The Fort Peck Dam Project
by
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Colonel Miles, Gentlemen -

The construction of the Fort Peck Project is quite similar in many aspects to war-time operations, not only on account of the speed with which the work had to be started and the fact that an organization had to be built up with nothing at all but also the handicaps and obstacles which were met with and had to be overcome. As a matter of fact, almost every phase of engineering that is met with in the A.E.F. was handled on this project - of course, on a much smaller scale.

This first slide will orient you with respect to the project. The Fort Peck Project is located in Northern Montana, about fifty miles from Canada and one hundred fifty miles from North Dakota, on the Missouri River. The nearest town on the railroad was twenty miles away - Glascow, a town of about two thousand people. This area represents the drainage area above the dam, about fifty thousand square miles. This area in black is the area which will be covered by the reservoir itself, a distance in length of about one hundred eighty miles, and which will hold about twenty million acre feet.

In the period from 1928 to 1932 the Corps of Engineers under an act of Congress, surveyed all streams of any consequence throughout the United States from the point of view of flood control, navigation, power, and reclamation. The site for the Fort Peck Dam was located when that survey was made, and a few preliminary borings were made.

This slide shows the main features of the project. There are really three main features: the dam, the diversion tunnels, and the spillway. The Missouri River flows north at this particular point. This represents the dam in plan; this is the down stream tow; this is the up stream tow. This particular site was selected for the reason that at this point the bluffs of the Missouri River come fairly close together - a distance of about nine thousand feet apart. Also, the foundation was suitable for an earthen dam and sufficient good material was available at or near the site for the construction of the dam. On the righthand side the bluffs are higher than the dam will be; on the lefthand side they are not. At this particular point the bluffs, which are called benchlands out there, are about eighty feet below the top of the dam, so the dam is really in two main sections: the flood plane from here to here about nine thousand feet in length, and what we call the dike section, which tapers on down to zero at this point, which is about twelve thousand feet in length. The total length of the dam is about eighteen thousand feet, or over three miles.

This shows the cross section of the dam. The dam is two hundred forty-two feet high; a distance from the upstream tow to the down stream tow of a little over half a mile. It is the largest hydraulically constructed earthen dam in the world. The previous largest dam up to the construction of the Fort Peck Dam was the Gatun Dam in Panama, which is eighty-five feet high as compared with two hundred and forty feet for this dam. The Gatun Dam has about twenty million yards of material in it as compared with a hundred million yards for this dam. The water at this particular point, when the reservoir is full, will be about two hundred twenty-five feet deep. The diversion tunnels run underneath the bluffs on the right side. The diversion tunnels vary in length from six thousand to seven thousand feet; total length of diversion tunnels about twenty-five thousand feet. These tunnels are concrete lined tunnels with a net diameter of twenty-four feet eight inches.

Since this is an earthen dam the spillway should not be located near the dam proper. A favorable site was found for the spillway about three miles away from the dam. The Missouri River, after flowing by the site of the dam, turns to the east just a few miles away, so this particular point was a favorable site for a spillway location. From this direction, that is from the direction of the reservoir, a coulee or deep ravine ran in this direction (indicating), so that reduced the amount of excavation to a minimum.

In that vicinity there was no place to house the workers on the project. We had a maximum force of over ten thousand five hundred working on the project, and it was necessary to build a town complete which would house about seventy-five per cent of the people.

The town was built on the benchland just below the dike section in the locality shown here. It was also necessary to bring communications in, especially a railroad. We were twelve miles from the Great Northern Railroad, and it was necessary to get this railroad constructed as soon as possible in order that work on the other features of the project could be pushed. It was also decided early that electricity would be the primary power at Fort Peck. The source of electricity was at Great Falls, about three hundred miles away, so it was necessary to survey a line from Great Falls, secure rights of way, and get that work done at an early date so that power would be available for the construction of the project.

The project was approved the middle of October in 1933. I was ordered to Fort Peck on a three day notice from Vicksburg, Mississippi, where I had been on flood control work. I arrived at Fort Peck the 2nd of November 1933. At that time a blizzard was on and I felt, especially with my thin blood at that time, that winter was really there. There was no organization. The only person there was a Lt. Broshous, who had just graduated that year. He had reported there for duty. As soon as the project was approved he got busy, got a force of about five hundred men, and started clearing the base of the dam. All this bottom was covered with willows and cottonwood. The instructions I received from higher authority were to the effect that work would be pushed without delay in order to give employment an early date. As you probably recall, at that time industry was at a low ebb throughout the country and unemployment was high. I was confronted with the task of building up an organization. Montana is very sparsely settled. Although it is the third largest state in the Union its population is less than that of Washington, D. C. The majority of the people are ranchers and very little construction work is carried on in Montana. In the western part of the state, around Butte, where there are quite a number of mines, we had a good source of mining engineers and skilled miners. North and South Dakota, Wyoming, and Idaho were a little better as a source of labor. I had to secure engineers in order to make detailed surveys so that the plans could be prepared for the main features of the project; had to get foremen, superintendents. In addition, I had to have an office force: men acquainted with Government purchasing, chief clerk, disbursing agent, financial help. At the time I left Vicksburg work there was tapering off to a large extent so I took with me from Vicksburg the nucleus of a district organization: finance people, assistant chief clerk, cost accountant, a couple of stenographers, and a plant man - in all about a dozen people - and with that organization started functioning as a district at once.

Building up the field organization was a difficult problem. I did not want to bring men there from a long distance, try them out, find that they were wanting, and then discharge them. It would have been hard on the men and it would not have been good for the project. Therefore, I adopted a policy of outlining my needs to other district engineers throughout the United States. They interviewed prospective applicants for me and reported to me. In that way I secured at the start a large part of the key field organization. Although it took time to build an organization up that way and threw a load on the small organization I had at the start, yet the results well justified the efforts because it was necessary to discharge but very few. The main changes made were promotions. Also, I had a number of Engineer officers whom I had transferred there, and each main feature of the project was in charge of an Engineer officer. For instance, I had one in charge of the dam, one in charge of the spillway, one in charge of the tunnels, and one as town manager and in charge of acquisition of land.

The construction of the railroad was the first big problem. We advertised that work in December 1933, but due to the gamble involved could secure no bids so we did that work ourselves. The railroad was scheduled for completion June 4, 1934. I inspected that job every single day, pushed it all possible ways, and the result was we had freight moving over April 4, 1934. That railroad was brought from the Great Northern to Fort Peck. Yards were constructed; then it was extended across the Missouri River. The channel of the Missouri River, when I arrived there, was over a half mile wide; a little island there in the center, or from here to here was over half mile (indicating). We constricted that channel down to only a few hundred feet. This bridge was constructed across; the railroad brought to the other side so that equipment and supplies could be brought to the tunnels for their construction. Then it was run out to the spillway to bring equipment and supplies out there. We had to bring equipment and supplies to the up stream end of the tunnel, also to put a facing of gravel and rock on the up stream face of the dam; so the railroad was brought back from the spillway to the up stream face of the dam. The total amount of railroad constructed there amounted to about forty miles, of which about a half was tracks and yards.

The dam itself was constructed by hired labor. The tunnels were started by a contract but due to the fact that the contractor did not make the progress desired and work was speeded up on the construction of the dam, we took over the construction of the tunnels and did that by hired labor. The spillway was constructed by contract. At the maximum employment there was over ten thousand five hundred, of which a little over seventy-five per cent were Government employees.

Another handicap on the project was the weather. The winters there are long, and the thermometer at times got down pretty low. In fact, at one time it got down to sixty-one degrees below zero, and that made it very difficult to carry on construction work.

This shows the town of Fort Peck. You can see here in the background the dike section I mentioned; and see the Missouri River beyond that. The town is divided into three main sections. The barracks for the men were located over in this general neighborhood. We had about three hundred houses for married foremen, engineers, and married clerical help. We constructed also about twelve permanent houses which will house the operating force after the project is completed. In this particular section was located the business area: theater, school, city hall. Our administration headquarters building was located here (indicating). This is the lower level where the railroad comes into Fort Peck. Naturally, our utilities: cold storage warehouse, commissary warehouse, and shops were located down near the railroad on the lower level.

In order to prevent any possible percolation of water underneath the dam a steel sheet piling was driven down to bedrock. This shows one of the gantries used, which is two hundred feet high. There were two of those for driving that steel sheet piling. The maximum depth to which the steel sheet piling was driven was one hundred sixty-five feet. This operation was unique in that the previous maximum depth of driving steel sheet piling was about eighty five or ninety feet. The sections are eighty-five feet long and are welded together. It required about two of those eighty-five foot sections for the maximum depth. This was driven across the river also.

This shows the temporary bridge that was constructed across the river along the center line for driving the steel sheet piling. Of course, the water had to pass there until the tunnels were completed. The tunnels were not completed until June of 1937. The steel sheet piling was driven in sections and then cut off for a distance of about two hundred feet flush with the river bottom by means of an electric torch surrounded with a neutral gas.

As I told you, the dam was constructed with hydraulic dredges.

We had a bill there for about four million dollars worth of dredging equipment and attendant plants. We started building that early in January 1934 and completed one dredging unit that fall. We started dredging that fall and completed the balance during the lay-up season of the winter 1934-1935, and when the spring opened up in 1935 all of our dredging equipment was ready to start work. This shows one of the dredges. These dredging units were unique in the amount of power we had. On the dredge we had two centrifugal pumps. Number one was a suction pump; number two was a booster pump. We had a floating booster about this size, not shown on this slide, which had two more pumps, both booster pumps. Then we had a third pump located on land which moved by rail. Each unit had five pumps, one a suction pump and the other four booster pumps; and each one of these pumps was operated with a twenty-five hundred horse power motor. This shows a floating line, twenty-eight inch, supported by pontoons. As I told you, the power at Fort Peck was electrical. In fact, the only coal used on the project was blacksmith coal. Electricity was by far the primary power, except for drag lines, bulldozers, etc., which were either gas or Diesel. We had a little tow boat which was built at the boat yards in Kansas City, and this was Diesel. We had two derrick posts for taking the pumps off the dredge and putting them back on, which were oil burners. That was the only oil burner outfit on the project. The power was brought to the dredge by means of a thousand foot cable. This shows the pontoons for supporting that power cable. These little containers were used in order to prevent the cable from being cut if the pontoons moved in on each other. Also, going out on our floating pipe line we had an electric line for lights and also a telephone line going out to the dredges.

The communication system there was very complete. In fact, you could call up Fort Peck from here and in less than a minute talk to any one dredge that you wanted to talk to.

This shows the cutterhead of one of the dredges for agitating the material. That cutterhead weighed about seven tons, was seven feet in diameter. It revolved about twenty-five revolutions per minute and loosened up the material. A suction pipe started right here, extended on up this ladder to the number one pump, brought the water and the material on up and pumped it to the fill. This ladder was seventy-five feet long and could dredge a depth of about fifty-five feet below the water surface. The banks were about fifteen, twenty feet above the water surface.

This gives us a schematic diagram of the dredging. Here is the first booster, floating line to land, then land line, then floating line again to the floating booster, then land line to the land booster up here, which gave the final kick to get it up to the fill. The maximum height we pumped the fill there was a little over two hundred forty feet, which was quite an increase over the previous maximum height of about eighty-five feet. We required a tremendous amount of this twenty-eight inch line. We pumped up to distances of over twenty thousand feet, and we had to use there on the project over a hundred thousand feet of the twenty-eight inch line.

This gives you a view of the dam itself under construction. The river flows in this direction (indicating), and you can see here how the channel has been constricted down. Instead of being a half mile wide, as it was at the start, at the down stream tow it was only two hundred feet wide; up stream tow about seven hundred feet wide. This shows the floating line coming across the river, floating to one of the boosters. Here are two of our land boosters. Pumped up the line here, discharged at either tow of the dam the water flows down that slope to the pool, down the spillway back into the river. The purpose of this pool was to settle out the very fine material: fine clay, silicon sand, to form the really impervious part of the dam. The balance of the dam merely supports that core which is about a fifth of the dam in cross section.

This slide gives you a better view of the pool - discharges here and here (indicating). At this particular time the discharge was at this point. The coarse material naturally settles out first. The water carries the finer material on down, keeps dropping until finally this pool is reached and all that is left is the very fine. Then, by controlling our spillway we could vary the amount of fines deposited in the core. If we were dredging material that contained a considerable amount of clay we wasted a considerable amount of fine. When we dredged material that had about eighty to eighty-five per cent sand and the rest clay and celt we had practically no wastage.

This shows the pool also for the dike section. This gives you a view of the discharge. This particular discharge was known as a cable discharge built up in that shape in order to spread the discharge and not excavate any ditch at this particular point. Also, what is known as baffleboard is in here to check the flow, to prevent the carrying down of the coarse material into the pool. Notice this little bulldozer, which is hauling some supplies, passing directly in front of that discharge pipe (indicating). That material is very firm. Those bulldozers are a very useful piece of equipment. That particular type is twenty horse power. We had them on the project varying from twenty to eighty-five horse power.

The discharge I just showed you had a disadvantage in that it built up too rapidly and we had to keep adding on sections of pipe at frequent intervals. In order to obviate that, we changed to what is known as a shutter discharge. Underneath each twelve foot section of pipe was a shutter which is about six inches long and four inches wide, which moved in a groove, and a man with a sledge hammer could open or close it. If we had thirty or forty of these opened that would take all the discharge and no material would come out of the end of the pipe. This shows the pipe line in place for the commencement of spring operations of last year. In this particular case we had a double line. The dam had already been built up to this height, and there was one near the edge and one further down. We did that in order to better still check the deposit of the material. All this was done during the winter time in preparation for the spring operations.

That brings up the point of how we took care of our laborers during the winter time. I did not want to lay the men off because that would be hard on the men. Fluctuations in employment are bad.

Also, it would have been difficult to have gotten those men back the following spring. Therefore, we postponed all work that could be postponed until winter time, such as repairing of equipment, clearing the reservoir area, putting in new lines, preparing the pipe lines, rotating them. In the dredging the majority of material is carried along the bottom of the pipe; naturally the wear is the greatest in that bottom segment, so in order that the pipe would last the entire project it was rotated at the end of each season.

This gives you a view of the river section just before closure was made last year, in June of 1937. Our original plan had been to close at the up stream tow for the reason that there was a railroad trestle there and we could dump rock. Although it was seven hundred feet as opposed to two hundred feet here, it would have been very easy to close by dumping rock and gravel; but, at the middle of June of last year we had a very high stage of water; it dropped very suddenly, and in dropping the bank was saturated and it moved about twenty thousand yards of material right in here, which cracked the main pier of that through span and it looked as though that span might go out. I immediately had a train of gravel brought on and dumped gravel in here as a counterweight in order to prevent that bridge from going out. It moved a considerable distance and we had difficulty even in getting our trains across, so I decided at once to scrap our plan of closing up here due to the fact that it would take longer and also having to run the trains all the way out to the spillway and back and attempt to close here. We could not dump rock so we had to attempt to close with gravel alone.

This shows the closure operation. We were able to dump a little bit of rock at the end of this through span; pushed it down with a bulldozer. We had the derrick boat moved up here, with a clam shell bucket on it; and that moved some rock; cast it into this channel. But the closure was mainly made with gravel. It took one hundred forty cars to close off the river. The closure was completed in two hours and ten minutes, a little less than a minute per car.

This shows the view of the river section about five days after closure. You can see there has been considerable fill of material already take place. Of course, that pool was gradually narrowed down at about this point here. This brought up another problem - taking care of the waste water. While the river was open the waste water from the pool could be taken care of by these spillways, known as the cascade type of spillway, one on each side. But after closure obviously that could not be done, so we took care of the waste water after closure by constructing four pump boats. We used the old worn out pumps from our dredges and constructed the boats themselves from the scrap material on hand; built and moved the boats in here before we made closure, two on each side, and then pumped the water from the pool through a twenty-eight inch pipe line up to the up stream core of the dam and then down into the old river channel. Three of those four pump boats were able to amply take care of the waste water, and the fourth one was used when we had to take out a section of pipe. At the start the output of these four dredging units was about three million two hundred thousand yards a month. That is what they were designed for, but by cutting down lost time and by experimenting we gradually increased the output to over five million yards a month.

One of the greatest problems there was training labor. We could get no trained labor so had to get unskilled labor and train them. For example, at the start to take out all five pumps of a dredging unit and replace them by five repaired pumps took us eighteen hours. After the men were trained we got that down to less than three hours. To take out a section of floating line at the start took a matter of about two hours. After the men were trained we got that down to fourteen minutes.

This gives you a general view of the tunnel outlet. The railroad came across here; brought supplies into the tunnel. This next view will show you the outlet a little better. As I told you, there are four tunnels. The excavated earth was brought out of the tunnel on a narrow-gauge railroad. Also, the concrete, steel, etc., was hauled into the tunnels on the same railroad. This shows you the concrete mixing plant located here. A small concrete mixing plant was located at the up stream. This shows the aggregate piles. There was a boiler for heating that aggregate in winter time, which also heated the water because at times this concrete had to be placed at very low temperatures.

This gives you the interior view of the tunnel. The first operation was constructing pilot tunnels which were about sixteen feet wide and fourteen feet high. They were constructed from the upper end to the lower end before any enlargement was started. This was done in order that we would have detailed knowledge of the material; what steel would be required in building the tunnel itself, building the tunnel lining. After these pilot tunnels were constructed, then work started on the enlargement. This material was a very dense shale, which weighed about one hundred forty pounds to the cubic foot and had about fifteen per cent moisture content.

This shows a view to the inlet of the tunnel. We dredged this out early in our dredging work and used that as a winter harbor for all of our dredging plates. I might add that we made closure June 26 of the dam. The tunnels were ready to receive water just about two hours before. This is a view taken at the outlet shortly after the closure. At that time about twenty-five cubic feet per second were flowing through the tunnels. The maximum capacity of these tunnels when the reservoir is full would be about eighty-four thousand cubic feet per second.

This is an aerial view of the spillway. This is the approach channel; the spillway structure itself located here, and a line channel about a half mile long extending in that direction. The river you can see flowing up here. This shows a view of the line channel. At the gates the channel is about seven hundred fifty feet wide but the flow of this spillway was on about a five one-half per cent slope, so naturally the water required greater velocity. To compensate for that we could bring the walls closer together, so at the lower end of the spillway about a half mile from the gates the walls were only about one hundred thirty feet apart. In order to prevent any possible undermining of the spillway lining, a cut-off structure was placed at the lower end which extended down into the earth about seventy-five feet.

This shows the spillway gates. There are sixteen of these gates, which moved up and down. The capacity of this spillway is about two hundred and fifty-five thousand cubic feet per second. That, together with the tunnels, would give a capacity of over twice the greatest flood of record on the Missouri River in the past seventy-five years, which was about one hundred fifty-five thousand cubic feet per second.

I have given a very sketchy talk here. It is impossible in the time to go into details, but if there are now any questions any one wishes to ask I will be glad to answer them.

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Q. Colonel, I believe the class would be interested in knowing whether or not the core was continuous throughout and if it was not continuous throughout what steps were taken to insure the impervious at the break?

A. You mean, continuous from the up stream to the down stream?

Q. No sir, where the cascades were put in.

A. The material in the shell itself, of course was sand; and sand is not like clay in that it gets hard on exposure to the air, and we set up a plane of cleavage. As the pool came up the sand would tumble into the water, so we had no trouble there. As regards the core, we brought the steel sheet piling that I showed you up through the core, and that extended about twenty-five feet into the section above so as to prevent any possible percolation of water through the sections on each side of the river and through the closure section. Does that answer your question?

Q. Yes sir.

Q. Was the Great Falls power plant below that dam or above?

A. Above - about three hundred miles above. I did not show it on the map.

Q. What is the voltage of that power from Great Falls?

A. The voltage which arrived at Fort Peck was one hundred fifty-seven thousand; transmitted at Great Falls at about one hundred sixty-one. Our line loss there, a very long line, was about ten per cent. Of course it varied with the load that we were drawing.

Q. Is that power at Fort Peck to be tied in with Great Falls?

A. Eventually?

Q. Yes.

A. The present project does not provide for the construction of a power unit there. One interesting point there with regard to the town is that we had complete, exclusive jurisdiction of the town of Fort Peck. We had our own law enforcement officers. Any one who was tried for an offense was not tried in a state court but in a federal court. The state could not come in there and tax; although across the river, still on the project, which is public domain, the state could come in and tax. The reason for that is this; it goes back to the Constitution: Where land is acquired by the Federal Government with the consent of the state, the Federal Government has exclusive jurisdiction, but public domain could not be acquired by the United States because it had it to start out with, so it is only on land which is acquired with the consent of the state that we had exclusive jurisdiction. It happened that the town of Fort Peck itself was situated in that particular territory.

Q. Did you have to pay gas tax, Colonel, just the same?

A. As a matter of fact, the county there sued. Of course they could not sue the Government; they could not sue me, and they did not, but they sued some of the concessionaires and they carried that suit to the State Supreme Court. I did not know what the State Supreme Court would decide. I knew it was going to get there eventually, so I told the county commissioners at the start that they could not tax the gas there for the reason that it was taxed when it came into the state. It was not taxed on the project itself. Of course I am referring to private gasoline, not to Government gasoline.

Q. I would like to know in general terms, Colonel, the conditions under which this three hundred mile power line was built and what became of it after you people left?

A. The Government acquired a perpetual lease on the power line. It is an excellent power line. It had to be very well constructed because it is a dead end power line in circuit, and we could not afford to have any outages on it. What will happen eventually to that power line I do not know. The dam is not yet completed. There remains about twenty million yards of fill yet to go in. That will be completed by September of this year.

Q. Did I understand you to say that one of the objects of that dam was to provide irrigation?

A. The primary purpose of the dam is to hold back the waters of the flood season and let them out during the low water season. Secondary purposes are: power (for example, we lined one of the tunnels with a steel lining so it can be used for power), reclamation, irrigation, and flood control. With regard to irrigation, the only way they can irrigate really below the dam is to develop power at the dam itself, transmit it down stream, and pump. It would be very expensive constructing conduits from the dam itself. It would be much cheaper to transmit power.

Q. What I want to get at is: what particular section of Montana or any of the sections of the country following the Missouri River expected or hoped to benefit any way by irrigation?

A. There are eighty thousand acres just below Fort Peck, extending a distance down stream of about one hundred twenty-five miles. Also, there are about one hundred thousand acres over in the

Yellowstone which could be irrigated by generating power at Fort Peck and transmitting it to Yellowstone and pumping it from there.

Colonel Miles: I am sure we are all very much obliged to the Colonel for his dissertation. I imagine that after a fight such as he had out there on this dam that the War College must seem like a cook's tour. Thank you very much, Colonel.