ADDENDUM 2: East Caroline Street to Harbor Area Stormwater Infrastructure

TO: City of Key West

FROM: CH2M HILL
Mitchell L. Griffin

DATE: June 11, 2012

The City of Key West is currently designing a street upgrade along Caroline Street. The area of Caroline Street roughly between Elizabeth Street and White Street is lower than the rest of the street and drains primarily to existing 24-inch outfalls along William, Margaret, and Grinnell Streets. There are two outfalls at Grinnell Street as the White Street intersection and the stores from Ace Hardware to the Ferry Terminal drain to one pipe, and the Grinnell Street corridor from Southard Street to the waterfront has a separate drain system. Figure 1 shows the drainage in the general region evaluated in this addendum to the 2012 Key West Stormwater Master Plan (2012 SWMP). The purpose of this addendum is to evaluate improvements that could be made in this area to support detailed design.

William Street has a 15-inch pipe leading from Caroline Street to the low spot. Then a 24-inch outfall is connected the last 110 feet to the seawall. Margaret Street has a 24-inch pipe from Carolina Street to the seawall. The Grinnell Street System has a pipe system leading from Southard Street to the south, but this pipe is 24-inches in diameter between Caroline Street and the seawall. The White Street and Eaton Street intersection and retail areas near the waterfront also leads to a second 24-inch outfall, but the inventory indicated that these systems may be interconnected at some inlets near the waterfront.

ICPR Model Changes

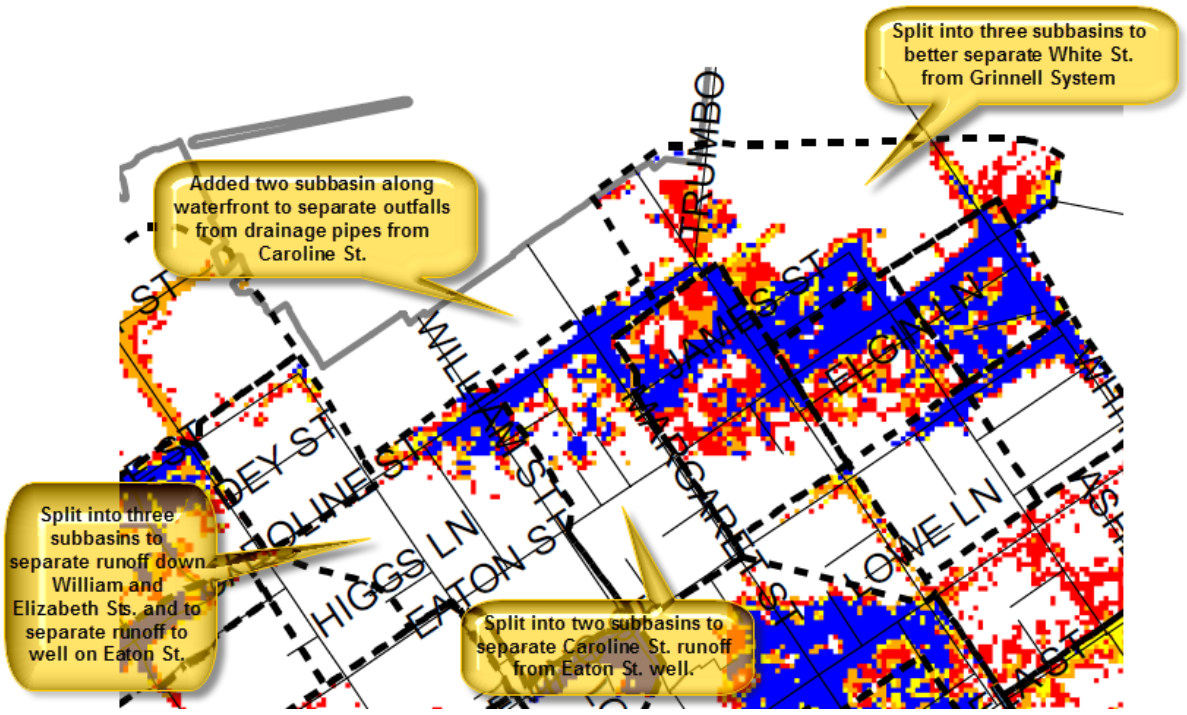
The area near the waterfront between Caroline Street and Key West Bight (Harbor) is lower than Caroline Street. The original SWMP model ended before the retail district of the harbor, because most of this area is drained directly to the Gulf. The results of the 2012 SWMP did not indicate severe flooding along Caroline St. but there was some staging above the crown. To support future design work, additional refinement to the ICPR model was made based on updated information.

FIGURE 1
Caroline Street Drainage Addendum Study Area

On May 9, 2012, CH2M HILL conducted a walking tour of most of the area between Whitehead (west), Eaton (south), Grinnell (east) and to the waterfront (north), making special note of the slopes of the streets and where there was evidence of extended standing water. Caroline Street is not the lowest spot in the old harbor area; the ends of the streets before the seawall and retail stores have the lowest elevations. The small inlets along Caroline Street allowed stormwater to stage up and flow down the streets (William, Margaret and Grinnell) to the low spots where the outfalls connect. Also it appears that the parking lots and retail area contribute more runoff to the inlets on the outfalls along here than was accounted for in the previous model. Consequently, CH2M HILL revised the model of the northern Duval/ Front St. area based on the 2012 SWMP model but with more detail in this area.

Changes to the 2012 model included adding the parking and retail areas between Caroline Street and waterfront between Elizabeth and Grinnell Streets., and breaking some subbasins into pieces so runoff moves more directly to the waterfront area through the streets or to the outfall pipes (see Figure 2). The modified model provided very close results for the 5-year storm simulated with the original 2012 SWMP model at all nodes except for those locations right where the model changes were made. This change allowed better evaluation of the drainage system between Caroline Street and the waterfront.

FIGURE 2
Modifications to 2012 SWMP Model to support future design work



Evaluation and Results

Certain drainage features will be changed based on general design conventions. The street drainage along Caroline Street will be improved with the new curbs, grading, and inlets. The inlets along Caroline Street will be replaced to reflect current design standards. However, if the pipe capacity is not sufficient, runoff will continue to flow down the streets to the low spots. Also, moving water off the road at Caroline will not improve the low spots near the end of the streets unless additional work is done to move the stormwater further down the system to the outfalls. Elevations below about 3 NAVD88 (North American Vertical Datum of 1988) will not be drained very well with gravity recharge injection wells. Therefore, unless pressurized recharge wells are installed at these low spots near the waterfront (elevations between 1.0 to 1.7 NAVD88), the outfalls also must be improved.

The ICPR model is best utilized to evaluate the capacity of the pipe system. This evaluation was primarily conducted to determine the benefits of up-sizing the pipes between Caroline Street and the seawall, including the outfalls.

The results of the alternatives evaluated are summarized into two recommended cases:

Case 1) Replace the 24-inch outfalls at William, Margaret, and one of the two 24-inch outfalls at Grinnell (i.e., the Grinnell Street System) with 30-inch pipes. These pipes extended from the seawall to the intersections with Caroline Street.

Case 2) Keep the 30-inch pipes between Caroline Street and the low spots at the end of the roads, but put in 36-inch pipes between the low spots and seawall. Again, this includes only the one outfall serving the Grinnell Street System at this street.

Table 1 provides the results of the ICPR simulations for the 5-, 10- and 25-year design storms. The locations receiving the primary benefits will be the low spots at the end of the roads. The desired level-of-service for local roads is to be passable by emergency vehicles (staging less than 6-inch deep) during the 10-year, 24-hour design storm (7-inches of rainfall); so only these results are discussed in more detail. During this design storm, the intersections along Caroline Street under the baseline simulation predict stages up to 0.5 feet or less. However, the low spots at the end of the streets are simulated to stage higher: 0.6 foot deep along William, 0.5 foot deep along Margaret, and 0.3 foot deep along Grinnell.

Adding larger pipes downstream of Caroline Street to the ends of Margaret, William, and/or Grinnell Streets will cause stormwater runoff to stage up faster and peak a little deeper at the end of the streets unless the larger pipes are installed all the way to the seawall (i.e., larger outfalls). If one was to increase the pipe sizes larger than the existing 24-inch outfalls, then the incremental cost between a 30- and 36-inch pipe should be relatively small; however, the overall feasibility of constructing larger outfalls at the seawall is not part of this evaluation.

TABLE 1
Summary of Results for Caroline Street Evaluation

Street Intersection Location in Model	Model ID and Design Storm		Baseline with modified ICPR model			Case 1 30-inch pipe from Caroline St. to seawall				Case 2 30-inch pipe from Caroline St. to end of street Then larger outfall			
(EL, Elevation in NAVD88)	Node No.	Simulation	Max Stage (ft)	Max Inflow (cfs)	Max Outflow (cfs)	Downstream Pipe Changes	Max Stage (ft)	Max Inflow (cfs)	Max Outflow (cfs)	Downstream Pipe Changes	Max Stage (ft)	Max Inflow (cfs)	Max Outflow (cfs)
Caroline and William	N2300	5 year, 24 hr	1.67	14.43	14.54	New 30"	1.62	14.43	26.89	New 30"	1.60	14.43	27.11
Road about 1.4 EL	N2300	10 year, 24 hr	1.75	17.42	14.42	New 30"	1.61	17.77	26.05	New 30"	1.60	17.67	25.97
	N2300	25 year, 72 hr	1.92	27.62	33.72	New 30"	1.78	29.19	27.45	New 30"	1.66	27.00	27.53
Waterfront at William (low)	N2310	5 year, 24 hr	1.50	25.36	19.98	New 30"	0.99	31.54	25.21	New 36"	0.56	31.87	28.42
Lowest about 1.0 EL	N2310	10 year, 24 hr	1.63	27.97	22.47	New 30"	1.23	36.84	28.02	New 36"	0.69	36.59	31.60
	N2310	25 year, 72 hr	1.91	51.48	27.62	New 30"	1.58	40.34	34.11	New 36"	1.14	43.57	40.53
Caroline and Elizabeth	N2300b	5 year, 24 hr	2.33	15.58	9.94	None	2.33	15.58	9.96	None	2.33	15.59	9.96
Road about 2.2 EL	N2300b	10 year, 24 hr	2.39	18.47	12.57	None	2.39	18.47	12.39	None	2.39	18.47	12.33
	N2300b	25 year, 72 hr	2.47	24.80	19.40	None	2.46	24.80	20.79	None	2.48	24.81	19.44
Caroline and Margaret	N2400	5 year, 24 hr	1.85	17.56	13.19	New 30"	1.67	18.46	25.05	New 30"	1.67	17.44	24.93
Road about 1.4 EL	N2400	10 year, 24 hr	1.93	21.26	16.46	New 30"	1.73	22.86	25.54	New 30"	1.67	21.60	25.06
	N2400	25 year, 72 hr	2.02	30.23	14.34	New 30"	1.88	32.13	27.26	New 30"	1.79	32.05	25.26
Waterfront at Margaret (low)	N2410	5 year, 24 hr	1.29	14.99	12.16	New 30"	1.04	26.86	18.96	New 36"	0.57	26.74	21.77
Lowest about 1.0 EL	N2410	10 year, 24 hr	1.52	17.86	13.19	New 30"	1.11	27.21	19.53	New 36"	0.65	26.75	23.24
	N2410	25 year, 72 hr	1.85	17.71	14.57	New 30"	1.32	28.43	21.30	New 36"	0.78	26.40	25.50
Grinnell St. System (low)	N2500	5 year, 24 hr	1.79	39.60	34.09	One New 30"	1.42	37.91	36.46	One New 36"	0.97	40.70	39.99
Road at about 1.7 to 2.0 EL	N2500	10 year, 24 hr	1.98	49.08	39.06	One New 30"	1.71	46.90	42.80	One New 36"	1.22	46.14	44.93
	N2500	25 year, 72 hr	2.24	64.88	46.42	One New 30"	2.08	64.99	53.25	One New 36"	1.71	60.30	56.44

Max inflow and outflow rates are instantaneous peak flows.
Low means that this is the approximate lowest elevation at the end of the street, NAVD88.

Case 1 was to place 30-inch pipes from Caroline Street to the seawall. The simulated staged 10-year storm is reduced at Caroline Street by only 2- to 3-inches, but the staged conditions at the low spots are predicted to be reduced by about 5-inches at the end of William and Margaret Streets and 3-inches at the end of Grinnell Street.

Case 2 was to put 30-inch pipes from Caroline Street to the low spots, then 36-inch pipes to the seawall. The larger outfalls improved conditions only at the low spots. The predicted reductions from existing conditions were 11- and 10-inches at William and Margaret Streets, respectively. The predicted reduction in staged stormwater at the low spot in Grinnell Street was 9-inches during the 10 year storm. These reductions essentially eliminated standing water during normal tide conditions at the low spots at these three streets. Additional reductions at Caroline Street were negligible with lower elevations downstream implying that the 30-inch pipes would be sufficient to transmit storm flows between Caroline and the end of the streets.

Summary of Conclusions

1. A 30-inch pipe between Caroline and the seawall (i.e., new outfalls) would reduce stages at the low spots at the end of William, Margaret, and Grinnell Streets to levels that are predicted to be only 3- to 5-inches deep. This may be acceptable from a level-of-service criterion. Caroline Street will receive most of its benefits from re-grading and new curb and inlets.

2. The 36-inch pipe from the low spots to the seawall (i.e., new outfalls) is predicted to eliminate staged water in the low spot under normal tide conditions. This assessment assumed that the pipes between Caroline and the end of the cross streets are up-sized to 30-inches in both cases.

In addition to improving the pipes and inlets, additional water quality treatment is recommended and will likely be required by regulators. A triple chamber water quality box along the system should be included in the design.

While not reported in Table 1, the addition of Tideflex check valves on the outfalls were also briefly evaluated. These would be used to keep the seasonal high tide from increasing standing water (typically up to 1 to 1.5 feet higher at times). The performance data from the TF-1 (an older pinch valve style) were simulated. The simulation results indicated that the 36-inch outfall would provide results closer to the unrestricted 30-inch outfall during normal conditions. Tideflex has a new in-line check valve product (called Checkmate) that has lower energy losses (approximately 30% losses of an equivalent 24-inch TF-1). These newer valves styles should be considered in the future. The City has recently installed one on the White Street outfall (south) and is evaluating its performance now.