2022 DRY WEATHER FLOW SOURCE INVESTIGATION REPORT

Submitted to:
City of Encinitas
Public Works Department
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Encinitas, CA 92024

Submitted by:
WSP USA
San Diego, California

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IMPORTANT NOTICE

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EXECUTIVE SUMMARY

In 2021 the City of Encinitas (City) and their consultant, WSP, conducted a multiple lines of evidence (MLOE) assessment at five MS4 outfalls to investigate the presence, abundance, and source(s) of flows observed during dry weather conditions. The assessment used flow classification, stable isotope end-member mixture analysis, geochemistry analysis (Piper diagram), and source indicator analyses (Figure E-1). Geochemistry and indicator analyses were mostly inconclusive in 2021, so only flow and stable isotopes were analyzed in 2022.

In 2022 the City conducted dry weather monitoring at five highest priority with persistent flow (HPPF) outfalls, four of which were monitored in 2021. Results from flow and stable isotope end-member mixture analyses were used to identify flow sources and quantify tap vs groundwater, and where possible, tap vs reclaimed water. These analyses may quantify the proportions of discharges from "controllable" versus "uncontrollable" sources (e.g., over-irrigation versus groundwater interflow). Some uncontrollable sources such as groundwater may be considered allowable exceptions in the MS4 Permit. The City may potentially obtain San Diego Regional Water Quality Control Board's (Regional Board) approval of modified flow reduction requirements on a site-by-site basis based on the MLOE findings.

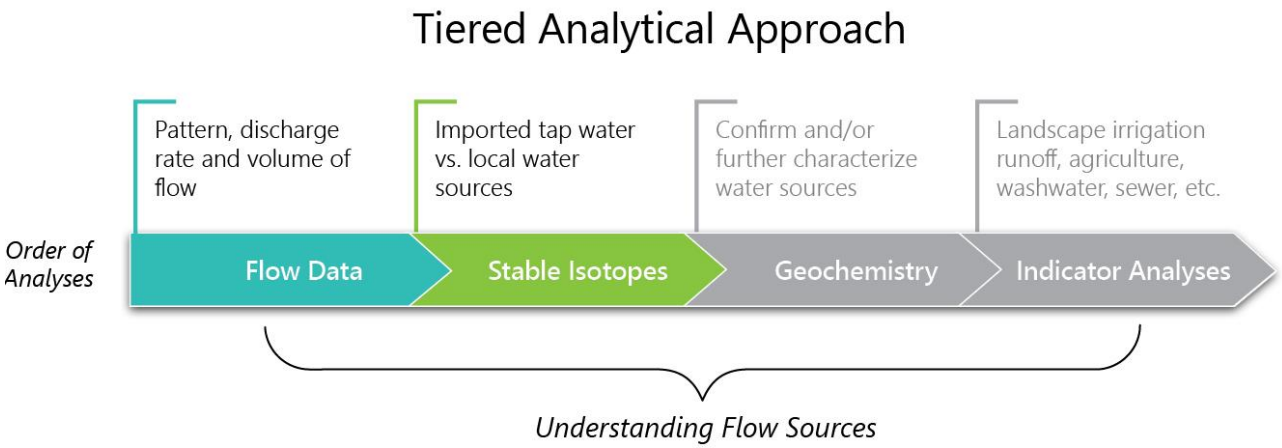

Figure ES-1. Conceptual Diagram of the Tiered Approach. Geochemistry and Indicator Analyses were not conclusive in 2021, so not analyzed in 2022

In a creative application of the stable isotope analysis method, in 2022 the City of Encinitas requested WSP sample and analyze stable isotopes at nine non-MS4 sites to determine the source(s) of persistent flows that presented a nuisance, hazard, or other aesthetically negative impact to pedestrians or vehicles. In some cases, these non-MS4 sites contributed to one of the five monitored MS4 outfalls and in other cases the flows caused persistent ponding at curbs, sidewalks, or retention basins. The City could then use the results to determine what potential actions could be directed at reducing controllable flows identified by the isotope results.

Flows were monitored continuously at the five MS4 sites, but only at the time of sample collection at non-MS4 sites. Sample collection and analysis at both MS4 and non-MS4 sites included stable isotopes of hydrogen and oxygen to assist in answering the primary study questions for this report:

What flow sources are evident in monitored MS4 and non-MS4 locations during dry weather conditions? What proportion of the flow is from Tap water vs Groundwater or Tap water vs Reclaimed water?

Average dry weather flow rates at the five monitored MS4 sites varied from 34 gallons per minute (gpm) at 1002SWOUTL to 2.7 gpm at 306SWOUTL. Flows at all sites showed a diurnal pattern to some extent, with regularly occurring high flows at night and early morning, and lower or no flow during the day. This pattern is consistent with residential area irrigation.

Baseflow is often assumed to be contributed by local groundwater but may also be comprised of infiltrated or leaking tap water sources. Baseflow separation showed that baseflow contributions varied from 87% at 1002SWOUTL to 51% at 306SWOUTL. 306SWOUTL was the only monitored outfall where flow was intermittent and coincided with local irrigation from tap and reclaimed sources. The other four outfalls flowed continuously, with flow patterns and magnitudes similar to 2021 results, indicating flow sources are likely unchanged from 2021.

The stable isotope data was used to quantify the percent contributions of tap and groundwater (and reclaimed where possible) in the MS4 based on the separation of “end members” characterizing the isotope composition of each reference source. Reference sources included Olivenhain Water District tap, San Dieguito Water District tap, San Elijo Reclaimed, and local groundwater (Santa Ysabel Creek). In 2021 both Water District tap references and Reclaimed reference end members were mostly similar, with good separation from the local reference, giving a high level of certainty in %TAP results even where multiple tap or reclaimed sources were present. In 2022, the San Dieguito Water District made a significant change in their tap water supply, using more local water, which changed the isotope end member to be more similar to local water. This change in San Dieguito tap reference end member complicated the analysis of %TAP for outfalls receiving water from both San Dieguito and Olivenhain Water Districts, or San Dieguito and Reclaimed. %TAP could not be calculated for 380SWOUTL because it receives water from both Water Districts, Reclaimed, and local. At 306SWOUTL, since local water and Olivenhain tap were ruled out as sources, %TAP vs %RECLAIMED was calculated.

Isotope end member mixture analysis showed that MS4 flows were mostly mixed, with average %TAP varying between 43-61% at the four outfalls that could be analyzed (Table E-1). Compared to 2021, %TAP results in 2022 had much higher variance and standard deviation due to the additional uncertainty from the change in San Dieguito tap isotope end member. Despite the higher uncertainty in the %TAP results, the assessments in 2022 were generally similar to 2021 results, with most sites remaining in the same category “Mixed Tap/Ground.” Only 172SWOUTL changed categories, from “Mainly Tap” in 2021 to “Mixed Tap/Ground.”

Nine non-MS4 sites were sampled for isotopes but not monitored for continuous flows. Flows at these sites were mostly very low (<1 gpm) except for Pipes Ramp (5-10 gpm), and several sites dried up after several weeks. Individual %TAP at these sites varied from 20-85%, with average %TAP varying from 20-77% (ES-2).

Table ES-1.Summary of Flow Source Assessment for Main MS4 Outfalls During the 2022 Monitoring Period

Flow Source from Isotope results	Sites Per Category	Site (%TAP±Standard Deviation)
Mainly tap water (>80% tap)	0	
Mixed Tap/Reclaimed (20-80% tap) [1]	1	306SWOUTL(61±21%)
Mixed Tap/Groundwater (20-80% tap)	4	1002SWOUTL (43±4%), 163SWOUTL(52±15%), 172SWOUTL (50±16%) 380SWOUTL[2]
Mainly groundwater (<20% tap)	0	
Total	**5**	

1. Groundwater was excluded as a possible source at this site, and adequate end member separation between San Dieguito tap and reclaimed water allowed an analysis of %TAP vs %RECLAIMED.
2. 380SWOUTL could not be analyzed for %TAP in 2022. In 2021 %TAP was 41±6% at 380SWOUTL. The assessment of mixed tap/ground was based off the flow results only in 2022.

Table ES-2.Summary of Flow Source Assessment for Non-MS4 Sites During the 2022 Monitoring Period

Flow Source from Isotope results	Sites Per Category	Site (%TAP±Standard Deviation)
Mainly tap water (>80% tap)	1	Blue Crest (77±5%)
Mixed Tap/Groundwater (20-80% tap)	4	Dunsmore Ct (72±14%), Raphael Ct (57±12%), Pipes Ramp (52±5%), Woodgrove HOA (39±9%)
Mainly groundwater (<20% tap)	1	776 Corinia St (20%[1])
Total	**6[2]**	

1. Only one sample could be collected at 776 Corinia St so no average or STD was calculated.
2. Nine sites were sampled but isotope results at three sites, 2313 Manchester, Bracero Rd and Rock Garden, were too uncertain to report here. %TAP was calculated and assessed but deemed unreliable.

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ACRONYMS AND ABBREVIATIONS

%	percent
%TAP	percent tap water
City	City of Encinitas
gal	gallons
GAMA	Groundwater Ambient Monitoring and Assessment Program
gpd	gallons per day
gpm	gallons per minute
IEMMA	isotopic end-member mixture analysis
mL	milliliter(s)
MLOE	multiple lines of evidence
MS4	municipal separate storm sewer system
PT	pressure transducer
STD	standard deviation
WD	water district

1.0 INTRODUCTION

Following a similar study in 2021, in 2022 the City of Encinitas (City) conducted a dry weather investigation to identify and characterize the flow sources at five highest priority with persistent flow (HPPF) outfalls and nine non-MS4 sites with persistent flow. The dry weather flow source investigation was designed to answer the following questions:

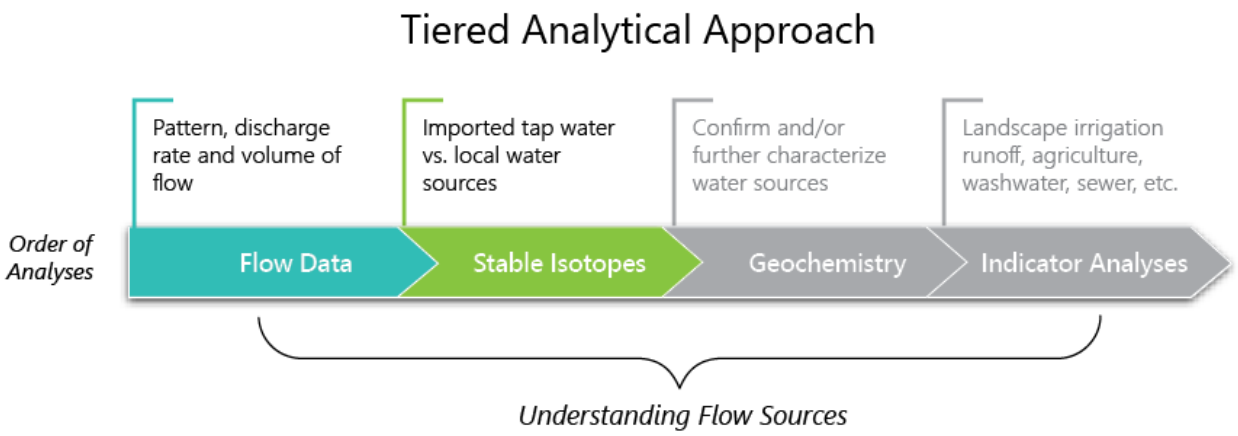
- What flow sources are evident in monitored MS4 locations during dry weather flows?
- What proportion of the flow is from Tap water vs Groundwater? or Tap water vs Reclaimed water?

The analysis was a tiered approach combining continuous flow monitoring with baseflow separation, and stable isotope analysis (Figure 1-1). The assessment approach is summarized as follows:

- Flow data provides necessary context and magnitudes of transient, anthropogenic discharges like over-irrigation, and slowly varying non-anthropogenic sources like groundwater intrusion, or creek inflows.
- Isotope data quantifies the proportion of tap water (%TAP), with the remainder assumed to be local groundwater or reclaimed water where no baseflow is observed (%RECLAIMED).

Table 1-1 describes the MS4, non-MS4, and isotope end member reference sites that were chosen for sampling.

Figure 1-1. Conceptual Diagram of the Tiered Approach.



Note: Geochemistry and Indicator Analyses were inconclusive in 2021 and were therefore not analyzed in 2022.

Table 1-1. Description of Sampling Sites (MS4, Non-MS4, and Reference)

Site ID	Site Name	Latitude	Longitude	Site Description
HPPF MS4 Continuous Monitoring Sites				
1002SWOUTL	Bajada	33.0559	-117.2625	400 N El Camino Real
163SWOUTL	Cardiff	33.0163	-117.2809	2357 San Elijo Ave
172SWOUTL	Pinebranch	33.0328	-117.2565	S. El Camino Real (South of Pinebranch Dr)
306SWOUTL	Encinitas Ranch	33.055045	-117.278342	Retention basin at intersection of Quail Gardens Dr and Paseo De las Verdes
380SWOUTL	Magdalena	33.0475	-117.2858	130 Calle Magdalena (Near In-N-Out)
Non-MS4 Sampling Sites				
2313 MANCHESTER AVE	2313 Manchester	33.01863	-117.278328	In street gutter in front of 2313 Manchester Ave.
776 Corinia Ct.	776 Corinia Ct.	33.052662	-117.235855	City street with street gutters
Blue Crest	Blue Crest	33.043512	-117.277049	Retention basin northwest of intersection Requeza St. and Sea Ridge Ct.
BRACERO ST	Bracero St	33.04285	-117.274889	Scupper drain draining trap channel from in front of 725 Bracero St.
DUNSMORE CT	Dunsmore Ct	33.053193	-117.2584	Near 444 Dunsmore Ct along west side street gutter
PIPES RAMP	Pipes Ramp	33.027967	-117.288109	Bottom of ramp north of the bathrooms along Hwy 101
RAPHAEL CT	Raphael Ct	33.052995	-117.257323	Near 426 Raphael Ct along west side street gutter
ROCKGARDEN	Rock Garden	33.048819	-117.294651	Southeast corner of Dave's Rock Garden
WOODGROVE HOA	Woodgrove HOA	33.030761	-117.269315	Park Place Private Park, V-ditch at southeast corner of park
Isotope End-Member Reference Sites				
OLIVENHAIN-REF	Olivenhain-Tap	33.0632	-117.2639	Water Fountain near bathrooms in Leo Mullen Park
PW-REF	San Dieguito-Tap	33.047	-117.2852	Outside tap in front of Public Works Building
RECLAIM-REF	Reclaim	33.0628	-117.2644	Recycle water backflow preventer tap in Leo Mullen Park
SYC-REF	Ref-Santa Ysabel Creek	33.1307	-116.7957	Santa Ysabel Creek 1 mile northwest of Lake Sutherland

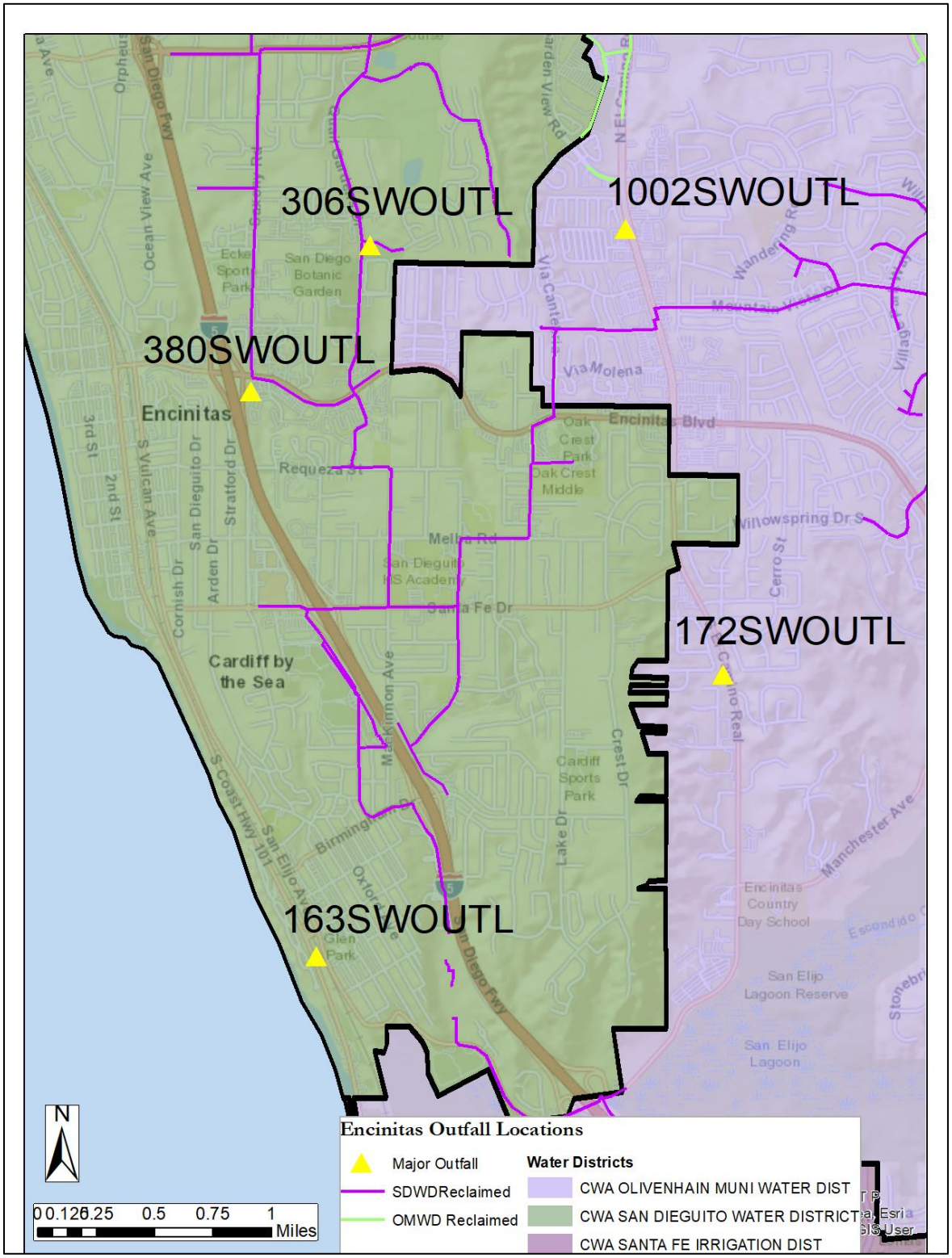


Figure 1-2. MS4 Outfall Monitoring Locations

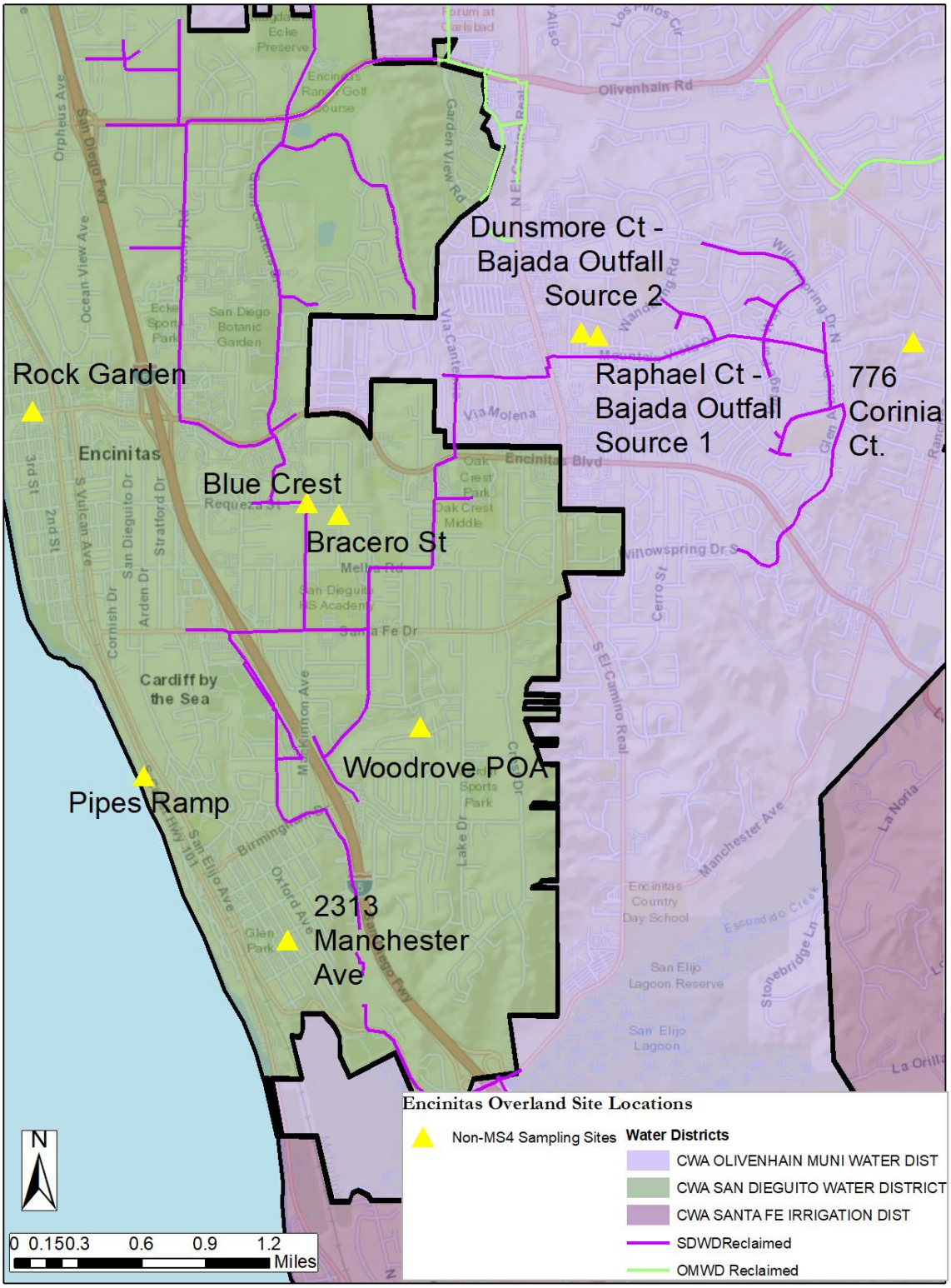


Figure 1-3. Non-MS4 Site Sampling Locations

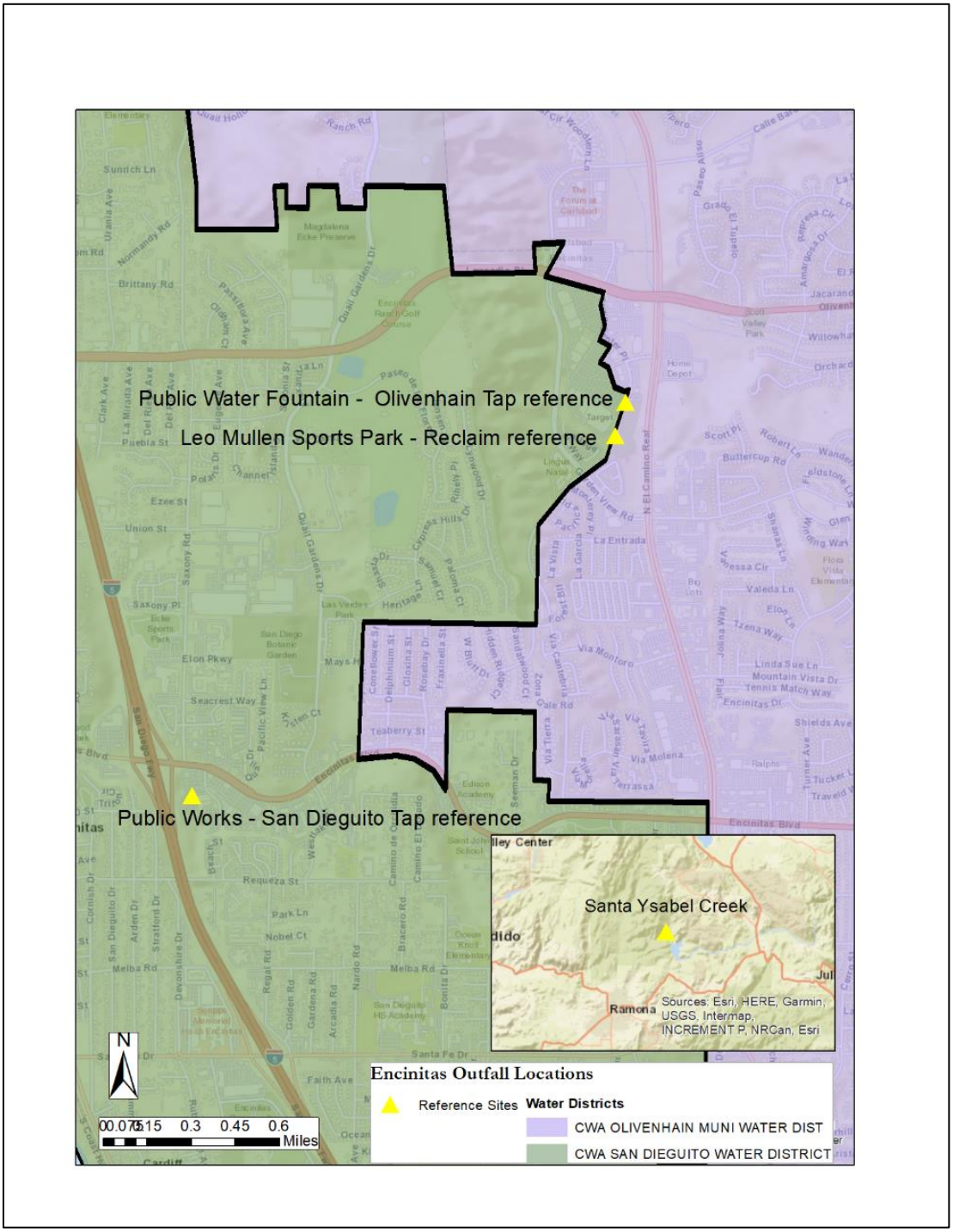


Figure 1-4. Map of Reference Sampling Sites for Local, Reclaimed, and Olivenhain and San Dieguito Water Districts

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2.0 MONITORING APPROACH AND ANALYTICAL METHODS

This section describes the approach for flow monitoring, stable isotope sampling and analysis, and data interpretation to make an assessment the flow sources present in the five priority MS4 outfalls and nine non-MS4 sites.

2.1 FLOW MONITORING APPROACH

Flows were monitored using 90-degree v-notch weirs at the five continuously monitored MS4 sites. A vented pressure transducer (Meter CTD-10) measured water level, temperature, and conductivity at 5 min intervals. Flows were calculated using a standard equation to convert water level to flow in gallons per minute (gpm). Sites were visited bi-weekly to manually measure water levels and flow rates for calibration and validation. Additionally, trail cameras recorded photos at 1 hr intervals to visually check water levels and unobstructed flow through the weir. Flows during periods with >0.01" precipitation were removed from this analysis.

Flows at non-MS4 sites were measured at the time of sample collection. Flows were measured by bucket fill where the flow could be channelized, or visually estimated if not. Many sites were ponded and no flow measurement was necessary.

2.2 SAMPLE COLLECTION FOR STABLE ISOTOPES

The MS4 sites are in two different water districts with potentially different water supplies and isotopic compositions. Table 2-1 lists each Water District, its selected "Tap" reference site, and the associated MS4 sites. Water samples were collected at four reference sites, one for each water district, one reclaimed water reference, and one local water reference to represent local groundwater. Grab samples for isotopic analysis were collected by syringe and filtered through a 0.45-micron GFF filter into unpreserved 2-milliliter (mL) vials with no headspace and refrigerated until they were shipped in August and October to the Stable Isotope Facility at UC Davis. There were five sampling events (n=5) on August 23-24, September 6-7 and 20-21, and October 3-4 and 6, 2022.

Table 2-1. Water Districts and Associated Reference and MS4 Sites

Water District	Associated Tap Reference Sites	Associated Sites
San Dieguito	PW-REF	**MS4:** 163SWOUTL, 306SWOUTL, 380SWOUTL[1] **Non-MS4:** 2313 Manchester Ave, Blue Crest, Bracero St, Pipes Ramp, Rock Garden, Woodgrove HOA
Olivenhain	OLIVENHAINTAP-REF	**MS4:** 1002SWOUTL[1], 172SWOUTL[1] **Non-MS4:** 776 Corinia St, Dunsmore Ct, Raphael Ct
San Elijo Reclaimed Water Facility	RECLAIM-REF	**MS4:** 1002SWOUTL, 306SWOUTL, 380SWOUTL **Non-MS4:** 2313 Manchester Ave, Blue Crest, Bracero Rd

1. 380 SWOUTL receives flows from both San Dieguito and Olivenhain Water District and could not be analyzed for %TAP.
2. 1002SWOUTL and 172SWOUTL have small parts of the watershed in San Dieguito Water District, however the majority of the watershed is in Olivenhain water district so only Olivenhain tap reference was used for analysis.

2.3 TIERED ASSESSMENT APPROACH

The assessment approach combines flow monitoring and isotope analysis results to support a final assessment of flow source(s) in each monitored MS4 and non-MS4 site. Each line of evidence was considered individually then assessed together and compared to watershed-specific characteristics and presence of reclaimed water infrastructure to make a final determination on flow sources. In 2021, geochemistry and indicator analytes were also sampled. The highest weight was placed on flow data, followed by stable isotopes, then geochemistry (Piper diagram), and then indicator analytes. The geochemistry and indicator analytes did not provide conclusive results in 2021 and were excluded from analysis in 2022; only flow and isotopes were sampled and analyzed in 2022 to determine flow sources.

2.3.1 Tier 1: Flow Patterns and Classification

Hydrographs for the five MS4 outfalls were analyzed for flow patterns that may indicate flow sources. Three flow characteristics were evaluated for each site: (1) mean flow rate, (2) pattern of baseflow, and (3) pattern of peak flows. Baseflow separation was applied to hydrographs using a digital filter technique (Spongberg, 2000) to determine the proportion of total flow comprised of baseflow and peak flows. Total baseflow was divided by total flow to determine a % baseflow.

Baseflow and peak flows were classified as consistent, intermittent, or absent. Consistent peak flows mean the peak flows occur at the same time every day or on some days. Intermittent peak flows mean peak flows occurred irregularly or seldomly. Rapidly changing, short duration peak flows, particularly in the night to early morning hours, are assumed to indicate an anthropogenic source (either tap, recycled water, or pumped groundwater) and often show a consistent pattern of peaks on certain days or times of day.

Consistent baseflow was assumed to indicate a constant source of groundwater in the MS4, either from infiltration or a “blue-line” (natural channel) stream entering the MS4. However, consistent baseflow may also indicate a constant source of tap water, reclaimed, or sewage, so the determination of flow source is not conclusive and should be corroborated by other lines of evidence.

At non-MS4 sites flow was measured only during the time of sampling. Flows were assessed to be variable, consistent, or drying. Variable flows indicated an anthropogenic source of either tap, reclaimed, or pumped groundwater like from a sump pump. Sites that dried up over the monitoring period may indicate a groundwater source that slowly recedes over the dry season.

2.3.2 Tier 2: Stable Isotope End-member Mixture Analysis

Stable isotopes of oxygen (18O/16O) and hydrogen (2H/1H) in water molecules were used to estimate %TAP using stable isotope end-member mixture analysis (IEMMA). This provides a quantitative assessment of the proportion of imported (tap) water versus local (groundwater). The %TAP is calculated:

$$\%TAP = 100\ (\delta S\ -\ \delta L)\ /\ (\delta T\text{-}\delta L)$$

where δS, δL and δT are the isotopic ($\delta^{18}O$ and δD) values of the MS4 sample (S), local water endmember (L), and tap water endmember (T). Where local water could be excluded the endmembers for tap water and reclaimed water were used to determine %TAP vs %RECLAIMED.

The %TAP results can be used to both support the initial assessments from tier 1 flow assessments and help differentiate inconclusive tier 1 assessments. For example, a site with both consistent baseflow and peak flows is inconclusive when only assessing flow data. Inclusion of the tier 2 assessment of stable isotope data can provide a quantitative estimate of the proportions of groundwater as baseflow, and if only peak flows are composed of tap water.

2.3.3 Flow Source Determination: Synthesis of Flow and Isotopes

Each line of evidence was assessed individually, and then those assessments were considered together to make a final determination. Depending on the relative strength of the evidence from the four tiers, flow sources were classified by one of four categories:

- Tap
- Tap/Reclaimed Mix
- Tap/Ground Mix
- Groundwater

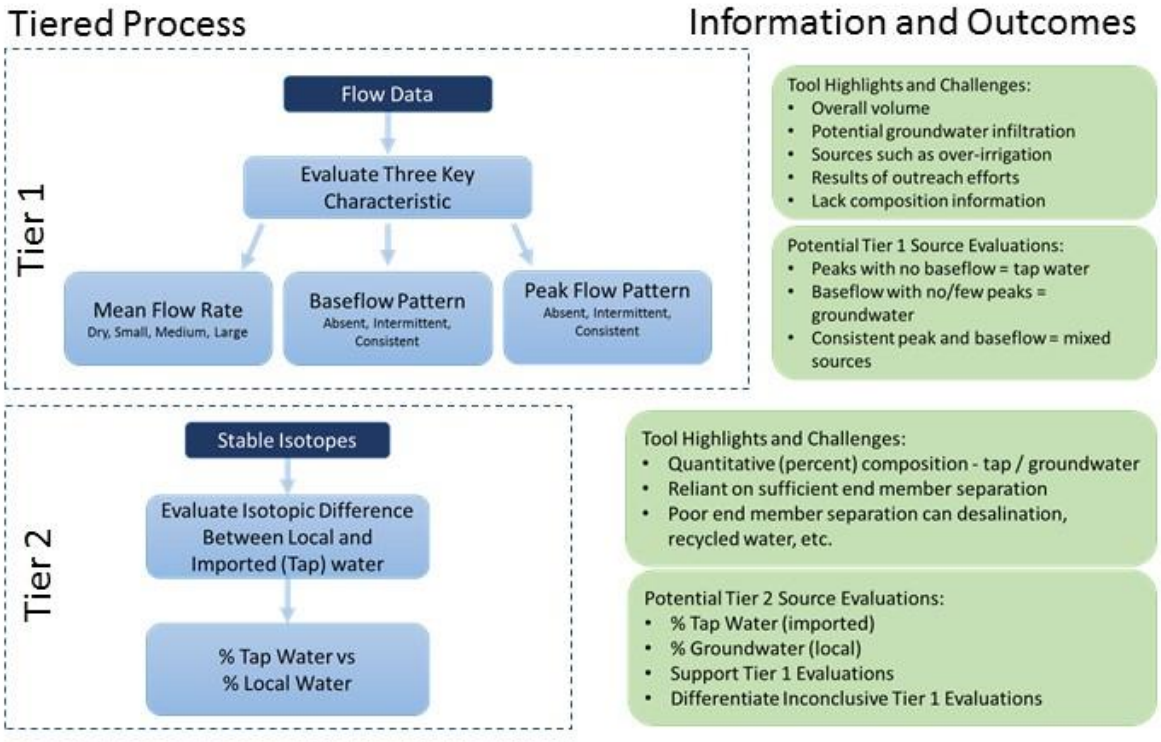

Figure 2-1. Tiered Approach Process, Challenges, and Potential Outcomes

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3.0 MONITORING RESULTS SUMMARY AND FINDINGS

3.1 MONITORING EVENTS SUMMARY

Sampling at the five outfalls, nine non-MS4 sites, and reference sources for tap water, reclaimed water, and local water was attempted on five sampling events but not all sites had flows for all five events (Table 3-1). The only exception was 776 Corinia St which was only visited and sampled on the final event.

Table 3-1. Summary of Sampling Events

Sampling Event	1	2	3	4	5
	8/3/22 – 8/4/22	8/23/22 – 8/24/22	9/6/22 – 9/7/22	9/20/22 - 9/21/22	10/3/22 – 10/4/22, 10/6/22
1002SWOUTL	x	x	x	x	x
163SWOUTL	x	x	x	x	x
172SWOUTL	x	x	x	x	x
306SWOUTL	x	x	x		
380SWOUTL	x	x	x	x	x
PW-REF	x	x	x	x	x
SYC-REF	x	x	x	x	x
OLIVENHAIN-REF	x	x	x	x	x
RECLAIM-REF	x	x	x	x	x
2313 Manchester Ave	x	x	x	x	x
776 Corinia Ct.					x
Blue Crest	x		x	x	
Bracero Rd	x	x	x	x	x
Dunsmore Ct.		x	x	x	x
Pipes Ramp	x	x	x	x	x
Raphael Ct.	x	x	x	x	
Rock Garden	x	x	x		
Woodgrove HOA	x	x	x	x	x

Notes:
SYC-REF = Santa Ysabel Creek – Reference; PW-REF = Public Works – Reference; RECLAIM-REF = Leo Mullen Park Recycle Water Tap – Reference; OLIVENHAINTAP-REF = Leo Mullen Park Water Tap (Olivenhain)– Reference

Despite targeting the dry weather season, several summer storms brought short periods of rain through the area affecting the outfall flows (Table 3-2). Less precipitation occurred during the monitoring period in 2022 (0.28”) compared to during the monitoring period in 2021 (1.17”). All sampling events were completed more than 72 hours after the end of any storm event to reduce the impact of rainfall.

Table 3-2. Summary of Storm Events

Date of Storm	Period of Rainfall	Cumulative Rainfall (in.)[1]
09/9/22 – 9/10/22	10:00 am – 08:00 am	0.17
10/11/22 – 10/13/22	5:00 pm – 4:00 am	0.04
10/22/22 – 10/23/22	10:00 pm – 01:00 am	0.07
Total rainfall		0.28[2]

Notes:
1. Precipitation data collected from Encinitas rain gauge (located on back of property of Sunset High School) via San Diego – One Rain network
2. Total rainfall during 2021 monitoring period was 1.17 in. Rainfall in 2021 was 0.14 in. Aug 21-22, 0.08 in. Sept 25-27, and 0.61 in. Oct 4-5, 0.34 in. Oct 8.

3.2 FLOW MONITORING RESULTS

Antecedent rainfall can affect the availability of groundwater and resulting flows at MS4's where groundwater contributes to the baseflow. Monitoring in both 2021 and 2022 was done in August-October to minimize the impact of the antecedent wet season precipitation. Wet season precipitation was 4.63 inches in 2020-21, and 8.67 inches in 2021-2022. These totals represent low to average rainfall for the City of Encinitas and likely would not cause large changes in groundwater availability during the two monitoring periods.

Average flow and baseflow rates for the monitoring period were ranked from largest to smallest (**Error! Reference source not found.** and Table 3-3; 2021 results are included for interannual comparison). In 2022, 1002WOUTL showed the highest average flow (34.4 gpm) by a significant margin. Flows were similar among the other four outfalls (380SWOUTL, 163SWOUTL, 172SWOUTL, 306SWOUTL) and fairly low, with average flow rates of 2.7 - 6.4 gpm. In general, flows were the same or slightly lower from 2021 to 2022, except for 172SWOUTL which was only slightly higher (1gpm higher). While storm events were removed from analysis, there was greater and more frequent precipitation during the 2021 monitoring period (1.17") than in 2022 (0.28"), so lower flows in 2022 may reflect the lower precipitation during the monitoring period. It's assumed antecedent wet season precipitation was not sufficiently different between years to cause much difference in groundwater-driven flows.

Baseflow separation was applied to hydrographs using a digital filter technique (Spongberg, 2000) to determine the proportion of total flow comprised of baseflow and peak flows. Baseflows accounted for 51-87% of total flow volumes. MS4 sites showed the regular presence and diurnal pattern of peak flow with peak flows at night or early in the morning. Consistent diurnal peak flows are often an indication of over-irrigation and typically occur at similar times of day and days of the week (e.g., landscape sprinkler systems on timer). At some sites there were regular diurnal peak flows, but the additional volume was small in comparison to the total daily volume each day. For example, at 172SWOUTL, there were regular peak flows but baseflow accounted for 80% of total flow (Figure 3-2).

While baseflow may be comprised of local groundwater it can also be a result of tap water infiltrating through the ground (interflow) or other leaks entering the MS4. Baseflow % results

should be considered with the %TAP results from isotope analysis to assess actual groundwater contributions in the MS4.

Table 3-3. Results of Baseflow Separation and Flow Pattern Assessment

MS4 ID	Baseflow	Baseflow		Peak Flow	Mean Flow (gpm)		Flow Volume Classification
		2021	2022		2021	2022	
375SWOUTL	Consistent	94%	NM[1]	Inconsistent	136.7	NM	Large
163SWOUTL	Consistent	91%	87%	Consistent	6.4	5.8	Small
1002SWOUTL	Consistent	80%	84%	Consistent	34.6	34.4	Medium
172SWOUTL	Consistent	70%	80%	Consistent	3.6	4.6	Small
380SWOUTL	Consistent	68%	69%	Consistent	7.8	6.4	Small
306SWOUTL	Absent	NM	51%[2]	Consistent	NM	2.7	Small

1. NM = Not Monitored
2. Baseflow percent at 306SWOUTL is likely an overestimate. Effective flow monitoring required installing a debris screen at this site. Water would pond behind the large amount of debris and slowly flow out. When free of debris this site had no or very little, intermittent baseflow.

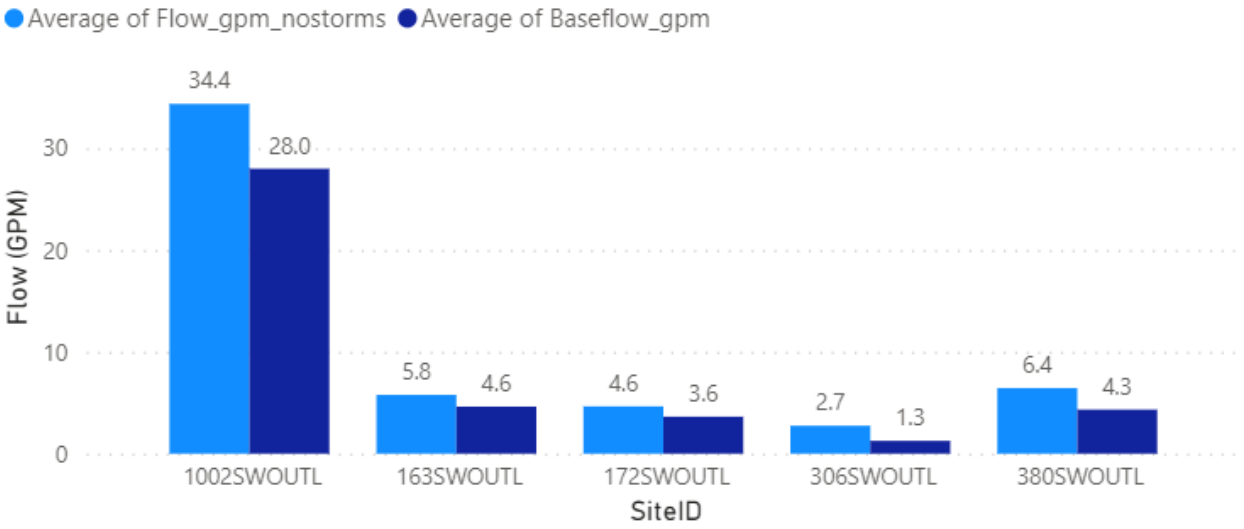

Figure 3-1. Flow Classification for All MS4 Sites Monitored in 2022

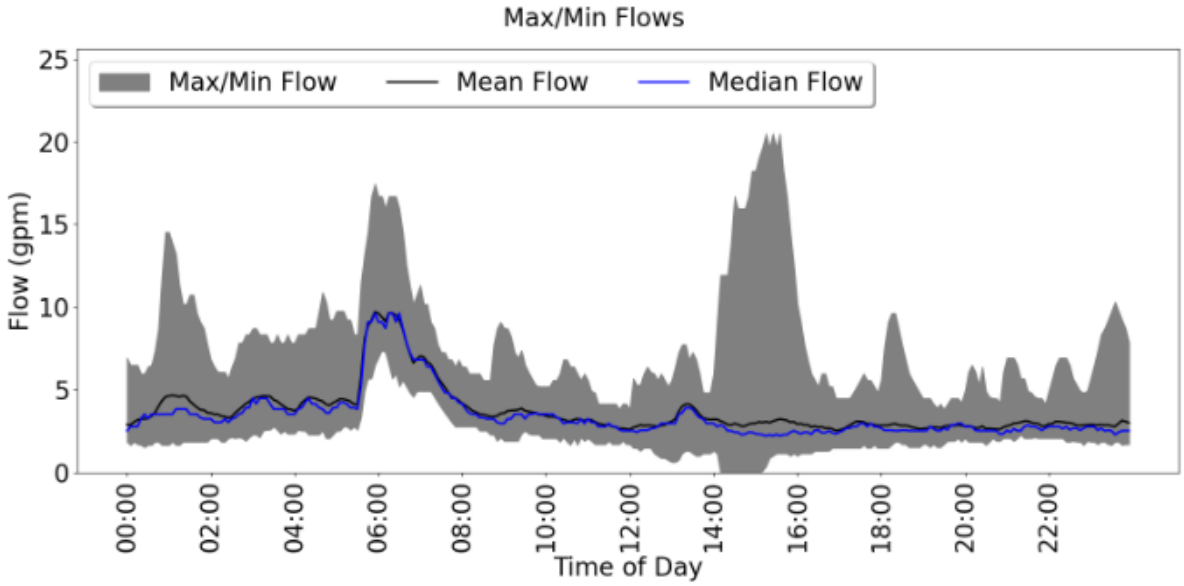

Figure 3-2. "Composite" Hydrograph (172SWOUTL) showing Max, Min, Mean, and Median flows for each 5 minute interval during the day. This illustrates patterns of repeated peak flows such as the consistent high flow around 6am each day (high median flow in blue line), and an anomalous peak flow from 2-4pm (high flow in grey area but low median flow in blue line).

Table 3-4. Results of Baseflow Separation and Flow Pattern Assessment

Site Name	Average Flow	Flow pattern
2313 Manchester	0 to < 1 gpm	Dried up
776 Corinia St	< 0.5 gpm	NA[1]
Blue Crest	NA[2]	Intermittent
Bracero	<1 gpm	Consistent
Dunsmore Ct	0 to < 0.5 gpm	Intermittent
Pipes Ramp	5 - 10 gpm	Consistent
Raphael Ct	0 - 10 gpm	Intermittent
Rock Garden	< 0.5 gpm	Dried up
Woodgrove HOA	< 1gpm	Consistent

1. 776 Corinia was only visited once. No pattern could be determined from single visit
2. No estimate of average flow could be made at Blue Crest. There was evidence of flow but no measurements during those flows were made.

3.3 ISOTOPE RESULTS

Isotope results for MS4 and non-MS4 sites are presented as %TAP based on IEMMA. The accuracy of IEMMA depends on the adequate separation of the isotopic end members of reference water sources: local (ground) water, reclaimed, and tap water. Results from 2021 showed good separation between the local water reference and tap water for both water districts in the City of Encinitas and Reclaimed water from the San Elijo Water Reclamation Facility (Figure 3-3, upper). Results from 2022, however, showed large changes in the isotopic end member for the San Dieguito Water District, which complicated the ability to conduct IEMMA at multiple sites (Figure 3-3, lower). In 2022, isotopic end members for the Olivenhain tap water reference and Reclaimed water reference were similar to 2021 results, so IEMMA results have high confidence at outfalls receiving runoff from only one or both of those sources.

In 2022 the San Dieguito Water District changed to more local water supply, which is isotopically similar to local groundwater and shows a high amount of evaporation in the isotopic signature. This complicates the use of IEMMA for outfalls receiving runoff from San Dieguito tap sources since the local groundwater and tap water are isotopically similar (both in the upper right quadrant of the mixing diagram) and different from Olivenhain Water District tap water (lower left quadrant of mixing diagram). While this makes it more difficult to distinguish between San Dieguito tap water and local groundwater, it did allow for the separation between tap and reclaimed water end members, if local groundwater could be ruled out as a potential source. For outfalls receiving a mix of tap water from both Olivenhain and San Dieguito water district, and/or reclaimed water, no assessment could be made from isotope data because all end members were not adequately separated.

In 2021 isotopic end members for both Olivenhain and San Dieguito tap water references and reclaimed water reference clustered near each other on the isotope mixing diagram (lower left quadrant). In that case the tap water and reclaimed water end members could not be separated, and so were analyzed as a single “anthropogenic” source distinguishable from local groundwater. All three sources were analyzed as a single source and used to calculate the %TAP results. Geochemistry data collected in 2021 was used to determine if reclaimed water was present at outfalls but the results were not conclusive due to the confounding presence of wash water in the MS4 (high boron, high MBAS) and inconclusive results from Piper diagram analysis. In 2022, however, the San Dieguito tap and reclaimed water end members were separated and could be analyzed for %TAP vs %RECLAIMED if local water could be excluded as a potential source.

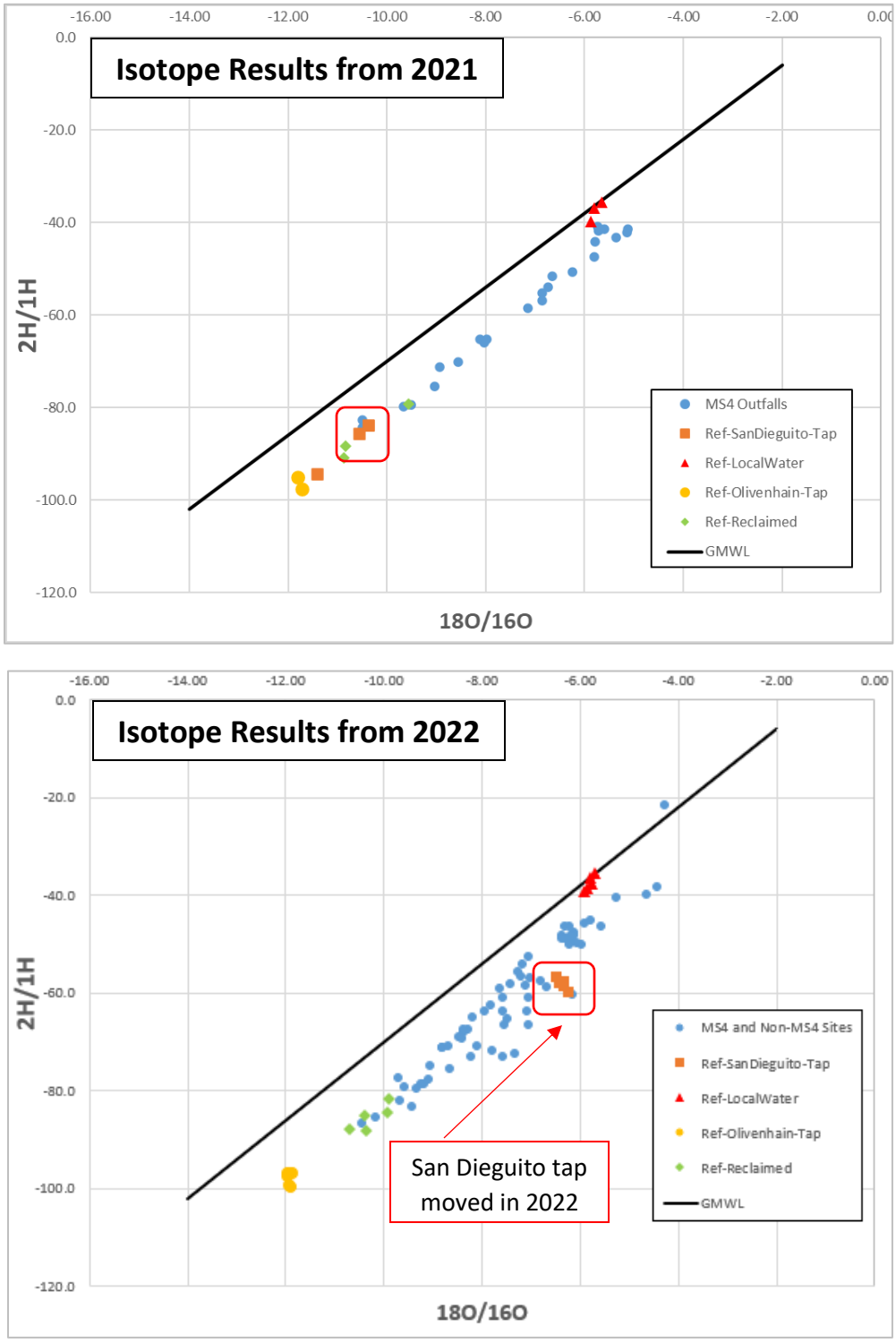

Figure 3-3. Isotope Mixing Diagrams for 2021-22 Monitoring Years. Ref-LocalWater samples showed good end-member separation from both Olivenhain and San Dieguito tap reference (circled in red) and Reclaimed reference in 2021 (TOP). However, in 2022, the San Dieguito Tap reference end member (circled in red) moved to the top right (BOTTOM).

MS4 outfalls and non-MS4 sites monitored in 2022 received water from both Olivenhain and San Dieguito water districts, as well as Reclaimed water from the San Elijo Water Reclamation Facility. Local water is also considered a source wherever constant baseflow is present in MS4, or there was consistent presence of water at non-MS4 sites.

Due to the change in the isotope end member for San Dieguito Water District described above, sites were grouped by potential water sources for analysis. One MS4 site that received both San Dieguito tap and Reclaimed water, 306SWOUTL showed little to no baseflow, so local water was ruled out as a potential source and was analyzed for %TAP and %Reclaimed. The one MS4 site (380SWOUTL) receiving tap water from both Olivenhain and San Dieguito and reclaimed water could not be analyzed due to uninterruptable isotope results.

The non-MS4 sites 2313 Manchester and Bracero Rd had consistent presence of water that may indicate a groundwater source, but the isotope results consistently fell on a mixing line between Reclaimed and San Dieguito tap so these sites were also analyzed as %TAP vs %Reclaimed. These results are considered highly uncertain but are reported here only to show that an effort was made to analyze the sampling results. An alternative explanation for the results at these two sites is that the source was mostly San Dieguito tap water but the flow through the ground is so delayed that there is a mix of 2022 San Dieguito tap and 2021 San Dieguito tap when the end member was isotopically similar to reclaimed water. It is not possible to distinguish between these multiple sources and the change in end members over time.

Isotope results for two non-MS4 sites, Rock Garden and 2313 Manchester, and some individual samples at Raphael Ct, were deemed too uncertain for analysis. This may have been caused by evaporation in ponded sites, matrix interferences, or a mix of multiple and varying reference end members.

Table 3-4. Potential flow sources and isotope end members for %TAP calculation

Water Source(s)	Site(s)
Olivenhain - Local	172SWOUTL[1], Dunsmore Ct, Raphael Ct, 776 Corinia St
Olivenhain/Reclaimed - Local	1002SWOUTL[1]
San Dieguito - Local	163SWOUTL, Pipes Ramp, Rock Garden, Woodgrove HOA
San Dieguito - Reclaimed	306SWOUTL, Blue Crest, Bracero Rd, 2313 Manchester Ave
San Dieguito, Olivenhain, Reclaimed, Local	380SWOUTL[2]

1. Receives some runoff from a small area in San Dieguito WD but the isotope results did not suggest San Dieguito WD as a dominant source.
2. The isotopic end members for all sources contributing to 380SWOUTL could not be adequately separated to make an assessment using IEMMA. No assessment from isotope data are available for this site for 2022.

3.3.1 Sites with Olivenhain tap, Local sources: 172SWOUTL, Dunsmore Ct, Raphael Ct, 776 Corinia St

MS4 site(s):

Part of the contributing area to the 172SWOUTL outfall lies in the San Dieguito Water District but visual inspection of the graphed isotope results for this site suggested minimal influence from the San Dieguito tap reference. All samples for 172SWOUTL lie on a mixing line between the

Olivenhain tap reference and local reference so for the purposes of this analysis the San Dieguito tap reference was not included for 172SWOUTL. If that assumption is incorrect, then the influence of the San Dieguito tap end member would shift isotope results towards the local water reference and cause an underestimate of the %TAP results for this site.

In 2021, %TAP at 172SWOUTL was 81-89%, with an average of 86% and STD of 3%. In 2022, %TAP at 172SWOUTL was 26-71%, with an average of 50% and STD of 16%. The flow patterns and magnitudes in both years are very similar but the %TAP results change from a narrow range of high %TAP in 2021 to wide range of %TAP values with a much lower average in 2022 (86% in 2021 to 50% in 2022). Taking this evidence together would indicate that the contributions of the San Dieguito tap reference are likely causing an underestimate of %TAP in 2022.

Non-MS4 site(s):

Figure 3-4 . 776 Corinia St. Water flowed from french drain in curb. This site was added later; only one site visit was made.

776 Corinia St was added at the end of the monitoring period so only one sample was collected on 10/6/2022. This site lies entirely in the Olivenhain Water District, and it was assumed no reclaimed water is in the drainage area. There is nearby reclaimed water use to the west on Glen Arbor Dr., but it's assumed this does not reach the sampling site via curb flow on Mountain Vista Dr. Flow <0.5gpm was discharged from the property through a small French drain. %TAP was 20% suggesting this is mainly local groundwater seeping out, with a small amount of tap water likely due to irrigation tap water infiltrating through the ground.

Figure 3-5 . Dunsmore Ct. Several french drains had trickle flows or ponded water in the curb. One french drain at 460 Dunsmore Ct had intermitten higher flows (1-5gpm).

Dunsmore Ct is an intermittent discharge from a French drain at 460 Dunsmore Ct. During one site visit this site was dry and no sample could be collected. Two samples were collected during flowing water (<0.5 gpm), and two were collected during ponded water (four total samples). The two ponded samples showed clear isotope signature of evaporation and were corrected to calculate the %TAP. Results showed %TAP varied from 85% in August to 49% in October with a clear seasonal trend towards more local water.

Figure 3-6 . Raphael Ct. Intermittent periods of high flow were observed but most sampes were taken in ponded water remaining in curb.

Raphael Ct is a discharge from a series of French drains from several homes at 426 – 443 Raphael Ct. A landscaper at the site suggested that the observed higher flows (5-10gpm) are likely due to a sump pump at 442 Raphael Ct that accumulates over-irrigation from the homes on Tzena Way. The final site visit on 10/3/2022 was dry, so four samples were collected. Three were collected when the flow was approximately 0.5-1 gpm, and one sample was collected on 9/20/2022 during a higher flow of 5-10 gpm. %TAP results varied from 75% in August to 44% at the end of September. Similar to Dunsmore Ct nearby, there was a clear seasonal trend toward more local water later in the monitoring period.

3.3.2 Sites with Olivenhain tap/Reclaimed, Local sources: 1002SWOUTL

MS4 site(s):

1002SWOUTL receives water from both Olivenhain Water District, Reclaimed water from San Elijo Reclamation Plant, and it is assumed from local groundwater. Similar to 172SWOUTL, part of the contributing area to 1002SWOUTL lies in the San Dieguito Water District. The isotope results don't show a clear impact of the San Dieguito Tap end member so an assessment of %TAP was made. Since the isotope end members for Olivenhain tap and Reclaimed water are well separated from local water, these two end members were combined for an assessment of %TAP that includes the contribution of Reclaimed water at this site.

As described above for 172SWOUTL, if San Dieguito tap water is affecting 1002SWOUTL, contrary to the assumptions, then the %TAP results will be an underestimate. In 2021, %TAP at 1002SWOUTL varied from 52-61%, with an average of 57% and STD of 4%. In 2022, the flow patterns and magnitudes were very similar, but %TAP varied from 39-49%, with an average of 43% and STD of 4%. Results from 2021 and 2022 are quite similar, with a slightly lower %TAP in 2022 but this may be an underestimate due to the change in San Dieguito tap reference.

3.3.3 Sites with San Dieguito tap, Local sources: 163SWOUTL, 2313 Manchester Ave, Pipes Ramp, Rock Garden, Woodgrove HOA

MS4 site(s):

Isotope results from 163SWOUTL appeared to be a mix of San Dieguito tap and local water. There is some reclaimed water infrastructure in the upper watershed potentially draining to this outfall, but no evidence of reclaimed water was observed in the isotope results. In 2021, %TAP for 163SWOUTL was 21-43%, with an average of 32% and STD of 11%. In 2022, %TAP was higher, varying from 29-72% with an average of 52% and STD of 15%. The upper bound of this range would indicate a significant increase in %TAP from 2021 to 2022 but given that flow patterns and magnitudes were mostly unchanged, the observed increase in %TAP is likely due to uncertainty caused by the shifting San Dieguito tap reference in 2022. Another possible factor causing an increase in %TAP in 2022 could be decreased groundwater intrusion due to lower precipitation. Prior wet season precipitation was lower in 2021 (4.63 inches) compared to 2022 (8.67 inches) but higher during the August-October monitoring period, with 1.17" in 2021 compared to 0.28" in 2022. Though immediate stormflow is removed from analysis, groundwater likely contributes to the MS4 over longer timescales and may have caused a dilution of tap water in 2021 compared to 2022. Flows were slightly lower in 2022 so this may indicate reduced groundwater contributions and led to increased %TAP results at some sites.

Non-MS4 site(s):

Pipes Ramp is not near reclaimed water or MS4 infrastructure (on the GIS layer) but there are some drainage pipes immediately upstream of the sampling point conducting approximately 5-8 gpm during the monitoring period. On the hillside is a junction box joining several pipes in a non-standard configuration. One pipe was an approximately 4-inch diameter cast iron pipe inside of a larger corrugated metal pipe. Another clay pipe appeared to be approximately 3 inch diameter.

While these could be French drains it wasn't clear what they would be draining from or where they originated. The pipes accounted for the majority of the flow but there were many seeps evident in the hillslope. The isotope results indicated a mix of San Dieguito tap water and local groundwater. %TAP varied from 43-57%, with an average of 52% and STD of 5%. These results suggest there is some consistently flowing tap source mixed with groundwater seeping out of the hillside. Further investigation of the potable water infrastructure in this area should be conducted to determine the source of the San Dieguito tap water flowing to this site.

Figure 3-7 . Pipes Ramp. Water flows from pipes further up the hillside to this concrete structure and from seeps in the hillside along the length of the pedestrian path.

The isotope results for Pipes Ramp were also remarkably similar to 163SWOUTL. Since both sites are near each other it may be possible that the unknown pipes on the hillside are somehow connected to the MS4 or the same flow source as 163SWOUTL. Further reconnaissance would be needed to make that determination.

Figure 3-8 . Rock Garden. A small seep flowed from the corner and curb cut and onto the sidewalk. This flow dried up during the monitoring period indicating the potential source was groundwater.

A small seep emanated from the area locally known as the Rock Garden located at the corner of B street and the alley between 2nd and 3rd streets. Three samples were collected 8/4/2022, 8/23/2022, and 9/6/2022 before the seep was completely dry. The isotope results are inconclusive. They do not lie on a mixing line between the San Dieguito tap reference and the local water reference so no analysis of %TAP could be determined based on those end members. Considering that the source dried up and did not resemble the San Dieguito tap reference, the only conclusion is that the sampled water was most likely groundwater since it dried up.

Figure 3-9 . Woodgrove HOA. This small concrete channel had numerous cracks with water seeping up from the below. Intermittent periods of flow from upstream were observed during sampling.

A small seep in the channelized drainage downstream of an MS4 outfall in the Woodgrove HOA was sampled five times. Some flow may be intermittently emitted from the MS4 outfall but during sample visits it was not observed. The small trickle flow from cracks in the channel was consistent throughout the monitoring period. No reclaimed water infrastructure is present in the watershed and isotope results appeared to be a mix of San Dieguito tap and local groundwater, with a high amount of evaporation consistent with the open concrete channel sampling location. %TAP varied from 27-53% with an average of 39% and STD of 9%.

3.3.4 Sites with San Dieguito tap, Reclaimed sources: 306SWOUTL, Blue Crest, 2313 Manchester, Bracero Rd

MS4 site(s):

306SWOUTL receives runoff from both San Dieguito tap and Reclaimed sources. There was not consistently flowing baseflow so local water was excluded as a potential source, and results were

analyzed as a mix of %TAP and %RECLAIMED. Reclaimed irrigation present on Paseo de las Verdes Road was observed entering the curb inlet during several site visits, and %RECLAIMED results were consequently higher for those samples. %TAP varied from 26-82%, with an average of 61% and STD of 21%. %RECLAIMED varied from 18%-74%, with an average of 39% and STD of 21%.

Non-MS4 site(s):

Figure 3-10 . Blue Crest. An 8 inch pipe enters a retention basin adjacent the neighborhood. Intermittent flow was observed.

A drainage pipe entering the retention basin on the southwest corner of Blue Crest neighborhood was visited 5 times for sampling. During two site visits the conveyance was dry, and isotope results for one sample were outside the mixing diagram, above local water likely due to excessive evaporation. Isotope results from two samples indicate a mix of reclaimed (23%) and SDG tap (average 77%). There is reclaimed water at this property so the results are plausible but an investigation into how reclaimed water is entering the conveyance is recommended.

Figure 3-11 . 2313 Manchester. Water seeped out of a french drain and curb joints. Ponding persisted until late September, then was dry.

Results for 2313 Manchester were difficult to interpret. The sample collected on 8/4/2022 appears to be 100% tap, and then off of the mixing line towards the 2021 San Dieguito end member on 8/23/2022, then somewhere between those two in September samples. This site dried up by 10/3/2022 sampling visit. The %TAP results for this site do not seem reliable and are not reported.

Figure 3-12 . Bracero Rd. A small concrete drainage channel runs between several houses, discharging onto Bracero Rd.

Bracero Rd isotope results appear to be a mix of reclaimed and SDG tap but there is no plausible source of reclaimed water draining to the sampling site. Local groundwater may also be a source, but the shift in end member for San Dieguito tap confounds the possibility of quantifying groundwater contributions. There are reclaimed water pipes both uphill and downhill from the site but none nearby or in the assumed contributing watershed area. A possible explanation is that the 2021 San Dieguito isotope end member was very similar to the reclaimed water end member and stored or slowly flowing 2021 San Dieguito tap water may be contributing to the water present at the Bracero Rd. sampling site, shifting the sample results towards the reclaimed end member and making it appear as though reclaimed water is present. However, no temporal trend towards the 2022 San Dieguito tap end member consistent with this changing source was evident and the amount of flow was similar throughout sampling. Further field reconnaissance would be helpful for this site to assess where water is entering the channel. %TAP varied from 0-41% and

%RECLAIMED varied from 58-100%, but results for this site are too uncertain to make any strong conclusions or recommendations other than to investigate further for sources of reclaimed water.

3.3.5 Summary of MS4 sites

Due to the change in isotope end member for San Dieguito tap reference, isotope results and assessments of %TAP at outfalls receiving tap water from San Dieguito Water District were more complicated and less certain in 2022 compared with 2021.

Drainage areas for 1002SWOUTL and 172SWOUTL are mainly served by Olivenhain water district but also include some areas served by San Dieguito Water District. %TAP at 1002SWOUTL and 172SWOUTL was lower in 2022 but this may be due to the influence of San Dieguito tap reference resembling local water and skewing the %TAP lower. 380SWOUTL received water from all four reference waters and no assessment could be made. At 306SWOUTL flow monitoring showed there was no baseflow and therefore no local groundwater, so an assessment could be made of %TAP vs %RECLAIMED. All isotope sampling results from 2022 are considered less certain than in 2021 but since all MS4 sites showed mostly similar patterns and magnitudes of flow in both years and isotope results were generally similar to last year (some mix of tap and groundwater), flow sources at these MS4 sites are assumed to be relatively unchanged from 2021 to 2022.

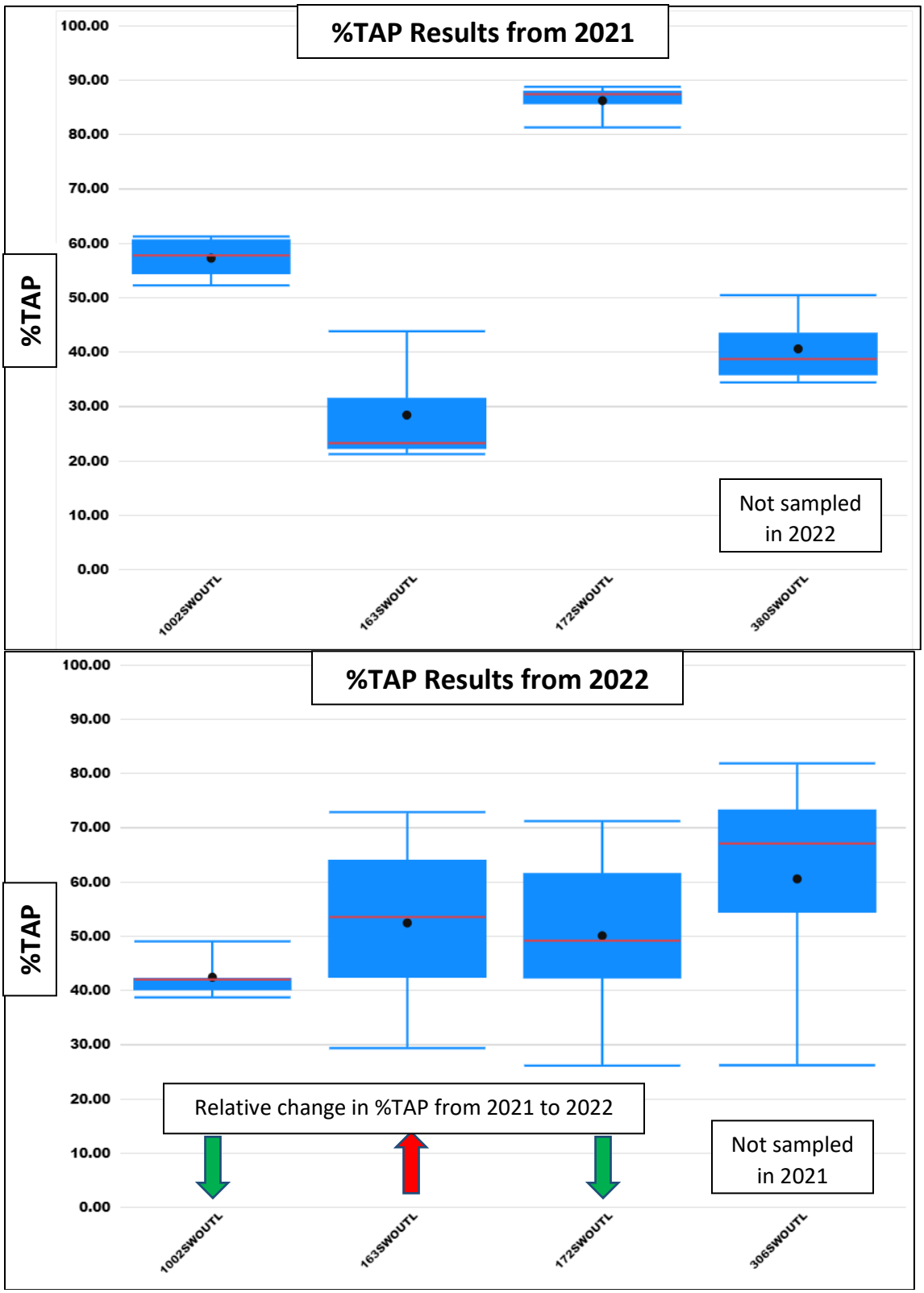

Figure 3-13. Plot of Isotope Analysis %TAP results for MS4 sites in 2021 (TOP) and 2022 (BOTTOM)

3.3.6 Summary of Non-MS4 sites

Most sites with persistent flow seeping from the ground or French drain would be assumed to be mainly groundwater, however, the water seeping out of the ground could be tap water that was used for irrigation. This makes the definition of "groundwater" more complicated. Nine Non-MS4 sites with persistent presence or flows of water were sampled. With the exception of Pipes Ramp (5-10gpm) and one sample at Raphael Ct, flows were very low (<1gpm), and several were dry during some site visits. During the monitoring period the isotope end member for San Dieguito tap reference was closer to local groundwater than in 2021, but it is uncertain when this change occurred between October 2021 and August 2022. San Dieguito tap water infiltrated into the groundwater prior to October 2021 may have been seeping out during this 2022 monitoring period, causing high uncertainty in the isotopic end member analysis.

Overall, the results show many sites had a higher %TAP than expected for a groundwater seep (>30%TAP), indicating a significant portion of the water is tap water that is infiltrating through the ground and seeping out (Figure 3-14).

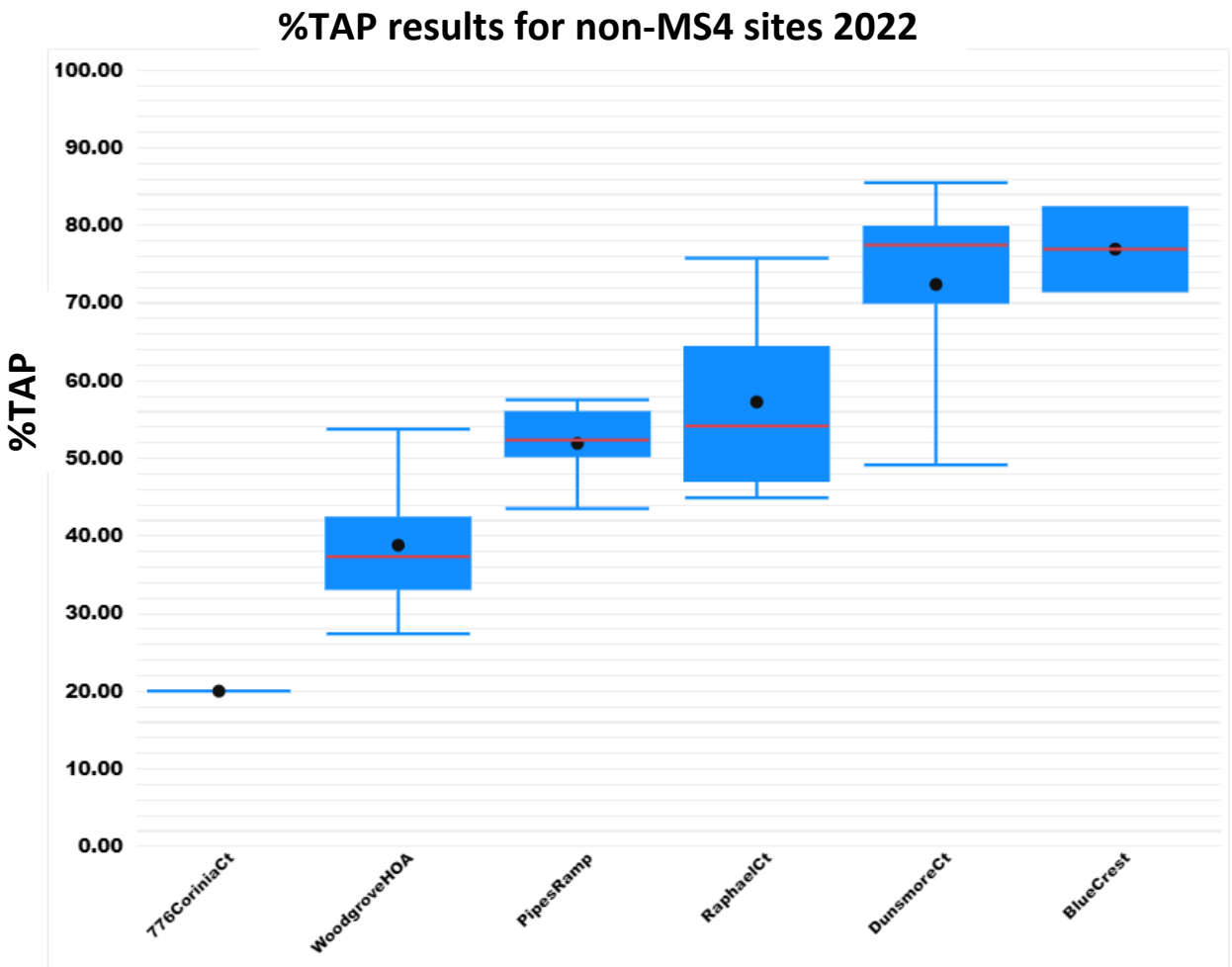

Figure 3-14 Box-whisker plot of %TAP results for Non-MS4 sites.

3.4 FLOW SOURCE ASSESSMENTS

Flow and isotope results were considered individually to determine potential flow sources, and then assessed together to make a final determination on flow sources. Since isotope results were not as certain in 2022, less weight was put on this evidence than in 2021. Table 3-4 presents the results of each line of evidence and a final assessment based on the two lines of evidence, following the methods described in Section 2.3.

Table 3-5. Summary of MS4 Site Assessment Results

MS4 ID	Site Name	Flow Source	Flow Details			Isotopes
			Mean Flow Class.	Base Flow	Peak Flow	%TAP
1002SWOUTL	Bajada	Mixed Tap/Groundwater	Medium	84%	Consistent	43±4%
163SWOUTL	Cardiff	Mixed Tap/Groundwater	Small	87%	Consistent	53±15%
172SWOUTL	Pinebranch	Mixed Tap/Groundwater	Small	80%	Consistent	50±16%
306SWOUTL	Encinitas Ranch	Mixed Tap/Reclaimed	Small	51%[1]	Consistent	61±21%
380SWOUTL	Magdalena	Mixed Tap/Groundwater	Small	NA	Consistent	-

1. Baseflow was mostly not present at 306SWOUTL but the baseflow separation algorithm classifies some parts of the hydrograph at low flows as baseflow. This site had a lot of leaf debris, so a screen was placed to keep the weir from clogging. Some water was retained behind the leaf-clogged screen and seeped out more slowly than it would have flowed without monitoring equipment in place.

Table 3-6.Summary of Non-MS4 Site Assessment Results

Site ID	Flow Source	Flow		Isotopes
		Persistent, Intermittent, or Dried?	Flow rate	%TAP
2313 Manchester Ave	Inconclusive[1]	Dried	<1gpm	-
776 Corinia Ct.	Mainly ground	Unknown	<1gpm	20%
Blue Crest	Mixed Tap/Groundwater	Intermittent	Varied	77±5%
Bracero St	Mainly ground	Persistent	<1gpm	22±14
Dunsmore Ct	Mixed Tap/Groundwater	Intermittent	Varied	72±14%
Pipes Ramp	Mixed Tap/Groundwater	Persistent	5-10gpm	41±9%
Raphael Ct	Mixed Tap/Groundwater	Intermittent	Varied	57±12%
Rock Garden	Inconclusive[1]	Dried	<1gpm	-
Woodgrove HOA	Mixed Tap/Groundwater	Persistent	<1gpm	39±9%

1. %TAP was calculated for these sites but the results were too uncertain to be relied on. Both of these sites slowly dried up over the monitoring period so they may be mostly groundwater.

4.0 Conclusions and Recommendations

The goal of this assessment was to answer the primary study questions:

What flow sources are evident in monitored MS4 locations during dry weather flows?

What proportion of the flow is from Tap water vs Groundwater or Tap water vs Reclaimed water?

Overall, flow monitoring showed similar patterns and magnitudes of flows in both 2021 and 2022, indicating flow sources are likely similar between monitored years. At many outfalls, the peak flows are still occurring at the same time of day as in 2021, pointing to persistent source areas of over-irrigation. While the %TAP results were less certain in 2022 they were generally similar to past results and the overall conclusion was that there have been no significant changes in flow sources to these outfalls.

Isotope analysis for the non-MS4 sites provided mixed results. Sampling at these kinds of sites is a novel approach and it was unknown if it would yield usable results, but it leveraged the concurrent sampling at MS4 sites and has the potential to assist the City in locating problematic sources of dry weather flow. Several samples showed extremely high amounts of evaporation making the results unusable or highly uncertain after correcting for evaporation. The change in San Dieguito tap end member proved especially problematic for analyzing these sites since the travel time of water seeping out of the ground may lead to a mixture of tap water from previous years with very different isotopic signatures. In some cases, the %TAP results were reliable and much higher than expected for groundwater seeps, such as Pipes Ramp, Dunsmore Ct, and Raphael Ct. These sites could be further investigated for sources of leaking tap water or over-irrigation.

4.1 RECOMMENDATIONS FOR FUTURE ASSESSMENTS

Data collected throughout this program proved useful for this assessment; however, the following are recommendations for future assessments. The significant change in isotopic composition of the San Dieguito tap reference complicated the use of stable isotopes for flow source tracking in watersheds served by the San Dieguito Water District. If further isotope analysis is conducted in San Dieguito Water District, the isotope reference end members should be assessed prior to sampling at the outfalls. If the San Dieguito tap reference remains similar to 2022 results, it is not recommended to conduct isotope analysis at sites with a mix of Olivenhain and San Dieguito tap or a mix of Reclaimed and San Dieguito tap.

4.2 RECOMMENDED ACTIONS

The City has been proactive in finding problem areas of persistent dry weather flow and conducting additional sampling using creative approaches to determine their flow sources. The results of flow and isotope analysis are intended to assist management decision-making and actions to then reduce those flow sources if possible. If flow sources at a given site are comprised of mainly controllable sources (tap and reclaimed), the City may be able to take actions to reduce those flows. If the main source is groundwater, then the City may better spend limited resources elsewhere.

Outcomes of this study provided insight into flow sources that address the City's Permit requirement to eliminate dry weather flow and the creative uses of analytical techniques to address other aesthetic or public safety issues. Specific recommendations following this study includes the following:

Eliminate reclaimed water discharging to 306SWOUTL

Focus efforts to eliminate the flow of reclaimed water from irrigation into the outfall at 306SWOUTL. This was a good example of the isotope results indicating a transient flow source that would have been difficult to observe through field surveys.

Follow-up reconnaissance of regular peak flows

All of the MS4 sites showed a regular pattern of high flows during the night and early morning but 172SWOUTL and 306SWOUT showed a very consistent, defined high peak flow at the same time each day. Further field reconnaissance or continuous flow monitoring upstream could likely identify the source of those flows and lead to management actions.

Follow-up reconnaissance of pipe connections

The isotope results for Pipes Ramp and 163SWOUTL were remarkably similar. Further investigation into the junction of pipes on the hillslope above would be needed to determine the potential source of water but these results suggest it may be an unmapped storm drain or leaking potable water source.

Targeted education and outreach to homeowners

At Dunsmore Ct and Raphael Ct the French drains discharging to the curb were assumed to be groundwater seeping from the hillside behind the homes, but the %TAP results were over 50% indicating a significant amount of tap water may be contributed by irrigation in the uphill areas. The flows at these two sites were also intermittent with several observed discharges > 5 gpm which indicates an anthropogenic source. The City could recommend to the homeowners that this water is better used for irrigation on their properties and reroute this nuisance flow.

Drainage modifications to reroute seasonal flow

The isotope results at Rock Garden were inconclusive due to the change in San Dieguito tap reference in 2022. However, flow at this site gradually decreased until it dried up in late September, indicating a potential groundwater source. If the flow source is indeed groundwater as it appears, it could reappear during the wet season each year and cause a nuisance flow until late summer. The City could route this flow away from the pedestrian walkway permanently to remove this nuisance.

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