BEFORE THE STATE WATER RESOURCES CONTROL BOARD

WSID CDO/BBID ACL ENFORCEMENT ACTIONS

ENFORCEMENT ACTION ENF01949 DRAFT CEASE AND DESIST ORDER REGARDING UNAUTHORIZED DIVERSIONS OR THREATENED UNAUTHORIZED DIVERSIONS OF WATER FROM OLD RIVER IN SAN JOAQUIN COUNTY	WRITTEN TESTIMONY OF THOMAS K BURKE, P.E.
ENFORCEMENT ACTION ENF01951- ADMINISTRATIVE CIVIL LIABILITY COMPLAINT REGARDING UNAUTHORIZED DIVERSIONS BY BYRON-BETHANY IRRIGATION DISTRICT	Hearing Date: March 21, 2016 Hearing Officers: Frances Spivy-Weber, Tam Doduc

1. I, Thomas Burke, submit this written testimony at the request of West Side Irrigation District (WSID), Central Delta Water Agency (CDWA), and South Delta Water Agency (SDWA) in the above referenced enforcement actions. The matters contained herein are true and correct and based upon my personal knowledge. If called upon to testify to them, I would and could do so.

Background and Qualifications

2. I am a hydrologist and water resources engineer with over 35 years of experience in surface water and groundwater hydrologic modeling. Prior to starting Hydrologic Systems Inc., I held the position of Senior Associate with PWA, Western Regional Director of Water Resources for EA Engineering Science and Technology, and Hydraulic Engineer with the US Army Corps of Engineers. My experience ranges from development of two and three dimensional river and reservoir flow and circulation models to local and regional groundwater and transport models for basin-wide

hydrologic analyses. My experience also includes the analysis of one and two-dimensional flow in river and wetland systems.

3. I hold a Master of Science in Civil Engineering from Colorado State University, Fort Collins (1992) and hold a Bachelor of Science in Civil Engineering from The University of Florida, Gainesville (1980). A copy of my current resume and list of representative experience is attached hereto.

4. I was retained in these matters by WSID, CDWA and SDWA to: 1) review and analyze the availability of water for diversion at the WSID and BBID points of diversion in the summer of 2015 as it relates to source and quality, and 2) the impact on Old River from WSID diversions of between 8 cfs to 14 cfs of treated wastewater discharged upstream from the City of Tracy.

5. I have prepared a report summarizing my conclusions, marked as Exhibit WSID0124. I hereby incorporate that report as part of my written testimony.

6. I have also prepared a technical memorandum analyzing the effect of WSIDôs diversion during the summer of 2015 on Old River. My technical memorandum is marked Exhibit WSID0125. I hereby incorporate the technical memorandum as part of written testimony.

Delta Hydrology and Hydrodynamics

7. Any analysis of water quality or availability in the Delta must begin with fundamental understanding of the hydrodynamics of the Delta. The Delta is connected to San Pablo Bay and San Francisco Bay through the Carquinez Straights. San Francisco Bay is connected to the Pacific Ocean. This connection allows the ocean tide

to move water that is west of the Delta into the Delta during the incoming tide. As such, the Delta is tidally influenced which results in a constant resupply of water to the Delta, including the WSID point of diversion, each day. The water entering the Delta from the west mixes with the water that is entering the Delta from the San Joaquin River, Sacramento River, and other small tributaries along the east side of the Delta.

8. The tide moving into the Delta as measured at the City of Martinez, which lies along the Carquinez Straights, is approximately 6 feet from the mean higher tide to lower low tide. Consequently, the tide moving into the Delta essentially equates to a 6 foot slow moving wave of water entering the Delta each day. The area between high and low tide lines is called the tidal prism. The tidal prism defines the volume of water which is moved into the Delta with each tide cycle. The area below the tidal prism never dries out. In addition to the volume of water within the tidal prism, there is water in the channel below the tidal prism which is also flowing into the Delta with each tidal cycle. Over a typical cycle during the summer months approximately 170,000 acre feet of water moves into the Delta twice each day. There are two tidal cycles each day. Typically one cycle is higher than the other. As such, there are two high tides and two low tides.

9. The Delta channels, including Old River, do not act like typical stream channels. Although it may appear counter-intuitive to some, water does not flow downhill. A basic law of physics is that water flows from a high head location to a low head location. In a typical stream the slope is the dominant factor that creates a high head location. But in a flat channel with little to no slope, the high head to low head condition can be created by pumping water out of the channel. If water is pumped from

one of the channel, the slight lowering of the water surface at that location creates a low head condition and water will flow in that direction, thus filling in water levels and mitigating the impact of most diversions. In the Delta there is a network of interconnected relatively flat channels. The complete network of channels in the Delta responds by moving water directly toward the direction, such as the WSID point of diversion, where a withdrawal has occurred. Given the numerous withdrawals in the Delta, and the effect of the tides, water is always moving back and forth in the channels but the elevations of the water in the channels experience little change.

10. Because of the interconnectivity to the Bay, the Delta channels, including Old River, always have water and, thus, during 2015 there was always water available at the WSID and BBID points of diversion.

WSID Diversion Analysis

11. With this basic fundamental understanding of hydrodynamics of the Delta, I conducted an analysis of the effects WSIDôs diversion of between 8 cfs and 14 cfs on Old River. Using the DSM2 model developed by DWR, analyzed the diversions by developing three separate DSM2 model scenarios. The first represented a condition where no diversion existed at the WSID point of diversion. For the second and third scenarios I ran DSM2 with an applied 8 cfs and 14 cfs diversion, respectively, at the WSID point of diversion. The difference in water surface elevation between these three scenarios was evaluated to determine the effect that each diversion had on the water in the channel at the WSID point of diversion.

12. For the 2015 period based results of the DSM2 model, the 14 cfs diversion reduced water level in the channel at the WSID point of diversion by an average of 0.005 feet with a maximum difference of 0.008. The 8 cfs diversion reduced the water level in the channel at the WSID point of diversion by an average of 0.003 feet with a maximum of 0.005 feet. A reduction in the water surface elevation for anything less than 0.01 feet is essentially zero, as it represents a measurement that is too small to be recognizable in the field and is within the error range of the model's calibration. As such, the reduction in water surface elevation from the 8 cfs and 14 cfs withdrawals at the WSID point of diversion is too small to be accurately measured by the model and is considered inconsequential. Figures 3-13 and 3-14 of my report depict the limited effects of the 8 cfs and 14 cfs diversions, respectively. As can be seen from those figures, the diversion of 14 cfs and 8 cfs have no impact on the available water in Old River.

13. It should be noted that I ran the model for 2014 and 2015 but chose June 2015 because it was representative of the typical summer conditions in both 2014 and 2015. It was also very near the time when the draft CDO and ACL complaint were issued against WSID and BBID so closely reflects the conditions at the time. Averaging the difference in scenarios over most other non-runoff periods would not result in any significant differences.

14. It should also be noted that flow is not an appropriate metric to measure the potential for impact when you are evaluating a diversion from a network of tidally influence channels. The flow in a network of tidally influenced channels is always changing, in magnitude as well as direction. The diurnal tidal refilling of the channels

within the network negates the concept that a reduction in flow is a reduction in water availability. An analysis changes in water level at or near the diversion point is a more appropriate metric for measuring the potential for an impact of a diversion on other nearby diverters.

Analysis of Water Quality and Availability

15. The water quality analysis which I conducted evaluated the historic water quality conditions that occurred during the 1930ôs, specifically the 1931 and 1939 drought years. Those two years, due to their similarity to the 2014 and 2015 drought years, provide a very good view into how the Delta responds in drought years with respect to water quality without the influence of the State Water Project and Central Valley Project (the ñProjectsò). The historic data collected at Clifton Court Ferry, Whitehall and Mansion House are representative of what the water quality would be at the points of diversion for the BBID and WSID. The data clearly show that the salinity, during these drought years, did not start to rise until the beginning of August, and didn't peak until late September and early October. This is well beyond the primary growing season. The BBID and WSID diversion data for the 1930ôs and the amount of acreage that was being irrigated during those drought years was on par with the acreage and irrigation diversions during wet years during the 1931 to 1943 period.

16. Using the DSM2 model, I also analyzed the source flow fingerprint analysis for 1931 and 1939 which showed that a significant amount of Sacramento River water naturally entered into Old River over the summer. The model indicated that Sacramento River water entering the Delta during these dry years exhibited a 4 month

delay prior to reaching the BBID and WSID PODs. Also, in the 1931 and 1939 Pre-Project conditions, the March, April, and May inflow from the Sacramento River amounted to a significant portion of the volume of water at the diversion points later in the summer.

17. Based on the fact that during the 1931 and 1939 drought years measured salinity levels did not rise until late in the year (at the end of the prime growing season), and there was no noticeable decline in irrigation diversions or irrigated acreage at BBID or WSID (when compared to normal or wet years) it is my opinion that the water quality during these two drought years did not hinder irrigation diversions.

18. From the results of a source flow fingerprint analysis, it is my opinion that a significant amount of Sacramento River water flows into Old River over the course of a summer, helping to keep the salinity levels down.

19. Given that the 1931 and 1939 water years were dryer than the 2014 and 2015 water years, it is my opinion that they provide a good, conservative proxy for determining water quality and availability at the WSID and BBID points of diversion during 2014 and 2015 without the influence of the Projects. Given that no noticeable reduction in irrigation diversions were observed in 1931 or 1939, I would expect that the water quality in 2014 and 2015 would have been acceptable for irrigation as well, especially since they were not as dry as 1931 and 1939. These acceptable water quality levels, as well as the physical reality that there is always water in tidally influenced Delta channels such as Old River, support my opinion that water would have been available for diversion by WSID and BBID in 2015 without the influence of the Projects.

I declare under penalty of perjury under the laws of the state of California that the foregoing is true and correct.

Executed this 19 th day of January in Sacramento, California.

Thomas K. Burke

THOMAS K BURKE, P.E.

Exhibit A - Resume

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Senior Water esources ngineer

Mr. Burke is a hydrologist and water resources engineer with over 35 years of experience in surfacewater and groundwater hydrologic modeling. Prior to starting Hydrologic Systems Inc., he held the position of Senior Associate with PWA, Western Regional Director of Water Resources for EA Engineering Science and Technology, and Hydraulic Engineer with the US Army Corps of Engineers. His experience ranges from development of 2-, and 3-dimensional river and reservoir flow and circulation models to local and regional groundwater and transport models for basin-wide hydrologic analyses. His experience also includes the analysis of one and two-dimensional flow in river and wetland systems. In his work, he has gained experienced in both steady and unsteady flow modeling in regional groundwater systems, estuaries, as well as fish passage and habitat analysis. Mr. Burke has performed numerous groundwater studies throughout California, Oregon and Washington. These models evaluated groundwater withdrawal for water supply, construction dewatering, subsidence analysis, and evaluation of surface-groundwater interaction. With the Corps of Engineers Mr. Burke worked on the hydraulic analysis and design of large multi-purpose flood control dams in Puerto Rico. Mr. Burke is also responsible for analysis and design of storm water management and flood control systems, sediment transport studies, river and habitat restoration studies, permitting, and urban hydrology. In addition, Mr. Burke has developed in-house computer models for statistical analyses of rainfall and runoff, eutrophication and phosphorus cycling in shallow lakes, hydraulic structure design, and conducted watershed-wide flood inundation and impact analyses. Mr. Burke is experienced in the development of project scope, plan formulation, as well as budgeting and scheduling of complex hydrologic and water resources studies.

Education:

M.S.; Civil Engineering, Colorado State University, Fort Collins; 1992

B.S.; Civil Engineering, University of Florida, Gainesville; 1980

Certifications:

Registered Professional Engineer, California P.E. No. 50051

Registered Professional Engineer, Florida P.E. No. 34798

FEMA Study Contractor Training

PADI certified “Open Water Diver”

USCG Class A Powerboat License

Specialty Courses:

FEMA Flood Insurance Study Contractor Training Course, FEMA

2-D Unsteady Flow Modeling Using SMS and RMA-2, EMRL

Dam Breach Analysis, ASCE

3-D Groundwater Modeling and Transport Analysis, Environmental Modeling Research Laboratory (EMRL)

Advanced Visual MODFLOW Groundwater Modeling, Waterloo Hydrogeologic

Start at the Source, Storm Water Quality Management, BASMAA

Fluvial Geomorphology, Luna Leopold and Dave Rosgin

Advanced Fluvial Geomorphology, Dave Rosgin

Design of Wetlands for Water Quality Treatment, U.C. Berkeley

Analysis of Wetlands and Aquatic Ecosystems, UC Berkeley

Experience:

Hydrologic Studies - Managed and participated in many urban and regional hydrologic studies. Investigations included rainfall and snowmelt runoff analysis, irrigation and water supply diversions, and the development of stream discharge hydrographs for gaged and ungaged basins in Florida, California, Puerto Rico, Idaho, and Oregon. Developed large regional regression models for basin runoff analysis. Developed statistical analyses for the evaluation of rainfall and flood frequency analysis. Supervised the collection and analysis of rainfall and stream flow records, developed flood frequency analyses, and developed

overland and stream flow models. Participated in numerous Flood Insurance Administration studies, preparing technical and administrative data for LOMAR requests. Used HEC-1, HMS, TR-55 and the TR-20 hydrologic models and calibrated models to existing basin conditions. Computed water surface profiles and delineated flood zones on flooded-area maps. Developed mitigation plans and prepared reports for wetlands restoration programs. Conducted water balance studies and analyzed evaporation and infiltration losses for rivers, lakes, and wetlands.

River Engineering - Directed the analysis of various large rivers and flood control systems in Florida, Georgia, California, Oregon, Idaho, and Puerto Rico. Hydraulic engineer for the Portugues and Bucana Flood Control Project. Developed custom hydraulic models and used existing commercial models to compute water surface profiles, develop stage-discharge relationships, and compute suspended and bed sediment transport loads. Developed 2-d flow models for complex river confluences, and analyzed tidal influences on delta flow characteristics. Computed design discharges for multiple-frequency floods and developed criteria for stable channel design. Responsible for the preparation of feasibility studies for structural and non-structural project alternatives. Developed unsteady flow and aquatic habitat model for the Oconee River, analyzing in-channel and floodplain connectivity.

Computer Modeling - Responsible for the design, development, and documentation of several large computer models for the U.S. Army Corps of Engineers, particularly for the analysis of hydraulic structures, surface water flow, statistical analyses of precipitation and runoff patterns and sediment transport analysis. Models include the simulation of supercritical flow in channel junctions, precipitation extreme event analysis, analysis of composite tunnels, superelevation in high-velocity channels, runoff analysis, spillway and stilling basin design, channel and reservoir routing, and water surface profile calculation. Experienced in Fortran, Basic, C, Java and mixed language programming. Extensive experience using existing computer models HEC-1, HEC-HMS, HEC-2, HEC-RAS, SAM, HEC-6, SED-2D, FESWMS, UNET, TR-20, TR-55, MODFLOW, and RMA-2 in hydrologic applications. Arc View GIS and Auto CAD are used for development of plans and development of graphical display of spatial data.

Storm Water Management and Urban Hydrology - Conducted numerous hydrologic studies for urban flood control projects and NPDES storm water permits. Participated in the nationwide Air Force Space Command storm water management program. Project manager responsible for Onizuka, Vandenberg, and Hickam air force bases. Coordinated onsite reviews of industrial facilities, analyzed storm water conveyance systems, and developed monitoring plans. Developed pollution prevention plans and designed natural conveyance facilities and other BMP's to minimize pollutant runoff. Project engineer for various water management studies and urban flood control projects. Developed runoff hydrographs for pre- and post-project conditions and designed water retention, detention, and conveyance systems. Coordinated project designs with local interests and regulatory agencies to procure necessary state and federal permits.

Hydraulic Structures - Responsible for the analysis and design of numerous hydrologic structures associated with dams, flood control projects, and channel stabilization programs. Analyzed and modeled railroad and highway bridge crossings. Was the design engineer for the development and analysis of the Cerrillos Dam diversion tunnel and emergency spillway, and project engineer for the Portugues Dam spillway and reservoir, Puerto Rico. Investigations include the design of supercritical- and subcritical-flow concrete channels, channel junctions, spillways, check structures, and sedimentation basins. Developed feasibility studies, prepared cost estimates, and produced detailed designs. Coordinated projects with federal, state, and local agencies.

River and Habitat Restoration Studies - Responsible for the development and analysis of hydrologic studies as part of multi-disciplinary teams in numerous restoration and mitigation projects. Developed stream restoration plans for unstable creeks, bridge replacements, and evaluated the effects of gravel mining and dam removal. Developed flood inundation-duration data to meet specified biologic criteria for aquatic vegetation. Worked with fisheries resource scientists the USFWS and NMFS to restore the habitat within river and estuarine systems. In an attempt to restore the native salmon fishery to the Salmon and Clearwater rivers, worked with the USGS, USFWS, and the Bureau of Indian Affairs to developed fisheries habitat models for over 1,100 rivers covering one third of the state of Idaho. Analyzed sediment transport characteristics to determine existing morphologic conditions and developed flow criteria for stream and bank restoration as well as the restoration of riparian communities. Analyzed hydrologic budgets for marsh systems and developed historic hydroperiod information for the redevelopment of native plant and animal communities.

Groundwater Modeling - Mr. Burke has extensive experience in groundwater analysis and modeling throughout California. For the past 20 years he has been analyzing groundwater movement, contaminant transport and dewatering studies under both localized and regional conditions. Mr. Burke developed a large groundwater model for the California Central Valley to analyze annual water movement and contaminant transport through the central valley. He has analyzed groundwater flow and recharge conditions for large agricultural landholdings. He has developed dewatering models and seepage studies for numerous construction projects in California, Oregon, and Washington. Prepares dewatering studies, pumping estimates, and impact

analyses for large scale pipeline and building construction projects. Analyzes hydrogeologic conditions, and conducts water quality studies of groundwater resources. Experienced in groundwater plume modeling and contaminant tracking in complex urban and rural settings. Mr Burke is familiar with numerous groundwater models and has developed specialized in-house computer models for specialized groundwater conditions.

Environmental Assessments - Managed and participated in environmental assessments for CEQA (the California implementation of NEPA) projects. Worked with clients and local agencies to develop project alternatives and perform environmental assessments of each alternative. Analyzed impacts resulting from the project alternatives, and assisted local authorities in the development of environmental assessments. Evaluated and developed required mitigation measures, and assisted local sponsors in developing monitoring plans to assure mitigation objectives. Participated in public scoping, and worked with clients to respond to comments from the public and agency review.

Project Management - Responsible for the development of project scope, schedules, cost estimates and resource tracking. He has managed the water resource modeling assessment team for the Klamath Water Adjudication Project covering a 3,000 mi2 basin. On this project, Mr. Burke was responsible for working with numerous State and Federal agencies to develop a resource management plan that would provide irrigation water to local farmers while also protecting the environmental resources. Trained and managed assessment teams for water resource development projects in California, Oregon, and Washington. Organized and managed training programs for field data collection studies and environmental modeling projects. Served as primary manager for coordinating project activities with clients, subconsultants, local, state and federal agencies on multi-million dollar projects.

Water Quality and Limnology - Participated in water quality assessments for a variety of large and small watersheds. Developed a water quality model to analyze eutrophication and water quality characteristics for the 41 mi2 Klamath Lake, and evaluated the impacts from changing land use conditions in the 3,000 square mile watershed. Conducted fisheries habitat assessments with respect to changing sediment conditions, channel stability, and pertinent water quality parameters. Developed 2-d hydrodynamic models analyzing circulation and sediment movement in large lakes. Directed water quality sampling programs, collected suspended and bedload sediment samples, and installed water quality monitoring field stations.

Institutional Development, Water Resources Engineering - Worked with local and Federal agencies to plan for and manage the analysis of various large rivers and flood control systems in Florida, Georgia, California, Oregon, Idaho, and Puerto Rico. Worked with the Corps of Engineers and the Commonwealth of Puerto Rico to develop criteria for two large multipurpose flood control dams. As Hydraulic consultant for the Portugues and Bucana Flood Control Project, assisted in the development of custom hydraulic models and used existing commercial models to compute water surface profiles, develop stage-discharge relationships, and compute sediment transport. Worked with hydroelectric power agencies to strengthen the capabilities of their in-house staff to develop and analyze 2-d flow models for complex river confluences and the analysis of tidal influences on delta flow characteristics. Responsible for coordinating agency and client interaction during the preparation of feasibility studies and cost estimates for structural and nonstructural water resource project alternatives. Trained staff from a large power consortium to develop an unsteady flow model for the Oconee River.

Selected Publications:

Burke, T.K. 2012. Mormon Island Auxiliary Dam Dewatering Design Plans., Prepared For the Bureau of Reclamation and Shimmick Construction, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, February 2012.

Burke, T.K. 2008. Milliken Creek Flood Mitigation and Restoration Analysis, Prepared For Napa County Dept of Public Works and The Silverado Property Owners Association, HSI Hydrologic Systems, 2175 East Francisco Blvd, San Rafael CA, December 2007.

Burke, T.K. 2011. New Irvington Tunnel Groundwater Analysis., Prepared For Brierley Associates, Moraga California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, August 2011.

Burke, T.K. 2008. Aquatic Park Circulation and Water Quality Improvement Project, Prepared for City of Berkeley Parks, Recreation and Waterfront Dept. and Laurel Marcus and Associates, HSI Hydrologic Systems, 2175 East Francisco Blvd, San Rafael, CA, February 2008

Burke, T.K., Trso, M. 2004. Lower Alamo Creek Restoration Design Alternatives, For ENGEO Inc., HSI Hydrologic Systems, 2175 East Francisco Blvd., Suite 303, May 2004.

Burke, T.K. 2008. Lake Curry Temperature Model and Cold Water Pool Analysis, Prepared for Laurel Marcus and Associates, HSI Hydrologic Systems, 2175 East Francisco Blvd, San Rafael, CA, June 2008

Burke, T.K. 2005. Tassajara Creek Channel Scour Analysis, Prepared for ENGEO Inc., HSI Hydrologic Systems, 2175 East Francisco Blvd, San Rafael CA, May 2005.

Burke, T.K., Dawdy, D., Trso M. 2002 "Long Term Evaluation of Scour For Alamo Creek", Prepared for ENGEO Inc., Submitted to Contra Costa County, March 2002.

Burke, T.K. 2000. "Instream Flow Modeling Techniques", Prepared for the Watershed Management Council Conference, "Managing Watersheds in the 21st Century", Pacific Grove California, November 2000

Burke, T.K. 2000. "Watershed Modeling Techniques and Pitfalls", Prepared for the Watershed Management Council Conference, "Managing Watersheds in the 21st Century", Pacific Grove California, November 2000

Welch E., Kann, J., Burke T.K. 2000. "Lake-level effects on water quality in Upper Klamath Lake, OR", The 21st International Symposium of the North American Lake Management Society, Miami Florida, November 2000.

Welch E., Burke T.K. 2000. Comprehensive Analysis of Lake Level, Water Quality, and Effects on Fish in Upper Klamath Lake, prepared for the Bureau of Indian Affairs and U.S. Justice Department, Portland Oregon, July 2000.

Burke, T.K., Hanson D. 1999. Hydraulic Analysis for the Simulation of Fisheries Habitat, For the ASCE International Water Resources Engineering Conference, Seattle, USA

Burke, T.K. 1994. Owens Gorge Habitat Restoration Test Flow Study, prepared for the Los Angeles Department of Water and Power, Los Angeles, CA.

Burke, T.K. 1990. Scour Downstream of Hydraulic Structures, in Readings in River Mechanics. Colorado State University, Fort Collins, Colorado.

Burke, T.K. 1998. Calibration of a Floodplain Model to Existing ALERT Data, For the 1998 Floodplain Management Association Fall Conference

Burke, T.K. 1989. Remote Data Acquisition in Hydrologic Modeling, Proceedings of the American Geophysical Union Hydrology Conference. Fort Collins, Colorado.

Burke, T.K. 2010. South Tahoe PUD WWTP Headworks Groundwater Analysis, Prepared For Viking Drillers, West Sacramento California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, April 2011.

Burke, T.K. 2010. Delta Water Supply Project, Raw Water Pipeline Analysis, Prepared For Viking Drillers, West Sacramento California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, March 2010.

Burke, T.K. 2009. Tulloch Hydroelectric Project, Dewatering Control Plan, Prepared For Proven Management, San Francisco California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, October 2009.

Burke, T.K. 2009. Perris Valley Raw Water Pipeline Dewatering Analysis, Prepared For Viking Drillers, West Sacramento California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, February 2009.

Burke, T.K. 2011. Napa Creek Groundwater Analysis., Prepared For Proven Management, San Francisco California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, September 2011.

Burke, T.K. 2012. Dewatering Analysis For The Orange County Water District, Groundwater Replenishment System, Prepared For McCarthy Building Companies, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, July 2012.

Burke, T.K. 2012. Dewatering Analysis For Mayfair Apartment Complex, Prepared For Thunder Mountain Enterprises, Sacramento California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, June 2012.

Burke, T.K. 2012. Groundwater Analysis and Dewatering requirements For the New Trans Bay Terminal, San Francisco, California, Prepared for Balfour Beatty Infrastructure, San Francisco, California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, January 2012.

Burke, T.K. 2009. Groundwater Analysis and Dewatering Requirements For The Sacramento International Airport Expansion, Sacramento, California, Prepared for Viking Drillers, West Sacramento, California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, January 2009.

Burke, T.K. 2008. Victoria Canal Intake Structure, Construction Dewatering Analysis, Prepared For Viking Drillers, West Sacramento California, HSI Hydrologic Systems, 936B 7th Street, Novato, CA 94945, September 2008.

EA Engineering 1994. Discovery Bay Draft Environmental Impact Report, contributing author, prepared for Contra Costa County Planning Department, California

EA Engineering 1995. Robins Air Force Base Resource Management Plan, contributed to impact analysis section, prepared for the US Air Force.

Burke, T.K., 1994 Hydrologic Assessment of the Klamath Basin, prepared for the Bureau of Indian Affairs, Portland Oregon.

Selected Project Experience:

Project Title - Napa River Oxbow Preserve Slough Channel Restoration

Client Name - City of Napa.

Project Dates -2005 - 2009

Project Role - HSI developed a 2-dimensional hydrodynamic model to analyze tidal flushing, storm flow, and sediment transport in several proposed wetland channels along the Napa River. The City of Napa needed to determine if the channels, which have been proposed for wetland habitat restoration, would be stable under normal tidal and flood flow conditions. The computer model RMA-2 was used to analyze flow within the downtown area of the Napa River and the slough channels leading off of the main river.

Project Title - Milliken Creek Flood Insurance Study

Client Name - Napa County.

Project Dates -2010 - Present

Project Role - Due to the frequency of extreme flood events recently experienced on Milliken Creek, HSI developed a computer model to perform a statistical analysis of precipitation gages in the vicinity Milliken Creek. The model developed precipitation datasets for the 25-year, 50-year, and 100-year design storm. The custom model was developed to evaluate and filter data from the rainfall gages, compute the precipitation intensity for various frequencies and durations, then automatically develop a synthetic design storm to apply to a HEC-RAS model that we developed for the watershed. The HEC-RAS model was then used to evaluate the extent of the 100-year flood, and develop various flood mitigation alternatives to reduce flood damages.

Project Title **- River Islands Surfacewater-Groundwater Interaction Model**

Client Name - River Islands Development Corp.

Project Dates -2004 - 2009

Project Role - HSI developed a 3-dimensional groundwater and contaminant transport model to evaluate the annual and storm-event groundwater levels across the site for a new city in the central valley. The 7 square mile development area will contain a 400 acre lake which will be tied to the prevailing groundwater level. All runoff from the city will drain to the lake. The lake will also receive contaminants from groundwater through-flow. The model was used to develop an understanding of the contaminant levels that could be expected in the lake and propose mitigation features such as wetlands and bioretention ponds to remove contaminants before the reach the lake. A circulation and aeration system was designed for the lake to help mitigate adverse water quality conditions.

Project Title **- Lake Curry Temperature Model**

Client Name - Laural Marcus and Associates

Project Dates -2006 - 2008

Project Role - HSI developed a 2-dimensional hydrodynamic and temperature model for Lake Curry. The model was developed to evaluate the resulting reservoir temperature under different regulatory release scenarios. The water is to be released to support fisheries habitat in the creek downstream of the dam. The temperature stratification and available cold water pool were evaluated for different climate scenarios.

Project Title **- Mormon Island Auxiliary Dam Dewatering**

Client Name - Shimmick Construction

Project Dates -2011-2013

Project Role - HSI designed the dewatering system for dewatering the base of the Mormon Island Auxiliary Dam in Folsom California. The system was designed to dewater 6-90' deep rectangular core blocks that were excavated along the downstream toe of the 110' high dam. The excavation was dewatered so that the construction could be completed in the dry. Once excavated, the core blocks were backfilled with concrete to stabilize the toe of the dam, which is subject to liquification during an earthquake. The design included the dewatering wells, pumps, piping, booster pumps, settling tanks and a sedimentation pond that was located 1,000 feet on the other side of a major road artery. HSI monitored and maintained the dewatering system during the 1.5 years of construction.

Project Title **- New Irvington Tunnel**

Client Name - San Francisco Public Utilities Commission and Brierley Associates, Inc.

Project Dates -2011-2012

Project Role - HSI developed a 3-dimensional groundwater model to analyze the construction dewatering requirements for the New Irvington Water Supply Tunnel near the city of Fremont. The San Francisco Public Utilities Commission is constructing this 10' diameter 3.6 mile long tunnel to augment the existing Irvington Tunnel. The tunnel is 200 feet deep and passes through sandstone, shale, and chert formations. The tunnel also crosses several fault lines. The dewatering analysis evaluated the required pumping to dewater the porus rock and fault formations. The dewatering model was calibrated to pump test data that was collected at the project site.

Project Title **- Tulloch Hydroelectric Plant Expansion**

Client Name - Proven Management

Project Dates -2009-2010

Project Role - HSI developed a 3-dimensional groundwater model to analyze the construction dewatering requirements for the new deep rock excavations required for the powerhouse, draft tube and penstock expansion. The groundwater was directly influenced by the water level in the dam as well as the ongoing grouting operation that was conducted with the excavation. The analysis included the expected groundwater inflow to the excavation as well as addressing water quality concerns for water that came in contact with the grouting operation. A discharge pipeline was designed for the operation as well as a water quality monitoring program.

Project Title **- Napa Creek Dewatering Analysis**

Client Name - US Army Corps of Engineers and Proven Management

Project Dates -2010-2012

Project Role - HSI developed a 3-dimensional MODFLOW groundwater model to analyze the construction dewatering requirements for dewatering Napa Creek through the downtown area of Napa California. The dewatered channel will be restored to a more natural condition. The analysis accounted for the close proximity to the Napa River and sensitive historic buildings that surround the lower portion of the creek. A pumping and groundwater cutoff system was developed to assist in lowering the groundwater down to dry out the creek during the summer construction periods of 2011 and 2012.

Project Title **- Perris Valley Water Supply Pipeline Dewatering**

Client Name - Viking Drillers and Brierley Associates.

Project Dates -2009

Project Role - HSI developed 3-dimensional groundwater model to analyze the construction dewatering for the 6.5 mile Perris Valley Water Supply Pipeline. The pipeline consisted of 2 parallel 8'dia water mains that connect the city of Riverside to the Moreno Valley. The groundwater analysis evaluated a trench drain system along with traditional dewatering well points. The analysis included the land portion of the tunnel as well as several crossings under I-205. The USGS MODFLOW model was used along with the Groundwater Modeling System (GMS) for model input and output analysis of the aquifer to the pumping system.

Project Title **- Sacramento Lower and Upper Northwest Interceptor Dewatering Analysis**

Client Name - Viking Drillers.

Project Dates -2005 - 2008

Project Role - HSI developed groundwater model to analyze the construction dewatering for the 6 mile Lower Northwest Interceptor (LNWI) project in Sacramento California. The LNWI consisted of 2 parallel 5'dia sewer force mains that crossed through the cities of Sacramento and West Sacramento. The groundwater analysis evaluated a trench drain system along with traditional dewatering well points. The analysis included the land portion of the tunnel as well as the launching and receiving shafts for two crossings under the Sacramento River. The USGS MODFLOW model was used along with the Groundwater Modeling System (GMS) for model input and output analysis of the aquifer to the pumping system.

Project Title - Stockton Regional Wastewater Control Facility Dewatering Analysis, Project No. 1196

Client Name - Viking Drillers.

Project Dates -2005

Project Role - HSI developed a dewatering plan for the Stockton Regional Wastewater Control Facility. The plan included a groundwater model to predict the required dewatering pumping rates and determine the groundwater drawdown in the vicinity of the project. Groundwater drawdown contours were developed showing the change in groundwater and the extent of the cone of depression over 1-, 2-, and 6-month periods.

Project Title **- Coleman Fish Hatchery, Barrier Weir and Fish Ladder Modification Dewatering Analysis**

Client Name - Gracon Corporation

Project Dates -2007

Project Role - HSI developed a water control plan for unwatering and dewatering the reconstructed barrier weir at the Coleman Fish Hatchery. During a portion of the construction phase, the river will need to continue flowing past the construction site. We evaluated the use of a temporary flexible river barrier to isolate the construction site from the river. We developed a 3-dimensional MODFLOW groundwater model to evaluate the rate of inflow to the site from surrounding groundwater as well as leakage beneath the barrier. HSI evaluated the change in flow as well as groundwater seepage from a temporary bypass channel that was built to bypass the river around the construction site.

Project Title - Aquatic Park 2-D Hydrodynamic and Sediment Transport Model

Client Name - City of Berkeley.

Project Dates -2004 - 2008

Project Role - HSI developed a 2-dimensional unsteady flow hydrodynamic model to evaluate circulation patterns within the system of 3 interconnected lakes. To develop the model, a topographic and bathymetric surveys were conducted to form a basis for the model. HSI set up a monitoring system to measure and record flow between, and water level within the lakes and San Francisco Bay on a real time basis. Pressure transducers were installed at various locations throughout the lake system. Each sensor was connected to a datalogger that collected and stored measurements every 10 minutes. A regression analysis was developed between the recorded data and a long term tidal station on San Francisco Bay. The results from the regression were used to compute normal and extreme tidal variations within the lake system. The recorded stage levels for 2006-2007 were used to calibrate the hydrodynamic model to the existing conditions. The computer models RMA-2 and SED-2d were used to analyze flow within the lake and between the lake and San Francisco Bay. The calibrated model was used to evaluate changes to the lake infrastructure to increase tidal flushing and sediment movement.

Project Title - Tassajara Parkway Long-Term Bridge Scour Analysis

Client Name - ENGEO Inc.

Project Dates -2000 - 2002

Project Role - HSI developed a sediment transport and bridge scour analysis for the new Tassajara Parkway Bridge over Tassajara Creek. Tassajara Parkway is a 4 lane divided highway in Contra Costa County. The bridge will cross over Tassajara Creek which has experienced approximately 40 feet of vertical scour over the past 50 years. HSI developed a geomorphic and sediment transport analysis to determine the expected lateral migration and vertical scour that could be experienced over the next 50-year period.

Project Title - Alamo Creek Sediment Transport and Long-Term Bridge Scour Analysis

Client Name - ENGEO Inc.

Project Dates -2001 - 2003

Project Role - HSI developed a sediment transport and bridge scour analysis for two bridges crossing over Alamo Creek. The analysis was conducted to determine the equilibrium scour conditions at each bridge location given the sediment load from the watershed and the erosion potential in the creek. The sediment production of the watershed above the site was computed, and a sediment transport model of the river developed. Erosional and depositional areas in the creek were identified and mapped. A review of historic photographs was conducted to determine channel planform morphology and meander potential.

Project Title - Sacramento Lower Northwest Interceptor Dewatering - Sacramento River Crossing

Client Name - Viking Drillers.

Project Dates -2005

Project Role HSI developed a MODFLOW groundwater model to analyze the construction dewatering for the Sacramento River crossing of the Lower Northwest Interceptor (LNWI) project in Sacramento, California. The LNWI consisted of 2 parallel 5'dia sewer force mains that crossed through the cities of Sacramento and West Sacramento. The groundwater analysis evaluated the dewatering of the launching and receiving shafts for the tunneling under the Sacramento River. The Groundwater Modeling System (GMS) developed by EMSI was used to model the response of the aquifer to the pumping system. Specifications were developed for the number of dewatering wells, their depth and spacing that was required to dewater the shaft construction on each side of the Sacramento River.

Project Title **- Santa Rosa Junior College - Parking Garage Dewatering Design**

Client Name - Viking Drillers.

Project Dates -2005

Project Role - HSI designed a construction dewatering system for a new multilevel parking garage at the Santa Rosa Junior College. The design included the development of a 3-dimensional groundwater pumping model covering the shallow aquifer below the garage. The program Visual MODFLOW was used for the analysis.

Project Title - Sulphur Creek Restoration and Bridge Replacement

Client Name - Gray Cary Ware Freidenrich LLP.

Project Dates -2000 - 2004

Project Role - HSI is developing a restoration plan for Sulphur Creek at the upper end of the Napa Valley. Sulphur Creek has been impacted by active gravel mining over the past 90 years. In 2000, mining was discontinued and local community groups along with Cal Trout and the California Department of Fish and Game are requesting that the stream be restored. A geomorphic evaluation of the stream was conducted in 2000 and a conceptual plan for restoring the stream and replacing a low flow crossing with a raised bridge was developed. A more detailed evaluation of the creek and bridge is presently underway to develop a restoration plan that will restore the creek and the instream habitat.

Project Title - Alamo Creek Stream Restoration

Client Name - ENGEO Inc.

Project Dates -2003 - 2005

Project Role - HSI developed a restoration plan for a 1.5 mile foot section of Alamo Creek in Contra Costa County. The channel was deeply incised and will be the focal water feature in the new 10,000 home development surrounding the river corridor.

As part of that study, we conducted a hydraulic and geomorphic analysis of the river. The hydraulic analysis consisted of developing a 1-d flow model through the river, a flood frequency analysis of river flows, and the design of 9 vortex weir control structures to dissipate energy within the river. We are presently conducting annual performance evaluations on the restored section of the river.

Project Title - Mondavi Vineyard Expansion Environmental Impact Report

Client Name - EDAW Inc.

Project Dates -2002 - 2003

Project Role - HSI evaluated the potential for pollutant loading to the Napa River from the proposed vineyard conversion project. A watershed model of the project was developed to determine the change in runoff patterns and the potential sediment load to the river. A literature search was conducted to determine potential pollutant loading from agricultural operations and local viticultural practices. To estimate potential pollutant loading from sediment bound contaminants, sediment samples of similar existing vineyards were collected and analyzed for contaminants. Mitigation recommendations were developed for the project applicant for reducing the potential pollutant loading.

Project Title - Ousley Creek Restoration Plan

Client Name - ENGEO Inc.

Project Dates -2001 - 2002

Project Role - HSI is developing a restoration plan for Ousley Creek in the city of Gilroy. Modifications to the creek from adjacent developments have caused the creek to severely incise and form an actively moving headcut that is migrating upstream. Lateral migration of the stream is also threatening nearby structures. A geomorphic assessment is being developed for the creek to determine an appropriate course of restoration. Preliminary designs for relocating the creek to an area where is can be connected to an active floodplain are being investigated. A hydraulic model of the creek has been developed as well as a hydrology model for the watershed. The models are being used to develop flow characteristics required in the restoration of the stream. Plans and specifications for the stream restoration will be developed, along with construction monitoring. A post project monitoring and adaptive management plan will be developed to insure stability of the restoration and timely response to changes within the stream.

Project Title - Shasta River Dam Removal

Client Name - Great Northern Corporation

Project Dates -1995

Project Role - Tom Burke conducted a reconnaissance level evaluation of six diversion dams along the Shasta River. The dams are barriers to upstream and downstream migration of salmon. The impoundments at each dam also result in elevated temperatures in the river. Meetings were conducted with landowners adjacent to the dams, and a conceptual plan for removing the structures was developed. A course of action for developing a detailed feasibility analysis to remove the barriers and replace the diversion facilities with fish friendly structures is presently being evaluated.

Project Title- Arroyo Mocho and Arroyo Las Positas Stream Restoration

Client Name- City of Livermore, Livermore California

Project Dates-1998 - 1999

Project Role- Working for Philip Williams and Associates, Mr. Burke was the project manager for a project to restore the sections of Arroyo Mocho and Arroyo Las Positas that run through the City of Livermore. Working with a team of biologists and geomorphologists, Tom assessed the stream conditions, evaluated alternatives for restoration, and developed a scope of work and cost estimate for analyzing and restoring the two arroyos.

Project Title- Klamath Industrial Park, Treatment Wetlands

Client Name- Klamath Economic Development Association, Klamath Falls Oregon

Project Dates-2000 - 2001

Project Role- HSI Developed a feasibility study and three alternative conceptual designs for a constructed wetland to treat storm water runoff and industrial process water for a proposed light industrial park. As the engineering firm for the project,

HSI analyzed the climate patterns, soils, groundwater, and water quality parameters to determine the feasibility of developing a wetland to biological filtration of the water discharging from the industrial park. Three alternative conceptual designs were developed to emphasize various concepts in the wetland design.

Project Title-Mitigation Wetlands Design and Construction

Client Name-ENGEO, San Ramon, California

Project Dates-2000

Project Role-Developed specifications and design criteria for 7 seasonal wetlands as a mitigation for developments in the Livermore Valley. Water budgets were developed taking into account precipitation, evapotranspiration, and infiltration to insure that the wetlands would dry out in the late summer to discourage bullfrog mating. Detailed plans were developed using Auto CAD software.

Project Title-Hydrodynamic and Sediment Transport Model of Sailing Lake

Client Name-City of Mountain View, California

Project Dates-2000-2003

Project Role- HSI is providing water resources consulting services to an interdisciplinary team of scientists to analyze ways to improve water quality and sediment buildup in Sailing Lake. The geomorphology of the streams entering the lake is being evaluated to insure that they will not be adversely impacted by the rising sediment levels entering the lake. Restoration plans to insure geomorphic stability of the inflow streams will be developed. A hydrodynamic model to describe the flushing and circulation patterns in the lake is under development. A 2-d sediment transport model is being combined with the hydrodynamic model to analyze sediment scour and deposition patterns in the lake. Various alternatives to improve water quality and maintain circulation are being evaluated.

Project Title- Peacock Lagoon Lake Management Plan

Client Name-Peacock Gap Golf and Country Club, San Rafael, California

Project Dates-1999-2000

Project Role-A water quality assessment and management plan were developed for the Peacock Gap Lagoon. The assessment considered internal water quality problems, watershed runoff, and ongoing eutrophication. Best management practices were developed to help decrease poor water quality inflow into the lake. A modified pumping plan was produced to force tidal flushing with the adjacent San Francisco Bay.

Project Title-Petaluma River Basin Hydrologic Model

Client Name-Resource management International / City of Petaluma

Project Dates-1997-2002

Project Role-As Senior hydrologist on the project, directed the development of an HEC-1 hydrologic model for the upper Petaluma River Basin. The model was calibrated to data collected from 5 separate storm events. Each storm was characterized by 8 precipitation gages and 5 stream gages. A GIS model was used to distribute the hourly precipitation data over the basin and output the HEC-1 input data for each subbasin. An HEC-2 hydraulic model of the Petaluma River was developed to compute stage discharge relationships at the location of each of the 5 stage gages. The lower end of the Petaluma River is influenced by tidal action. To model this section the Corps of Engineers UNET unsteady flow model was used to analyze the effect of tidal variations on flooding within the city.

Project Title-Salmon-Clearwater Instream Environmental Habitat Assessment

Client Name-Bureau of Indian Affairs

Project Dates-1991-1993

Project Role-As hydrologist, developed and calibrated hydrologic models for the largest instream flow study ever undertaken. The study included nearly 1,200 drainage basins, covering one-third of the state of Idaho. Reviewed criteria for channel maintenance and stability and developed flow requirements for the preservation of riparian growth. Developed an ArcView based statistical model to predict watershed patterns on ungaged watersheds based on data from 50 gaged watershed located throughout the state. Coordinated study efforts with the USGS, USFS, BIA, state agencies, and the various Indian tribes.

Project Title-Klamath Water Rights Adjudication

Client Name-Department of Justice and the Bureau of Indian Affairs

Project Dates-1991-1997

Project Role-As a technical expert for hydrologic and water resources issues, developed supporting data and hydrologic models to document and support the instream flow claims for the Klamath Indian Tribes. As part of this adjudication, a water quality model was developed to investigate nutrient loading and eutrophication in the 44 square mile Upper Klamath Lake. Hydrologic characteristics and flow requirements were also developed for all of the major streams in the 3,000 square mile Upper Klamath Basin. Details of the individual studies in this complex project are described below.

Project Title-Klamath Lake Sediment Resuspension Study

Client Name-Bureau of Indian Affairs

Project Dates-1998-2000

Project Role-As project engineer, developed a computer model that would predict sediment resuspension of bottom sediments due to the influx of energy from wind generated shallow waves. The model was an hourly model that computed bottom shear, sediment concentration, sediment deposition, and the flux of nutrients from the sediments from 1991 through 1998. A GIS model was developed to discritize the lake into 700 cells, and the interaction within and between each cell was evaluated.

Project Title-Klamath Lake Nutrient Loading Study

Client Name-Bureau of Indian Affairs

Project Dates-1991-2003

Project Role-As project hydrologist, developed a complex water budget model for Upper Klamath Lake, covering all surface and groundwater contributions and losses. Evaluated the impacts on the lake from the existing operating schedule. Reviewed measured water quality parameters and developed historic inflow data for the various components. Incorporated these elements into a custom multi-parameter lake water quality model that predicted the effects of nutrient loading on various lake regulation schedules. The model was updated annually based on the ongoing monitoring program for lake stage, WQ parameters, and inflow.

Project Title-Upper Klamath River Basin Hydrologic Characterization

Client Name-Bureau of Indian Affairs

Project Dates-1992-2003

Project Role-Project Engineer in charge of developing a regional hydrologic model for characterizing the streams within the 3,000 sq mi Upper Klamath Basin. The project involved development of a GIS database of subbasin characteristics, a multiple linear regression model for spatial and temporal data used in the model. The model was used to develop flood frequency data for all of the streams in the basin.

Project Title - Oconee River Unsteady Flow Model

Client Name - Georgia Power Corporation

Project Dates - 1993-1994

Project Role - As project engineer, directed the development and calibration of a one-dimensional unsteady flow model for a 75-mile section of the Oconee River below a hydroelectric peaking plant. Reviewed stage discharge time series collected at USGS gages along the study reach. The USGS data was used to create three calibration regimes for low flow high flow and overbank flow. The model results were input into fisheries habitat time series model to develop discharge criteria for the hydroelectric plant.

Project Title-Portugues and Bucana Flood Control Project, Ponce, Puerto Rico

Client Name-Commonwealth of Puerto Rico

Project Dates-1980-1988

Project Role-As hydraulic engineer, produced designs for several supercritical concrete flood control channels through the city of Ponce. Analyzed historic flood records and developed design discharges. Designed and analyzed alternative plans for a

sedimentation basin downstream from the Portugues Dam. Designed the outlet works for several river control structures required for the Portugues Dam and the downstream channel improvements.

Project Title-Cerrillos Dam, Puerto Rico

Client Name-Commonwealth of Puerto Rico

Project Dates-1980-1988

Project Role-As hydraulic engineer analyzed historic rainfall records and developed various stage storage alternatives for a cost-benefit analysis of an earth-filled dam. Designs were based on a consideration of water supply, flood control, and irrigation requirements. Developed discharge criteria and designed an 18' construction diversion tunnel through a mountain to bypass the dam site.

Project Title-South Florida Water Supply Study

Client Name-South Florida Water Management District

Project Dates-1986-1987

Project Role-As project engineer, analyzed historical inflow data and developed design discharges for the flood control and discharge structures on Lake Okeechobee. Developed wave runup criteria required for levee designs for various lake regulation schedules. Produced specifications for structure modifications and various changes in the regulation schedules.

Project Title-Portugues Dam, Puerto Rico

Client Name-Commonwealth of Puerto Rico

Project Dates-1980-1988

Project Role-As hydraulic engineer developed alternative bypass schemes for construction diversion of the Portugues River around the proposed Portugues Dam site. Designed regulating and emergency outlet sluices through the concrete dam. Developed design inflows to reservoir and produced stage storage criteria for routing of design inflow to determine optimum dam height. Responsible for sizing and designing the emergency spillway.

Project Title-Vichy Springs Floodway and Interior Drainage Assessment

Client Name-Vichy Springs Homeowners Association

Project Dates-1998-1999

Project Role-As a technical expert for water resources issues, reviewed the original design documents and permits for the Vichy Springs Subdivision. Based on this review, developed supporting data and hydrologic models for the litigation between the homeowners association and the developer of the Vichy Springs Subdivision.