Section 5
Monitoring, Reporting, and Accounting Practices to Estimate Long-Term Average Annual Net New Stormwater Recharge

One of the conclusions of the engineering investigations that supported the development of the Peace II Agreement was that the safe yield of the Chino Basin was declining due changes in landuse and stormwater management practices. In the Final Report and Recommendations on Motion for Approval of Peace II Documents (Schneider, 2007), the Special Referee recommended and the Court ultimately ordered that several elements be included within the 2010 RMPU (Motion to Approve Watermaster's Filing in Satisfaction of Condition Subsequent 5; Watermaster Compliance with Condition Subsequent 6, August 21, 2008) one of which was:

> "3. Measures should be evaluated to lessen or stop the projected Safe Yield decline. All practical measures should be evaluated in terms of their potential benefits and feasibility."

The 2010 RMPU identified that the implementation of Municipal Separate Storm Sewer System (MS4) permit in the Chino Basin watershed had the potential to mitigate or offset some of the projected decline in safe yield. In its acceptance of 2010 RMPU the Court ordered:

> "(3) Watermaster is hereby ordered to convene the committee described in item 3 of section 7.1 of the updated RMP to develop the monitoring, reporting, and accounting practices that will be required to estimate local project stormwater recharge and new yield."

Item 3 of Section 7.1 of the 2010 RMPU reads as follows:

> "3. In implementing the above, Watermaster should form a committee—consisting of itself, the landuse control entities, the County Flood Control Districts, the CBWCD, the IEUA, and others—to develop the monitoring, reporting, and accounting practices that will be required to estimate local project stormwater recharge and new yield. This committee should be formed immediately, and the monitoring, reporting, and accounting practices should be developed as soon as possible."[1]

[1] The term "new yield" is defined in the Peace Agreement to mean "proven increases in yield in quantities greater than historical amounts from sources of supply including but not limited to, capture of rising water, capture of available storm flow, operation of the Desalters (including the Chino I Desalter), induced recharge and other management activities implemented and operational after June 1, 2000."

The RMPU Steering Committee was formed in November 2011 in response to the Court's order. [2] This section describes the monitoring, reporting and accounting practices discussed and recommended by the RMPU Steering Committee. Starting in June of 2012, the Steering Committee started its investigation on the nature and occurrence of MS4 projects. A subcommittee of the Steering Committee (hereafter, the Subcommittee) was formed to review the formal process used by the MS4 permitees (land use control entities) to review and approve MS4 projects. The Subcommittee consisted of Dave Crosley of the City Chino, Rosemary Hoerning of the City of Upland, and Peter Kavounas of the Chino Basin Watermaster. The Subcommittee developed and presented draft procedures to the Steering Committee for the monitoring, reporting, and accounting practices required to estimate and account for recharge from MS4 projects.

The Watermaster pleading and subsequent Court order did not include the other two recommendations (1 and 2) described in Section 7.1 of the 2010 RMPU, which included:

> "1. Watermaster should allocate new yield that is created by new recharge above that required by MS4 permit compliance to the owners of those projects that create new recharge. This will require the development of (a) new agreements involving the Watermaster, project owners, and others, and (b) the development of new practices and procedures that can quantify new recharge during project development and subsequently verify that the new recharge is occurring during the project lifetime.
> 2. Watermaster, working with the Parties, should encourage the construction of local recharge projects in developed areas that will increase the capture and recharge of stormwater. The recommendations for local stormwater recharge projects in developed areas are the same as those for newly developed areas, articulated above."

MS4 Permit Background

The Cities and Counties that overlie the Chino Basin are obligated to implement the National Pollutant Discharge Elimination System (NPDES) MS4 Permit (Order R8-2010-0036 in San Bernardino County and Order R8-2010-0033 in Riverside County) adopted by the Santa Ana Regional Water Quality Control Board in 2010. Essentially, the new permits require that all stormwater generated from new

[2] The mandate of the Steering Committee was subsequently expanded to the scope of the entire 2013 RMPU amendment.

development from a 24-hour, 85th percentile storm (about 1 inch over 24-hours in the Chino Basin) be detained and recharged onsite if recharge is feasible; if recharge is not feasible, the stormwater must be detained and treated and subsequently discharged. The specific technologies for detention and recharge are to be developed by landuse control entities. The landuse control entities are responsible for the inspection and maintenance of these new stormwater management facilities. The recharge facilities could include detention and sedimentation basins, recharge basins, dry wells, and managed swales. The implementation of the new MS4 permits may result in new stormwater recharge relative to pre-project conditions in areas where recharge is feasible.

As part of the 2010 RMPU, projections of new stormwater recharge from the implementation of the 2010 MS4 permits were prepared. Models[3] were used to estimate the increase in stormwater recharge from new development by applying the stormwater management criteria from the new MS4 permit for two conditions: (1) half of the stormwater managed pursuant to the MS4 permit is recharged and (2) all of the stormwater managed pursuant to the MS4 permit is recharged. No assumptions were made as to the specific new stormwater management facilities used to comply with the permits except that they were maintained and functioned as originally conceived – there was no deterioration in infiltration capacity over time. The new stormwater recharge created through permit compliance was estimated to range from about 6,300 acre-ft/yr if half of the stormwater managed pursuant to the MS4 permit is recharged and 12,600 acre-ft/yr if all of the stormwater managed pursuant to the MS4 permit is recharged. This new recharge, if realized[4], would increase gradually from zero in the present to the above estimated value over the time that the land was improved. This could be a period of 40 to 50 years or more.

The recharge at downstream stormwater management facilities was projected to decrease slightly with MS4 permit implementation through the diversion of runoff that would have otherwise been recharged at these existing facilities. The adjusted recharge projections, correcting for reduction in downstream recharge, were about 5,300 acre-ft/yr if half of the stormwater managed pursuant to the MS4 permit is recharged and 10,500 acre-ft/yr if all of the stormwater managed pursuant to the MS4 permit is recharged. Finally, these adjusted estimates would need to be adjusted downward one more time to reduce them for incidental deep infiltration of precipitation that would have occurred in the pre-project condition. Thus, the net new recharge from the implementation of 2010 MS4 permit is equal to the stormwater recharge caused by the implementation of stormwater management projects pursuant to the MS4 permit minus the decrease in recharge at existing

[3] Specifically the Rainfall, Runoff, Router, and Rootzone (R4) Model (refer to Section 3 of the *2010 Recharge Master Plan Update* for more discussion on the recharge estimates for future MS4 compliance and more specifically to Appendix C of that report for a description of the R4 Model.

[4] ~~Providing that the original design capacity can be maintained over the life of the project.~~

stormwater management facilities minus the incidental deep infiltration of precipitation that would have occurred in the pre-project condition. A strict accounting method would have to be able to provide the information necessary to estimate net new recharge.

Alternatives for Estimation of Net New Recharge from MS4 Projects

Three alternative procedures were discussed by the Steering Committee. These alternatives included:

- Alternative 1 – Project-specific monitoring, reporting, and accounting;
- Alternative 2 – Indirect estimation during the periodic redetermination of safe yield;
- Alternative 3 – a hybrid of ~~the two~~Alternatives 1 and 2.

Alternative 1 Project-Specific Monitoring, Reporting, and Accounting Alternative

In this alternative, systematic data collection and evaluation would be used to identify MS4 projects as they were implemented, and estimate the projected long-term average annual net new stormwater recharge estimates for each project in the year that they were reported to the Watermaster. This alternative was identified by the Subcommittee.[5] The process to identify these projects and estimate net new recharge is illustrated in Figure 5-1 and Table 5-1. Figure 5-1 defines the proposed timeline and roles of the Chino Basin Watermaster and the Appropriator parties in this alternative. The process Figure 5-1 shows is as follows:

- The Watermaster will send quarterly reminders to the Appropriator parties to collect and compile Water Quality Management Plan (WQMP) reports and "as-built" drawings for all MS4 projects constructed (herein, collectively referred to as MS4 documentation) in the current fiscal year.
- In August, the Watermaster will request MS4 documentation from the Appropriators.
- The Appropriators will provide the MS4 documentation to the Watermaster in September in a digital format (e.g., an Adobe .pdf document).
- Watermaster staff will review the MS4 documentation, extract the information required to estimate the net new stormwater recharge from each new stormwater management facility ~~and net new recharge~~. These recharge estimates will be prepared in October. The results will be provided in the format shown in Table 5-1.

[5] The Subcommittee presented this alternative to the 2013 RMPU Steering Committee on February 7, 2013 and subsequently modified it to incorporate Steering Committee comments.

- Watermaster will prepare and distribute these estimates in an annual report in November.
- Watermaster will true up the net new stormwater recharge estimates during the next scheduled safe yield redetermination.
- The trued up values will be included in this safe yield redetermination.

Table 5-1 lists the data required to create an annual report and quantify the theoretical potential new yield. The table is organized as follows by column number.

1. Project Name
2. Date of Entry
3. Existence (or not) of Signed Maintenance Agreement
4. Ongoing Maintenance Verified (Every 3 years)
5. MS4-Required Capture volume (cubic feet)
6. Constructed Capture Volume (cubic feet)
7. Long-Term Average Annual Runoff from Site (acre-ft/yr)
8. Estimate of Pre-Project On-Site Incidental Recharge (acre-ft/yr)
9. Decrease in Recharge at Downstream Stormwater Management Facilities with MS4-required Capture Volume (acre-ft/yr)
10. Decrease in Recharge at Downstream Stormwater Management Facilities with Constructed Capture Volume (acre-ft/yr)
11. Long-Term Average Annual Recharge with MS4-Required Capture Volume (acre-ft/yr)
12. Long-Term Average Annual Recharge with Constructed Capture Volume (acre-ft/yr)
13. Long-Term Average Annual Net New Recharge with MS4-Required Capture Volume (acre-ft/yr)
14. Long-Term Average Annual Net New Recharge with Constructed Capture Volume (acre-ft/yr)
15. Chino Basin Management Zone
16. County
17. Land Use Control Agency
18. Service Provider (Appropriator)

The information contained in columns 1, 5, 6, and 15 through 18 can be found in the Water Quality Management Plan (WQMP) and drainage study reports associated with the new development. Column 2 needs to be verified by the Appropriator when the project is built.

Columns 3 and 4 need to be provided by the Appropriator. Order R8-2010-0036 and R8-2010-0033 contains the following language in reference to the operation and maintenance of post-construction BMP's:

1. The Permittees shall ensure, to the maximum extent possible (MEP), that all post-construction BMPs continue to operate as designed and implemented with control measures necessary to effectively minimize the creation of nuisance or pollution associated with vectors, such as mosquitoes, rodents, flies, etc. WQMPs shall identify the responsible party for maintenance, including vector minimization and control measures, and funding source(s) for operation and maintenance of all site design and structural treatment control systems. Permittees shall, through conditions of approval and during inspections, ensure proper maintenance and operation of all permanent structural post-construction BMPs installed in new developments. Design of these structures shall allow adequate access for maintenance.
2. Within twelve months of adoption of this Order, the Permittees shall develop a database to track operation and maintenance of post-construction BMPs. The database should include available BMP information such as the type of BMP design, location of BMPs (latitude and longitude), date of construction, party responsible for maintenance, maintenance frequency, source of funding for operation and maintenance, maintenance verification, and any problems identified during inspection including any vector or nuisance problems. A copy of this database shall be submitted with the annual report.

The values in columns 7 through 14 would be calculated using modeling tools such as those used in the 2010 RMPU and the Chino Basin Groundwater Model. Models are required to estimate stormwater recharge at the new MS4 facilities as these facilities are currently not metered nor can they be practically metered. Models are required to estimate pre-project incidental recharge and the impact of recharge at MS4 facilities on existing downstream stormwater management facilities. The existing modeling tools would be modified to enable Watermaster staff to efficiently estimate net new recharge from each MS4 project. The approximate cost to develop, demonstrate and document these modeling tools is about $50,000.[6] The cost to apply these tools to individual MS4 projects would be about $1,600 each.

The Chino Fire Station No.1 and Training Center was chosen by Watermaster staff to be a case study to demonstrate the major features of this alternative. Chino Fire Station 1 is located on a 3.6-acre site on the northeast corner of Schaefer and 4th Street. The WQMP for this site was provided by the City and reviewed by Watermaster staff. The data and results of this case study are shown in Table 5-1. The site has three subareas that drain to three bio retention basins. The storage

[6] The cost to revise the models alone is about $8,000. The additional cost includes the cost of documentation and demonstrating model to the Watermaster.

capacity of the bio retention basins is made up of 1) the surface volume of the swale, 2) the subsurface 6-foot diameter perforated storm drain which is filled through grated inlets, and 3) the volume of the void spaces that fill the 12-foot deep space below the bio retention basin. The total storage capacity was estimated to be about 24,243 cubic feet or about 0.55 acre-ft (column 6 on Table 5-1). The MS4 permit required stormwater management volume is 15,857 cubic feet or about 0.36 acre-ft (column 5 on Table 5-1).

The long-term average annual runoff generated on the project site is 3.17 acre-ft/yr (column 7 on Table 5-1). The pre-project condition was assumed to be the land use immediately before development; in this case vacant land[7]. The long-term average annual deep infiltration of precipitation for the pre-project condition was estimated to be about 1.33 acre-ft/yr (column 8 on Table 5-1). The table below shows the calculation of long-term average annual net new recharge (in units of acre-ft/yr) as a function of infiltration rate.

Estimated Long-Term Recharge Estimates for the Chino Fire Station No.1 and Training Center

	MS4-Required Capture Volume		Constructed Capture Volume	
Infiltration rate for MS4 Facility	0.5 ft/day	1.0 ft/day	0.5 ft/day	1.0 ft/day
Pre-project Deep Infiltration of Precipitation	1.33	1.33	1.33	1.33
Recharge at MS4 Facility	2.12	2.47	2.55	2.82
Net New Recharge	0.79	1.14	1.22	1.49

The recharge volumes shown in Table 5-1 columns 11 through 14 correspond to an infiltration rate of 0.5 ft/day. These recharge estimates assume that the infiltration rate is constant over the life of the project. This project is located downstream of the existing regional stormwater management facilities; therefore, an adjustment is not required to account for the reduction in recharge at the regional stormwater

[7] The appropriate assumption for pre-project condition is a significant unknown. The Steering Committee members have suggested various options including [i] land use immediately before development; [ii] land use in 1974, representing the end of the model calibration period; [iii] land use at the time nearby flood control channels were concrete-lined representing the loss of infiltration in those channels; and [iv] June 1, 2000 to be consistent with the definition of new yield in the Peace Agreement. For this example we have used the first of these possibilities.

management facilities that might be caused by construction of the BMP at the Chino Fire Station.

Alternative 2 Indirect Estimation during the Periodic Redetermination of Safe Yield Alternative

Watermaster is currently in the process of re-determining safe yield and will re-determine safe yield periodically in the future[8]. In this alternative, the net new recharge from determining safe yield would be automatically incorporated into the safe yield and the direct estimation of net new recharge would not be made. The volume of net new stormwater recharge caused by the implementation of stormwater management projects pursuant to the MS4 permit would likely be included as a minor calibration adjustment to parameters used in the equations (processes) that estimate the deep infiltration of precipitation and applied water.

Alternative 3 Hybrid Alternative

~~In this alternative Watermaster would implement the *indirect estimation during the periodic redetermination of safe yield*~~ Watermaster staff would annually acquire and store electronic versions of the MS4 project-related reports and maintenance verification databases. When scoping a future safe yield redetermination, Watermaster would use its judgment and discretion to determine if there has been a significant potential increase in MS4 project-related recharge. If judged significant then Watermaster would explicitly incorporate significant MS4 projects into the modeling and other technical activities required to redetermine safe yield. The calibration process for the groundwater model used in the safe yield redetermination would be used to refine the MS4 recharge estimates. Net new recharge would be estimated by rerunning the calibration without the new MS4 facilities and comparing both simulations.

Alternatives Comparison

Three criteria were used to evaluate these alternative methods to estimate net new recharge from MS4 projects: timeliness of the estimates, relative cost, and expected relative accuracy. This comparison is shown in Table 5-2 and discussed below.

Timeliness of Estimates

The timeliness criterion speaks to the utility of the net new stormwater recharge being classified as new yield and assigned to the Appropriators pursuant to the

[8] Watermaster is required to redetermine the safe yield every ten years pursuant to the OBMP Implementation Plan (page 45).

Peace Agreement. Alternative 1, the *project specific monitoring, reporting and accounting alternative*, will produce net new stormwater recharge estimates each year while the other two alternatives will produce estimates when Watermaster re-determines safe yield. The utility of annual net new stormwater recharge estimates over less frequent estimates would be the development of new yield estimates and the ~~application~~ allocation of these new yield estimates in the Watermaster assessment process pursuant to the Peace Agreement. T~~hat said t~~he accuracy of net new recharge estimates *from* ~~*projectspecific monitoring, reporting and accounting alternative*~~*Alternative 1* will likely be challenged during a subsequent safe yield redetermination causing Watermaster to make downward corrective adjustments in future assessment processes. By contrast the other two alternatives ~~*the indirect estimation during the periodic redetermination of safe yield* and *hybrid* alternatives~~ will not provide timely estimates of new yield – they will provide estimates of changes in safe yield that may or may not be attributable to new stormwater recharge.

Relative Cost

The relative cost to estimate net new stormwater recharge would be least (probably zero) for Alternative 2~~the *indirect estimation during the periodic redetermination of safe yield alternative*~~ and greatest for Alternative 1~~the *project-specific monitoring, reporting and accounting alternative*~~. Alternative 3, the *hybrid alternative*, would be relatively close in cost to ~~the *indirect estimation during the periodic redetermination of safe yield alternative*~~*Alternative 2* provided that Watermaster annually acquires and stores electronic versions of the MS4 project related reports and maintenance verification databases that are developed by the land use control agencies and mandated by the Regional Board. ~~The *indirect estimation during the periodic redetermination of safe yield* alternative will not produce an explicit estimate of the net new stormwater recharge. Rather, it will produce an estimate of the safe yield that includes the net new stormwater recharge.~~

Expected Relative Accuracy of the Net New Recharge Estimate

The expected relative accuracy of the net new stormwater recharge estimates derived by ~~the *project-specific monitoring, reporting and accounting alternative*~~Alternative 1 would be the lowest of the three alternatives because there is no way to validate the estimates. ~~And, the *hybrid alternative*~~Alternative 3 ~~would be~~is expected to have the greatest accuracy because preliminary estimates of the net new recharge and its location can be made (a theoretical cap) and subsequently adjusted and validated in calibration. The expected relative accuracy criterion is not applicable to ~~the *indirect estimation during periodic redetermination of safe yield alternative*~~Alternative 2 because net new stormwater recharge would not be explicitly estimated.

Discussion

The net new recharge from MS4 project implementation may, in the fullness of time, add significant recharge to the Chino Basin but there is reason to doubt that over the next 20 to 30 years that it will do so. First, it will be difficult to monitor on the surface and verify that each project is operating at design capacity. There are no provisions for monitoring the volume of water that will be recharged at these proposed facilities and in most cases it will be impossible to monitor them for recharge. From an engineering perspective, there is considerable doubt that most of these facilities can be maintained to ensure that these facilities will perform consistently and as designed for the next 20 to 30 years.

Second, these facilities will be constructed for new development and redevelopment. This means that these facilities will be constructed for relatively small areas spanning decades of time and thus will gradually increase recharge over time with each project contributing small amounts of new recharge. New, small amounts of recharge occurring over time and distributed across the basin will not noticeably impact groundwater levels and hence safe yield for several years[9], perhaps decades. The implication of the slow accumulation of net new recharge is that it will be difficult to quantify the changes in safe yield attributable to the MS4 project implementation in subsequent safe yield determination until considerable recharge, say 50,000 to 100,000 acre-ft, has occurred and accumulated in the basin.

If Alternative 1 were implemented its likely that most of the new yield estimated directly from the MS4 project documents will have to retracted in the next safe yield determination that will be done in 2021. Alternatives 2 and 3 will not have this problem and Alternative 3 has the best chance of providing estimates of net new recharge from implementation of future MS4 projects.

Alternative 3 is the most appropriate way to estimate net new stormwater recharge. Alternative 3 will produce the most accurate estimates of the safe yield during future safe yield redetermination efforts.

Recommended Alternative

[Steering Committee recommendation to be inserted here if SC makes one]

[9] Due to the time lag between recharge at the ground surface and arrival at the water table and the availability of groundwater level observations to sense it