STREAM MORPHOLOGY AND SEDIMENT TRANSPORT
NORTH FORK AND MAIN STEM CACHE LA Poudre RIVER
PROJECT EFFECTS REPORT
VOLUME II

for the

Halligan Water Supply Project Environmental Impact Statement

Prepared for
U.S. Army Corps of Engineers
Omaha District

Prepared by:
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May 20, 2019
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Appendix Table A-4. Seasonal Daily Flow Statistics, Fort Collins’ Proposed Action vs Current Conditions – March through April 15th.

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Anderson Consulting Engineers, Inc.

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### Appendix Table A-13. Exceedance Probability Discharge, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

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<th>75% Exceedance Probability Q (cfs)</th>
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<td>(228-318)</td>
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<tr>
<td></td>
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<td>(371-1834)</td>
<td>(324-705)</td>
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<td>111</td>
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PA3 = Fort Collins‘ Proposed Action Current Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI = Current Conditions Hydrology 95% Confidence Intervals

### Appendix Table A-14. Absolute Difference in Exceedance Discharge, Fort Collins’ Proposed Action vs Current Conditions

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### Appendix Table A-15. Percent Difference in Exceedance Discharge, Fort Collins’ Proposed Action vs Current Conditions

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<td>-8%</td>
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Appendix Figure A-2. Fort Collins’ Proposed Action vs Current Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.
Appendix Figure A-3. Flow Exceedance Discharge Profile (top) and Percent Change in Flow Exceedance Discharge, Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure A-4. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Fort Collins’ Proposed Action vs Current Conditions.

Anderson Consulting Engineers, Inc.
### Appendix Table A-16. Annual Maximum Floods for selected Recurrence Intervals, Fort Collins’ Proposed Action vs Current Conditions.

<table>
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<th>Study Reach</th>
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<td>382</td>
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<td>NF2</td>
<td>411</td>
<td>433</td>
<td>794</td>
<td>831</td>
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### Appendix Table A-17. Percent Change in Maximum Floods, Fort Collins’ Proposed Action vs Current Conditions.

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Appendix Table A-18. Bankfull Spells – Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

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<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Max Duration (days/year)</th>
<th>Total Days</th>
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<td>Run 1</td>
<td>2 (0-15)</td>
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<td>Livermore</td>
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<td>PA3</td>
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<td>4</td>
<td>6</td>
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<td>Run 1</td>
<td>2 (0-15)</td>
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<td>3 (0-7.9)</td>
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Appendix Table A-19. Absolute Difference in Bankfull Spells – Fort Collins’ Proposed Action vs Current Conditions.

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<th>Difference in Number Events in 19 Years</th>
<th>Difference in Min Duration (days/year)</th>
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## Bankfull Spells

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<td>Flow Threshold (cfs)</td>
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### Fort Collins’ Proposed Action

- **Number of Events**: 2
- **Min Duration (days)**: 2
- **Ave Duration (days)**: 2
- **Max Duration (days)**: 2
- **Total Days**: 4

### Current Conditions (95% CI*)

- **Number of Events**: 2 (0-15)
- **Min Duration (days)**: 2 (0-1)
- **Ave Duration (days)**: 2 (0-7.8)
- **Max Duration (days)**: 2 (0-48)
- **Total Days**: 4 (0-117)

*Values not shown graphically.*

### Water Year

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Appendix Figure A-5. Bankfull Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1) – Study Reach NF4.
### Bankfull Spells

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**Fort Collins’ Proposed Action**

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**Current Conditions (95% CI*)**

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* Values not shown graphically.

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**Appendix Figure A-6.** Bankfull Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1) – Study Reach NF5.
### Appendix Table A-20. Flushing Flow Spells – Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

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<th>Min Duration (days/year)</th>
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<th>Median Duration (days/year)</th>
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**Fort Collins’ Proposed Action vs Current Conditions**

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#### Occurrence and Duration

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- **Fort Collins’ Proposed Action (PA3)**
- **Current Conditions**

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure A-7. Flushing Flow Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF1.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

**Fort Collins’ Proposed Action vs Current Conditions**

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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure A-8. Flushing Flow Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF2.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

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Note: Duration does not distinguish between separate events occurring in one year.
## Flushing Flow Spells

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### Occurrence and Duration

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**Legend:**
- Red: Fort Collins’ Proposed Action (PA3)
- Black: Current Conditions

Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure A-10. Flushing Flow Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF5 and NF6.

Anderson Consulting Engineers, Inc.

A-18
### Flushing Flow Spells

#### Fort Collins’ Proposed Action vs Current Conditions

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure A-11. Flushing Flow Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF7.**

Anderson Consulting Engineers, Inc.
Appendix Figure A-12. Flow Duration for Channel Maintenance Flows (top) and Percent Change in Flow Duration (bottom) – Fort Collins’ Proposed Action vs Current Conditions.

Points represent the % of time (flow duration) in the 19 year data set in which the discharge to initiate motion is equal or exceeded. Absence of a data point at cross section locations indicates initiation of motion was not achieved for any flow in the 19 year current conditions data set.
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<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
<td>0 (n/a-n/a)</td>
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</tr>
<tr>
<td>NF4</td>
<td>Upstream of CR76H</td>
<td>79426</td>
<td>Livermore Gage</td>
<td>4,512</td>
<td>PA3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
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<td></td>
</tr>
<tr>
<td>NF4</td>
<td>Upstream of Cherokee Park Road</td>
<td>88856</td>
<td>Livermore Gage</td>
<td>&gt;5,000</td>
<td>PA3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
<td>0 (n/a-n/a)</td>
<td></td>
</tr>
<tr>
<td>NF3</td>
<td>Downstream of NPC</td>
<td>97916</td>
<td>Below NPC</td>
<td>&gt;5,000</td>
<td>PA3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
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<td></td>
</tr>
<tr>
<td>NF2</td>
<td>Upstream of NPC</td>
<td>98404</td>
<td>Below Halligan</td>
<td>&gt;5,000</td>
<td>PA3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
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<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
<td>0 (n/a-n/a)</td>
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<tr>
<td>NF2</td>
<td>Phantom Canyon</td>
<td>118491</td>
<td>Below Halligan</td>
<td>&gt;5,000</td>
<td>PA3</td>
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<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
<td>0 (n/a-n/a)</td>
<td></td>
</tr>
<tr>
<td>NF2</td>
<td>Downstream of Halligan</td>
<td>128865</td>
<td>Below Halligan</td>
<td>4,234</td>
<td>PA3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td></td>
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<td></td>
<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
<td>0 (n/a-n/a)</td>
<td></td>
</tr>
<tr>
<td>NF1</td>
<td>Upstream of Halligan</td>
<td>142403</td>
<td>Above Halligan</td>
<td>3,621</td>
<td>PA3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Run 1</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td>0 (0-0)</td>
<td>n/a (n/a-n/a)</td>
<td>n/a (n/a-n/a)</td>
<td>0 (n/a-n/a)</td>
<td></td>
</tr>
</tbody>
</table>

1 3-day independence criteria adopted between events for spells analysis.
2 n/a: not applicable, no events occurring in period of record.
3 Results of spells using upper and lower 95% confidence interval hydrology data set.
### Appendix Table A-23. Absolute Difference in the Occurrence of Channel Maintenance Flows, Fort Collins’ Proposed Action vs Current Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Location</th>
<th>HEC-RAS Cross Section ID</th>
<th>Hydrologic Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Difference Number of Events in 26 Years</th>
<th>Difference Min Event Duration (days)</th>
<th>Difference Ave Event Duration (days)</th>
<th>Difference Max Event Duration (days)</th>
<th>Difference Min Time between Events (days)</th>
<th>Difference Ave Time between Events (days)</th>
<th>Difference Max Time between Events (days)</th>
<th>Difference Total Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF7</td>
<td>Downstream of Seaman</td>
<td>2788</td>
<td>Below Seaman</td>
<td>2.130</td>
<td>-1</td>
<td>3</td>
<td>1.5</td>
<td>0</td>
<td>943</td>
<td>1582.5</td>
<td>1431</td>
<td>-1</td>
</tr>
<tr>
<td>NF6</td>
<td>Upstream of Seaman</td>
<td>18912</td>
<td>Livermore Gage</td>
<td>2.487</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NF5</td>
<td>Eagles Nest Open Space</td>
<td>40627</td>
<td>Livermore Gage</td>
<td>&gt;5,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NF4</td>
<td>Livermore Gage</td>
<td>57,360</td>
<td>Livermore Gage</td>
<td>&gt;5,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NF3</td>
<td>Between Lone Pine Ck and Red Feather Lakes Road</td>
<td>62,496</td>
<td>Livermore Gage</td>
<td>3.978</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NF2</td>
<td>Upstream of CR76H</td>
<td>79,426</td>
<td>Livermore Gage</td>
<td>4.512</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NF1</td>
<td>Upstream of Halligan</td>
<td>128,865</td>
<td>Below Halligan</td>
<td>4.234</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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</table>

**Water Year**: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep

**Fort Collins’ Proposed Action**

<table>
<thead>
<tr>
<th>Number of Events</th>
<th>Min Duration (days)</th>
<th>Max Duration (days)</th>
<th>Total Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Current Conditions (95% CI)**

<table>
<thead>
<tr>
<th>Number of Events</th>
<th>Min Duration (days)</th>
<th>Max Duration (days)</th>
<th>Total Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (0-13)</td>
<td>1 (0-21)</td>
<td>4 (0-42)</td>
<td>5 (0-138)</td>
</tr>
</tbody>
</table>

*Values not shown graphically.

---

### Appendix Figure A-13. Occurrence of Channel Maintenance Flows – Fort Collins’ Proposed Action vs Current Conditions.


**Fort Collins’ Proposed Action**

<table>
<thead>
<tr>
<th>Reach</th>
<th>NF6</th>
<th>Livermore Gage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF6</td>
<td>18912</td>
<td>2,487</td>
</tr>
</tbody>
</table>

**Current Conditions (95% CI)**

<table>
<thead>
<tr>
<th>Reach</th>
<th>NF6</th>
<th>Livermore Gage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF6</td>
<td>18912</td>
<td>2,487</td>
</tr>
</tbody>
</table>

*Values not shown graphically.
Appendix Figure A-14. Flow Duration for Movement of Coarse Bed Material at Each Cross Section (top) and Percent Change in Flow Duration (bottom) – Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure A-15. Total Work Done by the Flow on the Channel Boundary – Fort Collins’ Proposed Action vs Current Conditions.

Appendix Figure A-16. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure A-17. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Fort Collins’ Proposed Action vs Current Conditions.

Appendix Figure A-18. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Fort Collins’ Proposed Action vs Current Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrology</th>
<th>Total Sediment Transport Potential (tons/yr)</th>
<th>Sediment Transport Potential Sands (tons/yr)</th>
<th>Sediment Transport Potential Gravels (tons/yr)</th>
<th>Sediment Transport Potential Cobbles (tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>PA3</td>
<td>154,259</td>
<td>78,677</td>
<td>75,582</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1</td>
<td>155,263</td>
<td>79,094</td>
<td>76,169</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1 CI</td>
<td>(133439 - 189379)</td>
<td>(71077 - 90611)</td>
<td>(62362 - 98769)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF2</td>
<td>PA3</td>
<td>170,532</td>
<td>83,549</td>
<td>86,984</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1</td>
<td>171,797</td>
<td>83,307</td>
<td>88,490</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1 CI</td>
<td>(149476 - 246036)</td>
<td>(74721 - 106527)</td>
<td>(74755 - 139509)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF3</td>
<td>PA3</td>
<td>31,973</td>
<td>19,224</td>
<td>12,749</td>
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<tr>
<td></td>
<td>Run 1</td>
<td>30,812</td>
<td>18,379</td>
<td>12,433</td>
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<tr>
<td></td>
<td>Run 1 CI</td>
<td>(25689 - 49059)</td>
<td>(15657 - 26339)</td>
<td>(10032 - 22720)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF4</td>
<td>PA3</td>
<td>50,512</td>
<td>25,534</td>
<td>24,978</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1</td>
<td>50,308</td>
<td>25,015</td>
<td>25,293</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1 CI</td>
<td>(47557 - 101431)</td>
<td>(24259 - 44832)</td>
<td>(23298 - 56599)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF5</td>
<td>PA3</td>
<td>75,654</td>
<td>47,132</td>
<td>28,522</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1</td>
<td>72,132</td>
<td>44,289</td>
<td>27,843</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1 CI</td>
<td>(91324 - 148329)</td>
<td>(48459 - 70807)</td>
<td>(42865 - 77522)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF6</td>
<td>PA3</td>
<td>92,142</td>
<td>53,674</td>
<td>38,468</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1</td>
<td>89,571</td>
<td>51,329</td>
<td>38,242</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1 CI</td>
<td>(71239 - 133774)</td>
<td>(42593 - 69992)</td>
<td>(28646 - 63782)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF7</td>
<td>PA3</td>
<td>94,766</td>
<td>41,966</td>
<td>52,799</td>
<td>0</td>
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<tr>
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<td>Run 1</td>
<td>92,864</td>
<td>40,327</td>
<td>52,536</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Run 1 CI</td>
<td>(74251 - 140252)</td>
<td>(34071 - 53495)</td>
<td>(40180 - 86757)</td>
<td>(0 - 0)</td>
</tr>
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</table>

PA3 = Fort Collins’ Proposed Action Current Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI = Current Conditions Hydrology 95% Confidence Intervals

Appendix Table A-25. Percent Change in Reach Averaged Sediment Transport Potential – Fort Collins’ Proposed Action vs Current Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Percent Change Total Sediment Transport Potential</th>
<th>Percent Change Sediment Transport Potential Sands</th>
<th>Percent Change Sediment Transport Potential Gravels</th>
<th>Percent Change Sediment Transport Potential Cobbles</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>-0.6%</td>
<td>-0.5%</td>
<td>-0.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF2</td>
<td>-0.7%</td>
<td>0.3%</td>
<td>-1.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF3</td>
<td>3.8%</td>
<td>4.6%</td>
<td>2.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF4</td>
<td>0.4%</td>
<td>2.1%</td>
<td>-1.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF5</td>
<td>4.9%</td>
<td>6.4%</td>
<td>2.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF6</td>
<td>2.9%</td>
<td>4.6%</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF7</td>
<td>2.0%</td>
<td>4.1%</td>
<td>0.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Appendix Figure A-19. Reach Averaged Sediment Transport Potential (top) and Percent Change in Reach Averaged Sediment Transport Potential – Fort Collins' Proposed Action vs Current Conditions.
Appendix Figure A-20.  Distribution of Sediment Transport Potential with Flow, Study Reaches NF1 through NF4 – Fort Collins’ Proposed Action vs Current Conditions.

Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Current Conditions (open bars outlined in black) and the Fort Collins’ Proposed Action (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Current Conditions (black line) and the Fort Collins’ Proposed Action (red line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Current to the Fort Collins’ Proposed Action.
Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Current Conditions (open bars outlined in black) and the Fort Collins’ Proposed Action (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Current Conditions (black line) and the Fort Collins’ Proposed Action (red line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Current to the Fort Collins’ Proposed Action.

Appendix Figure A-21. Distribution of Sediment Transport Potential with Flow, Study Reaches NF5 through NF7 – Fort Collins’ Proposed Action vs Current Conditions.
### Appendix Table A-26. Effective Discharge Spells – Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Hydrology</th>
<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Above Halligan</td>
<td>300</td>
<td>PA3</td>
<td>12</td>
<td>63%</td>
<td>3</td>
<td>22.1</td>
<td>19.5</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>12</td>
<td>63%</td>
<td>3</td>
<td>22.2</td>
<td>19.5</td>
<td>54</td>
</tr>
<tr>
<td>NF2</td>
<td>Below Halligan</td>
<td>120</td>
<td>PA3</td>
<td>18</td>
<td>95%</td>
<td>14</td>
<td>67.5</td>
<td>74</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>19</td>
<td>100%</td>
<td>2</td>
<td>65.5</td>
<td>71</td>
<td>124</td>
</tr>
<tr>
<td>NF3</td>
<td>Below NPC</td>
<td>150</td>
<td>PA3</td>
<td>14</td>
<td>74%</td>
<td>4</td>
<td>24.2</td>
<td>21</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>15</td>
<td>79%</td>
<td>2</td>
<td>25.6</td>
<td>25</td>
<td>59</td>
</tr>
<tr>
<td>NF4</td>
<td>Below NPC</td>
<td>120</td>
<td>PA3</td>
<td>15</td>
<td>79%</td>
<td>5</td>
<td>30.1</td>
<td>31</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>15</td>
<td>79%</td>
<td>6</td>
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<td>13</td>
<td>68%</td>
<td>1</td>
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<td>16.3</td>
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<td>10</td>
<td>55</td>
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<td>15.1</td>
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## Appendix Table A-27. Absolute Difference in Effective Discharge Spells – Fort Collins’ Proposed Action vs Current Conditions.

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<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Difference in Number of Years of Occurrence</th>
<th>Difference in % of Years of Occurrence</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
<th>Difference in Median Duration (days/year)</th>
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<td>2.0</td>
<td>3.0</td>
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<td>-5%</td>
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### Effective Discharge Spells
**Fort Collins’ Proposed Action vs Current Conditions**

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<tr>
<td>Flow Node</td>
<td>Above Halligan Reservoir</td>
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#### Occurrence and Duration

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<td>Max Duration (days/year)</td>
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- **Fort Collins’ Proposed Action (PA3)**
- **Current Conditions**

Note: Duration does not distinguish between separate events occurring in one year.

---

Appendix Figure A-22. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF1.

Anderson Consulting Engineers, Inc.
**Effective Discharge Spells**

**Fort Collins’ Proposed Action vs Current Conditions**

<table>
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<th>Study Reach</th>
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<th>Reach Limits</th>
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</table>

*Note: Duration does not distinguish between separate events occurring in one year.*

**Appendix Figure A-23. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF2.**

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### Fort Collins' Proposed Action vs Current Conditions

<table>
<thead>
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<th>NF3</th>
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<tbody>
<tr>
<td>Reach Limits</td>
<td>NPCD to D/S End Lower Canyon</td>
</tr>
<tr>
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#### Occurrence and Duration

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<td># of Years of Occurrence</td>
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<tr>
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<td>Max Duration (days/year)</td>
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**Note:** Duration does not distinguish between separate events occurring in one year.

**Effective Discharge Spells, Fort Collins' Proposed Action vs Current Conditions – Study Reach NF3.**

Appendix Figure A-24. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF3.

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### Fort Collins' Proposed Action vs Current Conditions

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#### Occurrence and Duration

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Effective Discharge Spells — Study Reach NF4

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure A-25. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF4.

Anderson Consulting Engineers, Inc.

A-35
### Effective Discharge Spells

**Fort Collins' Proposed Action vs Current Conditions**

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<th>Flow Node</th>
<th>Effective Discharge (cfs)</th>
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#### Occurrence and Duration

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</table>

**Note:** Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure A-26. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF5.**

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### Fort Collins’ Proposed Action vs Current Conditions

<table>
<thead>
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<th>Study Reach</th>
<th>NF6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach Limits</td>
<td>U/S End Lower Canyon to Seaman</td>
</tr>
<tr>
<td>Flow Node</td>
<td>Livermore Gage</td>
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<td>Effective Discharge (cfs)</td>
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### Occurrence and Duration

<table>
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<tbody>
<tr>
<td># of Years of Occurrence</td>
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<td>% Occurrence</td>
<td>63%</td>
</tr>
<tr>
<td>Min Duration (days/year)</td>
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<tr>
<td>Median Duration (days/year)</td>
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<td>Max Duration (days/year)</td>
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</tbody>
</table>

**Note:** Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure A-27. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF6.**

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### Fort Collins’ Proposed Action vs Current Conditions

<table>
<thead>
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<th>Study Reach</th>
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<tbody>
<tr>
<td>Reach Limits</td>
<td>Seaman to Confluence</td>
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<td>Flow Node</td>
<td>Below Seaman Reservoir</td>
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<td>Effective Discharge (cfs)</td>
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#### Occurrence and Duration

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#### Duration (days/year)

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<th>Current Conditions</th>
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<td>2005</td>
<td>26</td>
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</table>

Note: Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure A-28. Effective Discharge Spells, Fort Collins’ Proposed Action vs Current Conditions – Study Reach NF7.**

Anderson Consulting Engineers, Inc.
Appendix B: North Fork Figures and Tables – Future Conditions (Run 2)

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<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Upstream Location of Study Reach</th>
<th>Upstream Station (ft)*</th>
<th>Reach Length in feet (miles)</th>
<th>Hydrologic Node</th>
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</thead>
<tbody>
<tr>
<td>NF 1</td>
<td>Dale Creek</td>
<td>149,600</td>
<td>8,600 (1.63 mi)</td>
<td>Above Halligan</td>
</tr>
<tr>
<td>NF 2</td>
<td>Halligan Reservoir Dam</td>
<td>130,156</td>
<td>32,099 (6.08 mi)</td>
<td>Below Halligan</td>
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<tr>
<td>NF 3</td>
<td>North Poudre Canal (NPC) Diversion</td>
<td>98,057</td>
<td>6,557 (1.24 mi)</td>
<td>Below NPC</td>
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<tr>
<td>NF 4</td>
<td>D/S End of Upper Canyon</td>
<td>91,500</td>
<td>15,195 (2.88 mi)</td>
<td>Below NPC</td>
</tr>
<tr>
<td>NF 5</td>
<td>Rabbit Creek</td>
<td>76,305</td>
<td>24,705 (4.68 mi)</td>
<td>Livermore Gage</td>
</tr>
<tr>
<td>NF 6</td>
<td>U/S End of Lower Canyon</td>
<td>51,600</td>
<td>33,600 (6.36 mi)</td>
<td>Livermore Gage</td>
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<tr>
<td>NF 7</td>
<td>Seaman Reservoir Dam</td>
<td>6,240</td>
<td>6,240 (1.18 mi)</td>
<td>Below Seaman</td>
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</tbody>
</table>

*River distance upstream of confluence with Main Stem based on 2009 aerial photography.
Appendix Figure B-1. Schematic of Study Reaches, Reservoirs, Tributaries, Gages, Crossings, and Hydrologic Nodes along the North Fork.

- Seaman Reservoir Dam: Sta 6,240
- USGS Gage @ Livermore: Sta 58,000
- Rabbit Creek: Sta 76,305
- Lone Pine Creek: Sta 68,825
- North Poudre Canal: Sta 98,057
- USGS Gage @ Livermore: Sta 58,060
- Dale Creek: Sta 149,600
- Seaman Reservoir Dam: Sta 6,240
- USGS Gage Below Halligan: Sta 129,756
- Seaman Reservoir Dam: Sta 6,240
- Halligan Reservoir Dam: Sta 130,156
- USGS Gage Below Halligan: Sta 129,756

Below Seaman

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<tr>
<th>Below Seaman</th>
<th>Live more Gage</th>
<th>Below Nc</th>
<th>Below Halligan</th>
<th>Above Halligan</th>
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<tbody>
<tr>
<td>NF 7</td>
<td>NF 6</td>
<td>NF 5</td>
<td>NF 4</td>
<td>NF 1</td>
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</table>

Study Reaches

- Noakes Runoff Bridge
- Red Feather Lakes Road
- Red Feather Lakes Road
- Cherokee Park Road

Hydrologic Nodes

- Cheroke Park Road
- Cherokee Park Road
- Cherokee Park Road
- Cherokee Park Road
### Appendix Table B-2. Flow Statistics by Season, Future Conditions – October through February.

<table>
<thead>
<tr>
<th>Hydrologic Node</th>
<th>Study Reach</th>
<th>Min Q (cfs)</th>
<th>10th Percentile Q (cfs)</th>
<th>Average Q (cfs)</th>
<th>90th Percentile Q (cfs)</th>
<th>Max Q (cfs)</th>
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</thead>
<tbody>
<tr>
<td>Above Halligan</td>
<td>NF1</td>
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<td>13</td>
<td>26</td>
<td>42</td>
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<tr>
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<td>NF2</td>
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<td>13</td>
<td>237</td>
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<td>Livermore Gage</td>
<td>NF5/NF6</td>
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<td>6</td>
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### Appendix Table B-3. Flow Statistics by Season, Future Conditions – March through April 15th.

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<th>Study Reach</th>
<th>Min Q (cfs)</th>
<th>10th Percentile Q (cfs)</th>
<th>Average Q (cfs)</th>
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<th>Max Q (cfs)</th>
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### Appendix Table B-4. Flow Statistics by Season, Future Conditions – April 16th through July 15th.

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<th>Study Reach</th>
<th>Min Q (cfs)</th>
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<th>Average Q (cfs)</th>
<th>90th Percentile Q (cfs)</th>
<th>Max Q (cfs)</th>
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</thead>
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### Appendix Table B-5. Flow Statistics by Season, Future Conditions – July 16th through September.

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<th>Study Reach</th>
<th>Min Q (cfs)</th>
<th>10th Percentile Q (cfs)</th>
<th>Average Q (cfs)</th>
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<td>0</td>
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<td>28</td>
<td>190</td>
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<tr>
<td>Livermore Gage</td>
<td>NF5/NF6</td>
<td>1</td>
<td>4</td>
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<td>50</td>
<td>178</td>
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Appendix Figure B-2. North Fork Future Conditions Seasonal Flow Statistics – October - February

Appendix Figure B-3. North Fork Future Conditions Seasonal Flow Statistics – March – April 15th.
Appendix Figure B-4. North Fork Future Conditions Seasonal Flow Statistics – April 16th – July 15th.

Appendix Figure B-5. North Fork Future Conditions Seasonal Flow Statistics - July 16th – September.

Anderson Consulting Engineers, Inc.
## Appendix Table B-6. Future Conditions Exceedance Probability Discharges.

<table>
<thead>
<tr>
<th>Hydrologic Node</th>
<th>Study Reach</th>
<th>Hydrology</th>
<th>% Exceedance Probability Q (cfs)</th>
<th>1% Exceedance Probability Q (cfs)</th>
<th>2% Exceedance Probability Q (cfs)</th>
<th>5% Exceedance Probability Q (cfs)</th>
<th>10% Exceedance Probability Q (cfs)</th>
<th>25% Exceedance Probability Q (cfs)</th>
<th>50% Exceedance Probability Q (cfs)</th>
<th>75% Exceedance Probability Q (cfs)</th>
<th>95% Exceedance Probability Q (cfs)</th>
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<tbody>
<tr>
<td>Above Halligan</td>
<td>N1</td>
<td>Run 2</td>
<td>1538</td>
<td>528</td>
<td>395</td>
<td>271</td>
<td>179</td>
<td>74</td>
<td>34</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>Livermore Gage</td>
<td>N5, N6</td>
<td>Run 2 CI</td>
<td>(342 - 1817)</td>
<td>(269 - 1817)</td>
<td>(205 - 574)</td>
<td>(129 - 220)</td>
<td>(75 - 107)</td>
<td>(17 - 23)</td>
<td>(4 - 5)</td>
<td>(2 - 2)</td>
<td>(0 - 0)</td>
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</table>

Run 2 = Future Conditions Hydrology
Run 2 CI = Future Conditions Hydrology 95% Confidence Intervals
Appendix Figure B-6. North Fork Future Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.
Appendix Figure B-7. Future Conditions Exceedance Discharge Profile.

<table>
<thead>
<tr>
<th>Hydrologic Node</th>
<th>Study Reach</th>
<th>Future Conditions 2-Year Q (cfs)</th>
<th>Future Conditions 5-Year Q (cfs)</th>
<th>Future Conditions 10-Year Q (cfs)</th>
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<tr>
<td>Above Halligan</td>
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<td>385</td>
<td>762</td>
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<td>Below Halligan</td>
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<td>444</td>
<td>843</td>
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<td>Below NPC</td>
<td>NF3/NF4</td>
<td>347</td>
<td>725</td>
<td>1,068</td>
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<td>Livermore Gage</td>
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<td>454</td>
<td>1,038</td>
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<td>NF7</td>
<td>417</td>
<td>954</td>
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### Appendix Table B-8. Bankfull Spells – Future Conditions (Run 2).

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Max Duration (days/year)</th>
<th>Total Days</th>
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<tr>
<td>NF4</td>
<td>Below NPC</td>
<td>1,160</td>
<td>Run 2</td>
<td>2 (0-14)</td>
<td>2 (0-1)</td>
<td>2 (0-8.4)</td>
<td>2 (0-49)</td>
<td>4 (0-117)</td>
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<tr>
<td>NF5</td>
<td>Livermore</td>
<td>1,872</td>
<td>Run 2</td>
<td>2 (0-14)</td>
<td>2 (0-1)</td>
<td>3 (0-8.6)</td>
<td>4 (0-42)</td>
<td>6 (0-120)</td>
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### Bankfull Flow

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<td>Flow Node</td>
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<td>Flow Threshold (cfs)</td>
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</tbody>
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### Future Conditions

- **Number of Events**: 2
- **Min Duration (days)**: 2
- **Ave Duration (days)**: 2
- **Max Duration (days)**: 2
- **Total Days**: 4

### Future Conditions 95% CIs

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<tr>
<th></th>
<th>Lower</th>
<th>Upper</th>
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<td>Number of Events</td>
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<td>14</td>
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<td>Min Duration (days)</td>
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<td>Ave Duration (days)</td>
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<td>Max Duration (days)</td>
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<td>Total Days</td>
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* Not shown graphically.

**Appendix Figure B-9. Bankfull Spells – Future Conditions, Reach NF4.**
## Bankfull Flow

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<tr>
<td>Flow Threshold (cfs)</td>
<td>1,872</td>
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</table>

## Future Conditions

- **Number of Events**: 2
- **Min Duration (days)**: 2
- **Ave Duration (days)**: 3
- **Max Duration (days)**: 4
- **Total Days**: 6

## Future Conditions 95% CIs

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<td>* Not shown graphically.</td>
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Appendix Figure B-10. Bankfull Spells – Future Conditions, Reach NF5.
### Appendix Table B-9. Flushing Flow Spells – Future Conditions (Run 2).

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<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Flushing Flow (cfs)</th>
<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
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<td>NF2</td>
<td>Below Halligan</td>
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<td>10</td>
<td>53%</td>
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<td>12.0</td>
<td>7.5</td>
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<td>NF3 / NF4</td>
<td>Below NPC</td>
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<td>12</td>
<td>63%</td>
<td>2</td>
<td>10.6</td>
<td>4</td>
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### Target Flushing Flow Spells - Future Conditions

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#### Occurrence and Duration

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<td># of Years of Occurrence</td>
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<tr>
<td>% Occurrence</td>
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<td>Min Duration (days/year)</td>
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<td>Average Duration (days/year)</td>
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Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure B-11. Flushing Flow Spells, Future Conditions – Study Reach NF2.
## Target Flushing Flow Spells - Future Conditions

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<th>Study Reach</th>
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<td>Flushing Flow (cfs)</td>
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### Occurrence and Duration Future Conditions

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### Future Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure B-12

**Flushing Flow Spells, Future Conditions – Study Reach NF3 and NF4.**
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Target Flushing Flow Spells - Future Conditions

Study Reach: NF5/NF6
Reach Limits: Rabbit Creek to Seaman Reservoir
Flow Node: Livermore Gage
Flushing Flow (cfs): 436

Occurrence and Duration

- # of Years of Occurrence: 11
- % Occurrence: 58%
- Min Duration (days/year): 1
- Average Duration (days/year): 11.5
- Median Duration (days/year): 5
- Max Duration (days/year): 48

Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure B-13. Flushing Flow Spells, Future Conditions – Study Reach NF5 and NF6.
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<td>Seaman Reservoir to Confluence</td>
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<td>Below Seaman Reservoir</td>
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<td>Flushing Flow (cfs)</td>
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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure B-14. Flushing Flow Spells, Future Conditions – Study Reach NF7.
Appendix Figure B-15. Critical Flow (top) and Flow Duration (top) for Channel Maintenance at each Cross Section – Future Conditions.
## Appendix Table B-10. Occurrence of Channel Maintenance Flows, Future Conditions (Run 2).

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Location</th>
<th>HEC-RAS Cross Section ID</th>
<th>Hydrologic Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Number of Events in 26 Years</th>
<th>Min Event Duration (days)</th>
<th>Ave Event Duration (days)</th>
<th>Max Event Duration (days)</th>
<th>Min Time between Events (days)</th>
<th>Ave Time between Events (days)</th>
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<tr>
<td>NF7</td>
<td>Downstream of Seaman</td>
<td>2788</td>
<td>Below Seaman</td>
<td>2.130</td>
<td>2 (0-12)</td>
<td>1 (0-1)</td>
<td>2.5 (0-9.8)</td>
<td>4 (0-49)</td>
<td>1430 (n/a-5)</td>
<td>3164 (n/a-721.2)</td>
<td>5669 (n/a-3122)</td>
<td>5 (0-118)</td>
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<tr>
<td>NF6</td>
<td>Upstream of Seaman</td>
<td>18912</td>
<td>Livermore Gage</td>
<td>2.487</td>
<td>1 (0-13)</td>
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<td>3 (0-8.9)</td>
<td>3 (0-41)</td>
<td>2374 (n/a-5)</td>
<td>4747 (n/a-670)</td>
<td>7120 (n/a-3122)</td>
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<td>Eagles Nest Open Space</td>
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<td>Upstream of Cherokee Park Road</td>
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<td>Livermore Gage</td>
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<td>Upstream of NPC</td>
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### Channel Maintenance Flows

**Reach:** NF7

**Flow Node:** Below Seaman Reservoir

**HEC-RAS Cross Section ID:** 2788

**Flow Threshold (cfs):** 2,130

**Future Conditions**

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<th>Number of Events</th>
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<th>Ave Duration (days)</th>
<th>Max Duration (days)</th>
<th>Total Days</th>
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**Future Conditions 95% CIs**

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**Number of Events:** 0

**Min Duration (days):** 0

**Max Duration (days):** 0

**Total Days:** 0

* Not shown graphically.

---

### Channel Maintenance Flows

**Reach:** NF6

**Flow Node:** Livermore Gage

**HEC-RAS Cross Section ID:** 18912

**Flow Threshold (cfs):** 2,487

**Future Conditions**

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**Future Conditions 95% CIs**

<table>
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<th>Lower</th>
<th>Upper</th>
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</table>

**Number of Events:** 0

**Min Duration (days):** 0

**Max Duration (days):** 0

**Total Days:** 0

* Not shown graphically.

---

Appendix Figure B-16. Occurrence of Channel Maintenance Flows –Future Conditions.
Appendix Figure B-17. Critical Flow (top) and Flow Duration (top) for Movement of Coarse Bed Material at each Cross Section – Future Conditions.
Appendix Figure B-18. Total Work Done by the Flow on the Cannel Boundary – Future Conditions.

Appendix Figure B-19. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Future Conditions.
Appendix Figure B-20. Reach Averaged Sediment Transport Potential - Future Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions Hydrology (blue bars) and the computed total sediment transport potential rating curves in tons/day independent of flow duration (black circles). Sediment transport potential computations are based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year (black line) which is a product of the annual flow duration and sediment transport potential rating curve.
3. The peak of total sediment transport potential curves indicates the effective discharge and is indicated in the table provided.

Appendix Figure B-21. Distribution of Sediment Transport Potential across Flow Range - Future Conditions.
### Appendix Table B-11. Effective Discharge Spells – Future Conditions (Run 2).

<table>
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<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Number of Years of Occurrence</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
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<td>NF1</td>
<td>Above Halligan</td>
<td>300</td>
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Appendix Figure B-22. Effective Discharge Spells, Future Conditions – Study Reach NF1.
### Effective Discharge Spells - Future Conditions

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#### Future Conditions

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**Occurrence and Duration**

- # of Years of Occurrence: 19
- % Occurrence: 100%
- Min Duration (days/year): 8
- Average Duration (days/year): 74.3
- Median Duration (days/year): 88
- Max Duration (days/year): 119

**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure B-23.** Effective Discharge Spells, Future Conditions – Study Reach NF2.
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Note: Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure B-24. Effective Discharge Spells, Future Conditions – Study Reach NF3.**
## Effective Discharge Spells - Future Conditions

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### Occurrence and Duration - Future Conditions

- **# of Years of Occurrence**: 16
- **% Occurrence**: 84%
- **Min Duration (days/year)**: 1
- **Average Duration (days/year)**: 31.8
- **Median Duration (days/year)**: 35
- **Max Duration (days/year)**: 67

### Table: Effective Discharge Spells - Future Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure B-25. Effective Discharge Spells, Future Conditions – Study Reach NF4.
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Note: Duration does not distinguish between separate events occurring in one year.

### Flow Node

- **Livermore Gage**
  - Effective Discharge (cfs): 340

### Study Reach

- **Study Reach**: NF5
- **Reach Limits**: Rabbit Creek to U/S End Lower Canyon
- **Flow Node**: Livermore Gage
- **Effective Discharge (cfs)**: 340

### Appendix Figure B-26

*Effective Discharge Spells, Future Conditions – Study Reach NF5.*
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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure B-27. Effective Discharge Spells, Future Conditions – Study Reach NF6.
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**Note:** Duration does not distinguish between separate events occurring in one year.

**Occurrence and Duration**

- # of Years of Occurrence: 14
- % Occurrence: 74%
- Min Duration (days/year): 1
- Average Duration (days/year): 15.7
- Median Duration (days/year): 13
- Max Duration (days/year): 56

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Anderson Consulting Engineers, Inc.
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Appendix Table C-4. Seasonal Daily Flow Statistics, Future vs Current Conditions – March through April 15th.

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Appendix Table C-5. Absolute Difference in Seasonal Daily Flow Statistics, Future vs Current Conditions – March through April 15th.

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Appendix Table C-7. Seasonal Daily Flow Statistics, Future vs Current Conditions – April 16th through July 15th.

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</tr>
<tr>
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</tr>
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Appendix Table C-10. Seasonal Daily Flow Statistics, Future vs Current Conditions – July 16th through September.

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<th>Hydrology</th>
<th>Min Q (cfs)</th>
<th>10th Percentile Q (cfs)</th>
<th>Average Q (cfs)</th>
<th>90th Percentile Q (cfs)</th>
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<th>Difference 10th Percentile Q (cfs)</th>
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<td>8</td>
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<th>Percent Difference Average Q</th>
<th>Percent Difference 90th Percentile Q</th>
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<td>0%</td>
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<td>100%</td>
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Appendix Table C-13. Exceedance Probability Discharge, Future Conditions (Run 2) vs Current Conditions (Run 1).

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<th>10% Exceedance Probability Q (cfs)</th>
<th>25% Exceedance Probability Q (cfs)</th>
<th>50% Exceedance Probability Q (cfs)</th>
<th>75% Exceedance Probability Q (cfs)</th>
<th>95% Exceedance Probability Q (cfs)</th>
<th>100% Exceedance Probability Q (cfs)</th>
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<td>528</td>
<td>395</td>
<td>271</td>
<td>179</td>
<td>74</td>
<td>34</td>
<td>20</td>
<td>11</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Run 1</td>
<td>1538</td>
<td>529</td>
<td>395</td>
<td>269</td>
<td>177</td>
<td>77</td>
<td>34</td>
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<td>11</td>
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<td>(359-683)</td>
<td>(228-318)</td>
<td>(156-199)</td>
<td>(70-84)</td>
<td>(32-35)</td>
<td>(19-20)</td>
<td>(9-12)</td>
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<td>413</td>
<td>275</td>
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<td>(224-335)</td>
<td>(151-192)</td>
<td>(95-103)</td>
<td>(31-38)</td>
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<td>(126-216)</td>
<td>(70-101)</td>
<td>(14-20)</td>
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<tr>
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<td>(195-320)</td>
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Run 2 = Future Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI = Current Conditions Hydrology 95% Confidence Intervals

Appendix Table C-14. Absolute Difference in Exceedance Discharge, Future vs Current Conditions

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<tr>
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<td>1</td>
<td>0</td>
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<td>-6</td>
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<td>4</td>
<td>2</td>
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<tr>
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<td>-9</td>
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Appendix Table C-15. Percent Difference in Exceedance Discharge, Future vs Current Conditions

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<td>1%</td>
<td>-2%</td>
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<td>47%</td>
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Appendix Figure C-2. Future vs Current Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.
Appendix Figure C-3. Flow Exceedance Discharge Profile (top) and Percent Change in Flow Exceedance Discharge (bottom), Future vs Current Conditions.
Appendix Figure C-4. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Future vs Current Conditions.

Anderson Consulting Engineers, Inc.
### Appendix Table C-16. Annual Maximum Floods for selected Recurrence Intervals, Future vs Current Conditions.

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<td>725</td>
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<td>1,091</td>
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### Appendix Table C-17. Percent Change in Maximum Floods, Future vs Current Conditions

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<td>1.5%</td>
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<td>Below NPC</td>
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</tr>
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<td>1.1%</td>
<td>0.5%</td>
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<tr>
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<td>NF7</td>
<td>-2.7%</td>
<td>-3.5%</td>
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### Appendix Table C-18. Bankfull Spells – Future Conditions (Run 2) vs Current Conditions (Run 1).

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<th>Hydrologic Node</th>
<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Max Duration (days/year)</th>
<th>Total Days</th>
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<td>4</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>2 (0-15)</td>
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<td>2 (0-7.8)</td>
<td>2 (0-48)</td>
<td>4 (0-117)</td>
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<td>1,872</td>
<td>Run 2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 1</td>
<td>2 (0-15)</td>
<td>2 (0-1)</td>
<td>3 (0-7.9)</td>
<td>4 (0-41)</td>
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### Appendix Table C-19. Absolute Difference in Bankfull Spells – Future Conditions (Run 2) vs Current Conditions.

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<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Difference in Number of Events in 19 Years</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
<th>Difference in Max Duration (days/year)</th>
<th>Difference in Total Days</th>
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<td>0</td>
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<tr>
<td>NF5</td>
<td>Livermore</td>
<td>1,872</td>
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### Bankfull Spells

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### Water Year

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### Current Conditions (95% CI*)

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* Values not shown graphically.

**Appendix Figure C-5. Bankfull Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1) – Study Reach NF4.**
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**Future Conditions**

- Number of Events: 2
- Min Duration (days): 2
- Ave Duration (days): 3
- Max Duration (days): 4
- Total Days: 6

**Current Conditions (95% CI*)**

- Number of Events: 2 (0-15)
- Min Duration (days): 2 (0-1)
- Ave Duration (days): 3 (0-7.9)
- Max Duration (days): 4 (0-41)
- Total Days: 6 (0-119)

*Values not shown graphically.

Appendix Figure C-6. Bankfull Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1) – Study Reach NF5.
### Appendix Table C-20. Flushing Flow Spells – Future Conditions (Run 2) vs Current Conditions (Run 1).

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<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
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### Appendix Table C-21. Absolute Difference in Flushing Flow Spells – Future vs Current Conditions.

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#### Summary

- **Flushing Flow Spells, Future vs Current Conditions – Study Reach NF1**
- **Note:** Duration does not distinguish between separate events occurring in one year.

Appendix Figure C-7. Flushing Flow Spells, Future vs Current Conditions – Study Reach NF1.

Andersson Consulting Engineers, Inc. C-15
### Flushing Flow Spells

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Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure C-8. Flushing Flow Spells, Future vs Current Conditions – Study Reach NF2.

Anderson Consulting Engineers, Inc.
## Flushing Flow Spells

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### Flushing Flow Spells

**Note:** Duration does not distinguish between separate events occurring in one year.

### Appendix Figure C-9. Flushing Flow Spells, Future vs Current Conditions – Study Reach NF3 and NF4.

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure C-10. Flushing Flow Spells, Future vs Current Conditions – Study Reach NF5 and NF6.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells
**Future Conditions vs Current Conditions**

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<th>Future Conditions</th>
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<th>Occurrence and Duration</th>
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<td>% Occurrence</td>
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<td>Min Duration (days/year)</td>
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<td>Max Duration (days/year)</td>
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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure C-11. Flushing Flow Spells, Future vs Current Conditions – Study Reach NF7.**

Anderson Consulting Engineers, Inc.
Appendix Figure C-12. Flow Duration for Channel Maintenance Flows (top) and Percent Change in Flow Duration (bottom) – Future vs Current Conditions.
### Appendix Table C-22. Occurrence of Channel Maintenance Flows, Future Conditions (Run 2) vs Current Conditions (Run 1).

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<th>Ave Event Duration (days)</th>
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<th>Max Time between Events (days)</th>
<th>Total Days</th>
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<td>2788</td>
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<td>2</td>
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<td>5689 (n/a-3122)</td>
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<td>NF6 Above Seaman</td>
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<td>7120</td>
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<td>4747 (n/a-586.3)</td>
<td>7120 (n/a-3122)</td>
<td>3 (0-116)</td>
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<tr>
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<td>Run 1</td>
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<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0 (0-0)</td>
</tr>
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<td>Run 1</td>
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1. 3-day independence criteria adopted between events for spells analysis.
2. n/a: not applicable, no events occurring in period of record.
3. Results of spells using upper and lower 95% confidence interval hydrology data set.

### Appendix Table C-23. Absolute Difference in the Occurrence of Channel Maintenance Flows, Future vs Current Conditions.

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<th>Difference Number of Events in 26 Years</th>
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<th>Difference Max Time between Events (days)</th>
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Anderson Consulting Engineers, Inc.
### Channel Maintenance Flows

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**Future Conditions**

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**Current Conditions (95% CI*)**

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*Values not shown graphically.

### Channel Maintenance Flows

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**Future Conditions**

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**Current Conditions (95% CI*)**

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*Values not shown graphically.

Appendix Figure C-13. Occurrence of Channel Maintenance Flows – Future vs Current Conditions.
Appendix Figure C-14. Flow Duration for Movement of Coarse Bed Material at Each Cross Section (top) and Percent Change in Flow Duration (bottom) – Future vs Current Conditions.
Appendix Figure C-15. Total Work Done by the Flow on the Cannel Boundary – Future vs Current Conditions.

Appendix Figure C-16. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Future vs Current Conditions.
Appendix Figure C-17. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Future vs Current Conditions.

Appendix Figure C-18. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Future vs Current Conditions.

Anderson Consulting Engineers, Inc.
Appendix Table C-24. Reach Averaged Sediment Transport Potential using SIAM – Future vs Current Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrology</th>
<th>Total Sediment Transport Potential (tons/yr)</th>
<th>Sediment Transport Potential Sands (tons/yr)</th>
<th>Sediment Transport Potential Gravels (tons/yr)</th>
<th>Sediment Transport Potential Cobbles (tons/yr)</th>
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</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Run 2</td>
<td>154,631</td>
<td>78,745</td>
<td>75,886</td>
<td>0</td>
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<td>Run 1</td>
<td>155,263</td>
<td>79,094</td>
<td>76,169</td>
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<tr>
<td></td>
<td>Run 1CI</td>
<td>(133439 - 189379)</td>
<td>(71077 - 90611)</td>
<td>(62362 - 98769)</td>
<td>(0 - 0)</td>
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<td>Run 2</td>
<td>176,898</td>
<td>85,634</td>
<td>91,264</td>
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<td>NF2</td>
<td>Run 1</td>
<td>171,797</td>
<td>83,307</td>
<td>88,490</td>
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<td>Run 1CI</td>
<td>(149476 - 246036)</td>
<td>(74721 - 106527)</td>
<td>(74755 - 139509)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF3</td>
<td>Run 2</td>
<td>33,303</td>
<td>19,925</td>
<td>13,378</td>
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<tr>
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<td>Run 1</td>
<td>30,812</td>
<td>18,379</td>
<td>12,433</td>
<td>0</td>
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<tr>
<td></td>
<td>Run 1CI</td>
<td>(25689 - 49059)</td>
<td>(15657 - 26339)</td>
<td>(10032 - 22720)</td>
<td>(0 - 0)</td>
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<td>NF4</td>
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<td>53,678</td>
<td>26,854</td>
<td>26,824</td>
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<td>50,308</td>
<td>25,015</td>
<td>25,293</td>
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<td></td>
<td>Run 1CI</td>
<td>(47557 - 101431)</td>
<td>(24259 - 44832)</td>
<td>(23298 - 56599)</td>
<td>(0 - 0)</td>
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<tr>
<td>NF5</td>
<td>Run 2</td>
<td>77,859</td>
<td>47,987</td>
<td>29,407</td>
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<td>44,289</td>
<td>27,843</td>
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<td>Run 1CI</td>
<td>(91324 - 148329)</td>
<td>(48459 - 70807)</td>
<td>(42865 - 77522)</td>
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<tr>
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<td>(71239 - 133774)</td>
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<td>Run 1CI</td>
<td>(74251 - 140252)</td>
<td>(34071 - 53495)</td>
<td>(40180 - 86757)</td>
<td>(0 - 0)</td>
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Run 2 = Future Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI – Current Conditions Hydrology 95% Confidence Intervals

Appendix Table C-25. Percent Change in Reach Averaged Sediment Transport Potential – Future vs Current Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Percent Change Total Sediment Transport Potential</th>
<th>Percent Change Sediment Transport Potential Sands</th>
<th>Percent Change Sediment Transport Potential Gravel</th>
<th>Percent Change Sediment Transport Potential Cobble</th>
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<tbody>
<tr>
<td>NF1</td>
<td>-0.4%</td>
<td>-0.4%</td>
<td>-0.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF2</td>
<td>3.0%</td>
<td>2.8%</td>
<td>3.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF3</td>
<td>8.1%</td>
<td>8.4%</td>
<td>7.6%</td>
<td>0.0%</td>
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<td>NF4</td>
<td>6.7%</td>
<td>7.4%</td>
<td>6.1%</td>
<td>0.0%</td>
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<td>NF5</td>
<td>7.9%</td>
<td>8.4%</td>
<td>5.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF6</td>
<td>6.9%</td>
<td>7.2%</td>
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<td>0.0%</td>
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<td>9.9%</td>
<td>12.7%</td>
<td>6.3%</td>
<td>0.0%</td>
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Appendix Figure C-19. Reach Averaged Sediment Transport Potential (top) and Percent Change in Reach Averaged Sediment Transport Potential – Future vs Current Conditions.

Anderson Consulting Engineers, Inc.
Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Current Conditions (open bars outlined in black) and the Future Conditions (blue bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Current Conditions (black line) and the Future Conditions (blue line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Current to the Future Conditions.

Appendix Figure C-20. Distribution of Sediment Transport Potential with Flow, Study Reaches NF1 through NF4 – Future vs Current Conditions.
Appendix Figure C-21. Distribution of Sediment Transport Potential with Flow, Study Reaches NF5 through NF7 – Future vs Current Conditions.

Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Current Conditions (open bars outlined in black) and the Future Conditions (blue bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Current Conditions (black line) and the Future Conditions (blue line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Current to the Future Conditions.
## Appendix Table C-26. Effective Discharge Spells – Future Conditions (Run 2) vs Current Conditions (Run 1).

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<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Hydrology</th>
<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
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<td>Above Halligan</td>
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<td>Run 2</td>
<td>12</td>
<td>63%</td>
<td>3</td>
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<td>54</td>
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<td></td>
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<td>Run 1</td>
<td>12</td>
<td>63%</td>
<td>3</td>
<td>22.2</td>
<td>19.5</td>
<td>54</td>
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<td>NF2</td>
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<td>19</td>
<td>100%</td>
<td>8</td>
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<td>19</td>
<td>100%</td>
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<td>60</td>
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<td>Run 1</td>
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<td>31.8</td>
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<td>32.5</td>
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<td>16.8</td>
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<td></td>
<td></td>
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<td>16.3</td>
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<td>55</td>
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<tr>
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<td>68%</td>
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### Appendix Table C-27. Absolute Difference in Effective Discharge Spells – Future vs Current Conditions.

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Effective Discharge Spells

Future Conditions vs Current Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure C-22. Effective Discharge Spells, Future vs Current Conditions – Study Reach NF1.
Anderson Consulting Engineers, Inc.
### Effective Discharge Spells
#### Future Conditions vs Current Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure C-23. Effective Discharge Spells, Future vs Current Conditions – Study Reach NF2.**

Anderson Consulting Engineers, Inc.
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Note: Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure C-24. Effective Discharge Spells, Future vs Current Conditions – Study Reach NF3.**

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### Future Conditions vs Current Conditions

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*Note: Duration does not distinguish between separate events occurring in one year.*

### Appendix Figure C-25

**Effective Discharge Spells, Future vs Current Conditions – Study Reach NF4.**

Anderson Consulting Engineers, Inc.  
C-35
### Effective Discharge Spells

#### Future Conditions vs Current Conditions

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#### Occurrence and Duration

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**Note:** Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure C-26. Effective Discharge Spells, Future vs Current Conditions – Study Reach NF5.**

Anderson Consulting Engineers, Inc. C-36
### Effective Discharge Spells

**Future Conditions vs Current Conditions**

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**Note:** Duration does not distinguish between separate events occurring in one year.

### Appendix Figure C-27. Effective Discharge Spells, Future vs Current Conditions – Study Reach NF6.

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

**Future Conditions vs Current Conditions**

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#### Occurrence and Duration

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Note:** Duration does not distinguish between separate events occurring in one year.

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Anderson Consulting Engineers, Inc.
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### Appendix Table D-4. Seasonal Daily Flow Statistics, Fort Collins’ Proposed Action vs Future Conditions – March through April 15th.

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### Appendix Table D-5. Absolute Difference in Seasonal Daily Flow Statistics, Fort Collins’ Proposed Action vs Future Conditions – March through April 15th.

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### Appendix Table D-7. Seasonal Daily Flow Statistics, Fort Collins’ Proposed Action vs Future Conditions – April 16th through July 15th.

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### Appendix Table D-10. Seasonal Daily Flow Statistics, Fort Collins’ Proposed Action vs Future Conditions – July 16th through September.

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### Appendix Table D-13. Exceedance Probability Discharge, Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2).

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<td>(16-17)</td>
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<tr>
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<td>N7</td>
<td>PA4</td>
<td>3101</td>
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<td>377</td>
<td>225</td>
<td>118</td>
<td>41</td>
<td>23</td>
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<td></td>
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<td>Run 2</td>
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<td>591</td>
<td>403</td>
<td>235</td>
<td>121</td>
<td>42</td>
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<tr>
<td></td>
<td></td>
<td>Run 2 CI</td>
<td>(439-3329)</td>
<td>(356-3329)</td>
<td>(301-772)</td>
<td>(186-315)</td>
<td>(99-149)</td>
<td>(39-45)</td>
<td>(20-21)</td>
<td>(11-13)</td>
<td>(2-4)</td>
<td>(0-1)</td>
</tr>
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</table>

PA4 = Fort Collins' Proposed Action Future Conditions Hydrology
Run 2 = Future Conditions Hydrology
Run 2 CI – Future Conditions Hydrology 95% Confidence Intervals

### Appendix Table D-14. Absolute Difference in Exceedance Discharge, Fort Collins’ Proposed Action vs Future Conditions

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<tr>
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<tr>
<td>Livermore Gage</td>
<td>N5, N6</td>
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<td>-31</td>
<td>-9</td>
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### Appendix Table D-15. Percent Difference in Exceedance Discharge, Fort Collins’ Proposed Action vs Future Conditions

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<td>0%</td>
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<tr>
<td>Below Halligan</td>
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<td>-7%</td>
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Appendix Figure D-2. Fort Collins’ Proposed Action vs Future Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.

Cumulative Frequency Distribution of Daily Flows

Frequency Distribution of Daily Flows

% of Time Flow

Max Flow in Interval (cfs)

Hydrologic Node: Above Halligan

Reach:

- NF1: Dale Creek to Halligan Dam
- Below Halligan
- Below NPC
- NF3/NF4: NPC to D/S End
- NF5/NF6: D/S End Upper Canyon
- Seaman
- NF7: Seaman Dam to Confluence w/ Mainstem

Appendix Figure D-2. Fort Collins’ Proposed Action vs Future Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.
Appendix Figure D-3. Flow Exceedance Discharge Profile (top) and Percent Change in Flow Exceedance Discharge, Fort Collins’ Proposed Action vs Future Conditions.

Anderson Consulting Engineers, Inc.
Appendix Figure D-4. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Fort Collins’ Proposed Action vs Future Conditions.

Anderson Consulting Engineers, Inc.
## Appendix Table D-16. Annual Maximum Floods for selected Recurrence Intervals, Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Hydrologic Node</th>
<th>Study Reach</th>
<th>Fort Collins’ Proposed Action 2-Year Q (cfs)</th>
<th>Future Conditions 2-Year Q (cfs)</th>
<th>Fort Collins’ Proposed Action 5-Year Q (cfs)</th>
<th>Future Conditions 5-Year Q (cfs)</th>
<th>Fort Collins’ Proposed Action 10-Year Q (cfs)</th>
<th>Future Conditions 10-Year Q (cfs)</th>
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<tbody>
<tr>
<td>Above Halligan</td>
<td>NF1</td>
<td>385</td>
<td>385</td>
<td>762</td>
<td>762</td>
<td>1,093</td>
<td>1,092</td>
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<tr>
<td>Below Halligan</td>
<td>NF2</td>
<td>418</td>
<td>444</td>
<td>803</td>
<td>843</td>
<td>1,144</td>
<td>1,192</td>
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<tr>
<td>Below NPC</td>
<td>NF3/NF4</td>
<td>305</td>
<td>347</td>
<td>664</td>
<td>725</td>
<td>995</td>
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<td>Livermore Gage</td>
<td>NF5/NF6</td>
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## Appendix Table D-17. Percent Change in Maximum Floods, Fort Collins’ Proposed Action vs Future Conditions

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<th>Percent Difference 5-Year Q</th>
<th>Percent Difference 10-Year Q</th>
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<td>Below Halligan</td>
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<td>-5.9%</td>
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<tr>
<td>Below NPC</td>
<td>NF3/NF4</td>
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<td>Livermore Gage</td>
<td>NF5/NF6</td>
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<td>-8.6%</td>
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### Appendix Table D-18. Bankfull Spells – Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2).

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<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Max Duration (days/year)</th>
<th>Total Days</th>
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<td></td>
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<td>Run 2</td>
<td>2 (0-14)</td>
<td>2 (0-1)</td>
<td>2 (0-8.4)</td>
<td>2 (0-49)</td>
<td>4 (0-117)</td>
</tr>
<tr>
<td>NF5</td>
<td>Livermore</td>
<td>1,872</td>
<td>PA4</td>
<td>2</td>
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<td>3</td>
<td>4</td>
<td>6</td>
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<tr>
<td></td>
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<td></td>
<td>Run 2</td>
<td>2 (0-14)</td>
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<td>3 (0-8.6)</td>
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### Appendix Table D-19. Absolute Difference in Bankfull Spells – Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2).

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<th>Study Reach</th>
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<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Difference in Number Events in 19 Years</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
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<tr>
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## Bankfull Flow

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### Fort Collins' Proposed Action

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<tr>
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<td>Ave Duration (days)</td>
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<td>Max Duration (days)</td>
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<tr>
<td>Total Days</td>
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### Future Conditions (95% CI*)

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</thead>
<tbody>
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<td>Number of Events</td>
<td>2 (0-14)</td>
<td>2 (0-1)</td>
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<td>2 (0-49)</td>
<td>4 (0-117)</td>
<td>2 (0-14)</td>
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<td>2 (0-8.4)</td>
<td>2 (0-49)</td>
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<tr>
<td>Min Duration (days)</td>
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<td>2 (0-1)</td>
<td>2 (0-8.4)</td>
<td>2 (0-49)</td>
<td>4 (0-117)</td>
<td>2 (0-14)</td>
<td>2 (0-1)</td>
<td>2 (0-8.4)</td>
<td>2 (0-49)</td>
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<td>Ave Duration (days)</td>
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<td>2 (0-8.4)</td>
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<td>Max Duration (days)</td>
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<td>2 (0-1)</td>
<td>2 (0-8.4)</td>
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<tr>
<td>Total Days</td>
<td>4 (0-14)</td>
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* Values not shown graphically.

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**Appendix Figure D-5. Bankfull Spells, Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2) – Study Reach NF4.**
### Bankfull Flow

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<td>Flow Threshold (cfs)</td>
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</tbody>
</table>

### Fort Collins' Proposed Action

- **Number of Events**: 2
- **Min Duration (days)**: 2
- **Ave Duration (days)**: 3
- **Max Duration (days)**: 4
- **Total Days**: 6

### Future Conditions (95% CI*)

- **Number of Events**: 2 (0-14)
- **Min Duration (days)**: 2 (0-1)
- **Ave Duration (days)**: 3 (0-8.6)
- **Max Duration (days)**: 4 (0-42)
- **Total Days**: 6 (0-120)

* Values not shown graphically.

### Water Year

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**Appendix Figure D-6. Bankfull Spells, Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2) – Study Reach NF5**
### Appendix Table D-20. Flushing Flow Spells – Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2).

<table>
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<th>Hydrologic Node</th>
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<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
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<td>328</td>
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<td>4</td>
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<td>13.1</td>
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### Appendix Table D-21. Absolute Difference in Flushing Flow Spells – Fort Collins’ Proposed Action vs Future Conditions.

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<th>Difference in % of Years of Occurrence</th>
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### Flushing Flow Spells

#### Fort Collins' Proposed Action vs Future Conditions

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#### Occurrence and Duration

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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure D-7. Flushing Flow Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF1.**

Anderson Consulting Engineers, Inc.

D-15
### Flushing Flow Spells

**Fort Collins' Proposed Action vs Future Conditions**

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure D-8. Flushing Flow Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF2.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

#### Fort Collins’ Proposed Action vs Future Conditions

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### Occurrence and Duration

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</table>

Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure D-9. Flushing Flow Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF3 and NF4.

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

**Fort Collins’ Proposed Action vs Future Conditions**

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**Appendix Figure D-10. Flushing Flow Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF5 and NF6.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

#### Fort Collins' Proposed Action vs Future Conditions

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure D-11. Flushing Flow Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF7.**

Anderson Consulting Engineers, Inc.
Appendix Figure D-12. Flow Duration for Channel Maintenance Flows (top) and Percent Change in Flow Duration (bottom) – Fort Collins’ Proposed Action vs Future Conditions.
### Appendix Table D-22. Occurrence of Channel Maintenance Flows, Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2).

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¹ 3-day independence criteria adopted between events for spells analysis.
² n/a: not applicable, no events occurring in period of record.
³ Results of spells using upper and lower 95% confidence interval hydrology data set.

### Appendix Table D-23. Absolute Difference in the Occurrence of Channel Maintenance Flows, Fort Collins’ Proposed Action vs Future Conditions.

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**Fort Collins' Proposed Action**

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**Future Conditions (95% CI)**

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*Values not shown graphically.*

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Appendix Figure D-13. Occurrence of Channel Maintenance Flows – Fort Collins’ Proposed Action vs Future Conditions.
Appendix Figure D-14. Flow Duration for Movement of Coarse Bed Material at Each Cross Section (top) and Percent Change in Flow Duration (bottom) – Fort Collins’ Proposed Action vs Future Conditions.
Appendix Figure D-15. Total Work Done by the Flow on the Channel Boundary – Fort Collins’ Proposed Action vs Future Conditions.

Appendix Figure D-16. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Fort Collins’ Proposed Action vs Future Conditions.
Appendix Figure D-17. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Fort Collins’ Proposed Action vs Future Conditions.

Appendix Figure D-18. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Fort Collins’ Proposed Action vs Future Conditions.
Appendix Table D-24. Reach Averaged Sediment Transport Potential using SIAM – Fort Collins’ Proposed Action vs Future Conditions.

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<td>Run 2</td>
<td>176,898</td>
<td>85,634</td>
<td>91,264</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(149476 - 246036)</td>
<td>(74721 - 106527)</td>
<td>(74755 - 139509)</td>
<td>(0 - 0)</td>
</tr>
<tr>
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<td>PA4</td>
<td>35,254</td>
<td>21,242</td>
<td>14,012</td>
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<td>Run 2</td>
<td>33,303</td>
<td>19,925</td>
<td>13,378</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(25689 - 49059)</td>
<td>(15657 - 26339)</td>
<td>(10032 - 22720)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF4</td>
<td>PA4</td>
<td>54,663</td>
<td>27,804</td>
<td>26,859</td>
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<td>Run 2</td>
<td>53,678</td>
<td>26,854</td>
<td>26,824</td>
<td>0</td>
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<tr>
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<td>Run 2 CI</td>
<td>(47557 - 101431)</td>
<td>(24259 - 44832)</td>
<td>(23298 - 56599)</td>
<td>(0 - 0)</td>
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<td>NF5</td>
<td>PA4</td>
<td>83,870</td>
<td>52,430</td>
<td>30,975</td>
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<td>Run 2</td>
<td>77,859</td>
<td>47,987</td>
<td>29,407</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(91324 - 148329)</td>
<td>(48459 - 70807)</td>
<td>(42865 - 77522)</td>
<td>(0 - 0)</td>
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<td>NF6</td>
<td>PA4</td>
<td>101,474</td>
<td>59,235</td>
<td>41,498</td>
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<td>Run 2</td>
<td>95,782</td>
<td>55,044</td>
<td>39,998</td>
<td>0</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(71239 - 133774)</td>
<td>(42593 - 69992)</td>
<td>(28646 - 63782)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF7</td>
<td>PA4</td>
<td>104,529</td>
<td>47,088</td>
<td>56,667</td>
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<td>Run 2</td>
<td>102,060</td>
<td>45,433</td>
<td>55,853</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(74251 - 140252)</td>
<td>(34071 - 53495)</td>
<td>(40180 - 86757)</td>
<td>(0 - 0)</td>
</tr>
</tbody>
</table>

PA4 = Fort Collins’ Proposed Action Future Conditions Hydrology
Run 2 = Future Conditions Hydrology
Run 2 CI = Future Conditions Hydrology 95% Confidence Intervals

Appendix Table D-25. Percent Change in Reach Averaged Sediment Transport Potential – Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Percent Change Total Sediment Transport Potential</th>
<th>Percent Change Sediment Transport Potential Sands</th>
<th>Percent Change Sediment Transport Potential Gravel</th>
<th>Percent Change Sediment Transport Potential Cobble</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF2</td>
<td>-1.5%</td>
<td>-0.4%</td>
<td>-2.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF3</td>
<td>5.9%</td>
<td>6.6%</td>
<td>4.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF4</td>
<td>1.8%</td>
<td>3.5%</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF5</td>
<td>7.7%</td>
<td>9.3%</td>
<td>5.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF6</td>
<td>5.9%</td>
<td>7.6%</td>
<td>3.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF7</td>
<td>2.4%</td>
<td>3.6%</td>
<td>1.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Appendix Figure D-19. Reach Averaged Sediment Transport Potential (top) and Percent Change in Reach Averaged Sediment Transport Potential – Fort Collins’ Proposed Action vs Future Conditions.

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Appendix Figure D-20. Distribution of Sediment Transport Potential with Flow, Study Reaches NF1 through NF4 – Fort Collins’ Proposed Action vs Future Conditions.

Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions (open bars outlined in black) and the Fort Collins’ Proposed Action (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Future Conditions (black line) and the Fort Collins’ Proposed Action (red line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Future Conditions to the Fort Collins’ Proposed Action.

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Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions (open bars outlined in black) and the Fort Collins’ Proposed Action (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Future Conditions (black line) and the Fort Collins’ Proposed Action (red line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Future Conditions to the Fort Collins’ Proposed Action.

Appendix Figure D-21. Distribution of Sediment Transport Potential with Flow, Study Reaches NF5 through NF7 – Fort Collins’ Proposed Action vs Future Conditions.
### Appendix Table D-26. Effective Discharge Spells – Fort Collins’ Proposed Action (PA4) vs Future Conditions (Run 2).

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Hydrology</th>
<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Above Halligan</td>
<td>300</td>
<td>PA4</td>
<td>12</td>
<td>63%</td>
<td>3</td>
<td>22.1</td>
<td>19.5</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 2</td>
<td>12</td>
<td>63%</td>
<td>3</td>
<td>22.1</td>
<td>19.5</td>
<td>54</td>
</tr>
<tr>
<td>NF2</td>
<td>Below Halligan</td>
<td>120</td>
<td>PA4</td>
<td>19</td>
<td>100%</td>
<td>2</td>
<td>67.1</td>
<td>81</td>
<td>116</td>
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<td>19</td>
<td>100%</td>
<td>8</td>
<td>74.3</td>
<td>88</td>
<td>119</td>
</tr>
<tr>
<td>NF3</td>
<td>Below NPC</td>
<td>150</td>
<td>PA4</td>
<td>16</td>
<td>84%</td>
<td>1</td>
<td>22.4</td>
<td>22</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 2</td>
<td>16</td>
<td>84%</td>
<td>1</td>
<td>25.3</td>
<td>25.5</td>
<td>60</td>
</tr>
<tr>
<td>NF4</td>
<td>Below NPC</td>
<td>120</td>
<td>PA4</td>
<td>16</td>
<td>84%</td>
<td>1</td>
<td>29.8</td>
<td>31</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 2</td>
<td>16</td>
<td>84%</td>
<td>1</td>
<td>31.8</td>
<td>35</td>
<td>67</td>
</tr>
<tr>
<td>NF5</td>
<td>Livermore Gage</td>
<td>340</td>
<td>PA4</td>
<td>13</td>
<td>68%</td>
<td>1</td>
<td>14.5</td>
<td>9</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 2</td>
<td>13</td>
<td>68%</td>
<td>2</td>
<td>16.8</td>
<td>12</td>
<td>56</td>
</tr>
<tr>
<td>NF6</td>
<td>Livermore Gage</td>
<td>350</td>
<td>PA4</td>
<td>13</td>
<td>68%</td>
<td>1</td>
<td>13.2</td>
<td>7</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 2</td>
<td>13</td>
<td>68%</td>
<td>2</td>
<td>15.9</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>NF7</td>
<td>Below Seaman</td>
<td>325</td>
<td>PA4</td>
<td>13</td>
<td>68%</td>
<td>1</td>
<td>14.3</td>
<td>10</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Run 2</td>
<td>14</td>
<td>74%</td>
<td>1</td>
<td>15.7</td>
<td>13</td>
<td>56</td>
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</table>
### Appendix Table D-27. Absolute Difference in Effective Discharge Spells – Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Difference in Number of Years of Occurrence</th>
<th>Difference in % of Years of Occurrence</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
<th>Difference in Median Duration (days/year)</th>
<th>Difference in Max Duration (days/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Above Halligan</td>
<td>300</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0.0</td>
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<td>NF2</td>
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<td>0</td>
<td>0%</td>
<td>-6</td>
<td>-7.2</td>
<td>-7.0</td>
<td>-3</td>
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<tr>
<td>NF3</td>
<td>Below NPC</td>
<td>150</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>-2.8</td>
<td>-3.5</td>
<td>-1</td>
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<tr>
<td>NF4</td>
<td>Below NPC</td>
<td>120</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>-2.1</td>
<td>-4.0</td>
<td>0</td>
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<tr>
<td>NF5</td>
<td>Livermore Gage</td>
<td>340</td>
<td>0</td>
<td>0%</td>
<td>-1</td>
<td>-2.3</td>
<td>-3.0</td>
<td>0</td>
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<tr>
<td>NF6</td>
<td>Livermore Gage</td>
<td>350</td>
<td>0</td>
<td>0%</td>
<td>-1</td>
<td>-2.7</td>
<td>-4.0</td>
<td>0</td>
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<tr>
<td>NF7</td>
<td>Below Seaman</td>
<td>325</td>
<td>-1</td>
<td>-5%</td>
<td>0</td>
<td>-1.4</td>
<td>-3.0</td>
<td>0</td>
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</table>
### Effective Discharge Spells
#### Fort Collins’ Proposed Action vs Future Conditions

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<th>Study Reach</th>
<th>Reach Limits</th>
<th>Flow Node</th>
<th>Effective Discharge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Above Halligan</td>
<td>Above Halligan Reservoir</td>
<td>300</td>
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#### Occurrence and Duration

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<tr>
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<th>Future Conditions</th>
<th>PA4</th>
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<tbody>
<tr>
<td># of Years of Occurrence</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>% Occurrence</td>
<td>63%</td>
<td>63%</td>
</tr>
<tr>
<td>Min Duration (days/year)</td>
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<tr>
<td>Average Duration (days/year)</td>
<td>22.1</td>
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<td>Median Duration (days/year)</td>
<td>19.5</td>
<td>19.5</td>
</tr>
<tr>
<td>Max Duration (days/year)</td>
<td>54</td>
<td>54</td>
</tr>
</tbody>
</table>

- **Fort Collins’ Proposed Action (PA4)**
- **Future Conditions**

#### wishes

**Note: Duration does not distinguish between separate events occurring in one year.**

### Appendix Figure D-22. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF1.

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Appendix Figure D-23. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF2.

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### Fort Collins’ Proposed Action vs Future Conditions

<table>
<thead>
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<th>Study Reach</th>
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<th>Flow Node</th>
<th>Effective Discharge (cfs)</th>
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<td>NPCD to D/S End Lower Canyon</td>
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<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Duration (days/year)</th>
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</tbody>
</table>

**Note:** Duration does not distinguish between separate events occurring in one year.

---

Appendix Figure D-24. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF3.

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### Effective Discharge Spells

#### Fort Collins’ Proposed Action vs Future Conditions

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>NF4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach Limits</td>
<td>D/S End Lower Canyon to Rabbit Creek</td>
</tr>
<tr>
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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Note:** Duration does not distinguish between separate events occurring in one year.

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Appendix Figure D-25. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF4.

Anderson Consulting Engineers, Inc.

D-35
## Effective Discharge Spells
### Fort Collins’ Proposed Action vs Future Conditions

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### Occurrence and Duration

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure D-26. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF5.

Anderson Consulting Engineers, Inc.  
D-36
### Effective Discharge Spells
**Fort Collins' Proposed Action vs Future Conditions**

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- **Fort Collins' Proposed Action (PA4)**
- **Future Conditions**

Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure D-27. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF6.
### Effective Discharge Spells

**Fort Collins’ Proposed Action vs Future Conditions**

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#### Duration (days/year)

**Note:** Duration does not distinguish between separate events occurring in one year.

### Appendix Figure D-28. Effective Discharge Spells, Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF7.

Anderson Consulting Engineers, Inc.
Appendix E: North Fork Figures and Tables – No-Action Alternative (NA4) vs Future Conditions (Run 2)

List of Appendix Tables

Appendix Table E-1. Seasonal Daily Flow Statistics, No-Action Alternative vs Future Conditions – October through February. ...............................................................................................E-2


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### Appendix Table E-7. Seasonal Daily Flow Statistics, No-Action Alternative vs Future Conditions – April 16th through July 15th.

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### Appendix Table E-13. Exceedance Probability Discharge, No-Action Alternative (NA4) vs Future Conditions (Run 2)

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<td>528</td>
<td>395</td>
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<td>417</td>
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<td>(129-220)</td>
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<td>(371-3258)</td>
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<td>(197-325)</td>
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<tr>
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NA4 = No-Action Alternative Future Conditions Hydrology  
Run 2 = Future Conditions Hydrology  
Run 2 CI = Future Conditions Hydrology 95% Confidence Intervals

### Appendix Table E-14. Absolute Difference in Exceedance Discharge, No-Action Alternative vs Future Conditions

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### Appendix Table E-15. Percent Difference in Exceedance Discharge, No-Action Alternative vs Future Conditions

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Appendix Figure E-2. No-Action Alternative vs Future Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.
Appendix Figure E-3. Flow Exceedance Discharge Profile (top) and Percent Change in Flow Exceedance Discharge, No-Action Alternative vs Future Conditions.
Appendix Figure E-4. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, No-Action Alternative vs Future Conditions.

Anderson Consulting Engineers, Inc.
Appendix Table E-16. Annual Maximum Floods for selected Recurrence Intervals, No-Action Alternative vs Future Conditions.

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Appendix Table E-17. Percent Change in Maximum Floods, No-Action Alternative vs Future Conditions

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<tr>
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<td>NF3/NF4</td>
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<td>-0.2%</td>
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<td>0.0%</td>
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### Appendix Table E-18. Bankfull Spells – No-Action Alternative (NA4) vs Future Conditions (Run 2).

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<th>Hydrologic Node</th>
<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Max Duration (days/year)</th>
<th>Total Days</th>
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### Appendix Table E-19. Absolute Difference in Bankfull Spells – No-Action Alternative (NA4) vs Future Conditions (Run 2).

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<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
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### Bankfull Flow

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#### No-Action Alternative

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<td>Max Duration (days)</td>
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#### Future Conditions (95% CI*)

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<td>Total Days</td>
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* Values not shown graphically.

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**Appendix Figure E-5. Bankfull Spells, No-Action Alternative (NA4) vs Future Conditions (Run 2) – Study Reach NF4.**
### Bankfull Flow

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<th>Reach</th>
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<td>Flow Threshold (cfs)</td>
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### No-Action Alternative

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<td>Min Duration (days)</td>
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<tr>
<td>Ave Duration (days)</td>
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<tr>
<td>Max Duration (days)</td>
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<td>Total Days</td>
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### Future Conditions (95% CI*)

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<tr>
<th>Number of Events</th>
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<tr>
<td>Min Duration (days)</td>
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<tr>
<td>Ave Duration (days)</td>
<td>3 (0-8.6)</td>
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<tr>
<td>Max Duration (days)</td>
<td>4 (0-42)</td>
</tr>
<tr>
<td>Total Days</td>
<td>6 (0-120)</td>
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</table>

* Values not shown graphically.

---

**Appendix Figure E-6.** Bankfull Spells, No-Action Alternative (NA4) vs Future Conditions (Run 2) – Study Reach NF5.
### Appendix Table E-20. Flushing Flow Spells – No-Action Alternative (NA4) vs Future Conditions (Run 2).

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Flushing Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
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</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Above Halligan</td>
<td>328</td>
<td>NA4</td>
<td>10</td>
<td>53%</td>
<td>2</td>
<td>15.4</td>
<td>9</td>
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<td></td>
<td>Run 2</td>
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<td></td>
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<td>53%</td>
<td>2</td>
<td>15.4</td>
<td>9</td>
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<tr>
<td>NF2</td>
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<td>433</td>
<td>NA4</td>
<td>10</td>
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<tr>
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<td>Run 2</td>
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<td>63%</td>
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<td>10.6</td>
<td>4</td>
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<tr>
<td>NF5 / NF6</td>
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<td>436</td>
<td>NA4</td>
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<td>58%</td>
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<tr>
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<td></td>
<td>11</td>
<td>58%</td>
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<td>48</td>
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<tr>
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<td>428</td>
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<tr>
<td></td>
<td>Run 2</td>
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<table>
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<th>Hydrologic Node</th>
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<th>Difference in Number of Years of Occurrence</th>
<th>Difference in % of Years of Occurrence</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
<th>Difference in Median Duration (days/year)</th>
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### Flushing Flow Spells

**No-Action Alternative vs Future Conditions**

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<td>Reach Limits</td>
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<td>Flow Node</td>
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#### Occurrence and Duration

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<td>% Occurrence</td>
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<td>53%</td>
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<td>Max Duration (days/year)</td>
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#### Appendix Figure E-7. Flushing Flow Spells, No-Action Alternative vs Future Conditions – Study Reach NF1.

Note: Duration does not distinguish between separate events occurring in one year.
### Flushing Flow Spells
#### No-Action Alternative vs Future Conditions

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#### Occurrence and Duration

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</tbody>
</table>

#### Note
Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure E-8. Flushing Flow Spells, No-Action Alternative vs Future Conditions – Study Reach NF2.**

Anderson Consulting Engineers, Inc.  E-16
### Flushing Flow Spells

**No-Action Alternative vs Future Conditions**

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>NF3 / NF4</th>
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</thead>
<tbody>
<tr>
<td>Reach Limits</td>
<td>NPCD to Rabbit Creek</td>
</tr>
<tr>
<td>Flow Node</td>
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<tr>
<td>Flushing Flow (cfs)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Occurrence and Duration</th>
<th>Future Conditions</th>
<th>NA4</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Years of Occurrence</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>% Occurrence</td>
<td>63%</td>
<td>63%</td>
</tr>
<tr>
<td>Min Duration (days/year)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Average Duration (days/year)</td>
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<td>10.6</td>
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<tr>
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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure E-9. Flushing Flow Spells, No-Action Alternative vs Future Conditions – Study Reach NF3 and NF4.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells

#### No-Action Alternative vs Future Conditions

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#### Occurrence and Duration

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Note: Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure E-10. Flushing Flow Spells, No-Action Alternative vs Future Conditions – Study Reach NF5 and NF6.**

Anderson Consulting Engineers, Inc.
Appendix Figure E-11. Flushing Flow Spells, No-Action Alternative vs Future Conditions – Study Reach NF7.

Anderson Consulting Engineers, Inc.
Appendix Figure E-12. Flow Duration for Channel Maintenance Flows (top) and Percent Change in Flow Duration (bottom) – No-Action Alternative vs Future Conditions.
Appendix Figure E-13. Flow Duration for Movement of Coarse Bed Material at Each Cross Section (top) and Percent Change in Flow Duration (bottom) – No-Action Alternative vs Future Conditions.
Appendix Table E-22. Occurrence of Channel Maintenance Flows, No-Action Alternative (NA4) vs Future Conditions (Run 2).

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<th>Min Event Duration (days)</th>
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<td>Below Seaman</td>
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1 3-day independence criteria adopted between events for spells analysis.
2 n/a: not applicable, no events occurring in period of record.
3 Results of spells using upper and lower 95% confidence interval hydrology data set.

Appendix Table E-23. Absolute Difference in the Occurrence of Channel Maintenance Flows, No-Action Alternative vs Future Conditions.

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<th>Difference Min Event Duration (days)</th>
<th>Difference Ave Event Duration (days)</th>
<th>Difference Max Event Duration (days)</th>
<th>Difference Min Time between Events (days)</th>
<th>Difference Ave Time between Events (days)</th>
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**No-Action Alternative**
- Number of Events: 2
- Min Duration (days): 3
- Ave Duration (days): 4
- Total Days: 5

**Future Conditions (95% CI)**
- Number of Events: 2 (0-12)
- Min Duration (days): 3 (0-1)
- Ave Duration (days): 4 (0-41)
- Total Days: 5 (0-118)

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### Channel Maintenance Flows - Reach NF6

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**No-Action Alternative**
- Number of Events: 1
- Min Duration (days): 3
- Ave Duration (days): 3
- Total Days: 3

**Future Conditions (95% CI)**
- Number of Events: 1 (0-13)
- Min Duration (days): 3 (0-1)
- Ave Duration (days): 3 (0-41)
- Total Days: 3 (0-118)

---

Appendix Figure E-14. Occurrence of Channel Maintenance Flows – No-Action Alternative vs Future Conditions.
Appendix Figure E-15. Total Work Done by the Flow on the Cannel Boundary – No-Action Alternative vs Future Conditions.

Appendix Figure E-16. Percent Change in the Total Work Done by the Flow on the Channel Boundary – No-Action Alternative vs Future Conditions.
Appendix Figure E-17. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – No-Action Alternative vs Future Conditions.

Appendix Figure E-18. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – No-Action Alternative vs Future Conditions.

<table>
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<th>Study Reach</th>
<th>Hydrology</th>
<th>Total Sediment Transport Potential (tons/yr)</th>
<th>Sediment Transport Potential Sands (tons/yr)</th>
<th>Sediment Transport Potential Gravels (tons/yr)</th>
<th>Sediment Transport Potential Cobbles (tons/yr)</th>
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<td>(133,439 - 189,379)</td>
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<td>(256,89 - 490,59)</td>
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<td>(100,032 - 227,20)</td>
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<td>(47,557 - 101,431)</td>
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<td>Run 2 CI</td>
<td>(91,324 - 148,329)</td>
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<td>(74,251 - 140,252)</td>
<td>(34,071 - 53,495)</td>
<td>(40,180 - 86,757)</td>
<td>(0 - 0)</td>
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NA4 = No-Action Alternative Future Conditions Hydrology
Run 2 = Future Conditions Hydrology
Run 2 CI – Future Conditions Hydrology 95% Confidence Intervals

## Appendix Table E-25. Percent Change in Reach Averaged Sediment Transport Potential – No-Action Alternative vs Future Conditions.

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<th>Study Reach</th>
<th>Percent Change Total Sediment Transport Potential</th>
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<th>Percent Change Sediment Transport Potential Gravels</th>
<th>Percent Change Sediment Transport Potential Cobble</th>
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<td>0.0%</td>
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<td>-1.0%</td>
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<tr>
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Appendix Figure E-19. Reach Averaged Sediment Transport Potential (top) and Percent Change in Reach Averaged Sediment Transport Potential – No-Action Alternative vs Future Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions (open bars outlined in black) and the No-Action Alternative (purple bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Future Conditions (black line) and the No-Action Alternative (purple line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Future Conditions to the No-Action Alternative.

Appendix Figure E-20. Distribution of Sediment Transport Potential with Flow, Study Reaches NF1 through NF4 – No-Action Alternative vs Future Conditions.
Appendix Figure E-21. Distribution of Sediment Transport Potential with Flow, Study Reaches NF5 through NF7 – No-Action Alternative vs Future Conditions.

Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions (open bars outlined in black) and the No-Action Alternative (purple bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Future Conditions (black line) and the No-Action Alternative (purple line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Future Conditions to the No-Action Alternative.
Appendix Table E-26. Effective Discharge Spells – No-Action Alternative (NA4) vs Future Conditions (Run 2).

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### Appendix Table E-27. Absolute Difference in Effective Discharge Spells – No-Action Alternative vs Future Conditions.

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### Effective Discharge Spells

#### No-Action Alternative vs Future Conditions

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#### Duration (days/year)

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Appendix Figure E-22. Effective Discharge Spells, No-Action Alternative vs Future Conditions – Study Reach NF1.
Appendix Figure E-23. Effective Discharge Spells, No-Action Alternative vs Future Conditions – Study Reach NF2.

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

#### No-Action Alternative vs Future Conditions

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#### Effective Discharge Spells, No-Action Alternative vs Future Conditions – Study Reach NF3.

Note: Duration does not distinguish between separate events occurring in one year.
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Note: Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure E-25. Effective Discharge Spells, No-Action Alternative vs Future Conditions – Study Reach NF4.**

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

**No-Action Alternative vs Future Conditions**

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure E-26. Effective Discharge Spells, No-Action Alternative vs Future Conditions – Study Reach NF5.**

Anderson Consulting Engineers, Inc. E-36
### Effective Discharge Spells
#### No-Action Alternative vs Future Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure E-27. Effective Discharge Spells, No-Action Alternative vs Future Conditions – Study Reach NF6.**

Anderson Consulting Engineers, Inc. E-37
## Effective Discharge Spells

### No-Action Alternative vs Future Conditions

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### Occurrence and Duration

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Note: Duration does not distinguish between separate events occurring in one year.

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Appendix Table F-7. Seasonal Daily Flow Statistics, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – April 16th through July 15th.

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### Appendix Table F-13. Exceedance Probability Discharge, Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2).

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<td>413</td>
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PA5 = Cumulative Effects with Fort Collins’ Proposed Action
Run 2 = Future Conditions Hydrology
Run 2 CI = Future Conditions Hydrology 95% Confidence Intervals

### Appendix Table F-14. Absolute Difference in Exceedance Discharge, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions

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<td>-18</td>
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<td>-4</td>
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### Appendix Table F-15. Percent Difference in Exceedance Discharge, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions

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Appendix Figure F-2. Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions Flow Frequency Histograms and Cumulative Frequency Distribution of Daily Flows.
Appendix Figure F-3. Flow Exceedance Discharge Profile (top) and Percent Change in Flow Exceedance Discharge, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

Anderson Consulting Engineers, Inc.
Appendix Figure F-4. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
Appendix Table F-16. Annual Maximum Floods for selected Recurrence Intervals, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Hydrologic Node</th>
<th>Study Reach</th>
<th>Cumulative Effects with Fort Collins’ Proposed Action 2-Year Q (cfs)</th>
<th>Future Conditions 2-Year Q (cfs)</th>
<th>Cumulative Effects with Fort Collins’ Proposed Action 5-Year Q (cfs)</th>
<th>Future Conditions 5-Year Q (cfs)</th>
<th>Cumulative Effects with Fort Collins’ Proposed Action 10-Year Q (cfs)</th>
<th>Future Conditions 10-Year Q (cfs)</th>
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<td>Above Halligan</td>
<td>NF1</td>
<td>385</td>
<td>385</td>
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<td>1,092</td>
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<td>NF2</td>
<td>416</td>
<td>444</td>
<td>800</td>
<td>843</td>
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<td>1,192</td>
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<td>725</td>
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<td>Livermore Gage</td>
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Appendix Table F-17. Percent Change in Maximum Floods, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions

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<td>-5.1%</td>
<td>-4.1%</td>
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<td>NF3/NF4</td>
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<td>-8.4%</td>
<td>-6.6%</td>
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<td>Livermore Gage</td>
<td>NF5/NF6</td>
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<td>NF7</td>
<td>-2.8%</td>
<td>1.4%</td>
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Appendix Table F-18. Bankfull Spells – Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2).

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<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Reach Ave Bankfull Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Max Duration (days/year)</th>
<th>Total Days</th>
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<td>NF4</td>
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<td></td>
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<td>Run 2</td>
<td>2 (0-14)</td>
<td>2 (0-1)</td>
<td>2 (0-8.4)</td>
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<td>4 (0-117)</td>
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<tr>
<td>NF5</td>
<td>Livermore</td>
<td>1,872</td>
<td>PA5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
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<td>Run 2</td>
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<td>3 (0-8.6)</td>
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Appendix Table F-19. Absolute Difference in Bankfull Spells – Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2).

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<th>Difference in Number Events in 19 Years</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
<th>Difference in Max Duration (days/year)</th>
<th>Difference in Total Days</th>
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Bankfull Flow

<table>
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<td>Flow Threshold (cfs)</td>
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Fort Collins' Proposed Action Cum Effects

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<td>Max Duration (days)</td>
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Future Conditions (95% CI*)

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<td>Max Duration (days)</td>
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<td>Total Days</td>
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* Values not shown graphically.

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### Appendix Figure F-5.
Bankfull Spells, Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2) – Study Reach NF4.
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**Fort Collins' Proposed Action Cum Effects**

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<th>Number of Events</th>
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**Future Conditions (95% CI*)**

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<td>Ave Duration (days)</td>
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<td>Total Days</td>
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* Values not shown graphically.

Appendix Figure F-6. Bankfull Spells, Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2) – Study Reach NF5.
### Appendix Table F-20. Flushing Flow Spells – Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2).

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<th>Study Reach</th>
<th>Hydrologic Node</th>
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<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
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<td>Run 2</td>
<td>10</td>
<td>53%</td>
<td>2</td>
<td>15.4</td>
<td>9</td>
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<td>53%</td>
<td>1</td>
<td>9.9</td>
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<td>36</td>
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<td>1</td>
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<td>12</td>
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<td>4</td>
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<tr>
<td>NF5 / NF6</td>
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<td>436</td>
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### Appendix Table F-21. Absolute Difference in Flushing Flow Spells – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

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Anderson Consulting Engineers, Inc.
### Flushing Flow Spells
**Fort Collins' Proposed Action Cum Effects vs Future Conditions**

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**Note:** Duration does not distinguish between separate events occurring in one year.

**Appendix Figure F-7. Flushing Flow Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF1.**

Anderson Consulting Engineers, Inc.
Appendix Figure F-8. Flushing Flow Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF2.

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Note: Duration does not distinguish between separate events occurring in one year.
### Flushing Flow Spells

*Fort Collins’ Proposed Action Cum Effcts vs Future Conditions*

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</table>

**Note:** Duration does not distinguish between separate events occurring in one year.

Appendix Figure F-9. Flushing Flow Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF3 and NF4.

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells
**Fort Collins’ Proposed Action Cum Effects vs Future Conditions**

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>NF5 / NF6</th>
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<tbody>
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<td>Reach Limits</td>
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<tr>
<td>Flow Node</td>
<td>Livermore Gage</td>
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#### Occurrence and Duration

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#### Duration (days/year)

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**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure F-10. Flushing Flow Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF5 and NF6.**

Anderson Consulting Engineers, Inc.
### Flushing Flow Spells
**Fort Collins' Proposed Action Cum Effects vs Future Conditions**

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<th>Study Reach</th>
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**Occurrence and Duration**

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<th># of Years of Occurrence</th>
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<td>Average Duration (days/year)</td>
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<td>Max Duration (days/year)</td>
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- **Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure F-11. Flushing Flow Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF7.**

Anderson Consulting Engineers, Inc.
Appendix Figure F-12. Flow Duration for Channel Maintenance Flows (top) and Percent Change in Flow Duration (bottom) – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
Appendix Figure F-13. Flow Duration for Movement of Coarse Bed Material at Each Cross Section (top) and Percent Change in Flow Duration (bottom) – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
### Appendix Table F-22. Occurrence of Channel Maintenance Flows, Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2).

<table>
<thead>
<tr>
<th>Study Reach Location</th>
<th>HEC-RAS Cross Section ID</th>
<th>Hydrologic Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 19 Years</th>
<th>Min Event Duration (days)</th>
<th>Ave Event Duration (days)</th>
<th>Max Event Duration (days)</th>
<th>Min Time between Events (days)</th>
<th>Ave Time between Events (days)</th>
<th>Max Time between Events (days)</th>
<th>Total Days</th>
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<tbody>
<tr>
<td>Below Seaman</td>
<td>2788</td>
<td>Below Seaman</td>
<td>2,130</td>
<td>PA5</td>
<td>2 (0-12)</td>
<td>1 (0-1)</td>
<td>2 (0-9.8)</td>
<td>4 (0-49)</td>
<td>1430</td>
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<td>Above Seaman</td>
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<td>Livermore Gage</td>
<td>2,487</td>
<td>Run 2</td>
<td>2 (0-12)</td>
<td>1 (0-1)</td>
<td>2 (0-9.8)</td>
<td>4 (0-49)</td>
<td>1430</td>
<td>3164 (n/a-721.2)</td>
<td>3164 (n/a-3122)</td>
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<td>Run 2</td>
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<td>1 (0-1)</td>
<td>2 (0-9.8)</td>
<td>4 (0-49)</td>
<td>1430</td>
<td>3164 (n/a-721.2)</td>
<td>3164 (n/a-670)</td>
<td>3164 (n/a-670)</td>
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<td>Upstream of Cherokee Park Road</td>
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<td>Livermore Gage</td>
<td>&gt;5,000</td>
<td>Run 2</td>
<td>2 (0-12)</td>
<td>1 (0-1)</td>
<td>2 (0-9.8)</td>
<td>4 (0-49)</td>
<td>1430</td>
<td>3164 (n/a-721.2)</td>
<td>3164 (n/a-670)</td>
<td>3164 (n/a-670)</td>
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<tr>
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<td>Below NPC</td>
<td>&gt;5,000</td>
<td>Run 2</td>
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<td>2 (0-9.8)</td>
<td>4 (0-49)</td>
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<td>3164 (n/a-721.2)</td>
<td>3164 (n/a-670)</td>
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</tr>
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</table>

1. 3-day independence criteria adopted between events for spells analysis.
2. n/a: not applicable, no events occurring in period of record.
3. Results of spells using upper and lower 95% confidence interval hydrology data set.

### Appendix Table F-23. Absolute Difference in the Occurrence of Channel Maintenance Flows, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Study Reach Location</th>
<th>HEC-RAS Cross Section ID</th>
<th>Hydrologic Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Difference Number of Events in 20 Years</th>
<th>Difference Min Event Duration (days)</th>
<th>Difference Ave Event Duration (days)</th>
<th>Difference Max Event Duration (days)</th>
<th>Difference Min Time between Events (days)</th>
<th>Difference Ave Time between Events (days)</th>
<th>Difference Max Time between Events (days)</th>
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<tbody>
<tr>
<td>Downstream of Seaman</td>
<td>2788</td>
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<td>Upstream of Seaman</td>
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</tr>
<tr>
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<td>&gt;5,000</td>
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### Channel Maintenance Flows

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#### Fort Collins' Proposed Action Cum Effects

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#### Future Conditions (95% CI*)

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*Values not shown graphically.

### Fort Collins' Proposed Action Cum Effects

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#### Future Conditions (95% CI*)

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*Values not shown graphically.

### Appendix Figure F-14. Occurrence of Channel Maintenance Flows – Cumulative Effects with Fort Collins' Proposed Action vs Future Conditions.
Appendix Figure F-15. Total Work Done by the Flow on the Channel Boundary – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

Appendix Figure F-16. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
Appendix Figure F-17. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

Appendix Figure F-18. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
## Appendix Table F-24. Reach Averaged Sediment Transport Potential using SIAM – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrology</th>
<th>Total Sediment Transport Potential (tons/yr)</th>
<th>Sediment Transport Potential Sands (tons/yr)</th>
<th>Sediment Transport Potential Gravels (tons/yr)</th>
<th>Sediment Transport Potential Cobbles (tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>PA5</td>
<td>154,450</td>
<td>78,682</td>
<td>75,768</td>
<td>0</td>
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<tr>
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<td>Run 2</td>
<td>154,631</td>
<td>78,745</td>
<td>75,886</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(133439 - 189379)</td>
<td>(71077 - 90611)</td>
<td>(62362 - 98769)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF2</td>
<td>PA5</td>
<td>174,087</td>
<td>85,191</td>
<td>88,896</td>
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<td>176,898</td>
<td>85,634</td>
<td>91,264</td>
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<tr>
<td></td>
<td>Run 2 CI</td>
<td>(149476 - 246036)</td>
<td>(74721 - 106527)</td>
<td>(74755 - 139509)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF3</td>
<td>PA5</td>
<td>34,178</td>
<td>20,551</td>
<td>13,627</td>
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<td>19,925</td>
<td>13,378</td>
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<tr>
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<td>(25689 - 49059)</td>
<td>(15657 - 26339)</td>
<td>(10032 - 22720)</td>
<td>(0 - 0)</td>
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<tr>
<td>NF4</td>
<td>PA5</td>
<td>53,419</td>
<td>27,056</td>
<td>26,363</td>
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<td>26,854</td>
<td>26,824</td>
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<tr>
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<td>(47557 - 101431)</td>
<td>(24259 - 44832)</td>
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<tr>
<td>NF5</td>
<td>PA5</td>
<td>83,202</td>
<td>52,025</td>
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<td>77,859</td>
<td>47,987</td>
<td>29,407</td>
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<td>Run 2 CI</td>
<td>(91324 - 148329)</td>
<td>(48459 - 70807)</td>
<td>(42865 - 77522)</td>
<td>(0 - 0)</td>
</tr>
<tr>
<td>NF6</td>
<td>PA5</td>
<td>100,586</td>
<td>58,735</td>
<td>41,110</td>
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<td>39,998</td>
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<td>Run 2 CI</td>
<td>(71239 - 133774)</td>
<td>(42593 - 69992)</td>
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<td>(74251 - 140252)</td>
<td>(34071 - 53495)</td>
<td>(40180 - 86757)</td>
<td>(0 - 0)</td>
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PA5 = Cumulative Effects with Fort Collins’ Proposed Action Future Conditions Hydrology
Run 2 = Future Conditions Hydrology
Run 2 CI – Future Conditions Hydrology 95% Confidence Intervals

## Appendix Table F-25. Percent Change in Reach Averaged Sediment Transport Potential – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Percent Change Total Sediment Transport Potential</th>
<th>Percent Change Sediment Transport Potential Sands</th>
<th>Percent Change Sediment Transport Potential Gravel</th>
<th>Percent Change Sediment Transport Potential Cobbles</th>
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<tbody>
<tr>
<td>NF1</td>
<td>-0.1%</td>
<td>-0.1%</td>
<td>-0.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF2</td>
<td>-1.6%</td>
<td>-0.5%</td>
<td>-2.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF3</td>
<td>2.6%</td>
<td>3.1%</td>
<td>1.9%</td>
<td>0.0%</td>
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<tr>
<td>NF4</td>
<td>-0.5%</td>
<td>0.8%</td>
<td>-1.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NF5</td>
<td>6.9%</td>
<td>8.4%</td>
<td>4.4%</td>
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</tr>
<tr>
<td>NF6</td>
<td>5.0%</td>
<td>6.7%</td>
<td>2.8%</td>
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</tr>
<tr>
<td>NF7</td>
<td>6.8%</td>
<td>9.0%</td>
<td>5.2%</td>
<td>0.0%</td>
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Appendix Figure F-19. Reach Averaged Sediment Transport Potential (top) and Percent Change in Reach Averaged Sediment Transport Potential – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions (open bars outlined in black) and the Fort Collins’ Proposed Action Cumulative Effects (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based on bed material composition.
2. Second row of plots show the total sediment transport potential in tons/year for Future Conditions (black line) and the Fort Collins’ Proposed Action Cumulative Effects (red line). The peak of the curves indicate the effective discharge.
3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Future Conditions to the Fort Collins’ Proposed Action Cumulative Effects.

Appendix Figure F-20. Distribution of Sediment Transport Potential with Flow, Study Reaches NF1 through NF4 – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.
1. Top row of plots show the annualized flow duration histogram in days/year for Future Conditions (open bars outlined in black) and the Fort Collins' Proposed Action Cumulative Effects (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.

2. Second row of plots show the total sediment transport potential in tons/year for Future Conditions (black line) and the Fort Collins' Proposed Action Cumulative Effects (red line). The peak of the curves indicate the effective discharge.

3. Third row of plots show the % change in sediment transport potential computed in each flow interval from Future Conditions to the Fort Collins' Proposed Action Cumulative Effects.

Appendix Figure F-21. Distribution of Sediment Transport Potential with Flow, Study Reaches NF5 through NF7 – Cumulative Effects with Fort Collins' Proposed Action vs Future Conditions.

Notes:
### Appendix Table F-26. Effective Discharge Spells – Cumulative Effects with Fort Collins’ Proposed Action (PA5) vs Future Conditions (Run 2).

<table>
<thead>
<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Hydrology</th>
<th>Number of Years of Occurrence (out of 19)</th>
<th>% of Years of Occurrence</th>
<th>Min Duration (days/year)</th>
<th>Average Duration (days/year)</th>
<th>Median Duration (days/year)</th>
<th>Max Duration (days/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Above Halligan</td>
<td>300</td>
<td>Run 2</td>
<td>12</td>
<td>63%</td>
<td>3</td>
<td>22.1</td>
<td>19.5</td>
<td>54</td>
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<tr>
<td>NF2</td>
<td>Below Halligan</td>
<td>120</td>
<td>Run 2</td>
<td>19</td>
<td>100%</td>
<td>8</td>
<td>74.3</td>
<td>88</td>
<td>119</td>
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<tr>
<td>NF3</td>
<td>Below NPC</td>
<td>150</td>
<td>Run 2</td>
<td>16</td>
<td>84%</td>
<td>1</td>
<td>22.7</td>
<td>21.5</td>
<td>59</td>
</tr>
<tr>
<td>NF4</td>
<td>Below NPC</td>
<td>120</td>
<td>Run 2</td>
<td>16</td>
<td>84%</td>
<td>1</td>
<td>25.3</td>
<td>25.5</td>
<td>60</td>
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<tr>
<td>NF5</td>
<td>Livermore Gage</td>
<td>340</td>
<td>Run 2</td>
<td>13</td>
<td>68%</td>
<td>1</td>
<td>14.9</td>
<td>10</td>
<td>56</td>
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<tr>
<td>NF6</td>
<td>Livermore Gage</td>
<td>350</td>
<td>Run 2</td>
<td>13</td>
<td>68%</td>
<td>2</td>
<td>16.8</td>
<td>12</td>
<td>56</td>
</tr>
<tr>
<td>NF7</td>
<td>Below Seaman</td>
<td>325</td>
<td>Run 2</td>
<td>14</td>
<td>74%</td>
<td>1</td>
<td>13.8</td>
<td>9</td>
<td>56</td>
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Appendix Table F-27. Absolute Difference in Effective Discharge Spells – Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions.

<table>
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<tr>
<th>Study Reach</th>
<th>Hydrologic Node</th>
<th>Effective Discharge (cfs)</th>
<th>Difference in Number of Years of Occurrence</th>
<th>Difference in % of Years of Occurrence</th>
<th>Difference in Min Duration (days/year)</th>
<th>Difference in Average Duration (days/year)</th>
<th>Difference in Median Duration (days/year)</th>
<th>Difference in Max Duration (days/year)</th>
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</thead>
<tbody>
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<td>Above Halligan</td>
<td>300</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0.0</td>
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<td>0</td>
<td>0%</td>
<td>-6</td>
<td>-6.6</td>
<td>-7.0</td>
<td>1</td>
</tr>
<tr>
<td>NF3</td>
<td>Below NPC</td>
<td>150</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>-2.6</td>
<td>-4.0</td>
<td>-1</td>
</tr>
<tr>
<td>NF4</td>
<td>Below NPC</td>
<td>120</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>-1.8</td>
<td>-6.0</td>
<td>0</td>
</tr>
<tr>
<td>NF5</td>
<td>Livermore Gage</td>
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<td>0%</td>
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Fort Collins' Proposed Action Cum Effects vs Future Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

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Appendix Figure F-22. Effective Discharge Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF1.

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells
Fort Collins' Proposed Action Cum Effects vs Future Conditions

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure F-23. Effective Discharge Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF2.
### Effective Discharge Spells
**Fort Collins' Proposed Action Cum Effects vs Future Conditions**

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**Future Conditions**

- Number of Years of Occurrence: 16
- % Occurrence: 84%
- Min Duration (days/year): 1
- Average Duration (days/year): 25.3
- Median Duration (days/year): 25.5
- Max Duration (days/year): 60

**Fort Collins' Proposed Action Cum Eff (PAS)**

- Number of Years of Occurrence: 16
- % Occurrence: 84%
- Min Duration (days/year): 1
- Average Duration (days/year): 22.7
- Median Duration (days/year): 21.5
- Max Duration (days/year): 59

Note: Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure F-24. Effective Discharge Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF3.**

Anderson Consulting Engineers, Inc.
### Effective Discharge Spells

**Fort Collins' Proposed Action Cum Effects vs Future Conditions**

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**Future Conditions** | **PA5**
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16 | 16
84% | 84%
1 | 1
31.8 | 30.0
35 | 29
67 | 67

**Note:** Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure F-25. Effective Discharge Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF4.**

Anderson Consulting Engineers, Inc.

P-35
### Effective Discharge Spells

**Fort Collins’ Proposed Action Cum Effects vs Future Conditions**

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**Occurrence and Duration**

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**Effective Discharge Spells**

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure F-26. Effective Discharge Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF5.
### Effective Discharge Spells

**Fort Collins’ Proposed Action Cum Effects vs Future Conditions**

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**Note:** Duration does not distinguish between separate events occurring in one year.

---

**Appendix Figure F-27. Effective Discharge Spells, Cumulative Effects with Fort Collins’ Proposed Action vs Future Conditions – Study Reach NF6.**

Anderson Consulting Engineers, Inc.

P-37
### Effective Discharge Spells

**Fort Collins’ Proposed Action Cum Effects vs Future Conditions**

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**Occurrence and Duration**

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<td>Max Duration (days/year)</td>
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**Note:** Duration does not distinguish between separate events occurring in one year.

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PA3 = Fort Collins’ Proposed Action; Current Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI = Current Conditions Hydrology Confidence Intervals
### Appendix Table G.2. Absolute Difference in Exceedance Discharge, Fort Collins’ Proposed Action vs Current Conditions.

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### Appendix Table G.3. Percent Difference in Exceedance Discharge, Fort Collins’ Proposed Action vs Current Conditions.

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Flow Exceedance Discharge vs Stream Distance, Fort Collins’ Proposed Action vs Current Conditions.

Appendix Figure G-5.
Appendix Figure G-6. Percent Change in Flow Exceedance Discharge vs Stream Distance, Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure G-7. Flow Statistics at Model Points along the River, October through February, Fort Collins' Proposed Action vs Current Conditions.
Appendix Figure G-8. Flow Statistics at Model Points along the River, March 1st through April 15th, Fort Collins’ Proposed Action vs Current Conditions.

1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Proposed Action and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Proposed Action hydrologic model results provided by CDM, May 2015.
5. “Data Delivery Mile (DDM)” is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
Appendix Figure G-9. Flow Statistics at Model Points along the River, April 16th through July 15th, Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure G-10. Flow Statistics at Model Points along the River, July 16th through September 30th, Fort Collins’ Proposed Action vs Current Conditions.

Notes
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Proposed Action and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Proposed Action hydrologic model results provided by CDM, May 2015.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
Appendix Figure G-11. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Fort Collins’ Proposed Action vs Current Conditions.
Appendix Table G-4. Annual Maximum Floods for Selected Recurrence Intervals, Fort Collins’ Proposed Action vs Current Conditions.

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### Appendix Table G-6. Flushing Flow Spells – Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

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Flushing Flow Spells - Fort Collins' Proposed Action (PA3) vs Current Conditions (Run 1)

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure G-12. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Laporte Reach Flow Node 2.
### Flushing Flow Spells - Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1)

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#### Occurrence and Duration

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure G-13. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Laporte Reach Flow Node 4.
### Flushing Flow Spells - Fort Collins' Proposed Action (PA3) vs Current Conditions (Run 1)

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*Note: Duration does not distinguish between separate events occurring in one year.*

---

**Appendix Figure G-14.** Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Laporte Reach Flow Node 7.
### Flushing Flow Spells - Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1)

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#### Occurrence and Duration

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure G-15. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Laporte Reach Flow Node 8.
### Flushing Flow Spells - Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1)

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<th>Flow Threshold (cfs)</th>
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### Occurrence and Duration

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<td>Max Duration (days/year)</td>
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### Water Year | Apr | May | Jun | Jul | Aug | Duration (days/year) |
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Note: Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure G-16.** Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Laporte Reach Flow Node 12.
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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure G-17. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 17.

Anderson Consulting Engineers, Inc.  G-22
### Flushing Flow Spells - Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1)

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<td>Location</td>
<td>Lake Canal to Cache la Poudre Reservoir Inlet Canal</td>
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#### Occurrence and Duration

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- **Fort Collins’ Proposed Action (PA3)**
- **Current Conditions (Run 1)**

#### Appendix Figure G-18. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 20.
Appendix Figure G-19. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 23.
Appendix Figure G-20. Flushing Flow Spells, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1), Timnath Reach Flow Node 32.
Appendix Figure G-21. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 2.
Appendix Figure G-22. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 4.
Appendix Figure G-23. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 7.
Appendix Figure G-24. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 8.
Appendix Figure G-25. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 12.
Appendix Figure G-26. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 17.
Appendix Figure G-27. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 20.
Appendix Figure G-28. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 23.
Appendix Figure G-29. Fort Collins’ Proposed Action and Current Conditions Annual Maximum Discharge vs Flushing Flow, Timnath Reach Flow Node 32.
Appendix Figure G-30. Critical Flow and Flow Duration for Channel Maintenance Flows at each Cross Section – Fort Collins’ Proposed Action vs Current Conditions.
### Appendix Table G-8. Occurrence of Channel Maintenance Flows, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

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<th>Flow Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 26 Years</th>
<th>Min Event Duration (days)</th>
<th>Ave Event Duration (days)</th>
<th>Max Event Duration (days)</th>
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2. Uses average dimensionless boundary shear stress = 0.02. Flow thresholds = 10,000 cfs not computed.
3. 3-day independence criteria adopted between events for spells analysis.
4. n/a: not applicable, no events occurring in period of record.
5. Results of spells using upper and lower 95% confidence interval current conditions hydrology data set for Current Conditions
## Appendix Table G-9. Absolute Difference in the Occurrence of Channel Maintenance Flows, Fort Collins’ Proposed Action vs Current Conditions

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Appendix Figure G-31. Critical Flow and Flow Duration for Movement of Coarse Bed Material at each Cross Section – Fort Collins’ Proposed Action vs Current Conditions.
Appendix Table G-10. Occurrence of Flows that Move Coarse Bed Material, Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

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2. Uses average dimensionless boundary shear stress = 0.03. Flow thresholds >10,000 cfs not computed.
3. 3-day independence criteria adopted between events for spills analysis.
4. n/a: not applicable, no events occurring in period of record.
5. Results of spills using upper and lower 95% confidence interval current conditions hydrology data set for Current Conditions.
## Appendix Table G-11. Absolute Difference in the Occurrence of Flows that Move Coarse Bed Material, Fort Collins’ Proposed Action vs Current Conditions.

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Anderson Consulting Engineers, Inc.
Appendix Figure G-32. Laporte Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Fort Collins’ Proposed Action vs Current Conditions.
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Anderson Consulting Engineers, Inc.  
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**Note:** Values not shown graphically.

Appendix Figure G-35. Fort Collins 4 & 5 Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Fort Collins’ Proposed Action vs Current Conditions.
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### River Morphology and Sediment Transport

**North Fork and Main Stem Cache La Poudre River**

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### Appendix Figure G-36.

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#### Appendix Figure G-37. Timnath B and Windsor Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure G-38. Greeley US & CH Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Fort Collins’ Proposed Action vs Current Conditions.

Anderson Consulting Engineers, Inc.
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### Flows that Move Coarse Bed Material

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* Values not shown graphically.

Appendix Figure G-39. Greeley DS Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Fort Collins’ Proposed Action vs Current Conditions.
Appendix Figure G-40. Total Work Done by the Flow on the Channel Boundary – Fort Collins' Proposed Action vs Current Conditions.

Appendix Figure G-41. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Fort Collins' Proposed Action vs Current Conditions.
Appendix Figure G-42. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Fort Collins’ Proposed Action vs Current Conditions.

Appendix Figure G-43. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Fort Collins’ Proposed Action vs Current Conditions.
### Appendix Table G-12. Reach Averaged Sediment Transport Potential using SIAM – Fort Collins’ Proposed Action (PA3) vs Current Conditions (Run 1).

<table>
<thead>
<tr>
<th>SIAM Reach</th>
<th>Hydrology</th>
<th>Total Sediment Transport Potential (tons/yr)</th>
<th>Sediment Transport Potential Sands (tons/yr)</th>
<th>Sediment Transport Potential Gravels (tons/yr)</th>
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<td>(69045 - 150164)</td>
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<td>83,145</td>
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<td>Run 1 CI</td>
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Anderson Consulting Engineers, Inc.  G-51
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<th>SIAM Reach</th>
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<th>Sediment Transport Potential Sands (tons/yr)</th>
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Appendix Table G-13. Percent Change in Reach Averaged Sediment Transport Potential –Fort Collins’ Proposed Action vs Current Conditions.

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<th>Percent Change Total Sediment Transport Potential</th>
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Appendix Figure G-44. Reach Averaged Annual Sediment Transport Potential for Sand, Gravel, and Cobbles (tons/year) – Fort Collins’ Proposed Action vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Proposed Action Hydrology (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/year, which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Proposed Action (red line). The peak of the curves indicates effective discharge.
2. Second row of plots shows the total sediment transport potential in tons/year, which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Proposed Action (red line).
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Proposed Action, shown on the second row of plots, computed in each flow interval.

Appendix Figure G-45. Distribution of Sediment Transport Potential with Flow-Laporte Reach, Fort Collins’ Proposed Action vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Proposed Action Hydrology (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Proposed Action (red line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Proposed Action, shown on the second row of plots, computed in each flow interval.

Appendix Figure G-46. Distribution of Sediment Transport Potential with Flow-Fort Collins Reaches 1 to 4, Fort Collins’ Proposed Action vs Current Conditions.
Sediment Transport Potential (ton/year)

1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Proposed Action Hydrology (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.

2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Proposed Action (red line). The peak of the curves indicates effective discharge.

3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Proposed Action, shown on the second row of plots, computed in each flow interval.

Appendix Figure G-47. Distribution of Sediment Transport Potential with Flow–Fort Collins Reach 5 to Windsor Reach, Fort Collins’ Proposed Action vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Proposed Action Hydrology (red bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Proposed Action (red line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Proposed Action, shown on the second row of plots, computed in each flow interval.

Appendix Figure G-48. Distribution of Sediment Transport Potential with Flow-Greeley US Reach to Greeley DS Reach, Fort Collins’ Proposed Action vs Current Conditions.
Appendix H: Main Stem Figures and Tables - Gravel Pits Alternative (GP3) vs Current Conditions (Run 1)

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Appendix Table H-3. Percent Difference in Exceedance Discharge, Gravel Pits Alternative vs Current Conditions. ............................................................................................................................................... H-6

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Appendix Table H-10. Occurrence of Flows that Move Coarse Bed Material, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1). ............................................................................................................................................. H-39

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<table>
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<tr>
<th>Study Reach</th>
<th>Flow Node</th>
<th>Upstream Location</th>
<th>Upstream Station (ft)</th>
<th>Hydrology</th>
<th>1% Exceedance Probability Q (cfs)</th>
<th>2% Exceedance Probability Q (cfs)</th>
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<td>2.816</td>
<td>2.307</td>
<td>1.568</td>
<td>1.001</td>
<td>0.548</td>
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<td>2.307</td>
<td>1.568</td>
<td>1.001</td>
<td>0.548</td>
<td>0.75</td>
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<td>1.82</td>
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<tr>
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GP3 = Gravel Pits Alternative Current Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI = Current Conditions Hydrology Confidence Intervals
Appendix Table H-2. Absolute Difference in Exceedance Discharge, Gravel Pits Alternative vs Current Conditions.

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<th>Upstream Station (ft)</th>
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Appendix Table H-3. Percent Difference in Exceedance Discharge, Gravel Pits Alternative vs Current Conditions.

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Appendix Figure H-5. Flow Exceedance Discharge vs Stream Distance, Gravel Pits Alternative vs Current Conditions.
Appendix Figure H-6. Percent Change in Flow Exceedance Discharge vs Stream Distance, Gravel Pits Alternative vs Current Conditions.
Appendix Figure H-7. Flow Statistics at Model Points along the River, October through February, Gravel Pits Alternative vs Current Conditions.

1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Gravel Pit Alternative and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Gravel Pit Alternative hydrologic model results provided by CDM, May 2015.
5. “Data Delivery Mile (DDM)” is a reference used by CDM and is representative of river distance downstream of Munroe Canal.

Anderson Consulting Engineers, Inc.
Appendix Figure H-8. Flow Statistics at Model Points along the River, March 1st through April 15th, Gravel Pits Alternative vs Current Conditions.

1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Gravel Pit Alternative and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Gravel Pit Alternative hydrologic model results provided by CDM, May 2013.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
Appendix Figure H-9. Flow Statistics at Model Points along the River, April 16th through July 15th, Gravel Pits Alternative vs Current Conditions.

Notes
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Proposed Action and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Gravel Pit Alternative hydrologic model results provided by CDM, May 2015.
5. “Data Delivery Mile (DDM)” is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
Appendix Figure H-10. Flow Statistics at Model Points along the River, July 16th through September 30th, Gravel Pits Alternative vs Current Conditions.

Notes
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Gravel Pit Alternative and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Gravel Pit Alternative hydrologic model results provided by CDM, May 2015.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
Appendix Figure H-11. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Gravel Pits Alternative vs Current Conditions.
Appendix Table H-4. Annual Maximum Floods for Selected Recurrence Intervals, Gravel Pits Alternative vs Current Conditions.

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### Appendix Table H-5. Percent Change in Maximum Floods, Gravel Pits Alternative vs Current Conditions.

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Appendix Table H-6. Flushing Flow Spells – Gravel Pits Alternative (GP3) vs Current Conditions (Run 1).

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### Flushing Flow Spells - Gravel Pit Alternative (GP3) vs Current Conditions (Run 1)

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### Occurrence and Duration Table

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Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure H-12.
Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Laporte Reach Flow Node 2.
### Flushing Flow Spells - Gravel Pit Alternative (GP3) vs Current Conditions (Run 1)

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#### Note
Duration does not distinguish between separate events occurring in one year.

### Appendix Figure H-13
Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Laporte Reach Flow Node 4.
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- **Note:** Duration does not distinguish between separate events occurring in one year.

### Appendix Figure H-14. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Laporte Reach Flow Node 7.
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#### Note:
- Duration does not distinguish between separate events occurring in one year.

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### Appendix Figure H-15. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Laporte Reach Flow Node 8.
### Flushing Flow Spells - Gravel Pit Alternative (GP3) vs Current Conditions (Run 1)

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*Note: Duration does not distinguish between separate events occurring in one year.*

#### Occurrence and Duration

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**Appendix Figure H-16. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Laporte Reach Flow Node 12.**
### Flushing Flow Spells - Gravel Pit Alternative (GP3) vs Current Conditions (Run 1)

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**Note:** Duration does not distinguish between separate events occurring in one year.

### Occurrence and Duration

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**Appendix Figure H-17. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 17.**
### Flushing Flow Spells - Gravel Pit Alternative (GP3) vs Current Conditions (Run 1)

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### Occurrence and Duration

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| Note: Duration does not distinguish between separate events occurring in one year. |

### Appendix Figure H-18. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 20.
Appendix Figure H-19. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 23.
### Flushing Flow Spells - Gravel Pit Alternative (GP3) vs Current Conditions (Run 1)

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- **Gravel Pit Alternative (GP3)**
- **Current Conditions (Run 1)**

Note: Duration does not distinguish between separate events occurring in one year.

### Appendix Figure H-20. Flushing Flow Spells, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1), Timnath Reach Flow Node 32.
Appendix Figure H-21. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 2.
Appendix Figure H-22. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 4.
Appendix Figure H-23. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 7.
Appendix Figure H-24. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 8.
Appendix Figure H-25. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 12.
Appendix Figure H-26. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 17.
Appendix Figure H-27. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 20.
Appendix Figure H-28. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 23.
Appendix Figure H-29. Gravel Pits Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Timnath Reach Flow Node 32.
Appendix Figure H-30. Critical Flow and Flow Duration for Channel Maintenance Flows at each Cross Section – Gravel Pits Alternative vs Current Conditions.
### Appendix Table H-8. Occurrence of Channel Maintenance Flows, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1).

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¹ For location of representative sections, see Appendix A-1Aa, Baseline Report (Anderson Consulting Engineers, Inc., 2013).
² Uses average dimensionless boundary shear stress = 0.02. Flow thresholds >10,000 cfs not computed.
³ 3-day independence criteria adopted between events for spills analysis.
⁴ n/a: not applicable, no events occurring in period of record.
⁵ Results of spills using upper and lower 95% confidence interval-current conditions hydrology data set for Current Conditions.
## Appendix Table H-9. Absolute Difference in the Occurrence of Channel Maintenance Flows, Gravel Pits Alternative vs Current Conditions

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<th>Flow Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Difference Number of Events in 26 Years</th>
<th>Difference Min Event Duration (days)</th>
<th>Difference Ave Event Duration (days)</th>
<th>Difference Max Event Duration (days)</th>
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Appendix Figure H-31. Critical Flow and Flow Duration for Movement of Coarse Bed Material at each Cross Section – Gravel Pits Alternative vs Current Conditions.
## Appendix Table H-10. Occurrence of Flows that Move Coarse Bed Material, Gravel Pits Alternative (GP3) vs Current Conditions (Run 1).

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$^3$ For location of representative sections, see Appendix A-10; Baseline Report (Anderson Consulting Engineers, Inc., 2013).

$^4$ Uses average dimensionless boundary shear stress = 0.03. Flow thresholds >10,000 cfs not computed.

$^5$ 3-day independence criteria adopted between events for spills analysis.

$^6$ n/a: not applicable, no events occurring in period of record.

$^7$ Results of spills using upper and lower 95% confidence interval-current conditions hydrology data set for Current Conditions.

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<th>Difference Number of Events in 26 Years</th>
<th>Difference AVE Event Duration (days)</th>
<th>Difference MAX Event Duration (days)</th>
<th>Difference Min Time between Events (days)</th>
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Note: Values in the table represent differences in the occurrence of flows that move coarse bed material, with differences in number of events, average event duration, maximum event duration, minimum time between events, average time between events, and maximum time between events, all compared to current conditions.
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* Values not shown graphically.

### Table: Flows that Move Coarse Bed Material

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<th>Flow Threshold (cfs)</th>
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No Spells

### Table: Flows that Move Coarse Bed Material

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<th>Bed Material d (mm)</th>
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### Note
Appendix Figure H-32. Laporte Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pits Alternative vs Current Conditions.
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* Values not shown graphically.

Appendix Figure H-33. Laporte and Fort Collins 1 Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pit Alternative vs Current Conditions.
### Channel Maintenance Flows

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**Appendix Figure H-34. Fort Collins 2 & 3 Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pits Alternative vs Current Conditions.**
## Appendix Figure H-35. Fort Collins 4 & 5 Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pits Alternative vs Current Conditions.

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**Flows that Coarse Move Bed Material**

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**Appendix Figure H-36. Fort Collins 6 and Timnath A Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pits Alternative vs Current Conditions.**

**Table 1: Channel Maintenance Flows**

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* Values not shown graphically.
### PROJECT EFFECTS TECHNICAL REPORT

**RIVER Morphology and Sediment Transport**

**North Fork and Main Stem Cache La Poudre River**

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**Legend:**
- Critical Shear Stress: 0.02
- Reach: Windsor
- Representative Section: 141905
- Bed Material d₅₀ (mm): 43
- Bed Threshold (cfs): 3,892

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**Table 2: Channel Maintenance Flows**

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**Legend:**
- Critical Shear Stress: 0.02
- Reach: Windsor
- Representative Section: 141905
- Bed Material d₅₀ (mm): 43
- Bed Threshold (cfs): 3,892

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**Appendix Figure H-37.** Timnath B and Windsor Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pits Alternative vs Current Conditions.
**Appendix Figure H-38. Greeley US & CH Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Gravel Pits Alternative vs Current Conditions.**

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<td>2001</td>
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<td>Current Conditions (95% CI*)</td>
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<td>Number of Events</td>
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<td>2004</td>
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<tr>
<td>Max Duration (days)</td>
<td>111</td>
<td>2005</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Min Duration (days)</td>
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<td></td>
<td></td>
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<tr>
<td>Total Days</td>
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</tbody>
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* Values not shown graphically.
Appendix Figure H-40. Total Work Done by the Flow on the Channel Boundary – Gravel Pits Alternative vs Current Conditions.

Appendix Figure H-41. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Gravel Pits Alternative vs Current Conditions.
Appendix Figure H-42. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Gravel Pits Alternative vs Current Conditions.

Appendix Figure H-43. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Gravel Pits Alternative vs Current Conditions.
## Appendix Table H-12. Reach Averaged Sediment Transport Potential using SIAM – Gravel Pits Alternative (GP3) vs Current Conditions (Run 1).

<table>
<thead>
<tr>
<th>SIAM Reach</th>
<th>Hydrology</th>
<th>Total Sediment Transport Potential (tons/yr)</th>
<th>Sediment Transport Potential Sands (tons/yr)</th>
<th>Sediment Transport Potential Gravels (tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Laporte A1</td>
<td>GP3</td>
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<td>130,682</td>
<td>106,860</td>
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<td>132,935</td>
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<td>(178294 - 308057)</td>
<td>(109250 - 157893)</td>
<td>(69045 - 150164)</td>
</tr>
<tr>
<td>2 Laporte A2</td>
<td>GP3</td>
<td>127,819</td>
<td>79,905</td>
<td>47,914</td>
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<td>Run 1</td>
<td>131,091</td>
<td>81,977</td>
<td>49,114</td>
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<tr>
<td></td>
<td>Run 1 CI</td>
<td>(93355 - 173512)</td>
<td>(65276 - 100585)</td>
<td>(28079 - 72926)</td>
</tr>
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<td>3 Laporte A3</td>
<td>GP3</td>
<td>127,132</td>
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<tr>
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<td>Run 1 CI</td>
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<td>(70924 - 102143)</td>
<td>(28182 - 64088)</td>
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<td>153,948</td>
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<td>Run 1 CI</td>
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<td>(249716 - 302184)</td>
<td>(132948 - 179004)</td>
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<td>Run 1 CI</td>
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<td>(23363 - 53027)</td>
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<td>Run 1 CI</td>
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<td>(19152 - 46753)</td>
<td>(4220 - 21612)</td>
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<td>32,584</td>
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<td>(7074 - 20739)</td>
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<td>8 FC2B</td>
<td>GP3</td>
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<td>8,560</td>
<td>996</td>
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<td>8,590</td>
<td>996</td>
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<tr>
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<td>Run 1 CI</td>
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<td>(4783 - 13449)</td>
<td>(406 - 1820)</td>
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<td>GP3</td>
<td>190,191</td>
<td>122,520</td>
<td>67,671</td>
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<td>Run 1</td>
<td>192,236</td>
<td>123,858</td>
<td>68,378</td>
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<td>GP3</td>
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<td>42,429</td>
<td>7,280</td>
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<td>(34270 - 53920)</td>
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<td>15,816</td>
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<td>GP3</td>
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<td>GP3</td>
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<td>Run 1 CI</td>
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<td>Sediment Transport Potential Gravels (tons/yr)</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
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Appendix Table H-13. Percent Change in Reach Averaged Sediment Transport Potential –Gravel Pits Alternative vs Current Conditions.

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<th>Percent Change Total Sediment Transport Potential</th>
<th>Percent Change Sediment Transport Potential Sands</th>
<th>Percent Change Sediment Transport Potential Gravel</th>
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<td>1 Laporte A1</td>
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<td>-1.3%</td>
</tr>
<tr>
<td>2 Laporte A2</td>
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<td>-2.5%</td>
<td>-2.4%</td>
</tr>
<tr>
<td>3 Laporte A3</td>
<td>-2.2%</td>
<td>-2.0%</td>
<td>-2.6%</td>
</tr>
<tr>
<td>4 Laporte A4</td>
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<td>-1.9%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>5 Laporte A5</td>
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</tr>
<tr>
<td>6 FC1</td>
<td>0.2%</td>
<td>-0.2%</td>
<td>1.4%</td>
</tr>
<tr>
<td>7 FC2A</td>
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</tr>
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<td>-0.4%</td>
<td>-0.7%</td>
</tr>
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<td>-1.1%</td>
<td>-1.0%</td>
</tr>
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<td>-0.9%</td>
</tr>
<tr>
<td>11 FC5</td>
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<td>-0.8%</td>
<td>-0.5%</td>
</tr>
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</tr>
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<td>13 Timnath A</td>
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<td>0.0%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>14 Timnath B</td>
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<td>2.2%</td>
<td>1.3%</td>
</tr>
<tr>
<td>15 Windsor</td>
<td>2.4%</td>
<td>3.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>16 Greeley US A</td>
<td>1.3%</td>
<td>1.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>17 Greeley US B</td>
<td>1.5%</td>
<td>1.8%</td>
<td>0.5%</td>
</tr>
<tr>
<td>18 Greeley Ch A</td>
<td>1.6%</td>
<td>2.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>19 Greeley Ch B</td>
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<td>1.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>20 Greeley DS</td>
<td>2.1%</td>
<td>2.1%</td>
<td>1.6%</td>
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</tbody>
</table>
Appendix Figure H-44. Reach Averaged Annual Sediment Transport Potential for Sand, Gravel, and Cobbles (tons/year) – Gravel Pits Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Gravel Pit Alternative Hydrology (green bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Gravel Pit Alternative (green line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Gravel Pit Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure H-45. Distribution of Sediment Transport Potential with Flow—Laporte Reach, Gravel Pits Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Gravel Pit Alternative Hydrology (green bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Gravel Pit Alternative (green line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Gravel Pit Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure H-46. Distribution of Sediment Transport Potential with Flow-Fort Collins Reaches 1 to 4, Gravel Pits Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Gravel Pit Alternative Hydrology (green bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Gravel Pit Alternative (green line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Gravel Pit Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure H-47. Distribution of Sediment Transport Potential with Flow—Fort Collins Reach 5 to Windsor Reach, Gravel Pits Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Gravel Pit Alternative Hydrology (green bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Gravel Pit Alternative (green line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Gravel Pit Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure H-48. Distribution of Sediment Transport Potential with Flow-Greeley US Reach to Greeley DS Reach, Gravel Pits Alternative vs Current Conditions.
Appendix I: Main Stem Figures and Tables - Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1)

List of Appendix Tables

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AR3 = Agricultural Reservoirs Alternative Current Conditions Hydrology
Run 1 = Current Conditions Hydrology
Run 1 CI = Current Conditions Hydrology Confidence Intervals
Appendix Table I-2. Absolute Difference in Exceedance Discharge, Agricultural Reservoirs Alternative vs Current Conditions.

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Appendix Table I-3. Percent Difference in Exceedance Discharge, Agricultural Reservoirs Alternative vs Current Conditions.

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Appendix Figure I-5. Flow Exceedance Discharge vs Stream Distance, Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Figure I-6. Percent Change in Flow Exceedance Discharge vs Stream Distance, Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Figure I-7. Flow Statistics at Model Points along the River, October through February, Agricultural Reservoirs Alternative vs Current Conditions.

Notes

1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Agricultural Reservoir Alternative and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Agricultural Reservoir Alternative hydrologic model results provided by CDM, May 2015.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.

2. Lines on bottom graph join the % change between the Agricultural Reservoir Alternative and Current Conditions in mean and maximum daily flows.

3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.

4. Data from the Agricultural Reservoir Alternative hydrologic model results provided by CDM, May 2015.

5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.

Appendix Figure I-8. Flow Statistics at Model Points along the River, March 1st through April 15th, Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Figure I-9. Flow Statistics at Model Points along the River, April 16th through July 15th, Agricultural Reservoirs Alternative vs Current Conditions.

Notes
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Agricultural Reservoir Alternative and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Agricultural Reservoir Alternative hydrologic model results provided by CDM, May 2015.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Agricultural Reservoir Alternative and Current Conditions in mean and maximum daily flows.
3. Data from Current Conditions Run 1 hydrologic model results provided by CDM, August 2012.
4. Data from the Agricultural Reservoir Alternative hydrologic model results provided by CDM, May 2015.
5. “Data Delivery Mile (DDM)” is a reference used by CDM and is representative of river distance downstream of Munroe Canal.

Appendix Figure I-10. Flow Statistics at Model Points along the River, July 16th through September 30th, Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Figure I-11. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Table I-4. Annual Maximum Floods for Selected Recurrence Intervals, Agricultural Reservoirs Alternative vs Current Conditions.

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# Appendix Table I-5. Percent Change in Maximum Floods, Agricultural Reservoirs Alternative vs Current Conditions.

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<th>Upstream Station (ft)</th>
<th>Percent Difference 2-Year Q</th>
<th>Percent Difference 10-Year Q</th>
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<td>322,944</td>
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<tr>
<td>Laporte</td>
<td>2</td>
<td>North Fork Confluence</td>
<td>315,220</td>
<td>-1%</td>
<td>-1%</td>
<td>0%</td>
</tr>
<tr>
<td>Laporte</td>
<td>4</td>
<td>Poudre Valley Canal</td>
<td>295,484</td>
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<td>-1%</td>
<td>0%</td>
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<tr>
<td>Laporte</td>
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<td>Hansen Supply Canal</td>
<td>287,670</td>
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<td>-1%</td>
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<td>Larimer County Canal</td>
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<td>-1%</td>
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<tr>
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<tr>
<td>Timnath</td>
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<td>-1%</td>
<td>-1%</td>
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<td>0%</td>
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<tr>
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<tr>
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### Appendix Table I-6. Flushing Flow Spells – Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1).

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<th>Ave Duration (days/yr)</th>
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<th>Max Duration (days/yr)</th>
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### Appendix Table I-7. Absolute Difference in Flushing Flow Spells – Agricultural Reservoirs Alternative – Current Conditions.

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Appendix Figure I-12. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Laporte Reach Flow Node 2.
Appendix Figure I-13. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Laporte Reach Flow Node 4.
### Flushing Flow Spells - Agricultural Reservoir Alternative (AR3) vs Current Conditions (Run 1)

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**Note:** Duration does not distinguish between separate events occurring in one year.

### Appendix Figure I-14. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Laporte Reach Flow Node 7.
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- **Agricultural Reservoir Alternative (AR3)**
- **Current Conditions (Run 1)**

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Note: Duration does not distinguish between separate events occurring in one year.

## Appendix Figure I-15. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Laporte Reach Flow Node 8.
### Flushing Flow Spells - Agricultural Reservoir Alternative (AR3) vs Current Conditions (Run 1)

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### Appendix Figure I-16. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Laporte Reach Flow Node 12.
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**Occurrence and Duration**

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**Legend**
- Agricultural Reservoir Alternative (AR3)
- Current Conditions (Run 1)

Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure I-17. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 17.
Appendix Figure I-18. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 20.
### Flushing Flow Spells - Agricultural Reservoir Alternative (AR3) vs Current Conditions (Run 1)

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**Flushing Flow Spells - Agricultural Reservoir Alternative (AR3) vs Current Conditions (Run 1), Fort Collins Reach Flow Node 23.**

Note: Duration does not distinguish between separate events occurring in one year.
Appendix Figure I-20. Flushing Flow Spells, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1), Timnath Reach Flow Node 32.
Appendix Figure I-21. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 2.
Appendix Figure I-22. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 4.
Appendix Figure I-23. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 7.
Appendix Figure I-25. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 12.
Appendix Figure I-26. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 17.
Appendix Figure I-27. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 20.
Appendix Figure I-28. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 23.
Appendix Figure I-29. Agricultural Reservoirs Alternative and Current Conditions Annual Maximum Discharge vs Flushing Flow, Timnath Reach Flow Node 32.
Appendix Figure I-30. Critical Flow and Flow Duration for Channel Maintenance Flows at each Cross Section – Agricultural Reservoirs Alternative vs Current Conditions.
### Appendix Table I-8. Occurrence of Channel Maintenance Flows, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1).

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¹ For location of representative sections, see Appendix A-Attias, Baseline Report (Anderson Consulting Engineers, Inc. 2013).
² Uses average dimensionless boundary shear stress = 0.02. Flow thresholds >10,000 cfs not computed.
³ 3-day independence criteria adopted between events for spills analysis.
⁴ n/a: not applicable, no events occurring in period of record.
⁵ Flow data using upper and lower 95% confidence interval current conditions hydrology data set for Current Conditions.
### Appendix Table I-9. Absolute Difference in the Occurrence of Channel Maintenance Flows, Agricultural Reservoir Alternative vs Current Conditions

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<th>Channel Maintenance Flow (cfs)</th>
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<th>Difference Min Event Duration (days)</th>
<th>Difference Ave Event Duration (days)</th>
<th>Difference Max Event Duration (days)</th>
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Appendix Figure I-31. Critical Flow and Flow Duration for Movement of Coarse Bed Material at each Cross Section – Agricultural Reservoirs Alternative vs Current Conditions.
## Appendix Table I-10. Occurrence of Flows that Move Coarse Bed Material, Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1).

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¹ For location of representative sections, see Appendix A-Atlas, Baseline Report (Anderson Consulting Engineers, Inc., 2013).
² Uses average dimensionless boundary shear stress = 0.033. Flow thresholds >10,000 cfs not computed.
³ 3-day independence criteria adopted between events for spells analysis.
⁴ n/a: not applicable; no events occurring in period of record.
⁵ Results of spells using upper and lower 95% confidence interval current conditions hydrology data set for Current Conditions.

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<th>Surface Bed Material $d_{50}$ (mm)</th>
<th>Flow Node</th>
<th>Flow That Moves Coarse Bed Material (cfs)</th>
<th>Difference Number of Events in 26 Years</th>
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Appendix Figure I-32. Laporte Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoir Alternative vs Current Conditions.
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### Flows that Move Coarse Bed Material

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### Appendix Figure I-33


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Anderson Consulting Engineers, Inc.
### Channel Maintenance Flows

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### Flows that Move Coarse Bed Material

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* Values not shown graphically.

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Appendix Figure I-34. Fort Collins 2 & 3 Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoir Alternative vs Current Conditions.

Anderson Consulting Engineers, Inc. I-43
### Appendix Figure I-35. Fort Collins 4 & 5 Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoirs Alternative vs Current Conditions.

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Appendix Figure I-36. Fort Collins 6 and Timnath A Reaches. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoirs Alternative vs Current Conditions.
### Appendix Figure I-37. Timnath B and Windsor Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoirs Alternative vs Current Conditions.

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Appendix Figure I-38. Greeley US & CH Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoirs Alternative vs Current Conditions.
## Appendix Figure I-39. Greeley DS Reach. Occurrence of Threshold Flows for Channel Maintenance and Movement of Coarse Bed Material, Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Figure I-40. Total Work Done by the Flow on the Channel Boundary – Agricultural Reservoirs Alternative vs Current Conditions.

Appendix Figure I-41. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Agricultural Reservoirs Alternative vs Current Conditions.
Appendix Figure I-42. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Agricultural Reservoirs Alternative vs Current Conditions.

Appendix Figure I-43. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Agricultural Reservoirs Alternative vs Current Conditions.
## Appendix Table I-12. Reach Averaged Sediment Transport Potential using SIAM – Agricultural Reservoirs Alternative (AR3) vs Current Conditions (Run 1).

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### Appendix Table I-13. Percent Change in Reach Averaged Sediment Transport Potential – Agricultural Reservoirs Alternative vs Current Conditions.

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Appendix Figure I-44. Reach Averaged Annual Sediment Transport Potential for Sand, Gravel, and Cobble (tons/year) – Agricultural Reservoirs Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Agricultural Reservoir Alternative Hydrology (orange bars). The plots also show the relationship between discharge and sediment transport potential in tons/year independent of flow duration. Sediment transport potential is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Agricultural Reservoir Alternative (orange line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Agricultural Reservoir Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure I-45. Distribution of Sediment Transport Potential with Flow-Laporte Reach, Agricultural Reservoirs Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Agricultural Reservoir Alternative Hydrology (orange bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential is now also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Agricultural Reservoir Alternative (orange line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Agricultural Reservoir Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure I-46. Distribution of Sediment Transport Potential with Flow-Fort Collins Reaches 1 to 4, Agricultural Reservoirs Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Agricultural Reservoir Alternative Hydrology (orange bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential is shown as an area under the curve.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Agricultural Reservoir Alternative (orange line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Agricultural Reservoir Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure I-47. Distribution of Sediment Transport Potential with Flow-Fort Collins Reach 5 to Windsor Reach, Agricultural Reservoirs Alternative vs Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for Current Conditions Hydrology (open bars outlined in black) and Agricultural Reservoir Alternative Hydrology (orange bars). The plots also show the relationship between discharge and sediment transport potential in tons/year independent of flow duration. Sediment transport potential is shown is computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for Current Conditions (black line) and Agricultural Reservoir Alternative (orange line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from Current Conditions to Agricultural Reservoir Alternative, shown on the second row of plots, computed in each flow interval.

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Run 3a = NISP Current Conditions Hydrology

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Appendix Table J-3. Percent Difference in Exceedance Discharge, Expanded Glade Alternative vs NISP Current Conditions.

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Appendix Figure J-5. Flow Exceedance Discharge vs Stream Distance, Expanded Glade Alternative vs NISP Current Conditions.
Appendix Figure J-6. Percent Change in Flow Exceedance Discharge vs Stream Distance, Expanded Glade Alternative vs NISP Current Conditions.
Appendix Figure J-7. Flow Statistics at Model Points along the River, October through February, Expanded Glade Alternative vs NISP Current Conditions.

Notes

1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Expanded Glade Alternative and Current Conditions in mean and maximum daily flows.
3. Data from NISP Current Conditions Run 3a hydrologic model results provided by CDM. June 2015.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.
Notes
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Expanded Glade Alternative and Current Conditions in mean and maximum daily flows.
3. Data from NISP Current Conditions Run 3a hydrologic model results provided by CDM. June 2013.
5. "Data Delivery Mile (DDM)" is a reference used by CDM and is representative of river distance downstream of Munroe Canal.

Appendix Figure J-8. Flow Statistics at Model Points along the River, March 1st through April 15th, Expanded Glade Alternative vs NISP Current Conditions.
1. Lines on top graph join minimum, mean, and maximum of daily flows at hydrologic model nodes along the river for specified month or season.
2. Lines on bottom graph join the % change between the Expanded Glade Alternative and Current Conditions in mean and maximum daily flows.
3. Data from NISP Current Conditions Run 3a hydrologic model results provided by CDM. June 2013.
5. “Data Delivery Mile (DDM)” is a reference used by CDM and is representative of river distance downstream of Munroe Canal.

Appendix Figure J-9. Flow Statistics at Model Points along the River, April 16th through July 15th, Expanded Glade Alternative vs NISP Current Conditions.
Appendix Figure J-10. Flow Statistics at Model Points along the River, July 16th through September 30th, Expanded Glade Alternative vs NISP Current Conditions.
Appendix Figure J-11. Flood Frequency Discharge Data Based on Maximum Daily Flow vs Stream Distance, Expanded Glade Alternative vs NISP Current Conditions.

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### Appendix Table J-5. Percent Change in Maximum Floods, Expanded Glade Alternative vs NISP Current Conditions.

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<th>Percent Difference 10-Year Q</th>
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<td>North Fork Confluence</td>
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<td>0%</td>
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<td>1%</td>
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<tr>
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<td>1%</td>
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Appendix Table J-6. Flushing Flow Spells – Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a).

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Note: Duration does not distinguish between separate events occurring in one year.

#### Appendix Figure J-12. Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Laporte Reach Flow Node 2.
Appendix Figure J-13. Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Laporte Reach Flow Node 4.
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### Note:
Duration does not distinguish between separate events occurring in one year.

Appendix Figure J-14. Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Laporte Reach Flow Node 7.
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### Flushing Flow Spells - Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a)

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**Note:** Duration does not distinguish between separate events occurring in one year.

### Appendix Figure J-15. Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Laporte Reach Flow Node 8.
### Flushing Flow Spells - Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a)

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**Location**: Little Cache la Poudre Ditch to Larimer & Weld Canal

**Flow Node**: 12

**Flow Threshold (cfs)**: 1,797

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**Appendix Figure J-16.** Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Laporte Reach Flow Node 12.
### Flushing Flow Spells - Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a)

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**Study Reach**: Fort Collins  
**Location**: Larimer & Weld Canal to Lake Canal  
**Flow Node**: 17  
**Flow Threshold (cfs)**: 1,381

### Occurrence and Duration

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Appendix Figure J-17. Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Fort Collins Reach Flow Node 17.
### Flushing Flow Spells - Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a)

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#### Flushing Flow Spells

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#### Note
Duration does not distinguish between separate events occurring in one year.

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**Appendix Figure J-18.** Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Fort Collins Reach Flow Node 20.
Flushing Flow Spells - Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a)

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Note: Duration does not distinguish between separate events occurring in one year.

Appendix Figure J-19. Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Fort Collins Reach Flow Node 23.
### Flushing Flow Spells - Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a)

| Study Reach | Timnath |
| Location    | Fossil Creek Reservoir Inlet to New Cache la Poudre Ditch |
| Flow Node   | 32 |
| Flow Threshold (cfs) | 972 |
| **Occurrence and Duration** | Run 3a | EG3 |
| # of Years of Occurrence | 11 | 12 |
| % Occurrence | 42% | 46% |
| Min Duration (days/year) | 2 | 1 |
| Average Duration (days/year) | 20.8 | 19.3 |
| Median Duration (days/year) | 13 | 12.5 |
| Max Duration (days/year) | 71 | 69 |

### Run 3a EG3
- NISP Current Conditions (Run 3a)

Note: Duration does not distinguish between separate events occurring in one year.

**Appendix Figure J-20.** Flushing Flow Spells, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a), Timnath Reach Flow Node 32.
Appendix Figure J-21. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 2.
Appendix Figure J-23. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 7.
Appendix Figure J-25. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Laporte Reach Flow Node 12.
Appendix Figure J-26. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 17.
Appendix Figure J-27. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 20.
Appendix Figure J-28. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Fort Collins Reach Flow Node 23.
Appendix Figure J-29. Expanded Glade Alternative and NISP Current Conditions Annual Maximum Discharge vs Flushing Flow, Timnath Reach Flow Node 32.
Appendix Figure J-30. Critical Flow and Flow Duration for Channel Maintenance Flows at each Cross Section – Expanded Glade Alternative vs NISP Current Conditions.
<table>
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<th>Representative Section</th>
<th>Surface Bed Material d90 (mm)</th>
<th>Flow Node</th>
<th>Channel Maintenance Flow (cfs)</th>
<th>Hydrology</th>
<th>Number of Events in 26 Years</th>
<th>Ave Event Duration (days)</th>
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* For location of representative sections, see Appendix A-Albue, Baseline Report (Anderson Consulting Engineers, Inc., 2013).
* b Uses average dimensionless boundary shear stress = 0.02. Flow thresholds >10,000 cfs not computed.
* c 3-day independence criteria adopted when events for spills analysis.
* d n/a: not applicable, no events occurring in period of record.

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Anderson Consulting Engineers, Inc.
Appendix Figure J-31. Critical Flow and Flow Duration for Movement of Coarse Bed Material at each Cross Section – Expanded Glade Alternative vs NISP Current Conditions.

Anderson Consulting Engineers, Inc.
## Appendix Table J-10. Occurrence of Flows that Move Coarse Bed Material, Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a).

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¹ For location of representative sections, see Appendix A-10a, Baseline Report (Anderson Consulting Engineers, Inc., 2013).

² Uses average dimensionless boundary shear stress = 0.03. Flow thresholds >10,000 cfs not computed.

³ 3-day independence criteria adopted between events for spells analysis.

4a) n/a: not applicable, no events occurring in period of record.

5 Results of spells using upper and lower 95% confidence interval NISP Current Conditions hydrology data set for NISP Current Conditions.

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<th>Difference Ave Event Duration (days)</th>
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**No Spells**

### Expanded Glade Alternative vs NISP Current Conditions

#### Critical Shear Stress

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Appendix Figure J-32. Laporte Reaches. Occurrence of Threshold Flows, Expanded Glade Alternative vs NISP Current Conditions.
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Appendix Figure J-33. Laporte and Fort Collins 1 Reaches. Occurrence of Threshold Flows, Expanded Glade Alternative vs NISP Current Conditions.
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Appendix Figure J-34. Fort Collins 2 & 3 Reaches. Occurrence of Threshold Flows, Expanded Glade Alternative vs NISP Current Conditions.
### Table: Channel Maintenance Flows

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<th>Critical Shear Stress</th>
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<th>Bed Material d_{50} (mm)</th>
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<th>Flow Threshold (cfs)</th>
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**Expanded Glade Alternative (EG2)**

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**Representative Section 219576**

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**Flow Node 23**

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**NISP Current Conditions (Run 3a)**

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- **Critical Shear Stress**: 0.03
- **Representative Section**: 220861
- **Bed Material d_{50} (mm)**: 80
- **Flow Node**: 20
- **Flow Threshold (cfs)**: 73.47

### Diagram: River Morphology and Sediment Transport

- **Flow Node**: 23
- **Reach**: FC5
- **Bed Material d_{50} (mm)**: 54
- **Flow Threshold (cfs)**: 2,240

### Appendix Figure J-35

## River Morphology and Sediment Transport


### Channel Maintenance Flows

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### Flows that Move Coarse Bed Material

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## Appendix Figure J-37. Timnath B and Windsor Reach. Occurrence of Threshold Flows, Expanded Glade Alternative vs NISP Current Conditions.
Appendix Figure J-38. Greeley US & CH Reach. Occurrence of Threshold Flows, Expanded Glade Alternative vs NISP Current Conditions.
### Appendix Figure J-39. Greeley DS Reach. Occurrence of Threshold Flows, Expanded Glade Alternative vs NISP Current Conditions.
Appendix Figure J-40. Total Work Done by the Flow on the Channel Boundary – Expanded Glade Alternative vs NISP Current Conditions.

Appendix Figure J-41. Percent Change in the Total Work Done by the Flow on the Channel Boundary – Expanded Glade Alternative vs NISP Current Conditions.
PROJECT EFFECTS TECHNICAL REPORT
RIVER MORPHOLOGY AND SEDIMENT TRANSPORT
NORTH FORK AND MAIN STEM CACHE LA Poudre River

Appendix Figure J-42. Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Expanded Glade Alternative vs NISP Current Conditions.

Appendix Figure J-43. Percent Change in the Total Work Done by the Flow on the Channel Boundary above a Critical Dimensionless Shear Stress of 0.03 – Expanded Glade Alternative vs NISP Current Conditions.
Appendix Table J-12. Reach Averaged Sediment Transport Potential using SIAM – Expanded Glade Alternative (EG3) vs NISP Current Conditions (Run 3a).

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<td>12,715</td>
<td>5,265</td>
</tr>
<tr>
<td></td>
<td>Run 3a</td>
<td>17,564</td>
<td>12,323</td>
<td>5,241</td>
</tr>
<tr>
<td>19 Greeley Ch B</td>
<td>EG3</td>
<td>18,609</td>
<td>13,242</td>
<td>5,367</td>
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<td>18,503</td>
<td>12,989</td>
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<tr>
<td>20 Greeley DS</td>
<td>EG3</td>
<td>45,082</td>
<td>42,367</td>
<td>2,715</td>
</tr>
<tr>
<td></td>
<td>Run 3a</td>
<td>43,859</td>
<td>41,213</td>
<td>2,647</td>
</tr>
</tbody>
</table>

Anderson Consulting Engineers, Inc.  
J-51
### Appendix Table J-13. Percent Change in Reach Averaged Sediment Transport Potential – Expanded Glade Alternative vs NISP Current Conditions.

<table>
<thead>
<tr>
<th>SIAM Reach</th>
<th>Percent Change Total Sediment Transport Potential</th>
<th>Percent Change Sediment Transport Potential Sands</th>
<th>Percent Change Sediment Transport Potential Gravel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Laporte A1</td>
<td>-1.9%</td>
<td>-2.0%</td>
<td>-1.7%</td>
</tr>
<tr>
<td>2 Laporte A2</td>
<td>-5.1%</td>
<td>-4.6%</td>
<td>-6.2%</td>
</tr>
<tr>
<td>3 Laporte A3</td>
<td>-6.2%</td>
<td>-6.2%</td>
<td>-6.4%</td>
</tr>
<tr>
<td>4 Laporte A4</td>
<td>-4.9%</td>
<td>-4.9%</td>
<td>-4.8%</td>
</tr>
<tr>
<td>5 Laporte A5</td>
<td>0.0%</td>
<td>-1.0%</td>
<td>1.2%</td>
</tr>
<tr>
<td>6 FC1</td>
<td>-2.1%</td>
<td>-1.8%</td>
<td>3.2%</td>
</tr>
<tr>
<td>7 FC2A</td>
<td>-1.0%</td>
<td>-0.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>8 FC2B</td>
<td>-0.7%</td>
<td>-0.6%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>9 FC3</td>
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<td>-6.9%</td>
<td>4.4%</td>
</tr>
<tr>
<td>10 FC4</td>
<td>-3.8%</td>
<td>-4.1%</td>
<td>1.4%</td>
</tr>
<tr>
<td>11 FC5</td>
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<td>-1.9%</td>
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</tr>
<tr>
<td>12 FC6</td>
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<td>3.4%</td>
</tr>
<tr>
<td>13 Timnath A</td>
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<td>0.0%</td>
<td>0.4%</td>
</tr>
<tr>
<td>14 Timnath B</td>
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<td>0.4%</td>
</tr>
<tr>
<td>15 Windsor</td>
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<td>1.8%</td>
</tr>
<tr>
<td>16 Greeley US A</td>
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</tr>
<tr>
<td>17 Greeley US B</td>
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<td>2.0%</td>
</tr>
<tr>
<td>18 Greeley Ch A</td>
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<tr>
<td>19 Greeley Ch B</td>
<td>0.6%</td>
<td>2.0%</td>
<td>2.7%</td>
</tr>
<tr>
<td>20 Greeley DS</td>
<td>2.8%</td>
<td>2.8%</td>
<td>2.6%</td>
</tr>
</tbody>
</table>
Appendix Figure J-44. Reach Averaged Annual Sediment Transport Potential for Sand, Gravel, and Cobbles (tons/year) – Expanded Glade Alternative vs NISP Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for NISP Current Conditions Hydrology (open bars outlined in black) and Expanded Glade Alternative Hydrology (blue bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for NISP Current Conditions (black line) and Expanded Glade Alternative (blue line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from NISP Current Conditions to Expanded Glade Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure J-45. Distribution of Sediment Transport Potential with Flow-Laporte Reach, Expanded Glade Alternative vs NISP Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for NISP Current Conditions Hydrology (open bars outlined in black) and Expanded Glade Alternative Hydrology (blue bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for NISP Current Conditions (black line) and Expanded Glade Alternative (blue line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from NISP Current Conditions to Expanded Glade Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure J-46. Distribution of Sediment Transport Potential with Flow--Fort Collins Reaches 1 to 4, Expanded Glade Alternative vs NISP Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for NISP Current Conditions Hydrology (open bars outlined in black) and Expanded Glade Alternative Hydrology (blue bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for NISP Current Conditions (black line) and Expanded Glade Alternative (blue line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from NISP Current Conditions to Expanded Glade Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure J-47. Distribution of Sediment Transport Potential with Flow-Fort Collins Reach 5 to Windsor Reach, Expanded Glade Alternative vs NISP Current Conditions.
Notes:
1. Top row of plots show the annualized flow duration histogram in day/year for NISP Current Conditions Hydrology (open bars outlined in black) and Expanded Glade Alternative Hydrology (blue bars). The plots also show the relationship between discharge and sediment transport potential in tons/day independent of flow duration. Sediment transport potential shown is also computed based upon bed material composition.
2. Second row of plots shows the total sediment transport potential in tons/year which is a combination of annual flow duration and sediment transport potential for NISP Current Conditions (black line) and Expanded Glade Alternative (blue line). The peak of the curves indicates effective discharge.
3. Third row of plots shows the % change in sediment transport potential from NISP Current Conditions to Expanded Glade Alternative, shown on the second row of plots, computed in each flow interval.

Appendix Figure J-48. Distribution of Sediment Transport Potential with Flow-Greeley US Reach to Greeley DS Reach, Expanded Glade Alternative vs NISP Current Conditions.