THE GREAT SALT LAKE RAILROAD CROSSING

FOR

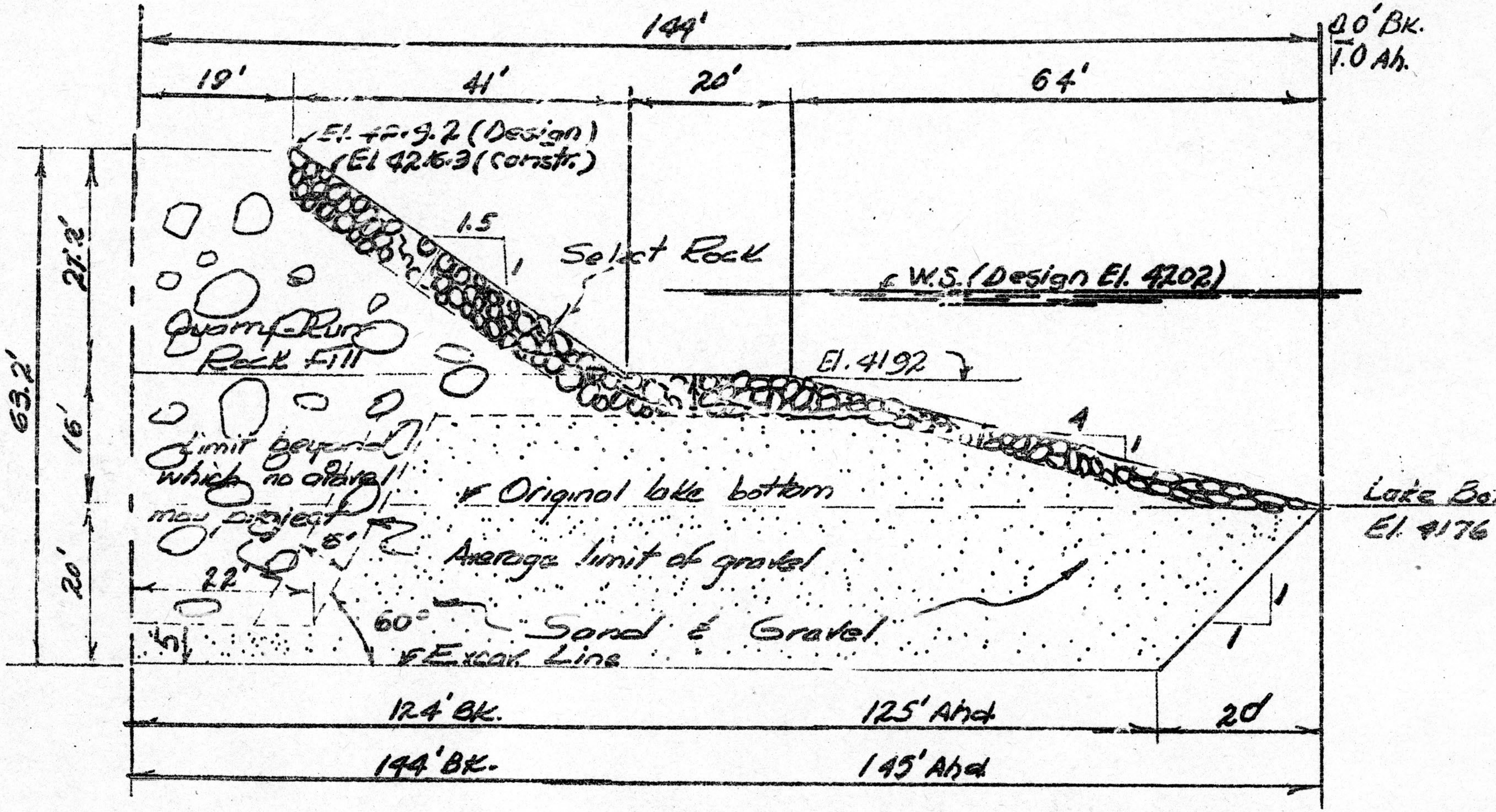
SOUTHERN PACIFIC COMPANY

BY

MORRISON-KNUDSEN COMPANY, INC.

BOISE, IDAHO

OCTOBER 1957



HALF SECTION - STA 3495+20

SALIENT STATISTICS

Award of Contract, Date	20 February 1956
Scheduled Completion Date	20 February 1960
Length of Fill	12.6 miles
Maximum Height of fill	102 feet
Height of fill above water surface	17 feet
Maximum Depth of Dredge Cut (Below W.S.)	85 feet
Maximum width of dredge cut	500 feet
Percent of fill on salt bottom	60%
Percent of fill on clay bottom	40%
Total Dredging Quantity (est)	17,646,000 c.y.
Total Fill Quantity (est)	34,667,000 c.y.
Rock fill (est)	9,854,000 c.y.
Gravel fill (est)	24,813,000 c.y.
Maximum quantity fill placed in 1 month	2,000,000 c.y.
Maximum quantity dredged in 1 month	1,200,000 c.y.
Maximum No. of employees on job	671

EQUIPMENT

3 150 B Shovels	8 c.y.	301 hp
3 150 B Shovels	6½ c.y.	301 hp
11 Euclid Bottom Dumps (with side boards)	30 c.y.	300 hp
19 Euclid End Dumps Mod. 63 TD	17 c.y.	300 hp
6 Gunderson Tugs	60 feet	1000 hp
2 Gunderson Tugs	54 feet	600 hp
1 Personnel boat	42 feet	450 hp
4 Personnel boats	30 feet	300 hp
1 Dredge Judah	Hydraulic	18 inch
1 Dredge Hood	Hydraulic	15 inch
6 Bottom Dump Barges	2000 c.y.	
5 Flat Deck Barges	1000 c.y.	

Man's most ambitious use of earthfill in the Intermountain West is under way on the Great Salt Lake, Utah.

Under a 45 million dollar contract with Southern Pacific Company, Morrison-Knudsen Company, Inc. is constructing a 35 million-yd., 12.6 mile earth and rock causeway which will span the Great Salt Lake from Promontory Point on the east shore to Lakeside, on the west shore. This Boise, Idaho construction firm's schedule calls for the excavation and placement of 1,200,000 cubic yards of earth and rock fill a month.

When M-K moved in, the job site wasn't much different from Golden Spike days, back in the last century. A townsite had to be built from scratch. Some 15 million dollars worth of new equipment had to be arranged for, including a complete marine fleet assembled to take care of underwater excavation and hauling on the lake.

For both M-K and Southern Pacific, the job had plenty of unknowns. To reduce them to a minimum before construction began, Southern Pacific engaged International Engineering Company to design the fill and to act as resident engineers during the construction. They in turn engaged some of the best experts in the nation to make recommendations and confirm their design. Some of the problems facing this august group were: What kinds of local fill material were suitable for this underwater construction? How fast could the load be placed on the foundation without precipitating failure? Exactly how much load would the two principal types of Great Salt Lake bottom material support? Facing M-K were such problems as selection of the right kind of equipment, buildup of a large construction force in a labor-scarce area where the possibility of turnover would be high due to the remoteness of the project and unknowns in the work. For example, nobody knew what would happen to a barge load of rock buffeted by waves weighing one and a half times as much as ordinary water because of their salt content, to say nothing of the effect of the heavy water on personnel boats and other small craft necessary to the job.

The railroad company needed this crossing badly. When the railroad first was built in 1869, it curved around the north arm of Great Salt Lake and connected with a direct overland link not far from Lucin, at the Utah-Nevada border. In 1902, in an effort to save miles on the Ogden-San Francisco route, the original overland portion along the north arm was replaced by a cut-off incorporating a wood pile trestle, driven 13 miles across the lake at a site close to the new fill. This 39,000 pile trestle has served long and well, but railroad company officials realized that maintenance was skyrocketing. Too, the threat of sabotage in wartime was very real. Even an ordinary type of accident could put the crossing out of commission for an extended period of time. For example, high wind and discarded fire waste from a hotbox burned out 600 feet of the trestle in May 1956. Rail traffic was rerouted until pony bents could be constructed and traffic resumed.

Investment in a new earthfill crossing was considered several years ago, and extensive preliminary surveys and foundation investigations were made. From a standpoint of economics, the best possible crossing site was one parallel to, and only 1500 feet away from the old trestle. Foundation investigations showed two principal types of material in the lake bottom. Best bearing-value material was a formation of Glauber's salt--hard and firm. There is about eight miles of this salt underlying the bottom of the middle and eastern portion of the lake. Over the remainder of the lake, the bottom was a much poorer clay material. An average of from 20 to 25 feet of soft clay ooze overburden lay over clay and salt alike. It is essential that this be removed by dredging prior to the start of the earth and rock fill.

EMBANKMENT DESIGN

Because of differences in foundation bearing qualities, the cross section of the fill varies from a wide cut over the clay bottom to a narrower base section on Glauber's salt. Generally speaking, the bottom width of the embankment will range from 175 to 480 feet, the fill will have a total height of from 85 to 102 feet (maximum water depth to the lake bed is about 32 feet), and the embankment crest will be 38 feet wide, at 17 feet above water surface, to accommodate the railroad tracks. There will be approximately 25 million cubic yards of sand and gravel plus about 10 million cubic yards of quarry-run rock. The North and South embankment faces, exposed to wave action, will be protected by a 5' wall of rip rap stone, the pieces weighing from one to three tons each. Normal water surface of Great Salt Lake is 4,200 feet above sea level, the final embankment will be at elevation 4,217.

CONSTRUCTION PLANT AND METHODS

Morrison-Knudsen Company has organized the project for optimum production costwise. In setting up equipment and methods, M-K's plan calls for bottom dumping the rock, sand and gravel fill to an elevation of minus 12, working directly over a cut dredged by one 15 and one 18-in. hydraulic dredge . From elevation minus twelve to water surface, construction of the fill is of material delivered by deck-barge and bulldozed off of the side by two D-8 dozers. Construction of the East End and Salt Section fill from the water surface to the finished elevation will be accomplished by the combined methods of hauling by truck and also by using a Manitowoc 4500 crane sitting on the fill and retrieving rock from deck-barges by skip. Combined with this is a second operation from the Lakeside terminus, where a train-hauling method of dumping is being used. The train will be utilized to bring the fill up to its final elevation on the West End of the project.

Four principal material supply sites were picked. On the Lakeside shore, quarry facilities were set up. At Promontory Point, there are three material supply sources. Borrow area No. 2, one of these sources, will supply the sand and gravel fill. It lies in a natural valley between mountain ridges, and is approximately two miles from the lake shore. Quarry No. 2, a source of large rock for the barge haul, is on the lake shore near the harbor. Quarry No. 1, the source of rock for the truck haul is farther down the lake to the southeast, not far from the existing Southern Pacific railroad trestle.

The nine-month preliminary get-ready program included construction of loading docks along the lake front, dredging of a harbor and turning basin to serve these docks, and dredging of an approach channel connecting the deepened harbor, with deeper water about 2.65 miles offshore. A sizable shipyard was necessary to build six 3,200-ton capacity hopper-type dump barges and the five 2,000-ton flat-top deck barges. Six tugs of 1,000 hp each and two tugs of 600 hp each also were assembled and launched there. In addition a dry dock excavation was made for the assembly of the two dredges.

CONVEYOR SYSTEM

What is reported to be the world's fastest conveyor system for transporting rock, sand and gravel had to be designed and built. Although its construction called for an investment of 2 million dollars, it was decided that a conveyor system would be the most economical method of transporting sand and gravel from borrow pit No. 2, over the two mile distance between the pit and the harbor docks. The contract for designing and furnishing the conveyor equipment was awarded to Hewitt-Robins, Inc., Stamford, Conneticut.

Several conveyor routes were considered, one calling for a beeline route up over the top of a mountain ridge and down to the lake shore. That would have called, however, for a 1,000 hp motor on the first conveyor run. A much more economical route lay over a little longer distance at a lower elevation, where smaller and less expensive motors could be used.

In working out the details of this installation, conveyor systems in France and Germany were considered, where coal was being moved on conveyors at the then unheard rate of 850 feet per minute. There was no reason why heavier sand, gravel and crushed rock couldn't be moved at the same rate of speed in the United States. Our system at Promontory Point was designed around that assumption.

The system has been designed so that there are multiple truck-dumping points in borrow pit No. 2. Conveyor run No. 6, which is the ultimate portion of the system, is a 200-ft. long run of 54-in. belt transferring on to Conveyor No. 5, which is 2000 feet long and also 54-in. wide five-ply Hewitt-Robins belt 4,200 feet long. This conveyor is self-energizing, generating at times up to 300 hp. Normally, it operates at 850 fpm, dropping to 800 fpm when driving.

No. 3 conveyor run is a 3,360-ft. length of 54-in. five ply belting. There is a transfer tower and accelerating conveyor between No. 3 and No. 4. No. 3 conveyor is designed to operate at 820 fpm, and is pitched slightly downgrade practically all the way.

The delivery conveyor dumps with the aid of a radial stacking arm, which stacks the material over two large recovery tunnels in which 10 tunnel belt feeders are located. The belt feeders, in turn, supply the other part of the system which includes two 72-inch conveyors approximately 500 feet long, operating at 550 fpm, powered by a 300-hp electric motor on each of the two conveyors. Each of these big loading conveyors will handle 6,000 tons per hour , delivering a total combined peak capacity of 12,000 tph. Capacity like this means that a 3,000-ton dump barge can be loaded in 15 minutes if feed piles come through the gates evenly without arching over the opening. To actuate the flow of material and prevent arching action a system of compressed air nozzles was installed at each feeder.

Designed to handle material weighing 100 pounds per cubic foot, the system is handling material nicely which sometimes goes as high as 130 pounds per cubic foot. The conveyor also is designed to record automatically the weight of material handled on the line, using a pneumatic-electronic recording weigh scale. Due to the extent of this project, this big conveyor installation offers an excellent opportunity to do horsepower research and to check many of the things conveyor people debate over. These include energy requirements for idler friction; force required to overcome idler jump of the belt at high speed; force requirements made necessary because of friction between material particles working against each other.

BORROW AREA OPERATION

Borrow area No. 2, where sand and gravel fill for the bottom of the embankment is being produced, is largely a high-speed bailing shovel operation. To serve this area, M-K and Southern Pacific purchased three Bucyrus-Erie 150-B shovels and equipped them with 8-yd. dippers. Electrically-powered, these big machines can load the material at high speed--up to 31,000 tons per machine in two 10-hour shifts. Hauling units from the 150-B's include thirteen 25-yd. bottom-dump Euclid No. 23 LDT's.

Hauling from the 150-B's, the Eucs dump into a pair of 60-yd. hoppers mounted at the top of a tall feeder tower at the start of the conveyor system. Each hopper will hold two full loads from the belly dumps. Between the dump point and the conveyor system, the material is handled by an apron-type Oro feeder 60 inches wide. These feeders are driven by 20-hp Varidrive motors through speed reducers, developing plate speeds up to 36.3 fpm. The feeders drop the material over a pair of 6 X 14-ft. scalping screens, whose 8-in. opening scalps off all oversize material and passes the remaining fraction down to the accelerator conveyor, at the start of the system. All oversize material--and this sometimes reaches as high as 13%--passes through a pair of 30 X 42 jaw crushers, which breaks oversize rocks down to meet specifications. This material also then drops to the accelerating conveyor.

The eventual disposal of material from borrow pit No. 2 is by way of a water route from a dock-loading point at the end of the stacker conveyor. Bottom-dump barges are loaded with 2000 cy of this material, and are pushed out to the dumping site by a fleet of eight tugs powered by 1,000 hp and 600-hp tug boats. Two hydraulic dredges--the Hood and the Judah-- have worked ahead to cut a dumping trench, which exposes foundation material on which the embankment rests. Positioning of the loaded barges for dumping is under control of a Barge Control Engineer. A method has been worked out in which towers are positioned on each side of the embankment, and a string of targets is set above water level, both longitudinally and perpendicular to the cut so that dumping is accurate in regard to both offset and stationing. Fathometers are used for underwater surveys to control the dumping and provide a means for determining job production.

QUARRY OPERATION

One of the principal features of interest regarding quarry No. 2 is the method of blasting the high rock face. A scheme was worked out in which two 5 X 7 ft. main tunnels, approximately 1,300 feet apart are being drilled straight into the side of a mountain. These are access tunnels pure and simple, and a method of blasting has been worked out so that even the explosion of 1,790,000 pounds of powder in one shot did not damage the tunnel walls materially.

From the main tunnel at approximately 100-ft. intervals, cross-connecting tunnels of approximately the same size lead off perpendicularly. These drifts extend out a sufficient distance to leave only a 50-ft. pillar of undrilled rock in the center of each pair of laterals. The tunnels are being drilled by a small jumbo mounted on a narrow gauge railroad track. The rock is primarily quartz with a 70-plus percentage of silica, so the use of tungstencarbide-tipped rock bits is necessary. In fact, the extremely hard drilling nature of this quartzite ruled out the use of large-diameter churn drills working from the top.

Tunnelmen drill a 24-hole face pattern, use delays and gelatin type powder, and are pulling 6-ft. average rounds at each shot. The broken material is then loaded out by an Eimco B-12 mucker and is hauled away to a dumpground by trainloads of ten-2-yd. cars pulled by tunnel locomotives.

The huge powder shots consist of Atlas ammonium-nitrate powder, together with approximately 25% of Atlas, conventional explosives. The powder is piled in the cross-connecting tunnel drifts, beginning with a pocket at the end of each tunnel. This powder breaks out the untunneled rock portion. After powder pockets are piled high, a small special agricultural-type loader throws special sand backfill in tight over the top of the powder and against the roof of the tunnel. Between pockets of powder, blocks of sand backfill are placed, with all powder pockets connected by two lines of reinforced Primacord. On powder loading the crew can fill about 100 feet of tunnel per shift.

The factor which prevents blast damage to the main-access tunnel walls is the method of loading powder in the cross drifts to a point within approximately 130 feet of the main tunnels. From the point back to the main tunnel, sand is heavily backfilled. When the shot goes off, the high face breaks out, leaving the access tunnels relatively intact. On a 2½ million cubic-yard shot, it took a crew only a few days to clean out the tunnel so that new advances and cross drifts could be made for the next shot.

895 tons

Recently, a 1,790,000 lb. explosive shot was pulled in quarry No. 2. Officials estimated that the shot cost approximately $160,000 for powder alone. Exploded by two Primacord trunklines, the blast rolled down approximately 2,500,000 cubic yards of rock for the big barrier.

20 trucks each with 50 ton Powder

Shovel loading at quarry No. 2 is being handled by two new Bucyrus-Erie 150-B power shovels, rigged with 6½ yd. dippers and teeth. Hauling units under these shovels include eight 17-yd. end-dump Euclid trucks, which haul to barges.

Quarry No. 1, also a rock production point, is a more typical example of the conventional coyote method. Here, M-K drilled coyote tunnels 150 feet apart, with approximate 50-ft. cross-connecting T's. In this case, both the main tunnel and the T's were loaded with the same type of powder on a similar one-pound-per-cubic-yard explosive ratio.

To drill these tunnels, the miners used a slusher system, consisting of two Ingersoll-Rand air-tugger hoists and a Gardner-Denver 600 cfm rotary air compressor. Drilling was done by three Thor jackleg-type drills, using tungsten-carbide bits which bottom-in at 1½" diameter. A 16-hole round was used with delays to pull approximately five feet per blast. When the main tunnels reached a distance of approximately 100 feet into the hillside, the mains and cross-connects were then loaded with ammonium-nitrate and regular powder and detonated in the same manner used in Quarry No. 2.

Loading equipment at quarry No. 1 included a new Bucyrus-Erie 150 B electric shovel with a 6½ yd. dipper. Hauling units under this shovel are a fleet of 17-yd. end-dump trucks like those used in quarry No. 2.

The Eucs haul the shot rock fill out to the embankment and end-dump it. The fill is being built in this manner up to approximately seven feet above water surface, leaving convenient turnaround points every 200 feet or so for convenience of the trucks.

The Lakeside quarry on the west shore of the lake is a separate operation. Instead of quartzite, the rock formation here is limestone, and a coyote-hole method of drilling and shooting similar to the quarry No. 1 was used. The loading shovel here is a Bucyrus-Erie 88-B with a 4-yd. dipper with shovel loading direct to the 30-yd. cars. A side-dumping method is being used to dump the cars, and the fill dveloped by the train haul is smoothed out by three Caterpillar dozers with the larger of the rock being utilized as rip-rap and placed on the sides in a 5' protective blanket.

CAMP FACILITIES

The camp at Little Valley consists of mess hall, barracks, a barber shop, two recreation centers, houses, trailer-parking facilities, a supermarket, post office, a schoolhouse, filling station, and practically all the other conveniences of a full-fledged town community, including a Sheriff and Fire Department. The job site also has an airstrip which does a land-office business, since many of the men commute by air each day. There is regularly scheduled air-taxi service, and the trip from Salt Lake City or Ogden takes only 20 to 25 minutes. There is a state secondary highway out to Promontory Point, but it is 92 miles from Ogden and part of the road is rough and potholed. Little Valley is served by a railroad spur with freight service four times per week. Over 2000 carloads of materials and equipment have come to the jobsite since work was commenced. Local passenger train service is also afforded twice daily at the mainline station of Saline, three miles from Little Valley.

EMPHASIZE SAFETY

The safety program, rigidly enforced has built up an enviable record. Now over a year old, the project rates as one of the safest in all of Morrison-Knudsen operations. Safety meetings with all supervisors are held regularly each two weeks. Safety rules are a practical, common sense combination of normal precautions coupled with enforcement of safety rules as outlined by the Associated General Contractors and state regulations.

An interesting study has been conducted and corrective measures taken to save money by reducing the number of serious cases caused by minor injuries. Every injury, no matter how minor--blisters, scratches, and splinters--are treated promptly by a company doctor to prevent infection.

The Salt Lake Crossing project is under the general supervision of Guy Reid, project manager, who is assisted by W. A. Stewart, assistant to project manager. The entire operation is divided into two operations with the land portion being supervised by Harvey Hardin, General Superintendent--Land; and Marine division being under the directorship of Frank Currey, General Superintendent--Marine. A group of most capable superintendents assist the above in both land and marine operation. They Are:

D. R. Bagley	Project Engineer
John Deagon	Master Mechanic
William Hamilton	Ass't. General Superintendent--Land
Fred Mack	Ass't. Marine Superintendent
Vern Quintel	Ass't. Marine Superintendant
Clyde Thomas	Ass't. General Superintendent--Land
R. K. Woodhead	Office Manager

Heading the project for Southern Pacific Company is W. M. Jaekle, Chief Engineer of that company. Resident Engineer on the project is Howard J. Willard, Construction Engineer. The preliminary investigation and design of the fill was done by International Engineering Company of San Francisco. I. E. Company is also doing the inspecting on the project under the direction of Norman K. Rands, Resident Engineer.