DEVELOPING A COMPREHENSIVE AND INTERACTIVE COUNTYWIDE STORMWATER INFRASTRUCTURE MAPPING SYSTEM FOR KANE COUNTY, ILLINOIS

May 2022



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Geneva, IL 60134

Fundamental Drainage Questions:

- How much land drains to my point of concern?
- Where does the stormwater flow to once it leaves my point of concern?





Kane County Area: 524 mi² Unincorporated Areas: 312 mi² Municipalities: 212 mi²

645 miles of shared boundary between the municipalities and unincorporated Kane County



Kane County Area: 524 mi² Unincorporated Areas: 312 mi² Municipalities: 212 mi²

645 miles of shared boundary between the municipalities and unincorporated Kane County

Also:

Section 9-83 of 2019 Stormwater Ordinance Update requires downstream jurisdictions to be notified (other municipalities, the County, active drainage districts, etc.)



Fundamental Drainage Questions:

- How much area drains to my point of concern?
- Where does the stormwater / floodwater flow from my point of concern go?

Who Needs to Know?

- Public works staff?
- Developers?
- Design Engineers?
- Emergency Response Personnel?
- General public?





Goals:

- Provide comprehensive, <u>planning-level</u> stormwater infrastructure mapping data that spans across the unincorporated areas as well as municipalities.
- Facilitate discussion and improve collaboration between municipalities (& the county) to address drainage problems & environmental resource issues from a watershed perspective.
- Create a tool that allows users to quickly and accurately answer those fundamental questions:
 - **1.** How much area drains to this point (anywhere within Kane County)?
 - 2. Where does the water flow to and exactly what flow path does it take to get there?



Deliverables – GIS Layers

- Stormwater Detention Basins
- Storm sewers, roadway, railroad & driveway culverts
- Countywide storm flow path network
- Potential Flood Inundation Areas & True Depressional Storage Areas
- Bare Earth Digital Elevation Model
- Hydro-enforced Digital Elevation Model

Deliverables – PDF Maps

• By Township; Showing stormwater basins, storm sewer, culverts, storm flow paths, regulatory floodplain, depressional storage areas, areas potentially vulnerable to urban flooding, hydric soils, ADID wetlands, dams, etc.

Deliverables – Real Time Flow Trace / Watershed Tool



Data & Resulting Maps & Map Tools can be used for:

- Drainage Investigations
- Stormwater Permitting
- Watershed Planning
- Stormwater Modeling & Master Planning
- Floodplain Modeling & Remapping
- MS4 Illicit Discharge Tracing
- Hazard Mitigation Planning
- Public Education / Outreach to increase stormwater awareness



GIS Products

Three File Geodatabases:

- Areas of Potential Flooding (Flood Inundation Layer)
 - Areas of Ponding, NOT Calculated Floodplain
- Stormwater Infrastructure
 - Storm sewers, culverts, detention basins, and inlets, manholes, etc.
- Stormwater Flow Path

Two Digital Elevation Models (DEMs)

- Bare Earth DEM
- Hydro-conditioned DEM
 - Storm sewers & culverts burned into the surface



Three File Geodatabases:

- CountywideDepressionalStorage.gdb
- KC_StormwaterDataFeb2022.gdb
- KC_StormFlowPathFeb2022.gdb

Two Digital Elevation Models (DEMs)

- Kane2017BE.tif
- Kane_DEM_Conditioned02242022.tif



Potential Flood Inundation Layer

(CountywideDepressionalStorage.gdb; 1.7 GB)

 File geodatabase that contains polygons for each 0.5 foot of flood depth for every depression in the landscape (using Bare Earth raster DEM)







Flood Inundation Layer

(CountywideDepressionalStorage.gdb; 1.7 GB)

- File geodatabase that contains polygons for each 0.5 foot of flood depth for every depression in the landscape (using Bare Earth raster DEM)
- Use DepressionalStorage.lyr to style layer to display graduated color scale according to depth.



KC_StormwaterDataFeb2022.gdb

Contains GIS layers for:

- Streams (updated to alignments/extents reflected in 2017-2021 time period)
- Storm Sewers (municipal storm sewers, railroad & roadway culverts, driveway culverts, drain tiles, etc.)
- Storm Structures (inlets, catch basins, flared end section inlets & outfalls, etc.)
- Stormwater Storage Basins (detention basins, recreational ponds, quarries, etc.)
- Watershed Boundaries (updated to factor in sewers & culverts)



KC_StormwaterDataFeb2021.gdb

Streams

- Updated to reflect the alignment of perennial stream channels in the 2017-2021 aerials
- Default was 2017 aerial as this corresponds to the Bare Earth DEM, but used 2019 – 2021 aerials where it was evident that major shift in channel alignment occurred (such as in places where a man-made project was done which realigned the channel.
- Many streams were "shortened" as the old Kane County streams layer reflected stream channel which had long ago been buried and converted to farm tile (no stream actually present).





KC_StormwaterDataFeb2022.gdb

Stormsewers

- Unincorporated storm sewers digitized from subdivision record drawings & KDOT plans.
- Municipal sewers were digitized manually using GIS data from municipalities as a guide.
 - Corrected whenever possible to match 2019 engineering-grade aerial ortho-pictometry.
 - Some GIS layers were off by 10-40 feet!
- Key inlets at street intersections included; all lateral inlets will eventually be added in.
- Storm sewers for which data was not 100% verified are coded with "VERIFY" in notes so that municipal staff can query the data, check these segments and provide confirmation that sewer is correctly represented or (ideally) provide better info, if possible.
- Goal for this layer is to illustrate system connectivity and provide data for hydro-conditioning of the DEM; it is NOT intended to be a replacement for each municipality's storm sewer GIS layer if the municipality has a current & well maintained GIS database of its storm sewers and structures.



KC_StormwaterDataFeb2022.gdb

Storm Structures

- Mainly contains structures for unincorporated storm sewered areas (county subdivisions & roads under KDOT jurisdiction/ownership)
- Some municipalities' storm sewer structures were included as they had to be created in order to convert those municipalities' CADD & PDF storm sewer data into GIS data.
- Inlets in municipal jurisdictions where no municipal storm sewer was provided (highlights areas where storm sewer is needed to refine the storm flow path mapping)



KC_StormwaterDataFeb2022.gdb

Stormwater Storage Basins

- Includes all water features: Stormwater Detention Basins, ponds, lakes, quarries & wetlands
- Best viewed by classifying by FUNCTION in attribute table (All detention facilities are classified as Function = "Stormwater")



Mapping Detention Basins in Kane County

Data Sources:

- Aerial photos 1939-2021
- Subdivision plans / record drawings
- 1 foot topography (2017)
- Municipal & Unincorporated storm sewer mapping
- Flood Inundation Analysis











Detention Basins in Kane County

3186 total





Detention Basins in Kane County (3186 Total)

Ownership	Det. Basins	Percentage
Public	725	23%
Private	2461	77%
	3186	





Detention Basins in Kane County

(3186 Total)





Storm Flow Paths

2 Versions:

Hydro-enforced

(Sewers/culverts burned in)

• Unconditioned (Bare Earth)



Storm Flow Paths 2 Versions:

Hydro-enforced

(Sewers/culverts burned in)

• Unconditioned (Bare Earth)



KC_StormwaterDataFeb2022.gdb Watersheds

- File name: Watersheds_Jan2022
- Represents watersheds for the perennial streams in Kane County and is based on the hydro-enforced DEM created on 1/1/2022
- **51 named watersheds** (vs. 12 in original Kane County Watershed Layer)



Digital Elevation Model

- Derived from LiDAR points flown Spring 2017
 - 20 points per square meter;
 - 0.2ft +/- Vertical Resolution (on hard surfaces)
- 2ft X 2ft Horizontal Resolution
- 30.8 miles E-W by 39.3 miles N-S
- 832 sq. miles (Kane County = 524 sq. mi.)
- 5.8 Billion Pixels



2019 Aerial Imagery

Streams

Detention Ponds



2017 Digital Elevation Model

- Bare Earth DEM
 - Bridge decks removed
 - Buildings removed
- Hydro-flattened
 - Water surface made flat
- Underground sewers & culverts are NOT reflected in the DEM

Bare Earth DEM





2017 Digital Elevation Model

• "Filled" DEM or "Depressionless" DEM

are Earth DEM

lled DEM



Depression "filled" in

Comparing Bare Earth DEM to the Filled DEM to generate a Flood **Inundation Layer**



Stearns Rd – SE area of South Elgin

Laver

Flood Inundation Layer displayed over aerial photography

Aids in identifying & visualizing potential urban flooding problems.

Helps answer questions:

"How deep could the water get around that house?"

"How deep could the water get on our street if the storm sewer failed during a storm & could it impact emergency vehicle access during a flood?"

Future Analysis will tell us:

"How many acre-feet of stormwater is stored in our detention basins?"



Developing an accurate Storm Path Network









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Flow direction





Developing an accurate Storm Path Network

Manmade drainage infrastructure & stream centerlines to be incorporated into Bare Earth DEM





Developing an accurate Storm Path Network

Burning the drainage infrastructure into the Bare Earth DEM creates a hydroenforced Digital Elevation Model

Storm flow path WITH manmade drainage infrastructure incorporated into DEM

Resolution of Storm Path Network can be adjusted to any drainage area threshold desired (this image shows 1 acre threshold)



No hydro-enforcement

Not necessarily an incorrect Storm Path Network – but a Storm Path Network that sheds light on how stormwater may flow during extreme events if parts of the underground drainage infrastructure fails.



653.3 Miles of Stream Channel

Centerline alignment manually adjusted using aerial photos, topo, & flood inundation analysis. (all 3.4 million feet!)




653.3 Miles of Stream Channel

2,483 Miles of Storm sewer Mapped

(as of May 2022)

- 226 Railroad Culverts
- 12637 Driveway Culverts
- 4182 Roadway Culverts
- 8338 Unincorporated Storm Sewer Segments (Kane Co / KDOT / IL Tollways)
- 59,306 Municipal Storm Sewer Segments
- 21,166 structures (mostly unincorporated areas; some municipal structures where sewer alignment is currently unmapped)
- 1522 Ag Drain tiles (179.9 miles NOT included in 2,483 miles of storm sewers)
- Started with unincorporated culverts & storm sewer
- Next major municipal storm sewers
- Then minor storm sewers
- Some street inlet laterals not included (yet)

Could not be done without the previous (& continued!) cooperation of municipal & transportation dept staff – THANK YOU!





1 acre Storm Flow Network (as of 2/24/22)

- 18,143 miles
- 1,371,588 segments

1500+ Hours to manually digitize/draw storm sewer

Processing Time (QGIS/ArcGIS):

- 8 hrs to "burn" storm sewer into DEM
- 8 hrs to "fill" DEM
- 6 hrs to compute Flow Direction Raster
- 48 hrs to compute Flow Accumulation Raster
- 2hrs to extract Storm Flow Path
- 8hrs to calculate watershed boundaries

Raster DEM File Sizes: 32GB

About 130GB file space needed for each iteration





0.1 acre Storm Flow Network (as of 2/24/22):

- 65,052 miles
- 11,667,905 segments

Draft Flood Inundation Maps are available on-line now at KCDEWR webpage

- Considered Draft- updated as additional storm sewer data is incorporated into the hydroconditioned DEM
- Static PDF maps viewable/downloadable by public

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Water HOME

Division

Division

Water Resources

Watershed Planning

and Special Projects

Contacts and Other Resources

Flood Hazards:

Kane County

Management

Stormwater Education

Electronic Payments

Emergency

Draft Flood Inundation Maps are available on-line now with direct link sent from KCDEWR.

- Considered Draft– updated as additional storm sewer data is incorporated into the hydroconditioned DEM
- PDF maps will be downloadable by the general public.



County Drainage Maps

The purpose of these maps are to provide a comprehensive, planning-level illustration of where stormwater may accumulate and how it flows across Kane County. Storm sewers and detention basins shown on these maps represent the best available data inventoried by the County to date and/or provided to Kane County by the municipalities. This data is considered planning level information and is not intended to serve as a regulatory map. Regulatory floodplain boundaries prepared by FEMA are shown on this map as a courtesy.

Areas of POTENTIAL flooding were determined through a simple surface "fill" analysis using the latest Digital Elevation Model (DEM) for Kane County (created from 2017 LiDAR data; 0.2ft vertical accuracy). The analysis illustrates the maximum potential flooding depth of all depressions in the landscape. These areas of potential inundation reflect the maximum possible level of flooding if the underlying drain tile, storm sewer or culvert pipe intended to drain these areas were not functional under extreme storm conditions; thus providing the viewer with an absolute "worst case scenario" illustration of possible flooding if the manmade infrastructure malfunctioned or became inoperable.

For specific questions about possible flooding within in a given municipality, contact the municipal public works or engineering department for that municipality to obtain more information.

The maps are updated as new information becomes available. Be sure to check back regularly for the latest updated maps.



Draft Flood Inundation Maps are available on-line now with direct link sent from KCDEWR.

- Considered Draft– updated as additional storm sewer data is incorporated into the hydroconditioned DEM
- Static PDF maps viewable/downloadable by public.

Have better data?

- See something that's incorrect?
- Send us your drainage info and we'll incorporate it!







- Beta Testing Spring 2022
- Live & available Summer 2022



- Downstream Flow Trace
- Performed real time from any point in the County
- 10-60 sec run time depending on flow length to river



- Upstream Watershed Delineation
- Performed real time from any point in the County
- 60 sec 10 min. run time depending on watershed size



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- Performed real time from any point in the County
- 60 sec 10 min. run time depending on watershed size



- Upstream Watershed Delineation
- Performed real time from any point in the County
- 60 sec 10 min. run time depending on watershed size

















Nearly 8K gallons of gasoline spill in Kane County, closing roadways in area

Gasoline spilled from gas station into drainage ditch, wetland: Elburn and Countryside Fire Protection District

By ABC7 Chicago Digital Team Thursday, April 7, 2022



EMBED <> MORE VIDEOS >

Gasoline mixed with rainwater was found flowing from a gas station into a drainage ditch and a nearby wetland area.

LILY LAKE, Ill. (WLS) -- Kane County officials have shut down a roadway in a western suburb after nearly 8,000 gallons of gasoline spilled in the area.

Route 64 in Lily Lake was shut down between Route 47 and Hanson Road throughout Wednesday and into Thursday morning after the leak, the Elburn and Countryside Fire Protection District said.





Special Thanks to those who have contributed data to make this project possible:

- City of Elgin
- City of Aurora
- City of St Charles
- City of Geneva
- City of Batavia
- Village of Algonquin
- Village of Carpentersville
- Village of West Dundee
- Village of East Dundee
- Village of Pingree Grove
- Village of Hampshire

- Village of Huntley
- Village of Elburn
- Village of Sugar Grove
- Village of North Aurora
- Village of Montgomery
- Village of Barrington Hills
- Village of Gilberts
 - Village of South Elgin
 - IL Toll Authority
 - Kane County DOT
- CMAP

Additional thanks to those who contributed technical expertise and

guidance:

Kurt Lebo, Kane County IT Dept (Potential Flood Inundation Layer) Tom Nicoski, Kane County GIS Dept (KaneCAD GIS Data Integration) Brett Lawson, GIS Solutions, Inc. (Flow Trace & Watershed Mapping Tool)



Questions?

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Appendix Slides

Data and Tool Publication Schedule

Spring 2022:

• Share GIS Layers

- Flood Inundation Layer
- Bare Earth DEM
- Storm Flow Path (2nd Edition)
- Countywide Storm Sewer & Culvert layer
- Updated Watershed Boundaries
- Hydro-enforced DEM (1st Edition)

Summer 2022

- Real-time online watershed / subcatchment delineation tool
- Real-time online flow tracing tool

Depressional Storage

Potential Urban Flooding

Flood Inundation Mapping

- Isolated Depressional Storage
- Potential Urban Flooding
- Restrictive Culverts/Bridges
- 93,319 individual areas
- 77,430 smaller than 5000 ft²
- 9,358 bet. 5000 ft² 25,000 ft²
- 1,995 bet. 25,000 ft² 43,560 ft²
- 4,536 > 1 acre (43,560 ft²)



GIS Analysis to Map Areas Potential Flood Inundation

Software: ArcGIS Pro & QGIS in combination

- Clip the Countywide Bare Earth DEM to watershed boundaries (entire county DEM is too big to process)
- Run the Geoprocessing tool FILL on each watershed DEM
- Using Raster Calculator tool, compare the original bare earth watershed dem to its filled DEM.
- Calculate contours using the Contour Shell Up option
- Export all the results to shapefiles.
- Use QGIS to process the shapefiles using the tool "Multipart to Single Part"
- Export all single part contours back to a feature in ArcGIS Pro
- Merge all single part contours
- Create a new layer with only 0.5 foot contour minimum and area greater than or equal to 100 sq ft
- Run the Smooth tool to smooth out the polygons

GIS Analytical Procedure to Create a County-wide Hydro-Conditioned Bare Earth Digital Elevation Model

Step 1: Convert storm sewer and stream lines into a raster

- 1. Use QGIS
- 2. Combine streams and sewers into 1 layer
- 3. Buffer line layer by 2 ft (equal to grid resolution of Bare Earth DEM)
- 4. Vector to Raster Tool



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Run Close

Help

GIS Analytical Procedure to Create a County-wide Hydro-Conditioned Bare Earth Digital Elevation Model Step 2: Add in "zeros" to

stream & storm line raster

- 1. Use QGIS
- 2. Reclassify Values Tool



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GIS Analytical Procedure
to Create a County-wide
Hydro-Conditioned Bare
Earth
Digital Elevation Model

Step 4: Multiply standardized DEM with stream & storm values subtracted by the original Bare Earth DEM to get the final hydroconditioned DEM

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GIS Analytical Procedure to Create a County-wide Hydro-Conditioned Bare Earth **Digital Elevation Model**

able Of Contents

Step 5: Create Fill Raster from Hydro-conditioned DEM

- **Using ArcGIS**
- Spatial Analyst -> **Hydrology Tools**
- Fill



GIS Analytical Procedure to Create a County-wide Hydro-Conditioned Bare Earth Digital Elevation Model

Step 6: Create Flow Direction Raster from Filled Hydro-conditioned DEM

- Using ArcGIS
- Spatial Analyst -> Hydrology Tools
- Flow Direction



GIS Analytical Procedure to Create a County-wide Hydro-Conditioned Bare Earth Digital Elevation Model

Step 7: Create Flow Accumulation Raster from Flow Direction RasterUsing ArcGIS

- Spatial Analyst -> Hydrology Tools
- Flow Accumulation





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Need Elevation Data Now? 2017 LiDAR (point) data for Kane County is available at IHMP website



Illinois Height Modernization (ILHMP): LiDAR Data

Data » Elevation Data » Illinois Height Modernization (ILHMP): LiDAR Data

Summary Data Services Viewer Project Sponsors

New* Download LiDAR Data thru our new Web Application Viewer. The Viewer allows users to zoom into an area of interest and then simply select LAS tiles to download.

Available LiDAR data for Illinois are listed below. These collections are organized by county and listed alphabetically with the year of collection listed first. If there is no year next to the county name, this collection is yet to be acquired. If the data is listed as "By Request" then this data is available by request only and a Help Request Form must be completed and submitted.

Note: ZIP files are large in size; some may take several hours to download. Make certain your Internet provider does not have a 2GB cap or time limit on file downloads. Some users have had success using a free downloadable compression and extraction software called "7zip", if you are experiences errors when extracting this data, please try using "7zip" to extract. Submit a Help Request Form to receive any county by mail.

County Collections

Filter list by C	ounty or Year	:									
County	Year	Status	Metadata	Tile Index	Breaklines	Derivatives	LAS	DGN	DAT	TIN	
Adams	2009	Available	Metadata	Tile Index		Derivatives (23.8 GB)	LAS (30.9 GB)	DGN (27.4 GB)	DAT (8.9 GB)	TIN (26.7 GB)	
Adams	2018	Available	Metadata	Tile Index	Breaklines	Derivatives (120.0 GB)	LAS (411.0 GB)				
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Boone	2007	Available	Metadata	Tile Index		Derivatives (4.2 GB)	LAS (22.8 GB)				
Boone	2018	Available	Metadata	Tile Index	Breaklines	Derivatives (23.9 GB)	LAS (81.5 GB)				
Brown	2017	Available	Metadata	Tile	Breaklines	Derivatives (20.2 GB)	LAS (123.0				

Want to work with GIS Data but don't have ArcGIS?

Download Open Source GIS Software

- QGIS version 3.22
- It's FREE!
- Powerful DEM visualization & processing tools
 - Drainage Area Delineation
 - Storm Flow Network Mapping
 - Terrain Analysis
- LOTS of video training available on YouTube
- Leverage available data and free software to quickly and more easily see how the landscape drains and help make informed decisions on addressing potential drainage problems
- www.qgis.org


Data Disclaimer / Liability Waiver accompanying shared GIS layers

COUNTY OF KANE

KANE COUNTY DEPARTMENT OF ENVIRONMENTAL & WATER RESOURCES Jodie L. Wollnik, P.E., CFM

Director

 County Government Center

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 Phone:
 (630) 232-3497

 Fax:
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DATA SUMMARY

Kane County Department of Environmental & Water Resources (KCDEWR) has created a Countywide Stormwater GIS Database, which consists of a set of <u>planning-level</u> GIS layers for stormwater features that span the entire area within Kane County. The datasets were created from a combination of analysis and interpretation of digital elevation models and aerial photography, mapping storm sewer infrastructure shown on archived subdivision development plans and record drawings for unincorporated areas, and digitizing storm sewers within incorporated areas using storm sewer layers provided by municipalities as a guide. The Countywide Stormwater GIS Database contains the following layers: Bare Earth DEM, Hydro-conditioned DEM, Streams, Watersheds, Storm Sewers, Stormwater Storage (layer includes lakes, ponds, wetlands, quarries & stormwater detention basins). Flood Inundation Layer (mapping of maximum potential flooding depth all depressions/basins within the Bare Earth DEM), stormwater flow paths with no hydro-conditioning (no sewers/culverts included), and stormwater flow paths with hydro-conditioning (storm sewers & culverts factored in).

The Countywide Stormwater GIS Database is an on-going project that will be periodically updated by KCDEWR, as new data/corrections are provided to the department and as the department has time to incorporate additional subdivision plans and record drawing information into the stormwater data layers. Digital storm sewer mapping information was contributed to this project by the following organizations: Village of Algonquin, Village of Barrington Hills, Village of Huntley, Village of Carpentersville, Village of East Dundee, Village of West Dundee, Village of Pingree Grove, Village of Gilberts, Village of Elburn, Village of Hampshire, City of Elgin, Village of South Elgin, City of St Charles, City of Geneva, City of Batavia, Village of North Aurora, City of Aurora, Village of Montgomery, Village of Sugar Grove and the Illinois Toll Authority.

DATA DISCLAIMER

This data is being provided with the express understanding that there is no guarantee that the data is free of errors or omissions. There is no guarantee that any updates will be supplied as errors or omissions become apparent or if updates are available. This is planning level data and is not intended to supersede engineering data or on-site topographic survey data.

By using digital data from the Kane County Countywide Stormwater GIS Database, you are agreeing to indennify, defend, and hold harmless the County of Kane and all organizations who contributed data from any and all liabilities, claims, demands, damages, losses and expenses (including, without limitation, defense costs and reasonable attorney fees) arising out of, or resulting from, the lack of accuracy or correctness of the data, or the use of the data. Please acknowledge 'Kane County Countywide Stormwater GIS Database' as a source, when this data is used in the preparation of reports, papers, maps, models, and other products. Neither the County of Kane nor those organizations who contributed data assume any liability for the data or derivative products based on the data supplied. To ensure that appropriate documentation and data limitations are provided, these databases shall not be redistributed to any other parties.

Inquiries about the Kane County Countywide Stormwater GIS Database should be directed to: Rob Linke, P.E., CFM Kane County Department of Environmental & Water Resources 719 Batavia Avenue Geneva, IL 60134 630-232-3498 / linkerobert@co.kane.il.us

Data Disclaimer on PDF Countyide Drainage Maps

(split up by Township)

The purpose of this map is to provide a comprehensive, <u>planning-level</u> map that illustrates where stormwater may accumulate and how it flows across Kane County. Storm sewers and detention basins shown on this map represent the best available data inventoried by the County to date and/or provided to Kane County by cooperating municipalities. This data is considered planning level information and is not intended to serve as a regulatory map. Regulatory floodplain boundaries prepared by FEMA are shown on this map as a courtesy.

Areas of POTENTIAL flooding (see graduated color scale on the left) were determined through a simple surface "fill" analysis using the latest Digital Elevation Model (DEM) for Kane County (created from 2017 LiDAR data; 0.2ft vertical accuracy). The analysis illustrates the maximum potential flooding depth of all depressions in the landscape. These areas of potential inundation reflect the maximum possible level of flooding if the underlying drain tile, storm sewer or culvert intended to drain these areas were not functional under extreme storm conditions; thus providing the viewer with a "worst case scenario" illustration of possible flooding if the manmade infrastructure malfunctioned or became inoperable.

For specific questions about possible flooding within in a given municipality, contact the municipal public works or engineering department for that municipality to obtain more information.



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