CRANES is a charter member of the Capital Region Sustainable Communities Partnership (CRSCP), funded by HUD/DOT/EPA. In Spring 2012, CRANES requested that CRSCP's City of Fitchburg Catalytic Project explore the feasibility of stormwater management toward "natural" hydrological conditions (defined as runoff, infiltration, evaporation, and transpiration conditions at the time of the 1830s Original Public Land Survey). CRANES calls this approach Ultimate Management Practices or UMPs (in contrast to Best Management Practices or BMPs, which in Dane County are usually benchmarked to "pre-development" conditions that are typically farmland which produces far more runoff than the oak savannahs, forests, and prairies of the 1830s. CRANES thanks EOR, and CRSC/Fitchburg staff for producing this memo, which confirms the feasibility of the UMP approach.

memo

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Date | December 20, 2012

To | City of Fitchburg

cc | Wade Thompson, City of Fitchburg Planning/Zoning Department Resource/Project Planner

From | Camilla Correll, P.E. and Tom Miller, P.E.

Regarding | Pre-settlement Runoff Evaluation

This memorandum summarizes the results of a pre-settlement runoff analysis that was completed as part of a larger modeling effort demonstrating how stormwater management criteria (primarily from CARPC) could be met on two higher density development scenarios within the McGaw Neighborhood Area. The results generated for this analysis are being compared to results presented in the City of Fitchburg Catalytic Project report (December 20, 2012) for the final proposed stormwater management plans. This final set of plans was based upon feedback gathered at the design charrette and represents a more optimized stormwater management plan for each development scenarios: medium density residential development and transit-oriented development.

I. Objective

The City of Fitchburg's, as well as other local regulatory agencies, current volume control standards require that when engaging in land-altering activity, applicants must ensure that under the proposed (post-development) condition, the peak rate and volume of stormwater runoff at the parcel boundary will not exceed "pre-development" levels. The definition of "pre-development" being the time preceding the creation of impervious surfaces or substantial changes in hydrology or site vegetation. In Wisconsin pre-development conditions are assigned a curve number (CN) per Chapter NR 151 of the Wisconsin Administrative Code. A permit applicant uses a hydrologic model to determine the difference in peak runoff rate and runoff volume from the pre-development to the proposed condition, and take measures to address that difference in volume.

If the goal of the stormwater manager is to more closely mimic natural conditions, matching a "pre-settlement" condition will more closely achieve this. Peak rate and volume control standards set at a pre-settlement level may result in a higher level of protection (depending upon how the standard is applied and the pre-existing land cover) that more closely approaches the conditions that sustained a landscape's resources historically. Pre-settlement conditions are typically defined by using historical information from the Public Land Survey. Because the pre-settlement curve numbers are often lower than those identified for pre-development conditions, revising a volume control standard so that post-development conditions are held to a pre-settlement condition results in lower maximum allowable rates and volumes.

Since the City of Fitchburg was evaluating the implication of the 1-year and 5-year pre-development volume control standard in the McGaw Park Neighborhood, it was requested that a separate evaluation of a pre-settlement volume control standard be made for comparison purposes. This memorandum briefly summarizes the findings of this additional analysis.

II. Method

The Program for Predicting Polluting Particle Passage thru Pits, Puddles & Ponds (P8) models developed for the City of Fitchburg Catalytic Project for the Medium Density Residential Development (R2) and the Transit-Oriented Development (TOD) were used for this analysis. Both models were used to compare runoff volumes from the existing (pre-development) condition (primarily farmland, curve number (CN) of 70) and the pre-settlement condition (oak savannah, curve number (CN) of 58) for the 5-year period-of-record (as defined by the Wisconsin Department of Natural Resources). Analysis of the 1-year period-of-record would generate the same results and conclusions.

Based on our experience with the development of volume control standards using a pre-settlement baseline condition, a single curve number is assigned to a larger geographic area (e.g. watershed). This is primarily based upon the resolution of the information provided by the Public Land Survey. As a result, a single curve number of 58 was used for this analysis. As Table 1 indicates, the pre-settlement curve number is typically lower than the pre-development CN. However, the pre-settlement curve number may be higher for those land cover types with higher interception and permeability (e.g. woodland). An example of the differences between pre-development and pre-settlement curve numbers for Hydrologic Soil Group (HSG) B is shown in Table 1.

Table 1. Example of the CN differences for pre-development and pre-settlement on HSG B

Land Cover	Pre-Development CN*	Pre-Settlement CN
Woodland	55	58
Grassland	61	58
Cropland	69/70	58

* Per NR 151.12 and NR 151/123(1) for HSG B soil type.

Results

The results of these two model runs illustrate the additional decrease needed for the 5-year (1980-1984) runoff volume from existing/pre-development conditions to pre-settlement conditions (Figures 1 and 2). As figures 1 and 2 illustrate, the post-development conditions volume is represented by the red bar + the blue bar. For the R2 scenario, the post-development runoff volume is a little over 15 acre-feet and for the TOD scenario it is approximately 120 acre-feet. The red bar illustrates the amount of runoff generated under pre-development conditions and under pre-settlement conditions. For the R2 scenario, 2.4 acre-feet of runoff is generated under pre-development conditions while 0.6 acre-feet are generated under pre-settlement conditions. For the TOD scenario, 20.8 acre-feet of runoff is generated under pre-development conditions while 2.8 acre-feet are generated under pre-settlement conditions. The difference between the total volume and the amount coming off the landscape under pre-development and pre-settlement conditions is what needs to be mitigated when the site is developed (the blue bar).

Discussion

Although the annual runoff volume decreases significantly from existing/pre-development conditions to pre-settlement conditions, the overall stormwater management plan designed to address a pre-settlement standard would require a moderate increase in size. This is because the requirements for meeting existing/pre-development conditions already requires a significant volume reduction and the amount of additional treatment required to meet pre-settlement conditions is small in comparison.

For example, the medium-density residential (R2) development requires the development of a stormwater management plan that will mitigate 13.0 acre-feet of stormwater runoff (15.4 - 2.4 acre-feet) if the existing/pre-development condition criteria is used. If the pre-settlement criteria are used, 14.8 acre-feet (15.4 – 0.6 acre-feet) of stormwater runoff requires mitigation. This amounts to an increase of 12% over the existing/pre-development condition requirements. Table 1 shows that for the two development scenarios (R2 and TOD), volume control BMPs would need to be increased by 12-15% to meet pre-settlement conditions for both the 1-year and 5-year time periods.

Table 2. Volume reduction required to meet CARPC 1d volume control requirement

	R2			TOD		
Time Frame	Existing	Pre-Settlement	Change	Existing	Pre-Settlement	Change
1-year	87%	98%	+12%	86%	99%	+13%
5-year	84%	96%	+12%	83%	98%	+15%

Given the findings presented in the City of Fitchburg Catalytic Project report for the final design, the stormwater management plan designed for the medium density residential (R2) development accounted for 4% of the total site area. The stormwater management plan designed for the Transit-Oriented Development (TOD) accounted for 6% of the total site area. If both of these stormwater management plans had been developed to meet a pre-settlement standard (versus the existing pre-development standard) these percentages would increase from 4% to 4.5% for the R2 scenario and from 6% to 7% for the TOD scenario. As the Catalytic Project report illustrates, there is additional room under both development scenarios to treat additional stormwater runoff which would make the application of the pre-settlement to post-development comparison standard viable for the McGaw Neighborhood Area.

III. Conclusions

If the City decides to adopt a pre-settlement volume control standard, it may want to consider allocating curve numbers for different land cover.

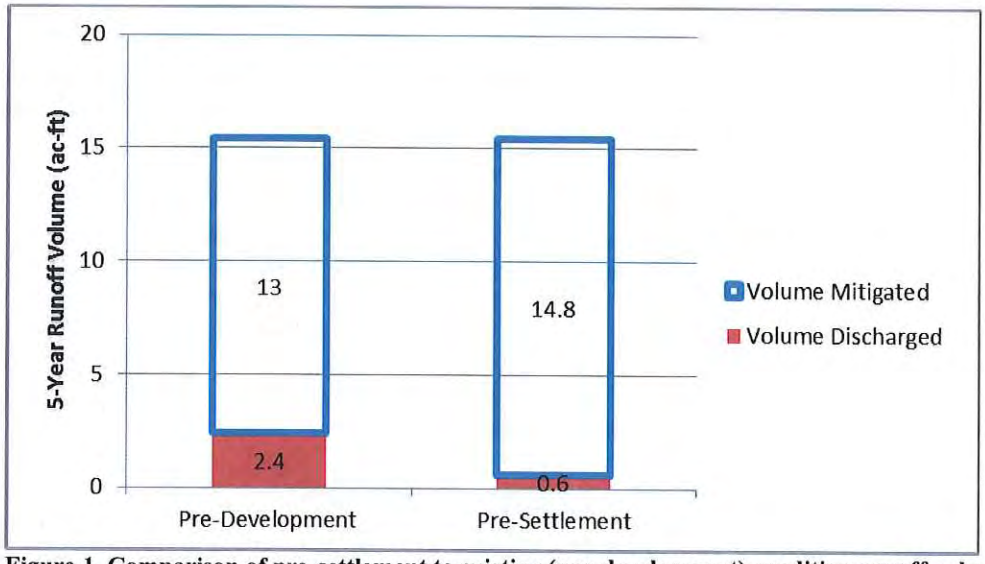

Figure 1. Comparison of pre-settlement to existing (pre-development) condition runoff volumes for a medium density residential development (R2)

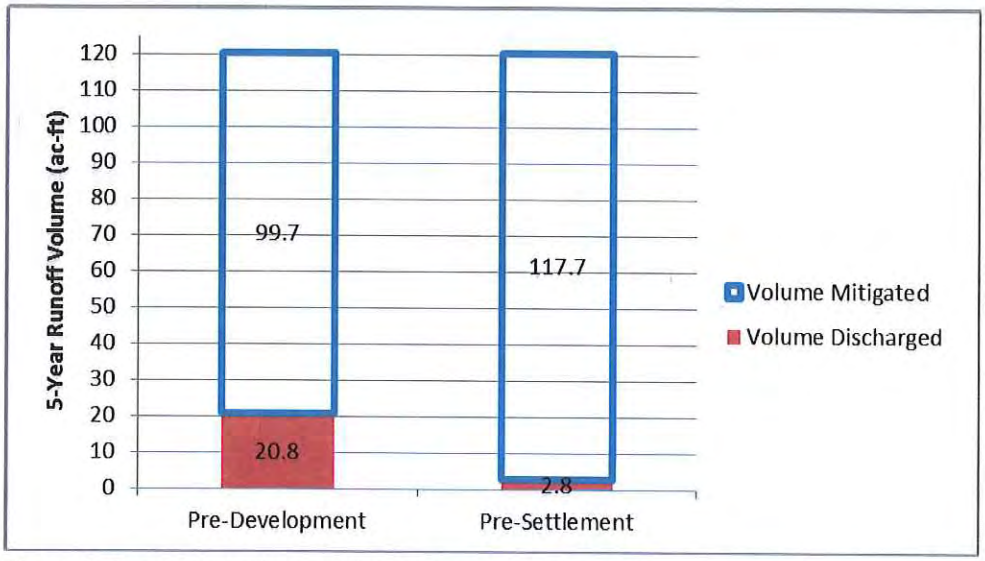

Figure 2. Comparison of pre-settlement to existing (pre-development) condition runoff volumes for a Transit-Oriented Development (TOD)

The volume mitigated increases more (as a greater percentage of the overall volume) for the TOD site than the R2 site. This difference is due to the pre-development curve number at the TOD site (CN=73) which is higher than the curve number at the R2 site (CN=70). As a result, the TOD site requires a greater change to reach the runoff volume generated by a pre-settlement condition (CN=58).