NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

(No.)

CODE 533

DEFINITION

A pumping facility installed to transfer water for a conservation need.

PURPOSE

Provide a dependable water source or disposal facility for water management.

CONDITIONS WHERE PRACTICE APPLIES

Wherever water must be pumped to accomplish a conservation objective, which may include (but is not limited to) one of the following:

- To provide a water supply for such purposes as irrigation, recreation, livestock, or wildlife
- To maintain critical water levels in swamps, marshes, open water, or newly constructed wetlands and ponds
- To transfer wastewater for utilization as part of a waste management system
- To provide drainage by the removal of surface runoff water or groundwater

CRITERIA

General Criteria Applicable to All Purposes

This practice shall conform to all federal, state, and local laws, rules, and regulations. Laws, rules, and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

The efficiency of units, type of power, quality of building, automation features, and other accessories installed shall be in keeping with the economic and environmental value of the system to accomplish the conservation objectives.

Criteria for the design of components not addressed in conservation practice standards shall be consistent with sound engineering principles.

Drainage. Design requirements for drainage by pumping are in Chapter 7 of National Engineering Handbook Section 16, *Drainage of Agricultural Land*.

Irrigation. Design requirements for irrigation pumping are in Chapter 8 of National Engineering Handbook Section 15, *Irrigation*.

Pump requirements. Capabilities, range of operating heads, and general class and efficiency of equipment shall be determined by appropriate technical means. Size and number of pumps and their performance shall be determined based on system conservation requirements in order to meet the intended purpose. Total head shall be determined for critical operating conditions, taking into account all hydraulic losses. Automatic controls shall be included as required.

Pumps utilized for the transfer of wastewater or manure shall be sized to transfer material at the required system head and flow rate determined by the waste management plan. The pump type shall be based on the consistency of material being pumped and the manufacturer's recommendations.

Pumps may be of the turbine, horizontal centrifugal, magnetic drive impeller, diaphragm, mixed flow, or propeller type designed to operate at not less than 70 percent efficiency for given site conditions, except for pumps powered

by photovoltaic panels which have no minimum efficiency requirement.

All pumps should be equipped with a strainer or screen at the intake end to prevent clogging. Horizontal centrifugal pumps shall be equipped with a suction line no less in size than the discharge. Horizontal pumps shall be equipped with the required appurtenances to enable them to be easily primed. Turbine pumps (except those with submersible motors) shall not be installed in wells that are not sufficiently straight and plumb to allow proper operation of the pump. Automatic plants generally will be equipped with self-priming pumps.

The capacity of pumps installed in wells should be based on the capacity curve for the well. Pump capacity shall not exceed 90 percent of the well capacity.

Power units. Power units shall be selected based on availability of fuel or power, costs, operating conditions, and conservation needs and objectives (including the need for automation). The power unit shall be matched to the pump and be capable of operating the pump efficiently and effectively within the range of operating conditions. The horsepower requirements, pump efficiency, and total head on the pump shall be computed.

Electric motors are usually 3-phase where power requirements exceed 5 horsepower, although phase converters may be used effectively up to 20 to 25 horsepower and shall not be loaded beyond their rated horsepower. The utility company serving the plant shall be consulted relative to power and phase requirements.

Electric motors may also be powered by photovoltaic cells (solar panels). The number and size of the solar panels will depend on the amperage and voltage required by the pump to meet head-discharge requirements. Use the manufacturer's recommendations to determine solar panel size and number and for the installation of the solar panels. Electrical components must be installed in accordance with all applicable codes.

Internal combustion engines shall be loaded 80 to 100 percent of the manufacturer's rating to achieve the best engine efficiency. The rating shall be reduced for temperature, altitude, and motor accessories.

Photovoltaic (PV) array. The PV array (panels) shall be sized to provide the power necessary to operate the pump at the design flow rate and pressure with appropriate service factor considering a minimum panel degradation of 10 years. Also, the PV array must have (as a minimum) a manufacturer's warranty against power degradation in excess of 10% of the rated power for no less than 10 years after installation. PV arrays shall be individually labeled as described in National Electric Code (NEC) Article 690 and shall be listed by Underwriters Laboratories Inc. (UL) or another nationally recognized testing laboratory.

To receive maximum sunlight, orient fixed arrays towards true south. Base the tilt angle on the latitude and time of year of power requirements. The array mounting structure may be fixed or portable. It must be designed with adequate anchors to maintain alignment under the normally expected loads and to support the array under extreme conditions.

A pump controller, inverter, fuses, surge protection, and other electronic components shall be provided as recommended by the pump and PV module manufacturers in accordance with NEC requirements.

Solar trackers or storage battery units may be included as components of a PV-powered pumping plant. When necessary, the batteries, battery enclosure, charge controller, and wiring design should be in accordance with the manufacturer’s recommendations and NEC Articles 300, 480, and 690.

Windmills. Size windmill pumping units according to manufacturer’s pumping lift and capacities. Use stroke length of the mill (short or long) and the average wind speed to select the diameter of the mill. Proportion the towers to the mill size and provide adequate height for efficient and safe operation. Select the height of the tower to place the wheel at least 15 feet above all surrounding wind obstructions (such as buildings and trees) within a radius of 400 feet.

Suction and discharge pipes. The size of suction and discharge pipes shall be based on a hydraulic analysis, operating cost, and compatibility with other system components. The arrangement and length of the discharge pipe shall be based on the need for recovery of

head through siphoning action and for the delivery of water in keeping with conservation and environmental objectives. Gates, valves, pipe connections, discharge bays, and other protective devices shall be installed (as needed) for satisfactory pumping plant operation.

Federal, state, and local laws and regulations concerning back flow prevention shall be followed when pumping from wells or chemigating.

Building and accessories. The design of the pumping plant and associated housing (if required) shall consider accessibility for equipment maintenance and repairs and the need for protecting equipment from the elements, vandalism, and fire. The appearance of the plant shall be compatible with the surrounding environment, as applicable.

Foundations shall be designed to safely support the loads imposed. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

Pumps may be mounted in the open, on piling or concrete foundations, in a well or pit, or by other appropriate means.

Suction bays (or sumps) shall be designed to conform to the hydraulic characteristics established by the pump manufacturer.

The discharge bay or connection with the distribution system shall meet hydraulic and structural requirements. Provisions for repair or removal of pumps and engines shall be provided. Trash racks shall be provided, as needed, to exclude debris and trash from the pump.

All structural features and equipment shall provide adequate safety features to protect workers and the public from injury.

CONSIDERATIONS

When planning this practice, the following items should be considered (as applicable):

- Effects on downstream flows or aquifer recharge volumes
- Effects on existing wetland hydrology
- Effects on surface and groundwater by leaked or spilled fuels and lubricants
- Secondary containment of spilled fuel for water quality as may be required by federal and state laws or regulations
- Protection of system components from “natural" events such as floods
- Float switches, timers, or other monitoring devices should be included to minimize the waste of water.
- Properly maintained PV arrays should have a service life in excess of 20 years. When feasible, other components of the pumping system, as well as the installation methods, should be of sufficient quality to maintain performance comparable to the arrays.
- Additional water storage volume for solar- or wind-driven pumps for days when the pumps will not be working
- Protection of the pumping plant from damage by livestock or wildlife with fencing or other appropriate measures

PLANS AND SPECIFICATIONS

Plans and specifications for constructing pumping plants shall comply with this standard and describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications must include the following:

- A plan view showing the location of the pumping plant in relationship to other structures or natural features
- Detail drawings of the pumping plant and appurtenances such as piping, input and output connections, mounting and foundation requirements, and other structural components
- Written specifications that describe the site-specific details of installation

OPERATION AND MAINTENANCE

An operation and maintenance plan specific to the facilities installed shall be prepared for use by the landowner or responsible operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly. As a minimum, the plan shall include provisions to address the following:

- Inspection or testing of all pumping plant components and appurtenances, as applicable
- Proper start-up procedures for the operation of the pumping plant
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer's recommendations
- Frequent checks for fuel or lubricant leaks (when applicable) of the power unit, fuel storage facilities, and fuel lines and for making repairs as needed
- Periodic checks and removal of debris as necessary from trash racks and structures to ensure that adequate capacity reaches the pumping plant
- Periodic removal of sediment in suction bays to maintain design capacity and efficiency
- Inspect and maintain anti-siphon devices, if applicable
- Routinely test and inspect all automation components of the pumping plant to ensure they are functioning as designed
- Inspect and maintain secondary containment facilities, if applicable
- Periodic inspection of all safety features to ensure they are in place and functional
- Prior to retrofitting any electrically-powered equipment, electrical service must be disconnected and the absence of stray electrical current verified
- For PV-powered pumping plants, adjust the tilt angle of the solar modules on a seasonal basis, if applicable
- Follow the windmill manufacturer’s recommendations for routine maintenance of all windmill mechanical components

REFERENCES

NEH Section 15, Chapter 8, Agricultural Pump Plant

NEH Part 652, National Irrigation Guide, Chapter 12

Fischbach, P. E. and Schroeder M. A., Irrigation Pumping Plant Performance Handbook, 4 ed. 1982, Agricultural Engineering department, Lincoln, Nebraska

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Naval Facilities Engineering Command. Maintenance & Operation of Stand-Alone Photovoltaic Systems. Revised 1991. Photovoltaic Design Assistance Center, Sandia National Laboratories, Albuquerque, NM, March 1993

Southwest Technology Development Institute. Photovoltaic Power Systems and the National Electrical Code: Suggested Practices. Review Draft, Sandia National Laboratories, Albuquerque, NM, August, 1994

Stevens, John W., et al. Photovoltaic Power As A Utility Service: Guidelines For Livestock Water Pumping. Photovoltaic Design Assistance Center, Sandia National Laboratories, Albuquerque, NM, March 1993

Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors. NREL TP-463-5607. National Renewable Energy Laboratory, Golden, CO, April, 1994

NFPA 70: National Electrical Code. National Fire Protection Association, Quincy, MA, 2008