HYDRAULIC CALCULATIONS

952 Arapahoe
952 Arapahoe Ave
Boulder, CO 80301

CONTENTS:

CALCULATION #1 - TWO HEAD CALC
CALCULATION METHOD - HAZEN WILLIAMS
## Job

**Job Number:** CA-11-0531  
**Design Engineer:** Jeremy Kobobel  
**Job Name:** 952 Arapahoe  
**Address 1:** 952 Arapahoe Ave  
**Address 2:** Boulder, CO 80301  
**City:** City of Boulder  
**Supply at Node 1 (1300.16, 0.00, 94.000, 70.000)**

## System

- **Density:** 0.050gpm/ft²  
- **Area of Application:** 512.00ft² (Actual 294.96ft²)

## Most Demanding Sprinkler Data

- **Coverage Per Sprinkler:** 256.00ft²  
- **Number Of Sprinklers Calculated:** 2

## System Pressure Demand

- **System Pressure Demand:** 64.714  
- **Pressure Result:** +29.268 (31.1%)  
- **Total Demand:** 26.11 @ 64.714

## Supplies

<table>
<thead>
<tr>
<th>Node</th>
<th>Flow(gpm)</th>
<th>Hose Flow(gpm)</th>
<th>Static(psi)</th>
<th>Residual(psi)</th>
<th>Identifier</th>
<th>Pressure(psi)</th>
<th>K-Factor(K)</th>
<th>Flow(gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1300.16</td>
<td>94.000</td>
<td>70.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Design Engineer

- **State Certification/License Number:** 11-1117  
- **Contact:** 970-587-7071 (Phone), 970-587-2988 (Fax)  

## Graphs

- [System demand curve](#)  
- [Pressure vs. Flow graph](#)
Job Number: CA-11-0531 - Two Head Calc
Report Description: Residential

Hydraulic Summary

System

Most Demanding Sprinkler Data
- 4.3 K-Factor: 13.00 at 9.140

Hose Allowance At Source
- 0.00

Additional Hose Supplies
- 0.00

Hose Allowance At Source Supplies
- 51.17 gal

Residential 0.050 gpm/ft²

Coverage Per Sprinkler
- 256.00 ft²

Area of Application
- 512.00 ft² (Actual 294.96 ft²)

Maximum Velocity Above Ground
- 10.77 between nodes 1 and 45

Maximum Velocity Under Ground
- 4.3 K-Factor: 13.00 at 9.140

Most Demanding Sprinkler Data
- System

Remote Area(s)

AutoPeak Results: Pressure For Remote Area(s) Adjacent To Most Remote Area
Left: 64.966

Job Number: CA-11-0531 - Two Head Calc
Report Description: Residential

Job

Job Number: CA-11-0531
Job Name: Arapahoe
Address 1: 952 Arapahoe Ave
Address 2: Boulder, CO 80301

Design Engineer
Jeremy Kobobel

State Certification/License Number: 11-1117

Job Site/Building
City of Boulder

Address 3: Drawing Name
CA-11-0531-1-1

Area of Application
512.00 ft² (Actual 294.96 ft²)

Coverage Per Sprinkler
256.00 ft²

Supplies

Node
Flow (gpm)
Static (psi)
Residual (psi)
Flow (gpm)
Available (psi)
Total Demand (psi)
Required (psi)
Safety Margin (psi)

1
94.000
70.000
1300.16
93.983
26.11
64.714
29.268

Boulder, CO 80301
Job Site/Building
City of Boulder

Additional Hose Supplies
- 0.00

Volume capacity of Wet Pipe
51.17 gal

Volume capacity of Dry Pipe

Supplies

Node
Hose Flow (gpm)
Static (psi)
Residual (psi)
Flow (gpm)
Available (psi)
Total Demand (psi)
Required (psi)
Safety Margin (psi)

1
94.000
70.000
1300.16
93.983
26.11
64.714
29.268

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### Summary Of Outflowing Devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Actual Flow (gpm)</th>
<th>Minimum Flow (gpm)</th>
<th>K-Factor (K)</th>
<th>Pressure (psi)</th>
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</thead>
<tbody>
<tr>
<td>Sprinkler 101</td>
<td>13.00</td>
<td>13.00</td>
<td>4.3</td>
<td>9.140</td>
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<tr>
<td>Sprinkler 102</td>
<td>13.11</td>
<td>13.00</td>
<td>4.3</td>
<td>9.301</td>
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# Node Analysis

<table>
<thead>
<tr>
<th>Node</th>
<th>Elevation(Foot)</th>
<th>Fittings</th>
<th>Pressure(psi)</th>
<th>Discharge(gpm)</th>
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<tbody>
<tr>
<td>1</td>
<td>-5'-8</td>
<td>S</td>
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<tr>
<td>101</td>
<td>17'-10</td>
<td>Spr(-9.140)</td>
<td>9.140</td>
<td>13.00</td>
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<td>41</td>
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<td>45</td>
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<td>E(2'-0)</td>
<td>40.472</td>
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<td>47</td>
<td>8'-2½</td>
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<td>17.753</td>
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<td>50</td>
<td>18'-3¼</td>
<td>T(5'-0)</td>
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<td>55</td>
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<td>T(5'-0), Tr(1'-0)</td>
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<tr>
<td>62</td>
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<td>T(5'-0)</td>
<td>9.119</td>
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<tr>
<td>Pipe Type</td>
<td>Diameter</td>
<td>Flow</td>
<td>Velocity</td>
<td>HWC</td>
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<td>55</td>
<td>18'-3½</td>
<td>13.11</td>
<td>9.282</td>
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<td>BL</td>
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<td>8.80</td>
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<tr>
<td>50</td>
<td>18'-3½</td>
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<tr>
<td>45</td>
<td>1'-6</td>
<td>40.472</td>
<td>Supply, 28B, E(2'-0), S</td>
<td>115-10</td>
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<tr>
<td>1</td>
<td>-5'-8</td>
<td>64.714</td>
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</tr>
</tbody>
</table>

Equivalent Pipe Lengths of Valves and Fittings (C=120 only)

\[
\text{Factor} = \left( \frac{\text{Actual Inside Diameter}}{\text{Schedule 40 Steel Pipe Inside Diameter}} \right)^{4.87}
\]
## Hydraulic Analysis

**Job Number:** CA-11-0531 - Two Head Calc  
**Report Description:** Residential

<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>Diameter</th>
<th>Flow</th>
<th>Velocity</th>
<th>HWC</th>
<th>Friction Loss</th>
<th>Length</th>
<th>Eq. Length</th>
<th>Total Length</th>
<th>Pressure Summary</th>
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</thead>
<tbody>
<tr>
<td>Downstream Elevation Discharge K-Factor Pt Pn Fittings</td>
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<td>Upstream Total Length</td>
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</tbody>
</table>

### Pipe Type Legend
- **AO:** Arm-Over
- **BL:** Branch Line
- **CM:** Cross Main
- **DN:** Drain
- **DR:** Drop
- **DY:** Dynamic
- **FM:** Feed Main
- **FR:** Feed Riser
- **MS:** Miscellaneous
- **OR:** Outrigger
- **SP:** Sprig
- **ST:** Stand Pipe
- **UG:** Underground

### Units Legend
- **Diameter:** Inch
- **Elevation:** Foot
- **Flow:** gpm
- **Discharge:** gpm
- **Velocity:** fps
- **Pressure:** psi
- **Length:** Foot
- **Friction Loss:** psi/Foot
- **HWC:** Hazen-Williams Constant
- **Pt:** Total pressure at a point in a pipe
- **Pn:** Normal pressure at a point in a pipe
- **Pf:** Pressure loss due to friction between points
- **Pe:** Pressure due to elevation difference between indicated points
- **Pv:** Velocity pressure at a point in a pipe

### Fittings Legend
- **ALV:** Alarm Valve
- **AngV:** Angle Valve
- **b:** Bushing
- **BalV:** Ball Valve
- **BFP:** Backflow Preventer
- **BV:** Butterfly Valve
- **C:** Cross Flow Turn 90°
- **cplg:** Coupling
- **Cr:** Cross Run
- **CV:** Check Valve
- **DelV:** Deluge Valve
- **DPV:** Dry Pipe Valve
- **E:** 90° Elbow
- **EE:** 45° Elbow
- **Ea1:** 11 1/4° Elbow
- **Ea2:** 22 1/4° Elbow
- **f:** Flow Device
- **fd:** Flex Drop
- **FDC:** Fire Department Connection
- **fE:** 90° FireLock(TM) Elbow
- **fEE:** 45° FireLock(TM) Elbow
- **flg:** Flange
- **FN:** Floating Node
- **fT:** FireLock(TM) Tee
- **g:** Gauge
- **GloV:** Globe Valve
- **GV:** Gate Valve
- **Ho:** Hose
- **Hose:** Hose
- **HV:** Hose Valve
- **Hyd:** Hydrant
- **LiE:** Long Turn Elbow
- **meC:** Mechanical Tee
- **Noz:** Nozzle
- **P1:** Pump In
- **P2:** Pump Out
- **PIV:** Post Indicating Valve
- **PO:** Pipe Outlet
- **PRV:** Pressure Reducing Valve
- **PrV:** Pressure Relief Valve
- **red:** Reducer/Adapter
- **S:** Supply
- **sCV:** Swing Check Valve
- **Spr:** Sprinkler
- **St:** Strainer
- **T:** Tee Flow Turn 90°
- **Tr:** Tee Run
- **U:** Union
- **WinF:** Wirso
- **WMV:** Water Meter Valve
- **Z:** Cap

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Supply at Node 1

- **Static Pressure**: 94.000
- **System Demand**: 70.000 @ 1300.16
- **Residual Pressure**: 94.000
- **Static Pressure at Node 1**: 64.714 @ 26.11
- **Available Pressure at Time of Test**: 93.983 @ 26.11
- **System Demand for System**: 64.714 @ 26.11
- **System Demand (Including Hose Allowance at Source)**: 64.714 @ 26.11
Private Fire Service Mains
Hydrant flow Test Report

Name of Property: 952 Arapahoe
Address: 952 Arapahoe Ave, Boulder, CO
Tested by: Kobobel Fire Protection, LLC
Contract No.: CA-11-0531
Date: 8/19/11
Time: 12:00 pm
Weather conditions: Sunny and 88 degrees
Location of test: Arapahoe Public Library
Residual hydrant location: 9th St & Arapahoe Ave
Flow hydrant(s) location: Arapahoe Public Library
Static pressure (residual hydrant) 94 psi (bar)
Residual pressure (residual hydrant) 70 psi (bar)
Nozzle size (flow hydrant) 2.5 in (mm)
Nozzle coefficient (flow hydrant) .9
Pitot pressure(s) 60 psi (bar)
Projected results: 2390.79 gpm (lpm) @ 20 psi (1.4 bar)

Remarks:

Sketch of Test Hydrants (N.T.S.)