Appendix D – Preliminary Hydrology Memorandum

# TECHNICAL MEMORANDUM

Date: May 20, 2021 BKF Job Number: C20210512-10

Deliver To: Jenn Bodine, Smith Development

From: Mona Sadeghian, BKF
Ryan Bernal, BKF

Subject: 123 Sherman Avenue
Preliminary Hydrology Memorandum

## Purpose

The purpose of this memorandum is to provide a preliminary hydrology analysis for the redevelopment of the 123 Sherman Avenue, 150 Grant Avenue and 2501 Park Boulevard parcels in Palo Alto, California. This analysis will estimate peak stormwater runoff from the site to Sherman Avenue and Grant Avenue on the southwestern end of the site in both the existing and redeveloped conditions.

## Background

The existing site is occupied by three office buildings and parking lot. The two lots will be merged into a single parcel totaling 0.79 acres. The site is bounded by Sherman Avenue, Grant Avenue, Park Boulevard and residential units. The runoff was estimated using three drainage areas that drain to Sherman Avenue, Grant Avenue, and Park Boulevard. Drainage Area 1 is 0.26 acres and drains to Sherman Avenue. Drainage Area 2 is 0.12 acres and drains to Park Boulevard and Drainage Area 3 is 0.41 acres and drains to Grant Avenue.

The existing site conditions are shown in Exhibit A. The proposed redevelopment is shown in Exhibit B. Table 1 outlines the total impervious and pervious areas in the drainage area that are used in Attachment A: Runoff Calculations.

**Table 1**: Impervious and Pervious Areas

| | | Pervious Area | Impervious Area | % Pervious | % Pervious Change |
|---|---|---|---|---|---|
| Drainage Area 1 | Existing Condition | 0.02 | 0.24 | 0.08 | 0 |
| | Proposed Condition | 0.02 | 0.24 | 0.08 | |
| Drainage Area 2 | Existing Condition | 0.01 | 0.11 | 0.08 | 0 |
| | Proposed Conditions | 0.01 | 0.11 | 0.08 | |
| Drainage Area 3 | Existing Conditions | 0.04 | 0.37 | 0.10 | +0.2 |
| | Proposed Conditions | 0.05 | 0.36 | 0.12 | |

## Methodology

This preliminary hydrology memorandum analyzes peak stormwater runoff from the site using the Rational Method for both the 10-year and 100-year storms in the existing and proposed conditions.

The Rational Method is defined by the formula:

Q = C I A, where:

Q = peak flow (cfs)

C = runoff coefficient factor (unitless)

I = rainfall intensity (in/hr) at the time of concentration

A = area (acres)

This analysis uses runoff coefficients (C) as documented in figures 819.2A and 819.2B of the Caltrans Highway Design Manual, and are summarized in Table 2.

**Table 2**: Runoff Coefficients

| Surface Type | C |
|---|---|
| Roof | 0.9 |
| Pavement | 0.9 |
| Landscape | 0.4 |

The rainfall intensities for the 10-year and 100-year design storm are determined using IDF (intensity-duration-frequency) Table: NOAA Atlas 14, Volume 6, and Version 2 for San Francisco International Airport, California. The rainfall intensity is based on the time of concentration ($T_c$), or the total time it takes rainfall to reach the analysis point along the longest path of travel. To simplify this preliminary analysis the existing time of concentration was conservatively set to be 10 minutes and the proposed time of concentration was set to be 15 minutes.

## Analysis

Exhibit A shows the existing site topography and the existing breakdown of pervious and impervious areas. The runoff from the 0.79 acre site flows to either Sherman Avenue, Park Boulevard or Grant Avenue and eventually into the stormdrain main along Park Avenue.

Exhibit B shows the proposed site conditions and the proposed breakdown of pervious and impervious areas. The site runoff will be directed to treatment planters prior to connecting to existing stormdrain lines and ultimately draining to the stormdrain main along Park Avenue. The proposed condition will match the existing condition.

The Rational Method was used to calculate peak stormwater runoff from the existing site and the proposed development for 10-year and 100-year storm events. The results are summarized in Tables 3 and 4. Calculation of existing condition and proposed development, peak stormwater runoff is shown in Attachment A: Runoff Calculations.

**Table 3**: Peak Stormwater Runoff, 10 Year Storm

| | Existing Condition | Proposed Development | Difference | |
|---|---|---|---|---|
| | (CFS) | (CFS) | (CFS) | % |
| Drainage Area 1 | 0.40 | 0.33 | -0.07 | -0.18 |
| Drainage Area 2 | 0.19 | 0.15 | -0.04 | -0.21 |
| Drainage Area 3 | 0.63 | 0.50 | -0.13 | -0.21 |

**Table 4**: Peak Stormwater Runoff, 100 Year Storm

| | Existing Condition | Proposed Development | Difference | |
|---|---|---|---|---|
| | (CFS) | (CFS) | (CFS) | % |
| Drainage Area 1 | 0.64 | 0.52 | -0.12 | -0.19 |
| Drainage Area 2 | 0.30 | 0.24 | -0.06 | -0.20 |
| Drainage Area 3 | 1.00 | 0.80 | -0.20 | -0.20 |

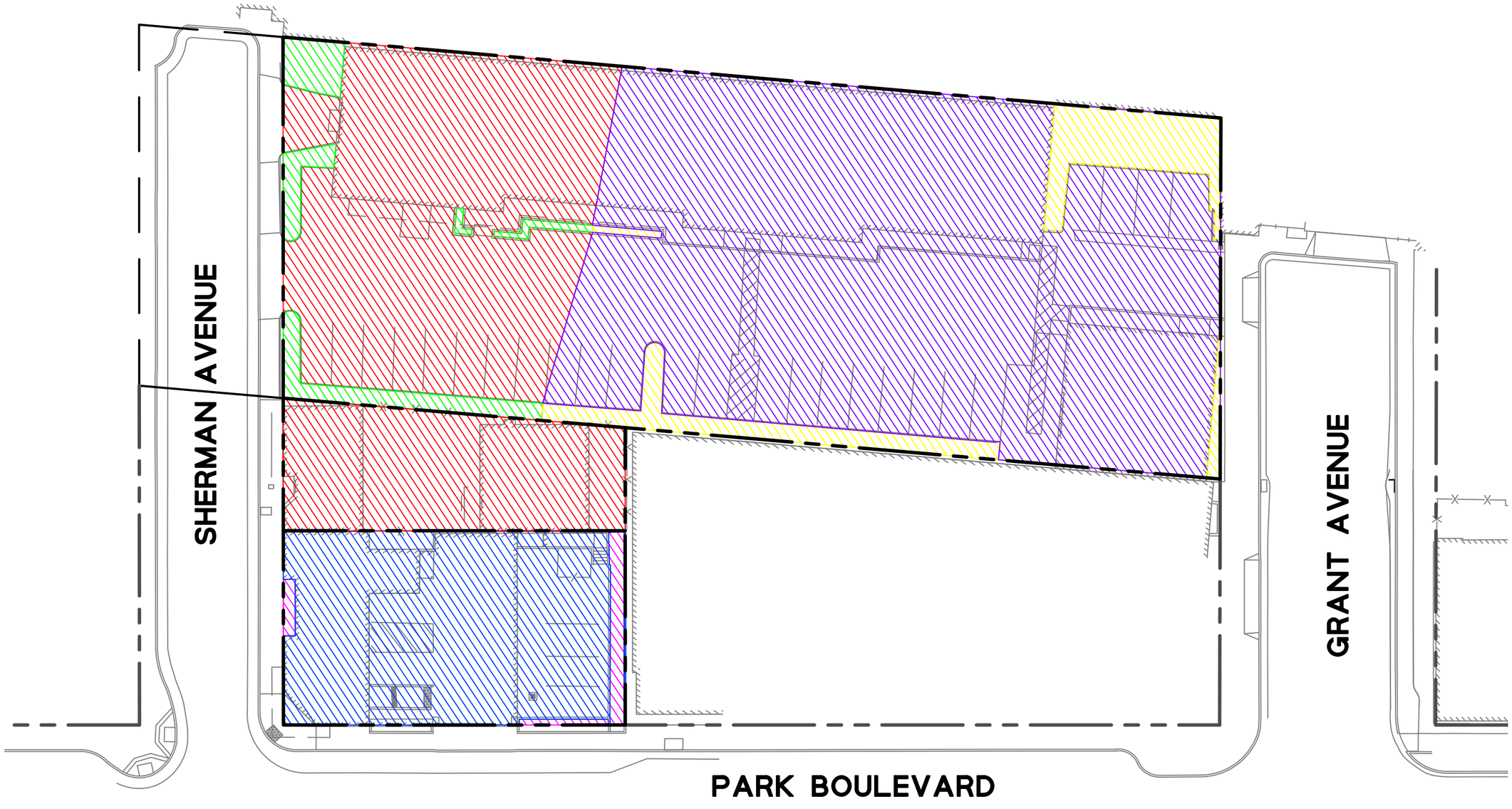
## Conclusion

Development of the project will not increase runoff to the City of Palo Alto storm drain system. Development of the site will increase landscape area, which will decrease peak stormwater discharge to the Park Boulevard stormdrain main by about 0.20% during the 10 year storm 100 year storm as shown in Tables 3 and 4.

A detailed storm drain study will be completed with development of the project improvement plans documenting the final design and hydraulics.

**Attachments:**

- Exhibit A:  123 Sherman Existing Conditions
- Exhibit B:  123 Sherman Proposed Conditions
- Attachment A: Existing and Proposed Runoff Calculations




**LEGEND:**

- PROPERTY LINE
- DRAINAGE AREA 1 IMPERVIOUS AREA
- DRAINAGE AREA 1 PERVIOUS AREA
- DRAINAGE AREA 2 IMPERVIOUS AREA
- DRAINAGE AREA 2 PERVIOUS AREA
- DRAINAGE AREA 3 IMPERVIOUS AREA
- DRAINAGE AREA 3 PERVIOUS AREA

GRAPHIC SCALE

30 0 30 60

BKF
ENGINEERS | SURVEYORS | PLANNERS
255 SHORELINE DRIVE, STE 200
REDWOOD CITY, CA 94065
650/482-6300
650/482-6399 (FAX)

# EXHIBIT A: EXISTING CONDITIONS
# 123 SHERMAN HYDROLOGY MEMORANDUM

PALO ALTO SANTA CLARA COUNTY CALIFORNIA

| No. | Revisions |
|---|---|

Date
Scale
Design
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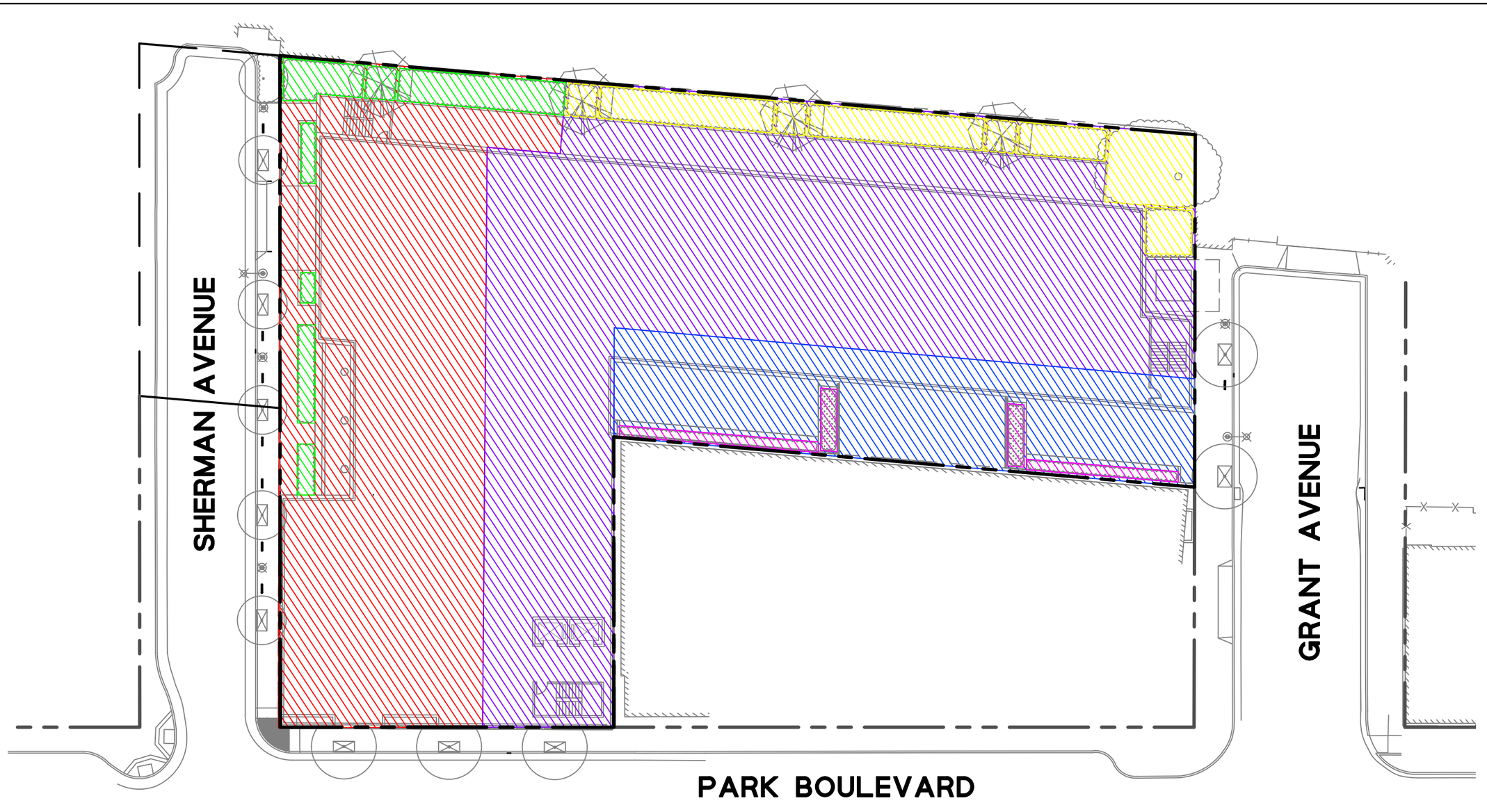
Approved
Job No

Sheet Number:
1 OF 1

DRAWING NAME: K:\2021\210512_123_Sherman_Ave\DOCS\06-Design\D-Stormwater_System\Hydrology_Memo\Exhibits\ExhibitA.dwg
PLOT DATE: 05-21-21 PLOTTED BY: rusl

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- DRAINAGE AREA 3 IMPERVIOUS AREA
- DRAINAGE AREA 3 PERVIOUS AREA

GRAPHIC SCALE

30 0 30 60

BKF
ENGINEERS | SURVEYORS | PLANNERS
255 SHORELINE DRIVE, STE 200
REDWOOD CITY, CA 94065
650/482-6300
650/482-6399 (FAX)

# EXHIBIT B: PROPOSED CONDITIONS
# 123 SHERMAN HYDROLOGY MEMORANDUM

PALO ALTO SANTA CLARA COUNTY CALIFORNIA

| No. | Revisions |
|---|---|

Date
Scale
Design
Drawn
Approved
Job No

Sheet Number:

1 OF 1

DRAWING NAME: K:\2021\210512_123_Sherman_Ave\DOCS\06-Design\D-Stormwater_System\Hydrology_Memo\Exhibits\ExhibitB.dwg
PLOT DATE: 05-21-21
PLOTTED BY: rusl

ATTACHMENT A: RUNOFF CALCULATIONS

**123 SHERMAN - EXISTING RUNOFF**

1. Development Parameters

Area Draining to Sherman Avenue = 0.26 acres
Area Draining to Park Boulevard = 0.12 acres
Area Draining to Grant Avenue = 0.41 acres
Assumed Time of Concentration ($T_c$) = 10 min

2. Time of Concentration & Rainfall Intensities

Rainfall intensities are taken from NOAA Atlas 14, Volume 6, and Version 2 for the San Francisco International Airport, California station. The rainfall intensity for the specified design storm over a duration equal to the time of concentration (10 min) is used.
$I_{10}$ = 1.81 in/hr
$I_{100}$ = 2.87 in/hr

3. Runoff Coefficient Calculations

Runoff coefficients (C) are documented in figures 819.2A and 819.2B from the Highway Design Manual, and are summarized below:

**Table 1**: Runoff Coefficients

| Surface Type | C |
|---|---|
| Roof | 0.9 |
| Pavement | 0.9 |
| Landscape | 0.4 |

In the existing conditions, there are a mix of impervious and pervious areas in the drainage basins. Drainage Area 1 contains 0.26 acres, and includes a total pervious area of 0.02 acres and a total impervious area of 0.24 acres. Drainage Area 2 contains 0.12 acres, and includes a total pervious area of 0.01 acres and a total impervious area of 0.11 acres. Drainage Area 3 contains 0.26 acres, and includes a total pervious area of 0.04 acres and a total impervious area of 0.37 acres. The runoff coefficients for the site can be calculated using a weighted average of the runoff coefficients for pavement and landscape.
$C_{\text{Drainage Area 1}}$ = (0.02 / 0.26) x (0.4) + (0.24 / 0.26) x (0.9) = 0.86
$C_{\text{Drainage Area 2}}$ = (0.01 / 0.12) x (0.4) + (0.11 / 0.12) x (0.9) = 0.86
$C_{\text{Drainage Area 3}}$ = (0.04 / 0.41) x (0.4) + (0.37 / 0.41) x (0.9) = 0.85

4. Runoff (Q) in cubic feet per second

Q = CIA, where:

Q = Peak Discharge (cubic feet of fluid per second)
C = Runoff Coefficient
I = Rainfall Intensity (inches per hour) at the time of concentration
A = Watershed Area (acres)

Drainage Area 1:

10 Year = (0.86) x (1.81 in/hr) x (0.26 acres) = 0.40 cfs
100 Year = (0.86) x (2.87 in/hr) x (0.26 acres) = 0.64 cfs

ATTACHMENT A: RUNOFF CALCULATIONS

Drainage Area 2:

10 Year = (0.86) x (1.81 in/hr) x (0.12 acres) = 0.19 cfs
100 Year = (0.86) x (2.87 in/hr) x (0.12 acres) = 0.30 cfs

Drainage Area 3:

10 Year = (0.85) x (1.81 in/hr) x (0.41 acres) = 0.63 cfs
100 Year = (0.85) x (2.87 in/hr) x (0.41 acres) = 1.00 cfs

**123 SHERMAN - PROPOSED RUNOFF**

1. Development Parameters

Area Draining to Sherman Avenue = 0.26 acres
Area Draining to Park Boulevard = 0.12 acres
Area Draining to Grant Avenue = 0.41 acres
Assumed Time of Concentration ($T_c$) = 15 min

2. Time of Concentration & Rainfall Intensities

Rainfall intensities are taken from NOAA Atlas 14, Volume 6, and Version 2 for the San Francisco International Airport, California station. The rainfall intensity for the specified design storm over a duration equal to the time of concentration (15 min) is used.
$I_{10}$ = 1.46 in/hr
$I_{100}$ = 2.32 in/hr

3. Runoff Coefficient Calculations

Runoff coefficients (C) are documented in figures 819.2A and 819.2B from the Highway Design Manual, and are summarized below:

**Table 1**: Runoff Coefficients

| Surface Type | C |
|---|---|
| Roof | 0.9 |
| Pavement | 0.9 |
| Landscape | 0.4 |

In the proposed conditions, there are a mix of impervious and pervious areas in the drainage basins. Drainage Area 1 contains 0.26 acres, and includes a total pervious area of 0.02 acres and a total impervious area of 0.24 acres. Drainage Area 2 contains 0.12 acres, and includes a total pervious area of 0.01 acres and a total impervious area of 0.11 acres. Drainage Area 3 contains 0.26 acres, and includes a total pervious area of 0.04 acres and a total impervious area of 0.37 acres. The runoff coefficients for the site can be calculated using a weighted average of the runoff coefficients for pavement and landscape.

$C_{\text{Drainage Area 1}}$ = (0.02 / 0.26) x (0.4) + (24 / 0.26) x (0.9) = 0.86
$C_{\text{Drainage Area 2}}$ = (0.01 / 0.12) x (0.4) + (0.11 / 0.12) x (0.9) = 0.86
$C_{\text{Drainage Area 3}}$ = (0.05 / 0.41) x (0.4) + (0.36 / 0.41) x (0.9) = 0.84

4. Runoff (Q) in cubic feet per second

Q = CIA, where:

Q = Peak Discharge (cubic feet of fluid per second)
C = Runoff Coefficient
I = Rainfall Intensity (inches per hour) at the time of concentration
A = Watershed Area (acres)

Drainage Area 1:

10 Year = (0.86) x (1.46 in/hr) x (0.26 acres) = 0.33 cfs
100 Year = (0.86) x (2.32 in/hr) x (0.26 acres) = 0.52 cfs

Drainage Area 2:

10 Year = (0.86) x (1.46 in/hr) x (0.12 acres) = 0.15 cfs
100 Year = (0.86) x (2.32 in/hr) x (0.12 acres) = 0.24 cfs

Drainage Area 3:

10 Year = (0.84) x (1.46 in/hr) x (0.41 acres) = 0.50 cfs
100 Year = (0.84) x (2.32 in/hr) x (0.41 acres) = 0.80 cfs