DRAFT

FEASIBILITY LEVEL CONCEPTUAL DESIGN

CONSTRUCTED WETLANDS OUTLET STRUCTURE FISH SCREENS
Eastern Municiple Water District
Riverside County, California

Prepared by

Joseph Kubitschek
Water Resources Research Laboratory

United States Department of the Interior
Bureau of Reclamation
Technical Services Center
Denver, Colorado 80225

July 1996

Introduction

The multipurpose constructed wetlands are owned and operated by the Eastern Municipal Water District (EMWD) located in Riverside County, near the towns of Hemet and San Jacinto, California. Recent concerns have developed over the introduction of the stickleback (*Gasterosteus aculeatus*) and mosquito (*Gambusia spp.*) fishes into the wetlands. It is felt that there is significant potential for clogging of irrigation sprinkler heads if these fish were to become entrained into outlet structure flows. Hence, positive barrier fish screens have been proposed for application at each of four existing outlet structures. The purpose of these screens is to exclude fish and debris from wetlands outflow entrainment. Figure 1 represents an overall plan view of the demonstration wetlands located on the Hemet/San Jacinto RWRF (Regional Water Reclamation Facility). Each of the four outlet structures are located at the apex of the outlet marsh as shown. Recent discharge records and design information indicate that each of the outlet structures is designed to pass up to 0.39 ft^3/s under normal operating conditions. However, peak flow conditions have been identified such that each outlet structure may be required to pass up to 1.16 ft^3/s, currently. Ultimately, there is future potential for increased peak flow conditions such that each outlet structure may be required to pass up to 1.9 ft^3/s. This potential future peak flow discharge has been used for the design of the proposed screen configurations for this application.

Concept Description

Although many alternatives exist for this type of screen application, cost has been given highest consideration. The least expensive alternative, at least in the short term, is likely a retrofit of the existing outlet structure to include a flat panel, vertical profile-wire screen. A total screen area of 9.5 ft^2 for each outlet structure is required to maintain a maximum normal component velocity of 0.2 ft/s over the screen face. Figure 2 represents the conceptual layout of this proposed alternative. The screen is comprised of 3/32-in pre-fabricated profile wire with a 50% open area, and is available from several vendors. Stainless steel is the recommended material of construction and is required to minimize corrosion. The screen cost is approximately $65/sq-ft for type 304 stainless steel. Alternate materials of construction may be required to prevent bio-growth on the screen and should be considered carefully. The bulk of the cost will be incurred in the fabrication and installation of each bulkhead/screen assembly and related support structure. The existing stoplog slots, located upstream of the weir gates, may be used to support the bulkhead/screen assembly, if available. This would allow for the removal and replacement of the bulkhead/screen assembly for periodic inspection and maintenance. Furthermore, the screen is intended to be removable from the bulkhead and support structure for periodic inspection and maintenance of the screen itself. The screen should in any case extend the full depth of the water column to minimize the influence it may have on the flow measurement device. In addition, slack water zones in front of the screens may be minimized to prevent debris accumulation. An automated cleaning system has not been included in this concept. Manual cleaning will be required. The screen may be cleaned in place using a suitable brush or rake, or it may be removed entirely for further cleaning or repair. Integration of an automated cleaning system would likely triple the cost. However, this opportunity would still be available in the future should automated cleaning be required.

Considerations

Some important considerations should be addressed in assessing the feasibility of positive barrier screens for this application.

Biological:

Many of the resource agencies have developed screening criteria which are specific to the target species and debris conditions for a particular application. Since this application is unique, consideration should be given to how the target species in this case will react to the hydraulic conditions created by the screen. From a fish protection standpoint, minimizing fish impingement on the screen is the primary objective. Currently, The California Department of Fish and Game requires that the normal component velocity along the screen not exceed 0.33 ft/s. In addition, a sweeping to normal component velocity ratio of not less than 2:1 is required. However, this criteria was specifically developed for the protection of salmonids based upon the swimming capabilities of various life stages. The maximum normal component criteria is required to minimize fish impingement potential. The sweeping to normal component velocity ratio is required to maintain fish movement along the screen; to minimize exposure time; and to facilitate cleaning of the screen. For this application, the sweeping to normal component velocity ratio will be non-existent. Thus, it is recommended that the swimming capability of the target species be determined. This will allow for the development of the maximum normal component or through-screen velocity which may be tolerated. Consequently, the screen size based upon discharge may be determined. If no information is available regarding the target species swimming capabilities, the best approach for this application may be to oversize the screens by a reasonable amount. The screen described for this application has been sized such that the normal component of velocity at the screen does not exceed 0.2 ft/s. The fact that no sweeping component of velocity along the screen will exist given the proposed concept, implies further important considerations.

Debris Load and Cleaning:

Due to the unique requirements of this application, the proposed screen concept presents unique problems associated with debris fouling and the corresponding cleaning requirements. Screen performance will be directly dependent upon site specific conditions which include: types of debris; amount of debris (debris load), and frequency of cleaning. The first two site specific characteristics will likely establish the cleaning requirements. Profile wire screen has been selected since the debris fouling characteristics of this type of screen have consistently proven to be better than wire mesh or perforated plate for nearly all types of debris. In addition, this type of screen has proven to be easier to clean. The trade-off is that this type of screen is more expensive. However, in the long term it may prove to be less expensive when considering the manual cleaning requirements.

Materials of construction should receive consideration in assessing the feasibility of screening for this application. Bio-growth on the screen itself may be a problem. Typically profile wire screens are constructed of type 304 or 316 stainless steel. However, alternate materials of construction may be specified for solving potential growth problems. In this case cost will increase.

Hydraulic:

The retrofit of the existing outlet structures to include positive barrier screens will directly affect existing hydraulic conditions. The first influence will be increased headloss and reduced outlet structure capacity for a given water surface elevation. This will be further compounded with increased debris loads and consequent debris fouling of the screens. This condition alone may influence assessment of the proposed concept feasibility. In any case, it will certainly contribute to establishing cleaning requirements.

Another important consideration is the proposed concepts influence on the existing flow measurement device for each outlet structure. Each outlet structure is equipped with a v-notch weir for flow measurement. Screen induced turbulence may affect the accuracy of this device since it is in close proximity. This effect will be further compounded with increased debris fouling. An alternate flow measurement device may be required should this concept be selected. Careful consideration should be given in this case prior to screen installation.

Finally, the fact that no sweeping component of velocity will exist for this proposed concept increases the potential for fish impingement and debris fouling. However, these problems may be overcome by the selection of a larger screen area, as specified in the concept description, and suitable cleaning procedures.

Structural:

The proposed concept will make use of the existing stoplog slots located upstream of the weir gate. An analysis should be performed to verify the adequacy of the stoplog slots for this purpose. The advantage of using the existing stoplog slots is that the screen/bulkhead structure may be easily removed and replaced during periodic inspection and maintenance. In addition, this will minimize installation costs.

A support structure should be designed for the screen which is suitable for ensuring structural integrity of the screen and to transfer hydrostatic loads to the outlet structure via the existing stoplog slots. The structure should be specified to sustain the entire hydrostatic load. This is required should the screen become fouled to a degree that causes de-watering of the structure downstream. Furthermore, since the sloplog slots will be occupied by the screen structure, de-watering of the outlet structure for inspection and maintenance will not be available using stoplogs. In this case, bulkheads may be placed over the screens or the screens may be replaced with flat plates for this purpose.

Cost Estimate

The estimated costs associated with the design, fabrication, and installation of each proposed screen for the four outlet structures will be comprised of the following:

ITEM	COST
Design	$408
Pre-fabricated Screen	$155
Support Structure Fabrication	$1,796
Assembly	$864
Installation	$1,296
Contingencies (5%)	$226
Total Cost	$4,745

The above estimate represents the cost per screen and does not include travel or per diem should our shops be tasked with this work. The total cost of screening all four outlet structures is estimated as $18,980. This figure does not include maintenance costs associated with manual screen cleaning. The pre-fabricated screen cost reflects type 304 stainless steel as the material of construction. The cost will increase significantly should alternate materials of construction be specified in the event that bio-growth is identified as a real problem. Finally, this estimate does not include an automated cleaning system. The integration of an automatic cleaning system is likely to significantly increase the cost associated with screening for this application.

Recommendations

The most important consideration associated with the assessment of viability for this application is the site specific conditions associated with debris and potential screen fouling. Manual cleaning may become a costly venture if debris loads are excessive or the potential for bio-growth on the screen exists. It is recommended that a survey of debris types and amounts be conducted prior to screen design and installation. It is also recommended depending upon the findings of this survey, that a single outlet structure be equipped with this screen concept for a period long enough to assess performance characteristics under site specific debris conditions. Finally, consideration from an operations and maintenance standpoint should be given to each of the topics described in this document. In short, this is a difficult screening application and has the potential to create extensive maintenance problems if each of the considerations are not carefully addressed.

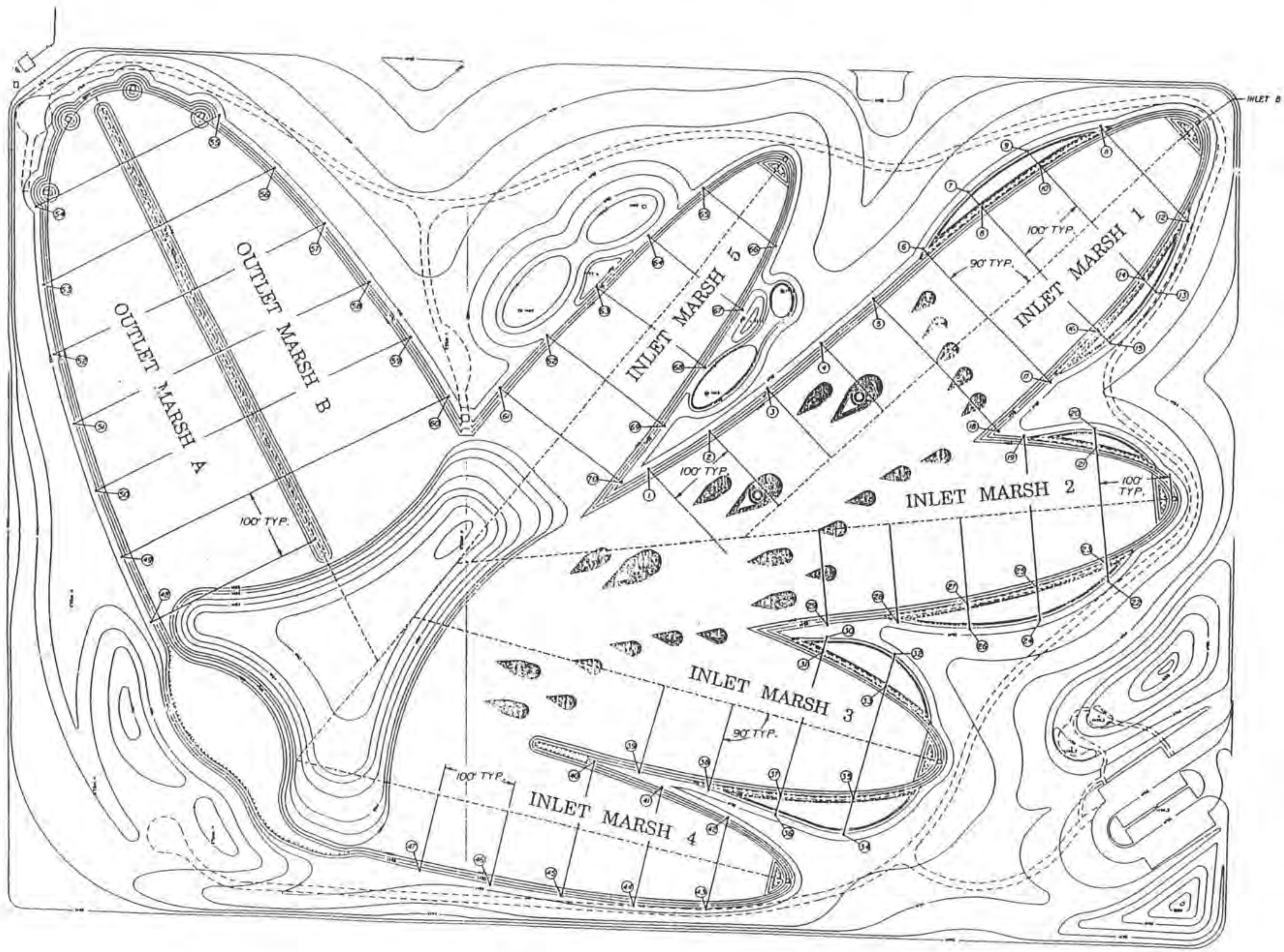

Figure 1. - Basic plan view of Hemet/San Jacinto Constructed Wetlands.

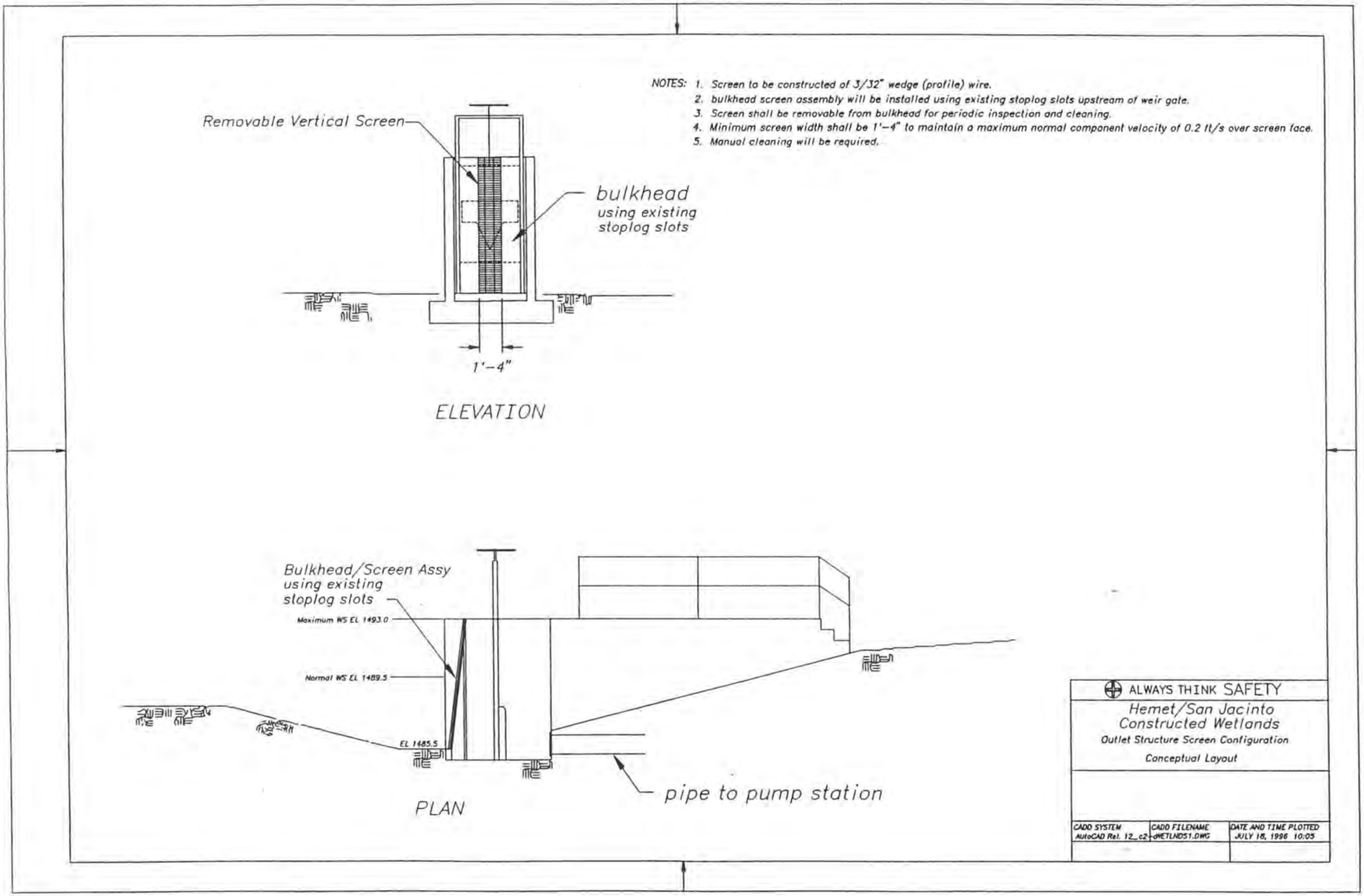

Figure 2. - Conceptual layout of proposed screen concept for each outlet structure.