CITY OF ALBUQUERQUE

May 21, 2014

Ron Bohannan, P.E.
Easterling Consultants
3613 NM 528, Suite E-2
Albuquerque, NM 87114

Re: MarketplaceI40 South and Unser Mini DMP
Engineer's Stamp Date 4-21-14 (K09D026)

Dear Mr. Easterling,

Based upon the information provided in your submittal received 4-21-14, the above referenced report cannot be approved for Drainage Masterplan until the following comments are addressed:

1. Use poipe for capciaty for entire basin.

If you have any questions, you can contact me at 924-3986.

Sincerely,

Curtis Cherne, P.E.
Principal Engineer, Hydrology
Planning Dept.

C: e-mail, Jon Niski

PO Box 1293

Albuquerque

New Mexico 87103

www.cabq.gov

Alanlun - Arroyo

1. Soil type in scour depth analysis

2 Verify w/ as-builts from
public construction plans for
pipe inverts into channel.

Del Webb®

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delwebb.com/nm

Changing location of drop structure has affected the grading on both sides of the arroyo.

Grader done the

5:15 AM 3-6-15

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Best hope to

salvage recent grading

is to put grade

control structure back

where they were then still

not convinced

Del Webb®

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parks ph1

PWRG — verify

channel grade

make sure roads

proper elevation

shown built items

on WO

CITY OF ALBUQUERQUE

April 28, 2014

Alandren Etlantus, P.E.
Bohannan Huston Inc.
7500 Jefferson NE
Albuquerque, NM 87107

Re: Mirehaven Improvements Grading Plan
Engineer's Stamp Date 4-15-14 (H09D017D)

Dear Ms. Etlantus,

Based upon the information provided in your submittal received 4-15-14, the above referenced plan meets the requirements for Grading Permit. The site is approved for Grading Permit when the Erosion and Sediment Control Plan is approved.

As you are aware, detailed grading of this facility is included in the Work Order. A certification of this plan is not required, as the certification of the grading will be part of the Work Order certification.

If you have any questions, you can contact me at 924-3986.

Sincerely,

Curtis Cherne, P.E.
Principal Engineer, Hydrology
Planning Dept.

C: e-mail

PO Box 1293

Albuquerque

NM 87103

www.cabq.gov

1 cfs

20 10,000 cf / 1 cfs · sec → 10,000 sec · hr / 3600 sec = 2.3 hr

Bohannan Huston

Engineering
Spatial Data
Advanced Technologies

Courtyard I
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Albuquerque, NM
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COA
Mirehvaen Arroyo Improvements
COA Conference Room
February 18, 2015
10:30 a.m. – 12:00 p.m.

Attendees: Curtis Cherne, COA
Rita Harmon, COA
Craig Hoover, BHI
Alandren Etlantus, BHI
Kevin Patton, Pulte

Meeting Objective: Discuss Mirehaven Arroyo Improvements Report and Plans

General Discussion

There was a general discussion on drop structures and the details of the final design. The final design reflects the drop heights and locations based on the easement boundary, the grade needed in the arroyo and the adjacent subdivision grades outside the arroyo. A profile with the proposed grades, the previous design grades, and the existing grades was reviewed.

The hydraulics of the channel and the existing culvert crossing at Tierra Pintada were reviewed. The final design does not adversely impact the hydraulics at Tierra Pintada, the headwater upstream and the velocities through culvert are about the same.

The following COA comments on the report and plans were discussed:

- As-built elevations for the storm drains that have already been constructed should be used.
- There has been evidence of scour near the storm drain outlets. The storm drains that come into the arroyos will be reviewed.
- BHI will review the manning's roughness value for shotcrete and revise if appropriate.
- There is a concern of the aesthetic fill washing away if landscaping is not installed right away. Curtis would like to see if the 2-yr storm is contained within the inverse crown section of the arroyo, particularly in the areas of aesthetic fill. Pulte will be completing the landscape plan while the channel is in construction. The landscaping, which will help stabilize the areas of aesthetic fill, will likely go in in the fall after the channel construction is complete and before May 2016.
- There are areas where the HGL comes close to the top of the channel shotcrete lining – this is okay. It has been agreed that the freeboard could be provided in the overbank, as shown in the sections.
- BHI will review the waterline casing near to Tierra Pintada and make sure it extends beyond the shotcrete.
- BHI will review the cross section of the channel and maintenance ramp at the downstream end near Tierra Pintada.

BHI will update and resubmit Addendum #2 to the DMP next week and send a set of plans along with it. The HEC-RAS profile at Tierra Pintada will be included along with full size copies of the exhibits.

It was discussed that it is important to get this channel constructed. The next DRC submittal will be for a signature session. Approval of Addendum #2 to the DMP is needed prior to that submittal.

Bohannan Huston

Engineering

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111.3 HYDRAULIC DESIGN

111.3.1 Uniform Flow

Open channels having a design flow rate less than five hundred (500) cfs may be designed assuming uniform flow conditions in conjunction with computed headwater depths at culverts and other hydraulic structures or reservoir stages at detention and sediment basins. Water surface profiles using techniques for gradually varied flow may be required for design flow rates less than five hundred (500) cfs where accurate determination flooding depths is necessary to ensure flood safety.

Under steady state, uniform flow conditions channel capacity shall be computed using Manning's Equation:

$$Q = \frac{1.49}{n} A\ R^{2/3} S^{1/2}$$, where

Q = rate of flow, cubic feet per second
n = Manning's roughness coefficient (See Table 111.1 below)
A = cross sectional area of flow, square feet
P = wetted perimeter, feet
R = hydraulic radius = A/P, feet
$S = S_f$ = friction slope

TABLE 111.1
MANNING'S ROUGHNESS COEFFICIENT FOR VARIOUS CHANNEL LININGS

Type of Surface	Manning's n Value
Concrete, float finish	0.013-0.015
Gunite, shotcrete	0.016-0.019
Concrete bottom, with pre-cast masonry unit sides	0.020-0.030
Gravel bottom with pre-cast masonry unit sides	0.023-0.033
Riprap, Note 3	0.050-0.060
Grouted riprap, Note 3	0.023-0.030
Grass Channels, VR>10	0.030-0.035
VR<10	0.030-0.200 (See Section 111.4.2)
Stream Channels: gravel, cobbles, few boulders	0.040-0.050
Floodplains	

111.2.6 Grades

Unless otherwise approved due to unavoidable physical constraints, the minimum centerline grade for various channels shall be as follows:

Concrete channels	0.25%
Composite channels with concrete inverts	0.5%
Grass channels	1.0%
Grass channels with concrete trickle channels	0.5%
Riprap and gabion channels	1.0%
All other channel types	Will be considered on a case by case basis

111.2.7 Allowable Velocities

The maximum average channel velocity shall be as follows for the design flow rate:

Channel Lining Type	Maximum Average Velocity, V
Grass	5 feet/second
Concrete	15 feet/second
Riprap, gabion	10 feet/second

Where reduction in velocity due to a reduction in slope would allow a transition from a concrete to a grass-lined channel, a grouted riprap lining shall be provided from the point where the theoretical average channel velocity would be five feet (5') per second or less, for a distance downstream equal to five (5) times the theoretical top width of the grass channel. The height of the riprap lining shall be equal to the height of the concrete lining upstream.

111.2.8 Utility Clearances

A minimum clear distance of twelve inches (12") vertically from any other utility line shall be maintained below the channel lining, unless otherwise approved. Utilities will not be permitted to cross through the channel flow area.

NOTES TO TABLE 111.1

1. Values in this Table were obtained from Appendix A of Federal Highway Administration, HDS-5, Design of Roadside Drainage Channels (Reference 111.5). Values for channels with precast masonry unit sides use the values given in the reference for dry rubble lining.

2. Use the high value in the range for determining channel capacity. Use the low value for determining maximum velocity.

3. City of Tulsa Design Criteria (Reference 111.3).

4. For pictorial examples of different channel roughnesses, see Chow, Open Channel Hydraulics (Reference 111.2).

Definitions

Critical depth, dc - the depth of flow at which the specific energy is a minimum for a given flow rate and channel cross shape, and a unique relationship exists between depth and specific energy.

Normal depth, dn - the depth at which uniform flow occurs when the discharge rate is constant. Friction and gravity forces are in balance.

Subcritical flow - lower energy, lower velocity flow, which occurs when the normal depth is greater than the critical depth. Subcritical flow is controlled by downstream conditions.

Supercritical flow - high energy, high velocity flow, which occurs when the normal depth is less than the critical depth. Supercritical flow is controlled by upstream conditions.

Froude number, $F_r = \frac{V}{\sqrt{gD}}$, where

D = hydraulic depth (feet) = A/T
A = cross sectional area of design flow (square feet)

structure at a slope equal to the maximum equilibrium slope of sediment upstream until it intersects the original streambed.

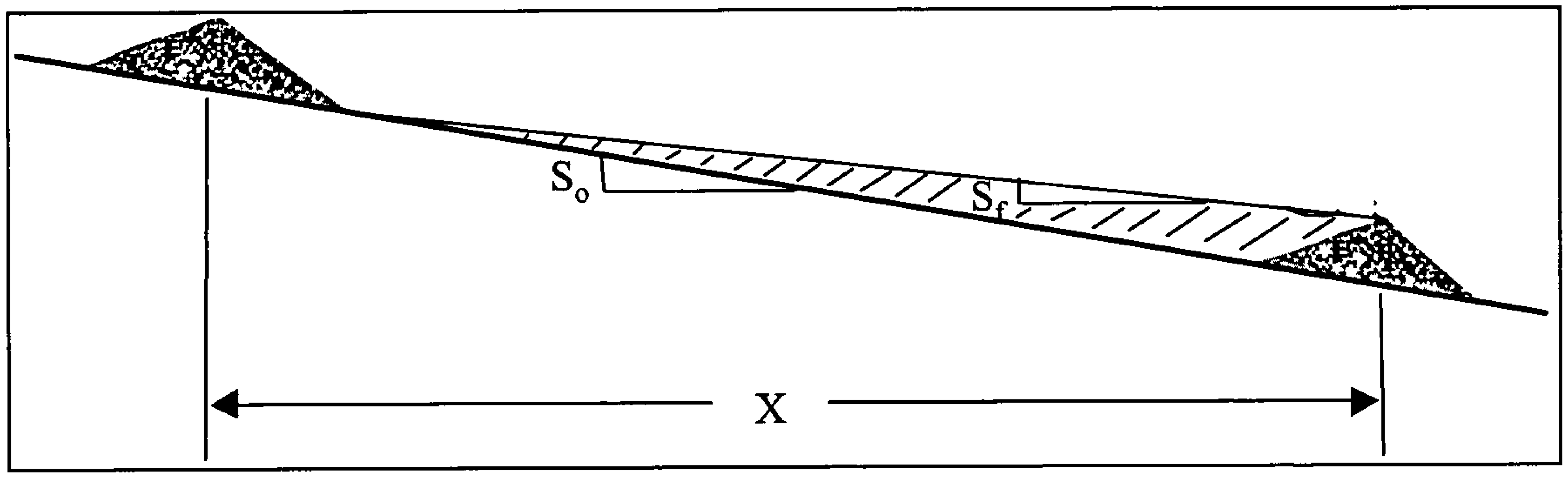


Figure 1. Spacing of grade control structure (adapted from Mussetter 1982)

Theoretically, the hydraulic siting of grade control structures is straightforward and can be determined by:

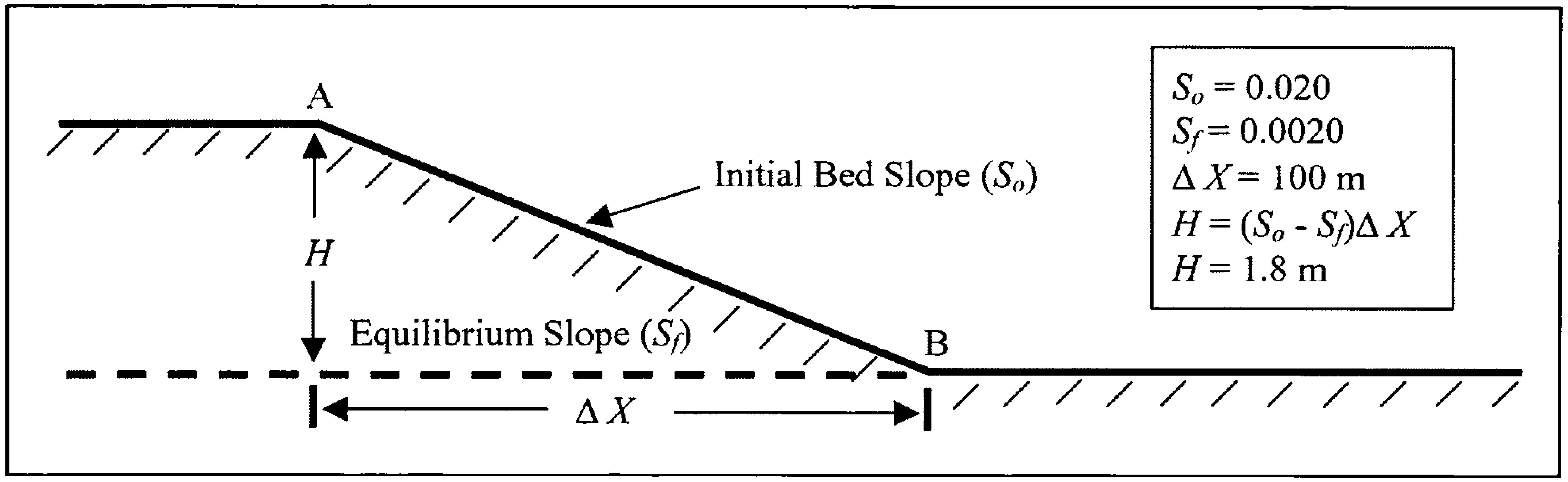
$$H = (S_o - S_f)X \quad (1)$$

where H is the amount of drop to be removed from the reach, S_o is the original bed slope, S_f is the final, or equilibrium slope, and X is the length of the reach (Goitom and Zeller 1989). The number of structures (N) required for a given reach can then be determined by:

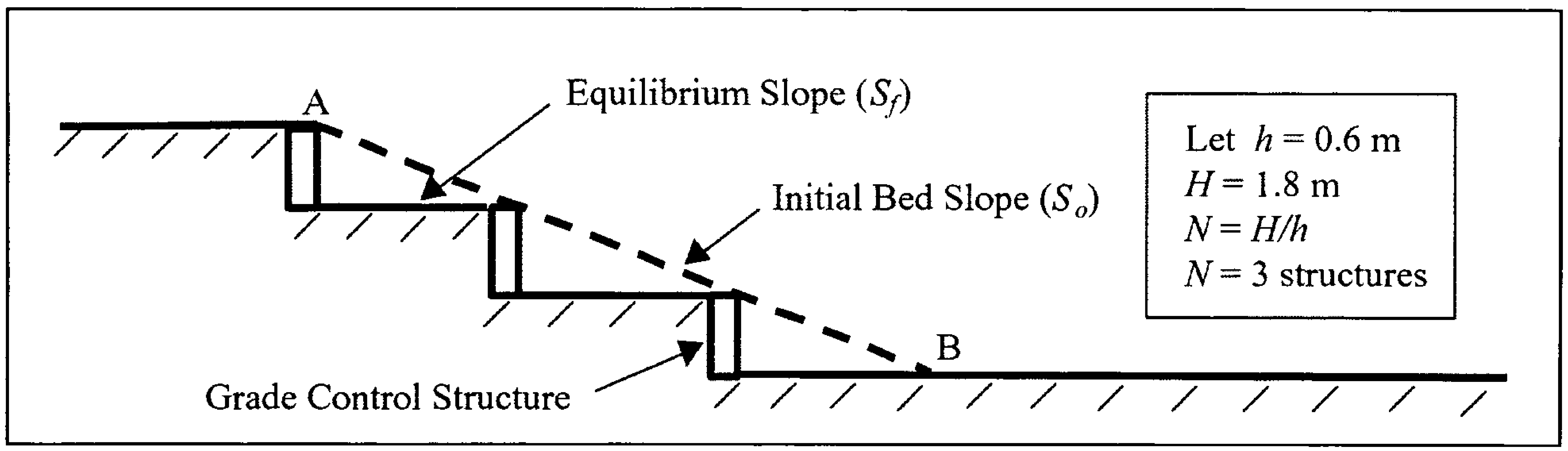
$$N = H/h \quad (2)$$

where h is the selected drop height of the structure.

The hydraulic siting of a series of bed control structures using the preceding procedure is illustrated in Figure 2. In contrast to bed control structures which are built at grade and the bed allowed to degrade between them (Figure 2b), hydraulic control structures are constructed with a raised and possibly constricted weir crest that drowns out the degradational zone (Figure 3b). It follows from Equation 1 that one of the most important factors to consider when siting grade control structures is the determination of the equilibrium slope (S_f). Unfortunately, this is also one of the most difficult parameters to define with any reliability. Failure to properly define the equilibrium slope can lead to costly, overly conservative designs, or inadequate design, resulting



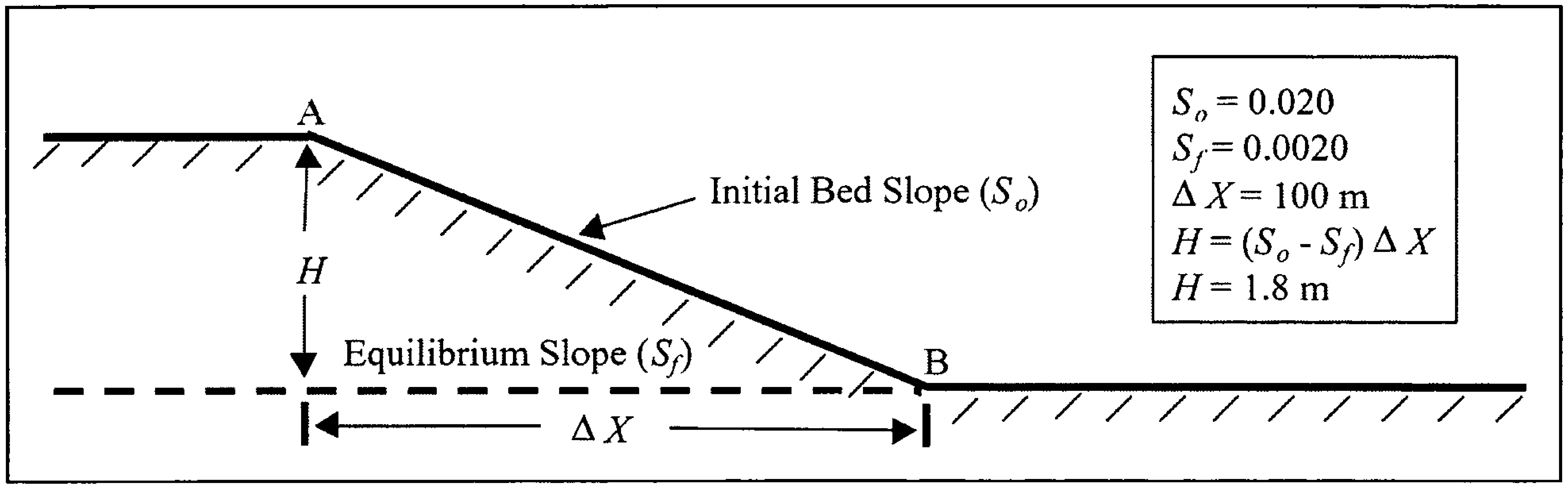
a. Initial condition of streambed showing degradational zone between points A and B. Total anticipated drop in reach is calculated to be 1.8 m



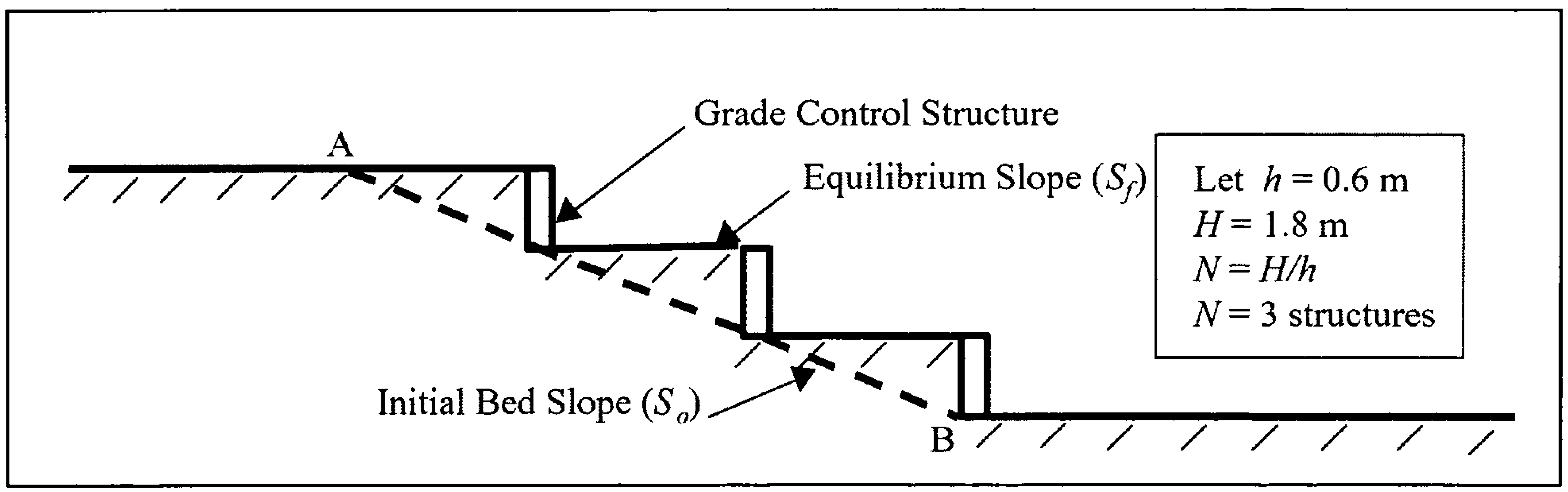
b. Stabilization of degradational zone using three bed control structures. Each structure has a design drop of 0.6 m

Figure 2. Hydraulic siting of bed control structures

There are many different methods for determining the equilibrium slope in a channel (Mussetter 1982; Federal Interagency Stream Restoration Working Group 1988; Watson, Biedenharn, and Scott 1999). These can range from detailed sediment transport modeling (Thomas et al. 1994; HQUSACE 1993) to less elaborate procedures involving empirical or process-based relationships such as regime analysis (Lacey 1931; Simons and Albertson 1963), tractive stress (Lane 1953a,b; Simons 1957; Simons and Sentürk 1992; HQUSACE 1994), or minimum permissible velocity (USDA 1977). In some cases, the equilibrium slope may be based solely on field experience with similar channels in the area. Regardless of the procedure used, the



a. Initial condition of streambed showing degradational zone between points A and B. Total anticipated drop in reach is calculated to be 1.8 m



b. Stabilization of degradational zone using three hydraulic control structures. Each structure has a design drop of 0.6 m

Figure 3. Hydraulic siting of hydraulic control structures

GEOTECHNICAL CONSIDERATIONS: The preceding discussion focused only on the hydraulic aspects of siting grade control structures. However, in some cases, the geotechnical stability of the reach may be an important or even the primary factor to consider when siting grade control structures. This is often the case where channel degradation has caused, or is anticipated to cause, severe bank instability due to exceedance of the critical bank height (Thorne and Osman 1988). When this occurs, bank instability may be widespread throughout the system rather than restricted to the concave banks in bendways. Traditional bank stabilization measures creating a backwater situation, velocities and scouring potential are reduced, which reduces or eliminates the severity and extent of basal cleanout of the failed bank material, thereby promoting self-healing of the banks.

FLOOD CONTROL IMPACTS: Channel improvements for flood control and channel stability often appear to be mutually exclusive objectives. For this reason, it is important to ensure that any increased postproject flood potential is identified. This is particularly important when hydraulic control structures are considered. In these instances, the potential for causing overbank flooding may be the limiting factor with respect to the height and amount of constriction at the structure. Grade control structures are often designed to be hydraulically submerged at flows less than bank-full so that the frequency of overbank flooding is not affected. However, if the structure exerts control through a wider range of flows including overbank, then the frequency and duration of overbank flows may be impacted. When this occurs, the impacts must be quantified and appropriate provisions such as acquiring flowage easements or modifying structure plans should be implemented.

Another factor that must be considered is the safe return of overbank flows back into the channel. This is particularly a problem when the flows are out of bank upstream of the structure but still within bank downstream. The resulting head differential can cause damage to the structure as well as severe erosion of the channel banks depending upon where the flow re-enters the channel. Some means of controlling the overbank return flows must be incorporated into the structure design. One method is simply to design the structure to be submerged below the top bank elevation, thereby reducing the potential for a head differential to develop across the structure during overbank flows. If the structure exerts hydraulic control throughout a wider range of flows including overbank, then a more direct means of controlling the overbank return flows must be provided. One method is to ensure that all flows pass only through the structure. This may be accomplished by building an earthen dike or berm extending from the structure to the valley walls which prevents any overbank flows from passing around the structure (Forsythe 1985). Another means of controlling overbank flows is to provide an auxiliary high-flow structure which will pass the overbank flows to a specified downstream location where the flows can re-enter the channel without causing significant damage (Hite and Pickering 1982).

ENVIRONMENTAL CONSIDERATIONS: In today's environment, projects must work in harmony with the natural system to meet the needs of the present without compromising the ability of future generations to meet their needs. Engineers and geomorphologists are responding to this challenge by trying to develop new and innovative methods for incorporating environmental features into channel projects. The final siting and design of a grade control structure is often modified to minimize adverse environmental impacts to the system.

Therefore, the impacts of grade control structures are not restricted to a local area around the structure, but can have far-reaching impacts on the whole channel system.

Grade control structures can provide direct environmental benefits to a stream. Cooper and Knight (1987) conducted a study of fisheries resources below natural scour holes and man-made pools below grade control structures in north Mississippi. They concluded that, although there was greater species diversity in the natural pools, there was increased growth of game fish and a larger percentage of harvestable-size fish in the man-made pools. They also observed that the man-made pools provided greater stability of reproductive habitat. Shields et al. (1990) reported that the physical aquatic habitat diversity was higher in stabilized reaches of Twentymile Creek, MS, than in reaches without grade control structures. They attributed the higher diversity values to the scour holes and low-flow channels created by the grade control structures. The use of grade control structures as environmental features is not limited to the low-gradient sand bed streams of the southeastern United States. Jackson (1974) documented the use of gabion grade control structures to stabilize a high-gradient trout stream in New York. She observed that, following construction of a series of bed sills, there was a significant increase in the density of trout. The increase in trout density was attributed to the accumulation of gravel between the sills which improved the spawning habitat for various species of trout.

Adverse environmental impacts can also be associated with grade control structures. During the construction of any structure there is always the potential for the destruction of riparian habitat. However, with grade control structures, these impacts are usually limited to a localized area at the structure as opposed to other types of channel improvement features (levees, bank stabilization, or channelization) where habitat destruction may occur continuously over long reaches of stream.

Perhaps the most serious negative environmental impact of grade control structures is the obstruction to fish passage. In many instances, fish passage is one of the primary considerations and may lead the engineer to select several small fish passable structures in lieu of one or more high drops that would restrict fish passage. In some cases, particularly when drop heights are small, fish are able to migrate upstream past a structure during high flows (Cooper and Knight 1987). However, in situations where structures are impassable, and where the migration of fish is an important concern, openings, fish ladders, or other passageways must be incorporated into the design of the structure to address the fish movement problems (Nunnally and Shields 1985). The various methods of accomplishing fish movement through structures are not discussed here. Interested readers are referred to Nunnally and Shields (1985); Clay (1961); and Smith (1985) for a more detailed discussion.

area should be conducted early in the design process. This will allow these factors to be incorporated into the initial plan rather than having to make costly and often less environmentally effective last minute modifications to the final design. Unfortunately, there is very little published guidance concerning the incorporation of environmental features into the design of grade control structures. One source of useful information can be found in the following technical reports published by the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory: Shields and Palermo (1982); Henderson and Shields (1984); and Nunnally and Shields (1985).

EXISTING STRUCTURES: Bed degradation can cause significant damage to bridges, culverts, pipelines, utility lines, and other structures along the channel perimeter. Grade control structures can prevent this degradation and thereby provide protection to these structures. For this reason, it is important to locate all potentially impacted structures when siting grade control structures. The final siting should be modified, as needed, within project restraints, to ensure protection of existing structures.

It must also be recognized that grade control structures can have adverse as well as beneficial effects on existing structures. This is a concern upstream of hydraulic control structures due to the potential for increased stages and sediment deposition. In these instances, the possibility of submerging upstream structures such as water intakes or drainage structures may become a deciding factor in the siting of grade control structures.

Whenever possible, the designer should take advantage of any existing structures which may already be providing some measure of grade control. This usually involves culverts or other structures that provide a nonerodible surface across the streambed. Unfortunately, these structures are usually not initially designed to accommodate any significant bed lowering and, therefore, cannot be relied on to provide long-term grade control. However, it may be possible to modify these structures to protect against the anticipated degradation. These modifications may be accomplished by simply adding some additional riprap with launching capability at the downstream end of the structure. In other situations, more elaborate modifications such as providing a sheet pile cutoff wall or energy dissipation devices may be required. Damage to and failure of bridges is the natural consequence of channel degradation. Consequently, it is not uncommon in a channel stabilization project to have several bridges that are in need of repair or replacement. In these situations it is often advantageous to integrate the grade control structure into the planned improvements at the bridge. If the bridge is not in immediate danger of failing and only needs some additional erosion protection, the grade control structure can be built at or immediately downstream of the bridge with the riprap from the structure tied into the bridge for protection. If the bridge is to be replaced, then it may be possible to construct the grade control channel to provide an adequate approach. Stabilization of the realigned channel may be required to ensure that the approach is maintained. Even if the structure is built in a straight reach, the possibility of upstream meanders migrating into the structure must be considered. In this case, the upstream meanders should be stabilized prior to, or concurrent with, the construction of the grade control structure.

Local inflows from tributaries, field drains, roadside ditches, or other sources often play an important part in the siting of grade control structures. Failure to provide protection from local drainage can result in severe damage to a structure (U.S. Army Corps of Engineers 1981). During the initial siting of the structure, all local drainage should be identified. Ideally, the structure should be located to avoid local drainage problems. However, there may be some situations where this is not possible. In these instances, the local drainage should either be redirected away from the structure or incorporated into the structure design in such a manner that there will be no damage to the structure.

DOWNSTREAM CHANNEL RESPONSE: Since grade control structures affect the sediment delivery to downstream reaches, it is necessary to consider the potential impacts to the downstream channel when grade control structures are planned. Bed control structures reduce the downstream sediment loading by preventing the erosion of the bed and banks, while hydraulic control structures have the added effect of trapping sediments. The ultimate response of the channel to the reduction in sediment supply will vary from site to site. In some instances, the effects of grade control structures on sediment loading may be so small that downstream degradational problems may not be encountered. However, in some situations such as when a series of hydraulic control structures is planned, the cumulative effects of sediment trapping may become significant. In these instances, it may be necessary to modify the plan to reduce the amount of sediment being trapped or to consider placing additional grade control structures in the downstream reach to protect against the induced degradation.

GEOLOGIC CONTROLS: Geologic controls often provide grade control in a similar manner to a bed control structure. In some cases, a grade control structure can actually be eliminated from the plan if an existing geologic control can be utilized to provide a similar level of bed stability. However, caution must always be used when relying on geologic outcrops to provide long- term grade control. In situations where geologic controls are to be used as permanent grade control structures, a detailed geotechnical investigation of the outcrop is needed to determine its vertical and lateral extent. This is necessary to ensure that the outcrop will neither be eroded, undermined, or flanked during the project life.

EFFECTS ON TRIBUTARIES: The effect of main stem structures on tributaries should be

SUMMARY: The preceding discussion illustrates that the siting of grade control structures is not simply a hydraulic exercise, and there are many other factors that must be included in the design process. For any specific situation, some or all of the factors discussed in this section may be critical elements in the final siting of grade control structures. It is recognized that this does not represent an all inclusive list since there may be other factors not discussed here that may be locally important. For example, in some cases, maintenance requirements, debris passage, ice conditions, esthetics or safety considerations may be controlling factors. Consequently, there is no definitive cookbook procedure for siting grade control structures that can be applied universally. Rather, each situation must be assessed on an individual basis.

ADDITIONAL INFORMATION: Questions about this CHETN can be addressed to David S. Biedenharn (601-634-4653), e-mail: David.S.Biedenharn@erdc.usace.army.mil or Lisa C. Hubbard (601-634-4150), e-mail: Lisa.C.Hubbard@erdc.usace.army.mil. This CHETN should be referenced as follows:

> Biedenharn, D. S., and Hubbard, L. C. (2001). "Design considerations for siting grade control structures," Coastal and Hydraulics Engineering Technical Note CHETN-VII-3 U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://chl.wes.army.mil/library/publications/chetn/

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Clean when 3" or greater
of sediment in [illegible] flow

[illegible]