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USACE / NAVFAC / AFCEC / NASA **UFGS-33 26 00.00 10 (April 2008)**

Preparing Activity: USACE **Superseding**
UFGS-33 26 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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04/08

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SECTION 33 26 00.00 10

RELIEF WELLS
04/08

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NOTE: This guide specification covers the requirements for relief wells, (except materials and equipment specified to be furnished by the Government) to be constructed near dams or levees to relieve the excess hydrostatic pressures created by the presence of pervious strata close to the surface. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: Relief wells should be constructed of materials which will resist corrosion when installed and should, where practicable, be designed to have a service life equal to that of the structure they are designed to protect. Factors to be considered in determining selection of material for wells are:

1. Operating conditions of wells,
2. Corrosive characteristics of soil and water,
3. Method of installations,

4. Size and depth of wells,
5. Type of joints, and
6. External pressures on well casings.

The riser pipe and screen should be designed in all cases to withstand, with a suitable factor of safety, the crushing pressures at depths to which wells extend. Design of relief wells to be constructed under structures must consider loads that will be induced into the well pipe due to structural settlement. The wells, including screen and riser pipe, should have a diameter which will permit the maximum design flow without excessive head losses but in no instance should the inside diameter be less than 150 mm 6 inches. Based on design parameters it may require the designer to include a minimum collapse strength for the pipe and well screen and a minimum clear inside diameter through the fittings and screen to allow the installation of pumps at a later date.

Because of the large variation in design and wall thickness of the different types of well screen, no generic specifications have been included. For large contracts, specific necessary characteristics should be presented in detail. References to manufacturers should be eliminated.

Information on the design of filter packs and relief wells can be found in the Engineering Manual EM 1110-2-1901, "Seepage Analysis and Control for Dams". The filter criteria specified in EM 1110-2-1901 should be used to determine the gradation band of the filter material. To minimize segregation during installation of the filter pack, the filter should have a relatively uniform grain-size distribution band. The gradation band of the filter material should be more or less parallel to the gradation curve of the material being drained. No point on the coarser filter gradation curve should be greater than 25 times the corresponding size of the material being drained.

The filter material should have a minimum thickness of 150 mm 6 inches measured radially from the outer circumference of the screen section, and its gradation should depend upon the gradation of the strata being drained. Where unusual conditions are encountered, filter tests should be performed in the laboratory using the foundation sand and the selected filter. For examples of laboratory investigations refer to Technical Report GL-87-22, dated August 1987, "Laboratory Tests on Granular Filters for Embankment Dams (Includes Appendixes A-E)"; and Technical Memoranda (TM) 183-1, dated Nov 1941, Rev Dec 1941, "Investigation of Filter Requirements for Underdrains"; and Technical Memoranda (TM) 195-1, dated Oct 1942, "Field and Laboratory Investigation of Design Criteria for

Drainage Wells", U. S. Waterways Experiment Station. Because of the high potential for clogging by migrating fines or chemical precipitate, filter cloth should not be used to protect relief well screens.

In adapting this specification to any project the form and phraseology should be changed as necessary to properly specify the work contemplated. Changes should be made in the original form to the extent required to adapt the guide specification to local conditions. Work such as concrete for backfill, painting of exposed metal surfaces and seeding of construction areas will have to be specified in this section when such sections cannot be referenced as a part of the contract.

For projects on which subsurface information is not sufficiently developed to permit detailed design of each well, a section should be added to the specifications requiring the drilling of a small diameter pilot hole at the location of each well. Pilot holes should be sampled and logged in sufficient detail to define the gradation of pervious zones and the depths between which screens should be set. The specifications should require that samples of pervious materials be taken at 750 mm 2.5 foot intervals of depth. Grain-size distribution tests should be performed to provide a basis for the design of the filter pack and the screen openings. Samples taken by fishtail drilling and other wash boring methods will not be permitted. Where the subsurface information previously obtained is sufficient, pilot holes are not required.

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1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

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1.1.1 Relief Wells

1.1.1.1 Payment

Payment will be made for costs associated with relief wells, which price shall constitute full compensation for construction of relief wells. Wells ordered abandoned by the Contracting Officer before installation of well screen and riser due to no fault of the Contractor will be paid for at [_____] percent of the contract unit price per linear meter foot, for Bid Item No. [_____] "Relief Wells". Wells ordered abandoned by the Contracting Officer due to no fault of the Contractor will be paid for at

the full contract unit price for Bid Item No. [_____] "Relief Wells". No payment will be made for placement or replacement of temporary casings or repair of damage resulting from Contractor operations. No separate payment will be made for relief well screen, riser, check valves, gravel pack, development, backfill, discharge or outfall pipes. No payment will be made for any wells that, in the opinion of the Contracting Officer, are abandoned due to Contractor fault or neglect.

1.1.1.2 Measurement

Relief wells will be measured for payment by the linear meter foot of completed well between ground surface and 300 mm 1 foot below the bottom of the [well screen][tail pipe]. Wells ordered abandoned by the Contracting Officer, due to no fault of the Contractor, will be measured for payment.

1.1.1.3 Unit of measure

Unit of measure: linear meter foot.

1.1.2 Pump Tests

1.1.2.1 Payment

Payment will be made for costs associated with pump test, which price shall constitute full compensation to perform a satisfactory pump test as specified. No payment will be made for pump test not successfully completed.

1.1.2.2 Measurement

Pump tests will be measured for payment for each hour, measured to the nearest 15 minutes, of pump test successfully performed as specified in paragraph PUMP TEST, and as otherwise directed. Testing time will not include time required to place and remove testing and pump equipment.

1.1.2.3 Unit of measure

Unit of measure: per hour.

1.1.3 Pump Installation/Removal

1.1.3.1 Payment

Payment will be made for costs associated with installation and removal of the pumps used in pay item "Pump Tests". No payment will be made for pump installation removal where pump test was not successfully completed.

1.1.3.2 Measurement

Pump installation/removal for pump test will be measured for payment on the base of the applicable contract unit price per relief well pump tested.

1.1.3.3 Unit of measure

Unit of measure: each.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B31.9	(2017) Building Services Piping

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A312/A312M	(2019) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2020) Standard Specification for Ready-Mixed Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C387/C387M	(2017) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D297	(2015; R 2019) Rubber Products - Chemical Analysis
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D1056	(2014) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM E11	(2020) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G[, [_____]]

SD-03 Product Data

Well Screen; G[, [_____]]

Filter Pack; G[, [_____]]

Cement Grout Mixture Proportion; G[, [_____]]

SD-06 Test Reports

Tests

1.4 QUALITY ASSURANCE

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NOTE: The Designer should select and/or insert the applicable obligations for compliance with specific code requirements of public authorities at the state and/or local level. Guidance is given in memorandum from CECW-EG, "State Regulation of Subsurface Drilling Activities", dated 21 February 91.

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The [state statutory and regulatory] [_____] requirements listed herein form a part of this specification to the extent referenced: [_____].

1.4.1 Shop Drawings

Show details of the proposed methods for drilling, coupling well screen

and riser sections together, placement of centralizers, installing the well screen and riser, and limit(s) of backfilling. Show on the shop drawings the type of screen and size; [perforation size] [or] [slot size], shape and pattern; [bottom plug] [tailpipe] material; and installation detail. The riser pipe, check valve(s) and well discharge details shall also be shown on the shop drawings. Any Contractor-proposed substitutes or alternates in material construction details or methods must be presented in the shop drawings. No phase of the work shall be initiated until all shop drawings concerning that activity have been approved.

1.4.2 Depth of Well

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NOTES: The first bracketed paragraph, Alternate, 1 is recommended for use whenever the design of the system permits.

The second bracketed paragraph, Alternate, 2 should be used only when fully penetrating wells are necessary, and when it is impracticable to predetermine the depth of individual wells. The need for field cutting of screen or riser pipe should be avoided. The depth of the well can ordinarily be varied in the field to permit the use of predetermined length of screen and riser pipe without field cutting.

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[The length of well screen, length of riser pipe and the well discharge elevation shall conform to the [schedule shown] [elevations established in the field by the Contracting Officer].] [The depth of wells as indicated on the drawings is approximate. Penetration of [bedrock] [impervious layer] might be required. The maximum well depth will not exceed [_____] meters feet. Whenever the depth to [bedrock] [impervious layer] is less than the maximum well depth, the bottom elevation of each well shall be as determined by the Contracting Officer after drilling of a pilot boring or the well boring.]

1.4.3 Well Design

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NOTE: This paragraph should be deleted when well design data have been determined in advance of the contract. Economical well construction cannot be secured unless the design of the wells is established in advance of the bidding period.

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From data obtained from exploratory drilling, the Contracting Officer will determine the diameter of the well screen, size of openings, the lengths and positions of the screens, and the gradation of the material for the filter pack which is to be installed around the well screen.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Location

The exact location of each well, [with respect to the toe of the embankment] [or] [with respect to distance from structure centerline],

will be determined in the field by the Contracting Officer. The total number of wells and spacings may be modified by the Contracting Officer as the work proceeds.

1.5.2 Obstructions Encountered

If obstructions are encountered in the foundation which, in the opinion of the Contracting Officer, render it impracticable to complete the well to the directed depth, the Contracting Officer may adjust the depth. Alternatively, the Contracting Officer may direct the Contractor to abandon the well, plug the hole by backfilling with approved material by an approved procedure, and construct another well at an adjacent site.

PART 2 PRODUCTS

2.1 WELL SCREEN

[The Contractor may, as an option, furnish and install well screen of any of the alternate types specified.] [Well screen shall be of the type and dimensions indicated.] Submit the proposed well screen prior to installation. Screen openings shall be uniform in size and pattern, and shall be spaced approximately equally around the circumference of the pipe.

2.1.1 PVC Pipe Screen

Pipe, fittings, and screen shall be of the size and types [specified][shown.] Pipe, fittings, and screen shall conform to ASTM D1784, ASTM D1785, ASTM D2466, or ASTM D2467. All joints in the PVC pipe shall include couplings and shall be glued with a solvent cement conforming to ASTM D2564. The PVC pipe strength properties shall be equivalent to PVC 1120 Schedule [40] [80] unthreaded plastic pipe. [The well screen, pipe, and fittings shall have a minimum collapse strength of [_____].] [The screen, pipe, and fittings shall have a clear inside diameter of [_____].]

2.1.1.1 Couplings

Couplings shall be [bonded socket][threaded][certilock] type. Fittings shall be produced of the same material and equal quality as specified for plastic pipe screen. Socket type fitting connections of pipe sections shall be bonded with solvent cement. The determination of the proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall be the responsibility of the Contractor. The system for making joints at the relief well site shall provide a curing period adequate to develop the ultimate strength of the solvent cement. Self-tapping screws or other devices for holding pipe in the couplings during the setting period may be utilized as long as the screws do not penetrate the inside of the pipe. In no case shall a newly-made joint in the casing be stressed, lowered into the relief well, or be submerged in water prior to complete curing of the solvent cement adhesive.

2.1.1.2 Perforations

The PVC well screen shall be [mill slot][continuous wire wrapped rod base] [continuous wire wrapped rod base on perforated pipe] [continuous wire wrapped on perforated pipe screen] [similar to that manufactured by [_____] Johnson Well Equipment, Inc., Pensacola, FL, telephone (904) 453-3131]. All well screen shall have smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior

surfaces of the pipe. [The [_____] mm inch diameter well screen shall have a number [_____] slot, [0.0_____] mm inch open slot.] [The length of the slots measured on the inside of the pipe shall be [_____] mm inches.] There shall be a total open area of not less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter well screen. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot, [parallel to,] [normal to,] [or] [diagonal with] the axis of the pipe.

2.1.2 Fiberglass Pipe Screen

Fiberglass pipe screen and fittings shall be manufactured from thermosetting epoxy resins and glass fiber by either a centrifugal casting process or by a filament winding process. Glass fiber used shall be continuous filament, electrical glass with a finish compatible with epoxy resins. Each glass fiber or filament shall be thoroughly impregnated with epoxy resin. The resins used shall be diglycidyl ether of bisphenoa A or cycloaliphatic diepoxides, or blends of the two. Curing agents for these resins shall be aromatic diamines, polycarboxylic acid anhydrides and eutectics therefrom. Curing of the resin system shall be at a temperature over 150 degrees C 300 degrees F for a minimum of one hour. Fiberglass pipe wall thickness, strength and durability requirements shall be equivalent to [_____][the Fiberglass/Epoxy pipe produced by Fiberglass Resources Corporation of Farmingdale, New York or Burgess Well Company, Inc., Minden, Nebraska, telephone (308) 832-1642]. All fiberglass pipe and fittings shall be round and straight, of uniform quality and workmanship, and free from all defects including indentation, delamination, bends, cracks, blisters, porosity, dry spots, resin segregation and resin-starved areas. The inside of the pipe and fittings shall be smooth and uniform. The impregnation of the glass fiber with resin shall be such that when the pipe is cut or slotted, no fraying or looseness of glass fiber occurs. [The well screen, pipe, and fittings shall have a minimum collapse strength of [_____].] [The screen, pipe, and fittings shall have a clear inside diameter of [_____].]

2.1.2.1 Couplings

Couplings for fiberglass pipe sections shall be socket threaded or mechanical key-type couplings. The couplings shall be manufactured of the same materials used for the fiberglass pipe specified herein and may be either cast integrally with the pipe sections or as separate components for attachment to the pipe in the manufacturers plant. Every coupling attached to the pipe section as a separate component shall be proof tested in the manufacturer's plant with a tensile load of 9 kN 2000 lbs. Key-type couplings shall consist of male and female halves designed for joining and locking together by means of a key strip inserted in grooves in the coupling halves. The minimum wall thickness remaining at any grooved section shall not be less than the minimum thickness specified for pipe. Key strips and locking strips shall be of fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the design load for the coupling. Socket type fitting connections of the pipe sections shall be bonded with epoxy adhesive. The epoxy materials and bonding agents shall be as recommended by the pipe manufacturer. The determination of the proportions and preparation of adhesives, the method of application, and the procedures used for the making and curing of the joints shall be the responsibility of the Contractor. The pot life, initial setting time and external heating requirements for curing of the adhesive shall be suitable for the

procedure and climatic and other conditions and shall be varied as required to suit changes in climatic and other conditions. The system for making joints at the relief well site shall provide a curing period adequate to develop the ultimate strength of the adhesive. Self-tapping screws or other devices for holding adhesive-joined pipe in the couplings during the curing period may be utilized. In no case shall a newly-made joint in the casing pipe be lowered into the relief well, or be submerged in water prior to complete curing of the adhesive.

2.1.2.2 Perforations

All fiberglass well screen shall be [mill slot][continuous wire wrapped rod base]. All relief well screen shall have smooth, sharp-edged openings free of burrs, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. [The [_____] mm inch diameter well screen shall have a number [_____] slot, [0.0__] mm inch open slot.] [The length of the slots measured on the inside of the pipe shall be [_____] mm inches.] There shall be a total open area not less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter well screen. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot [parallel to,] [normal to,] [or] [diagonal with] the axis of the pipe.

2.1.3 Steel Pipe Screen

****

NOTE: Metal pipes, plugs, screen and joints for most installations may require a coating to protect the metal from corrosive ground water and soil. The type of coating selected to accomplish this purpose will depend upon the corrosive characteristics of the ground water and soil. The Contracting Officer should therefore make complete analysis of the corrosive characteristics of the ground water and add to these specifications such requirements as are necessary to protect the pipe. The coating should be applied after perforating or slotting and should completely cover all exposed metal. Care should be taken to ensure that the openings are not closed or reduced in required size by the coating.

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Steel well screen shall consist of perforated or slotted sections of steel pipe conforming to the requirements of ASTM A53/A53M, Type [_____], Class [_____]. [The well screen, pipe, and fittings shall have a minimum collapse strength of [_____].] [The screen, pipe, and fittings shall have a clear inside diameter of [_____].]

2.1.3.1 Couplings

Couplings for steel pipe screen shall be welded joints or threaded couplings. Welding shall be performed in accordance with requirements in ASME B31.9. Couplings shall meet the material requirements specified for steel pipe screen, except perforations shall be omitted. All threaded pipe and fittings shall be threaded in accordance with ASME B1.20.2M ASME B1.20.1. All threaded pipe sections may be field connected. Couplings shall be given the same protection against corrosion as specified for the well screen pipe. Protective coatings damaged while making couplings shall have the areas recoated.

2.1.3.2 Perforations

All steel pipe to be used as relief well screen shall be provided with perforations which shall consist of either machine-cut slots; drilled or punched openings. The slots shall have a width of [_____] mm inch with a tolerance of plus or minus [_____] mm inch. The length of the slots measured on the inside of the pipe shall be [_____] mm inches with a tolerance of plus or minus [_____] mm inch. For slotted openings there shall be a total open area not less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter relief well. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot [parallel to,] [normal to,] [or] [diagonal with] the axis of the pipe. Drilled or punched openings shall be [_____] mm inch in diameter and shall provide a total open area not less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter well screen. The pattern of the openings shall be uniformly spaced around the periphery of the pipe.

2.1.4 Stainless Steel Well Screen

The well screen and fittings shall be fabricated entirely from stainless steel conforming to ASTM A312/A312M, Type 304, 304-L, 316 or 316-L. The well screen shall be of stainless steel with a keystone wire-wrapped continuous slot strainer equivalent to [_____] [that manufactured by [Howard Smith Screen Company, Houston, TX, telephone (713) 869-5771] [Johnson Screens, St. Paul, MN 55164, telephone (612) 636-3900]]. [The well screen, pipe, and fittings shall have a minimum collapse strength of [_____].] [The screen, pipe, and fittings shall have a clear inside diameter of [_____].]

2.1.4.1 Couplings

Couplings for the stainless steel well screen shall consist of the same material as the well screen and shall be threaded, flanged, and/or fitted with a welding ring. The couplings shall conform in design to the couplings recommended by the manufacturer of the well screen.

2.1.4.2 Perforations

The [_____] mm inch diameter well screen shall have a number [_____] slot, [0.0_____] mm inch open slot. There shall be a total opening of not less than [_____] square millimeters inches per meter foot of [_____] mm inch diameter well screen.

2.1.5 Tailpipe for Well Screen

The tailpipe for each well screen shall be made of the same material and at least the same minimum thickness as the riser pipe and shall include a bottom plug. Tailpipes shall be a minimum of [1] [_____] m [3] [_____] feet in length and fastened to the bottom of the screen in an approved manner.

2.2 RISER PIPE

The relief well riser pipe material and method of manufacture shall conform to the requirements specified in paragraph WELL SCREEN, except that the screen perforations or opening shall be omitted. The relief well

riser pipe diameter and discharge details shall be as shown. Couplings to the well screen and between riser pipe sections shall be as specified in paragraph COUPLING.

2.3 FILTER PACK

Submit proposed filter pack material and its gradation, before it is placed. Material for the filter pack around the riser pipes and screens shall be a [washed gravel] [washed sand] [dry processed sand] composed of hard, tough, and durable particles free from adherent coating. The filter pack shall not be crushed stone. The filter pack material shall contain no detrimental quantities of organic matter nor soft, friable, thin, or elongated particles in accordance with the quality requirements in ASTM C33/C33M, Table 1 and Table 3, Class 5S, and in ASTM E11, Table 1. The filter pack shall meet the following gradation requirements:

SIEVE SIZEU.S. STANDARD U.S. STANDARD	PERCENT PASSING BY WEIGHT
[_____]	[_____]
[_____]	[_____]

2.4 CHECK VALVES

****

NOTE: Insert provisions describing the materials and construction of a well pit, collector pipe, or ditch or any other proposed outlet for the relief well. Discharge details should be clearly shown on the drawings.

The following requirements are for two different check valves that have been specified by the Vicksburg District. Details of the fabricated check valves are available upon request from CELMK-ED-G, telephone (601) 631-5208 or (601) 631-5633 . The soft sponge rubber should be used on valves which can be replaced on a regular basis and used under low head conditions. The medium sponge rubber should be used where access to the check valve is limited.

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a. [The check valve shall be a one piece reinforced all rubber (neoprene) check valve with an integral elastomer flange similar and equal to the Red Valve Series [35][_____], Size [150][_____] mm [6][_____] inch, manufactured by Red Valve Company, Inc., 700 North Bell Ave., Pittsburgh, PA 15106, telephone (412) 279-0044. The check valve shall be designed to withstand a maximum back pressure of [100][_____] kPa [15][_____] psi. The backup ring for the check valve shall be stainless steel. Stainless steel bolts, washers, and nuts shall be used to fasten the valves onto the flanged end of the pipes. The check valve shall be installed with the flared end duck bill in a vertical position.]

b. [Fabricate check valves of [brass][stainless steel][aluminum] plate, threaded fasteners and rods as detailed on the drawings. Fabricate

sealing disc of [10][_____] mm [3/8][_____] inch silicone sponge rubber free of porous areas, foreign materials, and visible defects.]

c. Silicone sponge rubber shall meet the following specifications:

PHYSICAL TEST	TEST VALUE		ASTM TEST METHOD
	SOFT	MEDIUM	
Compression Deflection (compressed 25 percent at room temperature)	15 to 50 kPa2 to 7 psi	40 to 100 kPa6 to 14 psi	ASTM D1056
Tensile Strength	345 kPa50 psi (min)	515 kPa75 psi (min)	ASTM D412
Elongation at break	75 percent (min)	100 percent (min)	ASTM D412
Compression Set (Compressed 50 percent for 22 hours at 100 C212 F	15 percent (max)	5 percent (min)	ASTM D297
Density	0.33 g per cubic cm 0.012 pci (min)	0.47 g per cubic cm 0.017 pci (min)	ASTM D297 Hydrostatic Method

d. Workmanship and metalwork fabrication of check valves shall be in accordance with the details shown. Install check valves accurately vertically and adjust to the required elevation.

2.5 CONCRETE

Concrete shall conform to [the requirements specified in Section [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____]] [ASTM C94/C94M, Option A, with a [19][_____] mm [3/4][_____] inch Nominal Maximum Size of Aggregate, a maximum slump of 125 mm 5 inches, air content of [5] [_____] percent, and a compressive strength of [17.2][_____] MPa [2500][_____] psi] [packaged normal weight concrete conforming to ASTM C387/C387M].

PART 3 EXECUTION

3.1 DRILLING

Wells may be drilled by the reverse rotary circulation method or other method approved, which will insure proper placement of the well screen, riser pipe, and filter pack. Methods which involve radical displacement of the formation, or which may reduce the yield of the well, will not be permitted. Excavated material shall be disposed of as directed.

3.1.1 Reverse Circulation Method

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NOTE: Where the Contracting Officer approved use of drilling fluid, it will be a suspension of fine grained soil or commercial product of a recognized manufacturer, having the characteristic of being readily removable from the filter pack and the walls of the foundation by development as specified in paragraph DEVELOPMENT.

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If the reverse circulation method is used for drilling wells, remove all of the drilling fluid from the filter pack and the natural pervious formation. If in the opinion of the Contracting Officer the walls of the hole above the top of the filter pack require support during development operations, place a temporary casing similar to that specified in paragraph TEMPORARY CASING. The diameter of the hole shall be such as will permit the placement of the minimum thickness of filter pack as specified in paragraph FILTER PACK PLACEMENT. The drilling fluid shall be a suspension of fine grained soil or shall be a commercial product of a recognized manufacturer, shall be approved by the Contracting Officer, and shall have the characteristic of being readily removable from the filter pack and the walls of the formation by development as specified in paragraph DEVELOPMENT. The use of bentonite will not be permitted.

3.1.2 Temporary Casing

Temporary well casing of either iron or steel of sufficient length to case to the bottom of all borings shall be available at the construction site. The Contracting Officer will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and filter pack when he believes it is necessary to provide adequate support to the sides of the hole. When the walls of the boring will require support only during development operations a temporary casing will be required to extend only to a depth 1 m 3 feet below the top of the filter pack. The temporary casing, shall have an inside diameter of not less than [_____] mminches, shall have sufficient thickness to retain its shape and maintain a true section throughout its depth, and may be in sections of any convenient length. The temporary casing shall be such as to permit its removal without disturbing the filter pack, riser, or well screen. The setting of temporary casing shall be such that no cavity will be created outside of it at any point along its length. In the event the temporary casing should become unduly distorted or bent it should be discarded and a new casing should be used during installation of any additional relief wells.

3.2 INSTALLATION OF RISER PIPE AND SCREEN

3.2.1 Assembly

All riser pipe and screen shall be in good condition before installation and all couplings and other accessory parts shall be securely fastened in place. The successive lengths of pipe shall be arranged to provide accurate placement of the screen sections in the bore hole. [The riser-pipe shall be provided with an approved cap and a flanged top section, the top of which shall be set at the elevation directed or shown.] Centralizers shall be attached to the assembled riser pipe and screen in such numbers and of a type that they will satisfactorily center the riser pipe and screen in the well and will hold it securely in position while the filter pack material is being placed.

3.2.2 Joints

Sections of relief well pipe shall be joined together as specified in paragraph COUPLINGS. Joints shall be designed and constructed to have the strength of the pipe and where possible a strength capable to support the weight of the relief well stem as it is lowered into the hole. When not practicable to construct joints that will support the weight of the relief well stem, the stem shall be supported at the lower end by any approved means that will assure that the joints do not open while being lowered into place in the well.

3.2.3 Installation

The assembled riser pipe and screen shall be placed in the bore hole in such manner as to avoid jarring impacts and to insure that the assembly is centered and not damaged or disconnected. The screen should be suspended in the hole and not resting on the bottom of the hole. After the screen and riser pipe have been placed, a filter pack shall be constructed around the screen section as specified in paragraph FILTER PACK PLACEMENT and the well developed as specified in paragraph DEVELOPMENT. The top of the riser pipe shall be held at the designated elevation during placement of the filter pack.

3.2.4 Check for Plumbness and Alignment

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NOTES: Alignment and plumbness tests are performed to determine if a pump will be able to be installed into the well at the end of development so that a pump test can be performed. The variation of the plumbness should not vary more than two-thirds of the inside diameter of the well in 30 m 100 feet.

Select appropriate alternate paragraph.

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[Each well shall be sufficiently straight and plumb, such that a cylinder [3][6][10][15] m [10][20][40] feet in length and with an outside diameter 13 mm 1/2 inch smaller 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 well. Furnish the dummy cylinder and perform the alignment check and plumbness check in the presence of the Contracting Officer. A variation of [150][_____] mm [6][_____] inches per 30 m 100 feet of depth will be permitted in the plumbness of well 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 installation of the surging and pumping equipment required for testing and pumping the wells. At least one plumbness check and alignment check shall be performed on each well after placement of the filter pack. Additional tests may be made during the performance of the work at the option of the Contractor.]

[The well shall be constructed and all casing set round, plumb, and true. Perform the following tests after the installation of the well but prior to backfilling, and before its acceptance. Additional tests may be made during the performance of the work at the option of the Contractor. Should the Contractor fail to correct, at no additional cost to the Government, any faulty alignment or plumbness disclosed as a result of these tests, the Contracting Officer may refuse to accept the well. If in the judgement of the Contracting Officer the Contractor has exercised all

possible care in constructing the well and the defect is due to circumstances beyond the Contractor's control or if the utility of the completed well is not materially affected or if the cost of necessary remedial measures will be excessive, the requirements for plumbness may be waived. In no event will the provisions with respect to alignment be waived.]

3.2.4.1 Plumbness

Test plumbness by use of a plumb line. The plummet shall be a short cylinder with an outside diameter approximately 6 mm 1/4 inch smaller than the inside of the well and/or temporary casing. It shall be suspended from a small diameter wire rope and its point of suspension shall be in the exact center of the plummet. The plummet shall be sufficiently heavy to stretch the wire rope taut. The wire rope shall pass over a guide sheave which shall be positioned at least 3 m 10 feet above the top of the well and adjusted horizontally so that the plummet hangs in the center of the well. Displacement of the wire rope during the plumbness check shall be measured by means of a transparent plastic sheet on which a number of concentric circles shall be scribed or drawn, and which is centered on the top of the well. The exact center of these circles shall be marked, and then a slot, slightly larger than the plumb line and extending from this center to the edge, shall be cut in the plastic sheet. As the plummet is lowered, any out-of-plumb condition of the well will be indicated by the wire rope tending to drift away from the center, and the plastic sheet shall be rotated until the slot is oriented in the direction of this drift, while at all times maintaining the center of the concentric circles coincident with the center of the well. Measurement of the amount of drift shall be made along the edge of the slot for each increment by which the plummet is lowered into the well. Drift at any depth shall be determined by multiplying the measured plumb line displacement by the total length of the plumb line and dividing the result by the fixed distance between the guide sheave and the top of the well. If desired, alignment may be calculated from the plumbness data in lieu of the alignment check described in paragraph ALIGNMENT. Should the well vary from the vertical in excess of [150][_____] mm [6][_____] inches per 30 m 100 feet of depth, the plumbness of the well shall be corrected by the Contractor at no additional cost to the Government.

3.2.4.2 Alignment

Test the alignment by lowering into the well a section of cylinder [3][6][10][15] m [10][20][40] feet long or a dummy of the same length. The outside diameter of cylinder shall be not more than 13 mm 1/2 inch smaller than the inside diameter of the well. Should the cylinder fail to move freely throughout the length of the well, the alignment of the well shall be corrected at no additional expense to the Government.

3.3 FILTER PACK PLACEMENT

After the well screen and riser pipe have been installed, the filter pack material shall be placed by tremie, when using a well graded material, in an approved manner such that segregation will not occur. When using a uniform graded filter material, the material may be poured around the well screen at a rate that will prevent bridging of the material. The material should be placed around all sides of the screen to assure that the screen is not pushed against the side of the bore hole causing the screen to come in contact with foundation material or prevent the proper thickness of filter from being placed uniformly around the screen. The filter pack

shall have a minimum thickness of [_____] mm inches between the outside of the well screen and the natural formation. The filter pack shall be placed at a constant rate from the start of placement until it has reached the elevation [shown], [directed] [a minimum of 600 mm 2 feet above the top of the well screen]. If a tremie is required, a double string of tremie pipe shall be used. The pipes shall be placed on opposite sides of the screen and/or casing, that is, 180 degrees apart, and shall be guided in such a manner that they will remain in this position throughout the placing process. The tremie pipes shall be set in place, filled completely with filter pack prior to being lifted off the bottom of the hole. The filter pack in the tremie pipe shall be kept a minimum of 300 mm 1 foot above the water surface in the well throughout the placing process. In no case shall the gradation of the filter pack fall outside of the range specified in paragraph FILTER PACK.

3.4 DEVELOPMENT

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NOTE: The method of surging specified may be modified to specify a procedure considered most suitable for the particular project. Violent surging, as with compressed air, should not be permitted.

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Following placement of filter pack materials, develop the relief well by jetting, surging, intermittent pumping, or other approved methods as may be necessary to give the maximum yield of water per 300 mm foot of drawdown. At the time of development of any relief well, the well shall be free of drawdown or surcharge effects due to pump testing, developing or drilling at another location. The Contractor is responsible for maintaining at the relief well the needed access and work area and clearance in the relief well necessary to accomplish development. Furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage. Development shall be conducted to achieve a stable well of maximum efficiency and shall be continued until a satisfactory sand test, as specified in paragraph SAND TEST, is obtained. As development proceeds, filter pack material shall be added to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. Provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If, at any time during the development process it becomes apparent in the opinion of the Contracting Officer that the well may be damaged, development operations shall be immediately terminated. The Contracting Officer may require a change in method if the method selected does not accomplish the desired results. The Contracting Officer may order that wells which continue to produce excessive amounts of fines after development for 6 hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. All materials pulled into the well by the development process shall be removed prior to performing the pumping test.

3.4.1 Jetting

Perform using either a single or double ring jet. If a double ring jet is used the rings should be 600 mm 2 feet apart. The jetting tool shall be constructed of high-strength material and conservatively designed and proportioned so that it will withstand high pressures. The jetting tool

shall have [two [7][8][10] mm [3/16] [1/4][3/8] inch diameter hydraulically balanced nozzles spaced 180 degrees] [four [7][8][10] mm [3/16][1/4][3/8] inch diameter holes spaced 90 degrees] apart and which shall exert the jetting force horizontally through the screen slots. The rings shall be constructed such that the tips of the jets shall be within 13 mm 1/2 inch from the inner surface of the well screen. The pump used in conjunction with the jetting tool shall be capable of providing [pressures up to [1700] [_____] kPa [250][_____] psi.] [a minimum jetting fluid exit velocity of 45 meters per second 150 feet per second.] Prior to commencing jetting, and following each jetting cycle, all sand and/or other materials shall be removed from inside the screen. The jetting process shall start at the bottom of the screen and consist of rotating the jetting tool [slowly] [1 cycle per 30 seconds] [[_____] cycles per [_____] seconds] while rotating the pipe [180][90] degrees for two minutes at each location then raising the pipe [150][_____] mm [6][_____] inches. All wells, more than 100 mm 4 inches in diameter, shall be pumped during the jetting cycle to remove incoming sand and other material. Such pumping shall be at a rate not less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed. Water used for development shall be free of sand. The contracting officer may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

3.4.2 Intermittent Pumping

Perform by pumping the well at a capacity sufficient to produce a rapid drawdown of approximately [_____] m feet stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeating this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A pump discharge in excess of [_____] L/s gpm will be required. A deep well turbine pump, or electric submersible pump with check valve, shall be used with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. The intake shall be set at least 3 m 10 feet below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Contracting Officer, the efficiency of the well might otherwise be impaired.

3.4.3 Surging

Use a circular block which is approximately 25 mm 1 inch smaller in diameter than the inside diameter of the relief well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. The surging shall be continued for a period of approximately one hour or until little or no additional material from the foundation or filter pack can be pulled through the screen. The surge block shall be moved by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. Remove all materials pulled into the well by the surging process.

3.5 BACKFILLING

[After the well has been developed, additional filter pack should be added if necessary to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the annular space above the filter pack, shall be backfilled by first placing a 300 mm 12 inch minimum layer of concrete sand on the filter pack and then filling the remainder of the space up to the [finished ground surface] [well pit] with grout or concrete. The concrete backfill shall be placed to a depth at least equal to the existing impervious blanket, but in no case less than [_____] m feet.] [For PVC riser pipe, after the well has been developed, additional filter pack should be added if necessary for it to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the remaining annular space above the filter pack shall be backfilled by first placing a 300 mm 12 inch minimum layer of concrete sand on the filter pack and then filling the remainder of the space up to the [finished ground surface] [well pit] with bentonite.] The temporary casing, if used, shall be withdrawn in increments as the backfill is placed. Fill with impervious material, to original grade, all pits such as those incidental to the reverse rotary circulation method of drilling.

3.6 PLUGGING OF ABANDONED WELLS

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NOTE: Regulatory requirements shall be stated along with applicable paragraphs to direct Contractor on how a well is to be abandoned. If there are no code requirements the following should be used.

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[The Contractor has the option of attempting to remove the well screen. If the well screen can be removed, grout the bore hole starting from the bottom of the hole to within 1 m 3 feet of ground surface. The grouting shall start at the elevation of the bottom of the tailpipe of the well. If the well screen could not be removed or broke off during the removal attempt, the Contractor is still responsible for grouting the well from the bottom of the tailpipe to within 1 m 3 feet of ground surface. Either of the above abandonment procedures may require the Contractor to redrill the hole so that the bore hole can be grouted.][The well shall be grouted from the bottom of the tailpipe to within 1 m 3 feet of ground surface. After the grout has setup the riser pipe shall be cutoff 1 m 3 feet below ground. Then the hole shall be backfilled.] The cement grout mixture proportion to be used shall be submitted for approval.

3.7 TESTS

Submit sampling and testing reports for each relief well, logs of the borings, well screen and riser pipe, backfill material, and pump tests. Register each well with the state as required by the state in which the well is installed.

3.7.1 Pump Test

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NOTE: A six-hour continuous test is ordinarily adequate to determine that a well is performing properly. It is recommended that the specified draw-down (or discharge) during a routine test be approximately 1.5 times the estimated head (or discharge) for which the system is designed. In

addition to the routine tests, the wells may be pumped for longer periods and at various draw-downs or discharges to secure, or to check, design data.
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Upon completion but before acceptance, each well shall be subjected to a pump test of which a sand test will form a part. Provide a [deep well turbine] pump, capable of producing the specified drawdowns over periods of time sufficient to satisfactorily perform the pump test specified herein. The intake shall be set 3 m 10 feet below the maximum expected drawdown in the well. The amount of sand should be measured after each test. The pump shall be complete with either gasoline, diesel, or electric motor of adequate size. In case an electric motor is used, provide, without additional cost to the Government, the electric power and the necessary wiring. Provide an open tube or other approved means for accurately determining the water level in the well. Furnish and install an orifice meter of approved design or other approved equipment for the purpose of measuring the discharge from the well during the pumping test. Furnish, install, or construct the necessary pipe discharge line, troughs, or ditches necessary to dispose of the pumping test discharge a sufficient distance from the work area to prevent damage. The tests will be conducted under the direction of the Contracting Officer and may be made as soon as each well is completed [and adjacent Government installed piezometer tubes are operational]. Test data will be recorded by Government personnel. Test each well by pumping continuously for a minimum of [6] [_____] hours. Prior to starting the pump test all material shall be removed from the bottom of the well. The pumping shall be at a rate [of [_____] L/s gpm][sufficient to produce approximately [_____] m feet of draw-down]. If the test is interrupted, other than by order of the Contracting Officer, prior to the completion of the specified period of continuous operation, the test shall be re-run. In addition to the required pumping test, the Contracting Officer may direct the Contractor to perform additional pump tests. Such additional testing shall conform in general to the requirements specified herein except that the duration of the tests and the approximate draw-down will be determined by the Contracting Officer. In the event that sand or other material collects in the well as a result of the pump test, accurate measurements shall be taken as to the quantity of material in the well and all such material shall be removed. Upon completion of the pump test, remove all equipment, discharge lines, electrical lines, lumber, and debris, and shall backfill any excavated areas with impervious material.

3.7.2 Sand Test

As part of each Pump Test or at the end of each intermittent pumping a determination of the amount of sand (filter pack and/or foundation material) a well is producing shall be performed. Prior to starting the sand test all material shall be removed from the bottom of the tailpipe. Test each well by pumping at a rate [of [_____] L/sgpm] [sufficient to produce approximately [_____] m feet of draw-down]. After the pump is at the desired pumping rate the flow from the discharge shall be diverted [into a container that will collect all the sand being carried by the water][through a Rossum Sand Tester]. Development of the well is satisfactory if the amount of sand collected is less than 0.5 L per 100 000 L 1 pint per 25,000 gallons of water pumped at the specified rate. Upon completion of the test the amount of sand in the tailpipe shall be determined to verify that no material is being deposited in the bottom of the well.

3.7.3 Filter Pack Sampling and Testing

Verify that all materials conform to the specifications before delivery to the project. The particle size distribution of the filter pack shall be sampled and tested in accordance with ASTM C136/C136M and ASTM D75/D75M. [Prior to delivery to the project site, at least two samples of material should be collected and tested for every 700 metric tons 750 tons (2000 lb) produced under this contract.] [Within 48 hours before being placed in the relief well to be back-filled, the filter pack shall be sampled from the material stockpiled at the project site. There shall be at least one particle size distribution test on the filter pack for [each well] [every [_____] wells].] A pump test shall be performed in accordance with technical provisions herein specified.

3.7.4 Reports

Include in the reports for each relief well, logs of the boring, elevations of the well screen, top of riser pipe, bottom of the tailpipe, filter pack gradation, quantity of filter pack added during development, pump test, sand test, and report of backfilling. The elevation of changes between materials on these logs shall be to the nearest 30 mm 0.1 foot. The log of backfill material shall include the filter pack particle size distribution test data, and notes concerning installation and development of the relief well. The pump test log shall include the duration of the test and rate of flow in L/s gpm, and the draw-down response data with time in the pumped well, in adjacent wells, and in nearby piezometers. The relief well log and the pump test log shall be submitted to the Contracting Officer as part of the weekly quality control report specified in Section 01 45 00.00 10 QUALITY CONTROL. Also submit a report of the well installation to the appropriate public agency and in the form required by state statutory and/or regulatory requirements specified in paragraph REGULATORY REQUIREMENTS.

-- End of Section --