Introduction
This document represents the efforts of Nature Conservancy staff from Kentucky, with technical assistance from the Virginia and Tennessee Chapters. This Conservation Business Plan will guide The Conservancy’s (TNC) strategies and internal and partner collaboration to address major freshwater conservation challenges for the Green River Basin. This Conservation Business Plan is meant to create a formal structure for TNC staff, identify 10-year desired conservation outcomes, high priority basin-scale strategies, and implementation recommendations (resource, capacity, annual work plans) to advance this work in the next 5 years. The ultimate goals of TNC’s conservation planning and adaptive management approach are to support development of more effective strategies, better decision-making, improved return on investment, increased credibility, transparency, and accountability as practitioners and as an organization.¹

With this plan, we seek to elevate our focus from the Upper Green River Community Based Project area to a focus on the health and resilience of the entire Green River Basin, a globally-important natural system. A system may be resilient at a basin-scale, even as individual sites succumb to disturbance, by leveraging conservation to secure enough of the underlying ecosystem processes to ensure resilience to changes distributed across space and time. Additionally, opportunities for greater impact, efficiency, and flexibility emerge for operation at multiple, linked spatial scales. Demonstrations of on-the-ground practices, concepts, or tools in targeted locations can be leveraged, through economic and policy instruments to replicate solutions at the necessary pace and scale to achieve desired conservation outcomes. All of this conservation effort will lead to a healthy resilient system providing the needed resources for human use and enjoyment into the future.

The Green River Basin Project fits exceptionally well into the Conservancy’s “Global Challenges – Global Priorities” conservation framework, which is focused on effective resource use in order to contribute priority solutions (protecting & restoring natural systems, using nature sustainably, and broadening the constituency for conservation and strengthening our effectiveness) to the most significant global challenges (conserving critical lands, securing freshwater, restoring our oceans, and reducing the impact of climate change) (Figure 1).

Conservation of the Green River Basin must address conservation of critical riparian and karst lands, securing sustainable provision of adequate quality and quantity of freshwater and resiliency of the basin in the face of climate change, as well as Green River basin impacts to the larger Ohio River system, draining into the Mississippi River system (eventually flowing into the Gulf of Mexico).

The Green River Basin Project is clearly focused around protecting & restoring natural systems, as this basin includes some of the most unique and at-risk natural systems in the world.

¹ Appendix A provides brief overview of The Nature Conservancy’s Conservation Business Planning approach; See also: https://www.conservationgateway.org/ConservationPlanning/BusinessPlanning
tied to critical freshwater and karst systems and habitats. Using nature sustainably, through strategies around policies and practices, will play an enormous role in determining the extent of our success as we work with partners toward improving land management practices and conservation funding in the coming years. Broadening the constituency for conservation through people will be an inseparable part of our project efforts, as we seek to build a broader base to help support conservation initiatives. And finally, we will seek to improve our performance and organizational efficiency; the very existence of this Plan represents a big step forward in that regard.

**Making the Case**

The Green River Basin of Kentucky and Tennessee is ranked 4th in the southeastern US for global aquatic diversity and the most biologically-rich branch remaining of the Ohio River system, supporting more than 70 freshwater mussel and 150 fish species, as well as tremendous karst system diversity. Although its upper headwaters are impounded, the Green River flows unhindered for an approximately 125-mile stretch, where the greatest aquatic diversity is concentrated, through eight counties and Mammoth Cave National Park, the world’s largest cave system. Because of its great size and abundance of small, specialized habitats, the Mammoth Cave system supports one of the world’s richest collections of cave species. As of November 2012, there are 11 federally-listed freshwater mussels within the Green River basin, along with the Kentucky cave shrimp, and both the Indiana and Gray bat. There are also 2 additional proposed and 12 additional petitioned species for listing within the basin at this time.2 So, while the Green River Basin is clearly an extremely rich system, numerous species within the basin are globally imperiled with a need for protective measures and proactive management.

Not only is the Green River Basin a globally-important biodiversity resource, but the rivers and sinking streams provide clean drinking water, recreation, ecotourism, flood control, sustainable agriculture, and power reliability for 630,000 people that live in the basin. Fishing, hunting, and wildlife watching activities within the entire basin provide tremendous economic benefits (estimated in 2011 at ~$200, ~$330, and ~$225 million dollars annually, respectively3). However, nature’s continued provision of adequate quantity and quality of freshwater resources is not guaranteed for future generations. This unique freshwater basin is at risk to change dramatically over the next 50 years due to compounding threats of residential, industrial and commercial demands for water, inputs of excess nutrients, sediment, and contaminants due to ecologically-incompatible land management practices, riparian forest conversion, and potential volatile flood cycles/extended drought periods due to climate change. Traditional land protection alone is not enough to guarantee the future health of the Green River system.

The Nature Conservancy is uniquely positioned to play a major role in Green River Basin conservation in the years to come. TNC works across multiple spatial and operational scales and can bring essential capacity and expertise in science-based land management, restoration, stakeholder and partner-engagement, landscape-scale conservation analyses and planning, and government relations support to guide efforts toward achieving multiple objectives. TNC and its partners can build on 15 years of successful work in the Upper Green River, and can expand, replicate and leverage existing programs or pilot projects to influence land management, policy, and program implementation decisions that will support conservation of a resilient, connected, diverse Green River Basin in the coming decades.

**Plan Scope**

The Green River Basin, with a drainage area of 9,230 square miles, is located in west-central Kentucky with a small portion in north-central Tennessee. Thirty-one Kentucky counties have lands which fall entirely or partially within this basin. Topography in the basin varies from east to west, gently rolling in the east, to moderately-rugged western Kentucky coalfields, and extensively broad and nearly flat.

---

3 Brian Clark, Assistant Director of Public Affairs for KDFWR. May 23, 2014 email communication.
alluvial floodplains at the Green River- Ohio River confluence at the far western extent of the basin near Henderson, Kentucky.

The basin is divided into six hydrologic units (HUC-8); the Upper Green, Middle Green, Rough River, Pond River, Barren River, and Lower Green) (Figure 2). For the past 15 years, TNC’s area of focus has been on the portion of the Upper Green subwatershed with highest known aquatic biodiversity (Figure 1). Without doubt, widening our vision and work from the Upper Green sub-basin to conservation of the entire basin represents an aggressive and ambitious expansion! However, we believe taking a basin-wide approach is the correct scope for several important reasons:

- Research has shown impressive freshwater biodiversity within the Green River extends well downstream from the Upper Green region.
- The Green is an important tributary to the Ohio River with potentially significant impact therein and on to the Mississippi River.
- Recent spatial analysis tools, developed by TNC as part of this planning effort, can help us (and our partners) better focus and prioritize work within this large region.
- We can build upon our excellent track record of working successfully with partners within Kentucky as we seek to expand the scope of conservation work into the basin as a whole.
Vision for Conservation Success in the Green River Basin

Our Conservation Vision for the Green River basin, developed with key stakeholder input as part of The Conservancy’s conservation planning process, is illustrated below:

Desired Ultimate Conservation Outcomes

Specifically, we seek to ensure:

- Effective conservation of the Green River Basin, by ensuring the ecological processes (hydrologic, sediment, and nutrient regimes) influencing river and stream habitat conditions are within their natural range of variation. It is our assertion that restoration and/or maintenance of these ecological processes will lead to improved floodplain, wetland, tributary, and mainstream habitats and result in improved long-term basin-scale resilience.

- Sustained nature’s benefits (clean drinking water, flood control, energy/power reliability, sustainable agriculture, and recreation) essential for continued community well-being, economic growth, and prosperity for future generations.

Situation Analysis

Priority Impediments to Conservation Success

There are many challenges facing the Green River Basin which must be addressed or acknowledged in order to achieve conservation success. Full details related to Situation Analysis results from TNC’s Conservation Business Planning process are presented in Appendix A. Among these many challenges, the following basin-wide impediments have been identified:

- Lack of Shared Conservation Vision- The lands and waters within the basin are not collaboratively and cohesively managed for long-term resilience and sustainability. Several influences are at play here, including: varying levels of interaction and cooperation among local, regional, state, and federal land...
and water agencies, differing goals and objectives amongst these and ancillary stakeholders, and continually shifting politics surrounding conservation initiatives.

- **Increasing Pressure from Multiple Uses and Competing Resource Needs** - Human pressures for the natural benefits provided by the Green River basin are ever-increasing (e.g., flood control, water supply, natural resource extraction, recreational opportunities, agricultural production, etc.), sometimes with dependence upon obsolete infrastructure which present challenges to freshwater conservation initiatives. Concurrently, as the “gallons per day” demand from the waters of the basin increases in future years, incompatible land use practices may negatively impact both the quality and quantity of water within the basin without careful thought, planning, and cooperation amongst a diverse group of stakeholders.

- **Challenges Relating to Funding, Capacity, and Policies** - Funding for conservation initiatives in Kentucky have been inconsistent at best, and unfortunately has been on a downward trend in recent years. Kentucky lags behind neighboring states in conservation spending, ranking sixth out of seven neighboring states for the 1998-2008 time period. Compounding this already-significant problem, available funding is not necessarily prioritized and targeted in a collaborative, holistic manner. Organizational capacity is intrinsically linked to funding in many cases; many conservation agencies and organizations within Kentucky “know what to do,” but lack the capacity to implement landscape-scale conservation initiatives and best management practices. We must find a way to direct meaningful attention to securing lasting funding, policies, and capacity to implement and enforce conservation outcomes.

- **Complacency about Water Quality and Quantity** - Kentucky is well-blessed with freshwater resources, with over 90,000 miles of freshwater streams throughout the state. Thousands of stream-miles are classified as impaired, and Harmful Algae Blooms (HABs) in the four large Green River Basin lakes are becoming more frequent and troubling occurrences. In addition to these above-ground water quality issues, there is the karst component (structure of sinkholes, caves and underground drainage systems) within the basin, which is critical to the health of the Green River. Even more so than surface water, underground karst water resources are often literally “out of sight, out of mind” for residents and policymakers alike. A consistent, convincing basin-wide case for the importance of sustainable water quality and quantity must be made to ensure freshwater resources are valued and protected.

Within this challenging context, the Green River core planning team has identified specific risks (or “potential sources of stress”) to the Green River Basin that could inhibit progress toward desired ultimate conservation outcomes. Identified risks were grouped into four overall categories: Human Footprint, Agriculture, Resource Extraction, and Physical Barriers or River Alteration. All risks were carefully considered with regard to the scope and level of potential impacts, and ranked with staff and partner input. All risks were classified as a Low, Medium, High, or Very High level of risk. Without careful planning, policy-making, and implementation of risk-abatement conservation strategies, the following high priority risks could severely degrade the health, condition, and/or resilience of freshwater resources and thus, the sustainability of nature’s benefits in the next 10 years (Appendix A).

- **Ecologically-Incompatible Agricultural Land Use Practices** - While agriculture is critical to our economy and communities, certain practices can pose risks to freshwater resources. Examples of such risks include farm practices that result in the conversion/loss of forested riparian buffers along the main stem of the Green River and associated tributaries. These forested buffers provide critical bank stabilization, cooling shade, riverine habitat, and organic detritus that serve as the foundation for the aquatic nutrient cycle. Other risks include ecologically-incompatible tillage practices in highly erodible soils, excessive chemical and nutrient inputs that make their way into freshwater via sediment losses and/or karst drainage, loss of wetlands and floodplain connectivity, and other livestock and row crop production methods that do not adhere to conservation best management strategies.
practices (BMP’s). Simply put, Best Management Practices are farming methods that assure optimum plant growth and minimize adverse environmental effects.

- **Physical Barriers or River Alteration** - Risks in this category relate to the four large lake dams within the basin, and also six smaller lock and dam structures located on the main stem of the Green and Barren rivers. These structures present risks to the freshwater resources of the basin by altering the natural flow regime, associated with altered river hydrology, connectivity, nutrient and temperature regimes, and (unintended) municipal dependence upon artificially-created river pools. With regard to dams both large and small, better operational practices associated with these structures (and in some cases removal of obsolete structures) can help reduce the risks to freshwater resources and ensure sufficient quality/quantity of water for future generations.

- **Ecologically-Incompatible Residential and Commercial Development** - These are risks associated with human settlements or other non-agricultural land uses with a substantial footprint (e.g., housing, urban, commercial, industrial, etc.), especially in riparian areas and the karst region of the basin. Land use conversion away from natural land cover in the riparian and karst areas results in greater percentages of impervious surfaces, often leading to altered ecological processes, and excess chemical/nutrient inputs. Existing and future development can be upgraded and designed to be more compatible with natural resource conservation.

- **Ecologically-Incompatible Mineral Resource Extraction** - Risks are associated with both current and legacy mineral extraction activities in priority aquatic, karst, and wetland habitats in the western coalfield region of the Green River Basin. Certain legacy mine impacts and current mineral extraction practices (primarily large-scale surface coal mining) can result in significant and long-lasting impacts to water quality, habitat, and terrestrial and aquatic communities, including elevated levels of dissolved solids, conductivity, contaminants, erosion, and sedimentation, and direct loss of headwater streams, interior forests and connectivity, altered hydrology, and related biotic effects. TNC Central Appalachian Whole System staffs have engaged in efforts to reduce mining impacts recently in Tennessee, Virginia, and West Virginia via varying strategies. Recently, The Conservancy completed an Energy Impacts Analysis, predicting future energy development potential and identifying priority areas to employ future energy development risk abatement strategies. To abate risks to priority areas due to legacy or active mining, our strategies focus on: (1) shaping energy development (engaging with industry, policy-makers, and regulators) to avoid, minimize, and effectively offset impacts of this development in critical places, and (2) protecting and restoring critical lands to improve protection, management, and restoration objectives and outcomes.

**Enabling Conditions for Conservation Success**

In response to these risks and challenges, there are enabling conditions that give The Conservancy and its partners traction to engage meaningfully with major players, and leverage to implement actions that can be supported and adopted by essential partners. These include:

- **Increased Public-Private Conservation Partnerships** - Virtually the entire Green River Basin falls within Kentucky. While this may be a disadvantage in particular instances, we believe this is an opportunity for conservation success. A number of key state, federal, academic, and other partners already pursue conservation work and/or associated research within the basin. In addition, there are companies, foundations, and individuals looking to provide philanthropic support for science-based, practical Green River conservation activities. TNC is uniquely positioned via our relationships with many of these current and potential conservation partners within the basin to work towards a collaborative, broader ecological approach to conservation planning and implementation better supported through public-private partnerships.

- **Funding** - Dedicated conservation funding has always lagged in Kentucky as compared to other southeastern states and Kentucky’s neighbors, a condition which worsened during the recent economic recession. However, funding opportunities do exist. The Conserve Kentucky coalition and other conservation supporters continually make a strong case for increased conservation funding and associated legislative advancements. With improving economic conditions and stable to increasing
public support for conservation initiatives, it is not unreasonable or unrealistic to expect progress on this front in the coming years, so long as we and our partners keep making a strong case for conservation and its linkage to the health and well-being of Kentucky communities. In addition, there may be existing funding sources already available for conservation within the basin that are underutilized. For example, the Recovery Land Acquisition (RLA) program has been tapped in other areas of the state, but not in the Green River Basin. Conservation funding already in place and intended to promote agricultural best management practices and associated conservation work could be put to work in a more focused manner in key parts of the basin.

- **Spatial Analyses and Prioritization for Conservation Implementation**- Through this business planning process, TNC has completed a spatial analysis for the Green River Basin, collectively mapping ecological priorities and risks from multiple data sources, allowing analysis of lands and waters of the basin, based on their potential contribution to habitats of imperiled biota, and overall basin hydrologic, sediment, and nutrient cycles. The results of this model can be used by TNC and partners to more effectively and collaboratively target on-the-ground practices and funding (e.g., protection, restoration, and risk abatement) to those of greatest ecological need (see Appendix B for more details).

**Key Stakeholders**

The Conservancy’s role in the Green River basin is to provide vision, facilitate communication, ensure that conservation work capacity is effectively employed to good measure, and introduce and demonstrate the application of innovative science-based conservation tools to all key stakeholders. We also must advocate and build support for reasonable policy initiatives, regulations, and rules that protect the natural resources within the basin. In order to achieve conservation success, we need to continue to engage with and account for the needs of priority external major players and their respective constituencies. Within the Green River Basin, there are numerous stakeholders with varying degrees of influence and interest in our vision for conservation success in the region. In order to help us determine priority stakeholders (those that are most important to engage, inform, and involve in our planning and implementation efforts), we sought input during meetings with conservation partners, and also assessed potential stakeholders during a Green River Summit which was held in February 2014. While we clearly understand any such list will never be all-inclusive, identified primary stakeholders within the Green River Basin include:

**Key State Partners:** Kentucky Division of Water (KDOM), Kentucky Department of Fish & Wildlife Resources (KDFWR), Department for Surface Mining, Reclamation and Enforcement (DSMRE), Kentucky State Nature Preserves Commission (KSNPC), Kentucky Division of Forestry (KDOF), Kentucky Division of Conservation (KDOC), Kentucky Department of Travel, Kentucky Transportation Cabinet (KYTC), Kentucky State Parks, Kentucky Department of Agriculture (KYAGR), University of Kentucky Cooperative Extension county offices, Kentucky Association of Conservation Districts (KACD) and county Soil & Water Conservation Districts (SWCDs), Kentucky Heritage Land Conservation Fund (KHLCF) Board, Kentucky Natural Lands Trust (KNLT)

**Key Federal Partners:** United States Army Corps of Engineers (USACE), Farm Services Agency (FSA), Natural Resources Conservation Service (NRCS), National Park Service (NPS), United States Geological Survey (USGS), Environmental Protection Agency (EPA), United States Fish & Wildlife Service (USFWS), Office of Surface Mining Reclamation and Enforcement (OSMRE)

**Other Key Partners:** Kentucky Waterways Alliance (KWA), Kentucky League of Sportsmen, Conserve Kentucky, KCJEA-Association of County Judge Executives, Area Development Districts, Bowling Green Municipal Utilities (BGMU), Kentucky Agricultural Council (KAC), Kentucky Farm Bureau (KYFB), Kentucky Corn Growers Association (KYCGA), Kentucky Cattlemen’s Association (KCA), Kentucky Coal Association (KCA), Kentucky Rural Water Association (KRWA), Ingram Barge, Crounse, Brown-Forman,
Big Rivers Electric, BG Industries, Cargill and other Ag Seed Businesses, American Rivers, American Farmland Trust (AFT)

Internal Partners: Tennessee and Virginia Field Offices (TNFO, VAFO), Central Appalachian Whole System Energy by Design team, North America Freshwater Group, Central US Division Ag Team, Great Rivers Partnership, Sustainable Rivers Program, Mitigation Learning Network, Mississippi River Whole System (ORB Sub-basin), Farm Bill Liaison

Theory of Change
Conserving a diverse, resilient Green River Basin is certainly a long-term commitment. This Plan establishes meaningful strategies and goals over the next 5 years to ensure that we are moving in the right direction toward achieving our desired ultimate outcomes and vision for the basin. In the Green River Basin, our theory of change (explanation of how and why identified conservation strategies will achieve intended outcomes) rests firmly on the idea that behavioral change at a meaningful scale is necessary to support our outcomes. The Nature Conservancy’s contribution to behavioral change among our partners and key stakeholders will rely on our ability to generate actionable science-based information and then to facilitate strategic collaboration among diverse groups of stakeholders to apply and demonstrate these results on-the-ground as we implement identified priority Green River Basin conservation strategies. By working collaboratively, we can leverage expertise and lessons learned to replicate successes at multiple and increasing scales, large enough to address the scope and magnitude of today’s conservation challenges and to support the species, communities, and ecosystem processes and functions that will protect biodiversity and support people’s well-being now and into the future.

Conservation Strategies
Through TNC’s Conservation Business Planning process, the Planning Team, key partners and stakeholders identified nine potential Green River Basin FY15-19 conservation strategies, grouped into five overarching strategy categories (Table 1):

- Restore ecological processes, connectivity, and resilience in the Green River Basin altered by physical barriers (i.e., large lake dams and locks and dams).
- Reduce the footprint of ecologically-incompatible agricultural practices in critical riparian and karst areas of the Green River Basin.
- Improve karst landscape management practices in critical karst drainages.
- Conduct priority land protection, restoration, and partner engagement efforts, prioritized by potential sub-basin-scale impact to freshwater resources and potential linkages to human welfare and nature’s benefits.
- Abate risks from ecologically-incompatible legacy and current mineral extraction activities to critical Green River Basin areas.

While we recognize that additional strategies are likely necessary to ensure conservation success for the Green River Basin, this list represents the Planning Team’s recommendations for strategy engagement in the next 5 years in order to make significant progress towards achieving desired ultimate conservation outcomes and risk abatement to the basin. These strategies were chosen based on their potential contribution to achieving goals, considering enabling conditions and challenges for success, key stakeholder interests, feasibility, and leverage potential. Appendix C provides an overall theory of change diagram, as well as individual strategy background details, intermediate outcomes, spatial focus areas (where applicable), and theories of change. This list does not necessarily represent all strategies that have been “selected for action,” as an analysis of required versus available TNC and partner capacity and resources is necessary to determine the realistic level of engagement for determined priority strategies.
Table 1. Identified Strategies and related Action Steps for potential implementation in FY 15-19.

<table>
<thead>
<tr>
<th>Overarching Strategy</th>
<th>Strategy</th>
<th>Action Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Restore ecological processes, connectivity, and resilience in the Green River Basin (GRB) altered by physical barriers (i.e., large lake dams and locks and dams).</td>
<td>A. Collaborate with Sustainable Rivers Program (SRP) to incorporate ecological goals into large lake dam operations and management.</td>
<td>I.A(1). Increase collaboration with SRP to share successes and lessons learned, and to solicit expertise related to improved dam management and barrier removal strategies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I.A(2). Collaborate with SRP to determine opportunities and submit priority WRDA funding proposals annually (February deadline).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I.A(3). Continue to engage with USACE to implement environmental flows in dam re-operations at all 4 GRB lake dams and support efforts to monitor effects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I.A(4). Work with USACE to identify and secure funding for flood easements or acquisition of priority parcels preventing implementation of desired dam outflows downstream of 4 GRB lake dams (due to existing or future risk of flood damage to development or agricultural riparian land use).</td>
</tr>
<tr>
<td></td>
<td>B. Work to identify and remove/modify critical barriers (e.g., locks and dams) to improve habitat connectivity and resilience of the GRB.</td>
<td>I.A(5). Work with USACE to document logistics, rationale, and results from dam re-operation efforts incorporating environmental (seasonal) flows in Green, Nolin, and Rough River lake dams, to ensure long-term sustainability and continuity of re-operations in the face of uncertainty and staff turnover and to serve as examples for other SRP projects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I.A(6). Work with USACE to determine opportunities to incorporate improved temperature control in dam outflows and seek funding for modifications to dam outlet works.</td>
</tr>
<tr>
<td>II. Reduce the footprint of ecologically-incompatible agricultural practices in critical riparian and karst areas of the GRB.</td>
<td>A. Work to increase TNC’s credibility, visibility, and collaboration with the Agricultural Industry in Kentucky.</td>
<td>II.A(1). Conduct priority outreach (e.g., KY Ag Council annual summits) highlighting areas of overlap among conservation and agricultural industry goals, to increase awareness and collaboration with influential stakeholders in the agricultural community.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II.A(2). Identify appropriate KY Ag Council representative willing to serve on KY-TNC Board, or increase cross-board collaboration to help TNC identify effective engagement points and collaborative strategies with the agricultural industry.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II.A(3). Work with KY Ag Council to develop and export shared outreach messaging, focused on sustainable agriculture and best practices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II.A(4). Explore potential for new partnerships with other conservation groups with an agricultural focus (e.g., American Farmland Trust).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II.A(5). Determine opportunities to partner with groups that administer agricultural-related grant investments (e.g. SARE) and direct investments in education/research initiatives toward those of greatest conservation benefit.</td>
</tr>
<tr>
<td></td>
<td>B. Promote targeted, increased, and improved strategic Agricultural BMP program implementation.</td>
<td>II.B(1). Finalize and export GRB Spatial Priorities Model results and products to key partners (e.g., NRCS, KDFWR, Cooperative Extension, USFWS, etc.) to direct BMP implementation to areas of greatest freshwater and karst conservation need.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II.B(2). Support Farm Service Agency efforts to re-enroll maximum acreage into the Conservation Reserve Enhancement Program (CREP), via outreach and spatial prioritization support.</td>
</tr>
</tbody>
</table>
## III. Improve karst landscape management practices in critical karst drainages.

### A. Work with partners to conduct outreach in the greater Bowling Green municipal region, with the goal of developing the city into a model karst community.

#### III.A(1). Elevate Bowling Green community participation in TNC’s Corporate Sustainability Council work by including local manufacturing corporations as representatives and conducting priority outreach efforts (~2/yr).

#### III.A(2). Build organizational capacity and constituency in Bowling Green area by conducting relationship-building efforts with TNC contacts.

#### III.A(3). Research other model karst communities and create summary document of success stories and lessons learned for outreach, determine priority Bowling Green karst model community strategies, and export to key stakeholders (e.g., BRADD meetings, partner gatherings, outreach events, etc.).

#### III.A(4). Work with the city and Bowling Green Municipal Utilities to develop outreach initiatives related to water stewardship.

### B. Within the Green River Basin, work with partners to raise the level of karst awareness and related conservation action.

#### III.B(1). Using spatial model results, identify sub-basins, catchments, and/or karst drainage areas that are highly threatened by ecologically-incompatible agriculture and export priorities to KDOW for Nutrient Reduction Strategy (5yr-plan) focus areas and BMP monitoring efforts.

#### III.B(2). Support KWA efforts to promote the need for central waste water treatment/high-end septic systems within priority karst sub-regions (via KDOW nutrient reduction strategy input process), advocate for more stringent policies where needed, and work to secure funding for implementation.

#### III.B(3). Work with regional partners to develop new karst-oriented outreach materials.

#### III.B(4). Explore need for illegal sinkhole dump clean-ups in priority areas and utilize success stories (e.g., in Hart, Green Counties) and help direct potential applicants to available funding via county governments.

## IV. Conduct priority land protection, restoration, and partner engagement efforts, prioritized by potential sub-basin-scale impact to freshwater resources and potential linkages to human welfare and nature’s

### A. Conduct key land protection and/or restoration efforts to improve habitat condition and landscape connectivity or to abate current/future risks in identified priority areas.

#### IV.A(1). With partners (USACE, USFWS, NRCS, KDFWR), work to secure funding to restore highly degraded riparian areas in the Upper Green River sub-basin, as prioritized by TNC’s High Bank Erosion Study.

#### IV.A(2). Continue to work with partners to secure funding to conduct targeted, prioritized acquisition and/or other protection of critical habitats (aquatic, riparian, wetland, karst, high priority CREP-reenrollment acreage).

#### IV.A(3). Utilize wetland conservation easements through the NRCS Agriculture Conservation Easement Program to restore priority wetlands in the Lower Green sub-basin.

#### IV.A(4). Work with partners to build support for an eventual National Wildlife Refuge system along a portion of the Green River corridor.
These strategies and action steps focus heavily on engagement with agency and industry representatives and also include building and expanding our network of influence in order to achieve future conservation successes. The identification of these strategies as potentially having the greatest basin-wide impacts to priority risk abatement and/or achieving desired conservation outcomes reflects certain realities; specifically, that: (1) altered hydrologic regimes within the basin are largely a function of USACE infrastructure located on the main stem of the river, (2) the Bowling Green municipal area is the fastest growing city in Kentucky, situated squarely within the critical karst region of the basin and drawing all of its water from a major Green River tributary, (3) agricultural land use constitutes the largest percentage within the basin, and (4) fairly extensive mineral extraction activity takes place within the Pond, Lower and Middle subwatersheds of the basin (i.e., >160,000 acres, totaling ~11% of these subwatersheds, were under active mine permit in 20125).

The identified potential conservation strategies (and associated action steps) build upon the already-strong Sustainable Rivers Project partnership between the USACE and The Conservancy, bringing in multiple partners to work collaboratively on complex issues such as barrier removal, taking proactive steps to forge real partnerships and cooperation with the agricultural community, building a stronger foundation for conservation and organizational success within the Bowling Green community, and exploring mineral extraction risks and associated strategies to reduce those risks within the basin and identifying potential levers that can be employed to influence conservation outcomes therein.

Spatial Modeling to Determine Focus Areas
Results from the recently completed Green River Basin Ecological and Risk Priorities Spatial Model will guide our strategic implementation focus for certain strategies. See Appendix B for more details regarding the spatial model development and results, and Appendix C for strategy focus areas, where applicable.

Capacity and Funding
Dedicated TNC capacity for Green River basin-related work is currently limited to one dedicated full time staff person and small portions of a few additional employees’ time. To allow for capacity and resource analyses, and to serve as a guide for selecting priority strategies for implementation and resource allocation, the Planning Team has detailed the tasks and estimated resources necessary for TNC

5 Kentucky Division of Mine Permits, November 2012 GIS data
staff to implement the identified potential conservation strategies and has completed a draft work plan\(^6\). We present this information in three categories to prioritize recommendations for strategic plan implementation and future capacity needs\(^7\):

1) **Status Quo Implementation Option** - consists of strategies and action steps that are already planned or are feasible and of the highest priority, with existing capacity and resources (assuming continued State Chapter support at the current funding level). Without additional resources, TNC engagement would be heavily focused and limited to strategies related to physical barriers, agricultural BMPs, and protection/restoration of focus areas (i.e., Strategies I, II.B, and IV in Table 1), and minimal stewardship activities. To successfully implement these strategies at this level of engagement, it will require dedication of \(\sim 1.5\) Full Time Equivalent staff per year, costing \(\sim 225,000\) annually\(^7\). Additionally, \(\sim 1.05 - 2.1\) million dollars of funding is necessary for high priority land protection goals\(^6\).

2) **Increased Capacity Implementation Option** - consists of the Team’s recommended strategy engagement as the minimum standard for progress toward achieving basin-level conservation outcomes. This option calls for optimizing current capacity by focusing on high priority strategies, and seeks funding and support for additional capacity (in the form of increased state chapter or other internal staff engagement and collaborations with partners and a cost-share position to focus on agricultural and restoration strategies and improve stewardship of preserves). To successfully implement these strategies at this level of engagement, it will require dedication of \(\sim 2.5\) FTE staff per year, costing \(\sim 375,000\) annually\(^7\). Additionally, \(\sim 2 - 4\) million dollars of funding is necessary for priority land protection goals\(^6\).

3) **Full Implementation Option** - consists of estimated capacity and resource needs to fully engage in all nine identified Green River Basin strategies (in Table 1), including a few strategies that will require more significant resource allocation to achieve. While TNC is not currently planning on pursuing all of the identified action steps in the near term (due to capacity and funding constraints), this category contains “stretch” goals that could be considered, should the opportunities or resources present themselves. This option would allow for dedicated staff to highest priority strategies, TNC engagement in karst and energy strategies, wetland restoration, and greatly improved stewardship of preserves. To successfully implement these strategies at this level of engagement, it will require dedication of \(\sim 6\) FTE staff per year, costing \(\sim 900,000\) annually\(^7\). Additionally, \(\sim 12 - 24\) million dollars of funding is necessary for land protection goals, as is funding for wastewater treatment improvements and wetland restoration on the Lower Green\(^6\).

### Critical Next Steps Following Green River Basin Conservation Business Plan Development

- Present plan to the Chapter Board.
- Work with Philanthropy and Marketing to develop “one-pager” summary sheets that may be utilized for fundraising purposes.
- Reconvene with our partners to share our plan and Spatial Priorities Model results.
- Re-engage with Green River Summit participants.
- Determine additional GIS analysis needs to further the work outlined in this plan.
- Utilize this new plan to help develop staff objectives for the coming years.
- The Kentucky Chapter will use this plan as a guiding document in an effort to update our statewide Strategic Plan.

---


\(^7\) TNC estimates capacity in the form of Full Time Equivalents (FTE), which assume 1,820 hours of work per year, with a multiplier of \$150,000/year per FTE (including salary, fringe benefits, overhead costs and travel expenses).
Conclusions
We have developed a path forward that builds on our current capacity and strengths in the Green River, as well as requiring us to expand our on-the-ground capacity and fully utilize cross-collaboration among partners and key stakeholders. Over the next 5 years, we believe it is critically-important for TNC and our partners to focus on the key strategies identified within this Plan:

- Continue striving to re-operate the four large lake dams within the basin in the most ecologically-sensitive manner possible while also taking action to remove or modify other physical barriers (i.e., locks and dams), where possible.
- Reduce the footprint of ecologically-incompatible agricultural practices in critical riparian and karst areas within the river basin.
- Improve karst landscape management practices in critical karst drainages.
- Protect and restore the highest-value conservation acreages using the best spatial and prioritization tools at our disposal.
- Identify the action steps with the greatest potential to abate mineral extraction risks in high-priority regions and engage partners and stakeholders accordingly.

This Plan, and the recommendations made within, are ambitious and call to stretch their current involvement in the Green River basin. However, we believe the Plan’s final recommended actions, tempered by the realities of restricted funding and capacities are achievable. We hope that partners will embrace the vision and desired landscape-scale outcomes presented in this Plan, incorporate the recommended strategies into their own respective work plans, and thus endeavor to advance the conservation of this basin.

Having enough high quality freshwater to sustain natural processes and allow our own human population to survive and thrive should be an outcome that everyone can support. Globally, only 2.5% of the Earth’s water is freshwater, with most “locked up” in ice or groundwater and 21% contained within lakes. A scant 0.49% --- one half of one percent --- of our world’s surface freshwater is found in rivers, where many of us get our water from, including the Green River basin. As has been stated already, Kentucky is relatively blessed with freshwater resources; but, these blessings are fragile when viewed through the lenses of overall freshwater scarcity and highly at-risk freshwater biodiversity. Each and every one of us should view ourselves as stewards of the river and look at the various ways (personally and professionally) that we…and the organizations and associations we represent…can take appropriate actions and pull the necessary levers of stewardship and conservation.
Appendix A. Situation Analyses and relevant supporting Plan details, identified via TNC’s Green River Basin Conservation Business Planning Process

Developing a basin-wide, landscape-scale (or “whole-system”) freshwater conservation project requires leveraging freshwater conservation to the scale needed to solve a whole-system ecological problem whose causes are widely distributed and geographically removed from their impacts. Therefore, a project at this scale defined by the whole-system ecological problem(s) it is intended to solve, the causes of that problem, and the desired whole-system ecological outcomes. TNC develops concepts, tools, and approaches that, if implemented at scale, are solutions to the problem. We then identify institutional levers – typically policy or economic instruments – that will replicate the solutions at the pace and scale needed to solve the whole-system ecological problem. Almost always, the people with the power to “pull” the levers – for example, farmers, water suppliers, flood managers and politicians – desire certain socioeconomic outcomes such as reducing flood risk or increasing crop production. For our strategy to succeed, we may need to conduct site-scale demonstrations that show them how our solutions generate their socioeconomic outcomes. Therefore, desired ecological outcomes drive the project strategy; to succeed, the strategy must achieve desired socioeconomic outcomes of engaged sectors as well1 (Figure 1).

---

1 TNC’s Whole System Freshwater Conservation Project (July 2012)
TNC’s CONSERVATION BUSINESS PLANNING: The following figure provides an overview of TNC’s Conservation Business Planning process. To learn more about The Nature Conservancy’s Conservation Business Planning approach, visit:
https://www.conservationgateway.org/ConservationPlanning/BusinessPlanning

CONDITIONS FOR SUCCESS:

Institutional Levers - can be new or reformed laws, regulations, practices, guidelines, certification programs, or financing arrangements, or influence how existing program or policies are administered.

Important Institutional Levers in the Green River Basin:
- KDOW Basin Planning, Mussel Restoration Planning
- Ecologically-based river flow management recommendations
- Water withdrawal or other management regulations
- Farm Bill Programs (NRCS)
- Conservation easements- tax incentive & tax reform
- Farmers, Landowners in Priority Areas
- Flood Managers (ACOE, TVA)
- Water Suppliers
- Land Use Planners (municipalities)
- Public Land Managers
**Impediments to Conservation Success**

- Intense Use of the Basins
- Lack of shared vision around water regulation/management approach
- Rapid, unplanned growth = increased demands for water, infrastructure, etc.
- Many dams and locks
- Coal & Natural gas extraction in subwatersheds
- Program Hurdles & Uncertain Federal Funding
- Mostly fragmented, private land with small ownership patterns
- Heavily karst-influenced landscape
- Likelihood of Increased Droughts/Storms/Floods
- Lack of Perception of Rivers as Threatened
- Size of basin and Difference in Upper vs. Lower issues

**Enabling Conditions to Conservation Success**

- Partners (Corps, KDOH, KFW etc.) are working cohesively with the goal of integrated watershed management for the basin
- SRP program & TNC-Corps collaboration toward e-flow adoption for dam operations
- Farm Bill Programs & NRCS Soil Health Program
- History of environmental education creates ripe circumstances for Outreach
  - Green River clean-ups and potential for leverage/scale up around corporate engagement
  - Central KY Community Foundation is interested in Green River
- Blueway Designation Effort & Support
- Likelihood of increased statewide conservation funding
- Basin is mostly in KY
- High biodiversity & Mammoth Cave NP create awareness, appreciation, & potential funding avenues
**RISK ASSESSMENTS**

**Potential Risk Rankings to Green River Basin Desired Conservation Outcomes**: Risks are ranked Low-Very High based on expected impairment to desired outcomes without conservation intervention in the next ten years.

<table>
<thead>
<tr>
<th>Category</th>
<th>POTENTIAL RISK</th>
<th>Subwatershed Specific Risks</th>
<th>Risk to Nutrient/Sediments</th>
<th>Risk to Hydrology/Connectivity</th>
<th>Overall Green Basin Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Footprint</td>
<td>Residential and commercial development</td>
<td>Barren</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Municipal Water Management</td>
<td>Barren</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Transportation, Infrastructure (Roads &amp; Railroads)</td>
<td></td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Ecologically-incompatible Row Crop Agriculture Practices</td>
<td></td>
<td>High</td>
<td>Medium</td>
<td>Very High</td>
</tr>
<tr>
<td></td>
<td>Ecologically-incompatible Livestock Agriculture Practices</td>
<td></td>
<td>Medium</td>
<td>N/A</td>
<td>Low</td>
</tr>
<tr>
<td>Resource Extraction</td>
<td>Ecologically-incompatible Oil &amp; Gas Extraction Practices</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Tar Sands Mining</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td>Ecologically-incompatible Mining Practices</td>
<td>Lower &amp; Middle Green, Pond</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Legacy Coal Mining Impacts</td>
<td></td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Ecologically-incompatible Forestry Practices</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Physical Barriers or River Alteration</td>
<td>Channel Maintenance for Navigation</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dam Construction, Operation, and Water Management</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lock &amp; Dam Operation/ Other Barriers to Aquatic Species Movement</td>
<td>Medium</td>
<td>High</td>
<td>Very High</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Invasive or other problematic species</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Climate change: droughts, storms, &amp; flooding</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ecologically-incompatible Karst Management (Dumping, Burning, Filling)</td>
<td>Low</td>
<td>N/A</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

The Core Planning Team ranked risks by impacts to (a) Nutrient & Sediment Regimes and (b) Hydrologic Regime for each of the 6 Green River subwatersheds (HUC 8). These draft risk rankings may be refined via partner expertise and spatial data, where available.
Appendix B. Draft Results of the Green River Basin Spatial Priorities Model

Conservancy staff from Tennessee began collaborating (in 2005) with the Tennessee Wildlife Resources Agency on the development of the Tennessee State Wildlife Action Plan (TN-SWAP), and a GIS and relational database management system (RDBMS)-based system to manage the large amounts of data on Species of Greatest Conservation Need (SGCN), their habitats, and problems affecting these species and habitats. To support TN-SWAP plan development and implementation, taxonomic experts were consulted to map faunal species’ terrestrial, aquatic, and subterranean habitat preferences, scoring indexes of species global and state rarity, occurrence viability (confidence of persistence at the location), potential species distributions, and habitat suitability (preferred, suitable, or marginal habitat preferences) for all lands and waters in Tennessee. Furthermore, an Access-based hydrologic modeling framework was developed utilizing National Hydrography Plus (NHDPlus) datasets that defines: 1) the catchment areas draining into each individual stream segment in the hydrologic network, 2) hydrologic upstream/downstream connections among segments, and 3) hydrologically-relevant attributes (e.g., mean annual flow velocities and volumes). Additionally, various stressor footprint analyses were overlaid with catchments to determine area-weighted hazard ratings for stream segments and catchments. This analysis allowed the spatially-explicit identification and prioritization of habitats critical for the conservation of SGCN fauna across Tennessee (weighting areas based on mean annual flow travel time and percent flow contribution of individual watershed catchments), supporting evaluation of potential implications of upstream activities and conditions to downstream aquatic fauna. See Appendix B for the full report on datasets, analyses, and methods used to develop this model. The architecture of the SWAP database was designed to facilitate the incorporation of new and revised data over time. Since its initial development, various components of the database have been updated, revised, and expanded to support new functionality. An updated methods and results report for TN-SWAP database development is expected in early 2015.

In 2013-2014, TNC staff began updating the TN-SWAP database and also began incorporating analyses and data to model the Green River Basin in Kentucky & Tennessee. At the time this report was developed, known physical barriers (i.e., dams) and their attributes were mapped to determine relative flow contributions and travel times for the water flowing from the Green River and its’ tributaries. Information about location, rarity, and viability of rare species occurrences (Kentucky Natural Heritage Program (KYNHP)) was mapped. Spatial information about potential land uses that can pose risks to aquatic priorities were also incorporated and prioritized where available (agricultural practices, human development, and mining permits).

This appendix presents maps and tables that summarize the initial/ draft results from the Green River Basin Spatial Priorities Model, regarding 1) hydrologic flow model (travel time), 2) aquatic habitat priorities, and 3) risk or land use impacts to those priorities, with available data incorporated thus far. The Green River Basin Planning team has also identified remaining tasks and desired parameters that will further model results and implications. These additional spatial analyses will be completed as time and data availability allow, and remaining needs should be considered in future Plan implementation priorities. Additional desired spatial analyses are listed below, in priority order:

- Additional analyses needed to better model Ecological Priorities:
  - Integration of all available karst data (i.e., subsurface flow modeling via dye tracing) into hydro model to determine karst strategy priorities
  - Incorporation of new attributes in recently completed Appalachian LCC Active River Area (e.g., SSURGO data) to prioritize lands most likely to interact with the floodplain and better identify priority wetlands for restoration.
  - Upper Green Focus Area detailed analyses
    - Assessment of priorities based on overlay with NRCS High Bank Erosion Sites
    - Tract-level protection/ restoration priorities for key stretches, based on freshwater mussel assemblages, possibly linked to Blueway designation effort

---

1 Database Development & Spatial Analyses in Support of Tennessee’s State Wildlife Action Plan: 2012 Data and Methods Update
2 National Inventory of Dams GIS Dataset
3 2014 Element Occurrence GIS data, from Kentucky Natural Heritage Program
o Integration with TNC regional freshwater and resiliency analyses/results, as completed
  o New stream classifications (climate change, species movements, flow changes)
  o Terrestrial and Freshwater Resiliency Analyses
- Additional analyses needed to better model Risk Priorities:
  o Modeled predictive water supply via incorporation of water intake locations, linked to model population growth data to determine most affected downstream areas and tributaries at risk
  o Prioritization of barriers to natural flow to determine barrier removal strategy priorities (i.e., index scores for stream segments based on impoundment residence times)
  o Incorporation of locational risks posed by Animal Feeding Operations (e.g., model livestock density, depending on data available)

Below, we present a few maps depicting key results from the draft Green River Basin Spatial Priorities Model, thus far. Strategic Focus Areas have been selected, based on these results, for specific Green River conservation strategies and are presented in Appendix C.

Figure 1. Results of hydrological modeling, showing in-stream water travel time.
Figure 2. Map depicting known karst/sub-surface flow, yet to be incorporated in hydrologic modeling.
Figure 3. Map depicting aquatic conservation priority results, scored by stream segment and catchment, and Heritage element occurrence locations.
Figure 4. Agricultural lands in the GRB, scored by potential hazard to water quality (depending on type of agricultural land use).
Figure 5. Potential risk to aquatic conservation priorities from upstream agricultural lands.
Figure 6. Risks to aquatic conservation priorities due to existing and predicted (2040) Impervious Surfaces in the GRB.
Appendix C: Green River Basin Theory of Change and Conservation Strategy Details

Figure 1. Overall results chain, displaying conservation strategies, key intermediate outcomes, and intended risk abatement and desired ultimate conservation outcomes.
Figure 2. Map of strategic focus areas for Green River Basin conservation strategies, based on Spatial Model Analysis results.
Overarching Strategy 1. Restore ecological processes, connectivity, & resilience in the Green River Basin (GRB) altered by physical barriers (i.e., large lake dams and locks & dams).

**Strategy 1.A:** Collaborate with Sustainable Rivers Program (SRP) to incorporate ecological goals into large lake dam operations and management.

**Background:** With more than 70 species of mussels, 150 species of fish, and a host of species that live in its connected cave systems, the Green River in Kentucky features one of the richest and most unique aquatic arrays of species nationally and globally. Green River Dam was built by the U.S. Army Corps of Engineers (Corps) in 1968 to help manage flood risk and provide water supply and recreation. Over time, it was realized that the water regulating effects of the dam had negatively impacted the health of many of the river’s aquatic species. In 1998, personnel from The Nature Conservancy of Kentucky (Conservancy) approached the Corps’ Louisville District about modifying operations at Green River Dam. Working together, the Corps and the Conservancy developed an operations plan for Green River Dam that could improve conditions for downstream ecosystems while continuing to meet human needs.

Corps and Conservancy staff concluded that modifying flows on the Green River could benefit the spawning cycles of fish and freshwater mussels. At the same time, flood control benefits could be maintained and the Green River Lake recreation season would actually be extended by over a month. The new operations were implemented on a 3-year experimental basis in 2002. In 2006 operations at the Green River Dam were officially changed. This marked the first time that reservoir operating policies were changed at a Corps reservoir solely for ecological benefits. The project has restored “natural hydrologic variability” in flow and temperature in the Green River downstream of Green River Lake while continuing to provide flood control. Scientists are now reporting improved populations of fish and mussels in the river. The longer recreation season at Green River Lake has supported jobs and generated greater visitation and increased economic activity.

Activities at Green River Dam were the catalyst for the entire TNC / USACE Sustainable Rivers Project (SRP). They showed that water management can be more ecologically sustainable without sacrificing other important purposes. These successes sparked the growth of SRP, which began at a nationwide level in 2002 and expanded in its first decade to include work on 36 reservoirs in eight river basins. SRP aims to improve the health and life of rivers by modifying reservoir operations to achieve ecologically sustainable flows while maintaining or enhancing other project benefits. SRP practitioners have advanced this mission through a combination of reservoir reoperation efforts at project sites as well as through training, staff exchanges, and the development of new technologies - all designed to advance the implementation of environmental flows at Corps reservoirs.

Environmental flows are the flows of water in a river that sustain healthy ecosystems and the goods and services that humans derive from them. The goal is to attempt obtaining more natural, seasonal river flows conducive to maintaining conditions needed for healthy populations of Green River fish and mussels. The dam operations will mimic historic flows as close as possible by controlling outflows from the dam and reservoir. This means more frequent releases during the traditional wet season. During low flow seasons, higher river levels will be maintained.

While everything has been done at Green River Lake Dam that can be done without structural improvements to the facility, there is work ongoing to improve the E-flows from Green River Lake even further. Studies have been completed regarding a strategy to improve the temperatures of the releases from the Green River Dam by using a curtain to alter flows from the lake through the outlet structure. This has been shown to be a feasible strategy, but work must continue to obtain the funding necessary for this to happen.

Additionally, the Corps and the Conservancy are now working toward applying similar strategies at the three other Corps reservoirs within the watershed. The methods used and lessons learned at Green River Lake are being used help guide changes to dam operations throughout the Green

---

1 Monte McGregor (KDFWR) and Jim Layzer (TTU), 2012 personal communication.
River Basin. Conservancy staff and Corps personnel are looking at how Nolin, Rough River and Barren river dams might be “re-operated” with better E-flows and to make the Green River Basin the first river basin in the country to implement E-flows at all dams in a river basin. Work planned under this strategy will be aimed at making this a reality.

Numerous partners have been involved in the project to date, especially from the monitoring angle. This includes Mammoth Cave National Park, US Fish and Wildlife Service, KY Department of Fish and Wildlife Resources, KY Nature Preserves Commission, Campbellsville University, Southern Illinois University, Tennessee Technical University, University of Louisville, and Western Kentucky University. Long-term monitoring will help lead to adaptive management into the future to continue to improve management of these Green River Basin resources over time.

The Green River was the catalyst for the initiation of the Sustainable River Program. To our knowledge, this project is the only project to have had the environmental flows adopted as the standard operating procedure to be used in dam reoperations. This work will continue to be used as an example for improving flows at other USACE dams in Kentucky as well as throughout the nation.

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**

**FY15-16:**

- Conservancy staff work with partners to identify, prioritize, and annually seek funding to implement WRDA projects (e.g. longitudinal temperature studies, compiling landowner information below Barren River Lake to better inform flowage easement decisions, expanded field studies to ascertain the full range of various listed species, water intake, e-flow monitoring, research on improved nutrient levels immediately below dam outflows).
- Have documentation on file addressing logic, reasoning, and potential for e-flow implementation at Nolin River, Rough River, and Barren River lakes.
- Produce a GIS map of any impacted properties which hamper implementation of maximum e-flows per dam and determine flowage easement or land acquisition needs;

**FY17-19:**

- Secure funding and acquire needed Flowage Easements or Properties to allow maximum e-flow implementation at each dam within the GR Basin.

**Direct Outcome (Risk Abatement):** When e-flows have been implemented throughout the Green River Basin negative impacts to populations of aquatic organisms, including numerous globally imperiled fish and mussel species, will have been mitigated; thus leading to a healthier, more resilient river system.

**Risks & Assumptions:**

- To accomplish this strategy will require the Corps having the internal ability to accomplish the dam re-operations with some reasonable expectation of permanency.
- To fully implement this strategy will require the ability to acquire either flowage easements or properties in certain areas downstream from the dams.
- To fully accomplish this strategy will require funding to do studies and implement methodologies, such as the proposed Green River Lake curtain, to maximize potential e-flow benefits.
- A risk to seeing e-flows adopted within the entire Green River basin is the complexity surrounding the dam at Barren River Lake. Several unique factors (including the greater Bowling Green metropolitan area located downstream from this structure) combine to make eventual adoption of e-flows at this dam more challenging than the other three large lake dams.
**Target Impact (or Ultimate Outcome):** The Green River Basin is the first in the country to implement e-flow operations at the river basin level; leading to such implementation at other sites throughout the nation.

**Strategy I.B: Work to identify and remove or modify critical barriers (e.g., small locks & dams) to improve habitat connectivity and resilience of the GRB.**

**Background:** Another part of implementing e-flows to a river system is associated with establishing connectivity of the river to the maximum extent possible. In addition to the large high level dams addressed above, seven low level locks and dams were constructed on the Green and Barren rivers between 1836 to 1956 to aid in river barge transportation of goods. Today only Green River L&D’s #1 and #2, on the lower Green River, are functional.

The Corps has recently finished a disposition study of these structures. Green River Locks and Dams 3 through 6 and Barren River Lock and Dam 1 are navigation facilities that are no longer in use. The facilities and the pools are no longer maintained by the U.S. Army Corps of Engineers (USACE); however, the U.S. Army still has administrative accountability of the properties and USACE periodically inspects the facilities.

In 1991, the USACE conducted a study to determine if it would be feasible to restore navigation to the upper reaches of the Green River. This study found that the benefits from commercial navigation operations would be insufficient to support restoring navigation. Subsequently, in 2004 the USACE conducted a study to assess the impacts of— and make a recommendation to— de-authorize the Green River Locks and Dams 3 - 6 and Barren River Lock and Dam 1 and relinquish its interest in the property and facilities. No action was taken at that time to act on the study’s recommendations; therefore, the USACE maintains the properties in a caretaker status.

The 2014 study reevaluated current uses of the pools formed by these dams and the impacts if the pool were to be lost, either by demolition or failure of the lock and/or dam. The study reassessed the condition and safety of the structures. This study also took into account ecosystem restoration opportunities and the environmental and socio-economic impacts of each alternative, including impacts to water supply, recreation and transportation. The resulting recommended plan is to de-authorize all the projects and dispose of the properties after recommended construction is complete at each site. Currently, the recommended construction consists of demolishing the dam and filling the lock chamber at Green River Lock and Dam 6 and addressing stability at Green River Lock and Dam 3.

The strategy incorporated into this GR Basin plan will focus attention on achieving the removal of Lock and Dam # 6 and continue efforts to work with partners and communities to figure out feasible alternatives what will eventually lead to removal of all of the antiquated decommissioned Locks and Dams in the Green River Basin.

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**

FY15-16:

- Staff will work with partners to influence the final 2014 USACE Lock and Dam Disposition Study report to provide recommended removal of multiple decommissioned L&D’s.
- Staff will take a lead role in establishing a “Barrier Removal Working Group” to ensure attention stays focused on working out solutions to water intake structure needs and dam removal opportunities throughout the GR Basin.
- Staff will work with the Corps and other partners to figure out optimum operations for L&D’s 1 and 2 on the lower Green River which will allow movement of migratory spawning fish (and/or help control exotic fish movement) into and out of the Green River at appropriate seasons of the year.
FY17-19:

- Staff will help to find funding to assist communities with replacing or retro-fitting water intakes in a manner that will supply adequate water to communities while allowing removal of the old Locks and Dams.
- Staff will work with the Corps to obtain funding through congressional channels to pay for removal of the old structures and associated restoration of the riverine system.

**Direct Outcome (Risk Abatement):** Connectivity of the Green River aquatic resources is restored to the maximum extent possible, allowing free movement of water and aquatic organisms through the river system

**Risks & Assumptions:**

- Required budgetary authorization through Congress to the Louisville District of the Corps.
- Communities along the river will be cooperative and willing to work toward common goals that strike a balance between varying interests.

**Target Impact (or Ultimate Outcome):** Restoration of a free-flowing, connected riverine system with the Green River Basin from the each of the high level dams through the tributaries and into the Ohio River, resulting in improved hydrologic, sediment, and nutrient regimes of the basin, as well as basin resilience.
Theory of Change (Results Chain):

I. Restore ecological processes in the GRB altered by physical barriers.

A. Collaborate with SRP to incorporate ecological goals into large lake dam operations & management.

B. Work to identify and remove or modify critical barriers (e.g., small locks & dams) to improve habitat connectivity & resilience of the GRB.

Altered Hydrology: Green River Basin Strategy Results Chain

<table>
<thead>
<tr>
<th>Overarching Green River Basin Strategy &amp; Strategic Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Collaborate with SRP to incorporate ecological goals into large lake dam operations &amp; management.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intermediate Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased SRP Collaboration</td>
</tr>
<tr>
<td>Climate Change incorporated into Spatial Priorities Model</td>
</tr>
<tr>
<td>WRDA Proposals submitted, funded</td>
</tr>
<tr>
<td>Sustained USACE engagement</td>
</tr>
<tr>
<td>Funding, appropriations secured</td>
</tr>
<tr>
<td>Eflow Re-op Documentation</td>
</tr>
<tr>
<td>Sustained eflow reoperations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Abatement</th>
</tr>
</thead>
<tbody>
<tr>
<td>More ecologically-compatible large dam operation &amp; management</td>
</tr>
<tr>
<td>Removal or minimization of negative impacts due to lock &amp; dam and other small barriers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Desired Ultimate Conservation Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrologic Regime Improved</td>
</tr>
<tr>
<td>Sediment Regime Improved</td>
</tr>
<tr>
<td>Nutrient Regime Improved</td>
</tr>
<tr>
<td>Improved floodplain, wetland, tributary, &amp; main stem habitats &amp; improved basin-scale connectivity &amp; resilience</td>
</tr>
</tbody>
</table>

Vision

The quality & quantity of surface and ground water within the Green River basin is protected to preserve vital natural benefits which will sustain people, plants, & animals for future generations.
Overarching Strategy II: Reduce the footprint of ecologically-incompatible agricultural practices in critical riparian and karst areas of the GRB.

Background: TNC’s Kentucky Field Office (KYFO) has been actively involved in working with our federal and state partners to reduce negative agricultural impacts in the Green River project area for many years. The KYFO Director of Conservation is a member of the NRCS State Technical Committee and participates in various committee activities to help direct implementation of Farm Bill programs across the state. KYFO staff have historically worked to promote use of agricultural Best Management Practices (BMPs) for row-crop agriculture and livestock production. The largest effort the KYFO has been involved in helping to implement to date was the Green River Conservation Reserve Enhancement Program (CREP).

The KYFO was a significant partner in implementing a CREP in the Upper Green River Area. This project was the largest conservation project to ever hit the ground in Kentucky, enrolling 100,000 acres of cropland and pastureland into the program. Partners (USDA Natural Resources Conservation Service, USDA Farm Service Agency, US Fish and Wildlife Service, KY Department of Conservation, KY Department of Fish and Wildlife Resources, KY Division of Forestry, Western KY University, Tennessee Tech University) collaborated to develop the Green River CREP beginning in 2000 and officially starting to implement the approved project in 2001. The CREP was funded 80/20 federal/nonfederal resulting in an approved $110 million project to be implemented over a 10-year period. The over-arching goal was to reduce the sediment entering the Green River by 10%. State Agencies allocated budgets to support the CREP to the tune of approximately $22 million of which the KYFO committed to providing up to $5 M for the purchase of permanent conservation easements from willing landowners entering the CREP. A moderate sign-up of about 12,000 acres was achieved by spring 2007, at which time the program was modified to approximately double the acres and extended focus to the most of the sinkhole plain. Within the following year the 100,000 acre cap on the project was reached, with most sign-up occurring on the sinkhole plain. TNC purchased 55 CREP easements to protect 1,252 acres of mostly riparian acres. These CE’s protect approximately 142,362 feet of riparian habitat.

Since 2008 and the end of working on the CREP sign-ups, KYFO involvement in promoting agriculture BMP’s has slowed down as we worked on other priorities. However, as we now expand our efforts to the entire Green River Basin, there is a need to refocus on working to mitigate various agriculture related impacts to the watershed. In order to do this, priority needs to be focused on becoming better tied into agriculture industry associations and organizations in efforts to better promote innovative BMP’s. In addition to the above, our Chapter has also focused attention on helping to implement specific BMP’s to address specific issues and/or provide demonstrations of how particular problems can be solved.

Strategy II Spatial Focus Area: See Figure 2: “Agricultural BMP and Karst BMP Strategic Focus Areas.”

Strategy II.A: Work to increase TNC’s credibility, visibility, & collaboration with the Agricultural Industry in Kentucky.

Intermediate Outcomes and/or Strategy Effectiveness Measures:
FY15-19:

- Staff will conduct priority outreach (e.g., KY Ag Council annual summits, KY Association of Conservation Districts annual meetings) highlighting areas of overlap among conservation & agricultural industry goals, to increase awareness and collaboration with influential stakeholders in the agricultural community.
- Staff should explore the idea of identifying an appropriate KY Ag Council representative willing to serve on KY-TNC Board or increase cross-board collaboration to help TNC identify effective engagement points & collaborative strategies with the agricultural industry (NOTE: this may already be in place through Bob Wade?).
• Work with KY Ag Council, UK Extension, and other Ag leaders to develop and export shared outreach messaging, focused on sustainable agriculture and BMP’s.
• Explore potential for new partnerships with other conservation groups with an agricultural focus (e.g., American Farmland Trust).
• Determine opportunities to partner with groups that administer agricultural-related grant investments (e.g. SARE) and direct investments in education/research initiatives toward those of greatest conservation benefit.

**Direct Outcome (Risk Abatement):** TNC becomes a better participant in the larger agricultural community and recognized as a great resource and partner by agricultural industry associations and organizations working toward common goals, which will lead to greater leverage and opportunity to abate risks from incompatible agricultural practices.

**Risks & Assumptions:**

- To accomplish goals under this strategy, we must assume commitment of adequate staff time and resources to increase our partnership in the agricultural arena.
- To accomplish this strategy assumes a willingness of various agricultural organizations to be receptive to working with TNC;
- Little risk is identified for this strategy at this time.

**Target Impact (or Ultimate Outcome):** TNC would be recognized as a “Go-To” partner for agricultural industry partners throughout the Green River Basin (and perhaps the state).

**Strategy II.B: Promote targeted, increased, and improved strategic Agricultural Best Management Practice (BMP) program implementation.**

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**

**FY15 - 16:**

- Finalize & export GRB Spatial Priorities Model results & products to key partners (e.g., NRCS, KDFWR, Cooperative Extension, USFWS, etc.) to direct BMP implementation to areas of greatest freshwater and karst conservation need.
- Partner with NRCS Soil Health campaign, Conservation Stewardship Program, and other Farm Bill programs to promote increased implementation of BMPs in priority areas (e.g., co-presenting field days, assisting with Soil Health outreach, helping to acquire loaner equipment in strategic locations, etc.).
- Support Farm Service Agency efforts to re-enroll maximum acreage into the Conservation Reserve Enhancement Program (CREP), via outreach & spatial prioritization support.

**FY17 - 19:**

- With partners (e.g., KDFWR, NRCS, Roundstone Seed?), determine critical needs and promote mid-contract management (e.g., increased capacity for prescribed fire council work, FSA) to ensure long-term habitat management of enrolled CREP lands.
- Work to develop & submit proposal to secure and implement Soil Health Conservation Innovation Grant(s) (CIG), in collaboration with NRCS and University of Kentucky.

**Direct Outcome (Risk Abatement):** Implementing this strategy will directly reduce tons of sediment and agriculture-related runoff into the Green River system.
**Risks & Assumptions:**

- Financial support will be secured through various Farm Bill programs to pay for the bulk of the on-the-ground BMP’s.
- Partners will agree on priorities and be willing to put their resources toward the common goals.

**Target Impact (or Ultimate Outcome):** BMP’s will be implemented on critical priority river and tributary stretches to reduce sediment and chemical and fertilizer inputs from ecologically-incompatible agriculture into the river system at a large enough scale to significantly reduce the Green River Basin’s contribution to overall Mississippi River / Gulf Hypoxia issues.
Theory of Change (Results Chain):

II. Reduce the footprint of ecologically-incompatible agricultural practices in critical riparian and karst areas of the GRB.

A. Work to increase TNC's credibility, visibility, & collaboration with the Agricultural Industry in Kentucky.

B. Promote targeted, increased, and improved strategic Agricultural Best Management Practice (BMP) program implementation.

Improved Agricultural Practices: Green River Basin Strategy Results Chain
Overarching Strategy III: Improve karst landscape management practices in critical karst drainages.

Strategy III Spatial Focus Area: See Figure 2: “Karst BMP and Community Compatible Development Strategic Focus Areas.”

Strategy III.A: Work with partners to conduct outreach in the greater Bowling Green municipal region, with the goal of developing the city into a model karst community.

**Background:** The Bowling Green Metropolitan Statistical Area (MSA), as defined by the United States Census Bureau, is one of the fastest-growing population centers in Kentucky. As of 2012, the Bowling Green MSA (falling within the counties of Allen, Butler, Edmonson, and Warren) had a population of 162,231. The karst geology which underlies the Bowling Green MSA makes sound management of stormwater a challenge; the city of Bowling Green has over 1,200 stormwater injection wells already. Normally the water being directed into the karst drainages by these injection wells is not treated, and according to Mr. Warren Campbell (Civil Engineering, Western Kentucky University) this “approach to stormwater management will not be environmentally sustainable as population densities increase.” In addition to the challenges posed by stormwater management, the Bowling Green MSA also faces challenges relating to freshwater resources that are available for municipal use. Bowling Green Municipal Utilities (BGMU) utilizes water from the Barren River as its sole source of water. BGMU’s water intake falls between the USACE dam that forms Barren River Lake on the upstream side of the intake, and an obsolete USACE lock & dam (Barren River L&D #1) on the downstream side of the intake. Opportunities to improve how water is managed and conserved within the Bowling Green MSA abound in the areas of (1) general public outreach and (2) relationship-building and collaboration with partners. In some 2014 email exchanges, Bowling Green city staff acknowledged that while they have had ongoing outreach programs, those efforts have “never really focused on conservation” but expressed an interest in doing so in the future. Historically, TNC has not had a strong organizational presence in this region. But we have some promising “green shoots” in the region (especially tied to karst) that could be nurtured in coming years. Dr. Chris Groves (WKU) is an expert on karst matters, and also serves as a TNC-KY Chapter board member. We also have an excellent relationship with Mr. Dale Reynolds, a KDOW staff member based in Bowling Green who chairs a Green-Tradewater River Basin Team. We believe these individuals, and others, can help open some pathways for TNC to become more involved with water conservation strategies pertaining to the Bowling Green MSA.

Essentially, our approach for this strategy represents a blend of organizational capacity building within the Bowling Green area to support desired philanthropic and policy outcomes, along with collaborative partner-driven karst outreach efforts, which should (we believe) lead to a more intense focus on water conservation and associated investment in protective karst measures.

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**
FY15-16:

- Answer the question of “what would it take for a city to be defined as a model karst community” by researching other karst communities (nationally, globally) to discover success stories and how challenges may have been overcome. Create summary documents of lessons learned and recommendations that can be utilized in outreach and education efforts, and to help determine high priority Bowling Green karst/water conservation strategies.
- Build TNC’s organizational capacity in the region through increased grass-roots TNC membership and Corporate Sustainability Council (CSC) participation.
- Develop new relationships and strengthen existing relationships with key stakeholders within the region, including BGMU, WKU, BRADD, and others.
FY17-19:

• Work with the city of Bowling Green and BGMU to develop outreach initiatives and policies related to water stewardship, with the primary targets of (1) reducing overall usage of municipal water resources via conservation and (2) utilizing the best available technology and practices to treat and discharge stormwater.

**Direct Outcome (Risk Abatement):** Improved municipal water management (stormwater management) practices in critical places in the Barren River watershed (e.g., within the Bowling Green MSA) to improve the quality of water being introduced into karst drainages, along with greater focus on water conservation at the user level to reduce the overall water demands being placed on the Barren River, leading to risk abatement related to ecologically-incompatible residential and commercial development. Additional risk abatement is expected related to ecologically-incompatible agricultural practices in karst drainages.

**Risks & Assumptions:** Organizational risks include the possibility of “overplaying our hand” from the standpoint of what we would ask of the Bowling Green MSA water managers, with the possible negative result of having our input tuned out if we are perceived as pushing too hard, too fast for changes. We must always be cognizant and appreciative of the challenges faced by water management professionals and elected officials operating in such a complex environment. As we learn more about what it means to be a model karst community, we should take care to present those lessons as welcome solutions to problems already faced by water management professionals, and do what we can as an organization to help implement any solution we might see fit to recommend. In doing so, our assumption would be that TNC would come to be viewed as a trusted partner by our partners in the water management and conservation business within the Bowling Green MSA.

**Target Impact (or Ultimate Outcome):**

• An easy to comprehend, dynamic understanding of steps and practices that could define a “model karst community.”

• An improved network of TNC supporters and professional contacts within the greater Bowling Green municipal area.

• Key stakeholders, both internal and external, share information and work collaboratively towards commonly-held goals of (1) improving stormwater management systems and (2) strengthening water conservation measures to lessen the demands placed on the Barren River in the face of a growing populace.

**Strategy III.B: Within the Green River Basin, work with partners to raise the level of karst awareness and related conservation action.**

**Background:** Karst geology underlays a large portion of the entire Green River Basin. The 2001 Green and Tradewater Basins Status Report, prepared by the Kentucky Division of Water (KDOW), states that “interactions of karst topography, surface water, and groundwater produce water supplies that are extremely vulnerable to poor land-use practices.” This vulnerability is not limited to an obvious situation such as illegal dumping into an open-throat sinkhole. It is important to know that even in the absence of surface streams, a karst region is a zone of drainage into the aquifer; the entire area can be a recharge zone. Surface water over the whole area, not just within sinkholes, carries sediment and pollutants into the subsurface. In the Green River Basin, karst drainages are of exceptional importance and are worthy

---

of exceptional conservation efforts to protect both (1) the quality and quantity of water available to the human population with the Basin, and (2) to protect the world-renowned natural resources found within the Mammoth Cave National Park system, a World Heritage Site and Biosphere Reserve.

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**

**FY15-16:**

- Using spatial model results, identify sub-basins, catchments, and/or karst drainage areas that are highly at-risk from ecologically-incompatible land uses and export those priorities to KDOW for inclusion in their Nutrient Reduction Strategy five-year planning effort. Accordingly, priority focus areas may be selected within the karst plain for special nutrient reduction efforts.
- Work with regional partners to develop and disseminate effective karst-oriented outreach materials. Some level of material already does exist; there may not be a tremendous need to “reinvent the wheel” with regard to content. However, a fresh look at existing outreach materials, with an eye towards modern technology (virtual publishing, social media, etc.) may be warranted. The best outreach materials serve no purpose if they are not effectively distributed to a target audience. Specific measures should include (1) list of targeted audiences and (2) volume of outreach materials shared.

**FY17-19:**

- Support Kentucky Waterways Alliance (KWA) efforts to promote the need for central waste-water treatment systems and/or high-end septic systems to reduce contamination entering karst drainages via human waste-water products.
- Some counties have effectively utilized grant funding to clean up illegal dump sites in karst locales. Export these success stories to other counties to increase the number of illegal dump sites that are cleaned up.

**Direct Outcome (Risk Abatement):** Reduced ecologically-incompatible land use within the karst plain of the Green River basin, with associated reduction in sediments and/or pollutants being introduced into karst drainages.

**Risks & Assumptions:** The karst area within the Green River Basin is extensive. A very real risk is that despite a significant effort by TNC to effect positive change in this strategy, the scale involved may preclude significant, measurable outcomes. A key assumption we would operate under is that enhanced landscape-scale, whole-farm agricultural practices (e.g., a “soil health” approach to row crop operations) would be most effective in producing ecologically-significant results vs. a more limited approach (e.g., rely only upon buffers around sinkholes and riparian corridors).

**Target Impact (or Ultimate Outcome):**

- Our spatial data being utilized by KDOW, NRCS, and other conservation partners to identify shared priority focus areas for conservation within the karst region. These areas are defined as part of the KDOW Nutrient Reduction Strategy and are a focus of implementing USDA NRCS Nutrient Management programs.
- Increased karst awareness among all area stakeholders, including the general population, politicians, industries, and agriculture community.
Theory of Change (Results Chain):

III. Improve karst landscape management practices in critical karst drainages.

A. Work with partners to conduct outreach in the greater Bowling Green municipal region, with the goal of developing the city into a model karst community.

B. Work with partners to raise the level of karst awareness and related conservation action in the GRB.
Overarching Strategy IV. Conduct priority land protection, restoration, and partner engagement efforts, prioritized by potential sub-basin-scale impact to freshwater resources and potential linkages to human welfare and nature’s benefits.

_Strategy IV Spatial Focus Area:_ See Figure 2: “Agricultural and Karst BMP Strategic Focus Areas.”

**Strategy IV.A:** Conduct key land protection and/or restoration efforts to improve habitat condition and landscape connectivity or to abate current/future risks in identified priority areas.

**Background:** While much of the entire Green River Basin is full of natural wonders, TNC, our conservation partners, and academics worldwide have long known that a stretch of approximately 124 river miles of the Upper Green River represents “the best of the best,” an ever-so-thin river corridor that harbors aquatic and subterranean life forms so diverse that only a handful of other river systems on Earth can rival it. This portion of the Upper Green falls between the USACE Green River Lake dam to the east and the USACE Lock & Dam #6 to the west, all falling within the Upper Green River HUC. The land use within this HUC is predominately agricultural. Primary risks to this all-important stretch of the Green River include sediments and associated pollutants which may be delivered into the river via high bank erosion, karst inputs, insufficient riparian buffers, and ecologically-incompatible agricultural practices. Agriculture is, and will continue to be, a key foundation for the communities found within the Basin, and TNC supports sustainable agriculture. Our priorities relating to sustainable agriculture can be found elsewhere within this Plan, and we realize that the future of conservation lies in working landscapes that are managed properly to strike a balance between production values and conservation outcomes. However, there are still instances where direct, permanent land protection (acquisition, easement, habitat restoration) is still a vital conservation tool where it can be applied for greatest effect. Spatial analysis shows that an Active River Area (ARA) within the high-priority Upper Green River corridor described above contains a land area of approximately 6,818 acres. From a conservation standpoint, having all of these (mostly) riparian acres in some form of permanent conservation protection, along with associated habitat restoration measures would be a tremendous outcome. TNC and a number of our partners have already engaged in these Upper Green land protection efforts already, though much remains to be done. TNC has permanently protected some 5,400 acres within the Upper Green; WKU has permanently protected approximately 1,500 acres; the KDOW Wild Rivers program has protected several hundred acres, and of course there are the 52,830 acres found within Mammoth Cave National Park. But there are some 100,000 acres currently enrolled in fairly short duration CREP contracts, and only about 1,500 acres of those are under permanent protection. In the next five years, we should (with our partners) strive to put as many of these ARA and CREP acres under permanent protection as possible. There are approximately 1,130 acres of CREP-enrolled acres in the ARA within this high-priority stretch of the river; these parcels would rank very highly for their conservation values due to their proximity to key stretches of the river, listed species occurrences, and the fact that these parcels have already had some level of conservation work completed on them (planted to bottomland hardwoods and/or native grasses).

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**
**FY15-16:**

- Work with NRCS and other partners on a Regional Conservation Partnership Program (RCPP) proposal to deal specifically with high-bank erosion in the Upper Green system.
- Work with USFWS to continue identifying key Indiana/Gray bat habitat locations to expand the areas where IBCF funding can be utilized for land protection.
- Work in concert with USFWS and new leadership within KDFWR to develop new Recovery Lands Acquisition (RLA) proposals for the Upper Green.
• Fulfill 150-acre obligation to permanently protect forested riparian area and Green River corridor, related to potential Indiana and Gray bat habitat.
• Communicate with Partners to determine level of support for National Wildlife Refuge establishment and express interest to USFWS.

FY17-19:

• Seek matching funds which will be utilized as the required 50% match for Heritage Land Conservation Fund (HLCF) land protection funding, to be used for both outright acquisition of key parcels and permanent conservation easements. A minimum of two million to four million dollars would be needed to provide permanent protection (via conservation easements or fee simple acquisition) of 1,130 acres of currently-enrolled CREP acreage that falls within the high-priority section of the Green River ARA.
• Stay in close contact with FSA regarding CREP re-enrollments; be prepared to take action if re-enrollments are lagging significantly (less than 85% of acreage being re-enrolled).

**Direct Outcome (Risk Abatement):** Reduced sedimentation (and associated pollutants) into the river; mitigated high-bank erosion threat.

**Risks & Assumptions:** Several important risks & assumptions reside within this strategy:

• (Risk) CREP re-enrollments are unsatisfactory (sub 85% re-enrollment rate). Such a risk could manifest itself should grain/commodity prices rise substantially, which could make it more financially attractive for a producer to exit the CREP program in favor of crop production, or if the rental rates paid per CREP contract acre are deemed too low by participants.
• (Risk) Availability of funding for conservation land protection is always a tenuous affair in Kentucky. HLCF funds for land protection could be “swept” for non-conservation purposes, an outcome which already has taken place as of the 2014 legislative session. Other conservation funding sources could also be subject to reductions or outright elimination.
• (Risk) The high-bank erosion efforts described within this Plan will vary greatly in complexity and cost, depending on site conditions. Potential partners in this effort have already expressed doubt and concern that the high-bank erosion problem can be addressed with available resources and program limitations. Should a high-bank restoration project get underway, it will be important to show cost-effective, long-lasting outcomes are possible to obtain, or we risk losing future support for continuing efforts towards solving the problems of high-bank erosion.
• (Assumption) Initial reports regarding CREP re-enrollments are very encouraging. Rental rates being paid for re-enrollments are quite good, and after some early confusion (due to the uncertain future of the farm bill) all indications are that re-enrollments will be vigorous. Also, grain prices are fairly low as of 2014 and our assumption would incorporate the belief that (1) if CREP rental rates remain attractive and (2) grain prices remain level to only moderately increasing, then CREP re-enrollments should be strong. This is important, as these re-enrollments “buy time” for more permanent measures to be put into place.
• (Assumption) As more field work is completed to document the presence of certain bat species along the riparian corridors for both the main stem of the Green River and several important tributaries, increased funding for conservation via the Indiana Bat Conservation Fund (IBCF) may become available across a wider area.
• (Assumption) Should KDFWR be persuaded to tap into the Recovery Land Acquisition (RLA) funding mechanism, any Green River related grant application should score very highly and be strongly supported by our state USFWS personnel.
• (Assumption) Double the acres protected under Status Quo Plan Implementation Option,
based on ability to match funds 1:1, using HLCF funding.

**Target Impact (or Ultimate Outcome):**

- Have a mechanism in place to address high bank erosion sites along approximately 100 miles of the Green River and another 100 miles of tributary streams within the Upper Green. “Mechanism” being defined as science-driven prioritization of sites, cost-effective mitigation techniques, professional engineering where necessary, permanent protection considerations for sites, and funding for these processes.
- Secure larger, more consistent funding for targeted acquisition and/or other permanent protection of critical habitats (aquatic, riparian, wetland, karst, high-priority CREP acreages).

**Strategy IV.B: Work with partners to establish Green River "Blueway" recreational system.**

**Background:** A 2013 effort to seek inclusion for the Green River under the umbrella of the national Department of the Interior’s National Blueway System ran into a seemingly insurmountable hurdle with the January 2014 Secretarial Order that deactivated the National Blueway program. However, local and regional support for some type of a “blueway” or river trail system was so strong that the effort has continued under the Rivers, Trails, and Conservation Assistance (RTCA) program administered via the U.S. National Park Service (NPS). The Barren River Area Development District (BRADD) submitted a formal application for RTCA assistance to create a blueway/river trail system for the entire Green River. Several public outreach meetings have been held in 2013/2014, with strong support being expressed at each meeting. TNC personnel have been involved with this process and have attended almost all of the public meetings that have been held thus far. Kentucky Tourism officials are also now heavily involved in the “blueway” process, along with a number of county/municipal leaders from all throughout the Green River Basin. Note that TNC views this strategy not so much as a means for addressing a specific threat to the river, but more as an opportunity to develop and broadcast a message that the Green River provides an outstanding economic service and opportunity as an eco-tourism destination and route linking together many historically and culturally significant towns and communities throughout the basin. In the next five years, we believe some river trail/blueway system will become a reality, which should help all residents and policymakers within the Basin appreciate how valuable a resource the Green River is to our communities as a natural resource unto itself. A recent call, by paddle sport enthusiasts, for much greater public access points onto the river illustrates an opportunity to press for more conservation/public recreation funding that can potentially serve to not only provide new public recreation points along the Green River, but also protect and restore at-risk lands while doing so. In addition, the prospect of more recreational paddle sport enthusiasts and other river-goers on the Green River could increase the likelihood that one or more obsolete USACE lock and dams within the Basin might be removed.

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**

FY15-16:

- Continue our involvement with the RTCA planning process to do our part to see that the blueway process continues moving forward.
- As serious consideration leans toward increasing public access along the river corridor, lend our spatial analysis and local knowledge of properties with conservation potential to that decision making process.
FY17-19

- Continue leveraging greater visibility and appreciation of the Green River (arising from the blueway/river trail program) into greater conservation successes in future years. These local and regional efforts to establish the Green River as a premier eco-tourism destination should help future philanthropic efforts and grant funding opportunities.

**Direct Outcome (Risk Abatement):** Defining threats to be abated as a result of this strategy is a somewhat amorphous exercise. However, as has already been stated above, it could reasonably be inferred that a growing groundswell of support behind a Green River blueway system could also lead to an increase in public support for eventual removal of old USACE infrastructure on the river, a tremendously important objective in its own right. In addition, a greater overall appreciation for the Green River as a naturally-valuable resource should foster a greater sense of river stewardship among the general population and policymakers who appreciate the boost in economic benefits that a healthy, recreationally-friendly Green River provides to their local communities.

**Risks & Assumptions:** No known risks, with perhaps one possible exception; while TNC would like to see obsolete water infrastructures removed from the Green River system, we do not want our support of the blueway effort to be perceived as only being about dam removal. There are many reasons we support the blueway effort, as indicated in the Background section above. We would make the assumption that a growing effort to create a vibrant Green River blueway may lead to more conservation opportunities within the Green River Basin in the future, with likely tie-ins to increased public access/recreational opportunities along the river corridor.

**Target Impact (or Ultimate Outcome):**

- An extensive Green River Blueway/River Trail system is developed with many partners in the next five years with an emphasis on increased recreational public access to the river, and increased eco-tourism opportunities.
- High priority conservation properties are permanently protected/restored as part of an effort to increase public recreation opportunities along the Green River corridor, with technical assistance/input from TNC to guide these decisions.
- Increased visibility and awareness of the Green River as an important eco-tourism destination leads to increased philanthropic and grant opportunities.
Theory of Change (Results Chain):

A. Conduct key land protection/restoration efforts to improve habitat condition & landscape connectivity or to abate current/future risks in identified priority areas.

IV. Conduct priority land protection, restoration, & partner engagement efforts, with most potential to positively impact freshwater resources, human welfare & nature's benefits.

B. Work with partners to establish Green River "Blueway" recreational system.

TNC & Partners collaborate to secure funding and restore priority HBE sites, wetlands, riparian & karst areas.

TNC & partners collaborate on targeted protection of critical lands.

TNC GRB Spatial Priorities Model identifies karst priority areas for focused conservation efforts.

Recreational opportunities are maximized to benefit conservation priorities (e.g., public access sites, portages/barrier removal, etc).

Abated ecologically incompatible row crop agricultural practices in critical places.

desired ultimate conservation outcomes:

- Hydrologic Regime Improved
- Ecological processes (hydrologic, sediment, & nutrient regimes) are within their natural range of variation.
- Sediment Regime Improved
- Nutrient Regime Improved
- Improved floodplain, wetland, tributary, & mainstream habitats & improved basin-scale connectivity & resilience

Vision:
The quality & quantity of surface and ground water within the Green River basin is protected to preserve vital natural benefits which will sustain people, plants, & animals for future generations.
Overarching Strategy V. Abate risks from ecologically-incompatible legacy and current mineral extraction activities.

**Strategy IV Spatial Focus Area:** See Figure 2: “Compatible Energy Development Strategic Focus Area.”

**Strategy V.A:** Identify potential engagement points, partners, and potential strategies to abate risks to the Green River Basin from legacy, current, and future mineral extraction.

**Background:**
Risks are associated with legacy, current, and future gas and mineral extraction activities are found throughout the Green River Basin. There have been especially high levels of activity in the in priority aquatic, karst, and wetland habitats in the western coalfield region of the Green River Basin. Extensive coal mining extraction activity takes place within the Pond, Lower and Middle subwatersheds of the basin (i.e., >160,000 acres, totaling ~11% of these subwatersheds, were under active mine permit in 2012). Certain legacy mine impacts and current mineral extraction practices (primarily large-scale surface coal mining) can result in significant and long-lasting impacts to water quality, habitat, and terrestrial and aquatic communities, including elevated levels of dissolved solids, conductivity, contaminants, erosion, and sedimentation, and direct loss of headwater streams, interior forests and connectivity, altered hydrology, and related biotic effects.

TNC Central Appalachian Whole System staffs have engaged in efforts to reduce mining impacts in Virginia, Tennessee and West Virginia via varying strategies. Recently, The Conservancy completed an Energy Impacts Analysis, predicting future coal, gas, and wind energy development potential and identifying priority areas to employ future energy development risk abatement strategies. To abate risks to priority areas due to legacy or active mining impacts and future gas development, our strategies focus on: (1) shaping energy development (engaging with industry, policy-makers, and regulators) to avoid, minimize, and effectively offset impacts of this development in critical places, and (2) protecting and restoring critical lands to improve protection, management, and restoration objectives and outcomes. If capacity allows, Kentucky Conservancy staff can export and build on Central Appalachian Whole System energy strategies to assess appropriate engagement in these risk abatement strategies for the Green River Basin.

**Legacy Mineral Impacts:**
- Prior to enactment of the Surface Mining Control & Reclamation Act (SMCRA) in 1977, most coal mining was essentially unregulated and conducted with little regard for environmental impacts and consideration of future land use. “Pre-law” mining activities generated a substantial legacy of environmental and human health and safety problems due to these Abandoned Mine Lands (AMLs), including Acid Mine Drainage (AMD) and unreclaimed mine features (e.g., coal refuse piles, dangerous highwalls, portals, clogged streams, and abandoned equipment). These AMLs can pose serious risks to water quality, in-stream habitat, and health of humans and aquatic biota, via leaching of salts, minerals, metals, and acids (i.e., elevated levels of dissolved solids and conductivity), erosion, sedimentation, & poor water quality. AMLs rarely show significant ecological recovery so the alterations of the landscape may never fully abate naturally in several decades or more; therefore, once AMD or elevated TDS conditions exist they should be expected to persist until engineered solutions are employed to correct the problem. Consequently, many acres of abandoned mined land (AML) will continue to negatively affect native forests and streams for decades to come.
- The Federal Abandoned Mine Reclamation Fund recently allocated substantial funding (over $2 billion) from coal severance taxes to States for AML reclamation over the next 10-15 years (Kentucky is estimated to receive ~$800 million). AML Funds are typically restricted to remediation of the Priority 1 and 2 AML sites (those that directly threaten human safety or health), prior to addressing Priority 3 sites (environmental problems). In many cases, State Mining Agencies lack a
comprehensive spatial AML inventory & updated reclamation project ranking system to transparently apply these funds in the most beneficial manner. TNC has worked with Agencies in Virginia to improve the AML spatial inventory & reclamation prioritization methods, ensuring that reclamation priorities include ecologically-degrading AMLs with the greatest potential linkage to human health and safety impacts and impacts to areas with high biodiversity significance. This strategy (to maximize the use of federal AML funds for reclamation/ restoration projects to reduce threats/ enhance water quality for aquatic targets) can be applied throughout the coalfields and Kentucky TNC staff can work with partners to export lessons learned and determine the best ways to engage in this strategy.

• Another opportunity for restoring AMLs is through re-mining, a process where a mining company operates on a previously mined area, extracts the remaining coal from the site, and must follow current environmental regulations and reclamation standards. The limited knowledge about the relative importance of legacy mining impacts in comparison to active mining impacts makes deciding on the most efficient actions difficult. The limitations on using AML Fund resources to address environmental impacts are a significant hurdle to utilizing the largest source of restoration money available. Encouraging re-mining through favorable permitting conditions or monetary incentives can be effective at restoring local environmental problems but result in larger overall mining footprints.

**Current or Active Mineral Extraction Impacts:**

• All large scale surface mining methods (auger or highwall mining, mountain top removal, contour mining and area mining) can have significant ecological impacts because they all produce large amounts of overburden that must be disposed of, and all expose formerly sequestered rock to air and water which can leach metals and salts and possibly produce acidity (if the geology has significant pyrite). Large-scale surface mine practices can negatively impact forests by altering the functional size of forests (loss of interior forests and increase in edge effects), connectivity, and character and structure of soils, which can result in impaired species composition and dispersal, and habitat size and diversity. Without careful implementation of reclamation techniques, the hydrology and vegetation that recovers on mined lands is vastly different for decades or longer. In the Green River, few intact bottomland forests remain and often legacy mine sites have been reclaimed to fescue and *Servicea lespedeza*. Restoration to native grasslands and focus on restoration of critical wetland functions are a priority. Surface coal mining operations can negatively impact small rivers and headwater streams via physical and chemical impacts, including direct loss of streams and wetlands, downstream changes in habitat structure or water chemistry through flow alteration, sediment inputs, temperature changes, shifts in pH, total dissolved solids (TDS), and introductions of contaminants. Aquatic biota may or may not be able to respond to this range of changes and often these results in changes in the community composition or species richness of aquatic systems receiving drainage from mined sites.

• Additionally, natural gas and oil extraction risks need to be assessed in the Green River basin, in relation to potential freshwater resource impacts (including fragmentation, increased impervious surfaces due to infrastructure development, and potential impacts to amount and quality of water).

**Intermediate Outcomes and/or Strategy Effectiveness Measures:**

• State or GRB staff assess Green River Basin Spatial Priorities Model, Resiliency and Energy Impacts Analyses to identify priority areas under risk from active past, current, or future mining.

• Engage with KY state mining agency and Office of Surface Mining partners to determine status of AML reclamation funds and prioritization, and potential to direct funds to priority areas.

• Engage with Central Appalachian Energy team and State partners to identify strategies with the greatest potential to abate energy extraction risks to priority areas (e.g., by examining Energy Impact Analysis, public land management/ restoration needs, potential for corporate engagement, BMPs, siting, minimizing fragmentation and other new impacts, etc.).
• Explore potential to maximize ecological benefits to priority areas by influencing where and how ~$800 M in federal Abandoned Mine Land Reclamation Funds are being utilized in Kentucky.

**Direct Outcome (Risk Abatement):** Abatement of risks from ecologically-incompatible energy extraction practices in critical areas (remaining wetlands) in the Lower Green subwatershed; improved mitigation and restoration practices.

**Risks & Assumptions:** To Be Determined: these will be documented, once appropriate strategies are identified and selected for action.

**Target Impact (or Ultimate Outcome):** Improved ecological processes and abated future risks to those processes, leading to improved habitats and resiliency of the Green River.

**Theory of Change (Results Chain):** To Be Determined: will be developed, once appropriate strategies are identified and selected for action.