

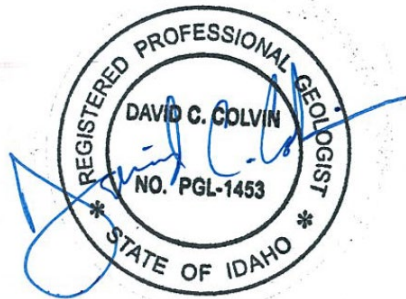
SWC/IGWA SETTLEMENT AGREEMENT MITIGATION PLAN – 2022 BREACH EXPERT REPORT Docket No. CM-MP-2016-001

Prepared for:
Idaho Surface Water Coalition

February 2024

Project Number 1604FLE01-24

The technical material in this report was prepared by or under the supervision and direction of the undersigned, whose seal as a Professional Geologist is affixed below.



The following members of the LRE Water staff contributed to the preparation of this report.

Principal-in-Charge	David C. Colvin, P.G.
Senior Project Geologist	Jacob Bauer, P.G.
Project Engineer	Allan Foster, E.I.
Project Geologist	Gus Womeldorph, P.G.
Staff Geologist	Scott Stokes

TABLE OF CONTENTS

Section 1:	Introduction	1
Section 2:	IGWA's 2022 Performance	1
2.1	Director's Apportionment of IGWA's 2022 Agreement Activities	1
2.2	Breach Procedures	2
2.3	Impacts of IGWA's 2022 Underperformance	3
2.3.1	Sentinel Well Index Impacts	4
2.3.2	Reach Gain Impacts	4
Section 3:	Proposed Remedy	5
3.1	Groundwater Pumping Measurement and Reporting	5
3.2	2022 Breach Remedy	5
Section 4:	Summary of Opinions	6
Section 5:	References	7

LIST OF FIGURES

Figure 1 - Sentinel Well Index	3
--------------------------------	---

LIST OF TABLES

Table 1 – Director's Quantification of IGWA's 2022 Underperformance	2
Table 2 – GWD 2022 Underperformance Impacts on Snake River Reach Gains	4
Table 3 - Recommended Remedy: 2024 Additional Pumping Reductions	6

LIST OF APPENDICES

Appendix A – Curriculum Vitae for David Colvin	
--	--

SECTION 1: INTRODUCTION

This report presents the opinions of David Colvin. I am a groundwater expert who has been retained by the Surface Water Coalition (SWC) for issues being addressed in Docket CM-MP-2016-001. I have 27 years of experience and am licensed as a Professional Geologist in Idaho. My curriculum vitae is included as Appendix A. I am basing my opinions on the information available at this time and reserve the right to alter my opinions should new or different information become available in the future.

In 2015, the SWC entered into an agreement (IDWR, 2016a) with Idaho Ground Water Appropriators, Inc. (IGWA) that is described in several documents and was ultimately approved by the Idaho Department of Water Resources (IDWR) Director in May of 2016 (IDWR, 2016b; “2016 Mitigation Plan”). On August 2, 2023, the Director issued the *Final Order Regarding IGWA’s 2022 Mitigation Plan Compliance* (IDWR, 2023a; “2022 Compliance Order”), which relates to IGWA’s 2022 underperformance compared to the 2016 Mitigation Plan terms and conditions.

My opinions expressed below provide additional discussion regarding IGWA’s 2022 underperformance according to the terms of the 2016 Mitigation Plan.

SECTION 2: IGWA’S 2022 PERFORMANCE

On April 1, 2023, IGWA provided their 2022 Settlement Agreement Performance Report which included reported activities IGWA implemented in 2022 to abide by the terms of the 2016 approved Mitigation Plan (“Plan”). In the report, they stated that “...*the enclosed spreadsheet does not purport to demonstrate compliance with the Agreement in 2022.*”

American Falls – Aberdeen Ground Water District has stipulated to mitigation resolving their 2022 Breach (IDWR, 2023b) and are therefore excluded from the following information.

During the spring of 2023, there were several issues related to the 2016 Mitigation Plan being addressed. The issues and sequence of events are important and are summarized in the Director’s 2022 Compliance Order. However, the 2022 Compliance Order incorporates the conclusions on the various issues and quantifies IGWA’s 2022 underperformance.

2.1 DIRECTOR’S APPORTIONMENT OF IGWA’S 2022 AGREEMENT ACTIVITIES

The Director’s 2022 Compliance Order findings of fact and conclusions of law #13 quantifies IGWA’s 2016 Mitigation Plan actions and specifies that Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts (GWDs) failed to satisfy their mitigation obligations in 2022 by the volumes in Table 1 below.

Table 1 - Director's Quantification of IGWA's 2022 Underperformance

Ground Water District	Deficiency (acre-feet)
Bingham	32,476
Bonneville-Jefferson	5,204
Jefferson-Clark	18,605
Total	56,285

2.2 BREACH PROCEDURES

Junior groundwater users are only protected from curtailment under the Conjunctive Management Rules when they are “covered by an approved and effectively operating mitigation plan.” (2022 Compliance Order, page 9)

IGWA's 2022 underperformance was caused by groundwater diversions in excess of allocations specified for Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts. These excess diversions constitute noncompliance with the 2016 Mitigation Plan, thereby disqualifying these Districts for protections afforded under the agreement. Specifically, they are now subject to curtailment or actions specified by the Director to cure the breach.

Excess pumping by these GWDs has long term effects that outlast any one irrigation season and further contributes to the declines in aquifer levels and reach gains that the 2016 Mitigation Plan is intended to address. The 2016 Mitigation Plan includes long term practices intended to address junior groundwater pumping impacts that extend beyond a single irrigation season.

The primary measure of 2016 Mitigation Plan activities impact on aquifer conditions is through the Sentinel Well Index, with a 2023 benchmark and a 2026 goal established. Figure 1 shows the historical Sentinel Well Index before and after the 2016 Mitigation Plan. The 2016 Mitigation Plan Sentinel Well Index targets are shown, including a 2023 target of -3.90 feet. The actual 2023 Sentinel Well Index was -8.97, with a 2022 value of -7.62. The Sentinel Well Index is at record low levels and was far short of the 2023 benchmark.

Excessive 2022 pumping by IGWA members contributed to the Sentinel Well Index declines which are far below the 2016 Mitigation Plan targets.

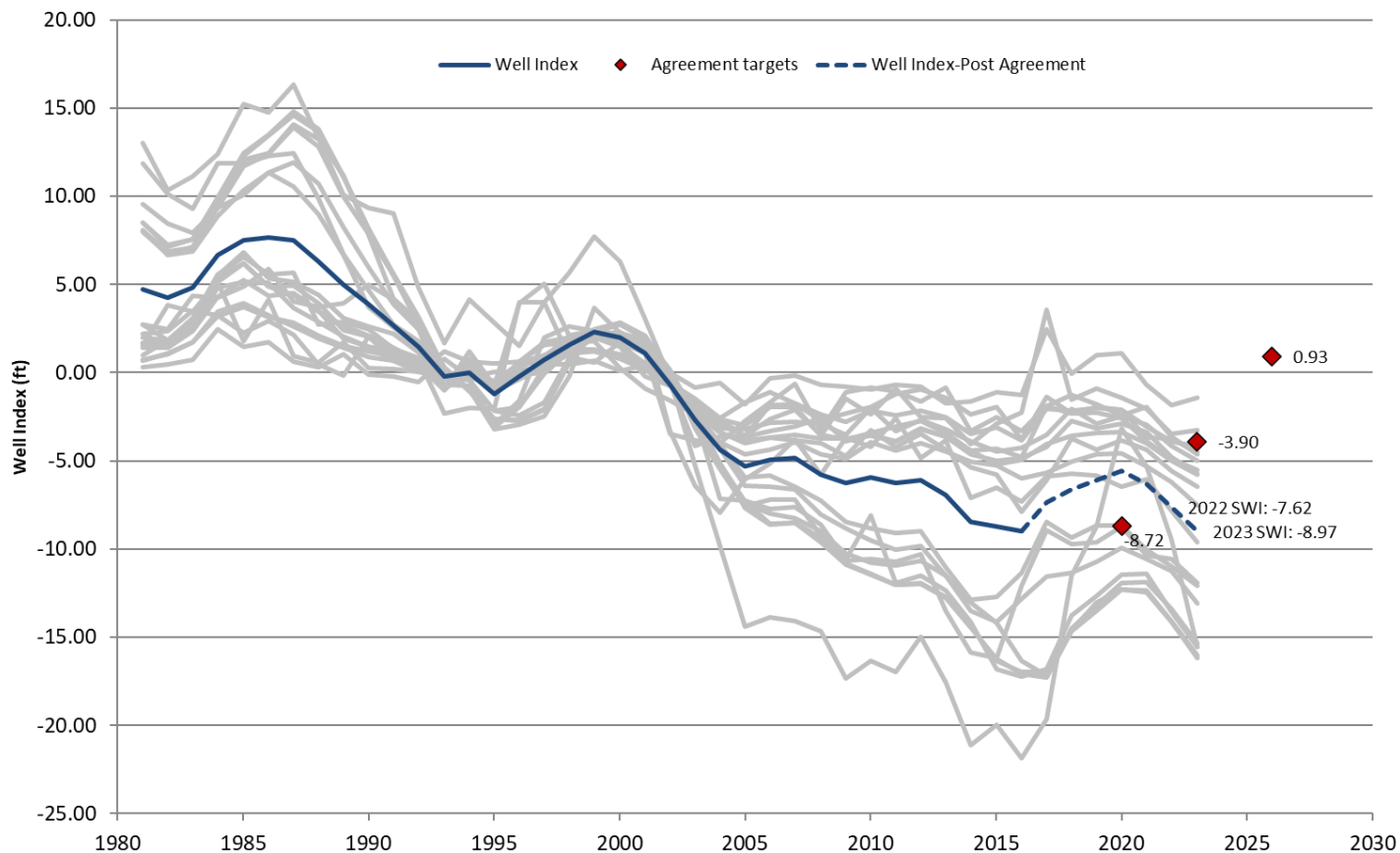


Figure 1 - Sentinel Well Index

2.3 IMPACTS OF IGWA'S 2022 UNDERPERFORMANCE

LRE Water has utilized the Eastern Snake Plain Aquifer Model¹ to evaluate the impacts of 2016 Agreement underperformance by the Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts. We utilized the ESPAM version 2.2 superposition model (IDWR, 2021) to evaluate junior groundwater pumping impacts to the 2016 Agreement Sentinel Wells and Snake River reach gains.

The 2016 Mitigation Plan recognizes the long-term, cumulative impacts of IGWA's junior groundwater pumping. Underperformance in 2022 causes impacts occurring in 2022 and for many years after.

¹ <https://idwr.idaho.gov/water-data/projects/espam/>

2.3.1 SENTINEL WELL INDEX IMPACTS

ESPAM results show that the 2022 underperformance by the Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts will cause a total of a 0.29 foot decline in the Sentinel Well Index.

A comparison to Eastern Snake Plain Aquifer (ESPA) groundwater storage numbers helps to put this Sentinel Well Index change number into perspective. In a recent Eastern Snake Hydrologic Modeling Committee (ESHMC) meeting, IDWR staff member Mike McVay presented historical ESPA groundwater storage changes (McVay, 2023). Mr. McVay presented the storage change from spring of 2015 to spring of 2016 as a loss of 300,000 acre-feet of water. During this same time frame, the Sentinel Well Index decreased by 0.27 feet. This is comparable to the decrease caused by IGWA’s 2022 underperformance and gives context to the scale of this type of impact.

The Sentinel Well Index decline due to IGWA’s 2022 underperformance is significant, especially since the 2016 Mitigation Plan goals are not being met. These impacts propagate into the future and warrant mitigation. These impacts will result in decreased Snake River reach gains, thereby reducing the volume of water available to SWC members and for storage fill as long as the impacts persist.

2.3.2 REACH GAIN IMPACTS

The 2016 Mitigation Plan’s ultimate goal is to restore Snake River reach gains between the near Blackfoot and Milner gages. This reach of the river provides the majority of SWC water supplies.

ESPAM v2.2 does not calculate any reach gains between Minidoka and Milner, and so the relevant modeled reach of interest for the 2016 Mitigation Plan is Near Blackfoot to Minidoka. Table 2 shows the ESPAM calculated reductions in reach gains over a 50-year period. A significant amount of impact has yet to happen.

Table 2 - GWD 2022 Underperformance Impacts on Snake River Reach Gains

Calendar Year	Reductions of Near Blackfoot to Minidoka Snake River Reach Gains (Acre-Feet)			
	Bingham	Bonneville	Jefferson-Clark	Total
2022 (Sept-Dec)	4,178	63	5	4,245
2023	6,165	536	150	6,850
2024	2,857	477	256	3,590
2025	1,703	340	294	2,337
2026	1,109	237	302	1,648
2027-2036	2,834	610	1,995	5,439
2037-2046	480	91	676	1,247
2047-2072	293	50	443	787
Totals	19,618	2,404	4,120	26,143

ESPAM results show that the 2022 underperformance by the Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts will cause a 26,143 AF decline in the near Blackfoot to Minidoka reach gains over a 50-year period. ESPAM calculates reach gain declines elsewhere in the river and predicts a total reach gain decline of 54,474 AF over 50 years.

These reach gain declines over the future decades are representative of the problem that the 2016 Mitigation Plan is intended to address and should be mitigated.

SECTION 3: PROPOSED REMEDY

Under the 2016 Mitigation Plan, any GWD not adhering to its terms and conditions is subject to curtailment or remedial actions specified by the Director to cure the breach. An appropriate remedy should mitigate all impacts of IGWA's excessive junior groundwater pumping, including long-term impacts that happen over many years.

3.1 GROUNDWATER PUMPING MEASUREMENT AND REPORTING

In the ideal future, breach of the 2016 Mitigation Plan would be minimized by accurate measurement and near real-time reporting of groundwater pumping. This would allow efficient and rapid administration of groundwater pumping limits.

Groundwater pumping measurement is effectively utilized around the world, particularly for water rights administration and groundwater resource management in water stressed areas. Current telemetry technology has been demonstrated as an effective reporting method. Areas implementing groundwater pumping measurements combined with telemetry include: California, Alberta, Spain, France, India, Australia, South Africa, and Morocco.

The 2016 Mitigation Plan requires flow meters to be installed on wells. However, the current reporting timelines are ineffective in preventing junior groundwater pumping in excess of 2016 Mitigation Plan limits. Rapid reporting of groundwater pumping volumes would increase the effectiveness of a remedy.

3.2 2022 BREACH REMEDY

Because it is now almost two years past, prevention of the 2022 breach is impossible. However, the multi-year or multi-decade impacts are demonstrated above and should be remedied as soon as possible.

An effective remedy to the 2022 Breach could include reducing 2024 pumping at the locations where the excessive pumping occurred. The 2016 Mitigation Plan includes pumping allocations at the GWD level rather than at the farm or well level. As such, a remedy for the 2022 Breach proposed here is at the GWD scale. It is important that a remedy happen in the same location as where the excessive pumping occurred. This will be the best way to most closely replicate the timing and location of over pumping impacts.

Additional reductions to pumping allocations for the Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts is one possible remedy for the 2022 Breach. Although it would have been preferable to implement these reductions in the 2023 irrigation season, that time has passed. Implementing additional pumping reductions for Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts in the 2024 irrigation season is a realistic remedy to address the long-term impacts of the 2022 Breach.

Table 3 presents the recommended 2024 additional pumping reductions, which are equal to the Director's quantification of 2022 excessive pumping amounts.

Table 3 - Recommended Remedy: 2024 Additional Pumping Reductions

Ground Water District	Additional Pumping Reductions (acre-feet)
Bingham	32,476
Bonneville-Jefferson	5,204
Jefferson-Clark	18,605
Total	56,285

SECTION 4: SUMMARY OF OPINIONS

The sections above present my opinions related to IGWA's 2022 Breach of the 2016 Mitigation Plan. My opinions are summarized in the following list.

1. Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts failed to satisfy their mitigation obligations in 2022. The Director quantified their 2022 excessive pumping amounts as 32,476; 5,204; and 18,605 acre-feet, respectively.
2. Excess groundwater diversions constitute noncompliance with the 2016 Mitigation Plan, thereby disqualifying these Districts for protections afforded under the agreement. Specifically, they are now subject to curtailment or actions specified by the Director to cure the breach.
3. The 2016 Mitigation Plan addresses declines in aquifer levels, Snake River reach gains, and junior groundwater pumping impacts that extend beyond a single irrigation season.
4. The primary measure of 2016 Mitigation Plan activities impact on aquifer conditions is through the Sentinel Well Index, with 2023 and 2026 goals established. The Sentinel Well Index is at record low levels and was far short of the 2023 goal.
5. ESPAM results show that the 2022 underperformance by the Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts will cause a total of a 0.29 foot decline in the Sentinel Well Index. This is a significant amount of Sentinel Well Index decline, especially since the 2016 Mitigation Plan goals are not being met. These impacts propagate into the future and warrant mitigation.

6. ESPAM results show that the 2022 underperformance by the Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts will cause a 26,143 AF decline in the near Blackfoot to Minidoka reach gains over a 50-year period. A significant amount of these declines have yet to happen.
7. The 2016 Mitigation Plan recognizes the long-term, cumulative impacts of IGWA's junior groundwater pumping. Underperformance in 2022 causes impacts occurring in 2022 and for many years after.
8. 2016 Mitigation Plan underperformance would be minimized by accurate measurement and near real-time reporting of groundwater pumping.
9. An effective remedy to the 2022 Breach could include reducing 2024 pumping at the locations where the excessive pumping occurred.
10. Implementing additional pumping reductions for Bingham, Bonneville-Jefferson, and Jefferson-Clark Ground Water Districts in the 2024 irrigation season is a realistic remedy to address the long-term impacts of the 2022 Breach. 2024 additional pumping reductions should equal the 2022 excessive pumping amounts of 32,476; 5,204; and 18,605 acre-feet, respectively.

SECTION 5: REFERENCES

IDWR, 2016a. *Docket No. CM-MP-2016-001, Surface Water Coalition's and IGWA's Stipulated Mitigation Plan and Request for Order*. Idaho Department of Water Resources, March, 2016. <https://idwr.idaho.gov/wp-content/uploads/sites/2/legal/CM-MP-2016-001/CM-MP-2016-001-20160309-SWCs-and-IGWAs-Stipulated-Mitigation-Plan-and-Request-for-Order.pdf>, accessed February 9, 2024.

IDWR, 2016b. *Docket No. CM-MP-2016-001, Final Order Approving Stipulated Mitigation Plan*. Idaho Department of Water Resources, May, 2016. <https://idwr.idaho.gov/wp-content/uploads/sites/2/legal/CM-MP-2016-001/CM-MP-2016-001-20160502-Final-Order-Approving-Stipulated-Mitigation-Plan.pdf>, accessed February 9, 2024.

IDWR, 2021. *Comparison of Superposition Model with Fully-Populated Model for Eastern Snake Plain Aquifer Model Version 2.2*. Idaho Department of Water Resources, March, 2021. https://research.idwr.idaho.gov/files/projects/espam/browse/ESPAM22_Reports/Scenarios/Super_FullyPop_Final.pdf, accessed February 9, 2024.

IDWR, 2023a. *Docket No. CM-MP-2016-001, Final Order Regarding IGWA's 2022 Mitigation Plan Compliance*. Idaho Department of Water Resources, August, 2023. <https://idwr.idaho.gov/wp-content/uploads/sites/2/legal/CM-MP-2016-001/CM-MP-2016-001-20230802-Final-Order-Regarding-IGWAs-2022-Mitigation-Plan-Compliance.pdf>, accessed February 9, 2024.

IDWR, 2023b. *Docket No. CM-MP-2016-001, Notice of Satisfaction of American Falls-Aberdeen Ground Water District 2022 Mitigation Obligation*. Idaho Department of Water Resources, November, 2023. <https://idwr.idaho.gov/wp-content/uploads/sites/2/legal/CM-MP-2016-001/CM->

[MP-2016-001-20231107-Notice-of-Satisfaction-of-American-Falls-Aberdeen-Ground-Water-District-2022-Mitigation-Obligation.pdf](#), accessed February 9, 2024.

McVay, 2023. *ESPA Storage Changes*, presentation to the Eastern Snake Hydrologic Modeling Committee on November 27, 2023.
[https://research.idwr.idaho.gov/files/projects/espam/browse/meetings/2023-ESHMC/20230927/ESPA Storage ESHMC 09272023.pdf](https://research.idwr.idaho.gov/files/projects/espam/browse/meetings/2023-ESHMC/20230927/ESPA_Storage_ESHMC_09272023.pdf), accessed February 9, 2024.

APPENDIX A – CURRICULUM VITAE FOR DAVID COLVIN

DAVE COLVIN, PG, PMP

Groundwater Team Leader | Senior Project Manager | Principal

EDUCATION

M.S. Environmental Science and Engineering, Colorado School of Mines, 2002

B.S. Geology, Syracuse University, 1996

PROFESSIONAL REGISTRATION

Professional Geoscientist

AZ RG#68926

ID #PGL-1453

TX #11440

WY #PG-3602

KS #958

Project Management Professional (PMP) #1749472

PROFESSIONAL ACTIVITIES

AWRA Colorado

2017/2018 Past President

Water Education Colorado

2012 Water Leaders Program

Colorado Groundwater Association

National Groundwater Association

Dave is a Principal Hydrogeologist and Senior Project Manager with over 25 years of experience in groundwater hydrology, water resources, and environmental sciences. He supervises teams of diverse subject matter experts and provides technical leadership to solve today's water resource challenges. Dave serves as the Groundwater Team Leader responsible for managing staff, resources, projects and clients for a group of hydrogeologists. His technical expertise subject areas include water supply and storage development, groundwater management, groundwater governance/administration, surface water/groundwater interaction, riverbank filtration (RBF), soil aquifer treatment (SAT), managed aquifer recharge (MAR), aquifer storage and recovery (ASR), aquifer characterization, groundwater modeling, and subsidence caused by groundwater pumping.

FEATURED PROGRAM & PROJECT EXPERIENCE

Salt River Project – Gila River Basin Adjudication, Arizona Superior Court Case W1-103, San Pedro Basin, AZ (2018 – ongoing)

Hydrogeologist providing groundwater analysis and modeling supporting adjudication of water rights in the San Pedro Basin. Tasks include review of groundwater model development, calibration and uncertainty analysis, and trial/litigation support. Provides protection of surface water flows, riparian habitat, and water rights from negative impacts due to groundwater pumping.

Surface Water Coalition, Idaho (2019-ongoing)

Lead Hydrogeologist and Project Manager providing litigation support related to water management of the Eastern Snake Plain Aquifer. Provides protection of surface water flows and senior surface water rights from negative impacts of junior groundwater pumping. Serves on the Eastern Snake Plain Hydrologic Modeling Committee supporting MODFLOW modeling activities related to complex surface water/groundwater management and water rights administration. Also serves as the SWC representative on technical working groups guiding the implementation and adaptation of a settlement agreement between the SWC and Idaho Ground Water Appropriators including monitoring/evaluation of hydrology, pumping reductions, consumptive use and planning for managed aquifer recharge. Provides technical input to the development of a Groundwater Management Area adaptive management plan.

Salt River Project – Gila River Basin Adjudication, Arizona Superior Court Case W1-106 Verde River Watershed, AZ (2019 – ongoing)

Project manager and hydrogeologist providing groundwater analysis of Verde River watershed water management impacts to the Verde River. Support includes review and response to subflow administrative procedures.

Salt River Project – Cooperative Agreement No. 1, Big Chino Sub-Basin, AZ (2016 – ongoing)

Project manager and hydrogeologist providing groundwater analysis characterizing water management impacts on flows of the Upper Verde River Springs. Support includes specialized technical consulting, review and oversight of modeling and monitoring programs implemented by a multi stakeholder group seeking science-based resolution of water rights conflict.

City of Aurora – Horizontal Well Project; Weld County, CO (2019 – ongoing)

Project Manager for feasibility evaluation and planning of two radial collector wells for the City's Prairie Waters System. The project targets increasing system yield while maximizing riverbank filtration water quality improvements. Investigation included hydrogeophysical surveys, exploratory drilling, aquifer testing, and groundwater modeling. Results included design of horizontal wells that maintain the existing system water quality while providing adaptable system operations that can increase yield during drought demands. Currently the Lead Hydrogeologist providing design phase services.

City of Northglenn – ASR Feasibility Evaluation and Pilot Testing (2020 – ongoing)

Lead hydrogeologist and Project Manager for feasibility investigation and pilot test system design services. Support includes ASR feasibility data analysis, water quality evaluation, DWR and EPA UIC permitting, pilot system design and test planning. The project will provide pilot storage of the City's fully consumable water rights, providing more surface storage space for other supplies. If recovered water quality is compatible, the pilot system will be converted into permanent infrastructure as the first phase of a larger ASR system.

Riverence Holdings LLC – Snake River Spring Supply Support (2022-ongoing)

Project Manager and lead hydrogeologist supporting multiple fish hatcheries throughout Idaho's Magic Valley. Provides hydrogeologic planning of spring fed aquaculture focusing on upgradient aquifer pumping and recharge impacts on water rights, water quality, and water supply reliability.

Dominion Water and Sanitation District – Groundwater Support; Douglas County, CO (2015-ongoing)

Lead Hydrogeologist providing Denver Basin and South Platte alluvial aquifer groundwater resources planning services including water rights evaluation, water quality assessment, well field yield estimation and project planning. Provides hydrogeologic and contractor management support during Denver Basin well site design, construction, testing, aquifer characterization, and sampling. Additional technical support includes regional groundwater management planning, documentation for County hearings, interactions with local water agencies, and groundwater transaction due diligence.

City of Aurora – Box Elder Basin Aquifer Storage and Recovery (ASR) Feasibility Investigation and Pilot Testing (2018 – Ongoing)

Project Manager and lead hydrogeologist investigating the feasibility of recharging and storing water in the Box Elder alluvial aquifer at the Aurora Center for Renewable Energy (ACRE). Tasks included hydrogeophysical surveys, exploratory drilling/test pits, and infiltration testing. The project identified recharge as a viable option for innovative underground water storage opportunities. Services include recharge source water characterization, water rights and permitting planning, water quality evaluation, groundwater modeling, and pilot system design.

Town of Erie – Water Supply Planning Support (2018 – ongoing)

Lead hydrogeologist and Project Manager providing groundwater support related to water supply planning. Services include aquifer characterization, water quality studies, ASR feasibility analysis, and water rights. Prepared Colorado Water Conservation Board and Division of Local Affairs grant applications to obtain project funding. Provided due diligence review and retrofit design of an existing horizontal well currently being incorporated as expanded supply. Provided feasibility investigation, alternatives analysis, water rights, design, construction procurement/oversight, and testing for a 1,000 foot long horizontal directionally drilled riverbank filtration well.

Town of Castle Rock – Groundwater Support; Douglas County, CO (2015-ongoing)

Project Manager providing comprehensive groundwater support. Projects have included:

- Denver Basin Well Drilling, Testing, and Aquifer Storage and Recovery (ASR) – Support includes Denver Basin ASR planning/permitting, bidding services, contractor management, construction oversight, well/pump design, aquifer testing, and groundwater regulatory support.
- Alluvial Well Field Expansion and Rehabilitation – Project Manager for two projects aimed at improving yields in well fields affected by biofouling and performance issues. Oversaw construction and testing of six horizontal directional drilled (HDD) wells installed to increase yield, performance, and sustainability.
- City of Aurora and Town of Castle Rock – Lost Creek Underground Storage Pilot Project; Lost Creek Designated Basin, CO (2017-2018)
- Project Manager for aquifer characterization and evaluation of recharge potential for underground water storage pilot project. Obtained grant funding and facilitated multiple stakeholder project planning and implementation. The project identified important field investigation methods and results for storage related aquifer characteristics previously overlooked in desktop studies.

City of Aurora – Prairie Waters North Campus Master Plan; Adams and Weld Counties, CO (2017-2019)

Lead hydrogeologist providing master planning services for approximately 20 MGD expansion of the Prairie Waters Project – North Campus over the next 20 years. Facility expansion included riverbank filtration well field, pipelines, and storage reservoirs. Led facilities operational planning, supported water resource planning, gap analysis, and capital improvements planning.

Denver Water – Aquifer Storage and Recovery (ASR) Pilot Project, City and County of Denver, CO (2016-current)

Groundwater technical support and project management for ASR feasibility investigation. Provided Denver Basin aquifer characterization including exploratory borehole drilling, hydrogeophysical investigation (Nuclear Magnetic Resonance and conventional methods), and 3-D geologic modeling. Current services include an advisory role for installation of a multi-aquifer Westbay Denver Basin monitoring well.

City of Greeley – ASR Feasibility Evaluation (2019-2021)

Senior Technical Advisor for a project evaluating the feasibility of new and existing ASR projects in multiple bedrock aquifers. Includes evaluation of water quality, aquifer characteristics, well construction/testing, project planning, and regulatory support, including negotiating an EPA UIC Rule Authorization in less than two months.

Project 7 Water Authority – Riverbank Filtration Feasibility Study, Montrose CO (2019-2020)

Project Manager for RBF feasibility study in the Uncompahgre River alluvial aquifer. The study included geophysical surveys, borehole drilling, pumping test analyses, water quality investigation, and groundwater modeling. The project objectives were to characterize vertical and horizontal well field alternatives for maximum yield while providing water quality pre-treatment improvements.

Colorado Water Conservation Board - HB16-1256 South Platte Storage Study; CO (2018)

Lead hydrogeologist providing evaluation of underground water storage options for the Lower South Platte alluvial aquifer. Provided alluvial storage site evaluation, conceptual design, cost estimates, and comparison to surface storage options.

Aurora Prairie Waters Project – North Campus; Weld County, CO (2008)

Supported City of Aurora's Prairie Waters project near the South Platte River, CO. Acted as team liaison for multi-consultant, multi-disciplinary project team. Field investigation and construction tasks included field oversight of drilling, well construction, pump/motor installation, aquifer testing, system start up testing, well field yield optimization, and geotechnical investigations. Support also included the design, construction, and operation of alluvial recharge and riverbank filtration pilot test facilities. Developed and implemented pilot test procedures, including tracer studies to assess flow paths, travel times, and stream/aquifer interaction. MODFLOW modeling support for the Prairie Waters Project included development of regional groundwater model for Colorado Division 1 case 2006CW104. Performed parallel processing model calibration using UCODE. Prepared expert and rebuttal reports, exhibits and materials used in settlement negotiations.

Eagle River Water and Sanitation District and Upper Eagle Regional Water Authority – Groundwater Support; Eagle County, CO (2010-ongoing)

Project Manager and lead Hydrogeologist for alluvial well field groundwater support. Projects have included:

- GWUDI Evaluation – Regulatory support, groundwater modeling and operational monitoring of alluvial well fields in support of CDPHE GWUDI evaluation

- Lake Creek Well Field Planning – Services included groundwater modeling, well drilling, aquifer testing, source water quality characterization, regulatory support for Eagle County 1041, CDPHE, and DWR permitting
- Well field maintenance and rehabilitation support – well rehabilitation in response to well issues including pump issues, casing holes, and water quality contamination

City of Steamboat Springs – Infiltration Gallery System Expansion; Routt County, CO (2018-ongoing)

Project Manager for feasibility evaluation of alluvial groundwater supply expansion alternatives. Expansion options being considered include vertical and horizontal well options. Tasks included exploratory drilling, aquifer testing, groundwater modeling and conceptual expansion system design. Modeling was performed to optimize well siting to maximize yield, maintain water quality, and to minimize pipeline costs.

Texas Water Development Board – Statewide Subsidence Risk Evaluation (2018)

Technical advisor for risk evaluation of subsidence due to groundwater pumping in all Texas major and minor aquifers. The project used well lithology data with model predicted water level declines to create a statewide risk map and prioritized table. Recommended follow up actions for identified areas of risk. The project provided important subsidence risk information for statewide planning and local user considerations.

Village at Taos Ski Valley – Spring Water Supply Expansion; Taos County, NM (2018-ongoing)

Senior Technical Advisor providing groundwater evaluation into the management, protection and expansion of spring water supplies.

City of Phoenix – ASR Tracer Test Design; Maricopa County, AZ (2017)

Provided MT3D groundwater modeling to assist in aquifer characterization, travel time estimates, and the design of an ASR tracer injection test for feasibility. The testing was in support of the Northeast Phoenix Reclaimed Water Recharge and Recovery Study. The system is intended to create a potable water resource through Indirect Potable Reuse (IPR), provide additional non-potable supplies, and to mitigate land subsidence issues.

Groundwater Relief – Kutupalong Refugee Camp Groundwater Supplies; Cox's Bazaar, Bangladesh (2019)

Volunteer hydrogeologist providing well testing and water quality support to field geologists. The project is developing emergency water supplies for nearly 1 million Rohingya refugees who have fled religious persecution in Myanmar.

City of San Angelo – Riverbank Filtration Feasibility Evaluation; Tom Green County, TX (2018)

Provided feasibility evaluation, preliminary siting, design and costs for a potential riverbank filtration (RBF) well field near the Concho River. This information was used to evaluate RBF as an alternative for expansion of the City's water supply.

Tarrant Regional Water District – Cedar Creek Wetlands; Kaufman County, TX (2013)

Project manager and lead Hydrogeologist for riverbank filtration feasibility investigation along the Trinity River. Project tasks include geotechnical, hydrogeologic, and surface geophysical surveys, groundwater modeling, and design, construction and testing of riverbank filtration pilot test sites.

Rangen, Inc. – Water Rights Support; Gooding County, ID (2010-2016)

Expert witness providing testimony and trial support for a water rights hearing (IDWR Case No. CM-DC-2011-004) involving springs and complex surface water/groundwater interaction of the Eastern Snake Plain Aquifer. Represented a fish hatchery reliant on spring flow that was being impacted by groundwater pumping. Served on the Eastern Snake Plain Hydrologic Modeling Committee supporting MODFLOW modeling activities in the Eastern Snake Plain of Idaho.

Overturf, McGath, and Hull, P.C. – Stewart No. 1 Ditch Company; Pitkin County, CO (2017)

Expert witness support including expert and rebuttal reports, depositions, and settlement negotiations for a civil case involving alleged roadway water damage from ditch operations.

Fredrickson Law Offices – In-Play Golf; Weld County, CO (2017)

Expert witness providing expert and rebuttal reports, depositions, and trial support for a civil case involving alleged water damages from golf course irrigation.

Boulder Valley School District – Douglass Elementary Non-Tributary Well Support; Boulder County, CO (2018)

Project Manager for a non-tributary well application in the Boulder Complex Area of the Denver Basin Aquifers. Provided aquifer characterization and regulatory support leading to a non-tributary determination and permit approval.

Boulder County Parks and Recreation – Kenosha Ponds Groundwater Evaluation; Boulder County, CO (2016)

Expert witness providing hydrogeology water rights support for a Boulder County Parks and Recreation augmentation pond. Technical support included expert report writing and trial exhibit preparation for the hydrologic characterization of a recharge pond between two streams where the pond bottom was below the water table.

City of Burkburnett, Texas – Alluvial Well Field Evaluation; Wichita County, TX (2016)

Project Manager and groundwater lead for evaluation of underperforming well fields near the Red River. Wells ranged from 3-50 years old with a variety of issues causing low yields. Project tasks included well operational data integration, analysis, and development of alternatives to improve well yields.

Penrose Water District – Arkansas River Alluvial Well Field; Fremont County, CO (2016)

Groundwater technical management for planning, design, and construction of an alluvial well field for diversion of Arkansas River water rights. Tasks included aquifer characterization, water rights support, groundwater modeling, contractor management, well drilling, construction and testing.

Salt River Project – New River Agua Fria Underground Storage Project; Phoenix, AZ (2013)

Project involved optimization and in-channel expansion design for an existing recharge facility. Support included evaluation of operational data and adaptation of an existing MODFLOW model for operational optimization and feasibility testing.

City of San Marcos, Texas – Well Performance Investigation and Replacement Plan; Hays County, TX (2015)

Project Manager and groundwater lead for investigation into reduced yield problems for a well in the Edwards Aquifer. Well construction and operational data were analyzed to test viability of rehabilitation or equipment replacement. Provided ultimate solution of siting a replacement well in a more productive aquifer area.

Oakwood Homes – Neighborhood Scale Dewatering Systems and Water Rights; CO (2016)

Project Manager and groundwater lead for planning, design, and permitting of neighborhood scale dewatering systems. Managed project work including groundwater modeling, system design, data analysis, contractor coordination, DWR and CDPHE permitting, and water rights evaluations.

Winkler Services – Well Field Siting and Design; Wink County, Texas (2017)

Technical advisor for well field siting in the Pecos Valley Alluvium and Upper Dockum Aquifer. Support included project planning, aquifer characterization, and geologic modeling.

Donala Water and Sanitation District – Reuse Evaluation; El Paso County, CO (2015)

Preliminary feasibility investigation into riverbank filtration alternatives for indirect potable reuse. Evaluated hydrogeologic conditions for permitting, cost, and performance feasibility considerations.

Confidential Client; Groundwater Supply and Subsidence Analysis; AZ (2011)

Development of regional MODFLOW models used to estimate well field yield and land subsidence due to groundwater pumping in Arizona. Work included statewide study of subsidence-related empirical relationships and prediction methods, aquifer characterization, 3-D geologic and groundwater flow modeling, automated model calibration and predictive uncertainty analysis using PEST, and numerical MODFLOW subsidence modeling.

City of Scottsbluff – Well Field Uranium Investigation and Monitoring; Scotts Bluff County, NE (2016)

Technical advisor for a project aimed at reducing uranium concentrations in an alluvial groundwater supply. Provided aquifer characterization and uranium monitoring data analysis.

Confidential Client - Oilfield Produced Water Infiltration Modeling, San Louis Obispo County, CA(2010)

Lead Hydrogeologist for the development of an engineering design MODFLOW-SURFACT model with the goal of infiltrating 13 acre-feet of water per day into the subsurface of a 200 acre alluvial site. Performed model calibration using PEST software in a parallel processing environment utilized 50 geologic conceptualizations for stochastic predictions of system performance.

Colorado Department of Public Health and Environment – Summitville Superfund Site; Summitville, CO (2008)

Provided support for abandoned mine hydrology and geochemistry, field sampling, monitoring and mine facility inspection, and database support. The project goal was to monitor and minimize mine waste impacts on the Alamosa River.

Various Mines – Groundwater Modeling and Analysis; Basin and Range Province; NV (2010)

Provided MODFLOW modeling and water balance studies in support of mine water management and regulatory reporting. Analyses included point flow surface water modeling to evaluate stream gain/loss; detailed water balance quantifications; well inventories and pumping estimates; groundwater underflow assessments.

Miron Construction - Laramie-Fox Hills Well; Hudson, Colorado (2008)

Assisted in design and field engineering for the construction and testing of a 960-foot deep, large capacity, municipal/industrial, Laramie-Fox Hills water supply well at the Hudson Correctional Facility.

Perini/US Army Corps of Engineers – Groundwater System Design and Optimization; Baghdad, Iraq (2007)

MODFLOW modeling support for the U.S. Agency for International Development in Baghdad, Iraq. Developed a numerical groundwater model for the optimization of water supply well locations and pumping operations. Main objectives were to maximize well yields while minimizing differential land subsidence across newly constructed East End Barracks.

Colorado Haiti Project (Volunteer Position); Petit Trou de Nippes, Haiti (2013)

Technical advisor for groundwater development, management, and protection in a rural, developing area of Haiti.

Water For People Groundwater Management Project (Volunteer Position); San Pedro Sula, Honduras (2008)

Technical advisor for development of a scope of work for a participatory groundwater management plan aimed at restoring and protecting an over utilized alluvial aquifer in a developing region.

ASARCO - California Gulch Superfund Site; Leadville, Colorado (2000-2005)

Conducted environmental sampling for the Kids First Program to identify and address sources of lead exposure for children in residential areas. Provided statistical analysis and reporting for evaluation of program effectiveness. Designed sampling plan and performed soil sampling and analysis to delineate extent of metals contamination at the Arkansas Valley Smelter Operable Unit. Provided technical support for hydrogeological and geochemical characterization of the Apache Tailings site; and implemented the surface water and groundwater performance monitoring program to assess the effectiveness of the remedial action. Conducted synoptic surface water flow measurement and water quality sampling.

Asarco - Omaha Lead Site, Omaha, Nebraska (2003)

Assisted in the development of program to identify sources of lead exposure for children in residential areas.

Mine Waste and Tailings Pile Sites, Various Locations (2000-2004)

Performed hydrologic evaluation of remedial alternatives for repository evaluation using Hydrologic Evaluation of Landfill Performance (HELP) model.

Industrial Groundwater Contamination Sites, Various Locations (2000-2005)

Performed groundwater modeling to assist design of groundwater extraction remediation wells using MODFLOW modeling code.

EPA - Vasquez Boulevard and Interstate 70 Superfund Site, Denver, Colorado (2002)

Designed, directed, and performed environmental sampling for project intended to identify sources of lead and arsenic exposure for children in residential areas.

Hertz Rent-a-Car - Former Underground Storage Tank, Colorado Springs, Colorado (2002)

Project Hydrogeologist and technical lead for the characterization, monitoring, and remediation of hydrocarbon contaminated soils and groundwater at a former underground storage tank site. Performed quarterly monitoring and reporting; developed and implemented an in-situ chemical oxidation remediation program.

R&R Super Service - Former Underground Storage Tank, Arvada, Colorado (2002)

Project Manager and technical lead for the characterization and remediation of soils and groundwater contaminated by petroleum hydrocarbons at a former service station. Responsibilities included client and regulatory interaction; site characterization activities to delineate the nature and extent of contamination in soil and groundwater; modeling of vapor and mass extraction rates using VENT2D; respirometry testing to quantify biodegradation rates in vadose zone soils; startup testing; operating, maintaining, and monitoring of an air sparge/soil vapor extraction system.

City and County of Denver - Former Stapleton International Airport Remediation; Denver, Colorado (2000)

Served as a hydrogeologist conducting field investigations to define nature and extent of hydrocarbon contamination and to determine remediation. Field tasks included lithologic logging with a hollow-stem auger and direct-push drilling rigs; soil, groundwater, and soil vapor testing, remediation system construction/operation/maintenance, data evaluation and reporting.

National Park Service – Mt. Rainier National Park, Longmire, Washington (1996-1997)

Biologist and crew leader for aquatic ecosystem studies in Mt. Rainier National Park. Conducted field surveys and sub-alpine wetland monitoring. Performed aquatic field sampling, wetland classification, biological species identification, and aquatic laboratory analyses.

PRESENTATIONS & PUBLICATIONS

Colvin, Dave, 2020. "Moving from Conflict to Collaboration: The Role of MAR in Mitigating Groundwater Pumping Impacts to Surface Water" 17th Biennial Symposium on Managed Aquifer Recharge. *Tempe, AZ*.

Colvin, Dave, 2020. "Drawing the Line in the Sand between Underground Water Storage and Augmentation Recharge." American Water Resources Association – Colorado Chapter & Colorado Groundwater Association *Joint Annual Symposium. Denver, CO*

Colvin, Dave, 2019. "Demonstrating Dominion and Control – Moving from Black Magic to Understandable Science." American Groundwater Trust Annual Colorado *Groundwater Conference*. Denver, CO.

Colvin, Dave, 2019. "Now We Know What We Don't Know: An ASR Regulatory Update". Colorado Groundwater Association *September Meeting*. Denver, CO.

Colvin, Dave, 2019. "The Evolution of Colorado Underground Water Storage Administration". American Water Resource Association / Colorado Groundwater Association 2019 Joint Annual *Symposium*. Denver, CO.

Colvin, Dave, 2018. "Technical Considerations for ASR Planning in Colorado's Front Range". American Groundwater Trust Annual Colorado *Groundwater Conference*. Denver, CO.

Colvin, Dave, 2018. "ASR Panel Discussion: The Revolution of Subsurface Water Storage". American Water Works Association ACE18 *Conference*. Las Vegas, Nevada.

Colvin, Dave, and Keester, Michael, 2017. "Applying Web-Based Information Management Tools to Increase Efficiency and Expand Opportunities for Groundwater Conservation Districts". Texas Association of Groundwater Districts *Groundwater Summit*. San Marcos, TX.

Colvin, Dave, and Pence, Rachel, 2017. "Using NMR and Hydrogeophysics to Evaluate ASR Feasibility in the Denver Basin". 2017 NGWA Conference on Hydrogeophysics and Deep Groundwater, Denver, CO. (<https://ngwa.confex.com/ngwa/hdg2017/webprogram/Paper11286.html>)

Colvin, Dave, and Justus, Heather, 2016. "Benefits of Directionally Drilled Alluvial Well Lateral Arms in the Town of Castle Rock". 2016 RMSAWWA/RMWEA Joint *Annual Conference*, Keystone, CO.

Colvin, Dave, and Furnans, Jordan, 2016. "Can/Should Texas learn from Colorado? A primer on groundwater-surface water interactions and regulation methods". 2016 Texas Water Conservation Association Spring meeting, Woodlands, TX. (<http://www.slideshare.net/TWCA/twca-annual-convention-canshould-texas-learn-from-colorado-jordan-furnans-and-dave-colvin>)

Colvin, Dave, 2015. "Methods for Confident Model Predictions and Integration". Colorado Water Congress 2015 Annual Conference; DARCA Workshop Series, "The Next Step: Modeling Colorado's Water Plan", Denver, CO.

Colvin, Dave, 2014. "Groundwater Challenges and Solutions for Colorado Watersheds." 2014 Colorado Sustaining *Watersheds Conference*, Avon, CO.

Colvin, Dave and Loopesko, William, 2014. "Advantages of Alluvial Aquifer Storage Alternatives for Managing Hydrologic Extremes and Future Water Supply Risks." 2014 Upper Colorado River Basin Water Forum, Grand Junction, CO.

Colvin, Dave, 2014. "Groundwater Solutions for Indirect Potable Reuse." 2014 Rocky Mountain *Water Reuse Workshop*, Golden, CO.

Colvin, Dave, Bauer, Jacob, and Noack, Tim, 2013. "Effective Tools and Project Planning for Riverbank Filtration Feasibility Investigation" Poster session at 2014 Texas Water, Dallas, TX.

(http://s3.amazonaws.com/eventmobi-assets/events/txwater14/documents/person/1366969/201404_RBF_Feasibility_Poster_Final.pdf)

Colvin, Dave, and Bauer, Jacob, 2013. "Cost Effective Feasibility Investigation of Natural Subsurface Reuse Treatment Systems." Poster session at the 2013 National Water Reuse Symposium, Denver, CO.

Colvin, Dave, Bauer, Jacob, and Neupauer, Roseanna, 2013. "Riverbank Filtration Feasibility Modeling." MODFLOW and More 2013. Integrated Groundwater Modeling Center. Golden, CO.

Colvin, David C., 2012. "Comparison of One and Three Dimensional MODFLOW Subsidence Results." 2012 Groundwater Summit, National Groundwater Association, Westerville, OH.

Colvin, David C., 2012. "One Dimensional MODFLOW Modeling of Land Subsidence Due to Fluid withdrawal." GSA 2012 Cordilleran Section Meeting, Vol. 44, No. 3. Geological Society of America. Boulder, CO.

EXPERT TESTIMONY

Dave has provided expert testimony in trial or depositions in the following cases:

Idaho Surface Water Coalition; Idaho Department of Water Resources Snake River Basin Moratorium, Administrative Hearing Regarding on the Consolidated Big Wood and Snake River Moratorium Matter, October 2023

Idaho Surface Water Coalition; Idaho Department of Water Resources Docket No. CM-DC-2010-001, Hearing Regarding the Fifth Methodology Order, June 2023

Idaho Surface Water Coalition; Idaho Department of Water Resources Docket No. AA-GWMA-2016-001, Order Designating the Eastern Snake Plain Aquifer Groundwater Management Area, February 2020

Stewart No. 1 Ditch Company; Pitkin County Case No: 2014CV30084, Pitkin County Board of County Commissioners v. Brothers, et. al., September, 2015.

In-Play Golf, Inc; Weld County Case 12CV727, Helen Hawkins et. al. v. Vista Ridge Development Corporation et. al., August, 2015.

Rangen, Inc.; In the Matter of Application for Water Rights Permit No., 36-17011, February, 2015.

Rangen, Inc.; Idaho Department of Water Resources Case No. CM-DC-2011-004, Distribution of Water To Water Right Nos. 36-02551 and 36-07694, May, 2013.

EXPERT REPORTS

Dave has performed groundwater analysis, provided assistance in settlement negotiations, and authored or contributed to reports in the following cases.

Idaho Surface Water Coalition; Idaho Department of Water Resources Snake River Basin Moratorium, Administrative Hearing Regarding on the Consolidated Big Wood and Snake River Moratorium Matter, October 2023

Idaho Surface Water Coalition; Idaho Department of Water Resources Docket No. CM-DC-2010-001, Hearing Regarding the Fifth Methodology Order, June 2023

Idaho Surface Water Coalition; Idaho Department of Water Resources Docket No. AA-GWMA-2016-001, Order Designating the Eastern Snake Plain Aquifer Groundwater Management Area, February 2020

Town of Erie; CO Division 1 Case Nos. 2019CW3063 and 2019CW3064, Application for Underground Water Rights and Plan for Augmentation, 2020.

Salt River Project; AZ Big Chino Cooperative Agreement #1, Evaluation of Big Chino Water Ranch impacts on Upper Verde Springs discharge, 2016 - ongoing.

Salt River Project; AZ Gila River Adjudication Contested Case No. W1-103, Groundwater adjudication and subflow depletion evaluation, 2017 – ongoing.

In-Play Golf, Inc; Weld County Case 12CV727, Helen Hawkins et. al. v. Vista Ridge Development Corporation et. al., August, 2015.

Stewart No. 1 Ditch Company; Pitkin County Case No: 2014CV30084, Pitkin County Board of County Commissioners v. Brothers, et. al., September, 2015.

Rangen, Inc.; In the Matter of Application for Permit No., 36-17011, February, 2015.

Rangen, Inc.; Idaho Department of Water Resources Case No. CM-DC-2011-004, Distribution of Water To Water Right Nos. 36-02551 and 36-07694, May, 2013.

Boulder County Parks and Open Space; CO Division 1 Case No. 2010CW320, Change of Use and Plan for Augmentation for Kenosha Ponds Open Space, 2013.

City of Aurora; CO Division 1 Case No. 2006CW104, Aurora's Prairie Waters Project, 2007.