Stormwater Basin Retrofitting
March 2013
Definition of retrofitting

• The act of installing, fitting, or adapting for use with something older.
Benefits of Stormwater Detention

- Reduces peak flows downstream of developments
Benefits of Stormwater Detention

- Creates open space
  - Recreation opportunity
  - Wildlife habitat
Benefits of Stormwater Detention

- **Water quality**
  - Promotes sedimentation
  - Groundwater infiltration
  - Vegetation absorption of nutrients
  - Filtration of oil, grease and other pollutants from urban runoff
Reasons for Retrofitting
Reasons for Retrofitting

- Flooding
  - Structure flooding
  - Roadway impassible
  - Reduces emergency service weather delays

- Tributary Changes
  - Urbanization
  - Diversions
  - Other stormwater basins

- Old Basin Design
  - Outdated engineering practices
  - Basin overtopping
  - Steep Slopes without safety shelf
Reasons for Retrofitting

• Scour
  – Wall scour
  – Outlet scour
  – Shoreline erosion

• Improve Water Quality / MS4 Permit
  – Retention
  – Wet bottom detention
  – Riparian vegetation

• Maintenance Issues
  – Overgrown
  – Difficult to access
  – Sediment deposit
  – Trash
Reasons for Retrofitting:
Flooding
Flooding

Problems you are likely seeing:

• Flooding homes and streets in developed areas
• Resident complains
• Emergency Vehicles are not able to pass flooding
Flooding

Why should the problem be corrected:

- Ensure resident safety
- Reduce Municipal liability
- Reduce Public Works time and cost
Flooding

Solutions:

• Increase conveyance to stormwater basin
  – Increase size of storm sewer
  – Overland flood routing

• Increase the volume of the stormwater basin
  – Adjacent On-site ($50,000/ac-ft)
  – Lower Invert On-site ($65,000/ac-ft)
  – Upstream ($75,000/ac-ft)
  – Underground ($250,000/ac-ft)
**Flooding**

**Solutions:**

- **Multi-stage outlets**
  - Two (2) or more outlet pipes to control the flow of stormwater
  - Establish Goals
    1. Reduce flood overflows from undersized basins
    2. Increase effectiveness of basin for more frequent storm events (10-year)
Flooding

Solutions:

- **Multi-stage Outlets – Reduce Flood Overflows**
  - Excellent for basins that open channel outlets
    - Maintain low-flow outlet
    - Additional conduits
    - Improve outlet as needed
    - Eliminate overflow

- **Existing 40 acre development**
  - 12” pipe outlet, Overflow weir
  - Max Outflow 10-year = 4.8 cfs
  - Max Outflow 100-year = 24.8 cfs

- **Proposed Multi-stage retrofit**
  - 12” pipe outlet, Overflow weir
  - 15” pipe outlet (new)
  - Max Outflow 10-year = 11.6 cfs (>100% increase)
  - Max Outflow 100-year = 17.4 cfs (30% decrease)
Flooding

Solutions:

- **Multi-stage Outlets – Effectiveness for Frequent Storms**
  - Excellent for basins that utilize sensitive downstream sewers
    - Reduce low-flow outlet size
    - Additional conduits
    - Maximize Storage
  - **Existing 40 acre development**
    - 12” pipe outlet, Overflow weir
    - Max Outflow 10-year = 4.9 cfs
    - Max Outflow 100-year = 6.5 cfs
  - **Proposed Multi-stage retrofit**
    - 8” pipe outlet (new), Overflow weir
    - 12” pipe outlet (new)
    - Max Outflow 10-year = 1.9 cfs (61% decrease)
    - Max Outflow 100-year = 7.1 cfs (10% increase)
Flooding

Solutions:

• Multi-stage outlets considerations
  – What kind of flooding is occurring downstream?
  – Should the multi-stage outlet system concentrate on 100-year flood event or more frequent storms (10-year)
  – How is the drainage system downstream functioning?
    • Limited downstream sewer system
    • Open channel / stream
Reasons for Retrofitting:

Tributary Changes
**Tributary Changes**

Problems you are likely seeing:

- Stormwater no longer fills the stormwater basin during major flooding event
- Dry bottom stormwater basins stay wet most of the year
Tributary Changes

2002

2010
Tributary Changes

Inflow from 350 acres tributary area

- **Existing Conditions (100yr,24hr)**
  - 310 acres of natural area
  - 40 acres of urban area with inline storage
  - Peak 230 cfs
  - Runoff Volume = 140 ac-ft
  - Flow ends at 25 hours

- **Urbanized Conditions**
  - 175 acres of natural area
  - 40 acres of urban area with inline storage
  - Newly created 135 acres of urbanized area with stormwater detention
  - Peak 135 cfs
  - Runoff Volume = 160 ac-ft
  - Flow ends at > 5 days
Tributary Changes

**Basin Function**

- **Existing Conditions**
  - Max Storage = 26 ac-ft

- **Urbanized Conditions**
  - Max Storage = 18 ac-ft
  - Storage Reduces = 8 ac-ft
**Tributary Changes**

Why should the problem be corrected:

- Reduce flooding in problematic areas downstream
- Maintain stormwater basins for athletic fields
- Increased pollutant loads from urbanized areas
Solutions:

• Modify stormwater basin outlet
  – Reduce outlet pipe
  – Increase storage volume
  – Increase benefits for major storm events

• Infiltration
  – Install underdrain system
  – Reduce nuisance flows
  – Reinstall dry athletic fields
Tributary Changes

Solutions:

• Two level basin
  – Wet Area
    • Naturalized area with native plants to help in infiltration and evapotranspiration
  – Dry Area
    • Athletic fields
Reasons for Retrofitting:

Old Basin Design
Old Basin Design

Problems you are likely seeing:

- Basin design includes steep slopes and no safety shelf
- Stormwater is overtopping the basin
- Lack of overland flood route
- Stormwater standing in neighborhood
Reason for the problem:

- **Change in engineering rainfall data**
  - Technical Paper 40 (1961) – 100-year event = 5.8” precipitation
  - Bulletin 70 (1989) – 100-year event = 7.58” precipitation
  - 30% increase in precipitation

- **Change in storm distributions**
  - SCS Method, Type II – conservative results
  - Huff Distribution – represent the typical rainfall distribution
Old Basin Design

Reason for the problem:

- **Available Data**
  - Contour Maps
    - OLD – USGS Quadrangle Map / Hydrologic Atlases
    - NEW – 2’ GIS Contours
  - Aerial Photography
Old Basin Design

Reason for the problem:

- **County / Municipal Ordinances**
  - DuPage County
    - Original Ordinance – 1991
    - Latest Update – 2012
  - Kane County
    - Original Ordinance – 1998
    - Latest Update – 2009
  - Lake County
    - Original Ordinance – 1992
    - Latest Update – 2012
  - McHenry County
    - Original Ordinance – 2004
    - Latest Update – 2011
  - Will County
    - Original Ordinance – 1998
    - Latest Update – 2010
  - Cook County
    - Full implementation coming soon
Old Basin Design

Reason for the problem:

• Other revelations
  – Overland flow routes are necessary for all developments
Old Basin Design

Why should the problem be corrected:

- Overtopping leading to flooding downstream
- Flooding upstream of the basin due to undersized storm sewers
- Overland flood routes area undersized and depressional areas are flooding
- Include safety measures
Old Basin Design

Solutions:

- Increase the volume of the basin
  - Added volume upstream, on-site, or underground to new engineering standards
- Multi-stage outlet
  - Improve the performance with additional control
- Increase conveyance to stormwater basin
  - Upsize the storm sewer and inlet structures
Reasons for Retrofitting:

Scour and Erosion
Scour and Erosion

Problems you are likely seeing:

• Erosion along the side of basin
• Scour at the inflow pipes
**Scour and Erosion**

Why should the problem be corrected:

- Sedimentation from erosion and scour can limit the conveyance of downstream sewer and culverts
- Infrastructure replacement due to scour
- Breach if an above-ground impoundment
Scour and Erosion

Solutions:

• Inflow protection
  – Rock rip-rap at the basin inlet
  – Plunge pool
Scour and Erosion

Solutions:

• Erosion protection
  – Collect the stormwater along the ridge of the basin and drop into basin with catch basin and sewers
  – Use deep rooted native plants to stabilize side and shoreline of basin
Reasons for Retrofitting:

Water Quality
Water Quality

Problems you are likely seeing:

- Stormwater is cloudy
- Odor
- Oil Sheen
Water Quality

Why should the problem be corrected:

• NPDES / MS4 Regulations
• Protection of State / County / Municipal natural areas
• Protection of wildlife
Water Quality

Solutions:

• Sedimentation Areas
  – Located near inflow to basin
  – Use rock check damn to promote sedimentation
  – Maintain as needed

• Increase detention time
  – Use stormwater “run around” to maximize travel distance
  – Use perforated riser
Water Quality

Solutions:

• Naturalize Basin
  – Install wetland, emergent and prairie plants to help remove pollutants
Reasons for Retrofitting:

Difficult to Maintain
Difficult to Maintain

Problems you are likely seeing:

• Cannot access stormwater basin
• Dense invasive species
• Trash
• Cannot locate points of inflow and outflow from basin
Difficult to Maintain

Why should the problem be corrected:

- No easement to access basin
- Stormwater does not move through the basin effectively
- Significant head needed to create flow
- Unable to check or maintain control structures
- Vegetation can plug outlet structures and overtopping can occur.
- Unsightly
Difficult to Maintain

Solutions:

• Obtain easements
  – Actively look for opportunities to obtain easement from property owners

• Natural area maintenance
  – Prescribed burn
  – Overseeding and plugs of low-profile vegetation
  – Maintenance plan and schedule
Questions and Contact Information

Randy Newkirk– Drainage and Environmental Engineer
Office: 847.697.6700
Cell phone: 630.803.7508
Email: rnewkirk@hlreng.com
Website: www.hlrengineering.com