Standard Operating Procedures for the Assessment of In-Channel Structures

Colorado Department of Public Health and Environment

Water Quality Control Division

Nonpoint Source Program

Measurable Results Project

January 2012

1.0 INTRODUCTION

This Standard Operation Procedure (SOP) describes a method for the qualitative field evaluation of in-channel structures for the purpose of stream restoration monitoring.

The Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division's (WQCD) Measurable Results Project (MRP) has the responsibility to assist in monitoring stream restoration projects aimed at reducing non-point source pollution. At select stream restoration projects funded by NPS 319 grants the MRP and 319-grant recipients are responsible for collecting reproducible monitoring data using established data collection methods. It is the intent of this SOP to formalize a methodology for the evaluation of in-channel structures in order to assist reporting efforts on restoration monitoring.

The WQCD's Quality Management Plan (QMP) states that the quality assurance and quality control program will be implemented through the mandatory use of smaller Sampling and Analysis Procedure Plans (SAPPs), which are originated for program-specific projects, under the umbrella of a more comprehensive, long-term Quality Assurance Project Plan (QAPP). One of the essential tools that will be used in meeting goals and implementing QAPPs/SAPPs will be the use of SOPs.

The goal and purpose of this SOP is to collect high quality reproducible data that can be: 1) Used to track and assess stream condition changes at a particular location within a project site over time; 2) To assess trends and to assist in determination if BMPs are working. The objective is to collect qualitative documentation on in-channel structures and to allow for that documentation to be easily revisited and reevaluated by other individuals in the future. It is therefore, important that collection methods are consistent to maximize data usefulness and to ensure that data collected by different samplers at different sites and at different times are comparable.

2.0 EQUIPMENT

1. MRP In-channel evaluation worksheet
2. Camera/Photo log/Field Notebook/ Pens/ pencils
3. GPS unit, a high quality topographic map or aerial photograph of the site

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3.0 SAMPLING PROCEDURES

Extent of this BMP evaluation will be fit to project goals and outlined in project Sampling and Analysis Plans and Procedures (SAPP) documents. The basic field application will consist of utilizing GPS or other navigational techniques to locate appropriate structures. This data will be transferred to GIS format for documentation. For each sampling occurrence, one worksheet is intended to be completely filled out for each structure evaluated. Map sketches may be combined based on professional judgment. Hand drawn maps may be substituted for identification of each structure on GIS, high quality topographic map or aerial photograph of the site.

4.0 QA/QC

See "Standard Operating Procedures for the Planning of and Field Procedures for the Conducting of Monitoring Activity". Colorado Department of Public Health and Environment Water Quality Control Division, May 2005.

5.0 DOCUMENTATION

1. MRP In-channel evaluation worksheet
2. GIS layer/shapefile

    Pinpoints exact location of structures for future re-location

Measurable Results Program: In-Channel Structure Assessment

Stream: ____ Date: _________________
Site ID: ____
Assessed by: ____
Location Coordinates: ____
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Structure Type: (Circle): Vane Cross-Vane J-Hook Other________
Structure Material (Circle): Rock Root Wad Timber pole
Intent of structure (Circle): Streambank stabilization Thalweg Direction Grade Adjustment
Aquatic habitat Other_________

Assessment: (Circle descriptive elements that apply to structure)

Bank Stability (upstream)
1__ Severe (Banks sloughing, undercut or vertical, exposed soils, evidence of property damage)
2__ Moderate (Banks unstable, some bank sloughing, bank slopes 60 to 80 degrees)
3__ Minor (Some bank erosion, slopes < 60 degrees)
4__ Stable (Well vegetated, gently sloping or low banks)

Bank Stability (downstream)
1__ Severe (Banks sloughing, undercut or vertical, exposed soils, evidence of property damage)
2__ Moderate (Banks unstable, some bank sloughing, bank slopes 60 to 80 degrees)
3__ Minor (Some bank erosion, slopes < 60 degrees)
4__ Stable (Well vegetated, gently sloping or low banks)

Structure Stability
1__ Severe (Numerous failure points along structure)
2__ Moderate (Some movement of rocks noticeable, some evidence of undermining or out-flanking)
3__ Minor (Minor movement of stones, structure appears to be stable and functional, sediment may not be in ideal location in relation to structure)
4__ Stable (Structure appears with no evident migration, looks to be trapping and/or moving sediment as intended)

Channel Stability
1___ No defined thalweg
2___ Defined thalweg, but not in the location designed or desired
3__ Defined thalweg in the location designed or desired

Total Score: __________

Stability Ranking (circle): Failing (4-7) Unstable (8-11) Stable (12-15)

Cause of Impairment: (Circle all that apply):

Drag and lift or tipping Undercutting Side-cutting

Improper alignment Piping Flow directed at bank Arms not tied in

Footers failing Poor spacing of boulders Insufficient backfill/fabric

Flow area constriction Excessive aggradation

Map- Hand drawn figure of the structures assessed in relation to permanent features in the landscape (houses, roads, bridges) to aid in future location of the structures

COMMENTS____

Failure Definitions [i]

Drag and Lift or Tipping Forces on Boulders
When the drag force is great enough, boulders may actually be lifted into the bulk of the flow and carried downstream. Also, boulders may be tipped off their footers and roll down-stream, especially when the boulders have been undercut or are overhanging the footers. Movement of the boulders into the downstream pool can lead to filling in of the scour pool or down-stream sediment bars forming. It also weakens the durability of the vane. Excessive drag force on boulders, when the boulders become separated from the banks of the bed can cause the banks to erode and scour as well as a head cut to form as the cross vane is no longer holding grade.

Undercutting
Undercutting is used to describe the scour that occurs at the toe of the banks or under the boulders of the rock cross vane. Undercutting is not detrimental until is threatens the durability of the structure or until a large amount of flow cuts through an undercut region. This can also lead to bank erosion and scour. From the downstream side of boulders, undercutting can be initiated by high drops causing an expanding scour to work its way to the base of boulders and constricted flow scouring beneath structures as energy attempts to dissipate.

Side cutting
Side-cutting refers to the main flow of the stream flowing to either side of the sill stones and eroding or cutting out a new thalweg.

Improper alignment
Flow should approach the vane perpendicular to the vane. If the flow approaches at an angle, it has improper alignment. Improper alignment does not allow the vane to function as it was designed and can leave the banks vulnerable. Sometimes improper alignment is simply an installation error and often-times it occurs do to shifting of the thalweg caused by rapid lateral migration of the stream.

Piping
Piping is the occurrence of flow between the boulders of the cross vane. It becomes a problem when the piping becomes so large at the sill that a head cut forms or when the durability of the vane is threatened by exposing the side surfaces of the sill stones. Piping will not cause a washout, but it weakens the connections to the bed and other boulders and de-creases the amount of drag force needed to move the boulders of the sill or arms, which can eventually lead to a washout. A small amount of piping is expected to occur but large amounts can be prevented by careful boulder placement, where the faces of the boulders that touch do not have large gaps between them. Also, fabric matting and good backfill prevent piping.

Flow Directed at Bank
Flow that is directed at the banks usually occurs from incorrect placement of the rock cross vane or improper alignment. Flow should be entering the vane parallel and on center to the vane. When the banks are exposed, this can lead to severe bank erosion and scour.

Arms not tied into banks
The ends of the arms are to be keyed into the banks. This does not mean they should be tied in to the top of bank, but rather be buried into the banks act the ends. The keying of the arms adds extra protection in the case of bank sloughing or erosion as it can provide a barricade for backfill and bank material washing around the sides of the cross vane. This is a difficult

secondary cause to notice and may only be noticeable in the cases of severe bank erosion; in these cases, the key stones may have been installed but washed downstream.

Footers Failing

Sill boulders are placed on top of footers stones recessed into the stream bed. If footers are missing or poorly spaced, sills may be undercut.

Poor spacing of boulders

Boulders should be placed tightly together. The faces of boulders should have similar surface shapes there are no gaps between to prevent piping

Insufficient backfill and or Fabric Material

Boulders should be supported by diversely sized materials from cobbles to fines just up-stream to prevent water from piping. The smaller materials fill in the gaps and the larger ones prevent scour. Backfill also adds stability by providing a smooth transition from the bed upstream to the top of the boulders. If backfill material is too small , it will easily wash out. If it is large homogeneous material, piping may still occur. Fabric matting is also essential to the prevention of piping and scour around the boulders. It can be very difficult to identify whether or not fabric matting has been used unless significant scouring reveals it is non-existent.

Flow area constriction

Flow expansion coming out of the vane occurs when there is constriction of flow through the cross vane. Constriction occurs when the rock cross vane is undersized, when the sill is elevated above bed elevation, or when the pool is crowded by boulders, meaning the cross sectional area is small compared to the representative cross sectional area of the stream. Flow expansion is harmful to the banks just downstream of the cross vane especially when the banks are not armored or protected with vegetation. In the case where the flow backs up over the vane and enters the floodplain, re-entry into the stream over the downstream banks may also cause bank erosion. Clues to this are heavy bank erosion at the downstream ends of the arms from re-entry of flow or a large scour pool just downstream of the arms of the cross vane.

Excessive aggradation

Characterized by development of large gravel bars upstream of the structure. May indicate an alignment, sizing, or elevation issue that was unintended. The aggradation may cause an avulsion and ultimate failure of the structure.

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[i] **from: Rock Cross Vane Rapid Assessment Tool. Puckett et. al.,** www4.ncsu.edu/~hprollin/rcvrat.pdf