DFG EXHIBIT 9

DESIGN CONSIDERATIONS FOR SALMONID FISH PASSAGE

Presented by Cindy Watanabe
California Department of Fish and Game

Introduction

A. Ultimate goal

1. Minimize passage problems for fish
2. Achievable in many ways
   a. Eliminate barrier
   b. Provide fish passage
   c. Move fish around barrier

B. Fish passage
1. Design considerations
2. Design process

Problem Identified
1. Who determined the problem
   a. DFG Biologist or Warden
   b. Landowner
   c. Individual
   d. Environmental organization
2. Contact property owner
   a. Permission to visit site

III. Preliminary Site Visit

A. Take photos
B. Observe problem
1. Natural barrier
2. Existing manmade structure, no fish ladder
3. Existing manmade structure, with fish ladder
C. Observe high and low flow conditions
D. Determine scope of problem
1. Perceived
2. Actual
E. Explore area
.F. Determine if passage feasible
G. Consider possible option's
1. Remove barrier
2. Trap and truck
3. Provide fish passage
   a. Construct new fish ladder
   b. Improve existing fish ladder
   c. Add another fish ladder
H. Discuss funding needs
1. Funding for preliminary design
2. Funding for final design and construction
3. Funding for operation and maintenance

I. Potential partners/designers
1. Cost share
2. Department desi gn
3. Other state agency
4. Consultant
5. Private
6. Property owner

J. Discuss situation with property owner

K. Discuss critical timeline
1. Species sensitive
2. Funding availability
3. Design time requirements

IV. Data Collection

A. Biological
1. Fish species description
a. Swimming ability
b. Jumping ability
c. Preference for passage
2. Migration period
a. Start, peak, end
b. Upstream, adult
c. Downstream, juvenile
d. How do they approach barrier
3. Fish activity at barrier
a. Partial barrier, some make it over
b. Complete barrier, none make it over
c. Can't find ladder
d. Wander, jump, find ladder
e. Swim over
f. Fatigued or injured
4. Where is barrier in fish migration route
a. Pass through
b. Spawning in vicinity
c. Rearing in area

B. Physical Site Conditions
1. Road maps
a. Nearest road to site
b. Condition of road
c. Access with minor equipment
d. Hike in, no equipment
2. Topography
a. Where is barrier in watershed
b. River section straight or on bend
c. What is watershed like
3. Existing features
a. Environmental issues
i. Sensitive plants or animals
ii. Riparian disruption or removal
iii. Archeological site
iv. Residential area nearby

b. Geological
   i. Bedrock, type and location
   ii. River bed material
   iii. Bank material
c. River Characteristics
   i. cross sections
   ii. Profile
   iii. Bank details
   iv. Water surface at varying flow conditions
d. Elevations of key features
   i. Establish job benchmark
   ii. Diversion location
   iii. Canal
   iv. Pump
   v. Fish screen and bypass
   vi. Headgates
   vii. Dam, plan and profile

4. Additional information
   a. As-built drawings for structure
   b. Require core samples, structure or soil
   c. Construction requirements
      i. Access
      ii. Dewatering required
      iii. Staging areas
      iv. Spoils area
   d. Utilities in area

C. Hydrology
1. River flow
   a. Stream gage nearby
   b. Basin hydrology
      i. Flow duration
      ii. Flood flows-annual, 10, 50 year
      iii. Bankfull discharge
      iv. During migration period
2. operating flows
   a. Dams
      1. Diversion
         i. Fish screen, existing or future
         ii. Bypass, existing or future
      2. Hydropower
      3. Abandoned
3. Headwater/Tailwater stage relationship during migration period
   a. Vertical difference
   b. Time period
4. Determine fish ladder design flow

V. Preliminary Fish Ladder Design

A. Fish ladder Entrance
1. Most important part of design
2. No fish in/no fish out
3. Fish must be able to find the entrance
   a. Location
      i. Near banks
      ii. Downstream of hydraulic jump
      iii. Downstream of turbulence or eddies
   b. Attraction water
      i. 10% of river flow
      ii. Auxiliary water
         - Velocities less than 1 fps
         - Add to last pool in ladder via diffusers through side wall or floor
      iii. Modify operation of dam/spillway
4. Swim in entrance
   a. Not elevated requiring d jump
   b. Minimum 4 fps, maximum 8 fps
   c. Stream bed scour and lowering of tailwater pool common problem
5. Can incorporate multiple entrances

B. Fish ladder options

1. Provide versatility in design
2. Ladders in remote areas should have minimal maintenance requirements
3. Safety should be considered
4. Access for maintenance and operation
5. Surfaces should drain away from fish ladder
6. Install staff gages in varying locations
   a. Should be easily read
   b. Operations may depend on readings
   c. Can record and develop stage relationships

C. Fish ladder exit

1. Locate away from spillway
2. Best near shoreline or in current
3. Trash rack
   a. Horizontal 1811 minimum
   b. Vertical 5-1011
   c. Horizontal bars placed behind vertical to promote cleaning
   d. Vertical slope to let debris ride up
4. Log booms can also deflect debris

5. Fish ladder flow controls
   a. orifice
   b. Vertical Slot
   c. Adjustable weirs
      i. Manual

ii. Automated

6. Future use of fish counter
7. Ability to close fish ladder for maintenance
8. Located in main channel for passage of d/s migrants

VI. Choose your fish ladder

A. Review information and determine best ladder considering following:

1. Site conditions
2. Barrier characteristics
3. Fish species
4. Debris
5. Bank protection
6. Stream Scour
7. Sedimentation
8. Cost
9. Hydraulic model

B. Prepare discharge rating curve for chosen ladder
   1. Compare low, average and high flows
   2. Include dam and diversion flows

C. Preliminary Drawings
   1. Show dimensions
   2. Approximate locations
   3. Elevations
   4. Plan, side and cross-section views
   5. Stream
   6. Structures
   7. Environmental concerns

D. Cost Estimate
   1. Accuracy of estimate dependent on experience
   2. Include high contingency if:
      a. Lots of site unknowns
      b. Inexperienced designer
   3. A generalized method to determine cost:
      a. Small simple ladder - $2000/vertical foot
      b. Medium - $10,000/vertical foot

c. Large, complex $50,000/vertical foot

E. Preliminary Design Review and Approval

1. Experienced engineer or specialist
2. Property owner
3. Staff
4. Agencies

F. Permit Process
   1. Usually takes several months
   2. Ensure all agencies have been contacted

G. Begin Developing Operations and Maintenance M-anual/Agreement

H. Deter-mine method(s) of funding
   1. Final Design
   2. Construction
   3. Operation and Maintenance

VII. Final Design

A. Prepare final cost estimate
   1. May change significantly from preliminary
   2. Ready to apply for funds

B. Final Drawings and specifications
   1. Reviewed and approved by experienced engineer or habitat specialist
   2. Property owner approves
   3. Permits reviewed and revised if necessary
      a. Time frames usually established here
      b. Construction restrictions identified

C. Finalize operations and Maintenance Manual
   1. Assign responsibilities
   2. Signed Agreement

VIII.Contracting Process

A. Contract Preparation
B. Bid
C. Award

XI. Construction

A. Contractor's Experience
   1. If Contractor lacks experience, may require full time inspector, extra time
   2. "Good" Contractor can handle difficult situations
   3. Dewatering may be very large element of construction
B. Inspector should have experience in construction techniques
C. Ensure permit requirements adhered to

X. Post Construction

A. Monitoring and Evaluation
   1. Biological
   2. Hydraulic
B. Operation
C. Maintenance

XI. Summary

A. No two sites are the same
B. Treat each job as a unique experience and review all pertinent information