Stormwater Management and Floods

Rapid City, South Dakota
Introduction

• History of Stormwater Management and Floods
• Meade Hawthorne Drainage Basin Discussion
• Sperlich Engineering Presentation
• Drainage Project Funding Source
• Protect Your Property, Flood Insurance
Early developers transformed range and forest lands to housing sites and streets with little consideration for the increased potential for flooding.

Rapid City founded 1876
Houses built next to beautiful spring fed streams and Rapid Creek for esthetics
Streets built across dry gullies with inadequate drainage facilities – “haven’t seen it flow in 10 years”
Early development on downstream end of basins and later development upstream
There were over 80 Flood Events on Rapid Creek and its tributaries

June 1909 Flood in Rapid City
Worst flood prior to 1972

- Canyon Lake washed out and remained dry until 1932
- Rapid Creek 13,000 cfs
- 4 deaths
- $100,000 damage
May 23, 1952 Flood

Rapid Creek in Rapid City – Flow 2,500 cfs

Bridge in center of photograph is Evergreen Drive
July 13, 1962 Flood

- 2-5 inches of rain fell west of Rapid City
- 6 bridges washed out over Rapid Creek
- 1200 – 1500 people temporarily displaced
- Damage $1.9 million

Pierre Street

Cleghorn Canyon
June 9, 1972 Flood

- 238 deaths
- 3,000 people injured
- 1,335 homes destroyed
- 2,820 homes damaged
- 200 businesses ruined
- 5,000 automobiles demolished
- Damage of $160 million in 1972 dollars

Chapel Lane Bridge
Since 1972 ....

- **6-8-1975** 2.5” rain in 30 min damage houses, cars and parks
- **6-23-1981** 0.71” in 15 min street flooding, youth swept into culvert (minor injuries)
- **8-6-1993** heavy rain, road flooding
- **5-24-1997** 4-5” rain, minor flooding
- **6-2-1997** 4.5” rain in 30 min in Chapel Valley, 6-10 ft water in Cleghorn Canyon and Red Rock Canyon, Highest flows in Rapid Creek since 1972
- **7-15-2001** Downtown Rapid City flooding moved vehicles
- **7-3-2004** 1-2” in 1 hour, Meade Street flooding
- **5-2008** 3-5” rain caused washed out roads, culverts and flooded yards
- **6-4-2008** 1-4” rain and 4” hail in 30 min, north RC flooding of streets and homes
- **5-24-2009** 2-3” rain, flooding RC at fairgrounds
- **6-24-2011** Heavy rain and Hail, street flooding
- **5-30-2013** 6” rain in few hours, flooding Sheridan Lake Rd and Fifth Street area

Most Recently May 18, 2018 Flood in the Robbinsdale Neighborhood
Recognizing the need to manage stormwater

Drainage Basin Design Plans (DBDPs) have been developed to address where and how much stormwater flows in Rapid City?

Many of the DBDP were prepared in the 1980’s and updates are needed prior to construction of major drainage projects.
Twenty-One Drainage Basins affecting Urbanization in Rapid City

Arrowhead
County Heights
Downtown Area
Haines Avenue
Hawthorne Morningside
Perrine
Red Dale
South Canyon/Lime Creek
Unnamed Tributary Wonderland Drive

Box Elder
Deadwood Avenue
East Hwy79/Landfill
Jackson Boulevard Knollwood Meade
Old Lime Creek
Race Track
Red Rock
South Robbinsdale South Truck Route

All basins are tributaries to Rapid Creek, with exception of the Box Elder Basin which is a tributary to Boxelder Creek
Location of Drainage Basins
Meade Hawthorne Drainage Basin

North to Signal Hill
South to Texas Street
West to Skyline Drive
East to Rapid Creek
Flooding 1974

Ditch behind 233 E Flormann St
Flooding 1975
photos from Joann Wilkins, 233 E Flormann St

234 East Flormann St.

East Flormann St. looking towards “dirt” channel
1979
Concrete Channel Construction
Flooding 1985
E St Anne Street south in concrete channel

1988 Berm constructed to prevent overflow of concrete channel onto E Flormann St properties and Michigan St ROW graded to allow overflow to flow towards E Meade St
2001 - 2002
Hawthorne Street Reconstruction
8’ x 4’ Box Culvert and 72” Arch Storm Sewer
Design and Construction 2003-2009

PHASE 1 MEADE STREET RECONSTRUCTION
E. MEADE STREET FROM BIRCH AVE. TO HOEFER CT.

ELM AVENUE/MEADE STREET RECONSTRUCTION
CITY OF RAPID CITY PROJECT NO. DR03-1333

CIPM 00235
PROJECT LOCATION

FINAL REPORT
FOR
ELM AVENUE PHASE
AND
MEADE STREET PHASE FROM
ELM AVENUE TO HOEFER COURT

August 9, 2004

PREPARED FOR:
CITY OF RAPID CITY
RAPID CITY, SOUTH DAKOTA

PREPARED BY:
FMG INC.
3700 STURGIS ROAD
RAPID CITY, SOUTH DAKOTA
2013 FEMA Revised 100-yr floodplain for Meade Hawthorne DB

- Green outline is old floodplain
- Blue area is 100-yr floodplain
- Yellow area is 500-yr floodplain
Flooding May 18, 2018

Concrete channel between E Flormann and E Meade streets

233 E Flormann Street
2004 Report – Preliminary Storm Sewer Design for Area Upstream of Elm Avenue

- Five Phase Construction for Storm Sewer
  - Each phase must follow simultaneously
  - Total cost in excess of 10 million dollars

- Report prepared prior to 2013 FEMA SFHA revision to Meade Street Channel area
  - Several properties placed in SFHA as a result of the revision

- Alternative designs not evaluated for Floodplain Management
  - Floodplain Channels
    - Natural function of floodprone areas
  - Property mitigation
    - Remove existing development from floodprone areas
  - Detention
    - Provide flood storage, reduce flows downstream
Analysis of FEMA SFHA – Meade Hawthorne Drainage Basin CIP 51190

• Funded for 2019 – Engineering Consultant RFP Fall of 2018
• Evaluate methodology used by FEMA for 2013 remapping
• Flow rates based on updated H&H information
• Establish a Floodway within the SFHA
  • Provides more restrictive regulations
• Evaluate current DBDP and FMG 2004 Preliminary Storm Sewer Design
• Identify drainage projects for maximum flood protection
• Construction costs / cost analysis for recommended improvements
Robbinsdale Park
Drainage Improvements

Sperlich Consulting, Inc.
*Engineering *Surveying *Planning
Background
Background - Before Reconst.
Background - Drainage Area

- Approximately 1 square mile of drainage basin is present upstream of Robbinsdale Park.
- Majority of inflow comes through E. Fairlane Drive.
New Drainage Improvements

- New 10' Wide Sidewalk
- Impact Basins
- Pond 1 Intake Structure
- E. Fairlane
- E. Idaho
- Pond 1
- Pond 2
- 4'x7' Box Culvert
- Playground
- Pond 2 Intake Structure
New Drainage Improvements
Impact Basins

- Greatly reduces water velocity and reduces downstream erosion
- Energy dissipation occurs inside the structure, increasing safety to the public
- Three (3) impact basins are installed but only one (1) is active
  - Additional upstream improvements are needed to put other impact basins online
New Drainage Improvements
Pond 1

- New pond is about 3X the volume of the original pond
- Includes volume for water quality (cleans the water)
- Greatly reduces discharge downstream (Approx. 60% reduction in flows)
New Drainage Improvements
Pond 1 - Intake Structure

Secondary Intake Stage

Primary Intake Stage

3.5-ft Depth Water Quality Control Volume (40-hr Drain Time)

Bottom of Spillway at 3335.00 6-ft Above Structure
May 18th, 2018 - Storm
May 18th, 2018 - Storm Event

During the Storm

- At approximately 6:15 p.m. on Friday May 18th, 2018 rain began to fall in the Rapid City area.
- The significant amount of storm runoff fills the existing 48" diameter storm sewer along E. Fairlane Drive to capacity.
- All additional stormwater flows are directed to the street section.
- Approximately 2-ft of water is present along E. Fairlane Drive.
- The National Weather Service (NWS) has an official rain depth of 1.79 inches. (Almost 1 inch fell in 15 minutes)
- Unofficially, rain intensity appeared much higher in a portion of the Hawthorne Drainage Basin (approximately 4.5 inches from residential rain gauges).
May 18th, 2018 - Storm Event
Pond 1

Morning of May 18th
Only about 2’ of water in the bottom

Approx. 7:45 pm

When full, Pond 1 has a volume of approx. 33 acre-ft

That’s a football field with 25 ft of water on top of it
May 18th, 2018 - Storm Event

- Pond 1 conveys a tremendous amount of water underground and can be seen from the Intake Structure in Pond 2.
May 18th, 2018
Storm Event

- Main Functions of Detention Pond
  - Reduces storm flows downstream
  - Changes timing of peak flows
Estimated Drainage Improvement Costs

- Total Drainage Reconstruction: Approx. $1.6 Million
  - Major Cost Items:
    - Excavation: $230,000
    - Clearing Trees: $63,000
    - Box Culvert: $204,000
    - Impact Basins: $140,000
    - Pond 1 Intake Structure (Big Pond): $26,000
    - Pond 2 Intake Structure: $55,000
Studying the May 18th Storm
Studying the May 18th Storm Predicted 100yr Floodplain

- E. Fairlane is a designated FEMA Floodplain (Zone A).

- As part of the reconstruction project, the floodplain was studied to obtain a more accurate boundary of the floodplain and determine probable flows.

- Terminology
  - 100-year Storm Event
    - Probability of occurring once every 100 years
    - Can occur more than once in any given amount of time.

- Estimated street flow along E. Fairlane during the 100-year Storm event is approximately **660 cubic feet per second**
Studying the May 18th Storm
How Much Water on the Road?

- From the photographic and measured information found on site it is estimated that the total flow on the street was approximately 660 cubic feet per second.

- It was assumed the existing 48” pipe in E. Fairlane Drive was at full capacity of approximately 200-cfs.
What if Improvements Were Not Constructed?

- In Robbinsdale Park
  - Flooding of yards adjacent to detention ponds
  - Probable spillway breach
- Hawthorne Ave.
  - Major flooding of residential structures

Estimated 100yr Floodplain with New Pond
(approx. 1’ of water in road)

Estimated 100yr Floodplain without New Pond
(2.5’-3’ of water in road)
Future Improvements

Mitigating Future Flooding
Future Improvements - Robbinsdale
The Near Future (2019)

- Reconstruction of E. Fairlane Drive from Elm Ave. to Detention Pond

- Extends storm sewer from offline impact basins to the intersection of Elm/Fairlane
  - Not enough stormwater can be captured along E. Fairlane in this 2019 project to mitigate flooding.
  - Future projects are needed to convey stormwater underground.
Future Improvements - Robbinsdale

- As part of the Robbinsdale Park Drainage Improvements Project, the City requested future recommendations for capturing stormwater upstream of E. Fairlane and conveying it underground.

- A report was created to study the existing infrastructure between the Robbinsdale Park detention cell and the detention cell behind the Hospital.
Future Improvements - Robbinsdale

- Recommended next step to reduce flooding along E. Fairlane.
  - Construct “mini-pond”
    - Large intake structure could capture a majority of stormwater flows on the street.
  - This location is a starting point for other future storm sewer projects connect to.
    - Junction point for existing drainage infrastructure
Recommendations from an Engineer

- **General Recommendations:**
  - “Quick” fixes
    - Maintenance of detention ponds
    - Our Stormwater Drainage Utility Fee is allowing needed maintenance to occur
  - Restudy and Reconstruct Existing Detention Ponds
    - Reconstruct and expand existing ponds if feasible (minimizes the need for larger infrastructure downstream)
    - Design ponds to be easily accessible for maintenance (mowing, repair, etc.)
Recommendations from an Engineer

- **Personal Recommendations:**
  - Update all Drainage Basin Design Plans (DBDP)
    - Account for new zoning not accounted for in the existing Plans
    - Rapid City now has a standard design process which wasn’t in place for a majority of the Plans (All plans can be consistent)
    - Design software has been greatly improved
  - Create a City Drainage Analysis Computer Model to incorporate all drainages within the City
    - Allows engineers to see the interactions when drainage basins combine.
      - Similar concept has been implemented for the municipal water system
      - Currently cannot determine how improvements to one drainage basin affects another downstream
    - “What if” analyses can be run much more efficiently to determine if changes significantly alter peak storm runoff
In Summary

- The City of Rapid City has made great strides in reducing major flooding, but we still have a long way to go.
- Drainage continues to be an issue in Rapid City.
- Improvements continue to be constructed but only as funding allows.
- An updated drainage analysis would allow the City to pinpoint improvements which are needed as well as provide criteria for the City to prioritize future construction projects using a need vs. cost analysis.
Stormwater Drainage Utility Fee

• Initiated in October 2013

• Funding
  • $2.4 million annual
    • $1.0 million - Maintenance
    • $1.4 million - CIP’s
Stormwater Drainage Utility Annual Fee =

Lot Size $\times$ Runoff Weighting Factor $\times$ unit charge

- Runoff Weighing Factor - based on impervious surface covering parcel of land
- Unit Financial Charge = 0.00040
  (unchanged since inception of utility in 2013)

Average residential fee in Rapid City = $35.55 / year

Comparison to Sioux Falls
Unit Financial Charge = 0.00085 (increases per ordinance annually)

In addition Sioux Falls has:
  Drainage System Cost Recovery (SFMC § 51.118)
  $1,978.65 / acre of platted residential property
  $6,529.54 / acre of platted commercial property

  Regional Detention Charge (SFMC § 51.118)
  $809.63 / acre of platted residential property
  $2,671.79 / acre of platted commercial property
Stormwater Utility Funded CIP Projects 2015-2018

- Robbinsdale-Ivy, E.Idaho, E.Nevada Reconstruction
- Meade-Hawthorne Elements 48
- Meade-Hawthorne Det Cell 380
- W Omaha Drainage & Utility Imp - Mt View to 11th
- National Street Storm Sewer Improvement
- West Memorial Park Improvements
- Drainage Improvements, Haines Ave. and North Rap. Addn.
- South Truck Route DBDP - Element 203
- Detailed Studies of FEMA SFHA
- Annual Detention Facility Maintenance
- Annual Channel Replacement/Improvement
- Annual Developer Drainage Oversize
- Annual Miscellaneous Drainage Replace/Improve
- Perrine and Unnamed Tributary DBDP
- Executive Golf Course Drainage Channel
Jetting of pipes 52,853 LF
Feet of Televising 52,575 LF
Drainage ditch cleaned 864,435 SF
Channel cleaned 1,048,935 SF
Number of Ponds cleaned 3
Number of inlets cleaned 532
Total complaints Reported 128
5th and Texas

Before

After
East Chicago

Before

After
Meade Ditch

Before

After
Sioux Park Levee Outlet Pipe

Before

After
Dover Ditch

Before

After
Protect Your Property – Anywhere it rains, it can flood

- Protect your own property
  - Downspouts
  - Grading
  - Landscaping
  - Debris
- Flood Insurance
Floods are leading natural disaster in the US

- All areas are susceptible to flooding

- Whether you live near the water or not, you should always be ready

- More than 20% of flood claims come from properties outside FEMA designated floodplains

- Homeowners insurance policies do not cover flooding
Congress passed the National Flood Insurance Act in 1968, creating the National Flood Insurance Program (NFIP)

- NFIP is a Federal program enabling property owners to purchase insurance as a protection against flood losses

- In order for a citizen to be able to purchase flood insurance, the community in which they live must be a participating member of the NFIP

- Rapid City is a participating member of the NFIP
Community Rating System (CRS)

• City’s Floodplain Management Practices exceed the minimum requirements of the NFIP

• CRS Communities receive reduced flood insurance premiums

• City has a Class 7 rating which allows for a premium discount of 15%
Everyone lives in a Flood Zone

- Zones are used to determine policy rates

- Zone A and AE are high risk
  - properties located in 100-yr floodplain

- Zone X are moderate- to low- risk
  - properties located outside 100-yr floodplain

- Approx 200 Flood Insurance policies in City – 35% are for properties located in Zone X areas
Flood Insurance

• If a property is located in a 100 year floodplain (Zone A, AE) and the owner has a mortgage through a federally regulated or insured lender – *flood insurance is required*

• If a property is located in a Zone X (outside 100 year floodplain) ask your agent if you are eligible for the Preferred Risk Policy (PRP) which provides inexpensive flood insurance protection

• National average cost of PRP is approx $395/year
Flood Insurance

• Renters and condo owners can purchase flood insurance

• You are still eligible to purchase flood insurance after being flooded

• Flood insurance can pay regardless of whether or not there is a Presidential Disaster Declaration

• Contact your insurance agent for flood insurance

• Questions regarding NFIP flood insurance and claims can be directed to:
  • Erin May, NFIP Regional Manager
  • emay@nfip/iservice.com
  • (303) – 674 - 1449
Conclusion and Questions