US 93 BIGHORN SHEEP BRIDGES

Presented by:
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Acknowledgement to:
Arizona Game and Fish Department
ADOT Bridge Group Design Sections A and C

Background - U.S. Highway 93

- Major international trade-route
- Traffic in the Hoover Dam area – unacceptable levels
- Accidents in the Hoover Dam area – unacceptable levels
- Security issues of traffic on Hoover Dam
- Bighorn-vehicle collisions

Background - U.S. Highway 93

- Hoover Dam Bypass Project (FWHA)
  Arizona and Nevada approaches
  New Hoover Dam Bypass Bridge

  Mileposts 0–3 in AZ
  Completed 2010

- U.S. Highway 93 Upgrade (ADOT)

  4-lane divided highway from Mileposts 3-17 in AZ

  Needed Completion Prior to Hoover Dam Bridge Opening

US 93 Hoover Dam to MP 17

- Stakeholders
- FHWA, ADOT, AZGFD, NPS, LMNR and BLM
- Technical Advisory Committee (TAC)
- Environmental Assessment
  - Identified a need for Wildlife Crossings
    - AZ Game and Fish Study

Background - Black Mountains Bighorn Herd

- Largest desert bighorn sheep herd in Arizona
- Important source for transplants throughout the SW US
- Population decline of 54% between 2001 and 2004

Background - Black Mountains Bighorn Herd Concerns

- Bighorn – vehicle collisions
- Isolation of bighorn on Wilson Ridge from the rest of the Black Mountains (fragmentation)
- Reduced movements and highway permeability
  - loss of travel corridors
  -reduced access to seasonal use areas
  -reduced genetic exchange and variability

Objectives

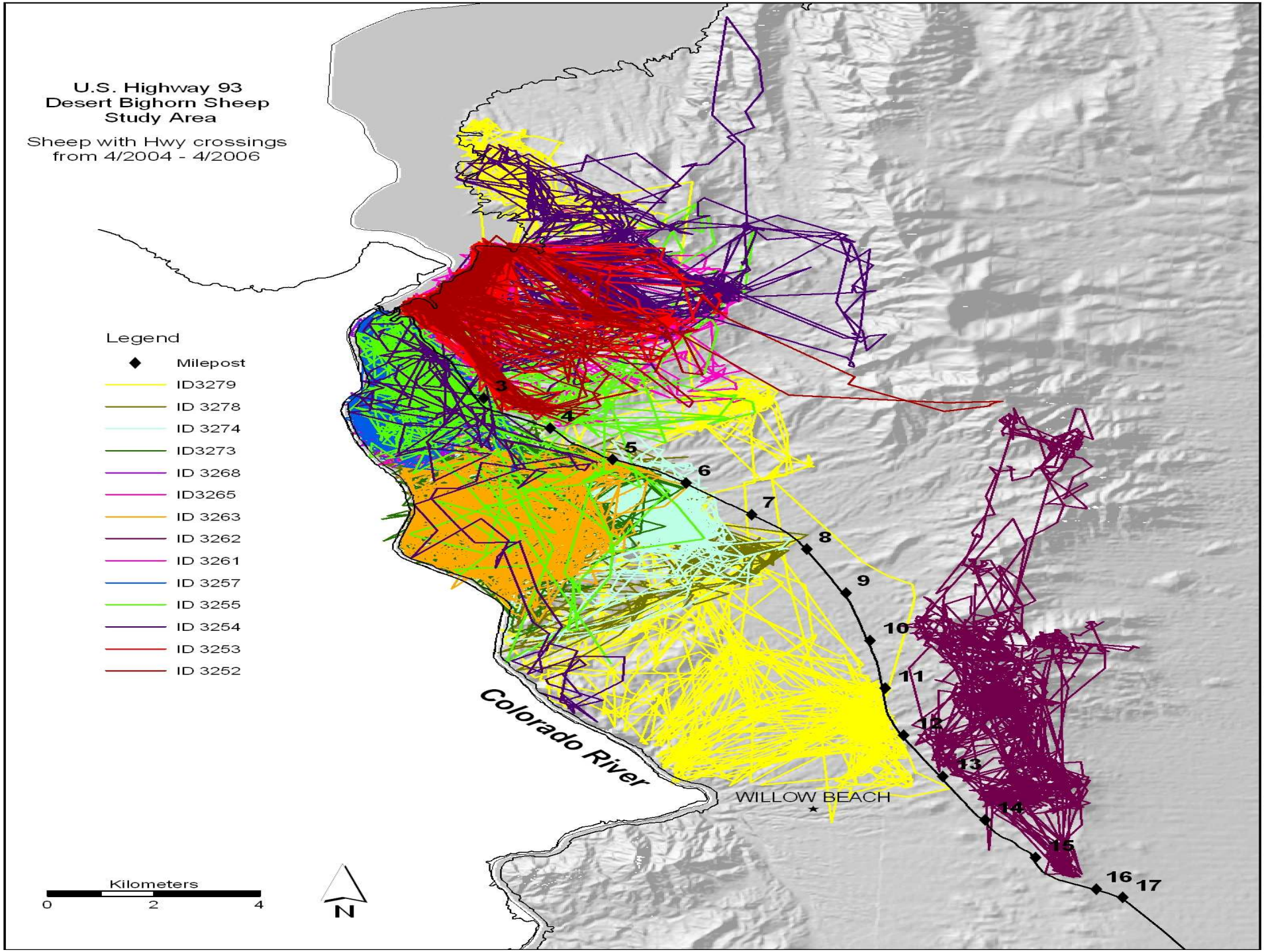
- U.S. Highway 93 Upgrade (MP 3-17)
  - Identify areas of concentrated bighorn crossings
  - Recommend placement of bighorn crossing mitigation features
  - Evaluate bighorn-vehicle related collisions and mortality

Methods

- Merge GIS and GPS technology
  - Captured 36 bighorn; fitted with spread-spectrum and store-on-board collars
  - Monthly download flights
- Ground Observations
  (morning and evening surveys)
- Track Beds
  (*N*=50)
- Vegetation Transects (N=165)

Results - Collar Data

- 34 collars provided 73,496 GPS locations
- 345 highway crossings by 9 ♀and 5 ♂ (41% of collared)
  232 from MP 0-3 and 113 from MP 3-17
  50 crossings by 8 bighorn using SLM underpass
- Numbers of crossings and bighorn that crossed declined southward from MP 0 to 17
- Home ranges were comparable to other studies yet showed the hwy was often the boundary of a range


U.S. Highway 93
Desert Bighorn Sheep
Study Area
Sheep with Hwy crossings
from 4/2004 - 4/2006
Legend
Milepost
ID3279
ID 3278
ID 3274
ID3273
ID 3268
ID3265
ID 3263
ID 3262
ID 3261
ID 3257
ID 3255
ID 3254
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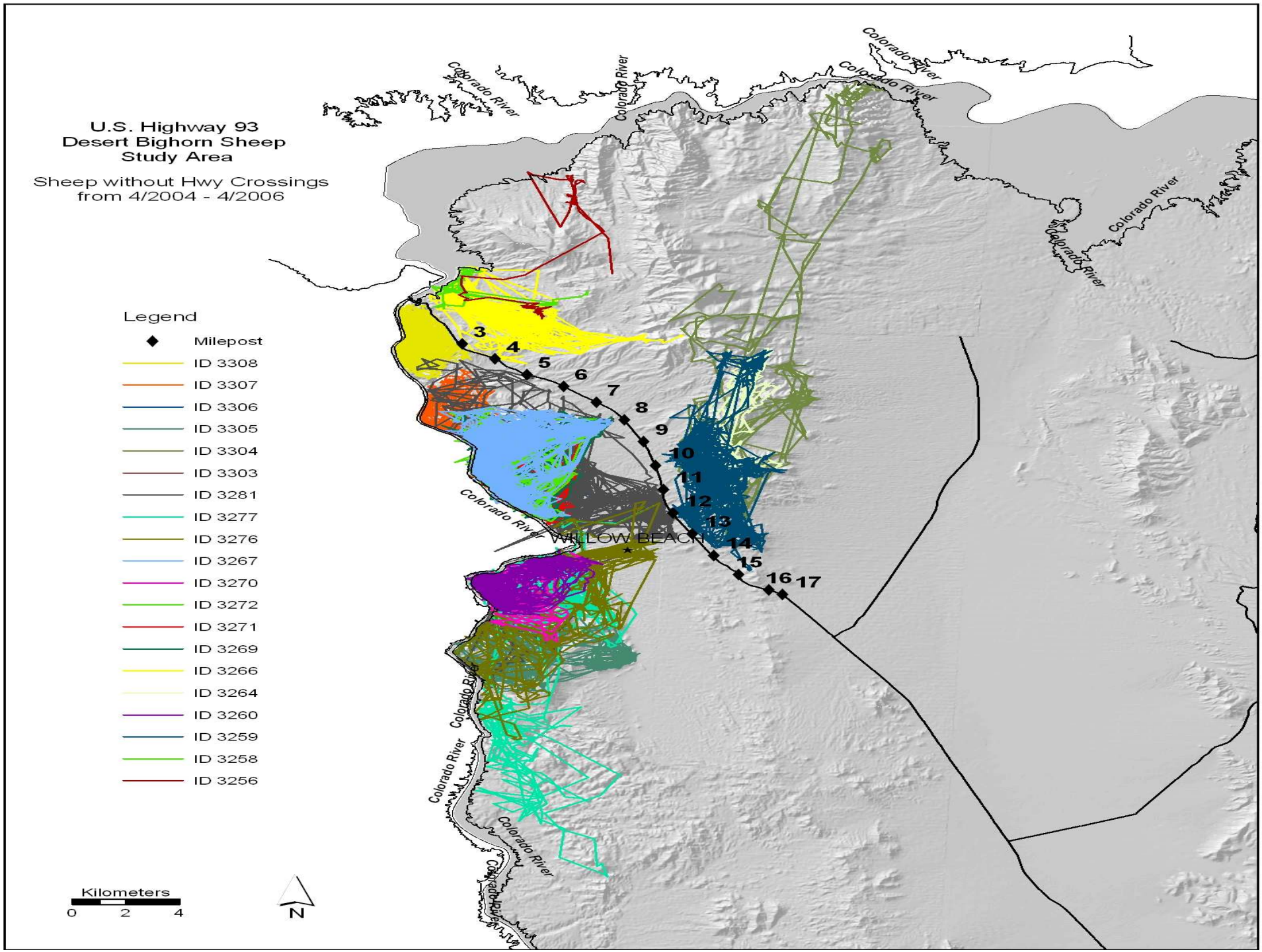
16
17
Colorado River
WILLOW BEACH
Kilometers
0
2
4
N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ID 3308
ID 3307
ID 3306
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ID 3304
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ID 3266
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Colorado River
WILLOW BEACH
3
4
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12
13
14
15
16
17
Kilometers
0
2
4
N

Conclusions MP 3-17

- U.S. 93 represented a barrier to both sheep that crossed and those that did not
- Management decisions should be directed toward identifying and preserving traditional routes of movement by rams, an essential factor that contributes to population stability
- Identified 5 continuous, linear, elevated guideways (CLEGs) associated with crossing activities, COAs, ground observations, and track bed data
- No known bighorn-vehicle mortality

Recommendations MP 3-17

- Recommend crossing structures at 4 CLEGs and consideration of a structure at a 5th CLEG

  MP 3.3 – overpass

  MP 5.2 – overpass/underpass

  MP 7.8 – overpass

  MP 12.2 – overpass/underpass

  MP 15.3 – underpass?

Crossing Mitigation Dimensions

- Nothing in the literature pertaining to bighorn
- Expert recommendation: 13-m wide by 4-m high as absolute minimum dimensions for open-span underpasses
- Overpasses in Europe and Canada are 30 to 200-m wide

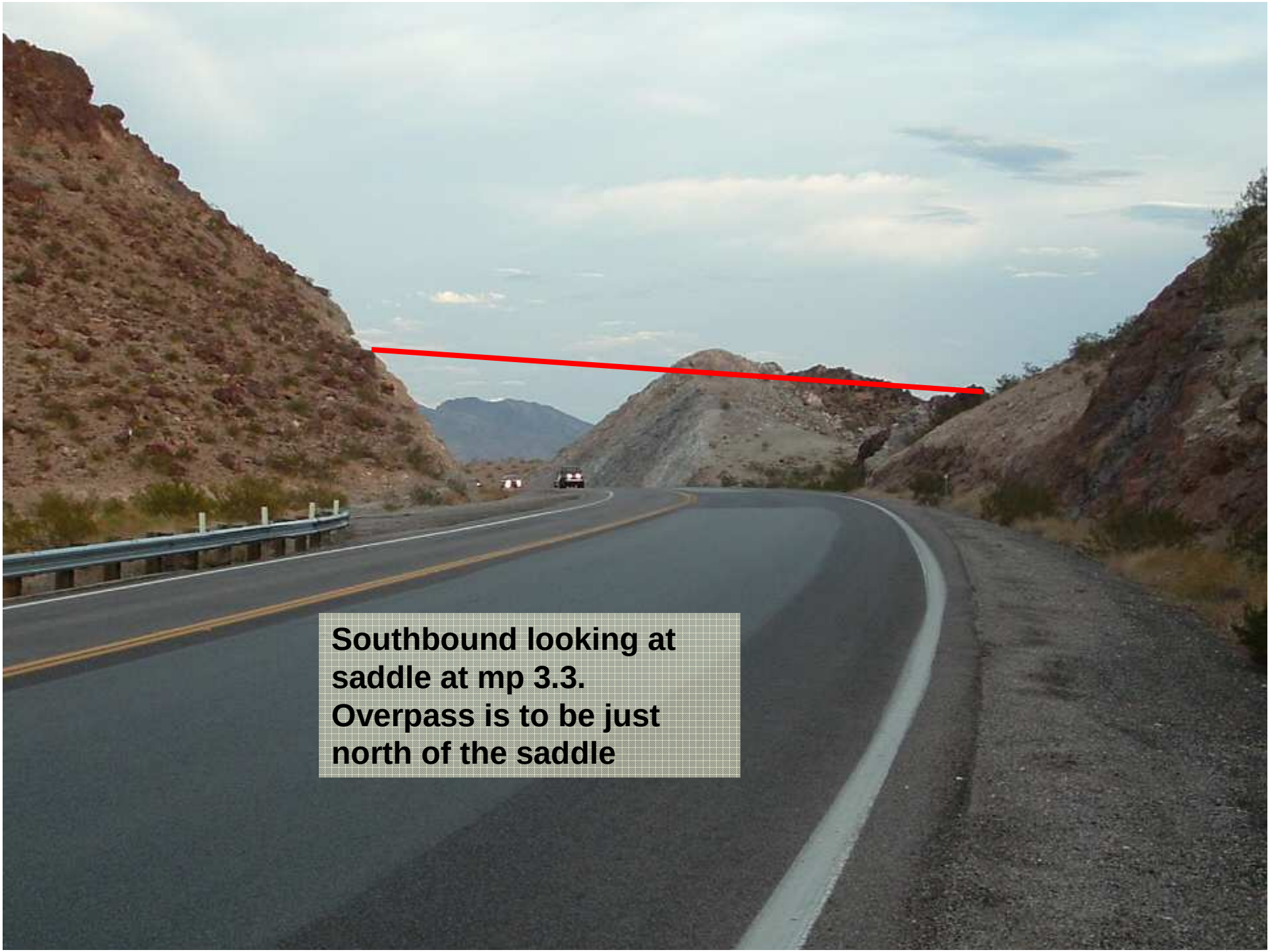
  Used with great success by many species

  However; expensive and we are targeting one species

Crossing Characteristics

- Placement and design are critical
- Connect high quality habitat
- Visibility is paramount
- “Openness” height x width/depth (underpass)
- Use the available natural substrate
- Incorporate terrain
- Create game trails to crossing
- Take advantage of animal behavior in design

Where’s Our Bridge???


Southbound looking at saddle at mp 3.3. Overpass is to be just north of the saddle


Location of overpass at mp 5.2
View is to the northwest


Location of overpass at mp 12.2

Bridge Selection Process

- Cost and Functionality
- Parameters
  - Roadway Geometry
  - Site Constraints
  - Constructibility
  - Construction Sequence

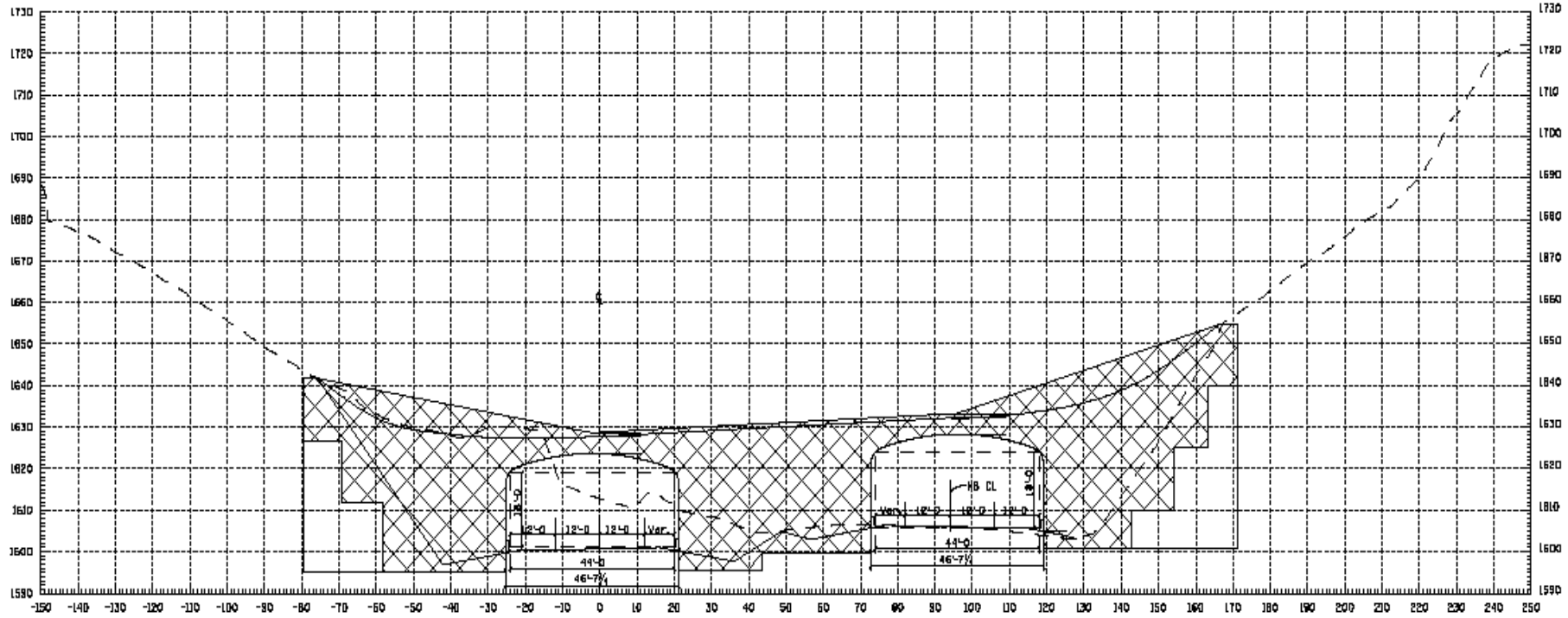
Bridge Selection Process

- What Type of Bridge would the Sheep Prefer?
- What type is both cost effective and functional, meeting our selection parameters?
- What type do we first envision for our sheep friends?

BANFF Wildlife Crossing

Bridge Selection Process

- Preliminary Structure Types
  - BANFF Inspiration Concept
    - CIP Rigid Frame
    - Precast Concrete Arch
    - Structural Plate Arch



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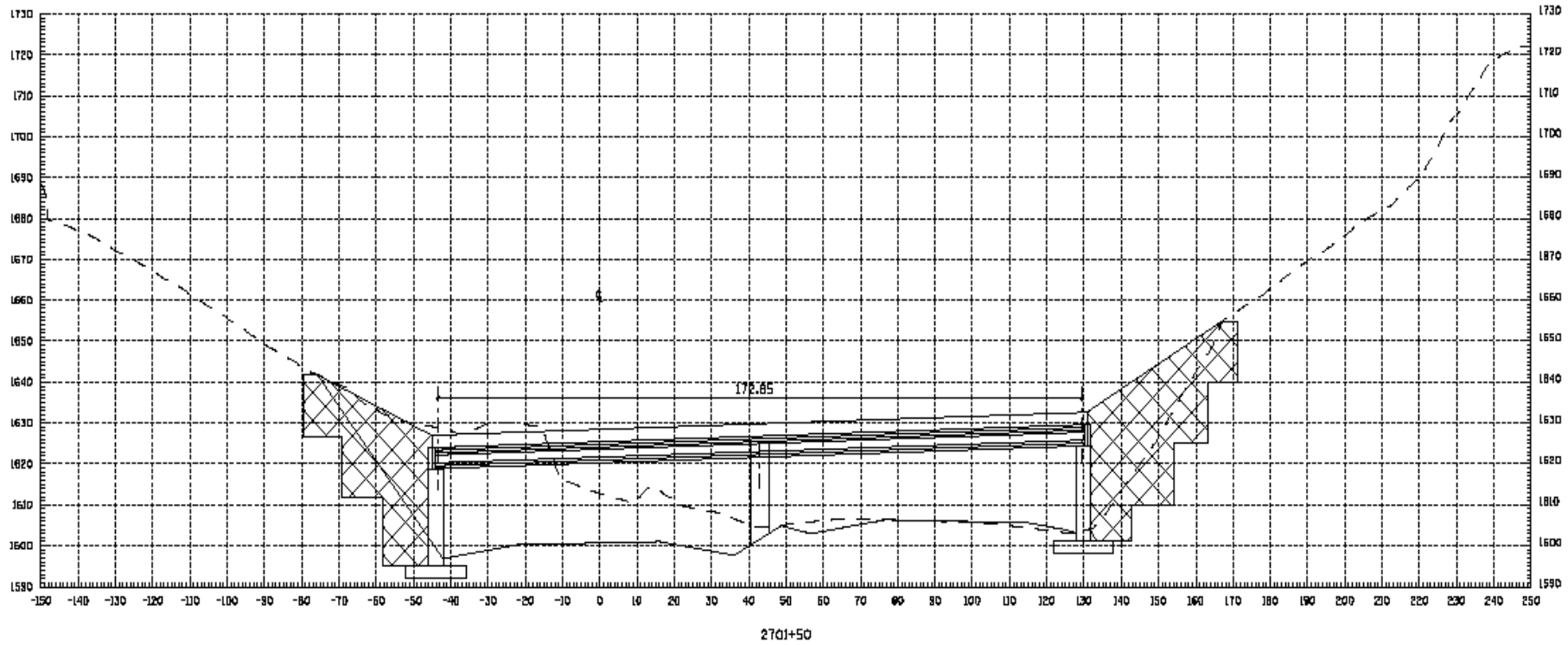
WILDLIFE CROSSING MP 3.3 (AZGFD-RANK #1)

ALTERNATE #1 (CONCRETE ARCH CULVERT BRIDGE)

Bridge Selection Process

- Preliminary Structure Types
  - Conventional Highway System
    - Precast I-Girder
    - Steel I-Girder



WILDLIFE CROSSING MP 3.3 (AZGFD Rank-#1)

ALTERNATE #3 (I-GIRDER BRIDGE W/ CLEAR ZONE)

Bridge Selection Process

- Arch/Frame and I-Girder Options
  - Cost
  - Roadway Geometry
  - Site Constraints
  - Constructibility
  - Construction Sequence

Bridge Selection Process

- TAC Consensus on Structure Type
- Wildlife Crossing MP 3.3
  - Twin CIP Rigid Frame Bridges
- Wildlife Crossing MP 5.2 and 12.2
  - 2-Span Precast I-Girder Bridge


US 93 - HOOVER DAM TO MP 17- WILDLIFE CROSSING @ M.P. 3.3


US 93 - HOOVER DAM TO MP 17 - WILDLIFE CROSSING @ M.P.5.2
ADOT

Bridge Selection Process

- What should be the width of crossing?
- What width is acceptable?

  50ft, 100ft, 200ft…
- 50ft wide crossings were chosen

Bridge Selection Process

- Wait there's a new development!!!
- Make Wildlife Crossing MP 3.3 wider.
  - Additional Funds from AZGFD
  - Increase width of 50 ft to 75ft, no make it 100ft
  - Change Bridge Type

Bridge Design

- All previous wildlife crossings in the State of Arizona have been:

"Traffic above,

Wildlife under"

Bridge Design

- These structures will be:

"Wildlife above,

Traffic under"

Bridge Design

- AASHTO Standard Specifications, 17th Edition
- ADOT Bridge Design Guidelines

Bridge Plan & Profile

- Tangent longitudinal grade and 1% cross slope to provide drainage
- Plan & Profile set by the bridge engineer
  - No horizontal curves
  - No superelevation transition

Vertical Clearance

- ADOT requires 16’-6” minimum for roadway bridges (17’-0” is preferred)
- ADOT requires 17’-6” for pedestrian bridges
- These bridges will be the only overpasses in the area, with no way to bypass them. They will be the limiting height.
- Bighorn Sheep prefer to be up high
- 18’-0” clearance was chosen

Dead Loads

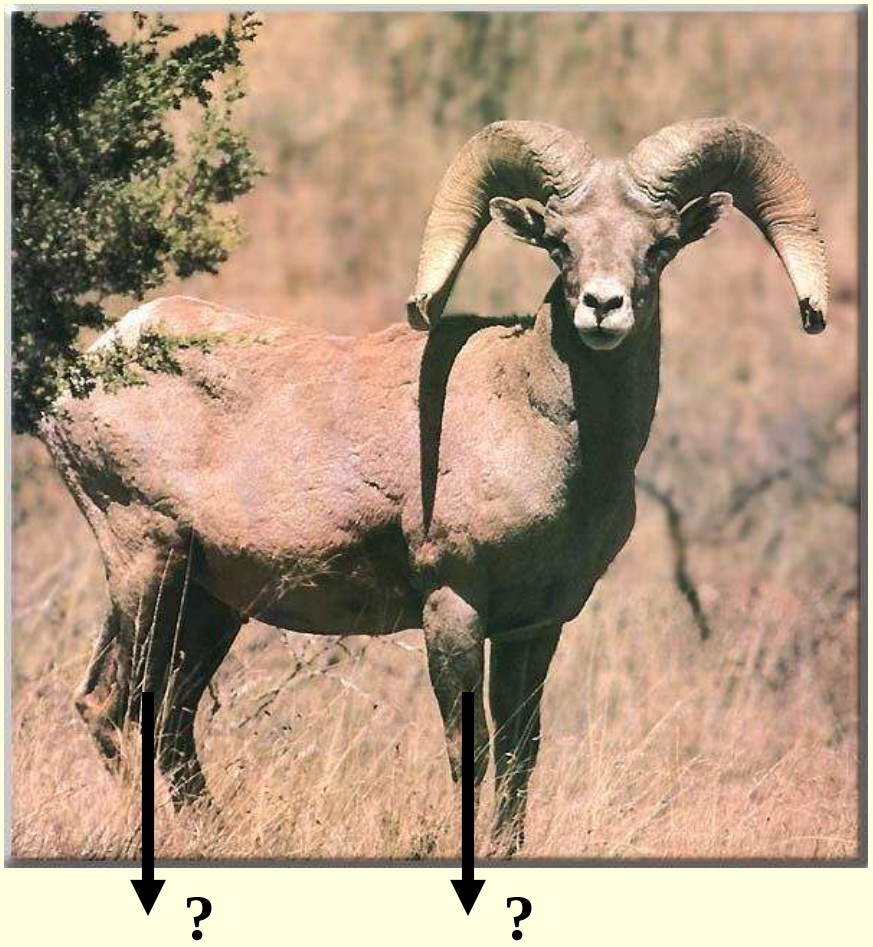
- 75 psf assumed for soil layer on top of deck
  - Actual system is 6” thick compacted soil confined between High Density Polyethylene (HDPE) cells
  - Actual weight will be less than 75 psf
- No future wearing surface (obviously)

Live Load

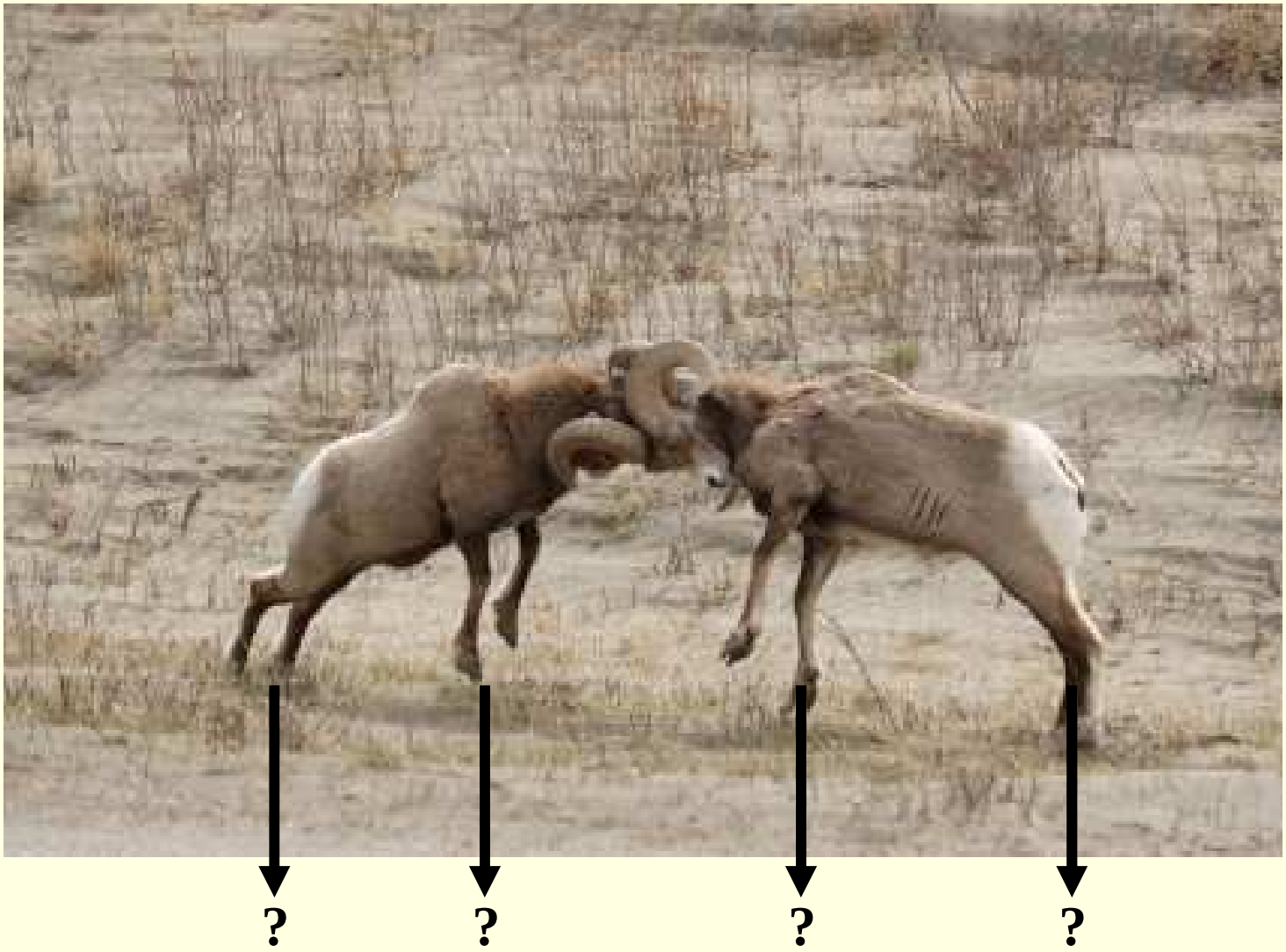
- We usually design for this (HS20-44)

Live Load

- But now we are dealing with this



Live Load



Live Load

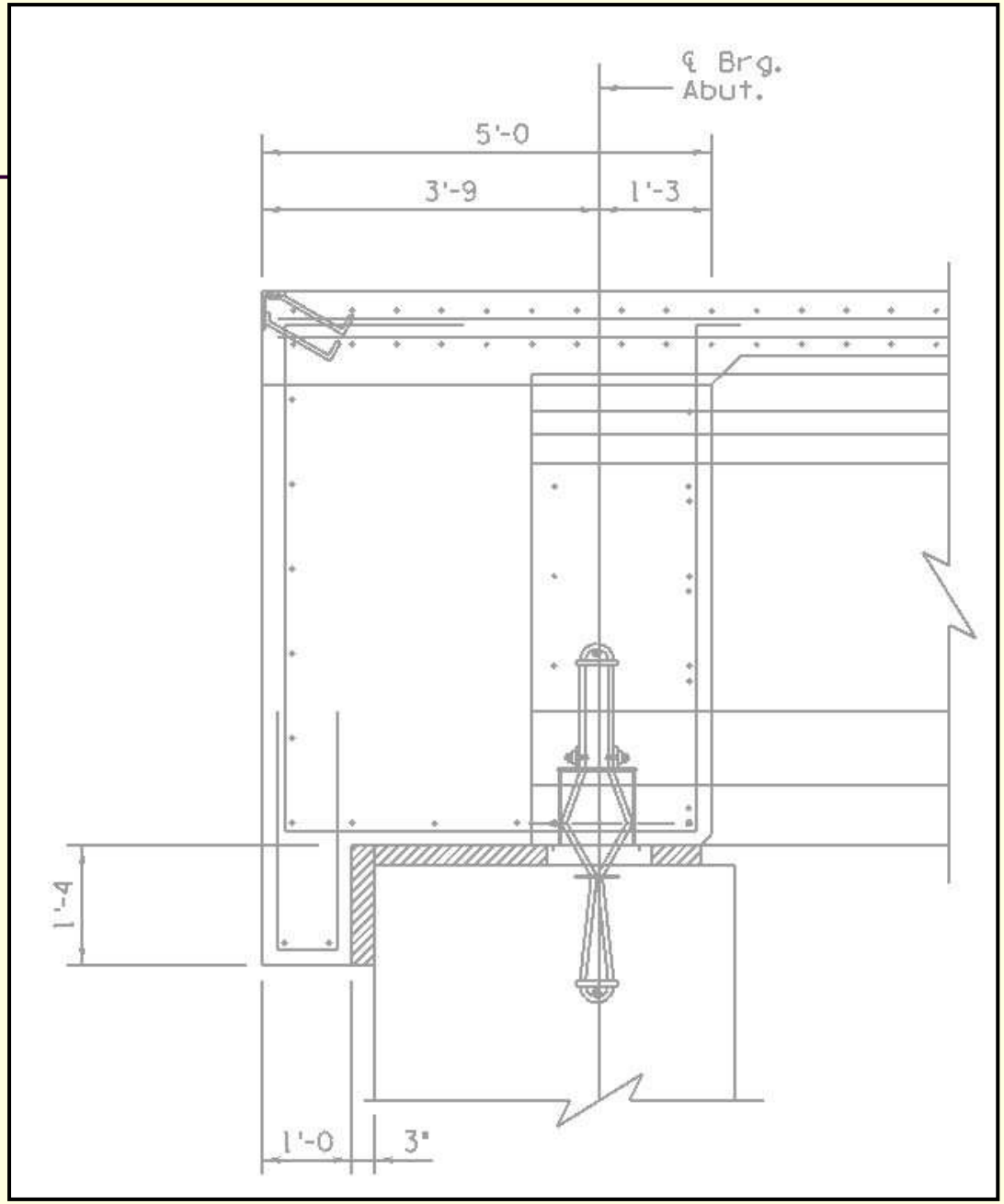
- H15-44 was chosen to account for:
  - Construction vehicles and equipment
  - Bighorn Sheep and other animals
  - Future maintenance vehicles
    - Graders and dump trucks may be needed in the future to replace the soil

Superstructure

- Type IV girders would work
- Type V-Mod girders allowed larger spacing, therefore less girders

Superstructure

- No backwall
- No roadway joint
- No approach slab



Soil Confinement System

- Technical Advisory Committee recommended a natural soil surface on the bridges, rather than concrete
- Team considered adding an irregular surface and boulders, but this would make maintenance very difficult
- Constant 6” layer of soil was chosen

Soil Confinement System

- Soil confinement system was chosen to keep the soil from eroding

Finished Product

Finished Product

Post Construction Monitoring

- AZGFD provided motion cameras and video at all 3 crossings
- Cameras were placed at approaches and at mid-span
- Powered by Solar Panels

Our First Crossing!!!

And the next day!!!