

MEMO



External Memorandum

To: Nick Tomczik
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From: Greg Bowles, P.E. *Greg Bowles*

Date: September 16, 2010

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Cc: Doug Thomas
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Subject: Volume Control Summary Memorandum

The purpose of this memorandum is to evaluate alternative regulation with equivalent volume reduction results to the current RCWD regulation, that if adopted, would simplify the current water quality and volume control requirements, enable easier RCWD administration of the rules, easier applicant response, and provide consistency with adjacent watershed districts. This evaluation may also be the basis for future water quality and volume control rule revisions.

BACKGROUND

On February 13, 2008, the Rice Creek Watershed District (RCWD) Board of Managers, pursuant to the Minnesota Statutes 103D.341, adopted a revised set of rules governing permits for work within the watershed that may affect water resources. The intent of these new rules was to protect the public health and welfare and the natural resources of the District by providing reasonable regulation with the intent to improve water resources.

Implementation of these rules has improved the water quality and volume control within the Rice Creek Watershed. Analysis conducted as part of recent Repair Reports for four public drainage systems administered by the District has examined the effect of the district stormwater rules on seasonal runoff volumes. Development within the contributing drainage areas of these public drainage systems is not only subject to the stormwater requirements of the current (2008) District stormwater rule, but also one of three adopted rules which are specific to a city or drainage system within the District: 1) Rule RMP-2 (Anoka/Washington Judicial Ditch 4 subwatershed, including Anoka County Ditch 15); 2) Rule RMP-3 (City of Lino Lakes); and 3) Rule RMP-4 (City of Columbus, outside of A/W JD 4). Since Rule RMP-4 has no stormwater requirements, development within the City of Columbus is subject to only the current District rule. Rules RMP-2 and RMP-3 contain requirements somewhat different than the current District rule with regard to volume mitigation BMP's accepted, but the net volume quantity required to be treated is nearly identical for these rules, and consequently the effect of Rules RMP-2 and RMP-3 were modeled identically to the District rule in the analysis. (Note: the effect of redevelopment --including public linear projects -- was not included as part of this analysis.)

Table 1 summarizes the estimated effect of the District stormwater rule (Rule C) on seasonal runoff volume as determined by the Repair Reports. This analysis shows that the stormwater rule not only mitigates the increased volume caused by new impervious surfaces, but it goes a step further and

decreases the volume when compared to existing conditions by 8% to 22%. The current District stormwater rule clearly provides its intended function.

Table 1 -- Effect of Future Development on Season Runoff Volumes

Public Drainage System	Net Change in Runoff Volume Due to Future Development Assuming No Volume Reduction Rule	Net Change in Runoff Volume Due to Future Development Assuming Current District Stormwater Rules
Anoka County Ditch 15 / Judicial Ditch 4	+140%	-21%
Anoka County Ditch 31	+184%	-15%
Anoka County Ditch 46	+174%	-8%
Anoka County Ditch 10-22-32	+116%	-22%

CURRENT RULE AND INTERPRETATION

As these revised stormwater rules have been implemented, the District Engineer and District Staff have identified that certain portions of Rule C, in particular *Section 5 Water Quality and Volume Control*, are not fully clear to permit applicants and other interested parties, and are often misinterpreted. Furthermore, as a result, permit reviewers have responded to repeated questions and confusion on how to calculate current water quality and volume control rules. The following is a summary of the primary components of the volume control rule leading to confusion.

Rule C.2(e):

If redevelopment will (i) disturb fifty percent or more of existing impervious surface or (ii) increase impervious surface by fifty percent or more, the requirement of paragraph 5(b) will account for all impervious surface on the site. For the purpose of this paragraph, the extent of disturbance is the area of exposure of underlying soils. This paragraph does not apply to public linear projects subject to paragraph 5(f).

Rule C.5(b):

Water quality and infiltration BMPs must be sized to infiltrate and/or retain the runoff volume generated within the contributing area by a two-year (2.8-inch) storm under the developed condition.

Rule C.5(c):

For impervious surface other than net increase required to be treated during redevelopment pursuant to paragraph 2(e) above, the standard is the 0.8-inch event rather than the 2.8-inch event.

The rules do not explicitly state if the two-year storm is applied to both pervious and impervious surfaces. As a policy, the RCWD has allowed applicants to calculate BMP volumes by one of two methods. The BMP volumes may be calculated using the Simple Calculation Method by multiplying the applicable rainfall depth times the impervious surface area, times an infiltration/evaporation loss

factor (0.9). The applicant also has the option to instead use the Model Calculation Method to hydrologically model the rainfall event (including pervious surface area), which enables them to reduce the BMP volume by the infiltration from that BMP during the rainfall event. Generally, the difference in volume requiring treatment is small. However, for larger sites with considerable pervious area, larger differences between the methods can result.

Implementation of the volume control requirements for public linear projects has also been at times challenging. These volume control standards are further modified in Rule C.5(f) for public linear projects (roadway, sidewalk and trail) as shown in **Table 2**.

Table 2 – RCWD Volume Control Requirements for Public Linear Projects

Project Type	Roadway Classification	Standard
New Construction (≥ 1.0 acre impervious)	Arterial, County Road or Highway	Standard for non-linear projects applies to runoff from the new and reconstructed impervious surface
	Collector, Subcollector or Access	Standard for non-linear projects applies to runoff from the new and reconstructed impervious surface and the directly connected impervious surfaces within the project corridor
Reconstruction or New Construction (< 1.0 acre impervious)	Arterial, County Road or Highway	Infiltration of 1.0-inch of runoff from the new and reconstructed impervious surface
	Collector, Subcollector or Access	Infiltration of 0.8-inch of runoff from the new and reconstructed impervious surface and the directly connected impervious surfaces within the project corridor
Rehabilitation	All	No water quality/volume control requirement
Mill & Overlay	All	No Rule C permit required

The reasons implementation has been challenging relates to the fact that this portion of the rule modifies earlier portions of the rule, differing requirements with regard to the project type, and a differing requirements for roadway classification.

VOLUME CONTROL RULE OF ADJACENT WATERSHED DISTRICTS

Permit applicants and cities within the RCWD have suggested simplifying the rule. For purposes of comparison, **Table 3** summarizes the infiltration requirements of RCWD and the watersheds that are directly adjacent to RCWD.

Table 3 – BMP Infiltration Requirements of Adjacent Watershed Districts

Entity	Infiltration Requirement
Brown's Creek	Difference between pre-and post-developed 2.8" rainfall event over the entire site (3.6" rainfall event if landlocked)
Capital Region	1" runoff over new and existing impervious surface area
Carnelian Marine St Croix	Difference between pre-and post-developed 2.8" rainfall event over the entire site (3.6" rainfall event if landlocked)
Comfort Lake-Forest Lake	Difference between pre-and post-developed 2.8" rainfall event over the entire site (3.6" rainfall event if landlocked)
Coon Creek	1" runoff over new and existing impervious surface area
Ramsey-Washington Metro Valley Branch	1" runoff over new and existing impervious surface area
	<p><u>Valley Creek & Edith Watershed:</u> Difference between 2.2" pre-developed rainfall event and 2.9" post-developed rainfall event over the entire site or 1" runoff over impervious surface area (Use greater of the two)</p> <p><u>All Other Areas Within Watershed:</u> Difference between pre-and post-developed 1" rainfall event over the entire site or 0.5" runoff over impervious surface area (Use greater of the two)</p>
Rice Creek	<p>Post-developed two-year (2.8") rainfall event over the contributing drainage area and 0.8" event over the redeveloped impervious surface area*</p> <p>*If redevelopment or increase of 50% or greater of existing impervious surface area then must account for all impervious surface area on the site</p> <p>or</p> <p>For public linear projects: Reconstruction or New Construction (< 1.0 acre impervious for</p>

Entity	Infiltration Requirement
	<p>Collector, Subcollector or Access) requires 0.8” event over new, reconstructed and directly connected impervious surface area within project corridor</p> <p>or</p> <p>Reconstruction or New Construction (< 1.0 acre impervious for Arterial, County Road or Highway) requires 1.0” event over new and reconstructed impervious surface area</p> <p>or</p> <p>New Construction (\geq 1.0 acre impervious for Collector, Subcollector or Access) requires 2.8” rainfall event over the new impervious area and 0.8” event over the reconstructed and directly connected impervious surface area within project corridor</p> <p>or</p> <p>New Construction (\geq 1.0 acre impervious for Arterial, County Road or Highway) requires 2.8” rainfall event over the new impervious area and 0.8” event over the redeveloped impervious surface area</p>

Clearly, a variety of volume control rules existing among the metro watershed district adjacent to the RCWD. However, the rules generally fall into one of two categories: 1) a 1-inch runoff depth over new and existing impervious surfaces; or 2) the difference between Pre-and Post- developed rainfall events. None of these volume control rules is as complex as the RCWD rule. The analysis which follows evaluates some of these differing rules.

In comparison to the volume control of the adjacent watersheds, the Minnesota Pollution Control Agency (MPCA) regulates the discharge of stormwater to waters of the state of Minnesota associated with construction activity by the National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) permit program. The MPCA requires permanent stormwater managements systems such as wet sedimentation basins, infiltration and filtration basins and regional ponds to provide the water quality volume of 0.5-inches over the new impervious surface created by the project.

PERMIT DATA

To evaluate the effect of utilizing alternative volume control rules in lieu of the current RCWD rule and policy, data was gathered from RCWD permit applications that were submitted after the February 13, 2008 rules were adopted. Permits that are received by RCWD are typically separated into three project types that include public linear roadway (street and utility projects), final site design, and land development. The size of the permits also ranges from small to large in total project area. The RCWD volume control requirements vary slightly for each type and size of permit. Data from each type and size of permit was chosen from for this analysis so that the results would represent a wide range of permit types and sizes. The data from a total of 25 permits were evaluated, eleven permits

from public linear roadway projects, ten from final site design and four from land development projects (because of the lack of recent land development within the district, only a small sample of these permits exist). Data collected from each permit includes:

- Permit number and type
- Overall project size
- Total project area within parcel requiring treatment
- Number and type of BMP's
- Existing impervious and pervious area of total project area
- Future new and redeveloped impervious area
- Total off-site contributing drainage and impervious area
- Project soil type
- RCWD permit volume control required

This data was assembled and organized within an excel spreadsheet (see **Appendix A**) that was used as a tool to evaluate the different methods of calculating volume treatment.

ALTERNATIVE VOLUME CONTROL STANDARDS

Alternative volume control standards selected for this analysis were based on existing standards of other metro watersheds and neighboring states. The implementation of these standards was analyzed using actual RCWD permitted projects so that a direct comparison of required volume treatment could be obtained between these different volume control standards and the RCWD permitted volume control requirements. The RCWD permitted volumes used in this comparison were calculated using both the simple and the modeling calculation methods. As state prior to this, the difference in volume requiring treatment between these two methods is small and should not affect the accuracy of the direct comparison. The alternative volume control standards analyzed are shown in **Table 4**.

Table 4 –Analyzed Volume Control Standards

Volume Control Standard	Requirements Applies to	Rainfall /Runoff Depths Analyzed
New impervious runoff volume	New impervious area	0.5", 1", 1.5", 2"
Total project impervious runoff volume	Impervious area	0.5", 1", 1.5", 2"
Difference between pre-and post-developed runoff from rainfall event over the entire site	Entire site	2-year (2.8")
RCWD current rule* simplification using the Simple Calculation Method	Impervious area	2.8" (new impervious) 0.8" (existing impervious)
Wisconsin requirements for residential development	Entire site	See explanation below

*The current rule was evaluated to allow comparison to other standards.

The required volumes for new impervious runoff volume and total impervious runoff volume standards were calculated by simply multiplying the runoff depth times the corresponding impervious surface area (no initial abstraction was used).

Volumes resulting from the change in rainfall runoff volume were calculated by subtracting the pre-developed runoff volume from the post-developed runoff volume resulting from a 2.8-inch rainfall event using the SCS Method. Pre-developed curve numbers for the pervious areas of the project were chosen based upon the project specific hydrologic soil group and the required curve numbers specified in RCWD Rule C.6. **Table 5** shows the curve numbers used in this analysis for existing conditions.

Table 5 – Curve Numbers for Existing Conditions

Curve Numbers for Use with Existing Condition Pervious Areas	
Hydrologic Soil Group	Runoff Curve Number*
A	39
B	61
C	74
D	80
* Curve numbers from USDA-NRCS, Technical Release 55	

To be consistent with RCWD rules and allow comparison of the results to permitted projects, post-developed runoff conditions were modeled by shifting the curve number down one classification of soil group to account for the impacts of grading on soil structure. A runoff coefficient of 0.9 was applied to impervious surfaces (consistent with RCWD policy). Composite curve numbers were not used in our analysis.

A simplification of the current District rule using the Simple Calculation Method was analyzed, utilizing only the on-site impervious surface requirement for non-linear projects. The main difference between this Simple Calculation Method and the current District rule is that volume control is only required on runoff volume generated from on-site impervious surface and not the runoff volume generated from the entire contributing drainage area (on-site and off-site pervious and impervious area). The required volume for this simplified standard was calculated by multiplying a rainfall depth of 2.8-inches by a 0.9 initial abstraction by the new impervious surface area, and likewise multiplying a 0.8-inch rainfall depth by a 0.9 initial abstraction by the redeveloped on-site impervious surface.

Wisconsin volume control requirements for residential development (Wisconsin Rule NR 151.12) require one of the following conditions to be met:

- 1) Sufficient infiltration runoff volume so that the post-developed infiltration volume shall be at least 90% of the pre-development infiltration volume, based on an average annual rainfall; or
- 2) Infiltration volume equivalent to 25% of the post-development runoff volume from a 2-year, 24 hour design storm with a type II distribution.

To determine an infiltration volume from an annual rainfall as required by Condition (1), a continuous simulation SWMM model was developed that simulated a typical annual rainfall distribution over unit pervious areas with varying infiltration rates represented by the hydrologic soil groups in **Table 5**. The resulting unit infiltration volumes were multiplied by the pre and post-developed surface areas from each permit to obtain pre-and post- developed annual soil surface infiltration volumes. The BMP volume requirement of Condition (1) was determined as 90% of the pre-developed surface infiltration volume minus 100% of the post-developed surface infiltration volume.

Calculations for Condition (2) were completed by multiplying 0.25 by the runoff volume of the 2-year, 24 hour storm event (2.8-inch rainfall) for the post-developed conditions over the entire site, using the SCS method.

The resulting volume requirements for each alternative standard, applied to the sampling of permit data described above, was tabulated with and compared to the actual RCWD required permit volume from the permit engineer's report. This tabulation is included in **Appendix A**.

RESULTS

The alternative volume control standards listed above were evaluated as an absolute difference and percentage difference from the permitted volume. This provides both a sense of the absolute magnitude of the volume difference and a relative difference.

The absolute difference analysis method averaged the volume per project when compared to the current permitted volume requirements. This was computed by subtracting the permitted volume from the volume calculated by the alternative method for each permit and then taking an average of all analyzed permits for each permit type. Values that are negative indicate that the alternative standard requires a BMP volume that is less than current RCWD volume control requirements. This method demonstrates the net effect of overall BMP volume (per permit) provided to the District if a different standard is applied. **Tables 6** summarizes the results of the absolute difference analyses method.

The percent difference analysis method averaged the percentage change in required volume compared to the current permitted volume requirements for each permit. This was computed by subtracting the permitted volume from the computed alternative volume and then dividing by the permitted volume to get a percentage. An average was then taken for each type of permit. This method essentially shows the net additional volume control demands on the permittee, disregarding the size of project. **Tables 7** summarizes the results of the percent difference analyses method.

Both of these analyses methods were completed for all 25 permits in the three types of projects. The computed averages for these analyses were then weighted by using the historic permit type distribution for RCWD from 1998 to 2009. The historic permit type distribution indicated that from 1998 to 2009 RCWD has permitted 23% public linear projects (street, utility and trails), 54% final site design projects, and 23% land development projects.

The net change in required BMP volume for the analyzed alternatives ranges from -16,286 cubic-feet to +48,628 cubic feet based on the historic permit weighted average volumes shown in **Table 6**. This range of values indicates that in some cases the alternative volume standards provides less than the current District rule and in other cases the alternatives provide more than the current District rule.

The alternative volume control standards that most closely match the effect of the current RCWD volume control rules are:

- 1.0-inch runoff event over total site impervious surface;
- 1.5-inch runoff event over total site impervious surface;
- RCWD Simple Calculation Method); and
- Change in Rainfall Runoff Volume (2.8-inch).

The required volume control of these “close match” alternatives varies between the three permit types. For example, the results of the runoff volume over total site impervious surface standards for final site design and street and utility projects indicate that the alternative volume would exceed the current permit volume requirements, while the remaining alternatives would provide somewhat less than current permitted volume requirements. The 1.0-inch runoff event over total site impervious and the RCWD Simple Calculation Method alternatives provide the closest correlation to the current application of the District rule for final site design projects. The 1.5-inch runoff event over total site impervious and change in rainfall runoff alternatives for street and utility projects provide the closest correlation to the current application of the District rule.

Table 6
Effect of Various Stormwater Rules on Required Project Infiltration Volume

	Runoff Volume Over New Impervious Surfaces				Runoff Volume Over Total Site Impervious Surfaces				RCWD Impervious Requirements	Change in Rainfall Runoff Volume	Wisconsin Requirements for Residential Development	
	0.5-inch	1.0-inch	1.5-inch	2.0-inch	0.5-inch	1.0-inch	1.5-inch	2.0-inch	2.8" new / 0.8" existing ⁽¹⁾	2.8 -inch ⁽²⁾	90% rule ⁽³⁾	25% 2-year ⁽⁴⁾
<i>Average Change in Volume Treated Per Project When Compared to Current Rule Application (cubic feet) ⁽⁵⁾</i>												
Final Site Design Projects	-12,459	-10,919	-9,379	-7,839	-7,274	-548	6,177	12,903	-633	-2,390	35,228	-3,433
Land Development Projects	-18,919	-15,066	-11,214	-7,362	-18,919	-15,066	-11,214	-7,362	-3,355	-6,812	117,830	-16,822
Street and Utility Projects	-22,638	-20,705	-18,772	-16,838	-15,902	-7,234	1,434	10,102	-5,706	-3,383	10,885	-8,587
Historic Permit (1998-2009) Weighted Average Change in Required Infiltration Volume ⁽⁶⁾	-16,286	-14,123	-11,961	-9,799	-11,937	-5,425	1,086	7,598	-2,426	-3,635	48,628	-7,698

Notes:

1. Infiltration volume required by RCWD rule derived from a 2.8" runoff event over new impervious surface plus 0.8" over redeveloped impervious surfaces.
2. Difference between proposed and existing runoff resulting from a 2.8" rainfall event (over entire site).
3. 90% of the predeveloped average annual infiltration across the site, minus 100% of the postdeveloped average annual infiltration (over entire site)
4. 25% of the post-developed runoff volume from the 2-year, 24-hour rainfall event (over entire site).
5. Sampling of projects initiated after adoption of current District rules (2008-2010).
6. Weighted average assumes the following historic distribution of projects by type, from 1998-2009:
 - Final Site Design Projects: 54%
 - Land Development Projects: 23%
 - Street and Utility Projects: 23%

Table 7
Relative Increase in Per-Project Required Infiltration Volume Resulting from Various Stormwater Rules ⁽¹⁾

	Runoff Volume Over New Impervious Surfaces				Runoff Volume Over Total Site Impervious Surfaces				RCWD Impervious Requirements 2.8" new / 0.8" existing ⁽²⁾	Change in Rainfall Runoff Volume 2.8 -inch ⁽³⁾	Wisconsin Requirements for Residential Development		
	0.5-inch	1.0-inch	1.5-inch	2.0-inch	0.5-inch	1.0-inch	1.5-inch	2.0-inch			90% rule ⁽⁴⁾	25% 2-year ⁽⁵⁾	
<i>Average Percentage Change in Required Volume Per Project When Compared to Current Rule Application (percent) ⁽⁶⁾</i>													
Final Site Design Projects	-96	-91	-87	-82	-2	97	195	294	6	2	24	74	
Land Development Projects	-80	-60	-40	-19	-80	-60	-40	-19	1	-3	632	-70	
Street and Utility Projects	-92	-83	-75	-66	-46	7	61	115	5	39	-18	9	
Historic Permit (1998-2009) Weighted Average Change in Required Infiltration Volume ⁽⁷⁾	-91	-82	-73	-64	-30	40	110	181	5	9	154	26	

Notes:

1. Disregarding size of project.
2. Infiltration volume required by RCWD rule derived from a 2.8" runoff event over new impervious surface plus 0.8" over redeveloped impervious surfaces.
3. Difference between proposed and existing runoff resulting from a 2.8" rainfall event.
4. 90% of the predeveloped average annual infiltration across the site, minus 100% of the postdeveloped average annual infiltration
5. 25% of the post-developed runoff volume from the 2-year, 24-hour rainfall event.
6. Sampling of projects initiated after adoption of current District rules (2008-2010).
7. Weighted average assumes the following historic distribution of projects by type, from 1998-2009:

Final Site Design Projects:	54%
Land Development Projects:	23%
Street and Utility Projects:	23%

These four alternative volume control standards provide less volume control for land development projects than the current application of the District rule. The RCWD Simple Calculation Method alternative provides the closest correlation to the current application of the District rule for land development projects. The results also indicate that the RCWD Simple Calculation Method and the change in rainfall runoff volume alternatives affect the average change in volume similarly for all types of permits.

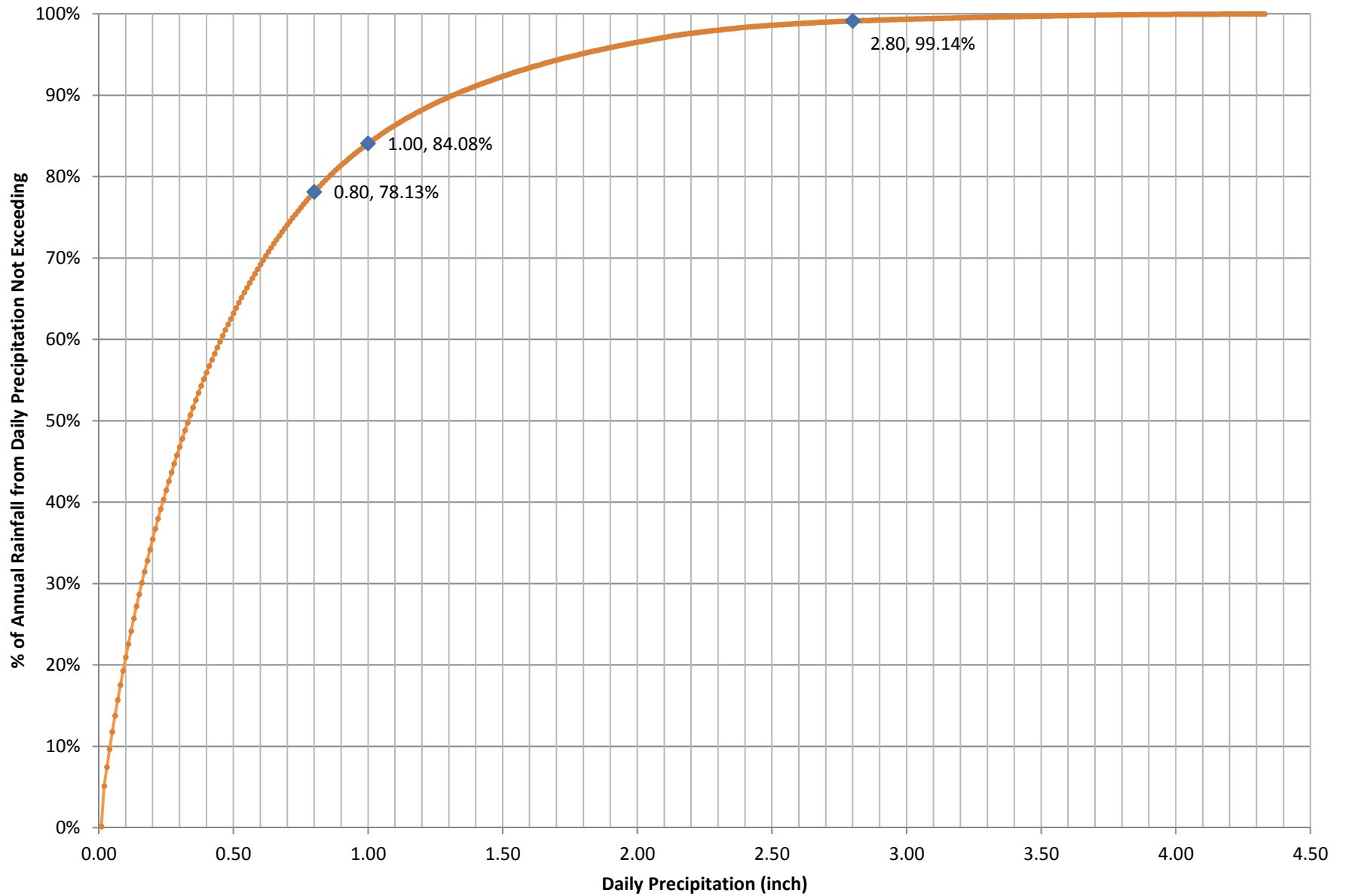
Table 7 shows that of the average percentage change in volume per project for the four alternatives list above the RCWD Simple Calculation Method and the change in rainfall runoff volume requirement alternatives correlate closest to the current rule application.

The change in rainfall runoff volume is calculated using the 2.8-inch, 24 hour rainfall event. This alternative would require the applicant to hydrologically model the project area to determine the volume control requirement. Because the inputs and techniques of hydrologic modeling are inherently subjective, this could add inconsistencies in submittal calculations by applicants resulting in additional review time. For this reason, a rule tied to rainfall is less desirable than a runoff-only rule.

A volume/frequency analysis of the daily precipitation depths over a typical growing season (April 15th to Oct. 15th) for the City of Centerville over a 30 year time period from 1980 to 2009 was completed (see **Figure 1**). This analysis was completed to quantify the percentage of daily precipitation depth that occurs over a typical growing season. This analysis was completed over the typical growing season because this is the period of time when a majority of the precipitation rainfall events occur and BMPs are properly functioning to provide stormwater runoff treatment. The results indicate that 78% of the average annual precipitation depth is from a 0.8-inch depth or less, 84% from a 1.0-inch depth or less, and 99% from a 2.8-inch or less. For example, if a BMP is sized to treat the volume of runoff from a 1.0-inch event then it would be treating approximately 84% of the average precipitation during a typical growing season.

Figure 1: Volume/Frequency Analysis of Daily Precipitation Depths During the Growing Season

Centerville, MN 1980-2009



CONCLUSION / RECOMMENDATION

In conclusion permit types such as final site design and street and utility projects are a mix of redeveloped and new impervious surface and show a close correlation to the current application of the District rule when compared to the four recommended alternative volume control standards list above. Land developments projects are entirely new impervious surface and show the best correlation to the current application of the District rule when compared to the RCWD Simple Calculation Method alternative.

Although the effects of various volume control standards can be quantified, qualified, and compared analytically, the selection of a standard to be adopted by the District is a policy decision that must be determined by the Board of Managers. However, the analysis performed as part of the memorandum points to three potential alternative standards that each would have relatively small effect on the overall volume calculated to be treated by a BMP yet provide a simple, fair, and effective rule:

- 1) 1.5-inch runoff over total site impervious surface;
- 2) 1-inch runoff over total site impervious surface; or
- 3) RCWD Simple Calculation Method (2.8-inch runoff over new impervious surface, plus 0.8-inch over existing site impervious surface).

The 1.5-inch runoff over total impervious standard would result in generation of infiltration BMP volume closest to the current application of the District rule, actually slightly exceeding the District rule. We recommend that the Board adopt this standard if the priority of the Board is to implement a simplified rule that most closely matches the overall BMP volume generated by the current rule.

The 1-inch runoff over total site impervious surface standard would generate 33% less infiltration BMP volume than the 1.5-inch standard. However, since 84% of the typical growing season rainfall volume results from the first inch of precipitation, the difference in volume infiltrated as a result of each standard would be relatively small. The 1-inch runoff over total site impervious surface standard is currently used by three adjacent watershed districts. If the priority of the Board is to adopt a simplified rule that matches rules of adjacent watershed districts and likely provides a similar annual infiltration volume to the current application of the District rule, then we recommend the volume control standard of 1-inch runoff over total site impervious.

The Simple Calculation Method standard which requires the infiltration volume of 2.8-inch runoff over new impervious surfaces, plus 0.8-inch over existing site impervious surfaces results in required volume control relatively similar to the current application of the District rule for all three major permit project types. This standard is also similar in application, though far less complicated, compared to the current rule. The main difference between this method and the current District rule in application is that volume control is only required on runoff volume generated from on-site impervious surface and not the runoff volume generated from the entire contributing drainage area (on-site and off-site pervious and impervious area). We recommend that the Board adopt this standard if their priority is to provide a simplified version of the current District rule that minimally changes the BMP volume required of applicants for all project types.

Any of these three standards, when implemented, would achieve the basic intent of the volume control requirements, namely to prevent development from increase runoff volume, and going a step farther, mitigate some of the volume increases caused by historic site development. We recommend that the Board, depending on which standard most closely matches their priorities and policies as described in the paragraphs above, provide direction to the engineer and district staff to undertake revising the rules. Furthermore, we recommend consideration by the Board that the following policies and conventions be used should a new rule be adopted, to facilitate the efficient and equitable implementation of the rule:

- 1) Require the permit applicant to calculate the required infiltration BMP volume simply as a multiplication of the runoff depth over the impervious surface area, with reductions for evaporation, soil infiltration, or other initial abstractions;
- 2) Provide no reductions in BMP volume due to infiltration within the BMP during the rainfall event;
- 3) Allow reductions for required BMP volume based on functional and maintained infiltration BMP's already existing on site; and
- 4) An infiltration BMP volume equivalency for recycling of stormwater via irrigation should be determined and implemented (the development of this equivalency is beyond the scope of this memorandum).

The adoption of one of these three alternative volume control standards will provide many potential benefits. Frustration felt by applicants and their consultants, due to misinterpretation and lack of understanding of the rules should be reduced. Simplified volume control rules will likely result in a reduction of administration time and permitting costs (mostly consultant fees).

APPENDIX A

DATA TABULATION

APPENDIX A - Volume Analysis Study Calculations

Permit Number	Permit Type	Overall Parcel Size (ac)	Total Project Area Within Parcel Requiring Treatment (ac)	Existing Project Area Impervious Area (SF)	Existing Project Pervious Area (SF)	Future Project Area New Impervious Area (SF)	Future Project Pervious Area (SF)	Future Project Area Redeveloped Impervious Area (SF)	Total Project Area Future Impervious Area (SF)	Off-site Impervious Area (outside project area and inside contributing drainage area) Requiring Treatment (SF)	Project Soil Type	Project Area and Off-site Drainage Area Existing Pervious CN Value	Project Area Future Pervious CN Value	New Impervious Runoff Volume												Impervious Pro
														New Impervious Project Area Future Volume 0.5-inch Event (CF)			New Impervious Project Area Future Volume 1.0-inch Event (CF)			New Impervious Project Area Future Volume 1.5-inch Event (CF)			New Impervious Project Area Future Volume 2.0-inch Event (CF)			
														(I*Runoff Coeff. * 0.5"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(I*Runoff Coeff. * 1.0"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(I*Runoff Coeff. * 1.5"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(I*Runoff Coeff. * 2.0"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	
(D)	(G)	(H) (D-G)	(I)	(J) (H-I)	(K)	(L) (G+I)	(N)	(Q) (CN from Rule C)	(R) (CN shift down)																	
09-026	FSD	2.30	0.06	1,842	728	144	584	1,842	1,986		b	61	74	6	-94	-99	12	-89	-93	18	-83	-87	24	-77	-81	83
09-077	FSD	68.00	0.55	24,000	2	0	2	24,000	24,000		b	61	74	0	-100	-1,440	0	-100	-1,440	0	-100	-1,440	0	-100	-1,440	1,000
10-010	FSD	1.40	1.40	43,560	17,424	1,300	16,124	43,560	44,860		c	74	80	54	-98	-2,124	108	-95	-2,070	163	-93	-2,016	217	-90	-1,961	1,869
08-069	FSD	4.97	4.97	48,636	167,857	528	167,329	34,589	49,164		b	61	74	22	-99	-2,164	44	-98	-2,142	66	-97	-2,120	88	-96	-2,098	2,049
09-005	FSD	13.84	13.84	242,194	360,676	1,300	359,376	44,637	243,494		c	74	80	54	-98	-2,897	108	-96	-2,843	163	-94	-2,789	217	-93	-2,734	10,146
09-060	FSD	42.69	6.60	133,729	153,767	0	153,767	91,476	133,729		b	61	74	0	-100	-5,489	0	-100	-5,489	0	-100	-5,489	0	-100	-5,489	5,572
08-063	FSD	2.16	2.16	94,090	0	0	0	87,120	94,090	0	d	80	80	0	-100	-5,808	0	-100	-5,808	0	-100	-5,808	0	-100	-5,808	3,920
09-012	FSD	8.87	2.00	34,412	52,708	52,708	0	0	87,120		c	74	80	2,196	-80	-8,954	4,392	-61	-6,758	6,589	-41	-4,562	8,785	-21	-2,365	3,630
09-040	FSD	11.07	11.07	341,075	141,134	0	141,134	325,829	341,075	0	c	74	80	0	-100	-16,771	0	-100	-16,771	0	-100	-16,771	0	-100	-16,771	14,211
10-813	FSD	82.00	28.00	280,962	938,718	313,632	625,086	280,962	594,594		a	39	61	13,068	-86	-78,844	26,136	-72	-65,776	39,204	-57	-52,708	52,272	-43	-39,640	24,775
10-012	LD	2.26	1.07		46,609	24,394	22,215		24,394	0	a	39	61	1,016	-70	-2,382	2,033	-40	-1,365	3,049	-10	-349	4,066	20	668	1,016
10-028	LD	2.40	2.40		104,544	52,272	52,272		52,272	0	b	61	74	2,178	-82	-10,018	4,356	-64	-7,840	6,534	-46	-5,662	8,712	-29	-3,484	2,178
10-018	LD	6.60	4.10	0	178,596	169,884	8,712	0	169,884		c	74	80	7,079	-80	-28,598	14,157	-60	-21,519	21,236	-40	-14,441	28,314	-21	-7,362	7,079
09-002	LD	7.60	6.02		262,231	123,275	138,956		123,275	0	c	74	80	5,136	-87	-34,678	10,273	-74	-29,541	15,409	-61	-24,405	20,546	-48	-19,268	5,136
09-051	S&UP	0.00	0.01	600	0	0	0	600	600	0	b	61	74	0	-100	-46	0	-100	-46	0	-100	-46	0	-100	-46	25
09-047	S&UP	3.03	3.03	0	131,987	8,940	123,047	0	8,940	0	b	61	74	373	-44	-299	745	11	74	1,118	67	447	1,490	122	819	373
08-060	S&UP	1.00	1.00	16,553	27,007	0	27,007	16,553	16,553	0	b	61	74	0	-100	-1,045	0	-100	-1,045	0	-100	-1,045	0	-100	-1,045	690
09-101	S&UP	50.00	1.04	45,441	1	0	1	45,441	45,441	0	a	39	61	0	-100	-3,067	0	-100	-3,067	0	-100	-3,067	0	-100	-3,067	1,893
09-022	S&UP	1.61	1.61	70,161	1	0	1	70,161	70,161	0	b	61	74	0	-100	-4,677	0	-100	-4,677	0	-100	-4,677	0	-100	-4,677	2,923
10-015	S&UP	4.00	4.00	87,991	86,249	0	86,249	87,991	87,991	0	b	61	74	0	-100	-5,279	0	-100	-5,279	0	-100	-5,279	0	-100	-5,279	3,666
09-071	S&UP	3.17	3.17	96,053	42,032	0	42,032	96,053	96,053	0	C	74	80	0	-100	-5,763	0	-100	-5,763	0	-100	-5,763	0	-100	-5,763	4,002
10-001	S&UP	6.33	6.33	169,448	106,287	46,174	60,113	111,514	215,622	0	b	61	74	1,924	-88	-14,463	3,848	-77	-12,539	5,772	-65	-10,615	7,696	-53	-8,691	8,984
09-080	S&UP	17.50	17.50	141,570	620,730	102,366	518,364	141,570	243,936	0	b	61	74	4,265	-86	-26,301	8,531	-72	-22,036	12,796	-58	-17,770	17,061	-44	-13,505	10,164
09-106	S&UP	30.54	15.21	662,382	0	0	0	614,687	662,382	715,418	b	61	74	0	-100	-79,775	0	-100	-79,775	0	-100	-79,775	0	-100	-79,775	27,599
08-068	S&UP	77.50	77.50	487,872	2,888,028	352,836	2,535,192	487,872	840,708	0	b	61	74	14,702	-88	-108,299	29,403	-76	-93,597	44,105	-64	-78,896	58,806	-52	-64,194	35,030

Total Project Impervious Runoff Volume											RCWD Requirements			Runoff Volume Difference			Wisconsin Requirements for Residential Development						RCWD Permit Volume (CF)
Project Area Future Volume 0.5-inch Event (CF)		Impervious Project Area Future Volume 1.0-inch Event (CF)			Impervious Project Area Future Volume 1.5-inch Event (CF)			Impervious Project Area Future Volume 2.0-inch Event (CF)			RCWD Requirements 2.8"/0.8" Runoff Event (project area) (CF)			Runoff Volume Difference for Project and Offsite Area (CF)			90% of the Predeveloped Average Annual Infiltration minus the Postdeveloped Average Annual Infiltration (CF)			25% of the Future Runoff Volume from 2-year, 24 hr Storm Event (CF)			
((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(L*Runoff Coeff. * 1.0"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(L*Runoff Coeff. * 0.5"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(L*Runoff Coeff. * 0.5"/12)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(2.8"*.9*1 + 0.8"*.9*K)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(Z-W) or (AK-AL)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(pre-dev. annual infiltration volume * 0.9 - post-dev. annual infiltration volume)	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	(2.8" rainfall of pervious area + runoff of impervious area) * .25	((Method - Permit Volume) / Permit Volume) * 100 (%)	District: Change in Volume between Method and Permitted volume	From permit ER
-21	-22	166	58	61	248	136	143	331	215	226	141	34	36	51	-52	-54	155	47	50	114	8	9	105
-31	-440	2,000	39	560	3,000	108	1,560	4,000	178	2,560	1,440	0	0	0	-100	-1,440	0	-100	-1,440	1,260	-12	-180	1,440
-14	-309	3,738	72	1,560	5,608	157	3,430	7,477	243	5,299	2,887	33	709	616	-72	-1,562	0	-100	-2,178	2,725	25	547	2,178
-6	-138	4,097	87	1,911	6,146	181	3,960	8,194	275	6,008	2,186	0	0	6,952	218	4,766	0	...	-2,186	5,314	143	3,128	2,186
244	7,195	20,291	588	17,340	30,437	931	27,486	40,582	1,275	37,631	2,951	0	0	9,715	229	6,764	0	-100	-2,951	21,035	613	18,084	2,951
2	83	11,144	103	5,655	16,716	205	11,227	22,288	306	16,799	5,489	0	0	6,299	15	810	0	-100	-5,489	9,532	74	4,043	5,489
-32	-1,888	7,841	35	2,033	11,761	103	5,953	15,682	170	9,874	5,227	-10	-581	0	-100	-5,808	0	-100	-5,808	4,940	-15	-868	5,808
-67	-7,520	7,260	-35	-3,890	10,890	-2	-260	14,520	30	3,370	11,069	-1	-81	7,625	-32	-3,525	70,775	535	59,625	4,574	-59	-6,576	11,150
-15	-2,560	28,423	69	11,652	42,634	154	25,863	56,846	239	40,075	19,550	17	2,779	3,741	-78	-13,030	0	-100	-16,771	21,147	26	4,376	16,771
-73	-67,137	49,550	-46	-42,363	74,324	-19	-17,588	99,099	8	7,187	82,720	-10	-9,192	81,095	-12	-10,817	421,342	358	329,430	35,024	-62	-56,888	91,912
-70	-2,382	2,033	-40	-1,365	3,049	-10	-349	4,066	20	668	5,123	51	1,725	5,664	67	2,266	36,907	986	33,509	1,416	-58	-1,982	3,398
-82	-10,018	4,356	-64	-7,840	6,534	-46	-5,662	8,712	-29	-3,484	10,977	-10	-1,219	11,845	-3	-351	78,076	540	65,880	3,598	-70	-8,598	12,196
-80	-28,598	14,157	-60	-21,519	21,236	-40	-14,441	28,314	-21	-7,362	35,676	0	0	24,808	-30	-10,868	269,252	655	233,576	9,119	-74	-26,557	35,676
-87	-34,678	10,273	-74	-29,541	15,409	-61	-24,405	20,546	-48	-19,268	25,888	-35	-13,926	21,518	-46	-18,296	178,170	348	138,356	9,662	-76	-30,152	39,814
-46	-21	50	9	4	75	63	29	100	117	54	36	-22	-10	0	-100	-46	0	-100	-46	31	-32	-15	46
-44	-299	745	11	74	1,118	67	447	1,490	122	819	1,877	180	1,206	6,700	898	6,029	0	-100	-671	2,479	269	1,808	671
-34	-355	1,379	32	334	2,069	98	1,024	2,759	164	1,714	993	-5	-52	1,106	6	61	0	-100	-1,045	1,310	25	265	1,045
-38	-1,174	3,787	23	720	5,680	85	2,613	7,574	147	4,507	2,726	-11	-341	0	-100	-3,067	0	-100	-3,067	2,386	-22	-681	3,067
-37	-1,754	5,847	25	1,170	8,770	88	4,093	11,694	150	7,017	4,210	-10	-467	0	-100	-4,677	0	-100	-4,677	3,683	-21	-994	4,677
-31	-1,613	7,333	39	2,054	10,999	108	5,720	14,665	178	9,386	5,279	0	0	3,533	-33	-1,746	0	-100	-5,279	6,028	14	749	5,279
-31	-1,761	8,004	39	2,241	12,007	108	6,244	16,009	178	10,246	5,763	0	0	1,114	-81	-4,649	0	-100	-5,763	6,008	4	245	5,763
-45	-7,403	17,969	10	1,582	26,953	64	10,566	35,937	119	19,550	16,387	0	0	11,034	-33	-5,353	67,053	309	50,666	12,302	-25	-4,085	16,387
-67	-20,402	20,328	-33	-10,238	30,492	0	-74	40,656	33	10,090	29,991	-2	-575	40,236	32	9,670	95,750	213	65,184	21,273	-30	-9,293	30,566
-65	-52,176	55,199	-31	-24,577	82,798	4	3,023	110,397	38	30,622	36,881	-54	-42,894	0	-100	-79,775	0	-100	-79,775	34,775	-56	-45,000	79,775
-72	-87,971	70,059	-43	-52,941	105,089	-15	-17,912	140,118	14	17,118	103,368	-16	-19,632	169,345	38	46,345	227,207	85	104,207	85,543	-30	-37,457	123,000