

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
PUMPING PLANT

(No.)

CODE 533

DEFINITION

A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy source(s), and protective structures.

PURPOSE

This practice may be applied as a part of a resource management system to achieve one or more of the following:

- Delivery of water for irrigation, watering facilities, wetlands, or fire protection
- Removal of excessive subsurface or surface water
- Provide efficient use of water on irrigated land
- Transfer of animal waste as part of a manure transfer system
- Improvement of air quality
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where conservation objectives require the addition of energy to pressurize and transfer water to maintain critical water levels in soils, wetlands, or reservoirs; transfer wastewater; or remove surface runoff or groundwater.

CRITERIA

General Criteria Applicable to All Purposes

Pump requirements. Design flow rate, range of operating heads, and pump type shall meet the requirements of the application.

Selection of pump materials shall be based on the physical and chemical qualities of the material being pumped and manufacturer's recommendations.

Power units. Pump power units shall be selected based on the availability and cost of power, operating conditions, need for automation, and other site specific objectives. Power units shall match the pump requirements and be capable of operating efficiently and effectively within the planned range of conditions. The power unit shall be sized to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Internal combustion engines must meet local air emission requirements.

Electric power units may include line power, photovoltaic panels, and wind or water powered turbines.

Electrical wiring shall meet the requirements of the National Electrical Code.

Renewable energy power units shall meet applicable design criteria in NRCS and/or industry standards and shall be in accordance with manufacturer's recommendations.

Variable Frequency Drives. The owner shall inform the electric power provider that a Variable Frequency Drive will be installed prior to installation, and be responsible for following requirements of the electric power provider.

The Variable Frequency Drive shall be protected against overheating.

The Variable Frequency Drive control panel shall provide the read out display of flow rate or pressure.

Photovoltaic panels. The photovoltaic array shall be sized based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. The photovoltaic array shall provide the power necessary to operate the pump at the design flow rate, with the appropriate service factor considering a

minimum panel degradation of 10 years. Fixed arrays shall be oriented to receive maximum sunlight. Panel tilt angle shall be based on the location latitude and time of year for power requirements. Panels shall be mounted securely to resist movement by environmental factors.

Windmills. Pumping units shall be sized according to pumping lifts and capacities, as specified by the manufacturer. The diameter of the mill shall be based on the stroke length and the average wind speed. A minimum annual average wind speed of 6.5 m/s is required. This is determined by using the U.S. Department of Energy's Average Annual Wind Speed at 80-m height for California (http://www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=ca) or anemometer data. Towers shall be proportioned to the mill diameter, with adequate height for efficient and safe operation.

Wind Generators. Wind generators are required to have automatic overspeed-governing systems to keep the rotor from spinning out of control in very high winds.

Towers (structures to which the generator are mounted) shall be proportioned to the blade span, with adequate height for efficient and safe operation. All towers need to be of sufficient height that the sweep of the blades is a minimum of 30 feet above and 100 feet away from any obstacle.

The structural components of tower wind generator shall be designed by a registered Civil Engineer, Structural Engineer or Architect, licensed to practice in California, to meet all state, county and local building codes. The tower shall be suitable for the site and designed to meet all site-specific requirements. NRCS shall provide the designer with a detailed site map (showing all planned practices), a detailed topographical map and NRCS Soil Survey information.

The engineer or architect shall provide signed and sealed construction plans, specifications and operation and maintenance guidance for the towers.

Wind generators shall not be installed within 200 feet of woody vegetation that may provide

suitable habitat for birds that are nesting, resting, or using such vegetation for protection from the cold weather. Exceptions to this distance may be given by NRCS biologists after the site has been accessed for any potential impacts.

Water powered pumps (hydraulic rams).

Pumping units shall be sized according to flow rate, lift, fall, and efficiency. Bypass water shall be returned to the stream or storage facility, without erosion or impairment to water quality.

Suction and discharge pipes. To prevent cavitation, suction and discharge pipes shall be designed to account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude. The size of suction and discharge pipes shall be based on hydraulic analysis, operating costs, and compatibility with other system components.

Appurtenances such as gate valves, check valves, pressure reducing valves, pressure gages, pipe connections, and other protective devices, shall be included to meet the requirements of the application.

Screens, filters, trash racks, or other devices shall be installed as needed to prevent the intake of sand, gravel, debris, or other objectionable material into the pump. Intake screens shall be designed according to applicable Federal and State guidelines, to avoid entrainment or trapping of aquatic organisms.

Backflow prevention devices shall be included according to federal, state, and local laws, to prevent contamination of water sources connected to the pumping plant.

Buildings and accessories. Pumps shall be securely mounted on a solid foundation such as pilings or concrete. Foundations shall be designed to safely support the loads imposed by the pumping plant and appurtenances. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

Where buildings are necessary to protect the pumping plant, provisions shall be included for adequate ventilation and accessibility for equipment maintenance, repairs, or removal.

Suction bays or sumps shall be designed to prevent the introduction of air at the intake.

The discharge bay or the connection to the distribution system shall meet all hydraulic and structural requirements.

Structures and equipment shall be designed to provide adequate safety features to protect operators, workers, and the public from potential injury. Drive shaft covers shall be required on all exposed rotating shafts.

Backflow Prevention to Protect Freshwater Sources. All pump discharge pipes not discharging to the atmosphere shall be equipped with a check valve or similar device to prevent backflow or backsiphonage into the source when the pump shuts down. Check valves shall be spring loaded and must have a low pressure drain (which opens and drains any remaining liquid onto the ground when the pressure drops) on the bottom of the upstream section. A large volume air vent/vacuum relief valve must be installed upstream of each check valve.

Additional Criteria Applicable to Providing the Efficient Use of Water on Irrigated Land

Provisions for the connection of flow and pressure measurement devices shall be included in power plant system design.

Additional Criteria Applicable to the Improvement of Air Quality

Replacement pumping plants shall have lower total emissions of oxides of nitrogen and fine particulate matter, compared to the unit being replaced.

New, replacement, or retrofitted pumping equipment shall utilize a non-combustion power source, or cleaner-burning technologies or fuels.

Additional Criteria Applicable to Reduce Energy Use

For fossil fuel or electrical grid power sources, pumping plant installations shall meet or exceed the Nebraska Pumping Plant Performance Criteria. Refer to the NRCS National Engineering Handbook, Part 652, National Irrigation Guide, Table 12-2

Table 12-2	Nebraska pumping plant performance criteria		
Energy source	bhp-h 1/ per unit of energy	wHp-h 2/ per unit of energy 3/	Energy units
Diesel	16.66	12.5	gallon
Gasoline	11.5 4/	8.66	gallon
Liquid Propane	9.20 4/	6.89	gallon
Natural gas	82.2 5/	61.7	1,000 cubic feet
Electricity	1.18 6/	0.885 7/	kilowatt-hour

1/ bhp-h (brake horsepower-hours) is the work being accomplished by the power unit (engine or motor) with only drive losses considered.

2/ wHp-h (water horsepower-hours) is the work being accomplished by the pumping plant, engine, or motor and pump.

3/ Based on 75 percent pump efficiency.

4/ Taken from Test D of Nebraska Tractor Test Reports. Drive losses are accounted for in the data. Assumes no cooling fan.

5/ Manufacturer's data corrected for 5 percent gear head drive loss with no cooling fan. Assumes natural gas energy content of 925 Btu per cubic foot. At 1,000 Btu per cubic foot, energy content uses 88.9 Hp-h per 1,000 cubic feet for natural gas. Btu per cubic feet can vary from season to season and from winter to summer.

6/ Assumes 88 percent electric motor efficiency.

7/ Direct connection, assumes no drive loss.

CONSIDERATIONS

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

- The removal of surface water by a pumping plant can affect downstream flows or aquifer recharge volumes. Consider potential the long term impacts downstream of the pumping plant.
- If using a pumping plant to remove surface water or ground water flowing into a wetland, consider the potential impacts on existing wetland hydrology.
- The operation and maintenance of a pumping plant can involve the use of fuels and lubricants that when spilled may adversely affect surface or ground water quality. Consider measures to protect the environment from potential spills. In some cases, secondary containment of spilled fuel may be required by Federal and State laws or regulations.
- Pumping plants are often constructed in flood-prone areas or can be subject to other unexpected natural events. Consider how the pumping plant may be protected from extreme natural events and the consequences of damage or failure.
- Include protective sensors to detect low or stopped flow, or pressures that are too high or too low.
- The visual appearance of buildings or structures associated with the pumping plant should be compatible with the surrounding environment.
- When installing new or replacing existing combustion equipment, non-combustion and renewable energy sources, such as solar, wind, and water, should be considered.
- Back-up power systems should be considered based on the risk associated with inoperability of the pumping plant.

Wind Generator or Photovoltaic System

The following items should be considered, as applicable:

- Protection from natural events such and fire, flood or hail
- Aesthetic concerns.
- Ambient noise level of the system
- The efficiency of a photovoltaic system can be enhanced with the addition of solar trackers.
- In lightning prone areas consideration should be given to locating the system away from high points in the topography, installing lightning rods adjacent to the system, and including lightning surge protection in the system specifications.
- There is potential to directly or indirectly have adverse impacts to birds, mammals, amphibian and/or reptiles that may be using cover in or near fields with wind generators. Noise produced when machines are in use may significantly disturb terrestrial species behavior.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing pumping plants shall be in accordance with this standard and describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications shall 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, inlet and outlet connections, mounting, foundations, 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 pumping plant being installed shall be prepared for use by the owner and responsible operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly as designed. As a minimum, the plan shall address the following:

- Inspection or testing of all pumping plant components and appurtenances.
- Proper start-up and shut-down 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.
- Procedures to protect the system from damage due to freezing temperatures.
- When applicable, procedures to frequently check the power unit, fuel storage facilities, and fuel lines, for leaks and repair as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures, to assure adequate flow capacity reaching the pumping plant intake.
- Periodic removal of sediment in suction bays, to maintain design capacity and efficiency.
- Inspection and maintenance of anti-siphon devices, if applicable.
- Routine test and inspection of all automated components of the pumping plant, to assure the proper functioning as designed.
- Inspection and maintenance of secondary containment facilities, if applicable.
- Periodic inspection of all safety features, to ensure proper placement and function.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.

REFERENCES

NRCS National Engineering Handbook, Part 652, National Irrigation Guide.