

Kansas Department of Agriculture
Division of Water Resources
PERMIT OF NEW APPLICATION WORKSHEET

1. File Number: <p style="text-align: center; font-size: 1.2em;">49,912</p>	2. Status Change Date: <p style="text-align: center; font-size: 1.2em;"><i>7/12/2018</i></p>	3. Field Office: <p style="text-align: center; font-size: 1.2em;">1</p>	4. GMD: <p style="text-align: center; font-size: 1.2em;">0</p>
5. Status: <input checked="" type="checkbox"/> Approved <input type="checkbox"/> Denied by DWR/GMD <input type="checkbox"/> Dismiss by Request/Failure to Return			
6. Enclosures: <input checked="" type="checkbox"/> Check Valve <input checked="" type="checkbox"/> N of C Form <input checked="" type="checkbox"/> Water Tube <input type="checkbox"/> Driller Copy <input checked="" type="checkbox"/> Meter			
<p>7a. Applicant(s) Person ID <u>10277</u> New to system <input type="checkbox"/> Add Seq# _____</p> <p style="text-align: center; margin-top: 20px;">CITY OF LEAVENWORTH WATERWORKS DEPT 601 CHEROKEE ST LEAVENWORTH KS 66048-2627</p> <p>7b. Landowner(s) Person ID _____ New to system <input type="checkbox"/> Add Seq# _____</p> <p style="margin-top: 20px;">7a.</p>	<p>7c. Landowner(s) Person ID _____ New to system <input type="checkbox"/> Add Seq# _____</p> <p>7d. Misc. Person ID _____ New to system <input type="checkbox"/> Add Seq# _____</p>		
<p>8. WUR Correspondent Person ID _____ New to system <input type="checkbox"/> Add Seq# _____ Overlap File (s) WUC Notarized WUC Form <input type="checkbox"/> Agree <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p style="margin-top: 20px;">7a.</p>	<p>9. Use of Water: Changing? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p style="margin-left: 40px;"><input checked="" type="checkbox"/> Groundwater <input type="checkbox"/> Surface Water</p> <p><input type="checkbox"/> IRR <input type="checkbox"/> REC <input type="checkbox"/> DEW <input checked="" type="checkbox"/> MUN</p> <p><input type="checkbox"/> STK <input type="checkbox"/> SED <input type="checkbox"/> DOM <input type="checkbox"/> CON</p> <p><input type="checkbox"/> HYD DRG <input type="checkbox"/> WTR PWR <input type="checkbox"/> ART RECHRG</p> <p><input type="checkbox"/> IND SIC: _____ <input type="checkbox"/> OTHER: _____</p>		
10. Completion Date: <u>12/31/2019</u> 11. Perfection Date: <u>12/31/2038</u> 12. Exp Date: _____			
13. Conservation Plan Required? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Date Required: _____ Date Approved: _____ Date to Comply: _____			
14. Water Level Measuring Device? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Date to Comply: _____ Date WLMD Installed: _____			
<p>Date Prepared: 4/4/2018 By: DWS Date Entered: <i>7/16/2018</i> By: <i>UM</i></p>			

File No. 49,912	15. Formation Code: 112	Drainage Basin: MISSOURI RIVER	County: LV	Special Use:	Stream:																																							
16. Points of Diversion T MOD DEL ENT			17. Rate and Quantity																																									
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18. Storage: Rate _____ NF Quantity _____ ac/ft Additional Rate _____ NF Additional Quantity _____ ac/ft																																												
19. Limitation: _____ at _____ gpm (_____ cfs) when combined with file number(s) _____ Limitation: _____ af/yr at _____ gpm (_____ cfs) when combined with file number(s) _____																																												
20. Meter Required? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No To be installed by <u>12/31/2019</u> Date Acceptable Meter Installed _____																																												
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Comments: *File Nos. LV-2; 3,578; 27,613; 49,912; AND 49,913 All Overlap in Place of Use.																																												

KANSAS DEPARTMENT OF AGRICULTURE
Division of Water Resources
M E M O R A N D U M

TO: Files

DATE: April 4, 2018

FROM: Doug Schemm

RE: Applications, File Nos. 49,912 and 49,913

Leavenworth Water has filed the above referenced applications for permits to appropriate a total of 2,594.983 million gallons (7,963.71 AF) of both groundwater (File No. 49,912) from the Missouri River alluvium and surface water (File No. 49,913) from natural flows in the Missouri River. The applicant is proposing to install a collector well adjacent to the Missouri River. The applicant has provided modeling results indicating that the overwhelming majority of water would be supplied by surface water infiltration from the river (approximately 92%). Therefore, File No. 49,912 is requesting 8% of the total quantity of water (207.6 million gallons) of groundwater, while File No. 49,913 is requesting 92% of the total quantity (2,387.383 million gallons of surface water). This ratio of surface water to groundwater is similar to other collector well modeling results in this general area. The point of diversion is located in the Southeast Quarter of Section 8, Township 9 South, Range 23 East, in Leavenworth County.

There are no existing water rights that overlap the proposed point of diversion. However, the City of Leavenworth has three senior files overlapping the proposed place of use, including both groundwater and surface water rights, LV-02; 3,578; and 27,613. Vested Water Right, File LV-02 is authorized 706 million gallons, Water Right, File No. 3,578 is authorized 300 million gallons, and Water Right, File No. 27,613 is authorized 1,786.292 million gallons (868.558 million gallons additional). File No. 27,613 is limited to 1,874.558 million gallons with the senior files.

On February 5, 2018 the Division of Water Resources received modeling results prepared by Black & Veatch, with detailed groundwater and river evaluation. The report evaluated various pumping scenarios and their related drawdown in the immediate area and impact to stream flow in the Missouri River, at both average and low flow conditions on the river. Model results show that even at maximum pumping capacity at the collector well (12 MGD) for 60 days, under low river flow levels, it would result in no water level change at the Lansing Correctional wells, and a minimal drawdown of less than one-half foot at the closer Stigers Island Farm well. The impact on flows in the Missouri River show that the collector well would reduce flows by only 0.02 percent of the average flow. Even during extreme drought conditions (lowest river flow of 4,600 c.f.s.), pumping the proposed collector well would only reduce streamflow by 0.2 percent. Potential impact to area wells is minimal with less than one-half foot of drawdown, which would not be significant given the saturated thickness in this area of over 60 feet.

The modeling results also supported the surface water (92% of the total) to groundwater (8%) ratio that had been expected. DWR Technical Services staff also reviewed the modeling summary report (*Leavenworth, Kansas, Water Department – Groundwater Flow Evaluation in Support of the Water Rights Application for a New Horizontal Collector Well along the Missouri River, February 2, 2018*) and study support document (*Collector Well Desktop Study Report, November 7, 2016*) provided by the Leavenworth Water District through Black & Veatch. They determined that the report provides all the information DWR requires related to collector well modeling. The split between groundwater and surface water contributions, drawdown descriptions, and other supporting data provides sufficient information to evaluate the proposed horizontal collector well.

However, the initial modeling results did not specifically address potential impairment to the applicant's own existing well field authorized under Water Right, File No. 27,613, wherein the proposed collector well will be located. Additional modeling data was provided by Black & Veatch on March 8, 2017, which showed that the nearest municipal wells to the collector well (Well Nos. 4, 5A and 6) will need to be abandoned due to expected impact from the collector well. The model was ran with the remaining six wells operating, and with only four wells operating. In both simulations, groundwater levels remained over 20 feet above the well screens.

It appears that the remaining municipal wells could still operate with drawdown levels ranging from only 0.15 feet to 1.3 feet. File No. 49,912 will contain a permit condition to ensure that the nearest municipal supply wells are adequately addressed, as follows:

“That due to potential projected impacts on nearby municipal wells authorized under Water Right, File No. 27,613, the owner shall eliminate or otherwise mitigate the impact to municipal water supply well Nos. 4, 5A and 6, covered under File No. 27,613 upon installation of the proposed horizontal collector well, and shall provide updates as necessary on any actions taken toward this goal.”

The applicant did not identify any wells of any kind (other than their nearby municipal well-field wells) within one-half mile of the proposed point of diversion. They indicated that Stigers Island Farm Inc. owns all of the surrounding properties, so a notification letter was sent to this landowner. No response of any kind was received. The WRIS database shows the nearest well not owned by the applicant is located over 3,800 feet away. The groundwater application complies with well spacing to all wells other than their own municipal supply wells. Because the alluvial aquifer was identified as the source of water, K.A.R. 5-4-4 requires a minimum spacing of 1,320 feet to nondomestic wells and 660 feet to domestic wells. There are no surface water appropriations within the same two (2) mile radius.

For an application proposing to appropriate groundwater (File No. 49,912), K.A.R. 5-3-11 states that calculated recharge in the Missouri River alluvium is determined by adding 100% of the available recharge plus the recharge from the Missouri River available to the well using an appropriate method. It is also important to note that the area of consideration shall not include any portion of the circle located outside the State of Kansas. For this file, the extent of the alluvium within the area of consideration provided a total of only 2,569 acres. Based on a potential recharge of 5.8 inches, with 100% available for appropriation, safe yield was determined to be 1,241.68 acre-feet. Existing water rights have appropriated 4,738.62 acre-feet, (the majority of this quantity is the applicant's senior File No. 27,613). Even with increased recharge from the river, there is no quantity of water available for appropriation.

This collector well is in essence a part of the applicant's existing municipal well field adjacent to the river, and will be replacing these vertical wells. The applicant is anticipating little use of their current municipal wells (they will maintain a portion of them for back-up supply). Based on modeling results, recharge available to the well from the Missouri River is 92%. Therefore only 8% of the requested groundwater (637.1 AF x .08) or 50.97 acre-feet is applicable to safe yield availability. In addition, the majority of groundwater appropriated at the existing well field under File No. 27,613 is clearly recharge from the Missouri River, and the groundwater portion would likely be a similar value of only 8% as well. Therefore, a **waiver** of safe yield (K.A.R. 5-3-11) is recommended.

As noted above, the proposed collector well is part of an existing well field currently authorized under senior water right (File No. 27,613). The individual wells were installed to operate as a well field in conjunction with each other, and the existing, individual wells do not meet minimum well spacing criteria to each other per the requirements in K.A.R. 5-4-4, which suggest 1,320 feet well spacing for “all other aquifers”. Spacing averages about 500 feet apart for the existing wells. The closest municipal well is located only 381 feet away from the proposed collector well, and there are several other wells located less than 1,320 feet away. However, K.A.R. 5-4-4 also provides that the spacing guidelines are not applicable if the required minimum well spacing criteria are not necessary to prevent direct impairment.

There are several unique circumstances that should be considered in this specific instance.

- The wells in a municipal well field are operated as a system, and are not likely to be separated or divided in any way in the future. The wells have historically been operated without evidence of impairing each other. The Missouri River alluvium has both significant saturated thickness of over 60 feet, and very high transmissivity values, which would minimize drawdown affects.
- A 2001 "Collector Well Feasibility Report: Leavenworth Energy Facility" by Malcolm Pirnie, estimated that a horizontal collector well adjacent to municipal well 9, pumping 8 MGD would lower groundwater levels at existing municipal wells 9, 8, and 7 by 11.8 feet, 4.3 feet, and 1.7 feet, respectively. The report also noted that these wells could still be operated, without being affected by the drawdown.
- The applicant has stated the existing municipal wells will be used as a backup source of supply if the collector well was not operating for some reason. As noted above, the closest three wells will be abandoned upon completion of the collector well.
- In addition, these wells are primarily dependent on capturing surface water that infiltrates from the Missouri River. The reduced well spacing is a key component to this "hydraulic capture" concept. Typically, well spacing is necessary to prevent overlapping cones of influence, which can lead to impairment concerns. However, based on similar well field designs, these wells are intentionally spaced close together to cause overlapping cones of depression and ultimately create a groundwater trough or sink adjacent to the river. This trough greatly increases the ability to capture surface water. Increasing surface water infiltration to the wells is obviously a benefit to the alluvial aquifer because it will minimize the amount of groundwater directly withdrawn from the aquifer.

Based on the specific design of this horizontal collector well, the well spacing guidelines in K.A.R. 5-4-4, are clearly not relevant in this instance in regard to the City's existing municipal well field. The minimum well spacing criteria is not necessary to prevent direct impairment since these existing municipal wells have operated for many years with spacing less than required. The proposed horizontal well complies with well spacing from all other existing wells, which will protect the public interest.

The applicant has provided a "Municipal Supplemental Sheet" projecting water needs of 2,709.451 million gallons by 2038. The municipal use supplemental sheet indicates a significant annual population growth within the City of Leavenworth and local service area, which would increase population from approximately 46,858 currently to 50,813 by 2038 (20-year projection). The applicant has indicated that their current water rights were nearly exceeded in 2012. So the requested quantity of water for the pending applications appears reasonable in order to meet the projected demand. The City of Leavenworth also provides water to Lan-del Water District, and multiple rural water districts (almost 20% of their total water is sold to other public water suppliers). The application was filed indicating current usage is equivalent to 78 gallons per capita per day, which is a low value, while the regional average for large public water suppliers in Region 8 was 128 gallons per capita per day. The City's unaccounted for water is also reasonable at just 9%.

Note that the per capita per day from the supplemental sheet does not reflect water sold to other public water suppliers and industrial users. Using the average value for per capita per day of 128, and based on a population projection of 50,813, the following estimate for water usage can be determined:

50,813 x 128 gallons per day x 365 days	=	2,374 million gallons
Projected public water suppliers and industrial users	=	<u>728</u> million gallons
20 Year Projection Total	=	3,102 million gallons

This quantity of water is certainly in-line with what the applicant has requested. It is also typical for large suppliers to estimate water needs even further into the future (up to 40 years). As noted above, current water rights are authorized a total of 1,874.558 million gallons, and the applicant is projecting needs of 2,709.451 million gallons, a difference of 834.893 million gallons. Therefore, File No. 49,912 will be all additional water (207.6 million gallons), while File No. 49,913 will be limited to all senior files not to exceed 3,200 million gallons (increased projected water needs slightly to reflect potential future growth beyond 20 years).

The files were reviewed by DWR personnel to determine if the proposed use of water would be regulated under the Water Transfer Act of 2001. The applications do not propose the transportation of water in a quantity of 2,000 acre-feet or more for beneficial use at a point of use outside a 35-mile radius from the point of diversion. Therefore, the proposed appropriations of water would not be regulated by this Act.

The place of use overlaps multiple other senior water rights, and is described as:

“Within the City of Leavenworth, Kansas and its immediate vicinity, within the boundaries of Lan-Del Water District, Leavenworth County, Kansas and its immediate vicinity, within the boundaries of Consolidated Rural Water District No. 1, Leavenworth and Wyandotte County, Kansas and its immediate vicinity, within the boundaries of Rural Water District Nos. 1, 2, 5 , and 8 Leavenworth County, Kansas and their immediate vicinity, within the boundaries of Rural Water District No. 12 Jefferson County, Kansas and its immediate vicinity, and within the boundaries of Fort Leavenworth, Kansas and the Lansing Correctional Facility in Lansing, Kansas and their immediate vicinity”.

The collector well will be properly permitted under the DWR Water Structures program, authorizing the applicant to construct the horizontal collector well in the floodway of the Missouri River.

In accordance with K.S.A. 82a-706c, the Chief Engineer retains full authority to require any water user to install meters, gages, or other measuring devices, which devices he or she or his or her agents may read at any time. Water flowmeter requirements are further described in K.A.R. 5-1-4 through K.A.R. 5-1-12. If any chemical or foreign substance is injected into the water pumped under these permits, check valves will also need to be installed.

In an April 3, 2018 discussion, Katie Tietsort, Water Commissioner, Topeka Field Office, recommended approval of the referenced applications.

Based on the above discussion, that approval of the applications will not prejudicially or unreasonably affect the public interest, and their approval will assist the City of Leavenworth in meeting their future water supply needs, it is recommended that the referenced applications be approved for construction of a horizontal collector well.

Douglas W. Schemm
Environmental Scientist
Topeka Field Office

STATE OF KANSAS

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TOPEKA, KS 66612
PHONE: (785) 296-3556
www.agriculture.ks.gov

GOVERNOR JEFF COLYER, M.D.
JACKIE McCLASKEY, SECRETARY OF AGRICULTURE

July 16, 2018

CITY OF LEAVENWORTH
WATERWORKS DEPT
601 CHEROKEE ST
LEAVENWORTH KS 66048-2627

FILE COPY

Re: Appropriation of Water, File Nos. 49,912 and 49,913

Dear Sir or Madam:

There are enclosed permits to appropriate water authorizing you to proceed with construction of the proposed diversion works (except those dams and stream obstructions regulated by K.S.A. 82a-301 through 305a), to divert such unappropriated water as may be available from the sources and at the location specified in these permits, and to use it for the purpose and at the location described in these permits.

Your attention is directed to the enclosures and to the terms, conditions, and limitations specified in these permits. A water meter is required on the proposed diversion works and you must install it prior to water being put to beneficial use in order for you to maintain accurate records of water use. The meter should be used to provide the information required on the annual water use report. Failure to notify the Chief Engineer of the Division of Water Resources of the completion of the diversion works within the time allowed, or within any authorized extension of time thereof, will result in the dismissal of these permits. Enclosed is a form which may be used to notify the Chief Engineer that the proposed diversion works have been completed for each file.

All requests for extensions of time to complete diversion works, or to perfect appropriations, must be submitted to the Chief Engineer before the expiration of time originally set forth in these permits to complete diversion works or to perfect an appropriation. If for any reason, you require an extension of time, you must request it before the expiration of time set forth in these permits. Failure to comply with this regulation will result in the dismissal of your permits or your water rights. Any request for an extension of time shall be accompanied by the required statutory fee, which is currently \$100.00 per file number. There is also enclosed an information sheet setting forth the procedure to obtain Certificates of Appropriation which will establish the extent of your water rights.

If you have any questions, please contact our office. If you wish to discuss a specific file, please have the file number ready so that we may help you more efficiently.

Sincerely,

Kristen A. Baum
New Application Unit Supervisor
Water Appropriation Program

KAB:dws
Enclosures
pc: Topeka Field Office



KANSAS DEPARTMENT OF AGRICULTURE
Jackie McClaskey, Secretary of Agriculture

DIVISION OF WATER RESOURCES
David W. Barfield, Chief Engineer

**APPROVAL OF APPLICATION
and
PERMIT TO PROCEED**

(This Is Not a Certificate of Appropriation)

This is to certify that I have examined Application, **File No. 49,912** of the applicant

**CITY OF LEAVENWORTH
WATERWORKS DEPT
601 CHEROKEE ST
LEAVENWORTH KS 66048-2627**

for a permit to appropriate water for beneficial use, together with the maps, plans and other submitted data, and that the application is hereby approved and the applicant is hereby authorized, subject to vested rights and prior appropriations, to proceed with the construction of the proposed diversion works (except those dams and stream obstructions regulated by K.S.A. 82a-301 through 305a, as amended), and to proceed with all steps necessary for the application of the water to the approved and proposed beneficial use and otherwise perfect the proposed appropriation subject to the following terms, conditions and limitations:

1. That the priority date assigned to such application is **September 22, 2017**.
2. That the water sought to be appropriated shall be used for municipal purposes within the City of Leavenworth, Kansas and its immediate vicinity, within the boundaries of Lan-Del Water District, Leavenworth County, Kansas and its immediate vicinity, within the boundaries of Consolidated Rural Water District No. 1, Leavenworth and Wyandotte County, Kansas and its immediate vicinity, within the boundaries of Rural Water District Nos. 1, 2, 5, and 8 Leavenworth County, Kansas and their immediate vicinity, within the boundaries of Rural Water District No. 12 Jefferson County, Kansas and its immediate vicinity, and within the boundaries of Fort Leavenworth, Kansas and the Lansing Correctional Facility in Lansing, Kansas and their immediate vicinity.
3. That the authorized source from which the appropriation shall be made is groundwater, to be withdrawn by means of a collector well located in the Northeast Quarter of the Southwest Quarter of the Southeast Quarter (NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$) of Section 8, more particularly described as being near a point 732 feet North and 1,600 feet West of the Southeast corner of said section, in Township 9 South, Range 23 East, Leavenworth County, Kansas, located substantially as shown on the topographic map accompanying the application.
4. That the appropriation sought shall be limited to a maximum diversion rate not in excess of **666.67 gallons per minute** (1.485 c.f.s.) and to a quantity not to exceed **207.6 million gallons** (637.1 acre-feet) of water for any calendar year.
5. That installation of works for diversion of water shall be completed on or before **December 31, 2019** or within any authorized extension thereof. The applicant shall notify the Chief Engineer and pay the statutorily required field inspection fee of \$400.00 when construction of the works has been completed. Failure to timely submit the notice and the fee will result in revocation of the permit. Any request for an extension of time shall be submitted prior to the expiration of the deadline and shall be accompanied by the required statutory fee of \$100.00.

6. That the proposed appropriation shall be perfected by the actual application of water to the proposed beneficial use on or before **December 31, 2038** or any authorized extension thereof. Any request for an extension of time shall be submitted prior to the expiration of the deadline and shall be accompanied by the required statutory fee of \$100.00.

7. That the applicant shall not be deemed to have acquired a water appropriation for a quantity in excess of the amount approved herein nor in excess of the amount found by the Chief Engineer to have been actually used for the approved purpose during one calendar year subsequent to approval of the application and within the time specified for perfection or any authorized extension thereof.

8. That the use of water herein authorized shall not be made so as to impair any use under existing water rights nor prejudicially and unreasonably affect the public interest.

9. That the right of the appropriator shall relate to a specific quantity of water and such right must allow for a reasonable raising or lowering of the static water level and for the reasonable increase or decrease of the streamflow at the appropriator's point of diversion.

10. That this permit does not constitute authority under K.S.A. 82a-301 through 305a to construct any dam or other obstruction; nor does it grant any right-of-way, or authorize entry upon or injury to, public or private property.

11. That all diversion works constructed under the authority of this permit into which any type of chemical or other foreign substance will be injected into the water pumped from the diversion works shall be equipped with an in-line, automatic quick-closing, check valve capable of preventing pollution of the source of the water supply. The type of valve installed shall meet specifications adopted by the Chief Engineer and shall be maintained in an operating condition satisfactory to the Chief Engineer.

12. That an acceptable water flow meter shall be installed and maintained on the diversion works authorized by this permit in accordance with the Kansas Administrative Regulations 5-1-4 through 5-1-12 adopted by the Chief Engineer. This water flow meter shall be used to provide an accurate quantity of water diverted as required for the annual water use report (including the meter reading at the beginning and end of the report year).

13. That the applicant shall maintain accurate and complete records from which the quantity of water diverted during each calendar year may be readily determined and the applicant shall file an annual water use report with the Chief Engineer by March 1 following the end of each calendar year. Failure to file the annual water use report by the due date shall cause the applicant to be subject to a civil penalty.

14. That no water user shall engage in nor allow the waste of any water diverted under the authority of this permit.

15. That failure without cause to comply with provisions of the permit and its terms, conditions and limitations will result in the forfeiture of the priority date, revocation of the permit and dismissal of the application.

16. That the right to appropriate water under authority of this permit is subject to any minimum desirable streamflow requirements identified and established pursuant to K.S.A. 82a-703c for the source of supply to which this water right applies.

17. That the permit holder shall submit a progress report to the office of the Chief Engineer by March 1, following the tenth full calendar year after the permit was issued. The progress report must be submitted on a form prescribed by the Chief Engineer, and shall compare annual water use projected in the original application with the actual annual water use for the prior 10 years. The progress report must document compliance with the approved conservation plan, contain sufficient details to determine the extent of perfection of the water right during the previous ten years, and demonstrate how the water right, in association with other water rights, meets the municipal use need.

18. That due to potential projected impacts on nearby municipal wells authorized under Water Right, File No. 27,613, the owner shall eliminate or otherwise mitigate the impact to municipal water supply well Nos. 4, 5A and 6, covered under File No. 27,613 upon installation of the proposed horizontal collector well, and shall provide updates as necessary on any actions taken toward this goal.

RIGHT TO A HEARING AND TO ADMINISTRATIVE REVIEW

If you are aggrieved by this Order, then pursuant to K.S.A. 82a-1901, you may:

- 1) request an evidentiary hearing before the Chief Engineer, or
- 2) request administrative review by the Secretary of Agriculture.

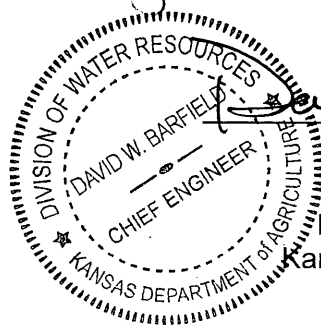
Failure to request an evidentiary hearing before the Chief Engineer does not preclude your right to administrative review by the Secretary.

To obtain an evidentiary hearing before the Chief Engineer, a written request for hearing must be filed within 15 days after service of this Order as provided in K.S.A. 77-531 (**i.e., within a total of 18 days after this Order was mailed to you**), with: Kansas Department of Agriculture, Attn: Legal Section, 1320 Research Park Drive, Manhattan, Kansas 66502, FAX (785) 564-6777.

If you do not file a request for an evidentiary hearing before the Chief Engineer, you may petition for administrative review of the Order by the Secretary of Agriculture. A petition for review shall be in writing and state the basis for requesting administrative review. The request for hearing may be denied if the request fails to clearly establish factual or legal issues for review. See K.S.A. 77-527. The petition must be filed within 30 days after service of this Order as provided in K.S.A. 77-531 (**i.e., within a total of 33 days after this Order was mailed to you**), and be filed with: Secretary of Agriculture, Attn: Legal Division, Kansas Department of Agriculture, 1320 Research Park Drive, Manhattan, Kansas 66502, FAX (785) 564-6777.

If neither a request for an evidentiary hearing nor a petition for administrative review is filed as set forth above, then this Order shall be effective and become a final agency action as defined in K.S.A. 77-607(b). Failure to timely request either an evidentiary hearing or administrative review may preclude further judicial review under the Kansas Judicial Review Act.

Ordered this 12th day of July, 2018, in Topeka, Shawnee County, Kansas.



David W. Barfield

David W. Barfield, P.E.
Chief Engineer
Division of Water Resources
Kansas Department of Agriculture

State of Kansas)
) SS
County of Riley)

The foregoing instrument was acknowledged before me this 12th day of July, 2018, by David W. Barfield, P.E., Chief Engineer, Division of Water Resources, Kansas Department of Agriculture.



Karen Hunter

Notary Public

CERTIFICATE OF SERVICE

On this 16th day of July, 2018, I hereby certify that the foregoing Approval of Application and Permit to Proceed, File No. 49,912, dated July 12th, 2018 was mailed postage prepaid, first class, US mail to the following:

CITY OF LEAVENWORTH
WATERWORKS DEPT
601 CHEROKEE ST
LEAVENWORTH KS 66048-2627

With photocopies to:

Topeka Field Office

Danielle Wilson

Division of Water Resources

Kansas Department of Agriculture
 Division of Water Resources
WAIVER REQUEST & WAIVER RULE WORKSHEET

File Number: 49,912

FO: 1 GMD: 0

WAIVER REQUEST:

UMW	Date Requested	Rule ID	Applies	Rule Type	Rule Subtype
MUN	4/4/2018	53	Statewide	Safe Yield	Yield of Unconfined Groundwater Exceeded
Rule Number	Date Granted	Date Denied	Justification: The alluvial aquifer is fully appropriated primarily because of the applicant's well field. This proposed collector well will in essence replace this vertical well field. Approximately 92% of the water diverted from this well will be surface water. The proposed use of water is in the public interest and will not cause impairment. This safe yield waiver is consistent with similar collector well applications.		
K.A.R. 5-3-11	7/17/18				

WAIVER RULE:

Rule ID	Applicability	Type	Subtype	Rule Number	Date Active	Date Inactive

Date Prepared 4/4/2018 By dws

Date Entered 7/16/2018 By UM

THE STATE OF KANSAS



KANSAS DEPARTMENT OF AGRICULTURE
Jackie McClaskey, Secretary of Agriculture

DIVISION OF WATER RESOURCES
David W. Barfield, Chief Engineer

WAIVER OF REGULATION
K.A.R. 5-3-11 Safe Yield

Date: 7/12, 2018.

Re: Appropriation of Water, File No. 49,912

1. That the source of water is the Missouri River alluvium. This application is to authorize the groundwater portion diverted from a collector well, which comprises only eight (8) percent of the total quantity of water.
2. That the application does not meet safe yield criteria as set forth in K.A.R. 5-3-11, primarily because of the applicant's municipal well field authorized under Water Right, File No. 27,613.
3. That this proposed waiver of safe yield is consistent with the approach used for the groundwater portion of similar collector wells.
4. That the collector well will become a part of the applicant's existing municipal well field adjacent to the river, and will be replacing these vertical wells. The applicant is anticipating little use of their current municipal wells (they will maintain a portion of them for back-up supply).
5. That the majority of groundwater appropriated at the existing well field under File No. 27,613 is clearly surface water infiltration from the Missouri River.
6. That a waiver of safe yield will not prejudicially or unreasonably affect the public interest, and no senior water rights will be impaired by the proposed use.

Comments:

A handwritten signature in cursive script that reads "David W. Barfield".

David W. Barfield, P.E.
Chief Engineer
Division of Water Resources
Kansas Department of Agriculture

APPLICATION COMPLETE
3/11/2018
Reviewer DWS

THE STATE OF KANSAS



KANSAS DEPARTMENT OF AGRICULTURE
Jackie McClaskey, Secretary of Agriculture

DIVISION OF WATER RESOURCES
David W. Barfield, Chief Engineer

File Number 49912
This item to be completed by the Division of Water Resources.

UNACCEPTABLE FOR PRIORITY
WATER RESOURCES RECEIVED
SEP 18 2017 11:39
DEPT OF AGRICULTURE
WATER RESOURCES RECEIVED

5-14-18
APPLICATION COMPLETE
4/3/18
Reviewer KAB for DWS

APPLICATION FOR PERMIT TO APPROPRIATE WATER FOR BENEFICIAL USE
Filing Fee Must Accompany the Application
(Please refer to Fee Schedule attached to this application form.)

SEP 22 2017
DEPT OF AGRICULTURE

To the Chief Engineer of the Division of Water Resources, Kansas Department of Agriculture,
1320 Research Park Drive, Manhattan, Kansas 66502

1. Name of Applicant (Please Print): Leavenworth Water
Address: 601 Cherokee
City: Leavenworth State KS Zip Code 66048
Telephone Number: (913) 682-1513 Ext.

2. The source of water is: surface water in _____ (stream)
OR groundwater in Missouri River (drainage basin)

Certain streams in Kansas have minimum target flows established by law or may be subject to administration when water is released from storage for use by water assurance district members. If your application is subject to these regulations on the date we receive your application, you will be sent the appropriate form to complete and return to the Division of Water Resources.

3. The maximum quantity of water desired is 637.10 acre-feet OR 207.6 million gallons per calendar year, to be diverted at a maximum rate of 666.67 gallons per minute OR _____ cubic feet per second.

Once your application has been assigned a priority, the requested maximum rate of diversion and maximum requested quantity of water under that priority number can **NOT** be increased. Please be certain your requested maximum rate of diversion and maximum quantity of water are appropriate and reasonable for your proposed project and are in agreement with the Division of Water Resources' requirements.

4. The water is intended to be appropriated for (Check use intended):
(a) Artificial Recharge (b) Irrigation (c) Recreational (d) Water Power
(e) Industrial (f) Municipal (g) Stockwatering (h) Sediment Control
(i) Domestic (j) Dewatering (k) Hydraulic Dredging (l) Fire Protection
(m) Thermal Exchange (n) Contamination Remediation

YOU **MUST** COMPLETE AND ATTACH ADDITIONAL DIVISION OF WATER RESOURCES FORM(S) PROVIDING INFORMATION TO SUBSTANTIATE YOUR REQUEST FOR THE AMOUNT OF WATER FOR THE INTENDED USE REFERENCED ABOVE.

For Office Use Only:
F.O. 1 GMD - Meets K.A.R. 5-3-1 (YES/NO) Use MUN Source G S County LV By DW Date 9/22/17
Code RE3 Fee \$ 380 TR # _____ Receipt Date 9/22/17 Check # 53836

SCANNED
9/27/2017 ULM

5. The location of the proposed wells, pump sites or other works for diversion of water is:

Note: For the application to be accepted, the point of diversion location must be described to at least a 10 acre tract, unless you specifically request a 60 day period of time in which to locate the site within a specifically described, minimal legal quarter section of land.

- (A) One in the ~~SE~~^{NE} quarter of the SW quarter of the SE quarter of Section 8, more particularly described as being near a point ~~491~~⁷³² feet North and ~~1527~~¹⁶⁰⁰ feet West of the Southeast corner of said section, in Township 9 South, Range 23 East/West (circle one), Leavenworth County, Kansas.
- (B) One in the _____ quarter of the _____ quarter of the _____ quarter of Section _____, more particularly described as being near a point _____ feet North and _____ feet West of the Southeast corner of said section, in Township _____ South, Range _____ East/West (circle one), _____ County, Kansas.
- (C) One in the _____ quarter of the _____ quarter of the _____ quarter of Section _____, more particularly described as being near a point _____ feet North and _____ feet West of the Southeast corner of said section, in Township _____ South, Range _____ East/West (circle one), _____ County, Kansas.
- (D) One in the _____ quarter of the _____ quarter of the _____ quarter of Section _____, more particularly described as being near a point _____ feet North and _____ feet West of the Southeast corner of said section, in Township _____ South, Range _____ East/West (circle one), _____ County, Kansas.

If the source of supply is groundwater, a separate application shall be filed for each proposed well or battery of wells, except that a single application may include up to four wells within a circle with a quarter (1/4) mile radius in the same local source of supply which do not exceed a maximum diversion rate of 20 gallons per minute per well.

A battery of wells is defined as two or more wells connected to a common pump by a manifold; or not more than four wells in the same local source of supply within a 300 foot radius circle which are being operated by pumps not to exceed a total maximum diversion rate of 800 gallons per minute and which supply water to a common distribution system.

6. The owner of the point of diversion, if other than the applicant is (please print):

_____ (name, address and telephone number)

_____ (name, address and telephone number)

You must provide evidence of legal access to, or control of, the point of diversion from the landowner or the landowner's authorized representative. Provide a copy of a recorded deed, lease, easement or other document with this application. In lieu thereof, you may sign the following sworn statement:

I have legal access to, or control of, the point of diversion described in this application from the landowner or the landowner's authorized representative. I declare under penalty of perjury that the foregoing is true and correct.

Executed on _____, 20____. _____
Applicant's Signature

The applicant must provide the required information or signature irrespective of whether they are the landowner. Failure to complete this portion of the application will cause it to be unacceptable for filing and the application will be returned to the applicant.

7. The proposed project for diversion of water will consist of one horizontal collector well
(number of wells, pumps or dams, etc.)
and (was) (will be) completed (by) _____
(Month/Day/Year - each was or will be completed)

8. The first actual application of water for the proposed beneficial use was or is estimated to be _____
(Mo/Day/Year)

As per email from K. Hahn dated 5-14-18

SEP 22 2017

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SEP 18 2017
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ACCEPTABLE

SCANNED

9. Will pesticide, fertilizer, or other foreign substance be injected into the water pumped from the diversion works?
 Yes No If "yes", a check valve shall be required.

All chemigation safety requirements must be met including a chemigation permit and reporting requirements.

10. If you are planning to impound water, please contact the Division of Water Resources for assistance, prior to submitting the application. Please attach a reservoir area capacity table and inform us of the total acres of surface drainage area above the reservoir.

Have you also made an application for a permit for construction of this dam and reservoir with the Division of Water Resources? Yes No

- If yes, show the Water Structures permit number here _____
- If no, explain here why a Water Structures permit is not required _____

11. The application must be supplemented by a U.S.G.S. topographic map, aerial photograph or a detailed plat showing the following information. On the topographic map, aerial photograph, or plat, identify the center of the section, the section lines or the section corners and show the appropriate section, township and range numbers. Also, please show the following information:

- (a) The location of the proposed point(s) of diversion (wells, stream-bank installations, dams, or other diversion works) should be plotted as described in Paragraph No. 5 of the application, showing the North-South distance and the East-West distance from a section line or southeast corner of section.
- (b) If the application is for groundwater, please show the location of any existing water wells of any kind within 1/2 mile of the proposed well or wells. Identify each existing well as to its use and furnish the name and mailing address of the property owner or owners. If there are no wells within 1/2 mile, please advise us.
- (c) If the application is for surface water, the names and addresses of the landowner(s) 1/2 mile downstream and 1/2 mile upstream from your property lines must be shown.
- (d) The location of the proposed place of use should be shown by crosshatching on the topographic map, aerial photograph or plat.
- (e) Show the location of the pipelines, canals, reservoirs or other facilities for conveying water from the point of diversion to the place of use.

A 7.5 minute U.S.G.S. topographic map may be obtained by providing the section, township and range numbers to: Kansas Geological Survey, 1930 Constant, Campus West, University of Kansas, Lawrence, Kansas 66047.

12. List any application, appropriation of water, water right, or vested right file number that covers the same diversion points or any of the same place of use described in this application. Also list any other recent modifications made to existing permits or water rights in conjunction with the filing of this application.

WR File No. 27613

WR LV2-00

WR No. 3578

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WATER RESOURCES
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13. Furnish the following well information if the proposed appropriation is for the use of groundwater. If the well has not been completed, give information obtained from test holes, if available.

Information below is from: Test holes Well as completed Drillers log attached

Test Hole No. 2-99 (near well 5A on attached map)

Well location as shown in paragraph No. (A) (B) (C) (D)

Date Drilled	<u>5/7/99</u>			
Total depth of well	<u>73'</u>			
Depth to water bearing formation	<u>23'</u>			
Depth to static water level	<u>14'</u>			
Depth to bottom of pump intake pipe	<u>--</u>			

14. The relationship of the applicant to the proposed place where the water will be used is that of

municipal / rural provider
(owner, tenant, agent or otherwise)

15. The owner(s) of the property where the water is used, if other than the applicant, is (please print):

(name, address and telephone number)

(name, address and telephone number)

16. The undersigned states that the information set forth above is true to the best of his/her knowledge and that this application is submitted in good faith.

Dated at LEAVENWORTH, Kansas, this 14TH day of SEPTEMBER, 2017.
(month) (year)

(Applicant Signature)

By 
(Agent or Officer Signature)

JOEL MAHINKEN
(Agent or Officer - Please Print)

Assisted by _____ Date: _____
(office/title)

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SCANNED

Applicant's Name Leavenworth Water
(Please Print)

MUNICIPAL (PUBLIC WATER SUPPLY) APPLICATION SUPPLEMENTAL INFORMATION SHEET

Application File Number

(assigned by DWR)

SECTION 1: PRESENT WATER USE SUMMARY (IF NO PREVIOUS MUNICIPAL WATER USE HAS BEEN UTILIZED, PROCEED TO SECTION 3)

NOTE: WORKSHEET FOR WATER PUMPED, PURCHASED, AND SOLD BY YOUR WATER DISTRIBUTION SYSTEM.

in 1000 gallons

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Raw Water Diverted Under Your Rights	Water Purchased From All Sources	Water Sold to Other Public Water Suppliers	Water Sold to Your Industrial, Stock, and Bulk Customers	Water Sold to Your Residential and Commercial Customers	Other Metered Water	Remaining Water Used (See Below Explanation)
1,800,508	0	425,558	35,239	1,051,258	99,025	189,428
TOTAL WATER = Columns 1 + 2		ACCOUNTED FOR WATER = Columns 3 + 4 + 5 + 6			UNACCOUNTED FOR WATER	

UNACCOUNTED FOR WATER = TOTAL WATER - ACCOUNTED FOR WATER

- Column 1: The amount of raw water diverted from all of your points of diversion.
- Column 2: The amount of water purchased wholesale from all other public water supply systems or the Kansas Water Office.
- Column 3: The amount of water sold wholesale to all other public water supply systems.
- Column 4: The amount of water sold retail to all industrial, pasture, stockwater, feedlot, and bulk water service connections. Include the amount of water sold to all farmsteads using at least 200,000 gallons of water per year.
- Column 5: The amount of water sold retail to your residential and commercial customers and to industries and farmsteads using less than 200,000 gallons of water per year.
- Column 6: The amount of water used that is metered at individual service connections and supplied free, such as for public service, treatment processes, and connections receiving free water.
- Column 7: The amount of remaining water used. The gallons reported in this column are found by adding the numbers in Columns 1 and 2 and subtracting the numbers in Columns 3, 4, 5, and 6.

UNACCOUNTED FOR WATER

Use the following to calculate your distribution system's Unaccounted For Water:
Start with the amount in Column 1 and add the amount in Column 2, then subtract the amounts in Columns 3, 4, 5, and 6 leaving an amount of water representing your unaccounted for water to enter in Column 7.

Use the following to calculate the percent Unaccounted For Water versus the Total Water of your system:

$$\text{Percent Unaccounted For Water} = \frac{\text{Unaccounted For Water}}{\text{Total Water (Columns 1,2)}} \times 100$$

If this number exceeds 20%, please explain the large amount of unaccounted for water and describe any steps being taken to reduce it.

SECTION 2: PAST WATER USE

COMPLETE THE FOLLOWING TABLE FROM YOUR PAST WATER USE RECORDS.

in 1000 gallons

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Raw Water Diverted Under Your Rights	Water Purchased From All Sources	Water Sold to Other Public Water Suppliers	Water Sold to Your Industrial, Stock, and Bulk Customers	Water Sold to Your Residential and Commercial Customers	Other Metered Water	Remaining Water Used (See Above Explanation)
20 years ago	1,778,636	0	422,471	39,389	1,212,094	2,815	101,867
15 years ago	1,805,886	0	374,665	21,558	1,268,380	5,467	135,816
10 years ago	1,669,958	0	401,452	34,974	1,049,734	1,972	181,826
5 years ago	1,860,109	0	478,698	31,361	1,084,239	2,553	263,258
	TOTAL WATER = Columns 1 + 2		ACCOUNTED FOR WATER = Columns 3 + 4 + 5 + 6			UNACCOUNTED FOR WATER	

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SEP 18 2017
SCANNED

49919

SECTION 3: PROJECTED FUTURE WATER NEEDS Acree-feet/year

PLEASE COMPLETE THE FOLLOWING TABLE SHOWING YOUR FUTURE WATER REQUIREMENTS FOR THE NEXT 20 YEARS:

	Column 1 Raw Water Diverted Under Your Rights	Column 2 Water Purchased From All Sources	Column 3 Water Sold to Other Public Water Suppliers	Column 4 Water Sold to Your Industrial, Stock, and Bulk Customers	Column 5 Water Sold to Your Residential and Commercial Customers	Column 6 Other Metered Water	Column 7 Remaining Water Used (See Explanation on other side)
Year 5	7897	0	1352	111	4000	202	404
Year 10	8034	0	1400	114	4087	207	414
Year 15	8173	0	1450	117	4176	212	425
Year 20	8315	0	1502	119	4261	218	436
TOTAL WATER = Columns 1 + 2			ACCOUNTED FOR WATER = Columns 3 + 4 + 5 + 6				UNACCOUNTED FOR WATER

SECTION 4: POPULATION AND SERVICE CONNECTIONS City/Rural (estim.)

ESTIMATE THE NUMBER OF PERSONS DIRECTLY SERVED BY YOUR WATER DISTRIBUTION SYSTEM

PAST POPULATION - PROVIDE INFORMATION BELOW:
(CENSUS BUREAU INFORMATION)

LAST 20 YEARS	POPULATION
20 years ago	35,448 / 10,772
15 years ago	35,251 / 10,712
10 years ago	35,526 / 10,796
5 years ago	35,800 / 10,879
Last Year	35,937 / 10,921

PROJECTED FUTURE POPULATION

ESTIMATE FUTURE POPULATION AND SUBSTANTIATE NUMBERS ON SEPARATE ATTACHMENTS

NEXT 20 YEARS	POPULATION
Year 5	36,534 / 11,326
Year 10	37,095 / 11,730
Year 15	37,660 / 12,149
Year 20	38,232 / 12,581

Provide number of current active service connections:

Residential _____ Industrial _____ Other (specify) _____
 Commercial _____ Pasture/ Stockwater/ Feedlot _____
 Total _____

SECTION 5: PRESENT GALLONS PER PERSON PER DAY

CALCULATE YOUR GALLONS PER PERSON PER DAY

Water from Columns 5, 6, and 7 ÷ Population ÷ 365 Days/Year = Gallons per Person per Day

$$\frac{15,771}{10^9} \div 46,858 \div 365 \text{ Days/Year} = 78.33 \text{ GALLONS PER PERSON PER DAY.}$$

Amount of water in Columns 5, 6, and 7 of Section 1
 Population from Last Year of Section 4

SECTION 6: AREA TO BE SERVED

Describe the area to be served or provide the legal description of the location where the water is to be used including any other city of water supply system (i.e. Rural Water District): _____

See attached page _____

You may attach additional information you believe will assist in informing the Division of the need for your request.

KS DEPT OF AGRICULTURE
 WATER RESOURCES DIVISION
 RECEIVED
 SEP 22 2017
 WATER RESOURCES DIVISION
 RECEIVED
 SEP 28 2017
 ATTACHED

49919

THE STATE OF KANSAS



KANSAS DEPARTMENT OF AGRICULTURE
Jackie McClaskey, Secretary of Agriculture

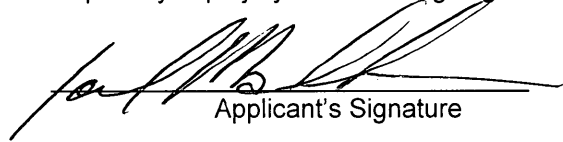
DIVISION OF WATER RESOURCES
David W. Barfield, Chief Engineer

SWORN STATEMENT
PURSUANT TO K.S.A. 82a-709

You must provide evidence of legal access to, or control of, the point of diversion from the landowner or the landowner's authorized representative. Provide a copy of a recorded deed, lease, easement or other document with this application. In lieu thereof, you may sign the following sworn statement:

I have legal access to, or control of, the point of diversion described in this application from the landowner or the landowner's authorized representative. I declare under penalty of perjury that the foregoing is true and correct.

Executed on SEPTEMBER 20, 2017.


Applicant's Signature

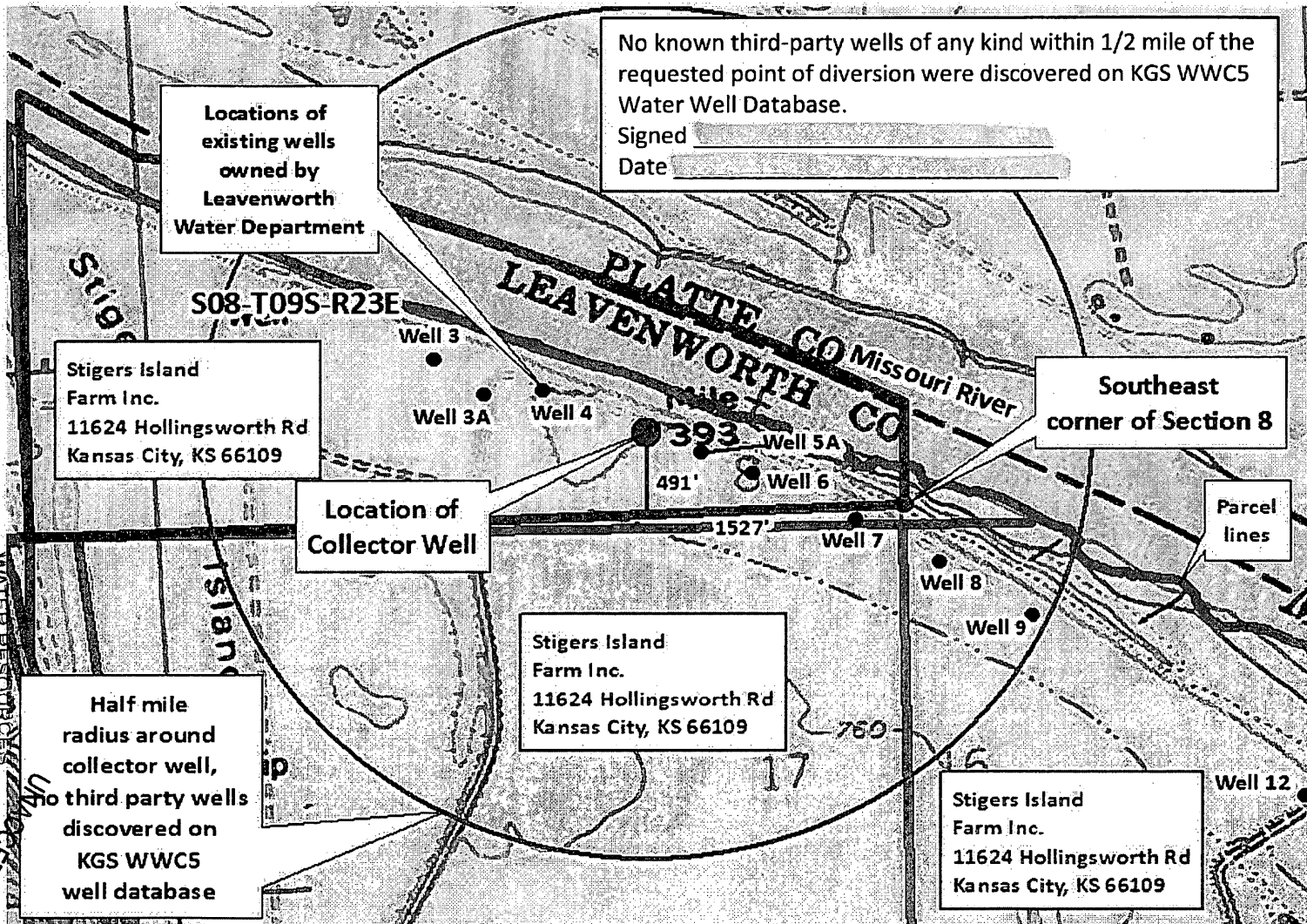
The applicant must provide the required information or signature irrespective of whether they are the landowner. Failure to complete this portion of the application will cause it to be unacceptable for filing and the application will be returned to the applicant.

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SEP 22 2017

KS DEPT OF AGRICULTURE

SCANNED



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SEP 22 2017

WATER RESOURCES RECEIVED

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SEP 18 2017

WATER RESOURCES RECEIVED

SCANNED



City limits

Locations of
existing wells
owned by
Leavenworth
Water Department

Rural WDs Served

S08-T09S-R23E

* 49,912

Fails safe yield

Analysis Results

The selected PD is in an area to new appropriations.

The safe yield, based on the variables listed below is 1,241.68 AF.

Total prior appropriation in the circle is 5,375.72 AF. - 637.1 = 4,738.62 AF

Total quantity of water available for appropriation is 0.00 AF.

Safe Yield Variables

The area used for the analysis is set at 2569 acres.

Potential annual recharge of the area is estimated to be 5.8 inches.

The percent of recharge available for appropriation is 100%.

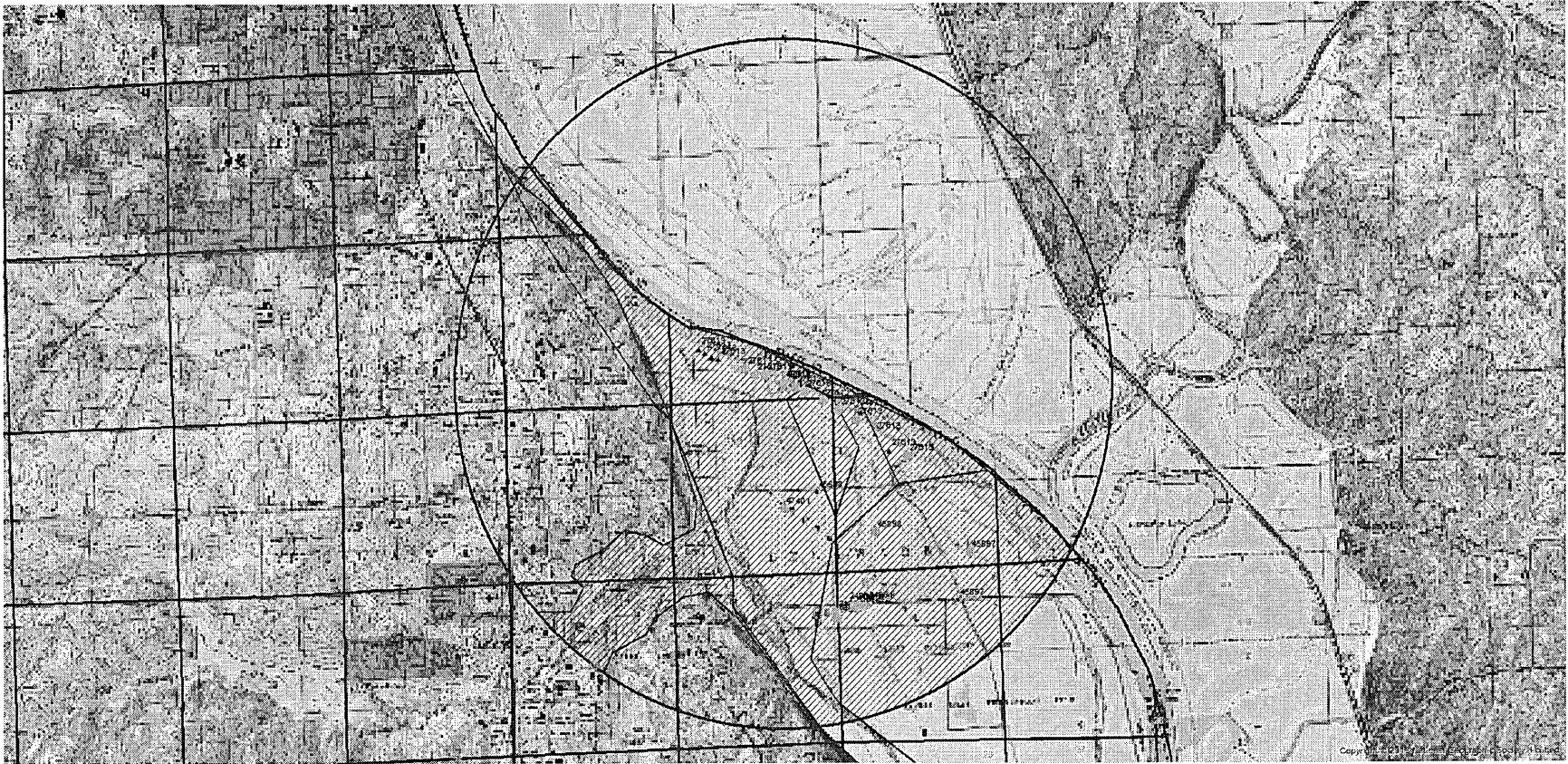
Authorized Quantity values are as of 19-OCT-2017 and are based on Appropriated and Vested ground water right and possible stream nodes for GMD #2. Domestic, Term and Temporary water rights have been excluded.

There are 7 water right(s) and 19 point(s) of diversion within the circle.

File Number	Use	ST	SR	Q4	Q3	Q2	Q1	FeetN	FeetW	Sec	Twp	Rng	ID	Qind	Auth_Quant	Add_Quant	Tacres	Nacres
A 24961 00	MUN	NK	G		NE	SE	NE	3816	12	20	09	23E	1	WR	306.89	306.89		
Same	MUN	NK	G		NE	NE	NE	4009	12	20	09	23E	2	WR				
Same	MUN	NK	G		NE	SE	NE	3913	12	20	09	23E	3	WR				
A 27613 00	MUN	NK	G					5278	203	17	09	23E	1	WR	5,481.93	2,665.51		
Same	MUN	NK	G		SE	NW	NW	4608	4399	16	09	23E	2	WR				
Same	MUN	NK	G		NE	SE	NW	3424	2819	16	09	23E	5	WR				
Same	MUN	NK	G		NW	SW	SE	774	2442	08	09	23E	9	WR				
Same	MUN	NK	G		NW	NW	NW	4946	4951	16	09	23E	1	WR				
Same	MUN	NK	G		NW	SW	SE	755	2108	08	09	23E	5	WR				
Same	MUN	NK	G		SW	SE	SE	202	879	08	09	23E	7	WR				
Same	MUN	NK	G		NE	SE	SW	970	2745	08	09	23E	4	WR				
Same	MUN	NK	G		SW	SE	SE	344	1176	08	09	23E	10	WR				
A 43272 00	MUN	KE	G		SE	NW	NW	4300	4580	21	09	23E	3	WR	767.22	767.22		
Same	MUN	KE	G		SW	NW	NW	4300	4725	21	09	23E	4	WR				
Same	MUN	KE	G		SE	NW	NW	4300	4435	21	09	23E	5	WR				
A 45897 00	IRR	MM	G		SW	SE	SE	415	899	16	09	23E	7	WR	999.00	999.00	999.70	999.70
A 45898 00	IRR	MM	G		NW	SE	SW	1136	3908	16	09	23E	8	WR	999.00	0.00	999.70	0.00
A 47401 00	IRR	MM	G					2032	1667	17	09	23E	3	WR	716.00	0.00	999.70	0.00
A 49912 00	MUN	AY	G		SE	SW	SE	491	1527	08	09	23E	11	WR	637.10	637.10		

49,912

Safe Yield Report Sheet
Water Right- A4991200
Point of Diversion in SESWSE 8-9S-23E 11 (86355)



AMOUNT STATISTICS REPORT FOR POINTS OF DIVERSION UNDER A 49912 00

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AMOUNT STATISTICS REPORT FOR POINTS OF DIVERSION UNDER A 49912 00 MUN

Water Right and Points of Diversion Within 2.00 miles of point defined as:

491 Feet North and 1527 Feet West of the Southeast Corner of Section 8 T 9S R 23E

Both SURFACE WATER and GROUNDWATER

Does not meet well spacing

File Number	Use	ST	SR	Dist (ft)	Q4	Q3	Q2	Q1	FeetN	FeetW	Sec	Twp	Rng	ID	Batt	Auth_Quan	Add_Quan	Unit		
A__ 24961	00	MUN	NK	G	7336	--	NE	SE	NE	3913	12	20	9	23E	3	G	2	306.89	306.89	AF
Same					7431	--	NE	SE	NE	3816	12	20	9	23E	1	B	2			
Same					7242	--	NE	NE	NE	4009	12	20	9	23E	2	B	2			
A__ 27613	00	MUN	NK	G	1309	--	NE	SE	SW	970	2745	8	9	23E	4		5481.93	2665.51	AF	
Same					638	--	NW	SW	SE	755	2108	8	9	23E	5					
Same					710	--	SW	SE	SE	202	879	8	9	23E	7					
Same					958	--	NW	SW	SE	774	2442	8	9	23E	9					
Same					381	--	SW	SE	SE	344	1176	8	9	23E	10					
Same					1937	--	NW	NW	NW	4946	4951	16	9	23E	1					
Same					2583	--	SE	NW	NW	4608	4399	16	9	23E	2					
Same					4545	--	NE	SE	NW	3424	2819	16	9	23E	5					
Same					1378	--	--	--	--	5278	203	17	9	23E	1					
A__ 43272	00	MUN	KE	G	7237	--	SE	NW	NW	4300	4580	21	9	23E	3	G	2	767.22	767.22	AF
Same					7195	--	SW	NW	NW	4300	4725	21	9	23E	4	B	2			
Same					7281	--	SE	NW	NW	4300	4435	21	9	23E	5	B	2			
A__ 45897	00	IRR	MM	G	7917	--	SW	SE	SE	415	899	16	9	23E	7		999.00	999.00	AF	
A__ 45898	00	IRR	MM	G	5448	--	NW	SE	SW	1136	3908	16	9	23E	8		999.00	.00	AF	
A__ 47401	00	IRR	MM	G	3855	--	--	--	--	2032	1667	17	9	23E	3		716.00	.00	AF	
A__ 49912	00	MUN	AY	G	0	--	SE	SW	SE	491	1527	8	9	23E	11		637.10	637.10	AF	
A__ 49913	00	MUN	AY	S	0	--	SE	SW	SE	491	1527	8	9	23E	11		7326.10	7326.10	AF	

Applicant's MUN well field wells.

nearest well not owned by Applicant.

Total Net Quantities Authorized:	Direct	Storage
Total Requested Amount (AF) =	7963.20	.00
Total Permitted Amount (AF) =	767.22	.00
Total Inspected Amount (AF) =	.00	.00
Total Pro_Cert Amount (AF) =	999.00	.00
Total Certified Amount (AF) =	2972.40	.00
Total Vested Amount (AF) =	.00	.00
TOTAL AMOUNT (AF) =	12701.82	.00

An * after the source of supply indicates a pending application for change under the file number.
 An * after the ID indicates a 15 AF exemption was granted under the file number.
 A "G" in the Batt column indicates the GEO CTR of a battery. A "B" indicates a well in the battery.
 The number in the Batt column is the number of wells in the battery.

Water Rights and Points of Diversion Within 2.00 miles of point defined as:

491 Feet North and 1527 Feet West of the Southeast Corner of Section 8 T 9S R 23E

Both SURFACE WATER and GROUNDWATER

WATER USE CORRESPONDENTS:

File Number	Use	ST	SR	
A__ 24961	00	MUN	NK	G
>	LANSING CORRECTIONAL FACILITY			
>				
>	PO BOX 2			

> LANSING KS 66043

>-----

A__ 27613 00 MUN NK G

> CITY OF LEAVENWORTH

> WATERWORKS DEPT

> 601 CHEROKEE ST

> LEAVENWORTH KS 66048

>-----

A__ 43272 00 MUN KE G

> LANSING CORRECTIONAL FACILITY

>

> PO BOX 2

> LANSING KS 66043

>-----

A__ 45897 00 IRR MM G

> STIGERS ISLAND FARM INC

> STEVE KNETTER

> 11801 HOLLINGSWORTH RD

> KANSAS CITY KS 66109

>-----

A__ 45898 00 IRR MM G

> STIGERS ISLAND FARM INC

> STEVE KNETTER

> 11801 HOLLINGSWORTH RD

> KANSAS CITY KS 66109

>-----

A__ 47401 00 IRR MM G

> STIGERS ISLAND FARM INC

> STEVE KNETTER

> 11801 HOLLINGSWORTH RD

> KANSAS CITY KS 66109

>-----

A__ 49912 00 MUN AY G

> CITY OF LEAVENWORTH

> WATERWORKS DEPT

> 601 CHEROKEE ST

> LEAVENWORTH KS 66048

>-----

A__ 49913 00 MUN AY S

> CITY OF LEAVENWORTH

> WATERWORKS DEPT

> 601 CHEROKEE ST

> LEAVENWORTH KS 66048

>-----

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DRAFT MEMORANDUM

Kansas Department of Agriculture
Division of Water Resources

B&V Project
B&V File
March 6, 2018

Subject: Leavenworth, Kansas, Water Department – Groundwater Flow Evaluation in Support of the Water Rights Application for a New Horizontal Collector Well along the Missouri River

Purpose and Study Area

Leavenworth Water Department (LWD) is in the process of reevaluating their current and future sources of water supply and making upgrades their aging wellfield which is located along the south bank of the Missouri River to the southeast of Leavenworth as shown on Figure 1.

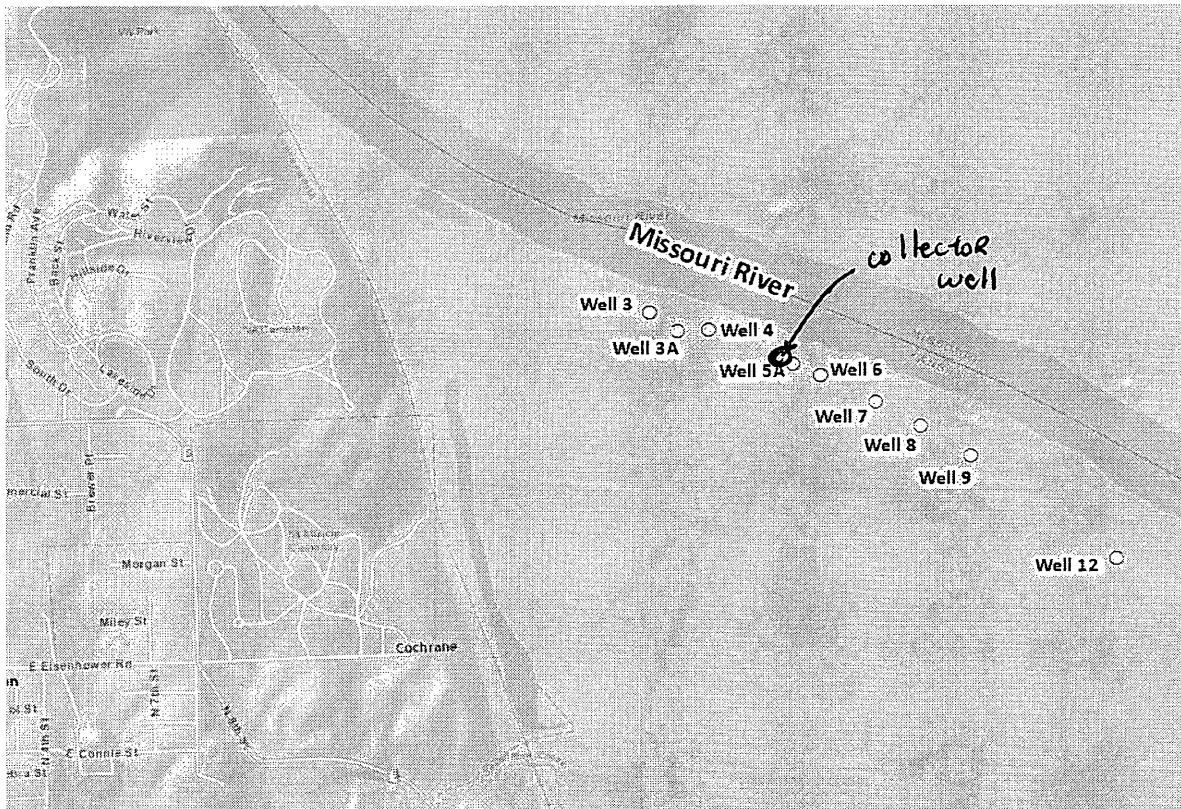


Figure 1. Existing Wellfield

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7 March 2018

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Current groundwater rights (Water Right No. 27613) for the wellfield are as follows:

- maximum diversion rate for each well pumped individually = 1050 gpm/well (1.512 mgd/well);
- maximum diversion rate with wells pumped simultaneously = 4750 gpm (6.84 mgd);
- total diversion volume = 1786.292 million gallons per calendar year (equivalent to an average annual groundwater rate of approximately 4.89 mgd).
- When combining the groundwater right at the wellfield with the 1955 surface water rights for their upstream river intake, LWD's total water rights (groundwater plus surface water) are capped at 1874.558 million gallons per calendar year, equivalent to an annual average of approximately 5.14 mgd which is approximately equal to the average annual water sales in the past 15 years (<http://www.lvnwater.com/history.html>). In 2001, this total diversion right was exceeded at 1894.648 million gallons; in 2012, the total water use of approximately 1860.109 million gallons approached the water right.

LWD is seeking additional water rights. Since the old wells are approaching the end of their useful life and since LWD may begin transitioning some of the surface water supply to the wellfield in the future, LWD is proposed to construct a new horizontal collector well (HCW) within the wellfield at the location indicated on Figure 2.

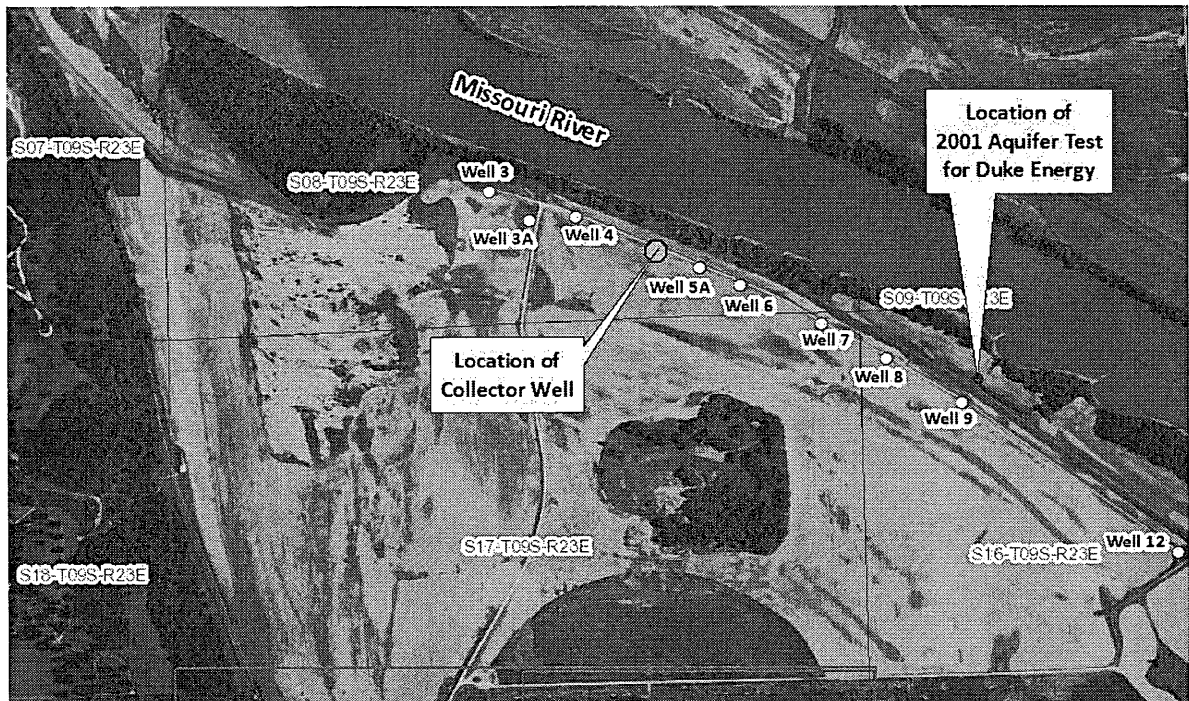


Figure 2. Proposed Horizontal Collector Well Location

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7 March 2018

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The design of a new HCW must consider the projected Year 2037 annual average and maximum day water supply of 7.11 mgd and 12 mgd, respectively. This memorandum provides documentation of a detailed groundwater-river evaluation as requested by the Division of Water Resources to supplement the water rights application for a new HCW.

Available Information

This evaluation is based on available data for the wellfield site which includes the following information:

- Kansas Geological Survey (KGS), WIZARD Water Level Database, <http://www.kgs.ku.edu/Magellan/WaterLevels/index.html>
- KGS, WIMAS Database, http://hercules.kgs.ku.edu/geohydro/wimas/query_setup.cfm
- KGS, WWC5 Well Database, <http://www.kgs.ku.edu/Magellan/WaterWell/index.html>
- LWD information for the existing wellfield
- Layne Christensen Company, 2015, *Water Supply Well Field Assessment*, prepared for the City of Leavenworth, Kansas, February.
- Malcolm Pirnie, 2001, *Collector Well Feasibility Report: Leavenworth Energy Facility*, prepared for Duke Energy Leavenworth LLC and Leavenworth Department of Water, September.
- USGS river gage data.

The 2015 Layne report and information from LWD provide information about the existing vertical wells. Each of the wells is 69 feet deep to the top of limestone bedrock, with the exception of Wells 8 and 9 which are about 79 feet deep. The diameter of each well is between 26 and 30 inches, and each well screen is 20 to 25 feet long. In general, the upper 10 feet of the alluvial sediments consist of fine grained sand, silt, and clay. The middle of the aquifer between about 10 feet and 50 feet below ground surface (bgs) is composed of sand, and the bottom 20 to 30 feet of the alluvium where the wells are screened is composed of coarser sand and gravel. The alluvial valley is approximately 2.5 miles wide at the wellfield site.

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Each existing vertical well could historically be pumped at rates of between 700 and 1000 gallons per minute (gpm); currently, each well is set to pump 695 gpm with the exception of one well that is set at 350 gpm. Specific capacity of each well has declined over time.

Figure 2 provides the location of a test well (PW-1) used in 2001 to estimate the yield of a potential HCW for a proposed power plant at that time. PW-1 was pumped for about a week at a rate of 1215 gpm. The aquifer characteristics at the site provided in the 2001 report are as follows:

- Transmissivity ~ 109,000 to 176,000 gallons per day per foot (gpd/foot)
- Saturated thickness ~ 60 feet
- Hydraulic conductivity ~ 240 to 390 feet per day (ft/d)

These hydraulic conductivities are in general agreement with the values at other municipal wellfield sites along the Missouri River. The 2001 report estimated that a HCW could yield up to 14.7 mgd for the conditions that occurred during the pumping test (July 2001, river elevation approximately 746 feet) and that more than 99 percent of the water produced by a HCW at this site would be drawn from the Missouri River into the alluvium to the well. The 2001 report indicates that a groundwater model was used to estimate that a new HCW at the PW-1 test site pumping 8 mgd would lower groundwater levels at existing Wells 9, 8, and 7 by 11.8 feet, 4.3 feet, and 1.7 feet, respectively, and mentions that there was enough available drawdown inside each of the vertical wells to accommodate this without affecting operations of the existing wells.









The KGS WIZARD database has 16 records for wells in Township 9S, Range 23E, which covers the extents of the City's existing wellfield and areas surrounding it. These 16 wells are listed in Table 1. None of these wells have water level measurements according to the database records. LWD does not have monitoring wells or a record of historical water levels at the wellfield. Therefore, the analysis relies on the aquifer hydraulic characteristics determined from the 2001 Duke Energy week-long pumping test.

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Table 1. KGS WIZARD Database – Wells in Vicinity of Existing Wellfield





WIZARD Water Well Listing





16 records currently selected. Only 50 are display at one time.
Records can be sorted ascending (asc) or descending (desc) which will affect ALL the records in the selection set.

View Records: 1-16										
Usgs ID asc desc	County asc desc	PLSS asc desc	Records asc desc	Date Range		Longitude asc desc	Latitude asc desc	Use of Site asc desc	Use of Water asc desc	Depth of Well asc desc
				Min Date	Max Date					
391516094492001	Leavenworth	09S 23E 22AC 01	0	none		-94.83269	39.254022	Unknown	Unknown	Unknown
391516094494801	Leavenworth	09S 23E 22BC 01	0	none		-94.830242	39.254446	Unknown	Unknown	Unknown
391516094500201	Leavenworth	09S 23E 21AD 01	0	none		-94.84667	39.254042	Unknown	Unknown	Unknown
391516094501601	Leavenworth	09S 23E 21AC 01	0	none		-94.85131	39.254052	Unknown	Unknown	Unknown
391516094502904	Leavenworth	09S 23E 21BD 04	0	none		-94.85594	39.254062	Unknown	Unknown	Unknown
391516094504303	Leavenworth	09S 23E 21BC 03	0	none		-94.845516	39.254446	Unknown	Unknown	Unknown
391516094505701	Leavenworth	09S 23E 20AD 01	0	none		-94.865201	39.254042	Unknown	Unknown	Unknown
391516094511101	Leavenworth	09S 23E 20AC 01	0	none		-94.869821	39.253982	Unknown	Unknown	Unknown
391516094511102	Leavenworth	09S 23E 20AC 02	0	none		-94.869821	39.253982	Unknown	Unknown	Unknown
391516094511103	Leavenworth	09S 23E 20AC 03	0	none		-94.869821	39.253982	Unknown	Unknown	Unknown
391516094523401	Leavenworth	09S 23E 19AC 01	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391516094523402	Leavenworth	09S 23E 19AC 02	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391516094523403	Leavenworth	09S 23E 19AC 03	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391516094523404	Leavenworth	09S 23E 19AC 04	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391523094513901	Leavenworth	09S 23E 21BBCD01	0	none		-94.861072	39.256391	Observation	Unknown	Unknown
391651094515301	Leavenworth	09S 23E 07DAA 01	0	none		-94.882101	39.280551	Withdrawal of Water	Unknown	69

Groundwater Model

A three-dimensional MODFLOW model of Leavenworth’s existing wellfield along the Missouri River was developed in 2016 using the Groundwater Modeling System (GMS) for the purpose of evaluating the yield of the alluvial aquifer under different climate and river conditions. Using the available information, the model development is summarized as follows:

- The alluvium is divided into an upper aquifer (to an elevation of 710 feet) and a lower aquifer (elevations 710 feet to 685 feet). Under normal conditions, the saturated thickness of the alluvial aquifer is approximately 60 feet.
- The model extends along more than 5 miles of the river between the bedrock valley walls as shown on Figure 3.

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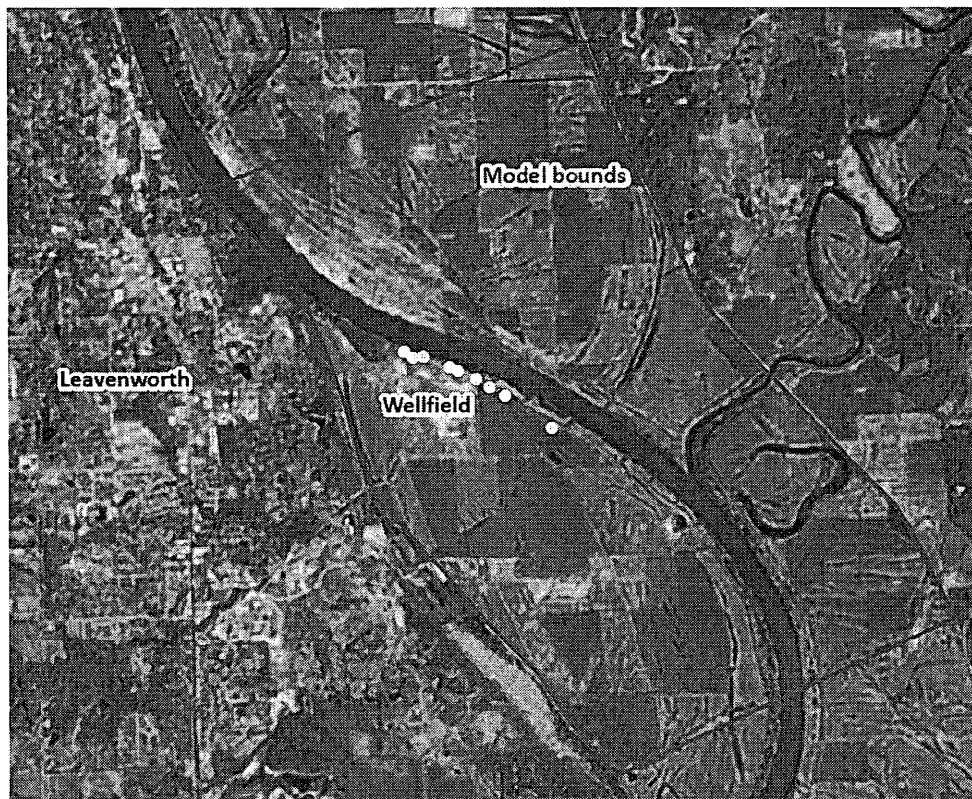


Figure 3. Model Limits

- In the deeper portion of the aquifer where the well screens are located, an average value of 300 ft/day was selected for the hydraulic conductivity of the alluvium for normal summer water temperatures based on the range of estimates from the 2001 Duke Energy report. Due to the presence of finer material at shallowing depths, it is assumed that the hydraulic conductivity of upper alluvial deposits is 250 ft/day.
- The nearest USGS river gage is located in St. Joseph. River elevations were roughly estimated at the site using the elevation reported for the July 2001 pumping test, daily historical flows at the St. Joseph gage, and river gradient provided in the 2001 report. The 2001 report indicates the river elevation was approximately 746 feet during the pumping test in the second week of July 2001. The average Missouri River flow at the St. Joseph gaging station leading up to the time of the test was about 43,000 to 44,000 cfs, which was almost equal to the median daily summertime river flow at St. Joe from 1990 to 2016 of 47,400 cfs. Therefore, it appears that the 2001 test was performed during relatively normal summer river conditions. To make sure water facilities are designed for conditions when water needs are critical, yield studies must consider drought conditions. Since the

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1960s (after construction of major dams on the Missouri River), the minimum 120-day average river flow during the summer months is 31,160 cfs from July to October of 2005. It is assumed for purposes of evaluating yield for this study that the 120-day average Missouri River elevation past the LWD wellfield during a dry summer is 740 feet.

- It is assumed that the riverbed permeability is approximately 1 ft/day based on experience with other wellfields along the Missouri River in the region.
- To conservatively account for drought conditions, the model considers a low recharge rate of 2 inches per year.
- The 2001 report provides estimates of aquifer storage coefficient of 0.0013 to 0.012, with an average reported value of 0.003. However, it is likely that the duration of the test was not long enough to establish the true specific yield of the sand and gravel alluvial aquifer which is typically on the order of about 0.15 to 0.2. For this conceptual analysis, it is assumed that the specific yield of the aquifer is 0.2.

Simulation of Current (Baseline) Groundwater Rights

Baseline conditions were simulated with the groundwater flow model for LWD's current groundwater right (No. 27613) for the existing vertical wells as follows:

- **Baseline for annual groundwater volume.** Currently authorized total diversion volume = 1786.292 million gallons per calendar year (equivalent to an average annual groundwater rate of approximately 4.894 mgd) total for the nine existing vertical wells # 3, 3A, 4, 5A, 6, 7, 8, 9, 12, with an average river elevation of 745 feet.
- **Baseline for maximum groundwater rate.** Currently authorized maximum diversion rate with wells pumping simultaneously = 4750 gpm (6.84 mgd) total for the nine existing vertical wells # 3, 3A, 4, 5A, 6, 7, 8, 9, 12, with a low river elevation of 740 feet.

The results of these baseline conditions analyses of the existing wells and current groundwater rights are shown on Figures 4 and 5.

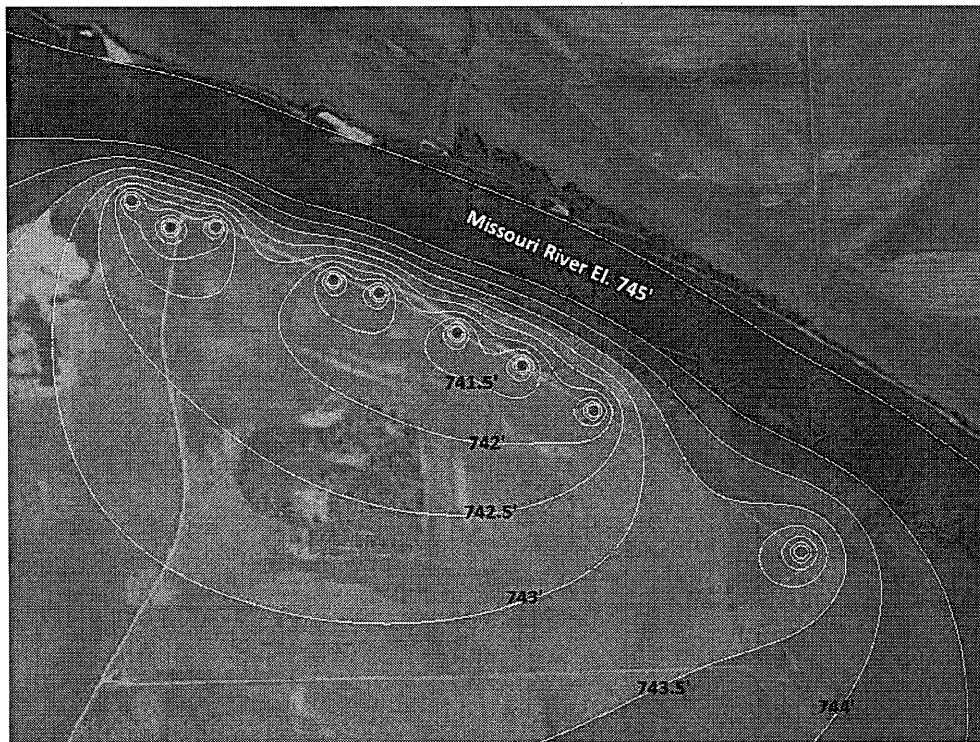


Figure 4. Baseline, Existing Wells, Current Annual Groundwater Rights, Normal River Condition, Steady-State Simulation

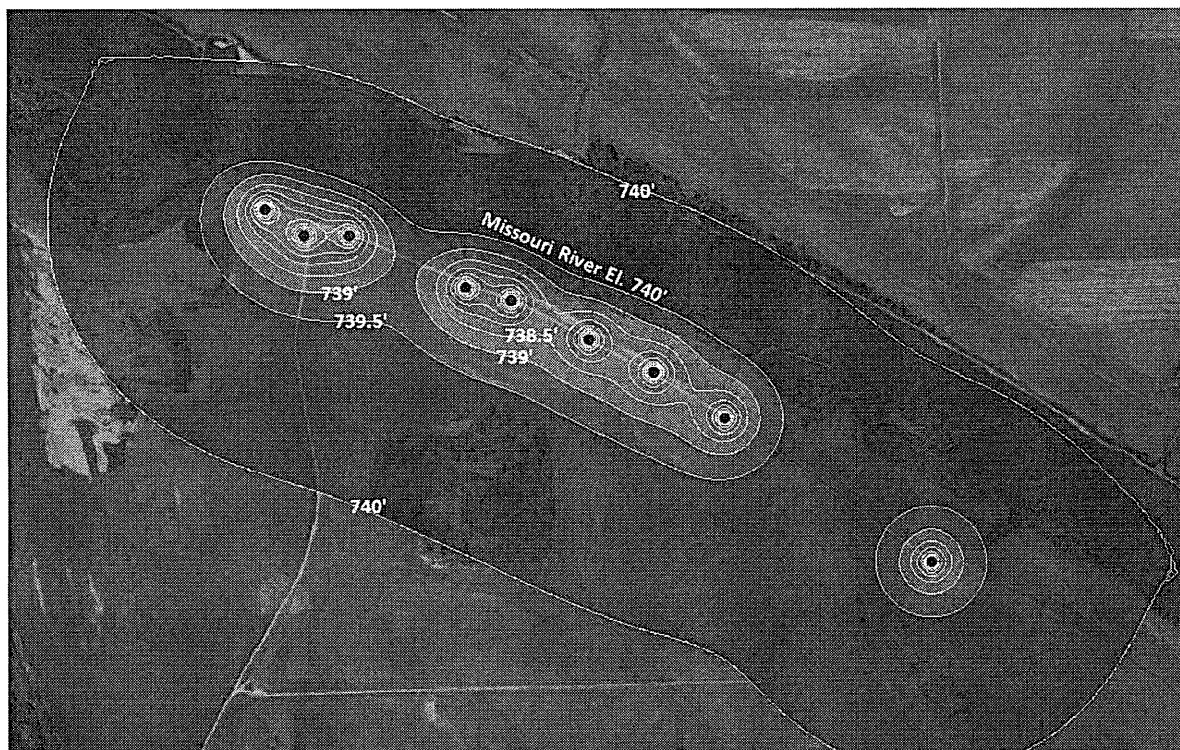


Figure 5. Baseline, Existing Wells, Current Maximum Rate Groundwater Rights, Low River Condition, 60th Day of Transient Simulation

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Sensitivity Analyses for Baseline Conditions

A sensitivity analysis was performed using the steady-state baseline conditions model. The river elevation was left at 745 ft and the total pumping rate from the existing wells was left at 4.894 mgd for these sensitivity analyses. The effect on groundwater levels was compared at the same location for all simulations. The results are as follows:

- Reduce horizontal hydraulic conductivity by 25%. A reduction in the hydraulic conductivity of 25 percent results in a reduction in groundwater levels near the middle of the wellfield of 0.7 ft.
- Reduce vertical hydraulic conductivity by 25%. A reduction in the hydraulic conductivity of 25 percent results in a reduction in groundwater levels near the middle of the wellfield of less than 0.1 ft.
- Reduce recharge by 25%. A reduction in recharge of 25 percent results in a reduction in groundwater levels near the middle of the wellfield of less than 0.1 ft.
- Reduce riverbed conductance by 25%. A reduction in riverbed conductance of 25 percent results in a reduction in groundwater levels near the middle of the wellfield by 0.1 ft.

These sensitivity analyses indicate that changes to the horizontal hydraulic conductivity of the alluvium has a much larger effect on the groundwater conditions within the wellfield than other parameters. Since the 2001 Duke Energy study included a week-long detailed aquifer test to determine the horizontal hydraulic conductivity of the aquifer, the confidence of this input parameter is high.

Proposed Steady-State Conditions

To evaluate proposed conditions, the baseline conditions steady-state model was modified by shutting off the 9 existing wells and adding the proposed HCW at the target average annual rate of 7.11 MGD. The simulated groundwater levels are provided on Figure 6. Figure 7 shows the difference in groundwater levels between the proposed and baseline conditions for steady-state with normal river levels. The KGS WWCS database was used to search for other production wells (excluding wells with the following designation or status: 'Monitoring well/observation/piezometer', 'Dewatering', 'Plugged') in Township 9S, Range 23E in and around the existing wellfield. Figure 8 shows the locations of other known production wells in the area, showing there are no known wells within a half-mile of the proposed HCW site. The model shows essentially no change in steady-state groundwater levels near the Lansing Correctional Facility wells, and an estimated decrease in steady-state groundwater levels near the Stigers Island Farm well of about -0.5 ft.

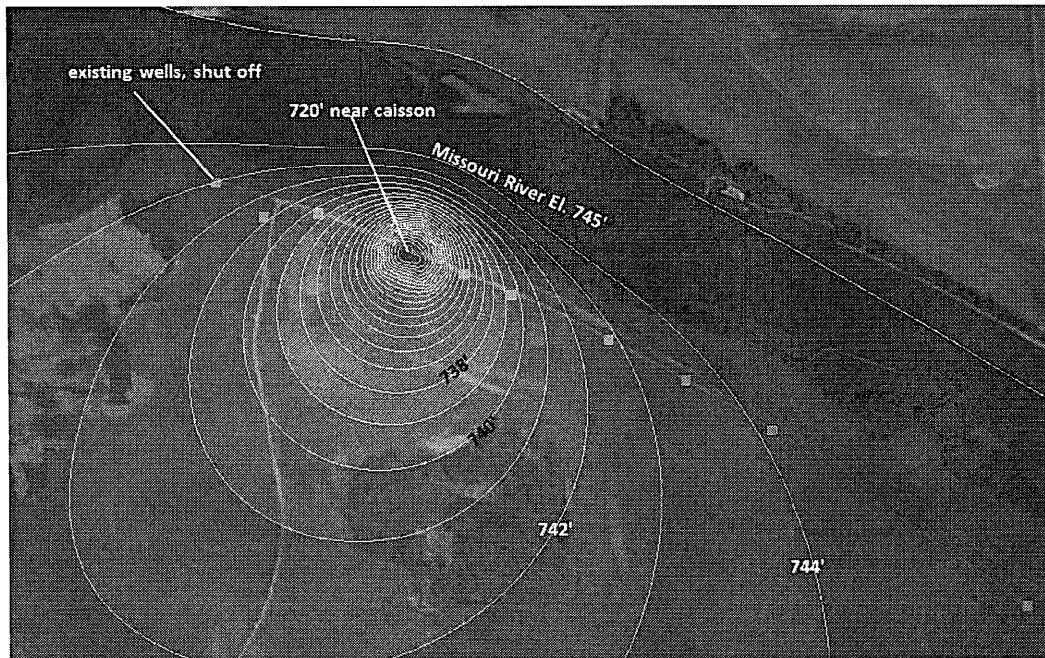


Figure 6. Proposed HCW at 7.11 MGD, Normal River Level, Steady-State Simulation

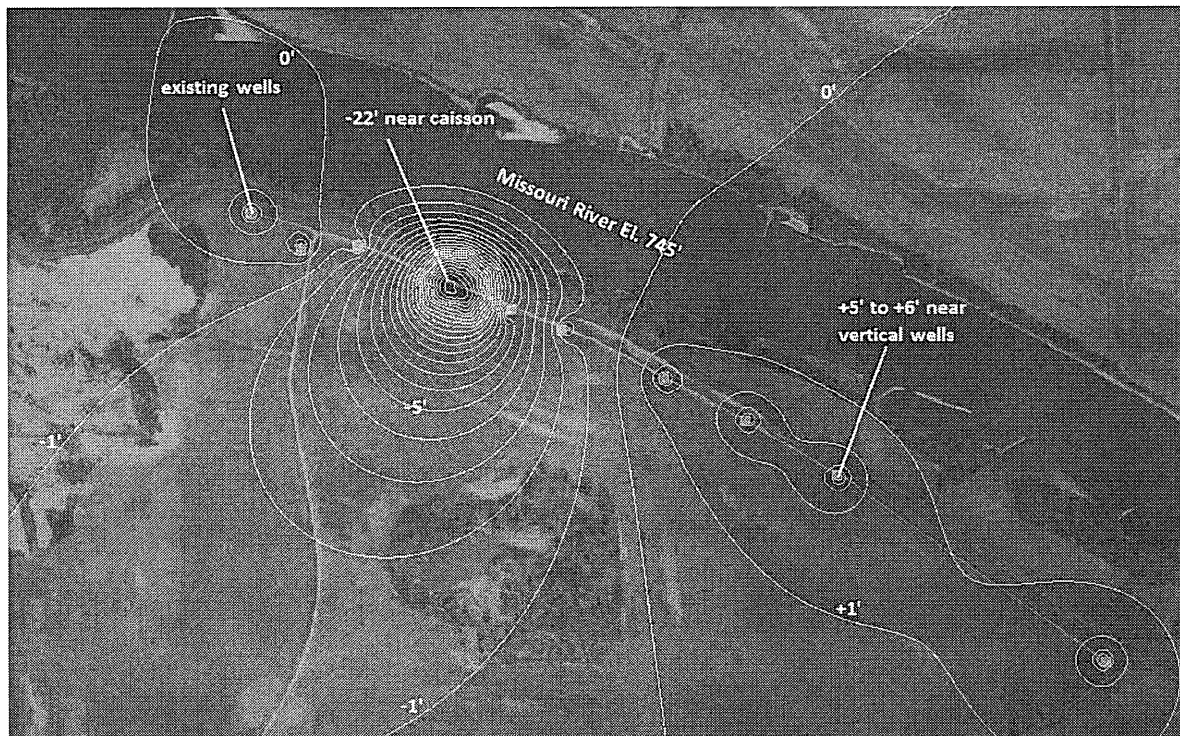


Figure 7. Steady-State Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells

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7 March 2018

Division of Water Resources

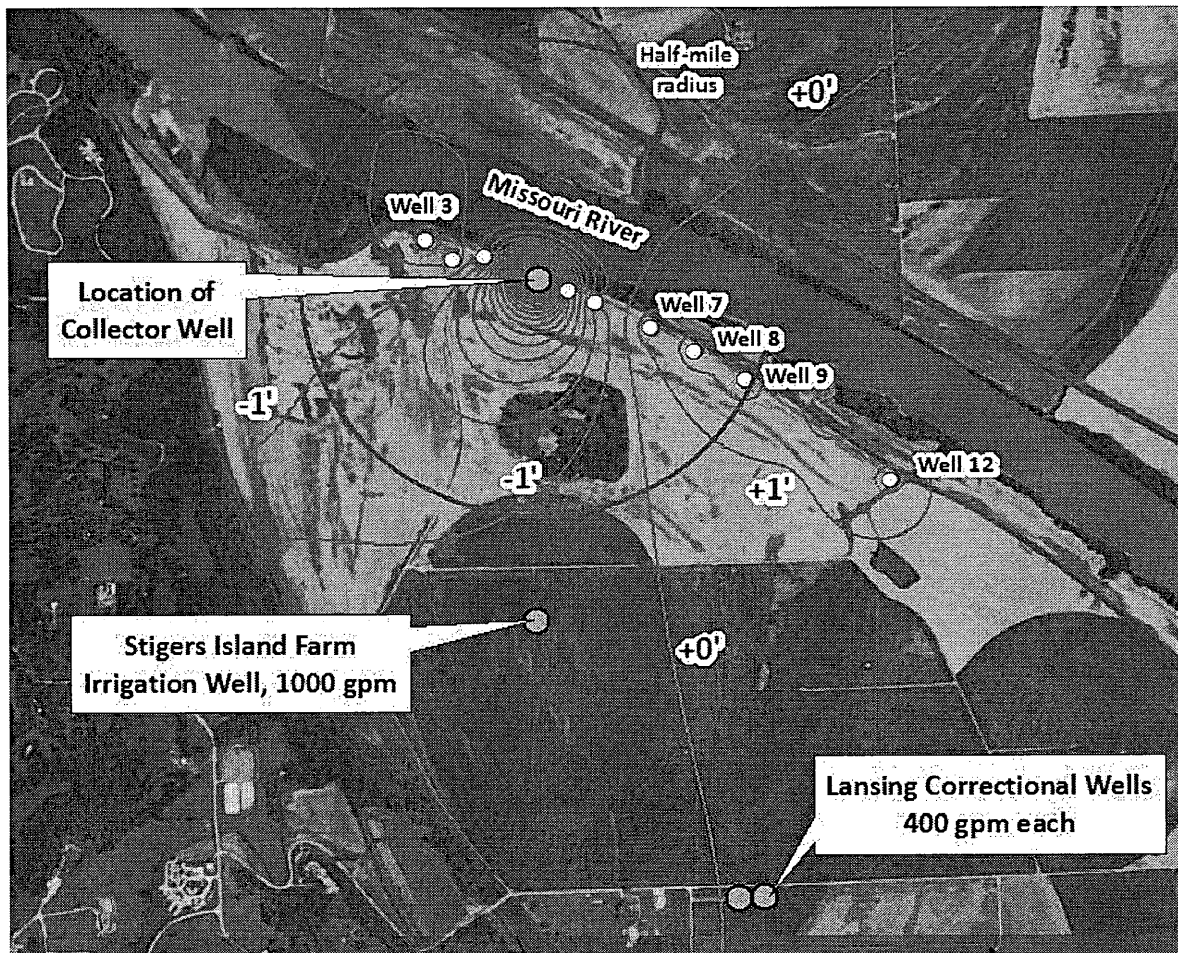


Figure 8. Steady-State Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells, in Relation to Known Wells in the Area

The alluvial aquifer water budget near the HCW is as follows:

- Inflow:
 - River = 6.61 MGD
 - Recharge = 0.29 MGD
 - Groundwater underflow from distant areas = 0.29 MGD
- Outflow:
 - HCW = 7.11 MGD
 - River = 0.05 MGD
 - Specified head = 0.02 MGD
 - Groundwater underflow to distant areas = 0.01 MGD

The net river contribution to the HCW is approximately 92 percent for the steady-state condition with a normal river level.

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Proposed 60-day Transient Conditions

To evaluate the proposed maximum production, the baseline conditions 60-day transient model was modified by shutting off the 9 existing wells and adding the proposed HCW at the maximum target rate of 12 MGD. The simulated groundwater levels are provided on Figure 9. Figure 10 shows the difference in groundwater levels between the proposed and baseline conditions on the 60th day with low river levels. The KGS WWC5 database was used to search for other production wells (excluding wells with the following designation or status: 'Monitoring well/observation/piezometer', 'Dewatering', 'Plugged') in Township 9S, Range 23E in and around the existing wellfield. Figure 11 shows the locations of other production wells in the area, showing there are no known wells within a half-mile of the proposed HCW site. The model shows essentially no change in groundwater levels near the Lansing Correctional Facility wells, and a decrease in groundwater levels near the Stigers Island Farm well of about -0.5 ft.

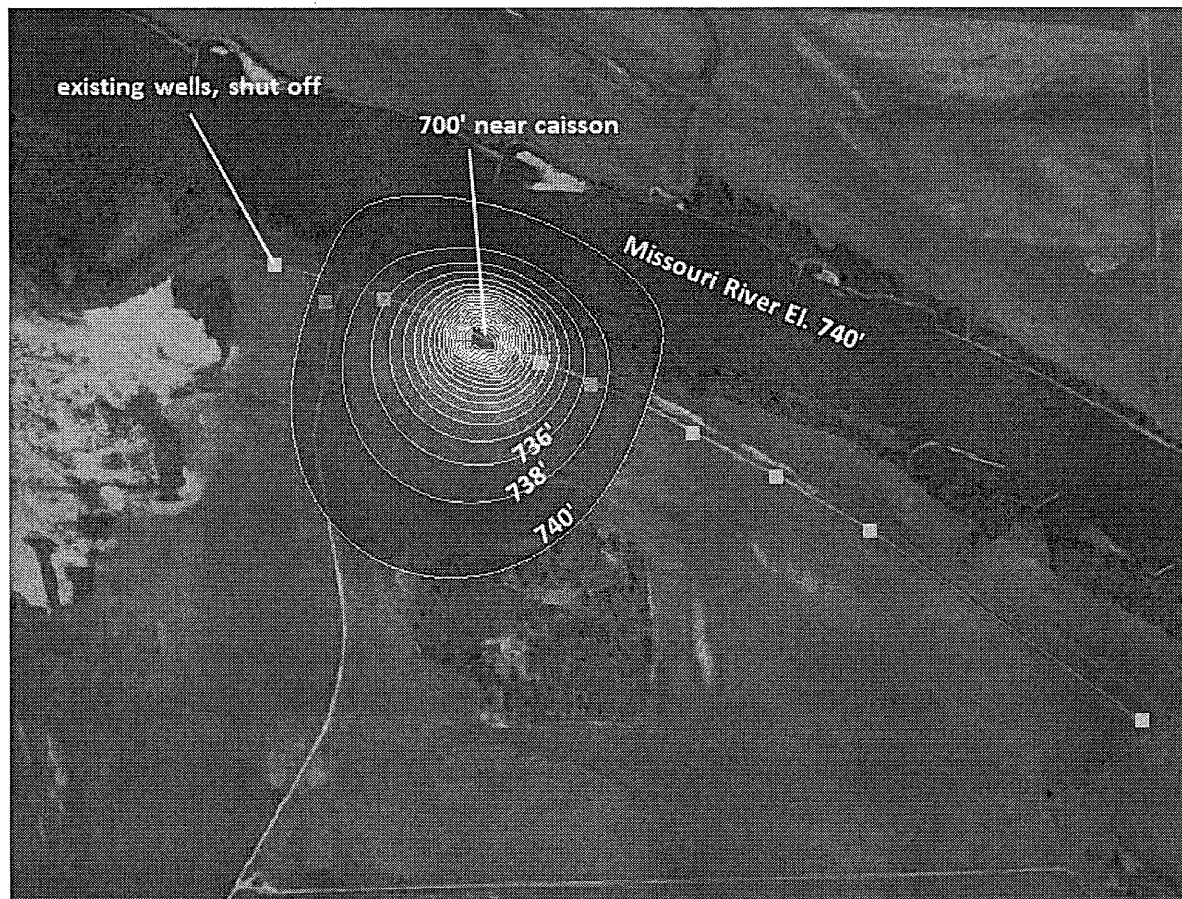


Figure 9. Proposed HCW at 12 MGD, Low River Level, 60th Day of Transient Simulation

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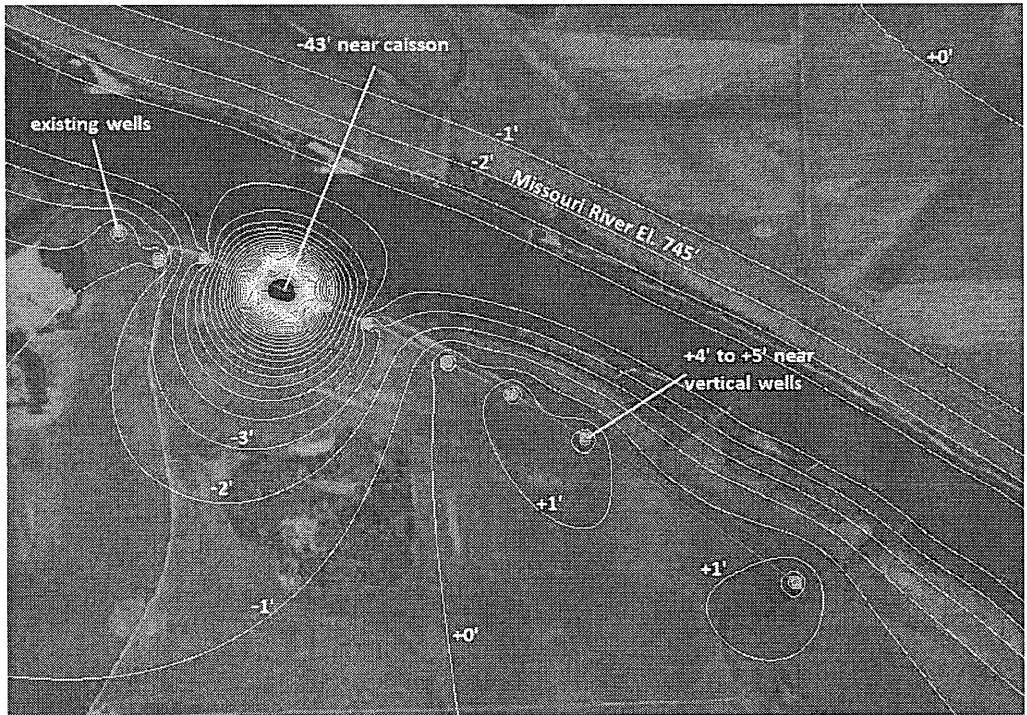


Figure 10. Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells on 60th Day of Transient Simulation with Low River Level

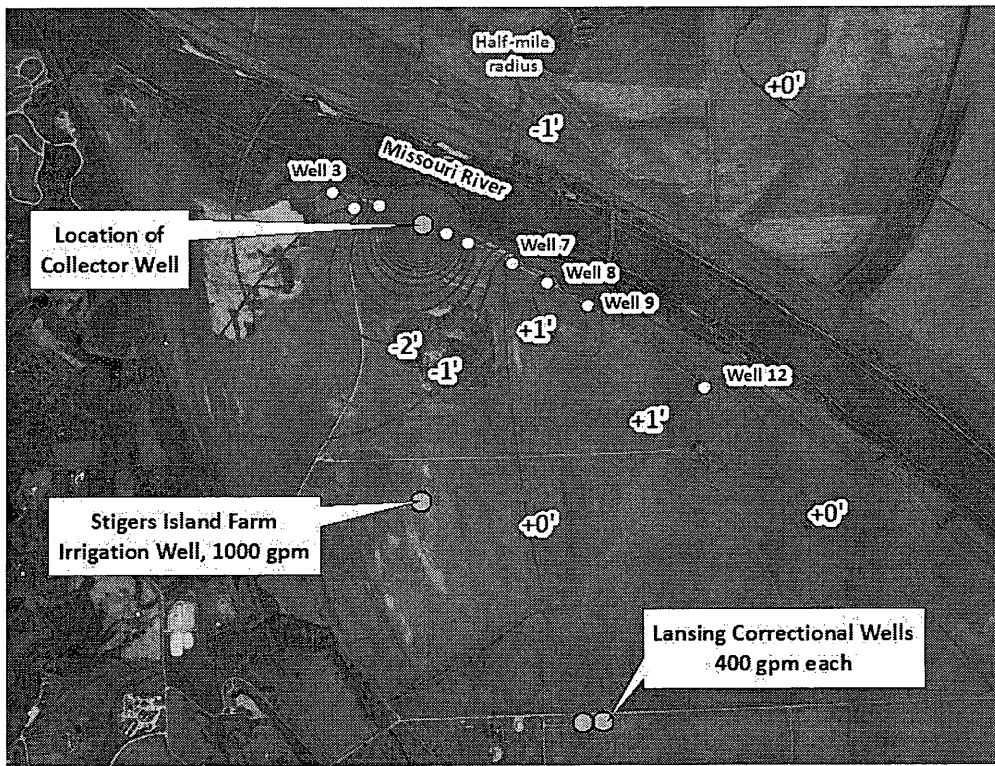


Figure 11. Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells on 60th Day of Transient Simulation with Low River Level, in Relation to Known Wells in the Area

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As expected for a HCW as river levels decline and well production increases to meet demands during dry weather conditions, the alluvial aquifer water budget for the model indicates the HCW begins to draw groundwater levels farther below the river level, temporarily tapping both groundwater storage and inducing more recharge from the river into the aquifer. The alluvial aquifer water budget near the HCW for transient conditions with a low river level is as follows:

- Inflow:
 - River = 6.59 MGD
 - Recharge = 0.29 MGD
 - Groundwater underflow from distant areas = 0.97 MGD
 - Specified head = 0.17 MGD
- Outflow:
 - HCW = 12 MGD
 - River = 0.53 MGD
 - Groundwater underflow to distant areas = 0.15 MGD

Assuming the inflow from the specified head boundary is part of the net groundwater underflow from distant areas, the 12 MGD of maximum HCW production is met by the following on a short-term basis: 39 percent from aquifer storage, 51 percent from the river, 8 percent from distant groundwater underflow, and 2 percent from recharge. In reality, the percentages are in a constant state of flux depending on continuous changes in recharge conditions, riverbed conditions, channel location, river and groundwater temperatures, river and groundwater levels, and well production driven by daily demands.

Effect on Missouri River Flow

As noted previously in this report, the historical median Missouri River flow at St. Joseph in recent decades is approximately 47,400 cfs (~30,600 MGD). The induced river recharge of about 6.1 to 6.5 MGD to the proposed collector well is about 0.02 percent of the median historical river flow. The lowest daily river flow of 4600 cfs occurred in February of 1989; assuming this reading was not affected by ice at the gage, the induced river recharge to the proposed HCW would be approximately 0.2 percent of river flow that day. The average of the 100 lowest daily river flows on record is approximately 11,000 cfs; the induced river recharge to the proposed HCW would be approximately 0.09 percent of this value.

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Initial Conditions after Collector Well Installation

The proposed conditions described above match the requested water rights as provided in the applications that were submitted to DNR for the new HCW, which are based on the projected amount of water that will need to be pumped from the well in Year 2037. When the HCW is initially placed into service, several existing vertical wells near the HCW will need to be taken out of service immediately, while other vertical wells located farther away from the HCW will likely remain in service for a number of years until they reach the end of their useful life. With this in mind, DWR requested another analysis of this initial period when both the new HCW and some of the vertical wells are operating in order to evaluate the potential effects of the new well on the existing groundwater rights (Water Right No. 27613). Based on correspondence with DWR, this simulation includes the following:

- Three vertical wells nearest the HCW (Wells 4, 5A, and 6) were removed from service. Well 5A is immediately adjacent to the proposed HCW location and will need to be abandoned. Wells 4 and 6 are both approaching the end of their useful life according to a recent study of specific capacities at the wellfield and are relatively close to the location of the HCW.
- The existing groundwater right of 1786.292 million gallons per year (MG/yr) was applied to the 6 remaining vertical wells (Wells 3, ^{3A}~~6~~, 7, 8, 9, and 12), for an average of 566 gpm per well on a steady-state basis, which is within the current maximum rate of 1050 gpm per well defined in Water River No. 27613.
- With the vertical wells running at the current right of 1786.292 MG/yr (equivalent to an annual average of 4.894 MGD), the collector well was simulated at an initial pumping rate of 7.11 MGD (the ultimate average annual demand projected for Year 2037) minus 4.894 MGD, equal to 2.22 MGD.

The model indicates that the new HCW would reduce groundwater levels near existing vertical well by a range of between 0.15 foot (near Well 12) and 1.2 feet (near Well 3A). These reduced water levels remain about 20 to 25 feet above the tops of the existing vertical well screens, allowing for a significant margin of safety to account for near-well head losses as groundwater approaches and enters each of the well screens. Another simulation was performed by removing 5 wells from services (Wells 3, 4, 6, and 7 which were identified with the lowest specific capacity in recent years and approaching the end of their useful life, along with Well 5A immediately adjacent to the selected location of the HCW) and pumping the remaining 4 wells (Wells 3A, 8, 9, and 12) at the current groundwater right of 1786.292 MG/year, while pumping the HCW at

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2.22 MGD. This simulation shows the groundwater levels near the vertical wells remains more than 20 feet above the tops of the well screens, allowing a significant margin of safety to account for near-well head losses.

In addition, both of these simulations include an additional margin of safety because it is highly unlikely that the wellfield (vertical wells + new HCW) will be immediately pumped at the projected 2037 average annual rate of 7.11 MGD¹ when the HCW is initially placed into service. For example, in the first year after the HCW is constructed, if the vertical wells are initially pumped at the current groundwater right of 1786.292 MG/yr (equivalent to an annual average of 4.894 MGD) and since the North surface water intake will still be in operation, the new HCW would initially be pumped at a lower rate than 2.22 MGD, resulting in less impact on groundwater levels at the existing vertical wells than simulated here.

¹ The projected 2037 average annual rate of 7.11 MGD accounts for the transition of water production from the City's North surface water plant to the wellfield, retirement of vertical wells, and growth in demands at the end of the 20-year planning horizon, as opposed to immediately when the HCW is placed into service.

Schemm, Doug [KDA]

From: Pugh, Ginger [KDA]
Sent: Monday, February 5, 2018 11:15 AM
To: Schemm, Doug [KDA]
Cc: Tietsort, Katie [KDA]
Subject: FW: Leavenworth wellfield information

Hi Doug,

I have reviewed the modeling summary report (*Leavenworth, Kansas, Water Department – Groundwater Flow Evaluation in Support of the Water Rights Application for a New Horizontal Collector Well along the Missouri River, February 2, 2018*) and study support document (*Collector Well Desktop Study Report, November 7, 2016*) provided by the Leavenworth Water District through B&V Water in regards to the new application for a collector well under water rights 49,912 (groundwater) and 49,913 (surface water). The summary document covers all of the information DWR requires related to collector well modeling. The split between groundwater and surface water contributions, drawdown descriptions and the support document provides sufficient information related to change from current conditions with vertical wells to the proposed horizontal collector well. It is noted that under maximum pumping conditions (12 MGD), the water level at the horizontal collector well will drop significantly, it is expected that the horizontal collector well will be drilled deep enough to fully utilize the saturated thickness -drawdowns at nearby wells (Stigers Island Farm and Lansing Correctional) under this maximum scenario were not significantly different from initial conditions.

A copy of both documents will need to be put in the file and DocuWare for these rights.

Thanks,
Ginger E. Pugh
Engineering Associate
Kansas Department of Agriculture
Division of Water Resources
(785) 564-6677

From: Pugh, Ginger [KDA]
Sent: Monday, February 5, 2018 8:11 AM
To: 'Hahn, Kristopher (Kris)' <HahnK@bv.com>; Schemm, Doug [KDA] <Doug.Schemm@ks.gov>
Cc: Joel Mahnken <JMahnken@lvnwater.org>; Hansen, Andrew J. <HansenAJ@bv.com>
Subject: RE: Leavenworth wellfield information

Kristopher,

I received the summary, will review and let you know if I have questions.

Thanks,
Ginger E. Pugh
Engineering Associate
Kansas Department of Agriculture
Division of Water Resources
(785) 564-6677

From: Hahn, Kristopher (Kris) [<mailto:HahnK@bv.com>]
Sent: Monday, February 5, 2018 8:04 AM

Tietsort, Katie [KDA]

From: Schemm, Doug [KDA]
Sent: Monday, February 5, 2018 8:08 AM
To: Tietsort, Katie [KDA]
Subject: FW: Leavenworth wellfield information
Attachments: Leavenworth - DWR requested modeling to support water rights application feb 5 2018.docx

FYI.

From: Hahn, Kristopher (Kris) [mailto:HahnK@bv.com]
Sent: Monday, February 5, 2018 8:04 AM
To: Schemm, Doug [KDA] <Doug.Schemm@ks.gov>; Pugh, Ginger [KDA] <Ginger.Pugh@ks.gov>
Cc: Joel Mahnken <JMahnken@lvnwater.org>; Hansen, Andrew J. <HansenAJ@bv.com>
Subject: RE: Leavenworth wellfield information

Doug/Ginger,

Please see the attached file summarizing the requested items detailed in the email below, to go along with the report, model, and applications sent last fall, and let me know if you have questions.

Thank you,

Kristopher Hahn, P.E. | B&V Water

Black & Veatch Corporation

913-458-3213

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From: Pugh, Ginger [KDA]
Sent: Wednesday, January 10, 2018 3:49 PM
To: kirmsell@bv.com
Cc: Schemm, Doug [KDA] <Doug.Schemm@ks.gov>
Subject: RE: Leavenworth wellfield information

Hello Kristopher,

As part of the review on the collector wells for Leavenworth Water Department Water Rights 49,912 and 49,913, KDA-DWR will need a summary relative to the collector well modeling that includes the following:

1. Base-model summary
 - a. Construction
 - b. Calibration
 - c. Sensitivity testing
2. Summary of modeling of the aquifer and stream system around the proposed well
 - a. Impacts on streamflow in the river
 - b. Drawdowns at existing wells resulting from the addition of the proposed collector well
 - c. Aquifer-river interaction
3. Modeling results should include:
 - a. Simulated groundwater levels for steady-state runs
 - b. Simulated groundwater levels at the end of a 60-day transient model run
 - c. Simulated drawdown at the end of a 60-day transient model run
 - d. Water budget for the average (steady-state) and dry (transient) conditions

- e. Percent of groundwater and surface water expected to contribute to production flow for each pumping condition simulated (i.e. average, dry)
- f. Amount of drawdown impact expected (Note that if modeling work is being completed to also show impacts to nearby wells from the operation of the collector well, the modeling needs to show the impacts at each well).

Let me know if you have any questions related to these items.

Thanks,
Ginger E. Pugh
Engineering Associate
Kansas Department of Agriculture
Division of Water Resources
(785) 564-6677

Dear User,

Doug, please see if this link works for you. The password is leavks

1. File: Collector Well Desktop Study Report - Final Draft_110716.zip

Link: https://u1860534.ct.sendgrid.net/wf/click?upn=IQCJQb1-2FWfpCiSoS9KPJhjRXIPcQboQmX9snal6ZqRAewvsoNbyXxscvx5HpqlRvD49-2F-2BiMkuaLOsO7d4Wl6nC9EMJCF7gwSTfc70DUx8OY-3D_ZwrSj8s5mF6g1PRIj-2FgNEhYMMEO-2FTLvb432cM-2BR4XtK5kbPsVlawGMmwB-2Fe8n2Jdvignr-2FVudrMvWFOeGRYd44EHekIOy29QVzjACfsIfZRIOUv7US0XQ-2FeDE6rJUij7eRqBgXAhtGd0D1HVGUMY6tjgSQfholoZutjmZqXlbgemMrm9YFxBp27-2BcJceBZO66U6Mfg9-2FFfXCI3bojaQ-2BmptUU-2BiUQE3TVgqzQdBI7jVqbokaMI3oHTmkVUE7uli



MEMORANDUM

Leavenworth Water
Water Supply

B&V Project 195857
B&V File
June 27, 2017

**Subject: Surface Water and Groundwater Percentages
for the Proposed Horizontal Collector Well**

Purpose

Leavenworth Water has recently submitted applications to the Kansas Department of Agriculture, Division of Water Resources (DWR) for new water appropriations from a proposed horizontal collector well to be constructed along the Missouri River. One application is submitted for the portion of water that is considered surface water (induced directly from the river by the collector well), and one application is submitted for the portion of water that is considered groundwater (such as groundwater underflow from the aquifer on the landward side of the collector well, groundwater underflow beneath the river, and direct precipitation recharge). This memorandum provides the basis for determining the percentages of surface water and groundwater being requested in the two applications.

Groundwater Flow Model

A conceptual three-dimensional groundwater flow model was developed in 2016 for Leavenworth for the purposes of evaluating the yield of the City's wellfield at the location shown on Figure 1. The Groundwater Modeling System (GMS, Version 10.0.5), which serves as a pre- and post-processor for the US Geological Survey's MODFLOW program, was used to develop the model of the Missouri River alluvial aquifer located to the southeast of the City of Leavenworth. The extents of the groundwater model along about 5.3 river miles are indicated on Figure 2.

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B&V Project 195857

27 June 2017

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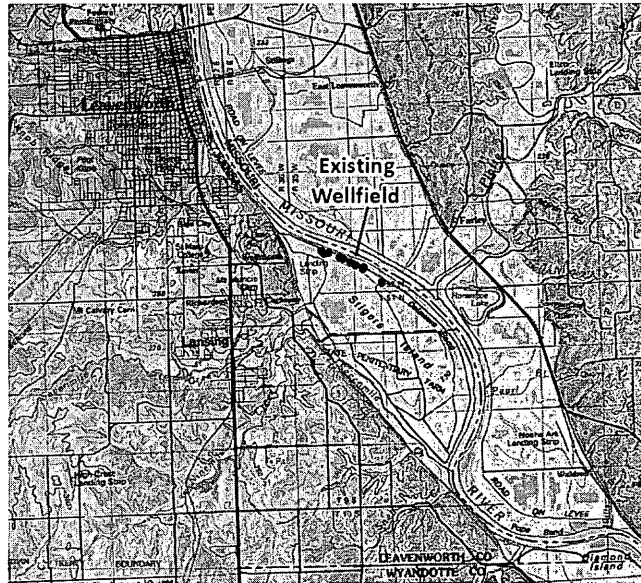


Figure 1. Existing Wellfield Location

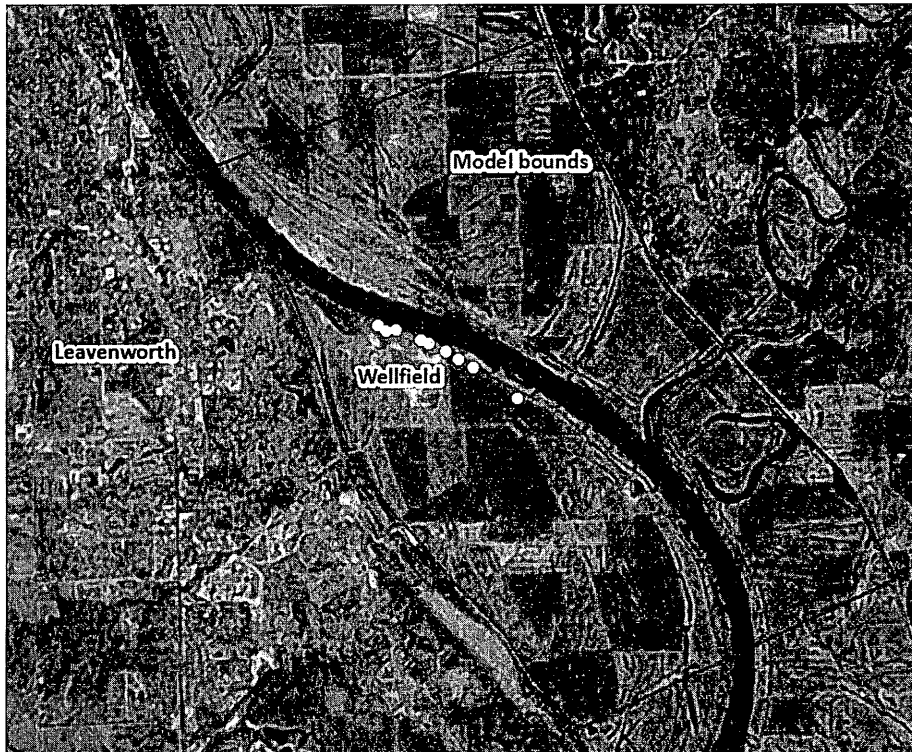


Figure 2. Model Bounds

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Groundwater Model Results

The model was used to simulate the estimated Year 2037 average annual water needs of 7.11 million gallons per day (MGD) on a steady-state basis during normal river conditions. Figure 3 shows how the aquifer was divided into zones to give the ability to analyze the contributing sources of water to the collector well (additional model zones were created, however, these particular zones provide the most important water budget information from the model). These zones represent the upper alluvial deposits that are hydraulically connected with the river.

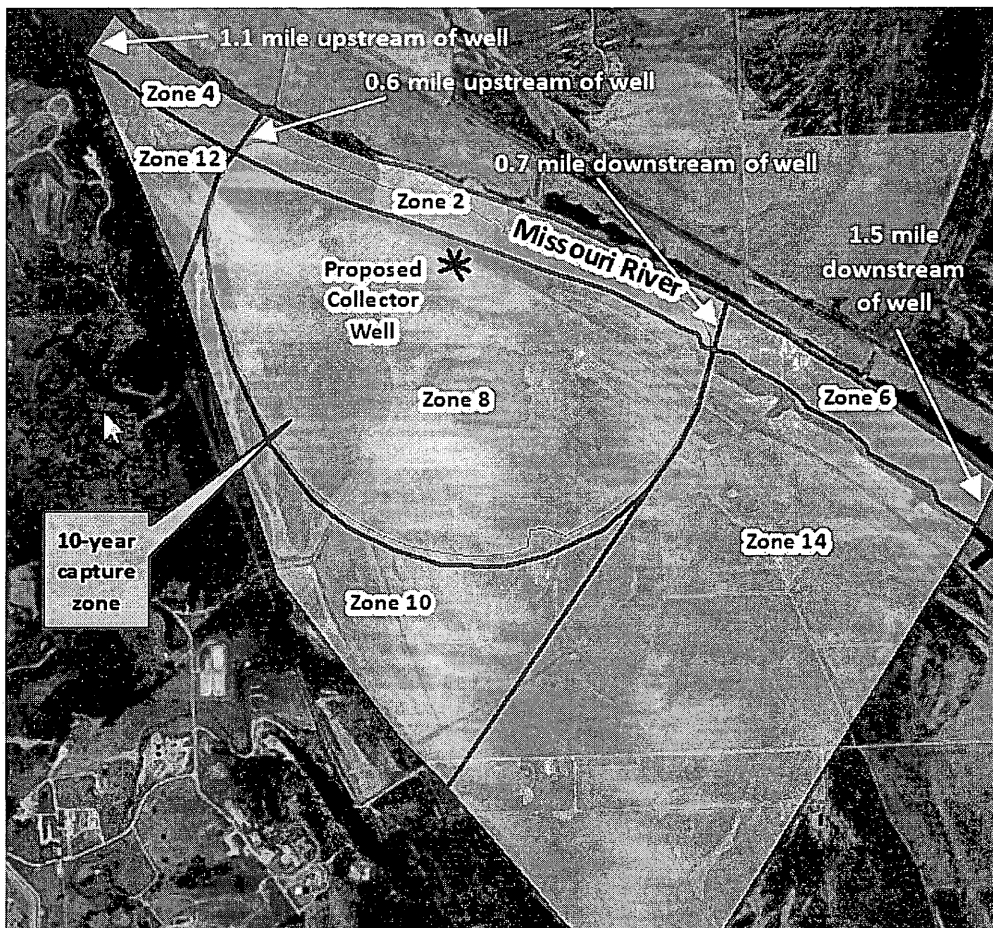


Figure 3. Zones for Water Budget Evaluation

The 10-year capture zone for the well, indicated by the light blue shading on the figure, gives an indication of the portions of the river and aquifer that contribute the greatest amount of water to the well. Figure 4 provides the resulting groundwater heads surrounding the well at 7.11 MGD.

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27 June 2017

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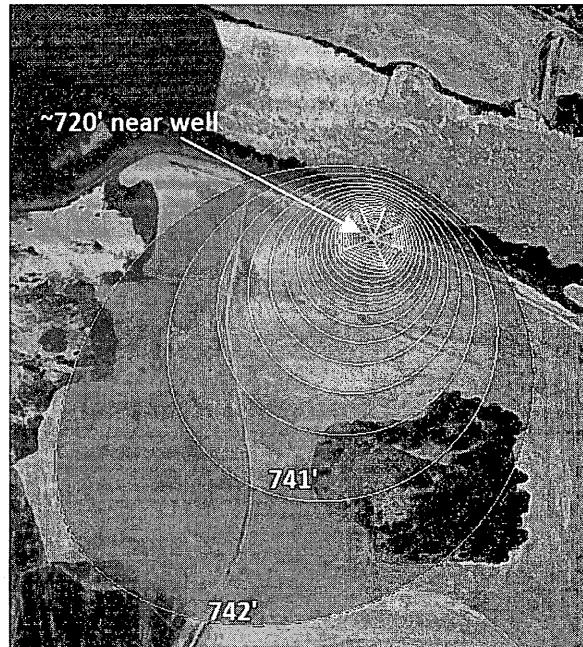


Figure 4. Resulting Steady-State Groundwater Elevations

The model results indicate the collector well induces water from the river into each alluvial aquifer zone as follows:

- Zone 2 = 6.09 MGD
- Zone 8 = 0.35 MGD
- Zone 4 = 0.066 MGD
- Zone 6 = 0.03 MGD
- Zone 14 = 0.0065 MGD
- Zone 12 = 0.0041 MGD
- Total = 6.55 MGD, or approximately 92 percent of the total pumping rate of 7.11 MGD¹

The steady-state model output is provided in Attachment 1. For sections of the river located upstream and downstream of the zones indicated on the figure, the model results indicate the river returns to a gaining stream. The remaining 8 percent of flow to the collector well comes from groundwater in the aquifer on the landward side of the well, groundwater underflow beneath the river from the north, and direct precipitation recharge to the valley.

¹ For the collector well, the applications for surface water and groundwater appropriations request 92% and 8%, respectively, of 7.11 MGD (equivalent to 7326.61 acre-feet per year for surface water and 637.10 acre-feet per year for groundwater).

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Attachment 1

Steady-State Model Output in cubic feet per day

Zone Zone

Budget Term	Flow (ft ³ /d)	Budget Term	Flow (ft ³ /d)
Flow Budget for Zone 2		Flow Budget for Zone 4	
IN:		IN:	
CONSTANT HEAD	0.0	CONSTANT HEAD	0.0
WELLS	0.0	WELLS	0.0
RIVER LEAKAGE	816708.76429071	RIVER LEAKAGE	10770.746313737

Zone Zone

Budget Term	Flow (ft ³ /d)	Budget Term	Flow (ft ³ /d)
Flow Budget for Zone 6		Flow Budget for Zone 8	
IN:		IN:	
CONSTANT HEAD	0.0	CONSTANT HEAD	0.0
WELLS	0.0	WELLS	0.0
RIVER LEAKAGE	12493.065901589	RIVER LEAKAGE	46751.797939416

Zone Zone

Budget Term	Flow (ft ³ /d)	Budget Term	Flow (ft ³ /d)
Flow Budget for Zone 12		Flow Budget for Zone 14	
IN:		IN:	
CONSTANT HEAD	0.0	CONSTANT HEAD	0.0
WELLS	0.0	WELLS	0.0
RIVER LEAKAGE	549.78358056396	RIVER LEAKAGE	863.5699189892

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1320 Research Park Drive
Manhattan, Kansas 66502

Jackie McClaskey, Secretary

Phone: (785) 564-6700
Fax: (785) 564-6777
Email: ksag@kda.ks.gov
www.agriculture.ks.gov
Sam Brownback, Governor

September 27, 2017

FILE COPY

LEAVENWORTH WATER
601 CHEROKEE
LEAVENWORTH KS 66048

RE: Application
File No. 49912

Dear Sir or Madam:

Your application for permit to appropriate water in 8-9S-23E in Leavenworth County, was received and has been assigned the file number noted above.

As a matter of record, the Division of Water Resources has on hand a large number of applications awaiting processing. Therefore to be fair to all concerned, and so that we can process those applications on hand in the order they were received, we intend to concentrate on the backlog of applications until the issue is resolved. Once review of your application has begun, we will contact you, if additional information is required.

In accordance with the provisions of the Kansas Water Appropriation Act, a portion of which is included below, the use of water as proposed prior to approval of the application is unlawful. Once approved, compliance with the terms, conditions and limitations of the permit is necessary. Conservation of the water resources of Kansas is required.

Section 82a-728 of the Kansas Water Appropriation Act, provides (a) except for the appropriation of water for the purpose of domestic use, . . . it shall be unlawful for any person to appropriate or threaten to appropriate water from any source without first applying for and obtaining a permit to appropriate water in accordance with the provisions of the Water Appropriation Act or for any person to violate any condition of a vested right, appropriation right or an approved application for a permit to appropriate water for beneficial use.

(b) (1) The violation of any provision of this section by any person is a class C misdemeanor . . .

A class C misdemeanor is punishable by a fine not to exceed \$500 and/or a term of confinement not to exceed one month in the county jail. Each day that the violation occurs constitutes a separate offense.

If you have any questions, please contact me at (785) 564-6645. If you wish to discuss a specific file, please have the file number ready so that we may help you more efficiently.

Sincerely,

Kristen A. Baum
New Applications Unit Supervisor
Water Appropriation Program

BAT: dlw
pc: TOPEKA Field Office
GMD

SCANNED

DRAFT MEMORANDUM

Kansas Department of Agriculture
Division of Water Resources

B&V Project
B&V File
February 2, 2018

Subject: Leavenworth, Kansas, Water Department – Groundwater Flow Evaluation in Support of the Water Rights Application for a New Horizontal Collector Well along the Missouri River

Purpose and Study Area

Leavenworth Water Department (LWD) is in the process of reevaluating their current and future sources of water supply and making upgrades their aging wellfield which is located along the south bank of the Missouri River to the southeast of Leavenworth as shown on Figure 1.

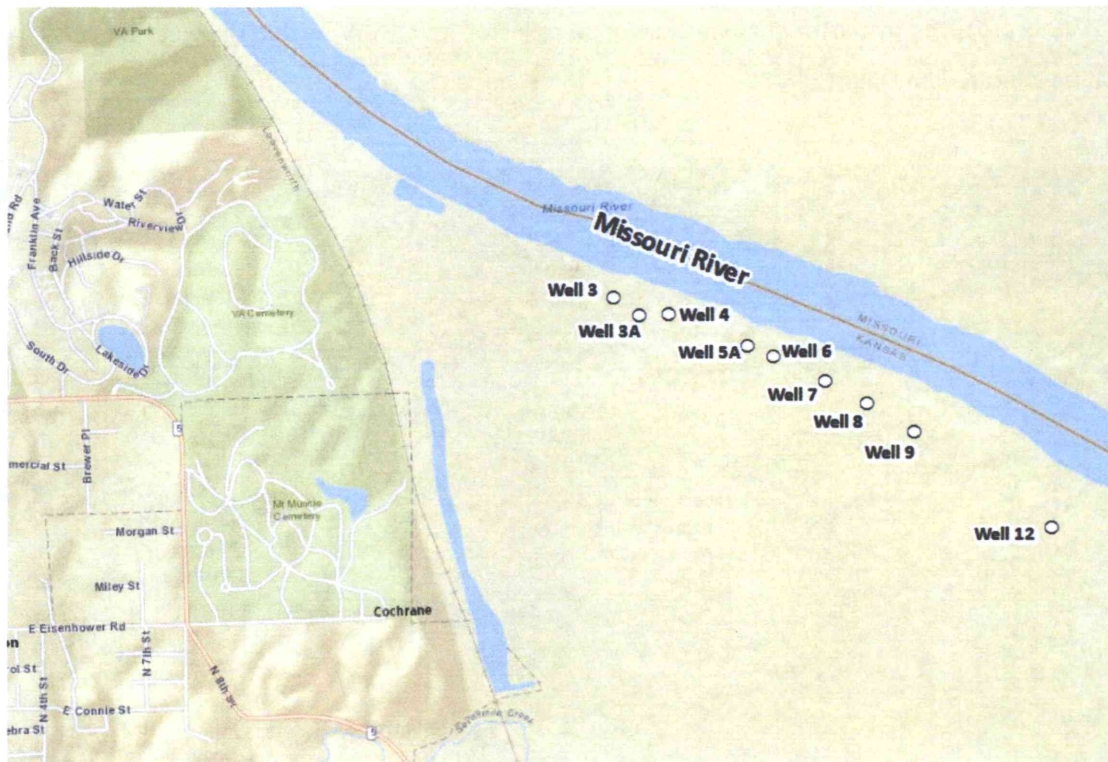


Figure 1. Existing Wellfield

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19 February 2018

Division of Water Resources

Current groundwater rights (Water Right No. 27613) for the wellfield are as follows:

- maximum diversion rate for each well pumped individually = 1050 gpm/well (1.512 mgd/well);
- maximum diversion rate with wells pumped simultaneously = 4750 gpm (6.84 mgd);
- total diversion volume = 1786.292 million gallons per calendar year (equivalent to an average annual groundwater rate of approximately 4.89 mgd).
- When combining the groundwater right at the wellfield with the 1955 surface water rights for their upstream river intake, LWD's total water rights (groundwater plus surface water) are capped at 1874.558 million gallons per calendar year, equivalent to an annual average of approximately 5.14 mgd which is approximately equal to the average annual water sales in the past 15 years (<http://www.lvnwater.com/history.html>). In 2001, this total diversion right was exceeded at 1894.648 million gallons; in 2012, the total water use of approximately 1860.109 million gallons approached the water right.

LWD is seeking additional water rights. Since the old wells are approaching the end of their useful life and since LWD may begin transitioning some of the surface water supply to the wellfield in the future, LWD is proposed to construct a new horizontal collector well (HCW) within the wellfield at the location indicated on Figure 2.

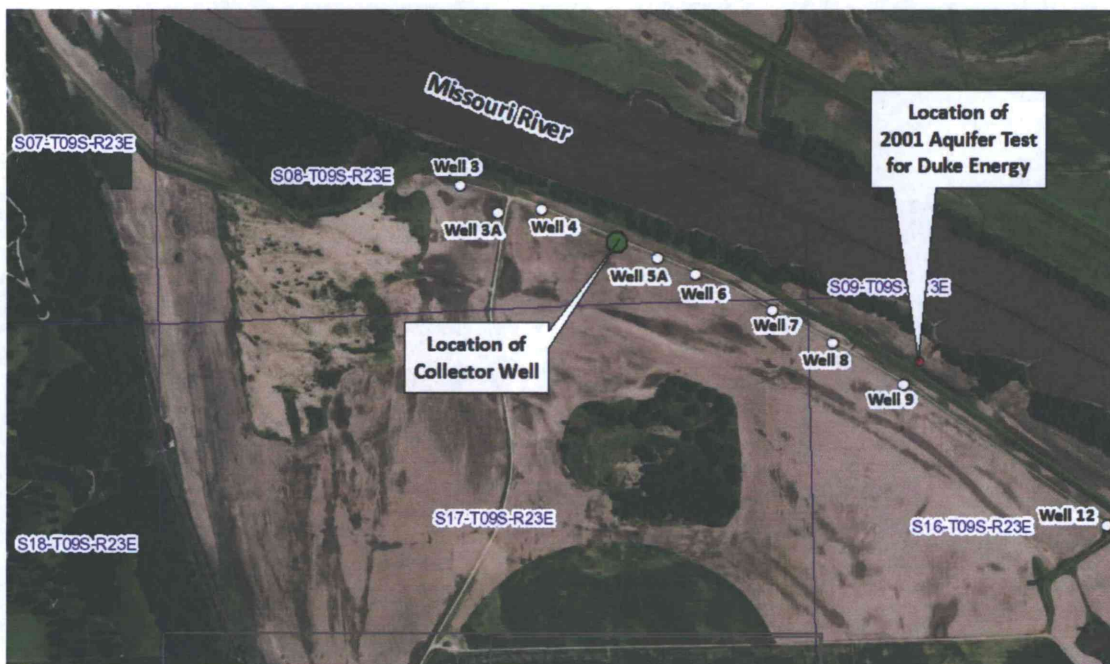


Figure 2. Proposed Horizontal Collector Well Location

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The design of a new HCW must consider the projected Year 2037 annual average and maximum day water supply of 7.11 mgd and 12 mgd, respectively. This memorandum provides documentation of a detailed groundwater-river evaluation as requested by the Division of Water Resources to supplement the water rights application for a new HCW.

Available Information

This evaluation is based on available data for the wellfield site which includes the following information:

- Kansas Geological Survey (KGS), WIZARD Water Level Database, <http://www.kgs.ku.edu/Magellan/WaterLevels/index.html>
- KGS, WIMAS Database, http://hercules.kgs.ku.edu/geohydro/wimas/query_setup.cfm
- KGS, WWC5 Well Database, <http://www.kgs.ku.edu/Magellan/WaterWell/index.html>
- LWD information for the existing wellfield
- Layne Christensen Company, 2015, *Water Supply Well Field Assessment*, prepared for the City of Leavenworth, Kansas, February.
- Malcolm Pirnie, 2001, *Collector Well Feasibility Report: Leavenworth Energy Facility*, prepared for Duke Energy Leavenworth LLC and Leavenworth Department of Water, September.
- USGS river gage data.

The 2015 Layne report and information from LWD provide information about the existing vertical wells. Each of the wells is 69 feet deep to the top of limestone bedrock, with the exception of Wells 8 and 9 which are about 79 feet deep. The diameter of each well is between 26 and 30 inches, and each well screen is 20 to 25 feet long. In general, the upper 10 feet of the alluvial sediments consist of fine grained sand, silt, and clay. The middle of the aquifer between about 10 feet and 50 feet below ground surface (bgs) is composed of sand, and the bottom 20 to 30 feet of the alluvium where the wells are screened is composed of coarser sand and gravel. The alluvial valley is approximately 2.5 miles wide at the wellfield site.

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19 February 2018

Division of Water Resources

Each existing vertical well could historically be pumped at rates of between 700 and 1000 gallons per minute (gpm); currently, each well is set to pump 695 gpm with the exception of one well that is set at 350 gpm. Specific capacity of each well has declined over time.

Figure 2 provides the location of a test well (PW-1) used in 2001 to estimate the yield of a potential HCW for a proposed power plant at that time. PW-1 was pumped for about a week at a rate of 1215 gpm. The aquifer characteristics at the site provided in the 2001 report are as follows:

- Transmissivity ~ 109,000 to 176,000 gallons per day per foot (gpd/foot)
- Saturated thickness ~ 60 feet
- Hydraulic conductivity ~ 240 to 390 feet per day (ft/d)

These hydraulic conductivities are in general agreement with the values at other municipal wellfield sites along the Missouri River. The 2001 report estimated that a HCW could yield up to 14.7 mgd for the conditions that occurred during the pumping test (July 2001, river elevation approximately 746 feet) and that more than 99 percent of the water produced by a HCW at this site would be drawn from the Missouri River into the alluvium to the well. The 2001 report indicates that a groundwater model was used to estimate that a new HCW at the PW-1 test site pumping 8 mgd would lower groundwater levels at existing Wells 9, 8, and 7 by 11.8 feet, 4.3 feet, and 1.7 feet, respectively, and mentions that there was enough available drawdown inside each of the vertical wells to accommodate this without affecting operations of the existing wells.









The KGS WIZARD database has 16 records for wells in Township 9S, Range 23E, which covers the extents of the City's existing wellfield and areas surrounding it. These 16 wells are listed in Table 1. None of these wells have water level measurements according to the database records. LWD does not have monitoring wells or a record of historical water levels at the wellfield. Therefore, the analysis relies on the aquifer hydraulic characteristics determined from the 2001 Duke Energy week-long pumping test.

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Table 1. KGS WIZARD Database – Wells in Vicinity of Existing Wellfield





WIZARD Water Well Listing





16 records currently selected. Only 50 are display at one time.
Records can be sorted ascending (asc) or descending (desc) which will affect ALL the records in the selection set.

View Records: 1-16										
Usgs ID <small>asc desc</small>	County <small>asc desc</small>	PLSS <small>asc desc</small>	Records <small>asc desc</small>	Date Range		Longitude <small>asc desc</small>	Latitude <small>asc desc</small>	Use of Site <small>asc desc</small>	Use of Water <small>asc desc</small>	Depth of Well <small>asc desc</small>
				Min Date	Max Date					
391516094492001	Leavenworth	09S 23E 22AC 01	0	none		-94.83269	39.254022	Unknown	Unknown	Unknown
391516094494801	Leavenworth	09S 23E 22BC 01	0	none		-94.830242	39.254446	Unknown	Unknown	Unknown
391516094500201	Leavenworth	09S 23E 21AD 01	0	none		-94.84667	39.254042	Unknown	Unknown	Unknown
391516094501601	Leavenworth	09S 23E 21AC 01	0	none		-94.85131	39.254052	Unknown	Unknown	Unknown
391516094502904	Leavenworth	09S 23E 21BD 04	0	none		-94.85594	39.254062	Unknown	Unknown	Unknown
391516094504303	Leavenworth	09S 23E 21BC 03	0	none		-94.845516	39.254446	Unknown	Unknown	Unknown
391516094505701	Leavenworth	09S 23E 20AD 01	0	none		-94.865201	39.254042	Unknown	Unknown	Unknown
391516094511101	Leavenworth	09S 23E 20AC 01	0	none		-94.869821	39.253982	Unknown	Unknown	Unknown
391516094511102	Leavenworth	09S 23E 20AC 02	0	none		-94.869821	39.253982	Unknown	Unknown	Unknown
391516094511103	Leavenworth	09S 23E 20AC 03	0	none		-94.869821	39.253982	Unknown	Unknown	Unknown
391516094523401	Leavenworth	09S 23E 19AC 01	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391516094523402	Leavenworth	09S 23E 19AC 02	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391516094523403	Leavenworth	09S 23E 19AC 03	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391516094523404	Leavenworth	09S 23E 19AC 04	0	none		-94.888361	39.253981	Unknown	Unknown	Unknown
391523094513901	Leavenworth	09S 23E 21BBCD01	0	none		-94.861072	39.256391	Observation	Unknown	Unknown
391651094515301	Leavenworth	09S 23E 07DAA 01	0	none		-94.882101	39.280551	Withdrawal of Water	Unknown	69

Groundwater Model

A three-dimensional MODFLOW model of Leavenworth’s existing wellfield along the Missouri River was developed in 2016 using the Groundwater Modeling System (GMS) for the purpose of evaluating the yield of the alluvial aquifer under different climate and river conditions. Using the available information, the model development is summarized as follows:

- The alluvium is divided into an upper aquifer (to an elevation of 710 feet) and a lower aquifer (elevations 710 feet to 685 feet). Under normal conditions, the saturated thickness of the alluvial aquifer is approximately 60 feet.
- The model extends along more than 5 miles of the river between the bedrock valley walls as shown on Figure 3.

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Figure 3. Model Limits

- In the deeper portion of the aquifer where the well screens are located, an average value of 300 ft/day was selected for the hydraulic conductivity of the alluvium for normal summer water temperatures based on the range of estimates from the 2001 Duke Energy report. Due to the presence of finer material at shallowing depths, it is assumed that the hydraulic conductivity of upper alluvial deposits is 250 ft/day.
- The nearest USGS river gage is located in St. Joseph. River elevations were roughly estimated at the site using the elevation reported for the July 2001 pumping test, daily historical flows at the St. Joseph gage, and river gradient provided in the 2001 report. The 2001 report indicates the river elevation was approximately 746 feet during the pumping test in the second week of July 2001. The average Missouri River flow at the St. Joseph gaging station leading up to the time of the test was about 43,000 to 44,000 cfs, which was almost equal to the median daily summertime river flow at St. Joe from 1990 to 2016 of 47,400 cfs. Therefore, it appears that the 2001 test was performed during relatively normal summer river conditions. To make sure water facilities are designed for conditions when water needs are critical, yield studies must consider drought conditions. Since the

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1960s (after construction of major dams on the Missouri River), the minimum 120-day average river flow during the summer months is 31,160 cfs from July to October of 2005. It is assumed for purposes of evaluating yield for this study that the 120-day average Missouri River elevation past the LWD wellfield during a dry summer is 740 feet.

- It is assumed that the riverbed permeability is approximately 1 ft/day based on experience with other wellfields along the Missouri River in the region.
- To conservatively account for drought conditions, the model considers a low recharge rate of 2 inches per year.
- The 2001 report provides estimates of aquifer storage coefficient of 0.0013 to 0.012, with an average reported value of 0.003. However, it is likely that the duration of the test was not long enough to establish the true specific yield of the sand and gravel alluvial aquifer which is typically on the order of about 0.15 to 0.2. For this conceptual analysis, it is assumed that the specific yield of the aquifer is 0.2.

Simulation of Current (Baseline) Groundwater Rights

Baseline conditions were simulated with the groundwater flow model for LWD's current groundwater right (No. 27613) for the existing vertical wells as follows:

- **Baseline for annual groundwater volume.** Currently authorized total diversion volume = 1786.292 million gallons per calendar year (equivalent to an average annual groundwater rate of approximately 4.894 mgd) total for the nine existing vertical wells # 3, 3A, 4, 5A, 6, 7, 8, 9, 12, with an average river elevation of 745 feet.
- **Baseline for maximum groundwater rate.** Currently authorized maximum diversion rate with wells pumping simultaneously = 4750 gpm (6.84 mgd) total for the nine existing vertical wells # 3, 3A, 4, 5A, 6, 7, 8, 9, 12, with a low river elevation of 740 feet.

The results of these baseline conditions analyses of the existing wells and current groundwater rights are shown on Figures 4 and 5.

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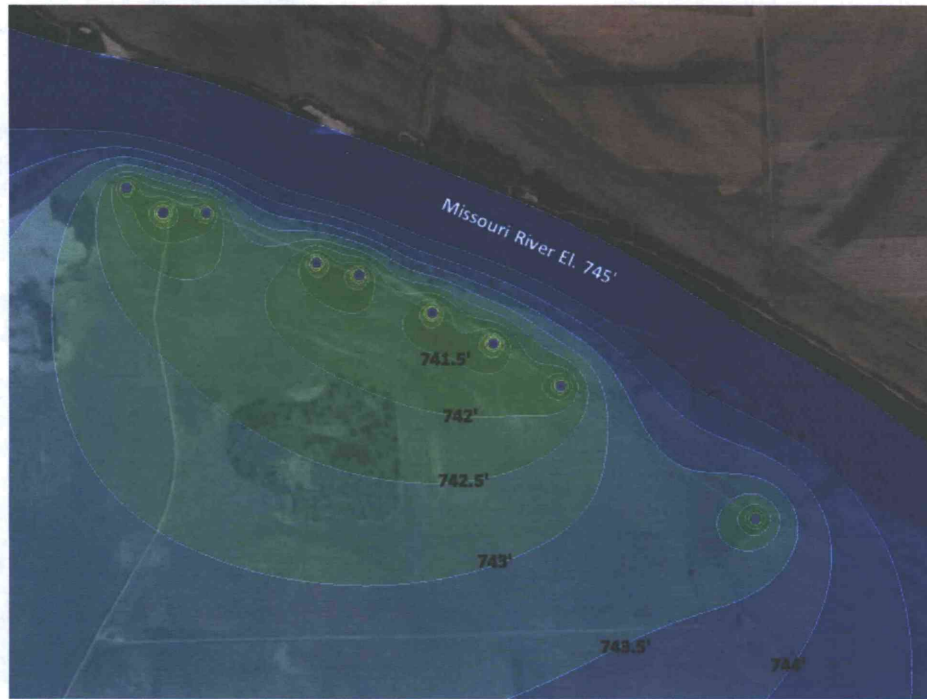


Figure 4. Baseline, Existing Wells, Current Annual Groundwater Rights, Normal River Condition, Steady-State Simulation

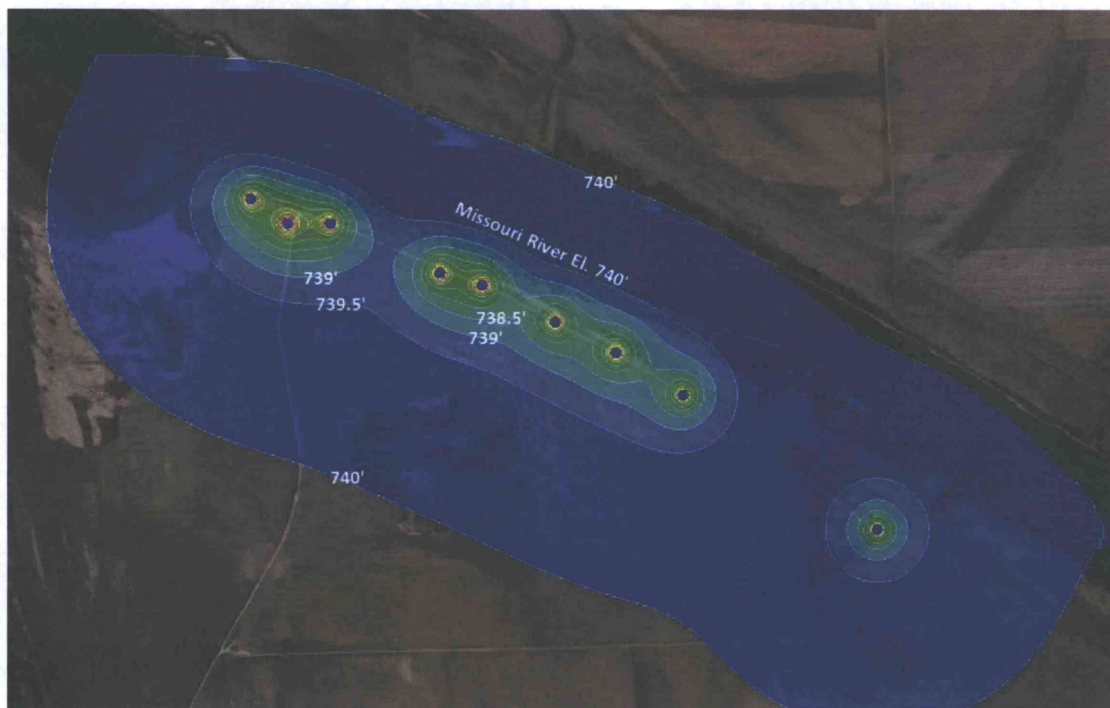


Figure 5. Baseline, Existing Wells, Current Maximum Rate Groundwater Rights, Low River Condition, 60th Day of Transient Simulation

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Sensitivity Analyses for Baseline Conditions

A sensitivity analysis was performed using the steady-state baseline conditions model. The river elevation was left at 745 ft and the total pumping rate from the existing wells was left at 4.894 mgd for these sensitivity analyses. The effect on groundwater levels was compared at the same location for all simulations. The results are as follows:

- Reduce horizontal hydraulic conductivity by 25%. A reduction in the hydraulic conductivity of 25 percent results in a reduction in groundwater levels near the middle of the wellfield of 0.7 ft.
- Reduce vertical hydraulic conductivity by 25%. A reduction in the hydraulic conductivity of 25 percent results in a reduction in groundwater levels near the middle of the wellfield of less than 0.1 ft.
- Reduce recharge by 25%. A reduction in recharge of 25 percent results in a reduction in groundwater levels near the middle of the wellfield of less than 0.1 ft.
- Reduce riverbed conductance by 25%. A reduction in riverbed conductance of 25 percent results in a reduction in groundwater levels near the middle of the wellfield by 0.1 ft.

These sensitivity analyses indicate that changes to the horizontal hydraulic conductivity of the alluvium has a much larger effect on the groundwater conditions within the wellfield than other parameters. Since the 2001 Duke Energy study included a week-long detailed aquifer test to determine the horizontal hydraulic conductivity of the aquifer, the confidence of this input parameter is high.

Proposed Steady-State Conditions

To evaluate proposed conditions, the baseline conditions steady-state model was modified by shutting off the 9 existing wells and adding the proposed HCW at the target average annual rate of 7.11 MGD. The simulated groundwater levels are provided on Figure 6. Figure 7 shows the difference in groundwater levels between the proposed and baseline conditions for steady-state with normal river levels. The KGS WWCS database was used to search for other production wells (excluding wells with the following designation or status: 'Monitoring well/observation/piezometer', 'Dewatering', 'Plugged') in Township 9S, Range 23E in and around the existing wellfield. Figure 8 shows the locations of other known production wells in the area, showing there are no known wells within a half-mile of the proposed HCW site. The model shows essentially no change in steady-state groundwater levels near the Lansing Correctional Facility wells, and an estimated decrease in steady-state groundwater levels near the Stigers Island Farm well of about -0.5 ft.

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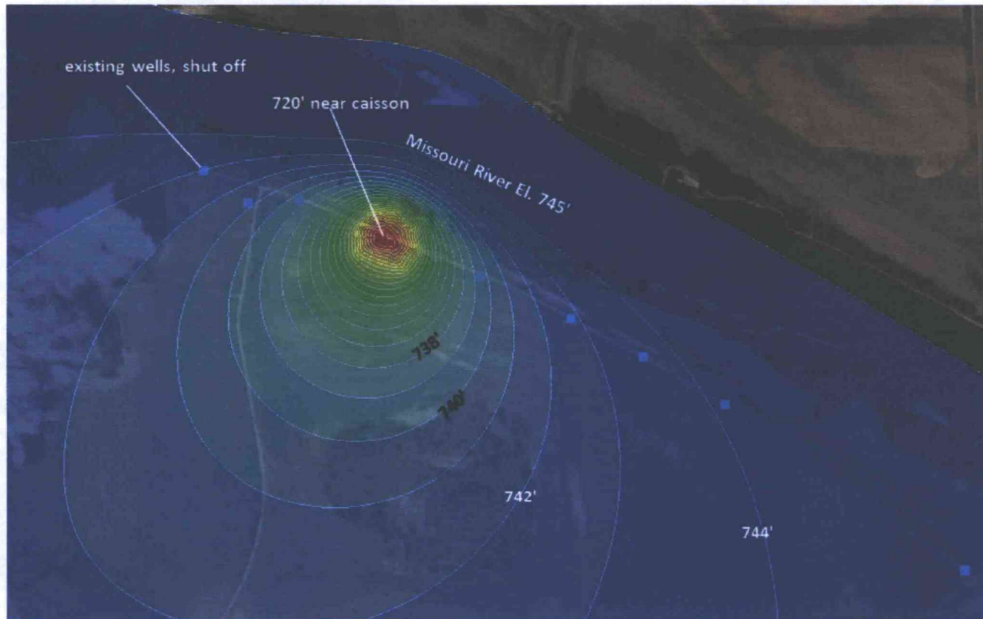


Figure 6. Proposed HCW at 7.11 MGD, Normal River Level, Steady-State Simulation

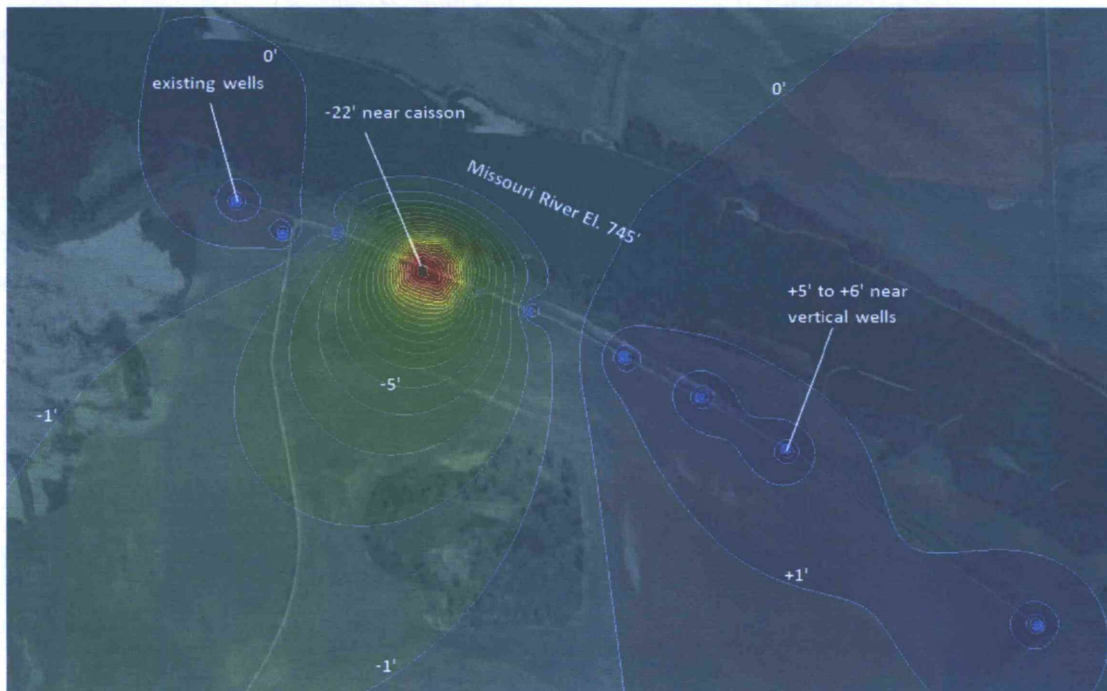


Figure 7. Steady-State Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells

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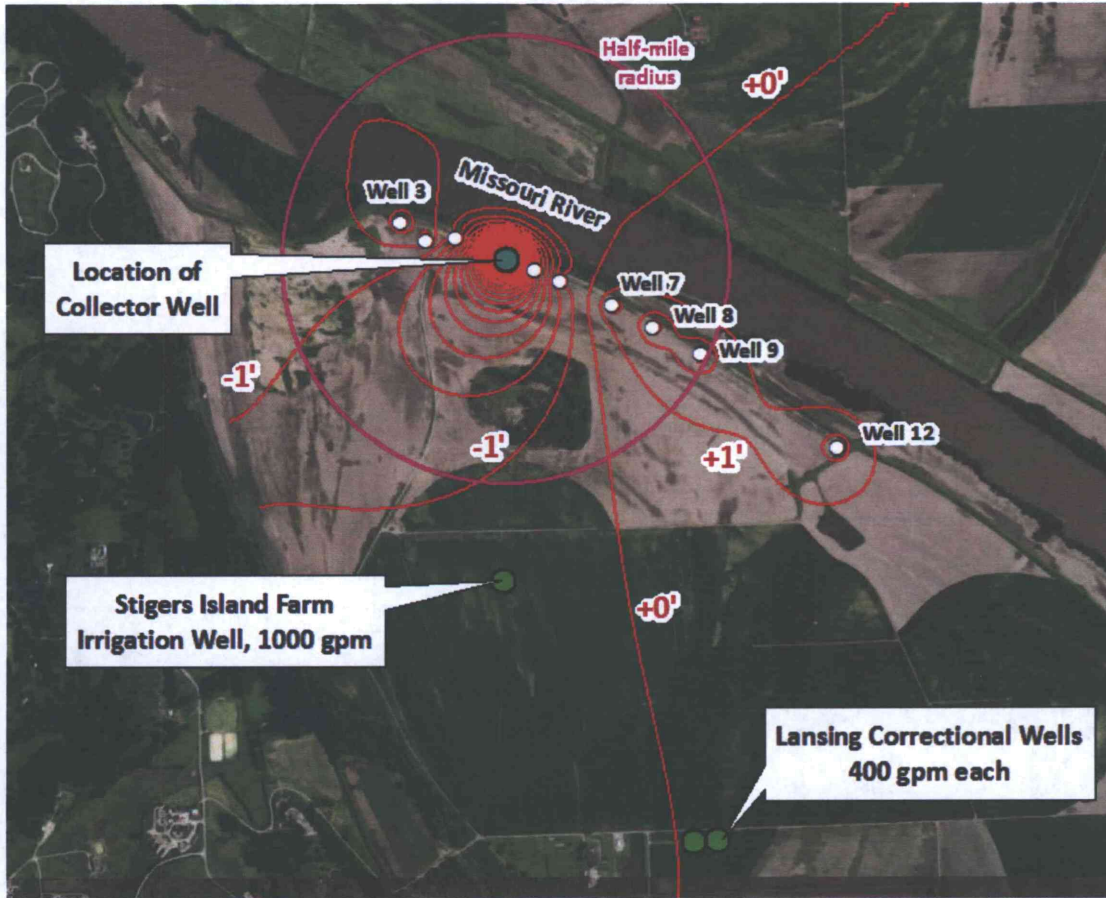


Figure 8. Steady-State Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells, in Relation to Known Wells in the Area

The alluvial aquifer water budget near the HCW is as follows:

- Inflow:
 - River = 6.61 MGD
 - Recharge = 0.29 MGD
 - Groundwater underflow from distant areas = 0.29 MGD
- Outflow:
 - HCW = 7.11 MGD
 - River = 0.05 MGD
 - Specified head = 0.02 MGD
 - Groundwater underflow to distant areas = 0.01 MGD

The net river contribution to the HCW is approximately 92 percent for the steady-state condition with a normal river level.

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Proposed 60-day Transient Conditions

To evaluate the proposed maximum production, the baseline conditions 60-day transient model was modified by shutting off the 9 existing wells and adding the proposed HCW at the maximum target rate of 12 MGD. The simulated groundwater levels are provided on Figure 9. Figure 10 shows the difference in groundwater levels between the proposed and baseline conditions on the 60th day with low river levels. The KGS WWC5 database was used to search for other production wells (excluding wells with the following designation or status: 'Monitoring well/observation/piezometer', 'Dewatering', 'Plugged') in Township 9S, Range 23E in and around the existing wellfield. Figure 11 shows the locations of other production wells in the area, showing there are no known wells within a half-mile of the proposed HCW site. The model shows essentially no change in groundwater levels near the Lansing Correctional Facility wells, and a decrease in groundwater levels near the Stigers Island Farm well of about -0.5 ft.

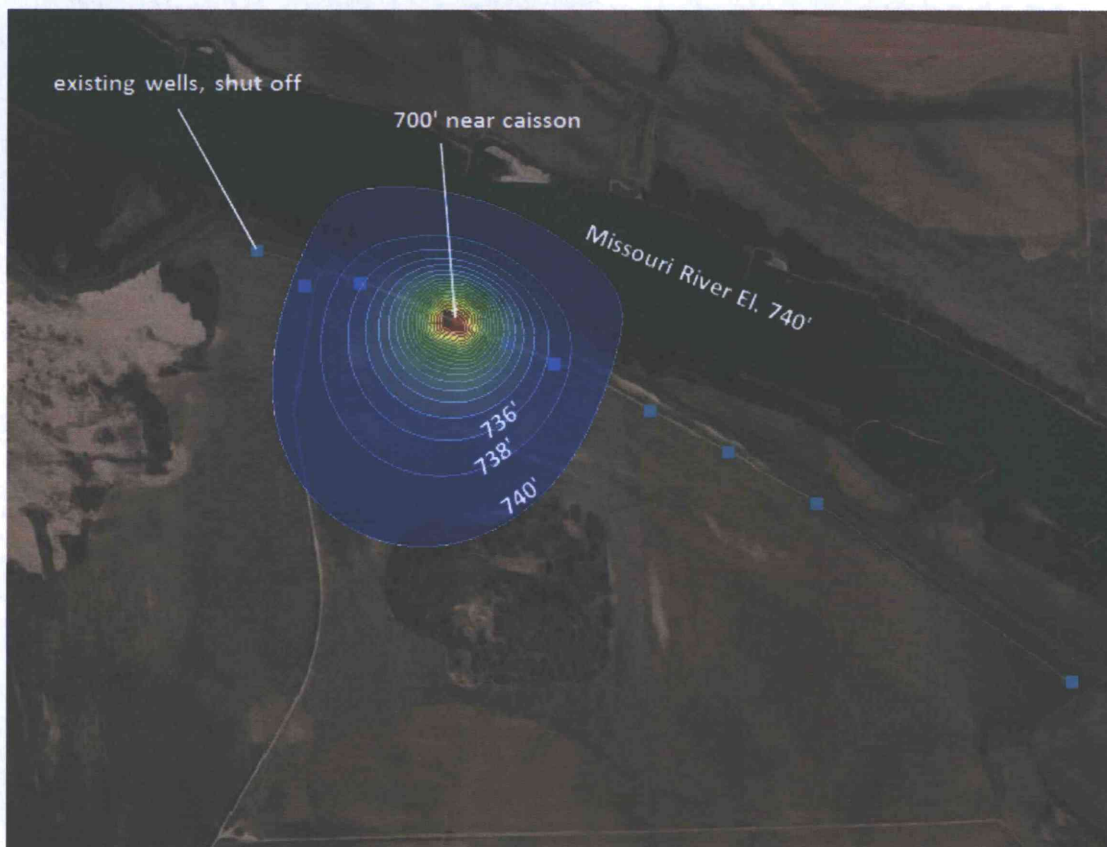


Figure 9. Proposed HCW at 12 MGD, Low River Level, 60th Day of Transient Simulation

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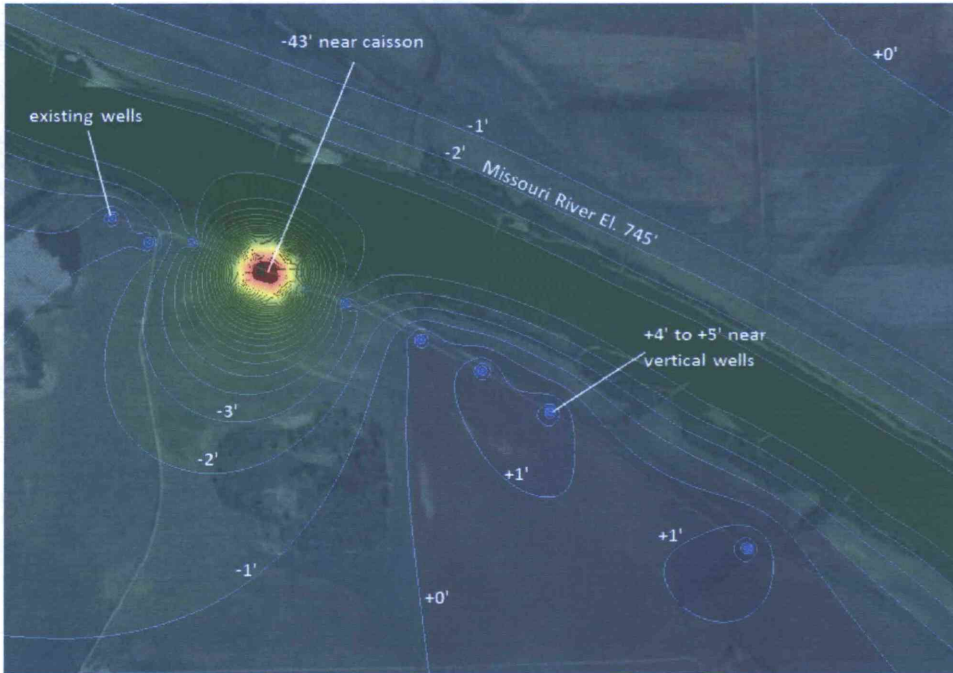


Figure 10. Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells on 60th Day of Transient Simulation with Low River Level

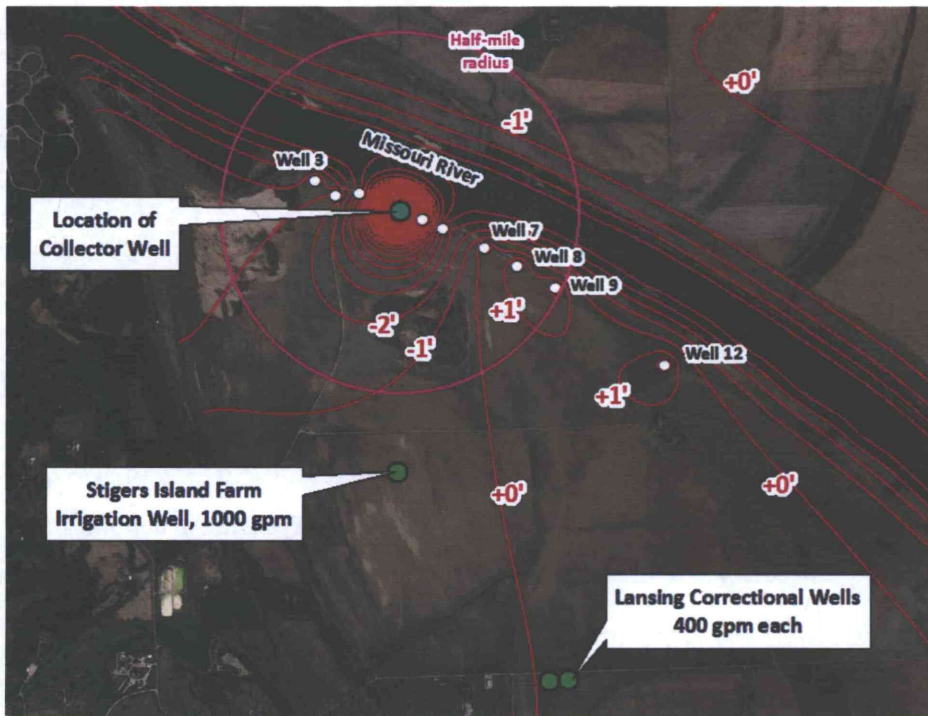


Figure 11. Groundwater Level Difference between Proposed Condition with HCW and Baseline Condition with Existing Vertical Wells on 60th Day of Transient Simulation with Low River Level, in Relation to Known Wells in the Area

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As expected for a HCW as river levels decline and well production increases to meet demands during dry weather conditions, the alluvial aquifer water budget for the model indicates the HCW begins to draw groundwater levels farther below the river level, temporarily tapping both groundwater storage and inducing more recharge from the river into the aquifer. The alluvial aquifer water budget near the HCW for transient conditions with a low river level is as follows:

- Inflow:
 - River = 6.59 MGD
 - Recharge = 0.29 MGD
 - Groundwater underflow from distant areas = 0.97 MGD
 - Specified head = 0.17 MGD
- Outflow:
 - HCW = 12 MGD
 - River = 0.53 MGD
 - Groundwater underflow to distant areas = 0.15 MGD

Assuming the inflow from the specified head boundary is part of the net groundwater underflow from distant areas, the 12 MGD of maximum HCW production is met by the following on a short-term basis: 39 percent from aquifer storage, 51 percent from the river, 8 percent from distant groundwater underflow, and 2 percent from recharge. In reality, the percentages are in a constant state of flux depending on continuous changes in recharge conditions, riverbed conditions, channel location, river and groundwater temperatures, river and groundwater levels, and well production driven by daily demands.

Effect on Missouri River Flow

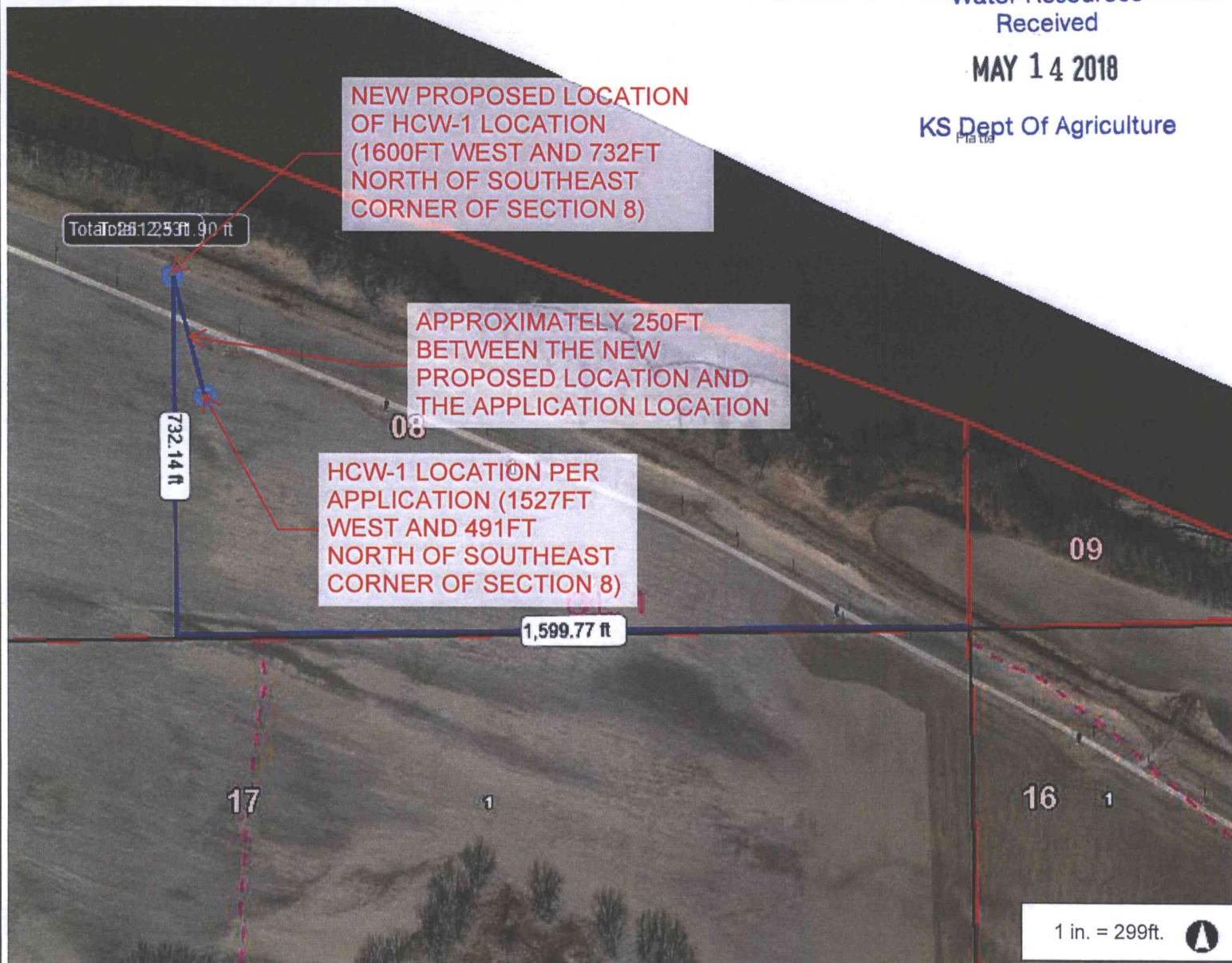
As noted previously in this report, the historical median Missouri River flow at St. Joseph in recent decades is approximately 47,400 cfs (~30,600 MGD). The induced river recharge of about 6.1 to 6.5 MGD to the proposed collector well is about 0.02 percent of the median historical river flow. The lowest daily river flow of 4600 cfs occurred in February of 1989; assuming this reading was not affected by ice at the gage, the induced river recharge to the proposed HCW would be approximately 0.2 percent of river flow that day. The average of the 100 lowest daily river flows on record is approximately 11,000 cfs; the induced river recharge to the proposed HCW would be approximately 0.09 percent of this value.

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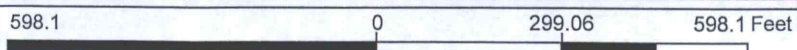
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Legend

Notes



1 in. = 299ft.

This Cadastral Map is for informational purposes only. It does not purport to represent a property boundary survey of the parcels shown and shall not be used for conveyances or the establishment of property boundaries.
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