Managing to the Future:

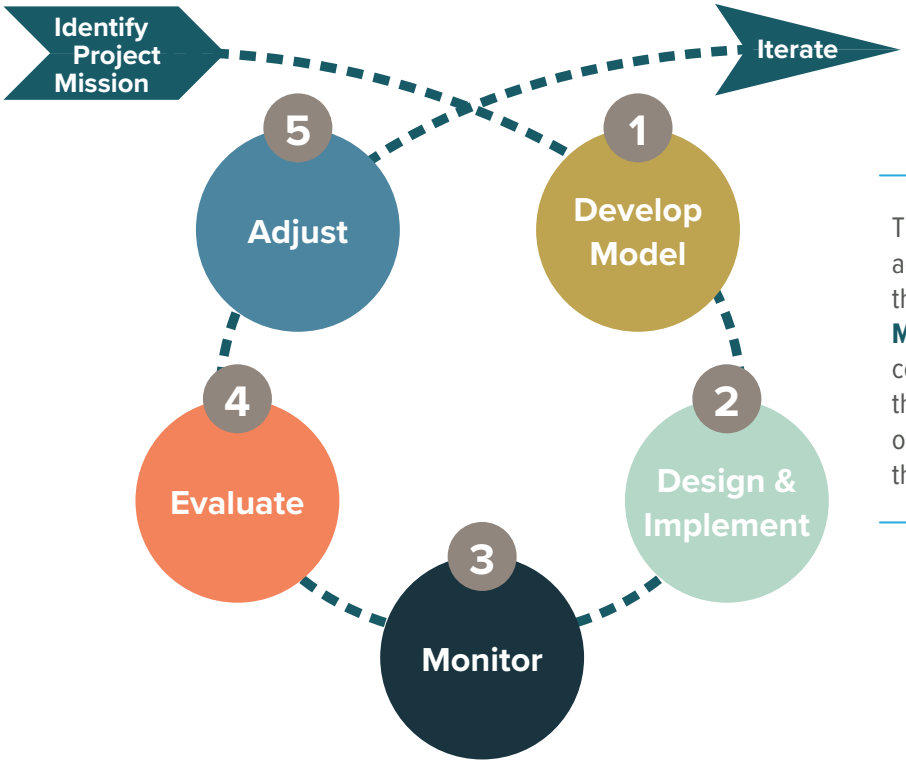
Adaptive Management in Left Hand Watershed

LEFT HAND
watershed center

How do we manage to future conditions?

How do we plan for uncertainty associated with climate change and dynamic watershed processes?

At **Left Hand Watershed Center (the Watershed Center)**, we use an adaptive management process to help reduce uncertainty and manage to the future as we work to improve the health and resilience of watersheds. We chose an adaptive management process because it offers the flexibility necessary to manage complex and changing ecosystems. Using adaptive management, we define our goals, quantitatively track progress toward our goals, and adjust management or monitoring actions iteratively, based on what is learned.



This figure shows each component of the adaptive management process. Based on this process, we developed this **Adaptive Management Plan** to assess watershed conditions and guide informed actions. On the following pages we describe each step of the process as it relates to our plan using the same colors and numbers as in the figure.

About Us

Left Hand Watershed Center works to protect and restore watersheds for people and the environment using a collaborative, science based approach.

LEFT HAND watershed center

Our Organizational Goals:

- Assess watershed health using science-based adaptive management.
- Bring together diverse community members with competing values to develop on-the-ground solutions through open communication and cooperation.
- Build community-wide stewardship ethic rooted in watershed science and place-based, participatory learning.
- Plan and implement on-the-ground projects that advance **watershed restoration practices.**

Established in 2005, we have strong roots in our community and we are led by a diverse board of enthusiastic stakeholders.

We value science and community, and embrace these values to implement on-the-ground projects.

While we maintain our roots in Left Hand Creek Watershed, we strive to apply out locally-developed tools regionally for the benefit of all Front Range watersheds and communities.

Project Mission:

Our overarching mission is to maintain or improve ecological conditions and resilience following restoration and recovery from the 2013 floods.

1 Develop Model

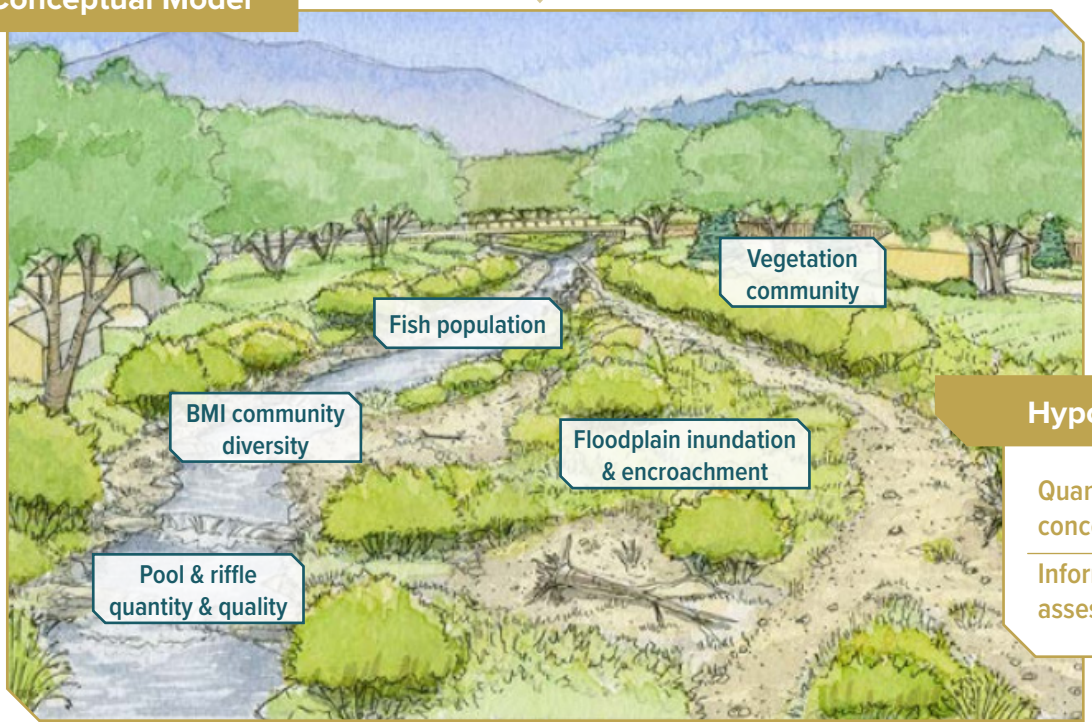
To meet our project mission, we identified the goals listed below. Each of these goals are rooted in the desired future conditions of our watershed, which we characterize using ecological conditions.

Key to our adaptive management approach is representing our goals in a conceptual model. We selected an illustrative approach for our model to inspire deeper and more critical thinking about the future of our watershed. The model was developed collaboratively with technical experts and community members that came together to define a common vision for the watershed. This step provided the essential foundation for (1) developing hypotheses and identifying monitoring parameters that enable us to effectively track progress toward goals while (2) utilizing a shared understanding of the desired future conditions with technical experts and community members alike. A sample section of the model is shown below with goals noted on the illustration.

Management Goals

1. Maintain or improve floodplain and channel connectivity;
2. Maintain or improve channel morphology and physical habitat;
3. Maintain or improve native riparian condition and the native plant community;
4. Maintain or improve benthic macroinvertebrate community;
5. Maintain or improve water quality;
6. Maintain or improve fish community and condition;
7. Reduce hazards and increase flood safety.

Conceptual Model



Hypotheses

Quantifiable and tie to conceptual model

Inform monitoring and assessment efforts

2 Design & Implement

Starting in 2016, we began implementing restoration projects to initiate the trajectory towards a healthy and resilient future. Eleven projects are complete and eight more are underway. Projects were designed to meet stated goals listed on the previous page.

3 Monitor & Assess

Building on hypotheses and goals from Step 1, we developed a robust Monitoring and Assessment Framework to follow our trajectory towards resilience by quantifying changes in the ecological health of our watershed. This approach helps us learn from our restoration efforts in a structured way to enhance the effectiveness of our restoration efforts over time. The aim of this approach is to help resolve why a goal was not achieved and what alternative or additional management actions may be needed for it to succeed. This framework is integral for managing to the future and planning for uncertainty because it provides both the accountability and flexibility needed to manage our complex watersheds. Key components of the framework are described below.

Hypotheses

Ties to goals in Conceptual Model

Performance Standard

Threshold of performance that's needed to meet goals

Management Trigger

Performance that triggers need for action

Actions

Additional data collection, management, or stewardship project

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Since our project goals focus on maintaining and improving ecological conditions, we chose to focus monitoring efforts on the related ecological parameters. Below we provide an example of this related to **pools**.

Related Management Goal: **2) Maintain or improve channel morphology and physical habitat.**

Hypothesis

Average residual pool depth will be maintained or increased to provide refugia for fish year to year.

Performance Standard

At low flow, average residual pool depth per reach is **maintained or increasing and greater** than 1.0 feet in Plains and Foothills, or 0.8 feet in Canyons.

Management Trigger

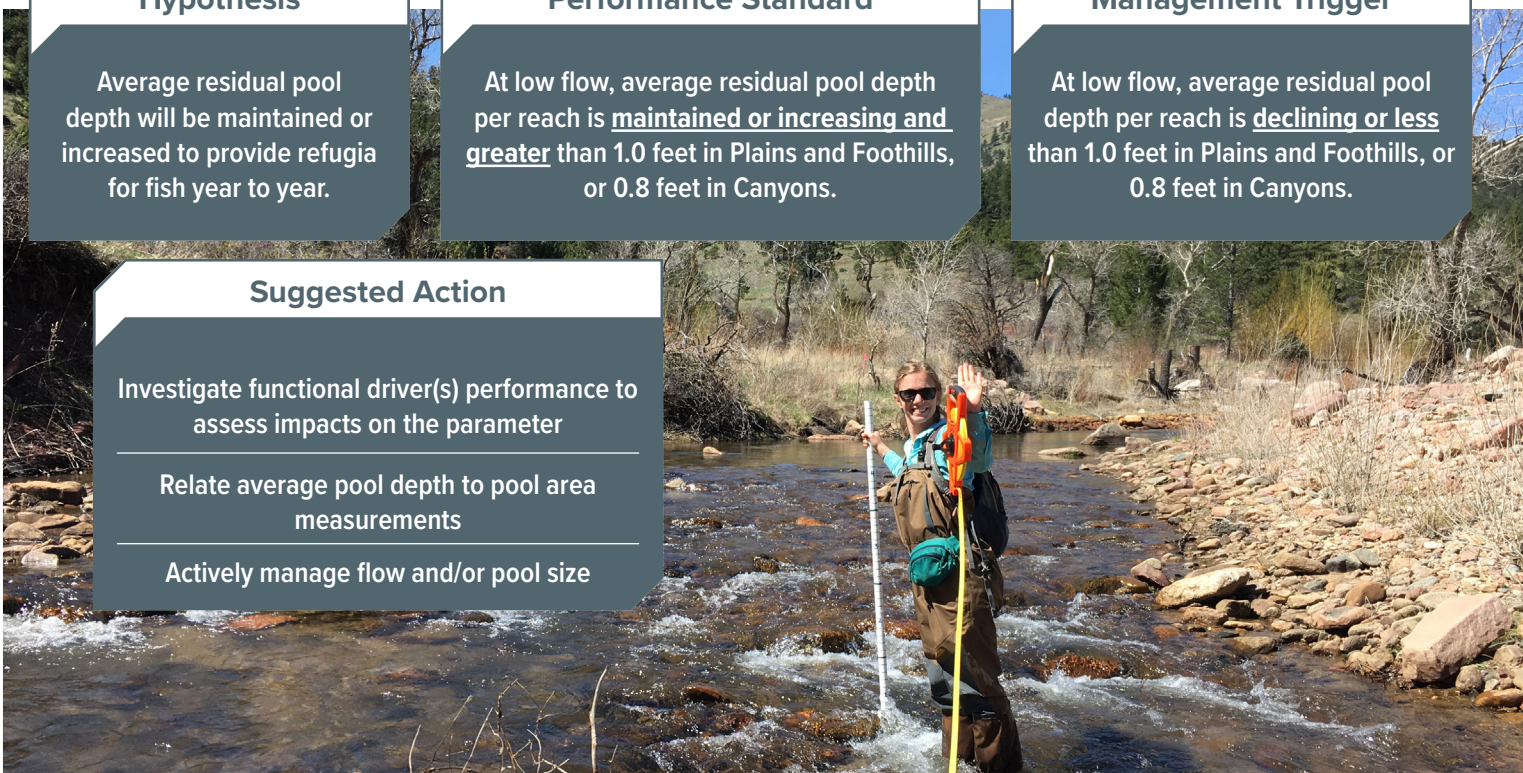
At low flow, average residual pool depth per reach is **declining or less** than 1.0 feet in Plains and Foothills, or 0.8 feet in Canyons.

Suggested Action

Investigate functional driver(s) performance to assess impacts on the parameter

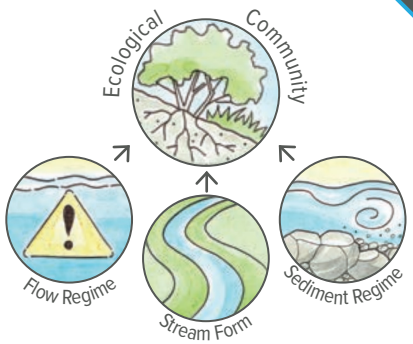
Relate average pool depth to pool area measurements

Actively manage flow and/or pool size



What Sets This Framework Apart?

Holistic



It addresses ecological conditions but accounts for all watershed functions as drivers.

Actionable

On-the-ground management actions are incorporated directly into the monitoring plan.

Flexible

New datasets can be incorporated seamlessly by modifying hypotheses.

Performance standards or management triggers can also be modified to accommodate unique project goals.

Data collection methods can also be adjusted for different systems or watershed needs.

4

Evaluate

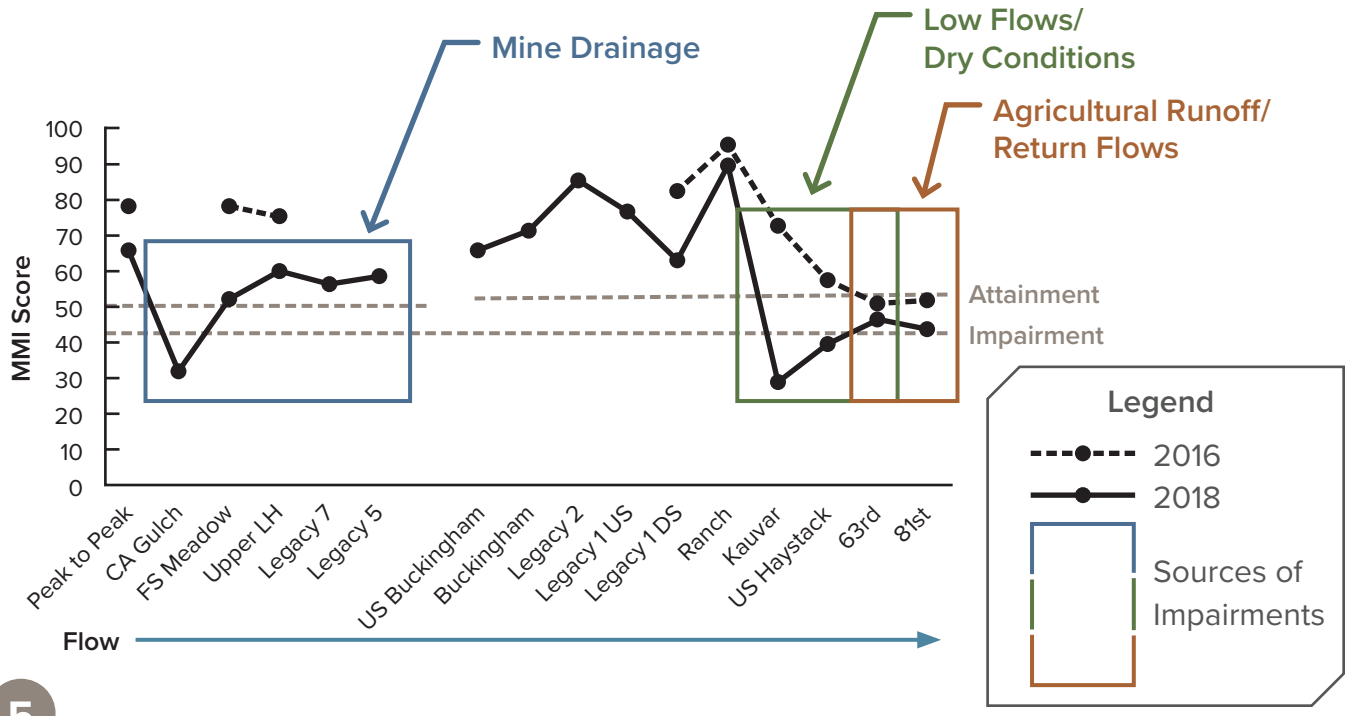
Data evaluation allows us to achieve a core value of adaptive management – learning and adjusting as new information is gathered. Recognizing that we are limited by just one year of data and additional year-to-year comparisons are needed to assess our trajectory towards resilience, we were able to gain some initial impressions by comparing our monitoring results to the conceptual model and our goals. Below we summarize key lessons from evaluating of one year of monitoring data.

Key Takeaways from Year 1:

1. **Annual data collection is important.** Since conditions vary year to year, collecting data each year is important to capture variation and conditions outside the "norm". In 2018, Left Hand Creek experienced a low water year compared to previous four years and a discrete mine drainage event which impacted water quality.
2. **Restoration increased habitat quantity.** Restored locations had broader and more accessible floodplains and more pool habitat than unrestored and pre-project sites demonstrating that project goals to restore floodplain connectivity and increase pool habitat were met in the first year following restoration.
3. **Lower benches and connected floodplains may increase native plant cover.** All sites had greater average native vegetation richness along the creek edge compared to upland zones, and restored locations had greater average percent native cover along the creek edge. The results demonstrated the importance of maximizing lower benches to attain greater levels of vegetation cover and richness.
4. **Three types of water quality impairments exist in Left Hand.** 2018 benthic macro invertebrate data indicated that three types of impairments exist based on location in the watershed (e.g. relative to mine, diversions, ag-water returns). This information presents an opportunity to identify which management actions may be most beneficial for improving watershed health.

Example of Evaluating and Adjusting - Benthic Macroinvertebrates:

Evaluation of benthic macroinvertebrate data indicated three potential sources of impairments depending on watershed location. The chronic and discrete nature of these impairments highlighted the need to collect BMI data more frequently and the need to correlate flow regime to better understand the causes of water quality impairments. To adjust, we are now collecting data on the location and frequency of dry up periods at low flow to better correlate BMI data results with flow data.



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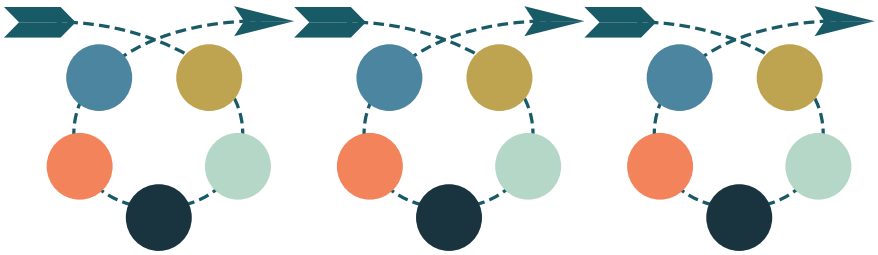
Adjust

Adjusting our actions based on what is learned is the last step in the adaptive management process, though iteration of the entire process continues cyclically. Below we summarize adjustments and priorities based on year one results. Moving forward we will implement these actions to improve our trajectory towards resilience.



Adjusting involves identifying and implementing actionable priorities and continuing the adaptive management process through new iterations of the cycle.

Adjustments - Monitoring

- **Real time results for water quality.** Conduct additional water quality monitoring using labs with faster processing time than River Watch to understand if water quality is improving from mine drainage issues.
- **More data on fish & bug recovery.** Conduct additional fish and benthic macroinvertebrate monitoring to understand how these communities are recovering from mine drainage issues.
- **Understand mine impacts.** Conduct comprehensive assessment of existing mines and related water quality issues.
- **Experimental restoration.** Monitor and set up experiments to better understand ecological benefits of different restoration methodologies and stream stages, particularly related to quantifying the relationship between vegetation and floodplain connectivity, as well as resulting resiliency outcomes.
- **Understand if pool conditions are viable for fish populations.** Collect data on pool depth and pool temperature data in summer months to determine whether pools are deep and cool enough to support fish habitat at low flow.

Future Initiatives

As we continue iterating the adaptive management process each year, we are growing our plan in new ways to make it more robust, comprehensive, and inclusive of our community.

Extending Geography

We are extending our geography to the St. Vrain Basin and beyond to expand the reach of our adaptive management approach and better refine drivers, triggers, and actions for diverse watersheds. Our goal is to help advance science to inform the broader conversation about improving watershed health and restoration practices.

Engaging Community

We are engaging our community in adaptive management through science by providing opportunities for place-based participatory learning as part of our Community Science Program. This includes partnering with local schools to adapt our adaptive management plan for K-8 curriculum and developing a "My Watershed" mobile app for community-driven data collection.

Incorporating Forests

We are incorporating upland forests into our process to bridge the forest-river divide for a truly holistic approach to adaptively managing watershed health. Our goal is to help achieve a shared understanding of desired future conditions among our community to help develop the social knowledge and consensus needed for successful forest health projects.

Adjustments - Management

- **Address flow related water quality impairments.** Assess and implement modifications to diversion structures and/or operations in lower reaches to address water quality impairment issues. Discussions with water owners about potential modifications have been initiated and potential options have been identified for nearly all diversions.
- **Re-connect floodplains in reaches without water quality impairments.** Identify areas with disconnected floodplains and implement restoration projects to reconnect the river to the floodplain where possible. Restoration efforts should first prioritize reaches without water quality impairment issues.
- **Prioritize restoration work in unconfined channels.** Identify unconfined reaches or floodplain pockets and implement projects to restore to a stage zero stream where possible.

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