COHYST 2010

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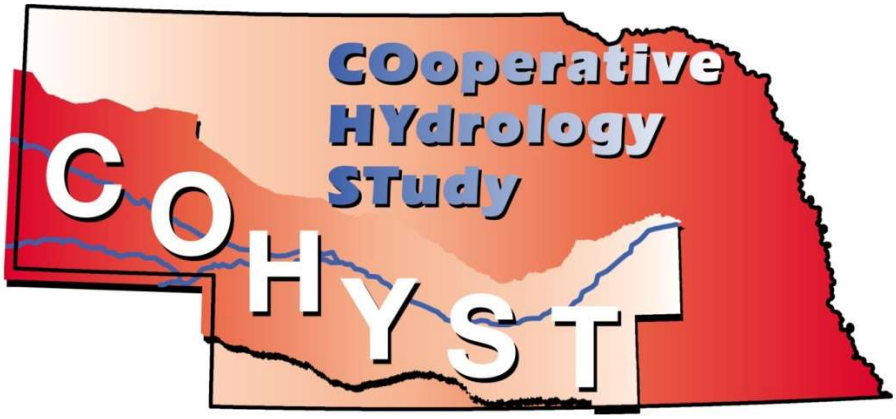
INTEGRATED MODEL
DOCUMENTATION REPORT




COHYST 2010—A Total Water Budget Approach to Integrated Water Management in the Platte River Nebraska

2017 Documentation of Revised Integrated Model



Sponsors:

Central Nebraska Public Power and Irrigation District

Central Platte Natural Resources District

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EXECUTIVE SUMMARY

ES.1 Overview

COHYST is a hydrologic study of the Platte River drainage basin in central Nebraska. COHYST 2010 is a specific project within COHYST that involves developing an integrated computer-based model of basin hydrology to be used to calculate river and aquifer effects of different management scenarios. The goal is to support water management to maintain the region's extensive irrigation economy and protect river habitats used by endangered species.

Phase I of COHYST 2010 involved design of the modeling work, and development of an observation-based water budget for the study area to be used in model evaluation. Phase II of COHYST 2010 had the objective of building the computer models. A potential Phase III may involve applications of and improvements to the modeling tools.

An initial COHYST 2010 model of the Platte River and adjoining basins was published in 2013. Subsequently this model has been successfully applied, especially in the evaluation of alternative scenarios. Significant simplifications of the 2013 model were recognized at the time and many have now been addressed in the model that was calibrated in December 2016 and documented here.

Water budgets are fundamental components of any model of a hydrologic system and provide a quantitative basis to relate water inputs to outputs and to changes in storage. Phase II of COHYST 2010 has built three individual models that address different components of the water budget: watershed model for soils, surface water for lakes, streams and canals, and groundwater model for aquifers. These models are integrated to quantify the total water balance of the system.

Key elements of the water budget that are represented in the models are as follows.

- External sources of water are precipitation, along with streamflow and groundwater from upstream of the study area.

- External sinks (losses) of water are evapotranspiration, along with streamflow and groundwater discharges to downstream of the study area.
- Within the study area, the primary simulations involve calculating water needs on irrigated lands that are not met by precipitation, and computing the diversions of surface and groundwater to satisfy those unmet needs, and the impacts of such diversions.
- The complex system of surface water reservoirs and canals is operated according to historic inflows and known rules to meet crop demands of lands irrigated by surface water. The surface water simulation also operates to represent power generation.
- Known irrigation wells are simulated as pumping in amounts necessary to satisfy crop demands on lands irrigated by groundwater. Pumping for municipal, industrial and domestic uses also is included.
- Water exchanges occur within the system. In particular, some portion of the precipitation and applied water is discharged as runoff to streams or becomes recharge to groundwater; canal seepage becomes recharge; and streams can seep to groundwater or gain flow from groundwater baseflow and from drains.

Common features of the models include the following.

- The three individual models and the integrated model have the same study area which is unchanged from the 2013 model.
- All model inputs and results are organized according to one of two spatial contexts: 160 acre cells, which reflect the landscape scale of typical farming enterprises in the region; or the network of major Platte Basin surface water features (streams, reservoirs, canals).
- The models are calibrated based on matching model results to observations for a 16 year period, 1990-2005. 1985-1989 results are considered where needed to define 1990 starting conditions. An extension of the model for 2006-2010 is used to evaluate model

performance. Time periods used within the models vary, but all results are integrated to a monthly time scale.

ES.2 Organization of Report

The models are documented in 10 sections of this report.

- Section 1 introduces the COHYST 2010 study, describes the structure of the work, and summarizes major changes from the prior 2013 model.
- Section 2 contains descriptive information about the setting of the study, with an emphasis on existing water resources.
- Section 3 describes the construction of the COHYST 2010 models and their relationship to the hydrologic cycle of the basin. The section also describes the model calibration process and presents the Phase 1 water budget, as determined from observed data.
- Section 4 documents data sets which were built during COHYST 2010 to provide external inputs to the model (e.g. climate, soils, land use, stream geometry, layout of canals, municipal pumping, and known aquifer properties) or to provide target observations used to calibrate the model (such as gaged streamflows, reservoir stages and volumes, diversions of surface water, groundwater levels and their changes, estimates of stream reach gains and losses from groundwater).
- Section 5 provides documentation for the watershed model. This model calculates the monthly land-soil water budget for each model cell based on land use, on soil properties, and on daily precipitation data. A UNL crop water use model (CROPSIM) is used to provide a temporal distribution of precipitation and supplied water into evapotranspiration (including consumption by crops), runoff, and deep percolation. For irrigated lands, the model estimates the demand for surface water diversions and groundwater pumping to satisfy crop demands not met by precipitation. Model calibration is judged primarily on whether the water partitioning in the watershed leads to a good performance by the surface water and groundwater models.
- Section 6 provides documentation for the surface water model. Operating rules for reservoirs and canals are used to route inflows from upstream (as augmented by local

runoff and return flows) to meet demands for irrigation, hydropower and power plant cooling. The rules reflect historic operation of major reservoirs and irrigation districts throughout the study area. Model calibration has considered how operations vary between wet and dry periods and how these changed during the period simulated. Model calibration is based on matching gaged streamflows, canal diversions and reservoir conditions.

- Section 7 provides documentation for the groundwater model. The model provides a two-dimensional (one layer) simulation of the response of the regional aquifer to recharge, pumping and discharges to drains and streams. The primary calibration parameter is aquifer hydraulic conductivity, Model performance is judged primarily on the match between simulated and observed hydrographs for a wide array of wells, with a focus on locations near the Platte River. The best calibration recognized the lag effect between recharge at the land surface and water table responses where there is a significant vadose zone thickness.
- Section 8 provides documentation for the final integrated version of the model, denoted as 028b_15_27 based on the model versions for the watershed, surface water and groundwater models respectively. In this, the current integrated model, runoff from the watershed model and discharge from the groundwater model replace the reach gain-loss inputs to the surface water model. The integrated model is the ultimate product of COHYST 2010 Phase II and, in addition to the standalone calibration of the component models, is judged based on the match between simulated and gaged streamflows and on the correspondence of the integrated water budget to the observation-based water budget presented in Section 3.
- Section 9 is the evaluation of model assumptions, limitations and quality, as judged by the modeling team.
- Section 10 provides a brief look forward to anticipated applications and upgrading of the models.

- In addition, Section 11 is a list of references cited in the report, and Section 12 compiles links to data files that provide the model inputs and most recent outputs and to documents that are part of the COHYST files.

Note that citations throughout this report are used to reference several dozen appendices which provide considerable detail about inputs to, the structure of, or outputs from the model.

ES.3 Results

Both the surface water model and groundwater model are considered to be calibrated, and because both calibrations rely on water budget information from the watershed model, that model also is considered to be calibrated. Results from the surface water model are illustrated extensively in Section 6. As shown in that Section, model results are in agreement with the hydrologic patterns over time and are consistent with the overall observed water budget. The agreement between simulated and observed hydrology provides confidence that the modeled surface water operations are a reasonable representation of what occurs in the system. The results also indicate that the watershed model provides reasonable estimates of the amount of water used for surface water irrigation. Most other results from the surface water model are similar in that there is acceptable agreement between model estimates and observed data, with cumulative water balance errors over the 1990-2005 period of a few percent or less at most locations.

Results from the groundwater model are illustrated extensively in Section 7. Comparisons of observed and simulated values indicate that overall model errors are acceptable, with only a few large errors that reflect local conditions that are beyond the ability of the current model to resolve and/or are located outside of the Platte basin and thus not critical to address. Most important, there is no marked spatial bias.

The integrated model water budget reported in Section 8 is in good balance. About 24.5 million acre-feet of annual inflow occurred in the 1985-2005 period, which compares to 24.3 million acre-feet of annual outflow; the total error of less than 0.2 million acre-feet per year is less than 1 percent. Larger errors occur in the prediction of some quantities, as for example gaged streamflow, and have a notable bias in that errors are highest for wet periods. This bias is the

expected result of focusing model calibration on the dry conditions that are most critical to water management for irrigation and environmental purposes. Even so, because the model outputs are summarized on a monthly basis, flows in dry periods can still be sometimes overestimated.

ES.4 Path Forward

The models are considered to be suitable for the intended purpose of Phase II of COHYST 2010, i.e. for many management applications they will provide useful results when run to reflect assumptions about water management, water supply or water use. Results of such runs are considered reliable when interpreted on a regional (county or larger) scale, and on a seasonal or multi-year time scale. The models also provide a platform that can be modified to address issues that were beyond the scope of Phase II, as for example to evaluate impacts from a single well. As with any typical predictive tool, the COHYST model is capable of further improvement but at this time there are no identified major weaknesses for the intended purposes.

Abbreviations and Acronyms

Abbreviation/Acronym	Descriptor
ac	acre
acft, or AF	acre-foot
acft/yr	acre-foot per year
AE	Irrigation Application Efficiencies
ARM	Absolute Residual Mean
ASTM	American Standard Testing Materials
Avg	Average
BAS	MODFLOW Basic Package
BF	Baseflow
BIGS	Big Springs
Calc	Calculated by Model
CALMIT	Center for Advanced Land Management Information Technologies
cf	cubic feet
cfs	cubic foot per second
CMU	Central Model Unit (Previous COHYST model)
CNPPID	Central Nebraska Public Power and Irrigation District
CO	Colorado
COHYST 2010	Cooperative Hydrology Study, of which this report is a part
CPNRD	Central Platte Natural Resources District
CROPSIM	Crop Simulation Model (Soil Water Balance)
CSD	Conservation Survey Division; also cited as NCSD
DEM	Digital Elevation Model
DIS	MODFLOW Discretization Package
DNR, NDNR, or Department	Nebraska Department of Natural Resources
DOI	U.S. Department of Interior
DP	Deep Percolation
DRN	MODFLOW Drain Package
EMU	Eastern Model Unit (Previous COHYST model)
EOM	End of Month
ET	Evapotranspiration
EVT	MODFLOW Evapotranspiration Package
FERC	Federal Energy Regulatory Commission
ft	feet
ft/d	foot per day

Abbreviation/Acronym	Descriptor
ft/mi	feet per mile
ft-msl	feet above mean sea level
FWS	U.S. Fish and Wildlife Service
GHB	MODFLOW General Head Boundary
GIS	Geographic Information System
GOTH	Gothenburg
GUI	Graphical User Interface
GW	Groundwater
GWI	Groundwater Inflow
GWO	Groundwater Outflow
HDR	HDR Engineering, Inc.
Hist	Historical
HSU	Hydrostratigraphic Units
I	Applied Irrigation Water
IMP	Integrated Management Plan
in.	inch
in/yr	inch per year
K	Hydraulic Conductivity
Kv	Vertical Hydraulic Conductivity
LPF	MODFLOW Layer Property Flow
LWA	Lee Wilson and Associates
M&I	Municipal and Industrial
MF2K	MODFLOW-2000
MGD	million gallons per day
mi	mile
mi^2 or sq.mi.	square miles
MODFLOW	Modular three-dimensional finite-difference ground-water flow model
NASS	National Agricultural Statistics Service
NCSD	Nebraska Conservation and Survey Division (we may want to cross-reference with CSD)
NDNR, DNR, or Department	Nebraska Department of Natural Resources
NE	Nebraska
NGPC	Nebraska Game and Parks Commission
NHD	National Hydrographic Dataset
NIR	Net Irrigation Requirement

Abbreviation/Acronym	Descriptor
NPPD	Nebraska Public Power District
NRCS	Natural Resource Conservation Service (Natural Resources Conservation Service)
NRD	Natural Resources District
NWIS	National Water Information System (of the USGS)
P	Precipitation
PEST	Parameter Estimation
PRRIP	Platte River Recovery Implementation Program
QA/QC	Quality Assurance and Quality Control
R	Recharge
RCH	MODFLOW Recharge Package
RGL	Reach Gain/Loss
RIV	MODFLOW River Package
RMSE	Root Mean Square Error
RO	Runoff
sqft/d	foot squared per day
Ss	Specific Storage
STATSGO	State Soil Geographic Database
STELLA	Software programs to facilitate the mapping, modeling, simulation, and communication of dynamic processes
STO	Storage
STR	MODFLOW Stream Package
SW	Surface Water
SWAT	Surface Water Assessment Tool
SWI	Surface Water Inflow
SWO	Surface Water Outflow
Sy	Specific Yield
TBNRD	Tri-Basin Natural Resources District
TPNRD	Twin Platte Natural Resources District
UNL	University of Nebraska at Lincoln
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WEL	MODFLOW Pumping Package
WHAT	Web-Based Hydrograph Analysis Tool
WL	Water Level

GLOSSARY

Acre-foot (acft, acre-ft, AF) – the volume of water required to cover 1 acre of land (43,560 square feet) to a depth of 1 foot. Equal to 325,851 gallons or 1,233 cubic meters.

Alluvium – deposits of clay, silt, sand, gravel, or other particulate material that has been deposited by a stream or other body of running water in a streambed, on a flood plain, on a delta, or at the base of a mountain.

Aquifer – a geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for people's uses.

Aquifer (confined) – soil or rock below the land surface that is saturated with water. There are layers of impermeable material both above and below it and it is under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer.

Aquifer (unconfined) – an aquifer whose upper water surface (water table) is at atmospheric pressure, and thus is able to rise and fall.

Artesian Water – groundwater that is under pressure when tapped by a well and is able to rise above the level at which it is first encountered. It may or may not flow out at ground level. The pressure in such an aquifer commonly is called artesian pressure, and the formation containing artesian water is an artesian aquifer or confined aquifer. See flowing well.

Artificial Recharge – an process where water is put back into groundwater storage from surface water supplies such as irrigation, or induced infiltration from streams or wells.

Baseflow – sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced streamflows. Natural base flow is sustained largely by groundwater discharges.

Bedrock – the solid rock beneath the soil and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material.

Consumptive Use – that part of water withdrawn that is evaporated, transpired by plants, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment. Also referred to as water consumed.

Conveyance Loss – water that is lost in transit from a pipe, canal, or ditch by leakage or evaporation. Generally, the water is not available for further use; however, leakage from an irrigation ditch, for example, may percolate to a groundwater source and be available for further use.

Cubic Feet Per Second (cfs) – a rate of the flow, in streams and rivers, for example. It is equal to a volume of water one foot high and one foot wide flowing a distance of one foot in one second. One "cfs" is equal to 7.48 gallons of water flowing each second. As an example, if your car's gas tank is 2 feet by 1 foot by 1 foot (2 cubic feet), then gas flowing at a rate of 1 cubic foot/second would fill the tank in two seconds.

Discharge – the volume of water that passes a given location within a given period of time. Usually expressed in cubic feet per second.

Domestic Water Use – water used for household purposes, such as drinking, food preparation, bathing, washing clothes, dishes, pets, flushing toilets, and watering lawns and gardens. About 85% of domestic water is delivered to homes by a public-supply facility, such as a county water department. About 15% of the Nation's population supply their own water, mainly from wells.

Drainage Basin – land area where precipitation runs off into streams, rivers, lakes, and reservoirs to a central point. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large drainage basins, like the area that drains into the Mississippi River contain thousands of smaller drainage basins. Also called a "watershed."

Drawdown – a lowering of the groundwater surface caused by pumping.

Effluent – water that flows from a sewage treatment plant after it has been treated.

Evaporation – the process of liquid water becoming water vapor, including vaporization from water surfaces, land surfaces, and snow fields, but not from leaf surfaces. See transpiration.

Evapotranspiration – the sum of evaporation and transpiration.

Flood – An overflow of water onto lands that are used or usable by man and not normally covered by water. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean.

Flood Plain – a strip of relatively flat and normally dry land alongside a stream, river, or lake that is covered by water during a flood.

Flowing Well/Spring – a well or spring that taps groundwater under pressure so that water rises without pumping. If the water rises above the surface, it is known as a flowing well.

Freshwater – water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids; generally, more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses.

Gage Height – the height of the water surface above the gage datum (zero point). Gage height is often used interchangeably with the more general term, stage, although gage height is more appropriate when used with a gage reading.

Gaging Station – a site on a stream, lake, reservoir or other body of water where observations and hydrologic data are obtained. The U.S. Geological Survey and other agencies measure stream discharge at gaging stations.

Gallons per Capita per Day – Annual water use by municipal water utility divided by the population and the number of days in a year.

Groundwater – (1) water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturated zone is called the water table. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust.

Groundwater, Confined – groundwater under pressure significantly greater than atmospheric, with its upper limit the bottom of a bed with hydraulic conductivity distinctly lower than that of the material in which the confined water occurs.

Groundwater Recharge – inflow of water to a groundwater reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. Also, the volume of water added by this process.

Groundwater, Unconfined – water in an aquifer that has a water table that is exposed to the atmosphere.

Headwater(s) – (1) the source and upper reaches of a stream; also the upper reaches of a reservoir. (2) the water upstream from a structure or point on a stream. (3) the small streams that come together to form a river. Also may be thought of as any and all parts of a river basin except the mainstream river and main tributaries.

Hydraulic Conductivity – the ease with which water can move through porous media. Units are expressed as a rate, such as ft/day.

Hydroelectric Power Water Use – the use of water in the generation of electricity at plants where the turbine generators are driven by falling water.

Hydrologic Cycle – the cyclic transfer of water vapor from the Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to earth, by infiltration into soils and aquifers, and through runoff and baseflow into streams, rivers, and lakes, and ultimately into the oceans.

Impermeable Layer – a layer of solid material, such as rock or clay, which does not allow water to pass through.

Industrial Water Use – water used for industrial purposes in such industries as steel, chemical, paper, and petroleum refining. Nationally, water for industrial uses comes mainly (80%) from self-supplied sources, such as a local wells or withdrawal points in a river, but some water comes from public-supplied sources, such as the county/city water department.

Infiltration – flow of water from the land surface into the subsurface.

Irrigation – the controlled application of water for agricultural purposes through manmade systems to supply water requirements not satisfied by rainfall.

Irrigation Water Use – water application on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands, such as parks and golf courses.

Land Use – Use of land for agricultural, industrial, residential, recreational, or other purposes.

Livestock Water Use – water used for livestock watering, feed lots, dairy operations, fish farming, and other on-farm needs.

Million Gallons Per Day (Mgd) – a rate of flow of water equal to 133,680.56 cubic feet per day, or 1.5472 cubic feet per second, or 3.0689 acre-feet per day. A flow of one million gallons per day for one year equals 1,120 acre-feet (365 million gallons).

Municipal Water System – a water system that has at least five service connections or which regularly serves 25 individuals for 60 days; also called a public water system.

Peak Flow – the maximum instantaneous discharge of a stream or river at a given location. It usually occurs at or near the time of maximum stage.

Percolation – (1) The movement of water through the openings in rock or soil. (2) the entrance of a portion of the streamflow into the channel materials to contribute to groundwater replenishment.

Permeability – the ability of a material to allow the passage of a liquid, such as water through rocks. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas impermeable material, such as clay, don't allow water to flow freely.

Porosity – a measure of the water-bearing capacity of subsurface rock. With respect to water movement, it is not just the total magnitude of porosity that is important, but the size of the voids and the extent to which they are interconnected, as the pores in a formation may be open, or interconnected, or closed and isolated. For example, clay may have a very high porosity with respect to potential water content, but it constitutes a poor medium as an aquifer because the pores are usually so small. The term Effective Porosity is often used to describe the porosity that is conducive to flow.

Precipitation – water from the atmosphere that reaches the land surface in the form of rain, snow, hail, sleet, dew, or frost.

Public Supply – water withdrawn by public governments and agencies, such as a county water department, and by private companies that is then delivered to users. Public suppliers provide water for domestic, commercial, thermoelectric power, industrial, and public water users. Most people's household water is delivered by a public water supplier. The systems have at least 15 service connections (such as households, businesses, or schools) or regularly serve at least 25 individuals daily for at least 60 days out of the year.

Rating Curve – A drawn curve showing the relation between gage height and discharge of a stream at a given gaging station.

Recharge – water added to an aquifer. For instance, rainfall that seeps into the ground and percolates to the water table.

Reservoir – a pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

Return Flow – (1) That part of a diverted flow that is not consumptively used and returned to its original source or another body of water. (2) (Irrigation) Drainage water from irrigated farmlands that re-enters the water system to be used further downstream. (3) (Wastewater) Water returned to the environment by wastewater-treatment facilities.

River – A natural stream of water of considerable volume, larger than a brook or creek.

Runoff – (1) That part of the precipitation, snowmelt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers. Runoff may be classified according to speed of appearance after rainfall or melting snow as direct runoff or base runoff, and according to source as surface runoff, storm interflow, or groundwater runoff. (2) The total discharge described in (1), above, during a

specified period of time. (3) Also defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it.

Sedimentary Rock – rock formed of sediment, and specifically: (1) sandstone and shale, formed of fragments of other rock transported from their sources and deposited in water; and (2) rocks formed by or from secretions of organisms, such as most limestone. Many sedimentary rocks show distinct layering, which is the result of different types of sediment being deposited in succession.

Seepage – (1) The slow movement of water through small cracks, pores, interstices, etc., of a material into or out of a body of surface or subsurface water. (2) The loss of water by infiltration into the soil from canals, ditches, laterals, watercourses, reservoirs, storage facilities, other bodies of water, or from fields.

Self-Supplied Water – water withdrawn from a surface water or groundwater source by a user rather than being obtained from a public supply. An example would be homeowners getting their water from their own well.

Specific Yield – quantity of water which a unit volume of aquifer, after being saturated, will yield by gravity. It is expressed as a ratio of groundwater volume to the volume of the aquifer.

Spring – a water body formed when the side of a hill, a valley bottom or other excavation intersects a flowing body of groundwater at or below the local water table, below which the subsurface material is saturated with water.

Storage – a general term for the amount of water in a reservoir or an aquifer.

Stream – a general term for a body of flowing water; natural watercourse containing water at least part of the year. In hydrology, it is generally applied to the water flowing in a natural channel as distinct from a canal.

Streamflow – the water discharge that occurs in a natural channel. A more general term than runoff, streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Surface Water – water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

Transmissivity – the capacity of a rock to transmit water under pressure. The coefficient of transmissibility is the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer one foot wide, extending the full saturated height of the aquifer under a hydraulic gradient of 100-percent. A hydraulic gradient of 100-percent means a one foot drop in head in one foot of flow distance.

Transpiration – process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, such as leaf pores. See evapotranspiration.

Tributary – a smaller river or stream that flows into a larger river or stream. Usually, a number of smaller tributaries merge to form a river.

Unsaturated Zone – the zone immediately below the land surface where the pores contain both water and air, but are not totally saturated with water. These zones differ from an aquifer, where the pores are saturated with water. Also referred to as the Vadose Zone.

Wastewater – water that has been used in homes, industries, and businesses that is not for reuse unless it is treated.

Water Table – the top of the water surface in the saturated part of an unconfined aquifer.

Water Use – water that is used for a specific purpose, such as for domestic use, irrigation, or industrial processing. Water use pertains to human's interaction with and influence on the hydrologic cycle, and includes elements, such as water withdrawal from surface- and groundwater sources, water delivery to homes and businesses, consumptive use of water, water released from wastewater-treatment plants, water returned to the environment, and instream uses, such as using water to produce hydroelectric power.

Watershed – the land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Platte River basin contain thousands of smaller watersheds.

Well (Water) – an artificial excavation put down by any method for the purposes of withdrawing water from the underground aquifers. A bored, drilled, or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground.

Withdrawal – water removed from a ground- or surface-water source for use.