Water Supply Intake Structures

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Overview

• Good intake design requires knowledge of sediment transport and geomorphic patterns.
• This presentation illustrates some basic river patterns associated with instream structures.
• Several examples of intake design based on these principles are presented.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Important for Water Supply</th>
<th>Important for Aquatic Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Structural Stability</td>
<td>Structure should be structurally sound and not damaged by floods.</td>
<td>Structure should not promote bank erosion or other forms of channel instability.</td>
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<tr>
<td>#2 Sustain Sediment Transport</td>
<td>The structure should sustain a pool of adequate depth in front of the intake, not accumulate sediment and debris.</td>
<td>The structure should sustain the transport of coarse materials along the stream, and environmentally-damaging maintenance activities should be avoided.</td>
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<td>#3 Migration Path</td>
<td>Not important</td>
<td>Provide a migration path so that both larval and adult stages are able to migrate, both in the upstream and the downstream direction.</td>
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<tr>
<td>#4 Minimum Flow</td>
<td>Structure should sustain withdrawals under all conditions</td>
<td>Guarantee continuous release of water downstream to sustain minimum instream flows.</td>
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</tbody>
</table>
Typical Water Supply Intakes

- Consist of low dam which accumulates sediment on upstream side.
- Prone to clogging by coarse sediment following floods.
- Can act as migration barriers.
Río Guajataca pumped intake, Quebradillas
Río Cañas gravity intake, Miradero FP, Mayagüez.
Sediment deposition in the vicinity of intake

Downstream scour protection

Madre Vieja intake, Puerta Plata, D.R.
Intake design can be improved by utilizing basic geomorphic patterns in streams

- Meanders
- This presentation illustrates some basic river patterns associated with instream structures.
- Several examples of intake design based on these principles are presented.
Basic geomorphic patterns in streams

- Thalweg
- Scour & meander migration
- Point bar: deposition
- Crossing
- Pools created by scour
Crossing:
Shallow water, flow parallel to banks

Banks generally stable on both sides, vegetated.

Flow depth relatively shallow, no deep pools

Section A-A CROSSING
Basic geomorphic patterns in streams

- Scour & meander migration
- Pools created by scour
- Point bar: deposition
- Crossing
- Thalweg
Pools: scour hole created by deflection of flow by the bank at a meander bend

Direction of Meander Migration

Point bar: zone of sediment deposition and vegetative colonization

Helicoidal flow

Section B-B MEANDER BEND
Main Current

Pool created by flow deflection

Point bar: deposition
• The natural riffle-pool sequence creates alternating areas of lesser and greater depth.
• It is logical to place intakes in areas that are naturally deep, or where depth can be created by scour.
Strategy #1: Locate intake in natural pool

- Use existing stable scour pool in the river.
- Typically results in intake being located at the exterior of a meander bend.
- Should have rock or engineered structure to insure stability of bankside structures.
Río Mameyes intake: An example of optimum intake design

Extraction limited to 5 mgd
Río Mameyes Intake
Miradero intake, Río Añasco

Río Grande de Añasco

Río Cañas

Miradero Intake

Scour in front of intake

Flow
Río Fajardo intake (offstream dam)

Scour in front of intake

Sediment deposition in channel

River weir to control bed level and guarantee minimum flow

Scour in front of rock
Río Fajardo intake (offstream dam)
Río Fajardo intake: designed to maintain instream flow.
Río Fajardo intake: designed to maintain instream flow.

Diversion weir to water supply facility set at minimum instream flow level.

Pipe

Scour hole and intake

Flow to water supply reservoir only after instream flow is exceeded.

River weir releasing minimum instream flow
Strategy #2: Use flow plunging over an obstruction which causes scour.

Backwater zone: greater depth and lower velocity causes sediment to deposit upstream of obstruction.

Scour zone: plunging flow creates localized erosion, while structure impedes downstream transport of sediment.

Sediment deposit upstream of obstruction.

Scour hole which may threaten structural integrity of low dam or roadway.
Río Blanco Intake
Create of a scour hole by overflow

- Intake area
- Scour
- Flow
- Large stone for grade control
- Level control weir
- Weir to create scour hole
- Weir for instream flow release
- To offstream weir
- Flow
- Large stone for grade control
Strategy #3: Create of a scour hole by flow obstruction
Horseshoe-shaped scour hole

Flow

Obstruction
Flow deflection will create scour. Example of scour pattern at a bridge pier.
Deflection of wind by a rock creates a similar scour pattern in a windy desert environment (southern Bolivia)
Water supply intake concept

Min. flow water level
Location of intake in center of the river has environmental advantages, but operational disadvantages.
Strategy #4:
Flush sediment by operating a gate

- Bottom opening gate to release sediment during high flow. May be either a radial gate (as shown), or a vertical lift type gate.
Concluding Remarks

• Traditional intake designs are not optimal from either engineering or environmental standpoint.
• Intake design can be greatly improved by understanding river geomorphology,
• Unfortunately, most engineers have very little, if any, understanding of river geomorphic processes.
• There are no standards or guidelines to assist engineers in designing intakes which are best for conditions in Puerto Rico.
Thank You

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To P.S.

Cleanout hatch
Labyrinth weir elev.

Migration ladder overflow to sustain min Q

Elevate above sluice bottom to prevent clogging