NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
ARIZONA

IRRIGATION LAND LEVELING

(Ac.)

CODE 464

DEFINITION

Reshaping the surface of land to be irrigated to planned grades.

PURPOSE

To permit uniform and efficient application of irrigation water to the leveled land.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to leveling irrigated land based on a detailed engineering survey, design, and layout. It does not include Precision Land Forming (462) or Land Smoothing (466).

CRITERIA

All planned work *associated with this practice* shall comply with all Federal, State, *Tribal*, and local laws and regulations. *Laws 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 owner is responsible for securing necessary permits and water rights, complying with all laws and regulations, and meeting legal requirements applicable to all the works associated with this practice..

Land to be leveled shall be suitable for irrigation, *suited to site conditions (combination of soils, topography, availability of an outlet, and slope), crops to be grown*, and for the proposed methods of water application. Water supplies and irrigation deliveries to the area to be leveled shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application method to be used.

Soils shall be deep enough so that after leveling an adequate, usable root zone remains that will permit satisfactory crop production with proper conservation measures. Limited areas of shallower soils may be leveled to provide adequate irrigation grades or a better field arrangement. The finished leveling work must not result in exposed areas of highly permeable materials that can inhibit proper distribution of water over the field.

After the planned leveling work is completed, the minimum usable root zone depth for the general area shall not be less than 12-inches for fine and medium textured soils, 18-inches for moderately textured soils and 24-inches for very coarse textured soils.

All leveling work shall be planned *and designed* as an integral part of an overall *plan of conservation land use and treatment or* farm irrigation system to enhance the conservation of soil and water resources *and shall be based on the capabilities of the land (natural resources), the landowner/operator goals and the needs of the irrigated area.*

The boundaries, elevations, and direction of irrigation of individual field leveling jobs shall be such that the requirements of all adjacent areas in the farm unit can be met. *This includes adequate land area to install a tail water system, rainfall runoff collection or water re-direction system so that there are no negative effects on other crops and land units.*

Design and implementation of subsidiary components and/or structures shall meet all applicable Natural Resource Conservation

Service (NRCS) conservation practice standards. The criteria for the design of any components not specifically addressed in NRCS practice standards or specifications shall be consistent with sound engineering principles and/or manufacturer recommendations.

***Cultural Resources and Wildlife**. Impact to cultural resources, wetlands and Federal and state protected species shall be evaluated and avoided or minimized to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH), National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).*

Field grades. If more than one method of water application or more than one kind of crop is planned, the land must be leveled to meet the requirements of the most restrictive method and crop. All leveling work must be designed within the slope limits required for the methods of water application to be used, to provide for the removal of excess surface water, and to control erosion caused by rainfall. Reverse grades in the direction of irrigation shall not be permitted.

Increasing field slopes in the direction of irrigation shall not be permitted; however, decreasing field slopes are encouraged where needed to increase irrigation uniformity.

Slope for level irrigation methods. The maximum fall in the direction of irrigation shall not exceed one-half the design depth of application for a normal irrigation. The difference in elevation across an individual border strip shall not exceed 0.10-feet.

The level basin (border or furrow) irrigation method shall not be used on 0.1 or 2.0 and greater intake family soils as defined in the National Engineering Handbook, Part 652 – Irrigation Guide.

Slope for graded irrigation methods. The maximum slope in the direction of irrigation if rainfall erosion is not a significant problem shall be as follows:

1. Furrows – 3.0 percent,
2. Corrugations – *4.0% for non-sod forming crops and* 8.0 percent *for sod forming crops,*
3. Borders for nonsod-forming crops, such as alfalfa or grain – 2 percent,
4. Borders for erosion-resistant grass or grass-legume crops or for nonsod-forming crops on sites where water application by the border method will not be required until after good crop stands have been established – 4.0 percent.

In areas where potential for rainfall erosion is great, the maximum slope for furrows shall be 0.5 percent and 2.0 percent for borders for sod forming grasses and 0.5 percent for other crops.

On slopes in the direction of irrigation of more than 0.5 percent where leveling designs provide for increasing or decreasing slopes, the following limits shall apply:

- The maximum slope in an irrigation run shall be no more than twice the minimum.
- The change in slope in any 100-foot reach shall not exceed one-half the maximum permissible change along the length of run. However, short level sections are permissible at the upper or lower ends of irrigation runs to facilitate water control or to reduce runoff.
- The maximum permissible slope change is the difference between the flattest and steepest design slope along the length of run.

Design field grades shall be such that, in combination with other planned conservation practices, erosion will be kept within acceptable limits.

Cross slope. The allowable cross slope for furrows and corrugations depends on the stability of the soil, the size of furrows that are to be used, and the rainfall pattern in the area. Cross slopes must be such that "breakthroughs" from both irrigation water and runoff from rainfall are held to a minimum. *The cross slope*

shall not exceed the down-slope under any condition.

For the irrigation methods shown below, cross slopes shall not exceed the following:

- *Border Irrigation* – The maximum cross slope for borders shall be *0.3-percent to* 0.1-foot per border strip width, *whichever is smaller. (however, in no case should the cross slope exceed1/2 of the grade in the direction of irrigation)*
- *Contour Deep Furrow Irrigation – 3-percent on fine and medium textured soils and 5-percent on moderately coarse textured soils.*
- *Contour Ditch Irrigation – ¼ of the general down-slope.*

Slope for subsurface irrigation methods. In areas where irrigation is practiced through ground water level control, the field surface shall be shaped to parallel the expected subsurface water elevations. The design shall consider the desired depth from the soil surface to the elevation of the ground water.

Surface drainage. Farm irrigation systems shall include plans for removing or otherwise controlling excess irrigation and storm water *(i.e., Surface field ditches, grassed waterways, and structures for water control).* Leveling designs must provide field elevations and field grades that will permit proper functioning of the planned drainage system facilities.

Maximum field elevation. All leveling work shall be designed to permit delivery of needed irrigating streams onto the highest point on the field surface. The field elevation shall be at least 0.33-feet below the water surface elevation at the point of delivery.

Investigations, Surveys and Design Criteria. *Documentation requirements will be as outlined below, in additional to the documentation requirements of the practice components used in the system.*

The proper field arrangement and farm distribution system must be planned before leveling is designed or installed. Make a preliminary site assessment or reconnaissance to determine site suitability, topography, watershed, soil limitations, and may include:

1. *Detailed soil survey information. The published soil survey data is generally not detailed enough for land leveling design requirements. A soil survey should be completed on the area to determine irrigation suitability, topsoil depths, depth to gravel, and presence of any other features which may affect the designers decisions on allowable depth of cut, suitable borrow areas, etc. Soil materials shall be classified using the Unified Soil Classification System.*
2. *Verify appropriate state laws for permitting and notify landowner of his/her responsibilities.*
3. *Verification or certification of used materials (if any).*

To adequately plan and layout this practice, a detailed topographic survey is required, that adequately details:

1. *Site topography, as needed to show the physical features of the site, including existing features/practices, field elevations, location of any utilities or markers, etc.*
2. *Perform a grid or survey to determine field slopes and corresponding contour map.*
3. *A permanent benchmark(s) shall be set and described. Preferably, the elevations and coordinates should be based on a local (assumed) or coordinate system (State or grid) and clearly stated on the plan. Datum may be in the form of Northing and Easting coordinates, or Longitude and Latitude.*
4. *Set reference stakes, as needed*

The design of a practice is the application of Field Office Technical Guide practice standards, and using experience and judgment in the development of a solution to the problem or the objective. All computations and decisions made during the design of a practice are to be checked by another qualified individual and appropriate notations made. Design computations, calculations or analysis shall meet the following criteria:

1. *Determine and record ground elevations, design elevation, and cut/fill requirements for*

all grid points, including the planned grades/slopes for each field or boundary.

2. *Location and elevations of structures, pads, ditches, etc.*
3. *Calculate or determine volume computations, including earthwork estimates, materials, etc. Set Balance lines (areas where cut/fill volumes are balanced), as needed.*
4. *All final design earthwork volumes shall be computed using the average end area, the 4-point method or other approved methods. Cut/Fill (C/F) ratios should be based upon local experience, soil texture, soil moisture, and cut/fill depths. It is recommended that the design cut/fill ratios range from 1.2 to 1.4 (cut volume/fill volume), but not greater than 2:1. The higher end of the range should be used when the design consists primarily of shallow cuts and fills.*
5. *Subsidiary and applicable components shall be designed in accordance with applicable conservation practice standards (i.e., structures shall meet the requirements of Conservation Practice 587, Structure for Water Control, etc.).*

***Installation and Basis of Acceptance**. For construction that does not meet State, OSHA, or Tribal criteria or requirements where deficient construction materials were used, NRCS may consider a waiver request for approval of construction after it has received a signed and sealed construction and/or material exemption from a licensed engineer. Required exemption shall be for installation of materials that do not meet minimum quality criteria as found in applicable Standards, Specifications, ASTM's, AWWA standards, etc.*

Contractors performing work under this practice shall abide by all Federal, State or Tribal laws or criteria, and must be licensed by the state DWR or board of technical registers where the work is being implemented.

CONSIDERATIONS

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

- In the design consider the excavation and fill material required for or obtained from such structures as ditches, ditch pads, and roadways. The appropriate yardage shall be included when balancing cuts and fills and determining borrow requirements.
- Consider related structures and measures needed to control irrigation water and/or storm water runoff.
- Consider crops, method of irrigation, soil intake rates, field slope, irrigation stream size and resulting deep percolation and runoff when determining or evaluating length of irrigation runs.
- Consider the depth of cuts and the resulting available plant rooting depths to saline soils and to shallow water tables.
- *Effects of water level control on the salinity of soils, soil water or downstream water quality.*
- *Impact of salt leaching on system management and capacity requirements.*
- In areas with sediment-laden irrigation water, consider increasing the required height of the water surface at the point of delivery.
- *Effects on erosion and the movement of sediment and soluble and sediment-attached substances that would be carried by runoff.*
- Consider effects on irrigation efficiencies, especially on volumes and rates of runoff, infiltration, evapotranspiration and deep percolation.
- *Effect on the water table of the field in providing a suitable rooting depth for anticipated land uses.*
- *Effects of nutrients and pesticides and other dissolved substances on surface and ground water quality.*
- *Effects on the movement of dissolved substances below the root zone or to ground water.*
- *Effects of water levels on such soil nutrient processes as plant nitrogen use or denitrification.*
- *Consider the potential for a change in plant growth and transpiration resulting from changes in the volume of water.*
- Consider effects on *downstream* water flows and aquifers, and the affect to other water uses and users.

- *Effects on the volume of downstream flow that could have undesirable environmental, social, or economic impacts.*
- Consider the effects on adjacent wetlands *or water-related wildlife habitats. Practical measures and construction shall be incorporated as needed to enhance wildlife values.*
- *Special attention shall be given to protecting aesthetic resources and maintaining key shade, food, and den trees or vegetation.*
- *Effects on cultural resources.*

Design alternatives presented to the client should address economics, ecological concerns and acceptable level of risk for design criteria as it relates to hazards to life or property.

***Soils**. Evaluation of the native soil types and textures shall be considered while planning a Land leveling operation for a Surface Irrigation System. Sites with a high percentage of sandy soils are not recommended, due to the high permeability of the soil. Sprinkler irrigation systems are deemed a better alternative for sandy soils.*

PLANS AND SPECIFICATIONS

Use Arizona standard drawings to the extent possible. These may be supplemented by additional drawings or specification notes on the drawings to provide full installation instructions.

Construction plans shall include all components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate. The plans shall address operations near existing utilities, trench excavations and any other items related to construction of the structure that may pose a safety risk to those involved.

Development of plans and specifications for irrigation land leveling shall be site specific, *guided by the National Engineering Handbook, (NEH) Part 641 "Drafting and Drawings" and Part 642 "Specifications for Construction Contracts", shall be in keeping with this standard* and shall *also* show the requirements for installing the practice to achieve its intended purpose.

Site specifics typically include field boundaries, planned cuts and fills, earthwork volumes, cut/fill ratio, direction of irrigation, design down slope and cross slope, required water surface and location of irrigation water delivery, tail water disposal, and appurtenant structures. *As a minimum, the plans and specifications shall include:*

- *Project location map, including section, township and range, North arrow, cooperator/owner acknowledgement and certification signature blocks, engineering job class (cover sheet);*
- *References that the owner/cooperator are responsible for all permits, rights-of-way, easements and the contact, coordination and location determination of any existing utilities or clearances (buried utility disclaimer);*
- *If applicable, a map showing the location of the practice(s) or system in reference to a known or established benchmark or reference point with the location, description and elevation clearly shown. Topographical features and/or controls shall be shown, showing tie in with existing or other planned practices;*
- *Field surveys and notes, soil investigations or geologic soil boring locations and soil classifications, earthwork or material estimates/quantities (if applicable);*
- *System overview and layout (i.e., field boundaries; cut/fill quantities on grid points and original ground elevations, planned or design elevations; balance lines (if needed); water delivery location and elevation (direction of irrigation; location and extent of borrow areas; construction/installation criteria, State and Federal [OSHA] safety requirements, and other necessary appurtenances and/or structures;*
- *Table with headings for field number or designation, area in acres, cut and fill yardage (cubic yards per acre), cut/fill ratio, , with appropriate totals for the entire area to be leveled;*
- *Use Arizona Construction and Material Specifications for each item of work and material, as applicable and available.*

Additional specifications may need to be written to provide full material and installation instructions. Fill in blanks and add or delete items from the specifications to make them fit the job as needed.

All designs completed by non-NRCS personal shall meet minimum State licensing board requirements and NRCS requirements and criteria as outlined in the General Manual, the National Engineering Manual (including Arizona Supplements), and the National Engineering Handbook.

ONCE ALL PARTIES HAVE ACCEPTED AND SIGNED THE PLANS AND SPECIFICATIONS, NO CHANGES SHALL BE MADE TO THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF NRCS.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan that is specific to the site and/or facilities installed shall be prepared, and reviewed, for use by the landowner, cooperator or operator responsible for operation and maintenance and shall be commensurate with the size and complexity of the project. The plan shall document needed actions, including reference to periodic inspections and the prompt repair or replacement of damaged components, and should provide specific instructions for operating and maintaining facilities to ensure they function properly and adequately throughout their expected life.

The maintenance on leveled fields includes the periodic removal or grading of mounds and/or depressions. Land grading may periodically be needed to restore the design gradient.

O&M requirements shall be determined as part of the design. Any requirements should be documented as brief statements in the plans, the specifications, or the conservation plan narrative, or as a separate O&M plan. The plan shall include provisions to address the following, as a minimum:

- *Avoid use of tillage equipment that leaves ridges or depressions that cannot be removed by subsequent tillage operation.*
- *Periodic cleaning and re-grading of collection facilities (fields, ditches, pipes, structures) to maintain proper flow lines and functionality and maintain design border/furrow spacing as designed.*
- *Periodic checks and removal of debris, foreign material obstructions, or blockage as necessary from trash racks, ditch/pipe inlets, outlets and structures to assure proper operation.*
- *Periodic removal and planned placement of sediment from traps and/or storage facilities to maintain design capacity and efficiency.*
- *Eradicate or otherwise remove all rodents or burrowing animals that have or may potentially damage any part of the delivery or application facilities. Immediately repair any damage caused by their activity.*
- *Immediately repair any damage resulting from vandalism, vehicles, or livestock.*
- *Install and maintain fences to prevent livestock access where excessive trampling of banks or ditch may occur, and do not allow livestock near equipment during operation.*
- *Maintain vigorous growth of vegetative coverings, this may include re-seeding, fertilization, and application or herbicides. Periodic mowing may also be needed to control excessive growth.*

REFERENCES

- *USDA-NRCS, National Engineering Manual (NEM), 2nd Edition*
- *National Engineering Handbook Part 623, Irrigation; and Part 652, Irrigation Guide*
- *National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 1 – Engineering Surveys; Chapter 2 – Hydrology, including the Emergency and Principal Spillway Proportioning Guide, Chapter 3 – Hydraulics, Chapter 4 – Elementary Soils Engineering, Chapter 5 – Preparation of Engineering Plans, Chapter 15 – Irrigation; and Chapter 17 – Construction & Construction Materials*

- *USDA-NRCS, TR-62 Engineering Layout, Notes, Staking and Calculations;*
- *General Manual, Title 420-Part 401, Title 450-Part 401, Title 190-Parts 410.22 and 410.26*
- *National Environmental Compliance Handbook*
- *National Planning Procedures Handbook*