Pilot Test Project for Produced Water near Hardtner, Kansas

Funding Opportunity Announcement No. BOR-DO-17-F004

Submitted by the Kansas Water Office

900 SW Jackson St., Suite 404

Topeka, KS 66612

785-296-3185

www.kwo.org

Project Manager: Kirk Tjelmeland

Kirk.tjelmeland@kwo.ks.gov

Table of Contents

TABLE OF CONTENTS: FOA No. BOR-DO-17-F004

Pilot Test Project

Executive Summary:

DATE: February 2, 2017

APPLICANT NAME: Kansas Water Office (KWO)

CITY: Topeka

COUNTY: Shawnee

STATE: Kansas

The Kansas Water Office (KWO) is very interested in working with oil and gas producers, farmers, ranchers, and communities in the Red Hills region to create a pilot project. The project will involve the treatment of produced oil field water to a quality standard acceptable for agricultural irrigation and the watering of livestock. A collection tank for a disposal well near Hardtner, Kansas will be the site of the project. This particular collection tank is capable of providing 500 barrels of oil field water per day; however, treatment will be conducted only during daylight hours. The treatment facility will be powered by natural gas with a nearby pond reaping the benefit of the treated water. A sixty day operating permit has been secured from the Kansas Department of Health and Environment with daily evaluations of effluent. Funding from the grant will provide a means to operate the equipment necessary to treat the produced water and also periodic testing of the effluent. This project aligns very well with the goals of this particular FOA by reusing an industrial by-product for the benefit of fish and wildlife or agricultural purposes. When this process is proven successful in the Red Hills region, it will certainly diversify the water supply and could provide flexibility during water shortages.

It is expected that if this project receives the grant award in May of 2017, mobilization of the equipment would start soon after the final award is made. The project is permitted for only a 60 day period so the entire project, including evaluation, would be completed by the spring of 2018.

Technical Project Description:

The injection of produced water is an issue that continues to draw attention from around the Midwest. An area of Kansas that has significant investment in the oil and gas industry is the Red Hills Region. A group of interested individuals have been working with a company that has a similar pilot project near Ardmore, Oklahoma. That project successfully treated produced water to an acceptable level, however the chlorides are much higher in Kansas' produced water.

The group of collaborators canvased the Red Hills region and found a nearly ideal location for the pilot project, Appendix 1. The disposal well is located just 3 miles west of Hardtner, Kansas and was tested by Servi-Tech Laboratories on 9/2/16. Two critical results of the test were Chlorides of 120,000 mg/l and Boron at 17 mg/l, both of which need to be reduced significantly to meet stock water or irrigation standards. The acceptable level for Chlorides for irrigation or stock water are 150-200 mg/l and the Boron level needs to be 1 mg/l for wheat and 4 mg/l for beans. The well is capable of providing 500 barrels per day of produced oilfield water. The project would be conducted during daylight hours only, essentially 8 hours per day or around 170 barrels (7,140 gallons) of water. There are three adjacent ponds with the largest one to be the recipient of the effluent from the treatment facility. Lidar was used to establish the current volume of the 11 acre pond which is more than sufficient to hold the effluent during the 60 day trial period. The landowner indicated that the pond has never filled completely.

Given the proven success of the company from Ardmore, OK, Contractor was chosen to be the contractor for this project. The treatment system Contractor intends to deploy for this pilot test includes electro-coagulation (EC) which will remove all oil and organics by creating a hydrophobic environment. Electrocoagulation utilizes electricity as the electromotive force to drive chemical reactions in a solution, suspension, or emulsion. A direct current is introduced into the water source as it passes between predetermined electrodes in the system module. The energy from the electricity is the engine-or driving force-that provides a mechanism for removing dissolved, suspended, or emulsified molecules. It can also remove elements or ions to the very minute levels. The modules are constructed with either iron or aluminum materials. Contractor have done thorough analysis on numerous materials, finding that iron and aluminum both provide the elements needed for electrocoagulation to be successful. They are both a high quality, cost-effective, and conductive materials that are widely available. These non-toxic materials have demonstrated proven results in a wide variety of contaminants. The treated water will be polished using a desalination unit. One stream from the EC will be sludge, which will include organics, metal and other solids; this will be benign and can be disposed of in a local

landfill or solid waste disposal facility. The waste water stream from the desalination unit will be clean brine or plain salt which can be recycled, used in the treatment of roads during winter condition or disposed of in a solid waste facility. The foot print of the facility will be relatively small, 30' x 120'. All normal safety procedures will be followed; commercial containment mates with raised sides will be used for the duration of the pilot project. The effluent that is discharged to the pond will be tested daily, using Servi-Tech irrigation suitability package (Appendix 2), for the first seven days and weekly pending successful samples.

There are a number of different technologies available: Media Filtration, Adsorption, Oxidation, Ceramic Microfiltration/Ultrafiltration, Electro dialysis/Electro dialysis Reversal, Captive Deionization, Forward Osmosis, Reverse Osmosis, Multi-Stage Flash Distillation and even Freeze/Thaw Evaporation. However, the purpose of this pilot is not to identify the best of these technologies, but simply prove that the concept works. The Kansas Department of Health and Environment (KDHE) has never issued a permit do conduct work like this before. Success on this project should open the door for many other ventures with the ultimate goal of recycling 10,000 barrels per day of produced oil field water by 2040.

Evaluation Criteria:

Section E.1.1

1. Water supplies in the Red Hills region are limited to a few lakes, alluvial aquifers and a small portion of the High Plains Aquifer. Currently, additional water rights are not available in many areas of the region. Any expansion of water use is very dependent on location. Reuse of production water would increase water availability, reduce stress on the local water resource and therefore allow development of additional use, adding to the economy.

The Chief Engineer, Kansas Department of Agriculture-Division of Water Resources (DWR), uses a dual review system for water right development in south central Kansas, a region that relies primarily on alluvial aquifers and limited stream flow. New applications for water rights are first evaluated for water availability based on a specific Designated Unit Area (DUA) water budget. If there is water available for appropriation in the DUA, the application then is evaluated for safe yield within a two-mile circle around the proposed point of diversion (water well).

The potential imbalance occurs with short term permits, most of which are not evaluated for safe yield or DUA water budgets. Term permits appropriate water for a specified time; if less than five years, no safe yield or DUA evaluation is conducted. Basin Term Permits appropriate up to 100 AF of water from a stream within a specific basin, within a calendar year. Temporary Permits are for water uses less than six months (and typically 90 days for oil and gas wells). In 2012, the Chief Engineer, DWR, raised the temporary permit cap from one million to four million gallons, a quantity needed for horizontal drilling and hydraulic fracturing.

In the early 2010's, petroleum prices and technology stimulated increased oil and gas development of the Mississippi Lime play. Water used in the oil and gas industry is usually permitted through temporary permits issued for six months or less. These are often granted, due to their short term, where permanent water appropriations are not available. The water demand associated with the increased oil and gas activities and increased municipal demands associated with the influx of workers brought up concerns from local water suppliers in their ability to meet demands at the time and into the future. (The Kansas Corporation Commission estimated 565 million gallons or approximately 1734 acre-feet was used by the oil and gas industry in 2013 in the area.)

In addition to water availability, wastewater disposal quantities can be reduced with the reclaiming of produced waters. In Kansas, there has been a correlation established between the disposal of produced water by underground injection and earthquakes in the area. Underground injection for disposal of produced waters has been modified through the Kansas Corporation Commission order under Docket No. 15-CONS-770-CMSC (Order) limiting the amount of saltwater disposal rates for more than 70 wells in Harper and Sumner County, KS to monitor the effects on seismic activity. The order limited all Arbuckle disposal wells to no more than 25,000 barrels of fluid per well, per day in Harper and Sumner Counties. Reducing quantities of produced waters needing disposal through underground injection could lessen the overall underground injection quantities as well as reduce the need to transport or store produced waters for later disposal. When trucked offsite expenses to the industry climb and reduce profitability, often taking oil and gas wells out of production.

2. As mentioned above, additional water rights are not available in many areas. These limited resources do not allow for much economic growth. As seen in 2012-2013, during times of drought, the dependability of these water resources can be an issue. Developing an additional source of supply, through reuse of produced water can help address these concerns. A 2013 Kansas Water Office in-depth look at Harper County municipal supplies and oil field fresh water

usage recommended the oil and gas industry use the lowest quality water available to meet its needs and encouraged reuse and water recycling for drilling and development.

Section E.1.2

1. Research and development of more cost-effective treatment solutions would promote large-scale produced water recycling and reuse. Due to the poor quality of Kansas "produced waters", the research of treatment technologies and reuse potential is needed. It has been estimated that in 2012, 1.06 billion barrels of produced water were the products of oil and gas activities in Kansas. In that year, approximately 135, 546, 700 barrels were produced in the 7 counties that are included in the Red Hills region in south central Kansas. Estimates are based on 22 barrels of produced water per 1 barrel of oil, and 300 barrels of produced water per million cubic feet (mmcf) of gas. Recycling 10,000 barrels a day equates to 420,000 gallons per day or 1.289 acre-feet per day. Over one year, this totals 3,650,000 barrels, 153,299,997 gallons or 470.5 acre feet per year. (1 barrel = 42 gallons =0.000128893 acre feet) Due to the poor quality of Kansas produced waters, the research of treatment technologies and reuse potential could also be applied to low quality surface and ground waters not presently being utilized.

Produced water is typically characterized by salt concentration, inorganic matter, organic matter, radioactive material, and chemical additives. Salinity, described as TDS, is major attribute of produced water. Conventional oil and gas wells in central Kansas produced water between 1,000 and 300,000 mg/L. Generally, over half of all wells are below 60,000 mg/L. Sodium chloride dominates the salt type in Kansas water.

High salt concentrations can be potential harmful to agriculture. Excessive salt can make it difficult for plants to absorb water and nutrients from the soil. It can also reduce the health of the soil making the area infertile for extended periods of time.

Inorganic matter is measured by the sodium absorption ratio (SAR), which tends to increase as salinity increases. Kansas waters have moderate to high SAR. SAR is commonly used as an index for evaluation of the sodium hazard associated with irrigation water supply. Excessive SAR can cause Na buildup, overtime leading to soil crusting, poor seed emergence, and poor aeration.

2. This study will support water reclamation for additional beneficial use that will add to the economy of the region. Since little reuse is currently occurring this research could identify a market potential for reuse waters. Reuse could be developed for industry as enhanced recovery operations for oil and gas, new drilling or fracking fluids and dust control. Produced water reuse in oil and gas may be the most effective solution due to lower treatment costs and decreased health hazard through increased exposure. The use of produced water after treatment has already been proved practical by industry in some parts of the United States. This study will provide data for the Kansas oil and gas industry to reduce use of freshwaters, freeing these up for other beneficial uses.

Although the focus of this study is to treat produced water to standards acceptable for irrigation and stock watering, the potential to utilize reclaimed water includes other industrial uses, irrigation and stock watering and could provide additional water for fish and wildlife, recreation and possibly groundwater recharge, depending on the level of treatment. Location of holding areas above groundwater aquifers could recharge these aquifers storing water for future use. If these aquifers are continually recharged additional beneficial uses can be developed or existing use made more sustainable during times of drought.

3. Little reuse of produced waters is currently occurring. This research will allow for the broadening of understanding of treatment levels needed to increase the reuse of low quality waters including produced waters. After treatment water will be discharged into private ponds, enhancing habitat for fish and wildlife, increasing recreational opportunities and providing water for irrigation and other uses.

Section E.1.3

1. The objective of this study is to simply prove that produce oil field water can be treated to a level suitable for irrigation or stock watering. Currently no produced oil field water is permitted for reuse and if this project proves successful there could be a big expansion of this industry into Kansas.

2. The list of collaborators on this project is fairly lengthy. The Kansas Water Office is applying for the grant and will responsible for project oversite. The Kansas Department of Health and Environment issued the 60 day permit allowing the pilot project to move forward and will be monitoring the water samples from Servi-Tech. Contractor is the contractor who will be supplying the labor, equipment and technology for the project. Lotus Operating will be responsible for collecting the effluent samples and making sure they are delivered to Servi-Tech.

Directional Drilling Systems, LLC assisted with initial location of disposal well and communication with the property owner. Achenbach Trust is the mineral right owners for this particular piece of property. BarBoot Ranch is the property owner for the property that the disposal well sets on. Finally the Red Hills Regional Advisory Committee (RAC) has a goal of seeing 10,000 barrels per day of produced water recycled by 2040.

3. The Kansas Water Office has a small staff that has years of experience dealing with most water issues in Kansas. The professional staff is fully competent with a wide variety of degrees and multitudes of grants that have been completed under their direction. The Kansas Department of Health and Environment is a much larger agency with a broader base of employees. As their name implies this particular agency has been and is responsible for anything that might impact the Kansas environment. Contractor has been in business for a good many years and is responsible for the successful produced water test in Ardmore, OK that has opened that state up for more reuse projects. Lotus Operating has been in business since 1985 and has had a presence and reputation in the area second to none. Achenbach Trust and BarBoot Ranch are the reason this project is taking place. They have offered up their property and will be providing the natural gas to power the E-C unit. The Red Hills RAC was given a set of goals approximately one year ago and have put together action plans to accomplish those goals. They are local people driven by a deep seated interest in their community.

Section E.1.4

1. This pilot project over the 60 day period has the potential of providing 428,400 gallons of water to an adjacent pond. Barber County, where this project is located has several Threatened and Endangered (T&E) Species listed, as well as several Species In Need of Conservation (SINC) Species. None of these species have been documented at the pond however with the additional water some of the migrant species might be more inclined to visit the pond. If this project is proven successful, the potential for produced oil field water within the region seeping into groundwater would be much smaller, especially if the goal of the Red Hills RAC for 2040 is reached.

2. The potential to improve flow conditions in a natural stream would be unlikely following this reuse project. KDHE has established highly regarded regulations that would need to be considered before allowing any reuse water from this pilot project to enter a natural stream. With completion of this pilot, KDHE will have additional information to help determine future instances that may occur in regards to improve flow conditions in natural streams.

3. With Barber County in the south central portion of Kansas it does have lower precipitation totals and higher evaporation rates than portions of eastern Kansas. The addition of any surface water to this region would lend itself to increasing habitat and possible propagation of a few T&E or SINC species.

Section E.1.5

1. Contractor preformed a bench test on a two gallon sample of water from the disposal well. It was determined that the process of EC alone would not be sufficient to produce the quality of water that was needed to water livestock or irrigate crops. The professional from H20 will add a desalination unit to the process to achieve the goals.

2. The success of the project could eliminate a huge hurdle; KDHE has issued no other permits for this type of project before. Obtaining the 60 day permit from KDHE was no simple task however with project success, future permits should be much easier to obtain. Building on the success of the Ardmore, OK project and the preliminary bench test this project could prove extremely valuable to the residents of Kansas. There shouldn't be any environmental issues that will delay the mobilization, project startup and demobilization other than adverse weather conditions.

Section E.1.6

1. The plant that Contractor will assemble is going to use donated natural gas from a local well to power the unit. The unit requires a significant amount of energy to power the desalination portion of the process. I don't see wind or solar energy playing a major role in this particular project. Future ideas may require less energy that could be supplied by renewable energy sources.

Section E.1.7

1. This study has been developed as part of the 50-year Vision for the Future of Water in Kansas to find additional sources of water. The Red Hills Regional Goals, a part of the Vision process and the Kansas Water Plan include reducing the freshwater used in oil and gas completion operations by four percent annually and having 10,000 barrels per day of fresh water being recycled from oil production. The Vision and the Kansas Water Plan provide identification of water issues in the state and actions to address them. Local stakeholders developed goals in 2015 and corresponding actions plans to achieve these goals in 2016. This research-is included in the action plan for the Red Hills region as a pilot project which can demonstrate the potential for reuse and educate industry and local citizens.

2. Understanding the potential and limitations of reuse of produced waters and other low quality waters will allow for increased water reuse in an area that is not water rich. Treatment

technologies may be transferred to other uses, such as municipal, should water quality deteriorate as some believe is occurring in the area. At least two cities and three rural water districts that purchase water, use water that is treated through ion exchange, which has been greatly needed in recent years to address water quality issues. If other suppliers are adversely affected by water quality, treatment of low quality waters may become more standard. This research will aid in understanding this additional source of supply, the treatment and contribute to the public's understanding of treatment and reuse.

Section E.1.8

1. The produced water in south central Kansas has a relatively high chloride content compared to produced water from the Ardmore, OK project. The combing of multiple processes to produce water that is palatable for animals or plants is essential to tackle the water needs of Kansas.

2. The success of this project will benefit Kansas more than most states because there are many other states that have already moved into the arena of treating produced water. The process developed in this project may prove beneficial to other areas that have produced water with similar water characteristics. The pilot project will set an economic goal that later projects will try and improve on, driven by the economics of the oil and gas industry.

3. This project has drawn several groups and individuals together that typically wouldn't be working side by side. Having a common goal, a possible new water source, has driven this group to work together to strive for success. Success will be measured differently by state agencies, businesses, landowners, the Red Hills RAC and the residents of Kansas. Ultimately treating produced water to an acceptable level is a point of success for all of these groups.

Environmental and Cultural Resources Compliance:

The foot print of the EC plant is relatively small, at 30' x 120', however there will be some ground disturbance. The area that is to be impacted has a vegetation cover of some annual and perineal forbs and grasses. A commercial retention mat will be placed down prior to the placement of the unit. This mat has sides that will contain any spills. With the time the mat will be down on the ground, this will kill all vegetation that will be under the mat eliminating a minimal amount of habitat for smaller creatures. There will be a minor amount of emission to the air with the use of natural gas to run the plant.

With a list provided by the Kansas Department of Wildlife, Parks and Tourism, the KWO is not aware of any T&E or SINC species that reside in the project area. Appendix 3 lists these species and Appendix 4 is the Invasive species manual. If any of these species were to be found in the project area, they would be positively affected by the addition of water to the pond. Chloride levels of treated effluent are below tolerable limits of aquatic life in the pond. There are three ponds in close proximity, however only one of them will receive effluent and there are no wetlands.

The water delivery system for the effluent to the pond will be temporary and constructed when the plant is being installed. There will be no modifications of any type to an irrigation system and no irrigation equipment of any type will be used or altered during the project.

There are no known archeological sites in the proposed project area. This project will have no adverse effect on low income or minority populations. Also the project will not limit access to any sacred Indian sites or tribal lands. The project will not introduce or help spread any noxious weeds or non-native invasive species.

Letters of Support:

Four letters of support have been submitted so far for this project and I am expecting one more from the Red Hills Regional Advisory Committee. The agencies that submitted letters of support are: Kansas Department of Agricultural-Division of Conservation, Kansas Department of Health and Environment-Watershed Management Section, the Nature Conservancy and Kansas Alliance for Wetlands and Streams, Inc. All of these can be found in Appendix 5.

Required Permits or Approvals:

The Kansas Water Office has received a 60 day permit from Don Carlson (KDHE), "For the short term (60 day) one-time pilot test we will only require oil & grease and chlorides. They will need to sample at least daily until the treatment system becomes stabilized and at that point they can go to weekly sampling. The sample should be collected at the discharge from the treatment unit."

900 SW Jackson St. Suite 404
Topeka, KS 66612

Phone: (785)-296-3185
Fax: (785)-296-0878
www.kwo.org

Gary Harshberger, Chair

Sam Brownback, Governor

February 2, 2017

Bureau of Reclamation, Financial Assistance Services
Attn: Mathew Reichert
Mail Code: 84-27852, P.O. Box 25007
Denver, CO 80225

RE: Pilot Test Project for Produced Water near Hardtner, Kansas

Dear Mr. Reichert and Review Committee:

The Kansas Water Authority makes this resolution to enter into a contractual agreement with the Bureau of Reclamation for a Title XVI WaterSMART grant for the above referenced study, if it should be awarded. The Kansas Water Authority is the arm of the Kansas Water Office that approves entering into federal contracts.

Several entities both private and public would like to see produced oil field water used for something other than injecting it into the Arbuckle. There are several technologies available to treat produced oil field water however to this point Kansas has not been a proponent this. A short term permit has been issued by Kansas Department of Health and Environment to allow this pilot project. The chlorides of the test well are in the 120,000 ppm and the goal is to treat this water to either irrigation or stockwater standards. This project will evaluate the feasibility of produced water treatment in Kansas with an eye towards large scale treatment facilities.

The Kansas Water Office (KWO) commits to the legal and financial obligations as outlined in the proposal. The KWO would be the lead agency to receive the federal funds for this project with Contractor being the primary contractor. Other contributing partners are: The Kanas Department of Health and Environment, Lotus Operating, Directional Drilling Systems, LLC, Achenbach Trust, BarBoot Ranch, and the Red Hills RAC. The project budget totals $1,299,175. Of this amount, the non-federal share is $1,100,000 an in-kind match with the requested federal funds being $199,175. The Kansas Water Office will serve at project manager and will receive indirect funding totaling $23,225.

The Kansas Water Office will work with the Bureau of Reclamation and our partners to meet pilot project objectives and established deadlines.

Sincerely,

Gary Harshberger
Chairman, Kansas Water Authority

Project Budget:

Funding Plan and letter of commitment:

The Pilot Test Project for Produced Water near Hardtner, KS would be a Funding Group III project with funding needs between $150,000 and $300,000. The total cost of the project is $1,295,779. The contractor Contractor has committed $1,1 million worth of their equipment for the duration of the project which will serve as the in-kind portion of this grant, Appendix 6.

Table 1. Summary of Non-Federal and Federal Funding Sources

FUNDING SOURCES	AMOUNT
Non-Federal Entities	
Contractor Inc.	$1,100,000*
2	
3	
Non-Federal Subtotal	$1,100,000*
Other Federal Entities	
1	
2	
3	
Other Federal Subtotal	$0.00
REQUESTED RECLAMATION FUNDING	$195,780.00

The equipment listed in Table 2, was supplied by Contractor as needed for the pilot project. These pieces of equipment were necessary for the successful project in Ardmore, OK.

Table 2. Summary of Pilot Project Equipment and Value

Description	Value
EC Module System	$230,000
Power Unit	$76,000
Power Container/Office	$74,000
Automation	$150,000
Wiring	$30,000
Heat Exchanger	$200,000
Pumps/piping	$20,000
DAF Unit/filter press	$300,000
Filter System	$20,000
Total	$1,100,000

Budget Proposal:

The total cost of this pilot project is $1,295,779 of which there is a large in-kind match provided by Contractor Inc. We are requesting $195,780 from the BOR to fund the remainder of the project. Employee wages, fringe benefits and travel accounts for $47,001.60. Equipment rental – gas powered generator accounts for $20,000. Replacement of the plates in the EC module a total of 8 times accounts for $10,000. The mobilization and demobilization of the plant and routine water sampling accounts for $80,948 of the requested funds. Shipping of materials on 4 separate occasions accounts for $15,000 of the requested funds from the BOR. The final cost is a negotiated indirect cost for the KWO, see Appendix 7, of $22,829. Table 3 further explains these values.

Table 3. Budget Proposal

BUDGET ITEM DESCRITPTION	COMPUTATION $/Unit	Quantity	TOTAL COST
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]			[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]		[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]		[redacted]

Budget Narrative:

As mentioned before this project is similar to the project conducted in Ardmore, OK so most of the leg work has been completed. The oversite of the project will be completed by Stan Abrams, CEO of Contractor. He has budgeted for two employees for the duration of the 60 day project along with travel expenses. Their primary function is to follow day to day treatment of the produced water and monitor equipment. Travel for the employees includes lodging and meals. The equipment he intends to use is primarily custom built by his company however he does list some factory manufactured equipment on the list of in-kind equipment: the pre filter is a SM WB300 CDF and the DAF is a PWS 36-42. Under supplies and materials there is the replacement of the plates that are used in the EC unit, it is anticipated that they will need to be changed 8 times over the 60 day project. Sampling of the effluent will take place to evaluate the effectiveness of the plant on the produced water and will be conducted by Servi-Tech, a local company.

900 SW Jackson Street, Suite 404
Topeka, KS 66612

Kansas Water Office

Phone: (785)-296-3185
Fax: (785)-296-0878
www.kwo.org

Tracy Streeter, Director

Sam Brownback, Governor

February 1, 2017

Bureau of Reclamation Acquisition Operation Branch
Attn: Matthew Reichert
Mail Code: 84-27852
P.O. Box 25007
Denver, Colorado 80225

Re: Unique Entity Identifier and System for Award Management

Mr. Reichert:

As an employee of the Kansas Water Office (KWO) Kirk D. Tjelmeland has a SAM expiration date of 01/13/2018 and has the role of AOR. The DUNS number that KWO holds is 1762592400000.

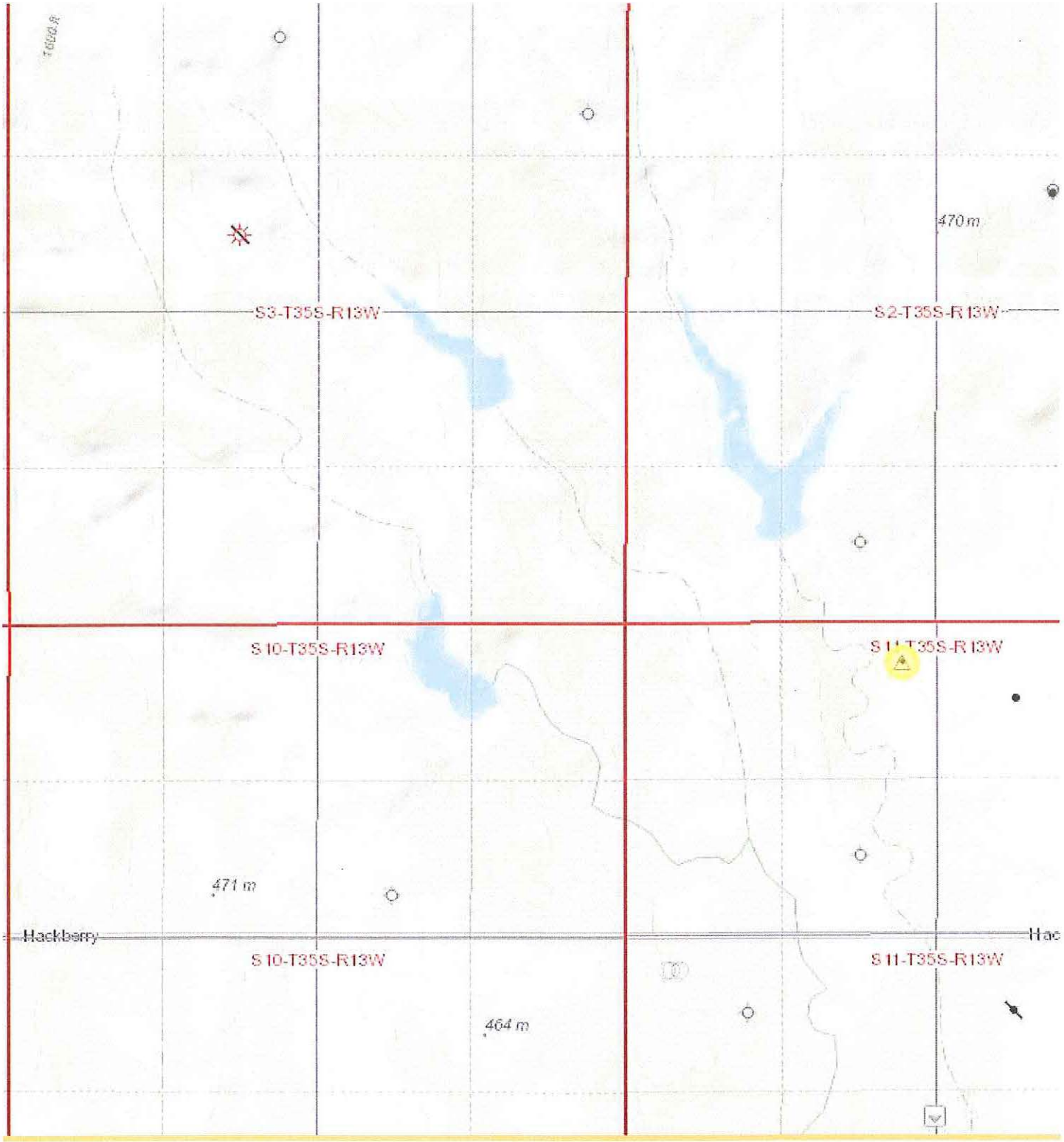
Sincerely,

Tracy Streeter

Tracy Streeter, Director
Kansas Water Office

Thanks.

Hi


S3-T35S-R13W
S2-T35S-R13W
S10-T35S-R13W
S11-T35S-R13W
470 m
471 m
464 m
Hackberry
S10-T35S-R13W
S11-T35S-R13W

Servi-Tech Laboratories - Irrigation Suitability Package

Nitrate Nitrogen

Chloride

Sulfate/sulfate sulfur

Alkalinity

Bicarbonate

Carbonate

Electrical Conductivity

PH

Total Dissolved Solids

Hardness

Sodium Adsorption Ratio

Adjusted Sodium Adsorption Ratio

Langlier Index

Aggressive Index

Boron

Calcium

Magnesium

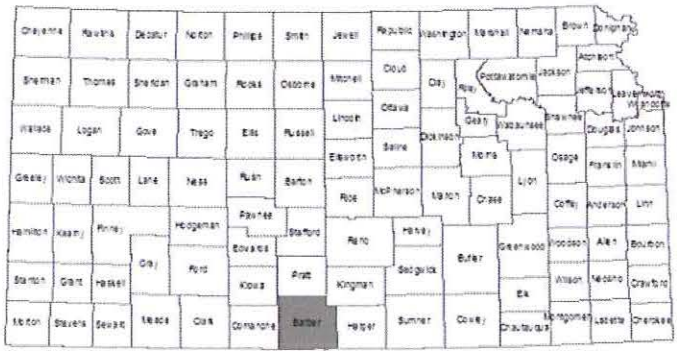
Manganese

Potassium

Sodium

Wildlife, Parks & Tourism
Kansas

Barber County



Threatened and Endangered (T&E) Species

Critical

STRECKER'S CHORUS FROG *Pseudacris streckeri*
State: Threatened **Federal:** N/A **Critical Habitat:** Yes

ARKANSAS DARTER *Etheostoma cragini*
State: Threatened **Federal:** Candidate **Critical Habitat:** Yes

PLAINS MINNOW *Hybognathus placitus*
State: Threatened **Federal:** N/A **Critical Habitat:** Yes

CHECKERED GARTER SNAKE *Thamnophis marcianus*
State: Threatened **Federal:** N/A **Critical Habitat:** Yes

PEPPERED CHUB *Macrhybopsis tetranema*
State: Endangered **Federal:** N/A **Critical Habitat:** Yes

NEW MEXICO THREADSNAKE *Rena dissecta*
State: Threatened **Federal:** N/A **Critical Habitat:** Yes

Non-Critical

ARKANSAS RIVER SHINER *Notropis girardi*
State: Endangered **Federal:** Threatened **Critical Habitat:** No

TOPEKA SHINER *Notropis topeka*
State: Threatened **Federal:** Endangered **Critical Habitat:** No

WHOOPING CRANE *Grus americana*
State: Endangered **Federal:** Endangered **Critical Habitat:** No

LEAST TERN *Stema antillarum*
State: Endangered **Federal:** Endangered **Critical Habitat:** No

PIPING PLOVER *Charadrius melodus*
State: Threatened **Federal:** Threatened **Critical Habitat:** No

SNOWY PLOVER *Charadrius alexandrinus*
State: Threatened **Federal:** N/A **Critical Habitat:** No

EASTERN SPOTTED SKUNK *Spilogale putorius*
State: Threatened **Federal:** N/A **Critical Habitat:** No

Species In Need of Conservation (SINC)

Critical

LONGNOSE SNAKE *Rhinocheilus lecontei*
State: SINC **Federal:** N/A **Critical Habitat:** Yes

Non-Critical

Southern Bog Lemming *Synaptomys cooperi*
State: SINC **Federal:** N/A **Critical Habitat:** No

Western Hognose Snake *Heterodon nasicus*
State: SINC **Federal:** N/A **Critical Habitat:** No

Black Tern *Chlidonias niger*
State: SINC **Federal:** N/A **Critical Habitat:** No

Short-eared Owl *Asio flammeus*
State: SINC **Federal:** N/A **Critical Habitat:** No

Ferruginous Hawk *Buteo regalis*
State: SINC **Federal:** N/A **Critical Habitat:** No

Golden Eagle *Aquila chrysaetos*

Wildlife, Parks & Tourism
Kansas

Townsend's Big-eared Bat *Corynorhinus townsendii*
State: SINC **Federal:** N/A **Critical Habitat:** No

Eastern Hognose Snake *Heterodon platirhinos*
State: SINC **Federal:** N/A **Critical Habitat:** No

Black Rail *Laterallus jamaicensis*
State: SINC **Federal:** N/A **Critical Habitat:** No

Southern Redbelly Dace *Chrosomus erythrogaster*
State: SINC **Federal:** N/A **Critical Habitat:** No

Chihuahuan Night Snake *Hypsiglena jani*
State: SINC **Federal:** N/A **Critical Habitat:** No

Red-spotted Toad *Anaxyrus punctatus*
State: SINC **Federal:** N/A **Critical Habitat:** No

KANSAS AQUATIC NUISANCE SPECIES MANAGEMENT PLAN

K
Aquatic
Nuisance
Species
A
S

State of Kansas
Kathleen Sebelius, Governor

Kansas Department of Wildlife & Parks
J. Michael Hayden, Secretary

Prepared by:
Jason Goeckler
Aquatic Nuisance Species Coordinator
1830 Merchant St.-P.O. Box 1525
Emporia, KS 66801-1525
(620) 342-0658

Kathleen Sebelius 04/26/09

Approved by Kathleen Sebelius, Governor **Date**

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Aquatic Nuisance Species (ANS) are a source of significant ecological and socio-economic problems throughout North America. Kansas's aquatic ecosystems have already been invaded by ANS such as zebra mussels, white perch, and purple loosestrife. While their initial impacts have been limited and localized, there is little doubt that these and other ANS pose a serious threat to Kansas water resources. The importance of Kansas's aquatic resources requires a coherent response to the threat posed by ANS. Using guidance from the National ANS Task Force and other accepted state agency plans, this management plan was developed to establish management actions to address the prevention, control, and effects of non-indigenous aquatic nuisance species that have invaded or may invade Kansas waters. The Kansas non-indigenous aquatic nuisance species management plan serves as the initial step in establishing a program to specifically address ANS issues in Kansas.

The development of a state ANS management plan, as called for in Section 1204 of the Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990, provides an opportunity for federal cost-share support for implementation of the plan. NANPCA, reauthorized in 1996 as the National Invasive Species Act (NISA), specifies that state plans identify feasible, cost-effective management practices and measures that can be implemented by the state to prevent and control ANS infestations in an environmentally sound manner.

The goals of this ANS management plan are:

1. To prevent new introductions of ANS to Kansas.

2. To prevent dispersal of established populations of ANS into uninfested waters in Kansas.

3. To eradicate or control to minimize the adverse ecological, economic, social, and public health effects of ANS in an environmentally sound manner.

4. To educate all aquatic users of ANS risks and how to reduce the harmful impacts.

5. To support research on ANS in Kansas, and develop systems to disseminate information.

Included in this plan are discussions of existing problems; a summary of federal, regional, and state policy; a list of non-indigenous species known to exist in Kansas; identification of existing priority ANS; and a discussion of regional ANS that pose a threat to Kansas aquatic ecosystems.

To ensure that the goals of this plan are being effectively addressed, a procedure for monitoring and evaluating the implementation of strategies and tasks will be initiated. This evaluation will focus on the feasibility and cost-effectiveness of management activities. The plan is a working document and will be periodically updated and expanded based upon the experience gained from implementation, scientific research, and new tools as they become available.

The effort to develop a state ANS management plan for Kansas was led by the Department of Wildlife and Parks in conjunction with personnel from other government agencies and private organizations (Appendix D). Public comments were solicited from local governments, regional entities, public and private organizations, and resource user groups that have expertise and interest in the control of ANS. Comments were considered, and revisions have been made to the plan.

INTRODUCTION

Non-indigenous aquatic nuisance species (ANS) are the cause of significant ecological and socio-economic problems for water users in North America. ANS have spread beyond historic ranges and have adversely affected infested waters by threatening the integrity of the water resources. Since non-indigenous ANS have few natural controls in their new habitats, they spread rapidly, destroying native plant and animal habitat, threaten the diversity and abundance of native species, and damage industrial, agricultural, and recreational activities dependent on surface waters.

A number of these ANS have become established in the United States and represent a threat to the nation's aquatic resources. As the introduction and spread of ANS continues, the associated problems intensify and create a wide variety of ecological and socio-economic problems for water users. In 1990, the Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) was passed to address ANS problems in the United States. This legislation provided an opportunity for federal cost-share support for implementation of state plans. While programs created by this legislation were initially aimed at problems in the Great Lakes region, reauthorization of NANPCA in 1996 as the National Invasive Species Act (NISA) established a national goal of preventing new ANS introductions and limiting the dispersal of existing ANS in all of the states. NISA specifies that state plans identify feasible, cost-effective management practices and measures that can be implemented by the state to prevent and control ANS infestations in a manner that is environmentally sound. Approval of a state ANS management plan by the Federal Aquatic Nuisance Species Task Force is required for Kansas to be eligible for federal cost-share support.

According to Rendall (1997), the following points must be considered in addressing ANS issues and establishing ANS management programs. These points have provided guidance in the development of this ANS long-term management plan.

- There are many pathways of introduction and spread for ANS, most of which are related to human activities, both accidental and intentional. New species continue to be introduced and spread within North America through these pathways.

- Introductions have many costs associated with them: control and management costs; long-term ecosystem changes; and loss of recreational opportunities.

- Often there are few, if any, acceptable controls available for use in natural water bodies once ANS become established.

- Once species are successfully introduced, any control efforts will be very expensive and eradication very unlikely.

- Prevention is the best course of action. Management plans, education programs, and regulations are strategies that can help prevent the spread of ANS.

The coordinated efforts contained within this plan are designed to protect residents of Kansas and the state's aquatic resources from the multitude of potential losses associated with ANS plants and animals. This management plan focuses on preventing the accidental introductions of new ANS, limiting the spread of existing ANS, and controlling or eradicating ANS where environmentally and economically feasible. The intentional introduction of non-indigenous species for aquaculture, commercial, or recreational purposes is addressed to insure that these beneficial introductions do not result in accidental ANS introductions, and to improve information sharing among those agencies responsible for regulation of intentional introductions.

It is the intent of the State of Kansas to prepare for the introduction of destructive ANS currently found in regional waters and take measures to prevent their infestation of state water bodies. With the recent introduction of one of the most destructive ANS, the zebra mussel *Dreissena polymorpha*, it is realized that a coordinated and effective effort to address this and other ANS introductions is necessary. Kansas has the opportunity to develop a program to allow the state to quickly and effectively deal with both existing and potential ANS threats before they cause significant environmental and economic damage.

In the United States, control of the zebra mussel cost municipalities and industries almost $70 million a year between 1989 and 1995 (U.S. General Accounting Office 2001). Over the next 10 years, the zebra mussel invasion will cost an estimated $3.1 billion including cost to industry, recreation, and fisheries (Preliminary Report of the U.S. Commission on Ocean Policy, governors' draft 2004). The costs and effects of exotics in Kansas have not been determined precisely; however costs are incurred in two main categories. First is the loss in potential economic output, such as reductions in aquaculture, fisheries, and crop production. Second is the direct cost of combating and mitigating the impacts of invasion, including all forms of quarantine, control, and eradication (Mack et al. 2000).

The Aquatic Nuisance Species committee was responsible for developing the Kansas ANS management plan. Members of the committee assumed an active role in preparation for the plan by reviewing draft plans and providing guidance. A list of the committee members is provided in Appendix D. The Kansas Department of Wildlife and Parks (KDWP) was the lead agency assigned to coordinate the drafting of the plan. Public comments were solicited from local governments, regional entities, public and private organizations, and resource user groups that have expertise and interest in the control of ANS. Comments were considered and revisions have been made to the plan.

This ANS management plan was developed primarily to serve as an essential guide to state agencies, local governments, public and private organizations, and aquatic resource user groups in developing management strategies, designing public awareness/educational materials, and prioritizing activities related to ANS issues. While the Department of Wildlife and Parks will be

the state agency responsible for administration of this plan, it is expected that there will be broad participation in ANS programs and activities by various state and local entities. The ANS plan for Kansas will provide guidance in coordinating these programs and activities.

The Kansas ANS management plan will be reviewed and revised annually or more frequently if needed to address the unexpected arrival of new ANS. Advances in knowledge of ANS management techniques could warrant alterations in proposed management strategies. The specific tasks employed to accomplish the goals and objectives of the plan must remain flexible to assure efficiency and effectiveness. While this version of the plan is a good starting point for identifying and integrating existing ANS programs, and implementing new programs, future editions will be necessary to achieve Kansas's ANS management goals.

ANS AUTHORITITES AND PROGRAMS

STATE

The State of Kansas currently has a limited number of statutory and regulatory authorities to addresses or potentially address the issue of prevention and control of ANS. Those that exist were developed in response to individual target species and specific concerns as they arose. Kansas does not have a comprehensive, coordinated, and vigorously enforced policy framework to deal with ANS and their affects. For this reason, one objective of Kansas's ANS management plan is to identify gaps within state policies and statutes and develop recommendations for improvements. Such improvements may entail developing new legislation and regulations, revising existing authorities, and developing methods for improving enforcement, coordination, and information dissemination regarding new or existing authorities.

Department of Wildlife & Parks

The mission of the Kansas Department of Wildlife and Parks is to conserve and enhance Kansas' natural heritage, its wildlife, and its habitats. KDWP's underlying philosophy is to manage natural systems properly by striking a balance between natural resource integrity and human benefits.

The following existing policies have been administered by the Department of Wildlife and Parks and identified relative to Kansas's management of ANS are:

1. Prohibited species list, permit requirement, and restrictions (KAR 115-18-10)

Prohibits the importation, possession, or release of the following species:

a. walking catfish *Clarias batrachus*
b. silver carp *Hypophthalmichthys molitrix*
c. bighead carp *Aristichthys nobilis*
d. black carp *Mylopharyngodon piceus*
e. snakehead fish Channidae family
f. zebra mussel *Dreissena polymorpha*
g. quagga mussel *Dreissena bugensis*

h. round goby *Neogobius melanostomus*
i. New Zealand mudsnail *Potamopyrgus antipodarum*

2. Prohibited release of exotics (KAR 115-20-3)

Prohibits the release of all exotic wildlife onto the lands or into the waters of the state.

3. Prohibited stocking (KAR 115-8-12)

Prohibits stocking or releasing of wildlife on department lands or waters and specifies authorization structure.

4. Prohibited transfer of baitfish (KAR 115-8-6)

Fishing bait may be used only in the water where taken.

Department of Agriculture

The Kansas Department of Agriculture (KDA) is a regulatory agency established to ensure a safe meat, milk and egg supply; responsible and judicious use of pesticides and nutrients; the protection of Kansas' natural and cultivated plants; integrity of weighing and measuring devices in commerce; and that the state's waters are put to beneficial use. In 2002 the KDA issued the first ANS plant quarantine in Kansas by levying quarantine on purple loosestrife *Lythrum salicaria* (KSA 2-2113). In January 2004, the KDA enacted a quarantine for all federally listed noxious weeds including 19 aquatic plants, representing the first large scale effort to control ANS plants into and within the State of Kansas.

Department of Health and Environment

The mission of the Kansas Department of Health and Environment (KDHE) is to optimize the promotion and protection of the health of Kansans through efficient and effective public health programs and services and through preservation, protection, and remediation of natural resources of the environment. KDHE has not officially addressed ANS and has historically only documented presence of ANS in field notes that are maintained in a searchable computer database. The Chemical Control Act identifies that KDHE has regulatory control over toxins that potentially may be used to control ANS.

Kansas Water Office

The Kansas Water Office develops the Kansas Water Plan, which is revised annually and approved by the Kansas Water Authority. The Kansas Water Plan is the tool used in Kansas to address current water issues and to plan for future water quality and quantity needs. The State Water Resource Planning Act (KSA 82a-901a) declares that "the state can best achieve the proper utilization and control of the water resources of the state through comprehensive planning which coordinates and provides guidance for the management, conservation, and development of the state's water resources." This is accomplished through development of the Kansas Water

Plan. The Kansas Water Plan is based upon a comprehensive, watershed oriented approach to planning. The planning process is designed to be comprehensive, coordinated, and continuous.

The Kansas Water Office has no specific statutory authority to address ANS. However, because the Kansas Water Plan is watershed based, basin specific ANS issues can be included in the Plan. A basin plan can include a management strategy for addressing an ANS including technical information and public education.

FEDERAL

The current federal effort regarding the management of ANS is a patchwork of laws, regulations, policies, and programs. At least 20 agencies currently work at researching and controlling non-indigenous species. Federal laws that apply directly to the introduction of non-indigenous species include the Lacey Act, the Federal Noxious Weed Act, the Federal Seed Act, the Federal Plant Protection Act of 2000, the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990, and the National Invasive Species Act of 1996. The Endangered Species Act could also have indirect application if an ANS was shown to threaten the survival of a federally listed species, such as the neosho mucket *Lampsilis rafinesqueana* or the Topeka shiner *Notropis topeka*. A description of federal agencies with programs specific to Kansas ANS follows.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) provides federal funding for implementation of state and regional ANS management plans that have been approved by the Aquatic Nuisance Species Task Force (ANSTF). One of the major USFWS efforts on ANS is the 100th Meridian Initiative. The goals of this Initiative are to 1) prevent the spread of zebra mussels and other ANS in the 100th meridian jurisdictions and west and 2) monitor and control zebra mussels and other ANS if detected in these areas. These goals will be attained through the implementation of the following six components: 1) information and education, 2) voluntary boat inspections and boater surveys, 3) involvement of those who haul boats for commercial purposes, 4) monitoring, 5) rapid response, and 6) evaluation. This initiative represents the first large-scale focused and coordinated effort, working with federal, state, provincial and tribal entities, potentially affected industries, and other interested parties to begin addressing the pathway to prevent the spread of zebra mussels. The success of this Initiative depends on the commitment of these groups to combat the spread of this destructive invader.

U.S. Corps of Engineers

It is the policy of the Corps of Engineers to develop, control, maintain, and conserve the nation's water resources in accordance with the laws and policies established by Congress and the Administration. The Corps' Zebra Mussel Research Program (ZMRP) was authorized by the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990, Public Law 101-646, and is the only federally authorized research program for the development of technology to control zebra mussels. The Corps ANS programs were integrated into the ANS Task Force to ensure total coordination and leveraging to address all ANS issues.

U.S. Coast Guard

The U.S. Coast Guard gets its authority to regulate ballast water and ANS from NANPCA and NISA. NANPCA directed the Coast Guard to issue regulations and guidelines to control the introduction and spread of ANS in the Great Lakes ecosystem. It also required an assessment of ballast water management practices in all U.S. ports. NISA tasked the Coast Guard with establishing a voluntary ballast water management (BWM) program for virtually all U.S. ports. The Coast Guard's BWM program is the primary emphasis related to ANS in the inland river system. Current Coast Guard efforts include establishing mandatory BWM standards and practices, establishing a program to approve ballast water treatment technologies, establishing penalties for failure to submit required reports, and increasing the applicability to all ships with ballast water tanks bound for all ports or places in U.S. waters.

REGIONAL

The Western Regional Panel

The Western Regional Panel (WRP) on ANS was formed under a provision of NISA. The WRP was formed to help limit the introduction, spread, and impacts of ANS into western North America. This panel includes representatives from federal, state, tribal, Canadian provincial, local agencies, and from private environmental and commercial interests.

The Mississippi River Basin Regional Panel

The Mississippi River Basin Regional Panel (MRBP) on ANS was formed under a provision of NISA to identify priorities for activities, develop and submit recommendations to the national ANSTF, coordinate aquatic nuisance species program activities, advise public and private interests on control efforts, and submit an annual report to the ANSTF describing prevention, research, and control activities in the Mississippi River Basin. This panel includes representatives from federal, state, tribal, and local agencies and from private environmental and commercial interests.

Western Governors Association

The Western Governors Association (WGA) is developing a new program to address undesirable non-indigenous aquatic and terrestrial species in the West because of the significant economic and ecological harm they cause. WGA has formed a working group of state and federal agencies, industry, non-governmental organizations and academia to develop Western strategies to limit the spread of these species.

PROBLEMS AND CONCERNS

Several ANS have already been introduced and dispersed in Kansas by various pathways. The environmental and socio-economic costs resulting from ANS infestations will only continue to rise with further introductions. Although an awareness of the problems caused by ANS is emerging, the solutions are often not readily available. This comprehensive state plan for the

management of ANS provides guidance for preparing management actions to address the prevention, control and impacts of ANS that have or may invade and alter the aquatic resources of Kansas.

A newly introduced species can disrupt the natural ecosystems by altering the composition, density, and interactions of native species. A lack of natural controls may allow a new population to increase at an exponential rate and disrupt native species as the introduced species may prey upon, out compete, or transmit disease to the native species. This disruption can cause significant alterations to food webs, nutrient dynamics, and biodiversity. Changes in the ecology of lakes and rivers, degraded habitat value in infested waters, and stunted fish populations may also result from the disruption caused by a newly introduced species.

ANS not only represent a potential threat to the environment; they threaten industry and the economy. These negative impacts include:

- decreased property values
- decreased recreational opportunities
- decreased water quality
- fouled water intakes
- frequently burned-out irrigation and water pumps
- impacts on power generation
- impeded water flow and decreased efficiency of water delivery systems
- increased risk of flooding due to increased biomass in water or clogging lake outlets

The number of new ANS introductions in Kansas will continue to grow as new and existing ANS become established in Midwestern states, especially those that border Kansas. There are several major pathways through which ANS are introduced, but most are the result of human activities both intentional and unintentional. Pathways of introduction into water bodies include aquaculture, aquarium trade, commercial navigation, transport via vessel fouling, recreational boating and fishing, sale of bait fish, research activities, and distribution through interconnected waterways. In Kansas, there is limited regulation of these pathways.

Non-indigenous Aquatic Animals

A draft list of non-indigenous aquatic animals in Kansas is included in Appendix A and is based on existing data. As such, the list is undoubtedly incomplete as information on non-indigenous aquatic animals in Kansas is limited. The following ANS species are considered of special concern in Kansas; bighead carp, black carp, exotic waterflea, New Zealand mudsnail, round goby, rudd, ruffe, rusty crayfish, silver carp, spiny waterflea, white perch, and zebra mussel. Currently, the zebra mussel, white perch, bighead carp, silver carp, black carp, and New Zealand mudsnail are considered priority species. A discussion of each species follows.

Bighead carp *Hypophthalmichthys nobilis*. The bighead carp is a large-bodied planktivore endemic to eastern China. In 1973, an aquaculturist introduced bighead carp into Arkansas in an attempt to improve water quality in production ponds (Freeze and Henderson 1982). In 1974, regulations were mandated to restrict bighead carp stocking into Arkansas public waters to reduce the probability of accidental introductions. Despite these regulations, bighead carp escaped from aquaculture facilities and subsequently dispersed upstream into the Mississippi and

Missouri River systems. Currently, bighead carp are present in 19 states (Benson et al. 2001; Fuller et al. 1999). While no data are presently available concerning the effects of this species on river ecosystems and their fisheries, observed habitat preferences suggest that bighead carp may directly affect populations of paddlefish *Polyodon spathula*, and other commercially valuable filter feeders (Tucker et al. 1998). Bighead carp are currently found in Kansas waters but do not appear to be causing any severe problems at this point. This situation may change as bighead carp become more widespread in Kansas. Monitoring of this species will be needed.

Black carp *Mylopharyngodon piceus*. The black carp is a large river fish native to Pacific drainages in eastern Asia. Black carp entered the United States in the early 1970s as a contaminant in imported grass carp *Ctenopharyngodon idella* and are currently being maintained in research and fish production facilities in seven states including two that border Kansas (U.S. Fish and Wildlife Service 2002). Approximately 30 black carp escaped from a fish farm in Missouri into the Osage River, Missouri River basin, in April 1994. The first specimen reported from the wild was captured in March 2003 from Horseshoe Lake, Illinois. A second specimen was captured from the wild in the lower Red River, Louisiana in April 2004 (Nico and Fuller 2004). Black carp are likely to survive in the wild and spread throughout the Mississippi drainage. Black carp are molluscivores but also feed on freshwater shrimp, crayfish, and insects thus competing for food with native fish and wildlife species (Nico and Williams 1996). If black carp become established in North American ecosystems, their feeding habits could drastically modify the ecological balance and forever change the native aquatic system's aesthetic, recreational, and economical values. This species would also be especially harmful to native unionid mussels, a taxonomic group that is already imperiled throughout its native range. The potential ecological harm posed by black carp and their current proximity to Kansas make it a significant threat that warrants attention.

Exotic waterflea *Daphnia lumholtzi*. Native to Africa, Australia, and India, this species was first discovered in 1990 in Texas. It has since been found in several Midwestern states including Kansas. The continuing discovery of *D. lumholtzi* in new locations could be due to contaminated stockings of fish through international commercial trade. At the same time, the close proximity of affected reservoirs might lead to the conclusion that *D. lumholtzi* may have spread by recreational boating from the initially infested reservoirs (Benson et al. 2005). Analyses of pre-invasion zooplankton communities indicate that *D. lumholtzi* may be invading reservoirs in which native *Daphnia* species are rare. While the long-term effects of the invasion of *D. lumholtzi* are unknown, it has the potential to dominate late summer zooplankton communities in eastern Kansas reservoirs (Dzialowski et al. 2000). The presence of *D. lumholtzi* in some Kansas reservoirs indicates a need to monitor invaded reservoirs to document the range expansion and determine the long-term implications of the introduction of this invader.

New Zealand mudsnail *Potamopyrgus antipodarum*. Native to New Zealand, this species was discovered in North America in 1987 and has rapidly spread throughout the western United States. It is a parthenogenetic livebearer with a high reproductive potential. Mature New Zealand mudsnails (NZMS) average 5 mm in length; juveniles are much smaller, making them difficult to notice on gear. NZMS populations can reach densities greater than 100,000/m^2 in suitable habitat. The highest recorded densities reported are 800,000/m^2 in Lake Zurich, Switzerland, where this species colonized the entire lake in less than seven years (Richards

2002). To date, few data have been reported or research conducted on the impacts of the New Zealand mudsnail on native macroinvertebrate populations or aquatic ecosystems. Concern about the potential impacts of the NZMS on native species, fisheries and aquatic ecosystems in the western United States has been generated by the rapid spread of this species. NZMS degrade habitat with their high reproductive capacity and the subsequent impacts on invertebrate food sources. Its spread into new systems is considered to be primarily human-caused and unintentional transport by people is probably the primary vector for the spread of NZMS. The New Zealand mudsnail has not been reported in Kansas, but is considered a priority species because of the late 2004 introduction into Colorado.

Round goby *Neogobius melanostomus*. The round goby was introduced via ballast water into the St. Clair River, near Detroit in 1990 and has spread into Lake Erie and Lake Michigan where the largest populations are found. The primary concern with the round goby is the tremendous range expansion exhibited since its introduction in 1990. It is an aggressive fish and feeds voraciously upon bottom-feeding fishes (e.g., darters and logperch) (Corkum et al.1998), snails, mussels, and aquatic insects. The Great Lakes fisheries, particularly those in Lake Michigan and Lake Erie, are threatened by this ANS due to its robust characteristics and ability to displace native species from prime habitat and spawning areas (MacInnis et al. 2000). While the round goby has not been reported in Kansas waters, the rapid spread of this species in the Great Lakes and the Illinois River suggests that it possesses a significant threat to all Midwestern states.

Rudd *Scardinius erythrophthalmus*. Introduced into the United States in the early 1900s as baitfish, this Eurasian native is found in 20 states, including Kansas (Nico and Fuller 2003). Similar in appearance to the golden shiner *Notemigonus crysoleucas,* the rudd is capable of growing to 20 inches in length. Currently, the rudd is one of the most rapidly spreading non-indigenous fishes in the United States. The greatest threat posed by the rudd is its ability to hybridize with the golden shiner which may endanger that species' genetic integrity (Burkhead and Williams 1991). While little is known about the threat posed by rudd, its occurrence in several Kansas reservoirs suggests the need to monitor this ANS.

Ruffe *Gymnocephalus cernuus*. The ruffe was introduced to North America in the 1980s in ballast water of a seagoing vessel. Since its introduction, the ruffe has become established in the nearshore waters of western Lake Superior, with an estimated average rate of range expansion of 18 shoreline miles per year. By the fall of 1994, ruffe populations were found in Michigan waters of Lake Superior and in August of 1995, three ruffe were discovered in a commercial harbor in northern Lake Huron, more than 300 miles east of the previously known range. The ruffe matures quickly, has a high reproductive capacity, and adapts to a wide variety of environments. It is considered a serious threat to commercial and sport fishing. It also has the potential to seriously disrupt the delicate predator-prey balance vital to sustaining a healthy fishery (McLean et al. 1995). While there are no reports of ruffe in Kansas, this highly adaptable species poses a threat similar to that of the round goby.

Rusty crayfish *Orconectes rusticus*. The native range of the rusty crayfish is Illinois, Indiana, and Ohio. However, in recent years its distribution has expanded because of the use of live crayfish as bait by anglers. When introduced into new habitats, it quickly displaces native crayfish and becomes over-abundant. As a result of its voracious appetite, it competes with other

aquatic organisms for food. The rusty crayfish's feeding behavior includes consumption of submerged aquatic vegetation. Large populations can adversely impact native plant populations (Lodge et al. 2000). The rusty crayfish has not been found in Kansas, but it has been transplanted to new waters in neighboring states where self-sustaining populations have become established. The species warrants attention.

Silver carp *Hypophthalmichthys molitrix.* Silver carp were imported and stocked for phytoplankton control in eutrophic water bodies and also as a food fish. It was first brought into the United States in 1973 when a private fish farmer imported silver carp into Arkansas. By 1980 the species was discovered in natural waters, probably a result of escapes from fish hatcheries and other types of aquaculture facilities (Freeze and Henderson 1982). In numbers, the silver carp has the potential to cause enormous damage to native species because it feeds on plankton required by larval fish and native mussels. Presently, silver carp have been recorded in 12 states including Kansas (Benson et al. 2001). Although they have been found in Kansas, silver carp do not appear to be causing any severe problems at this point. This situation could change as silver carp become more widespread. Monitoring of this species will be needed.

Spiny waterflea *Bythotrephes cederstroemi*. The spiny waterflea, likely a ballast water introduction, is a tiny crustacean with a sharply barbed tail spine. The northern European native was first found in Lake Huron in 1984. The spiny waterflea is now found throughout the Great Lakes and in some inland lakes (Parker et al. 2001). Although scientists do not know exactly what effect this invader will have on aquatic ecosystems, resource managers suspect that the spiny waterflea will compete directly with other zooplankton or larval fish for food (Lehman 1991). The spiny waterflea has not been reported in Kansas but warrants continued attention to determine the significance of this threat.

White perch *Morone americana*. A native to the Atlantic coast region of North America, the white perch invaded the Great Lakes in the 1950s through the Welland and Erie canals (Boileau 1985). Since its arrival, it has been associated with declines in both walleye *Sander vitreus* and white bass *Morone chrysops* populations in those areas where it has become well-established due to predation on the eggs of both species. White perch also feed heavily on baitfish utilized by other game species. It is known to hybridize with white bass, resulting in the dilution of the gene pools of both species (Madenjian et al. 2000). White perch have established populations in Wilson and Cheney Reservoirs in Kansas thus as a priority species, demand immediate attention and management.

Zebra mussel *Dreissena polymorpha*. The zebra mussel is one of the best known invaders of the Great Lakes region and other areas of the country where it has spread. Since introduction into the United States, this aquatic nuisance species has caused serious economic and ecosystem impacts and prompted passage of federal ANS legislation. The zebra mussel, a highly opportunistic mollusk, reproduces rapidly, and consumes large quantities of microscopic aquatic plants and animals from the water column (Trometer et al. 1999). The potential impact on fisheries can be profound. Reductions in density and biomass of the zooplankton community may result in reduced growth or abundance of age-0 fish. The first year of a fishes' life is a time when it is most vulnerable to predation; reduced growth rates at this age may extend this period of vulnerability (Wu and Culver 1991). Economic impacts are as pervasive as the ecosystem

impacts. Due to zebra mussels in intake/discharge pipes, Great Lakes municipalities, utilities, and industries have incurred significant costs associated with monitoring, cleaning, and controlling infestations. According to a recent economic impact study, each of 84 Great Lakes water users reported average total expenditures of $513,600 over the five-year period from 1989 to 1994 (Hushak et al. 1995). Nationwide expenditures to control zebra mussels in water intake pipes, water filtration equipment, and electric generating plants are estimated at $3.1 billion over 10 years (U.S. Congress Office of Technology Assessment 1993). Commercial and recreational vessels and beach areas also are vulnerable to the negative impacts of the zebra mussel. Zebra mussels are currently found in El Dorado Reservoir, the Walnut River below El Dorado Reservoir, and have been reported in Cheney Reservoir in Kansas. Currently, there is no evidence that they have expanded their range into other water bodies within Kansas. Considered a priority species, zebra mussels represent a serious threat to Kansas's aquatic resources and deserve immediate management action.

Non-indigenous Aquatic Plants

A draft list of non-indigenous aquatic plants in Kansas is included in Appendix B. Species listed have a wetland indicator status of "facultative wetland" or "obligate" in USFWS Region 5. This list is incomplete as information on non-indigenous aquatic plants in Kansas is limited. The following ANS species are considered of special concern in Kansas; purple loosestrife, curly-leaf pondweed, Eurasian watermilfoil, hydrilla, and saltcedar. Currently, Eurasian watermilfoil, purple loosestrife, and saltcedar are considered priority species. A discussion of each species follows.

Curly-leaf pondweed *Potamogeton crispus*. Curly-leaf pondweed, a perennial, rooted, submerged aquatic vascular plant is a native to Eurasia, Africa, and Australia. By 1950, curly-leaf pondweed had infested most of the United States. In the spring, it forms dense mats that interfere with recreation and limit the growth of native aquatic plants. The reproductive ecology of this species is poorly known. By the end of the growing season, curly-leaf pondweed senesces and forms vegetative propagules called turions. Turions are dispersed by water movement throughout a water body and may also be transferred to uninfested waters. The turions germinate in the fall, beginning a new life cycle. (Sastroutomo 1981). Although not widespread, curly-leaf pondweed has been reported in Kansas waters and may pose a significant threat to native vegetation.

Eurasian watermilfoil *Myriophyllum spicatum*. Eurasian watermilfoil, a submerged aquatic plant from Europe, Asia, and northern Africa, is spreading rapidly throughout the United States. It has been reported in 33 states including Kansas. Eurasian watermilfoil is capable of growing under a wide range of environmental conditions and on a variety of bottom substrates. It typically grows in shallow water, but in clear water conditions it can inhabit water up to 30 feet deep. Eurasian watermilfoil's surface canopy can out-compete and eliminate native aquatic vegetation, as well as threaten native fish and wildlife populations (Smith and Barko 1990; Valley and Bremigan 2002). The plant disperses primarily by vegetative propagation through stem fragmentation. Boat propellers and trailers are a major source of long-distance spread of Eurasian watermilfoil (Westbrooks 1998).

Hydrilla *Hydrilla verticillata*. Hydrilla, a submerged, perennial plant is native to Asia, but has spread into Europe, Australia, New Zealand, the Pacific Islands, Africa, South America and North America. This plant was first introduced into Florida waters in the early 1960s and now occurs in almost all of the Gulf and Atlantic coast states and on the west coast in California and Washington (Westbrooks 1998). A highly prolific aquatic plant, hydrilla can out-compete native vegetation by photosynthesizing under low light conditions and can form a thick free-floating mat (Tate et al. 2003). Hydrilla causes major problems with water use. In drainage and irrigation canals, it greatly reduces flow and causes clogging, which can result in flooding and damage to canal banks, structures, and pumps. Hydrilla also has negative effects on fish populations in addition to a decreased recreational opportunity. Excessive vegetation decreases growth and condition of adult fish (Colle and Shireman 1980), and extremely high amounts of hydrilla (>80% coverage) may decrease angler harvest and effort (Colle et al. 1987). Hydrilla is most likely to spread when plant fragments are carried along with recreational boats into new habitat. Hydrilla has not been detected in Kansas, surveillance efforts have been limited.

Purple loosestrife *Lythrum salicaria.* Purple loosestrife is an invasive wetland perennial from Europe and Asia. It became established in North America in the early 1800s via ship ballast, as a medicinal herb, and ornamental plant (Westbrooks 1998). When growing conditions are optimal, initial loosestrife infestations are followed by dramatic population increases. In one growing season, an individual plant may produce over one million seeds, which can remain viable for several years (Welling and Becker 1990). The seeds appear to be moved easily by water, vehicles, and wildlife, and germination can occur under a wide range of temperatures, pH, nutrient levels, and soil types (Shamsi and Whitehead 1974; Keddy and Constabel 1986; Mitich 1999). Once established, purple loosestrife often readily spreads to additional wetland sites. Seed germination occurs in such high densities that seedlings of native plants are frequently suppressed, resulting in eventual creation of a purple loosestrife monoculture (Gardner et al. 2001). While currently present in Kansas, purple loosestrife has yet to cause the level of ecological disruption that other states have experienced.

Saltcedar *Tamarix spp.* Saltcedar is a small tree or large shrub that was introduced into the United States in the early 1800s as an ornamental, for use in wind breaks, or to stabilize eroding stream banks. One mature plant can produce one-half million seeds each year. After summer rains, saltcedar seedlings quickly colonize moist areas due to the constant availability of seeds. The plant's ability to exploit suitable germinating conditions over a long time period gives saltcedar a considerable advantage over native riparian species. Mature plants can sprout vegetatively after fire, flood, or treatment with herbicides and can adapt to wide variations in soil and mineral gradients (Westbrooks 1998). Large saltcedar plants can use up to 200 gallons of water a day, reducing and even eliminating water flow in streams and rivers. Saltcedar is capable of forming dense monocultures and dramatically changing vegetation structure, animal species diversity, soil salinity, and hydrology of sites where it has become dominant (Sher et al. 2002). Saltcedar has been reported in Kansas, and is a severe threat to the structure and stability of native plant communities. It warrants control; eradication techniques need to be investigated.

STATUS OF AQUATIC NUISANCE SPECIES IN KANSAS

All non-indigenous species affect native species and habitat in some manner, but not all of them pose a significant threat, and some provide an economic and recreational benefit in certain areas. It is a difficult task to predict the effects that species will have once they are introduced. Although ANS problems are relatively new to Kansas, four (purple loosestrife, saltcedar, white perch, and zebra mussel) of the special concern species mentioned in the previous text have become established and are beginning to pose threats to aquatic ecosystems. Other ANS that have been reported in Kansas that have not yet become serious problems include bighead carp, curly-leaf pondweed, rudd, and silver carp. These species are currently considered priority ANS in Kansas. Additional ANS exist in bordering states and pose additional threats to Kansas's water resources.

Priorities for Action

Often many efforts to address ANS problems are implemented after the species has arrived and become widely distributed. As a result, these efforts are often reactive and ineffective. The purpose of this management plan is to expand the scope of efforts in Kansas to deal with the threats posed by all ANS. The goal of this management plan is to implement a coordinated strategy designed to minimize the risk of further ANS introductions into Kansas through all known pathways, develop funding mechanisms to implement and staff a Kansas ANS management program, where practical, stop the spread of ANS already present and eradicate or control ANS to a minimal level of impact. By forming this management plan, it is expected that the problems other states have experienced can be minimized or completely avoided. Initially, this plan will focus on the priority species listed below. As this program evolves, the focus will shift to the development and implementation of new programs designed to prevent or control the introduction of new ANS to Kansas.

Priority Species

The management actions outlined in this plan focus on the following priority species. By addressing pathways of introduction for priority species, the introduction of other lower priority or perhaps unidentified ANS may also be prevented since they may share common pathways of introduction.

- bighead carp *Hypophthalmichthys nobilis*
- black carp *Mylopharyngodon piceus*
- Eurasian watermilfoil *Myriophyllum spicatum*
- New Zealand mudsnail *Potamopyrgus antipodarum*
- purple loosestrife *Lythrum salicaria*
- saltcedar *Tamarix* spp.
- silver carp *Hypophthalmichthys molitrix*
- white perch *Morone americana*
- zebra mussel *Dreissena polymorpha*

MANAGEMENT ACTIONS

The goal of the Kansas ANS management plan is to minimize the harmful ecological, economic, and social affect of ANS through prevention and management of introduction, population growth, and dispersal of ANS into, within, and from Kansas. The goal will be achieved through

implementation of a plan that will emphasize prevention of introductions while effectively addressing established ANS populations. The introduction of ANS into state waters may cause environmental, socio-economic, and possible public health effects. Several damaging ANS already have been introduced into Kansas, and new introductions are highly likely. An effective management plan must:

- require an impact assessment and review for all aquatic non-indigenous species prior to their importation, transport, or use in Kansas;
- allow for early detection;
- include development of contingency plans;
- permit appropriate and timely management response to new and existing populations;
- protect and restore native plant and animal communities;
- provide for easy access to accurate and up to date species distribution and management information;
- incorporate education and research elements;
- recommend funding levels adequate for effective implementation;
- produce agency collaboration through an invasive species council;
- facilitate inter-jurisdictional coordination with state and federal agencies; and
- seek cooperative solutions with the private sector and user groups.

It is impossible to address all potential invaders, their impacts, and the constraints and contingencies that may develop. Consequently, this plan is intended to be adaptable to changing circumstances to avoid a delayed response approach that often limits the vision and opportunity for the prevention of new introductions, leaving the state with ANS management problems that are economically costly, technically challenging, and possibly unfeasible to solve. To effectively address ANS problems in Kansas, prevention of new ANS introductions and control of existing ANS populations is essential.

Management Objectives

OBJECTIVE 1: Coordinate and implement a comprehensive management plan.
1A. Problem: There is no clear authority or agency in Kansas charged with limiting and managing ANS. Kansas needs an organized and centralized approach to ANS management to prevent duplication of effort and eliminate gaps in coverage of ANS issues. State ANS management efforts need to be coordinated with regional and national efforts. Currently, most management activities are focused on isolated problems and not concerned with addressing the

issue of ANS comprehensively. The lack of coordination, oversight, and funding has allowed ANS to become established in Kansas and continues to allow for new introductions. Gaps in ANS management include: unclear authorities, uncoordinated state activities, and staffing and funding shortages.

1A1. Strategic Action: Implement a Kansas ANS management program and coordinate activities.

Task 1A1a: Receive approval of the ANS management plan for Kansas from the Natural Resources Sub-Cabinet.

Task 1A1b: Receive approval of the ANS management plan for Kansas from the governor.

Task 1A1c: Receive approval of the ANS management plan for Kansas from the Kansas Wildlife and Parks Commission.

Task 1A1d: Receive approval for the ANS management plan for Kansas from the Federal Aquatic Nuisance Species Task Force.

Task 1A1e: Implement the Kansas ANS management plan.

Strategic Action 1A2: Create and fund an ANS coordinator position using ANS Task Force monies and matching funds.

Task 1A2a: Hire a coordinator (1.0 FTE) for the Kansas Aquatic Nuisance Species Program. This position will coordinate and direct the Kansas Aquatic Nuisance Species Program out of the KDWP Emporia Research and Survey Office.

Strategic Action 1A3: Coordinate all ANS management programs and activities within Kansas and collaborate with regional and national ANS programs.

Task 1A3a: The Kansas Aquatic Nuisance Species Program coordinator will identify key personnel in state and federal government and private entities for ANS responsibilities.

Task 1A3b: Work to ensure that the ANS strategy is coherent and consistent throughout Kansas.

Task 1A3c: Establish working partnerships with ANS management programs in regional states to facilitate the sharing of data and coordination of management activities.

Task 1A3d: Participate in regional and national forums to ensure that ANS efforts in Kansas remain current and are coordinated with regional and national programs.

Task 1A3e: Conduct an annual forum focused on ANS in Kansas and potential management alternatives.

Strategic Action 1A4: Develop a permanent funding mechanism for ANS management in Kansas.

Task 1A4a: Explore ideas for permanent funding of ANS management activities.

Task 1A4b: Work with the Kansas legislature to establish a permanent funding mechanism for ANS management activities in Kansas.

OBJECTIVE 2: Prevent the introduction of new ANS into Kansas waters.

2A. Problem: There are several pathways by which new species can arrive in Kansas. Implementation of a program that reviews and regulates which species are intentionally allowed

into Kansas, and monitors the pathways by which species can be unintentionally transported into the state, is necessary to slow the rate at which new species become established. Understanding how various pathways function as conduits for ANS into Kansas is critical for intercepting species and preventing introductions. Prevention is the most cost effective and environmentally sound method of addressing this problem. Kansas has no comprehensive program to prevent new ANS introductions or address new species if one should arrive.

Strategic Action 2A1: Identify ANS that have the greatest potential to infest Kansas aquatic resources and identify existing and potential pathways that facilitate new ANS introductions.

Task 2A1a: Generate a regional list of ANS and evaluate the potential threat posed to Kansas by each.

Task 2A1b: Compile movement information of ANS on a regional level and predict the potential for possible invasion into Kansas waters.

Task 2A1c: Identify existing and potential transport pathways that would facilitate the introduction of these ANS into Kansas.

Strategic Action 2A2: Establish approaches to facilitate legislative, regulatory, and other actions needed to prevent new ANS introductions in Kansas and promote rules that establish the state's authority to control these introductions.

Task 2A2a: Determine statutory authority for ANS issues.

Task 2A2b: Prohibit the importation of non-indigenous aquatic species based upon their invasive potential.

Task 2A2c: Develop a list of approved species that may be imported into Kansas.

Task 2A2d: Examine existing ANS regulations and determine their effectiveness and revise when necessary.

Task 2A2e: Establish penalties for illegal introductions of ANS into Kansas waters.

Task 2A2f: Participate in regional and national forums to ensure coordinated efforts to prevent the introduction of new ANS into Kansas.

OBJECTIVE 3: Detect, monitor, and eradicate ANS.

3A. Problem: Kansas must be able to rapidly detect new ANS invasions and the spread of established ANS so emergency response plans can be implemented while there is potential to eradicate the problem species. Once invasive species have arrived, a brief window of opportunity exists to eradicate small pioneering populations exists. By initiating detection and monitoring programs, Kansas will be able to discover and manage pioneering infestations at a point when the species can possibly be eradicated in a cost effective manner.

Strategic Action 3A1: Implement a surveillance program.

Task 3A1a: Conduct annual surveys on state waters to determine the occurrence and distribution of ANS.

Task 3A1b: Encourage and train citizen-monitoring networks to work in cooperation with state agencies.

Task 3A1c: Develop and distribute a complete listing of ANS existing in Kansas based on survey data.

Strategic Action 3A2: Develop an early response device for detected and potential invasive species.

Task 3A2a: Prioritize regional species that merit ANS management if introduced into Kansas.

Task 3A2b: Develop a rapid response plan for all ANS detected or those ANS that immediately pose a threat to Kansas.

Task 3A2c: Identify funding sources for implementing rapid response plan actions.

Strategic Action 3A3: Eradicate pioneering populations of ANS.

Task 3A3a: Develop and implement an eradication and management program for pioneering ANS.

Task 3A3b: Establish cooperative policies with states sharing watersheds for eradication and to limit the spread of regional ANS populations.

OBJECTIVE 4: Control and eradicate established ANS that have significant impacts.

4A. Problem: Established ANS populations can spread to uninfested waters, thereby increasing their potential for economic and ecological damage. Management activities are most effective when they are directed at limiting the affects of a population or stopping that population from spreading to new waterbodies.

Strategic Action 4A1: Limit the dispersal of established ANS to new waterbodies or to new areas of a waterbody.

Task 4A1a: Establish protocols that will provide guidance in designing and implementing control and eradication strategies.

Task 4A1b: Support scientific research between state and federal agencies and academic institutions that investigate potential control strategies and associated environmental impacts.

Task 4A1c: Ensure that the control strategies developed and implemented by the state are done in coordination with federal agencies, local governments, interjurisdictional organizations and other appropriate entities.

Task 4A1d: Ensure that control strategies are based on the best available scientific information and conducted in an environmentally sound manner.

Task 4A1e: Develop guidelines to ensure the cleaning of water-based equipment that may accidentally spread ANS when moved from infested to uninfested waters.

Strategic Action 4A2: Develop means of adapting human activities to accommodate infestations of ANS.

Task 4A2a: Support scientific research between state and federal agencies and academic institutions that investigate potential means of adapting human activities to accommodate infestations of ANS where eradication or control is not feasible.

OBJECTIVE 5: Educate resource user groups about the risks and impacts of ANS and how to reduce the harmful impacts.

5A. Problem: New ANS introductions occur through a variety of pathways, most of which are closely related to human activities. Although some education programs include ANS information, public awareness of these issues and threats in Kansas are inadequate.

Strategic Action 5A1: Develop and distribute ANS educational materials to increase awareness of the ANS problem.

Task 5A1a: Develop and distribute educational materials to educate what ANS are, the problems they cause, and the avenues available for the public to help address the issue.
Task 5A1b: Develop and distribute ANS fact sheets and ID cards describing the methods to prevent their spread. Materials will include a contact number of where to report potential sightings.
Task 5A1c: Incorporate ANS information into boater safety classes.
Task 5A1d: Produce periodic press releases and public service announcements on specific ANS threats.
Task 5A1e: Create web-based media concerning ANS.
Task 5A1f: Develop ANS curriculum materials to be tied to existing Kansas Wildlife and Parks environmental science curriculum.
Task 5A1g: Make presentations on ANS issues to aquatic resource user groups.
Task 5A1h: Maintain and upgrade ANS information on the Kansas Wildlife and Parks agency website
Task 5A1i: Continue to include information on ANS in state hunting, fishing, and boating regulations.

Strategic Action 5A2: Develop and distribute ANS educational materials targeted at specific, public pathways of introductions.

Task 5A2a: Install appropriate signage at all infested waterbodies along with buoys to encourage public awareness of ANS.
Task 5A2b: Create a pamphlet about the spread of ANS via the release of aquarium animals and aquatic ornamental plants. The brochure will identify ANS, the laws regulating them, and their harmful effects in natural systems. Distribute the brochure to pet stores, garden centers, and bait dealers for distribution to customers.
Task 5A2c: Distribute ANS educational materials to the recreational boating industry (i.e. marinas and boat dealers), and include materials with special event permits.
Task 5A2d: Distribute ANS educational materials to aquaculture industry.
Task 5A2e: Distribute ANS educational materials to aquatic user groups (i.e. dive clubs, angling clubs, sailing clubs, etc.).

Strategic Action 5A3: Develop and distribute ANS identification and management information to resource agency staff.

Task 5A3a: Distribute ANS educational materials to all Kansas resource agency field staff, municipalities using surface water supplies, city park departments, county conservation boards, Coast Guard Auxiliary groups, and other entities with aquatic resource management responsibilities.
Task 5A3b: Organize and facilitate ANS identification workshops for state aquatic resource managers.
Task 5A3c: Develop and maintain a list of experts to whom ANS samples can be sent for identification. This list will be published on state agency websites for easy access.

OBJECTIVE 6: Support research on ANS in Kansas, and develop efficient systems to disseminate information to research and management communities.

6A. Problem: Little is known about the effects of ANS in Kansas. Research questions relevant to the ANS problem include determining the risks associated with each pathway of ANS introductions, the environmental conditions which must be necessary for certain ANS to become established in Kansas waters, the likely interactions between ANS and native species, and which management options will provide the best results in controlling or eradicating ANS populations. Research is needed to quantify and clarify the effect ANS poses to Kansas water resources.

Strategic Action 6A1: Support research that identifies, predicts, and prioritizes potential ANS introductions.

Task 6A1a: Identify life histories and impacts of introduced aquatic plants and animals.

Task 6A1b: Identify critical data needed to prevent the introduction of new ANS.

Task 6A1c: Attend scientific and technical conferences addressing the mechanisms by which new ANS spread.

Task 6A1d: Monitor ongoing research efforts attempting to develop control mechanisms for new ANS.

Strategic Action 6A2: Support research management alternatives for their effect on ANS and native species.

Task 6A2a: Investigate the relationship between human-induced disturbance of aquatic and riparian systems and ANS invasion, establishment, and impacts.

Task 6A2b: Investigate new and innovative methods of managing ANS.

Strategic Action 6A3: Facilitate the collection and dispersal of information, research, and data on ANS in Kansas.

Task 6A3a: Utilize existing field personnel to document the distribution and abundance of ANS.

Task 6A3b: Create a database of interested parties to receive annual ANS updates.

Task 6A3c: Utilize the internet to distribute information and research findings via an agency website.

IMPLEMENTATION TABLE

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's		Planned ($000/FTE's)		
Plan #	Description	Source	Agency	Agency	FY03	FY04	FY05	FY06	FY07
Objective 1: Coordinate and implement a comprehensive management plan									
1A1	**Implement a state ANS management program**								
1A1a	Receive plan approval by Natural Resources Sub-Cabinet	State	KDWP	KDHE,KDA					
1A1b	Receive plan approval by Kansas Governor	State	KDWP	KDHE,KDA					
1A1c	Receive plan approval by KDWP commission	State	KDWP						
1A1d	Receive plan approval by Federal ANSTF	State	KDWP	FWS					
1A1e	Implement the Kansas ANS management plan	State & Fed	KDWP	various		128/1	140/1	140/1	140/1
1A2	**Create and Fund ANS coordinator position**								
1A2a	Hire a program coordinator	State	KDWP			55/1	55/1	55/1	55/1
1A3	**Coordinate ANS activities with regional/national programs**								
1A3a	Identify key personnel with ANS responsibilities	State	KDWP	various					
1A3b	Ensure coherent ANS strategy	State	KDWP	various					
1A3c	Establish partnerships for data sharing	State	KDWP	various					
1A3d	Participate in national and regional coordination forums	State	KDWP						
1A3e	Conduct annual ANS forum in KS	State	KDWP	various			5/1	5/1	5/1
1A4	**Develop a permanent funding mechanism for ANS management in Kansas**								
1A4a	Explore ideas for permanent funding	State	KDWP	various					
1A4b	Establish permanent funding with KS Legislature	State	KDWP	KDHE, KDA, KWO					
Objective 2: Prevent the introduction of new ANS into Kansas waters									
2A1	**Identify ANS with greatest potential to infest Kansas**								
2A1a	Generate regional listing of ANS	State	KDWP	KDHE, KDA, KBS					
2A1b	Compile data on regional scale movement of ANS	State	KDWP	KDHE, KDA, KBS					
2A1c	Identify ANS transport mechanisms	State	KDWP	various					
2A2	**Establish approaches to prevent new ANS introductions**								
2A2a	Determine statutory authority	State	KDWP	various					
2A2b	Prohibit transport of invasive ANS	State & Fed	KDWP	various					
2A2c	Develop list of approved species for import	State	KDWP	various					
2A2d	Examine ANS regulations and revise as needed	State	KDWP	KDHE, KDA					
2A2e	Establish penalties for illegal introductions of ANS	State	KDWP	KDHE, KDA					
2A2f	Participate in regional and national forums for prevention	various	KDWP	various					

Table Legend: COE-United States Army Corps of Engineers, FWS-United States Fish and Wildlife Service, KBS-Kansas Biological Survey, KDA-Kansas Department of Agriculture, KDHE-Kansas Department of Health & Environment, KDWP-Kansas Department of Wildlife & Parks, KWO-Kansas Water Office, MRBP-Mississippi River Basin Panel on Aquatic Nuisance Species, Various-includes numerous interested parties both public and private, WGA-Western Governors Association, WRP-Western Regional Panel

IMPLEMENTATION TABLE

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's)		Planned ($000/FTE's)		
Plan #	Description	Source	Agency	Agency	FY03	FY04	FY05	FY06	FY07
OBJECTIVE 3: Detect, monitor, and eradicate ANS									
3A1	**Implement a surveillance program**								
3A1a	Conduct annual surveys for distribution data	State	KDWP	KDHE, KDA, KBS	4/0	15/0	15/0	15/0	15/0
3A1b	Encourage monitoring networks and coordination	State	KDWP	various					
3A1c	Distribute list of ANS in Kansas	State	KDWP						
3A2	**Develop early response device**								
3A2a	Prioritize regional ANS that merit management	State	KDWP	WRP, MRBP, WGA					
3A2b	Develop rapid response plan for priority species	State	KDWP	various					
3A2c	Identify funding sources for plan action implementation	State	KDWP	various	1/0	2/0			
3A3	**Eradicate pioneering ANS populations**								
3A3a	Develop eradication program for pioneering ANS	State	KDWP	KDHE, KDA					
3A3b	Establish policies for shared watersheds	State	KDWP	various					
OBJECTIVE 4: Control and eradicate established ANS that have significant impacts									
4A1	**Limit dispersal of established ANS**								
4A1a	Establish control protocol	State	KDWP	KDHE, KDA					
4A1b	Support research for control mechanisms	various	KDWP	various					
4A1c	Ensure coordinated control strategies	State	KDWP	various					
4A1d	Ensure environmentally sound control strategies	State	KDWP	various					
4A1e	Develop cleaning guidelines for equipment	State	KDWP	KDHE, KDA, KBS					
4A2	**Develop means of adapting human activities**								
4A2a	Support research to adapt human activities	various	KDWP	various					

Table Legend: COE-United States Army Corps of Engineers, FWS-United States Fish and Wildlife Service, KBS-Kansas Biological Survey, KDA-Kansas Department of Agriculture, KDHE-Kansas Department of Health & Environment, KDWP-Kansas Department of Wildlife & Parks, KWO-Kansas Water Office, MRBP-Mississippi River Basin Panel on Aquatic Nuisance Species, Various-includes numerous interested parties both public and private, WGA-Western Governors Association, WRP-Western Regional Panel.

IMPLEMENTATION TABLE

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's		Planned ($000/FTE's)		
Plan #	Description	Source	Agency	Agency	FY03	FY04	FY05	FY06	FY07
OBJECTIVE 5: Educate users of risks and how to reduce the harmful impacts									
5A1	**Develop and distribute ANS educational materials**								
5A1a	Develop ANS educational materials to raise awareness	State	KDWP	various	1/0	10/0			
5A1b	Develop ANS prevention fact sheets and ID cards	State	KDWP	various		3/0			
5A1c	Incorporate ANS information into boater safety classes	State	KDWP						
5A1d	Produce PSA's and press releases	State	KDWP	various					
5A1e	Create web based media on ANS	State	KDWP	various					
5A1f	Develop ANS curriculum	State	KDWP	KDHE, KDA					
5A1g	Present ANS issues and information to interested groups	State	KDWP	various	1/0	1/0			
5A1h	Maintain ANS information database on KDWP website	State	KDWP						
5A1i	Include ANS information in regulation booklets	State	KDWP						
5A2	**Develop and distribute ANS educational materials targeted at public pathways of introduction**								
5A2a	Install appropriate signage at infested waterbodies	State	KDWP		1/0	5/0			
5A2b	Distribute ANS dispersal information to aquatic dealers	State	KDWP						
5A2c	Distribute ANS materials to recreational boat industry	State	KDWP						
5A2d	Distribute ANS materials to aquaculture industry	State	KDWP						
5A2e	Distribute ANS materials to aquatic user groups	State	KDWP	COE					
5A3	**Develop and distribute ANS identification and management information to resource agency staff**								
5A3a	Distribute ANS material to aquatic resource managers	State	KDWP	various					
5A3b	Facilitate ANS ID workshops for resource managers	State	KDWP	various					
5A3c	Develop list of ANS experts for ID	State	KDWP	various					

Table Legend: COE-United States Army Corps of Engineers, FWS-United States Fish and Wildlife Service, KBS-Kansas Biological Survey, KDA-Kansas Department of Agriculture, KDHE-Kansas Department of Health & Environment, KDWP-Kansas Department of Wildlife & Parks, KWO-Kansas Water Office, MRBP-Mississippi River Basin Panel on Aquatic Nuisance Species, Various-includes numerous interested parties both public and private, WGA-Western Governors Association, WRP-Western Regional Panel.

IMPLEMENTATION TABLE

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's		Planned ($000/FTE's)		
Plan #	Description	Source	Agency	Agency	FY03	FY04	FY05	FY06	FY07
OBJECTIVE 6: Support research on ANS in Kansas, and develop systems to disseminate information									
6A1	**Support research that identifies, predicts, and prioritizes potential ANS introductions**								
6A1a	Identify life histories and impacts of introduced ANS	State	KDWP	KDHE, KDA, KBS					
6A1b	Identify critical data to prevent the introduction of ANS	State	KDWP	KDHE, KDA, KBS, COE		30/0			
6A1c	Attend conferences on the mechanisms of ANS spread	various	KDWP	various	1/0	2/0			
6A1d	Monitor research efforts to develop ANS control methods	various	KDWP	various					
6A2	**Support research management alternatives for their effect on ANS and native species**								
6A2a	Investigate human-induced disturbance and ANS invasion	various	KDWP	various					
6A2b	Investigate new and innovative methods to manage ANS	various	KDWP	KDHE, KDA, KBS					
6A3	**Facilitate the collection and dispersal of information, research, and data on ANS in Kansas**								
6A3a	Utilize existing field personnel to document ANS	State	KDWP	various		5/0			
6A3b	Identify interested parties to receive annual ANS updates	State	KDWP	various					
6A3c	Utilize the internet to distribute research findings	State	KDWP	various					

Table Legend: COE-United States Army Corps of Engineers, FWS-United States Fish and Wildlife Service, KBS-Kansas Biological Survey, KDA-Kansas Department of Agriculture, KDHE-Kansas Department of Health & Environment, KDWP-Kansas Department of Wildlife & Parks, KWO-Kansas Water Office, MRBP-Mississippi River Basin Panel on Aquatic Nuisance Species, Various-includes numerous interested parties both public and private, WGA-Western Governors Association, WRP-Western Regional Panel.

GLOSSARY

Accidental introduction: An introduction of non-indigenous aquatic species that occurs as the result of activities other than the purposeful or intentional introduction of the species involved, such as the transport of non-indigenous species in ballast water or in water used to transport fish, mollusks, or crustaceans for aquaculture or other purposes.

Aquatic nuisance species (ANS): A non-indigenous species that threatens the diversity and abundance of native species or the ecological stability of infested waters, or commercial, agricultural, or recreational activities dependant on such waters.

Baitfish: Fish species commonly sold for use as bait for recreational fishing.

Ballast water: Any water or associated sediments used to manipulate the trim and stability of a vessel.

Control: Limiting the distribution and abundance of a species.

Ecological integrity: The extent to which an ecosystem has been altered by human behavior; an ecosystem with minimal impact from human activity has a high level of integrity; an ecosystem that has been substantially altered by human activity has a low level of integrity.

Environmentally sound: Methods, efforts, actions, or programs to prevent introductions or to control infestations of ANS that minimize adverse environmental impacts.

Eradicate: The act or process of eliminating an ANS.

Exotic: Any species or other biological material that enters an ecosystem beyond its historic range on the continent.

Great Lakes: Lake Ontario, Lake Erie, Lake Huron (including Lake St. Clair), Lake Michigan, Lake Superior, and the connecting channels (Saint Mary's River, Saint Clair River, Detroit River, Niagara River, and Saint Lawrence River to the Canadian Border), and includes all other bodies of water within the drainage basin of such lakes and connecting channels.

Infested: Any waterbody where an aquatic nuisance species is known to occur.

Intentional introduction: All or part of the process by which a non-indigenous species is purposefully introduced into a new area.

Native: A plant or animal species that naturally occurs in Kansas and has not been introduced from another state or continent.

Non-indigenous species: Any species or other variable biological material that enters an ecosystem beyond its historic range.

Pioneer infestation: A small ANS colony that has spread to a new area from an established colony.

Population: A group of individual plant or animal species occupying a particular area at the same time.

REFERENCES

Benson, A. J., P. L. Fuller, and C. C. Jacono. 2001. Summary report of nonindigenous aquatic species in U.S. Fish and Wildlife Service Region 4. USFWS report. Arlington, VA.

Benson, A.J. E. Maynard, and D. Raikow. 2005. *Daphnia lumholtzi* . Nonindigenous Aquatic Species Database, Gainesville, FL.

Boileau, M. G. 1985. The expansion of white perch *Morone americana* in the Lower Great Lakes. Fisheries 10(1):6–10.

Burkhead, N. M., and J. D. Williams. 1991. An intergeneric hybrid of a native minnow, the golden shiner, and an exotic minnow, the rudd. Transactions of the American Fisheries Society 120:781–795.

Colle, D. E., and J. V. Shireman. 1980. Coefficients of condition for largemouth bass, bluegill, and redear sunfish in hydrilla infested lakes. Transactions of the American Fisheries Society 109:521–531.

Colle, D. E., J. V. Shireman, W. T. Haller, J. C. Joyce, and D. E. Canfield. 1987. Influence of hydrilla on harvestable sport-fish populations, angler use, and angler expenditures at Orange Lake, Florida. North American Journal of Fisheries Management 7: 410–417.

Corkum, L. D. 1996. Behavioral interactions between round gobies *Neogobius melanostomus* and mottled sculpins *Cottus bairdi*. Journal of Great Lakes Research 22:838–844.

Dzialowski, A. R., W. J. O'Brien and S. M. Swaffar. 2000. Range expansion and potential dispersal mechanisms of the exotic cladoceran *Daphnia lumholtzi*. Journal of Plankton Research 22(12):2205-2223.

Freeze, M. and S. Henderson. 1982. Distribution and status of the bighead carp and silver carp in Arkansas. North American Journal of Fisheries Management 2:197–200.

Fuller, P. L., L. G. Nico, and J. D. Williams. 1999. Non-indigenous fishes introduced into inland waters of the United States: American Fisheries Society, Special Publication 27, Bethesda, Maryland.

Gardner, S. C., C. E. Grue, W. W. Major III, and L. L. Conquest. 2001. Aquatic invertebrate communities associated with purple loosestrife *Lythrum salicaria*, cattail *Typha latifolia*, and bulrush *Scirpus acutus* in Central Washington, USA. Wetlands 21:593-601.

Hushak, L. J., Y. Deng, and M. Bielen. 1995. The Cost of Zebra Mussel Monitoring and Control. Aquatic Nuisance Species Digest 1(1).

Keddy, P. A., and P. Constabel. 1986. Germination of ten shoreline plants in relation to seed, soil particle size, and water level: an experimental study. Journal of Ecology 74:133–141.

Lehman, J. T. 1991. Causes and consequences of cladoceran dynamics in Lake Michigan: implications of species invasion by *Bythotrephes*. Journal of Great Lakes Research 17:437–445.

Lodge, D. M., C. A. Taylor, D. M. Holdich, J. Skurdal. 2000. Non-indigenous crayfishes threaten North American freshwater biodiversity: lessons from Europe. Fisheries 25(8):7–20.

MacInnis, A. J., and L. D. Corkum. 2000. Fecundity and reproductive season of the round goby *Neogobius melanostomus* in the Upper Detroit River. Transactions of the American Fisheries Society 129:136–144.

Mack, R. N., D. Simberloff, W. M. Lonsdale, H. Evans, M. Clout, and F. Bazzaz. 2000. Biotic Invasions: Causes, Epidemiology, Global Consequences and Control. Ecological Society of America. Washington, DC.

Madenjian, C. P., R. Knight, L. Bur, T. Michael, and J. L. Forney. 2000. Reduction in recruitment of white bass in Lake Erie after invasion of white perch. Transactions of the American Fisheries Society 129:1340–1353.

McLean, M., D. Ogle, and J. Gunderson. 1995. Ruffe: A new threat to our fisheries. Great Lakes Sea Grant publication.

Mitich, L. W. 1999. Purple loosestrife *Lythrum salicaria*. Weed Technology 13:843–846.

New York Sea Grant. 1994. Policy issues: *Dreissena polymorpha* information review. Zebra Mussel Clearinghouse 5:14-15.

Nico, L. G., and P. Fuller. 2003. Rudd *Scardinius erythrophthalmus* fact sheet. USGS Nonindigenous aquatic species database. Gainsville, FL.

Nico, L. G., and P. Fuller. 2004. Black carp *Mylopharyngodon piceus* fact sheet. USGS Nonindigenous aquatic species database. Gainsville, FL.

Nico, L. G., and J. D. Williams. 1996. Risk assessment on black carp (Pisces: Cyprinidae). Final Report to the Risk Assessment and Management Committee of the Aquatic Nuisance Species Task Force. U.S. Geological Survey, Biological Resources Division, Gainesville, FL. 61 pp.

Parker, S. L. L. G. Rudstam, E. L. Mills, and D. W. Einhouse. 2001. Retention of *Bythotrephes* spines in the stomachs of Eastern Lake Erie rainbow smelt. Transactions of the American Fisheries Society 130:988–994.

Preliminary Report of the U.S. Commission on Ocean Policy, governors' draft. 2004. Washington, DC.

Rendall, W. 1997. Nonindigenous species and upcoming guidelines for prevention. Aquatic Nuisance Species Digest 2(2):13, 18-19.

Richards, D. C. 2002. The New Zealand mudsnail invades. Aquatic Nuisance Species Digest Vol. 4(4):42-44.

Sastroutomo, S. S. 1981. Turion formation, dormancy and germination of curly pondweed *Potamogeton crispus*. Aquatic Botany 10:161-173.

Shamsi, S. R. A., and F. H. Whitehead. 1974. Comparative eco-physiology of *Epilobium hirsutum* and *Lythrum salicaria* General biology, distribution and germination. Journal of Ecology. 62:279–290.

Sher, A. A., D. L. Marshall, and J. P. Taylor. 2002. Establishment patterns of native Populus and Salix in the presence of invasive nonnative Tamarix. Ecological Applications 12:760-772.

Smith, C., and J. Barko. 1990. Ecology of Eurasian watermilfoil. Journal of Aquatic Plant Management 28:55-64.

Tate, W. B., M. S. Allen, R. A. Myers, E. J. Nagid, and J. R. Estes. 2003. Relation of age-0 largemouth bass abundance to hydrilla coverage and water level at Lochloosa and Orange Lakes, Florida. North American Journal of Fisheries Management 23:251–257.

Trometer, E. S., Busch, W. D. N. 1999: Changes in Age-0 Fish Growth and Abundance Following the Introduction of Zebra Mussels *Dreissena polymorpha* in the Western Basin of Lake Erie. North American Journal of Fisheries Management 19:604–609.

Tucker, J. K., F. A. Cronin, J. Stone, and T. B. Mihuc. 1998. The bighead carp *Hypophthalmichthys nobilis* in reach 26 of the Mississippi River. Illinois Natural History Survey, Champaign, IL.

U.S. Congress Office of Technology Assessment. 1993. Harmful non-indigenous species in the United States, OTA-F-565. Washington, DC.

U.S. Fish and Wildlife Service. 2002. Black carp: invasive species program. USFWS report. Arlington, VA.

U.S. General Accounting Office. 2001. Invasive Species: Obstacles hinder federal rapid response to growing threat. Report GAO-01-724. Washington DC.

Welling, C. H., and R. L. Becker. 1990. Seed bank dynamics of *Lythrum salicaria*: Implications for control of this species in North America. Aquatic Botany 38:303–309.

Westbrooks, R. 1998. Invasive plants, changing the landscape of America: Fact book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), Washington, D.C. 109 pp.

Wu, L., and D. A. Culver. 1991. Zooplankton grazing and phytoplankton abundance: An assessment before and after invasion of *Dreissena polymorpha*. Journal of Great Lakes Research 17: 425-436.

Valley, R. D., and M. T. Bremigan. 2002. Effects of macrophyte bed architecture on largemouth bass foraging: implications of exotic macrophyte invasions. Transactions of the American Fisheries Society 131:234–244.

APPENDIX A
Non-indigenous aquatic animals

Common Name	Scientific Name
Amphibians	
Dusky Salamander	*Desmognathus fuscus*
Green tree frog	*Hyla cinerea*
Wood Frog	*Rana sylvatica*
Fish	
Bighead carp*	*Hypophthalmichthys nobilis*
Black crappie	*Pomoxis nigromaculatus*
Blue tilapia	*Oreochromis aureus*
Brown bullhead	*Ameiurus nebulosus*
Common carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Grass carp	*Ctenopharyngodon idella*
Mosquitofish	*Gambusia affinis*
Northern Pike	*Esox lucius*
Palmetto bass	*Morone hybrid*
Rainbow smelt	*Osmerus mordax*
Rainbow trout	*Oncorhynchus mykiss*
Redear sunfish	*Lepomis microlophus*
Red River Shiner	*Notropis bairdi*
Rock bass	*Ambloplites rupestris*
Rudd	*Scardinius erythrophthalmus*
Saugeye	*Sander hybrid*
Silver carp*	*Hypophthalmichthys molitrix*
Striped bass	*Morone saxatilis*
Threadfin shad	*Dorosoma petenense*
White perch*	*Morone americana*
Yellow bass	*Morone mississippiensis*
Yellow perch	*Perca flavenscens*
Invertebrates	
Asian clam	*Corbicula fluminea*
Freshwater jellyfish	*Craspedacusta sowerbyii*
Exotic waterflea	*Daphnia lumholtzi*
Zebra mussel*	*Dreissena polymorpha*

* Denotes priority species.

APPENDIX B
Non-indigenous aquatic plants

Common name	Scientific name
American sloughgrass	*Beckmannia syzigachne*
American wisteria	*Wisteria frutescens*
Annual rabbit's-foot grass	*Polypogon monspeliensis*
Blue water speedwell	*Veronica anagallis-aquatica*
Brazilian waterweed	*Egeria densa*
Broadleaved peppergrass	*Lepidium latifolium*
Carolina fanwort	*Cabomba caroliniana*
Common barnyard grass	*Echinochloa crusgalli*
Common velvet grass	*Holcus lanatus*
Creeping bent grass	*Agrostis stolonifera*
Creeping yellowcress	*Rorippa sylvestris*
Curly dock	*Rumex crispus*
Curly pondweed	*Potamogeton crispus*
Eurasian watermilfoil*	*Myriophyllum spicatum*
Garden orache	*Atriplex hortensis*
Garlic mustard	*Alliaria petiolata*
Glinus	*Glinus lotoides*
Indian heliotrope	*Heliotropium indicum*
Jungle rice	*Echinochloa colona*
Lady's thumb smartweed	*Persicaria maculosa*
Meadow foxtail	*Alopecurus pratensis*
Moneywort	*Lysimachia nummularia*
Mouse foxtail	*Alopecurus myosuroides*
Narrow leaf cattail	*Typha angustifolia*
Narrowleaf dock	*Rumex stenophyllus*
Water lettuce	*Pistia stratiotes*
Oakleaf goosefoot	*Chenopodium glaucum*
Parrot's feather	*Myriophyllum aquaticum*
Prickly sowthistle	*Sonchus asper*
Prostrate knotweed	*Polygonum aviculare*
Purple loosestrife*	*Lythrum salicaria*
Ravennagrass	*Saccharum ravennae*
Red goosefoot	*Chenopodium rubrum*
Red orache	*Atriplex rosea*
Rough blue grass	*Poa trivialis*
Saltcedar*	*Tamarix spp.*

*Denotes priority species

APPENDIX B (continued)
Non-indigenous aquatic plants

Common name	Scientific name
Schreber's watershield	*Brasenia schreberi*
Seaside heliotrope	*Heliotropium curassavicum*
Tall buttercup	*Ranunculus acris*
Thymeleaf speedwell	*Veronica serpyllifolia*
Watercress	*Nasturtium officinale*
Water hyacinth	*Eichhornia crassipes*
Water pepper smartweed	*Persicaria hydropiper*
Weeping willow	*Salix babylonica*
Yellow iris	*Iris pseudacorus*

*Denotes priority species.

APPENDIX C
Acronyms Defined

Acronym	Definition
ANS	Aquatic Nuisance Species
ANSTF	Aquatic Nuisance Species Task Force
BWM	Ballast Water Management
FTE	Full Time Employee
KAR	Kansas Administrative Regulation
KDA	Kansas Department of Agriculture
KDWP	Kansas Department of Wildlife & Parks
KDHE	Kansas Department of Health & Environment
KSA	Kansas Statutory Authority
MRBP	Mississippi River Basin Regional Panel
NANPCA	Non-indigenous Aquatic Nuisance Prevention and Control Act
NISA	National Invasive Species Act
NZMS	New Zealand Mudsnail
USFWS	U.S. Fish and Wildlife Service
WGA	Western Governors Association
WRP	Western Regional Panel
ZMRP	Zebra Mussel Research Program

APPENDIX D
ANS Committee Members and Technical Advisors

Jason M. Goeckler
Nuisance Species Coordinator
Kansas Department of Wildlife & Parks
1830 Merchant St. P.O. Box 1525
Emporia, KS 66801-1525
jasong@wp.state.ks.us

Doug Nygren
Fisheries Section Chief
Kansas Department of Wildlife & Parks
512 SE 25th Ave.
Pratt, KS 67124-5911
dougn@wp.state.ks.us

Tom D. Mosher
Fisheries Research Coordinator
Kansas Department of Wildlife & Parks
1830 Merchant St. P.O. Box 1525
Emporia, KS 66801-1525
tomm@wp.state.ks.us

Bill Scott
Weed Specialist
Kansas Department of Agriculture
P.O. Box 19282
Topeka, KS 66619-0282
bscott@kda.state.ks.us

Tony Stahl
Environmental Scientist
Kansas Department of Health & Environment
1000 SW Jackson St.-Suite 430
Topeka, KS 66612
TStahl@kdhe.state.ks.us

Dan E. Haines
Environmental Biologist
Wolf Creek Nuclear Operation Corporation
1550 Oxen LN
Burlington, KS 66839
dahaine@wcnoc.com

Joseph E. Werner
Senior Environmental Biologist
Great Plains Energy
P.O. Box 418679
Kansas City, MO 64141-9679
joe.werner@kcpl.com

Steve Adams
Natural Resources Coordinator
Kansas Department of Wildlife & Parks
1020 S Kansas Ave. Suite 200
Topeka, KS 66612-1327
(785) 296-2281
steva@wp.state.ks.us

Bob Angelo
Environmental Scientist
Kansas Department of Health and Environment
1000 SW Jackson
Topeka, KS 66612
bangelo@kdhe.state.ks.us

Paul Liechti
Assistant Director
Kansas Biological Survey
2101 Constant Ave.
Lawrence, KS 66047
pliechti@ku.edu

Craig C. Freeman
Associate Scientist/Botanist
Kansas Biological Survey
2101 Constant Ave.
Lawrence, KS 66047
ccfree@ku.edu

Brad Loveless
Biologist
Westar Energy
122 SW 2nd
Topeka, KS 66603
brad_loveless@wr.com

Michele D. McNulty
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
315 Houston, Suite E
Manhattan, Kansas 66502
michelle_mcnulty@fws.gov

Everett Laney
Biologist
U.S. Army Corp of Engineers
1645 S 101 E Ave.
Tulsa, OK 74128
everett.laney@usace.army.mil

Debra Baker
Environmental Scientist
Kansas Water Office
901 S Kansas Ave.
Topeka, KS 66612-1249
dbaker@kwo.state.ks.us

Pamela K. Chaffee
Marine Safety & Environmental Protection Officer
Division 31, Eighth Western Rivers District
U.S. Coast Guard Auxiliary
847 N. 1909 Rd.
Lecompton, KS 66050
pchaffee@mindspring.com

Lt. Tom Morgan
Planning Officer
U.S. Coast Guard
1222 Spruce St. Suite 8.104E
St. Louis, MO 63103-2865
TMorgan@cgstl.uscg.mil

APPENDIX E
Acknowledgements

We appreciate the contributions made in an earlier draft by Reese Hobby, Linda Drees, Bill Gill, Everett Laney, Steve Adams, and Tom Mosher.

1320 Research Park Drive
Manhattan, Kansas 66502
(785) 564-6700

Kansas
Department of Agriculture
agriculture.ks.gov

900 SW Jackson, Room 456
Topeka, Kansas 66612
(785) 296-3556

Jackie McClaskey, Secretary

Governor Sam Brownback

January 27, 2017

Mr. Tracy Streeter, Director
Kansas Water Office
900 SW Jackson Street, Suite 404
Topeka, Kansas 66612

Dear Mr. Streeter,

The Kansas Department of Agriculture's Division of Conservation (DOC) offers our support of the Kansas Water Office grant proposal to the Bureau of Land Reclamation titled "Pilot Test Project for Produced Water near Hardtner, Kansas". The DOC is allied with the fundamental objectives of the Kansas Water Office in protecting and conserving the valuable water resources of our state, and we are pleased to offer this endorsement of their grant proposal.

In the midst of Kansas's 50-Year Water Vision, DOC recognizes the value in being able to reuse oil field water for agricultural uses. A project to treat oil field water in Hardtner, Kansas, for reuse in the agricultural industry benefits our state in terms of water conservation, water quality improvements, and also provides options to producers looking for alternatives in water use. Though this project is currently small in scope, results from the project could provide a very valuable alternative opportunity for water use across our state, especially in agricultural areas prone to drought.

This project is a great example of government and private partnerships working toward solutions for water use under the umbrella of conservation. Thank you for the opportunity to provide support for a meaningful study. We value your partnership and stand ready to assist the KWO in any way we can.

Sincerely,

Rob Reschke
Executive Director
Division of Conservation

Bureau of Water
Watershed Management Section
1000 SW Jackson, Suite 420
Topeka, KS 66612-1367

Phone: 785-296-4195
Fax: 785-296-5509
nps@kdheks.gov
www.kdheks.gov/water

Kansas
Department of Health & Environment

Susan Mosier, MD, Secretary

Sam Brownback, Governor

February 1, 2017

Kirk Tjelmeland
Kansas Water Office
900 SW Jackson, STE 404

Regarding: Letter of support for WaterSMART Water Recycling and Research grant application sponsored by the Kansas Water Office

Mr. Kirk Tjelmeland

On behalf of the Kansas Department of Health and Environment, Watershed Management Section, we are pleased to provide a letter of support for the Kansas Water Office WaterSMART Water Recycling and Research proposal to the U.S. Department of the Interior, Bureau of Reclamation. The Kansas Department of Health and Environment, Watershed Management Section is committed to protecting and restoring water quality in Kansas watersheds, through the Watershed Restoration and Protection Strategy (WRAPS) program. The WRAPS program encourages the water quality improvement and protection of surface and ground water through implementation of Best Management Practices (BMP). The research outlined in your proposal complements the WRAPS platform, which emphasizes the development of new BMPs and new tools for landowners to use to improve water quality.

In addition, your proposal identifies the opportunity to work with local farmers and ranchers to repurpose low quality water into a higher quality water resource for irrigation and watering of livestock. This philosophy of landowners understanding the importance of water quality in relation to water use is a strong component to the WRAPS program. Thank you for considering our support of the Kansas Water Office Water SMART Water Recycling and Research proposal to protect the environment and water quality.

Sincerely,

Amanda Reed

Amanda Reed
Chief, Watershed Management Section
Kansas Department of Health and Environment

The Nature Conservancy
Protecting nature. Preserving life.

Kansas Chapter
2420 NW Button Road
Topeka, KS 66618

Tel (785) 233-4400
Fax (703) 233-2022

nature.org

January 9, 2017

Kansas Water Office
900 SW Jackson, Suite 404,
Topeka, KS 66612

RE: Support for Proposed study - Pilot Test Project for Produced Water in Kansas
BOR funding opportunity: WaterSMART: Water Recycling and Reuse Research under the Title XVI Water Reclamation and Reuse Program for Fiscal Year 2017.

To whom it may concern:

The Nature Conservancy of Kansas endorses the proposed **Pilot Test Project for Produced Water in Kansas** to test the efficacy of treatment of produced oil field water to a level which may serve as suitable irrigation or livestock drinking water. The potential of this process may serve significant purpose as an overall water conservation measure for the Red Hills of Kansas and beyond.

The State of Kansas is currently pursuing innovative strategies to improve our water quality and security into the future, while continuing to support municipal supplies, industry, and agriculture. The Nature Conservancy supports efforts such as the proposed study to conserve our limited and valuable water resources in Kansas. We also find utilization of produced water preferable to underground injection. Many long-term risk of wastewater injection remain unknown, although evidence is emerging that these activities may impact nearby streams and alter the biogeochemistry of nearby ecosystems. Therefore, the proposed project will be of value to streams and wildlife as well.

Sincerely,

Rob Manes
State Director, Kansas
The Nature Conservancy

Kansas Alliance for Wetlands and Streams, Inc.

PO Box 5 | Cheney KS 67025 | (785) 410-0040 | www.kaws.org

January 16, 2017

Dear Kansas Water Office:

The Kansas Alliance for Wetlands and Streams (KAWS) is pleased to offer enthusiastic support to the Kansas Water Office in their grant application to the Bureau of Reclamation called "Pilot Test Project for Produced Water near Hardtner, Kansas," through the Funding Opportunity Announcement No. BOR-DO-17-F004.

KAWS has a long history of partnerships with agencies such as the Kansas Water Office as well as working with organizations and landowners to ensure the future of wetlands, streams and their adjacent riparian areas as an integral part of our Kansas heritage and landscape. Because this project will involve the treatment of produced oil field water to a quality standard acceptable for agricultural irrigation and the watering of livestock; and that same produced oil field water could be a source of new water for counties in Kansas prone to drought conditions, this project could fill one of the gaps in water quality and quantity needs for agricultural production and water conservation. As similar projects have been implemented in other states, KAWS understands that this technology is reliable and that the success of this project depends on funding and partner support.

In order to ensure the success of the project, KAWS is prepared to offer some technical expertise as well as outreach and promotion of this project to our established partners.

We encourage you to support this important work in Kansas and provide funding for this innovative grant proposal.

Sincerely,

Jessica Mounts
Executive Director
jmounts@kaws.org

To ensure the future of wetlands, streams, and their adjacent riparian areas as an integral part of our Kansas heritage and landscape.

[redacted]

February 2, 2017

Kirk Tjemelad

Kansas Water Office
500 SW Jackson, Ste 404
Topeka, KS 66612

Dear Kirk,

This letter will confirm that Contractor, Inc. will provide $1,100,000 worth of water treatment

equipment as per current prices at this date, for the pilot project WaterSmart: Water Reclamation
Research under the Title XVI Water Reclamation and Reuse Program for Fiscal Year 2017.

We are excited to work with your department to proceed with this pilot project to prove the reuse of oil field water.

Best,

[redacted]

[redacted]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

December 18, 2014

OFFICE OF
ADMINISTRATION
AND RESOURCES
MANAGEMENT

Ms. Katie Mitchell
Chief Fiscal Officer
900 SW Jackson, Suite 404
Topeka, KS 66612

Dear Ms. Mitchell:

Enclosed is a negotiation agreement reflecting an understanding reached with your office concerning the indirect cost rate to be used on grants with the Federal Government.

I have already signed the agreement. Please have the agreement countersigned by a duly authorized representative of your organization. Photocopy the agreement for your files and return the original to me. Since I work in a secure location, I am unable to receive FedEx, DSL or UPS Overnight packages; therefore, if you mail the Agreement back to me using FedEx, DSL or UPS Overnight, please use the Overnight address listed below. If you have questions, please contact me on (202) 564-5055. Please give this matter your immediate attention.

Please return the countersigned original agreement to one of the following addresses:

Jackie Smith, Rate Negotiator (3802R)
Financial Analysis and Oversight Service Center
U.S. Environmental Protection Agency

REGULAR MAIL
WJC North
1200 Pennsylvania Avenue, N.W
Washington, D.C. 20460-0001

OVERNIGHT MAIL
Ronald Reagan Building
Bid & Proposal Room #61107
1300 *Pennsylvania Ave*
Washington, D.C. 20004

Sincerely yours,

Jackie Smith

Jackie Smith, Rate Negotiator
Financial Analysis and
Oversight Service Center

Enclosure

JAN 05 2015

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

STATE AND LOCAL GOVERNMENTS RATE AGREEMENT

Kansas Water Office
Topeka, Kansas

Date: December 18, 2014
Filing Ref: February 1, 2012

The indirect cost rates contained herein are for use on grants with the Federal Government to which Office of Management and Budget Uniform Guidelines applies, subject to the limitations contained in the Circular and in Section II, A below.

SECTION I: RATES

Type	Effective Period From	To	Rate	Base
Predetermined	07/1/2015	6/30/2016	13.2%	(a)
Predetermined	07/1/2016	6/30/2017	13.2%	(a)
Predetermined	07/1/2017	6/30/2018	13.2%	(a)
Predetermined	07/1/2018	6/30/2019	13.2%	(a)

Basis for Application:
a) Total direct costs less flow through funds, land, building, and equipment.

Treatment of Fringe Benefits: Fringe benefits applicable to direct salaries and wages are treated as direct costs.

SECTION II: GENERAL

A. LIMITATIONS: The rates in this Agreement are subject to any statutory and administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the department/agency or allocated to the department/agency by an approved cost allocation plan were included in the indirect cost pool as finally accepted; such costs are legal obligations of the department/agency and are allowable under governing cost principles; (2) The same costs that have been treated as indirect costs have not been claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the department/agency which was used to establish the rates is not later found to be materially incomplete or inaccurate by the

Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. ACCOUNTING CHANGES: This Agreement is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from indirect to direct. Failure to obtain approval may result in cost disallowances.

C. NOTIFICATION TO FEDERAL AGENCIES: Copies of this document may be provided to other Federal agencies as a means of notifying them of the agreement contained herein.

D. SPECIAL REMARKS: None.

ACCEPTANCE

By the State Agency:

Tracy Streeter
(Signature)

TRACY STREETER
(Name)

DIRECTOR
(Title)

KS Water Office
(Agency)

1-5-2015
(Date)

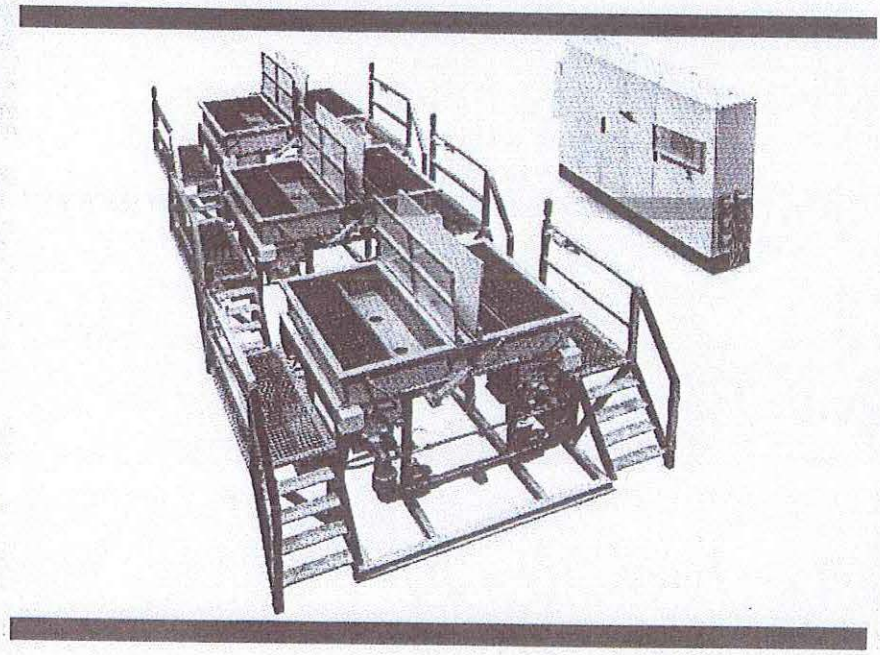
By the Federal Agency:

Jacqueline Smith
(Signature)

Jacqueline Smith, Rate Negotiator
Financial Analysis and
Oversight Service Center
U.S. Environmental
Protection Agency
December 18, 2014

Negotiated by: Jacqueline Smith
Telephone: (202) 564-5055

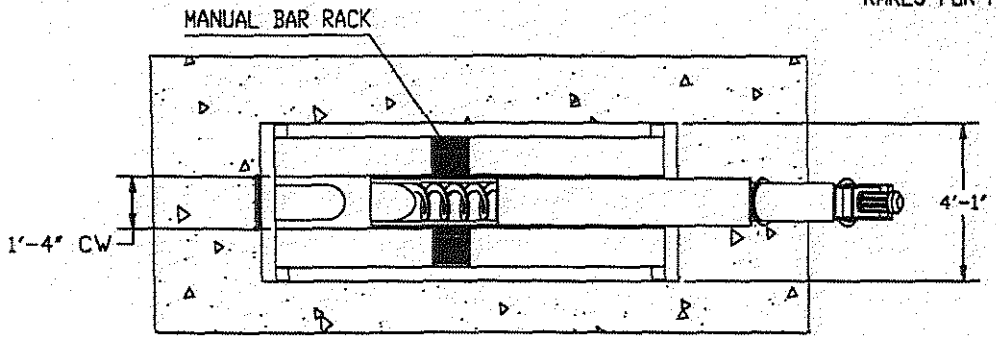
JAN 05 2015



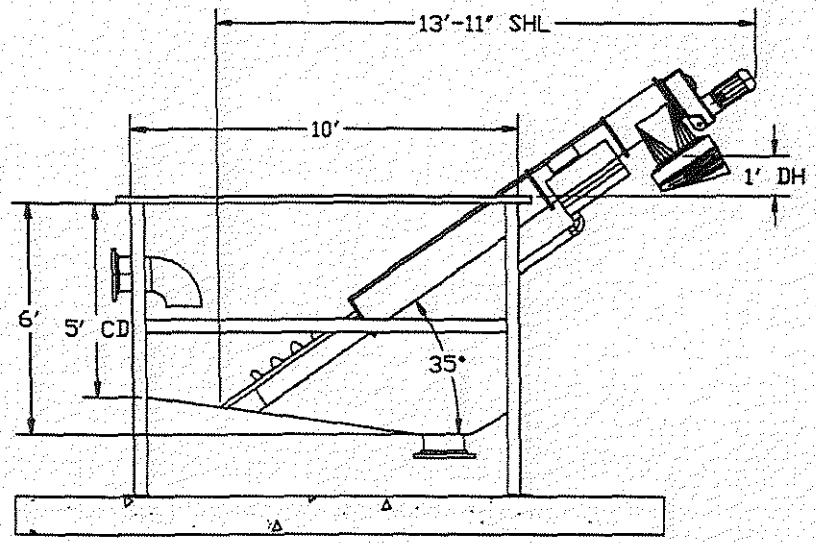
EC System w 6 Modules & Power Unit

Note: ALL DIMENSIONS ARE IN FEET AND INCHES
RAKES FOR MANUAL BAR RACKS NOT SHOWN

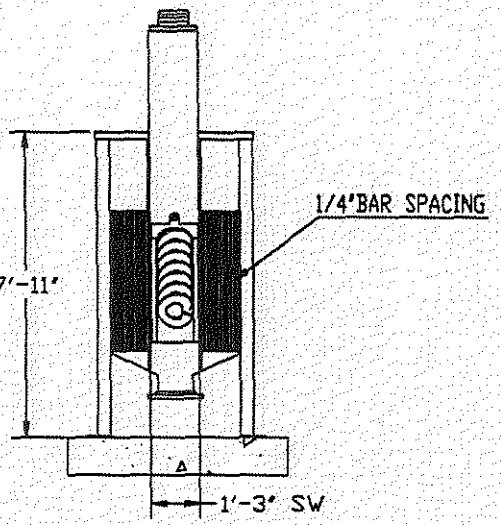
Screenfield Width .....SFW
Screen Frame Width.....SW
Channel Depth.....CD
Channel Width.....CW
Discharge Height.....DH
Screen Horizontal Length....SHL



PLAN VIEW



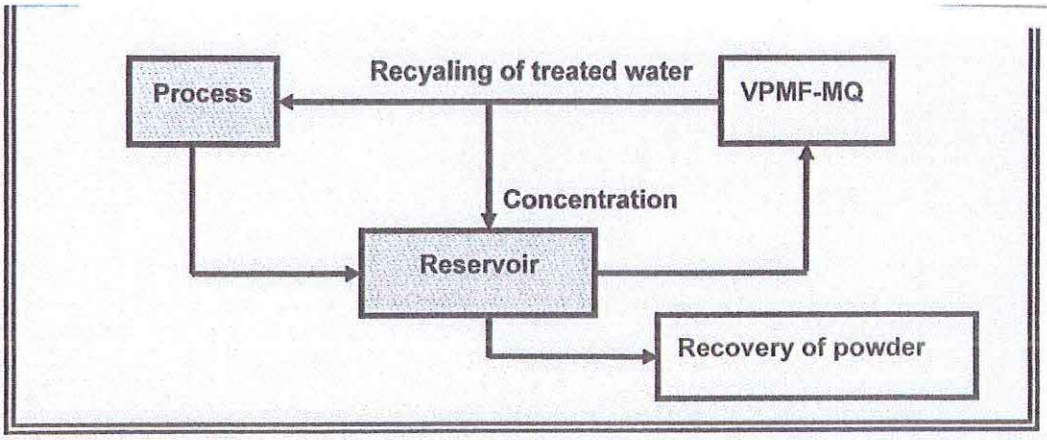
FRONT VIEW



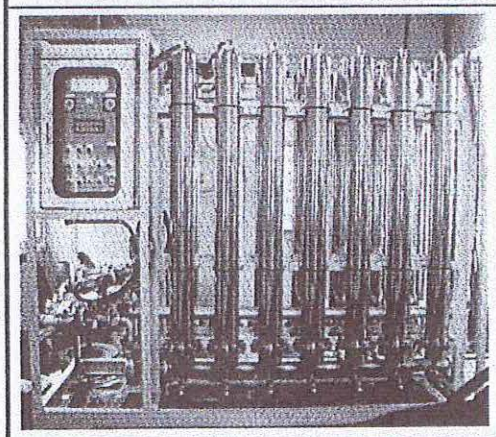
ELEVATION VIEW

TEMPLATE DRAWING
SH VB300 CDF

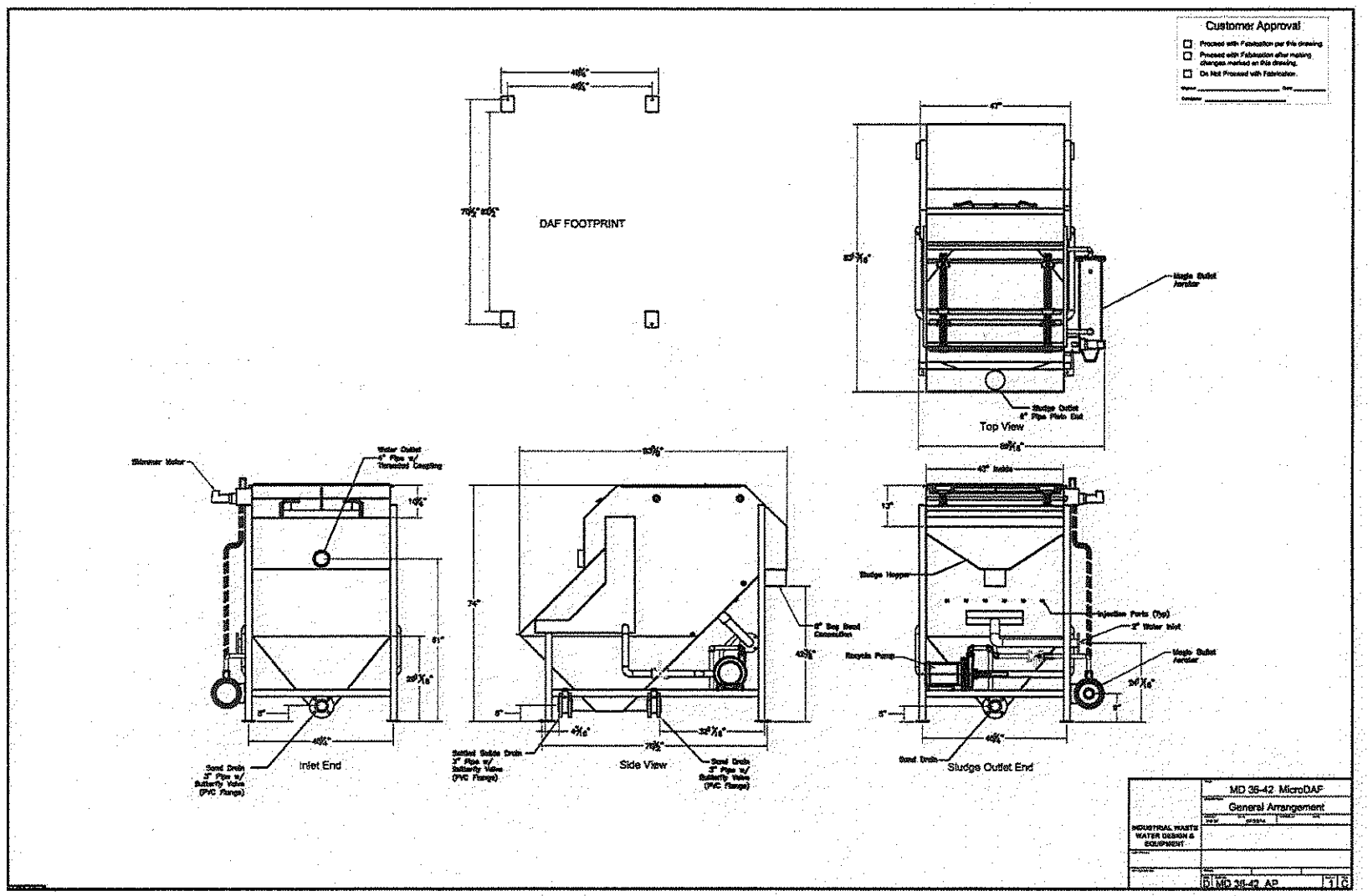
Pre filter



▫ Reference & Datas

Hanhwa Complex Chemicals	Datas		
	Capacity	25m3/Hr	
	Date	2009.7.	
	Operation		
	Item	Before	After
	SS	2000~3,000ppm	1~3ppm
	Model	S20-MQ*14EA	
	Concentrated W/W	2~3%	

Manufacture's Picture of an installation of filter


Customer Approval
Proceed with Fabrication per this drawing.
Proceed with Fabrication after making changes marked on this drawing.
Do Not Proceed with Fabrication.
DAF FOOTPRINT
Top View
Inlet End
Side View
Sludge Outlet End
Skimmer Motor
Water Outlet
Sand Drain
Sludge Hopper
Injection Ports (Typ)
Recycle Pump
Sludge Outlet
Aerator
INDUSTRIAL WASTE WATER DESIGN & EQUIPMENT
MD 36-42 MicroDAF
General Arrangement
MD 36-42 AP

DAF Unit