RECOVERY PLAN FOR THE SCOTT RIFFLE BEETLE, *Optioservus phaeus* Gilbert, IN KANSAS

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for

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Approved: ______________________ **Date:** 7/25/02
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I. Introduction

The Scott riffle beetle, *Optioservus phaeus* White, is an endangered species in Kansas. This small inhabitant of springs was first described as a separate species by White (1878a), having previously been misidentified as another species or listed as an unknown species (Brown and Huggins 1977). The species is only known to inhabit the area of its type locality, Big Springs in Scott County, Kansas (Figure 1). Studies of other similar habitats in the High Plains of North America have failed to reveal additional populations of *O. phaeus* (Ferrington 1985, Ferrington et al. 1991). Due to its endemic status in Kansas and very restricted range and habitat, the Scott Riffle Beetle was designated as a threatened species in 1978 (Kansas Endangered Species Act, K.S.A. 32-504 and K.S.A. 32-507). This status was later upgraded to endangered by K.A.R. 115-15-1 (Kansas Register 1999).

II. Species Account

A. Taxonomy Description

1. Original Description

From White 1978a…

"*Diagnosis*. Length 2.62-2.90 mm, width 1.22-1.34 mm. Immaculate to faintly bimaculate. Parameters short, rounded; processes of basal sheath not deeply notched between.

Pronotum. Length 0.75-0.84 mm, width 0.88-0.85 mm. Piceous to black. Punctures uniformly spaced on disk. Sublateral carinae pronounced. Moderately pubescent: hairs short, black to testaceous.

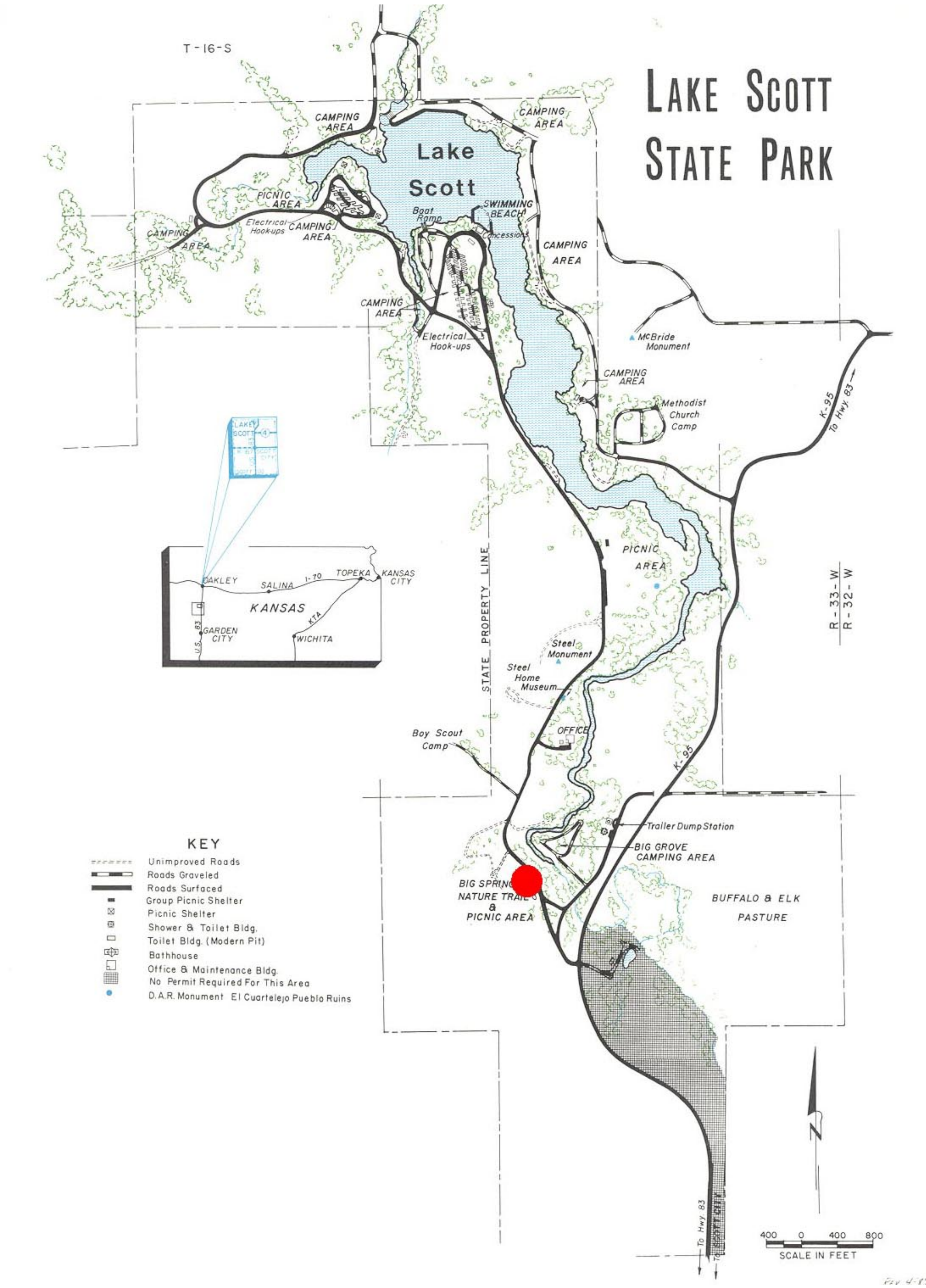

Figure 1. Location of Big Springs (red circle) within Scott County Park. Courtesy of KDWP.

Elytra. Length 1.86-2.06 mm, width 1.22-1.34 mm. Testaceous to dark brown. Elongate, only slightly diverging to apical third then gently rounded to apex. Heavily pubescent in both males and females, hairs testaceous to brown giving a dull appearance to elytra. Striae will developed with deep punctures. Appearing immaculate: faintly bimaculate in some, with humeral spot small and rounded, apical spot slightly elongate.

Venture. Testaceous to dark brown. Pubescence short and thick, golden to testaceous.

Male genitalia. Length 0.73-0.75 mm, width 0.27-0.30 mm. Penis tapering in apical half to rounded apex, processes curved outward and pointed. Paramers short, broad, rounded at apex. Processes of basal sheath slightly notched between.

Notes. This species is closely related to *castanipennis* and *divergens*. The locality of the collection, its larger size, and differences in the male genitalia warrant its separate designation. The type-locality is quite isolated, the habitat consisting of a spring-fed brook which flows but a few meters before joining a larger stream that disappears into a sink. The sink most likely enters into the Missouri River drainage.

Holotype ♂, UNITED STATES. Kansas, Scott County State Park, springs at 1006 m above M.S.L. 4. ix. 1971 (H.P. Brown) (USNM).

Paratypes, with same date as above. Forty-eight adults (CAS. INHS. MCZ. SMSH. USNM)."

2. Taxonomic Description

The Scott riffle beetle with this description are in Section II. A. 1. Prior to this it was incorrectly identified as *Optioservus divergens* (Huggins et al. 1976) and identified as an undescribed species (Brown and Huggins 1977). There are not synonyms for the species.

Optioservus phaeus is classified in the order Coleoptera and the family Elmidae. Members of this family are known commonly as riffle beetles. The genus *Optioservus* is found in North America, Japan and Sakhalin Island (Russia) (White 1978a). Nearctic members of *Optioservus* are divided into Eastern and Western groups based on characteristics of the male genitalia, elytral patterns and overall body shapes. *O. phaeus* is included in the Western group and is very closely related to *O. castanipennis* and *O. divergens* (White 1978a). Of significance is the fact that these two species have extensive ranges throughout the Rocky Mountains and the High Plains while *O. phaeus* is very restricted in its range. Another member of the Western group, *O. canus*, is possibly limited in distribution to its type locality in Chalone Creek, Pinnacles National Monument, San Benito County, California. Ferington et al. (1991) suggested that this species could represent a phylogenetic analogue to *O. phaeus*.

B. Historical and Current Distribution

1. Description of habitats and locations of occurrence

Due largely to the fact that the Scott riffle beetle was identified as a species in 1978, no information exists that can describe a historic distribution for the species. Based on current knowledge, *O. phaeus* has a range restricted to the pool and short run emanating from Big Springs in Scott State Park, Scott County, Kansas (Ferrington et al. 1991). No populations are known to have been extirpated from other locales in the state. Several searches have been conducted without success for additional populations in similar habits throughout the High Plans region of Kansas, Nebraska, Wyoming, Colorado and New Mexico (Ferrington 1985, Ferrington et al. 1991). From this information we assume that the population in Scott County is part of a population of a similar Western species that became isolated in prehistoric times.

The spring discharge at Scott County Park originates from beneath the sediments of the Ogallala formation near its contact with the underlying Smoky Hill chalk member of the Niobrara formation (Ferrington et al. 1995). Several small springs emanate from the sandy substrate at the base of a bluff and feed the limnocrene habitat at the head of Big Springs. From this pool the water flows through a narrow, swift erosional zone and empties into a larger pool before eventually flowing in Lake Scott. Waite (1974) reported that the spring had a yield of 400 gallons per minute. The spring currently has a flow of 350 gallons per minute with a water temperature of 15.5° C according to the Kansas Geological Survey (1998).

The habitat of Big Springs and its associated spring run were well documented by Ferrington (1985) and Ferrington et al. (1995). Most of the following description comes from the above works. The substrate within the limnocrene area consist of almost exclusively sand, pebbles, or sand overlain with silt. Water bubbling up through the substrate contributes to the spring flow. The pool also contains dense growths of watercress and monkey flower with various grasses and sedges along the border. The maximum depth is less than 0.4 meters with a current velocity usually less than 20 cm/sec. Temperatures were listed as ranging from 11-12.9° C.

The spring run emanating from Big Springs contains substrates ranging from course gravel to cobble, with some sand and silt near the transition with the next pool. Maximum depth is reported as less than 0.2 meters. Velocity is slow to swift, with some areas exceeding 30 cm/sec. Water temperatures are similar to those found in the pool. The primary vegetation found in the run is watercress, which is concentrated near the end of the run where it empties into the next pool. There are also several small spring seeps on the north side of the run, however, they have little flow and depths of less than 2.0 cm. Some of the water from the spring source runs through a pipe and forms an artificial splash zone where it empties into the run. There is also a bridged walking path that crosses the spring run.

The pool that the spring runs empties into is the result of a retaining dam about 70 meters downstream of the spring source. The pool ranges from 2.5 to 3.0 meters wide with a depth from 0.2 meters near the run entrance to 1.75 meters near the dam. The pool has little flow and the substrate consists of sand, silt and detritus. Water flowing out of this pool eventually enters Lake Scott.

C. Population sizes and abundance

As previously mentioned, *O. Phaeus* is only known to occur in Big Springs and its associated spring run. Within this very limited area, however, the species seems to be thriving. A study by Ferrington (1985) focused on the population density and distribution of *O. phaeus* within the Big Spring system. This study is the basis for the following information.

Leonard Ferrington Jr. sampled Scott riffle beetles on seven occasions during 1983 and 1984. Because of the limited distribution and population of *O. phaeus*, non-lethal collection methods were used and the habitat at the sites was disturbed as little as possible. Collections in the spring run were accomplished by removing individual rocks and counting the number of adult and larval individuals. Collections in the pool at the source of the spring were made with a dip net.

Sites were sampled with the Spring Run were evaluated to determine physical habitat preferences. Water velocity next to each rock was visually estimated using a I-IV scale, with IV being the fastest. After counting the number of larvae and/or adults, each rock was assigned a size class ranging from I (smallest) to V (largest). These classifications correspond to the phi classes –4 to –8 of Cummings (1962). Each rock was also give a regulosity score of I to IV based on the amount of surface sculpturing, with a I indicating the smoothest surfaces and a IV indicating rocks with extensive scalloping, deep cracks, and very rough edges.

Ferrington (1985) divided the spring run habitat of Big Springs into the following five zones based on characteristics of flow regime, relief, substrate composition and vegetative growth: A) lower spring run; B) upper edge of zone A to outlet pipe; C) outlet pipe to lower end of the bridge; D) under the bridge; E) upper end of the bridge to the point where the run merges with the main pool of Big Springs. Although sampling was conducted within the main pool of Big Springs, the number of larvae found numbered less than 1 for every 30 plants and additional sampling was not performed. Sampling revealed larval and/or adult specimens of *O phaeus* in the main pool of the spring, the spring run, and the small spring seepages near the spring run. Several specimens were also found near the man-made dam at the lower end of the second pool. Ferrington considered the spring run to be the population center for the species and considered the other funds to be the results of random dispersal and egg laying activities. Because of this he focused the rest of the study on the population within the spring run.

The spring run was sampled seven times over the course of a year and a half. The lowest average density of adults per rock was 0.11 on 8 May 1984 while the 30 November 1984 sample had the highest with 1.71 adults/rock. The most adults found on a single rock numbered 21. The average number of larvae (including all instars) was lowest on 5 October 1983 with 0.58 larvae/rock. The larvae were most dense on 15 March 1984 with rocks averaging 9.52 larvae. The most larvae found on an individual rock numbered 162. These numbers take into account rocks of all size and regulosity ratings.

When densities were averaged for all sample dates, adult individuals of *O. phaeus* provide to be most numerous in zone E with 1.16 adult/rock. This was the uppermost portion of the spring run directly downstream of the mail pool. The densities of adults steadily declined in downstream zones and were collected during only one sample date from zone A. In contract to the adults, larvae were most abundant in zones C and B, with densities of 5.78 and 5.60 larvae/rock respectively. Larvae were the least dense in zone E.

The rock size, rock regularity, and water velocity ratings were compared to the larval densities to determine if any trends in physical habitat preference were present. By averaging all sample dates, Ferrington determined that larvae were most numerous on rocks of size class IV with 8.4 larvae/rock. Larvae were least dense on rocks of size class I with only 2.68 larvae/rock. Larvae averaged most dense on rocks of regulosity class IV with 14.269 larvae/rock. *O. phaeus* larvae overwhelmingly preferred highly irregular and sculptured rocks. Rock with regularity ratings of I, II, and III averaged densities of 1.42, 3.33, and 4.98 larvae/rock respectively. As the water velocity rating near each rock increased, the larvae increased correspondingly. Densities averaged a low of 0.96 larvae/rock in water with a rating of I and 6.76 larvae/rock in water with a velocity rating of IV. Aggregation indices were also developed for the larvae. In cases where the index value differed from a poisson distribution on rocks, an aggregation rather than uniform or regular distribution was indicated. When averaged over all sample dates, rocks of size rating IV showed the highest degree of larval aggregation. From this data it is clear that *O. phaeus* larvae in Big Springs prefer large, highly sculptured rocks lying in areas of swift current.

D. Reproductive habits, habitats, requirements, and strategies

No research has been conducted pertaining to the reproductive habits or requirements of *O. phaeus.* We assume that these are similar to those of other members of the family Elmidae, or riffle beetles. Much of the basic life history of riffle beetles is taken from Brown (1972), Holland (1972), White (1978a, 1978b), White et al. (1984) and Ferrington (1985).

All members of Elmidae with known reproductive histories are classified as homometabolous, meaning they have a distinct egg, larval, pupal, and adult stage. The pupal stage is the only one spent in a terrestrial setting. Adults of age one year or more deposit eggs on the underside of rocks, on vegetation, or in debris. Depending on the water temperature, the eggs take one to two weeks to hatch. Newly hatched larvae attach to the available substrate and immediately begin feeding. They remain in this stage for one to two years, depending on the species and water temperature. It is not known for certain how many instar stages occur for most species, although the number ranges from 5 to 8 for those that have been studied. Mature larvae leave the water in early to mid-summer to construct pupal chambers under rocks, in debris, or in moist soil. The pupal stage lasts for approximately two weeks. After emergence from the pupal chamber most species are capable of flight for a short period of time. This is thought to be a means of dispersal to distant suitable habitats. Riffle beetles lack sufficient mobility in the water to travel long distances. The lifespan of most wild riffle beetles is not known, but individuals have been kept in aquaria for up to 9 years. Many species appear to mate after their second summer in the adult stage.

E. Food and feeding requirements

The primary food items of most Elmids, both larvae and adults, include diatoms and amorphous fine particulate organic matter. The majority of these items are acquired from the periphyton that covers much of the hard substrates underwater. They ingest the periphyton by scraping their mouthparts along the substrate.

Riffle beetles are superbly suited for feeding along the bottom of swift, cobble-laden streams. The adults possess long legs with well-developed claws for keeping a grip on the substrate. The larvae have an elongated, spindle-shaped form. They have shorter legs than the adults with the exception of one elongated apical claw that is well-developed. Both adult and larval stages are capable of moving upstream against swift currents.

F. Other pertinent information and summary

Larval and adult riffle beetles do not utilize atmospheric oxygen. The larvae have tracheal gills located in the terminal abdominal segment. The gill can be completely retracted and hidden by an operculum. If the oxygen tension of the water they inhabit becomes low, the larvae can ventilate, or rhythmically expand and retract the gills to artificially circulate oxygen free water away and bring in oxygen rich water. Adults use a plastron strategy to obtain dissolved oxygen from the water. The ventral surface of the abdominal segments contains densely packed setae or bristles with hydrophobic characteristics. These bristles, known ad the hydrofuge pile, maintain a thin layer of gas next to the body. Ad the oxygen in the film is utilized through respiration, dissolved oxygen in the water diffuses into the layer of gas. Although this mode of respiration is very efficient, it restricts adult Elmids to habitats that are rich in dissolved oxygen.

III. Ownership of Species Habitat by County

The only habitat of *O. phaeus*, Big Springs, is within the boundaries of Scott State Park in Scott County, Kansas. Due to ownership by the state of Kansas, more strict regulations regarding protection of the springs within the park can be mandated. Because no other known populations exist outside of the park, no list of private land ownership is included. Ferrington (1985) suggested that no suitable habitats exist in Western Kansas outside of Scott State Park. Extensive searches of springs in Western Kansas and bordering states within the High Plains region revealed no additional populations of *O. phaeus* (Ferrington 1985, Ferrington et al. 1991).

IV. Potential Threats to the Species or its Habitat

Due to its extremely limited range, potential threats to the habitat of *O. phaeus* come in many forms. Fortunately, Big Springs and its associated run and seeps all lie within the boundaries of Scott State Park. The habitat within the park is designated as critical habitat for the Scott Riffle Beetle by the Kansas Department of Wildlife and Parks. This designation, along with the protection afforded by park personnel, greatly reduces, though does not eliminate, the changes of direct damage or contamination of the springs and associated runs. A much greater threat to the survival of *O. phaeus* is the depletion or contamination of the aquifer which provides the water to Big Springs.

Greatly reduced flow could be detrimental to the species, and complete cessation of flow would most certainly cause the extinction of the Scott Riffle Beetle. Contamination of the aquifer by pesticides or other chemicals could also lead to the loss of the species. The following list details the potential threats to the survival of *O. phaeus.*

1) **Direct physical destruction of habitat –** Because of its location within Scott State Park this scenario seems unlikely. There is no chance of damage from cattle, construction, or damming. A portion of the run was inundated due to the addition of a retaining dam near its base. A small footbridge also spans the run. A portion of the spring's flow is also diverted into a small pipe that empties into the run. These modifications were all constructed prior to the recognition of *O. phaeus* as a separate, endangered species, and the designation by the KDWP of Big Springs as critical habitat. Ferrington (1985) reported seeing visitors to the park wading in the spring and run on several occasions. Removal of the watercress growing within the spring was also reported. Park personnel are now more aware of the situation and it seems unlikely that this will be a major problem in the future.
2) **Direct chemical contamination of the spring water –** The likelihood of such an incident occurring seems remote. One possible scenario listed by Ferrington et al. (1991) was the washing of pets in the spring or run using soaps or insecticides. Although actions such as this could have an impact on the population, strict monitoring by park personnel should keep this from occurring.

3) **Reduction of water quality through chemical contamination of the aquifer –** This problem is more likely than the two listed above. The continued use of large amounts of pesticides in the areas near and to the west of Scott State Park could lead to the contamination of the groundwater supply that feeds Big Springs. The tolerance of *O. phaeus* to such contamination is unknown, but increased levels could lead to the reduction or extinction of the species. However, Big Springs originates from a deep aquifer and this threat seems unlikely as well.

4) **Introduction of predatory fish species –** The introduction of an insectivorous species of fish to the spring or the run and pool below it could greatly reduce or eliminate the population of Scott riffle beetles. Possible introductions could result from well meaning people attempting to stock game fish from Lake Scott into the spring. Introductions could also occur from the release of aquarium fish.

5) **Reduction of spring flow due to lowered groundwater levels –** The water issuing from Big Springs emanates from the Ogallala formation that underlies much of Western Kansas (Ferrington 1995). The depletion of groundwater resources has recently become an issue of national scope, although officials have been aware of the problem in Kansas for decades. Kansas has five Groundwater Management Districts (GMD’s) authorized by the Kansas Groundwater Act of 1972 to direct the development and use of groundwater resources. Three of these districts (GMD’s 1, 3 and 4) overlie most of the Ogallala aquifer in Kansas. This area of Kansas has the greatest number of

large-capacity wells and the highest rate of aquifer declines while having the least amount of rainfall and aquifer recharge. Each of these GMD's had adopted a 20 to 25 year planned depletion policy, implying that the Ogallala is not a renewable resources (Sophocleous and Sawin 1997). However GMD 1 has since adopted a safe yield policy. GMD's 2 and 5 have had sustained-yield policies for groundwater management for many years. This policy balances water withdrawal and recharge rates while taking into account natural groundwater discharge into streams. Waite (1947) reported that Big Springs had a discharge rate of 400 gallons per minute. This was prior to the increase in development of center pivot irrigation for crops in Western Kansas. The Kansas Geological Survey (1998) currently lists the discharge rate as 350 gallons per minutes. It is possible the more recently adopted safe yield policy of GMD #1 could serve to reduce the impact of water level depletion on this spring.

V. Current Protective Laws, Regulations, and Policies

A. Federal

The Scott riffle beetle currently is not classified as threatened or endangered by the U.S. Fish and Wildlife Service. A report was submitted by Ferrington et al. (1991) recommending that they be listed as an endangered species. Currently, *O. phaeus* is not listed as a candidate for the threatened or endangered list under federal law. Although it is doubtful that any direct physical alteration will ever occur within the designated critical habitat of the Scott riffle beetle, several federal permitting regulations would apply if such work were undertaken. Section

404 of the Clean Water Act requires the U.S. Corps of Engineers to administer the issuing of permits when the addition of fill material or the alteration of channels takes place within the streams and lakes of the U.S. and their adjoining wetlands. Section 401 of the same act provides states the opportunity to review the water quality impacts of any such projects. The U.S. Fish and Wildlife Coordination Act provides for the review and comment of state and federal agencies concerning the impacts on fish and wildlife resulting from any project, federal or nonfederal, that is approved by a federal agency and involves impoundment, channel alteration, or any other form of control or pollution of water of the United States. The presence of a sensitive species such as *O. phaeus* would in all likelihood negate the issuance of a 404 permit within its critical habitat. A full review of applicable federal regulations can be found in Layher (1985) and Monda et al. (1992).

B. State

1. Permitting Requirements

The state of Kansas has several statutes and regulations concerning the alteration of habitat containing populations of the Scott riffle beetle. Most important among these are K.A.R. 115-15-1 and K.A.R. 115-15-2 that provide for the listing of threatened and endangered species at a state level. K.A.R. 115-15-3 provides a permit system that provides a critical review of projects affecting the habitat of species listed as threatened or endangered. Once reviewed to assess the possible impacts to the species, a project can be accepted, modified or revoked.

The State Board of Agriculture's Division of Water Resources also issues permits for discharges, dam construction, stream alteration and floodplain development. Due to the Water Projects Coordination Act, permits applied for through the Division of Water Resources must also be reviewed by the Kansas Department of Wildlife and Parks. If a project is identified as a possible threat to a threatened or endangered species, an appropriate permit from the KDWP is also required. This assures that all water projects affecting fish and wildlife in Kansas are reviewed from the viewpoint of conserving rare organisms. A complete review of applicable permitting systems in Kansas can be found in Monda et al. (1992) and Layher (1985).

2. Critical Habitat Designation

The Scott rifle beetle was formally given threatened status in Kansas in 1978 by K.S.A. 32-504 and K.S.A. 32-507. It was later given endangered status by K.A.R. 115-15-1 (Kansas Register 1999). As a result of this status, the locations of critical habitat were compiled by the KDWP. Critical habitat for *O. Phaeus* is listed as: All springs and spring-fed streams that lie within Section 15, T16S, R33W, Scott County. These lands and waters are currently within the boundaries of Scott State Park (KDWP 2000).

VI. Recovery Criteria

A. Additional Species Information Needs

Although *O. phaeus* was recognized as a separate species over 20 years ago, even basic life history information is lacking. Aside from casual observation, only Ferrington (1985) has attempted to study the ecology and life history of this species. Information on the lifespan, recruitment rate, water quality requirement, etc., are either unknown or speculative based on the life history of other riffle beetle species. Ferrington (1985) shed light on the habitat use of larval and adults of the species within Big Springs and its associated habitats. However, it is unknown if *O. phaeus* can survive in similar habitats outside of Scott State park. Specific information on other life history aspects of the species will allow the formulation of an informed management plan.

1. Management Activities for Maintaining Species Population and for Species Recovery

1.1 Identification of conservation measures and assistance programs

Irregular visits by employees of the Kansas Biological Survey from the mid-1970's through the 1990's revealed that *O. phaeus* larvae are always present in noticeable numbers and that adults can usually be found as well. Ferrington et al. (1991) proposed that this information, while not a quantitative estimate of the population, does show that the population has been self-sustaining for the last few decades without direct management by the KDWP. They concluded that the species will continue to maintain itself provided that its critical habitat (Big Springs) remains protected and that groundwater quality and quantity remain sufficient to maintain the current spring conditions. Although the species population currently appears stable, there are several preventative measures that should be taken due to its extremely limited range.

Ferrington (1985) concluded the need for many of the same management options. They include the following:

1.1.1 Restricting direct access to the spring and its associated run –

Ferrington (1985) and Ferrington et al. (1995) reported several incidences of individuals wading in the spring run as well as reports of people moving the cobble within the run. He also reported that a local family was collecting watercress from the spring for consumption. Although occasional human disturbance will likely have little effect on the population of *O. phaeus* inhabiting the spring and spring run in Scott State Park, continued frequent disturbance could have a negative effect. We recommend that direct access to the waters of the spring and spring run be restricted to qualified personnel conducting studies of the Scott riffle beetle or other organisms inhabiting the springs. Scientific collectors should be restricted as well in the methods of collection and number of organisms collected so as not to inflict irreversible damage to the population. Visitors to the park should not be restricted in their viewing of the springs and their associated run. The site is very popular due to its uniqueness in Western Kansas. The KDWP should consider placing signs around the area boasting the uniqueness of the habitat and the importance of protecting the rare creatures that utilize it. Ferrington (1985) suggested putting guardrails around the area to prevent access. We feel this would unnecessarily detract from the natural beauty of the area and would do little to deter determined violators. The above suggested signs and a regular patrol of the area by park personnel should be enough to deter destruction of habitat by visitors.

1.1.2 Water quality and quantity monitoring – The amount of water discharged from Big Springs should be monitored on a yearly basis. Ferrington (1985) suggested this could be accomplished by placing a weir at the downstream edge of the small pond at the base of the spring run. If a declining trend is found in the discharge of water from the springs, coordination with the GMD's in charge of water management of the Ogallala aquifer should occur to explore additional water management strategies. GMD1 (in charge of groundwater management in Scott County) is currently utilizing a planned depletion plan that all but assures the eventual reduction or stoppage of water flow from Big Springs. Along with yearly testing of water discharge from Big Springs, water quality should be tested yearly as well. This will be used to determine the levels of pesticides, nutrients, dissolved oxygen and other chemical in the water. This will not only allow investigators to watch for upward trends in the levels of contaminants, but will also allow an accurate profile o the water quality needs and tolerances of the Scott riffle beetle. Parameters tested should include salinity, chlorides and other typical parameters that often increase in over-utilized aquifers.

1.1.3. **Population Monitoring –** The population of *O. phaeus* should be evaluated a minimum of once a year to determine the density. A competent entomologist should be entrusted to conduct these surveys in the least intrusive manner possible. The method used by Ferrington (1985) would be suitable to determine densities of adults and larvae/rock. This information would become valuable over time for use in determining whether populations are in decline or remaining stable.

1.2 **Active Management Options –** In addition to preventative measures to ensure to survival of *O. phaeus*, there are several active management options that could be incorporated to increase the size of the current population. We recommend that the preventative measures be implemented before consideration of any of the following options. The following should only be considered if population monitoring or habitat monitoring indicates that the species is in decline, or that its habitat is in immediate jeopardy.

1.2.1 Addition of favorable habitat within Scott County Park

- The construction of the retaining dam near the base of the spring run inundated an unknown length of suitable habitat. Conceivably, the dam could be removed to make more run habitat available for expansion of the current population. The problems associated with this were pointed out by Ferrington (1991) and include: a) removal of the pool below the run could cause public relations problems with park visitors. The pool is a popular wading and relaxing spot for many people and removal could cause resentment and lead to more hazards to the beetle population through vandalism, etc.; b) it is unclear if the amount of habitat created by removing the pool would be significant enough to aid the recover of the population; and c) the disturbance caused during removal of the dam could do more harm than good.

Ferrington (1985) suggested that suitable habitat within the spring run at Scott County Park could be increased in hopes of increasing the population size of *O. phaeus*. His reasoning took into account the fact that larvae were highly aggregated on rocks of specific classes during the portion of the year that larvae were most dense. He suggested that perhaps this microhabitat was in short supply and acted as a limiting resource during peak larval densities. He recommended that rocks primarily of size classes IV and III with significant surface sculpturing should be gathered from the base of a nearby bluff and placed in zones A, B and C of the spring run. While this strategy might temporarily increase the population of Scott riffle beetles, it is not a viable solution. In all likelihood any problems facing *O. phaeus* will be related to water quality or quantity, in which case additional microhabitat within the run would not afford any further protection. The population has remained stable thus far without additional rock cover and will presumably continue to do so as long as water conditions remain favorable.

1.2.2 Introduction of *O. phaeus* into nearby suitable habitat – This strategy should be utilized only as a last resort. It could be used to save the species if water quality or quantity degrades to the point that the Big Springs population is severely impacted. Long term monitoring of the population should allow for intervention if the numbers fall below half the current density. We recommend that studies be conducted on the artificial propagation of the species in a man-made environment. Such knowledge could be invaluable if a temporary refuge were needed before permanent transplantation to a new location.

Ferrington (1985) recommended against transplantation of *O. phaeus* into Eastern Kansas due to the unknown interactions with other species that could occur. He also suggested that in all likelihood no suitable habitat outside of Scott State Park exists in Western Kansas. A survey of likely streams during his study revealed no additional populations or locations that fit the habitat requirements of the Scott riffle beetle. An additional 1990-1991 search of springs and spring runs throughout the High Plans region of Nebraska, Kansas, Wyoming, Colorado and New Mexico failed to reveal additional populations (Ferrington et al. 1991). As previously stated, the Scott riffle beetle is most threatened by reductions in water quantity and/or quality. It is likely that if any suitable habitat does exist near the current population, it will be affected along with Big Springs. Despite the difficulties and problems associated with transplanting an endemic species into a new location, a list of possible introduction sites in Western Kansas is provided below (Table 1). The locations were chosen based on a list of Kansas springs surveyed by the Kansas Geological Survey. Included in a comparison of discharge, conductivity, sulphate concentration, chloride concentration, nitrate concentration and water temperature. As this is the only data provided for the springs, no information on the substrate of springs or spring runs is included. This information could be crucial when deciding on introduction sites. Only springs from within or near the High Plains region of Kansas with discharges of 50 gpm or greater are considered as possibilities here (Table 1).

Table 1. Possible Scott riffle beetle relocation sites in Western Kansas (including Big Springs for comparison).

County	**Name**	**Cond.**	**SO4**	**C1**	**NO3**	**Temp**	**GPM**
Scott	Big Springs	474	38.7	16.9	18.8	60	350
Kiowa	Thompson Creek Spring	444	14.6	11.0	14.6	60	100
Pratt	N/A	403	14.3	20.2	1.1	6.2	250

A full listing of all springs surveyed by the Kansas Geological Survey is presented in Appendix A. The vast majority of these springs are found in Eastern Kansas and lack sufficient flow to sustain habitat similar to that found at Big Springs. They could, however, serve as possible relations sites if it was deemed that the habitat was suitable and that no negative interactions with existing species would occur. Specific locations of most spring sites were not given due to the fact that the majority are located on privately held land.

B. Currently existing programs

Several programs offered by the United States Department of Agriculture are currently available to landowners owning property within the Ogallala aquifer recharge area. Included among these are CRP, WRP, and EQIP. The Conservation Reserve Program (CRP) encourages farmers to set aside marginal farmland for reseeding with native grasses or reforesting with native trees. The USDA enters into a contract with the landowner that provides for the payment of rental rates on the land for a predetermined length of time (usually 10 or 15 years). The Wetlands Reserve Program (WRP) is similar but usually results in one lump sum payment (30 year or permanent easements). Both programs assist in the conservation of groundwater as well as soil. Every acre of farmland enrolled in CRP or WRP is an acre that will not require irrigation in future years. Vegetated land also slows the runoff of rainwater and allows the soil to absorb more water than cultivated or barren land. Many millions of acres of land are already enrolled in these programs throughout the state of Kansas. State officials should put extra emphasis on promoting these programs in the western part of the state. They provide an extra income to the farmer from marginal cropland, conserve soil, provide wildlife habitat, and most importantly in this case, help to conserve groundwater resources. The Water Rights Conservation Program

(WRCP) is a relatively new program which water users can enroll their water right into and protect them from forfeiture for nonuse. This allows them not to have to pump their wells.

Another federal program called EQIP (Environmental Quality Incentive Program) provides cost share assistance to farmers that implement a variety of conservation practices on their land. Practices can include things such as irrigation water management, tail-water recovery, nutrient management, and conservation tillage. Conservation tillage was developed as a solution to soil erosion problems, though it also has other benefits to the farmer and the environment. One of the advantages of conservation tillage is reduced irrigation requirements. This type of farming emphasizes leaving stubble and crop debris on the field between plantings. This debris decreases the speed of water runoff thereby allowing more time for the soil to absorb rainfall while enhancing its ability to hold moisture during dry periods. Farmers in the Great Plains who use continuous conservation tillage can expect to save 2-4 inches of soil moisture per year (Conservation Technology Information Center 2000). This allows farmers to lessen the amount of irrigation water needed and increase the time between waterings.

C. Potential Programs

Although many landowners have enrolled in government conservation programs in the last 15 years, there is a definite need for additional programs that assist landowners in conserving groundwater supplies. Portions of the Ogallala aquifer in Scott, Finney, Wichita, Greeley, and Wallace Counties have experienced 50% drops in saturated thickness (Sophocleous 1997). The township directly west of Scott State Park has experienced an average drop of 16.87 feet in the water table over the last 30 to 50 year. The amount of drop varied within five monitored wells based on locations and depth and ranged from 0.36 feet to 34.66 feet (Kansas Geological Survey 2000).

Another potential option for slowing groundwater depletion is implementation of a program similar to that within the Rattlesnake Creek drainage in central Kansas (Rattlesnake Creek/Quivira Partnership 2000). This is a cooperative plan put together by the Water Protection Association of Kansas, GMD #5, the U.S. Fish and Wildlife Service, and the Kansas Department of Agriculture, Division of Water Resources. One of the primary water savings tactics discussed in the plan is the purchase of water rights from landowners using cost share money from the State Conservation Commission and money from local entities. Other options listed include water banking, conservation practices and irrigation management, voluntary removal of end guns on center pivot irrigation equipment, enhanced enforcement of regulations, and transfer of water appropriations from critical groundwater areas to areas with less de-watering problems. Similar programs should be developed in western Kansas, especially within zones of major groundwater depletion.

Unfortunately, the recharge rate of large, deep aquifers such as the Ogallala are measured in the tenths of an inch per year. Sustainable use is not an option in the western Groundwater Management Districts. Even if all pumping were stopped today, many generations would pass before the aquifer became fully charged again. Unless the demand for water in the arid regions of western Kansas diminishes greatly, the best management option seems to be that of slowing water depletion through conservation and buyout programs, especially in area critical to drinking water supplies and fish and wildlife habitat.

D. Information and educational opportunities for public and private lands containing Scott riffle beetle habitats

The only known habitat of *O. phaeus* lies completely within the boundaries of Scott State Park in Scott County, Kansas. Because of the extremely limited range of the organism, the task of educating the public about the resource's importance is greatly simplified. One suggestion previously mentioned is the placement of informative signs as strategic points along the path at Bring Springs. Some possibilities for sign topics include: 1) an explanation of the uniqueness of a large spring pool/run habitat in the High Plains of Western Kansas; 2) an explanation of the flora and fauna (most notably the Scott riffle beetle) inhabiting the spring; 3) an explanation of the importance of enjoying the spring and run from a distance due to the sensitive nature of the endemic species inhabiting it; 4) an explanation of the source of Big Springs and some of the problems facing it.

Another option for educating the public is the publication of a handout or brochure that would be available at a dispenser near Big Springs as well as at local KDWP offices statewide. The brochure could contain much of the same information found in the signs near the springs. The brochure format would also allow more detailed information regarding threats to the springs, most notably that of groundwater depletion. Broad public knowledge of the planned depletion policies of the GMD's overseeing management of Ogallala aquifer water could be the catalyst for agencies to develop plans that take into account future water needs and spring preservation. Similar information could also be conveyed through articles in the Kansas Wildlife magazine.

E. Criteria for down-listing

Except in the unlikely event that additional healthy population of *O. phaeus* are found within Kansas, we do not recommend down-listing or de-listing of the Scott riffle beetle. Although the population has remained healthy and stable over the last few decades, its unique habitat and extremely restricted range constitute a constant threat of extinction. A single incident of chemical contamination at Big Springs could conceivable cause extinction. There is also the looming threat of de-watering of aquifers in Western Kansas. This combination of threats warrants the continued listing of *O. phaeus* as an endangered species in Kansas.

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Appendix A. Complete listing of Kansas springs surveyed by the Kansas Geological Survey (1996 – 2000).

County	Name	Cond.	SO4	C1	NO3	Temp.	GPM
Atchison		676	31.6	18.2	4.0	57	0.5
Atchison		322	28.2	9.6	53.0	50	1.5
Atchison		570	32.8	19.0	73.2	50	2.0
Barber		560	14.8	17.3	1.2		25.0
Barber		287	11.7	5.8	13.4	63	3.0
Bourbon		480	15.0	1.5	2.0	60	85.0
Bourbon		498	21.3	6.0	2.2	59	1.0
Brown		635	23.6	5.6	38.4		
Brown		372	21.5	1.7	41.8	44	38.0
Brown		529	18.4	6.4	42.8	56	25.0
Brown		598	22.8	10.1	46.2	54	<1.0
Brown	Sun Spr.	2580	1416.0	31.2	0.4	57	5.0
Brown	Sycamore Spr.	2770	1455.0	78.4	0.2	56	45.0
Brown	Meadowland Spr.	663	30.9	3.9	50.0	54	35.0
Brown		850	59.3	19.5	69.9	47	<1.0
Butler		563	10.9	7.5	6.1		112.0
Butler		512	10.5	16.2	1.2		75.0
Butler		1875	44.2	384.0	4.6		8.0
Chase	Rock Spr.	572	19.7	4.1	2.3		62.0
Chase	Perkins Spr.	500	16.5	6.8	0.8		150.0
Chase	Jack Spr.	570	14.8	6.4	2.2		175.0
Chase	Palmer Spr.	475	17.8	3.0	0.6		175.0
Chase		483	17.8	3.4	0.7		20.0
Chase	Red House Spr.	523	9.8	1.9	0.3	58	100.0
Chase		552	10.7	2.0	1.0	60	10.0
Chase		592	11.2	2.9	0.9	59	<1.0
Chase		654	24.3	6.1	1.3	58	8.0
Chase		530	12.5	2.0	0.6	60	8.0
Chase		530	14.4	2.3	0.7	58	
Chautauqua	Chautauqua Spr.	1059	228.0	136.0	0.3	57	2.5
Cherokee	Schermerhorn Spr.	383	45.3	14.0	6.2	56	15.0
Cherokee		1305	466.0	30.5	<0.1	60	5.0
Cheyenne		497	18.9	6.4	6.9	62	2.0
Clark		441	15.7	3.1	9.7		<1.0
Clark		562	22.9	29.4	6.8		<1.0
Clark		472	11.6	9.3	0.1	72	
Clark		485	12.7	2.8	<0.1	67	3.9
Clark	St. Jacob’s Well	225	4.5	8.9	1.0	84	
Clark		765	8.8	30.5	<0.1	74	1.0
Clark		463	17.7	17.3	4.0	68	0.9
Clay		58	8.7	2.7	<0.1		5.0

County	Name	Cond.	SO4	C1	NO3	Temp.	GPM
Clay		123	10.7	6.4	5.9	58	3.0
Clay		2570	1366.0	26.5	0.6	57	
Clay		278	13.9	2.7	0.7		
Cloud		227	23.7	6.2	4.2		<1.0
Comanche		533	17.5	9.9	43.6	64	2.0
Cowley		825	79.0	19.1	4.9		50.0
Cowley		563	13.5	8.4	5.3		200.0
Cowley		598	18.3	4.1	29.8		50.0
Cowley		830	110.0	8.2	8.5		435.0
Cowley		752	56.0	12.4	12.0		200.0
Dickinson	Rock Spr.	565	18.1	7.6	5.1	54	1000.0
Dickinson		633	18.4	5.8	10.7		50.0
Dickinson		670	22.5	8.0	17.7		12.0
Dickinson		704	20.7	5.0	12.7		80.0
Doniphan		683	22.6	2.8	12.9	56	12.0
Doniphan		1105	41.7	114.0	64.7	48	<1.0
Douglas	Willow Spr.	589	41.6	15.1	11.0	36	
Douglas		1000	162.0	84.2	6.0	55	2.5
Douglas		511	31.2	2.1	0.1	42	1.0
Douglas		1540	291.0	107.0	33.5		<1.0
Douglas	Willow Spr.	618	73.6	4.6	10.5	58	4.0
Douglas	Bobcat Spr.	880	142.0	11.8	4.2	56	5.0
Douglas		584	30.9	15.3	15.8	58	2.0
Elk		549	16.8	2.1	0.4	56	4.0
Ellis	Swimming Hole Spr.	763	138.0	20.9	0.7		
Ellis		650	35.6	35.6	14.2	52	<1.0
Ellsworth		658	64.9	37.9	<0.1	62	1.0
Ellsworth	Palmer’s Cave Spr.	120	10.3	2.8	2.5	62	2.0
Ellsworth		265	18.7	3.3	3.2	58	2.0
Ellsworth		172	20.9	7.5	3.8	54	2.4
Ellsworth		321	53.9	20.7	4.5	52	13.0
Ellsworth		778	25.1	128.0	2.8	70	2.0
Finney		660	44.6	72.0	25.7	70	1.8
Finney		428	14.5	17.5	17.1	73	2.0
Finney		2020	517.0	97.0	1.1		
Franklin	California Spr.	587	16.3	4.3	11.0		<1.0
Geary		645	19.3	9.0	4.5		200.0
Geary	Moss Spr.	680	13.8	6.8	11.9	59	1.5
Geary		609	17.0	12.0	2.8	61	4.0
Geary		578	15.2	14.2	1.4	50	10.0
Geary	Seven Spr.	508	18.1	19.4	28.1	58	175.0
Gove	Jacka Spr.	1355	396.0	51.5	16.2		2.0
Graham		473	15.6	7.8	3.8	64	4.0
Graham		504	30.7	10.2	6.6	64	8.0

County	Name	Cond.	SO4	C1	NO3	Temp.	GPM
Graham		739	74.4	49.1	18.6	60	8.0
Greenwood		985	25.8	144.0	1.2		35.0
Hodgeman		943	88.3	103.0	44.4	62	5.0
Jackson		645	30.4	5.5	12.3	60	5.0
Johnson	Blackbob Cave Spr.	573	22.8	5.7	4.9	58	5.0
Johnson		1245	123.0	145.0	2.3	58	8.0
Johnson		610	32.6	24.3	4.6	64	20.0
Kearny		3650	1844.0	123.0	4.5	60	10.0
Kingman	Flowing Well	375	18.5	21.6	4.4	58	<1.0
Kingman		264	11.5	6.3	33.8	57	20.0
Kiowa		1120	109.0	157.0	28.3	61	6.0
Kiowa	Thompson Creek Spr.	444	14.6	11.0	14.6	60	100.0
Lane		440	19.9	13.8	11.6	60	15.0
Leavenworth		473	16.3	5.3	11.0	48	50.0+
Leavenworth	Kickapoo Spr.	810	45.3	32.9	32.3	54	1.0
Lincoln		432	50.4	39.2	0.3		8.0
Lincoln		1425	444.0	15.2	0.6		<1.0
Logan		1600	584.0	87.3	14.6	62	5.0
Logan	Hinshaw Spr.	1820	765.0	57.9	0.9	72	<1.0
Logan	Nickle Mine Spr.	611	85.4	25.2	9.3	58	1.0
Lyon		1100	119.0	36.9	102.0	66	3.0
Lyon		1165	300.0	10.5	17.0	56	10.0
Marion	Lee Spr.	3130	1489.0	186.0	0.5		200.0
Marion		2700	1487.0	43.5	<0.1	52	250.0
Marion	Meyer Spr.	2570	1513.0	16.8	3.8	58	200.0
Marion		2690	1594.0	14.5	4.1	58	1.0
Marion	Old Coin Spr.	652	42.5	9.2	6.2		
Marion	Allison Spr.	694	19.0	34.0	3.5		900.0
Marion	Crystal Spr.	598	22.2	4.9	3.2		
Marion	Crystal Spr.	622	26.3	6.1	3.0		
Marion	Chingawassa Spr.	1720	610.0	118.0	14.2		200.0
Marion	McCarthy Spr.	2570	1015.0	207.0	6.4		
Marion	Flowing Well	3370	1560.0	282.0	<0.1		
Marion	Lost Spr.	2340	113.0	523.0	26.2		40.0
Marion	Elm Spr.	539	76.3	2.4	0.2		5.0
Marshall	Alcove Spr.	640	27.2	2.2	0.5	53	10.0
Marshall		650	12.7	5.9	3.5	62	2.5
McPherson		60	4.2	1.3	0.8		12.0
Meade		442	56.6	8.6	6.7	64	5.5
Meade		457	51.8	10.4	4.2	65	1.0
Meade		370	8.0	4.6	3.1		<1.0
Meade		705	33.0	83.7	7.4	64	<1.0
Miami		610	24.6	3.8	0.4		<1.0
Miami		602	15.7	3.8	0.6		

County	Name	Cond.	SO4	C1	NO3	Temp.	GPM
Miami		530	15.3	4.2	3.7	56	10.0
Miami	Cave Spr.	689	26.3	20.8	19.8	58	15.0
Mitchell		760	47.3	11.3	<0.1		<1.0
Montgomery	Meadow Brook Spr.	340	55.8	4.3	5.0	54	5.0
Montgomery	Spring Hill Spr.	186	34.6	2.8	4.3	52	7.5
Montgomery		1110	131.0	113.0	17.9	60	50.0
Montgomery	Childs Spr.	148	24.8	4.3	6.5	54	2.5
Morris	Diamond Spr.	679	15.0	7.1	7.5		400.0
Morris		645	21.8	7.5	8.0		7.0
Morris		698	33.1	8.3	12.5		200.0
Morris	Big John Spr.	604	29.1	7.3	2.6		1.5
Morris		777	16.9	74.2	1.2		5.0
Morris		540	22.3	3.1	1.9		250.0
Morris		511	20.4	3.3	1.4		
Morris		610	16.9	3.8	2.5	56	350.0
Morton		2200	1200.0	8.6	9.4	64	
Morton	Middle Spr.	1045	218.0	48.8	0.9	66	
Nemaha	Maxwell Spr.	690	19.6	6.9	26.1	59	75.0
Nemaha		402	9.4	1.7	1.5	61	4.0
Ottawa		400	27.3	17.1	2.1		<1.0
Pottawatomie	Scott Spr.	610	45.2	4.0	3.2	50	10.0
Pottawatomie	Blackjack Spr.	343	20.4	4.6	25.0		2.0
Pottawatomie	Louisville Spr.	600	14.1	12.6	16.8		2.0
Pratt		403	14.3	20.2	1.1	62	250.0
Pratt		530	13.8	21.1	41.5	54	
Rawlins		508	24.0	8.5	13.4	64	0.75
Reno		789	27.2	123.0	23.0		25.0
Reno		638	23.1	77.9			5.0
Reno		378	14.6	35.0	41.6		
Reno		573	19.6	84.7			10.0
Reno	Flowing Well	2350	83.3	586.0	15.1	57	15.0
Reno		486	18.4	36.7	32.5	56	60.0
Reno		259	11.2	12.8	31.0	57	
Reno	Flowing Well	3820	2056.0	203.0	0.2	57	5.0
Rice		1150	63.8	193.0	10.1	58	15.0
Rice		235	15.4	3.6	0.9	59	2.0
Rice		383	21.8	10.2	13.3	60	5.0
Rice		372	12.6	20.0	0.9	58	1.0
Rice		127	17.1	3.7	5.8	60	10.0
Rice		116	11.1	2.8	7.8	60	1.5
Rice		725	22.0	4.1	19.9	56	1.5
Rice		766	72.0	53.6	15.0		5.0
Riley	May Day Spr.	830	101.0	7.4	8.8		30.0
Riley		640	17.2	3.1	14.8	60	40.0

County	Name	Cond.	SO4	C1	NO3	Temp.	GPM
Riley		650	33.3	1.1	0.2	58	<1.0
Riley		560	28.0	0.9	0.2		1.5
Riley	Blasing's Art. Well	2400	1282.0	27.9	0.3	62	
Riley		690	43.6	36.7	0.9	56	67.0
Riley		654	52.0	1.8	0.5		1.0
Riley		718	39.2	6.8	6.0	58	40.0
Riley		588	17.8	2.3	1.4	59	5.0
Russell		1065	238.0	51.1	16.8	58	50.0
Saline	Crystal Spr.	232	14.4	1.9	0.1	60	1.0
Saline		133	16.6	3.3	1.4	56	2.0
Saline		1730	308.0	256.0	1.4	58	0.78
Scott	Big Spr.	474	38.7	16.9	18.8	60	350.0
Scott	Old Steele Home Spr.	540	40.6	34.9	22.8	64	8.0
Sedgwick	Seltzer Spr.	2790	1343.0	147.0	0.2		175.0
Sedgwick		2730	1573.0	54.1	0.2	59	17.0
Sheridan		501	19.8	22.4	14.4	58	8.0
Sherman		432	28.9	9.0	10.5	59	5.0
Stafford		2530	51.9	687.0	6.1		20.0
Stafford	Artesian Well	574	10.9	75.2	10.7		20.0
Stafford	Boiling Spr.	949	16.4	185.0	10.0		15.0
Stafford	Salt Spr.	8460	271.0	2500.0	2.0		20.0
Stafford		50300	1912.0	18410.0	0.4	52	1.5
Sumner	Conway Spr.	350	46.0	16.0	45.4	56	5.0
Sumner		1090	62.6	138.0	23.6	60	20.0
Trego		1225	194.0	120.0	31.1	66	1.9
Trego		597	21.1	28.2	27.7	62	1.6
Trego		580	21.5	27.3	16.9	58	25.0
Trego	Indian Bead Spr.	835	79.5	5.2	0.5	62	3.2
Wabaunsee		633	45.8	1.7	0.4	64	1.5
Wabaunsee		695	68.5	6.1	12.3	58	10.0
Wabaunsee		587	15.5	1.8	0.8	66	1.5
Wabaunsee		539	19.2	2.2	1.0	59	8.4
Wallace		540	38.7	5.0	1.0		28.0
Wallace	Big Spr.	443	20.7	5.6	10.1		<1.0
Wallace	Wilson Spr.	2150	966.0	62.9	2.8		3.0
Washington		868	110.0	14.6	30.0	58	15.0
Washington	Baxter Spr.	2700	1400.0	33.1	5.9	57	300.0
Washington	Mormon Spr.	253	19.4	5.2	12.8		
Washington		317	65.4	8.9	15.3	56	1.0