PROCEDURES FOR PREPARATION OF

WELL SOURCE AND PUMPING IMPACT ASSESSMENTS

September 2005

Revised May 2006

Purpose and Applicability

Monterey Peninsula Water Management District (MPWMD or District) Rules 20 and 21 require that an application to create or amend a water distribution system (WDS) be submitted to the District. Ordinance No. 122, adopted on August 15, 2005 and effective September 14, 2005, establishes new "impact-based" criteria and four levels of evaluation for WDS applications. Detailed well testing and analysis are required as part of the WDS permit application process for Review Levels 1, 2, 3, and 4, as described in the MPWMD rules and regulations.

The information is to be provided in the form of a "**Well Source and Pumping Impact Assessment**" report (*Assessment*) which is required for three specific purposes: (1) to evaluate the well's capability to meet the proposed demand, (2) to analyze the well's potential impact on water resources in the vicinity, and (3) to analyze the well's potential impact on existing wells in the vicinity. This document describes the minimum required procedures for completing an *Assessment* by a qualified professional.[1] The procedures described herein focus on standard cases that are commonly anticipated within the District (i.e., a WDS intended to serve a single-family dwelling and associated landscaping requirements); accordingly, some modifications and/or additions to these procedures may be required for other cases. This document is prepared using the single-well WDS format; however, the same procedures would apply to WDSs intended for service from multiple well sources. Costs associated with preparation of the *Assessment* shall be borne by the applicant. It should be noted that in cases where a Hydrogeologic Report is also required by Monterey County, it is acceptable to include the required information described herein as part of the Hydrogeologic Report, so that applicants do not need to prepare a separate document to satisfy the District's requirements.

The following sections outline the <u>minimum requirements</u> for production testing, analysis and reporting of groundwater information to comply with the MPWMD rules and regulations. The procedures described herein may be periodically revised as warranted.

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[1] Qualified professionals include a certified hydrogeologist, a professional geologist with a specialty in hydrogeology, a certified engineering geologist with a specialty in hydrogeology, or a registered civil engineer with a specialty in hydrogeology. These professionals shall be licensed in the State of California. A list of qualified consultants is available from the District. Advice in preparing the *Assessment* can be provided by District staff, but will be billed at the hourly rates as explained in the application.

General Pumping Test Methodology

The following eight **(8) general testing methods** apply for **<u>all</u>** well pumping tests, regardless of the hydrogeologic setting. The District must approve any variation from these general methods in advance on a case-by-case basis.

1. ***Witnessing of Pumping Tests***. The Monterey County Health Department (MCHD) shall be notified in advance of the pumping test. Contact the MCHD at 755-4507 in advance to schedule the planned test start date.

2. ***Well Testing Method***. A qualified individual or firm should conduct the pumping test; a state-licensed C-57 well contractor is recommended. The pumping test shall be conducted with the use of a mechanical well pump (vertical turbine or submersible), unless a specific alternate testing method is approved in advance. Pumping tests conducted with airlift pumping techniques are not acceptable. It is strongly recommended that the qualified professional preparing the *Assessment* be onsite at critical points during the test (e.g., test start, test stop), or otherwise oversee the testing program, in order to minimize the potential requirement to repeat the pumping test due to poor testing or data collection methods.

3. ***Timing of Tests***. Pumping tests shall be conducted during the dry period of the year to better assess well performance under reduced groundwater availability conditions. Accordingly, the period for conducting pumping tests is the six-month period from June 1 through November 30.[2] This period shall apply to all pumping tests required for an *Assessment* unless the District determines a specific alternate testing period, which may be based upon the occurrence of unusually wet hydrologic conditions within the dry season. Given that hydrologic conditions vary from year to year, scheduling of pumping tests outside the dry season shall be guided by Carmel River flows, as a relative measure of dry season conditions.[3] Accordingly, pumping tests outside the dry season shall only be conducted during "Low Flow Periods", defined as "times when stream flow in the Carmel River at the Don Juan Bridge (river mile 10.8) gaging station is less than 20 cubic feet per second (cfs) for five consecutive days". Applicants or consultants wishing to conduct pumping tests outside the six-month dry season must obtain authorization in advance from the MPWMD.

4. ***Discharge Rate***. The testing must be conducted at a pre-determined flow rate that is held constant over the duration of the test (i.e., Constant Rate Test). The discharge rate shall be maintained within no more than a 10% range, and shall be

[2] Carmel River flows are used as a guide for local hydrologic conditions for the timing of pumping tests; the June 1 through November 30 period corresponds to the six lowest months of Carmel River flows, on average.

[3] The criterion for determining "Low Flow Periods" is from an agreement (referred to as the "Conservation Agreement") entered into between the National Marine Fisheries Service and California-American Water in 2001. Elements of this Agreement were later adopted as part of State Water Resources Control Board Order 2002-0002. In the Agreement and Order, specific operational restrictions are linked to Low Flow Periods, defined as "times when stream flow in the Carmel River at the Don Juan Bridge (RM 10.8) gage is less than 20 cfs for five consecutive days".

closely monitored and documented.[4] For both potable and non-potable intended uses, the minimum test-pumping rate shall be three (3) gallons per minute (GPM)[5], unless another minimum rate is authorized in advance by the MPWMD.

5. ***Control of Well Discharge***. The discharge water from pumping tests shall be managed to prevent recharge of the well during the testing and recovery periods and shall not be allowed to pond/percolate within 200 feet of the well. Where possible, the discharge water should be directed to storage tanks or applied for irrigation as a means to put the discharge water to beneficial use.

6. ***Wells Monitored.*** In all cases, the production well that is being tested shall be monitored as described in this section. In addition, nearby wells in the expected area of influence of the pumping well shall be monitored where feasible. The District recognizes that it may not be feasible to monitor all nearby wells due to logistical constraints (e.g., availability, monitoring equipment access, pumping requirements, etc.). Accordingly, in cases where nearby wells are not available for use as monitor wells during pumping tests, and the reasons for this are clearly documented in the *Assessment*, data developed from the production well shall be used to the extent possible to support the required analysis and evaluation.

7. ***Data Collection***. Data collected during the pumping test must be well documented. The following parameters should be collected and recorded during the drawdown (i.e., pumping) phase of the test:

   (1) Initial flow meter totalizer reading,
   (2) Static water level prior to test start,
   (3) Clock time at pump start,
   (4) Water levels in the pumping and monitor wells at the reported times since pump start,
   (5) Pumping rate at the time of each reported water level measurement,
   (6) Flow meter totalizer reading at the time of each reported water level measurement, and,
   (7) Final flow meter totalizer reading.

   The following parameters should be collected and documented during the recovery (i.e., non-pumping) phase of the test:

   (8) Clock time at pump stop, and
   (9) Water levels in the pumping and monitor wells at the reported times since pump stop.

[4] Automatic recording pumping rate devices are recommended as these devices improve data collection and can reduce operator time and expense.
[5] The minimum 3 GPM test-pumping rate (i.e., total test average) is set as lower pumping rates may not adequately demonstrate the well's production capability. In addition, lower rates become more difficult to accurately measure and control, and may not adequately stress the aquifer system during testing. The test pumping rate should not be confused with the "calculated well yield" as described in this document.

8. ***Water Level Monitoring***. Water level measurements should be recorded to 0.1-foot precision. Acceptable time intervals for reporting water level measurements at the pumped well during pumping tests are as follows:

Time since pump start (or stop) (in minutes)	Time intervals between measurements (in minutes)
0 to 10	0.5 to 1
10 to 15	1
15 to 60	5
60 to 300	30
300 to 1440	60
1440 to end	480 (8 hr)

The type of water level monitoring device to be used must be specified. Due to the potential for inaccurate water level measurements during pumping (e.g., false readings of pumping water levels due to cascading water in the well, pump turbulence, etc.), the use of electrical water level measuring devices (i.e., water level probes) are discouraged during the conduct of the well pumping test.[6] Instead, it is strongly recommended that pressure transducer/datalogger technology be used for the test. With the pressure transducer properly located below the lowest anticipated water level during the test, the potential for false readings due to cascading water above the pumping water level or pump turbulence is minimized. If water level probes are used in place of pressure transducer/dataloggers and there is uncertainty about the quality of the recorded data, the results of the test will be subject to more conservative interpretation by the District. Water levels shall be monitored and recorded during the recovery phase as required in Step 2 of the procedures for each specific setting, as described on the following pages.

Water Quality Testing

If the water well is to supply potable water for a proposed single-connection WDS, the *Assessment* shall include a water quality (chemical) analysis that as a minimum includes primary inorganics, secondary compounds and coliform bacteria (commonly referred to as general mineral, general physical, inorganics), as described in Title 22, Chapter 15 of the California Code of Regulations. Applicants should check with the MCHD for specific requirements if the proposed WDS is intended to serve 2 or more connections. Water quality testing is not required (but is recommended) for wells intended to supply non-potable irrigation uses.

[6] Water level probes are discouraged as the primary measurement device unless used with a sounding tube properly installed below the lowest expected pumping water level. Water level probes are acceptable for the purpose of calibrating/confirming pressure transducer measurements. Water level probes should have clearly marked depth graduations.

Methodology, Contents and Format of Tests and Assessments

The methodology for well pumping tests and calculations of well and aquifer parameters shall be consistent with standard hydrogeologic practices. References and descriptions of these practices are available from the District.

Prior to the preparation of an *Assessment*, the applicant or their consultant will need to request and obtain from the District a map of all known registered wells and potential "sensitive environmental receptors" (SERs) in the vicinity of the well.[7] This map, or a modified version of it, shall be included in the *Assessment*. The *Assessment* will also need to include the items required per Item 17 of the District's WDS application form. Three key items include:

(1) A copy of the MCHD well construction permit,
(2) A copy of the State Department of Water Resources Well Completion Report (well log), and
(3) Water quality testing results if the well is to supply water for potable use.

The *Assessment* shall include sufficient background to briefly describe the:

(1) Site location (nearby streets, lot size, topography),
(2) Well location on the site,
(3) Well construction (size, depth, materials) and completion (screened intervals), and
(4) Hydrogeologic setting (site geology and aquifer system identification).

In addition, a pumping test set-up description shall also be provided, including the:

(1) Pump size (horsepower),
(2) Pump intake setting (feet below ground surface),
(3) Method for maintaining pumping rate (e.g., dole valve, gate valve, etc.), and
(4) Control of discharge water.

The *Assessment* shall be submitted in a format for direct comparison to the step-by-step procedures outlined herein. All references, attachments and supporting data/documents shall be listed in the *Assessment*, and be clearly labeled. The Assessment shall be provided in both printed (three copies) and digital (one compact disk) formats. ***Other analytical methods not conforming to the procedures described herein may be acceptable, but shall be approved in advance on a case-by-case basis by the District.***

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[7] A "Sensitive Environmental Receptor (SER)" is any one of the following areas or locations: (1) the Carmel Valley Alluvial Aquifer (alluvium) as delineated by the State Water Resources Control Board (SWRCB) in Order WR 95-10 as modified by Order 98-04, and as shown on maps at the District office; (2) the five tributaries listed in MPWMD Rule 20, including Tularcitos, Hitchcock Canyon, Garzas, Robinson Canyon and Potrero Creeks; (3) the Seaside Groundwater Basin as delineated by MPWMD, and as shown on maps at the District office; (4) the Pacific Ocean as delineated by the mean high tide line; or (5) other sensitive locations as designated by Resolution of the MPWMD Board of Directors.

Step-by-Step Well Assessment Procedures for Four Settings within the District

The District has developed four (4) sets of specific testing procedures. Each set of procedures is specific to the four hydrogeologic "settings" (or locations) within the District that the well is located. If there is a question as to which setting is appropriate for a specific application, it is strongly recommended that the applicant, or the applicant's consultant, contact District staff before completing the *Assessment* to confirm the appropriate set of procedures that apply **and** to determine what special, site-specific circumstances may require modification to these procedures. Maps showing the location of the four settings described below are available for review at the District office. The four settings are the:

(1) **Carmel Valley Alluvial Aquifer,**

(2) **Carmel Valley Uplands[8] or other fractured/consolidated bedrock formations,**

(3) **Carmel Valley Uplands and within 1,000 feet of the Carmel Valley Alluvial Aquifer or certain tributary creeks, and**

(4) **Seaside Groundwater Basin.**

[8] "Carmel Valley Uplands" collectively refers to the assemblage of consolidated sedimentary, igneous and metamorphic rocks with common moderate-to-extensive fracturing, within the Carmel River Basin Watershed.

SETTING #1:
PROCEDURES FOR WELLS WITHIN THE CARMEL VALLEY ALLUVIAL AQUIFER

Step 1, Test Length. Pumping tests for wells completed in the Carmel Valley alluvial aquifer shall be for a minimum of 8 hours unless an alternate test length is authorized in advance by the District. Consult with District staff prior to initiating the test to determine if the test length needs to be increased due to site specific factors including: distance to bedrock, known groundwater supply problems in the area, large pumping drawdowns, drawdown curve slope not stabilized, drought conditions, etc. If pre-testing is conducted to determine the proper pumping rate, the formal constant-rate pumping test shall be delayed until at least twice the pre-testing time has elapsed to allow water level recovery from the pre-testing.

Step 2, Documentation of Drawdown and Recovery. Drawdown and recovery data in the pumping and monitor wells shall be documented in a summary table(s) and shall include: static water level, flow meter totalizer readings, clock time, elapsed time since pump start (minutes), pumping water levels (feet below ground surface or specified reference point), drawdown (pumping water level minus static water level), elapsed time since pump stop (minutes), residual drawdown (non-pumping water level minus static water level). Water level recovery data shall be measured until the recovering water level in the pumping well reaches 90% of the pre-test static water level. If 90% percent recovery is not achieved in the equivalent amount of time as the pumping period, then an evaluation of the test will be conducted by the District to determine whether or not the calculated yield should be reduced.

Step 3, Calculation of Specific Capacity. The transmissivity shall be determined and the specific capacity calculated from the test drawdown data. If casing storage effects[9] are suspected to influence early test data from the pumping well, these effects should be factored out of the transmissivity determination. If the apparent transmissivity decreases between the first half of the test and the end of the test, the 8-hour specific capacity shall be adjusted by multiplying the ratio of late-time transmissivity to early-time transmissivity.

Step 4, Calculation of Available Drawdown. Unless an alternate methodology is authorized in advance, available drawdown for setting #1is defined as the lesser of:

A) The distance from the static water level to the top of the perforations, or
B) One-half of the saturated thickness penetrated by the well.

Step 5, Calculation of Well Yield. Unless modified as per **Step 2** above, the yield of the well shall be calculated by multiplying the 8-hour specific capacity by the available drawdown. The well yield represents the theoretical maximum sustainable pumping rate

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[9] For an example discussion of casing storage effects, see *Groundwater and Wells* (Driscoll, 1986, page 232).

for the well.[10] A well yield of 3 GPM per single-family dwelling is the minimum standard for WDS applications.[11] The District must approve any variation from this minimum standard on a case-by-case basis.

Step 6, Estimation of Demand. Estimated "annual demand" for the well shall be based upon all the intended potable and/or non-potable uses on the parcel. For most parcels in the unincorporated areas of the District, the District will accept up to 0.5 acre-feet per year (AFY) as the estimated annual demand for a typical single-family dwelling with standard outdoor landscaping. If the well is intended to supply water for large residences on large parcels with extensive landscaping, agriculture or other non-standard uses, then additional documentation (e.g., residential fixture unit count, non-residential demand based on square footage and type of use, area and type of irrigated use) must be provided as justification for the annual demand estimate. Once the annual demand estimate is established, it should be used to calculate "average day", "dry season" and "maximum day" demands. Average day demand is the estimated annual demand divided by 365 days, and expressed as GPM. The six-month period from May through October should be used to estimate typical dry season demand. Based on Cal-Am system long-term water production records, May through October represents the highest six-month demand period, with approximately 60% of annual demand occurring during this period.[12] Similarly, maximum day demand can be estimated at 1.5 times the average day demand.[13] These estimates are acceptable for most single-family residential applications, but may not be appropriate for applications associated with extensive non-potable uses (e.g., commercial, agricultural). Please contact the District with questions regarding selection of the appropriate demand estimation factors. The *dry season demand estimate* should be expressed in equivalent GPM over six months (183 days), and will be used in **Step 8** below. The *maximum day demand estimate* will be used in **Step 7** below and should be expressed in equivalent GPM over 12 hours pumping duration, as wells should not be planned to operate at more than 12-hour daily pumping cycles during maximum demand periods, when supply requirements will be most critical.[14]

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[10] The well casing size, pump size and discharge pipe size are factors that will influence the maximum sustainable pumping rate of a well. These factors may limit achieving the calculated well yield in practice and should be considered in the *Assessment*.

[11] A well pumping at 3 GPM each day on maximum 12-hour daily pumping cycles would produce 2.4 acre-feet in a year, which may exceed demand requirements for some WDSs. However, experience has shown that actual well yields in most hydrogeologic settings, tend to decline with time. This can be due to declines in ground water levels, degradation of well casing materials, well encrustation or other biological activity that reduces permeability in the zone around the well, pump wear, or a combination of any or all of these factors. The 3 GPM minimum well yield rate provides a safety factor that allows for declines in well performance over time.

[12] Monthly production records for the Monterey Division of California American Water for Water Years 1992 to 2003. Monthly breakdown is available from MPWMD.

[13] Analysis of Cal-Am production records *in* Monterey Peninsula Water Supply Project Alternatives, Phase I Technical Memorandum (Camp, Dresser & McKee, March 2003). See page 2-3.

[14] The maximum 12-hour daily well pumping limitation is incorporated into recommended mitigations for maintaining supply capacity for a large groundwater-supplied project in Carmel Valley (see Jones & Stokes Associates, Inc., 1995, Santa Lucia Preserve Project, Final EIR, page 8-31). This limitation is based on the understanding that pumping tests begin with static water level conditions in the well, in contrast to actual pumping conditions during maximum demand periods, when wells will already have undergone some cumulative seasonal drawdown from prior pumpage. Therefore, wells should not be relied upon to operate

Step 7, Confirmation of Well Capacity. If the *maximum day demand estimate* (in equivalent GPM over 12 hours pumping), as determined in **Step 6**, is equal to or <u>less</u> than the *calculated well yield* from **Step 5**, then proceed to **Step 8**. If the *maximum day demand estimate* <u>exceeds</u> the *calculated well yield*, then additional analysis to estimate anticipated drawdown under intermittent (cyclic) pumping conditions is required to confirm the well's capability to supply anticipated demands without excessive drawdown. An acceptable method to approximate drawdown from intermittent pumping can be found in <u>*Groundwater and Wells*</u> (Driscoll, 1986, page 235). This analysis should be conducted at the maximum day demand rate with maximum daily 12-hour pumping and 12-hour recovery cycles for a 30-day period to represent a reasonable assessment of the length of time that the well may be required to operate at or near the maximum rate. If *cumulative drawdown* from the intermittent pumping calculation <u>exceeds</u> *available drawdown* as determined in **Step 4**, then these results will be used by the District to further assess and adjust the allowable system capacity (i.e., production limit) for the proposed WDS.

Step 8, Calculation of Projected Drawdown. To evaluate the potential well pumping effects in the vicinity of the well, calculated drawdown projections shall be made. Comparison of calculated drawdowns should be made with actual drawdowns measured from nearby monitor wells where available. Drawdown calculations shall be based upon conventional hydrogeologic practices.[15] For drawdown calculations, estimates of hydrogeologic parameters (i.e., transmissivity, storativity) are required. From **Step 3** above, the transmissivity as determined from late-time test data, if applicable, should be used. If storativity cannot be determined from the subject test data, then it should be approximated from other tests, formulas or available literature, as appropriate. The drawdown calculations should utilize the *dry season demand estimate*, expressed in equivalent GPM over six months (183 days), as determined from **Step 6** above. At a minimum, drawdowns shall be calculated for the end of the dry season at the locations of the nearest and farthest existing wells or other receptors within a 300-foot radius of the pumping well.

Step 9, Evaluation of Projected Drawdown Impacts. Using the drawdown calculations as determined from **Step 8** above, evaluate the significance of the projected drawdowns on existing wells or other receptors, as a result of pumping for the proposed WDS. Where available, well completion data (e.g., static and pumping water levels, well screened depths, depth of pump setting) for the existing wells within 300 feet shall be assembled and reviewed for this evaluation.

Optional Procedures for wells in Carmel Valley Alluvial Aquifer

The District strongly recommends that well testing and analysis be conducted for the actual well to be permitted, but this is not required for all wells completed in the Carmel

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more than 12 hours per day to reduce the potential for exhausting available drawdown during maximum demand periods.

[15] Drawdown calculations should utilize standard methods (e.g., Theis Nonequilibrium Equation, Cooper-Jacob Nonequilibrium Equation) that are described in most hydrogeology textbooks. The District can be contacted for assistance in determining the appropriate analytical methods.

Valley alluvial aquifer, provided that sufficient data are available from other nearby wells. Because groundwater is generally more available and well production more reliable within the Carmel Valley alluvial aquifer, the District may conditionally approve a WDS permit prior to the well's construction or completion of a pumping test for a new well. Accordingly, groundwater information from existing, nearby wells may provide sufficient data to process a WDS permit. Authorization to process the WDS permit based on information from existing nearby wells must be obtained from District staff and will be assessed on a case-by-case taking into account the following factors:

- Location of the proposed well within 1,000 feet of the existing well(s),
- Location of the proposed well and the existing well(s) in similar hydrogeologic settings within the alluvial aquifer (with respect to distances from the river, bedrock, creeks, water table, etc.),
- Similar construction of the proposed well and the existing well(s) including depth, screened depths, pump depth, etc.,
- Occurrence of any known water quantity or quality problems in the area,
- Willingness of nearby well owner(s) to provide well information,
- Acceptable quality of the existing well data to address these step-by-step procedures.

SETTING #2:
PROCEDURES FOR WELLS IN THE CARMEL VALLEY UPLANDS OR OTHER FRACTURED/CONSOLIDATED BEDROCK FORMATIONS

Step 1, Test Length. Pumping tests for wells completed in the Carmel Valley uplands bedrock complex or fractured/consolidated bedrock formations in other locations shall be for a minimum of 72 hours. If pre-testing is conducted to determine the proper pumping rate, the formal constant-rate pumping test shall be delayed until at least twice the pre-testing time has elapsed to allow water level recovery from the pre-testing.

Step 2, Documentation of Drawdown and Recovery. Drawdown and recovery data in the pumping and monitor wells shall be documented in a summary table(s) and shall include: static water level, flow meter totalizer readings, clock time, elapsed time since pump start (minutes), pumping water levels (feet below ground surface or specified reference point), drawdown (pumping water level minus static water level), elapsed time since pump stop (minutes), residual drawdown (non-pumping water level minus static water level). Water level recovery data shall be measured until the recovering water level in the pumping well reaches 95% of the pre-test static water level. If 95% percent recovery is not achieved after two times the pumping period has elapsed, then an evaluation of the test will be conducted by the District to determine whether or not the calculated yield should be reduced.

Step 3, Calculation of Specific Capacity. The transmissivity shall be determined and the specific capacity calculated from the test drawdown data. If casing storage effects[16] are suspected to influence early test data from the pumping well, these effects should be factored out of the transmissivity determination. If the apparent transmissivity decreases between the first half of the test and the end of the test, the 24-hour specific capacity shall be adjusted by multiplying the ratio of late-time transmissivity to early-time transmissivity.

Step 4, Calculation of Available Drawdown. Unless an alternate methodology is authorized in advance, available drawdown for setting #2 is defined as:

one-third of the vertical distance from the static water level to the bottom of the well perforations (i.e., well screen).

Step 5, Calculation of Yield. Unless modified as per **Step 2** above, the yield of the well shall be calculated by multiplying the 24-hour specific capacity by the available drawdown. The well yield represents the theoretical maximum sustainable pumping rate for the well.[17] A well yield of 3 GPM per single-family dwelling is the minimum

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[16] For an example discussion of casing storage effects, see _Groundwater and Wells_ (Driscoll, 1986, page 232).

[17] The well casing size, pump size and discharge pipe size are factors that will influence the maximum sustainable pumping rate of a well. These factors may limit achieving the calculated well yield in practice and should be considered in the *Assessment*.

standard for WDS applications.[18] The District must approve any variation from this minimum standard on a case-by-case basis.

Step 6, Estimation of Demand. Estimated "annual" demand for the well should be based upon all the intended potable and/or non-potable uses on the parcel. For most parcels in the unincorporated areas of the District, the District will accept up to 0.5 acre-feet per year (AFY) as the estimated annual demand for a typical single-family dwelling with standard outdoor landscaping. If the well is intended to supply water for large residences on large parcels with extensive landscaping, agriculture or other non-standard uses, then additional documentation (e.g., residential fixture unit count, non-residential demand based on square footage and type of use, area and type of irrigated use) must be provided as justification for the annual demand estimate. Once the annual demand estimate is established, it should be used to calculate "average day", "dry season" and "maximum day" demands. Average day demand is the estimated annual demand divided by 365 days, and expressed as GPM. The six-month period from May through October should be used to estimate typical dry season demand. Based on Cal-Am system long-term water production records, May through October represents the highest six-month demand period, with approximately 60% of annual demand occurring during this period.[19] Similarly, maximum day demand can be estimated at 1.5 times the average day demand.[20] These estimates are acceptable for most single-family residential applications, but may not be appropriate for applications associated with extensive non-potable uses (e.g., commercial, agricultural). Please contact the District with questions regarding selection of the appropriate demand estimation factors. The *dry season demand estimate* should be expressed in equivalent GPM over six months (183 days), and will be used in **Step 8** below. The *maximum day demand estimate* will be used in **Step 7** below and should be expressed in equivalent GPM over 12 hours pumping duration, as wells should not be planned to operate at more than 12-hour daily pumping cycles during maximum demand periods, when supply requirements will be most critical.[21]

Step 7, Confirmation of Well Capacity. If the *maximum day demand estimate* (in equivalent GPM over 12 hours pumping), as determined in **Step 6**, is equal to or <u>less</u> than

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[18] A well pumping at 3 GPM each day on maximum 12-hour daily pumping cycles would produce 2.4 acre-feet in a year, which may exceed demand requirements for some WDSs. However, experience has shown that actual well yields in most hydrogeologic settings, including local fractured rock aquifers, tend to decline with time. This can be due to declines in ground water levels, degradation of well casing materials, well encrustation or other biological activity that reduces permeability in the zone around the well, pump wear, or a combination of any or all of these factors. The 3 GPM minimum well yield rate provides a safety factor that allows for declines in well performance over time.

[19] Monthly production records for the Monterey Division of California American Water for Water Years 1992 to 2003. Monthly breakdown is available from MPWMD.

[20] Analysis of Cal-Am production records *in* <u>Monterey Peninsula Water Supply Project Alternatives, Phase I Technical Memorandum</u> (Camp, Dresser & McKee, March 2003). See page 2-3.

[21] The maximum 12-hour daily well pumping limitation is incorporated into recommended mitigations for maintaining supply capacity for a large groundwater-supplied project in Carmel Valley (see Jones & Stokes Associates, Inc., 1995, Santa Lucia Preserve Project, Final EIR, page 8-31). This limitation is based on the understanding that pumping tests begin with static water level conditions in the well, in contrast to actual pumping conditions during maximum demand periods, when wells will already have undergone some cumulative seasonal drawdown from prior pumpage. Therefore, wells should not be relied upon to operate more than 12 hours per day to reduce the potential for exhausting available drawdown during maximum demand periods.

the *calculated well yield* from **Step 5**, then proceed to **Step 8**. If the *maximum day demand estimate* exceeds the *calculated well yield*, then additional analysis to estimate anticipated drawdown under intermittent (cyclic) pumping conditions is required to confirm the well's capability to supply anticipated demands without excessive drawdown. An acceptable method to approximate drawdown from intermittent pumping can be found in *Groundwater and Wells* (Driscoll, 1986, page 235). This analysis should be conducted at the maximum day demand rate with maximum daily 12-hour pumping and 12-hour recovery cycles for a 30-day period to represent a reasonable assessment of the length of time that the well may be required to operate at or near the maximum rate. If *cumulative drawdown* from the intermittent pumping calculation exceeds *available drawdown* as determined in **Step 4**, then these results will be used by the District to further assess and adjust the allowable system capacity (i.e., production limit) for the proposed WDS.

Step 8, Calculation of Projected Drawdown.[22] To evaluate the potential well pumping effects in the vicinity of the well, calculated drawdown projections shall be made. Comparison of calculated drawdowns shall be made with actual drawdowns measured from nearby monitor wells where available. Drawdown calculations shall be based upon conventional hydrogeologic practice.[23] For drawdown calculations, estimates of hydrogeologic parameters (i.e., transmissivity, storativity) are required. From **Step 3** above, the transmissivity as determined from late-time test data, if applicable, should be used. If storativity cannot be determined from the subject test data, then it should be approximated from other tests, formulas or available literature, as appropriate. The drawdown calculations should utilize the *dry season demand estimate*, expressed in equivalent GPM over six months (183 days), as determined from **Step 6** above. At a minimum, drawdowns shall be calculated for the end of the dry season at the locations of the nearest and farthest existing wells or other receptors within a 1,000-foot radius of the pumping well.

Step 9, Evaluation of Projected Drawdown Impacts. Using the drawdown calculations as determined from **Step 8** above, evaluate the significance of the projected drawdowns on existing wells or other receptors, as a result of pumping for the proposed WDS. Where available, well completion data (e.g., static and pumping water levels, well screened depths, depth of pump setting) for the existing wells within 1,000 feet shall be assembled and reviewed for this evaluation.

[22] Calculation and evaluation of projected drawdown impacts are not required for Review Level 1 WDS permit applications.
[23] Drawdown calculations should utilize standard methods (e.g., Theis Nonequilibrium Equation, Cooper-Jacob Nonequilibrium Equation) that are described in most hydrogeology textbooks. The District can be contacted for assistance in determining the appropriate analytical methods.

SETTING #3:

PROCEDURES FOR WELLS IN THE CARMEL VALLEY UPLANDS AND WITHIN 1,000 FEET OF THE CARMEL VALLEY ALLUVIAL AQUIFER OR CERTAIN TRIBUTORY CREEKS

If the proposed WDS supply well is located within 1,000 feet of the mapped extent of the Carmel Valley Alluvial Aquifer and/or the following five named Carmel River tributaries: Tularcitos Creek, Hitchcock Canyon Creek, Garzas Creek, Robinson Canyon Creek, Potrero Creek, then additional information and analysis are required to evaluate potential impacts from the supply well on those water sources on a seasonal and annual basis. The additional information required is found in Step 10. The additional analysis required is found in Step 11.

Steps 1 through 9 – refer to these under Setting #2.

Step 10, Compile Additional Information and Maps.

- ✓ A map that clearly delineates the relationship of the existing legal parcel to the location of the creek and/or the location of the Carmel Valley Alluvial Aquifer;
- ✓ Hydrological information describing the relationship of the proposed WDS well to the creek and/or Carmel Valley Alluvial Aquifer, and the potential use of the well both seasonally and annually;
- ✓ Existing and planned uses of any other existing wells on the applicant's property that are not part of the proposed WDS (non-WDS wells);
- ✓ Plan view drawing showing the distance of the proposed WDS well to the creek and/or Carmel Valley Alluvial Aquifer, and the distance to other wells not owned by the applicant within 1,000 feet of the proposed WDS well;
- ✓ Cross-sectional drawing showing elevation of channel bottom (thalweg) and/or Carmel Valley Alluvial Aquifer boundaries, the proposed WDS well perforations, and the expected water level elevations during operation;
- ✓ A table showing monthly breakdown of annual production expected from the proposed WDS well (in acre-feet and equivalent GPM);
- ✓ Location and volume of water associated with septic system and other sources of return flows, such as irrigation, and how these sources may contribute to the groundwater system.

Step 11, Calculation/Evaluation of Projected Drawdown Impacts on Creek Flow.

- ✓ Utilizing available streamflow information from the District and any other information the applicant wishes to develop, assess the potential well drawdown and the degree of dry season impact expected to the creek;
- ✓ Assess whether production from the proposed WDS well would affect the creek streamflow dynamics in a significant, measurable way (e.g., make the alluvial section of the creek dry up sooner or take the creek longer to resume flow upon return of the precipitation season);

- ✓ Base drawdown calculations on the distance of the proposed WDS well to the nearest potentially impacted receptor (creek or alluvium);
- ✓ Assess potential cumulative effects of the proposed WDS well with other non-WDS wells on the applicant's property and wells on other properties within 1,000 feet of the WDS well.

SETTING #4:
PROCEDURES FOR WELLS WITHIN THE SEASIDE GROUNDWATER BASIN

Step 1, Test Length. Pumping tests for wells completed within the Seaside Groundwater Basin shall be for a minimum of 24 hours. Consult with District staff prior to beginning the test to determine if the test length needs to be increased due to site specific factors including: distance to bedrock, known groundwater supply problems in the area, large pumping drawdowns, persistent pumping test water level declines, drought conditions, etc. If pre-testing is conducted to determine the proper pumping rate, the formal constant-rate pumping test shall be delayed until at least twice the pre-testing time has elapsed to allow water level recovery from the pre-testing.

Step 2, Documentation of Drawdown and Recovery. Drawdown and recovery data in the pumping and monitor wells shall be documented in a summary table(s) and shall include: static water level, flow meter totalizer readings, clock time, elapsed time since pump start (minutes), pumping water levels (feet below ground surface or specified reference point), drawdown (pumping water level minus static water level), elapsed time since pump stop (minutes), residual drawdown (non-pumping water level minus static water level). Water level recovery data shall be measured until the recovering water level in the pumping well reaches 90% of the pre-pumping static water level. If 90% percent recovery is not achieved in the equivalent amount of time as the pumping period, then an evaluation of the test will be conducted by the District to determine whether or not the calculated yield should be reduced.

Step 3, Calculation of Specific Capacity. The transmissivity shall be determined and the specific capacity calculated from the test drawdown data. If casing storage effects[24] are suspected to influence early test data from the pumping well, these effects should be factored out of the transmissivity determination. If the apparent transmissivity decreases between the first half of the test and the end of the test, the 24-hour specific capacity shall be adjusted by multiplying the ratio of late-time transmissivity to early-time transmissivity.

Step 4, Calculation of Available Drawdown. Unless an alternate methodology is authorized in advance, available drawdown for setting #4 is defined as:

one-third of the vertical distance from the static water level to the bottom of the well perforations (i.e., well screen).

Step 5, Calculation of Well Yield. Unless modified as per **Step 2** above, the yield of the well shall be calculated by multiplying the 24-hour specific capacity by the available drawdown. The well yield represents the theoretical maximum sustainable pumping rate

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[24] For an example discussion of casing storage effects, see *Groundwater and Wells* (Driscoll, 1986, page 232).

for the well.[25] A yield of 3 GPM per single-family dwelling is the minimum standard for WDS applications.[26] The District must approve any variation from this minimum standard on a case-by-case basis.

Step 6, Estimation of Demand. Estimated annual demand for the well should be based upon all the intended potable and/or non-potable uses on the parcel. Appropriate documentation of anticipated water use (e.g., residential fixture unit count, non-residential demand based on square footage and type of use, area and type of irrigated use) must be provided as justification for the annual demand estimate. Once the annual demand estimate is established, it should be used to calculate "average day", "dry season" and "maximum day" demands. Average day demand is the estimated annual demand divided by 365 days, and expressed as GPM. The six-month period from May through October should be used to estimate typical dry season demand. Based on Cal-Am system water production records, May through October represents the highest six-month demand period, with approximately 60% of annual demand occurring during this period.[27] Similarly, maximum day demand can be estimated at 1.5 times the average day demand.[28] These estimates are acceptable for most single-family residential applications, but may not be appropriate for applications associated with extensive non-potable uses (e.g., commercial, agricultural). Please contact the District with questions regarding selection of the appropriate demand estimation factors. The *dry season demand estimate* should be expressed in equivalent GPM over six months (183 days), and will be used in **Step 8** below. The *maximum day demand estimate* will be used in **Step 7** below and should be expressed in equivalent GPM over 12 hours pumping duration, as wells should not be planned to operate at more than 12-hour daily pumping cycles during maximum demand periods, when supply requirements will be most critical.[29]

Step 7, Confirmation of Well Capacity. If the *maximum day demand estimate* (in equivalent GPM over 12 hours pumping), as determined in **Step 6**, is equal to or <u>less</u> than

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[25] The well casing size, pump size and discharge pipe size are factors that will influence the maximum sustainable pumping rate of a well. These factors may limit achieving the calculated well yield in practice and should be considered in the *Assessment*.

[26] A well pumping at 3 GPM each day on maximum 12-hour daily pumping cycles would produce 2.4 acre-feet in a year, which may exceed demand requirements for some WDSs. However, experience has shown that actual well yields in most hydrogeologic settings, tend to decline with time. This can be due to declines in ground water levels, degradation of well casing materials, well encrustation or other biological activity that reduces permeability in the zone around the well, pump wear, or a combination of any or all of these factors. The 3 GPM minimum well yield rate provides a safety factor that allows for declines in well performance over time.

[27] Monthly production records for the Monterey Division of California American Water for Water Years 1992 to 2003. Monthly breakdown is available from MPWMD.

[28] Analysis of Cal-Am production records *in* <u>Monterey Peninsula Water Supply Project Alternatives, Phase I Technical Memorandum</u> (Camp, Dresser & McKee, March 2003). See page 2-3.

[29] The maximum 12-hour daily well pumping limitation is incorporated into recommended mitigations for maintaining supply capacity for a large groundwater-supplied project in Carmel Valley (see Jones & Stokes Associates, Inc., 1995, Santa Lucia Preserve Project, Final EIR, page 8-31). This limitation is based on the understanding that pumping tests begin with static water level conditions in the well, in contrast to actual pumping conditions during maximum demand periods, when wells will already have undergone some cumulative seasonal drawdown from prior pumpage. Therefore, wells should not be relied upon to operate more than 12 hours per day to reduce the potential for exhausting available drawdown during maximum demand periods.

the *calculated well yield* from **Step 5**, then proceed to **Step 8**. If the *maximum day demand estimate* exceeds the *calculated well yield*, then additional analysis to estimate anticipated drawdown under intermittent (cyclic) pumping conditions is required to confirm the well's capability to supply anticipated demands without excessive drawdown. An acceptable method to approximate drawdown from intermittent pumping can be found in *Groundwater and Wells* (Driscoll, 1986, page 235). This analysis should be conducted at the maximum day demand rate with maximum daily 12-hour pumping and 12-hour recovery cycles for a 30-day period to represent a reasonable assessment of the length of time that the well may be required to operate at or near the maximum rate. If *cumulative drawdown* from the intermittent pumping calculation exceeds *available drawdown* as determined in **Step 4**, then these results will be used by the District to further assess and adjust the allowable system capacity (i.e., production limit) for the proposed WDS.

Step 8, Calculation of Projected Drawdown. To evaluate the potential well pumping effects in the vicinity of the well, drawdown projections shall be made. Comparison of calculated drawdowns should be made with actual drawdowns measured from nearby monitor wells where available. Drawdown calculations shall be based upon conventional hydrogeologic practices.[30] For drawdown calculations, estimates of hydrogeologic parameters (i.e., transmissivity, storativity) are required. From **Step 3** above, the transmissivity as determined from late-time test data, if applicable, should be used. If storativity cannot be determined from the subject test data, then it should be approximated from other tests, formulas or available literature, as appropriate. The drawdown calculations should utilize the *dry season demand estimate*, expressed in equivalent GPM over six months (183 days), as determined from **Step 6** above. At a minimum, drawdowns shall be calculated for the end of the dry season at the locations of the nearest and farthest existing wells or other receptors within a 300-foot radius of the pumping well.

Step 9, Evaluation of Projected Drawdown Impacts. Using the drawdown calculations as determined from **Step 8** above, evaluate the significance of the projected drawdowns on existing wells or other receptors, as a result of pumping for the proposed WDS. Where available, well completion data (e.g., static and pumping water levels, well screened depths, depth of pump setting) for the existing wells within 300 feet shall be assembled and reviewed for this evaluation.

Step 10, Evaluation of Proposed WDS Impacts to Seaside Basin Water Resources. Notwithstanding the determinations based on the above steps, the projected water supply impacts of the proposed WDS in light of the current overpumped condition of the Seaside Basin need to be evaluated. District staff should be consulted in advance regarding the required scope and format of this evaluation.

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Last revised 5/31/2006

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[30] Drawdown calculations should utilize standard methods (e.g., Theis Nonequilibrium Equation, Cooper-Jacob Nonequilibrium Equation) that are described in most hydrogeology textbooks. The District can be contacted for assistance in determining the appropriate analytical methods.