

**Colorado Water Institute  
Colorado State University**

**Annual Technical Report  
2018**

# WRI Annual Reports: General Information

Email: [Reagan.Waskom@Colostate.edu](mailto:Reagan.Waskom@Colostate.edu)

Colorado

## Products

### **2018CO-ADMIN, Reagan Waskom**

- Reagan Waskom, Colorado Water Center director, attended the Annual NIWR Meeting in Washington D.C. and represented Colorado State University, NIWR, and academic research at numerous water meetings, conferences and lectures throughout the state of Colorado.

### **2018CO343B – Technology Transfer and Information Dissemination, Reagan Waskom**

- Completion reports and newsletters (<https://watercenter.colostate.edu>)

### **2018CO344B – Investigating Bi-Directional Water Exchanges Across Intact and Degraded Floodplains, Alexander C. Brooks (Tim Covino), Colorado State University, \$4,934.00 (104b)**

- Brooks, A.C., Covino, T., (poster) Parsing hydrologic and biogeochemical connectivity in a montane floodplain. Society for Freshwater Science Annual Meeting. *Salt Lake City, UT*, May 22, 2019.
- Brooks, A.C., Covino, T., Wohl, E., Hall, E. (poster) Evaluating metrics of lateral connectivity in a complex montane floodplain. AGU Fall Meeting. *Washington DC*, December 12, 2018.
- Covino, T., (oral) Linking hillslopes to river corridors to understand dissolved organic matter export at the watershed scale. AGU Fall Meeting. *Washington DC*, December 11, 2018.
- Brooks, A.C., Covino, T. (oral) Hydrologic connectivity as a tool for watershed management: moving from theory to application. 2018 Sustaining Colorado Watersheds Conference. Avon, CO, October 10, 2018.

### **2018CO346B – Streamflow Depletion on the South Platte River due to Groundwater Pumping: Analysis via Field Work and Groundwater Modeling, Luke Flores (Ryan Bailey), Colorado State University, \$4,993.09 (104b)**

- Journal article (in second review): "An analytical modeling approach for estimating streamflow loss impacted by groundwater pumping" (Journal of the American Water Resources Association)

- Journal article (to submit): "MODFLOW module for simulating stream/aquifer interactions in width-variable streams using shallow water equations" (Environmental Modelling & Software)

**2018CO347B – History of South Platte River Riparian Ecosystem and Channel Change, Joshua Rogerson (Jessica Salo), University of Northern Colorado, \$5,000.00 (104b)**

- Joshua Rogerson presented some of his findings at GIS in the Rockies, Denver, CO, September 2018 in a talk titled: The effect of channel migration on riparian vegetation along the South Platte River.
- Jessica Salo presented a poster at the South Platte Forum, Loveland, CO, October 2018, titled: Floodplain Land Cover Change (1998 – 2015) South Platte River, Colorado.

**2018CO348B – Assessment of Floodplain Storage Dynamics in Colorado, Ryan Morrison, Colorado State University, \$25,000.00 (104b)**

- Karpack, M. (2019). Quantitative Assessment of Floodplain Functionality Using an Index of Integrity. M.S. Thesis. Colorado State University, Fort Collins, Colorado.
- Karpack, M., Morrison, R.R., and McManamay, R. In Review. Quantitative Assessment of Floodplain Functionality Using an Index of Integrity. Ecological Indicators.

**G17AP00133– Hydrodynamic-enhancement of nitrate attenuation by integrating reactive biobarriers into shallow, open water treatment wetlands, Josh Sharp, Colorado School of Mines, \$250,000.00 (104g)**

***Publications:***

- Jones ZL, Mikkelson KM, Nygren S, Sedlak DL, Sharp JO. (2018) Establishment and convergence of photosynthetic microbial biomas in shallow unit process open-water wetlands. *Water Research*. 133:132-141. <https://doi.org/10.1016/j.watres.2018.01.021>

***Presentations:***

- **Vega, M, Brady A, Lundeen E, Mikkelson K, Sharp JO.** Impact of diatom photosynthesis on denitrification processes in a benthic, redox-stratified wetland biomat. Poster. Front Range Microbiome Symposium, April 19, 2019. Fort Collins, CO. \*\*Best graduate student poster award.
- **Vega, M, Brady A, Lundeen E, Mikkelson K, Sharp JO.** Distribution of potentially active nitrogen cycling taxa in a photosynthetic wetland biomat. Poster. Rocky Mountain Geobiology Symposium, April 5, 2019. Boulder, CO. \*\*Best poster award.
- **Vega M, Brady A, Lundeen E, Mikkelson K, Sharp JO.** Diel controls on nitrogen loss pathways within a photosynthetic wetland biomat. Poster. American Geophysical Union (AGU), Dec 10-14, 2018. Washington, DC.

- **Vega, M, Brady A**, Lundeen E, **Mikkelson K, Sharp JO**. Nitrogen biogeochemistry and attenuation processes. Poster. ReNUWIt Industrial Advisory Board Meeting. Orange County, CA. October 20, 2018.
- Sharp J. Microbiological opportunities in open water wetlands. **NSF ReNUWIt ERC Industrial Advisory Board**. Oct 19<sup>th</sup>, 2018. Fountain Valley, CA
- Sharp J. Within the green box: contaminant attenuation in shallow open water treatment wetlands. **NASA Ames Research Center**. June 5<sup>th</sup>, 2018. Mountain View, CA
- Lundeen E, **Vega M, Mikkelson K, Reed A, Sharp JO**. Understanding nitrogen removal processes in engineered treatment wetlands. CSM undergraduate research symposium. Poster. April 26, 2018. Golden, CO \*\*2<sup>nd</sup> place award winner for campus contest
- Sharp J. Within the green box: contaminant attenuation in shallow open water treatment wetlands. CEE Dept. **Stanford University**. April 19<sup>th</sup>, 2018. Palo Alto, CA
- **Vega M, Mikkelson K, Jones Z, Reed A, Sharp JO**. Assessing the role of diurnal cycling on nitrogen biogeochemistry in a wetland biomat. Poster. Rocky Mountain Geobiology Symposium, April 7, 2018. Golden, CO

**G15AP00168 -Trace Organic Contaminants (TOrcs) in Urban Stormwater and Performance of Urban Bioretention Systems: a Field and Modeling Study, Christopher Higgins, \$249,900 (104g)**

- Burant, A.; Selbig, W.; Furlong E.; Higgins C.P. (2018) Trace organic contaminants in urban runoff: Associations with urban land-use. *Environmental Pollution*. 242(B). 2068-2077. doi: [10.1016/j.envpol.2018.06.066](https://doi.org/10.1016/j.envpol.2018.06.066)
- Brown, J., Bell, C.D., Hogue, T.S., Higgins, C.P., Selbig, W.R. (In review). An integrated statistical and deterministic hydrologic model for analyzing trace organic contaminants in commercial and high-density residential stormwater runoff. *Science of the Total Environment*.

**G17AL00414 – National Domain Water Budgets NIWR-USGS Student Internship Program, Katie Schneider (William Farmer) \$34,043.00**

- Katie E. Schneider, Jessica M. Driscoll, William H. Farmer and Terri S. Hogue. *Application of the Monthly Water Balance Model to Better Understanding Data Availability and Cryospheric Processes in Alaska*. Conference Talk. National Water Quality Monitoring Conference (Denver, CO). March 26, 2019.

**2017CO338B – Effects of Snow Persistence on Soil Water Nitrogen Along the Colorado Front Range, Alyssa Nicole Anenberg (Kampf), Colorado State University, \$5,000.00 (104b)**

- Anenberg A, Kampf S, Baron J. (2018) Effects of snow persistence on soil moisture and soil water nitrogen along the Colorado Front Range. *Colorado Water*. (article in the May/June 2018 student research issue of the CoWC newsletter [http://www.watercenter.colostate.edu/media/img/newsletters/2018/CW\\_35\\_3.pdf](http://www.watercenter.colostate.edu/media/img/newsletters/2018/CW_35_3.pdf))

- Student spotlight in *The Current*, a newsletter from the Colorado Water Center

### ***Conference presentations***

- Effects of snow persistence on soil moisture and soil water nitrogen along the Colorado Front Range. Poster Presentation at the American Geophysical Union Fall Meeting, Washington D.C., December 2018.
- From Snow to Flow: Integrating research hydrology into the classroom using ESRI Story Maps. Poster Presentation at the American Geophysical Union Fall Meeting, Washington D.C., December 2018.
- Effects of snow persistence on soil moisture and soil water nitrogen along the Colorado Front Range. Poster Presentation at CSU Hydrology Days, Fort Collins, CO. March 2019.
- Research poster received an award for 3rd place in the Hydrology Days research poster presentation

### **2017CO336B – Understanding Post-Flood Channel Adjustments and Reservoir Sedimentation to Inform Water Management Practices, Johanna Eidmann (Rathburn), Colorado State University, \$5,000.00 (104b)**

- Poster presentation (by J.Eidmann) titled: **Tracking the Fate of Sediment After an Extreme Flood** at Rocky Mountain Hydrologic Reserch Center
- Presentation (by J.Eidmann) titled: **Tracking the Fate of Sediment After an Extreme Flood** at the 38<sup>th</sup> annual American Geophysical Union *Hydrology Days*
- Presentation as invited speaker (by S.Rathburn) titled: **By Water, Land and Air: Tracking the Fate of 2013 Flood Sediment and Wood, North St. Vrain Creek, CO** at Boulder Hydrologic Sciences Symposium
- Anticipated Presentation on April 27th (by J.Eidmann) titled: **Tracking the Fate of Sediment After an Extreme Flood** at the 2018 American Water Resources Association Colorado Symposium

### **2017CO334B – Effects of Water Velocity on Algal-Nutrient Interactions in Streams of the Poudre Watershed, Colorado, Whitney S. Beck (Poff), Colorado State University, \$5,000.00 (104b)**

- Beck, W.S. 2018. Effects of Water Velocity on Algal-Nutrient Interactions in Streams of the Poudre Watershed, Colorado. *Colorado Waters Magazine*. Colorado Water Institute.

### **2017CO332B – Water yield sensitivity to snow loss in Colorado headwater streams, Stephanie Kampf/Gigi Richard, \$20,000 (104b)**

- Kampf, S., Hammond, J., Eurich, A., Puntenney-Desmond, K., 2019. Where and when does river flow originate? *Colorado Water*. 36(2)
- Harrison, H., 2019. Water balance comparison for headwater catchments across an elevation gradient in northern Colorado. Honors Thesis, Colorado State University.

**5371931 – MOWS - Modeling of Watershed Systems NIWR-USGS Internship III, Roland Viger, \$20,000**

- McCabe, G.J., D.M. Wolock, and M. Valentin, 2018: Warming is Driving Decreases in Snow Fractions While Runoff Efficiency Remains Mostly Unchanged in Snow-Covered Areas of the Western United States. *J. Hydrometeor.*, 19, 803–814, <https://doi.org/10.1175/JHM-D-17-0227.1>
- Valentin, Melissa M.; Hogue, Terri S.; Hay, Lauren E. 2018. "Hydrologic Regime Changes in a High-Latitude Glacierized Watershed under Future Climate Conditions." *Water* 10, no. 2: 128.
- Valentin, M. M., Viger, R. J., Van Beusekom, A. E., Hay, L. E., Hogue, T. S., & Foks, N. L. (2018). Enhancement of a parsimonious water balance model to simulate surface hydrology in a glacierized watershed. *Journal of Geophysical Research: Earth Surface*, 123, 1116– 1132. <https://doi.org/10.1029/2017JF004482>
- Valentin, Melissa. (2018). Calculation of the Palmer drought severity index (PDSI) in cold region watersheds with glaciers and permafrost. ([conference abstract](#)).

**2016CO326B – Comparing fine scale snow depth measurements at rocky and flat surfaces using lidar and photogrammetry derived digital elevation models, Roy Gilbert (Fassnacht), \$4,891 (104b)**

- Gilbert, R.A. Jr., and S.R. Fassnacht, 2017. Comparing Fine Scale Snow Depth Measurements Using LiDAR and Photogrammetry. *Colorado Water*, 34(2), 2-4.

**2016CO325B – Microbial community responses to metals contamination: mechanisms of metals exposure and bioaccumulation in a stream food web, Brian Wolff (Clements), Colorado State University, \$5,000 (104b)**

***Peer-reviewed publications***

- Clements, William; Cadmus, Pete; Kotalik, Christopher; Wolff, Brian. 2019. Context-dependent responses of aquatic insects to metals and metal mixtures: a quantitative analysis summarizing 24 years of stream mesocosm experiments. *Environmental Toxicology and Chemistry* (accepted with minor revisions)
- Cadmus, P., Guasch, H, Herdrich, A.T., Bonet, B., Urrea, G., and W.H. Clements. 2019. Structural and functional responses of periphyton and macroinvertebrate communities to ferric Fe, Cu, and Zn in stream mesocosms. *Environmental Toxicology and Chemistry*. (in press)
- Wolff, B. A., S. B. Duggan and W. H. Clements. Resilience and regime shifts: do novel communities impede ecological recovery in a historically metal-contaminated stream? *Journal of Applied Ecology* (in review)
- Wolff, B.A., Clements, W.H. and Hall, E.K. – Metals alter membership but not diversity of a headwater river microbiome (*in prep*)

***Grants received***

- Clements, W.H. and E. Richer. 2019-2021. Post-restoration assessment of the upper Arkansas River: a watershed-level analysis of responses to improvements in habitat and water quality. Colorado Parks and Wildlife. \$166,352

**2016CO323B – Channel restoration monitoring of the upper Colorado River, Rocky Mountain National Park, CO, Matthew Sparacino (Rathburn), Colorado State University, \$5,000 (104b)**

- MS Thesis presentation and paper titled Post-flood Sediment Flux Into Ralph Price Reservoir, North St. Vrain Creek, CO
- 2019 Geological Society of America Meeting titled: Fires, Floods, and Debris Flows: Understanding Sediment Flux, Geomorphic Impacts, and Fluvial System Recovery Following Disturbances
- 2019 American Geophysical Union Meeting titled: Channel and Delta Response to Export of 2013 Flood Sediment and Wood, North St. Vrain Creek, CO
- Rocky Mountain Hydrologic Research Center Meeting titled: Tracking the Fate of Sediment After an Extreme Flood
- American Water Resource Association Colorado Chapter Meeting titled: Tracking the Fate of Sediment After an Extreme Flood
- Colorado State University Hydrology Days titled: Tracking the Fate of Sediment After an Extreme Flood

**2016CO322B – Evaluating wood jam stability in rivers, Daniel Scott (Wohl), Colorado State University, \$5,000 (104b)**

- Scott et al., in press, River Research and Applications (<https://onlinelibrary.wiley.com/doi/full/10.1002/rra.3481>)
- A USDA Forest Service General Technical Report (no identification number yet). Wohl & Scott. in press. Managing for large wood and beaver dams in stream corridors.

**2016CO320B – Changes in water, sediment, and organic carbon storage in active and abandoned beaver meadows, DeAnna Laurel (Wohl), Colorado State University, \$4912 (104b)**

- Laurel & Wohl, 2019, Earth Surface Processes and Landforms (<https://onlinelibrary.wiley.com/doi/10.1002/esp.4486>)

**2016CO319B – Watershed monitoring across the snow transition zone: an east slope-west slope comparison, John Hammond (Kampf), Colorado State University, \$4,770 (104b)**

- Kampf, S., Hammond, J., Eurich, A., Puntenney-Desmond, K., 2019. Where and when does river flow originate? Colorado Water. 36(2)
- Harrison, H., 2019. Water balance comparison for headwater catchments across an elevation gradient in northern Colorado. Honors Thesis, Colorado State University.

**2016CO318B – Investigating relationships between drought management strategies and factors contributing to their selection in analysis of adaptive capacity of South Platte River Basin water providers, Amber Childress Runyon (Ojima), Colorado State University, \$4,948 (104b)**

- Runyon, A.C. 2019. Factors contributing to the adaptive capacity of South Platte River Basin water providers and implications for regional vulnerability. Doctoral Dissertation. Colorado State University. (<https://mountainscholar.org/handle/10217/195282>)

**5340021 – MOWS - Modeling of Watershed Systems NIWR-USGS Student Internship II, Reagan Waskom, \$30,850**

- McCabe, G.J., D.M. Wolock, and M. Valentin, 2018: Warming is Driving Decreases in Snow Fractions While Runoff Efficiency Remains Mostly Unchanged in Snow-Covered Areas of the Western United States. *J. Hydrometeor.*, 19, 803–814, <https://doi.org/10.1175/JHM-D-17-0227.1>
- Valentin, Melissa M.; Hogue, Terri S.; Hay, Lauren E. 2018. "Hydrologic Regime Changes in a High-Latitude Glacierized Watershed under Future Climate Conditions." *Water* 10, no. 2: 128.
- Valentin, M. M., Viger, R. J., Van Beusekom, A. E., Hay, L. E., Hogue, T. S., & Foks, N. L. (2018). Enhancement of a parsimonious water balance model to simulate surface hydrology in a glacierized watershed. *Journal of Geophysical Research: Earth Surface*, 123, 1116– 1132. <https://doi.org/10.1029/2017JF004482>
- Valentin, Melissa. (2018). Calculation of the Palmer drought severity index (PDSI) in cold region watersheds with glaciers and permafrost. ([conference abstract](#)).

**5369531 – Climate Risk Informed Decision Analysis (CRIDA), Reagan Waskom, \$15,273.00**

- **IMTA Water Security Conference.** CRIDA was presented during the 2<sup>nd</sup> International Seminar on Water Security from 26 to 28 September 2018 at the Mexican Institute of Water Technology (IMTA).
- **Asia-Pacific Climate Adaptation Forum.** CRIDA was presented during the Sixth Asia Pacific Climate Change Adaptation Forum from 17 to 19 October 2018 at Asian Development Bank HQ in Manila.
- **The Resilience Shift Workshop.** CRIDA was presented during a workshop hosted by the Resilience Shift on 15 November 2018 in New Orleans.
- **Water Day at the Wilson Center.** CRIDA was presented as part of Water Day at the Wilson Center on 28 November 2018 in Washington, DC.



- **UNECE Ecosystem-Based Adaptation Workshop.** CRIDA was presented during the UNECE's Workshop on Ecosystem-Based Adaptation in Transboundary Basins from 29-30 April 2018 in Geneva.

**2015CO309B – Temporal Consistency of Spatial Snowpack Properties, Ben Von Thaden (Fassnacht), Colorado State University, \$5,000 (104b)**

- Spatial Accumulation Patterns of Snow Water Equivalent in the Southern Rocky Mountains. MS thesis Benjamin C. Von Thaden, Watershed Science 2016.

**5311002 – Application of Remotely Sensed Data for Improved Regional and National Hydrologic Simulations - Year 2, Terri Hogue, Colorado School of Mines, \$80,346 (DOI-USGS-Geological Survey)**

- Katie E. Schneider, Jessica M. Driscoll, William H. Farmer and Terri S. Hogue. *Application of the Monthly Water Balance Model to Better Understanding Data Availability and Cryospheric Processes in Alaska*. Conference Talk. National Water Quality Monitoring Conference (Denver, CO). March 26, 2019.

**5333001 – Application of Remotely Sensed Data for Improved Regional and National Hydrologic Simulations - Year 1, Terri Hogue, Colorado School of Mines, \$60,000 (DOI-USGS-Geological Survey)**

- Katie E. Schneider, Jessica M. Driscoll, William H. Farmer and Terri S. Hogue. *Application of the Monthly Water Balance Model to Better Understanding Data Availability and Cryospheric Processes in Alaska*. Conference Talk. National Water Quality Monitoring Conference (Denver, CO). March 26, 2019.

# WRI Annual Reports: General Information

Email: [Reagan.Waskom@Colostate.edu](mailto:Reagan.Waskom@Colostate.edu)

Colorado

## Information Transfer Program

### 2018CO-ADMIN, Reagan Waskom

The director transferred project information at numerous meetings in Colorado and the region.

### 2018CO343B – Technology Transfer and Information Dissemination, Reagan Waskom

#### *Programs*

- Poudre Runs Through It <https://watercenter.colostate.edu/prti/>
- Poudre River Forum
- Water Literate Leaders <https://watercenter.colostate.edu/wll/>
- World Water Day (March 2019) <https://watercenter.colostate.edu/water-and-power/>
- Hach Walk For Water (March 2019) <https://watercenter.colostate.edu/hach-walk-for-water/>
- Dr. Norm Evans Lecture Series <https://watercenter.colostate.edu/evans/>

#### *Education*

- SWIM (Sustainable Water Interdisciplinary Minor)
- GRAD 592 (Interdisciplinary Water Resources Seminar Series)
- GES 120 (Water Sustainability in the Western U.S.)
- Water MOOCs: Water Scarcity: Crisis and Response; Water for the People: Gender, Human Rights, and Diplomacy; Water, Civilization, and Nature: Addressing Water Challenges of the 21<sup>st</sup> Century

#### *Conferences and Workshops*

- Birdsall-Driess Distinguished Lecture – David Boutt (September 2018)
- Adams State Lecture, San Luis Valley (September 2018)
- Seminar with David Mau, USGS (October 2018)
- Steamboat Ag. Water Meeting (October 2018)
- South Platte Forum (October 2018)
- Subsurface Water Storage Symposium (November 2018)
- CWI Advisory Committee Meeting (November 2018)
- Water in the West Symposium (March 2018)

- CSU Hydrology Days (March 2019) <http://hydrologydays.colostate.edu/>
- Water in Africa Symposium (April 2019)

#### **Websites**

- Colorado Water Center <https://watercenter.colostate.edu>
- Colorado Water Knowledge <https://waterknowledge.colostate.edu/>
- Poudre Runs Through It <https://watercenter.colostate.edu/prti/>
- Water Literate Leaders <https://watercenter.colostate.edu/wll/>
- Irrigation Innovation Consortium <https://irrigationinnovation.org/>

#### **Newsletters**

- *Colorado Water*, bi-monthly publication highlighting water research and activities at Colorado State University and throughout Colorado  
<https://watercenter.colostate.edu/colorado-water-archive/>
- *The Current*, e-newsletter published every three weeks dedicated to stories about water faculty, staff, and students in Colorado, as well as important information regarding the water community <https://watercenter.colostate.edu/the-current-archive/>

**2018CO346B – Streamflow Depletion on the South Platte River due to Groundwater Pumping: Analysis via Field Work and Groundwater Modeling, Luke Flores (Ryan Bailey), Colorado State University, \$4,993.09 (104b)**

- Conference presentation "New module to simulate groundwater-surface water interactions in small-scale alluvial aquifer systems" (June 25, 2018, 9th International Congress on Environmental Modelling and Software, Fort Collins, CO)

**2018CO347B – History of South Platte River Riparian Ecosystem and Channel Change, Joshua Rogerson (Jessica Salo), University of Northern Colorado, \$5,000.00 (104b)**

- Jessica Salo and Joshua Rogerson participated in Central Colorado Water Conservancy District's Children's Water Festival and used examples from this research to teach children about the dynamic nature of local rivers.

**G17AP00133– Hydrodynamic-enhancement of nitrate attenuation by integrating reactive biobarriers into shallow, open water treatment wetlands, Josh Sharp, Colorado School of Mines, \$250,000.00 (104g)**

In addition to publications and presentations (above) information transfer was actively targeted toward industry members in the water sector through the following activities:

- May 2018 **OCWD Newsletter Feature Article** on their website. “Three-year project is focus during American wetlands Month” highlighting this project. <https://www.ocwd.com/news-events/newsletter/2018/may-2018/three-year-project-is-focus-during-american-wetlands-month/>
- Presentation to OCWD Industrial Collaborative Team by PI Sharp. “Past, Present and Future of Research in the Prado Engineered Wetlands.” **Orange County Water District** Prado Wetlands Field Office. Sept 20<sup>th</sup>, 2018. Corona, CA.
- Tour of Prado Wetlands Facilities to ReNUWIt Students, Faculty, and **Industrial Advisory Board** members. “Exemplary Illustration of Industry, Academic, and Government Academic Cooperation: a Tour of the **Orange County Water District** Prado Wetlands Test Bed Facility.” Oct 18<sup>th</sup>, 2018. Corona, CA.

**G15AP00168 -Trace Organic Contaminants (TOrcs) in Urban Stormwater and Performance of Urban Bioretention Systems: a Field and Modeling Study, Christopher Higgins, \$249,900 (104g)**

- Nicole Fitzgerald, Benjamin Kranner, Nabiul Afrooz, Holly Piza, Alexandria Boehm, Chris Higgins (2019). The Removal of Trace Organic Contaminants (TOrcs) in Urban Stormwater by Bioretention Processes. Remediation Technology Summit. Denver, CO. (Poster)
- Nicole Fitzgerald, Benjamin Kranner, Nabiul Afrooz, Holly Piza, Alexandria Boehm, Chris Higgins (2019). The Removal of Trace Organic Contaminants (TOrcs) in Urban Stormwater by Bioretention Processes. Battelle Bioremediation Symposium. Baltimore, MD (Poster)
- Nicole Fitzgerald, Benjamin Kranner, Nabiul Afrooz, Holly Piza, Alexandria Boehm, Chris Higgins (2019). The Removal of Trace Organic Contaminants (TOrcs) in Urban Stormwater by Bioretention Processes. Association of Environmental Engineering Scientists and Professionals (AEESP). Phoenix, AZ (Podium)
- Nicole Fitzgerald, Benjamin Kranner, Nabiul Afrooz, Holly Piza, Alexandria Boehm, Chris Higgins (2019). The Removal of Trace Organic Contaminants (TOrcs) in Urban Stormwater by Bioretention Processes. Reinventing the Nation’s Urban Water Infrastructure (ReNUWIt) Annual Meeting. Stanford, CA (Poster)

**G17AL00414 – National Domain Water Budgets NIWR-USGS Student Internship Program, Katie Schneider (William Farmer) \$34,043.00**

- Ms. Schneider has been active in sharing her research and the research of the larger project with colleagues in her University department through informal research seminars throughout the year.

**2017CO336B – Understanding Post-Flood Channel Adjustments and Reservoir Sedimentation to Inform Water Management Practices, Johanna Eidmenn (Rathburn), Colorado State University, \$5,000.00 (104b)**

- This project involves a close partnership with the City of Longmont, and has contributed to their online website, informing the public about the impacts of the September 2013 flood and recovery since then.

**2017CO332B – Water yield sensitivity to snow loss in Colorado headwater streams, Gigi Richard, \$20,000 (104b)**

- Feb 27 and 28, 2019, Naturalist Nights presentations in Carbondale and Aspen, CO Colorado's Snowpack: Adventures in Monitoring and What It Means for Our Water Supply, Gigi A. Richard, Ph.D., Ft. Lewis College
- June 19, 2019, Animas & San Juan Watersheds Conference, Farmington, NM Watershed Monitoring Across the Persistent to Intermittent Snow Transition Zone in Colorado, Gigi Richard, Fort Lewis College
- Snow Loss, Runoff Efficiency, and Hydrologic Response in the Semi-Arid Western U.S. USGS-wide research seminar. 4/09/19. MD-DE-DC WSC. John Hammond presentation. Presentation at Community Teach-in at the Navajo Chapter House in Shiprock, NM on June 21, 2019, Gigi Richard

**2016CO325B – Microbial community responses to metals contamination: mechanisms of metals exposure and bioaccumulation in a stream food web, Brian Wolff (Clements), Colorado State University, \$5,000 (104b)**

***Papers presented at professional meetings***

- Clements, W.H. and B.A. Wolff. 2019. Resilience and regime shifts: novel benthic communities impede ecological recovery in a historically metal-contaminated stream. Annual Meeting of the Society of Freshwater Science. Salt Lake City, UT.
- Kotalik, C. and W. Clements. 2019. The influence of life stage on the sensitivity of aquatic insects to metals in streams. Annual Meeting of the Society of Freshwater Science. Salt Lake City, UT.
- Cadmus, P., A.L. Jefferson, C. Kotalik, W. Clements, J.F. Ranville 2018. Predicting recovery of aquatic ecosystems after mine reclamation: mesocosms and in-stream experiments on the North Fork of Clear Creek, Colorado. Annual Meeting of the Society of Environmental Toxicology and Chemistry. Sacramento, CA.
- Wolff, B.A., W. H. Clements, Ed K. Hall. 2018. Responses of mountain stream microbial communities along a gradient of metals contamination. Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Fort Collins, CO.
- Wheeler, S., C. Kotalik, W. H. Clements. 2018. Effect of benthic macroinvertebrate size on mortality due to trace metal contamination in Colorado streams. Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Fort Collins, CO.
- Clements, W. H. Clements, Kotalik, Brian Wolff, Pete Cadmus. 2018. Mesocosm experiments conducted with metal mixtures often reveal ecological surprises. Annual Meeting of the Society for freshwater Science, Detroit, MI.
- Wolff, B.A., W. H. Clements and E. Hall. 2018. Monitoring of microbial communities at a high elevation stream impaired by chronic metals contamination. Annual Meeting of the Society for freshwater Science, Detroit, MI.
- Hall, E.K. 2019 The bacterial biogeography of a large tropical watershed Association for the Science of Limnology and Oceanography, San Juan, Puerto Rico

- Hall, E.K., Harrington, K.M., Wolff, B., and Manzella, M., 2018 Is heavy metal bad for your biomass? consequences of metal exposure to bacterial stoichiometry upstream and downstream from a Superfund Site (poster talk and poster) American Society for Microbiology Atlanta, GA

**2016CO323B – Channel restoration monitoring of the upper Colorado River, Rocky Mountain National Park, CO, Matthew Sparacino (Rathburn), Colorado State University, \$5,000 (104b)**

- Throughout this research we have been and still are in close collaboration with the City of Longmont watershed managers. As part of our on-going effort, we are providing the water managers with any and all information that we have obtained through this project. Additionally, the City of Longmont has published our research and posters on their website, as to inform the public about post-storm sedimentation. Lastly, Dr. Rathburn discussed our research and its implications for Colorado's water supply on KUNC/Colorado Public Radio, in a segment titled *Flood Waters Fundamentally Changed the Front Range—In Landscape and Human Tragedy*.

**2016CO322B – Evaluating wood jam stability in rivers, Daniel Scott (Wohl), Colorado State University, \$5,000 (104b)**

- Dan Scott and Ellen Wohl have included mention of the evolving statistical model produced as part of this project at the American Geophysical Union meeting (Dec. 2018) and the River Restoration Northwest Conference (Feb. 2019).

**2016CO320B – Changes in water, sediment, and organic carbon storage in active and abandoned beaver meadows, DeAnna Laurel (Wohl), Colorado State University, \$4912 (104b)**

- DeAnna Laurel and Ellen Wohl have presented some of the results from this project as part of a broader-focus talk at the American Geophysical Union meeting (Dec. 2018).

**2016CO319B – Watershed monitoring across the snow transition zone: an east slope-west slope comparison, John Hammond (Kampf), Colorado State University, \$4,770 (104b)**

- Feb 27 and 28, 2019, Naturalist Nights presentations in Carbondale and Aspen, CO Colorado's Snowpack: Adventures in Monitoring and What It Means for Our Water Supply, Gigi A. Richard, Ph.D., Ft. Lewis College
- June 19, 2019, Animas & San Juan Watersheds Conference, Farmington, NM Watershed Monitoring Across the Persistent to Intermittent Snow Transition Zone in Colorado, Gigi Richard, Fort Lewis College
- Snow Loss, Runoff Efficiency, and Hydrologic Response in the Semi-Arid Western U.S. USGS-wide research seminar. 4/09/19. MD-DE-DC WSC. John Hammond presentation. Presentation at Community Teach-in at the Navajo Chapter House in Shiprock, NM on June 21, 2019, Gigi Richard

**5369531 – Climate Risk Informed Decision Analysis (CRIDA), Reagan Waskom, \$15,273.00**

- **UNFCCC Regional Training Workshops.** AGWA was asked by the UNFCCC Consultative Group of Experts (CGE) to contribute to three regional multi-day workshops for adaptation focal points from around 100 national governments on how to help countries and communities adjust to climate impacts expressed through freshwater. Regional workshops were held for Africa, Latin America and Caribbean (LAC), and Eastern Europe & Asia-Pacific between July and October 2018. CRIDA was highlighted as one of the new best practices.
- **University of Idaho Workshop.** In April 2019, the University of Idaho invited AGWA to run a two-day CRIDA training workshop for faculty as well as graduate students in engineering, law, and ecology.
- **UNESCO S. African Workshop.** In May 2019 UNESCO organized a week-long CRIDA workshop in South Africa focused on developing regional applications and projects. An international UNESCO CRIDA conference is planned for 2020. Another regional workshop will take place September 2019 in Uganda with Asian regional workshops scheduled for 2020.
- **ClimateReady Podcast Episode.** AGWA's *ClimateReady* podcast produced an episode about CRIDA featuring insight from the three lead authors. The episode was released in November 2018 and received over 1,100 listens across numerous platforms and devices.

**2015CO309B – Temporal Consistency of Spatial Snowpack Properties, Ben Von Thaden (Fassnacht), Colorado State University, \$5,000 (104b)**

- Fassnacht, S.R., G.A. Sexstone, A.H. Kashipazha, B.C. Von Thaden, M.F. Jasinski, J.I. López-Moreno, S.K. Kampf, 2015. Snow-cover Depletion Curves for Individual Stations and an Entire Snow-Dominated Domain. Poster presentation at the Eastern Snow Conference, Sherbrooke, QB, June 9-10, 2015.
- Von Thaden, B.C., and S.R. Fassnacht, 2015. Spatial Accumulation Patterns of Snow Water Equivalent. Poster presentation at the Eastern Snow Conference, Sherbrooke, QB, June 9-10, 2015.
- Von Thaden, B.C., and S.R. Fassnacht, 2015. Relative snow accumulation patterns and inconsistencies across the Southern Rockies, U.S.A. Poster presentation at the American Geophysical Union Fall Meeting, San Francisco CA, December 14-18, 2015 (C33C-0837).

**5311002 – Application of Remotely Sensed Data for Improved Regional and National Hydrologic Simulations - Year 2, Terri Hogue, Colorado School of Mines, \$80,346 (DOI-USGS-Geological Survey)**

- This project was designed to improve our ability to model hydrologic processes in Alaska, adding this functionality to the USGS national hydrologic model. This year focused on building the monthly water balance model required to simulate daily hydrologic fluxes, including the impacts of snow and glaciers in the cryosphere. Ms. Schneider's work has

- incorporated new processes into our model framework and greatly advance national modeling capacity beyond Alaska.
- Ms. Schneider has been active in sharing her research and the research of the larger project with colleagues in her University department through informal research seminars throughout the year.

**5333001 – Application of Remotely Sensed Data for Improved Regional and National Hydrologic Simulations - Year 1, Terri Hogue, Colorado School of Mines, \$60,000 (DOI-USGS-Geological Survey)**

- This project was designed to improve our ability to model hydrologic processes in Alaska, adding this functionality to the USGS national hydrologic model. This year focused on building the monthly water balance model required to simulate daily hydrologic fluxes, including the impacts of snow and glaciers in the cryosphere. Ms. Schneider’s work has incorporated new processes into our model framework and greatly advance national modeling capacity beyond Alaska.
- Ms. Schneider has been active in sharing her research and the research of the larger project with colleagues in her University department through informal research seminars throughout the year.



# WRI Annual Reports: General Information

Email: [Reagan.Waskom@Colostate.edu](mailto:Reagan.Waskom@Colostate.edu)

Colorado

## Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	11	1	0	0	12
Masters	5	2	1	0	8
Ph.D.	2	2	0	0	4
Post-Doc.	0	0	0	0	0
Total	18	5	1	0	24

# WRI Annual Reports: General Information

Email: [Reagan.Waskom@Colostate.edu](mailto:Reagan.Waskom@Colostate.edu)

Colorado

## Notable Achievements and Awards

### **2018CO-ADMIN, Reagan Waskom**

- Reagan Waskom Awarded 2019 Who's Who & Colorado Agriculture Award, Denver Business Journal, Brown Palace, May 9, 2019

### **2018CO343B – Technology Transfer and Information Dissemination, Reagan Waskom**

- 2018-2019 John Fetcher Upper Yampa Water Conservancy District Scholarship, awarded to Marissa Karpack, Master of Science in Civil and Environmental Engineering, Colorado State University

### **2018CO347B – History of South Platte River Riparian Ecosystem and Channel Change, Joshua Rogerson (Jessica Salo), University of Northern Colorado, \$5,000.00 (104b)**

- Joshua Rogerson received a small grant from the University of Northern Colorado's Office of Undergraduate Research to support this research.

### **2018CO348B – Assessment of Floodplain Storage Dynamics in Colorado, Ryan Morrison, Colorado State University, \$25,000.00 (104b)**

While contributing to this research, Marissa Karpack was awarded the following:

- Dr. Jeng-Song Wang Memorial Scholarship, 2018-2019
- Colorado Environmental Management Society Scholarship, 2018-2019
- John Fetcher Upper Yampa Water Conservancy District Scholarship, 2018-2019
- AWRA Colorado Rich Herbert Memorial Scholarship, 2018-2019
- CSU Graduate Student Showcase Excellence in Research Award, 2018
- Third place oral presentation, AGU Hydrology Days, 2019

### **G17AP00133– Hydrodynamic-enhancement of nitrate attenuation by integrating reactive biobarriers into shallow, open water treatment wetlands, Josh Sharp, Colorado School of Mines, \$250,000.00 (104g)**

- Ariel Reed graduated after successfully defending her MS-Thesis in association with this project in May 2018. She is now employed at the USGS in Boulder.
- Evelyn Lundeen was commended the highest honor of CEE undergraduates at CSM, receiving the "Outstanding CEE Undergraduate Student" in May 2019.

- Graduate student Michael Vega won two separate “best presentation” awards at conferences in the Colorado Front Range as listed above.
- Evelyn Lundeen won 2<sup>nd</sup> best poster in a Mines campus-wide competition for her work highlighting the role of biomat thickness on nitrogen attenuation processes in open water wetlands in April 2018.
- PI Sharp was named a Kavli Fellow of the National Academy of Science in 2018

**2017CO336B – Understanding Post-Flood Channel Adjustments and Reservoir Sedimentation to Inform Water Management Practices, Johanna Eidmenn (Rathburn), Colorado State University, \$5,000.00 (104b)**

- Herbert Memorial Scholarship (Colorado and National awards) from American Water Resources Association
- Graduate Scholarship from Anchor QEA, LLC
- Hill Memorial Fellowship from Colorado State University
- Schumm Graduate Scholarship from Colorado State University
- Norman R. Tilford Field Studies Scholarship from Association of Environmental and Engineering Geologists
- Eckel Memorial Scholarship from the Colorado Scientific Society

**2017CO334B – Effects of Water Velocity on Algal-Nutrient Interactions in Streams of the Poudre Watershed, Colorado, Whitney S. Beck (Poff), Colorado State University, \$5,000.00 (104b)**

***Journal publications***

- Beck, W.S., Markman, D.W., Oleksy, I.A., Lafferty, M.H., and N. L. Poff. 2018. Seasonal Shifts in the Importance of Bottom-Up and Top-Down Factors on Periphyton Community Structure. *Oikos*. 128(5): 680-691.
- Beck, W.S. and N.L. Poff. Current Velocity Enhances Responses of Stream Algae to Limiting Nutrients. *In Prep, Hydrobiologia*.

***Conference presentations***

- Beck, W.S. and N. L. Poff. Current Velocity Enhances Responses of Algae to Limiting Nutrients in Poudre Watershed Streams. CU Boulder Hydrologic Sciences Conference, Boulder, CO. 12 April, 2018.

**2016CO325B – Microbial community responses to metals contamination: mechanisms of metals exposure and bioaccumulation in a stream food web, Brian Wolff (Clements), Colorado State University, \$5,000 (104b)**

- Clements – Invited Plenary Lecture. Annual meeting of the Australasia Society of Environmental Toxicology and Chemistry, Darwin Australia.

- Hall – Invited Seminar, Department of Ecology and Evolutionary Biology, University of California, Irvine
- Hall – Invited Seminar, Department of Natural Resources and The Environment, University of New Hampshire

**2016CO323B – Channel restoration monitoring of the upper Colorado River, Rocky Mountain National Park, CO, Matthew Sparacino (Rathburn), Colorado State University, \$5,000 (104b)**

- This project enabled us to obtain a breadth of data, enough for two publications, which we currently are working on writing. In addition, the thesis from this project was chosen to be Colorado State University's single nomination for the Western Association of Graduate Schools and ProQuest *Innovation in Technology Award*.
- This research was nominated for a 2018 CSU Community Engagement Scholarship Award, with partners of Sara Rathburn (Geosciences) and the City of Longmont. Title: After the Flood: Community-University Partnership to Improve Reservoir Operation and Management.

**5369531 – Climate Risk Informed Decision Analysis (CRIDA), Reagan Waskom, \$15,273.00**

- **CRIDA Book Launch.** The CRIDA publication was officially launched in October 2018 at an event hosted by one of the co-publishers, UHESCO-IHP, in Paris. A launch / promotional event was also held at COP24 in Katowice, Poland at the IPCC booth in December. AGWA organized a launch in the U.S. with Millennium Challenge Corporation for the American Geophysical Union Annual meeting in Washington, D.C. Core Dutch partners also held an event for the CRIDA publication in Den Haag in December. UNESCO is nearing completion of the Spanish translation. French will come up next.
- **Scaling Up Implementation.** Efforts have shifted more towards training and implementation of the methodology. CRIDA is now being or has been implemented in 19 countries including for single investments worth up to 20 million euros, with many instances being independently led by groups other than AGWA.
- **CRIDA Written into UNECE Protocol on Water and Health.** In January 2019 CRIDA was written into the UNECE's Protocol on Water and Health, which is co-managed between UNECE and the World Health Organization. CRIDA is listed as a method to build capacity and resilience to climate change for water and wastewater operators.
- **CRIDA Implemented at National Scale in Mexico.** Together with WWF-Mexico, AGWA conducted a CRIDA analysis of seven case study basins in Mexico to quantify the adaptation benefits of their water reserves program. The project has since been scaled up to a national level, with an expansion from the Inter-American Development Bank into five other LAC countries.

# WRRRI Annual Reports: General Information

Email: [Reagan.Waskom@Colostate.edu](mailto:Reagan.Waskom@Colostate.edu)

Colorado

## Student Internship Program

Student Name: Katie Schneider

Internship Evaluation	
Question	Score
Utilization of your knowledge and experience	Very Good
Technical interaction with USGS scientists	Good
Treatment by USGS as member of a team	Good
Exposure and access to scientific equipment	Good
Learning Experience	Very Good
Travel	About Right
Field Experience Provided	Too Little
Overall Rating	A

### Any additional remarks?

*This has been a tremendous learning experience that has allowed me to apply/sharpen old skills and learn many new skills that will continue to serve me as I complete my PhD and beyond. Beyond technical skills, this internship has exposed me to the day-to-day (and overall) dynamics of the federal science realm- a field I have considered pursuing after completing a PhD. I'm so grateful to have been given this opportunity.*

### Please highlight your degree level

Undergraduate

Masters

**Ph.D. <- I have a MS, but am working toward PhD as part of the WRRRI internship.**

Post-Doc

# FY18 Project Summary

## Section 104 Base Grant – 104b

### 2018CO-ADMIN

1. [2018CO-ADMIN](#), Reagan Waskom

### 2018CO343B

2. [2018CO343B](#) – Technology Transfer and Information Dissemination, Reagan Waskom

### Student Research

3. [2018CO344B](#) – Investigating Bi-Directional Water Exchanges Across Intact and Degraded Floodplains, Alexander C. Brooks (Tim Covino), Colorado State University, \$4,934.00 (104b)
4. [2018CO345B](#) – Dirty Snow: Turning Qualitative Assessments into Quantitative Factors for the Effect of Dust on Snow Albedo and Melt Rate, Caroline Duncan (Steven Fassnacht), Colorado State University, \$5,000.00 (104b)
5. [2018CO346B](#) – Streamflow Depletion on the South Platte River due to Groundwater Pumping: Analysis via Field Work and Groundwater Modeling, Luke Flores (Ryan Bailey), Colorado State University, \$4,993.09 (104b)
6. [2018CO347B](#) – History of South Platte River Riparian Ecosystem and Channel Change, Joshua Rogerson (Jessica Salo), University of Northern Colorado, \$5,000.00 (104b)

### Faculty Research

1. [2018CO348B](#) – Assessment of Floodplain Storage Dynamics in Colorado, Ryan Morrison, Colorado State University, \$25,000.00 (104b)

## NCGP Award – 104g

1. [G17AP00133](#)– Hydrodynamic-enhancement of nitrate attenuation by integrating reactive biobarriers into shallow, open water treatment wetlands, Josh Sharp, Colorado School of Mines, \$250,000.00 (104g)
2. [G15AP00168](#) -Trace Organic Contaminants (TOrcs) in Urban Stormwater and Performance of Urban Bioretention Systems: a Field and Modeling Study, Christopher Higgins, \$249,900 (104g)

## NIWR-USGS Internship

1. [G17AL00414](#) – National Domain Water Budgets NIWR-USGS Student Internship Program, Katie Schneider (William Farmer) \$34,043.00

## WRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	
<b>Project ID</b>	2018CO-ADMIN

### Project Impact

The Colorado Water Institute merged with the CSU Water Center this year to become the Colorado Water Center (CoWC). This merger will expand our impact by increasing the unit budget, mandate and reach as we continue to address the water information and education challenges facing Colorado. CoWC reports to the Vice President for Engagement at Colorado State University, an administration unit charged with primary responsibilities for outreach and the formation of partnerships to further the activities of a variety of units at the university. The inclusion of CoWC in this cluster acknowledges work already accomplished to connect faculty with water expertise in various institutions of higher education with policy makers, water providers, water managers, and water users throughout the state. CoWC receives state funding for water research and works with the Advisory Committee on Water Research Policy to establish research priorities and award research project funding for the coming year. Among our FY18 impacts are our progress on the Colorado River water bank, Ogallala Aquifer sustainability, our Water Literate Leaders program for elected and community leaders, and our Water Sustainability Fellows program for underserved college and high school students.

## WRRRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	Technology Transfer and Information Dissemination
<b>Project ID</b>	2018CO343B

### Project Impact

Technology transfer activities of CoWC rely heavily on the sponsorship and participation in various water meeting across Colorado by the director, the publication of Colorado Water, the bimonthly newsletter, the Current, our electronic newsletter, and the various web pages where research results and other archives are available to the public. With current state and federal funding and new PIs this year, CoWC will have the opportunity to infuse new research topics and new faculty faces in the water conversations around Colorado. Our newsletter, research reports, and web pages will be used to keep the University contributions before the water management community. Participation in various regional conversations about water will be an important activity for the director of CoWC. The Colorado Water Center technology transfer activities include oversight and coordination of the CSU Extension Water Team, allowing us to reach to the local level through interaction at the county and local level. The Colorado Legislature has mandated research and specific roundtables to facilitate discussion of water policy and water use within the state. Expertise and research from the CoWC community of scholars is frequently called upon. For this reason, the CoWC online information database has become an important asset for the water community that must be monitored and updated as new information becomes available.

Included in CoWC's database are several websites that CoWC maintains and monitors, including:

- Colorado Water Center <https://watercenter.colostate.edu>
- The South Platte River and Alluvial Aquifer <https://southplatte.colostate.edu>
- The Poudre Runs Through It <https://prti.colostate.edu>

Irrigation Innovation Consortium <https://irrigationinnovation.org/>

- Water Literate Leaders <https://watercenter.colostate.edu/wll/>



## WRRRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	Investigating Bi-Directional Water Exchanges Across Intact and Degraded Floodplains, Alexander C. Brooks (Tim Covino)
<b>Project ID</b>	2018CO344B

### Project Impact

This study found that that water chemistry is a strong metric of seasonal dynamics in river-floodplain connectivity. Patterns in geochemical similarity between the floodplain inflow and other sites in the complex revealed three distinct patterns of connectivity: sites that were always connected to the inflow site, sites that had intermittent connectivity and sites that had no evidence of connection to the main channel inflow to the floodplain. Despite strong connections between the river and floodplain, the majority of water moving longitudinally through the river network did not remain in the floodplain complex for longer than several hours. This is corroborated by the tracer experiments which show that at high flow,  $97\% \pm 10\%$  of water from the inflow reached the outflow within 2.5 hours. During the low flow experiment,  $87\% \pm 10\%$  of flow at the inflow reached the outflow within 4 hours. Despite the relatively low percentage of exchange, we did observe some water quality benefits of the floodplain as nitrate concentrations were consistently reduced by 10-20% over the reach. Reducing nitrate concentrations in streams can help prevent downstream water quality problems in reservoirs and drinking water. Building on this preliminary work, we plan to explore how hydrologic connectivity controls important aspects of floodplain function including growing season water availability to plants, dissolved oxygen and temperature in aquatic habitats and retention and transformation of dissolved organic carbon. We expect this work will inform current and future restoration efforts that aim to restore functionality to the many degraded floodplains across the state.

## WRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	Investigating Bi-Directional Water Exchanges Across Intact and Degraded Floodplains, Caroline Duncan (Steven Fassnacht)
<b>Project ID</b>	2018CO345B

### Project Impact

The presence of light absorbing particulates on the surface of the snowpack can greatly enhance melt due to the decreased albedo and thus increase absorption of short wave radiation. In Southwestern Colorado, these light absorbing particulates are present every winter in the form of dust on snow. This dust often comes from the four-corners region, yet dust can be present in the snowpack through the Western US from other global sources. The main objective of this work is to evaluate the difference in radiative forcing caused by the presence of dust on snow at the Senator Beck Basin (SBB) study site, operated by the Center for Snow and Avalanche Studies. The water year 2013 was examined where the snowpack melted down to a dust layer on April 22. Over the next 27 days before the snowpack melted out, the observed midday average albedo was about 0.49, while modeled clean snow albedo was greater than 0.7. This resulted in a 122% increase in absorption of solar radiation. Without the presence of the dust on snow, melt would have taken almost twice as long. Ongoing work is examining other years between 2005 and present with different intensities of dust deposition in the winter.

## WRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	Streamflow Depletion on the South Platte River due to Groundwater Pumping: Analysis via Field Work and Groundwater Modeling, Luke Flores (Ryan Bailey)
<b>Project ID</b>	2018CO346B

### Project Impact

Ultimately the interactions between streams and underlying alluviums are inherently intricate. While each system must be analyzed independently this reach of the South Platte River exhibited behaviors indicative of a stream that is highly interactive with its alluvium. Groundwater wells show that in close proximity to the stream, water levels between the two systems were nearly linearly related. Subsequently, pumping wells were able to reduce both stream stage and streamflow. At the same time, factors beyond pumping will always contribute to streamflow loss. For the reach of this study, a highly variable upstream streamflow contributed a highly variable stream width which led to bank storage and resulting unsaturated zone flow. However consequential stream-aquifer studies, for both humans, animal and biota, often do not include such processes. It is our hope that this work serves to further encourage comprehensive stream-aquifer studies that do not exclusively rely on existing methods and are willing to use unique methodologies and models for their specific site.

## WRRRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	History of South Platte River Riparian Ecosystem and Channel Change, Joshua Rogerson (Jessica Salo)
<b>Project ID</b>	2018CO347B

### Project Impact

Since the 1840's, water management has substantially altered the hydrology of the South Platte River in Colorado. Although the river experiences substantial natural inter-annual flow variability, the altered annual flow regime is characterized by enhanced seasonal consistency of surface and ground water levels. Today, the river supports a broad cottonwood-willow riparian forest that established from 1900-1930, in a pulse of channel narrowing that accompanied historic flow alterations. The status of this forest is not well understood. We developed and tested methods to assess historic riparian land cover change and channel movement on the South Platte River downstream of Greeley, Colorado. We digitized floodplain land cover on orthophotos taken at ~10 year intervals for a 30 km river segment located in Weld and Morgan Counties, Colorado. The analysis revealed that during low flow periods (1999 – 2006), the active channel constricted and there was a corresponding increase in riparian shrubs, herbs, and both dense and open forests. During times of high flow (2006 – 2015), an increase in active channel area, accompanied by decreases in in riparian shrubs, herbs, and both dense and open forests, was observed. We found that studying the dynamics of the South Platte riparian ecosystem at the decadal scale reveal different relationships that can be capture over longer durations of time, as thus future research should focus on roughly decadal increments. Understanding historic rates and patterns of South Platte River riparian land cover dynamics provides important context for informing management of this critical natural resource.

## WRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Annual Base Grant, 104b
<b>Project Title</b>	Assessment of Floodplain Storage Dynamics in Colorado, Ryan Morrison
<b>Project ID</b>	2018CO348B

### Project Impact

Floodplain integrity can be defined as the ability of a floodplain to support essential geomorphic, hydrologic, and ecological functions that maintain biodiversity and ecosystem services. Humans alter floodplain functionality by changing the physical landscape of the floodplain or by altering river flow regimes and subsequent floodplain inundation dynamics. This research evaluates floodplain integrity by assessing the prevalence of anthropogenic modifications to hydrology and landscape. Specifically, the objectives of this research are to: 1) develop a methodology to assess floodplain integrity using geospatial datasets available for large spatial scales; and 2) use the methodology to evaluate spatial patterns of floodplain integrity in the state of Colorado. To accomplish these objectives, we evaluated the critical floodplain functions of attenuating floods, storing groundwater, regulating sediment, providing habitat, and regulating organics and solutes. At present, this work is the first to quantify the integrity of specific floodplain functions instead of measuring floodplain health solely by ecological integrity. We applied the index of floodplain integrity methodology in the state of Colorado to analyze the integrity of each of the five floodplain functions and the aggregated overall integrity. In Colorado, overall floodplain integrity decreased as stream order increased above third order streams. Floodplain integrity was also lower in floodplains that intersected urban areas than those that did not. By quantifying anthropogenic reductions to floodplain functionality at broad spatial scales, the index of floodplain integrity can help target restoration efforts towards the most affected functions and areas.

## WRRRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	National Competitive Grant – 104g
<b>Project Title</b>	Hydrodynamic-enhancement of nitrate attenuation by integrating reactive biobarriers into shallow, open water treatment wetlands, Josh Sharp
<b>Project ID</b>	G17AP00133

### Project Impact

Field data collected in the summer and fall of the project window supports a better understanding of system biogeochemistry. Specifically, shifts in inorganic nitrogen attenuation in shallow, open water wetlands varies on day/night time-scales in association with photosynthesis-driven increases in dissolved oxygen and pH during peak sunlight. Nitrate concentrations were lowest at night with commensurate increases in nitrite and ammonium. These higher nighttime nitrate attenuation rates were accompanied by increased flux of the greenhouse gas N<sub>2</sub>O. Depth profiles of the biomat revealed pronounced redox stratification in the first 1-2cm of depth. Salt tracer tests revealed high exchange between the top <3cm of the biomat and water column but limited exchange into the further reaches of the biomat, which can be in excess of 10cm deep. This suggests that our hydrodynamic exchange should focus on this most permeable biomat region. To address limitations in hydraulic head associated with the initial construction and by extension our capability to control flow, we retrofitted the intake bay so that we could better control flow in future experiments and contrast the performance of the different cells. Within several cells, we replaced boards installed for hydrodynamic manipulation with sand bags to address unexpected buoyancy issues encountered during system operation. Further retrofits and reconstruction of cells was conducted in spring of 2019 after a large storm event that winter that caused damage across the cells (and an opportunity to address initial design limitations).

## WRRRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	National Competitive Grant – 104g
<b>Project Title</b>	Trace Organic Contaminants (TOrcs) in Urban Stormwater and Performance of Urban Bioretention Systems: a Field and Modeling Study, Christopher Higgins
<b>Project ID</b>	G15AP00168

### Project Impact

Land-use may be indicative of different sources of organic contaminants that may be found in urban runoff. All land- use should not be treated as having the same contributions from various pollutants in stormwater modeling. Contaminant loads are strongly correlated to precipitation depth and can be statistically modeled with precipitation depth. There is no correlation with antecedent moisture which indicates TOrc export is transport-limited, not supply-limited, during storm events. Statistical models can be used in WinSLAMM to model TOrcs in runoff. The pollutant loading input files to the WinSLAMM model (which will be published pending USGS internal review) can be used by other modelers in the region to predict TOrc loading at their urban sites. The Iris Rain Garden was not effective at removing TOrcs in stormwater. This is likely a result of the limited sorptive capacity of the geomedia. The geomedia at the Iris Rain Garden is only 15% organic matter (compost) and 85% sand. There is an opportunity for bioretention systems to be enhanced to improve removal of TOrcs by increasing the sorptive capacity of the geomedia through amendments (add biochar or activated carbon).

## WRRI Annual Reports: Project Synopsis

<b>Email address</b>	<a href="mailto:Reagan.Waskom@Colostate.edu">Reagan.Waskom@Colostate.edu</a>
<b>Institute</b>	Colorado
<b>Grant Type</b>	Student Internship
<b>Project Title</b>	National Domain Water Budgets NIWR-USGS Student Internship Program, Katie Schneider (William Farmer)
<b>Project ID</b>	G17AL00414

### Project Impact

This project was designed to improve our ability to model hydrologic processes in Alaska, adding this functionality to the USGS national hydrologic model. This year focused on building the monthly water balance model required to simulate daily hydrologic fluxes, including the impacts of snow and glaciers in the cryosphere. Ms. Schneider's work has incorporated new processes into our model framework and greatly advance national modeling capacity beyond Alaska.