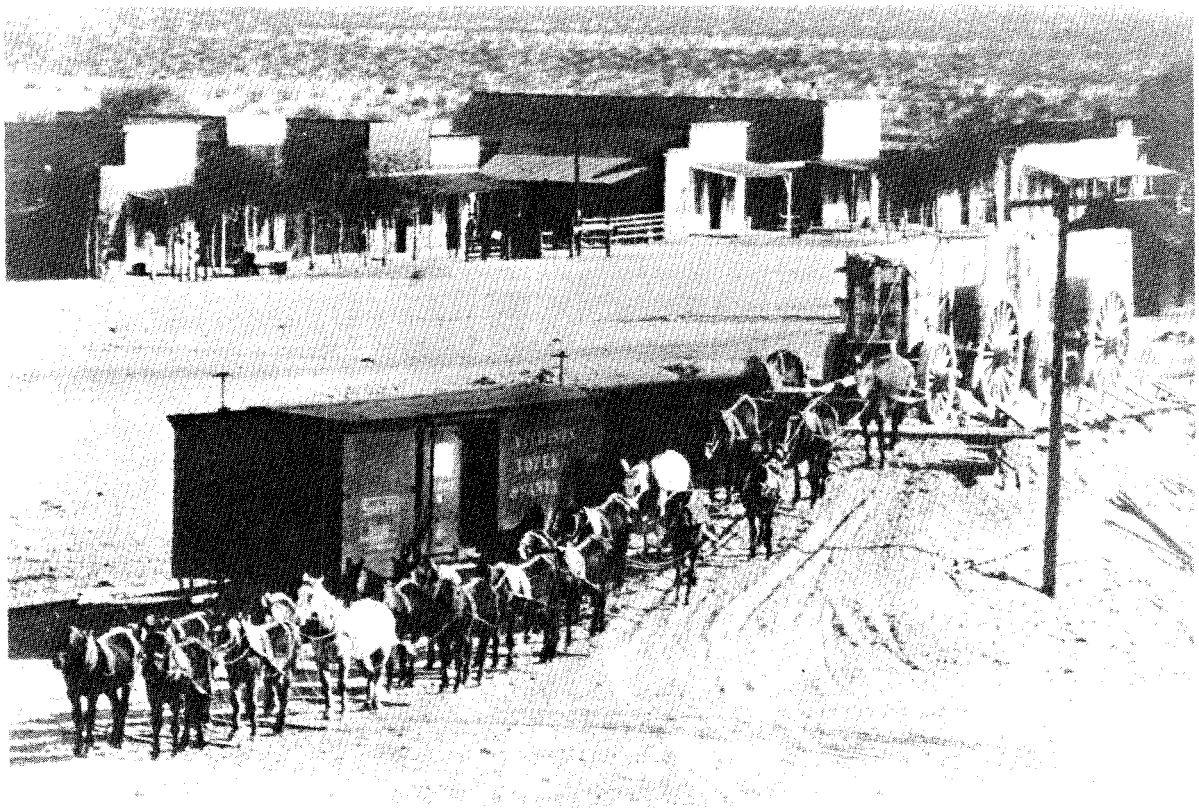
Illustration No. 24

Chinese laborers gathering cotton ball borax near Harmony around 1885. Photo in files of Death Valley National Monument.

Illustration No. 25

Delivering borax to the railhead at Mojave about 1891. Photo in files of Death Valley National Monument.





GPO 923-075