Appendix 4-C

Drainage Network and Hydrography Datasets

Drainage Network and Hydrography Datasets

Simulation of a dynamic surface water system and its interconnections with a groundwater system requires information on the distribution and character of surface water drainage. While built upon the relevant components of previous COHYST groundwater models, the refinements in the COHYST2010 model sought to improve simulation of regional groundwater-surface water interactions through a more spatially and hydrologically balanced representation of the surface water system. The National Hydrography Dataset (NHD) augmented with select aerial imagery was used for the COHYST 2010 model area to serve this purpose.

The NHD is a "comprehensive set of digital spatial data that contains information about surface water features such as lakes, ponds, streams, rivers, springs and wells" (http://dnr.nebraska.gov/surface-water-data) that is developed and maintained in Nebraska by a partnership between the NDNR and the USGS. The NHD consists of vector data types that represent flowlines, water body outlines, points, connectors, and other hydrologic features that, collectively, give scientists and hydrographers a means for mapping and quantifying spatial relationships of a drainage network.

The NDNR maintains and distributes an interpreted NHD dataset for Nebraska that specifically contains polyline features that represent perennial stream and river reaches (a copy used in the COHYST model is available on the COHYST website. In the NHD, a perennial reach is defined as a body of flowing water that contains water throughout the year except for infrequent periods of drought (http://nhd.usgs.gov). This dataset, in conjunction with the more detailed NHD flowline datasets containing intermittent, ephemeral, and artificial reaches, was used as the basis for defining the extent of the surface water system to be simulated in the set of loosely coupled models that make up COHYST2010 (MODFLOW, CROPSIM, and STELLA).

The surface drainage network is simulated differently in each of the component models. Because the MODFLOW groundwater model requires the most specific and extensive information about the drainage network (CROPSIM utilizes lumped runoff zones, STELLA simply uses the interconnection of nodes on the network), the selection of reaches and extents to include was weighted heavily toward application in MODFLOW's grid-based discretization scheme.

The groundwater model grid for the COHYST2010 model area has half-mile square grid cells. Thus, the drainage network defined for model purposes had to be condensed from complex polylines into a sequence of adjacent, relatively coarse, square grid cells based on available data and professional judgment. The process of selecting reaches involved an iterative evaluation of the extent and detail of perennial, intermittent, and ephemeral reach types. Perennial reaches were first selected and simplified where complex flow paths existed, primarily in areas of extensive multi-channel braiding on the Platte River mainstem. This simplification relied on the identification, via aerial imagery and consultation with NDNR field staff, of channel sections that tend to consistently conduct more water. Except where simplified or overlapped by a non-flowing water body (e.g. Lake McConaughy), all NHD perennial stream reaches were included in the model drainage network. This captured the Platte River mainstem as well as the Loup River, the Republican River, and some tributaries to the Blue and Republican Rivers.

Intermittent streams, defined in the NHD as a channel that contains flowing water for part of the year but is actively flowing beyond runoff and snowmelt events, were examined next for inclusion in the model drainage network. These stream reaches, by definition, indicate some periodic baseflow contribution but the considerable detail represented in the dataset precluded comprehensive inclusion in the model. In this case, the drainage network was extended from the perennial reaches upstream to capture the character and general location of the waterway through to its headwaters. In many cases this meant extending the main channel of the perennial reach and adding intermittent tributary reaches or complexity as indicated by aerial imagery or field observation. Care was taken to include stream reaches in the model drainage network that would represent the complexity of the drainage system and spatial extent of probable groundwater-surface water interaction without overly constraining the resulting groundwater model through profligate definition of boundary conditions. This was addressed separately for each basin to reflect topographic and hydrologic differences, so the distribution and complexity of the drainage network varies throughout the model area. The selected drainage network used by the models is shown, mapped to the half mile model grid, in Figure 4C-1.

As mentioned above, the drainage network defined in the process described here was used primarily as a means for building the MODFLOW groundwater model. However, because the CROPSIM and STELLA processes interface with the MODFLOW model at the stream channel, these processes necessarily rely on this drainage network and other NHD information (diversions, irrigation canals, structures) as well. For more specific information how these datasets were used in individual model applications, see sections 5, 6, and 7 of the main report and associated appendices

Table 4C-1 COHYST2010 Drainage Network Data Files

File Name	Description
NHDH_NE_931v210.zip	Set of all NHD data files as a geodatabase, including **Hydrography** (feature class) and **NHDFlowline** (feature dataset) **Note: NHD datasets are regularly reviewed and updated. The version presently available on the NDNR website is not necessarily the one listed here or the one used to develop the drainage network for the COHYST2010 model. However, there have been no significant changes to the location and extent of perennial, intermittent, and ephemeral reaches at a regional scale in the time between original selection of drainage network reaches and the time of this documentation.*
COHYST2010_SelectedDrainageNetwork.shp	GIS shapefile (polyline) showing the selected reaches used to represent the drainage network in the COHYST2010 model; Does not include irrigation canals

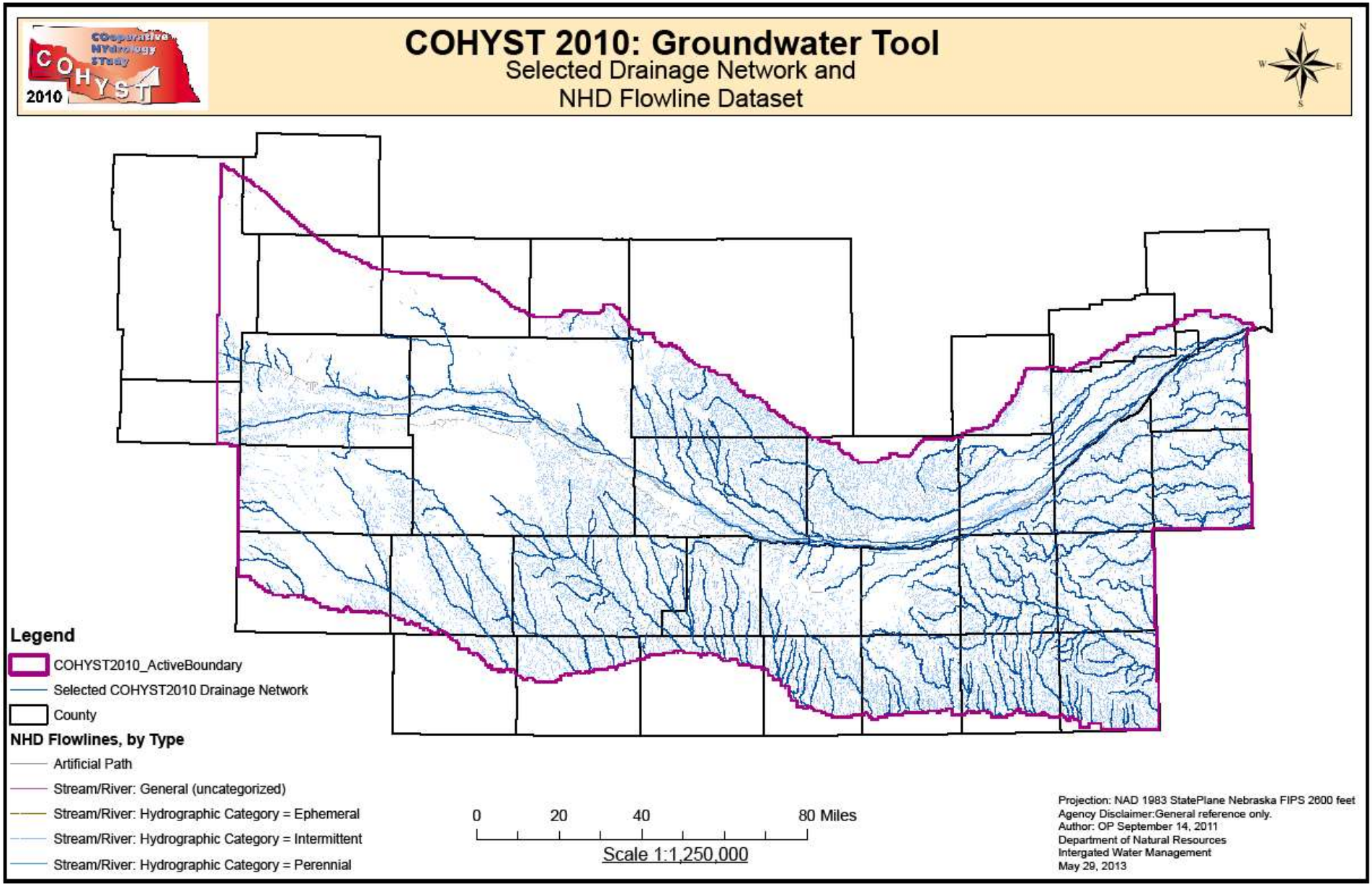

Figure 4C-1 – Selected Drainage Network from Nebraska NHD flowline dataset

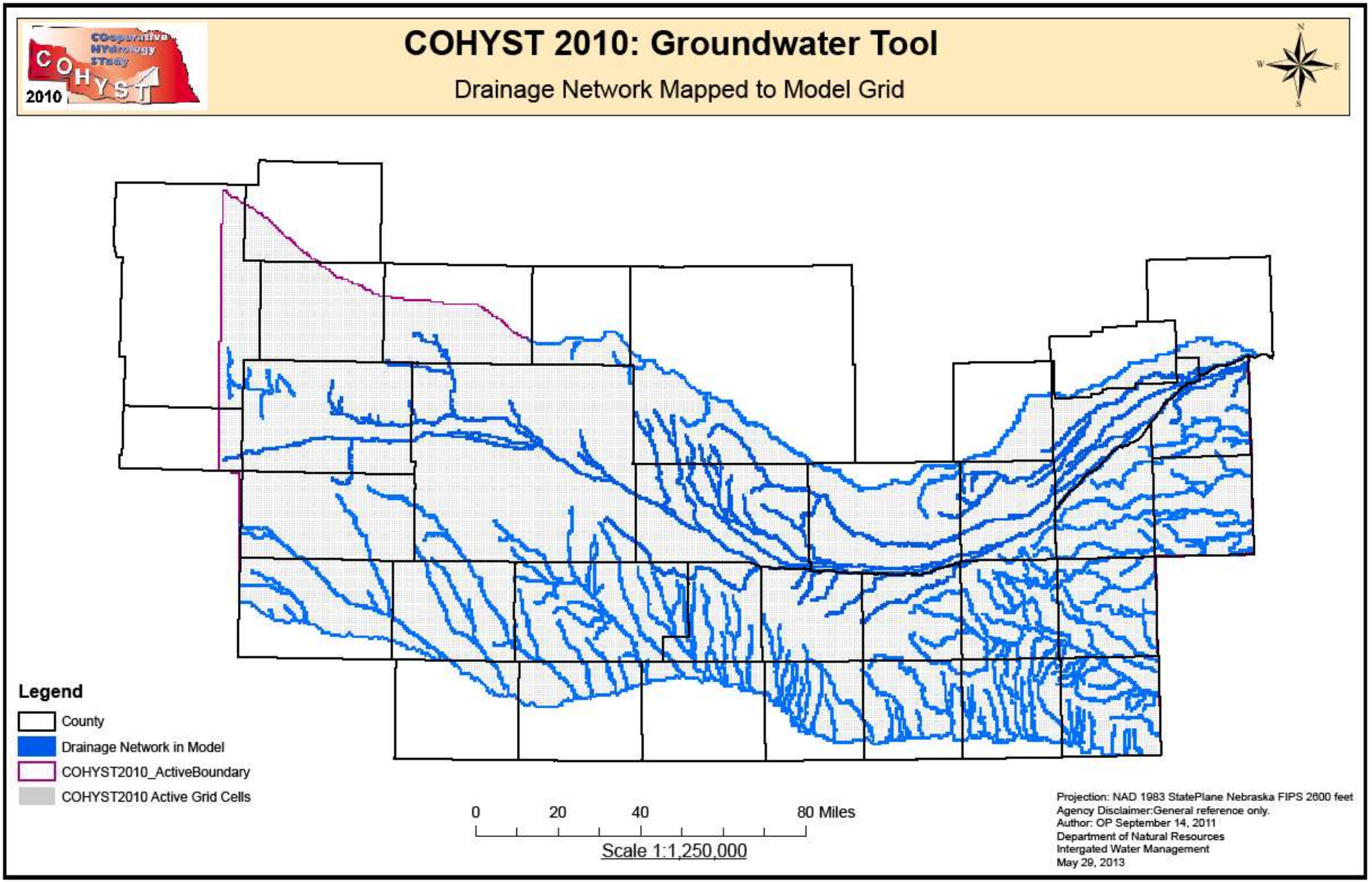

Figure 4C-2 – COHYST2010 Drainage Network Derived from Nebraska NHD and Mapped to Half-Mile Model Grid