

# **I-15 Freeway Channel Drop Inlet Modification**

**Alternative Selection:** Charleston Blvd. and Waldman St.

**Basic Assumptions:** Clogging Factor for Grate Inlet =  
0.5  
Clogging Factor for Curb Opening =  
0.5  
Ignore 2.5cfs Trough Section  
Capacity

**Software Used:** FHWA Urban Drainage Design  
Program, HY-22

RECD  
2009 MAR 20 PM 4:14

# **I-15 Freeway Channel Drop Inlet Modification**

**Alternative No.1 :    Extend Charleston System with 2 New  
Modified Drop Inlet**

I-15 Freeway Channel : Charleston Blvd (North Half Street, with Charleston Extension Partially In-placed, Ignore 2.5cfs Trough Capacity)

Street Longitudinal Slope : Varies

Street Crown Slope : Varies

Clogging Factor : 50%

Design Flow (South Half) 395.0 cfs

Design Condition : Modified Drop Inlet Applied

GUTTER EDGE OF GRATE

OK  
EXCEEDS TROUGH CAPACITY

sht C-41 vol 1  
NORTH SIDE ONLY  
NO DETAIL

LATERAL SIZE?

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"XLM" 2+540.000	153.82	18	3.40	20	N/A	N/A	157.23	237.78	6 Grates, 20 feet curb opening
"XLM" 2+583.926	106.05	18	2.53	20	N/A	N/A	108.58	129.20	6 Grates, 20 feet curb opening
"XLM" 2+675.000	7.99	3	9.97	20	N/A	N/A	17.96	111.24	Modified
"XLM" 2+706.000	7.37	3	9.29	20	N/A	N/A	16.66	94.58	Modified
"XLM" 2+765.000	6.77	3	1.48	3	0.00	17	8.25	86.32	Original
"XLM" 2+804.000	6.40	3	1.40	3	0.00	17	7.80	78.52	Original
"XLM" 2+823.000	6.03	3	1.33	3	0.00	17	7.36	71.16	Original
"XLM" 2+845.000	5.96	3	1.28	3	0.00	17	7.24	63.92	Original
"XLM" 2+876.000	5.65	3	1.23	3	0.00	17	6.88	57.04	Original
"XLM" 2+898.000	5.63	3	1.22	3	0.00	17	6.85	50.19	Original
"XLM" 2+923.000	5.99	3	1.30	3	0.00	17	7.29	42.90	Original
"XLM" 2+960.000	37.41	40m (slot Drain)	0.00	0	0.00	N/A	37.41	5.49	Slot Drain
"XLM" 2+979.000	1.18	3	0.34	3	0.00	17	1.52	3.97	Original
"XLM" 3+022.000	1.25	3	0.32	3	0.00	17	1.57	2.40	Original
"XLM" 3+102.000	0.88	3	0.24	3	0.00	7	1.11	1.28	Original
"XLM" 3+117.000	0.56	3	0.16	3	0.00	7	0.72	0.57	Original

Total Catch 236.49 cfs  
 Carry-Over 0.00 cfs  
 Flow Depth @Side Walk Inch  
 Water Spread ft

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. : Charleston Blvd  
 Project Name.: DI 2+540.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0070
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200 CONSERVATIVE
n	Manning's Coefficient	0.016 ✓
W	Gutter Width (ft)	1.50 OK
a	Gutter Depression (inch)	0.00 CONSERVATIVE
Q	Discharge (cfs)	395.000
T	Width of Spread (ft)	72.57

Gutter Flow

Eo	Gutter Flow Ratio	0.054
d	Depth of Flow (ft)	1.45 ORIG STUDY SAID (.22)
V	Average Velocity (ft/sec)	1.50 MAY ASSUME TRIANGULAR SECTION NO BACK AT CURB

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb opening	208.53	10.00	0.01	3.403	391.597
Parallel Bar P-1-7/8	1.50	9.00	0.39	153.822	237.775
Combination			0.40	157.225	237.775

3 GRATES OPEN  
 3 GRATES CLOGGED > 50%

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

CURB  
 GRATE

10  
 9  


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 20

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+583.926  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0070
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	237.775
T	width of Spread (ft)	60.00

Gutter Flow

Eo	Gutter Flow Ratio	0.065
d	Depth of Flow (ft)	1.20
V	Average Velocity (ft/sec)	6.61

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	168.49	10.00	0.01	2.534	235.241
Parallel Bar P-1-7/8	1.50	9.00	0.45	106.045	129.195
Combination			0.46	108.580	129.195

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+675.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0102
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	129.195
T	width of spread (ft)	71.38

Gutter Flow

Eo	Gutter Flow Ratio	0.056
d	Depth of Flow (ft)	0.74
V	Average Velocity (ft/sec)	4.97

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	194.78	10.00	0.08	9.971	119.224
Parallel Bar P-1-7/8	1.50	1.50	0.07	7.986	111.238
Combination			0.14	17.957	111.238

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. : Charleston Blvd  
 Project Name.: DI 2+706.000  
 Computed by :

*TO BE  
 MODIFIED*

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

		Composite
S	Cross Slope	
S	Longitudinal slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0105
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	111.238
T	Width of Spread (ft)	66.28

Gutter Flow

Eo	Gutter Flow Ratio	0.060
d	Depth of Flow (ft)	0.71
V	Average Velocity (ft/sec)	4.82

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	179.69	10.00 <sup>20</sup>	0.08	9.292	101.946
Parallel Bar P-1-7/8	1.50	1.50 <sup>3</sup>	0.07	7.370	94.576
Combination			0.15	16.662	94.576

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+765.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	94.576
T	width of spread (ft)	64.29

Gutter Flow

Eo	Gutter Flow Ratio	0.062
d	Depth of Flow (ft)	0.66
V	Average velocity (ft/sec)	4.57

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	172.09	3.00	0.02	1.479	93.097
Parallel Bar P-1-7/8	1.50	$\frac{3}{2} = 1.50$	0.07	6.774	86.323
Combination			0.09	8.253	86.323

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

*should be 1.5 FOR JUST ALONG GRATE. BUT DOES NOT EXCEED 2.5 cfs THROUGH CAP = OK*



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+804.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	86.323
T	Width of Spread (ft)	62.13

Gutter Flow

Eo	Gutter Flow Ratio	0.064
d	Depth of Flow (ft)	0.64
V	Average Velocity (ft/sec)	4.47

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	165.41	3.00	0.02	1.404	84.919
Parallel Bar P-1-7/8	1.50	1.50	0.08	6.399	78.520
Combination			0.09	7.803	78.520

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+823.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	78.520
T	width of Spread (ft)	59.96

Gutter Flow

Eo	Gutter Flow Ratio	0.067
d	Depth of Flow (ft)	0.61
V	Average Velocity (ft/sec)	4.37

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	158.75	3.00	0.02	1.330	77.190
Parallel Bar P-1-7/8	1.50	1.50	0.08	6.032	71.158
Combination			0.09	7.362	71.158

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+845.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0083
Sx	Pavement Cross Slope (ft/ft)	0.0108
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	71.158
T	Width of Spread (ft)	54.31

Gutter Flow

Eo	Gutter Flow Ratio	0.073
d	Depth of Flow (ft)	0.60
V	Average velocity (ft/sec)	4.46

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	149.11	3.00	0.02	1.283	69.875
Parallel Bar P-1-7/8	1.50	1.50	0.09	5.955	63.920
Combination			0.10	7.238	63.920

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

**Gale Fraser - Chas. Drop Inlet**

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**From:** Jill REILLY  
**To:** Gale Fraser  
**Date:** 3/26/2002 1:31 PM  
**Subject:** Chas. Drop Inlet

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I just ran a check on the proposed drop inlet "fix" for Charleston. I entered 18 feet of grate with curb opening and an additional 2-ft curb opening. According to HEC-12, combined inlet capacity is 118.7 cfs. I believe this is less than PB's result, yet this software program has agreed with hand calculation methods.

*Charleston & E. of MCK - under I-15*

## **Gale Fraser - GWF/Kajkowski, et. al.,/I-15 Fwy Channel**

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**From:** Carolyn Frazier  
**To:** Carolyn Frazier; Gale Fraser; RFCD General  
**Date:** 3/26/2002  
**Time:** 2:00 PM - 3:00 PM  
**Subject:** GWF/Kajkowski, et. al.,/I-15 Fwy Channel  
**Place:** 420 N. 4th Street, City Engr's Conf. Rm

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Contact person, Joann in Charlie's Office @ 229-6272.

Other attendees:  
Randy Fultz, Greg McDermott, Marvin Stine, Denis Atwood.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+876.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0083
Sx	Pavement Cross Slope (ft/ft)	0.0111
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	63.920
T	width of Spread (ft)	51.28

Gutter Flow

Eo	Gutter Flow Ratio	0.078
d	Depth of Flow (ft)	0.58
V	Average Velocity (ft/sec)	4.38

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	140.24	3.00	0.02	1.225	62.695
Parallel Bar P-1-7/8	1.50	1.50	0.09	5.654	57.041
Combination			0.11	6.879	57.041

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+898.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0085
Sx	Pavement Cross Slope (ft/ft)	0.0125
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	57.041
T	width of spread (ft)	45.43

Gutter Flow

Eo	Gutter Flow Ratio	0.087
d	Depth of Flow (ft)	0.58
V	Average velocity (ft/sec)	4.42

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	126.10	3.00	0.02	1.216	55.825
Parallel Bar P-1-7/8	1.50	1.50	0.10	5.633	50.192
Combination			0.12	6.849	50.192

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+923.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0085
Sx	Pavement Cross Slope (ft/ft)	0.0162
Sw	Gutter Cross slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	50.192
T	Width of spread (ft)	36.85

Gutter Flow

Eo	Gutter Flow Ratio	0.106
d	Depth of Flow (ft)	0.60
V	Average Velocity (ft/sec)	4.56

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	103.92	3.00	0.03	1.297	48.895
Parallel Bar P-1-7/8	1.50	1.50	0.12	5.992	42.904
Combination			0.15	7.288	42.904

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+960.000  
 Computed by :

Inlets on Grade: Slotted Drain Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0060
Sx	Pavement Cross Slope (ft/ft)	0.0138
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	42.904
T	width of Spread (ft)	40.98

Gutter Flow

Eo	Gutter Flow Ratio	0.096
d	Depth of Flow (ft)	0.57
V	Average Velocity (ft/sec)	3.70

Inlet Interception

	Inlet Type	Slotted Drain
LT	Length for 100% Inteception (ft)	95.47
L	Slotted Drain Length (ft)	65.00
e	Inlet Efficiency	0.872
Qi	Intercepted Flow (cfs)	37.413
Qb	By-pass Flow (cfs)	5.491

ADJUST 120 OK

$A = \frac{Q}{V} = \frac{37.41}{3.70}$   
 $A = 10.11$   
 MUST BE 48" PIPE

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+979.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0060
Sx	Pavement Cross Slope (ft/ft)	0.0115
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	5.491
T	Width of spread (ft)	21.17

Gutter Flow

Eo	Gutter Flow Ratio	0.185
d	Depth of Flow (ft)	0.26
V	Average velocity (ft/sec)	2.12

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	42.66	3.00	0.06	0.343	5.148
Parallel Bar P-1-7/8	1.50	1.50	0.23	1.179	3.970
Combination			0.28	1.521	3.970

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+022.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	3.970
T	width of Spread (ft)	12.23

Gutter Flow

Eo	Gutter Flow Ratio	0.295
d	Depth of Flow (ft)	0.24
V	Average Velocity (ft/sec)	2.65

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	33.00	3.00	0.08	0.319	3.651
Parallel Bar P-1-7/8	1.50	1.50	0.34	1.252	2.399
Combination			0.40	1.571	2.399

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+102.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	2.399
T	width of Spread (ft)	10.13

Gutter Flow

Eo	Gutter Flow Ratio	0.348
d	Depth of Flow (ft)	0.20
V	Average Velocity (ft/sec)	2.34

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	26.71	3.00	0.10	0.237	2.162
Parallel Bar P-1-7/8	1.50	1.50	0.41	0.877	1.285
Combination			0.46	1.114	1.285

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+117.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	1.285
T	width of Spread (ft)	8.01

Gutter Flow

Eo	Gutter Flow Ratio	0.425
d	Depth of Flow (ft)	0.16
V	Average Velocity (ft/sec)	2.00

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	20.55	3.00	0.13	0.164	1.121
Parallel Bar P-1-7/8	1.50	1.50	0.50	0.555	0.566
Combination			0.56	0.719	0.566

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

## **I-15 Freeway Channel Drop Inlet Modification**

**Alternative No.2 :   Extend Charleston System with 1 New  
Modified Drop Inlet and Modify Existing  
Drop Inlet @ 2+675.000**

I-15 Freeway Channel : Charleston Blvd (North Half Street, with Charleston Extension 1 Inlet Upstream, Ignore 2.5cfs Trough Capacity)

Street Longitudinal Slope : Varies

Street Crown Slope : Varies

Clogging Factor : 50%

Design Flow (South Half) 395.0 cfs

Design Condition : Modified Drop Inlet Applied

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"XLM" 2+583.926	153.82	18	3.40	20	N/A	N/A	157.23	237.78	6 Grates, 20 feet curb opening
"XLM" 2+675.000	81.25	18	0.00	0	N/A	N/A	81.25	156.53	6 Grates Only
"XLM" 2+706.000	9.18	3	11.32 <i>modified</i>	20	N/A	N/A	20.49	136.04	Modified
"XLM" 2+765.000	8.50	3	1.82	3	0.00	17	10.31	125.72	Original
"XLM" 2+804.000	8.09	3	1.74	3	0.00	17	9.83	115.89	Original
"XLM" 2+823.000	7.69	3	1.66	3	0.00	17	9.35	106.54	Original
"XLM" 2+845.000	7.67	3	1.62	3	0.00	17	9.28	97.26	Original
"XLM" 2+876.000	7.32	3	1.55	3	0.00	17	8.87	88.40	Original
"XLM" 2+898.000	7.42	3	1.56	3	0.00	17	8.98	79.41	Original
"XLM" 2+923.000	6.94	3	1.47	3	0.00	17	8.41	71.01	Original
"XLM" 2+960.000	54.05	40m (slot Drain)	0.00	0	0.00	N/A	54.05	16.96	Slot Drain
"XLM" 2+979.000	2.45	3	0.65	3	0.00	17	3.09	13.87	Original
"XLM" 3+022.000	2.93	3	0.66	3	0.00	17	3.59	10.28	Original
"XLM" 3+102.000	2.40	3	0.56	3	0.00	7	2.95	7.32	Original
"XLM" 3+117.000	1.91	3	0.46	3	0.00	7	2.36	4.96	Original
Total Catch	387.68 cfs								
Carry-Over	0.00 cfs								
Flow Depth @Side Walk		Inch							
Water Spread		ft							

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+583.926  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0070
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	395.000
T	width of Spread (ft)	72.57

Gutter Flow

Eo	Gutter Flow Ratio	0.054
d	Depth of Flow (ft)	1.45
V	Average Velocity (ft/sec)	7.50

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	208.53	10.00	0.01	3.403	391.597
Parallel Bar P-1-7/8	1.50	9.00	0.39	153.822	237.775
Combination			0.40	157.225	237.775

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
Drainage of Highway Pavements

Inlets on Grade  
Date: 02/27/2002

Project No. :Charleston Blvd  
Project Name.:DI 2+675.000  
Computed by :

Inlets on Grade: Grate Inlet  
Roadway and Discharge Data

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	Cross Slope		Composite
S	Longitudinal slope (ft/ft)		0.0077
Sx	Pavement Cross Slope (ft/ft)		0.0102
Sw	Gutter Cross Slope (ft/ft)		0.0200
n	Manning's Coefficient		0.016
W	Gutter width (ft)		1.50
a	Gutter Depression (inch)		0.00
Q	Discharge (cfs)		237.775
T	Width of Spread (ft)		89.73

Gutter Flow

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Eo	Gutter Flow Ratio		0.045
d	Depth of Flow (ft)		0.93
V	Average velocity (ft/sec)		5.79

Inlet Interception

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	Inlet Type	Parallel Bar P-1-7/8	
L	Grate Length (ft)		9.00
WGR	Grate Width (ft)		1.50
e	Inlet Efficiency		0.342
Qi	Intercepted Flow (cfs)		81.249
Qb	By-pass Flow (cfs)		156.526

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+706.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

		Composite
S	Cross Slope Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0105
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	156.526
T	width of Spread (ft)	75.33

Gutter Flow

Eo	Gutter Flow Ratio	0.053
d	Depth of Flow (ft)	0.81
V	Average Velocity (ft/sec)	5.25

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb opening	208.18	10.00	0.07	11.315	145.211
Parallel Bar P-1-7/8	1.50	1.50	0.06	9.176	136.035
Combination			0.13	20.491	136.035

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+765.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	136.035
T	width of spread (ft)	73.68

Gutter Flow

Eo	Gutter Flow Ratio	0.054
d	Depth of Flow (ft)	0.75
V	Average velocity (ft/sec)	5.01

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	201.37	3.00	0.01	1.819	134.216
Parallel Bar P-1-7/8	1.50	1.50	0.06	8.495	125.721
Combination			0.08	10.314	125.721

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+804.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	125.721
T	width of spread (ft)	71.54

Gutter Flow

Eo	Gutter Flow Ratio	0.056
d	Depth of Flow (ft)	0.73
V	Average Velocity (ft/sec)	4.91

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	194.63	3.00	0.01	1.739	123.982
Parallel Bar P-1-7/8	1.50	1.50	0.07	8.089	115.894
Combination			0.08	9.827	115.894

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+823.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	115.894
T	Width of Spread (ft)	69.39

Gutter Flow

Eo	Gutter Flow Ratio	0.058
d	Depth of Flow (ft)	0.71
V	Average Velocity (ft/sec)	4.81

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb opening	187.91	3.00	0.01	1.660	114.234
Parallel Bar P-1-7/8	1.50	1.50	0.07	7.689	106.545
Combination			0.08	9.349	106.545

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+845.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0083
Sx	Pavement Cross Slope (ft/ft)	0.0108
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	106.545
T	width of Spread (ft)	63.18

Gutter Flow

Eo	Gutter Flow Ratio	0.063
d	Depth of Flow (ft)	0.70
V	Average Velocity (ft/sec)	4.94

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	177.53	3.00	0.02	1.615	104.930
Parallel Bar P-1-7/8	1.50	1.50	0.07	7.665	97.265
Combination			0.09	9.280	97.265

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+876.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0083
Sx	Pavement Cross Slope (ft/ft)	0.0110
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	97.265
T	Width of Spread (ft)	60.37

Gutter Flow

Eo	Gutter Flow Ratio	0.066
d	Depth of Flow (ft)	0.68
V	Average Velocity (ft/sec)	4.85

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	168.97	3.00	0.02	1.549	95.716
Parallel Bar P-1-7/8	1.50	1.50	0.08	7.317	88.399
Combination			0.09	8.866	88.399

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+898.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0085
Sx	Pavement Cross Slope (ft/ft)	0.0125
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	88.399
T	Width of Spread (ft)	53.54

Gutter Flow

Eo	Gutter Flow Ratio	0.074
d	Depth of Flow (ft)	0.68
V	Average Velocity (ft/sec)	4.93

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	152.25	3.00	0.02	1.561	86.838
Parallel Bar P-1-7/8	1.50	1.50	0.09	7.423	79.415
Combination			0.10	8.984	79.415

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+923.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

		Composite
S	Cross Slope Longitudinal slope (ft/ft)	0.0085
Sx	Pavement Cross Slope (ft/ft)	0.0125
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	79.415
T	Width of Spread (ft)	51.43

Gutter Flow

Eo	Gutter Flow Ratio	0.077
d	Depth of Flow (ft)	0.65
V	Average Velocity (ft/sec)	4.80

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb opening	145.40	3.00	0.02	1.469	77.946
Parallel Bar P-1-7/8	1.50	1.50	0.09	6.939	71.007
Combination			0.11	8.408	71.007

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+960.000  
 Computed by :

Inlets on Grade: Slotted Drain Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0060
Sx	Pavement Cross Slope (ft/ft)	0.0138
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	71.007
T	width of spread (ft)	49.49

Gutter Flow

Eo	Gutter Flow Ratio	0.080
d	Depth of Flow (ft)	0.69
V	Average Velocity (ft/sec)	4.20

Inlet Interception

	Inlet Type	Slotted Drain
LT	Length for 100% Inteception (ft)	118.46
L	Slotted Drain Length (ft)	65.00
e	Inlet Efficiency	0.761
Qi	Intercepted Flow (cfs)	54.050
Qb	By-pass Flow (cfs)	16.957

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+979.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0060
Sx	Pavement Cross Slope (ft/ft)	0.0115
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	16.957
T	width of spread (ft)	32.42

Gutter Flow

Eo	Gutter Flow Ratio	0.122
d	Depth of Flow (ft)	0.39
V	Average Velocity (ft/sec)	2.80

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	70.24	3.00	0.04	0.646	16.311
Parallel Bar P-1-7/8	1.50	1.50	0.15	2.445	13.866
Combination			0.18	3.091	13.866

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+022.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	13.866
T	Width of Spread (ft)	19.55

Gutter Flow

Eo	Gutter Flow Ratio	0.192
d	Depth of Flow (ft)	0.39
V	Average Velocity (ft/sec)	3.63

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	55.80	3.00	0.05	0.664	13.202
Parallel Bar P-1-7/8	1.50	1.50	0.22	2.925	10.277
Combination			0.26	3.589	10.277

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+102.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	10.277
T	Width of spread (ft)	17.47

Gutter Flow

Eo	Gutter Flow Ratio	0.213
d	Depth of Flow (ft)	0.35
V	Average Velocity (ft/sec)	3.37

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	49.20	3.00	0.05	0.557	9.720
Parallel Bar P-1-7/8	1.50	1.50	0.25	2.396	7.324
Combination			0.29	2.953	7.324

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+117.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

Cross Slope		Uniform
S	Longitudinal slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	7.324
T	width of spread (ft)	15.39

Gutter Flow

Eo	Gutter Flow Ratio	0.239
d	Depth of Flow (ft)	0.31
V	Average Velocity (ft/sec)	3.09

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	42.68	3.00	0.06	0.457	6.867
Parallel Bar P-1-7/8	1.50	1.50	0.28	1.907	4.961
Combination			0.32	2.363	4.961

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

# **I-15 Freeway Channel Drop Inlet Modification**

**Alternative No.3 :    Extend Charleston System with 1 New  
Modified Drop Inlet only**

I-15 Freeway Channel : Charleston Blvd (North Half Street, with Charleston Extension 1 Inlet Upstream, Ignore 2.5cfs Trough Capacity)

Street Longitudinal Slope : Varies

Street Crown Slope : Varies

Clogging Factor : 50%

Design Flow (South Half) 395.0 cfs

Design Condition : Modified Drop Inlet Applied

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"XLM" 2+583.926	153.82	18	3.40	20	N/A	N/A	157.23	237.78	6 Grates, 20 feet curb opening
"XLM" 2+675.000	17.94	3	11.70	0	N/A	N/A	29.64	208.14	Modified
"XLM" 2+706.000	16.77	3	11.01	20	N/A	N/A	27.79	180.35	Modified
"XLM" 2+765.000	10.12	3	2.14	3	0.00	17	12.26	168.09	Original
"XLM" 2+804.000	9.69	3	2.05	3	0.00	17	11.74	156.35	Original
"XLM" 2+823.000	9.26	3	1.97	3	0.00	17	11.23	145.12	Original
"XLM" 2+845.000	9.30	3	1.93	3	0.00	17	11.22	133.89	Original
"XLM" 2+876.000	8.98	3	1.87	3	0.00	17	10.85	123.05	Original
"XLM" 2+898.000	9.14	3	1.89	3	0.00	17	11.02	112.02	Original
"XLM" 2+923.000	9.98	3	2.06	3	0.00	17	12.04	99.99	Original
"XLM" 2+960.000	73.09	40m (slot Drain)	0.00	0	0.00	N/A	73.09	26.90	Slot Drain
"XLM" 2+979.000	3.28	3	0.84	3	0.00	17	4.12	22.78	Original
"XLM" 3+022.000	4.05	3	0.89	3	0.00	17	4.94	17.84	Original
"XLM" 3+102.000	3.45	3	0.77	3	0.00	7	4.22	13.62	Original
"XLM" 3+117.000	2.89	3	0.66	3	0.00	7	3.55	10.07	Original

Total Catch

381.38 cfs

Carry-Over

0.00 cfs

Flow Depth @Side Walk

Inch

Water Spread

ft



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+583.926  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0070
Sx	Pavement Cross Slope (ft/ft)	0.0200
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	395.000
T	width of spread (ft)	72.57

Gutter Flow

Eo	Gutter Flow Ratio	0.054
d	Depth of Flow (ft)	1.45
V	Average Velocity (ft/sec)	7.50

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	208.53	10.00	0.01	3.403	391.597
Parallel Bar P-1-7/8	1.50	9.00	0.39	153.822	237.775
Combination			0.40	157.225	237.775

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+675.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0102
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	237.775
T	width of Spread (ft)	89.73

Gutter Flow

Eo	Gutter Flow Ratio	0.045
d	Depth of Flow (ft)	0.93
V	Average Velocity (ft/sec)	5.79

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	253.24	10.00	0.05	11.699	226.076
Parallel Bar P-1-7/8	1.50	3.00	0.08	17.940	208.136
Combination			0.12	29.639	208.136

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+706.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0105
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	208.136
T	width of Spread (ft)	83.83

Gutter Flow

Eo	Gutter Flow Ratio	0.048
d	Depth of Flow (ft)	0.89
V	Average Velocity (ft/sec)	5.64

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb opening	235.30	10.00	0.05	11.012	197.124
Parallel Bar P-1-7/8	1.50	3.00	0.09	16.773	180.350
Combination			0.13	27.786	180.350

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+765.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	180.350
T	width of Spread (ft)	81.90

Gutter Flow

Eo	Gutter Flow Ratio	0.049
d	Depth of Flow (ft)	0.83
V	Average Velocity (ft/sec)	5.38

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	227.39	3.00	0.01	2.136	178.214
Parallel Bar P-1-7/8	1.50	1.50	0.06	10.124	168.091
Combination			0.07	12.259	168.091

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+804.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	168.091
T	Width of Spread (ft)	79.77

Gutter Flow

Eo	Gutter Flow Ratio	0.050
d	Depth of Flow (ft)	0.81
V	Average Velocity (ft/sec)	5.28

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	220.60	3.00	0.01	2.052	166.039
Parallel Bar P-1-7/8	1.50	1.50	0.06	9.690	156.349
Combination			0.07	11.742	156.349

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+823.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal slope (ft/ft)	0.0077
Sx	Pavement Cross Slope (ft/ft)	0.0100
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	156.349
T	width of Spread (ft)	77.63

Gutter Flow

Eo	Gutter Flow Ratio	0.051
d	Depth of Flow (ft)	0.79
V	Average Velocity (ft/sec)	5.19

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	qb (cfs)
Curb Opening	213.83	3.00	0.01	1.969	154.380
Parallel Bar P-1-7/8	1.50	1.50	0.06	9.264	145.117
Combination			0.07	11.232	145.117

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+845.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0083
Sx	Pavement Cross Slope (ft/ft)	0.0108
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	145.117
T	width of Spread (ft)	70.94

Gutter Flow

Eo	Gutter Flow Ratio	0.056
d	Depth of Flow (ft)	0.78
V	Average Velocity (ft/sec)	5.34

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	202.81	3.00	0.01	1.926	143.191
Parallel Bar P-1-7/8	1.50	1.50	0.06	9.296	133.895
Combination			0.08	11.222	133.895

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+876.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0083
SX	Pavement Cross Slope (ft/ft)	0.0111
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	133.895
T	width of Spread (ft)	67.67

Gutter Flow

Eo	Gutter Flow Ratio	0.059
d	Depth of Flow (ft)	0.76
V	Average velocity (ft/sec)	5.27

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	192.95	3.00	0.01	1.868	132.027
Parallel Bar P-1-7/8	1.50	1.50	0.07	8.981	123.046
Combination			0.08	10.849	123.046

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+898.000  
 Computed by :

Inlets on Grade: Curb opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0085
Sx	Pavement Cross Slope (ft/ft)	0.0125
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	123.046
T	width of Spread (ft)	60.60

Gutter Flow

Eo	Gutter Flow Ratio	0.065
d	Depth of Flow (ft)	0.77
V	Average Velocity (ft/sec)	5.36

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	175.45	3.00	0.02	1.887	121.159
Parallel Bar P-1-7/8	1.50	1.50	0.08	9.135	112.024
Combination			0.09	11.022	112.024

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+923.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0085
Sx	Pavement Cross Slope (ft/ft)	0.0162
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	112.024
T	Width of Spread (ft)	49.77

Gutter Flow

Eo	Gutter Flow Ratio	0.079
d	Depth of Flow (ft)	0.81
V	Average Velocity (ft/sec)	5.58

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	146.13	3.00	0.02	2.061	109.963
Parallel Bar P-1-7/8	1.50	1.50	0.09	9.977	99.986
Combination			0.11	12.038	99.986

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+960.000  
 Computed by :

Inlets on Grade: Slotted Drain Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0060
SX	Pavement Cross Slope (ft/ft)	0.0162
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	99.986
T	width of Spread (ft)	50.91

Gutter Flow

Eo	Gutter Flow Ratio	0.077
d	Depth of Flow (ft)	0.83
V	Average Velocity (ft/sec)	4.76

Inlet Interception

	Inlet Type	Slotted Drain
LT	Length for 100% Inteception (ft)	125.52
L	Slotted Drain Length (ft)	65.00
e	Inlet Efficiency	0.731
Qi	Intercepted Flow (cfs)	73.090
Qb	By-pass Flow (cfs)	26.896

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 2+979.000  
 Computed by :

Inlets on Grade: Curb opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Composite
S	Longitudinal Slope (ft/ft)	0.0060
Sx	Pavement Cross Slope (ft/ft)	0.0115
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	26.896
T	width of Spread (ft)	38.54

Gutter Flow

Eo	Gutter Flow Ratio	0.103
d	Depth of Flow (ft)	0.46
V	Average Velocity (ft/sec)	3.15

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	85.92	3.00	0.03	0.839	26.057
Parallel Bar P-1-7/8	1.50	1.50	0.13	3.279	22.778
Combination			0.15	4.118	22.778

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+022.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
SX	Pavement Cross Slope (ft/ft)	0.0200
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	22.778
T	Width of Spread (ft)	23.62

Gutter Flow

Eo	Gutter Flow Ratio	0.161
d	Depth of Flow (ft)	0.47
V	Average Velocity (ft/sec)	4.08

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	68.73	3.00	0.04	0.887	21.891
Parallel Bar P-1-7/8	1.50	1.50	0.19	4.053	17.838
Combination			0.22	4.940	17.838

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+102.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

		Uniform
	Cross Slope	
S	Longitudinal Slope (ft/ft)	0.0094
SX	Pavement Cross Slope (ft/ft)	0.0200
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	17.838
T	Width of Spread (ft)	21.56

Gutter Flow

Eo	Gutter Flow Ratio	0.175
d	Depth of Flow (ft)	0.43
V	Average Velocity (ft/sec)	3.84

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	qb (cfs)
Curb Opening	62.02	3.00	0.04	0.769	17.069
Parallel Bar P-1-7/8	1.50	1.50	0.20	3.451	13.618
Combination			0.24	4.220	13.618

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 02/27/2002

Project No. :Charleston Blvd  
 Project Name.:DI 3+117.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0094
Sx	Pavement Cross Slope (ft/ft)	0.0200
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	13.618
T	width of spread (ft)	19.42

Gutter Flow

Eo	Gutter Flow Ratio	0.193
d	Depth of Flow (ft)	0.39
V	Average Velocity (ft/sec)	3.61

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	55.38	3.00	0.05	0.657	12.961
Parallel Bar P-1-7/8	1.50	1.50	0.22	2.891	10.071
Combination			0.26	3.547	10.071

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

# **I-15 Freeway Channel Drop Inlet Modification**

**Cost Estimation – by Harris & Associates**



## Drainage Modification on I-15 Channel Project

### Extend RCB's on Charleston:

#### Concerns: Manufacture Lead time on Precast RCB.

Assumptions: Extend RCB's (3.0m X 2.1m) 100meters to west, install 4 Modified Type "C" DI's at \$20,000/Ea., install 1520mm (60") pipe for laterals, traffic control and mobilization/demobilization Lump Sum.  
Extend Bid Items at unit Costs where applicable.\*

RCB's *	100 M @ \$2781.00/LM	\$278,000.00
Mod. Type "C" DI	4 Ea. @ \$20,000/Ea.	\$80,000.00
60" HDPE Pipe*	26 M @ \$1000.00/LM	\$26,000.00
Remove Curb and Gutter @ Medians*	60 M @ \$8.00/LM	\$480.00
Replace Curb And Gutter @ Medians*	60 M @ \$57.50/LM	\$3,450.00
Remove & Reset Palm Trees	6 Ea. @ \$1800.00/Ea.	\$10,800.00
Reconnect Water Service to Median*	1 Ea. @ \$800.00/Ea.	\$ 800.00
Reconnect Electrical Service	1 Ea. @ \$1000.00/Ea.	\$1,000.00
Median Paving*	120 SM @ \$13.00/SM	\$1560.00
Remove AC Paving*	560 SM @ \$4.10/SM	\$2,296.00
Type Agg. Base*	630 CM @ \$33.00/CM	\$20,790.00
Replace AC Paving*	560 SM @ \$15.00/SM	\$8,400.00
Open Grade*	2550 SM @ \$2.25/SM	\$5,737.50
Traffic Control	1 LS @ \$10,000.00	\$10,000.00
Mob./Demob.	1 LS @ \$25,000.00	\$25,000.00
 Total		 <u>\$474,313.50</u>

# **I-15 Freeway Channel Drop Inlet Modification**

**Cost Estimation – by Parsons Brinckerhoff**

**Cost Estimation : I-15 Freeway Channel - Charleston Blvd. (North Side Only)**

Design Flow: 395.0cfs

Alternative 1: Extend Charleston System Upstream with 1 Modify Drop Inlet	Alternative 2: Extend Charleston System Upstream to with 2 Modify Drop Inlet	Alternative 3: Extend Charleston System Upstream to with 1 Modify Drop Inlet and Modify Existing Drop Inlet at Sta. 2+675.000
10.07	0.57	4.96

Carry-Over Flow (cfs): Before Charleston Underpass

( 50% Clogging Factor is applied to all Inlet Analysis)

**Option 1: HDPE as Extention on Charleston Blvd**

Item No.	Item	Unit	Unit Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	24-ft Curb Opening, 6 Grates Inlet*	LS	\$20,000.0	1	\$20,000.0	2	\$40,000.0	1	\$20,000.0
2	6 Grates Inlet*	LS	\$18,000.0	0	\$0.0	0	\$0.0	1	\$18,000.0
3	1520mm (60-in) PVC DR-18 Pipe <sup>1</sup>	M	\$1,000.0	15	\$15,000.0	30	\$30,000.0	15	\$15,000.0
4	Connection Manhole	LS	\$8,000.0	1	\$8,000.0	1	\$8,000.0	1	\$8,000.0
5	Connect to Existing Box	LS	\$1,000.0	1	\$1,000.0	2	\$2,000.0	1	\$1,000.0
6	1520mm (60-in) HDPE Pipe <sup>2</sup>	M	\$1,000.0	91	\$91,000.0	135	\$135,000.0	91	\$91,000.0
7	Type II Aggregate Base	CM	\$33.0	30	\$990.0	42	\$1,386.0	30	\$990.0
8	150mm Plantmix Bituminous Surface	SM	\$15.0	300	\$4,500.0	420	\$6,300.0	300	\$4,500.0
9	Milling & Overlay	SM	\$3.0	500	\$1,500.0	700	\$2,100.0	500	\$1,500.0
10	Traffic Control	LS	\$10,000.0	1	\$10,000.0	1	\$10,000.0	1	\$10,000.0
<b>Total</b>					<b>\$141,990.0</b>		<b>\$224,786.0</b>		<b>\$159,990.0</b>

**Option 2: 3m x 2.1m RCB as Extention on Charleston Blvd**

Item No.	Item	Unit	Unit Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	24-ft Curb Opening, 6 Grates Inlet*	LS	\$20,000.0	1	\$20,000.0	2	\$40,000.0	1	\$20,000.0
2	6 Grates Inlet*	LS	\$18,000.0	0	\$0.0	0	\$0.0	1	\$18,000.0
3	1520mm (60-in) PVC DR-18 Pipe <sup>1</sup>	M	\$1,000.0	15	\$15,000.0	30	\$30,000.0	15	\$15,000.0
4	Connection Manhole	LS	\$8,000.0	0	\$0.0	0	\$0.0	0	\$0.0
5	Connect to Existing Box	LS	\$1,000.0	1	\$1,000.0	2	\$2,000.0	1	\$1,000.0
6	3m x 2.1m RCB <sup>2</sup>	M	\$2,700.0	91	\$245,700.0	135	\$364,500.0	91	\$245,700.0
7	Type II Aggregate Base	CM	\$33.0	55	\$1,815.0	81	\$2,673.0	55	\$1,815.0
8	150mm Plantmix Bituminous Surface	SM	\$15.0	550	\$8,250.0	810	\$12,150.0	550	\$8,250.0
9	Milling & Overlay	SM	\$3.0	1450	\$4,350.0	2160	\$6,480.0	1450	\$4,350.0
10	Traffic Control	LS	\$10,000.0	1	\$10,000.0	1	\$10,000.0	1	\$10,000.0
<b>Total</b>					<b>\$296,115.0</b>		<b>\$457,803.0</b>		<b>\$314,115.0</b>

\*: Suggested by CCRFCD to prevent the first section of Clogging

1, 2: Open Cut, Backfill cost are included

Referenced Cost Data from I-15 Freeway Channel Project Bid-Tab (Las Vegas Paving), Bid No. 00.1730.03RC, Except Item 1and 2

# **I-15 Freeway Channel Drop Inlet Modification**

**Existing Condition: Waldman St. (North Side and South Side)**

**I-15 Freeway Channel : Waldman Street**

**Street Longitudinal Slope : 0.78 %**

**Street Crown Slope : 2.00%**

**Clogging Factor : 50%**

**Design Flow (North Half) 160.0 cfs**

**Design Condition : Modified Drop Inlet Applied**

**Original Drop Inlet Applied (Trough Section Maximum Capacity = 2.5 cfs)**

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"WD" 1+102.000	13.21	3	16.23	20	N/A	N/A	29.44	130.56	Modified
"WD" 1+134.000	11.57	3	14.39	20	N/A	N/A	25.96	104.60	Modified
"WD" 1+149.000	9.98	3	12.62	20	N/A	N/A	22.61	82.00	Modified
"WD" 1+161.000	8.48	3	10.93	20	N/A	N/A	19.41	62.59	Modified
"WD" 1+180.000	7.69	3	1.69	3	2.5	17	11.88	50.71	Original
"WD" 1+191.000	6.72	3	1.50	3	2.5	17	10.71	40.00	Original
"WD" 1+209.000	5.76	3	1.30	3	2.5	17	9.57	30.43	Original
"WD" 1+215.248	4.83	3	1.11	3	2.5	17	8.44	21.99	Original
"WD" 1+216.791	3.91	3	0.92	3	2.5	17	7.33	14.66	Original
Total Catch	145.34 cfs								
Carry-Over	14.66 cfs								
Flow Depth @Side Walk	5.00 Inch								
Water Spread	18.00 ft								

**I-15 Freeway Channel : Waldman Street**

**Street Longitudinal Slope : 0.78 %**

**Street Crown Slope : 2.00%**

**Clogging Factor : 50%**

**Design Flow (South Half) 160.0 cfs**

**Design Condition : Modified Drop Inlet Applied**

**Original Drop Inlet Applied (Trough Section Maximum Capacity = 2.5 cfs)**

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"WD" 1+102.000	13.99	3	2.92	3	2.5	17	19.41	140.59	Original
"WD" 1+134.000	12.89	3	2.71	3	2.5	17	18.10	122.50	Original
"WD" 1+149.000	11.81	3	2.50	3	2.5	17	16.81	105.69	Original
"WD" 1+161.000	10.75	3	2.29	3	2.5	17	15.54	90.15	Original
"WD" 1+180.000	9.71	3	2.09	3	2.5	17	14.31	75.84	Original
"WD" 1+191.000	8.70	3	1.89	3	2.5	17	13.09	62.75	Original
"WD" 1+209.000	7.71	3	1.69	3	2.5	17	11.90	50.85	Original
"WD" 1+215.248	6.73	3	1.50	3	2.5	17	10.73	40.12	Original
"WD" 1+216.791	5.78	3	1.31	3	2.5	17	9.58	30.54	Original
Total Catch	129.46 cfs								
Carry-Over	30.54 cfs								
Flow Depth @Side Walk	6.5 Inch								
Water Spread	22.00 ft								

# **I-15 Freeway Channel Drop Inlet Modification**

**Alternative No.1:      Extend Waldman System with 2 New  
Modified Drop Inlet**

I-15 Freeway Channel : Waldman Street

Street Longitudinal Slope : 0.78 %

Street Crown Slope : 2.00%

Clogging Factor : 50%

Design Flow (South Half) 160.0 cfs

Design Condition : Modified Drop Inlet Applied

Original Drop Inlet Applied (Trough Section Maximum Capacity = 0.0 cfs)

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"WD" Ext 1	76.14	18	1.95	20	0.0	N/A	78.09	81.91	Modified
"WD" Ext 2	45.30	18	1.32	20	0.0	N/A	46.62	35.29	Modified
"WD" 1+102.000	5.32	3	1.21	3	0.0	17	6.53	28.76	Original
"WD" 1+134.000	4.66	3	1.07	3	0.0	17	5.73	23.03	Original
"WD" 1+149.000	4.03	3	0.94	3	0.0	17	4.97	18.06	Original
"WD" 1+161.000	3.43	3	0.82	3	0.0	17	4.25	13.81	Original
"WD" 1+180.000	2.88	3	0.70	3	0.0	17	3.58	10.23	Original
"WD" 1+191.000	2.36	3	0.59	3	0.0	17	2.94	7.29	Original
"WD" 1+209.000	1.87	3	0.48	3	0.0	17	2.36	4.93	Original
"WD" 1+215.248	1.43	3	0.38	3	0.0	17	1.82	3.11	Original
"WD" 1+216.791	1.04	3	0.29	3	0.0	17	1.33	1.78	Original
Total Catch	158.22 cfs								
Carry-Over	1.78 cfs								
Flow Depth @Side Walk	Inch								
Water Spread	ft								

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. : Waldman Street (South Side)  
 Project Name.: DI Ext. 1  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	160.000
T	width of Spread (ft)	50.69

Gutter Flow

Eo	Gutter Flow Ratio	0.077
d	Depth of Flow (ft)	1.01
V	Average Velocity (ft/sec)	6.23

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	147.37	10.00	0.01	1.949	158.051
Parallel Bar P-1-7/8	1.50	9.00	0.48	76.142	81.909
Combination			0.49	78.091	81.909

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI Ext. 2  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

		Uniform
	Cross Slope	
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	81.909
T	width of Spread (ft)	39.45

Gutter Flow

Eo	Gutter Flow Ratio	0.098
d	Depth of Flow (ft)	0.79
V	Average Velocity (ft/sec)	5.26

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	111.25	10.00	0.02	1.321	80.588
Parallel Bar P-1-7/8	1.50	9.00	0.56	45.303	35.285
Combination			0.57	46.624	35.285

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI 1+102.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	35.285
T	width of spread (ft)	28.79

Gutter Flow

Eo	Gutter Flow Ratio	0.133
d	Depth of Flow (ft)	0.58
V	Average Velocity (ft/sec)	4.26

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	78.10	3.00	0.03	1.210	34.075
Parallel Bar P-1-7/8	1.50	1.50	0.16	5.318	28.757
Combination			0.19	6.528	28.757

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI 1+134.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	28.757
T	Width of Spread (ft)	26.67

Gutter Flow

Eo	Gutter Flow Ratio	0.143
d	Depth of Flow (ft)	0.53
V	Average velocity (ft/sec)	4.04

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	71.67	3.00	0.04	1.074	27.683
Parallel Bar P-1-7/8	1.50	1.50	0.17	4.656	23.027
Combination			0.20	5.730	23.027

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI 1+149.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	23.027
T	Width of Spread (ft)	24.55

Gutter Flow

Eo	Gutter Flow Ratio	0.155
d	Depth of Flow (ft)	0.49
V	Average Velocity (ft/sec)	3.82

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	65.29	3.00	0.04	0.944	22.083
Parallel Bar P-1-7/8	1.50	1.50	0.18	4.027	18.057
Combination			0.22	4.970	18.057

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+161.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
SX	Pavement Cross Slope (ft/ft)	0.0200
SW	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	18.057
T	Width of Spread (ft)	22.42

Gutter Flow

Eo	Gutter Flow Ratio	0.169
d	Depth of Flow (ft)	0.45
V	Average velocity (ft/sec)	3.59

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	58.95	3.00	0.05	0.819	17.238
Parallel Bar P-1-7/8	1.50	1.50	0.20	3.432	13.806
Combination			0.24	4.251	13.806

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+180.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	13.806
T	width of spread (ft)	20.21

Gutter Flow

Eo	Gutter Flow Ratio	0.186
d	Depth of Flow (ft)	0.40
V	Average velocity (ft/sec)	3.38

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	52.66	3.00	0.05	0.700	13.106
Parallel Bar P-1-7/8	1.50	1.50	0.22	2.877	10.229
Combination			0.26	3.577	10.229

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. : Waldman Street (South Side)  
 Project Name.: DI 1+191.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	10.229
T	width of spread (ft)	18.06

Gutter Flow

Eo	Gutter Flow Ratio	0.206
d	Depth of Flow (ft)	0.36
V	Average Velocity (ft/sec)	3.14

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	46.43	3.00	0.06	0.587	9.642
Parallel Bar P-1-7/8	1.50	1.50	0.24	2.356	7.286
Combination			0.29	2.943	7.286

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+209.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	7.286
T	width of spread (ft)	15.90

Gutter Flow

Eo	Gutter Flow Ratio	0.232
d	Depth of Flow (ft)	0.32
V	Average velocity (ft/sec)	2.88

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	40.27	3.00	0.07	0.481	6.805
Parallel Bar P-1-7/8	1.50	1.50	0.28	1.874	4.931
Combination			0.32	2.355	4.931

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+215.248  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	4.931
T	Width of Spread (ft)	13.74

Gutter Flow

Eo	Gutter Flow Ratio	0.265
d	Depth of Flow (ft)	0.27
V	Average velocity (ft/sec)	2.61

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	34.18	3.00	0.08	0.383	4.548
Parallel Bar P-1-7/8	1.50	1.50	0.32	1.434	3.114
Combination			0.37	1.817	3.114

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI 1+216.791  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	3.114
T	Width of Spread (ft)	11.56

Gutter Flow

Eo	Gutter Flow Ratio	0.310
d	Depth of Flow (ft)	0.23
V	Average Velocity (ft/sec)	2.33

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	28.18	3.00	0.09	0.292	2.822
Parallel Bar P-1-7/8	1.50	1.50	0.37	1.040	1.781
Combination			0.43	1.333	1.781

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

# **I-15 Freeway Channel Drop Inlet Modification**

**Alternative No.2:      Extend Waldman System with 1 New  
Modified Drop Inlet**

**I-15 Freeway Channel : Waldman Street**

**Street Longitudinal Slope : 0.78 %**

**Street Crown Slope : 2.00%**

**Clogging Factor : 50%**

**Design Flow (South Half) 160.0 cfs**

**Design Condition : Modified Drop Inlet Applied**

**Original Drop Inlet Applied (Trough Section Maximum Capacity = 0.0 cfs)**

STATION	Flow Catch @ Grate inlet (cfs)	Grate Inlet Length (ft)	Flow Catch @ Curb Opening (cfs)	Curb Opening Length (ft)	Flow Catch @ Trough (cfs)	Trough Length (ft)	Total Capture Flow (cfs)	Carry Over Flow (ft)	Inlet Type
"WD" Ext 1	76.14	18	1.95	20	0.0	N/A	78.09	81.91	Modified
"WD" 1+102.000	9.14	3	1.98	3	0.0	17	11.12	70.79	Original
"WD" 1+134.000	8.33	3	1.82	3	0.0	17	10.14	60.65	Original
"WD" 1+149.000	7.54	3	1.66	3	0.0	17	9.20	51.45	Original
"WD" 1+161.000	6.78	3	1.51	3	0.0	17	8.29	43.16	Original
"WD" 1+180.000	6.06	3	1.36	3	0.0	17	7.42	35.74	Original
"WD" 1+191.000	5.36	3	1.22	3	0.0	17	6.58	29.16	Original
"WD" 1+209.000	4.70	3	1.08	3	0.0	17	5.78	23.38	Original
"WD" 1+215.248	4.07	3	0.95	3	0.0	17	5.02	18.36	Original
"WD" 1+216.791	3.47	3	0.83	3	0.0	17	4.30	14.06	Original
Total Catch	145.94 cfs								
Carry-Over	14.06 cfs								
Flow Depth @Side Walk	Inch								
Water Spread	ft								

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI Ext 1  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	160.000
T	width of spread (ft)	50.69

Gutter Flow

Eo	Gutter Flow Ratio	0.077
d	Depth of Flow (ft)	1.01
V	Average Velocity (ft/sec)	6.23

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	147.37	10.00	0.01	1.949	158.051
Parallel Bar P-1-7/8	1.50	9.00	0.48	76.142	81.909
Combination			0.49	78.091	81.909

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+102.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	81.909
T	width of spread (ft)	39.45

Gutter Flow

Eo	Gutter Flow Ratio	0.098
d	Depth of Flow (ft)	0.79
V	Average velocity (ft/sec)	5.26

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	111.25	3.00	0.02	1.977	79.932
Parallel Bar P-1-7/8	1.50	1.50	0.11	9.140	70.791
Combination			0.14	11.118	70.791

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+134.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	70.791
T	width of spread (ft)	37.35

Gutter Flow

Eo	Gutter Flow Ratio	0.104
d	Depth of Flow (ft)	0.75
V	Average Velocity (ft/sec)	5.07

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	104.64	3.00	0.03	1.816	68.975
Parallel Bar P-1-7/8	1.50	1.50	0.12	8.326	60.649
Combination			0.14	10.142	60.649

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+149.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	60.649
T	Width of Spread (ft)	35.25

Gutter Flow

Eo	Gutter Flow Ratio	0.109
d	Depth of Flow (ft)	0.71
V	Average velocity (ft/sec)	4.88

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	98.06	3.00	0.03	1.660	58.989
Parallel Bar P-1-7/8	1.50	1.50	0.13	7.541	51.449
Combination			0.15	9.200	51.449

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.



FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+161.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	51.449
T	width of spread (ft)	33.15

Gutter Flow

Eo	Gutter Flow Ratio	0.116
d	Depth of Flow (ft)	0.66
V	Average Velocity (ft/sec)	4.68

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	91.51	3.00	0.03	1.508	49.941
Parallel Bar P-1-7/8	1.50	1.50	0.14	6.784	43.157
Combination			0.16	8.292	43.157

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+180.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	43.157
T	width of Spread (ft)	31.04

Gutter Flow

Eo	Gutter Flow Ratio	0.124
d	Depth of Flow (ft)	0.62
V	Average Velocity (ft/sec)	4.48

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	85.00	3.00	0.03	1.361	41.796
Parallel Bar P-1-7/8	1.50	1.50	0.14	6.058	35.738
Combination			0.17	7.419	35.738

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :waldman Street (South Side)  
 Project Name.:DI 1+191.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet

Roadway and Discharge Data

		Uniform
	Cross Slope	
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	35.738
T	width of spread (ft)	28.93

Gutter Flow

Eo	Gutter Flow Ratio	0.132
d	Depth of Flow (ft)	0.58
V	Average velocity (ft/sec)	4.27

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	78.52	3.00	0.03	1.219	34.519
Parallel Bar P-1-7/8	1.50	1.50	0.16	5.362	29.157
Combination			0.18	6.581	29.157

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+209.000  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	29.157
T	Width of Spread (ft)	26.81

Gutter Flow

Eo	Gutter Flow Ratio	0.142
d	Depth of Flow (ft)	0.54
V	Average Velocity (ft/sec)	4.06

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	72.09	3.00	0.04	1.083	28.074
Parallel Bar P-1-7/8	1.50	1.50	0.17	4.698	23.376
Combination			0.20	5.781	23.376

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+215.248  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter Width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	23.376
T	Width of Spread (ft)	24.69

Gutter Flow

Eo	Gutter Flow Ratio	0.154
d	Depth of Flow (ft)	0.49
V	Average Velocity (ft/sec)	3.83

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	65.70	3.00	0.04	0.952	22.424
Parallel Bar P-1-7/8	1.50	1.50	0.18	4.067	18.358
Combination			0.21	5.018	18.358

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.

FHWA Urban Drainage Design Program, HY-22  
 Drainage of Highway Pavements

Inlets on Grade  
 Date: 03/12/2002

Project No. :Waldman Street (South Side)  
 Project Name.:DI 1+216.791  
 Computed by :

Inlets on Grade: Curb Opening, Grate Inlet  
 Roadway and Discharge Data

	Cross Slope	Uniform
S	Longitudinal Slope (ft/ft)	0.0078
Sx	Pavement Cross Slope (ft/ft)	0.0200
Sw	Gutter Cross Slope (ft/ft)	0.0200
n	Manning's Coefficient	0.016
W	Gutter width (ft)	1.50
a	Gutter Depression (inch)	0.00
Q	Discharge (cfs)	18.358
T	Width of spread (ft)	22.56

Gutter Flow

Eo	Gutter Flow Ratio	0.168
d	Depth of Flow (ft)	0.45
V	Average velocity (ft/sec)	3.61

Inlet Interception

INLET INTERCEPTION	LT or WGR (ft)	L (ft)	E	Qi (cfs)	Qb (cfs)
Curb Opening	59.36	3.00	0.05	0.827	17.531
Parallel Bar P-1-7/8	1.50	1.50	0.20	3.470	14.061
Combination			0.23	4.297	14.061

Note: The curb opening length in the input screen is the total length of the curb opening including its length along the grate.