Colorado Flood Event

USACE Infrastructure Recovery Support Function: Stream Recovery

Tim Gouger,
Infrastructure RSF Field Coordinator
Colorado Flood Recovery

- Topics of Discussion
  - USACE Role – NDRF
  - Colorado Flood Event
  - Unmet Stream Recovery Needs
  - USACE – Stream Recovery
  - USACE Permitting
Federal Disaster Recovery Coordination

Long-Term Recovery

1. Community Planning and Capacity Building - FEMA lead agency
2. Infrastructure - USACE Lead Agency
3. Economic – Department of Commerce Lead Agency
4. Housing – Department of Housing and Urban Development
5. Natural and Cultural Resources: Department of Interior
6. Health and Human Services – HHS. Not activated
Colorado Flood Event

• Record breaking rainfall
  • 17 inches
  • Breach Banks
    • Big Thompson, St Vrain, and South Platte
• Flooding Extent
  • North to South: Fort Collins to Manitou Springs
  • East to West: Estes Park to Sterling
Some 7-day totals approaching 20” exceeded average annual amounts.
- 240 Rainfall Rate Alarms
  - > 5” in 6 hours
  - > 3” in 2 hours
  - > 1” in 1 hour

<table>
<thead>
<tr>
<th>Duration</th>
<th>~1% Thresholds</th>
<th>Thresholds Exceeded at:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-hour</td>
<td>&gt;2.5”</td>
<td>3 gage sites (all in Aurora)</td>
</tr>
<tr>
<td>6-hour</td>
<td>&gt;3.5”</td>
<td>49 sites</td>
</tr>
<tr>
<td>24-hour</td>
<td>&gt;5”</td>
<td>59 sites</td>
</tr>
</tbody>
</table>
Colorado Flood Recovery

- Flood Event
  - Flooding and mudslides
    - Largest Domestic Evacuation since Hurricane Katrina
    - Killed 10
  - Adverse impact infrastructure systems
    - Cache La Poudre/Big Thompson
    - Greater South Platte
    - St Vrain/Boulder Creek
    - Arkansas/Fountain Creek
Colorado Flood Recovery

- Flood Event
  - Flooding and mudslides
    - Destroyed
      - 1,800 residential
      - 200 non-residential
      - 2,000 minor structures
    - Damaged
      - 16,000 residential
      - 50 minor structures
Colorado Flood Damages

- Estimated Damages
  - 81 miles of streams: $118M
  - 485 miles of roads and 30 bridges: $485M
  - 284 Irrigation Ditches: $63.5M
  - 54 Potable Water supply and Wastewater Treatment Plants:
  - 27 dams/detention ponds, reservoirs: $5.4M
  - Agricultural Repairs: $5M
  - 24 Stream Gauges: $0.5M
USACE Infrastructure RSF

- USACE Infrastructure Recovery Coordination
  - Infrastructure
    - Potable Water Supply
    - Wastewater treatment
    - Roads, bridges, culverts
    - Storm water conveyance
    - Critical Facilities
    - Dams
  - Stream Recovery
    - Near – Term, Mid-Term, Long-Term
Stream Recovery Funding

- Exigent Needs
  - Natural Resources Conservation Service
    - Emergency Watershed Program
      - $13.8M
      - Exigent Project
  - No other funding mechanism
  - Stream capacity and stability insufficient
    - Spring runoff
South Platte River Basin Time Series Snowpack Summary

Based on Provisional SNOTEL data as of Apr 15, 2014

Current as Pct of Normal: 134%
Current as Pct of Avg: 132%
Current as Pct of Last Year: 163%
Current as Pct of Peak: 128%
Normal as Pct of Peak: 96%
Pct of Normal Needed to Reach Peak: Current
SWE Equals or Exceeds Avg Peak
Normal Peak Date: Apr 26

[Graph showing snow water equivalent over time]
<table>
<thead>
<tr>
<th>Year</th>
<th>Jan*</th>
<th>Feb*</th>
<th>Mar*</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct*</th>
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<tbody>
<tr>
<td>2006</td>
<td>4.62</td>
<td>5.92</td>
<td>18.39</td>
<td>20.47</td>
<td>19.44</td>
<td>13.75</td>
<td>74.03</td>
<td>46.89</td>
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<td>2007</td>
<td>11.56</td>
<td>5.40</td>
<td>29.75</td>
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<td>68.30</td>
<td>15.87</td>
<td>36.20</td>
<td>46.38</td>
<td>22.13</td>
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<td>2008</td>
<td>4.05</td>
<td>7.38</td>
<td>12.26</td>
<td>20.57</td>
<td>54.82</td>
<td>26.06</td>
<td>16.43</td>
<td><strong>90.20</strong></td>
<td>37.54</td>
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<td>2009</td>
<td>6.33</td>
<td>3.11</td>
<td>11.37</td>
<td>59.26</td>
<td>63.45</td>
<td>68.00</td>
<td>65.00</td>
<td>20.00</td>
<td>27.29</td>
<td>30.24</td>
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<tr>
<td>2010</td>
<td>5.97</td>
<td>11.90</td>
<td>32.54</td>
<td>70.57</td>
<td>39.63</td>
<td>56.04</td>
<td>50.23</td>
<td>31.01</td>
<td>4.18</td>
<td>18.31</td>
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<td>2011</td>
<td>6.78</td>
<td>7.45</td>
<td>7.54</td>
<td>33.94</td>
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<td>18.25</td>
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<td>25.73</td>
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<td>2012</td>
<td>4.89</td>
<td>13.57</td>
<td>2.35</td>
<td>30.17</td>
<td>38.97</td>
<td>19.35</td>
<td>73.03</td>
<td>11.31</td>
<td>48.81</td>
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<td>2013</td>
<td>2.96</td>
<td>14.31</td>
<td>21.86</td>
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<td>45.87</td>
<td>16.39</td>
<td>52.33</td>
<td>50.63</td>
<td><strong>229.74</strong></td>
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</table>
Flood Risk Reduction

- Potential Outcomes from spring runoff
  - BEST CASE: Slow snow melt over runoff season
    - Successful flood mitigation
  - MODERATE: Slow snow melt - flash temperatures
    - Lots of Flood Mitigation
    - Potential Flooding
  - EXTREME: Flash temperatures/precipitation events
    - Potential Flooding in several locations
Flood Risk Reduction

- Stream Channel Scientific Restoration
  - Modeling
    - HECRAS/GeoRas
      - Hydraulic analysis per topographic and X-sectional information
      - Illustrative Example
Flood Risk Reduction

• Potential Areas of Concern
  • Sediment Deposition
    • Flat Topography
    • Structures
    • Bridges
    • Culverts
  • Sheer Banks
  • Avulsions
• Vegetative Debris
4-ft Water Surface Increase at 25-yr Flood Event

6-ft of Sediment Deposition
Flood Risk Reduction

- Structures
  - Bridges, culvert
    - “Catch” vegetative debris
    - Impede flow during flood events
      - Heavy Fractions fall out
      - Head cut structure
        - Avulsions
        - Blow out structure
PRE Event Aerial Photography at Bridge on Apple Valley Road
Summary of Cross Sections for Bridge at Apple Valley Road on North St Vrain Creek

### Upstream

- **1**
- **2**
- **3**

### Downstream

- **4**
- **5**
- **6**
Apple Valley Rd at St Vrain

~ 582 cu yards of sediment adjacent to the bridge

<table>
<thead>
<tr>
<th>Distance to Bridge</th>
<th>139 ft</th>
<th>23 ft</th>
<th>1 ft</th>
<th>-1 ft</th>
<th>-24 ft</th>
<th>-169 ft</th>
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<tr>
<td>Post Elevation</td>
<td>5503.5</td>
<td>5505</td>
<td>5510</td>
<td>5512</td>
<td>5505</td>
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<td>depth</td>
<td>0.5</td>
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<td>10</td>
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<tr>
<td>length</td>
<td>139</td>
<td>23</td>
<td>1</td>
<td>4</td>
<td>24</td>
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<tr>
<td>width</td>
<td>20</td>
<td>70</td>
<td>80</td>
<td>100</td>
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<td>90</td>
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<tr>
<td>cu feet</td>
<td>1160</td>
<td>8050</td>
<td>800</td>
<td>1100</td>
<td>7680</td>
<td>52200</td>
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<tr>
<td>cu yards</td>
<td>42</td>
<td>298</td>
<td>29</td>
<td>41</td>
<td>284</td>
<td>1718</td>
</tr>
</tbody>
</table>

diff. between 23 ft & -24 ft: 652 cu yards
diff. between 139 ft & -169 ft: 2412 cu yards
Flood Risk Reduction

- USACE: Unmet Needs Stream Channel Restoration
  - Impede Flow
    - 2.5M CY sediment deposition
    - 119 Miles of bank stabilization
    - 60k CY vegetative debris recovery
- Boulder County: Threat and Hazard Identification and Risk Assessment (THIRA)
- FEMA PA determines stream recovery eligible
  - March 10, 2014
Additional Dates:

- 30%, 60%, 90% and Final Designs (6 months-2 years)
- Contract Awards (3 months)
- Permits (1-3 months)
- Contract Execution (6 months-2 years)

**DRAFT 4/24/14**
Stream Recovery – Near Term

- Information Management System
  - Develop database-PDA-GIS Platform
The ArcGIS application (produced by Esri) appears on the user’s home screen as any other app does.
IPAD (Personal Data Assistant) Picture taking and data entry
Input and edit Geo-referenced data points for stream recovery damages, scopes of restoration, and pictures. ~700 data entry points
A context menu opens up that lists the various parameters of the site when the user chooses a specific point. These include type of feature, kind of damage done, scope of damage...
...Who investigated the area, the date of the survey, and even attachments such as photos of the scene.
Flood Plain loss from sediment deposition, Estes Park, HWY 34
Stream Recovery – Near Term

- Information Management
  - Used to create projects for NRCS Exigent projects
    - 26 Funded Work items
    - 169 Project sites
  - Used to justify congressional funding for Phase 2
    - 76 Funded Work Items
    - $63.5M
Stream Recovery – Near Term

• Stream Channel Restoration
  • Modeling
    • HECRAS/GeoRas
      • Hydraulic analysis per topographic and X-sectional information
      • Illustrative Example
## Infrastructure Progress

<table>
<thead>
<tr>
<th>Site</th>
<th>Area (m²)</th>
<th>× Conversion to ft²</th>
<th>× Avg. Depth (ft)</th>
<th>÷ Conversion to yd³</th>
<th>= Total Deposition (yd³)</th>
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<tbody>
<tr>
<td>1</td>
<td>5,680</td>
<td>10.76</td>
<td>1.87</td>
<td>27</td>
<td>4,234</td>
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<tr>
<td>2</td>
<td>1,229</td>
<td>10.76</td>
<td>1.13</td>
<td>27</td>
<td>553</td>
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<tr>
<td>3</td>
<td>3,219</td>
<td>10.76</td>
<td>1.26</td>
<td>27</td>
<td>1,617</td>
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<tr>
<td>4</td>
<td>2,176</td>
<td>10.76</td>
<td>1.74</td>
<td>27</td>
<td>1,510</td>
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<tr>
<td>5</td>
<td>5,208</td>
<td>10.76</td>
<td>1.36</td>
<td>27</td>
<td>2,824</td>
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<td>6</td>
<td>2,636</td>
<td>10.76</td>
<td>2.58</td>
<td>27</td>
<td>2,711</td>
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<tr>
<td>7</td>
<td>11,721</td>
<td>10.76</td>
<td>3.59</td>
<td>27</td>
<td>16,775</td>
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<tr>
<td>TOTAL</td>
<td>30,224</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL Deposition (yd³): 30,224
NORTH SAINT VRAIN CREEK: DEPOSITION MODEL

Deosition Depth (ft)

- High: 8
- Low: 0

Streams

Deposition Areas

Site 1: 4234 cu yd
Site 2: 553 cu yd
Site 3: 1617 cu yd
Site 4: 1510 cu yd
Site 5: 2824 cu yd

MAP SHEET: 19
1-ft Water Surface Increase at 25-yr Flood Event

4-ft of Sediment Deposition
Site 6

Infrastructure Progress

COLORADO FLOODING    DR- 4145 - CO
Site 6
2nd Ave. Bridge
Highland Diversion Pre-event
Highland Diversion current
Stream Recovery – Near Term

- Estes Park (Total hazard removal estimates)
  - Elkhorn Lodge (Fall River)
    - 4700 Cubic Yards
  - Rock Shop to Riverside (Big Thompson River)
    - 4000 CY
  - Riverside Condos to Confluence (Fall River)
    - 2300 CY
  - Rock Acres Pond (Black Canyon Creek)
    - 2000 CY
  - Lower Fish Creek Above Delta (Fish Creek)
  - Proposed Additional Fall River Sites
    - 1250 CY
- Total – 14250 CY
Infrastructure Progress

• Lake Estes
  • Owned, operated, maintained by Bureau of Reclamation
  • Sediment deposition in Lake over last 50 yrs (1948-2001):
    • 12.8% of lake capacity
  • Sediment deposition in Deltas alone from 2013 flood event:
    • 11%
    • 527k CY
  • Potential Flood Plain loss in Fish Creek, as part of Delta
LAKE ESTES: PRE-EVENT AND DRAW DOWN

PRE-EVENT, NORMAL POOL
DATE: 28 APR 2011
WSE: 7471.8'

POST-EVENT, DRAW DOWN
DATE: 22 OCT 2013
WSE: 7460.6'

FEMA
**LAKE ESTES: SEDIMENT VOLUMES**

**LiDAR - Derived Water Surface Elevation:**
7465' NAVD 88

**Sediment Volume Above Water Surface**:
386,000 Cubic Yards

*Estes Park Public Works removed ~110,000 cubic yards before, during and after LiDAR collection.*
ESTES PARK, FISH CREEK: DEPOSITION MODEL

**Sediment Volume Calculations - Estes Park**

\[
\text{Total Deposition (yd}^3\text{)} = \frac{\text{Pixel Depth (ft) } \times \text{ Pixel Area (ft}^2\text{)}}{2.691} \times 27 + \text{Sum of pixels}
\]

<table>
<thead>
<tr>
<th>Pixel Depth (ft)</th>
<th>Pixel Area (ft(^2))</th>
<th>Conversion to yd(^3)</th>
<th>Sum of pixels</th>
<th>Total Deposition (yd(^3))</th>
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<tr>
<td>2-18 range</td>
<td>2.691</td>
<td>27</td>
<td></td>
<td>114,285</td>
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</tbody>
</table>

**Deposition Depth (ft)**

- High: 18
- Low: 2

**Area of Interest:** 5

**Streams:**
- Big Thompson River
- Fish Creek

**Deposition Area:**
- Represented by the shaded region in the map.

**Map Scale:**
- 0 feet (0 feet) - 375 feet (750 feet) - 1,500 feet
Stream Recovery – Mid-Term

- Colorado Water Conservation Board
- $2M Grants
- Watershed Coalitions
- Master Planning
- Conceptual Design

<table>
<thead>
<tr>
<th>Applicant</th>
<th>Location (Stream, Town or County, Basin)</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fountain Creek Watershed Flood Control and Greenway District</td>
<td>Fountain Creek, El Paso Co., Arkansas</td>
<td>Upper Fountain Creek and Cheyenne Creek Flood Restoration Master Plan</td>
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<tr>
<td>Town of Estes Park</td>
<td>Fall River, Estes Park, South Platte</td>
<td>Master Plan for Fall River Restoration</td>
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<tr>
<td>Wildlands Restoration Volunteers</td>
<td>Big Thompson, Estes to South Platte</td>
<td>River Restoration Master Planning for the Big Thompson River</td>
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<tr>
<td>Boulder County</td>
<td>Boulder County streams – St Vrain through South Platte</td>
<td>Boulder County Comprehensive Stream Planning Initiative</td>
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<tr>
<td>Wildland Restoration Volunteers</td>
<td>Big Thompson, Estes to South Platte</td>
<td>Master Planning</td>
</tr>
<tr>
<td>Coal Creek Canyon</td>
<td>Jefferson, Gilpin, and Boulder Counties</td>
<td>More information forthcoming</td>
</tr>
<tr>
<td>Little Thompson River</td>
<td>Larimer and Boulder Counties</td>
<td>More information forthcoming</td>
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<tr>
<td>Big Elk Meadows</td>
<td>Little Deer Creek, Little Thompson River, South Platte</td>
<td>Master Planning</td>
</tr>
<tr>
<td>The Environmental Group</td>
<td>Coal Creek Canyon Watershed</td>
<td>Master Planning</td>
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<tr>
<td>Big Thompson Conservation District and Town of Milliken</td>
<td>Little Thompson Watershed – South Platte</td>
<td>Master Planning</td>
</tr>
<tr>
<td>City of Evans</td>
<td>South Platte River b/t Big Thompson and Poudre Confluences</td>
<td>Master Planning</td>
</tr>
</tbody>
</table>
Stream Recovery – Long-Term

- Stream Steering Committee
  - USACE
    - Amended General Investigation Program
      - Inclusive of St Vrain and Big Thompson Wathersheds
    - Letter from State of CO Delegation
    - Funding FY16
- Flood Plain Management Program
  - Solicit Funding this FY for
    - LIDAR
    - Flood Plain Management Services
- Water Resources Appropriation
  - Funding FY15
October/November FEMA & DRCOG LiDAR

6408 Sq. Miles flown
$2.65 M
Roughly $400/Sq. Mile

Proposed Flight (2014)
Approx. 375 Sq. Miles
$150,000, if $400/Sq. Mile
Possible partners: USACE, FEMA, CWCB, DRCOG
Stream Recovery – Permitting

• Nationwide Permits Issued
  • 596
    • Boulder County
    • Larimer County
    • Weld
    • El Paso
    • September, 2013 through April, 2014
    • Average TAT: 1 - 3 days
• Regional General Permits
  • 34
Questions

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