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Final Report—
Operations Division

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FINAL REPORT
OPERATIONS DIVISION--ENGINEERING SECTION
by
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WAR RELOCATION AUTHORITY
UNITED STATES DEPARTMENT OF THE INTERIOR
GRANADA PROJECT
Amache, Colorado

ENGINEERING REPORT

The Engineering Section of the Operation Division was responsible for, and in charge of, all new construction and the maintenance of the center and project buildings and facilities, including the canal systems providing irrigation water for the farm lands of the project.

The original administrative personnel were Ralph J. O'Rourke, Senior Engineer; August Zanoni, Highway Engineer; William B. Wroth, Irrigation Engineer; Sidney U. Sandvos, Design Engineer; Lewis G. Temple, Landscape Supervisor and Robert Lundgren as Superintendent of Irrigation. Lewis J. Dakan was later employed as Sanitation Engineer. Numerous changes in personnel were caused by War and other conditions, and the final administrative staff at the closing of the center consisted of William B. Wroth, Senior Engineer; Theodore H. Staeffler, Construction and Maintenance Engineer; and Lewis G. Temple, Landscape and Sanitation Engineer.

The detailed functions of the section included the designing and supervising of new construction and reconstruction, the maintenance of all center and project buildings, the operation and maintenance of the water, sewer and light systems and refrigeration equipment, the operation of the boiler plant supplying steam for the hospital, the collection

of garbage and maintenance of sanitary conditions, the operation of janitorial service for the administration buildings and staff quarters, and the operation and maintenance of the irrigation canal system; in connection with the construction and maintenance work the Engineering Section operated a complete carpenter shop. In the performance of these functions, which included twenty-four hour operation of the hospital boiler plant and the pumps on the water system, a maximum of twenty-seven appointed personnel and four-hundred eighty-five evacuee personnel was used at the peak of all operations.

Nearly all of the construction work was done by employees of the Engineering Section, the principal exception being the high school which was built under contract. The original contract included the high school and two elementary schools, but the latter two were eliminated by restrictions of the War Production Board. The construction of the high school was under the direct supervision of Mr. Ralph J. O'Rourke, Senior Engineer, as representative of the Project Director, and detailed inspection and checking was done by Mr. Sidney U. Sandvos. Elementary school facilities to replace the two schools eliminated in the contract were obtained by the re-modelling of the block 8H and of a number of the recreation halls in the various blocks.

A. BASIC CONSTRUCTION

The location of the center was one mile west and one mile south of the railroad station at Granada but no track facilities to the center were provided. Request was made by the WRA during the construction period to the USED and to the Santa Fe railroad for side track facilities but the request was denied. As a result, handling costs for all materials used in the operation of the center was very high as almost everything had to be reloaded on trucks and hauled to the center and rehandled to the warehouse or points of use. Coal, mess hall and maintenance supplies, etc., all had to be handled in this way.

This handling was also difficult because the floors of warehouses were at ground level, requiring excessive handling in unloading or loading operations. Request was made by the Project Director during the construction period, to have at least a few of the warehouses built with the floors at truck platform height or to have loading ramps built at each warehouse; both requests were denied with the result that warehouse loading and unloading was unnecessarily hampered. All warehouse floors should be at truck platform height.

The basic construction of the buildings was provided by the USED was done under contract. Lambie Moss Leitell and James were the General Contractors starting work in June,

1942 and completing the project as modified in December 1942. The subcontractors were Burke, MacIndoe-Porter Co. for the plumbing, water system and outside lines, P & E Construction Co. for the sewage plant, Foley Electric Co. for the electric distribution system, and Broome Electric Co. for the interior wiring.

Basic construction of all buildings of the center was of the army T.O. type of cantonment construction, wood frame walls and roofs on concrete foundations; approximately one hundred of the various evacuee buildings were sheathed with one inch boards and covered with asphalt roll roofing paper; the rest of the evacuee buildings and the administration offices, warehouses and Military Police are buildings were covered with granulated siding. The evacuee mess halls and laundry building had concrete floors; the evacuee barrack buildings, with the exception of a few with concrete floors, had brick floors laid on a sand cushion; the administration office buildings and warehouses had concrete floors. Roofs were covered with 75 pound roofing with wood strips every four feet.

The concrete floors in the mess halls, lavatories and laundries and the administration offices and warehouses gave satisfactory service; the brick floors in the barrack build-

ings were not satisfactory due to the fact that these were laid directly on a sand cushion without any other foundation, and in the summer time permitted the access of vermin (ants, mice, cockroaches, etc.) between the bricks; the brick floors were uneven and under use could not be kept in place. In a considerable number of buildings parts of which were below the outside ground surface, these loose brick floors permitted water to come up into the apartments between the brick. The brick floors were made the subject of protest before they were built, but the project director's protest was ignored. Roofs were fairly satisfactory but the weight of roofing used and the method of application were not suitable to the wind conditions in Amache. The strips and roof sheeting was mostly unseasoned lumber as the materials available at the time quickly dried out, and the nails worked loose with the result that the roof itself soon exposed to the winds, without proper support and leaks, resulted in the seams and joints, through the nail holes and where the roofing became cracked. Considerable maintenance after every rain storm was necessary and at the time of closing, further occupancy of the barracks would have required extensive or re-coating of the roofs, and replacing a considerable proportion.

Heating in the evacuee barracks, mess halls and laundries

was provided by standard army space heaters. In the barracks, the heaters in the adjacent apartments were connected to a single chimney consisting of vitrified tile stacks resting on the concrete stove foundations and carried up into the attic of the buildings, with a vitrified tile through the partition to the second stove; the stack was connected with metal stove pipe to a regular metal roof jack. The vitrified tile, both in the sections through the partition and in the stacks, was not satisfactory and the joints were impossible to maintain; prior to the completion of the original contract, a considerable number of these partition tiles were replaced with metallic wall symbols and materials were provided by the USED for the complete replacement of all such pieces.

Space heaters in the recreation hall, lavatories and mess halls were provided with straight metal stove pipe stacks connecting to the roof jacks. The large hot water heaters in the laundry were connected with metal stove pipe to brick stacks.

No evacuee buildings on the project were lined on the inside of the exterior walls; the administration offices were lined with wall board.

The foundations of the various buildings were averaged to the slope of the ground at the location of each building,

- that is, the center of the building was approximately the existing ground level with sufficient excavation into the high ground to permit suitable foundation for this portion of the building with a higher foundation at the other end of the building to meet the particular floor level. In many cases, this resulted in the floor level at one end of the building being from two to five feet below ground surface and the other end of the building being an equal distance above ground surface.

Because of conditions during the period of construction, insufficient grading was done; the excavation as completed was approximately two feet outside the building at floor level with a slope of 1.1 to ground surface.

This was unsatisfactory on account of conditions at Amache. The narrow excavation filled rapidly with trash and sand in the frequent sand storms, obstructing the intended drainage and in heavy rain storms with rapid run off (the type of storm usual in this country) causing floods into the barracks, the sandy soil permitting the percolation of water up through the brick floors.

The hospital buildings were of timber frame construction on wood posts and wood beam foundations resting on concrete footings; walls were sheathed with one inch wood

sheathing and covered with asbestos shingles; roofs were three layer asphalt rolled roofing on one inch wood sheathing supported on wood frame trusses; floors were double with finished flooring laid over the sub floor; all buildings were lined and ceiled with wall board and partitions were finished on both sides.

The walk ways between the buildings of the hospital were not lined outside with the result that in cold weather these walkways were very uncomfortable for the hospital staff and when moving patients between wards, in spite of the fact that the steam heating lines were installed under the roofs of the walk ways. In order to improve these conditions, the walk ways and ceilings were completely relined with wall board.

Plans and details of buildings are shown on the tracings of the "Basic Construction" transmitted with this report. Detailed description of all buildings is given in the appraisers report of "Fixed Assets".

1. WATER SYSTEM

The water system for the Granada Center provided the domestic water supply, pumped water from four deep wells drilled to the Dakota Sandstone; these wells were spaced at intervals of approximately 1,000 feet as shown on the attached lay out plan and were from 700 to 800 feet deep. Three wells

were originally planned, but when capacity tests were made, the fourth well (south of the hospital) was drilled. The well was provided with deep well turbine pumps direct connected to electric motors, with an auxiliary gas engine motor for emergency operations on well No. #3; the original setting of all pumps was 400 feet below the surface. These wells at the time of drilling were artesian having a capacity of approximately twenty-five to thirty gallons per minute each and were tested with a small test pump to partial capacity and the maximum capacity estimated by the USED from this single reading.

These wells were interconnected, with a common delivery pipe from which delivery was made to the open storage reservoir of approximately 200,000 gallon capacity near the pump house. Chlorination was provided on the delivery line to the storage reservoir.

Water from the storage reservoir is pumped into the distribution system with direct connected centrifugal pumps, - two motor driven and one gas engine driven. At the high point of the distribution system a 25,000 gallon red wood surge tank mounted on a 70 foot wooden tower maintained pressure.

The water from the wells was fairly hard but no treatment facilities were provided. Considerable difficulty was found from scaling in the hospital plant boilers and in the hot

water heaters used in the center, frequent replacements of hot water heaters was necessary throughout the life of the center.

One treatment was attempted with Malco solid chemical induced into the well discharge line to the storage reservoir. This treatment improved results but did not completely remedy them so that excessive scaling and damage to hot water heaters continued. It is probable that frequent blowing-off of the hot water heaters would have removed the soft sludge and reduced scaling in the heaters; instructions were issued and training given to the stokers, but, due to the character of the labor employed and to the frequent turnover, these instructions were not carried out and repairing of heaters was one of the most frequent maintenance jobs.

Details of the layout plan and distribution system are shown on record prints transmitted with this report. Details of pumps, motors, engines, etc. are given in the Fire Department report and the appraisers report of "Fixed Assets".

2. SEWAGE SYSTEM

Sewage system for the center from the lavatory and mess halls in the project blocks and from the hospital, administrative buildings and staff quarters, was of the gravity type; discharging to two Imhoff tanks from which the effluent

passed through three aeration ponds and through an open discharge channel to Wolf Creek. The Imhoff tanks and aeration ponds are located in the northwest part of the center area.

Details of the layout and of the construction are shown on the tracing of record prints transmitted in this report.

3. ELECTRICAL DISTRIBUTION AND SIGNAL SYSTEM

Three phase 60 cycle 12,400 volt power was supplied to the center by the REA electric system from their substation in Lamar, approximately seventeen miles from the center, with an automatic voltage regulator at Koen, about two miles from the center. Approximately two miles of new three phase line (from Koen to the center) were built.

No substation was used as distribution in the center and was made at the same voltage as the power supplied; metering equipment for 1000 KVA was provided. Transformers at points of use in the center provided the necessary reduction from the distribution voltage.

All electrical used power motors, - well pumps, water system pumps, refrigerated warehouse units, hospital laundry, motor pool repair shop motors - were three phase; all other small motors including refrigeration units in the evacuee mess halls were single phase. Transformers at each point of use provided for the necessary reduction in voltage. In the

project residence area such transformers served with one block or one pair of blocks according to the layout as shown on the plans transmitted with this report.

WRA installed in the primary lines an automatic oil circuit breaker, adjacent to the metering equipment at the main gate.

4. REFRIGERATION

The basic construction provided two refrigerated warehouses, each having twenty feet by eight feet refrigerated storage space; cooling equipment for each consists of two $7\frac{1}{2}$ horse power York refrigerating machines with automatic controls. Walk-in refrigerating boxes with suitable units were provided for the hospital mess hall, hospital morgue, M.P. mess hall and staff mess hall. Large reach-in boxes with suitable units were provided for each evacuee mess hall; other refrigeration needed such as baby food refrigeration in the blocks, refrigeration in hospital wards and quarters and in the staff quarters was provided by domestic type refrigerators.

An additional refrigerator warehouse (20ft. by 20ft.) chiefly for fish storage was built by the WRA.

5. IRRIGATION

Irrigation facilities acquired with the project included 10,750 shares in the Lamar Canal and Irrigation Company; 3,340 in the Manvel ditch and irrigation company and 129 out of

138 shares in the XY canal.

Both the Manvel ditch and the XY canal had been seriously damaged by heavy floods in 1942 so that neither of these canals could take water out of the river due to heavy silting in the upper portions in each canal. Maintenance consisted of cleaning approximately 4,000 feet of the Manvel canal and over a mile of the XY canal before water could be diverted. This work was completed early in the summer of 1943 and with the exception of structure maintenance and a few incidental cleanings these ditches have since been in continuous service.

Distribution of water through the laterals was performed by an irrigation supervisor and ditch rider, both appointed personnel; maintenance of structures, installation of new structures and cleaning of ditches was performed by evacuee employees under the supervision of the above men.

The Lamar canal is a cooperative ditch in which WRA owned approximately forty-one percent of the shares; the Granada Project was located at the end of the Lamar canal and the distribution of this water through the project laterals, and the maintenance of these laterals and structure was performed by WRA.

The Manvel ditch is also a cooperative ditch of which the government owns approximately sixty-six percent of the shares and delivery of water was made through the same project laterals.

The XY canal supplied water to that portion of the project known as the XY ranch and was almost entirely owned by the government (132 out of 1938 share).

At the time of acquisition due to heavy floods in the Arkansas River no diversion of water were possible in the Manvel and XY ditches.

B. WAR RELOCATION AUTHORITY CONSTRUCTION

The principal items of construction during the operation of the center was the high school which was built under a contract which originally provided also for two elementary schools. The construction of the elementary schools was eliminated by restriction of the War Production Board so that only the high school was completed. Supervision of construction of checking was under the direction of the Engineering Section.

The principal construction jobs performed by WRA itself were the Staff quarters, the cooperative store and warehouse, finance office building, motor pool office and equipment repair shop, root cellar, meat cutting shop, and two buildings for the junior high school.

Considerable amount of reconstruction and remodeling was also done, including the lining of all the evacuee residence barracks and mess halls with wall board for insulation, the laying of linoleum in the hospital buildings as well as the remodeling of other buildings to meet changing requirements.

This later work included remodeling block 8H for elementary school purposes, additional evacuee apartments in recreation halls, remodeling of two recreation halls for use by the silk screen, the remodeling of four M.P. barracks for staff personnel living quarters etc.

The work performed by WRA and the cost thereof are shown on the layout prints attached to this report.

C. LAND IMPROVEMENTS

Very little land improvement was done on the project. The lands acquired for agricultural purposes were under cultivation and were adapted for the crops needed for supplies for the center; irrigation ditches and laterals had been constructed and regular maintenance work was all that was required.

In the course of the agricultural operations some changes were necessary due to the variety crops and to the putting under cultivation of some land which had not been farmed for several years. This work involved the following items; 300 acres leveled land; developed areas 900 acres; lateral construction miles 50.

Roads on the project and in the center were adequate, with the exception of an access road. As completed by the USED the center was accessible by a road from Granada and a short road to highway 50, one mile west of the center. To provide direct access to the main gate from Highway 50 a road was constructed

along the center line of the section 11, running directly north one half mile from the main gate to Highway 50. This was a class B road with 24 feet top width; the foundation was limestone rock material approximately two feet thick, filled with earth and limestone fragments and surfaced with a six inch top layer of gravel.

1. FENCING

Fencing consisted chiefly of repairs to the fences existing along the boundary of the project and the construction of fences where none had been built. The boundary fence was a standard four wire fence on cedar post and a total of approximately 14 miles was built and approximately twenty miles repaired.

D. MAINTENANCE

Maintenance of project buildings was handled by a crew of evacuees under an evacuee chief foreman and three to four evacuee sub-foremen as the work required, under the supervision of the Construction and Maintenance Engineer. This crew also maintained mess hall ranges and heating stoves in the evacuee barracks and grates of hot water heaters and furnaces in staff quarters; they also performed miscellaneous jobs of reconstruction and remodeling as conditions required and as normal maintenance work permitted.

The T.O. type required very little maintenance except for repairs of fire damage and maintenance from vandalism. There was no difference in maintenance requirements of the two types of wall construction, - granulated siding and wood sheathing covered with rolled roofing paper. Roofs required considerable and regular maintenance after heavy severe storms, due probably to the light weight material used and to the fact that the roofs were laid on unseasoned sheathing and the strips were also unseasoned, so that the nails became loose as the wood dried out. This permitted the roof to be subject to vibration from wind with resulting cracks and damage.

The hospital buildings required no maintenance whatsoever, except for one small section of roofing on the administration building which was blown off in a storm. Only a small section of the top layer of the three-layer roof was damaged.

Maintenance of the plumbing and water and sewer services in laundries and mess halls was carried on by a crew of evacuee plumbers under the appointed foreman plumber under the supervision of the Construction and Maintenance Engineer. Considerable maintenance of plumbing equipment was necessary because of vandalism and improper use; a great deal of maintenance was required on water piping because of poor materials (which were all that could be obtained at the time of construction). The men's

shower rooms were originally provided with an automatic thermostatic valve to control the temperature of the water in the showers, - the valve controlling the water supply to two shower rooms each with six showers. This system was unsatisfactory, - because all showers had water of the same temperature and variation to the individual showers was not possible; second because the automatic valves required high maintenance and after a short period repair parts were unavailable so that hand regulating valve had to be substituted for the automatic valve. The women's shower rooms were provided with individual hot and cold water valves at each shower.

Almost constant maintenance was required on all water piping and on the distribution system, due to the poor quality of materials used in installation. Very little maintenance was required on the gravity type sewer lines and system except the removal of obstructions caused by the evacuees dropping refuse into the sewer manholes. It became necessary to cement the manhole covers in place to prevent this condition.

The mess halls were originally equipped with porcelain grease traps on the drain lines from the sinks, placed inside the mess hall building for convenience in cleaning. These grease traps proved unsatisfactory as they were of insufficient capacity and

it was difficult to get the evacuee mess hall crews to clean them regularly. On this account, they caused odors and stench in the mess hall kitchens, and were all soon removed, and replaced by 2 1/4 inch tile grease traps in the sewer lines outside. These changes eliminated the necessity for frequent cleaning and eliminated the odors inside the mess halls.

Maintenance of service lines and house wiring was carried on by a crew of evacuee electricians and helpers under the appointed electrical lineman and electrician under the supervision of the Construction and Maintenance Engineer. Each barracks building was wired with a single circuit of No. 12 or No. 14 wire (depending on materials available) with one ceiling outlet in each of the six apartments. These wire sizes would have been sufficient for the six outlets but multiple drop cords for additional outlets, and appliances were uniformly used in all apartments with the result that excessive overload of the sockets and wiring circuits occurred with resulting low voltage and unsatisfactory operation. Considerable maintenance in the replacement of the sockets was necessary; later in the life of the project, due to scarcity of materials, great difficulties were encountered in obtaining replacement sockets. In future housing of this character with families occupying a single room additional outlets should

be provided; at least one wall plug receptacle and one additional ceiling outlet should be provided in each room to prevent fire hazard due to lamp cords etc. and overloading of the ceiling receptacle. While very few fires were caused from this condition and these caused small damage, it was only good fortune that prevented serious results from the hazard of the general condition of electrical overloading on the receptacles and wiring of the evacuee barracks.

1. WATER SYSTEM

The distribution main for the center required an excessive amount of maintenance due to the poor materials used in construction. Suitable materials were unavailable and in emergency second-hand pipe and used wall casings were installed; this material not only was of poor quality but, since proper fittings were also unavailable, welded connections were necessary and good welds could not be obtained on the materials used.

The irrigation systems required heavy maintenance, - in fact reconstruction due to damage from the floods in 1942. These floods had left from two feet to five feet of silt in the upper ends of both the Marvel and the XY ditches and the head gates of both canals had been damaged; the XY ditch was also in poor condition throughout its length. Cleaning of the silt in both ditches was completed in the summer of 1943 and temporary repairs made to the head gates so that diversions of water from the reservoir could be made. Subse-

quent cleanings of other sections of both canals was done in the course of regular maintenance work as was the reconstruction and repair of turn out gates and other construction.

Unusual building maintenance jobs consisted chiefly of repairs after a few fires in mess halls and barracks and the repairing of the motor repair shop after a storm. A violent wind storm on July 24, 1945, blew off approximately one half of the roof of the repair shop taking the roof trusses with it; two oil fired heaters suspended from the roof trusses were also carried away; the damaged section of the roof was broken into two parts which were dropped approximately one hundred-fifty feet from the building. Walls of the damaged section were left standing but were out of line, as were also the center line of posts. The roofs and trusses were replaced after the walls had been re-aligned.

The greatest equipment maintenance was the repairing of the pumps in wells No.#1 and No.#2. The impellers and shaft bearings became badly worn and the operation of the pumps was unsafe. The pumps were pulled and the impellers were sent to the manufacturer for repair and the new bearings installed on the pump shaft. In order to increase the capacity of these wells, the pump setting was increased at the same time that the repairs were made.

F. OPERATIONS OF UTILITIES

The operation of utilities was assigned to the person in the

organization to whom the service was of principal importance, for example, sewage disposal (and garbage collection) were under the supervision of the sanitary engineer; water system operation and electric power under the Construction and Maintenance Engineer, and Refrigeration under the immediate direction of the Mess Division with supervision by the Engineering Section.

1. WATER SYSTEM

The water system was not provided with sufficient pressure storage to provide the needs of the center for any appreciable period so that twenty-four-hour operation of the system was required; for the first year and a half, the operation was performed by the Civil Service Pump Operators and after July 1, 1944, by evacuee operators, - two on each shift-under the supervision of a Civil Service Pump Foreman, who also supervised the maintenance and repairs of the pumping equipment.

The four wells supplying water were originally artesian, having a capacity of twenty-five to thirty gallons to each minute. At the time of drilling one test of capacity was made with a small pump and the probable capacity of each well estimated from this one reading. These capacities as estimated by the USED were; well No.#1 250; well No.#2 --250; well No.#3--350; well No.#4--350. This gave an estimated total capacity of 1200 gallons per minute, which was ample, according to the designed figures of one hundred gallons per

day per capita for a maximum expected population of 8,000 and should have permitted reserve capacity for emergencies. However, the actual production of the wells did not reach its estimated amount, and within 18 months from the opening of the center, operation tests showed that the capacities were:

Well No. #1	---	170	gallons	per	minute
Well No. #2	---	182	"	"	"
Well No. #3	---	242	"	"	"
Well No. #4	---	<u>209</u>	"	"	"
TOTAL		803	"	"	"

Also consumption of water by capacity was nearer two hundred gallons per capita per day than the estimated one hundred gallons. This resulted in the necessity of running all well pumps from twenty-one to twenty-three hours per day to meet the demands and running the pressure pumps delivering to the disposal system the same number of hours, so that there was no reserve capacity. In the event of trouble with any of the pumps a temporary shortage of water resulted. This continuous operation of the well pumps also resulted in rapid wear so that it was necessary to replace the shaft bearings and to recondition the pumps and impellers in wells No.#1 and No.#2 in the winter and spring of 1944. At this time, in order to increase the well capacity the pump settings on these wells were increased in depth. Well No.#1 to 500 feet and well No.#2 to 460 feet. Plans were made at the same time to replace

the bearings and increase the setting of the pumps in wells No.#3 and No.#4, however, reduction in population due to relocation and the resulting reduction in water used enabled the operation of these pumps to be carried on to Center closing without this work being done.

Excessive use of water was due to the character of the population, who apparently used more water per capita than the normal average use and also to sprinkling of the sandy soil in the blocks in order to prevent dust in the frequent dust storms. It was evident for the particular conditions of Amache that the usual design figures of 100 gallons per day per capita was not enough; also the small capacity of the distribution lines and static pressure tank, - 25,000 gallons - was not sufficient, as it required the continuous operation of the pressure pumps. Capacity of these pumps as installed was sufficient to maintain a greater storage which would have permitted less continuous operation of the pressure pumps. It is recommended for an installation of this size that a minimum storage capacity on the distribution system be at least 100,000 gallons and more desirably 200,000 gallons.

All of the well pumps were electric power driven, and well No.#3 had an auxiliary gasoline engine for emergency use; two of the pressure distribution pumps were motor driven and a third was provided with gasoline engine drive. Electric power outages were usually of

short duration so that little difficulty was experienced from this cause; however, several power outages of considerable duration due to storms and one due to damage to transformers on two wells on the center resulted in water shortages. Other than these there were only a few periods when restriction on the use of water by the residents was necessary to maintain sufficient supply for fire protection.

2. SEWAGE DISPOSAL

The operation of the sewage disposal plant was under the Sanitation Engineer in the Engineering Section. This gravity system required no operation except the addition of chlorinated lime at the entrance to the Imhoff tanks, and the occasional pumping of sludge out to the Imhoff tanks.

The design figures were 75 gallons per day per capita, but this quantity was greatly exceeded, and the capacity of the disposal plant was insufficient. The Imhoff tanks were completed and the system put into operation in November 1942, when the weather was cold. No activated sludge was introduced and the normal production of sludge was hampered by the cold weather so that the Imhoff tanks did not function properly until warm weather in the spring of 1943 permitted formation of active material. As a result considerable odors were generated both in the Imhoff tanks and in the aeration ponds and as stated above the quantity through

the plant was much greater than estimated and the plant was not capable of handling this quantity without odor.

3. ELECTRIC POWER

Power requirements were purchased from the REA and no regular operational duties were necessary. Being on the end of a seventeen mile transmission line rendered minor outages from storms fairly frequent occurrences. For the mutual protection of the center installation and of service on the balance of the REA lines in case of trouble on the center, WRA installed a primary automatic reclosing oil breaker at the entrance to the center. This equipment functioned satisfactory.

The power requirements of the center were of two classes; - power for motor driven equipment and for electric stoves, and lighting requirements. A total of approximately 300 horse power in motors and 400 KVA in electric stoves, (staff quarters and hospital wards) were installed; the balance of the power requirements was for lighting.

The original design estimated on 2,000 KVA for a community of 10,000 population were not reached in Amache, which had a peak demand of approximately 960 KVA with a maximum population of 7,500. The power use varied greatly between the summer and winter months due to the fact that the greater part of the demand was for the lighting requirements; in the winter months the use reached a

peak of 393,000 KWH with a maximum bill of \$4,227 for the month of December 1944. A

Ordinarily the replacement of primary and secondary fuses was all that was required with the elimination of occasional minor sources of trouble in the distribution lines.

One serious disturbance, probably lightning, burned out six of the well pump transmissions and two of the distribution transformers and the repairs of this equipment was the greatest single item of cost.

Power distribution lines were largely built of second hand material because of restrictions on new material at the time of construction; in spite of this condition there were relatively few distribution line breaks. Considerable difficulty was found in the distribution lines within the blocks; due to ground topography, the buildings in many blocks were depressed and the distribution wires between buildings was hence very low. Trucks and other uncontrolled traffic between the barracks at these points frequently resulted in damage to the distribution lines.

The signal system of fire reporting phones was installed and maintenance by the telephone company and the only maintenance work required was the replacement of lights.

4. REFRIGERATION

All equipment was automatically controlled so that periodic inspection was all that was required.

This inspection was carried out by an evacuee crew of from two to four men (depending on an availability of satisfactory labor) under the supervision of an appointed refrigeration foreman.

All of the original equipment was originally supplied with Freon refrigerant, but during the period of the war and the critical demands for this material, it was necessary to change over to Methyl chloride. This change was accomplished in most of the equipment satisfactorily, but it was necessary to replace a few of the expansion valves. Capacity of the equipment after the change were satisfactory for the needs and no difficulties were experienced.

5. HOSPITAL BOILER HOUSE

The operation of the boiler plant at the hospital supplied steam for heating, laundry and other purposes and was under the supervision of the Engineering Section. The plant was operated by Civil Service boiler men as no satisfactory evacuees were found for this work. The plant operated at 100 bl. boiler pressure and supplied steam at this pressure to the laundry and for the operation of pumps etc., in the boiler room; with reducing valve steam at 50 lb. pressure was provided for sterilization, mess hall cooks etc. and at 15 lb. for the heating system. All

return lines were supplied with steam traps and the condensed steam returned to the boiler plant.

The boiler equipment was second hand and minor difficulties occurred, such as leaking flue and connections, were easily handled in normal maintenance. Three boilers were provided and during most of the year the operation of one boiler at a time was sufficient.

After the completion of operation the plant is in good condition except for normal wear and a crack in the mud ring of boiler number two.

JANITORIAL AND SANITATION SERVICES

The collection of garbage and rubbish from the evacuee block and other areas, the janitorial services in the evacuee blocks, the administration buildings, and staff quarters were functions of the Engineering Section.

A report is attached from the Engineering in charge of the Sanitation and garbage disposal crews. The work of the garbage collection included collection and delivery of garbage used for hog feeding, the collection and disposal of other wet garbage and the collection and disposal of ashes and trash, and of offal from the slaughter house.

These operations required a total of between 75 to 80 evacuees under the supervision of an evacuee foreman and three sub-foremen.

Janitorial services in the administration office buildings in-

cluded the sweeping and general clean up of these buildings and attending to the furnaces and space heaters; in the staff quarters, attending to the furnaces and hot water heaters was all that was done by the Engineering Section. Those apartments which were provided with individual heating stoves attended to their own coal and ashes. A crew of 24 janitors and stokers was required at the peak of operation.

Janitorial services for the laundries and lavatories in the evacuee blocks and attending the hot water heaters was set up as a function of the Engineering Section by supervision and satisfactory operation under these conditions could not be obtained. The janitors and hot water heater stokers in each block were placed under the direct supervision of the block managers in each block; this supervision worked out to the mutual advantage of the residents and the janitors and stokers.

Janitorial service in the hospital was provided by the hospital staff.

LANDSCAPING

Lawns and shrubs were planted around the hospital buildings, the high school, the administration office buildings, and the staff quarters in order to improve the appearance and reduce the blowing of sand to improve the comfort of the employees in these areas. The sandy soil of the area was not suitable for lawns or shrubs and

considerable and frequent fertilization and very frequent watering were required. At the maximum a crew of eighteen men was required for the maintenance of these areas.

IRRIGATION

The operation of the irrigation systems was performed by the irrigation superintendent and one Civil Service ditch rider with a crew of evacuees for cleaning and maintenance. The operation of all canals and laterals required considerable and frequent cleaning to remove brush and weeds blown in during the frequent wind storms, which usually accumulated in "jams" causing stoppage of the ditches and overflows and damage to the ditch bank. The operation of approximately seventeen miles of main canal and twenty miles of lateral, -- as far as the control and distribution of water -- was satisfactorily performed by the irrigation superintendent and the ditch rider; however, this required long hours of duty and better results would be obtained with two ditch riders.

LANDSCAPING, CONSTRUCTION AND MAINTENANCE

I entered the service of the War Relocation Authority on August 4, 1942. My assigned duties were:

1. Planning and directing all landscaping within the center.
2. Supervision of maintenance of the streets, roads, irrigation and drainage within the center.
3. Supervision of construction and maintenance of roads throughout the project.

The soil within the center for the most part, consists of fine blow sand, with little or no clay binder, which has been a continuous source of trouble through erosion by both wind and water. Approximately eight acres of soil around the administration buildings, staff quarters, hospital and high school was stabilized and seeded with grass, resulting in good lawns.

Due to the steep grade in the administrative area, terracing with rock retaining walls was necessary. The only rock available close to the center is a soft limestone, which absorbed water. During the winter the water in this rock freezes and thaws, causing the walls to disintegrate. Sidewalks were constructed around the administration buildings with the same material and with the same results.

A total of 900 chinese elm trees, twelve to eighteen feet in height, were planted during 1943 and 1944 with excellent results. Also, a total of 1400 assorted shrubs were planted dur-

ing the same period of time. While our losses were negligible, some of these shrubs have not grown as well as expected, partially due to the sand blasting they have received during the numerous high winds.

It was necessary to remove the drifted sand and re-seed some of the lawns around the high school and hospital, three different times. Finally, we built a barricade against the sand, using salvaged cinder blocks.

Removal of sand from drainage ditches and culverts in the center has been a continuous operation. All culverts at the street intersections were set too deep in the ground, necessitating the construction of rock retaining walls and drops in the drainage ditches.

During the construction of the center the land was denuded of all vegetation. An effort was made to stabilize the sand in the fall of 1942, by planting fall rye for a cover crop. We also planned to seed this area with hardy grasses the following spring. This plan was abandoned because we could not get the evacuees to cooperate by walking in established paths and confine their play activities to definite play grounds.

Little or no preliminary grading was done prior to the construction of the buildings within the center. This constituted a great handicap in all landscape operations, especially drainage.

The limestone used in the sidewalks and rock masonry, the semi-rotted straw and manure used to stabilize and fertilize the soil within the center, was available on the project, without cost.

LANDSCAPING OF HOSPITAL GROUNDS

1. Removed drifted sand from around the buildings, blown in by high winds. Some of these drifts were as much as three feet in depth. This work was done with heavy equipment.
2. Graded grounds with heavy equipment and fine graded with hand labor.
3. Soil was stabilized and fertilized with semi-rotted straw and manure. Semi-rotted straw and manure was spread over the ground, then worked into the soil with a tractor with cultivator attachments.
4. Constructed sidewalks; walks edged with limestone, backfilled with shale and clay, top cover, one inch of sand.
5. Planted trees and shrubs.
6. Seeded area to grass; grass mixture, $\frac{1}{3}$ Ky. Blue, $\frac{1}{3}$ Red Top, $\frac{1}{3}$ Domestic Rye.
7. Constructed one coal bunker, "rock masonry".

LANDSCAPING OF ADMINISTRATION AREA

1. The slope through this area is 4.34 per cent.

2. The grading of this area was a cut and fill operation.
(Heavy equipment used)
3. This area was terraced.
4. Seven rock masonry retaining walls and two rock masonry coal bunkers were constructed.
5. Sidewalks were constructed with limestone, joints grouted with cement.
6. Soil was stabilized and fertilized.
7. Trees and shrubs were planted.
8. Parking areas with log guard rails were constructed.
9. Grass seed used in lawns, 1/3 Ky. Blue, 1/3 Red Top, 1/3 Domestic Rye.

LANDSCAPING OF HIGH SCHOOL AREA

1. Area graded with heavy equipment.
2. Service road and parking areas constructed. Service road and parking areas surfaced with shale and clay with a top coating of gravel.
3. Sidewalks were constructed; walks edged with limestone, back-filled with shale and clay, top cover, one inch of sand.
4. Soil in grassed areas was stabilized and fertilized.
5. Trees and shrubs were planted.
6. Grass seed used, 1/3 Ky. Blue, 1/3 Red Top, 1/3 Domestic Rye.
7. Providing drainage was a difficult problem in this area.

LANDSCAPING OF STAFF QUARTERS AREA

1. Area graded with heavy equipment.
2. Service road and parking areas were constructed, road and parking areas surfaced with shale and clay with a top coating of gravel.
3. Seven, rock masonry, coal bunkers were constructed.
4. Two sets (4 line) clothes lines, for each building (4 apartments) were constructed.
5. Sidewalks were constructed; walks edged with limestone, back-filled with shale and clay, top cover, one inch of sand.
6. Soil in grassed areas, was stabilized and fertilized.
7. Trees and shrubs were planted.
8. Grass seed used, 1/3 Ky Blue, 1/3 Red Top, 1/3 Domestic Rye.

LANDSCAPING OF THE CEMETERY

1. Graded approximately one fourth mile of road to cemetery.
2. Planted 66 chinese elm trees and approximately 100 shrubs.
3. These trees and shrubs have not grown very well, due to the fact that it was necessary to haul water in a water tank for irrigation.

L. G. Temple
Ass't Construction & Maintenance Supt.

SANITATION UNIT

1. About September 15, 1942, the sanitation unit was placed under my supervision, prior to that date it was under the supervision of the welfare section.

It was quite obvious that little or no supervision or control had been exercised over the evacuees, as they were literally running the unit.

This lack of control, to a great extent, was due to the fact that the evacuees were received while the center was still under construction and no time was allowed to set up a plan of procedure in any of the various units. However, during this period of time, a precedent was established which was hard to correct.

2. In November 1942, a Sanitary Engineer was employed and I was released to proceed with my regularly assigned duties.
3. In April 1944, Mr. Dakan, Sanitary Engineer, resigned and the sanitation unit was again placed under my supervision.
4. The duties of the supervisor of the sanitation unit were as follows:

- (a) Requisition sanitary and domestic supplies for the project as needed and direct the issuing of supplies.
- (b) Direct the operation of the sewage disposal plant. Removal of ashes, garbage and rubbish. Washing of garbage cans daily.

- (c) Each mess hall was provided with garbage cans.
Garbage placed in cans marked "hog feed" was
hauled to the WRA hogs. Other garbage, rubbish
and ashes was hauled to a well maintained dump.
- (d) Offal from the slaughter house was hauled to a
pit and covered with quick lime, with a final cov-
ering of about two feet of earth.

Record of Garbage Removal
Month of February, 1944

Evacuee population Feb. 1, 1944 --- 6766
" " " 28, " --- 6605

60 loads (stake truck) dry rubbish; hauled to dump.
971 (loadlugger buckets) ashes; hauled to dump.

1600 cans - 85 lbs. to can -- 136,000 lbs. (hog feed) hauled
to hog farm
112 loads (dump truck) 500 lbs. to load; 56,000 lbs. hauled to
hog farm
Total amount (hog feed) hog farm; 192,000 lbs.

Average population Feb. 1944 --- 6685
1.03 lbs. per person, per day (hog feed) hauled to hog farm
February 1 -- 28, 1944

L. G. Temple
Ass't Construction & Maintenance Supt.

MANVEL DITCH AND IRRIGATION COMPANY

The government acquired in 1942, 3340 shares of a total of 5250 shares in this mutual ditch association which has water rights to divert 54 sec.-ft. of water from the Arkansas River. Diversion up to this quantity have never been made due to limited ditch capacity and the fact that river flow conditions in the past were seldom such that the ditch company could exercise its water right. The principal diversions of water in the past has been early spring flows and waste water from the Lamar canal through the Manvel lateral of the Lamar canal; the water so received was distributed through the Manvel ditch. Heavy floods in the spring and summer of 1942, almost washed out the head gate and filled the upper 4,000 feet of the Manvel ditch with silt so that no diversion from the river were possible. During the season of 1942, the lower end of the Manvel ditch was used only to distribute waste water from the Lamar canal.

The ditch is operated in the usual manner of the mutual ditch with the WRA participating with the other share holders. Regular assessments were made with a special assessment in 1943, for reconstruction. The upper end of the ditch was cleaned in 1943, so that diversions were possible in the latter part of the summer and fall of that year. In order to hold the expenses as low as possible no repairs were made to the head gate. Repair work on the head gate

also was not done for the additional reason that river channel conditions at the head gate are such that the present channel or other work in the Arkansas River and the future location of a head gate will be governed by the extent and kind of such work. The present head gate is not in satisfactory condition but can be operated and it is recommended that its operation be continued as long as possible and until such time as a new head gate can be built in a satisfactory location after the probable river channel control work is completed.

It is expected that the installation of gates in John Martin Dam and agreement between Kansas and Colorado on the distribution of water from the Dam will be in the near future improve stream flow conditions in the Arkansas River so that the Marvel Ditch can divert the full quantity of water under its water right, regularly and continuously through the irrigation season. At such time it will be necessary to enlarge the canal section to handle the larger quantities of water and water will be available with increased amounts on the present irrigated lands or for additional land with additional shares being issued for the use of such water.

For the present diversion and present use of water, the canal structures are in fair condition with only routine cleaning and repairs necessary to maintain service. With the increased flows

to be diverted later new structures are recommended; structures and turn outs in the main canal should be replaced when the canal section is enlarged. The present head gate may continue to be serviceable if there are no severe floods, and for the reasons outlined above, no extensive repairs are recommended at this time. The present waste way structure needs repairs, chiefly the replacement of the floor below the waste gates.

The grade of the ditch below the rating flume is very flat and in order to increase the capacity of the ditch and of the boxes under the railway and Highway 50, the ditch should be straightened between the point just after it passes over Highway 50 and before it reaches the cultivated land west of Carlton. In this section there are a number of long curves and the length of canal would be considerably reduced by a straight line across the pasture lands of Smith Arroyo. This shortening of the length of canal would increase the draw on the boxes under the railroad and Highway 50 and also on the canal section between the railroad and the rating flume and would decrease silting in this section.

At the present time the waste ditch from the Manvel lateral of the Lamar canal discharges into the Manvel ditch opposite the Manvel waste way and above the rating flume, with the result that all waste water received from the Manvel lateral is measured and

included as water diverted from the river. At some future date when replacement of the waste way gates are necessary) it is recommended that a new waste way structure be built approximately 200 feet west of the present location and a new rating flume be built near this new waste way; in this way the waste water from the Manvel lateral will enter the Manvel ditch below the rating flume and will not be included as river diversion. If the present location of the waste way structure and rating flume are maintained, it is recommended that a new waste ditch from the Manvel lateral be built to deliver below the rating flume.

At the point where the Manvel ditch crosses the Carlton lateral of Lamar canal where the combination structure also permits delivery of water from the Manvel ditch to the Carlton lateral the present concrete structure is satisfactory for present conditions but it is beginning to deteriorate and should be redesigned and rebuilt when the capacity of the canal is increased.

XY CANAL

The XY Canal is a private corporation for the delivery of water to the lands on the XY ranch adjacent to Granada. It is not a mutual ditch as are most of the ditches in the Arkansas Valley; these mutual ditches actually own the water rights for diversion from the river and the canal and structures are owned mutually by the owners of the land for which water is diverted.

The XY ditch is a private corporation handling the water diverted from the river under water rights owned by the owners of land to which water is delivered. That is the water rights are actually owned by the land owners and not by the ditch company. The largest owner of land (and water rights) was the XY Ranch. The water rights for the diversions of 69 sec.-ft were originally owned by the XY ranch, and applicable to lands owned by it; sales of several small parcels of land with proportionate water rights, have resulted in private ownership of a few shares of stock.

The government acquired in 1942, 129 shares out of a total of 138 shares issued by the XY Canal company; six shares are held by private owners of small parcels of land near Granada; the other three shares have not been located.

The water right for the diversion of 69 sec.-ft. has excellent priority and in the past, diversions have been possible at all

times that the ditch itself was in condition to deliver water; the XY water rights is prior to the Manvel ditch. River flow conditions due to John Martin Dam should improve in the future so that the right to divert 69 sec.-ft should be increasingly valuable. In the past diversion of the full amount has never been done due to the small acreage of land cultivated at any particular time and to the fact that the ditch capacity was not sufficient.

The river floods in 1942, damaged the head gate and filled up the upper mile of the canal with silt. This silt was removed in 1943, by WRA and the head gate put in the operating condition and the rating flume at the Carlton road repaired and a recording guage installed. Water has been diverted practically continuously throughout the irrigation seasons of 1944-45. During this period the canal below the town of Granada was cleaned and enlarged and several long curves were corrected by building sections of new ditches; additional cleaning between the town of Granada and Koen were also cleaned; and new turn outs installed. At the present time this cleaning is being continued from Koen to the rating flume and will put the ditch in good condition.

The present ditch is not large enough to carry the full quantity of water allowable under the water right and the upper section of the canal should be enlarged. The present ditch will, however,

carry sufficient water for all the land on the XY Ranch, which has been, and can be, cultivated at the present time.

The present head gate is in very poor condition although it still can be operated; it should be replaced. The present site is the most desirable location for a distance of one or two miles along the river and a new head gate can be built adjacent to the present structure which will correct a curve in the canal just below the head gate. When this new head gate is built it is recommended that a low cable and brush dam be placed across the river 75 to 100 feet below the head gate.

The canal between the rating flume and the Marvel Ranch has a very flat grade and it also has, a number of irregular curves between the Carlton road and the Harry Higbee Ranch. It is recommended that the canal be straightened between these two points which will reduce the length and increase the grade of the canal and its capacity.

The XY Canal has no waste way. The waste way originally constructed was filled up with silt by the floods in 1942; however, its location is not satisfactory, because it does not have enough drop to keep the upper end of the canal free from silt. When the canal east of the Carlton road is straightened it is recommended that a new waste way be built starting approximately a mile east of the Carlton road and running northeast to the river across the state land in section 32 T22SR45W. This waste way will

discharge above the intake of the Buffalo ditch so that water can be diverted through the upper end of the XY and wasted to the river for the Buffalo to pick up. The location of this waste way will be below the present rating flume so that a new rating flume must be built when the waste way is constructed. It is recommended that a larger capacity flume be built at this time so that the full water rights can be diverted.

In addition to the physical changes recommended to handle full quantities of the water rights, it is recommended that this ditch be mutualized with the present (or future) owners of the land to whom the water rights belong, -- that is that the shares of the XY ditch be porportioned among the owners of the land as shares in a re-organized mutual ditch company operated by the land owners as share holders in the ditch. At the present time the minority share holders pay to the XY ditch company a certain fee for the delivery of their water but all the expenses of operation and maintenance of the ditch is paid by the owner of the ditch (which in the past was the XY ranch). The amount paid by the minority owners did not depend on actual expense and in many cases were a very small share of what should have been paid. Making the ditch company a mutual organization will distribute the actual cost equably.