CDM

Draft Memorandum

To: *Santa Ana Stormwater Quality Standards Task Force*

From: *CDM*

Date: *August 31, 2010*

Subject: *Draft - Analysis of Diversion of Dry Weather Urban Runoff to POTWs for Bacteria Control within the Santa Ana River Watershed Portion of San Bernardino County*

This technical memorandum describes a theoretical engineering analysis performed to produce a cost estimate for diverting urban dry weather runoff from human/controllable sources to Publicly Owned Treatment Works (POTWs) to control bacteria levels during dry weather conditions within the San Bernardino County portion of the Santa Ana River watershed. Waterbodies currently listed as having recreational use designations (REC-1 or REC-2) are identified in the Santa Ana Regional Water Quality Control Plan (Basin Plan). To comply with the requirements of the Basin Plan and Municipal Separate Storm Sewer System (MS4) permits adopted by the Santa Ana Regional Water Quality Control Board, some or most of these waterbodies may require implementation of dry weather runoff controls to reduce bacteria levels in the waterbodies to support recreational uses and adequately assure compliance.

Engineering alternatives that could approach reasonable assurance of complying with Basin Plan bacteria objectives were considered, including distributed full / tertiary treatment of dry weather runoff in numerous locations (end of pipe / storm drain treatment) and diversion of dry weather flows to already existing collection systems and POTWs. Based upon work previously performed by the Task Force related to BMP options for controlling bacteria, dry weather diversion to POTWs was assumed to be the lowest cost option for adequately assuring compliance. Other approaches such as source control, local or regional infiltration, or bio-treatment BMPs may be feasible in some subwatersheds to reduce bacteria loads during dry weather conditions, however these options may be less reliable with respect to meeting water quality objectives for bacterial indicators. Additionally, dry weather diversion facilities should require a minimal footprint to implement relative to larger regional BMPs or more natural solutions.

Though based upon standard engineering infrastructure assumptions and cost factors, the costs presented in this memorandum are theoretical. They were prepared as a means to provide a realistic, high-level (low detail) estimate of the costs that could be expected to be incurred to divert dry weather flows to POTWs on a regional basis.

The approach used to evaluate dry weather diversions to POTWs involved two primary steps:

- Identify MS4 outfall locations to surface waterbodies within the county.
- Based on the number of outfalls, estimate capital and operations and maintenance (O&M) costs associated with dry weather diversions to POTWs.

Identification of Diversion Locations

For this analysis, it was assumed that all storm drain outfalls from MS4 facilities to surface waterbodies will require a diversion. The resulting costs are representative of what could be required under a condition where exceedances of bacterial indicator water quality objectives regularly occur in all surface waterbodies under dry weather flow and runoff from MS4 facilities is present at all storm drain outfalls during dry weather.

Potential locations for dry weather runoff diversions were determined by comparing GIS layers of surface waterbodies and enclosed MS4 facilities throughout the portion of the Santa Ana River watershed within San Bernardino County. This spatial analysis utilized a recently completed GIS database of flood control and MS4 facilities compiled by the San Bernardino County Flood Control District (SBCFCD), which included attribute information distinguishing surface drainage systems (e.g., channels) from enclosed MS4 facilities (e.g., storm drains). The SBCFCD GIS database encompasses both county and city-owned facilities. Cities that have provided data to this database include Chino Hills, Colton, Fontana, Grand Terrace, Highland, Loma Linda, Montclair, Ontario, Rancho Cucamonga, Redlands, Rialto, San Bernardino, Upland, and Yucaipa. Data were not available from all cities in the watershed within San Bernardino County, including Big Bear Lake, Chino, Grand Terrace, and Highland. This desktop GIS analysis was completed using both ArcGIS and Google Earth mapping tools.

A total of 183 outfall locations were identified using this spatial analysis. These outfalls, shown in Figure 1, represent potential locations where diversion of dry weather urban runoff could be implemented in the San Bernardino County portion of the Santa Ana watershed. Because MS4 facility data was not available from all cities, this number is likely an underestimate.

Theoretical Cost Estimate

Cost estimates were developed for the three main components that would be necessary for implementation of dry weather diversion facilities in the county: 1) construction of a typical

dry weather diversion facility, 2) construction cost to provide increased capacity at a POTW where dry weather flows would be diverted, and 3) annual cost of operation and maintenance (O&M) for operating the diversion facility and providing treatment.

The costs developed for by this analysis are theoretical, based on typical costs but not specific to any existing sanitary sewer agency in the county. If low flow diversions were implemented, it would be necessary to work with local sanitary sewer agencies to determine their willingness to accept dry weather runoff in their facility. Agreements would then need to be established with locally negotiated costs.

Component 1: Typical Dry Weather Diversion Facility
A typical dry weather diversion facility at an existing MS4 facility outfall location would consist of the following elements:

- **Diversion Structure (two additional manholes or junction boxes).** One manhole or junction box would be equipped with a gross solids removal device to protect pumping equipment and provide wet weather bypass. The second would be used as a wet well for pumping dry weather flows to the closest location in the sanitary sewer collection system with adequate capacity to accept the flow. Capital cost for construction of similar facilities in southern California is approximately $1.7 million[1].

- **Forcemain.** In most cases within urban settings, existing sanitary and MS4 facilities are relatively close in proximity. For this analysis, it is assumed that 1,000-feet of small diameter (six-inch) forcemain pipeline would be required to connect the dry weather diversion pumping structure to the nearest sanitary sewer manhole. At a rate of $100 per linear foot, the cost of the forcemain per diversion structure would be approximately $100,000.

Table 1 summarizes total cost estimates of diversion facilities required in each city in the San Bernardino County portion of the Santa Ana River watershed, based on the following equation:

$$\begin{pmatrix} Dry\ Weather\ Diversion \\ Facility\ Cost \end{pmatrix} = (\$1.7\ million + \$100{,}000) * (Number\ of\ Diversions\ )$$

The total dry weather diversion structure cost is estimated at $329.4 million. Individual project costs would need to be revisited prior to proceeding with design and construction to account for varying site characteristics and dry weather flow conditions.

[1] Take-off estimate completed by CDM Constructors Inc. for similar facilities for City of Los Angeles Bureau of Sanitation

Component 2: Capacity Improvements to Existing Sanitary Sewer Collection System and Treatment Facilities

Capital costs for potential conveyance and treatment upgrades that would be required for increased flow to the sanitary sewer collection system are specific to each sewering agency. Within the San Bernardino County portion of the Santa Ana River watershed, there are a number of sewer collection, treatment and discharge/reuse agencies; including Inland Empire Utilities Agency (IEUA) that treats and discharges or reuses wastewater from a number of cities (Cities of Colton, Redlands, Rialto); the City of San Bernardino that treats and discharges or reuses wastewater from several cities, and the City of Yucaipa.

Wastewater agencies recover their capital costs for providing treatment capacity by collecting connection fees from new users. Discussions with these agencies indicate that, in most cases, connection fees have not been established for stormwater or urban nuisance flows, because current policies are aimed at keeping such flows out of the sewer system in order to avoid hydraulic overloading and preserve capacity for future growth. Although dry weather flow typically has very low total suspended solids and biological oxygen demand relative to municipal wastewater, it still imposes a hydraulic load on a wastewater plant, so that individual wastewater agencies would need to assess both their hydraulic capacity to accept flows and whether any special rate would be applied other than the fee typically charged for new wastewater connections.

For this analysis, it is assumed that the same connection fees as those currently applied to new development would be used. Based on a review of connection fees charged by several different wastewater agencies in the area, an assumed range of $6 million to $17 million per MGD of flow was used for this analysis.

To estimate the cost of conveyance and treatment, flow at each diversion was assumed to occur at a constant rate of 0.4-cubic foot per second (cfs). This estimate is based on an assumed urban dry weather runoff generation rate of 190 gallons per acre per day routed to 183 outfalls over the urbanized area (391 square miles).[2]

[2] City of Los Angeles, Integrated Resources Plan, Department of Public Works Bureau of Sanitation and Department of Water and Power, 2006.

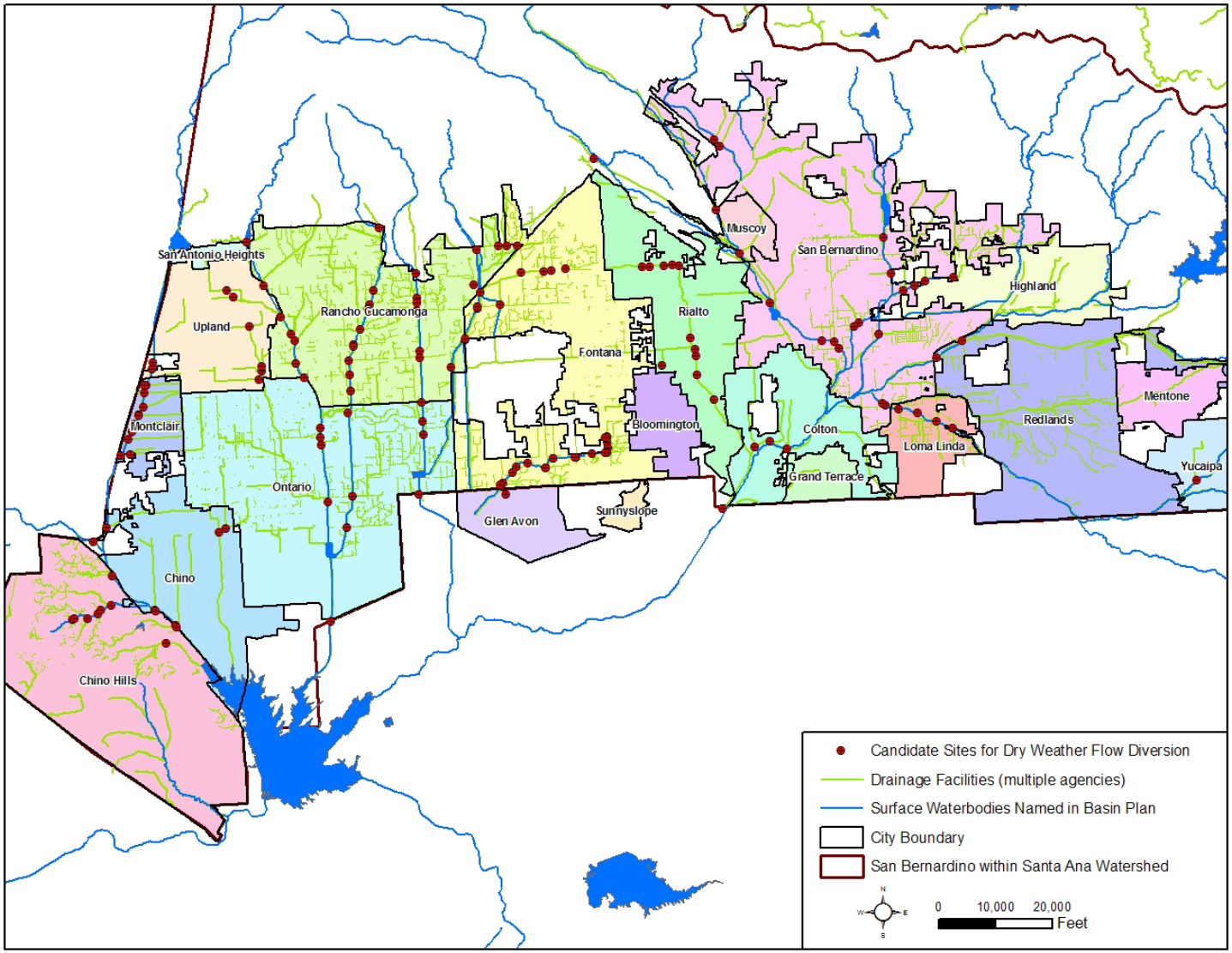

Figure 1
Map of Candidate Dry Weather Runoff Diversion Locations in San Bernardino County within the Santa Ana River Watershed

Table 1: Total Cost of Diversion Facilities in San Bernardino County

Jurisdiction	Number of Outfalls	Drainage Area (mi^2)	Typical Dry Weather Facilities Cost	Conveyance & Treatment Cost Range			Annual O&M Cost Range ($/yr)		
				Low		High	Low		High
Chino[1]	7	17	$12,600,000	$10,890,000	-	$30,840,000	$1,140,000	-	$1,740,000
Chino Hills	9	18	$16,200,000	$14,000,000	-	$39,660,000	$1,460,000	-	$2,240,000
Colton[2]	6	15	$10,800,000	$9,330,000	-	$26,440,000	$980,000	-	$1,490,000
Fontana	31	36	$55,800,000	$48,210,000	-	$136,590,000	$5,050,000	-	$7,690,000
Grand Terrace[1]	2	4	$3,600,000	$3,110,000	-	$8,810,000	$330,000	-	$500,000
Highland[1]	5	14	$9,000,000	$7,780,000	-	$22,030,000	$810,000	-	$1,240,000
Loma Linda	5	7	$9,000,000	$7,780,000	-	$22,030,000	$810,000	-	$1,240,000
Montclair	15	5	$27,000,000	$23,330,000	-	$66,090,000	$2,440,000	-	$3,720,000
Ontario	11	37	$19,800,000	$17,110,000	-	$48,470,000	$1,790,000	-	$2,730,000
Rancho Cucamonga	30	38	$54,000,000	$46,650,000	-	$132,190,000	$4,890,000	-	$7,440,000
Redlands	3	25	$5,400,000	$4,670,000	-	$13,220,000	$490,000	-	$740,000
Rialto	11	21	$19,800,000	$17,110,000	-	$48,470,000	$1,790,000	-	$2,730,000
San Bernardino	15	56	$27,000,000	$23,330,000	-	$66,090,000	$2,440,000	-	$3,720,000
Unincorporated	16	58	$28,800,000	$24,880,000	-	$70,500,000	$2,610,000	-	$3,970,000
Upland	7	15	$12,600,000	$10,890,000	-	$30,840,000	$1,140,000	-	$1,740,000
Yucaipa[2]	10	27	$18,000,000	$15,550,000	-	$44,060,000	$1,630,000	-	$2,480,000
Total	**183**	**391**	**$329,400,000**	**$284,620,000**	**-**	**$806,330,000**	**$29,800,000**	**-**	**$45,410,000**

1) Approximated value due to unavailable data. Number of diversions based on assumption of 1,800 acres of drainage area per diversion.
2) Analysis completed in Fall 2009. This number is more conservative than the number of outfall identified through visual identification process.

Using the following equation, the conveyance and treatment capital cost was estimated for each city, shown in Table 1. Using a range of potential connection fees for the area, the range of conveyance and treatment costs for San Bernardino County is $284.6 million to $806.3 million with an estimated average of $545.5 million.

$$\begin{pmatrix} Conveyance\ and \\ Treatment\ Cost \end{pmatrix} = \left(\frac{\$}{MGD}\right) * \begin{pmatrix} Dry\ Weather\ Flow \\ per\ Diversion \end{pmatrix} * (Number\ of\ Diversions)$$

Component 3: Operations and Maintenance (O&M)
Annual O&M costs for the dry weather diversion facilities include costs to pump runoff and maintain the diversion structure as well as rates for treatment at the POTW. Costs associated with O&M of a single diversion facility, at an assumed rate of 2 percent of total capital cost, would be approximately $40,000 per year. Treatment O&M costs at POTWs in the watershed have not been evaluated or established specifically for dry weather runoff. Therefore, assuming the costs would be the same as monthly service charges for existing wastewater dischargers, the approximate O&M unit cost for urban runoff would range from $1,300 to $2,200 per MG of treated runoff (again using information developed from a range of local agency rates). These O&M costs are incorporated into the estimate shown in Table 1. Using a range of potential monthly service charges for the area, the range of O&M costs for San Bernardino County is $29.8 million to $45.4 million with an estimated average of $37.6 million.

Summary of Costs
Table 2 provides a summary of the total theoretical (high-level) costs for San Bernardino County area of the Santa Ana River watershed.

Table 2: Total Costs

	San Bernardino County (millions of $)
Dry Weather Facilities	$329.4
Conveyance & Treatment (average)	$545.5
Total	**$874.9**
Annual O&M (average)	$37.6/yr

Limits of Analysis

The costs presented in this technical memorandum are high-level estimates based on broad assumptions about the required level of implementation for adequate assured compliance with bacterial indicator water quality objectives. There a number of factors or considerations that would influence the actual cost:

- Limited data from some cities within the area of analysis suggest that the number of outfalls requiring treatment could increase significantly in certain areas.

- Additionally, the cost and feasibility for local sewering agencies to collect and treat urban dry weather runoff is not fully quantified. A number of factors, many of which are site-specific, could influence the cost and feasibility of implementing dry weather runoff diversions. These factors include, but certainly not limited to:
  - Costs associated with capital improvement projects at POTWs necessary to accept additional flows;
  - Costs of financing and inflation over time;
  - Constraints on local sanitary sewer collection and treatment systems – potential increases necessary in the capacity of collection system pipelines, pump stations, etc;
  - Flow rate and presence of continuous flow - flow may be more peaky in nature, not the constant rate of 0.4 cfs assumed for this analysis. Typical dry weather runoff occurs mainly in the early morning hours due to irrigation;
  - Operation and maintenance considerations – manual operation or automatic, manual or remote switching from wet to dry and dry to wet, telemetry and remote observation or control, potential for system malfunctions causing sanitary system overflows;
  - Compliance sampling and reporting costs; and
  - Timing of flows - acceptance of flows only during off-peak hours, necessitating storage.
- The number of MS4 outfall locations actually discharging during dry weather conditions could have a significant impact on the costs associated with diversion and treatment. This preliminary analysis has assumed that each outfall described above is discharging at the assumed flow rate. The number or percentage of outfalls expected to be discharging during dry weather conditions would need to be investigated and predicted to further refine the analysis costs. There may be a large percentage of outfalls within the county not contributing dry weather flows.
- Not all areas of the County are sewered, making diversion to a POTW potentially more complicated and costly.

Other Considerations

Additional Treatment Alternatives - This analysis focused on a treatment method that provides high certainty for bringing MS4 facilities in compliance with water quality objectives for bacterial indicators. An alternative to diversion from MS4 facilities to the sanitary collection system is to construct on-site treatment or infiltration, in the form of an urban runoff plant (URP), infiltration BMPs, treat and release wetlands, etc. These types of facilities can provide integrated resource benefits and are potentially more land intensive than diversion to the

sanitary sewer system. In the case of URPs, treatment and discharge provides a low bacteria source of water to receiving waterbodies, which can dilute uncontrolled sources of bacteria, or the URP can be designed for reuse for irrigation demands near the project site. Similarly, infiltration BMPs or treat and release wetlands can provide "clean" runoff to impaired waterbodies or recharge underlying groundwater basins through infiltration.

Potential Environmental Impact of Dry Weather Flow Diversion - Aside from the potential physical infrastructure impacts, analysis of the options for controlling dry weather flow would need to consider the environmental impacts. Besides the direct environment impacts, such as energy consumption and greenhouse gas generation, indirect impacts of removing dry weather flows from waterbodies would need to be considered. Most drainages in the Santa Ana River watershed have aquatic communities at least in part dependent on dry weather flows.

Assured Compliance – This memorandum evaluates the cost of bringing MS4 facilities into compliance with bacterial indicator water quality objectives. However, there are other miscellaneous water sources and temporary discharges (e.g., permitted "de minimus" discharges, permitted intermittent discharges such as potable water system flushing, construction activities, illegal and unauthorized activities such as homeless encampments, and emergency activities such as fire fighting) that may influence water quality. Additionally, flood control channels are frequently used for transport of water through controlled dam releases or raw water pipeline turnouts and for transport of recycled water to downstream spreading basins. The impact of these activities on water quality is not well understood.

Modifications to Recreational Uses – Modifications to receiving water recreational uses to better reflect existing and potential recreational activity would result in changes to the applicable bacterial indictor water quality objectives. The outcome of these changes (which would be accomplished through the development of use attainability analyses) could be a significant reduction in the number of outfalls requiring diversion and treatment. This approach would greatly reduce the cost of compliance.