NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
ARIZONA

STREAMBANK AND SHORELINE PROTECTION

(Ft.)

CODE 580

DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

PURPOSE

- To prevent the loss of land or damage to land uses, or facilities adjacent to the banks of streams or constructed channels, shoreline of lakes, reservoirs, or estuaries including the protection of known historical, archeological, and traditional cultural properties.
- To maintain the flow capacity of streams or channels.
- Reduce the offsite or downstream effects of sediment resulting from bank erosion.
- To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, recreation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. *It applies to controlling erosion where the problem can be solved with relatively simple structural measures, (as shown in the Engineering Field Handbook, Chapter 16, Part 650, Section 650.1601−Streambank Protection) vegetation (herbaceous or woody), or upland erosion control practices. It also applies to treatments or measures to control channel meander that would adversely affect downstream facilities.* It does not apply to erosion problems on main ocean fronts, beaches or similar areas of complexity.

CRITERIA

General Criteria Applicable to All Purposes

Conservation practices shall be designed on an individual basis to meet site conditions and functional requirements. They shall be part of an approved and overall engineering plan for channel improvement, erosion control or similar purposes.

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.

Laws and Regulations. Treatments *and/or measures* shall be *designed and installed* in accordance with all applicable local, state, *tribal,* and federal 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 participant is responsible for securing necessary permits, complying with all laws and regulations, and meeting legal requirements applicable to the installation and operation, and maintenance of this practice and associated structures.

Fish and Wildlife. Treatments applied shall seek to avoid adverse effects to endangered, threatened, and candidate species and their habitats, whenever possible. *Special consideration should be given to maintaining or improving habitat for fish and wildlife where applicable.*

This practice is not likely to adversely affect listed species or their critical habitat if the following conservation measures are implemented. Non-implemented measures require additional effect determination.

- Use existing stream crossings for equipment access during practice installation

- Minimize soil and vegetation disturbance during practice installation. Remove only targeted species and leave native herbaceous layer undisturbed to allow for regrowth.
- Reestablish vegetation on disturbed areas after practice installation using native species.
- Ensure equipment does not have oil or fuel leaks, and maintenance work is done away from water.
- Immediately clean any grease, oil, or other contaminant spills and remove from the site.
- Minimize or eliminate streambank disturbance during practice installation.
- Avoid planting of non native plants in disturbed areas. NRCS will consult with FWS if the planting of non native plants is unavoidable.
- Leave adequate vegetation buffer and/or install best management practices along downslope edge of project area to prevent disturbed ground sediment runoff from entering aquatic habitats. These can include straw baffles, silt fence, hay bales, etc.
- Water will not be diverted from perennial streams that are occupied by listed fish or other listed aquatic species.
- Minimize upland soil compaction during practice installation by scheduling installation during dry periods.
- Design stream crossings and fences to allow water flow during low flow periods and prevent blockage of debris during high flow periods.
- Install practices when any ephemeral streambed within the action area is dry; or at times when hydrologic, migration or reproduction conditions ensure that covered species are not present
- Use existing roads and limit cross country travel.
- Where clearing of vegetation is determined to be necessary during planned construction or maintenance, limit the width of clearance to 25 feet maximum.
- Flag individuals of a listed plant species for protection during construction.
- Do not demolish or remove existing vegetation, habitat structures, covers or nest materials located within a 250 feet wide undisturbed buffer.
- Conduct a pre-installation, pedestrian survey for wildlife that may be trapped within a temporarily fenced construction area. Trapped wildlife will be allowed to escape prior to construction.
- Complete practice outside the periods considered as critical for the covered species.
- Clean equipment used in practice implementation (vehicles, farm equipment, and tools) before entering and leaving project site to prevent the spread of non-native plant/animals or disease

Cultural Resources. Treatments applied shall seek to avoid adverse effects to archaeological, historic, structural, and traditional cultural properties, whenever possible. *Consider existence of cultural resources in the project area and any project impacts on such resources. Consider conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.*

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).

Site Investigation. An assessment of unstable streambank or shoreline sites shall be conducted in sufficient detail to identify the causes contributing to the instability (e.g. livestock access, watershed alterations resulting in significant modifications of discharge or sediment production, in channel modifications such as gravel mining, head cutting, water level fluctuations, boat-generated waves, etc.).

Design Criteria. *National Engineering Handbook (NEH), Part 650, Chapter 16, Streambank and Shoreline Protection and NRCS NEH, Part 653, Stream Corridor Restoration: Principles, Processes, and Practices provide guidance in planning and*

designing streambank and shoreline protection treatments.

Proposed protective treatments to be applied shall be compatible with improvements being planned or installed by others.

Protective treatments shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics above and below the water line.

Bioengineering techniques shall be considered in conjunction with structural measures. Refer to the Streambank Soil Bioengineering Field Guide for Low Precipitation Areas for guidance.

End sections of treatment areas shall be adequately anchored to existing treatments, terminate in stable areas, or be otherwise stabilized to prevent flanking of the treatment. *Structural measures shall be keyed into the bank at both the upstream and downstream ends, with additional keys along the design reach as needed to prevent flanking. The keys shall extend from the elevation of the anticipated scour depth to the low bank elevation and shall extend into the bank a minimum of 5 feet (as measured perpendicular to the bank slope).*

Protective treatments shall be installed that result in stable slopes. Design limitations of the bank or shoreline materials and type of measure installed shall determine steepest permissible slopes.

Designs will provide for protection of installed treatments from overbank flows resulting from upslope runoff and flood return flows.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be incorporated with structural measures where there is the potential for migration of material from behind the measure.

Treatments shall be designed to account for any anticipated ice action, wave action, and fluctuating water levels.

All disturbed areas around protective treatments shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction.

Vegetation shall be selected that is best suited for the site conditions and achieves the intended purpose(s).
In order to ensure plant community establishment and integrity, a vegetative management plan shall be prepared in accordance with NRCS conservation practice standard, Channel Bank Vegetation, Code 322.

Additional Criteria for Streambanks
Stream segments to be protected shall be classified according to a system deemed appropriate by the state. *The stream shall be classified according to either the Schumm channel evolution model, the Rosgen stream channel classification system (Chapter 7 of NEH Part 653), or other approved method.* Segments that are incised or that contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

A site assessment shall be performed to determine if the causes of instability are local (e.g. poor soils, high water table in banks, alignment, obstructions deflecting flows into bank, etc.) or systemic in nature (e.g. aggradation due to increased sediment from the watershed, increased runoff due to urban development in the watershed, degradation due to channel modifications, etc.). The assessment need only be of the extent and detail necessary to provide *(1)* a basis for design of the bank treatments and *(2)* reasonable confidence that the treatments will perform adequately for the design life of the measure.

The streambed and bank stability shall be evaluated to determine if the toe (the lower edge of the bank) requires protection. Bank protection must be constructed to a depth below the anticipated lowest depth of streambed scour.

Changes in channel alignment shall not be made without an assessment of both upstream and downstream fluvial geomorphology that evaluates the affects of the proposed alignment. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment. *The checklist, "Measurable Attributes for Describing Conditions in the Stream Corridor," found in Chapter 4 of NEH 653, shall*

be used to document the current and future condition of the stream and watershed.

The channel grade of the streambed shall be stable, based on a field assessment (such as Stream Visual Assessment Protocol), before any permanent type of bank protection can be considered feasible, unless the protection can be constructed to a depth below the anticipated lowest depth of streambed scour.

Bank protection treatment shall not be installed in channel systems undergoing rapid and extensive changes in bottom grade and/or alignment unless the treatments are designed to control or accommodate the changes. Bank treatment shall be constructed to a depth at or below the anticipated lowest depth of streambed scour.

If the failure mechanism is a result of the degradation or removal of riparian vegetation, stream corridor restoration shall be implemented, where feasible, (see Additional Criteria for Stream Corridor Improvement) as well as treating the banks.

Toe erosion shall be stabilized by treatments that redirect the stream flow away from the toe or by structural treatments that armor the toe. Additional design guidance is found in the EFH Part 650, Chapter 16, Streambank and Shoreline Protection, *Part 653, Stream Corridor Restoration: Principles, Processes, and Practices, and Part 654, Stream Restoration Design.*

Where toe protection alone is inadequate to stabilize the bank, the upper bank shall be shaped to a stable slope and vegetated, or shall be stabilized with structural or soil-bioengineering treatments. *This protection shall extend from the maximum anticipated scour depth of the channel to the geomorphic bank full level.*

Channel clearing to remove stumps, fallen trees, debris, and sediment bars shall only be performed when they are causing or could cause unacceptable bank erosion, flow restriction, or damage to structures. Habitat forming elements that provide cover, food, pools, and water turbulence shall be retained or replaced to the extent possible.

Treatments shall be functional and stable for the design flow and sustainable for higher flow conditions.

Treatments shall not induce an increase in natural erosion.

Treatments shall not limit stream flow access to the floodplain.

Where flooding is a concern, the effects of protective treatments shall not increase flow levels above those that existed prior to installation.

Bank stabilization for wetlands adjoining streams may be evaluated for wetland functions and values using the riverine hydrogeomorphic (HGM) model.

Additional Criteria for Shorelines

All revetments, bulkheads or groins are to be no higher than 3 feet (1 meter) above mean high tide, or mean high water in non-tidal areas.

Structural shoreline protective treatments shall be keyed to a depth to prevent scour during low water.

For the design of structural treatments, the site characteristics below the waterline shall be evaluated for a minimum of 50 feet (15 meters) horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave height and freeboard. The design water surface in tidal areas shall be mean high tide.

When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

Shoreline stabilization for wetlands must be evaluated for wetland functions and values using the riverine HGM model.

Additional Criteria for Stream Corridor Improvement

Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key

element in preventing excess long-term channel migration in re-established stream corridors. The establishment of vegetation on channel banks and associated areas shall also be in accordance with conservation practice standards Channel Bank Vegetation, Code 322, *and Critical Area Planting, Code 342*.

A site-specific assessment shall be conducted to determine the appropriate elements needing treatment. Acceptable assessment methods include Stream Visual Assessment Protocol (SVAP), Missouri Stream Mitigation Method, or other approved method.

Treatments shall be designed to achieve habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives shall be based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Treatments shall be designed to meet aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives shall be based on human needs, including visual quality, noise control, and microclimate control. Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Treatments shall be designed to achieve recreation objectives as determined by a site-specific assessment or management plan. Safety requirements shall be based on type of human use and recreation objectives.

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.*

Make a preliminary site assessment or reconnaissance to determine site suitability, type of treatment/measure needed to protect the Streambank, topography, watershed (drainage area), soil limitations, and may include:

1. *Aerial photographs, as needed, to compare historical photos with current stream configuration to assess recent changes, alterations, sinuosity, etc.*
2. *Soil borings, geological site investigation or soil survey/investigation, depending on existing site conditions or scope and complexity.*
   a. *Soil classification by the Unified Soil Classification System,*
   b. *determination of bed and bank materials*
3. *Channel characteristics of stable reaches upstream and/or downstream of project site, including riparian vegetation, channel geometry, grazing influences, etc.*
4. *Assessment of causes relative to the stream instability (i.e., channelization, down-cutting, grazing impacts, natural lateral migration, other man caused disturbances, etc.)*
5. *Project location relative to habitat/range of threatened and endangered species*
6. *Stream classification – stream segments to be protected or treated shall be classified to insure protection measures/treatments are compatible with stream type, and may include:*
   a. *Field determined bank full stage*
   b. *Bank full discharge (1.5 year)*
   c. *Survey data, as needed, to determine stream type*
   d. *Width to depth ratio, an index value computed using the bankfull width/mean bank full depth*
   e. *Entrenchment ratio, a computed index value which is the flood prone width (which occurs at an elevation twice the maximum bankfull depth/bankfull width)*
7. *Verify appropriate state laws for permitting (404 permit, document if individual permit, nationwide permit applies, or if practice is exempt) and notify participant of their responsibilities.*
8. *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. *Centerline profiles and cross sections, as needed, upstream and downstream of project for water surface profile computation, design, etc.*
   a. *Profiles of thalweg of channel, low bank height, water surface elevation*
   b. *Location of stream morphology features (i.e., start and end of pool and riffle sections, etc.), if applicable*
   c. *Cross sections, 100-feet interval (maximum), or as necessary to depict irregularity of the natural channel and/or area to be protected. Elevations along cross sections will show all breaks and should extend from the stream center line beyond the estimated construction area*
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. Coordinates may be in the form of Northing and Easting coordinates, or Longitude and Latitude.*
4. *Set reference stakes, as needed*

Where applicable, USGS 7.5-minute topographic Quadrangles may be used, provided hydrologic analysis verifies minimum criteria are meet at all locations.

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. *Plot profiles and cross sections of area to be protected and verify the type of treatment selected to protect the streambank. Protection shall be in accordance with NEH, Part 653*
2. *Determine frequency vs. discharge data – use EFM2, TR-55, or USGS flood frequency data, as applicable (hydrology determined with EFM2 and/or TR-55 may not accurately reflect the bankfull geomorphic characteristics of natural channels, but may provide a quick approximation)*
3. *Hydraulic analysis (stage, discharge, velocity relationships), calculate water surface profile elevations, as appropriate (WSP2, HEC-RAS)*
4. *Protective measure or treatment analysis, develop cross sections with sufficient details to install the practice*
5. *Design Bank protection measures, considering geomorphic principles, risk tolerance, economics, esthetics, etc.*
6. *Stability analysis, as appropriate, for structural and/or bioengineering measures*
7. *Structural analysis and Design elevations*
8. *Determine type, quality, and quantities of all materials, includes estimates of earthwork, rock, vegetative components, geotextile or erosion control fabrics, etc.*
9. *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 board of technical registers where the work is being implemented.

CONSIDERATIONS

An assessment of streambank or shoreline protection needs should be made in sufficient detail to identify the causes contributing to the instability prior to the development of the proposed treatments (e.g. watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment, an interdisciplinary team should be utilized.

When designing protective treatments, consider the changes that may occur in the watershed

hydrology and sedimentation over the design life of the treatments.

Consider utilizing debris removed from the channel or streambank into the treatment design when it is compatible with the intended purpose.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive disturbance and compaction of the site during installation. *In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.*

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

Treatments that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife by including treatments that provide aquatic habitat in the treatment design and that may lower or moderate water temperature and improve water quality.

Consider the need to stabilize side channel inlets and outlets and outlets of tributary streams from erosion.

Consider aquatic habitat when selecting the type of toe stabilization. *Toe rock should be large enough to provide a stable base or placed to provide aquatic habitat.*

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects *on downstream flows and impacts to environment* to existing wetland functions and values, *aquifers, and social and economic impacts to downstream uses or users*.

Livestock exclusion shall be considered during establishment of vegetative treatments and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative treatments. Temporary and local population control methods should be used with caution and within state and local regulations.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed treatments, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider the short-term and construction-related effects of this practice on the visual quality of downstream water courses and the potential for earth moving to uncover or redistribute toxic materials such as saline soils.

Consider conservation and stabilization of archeological, historic, structural and traditional cultural properties when applicable.

Consider safety hazards to boaters, swimmers, or people using the shoreline or streambank when designing treatments.

Protective treatments should be self-sustaining *(integrating soil bioengineering with structural measures)* or require minimum maintenance.

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.

***Gabion Structures**. If gabion structures are used they shall meet the following conditions:*

- *Gabions shall be installed (vertical elevation) a minimum of three feet below the lowest point of the streambed, to bedrock or below the*

potential scour depth (select the most limiting criteria).

- *Gabion mattresses shall be a minimum of 1 foot thick where water velocities are less than 9 feet per second and 18 inches thick for water velocities of 9 to 14 feet per second.*
- *Gabion retaining walls shall be a minimum of 3 feet thick. A stair step configuration is recommended. The design analysis shall show stability against overturning, sliding and foundation settlement.*

***Sand-Gravel Filter**. If a sand-gravel filter is specified, the filter gradation shall be designed in accordance with Chapter 26 in National Engineering Handbook (NEH) Part 633.*

Geotextile shall meet the minimum criteria as outlined in applicable Arizona material specifications.

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 *installing* streambank and shoreline protection *will be guided by the National Engineering Handbook, Part 650, the Engineering Field Handbook, Chapter 5, and shall be in accordance with the National Engineering Manual, Parts 541 and 542,* shall be prepared for specific field sites and based on this standard and shall *adequately* describe the requirements for applying *or installing* the practice to achieve its intended purpose. Plans shall include treatments to minimize erosion and sediment production during construction and provisions necessary to comply with conditions of any environmental agreements, biological opinions or other terms of applicable permits. *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 (foundation or subgrade preparation and requirements);*
- *System overview and layout (i.e., location, stationing, and planned protective measures; limits or area requiring streambank or shoreline protection; profile along centerline of stream channel, as needed; cross sections; section views, as required for detailing, dimensioning, and design elevations of measures/treatment [rock riprap, concrete, etc.], thickness of material, and toe reinforcement; special end conditions or keys; treatments to minimize erosion and sediment during construction; special requirements for foundation preparation or filter requirements; specifications for diverting water or de-watering the site; soil or waste disposal, location and extent of borrow source; vegetative requirements; construction/installation criteria; State and Federal [OSHA] safety requirements, etc.),, necessary appurtenances and/or structures;*
- *Sufficient sectional, dimension or detail views of all system components and appurtenances (i.e., requirements for geotextile; bedding; stone, rock riprap, concrete; etc.) as required, for proper system functionality.*
- *Provisions necessary to comply with conditions of any environmental agreements, biological opinions or other terms of applicable permits.*
- *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 plan *(O&M) specific to each site and facilities installed* shall be *reviewed and* prepared for use by the owner, *cooperator* or others responsible for operating and maintaining the system *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 the system to insure that it functions properly *and adequately throughout their expected life*. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion.

The plan shall include provisions to address the following, as a minimum:

- *The treatments or measures should be inspected periodically, especially after major storm events to determine whether it is functioning properly or if repairs are needed.*
- *Maintain vigorous growth of desirable vegetative coverings. The vegetative cover shall be maintained by mowing, fertilizing or burning when needed. Trees can cause leaks and safety hazards and should not be permitted on the embankment.*
- *Erosion shall be repaired and if necessary protected to prevent additional erosion.*
- *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.*
- *Inspect for safety of people or animals using the area near the treatments or measures.*
- *Inspect the integrity of fences, access roads, water access, crossings and other livestock control measures. Replace or repair as necessary. All fences, railings, and/or warning signs shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.*
- *Soil bioengineering measures should be assessed during drought and immediately after high flows. Inspection of bank and channel measures should be conducted during low-water conditions to allow viewing of the measure as well as changes to the stream bed that may affect future integrity of the system. Early failure is an inherent risk of soil bioengineered structures systems that are not fully effective until the plants are well rooted and the stems reach a particular size and density. Repair and replant as required.*
- *Appurtenances such as trash racks, outlet structures, and valves shall be kept free of trash, debris, foreign materials or blockage and replaced when needed.*
- *All settlement or cracks in the soil should be investigated to determine the cause and immediately repaired.*
- *Check all timber or lumber sections for decay and other damage, especially sections in contact with earth or other materials. Repair damaged sections.*
- *Repair spells, cracks and weathered areas in concrete surfaces.*
- *Repair or replace rusted or damaged metal and apply paint as a protective coating.*
- *Repair and/or fertilize damaged vegetation in accordance with NRCS conservation practice standard Critical Area Planting, Code 342.*
- *Control grazing on the streambank or shoreline, as necessary*

Kellner Jacks and Spider Jacks

- *Steel legged Kellner Jacks and Spider Jacks are relatively maintenance free. Usually, the greatest need for maintenance is for the vegetation within the jetty field. However, vandals can remove steel angle iron, cable, poles, and fasteners. Impact from massive floating debris can bend or break jack legs and break wires.*

- *Inspect individual jacks for bent legs or broken lacing wires. Replace wires as necessary.*
- *Inspect for broken cables or dislodged anchors. Repair cables, reset anchors, or install new jetty lines as necessary.*
- *Inspect the riverbank, particularly at the upstream end of the line and at all anchors, to determine if the jetty line is in danger of becoming ineffective from bank erosion or if anchors are in danger of being washed out. Take corrective action as required.*

Rock Riprap

- *Remove tree or brush vegetation growing through the rock riprap. Only grass-like vegetation is to be allowed to thrive and spread.*
- *Replace or reposition rock as needed to maintain slopes and cover over base materials. Replacement rock should be similar to original rock. Replace to original grades, as necessary.*
- *Check overland flow and side drainages to insure that floodwaters from the sides will not damage the riprap. Divert or otherwise handle overland and side flows away from the rock riprap.*
- *Check all rock sections for cracking, accelerated weathering, delamination and disintegration.*

Soil Cement

- *Inspect for excessive scour and cracking. Repair major damage by replacing soil cement to its full thickness and compacting to design grade and specification.*

Gabions and Reno Mattresses

- *Gabion structures are flexible and will bend or shape themselves as a result of natural settlement but there are limits as to how much a gabion can move without failure. A critical item is to maintain support at the toe. Check for scour at the toe or scour that might advance to the toe.*
- *Wire mesh is subject to damage from floating debris, water pollution, corrosion, wear from high velocity sediments, vandalism, etc. Repair broken wires and damaged baskets. Replace rock. After settlement has occurred, it might be necessary to place a concrete cap on some sections.*

REFERENCES

- *National Engineering Handbook* (NEH) Part 650, *Engineering Field Handbook, Chapter 1, Engineering Surveys; Chapter 3, Hydraulics; Chapter 4, Elementary Soils Engineering; Chapter 5, Preparation of Engineering Plans; Chapter 6, Structures;* Chapter 16, Streambank and Shoreline Protection; *Chapter 17 – Construction & Construction Materials; Chapter 18, Soil Bio-Engineering for Upland Slope Protection and Erosion Protection*
- NRCS Conservation Practice Standards, Channel Bank Vegetation, Code 322; *Critical Area Planting, Code 342*
- *NEH Part 653, Stream Corridor Restoration: Principles, Processes, and Practices; Part 654, Stream Restoration Design*
- *Hoag, J.C. and G. Bentrup. 1998. The Practical Streambank Bioengineering Guide. USDA NRCS Plant Materials Center. Aberdeen, ID.*
- *Hoag, C. and J. Fripp. 2002. Streambank Soil Bioengineering Field Guide for Low Precipitation Areas. NRCS National Design, Construction, and Soil Mechanics Center .*
- *Rosgen, D.L. and H. L. Silvey. 1996. Applied River Morphology. Wildland Hydrology Books, Fort Collins, CO.*
- *Rosgen, D.L. and H.L. Silvey 1996. Field Guide for Stream Classification. Wildland Hydrology Books, Fort Collins, CO*
- *Schumm, S.A., M.D. Harvey, and C.C. Watson. 1984. Incised channels: morphology, dynamics, and control. Water Resources Publications, Littleton, Colorado.*
- *Simon, A. 1989a. A model of channel response in distributed channels. Earth Surface Processes and Landforms 14(1): 11-26.*
- *NRCS, Idaho, Engineering Technical Note #6, "Design of Dumped Rock Riprap Stream Channel Stabilization"*
- *NRCS, Idaho, Engineering Technical Note #12, "Design of Rock Barbs"*
- *Engineering Field Manual, Chapter 10*
- *National Water and Climate Center Technical Note 99-1, Stream Visual Assessment Protocol*
- *Stream Barb Design Note, Version 1, West Region Technical Specialists, 1998*
- *Streambank Erosion Control Manual, U.S. Army COE, 3/93*
- *USDA-NRCS, National Engineering Manual (NEM), 2nd Edition*
- *USDA-NRCS, TR-62 Engineering Layout, Notes, Staking and Calculations; TR-25, Design of Open Channels; TR-59, Hydraulic Design of Riprap Gradient Control Structures; TR-69,*

Riprap For Slope Protection Against Wave Action;

- *General Manual, Title 420-Part 401, Title 450-Part 401, Title 190-Parts 410.22 and 410.26*
- *National Planning Procedures Handbook*
- *USDA NRCS, Engineering Design Standards – Far West States*
- *National Cultural Resources Handbook*