APPENDIX G

EXAMPLES OF DETAILED DEWATERING SPECIFICATIONS

G-l. General. This appendix provides examples based on actual specifications for installation of dewatering or pressure relief systems, extracted from Government and private industry contract documents. They have been selected and presented to illustrate the various types of specifications described in the test (para 7-2).

G-2. Types of specifications.

a. Type A specifications are projects where the dewatering is not too critical with respect to damage to the permanent work or safety to personnel, and only the desired results are to be specified. This type of specifications makes the Contractor completely responsible for design, installation, and operation of the system(s). Specifications may be brief (type A-l) or more detailed (type A-2), depending upon complexity and criticality of the dewatering or pressure relief system. The examples of these two types are from Corps of Engineers projects.

b. Type B specifications are recommended for large, complex systems, or where the dewatering or pressure relief is critical with regard to construction of the project, damage to permanent work, and safety.

(1) *Type B- 1.* A specification that gives a detailed design and requirements for installation of a "minimum" system but makes the Contractor responsible for operating and maintaining the system, supplementing it as necessary to obtain the required results. The installation is then checked with a full-scale pumping test to verify its adequacy.

(2) *Type* B-2. A specification that gives a detailed design and installation procedure but makes the Contractor responsible only for normal repairs and operations. The Government or Owner thus assumes the responsibility for the adequacy of the system and its components, major repairs, and replacement of equipment if necessary.

(3) *Type* B-3. A specification that is similar to type A, wherein only the desired results are specified, except the degree of difficulty or criticality of the system requires that the Contractor retain an "Expert" in the field of dewatering or pressure relief systems to design, supervise installation, and monitor the system.

c. Types A-l and B-3 specifications should not be used unless the issuing agency has considerable confidence in the (dewatering) qualification of the bidders; ample time and knowledge to check the Contractor's submittals; and a willingness to reject the Contractor's proposals and accept any associated delays in starting the project until an acceptable design is submitted.

d. For large and complex dewatering projects where dewatering is critical to the safety of the work, type B-l specifications are recommended; types A-2 and B-3 may be suitable if the Owner or Engineer can or will enforce the provisions relating to approval of design, installation, and operation.

G-3. Example of type A-l specifications (dewatering).

a. General. The Contractor shall provide all dewatering necessary to keep the construction and work areas dry. The Contractor shall design, install, operate, and maintain an adequate system. The system shall be of sufficient size and capacity to maintain a dry condition without delays to construction operations.

b. Submittals. The Contractor shall submit a *proposed dewatering plan* for approval of the Contracting Officer prior to initiation of any construction or excavation operations, The plan shall show all facilities proposed for complying with this section.

c. Puyments. Payment for all work covered in this specification will be made at the contract lump sum price for "dewatering," which price shall constitute full compensation for furnishing all plant, equipment, labor, and materials to install, operate, maintain, and remove the dewatering system.

G-4. Example of type A-2 specifications (dewatering).

a. Scope. This section covers the design, furnishing, installation, operation, maintenance, and removal of a dewatering system, complete.

b. Dewatering.

(1) *General.* The dewatering system shall be of a sufficient size and capacity as required to control hydrostatic pressure on all clay strata below elevation – 13.0 feet to depths indicated by the logs of borings, to permit dewatering of the area specified in paragraph *d* below, and to allow all material to be excavated, piles driven, and concrete placed, all in a dry condition. The system shall include a deep-well system, a wellpoint system, other equipment, appurte-

nances, and related earthwork necessary for the required control of water. The sequence of installation of components of the dewatering system shall be in accordance with the specifications and drawings. The system shall remain in continuous operation, as specified, until a written directive to cease dewatering operations has been received from the Contracting Officer.

(2) *Control of water.* The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled and its disposal provided for at each berm. The entire periphery of the excavation area shall be ditched and diked to prevent water from entering the excavation. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional cost to the Government.

c. *Design.* The dewatering system shall be designed using accepted and professional methods of design and engineering consistent with the best modern practice. The dewatering system shall include the deep wells, wellpoints, and other equipment, appurtenances, and related earthwork necessary to perform the function. A representative of the Contractor shall visit the site to determine the conditions thereof. The Contractor shall be responsible for the accuracy of the drawings and design data required hereinafter.

(1) *Drawings and design data.* The Contractor shall submit for the approval of the Contracting Officer, within 30 calendar days after receipt of Notice to Proceed, drawings and complete design data showing methods and equipment he or she proposes to utilize in dewatering, including relief of hydrostatic head, and in maintaining the excavation in a dewatered and in a hydrostatically relieved condition. The material to be submitted shall include, but not necessarily be limited to, the following:

(*a*) Drawings indicating the location and size of berms, dikes, ditches, all deep wells, observation wells, wellpoints, sumps, and discharge lines, including their relation to water disposal ditches.

(*b*) Capacities of pumps, prime movers, and standby equipment.

(*b*) Design calculations proving adequacy of system and selected equipment.

(d) Detailed description of dewatering procedure and maintenance method.

(2) *Responsibility.* Approval by the Contracting Officer of the plans and data submitted by the Contractor shall not in any way be considered to relieve the Contractor from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of the system in controlling the water level in the excavated area and for control of the hydrostatic pressures to the depths hereinbefore specified. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.

d. Dewa tering sys tern,

(1) *Deep-well system.* The clay and sand strata below elevation -13.0 feet are continuous over a large area. Removal of soils above elevation -25.0 feet. A deep-well system shall be provided to relieve this pressure. The pressure shall be relieved in the sand strata such as those indicated on boring S-II-SS-1-62(A) from 67.5 to 72.0 feet and from 85.5 to 142.5 feet. These strata will vary in elevation and thickness over the area. The deep-well system shall be of sufficient capacity to lower the hydrostatic head to elevation -40.0 feet as measured in observation wells at nine points in the excavation. One installed spare deep well, complete and ready for immediate operation, shall be provided for each two operating wells. The use of gasoline prime movers will not be permitted in the operation of deep wells. At each of the nine points two observation wells shall be installed. One observation well shall be installed with the screen in the upper sands, and one observation well shall be installed with the screen in the lower sands. The riser pipe for the observation wells will be 2-inch pipe in 5-foot sections. One of the observation points shall be constructed at coordinate N254 460, E260 065. The remainder of the observation points will be located by the Contracting Officer after the dewatering plan is submitted. The exact tip elevation of all observation wells will be established after the dewatering plan is submitted; however, the tip elevation in the lower sand will be at least 100 feet below original ground surface, and the tip elevation of the observation wells in the upper sands will be approximately 70 feet below original ground surface. The Contractor shall maintain the observation wells and keep daily records of readings until otherwise directed by the Contracting Officer.

(2) *Wellpoint system.* A wellpoint system shall be used above the top of clay shown on the borings at approximate elevation -14.0 feet but to dewater the area from original ground surface to the top of the clay. This system shall have sufficient capacity to lower the head within the excavation to the top of the clay.

e. *Available soil test data and pumping test data.* The soil test data obtained by the Government are shown on the boring logs. Additional laboratory data and samples of the soils from borings shown in the plans are available in the District office for inspection by bidders. Typical permeability data from laboratory tests at this site are tabulated. Pumping tests have not been made at the site; however, the soil profile at the B-l and B-2 test stand excavation is similar to this site and this excavation is now being dewatered by a deep-well system. Data on this system can be inspected

at the office of the Area Engineer or in the District office.

f. Standby equipment. The Contractor shall furnish standby pumping equipment power as follows:

(1) Diesel, liquid petroleum gas, and gasoline fueled prime movers for pumps shall have 50 percent standby equipment.

(2) Portable electric generators shall have 100 percent standby generating equipment.

(3) Commercial electric power, which is available at the site, shall have 100 percent standby electric generating equipment.

(4) The Contractor shall provide not less than one complete spare pumping unit for every five pumping units other than deep-well pumps in the system. In no case shall less than one standby pumping unit be provided. The sizes of the standby pumping units shall be subject to the approval of the Contracting Officer.

g. *Damages.* The Contractor shall be responsible for, and shall repair without cost to the Government, any damage to work in place, the other Contractors' equipment, and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area that may result from his or her negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.

h. Maintaining excavation in dewatered condition.

(1) General. Subsequent to completion and acceptance of all work, including piling and concrete work, in the excavated area, the Contractor shall maintain the excavation in a dewatered condition and the water level in the observation wells at the specified and approved elevation until such time as the succeeding Contractor commences dewatering operations, and a written directive to cease pumping operations has been received from the Contracting Officer. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components; standby and spare equipment of the same capacity and quantity as specified in *f* above; and any other work required by the Contracting Officer to maintain the excavation in a dewatered condition. Dewatering shall be a continuous operation and interruptions due to outages, or any other reason, shall not be permitted.

(2) *Responsibility.* The Contractor shall be responsible for all damages to accepted work in the excavation area and for damages to any other area caused by his or her failure to maintain and operate the system as specified above or from water overflowing his or her ditch.

i. System removal. Upon receipt of written directive to cease dewatering operations from the Contracting Officer, the Contractor shall remove all dewatering equipment from the site, including related temporary electrical secondary as approved by the Contracting Officer. All wells shall be plugged and/or filled, Removal work required under this paragraph does not include any of site cleanup work as required elsewhere in these specifications.

j. *Method of measurement.* Dewatering, as specified in *k*(2) below, to be paid for will be determined by the number of calendar days (24 hours), counted on a day-to-day basis, the excavation is maintained in a dewatered condition, measured to the nearest hour, from completion and final acceptance of the concrete foundation for the A-1 test stand area to the date on which a written directive to cease pumping operations is received from the Contracting Officer.

k. Payment.

(1) *Dewatering during excavation and construction.* Payment for furnishing all designs and engineering data, plant, labor, equipment, material, and appurtenances and for performing all operations in connection with designing, furnishing, installing, operating, and maintaining the dewatering system until the work in the area is completed and accepted will be made at the applicable contract lump sum price for "Dewatering A-l Test Stand Area, Deep Wells," and "Dewatering A-l Test Stand Area, Except for Deep Wells." Twenty-five percent of the contract price for each item will be paid upon completion of the installation of the dewatering system for the excavation. A second 25 percent of the contract price for each item will be paid upon satisfactory completion of 80 percent of the estimated excavation quantity. A third 25 percent of the contract price for each item will be paid upon satisfactory completion of 100 percent of the required excavation. Fifteen percent of the contract price for each item will be paid when final acceptance of all work in the excavation is made. The remaining 10 percent of the contract price for each item will be paid after written notice to cease dewatering operations has been issued and final cleanup and final acceptance of all work has been made.

(2) *Maintaining area in dewatered condition.* Payment for furnishing all plant, labor, equipment, and material and for performing all operations in connection with maintaining the accepted excavations in a dewatered condition will be made at the applicable contract unit price per calendar day for "Maintaining A-l Test Stand Excavation in Dewatered Condition." No payment will be made for this item for periods, measured to nearest hour, during which the dewatering system is not operated and maintained as specified hereinbefore.

(3) *Removal of systems.* Payment for furnishing all plant, labor, equipment, and material and for performing all operations in connection with removal of

the dewatering system will be made at the applicable contract lump sum price for "Removal of A-l Test Stand Dewatering System." However, if the Contractor so elects to sell the installed and operating system to the succeeding Contractor or to dispose of the system in place by other means, as approved by the Contracting Officer, the Contractor shall be relieved from the requirements of the specified removal work and no payment will be made for this item.

G-5. Example of type B-l specifications (dewatering and pressure relief).

a. Scope. This section covers furnishing, installation, operation, maintenance, and removal of the jet-eductor wellpoint and pressure relief well systems, as subsequently specified in this section; control of any seepage from the soils above the bottom of the excavation not intercepted by the jet-eductor wellpoint system deemed necessary by the Contractor to permit installation of the sheeting shown to grade as specified; pumping of surface water or seepage through the sheeting during excavation or after the jet-eductor dewatering system is turned off or removed; and installing any additional pressure relief wells, pumps, and appurtenances, if necessary, to maintain the hydrostatic water level in the clayey silty sand and sandy silt (semipervious) stratum (about el 235± 1 foot) beneath the excavation at all times.

b. Responsibility. The Contractor shall be fully responsible for furnishing, installing, operating, maintaining, and removing all wellpoint, pressure relief, and seepage or surface water control systems. However, any pressure relief wells, pumps, piping, and electrical wiring and controls required to lower and maintain the hydrostatic water level in the semipervious stratum below the bottom of the excavation, other than the pressure relief system specified, will be paid for as an extra.

(1) The Contractor shall be responsible for:

(a) Installing and testing the wellpoint and pressure relief systems as specified.

(b) Dewatering or controlling any seepage from the soils above the bottom of the excavation so that the sheeting may be installed without any significant sloughing of earth during excavation and placement of sheeting and pea gravel backpack.

(c) Maintaining the hydrostatic water level in the semipervious stratum below elevation 250.0 feet at all times.

(d) Maintaining the bottom of the excavation free of all seepage or surface water until the structural mat has been placed and the waterproofing installed up to the top of the mat.

(e) Operating, maintaining, and monitoring the wellpoint and pressure relief well systems. System maintenance shall include but not be limited to at least daily supervision by someone skilled in the operation, maintenance, and replacement of system components; at least one spare submersible pump and controls and one pressure pump of the same capacity as specified; and any other work required by the Contracting Officer to maintain the excavation in a dewatered and hydrostatically relieved condition. Dewatering and pressure relief shall be a continuous operation and interruptions due to power outages, or any other reason, shall not be permitted. Some responsible person shall also monitor the dewatering sump pumping, and pumping the relief wells continuously until the succeeding contractor assumes the responsibility for such, and the Contractor has received a written instructive that he or she is no longer responsible for this operation.

(2) The Contractor shall also be fully responsible for any failure of any component of the systems. The Contractor shall be responsible for all damages to work in the excavation area and for damages to any other area caused by failure to maintain and operate the dewatering and pressure relief systems as specified.

c. *Wellpoint and pressure relief systems.*

(1) *General.* The jet-eductor wellpoint system specified is to lower the groundwater table adjacent to the excavation and intercept seepage from the sandy and gravelly soil above the Cockfield formation (at about el 253.0 feet) so that excavation and placement of the wood sheeting and pea gravel backpack can be accomplished with minimum difficulty, and with little if any sloughing of the soil from the cut slope. The wellpoint system combined with a sump ditch between the sheeting and edge of structural mat when properly installed, maintained, and pumped should permit placing the "mud" mat on foundation soils free of any surface water. If the Contractor considers the spacing of the wellpoints inadequate to accomplish the excavation and placement of the wood sheeting, as specified, he or she should space the wellpoints closer. The wellpoint system shall remain in continuous operation until the excavation has been dug to grade and the "mud" mat poured. After the "mud" mat has been placed, the wellpoint system may be turned off and any seepage through the wood sheeting removed by sump pumping. After the "A" piezometers for monitoring the groundwater table above the Cockfield formation and the wellpoint system have been installed, the system shall be tested for flow and groundwater lowering prior to starting any excavation. The well system is to relieve excess hydrostatic pressure in the semipervious stratum below the excavation to insure no heave of the soil strata above this stratum. It is imperative that no heave of the soil strata above the semipervious stratum occur inasmuch as the building will be founded directly on the foundation soils above this stratum.

(2) Control of water. The Contractor shall control all surface water, any seepage into the excavation, and hydrostatic pressure in the semipervious stratum beneath the excavation, regardless of source. Any opening in the wood lagging, through which seepage is carrying any soil, shall be promptly caulked. Any water seeping, falling, or running into the excavation as it is dug shall be promptly pumped out. The entire periphery of the excavation area shall be suitably diked, and the dike maintained, to prevent any surface water from running into the excavation. The Contractor shall be fully responsible for disposal of all water from the excavation and from the wellpoint and relief well systems in an approved manner at no additional cost to the Government.

(3) *Wellpoint and pressure relief system data.* The Contractor shall submit for approval by the Contracting Officer, within 10 calendar days after receipt of Notice to Proceed, complete information regarding motor generator, pumps, wellpoints, jet-eductors, well screens, and any other equipment that he or she proposes to utilize in dewatering and relieving hydrostatic pressure, and in maintaining the excavation in a dewatered and hydrostatically relieved condition. The data to be submitted shall include, but not necessarily be limited to, the following:

(*a*) Characteristics of pumps and motor generator, and types and pertinent features of well screens, wellpoints, and jet-eductor pumps.

(*b*) Plans for operating, maintaining, and monitoring the wellpoint and relief well systems.

(4) *Jet-eductor wellpoint system.*

(*a*) The soils at the site consist essentially of fill, clays and silts, and some silty sand and clay sands with occasionally pea gravel above the Cockfield formation. The jet-eductor wellpoint system has been designed to lower the groundwater table and intercept most of the seepage that will flow toward the excavation. Because of the impervious Cockfield formation at about the bottom of the excavation, it is not possible to lower the groundwater table and intercept most of the seepage that will flow toward the excavation as it is dug. Because of the impervious Cockfield formation at about the bottom of the excavation, it is not possible to lower the groundwater table completely down to the top of this stratum or to intercept all seepage above it. By proper installation, the jet-eductor wellpoint system should intercept most of the seepage and stabilize the soil sufficiently to install the wood sheeting subsequently specified without any significant sloughing of the soil behind the sheeting prior to placement of the pea gravel backpack. The fact that some minor seepage may bypass the wellpoints should be anticipated by the Contractor. The tips for the wellpoints shall be installed approximately 12 inches below the top of the Cockfield formation as encountered during installation of the system.

(*b*) The wellpoints shall have a minimum screen *or* slotted length of 30 inches and shall be of the "bottom suction" type. The wellpoint screens shall be of 30-mesh cloth or have #25 slots. The wellpoints shall be of a high-capacity type with a diameter of approximately 2% inches. The jet-eductor pumps and pressure and return riser pipes shall have a capacity and be operated at a pressure which will produce a minimum flow of 2 gallons per minute with a static lift of 25 feet. If the Contractor uses jet-eductor pumps with a yield capacity greater than 3 gallons per minute, it will be necessary for him to redesign the pressure and return header lines. The pressure pumps and recirculation tank shall be designed by the Contractor. The pumps shall have adequate head and pumping characteristics to match the number and capacity of the jet-eductors being used. Both the pressure and return header lines shall be provided with pressure gages at the pumps and across the excavation from the pumps. Overflow from the recirculation tank shall be arranged so that the flow from the wellpoint system can ye readily measured.

(c) The filter sand to be placed around the wellpoints and up to within 10 feet of the ground surface shall be a clean, washed sand (A) having a gradation falling within the following range:

U.S. Standard Sieve Size	*Filter Sand A Percent Passing*
10	78-100
16	35-82
20	15-58
30	3-32
40	0-13
50	0-3

(d) The wellpoints shall be installed by a combination of driving and jetting (with a hole puncher) a 12-inch "sanding" casing to approximately 1 foot below the top of the Cockfield formation, rinsing the "sanding" casing until there is no more sediment in the casing, centering the wellpoint and lowering it to the bottom of the hole, placing Filter Sand A in the casing around the wellpoint in a heavy continuous stream up to within 10 feet of the ground surface, and then filling the remainder of the hole with a thick bentonitic grout or by pouring in a mixture of dry sand containing 10 percent granular bentonite, up to the ground surface. Before the working day is over, all wellpoints installed that day shall be pumped with a small centrifugal pump, capable of producing a 25-foot vacuum, until the effluent becomes clear. Jet water used for installing the wellpoints shall be clear polished so that return of jet water up through the sanding casing is achieved before the casing has been driven to a depth of more than about 10 feet from the surface. It may be necessary or expeditious to prebore the holes for the

wellpoints with a lo-inch auger prior to driving and jetting the 12-inch sanding casing to grade, Any such predrilling should be accomplished in a manner which will not cause any caving of the hole as it is drilled. In jetting the sanding casing for the wellpoints, provision shall be made to prevent jet water from spraying over sidewalks and streets being used for pedestrians and/or vehicular traffic, and from running over or into streets being used by such. The Contractor will be responsible for disposal of jet water in a manner satisfactory to the City and the Construction Manager.

(e) Each jet-eductor wellpoint shall be provided with a suitable strainer at the top of the pressure riser pipe to prevent the entrance of any particles, which might clog the jet-eductor nozzle, and a stopcock or valves, which will permit isolating the wellpoint to permit pressure testing and pumping the wellpoint separately if desired,

(5) *Pressure relief wells and pumps. The* pressure relief wells shall be installed at the locations specified, These wells are to reduce the hydrostatic head in the semipervious stratum below the excavation to elevation 250.0 feet or lower as measured by the B piezometers installed in this same stratum at the locations, as subsequently specified.

(a) The screens for the relief wells shall be 10 feet long and shall be installed in the semipervious stratum at about elevation 235±1 foot. The screens shall have a nominal diameter of 4 inches. They may be manufactured of slotted Schedule 40 PVC pipe, Johnson wire-wrapped screen, or other approved screen. The screens shall be covered with 30-mesh brass or stainless steel gauze or slotted with #20 slots with a minimum open area of 5 percent. The riser pipe shall also have a 4-inch nominal diameter; it may be either PVC plastic pipe or steel. The screen portion of the wells and up for a distance of 5 feet above the top of screen shall be surrounded with a clean, washed uniform filter sand (B) with the following gradation:

U.S. Standard Sieve Size	*Filter Sand B Percent Passing*
10	95-100
20	*58-90*
30	*30-73*
40	5-50
50	*0-25*
70	*0-8*

Suppliers who can furnish Filter Sands A and B are as follows:

	Supplier	Filter Sand A	Filter Sand B
1.	—	—	—
2.	—	—	—
3.	—	—	—

(*b*) Pumps for the relief wells shall be submersible pumps suitable for installation in 4-inch nominal diameter wells with a capacity of 3 to 10 gallons per minute at a total dynamic head (TDH) equal to 50 feet. The Contractor shall be responsible for designing and installing the electrical system for powering the submersible pumps in the relief wells. The electrical system shall meet the local electrical code and be approved by the Contracting Officer. Each pump shall be provided with a starter and fuse disconnect with a clearly visible red light mounted on the control panel that shows red when the pump is running. A motor generator with a capacity capable of starting all of the submersible pumps in the relief wells at one time shall be provided and hooked into the electrical system at all times. This generator shall be operated to keep the pumps in the relief wells running in event of power failure. It shall be maintained in first class condition, protected from the weather, and started at least twice a week to check its operating condition.

(*c*) The bottom of the screens for the relief wells shall be installed at or slightly below the bottom of the semipervious stratum as encountered during installation. They shall be installed using the same procedure as specified for the wellpoints except that in all probability it will be necessary to predrill the holes to grade with a lo-inch auger because of the difficulty in jetting through some of the clay strata to be penetrated. After the (12-inch) sanding casing has been driven and jetted to grade, the well screen and riser pipe shall be centered accurately and lowered to within 1 foot of the bottom of the casing. Filter Sand B poured into the sanding casing around the well riser pipe in a heavy steady stream until the filter sand is at least 5 feet above the top of the screen; the remainder of the hole may be filled with clean medium sand. The sanding casing shall then be immediately pulled. After the well has been installed, it shall be promptly pumped with a centrifugal pump capable of producing a 25-foot vacuum until the effluent is clear. The submersible pump then shall be lowered and suspended in the well with the intake of the pump at about the top of the well screen. The pump or discharge pipe shall be provided with a check valve, and the connection between the discharge pipe from the pump to header pipe shall be provided with a gate valve which will permit removal of the pump if necessary. The top of the well shall be sealed with a suitable well cap or plate provided with a hole through which a sounding line may be lowered to determine the water level in the well when testing and monitoring the system, A full-scale pumping test shall be run on the completed system to determine its adequacy and pumping rate. This test shall be run for a minimum of 6 hours. The water level in the B piezometers and in the wells and flow from the system shall be measured at the following intervals after the start of pumping: 10 minutes, 30 minutes, 1 hour, 2 hours, 3 hours, 4 hours, and 6 hours.

(d) All of the submersible pumps shall be new,

and one new spare pump and controls shall be at the job site at all times. The electrical system and controls shall be designed so that failure of any one pump, or the need to disconnect and replace a pump, does not adversely affect operation of any other pump.

(e) The Contractor shall be responsible for recording the results of the pumping tests on the well system and furnishing them to the Construction Manager. He shall also advise the Construction Manager at least three days in advance of making this test so that a representative of the Government can observe the test.

(*f*) Because of the importance of preventing any significant artesian head in the semipervious stratum above the bottom of the excavation, tees shall be installed in the riser pipe for the deep wells to provide relief of this artesian pressure in event of any pump *or* electrical failure. These tees shall be provided with plugs during installation of the wells; as the excavation is carried down to each tee, the plug in that tee shall be removed and a Z-inch pipe with brass check valve inserted in the tee so that water can flow into the excavation. As each tee is connected into the excavation, the tee above shall be sealed.

(*g*) Installation of the wellpoint and the relief well systems shall be supervised by someone with at least 5 years actual experience in installing such systems. A log of each relief well shall be maintained by the Contractor; forms for logging installation of the wells will be furnished by the Contracting Officer.

(6) *Piezometers.* Piezometers shall be installed at the locations specified to measure the groundwater table in the line of wellpoints and in the excavation (A piezometers), and to measure the hydrostatic water level in the semipervious stratum beneath the excavation (B piezometers). The tips of the A piezometers shall be set at the top of the Cockfield formation; the tips of the B piezometers shall be set in the middle of the semipervious stratum. The A piezometers shall be surrounded with Filter Sand A; the tips of the B piezometers shall be surrounded with Filter Sand B. The A piezometers shall be installed using the same equipment and procedure specified for installing the wellpoints; the B piezometers shall be sealed with an expanding cement bentonite grout up to at least elevation 252.0 feet. After sealing around a B piezometer, the sanding casing shall be checked to see if there is any bentonite or cement in the casing; and if such exists, the casing shall be thoroughly washed prior to installation of the next piezometer.

(*a*) The piezometers shall consist of a 1.50-inch inside diameter (I.D.) (Sch 40 or 80) PVC screen with 0.025- to 0.030-inch slots connected to 1.50-inch I.D. (Sch 40 or 80) PVC riser pipe. Screens shall be 5 feet long. The joints of the screen and riser shall be flush (inside and outside) and shall be glued together with PVC pipe cement. The top of the riser shall be cut off 30 inches above the ground surface and provided with a threaded cap with a ‘&inch hole in the side. The upper part of the piezometer shall be protected by installing a 6-inch I.D. cardboard casing around the riser embedded 2 feet below the ground surface and filling the casing with concrete. After removal of the cardboard casing, the top 30 inches of each piezometer shall be painted day-glo orange, and the piezometer number marked in 3-inch-high black characters.

(*b*) Each piezometer shall be pumped after installation and then checked to determine if it is functioning properly by filling with water and observing the rate of fall. For the piezometer to be considered acceptable it shall pump at a rate of at least 0.5 gallon per minute, or when the piezometer is filled with water, the water level shall fall approximately half the distance to the groundwater table in a time less than the time given below for various types of soil:

Type of Soil in which piezometer screen is wet	*Period of observation minutes*	*Approximate time of 5Opercent fall, minutes*
Sandy silt (>50% silt)	30	30
Silty sand (<50% silt, >12% silt)	10	5
Fine sand (<12%silt)	5	1

If the piezometer does not function properly, it shall be developed by air surging or pumping with air if necessary to make it perform properly.

d. Availalble soil data. Generalized soil profiles and logs of boring were made for Government. Samples of the soils from the borings made by _____ are available for inspection by bidders at _____

e. *Damages.* The Contractor shall be responsible and shall repair any damage to the excavation, including damage to the bottom due to heave, that may result from his or her negligence, improper operation of the dewatering and pressure relief systems, and any mechanical or electrical failure of the systems.

f. *Maintaining excavation unwatered and pressure relieved.* Subsequent to completion and acceptance of all work in the excavated area, the Contractor shall maintain the excavation unwatered and the water level in the B piezometers at or below elevation 250.0 feet until placement of the structural mat is complete and the backfill has been placed to elevation 256.0 feet, and a written directive to cease pumping has been received from the Contracting Officer. The Contractor shall be responsible for maintaining the excavation unwatered and pressure relieved during this period as set for above except for operation of the wellpoint system.

g. *Removal of wellpoin t sys tern.* After excavation to grade, installation of drainage ditch, sump pump, and placement of the “mud” mat, the wellpoint system may be removed, Removal of the wellpoint dewatering sys-

tern shall include pulling all of the wellpoints and related header pipes, pumps, recirculation tank, and temporary electrical secondary, as approved by the Contracting Officer. Any holes remaining after pulling the wellpoints shall be filled with sand. Sump pumping of seepage and surface water thereafter shall continue as required to keep the excavation in an unwatered condition until all structural concrete work and backfill are complete, and the succeeding Contractor has assumed responsibility for maintaining the excavation in an unwatered condition.

h. Method of measurement. Dewatering, as specified in *f* above, to be paid for will be determined by the number of calendar days (24 hours), counted on a day-to-day basis, the excavation is maintained in an unwatered condition and pressure relieved, from completion and final acceptance of the concrete mat to the date on which a written directive to cease pumping operations is received from the Contracting Officer.

i. Unit price. Any pressure relief wells and related apurtenances required in addition to the specified pressure relief system shall be paid for at the unit price for "additional pressure relief wells."

G-6. Example of type B-2 specifications (dewatering and pressure relief).

a. Scope. This section covers: furnishing, installing, operating, and maintaining the dewatering systems shown on the drawings and specified herein; unwatering the Phase I excavation; installing any additional dewatering wells. pumps, and appurtenances, if necessary, to lower and maintain the hydrostatic water level in the sand formation beneath the excavation to a level at least 5 feet beneath any Phase II excavated surfaces, and have the capacity to lower the water level to elevations – 29.0 and – 35.0 feet beneath the chamber and gate bay sections, respectively, of the lock for a Red River stage of elevation 60.0 feet; and controlling seepage from the soils above and below the bottom of the excavation, not intercepted by the specified well and jet-eductor systems, by installing additional jet-eductor wells, wellpoints, pumps, and appurtenances if necessary, so as to assure a stable bottom at grade for the Phase II excavation and prevent any significant seepage or raveling of excavated slopes. The dewatering systems shall include deep wells; jet-eductor wells; wellpoints and/or sand drains if required; pumps, engines, and piping; and related appurtenances; and dikes, ditches, sumps, and pumps necessary for control of surface water. The dewatering systems shall remain in continuous operation, as specified, until completion of this (Phase II) Contract and the systems are transferred to the Phase III Contractor or to the Government.

b. Compliance with specifications and drawings. The contractor shall designate a representative or engineer experienced in dewatering large excavations whose responsibility will be to assure that the dewatering systems comply with the contract plans and specifications with respect to materials, installation, maintenance, and operation of the dewatering systems so as to control subsurface pressures, groundwater and seepage, and surface water, and maintain records as specified herein. The "dewatering" engineer's duties shall include the following:

(1) *Materials and equipment.* The Contractor's "dewatering" engineer shall obtain all specified data and supervise making all tests and/or measurements to determine that all materials incorporated in the work are in accordance with the plans and specifications. Materials and equipment to be checked shall include, but not be limited to, well screens, riser pipes, filter sand, pumps, column pipe, gear drives, couplings, diesel engines, well discharge pipe and fittings, header pipe, valves, discharge system outlet structures, piezometers, and related appurtenances.

(2) *Installation.* The Contractor's "dewatering" engineer shall check to be sure that specified procedures and methods for installing wells, pumps, jet-eductor wells, piezometers, and any other supplemental dewatering or groundwater control system required are installed in accordance with the specifications and drawings.

(3) *Operation and maintenance.* The Contractor's "dewatering" engineer shall supervise the operation and maintenance of the dewatering systems, supplemental groundwater control facilities if any, surface water control systems, and shall assist with obtaining all required piezometric, well performance, and flow data. The Contractor shall inspect the test starting of each nonoperating dewatering pump and engine installed in a well or on the system on a weekly basis and include in a daily report reference to the conduct of the test, the number of pumps and engines tested, and any unsatisfactory performance data and remedial action taken. The Contractor's "dewatering" engineer shall notify the Contractor and the Contracting Officer's Representative (C.O.R.) immediately of any event or information not in accordance with the specifications. Thirty days prior to completion of the work under this contract, the Contractor shall furnish to the Government a complete set of "as-built" drawings of the dewatering facilities installed, and all significant operational, maintenance, and performance data and records.

(4) *Records.* A copy of all inspection and test data relating to materials, installation, operation and maintenance, and performance of the dewatering systems, and supplemental groundwater control facilities if any, as required, shall be promptly furnished to the Contracting Officer.

c. General. The dewatering systems shall be installed, operated, and maintained so as to reduce the artesian pressure in the sand formation below the excavation, and control seepage from any excavated slopes or into the bottom of the excavation as specified below, so that the work covered under this contract can be accomplished in stable areas free of water and without heaving of soil strata overlying the sand aquifer within the cofferdammed area.

(1) *Dewatering requirements.* Construction dewatering to be performed by the Contractor shall consist of:

(a) Dewatering lock and dam excavation by pumping from deep wells; jet-eductor wells; and any other supplemental groundwater control facilities if required.

(*b*) Unwatering the Phase I excavation.

(c) Testing adequacy of deep-well system prior to and after unwatering the Phase I excavation. Evaluation of the adequacy of the jeteductor system after unwatering the excavation.

(*d*) Controlling and removing of surface water falling into the excavation.

The dewatering systems for Phase II excavation for the lock and dam shall be constructed in accordance with the details shown on the drawings and the requirements herein specified. The dewatering systems shall be installed and operated by the Contractor to control seepage from any excavated slopes or the bottom of the excavation so as to assure a stable work area at grade and prevent raveling or sloughing of excavated slopes, and to lower the hydrostatic water level in the deep underlying sand formation so that as the excavation progresses the piezometric heads and groundwater table are maintained at least 5 feet below the bottom of the excavation and 3 feet below the slopes at all times, as measured by construction piezometers. After the hydrostatic water level in the deep sand formation has been lowered to the required levels beneath the excavation, it shall be maintained at the required elevations so that all testing and construction operations can be performed in the dry without interruption.

(2) *Design of dewatering systems. The* (dewatering) well system has been designed to lower the hydrostatic water level to elevation -26.0 feet in the deep sand formation beneath the excavation for the dam and to elevation – 35.0 feet beneath the lock (or below) with a river stage at elevation 60.0 feet, with as many as two to five well pumps off depending on their location.

(a) The jet-eductor wells (indicated by borings made in and around the excavation) have been designed to drain semipervious soils in the top stratum to prevent or minimize any detrimental seepage from the (main) excavated slopes around the excavation. Additional jet-eductor wells may be required to control seepage from other sections of the slopes around the excavation. As shown by the boring logs and subsequently referenced reports, the stratification of the top stratum soils above the deep sands is erratic (more so in some areas than others). The deep wells and jet-eductor wells, subsequently installed around the top or upper berm for the excavation, may or may not completely dewater or stabilize all slopes or areas in the bottom of the excavation. Dewatering facilities for control of groundwater in the lower part or bottom of the excavation, if required, shall be designed by the Contractor subject to approval of the Contracting Officer. Facilities for unwatering the Phase II excavation, and controlling and sump pumping surface water, shall be designed by the Contractor.

(*b*) The Contractor shall submit for approval by the C.O. within 15 calendar days after receipt of Notice to Proceed complete information regarding methods and equipment he or she proposes to utilize for installing the jet-eductor wells and pumping the dewatering wells required by these specifications. The Contractor shall at the same time submit detailed design data and drawings for the system he or she plans for controlling surface water and unwatering the excavation for the Phase I work. The material to be submitted shall include, but not necessarily be limited to, the following: capacities and characteristics of all well and jeteductor pumps, engines, gear heads, flexible couplings, and standby equipment; description of equipment and procedures he or she proposes to use for installing the dewatering wells, jet-eductor wells, and any supplemental dewatering facilities, if required, in the bottom or lower part of the excavation; calculations and drawings of dikes, ditches, sumps, pumps, and discharge piping for unwatering the Phase I excavation and for controlling surface water; and a detailed description of his *or* her procedures and plans for supervising the installation, operation, and maintenance of the dewatering systems to insure that the systems are installed as specified herein and that they are operated and maintained so as to preserve the systems in first class working conditions subject to normal wear, throughout the life of this contract.

(c) Approval by the Contracting Officer of the plans and data submitted by the Contractor shall not relieve the Contractor from the responsibility for controlling surface water, seepage, and artesian head and groundwater levels in the excavated areas as, and to the extent, specified herein.

(3) *Responsibility. The* Contractor shall be fully responsible for furnishing, installing, operating, and maintaining the dewatering and jet-eductor well systems, as specified, and any other seepage and surface water control systems required for control of groundwater as herein specified. However, any jet-eductor or

dewatering wells, pumps, piping, etc., required to control groundwater in the main excavated slopes around the excavation and in the deep sand stratum below the bottom of the excavation will be paid for as an extra. Any supplemental measures for control of seepage, whether perched or otherwise, in the bottom of the Phase II excavation or from excavated slopes in the bottom of the excavation, will *not* be paid for as an extra.

(*a*) The Contractor shall be responsible for: installing and testing the dewatering well and jet-eductor system as specified prior to and after unwatering the Phase I excavation; unwatering the Phase I excavation; dewatering and/or controlling any seepage from specified excavated slopes or in the bottom of the excavation so as to prevent any raveling or other instability of the slopes while unwatering of the Phase I excavation and driving the test and foundation piling under this contract; maintaining the hydrostatic water level in the deep sand formation at least 5 feet below the bottom of the excavation and any excavated slopes, and controlling any detrimental seepage emerging from pervious soils in the top stratum; lowering the groundwater table in pervious or semipervious strata in the top stratum at least 3 feet below any excavated slopes except at the contact with an underlying impervious stratum; maintaining the bottom of the excavation free of all seepage or surface water until the end of this contract; and operating and maintaining the dewatering systems.

(*b*) The Contractor shall be responsible for installing and operating continuously the dewatering well systems specified herein, and any other supplemental wells, pumps, and engines, necessary to lower and maintain the hydrostatic head in the deep underlying sand formation 5 feet or more below any Phase II excavation, and with the capacity of lowering the groundwater table below elevation -29.0 feet in the chamber and elevation -35.0 feet in the gate bay areas for the lock, for a projected Red River stage of elevation 60.0 feet. The Contractor shall also be responsible for maintaining the groundwater table in silt, silty sand, and sand strata, penetrated by the Phase I or Phase II excavation at least 3 feet below the surface of the slope, and shall control any seepage at the contact between seeping soil strata and impervious strata occurring at any time which might otherwise cause raveling or instability of the slope at that level. Any noncompliance with the above specified groundwater control requirements shall be promptly rectified in accordance with these specifications.

(c) The Contractor shall be responsible for all damage to work in excavated areas caused by failure to maintain and operate the dewatering systems as specified.

(4) *Installation sequence.* Prior to installation of the deep and jet-eductors dewatering wells, the Contractor shall submit a plan of his or her procedures and equipment for accomplishing the work within fifteen (15) days of his or her Notice to Proceed. After receiving approval of such procedures and equipment, he or she shall install and test the above dewatering system, including unwatering the Phase I excavation, within 120 calendar days. Any apparent deficiencies in the deep or jet-eductor well systems for whatever cause shall be corrected within 15 calendar days after evaluation of the pumping tests made on the systems and notification by the Contracting Officer. There shall be no unwatering of the Phase I excavation until the deep-well system has been installed and tested, and no unwatering of the excavation more than 3 to 5 feet below any reach of the uppermost berm, where jet-eductor wells are to be installed, until all of the jet-eductor wells specified are installed.

(5) *Testing dewatering system.* After the deep-well dewatering system has been completely installed, its adequacy shall be checked by the Contractor making a pumping test on the entire system, as directed by the C.O.R., prior to unwatering the Phase I excavation and at the completion of unwatering the Phase I excavation. The jet-eductor systems shall be continuously operated while unwatering the Phase I excavation and the adequacy of its performance evaluated after completion of unwatering and as the excavation for Phase II is carried to grade. The performance of the dewatering systems will be evaluated by the Government. If the dewatering well system and jet-eductor wells are found to be inadequate to control the groundwater and artesian head below the excavation, they shall be supplemented as provided for subsequently in these specifications.

(6) *Operation during contract.* The Contractor shall operate and maintain the specified dewatering well and jet-eductor systems and any supplementary wells or seepage control measures that may have been installed, as needed to comply with these specifications during the complete period of this contract.

(7) *Transfer of dewatering system to Phase III Contractor.* Upon completion of this contract, the Contractor shall turn over the complete deep-well, jet-eductor, and surface water control systems and all standby equipment to the Phase III Contractor or the Government who will at that time assume ownership and operation of the dewatering and surface water control systems. The Phase III Contractor will be responsible for removal of the systems in accordance with his Phase III contract.

(8) *Unwatering excavation for Phase I contract.* It will be the responsibility of the contractor to unwater the excavation made during the Phase I contract for this project. No unwatering of the excavation shall be started until after the deep-well and jet-eductor dewa-

tering systems have been completely installed and initially tested. When, and if, the first full-scale pumping test conducted on the dewatering system shows the system adequate to lower and maintain the hydrostatic water level in the deep underlying foundation 3 to 5 feet below the water level in the excavation as it is unwatered, the Contracting Officer will advise in writing that the Contractor may proceed with unwatering the excavation The water level in the Phase I excavation shall be lowered at a rate not to exceed 1 foot per day or slower if there is any sign of raveling or instability of the excavated slopes.

(9) *Surface water control. The* Contractor shall install, operate, and maintain dikes, ditches, sumps, pumps, and discharge piping for controlling surface water so as to prevent flooding of the work area for driving the test and foundation piles for the dam.

(10) *Available soilandpumping test data.*

(a) Some of the soil test data obtained by the Government are shown on the boring logs. Additional logs of borings made for the project are plotted in _____ dated _____. *The* above report and additional laboratory data and samples of soils from the borings shown on the plans are available in the _____ office of _____.

(b) Pumping tests have been performed on three wells installed at the site. One of these test wells (Well A) was installed with 190 feet of 16-inch nominal diameter well screen that more or less fully penetrated the deep sand aquifer beneath the excavation site; two of the test wells (Wells B and C) were installed to a depth of approximately 80 feet for the purpose of testing the upper top strata of silty sands and sandy silts. The locations of the test wells and some of the piezometers installed in connection with making the pumping tests are shown on the drawings. The elevation of the well screens for the test wells and piezometers and logs of borings made along the piezometer lines radiating out from the test wells were plotted. A hydrograph of the Red River and Piezometers PA9 and PA9A installed 2970 and 3970 feet from Test Well A, observed during the test on Well A, are shown on a drawing of these specifications. Plots were made of drawdown observed while pumping Test Well A, corrected for an estimated (natural) change in the groundwater table during these tests as a result of a rise on the Red River. Results of the pumping tests made on Test Wells B and C were also plotted. No correction was made for any natural change in the groundwater table during the pumping test on Wells B and C inasmuch as there was very little change in the river stage during the pumping test on these wells. A report on the pumping test made at the site by _____ and design of the dewatering systems may be examined at the New Orleans District Office or at the office of _____. The Government guarantees the accuracy of the basic river stage and pumping test data as obtained for the particular wells installed at the locations tested; however, as the logs of borings indicate, the characteristics of the subsurface soils at the site vary considerably, and therefore the Contractor should not assume that the data obtained from the pumping tests made at the locations specified are representative of all conditions that exist at the site. Therefore, it shall be the responsibility of the Contractor to make his or her own evaluation of the relation of the pumping test data to subsurface conditions at other locations at the site.

(c) The subsurface soils at the site consist of a top stratum of clays, silts, and fine sands, with widely varying degrees of arrangement and stratification, with *a* depth of about 80 to 120 feet. A stratum of rather pervious sand underlies the entire site with a thickness of approximately 220 feet. The top of this deep thick sand stratum varies from about elevation - 20.0 to - 70.0 feet. Logs of three borings (M-l, M-2, and M-3) made 500 feet deep indicate that this sand stratum is underlain by a clay stratum about 120 feet thick at a depth of about 290 to 380 feet. This clay stratum may or may not be continuous, It is underlain by more sand to a depth of about 400 feet.

(d) *The* Red River flows along and around a portion of the site for the excavation, the deeper parts of the river in the vicinity of the excavation range from approximately elevation 10.0 to -20.0 feet. To what extent the channel of the river provides an open source of seepage into the underlying deep sand formation is not known; the logs of a few borings made in the bed and along the bank of the river are shown in the previously referenced report by _____. It will be the responsibility of the Contractor to make his or her own evaluation of the effect of the Red River on dewatering and control of seepage into the excavation, not otherwise covered by these specifications.

(e) Chemical analyses of sample of groundwater taken from Test Wells A, B, and C on 28 April 1 8 gave the following results:

	Well A			
Total	*137-ft depth*	*260-ft depth*	*Well B*	*Well C*
pH	*6.8*	7.0	*7.0*	*6.9*
Chloride (Cl)	115	30	*60*	110
Suspended Solids (ppm)	*52*	*34*	*62*	*37*
Volatile Solids (ppm)	*8*	*5.5*	*7*	*5*
Total Solids (ppm)	*520*	*762*	*977*	*1620*
Total Dissolved Solids (ppm)	*468*	728	915	1583
Total Volatile Solids (ppm)	*50*	*65*	88	*227*
Sulfate (ppm)	*7*	*9*	*539*	*202*
Hardness ($CaCO_3$) (ppm)	*390*	*423*	*694*	*1066*
Magnesium	*26*	*28*	*54*	*94*

Total	Well A 137-ft depth	Well A 260-ft depth	Well B	Well C
Manganese	2	2	1	1
Calcium (ppm)	105	95	165	244
Iron (total) (ppm)	8	19	13	9
Hydrogen Sulfide (ppm)	<0.1	<0.1	<0.1	<0.1
Total Alkalinity ($CaCO_3$) (ppm)	405	479	567	480
Carbon Dioxide (CO_2) (ppm)	120	95	120	110

d. Deep-well dewatering system.

(1) *Scope.* The work provided for herein consists of furnishing all labor, material, equipment, and tools to construct, develop, test pump, and disinfect the filter sand, well, and pump for the dewatering wells to be installed around the perimeter of the excavation at the locations shown on the drawings and as specified herein. The work also includes installation of the pumps, diesel engines, gear drives, couplings, discharge pipes, valves, fitings, flow measurement devices, and discharge pipe.

(2) *Design.* The deep-well system specified has been designed to lower the groundwater table in the deep sand stratum beneath the excavation to elevation – 26.0 feet beneath the dam, elevation – 29.0 feet beneath the lock chamber, and elevation -35.0 feet beneath the gate bays for a design Red River stage of elevation of 60.0 feet (estimated maximum river stage for a frequency of 1 in 20 years). The purpose of the deep-well system is to lower the hydrostatic head in this sand stratum so as to prevent seepage into the bottom of the excavation and to prevent any heave of impervious soil strata that overlie the deep sand formation in certain areas of the excavation. It is imperative that there be no heave of the bottom of the excavation during either Phase II or Phase III construction of the lock and dam, If evaluation of the pumping test made at the completion of unwatering the Phase I excavation indicates the need for additional dewatering wells, pumps, engines, discharge piping, and appurtenances, the Government will design the supplemental system and furnish the design to the Contractor for installation. The Contractor will be reimbursed for the cost of installing any supplemental wells, pumps, engines, discharge piping, and appurtenances, when completely installed and ready for operation. The Contractor shall be responsible for designing any features of the well system not specifically covered by these specifications or drawings.

(3) *Installation of wells.*

(a) Locution of wells. The dewatering wells shall be installed at the designated locations. Soil conditions in the areas where the wells are to be installed are depicted in a general way by the boring logs made around the excavation. Subsurface conditions and stratification are erratic at this site, and clay, silt, and sand strata (with or without gravel and cobbles) may be encountered in drilling the holes for the specified wells. Logs and wood debris have also been encountered in making borings and drilling wells at some locations at the site,

(b) Depth of wells. The wells shall be installed to a depth so that the top of the specified length of screen (100 feet) is set approximately 5 feet below the top of fine (or coarser) sand as determined at the time of drilling by the C.O.R. The elevation at which the top of the screen shall be set is shown on certain logs of borings along the line of the dewatering wells. The top of fine sand ($D_{10} \geq \pm 0.12$ mm) below which the screen is to be set will probably vary from what is shown on the boring logs. The hole drilled for the wells will be logged by the C.O.R. If buried logs or boulders are encountered which, in the opinion of the C.O.R., render it impractical to advance the drill hole to the design depth, the C.O.R. may adjust the depth in order to utilize the well in the system at the depth actually obtained, or he or she may request the Contractor to abandon the well, plug the hole by backfilling, and construct another well at an adjacent location.

(c) *Drilling.* The dewatering wells shall be drilled by the reverse rotary method to a depth which will permit setting the top of the screen in fine (or coarser) sand as determined at the time of drilling by the C.O.R. The water level in the sump pit and the well shall be maintained a minimum of 8 feet above the groundwater table at all times until the well screen, riser pipe, filter, and backfill have been placed. Drilling of the well shall be carried out so as to prevent any appreciable displacement of materials adjacent to the hole or cause any reduction in the yield of the well. (A temporary surface casing with a *minimum* length of 20 feet shall be set prior to the start of drilling.) The diameter of the hole drilled for the well shall be 28 to 30 inches. The hole shall be advanced using a reverse-rotary drill rig with a (minimum) 5-inch I.D. drill stem. While drilling and installing the well, the drill hole shall be kept full of (natural) drilling fluid up to the ground surface with turbidity of about 3000 parts per million. No bentonite drilling mud shall be used while drilling or installing the well. Silt may be added to the drilling water to attain the desired degree of muddiness (approximately 3000 parts per million) if necesary. If natural turbid water, or with silt added, proves insufficient to keep the hole stable, an approved organic drilling compound such as Johnson's Revert, or equivalent, may be added to the drilling fluid. The Contractor shall dig a sump pit large enough to allow the sand to settle out but small enough so that some silt is kept in suspension. The drilled hole shall be 3 feet deeper than the well screen and riser to be installed in the hole. All drilling fluid shall be removed

from the well filter and the natural pervious information after the well is installed.

(d) Installation of well screen and riser.

Step 1. Assembly. The joints between the screen sections and between the screen and riser pipe shall be welded with stainless steel rod. Particular care should be exercised to avoid damaging the screen and riser. It shall be centered in the well hole or casing and held securely in place during placement of the filter by means of spiders and approved centering guide, tremie holder, or other approved method. Prior to installation of any screen and riser the Contractor shall submit to the Contracting Officer for approval full details of the method, equipment, and devices he proposes to use for centering and holding the screen and riser pipe in the well hole.

Step 2. Install&ion. The assembled screen and riser pipe shall be placed in the well hole in such a manner as to avoid jarring impacts and to insure that the assembly is not damaged or misaligned.

Step 3. Alignment. Each completed well shall be sufficiently straight and plumb that a cylinder 10 feet in length and 2 inches smaller in diameter than the inside diameter of the well may be lowered for the full depth of the well and withdrawn without binding against the sides of the screen or riser pipe. A variation of 6 to 12 inches will be permitted in the alignment of the screen and riser pipe from a plumb line at the top of the well; however, this will not relieve the Contractor of the responsibility of maintaining adequate clearance for bailing, surging, and pumping required for pumping the wells.

(e) *Placement of sand filter (A).* After the screen and riser pipe have been placed, the filter sand shall be tremied into the annular space between the well screen or riser pipe and the drilled hole using a 4- or 5-inch-diameter tremie pipe with flush screw joints and at least two slots $\frac{1}{16}$ inch wide and about 6 inches long per linear foot of tremie. The tremie pipe shall be lowered to the bottom of the hole and then filled with filter sand. (If the filter sand has a tendency to segregate, the filter sand shall be kept moist following delivery to the work site in order to minimize segregation.) After the tremie has been filled with filter sand, it shall be slowly raised, keeping the tremie full of filter sand at all times until the filter sand has filled the hole up to within 15± feet of the ground surface. The bottom of the tremie pipe shall be kept slightly below the surface of the filter sand in the hole as the tremie is raised.

(f) Development of well. After installation of the well, it shall be developed by surging with a surge block and pumping, as described below, for not less than 30 minutes. (If Revert or equivalent approved organic drilling additive has been used in drilling the hole, a breakdown agent such as Johnson's Fast-Break or equivalent shall be added to the well in accordance with the manufacturer's recommendations prior to surging.) Development of the well shall be started within 4 to 12 hours after the well has been installed. Surging of the well shall be accomplished with a surge block raised and lowered through the well screen at a speed of 2 to 3 feet per second. The gaskets on the surge block shall be slightly flexible and have a diameter about 1 inch smaller than the inside diameter of the well screen. The amount of material deposited in the bottom of the well shall be determined after each cycle (about 10 to 20 trips per cycle). Surging shall continue until the accumulation of material pulled through the well screen in any one cycle becomes less than 0.2 foot. The well screen shall be bailed clean with a piston-type bailer when the accumulation of material in the bottom of the screen becomes more than 2 to 3 feet at any time during surging; the well shall also be cleaned after surging is completed. After completion of surging, the well shall be pumped with the pump section about 1 foot off the bottom of the well until the discharge is clear and is reasonably free of sand (less than 10 to 20 parts per million sand). Such pumping shall begin within 2 hours after surging and shall continue for not less than 30 minutes. The well shall be pumped so as to achieve a drawdown of not less than 20 feet, or a flow of approximately 1000 gallons per minute, whichever is first. If, at the completion of pumping, the well is producing sand at a rate in excess of 10 to 20 parts per million, it shall be resurged and pumped again, Alternate surging and pumping shall be continued until material entering the well during either surging or pumping is less than the amount specified above, but not for a period longer than 6 hours. Wells which continue to produce an excessive amount of sand or filter material during development shall be abandoned as requested by the C.O.R. except that, if he or she so elects, he or she may request the Contractor to continue to develop the well by an approved method. If, after such further development, a well meets the above stated requirements, it shall be completed, and after successful completion of the required pumping test, the well will be accepted. If, after completion of all surging and pumping, there is more than 0.5 foot of material in the bottom of the well, such material shall be carefully removed with either a piston-type bailer or by pumping. The water resulting from pumping the well shall be discharged outside the work area at locations approved by the C.O.R. Pertinent data regarding installation of the wells will be recorded by the C.O.R. After completion of satisfactory development of a well, the grout seal shall be placed.

(g) Disinfection of drill hole and filter sand. During the drilling operation, a minimum of 1 pound of calcium hypochlorite shall be added to the drilling fluid every 2 hours. As the filter sand is placed in the

well, calcium hypochlorite shall be added to evenly distribute a minimum of 2 pounds per ton of filter. Upon completion of development of the well and prior to installing the well cover, a minimum of 5 pounds of granular 70 percent calcium hypochlorite shall be dropped in the well and allowed to settle to the bottom.

(*h*) *Covers.* The top of a well shall be sealed immediately after completion of installation with a watertight seal which shall be kept in place at all times, except during cleaning and pumping operations, until the pump and gear drive are installed.

(*i*) *Abandoned wells.* Holes for wells abandoned prior to placement of well screen and riser pipe shall be filled with sand and cement grout. Wells abandoned after placement of well screen and riser pipe may be pulled and the remaining hole filled with sand to within 25 feet of the surface. The remaining 25 feet should then be backfilled with an approved cement grout. Bentonite may be added to the grout to improve its pumpability. If the Contractor elects to leave an abandoned well screen and riser in place, it shall be plugged as described above. Wells which are abandoned as a result of alignment or plumbness being outside of these specifications, or wells which produce sand in excess of 5 parts per million after development and pump testing, shall be replaced by the Contractor at no cost to the Government.

(*j*) *Well records.* The following information regarding the installation of each well will be recorded by the C.O.R. The Contractor shall cooperate and assist the C.O.R. in obtaining the following information: well number, location, top of riser (mean sea level), date and time test started and stopped, depth to water in well before and at end of pumping, elevation of water in well immediately before and at end of pumping, flow in gallons per minute, depth of sand in well before and after completion of pumping, rate of sanding at end of pumping period, depth of sand in well after cleaning, screen length, depth of hole, inside depth of well, depth to sand in well after cleaning, top of well screen (mean sea level), top of filter (mean sea level), bottom of well (mean sea level), top of well, method of surging, material surged into well (last cycle) in feet, total material surged into well in feet, rate of pumping and drawdown, total pumping time, and rage of sand infiltration at end of pumping in parts per million.

(4) *Pumping test on each well.*

(*a*) Upon completion of installation, surging, and developing pumping, each well shall be subjected to a pumping test. Prior to commencement of the pumping test, and again after completion of the pumping test, the depth of the well shall be measured when the C.O.R. is present by means of an approved flat-bottom sounding device.

(*b*) The pump shall be capable of pumping at the rate of 1500 gallons per minute, over a period of time sufficient to satisfactorily perform the pumping test specified. An approved means for accurately determining the water level in the well and a calibrated flow meter or orifice of standard design for the purpose of measuring the discharge from the well during the pumping test shall be provided. The Contractor shall furnish and install the necessary discharge line so that the flow from the well can be pumped into an adjacent area approved by the C.O.R. The pumping and sand infiltration test shall be conducted in the presence of the C.O.R., who will record the following test data: well number, location, top of riser (mean sea level), date and time test started and stopped, depth to water in well before and at end of pumping, elevation of water in well immediately before and at the end of pumping, rate of sanding at end of pumping period, and depth of sand in well after cleaning.

(c) The Contractor shall test each well by pumping continuously for a minimum of 2 hours. Pumping shall be at a constant rate sufficient to produce either a drawdown of 20 feet, or a constant rate of flow of 1500 gallons per minute, whichever occurs first. The computed rate of sanding shall take into consideration the pumping rate, the rate of sand emerging from the pump, and the amount of emptying or buildup of sand in the bottom of the well during the (sand) testing period as determined accurately with a flat-bottom sanding device. No test pumping of a well will be permitted concurrently with drilling, surging, or pumping of any other well within 300 feet thereof.

(d) In the event that sand or other materials infiltrate into the well during the pumping test, the following procedure will be followed: If the rate of sand infiltration durng the last 15 minutes of the pumping test is more than 5 parts per million, the well shall be resurged by manipulation of the test pump for 15 minutes after which the test pumping shall be resumed and continued at the rate specified above until the sand infiltration rate is reduced to less than 5 parts per million. If at the end of 6 hours of pumping the rate of infiltration of sand is more than 5 parts per million, the well shall be abandoned unless the C.O.R. requests the Contractor to continue to test pump and perform such other approved remedial work as he considers desirable. If, after such additional test pumping and other remedial measures, the sand infiltration rate of the well is reduced to less than 5 parts per million, the well will be accepted. Upon completion of the pumping test, any sand or filter material in the bottom of the well shall be removed by pumping or with a piston-type bailer.

(5) *Installation of pump and chlorination.* Each dewatering well shall be chemically treated with calcium hypochlorite (chlorine) within 24 hours after the

test pump is removed, A solution of calcium hypochlorate (HTH) shall be mixed with water in a tank (minimum capacity of 3000 gallons to obtain a 1000-parts-per-million chlorine solution). (Fifteen pounds of (dry) 70 percent calcium hypochlorite will make 1000 gallons of 1000-parts-per-million chlorine solution.) A minimum of 30 gallons per foot of screen shall be pumped into the well through a hose extended to the bottom of the well. As the chlorine solution is pumped into the well, the hose shall be withdrawn at a rate which will insure that the chlorine solution is added uniformly from the bottom of the well to a point 10 feet above the top of the well screen. The chlorine solution in the well shall then be surged with a loose fitting surge block for 1 hour. The permanent dewatering pump shall then be immediately installed, and the well pumped until the chlorine is essentially removed. (If it is not possible to promptly install, the permanent pump, the chlorine should be allowed to set 3 or 4 hours, and the well pumped by some means to remove the chlorine.) If the permanent pump is subsequently installed, the well and pump shall be rechlorinated as described above except the surging shall be omitted.

(6) *Equipment and materials.*

(a) Quality. All installed equipment and materials shall be new except the discharge header system which may be either new or 'like new" used pipe.

(b) Power units. Each of the 64 deep wells shall be equipped with a direct drive diesel power unit. The engines shall be certified to produce a minimum of 115 continuous net horsepower at 1800 revolutions per minute to the gear drive and shall be a Caterpillar Model 3304 T, Detroit Diesel Model 4-71N, or equivalent as approved by the Contracting Officer. The unit shall be skid mounted with clutch power takeoff, have hood and side panels, fan shroud, muffler, high temperature and low oil pressure shutdown, battery, and fuel supply. Any additional item to make the unit function on a continuous 24-hour-per-day operation shall also be included. Engines shall be operated within the revolution-per-minute limits of the manufacturer's recommendations. The unit shall be leveled and mounted on a 6-inch-thick concrete base. Prior to operation, each unit shall be started and serviced by a manufacturer's factory trained representative, or equally qualified mechanic. The power units shall be operated and maintained in accordance with the manufacturer's recommendations. Each power unit shall have an independent fuel tank with a capacity of at least 500 gallons. Fuel lines shall be provided with an approved screen or filter and shall be attached to the tank so that rain or contaminants may not enter the tank. The tank shall be properly vented and equipped with a drain plus and filler port. All fuel tanks shall be new and cleaned prior to being placed in service. At the commencement of pumping, the Contractor shall have at the jobsite five new complete diesel power units. During the pumping period, the Contractor shall have a minimum of five (new or remanufactured) diesel power units, complete with all components, available as standby. The Contractor shall also keep in stock on the jobsite other miscellaneous spare parts essential to routine maintenance of the engines, pumps, gear heads, flexible couplings, valves, etc., as considered appropriate and approved by the C.O.R.

(c) *Pumps.* Deep-well turbine pumps, similar or equivalent to such pumps manufactured by Layne-Bowler, Fairbanks-Morse, Johnston, Jacuzzi, or other qualified pump manufacturer, shall be designed for pumping clear water at a rated capacity of 1500 gallons per minute at a total dynamic head of 200 feet and pump speed of 1800 revolutions per minute with a bowl efficiency of about 80 percent. The pump bowl assembly shall be of close-grained cast iron porcelain enamel-coated inside and fitted with replaceable bronze wear rings and sleeve-type shaft bushings, Impellers shall be cast iron or bronze and designed for nonoverloading. The bowl shaft shall be high-chrome stainless steel of sufficient diameter to transmit the pump horsepower with a liberal safety factor and rigidly support the impellers between the bowl or case bearings. The pump column assembly shall consist of thirteen lo-foot sections of lo-inch steel threaded pipe with line pipe couplings. Bronze spiders with rubber bearings shall align the shaft bearings in each section. Line shafts shall be of Grade 1045 (ASTM A 108) steel ground and polished with Type 304 (ASTM A 743) stainless steel sleeves to act as a journal for each rubber line shaft bearing. A lo-foot section of lo-inch threaded suction pipe shall be screwed into the bottom of the pump bowl. The discharge head shall be provided for mounting the gear drive and supporting the pump columns, bowls, and suction pipe. The design shall permit the drive shaft to be coupled about the stuffing box to facilitate easy removal and replacement of the driver. The stuffing box shall be of the deep bore type with a minimum of six rings of packing and a steel case. The packing gland shall be the bronze split-type and secured with stainless steel studs and silicone bronze nuts.

(d) Gear drive and flexible coupling. A right angle gear drive with a gear ratio of 1:1 shall be installed on each pump. Horsepower rating shall be based on American Gear Manufacturers Association standards for spiral bevel gears. Ball and roller bearings shall have a capacity to carry the horsepower and thrust loads for a minimum of 20,000 hours. The housing shall be a rigid semisteel casting properly proportioned to insure correct alignment of the gears under full load. Case-hardened spiral bevel gears shall be held in position by antifriction bearings selected to

convey the loads over a 4-year period of operation. A large stream of oil shall be pumped to the gears and bearings by a pump located in the base of the housing. The vertical shaft shall be hollow to allow for easy adjustment of the pump shaft. Provision shall be made for circulating water through a copper coil installed inside the case. A flexible drive shaft, Watson-Spicer WL-48, or equal, shall be provided with each gear drive. The shaft shall be a minimum of 36 inches long and provided with drive flanges to fit the engine and gear drive. A protective cover made of galvanized sheet metal or expanded metal shall be permanently attached between the engine and gear drive to shield the drive shaft.

(e) *Standby equipment.* At the commencement of pumping, the Contractor shall provide and have in stock at the jobsite three new complete standby turbine pumps. During the pumping period, the Contractor shall continue to have a minimum of three (new of rebuilt) pumps available as standby units, which shall be complete with column, shafting, pump head, gear drive, and flexible coupling.

(*f*) A minimum of 20 feet of each size of header pipe and two of each size of Dresser couplings (or equivalent) shall be on site for emergency repair if necessary. Twelve S-inch flanged nipples shall also be kept on site for adding S-inch rubber or plastic cloth discharge hose for emergency pumping of the deep wells in event of discharge pipe failure. Sixty-five hundred feet of S-inch rubber or plastic cloth hose shall be kept on site for pumping of individual wells.

(*g*) *Operation and repair or replacement.* The pumps shall be operated so that the water level in the wells is not lowered below the pump bowl. The pumps and engines shall remain in operable condition at all times with no more than two wells or pumps being inoperative at any one time. No two adjacent wells or pumps shall be inoperative at the same time. The Contractor shall take immediate steps to repair or replace any well, pump, gear drive, or engine which is inoperative. Should the efficiency of a dewatering well show any significant reduction from its initial efficiency, the Contractor may, at the direction of the C.O.R., be required to redevelop and/or chemically treat the well as directed by the Contracting Officer, the cost of which will be paid for under paragraph 3 (Changes) of the General Provisions of the Contract.

(*h*) *Riser pipe.* The riser pipe for the wells shall be 16-inch diameter, 0.250-inch or thicker wall, steel pipe.

(i) Well screen. The well screen shall be Johnson, Houston, or equal, wire-wrap type 304 stainless steel screen with a minimum inner diameter of 15 inches (16-inch pipe size) with a nominal length of 100 feet. The width of the slots will be 0.040 inch. The (keystone or trapezoidally shaped) screen wire shall be wrapped and welded on 0.177-inch round rod. The well screen shall be furnished in lengths of 10 or 20 feet. One section of screen for each well will be provided with a stainless steel bottom plate.

(*j*) *Filter sand.* The filter around the well screen and riser pipe shall be an approved washed (clean) sand or crushed stone composed of hard, durable, uniformly graded particles free from any inherent coating. The filter sand shall contain no detrimental quantities of vegetable matter, nor soft friable, thin, or elongated particles, and shall meet the following gradation requirements:

Filter Sand A

U.S. Standard Sieve No.	*Percent by weight passing*
1/4	100
4	95-100
6	*85-100*
10	*55-85*
14	*28-65*
16	*20-55*
20	10-32
30	*0-18*
40	0-10

If blending of two or more sands is required to obtain the specified gradation, the blending shall be accomplished so as to achieve a uniform mix approved by the C.O.R.

(k) Discharge system. The discharge piping is for the purpose of conveying the water from the dewatering wells to the flotation channel on the south side of the cofferdam area. Under no conditions shall the Contractor discharge water from the dewatering systems outside of the cofferdam dike other than at the specified location. The header pipe installed at the specified locations shall be standard structural grade pipe with the following minimum wall thicknesses:

Pipe diameter, inches	*Minimum wall thickness, inches*
12	*0.22*
18	*0.25*
24	*0.25*
30	*0.25*
36	*0.28*
42	*0.28*

The diameter of the pipe will vary from 12 to 42 inches. Connections may be made either by welding or by Dresser couplings with tie rods. The pipe shall be laid straight, on approved blocking, in a workmanlike manner. Where crossing a road or ramp, the pipe shall be laid in an open separate culvert. The discharge pipe through the cofferdam dike shall have welded joints and be provided with "seepage" fins. A 42-inch Calco, or equivalent, flap gate shall be installed on the end of each discharge pipe. The discharge line from the well to the header shall be 8 inches in diameter and include a gate valve that can be locked or will remain in a fixed position while partially closed, a positive check valve and a pitometer cock for insertion of a pitot tube to

measure well flow. Certain wells shall be provided with a tee and blind flange for connection of an 8-inch discharge hose in event of damage or failure of the main discharge header pipe. The Contractor shall construct splash facilities for discharge water at the dredge channel. The Contractor shall maintain the discharge splash facilities so as to prevent erosion or damage to the channel slopes and to modify such if found necessary.

(7) *Pumping test on the dewatering systems.*

(a) After the deep-well dewatering system is completely installed, a pumping test shall be made on the entire sysem by pumping all the wells at the same time at a constant pump speed or flow rate for each well, the pumping rate to be determined by the C.O.R. prior to the test. If the selected pumping rate lowers the water level in any well below the pump bowl, the engine speed shall be reduced or the discharge valve partially closed so that the water level in that well is not lowered below the pump bowl.

(*b*) This test, the first, shall be made prior to starting to unwater the Phase I excavation. The wells shall be pumped continuously for at least 24 hours and for not more than 48 hours as required by the C.O.R. The Contractor shall have previously installed the M piezometers around the perimeter of the excavation, the R, S, and T piezometers on lines out from the excavation, and provision has been made to measure the flow as shown on the drawings and specified herein. The C.O.R. will keep a systematic record of discharge throughout the test period and will record the water level in the piezometers and wells immediately prior to commencing the test and at certain intervals thereafter, The pumping test shall be conducted under the general direction of the C.O.R. with the Contractor being responsible for actual operation of the system.

(c) If an analysis of the pumping data by the Government indicates probable adequacy of the system, the Contractor may start unwatering the Phase I excavation while continuing to operate the dewatering well system so as to maintain the groundwater table in the deep sand formation, as indicated by the M piezometers installed around the top of the excavation, 3 to 5 feet or more below the water level in the excavation.

(d) After the Phase I excavation is unwatered, all wells shall be pumped at a constant rate to be prescribed by the C.O.R. for at least 48 hours and not more than 120 hours, as determined by the C.O.R., as a further check on the adequacy of the dewatering well system with the excavation unwatered. As during the first test, the rate of flow from each well and the entire system shall be measured throughout the test period, and the water level in the M, R, S, and T piezometers and in the dewatering wells will be measured and recorded at certain intervals during the test. The adequacy of the deep-well system will be evaluated on the basis of the pumping test made upon completion of unwatering of the excavation, for a Red River stage of elevation 60 feet. If at the end of the pumping test, an analysis of the data by the Contracting Officer or his C.O.R. indicates the system to be adequate, it will be approved; if the dewatering well system appears to be inadequate, for a design Red River stage of elevation 60 feet, the Contracting Officer will direct the Contractor to install additional dewatering wells, pumps, engines, and necessary pertinent piping and fittings for which he will be compensated as an extra.

(e) If it appears, while unwatering the Phase I excavation and the second pumping tests on the deep-well system, that the groundwater table in the top stratum has not been adequately lowered by the specified jet-eductors wells and pumping the deep-well system, the Contractor shall install whatever additional jet-eductor wells, pumps, and piping considered necessary by the C.O.R. for which he will be compensated as an extra.

e. *Jet-eductor well system.*

(1) *Scope.* The work provided for herein consists of furnishing all labor, material, equipment, and tools to install, develop, and test pump the jet-eductor wells to be installed around the perimeter of the excavation at the locations shown on the drawings and as specified herein.

(2) *Design.* The jet-eductor wells to be installed on the upper berm around the excavation at elevation 28 to 34 feet are to intercept the seepage from silt, sandy silt, silty sand, and sand strata which are penetrated in some areas by the outer excavation slopes. The purpose of the jet-eductor wells is to lower the groundwater table below the slopes of the main excavation and to prevent any detrimental raveling or instability of the slopes caused by seepage. The jet-eductor wells shown on the contract drawings and as specified herein have been designed to lower the groundwater table in the upper silts and sands to within about 2 or 3 feet of the contact with any underlying impervious stratum where shown on the drawing. However, other reaches of the outer excavated slopes than shown on the drawings may require dewatering or drainage. If observations indicate the need for dewatering other reaches of the outer slopes, the Government will design the supplemental jet-eductor wells and system and furnish the design to the Contractor for installation. The Contractor will be reimbursed for the cost of any supplemental wells, jet-eductor pumps, and piping when completely installed and ready for operation, as an extra, The Contractor shall be fully responsible for controlling the groundwater table and seepage from and below the main excavated slopes as specified herein, and for proper installation, operation, maintenance of the specified jet-eductor wells, and any sup-

plemental dewatering measures installed for controlling the groundwater within the excavation.

(3) *Installation of jet-eductor wells.*

(a) *Location and depth of wells.* The jet-eductor wells shall be installed at the designated locations. Soil conditions where the jet-eductor wells are to be installed are depicted in a general way by the logs of borings made around the excavation. The wells should extend about 2 feet below the bottom of the pervious strata being drained. The required depth of the wells may vary considerably from those indicated on the drawings.

(b) *Drilling and jetting.* The jet-eductor wells shall be installed in the following manner:

Step 1. Predrill a 10- or 11-inch hole 2 feet below the silt or silty sand stratum to be drained. Hydraulic rotary, or auger, methods of drilling may be used. No drilling muds or additives, other than clear water, shall be used in drilling the hole for the well. The hole shall be kept full of water during the predrilling, and withdrawal of the auger, so as to minimize caving.

Step 2. After predrilling the hole to grade, it shall be washed out by driving and jetting (with clear water) a 12-inch "sanding casing" with a hole puncher to the bottom of the predrilled hole.

Step 3. After the "sanding casing" is driven and jetted to the required depth, it shall be washed clean by jetting with clear water. The jet pump, pipe, and hose shall be of sufficient capacity to produce an upward velocity inside the casing to efficiently remove all material in the casing, so that the well screen and riser can be set to grade. The "sanding casing" shall be kept filled with water until the well screen and filter sand have been placed so as to prevent any "blow in" of the bottom of the hole.

(c) *Installation of well screen and filter sand.* After the sanding casing has been cleaned by jetting and the clear depth in the casing checked by sounding with an approved device, the well screen shall be lowered to the bottom of the casing. Particular care shall be exercised in handling and placing the screen so as not to damage it. Complete assembly of the screen and riser pipe on the ground'surface will not be permitted. Two or three connections shall be made to the assembly as it is placed in the casing. Approved centralizers shall be furnished and attached to the screen at intervals not greater than 20 feet. The design and attachment of the centralizers to the well screen shall be submitted to the C.O.R. for approval. The top of the riser pipe shall be securely covered or capped to prevent the filter sand from falling into the well. The method of placement shall assure a fairly rapid, continuous, uniform rate of placement of filter sand, which will evenly distribute the filter sand around the screen. The rate of placing the filter sand shall not cause bridging of the sand in the "sanding" casing. As the filter material is placed in the well screen, 70 percent granular calcium hypochlorite shall be added to evenly distribute a minimum of 2 pounds per ton of filter. The method of placement shall be approved by the C.O.R.

(d) Development of jet-eductor wells. Within 12 hours after installation of each well, it shall be developed by means of air-lifting. A 2-inch inner diameter air line shall be lowered in the well to within 1 foot of the bottom of the well and sufficient air be pumped through the air line to cause the well to flow. For low-yielding wells, it may be necessary to add clear water to help develop the well and remove any sand that may have entered the screen. Air-lifting shall continue until all sand or filter material is removed from inside the screen and water from the well flows clear. Each well shall be developed for a minimum of 20 minutes.

(e) *Chlorination of well.* Upon completion of installation of the well and prior to installing a cap on the top of the riser, a minimum of 3 pounds of 70 percent granular calcium hypochlorite shall be dropped into the well,

(f) Well top. The 4-inch riser shall extend 6 inches above the ground surface and shall be sealed around the riser pipe for the jet-eductor pump. The well number shall be painted on the top of the riser pipe.

(g) *Riser pipe.* The 4-inch riser pipe for the wells shall be 15 feet in length. The filter sand shall extend to within 8 to 10 feet of the berm surface; the space around the riser pipe from the filter to the berm surface shall be grouted with an approved bentonite-cement grout.

(h) Well records. A report showing depth, elevations, date of installation, approximate rate of flow during development, and any other data concerning installation of each well will be completed by the C.O.R. The water level in the well shall be recorded at the time of installation. The Contractor shall assist in obtaining the installation data. If the jet-eductors or pumps appear to be losing their efficiency with the passage of time, the Contractor may be required to redevelop and/or chemically treat the wells as directed by the Contracting Officer, the cost of which will be paid for under paragraph 3 (Changes) of the General Provisions of the Contract.

(4) *Materials.*

(a) *Riser pipe.* The riser pipe and the 2-foot blank pipe on the bottom of the screen shall be 4-inch diameter, flush-joint Schedule 80, type 2110 PVC pipe.

(b) ***Screen.*** The screen shall be 4-inch, Schedule 80, type 2110 PVC screen. The screen shall be slotted with .025-inch slots in sufficient numbers to give a minimum area of opening of 5 percent. The screen section of the well shall extend from the top of any semi-

pervious strata as shown by the boring logs, or as encountered, to the depth specified.

(c) *Filter sand.* Filter sand around the well screen shall be washed (clean) uniform sand or crushed stone composed of hard, tough, and durable particles free from any adherent coating. The filter sand shall contain no detrimental quantities of vegetable matter, nor soft, friable, thin, or elongated particles, and shall meet the following gradation requirements:

Filter Sand B

U.S. Standard Sieve No.	*Percent by weight passing*
8	95-100
10	92-100
14	75-100
16	65-95
20	30-77
30	10-30
40	1-13
50	0-5

(5) *Jet-eductor pumps and header pipe.* The jet-eductor pumps shall have the specified pumping capacities, The pressure pumps for operating the jet-eductor pumps shall have a diesel engine with a horsepower of at least 110 and a capacity of 1800 gallons per minute at a total dynamic head of at least 150 feet on a continuous basis. The standby pumps shall have the same horsepower and capacity. The pressure header pipe shall be Schedule 40; the return header pipe shall have a minimum wall thickness of 0.20 inch. The sump pumps for the jet-eductor systems shall be an electric, automatic priming type, with a capacity of pumping 600 gallons per minute at TDH = 50 feet.

f. Surface water control

(1) The Contractor shall be fully responsible for designing all features of the system for unwatering the excavation and controlling surface water that may fall into the excavation. The sump pumping system shall be designed with sufficient storage and pumping capacity to prevent flooding the bottom of the excavation for the dam for at least a 1 in lo-year rainfall intensity, assuming 100 percent runoff, for the following periods:

	Rainfall	
Period	*Intensity, inch/hour*	*Amount, inches*
30 minutes	*4.5*	*2.25*
1 hour	3.0	3.00
2 hours	2.0	4.00

In any event, the Contractor shall be responsible for controlling whatever surface runoff occurs, regardless of rainfall intensity, so as to protect the area for pile driving and testing from flooding.

(2) The Contractor shall submit for approval within 15 calendar days, after he or she has received a Notice to Proceed, drawings, design data, and characteristics of the equipment he proposes to utilize in unwatering and controlling surface water. The data and drawings to be submitted shall include, but not necessarily be limited to:

(*a*) Location and size of sumps, pumps, and dikes.

(*b*) Height and elevation of dike around excavation.

(c) Characteristics of sump pumps and horsepower of engines.

(d) Location and size of discharge piping. (Surface water shall not be pumped into the discharge header for the dewatering (well) system.)

g. Dewatering perched groundwater in lower part or bottom of excavation. The Contractor shall be fully responsible for design and installation of any supplemental dewatering facilities that may be required to control any seepage or groundwater in the bottom or lower part of the excavation in order to assure a stable subbase and permit work to be conducted in the "dry." These supplemental measures may include well-points, sand drains, French drains, and appropriate pumps, piping, and appurtenances as necessary and approved by the C.O.R. subject to satisfactory performance of the facility installed. Pay for any such supplemental dewatering, if required, for the lower or bottom part of the excavation should be included in the price for excavation. There will be no charges or claims for extra compensation or time extension for any supplemental dewatering performed in the bottom or lower part of the excavation.

h. Monitoring dewatering systems.

(1) General. Continuous control of seepage into and artesian pressure beneath the excavation is essential for driving the test and foundation piles for the dam, and subsequent construction of the lock and dam. It is therefore imperative that the dewatering systems have adequate capacity to control the groundwater beneath the slopes and the excavation as specified at all times, In order to check the adequacy and performance of the dewatering systems, the Government will make the following measurements and evaluate the data:

(*a*) Measure the groundwater table beneath the bottom of the excavation by means of M, R, S, and T piezometers installed in the deep sand aquifer that underlies the site at specified locations.

(*b*) Measure the groundwater table at selected locations where the excavation penetrates silts and silty sands in the top stratum overlying the deep sand formation by means of N piezometers installed at the locations.

(c) Measure the flow from individual wells and from the complete dewatering system.

(d) Measure the water level in the dewatering wells.

(e) Measure sand in the flow from dewatering wells.

(*f*) Measure the head loss through the filter and well screen for selected wells.

(g) Read river stages.

The piezometers for monitoring the groundwater table beneath the slopes and bottom of the excavation shall be installed by the Contractor. The pitometers for measuring the flow from individual wells and from the complete system will be furnished by the Government. Copies of the data obtained by the Government will be promptly furnished to the Contractor. The Contractor will furnish and install the pitometer inserts. Operation and maintenance of the dewatering systems, any supplemental groundwater control facilities if required, and surface water control facilities shall be supervised by someone trained and with at least 5 years of actual experience in managing large dewatering systems and operating pumps and engines.

(2) *Piezometers.*

(*a*) *Locations.* The M, R, S, and T piezometers shall be installed to measure the groundwater table in the deep sand formation beneath the excavation, between the dewatering wells, and on three lines out from the excavation at the approximate locations shown on the drawings. The N piezometers shall be installed to measure the groundwater table in semipervious strata in the bottom of the excavation and midway between jet-eductor wells at the approximate locations. The Contractor shall stake the piezometers at designated locations. The tips of M, R, S, and T piezometers for measuring the groundwater table in the deep sand formation shall be set in clean sand at elevation -80.0 feet or below as necessary; the tips of the N piezometers for measuring the groundwater table in semipervious strata in the top stratum shall be set at the bottom of the semipervious strata.

(*b*) *Piezometer materials.* The N piezometers shall consist of a 1.50-inch I.D. (Schedule 80) PVC screen with 0.025-inch slots connected to a 1.50-inch I.D. (Schedule 80) PVC riser pipe. The screens shall be 10 feet long. The joints of the screen and riser shall be flush (inside and outside) and shall be glued together with PVC pipe cement. The filter sand (B) shall meet the specifications set forth for jet-eductor wells. Depending upon the method of installation, the riser and screens for the M, R, S, and T piezometers shall be as specified above, or 1.5-inch galvanized iron riser pipe connected to a 1.5- by 30-inch self-jetting wellpoint with a 30- to 40-mesh stainless steel screen.

(c) *Installation of piezometers.* Holes for piezometers may be advanced by either: using an S-inch O.D. continuous flight auger with a 3⅜-inch I.D. hollow stem with the hollow stem plugged at the bottom with a removable plug; augering and more or less simultaneous installation of a 6-inch casing; or using a rotary wash drilling procedure (6-inch diameter) and an organic drilling fluid, such as Revert, if necessary, to keep the drilled hole open. The tip of the piezometers shall be installed at approximate depths or elevations as approved by the C.O.R.; piezometers shall also be installed as instructed. The hole for a piezometer shall be kept filled with water or an approved organic drilling fluid at all times. Bentonitic drilling mud shall not be used. Any auger used in advancing the hole shall be withdrawn slowly from the hole so as to minimize any suction effect caused by withdrawing the auger. (Hollow-stem augers shall be filled with drilling fluid before pulling the plug in the bottom of the auger.) Drilling and installation procedures shall be as specified below and shall be in accordance with accepted practice and to the satisfaction of the C.O.R.

Method 1. Hollow-stem auger. After advancing the hole for the piezometer to grade (1 to 2 feet below the piezometer tip), or after taking the last sample in a hole to receive a piezometer, the hollow-stem auger shall be flushed clean with water and the plug reinserted at the bottom of the auger. The auger shall then be slowly raised to the elevation that the piezometer tip is to be installed. At this elevation the hollow stem shall be filled with clean water and the plug removed. Water shall be added to keep the stem full of water during withdrawal of the plug. The hole shall then be sounded to determine whether or not the hollow stem is open to the bottom of the auger. If material has entered the hollow stem of the auger, the hollow stem shall be cleaned by flushing with clear water, or clean Revert drilling fluid, if necessary, to stabilize the bottom of the hole, through a bit designed to deflect the flow of water upward, until the discharge is free of soil particles. The piezometer screen and riser shall then be lowered to the proper depth inside the hollow stem and the filter sand placed. (A wire spider of design approved by the C.O.R. shall be attached to the bottom of the piezometer screen so as to center the piezometer screen in the hole in which it is to be placed. Use two crossed wires just above the plug in the tip.) Filter sand shall be poured down the hollow stem around the riser at a rate (determined in the field) that will ensure continuous filter sand flow down the hollow stem around the riser and piezometer, and will keep the 8-inch hole below the auger filled with filter sand as the auger is withdrawn. Withdrawal of the auger and filling the space around the piezometer tip and riser with filter sand shall continue until the hole is filled to a point about 5 feet above the top of the piezometer screen. Above this elevation, the space around the riser pipe may be filled with any clean, uniform sand with less than 5 percent passing a No. 100 U.S. Standard sieve up to within 20 feet of the ground or excavated surface. An impervious grout seal shall be placed around the top 20 feet of the ground or excavated surface. An impervious grout seal shall be placed around the top 20 feet of the hole for the M, R, S, and T pie-

zometers, and 5 feet for the N piezometers.

Method 2. Casing. The hole for a piezometer may be formed by setting a 6-inch casing to an elevation 1 to 2 feet deeper than the elevation of the piezometer tip. The casing may be set by a combination of rotary drilling and driving the casing. The casing shall be kept filled with water, or organic drilling fluid if necessary, to keep the bottom of the hole from 'blowing." After the casing has been set to grade, it shall be flushed with water or (clean) drilling fluid until clear of any sand. The piezometer tip and riser pipe shall then be installed and the filter sand poured in around the riser at a rate (to be determined in the field) which will insure a continuous flow of filter sand down the casing that will keep the hole around the riser pipe and below the casing filled with filter sand as the casing is withdrawn without "sand-locking" the casing and riser pipe. (Placement of the filter sand and withdrawal of the casing may be accomplished in steps as long as the top of the filter sand is maintained above the bottom of the casing but not so much as to "sand-lock" the riser pipe and casing.) Filling the space around the piezometer tip and riser with filter sand shall continue until the hole is filled to a point about 5 feet above the top of the piezometer screen. Above this elevation, the space around the riser pipe may be filled with any clean, uniform sand and the hole grouted as specified in Method 1 above.

Method 3. Rotary. The hole for a piezometer may be advanced by the hydraulic rotary method using water or an organic drilling fluid. The hole shall have a minimum diameter of 6 inches. After the hole has been advanced to a depth of 1 or 2 feet below the piezometer tip elevation, it shall be flushed with clear water or clean drilling fluid, and the piezometer, filter sand, sand backfill, and grout placed as specified in Method 2 above, except there will be no casing to pull.

Method 4. Self-jetting. The M, R, S, and T piezometers may be drilled to within 4 feet of planned total depth, then clean water used to advance the self-jetting wellpoint to the design grade without the use of filter sand around the wellpoint. The seal and backfill for the piezometers shall consist of a pumpable cementbentonite grout, with a ratio of 1 gallon of bentonite per bag of cement, or equivalent cement grout approved by the C.O.R. (Only enough water shall be added to make the grout pumpable.) The tops of the risers shall be cut off 36 inches above the ground surface. The upper part of the piezometer shall be protected by installing a 6-inch I.D. PVC or corrugated metal pipe around the riser cemented in to a depth of 3 feet below the ground surface. The number of the piezometer shall be marked with 3-inch-high black letters on the pipe guard around the riser pipe.

Method 5. Sampling. Split-barrel samples shall be obtained at 5-foot intervals and at every strata change for the N piezometers. Samples shall be obtained using a 1⅜-inch (minimum) I.D. split-barrel or 3-inch Shelby tube sampler by driving or pushing. The length of drive or push shall not be less than 3 inches. If there is insufficient sample recovery to identify the soil properly, another sample shall be obtained immediately below the missed sample. If desired, the sampler may be advanced using driving jars on a wireline.

(d) Development and testing. After each piezometer is installed, it shall be promptly flushed with clean water, developed, and pumped to determine if it is functioning properly. (If an organic drilling fluid has been used, Johnson's Fast Break, or equivalent, shall be added in accordance with the manufacturer's recommendations to break down the drilling fluid,) A 10-foot minimum positive head shall be maintained in the piezometer following addition of the Fast Break. After at least 30 minutes has elapsed, the piezometer shall be flushed with clear water and pumped. The piezometer may be pumped with either a suction pump or by means of compressed air. The approximate rate of pumping during development shall be measured, Piezometers installed in the deep sand formation will be considered acceptable if they will pump at a rate of 2 to 5 gallons per minute or more. Piezometers installed in the semipervious strata within the top strata will be considered acceptable if they will pump at a rate of at least 0.5 gallon per minute, or when the piezometer is filled with water, the water level falls approximately half the distance of the groundwater table in a time less than the time given below for various types of soil:

Type of soil in which piezometer screen is set	*Period of observation minutes*	*Approximate time of 5Opercent fall minutes*
Sandy silt (> *50%* silt)	*30*	*30*
Silty sand (< *50%* silt, > *12%* silt)	10	*5*
Fine sand (<12% silt)	*5*	1

If the piezometer does not function properly, it shall be developed by a combination of air surging and pumping with air as necessary to make it perform properly. If the piezometer still will not perform properly, it shall be reinstalled at a nearby location selected by the C.O.R.

(e) *Monitoring groundwater table.* The Contractor shall read all M and N piezometers at least once a week, selected piezometers at least twice a week, some of the piezometers in the deep sand formation daily, and the water level in the dewatering and the jet-eductor wells at least once a week for his or her information and use in operation of the dewatering systems and control of groundwater as specified. The Contractor shall record what deep well and jet-eductor wells are being pumped when he takes his piezometer or water level readings. The C.O.R. will also read the M

and N piezometers on a schedule similar to the above for his own check and evaluation purposes.

(f) Records, The Contractor shall furnish copies of all piezometer and water level readings to the C.O.R. within 24 hours of being taken. Copies of piezometer , water level, and flow measurements made by the C.O.R. will be furnished to the Contractor within 24 hours.

(3) *Dewatering system flow.*

(a) Flow measurements. The flow from individual dewatering wells will be measured by means of a pitometer installed in the discharge pipe from the well. As a check on the pitometer measurements and on the performance of the well pump, the rate of flow being pumped will also be estimated from the pump characteristic curve, engine speed, static lift of the water, and the pressure in the discharge pipe at the top of the well. Flow from the entire dewatering system will also be measured by means of a pitometer. All flow measurements will be made by the C.O.R. assisted by the Contractor's "dewatering" engineer.

(b) Frequency of measurement. The total flow from the dewatering system shall be measured once or twice a week and the flow from individual wells weekly or biweekly, as appears appropriate.

(c) *Records.* All flow measurements will be recorded by the C.O.R. and a copy of the data furnished to the Contractor within 24 hours. The C.O.R. will be responsible for reading the river gage and recording the data; a copy of the river gage reading will be furnished to the Contractor each day.

(4) *Sanding.* The flow from each dewatering well will be monitored for sanding. The rate of sanding will be determined by taking a measured amount of water being pumped from each well and the sand content determined. The maximum rate of sanding acceptable will be 5 parts per million. The rate of sanding will be checked once a week by the C.O.R. and the data recorded. A copy of the data will be furnished to the Contractor within 24 hours.

i. Operation and maintenance of dewatering and surface water control systems.

(1) Supervision. Supervisory personnel shall be present onsite during normal working hours and shall be available on call 24 hours a day, 7 days per week, including holidays.

(2) *Operating personnel.* Sufficient personnel skilled in the operation, maintenance, and replacement of the dewatering and surface water control systems, components, and equipment shall be onsite 24 hours a day, 7 days per week, including holidays, at all times when the systems are in operation.

(3) *Well pumping restriction.* The pumping rate of any dewatering (deep) well shall be adjusted, if necessary, by adjustment of engine speed or valving so that the water level in no well is lowered below the pump bowl. With approval of the C.O.R., the pump bowl may be lowered. In order to maintain maximum well efficiency, the deep-well system shall be operated by pumping whatever number of wells are required to achieve the specified water level lowering in the deep sand formation without pumping any well more than 1200 gallons per minute except in an emergency or if required to achieve the specified water level lowering.

(4) *Responsibility.* Dewatering the excavation includes the control of seepage and artesian pressure in the deep sand stratum underlying the site and the control of seepage from the upper silts and silty sand for the duration of this contract. Included are the operation and maintenance of the deep-well, jet-eductor well, and surface water control systems.

(5) *Repair and replacement.* The specified number of wells and pumps shall be available for use at all times. All damaged or malfunctioning wells or well components shall be repaired or renewed as expeditiously as possible while continuing to maintain the required water levels. The Contractor shall be responsible for all replacement equipment and the repair and maintenance of all system components so as to maintain the system fully operational. Replacement equipment and materials shall conform to the requirements of these specifications.

(6) *Maintenance criteria.* The Contractor shall maintain a regularly scheduled maintenance program which shall conform with the equipment manufacturer's recommendations and include all other work necessary to maintain all components fully operational. The maintenance program shall include, but not be limited to, checking the flow rate and water elevation in each well. All data and records shall be submitted to the C.O.R. at the completion of this contract. The Contractor shall also maintain any nonoperating pumps and engines. Maintenance shall include, but not be limited to, starting each nonoperating pump and engine on a weekly basis and operating the pump for a minimum of 15 minutes. All pumps, both operating and nonoperating, shall be tested for wear, independently, on a monthly basis. The Contractor shall conduct a shutoff head test and a test to verify that the pump is capable of operating at its rated head capacity. The Contractor shall renew all pumps having a test result less than 75 percent of the manufacturer's rated shutoff head or rated capacity. The maintenance tests shall be conducted under the supervision of the Contractor Quality Control representative and under the observation of the C.O.R.

j. *Damages.* The Contractor shall be responsible and shall repair without cost to the Government, any work in place, another contractor's equipment, and any damage to the excavation, including damage to the bottom due to heave that may result from his negligence, improper operation and/or maintenance of the

dewatering system, and any mechanical failure of the system.

k. Transfer of system. The succeeding Contractor for Phase III construction, or the Government, shall take title to the complete surface and dewatering systems when the Contractor for Phase II completes his *or* her work. The facilities to be transferred include all dewatering wells, jet-eductor wells, pumps, engines, gear drives, piezometers, header pipe, valves, and all spare parts and standby equipment pertinent to the surface and groundwater control systems. The dewatering systems shall be continuously operated during the transfer of the system to either the Phase III Contractor or to the Government. The (succeeding) Contractor for Phase III work, or the Government, shall take title to the complete dewatering well, jet-eductor, and surface water control systems as installed when either assumes responsibility for maintaining the excavation dewatered. The Contractor (Phase II) shall not be responsible for removing any of the dewatering systems or grouting of wells or supplemental dewatering facilities, if any, installed by him or her, at the end of his or her contract or subsequently thereafter.

l. Measurement and payment.

(1) *Unwatering Phase I excavation.*

(a) No measurement will be made for unwatering Phase I excavation.

(*b*) Payment for unwatering Phase I excavation will be made at the lump sum price and shall constitute full compensation for furnishing all plant, labor, materials, and equipment necessary to unwater Phase I excavation.

(2) *Surface water control and sump pumping.*

(a) No measurement will be made for surface water control and sump pumping.

(*b*) Payment for surface water control and sump pumping will be made at the lump sum price and shall constitute full compensation for furnishing all plant, labor, materials, and equipment for surface water control and sump pumping, irregardless of the source of water.

(3) *Deep dewatering wells.*

(a) Dewatering wells will be measured for payment on the basis of each well successfully completed and accepted by the Government.

(*b*) Payment at the contract unit price for installation of dewatering wells shall constitute full compensation for furnishing all plant, labor, materials, and equipment for performing all operations necessary to install, develop, and test pump each well.

(4) *Dewatering turbine pumps, engines, and accessories.*

(a) Dewatering turbine pumps, engines, and accessories as specified on the drawings will be measured for payment on the basis of each pump properly installed and fully operational.

(*b*) Payment at the contract unit *price* for installation of dewatering turbine pumps, engines, and accessories shall constitute full compensation for furnishing all plant, labor, materials, and equipment for furnishing and installing the pumps and engines.

(5) *Standby turbine pumps,*

(a) Standby turbine pumps will be measured for payment on the basis of each complete pump placed on the jobsite.

(*b*) Payment at the contract unit price for furnishing standby turbine pumps shall constitute full compensation for furnishing the pumps and placing in appropriate storage. Each standby turbine pump shall include all components shown on the drawings including, but not limited to, 130 feet of column pipe and shafting, pump bowls, suction pipe, pump head, gear drive, and flexible coupling.

(6) *Standby dieselpower units.*

(a) Standby diesel power units will be measured for payment on the basis of each complete power unit placed on the jobsite.

(*b*) Payment at the contract unit price for furnishing standby diesel power units shall constitute full compensation for furnishing all plant, labor, materials, and equipment for furnishing the diesel engines and placing in appropriate storage. Each standby diesel power unit shall include all components shown on the drawings including the 110-horsepower diesel engine with clutch power takeoff and fuel tank.

(7) *Well discharge header system.*

(a) No measurement will be made for the well discharge header system.

(*b*) Payment for the well discharge header system will be made at the lump sum price and shall constitute full compensation for furnishing all plant, labor, materials, and equipment necessary to install the system. The system includes, but is not limited to, header pipe, valves, fittings, outfall structures, and accessories.

(8) *Jet-eductor wells.*

(a) Jet-eductor wells will be measured for payment by the linear foot to the nearest foot from the (berm) ground surface to the bottom of the PVC pipe as installed.

(*b*) Payment at the contract unit price for installation of jet-eductor wells shall constitute full compensation for all plant, labor, header pipe, pumps, engines, tanks, valves, connections, materials, and equipment for performing all operations necessary to install the jet eductors and pumping system as shown on the drawings.

(9) *Piezometers.*

(a) M, R, S, T, and N piezometers will be measured for payment on the basis of each piezometer suc-

cessfully installed and tested.

(*b*) Payment at the contract unit price for installation of M, R, S, and T piezometers shall constitute full compensation for furnishing all plant, labor, materials, and equipment for performing all operations necessary to install, develop, and test the M, R, S, and T piezometers.

(*c*) Payment at the contract unit price for installation of N piezometers shall constitute full compensation for furnishing all plant, labor, materials, and equipment for performing all operations necessary to install, develop, and test N piezometers.

(10) *Testing, operation, and maintenance of dewatering sys terns.*

(a) No measurements will be made for testing, operation, and maintenance of the deep-well and jet-eductor well systems.

(*b*) Payment for testing, operations, and maintenance of the dewatering systems as specified will be made at the lump sum price and shall constitute full compensation for the duration of this contract and until the systems are transferred to the Phase III Contractor or the Government.

G-7. Example of type B-3 specifications (dewatering).

a. General.

(1) The dewatering system shall be designed by the Contractor using accepted and professional methods of design and engineering consistent with the best modern practice.

(2) The dewatering system shall be of sufficient size and capacity as required to control ground and surface water flow into the excavation and to allow all work to be accomplished in the "dry."

(3) The Contractor shall control, by acceptable means, all water regardless of source and shall be fully responsible for disposal of the water. The Contractor shall confine all discharge piping and/or ditches to the available easement or to additional easement obtained by the Contractor. All necessary means for disposal of the water, including obtaining additional easement, shall be provided by the Contractor at no additional cost to the owner.

b. Design.

(1) Contractor shall obtain the services of a qualified dewatering "Expert" or a firm to provide a detailed plan for dewatering the excavation. Contractor shall submit his or her dewatering plan to the Engineer for review and approval. The material to be submitted shall include, but not be limited to, the following:

(a) The qualifications and experience of the selected dewatering "Expert" or the firm (minimum of 5 years of proven experience in the design of equivalent system required).

(*b*) Drawings showing the soil conditions, stratification, and characteristics; location and size of berms, ditches, and deep wells; piezometers, well-points; and sumps and discharge lines or ditches.

(c) Capacities of pumps, prime movers, and standby equipment.

(d) Design calculations including design parameters and basis of such parameters, factors of safety, characteristics of pumping equipment, piping, etc.

(*e*) Detailed description of procedures for installing, maintaining, and monitoring performance of the system.

(2) Notice to Proceed issued by Engineer or receipt of the dewatering plans and data submitted by Contractor shall not in any way be considered to relieve the Contractor from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of the system in controlling the groundwater in the excavated areas, The Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failures of any component of the system.

(3) The Contractor shall be responsible for the accuracy of the drawings, design data, and operational records required.

c. *Damages.* The Contractor shall be responsible for and shall repair without cost to the Owner any damage to work in place, other Contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, and the excavation, that may result from his or her negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.

d. *Maintaining excavation in dewatered condition,* Subsequent to completion of excavation and during the installation of all work in the excavated area, the Contractor shall maintain the excavations to a dewatered condition. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain the excavation in a dewatered condition. Dewatering shall be a continuous operation and interruptions due to outages, or any other reason, shall not be permitted.

e. *System removal.* The Contractor shall remove all dewatering equipment from the site, including related temporary electrical service. All wells shall be removed or cut off a minimum of 3 feet below the final ground surface and capped. Holes left from pulling wells or wells that are capped shall be grouted in a manner approved by the Engineer.