San Joaquin River Restoration
Structural Option Description
Pre-Appraisal Level

Option No.	Structural Option Name		Revision Date
6	Arroyo Canal Water Diversion		4 Jan 2008
Reach Number	**River Mile**	**Program Goal**	**Phase**
3	182.0	Restoration	I

Task	Responsible Author	Peer Reviewer
Option Description	D. Whitbeck	D. Dorratcague
Engineering		

Costs (October 2007):
Cost Level: Pre-appraisal
Total Construction Cost: Not available at this time.
Annual O&M Cost: Not available at this time.

Objective of Option
The Arroyo canal diverts water directly from the San Joaquin River and represents an entrainment hazard for migrating fish. A fish screen will be required to redirect fish that enter the Arroyo Canal back to the San Joaquin River.

Performance Criteria
1 Pass 600 CFS from San Joaquin River into Arroyo Canal.
2 Screen fish at all water levels for all restoration flows from 45 to 4,500 cfs and safely return them to the river downstream of Sack Dam.

Design Criteria
1 NOAA Fisheries Anadromous Salmonid Passage Facility Design (2007)
2 CDFG Fish Screen Criteria
3 Reclamation Cost Estimating Guidelines

Description

A fish screen will be placed in the channel immediately upstream of the existing headworks to the Arroyo canal (refer to **Attachment 6-1)**. This location will be between the old headworks (refer to **Attachment 6-2**) and the existing headworks. See **Drawing 6-1**. The structure will be 264 feet long, 57 feet wide, and as high as the deck of the existing headworks, elev. 132.5 ft. A maximum flow of 622 cfs will pass through the structure. Of the total flow at any given time, 22 cfs will be diverted along with fish back to the river downstream of Sack Dam. Refer to **Attachment 6-3**.

Water Levels:
The amount of water required for diversion into Arroyo Canal will be released into Reach 3 from Mendota pool as an addition to the restoration flows required by the Settlement Agreement. At certain times of the year, as little as 45 cfs will flow in the river past the Arroyo Canal intake. During wet years, maximum restoration flows of 3,655 cfs will be in the river. The flood capacity of the river in reaches 3 and 4A is 4,500 cfs. The screen will be designed to operate with 4,500 cfs in the river. Operation of Sack Dam will be required to maintain a water level of 120.5 ft at the entrance to the screen structure in order to meet criteria while passing 600 cfs. Flood waters are estimated to reach an elevation of 126.8 ft.

Structure Features:
A trash rack will be installed at the entrance to the screen structure to prevent logs, trash, and other large debris from entering and damaging the screens. The trash racks will extend from the floor, elevation 115.0, to the deck at a 5V:1H angle and the spacing between the bars will be 6 inches. A debris boom may be

installed in the river upstream of the old headworks to help keep large debris from collecting on the trash rack. Trash rack cleaning will be accomplished with a bar screen raking machine.

The screen structure will be a single vee layout. Two rows of screens will span the entire opening width, 45 feet, and converge to a narrow channel downstream. Water will pass through the screens at a rate no greater than 0.33 fps, perpendicular to the screens, and the spacing will be small enough that fish cannot pass through (1.75 mm according to NOAA Fisheries criteria). Fish moving through the structure will enter a full-height, 1.5-feet wide channel at the downstream end of the screens, and be guided by a sloping headwall to enter a 28-inch diameter pipe. The pipe will carry the fish out of the structure through a pump house and then return them to the river downstream of Sack Dam

The screens will consist of 16 panels on each side that are 12-feet long and 5-feet high. This provides an average approach velocity of 0.313 fps. The top of the screens will be set at the minimum water surface, 120.5 feet, which will be maintained by operation of Sack Dam. The floor of the structure will be at elevation 115.0, 0.5 feet beneath the base of the screens, to help reduce the impact of potential sediment accumulation in the structure. The maximum flood level in the San Joaquin is estimated to be 126.8 ft, corresponding to a flow rate in the river of 4,500 cfs. The deck of the structure will be at 132.5 ft, also the elevation of the top of the existing headworks structure. See **Drawing 6-2**.

Depending on the amount of water to be diverted into Arroyo Canal and the depth of the water in the river, the velocity of water entering the screen structure will vary. At the maximum flow of 622 cfs entering the structure and a minimum water level of 120.5, the velocity will be 2.5 fps. At the maximum water level, the velocity will be 1.2 fps. These velocities meet sweeping flow criteria. At the end of the screens, 22 cfs will remain in the channel and the velocity will be 2.7 fps and 1.2 fps for the low water and high water levels, respectively.

Table 1: Velocities entering the screen Structure.

Water Surface Elev. (ft)	120.5	120.5	126.8
Water Depth (ft)	5.5	5.5	11.8
Flow to Screens (cfs)	272	622	622
Velocity - Screen Entrance (fps)	1.1	2.5	1.2
Screen Approach Velocity (fps)	0.130	0.313	0.313
Velocity – Screen Exit (fps)	2.7	2.7	1.2
Velocity – Pipe Entrance (fps)	5.1	5.1	5.1

Water passing the screens will enter a 17-feet long transition section with a sloping headwall. A 28-inch diameter pipe takes water from the downstream end of the transition and runs full-flow to the pump station. Depending on the water level in the river, fish will either be diverted into a gravity-flow pipe that will run directly back to the river or they will be diverted to a fish pump. The pump will operate when flows in the river are greater than approximately 1,800 cfs, an average of about 3 weeks per year. A pump is required because the head loss across Sack Dam at high flow rates is not sufficient to allow a bypass pipe with gravity flow to operate at all water levels.

A WEMCO-Hidrostal 28.0" centrifugal-screw fish pump will be used to add energy such that the pipe can discharge downstream of Sack dam. Only 2-3 feet of head is available for the pump to operate at high water levels, and it is assumed that this pump can operate under these conditions. The alternative to a pump would be to run the bypass pipe along the river downstream until suitable friction loss in the river allows the bypass pipe to be effective at all water levels. The shallow slope of the river in this region, however, precludes the feasibility of this option.

Two bypass pipes leave the pump house, one which will be used at times when gravity flow is sufficient to allow discharge just downstream of Sack Dam, the other which will be connected to the pump and will be used during high flows. The bypass pipes from the pump house will be HDPE, 28 inches in diameter, and carry the fish at 5.1 fps for approximately 500 feet back to the San Joaquin River. The pipe will discharge

at elevation 113.0 ft in the pool just downstream of Sack dam.

Other Features:
A sediment control system will help keep sediment from accumulating on the floor of the structure. A pump, located behind the screens, will discharge water out series of pipes located along the floor of the structure to re-suspend sediment to be carried downstream.

The structure will have bulkheads that may be installed at the upstream end of the screen structure for dewatering. Dewatering of the structure may only occur at times in the winter when flow rates in the river are low. It is assumed that Sack Dam will be built with gates to allow the forebay to be lowered during low to moderate flows. Perforated pipes will be installed in the backfill on the sides of the structure to help relieve water pressure and reduce uplift pressures on the structure.

Temporary Water Supply Channel
Construction of the fish screen will temporarily block all flow from entering the Arroyo Canal in the normal flow path. A temporary water supply channel will be required to allow water to flow from the San Joaquin River into the canal. The temporary channel will be constructed from just upstream of the old headworks site to downstream of the existing head works. The water will flow through pre-fabricated box culverts beneath the roadway and Helm's Ditch canal, and discharge into the canal west of the existing Arroyo Canal headworks. A section of the roadway and canal will be removed during construction to provide the flow path for the temporary channel.

Construction of the fish screen will require approximately 12,200 cubic yards of excavation for the screen structure, pump house, bypass pipe, and temporary water supply channel. Approximately 9,400 cubic yards of the excavated material may be reused as backfill. The disturbance footprint for construction will be about 2.5 acres. Staging and storage will occur on an easement on the north side of the structure, as the temporary channel will be constructed along the south side. It is assumed that power supply for the structure may be obtained from the infrastructure currently on site for the existing headworks.

Construction Considerations
Construction of the fish screen structure will need to be performed during the winter and be completed in one season. Construction must be completed during winter because less water is diverted to Arroyo canal at this time and the Helm's Ditch canal running next to the roadway is inoperative. A cofferdam will need to be built to keep flood waters out of the construction site. Because excavation will also completely separate the adjoining Arroyo Canal from its water supply, a temporary channel under the roadway will be required to supply water to the canal during construction. The temporary channel will require removal of a 20-ft stretch of the roadway and Helm's Ditch canal, which will take both out of commission temporarily. Construction should be completed in one season so that operation of Helm's Ditch during irrigation season is not disrupted.

Schedule
- Fish screen structure completed by 2012.
- Salmon to be reintroduced by December 31, 2012.

Real Estate Requirements

- **Fee Purchase:** Approximately one acre of land will need to be obtained from the San Luis Canal company to contain the fish screen.
- **Access Rights:** Land between the old Arroyo canal headworks and the existing headworks, including space on the banks for vehicles, will be required for permanent access to the structure. Land where the pump house on the north bank and above the path of the underground pipe will also require permanent access.
- **Permanent and Temporary Easements:** A temporary easement will be necessary to provide space construction staging and laydown. A permanent easement with width of approximately 40 feet will also be required for the underground pipe carrying fish from the structure back to the river.
- **Flowage Easements:** A temporary flowage easement will be required for the temporary diversion of the San Joaquin River around the construction site into Arroyo Canal

Coordination with Other Options

The Arroyo Canal does not rejoin the river once water is diverted and represents an entrainment hazard if a screen is not constructed. This option would be required if fish are to travel along the main stem of the San Joaquin River between Mendota Pool and the Sand Slough Control Structure.

If it is desired to not build a fish screen, an alternative form of transport for water to supply the canal would have to be adopted, such as diverting water for Arroyo Canal through an expanded Helm's ditch from the Mendota Pool. This assumes that the bypass is built around Mendota Pool preventing fish from entering the Pool.

Operational and Maintenance Requirements

- **Operations**

This fish screen will be operated by a Programmable Logic Controller (PLC). Sensors will communicate to the PLC the water level in the river, the flow rate to the Arroyo Canal, the head differential across the screens, and other pertinent operation data. The PLC will control the screen cleaners, the speed of the pump, and the trash rack cleaner. The site will not require full-time attendance, although inspections and debris removal may be required based on weather and other factors. An off-site control center will be utilized to monitor alarms from the PLC.

- **Maintenance**

The trash rack cleaner will move debris from the screens to a debris bin next to the structure. The debris bin will need to be serviced approximately once per week, as necessary. Sediment build-up is anticipated to be an issue, and the structure will have to be dewatered once per year to remove sediment.

- **Monitoring Requirements**

A hydraulic evaluation will be required to adjust baffles and make sure the fish screen is operating within specified criteria, especially the approach velocity to the screens. Biological evaluation might be required, as specified by the Fishery Group.

Future Requirements for Design

- A rating curve for the river will be necessary to finalize the screen height and invert elevation.
- Operation of Sack Dam including head drop across the dam at all flow rates and better definition of the water level able to be maintained at the screen entrance.
- Sedimentation rates in the river to evaluate the effectiveness of a sediment control system.
- Permitting Requirements

Potential Environmental Impacts

- **Temporary (During Construction)**
    - Operation of the Helm Ditch canal will be impacted and not operable for a brief period during construction as a result of the temporary water supply channel.

- **Permanent (Operation-Related)**
    - Operation of a fish pump will have some impact on fish health.
    - Maintaining a water surface at the fish screen will require Sack Dam to operate sluice or spill gates automatically to maintain a desired forebay. A fish ladder will be required around the dam for migrating salmonids.

Sub-Options considered but Rejected

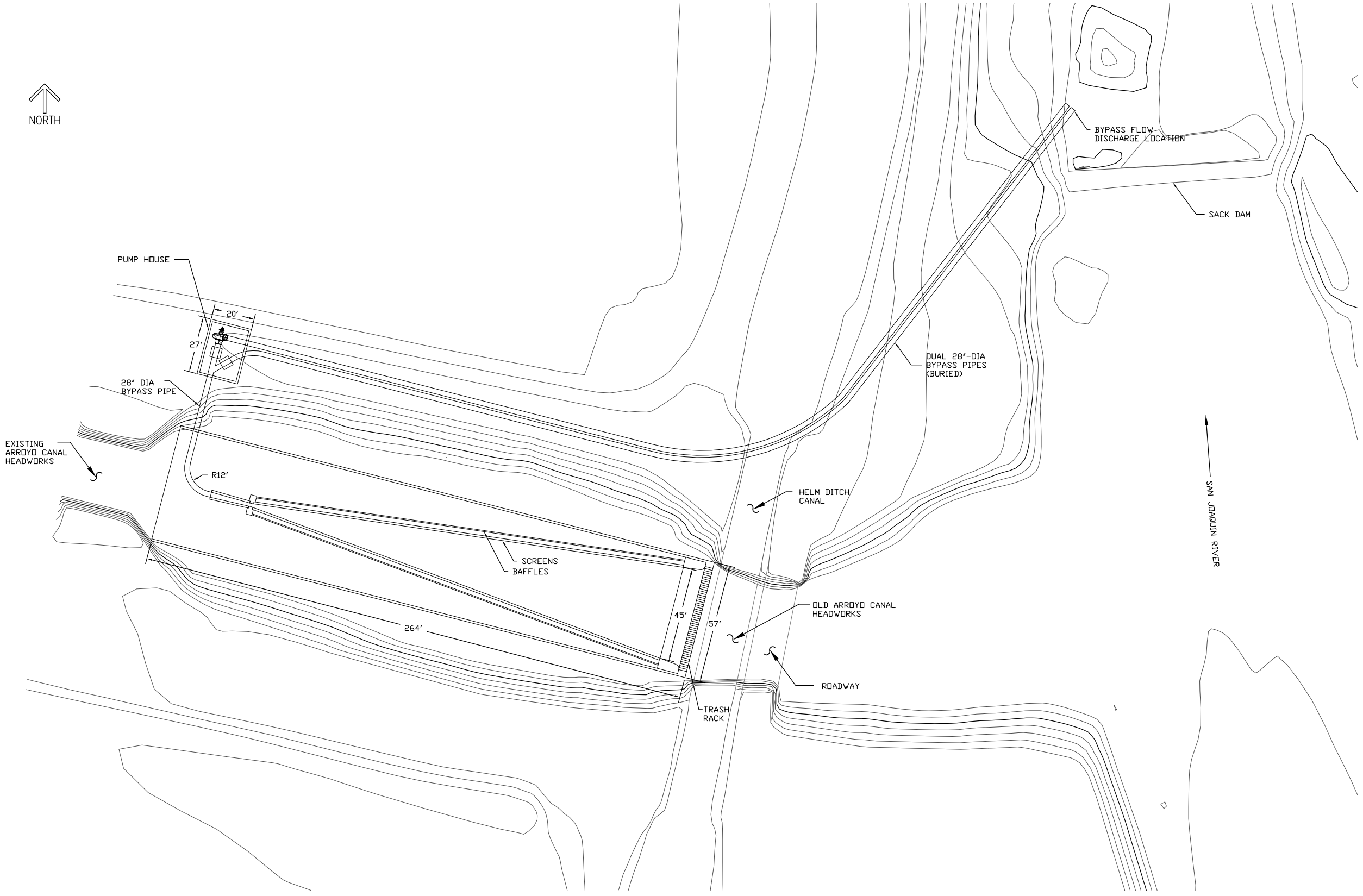
No sub-options considered for this task. However, an alternative might be to increase the capacity of Helms Ditch to the Arroyo Canal to carry the 600 cfs to Arroyo Canal. A fish screen would not be required since fish will be prevented from entering the Mendota Pool by the bypass channel.

Drawings

6-1 Site Plan
6-2 Fish Screen and Bypass Pipe Profiles

Attachments

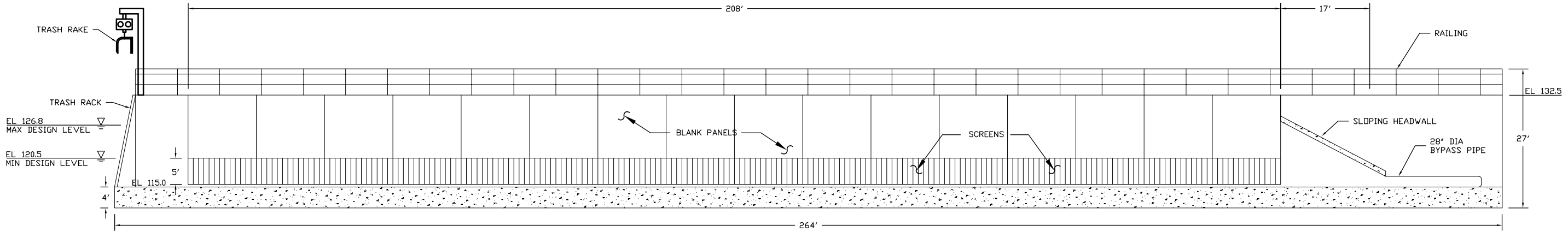
6-1 Photo 1: Arroyo Canal Existing Headworks (u/s)
6-2 Photo 2: Arroyo Canal Old Headworks (d/s)
6-3 Photo 3: Sack Dam (u/s)



GRAPHIC SCALE

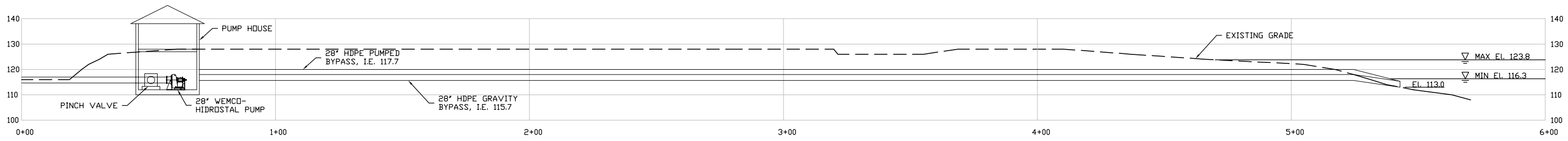
0 50' 100' 150'

DRAWING 6-1: SITE PLAN



FISH SCREEN PROFILE
1"=20'

GRAPHIC SCALE
0 20' 40'



BYPASS PIPE PROFILE
1"=40'

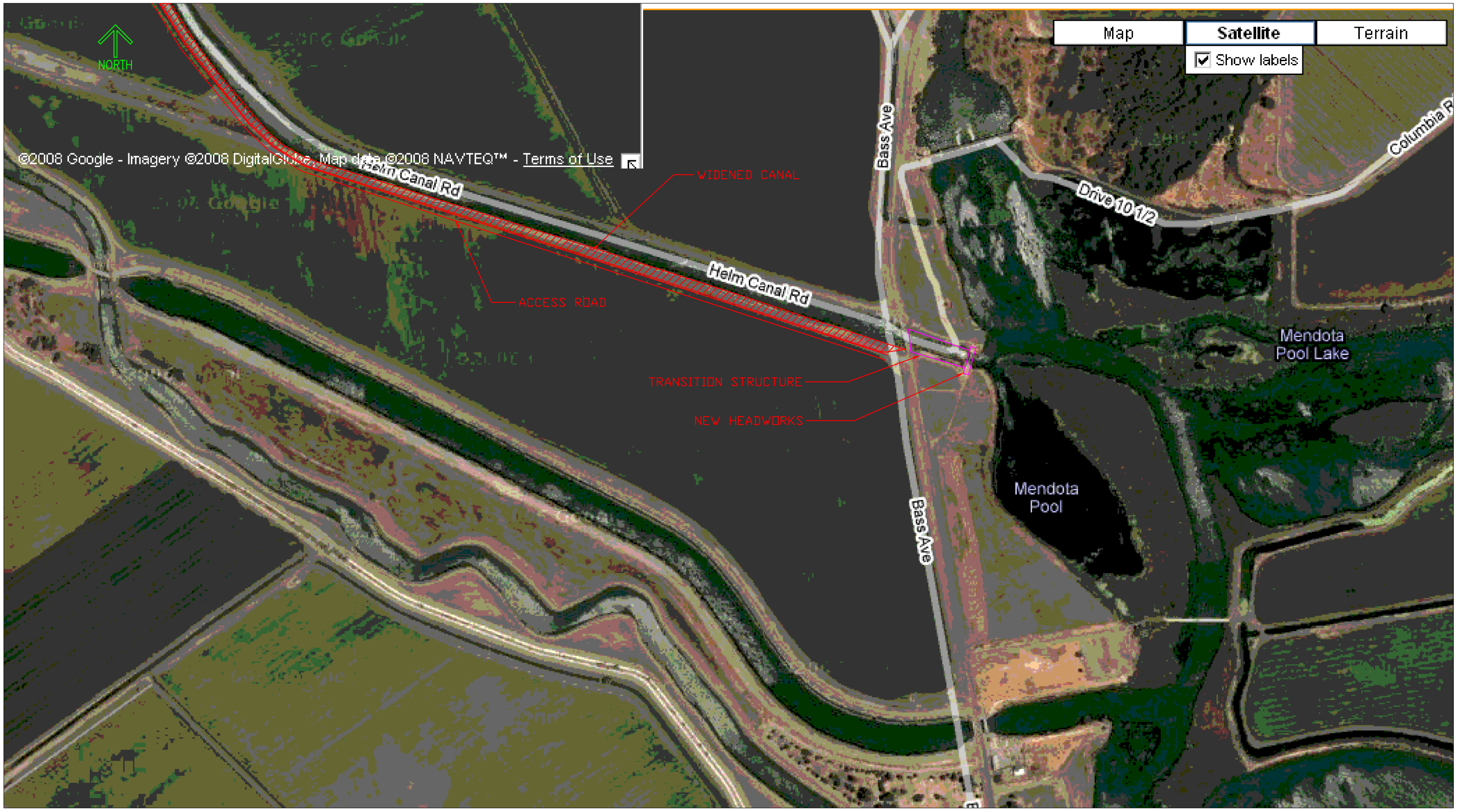
GRAPHIC SCALE
0 40' 80'

DRAWING 6-2: FISH SCREEN AND BYPASS PIPE PROFILES

Attachment 6-1:
Photo 1 - Arroyo Canal Existing Headworks (u/s)

Attachment 6-2:
Photo 2 - Arroyo Canal Old Headworks (d/s)

Attachment 6-3:
Photo 3 - Sack Dam (u/s)



0 400 800

Scale: 1"=400'

Alternative 6B - Supply Arroyo Canal from Mendota Pool

Plan - Sheet 1 Of 22

Drawing 6B-1

0 400 800

Scale: 1″=400′

Alternative 6B – Supply Arroyo Canal from Mendota Pool
Plan – Sheet 2 Of 22

Drawing 6B-2