Engineering Data Sheet

4285

Application: Ogallala Aquifer Restoration Through Wastes-To-Energy Technologies

The High Plains aquifer system underlies 174,000 square miles in parts of the eight states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. Because of its large size, the High Plains aquifer has been divided into three regions: the Southern High Plains, Central High Plains, and Northern High Plains. The Ogallala Formation underlies about 80% of the High Plains and represents the principal geologic unit forming the aquifer. It was initially formed by braided streams flowing eastward from the ancestral Rocky Mountains that deposited random sequences of gravel, sand, silt, and clay. These river systems include the Arkansas, Canadian, Cimarron, Platte, and Republican Rivers. Groundwater generally flows from west to east and discharges naturally to streams and springs, and by evapor-transpiration in areas where the water table is near land surface. Precipitation is the main source of recharge to the aquifer. Agricultural irrigation pumping from more than 165,000 wells has been identified as causing significant depletion of the aquifer with some water level tables declining as much as 150 feet. The U.S. Geological Survey (USGS) estimates that Texas has now lost 27% of its original aquifer with Kansas in second place at 16% due to irrigation practices since 1940. About 2.3 million people (1990 census) live and work within the geographic boundaries of the High Plains.

Agriculture is the dominant land use (54%) and is responsible for the widespread development of the High Plains aquifer. Major agricultural activities in the High Plains include dryland and irrigated agriculture, mostly wheat, cotton, and corn. Of the total crop production in the United States, the High Plains aquifer area accounts for about 19% of the wheat, 19% of the cotton, 15% of the corn, and 3% of the sorghum. In addition, the region accounts for nearly 18% of the cattle in the United States and is rapidly becoming a center for swine production. When one approaches the High Plains aquifer from any direction the sudden increase in agricultural activities is breathtaking. The sustainability of the Ogallala is extremely important to Kansas as 40% of the nation's packaged beef comes from within 250 miles of Garden City. This once grand aquifer is perhaps even more economically important to Texas as almost half of the total extraction wells are located there.

Water from the High Plains aquifer is the principal source of supply for irrigated agriculture. During 1995, water use in the High Plains was estimated to be 19.9 billion gallons per day. Of this amount, 81% was pumped from aquifers, and 19% was withdrawn from rivers and streams. Almost all of the surface water withdrawn for use (about 85%) is from the Platte River in Nebraska. Outside of the Platte River Valley, 92% of the water used in the High Plains is supplied by groundwater.

Water Quality Issues and concerns consist of:

- CAFOs, especially dairy farms in eastern New Mexico, and their impacts on drinking water supplies.
- CAFOs in Nebraska and their impacts on drinking water supplies.
- Salinity and pH in groundwater and their impacts on crops.
- CAFOs in Kansas from a non-point source contamination purview.
- Effect of bedrock sources (salinity) on the water quality in the High Plains aquifer.
- Effects of nutrients and pesticides from point and non-point agricultural and livestock sources on groundwater resources.
- Degradation of groundwater resources within the High Plains aquifer in Texas.
- Uncertainty of how water quality changes with water table depth.
- Quality of irrigation return flows and their impacts on the groundwater resource.
- Water quality unknowns with respect to the deep vadose zone.
- Playas and water quality in the central and southern High Plains.

Global Warming has recently entered the Ogallala picture. The High Plains is clearly threatened by the world's changing climate due to greater quantities of industrial and automobile carbon dioxide gas and from methane gas being emitted from a variety of sources—including agricultural sources. According to the computerized global climate modeling at both Princeton, New Jersey and Boulder, Colorado, the United States High Plains is one of several regions around the world that will turn into a major desert if the predicted CO_2 induced greenhouse effect takes place (Opie, 1993). Farmers will have a more difficult time preventing desertification because they would need to take three times more water than today's rate to compensate for global warming. Irrigation on the High Plains is still in a self-destruct mode and the Ogallala aquifer is still a non-renewable resource. So long as aquifer withdrawals exceed aquifer recharge the Ogallala represents a non-sustainable water resource.

Irrigation water loss has been diminished over the years by the use of low energy precision application (LEPA) center pivots and by drip irrigation and other technologies.

No-tillage farming has also been practiced. Overall irrigation water loss due to evaporation is now estimated at around 2% and on the decrease due to extensive efforts in the agricultural marketplace. At one time High Plains aquifer water withdrawals were estimated as high as 20 billion gallons per day (BGD). During the last 5 years irrigation withdrawals have decreased somewhat due to the higher costs of pumping water from greater depths as well as the significantly increased costs of natural gas. The High Plains aquifer depletion problem has been studied by just about every known water district and land management agency. Arthur D. Little, Inc., Black & Veatch, Camp Dresser & McKee, Inc., and James M Montgomery (now Montgomery Watson) are major consulting engineering companies who have studied the High Plains aquifer. A **total solution** has not been proposed by a single party until now. A solution that has the potential for recharging the High Plains aquifer to its pre-1940 levels thus making the technology fully sustainable. The proposed waste-to-renewable energy technology fully complies with all Kyoto Protocols on climate change. In fact, since there is a small but continuing consumptive use of carbon dioxide, the technology has the clear potential for achieving **global cooling** if generally applied throughout the world.

The master plan is quite simple. It generally consists of capturing the sanitary wastewater and stormwaters throughout the High Plains to include nearby cities such as Sioux Falls, South Dakota; Omaha, Nebraska; Cheyenne, Wyoming; Lubbock, Odessa, and Amarillo, Texas; and perhaps 50 more. These waters will be beneficially used in the anaerobic digestion of municipal solid wastes (MSW) by a waste-to-energy technology that will generate electricity, fuels, and high quality reverse osmosis (RO) water. The produced RO water will be donated to the High Plains aquifer.

If the **daily withdrawals** from the High Plains aquifer is, say, 17 BGD (accurate for year 2000), a 2% loss on evaporation equals 340 million gallons per day (MGD). The High Plains is home to about 2.2 million people. Cities near to but not on the Ogallala consist of Amarillo, Texas (157,000 population), Cheyenne, Wyoming (53,000 population), Lubbock, Texas (200,000 population), Odessa, Texas (90,000 population), Omaha, Nebraska (390,000 population), and Sioux Falls, South Dakota (124,000 population). These and other nearby cities add at least another 1 million to the greater High Plains population base for a total of about 3.2 million population. At the standard human water use rate of 100 GPD/person, the 3.2 million population is generating about 320 million gallons of sanitary wastewater each day. High Plains withdrawals for CAFOs is about 222 MGD according to the USGS. The amount of stormwater which occurs in the greater High Plains communities adds to the total water captured but is not quantified for the purpose of establishing the viability of the proposed technology. The total of 320 MGD of sanitary wastewater plus 222 MGD of CAFO wastewater totals 542 MGD or 200 MGD greater than the loss on evaporation. The RO water from CAFOs would be immediately recycled in situ rather than sending it back to the aquifer. The RO water from municipalities would be sent back to the aquifer in the same manner as Orange County has been doing for the last 25 years (Water Factory 21 Project). The collection of the stormwater would increase the net recharge to greater than 200 MGD. As irrigation efficiencies continue to improve the net recharge rate will increase even further. There are many other smaller cities near to the High Plains aquifer that can also join in the effort. The sanitary wastes and stormwaters from these additional cities have not been taken into consideration. The proposed solution is therefore sound from a **water balance** standpoint with considerable room-to-spare.

Bipartisan political support on the parts of US Senators Jeff Bingaman (D-NM), Sam Brownback (R-KS), and Pete Domenici (R-NM) is expected since all three have long supported the sustainability of the High Plains aquifer.

The proposed for-profit wastes-to-renewable energy technology is marketed on a build-own-operate basis with financing furnished by the marketplace. Annual profits are automatically shared with each municipality or county on a 50:50 basis to improve governmental payroll salaries and to help fund governmental projects. The technology is designed to provide 100% of a communities electricity, methane (natural gas), potable water, and fuel requirements. Since all municipal solid wastes are anaerobically digested there are no waste residuals which require landfill disposal. Communities thereby become zero waste-to-landfill societies. The produced electricity, natural gas, potable water, and fuels (biodiesel and compressed natural gas [CNG]), are then sold to all businesses and citizens at a 20% discount from retail.

Implementation of the proposed waste-to-renewable technology can be accomplished through a public-private partnership, also known as a **concession agreement**. Most projects can be completed within 3 years from start to finish. The same technology is used at CAFOs. The principal purpose of the technology is economic development with an associated quite favorable environmental impact.

The Engineers, Chemists, and Scientists at ***WaterSmart Environmental, Inc.*** welcome your inquiries with enthusiasm.

From the Engineering Department of

WaterSmart

Environmental, Inc.