

**Appendix D1. Annotated List of Geotechnical Reports
Prepared for the Delta Wetlands Project**

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Harding Lawson Associates, Inc. 1989. Preliminary geotechnical investigation for the Delta Wetlands project. By K. Tillis, E. Hultgren, and C. Wood. February 15, 1989. (HLA No. 18749,001.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents the results of a preliminary geotechnical investigation performed by Harding Lawson Associates (HLA) for the Delta Wetlands (DW) project. The investigation was to provide preliminary geotechnical design for the project. The report describes the results of collecting available data on soil conditions and physical properties of Delta levees and foundation materials and of exploring subsurface conditions to define site stratigraphy and obtain soil samples for visual observation and laboratory testing. The report also provides preliminary conclusions and recommendations regarding geotechnical engineering concerns.

HLA's field investigations consisted of drilling, logging, and sampling exploratory borings; performing cone penetration test soundings; and installing and monitoring piezometers at representative locations around the island perimeters. Soil samples were collected and analyzed from levees and levee foundations on each of the project islands. Soil tests included particle size analyses, consolidation tests, and the determination of soil moisture content, dry density, shear strength, and permeability. The effects of levee reconstruction on levee settlement were estimated from the boring data, soil sample consolidation test results, and published data on settlement of fill material placed on peat soils of the Delta. HLA analyzed slope stability toward island interiors and toward Delta channels for the existing, after-construction, and long-term conditions.

_____. 1990a. Project status report: McDonald Island drawdown demonstration. By K. Tillis, D. Holloway, and E. Hultgren. February 22, 1990. (HLA No. 18749,013.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report summarizes results of the McDonald Island drawdown demonstration study. The purpose of the investigation was to demonstrate that hydraulic head within the sand aquifer can be lowered by pumping through a groundwater relief well system, and that similar systems would be viable options for controlling seepage resulting from the operation of DW reservoirs. HLA conducted a field investigation to confirm stratigraphy and install observation piezometers and the relief well system between July 10 and September 1, 1989. Water levels were then monitored before, during, and after the pumping phase of the demonstration (November 14, 1989, to January 24, 1990). The report concludes that pumping is effective in controlling essentially all seepage into the island, as indicated by the flattening of the hydraulic grade line beneath the island interiors.

_____. 1990b. Groundwater data transmittal, Delta Wetlands monitoring program. By D. Holloway, K. Tillis, and E. Hultgren. April 12, 1990. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents groundwater monitoring data collected through March 1990 for a groundwater monitoring program performed by HLA for the DW project. The groundwater monitoring program is to provide baseline information on existing groundwater levels in the Delta. Data were obtained from a network of piezometers installed to monitor pore pressure (i.e., hydraulic head) within the sand aquifer at varying locations on the DW islands and other Delta islands. Water levels were measured weekly during spring 1989, and from fall 1989 through March 1990. To supplement manual measurements, water-level data were continuously recorded for 1-2 weeks at a time. The report presents boring logs, results of grain size analyses, well completion diagrams for 27 piezometers, and data on groundwater level.

_____. 1990c. Project status report: McDonald drawdown demonstration Phase II. By K. Tillis, D. Holloway, and E. Hultgren. November 19, 1990.

(HLA No. 18749,013.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents results of a Phase II drawdown demonstration study performed by HLA for the DW project. The purpose of the Phase II study was to demonstrate that artesian head in the sand aquifer can be lowered by a groundwater gravity dewatering system for seepage control. Between June and mid-July 1990, the existing relief well system (pump system) was converted to a gravity-flow system, in which groundwater flows from wells into seepage ditches by artesian pressure in the sand aquifer. The report concludes that, based on groundwater level monitoring, the gravity flow system shows results that are similar to those of the pumped well system.

_____. 1991a. Groundwater data transmittal No. 2, Delta Wetlands monitoring program. By D. Holloway, K. Tillis, and E. Hultgren. January 7, 1991. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents the status of the groundwater monitoring program described above (HLA 1990b). This report presents data collected from March to December 1990. Seven additional piezometers were installed in September 1990, resulting in a total of 34 piezometers on 17 Delta islands. Groundwater data for the piezometers from March through December 1990 are presented in this report.

_____. 1991b. Interceptor well modeling for the Delta Wetlands project. By D. Holloway, K. Tillis, and E. Hultgren. (HLA No. 18749,016.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents the results of HLA's groundwater modeling effort for the DW project. The model simulated various pumping well systems located on DW island levees for controlling groundwater flow off the island. The purpose of the study was to establish parametric relationships that could serve as the basis for conceptual design of pumping and interceptor well systems on DW islands. The goal of the modeling was to simulate groundwater withdrawal required to offset the increase in head in the sand aquifer, keeping groundwater levels on neighboring islands unaffected by water storage on the DW islands. The report describes the modeling approach and procedures and results of three conceptual aquifer system models. Results of the study provide a range of well spacing distances for corresponding ranges

of aquifer properties, system dimensions, and pumping rates.

_____. 1991c. Groundwater monitoring plan for the Delta Wetlands project. By D. Holloway, K. Tillis, and E. Hultgren. January 23, 1991. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This document presents a seepage monitoring plan for the DW project. The report describes the rationale for spacing of piezometers on neighboring islands. The proposed piezometer locations are shown on a regional map. Piezometers are planned for all levee reaches located across from DW reservoir islands. Additional piezometers are proposed at locations remote from the reservoirs to provide data on general Delta-wide groundwater level variations for comparison with water level fluctuations near DW reservoirs during project operation. The report describes methods for evaluating the groundwater level and outlines criteria for determining whether a net seepage impact is occurring.

_____. 1991d. Seepage control program for the Delta Wetlands project. By D. Holloway, K. Tillis, and E. Hultgren. January 24, 1991. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report summarizes existing conditions on and adjacent to the DW project islands and outlines a seepage control program for the DW project. The program is based on information and recommendations presented in HLA's preliminary geotechnical investigation, McDonald Island drawdown demonstration project status reports, groundwater data transmittals, and interceptor well modeling reports. The report describes potential seepage effects of farming, wetland management, and reservoir management and outlines potential measures to control seepage, including cutoff walls, interceptor wells, and relief wells.

_____. 1992a. Wave erosion monitoring and mitigation for the Delta Wetlands project. By K. Tillis and E. Hultgren. January 6, 1992. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report describes measurable performance standards, monitoring, and mitigation measures for wave erosion on the interior slopes of the DW project levees. This report assumes a spending beach design for the

interior levees. (The current project description for this environmental impact report/environmental impact statement [EIR/EIS] does not include spending beach design.)

_____. 1992b. Monitoring and mitigation of geotechnical impacts on State Route 12 for the Delta Wetlands project. By K. Tillis and E. Hultgren. January 7, 1992. (HLA No. 18749, 007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents a proposed design for a new dam to impound a reservoir south of State Route 12 on Bouldin Island. The report describes proposed drainage structures, performance standards for settlement and shallow groundwater, potential and anticipated geotechnical effects of the new dam, and monitoring needs. This proposal is for the four-island, maximum fill alternative (Alternative 3).

_____. 1992c. Seepage monitoring and mitigation for the Delta Wetlands project. By K. Tillis and E. Hultgren. January 8, 1992. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report provides an overview of seepage issues that affect Delta islands and how water storage on one island may affect an adjacent island. This report proposes a seepage monitoring plan and measures to mitigate seepage.

_____. 1992d. Phreatic surface in perimeter levees for the Delta Wetland project. Letter report by K. Tillis and E. Hultgren to J. Winther, President, Delta Wetlands. January 9, 1992. (HLA No. 18749,007.03.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This letter report addresses the anticipated level of phreatic surface within the buttressed perimeter levees on the DW project islands. The phreatic surface (free water surface) is the level below which groundwater would seep into an excavation, boring, or well. To estimate the phreatic surface, HLA created flow nets to assess seepage through the levee. The report describes factors affecting the phreatic surface and results of analyses conducted on Holland Tract. The report concludes that the phreatic surface would rise as fill is placed for levee reconstruction.

_____. 1992e. Geotechnical investigation and design for the Wilkerson Dam on Bouldin Island. By K. Tillis, S. Vahdani, and K. Bergman. May 27, 1992. (HLA No. 11472-008.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents the results of a geotechnical investigation and design studies for Wilkerson Dam on Bouldin Island. The purpose of the investigation was to develop design criteria appropriate for a dam that falls under the jurisdiction of the State of California (California Department of Water Resources' Division of Safety of Dams). The report describes site conditions, design considerations, and several analyses performed to design Wilkerson Dam. Two alignments were investigated in detail as part of the study.

The study included an extensive field investigation using cone penetration test probes, borings, piezometers, down-hole seismic techniques, and a test fill constructed on peat. Laboratory tests were also conducted to evaluate strength and compressibility characteristics of soft marsh deposits, grain size distribution of sandy soils, permeability of planned fill and in situ soils, and basic index properties. Results of these analyses were used to develop engineering parameters for design. This proposal is for the four-island, maximum fill alternative (Alternative 3).

_____. 1992f. Groundwater data transmittal No. 3 Delta Wetlands monitoring program. By K. Tillis and E. Hultgren. June 25, 1992. (HLA No. 18749,007.03 [11471.007].) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report presents the status of the groundwater monitoring program described above (HLA 1990b). This report presents data collected from December 1990 to October 1991. Groundwater data for the 34 piezometers discussed above are presented in this report.

_____. 1993a. Geotechnical evaluation of perimeter levees for the Delta Wetlands project. Letter report by K. Tillis and E. Hultgren to J. Winther, President, Delta Wetlands. November 16, 1993. (HLA No. 11471,007.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This letter report discusses the results of the geotechnical evaluation for perimeter levee improvements planned in response to revisions to the DW project and alternatives description. The impact of planned levee improvements on slope stability were evaluated for two

different existing levee conditions. Changes in the factor of safety from existing conditions were computed for the revised levee reconstruction design.

_____. 1993b. Description of Wilkerson Dam on Bouldin Island for the Delta Wetlands project. Letter report by K. Tillis and E. Hultgren to J. Winther, President, Delta Wetlands. November 17, 1993. (HLA No. 11471,007.) Concord, CA. Prepared for Delta Wetlands, Lafayette, CA.

This report describes in conceptual terms the size and nature of Wilkerson Dam under the revised four-island, maximum storage alternative (Alternative 3). This information is presented in Appendix E1, "Design and Construction of Wilkerson Dam South of SR 12 on Bouldin Island".