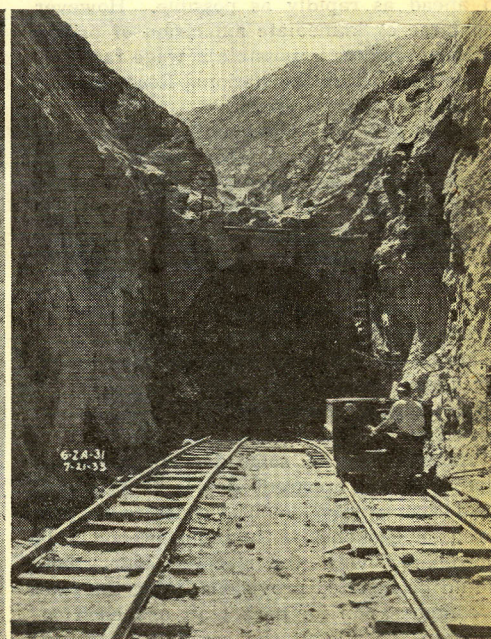
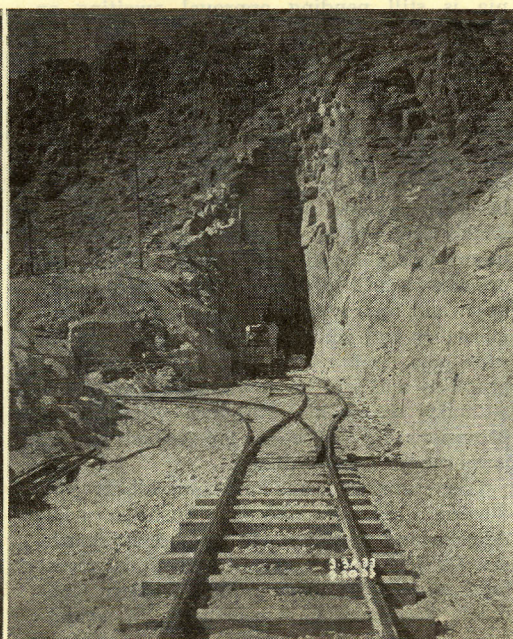
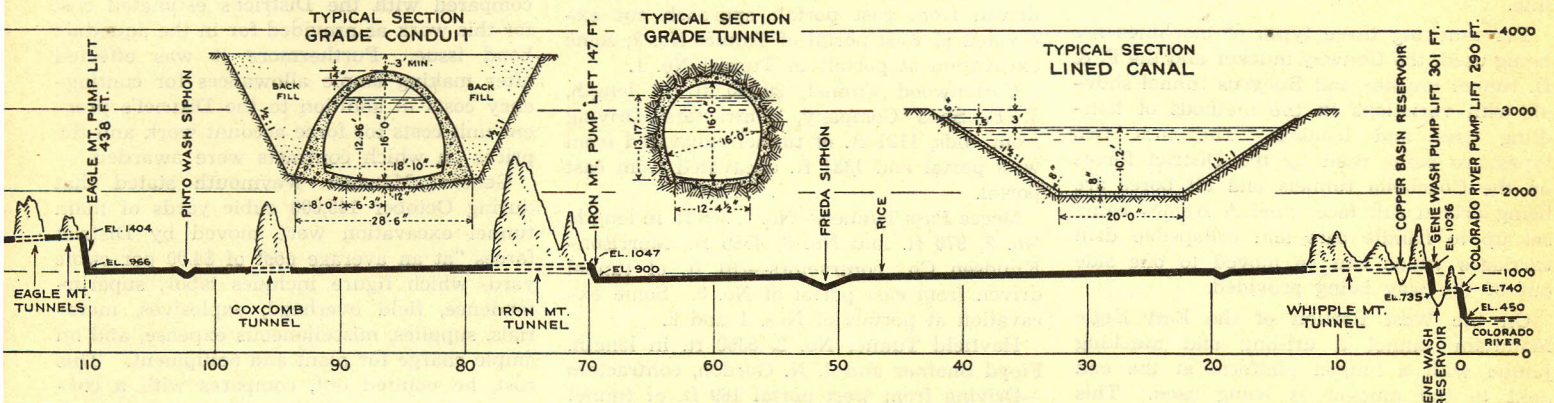
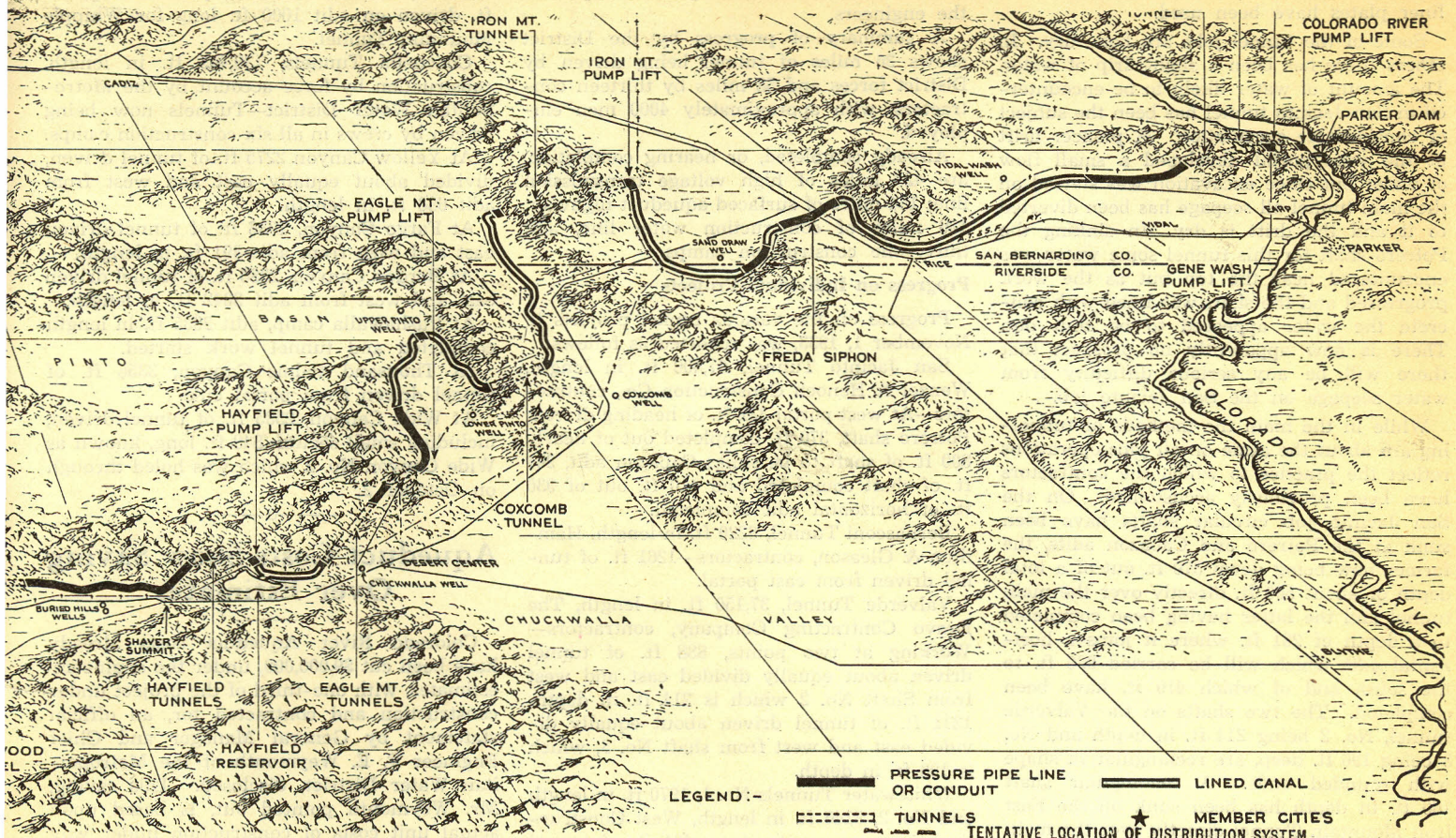




Picture at left shows "holing" through of first short section of tunnel in Coachella division of Aqueduct. Middle, east portal of Coxcomb tunnel showing picturesque "chimney rock." Right, east portal of Bernasconi tunnel, reached by heavy access cut.

SHOWING THE LOCATION OF THE VARIOUS TUNNELS NOW UNDER CONSTRUCTION



Progress of Tunnel Work On Colorado River Aqueduct Reviewed

All Forces Now Working Under Ground New 24-Hour Record Reported by District

Construction inaugurated on 84 of the 91 miles of 16-ft. tunnel for the Colorado River Aqueduct is progressing satisfactorily and contractors and the Metropolitan Water District forces are getting well under way on the long grind which will end with the completion of the 13-mile bore through San Jacinto mountain four or five years hence, this particular project requiring the longest time of all the 21 tunnels to finish. Most of the contractors and all of the District's crews are now working underground and with the advent of winter and lower temperatures bringing better living and working conditions in the desert region traversed by the

aqueduct operations will be materially accelerated.

Progress to date has revealed that in the main the formations through which the tunnels will be driven will not be much different from what test borings and reconnaissance surveys had led engineers and contractors to expect. Tunnels driven from portals are encountering in the first reaches weathered material which requires support and in some instances large boulders. As the bores penetrate farther into the mountain mass, however, harder material with less blocking is indicated. Generally granitic rock prevails with seams of softer material at intervals in some localities.

Whitewater Tunnel No. 2 through what is known as Gravel Hill, started at the east portal in the wall of a canyon, is being driven in a deposit of cemented sand and gravel which is quite firm but easily loosened with light charges of powder. Here work is being carried on with heading and bench excavated alternately in short stages. For the present it is only a jackhammer job. This tunnel is all timbered, in marked contrast to the Valverde tunnel where approximately 2130 ft. of tunnel has been driven from two shafts at a depth around 200 ft. in hard granite requiring no supports.

The West Iron Mountain Tunnel has been driven from the west portal 1962 ft. through compacted sand, some of it desert blow sand, requiring full timbering. Excavation here has been at the rate of 35 to 40 ft. per day. It is expected this tunnel will soon be in rock.

Up to November 1 approximately 4.19 miles of tunnel has been driven on all jobs, of which 1.86 miles was on contract jobs and 2.33 miles on the District force account jobs in the Coachella Division. About 60 per cent of the latter has required support. On some

jobs where support was needed the tunnels have been timbered while on others steel liner plates have been used.

Some of the tunnel jobs are bone dry. In others there has been a slight drip of water. The amount of water likely to be encountered in San Jacinto tunnel has been the subject of considerable speculation. A pioneer drift at the west portal developed a small flow of water but since excavation was started on the main tunnel all seepage has been diverted to it and the drift is dry. In sinking the Potrero shaft for this tunnel some water was encountered near the top but as the work progressed and the shaft was lined with concrete the water appeared to be shut out. There is now apparently no prospect that there will be any serious difficulty from water seepage on the San Jacinto job.

While in the main the methods of tunneling are about the same on all jobs operations reflect the practice to which the contractors have been previously accustomed. On the San Jacinto job circular shafts have been sunk at the Potrero and Cabazon adits, the former now being down 370 ft. out of a total depth of about 800 ft. directly over the main tunnel and the latter having been completed to a depth of 261 ft. where it joins a horizontal adit which will be carried 936 ft. to the south and of which 410 ft. have been completed. The two shafts on the Valverde tunnel, No. 2 being 214 ft. in depth and No. 3 being 196 ft. deep, are rectangular in shape with rounded ends. A rectangular shaft 160 ft. in depth has been sunk on the East Iron Mountain Tunnel directly over the main line.

For mucking three types of machines are being used, the Conway mucker and the P. & H. tunnel mucker and Bucyrus tunnel shovels, with variations in the methods of handling cars and loading. The first two types are being used by the District forces on the Coachella tunnels and all bores are being driven full face, steel A frames being set up to handle cars and collapsible drill carriages which can be moved to one side out of the way being provided.

On the West Portion of the East Eagle Mountain tunnel a drilling and mucking jumbo with a hinged platform at the end next to the mucker is being used. This jumbo runs on two rails and the tracks for the cars extend underneath. A train of cars is backed under the jumbo and the cars are loaded starting with the one next to the locomotive by a belt conveyor operating on the platform of the jumbo which carries the material from the mucking machine and drops it into the car. The loaded train then pulls out and another train of empties backs in. This plan obviates the switching of cars.

On some jobs work has not progressed far enough to definitely establish the methods that will eventually be followed but these will probably vary according to the conditions encountered and requirements for the particular job. Relative merits of the different methods being used and the plant set-up will be more readily appraised when the work is well under way.

The district forces at the Thousand Palms camp in the Little San Bernardino Mountains report what the District engineers believe to be a new continental tunnel driving record when 73 ft. of tunnel was drilled, blasted, excavated and timbered in 24 hours. This followed a record of 66 ft. driven in 24 hours by the crews of the Yellow Canyon

camp. The District's operations are now ahead of schedule according to the report of the engineers.

A summary of progress by the District shows 26 miles of tunnel being driven by District forces and 58 miles by thirteen contractors, with approximately 4000 men employed.

Already completed, or nearing completion, are 428 miles of high voltage transmission line; 154 miles of surfaced aqueduct highway; 180 miles of construction water line, and thirty-one construction camps.

Progress on Individual Projects

Progress on the various tunnel projects to November 1, 1933, was reported as follows:

San Jacinto Tunnel, 67,400 ft. in length, Wenzel & Henoch Construction Co., contractors—At west portal 321 ft. of heading driven; Potrero shaft, 370 ft. completed out of nearly 800 ft. of shaft to be sunk; Cabazon adit, 261 ft. of shaft completed and 410 ft. out of 936 ft. of horizontal adit completed.

Bernasconi Tunnel, 6220 ft. in length, Hamilton & Gleason, contractors—1261 ft. of tunnel driven from east portal.

Valverde Tunnel, 37,150 ft. in length, The Dravo Contracting Company, contractors—Working at two points, 888 ft. of tunnel driven about equally divided east and west from Shaft No. 2 which is 214 ft. in depth; 1231 ft. of tunnel driven about equally divided east and west from shaft No. 3, which is 196 ft. in depth.

Whitewater Tunnels No. 1, 1970 ft. in length and No. 2, 8146 ft. in length, West Construction Company, contractors—461 ft. of tunnel driven from east portal; approach cut excavated at west portal of Tunnel No. 2; some excavation at portals of Tunnel No. 1.

Cottonwood Tunnel, 20,100 ft. in length, J. F. Shea Company, contractors—Driving from ends, 1121 ft. of tunnel excavated from west portal and 1321 ft. excavated from east portal.

Mecca Pass Tunnels—No. 1, 325 ft. in length, No. 2, 970 ft. and No. 3, 4580 ft., Morrison-Knudsen Co., contractors—201 ft. of tunnel driven from east portal of No. 3. Some excavation at portals of Nos. 1 and 2.

Hayfield Tunnel No. 2, 5360 ft. in length, Floyd Shofner and J. N. Gordon, contractors—Driving from west portal 169 ft. of tunnel excavated.

Hayfield Tunnel No. 2, Hunkin-Conkey Construction Co., contractors—Work just started on adit from West Lake Canyon.

West Portion of West Eagle Mountain Tunnel, 10,650 ft. in length, L. E. Dixon Co. and Bent Bros., contractors—This section to be driven all from one point, 306 ft. excavated from west portal.

East Portion of West Eagle Mountain Tunnel, 15,669 ft. in length, Broderick & Gordon, contractors—Driving of adit about 2150 ft. in length started, 145 ft. being excavated.

East Iron Mountain Tunnel, 23,633 ft. in length, and **Coxcomb Tunnel**, 17,530 ft. in length, Winston Bros. Company, contractors—608 ft. of tunnel driven from east portal and access cut made for west portal of Coxcomb tunnel; 31 ft. of tunnel driven, about equally divided east and west from shaft 162 ft. in depth on East Iron Mountain Tunnel.

West Iron Mountain Tunnel, 16,172 ft. in length, Utah Construction Co., contractors—Working from west portal 1962 ft. of tunnel driven.

Colorado River Tunnel, 5640 ft. in length; **Copper Basin Tunnel**, 12,280 ft.; **Whipple**

Mountain Tunnel, 32,190 ft., Walsh Construction Co., contractors—Work just starting; 400 ft. driven on adit 1000 ft. long for Whipple Mountain Tunnel.

Coachella Tunnels, 138,445 ft. in length, construction by force account by the Metropolitan Water District—Tunnels now being driven by crews in all six construction camps.

At Yellow Canyon 2275 ft. of tunnel driven, divided about equally east and west from adit 686 ft. in length.

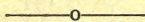
At Fargo Canyon, 1936 ft. of tunnel driven east and west from adit 891 ft. in length.

At Berdoo Canyon, 2386 ft. of tunnel driven east and west from adit 2042 ft. in length.

At Pushawalla camp, adit 2935 ft. in length completed and tunnel work started.

At Thousand Palms Canyon, 3356 ft. of tunnel driven from portal cuts.

At Wide Canyon, 2335 ft. of tunnel driven, including small section 848 ft. long, known as Wide Canyon No. 2 which was holed through on October 2.



Aqueduct Costs Show Saving Over Estimates

Colorado River Aqueduct costs already have been cut \$9,000,000, under the engineers' estimates, with one-third of the project under construction and contracted for, an official statement by General Manager and Chief Engineer F. E. Weymouth of the Metropolitan Water District, disclosed. This saving, Mr. Weymouth pointed out, is based upon actual unit costs of construction under way compared with the District's estimated cost for this work as provided for in the aqueduct bond issue. Furthermore it was effected after making ample allowances for contingency costs in addition to the District's present unit costs for force account work and the prices on which contracts were awarded.

General Manager Weymouth stated that during October 145,000 cubic yards of main tunnel excavation were moved by District forces "at an average cost of \$4.00 per cubic yard, which figure includes labor, superintendence, field overhead, explosives, materials, supplies, miscellaneous expense, and an ample charge for plant and equipment." This cost, he pointed out, compares with a corresponding estimate of \$5.25 per cubic yard. The average price for tunnel excavation by contract is \$6.25.

The \$9,000,000 saving, District records show, has been made on the basis of District commitments totaling approximately \$60,000,000, or about one-third of the main aqueduct line.