The Groundwater Management Program

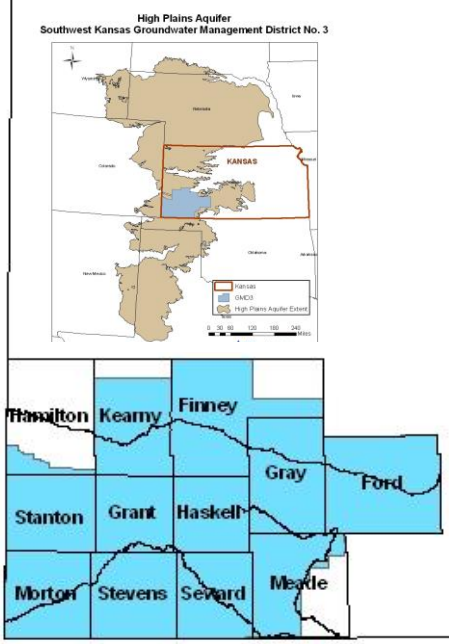
Southwest Kansas Groundwater Management District Number 3 (GMD3)

2009 E. Spruce Street, Garden City, Kansas 67846 (620) 275-7147

URL: HTTP://www.gmd3.org

All policy and opinion expressed herein are intended only as that of GMD3

Proposed Revised (Draft), 11/18/18



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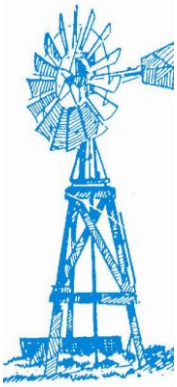

Southwest Kansas Working Aquifers – Conserving Every Day in Every Way

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I. PURPOSE FOR LOCAL GROUNDWATER MANAGEMENT

The necessity for organized local groundwater management. Water is a great connector in that everyone uses it and relies on its availability. Kansas water planning studies recognized in 1958 a need for formal local groundwater management activity to work with the centralized administration of state water resources. Groundwater is local water storage that is best managed locally for the proper management of the groundwater resources; for the conservation of groundwater resources; for the prevention of economic deterioration; for associated endeavors within the state of Kansas through the stabilization of agriculture; and to secure for Kansas the benefit of its fertile soils and favorable location with respect to national and world markets. These needs identified by the Kansas legislature for local groundwater management activity made it necessary to provide for the formation of groundwater management districts (GMD's).

Kansas runs on water. Water has always been the key resource for the prosperity of all. There are other resources which may mean the difference between wealth and poverty, such as oil or gas or fertile soil, but none is like water as a fundamental necessity for our existence and nearly all other economic development. Local management of groundwater supply requires the will to manage and sustain enough useable inventories with significant assistance from many partners, and in a manner consistent with the public interest. Ultimately, all water supply to be managed depends on precipitation, transportation and storage; capturing rain and runoff flow and parking it for later use in surface and groundwater reservoirs. Overdraft on storage without replenishment creates a depleted supply and a threatened economy. The extent of future economy and water services depends in large part on the water management program activities implemented today to address those public interest factors.

Groundwater management program policy. The Southwest Kansas Groundwater Management District No. 3 (GMD3) Water Management Program is intended to steer the course of activities for public water management by local stakeholders to meet demands for water supply as the key public resource in southwest Kansas for the economy that is the hallmark of the Kansas economy. This management program provides a basis for formal and informal policy norms and practices adopted for groundwater management purposes by GMD3 and compatible with Kansas laws and policies (See K.S.A. 82a-1020, K.S.A. 82a-1029 and K.S.A.82a-1039). Policy statements contained herein are an expression of the GMD3 policies and practices for the local management program and are not intended as an expression of state policy. Accordingly, this document is a written report describing the characteristics of the district and the nature and methods of dealing with groundwater supply problems of the district by the district as provisioned in state law for that purpose. In addition to this document, any policies expressed in Board resolutions and guidance documents adopted by the GMD3 governing body must also be considered GMD3 policy for the GMD3 area organized for groundwater management purposes. Guidance and implementation documents that target strategic activities with available funding will be publicly considered and posted on the GMD3 website when adopted by the governing body of GMD3.

Regular program review and revision. An up-to-date management program document is required by K.S.A. 82a-1029. This is a necessary activity in the provisions of the Kansas legislature under the right to organize and conduct groundwater management activities in the

GMD3 area and to coordinate with local and state agencies and other partners and authorities for management program activities solving water supply problems. If it is proposed that the management program for the district be revised, the board and others, upon the board making such a determination, must follow the same prescribed procedure towards adoption of a revised management program as prescribed for the original management program of GMD3. Any update of the water management program and associated implementation documents by the board will incorporate the needs of the district and partners for revising formal and informal policy norms and practices affecting groundwater management activities. All policy and program proposals that may affect the water management program in the district will be reviewed by GMD3 for proper consideration as to whether such policy or activity is consistent with the management program and if management program revisions are needed in the local public interest.

Resource management. Demand is increasing for the GMD3 governing body to take significant steps to add water conservation, economic benefits and drought resiliency into the future of the district area for agricultural production systems and to enhance the future useable groundwater supply in the interest of all members and for Kansas. Demand for water conservation and use value grows as groundwater supplies decline. Data review indicates a direct correlation between timely rainfall and groundwater pumping in the district, where the water demands of soil moisture deficits and dry cycles must be balanced with conservation opportunities of wet cycles to leave or replenish water in aquifer storage and encourage efficient water use without waste. The reality of groundwater mining activity drives the necessity to also conserve available surface water leaving the state as streamflow in amounts nearly 10 times what is consumed annually from groundwater sources. So, like other public entities around the world with similar supply conditions, GMD3 is working on replenishment strategies while conservative groundwater use policies bridge the gap to sustainable water benefits that will fuel the future economy in Kansas.

Groundwater governance can be difficult for many reasons (From California groundwater guidance), including:

1. Groundwater is a shared resource;
2. Groundwater inflows and outflows are difficult to observe and cannot be measured directly;
3. Surface water and groundwater are interconnected;
4. Aquifer boundaries and characteristics may be locally unknown or poorly defined;
5. Groundwater management requires specialized model tools;
6. Groundwater conditions can vary on multiple time scales;
7. Groundwater use can pit present needs against future needs; especially in declining aquifer supplies;
8. Diverse local, state and federal interests, institutions and authorities require significant coordination activity to maintain productive partnerships that accomplish the purposes of the groundwater management program and resource governance in the public interest.

Program methods that address the problems of groundwater decline and proper management activities for the GMD3 area are identified in chapter V of the management program. These program activities will be implemented by the governing body of GMD3 through the adoption of separate implementation and guidance documents containing strategic goals and action plans, based on available funding, that can be readily updated and distributed for coordination and assistance purposes.

II. GMD3 MISSION, OBJECTIVES & PRINCIPLES

MISSION: Act on a shared commitment to conserve and develop water supply to grow the social, economic and natural resources well-being for current members and future generations in the public interest.

Kansas Water Law.

See: Water Primer, Part 5: Water Law, Kansas State University, January 2013. https://www.bookstore.ksre.ksu.edu/pubs/mf3024.pdf ; and Water Law Basics. https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/water-law-basics

Kansas water rights. A water right in Kansas water law refers to the right of a person to take water under control from a Kansas public water source for beneficial use, such as from a groundwater aquifer, and to have that right continue unimpaired into the future, subject to senior water right demands under prior rights. The western US water doctrine of prior appropriation (or "first in time is first in right") has been a part of water policy in Kansas since the mid 1800's (See Appendix for *Kansas Water Law and History Notes*). Uniform prior appropriation policy was not fully adopted statewide for all usable water sources until the Kansas Water Appropriation Act (WAA) of 1945, whereby ownership of the water is dedicated to the people of Kansas as a public good, but the right to use the public water is a private right created under an application and state grant. The grant included water user actions and investment to apply the water to any of a variety of authorized beneficial uses and certified as a real property right. Water rights may be recorded as developed and established real property rights that are part of a traditional "bundle of legal rights" transferred with land from seller to buyer as an appurtenance to the land, or a water right can be separated from the land and conveyed by evidence of a separate deed or lease. Domestic rights are not required to be recorded with the state. Domestic use has an implied Appropriation Right for domestic use to the extent of actual use, and with all of the protections of right under the WAA and management program participation under the GMD Act.

One water user can affect another's ability to exercise their prior right to enjoy resource benefits. So, a system of concepts was adopted under the WAA to evaluate what effects on other rights may be reasonably tolerated for new appropriations or changes to appropriations and to resolve complaints as to first right to the available local source of supply. The principle of prior appropriation means water rights are each assigned a priority date to establish who has first right to water. The WAA is administered by the Kansas Department of Agriculture's Division of Water Resources, which issues permits to appropriate water, regulates usage, and keeps records of all water rights in the state. The maintenance of water right and permit records allows Kansas water use to be defined, apportioned and managed fairly. In times of plenty, there may be enough water to satisfy all water rights. However, in times of water scarcity, those who have earlier or more senior water rights are entitled to be satisfied before those who have rights junior to them. Except for domestic use, public water cannot be unlawfully appropriated, or even a threatened appropriation, without first making application and receiving approval by the state for diversion and use of water in Kansas. The job of the state is guided by ascertaining whether a proposed use (or change in use) will prejudicially and unreasonably affect the public interest.

Groundwater depletion. By the late 1960's, the legislature had become concerned with the groundwater "mining" (depletion) conditions of Kansas aquifers and passed legislation in 1968 to enable the creation of groundwater management districts. When this legislation produced no GMD's, the legislature enacted the GMD Act in 1972. This Act deemed that in addition to water appropriation for beneficial use as a public good, it was also a public good "…to preserve basic water use doctrine and to establish the right of local water users to determine their destiny with respect to the use of the groundwater…" in providing for the formation and funding of GMD's by the local groundwater users and land owners.

Local authority. *The United States' system of governance has many different levels. These levels – federal, state and local – all have a specific role to play in providing public services for the citizenry. At times, these levels of governance can overlap, or create gaps in the provision of services, leaving uncertainty about who has what type of authority.... (Source: "Dillon's Rule or Not?" National Association of Counties, Research Brief, January 2004, Vol. 2, No. 1.)* According to the *Kansas Legislative Research Department 2015 Briefing Book*, Dillon's Rule states that a local government has only those powers granted in express words, those powers necessarily or fairly interpreted as implied in the statutory grant, and those powers essential to the accomplishment of the declared objects and purposes of the local unit. Local governments without home rule powers are limited to those powers specifically granted to them by the Legislature.

The GMD Act and "the right" to manage groundwater use. The 1972 GMD Act recognized a public interest *"… need for the creation of special districts for the proper management of the groundwater resources of the state; for the conservation of groundwater resources; for the prevention of economic deterioration; for associated endeavors within the state of Kansas through the stabilization of agriculture; and to secure for Kansas the benefit of its fertile soils and favorable location with respect to national and world markets (K.S.A. 82a-1020)."* In that statute, the legislature set two elements of policy in law for groundwater management: *"…to preserve basic water use doctrine and to establish the right of local water users to determine their destiny with respect to the use of the groundwater insofar as it does not conflict with the basic laws and policies of the state of Kansas."*

It is the opinion of GMD3 that the GMD Act establishes the "right" as a noun. According to Black's Law Dictionary, 4th addition, pg. 1486, a right is: *"as a noun, and taken in a concrete sense, a power, privilege, faculty, or demand, inherent in one person and incident upon another."* This definition applied to the plain language of the statute indicates that a duly formed GMD3 governing body, as the intended legal public entity, has the power, privilege, faculty, or demand vested by the legislature to make decisions and provide recommendations and conduct activities that determine the destiny of the area with respect to the use of the groundwater, provided it is done in a manner compatible with the other laws and policies of the state as a declared matter of public interest.

The GMD Act does not alter any duty or power of the chief state official (Chief Engineer) responsible for administering Kansas water rights under the WAA (K.S.A.82a-1039) or the duties or powers of other state officials. Nor does it prevent anyone from upholding basic Kansas water use doctrine. In fact, it confirms basic water use doctrine while establishing the right to manage groundwater locally by a GMD. The GMD Act also stipulates the process required to

form, fund and operate a GMD and groundwater management program with direction for activities either required or eligible to be undertaken.

Another policy of the legislature (K.S.A. 82a-1042) recently added to the GMD Act provides that when rules and regulations are proposed by the Kansas Secretary of Agriculture or the Chief Engineer that may change an adopted local groundwater management program or impact groundwater use in a GMD, the state official *"…shall notify the groundwater management district board of directors of such requested management program change or proposed rules and regulations. Upon such notice, the board of directors shall prepare a response of intended board actions. The board of directors shall follow the provisions of K.S.A. 82a-1029, and amendments thereto, for revising active groundwater management programs."*

Powers. To conduct the affairs of groundwater management as a public agency, a GMD must have a management program, sources of funding, regular meetings of the elected Board and members, respond to certain proposed management program changes or administrative rule changes that may affect the management program, and operate using a list of powers (K.S.A. 82a-1028) provided to accomplish the management and conservation of groundwater within the GMD area. Powers provided to GMD3 to manage groundwater include:

1. Construct and operate works for drainage, recharge, storage, distribution or importation of water;
2. Levy groundwater user charges and land assessments, issue bonds and incur indebtedness;
3. Contract with persons, firms, or agencies of state or federal governments or private entities;
4. Conduct or participate in research and demonstration projects;
5. Sue and be sued;
6. Maintain equip, staff and an office;
7. Extend or reduce district boundaries;
8. Hold and sell certain property and water rights;
9. Require installation and reading of meters or gauges;
10. Provide management assistance of drainage, storage, recharge, surface water and other problems;
11. Recommend to state officials' rules and regulations necessary to implement and enforce Board policies that are not inconsistent with law, which relate to the conservation and management of groundwater within the district;
12. Enforce by suitable action, administrative or otherwise, rules and regulations adopted;
13. Enter upon private property for inspection purposes to determine conformance with policies;
14. Seek and accept grants or other financial assistance from federal, public or private sources;
15. Recommend to the chief engineer the initiation of proceedings to establish special groundwater management areas, including an IGUCA or a LEMA.

GMD3 membership. A GMD3 member is an eligible voter as described in K.S.A. 82a-1021(a)(5):

> *"Eligible voter" means a natural person 18 years of age or older, or a public or private corporation, municipality or any other legal or commercial entity that:*

(A) Is a landowner that owns, of record, any land, or any interest in land, comprising 40 or more contiguous acres located within the boundaries of the district and not within the corporate limits of any municipality; or

(B) withdraws or uses groundwater from within the boundaries of the district in an amount of one acre-foot or more per year.

An acre-foot of water is equal to 325,851 gallons, so nearly all domestic well users divert or use that amount of groundwater in a year and can be considered eligible voters and members, for any who use a well in the district. Water users who get their water from a public or wholesale supply system are represented by someone appointed by the owner of the system.

Objectives of the legislature for GMDs (GMD Act):

1. Proper management of the groundwater resources of the state;
2. Conservation of groundwater resources;
3. Prevention of economic deterioration;
4. Associated endeavors within the state of Kansas through the stabilization of agriculture;
5. To secure for Kansas the benefit of its fertile soils and favorable location with respect to national and world markets

Purposes for which GMD3 was organized in 1976:

1. To organize and develop the efforts of the entire Groundwater Management District for the proper management and conservation of its groundwater resources;
2. Provide local input into the use and management of groundwater;
3. Provide for the greatest total social and economic benefits from the development, use and management of groundwater;
4. Support research and education concerning proper water management;
5. Work cooperatively with all federal, state, and local units of government to accomplish the objectives of the district and the GMD Act and amendments thereto.

GMD3 Management Program Guiding Principles:

1. Represent all district members (eligible voters) for water management purposes;
2. Grow trust and community involvement in water conservation to meet supply needs;
3. Seek adequate funding to protect and enhance access to safe and usable water;
4. Pursue the highest value for the groundwater consumed using a portfolio of approaches;
5. Develop accurate data and information to support prudent water management decisions;
6. Target management program activity with performance metrics to meet local water needs for today and in the future;
7. Justly advise stakeholders in the protection of water quantity and quality and the administration of water rights as real property rights owned by eligible voters of the district.

III. ORGANIZATIONAL HISTORY OF THE DISTRICT

In the 1960's, good, creative, local problem-solving folks saw that unregulated groundwater use was hastening the decline of local groundwater supplies. As stated earlier, mandatory permitting for all non-domestic uses was not yet provisioned in Kansas law until 1978. These local leaders insisted on the adoption of mandatory standards for groundwater water rights, use limits and special management area authority in their interest for protecting the health and welfare of Kansans. Good state and local action followed. After the passage of the GMD Act, a series of informational meetings were sponsored by the Southwest Kansas Irrigation Association in the fall of 1973 to determine the will of the people relative to the formation of a local groundwater management district, also commonly referred to as a GMD. As a result of these meetings a steering committee was formed to carry out the organization of the GMD according to procedures provided in the GMD Act. On December 4, 1974, the steering committee filed a declaration of intent, along with a map of the proposed district, with the Chief Engineer of the Division of Water Resources (DWR), Kansas State Board of Agriculture (now a state Department), who acts as technical agent of the legislature prescribed under the GMD Act, consulted with the steering committee to assure a manageable area was determined. On August 25, 1975, the Chief Engineer certified the description of the lands proposed to be included in the third such self-funded local instrumentality of the State with the official name *Southwest Kansas Groundwater Management District Number three*.

Petition. The steering committee circulated a petition which was submitted to the Secretary of State for approval. The petition was approved on October 13, 1975 and was followed by an election that was held on February 24, 1976. The election resulted in 1,155 voters in favor and 230 opposed. The Secretary of State was compelled by the election results to issue a Certificate of Incorporation on March 23, 1976. The Certificate of Incorporation has been filed at each county's Register of Deeds Office that is located within the district. An organizational meeting to elect the initial Board of Directors was held in Garden City, Kansas on April 6, 1976. The second Annual Meeting was held March 23, 1977 and now all annual meetings are held on the second Wednesday of March unless appropriately changed with notice.

Governing body. GMD3 is governed by a 15-member volunteer Board of Directors that is elected by a general constituency of the qualified voters present at an annual meeting. Each county is represented on the Board by one director who must reside in that county. Accordingly, any type of "water user", as defined in K.S.A. 82a-1021(k), may be elected to serve as one of the 12 county positions. In addition, there are also 3 "at-large" Board positions that are designated to represent that single type of water usage. These "at-large" water use types include Municipal, Surface water, and Industrial use. All qualified voters present at an annual meeting may vote on each position up for election.

District financing. GMD3 activity is financed by an annual land assessment and groundwater user fee that is levied against landowners and water users in the district. This is accomplished through an annual budgeting process that includes a review of the GMD3 financial status, management program and draft budget for the ensuing year at the annual meeting. A public hearing of the proposed budget and level of assessments to finance the budget is also conducted annually with notice (usually in July). For 2017 through 2019, the land assessment has been

$0.05 per acre and the water user fee has been $0.14 per acre foot. Currently, a user fee of $0.02 generates about $70,000 to the GMD3 general fund. The maximum land assessment allowed under the GMD Act is $0.05 per acre and the maximum user fee per acre foot is $2.00. If needed, debt funding of bonds for infrastructure improvements is also authorized for GMD3.

Eligible land for GMD3 land assessment and water appropriations for the water user fee

County	Total Assessable Acres	Assessed Acres	Excluded Acres	Wells	Authorized Appropriation in Acre Feet
Finney	625,637.27	624,438.81	1,198.46	1,085	581,233.00
Ford	662,719.10	662,006.70	712.40	660	200,531.00
Grant	357,715.95	357,570.35	145.60	642	328,266.00
Gray	536,554.15	536,063.78	490.37	1,303	420,880.00
Hamilton	71,209.95	71,209.95	0.00	73	40,871.00
Haskell	359,790.37	359,696.36	94.01	907	461,581.00
Kearny	449,230.77	448,767.60	463.17	494	233,298.00
Meade	399,646.59	399,449.21	197.38	553	278,636.00
Morton	481,659.65	481,414.11	245.54	307	129,058.00
Seward	381,891.63	381,566.10	325.53	501	281,904.00
Stanton	439,975.96	439,848.76	127.20	625	333,354.00
Stevens	467,219.07	467,018.89	200.18	705	383,949.00
GMD3 totals	**5,233,250.46**	**5,229,050.62**	**4,199.84**	**7,855**	**3,673,561.00**

**All information from GMD3 2018 Assessment Information. Wells are those with permanent non-domestic water rights. Other uses of water may be assessed subject to board resolution. Numbers are subject to change. Completed 9-4-2018 **

Home office. The GMD3 office is located in Garden City, Kansas. The Board conducts regular monthly business meetings on the second Wednesday of each month (unless changed for cause) and an Annual meeting for the election of Board members held on the same day as the regular March Board meeting. Public hearings are regularly conducted by the Board or conducted by others on district matters where GMD3 is a participant, to allow input on the budget, management program activities, and other pertinent public interest activities for the district. A detailed set of bylaws has been adopted that are revised by the Board as necessary.

GMD3 working committees and advisory groups. Each year GMD3 Board members are appointed by the Board president to serve on at least one sub-committee of the governing body. Each Board committee addresses issues on an as-needed basis. The Board committees include:

Executive;
Policy and Legal;
Finance;
Research and Development;
Renewable Supplies; and
Annual Meeting/Nominations.

In addition to formal Board committees, there are special project committees appointed or required by contract or other management activity. For example, the Western Water Conservation Projects Fund Advisory Committee. See: http://www.gmd3.org/about/special-meetings-and-committees/

GMD3 also works with numerous other public and private member advisory groups on water management concerns. Such advisory groups contribute to and affect the implementation of the GMD3 management program and the governing body of GMD3. Example groups include:

- The Associated Ditches of Kansas;
- 12 County Commissions and staff for county areas in the district;
- 12 County Conservation District (CCD) Boards for CCD areas within GMD3 (See Conservation Districts Directory at: http://agriculture.ks.gov/docs/default-source/doc---directories/cd-directory-for-web-2013FB46A7A690AA.pdf?sfvrsn=46);
- Drainage, Watershed and Water Supply District Boards having areas within GMD3;
- All classes of cities, towns and communities in the district as eligible voting members;
- Upper Arkansas Regional Advisory Committee (RAC) to the Kansas Water Office and Authority (KWO-KWA) (see: https://kwo.ks.gov/about-the-kwo/regional-advisory-committees/upper-arkansas-regional-advisory-committee);
- Cimarron Regional Advisory Committee (RAC) to KWO-KWA (see: https://kwo.ks.gov/about-the-kwo/regional-advisory-committees/cimarron-regional-advisory-committee);
- Southwest Kansas Local Environmental Planning Group (see: http://www.lepg.net/index.html);
- Southwest Kansas Irrigation Association;
- Kearny-Finney LEMA steering committee initiative (See https://kfl2017.weebly.com/);
- State and Federal agencies with land or water rights in the district; and
- Numerous other agricultural, business, commodity, service, finance, policy and trade organization partners.

IV. CHARACTERISTICS OF THE DISTRICT

General Characteristics

The district includes approximately 5,338,334 acres, or approximately 8,341 square miles of land. This includes all of Morton, Stevens, Seward, Stanton, Grant, Haskell, Gray, and Ford Counties as well as parts of Meade, Finney, Kearny, and Hamilton Counties in the southwest part of Kansas and the west central part of the Great Plains region of the United State. Land surface elevations range from approximately 3500 feet above sea level (ASL) in the west to less than 2300 feet ASL in the eastern side of the district. The land surface slopes in an east-southeast direction at a gradient ranging from 5 to 20 feet per mile. The district is closed to most new appropriations from the Ogallala/High Plains (OHP) Aquifer and new projects must change existing rights to meet new use needs.

Number of counties served by GMD3	12
Number of non-domestic water rights	12,500
Average annual use authorized	3.6 million acre-feet
Average annual use	2 million acre-feet
Average annual reduction in storage	776,000 acre-feet
Average annual recharge from precipitation	210,000 acre-feet
Estimated annual Domestic use	125,115 acre-feet (15 AF/section)
Estimated max. allowed annual use to avoid 40% depletion in 25 Years (40/25 rule)	1,732,832 acre-feet
Average net annual lateral aquifer inflow/outflow	6,000 acre-feet gain
Average annual return flow recharge (13%)	260,000 acre-feet returned
Irrigation-enhanced precipitation recharge, dewatered unit drainage, inflows from Dakota system, streamflow capture.	621,625 acre-feet gained or returned to the High Plains Aquifer

See *KGS Water Level Change image* and *Isolating High Plains Aquifer Change* in Appendix. Values are GMD3 gross estimates from KGS models. Model updates will improve estimates. Local values will vary significantly.

Source Water. The most common source of water for thousands of district wells is the Ogallala/ High Plains (OHP) Aquifer. The stored water comes from drainage of the pores of the sediments at or below the water table. The OHP sediments are primarily comprised of the unconsolidated, unconfined Ogallala Formation, older less permeable finer grained Oligocene deposits and unconfined sub-cropping Dakota Aquifer System formations that receive very little recharge. In comparison, less than 100 non-domestic wells are authorized to tap into the confined bedrock Dakota Aquifer System of Dakota sandstone, Kiowa shall and Cheyanne sandstone sediment formations, which is commonly referred to together as the "Dakota Aquifer." The characteristics of these aquifers can vary dramatically at points throughout the District and recharge areas are located at the sub-crop region where the Dakota Aquifer system is hydrologically connected to and under (or considered a part of) the High Plains Aquifer across the central part of the district. Also, direct recharge source areas occur generally west of the district at higher elevations in southeast Colorado. Additional development in these areas of Colorado will likely reduce Dakota Aquifer supply to the District over time.

Water quality. The quality (or usability) of the groundwater in the High Plains and Dakota Aquifers is generally fresh. In some locations, the salinity and/or radio-nuclei levels exceed recommended limits or maximum contaminant levels (MCLs) for drinking water established by the US Environmental Protection Agency (EPA). River flows are declining in both quality and quantity, and declining aquifer storage tend to also decline in quality as well.

Aquifer thickness. The remaining saturated thickness of the principle aquifer, the High Plains Aquifer, ranges from 20 feet to 600 feet within the district, with significant variability in the productive part of this thickness. Thus, well capacities range from a few gallons per minute (gpm) to 3,000 gpm. Historic depletion of saturated thicknesses also varies spatially across the district as documented in the Kansas Geological Survey (KGS) High Plains Aquifer Atlas. A 2010 model of the GMD3 area indicates that groundwater pumping caused a nearly 30% decrease in aquifer storage from pre-development to 2007, for an average decline of roughly 70 feet, which equates to roughly 10 feet of water across the aquifer areas of the district. These groundwater level declines have created an end to the loss of groundwater storage discharging to streams, resulting in low to no stream flows (2014 Kansas Water Plan) and the conservation of aquifer inflows. The aquifer formation pore space dewatered under historical mining presents an available capacity for new or replenishment storage of about 63 million acre-feet (KGS model for GMD3). The 2010 GMD3 model is due to be updated in 2020.

River and stream resources. The Arkansas (Ark) River flows from Colorado, across Hamilton County and into the district. It is the only river or stream with constant flow into the GMD3 area. The Ark River is highly regulated upstream of the district and deliveries of flow today rarely reach the lower portion of the basin in GMD3 (also known as the GMD3 lower Ark GMA). For all intermittent river and stream segments in the GMD3 area, flows occur as **pulse distribution** or runoff flows that interact with their respective alluvial aquifers and the Ogallala/High Plains Aquifer to provide conservation storage as groundwater recharge to the underlying aquifers. This means that a significant portion of any flow is lost as flow and gained as conservation storage to alluvial aquifers and the OHP Aquifer through gravity induced deep percolation and providing a critical historical source water supply to groundwater rights in the district. Protecting pulse distribution of recharge benefits is part of the management program.

Arkansas River Basin. There are six surface water irrigation ditch systems today that have historically diverted water from the Arkansas River between the Colorado-Kansas Stateline and Garden City. Collectively, these irrigation ditch companies owned by farmer-shareholders control approximately 140,000 acre-feet of senior surface water rights from available Arkansas River flows governed by a federal court decree, vested rights and an interstate river basin compact. Surface water rights historically developed below Garden City have lost historical supply flows and now rarely receive any river flow for use. Lands below Garden City historically irrigated from surface water years ago now rely on groundwater sources or may not receive any water except for the rare large river pulse event. The GMD3 management program has adopted historical practices for management of flows at the Garden City river gage and management program activities for both above and below the gage as the GMD3 Upper and Lower Ark GMA's respectively. Additional geohydrology information can be found at: http://www.kgs.ku.edu/Hydro/UARC/index.html

Cimarron River Basin. Natural pulse flows from precipitation runoff events are identified historically in in the hydrologic record and literature. Natural pulse flows should be managed

and protected under the management program for groundwater recharge as an important renewable supply to GMD3 member water rights. The exception is about a 20-mile reach of the Cimarron River below Highway 54 east of Liberal, Kansas, where the river normally has base flow primarily from upper Permian natural salt springs as flow leaves the district and the state after crossing southeast Seward and Meade counties. Cimarron River flows entering Kansas in Morton County and exiting Kansas from Meade County have decreased in quantity and quality over time. Cimarron River water entering Kansas has high sulfate concentration, whereas Cimarron River flow in southern Meade County has high chloride concentration. River salinity in Morton County has increased and in Meade County has increased substantially over time. Decreased flow of the river entering Morton County is likely mainly due to irrigation use in Colorado, Oklahoma and New Mexico, although phreatophyte water consumption could contribute. Decreased flow and increased salinity of the river in Meade County is mainly from declining discharge of fresh ground water from the High Plains aquifer that dilutes discharge of natural saline water from Permian bedrock, with some impact from phreatophyte water consumption. More geohydrology information on the Cimarron basin can be found at: http://www.kgs.ku.edu/Hydro/Publications/2005/OFR05_26/OFR2005_26.pdf
And http://www.kgs.ku.edu/Hydro/Publications/2005/OFR05_27/index.html

Pawnee River Basin. Portions of the headwaters of tributaries to the Pawnee River system are in eastern Finney, northeastern Gray, and northern Ford Counties of GMD3. Some spring discharge from the base of thin Ogallala deposits and precipitation runoff events provide public recreation and other services at Horse Thief Reservoir on Buckner Creek in Hodgeman County and other surface structures in the basin. A portion of Hodgeman County was originally included in the district. Controversy over water flowmeters mandated by the governing body of GMD3 drove an organized objection and request in that area to leave the district. The GMD3 Board agreed to an exclusion petition that resulted in the loss of district services in Hodgeman County. The alluvial aquifers of these headwaters contain some water supply locally. However, projected yields are too small to be a significant water source to meet district demands for water.

Interstate compacts. Both the Arkansas River and the Cimarron River sub-basin water systems (including Crooked Creek) are associated with interstate compact agreements that are both state and federal law. Each establishes an interstate administrative body with water management purposes consistent with the authorities established by each compact agreement. See compacts map in Appendix.

Colorado and Kansas Arkansas River Compact. The 1949 Colorado and Kansas Arkansas River Compact relates to the waters of the Arkansas River drainage basin primarily above Dodge City to apportion the benefits of John Martin Reservoir and to protect the usability of the basin Stateline flows available at the time of the compact. The compact is administered by an interstate administrative agency called the Colorado-Kansas Arkansas River Compact Administration (ARCA). Their website can be found at:
http://www.co-ks-arkansasrivercompactadmin.org/resources.html

Kansas and Oklahoma Arkansas River Compact. The 1966 Kansas and Oklahoma Arkansas River Compact limits new conservation storage capacity or water transfer amounts for each state in six major topographic sub-basins tributary to the Arkansas River basin from Wichita, Kansas to the confluence with the Arkansas River Mainstem in Oklahoma that together span the entire southern border of Kansas. The Cimarron River sub-basin, that includes Crooked Creek drainage, directly relates to the district as an upstream area. The compact also pledges

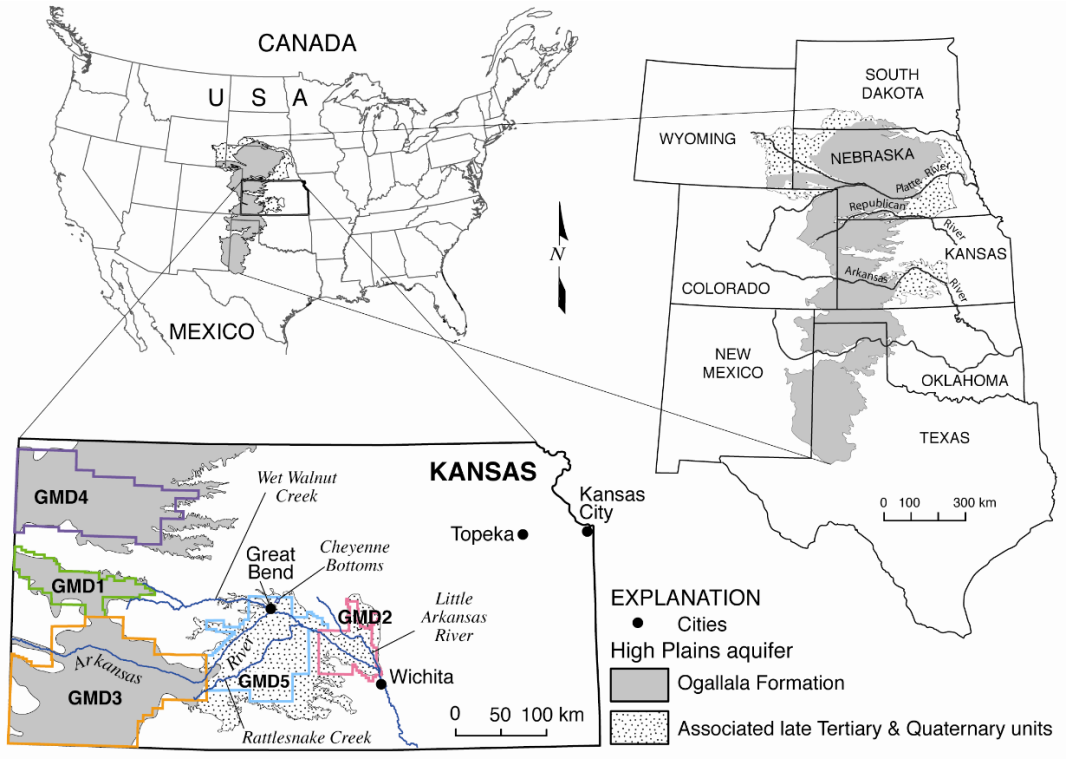
cooperation between the states in man-made pollution abatements. The Kansas – Oklahoma Arkansas River Commission is the interstate administrative agency that operates this compact, and more information can be found online at: https://agriculture.ks.gov/divisions-programs/dwr/interstate-rivers-and-compacts/kansas-oklahoma-arkansas-river-compact.

Water use and supply decline. GMD3 is blessed with available groundwater and has some of the highest-intensity groundwater use areas in the country. Total annual use in GMD3 nears half of all annual consumptive use in Kansas. This use, when combined with low groundwater recharge from rainfall and low inflow from outside the district, has created large declines in water storage that will not recover and will not sustain present use levels without new sources for aquifer replenishment yet to be developed. The resulting programs for the Ogallala/High Plains Aquifer water supply by GMD3 has historically been one of controlled decline and distributed demand to manage shared groundwater access and depletion under reasonable limits in order to allow economic growth in each county. The High Plains Aquifer remains the most productive water resource for the people within the district and for Kansas. Technology improvements for use efficiency help improve the value of supply and maintain economy with less water use.

Domestic water supply. As described earlier in *Kansas Water Rights*, ownership of the water is dedicated as a public good, but the right to use the public water is a private right created under an application and state grant. Domestic water rights are the exception in the WAA where domestic use is not required to be applied for and granted by the state. A domestic water right becomes a lawful appropriation of water by actual use for prescribed domestic purposes. An application to appropriate water for domestic use can be made in a manner like other appropriations, or an unquantified domestic water right can simply exist upon first use made for domestic purposes. Domestic water supply is only partially managed in the GMD3 as most domestic uses are not quantified or reported in the district. Domestic use is generally estimated in the management program as 15 acre-feet annually per section of land in GMD3.

Public water supply. In Kansas, a public water supply system is defined by Kansas Statutes Annotated (K.S.A.) 65-162a and Kansas Administrative Regulations (K.A.R.) 28-15a-2 as a "system for delivery to the public of piped water for human consumption that has at least 10 service connections or regularly serves at least 25 individuals daily at least 60 days out of the year." These systems are regulated by the state to assure the citizenry safe and pathogen-free drinking water and are comprised of water intakes, wells, and water treatment facilities.

The Kansas Department of Health and Environment (KDHE) oversees 68 public water systems in GMD3 that include municipalities, rural water districts, and privately-owned public water supply systems. If drinking water is supplied by a private water company, the Kansas Corporation Commission supervises the rates charged. An example of one such company operating in GMD3 is the water supply activities of Wheatland Electric Power Cooperative. There are 242 active and emergency public supply wells within the boundaries of GMD3. These systems serve anywhere from a small community of 10 or more homes to the largest cities of Garden City, Dodge City and Liberal. With a lack of surface water sources, groundwater sources supply all drinking water in the district.



KGS Map of the Ogallala/High Plains aquifer.

Ogallala/High Plains Aquifer Characteristics

The Ogallala/High Plains (OHP) Aquifer consists mainly of a heterogeneous assortment of sand, gravel, silt, and clay of Tertiary and Quaternary age that were deposited by sluggish streams that flowed eastward from the Rocky Mountains. The aquifer sediments overlie an eroded bedrock surface of Permian and Cretaceous age. The Tertiary Ogallala Formation makes up the main part of the aquifer, though aquifer dewatering is creating more semi-confined behavior of the aquifer in the district. The Ogallala Formation is a coarse-grained unit that is highly productive from water-saturated intervals. The oldest part of the Miocene Ogallala Formation in Kansas is ~ 12 million years old. The older Oligocene deposits (a.k.a. White River Group/High Plains Aquifer, 26 million years or older) are finer grained than the Ogallala, not nearly as productive for water and roughly coincide with the area of the thickest Tertiary deposits in SW Kansas. They also coincide with the area of the greatest water-level declines (from KGS). Because of the similarity in composition, the older Tertiary sediments are difficult to distinguish from the younger Quaternary sediments. Many recent maps can be found in the Kansas Geological Survey High Plains Aquifer Atlas, at: http://www.kgs.ku.edu/HighPlains/HPA_Atlas/

Aquifer variability. The OHP Aquifer in the district varies widely in type of material, thickness, and layer continuity. Individual beds generally are not continuous and within short distances may grade laterally or vertically into material of different composition. Hydraulic conductivity and specific yield depend on sediment types and therefore also vary widely both vertically and laterally. Some layers are cemented and are referred to as mortar beds and caliche. Although the aquifer is generally unconfined, confined and semi-confined conditions may occur locally. Thick shale layers are present in areas of the OHP Aquifer where significant saturated formation

thickness may only provide small amounts of water to wells and the density of wells is very low like in parts of Seward and Meade counties

Aquifer thickness. The thickness of the unconsolidated sediments of the OHP aquifer varies greatly due mostly to the uneven bedrock surface. An estimated 63 million acre-feet of aquifer poor space has been drained of water since pre-development. Remaining saturated thickness ranges from zero to more than 500 feet as illustrated in the Kansas High Plains Aquifer Atlas (Kansas Geological Survey 2016). The areas of greatest thickness are found in the southern portions of Stevens, Seward, and Meade Counties.

Groundwater rate of travel. Regional lateral flow of groundwater is generally from west to east-southeast across the district at an average rate of about 1 foot per day or less under the normal regional tilt in the static water table. Locally, a higher rate of groundwater flow can be estimated where there is a greater slope in the water table, especially during well pumping. Groundwater travel rates can be significantly affected where water level gradient is increased near a pumping well and flow can exceed 300 feet per day (KGS). Depth to static water elevation from the land surface is highly variable and can exceeds 400 feet in the district.

In some areas, such as the Arkansas and Cimarron River corridors, the OHP Aquifer is hydraulically connected to overlying alluvium. In parts of the Arkansas and upper Cimarron River corridors, the alluvium is differentiated from the OHP Aquifer based on the greater permeability of the alluvium and underlying lower permeability zone, which results in differences in water levels between the aquifers. The OHP Aquifer is also hydraulically connected to the underlying Lower Cretaceous Dakota Aquifer across the central portion of the district.

Aquifer depletion rate. The rate of depletion of district aquifers generally decreases with increased precipitation. For the High Plains Aquifer, the maximum allowable rate of depletion when new water permits were issued in the district has been 40% in 25 years. Recent figures from the GMD3 groundwater model indicate an overall decline in supply in excess of 30% since pre-development (50 years) conditions. However, that estimate is considered short of actual depletion based on observed well yield declines and an estimate to be improved under the area OHP groundwater model update scheduled for 2020.

Bedrock Aquifer Characteristics

Dakota. The Dakota Aquifer system is comprised of sandstones and shale that typically yield much smaller amounts than the yield of wells in the OHP Aquifer. The Dakota Aquifer underlies and is in hydraulic connection with the High Plains Aquifer in much of the southern part of GMD3. In western Stanton, western Morton, and southern Hamilton counties, the OHP Aquifer is absent or is very thinly saturated and the Dakota aquifer (with some Morrison-Dockum strata contributing in Stanton and Morton counties) is the primary shallow aquifer. Additional Dakota Aquifer information can be found at: http://www.kgs.ku.edu/Dakota/vol3/ofr961a/man02.htm.

In the northern part of the district, low permeability shale and chalk overlie and hydraulically isolate the Dakota Aquifer from the overlying OHP Aquifer. Some wells in northern Finney County may be completed in geologic voids in the Niobrara Chalk formation and are referred to as crack wells that typically produce a good amount of water until the crack or void is dewatered.

For additional geologic information on groundwater formations above the Dakota, see: http://www.kgs.ku.edu/Dakota/vol3/ofr961a/man03.htm

In the southernmost part of the district, Cretaceous age formations may be absent where Permian bedrock formations directly underlie the High Plains Aquifer. For additional information with additional study needs, see: http://www.kgs.ku.edu/Publications/Bulletins/IRR8/05_deve.html

Morrison-Dockum. The Morrison-Dockum Formations are a distinctive sequence of Upper Jurassic Morrison and Late Triassic Dockum sedimentary formations that provide some water supply in the district that may be included as part of the OHP Aquifer system where hydrostatically connected in the subsurface. They are generally composed of mudstone, sandstone, siltstone and limestone and is light gray, greenish gray, or red. The lower sandstones of the Morrison are relics of the rivers and floodplains of the Jurassic period.

Permian. The Upper Permian age red beds may contain sandstones with some usable groundwater locally and may also have water quality concerns that require careful water sample evaluation, monitoring and supervision to prevent water usability depletion of fresher groundwater supplies. Further investigation of potential uses of Permian age aquifer water for irrigation can be expensive, and some geological testing and completion of deep wells for irrigation have occurred as shallower sources become depleted and oil and gas production tests indicate some limited deeper water sources are available. Efforts to evaluate the usability, reliability and feasibility of these potential sources together with newer technologies to treat poor quality water from marginal sources to usable standards are necessary as part of the district development and management of additional supply.

Deep brackish water aquifers. Kansas regulations require the petroleum industry to protect fresh and usable aquifers from contamination by confirming minimum depths for surface casing in a petroleum exploration borehole. The surface casing is a pipe that is inserted into the borehole being drilled during oil or gas exploration and sealed in the annular space between casing and formation by injecting cement under pressure to fill and seal the space. Concern exists when old wells established early when surface casing depths were short or not fully cemented in from top to bottom may eventually allow usable fresh water from an upper formation to flow uncontrolled to a deeper formation. For example, recently in northeastern Haskell County, additional study is needed to assure the protection of usable district groundwater supply. Partnerships with Kansas Corporation Commission and the petroleum industry may help protect aquifers that may become usable groundwater sources through advancements in technology for water treatment.

Groundwater management concerns for deep confined brackish water aquifers are to protect fresh or usable water supply from usability depletion and to identify ways to better utilize the non-fresh water resources of the district for energy management and added water supply using activities that are technologically and economically feasible. Kansas law requires the state to permit such priority use of poor quality where feasible ahead of authorizing fresh water sources. The successful implementation of this policy may require adoption of criteria to further implement water conservation under the management program.

Groundwater or surface water. Most surface water in the district is destined to become one of three uses: direct use; unused evaporative loss; or groundwater storage in the pores of the soils

and sediments for the GMD3 area. For quality purposes, Kansas regulations broadly define groundwater as "water located under the surface of the land that is or can be the source of supply for wells, springs, or seeps, or that is held in aquifers or the soil profile" (K.A.R. 28-16-28b(dd)). For quantity purposes, Kansas regulations simply say "Groundwater" means "water below the surface of the earth" (K.A.R. 5-1-1(ii)). Given that no water is truly static and can move both directions above and below the surface of the earth, it can be useful to consider residency time as a measure of what may be considered a groundwater vs. surface water source of supply and whether that residency is induced by member diversion activity. For example, groundwater discharged to a river bed may, at that point, become surface water. Water in a sand pit exposed to surface evaporation may be considered a well of groundwater. How long must surface water travel through or reside in the ground before it is considered groundwater and vice versa? The answer may depend on the practical effect on the supply systems of the management program and water rights administration. Surface water may be groundwater on its way to storage below the surface of the earth.

Precipitation and groundwater recharge. The climate of southwestern Kansas is semiarid, characterized by moderate precipitation, low humidity and high evaporation. Annual precipitation increases to the east across the district and typically ranges from 16 to 24 inches annual average. Most of the precipitation falls during the growing season, April through September. Drought conditions can yield as little as 4 inches of annual rainfall in the southwest corner. Annual pan evaporation rates average 68 inches annually. Potential sources of natural aquifer recharge include precipitation, surface water deep percolation (including the Arkansas and Cimarron Rivers and irrigation ditch areas), return flow from irrigation use, lateral groundwater flow, and flow from adjacent aquifers. The most effective recharge occurs on clean residue covered soils where ET, runoff and direct evaporation are minimized. No large-scale water importation sources have yet been developed to move additional surface water into the GMD3 area, though some small-scale private import and export projects occur on the fringes of the district.

Natural or artificial aquifer recharge. Managed aquifer recharge through natural surface water process or artificial enhanced process to refill aquifer pore spaces can provide efficient and practical management of precipitation, accumulated surface water and, reclaimed water sources in the public interest. Surface water known to recharge aquifer supply can be protected and managed for new or sustained benefits. This activity can maximize storage, improve management of seasonal surplus water supplies, reduce evaporative losses and reduce depletion draw down levels resulting from use demands in targeted aquifer areas. Managed aquifer recharge projects may include managed natural aquifer infiltration areas, constructed infiltration basins, infiltration galleries, vadose zone infiltration wells or aquifer injection wells.

Recharge rates. Local natural recharge rates are affected by evaporation, soil properties, land cover, land use and proximity to sources of recharge water. Natural replenishment estimates are low, typically less than one inch of water annually. Generally, one inch of water fills about 6 to 8 inches or more of aquifer formation to saturation, depending on the size and connectivity of sediment pore spaces. Recharge rates may be higher locally, such as beneath river and ditch corridors, irrigated land, and sandy soils. The overall imbalance between water use and enough recharge or alternate supply is projected to cause billions of dollars in future lost economy.

Recent estimates from the Kansas Geological Survey indicate about 800,000 acre-feet net loss occurs annually on average beyond what is returned to district aquifers.

Weather modification. Contemporary sustainable water supply initiatives in water short areas may include water from air (WFA) technologies that tap the water vapor reservoir in the air. The GMD3 management program has historically provided support for a Western Kansas Weather Modification Program (originally "Muddy Roads" project) to increase precipitation and reduce damaging hail loss of crops and other property that reduces value from irrigation water use. GMD3 participation in weather modification occurred from 1995 through 2015 in support of counties served by GMD3 who elected to participate. Currently, no counties served by the GMD3 participate in a weather modification program. Therefore, GMD3 has suspended weather modification program support. Several other regions and water management programs around the country continue to operate weather modification programs and new programs and studies indicating program benefits are ongoing in western states. GMD3 will monitor programs and study results for consideration for possible future management program implementation.

Economy

Water fuels the engine of economy. In an area of the country where there is little surface water, groundwater management is a management activity of both water and the economy. From the Kansas Department of Agriculture (KDA) 2016 annual report, agriculture is the largest industry, employer and economic driver in Kansas, accounting for nearly 43 percent of the state's economy and valued at more than $64 billion annually. More than 229,000 Kansans, or 12 percent of the state's workforce, are employed in agriculture. Kansas is among the nation's leaders in beef cattle, sorghum and wheat, with expanding roles in Dairy and cotton. At 28.2 million acres, Kansas has the second-most cropland of any state.

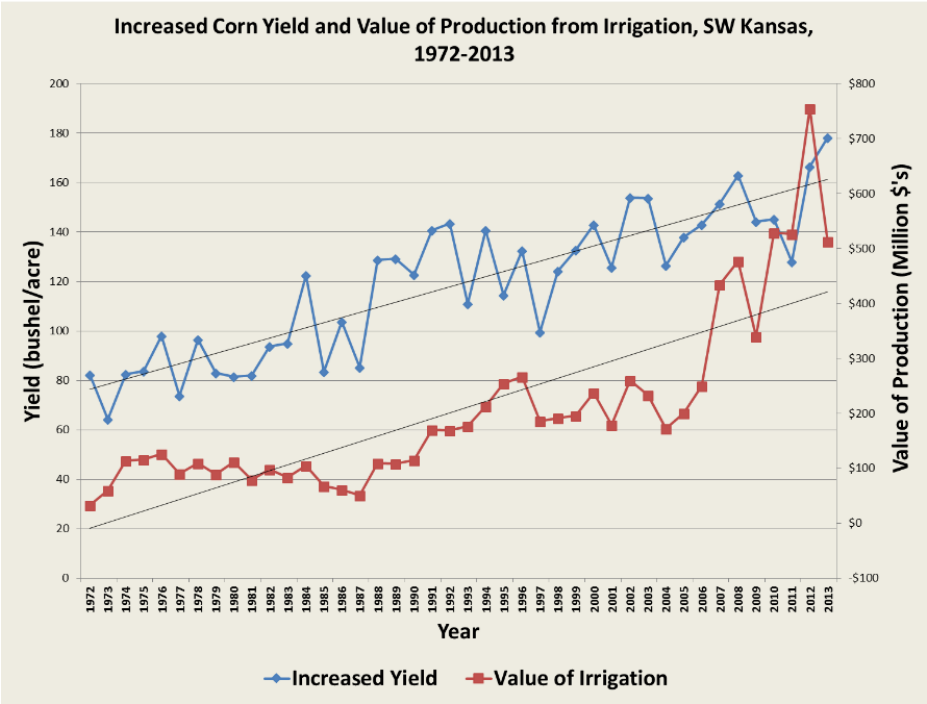
GMD3 member farmers and ranchers not only manage the soils for sustainable production systems but they also work to improve management and conservation of district water resources. GMD3 works to provide leadership in developing the efforts of the entire groundwater management district for the proper management and conservation of groundwater resources and to secure for Kansas the benefit of fertile soils and favorable location with respect to national and world markets.

2012 County Farm Facts (most recent federal data available)

GMD3 COUNTY	# OF FARMS	FARM LAND	CROP ACRES	CROP MRKT VALUE	LVSTK VALUE
				----- $1000 ----	----- $1000 ----
Finney	516	760,110	370,072	140,746	552,781
Ford	664	634,240	286,263	87,004	387,072
Grant	326	337,320	175,725	63,853	513,055
Gray	473	546,118	273,329	109,340	582,042
Hamilton	431	610,864	217,281	51,817	215,208
Haskell	248	398,805	242,130	116,154	602,139
Kearny	337	519,424	187,892	66,321	154,747
Meade	448	602,281	232,429	91,206	103,386
Morton	353	441,926	178,875	42,645	76,500
Seward	342	395,981	188,729	81,688	279,966
Stanton	328	414,184	204,776	76,592	105,158
Stevens	425	503,439	267,698	124,066	108,850
Totals	4,440 Farms	6,164,692 acres	2,413,895 acres	$1,051,432,000	$3,680,904,000

USDA information on farms, crops and livestock in district counties (updates in 2019).

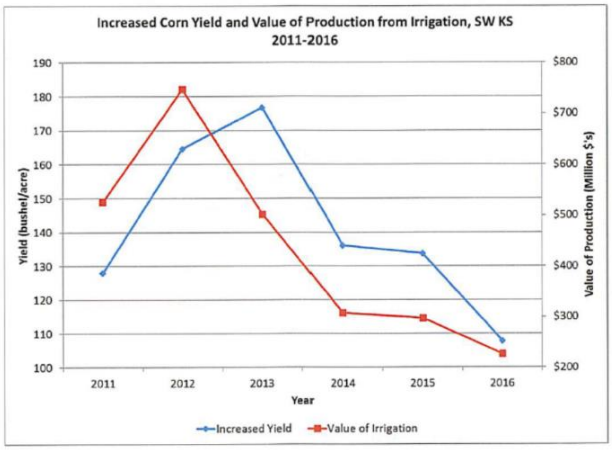
The corn standard. Corn is the most popular irrigated crop in the district according to annual water use reports collected by the Chief Engineer. According to the Kansas Department of Agriculture, the value of irrigated corn produced in southwest Kansas was $582.77 million in 2013 and the total economic income generated by that corn was $842 million. The Net Irrigation Requirement (NIR) for corn ranges from 13.7" in Ford County to 15.4" in Morton County; this is in addition to the average precipitation of only 19 inches (K.A.R. 5-5-12, NIR at 50% chance of rainfall; K.A.R. 5-6-12, Average annual precipitation). Corn is the first irrigated crop in the district to be provided a limited irrigation risk management option in the federal crop insurance program of USDA Risk Management Agency. USDA irrigated corn yield average in Kansas 1972-2016 was 165 bushels per acre (average 32 million acres harvested) and non-irrigated average 1972-2016 was 46 bushels per acre (average 557 million acres harvested). If corn acres were all dryland the economic impact from reduced value and surety would be significant. Some years, dryland production is wiped out by drought without the safety-net of irrigation.

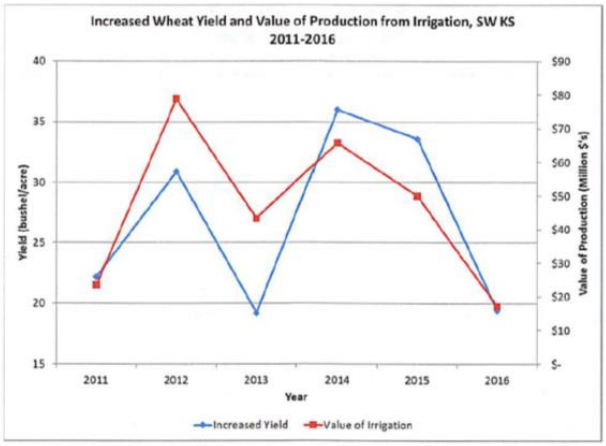


Source: Kansas Department of Agriculture

Economy decline from irrigation decline. From a Kansas Department of Agriculture (KDA) presentation to the Governors economic advisory council, Dodge City, 2013 when commodity prices were strong, one less irrigated acre in Southwest Kansas will lead to an estimated loss of value to Kansas of $2,200 land resale value and 122.5 bu of corn at $6.78 = $831 and 2 cattle on feed, approximately equal to 1,060 usable pounds of meat or a 2012 wholesale value of $3,080 (assumes an average price of $2.90/lb. of beef). This is a yearly loss of $3,911 per irrigated acre transitioned completely to dryland. There are about 1,500,000 acres authorized for irrigation in GMD3. In the district, value added from irrigated corn and wheat production is, for SW KS, $556,532,840 in 2013. Additional production generates income from agricultural producers and input suppliers, and this income circulates through local and state economies, creating a multiplier effect dependent on available water supply.

Market adjustments. In 2016 according to KDA, the return associated with irrigation (value of production) for corn in southwest Kansas was $226,638,720, while the return to irrigation for wheat was $17,227,200. Combined, the increased return to irrigation from corn and wheat in southwest Kansas in 2016 was nearly $243.9 million. Considering generally accepted economic multipliers, the economic impact of this increased production was valued at almost $582.2 million. It is important to note that the value of irrigation is directly impacted by commodity crop prices and dryland yields. From 2014 onward, we have seen the combination of both declining prices and increasing dryland yields, which caused a market adjustment and reduced the return associated with irrigation. However, a change in either the dryland and irrigated yield spread, or the relative price would create a notable increase for the value of irrigation. This is evident in the recent year's corn yields and value.





From K. Liebsch, Economist, Kansas Department of Agriculture, February 2018.

Beef and Dairy animal agriculture. Kansas ranked third nationally in numbers of cattle and calves on ranches and in feed yards in 2015 with 6 million head and second in the fed cattle market in 2014 (USDA, 2016). Revenue from cattle production grew more than 36% from 2010 to 2014, with cattle providing $7.75 billion in cash receipts in 2013 (KLA, 2016). Nearly half of the state's agricultural cash receipts in 2013 came from the sale of cattle and calves. Kansas ranked 16th nationally in milk production in 2015 when milk production was valued at $746 million (USDA, 2016). District animal agriculture provides a significant portion of these state numbers, due to reliability of irrigated grains and forage.

The district is one of the fastest growing regions for dairy production in the United States with the advantages of open spaces, favorable climate, irrigation for consistent high-quality forage, and abundant groundwater at a safe depth that separates nutrient management activity from the hydrologic cycle. The district is now home to the largest milk drying plant in North America, located in Garden City.

Economic analysis. Economic analysis drives water use and development projects. It is a critical element of the water resources planning and management processes because it not only evaluates the economic justification of plans, but it can assist in plan formulation and alternatives. Although economic analysis is traditionally performed by economists, the implications of the economic analysis (which often can dictate whether a project is implemented) make it imperative that the concepts, methods, and tools used in the economic analysis be understandable to (a) the other specialists involved in the feasibility studies, (b) management who must make a decision

concerning the proposed project, and (c) the various stakeholders who are involved in the planning process and who will ultimately be affected by the project or be asked to fund it in whole or in part. For example, a cost to benefit analysis is included in water conservation plan guidelines of the Kansas Water Office.

The value of water in the GMD3 area. Water is widely considered to be undervalued. Especially when considering security of future water supply. There are several factors that influence the value of district water. GMD3 commissioned a study by the Docking Institute of Public Affair's in 2000 to examine through 2020 "*The economic impact of an acre-foot of water on the economy of Southwest Kansas* (2001)." Five scenarios of water utilization and economic impact were developed and analyzed. The first scenario modeled the farming and water utilization practices. This scenario found that excluding government subsidies, the average net present value per section over 20 years (2020) is $ -150,000, while the saturated thickness of the aquifer would decrease by about 30%. Including subsidies from external sources, the study found that on an annual basis, the total economic impact on the GMD3 area from irrigation was estimated at $188,496,000 in 1998 dollars. This equals about $80 per acre foot. Over the course of the 20-year period of the study, the net present value of this impact in current dollars was estimated at $3,769,920,000.

In the remaining four scenarios of the Docking study, the team explored the impact of changing irrigation methods and water requirements (and thus yields) for irrigated crops on depletion of groundwater supply and the net present value for irrigators. The study found that the most viable scenario for achieving near zero depletion was one that changed all flood irrigation to center pivot and reduced the water utilization for corn by 50%. Significant, the reduced water for corn would only result in a 10% reduction in yield. However, the cost to the irrigator of these changes would have a net present value per section of -$4,200 annually, or -$84,000 over the course of the 20-year study. The total cost of this near zero depletion scenario would be about $11 million (1998 dollars) annually ($4,200 X 2618 sections). Of course, government subsidies and low interest loans will substantially lower the cost to members of GMD3 and the cost for individual irrigators will vary by specific circumstances related to their operations. An evaluation of predictions and update of the study outcome is due for consideration in 2020.

Damage claim example of deficient groundwater valuation. Of the many studies of the economic value of district water supply, the most comparable to the Docking study example is the "Kansas' Expert Reports in Support of its Claim for Money Damages for Colorado's Violations of the Arkansas River Compact 1950-94" (1998). Using only classic cost-benefit analysis, the experts found that the value of Arkansas River water in 1998 dollars was an average $514 per acre foot for all uses (irrigation agriculture, industrial, and municipal). A notable deficiency of the cost-benefit analysis for groundwater occurred under the classic cost-benefit analysis when experts were unable to identify present value lost for the over 400,000 acre-feet of stored groundwater found absent from district aquifer storage that went to replaced supply shortages of Arkansas River basin water from Colorado. The missing groundwater itself was considered to have no present value as a lost future supply when projected market use values (in 50 years) were discounted back to present. The resulting present value estimate of the sizeable missing future supply from storage was determined near zero.

Counter intuitive valuation of groundwater. A no present value to a future groundwater supply conclusion like that of the damage claim example is highly counter intuitive and not

consistent with the management program activities, knowing that an extreme future supply shortage should find stored water value significantly elevated and at a premium. The no value conclusion also strikes at the very heart of present conservation efforts to leave water in storage to meet higher future value demand and suggests a waste of public resources to accomplish this activity. The recognition of error in the no present value conclusion also suggests vigilance is needed in the application of public water policy to protect against value judgements that may prejudicially and unreasonably affect the local public interest. Valuation of groundwater should adequately consider that groundwater storage and use have elements of both market and non-market services and product over time. Monetizing and quantifying the services of groundwater and surface water that recharges groundwater sources for the district over time should consider the broader natural and intrinsic values that result in groundwater existing in the future destiny of an area and not just consider it a free good under all possible supply value scenarios.

Groundwater value and "tragedy of the commons." Tragedy of the commons is an economic theory that describes "a problem that occurs when individuals exploit a shared resource to the extent that demand overwhelms supply, and the resource becomes unavailable to some or all," according to an oft-cited 1968 article in the journal Science. Several strategies that may be employed in cases of "overwhelmed" or completely developed and declining supply in GMD3 may depend significantly on valuing several thing: management philosophy for use of the groundwater resources; water conservation; and water transportation infrastructure to sustained supply to meet demand for water. If groundwater value is only measured by its production cost to meet near-term needs, the value will always appear cheap until we look at cost to replace or get close to depletion, for which we did not protect or replenish supply and the loss of both market and non-market values become evident.

Meet needs and preserve or replace storage when possible. The water conservation program of GMD3 seeks members use what they need under modern efficiencies and leave in storage what they can in order to preserve an improved future value for the stored water supply. Whether used to meet a valuable service, preserved as reserved water left in the aquifer or appropriated as new source development, water management with a proper water valuing tool can inform decisions about allocating water across multiple uses and services to maximize Kansans well-being. Allocation of water can take different forms, such as regulation or use of economic instruments that avoid waste and promote conservation. Properly valuing water by members and by GMD3 and program partners can make the cost of usability depletion and waste apparent and can promote greater efficiency and demand improved program practices.

Usability Factor in valuing water. The usability of water as a water quality factor must be considered when assessing the value of district water supply. Models used for estimating economic value rarely apply assumptions to address water quality change over time; what is referred to as "water usability depletion." Water usability depletion is when normal uses of historical supply are lessened or impaired by a decline in the water quality, causing a material depletion in the utility of the water. This depletion in water utility is a depletion in water value that occurs when it becomes necessary to increase the amount of water needed, and/or incur higher costs, to achieve similar valued services. For example, membrane filtration water treatment necessary to remove radio-nuclei contaminants requires additional energy expense and eliminates about 15% of the water as waste permeate disposed of through injection into deep geological formations. So, more energy cost and a depletion of water quantity. As stated earlier,

such water usability depletion factors are missing from most economic models. A water usability factor should be employed in each water project or compact risk evaluation in the district.

Replacement Costs in valuing water. Replacement cost analysis is another way of valuing stored water inventory in the district as well as the value benefit of waste reduction costs. The water importation strategy to replace or replenish aquifer supply figures prominently as a key bulk water source that pushes replacement cost analysis for the district to new heights. The debate over importing water intense goods vs. the water itself for the future economy may suffer from similar water valuing deficiencies in value methodology used in projecting future lost opportunity cost as in the KS vs CO damage case. Water import projects would likely be as much about energy management economy as they would be about water management economy. More study of identifying appropriate future cost-benefit criteria and aggressive alternatives for viable water transport partnering with energy management projects are needed to gain value multipliers for enough and appropriate feasibility analysis to overcome the proverbial kicking of the can down the road regarding risk and leadership issues.

Energy Costs in valuing water. One cost of water is the cost of energy to transport water from storage to beneficial use. For example, groundwater pumping in the district uses a great deal of energy just in lifting costs in order to use the groundwater. Well depths average about 300 feet of lift. Of the 12,826 authorized non-domestic wells in the district, about 8,480 are used annually for providing irrigation water supply. If the estimated energy used by those wells is expressed in terms of electric power, the total energy required annually in the district would be approximately 1679.04 gigawatt hours to move 2,000,000 acre-feet (estimated from Pioneer Electric Coop data and state well data). Actual energy sources used include Electricity, Natural Gas, Propane, and Diesel fuel.

Infrastructure cost in valuing water. All water supply and use rely on both natural and constructed private and public water infrastructure. Valuing water properly is a critical activity to support present and future infrastructure for water supply, and to balance the multiple uses and services provided by water over multiple timeframes and with multiple partners. Pricing is not synonymous with value but is one way of covering costs, reflecting part of the value of these uses, and ensuring adequate consideration of resources and finance needed for new infrastructure and water sources that may be technologically and economically feasible sources of supply.

V. GMD3 PROGRAM ACTIVITIES - NATURE AND METHODS

Elements of the Groundwater Management Program

1. Working relationships with other local, state and federal regulatory agencies;
2. Harmonizing the activities of the GMD3 Management Program with state and federal activities of administration of water rights, natural resource conservation, water planning, water quality protection, infrastructure development and other government services;
3. Facilitating planned surface water and groundwater conjunctive use operations;
4. Monitoring groundwater levels and storage inventory;
5. Mitigating conditions of overdraft by encouraging conservation and exploring opportunities for additional sources of supply;
6. Developing imported supply for use services and groundwater conservation storage replenishment;
7. Demonstrating leadership in the construction and operation of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects;
8. Collaborating with members and government offices to achieve efficient infrastructure management and investment, proper well construction, evaluation, abandonment, monitoring and plugging program;
9. Identifying and partnering to protect wellhead and recharge sources and areas;
10. Managing activity to migrate and remediate contaminated groundwater;
11. Controlling saline water intrusion into fresh groundwater supplies; and,
12. Reviewing water, aquifer and land use plans and coordinating with water and land use planning agencies to harmonize economic development activities with the management program and assess activities which may create opportunity or risk to members and the management program.

The Kansas Legislature expected locally prudent groundwater supply decision-making guided by a formal local board and program to manage groundwater supply and economy in the public interest. In more than 500 monthly meetings, the locally elected volunteer Board of Directors of GMD3 has identified district water supply problems and considered the nature and methods of addressing those supply problems with help from members, professional staff, consultants, state staff and other important partners in groundwater management. Even with the significant progress realized in water conservation and efficient water use, individual well yields and the number of irrigated fields have declined dramatically in many areas. Reduced pumping rates and unproductive wells are real and current events in an increasing area of western Kansas. Reduced pumping rates also indiscriminately and adversely impact livestock feeding operations, dairies, ethanol plants, and municipal and industrial users, making it more difficult for them to meet demands for water. But there are areas where the aquifer water column and recharge rates offer hope for sustainable economic activity.

This districtwide management program contains the program activities that describe the nature and methods undertaken to address water supply problems in the district. The governing body of GMD3 regularly adopts resolutions creating Board policy and selects supply problem actions and funding sources to be implemented with goals and action plans that are SMART FOR GMDs. Setting goals and action plans will use guidance documents separate from this management program document to better react to the needs and opportunities provided by other stakeholder initiatives with minimal government red tape. Supporting management program guidance documents and action plans will be posted on the GMD3 website.

GMD3 Water Rights Administration Program

Members use waters of the state of Kansas according to their water rights. Water rights are granted, and use is supervised administratively by the state Department of Agriculture, Division of Water Resources in a manner to be consistent with the real property rights of GMD3 members according to the WAA and the public interest of the management program under the GMD Act. A key legislative policy for such activity that pre-dates the GMD Act is found in K.S.A. 82a-711(a) *"…to the end that the highest public benefit and maximum economical development may result from the use of such water."* Once granted, a water right becomes a real private property right to use available water in a manner consistent with the terms, limitations or conditions of use. A water right is not a grantee of a water supply and is subject to demands for water by owners of prior rights. The question of whether a hardship or injury to water supply may be realized under member use or threatened by new use proposals for pumping wells from depleting local supply has always been a public interest concern of GMD3. Just and proper administration of rights under the activities of the district management program has been a fundamental consideration from the original formation of the district and reason for GMD3 review of applications and projects, guided by adopted standards of recommended well spacing and allowable appropriation rules to mitigate reasonable changes by appropriators in the aquifer conditions of the time upon which other appropriators depend. These considerations may be further complicated when applying due consideration for efforts of individual members to save or recharge water in their local aquifer source of supply and the extent their management efforts may be undermined by the proposals and activities of others in search of better groundwater supply to meet their needs. More than 40 years of additional data, groundwater case law and input of membership since GMD3 formed has significantly affected perspectives of proper management policies for the use of the groundwater in the district.

K.S.A.82a-706b(a) provides in pertinent part:

> *It shall be unlawful for any person to prevent, by diversion or otherwise, any waters of this state from moving to a person having a prior right to use the same…*"

Also, K.S.A.82a-711(c) provides in pertinent part:

> "*With regard to whether a proposed use will impair a use under an existing water right, impairment shall include the unreasonable raising or lowering of the static water level or the unreasonable increase or decrease of the streamflow or the unreasonable deterioration of the water quality at the water user's point of diversion beyond a reasonable economic limit.*"

It is widely accepted that the Kansas Water Appropriation Act (WAA) endowed the Chief Engineer with certain statutory duties to grant and protect water rights according to the doctrine of prior appropriation under prescribed considerations (K.S.A.82a-710). These prescribed considerations include the effects on other wells within reasonable economic limits as described above and to consider all matters pertaining to public interest per K.S.A.82a-710(b) as follows:

> *"(b) In ascertaining whether a proposed use will prejudicially and unreasonably affect the public interest, the chief engineer shall take into consideration:*

(1) Established minimum desirable streamflow requirements;

(2) the area, safe yield and recharge rate of the appropriate water supply;

(3) the priority of existing claims of all persons to use the water of the appropriate water supply;

(4) the amount of each claim to use water from the appropriate water supply; and

(5) all other matters pertaining to such question." (Emphasis added)

It is the opinion of GMD3 that "*all other matters pertaining to the question*" under K.S.A. 82a-710 necessarily must include the legislative declaration of public interest under K.S.A. 82a-1020 of the GMD Act and a management program. Thus, the GMD3 management program and recommendations of the governing body are to be included as part of the prescribed necessary considerations of the Chief Engineer under the WAA. The outcome of application review for hundreds of use proposals can profoundly affect the future and success of the management program and local groundwater conservation efforts.

1. **GMD3 will use physical and economic limit well constraints to identify, inform and consider critical wells and associated water rights to aquifer supply.** In the declining aquifers of the GMD3 area, there is an ever-diminishing supply to make available to members water rights that authorize well use and to new proposals that alter conditions of well use for local water supply. Under a physical solution to well hardship or injury in a declining groundwater inventory, the objective often is to enable an existing use to continue but using less water. Such an approach is explicitly based on the understanding that it is the use that is protected by a water right and not necessarily any fixed quantity of water in a depleting supply.

    A. **Drawdown Allowance.** In a process for review of new proposals affecting water use in the district, preventing any level of new impact on a well is impractical, as this would result in the denial of all applications including those causing relatively small or de minimis impacts. A drawdown allowance may be used to define the relatively small impact due to a proposed diversion that may be allowed to occur on wells in which economical and/or physical constraints are exceeded. This allowance may be applied more conservatively for conservation plans where rule waivers and new well effects are considered vs. members seeking to replace their supply well. These will be determined in a separate guidance document or by rule.

    B. **Critical wells.** Wells in which economic and/or physical constraints are exceeded due to adopted evaluation period criteria are referred to as "critical wells." Wells may become critical due to the use of existing water rights alone or the combined effects of dynamic drawdown, existing uses, and proposed uses if one or more of the drawdown constraints are exceeded. The drawdown allowance can be used as a screening tool to identify wells that require additional evaluation.

    C. **Economical Drawdown Constraint.** The economical drawdown constraint is calculated based on the percent of initial water column that can be lost before the well falls below economical viability. In the absence of more reliable data, a value of 70 percent of the initial water column may be assumed as the economical

drawdown constraint where from a theoretical (hydraulic) standpoint, it is impractical to pump a well in an unconfined aquifer at a drawdown that exceeds two-thirds of the thickness of the water-bearing formation (Groundwater and Wells, Third Addition, Johnson Screens, 2007, page 429).

D. **Physical Drawdown Constraint.** Physical hardship is the loss of the required well yield due to excessive water level decline. The physical drawdown constraint is the difference between the depth to the current static water level (or depth to the potentiometric surface) and depth to the **Lowest Practical Pumping Level** (LPPL). The LPPL depends on the availability of well completion information such as the depth and thickness of the water bearing zone or confining unit, pump setting, and screen setting.

   For non-domestic wells in an unconfined aquifer, the LPPL may be assumed to be 60 feet above the base of the water column, if the screen interval or pump setting is unknown, unless this assumption is unreasonable. The LPPL for non-domestic wells in a confined bedrock aquifer may be assumed at the base of the upper confining unit unless this assumption is unreasonable (Sterrett, 2007). If the total drawdown extends below the LPPL that well becomes a critical well.

E. **Domestic wells.** Due to the relatively low volume of water produced by domestic wells, and other construction factors, some wells may be constructed with pumps set within the screen interval or close to the bottom of the well. The LPPL is typically assumed to be 20 feet above the base of the water column for domestic wells unless a different value is supported. At least 20 feet may be necessary to maintain submerged conditions, to allow a pump setting above the bottom to avoid sediment problems, and to allow for dynamic drawdown and other components (length of pump and net positive suction head).

F. **Maximum allowable rate of depletion.** For the OHP Aquifer district wide, a maximum allowable rate of depletion has been used historically as a standard under the management program for more than 40 years. The GMD3 40/25 maximum allowable rate of depletion calculation will be used to insure any proposal will not result in exceed nor add to such a rate of aquifer depletion.

Well constraints illustrated. Illustration of economical and physical well evaluation constraints are provided in four images in the Appendix. The 40-year evaluation period illustrated may become a different evaluation period applied in GMD3.

Local source management. In a closed and declining aquifer area, each administrative well evaluation should be consistent with the overall management program and consider available supply, priority of right and any opinion of other members to avoid wasteful infrastructure investments and objectionable clustering of demand from increasing the rate of mining remaining productive local sources of supply. Adding depletion to local sources by moving paper rights from adjoining depleted areas is known as “chasing water.” As part of a management program promoting local source management, water rights authorizing use in rapidly depleting local sources of supply must be allowed to

keep the existing supply conditions and be reasonably limited in options for new well locations that may cause unreasonable critical well supply concerns under prior rights. Wise water use and conservation activity under the management program should provide for well evaluations that assure reasonable prospective supply and reasonable impairment protections that inform and engage members under their owned real private property right supply considerations. Such a well evaluation system under the WAA should be implemented first, before jumping to regional blanket reductions, to guide the destiny of water use under the GMD Act.

2. **GMD3 Water Rights Administration Guiding Principles:**

   A. **Conserve and grow supply** – Engage members to be conservative in present water use and management and support growing future benefits from preserved or replenished usable water supply to conform to the public interest to the end that the highest public benefit and maximum economical development may result from the use of such water (K.S.A.82a-711(a)).

   B. **A closed aquifer dedicates native supply to existing usufruct rights** – Aquifer inventory and recharge sources become dedicated to use by existing real property rights owned by district eligible voters of GMD3 when the Ogallala/High Plains Aquifer is closed to new water rights, except for the small uses or new domestic use, temporary and term permits. New appropriations should be offset by non-use of prior rights or replaced to assure a net zero or less change in aquifer depletion rate and remaining future supply.

   C. **Drinking water matters -** Safe drinking water is a fundamental necessity of every person which must be considered in member management activity for future supply, with considerable assistance from GMD3 and all partners. It is an anomaly in the law and in proper management of groundwater if one person can for individual profit destroy the community and render the neighborhood uninhabitable.

   D. **Contributions to future supply -** An unexercised right to enjoy an acre foot or more of groundwater from a declining aquifer supply in the district that is physically and lawfully divertible from an existing operable well has a present groundwater conservation value that GMD3 can recognize as a contribution to future district supply.

   E. **Communicate to exchange information -** Good and effective communications between GMD3, its members and state and federal regulators are necessary for productive partnerships that implement the management program.

   F. **Seek mutual benefits and good will -** Encourage all water users and land owners to make water right decisions, agreements or stipulations that promote mutual benefits and goodwill in the use and conservation of the groundwater supply in the district for a reasonable future period.

G. **Evaluate water right applications and plans** - Administrative review of each application or request for an order of the Chief Engineer that may affect the groundwater supply to a well owned by any GMD3 eligible voter should include:

i. A public process to identify and disclose well evaluations and considerations implementing the groundwater management program;

ii. The applicable rules of the Chief Engineer; and,

iii. Needs to satisfy prior rights to available supply for a minimum 25-year prospective period.

Making water available is one obligation of the Chief Engineer WAA, but with other obligations to protect public interests and prior rights to the available supply. Conservation interpretations of prior rights and public interests should provide due consideration of declining local sources of supply that are already over committed to use by prior rights, and it may be difficult to further appropriate by making additional water available under a management program that emphasizes aquifer benefiting conservation. GMD3 and partners in the water rights administration program in the GMD3 area may find it easier to consider general reductions in water allocations rather than to preserve limits on individual applicants seeking to benefit their circumstance, but with the effect of further depleting a local source near their problem area. It is difficult to refuse requests when there is water diversion capacity to be further mined

Nobody wants to see anybody lose any groundwater supply, but people are. Nobody wants to see that hardship come to anybody, but there is going to be hardship (well decline, supply decline and increased water costs) and the question is how GMD3 and its partners deal with it and how members accept responsibility for their pumping decisions and effects to share and conserve the available resource and burdens of water shortage. Sharing of shortage may include added well evaluation process, delay in administrative decisions when evaluating proposed permits to more fully develop, distribute to neighboring members and consider the actual supply condition and future supply effect of each proposal..

3. **GMD3 will assist in the preparation of applications.** Assistance provided by GMD3 staff may be for completing an application for a state permit or for other such water-rights related member project planning and paperwork, but it shall be the responsibility of the proposer to review all such information and to submit same to the Chief Engineer as required by law and as advised by their own independent legal counsel and/or technical expert.

4. **GMD3 will review** water right applications and evaluate considerations of surface water and groundwater and any operating plans that may affect supply to members to insure compliance with the management program and Board policies.

5. **GMD3 will recommend** to the Chief Engineer or other appropriate local, state or federal officials any actions, rules or terms and conditions that support implementation of the management program and policies adopted by the GMD3 Board of Directors.

6. **GMD3 will work with members and officials** to provide options to resolve concerns that may include seeking a facilitated consent agreement recognized by order of the Chief Engineer to address uncertainties of water right administration and future supply and include a full review of proposals or complaints using a 25-year prospective supply evaluation period. This will occur as requested and as needed to secure member water supply, including any needed trigger points, mitigation measures or forbearance agreements that may be negotiated between informed members for added confidence and value in member real property rights to present and future groundwater supply.

7. **GMD3 will monitor annual water use from within the district.** GMD3 will work with and assist the Chief Engineer in improving the reporting process to correct any deficiencies found necessary to support implementation of the groundwater management program.

8. **GMD3 will provide on-site diversion inspection services to members.** Installed water flowmeters and other devices have been required by the governing body of GMD3 since the early 1990s on every non-domestic well in the district. On-site services assure good water measurement assistance to members and partners, and that the groundwater program activities are based on good data and member management assistance.

9. **GMD3 will provide collaboration.** GMD3 will collaborate with members, the Chief Engineer and other state and federal officials, interests, institutions and authorities on water rights, water supply or special management planning and program activity which might affect the district supply or the management program operations.

10. **GMD3 will provide comments and recommendations.** As local groundwater supply in district managed aquifers declines, the value of usable groundwater goes up. The pressure on water users to seek consent agreements and waivers of rule standards to improve their enjoyment of remaining groundwater supply will also increase. To operate the management program, GMD3 will provide comments and recommendations to the Chief Engineer and other program partners as needed.

    The Board of GMD3 may include the following considerations in their deliberations and recommendations concerning the management program and standards governing groundwater supply.

    A. **Public and domestic drinking water supplies.** Steps to ensure quality drinking water is available locally for people and animals is recognized as a necessary element of the groundwater management program. No modification to historic terms of groundwater use should contribute to unreasonable or unsafe drinking water supply conditions, including deteriorating drinking water quality (Water Usability Depletion).

    B. **Water usability depletion.** An increasingly important type of water consumption is the degradation of water quality. The degradation of quality can either restrict

or eliminate the use or reuse of water or require additional "fresh" water be used to dilute or replace the degraded water. People clearly understand the situation of water flowing into a salty sea or less clearly understand loss when brackish water is disposed into deep geologic formations, but poorly understand "the equivalent amount of water" lost when "good" aquifers have a slow degradation in water quality to a point beyond a reasonable economic limit (K.S.A. 82a-711(c)).

C. **Maximum allowable rate of aquifer depletion.** For groundwater quantity management purposes, available groundwater supply of the High Plains Aquifer is subject to a maximum allowable rate of depletion not to exceed 40% in 25 years; a limit adopted by GMD3 on July 12, 1978 and fixed by rule of the Chief Engineer for new water rights. This depletion rate cap secures the maximum allowable local consumption rate of natural stored water supply used in local routine High Plains Aquifer well evaluations.

D. **Critical wells.** Conducting well evaluations in declining aquifers to identify critical wells (supply hardship wells) with supply concerns will provide a framework where analytical tools such as a Theis Calculation and numerical tools such as the GMD3 Groundwater Model can be applied and considered to inform water right administrative decisions where critical wells may be considered strong candidates for possible impairment of associated water rights.

E. **Local source of supply.** In the history of the GMD3 management program, GMD3 has used local areas of aquifer supply, ranging from a 9 square mile block to a two-mile radius circle, centered on a proposed point of diversion and using maximum allowable depletion or safe yield calculations. Administrative practice and hydrological constraints suggest a local source of supply for a K.S.A.82a-708b(a)(3) demonstration should not exceed 2 miles, or 10,560 sq. ft.

F. **Water right priority contribution.** GMD3 member-owners of senior water right interests who stipulate conditions, provide forbearance agreements or otherwise withhold priority against other users in a local source of supply provide mutual benefits and good will that should be recognized as contributing to the GMD3 management program.

G. **Use of lessor quality water where economically and technologically feasible.** Under state law (K.S.A.82a-711), lessor quality water with a lower usability factor must be considered for uses over better quality water where technology and economics will allow it.

H. **Member agreements or modifying historical use.** Developing and changing terms, limitations or conditions of groundwater use caries statutorily prescribed considerations that include all matters of public interest (K.S.A.82a-711(b)(5)). It is the opinion of GMD3 that public interest includes the complete consideration of the management program. GMD3 members seeking rule waivers or negotiated water management plans who include consideration for their neighbors' rights in developing a proposal, and who meet the requirements of K.S.A. 82a-711 and

K.S.A.82a-706b for elements needed to satisfy prior rights for at least 25 years, should be recognized as contributing to the GMD3 management program.

I. **Economic use value.** Influencing water management as an economic public interest is a key element of the management program and an important way of achieving efficient and equitable groundwater use without waste to realize the greatest value for the water used. Plans or proposals that significantly increase groundwater use value while lessening actual decline rates should be recognized as contributing to the GMD3 management program in the public interest.

J. **Alternate supply development.** Proposals to conserve High Plains Aquifer water by seeking an economically and technologically feasible lessor quality alternative groundwater source should be recognized as contributing to the GMD3 management program.

K. **Groundwater inventory estimate improvement.** Information provided by members that improves knowledge of usable supply estimates, including donating geological test well logs and other data, should be recognized as contributing to the GMD3 management program.

L. **Water imports and transportation of water.** Where the demand for water within the district exceeds long term groundwater supply, any member pursuit of additional sources of water to meet sustainable agriculture water needs or for managed aquifer recharge should be recognized as contributing a critical part to for securing water services in the district, the state and the region in the public interest.

M. **New flexible use of prior well allocations.** New use flexibility may provide a net increase in water access and use efficiency as better managed water supply, provided that adequate evaluation of well and aquifer constraints occur to avoid creating critical well problems for other members and the management program. New use flexibility between wells presents a significant potential for added pumping onto the remaining better producing wells, and for new effects on other wells with their prior use rights. Also, with improvements to type (1) water conservation (efficiencies), there is risk that no real type (2) conservation (aquifer maintenance) is achieved to mitigate the added use effect on the neighbor. Especially where "paper water" is allowed to be relocated to a productive supply well. For more information on flexible use of appropriation rights, see *Out-of-Priority Water Use: Adding Flexibility to the Water Appropriation System*, Lawrence J. MacDonnell, Nebraska law review, 2004. See: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1272&context=nlr

GMD3 Water Conservation Program

Wise use. Under the GMD3 management program for depleting groundwater resources, water has generally become a commodity to be weighed, measured, allotted and metered out by the gallon or acre foot. These are important management program activities, but a better public policy strategy might be devised than one that only conveys the message that water use is something to be minimized or even defeated by water conservation. Instead it should be stressed that conservation is not so much about prohibiting water use as using water wisely. Such uses are many and include those that encourage a respect and understanding for the emotional and aesthetic power of water.

Water Conservation. Under the GMD3 management program, water conservation is divided into two types of activity: (1.) **Use efficiency:** improves wise use by adding present economic value and benefit to each unit of water diverted, but may also add some risk of reduced supply to other rights and a capacity to consume every drop of available supply; and (2.) **Aquifer maintenance:** adds future water supply by preserving and/or replenishing useable aquifer storage for future resource benefits.

Type (1) - use efficiency. Efficient water use technologies, products and services are an effective means of increasing or sustaining water use by adding value and water productivity. Use efficiency is the first activity generally thought of as water conservation under wise use without waste. As the cost of water increases, the benefits associated with efficient use increase. Use efficiency is the amount of valued output per unit of applied water. It is also noteworthy that as efficiencies increase, historical return flow that replenished the aquifer decrease. In a declining aquifer, increasing efficiency adds both opportunity for aquifer maintenance and opportunity to preserve or increase the rate of consumption.

Type (2) - aquifer maintenance. Supply maintenance activity, protecting renewable recharge sources, adopting project and local source corrective controls, administering the exercise of water rights based on long term projected needs and projected supply, and allowing replacement sources for storage or direct use; all are effective means of assuring needed future water supply. Aquifer maintenance activity may be coupled with type (1) efficiency activity. However, a groundwater conservation factor evaluation is necessary in order to determine useable preserved or replaced storage vs unusable or inaccessible storage.

Wise use and waste of water. GMD3 member activities promoting present use efficiency and value (type (1) conservation) while also leaving and/or replenishing groundwater in storage for a net increase in future supply (type (2) conservation) should receive due consideration for contributing to the GMD3 management program in the public interest. Activity that may unreasonably diminish groundwater value and/or be consumed with an efficiency below what is normally considered technologically and economically feasible may receive due consideration for impairing the GMD3 management program with a method of use that includes preventable waste of water. Surface water flows or delivery gains to aquifer storage are quantifiable historical sources of groundwater supply and are considered an important part of the supply considerations under management program activities. Aquifer recharge from surface flows are therefore not considered a waste of water, unless manageable water quality or preventable evaporative waste problems locally dictate otherwise.

Groundwater conservation factor. The management program necessitates management considerations for every acre foot of water supply available to the area. Of the 3.6 million acre-feet of annual authorized groundwater use in the declining district inventories, generally about 44% is annually not diverted for various reasons, including voluntary groundwater conservation activity or diminished well yields from depleted aquifer conditions. For the many non-performing wells, there is a significant amount of "paper water" (water rights on paper only, with little or no accessible supply remaining). A groundwater conservation factor calculation requires a separation of the inevitable non-use under each water right (insufficient supply) from aquifer maintenance action (demand reduction choice or aquifer replenishment action that preserves physically and legally available storage) that most agree can be credited as adding future groundwater supply. The resulting preserved or replenished supply may be considered conserved storage or the conservation factor of a project, expressed in an acre-foot amount. So, it will be necessary to determine through some form of practice suitability audit and appropriate data review the actual groundwater conservation factor for any aquifer maintenance crediting or due consideration undertaken for any specific well in GMD3.

Groundwater conservation reporting. Conservation actions that routinely occur should be routinely documented by members and GMD3 for member benefits; benefits realized either in extended supply, program incentives or in matters of water right administration. Voluntary groundwater conservation efforts generally go undocumented or are not fully realized in state water planning, administration or legislative considerations. There is little standardized data available to quantify the extent of water conservation now occurring in the district. GMD3 members with water conservation activities will be encouraged to voluntarily submit annual water conservation reports for their water right record covering both forms of water conservation activity to receive due consideration for contributing to the GMD3 management program.

Aquifer maintenance credit. GMD3 may accept, record and audit voluntary groundwater conservation factor amounts as aquifer maintenance credits under the management program. Development of the aquifer maintenance credit activity has several considerations for local sources of supply that may be best implemented through separate GMD3 program guidance and/or accounting documentation under the management program. Such a program may enable the tracking of banked groundwater supplies on a farm level.

Every manager a water conserver activity. As business managers who juggle many related business concerns, GMD3 members are encouraged to make it a priority to be their own leader in groundwater conservation and determining the destiny of their water dependent enterprise. The actions of every manager as water conserver (EMAWC) may ultimately determine the fate of the groundwater supply for each farm and for the agricultural industry in the GMD3 area.

A fundamentally sound way for each member to conserve groundwater is to encourage the development of a personal or project level plan to budget and secure use and supply; incorporating actual use, water sources and identifying conservation opportunities with a long view of water supply. This can significantly benefit both the GMD3 member and the district management program. An EMAWC activity incorporates actual well conditions, aquifer supply, recharge rate and storage capacity into a business and multi-generational water strategy. Using observed and measured farm data, water rights analysis and available extensive expert assistance, an EMAWC activity on the farm requires many careful use considerations and steps to assure

conservative water use, maximum recharge of supply and awareness of changes in use by other water users in the local supply neighborhood. Managing rain benefits and evaporation is an excellent place to start, with use of irrigation scheduling and sensor technologies. With local groundwater storage generally slow in lateral flow, each member can expect benefits from their conservation efforts to stay home. This puts each member on the front lines of managing water use and storage for their farm with the responsibility to protect the Ag industry and community with more sustainable Ag system activities. Significant assistance is available through GMD3 and a wealth of potential partners implementing the district management program.

State mandated water conservation plans for efficient use. There are over 500 mandated irrigation water conservation plans in GMD3. The chief engineer of the Division of Water Resources may require applicants for permits to appropriate water, water users with relatively high use, and water users applying for any state administered grant, loan or cost-share moneys for water-related projects to develop water conservation plans, as per K.S.A. 82a-733. These plans have been required and made a condition of water use. GMD3 has historically provided assistance to members with completion of conservation plan requirements.

The Kansas Water Office develops and maintains guidelines for water conservation plans, with current guidelines for irrigation available at:

https://kwo.ks.gov/docs/default-source/reports-page/water-conservation-reports/2006-kansas-irrigation-wcp-guidelines-jan2006.pdf?sfvrsn=6

And for municipal (public water supply) use available at:

https://kwo.ks.gov/docs/default-source/reports-page/water-conservation-reports/2007-municipal-wcp-guidelines-aug2007.pdf?sfvrsn=4

Water conservation under state guidelines. Under Kansas Water Office water conservation plan guidelines, water conservation is defined as:

> "***The utilization of cost-effective water use efficiency practices to curtail the waste of water and to ensure that water use does not exceed reasonable needs.***

This general definition to implement K.S.A. 82a-733 of the WAA and other water use considerations of the Kansas Water Office addresses use efficiency of water supply; which is consistent with type (1) water conservation under the GMD3 management program. Type (2) water conservation under the management program require guidelines in addition to the type (1) Water Office guidelines for the added benefits of aquifer maintenance and corrective controls. GMD3 will seek to maintain district guidance and assist members in an understanding of the terms, limitations and conditions of water use that may be a provision of their water right, water use agreements and/or GMD3 management program activities. Per Subsection (g) and (h) of K.S.A 82a-733, GMD3 will review and consider approval of conservation plans and practices required pursuant to this section unless such plans and practices are incorporated in the groundwater management district's management program which has been approved by the chief engineer pursuant to K.S.A. 82a-1029 and amendments thereto.

GMD3 water conservation plan guidelines. GMD3 guidelines will be investigated, developed and updated as needed under separate guidance documentation to this management program that achieve the following:

1. Provide a plan template that can be used to develop a water conservation plan to meet the requirements of GMD3 management program, the state, and/or other partners, federal interests, institutions and authorities.
2. Provide considerable flexibility to develop and monitor water conservation plans based on management program desires and initiatives;
3. Provide Internet access to the Guidelines and the Plan template, so that members, consultants and other management partners can easily download the template or develop a Plan.
4. Include a subsection on source conditions and management goals.
5. Plans more useful to member water managers, so that the majority of GMD3 water users can be directly involved in the management of their local water sources and use destiny;
6. Provide for an efficient, source benefiting, and consistent water conservation plan format; and
7. Curtail waste of water using readily available best practices that ensure that water use does not exceed reasonable needs.

Cost-to-benefit ratio effect of conservation plans. The more documentation obtained on the actual benefits from water conservation, the more believable are the results from a cost-benefit analysis of potential programs. Once benefits and costs over the projected life of the water conservation plan have been estimated and discounted to their present value equivalents, it is straightforward to determine whether a project's conservation plan benefits would be expected to exceed its costs under classic economic theory. A common way to compare the benefits and costs of a conservation plan is to divide total benefits by total costs. The result is called the benefit-to-cost ratio, or B/C ratio. A B/C ratio greater than one indicates that benefits are greater than costs while a B/C ratio less than one indicates that costs are greater than benefits. A B/C ratio exactly equal to one indicates that costs are expected to exactly balance benefits of the water conservation plan. Alternative conservation projects can be ranked by their net benefits or B/C ratios to identify which projects are expected to provide the greatest amount of benefit to members and the district. More information on B/C ratio calculations may be provided in separate guidance documentation of the management program.

Water flowmeters. Water measurement is more than a water right compliance tool. Recognizing the difficulties of managing what is not measured is the principle reason GMD3 was an early leader in advocating for and requiring water flowmeters and flowmeter reporting on all non-domestic water uses. Measurement is critical to identify opportunities for water project improvement, showcase examples of efficient use, tie use to supply response and other valued data uses. Use measurement at the project level empowers and demonstrates water stewardship. Metering of water use is an important management tool to adequately monitor and evaluate the effectiveness of groundwater management at the project level and regionally as a GMD area.

Infrastructure performance and conservation awareness. From recent water use data for nondomestic wells in the district, nearly one quarter (23%) of the authorized wells are not used annually (about 2440 wells) and about 1.6 million acre-feet of authorized groundwater use does not occur annually on average. Water conservation activity that has been occurring in many forms within the district will continue to improve as new technology, new water project feasibility formulations and new tools add value to wise use of present and future supply. A key response to the problem of encouraging water conservation is in member awareness of risk and opportunity: water right relative priority and legal setting, physical well conditions, their projected remaining water supply, local source protection and depletion rate. Well performance

decline, supply constraints and supply outlook are important to review in the routine exchanges between members, the groundwater district and state staff to update everyone concerned that may have water supply rights and or investment and equity interest associated with the future of their local source of water supply.

Capping new appropriations to conserve and extend groundwater supply. Once water rights were made mandatory in the state, GMD3 adopted conservation measures and conducted maximum allowable depletion rate water availability calculations and made recommendations to the Chief Engineer for each new water appropriation application. The Chief Engineer relied upon GMD3 calculations to grant or deny new water rights in the district based on a maximum allowable rate of depletion not to exceed 40% in 25 years. This conservation partnership includes recent GMD3 action to adopt a closed aquifer policy and to request that the Chief Engineer close the High Plains Aquifer to new water rights with some small use exceptions. Those small use exceptions have subsequently been reviewed by GMD3 and Board resolution 2018-5 was passed to require a minimum of offsets for any new non-domestic water right to help avoid nullifying member local source conservation efforts and not inflate appropriation totals. In addition, GMD3 will be working with well owners in a review process to reveal and evaluate current well and aquifer conditions with each administrative request to the state. The fundamental conservation policy of GMD3 in such cases is that there is no additional water available from the source beyond what is needed to satisfy existing water rights under the management program.

Water conservation stewardship. There is extensive undocumented groundwater conservation actions and activities by individual members within the district that are implemented as a matter of good practice and resource conservation stewardship. A full review of the many water conservation activities is too lengthy to list here and may be enumerated in separate GMD3 implementation documents. Some voluntary water conservation efforts in the district include:

- Water use measurement and reporting
- No-till farming methods which improve soil moisture retention.
- Crop selection and rotations that require less water than historically needed.
- Improved irrigation system efficiency technology.
- Enrollment in sponsored programs of GMD3, the state and the federal government, such as the Conservation Reserve Enhancement Program (CREP) and Regional Resource Partnership Program (RCPP).
- Local conjunctive management of surface water and groundwater.
- Voluntary conservation, including non-use of viable wells.
- Reuse of wastewater and effluent left over from primary beneficial uses.
- Use of lessor quality water where economically and technologically feasible.

GMD3 conservation leadership. Public policy can and does accelerate the adoption of conservation products and services through incentives, including cost sharing, regulatory relief, tax credits, rebates and technical assistance. Examples of successful incentives include the Environmental Quality Incentives Program for agriculture and a wide range of other programs that encourage adoption of efficient irrigation technologies and practices for other applications. GMD3 will continue to provide leadership and support activities for water conservation as defined in this management program in coordination with other local, state and federal partners

to conserve, extend and replenish the groundwater inventory of the district. Recent examples include:

Over 2500 project diversion site visits **(PDSV)** annually, including flowmeter instillation checks, management plan audits and Groundwater pump flow verification testing.

Western Water Conservation Projects **(WWCP)** developed and constructed by GMD3 members and funded by GMD3 that targeted surface water and groundwater management projects (including Technology Farms), working through a nearly $10 million grant (2008) from the Kansas legislature Upper Arkansas Water Conservation Projects Fund, an agreement with the Kansas Water Office and advised by a special advisory committee.

Conservation Reserve Enhancement Program (**CREP**) working with many partners to retire water rights and transition irrigated agriculture to native grassland, including conducting program feasible supply evaluation on soils unsuitable for dryland farming;

Agricultural Water Enhancement Program (**AWEP**) agreement with USDA to transition irrigated acres to dryland agriculture (completed). Support for Environmental Quality Initiative Program (**EQIP**) incentivized practices that address management program resource concerns is ongoing;

Regional Conservation Partnership Program (**RCPP**) agreement with USDA. In 2015, GMD3 was awarded a $2.4 million-dollar grant from the NRCS to help incentivize Advanced Irrigation Water Management across the region through telemetry technology, remote soil moisture and flowmeter monitoring as added conservation activities;

Conservation Innovation Grant (**CIG**) agreement (2016 - 18) with USDA that evaluates mobile drip irrigation and other innovations with the goal of developing federal implementation assistance programs for technology and conservation in district fields;

System Optimization Review (**SOR**) with the US Department of Interior, bureau of Reclamation (Reclamation), which evaluated the irrigation ditch delivery systems along the Arkansas River corridor for efficiency improvements;

Local Enhanced Management Area (**LEMA**) discussions to consider local mandatory and voluntary groundwater conservation strategies with corrective controls in priority areas of the district;

Water Conservation Area (**WCA**) considerations to assist members and the district in developing reasonable voluntary water conservation plans for both forms of water conservation and appropriate groundwater management;

Planning Assistance to States (**PAS**) partnering with the Kansas Water Office and the US Army Corps of Engineers in 2015 to update a 1982 High Plains Study Water Transfer Element for the conservation of surface water normally lost annually from use in Kansas.

Public Water Supply **(PWS)** WaterSMART study grants working with Reclamation and Kansas Water Office to examine public water supply options for systems to maintain safe drinking water in the depletion usability of the GMD3 Upper Ark groundwater management area supply that includes the IGUCA above Garden City.

Basin Plan of Study **(POS)** effort with Reclamation seeking Ark River basin planning partners in the Arkansas River Valley on both sides of the Stateline with Colorado and the Hamilton County river corridor outside the district to address water quality concerns in the valley.

Value of Water **(VOW)** evaluations with the Docking Institute for Public Policy (2000) and the Kansas Aqueduct Coalition and Apparet Analytics, LLC (2015) on the value of water to Kansas and the GMD3 area.

Water from air **(WFA)** to harvest district water vapor for usable supply and use value protection activities, also known as weather modification activity (suspended in 2015).

Conserving runoff to replenish storage. The GMD3 water conservation program will encourage activities that conserve and extend existing water supply sources while also developing added control and conservation of new supply sources to replace or replenish stored aquifer supply. Both are equally key and necessary elements of the management program activities adopted by GMD3 to move the present economy forward and to fuel the future economy. Strengthening links between natural infrastructure (Rivers, streams, playa lakes and aquifers) with private, community and public infrastructure (Wells, tanks, pipelines, canals, pits, lakes, and reservoirs) will help build climate resilience for members and the GMD3 area.

Rain captured, re-used and recycled water. As members confront the challenges of capturing and delivering enough freshwater to meet the needs of agricultural, industrial, municipal and environmental users, one way of expanding the usable supply of water is using harvested, recycled and/or reclaimed water for irrigation and other purposes. In some cases, potable water has been the only water resource available for irrigation, either because of infrastructure constraints or regulation. Under suitable conditions, irrigating crops, landscapes and recreational areas with harvested, recycled and/or reclaimed water will not only increase the water available for health and human safety, but will also support the environment through economic, social and environmental benefits. Limited water usability will necessitate treatment to gain appropriate purity levels for use and the effects on supply of other users should be adequately evaluated.

Non-potable water conservation. Like potable water, non-potable water is a vital and limited resource that requires management to avoid waste in value of water resources. GMD3 will encourage additional study and implementation of recycling and reuse projects that have historically occurred as part of water resource management activity in the water short environments and economy of the GMD3 area.

MYFA conservation considerations. Starting in 2001 and revised several times in subsequent years in response to wide spread drought, the Kansas legislature provided a multi-year flex account, or MYFA water management policy for owners of groundwater rights and authority of the Chief Engineer in the WAA. The MYFA policy provides for flexible groundwater use over five years as follows:

> **K.S.A. 82a-736. Multi-year flex accounts; term permits.** *(a) It is hereby recognized that an opportunity exists to improve water management by enabling multi-year flexibility in the use of water authorized to be diverted under a groundwater water right, provided, that such flexibility neither impairs existing water rights, nor increases the total amount of water diverted, so that such flexibility has no long-term negative effect on the source of supply. …*

The updated law contains two provisions for considering past implemented water conservation. Paragraph K.S.A. 82a-736(b)(3)(B) of the MYFA statute provides for the Chief Engineer to consider member implemented groundwater conservation activity that *"reduced water use under the base water right during calendar years 2000 through 2009, in which case the average amount of water actually diverted for a beneficial use under the base water right during the five calendar years immediately before the calendar year when water conservation began, …"* can be used to establish the amount eligible for deposit into a MYFA. Also, under paragraph K.S.A. 82a-736 (b)(5)(B): *"If water conservation reduced water use under the base water right during calendar years 2000 through 2009, the calendar year is a year within the five calendar years immediately prior to the calendar year when water conservation began."* Under the GMD3 management program, a groundwater conservation factor calculation is needed in order to properly implement the MYFA provision for considering member implemented groundwater conservation activity in the district.

Due consideration for past management or conservation measures. In 2015, the Kansas legislature added the following policy to the Water Appropriation Act:

> ***K.S.A. 82a-744. Water management and conservation measures; due consideration by chief engineer.*** *(a) The chief engineer shall give due consideration to water management or conservation measures previously implemented by a water right holder when implementing any further limitations on a water right pursuant to any program established or implemented on and after July 1, 2015. The chief engineer shall take into account reductions in water use, changes in water management practices and other measures undertaken by such water right holder.*

This statewide policy under the WAA requires "due consideration" to previously implemented management and conservation measures when the Chief Engineer implements new limits on a member water right for any new program after July 1, 2015. Under the GMD3 management program for the unique considerations of the district, it is the opinion of GMD3 this means the Chief Engineer will sit down and think about a number of public interest considerations that include: priority of right; the water management or conservation measures previously implemented by each member water right holder; account for changes in groundwater use practices; consider the advice and guidance of GMD3; and decided how to implement the new program in the GMD3 area in a manner consistent with the management program, or any proposed revision per K.S.A. 82a-1042.

Surface water conservation storage as groundwater. Linking natural and constructed water infrastructure to conserve and manage water supply is a key activity to add water value and manage sustainable supply systems for Kansas. The significant demand annually for water (more than 2 million acre-feet), along with the more that 60 million acre-feet of available aquifer storage space in GMD3 compels action to secure additional supplies to meet future water needs for the GMD3 area and for Kansas. Today on average, more than eight times the annual amount of groundwater used in Kansas leaves the state annually as river flow. So, the conservation and management of available surface water presents a need to evaluate and develop the leadership that will find the opportunities to divert, transport and store water in the aquifer poor space in the GMD3 area. Available surface water flow is a limited time supply opportunity that should be conserved and managed accordingly to meet demand and to replenish groundwater inventories. Any GMD3 management program activity looking to include future agreements or contracts to

purchase and transfer excess water from local, state or federal surface water conservation capacity may carry a requirement to adopt and implement water conservation plans and practices that are consistent with the state guidelines as per K.S.A. 82a-1311a. It is a purpose of the GMD3 water conservation program to exceed state standards for type (1) efficiency and waste elimination activity by implementing type (2) water conservation activities across the district.

Conservation storage in aquifer pore space in GMD3. In recent years the issues surrounding geological pore space and rock structure ownership has been raised in discussions generally connected to both oil and gas operations for carbon capture sequestration into subsurface geologic formations and for ownership and management rights in areas of water rights administration, federal reserved water rights, deep formation disposal projects and in artificial storage and recovery of water. With water being an exception in Kansas, generally ownership of the surface of the land includes ownership of all that lies beneath the surface boundaries, to include mineral, rock structures and voids (David Pierce, Washburn Law School, legislative briefing, 2011).

Ownership of the surface estate can be separated from one or more mineral estates. The Owner of the surface estate generally retains ownership of minerals not expressly encompassed by the conveyed mineral estate. Owners of minerals (oil and gas) also have the right to access the rock structure where the oil and gas are found so they can be developed, even though the mineral owner may not "own" the minerals comprising the rock structure. Similarly, a water right to use groundwater may be a right to access the water in the poor space even though the water user may not own either the surface or the mineral estate. Regardless of who owns the pore space, it is going to be connected and one cannot control where it goes. Pore space structure, like oil and gas reservoirs or aquifers, are not compartmentalized areas beneath a single tract of land but interconnected by body of rock. The naturally stored usable water within the rock formations is a part of the "waters of the state" as governed under the provisions of the WAA and a part of the management program activity for natural water infrastructure.

In the opinion of GMD3, as waters of the state are declared a public good dedicated to the use of the people of the state subject to private appropriation (K.S.A. 82a-702), so too is aquifer pore space a necessary part of the public good of groundwater management activity by GMD3 for the geological formations having pore space with both natural and artificial water storage potential (K.S.A.82a-1020). This is based on the theory that no owner of either the mineral estate or the surface estate or of a water right should be allowed to hold management improvements of water storage and supply in aquifer pore space for ransom.

K.S.A.82a-1021(a)(7) defines a "land owner" for purposes of the GMD Act, but also includes the following: *"Owners of oil leases, gas leases, mineral rights, easements, or mortgages shall not be considered landowners by reason of such ownership."* In groundwater management affairs, the risks associate with ownership in either the surface estate or mineral estate may be intertwined with a number of factors that include land use, the quality and quantity of available water supply, the effects of mineral estate exploitation on usable groundwater supply, and the opportunity to participate in the groundwater management activities of GMD3 as an eligible voter of the district. A natural aquifer may be considered a natural body of water, but artificial use of aquifer poor space for private storage may be something different. Under similar concepts, a natural water course use is provided in Kansas policy for private conveyance of water (K.S.A. 42-303) but a constructed reservoir on a water course requires easement or ownership of the surface estate. Use of natural recharge infrastructure vs. artificial constructed well or pit recharge

infrastructure and the retained ownership of water conservation storage in aquifer pore space for later use may be a key factor as to the question of whether any pore space use easement may be needed.

Groundwater conservation in preparing for surface water transfer imports. As society confronts the challenges of capturing and delivering enough fresh water to meet the needs of agricultural, industrial, municipal and environmental users, multiple sources must be managed with type (2) aquifer maintenance conservation of local groundwater and transferred sources. Subsection (b) of K.S.A. 82a-1502 (part of the Kansas Water Transfer Act) contains the statement:

> "*No water transfer shall be approved under the provision of this act: (1) if such transfer would impair water reservation rights, vested rights, appropriation rights or prior applications for permits to appropriate water; and (2) unless the hearing officer determines that the applicant has adopted and implemented conservation plans and practices that (A) are consistent with the guidelines developed and maintained by the Kansas water office pursuant to K.S.A. 74-2608 and amendments thereto, (B) have been in effect for not less than 12 consecutive months immediately prior to the filing of the application on which the hearing is being held."*

Subsection (c) of K.S.A. 82a-1502 contains the following policy:

> *"To determine whether the benefits to the state for approving the transfer outweigh the benefits to the state for not approving the transfer, the hearing officer shall consider all matter pertaining thereto, including specifically:…(7) the effectiveness of conservation plans and practices adopted and implemented by the applicant and any other entities to be supplied water by the applicant; (8) the conservation plans and practices adopted and implemented by any persons protesting or potentially affected by the proposed transfer, which plans and practices shall be consistent with the guidelines for conservation plans and practices developed and maintained by the Kansas water office pursuant to K.S.A 74-2608 and amendments thereto."*

The conservation of water under the GMD3 water conservation program and in fulfillment of the purposes of the WAA by GMD3 members shall generally exceed the statewide guidelines set forth by the Kansas Water Office because of the need for emphasis on type (2) aquifer maintenance water conservation. This will be promoted to ensure adequate conservation of existing water resources that allows new conservation storage of transient surface water sources to be transferred into the more that 60 million acre-feet of available aquifer storage space in the GMD3 area.

Supplemental wells and "chasing water." Prohibiting adding additional wells to water rights or in use flexibilities between wells for the purpose of adding or restoring groundwater extraction capacity in declining aquifer supply has been a Board policy concern since the 1980's as being inconsistent with the district water conservation strategy. Additional wells to restore extraction capacity raises a concern known as "chasing water" to eventual complete depletion of supply. Individual members may favor a better management of allocations using additional wells. However, careful evaluation procedures to identify critical wells in such proposals are necessary to: conserve and protect the future local source of supply of prior water rights; preserves local water conservation effort benefits; preserves management program strategies and limits future

adverse economic impacts from surprise administrative fiat from impairment claims. Paper water rights on wells in a depleted local source of supply must be allowed to remain paper. Paper allocations should not be considered a right to chase water from other wells in a depleting local source unless a plan for replenishing supply is included.

Growing the market for water conservation. Growing a culture of conservation involves a strategy of reaching out to specific industry groups and locales which have comparatively low rates of participation and engagement around water conservation and efficiency. As more members participate, vendors can develop economies of scale and more cost-effectively run active and passive programs. "Growing the culture" naturally increases programs' impact, as participation rates increase across the district. While programs might lose their potential for scale as more members participate, the proportion of the population engaged increases.

Targeting water conservation in a Groundwater Management Area (GMA).

GMA. GMA is a general term for any targeted area in the district identified for specified groundwater management program activity. GMD3 conservation and/or management activity may have a targeted goal and use one or more institutional tools uniquely applied to the district management program purposes of each GMA.

GMD3 conservation barriers and enablers. GMD3 and other Kansas GMD's pursued forming special GMAs for corrective controls in 1977, but found a lack of local and state authority, which was considered barriers in attempting to manage groundwater supply and use. Local or state permitting of all non-domestic water use was not required in Kansas at the time and the extent of water use was not known. The GMD3 Board immediately requested an official moratorium on granting new water rights by the Chief Engineer for an area in the Arkansas River basin above garden City to allow work for data and policy development on those over allocated water short areas. Cooperation by state officials is crucial to implement local policy and strategies under the management program or to identify alternatives that are consistent with Kansas law and policy.

Mandated permitting and IGUCAs. Legislation was successful in 1978 to add state policy requiring permitting of water rights that define water use across the state in the WAA and to add authority for GMD's or a group of members to initiate water use corrective control actions in a GMD under the GMD Act. The new GMA tool was called an **Intensive Groundwater Use Control Area, or** "IGUCA." A request is made to the Chief Engineer, who must conduct the process to consider the formation of the IGUCA. The IGUCA tool, once requested, involves a prescribed review and fact-finding process that includes conducting one or more public hearings and an order of the Chief Engineer imposing corrective controls. This IGUCA tool was also extended by the legislature to allow the chief engineer to initiate proceedings on his own initiative in water use areas outside of GMD's. A few IGUCA management plans have been developed and ordered to implement mandatory corrective controls onto groundwater rights in designated areas across the state.

GMD3 Upper Arkansas River IGUCA. The Upper Arkansas River IGUCA was requested by the GMD3 Board in 1984 as a GMA to replace the 1977 moratorium on new appropriations and to extend corrective controls from the Colorado and Kansas Stateline corridor across GMD3 along the river. This IGUCA was ordered after significant public process, testimony and recommendations of the Board and district members to the Chief Engineer. See map of the

IGUCA area in the Appendix. Additional state information on the Upper Arkansas River IGUCA is available at: http://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/intensive-groundwater-use-control-areas/arkansas-iguca

Corrective controls. Water right administration of the prior appropriation doctrine under the WAA is the most direct form of corrective control provided by the Kansas legislature for water short supply conditions. Protecting prior rights requires a complaint, opposition to an administrative action or requests to secure water entitlement. Beyond water right administration, corrective controls are new actions intended to secure improvements to water supply decline problems. Corrective controls are intended to benefit future aquifer supply in addition to present delivery and use. It is well established that the supply problem conditions set forth in K.S.A.82a-1038 exist across the entire GMD3 area for the OHP Aquifer. These conditions are known and perpetuated in the routine administration decisions of water right applications in the GMD3 area. Corrective controls in the declining OHP Aquifer must add new benefits as type (2) aquifer benefiting water conservation to improve future aquifer supply under the management program. Corrective controls should insure that member water users seeking added use efficiency and to avoid standard rule limits do not already have higher use than their peers from the same supply area with comparable circumstances and benefit from the higher use in the application of corrective controls. GMD3 management program guidance documents may provide standards and mitigation methods for evaluating and securing proper corrective controls.

LEMA. The Legislature added a new GMA tool in 2012 for GMD's after more than a decade of development work by Northwest Kansas GMD4 and partners. The LEMA statute (K.S.A. 82a-1041) provides a procedural structure for the development of LEMA management plans that are consistent with state law. These plans can be developed and requested by a GMD governing body to the Chief Engineer for needed corrective controls. If accepted after a public process, enforcement of the LEMA plan by the state occurs. A LEMA management plan can add temporary or permanent corrective controls that affect existing water rights in a specific geographical area designated by a groundwater management district and approved by the chief engineer.

A LEMA plan. A LEMA plan is intended to further empower local groundwater management leaders and the GMD3 governing body to address local groundwater concerns. Local water right owners and other members of GMD3 can come together to seek ways to reduce the rate of groundwater decline in their region. The GMD3 Board has the authority to recommend a plan and to initiate the process to seek formation of a LEMA by the chief engineer, who must consider only the requested plan for adoption without altering it or applying constraints not requested by GMD3.

GMD3 adopted a LEMA plan policy that a proposal should be recommended to the GMD3 Board by members as a priority GMA to be further managed with infrastructure development and/or corrective controls in the public interest. Basic steps for establishing a GMD3 LEMA involve formulation of a plan generally accepted by area members, presentation of the plan to the Board, Board adoption of the proposed plan, Board request for a LEMA to the Chief Engineer, two prescribed public hearings considering the proposed plan, and a decision order of the Chief Engineer approving, returning, or rejecting the LEMA.

Any LEMA plan proposed to the Board for adoption shall include: 1) A clear groundwater management goal; 2) A basis for the proposed boundaries; 3) Evidence in the record of plan development that multiple alternatives were formulated for setting additional groundwater corrective controls on member water rights, including use of the principle of prior appropriation; 4) Reasoning for the use or rejection of each alternative; and, 5) The recommended strategy for determining the will of the eligible voters of the district having property rights within the proposed LEMA area.

GMD3 staff will support the development of a LEMA by members and will identify facilitation resources to coordinate consideration and development with member interests, organizations and authorities for beneficial conservation plans that also consider impacts of the conservation goals for corrective controls, including evaluating effects on present and future property valuations and economy.

Special rule conservation areas. Another GMA tool identified by management program special rule controls may be requested as a state administrative rule area to address unique groundwater management concerns in a defined area. These concerns may be quantity, usability or use practice related concerns that require administrative standards to manage efficient groundwater use while protecting useable supply. An example of this is the provision in a GMD3 rule K.A.R. 5-23-4(c) for a water quality control area in parts of Seward and Meade Counties. The potential for upwelling of naturally occurring saltwater in Upper Permian Age formations to invade into the overlying connected Ogallala Aquifer formation threatens water usability depletion and the impairment of water rights.

Voluntary consent agreements. A voluntary agreement can be a highly effective tool to obtain regulatory, conservation or other water right administration and management program needs. This tool was implemented in southwest Kansas by private initiatives early in Kansas water right administration history as exemplified by the consent decree action of 1910 establishing the Associated Ditches of Kansas along the Upper Arkansas River. It was also recommended early in state water planning for groundwater management in the 1958 Cimarron Basin Water Resources Report. Voluntary agreements for water conservation and better management that are lawful and consistent with the management program are highly supported and encouraged by GMD3. Today, the voluntary consent agreement tool includes various conservation plans, groundwater banking activities and other water management activities that require consent agreement to resolve water supply problems.

WCA. In 2015, the Legislature provided another statewide GMA tool called a Water Conservation Area (WCA). A WCA is a tool where producers can develop a water conservation plan for consideration and agreement of the Chief Engineer under the WAA to commit to voluntary conservation and corrective controls. Upon agreement, the WCA plan becomes a consent agreement and order of the Chief Engineer that changes water use conditions without changing base water rights that become suspended during the period of the WCA. A WCA is not considered a state water right or water permit, though subject to all Kansas water laws and rules. WCAs are intended to encourage conservation by implementing volunteered corrective controls as a plan that does not alter the base water right(s) when adopted by order of the Chief Engineer.

Changing WCA plans and agreements. With the consent of all participating water right owners in a WCA, the Chief Engineer may amend the agreement and order to modify corrective

controls or boundaries, add or remove water rights, terminate the WCA or make other changes requested by the water right owner(s). When a WCA includes an aquifer area subject to the GMD3 management program, GMD3 will seek to review each proposed WCA change or extension and provide recommendations to the chief engineer in a manner consistent with the norms and practices for water right new appropriations and change applications and the management program.

GMD3 supports and encourages the voluntary implementation of aquifer maintaining corrective controls in WCA consent agreements that are consistent with the policies of the GMD3 Board and management program. Through Board resolution 2017-2 and notice to the Chief Engineer, GMD3 has requested promulgation of the rules required to implement the WCA law in harmony with other state laws and policies. GMD3 may seek rules applicable only to the district for WCA's and for other purposes of the management program as an intent in the GMD Act. For more state information on the WCA tool, see: http://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/wca.

Multi-well use flexibility in GMD3. New multi-well water use flexibility can be encouraged when done lawfully and with activities that are consistent with the management program. Concerns for reallocating water right amounts to wells where water is otherwise not available or under provisions not otherwise allowed under Kansas law, rule or the management program should include sufficient well and aquifer evaluation to insure future supply improvement under type (2) water conservation and to protect prior water rights from impairment. A process of review should recognize any new adverse effects on other member real property rights into the future best be handled through consent agreement. As an example of granting new use flexibility for better water management, the statewide WCA law limitations include in K.S.A.82a-745(e)(2):

> *"the management plan may allow, in any given calendar year, the water use of an individual water right or rights to exceed the annual authorized quantity of the individual water right or rights participating in the management plan, provided that the water use shall not exceed the total annual authorized aggregate quantity and rate of all the water rights participating in the management plan in any given calendar year."*

In declining groundwater sources in GMD3, this statewide WCA provision and limitation caries a management concern if new appropriations on wells with declining supply and where no water is otherwise available under existing management rules are allowed. The statewide provision in the WCA law example is not adequate by itself to meet GMD3 water rights administration program and the GMD3 conservation program needs for fair administration and type (2) aquifer maintenance water conservation. Legislative policy in K.S.A. 82a-745 further provides the following paragraph:

> *(m) Notwithstanding K.S.A. 82a-1039, and amendments thereto, nothing in this section shall be construed as limiting or affecting any duty or power of a groundwater management district granted to such district by the Kansas groundwater management district act.*

It is the opinion of GMD3 that this provision assures the right of GMD3 vested by the legislature to make decisions and provide recommendations that determine the destiny of the area with respect to the use of the groundwater as discussed in section II of the management program. Implicit entitlement driven water appropriation actions without the public interest guidance of the GMD3 management program can place public interest at risk, and result in added overdevelopment and more rapid groundwater depletion at local aquifer supply sources. The statewide WCA tool will be encouraged and applied appropriately in the GMD3 area for needed aquifer saving water conservation under the management program while avoiding the administrative concerns that occurred under the WAA before the GMD Act and district management program. GMD3 well evaluation methods will be applied as needed to identify critical wells with prior rights at risk of being impaired and communicate the groundwater supplies and well affects to aid in securing controls that are consistent with the management program and public interest. The conservation program activities seek to assure members that real type (2) water conservation occurs under GMA corrective controls. In a depleting aquifer, limiting "paper water" on the poor wells (incapable of providing the water) from moving to remaining good wells (a concept termed "chasing water") will help protect the benefits of type (2) conservation and limit new future well hardship effects being imposed on others.

Water banking conservation. Like other activities implementing statewide water policy, water banking policy may have significantly different considerations for implementation in the differing water supply areas across Kansas. Concepts like independent funding, water conservation storage accounting, aquifer maintenance crediting, use flexibility under existing water rights, unique local source characteristics and the management program are potential factors in a water banking activity. A water bank can have many elements of groundwater management activity that have both good and bad implications on a local GMD management program. Some statutory provisions, such as "Flex Accounts", LEMAs, WCA's and consent agreement provisions between the Chief Engineer and member water users that affect aquifer use and aquifer storage that authorize elements of water banking. Therefore, a water bank activity can have a profound impact on the management program for GMD3.

Water banking activity review. GMD3 will review each water bank or banking proposal that includes district aquifer supply for consistency with the management program and the public interest. Water bank charters or other proposed water banking activities whose advocates seek to operate in groundwater areas of the district should submit a banking plan or proposal for review and approval by GMD3 as part of any bank charter development or any banking application process. The GMD3 Board will provide a recommendation to the chief engineer prior to adoption or amendment of any water banking activity or charter under the Water Banking Act (K.S.A. 82a-761 through 82a-773, and as may be amended) or other aquifer storage and recovery activity.

GMD3 Ark River Management Program

The management program for Southwest Kansas includes management considerations and activities associated with the Arkansas (Ark) River. Ark River flows from upstream snow melt, runoff events, groundwater discharge and reservoir conservation storage deliveries. The Ark River is a historically significant source of renewable water supply for direct use and groundwater recharge in a highly regulated basin that necessitates management activity by GMD3 in the public interest. Relevant authority for the Ark River management program activities are included in the GMD Act and in the list of district powers in K.S.A. 82a-1028 that include:

> ***(g)*** *construct, operate and maintain such works as may be determined necessary for drainage, recharge, storage, distribution or importation of water, and all other appropriate facilities of concern to the district; …*
> ***(i)*** *contract with persons, firms, associations, partnerships, corporations or agencies of the or federal government, and enter into cooperative agreements with any of them; …*
> ***(m)*** *provide advice and assistance in the management of drainage problems, storage, groundwater recharge, surface water management, and all other appropriate matters of concern to the district;*
> ***(n)*** *adopt administrative standards and policies relating to the management of the district which are not inconsistent with the provisions of article 10 of chapter 82a of the Kansas Statutes Annotated, and amendments thereto, or the Kansas water appropriation act; …*
> ***(u)*** *recommend to the chief engineer the initiation of proceedings for the designation of a certain area within the district as an intensive groundwater use control area.*

Resource degradation. Over time, water changes have occurred in the basin from the development of surface water reservoir storage, re-regulation of river flows, direct diversion development, groundwater development, land use changes and water use efficiency changes have caused fewer and less intense rain runoff flows, river bed and banks to narrow, diminished beneficial recharge to adjacent aquifers, cottonwoods and tamarisk salt cedar to proliferate and water quality to decline. These changes have created a problem of mounting water management and supply concerns all along the basin. Opportunities exist for collaborative initiatives to provide management assistance in the district to address a number of groundwater management related concerns.

Water development. Some of the water management concerns that influenced the two states of Colorado and Kansas to enter into a compact agreement also influenced the adoption of the GMD Act in Kansas in 1972 and the formation of GMD3 in 1976. Immediate action was taken by GMD3, working with local and state partners to address special GMA needs as discussed earlier in the GMD3 Water Conservation Program section. Significant additional need and opportunity exists for GMD3 to continue collaborative work with other local, state and federal interests, institutions and authorities to address the unique water resource needs of Arkansas River basin water management within GMD3 and upstream of the district that affect water supply and water usability under the management program.

GMD3 Upper Ark GMA. The portion of the basin above Garden City to the Colorado and Kansas Stateline that include the IGUCA, ditch service areas and tributary underflow affecting supply within a 25-year prospective evaluation period is considered the GMD3 Upper Ark GMA for the purposes of the management program. For this area, native river flow, runoff events,

reservoir deliveries, reservoir spill supply, aquifer water level management, irrigation return flow management and other activities upstream generally maintain river flow year round to a point near the Kearny–Finney County line above Garden City. The problems of dwindling supply, river sediment accumulation and water usability depletion due to poor river water quality are significant growing concerns in the district river reach.

Upstream reservoir development. The loss of large spring freshet flows out of Colorado that historically flushed the river system down the basin has now left few options for affordable local solutions to river basin problems under a highly regulated river flow regime. Sediment load transported to points of water delivery and diversion cause accumulation of remaining sediment load that fills the floodway, increases flood risk and restrict surface water diversion and operating capacity of distribution systems. In addition, the river's poor and declining water quality also creates water usability depletion of the water resources of GMD3, affecting the fertility of soils receiving irrigation water within river water delivery areas and in adjacent groundwater use areas. Under such conditions, land valuation is diminished, and water quality threatens public health and the health of the local economy.

Water quality. Arkansas River basin Stateline flow entering the state and district as High Plains Aquifer underflow is generally of good quality. However, water entering the state in the Arkansas River basin river corridor is not good quality and high in contaminants, including sulfate salinity and uranium. In addition to concerns of other contaminants, high radio nuclei levels have a significant effect on water treatment costs to restore water usability for public water supply and other systems. Estimates from the Kansas Geological Survey of the weight of uranium coming into Kansas annually from Colorado via the Arkansas River are concerning.

Year	Annual uranium load, metric ton/yr	Annual uranium load, ton/yr	Annual uranium load, lbs/yr
2012	1.80	1.98	3,960
2013	1.61	1.78	3,560
2014	3.77	4.15	8,300
2015	6.01	6.63	13,260
2016	7.47	8.23	16,460
2017	9.10	10.03	20,050

KGS Open File Report 2017-2, January 2017, updated January 2018

Water usability depletion. This low quality river water deep percolates into the subsurface and replenishes and contaminates the groundwater under the river bed and ditch service areas. The saline nature of the water reduces its usability and reduces crop yields. Mitigation efforts are employed to dilute the river water with fresher local groundwater in the ditch service areas, with return flows back to the aquifer continuing the water usability depletion of the High Plains Aquifer. The declining surface water and groundwater quality also greatly increases the operation and maintenance cost of irrigation systems due to its corrosive effects on water diversion works.

Public drinking water supplies. Within GMD3, the cities of Lakin, Deerfield, Holcomb and Garden City have experienced a decline in water quality due to infiltration of river water near their city well fields. District member City of Lakin recently had to construct a nanofiltration water treatment facility at great local expense to get their drinking water within the

Environmental Protection Agency's (EPA) maximum contaminant limit (MCL) for uranium. The community must now bear an ongoing water usability depletion cost of millions of dollars. The water extracted from the Deerfield and Holcomb wellfields has been within safe drinking water standards. However, it has been deteriorating and water usability is depleting. Those cities will have to develop a treatment or alternate solution in the future.

Study partners. GMD3 worked with the US Department of Interior, Bureau of Reclamation (Reclamation) and Kansas Water Office to evaluate public water sources in the river basin above Garden City. The purpose was to help identify a plan, considering the deteriorating water quality and declining aquifer levels. The 2012 study included the cities of Coolidge, Syracuse, Kendall, Lakin, Deerfield, and Holcomb to identify possible solutions, including construction of new facilities, infrastructure, and collaboration efforts. The 2012 study identified need for added study and identified local potential options for future public drinking water supply. GMD3 remains committed to monitoring the river water quality and to seek collaborative programs and practices that can address the declining usability of river flow and adjacent aquifer degradation in the basin to assist affected communities and individuals in mitigating water usability depletion in the Arkansas River basin.

Lake McKinney. Lake McKinney originally cost $350,000 in 1906 and was the largest manmade lake in Kansas at the time. It was called Reservoir No. 5 at first but was renamed after J.R. McKinney, the sugar beet pioneer. In 1909, capacity increased to 31,063 acre-feet at a gage height of 3,030 feet above sea level, a maximum depth of 30 feet and surface area of 3,200 acres. At the time of vested right determination for the associated Great Eastern ditch system, all water deliveries had to pass through the lake, and loss needs associated with Lake McKinney operations factored into the determination of the vested right. The capacity of Lake McKinney has since been significantly reduced due in large part to declining available river flows in the basin in the 1970s. Lake McKinney remains an important local groundwater management feature of a ditch system that provides deep percolation losses that replenishing area groundwater supplies.

Ark River Watershed Group. GMD3 may continue to provide leadership in the consideration and development of an Ark River Watershed group. This may be appropriate as the upper Ark River watershed in Kansas serves as a source of water for a diverse array of stakeholders that include and extend beyond the membership of GMD3, including municipalities, irrigators, feedlots, dairies, power plants, domestic users, small acreage land owners, river bed recreation users and the environmental concerns. All stakeholders share concerns regarding declining surface and groundwater quality, insufficient supply, occasional flood flows, land use, natural resources management, and intermittent streamflow. A watershed group boundary could encompass a portion of the Arkansas River basin that has been experiencing diminished and degraded flows and water quality. This has affected surface water ditch company areas, municipalities, and most other water users within the watershed. The water quality within the upper portion of the Arkansas River in Kansas is very poor due largely to diminished stream flows, underlying geology of irrigated fields upstream of the proposed area, and other uses. The Kansas Department of Health and Environment (KDHE) has identified this stretch of the river as impaired waters due to gross alpha (bundled with uranium), fluoride, total suspended solids, boron, selenium, and sulfate.

The contamination of the Arkansas River basin water, especially the high levels of salinity and uranium, is diminishing the usefulness of the water, and in some instances, is creating problems that must be addressed at great cost to local stakeholders. Local irrigators who rely on surface water from river flows must run water through plastic pipes beneath their pivot systems because the saline river water is highly corrosive and will corrode and collapse a galvanized steel pipe sometimes within a single growing season. Higher volumes of river water must be used for irrigation than would be the case if the water were less saline, and often producers must either blend or run groundwater onto their fields after applying the water from the river to mitigate the effect of the salinity of the river water. It is in the best interest of all potential group partners to ensure that the Arkansas River within the proposed group area maintains a reasonable flow and water quality.

GMD3 Lower Ark GMA. The river reach below Garden City and adjacent areas of the IGUCA is considered the GMD3 lower Ark GMA under the management program. River flow at the Garden City USGS river gage is now a rare occurrence beyond local public infrastructure discharge. Groundwater development and loss of surface flows that replenished adjacent aquifer supplies occurred prior to the formation of GMD3, making it necessary to employ groundwater management activities immediately upon the formation of GMD3 to mitigate problems, limit additional appropriations and issues associated with the relocating of wells closer to the river channel.

Declining pulse flows. Over time, the GMD3 Lower Ark GMA river reach has lost the seasonal flushing flows from upstream spring snow melt and runoff events. Also, groundwater mining has nearly eliminated aquifer discharge losses to the river reach, except for a reach of perched alluvial water table in the vicinity of the town of Cimarron. The rare pulse of river flow that does occur in the GMD3 Lower Ark GMA now deep percolates into adjacent aquifers as critical aquifer recharge storage. The lack of regular river flow also creates similar land management and flood control problems as occur in the GMD3 Upper Ark GMA.

Management activity for pre-compact water rights. There are existing vested rights (pre-1945) and pre-compact (1949) water rights in the portion of the Arkansas River IGUCA between Garden City and Dodge City that are authorized a cumulative rate of diversion of more than 200 cubic feet per second (CFS). Since the formation of the district, only a few large extended river flow events have occurred in the reach of the GMD3 Lower Ark River GMA to Dodge City to supply those water demands. In actions that seek to meet pre-compact water supply needs in both the GMD3 Upper and Lower Ark GMAs under wet river conditions, state permits have authorized up to an additional acre foot per acre for existing surface water ditch company irrigated acreage in the GMD3 Upper Ark GMA without exceeding the total authorized amount of all vested water rights of said irrigation ditch companies only when 200 CFS average flow is measured at Garden City with continuous river flow measured to the Dodge City river gage. This GMD3 Lower Ark GMA 200 CFS flow criteria at Garden City has, in the opinion of GMD3, become a standard of practice and adopted consideration of the management program to preserve a river flow supply to pre-compact water rights in the GMD3 Lower Ark GMA during wet river conditions or for deliveries to those water rights.

Ark River IGUCA review and revisions. As of this management program revision, the Arkansas River IGUCA area within GMD3 applies little additional corrective control not already

superseded by administrative rules or practices. Relocating groundwater wells closer to the river channel in excess of ten percent (10%) is a remaining limitation in place under the IGUCA order that has been waived recently in certain WCA cases and may be best converted to administrative rule. Several state modifications to the first IGUCA order from the original GMD3 request and hearing process have occurred without the benefit of IGUCA public process or GMD3 management recommendations. Under statewide rules adopted by the Chief Engineer, the Arkansas River IGUCA is required to be periodically review but is more than two years overdue. GMD3 will assist and advise DWR as per the GMD Act in any review to consider changes to the Upper Ark River IGUCA corrective controls established over 32 years ago and provide its recommendations.

River navigability for title and management program activity. The Ark River in the GMD3 area should be fully utilized for aquifer recharge purposes and other natural and managed uses. Problems of natural resource management activity along the Ark River in southwest Kansas grew up with the development and demands for services from river flows in the entire basin. Management challenges today include the lack of delegation by the Kansas legislature to any person or office to manage the state-owned land in title as a navigable stream defined and conveyed to the state by the federal government at the time of statehood; a federal doctrine called "navigability for title." According to the Land Title Institute (2001) *Navigability (For Title Purposes) means a body of water, existing naturally at the time of statehood that was used or is susceptible of being used in its ordinary condition, for commerce, navigation, fisheries, and more recently in other general statewide public uses such as canoeing, swimming, diving and similar related uses.* For Kansas, this ownership of the historical bed and banks of the river up to the normal high-water mark raises a set of property boundary and easement questions that are intertwined together with the history of river flow changes and navigable stream law for the basin in GMD3. A problem exists for natural resource management when recognizing the difficulty of interpreting "normal high-water mark" under the development of water resources and shrinking or perineal river flow conditions at the hands of man's development of the basin river water supply. The obvious effect of water development for use in the basin on what should be considered "normal high-water mark" raises a resource management reality that one cannot manage what one cannot define.

GMD3 riparian interest and administrative river boundaries. The GMD3 Ark River riparian interests under the management program include the use of the river supply and natural infrastructure for the purposes of water supply delivery and diversion, aquifer recharge benefits and the equitable management activity to distribute and enhance those benefits and address associated supply concerns of water usability depletion and other expressed management program activities. Functional and consistent state land boundary determinations along the Arkansas River in GMD3 is needed for water management purposes, including bed and bank maintenance, easements, water control and distribution, water quality and aquifer recharge activities. GMD3 may propose river administration easement boundaries that are consistent with prior administrative boundary determinations, working with the Secretary of State, Director of Kansas Water Office, the Chief Engineer of the Kansas Department of Agriculture and others.

Managing GMD3 Ark River GMA's for water storage. In western states, depleted aquifers have been used to store water by substituting surface water use for groundwater pumpage (conjunctive use, CU) or recharging groundwater with surface water (managed aquifer recharge,

MAR). Improved management activity to enhance natural and ditch area infrastructure can improve management program results in the GMD3 Upper and Lower Ark GMA's. For example, in an environmental letter entitled *Enhancing drought resilience with conjunctive use and managed aquifer recharge in California and Arizona (published in 2016 Environ. Res. Lett. 11 049501)*, unique multi-decadal monitoring from thousands of wells and regional modeling datasets for the California Central Valley and central Arizona were used to assess CU and MAR. In addition to natural reservoir capacity related to deep water tables, historical groundwater depletion further expanded aquifer storage by ~44 km3 in the Central Valley and by ~100 km3 in Arizona, like or exceeding current surface reservoir capacity by up to three times. Local river water and imported surface water, transported through 100s of km of canals, is substituted for groundwater (≤15 km3 yr−1, CU) or is used to recharge groundwater (MAR, ≤1.5 km3 yr−1) during wet years shifting to mostly groundwater pumpage during droughts. In the Central Valley, CU and MAR locally reversed historically declining water-level trends, which contrasts with simulated net regional groundwater depletion.

The GMD3 OHP aquifer hydrographs look like the California simulated depletion model hydrographs of the central valley and in Arizona. With indications of similar aquifer storage results in the ditch service areas in GMD3, water imports and managed aquifer storage is a favorable and possible outcome for use of the 60 million acre-feet of depleted aquifer poor space along the Ark River and in GMD3 as a conservation storage reservoir. Water managers in Kansas could expand this benefit with winter ditch area flood irrigation, enhancing distribution of Ark river flows across GMD3 for natural infiltration and/or capturing and transporting unappropriated river discharges transferred with additional infrastructure in Kansas. Because flexibility and expanded portfolio options translate to resilience, conjunctive use and managed aquifer recharge enhance drought resilience through multi-year storage, complementing shorter term surface reservoir storage, and facilitating water markets across the state and the High Plains.

GMD3 Economic preservation and development program

Southwest Kansas runs on water. Preserving and growing the economy of the GMD3 area depends on the development of more sustainable and value-added agricultural systems and further development of natural and constructed water infrastructure. Among the state policy purposes in granting the right to manage groundwater locally "… to determine their destiny …" in K.S.A.82a-1020, the Kansas legislature included: "…for the prevention of economic deterioration; for associated endeavors within the state of Kansas through the stabilization of agriculture; and to secure for Kansas the benefit of its fertile soils and favorable location with respect to national and world markets..." These purposes are in line with the activities of the Kansas Department of Agriculture and require both forms of water conservation that (1) add economic value to water used and (2) benefit aquifer storage for more sustainable management systems for the economic health of Kansas. Economic preservation involves GMD3 members operating for maximum profit rather than maximum water use and applying more effective management activities that preserve water availability to private projects at levels that will sustain or improve net income and property valuation.

Funding water management activities for economic growth. The priorities for planning areas across Kansas now range from water development and protection projects to conservation programs and enhancing the future value of existing storage. Under the theory that an ounce of prevention is worth a pound of cure, steps to extending future supply with sediment reduction, new reservoirs, water transport features and aquifer storage are prudent investments towards future economic growth. The extent of funding water conservation and supply improvements will determine how much Kansas communities and the economy will grow. Without these Water Vision strategies and the investment activities of the GMD3 management program and partner interests, GMD3 consultants estimate annual future economic loss could see reductions in gross state product of approximately $18 million annually, with a $10 million portion of that amount lost in GMD3 if current trends continue for several decades.

Water development is economic development. With agriculture as the key industry of the economy, the GMD3 area is an example where decoupling economy from rainfall variability promotes significant gains in both personal wealth and gross state product. Sustaining this benefit with sustainable water sources is a key interest of the management program activities. There are a few reasons for market benefits from irrigation agriculture in a semi-arid climate that include stabilizing market confidence in agricultural product quality and quantity and the options made available through water use in managing the non-water related variables of the agriculture industry. These considerations were part of the purpose for the formation of GMD3. If use plans or policy questions do not add use value or new water for sustainable agricultural systems, then such use planning may not be aligned with the management program.

Supply. For the GMD3 declining aquifer, supply and demand are generally considered two sides of the same economic coin. Crop water demands are generally strategically planned by project managers based on expected supply and risk management opportunities. On the supply side, it is fundamentally important to water managers to enhance operation and maintenance capacity. Reducing non-revenue water (NRW), leakages, and energy use, as well as improving the capacity of the workforce to understand and operate systems efficiently is activity that will be

encouraged by GMD3 under the management program. It is also necessary to ensure cost-recovery through a fair tariff system and "intelligent" public investment planning or for wise private investment planning for infrastructure improvements. All alternatives to increase usable water supply must be analyzed considering the entire life cycle of existing water supply and infrastructure. Supply-side solutions, such as new water capture, transportation and storage infrastructure also have an important role to play in a comprehensive water management strategy and local activity.

Demand. On the demand side, demand that exceeds sustainable supply has been demonstrated in the district. The adoption of water efficient technology can considerably reduce the rate of water consumption and/or add value by sustaining economic opportunity in a declining supply. Investments in less water intensive methods of production and processes with more efficient use can lead to a more sustainable water-based economy if properly managed. Concrete possibilities of economic savings, social benefits and a range of incentivized environmental gains through state and federal programs make the adoption of water efficient technologies viable and a good idea. Mandatory limits on permissible demand are invariably debated amongst stakeholders in the groundwater resources of the district given the propensity of most government organizations to support progress in the interest of the people and the interests of individual investments and estates whose equities or pursuits depend on a usable water supply. New water restrictions without a natural change in supply are especially difficult for government to consider without new source initiatives. Regardless of what solutions may be considered, new costs are a forgone conclusion for the GMD3 that bring the questions of who will pay them and for what benefit and when this will occur.

Comprehensive planning and combining local initiatives. Sustainable economy that is now reliant on declining water supply involves a sequence of comprehensive planning and combined long-term actions and not isolated or silo strategies. Communications and coordinated actions should occur to encourage industrial and agricultural processes reformulation and migrate economic opportunities for individuals willing to develop alternatives that use less water. The challenge is to create mechanisms of reasonable regulation, incentives, economic development feasibility and finance investment security for needed water supply.

Eliminating barriers to retaining local wealth investment and importing venture capital. The activities of the management program will focus on opportunities to add value and investor confidence in water projects by providing rigor and relevance in the evaluations of local water supply conditions and use. Then working with industry and other partners to facilitate leveraging local use benefits with funding mechanisms that can aid members in securing venture capital and funding advancements in agriculture methods and the manufacturing of end products that are produced and shipped from within the GMD3 area. GMD3 will provide appropriate levels of strategic and confidential resource information and assistance to identifying the physical and legal considerations for building supply and economy under the activities of the management program.

Private, wholesale and retail water suppliers. Enhanced information resources are needed for making more prudent public and private water infrastructure investments. Policy for supply appropriate water conservation, water rights administration and coordinated use and reuse efficiencies should grow agriculture and market value from the water consumed from storage.

Distributed water supply system alternatives to local source groundwater supply will be monitored and investigated, working with KCC and other state partners to identify alternative sources in highly depleted or usability depleted aquifer areas that may require expensive water treatment before use.

Public water places in a semi-arid climate. The role of water as the key resource for community wellbeing places a burden on the management program for activities that encourage well managed public drinking water systems, enjoyable public water features and for places that educate and inform on the importance of water. Wise water use includes encouraging a respect and understanding for the emotional and aesthetic power of water that comes from places of water enjoyment and education. Water places are needed in addition to member direct uses, green fields and local products in local communities for healthy community building and water resource enjoyment. Water places such as public water bodies, water displays, playa lake education sites, water and river walks, and multi-purpose sites along natural or constructed water features enhance water value awareness and encourages responsible personal and community water management.

GMD3 Outreach, Advocacy and Public Education Program

Policies, programs, newsletters, presentations, documentary specials, public meetings, school courses, testimony and other educational efforts are all an integral part of the GMD3 outreach program. One of the purposes of GMD3 is to promote the management, conservation and use of the district groundwater resources for the stabilization and improvement of agribusiness benefits relative to national and world markets. GMD3 has a responsibility to represent and inform members on local, state, regional and national issues affecting the interests of member water users and land owners of the district.

1. Through pro-active involvement and dedication of resources, GMD3 will seek to inform, shape and influence public policy and legislation affecting local groundwater management, beneficial use of supply, district member interests, and the operations and funding of the district management program to meet Kansas water needs for today and for future generations.

2. GMD3 will continue to enhance and expand partnerships and working relationships with key elected and appointed officials to advance Southwest Kansas perspectives on proposed legislation and regulations at the state, interstate and federal levels that may affect existing and potential district water resources.

3. Member and public support will be required in order to achieve the various activities and methods of the management program described in this document. GMD3 will expand its efforts to actively engage members and the public through original initiatives and cooperative activities for:
    a. Promotions of program activities and access to program implementation documents, website postings and other social media, including a YouTube channel of informational videos, with a purpose of reaching and engaging all generations of water users, young professionals and potential partners.
    b. On-site project signage, resource education stations, community public water awareness features and water and agriculture benefit promotions.
    c. Conduct education activities within the District to push water savings measures and practices, particularly those which maintain the economic benefits of water use, such as alternate crops, use of technology and irrigation scheduling to reduce waste.
    d. GMD3 support and the results of research on water conservation methods.
    e. Stories and strategies from those who are using less water than their peers.
    f. Use demonstration projects to help producers to economically reduce net water supply loss. (CIG project with USDA, Master Irrigator Certification, Water technology farms, K-State Research and Extension farm projects and other water management projects to provide valuable examples and information to producers to encourage their participation in water saving efforts.)

The overall emphasis for these activities is on the widest possible method of disseminating information and activities that promote water, supply and elements of the management program.

GMD3 State Water Planning Coordination Program

State Water Plan Fund, Kansas Water Authority, and State Water Plan. For as long as Kansas has been a state, water has been an issue for policymakers, and for years the Legislature has passed legislation dealing with the regulation of water. In 1981, the Legislature created the Kansas Water Authority. One role of the Kansas Water Authority is to make policy recommendations for inclusion in the State Water Plan. The State Water Plan Fund was created in 1989 to fund water-related projects and programs consistent with the objectives of the State Water Plan.

1. GMD3 will work with the Kansas Water Office, the Kansas Water Authority and Regional Advisory Committees (RAC's) that advise them to add value to the deliberations and recommendations of these entities and for appropriate funding of State water needs and Water Plan Fund activities consistent with the management program activities of the district.

2. GMD3 water planning activities will further implement the long-term goals and objectives of the legislature and the district management program.

3. GMD3 will work with RAC members and advisors across the state to enhance understanding of any differing perspectives of common water supply interests and concerns.

4. The Regional Goal Action Plans developed through the Kansas Water Authority shall constitute an important consideration to GMD3 in setting GMD3 goals and action plan guidance documents implementing the GMD3 management program.

5. GMD3 will work with legislative partners to achieve a consistent and informed perspective on appropriate water planning and interstate supply management activities, including cost and risk considerations and appropriate funding sources for needed management action.

6. GMD3 will work to restore dedicated state funding for timely interstate water management support studies and evaluations needed to assure compact administration and other interstate water management purposes for Kansas. Dedicated funding is necessary to generate timely information to preserve productive interstate partnerships.

7. GMD3 will support comprehensive natural and constructed infrastructure planning through its Renewable Supplies Committee to include water transportation and storage infrastructure, including aquifer replenishment. The renewable supplies committee will recommend priority activities from the Kansas Water Vision and Kansas Water Plan for enhancing conservation of interstate supplies to Kansas and the district (e.g. January 22, 2018 letter from GMD3 President Kirk Heger to Dr. Dan Devlin, Kansas Water Resources Institute, Tracy Streeter, Kansas Water Office and Gary Harshberger, Chairman, Kansas Water Authority transmitting 23 requested or recommended Water Vision activities).

8. GMD3 will act to protect and enhance Kansas water supply in a manner consistent with its mission. GMD3 will seek Water Plan funding support at a level commensurate with what is paid into the Water Plan Fund from the GMD3 area.

GMD3 Interstate Aquifer Management Coordination Program

Water supply concerns extend beyond district boundaries and include the Stateline with Oklahoma and with Colorado. GMD3 historically receives replenishing interstate water supply from both the Arkansas River and Cimarron River basins and lateral flow of basin aquifers, having a west-to-east tilt and lateral flow gradient. GMD3, in coordination with state officials, will work with other local, state and federal partners to improve water management and opportunities for partnerships and communicating in other states for more consistency in the management programs of the OHP aquifer.

Two interstate compacts are in place with administrative bodies staffed by officials from Kansas and each respective sister state bordering the district. While each Compact and administrative body is a forum for the states to pursue "interstate comity," the purposes of these compacts must be read within the express terms of each compact. The annual meeting of each compact administrative body provides a potential forum for GMD3 communications with officials in each state to express interests and concerns regarding interstate water supply and the GMD3 management program. GMD3 will seek the development of any needed interstate agreements.

There is no compact agreement for the Cimarron river basin in Colorado and its historical contributions to district water supply. Nor are there any direct regional aquifer compacts governing surface water runoff flows that provide OHP aquifer recharge and lateral flows into Kansas and GMD3. GMD3 has reached out in providing invitations to state officials in Kansas, Colorado and Oklahoma to meet and address interstate aquifer management improvements in the mutual interests common to citizens in each state portion of the resource area.

Groundwater lateral flow entering or leaving the district is generally considered underflow. The awareness and protection of underflow supply and aquifer replenishment from surface water flows into the district are elements of the district models and are important considerations for successful partnerships to secure and improve future groundwater supply.

1. Interstate Aquifer Management Coordination is appropriate activity under the management program considering GMD3 conservation efforts that resulted in the state closing the Arkansas River moratorium and IGUCA, Cimarron River Alluvium and the High Plains Aquifer to additional groundwater appropriations. The district will host meetings to exchange hydrological information and basin aquifer concerns across political boundaries.

2. GMD3 will encourage interstate partnerships and collaborative efforts to manage and restore the quantity and usability of existing and new sources of water supply.

3. Interstate partnerships may include investments seeking participation by GMD3 in the administrative processes of other states.

4. Interstate aquifer management and renewable supply activity of GMD3 will be based on reliable data and professional technical and legal judgement.

5. GMD3 will work with landowners of properties outside the district and the state to further GMD3 management program purposes.

GMD3 Models Improvement Program

Models that are used by the district in management program activities include models of district aquifers, wells, surface water resources and economy. They are necessary management tools. However, the nature of models and available information means that each model is a work in progress. It is important to the success of the district groundwater management program to create and maintain models based on the most up to date information available. Each model is a tool designed to represent a simplified version of reality. The reliability of the tool depends on how well the model approximates field conditions. It should be remembered that some extreme events or conditions may be beyond the calibration of a model.

1. **Resources for models.** GMD3 will work with state and other partners to apply the appropriate resources to use and improve important analytical and numerical models that elevate the district groundwater knowledge base and improve application evaluations and management considerations for GMD3 members and partners.

2. **GMD3 area High Plains Aquifer groundwater model update.** The KGS groundwater model for the GMD3 area is slated for updating in 2020. GMD3 will partner with the KGS and others to complete a successful update project. Additional data is needed for improving the model function and utility. They include:

    a. Index well measurements of groundwater exchange between aquifer formations.
    b. Index well measurements of recharge benefits from surface water flow.
    c. Index well measurements of lateral flow
    d. Data needed for improved model calibration.
    e. Graphical user interface tools to connect members to local groundwater model information.

3. **New aquifer information and data.** New aquifer information and data provided to GMD3 members and partners will be shared with other state, local, and regional partners to assist in the development of the best possible models. This information may include, but is not limited to, member test hole contributions and aquifer tests. Such efforts on the part of members should be recognized as benefiting model updates and the recalibration of supply and economic models needed for implementing the management program.

4. **Economic and valuation models.** Economic and valuation models are a growing source of information used in policy and management program activities. GMD3 will look to develop and update economic models, such as the 20-year projection of Docking Institute Study of 2000 and the 50-year projection of Apparat Analytics LLC., according to the guidance documents, action plans and funding of the Board to further implement the management program.

GMD3 Investigations and Research Program

There is significant room for GMD3 to expand leadership in research on water conservation and new supply improvements. GMD3 shall maintain an active interest in this area and include the following topics for funding and for partnerships to support initiatives and researched education concerning proper water management at all project levels:

1. **Managed Aquifer Recharge**. Managed aquifer recharge activity may involve both projects that use natural infrastructure and delivery activity and projects using artificial infrastructure and delivery to recharge or replenish groundwater inventories. GMD3 will encourage both natural and artificial project feasibility investigations and collaborative means to increase the amount and/or usability of water inventory of the district. Although the state has no formal groundwater quality standards, application of the groundwater recharge use to many classified streams is intended to prevent "statistically significant increase[s] in the concentration of any chemical or radiological contaminant or infectious microorganism in groundwater resulting from surface water infiltration or injection" (K.A.R. 28-26-28d(b)(5) and 28-16-28e(c)(5)).

2. **Water Transfers - Importation**. Western Kansas and the Great Plains region offers the nation a large food production area which has not yet reached its production potential and is losing established economy as aquifer levels decline. The major limiting factor in preserving and developing this national food security potential is water. Since presently stored water supplies are inadequate to fully develop or maintain the area's production potential, transient water conserved from loss downstream in other areas could be made available for conservation storage in the ground if the existing economy is to be preserved or the natural increase of future development is to have a drought resilient and dependable water supply.

   Importation of water from other areas under conditions of surplus supply seems to be technically feasible if the economic and political aspects of such ventures can be resolved. Some opportunities may exist with pipelines previously used for other purposes and now abandoned are re-tasked for transport of water. Some of the problems are legal in nature and deal with issues such as inter/intra basin transfers. Any significant importation of water for added conservation storage under the management program will by necessity be a larger scale project and will require the coordination of many water-related entities, and authorities to maintain productive partnerships that accomplish the many steps to water transportation and energy management that will be necessary to power water transportation forward. Other smaller-scale in-state transfers will also take considerable coordination and planning to pilot such projects.

   GMD3 shall take a leadership role with partner agencies, organizations and other partner to accomplish the long-range planning and study for projects which may become economically feasible under future dollars and which offer potential for the importation of water into southwest Kansas to meet future resource service needs in the district.

3. **Water exports**. The Board shall involve itself with any proposed direct exportation of groundwater from the district to any area or location outside the district to ensure that all management program purposes are met and seek opportunities to meet the needs for present

and future water supply in adjoining areas in the public interest. Exported water use may be evaluated to consider assessing higher user fees than for in-district uses or for net use between imported supplies and those exported out of state.

4. **Federal Farm Programs**. As we look at the farm bill through the lens of the farm economy, innovation and technology will remain essential for district farmers and ranchers to continue producing more food and fiber with less water. The federal farm bill research and other programs have a significant influence on the implementation of the GMD3 groundwater management program for district members and partners.

    a. GMD3 will engage farm bill development, adoption and implementation, working with industry and other partners to guide national funding and program commitments that support the district groundwater management program.

    b. GMD3 will partner in the work of USDA Agriculture Research Service Ogallala Aquifer Program whose goal is to sustain rural prosperity across the Southern High Plains, including the district, in seeking solutions to problems from declining water availability. See: https://www.ars.usda.gov/research/project?accnNo=429690

    c. GMD3 will participate in farm bill development and implementation of the best policies that preserve and enhance water conservation incentives. Water conservation programs like those enveloped in the EQIP program should incentivize and reward real water conservation. Using historic water usage and not recognizing real conservation credits may only encourage maximizing a water use record prior to enrollment, which is contrary to the district Management Program. Those who already work to conserve groundwater in a declining supply have a larger burden to achieve the added conservation so valued to address the resource concern. Partnerships and programs that demonstrate use of new water conservation, efficiency technologies and crop variety choices that are revolutionizing groundwater management on the High Plains must be encouraged, such as mobile drip irrigation, new soil moisture probes, and other project level sensor and data communications that increase resource and economy sustainability.

    d. Risk management is a key influence of the farm bill on the district groundwater management program. Input and potential partnerships with RMA and others will occur to further develop useful risk management products for limited irrigation policy coverage and supported for farms and regions suffering from limited well yields or areas where intensive water management are called for while not forcing unnecessary irrigation in declining groundwater areas.

    e. GMD3 will advocate for flexibility in the use of field level crop bases to encourage crop changes that conserve water use over program elements that economically force members to continue high water use crops to preserve valuable crop bases.

5. **State water conservation incentive programs.** GMD3 will continue to encourage and develop additional partner activities in state sponsored water conservation incentive programs to be made available to members and investigate opportunities to leverage management program activities with incentivized conservation activities that further the purposes of the management program for the district. Programs considered include:
    a. The Conservation Reserve Enhancement Program (CREP) that as of September 30, 2017, a total of 112 state CREP contracts on 18,659 acres have been approved by the State of Kansas (with the addition of 385 acres this year). These contracts have resulted in the permanent retirement of 37,999 acre-feet of annual water appropriation on 135 water rights from 166 wells, mostly in GMD3. The contracts represent a total of $1,210,511 in state sign-up payments to producers over the past ten years. These payments are matched by annual rental payments to producers from FSA totaling about $2,191,213 in FY2017.
    b. The Water Transition Assistance Program (WaterTAP) is a voluntary, incentive-based program that has permanently retired a hand full of privately held irrigation water rights in exchange for payment by the State of Kansas. It is intended to help restore aquifers and recover stream flows in critically depleted target areas. The 2012 Kansas Legislature extended WTAP until June 30, 2022 based on past results of the recent pilot project. GMD3 will consider options to target the modest funds available under this program.
    c. Other Kansas Water Plan Fund supported projects for feasibility, study and funding.

6. **Brackish water use technology and feasibility.** Brackish water or briny water is water more saline than fresh water, but not as much as seawater. In GMD3, it may occur in deep geologic formations or in Arkansas River surface water from Colorado or in Cimarron river flows from the district into Oklahoma. Brackish waters are viewed recently as potential and viable resources to alleviate water scarcity and overcome water budget deficits for some project uses. Kansas law requires consideration of such water sources used first during water appropriation permitting per K.S.A. 82a- 711, where " *…the chief engineer shall not approve any application submitted for the proposed use of fresh water in any case where other waters are available for such proposed use and the use thereof is technologically and economically feasible*." The evaluation of various desalination technologies will be encouraged as one of many options to conserve and manage district surface and groundwater supply.

7. **Strategic and environmental planning support.** GMD3 participation and outreach support of planning efforts by local authorities and their targeted interests in water related economic development planning and environmental protection activities is a necessary and desirable activity of the GMD3 to effectively implement the management program. Coordinating with other local government entities provides efficiency of resource management in support of members and the leadership of cities, counties and special districts affecting GMD3 management to ensure conditions for member health, safety and welfare are maintained.

8. **Water reuse reporting and support.** Since first use of water is the use authorized and reported under water rights administration, little comprehensive data is available or reported on water reuse in the district. The management program supports the efficient first use and appropriate reuse of water resources for irrigation. Efforts to increase water use value is an important response to dwindling local supplies and increasing water costs. Water reuse can also be a source of depletion of historical return flows to local aquifer areas that may be an important sustaining source for other water rights. In recognition that GMD3 can't manage what isn't measure, GMD3 will work to develop methods for tracking the extent of water reuse and assist in developing feasibility studies and researching water recycling projects as requested by members or required by grant opportunities to benefit the management program.

9. **Data Collection and exchange.** The data collection needs of GMD3 are expected to be very broad as various plans and programs are implemented. Data needs will range from water quantity and water quality issues, to research and investigation needs, to land ownership records and socio-economic and use value needs as necessary to implement the groundwater management program. This could include at any time additional supply, water use, cropping, soils or well and water flowmeter data needed to support improved supply, water use efficiency, conservation efforts and program compliance. GMD3 will communicate and cooperate with local, state and federal interests for data exchange to accomplish the purposes of the groundwater management program and mutual support of partner initiatives. Such cooperative efforts with partner organizations can be an efficient use of GMD3 manpower, technical and financial resources.

10. **Application software.** GMD3 will improve data collection application software and hardware tools for efficient data collection and information mining from outside data sources, including: a water well and water flowmeter inventory designed to show the location and status of each non-domestic well; installed water flowmeter type and performance reliability data; map based data concerning area groundwater inventories; water quality information that is available or can be collected; a land ownership and mailing list data base for member communications and enforcement purposes; and climate data for the region that is necessary for any irrigation scheduling programs or research.

GMD3 Water Quality Protection Program

Water quality is both a water usability question and a concern for the public health, safety and welfare of Kansas citizens, including members of GMD3. GMD3 will monitor and look to implement and address the following water quality activities in coordination with federal, state and local partners:

1. **Existing Pollution Problems.** Known pollution problems that pose a direct threat to the usability of groundwater supply within the district will be researched and evaluated by staff, in conjunction with KDHE programs and other potential partners to seek adequate mitigation and/or remediation for net improvements. If staff deems it necessary to seek further control measures, whether it be in conjunction with other federal, state or local water-related agencies, or as a sole initiative, staff will present its recommendations to the Board for consideration of appropriate action and funding measures.

2. **Pollution risk.** The water quality program activity will work to conserve groundwater by preventing future degradation of groundwater quality that will cause water usability depletion. GMD3 will work to identify the major sources of water usability depletion, and work to have those concerns addressed in targeted local sources of supply before they create significant water usability depletion of district groundwater or surface water and risk to public health, safety and welfare. For example, aquifer recharge activity from waste water and nutrient management effluent activities can pose water pollution risk that will be addressed with practical member and industry considerations in collaboration with state water quality and water quantity administrative policies and practices. Within the domestic beneficial use classification is a sub-group containing groundwater members who use a nonpublic household water well. Management program activities may focus on advancing drinking water quality monitoring and supply protection with recommended triggering events to have drinking water wells inspected and for testing water quality.

3. **Oil and gas industry water use and supply risk**. GMD3 should consider accessing data on historical oil and gas activity in the district for staff review of information with appropriate state officials to screen for possible constructed or casing failure that creates fresh water drains to deeper formations and threaten loss of usable groundwater. Additionally, opportunities for new technology-based water treatment to improve usability of low-quality water and safe waste disposal will be reviewed periodically.

4. **Abandoned water supply wells**. With about 1/4th of district non-domestic wells idle per annum, GMD3 may consider working with KDHE Bureau of water in their permitting of temporarily abandoned water wells under administration of the Groundwater Exploration and Protection Act to assist members in the management of wells to comply with state law and manage well equities, groundwater usability, data collection opportunities and on-site safety concerns.

5. **Groundwater gage network for quality and usability**. GMD3 has developed a district monitoring well network and obtained water samples that were analyzed for contaminants.

GMD3 has also worked with partners to establish Stateline groundwater gages to provide quantity and quality data for interstate partner and policy development and secured funding sources and partners for the needed gage records. GMD3 continues work to set up a network of observation wells in any area that additional water level, flow and water quality data is needed to support the management program and partner activities.

CONCLUSION

All policy discussions of this management program are those of the governing body of GMD3. Activities of GMD3 are conducted with due consideration and appreciation for the diverse local, state and federal institutions and partner interests. The management of groundwater in the district pursuant to the GMD ACT, and all rights and powers granted by the Kansas Legislature, are fully retained here. The rights, powers and program activities are implemented in a manner consistent with state and federal law through the elected Board supervision of the adopted Management Program, guidance documents, Board by-laws and resolutions, state administrative rules and orders adopted and issued for the district, and other actions of the GMD3 Board that provide guidance and services as authorized under the Kansas GMD Act.

11. **APPENDIX**

Kansas water law and planning legislation history notes.

Selected from work by **John Peck** who provides a water rights and planning history outline in his writing on drought concern and Kansas water law: ***Legal Responses to Drought in Kansas,*** Kansas Law Review, Vol. 62, No. 1141, 2014, University of Kansas - School of Law.

Legislation

A. Pre-1945 water statutes: Drought not mentioned specifically, but perhaps can be inferred as one of the background reasons for some legislation:

1. 1866 (irrigation companies empowered to construct canals)
2. 1886 (stream water may be used for irrigation by appropriation, and first in time is first in right)
3. 1889 (ditch and canal companies empowered to condemn water rights)
4. 1891 (waters west of 99th meridian to be devoted first to irrigation use, subject to domestic, 2nd to industrial use; irrigation districts may be created)
5. 1899 (irrigation companies empowered to condemn to aid in establishing reservoirs, lakes, or ponds for water storage)
6. 1917 (Kansas Water Commission established to investigate problems of, *inter alia*, domestic water supply and irrigation; to establish river gaging stations; to make general plan for development of river basins; repealed 1927)
7. 1919 (Division of Irrigation created in State Board of Agriculture (BOA), under control of commissioner of irrigation; duties of commissioner included gathering data, visiting sites, and making quarterly reports to BOA)
8. 1927 (legislature abolished Water Commission and Division of Irrigation; Division of Water Resources (DWR) created to take over duties) [chief engineer position created]
9. 1933 (Chief Engineer made head of DWR)

B. The 1945 Water Appropriation Act: Activity related to and resulting from 1930s drought: Richard Pfister, WATER RESOURCES AND IRRIGATION, PART IV OF ECONOMIC DEVELOPMENT IN SOUTHWESTERN KANSAS, KU School of Business (March 1955)

1. 1940 (Governor appointed committee and held conference to study problems and make recommendations; committee report recognized need for a state plan to control the water resources)
2. 1941 (legislature repeals part of 1886 Act and established administrative procedures for handling applications for water appropriations)
3. 1944 (*State ex rel. Peterson v. Kansas State Board of Agriculture*, 158 Kan. 603, 149 P.2d 604 (1944) (affirmed common law doctrine of absolute ownership for groundwater; concluded that the chief engineer had been given no power over groundwater allocation))
4. 1944 (Governor appoints committee to study state water law, which produces "The Appropriation of Water for Beneficial Purposes: A Report to the Governor" (Dec. 1944) recommending adoption of Doctrine of Prior Appropriation)
5. 1945 (legislation adopts the Water Appropriation Act (WAA)) [Now all Kansas water rights to follow one doctrine and unused water is dedicated to the people of the state subject to beneficial appropriation as provided in WAA]

6. 1956 (clarify water rights as changeable real property that must tolerate reasonable economic effects between users)
7. 1972 GMD Act (legislature dedicates local groundwater management rights)
8. 1978 (legislature restrict all non-domestic use without first obtaining state permission and adds Intensive Groundwater Use Control Area provision in GMD Act)
9. 1986 (mandated annual water use reports by March 1st each year subject to fines)
10. Water right management tools developed since then.
    [2012: Local Enhanced Management Areas (LEMA's) allowed]
    [2012: Eliminating forfeiture of groundwater rights for non-use in closed areas]
    [2015: Water Conservation Areas (WCA's) allowed]
    [2015: Requirement for chief engineer to give due consideration of past management and voluntary conservation in new conservation programs.]

Kansas Water Planning Acts

1. 1917 (Kansas Water Commission established to investigate problems of, *inter alia*, domestic water supply and irrigation; to establish river gaging stations; to make general plan for development of river basins; repealed 1927)
2. 1955 (Kansas Water Resources Board and executive director established)
    a. Charged with working on and working out a state water plan of water resources development.
    b. Background: "The State of Kansas had no sooner recovered from the spectacular floods of 1951 when it plunged into one of the most severe droughts in Kansas history from 1952 through 1956. This sequence of disasters led to legislative creation of the Kansas Water Resources Board in 1955 as a move to try to do something to avert or at least alleviate future crises through aggressive planning.

3. 1963 (State Water Plan Act, 82a-901 *et seq.)*
4. 1981 (Kansas Water Resources Board replaced by the Kansas Water Authority, the Kansas Water Office, and the director of the Kansas Water Office)
5. 1984 (State Water Resource Planning Act: major amendments to K.S.A. 82a-901a, *et seq.*)
6. 1985 (K.S.A. 82a-906 amended to provide dynamic planning process, under which KWO presents annual water plan and recommendations to the legislature)

End of Legislation History notes.

Maps and groundwater model information

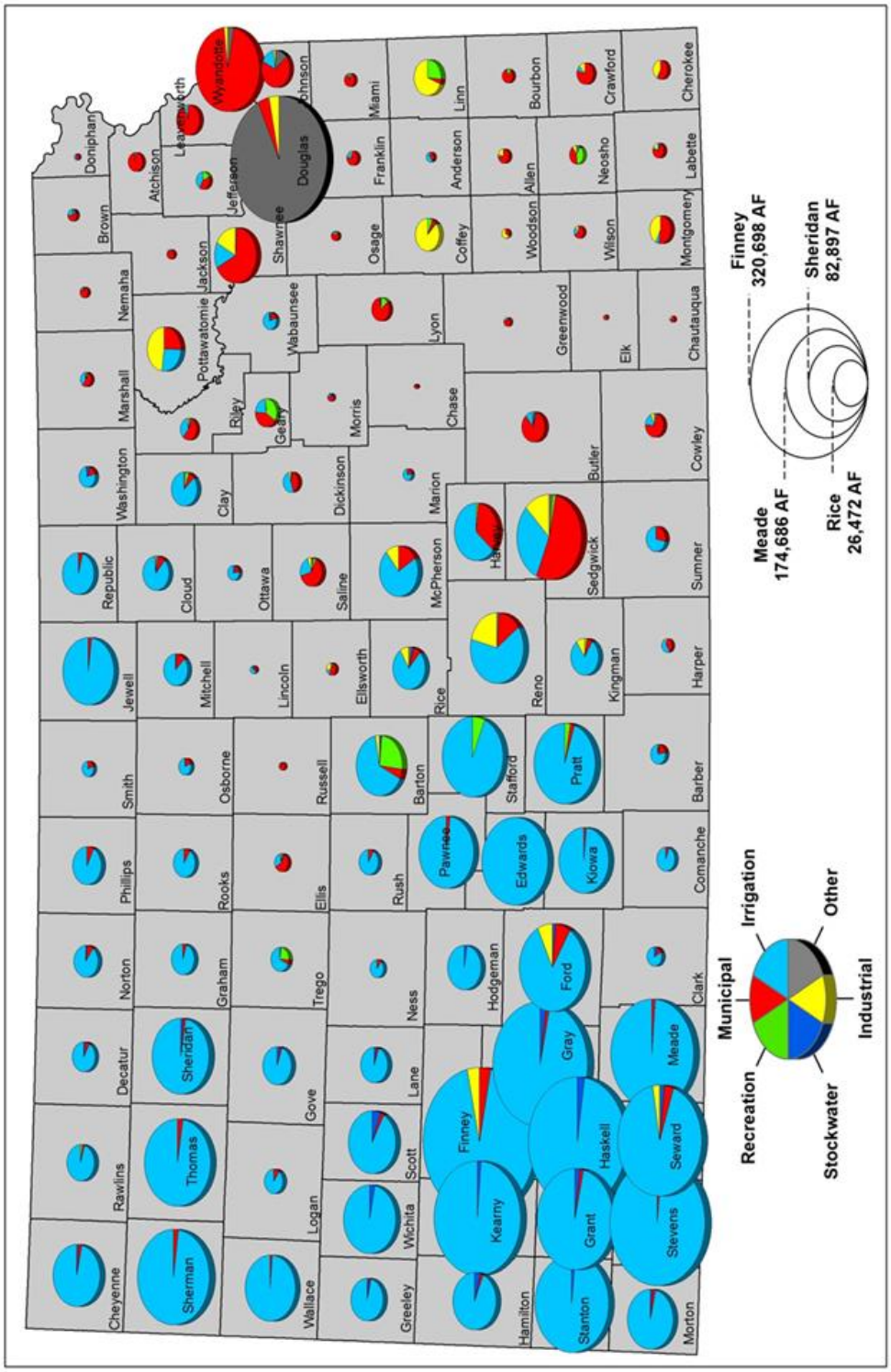
The following maps display the pumping density distribution, the percent loss in saturated thickness, and the remaining saturated thickness of the High Plains Aquifer in Kansas. The High Plains Aquifer Atlas can be found at:
http://www.kgs.ku.edu/HighPlains/HPA_Atlas/Water%20Rights%20and%20Water%20Use/index.html

The most recent GMD3 groundwater model information can be found at the following urls:

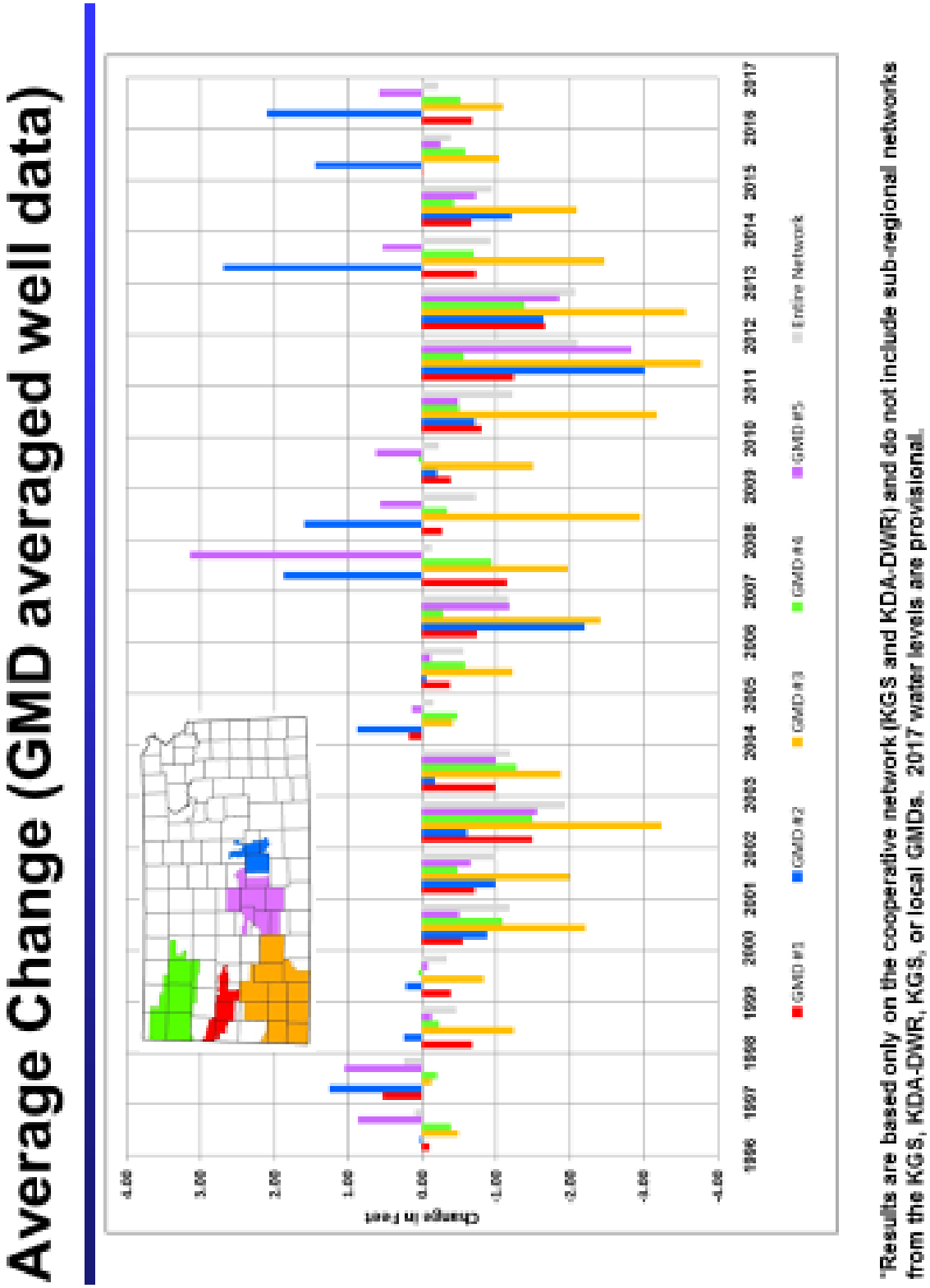
GMD3 Ground-Water Model: http://www.kgs.ku.edu/Hydro/Publications/2010/OFR10_18/

GMD3 Model Future Scenarios: http://www.kgs.ku.edu/Hydro/Publications/2012/OFR12_3/

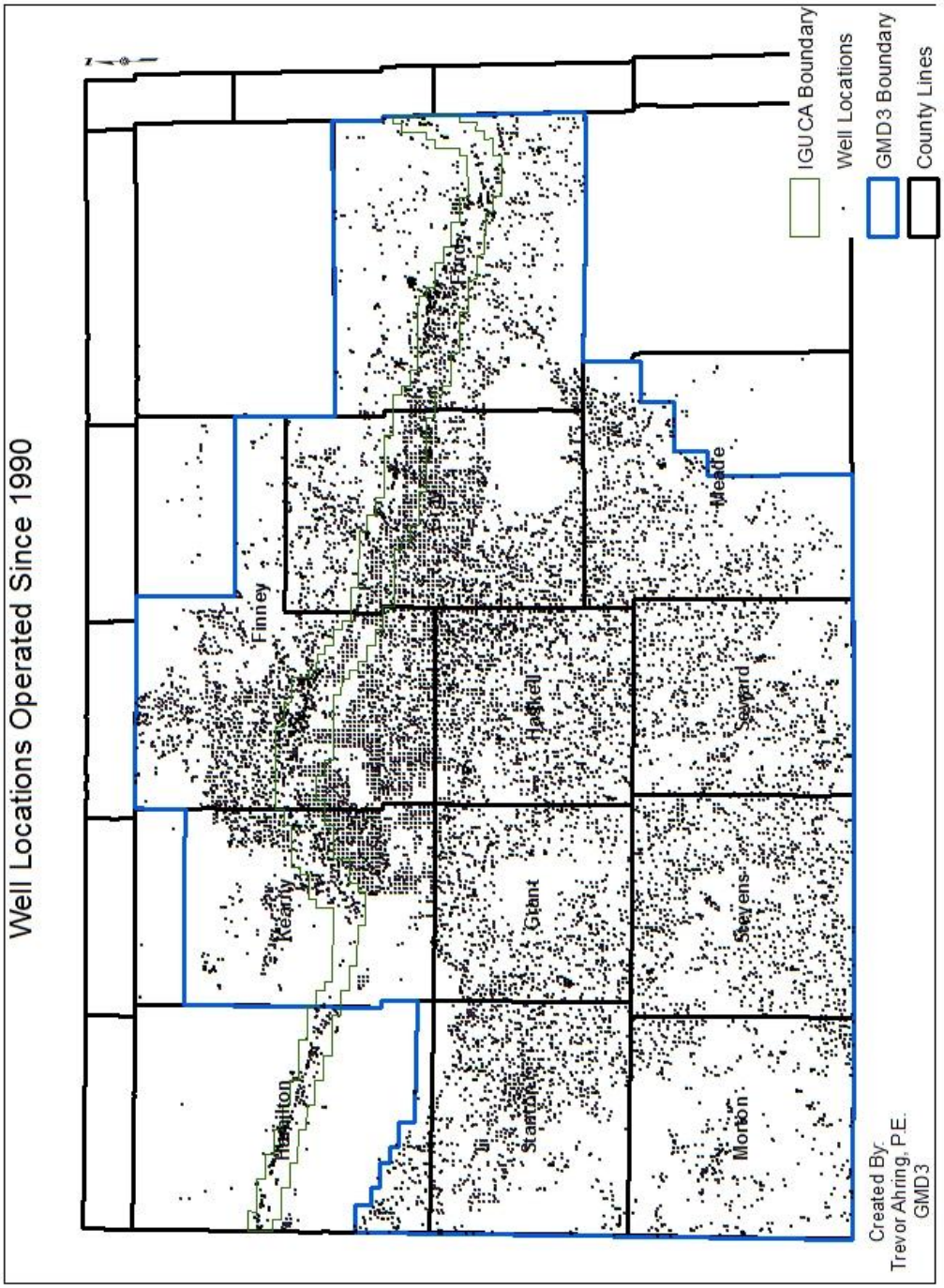
Potential economic impacts of water-use changes in Southwest Kansas:
http://www.tandfonline.com/doi/abs/10.1080/19390459.2013.811855

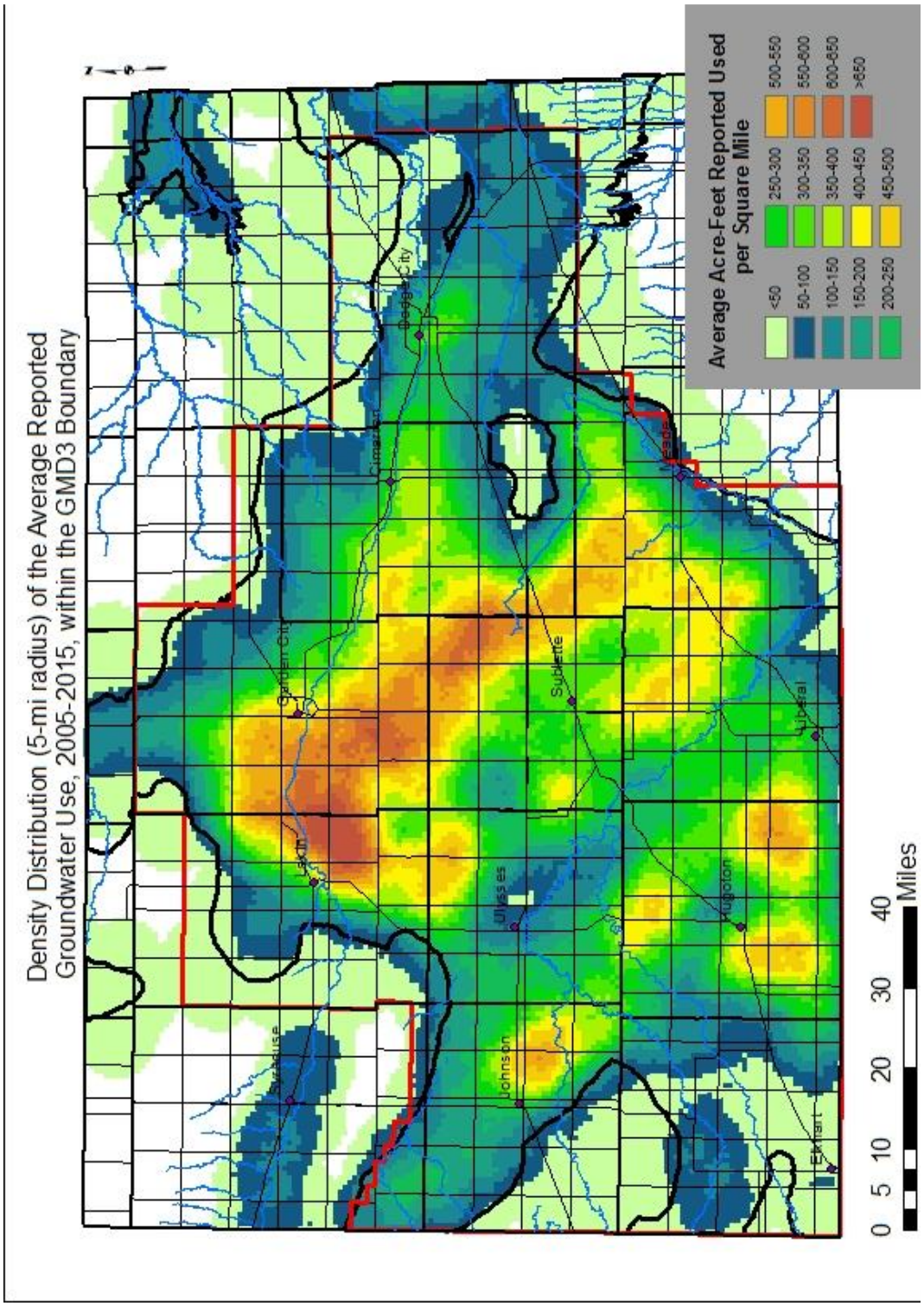


Average annual reported water use 1995 to 2014 influenced by the precipitation patterns and available groundwater. “Other” use is primarily flow through hydropower. Source: KGS. A complete list of Kansas beneficial uses under K.A.R.

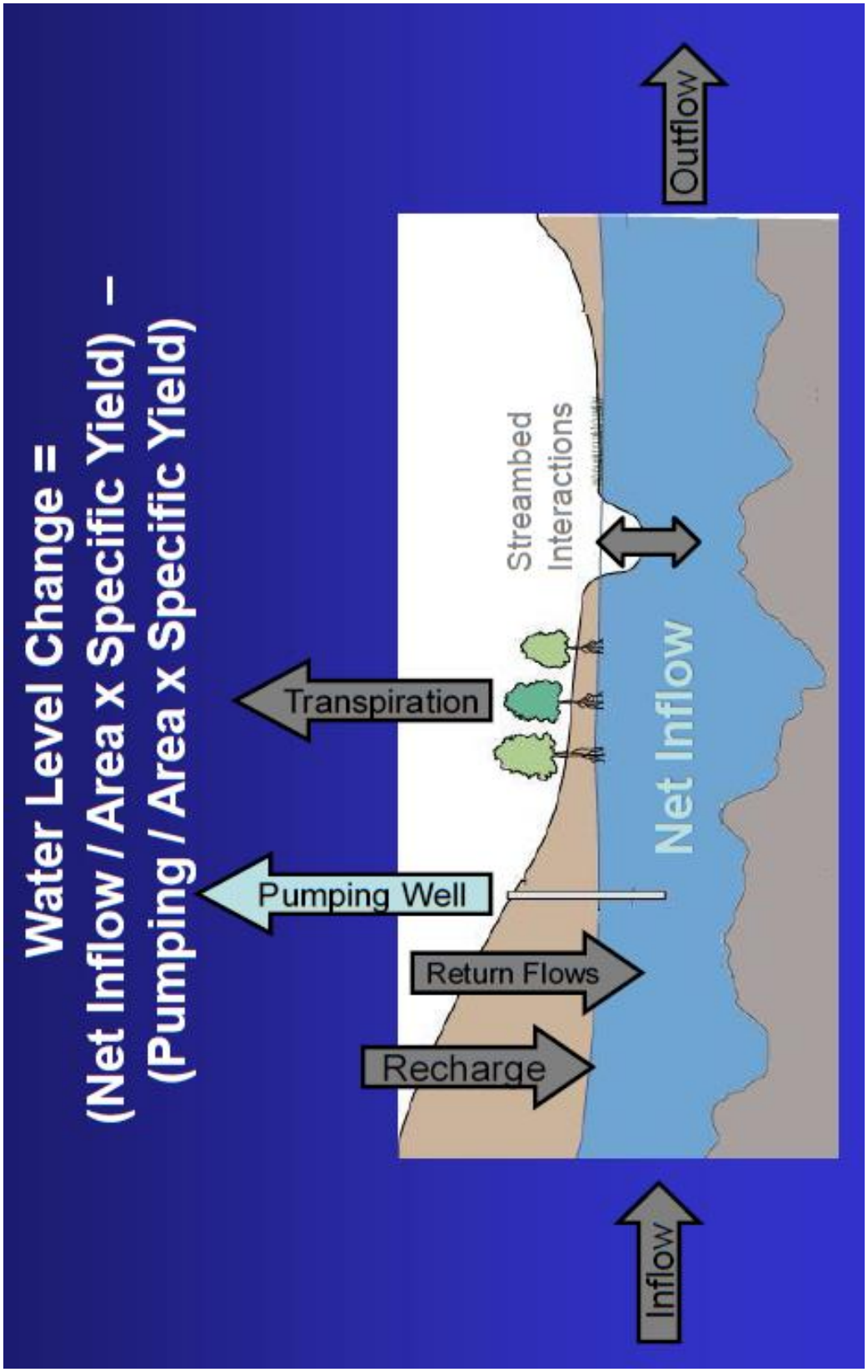


Average annual water level change (ft) of each GMD, 1996 through 2017, KGS

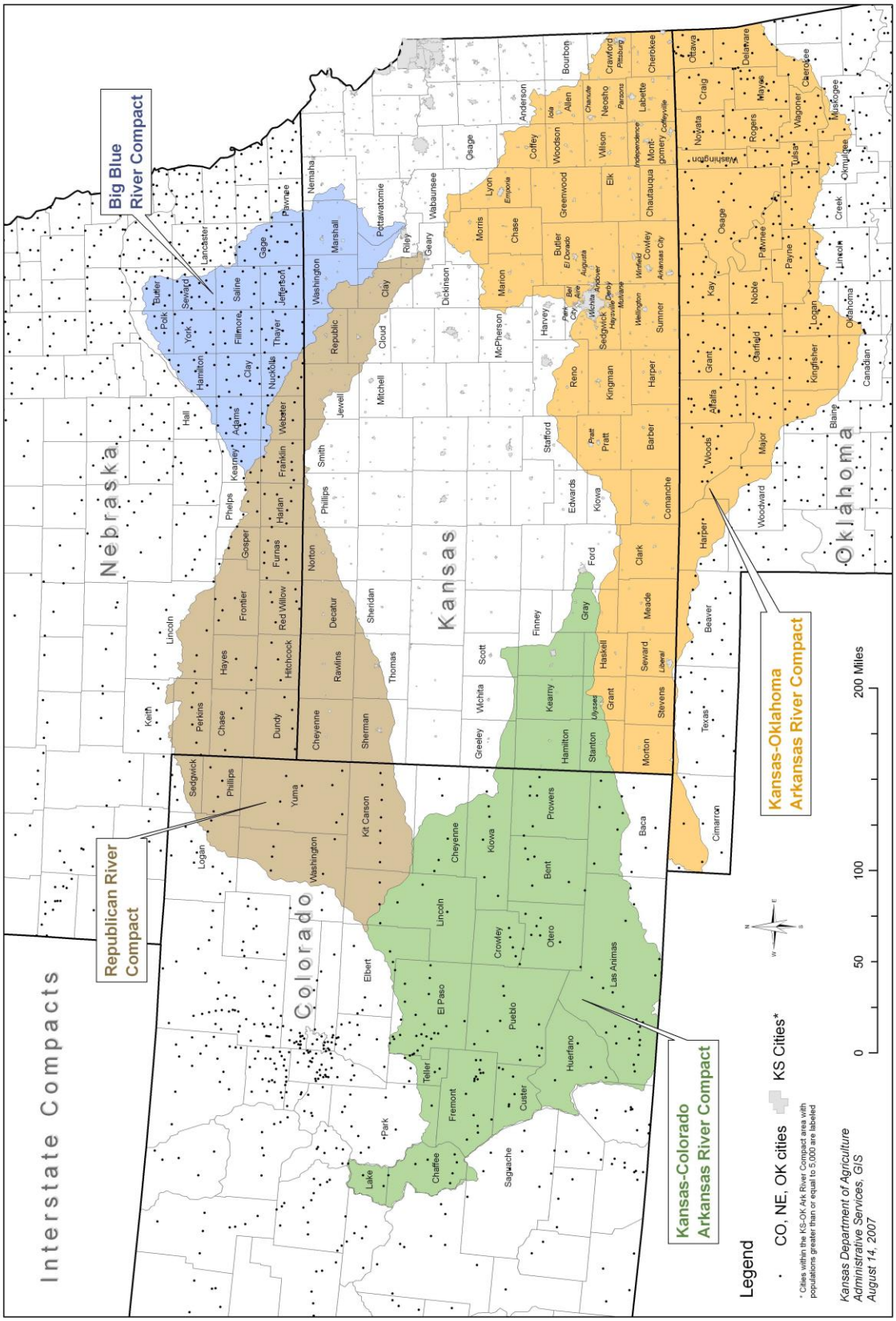

Well Locations Operated Since 1990
Finney
Kearny
Hamilton
Stanton
Grant
Haskell
Meade
Seward
Stevens
Morton
IGUCA Boundary
Well Locations
GMD3 Boundary
County Lines
Created By:
Trevor Ahring, P.E.
GMD3



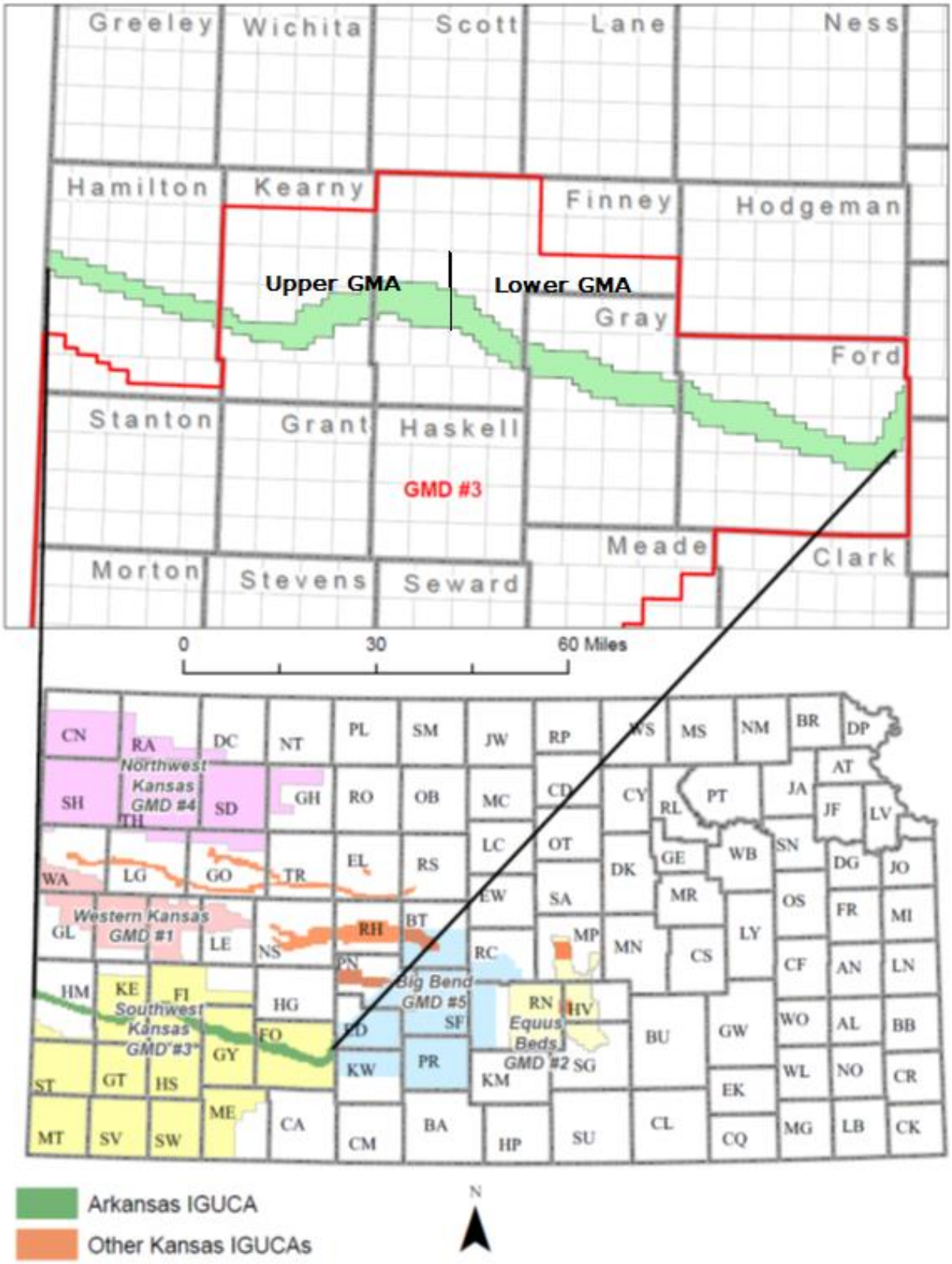
Pumping Density of the High Plains Aquifer in Kansas.
Source: Kansas Geological Survey,



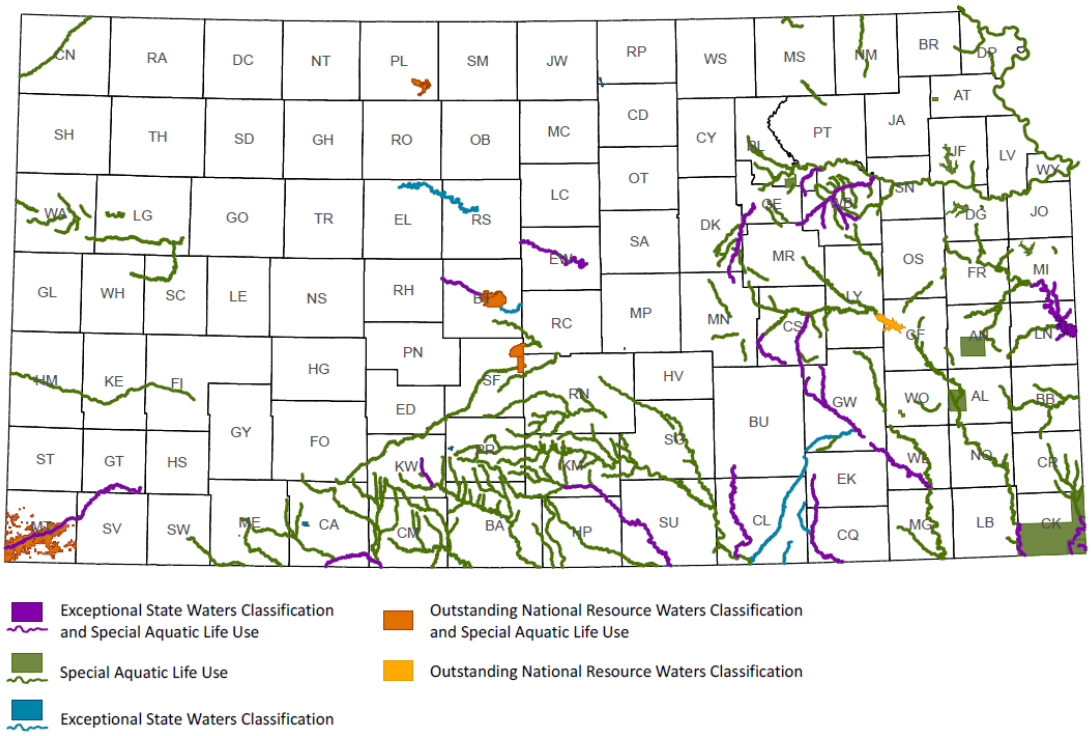
Source: Kansas Geological Survey


Interstate Compacts
Big Blue River Compact
Republican River Compact
Kansas-Colorado Arkansas River Compact
Kansas-Oklahoma Arkansas River Compact
Nebraska
Kansas
Colorado
Oklahoma
Legend
CO, NE, OK cities
KS Cities*
* Cities within the KS-OK Ark River Compact area with populations greater than or equal to 5,000 are labeled
Kansas Department of Agriculture
Administrative Services, GIS
August 14, 2007
0
50
100
200 Miles

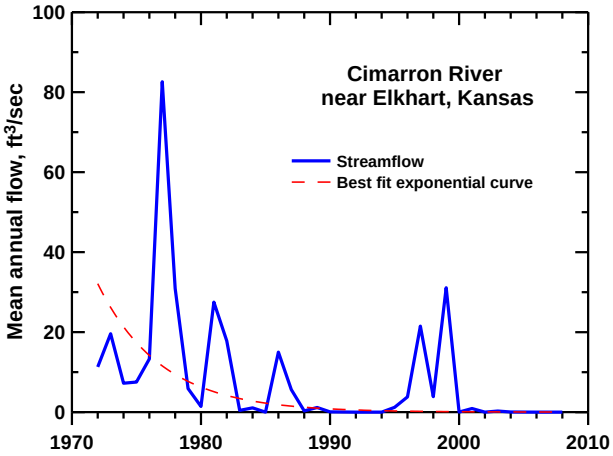
Arkansas IGUCA



High Value Surface Water Designations within Kansas



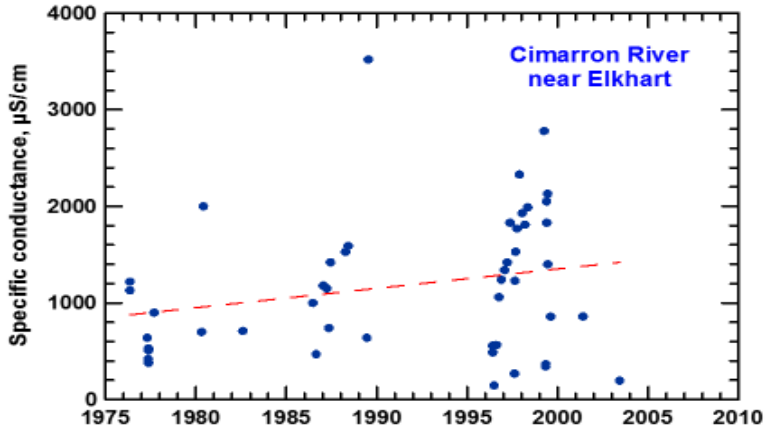
Map showing Exceptional State Waters and Outstanding National Resource Waters of the Cimarron River and National Grassland. Source: KDHE, 2010

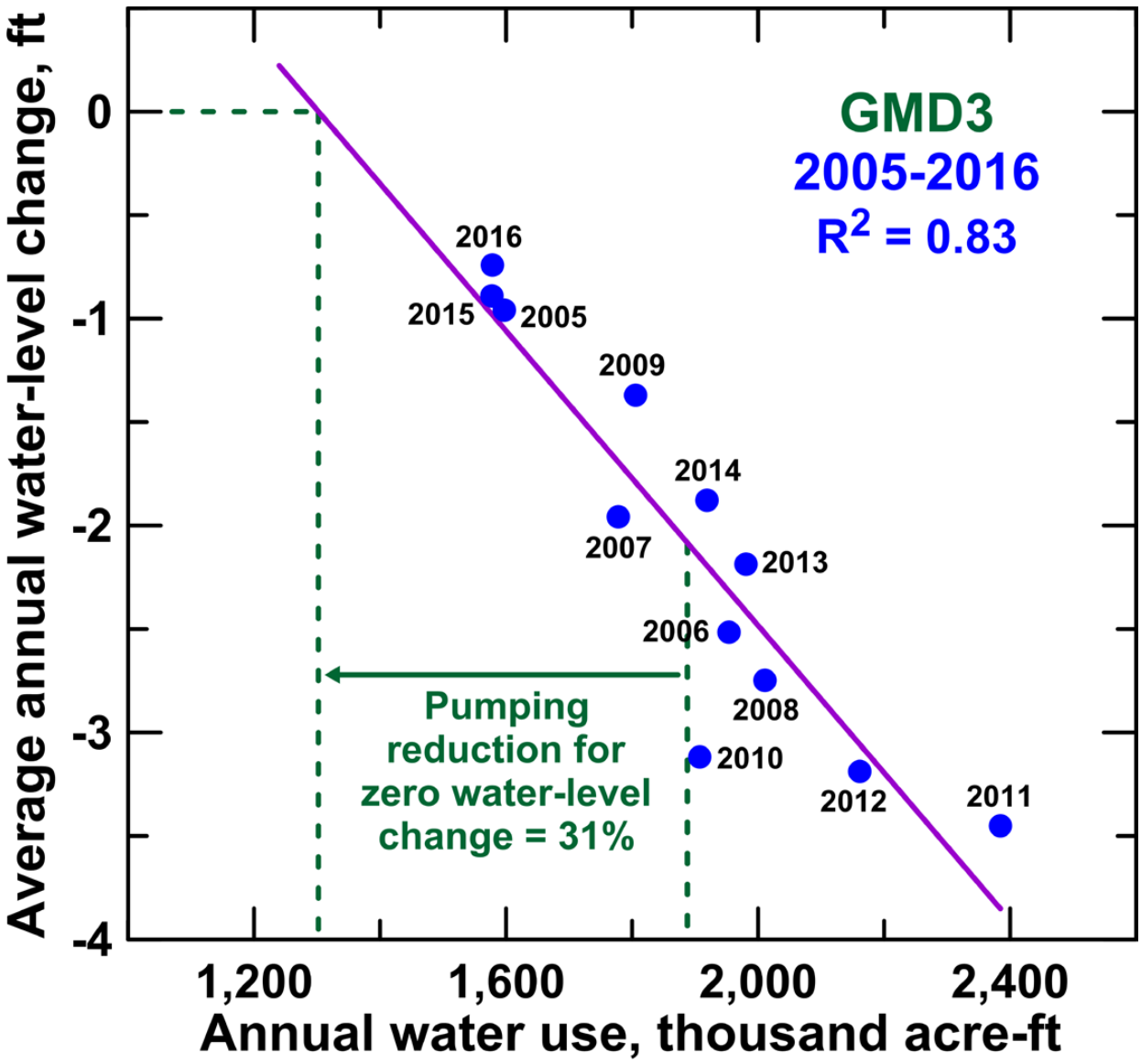


Cimarron River entering Kansas in Morton County

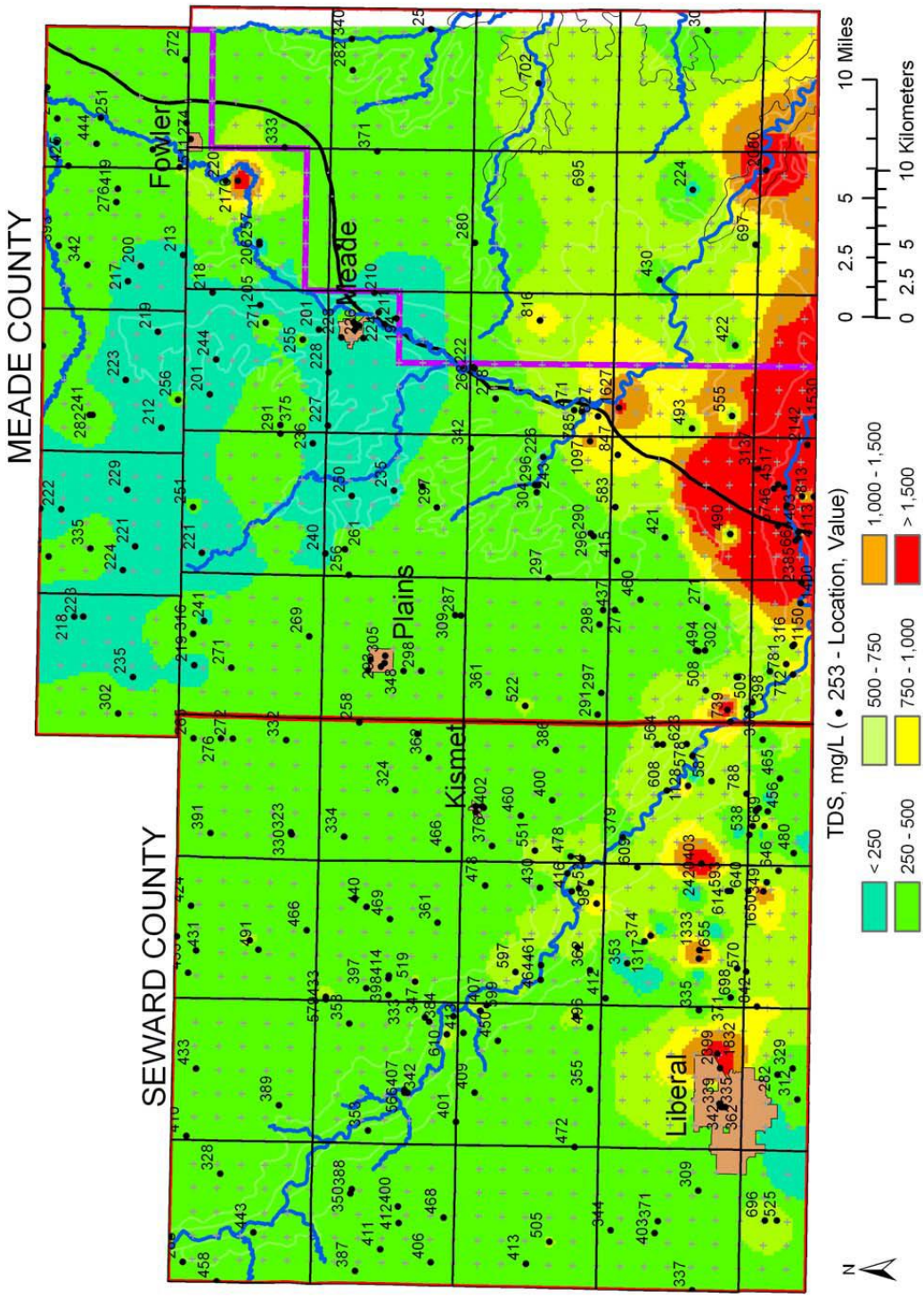
Water use in the Cimarron River valley upstream of Kansas has decreased flow and increased salinity in the river entering Kansas. The river no longer usually flows, thus, impact of saline (high sulfate) river water on groundwater in Kansas is minimal.

From Kansas Geological Survey Open File Report 2005-27

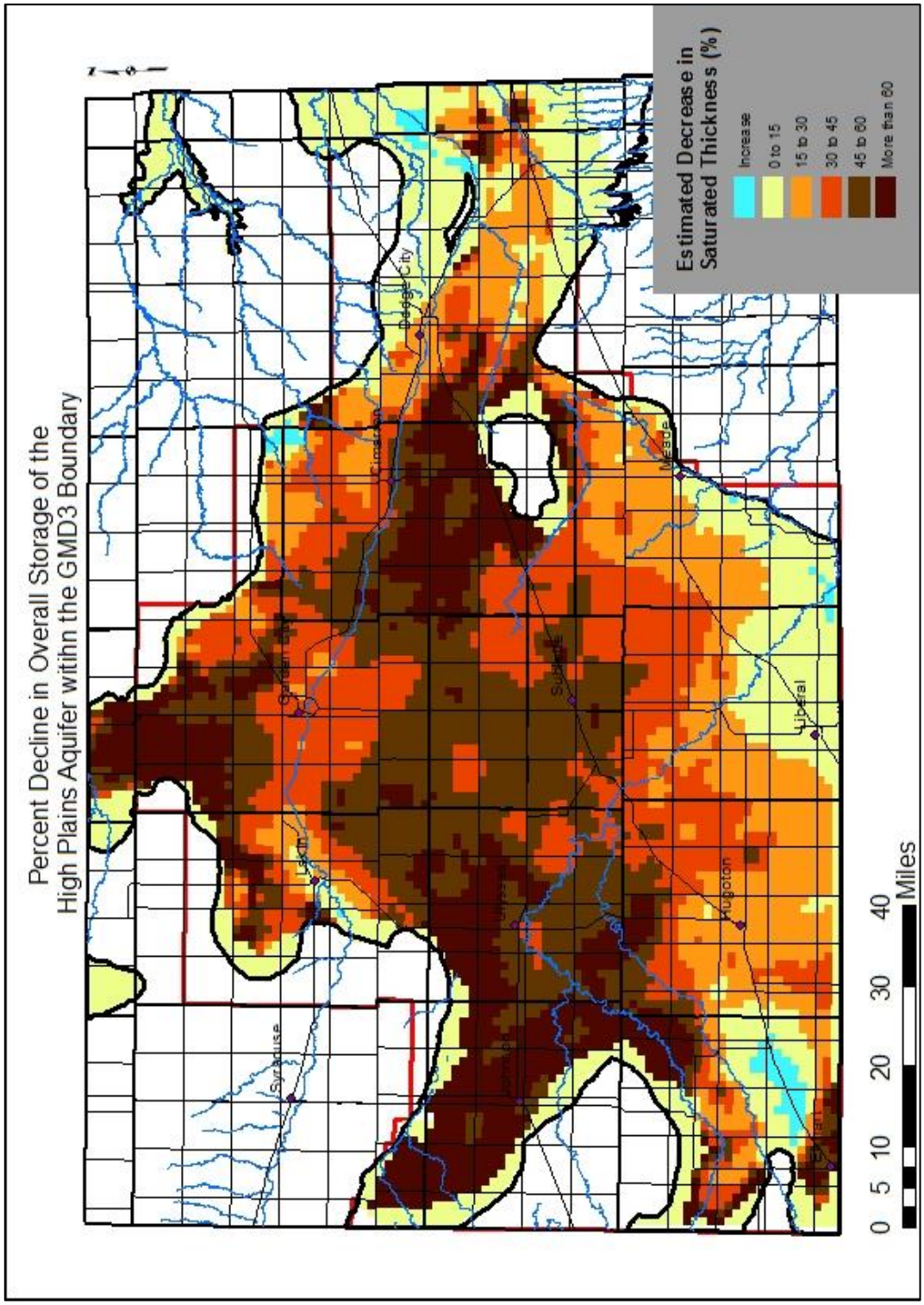




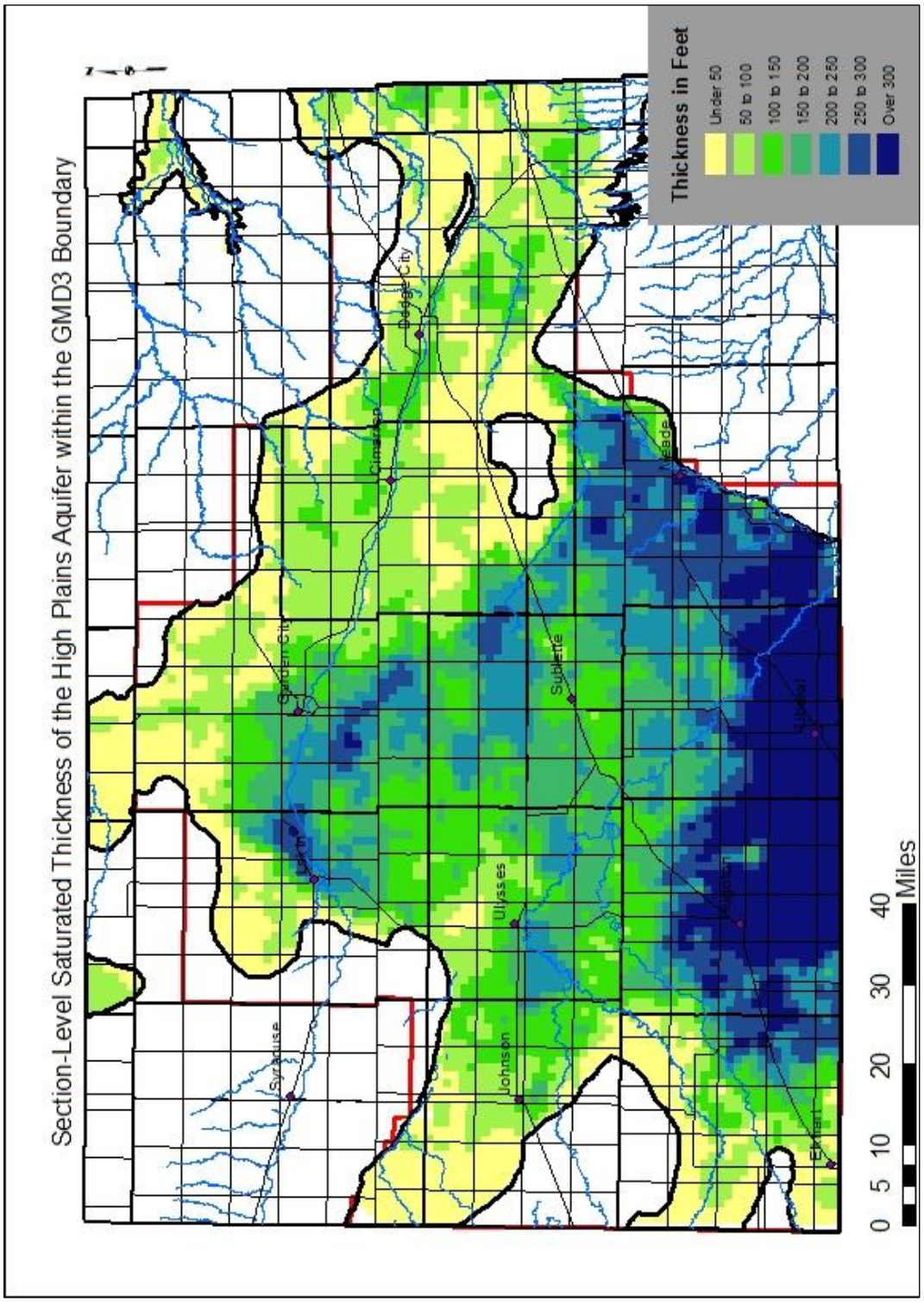
How close to sustainable? Average annual water-level change versus annual water use for GMD3 for 2005–2016. Water-level data are for KGS-DWR cooperative network wells measured each winter during the period. The solid line is the best-fit straight line to the plot. The pumping reduction from the average water use for 2005–2016 to that needed to achieve a zero water-level change is shown by the vertical dashed green lines. From *Status of the High Plains Aquifer in Kansas* | Whittemore, Butler, & Wilson, KGS Technical series 22, 2018.



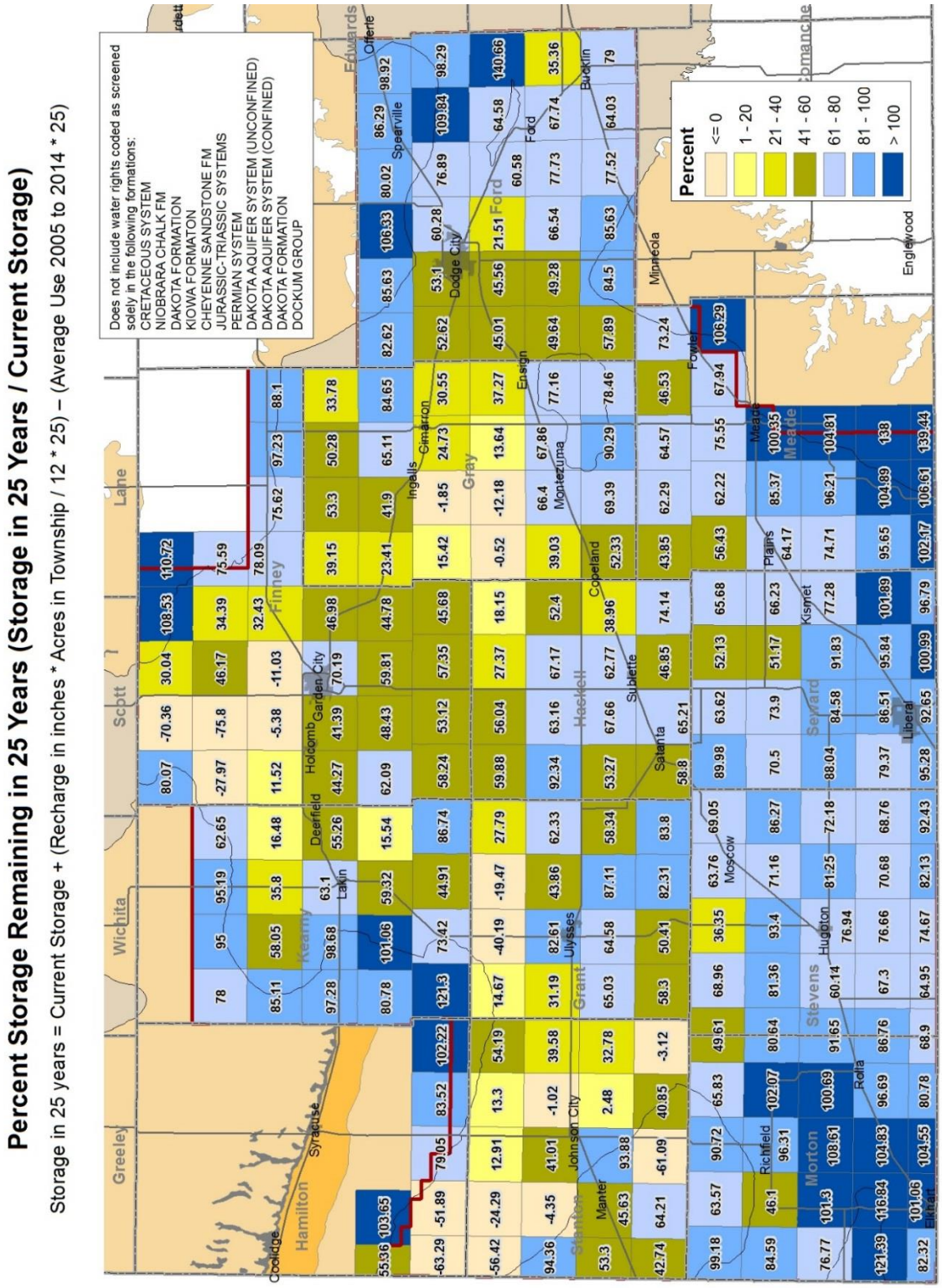
Distribution of chloride concentration in groundwater in aquifers in Seward and Meade counties. The blue line extending from northwest to southeast Seward County and through southwest Meade County is the Cimarron River. Most of the blue lines in northern, central, and southeast Meade County are streams that are part of the Crooked Creek drainage basin. The vertical red line is the boundary between Seward and Meade counties. The purple line within Meade County is part of the eastern boundary of GMD3. The black line extending from southwest to northeast Meade County represents the eastern extent of the saturated part of the High Plains Aquifer in the figure. From KGS Open File Report 2005-27.



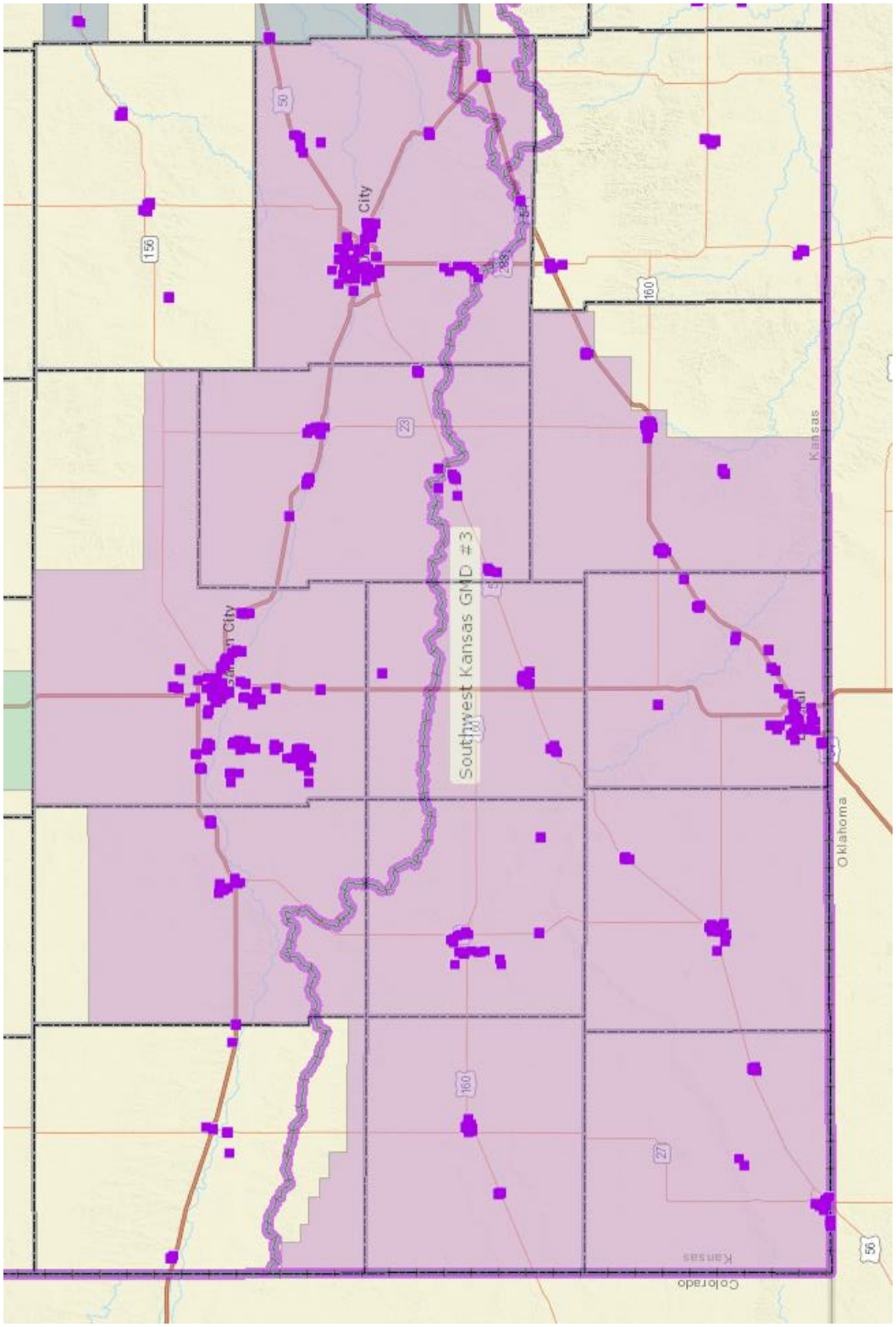
Section level percent decline in storage (since 1950) of the High Plains Aquifer in GMD3.
Source: KGS, http://www.kgs.ku.edu/Publications/pic18/index.html



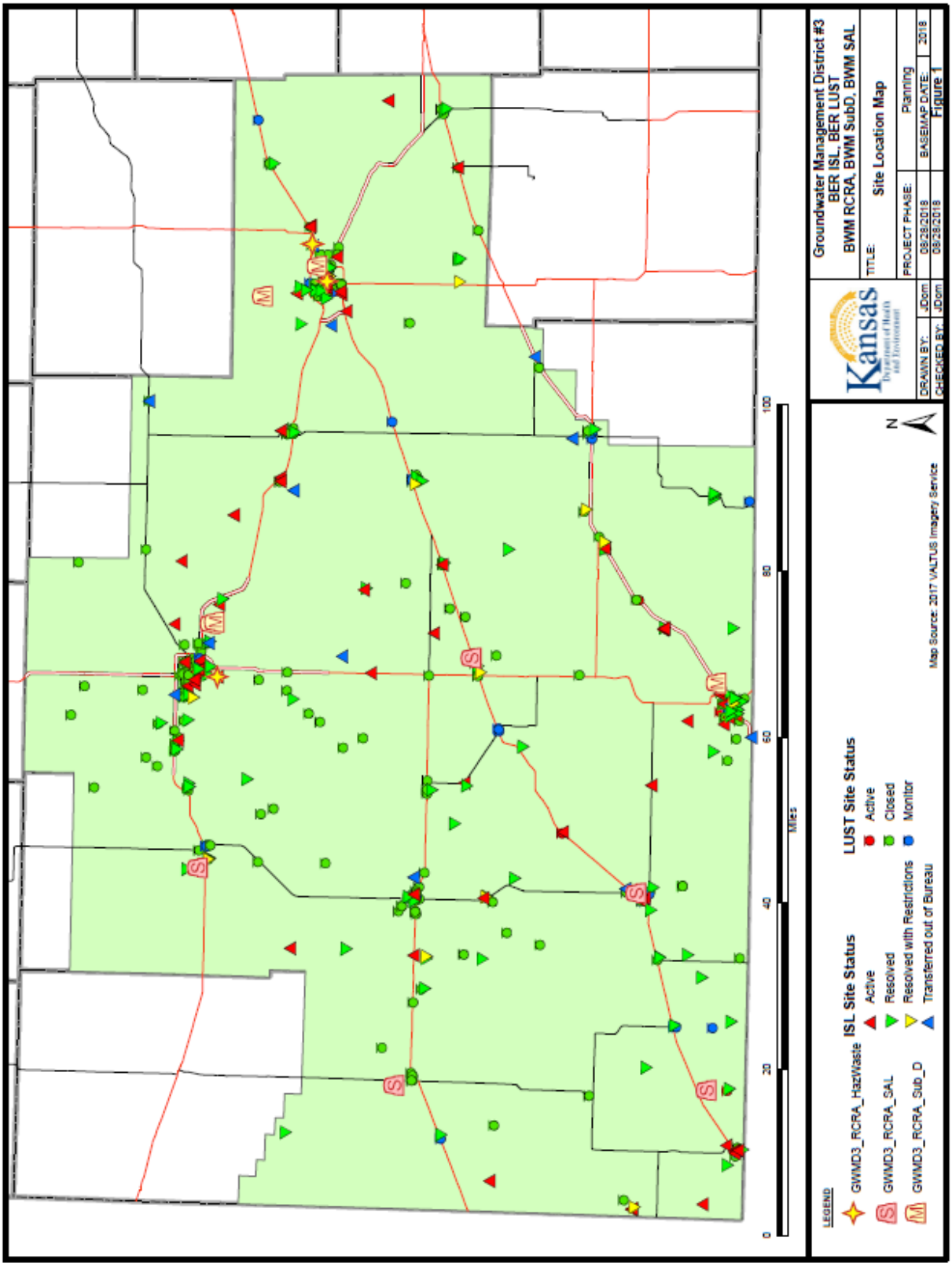
Saturated Thickness of the Ogallala/High Plains Aquifer, 2015.
Source: KGS, http://www.kgs.ku.edu/Publications/pic18/index.html



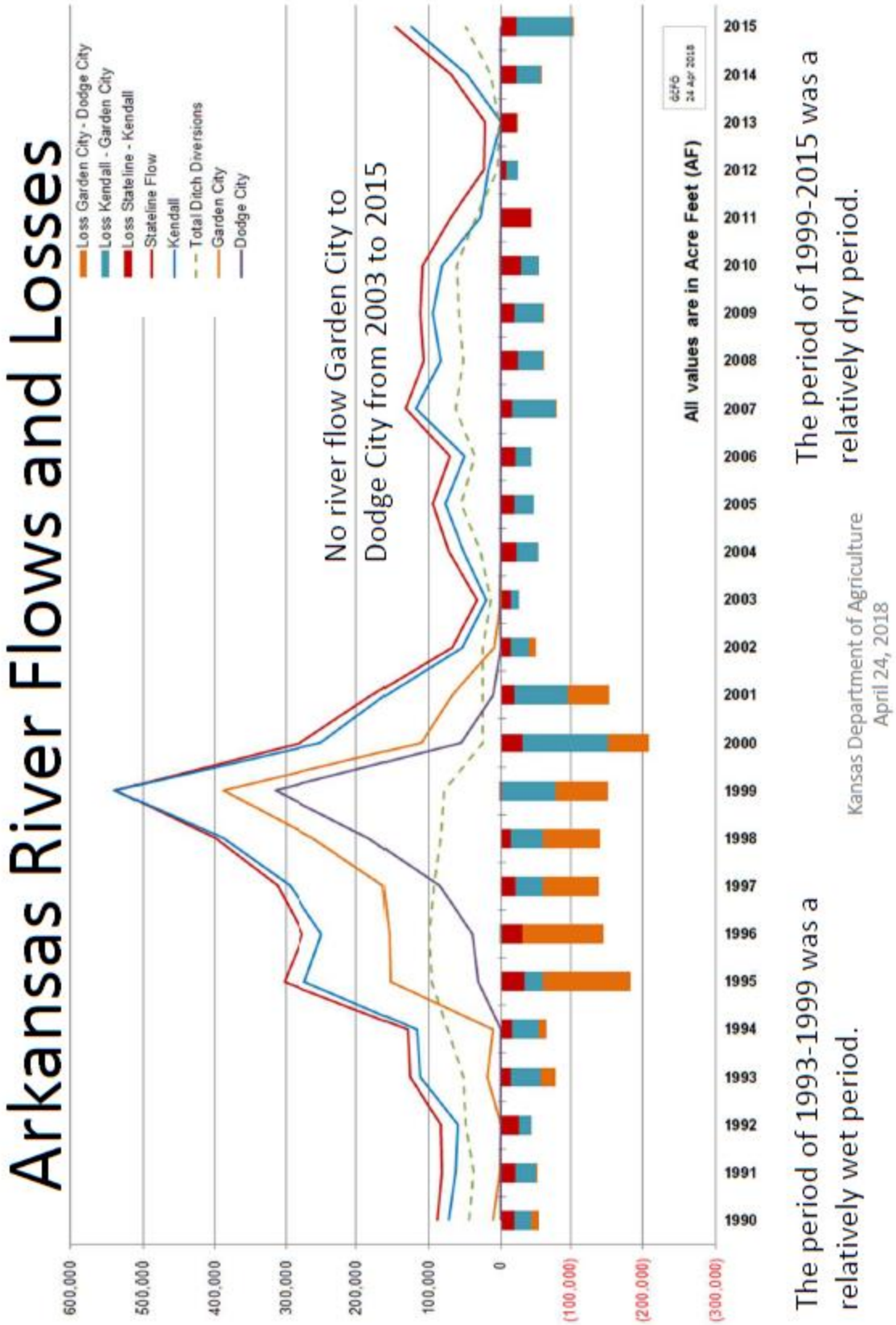
2015 percent average saturated thickness projected to remain in 25 years (from KGS).
All shades of blue townships meet the maximum allowable depletion rate of 40% in 25 years.
Updates using more current data will be made and implemented as needed.



2018 KDHE map of the 67 public water system infrastructure locations within or near GMD3. Map includes the boundary through the district between the Upper Ark and the Cimarron basins. Southeast Ford County includes the upper Rattlesnake Creek basin.



KDHE 2018 map of contaminated sites documented in the Identified Site List (ISL) and Leaking Underground Storage Tanks (LUST).



Arkansas River flow/loss chart. Source: KDA/Div. of Water Resources

Setting goals that are SMART FOR GMDs

- **Specific:** Goals should be specific. They must outline precisely what it is that you would like to achieve. The more detail, the better. Specifically, focus on what you want and not on how you will accomplish these things.
- **Measurable:** Goals should be measurable. Spend some time developing a process that you will use to measure your progress as you work toward your goals. How will you know you are making progress?
- **Attainable:** Goals should be attainable. This effectively means that you must wholeheartedly believe that you can achieve your goals.
- **Realistic:** Goals should be realistic. Your goals are realistic when you have the time, money, resources, and skills needed to achieve the goal. If you lack in any of these areas, then you need to get to work adding resources or set a different objective.
- **Timed:** Goals should be timed. You must set a deadline for the achievement of your goal. Without clear deadlines, you will likely succumb to procrastination and instant gratification.
- **Focused:** Goals should be focused. When setting goals, don't spread yourself too thin. Focus your attention on two to three primary goals that support your purpose, then direct all your skills, resources, money, and time toward these objectives.
- **Optimistic:** Goals should be optimistic. Write your goals in a positive way.
- **Ready:** Goals should be ready. This essentially means that you must be at a point where you are ready and able to achieve these goals. Set goals that are within your control and sphere of influence.
- **Great:** Goals should be great. They must move you emotionally, must inspire proactive action, and must breed a deep-seated passion for achievement.
- **Meaningful:** Goals should be meaningful. In other words, they must have a profound significance, which is tied to your purpose. Meaningful goals are also tied to your legacy. What kind of legacy would you like to leave behind?
- **Deliverable:** Goals should be deliverable. If you lack the time, money, resources, or skills needed to achieve the goal, you must invest some of your resources into partnerships that can provide what is needed to complete the goal.

Setting goals that are aligned with the SMART FOR GMDs guidelines will aid in structuring optimal goals. Each goal should have a checklist of things to include in a plan of objectives with activities to meet the goal. In other words, this approach will inform how to determine if a goal has been reached. If a goal involves working with other people and organizations, they will need to know this as well.

GMD3 Draft WCA Conservation Plan Executive Summary

For GMD3 management program appendix

The Proposal: A Water Conservation Area for Southwest Kansas

New state law allows water users to develop management plans with flexibilities that substantially exceed the limitations of current water rights in return for achievement of measurable conservation. Under the management program, this is considered type (2) aquifer maintenance water conservation. A 15-member team formed in early 1976 to explore the development of an early form of a Water Conservation Area (WCA). The team has invested more than 600 monthly meetings and thousands of hours in this process. They provided their own funds and obtained support from the Kansas legislature to guide their process. The present elected board and staff is comprised of industry representatives, community leaders, city commissioners, county commissioners, school board members, COOP board members, and surface water and groundwater managers. The result is a management program and formal public agency to oversee a Southwest Kansas GMD3 Water Conservation Area with local, state and federal partner activity assistance.

The Issue: Water

Our communities, economy, and quality of life depend upon water. The Ogallala aquifer is our primary and most important water resource. Overall, about 38% of the water stored in the Ogallala aquifer underlying southwest Kansas has been used. Irrigation accounts for 96% of the water withdrawn from the aquifer. Despite a diminishing number of wells and reduced pumping capacity, our aquifer water level continues to decline at a rate of about 24 inches per year, or about 3.6 inches of actual water supply decline per year on average over the productive aquifer areas. Some areas exceed the maximum allowable rate of water supply decline adopted by GMD3 of 40% in 25 years.

The Solution: Water Conservation

Conserve water now by reducing irrigation use and replenishing groundwater supply through a coordinated, district-wide water management program that extends the life of our portion of the Ogallala aquifer. This approach extends the life of the aquifer to provide time for new technologies to emerge and for businesses to adapt to changing conditions while renewable sources of water for aquifer replenishment are developed and conserved as conservation storage in the 60 million acre-feet of available Ogallala aquifer storage space in the district.

Key Features of the GMD3 WCA Water Management Plan

- Developed by district water users for the benefit of their own communities
- Provides a process based on local and state conditions to achieve conservation goals
- Participation is voluntary
- The WCA management plan is reviewed, amended, and governed by participants and a locally elected board
- Includes provisions to hold participants accountable so that commitments will be fulfilled

Goal of the WCA Water Management Plan

- Implement water conservation in the WCA in excess of state conservation guidelines and capture transient surface water of the state and transferred to the WCA for conservation storage to meet existing supply demands and provide drought resiliency for the WCA.

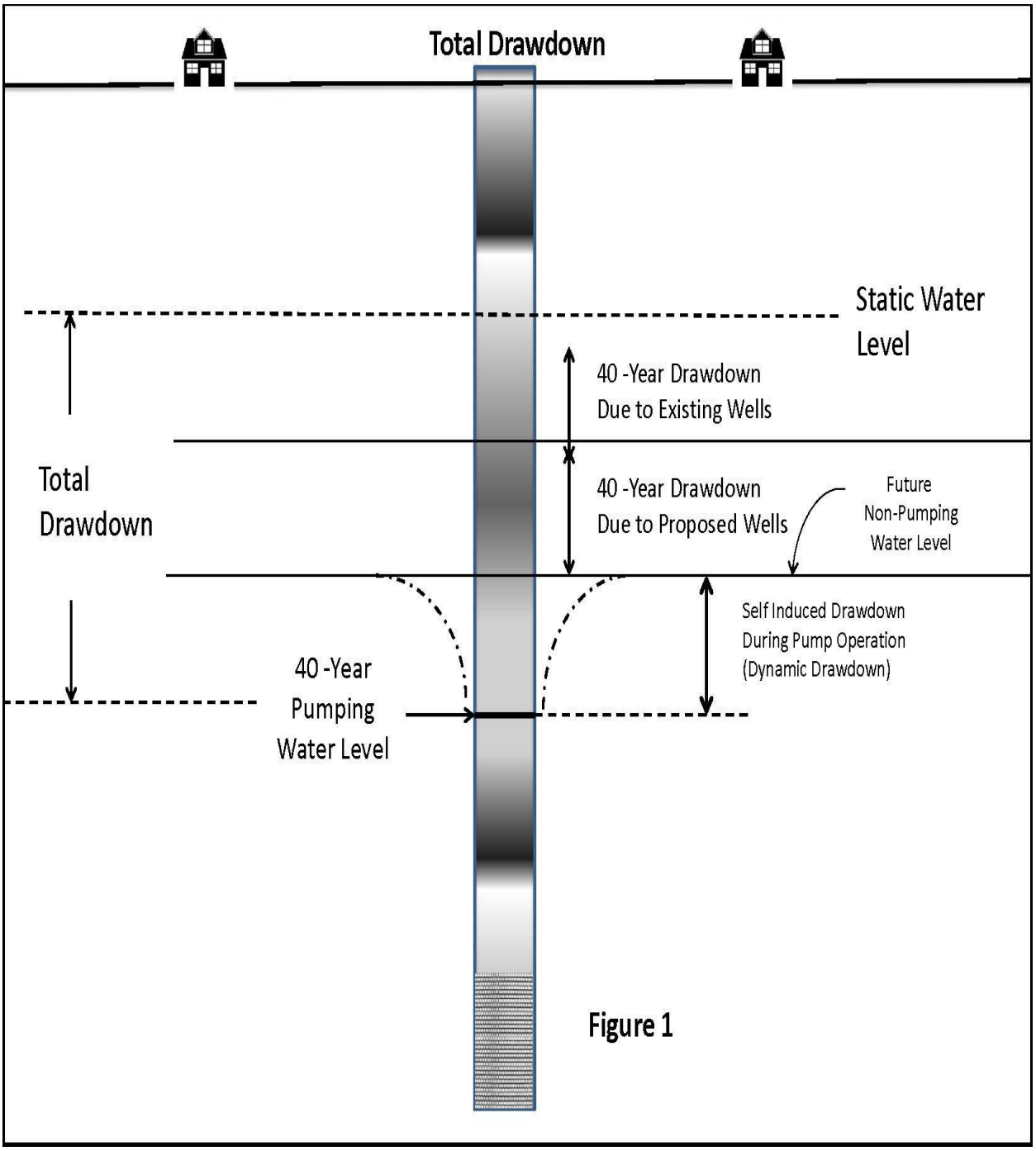
Details of the GMD3 WCA Water Management Plan

- Annual conservation allocations are based on existing water use capacity and adjusted to your priority of right portion of local source in a 25-year supply, not to exceed 40% depletion of today's groundwater supply in the coming 25 years, to provide time while aquifer replenishment sources of supply are developed.
- Uses four incremental steps to achieve groundwater conservation compliance and assure work on a new conservation source of supply to bridge the supply and demand gap when new sources for conservation storage in aquifer pore space can be delivered.
- The initiation of one or more applications of permits to appropriate water for conservation storage in the GMD3 WCA aquifer storage spaces.
- Each incremental step is for a period or term of 6 years; this is the period of commitment
- Includes provisions for continuous enrollment or participation with a graduated structure of limits based on supply and while alternate sources are developed and delivered.
- Substantial flexibility is provided for place of use and water may be used for any legal beneficial use while replenishment supply is being developed, subject to neighborhood participations.
- Multiple wells may be grouped into a management unit that is subject to one overall allocation of water, subject to state permitting.
- Unused annual allocations may be carried forward for use in the future – a form of water banking or aquifer maintenance credit.
- Two times the annual quantity will be allocated for use in the first year to provide a safety net for early drought years.
- Includes provisions for establishing an annual allocation for wells that were operated under aquifer preserving voluntary conservation or were enrolled in a state or federal conservation program that preserved aquifer supply.
- The management plan is reviewed every year by the GMD3 board and can be revised to incorporate lessons learned through experience and to accommodate changes in technology and partner support.
- Works in harmony with local and state officials and agricultural associations

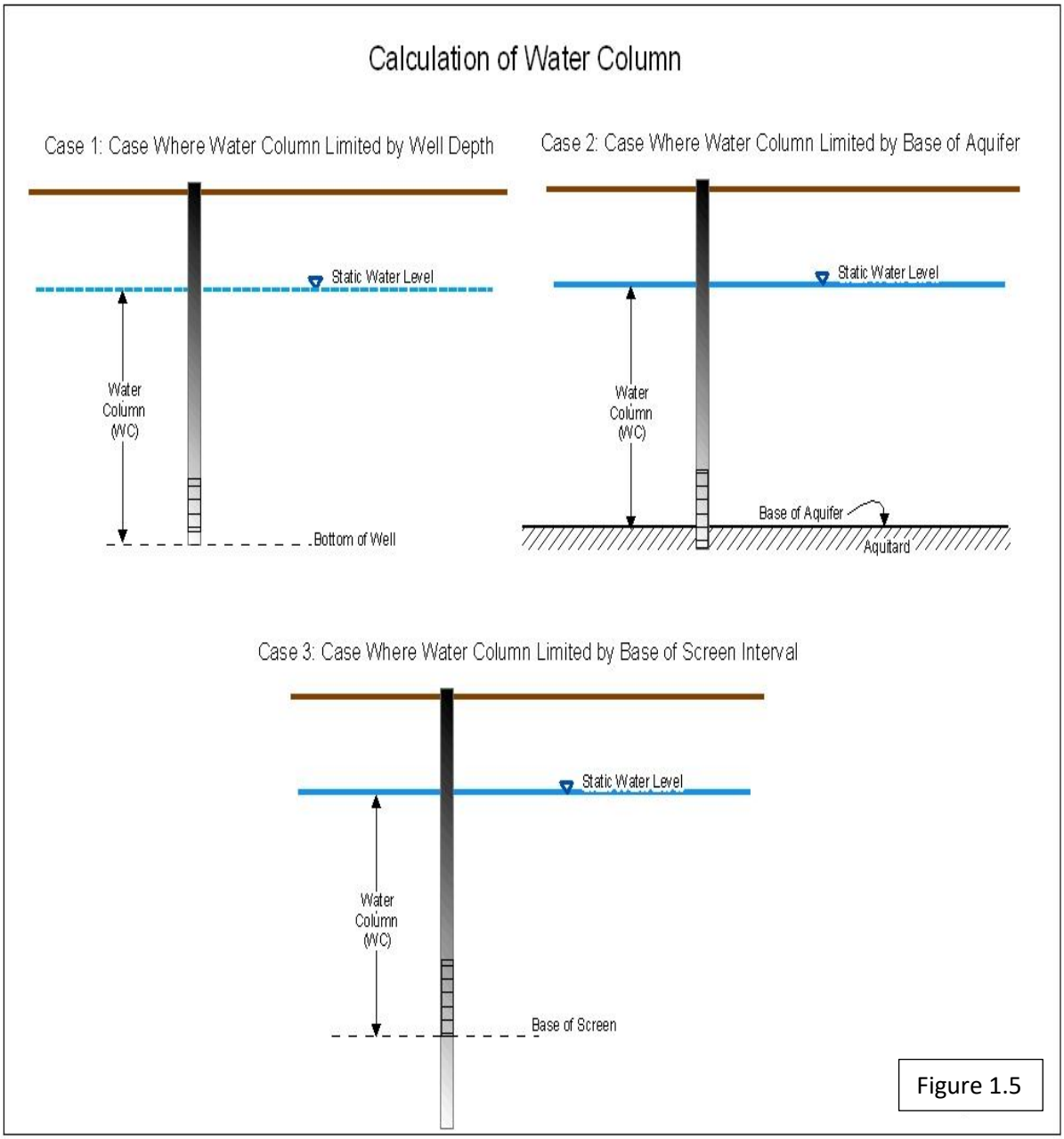
For information call:

Kirk Heger, President - Stevens County
Bret Rooney, Vice President - Haskell County
Mike McNiece, Secretary - Industrial
Mike O'Brate, Treasurer - Gray County
Fred Claassen, Director - Morton County
Kent Dunn, Director – Seward County
Doug Fox, Director - Meade County
Zachary Gale, Director - Hamilton County
Randy Hayzlett, Director - Surface Water
Hal Scheuerman, Director - Kearny County
Fred Jones, Director - Municipal
Seth Nelson, Director - Stanton County
Dave Casterline, Director - Ford County
Clay Scott, Director - Grant County
Steve Stone, Director - Finney County

Or call the GMD3 office or state DWR staff working to support community driven WCA's



From *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing* (New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017, by Tom Morrison, et. al.). GMD3 may use a different period of pumping, such as 25 years, to be consistent with GMD3 Board policy on maximum allowable rate of aquifer depletion.



From: *ASSESSMENT OF DRAWDOWN ESTIMATES,* Training manual for GMD3 by Tom Morrison, 2017.

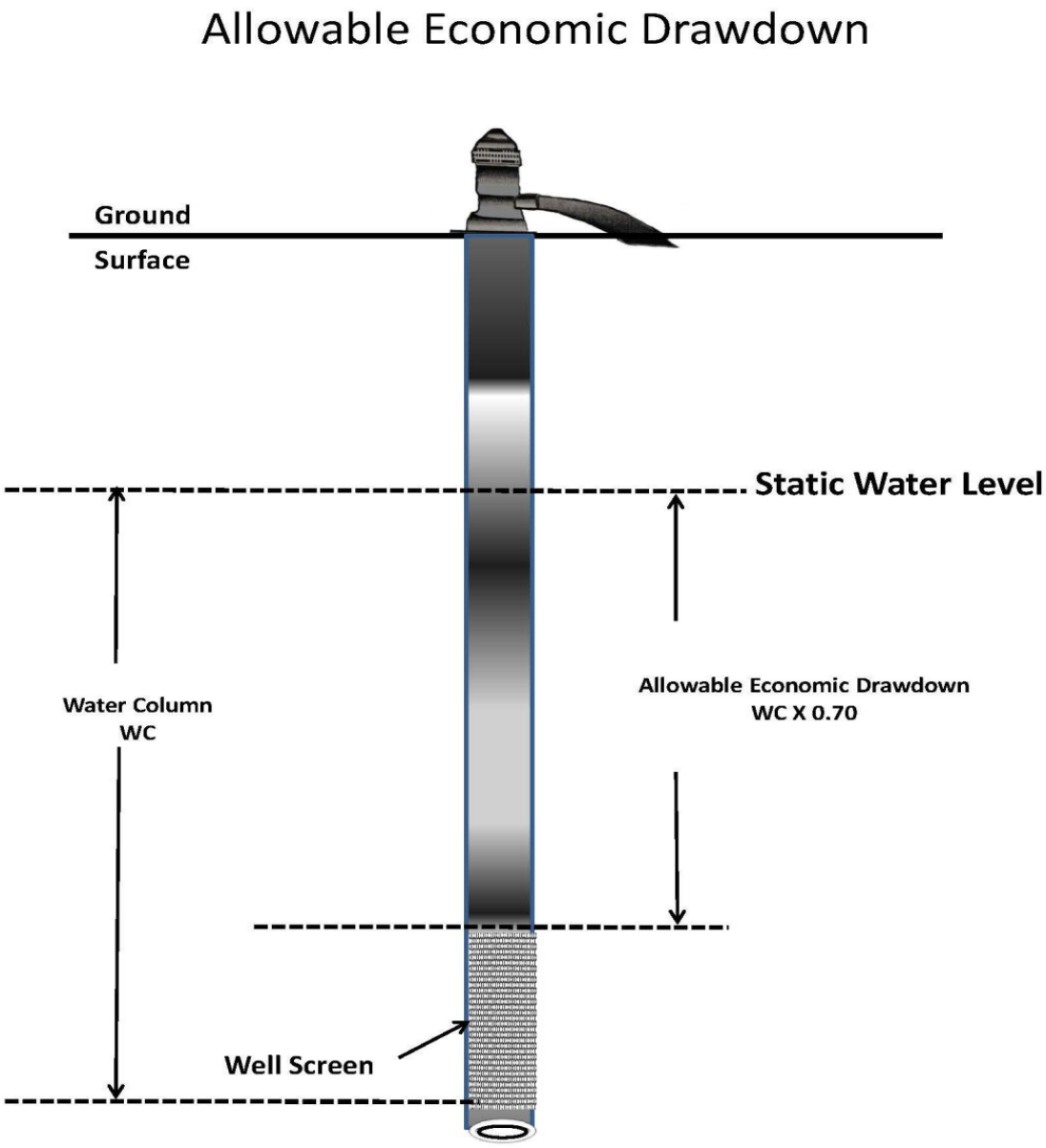
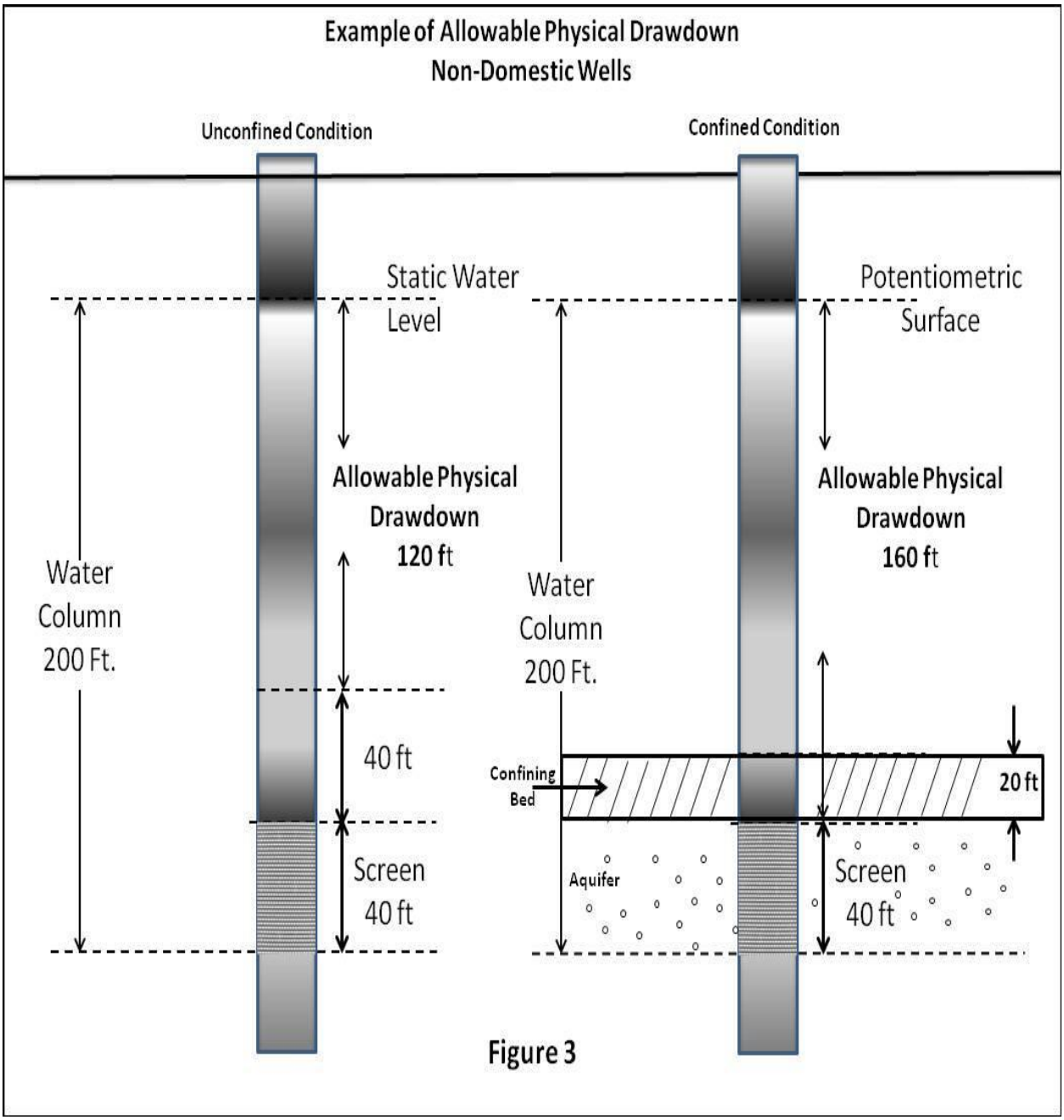


Figure 2

From: *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing* (New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017, by Tom Morrison, et. al.).



From *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing* (New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017, by Tom Morrison, et. al.).

Dynamic Drawdown (Self-Induced Drawdown)

- The Theis equation estimates drawdown in aquifer but not inside of the well
- Dynamic drawdown represents drawdown inside of casing
- Dynamic drawdown represents fluctuating drawdown as pumps are cycled on and off

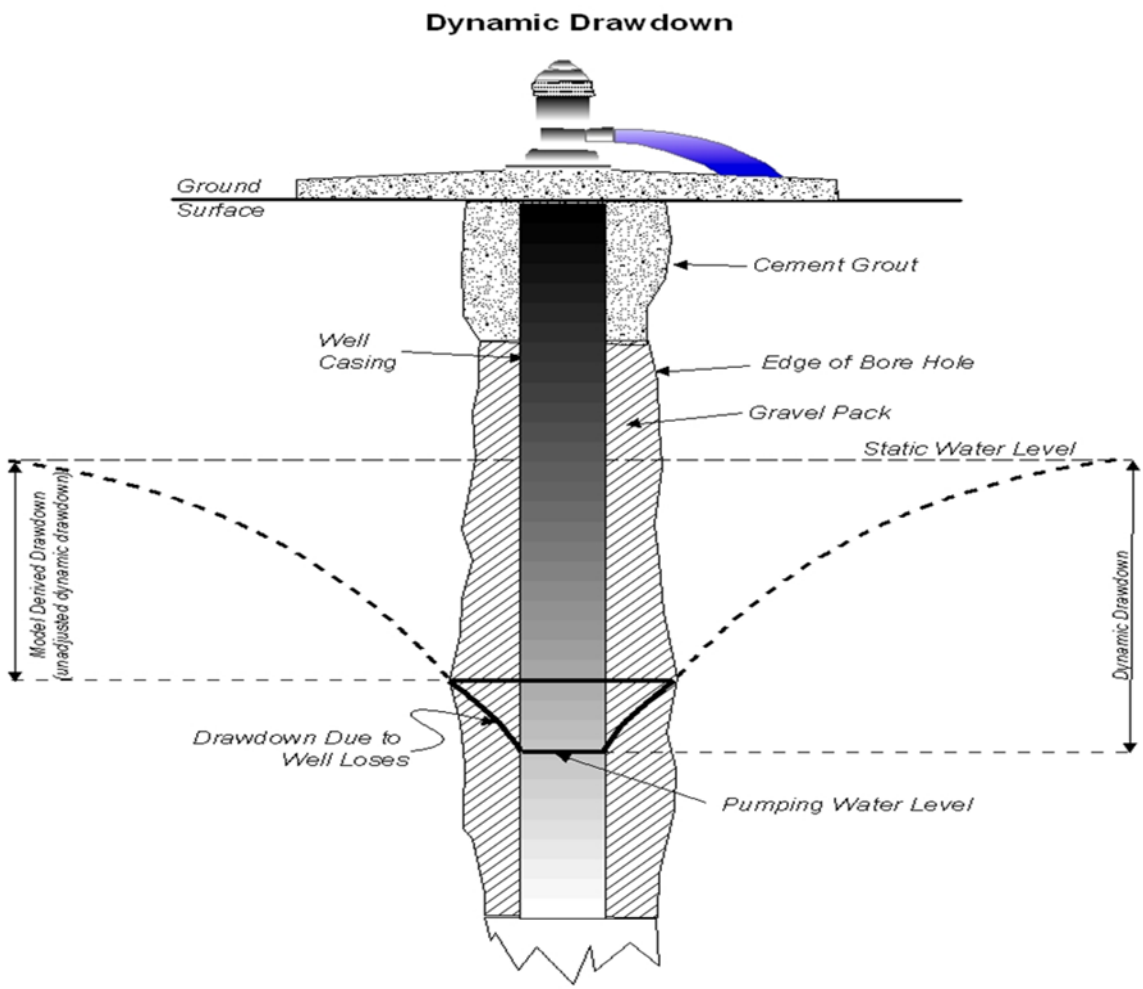


Figure 4

From: *ASSESSMENT OF DRAWDOWN ESTIMATES*, Training manual for GMD3 by Tom Morrison, 2017.