E-PARCC
COLLABORATIVE GOVERNANCE INITIATIVE
Syracuse University
Maxwell School of Citizenship and Public Affairs
Program for the Advancement of Research on Conflict and Collaboration

NEGOTIATING SCIENCE AND POLICY IN COLLABORATIVE HYDROPOWER LICENSING

General Background Information

This is a hypothetical case drawing on multiple hydropower relicensing processes. Students should draw only on the material presented in the case.

The negotiation will proceed through four sequential stages, resulting in an application package that the Federal Energy Regulatory Commission (FERC) will judge to create the hydropower operating license. FERC only considers management requirements that have a scientific basis. It is up to the stakeholder negotiations to develop and present this science, in order to inform the operating requirements they propose.

As a group of stakeholders in the FERC relicensing process, your collective task is to:

1. decide what resources might be affected by the hydropower plant.
2. negotiate what studies to conduct to evaluate the effect of potential hydropower management approaches on those resources.
3. use study findings to negotiate proposed operating requirements.

In your role as an individual stakeholder, you must advocate for your party's interests you hope to achieve during the relicensing. You are encouraged to fully embody your organization's identity. At the same time, this is a chance to practice interest-based negotiation. As you interact, focus on each party's interests and the content of what they are saying; try not to attack the people behind the statements. Be civil—remember that in a real relicensing you

would probably be interacting with these same individuals many times over the course of your career.

More detailed background for each party to the relicensing is included in the confidential role information sheets. **Before class, please read through all provided materials and complete Role Play Preparation (Worksheet 1) and Positions and Interests (Worksheet 2). If there are multiple students representing each party, arrange to meet before class or at the start of class to complete the two worksheets together.**

Scenario and Additional Information about the Relicensing Process

Silver Lake Hydroelectric Project is located on the Silver River in the Silver Lake Mountain region of western Colorado. The facility is owned by Mountain Energy, also called "the licensee." The project's current 50-year operating license, issued by the Federal Energy Regulatory Commission (FERC), is due to expire in five years. Under the terms of the Electric Consumer's Protection Act of 1986, FERC must balance between power and non-power interests in approving license requirements and must ensure that they conform to other pertinent regulations, such as the Endangered Species Act. Your task as a group is to develop a set of operating requirements to propose in the project's license application that you think meet these criteria and that satisfy all parties participating in the relicensing.

You will develop these operating requirements by negotiating the three primary decision points in FERC's Integrated Licensing Process (ILP). The ILP was developed to increase collaborative engagement between the licensee and other stakeholders in order to improve relicensing decisions, reduce the overall time needed for permitting, and minimize legal challenges. The ILP begins with a scoping process to identify all resources that might be affected by the hydropower facility. The utility and participants then develop studies to quantify those impacts. Finally, after 1-3 years of technical studies, parties use the study results to suggest operating requirements via the license application. Once FERC receives the license application, they analyze proposed operating requirements and determine the final contents of the license.

Thus, the three key decision points that you, as the utility and other stakeholders, will negotiate are:

1. What resources are potentially being affected by the project or its operations?

Generally, the licensee suggests resources (including aquatic species, water supply, water quality, economics, recreation, and cultural/historic resources) that might be affected by the project and what the effects might be. The other parties then negotiate additions or edits to this list. The list of impacted resources determines the scope of what studies can be done and

therefore what resources will be addressed in the final license. The initial negotiation focuses on delineating these potential resource impacts.

2. What studies need to be conducted to assess project impacts on those resources?

This negotiation focuses on what studies (and specifically which scientific methodologies) are needed to best assess project impacts. For instance, studies quantifying a facility's impacts on a fish species could include a tagging study to see how many individuals are in the system, habitat modeling to see how potential habitat varies with flow/temperature/velocity, or a literature review to assess the stressors on fish in the entire river system. Each study carries a somewhat normative stance, as mapping actual population numbers over time often makes the impacts of the project look much worse than simply predicting available habitat.

3. What do study results suggest would be a useful operating regime to minimize project impacts? What operating requirements do you recommend to FERC?

This is the meat of the relicensing process. The studies provide data, such as counts of a particular species in the basin or maps of the river's geomorphology. The parties then digest this information to suggest management plans and flow regimes to mitigate impacts. These can be construction projects (e.g., restore a stretch of river or build a campground and boat ramp to increase recreational access) or a specified operating plan (how much and when water will be released from the dam in order to provide fish spawning habitat, whitewater rafting, power production, water supply, etc.). Participants develop a single package to propose to FERC (who will accept it, reject it, or accept it with modifications, based on review of the application to ensure that it is science-based and meets all relevant federal and state regulations). It is in most parties' interests to work toward consensus, as leaving decisions up to FERC lessens the likelihood one's interest is in the final license.

Stakeholders in the Relicensing

Mountain Energy, LLC

- Mountain Energy, LLC is a large multi-national corporation headquartered in San Francisco, CA, with a regional office in Denver, Colorado. They own Silver Lake Hydroelectric Project, having purchased the facility from a local electrical utility in 1980.
- The Silver Lake facility is a key part of Mountain Energy's domestic generating portfolio, meeting a significant portion of the region's electrical demand. The company values having the hydroelectric facility to balance its other generating sources in the western

United States, which are primarily coal-based.

- Regarding flow, Mountain Energy would like to store water and then release it through the turbines only during peak electrical demand times (in other words, to not send any water downstream unless it generates valuable electricity).

U.S. Fish and Wildlife Service (FWS)

- The US Fish and Wildlife Service, a federal agency housed in the U.S. Department of the Interior, has jurisdiction over endangered species found within the project area. The project has historically affected several culturally and economically important species, including the razorback sucker (*Xyrauchen texanus*), a federally listed endangered fish species. Under Section 7 of the Endangered Species Act, FERC and Mountain Energy are required to consult with FWS on the potential impacts of continued project operations on listed species. In addition, under Section 9 of the Federal Power Act, the FWS can mandate that fish passage be installed on any hydropower project.
- Regarding flow, the FWS want enough instream flow to provide habitat for razorback suckers.

U.S. Forest Service (USFS)

- The USFS is a federal land management agency housed in the US Department of Agriculture. USFS manages Silver Lake Mountain National Forest, where the hydropower facility is located.
- Under Section 4(e) of the Federal Power Act, FERC may only issue a license to a project occupying a federal reservation that will not interfere with the purposes for which the reservation was created. Furthermore, as the primary landowner in the project area, the USFS, a federal agency within the U.S. Department of Agriculture, has mandatory conditioning authority over the project and can make any recommendations it deems necessary for the adequate protection and utilization of the public resource.
- Regarding flow, the Forest Service wants to maintain riparian habitat, ensure that the river's aesthetic resources have sufficient flow, and reduce erosion in the system. It is also interested in ensuring recreational access to both the reservoir and the river, and it maintains several campgrounds and boat ramps throughout the system.

American Whitewater

- American Whitewater is a national, non-profit 501(c)(3) organization that aims "to conserve and restore America's whitewater resources and to enhance opportunities to enjoy them safely." They have a regional office in Longmont, CO.
- Regarding flow, American Whitewater wants flows in the river to be at a safe but

enjoyable range for whitewater boaters to enjoy the river, preferably on weekend days.

Silver County Government

- Silver County is the heart of the Silver Lake Mountain region. Silver mining, forestry and agriculture once fueled its economy, but a decline in those sectors in the 1990s led to overall outmigration from the area. The County is currently seeing rapid growth in tourism and second home development. Commercial fishing used to be a key economic driver, but has not contributed substantially to the economy since fish runs declined in the last few decades. The Silver County Administration sees the relicensing process as an opportunity to ensure a reliable energy source for more residential growth and to develop recreational opportunities associated with the dam and reservoir to attract tourists.
- Regarding flow, the country wants a little of everything. Its primary goal is to protect its cheap energy source, aligning its flow interests with that of Mountain Energy, but it also realizes that having instream flows that attract fish and tourists is beneficial to the region.

Silver Irrigation District

- The Silver Irrigation District provides irrigation water released from Silver Lake Reservoir to the region's wheat, barley and corn farmers. Farmers have become increasingly dependent on irrigation water over the last 10 years due to an ongoing drought; irrigation's importance will likely continue for the foreseeable future given climate projections for the region.
- As mining declined in the region, farming has become the predominant economic driver in the region, accounting for more than 40% of GDP.
- Regarding flow, the Irrigation District's primary interest is that its water rights are fulfilled; it is also interested in securing additional rights given the uncertainty of annual rainfall rates and high temperatures.

Background on the Silver Lake Hydroelectric Project

The Silver Lake Hydroelectric Project is located between river miles 40 and 75 on the Silver River in western Colorado. The project features include Jackson Dam (a 500-foot-high concrete gravity dam), Silver Lake reservoir, the Silver Lake powerhouse, and an intake tunnel leading to Silver Lake Irrigation District's aqueduct (see Figure 1). The powerhouse has two turbine-generator units with a total installed capacity of 200 MW.

The facilities were constructed between 1925 and 1928 by the Silver Lake Mining Company as a power supply for the region' mining operations. In 1950, the project was transferred to the Northern Colorado Electric Company, a regional public utility. Then, in 1980, during the last hydropower licensing process, Silver Lake Hydroelectric again changed hands to Mountain Energy, LLC, who purchased the project as part of a campaign to increase renewable holdings.

Mountain Energy operates the Silver Lake Hydroelectric Project primarily as a peaking facility, meaning that it varies generation to meet short-term demands for electricity. The project generates an average of 600,000 MWh annually, enough energy to serve about 60,000 households. The greatest demand for hydropower's peaking generation occurs midday during the hot summer months of mid-May to mid-September.

Silver Lake Reservoir has a capacity of 400,000 acre-feet (AF) and a 2000-acre surface when full. The lake is a popular site for camping, boating, jet skiing, and fishing, especially during the summer months. Whitewater boaters typically use the river during weekends from May to September. Additionally, Silver Irrigation District leases 150,000 AF of the reservoir's capacity to store water, which it uses during the irrigation season (June through September). The reservoir surface elevation (measured in feet above sea level) has historically been kept between 6700 and 7000.

Under its current license, the project operates with a year-round minimum instream flow of 50 cfs. Otherwise, there are no restrictions on project operations.

Razorback suckers, the only known endangered fish species in the basin, are present in the river below the dam year-round. The fish spawn during spring runoff, typically between April and June.

Table 1. Current Project Data

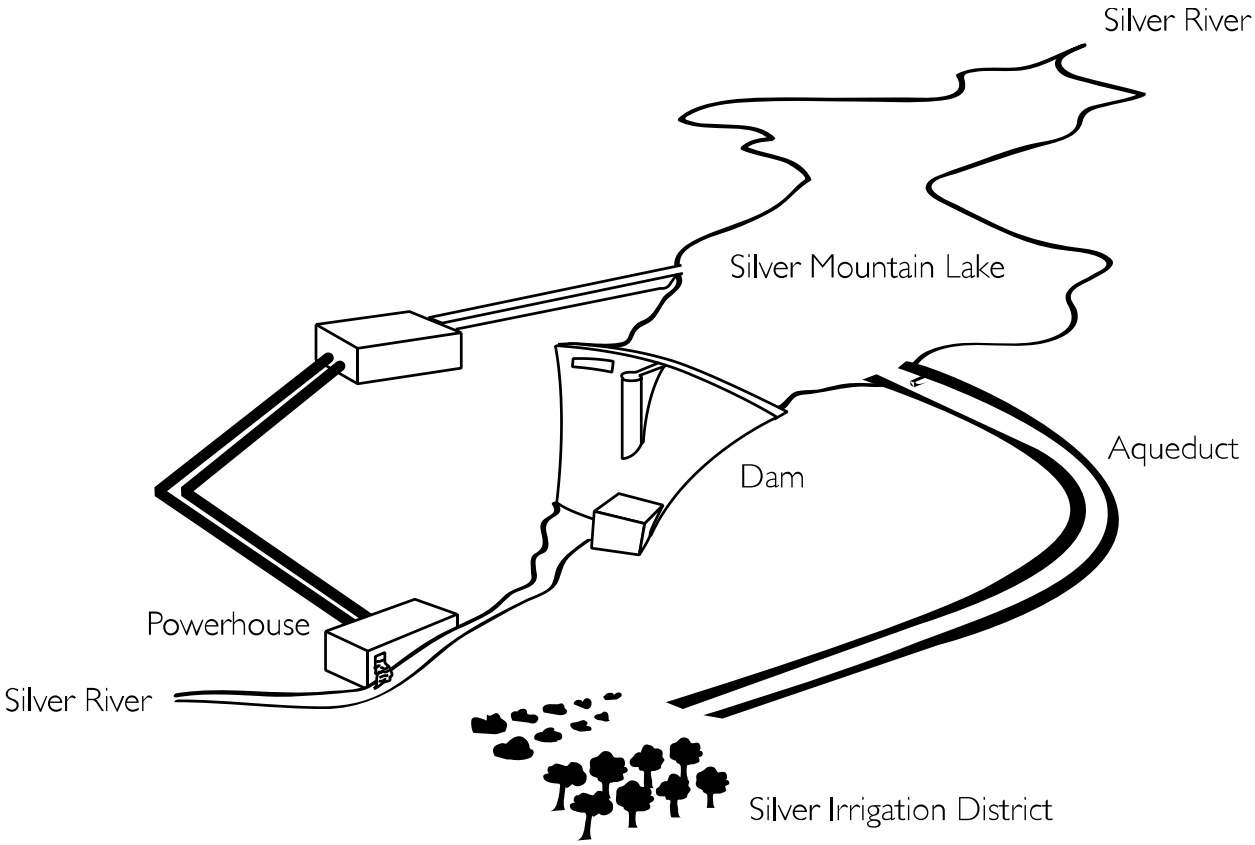
	Winter (Dec-Feb)	**Spring (Mar-May)**	**Summer (Jun-Aug)**	**Fall (Sep-Dec)**
Mean monthly inflow[1] (cfs)	400-500	1500-4000	500-1000	400-500
Mean monthly outflow[2] (cfs)	50	100-500	400-500	100-300
Mean generation (MWh)	50,000	150,000	300,000	100,000
Mean temperature range (^{o}C)	0-10	5-20	15-30	10-25
Irrigation deliveries (cfs)	0	100-250	250-400	100 (Sep)

[1] Monthly inflow can also be thought of as the outflow that would occur if the dam and irrigation project did not exist (i.e., the natural hydrograph).

[2] The outflow is the flow released below the powerhouse, and does not include irrigation deliveries (which take place from a separate outlet in the reservoir). Outflows must be greater than the required minimum instream flow.

Table 1 summarizes the project's historic operations. The project currently operates with a 50 cfs minimum instream flow, a 6700 ft minimum surface elevation, and a 7000 ft maximum surface elevation. Note that any water diverted for irrigation cannot be used to generate electricity, as diversions occur upstream of the powerhouse.

Figure 1. System map (not to scale)



Detailed Instructions for the Negotiation

The relicensing negotiation will take place over four stages. As you negotiate, bear in mind that the results from each stage inform what options are on the table in subsequent stages.

Stage 1: Decide what resources might be impacted

At this stage, the group is negotiating the suite of resources that have the potential to be addressed by the relicensing. It is therefore critical that any resource interests you have are included. Try to phrase your ideas about project impacts in terms of your interests.

Stage 2: Select studies

At this stage of the relicensing, stakeholders negotiate which set of studies the utility will

conduct. **Use Worksheet 3 to prepare for this negotiation**. Table 2 includes a list of studies that are commonly used in hydropower relicensing; they are grouped by resource and include a short description of the types of information the study will provide and an estimated cost. For each resource identified in Stage 1, decide which study(ies) the utility will run. You are also welcome to propose a study that is not included in Table 2 if you think there is additional information that would be valuable.

As you select studies, think about how the information provided might enhance or undermine your interests. Consider what information each study provides, and whether you think that information best meets your interests and the needs of the group. Overall, the studies for which data are gathered directly (rather than modeled) are going to be more specific to the characteristics of the Silver Lake Project. However, you are limited to one to three years of data, which may or may not be representative of the system over the longer term. Models are useful for observing both historical operations and potential management scenarios. However, models are only as good as the data feeding into them and in some instances available data may be highly uncertain.

Table 2. Potential Technical Studies

Resource	Study Options	Types of data provided	Cost
Electricity	Project operations model	A project operations model estimates a time-series distribution and fluxes of water through the project system: reservoir inflows, surface elevation, reservoir storage, reservoir outflows, and electrical generation. Results from the operations model also typically feed into other models (like habitat, economics, or temperature) to test the effect of different operating regimes on other resources.	$100k
Fish	Habitat model	A habitat model simulates the relationship between flow and habitat for different species. It requires estimates of “habitat quality” by depth, velocity, and temperature, as well as other characteristics like substrate or shade. It then develops a map of where there is good, acceptable, and poor habitat throughout the river.	$50k

Resource	Study Options	Types of data provided	Cost
Fish	Population model	This model estimates the effect of different environmental stressors (e.g., predation, disease, temperature) on a species' population at different lifestages. It directly estimates fish survival rates, rather than potential survival based on habitat available in a system.	$20k
Fish	Population counts	This study samples fish in the river to estimate a total population as well as the age structure of the population. These data can feed into a population model or be used independently to track species health.	$60k
Fish	Literature review	A literature review collects information on species characteristics, population dynamics, and stressors, with information drawn from prior studies in the basin or other rivers. It is the least time and resource-intensive method, but is not specific to the Silver Lake project or fish population.	$10k
Water temperature	Temperature model	This model estimates a time series of temperatures throughout the system based on flow and climate variables.	$20k
Water temperature	Temperature monitoring	This study uses temperature loggers to measure temperature at specific points throughout the system. These data can feed into a temperature model or be used independently. Monitoring more points provides better quality data, but each logger is expensive.	$50k
Recreational use	Current use survey	This study samples recreational users at the facility to understand how many people currently visit it, what they do (e.g., camping, boating, fishing), what they like/dislike, and how much money they spend.	$80k
Recreational use	Forecasted use model	This study uses demographic projections and data from the current use survey to forecast potential recreational visits given upgrades to the system and changing societal demands and economics.	$30k

Resource	Study Options	Types of data provided	Cost
Recreational use	Boatable flow study	In this study, rafters/kayakers/canoeists/fishermen traverse the river at varied flow rates, and then are surveyed to assess how enjoyable the experience was and whether they encountered any problems. It gives an estimate of what an ideal flow range would be for different types of watercraft.	$50k
Irrigation	Economic impacts of irrigation	This study estimates the total value of goods produced with irrigation water, including crops grown and jobs associated with those crops.	$80k
Sediment/erosion	Sediment mobilization experiment	This study measures sediment deposition along the river before and after a high-flow event, to observe how different flows move sediment along the river. The flows can be managed (a controlled release from the dam) or opportunistic (before and after a storm).	$60k
Sediment/erosion	Contaminant testing	In this study, sediment samples are collected from the reservoir and analyzed for potential contaminants.	$50k
Sediment/erosion	Sediment fate and transport model	This study models the transport of contaminants through the system (within and below the reservoir), as well as any chemical fluxes that occur over time.	$20k
Riparian habitat	Habitat mapping	In this study, plant cover (species type and diversity) is mapped along representative stretches of the river bank.	$50k
Riparian habitat	Cottonwood germination experiment	This study entails a laboratory experiment to identify optimal water levels and soil moisture contents to enhance cottonwood germination.	$30k
Riparian habitat & Fish	Floodplain inundation mapping	This study uses historical aerial photos and topographic data to map out-of-bank water levels at different flows. This provides an estimate for where cottonwood seed germination and/or razorback sucker maturation might take place.	$50k

Stage 3: Review study results and prepare for final negotiations

During this stage, students will work independently or in your stakeholder group to consider the implications of the study results. You will receive the study results and **complete Worksheet 4** to clarify and specify your interests and optimal outcomes. The studies provide

data; such as counts of a particular species in the basin or maps of the river's geomorphology. The stakeholders then digest this information to propose management plans and flow regimes to mitigate impacts. Potential components of the plan are described below for Stage 4, but students are welcome to brainstorm additional requirements you think would be beneficial. During this stage, stakeholders additionally develop their negotiating strategy for Stage 4. This may include holding caucuses with other stakeholders to determine common interests and consider how you might modify your positions or build coalitions.

Stage 4: Develop a management plan

At this stage, the full group works to negotiate the actual management plan. Select from among the following operating requirements, using your knowledge of project impacts, the study results, and your organization's interests to advocate for your choices. Note that there is no "ideal" operating plan, and any combination of the following requirements (except dam removal, which is stand-alone) is feasible. However, you should be conscious about the criteria you are using to judge whether operating requirements are better or worse. For instance, do they meet your resource interests? Do they meet the interest of other parties? Are they feasible? Additionally, as you negotiate, think about potential synergies between operating requirements: are there ways to meet multiple resource goals with a single tool?

Minimum flows

Increasing minimum flows can improve fish habitat, riparian generation, and water temperature. While the hydropower project can generate electricity while releasing most flows, this generation is less efficient than with flows released for the sole purpose of generating electricity. If the group decides to increase the minimum flow requirements (the current requirement is 50 cfs year round), the decision entails deciding what the target flows are, when in the season those flows should occur, and whether they should happen every year or in a subset of years.

Release a percent inflow through the dam, mimicking run-of-river system

Releasing a percent inflow allows the river to return to a natural hydrograph for a portion of the year. This would benefit fish (and may be particularly important during spawning and maturation periods), regenerate riparian habitat through seedling germination, and mobilize sediment through the system. Electricity can still be generated during the flush through, but the plant would be effectively operated as a run-of-river plant with no peaking capabilities.

If the group opts to operate the dam this way, the decision entails deciding what percent of the project inflow to release (any amount up to 100%), when the flush through should occur (which depends on the resource the flow is trying to target), and whether to flush through every year

or in a subset of years.

Increase generating capacity

The utility could install new turbines or upgrade their existing turbines. This would mean the facility could generate additional power at higher flows than the current turbines ratings, increasing the facility's flexibility. A new turbine costs approximately $300,000.

Provide whitewater boating flows

This entails releasing whitewater flows (generally 500-1000 cfs). The decision covers whether to include whitewater flows, how many the utility should provide, and if there are timing constraints (like targeting certain months or days of the week). Note that these flows might be achieved when meeting other operating requirements.

Expand recreational access

This entails any additional changes to the facility to expand recreational access. Options here could include upgrading or expanding campgrounds and picnic areas along the river and reservoir and/or creating educational or marketing materials to attract visitors.

Inject sediment

In some systems, sediment injection is used as a supplement or alternative to increasing flows to provide fish habitat. The idea is that depositing spawning gravels below the dam can improve habitat quality without requiring additional water. If the group opts to inject sediment, the decision should also entail timing so the gravel is in place when spawning occurs.

Monitoring and compliance

You may want to consider including requirements to monitor implementation of the license to ensure that it is happening and is resulting in the desired outcomes. This could include annual reports by the utility, studying any of the managed resources, or scheduled stakeholder meetings to discuss implementation.

Remove dam

In some relicensings, stakeholders determine that the costs of bringing a project up to compliance outweigh the potential value of the electricity and other services it provides. In these cases, removing the dam entirely is an option. It allows the return of full natural flows to the river, benefiting fish, sediment movement, aesthetic quality, and whitewater boating; it also removes the dam as a barrier to fish migration. However, removing the dam means there is

no longer the potential to generate electricity, store water for irrigation, or have any lake-based recreation.

The cost of decommissioning a dam the size of the Silver Mountain Project is estimated at $2 million.

2. Confidential Role Descriptions

Role: Colorado Projects Lead Manager, MOUNTAIN ENERGY, LLC

You are directly responsible for the relicensing process, but all final decisions, including budgets for studies and the final license proposal, must be approved by Mountain Energy's General Manager and Board of Directors.

Background

Mountain Energy, LLC is a large multi-national corporation headquartered in San Francisco, CA, and with a regional office in Denver, CO. It has owned the Silver Lake Hydroelectric Project since 1980. The Silver Lake facility is a key part of Mountain Energy, LLC's domestic generating portfolio, meeting a significant portion of the region's electrical demand. The company values having the hydroelectric facility to balance its other generating sources in the western United States, which are primarily coal-based. Regarding flow, Mountain Energy, LLC would like to store water and release it through the turbines only during peak electrical demand times (in other words, to not send any water downstream unless it contributes electricity to the grid).

Your Interests

- Stay in business
- Maintain competitive rates for customers
- Earn allowed rate of return on shareholder investments
- Maintain and expand distribution business
- Maintain good relationships with public and agencies
- Maintain control of the relicensing process and complete relicensing as soon as possible

Issues of Concern

a) As the licensee, Mountain Energy is responsible for funding the relicensing process, including hiring consultants to conduct studies. The costs of innumerable studies in terms of resources, staff and time will be considerable, so it is in your interest to select only those studies that will be the most useful. Opportunities to share study costs may also be pursued. Remember that while less studies can save money, lawsuits from unappeased stakeholders after the permit submission can be equally costly.
b) Increased minimum instream flows, percent-of-flow releases, and any other changes to water flow may translate directly into reduced electricity production, higher rates, and lower return for your shareholders.

Additional Role Characteristics

Mountain Energy prides itself on being a renewable energy producer and stands up with the industry to promote a cleaner energy portfolio for the Nation. You can afford to collaborate and try to meet local interests, because you know from experience that litigation will take even more time. That said, you have strong and close relationships in Washington, D.C. with key Congressmen who may have to be relied on to move this process along. It wouldn't be the first time that political pressure was placed on a FERC commissioner if this permitting process deteriorates.

Role: Fisheries Biologist, Mountain-Prairie Region, U.S. FISH & WILDLIFE SERVICE (FWS)

You are the lead negotiator representing the FWS.

Background

The FWS is a federal agency housed in the U.S. Department of the Interior, with jurisdiction over endangered species found within the project area. The project has historically affected several culturally and economically important species, including the razorback sucker (*Xyrauchen texanus*), a federally listed endangered fish species. Under Section 7 of the Endangered Species Act, FERC and Mountain Energy are required to consult with FWS to determine the potential impacts of continued project operations on listed species. In addition, under Section 9 of the Federal Power Act, the FWS can mandate that fish passages be installed on any hydropower project if you deem it necessary.

Your Interests

- Conserve public trust and provide sustainable recreational and commercial fisheries
- Participate in a process that promotes the fair and respectful resolution of different interests
- Conserve, protect, and enhance fish, wildlife, and plants and their habitats that continue to be affected by the project
- Provide for protection, mitigation, and enhancement of aquatic and terrestrial species populations and habitats that would be affected by impacts from the development, operation, and management of the project
- Maintain and develop habitat connectivity to provide long-term plant and animal movement and dispersal
- Manage or eradicate non-native plants and animals
- Comply with state and federal laws, comprehensive plans and treaties
- Facilitate the recovery of species proposed or listed under the Federal Endangered Species Act

Issues of Concern

a) Damming the river creates a barrier to upstream and downstream fish migration, hugely limiting access to various fish habitats. Suckers historically migrated annually between spawning areas (located in river tributaries) and summer-use areas in the mainstem of the river, with some populations moving as many as 30 kilometers.

b) Reservoirs create prime habitat for invasive species like striped bass (they are often introduced for sport fishing), who compete with and eat native species.
c) Intake structures for the penstocks and other water conduits often entrain (trap) fish against the screens, adding a sometimes-significant source of mortality.
d) The razorback sucker is in serious jeopardy and without some modification in the flow regime is likely to be extirpated. There are several studies that Mountain Energy could underwrite to get needed information on this elusive species. But there needs to be some immediate protective action if at all possible while the studies are being conducted.
e) During spawning, which occurs during the spring runoff between March and May, fertilized eggs cannot survive in water temperatures below 10ºC. In the southwest, water released from reservoirs is typically colder than natural stream water. However, there may be opportunities to release warmer water by taking it from higher in the reservoir or by adjusting the flow rate.
f) Spawning occurs on cobble or gravel bars on the edge of rivers. Dams can alter the geomorphological characteristics of rivers, particularly by limiting inputs of gravel and other sediment into the stretch of river below a dam. Gravels can only be mobilized by high flow events. In addition, you are aware of other hydropower projects that have introduced gravel to below-dam stretches. Operating hydropower facilities in peaking mode can also make spawning difficult, as spawning beds may be repeatedly dewatered and then flooded.

<u>Additional Role Characteristics</u>

Before coming to the Rocky Mountains, you participated in the Penobscot River dam relicensing process in Maine where they successfully decommissioned two of a series of eight dams. You are curious if there are other dams in this watershed or within Mountain Energy's portfolio that could be decommissioned to mitigate habitat loss, if restoration isn't possible here.

Role: Deputy Supervisor, Silver Lake Mountain National Forest, U.S. FOREST SERVICE (USFS)

You are the lead representative for Lake Mountain National Forest.

Background

The USFS is a federal land management agency housed in the U.S. Department of Agriculture. USFS manages Silver Lake Mountain National Forest, where the hydropower facility is located. Under Section 4(e) of the Federal Power Act, FERC may only issue a license to a project occupying a federal reservation (or public land) if it does not interfere with the purposes for which the federal reservation was created. Silver Lake Mountain National Forest's purpose is to care for the land so that forest resources—including recreational access, habitat for animals and plants, wood for lumber and firewood, and high quality water—can be available now and in the future. Furthermore, as the primary landowner in the project area, the USFS has mandatory conditioning authority over the project and can make any recommendations it deems necessary for the adequate protection and utilization of the public's land.

Your Interests

- Assure National Forest ecosystems are sustainable, diverse and productive
- Have sites, settings, and natural landscapes that nurture societal and individual needs and values
- Ensure recreational access along the reservoir and river
- Maintain and restore riparian habitat
- Contribute natural resource outputs as available to support society's needs
- Conduct business in a manner that fosters confidence and trust of National Forest stakeholders

Issues of Concern

a) Improving river flows would increase visitation to the forest for river rafting and fishing. At the same time, keeping reservoir elevations relatively stable ensures access to the reservoir at boat ramps.
b) The river reach immediately below the dam to where the water is released from the turbines is often partially or completely dewatered and is an eyesore for visitors.
c) Cottonwood trees (*Populus sect. Aigeiros*), a cornerstone species of the riparian corridor in Silver Lake National Forest, need springtime floodwaters to germinate.

d) Dams often accumulate sediment carried from upstream, and if the watershed contains many mining or agricultural areas, the sediment often contains heavy metals, pesticides, PCPs, and other contaminants, creating a water quality concern.

Additional Role Characteristics

USFS is intent on ensuring that this process is conducted properly and is legitimate in the eyes of stakeholders, the public and FERC. If it gets off to the wrong start or key parties are not invited or choose to disengage, that will not bode well for the success of this process.

Role: Director, Longmont Office, AMERICAN WHITEWATER

While you coordinate with staff members at other regional offices to ensure a more unified approach to hydropower relicensing, you are entrusted to make the best decisions for Colorado's local rivers.

Background

American Whitewater is a national, non-profit 501(c)(3) organization that aims "to conserve and restore America's whitewater resources and to enhance opportunities to enjoy them safely." AW has a regional office in Longmont, CO. Whitewater rafting and kayaking have grown substantially in western Colorado over the last two decades. While the river is currently used by die-hard boaters who follow good flows whenever or wherever they are available, AW believes that with the right water releases and a notification system the river could be made more accessible for weekend-only boaters.

Your Interests

- Improve access to whitewater resources in the river
- Education/interpretation/outreach to the public and potential whitewater users
- Educate youth as present and future citizens who value and protect water resources and the species that depend on them
- Maintain ecological relationships in the watershed

Issues of Concern

a) To operate a hydropower facility in peaking mode, water levels in the reservoir and downstream from the dam may fluctuate significantly on a daily basis. This can create hazards for river access, as the river may flood quickly when water levels rise and then be dewatered.
b) At present, flow releases are determined by project generation demands, so whether flows are good for whitewater boating is a matter of luck. You believe that with recreation-specific releases, the river could be a great whitewater destination.
c) The recreational facilities around the reservoir and access points along the river are old and would likely not withstand a large increase in visitation.

Additional Role Characteristics

American Whitewater is convinced the Irrigation District plans to use this exercise to grab more water rights and contest any flow restrictions for environmental or recreational reasons that would decrease their allocations. You need to be sure to buttress the USFS's commitment to

improving recreational access, and can possibly also find synergies with flows required to improve fish habitat.

Role: Staff Member, SILVER COUNTY GOVERNMENT

You work directly under the county manager for Silver County and will be reporting to her with recommendations concerning the relicensing conditions.

Background

Silver County is the heart of the Silver Lake Mountain region. Its economy was once fueled by silver mining, forestry and agriculture, but declining mining and forestry sectors in the 1980s led to population declines. However, the area is currently seeing rapid growth in tourism and second home development. Commercial fishing used to be a key economic driver, but has not contributed substantially to the economy since fish runs declined in the last few decades. The Silver County Administration sees the relicensing process as an opportunity to ensure a reliable energy source for more residential growth and to develop recreational opportunities associated with the dam and reservoir to attract tourists.

Your Interests

- Help the county's economic revitalization by branding as a tourist destination and second home community
- Include the county as a major node and service center in the network of recreational facilities and linkages surrounding the Silver River
- Support license renewal and continued operation of the project (the County Commission has already issued a resolution to this effect)
- The citizens, farms, businesses, tribes, natural resources, and industry of the county benefit from the presence and operation of the dams flood control
- The project produces and distributes clean, economical hydroelectric energy to more than 60,000 homes and businesses in the county and surrounding region

Issues of Concern

a) The hydropower facility provides a cheap source of electricity to the community, likely making it more attractive for new businesses and residents.
b) The facility could serve as a tourist attraction for the community, and having the reservoir creates lake-based recreational jobs.
c) The facility negatively impacts other recreational opportunities by keeping flows too low for whitewater boating and depressing riverine fish populations.

Additional Role Characteristics

There is a growing political split in the town reflected in the five seats on the County Commission, between those seeking protection for farming and the relative newcomers who are pushing for recreational opportunities and at the same time trying to slow down development. An upcoming election may shift the balance of power from the traditionalists to the newcomers in town. The county manager has been around for 25 years and while she is the consummate professional, she is politically savvy enough to know that dragging this process out may be the best way to handle this negotiation, until the political winds settle down.

Role: Director of Irrigation Services, SILVER IRRIGATION DISTRICT

You represent the region's farmers who depend on seasonal irrigation for their crops.

Background The Silver Irrigation District, founded in 1920, provides irrigation water to the region's wheat, barley and corn farmers. The district has 150,000 acre-feet (AF) of vested water rights: 100,000 AF dating from 1920 (and therefore senior to Mountain Energy's rights) and 50,000 AF dating from 1940. The rights are fulfilled by releases from the Silver Lake reservoir via the District's intake tunnel.

Your Interests

- Receive clean, reliable and cheap water supply that meets the needs of the District, now and in the future
- Protect existing water rights
- Maintain or improve the quality of water received from the project

Impacts

a) With any reduced water allocations, the irrigation district estimates that you will likely see 5-10 farms go under (20% of the agricultural lands currently in production), as these farms can barely survive with existing conditions. This would hasten the conversion of farmlands to suburban and second home development.
b) Maintaining current water allocation rights is seen as detrimental to future production; with the continuation of the drought, crop production will almost inevitably decline.
c) Dams often accumulate sediment carried from upstream, and if the watershed contains many mining or agricultural areas, the sediment often contains heavy metals, pesticides, PCPs, and other contaminants, creating a water quality concern.

Additional Role Characteristics

The district sees this as a chance to gain additional water rights as insurance against future drought and warmer temperatures. Irrigation district members, who depend on the water as a livelihood, are adamant against trading rights for city slicker rafters and fishermen to gain. The farmers have been here for generations. That said, there is money to be made by selling their farms and moving on. The district could walk away from these negotiations and pursue litigation, where your chances of a favorable outcome are strong, given the seniority of most of your water rights.

3. Instructions for the Facilitator

Background

Silver Lake Hydroelectric Project is located on the Silver River in the Silver Lake Mountain region of western Colorado. The facility is owned by Mountain Energy, also called "the licensee." The project's current 50-year operating license, issued by the Federal Energy Regulatory Commission (FERC), is due to expire in five years. Under the terms of the Electric Consumer's Protection Act of 1986, FERC must balance between power and non-power interests in approving license requirements and must ensure that they conform to other pertinent regulations, such as the Endangered Species Act. The group's task is to develop a set of operating requirements to propose in the project's license application that you think meet these criteria and that best satisfy all parties participating in the relicensing.

You have been called in as a facilitator for these multi-party negotiations. FERC is paying for your time, and your role is to serve in a policy-neutral capacity to assist the parties as they negotiate the three decision points below.

You should become familiar with the background material and the ILP process, enough to be conversant with the process requirements and to understand the value of the decisions that need to be made. Also familiarize yourself with each of the stakeholders' background information as well. You can presume that you have talked with each stakeholder ahead of time through phone call or in person interviews. You should take care to not reveal any confidential information, but take it into account as you encourage parties to engage in the negotiations.

FERC's Integrated Licensing Process (ILP) was developed to increase collaborative engagement of the applicant with other stakeholders and agencies in order to improve relicensing decisions, reduce the overall time needed for permitting, and minimize legal challenges.

You have no direct substantive stake in the outcomes. However, professionally, you would like to see the negotiations succeed and come to resolution over the decisions that need to be made.

Work with the class instructor to prepare the agenda for the available time for this simulation. The minimum recommended time would be 5-6 hours of play plus debriefing. The simulation could run for a full day or 2-3 class periods over a number of weeks. The agenda should be based on creating time for reaching the decision points below. The instructor has several sample agendas with recommended time allocations for each stage.

Introductions and Agenda

Start the meeting by introducing yourself and who you work for, establishing your impartiality and your experience. Then review an agenda, emphasizing the three different collective decisions the group is being asked to make, and allocate the time that should be spent on each decision. Ask everyone to go around and introduce themselves and briefly explain why they are here at the meeting.

There will be easels and paper to write on; you might want to come to the classroom a bit early to make sure that they are set up as you would like. Throughout the day, think about what information (such as an agenda or ground rules) should be posted. You should also use the easels to capture stakeholders interests and the course of the negotiations.

Setting Ground Rules and Decision Rules

You can provide a few ground rules and ask the group to add to them, or have the group generate the ground rules from scratch. Ground rules should cover how stakeholders interact. Decision rules will be important as well. Here you can ask the group how they want to make group decisions: 100% consensus (all thumbs up or down); modified consensus (where participants rate their support of a decision on a 5-point scale and a preset percentage of the group has to be above a certain level); majority or super-majority vote; or a minimum block rule (e.g. at least two stakeholders can block a decisions). Unanimous support should be sought when approving both ground rules and decision rules.

Stage 1: Generating Scope of Potential Project Impacts

What resources are potentially being affected by the project or its operations?

Generally, the licensee suggests resources (including aquatic species, water supply, water quality, economics, recreation, and cultural/historic resources) that might be affected by the project and what the effects might be. The other parties then negotiate additions or edits to this list. The list of impacted resources determines the scope of what studies can be done and therefore what resources will be addressed in the final license. The initial negotiation focuses on delineating these potential resource impacts.

- It may be helpful for the licensee to speak first here (as you list responses on the easel paper, with room between lines to amend/add as needed) and then ask each stakeholder to add/edit the list. When the topics are complete, you might want to do a second round of clarifying and getting more specific about the nature of the potential

impacts. Consider creating a table with the headers: Resource----Nature of Potential Impacts

- You will want to discourage the stakeholders from arguing the extent of the impacts that would come later after studies are conducted.

The full list of resources potentially impacted by the dam relicensing proposal that stakeholders may raise:

Resource	**Participant**
Electricity Generation	Mountain Energy, Silver County
Razorback Sucker Survival	U.S. Fish & Wildlife Service
Water Temperatures & Gradients	U.S. Fish & Wildlife Service
Recreation: Whitewater Boating	American Whitewater, Silver County, U.S. Forest Service
Recreational: Reservoir	Silver County, U.S. Forest Service
Irrigation Rights and Capacity	Irrigation District, Silver County
Sediment/Gravel Deposition	U.S. Forest Service, U.S Fish & Wildlife Service
Riparian Habitat Conservation	U.S. Forest Service, U.S. Fish & Wildlife Service
Economic Stability/Development	Silver County, Irrigation District

Stage 2: Determining Needed Studies

What studies need to be conducted to assess project impacts on those resources?

This negotiation focuses on what studies (and specifically which scientific methodologies) are needed to best assess project impacts. Therefore, you will want to start with a specific resource area and the impacts mentioned previously and ask: what do stakeholders need to know about the potential impacts and how would they determine the answers? As an example, studies quantifying a facility's impacts on a fish species could include a tagging study to see how many individuals are in the system, habitat modeling to see how potential habitat varies with flow/temperature/velocity, or a literature review to assess the stressors on fish in the entire river system. Each study carries a somewhat normative stance, as mapping actual population numbers over time often makes the impacts of the project look much worse than simply predicting available habitat.

- As you record this discussion on the easel paper, group the studies into different basic impact areas - hydrology, fish, economic development, etc.

To begin, have stakeholders suggest as many studies as they deem necessary and get them all listed. Then tell them that the consulting firm has informed you that, given the timeframe, they only have the staff and funding available to conduct seven studies, one of which will be the

Project Operations Model. Ask the group to decide which six other studies to choose and use the decision rule to assure the group comes to agreement on the seven studies to be conducted. If you are short on time, ask them to discuss the criteria they would use to decide which studies to prioritize.

Stage 3: Develop Negotiating Strategy

What do study results suggest would be a useful operating regime to minimize project impacts on the resources of most concern to you?

- Prepared study results for expected studies are available in the Study Results handout. Note that these will likely not correspond exactly to the seven studies stakeholders negotiated. This is intentional, so students recognize the constraints of working in a federal process with constrained resources. However, if you are running the negotiation over several days, you are welcome to work with the instructor to create results for any studies you wish.

This stage enables stakeholders to consider the implications of the study results they will be given. The studies provide data, such as counts of a particular species in the basin or maps of the river's geomorphology. The stakeholders then digest this information to propose management plans and flow regimes to mitigate impacts. These can be construction projects (e.g., restore a stretch of river or build a campground and boat ramp to increase recreational access) or a specified operating plan (how much water will be released from the dam and when in order to provide fish spawning habitat, whitewater rafting, power production, water supply, etc.). During this stage, stakeholders begin developing their negotiating strategy for Stage 4. This may include holding caucuses with other stakeholders to determine common interests and consider how they might modify their positions or consider building coalitions.

- Depending on the time allotted, you can either hand out the study results and leave the stakeholders to digest them on their own, or you can start the session by explaining the study results to the full group and then have them break up into their stakeholder subgroups.

Stage 4: Developing Management Plan Options

Based on what we know now, what operating requirements do you recommend to FERC?

This is the meat of the relicensing process- engaging the diverse stakeholders in reaching agreement on a management plan recommendation. During this final stage, participants work to develop a single package they propose to FERC (who will accept it, reject it, or accept it with modifications, based on review of the application to ensure that it is science-based and meets

all relevant federal and state regulations). It is in most parties' interest to reach full agreement; otherwise FERC may be less likely to take everyone's interests into account in finalizing the final license conditions.

Have the group start with brainstorming (all ideas count, no judgments, etc.), then before you let people dig deeper into each option, spend some time having them come up with criteria for how they will select among the options (e.g., address everyone's needs to some extent, assure some particular function, be based on best available data, etc.). If time is available, ask them to clarify each proposal, discuss pros and cons, refine if possible, before moving on to the next option. As they move through ideas, encourage students to think about potential synergies between management solutions (can they meet two resource goals with a single management option?).

- Don't make short shrift of this stage. Work hard to leave sufficient time for the negotiation. If necessary, shorten stage 2 or 3 to be sure there is time to enable this negotiation.

4. Stakeholder Worksheets

FERC RELICENSING WORKSHEET 1: ROLE PLAY PREPARATION

After reviewing all materials provided for the relicensing simulation, please prepare answers to the following questions prior to the first stage of the negotiation.

1. What are your organization's interests?

2. How might the dam's operations affect those interests?

3. How would you define success for your organization by participating in the relicensing process? What outcomes would you like to see in an ideal world, and what outcomes do you think you can realistically expect?

4. What sources of power or influence do you have that can help you at the table (e.g., regulatory authority, information, political influence, etc.)?

5. Are there better alternatives for you than participating directly in this relicensing process (i.e., your BATNA)? What outcome could you reasonably expect if you chose not to participate in the negotiations?

FERC RELICENSING WORKSHEET 2: STAKEHOLDER POSITIONS & INTERESTS

	YOU	**Other Party: _____**	**Other Party: _____**	**Other Party: _____**	**Other Party: _____**	**Other Party: _____**
Position *(Desired best outcome/solution*)						
Interests *(Underlying baseline needs)* Order by importance						

FERC RELICENSING WORKSHEET 3: STUDY NEEDS

1. What available information can you draw on to determine how your interests would be affected?

2. What else would you need to know to determine how your interests would be affected?

3. What kind of studies would you want to commission to get that information?

4. Once you had those study findings, what would be the basis or criteria you would use to determine if your interests would be adequately met or in jeopardy?

FERC RELICENSING WORKSHEET 4: NEGOTIATION PREPARATION

Now that you have the study results, complete the following worksheet before commencing Stage 4 of the negotiation.

1. Review worksheet 2. Now re-state your interests more specifically and prioritize them.

2. Which stakeholders have significantly different, if not opposing, interests? Is there anything you could do or offer that would reduce their opposition to your getting your interests met?

3. Do any of the other stakeholders have potentially overlapping interests? What are they? How are they similar and how are they different? How might you approach them about a coalition?

4. How do you think each of the potential management approaches presented in stage four could affect your interests? Are there other stakeholders that might also benefit from that management approach?

5. Study Results Summary

Due to an unforeseen drought and a federal sequestration of agency funds, the engineering consulting firm hired to conduct your requested studies was forced to reprioritize in order to complete the studies in the required timeline. They were able to complete four studies: the project operations model, the fish habitat model, the recreation current use survey, and the economic impacts of irrigation study.

Project Operations Model

The project operations model depicts reservoir levels, instream flows, electrical generation, and irrigation deliveries for the Silver Lake Hydroelectric Project, using data from the last 30 years. Key results from the model are:

- The existing turbines generate electricity most efficiently at flows between 200 and 400 cfs. They are capable of generating at flows between 50 and 500 cfs.
- The average annual value of electrical generation is $25.6 million.
- In an average water year, the inflow to the project is slightly higher than outflow (both to the river via the powerhouse and to irrigation deliveries). This allows the project to store excess water for use in dry years. In wet years, the dam often spills, meaning that excess water is released via an emergency outlet rather than through the powerhouse (to avoid overtopping the dam).
- In a dry year (which occur approximately 30% of the time), inflows average 50 cfs in winter, 400 cfs in spring, 300 cfs in summer, and 100 cfs in fall.
- In a wet year (which occur approximately 20% of the time), inflows average 500 cfs in winter, 5000 cfs in spring, 1500 cfs in summer, and 800 cfs in fall.
- The irrigation district received its senior rights of 100,000 AF in all years. However, during the 6 driest years, they did not receive their full 50,000 AF of junior rights, as there was not enough water to maintain the 50 cfs instream flows and not draw the reservoir down below its minimum level.[3]

Fish Habitat Model

Drawing on existing razorback sucker population data from the Silver River and populations in nearby rivers, the fish habitat model found the following results.

[3] Irrigation deliveries take place from a separate outlet in the reservoir (upstream from the dam and powerhouse), and therefore do not count toward the 50 cfs minimum instream flow.

- Spawning takes place during spring high flows (March-May). Adult females lay eggs on cobble bars along the river edge. These cobbles are abundant at flows between 300-600 cfs. At lower flows, the water is not deep enough for spawning; at higher flows, the eggs are sometimes scoured away.
- The best quality habitat for juvenile razorback suckers is floodplain wetlands, which occur when high flows overtop sections of the riverbank. These wetlands are warm and slow moving and allow for optimal growth. According to the models, floodplain wetlands begin to occur at 400 cfs, are prominent between 600 and 1000 cfs, and optimal above 1000 cfs. It is uncertain whether juveniles can successfully mature without these floodwater conditions, but the models suggest that similar flows and water temperatures could be achieved in river at 100-150 cfs. [From previous studies on razorback sucker, juveniles are known to need protected habitat between May and July.]
- Adults, which are present in the river year-round, prefer relatively mild currents (but higher than the current minimum instream flows), with habitat quality peaking at 500 cfs.

Recreation Current Use

The current use survey targeted fishermen, boaters, campers, and other recreationalists who were using the reservoir and the river reach up to 10 miles below the dam. The survey took place on three days to try to capture variation over the summer: June 15 (a Tuesday), July 3 (a Saturday), and August 14 (a Saturday).

- Visitation was split, with 60% of respondents saying they only planned to visit the reservoir, 30% saying they only planned to visit the river, and 10% planning to do both.
- The predominant activity along the reservoir was camping (85% of respondents along the reservoir). Most campers were families from Silver County, although a portion (~20%) came from elsewhere in Colorado. Other popular activities were fishing (60%), boating (50%), and jet skiing (30%).
- Along the river, popular activities were kayaking (65%), rafting (20%), and fishing (15%). Most people visiting the river were from counties neighboring Silver County. 20% were families with children, and the rest were solo adults or groups of friends.
- Visitation was the highest during the 4th of July holiday, with 1300 people estimated along all stretches of the project. 300 people were visiting on June 15, and 800 on August 14.
- For the two weekend surveys, 95% of visitors were staying for the weekend (Friday to Sunday). For the mid-week survey, about half of the respondents were in the area for a single day (as part of a larger vacation) and half were staying for two or more nights.

- 54% of the respondents said they visited the Silver Lake/River multiple times (often once per month) each summer, and sometimes visited during other seasons as well. For the remaining 46%, this was their only trip to the area for the year.
- When asked what they liked about coming to Silver Lake/River, the most popular responses were that it is beautiful (75%), relaxing (60%), has opportunities for adventure (40%), is uncrowded (40%), offers a variety of activities (30%), and is family friendly (30%).
- One-quarter of visitors had rented camping and/or boating gear from shops in Silver County. 85% of visitors had purchased gas, food, or other supplies in the County during their visit. The average visitor spent $100 per day spent in the County.
- First-time visitors to the area had heard about Silver Lake/River by word of mouth (50%) or from online travel blogs (30%).

Economic Impacts of Irrigation

This study uses an agricultural production model to estimate the economic value of irrigation water, based on data from the last 30 years of production in Silver County.

- For wheat and barley, the average crop value was $850/acre (for a yield of 4.25 tons/acre). The average water use per acre was 2 acre-feet. In Silver Lake Irrigation District, there are 12,000 acres currently producing wheat and 6,000 producing barley.
- For corn, the average crop value was $1200/acre (for a yield of 27.8 tons/acre). The average irrigation input was 3.5 AF per acre. There are 8,000 acres currently producing corn.
- In hot, dry years, irrigation water applications (to maintain the same yield) increase to 3 AF for wheat and barley and 5 AF for corn. Because the Irrigation District does not have enough water to meet these demands, fields are often fallowed during droughts.
- Farmers currently pay $9.80 per AF delivered by the Irrigation District; the District uses this income to maintain its infrastructure.
- In addition to the direct value created by crops, the irrigation water is estimated to directly support 2,000 jobs in on-farm labor and indirectly support 1,000 service jobs. (The total population of Silver County is 6,000.)

6. Glossary of Terms and Units

Acre-foot (AF) – a common volumetric measure of water. It is the amount of water that would cover an acre of land one foot deep. It is equivalent to 43,560 cubic feet or 325,851 gallons.

Basin – the land area that is upstream of a particular point along a river. In theory, a drop of water falling anywhere in the basin should make its way over land and eventually into the river channel. A basin is also called a **watershed** or **catchment**.

cfs – cubic feet per second. A common measure of **flow** rates in the United States.

Dam – a barrier to obstruct the flow of water. Behind the dam, the water's level is raised; the difference in elevation between the reservoir surface and the river creates potential energy. Dams are often made of concrete or earth.

Flow (sometimes referred to as **instream flow**) – the amount of water flowing in a river or other channel. It is measured in units of volume per time (how much water flowed past a specific point in the river over a given timespan); the standard unit in the United States is cubic feet per second or cfs.

Geomorphology – the study of the earth's topography (above ground surface elevation and slopes) and bathymetry (depths of land under water) and how they change as a result of chemical, physical, and biological processes.

Hydrograph – a graph depicting flow rates over time moving past a particular location.

Hydropower – energy generated by capturing the force contained in flowing water. Hydropower is a renewable energy source and produces minimal amounts of greenhouse gas emissions.

Irrigation – the application of imported water to agricultural crops. It stands in contrast to agriculture that receives its water entirely from rain or from groundwater.

Peaking – an approach to operating a hydropower facility such that electricity is generated to respond to changes in electrical demand over short-term time scales. The amount of water released through the powerhouse (and resulting in instream flow) is adjusted based on short-term forecasted demand.

Reservoir – the water impounded behind a dam.

Run of river – a hydropower facility that generates electricity based on how much flow is in the river upstream of the facility. Run-of-river facilities often lack storage dams, instead responding to the natural flow of the river. However, storage facilities can be operated such that they release the same amount water flowing into the reservoir out of the turbines or other outlets.