# Childs/Irving Hydroelectric Project

## Plan for Diversion Structure and Dam Removal

Revision 4 –
Remove proposed from plan
Remove “Option B – “Partial Removal” to -6’- 0”” and “Option C – “Full Removal”
Rewrite Irving Diversion removal to support full flow removal
Add Attachment 2. “Photos and Images for Proposed – 14’-0” Removal of Fossil Springs Dam”

**Childs-Irving Document Number - CI-ENG -2**

# Plan for Diversion Structure and Dam Removal

Childs/Irving Hydroelectric Project Facilities Decommissioning

# INTRODUCTION

The purpose of the following document is to provide a plan for deconstruction of the dams and diversion structures related to the Childs – Irving Hydroelectric Project Facilities. The tasks and methods defined in this document are intended as a guide to future construction engineering tasks and will be revised as required by future determination of changes in the scope of removal dictated by the Final Environmental Assessment and the Adaptive Management Plan.

The areas covered by this document include the Fossil Springs diversion structure located approximately ¼ mile downstream of Fossil Springs, the Irving diversion structure located approximately 350 feet upstream of the Irving Power Plant, and two earthen dams that retain Stehr Lake, a regulating reservoir upstream from the Childs Power plant.

# CHILDS IRVING SITE PLAN

## Site Location and Access

The Childs Irving Project is an operating hydroelectric facility located on Fossil Creek in Central Arizona. It consists of two developments: Childs and Irving. The project is located entirely on land of the United States, managed by the Forest Service and is part of the Coconino and Tonto National Forests.

Childs and Irving hydroelectric power plants are located approximately 110 miles north of Phoenix, Arizona. Environmentally sensitive areas surround each one. The only access to the facility is to use winding and gravel roads. One of the roads is approximately 22 miles long and enters off of the State Highway 260, which is six miles east of Camp Verde. The other access road is approximately 15 miles long and the entrance is off of State Highway 87 at Strawberry, Arizona.

## Site Layout

### Irving site

The Irving plant is the upstream-most hydroelectric system. Water is collected at a concrete diversion located approximate 1/4 mile downstream of Fossil Springs. The water is conveyed through a steel flume constructed on a wooden trestle, passing through one tunnel and one siphon before reaching the penstock pipe. The penstock pipe delivers the water through the plant site to the powerhouse turbine/generator, discharging the water into the Childs flume intake system. The Irving plant site consists of a powerhouse, office, miscellaneous buildings, and houses. Fossil Creek water not conveyed in the Irving flume system can be collected into the Childs system by means of a diversion dam and forebay located adjacent to the Irving plant.

### Childs site

The Childs system begins at the discharge point of the Irving powerhouse. Water is collected and conveyed down a series of concrete or steel box flumes, bridges, tunnels and a siphon before entering Stehr Lake. The water exits Stehr Lake through a tunnel into a pressure pipe before reaching the surge tank and penstock pipe. The penstock pipe delivers water to the powerhouse's three turbine/generators, which discharge the water into the Verde River. The Childs plant site consists of a powerhouse, office, miscellaneous buildings, substation, and houses.

# Diversion and Dam Structure Removal

## Fossil Springs Diversion Structure

### Description of Structure

The Fossil Springs diversion structure is a concrete masonry gravity dam founded on bedrock, approximately 24 feet thick at the base and 5 feet thick at the top. The dam is approximately 100 feet long and 25 feet from the crest of the dam to bedrock. A very small portion of dam extends 27 additional feet to the base of a deep chasm in the historic rock formation. Located at the West end of the structure is a concrete intake structure and mechanical trash rake. This intake structure diverts the flows of Fossil Springs to a flume system, which supplies the Irving and Childs hydroelectric power plants.

The dam is a state of Arizona non-jurisdictional dam but is licensed with the Federal Energy Regulatory Commission and is classified as a low hazard structure.

### Diversion Structure Removal

Final determination for removal of the Fossil Springs Diversion structure either partially or in its entirety has not yet been made. The proposed options for the structure and the methods for these removal processes have been narrowed down to Option A and Option D which are listed below:

**Option A – "Left in Place"**

This option was not directed by the Surrender Order and is only preserved here for reference if directed by the Final Environmental Assessment Adaptive Management Plan.

The Diversion Structure is a non-jurisdictional structure in the State of Arizona but is licensed with the Federal Energy Regulatory Commission and is classified as a low hazard structure. The factors of safety for the dam are below FERC's recommendation of 2.0 for Usual Loading Condition (Case I) and 1.25 for Unusual Loading Condition (Case II (flood)). When taking into consideration a sloping base, a simplified two- dimensional analysis, allowing hydraulic uplift in the foundation, and the silt loading that exists on the upstream face, the Diversion Structure has a Case I factor of safety of 1.6 and .9 for Case II. These safety factors were calculated using these assumptions due to the lack any engineering data from construction. Without further study of the foundation, this points to the necessity of stabilization for the option of leaving the diversion in place. This analysis represents a sliding failure of the structure that could be stabilized to assure stability as the structure degrades over time.

The least disruptive stabilization would be the installation of rock anchors every six feet through the crest of the structure into the foundation limestone. The most common rock anchor for this type of application is a Williams rock anchor. These rock anchors can be grout shielded and made of stainless steel to increase the design life to match that of the concrete itself.

Stabilization of the structure by increasing the gravity loads of the dam would require either foundation amendments to prevent hydrostatic uplift or adding an upstream ballast section that would extend up to 20 feet upstream from the upstream face of the structure. This type of construction activity is covered in the partial and full removal options.

**Option D – "Partial Removal" to –14'-0"** See APS Dwg. No. CIC-C-17-PFS-151290-1

The 14 foot removal option is another method to address the desire to achieve a zero maintenance structure meeting FERC stability recommendations and leaving a remnant structure to serve as a fish barrier. The factor of safety of the remnant structure far exceeds the 2.0 static recommendation and does not require rock anchors. The wildlife impacts of this option have not been directly addressed due to just being introduced.

A diversion channel shall be installed upstream of Fossil Springs Dam to convey the Fossil Springs baseflow of 42cfs around the deconstruction area near the dam structure. This channel shall utilize a currently abandoned channel within the upstream riparian area. This channel shall be modified to accept baseflows. A continuation of this channel will be constructed near the end of the existing channel extending to approximately 50' upstream of the dam structure. At this point the base flows will be conveyed through a 36" HDPE pipe that will exit through a notch or removed portion of Fossil Springs Dam at the east end or stream left. See Attachment 1 "Fossil Springs Diversion Channel Design Report" and drawings CIC-C -16-PFS-151984 sheets 1 through 3.

After base flows are being moved through this new diversion channel, a cut-off structure shall be constructed at the current flow channel to assure complete diversion through the designed diversion channel around the deconstruction site. See "Partial Plan View" on drawing CIC-C-17-PFS-151290 sheet 2 for details of the cutoff structure.

Sediment behind the diversion structure will be removed as required to remove the concrete structure in approximately 3'-0" sections. The grade behind the structure will be sloped at a 3:1 slope as required. The final removal of sediment will remove material to 14'-0" below the top of structure (approx. el. 4260'-0') to meet existing grade or natural bedrock or un-weathered firm material approximately 50' – 55' upstream of the structure. The sediment (approximately 1740 cy if it were all non bedrock or firm material) shall be relocated to the Fossil Springs staging area for dewatering and then used as fill / cover material during re-grading and revegetation of the staging area at project completion. Final slope will be determined by erosion that will occur due to natural stream flows.

Equipment access shall be from the existing staging area through the area currently occupied by the mechanical trash rake. Equipment used for the removal of sediment and grading shall be a small Bobcat or front end loaders.

Scaffolding structure shall be erected on the front face of the diversion structure. The top 14 feet of the structure shall be removed in 3 foot stages using concrete drills and air operated or hydraulic breaking equipment. Concrete material shall be removed to bedrock limits on the east and west end of the diversion structure where deconstruction allows. High line rigging shall be installed for concrete removal from the structure. Preventive measures will be taken to prevent debris from falling into the channel downstream of the dam during deconstruction.

Concrete material shall be lifted and removed from the structure and shall be relocated to the Irving flume tunnel using front end loaders for disposal prior to the sealing of the tunnel. Remaining concrete debris shall be placed at a disposal site near the west end of the Irving flume tunnel in an area that has been previously utilized for staging and access during construction of the Irving flume system (See drawing CIC-C-17-PFS-151980-1) The survey and plans for this site are currently in development and shall follow the Sediment and Erosion Control Plan and Revegetation Plans established by APS.

After removal of the top 14'-0" of the dam structure, "adaptive management" measures shall be taken to finalize the disposition of the structure. The following considerations shall be addressed as a project team effort between APS and the USFS at completion of dam removal:

1) The concrete structure shall be removed at a minimum of 14'-0" (approximately elevation 4260'-0")

2) The remaining structure shall blend with the natural stream structure / shape and appear similar to natural formation.

3) The remaining structure shall retain fish barrier characteristics at an elevation below 4260'-0" and shall provide no side channels.

4) Structure shall address safety issues such as: all exposed metal shall be removed, no other sharp structures that could cause injury shall remain, and other factors that may be a danger to the recreating public and the dam shall not be subject to toppling or sliding.

5) The remaining structure shall assist in channel stability upstream of the dam structure. Further removal of concrete should not degrade this channel stability or provide additional environmental impacts to the upstream riparian area.

Final removal of all remaining concrete from the historic diversion channel and flume inlet shall be removed.

The remaining sediment behind the structure shall be left in place and allowed to naturally transport through seasonal storm events. The constructed diversion channel shall remain in place to divert base flows around disturbed sediment to control sediment transport through base flow until a series of storm events provide a natural transport of sediments behind the dam. If storm events transport this sediment prior to APS transferring this site to the USFS, APS will remove all HDPE piping from the riparian area. If conditions exist that do not begin this natural transport, APS will replace this HDPE pipe with a natural constructed trench to conduct baseflows past the existing Dam site after the site is transferred to the USFS.

### Schedule for Removal

Deconstruction activities for the Fossil Springs diversion structure shall begin in September, 2007 after confirmation from the USFS that habitat formation has occurred to their satisfaction and APS has been approved to begin deconstruction. Diversion channel construction is expected to take approximately 2 weeks and dam deconstruction is expected to take approximately 12 – 16 weeks.

## Irving Diversion Structure

### Description of Structure

The Irving diversion structure is a minor diversion constructed of concrete approximately 27 feet long, 5 feet high, with a base width of 5 feet to 1 foot wide at the crest. A steel faceplate has been added to the upstream face of the diversion for additional protection.

The structure originally diverted water from Fossil Creek to the Childs system prior to the construction of the Irving Power Plant. Today it provides a bypass to the Childs system when Irving is taken offline.

### Diversion Structure Removal

See APS DWG. No. CIC-C-17-PFS-151165-1

Previous Low flow alternative: A HDPE hydro-coffer diversion shall be installed from the existing road crossing at an approximate angle of 45 degrees to divert the .2cfs flow through the existing trash rake. The steel face plate shall be removed from the structure. The existing concrete structure will then be broken up utilizing air operated or hydraulic operated equipment. Concrete pieces will be lifted from the site using a small boom crane mounted on a back hoe or similar small piece of equipment. All concrete material shall be relocated to a small staging location on the Southeast side of Fossil Creek near Fossil Creek Road. Concrete material shall be used as fill material for the proposed bridge abutments and bridge approach.

The HDPE coffer diversion shall then be relocated to a location stream right to provide diversion away from the northwest end of the diversion structure. The concrete dam remains and inlet structure shall be removed from the northwest side of the creek. The existing streamside concrete forebay wall shall be removed

Full flow alternative: The original work plan proposed removal during low flow when the stream is diverted to the Irving flume. Native Fish Restoration has extended the return of flows so that most likely removal will occur during full flow. This will require an HDPE tube dam ("Aqua Dam") over the at grade crossing just upstream of the diversion to act as a head wall for diversion into an HDPE pipe system that will conduct the full flow past the demolition to the existing diversion outfall channel.

### Schedule for Removal

Deconstruction activities for the Irving diversion structure was expected to begin in September 2004 or immediately following the Arizona monsoon season but to assure the success of the Native Fish Restoration Project the diversion removal will be delayed until the restoration is complete (possibly March 2005). Deconstruction of the diversion including HDPE hydro cofferdam installation is expected to take approximately 4 weeks.

## Stehr Lake Dams

### Description of Structures

Stehr Lake is a small regulating reservoir contained by two earth fill dams constructed at each end of a shallow natural depression. The impoundment originally had a surface area of 23 acres and a maximum depth of 16 feet. It has been silted in over the years. The (upper) dam is located approximately 1,800 feet north of the main (lower) dam.

The main (lower) dam has an embankment height of 20 feet and a maximum base width of 140 feet. The crest is about 20 feet wide and 450 feet long.

The Childs conduit/flume system extends from the Irving plant to Stehr Lake and discharges into a concrete weir and gauging station at the north end of the lake. The concrete weir essentially divides the upper dam into two embankments which are indicated as the northwest (upper) dam and the northeast (upper) dam.

The northwest and northeast (upper) dams both have embankment heights of 12 feet and maximum base widths of 80 feet. The northwest (upper) dam crest is about 20 feet wide and 450 feet long. The northeast (upper) dam crest is about 20 feet wide and 800 feet long. There are no as-built construction records of the dams. It is assumed that the embankments are constructed of homogeneous earth fill. Maximum side slopes are 2:1.

### Dam Removal

See APS Dwg. No. CIC-C-17-PFS-151170-1

The Stehr lake dams will be breached after lake water has receded. The earthen material from the dams will be utilized as fill while re-grading Stehr Lake to match the surrounding natural grade. The lake area will revegetated by seeding and/or be allowed to return to native vegetation.

### Schedule for Removal

Deconstruction and re-grading activities for the Stehr Lake Dams are expected to begin about February 2007.

## Equipment Requirements for Diversion/Dam Deconstruction

Current plans may require the following equipment: trucks, trailers, front end loader(s), track hoe(s), air/hydraulic breaking equipment, gas powered earth drills and gas/electric/air operated winches. Final determination of equipment requirements will be determined by limits of deconstruction, cost and contractor requirements.

## Petroleum and Hazardous Product Handling

Bulk storage of diesel fuel and gasoline will be required at specified staging areas including the Fossil Springs staging area and Irving staging area. Future construction plans and requirements will determine fuel storage containment.

**The following standards for material and chemical substance identification and control will be required for all contractors during deconstruction of the Childs / Irving facilities:**

Supplier shall notify Company's designated representative in writing, on an on-going basis, at least fifteen (15) days prior to its use, of all materials or chemical substances to be used in performance of the Services that may be considered toxic, hazardous to health or the environment, or that could become hazardous waste, as determined in accordance with Applicable Law.

1.The identity and quantity of each material and chemical substance to be used, by trade name, chemical name, and manufacturers' name. Copies of all manufacturers' Material Safety Data Sheets ("MSDS") for each material and chemical substance shall be included.

2. The detailed chemical constituents of each material and chemical substance, or the process to be used that makes it a hazardous waste once expended.

3. The quantities of hazardous waste that Supplier anticipates will result from use of each material and chemical substance referred to above.
4. The use proposed for each material or chemical substance in connection with the Services.

5. A description of Supplier's procedures for handling hazardous waste generated during performance of the Services. A copy of any written plan or procedure in effect shall be included.

6. The identity of the support, special facilities, and other assistance from Company, if any, Supplier will require for the on-Site handling of the materials, chemical substances, and hazardous wastes referred to above. Company will dispose of all such hazardous wastes, unless otherwise specified in this Agreement or any Order.

All materials and chemical substances shall be properly labeled before being brought onto the Site, in accordance with OSHA and any other applicable labeling requirements, including those for preservation of labels from manufacturers' containers and the labeling of secondary containers. Company reserves the right to prohibit any materials and chemical substances from being brought onto the Site or used in performance of the Services.

## Reference Drawings

### Drawings:

CIC-C-17-PFS-151165-1 – Irving Diversion Structure Removal Plan

CIC-C-17-PFS-151170-1 – Stehr Lake Dam Removal Plan

CIC-C-17-PFS-151290-1 – Partial Fossil Springs Diversion Removal @ -14' Plan

CIC-C-17-PFS-151290-2 – Partial Fossil Springs Diversion Removal @ -14' Sections and Details

CIC-C-17-PFS-151980-1 – Fossil Springs Dam Material Disposal Site Location Plan

CIC-C-17-PFS-151984-1 – Fossil Springs Diversion Channel Construction Plans Cover Sheet

CIC-C-17-PFS-151984-2 – Fossil Springs Diversion Channel Construction Plans Plan and Profile Sheet

CIC-C-17-PFS-151984-3 – Fossil Springs Diversion Channel Construction Plans Notes and Details Sheet

## Attachment 1

**Fossil Springs Diversion Channel Design Report**

Childs-Irving Document Number - CI-ENG-6

## Attachment 2

**Photos and Images for Proposed – 14'–0" Removal of Fossil Springs Dam**

Childs-Irving Document Number - CI-ENG-7