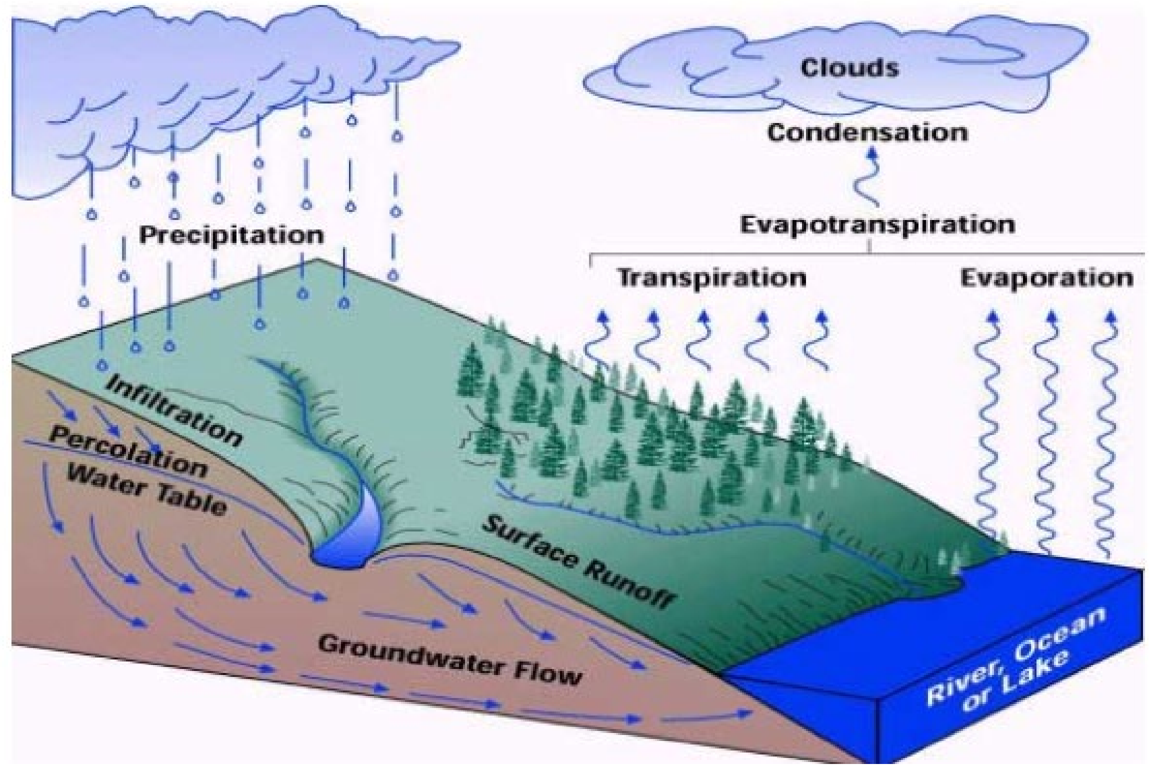
stormwater basics: hydrology defined

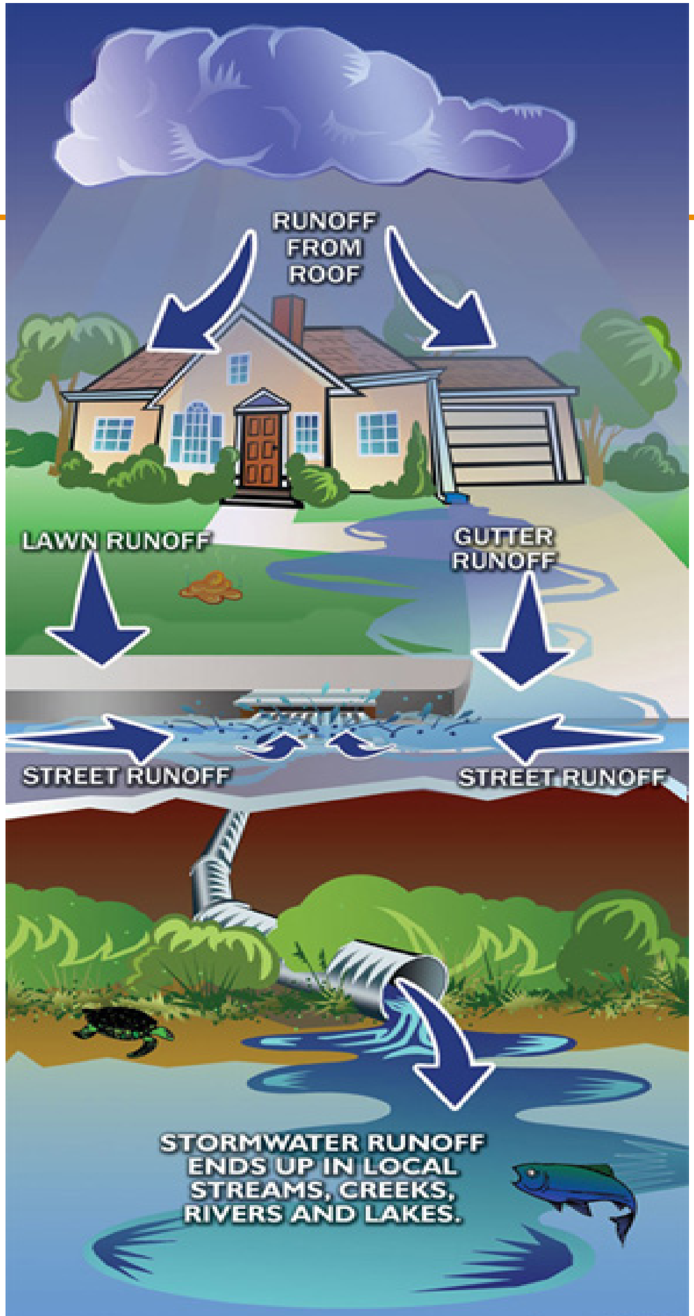
- Hydrology is the science that encompasses the occurrence, distribution, movement and properties of the waters of the earth and their relationship with the environment within each phase of the hydrologic cycle.



stormwater basics: hydrologic parameters

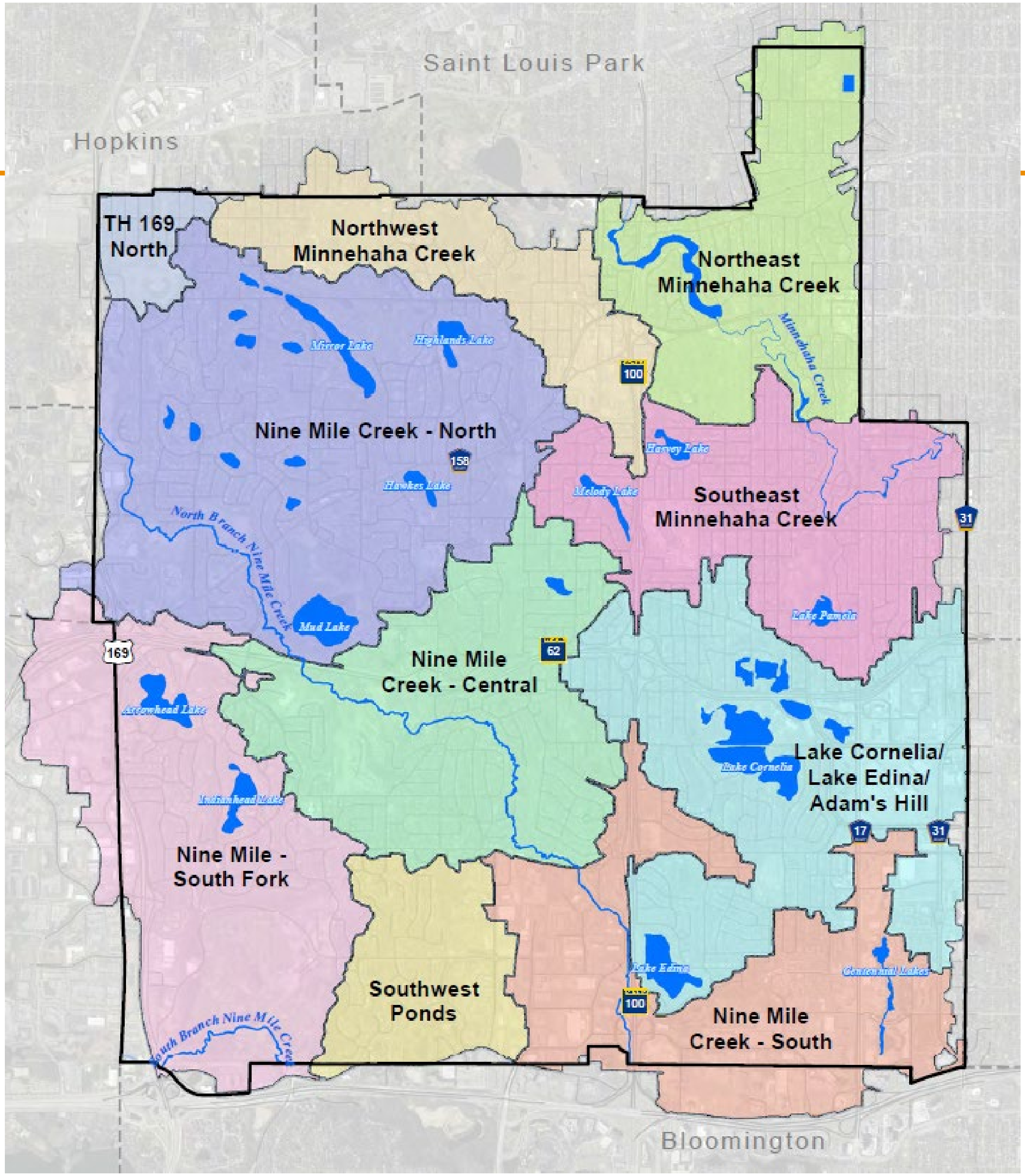
Hydrologic parameters refer to model parameters used to calculate the volume and rate at which runoff is generated from a watershed.

- Watershed data
  - Watershed area
  - Land use data - determines the amount of pervious, impervious, and open water area for each subwatershed
- Rainfall data
  - "24-hour" storms
  - Also a 10-day snowmelt event
- Infiltration data
  - Soils



North Carolina Department of Environment and Natural Resources

Major Drainage Areas

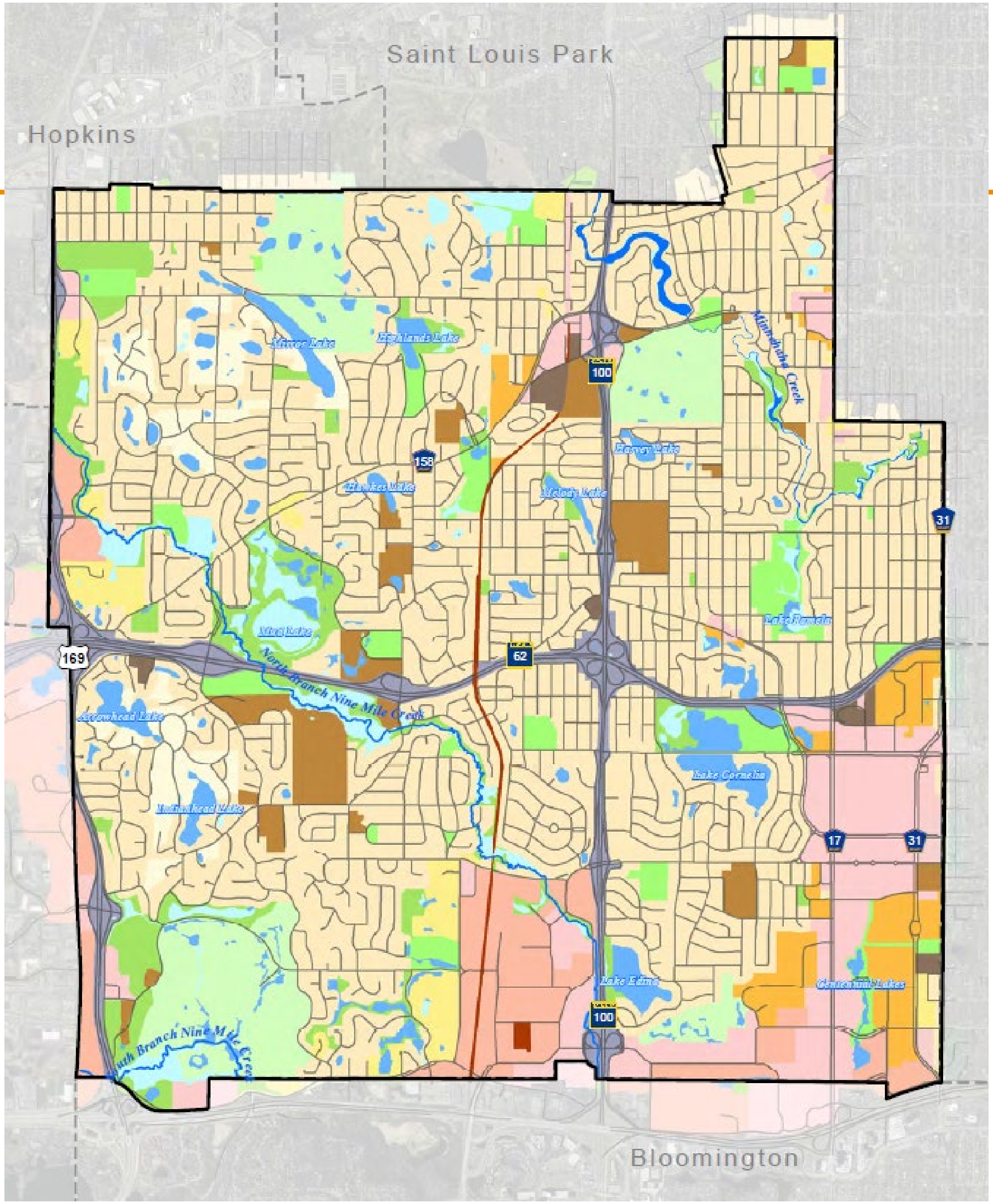


Land Use Classification

Land Use Classification[1]

- Agricultural
- Natural/Park/Open
- Developed Parkland
- Golf Course
- Very Low Density Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Institutional
- Institutional - High Imperv.
- Airport
- Highway
- Roads
- Commercial
- Industrial/Office
- Other
- Open Water
- Wetland
- Graded Pit
- Streets and Highways
- Creek/Stream
- City of Edina Boundary

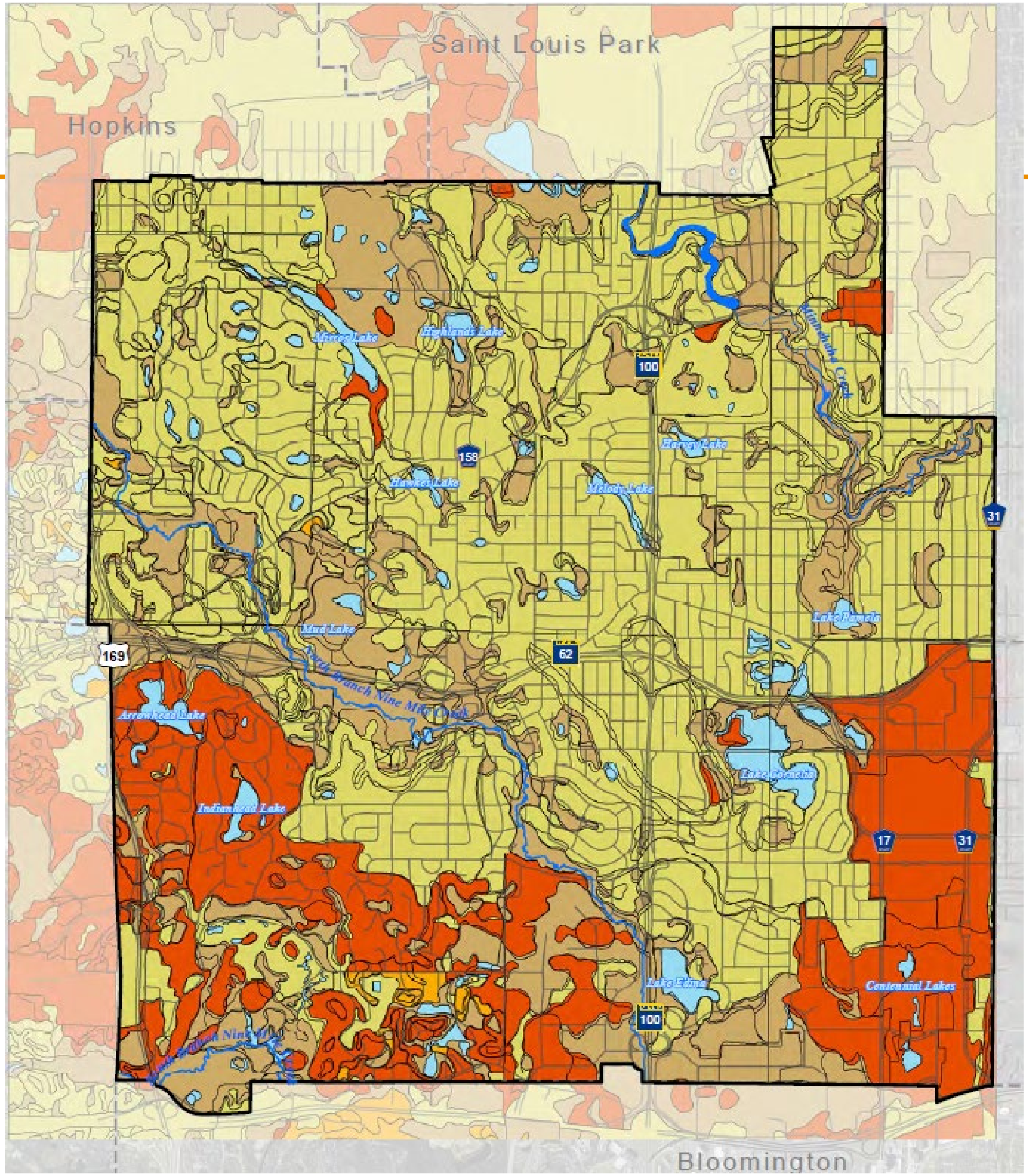
[1]Data Source: City of Edina, 2000



Soils Classification

Hydrologic Soil Groups

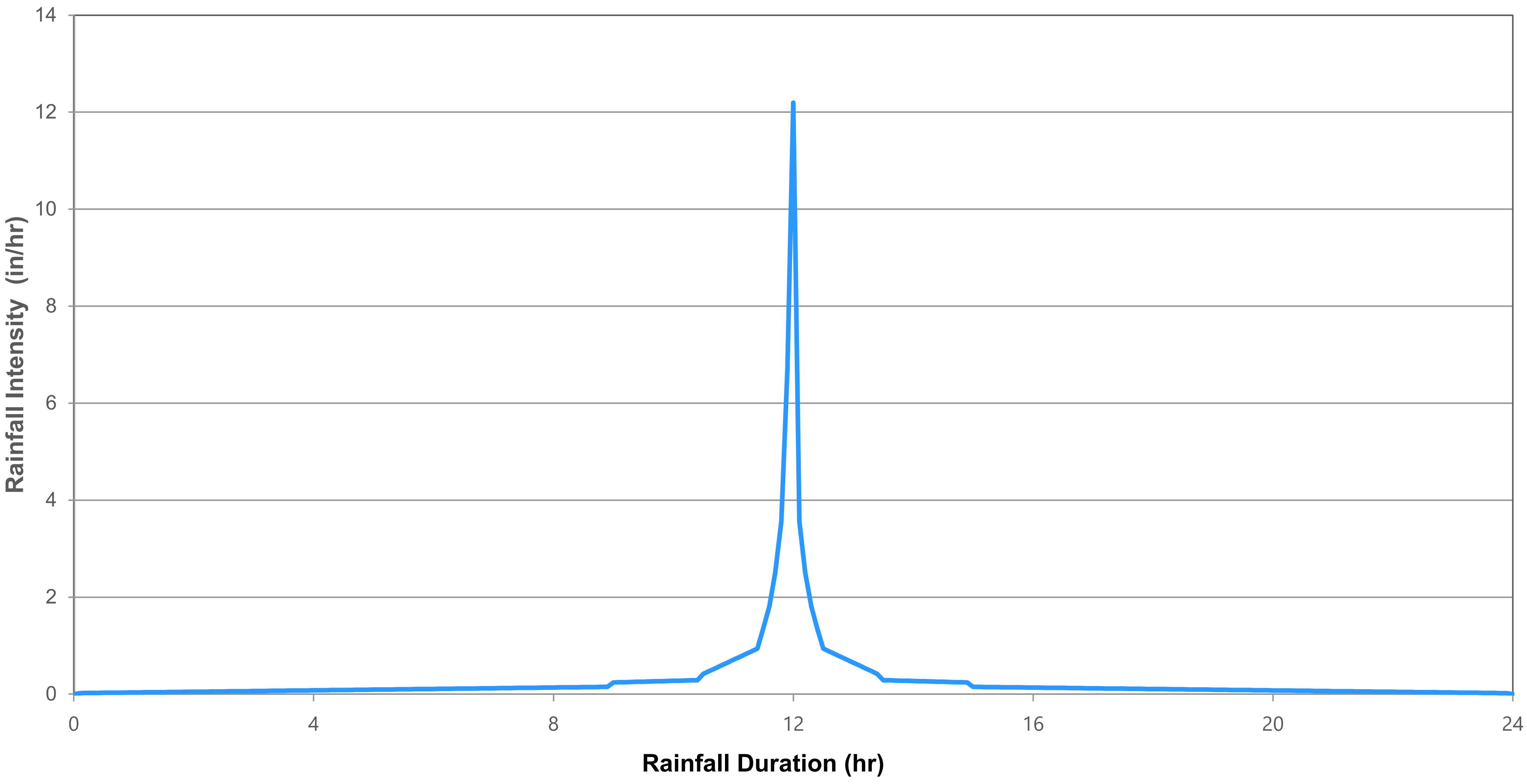
- A - High infiltration rates. Low runoff Potential.
- B - Moderate infiltration rates. Low to medium runoff potential.
- C - Slow infiltration rates. Medium to high runoff potential.
- D - Very slow infiltration rates. High runoff potential.
- Water
- Streets and Highways
- Creek/Stream
- City of Edina Boundary



Design Storms Used for Stormwater Modeling

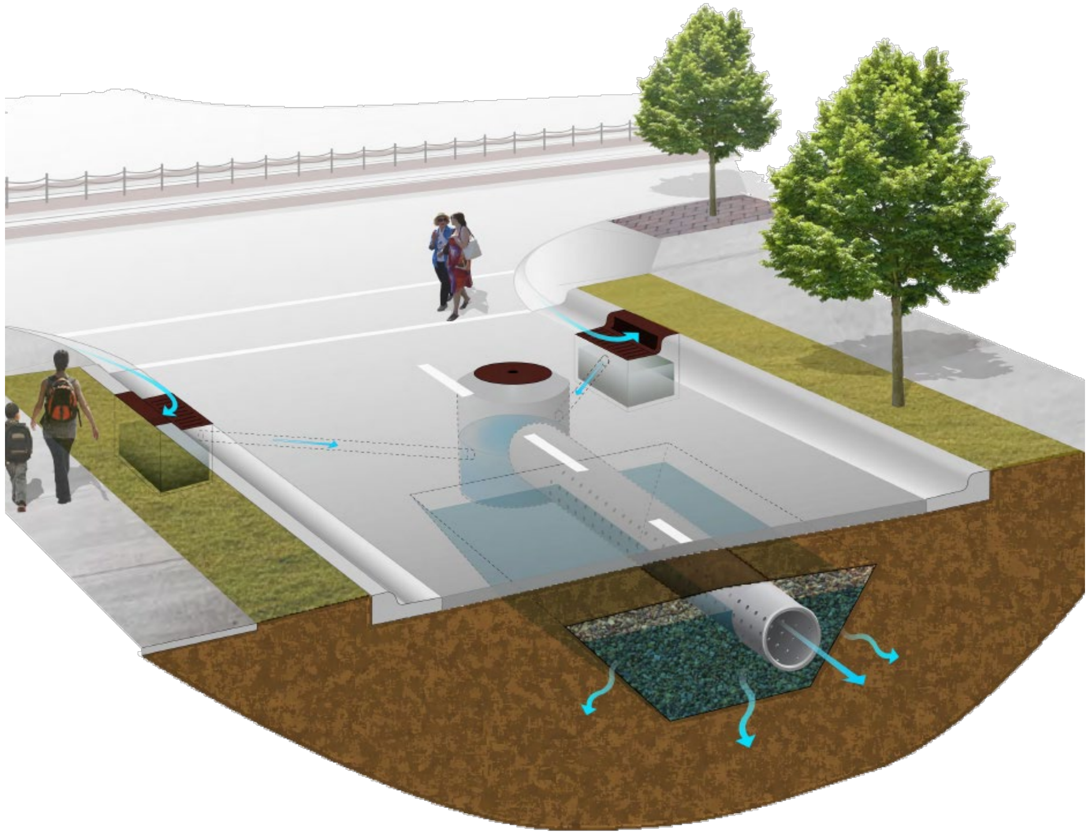
Design Storm Event	Annual Chance of Exceedance	24-hour Storm Depth	Peak Intensity[2]
5-year	20%	3.59 inches	5.9 in/hr
10-year	10%	4.29 inches	7.1 in/hr
25-year	4%	5.41 inches	8.9 in/hr
50-year	2%	6.39 inches	10.5 in/hr
100-year	1%	7.49 inches	12.3 in/hr
500-year	0.2%	10.5 inches	17.3 in/hr

100-Year (1%-Annual-Chance) 24-Hour Storm



stormwater basics: hydraulics

- the branch of science and technology concerned with the conveyance of liquids through pipes and channels



Storm drain installation

stormwater basics: hydraulic parameters

Hydraulic parameters refer to any and all parameters related to conveyance of water through storage areas, pipes, and overland flow channels.

- Storage in lakes/ponds/wetlands
- Storm sewer network
- Tailwater effects (e.g., if Minnehaha Creek is high, it can impact the water levels in the storm sewer pipes that flow into it)
- Inlet capacity
- Overland flow network (along streets, along natural areas)

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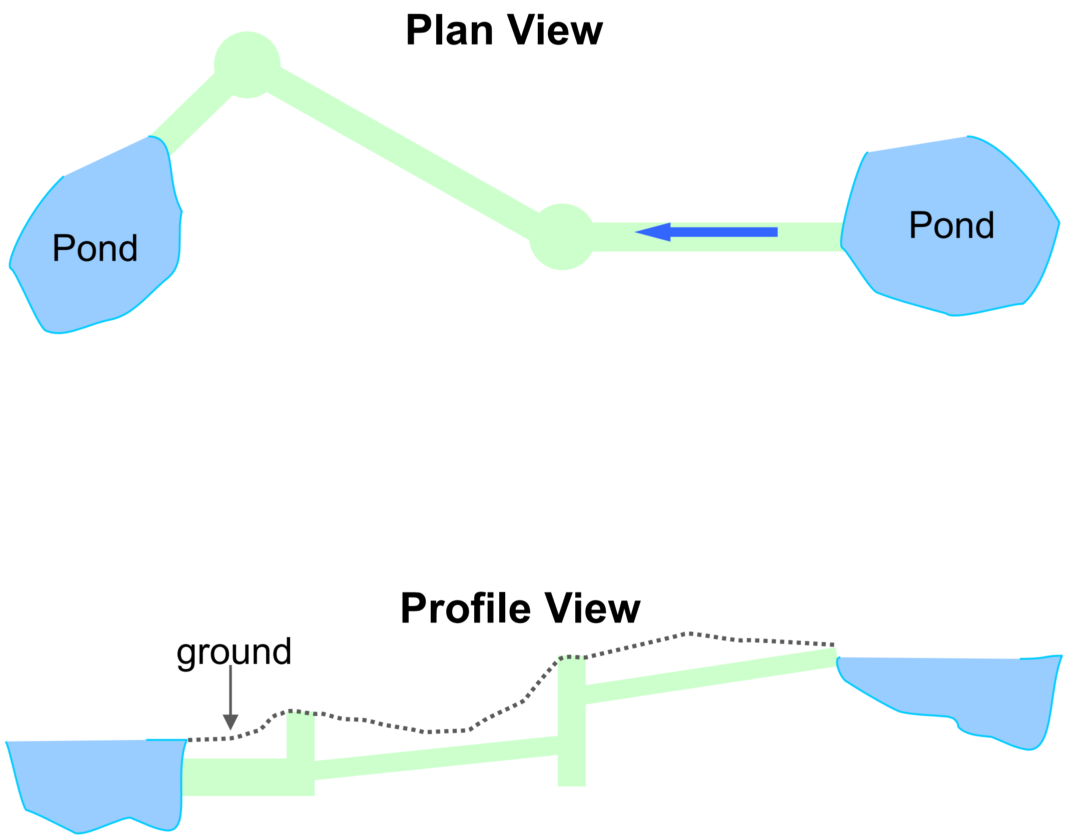
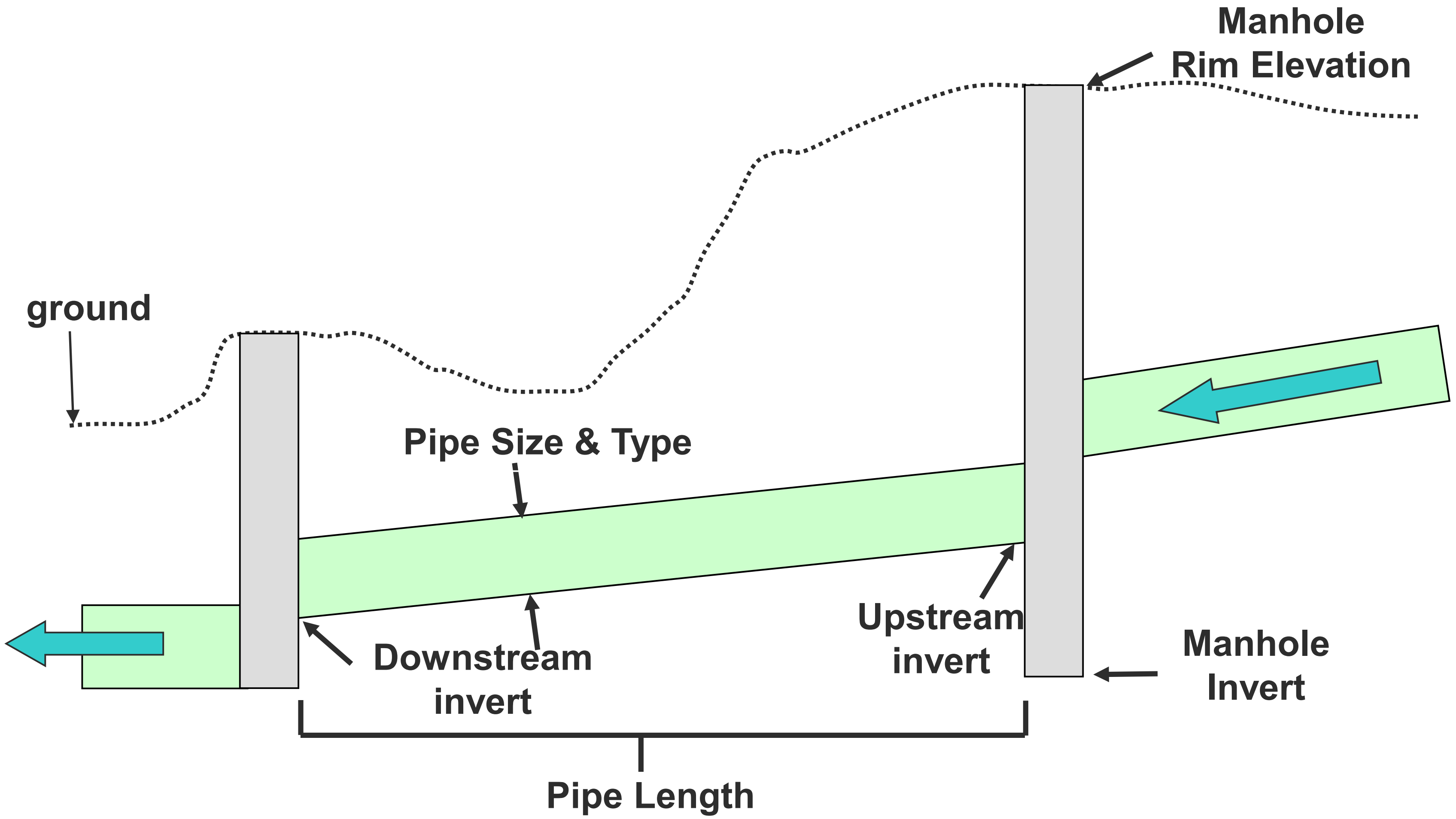
stormwater basics: hydraulic parameters

- Stormwater simulation model has advanced routing capabilities:
  - Detention (storage) in ponding areas
  - Backflow in pipes
  - Surcharging of manholes
  - Tailwater conditions that affect upstream storage or pipe flows

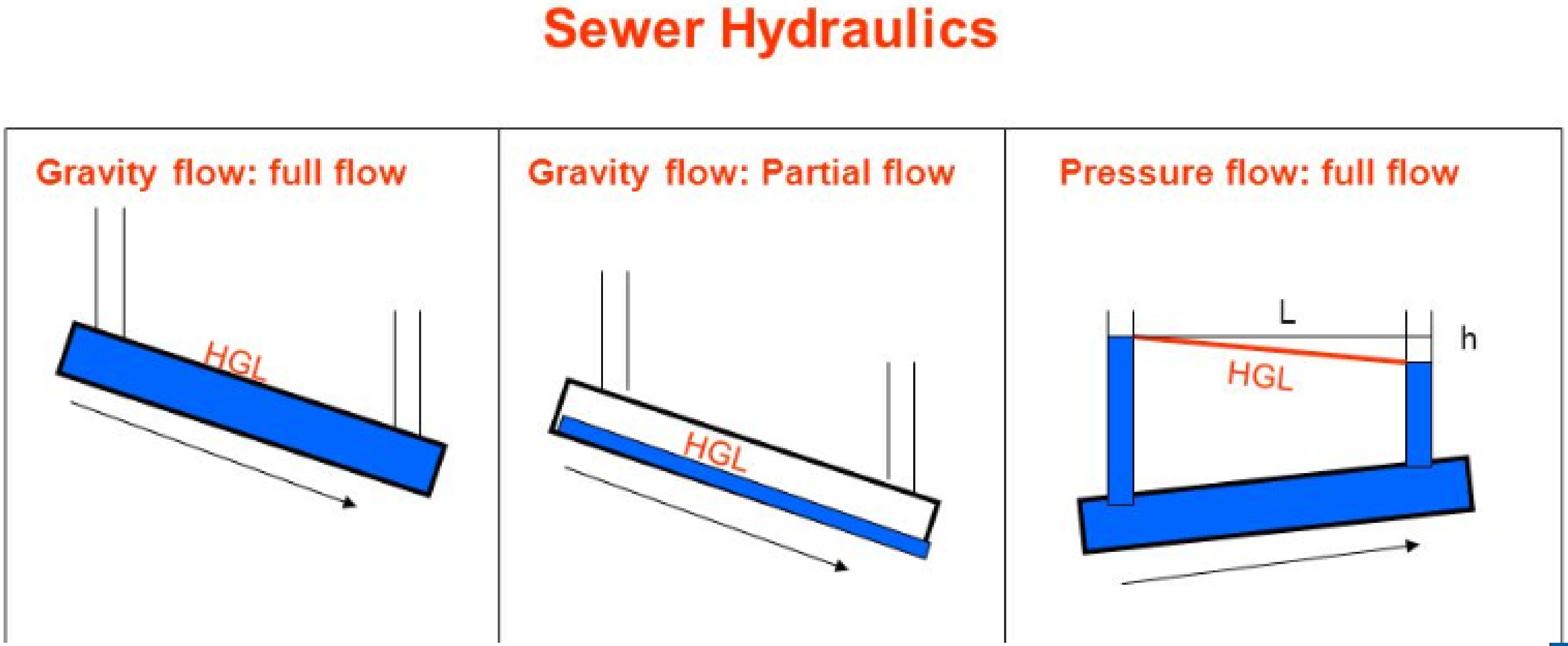


stormwater basics: hydraulics

- Storm sewer network schematic



stormwater basics: hydraulics



Why does imperviousness matter?

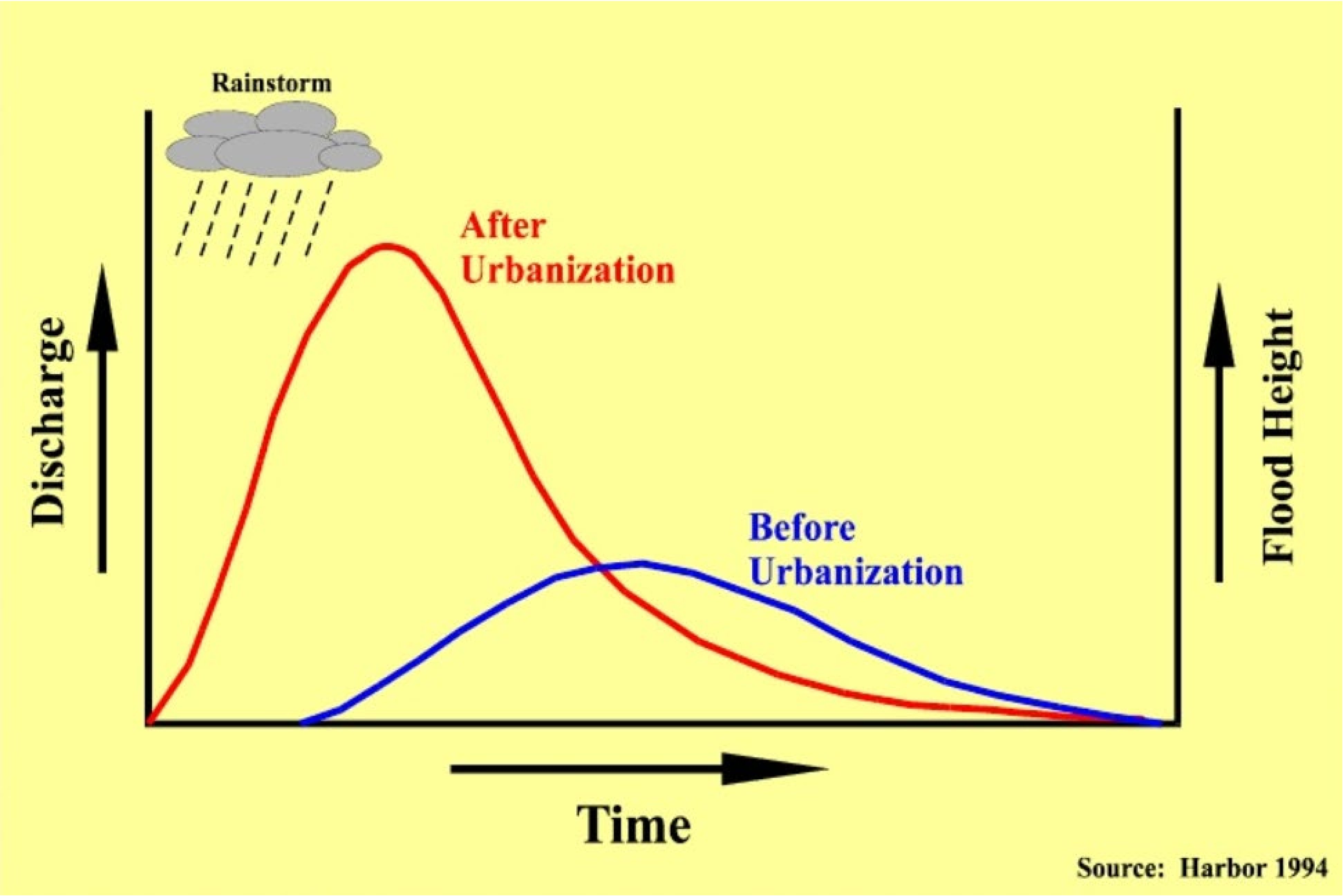
- Hard surface areas prevent infiltration of stormwater

  -Rooftops
  -Parking Lots
  -Streets
  -Driveways
  -Sidewalks

- Less infiltration = More Runoff

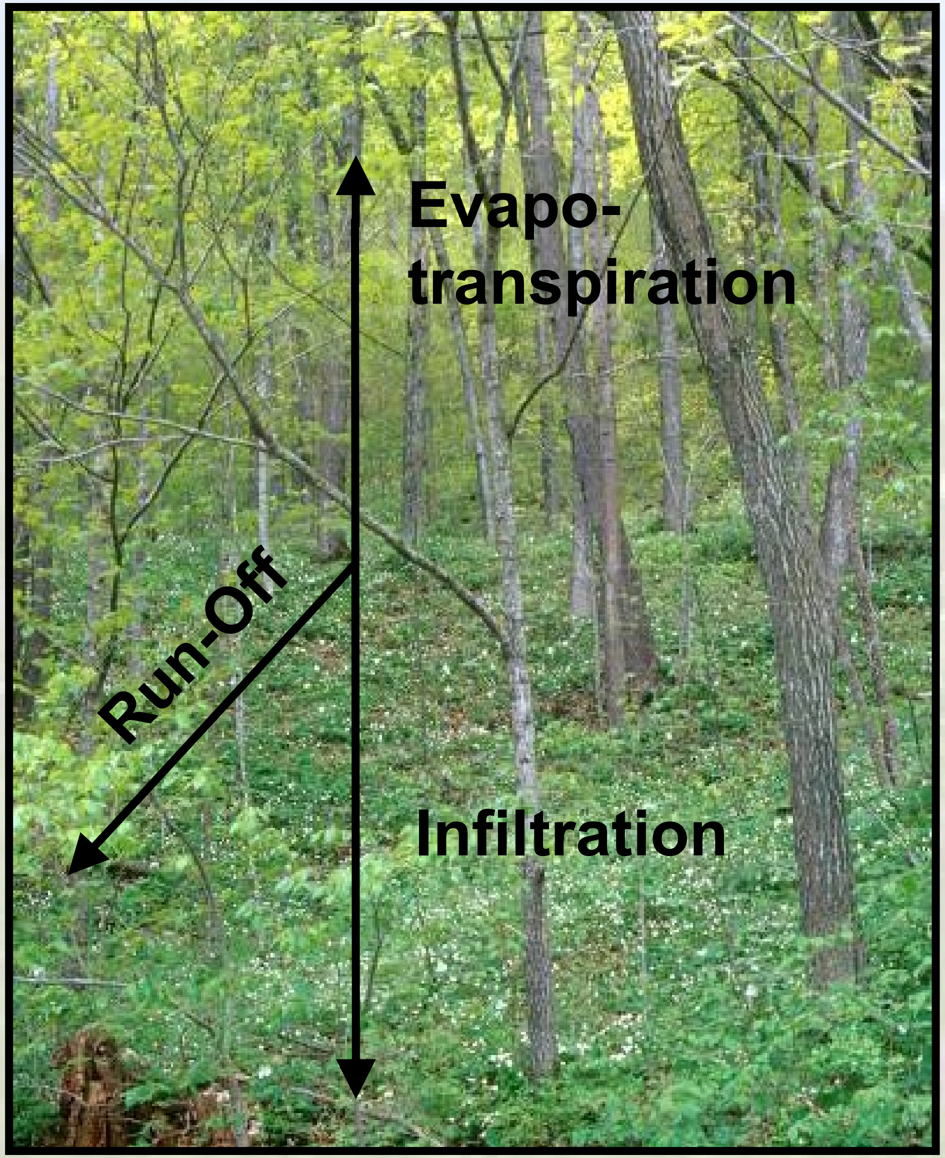
  = More Pollutants

Effects of Urbanization on Flow



land use affects stormwater runoff

- native conditions (undisturbed)
- little runoff ~10%



land use affects stormwater runoff

- natural hydrology
- little runoff ~10%

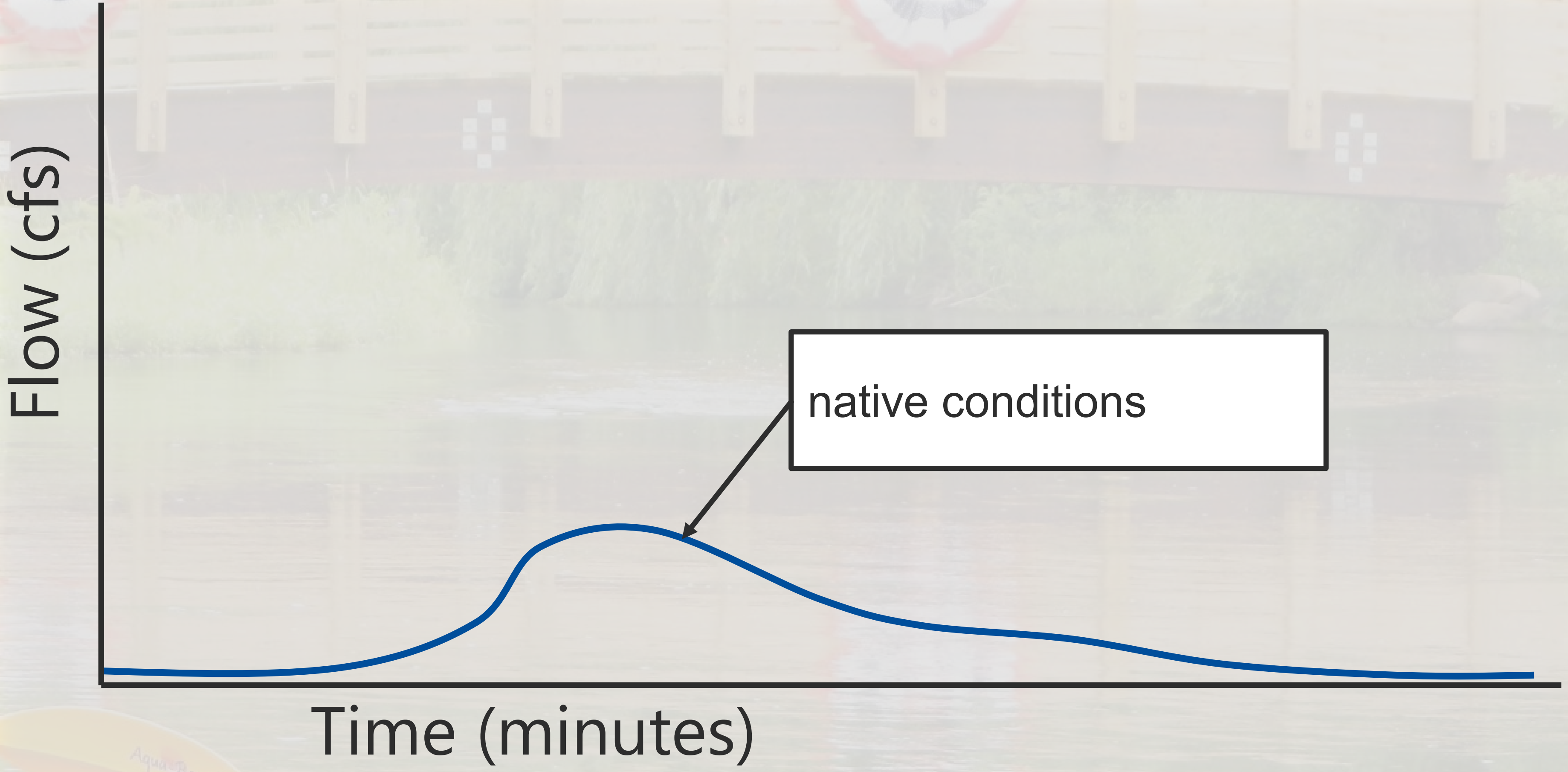
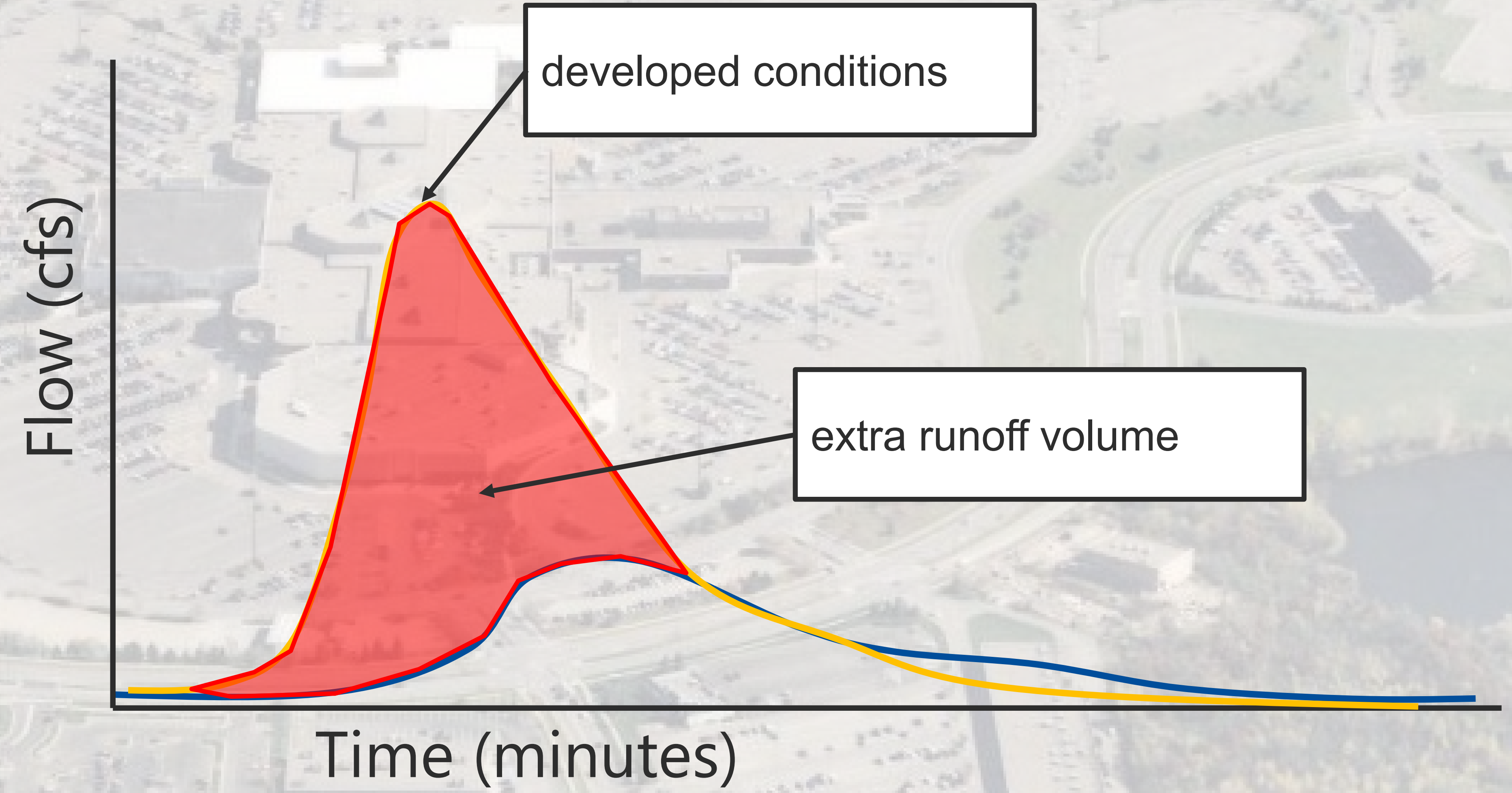


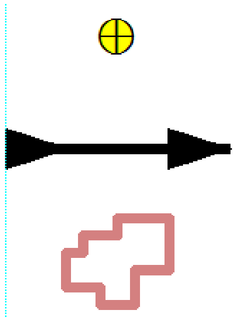
Photo: Minnetonka Mills

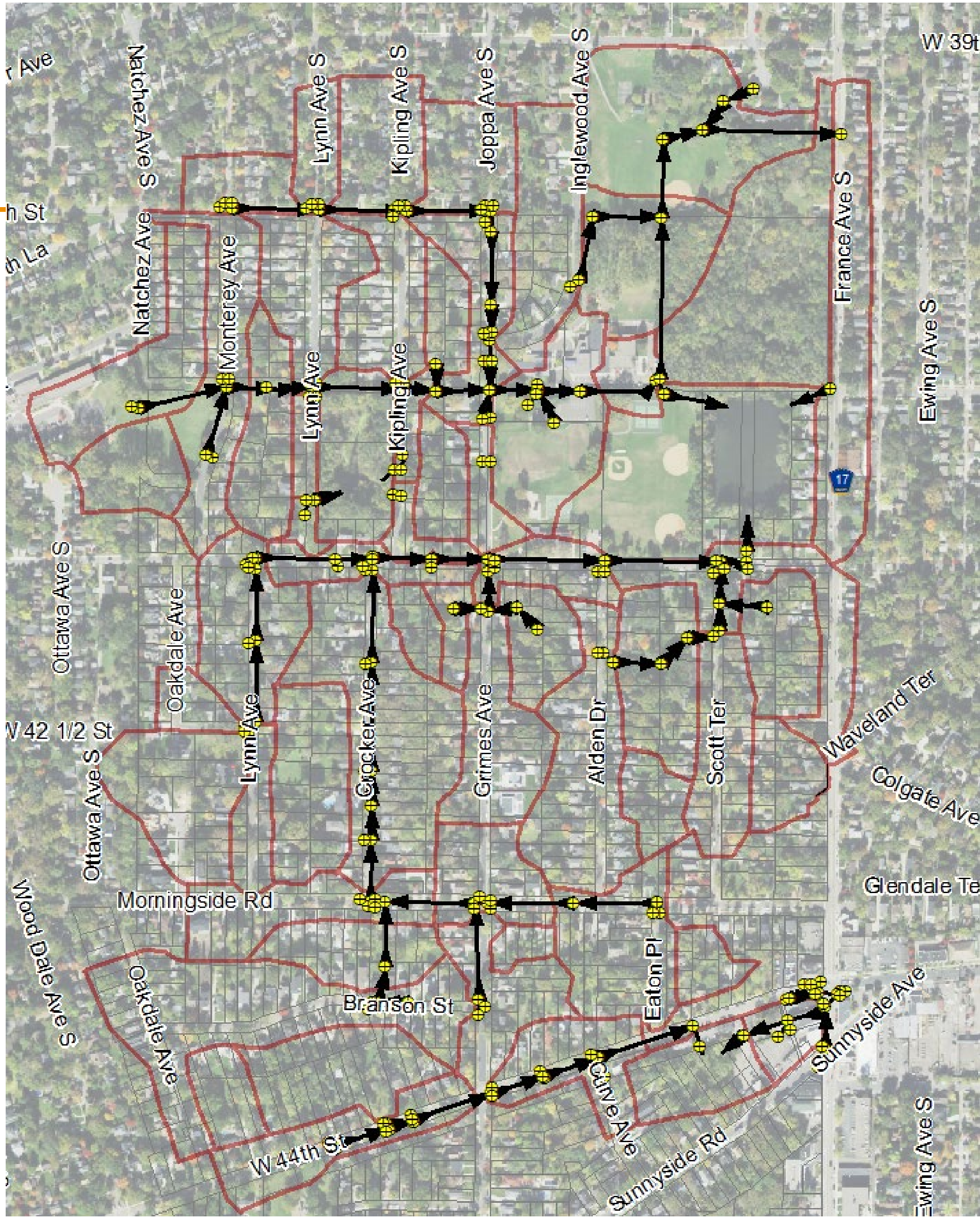
land use affects stormwater runoff

- impervious surfaces
- more runoff >50%

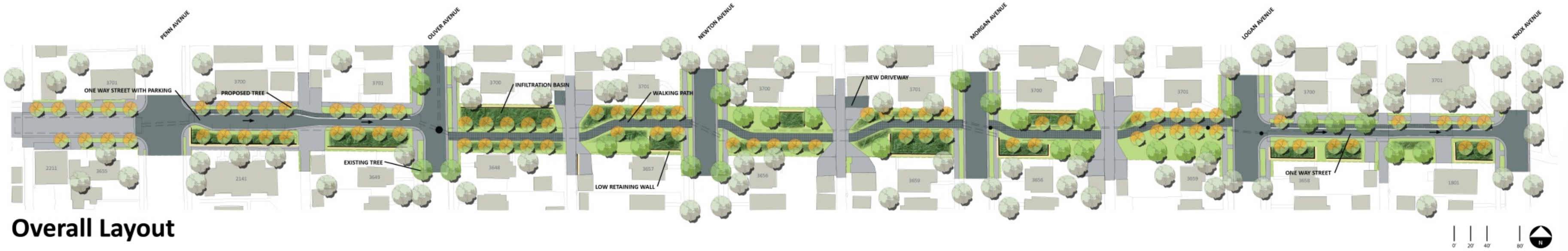


Morningside Neighborhood

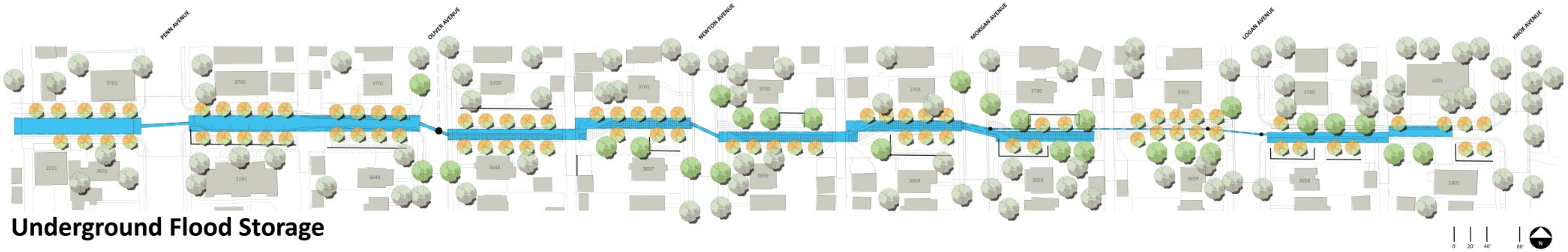




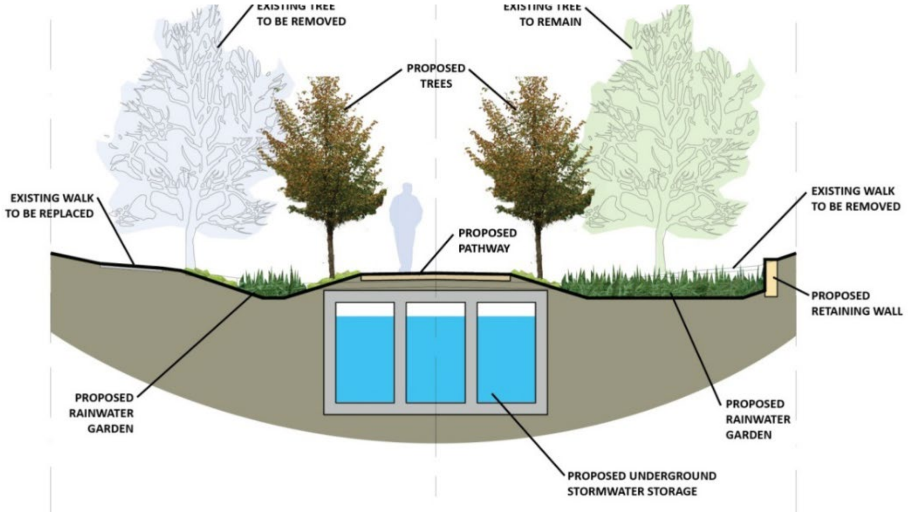
What does underground storage look like?



Overall Layout



Underground Flood Storage



37th Avenue Greenway, Minneapolis, MN

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37th Avenue Greenway, Minneapolis, MN

What does large-scale underground storage look like?

Towerside District Stormwater System (Minneapolis)
https://www.mwmo.org/projects/towerside-district-stormwater-system/

What does large-scale underground storage look like?

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What does large-scale underground storage look like?

Towerside District Stormwater System (Minneapolis)
https://www.mwmo.org/projects/towerside-district-stormwater-system/

Flood walls

Grand Forks, ND

Fargo, ND

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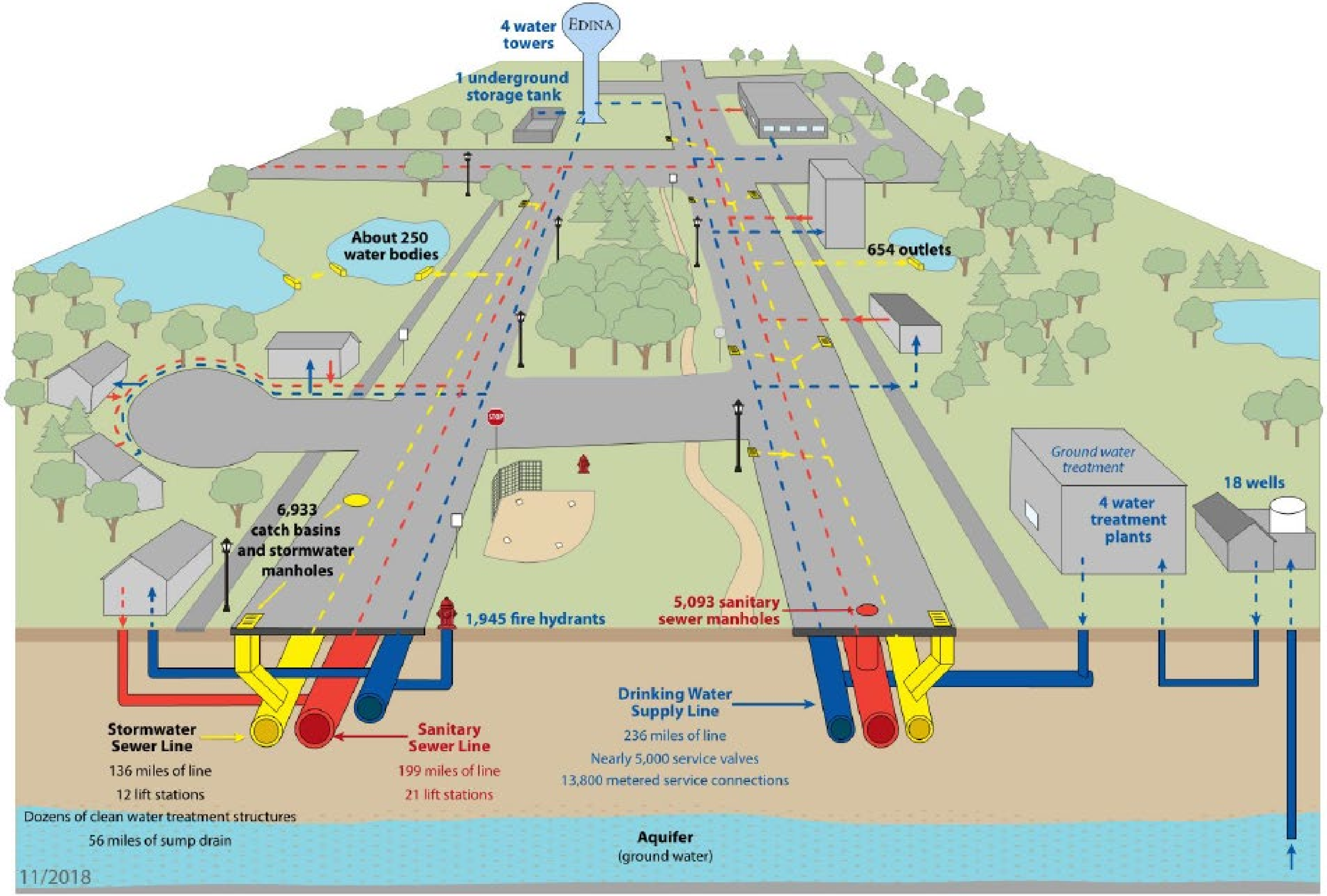
UTILITY INFRASTRUCTURE



mimicking native hydrology through **volume control**

- infiltration most common approach
  - infiltration basins / rain gardens
  - underground infiltration
  - tree trenches
- other volume control methods
  - pervious pavements
  - green roofs
  - stormwater reuse (irrigation, toilet-flushing, industrial)
  - tree interception
- part of climate change resiliency

Green Line Green Infrastructure, Saint Paul

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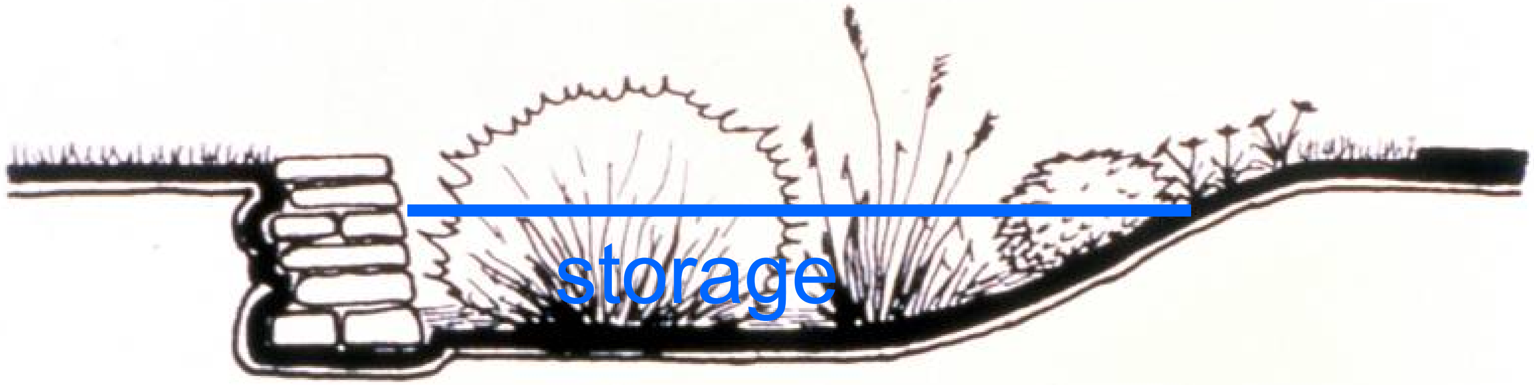
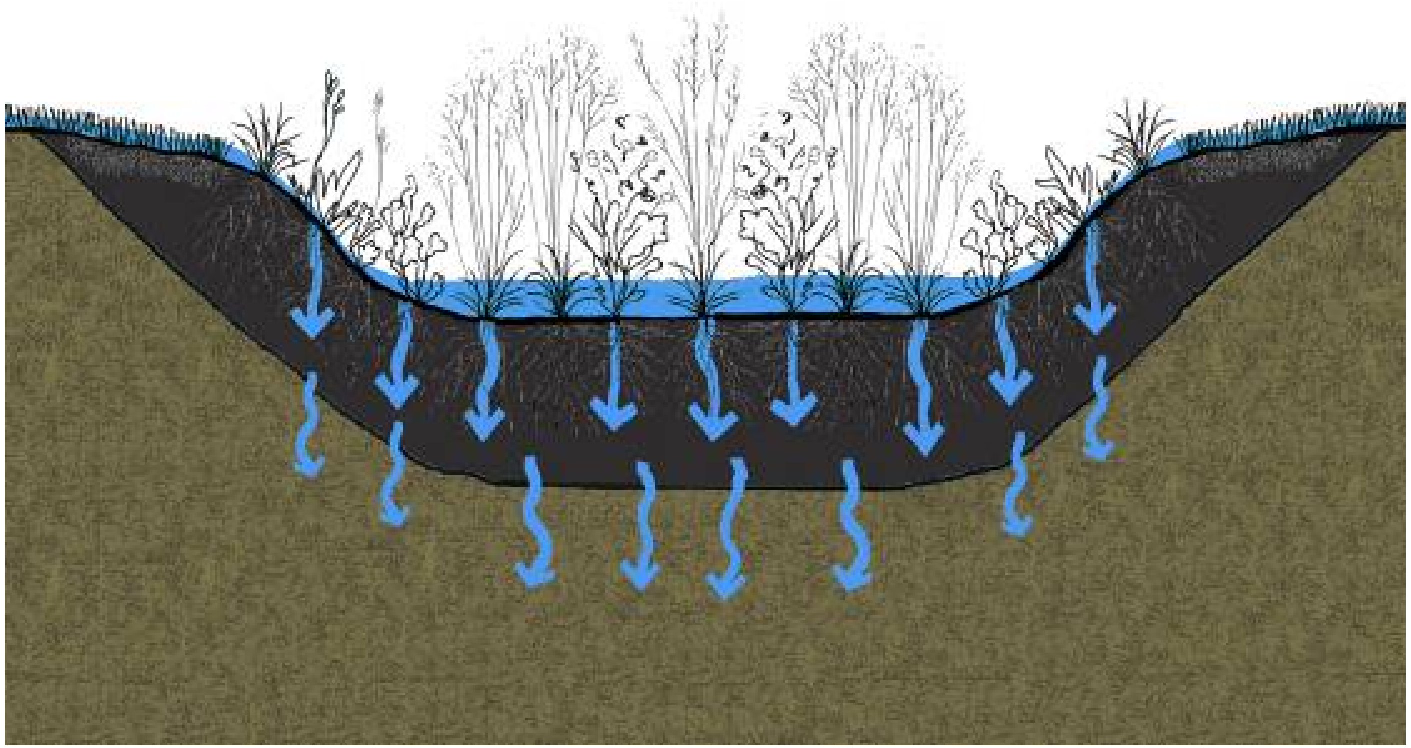
Before and After


storage

Green Infrastructure- a new era of stormwater management

- Using stormwater management techniques that mimic nature by infiltrating and/or storing rainfall runoff where it lands



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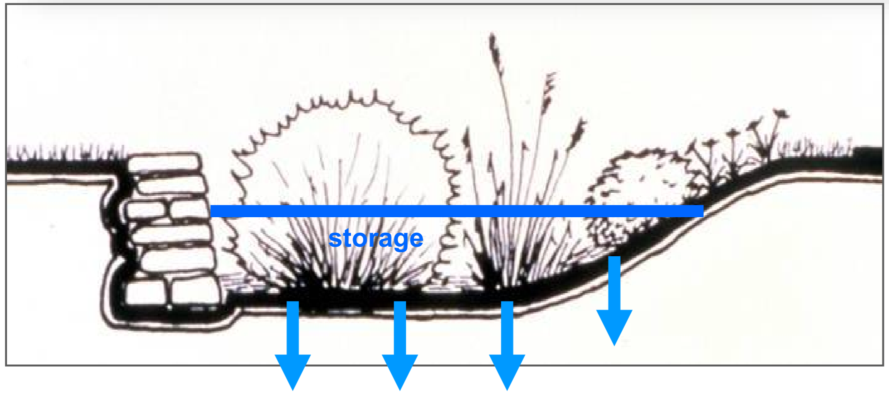
storage

University of Minnesota Duluth

City of Minnetonka Civic Center

Benefits of City Stormwater Models

- Models provide runoff information on an individual subwatershed scale
  - Detailed nature allows models to be used to evaluate the effects of small or large scale changes within the city

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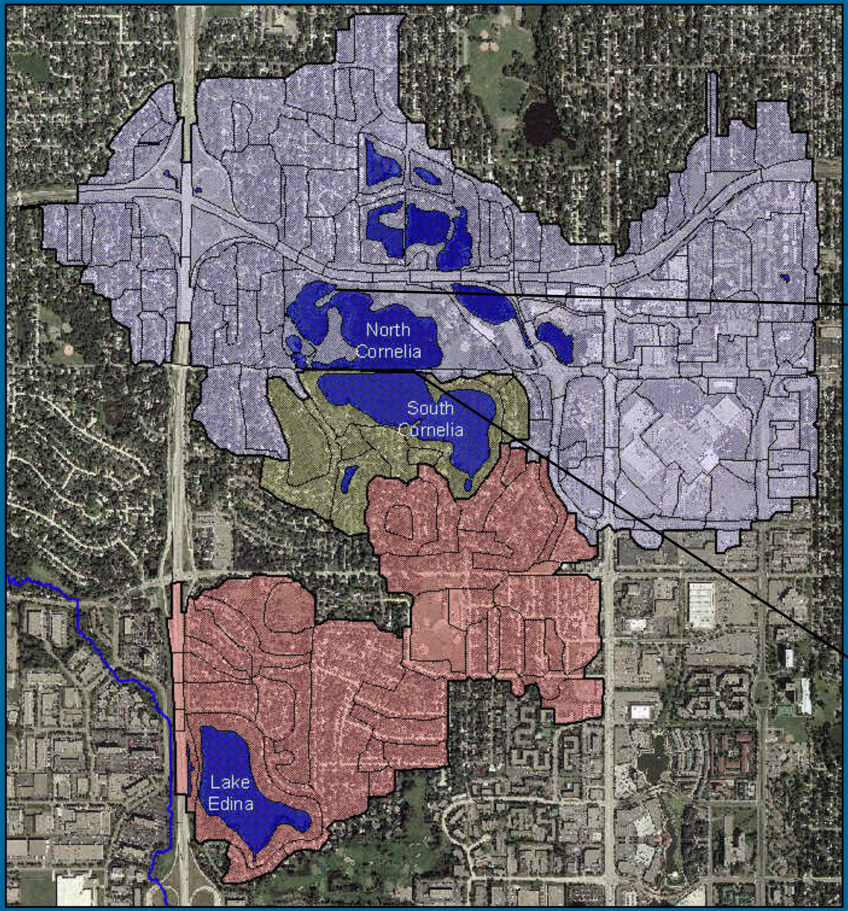
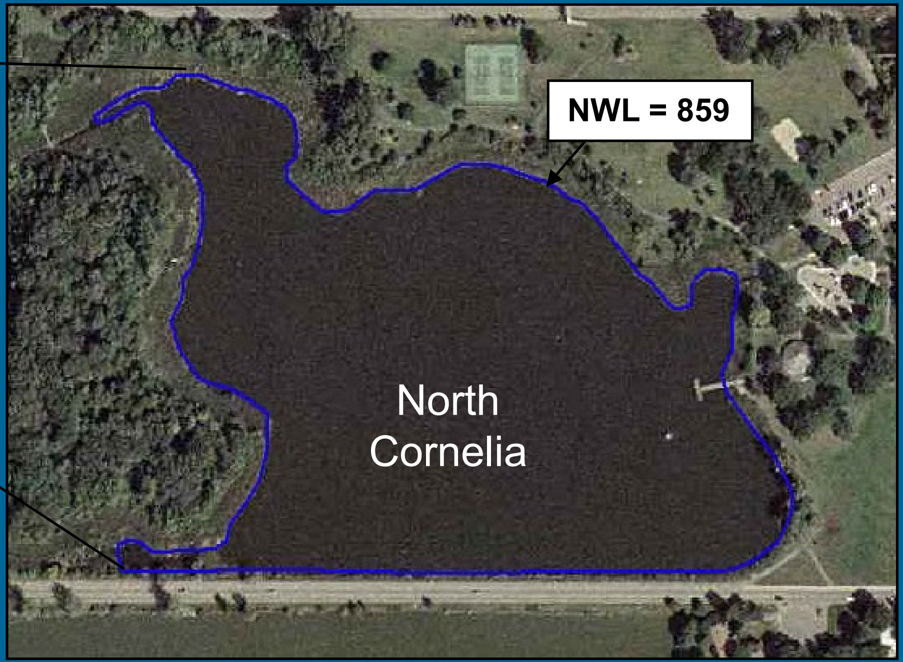
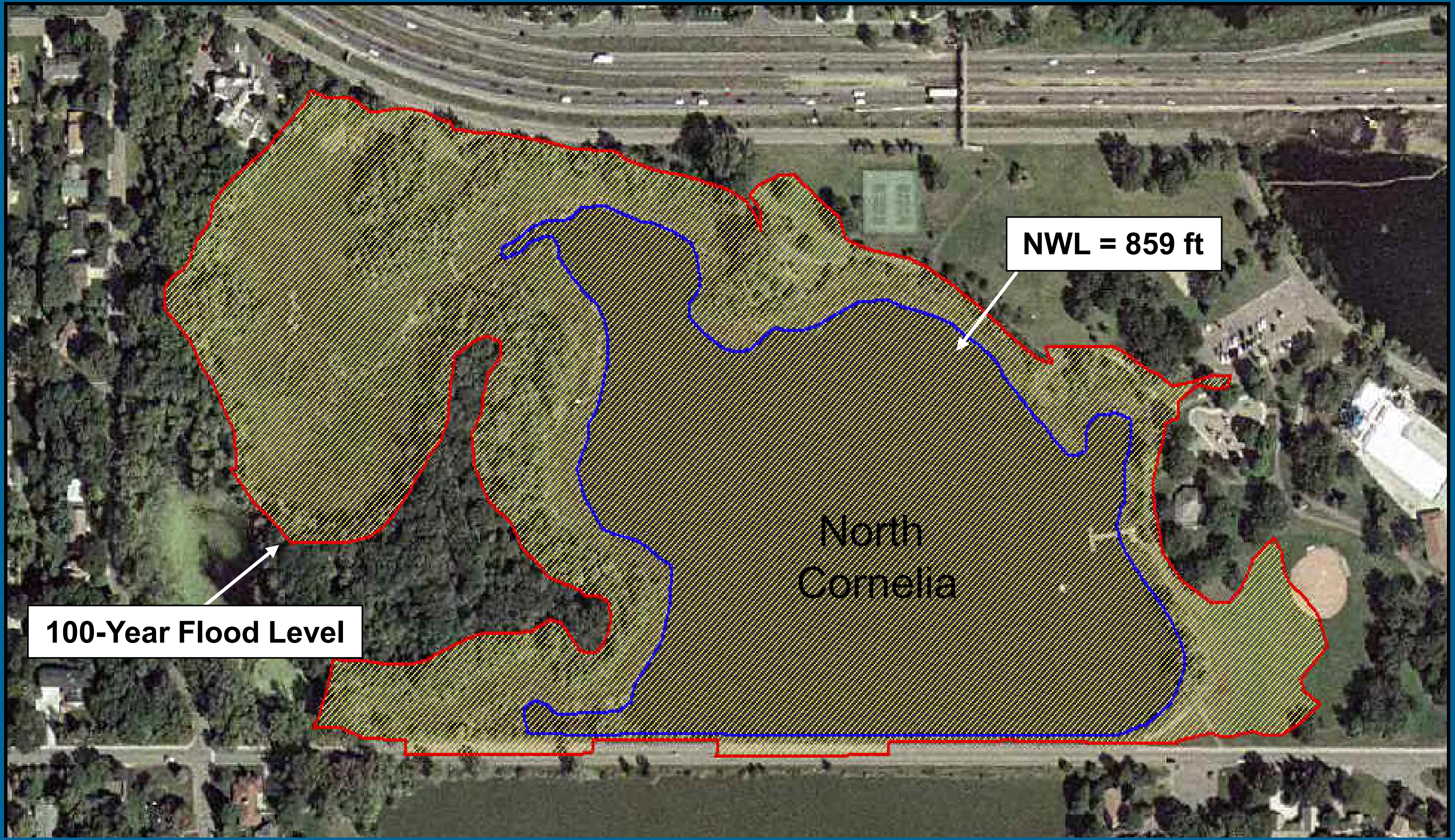
Benefits of City Stormwater Models

- Models provide flood levels for interior water bodies





Benefits of City Stormwater Models



City models provide flood levels for interior lakes and ponds

Benefits of City Stormwater Models

- Models identify areas with flooding issues
  - Identify areas where streets may be flooded
  - Identify areas where homes may be inundated

Benefits of City Stormwater Models

- Models provide detailed routing of stormwater to the creek
  - Timing issues critical when modeling inflows to the Creek
  - Discuss example of different peak timing

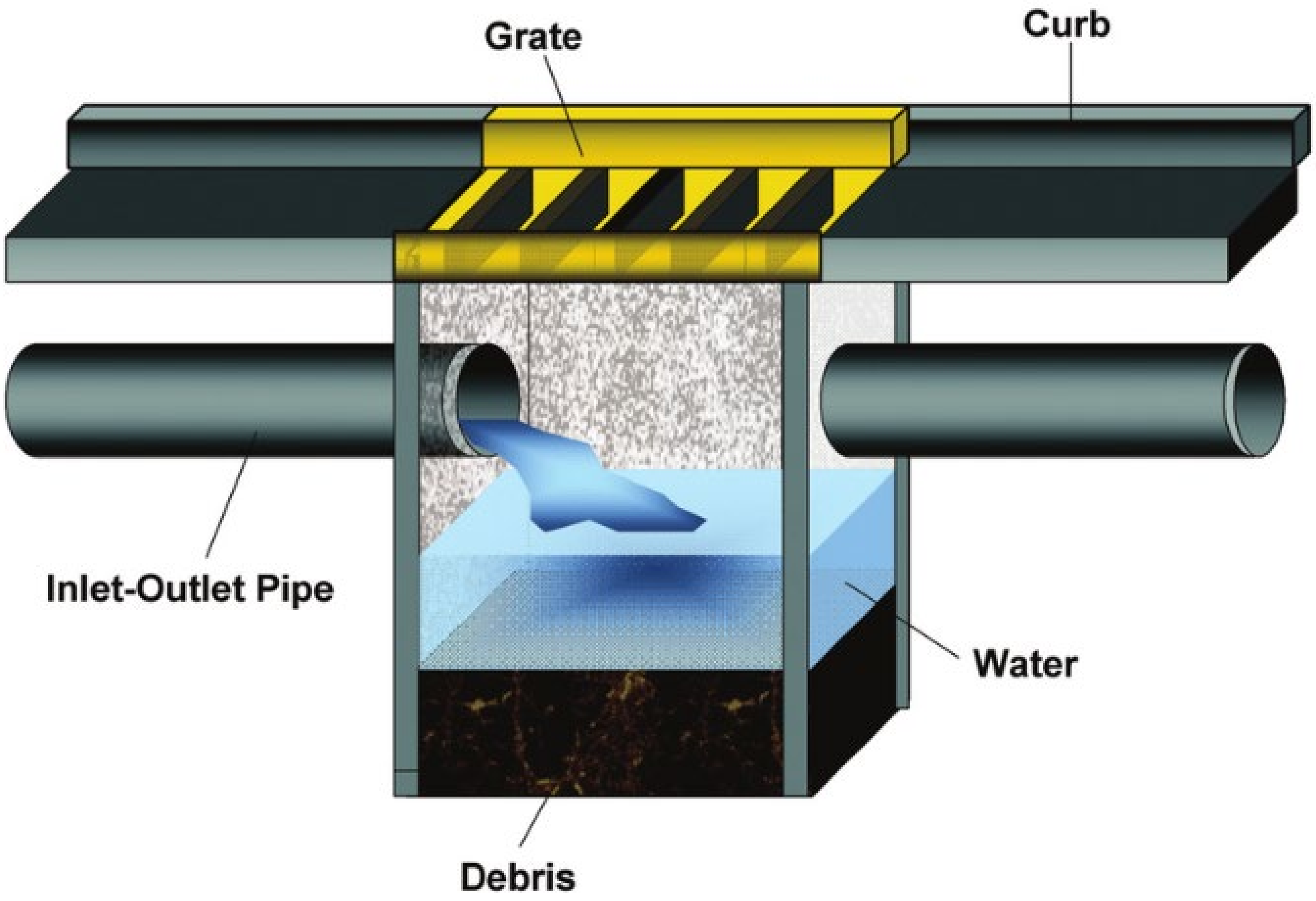
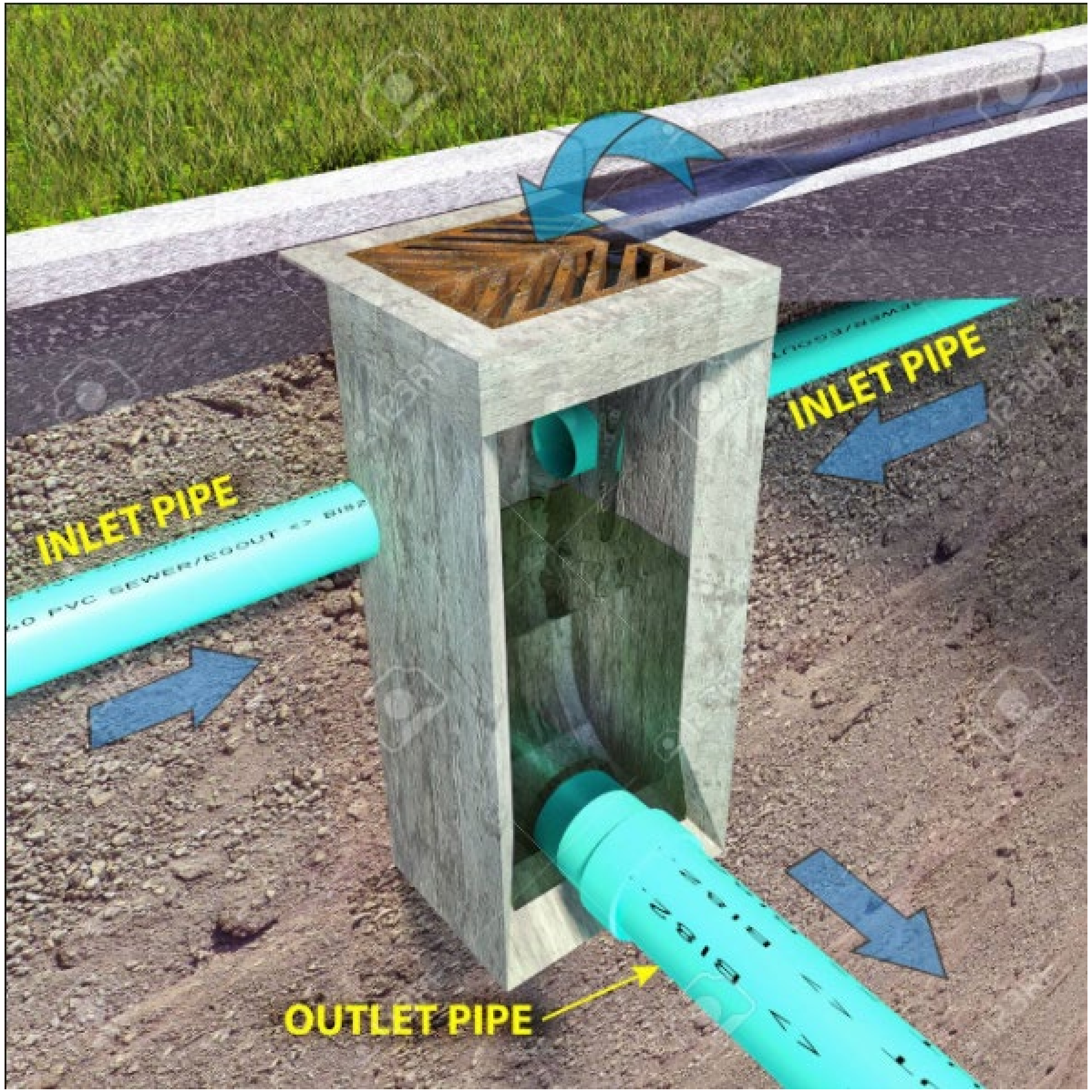
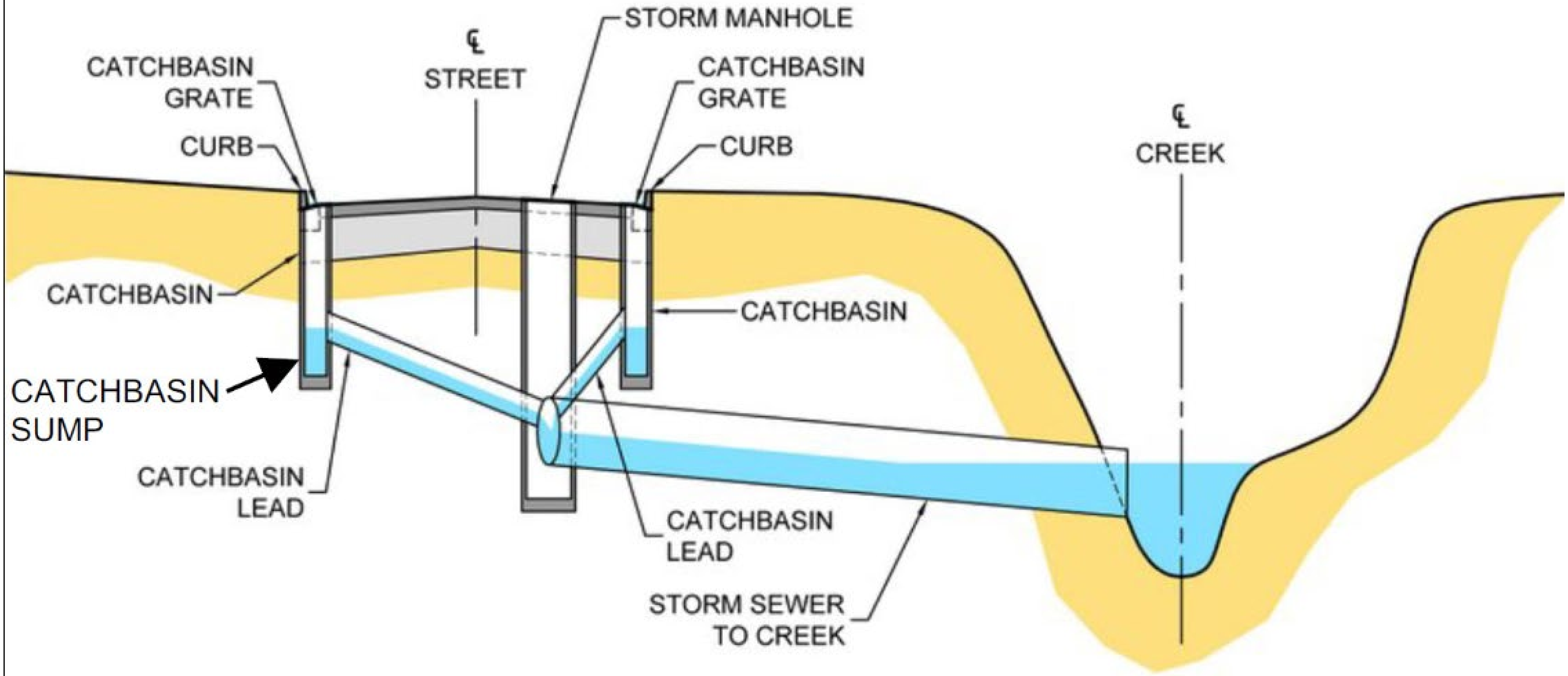


Illustration of a storm water catch basin. Storm water carrying debris and organic material flows from above-ground into the grate. Debris settles and excess water is carried out. Water below the inlet/outlet pipe remains in the catch basin. Catch basins often retain water even during dry periods.


INLET PIPE
INLET PIPE
OUTLET PIPE



https://www.chijournal.org/C435

http://www.edcsc.org/wp-content/uploads/2017/01/ECS_Stormwater-House-Illustration.jpg

Percent Imperviousness (2011 U of M Dataset)

Percent Imperviousness

High : 100

Low : 0

Edina Neighborhoods

Note: Raster grid cells with 0% imperviousness are transparent and the background imagery is visible.