

**KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 86-12**

TECHNICAL SPECIFICATIONS FOR DRILLING AND TESTING NEAR
THE ARKANSAS RIVER BY GREAT BEND, KANSAS

by

Marios Sophocleous

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SCOPE AND PURPOSE OF WORK

It is the intent of these specifications to cover the construction and development of a high yield irrigation well and a minimum of two test holes (to be converted to 5 inch observation wells) as well as test pumping at a location near the Arkansas River within ten miles of the City of Great Bend, Kansas.

The purpose of test pumping near the Arkansas River within a distance not exceeding 500 ft from the River and not less than 50 ft from the River, is to attempt to bring the water table elevation at the pump test site below the bottom of the stream during the pump testing period. To ensure this requirement it is expected that the well will be pumped continuously at a high rate of approximately 2000 gpm and for a period of time not to exceed 15 days. It is required that the contractor would provide the appropriate pumping facilities and supervision for KGS staff to run and monitor the pumping test as well as monitor water levels in observation wells during and after the test (groundwater recovery monitoring), right after completion, development and testing of the irrigation well, as required by KGS.

It is expected that all drilling and testing of the irrigation well will be completed during March or not later than early April 1986, before the irrigation season is underway.

EXPECTED CONDITIONS

The Arkansas River alluvium near the stream consists mainly of medium to coarse sand and fine to medium gravel of unconsolidated or relatively loose state, and characterized by shallow water table. Therefore, some caving during drilling may occur and should be expected. It is expected that the depth to bedrock (Dakota Formation) will not exceed 100 ft.

Tentative results from a KGS-drilled test hole near the expected drilling location, T.19S, R.12W, Section 32, shown in Fig. 1, show that the alluvial material is relatively uniform with depth, consisting mainly of coarse sand and fine gravel. Bedrock (Dakota clay) was encountered at 74 ft at the test hole location. A sieve analysis conducted at KGS for a representative sample from a depth of 50 - 60 ft. indicates an effective grain size of approximately 12 thousands of an inch, and a uniformity coefficient of 3.5. The grain size curve which is believed to be representative of the alluvial material at the drilling location is shown in Fig. 2.

It is required that all KDHE rules and regulations regarding construction, development and testing of the proposed well as well as observation wells will be followed.

KGS may request temporary halting of operations until a borehole geophysical survey is conducted at the site, in which case stand-by time would be paid.

It is expected that the contractor's drilling experience be incorporated into this project so that unforeseen conditions are taken into account. The driller shall visit the site so that the

extent of the work to be done and the local conditions be fully understood. It should be noted that no electric power facilities are available at the site.

TEST DRILLING

Hole Location and Purpose: The contractor is to construct at least two test holes down to bedrock in the vicinity of the proposed irrigation well, of at least 8 inches in diameter. It is anticipated that the test holes will be located in Section 32, Township 19S, Range 12W. The purpose of the test holes is to obtain information regarding depth to bedrock, thickness and nature of drilled formations, and static water level. In addition, these test holes will be converted to 5-inch observation wells for recording water level information as specified further below.

Drilling method: The contractor shall provide all equipment that will assure proper execution of the test drilling and sampling program specified herein.

Driller's Logs: During the drilling of the test holes, a daily, detailed driller's report shall be maintained and delivered upon request to KGS. The report shall give a complete description of all formations encountered at every one foot interval drilled, number of feet drilled, number of hours on the job, shut down due to breakdown, the water level in the well and such other pertinent data as may be requested by KGS. Notation

of circulation or fluid losses shall be recorded in the log. A KGS representative would be available at the site to assist in drilled formation description and recording.

Formation sampling method: At least one test hole shall be sampled by the contractor with the method of sampling left to his discretion, but approved by KGS, provided representative half-gallon samples are identified at least every other foot from the land surface down to bedrock, and stored and labelled appropriately so as to permit a thorough evaluation of formation properties. A KGS representative would be available at the site to assist in labelling and storing the samples.

Conversion of test holes to observation wells: The test holes shall be converted to observation wells using 5 inch PVC casing. The test holes shall be screened and cased using materials provided by KGS. All KDHE regulations shall be followed for completing these wells. After the casing and screen have been set, the contractor shall complete these wells according to KDHE regulations and shall pump water from the observation wells until the water clears.

IRRIGATION WELL CONSTRUCTION

After KGS has made a decision as to the exact location of the irrigation well from the basis of the drilling reports of the test holes, the irrigation well shall be installed at the location designated in Section 32, Township 19S and Range 12W. The depth of the well will be down to bedrock. It is anticipated that the depth of the well will be approximately 100 ft. or less.

Method of Construction: The contractor shall choose the construction method(s) to be used, such as the reverse circulation drilling method or other suitable method subject to approval by KGS.

Diameter of the well: The diameter of the drilled hole shall be a minimum of eight inches larger than the outside diameter of the casing, which shall be 20 inches in diameter or larger.

Drilling fluid control program: Material used by the Contractor to prepare the drilling fluid shall be composed of fresh, non-polluted water and sodium bentonite type drilling clay. All drilling fluid additives used will comply with recognized industry standards and will be used as prescribed by the manufacturer. The drilling fluids program should be agreed to by the contractor and KGS. The contractor shall be responsible for maintaining the quality of the drilling fluid to assure 1) protection of water bearing and potential water bearing formations exposed in the bore hole and 2) good representative samples of the formation materials. The contractor is responsible for the removal of the drilling mud from the hole and the development of the well as will be specified further on.

Driller's log & report: The driller's log of the well and other pertinent information shall be prepared as specified under the TEST DRILLING section.

Temporary capping: If the well is left uncompleted due to a recess or delay in construction, or which is completed for a period prior to being placed in service shall be capped with a water-tight welded or threaded cap or equipped with some other type of "vandal-proof" cover.

WELL CASING SELECTION AND INSTALLATION

Casing Selection: All well casing shall be new and made of steel conforming to the API 5L standard or equivalent ASTM standards. All casing shall bear mill markings that will identify the material. The diameter of the casing should be commensurate with a high yield irrigation well, of at least 20 inches. The length of the casing is expected to be approximately 50 feet.

Method of joining: Casing lengths shall be joined water-tight so that the resulting join shall have the same structural integrity as the casing itself. If metallic casing is welded, the standards of the American Welding Society shall apply. If threaded and coupled joints are used, couplings shall be API or equivalent, made up so that when tight, all threads will be buried in the lip of the coupling.

Sanitary protection of well: At all times during the progress of the work the Contractor shall use reasonable precautions to prevent either tampering with the well or the entrance of foreign material into it. Upon completion of the well, the contractor shall install a suitable threaded, flanged, or welded cap or compression seal so as to prevent any pollutants

from entering the well. The watertight casing, curbing or pitless unit shall extend a minimum of 24 inches above the pumphouse floor or final ground level elevation. The ground immediately surrounding the top of the well casing or pitless unit shall be sloped away from the well. There shall be no openings in the casing wall below its top except for approved pitless well adapters or units, measurement access ports and ground nipples installed in conformance with these standards.

The pitless adapter or unit, including the cap or cover, the pitless case and other attachments shall be designed and constructed to prevent the entrance of contaminants into the well from surface or near-surface sources. Pitless units shall be attached to the casing by threading or welding in a manner which will make the joint sound and watertight.

Air line for water level measurements in the irrigation well: A one-inch diameter PVC pipe shall be installed from a point 2 feet above the pump intake to the well head. The top of the pipe shall be readily accessible to insert, remove, and read the depth to water measurements on an electric sonde or pressure transducer which shall be used to measure the static water level and drawdown in the well.

WELL GROUTING

Grouting materials to be used: A mixture of Portland Cement (ASTM C150), sand and water in the proportion of not more than two parts by weight of sand to one part of cement with not more than 6 gallons of clean water per bag of cement (one cubic foot

or 94 pounds) shall be used. The use of special cements, bentonite to reduce shrinkage or other admixtures (ASTM C494) to reduce permeability, increase fluidity and/or control time of set, and the composition of the resultant slurry must be approved by KGS.

Method of installation of grout: The tremie method or a positive displacement method (such as pumping or forced injection by air pressure) shall be used.

Location of grout: Grout shall be placed in the annular space surrounding the casing by the method specified. Grouting shall be continuous from the top of the gravel pack to the land surface. It is expected that the grouting annular space length would be approximately less than 50 feet.

Centralizer: Centralizers shall be required at the bottom of the casing.

WELL SCREEN AND PERFORATIONS

Screen-type selection: The screen shall be constructed of wound wire, reinforced with longitudinal bars, the bars having a cross section that will form an opening between each adjacent coil of wire that is shaped in such a manner as to increase in size inward. The wire shall be firmly attached to the bars which will, in turn, be attached to a coupling adapter. The total open area shall be such that the entrance velocity at the design condition shall not exceed 6 feet per minute (0.1 ft/sec).

Screen-aperature size: The screen aperature size shall be in accordance with the "Selection of gravel pack grain size and

screen aperature size" paragraph of the GRAVEL PACK CONSTRUCTION section. The screen entrance velocity shall not exceed 6 feet per minute. In addition, the aperature size shall be small enough to retain at least 90 percent of the gravel pack during well development.

Screen length: The length of the screen shall be at least 1/2 of the aquifer thickness and should be positioned in the lower 1/2 of the aquifer. It is expected that the length of the screen will be approximately 50 feet, unless localized conditions dictate otherwise.

Method of screen installation: The screen, with closed bottom, shall be attached by an approved manner, as specified further on, to the casing and lowered into the well with the casing. In no instance shall it be driven or forced. It shall remain suspended from the surface until the gravel pack material has been added.

Method of joining screen to screen: Screen sections for a single interval shall be joined by threaded and coupled joints, socket-type fittings and solvent welding, or electric arc or acetylene welding. Resulting joints must be straight, sand tight and retain 100% of the screen strength.

Method of connecting screen to casing: The casing and screen shall be joined by threaded and coupled joints, socket fitting and solvent welding, or acetylene welding using materials and procedures specified by the screen manufacturer and as specified in paragraph "Methods of Joining" of the WELL CASING SELECTION AND INSTALLATION section. The resulting joints must be

straight, sand tight and retain 100 percent of the screen strength.

Method of sealing bottom: The screen bottom shall be sealed by an appropriate and effective method such as a welded steel plate or cement plug.

GRAVEL PACK (WELL FILTER) CONSTRUCTION

Selection of gravel pack grain size and screen aperature size: The gravel pack particle size shall be determined by taking the 70 percent retained grain size of the finest formation to be gravel packed and multiplying it by 5 or 6. In the present case, looking at Fig. 2, this size would lie in the range form 0.100 in to 0.125 in. This is the 70 percent retained grain size of the gravel pack to be used. The uniformity coefficient (the size of sieve that retains 40 percent of the sample divided by the size that retains 90 percent) shall not be greater than 2.5. The gradation of the gravel pack material shall form a smooth and gradual size distribution curve when plotted, similar to the ones shown by dashed lines in Fig. 2. The screen aperature openings shall be of such size as to retain 90 percent or more of the gravel pack material. In the percent case, using Fig. 2, the slot opening of 0.100 in would be an acceptable value (being approximately the average effective size of the two gravel pack distribution curves of Fig. 2). The thickness of the gravel pack shall range from a minimum of 4 inches to approximately 9 inches.

Length of gravel pack: The gravel pack material shall extend from a point equal in distance to 2 1/2 times the largest diameter of the well below the lowest screen section to the same distance above the highest screen section. The annular space above the gravel pack shall be filled with approved grout material to the land surface as specified in the WELL GROUTING section.

Method of installation of gravel pack material: The gravel pack shall be placed by the use of a tremie pipe lowered to the bottom of the space to be gravel packed and slowly raised as the filter is placed. Water or thin drilling fluid shall be pumped from the inner casing and allowed to flow into or be pumped in with the gravel pack material.

WELL PLUMBNESS AND ALIGNMENT

The completed well shall be sufficiently plumb and straight so that there will be no interference with installation, alignment, operation or future removal of the well pump.

WELL DEVELOPMENT

The contractor shall develop the well by such methods, as indicated below, so as to effectively extract from the water-bearing formation the maximum practical quantity of sand, drilling mud and other fine materials in order to bring the well to maximum yield per foot of drawdown and to a sand-free condition. The development work must be done in a manner that does not cause undue settlement and disturbance of the strata

above the water-bearing formation nor disturb the seal effected around the well casing and thereby reduce the sanitary protection otherwise afforded by such seal.

Surging and pumping: The development process shall be carried out by surging and pumping the well. The surging shall be done by a single or double solid (or valved) surge block. Surging shall start at the bottom of the lowest screen section in the well and proceed upwards. The pumping shall be done through the surge block which incorporates a piece of the suction pipe in the fabrication of the block. Pumping shall be done simultaneously with the surging at rates up to 1/2 of the design capacity of the well. Fines drawn into the well shall be pumped out periodically before such accumulation reaches 10 percent of the screen length. Upon completion of the development work the well shall be cleaned to the bottom.

Hydraulic jetting: Development shall be accomplished by simultaneous high-velocity, horizontal-jetting and pumping. The minimum exit velocity of the jetting fluid at the jet nozzle shall be 150 ft/sec. The tool shall be rotated at a speed less than one rpm. The jetting shall proceed from the bottom of the screen to the top. Pumping from the well shall be at a rate of 5 to 15 percent more than the rate at which water is introduced through the jetting tool. Water to be used for jetting must contain not more than 1 ppm suspended solids.

Air development method: Development shall be done by the utilization of a single pipe air-pumping system using the casing or the bore hole itself as the eductor line. The compressors,

air lines, hoses, fittings, etc. shall be of adequate size to pump the well by the air lift principle at 1 1/2 to 2 times the design capacity of the well. The contractor shall initially pump the well with air until the well is developed to the point that it yields clear, sand-free water. He shall then shut off the air and allow water in the well to return to the static condition. He shall then reopen the valve and reintroduce air into the well until water is again brought to the surface by the air lift, at which time he will close the air valve and allow the water to drop back down the well and return to a static condition. He shall repeat this lifting and dropping of the column of water until the water in the well becomes turbid at which time he will continuously pump the well with air until it again yields clear sand-free water. The contractor shall repeat the above operations until the well no longer produces fine material when it is surged and backwashed as described above.

The bottom of the air line shall be placed at different levels in order to facilitate development of all intake areas and the process repeated until all zones yield water free of turbidity when surged and backwashed.

Development aids: Clean, clear water shall be circulated to remove sediment from the well. Where applicable and required, mud dispersing agents, such as polyphosphates, may be added to water that is circulated to displace drilling fluid; to water used for backwashig or jetting, and to water standing in the well to help in mud removal. About 5 pounds of the chemical to each 100 gallons of water should be used, if needed.

Sand content limits: Well development shall continue until less than 6 ppm sand content is achieved as measured by averaging several samples collected at different times during a pumping test by the contractor and demonstrated to KGS.

Record of measurements: A record shall be made showing time, type of operation, specific capacity during pumping, pumping rate and sand content measured and recorded.

WELL TESTING FOR PERFORMANCE

Step-continuous composite testing: The contractor shall furnish, install, operate and remove the necessary measuring instruments and pumping equipment capable of pumping to the required point of discharge a minimum of 2000 gpm with a maximum pumping level of approximately 30 ft and with satisfactory throttling devices, so that the discharge may be reduced to 500 gpm. The pumping unit shall be complete with an ample power source, controls and appurtenances and shall be capable of being operated without interruption for a period of 15 days.

Prior to starting the pump, water level measurements shall be made hourly for several hours (by KGS staff) in the production well and observation wells. The well shall be "step" tested at rates of approximately 1/4, 1/2, 3/4, 1 and 1 1/2 times the design capacity of 2000 gpm. Each rate should be maintained constant for about 1 hour in duration (or until the water levels have been stabilized) while the water levels in the pumping and observation wells are periodically measured by KGS staff. The complete test is estimated to require less than one day. The

contractor shall operate the pump. Discharge of the pump shall be controlled by a gate valve and engine throttle. The discharge shall be controlled and maintained at approximately the desired discharge for each step with an accuracy within 5 percent of the desired discharge. Pump discharge shall be measured with a totalizing meter and stopwatch, circular orifice meter, or Venturi meter.

Right after recovery from the step test is complete, a constant rate test shall be conducted by pumping the well at the design rate for a period of approximately 24 hours and until the pumping level remains constant for several hours.

Aborted tests: Whenever continuous pumping at a uniform rate has been specified, failure of pump operation for a period greater than one per cent of the elapsed pumping time shall require suspension of the test until the water level in the pumped well has recovered to its original level. KGS shall be the judge of this condition.

Location of discharge: Discharge water shall be conducted from the pump to the Arkansas River downstream from the pump test site at a distance of at least 400 ft through pipe to prevent recirculation of discharged water into the aquifer being tested.

Records of testing: The contractor shall keep accurate records of the pumping test and furnish copies of all records to KGS. The records shall also be available to KGS representatives for inspection at any time during the test.

Measurement of water levels: Water levels in the pumping of observation wells shall be measured with steel tape, electrical tape, or equivalent KGS-approved method. Measurements will be recorded in feet, tenths and hundredths of feet.

CLEANUP

Right after completion of drilling of each test or observation hole or well, the surrounding area shall be cleaned of all debris resulting from the work. Slush pits and ditches shall be filled, and all sand or other material which may have been removed from the test or observation hole shall be leveled or removed from the site as directed by KGS personnel. The areas surrounding the test and observations holes shall be left in a clean and sightly condition, as determined by KGS.

Upon completion of the test pumping, the test pump shall be removed from the test well and the well casing securely covered and locked. Sludge pits and stilling basins shall be filled and leveled, and all sand or other material which may have been pumped from the well shall be leveled or removed as directed by KGS leaving the area in a clean and sightly condition.

STREAM-AQUIFER PUMP TESTING

After completion of drilling, development and testing of the irrigation well, and within a short period of time not to exceed several days, KGS would conduct a multi-day (not to exceed 15 days) stream-aquifer pumping followed by recovery testing. The contractor shall assist in the operation by furnishing,

installing and removing the necessary instruments in a demonstrably operational condition, fuel and pumping equipment capable of pumping to the required point of discharge (as specified under WELL TESTING FOR PERFORMANCE) a minimum of 2000 gpm with a maximum pumping level of approximately 30 ft. The pumping unit shall be complete with an ample power source, controls and appurtenances and shall be capable of being operated without interruption for a period of 15 days. The operator shall provide guidance and supervision (by daily visitations) to KGS personnel for operating all above-mentioned equipment. The Contractor shall be responsible for overseeing that all equipment and instruments provided to KGS work properly to KGS satisfaction.

METHOD OF PAYMENT

All work performed shall be paid for at the unit price bid per hour on services, plus actual cost of materials per invoice. A fixed fee on other services and rentals which do not fit well in the above time and material contract may be negotiated with KGS, as well as materials and services not accounted for in this document. Vendors should provide a target price for the job with actual costs being reimbursed. Payment will be made at the completion of the work and stream-aquifer testing.

- a. Test Hole and Well Construction.....Per foot
- b. Stratigraphic logs.....Lump sum
- c. Formation sampling.....Unit price
- d. Casing Furnished and Installed.....Unit price

- e. Furnish and Install Grout.....Unit price per sack
- f. Pumping Grout Service.....Lump sum
- g. Screen Furnished & Installed.....Unit price/foot
- h. Gravel pack.....Unit price/cu. yard
- i. Artificial gravel pack Furnished and Installed..Unit price/foot
- j. Well development.....Unit price/hour
- k. Chemicals.....Unit price/bag
- l. Installation and Removal of Testing Equipment.....Lump sum
- m. Stand-by Time.....Unit price/hour
- n. Discharge Pipe.....Unit price/foot
- o. Air line (1 in).....Unit price/foot
- p. Equipment rental, including fuel, running stream-aquifer pump
test soon after well development.....Unit price/day
- q. Inspection-Overseeing time.....Unit price/hour

FIGURE 1

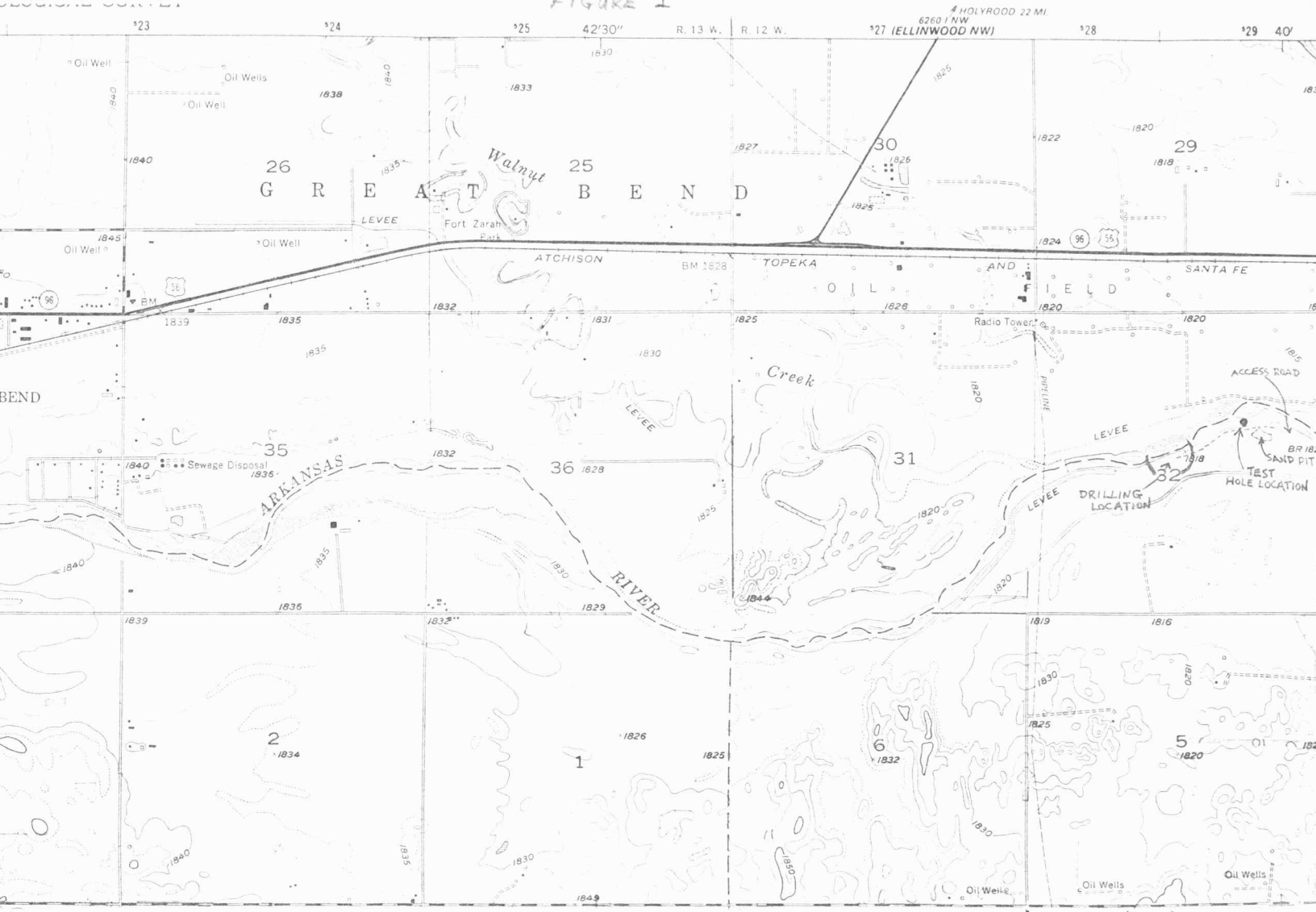


FIG. 1

1 mile SCALE

FIGURE 2

GRAIN SIZE ANALYSIS

50-60 FT. SAMPLE FROM TEST HOLE IN SEC. 32, T19S, R.12W, DRILLED NOV. 1985.

