Expert Report of Michael Tansey

1. Introduction and Summary of Opinions:

I, Michael Tansey, have been identified as an expert by the U.S. Department of Justice to provide testimony in *NRDC v. Rodgers*. I have been asked to express opinions on the "Expert Report of Dr. Steven J. Deverel, Ph.D ". Dr. Deverel was asked to express his opinion about the groundwater gains and losses described in the expert report of Dr. Mathew Kondolf. The Deverel report is divided into three sections including:

1. River gains and losses to and from groundwater resulting from restoration flows
2. Temperature effects of stream-aquifer interactions
3. Impacts of increased flows on the adjacent aquifer and water supply ramifications

As a result of my review of the Deverel report, I have reached the following conclusions:

1. For Reaches 1 and 2, Deverel's proposed conceptual model is only partially correct because he ignores the effect of sediment layering on unsaturated flow beneath the river bed. In general, this deficiency could result in incorrect estimates of losses during restoration flows.
2. For Reaches 3, 4 and 5, Deverel's proposed conceptual models are reasonable. What is missing from his report is a quantitative assessment of the magnitudes of gains and losses that would occur under restoration.
3. Deverel presents conceptual models for gaining and losing river reaches describing the effects of groundwater on fluctuations in river water temperatures. Deverel's conceptual models are overly simplistic because they do not clearly identify the time and space scale of the water temperature fluctuations nor do they consider the many other factors which would be likely to exert potentially more significant influences on river water temperature fluctuations. Furthermore, Deverel presents no information to confirm in any way that the effects he claims actually occur now or would occur in the future during restoration.
4. Deverel's opinions on the effects of restoration flows on the adjacent aquifer are reasonable but the discussion of the impacts is more qualitative than quantitative.

2. Professional Qualifications

I have been employed by Bureau of Reclamation since 2000 and received a doctorate degree in Hydrologic Science in 1999. A copy of my curriculum vitae is attached as Appendix A. It includes a list of all of the publications that I have authored in the last 10 years. Appendix B contains a list of other cases in which I have testified as an expert at trial or by deposition within the preceding four years, and sets forth the compensation that I will be paid for the study I conducted and my testimony.

3. Data and Other Information Considered by the Witness in Forming Opinions:

In forming the opinions set forth herein and in preparing this expert report, I reviewed the the "Expert Report of Dr. Steven J. Deverel, Ph.D ". It is important to note that I have only reviewed the Deverel report and not the supporting materials that he used to form his opinions. Consequently, I have only commented on his opinions relative to the discussion presented in his Report and not on his interpretation of the material he relied on in forming his opinions.

4. Discussion:

In Section I of his report, Dr. Deverel expresses his opinions on gains and losses to and from groundwater based several reach specific Conceptual Models. The Conceptual Model for Reaches 1 & 2 is discussed in Paragraphs 16 – 34 and accompanying Figures 1.1 - 1.16. The principal basis for Deverel's Conceptual Model for Reaches 1 & 2 is the observation that groundwater elevations are usually below the bottom of the river channel between Friant Dam and the Mendota Pool. Deverel cites historic groundwater data from several sources including the Riparian Pilot Project Release (RPPR) along with the observation that Reach 2 is typically dry as evidence that unsaturated flow beneath the river bottom is the appropriate conceptual model for determining river losses in these reaches. Deverel also states that borehole data obtained during the RPPR indicates that the sediments beneath the River bottom consists of unsaturated fine sand that becomes coarser with depth.

Based of these observations, Deverel proposed that river losses can be estimated with a transient unsaturated flow approach. Using river losses developed during RPPR, Deverel develops a linear regression relationship between river losses and the reciprocal of the square root of time (see Figures 1.2a – 1.2d). His selection of this particular mathematic relationship is because it matches the well-known Philip's approximate solution for infiltration into a homogeneous soil having an initial soil water content that is constant throughout the profile.

It is important to note that the sediments below the river are not consistent with the assumptions of this equation. As described by Deverel, the subsurface sediments are not homogeneous. In paragraph 21, Deverel states that "adjacent to the river, shallow fine grained sediments are present." with coarser sediments deeper in the profile. This description is more characteristic of a layered profile than one that is homogeneous. Such layered profiles are very typical of alluvial deposits associated with rivers like the San Joaquin. When a layered profile is representative of subsurface conditions, the use of the Philip's equation to calculate a single hydraulic conductivity characteristic of the sediments beneath the river bed is likely to produce inappropriate values. This problem results from the fact that unsaturated conditions will likely persist in the coarse layer for some period of time after the fine layer becomes saturated. The result is a hydraulic gradient across the fine layer that will be greater than unity until the water table rises into the fine layer.

The Philip's equation does not represent these conditions and its use by Deverel to compute a saturated hydraulic conductivity in Paragraph 22 is inappropriate. This conclusion also appears to be substantiated by my examination of Figures 1.2 a and b. After about 30 days, the RPPR losses appear to be approximately constant and don't follow a linear relationship relative to the square root of time. On the other hand, a constant seepage rate would be anticipated in a layered profile in which unsaturated flow conditions could continues beneath the saturated, overlying fine sediments. Furthermore, assuming a hydraulic gradient of unity across the fine layer as Deverel does to calculate the long term seepage rate is also inappropriate as long as unsaturated flow conditions remain in the coarse deposits. During this period of time, the gradient across the fine layer will be greater than unity because the matrix potential of the coarse sediments will be at less than atmospheric pressure. Consequently, Deverel's calculations are likely to be incorrect because he doesn't use the right hydraulic conductivity and the correct hydraulic gradient.

In Paragraph 23, Deverel uses Darcy's Law assuming a hydraulic gradient of unity and an estimated mean hydraulic conductivity value to calculate an infiltration rate for Reach 2 of 80 cfs. I tried to reproduce his calculations and obtained a value of 38 cfs. At present, I am unable to explain the discrepancy.

For Reaches 3, 4 and 5 Deverel proposes a different Conceptual Model for losing and gaining reaches. Each of these conceptual models uses a two layer sediment stratigraphy with a fine layer overlying a coarse layer (see Figures 1.17 and 1.18). Deverel indicates that Reaches 4 & 5 are more typical of gaining reaches and Reach 3 is usually a losing reach. He presents a significant amount of historic groundwater elevation data to support his conclusions (see Figures 1.26 – 1.34). Deverel indicates that the sources of river gains include groundwater, storm water and agricultural return flows but does not provide any detailed information concerning the relative importance of these sources. For gaining reaches Deverel indicates that groundwater inflows have potential sources both to east and west of the San Joaquin River (see Figure 1.21). He also indicates that river gains are inversely proportional to groundwater pumping (see Figure 1.23) and that winter and spring seasons are the times when river gains from groundwater are typically the greatest.

In Section II of the report, Deverel addresses the potential effects of groundwater on the temperature of water in the River. He presents two Conceptual Models, one for gaining reaches and another for losing reaches. Deverel asserts that for a similar set of river flow and atmospheric conditions, a gaining reach will have considerably less variation in water temperature than a losing reach. However, Deverel does not define the time and space scale of temperature fluctuations. Clarification of the time and space scales to which he refers is important from the standpoint of river restoration as most species can tolerate a range of temperatures over certain period of time.

Deverel presents information concerning groundwater temperature measured in the vicinity of the San Joaquin River and indicates that a temperature of about 20^{o} C (68^{o} F) is a representative groundwater temperature. Deverel provides a certain amount of discussion concerning basic principles of heat transfer to substantiate his hypothesis concerning reduced temperature variability in gaining reaches.

Deverel's basic argument that cooler groundwater will moderate river water temperatures is valid to a point but the significance of this groundwater inflow will be highly dependent on other factors such as the relative magnitude of groundwater and surface water flow rates, differences between surface and ground water temperatures, surface water depth, air temperature, wind speed, relative humidity, and the amount of shading provided by riparian vegetation. These other factors could easily outweigh the moderating effect of the groundwater inflow.

Since Deverel provides no quantitative information beyond groundwater temperatures to confirm his hypothesis, it is impossible to determine the efficacy of groundwater inflows in Reaches 4 and 5 on surface water temperatures. Consequently, Deverel's opinions remain theoretical conjecture without the necessary supporting quantitative analyses.

In Section III of the report, Deverel addresses the impact of restoration flows on the adjacent aquifer and potential water supply ramifications. Deverel discusses losses in Reach 2 of the River. He presents historic data that indicates losses in this reach related to restoration flows could range from 80 to 175 cfs provided no additional diversions occur. He estimated a normal dry year average of loss of 90 cfs. Deverel also indicates a relationship between Friant releases and groundwater levels in the adjacent aquifer exists. Although it seems reasonable that such a relationship could exist, Deverel's figures exhibit a rather poor correlation which seems to also be reflected in many of the well hydrographs he presents.

5. Conclusion

In my opinion, the appropriate methodology for determining loss rates from Reach 1 and 2 would be to employ a variably saturated numerical model. Unlike the simple analytical solution used by Deverel, such a model can account for important factors affecting river losses such as non-homogeneous material properties and changes in boundaries conditions associated with river stage and water table elevations that the Philip's solution can not address.

In my opinion Deverel's conceptual models and opinions relative to Reaches 3, 4 & 5 seem reasonable. What is really lacking in his discussion is a quantitative assessment of the magnitudes of the gains and losses of water from the river relative to the various potential sources. Since any attempt to restore fisheries in the San Joaquin watershed will require establishing suitable physical conditions, quantitative assessments of river velocity, depths, bottom sediments, water quality and temperature are necessary. Based on Deverel's qualitative discussion of river gains and losses, it is not possible to determine whether favorable conditions would actually exist. The only way such a quantitative assessment can be developed is by the use of numerical models that are capable of simulating the appropriate physical processes using material properties reasonably characteristic of conditions in the San Joaquin Valley. No amount of expert opinion even if it were conceptually correct can substitute for such an analysis.

In my opinion, Deverel's conceptual models in Section II of the report regarding the significance of groundwater inflows on river water temperature are overly simplistic because they neglect many other physical processes which are likely to have a potentially significant effect on the temporal and spatial variability of river water temperatures. The assessment of these factors will require developing field data that can be used to develop a numerical model based on these observations. Such a model could then be used to estimate quantitatively the spatial and temporal characteristics of river – aquifer water temperatures during restoration flows.

In Section III of the report, Deverel's opinion regarding the effect of the restoration flows on the adjacent aquifer seems reasonable but as he points out additional diversions and pumping could have significant impacts on groundwater levels. A calibrated groundwater – surface interaction model capable of simulating unsaturated flow beneath the river bed would be required to properly determine the significance of the restoration flows on the adjacent aquifer. Such a model could also be used to determine the effects that groundwater pumping in the adjacent aquifer might have on the achieving the restoration objectives.

Dated: September 15, 2005

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Michael K. Tansey, PhD

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EDUCATION:

University of California at Davis
Davis, CA 95616
Ph.D., 1999
145 Quarter Hours
Major: Hydrologic Science
Minor: Fluid Mechanics
GPA: 3.9 out of 4.0

New Mexico Institute of Mining & Technology
Socorro, NM 87801
M.S., 1984
50 Semester Hours
Major: Hydrology
GPA: 4.0 out of 4.0

Montana State University
Bozeman, MT 59715
B.S., 1972
127 Quarter Hours
Major: Soil Science
Minor: Chemistry
GPA: 3.5 out of 4.0

High School Graduation
Rockville High School
Rockville, CT 06066
June, 1967

WORK EXPERIENCE:

Bureau of Reclamation
Mid Pacific Regional Office
Division of Planning
Sacramento, CA 95825

Dates Employed: 6/15/04 - present

Position: Hydrologist

Major duties include providing technical support to program managers related to hydrology, water quality, groundwater, fluvial processes and water resource management modeling. Major duties involve participation in multi-agency efforts to develop new methods for characterization of hydrologic inputs for the CALSIM III water resource planning model; participation in the multi-disciplinary team to develop new, integrated multi-scale software tools for the evaluation of the effects of alternative reservoir releases on the establishment and survival of riparian habitat n the Sacramento River watershed; development of the Land Atmosphere Water Simulator(LAWS) software for water resource planning and management; provide review and analysis of computer modeling, project plans and environmental documents related to water quality and temperature, flows, stream-aquifer interactions, groundwater, and riparian and fish habitats. Other duties involve providing support to project managers in the development of statements of work, budgets and schedules related to NEPA, ESA, and Feasibility Studies.

Bureau of Reclamation Dates Employed: 3/10/02-6/15/04
Mid Pacific Regional Office
Division of Planning
Sacramento, CA 95825

Position: Physical Scientist (Project Management)

Principal responsibilities included planning and coordination of regional investigations to evaluate the engineering, environmental, economic and social feasibility of developing additional reservoir storage and conveyance capacity in the Central Valley of California. Management responsibilities include developing study plans, budgets and schedules for a Federal Feasibility Study (FS) and Environmental Impact Statement (EIS) related to the proposed North of Delta Off-stream Storage Project. Development of planning studies includes applying technical expertise to develop detailed statements of work and cost estimates for hydrologic investigations, operational modeling of project benefits/impacts related to yield and hydropower generation as well as simulation of in-stream hydraulic, water quality, sediment and riparian/fishery habitat conditions. Project coordination activities include organizing, directing, and reviewing the work of technical specialists in a wide range of disciplines to insure work products meet applicable Federal laws and guidelines for the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Fish and Wildlife Coordination Act (FWCA), National Historic Preservation Act (NHPA), Federal Indian Trust Assets, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&Gs)and public involvement in planning process. Project management responsibilities also include representing Reclamation in meetings and negotiations with other Federal, State, and stakeholder groups and the public to provide information, obtain participation and cooperation, provide advice on Reclamation policies and procedures and resolve controversial issues. Serve as Contracting Officer Technical Representative (COTR) on multiple contracts, grants and agreements with other Federal, State, Tribal and consulting organizations.

Bureau of Reclamation Dates Employed: 10/10/00-3/10/02
Mid Pacific Regional Office
Division of Planning
Sacramento, CA 95825

Position: Hydrologist

Major duties included the application, refinement, and development of computer models to simulate the effects of current and potential alternative Central Valley Project (CVP) and State Water Project (SWP) operations in the Sacramento and San Joaquin Valleys. Long-term planning studies involved the use of the California Simulation model (CALSIM), a linear programming optimization model, to simulate the coordinated operations of the CVP and SWP systems including priorities and constraints on water supply deliveries, reservoir releases for flood control, in-stream flows for water quality, temperature, and navigation, Sacramento-San Joaquin Delta salinity control, CVP/SWP export pumping, CVPIA B(2) environmental actions, and VAMP pulse flows. Other model development studies included planning and supervising contractor development of a graphical user interface(GUI) based the Corps of Engineers Water Management System (CWMS) interface and calibration of an integrated multiple reservoir (Shasta, Lewiston, Whiskeytown, and Keswick) operations/water quality model (HEC5Q) and multi-dimensional hydrodynamic/water quality model (RMA2/11) of the Upper Sacramento River. Developed statement of work and supervised contractor development of a GIS based Land, Atmosphere, Water Simulator (LAWS) model to simulate the effects of alternative management strategies on surface and groundwater supplies by computing consumptive use demand based on remote sensing of crop types, historic or real-time meteorological data, and soil-water-plant growth relationships. Developed a coordinated reservoir operation -stream flow - aquifer recharge/extraction model by integrating CALSIM with a 3-dimensional stream/aquifer model (MODFLOW) to demonstrate the potential for conjunctive use management to increase yield from New Melones Reservoir. Other related duties included serving as the Mid Pacific Regional Science and Technology Program Coordinator.

West World Water   Dates Employed: 11/1999-10/10/00
712 5th St., Suite B
Davis, CA 95616

Position: Senior Hydrologist/Soil Scientist

Principal responsibilities included the planning, managing, and conducting regional water resource and vadose zone hydrologic investigations for an Environmental Impact Report (EIR) related to a proposed groundwater banking project in San Joaquin Valley. Project objectives included evaluating the impacts of surface water recharge and groundwater extraction operations on water resources and water quality in agricultural, urban, rangelands, wetlands, fish and wildlife habitat, and riparian resource areas. Project tasks included development of a geographic information system (GIS) for hydrologic, geologic, soil, climatic, vegetative, and land use data management analysis to support hydrologic modeling activities; design of field investigation and laboratory testing programs to characterize the hydraulic and chemical characteristics of vadose zone soils and geologic sediments; selection, development, calibration, and application of saturated and unsaturated flow and transport models for simulation of project impacts for CEQA analyses of environmental impacts.

University of California at Davis — Dates Employed: 09/1995-12/1999
Dept. Land, Air, & Water Resources
Davis, CA 95616

Position: Graduate Research Assistant / Teaching Assistant / EPA STAR Fellow

Research activities involved numerical solutions of Navier-Stokes and connvection-diffusion equations to predict Darcy-scale permeability and dispersion coefficients for three-dimensional porous media over a wide range of Reynolds and Peclet numbers. Teaching duties included assisting students in fluid mechanics and soil physics courses. Other assignments involved directing laboratory and discussion sections, developing and grading homework assignments and exams, and occasionally substituting as a classroom lecturer. Coordinated and wrote several research proposals for Ph.D. dissertation and other projects resulting in funding awards from Environmental Protection Agency and university sources.

Borcalli & Associates — Dates Employed: 05/1994-09/1995
4620 Northgate Blvd.
Sacramento, CA 95834
Position: Associate Hydrologist / Soil Scientist

Daniel B. Stephens & Associates — Dates Employed: 01/1993-05/1994
6020 Academy Rd. NE
Albuquerque, NM 87109
Position: Associate Hydrologist

Harding Lawson Associates — Dates Employed: 09/1988-01/1993
10265 Rockingham Dr.
Sacramento, CA 95827
Position: Senior Associate Hydrologist

SS Papadopoulus & Associates — Dates Employed: 08/1986-08/1988
260 Russell Blvd.
Davis, CA 95616
Position: Project Hydrologist

Bureau of Indian Affairs — Dates Employed: 06/1985-08/1986
Albuquerque Area Office
Branch of Rights Protection
Albuquerque, NM 87108
Position: Hydrologist

International Technology — Dates Employed: 08/1984-06/1985
5301 Central Ave. NE
Albuquerque, NM 87108
Position: Project Hydrogeologist

PUBLICATIONS:

Tansey, M.K., 2005. Land Atmosphere Water Simulator (LAWS) An Integrated, Scalable Approach to Planning and Managemant of Irrigation Projects. Brazilian National Soil Science Society Congress Proceedings, Receife, Brazil.

Tansey, M.K., 1999. Three-dimensional solution of the permeability and dispersion closure problems in porous media by the method of volume averaging, Ph.D. dissertation, University of California, Davis, CA.

Tansey, M.K. and Peterson, D.M., 1994. Simulation of steady-state unsaturated flow beneath streams and artificial recharge basins affected by clogging. In the Proceedings of The Role of Recharge in Integrated Water Management, Seventh Biennial Symposium on Artificial Recharge of Groundwater, Tempe Arizona, May 17-19, 145-159.

Phillips, F.M., Tansey, M.K., Peters, L.A., Cheng, S. and Long, A., 1989, An isotopic investigation of groundwater in the central San Juan Basin, New Mexico: Carbon 14 dating as a basis for numerical flow modeling. Water Resources Research 25:2259-2273.

Phillips, F.M., Peters, L.A., Tansey, M.K. and Davis, S., 1986, Paleoclimatic inferences from an isotopic investigation of groundwater in the central San Juan Basin, New Mexico. Quaternary Research 26:179-193.

Phillips, F.M. and Tansey, M.K., 1984, An integrated isotopic/physical approach to a numerical model of groundwater flow in the San Juan Basin. New Mexico Water Resources Research Institute, Las Cruces, New Mexico.

Authored and co-authored numerous consulting reports related to environmental impact assessment and water resource issues.

PRESENTATIONS:

Land Atmosphere Water Simulator (LAWS) An Integrated, Scalable Approach to Planning and Management of Irrigation Projects, Brazilian National Soil Science Society Congress, Receife, Brazil, 2005

Modeling Conjunctive Use of Surface and Groundwater Operations presented at the Bureau of Reclamation River Systems Management Conference, Boise, Idaho, 2001

Method of Volume Averaging: Theory and Applications to Flow and Transport in Porous Media presented at the American Society of Agronomy Fall Meeting, Salt Lake City, Utah, 1999

Simulation of steady-state unsaturated flow beneath streams and artificial recharge basins affected by clogging presented at the Seventh Biennial Symposium on Artificial Recharge of Groundwater, Tempe Arizona, 1994

CONTINUING EDUCATION AND TRAINING:

* Introduction to Geographic Information Systems, Sacramento City College, 2005
* Introduction & Intermediate Desktop GIS, Sacramento City College, 2005
* Data Structures in C++, Sacramento City College, 2004
* Activity Management Training Session, Bureau of Reclamation, 2003
* Object Oriented Programming in C++, Sacramento City College, 2003
* Structured Programming in C, Sacramento City College, 2003
* Intermediate Portuguese, California State University Sacramento, 2003
* Beginning Portuguese, California State University Sacramento, 2002
* Level II COR/COTR Inspector Workshop, Bureau of Reclamation, 2001
* Security Awareness Web-Based Training, Bureau of Reclamation, 2001
* Remote Sensing in GIS Parts I & II, California State University San Francisco, 2001
* CALSIM II Training Workshop, California Department of Water Resources, 2001

JOB-RELATED SKILLS:

* Knowledge of computer programming in Fortran, Visual Basic, C, C++, and JAVA
* Knowledge of a wide range of data visualization, GIS, relational database and statistical analysis tools.
* Familiarity with various field mapping, drilling and borehole and surface geophysical characterization techniques, and automated data collection technology for hydrologic investigations.

JOB-RELATED HONORS, AWARDS, & MEMBERSHIPS:

* STAR Award for Development of Land Atmosphere Water Simulator (2005)
* STAR Award for Development of Sacramento River Water Quality Model (2005)
* STAR Award for NODOS Project Management (2004)
* STAR Award for Science & Technology Research Program Coordinator (2003)
* On the Spot Award for excellence in CALSIM briefing (2001)
* Mid Pacific Region Employee of the Month for exceptional work (2001)
* On the Spot Award for contributions to Matilija Dam Removal (2000)
* EPA STAR Fellowship (1996-1999)
* Jastro Shields Research Awards (1996 & 1998)
* Member of the American Geophysical Union since 1986
* Graduate with Distinction from Montana State University

I have not testified as an expert at trial or by deposition within the preceding four years.