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Assessing Stakeholder Perceptions about a Proposed Method to Prioritize Watersheds for Environmental Restoration

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Assessing Stakeholder Perceptions About A Proposed Method to Prioritize Watersheds for Environmental Restoration

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Introduction

During the past 150 years, Texas watersheds have undergone significant changes that affect land use, the amount of water flowing through these systems, water quality, and the numbers and types of fish and aquatic species that live in rivers and lakes (McKinney, 2002). Largely, these changes can be attributed to human activities such as dam building and reservoir management, population growth and greater water use, increased runoff from paved surfaces, and the introduction of non-native plant species (Jensen, 2003). As a result, competition for waters between human uses and environmental purposes has risen to such a level that aquatic habitats and ecosystems may be in peril, especially in arid regions of Texas (TWDB, 2002).

Recently, there has been increased public interest in investigating whether policies and management strategies could be implemented to restore watersheds, riparian zones, and other natural areas that support wildlife, fisheries, and habitats (Brown, 2000 and Alnwick, 2003). Often, the goal is to restore these sites to conditions that approximate conditions that existed prior to intensive human settlement. Interest in restoring watersheds and ecosystems has been expressed by several agencies including the U.S. Environmental Protection Agency or EPA (2000 and 2001) and the U.S. Fish and Wildlife Service (USFWS) (2000).

In Texas, efforts have been undertaken to identify restoration opportunities along the Gulf Coast by the Texas General Land Office (GLO) Natural Resources Inventory program (1998). Organizations including the Nature Conservancy (2000), the National Wildlife Federation (NWF) (1998), and the Galveston Bay Foundation (1998) have examined the need to set priorities for environmental restoration. The Nature Conservancy published a report, *Designing a Geography of Hope* (Groves et al, 2000), that describes one method of assessing restoration opportunities across ecosystems and watersheds.

A challenge facing restoration efforts is to develop management strategies that will benefit ecological conditions in watersheds while preserving existing land uses (including homes, businesses, dams, and infrastructure. Methods to identify estuaries and other watersheds that may be the highest priorities for restoration efforts have been identified by the U.S. Army Corps of Engineers (Corps) (2000) and the National Oceanic and Atmospheric Administration (NOAA) (2002). To deal with these concerns, the U.S. Army Corps of Engineers Fort Worth District Office expressed interest in determining how watershed restoration programs could be designed and implemented. A primary need of the Corps is to develop a science-based process that can objectively evaluate, prioritize, and identify watersheds that most need restoration efforts as well as regions where these measures are most likely to succeed. If such a methodology were developed, the Corps could use these recommendations to develop full-fledged feasibility studies within targeted watersheds. Such a method could be used by other natural resources agencies and organizations in Texas and elsewhere.

The Corps is already engaged in watershed restoration projects in some parts of Texas as a part of comprehensive Corps projects. These projects include work in San Antonio (Salado Creek), Dallas, Houston, the North Bosque River watershed, and other regions. This project

seeks to create a methodology that can be used to prioritize watersheds throughout Texas for restoration projects.

Environmental operating principles that should guide the Corps in its public works and water resources projects were identified in a March 2002 speech in Louisiana by Lt. General Robert Flowers (Corps of Engineers, 2002). The main points are shown below.

- The Corps should strive to achieve environmental sustainability,
- Balance should be sought between human activities and natural systems
- Potential problems should be resolved by designing environmental and economic solutions that complement one another.
- The Corps should seek ways to assess and mitigate potential adverse affects caused by Corps projects on the environment.

Objectives of This Project

1) To develop data about a number of parameters that indicate watershed values and watershed threats throughout Texas,

2) To develop a method by which these data can be used to compare and prioritize watersheds which would be the best candidates for restoration activities, and

3) To gather feedback from stakeholders about the extent to which the data developed in this effort and the methods used are appropriate to prioritize watersheds for restoration efforts.

Methodology

In August 2002, the Texas Water Resources Institute (TWRI) began efforts to coordinate the data gathering and analyses for this project. Key partners were identified who would meet regularly to define and adjust (as needed) the scope of the project and associated data gathering tasks. Individuals who cooperated with TWRI on an ongoing basis include the following:

- Becky Griffith and Kevin Craig, U.S. Army Corps of Engineers, Fort Worth
- Raghavan Srinivasan and Jennifer Hadley Jacobs, Texas A&M University (TAMU) Spatial Sciences Laboratory
- Ralph Wurbs and Gaurav Garg, TAMU University Civil Engineering Department.
- Andy Manale, EPA Headquarters, Washington, DC
- Andrew Sansom, Texas State University
- Allan Jones, B.L. Harris, and Ric Jensen, TWRI
- Ron Lacewell, Texas Agricultural Experiment Station
- Jim Bergan, the Nature Conservancy of Texas (TNC)
- Karen Chapman and Linda Brock, Environmental Defense
- Kirby Brown, Texas Wildlife Association
- Steve Manning, Central Texas Cattlemen’s Association
- David Burnett, TAMU University Petroleum Engineering Department.

An initial task associated with this project was to identify the types of data needed to identify watershed threats and values. As the project evolved, watershed values were represented by data associated with aquatic and terrestrial “portfolios” developed by TNC, major rivers, aquifer recharge zones, major reservoirs, and critical stream segments. Watershed threats were identified by assessing data on water and wind erosion, impaired streams, human populations, concentrated animal feeding operations (CAFOs), land fragmentation, the presence of brush species, and the extent to which flows have been altered by human activity in rivers and streams.

Early in this project, TWRI began working with the TAMU University Spatial Sciences Laboratory (SSL) to develop data layers associated with the watershed values and threats (mentioned above) into a geographic information system (GIS) framework. This work was led by R. Srinivasan and Jennifer Hadley Jacobs. In this effort, the State of Texas was divided into a series of 207 8-digit hydrologic unit code (HUC) watersheds (sub-basins) that are displayed on maps created with GIS.

Throughout the course of the project, some of the initial data sets were modified to better reflect the factors that need to be considered when prioritizing watersheds for restoration activities. Early in the project, a data layer was created that shows priority groundwater management areas designated by the Texas Commission on Environmental Quality (TCEQ), but this layer was omitted from the final report because it was not deemed to be relevant.

Data were developed by researcher Ralph Wurbs and graduate student Gaurav Garg of the TAMU University Civil Engineering Department to show the ratio of regulated to naturalized streamflows upstream of dams during high flow, median flow, and low flow conditions. This data was not included in the final report because the modeling upon which it is based does not cover the entire state.

During this project, several members of the working group expressed interest in developing data that would show the extent to which conditions have changed over time so that trends could be identified. However, most of the GIS layers and data sets developed for this project depict conditions at one point in time because data were often not available over a period of years that would allow such comparisons to be made.

Brief Description of Data Sets Developed for the Project

Throughout this project, the following data sets were developed. Each data layer consists of a GIS-generated map and related information. For most of the maps, threshold values were identified on the basis of “natural breaks” selected by ArcView GIS software. Where thresholds were not identified, the top 20% of values or the presence of a parameter within a HUC was determined to be significant. Threshold values were determined for the following variables:

- Water Erosion (the threshold value is more than 0.85 tons per acre),
- Wind Erosion (the threshold is more than 3 tons per acre),
- Projected change in human population density (the threshold is greater than 225 people per square mile),
- CAFOs (the threshold is greater than 7 CAFOs in a watershed),
- Fragmentation Index (the threshold is an annual increase of 8% or more in ranches less than 500 acres),
- Percent of cropland near streams (threshold is 30% or more of cropland within 120 meters of National Hydrography Dataset or NHD streams),
- Ratio of regulated to naturalized flow during low flow conditions (the threshold is 0 to 0.6).

Some indicator variables did not use threshold values. These datasets count the presence of absence of specific conditions within each HUC. Maps using this approach include:

- The presence of impaired streams that do not meet designated uses, as identified by TCEQ (i.e., the draft 303-d list,
- The occurrence of mesquite, juniper and saltcedar infestation,
- The presence of major rivers,
- The occurrence of groundwater recharge zones,

- The presence of reservoirs,
- The occurrence of ecologically significant stream segments identified by the Texas Parks and Wildlife Department (TPWD),
- The presence of Texas Nature Conservancy (TNC) Aquatic, Terrestrial and Marine Portfolios.

For each HUC the percentage of riparian cropland was determined. Those HUCs within the top 20% were determined to be significant for this application.

Indicators of Watershed Values

TNC Aquatic Portfolio – TNC created data about watersheds and areas where water resources are important to maintain environmental quality. TNC provided these data to the Spatial Sciences Lab (SSL) in a shapefile format, but that data did not initially include a significant portion of the Texas Gulf Coast or East Texas. In the final version of this report, this data layer is presented for illustration purposes only and was not used as a weighing factor to identify watersheds in need of restoration because it did not provide statewide coverage.

TNC Terrestrial Portfolio – These data identify the presence of important terrestrial ecological resources throughout Texas, as identified by TNC. It is unclear whether water resources may have a direct link to the ecological quality of all these sites. Initially, TNC had not gathered extensive data on terrestrial resources in East Texas and along the Upper Texas Gulf Coast. In the final version of this report, this data layer was presented for illustration purposes only and was not used as a weighing factor to identify watersheds in need of restoration because it did not provide statewide coverage.

TNC Marine Portfolio – The marine portfolio identifies coastal waters and bay and estuary systems where water resources are vital to support ecological functions. Initial TNC data identified only bay and estuary systems along the Southern Texas coast. In the final version of this report, this data layer is presented for illustration purposes only and is not used as a weighing factor to identify watersheds in need of restoration because it did not provide statewide coverage.

Major Rivers – Data for this layer were supplied by the Texas Water Development Board (TWDB) in shapefile format. Rivers included in this data layer include the Brazos, Canadian, Colorado, Guadalupe, Lavaca, Medina, Neches, Nueces, Red, Rio Grande, Sabine, San Antonio, San Jacinto, Sulphur, and Trinity, as well as Cypress Creek.

Selected Aquifer Recharge Zones – Aquifer boundaries were obtained from TWDB. This data was supplied in shapefile format and modified by the SSL to show only “significant” aquifer recharge zones determined by the project team. Recharge areas are shown for the Carrizo, Edwards, Seymour and Trinity aquifer groups.

Existing Reservoirs – This data layer was created using information from TWDB about existing major reservoirs (larger than 5,000 acre-feet) throughout Texas. The existence of a reservoir was thought to be a watershed value since dams provide year-round aquatic habitat. Some workshop members contended that the presence of reservoirs should be viewed as a watershed threat since the building of a dam alters the natural habitat.

Ecologically Significant River and Stream Segments – This data layer depicts ecologically important river and stream segments identified by TPWD. As a result of Senate Bill 1 (1997), TPWD allowed regional water planning groups to designate ecologically unique river and stream segments in their area, based on biological and hydrological functions, high quality waters, aesthetic values, riparian areas and the presence of threatened or endangered species.

Indicators of Watershed Threats and Impairments

Total Water Erosion – Data for this layer was provided by the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Natural Resources Inventory. It shows the amount of soil erosion (in tons per acre) caused by runoff.

Total Wind Erosion – Data for this layer was provided by the USDA-NRCS Natural Resources Inventory. It shows the amount of soil erosion (in tons per acre) caused by wind.

Impaired Water Bodies – This data layer shows river and stream segments in Texas that have been identified by TCEQ as not meeting designated uses due to water quality impairments. These stream segments are listed on the draft 2002 Section 303 (d) list developed by TCEQ to comply with the federal Clean Water Act.

Projected Percent Change in Human Population Density –This data layer was created based on information provided by the U.S. Census Bureau for the year 2000 and population trends for the year 2040 developed by the Office of the State Demographer at TAMU. The map shows the average projected percent change in population.

CAFO Locations–This data layer was developed from information provided by TCEQ. It includes the locations of various types of CAFOs, including cattle feedlots; dairies; chicken and turkey operations; and sites where sheep and swine are raised. This map is presented only for illustration purposes and was not used as a weighing factor.

CAFO Density – This map depicts the number of CAFOs per HUC. It does not differentiate between CAFOs with various numbers of animals. This map and data set were used as a weighing factor and were incorporated into the matrix of watershed values and impairments.

Fragmentation Index – This data layer was developed using analyses carried out by Neal Wilkins of Texas Cooperative Extension (Extension). The information shows areas where there have been increases in ranches less than 500 acres in size from 1992 to 1997. These data suggest that large tracts of agricultural lands are being subdivided, perhaps affecting ecosystem quality. In the final version of this report, this data layer was presented for illustration purposes only.

Percent Riparian Cropland–This data layer was developed using 1992 information from the National Land Cover Dataset created by the U.S. Geological Survey (USGS). The data layer displays the percent of lands used to grow crops within 120 meters of streams in the NHD. This data identifies watersheds where agricultural activities might affect stream water quality.

Mesquite, Juniper and Salt Cedar Infestation– In earlier versions, this data layer consisted of one map that combined data on the spread of mesquite, juniper and saltcedar. In the final version of this report, separate data layers and maps have been created for each species This data layer was created using information from the TPWD 1984 statewide vegetation survey and the NRCS 1982 brush survey. The SSL extracted data for mesquite and juniper from the TPWD database, and plotted each species on a separate map. The map for saltcedar infestation was created from the TPWD database and the NRCS brush survey. Saltcedar was assigned the highest weight (3x) while mesquite and juniper were each assigned a weight of 2x, based on the suggestions of the San Angelo workshop.

Ratios of Regulated Flows to Naturalized Flows During Low Flow Conditions—Three maps were created describing the ratio of regulated flows to naturalized flows during low-flow, median-flow, and high-flow conditions. These data were created by researcher Ralph Wurbs and graduate student Gaurav Garg of the TAMU University Civil Engineering Department. The researchers used the TAMU Water Rights Analysis Package (WRAP) to compare the extent to which streamflows during low-flow conditions (75% of flows are greater than this value), median flows (50% of flows are greater than this value), and high flows (25% of flows are

greater than this value) have been altered upstream of dams. The streamflow data were entered into a GIS framework and displayed over the 207 8-digit watersheds. In the final version of this report, these data layers are presented only for information purposes and are not used as a weighing factor to prioritize watersheds that need to be restored, because WRAP modeling has not been performed for the Rio Grande watershed and does not provide statewide coverage.

In this project, several modeling scenarios were attempted to simulate the extent to which human activities altered streamflows. As the project progressed, it was decided that the choice of control points was critical in determining how flows had been affected by human activities; so efforts were made to identify control points immediately upstream of reservoirs. Efforts are now under way to refine these modeling exercises to select the most appropriate control points that will best reflect the influence of human influence on streamflows.

Developing a Framework to Use this Data to Prioritize Watersheds

These data layers were used to develop a matrix that provides a way for the working group to rank the relative importance of these factors and create comprehensive maps of watershed threats and values.

Tables have been developed that present information on the percentage of sub-basins in which each parameter was defined as having significant value or causing significant impairment. A table provides the parameter weights suggested by the project team. Some parameters present in earlier versions of this study have been removed from the final report and are not included as weighing criteria.

Based on the weights assigned to these data layers, and a merging of this information, a map was developed that combines the weighted watershed threats and values (Figure 1).

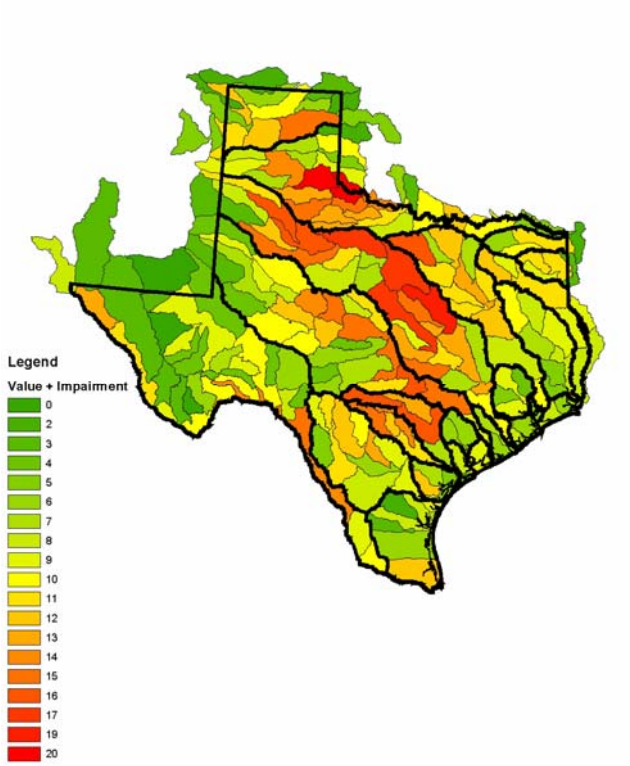

Figure 1. Map of Weighted Watershed Values and Threats to Prioritize Restoration Efforts.

Gathering Stakeholder Perceptions About This Project

To confirm whether the data developed for this project and the methods proposed to rank and prioritize watersheds were viewed as being valid by key stakeholders, TWRI hosted half-day workshops in San Angelo, San Antonio, and College Station.

In these workshops, TWRI invited natural resources and watershed experts from academia, agencies, and organizations to listen to presentations by Institute Director Allan Jones and Raghavan Srinivasan and Jennifer Jacobs of SSL about the various data layers. At these workshops, participants were encouraged to ask questions, provide observations and comments, and offer suggestions about how the datasets and the priority-setting process could be improved.

At each workshop, naturalistic methods commonly used in focus group research were employed (Edmunds, 2000; Proctor, 1997). Jones served as the moderator, leading and facilitating group discussion. To the greatest extent possible, Jones used open-ended questions, fostered spontaneous interactions that engaged participants, and avoided any preconceived conclusions. Participants' comments were used to guide ongoing efforts to refine this methodology and ensured that this effort utilized grounded theory.

At each workshop, Ric Jensen of TWRI gathered and recorded by hand the comments made by all participants. A written transcript was created that identifies which individuals offered specific comments. Action items (suggestions on how the data sets or the priority setting process could be improved) were taken from the transcripts and incorporated into a comprehensive list of items for future study. From this list of action items, themes were identified using principles of naturalistic inquiry.

A total of 29 people met in the three focus groups. They included 10 individuals from higher education, seven from federal agencies, six from state agencies, two from local agencies, and one person from the private sector. The first workshop was held in College Station in November 2003 and involved nine people; 14 people met in San Antonio and 14 participants took part in San Angelo. Participants included the following individuals:

College Station Workshop--Allan Jones, B.L. Harris, and Ric Jensen (TWRI), Jennifer Hadley Jacobs and Raghavan Srinivasan (TAMU SSL); Kevin Craig, U.S. Army Corps of Engineers; Bill Neill, TAMU Wildlife and Fisheries Sciences Department; Nicky Dixon, TAMU Rangeland Ecology and Management Department; and Brian Crook, USDA Farm Security Administration.

San Antonio Workshop -- Allan Jones and Ric Jensen (TWRI); Jennifer Hadley Jacobs, SSL; John Burgin, University of Texas—San Antonio; Kathy Boydston, Tom Hagger, and Rollin McRae, TPWD; Philip Wright, USDA-NRCS; Comer Tuck, TWDB; Janet Black, Texas Engineering Extension Service; Paul Barnes, Texas State University; Dana Nicholls, San Antonio Water System; and Darwin Ockerman, USGS.

San Angelo Workshop – Allan Jones and Ric Jensen (TWRI); John Walker and Darrell Ueckert, (TAMU Agricultural Research and Extension Center in San Angelo); Mike Mecke, TWRI and Extension; Steve Nelle, USDA-NRCS; Sonny Kretzschmar, HDR Engineering; Paul Loeffler, GLO; Ruben Cantu, TPWD; Kevin Craig, US Army Corps of Engineers; Tim Schumann, USFWS; Ned Strenth, Angelo State University; Okla Thornton, Colorado River Municipal Water District; and Marvin Ensor, Extension.

Fifteen comments were made about the maps of brush infestation. A frequent comment was that data on saltcedar needed to be added, especially for the Pecos River basin and the Lower Rio Grande Valley. Others commented the map needed to be broken up into separate

layers for saltcedar, mesquite, and juniper and this was done for the final report. Several participants asked if more recent information might be available than the 1984 data from the TPWD used in this project, and urged that efforts be initiated to develop new data on this issue.

Twelve observations were given about the land fragmentation map. Several people had a difficult time understanding what this data layer was showing and how this might yield insights on watershed impairments. Some participants commented that the trends they expected to see from this data set (the proliferation of subdivisions in the Hill Country and the Houston area) were not reflected on the map. Respondents suggested that other datasets might better reflect the breakup of agricultural lands, including numbers of septic systems, development of subdivisions, miles of roads, and changes in land value.

Eight comments were offered about the data layers provided by TNC. Several participants were concerned that these data did not provide statewide coverage and wanted to know more about how these portfolios were developed. Others asked whether data from special interest groups is as objective as information developed by agencies or higher education.

Several observations were offered about the maps that combine values and impairments, the need to capture data trends, and the types of restoration projects participants want the Corps to consider. 13 comments were given about results of the use of the matrices that use data sets and weighing factors to prioritize watersheds. Many commented that the maps of watershed priorities seem to undervalue watersheds in the Lower Rio Grande Valley and the Gulf Coast. but two people noted that omitting TNC maps from the analyses would shift the highest priority watersheds from West Texas to other regions. Others suggested that the data sets do not pay enough attention to industrial and urban pollutants and that there seems to be more information on watershed threats than watershed values.

Six comments were given about the need to capture trends. The Corps said they would prefer that datasets should be created that show changes over time as well as future projections. SSL staff responded that the data layers needed for such trend analyses are often not available.

Attendees also spoke of the types of restoration programs they wanted the Corps to consider. 10 comments were given in this regard. Types of restoration work participants wanted the Corps to consider included the development and implementation of vegetative buffers; brush control; restoring bottomland hardwoods and forests, uplands, and other habitats; buying out lands in floodplains; developing “soft” solutions to flood control; putting oxbows and bends back in channelized rivers; removal of dams; increasing streamflows; putting more water back in streams; weather modification, and education. The Corps said that they might have an open mind to most of these options, including even dam removal in some cases.

Most importantly, 14 of the 26 participants said the process used in this study, the methodologies used to create the maps of values plus impairments, and the cumulative maps were an excellent screening tool. These comments show that a majority of participants agreed that this project had created an excellent tool to identify watersheds for prioritization efforts.

Some of these comments included the following:

“I like this process because you can see the issues in the maps and clearly identify watersheds that might be good candidates for restoration” (College Station, participant 4).

“You’re on the right track...This process has created quality data layers that can be used to examine important issues on a watershed scale” (San Antonio, participant 2).

“This data set outlines the issues and helps prioritize them...It gets you thinking and tells you there is a lot more work to do, but it points you in the right direction” (San Antonio, participant 9).

"I like this project a lot and think it's important, useful, and valuable...I will take it back to my agency and see if and how we can use it" (San Angelo, participant 5).

Summary and Next Steps

This project presents comprehensive data about conditions in Texas watersheds. It represents a thorough effort to gather data on watershed values and threats. Methods used to develop these datasets include recent technological advancements, such as GIS and complex water resource models. This project proposes a method through which comprehensive watershed data can be used to identify watersheds that most need restoration efforts, and it allows stakeholders to make value judgments about the importance of these parameters.

The final report for this project is still under review. When finished and approved, it is anticipated that the final report will include software that allows users to view the maps and data layers created for this project and to assign weighing factors based on their restoration goals. It will also allow users to create custom maps that identify the highest priority watersheds. Efforts are now being made to develop a table showing the duration for which quality data are available for each spatial layer.

The project included significant provisions for obtaining perceptions from key stakeholders (i.e., scientists, water resources managers, natural resource professionals, and the public) to comment on and verify the extent to which this effort has merit. By involving participants, essential information was gained about the types of watershed restoration projects these stakeholders most want to pursue.

Ultimately, it is hoped that the Corps and other and entities pursuing environmental planning work will use the methodologies and datasets developed for this project to identify and prioritize watersheds for restoration activities. Development and use of a science-based tool to assess watersheds that most need restoration work provides a sound basis for initiating full-scale, comprehensive assessments of restoration work needed in watersheds.

Recommendations for Future Study

At the workshops, participants suggested that more data layers could be created to further refine the prioritization process, and recommended that the method used to rank watersheds could be improved. These ideas are presented here. Please note that these items are outside the scope of this study and cannot be developed without additional resources.

Data could be gathered on populations of key aquatic species in watersheds,

Data could be displayed about surface- and ground-water interactions.

A map could be developed showing springs that no longer flow.

A data layer is needed showing the total number of animals in CAFOs.

Threatened and endangered species could be mapped and displayed using TPWD data.

Maps are needed to reflect trends in land development (i.e., the number of septic systems, miles of roads, and the spread of subdivisions).

A dataset could be assembled about large rural land tracts that have been left intact.

2004 data from the USDA Farm Service Agency about crop acreage, rural land use, and agricultural production could be developed into datasets.

More data are needed on industrial and urban pollution (i.e., Superfund sites).

Maps showing Corps activities in Texas (e.g., wetlands mitigation, flood control, and dredge and fill operations) could show opportunities to offset the effects of Corps projects.

The draft 303-d list could be transformed into separate maps showing different types of impairments (i.e., bacteria, sediments, heavy metals, etc.).

The Rio Grande needs to be modeled using WRAP to provide a statewide assessment of how human activities have influenced flows.

Tools created for this project could be utilized to analyze other environmental policy issues (i.e., the effects of federal and state agricultural policies on water resources).

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