SSFL CDO Expert Panel[1]

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To: Los Angeles Regional Board Staff

Re: Design Storm Technical Memorandum from Geosyntec Consultants

Date: November 3, 2008

The purpose of this letter is to transmit Geosyntec's October 31, 2008 design storm technical memorandum. Geosyntec is responsible for the memorandum's content in that they performed the detailed engineering analysis. The Expert Panel has reviewed this memorandum and has found that it accurately characterizes the evaluation approach that we used to develop our design storm recommendation. Geosyntec acted under the Panel's general instructions as they conducted the work supporting the Expert Panel's design storm recommendation and as they developed this technical memorandum

As chair of the Expert Panel, I am signing on behalf of the other members (having been given their authorization to do so), with the exception of Dr. Richard Horner, who, in his reduced level of involvement with the Panel, has not conducted a comprehensive review of the memo.

Very truly yours,

Michael K. Stenstrom

[1] The Expert Panel members are acting as independent technical experts in order to assist the Regional Board and The Boeing Company develop and implement methods to meet the requirements of Cease and Desist Order R4-2007-0056, dated November 1, 2007. Their opinions and directives are not the opinions and directives of their respective employers.

Geosyntec consultants

Memorandum

Date: November 3, 2008

To: Paul Costa, The Boeing Company

Copies to:

From: Brandon Steets, Eric Strecker, and Andi Thayumanavan, Geosyntec Consultants

Subject: Expert Panel's Basis for Selection of Site-specific Design Storm

Geosyntec Project Number: SB0363M/1-5

EXECUTIVE SUMMARY

This memo was prepared by Geosyntec Consultants (Geosyntec) at the request of Los Angeles Regional Water Quality Control Board (Regional Board) staff, and is intended to summarize the Expert Panel's approach and basis for developing a site-specific design storm recommendation for the Santa Susana Field Laboratory (SSFL) NPDES permit for stormwater discharges (Order No. R4-2007-0055). This memo also describes the data that were used for the analysis, and compares ENTS sizes and associated environmental impacts if larger design storms were selected. This memo was reviewed by the Expert Panel.

The Expert Panel's recommendation for a site-specific design storm for the SSFL NPDES permit was primarily based on the following factors and considerations:

- Regional and State-wide Best Management Practice (BMP) sizing guidance and recommendations of the Los Angeles regional design storm task force (with the SSFL's site-specific design storm being conservatively protective relative to these);
- The frequency and percentage of storms that would exceed a particular design storm event, based on analysis of local rain gauge datasets;
- The nature of the contaminant sources at the site as well as measured concentrations of contaminants in soil and stormwater at the site;
- The future planned use of the site as open space (including the fact that the proposed Engineered Natural Treatment Systems [ENTS] are intended to serve as a stormwater

quality solution only for the next ten years or so, prior to completion of DTSC-approved site remediation measures);

- Recognition of the stringent numeric effluent limits for stormwater discharges in the NPDES permit; and

- Experiences of the Panel members with stormwater BMP design and performance assessment, and with NPDES permitting.

The site-specific design storm recommendation was also based on the following factors and considerations that are specifically related to the design of stormwater quality treatment systems, including ENTS:

- The average percentage of runoff volume that is fully captured and treated in BMPs that are sized to a particular design storm event, based on long-term hydrologic modeling of hypothetical and final recommended ENTS for the Outfall 008 and 009 watersheds;

- "Point of diminishing returns" concept (i.e., treatment system size range at which minimal runoff volume capture benefits are gained relative to increased environmental impact);

- Site-specific opportunities and constraints for ENTS construction in the Outfall 008 and 009 watersheds, including the potential environmental impacts of sizing treatment systems to larger design storms; and

- The level of partial treatment that is expected to occur for additional runoff from storms that exceed a particular design storm event.

The Panel's final recommendation for a site-specific design storm for implementation in the SSFL NPDES permit for stormwater discharges is the **1-year recurrence interval event** (i.e, a storm of this size is anticipated to occur once every year, on average, based on the period of record for a local representative rain gauge) based on the Panel's directed analyses and considerations above. The 1-year storm corresponds to 2.5 inches for the 24-hour duration event or 0.6 inches for the 1-hour duration intensity[1]. Specifically related to the Panel's scope to develop ENTS for the Outfall 008 and 009 watersheds[2], the Panel recommended that the ENTS

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[1] For simplicity, the focus of the analysis contained in this memo is on the 2.5 inch 24-hour duration event.
[2] These were the two outfall watersheds that were identified by the Regional Board in the Cease and Desist Order (No. R4-2007-0056) for the Panel to develop ENTS, and thus these were the two test watersheds evaluated by the Panel to develop the proposed site specific design storm.

facilities be sized as large as feasible (and in all cases, greater than the 1-year 24-hour event) – while considering other environmental impacts, schedule[3], and physical site constraints – with a minimum sizing criterion (or design basis) of 90% long-term runoff volume capture. The Panel also recommended ENTS facilities that provide treatment redundancy, or multiple treatment opportunities, through treatment trains (where unit processes operate in series) or through downstream ENTS that receive treated water from facilities further upstream in the watershed.

BACKGROUND AND PURPOSE

In response to Cassandra Owens' request for additional information during our call on Friday June 13, 2008 and the meeting on Wednesday June 25, 2008, the following information is being provided to The Boeing Company for Regional Board staff review and use as the Regional Board considers a site-specific design storm for the SSFL NPDES permit. This memorandum summarizes the Expert Panel's basis for selection of a site-specific design storm for the SSFL.

PANEL'S DESIGN STORM DEVELOPMENT APPROACH

The Expert Panel's goal for developing the SSFL's site-specific design storm was to recommend a design storm that would: (1) be appropriate and applicable for use in the NPDES permit for compliance determination purposes, and (2) reflect current scientific and technical understanding of the relationship between design storms and stormwater treatment. For the evaluation process the Panel chose average runoff volume capture based on long-term continuous hydrologic modeling as one of the key metrics to assess design storm effectiveness. Average runoff volume capture is the percent of stormwater runoff from a drainage area that is retained (i.e., infiltrated, evaporated, or evapotranspirated) or *fully* treated and discharged by a BMP (whereas portions of larger storms are only *partially* treated by in-line treatment systems and therefore are not included in this percentage) for the modeled period of record. This metric is computed based on long-term continuous hydrologic modeling of a drainage area and the proposed BMP design. Use of this metric is consistent with the approach taken by the Los Angeles Design Storm Task Force that was tasked with developing a preliminary design storm recommendation for TMDL implementation in the Los Angeles Region.

In addition to long-term continuous modeling of runoff capture, the Panel also considered other factors for their recommendation, including:

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[3] Cease and Desist Order No. R4-2007-0056 states that the final effluent limits become effective at Outfalls 008 and 009 on June 10, 2009, therefore the Panel recognizes that permitting, design, and construction of the proposed ENTS should be completed prior to the start of the following rainy season, or October 2009.

- Regional and State-wide Best Management Practice (BMP) sizing guidance and recommendations of the Los Angeles regional design storm task force (with the SSFL’s site-specific design storm being conservatively protective relative to these);

- The frequency and percentage of storms that would exceed a particular design storm event, based on analysis of local rain gauge datasets;

- The nature of the contaminant sources at the site as well as measured concentrations of contaminants in soil and stormwater at the site;

- The future planned use of the site as open space (including the fact that the proposed Engineered Natural Treatment Systems [ENTS] are intended to serve as a stormwater quality solution only for the next ten years or so, prior to completion of DTSC-approved site remediation measures);

- Recognition of the stringent numeric effluent limits for stormwater discharges in the NPDES permit (Order No. R4-2007-0055);

- Experiences of the Panel members with stormwater BMP design and performance assessment, and with NPDES permitting;

- “Point of diminishing returns” concept (i.e., treatment system size range at which minimal runoff volume capture benefits are gained relative to increased environmental impact);

- Site-specific opportunities and constraints for ENTS construction in the Outfall 008 and 009 watersheds, including the potential environmental impacts of sizing treatment systems to larger design storms; and

- The level of partial treatment that is expected to be provided by hypothetical ENTS facilities for runoff from storms that exceed a particular design storm sizing basis.

For the development of the design storm recommendation, the Expert Panel conducted the steps that are described below:

Assess previously proposed design storm. The Panel was provided with background information regarding the previously proposed design storm for the site, which was the 1-year recurrence interval event. This event was initially proposed for the site based on discussions between Boeing and Jon Bishop (former Executive Officer of the LARWQCB) prior to formation of the Panel, where Mr. Bishop suggested a one-year storm based on the Los Angeles

River and Ballona Creek Trash TMDLs design treatment capacity for full capture devices. A technical memo from Boeing's consultant, MWH, dated March 29, 2007 defined this event for the site as the 2.3 inch depth for a 24-hour duration period based on local rain gauge data (MWH, 2007). The Panel's initial directive from Regional Board staff was to assess this previously proposed design storm for use at the site.

Select preliminary volume capture target. For purposes of designing and implementing ENTS in the 008 and 009 watersheds, the Panel also set a preliminary volume capture target of 90%[4] for design storm selection and ENTS sizing. Given the nature of the site, this target was initially selected by the Panel on the basis of their desire for the design storm to be ambitious relative to the following examples of guidance, which generally recommend 80-85% volume capture as a basis for BMP design:

- standard urban runoff sizing criteria (e.g., CASQA [2003] and ASCE [1998] Manuals)
- regional design storm guidance (e.g., Los Angeles County SUSMP [2002])
- the preliminary recommendation from the Design Storm Task Force for the Los Angeles Region (SCCWRP and Geosyntec, 2007)

The Panel considered the potential for designing larger ENTS to target greater capture, and the associated effects, such as (1) increased environmental impacts that are not acceptable, and (2) an environmental review and permitting period that may be longer than the implementation schedule allowed in the CDO (where final permit limits become effective on June 10, 2009). The Panel also recognized that it is typically more difficult to achieve a high percent capture and treatment of runoff in areas with significant open space since runoff in these kinds of watersheds does not occur as frequently as in areas with more imperviousness, particularly for the smaller, more frequent storm events. Finally, the Panel recognized that 90% capture and treatment is very conservative compared to most other BMP design efforts that they have been involved with in large watersheds.

The Panel's preliminary target was partially based on the concept of "the point of diminishing returns." This concept means that there is a range at which increased ENTS sizes provide only minimal additional treatment benefit. This was directly coupled with the potential downside that

[4] The percent runoff volume capture estimates reported in this memo are based on modeling of individual ENTS (i.e., capture of runoff from the ENTS drainage area only), NOT on cumulative percent capture for multiple ENTS for an entire watershed. In the case of the Outfall 009, there are some areas of the watershed that will not receive ENTS treatment (due to ENTS implementation feasibility constraints) therefore total percent capture for the watershed will be less than the volume-weighted average of all the individual ENTS percent capture values.

increasing the design storm size could result in increased environmental impacts due to the larger treatment system footprints. This concept can be demonstrated by a chart of modeled percent runoff capture versus ENTS size. **Figure 1a** shows the facility size (in terms of 24-hour design storm depth) versus percent capture for an example “treatment train” ENTS (i.e., a detention basin followed by a bioretention filter). This example ENTS is referred to as TT5, which is located at the lower parking lot near the administrative buildings near the SSFL entrance at the eastern side of the Outfall 009 watershed. The TT5 drainage area is 41 acres and 35% imperviousness, most of which is “directly-connected”. Actual long-term runoff volume capture results will vary by ENTS type, location and drainage area characteristics. However, this example of a percent runoff capture curve demonstrates the design storm size range at which additional sizing does not significantly increase the percent capture. For example, by increasing the size of the facility from 2.5 inches (i.e., the 1-year 24-hour return interval event) to 3.1 inches (i.e., the 2-year 24-hour event, or a 20 percent increase in design storm size) the percent capture would only increase from 90 to 96 percent. Stated another way, this is a roughly 1 to 3 ratio of percentage benefit to percentage increase in design storm size (and accompanying footprint impacts).

Figure 1b shows the facility size (in terms of 24-hour design storm depth) versus percent capture for another example treatment train ENTS, TT7. TT7 is located at Outfall 008. The TT7 drainage area is 62 acres and 100% open space (the imperviousness, which is entirely disconnected, is just 12% and due only to exposed bedrock and dirt roads). Consistent with what was mentioned previously, Figure 1b demonstrates that high percent runoff capture is more difficult to achieve for drainage areas (like the Outfall 008 watershed) that are primarily undeveloped, or with little impervious area, than for areas that have significant, connected impervious area (like the TT5 drainage area in the Outfall 009 watershed). This can be understood if we think of a small rainfall event, such as 0.5 inch in 24 hours. In developed portions of the 009 watershed, with considerable impervious area, this rainfall will generate runoff that the ENTS can capture, store and treat, thus contributing to a relatively high percent runoff capture on Figure 1a. By contrast, in the Outfall 008 watershed, with little impervious area, rainfall and runoff from the 0.5 inch, 24-storm is stored in surface depressions, evapotranspired, infiltrated and otherwise “lost” rather than producing surface discharge at the outlet. Thus, an ENTS at Outfall 008 (Figure 1b) that is sized to capture and treat runoff from smaller rain events gets little “credit” for long-term runoff capture (an analysis that includes many small storms and fewer large storms, based on the period of record for the local rain gauge that is used) because the larger rain events produce a greater fraction of the long-term cumulative runoff volume. From the standpoint of managing storm flows prior to off-site discharge, the key point to recognize with Figure 1b is that the *combination* of on-site losses and ENTS capture/treatment is what provides a high level of runoff control.

Regarding the “point of diminishing returns” concept, while *rainfall depth* only increases by 20% between the 1-year and 2-year design storm events along the x-axis of Figure 1b, *runoff volume* for each design storm event does increase much more rapidly. For instance, at TT7, while 0.8 acre-feet of basin storage volume is needed to capture and treat 100% of runoff from the 2.5 inch 1-year design storm event, 2.2 acre-feet of basin storage volume is needed to capture and treat 100% of runoff from the 3.1 inch 2-year design storm event. Therefore, to increase from 65% to 85% runoff capture (a 31% increase), the required basin storage volume must increase from 0.8 to 2.2 acre-feet, or a 175% increase. In this case, this is roughly a 1 to 6 ratio of percentage benefit to percentage increase in required basin storage volume.

Therefore, based on this information, the Panel agreed that the 1-year 24-hour event was appropriate and sufficiently conservative for the site-specific design storm for use in the NPDES permit based on the factors that they considered as stated above.

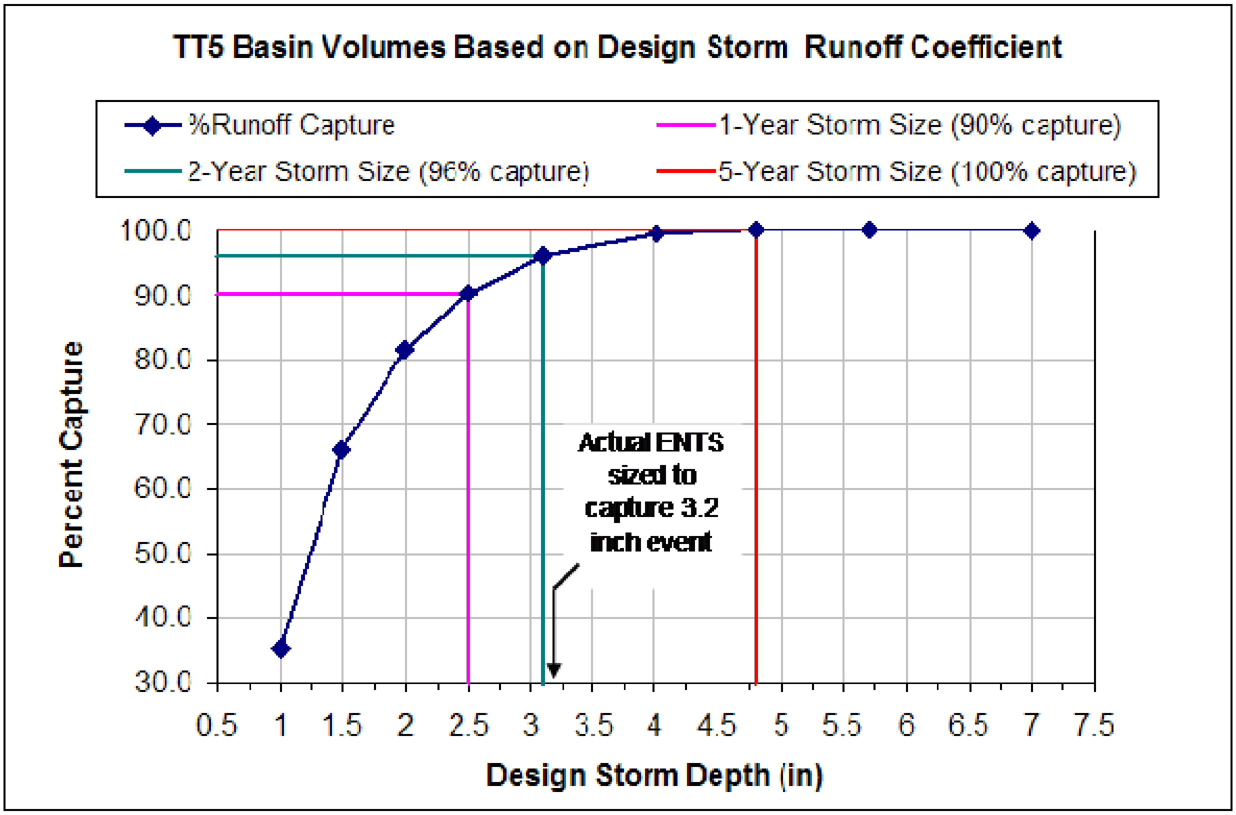

Figure 1a. Percent average volume capture vs 24-hour design storm depth[5] for an example treatment train (i.e., a detention basin followed by a bioretention filter), or TT5, which is located at the lower parking lot in the Outfall 009 watershed (note that actual TT5 design is maximized based on available area and environmental considerations)

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[5] It should be noted that, for the purpose of these conceptual percent capture charts (Figures 1a and 1b), percent runoff volume capture (y-axis) was determined through *long-term continuous SWMM modeling*, however the example detention basin sizes for each design storm depth (x-axis) were estimated using the rational method (to estimate runoff volumes, which were used for basin sizing) with event-based runoff coefficients that were derived through *event-based simulations* using SWMM. For each event simulation, the antecedent soil moisture condition was assumed to be equal to field capacity (i.e., as if a recent storm had previously occurred, but soils no longer fully saturated). This assumption is consistent with Los Angeles County Department of Public Works' (LACDPW) Modrat methodology as described in the 2006 LACDPW Hydrology Manual. Similarly, the event simulations assumed LACDPW's 24-hour hyetograph or rainfall distribution.

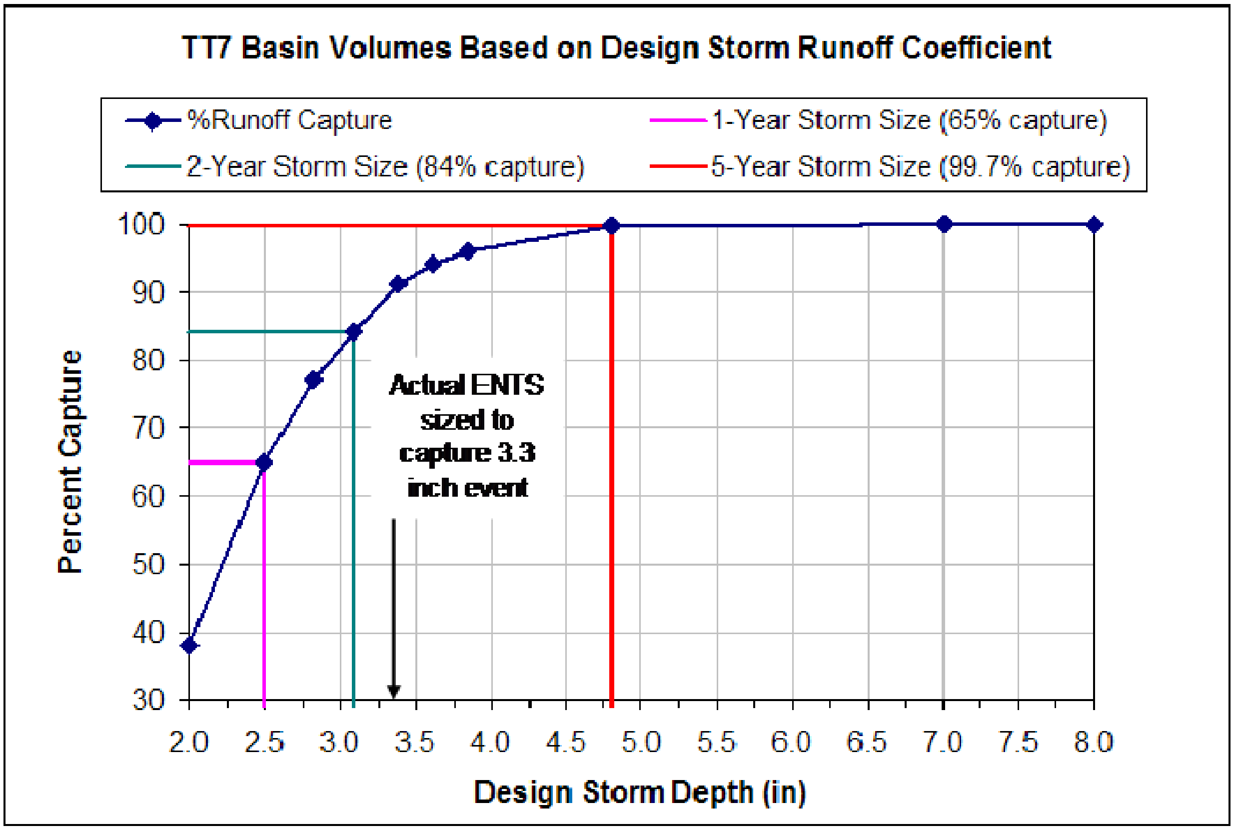


Figure 1b. Percent average volume capture vs 24-hour design storm depth for an example treatment train, or TT7, which is located at Outfall 008 (note that actual TT7 design is maximized based on available area and environmental considerations)

Select design storm recurrence interval. Based on long-term continuous hydrologic modeling of hypothetical ENTS implementation scenarios using data from a local rain gauge (adjusted for site-specific and elevation effects), it was found that 65-90% capture occurred at approximately the 1-year storm recurrence interval storm event (2.5 inches over a 24-hour duration). Furthermore, it was noted that 95% of daily rainfall totals that exceeded 0.1 inches were at or below this depth.

Finalize design storm on the basis of ENTS concepts. The Expert Panel's preliminary site-specific design storm recommendation became final after the initial ENTS concepts – which were initially sited and sized based on maximizing the number, areas, and volumes of ENTS within the 008 and 009 watersheds, as feasible – were initially designed and modeled to assess the actual volume capture for these more realistic ENTS implementation scenarios. It was determined that the long-term average runoff capture for each of the proposed conceptual designs was near or above 90% (i.e., each ENTS was actually sized to greater than the 2-year 24-

hour event). Therefore, given these results, in addition to site-specific feasibility, environmental impact, protectiveness, and other considerations, the Panel's 1-year preliminary site-specific design storm recommendation became final. A summary of the volume capture estimates for each of the final conceptual ENTS designs is included in **Table 1**. For more information on runoff capture calculations, the long-term precipitation data used for the analysis, or the continuous hydrologic modeling approach that was developed and implemented for the project, details are provide below. For additional information, the reader is referred to the ENTS hydrology and water quality CEQA technical reports (Geosyntec, 2008a, 2008b). Appendix B to the ENTS hydrology report is a section that is dedicated exclusively to the set-up and calibration of the continuous SWMM model. For more information on the ENTS sizing and design iteration process, see the Expert Panel's July 3, 2008 ENTS alternatives white paper (Expert Panel, 2008). This report is posted at Boeing's ENTS project website:

http://www.boeing.com/aboutus/environment/santa_susana/ents/index.html

Table 1: Hydrologic Effectiveness of the Proposed ENTS[6] – Runoff Volume Capture Summary

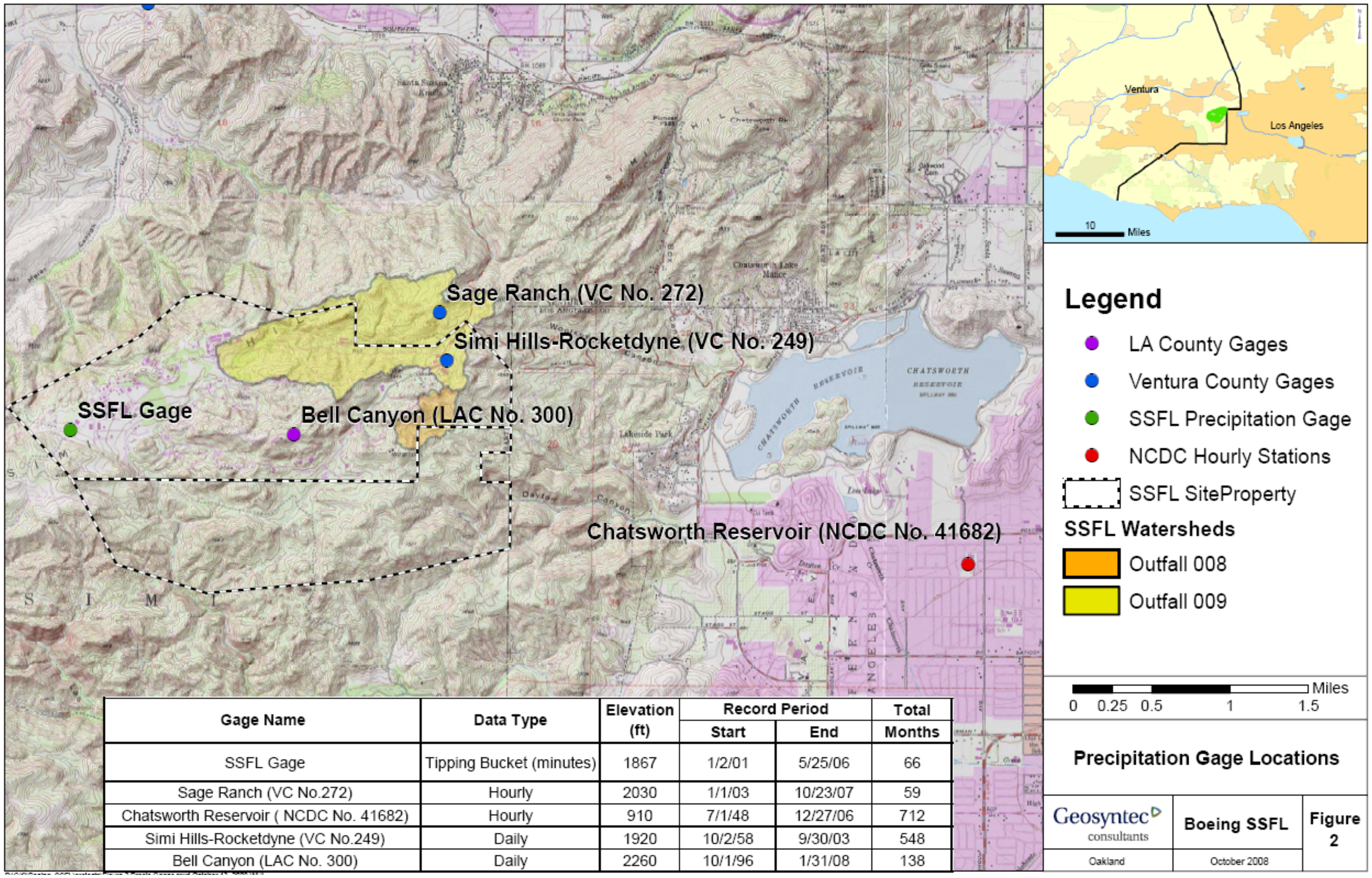
ENTS ID	ENTS Type	Location	Percent Capture for 1 Year Design Storm	Long Term Percent Capture
TT1	Treatment Train	Fire Station	100	92
TT2	Treatment Train	Helipad	100	91
TT3	Treatment Train	LOX	100	88
TT4	Treatment Train	Area 1 landfill	100	96
TT5	Treatment Train	Lower Parking Lot	100	90
TT6	Treatment Train	Sage Ranch Trail Head	100	97
TT7	Treatment Train	Outfall 008	100	90
BIO1	Bioretention	Ashpile	100	99
BIO2	Bioswale	Ashpile	100	99.7
BIO3	Bioretention	Roadway ENT	100	99.5
BIO4	Bioswale	Area 2 Landfill	100	94
BIO5	Bioswale	Area 2 Landfill	100	92
BIO6	Bioretention	Roadway ENT	100	94
BIO7	Bioretention	Roadway ENT	100	94

[6] Implementation of each ENTS is subject to landowner approval.

PRECIPITATION DATA AND ANALYSIS BEHIND DESIGN STORM RECOMMENDATION

As described above, to calculate percent runoff volume capture, continuous long-term hydrologic modeling of ENTS implementation scenarios is required. The following steps describe the precipitation data and analysis that serve as the basis for the Panel's design storm recommendation and modeling analysis approach.

1. A long-term precipitation record was required to perform the necessary continuous hydrologic modeling to compute long-term runoff volume capture, the results of which are presented and discussed throughout this technical memorandum. The Ventura County Watershed Protection District's Chatsworth gage was selected as the most appropriate dataset to use for long-term simulation due to its long period of record (58 years) and 1-hour measurement interval (necessary for ENTS performance modeling). Other nearby or on-site gages had either daily records (shorter time steps are necessary for continuous modeling) or much shorter record lengths. A map showing the location of the Chatsworth gage and other nearby rain gages that were considered is shown in **Figure 2**. This figure includes information on the period of record and measurement interval for each gage shown.



Gage Name	Data Type	Elevation (ft)	Record Period		Total
			Start	End	Months
SSFL Gage	Tipping Bucket (minutes)	1867	1/2/01	5/25/06	66
Sage Ranch (VC No.272)	Hourly	2030	1/1/03	10/23/07	59
Chatsworth Reservoir (NCDC No. 41682)	Hourly	910	7/1/48	12/27/06	712
Simi Hills-Rocketdyne (VC No.249)	Daily	1920	10/2/58	9/30/03	548
Bell Canyon (LAC No. 300)	Daily	2260	10/1/96	1/31/08	138

Figure 2. Map of local rain gauge locations and summary of data available for each

2. To adjust for site-specific meteorologic factors such as elevation and location that varied between the Chatsworth gage and the site, a correlation was established between monthly rain totals for this gauge versus a local on-site rain gauge (data from this gauge couldn't be used for continuous simulation as it is a daily total precipitation gage only; other gages exist but their periods of record are too short. This correlation is shown in **Figure 3**. An adjustment factor of 1.2 was established based on this correlation, and this value was applied to all historic measurements for the long-term continuous hydrologic modeling. The adjusted gauge data were plotted versus recurrence interval to determine the 1 year 24-hour and 1-hour depths. These charts are shown in **Figures 4 and 5**, respectively. The Panel's site specific design storm recommendation was based on these results for the 1-year recurrence interval event – 2.5 inches for the 24-hour duration and 0.6 inches per hour for the hourly intensity.

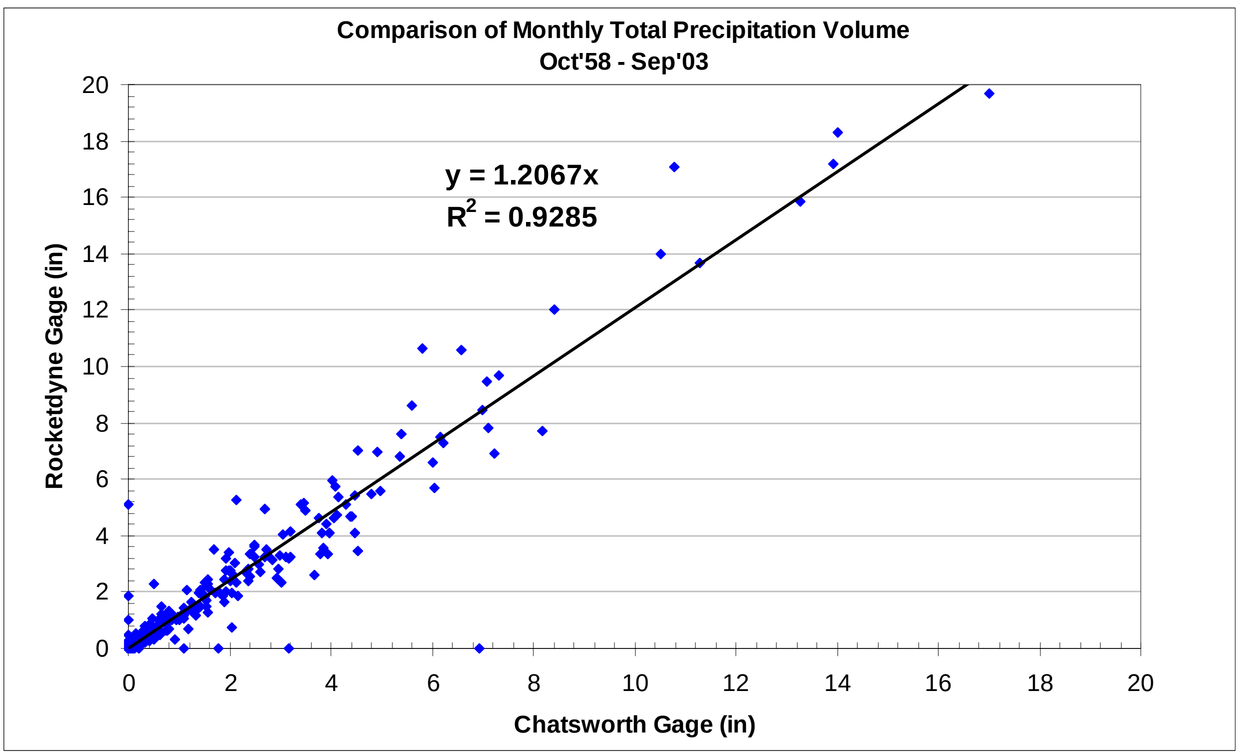


Figure 3. Correlation chart between Rocketdyne gauge (on-site & representative elevation but *daily* data available) and Chatsworth gauge (off-site & low elevation but *hourly* data available)

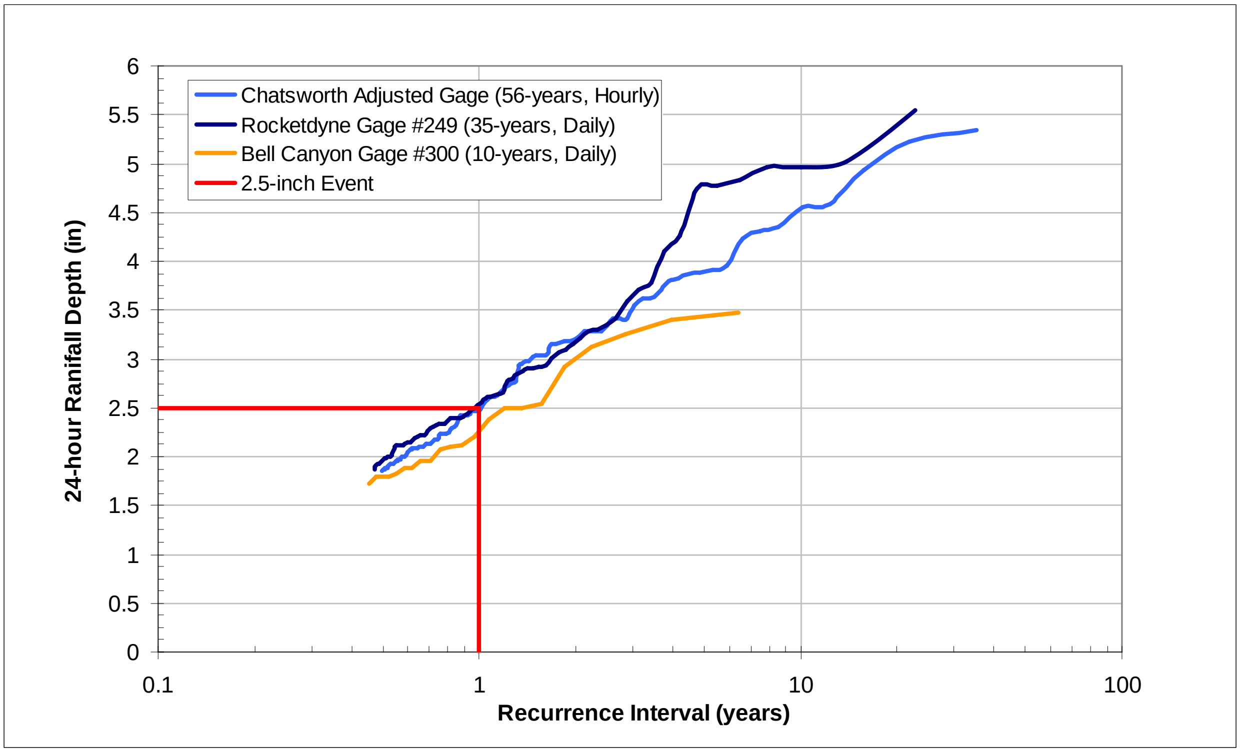


Figure 4. Chart comparing 24-hour rainfall depth recurrence intervals for three precipitation gages that were used in the derivation of 2.5 inch 24-hour depth for 1-year recurrence interval event

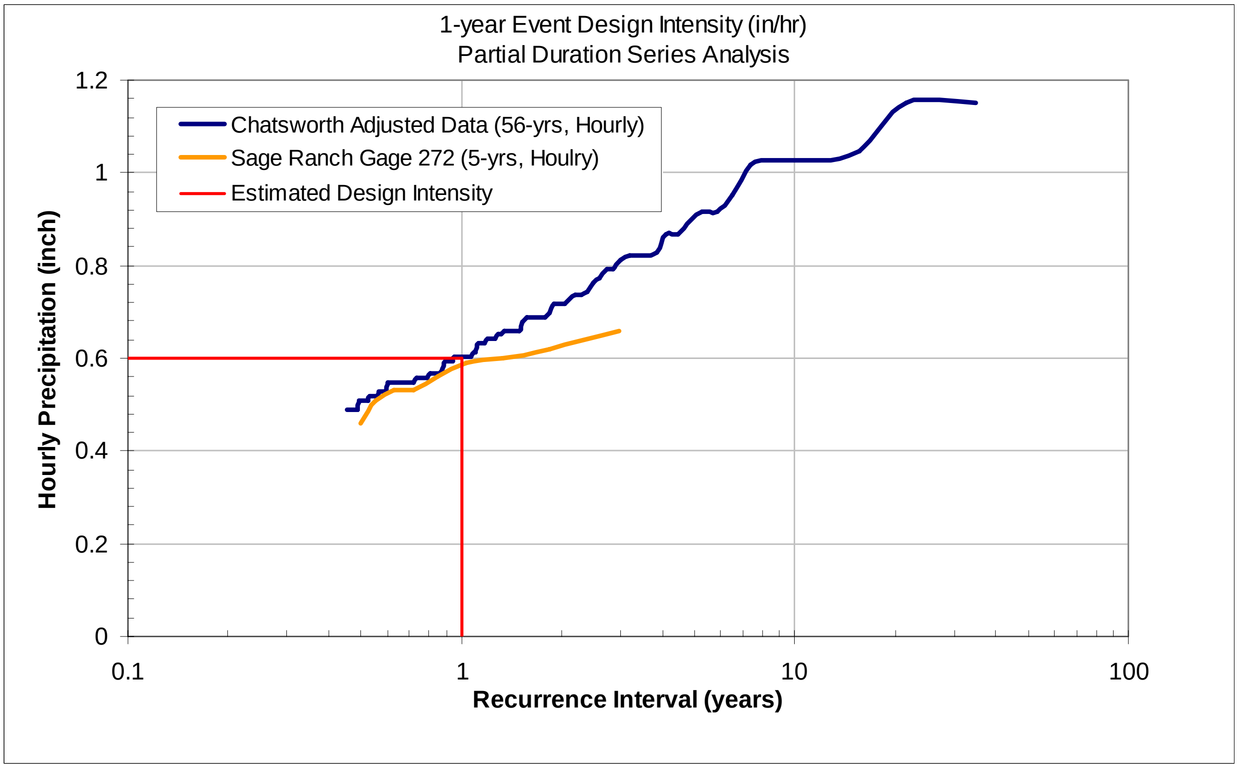


Figure 5. Chart comparing hourly precipitation vs. recurrence interval used in the derivation of 0.6 inch 1-hour depth for 1-year recurrence interval event (intensity)

3. The SWMM model was selected for use in modeling due to its ability to model hydrology and hydraulics of BMPs at the level of complexity required for the project. Modeled processes include precipitation, surface runoff, evapotranspiration, interflow (i.e., shallow subsurface lateral flow and diffuse discharge to drainages), deep recharge to groundwater, and surface/depression and subsurface (i.e., soil moisture content) storage. The reader is referred to the ENTS hydrology report (Geosyntec, 2008a), including Appendix B on SWMM model setup and calibration, and including input and output files and final input parameter values by subbasin. The model was initially set up for the pre-project, existing condition. The model was calibrated versus discharge measurements at Outfall 008 collected during the 2007/08 rain season, as this was the only continuous discharge measurement data available for either Outfall 008 or 009. No calibration data are available for Outfall 009. A chart of post-calibration model results versus measurements at Outfall 008 is included in **Figure 6**. The calibrated model was then set up for the post-project, proposed condition to evaluate ENTS percent runoff volume capture.

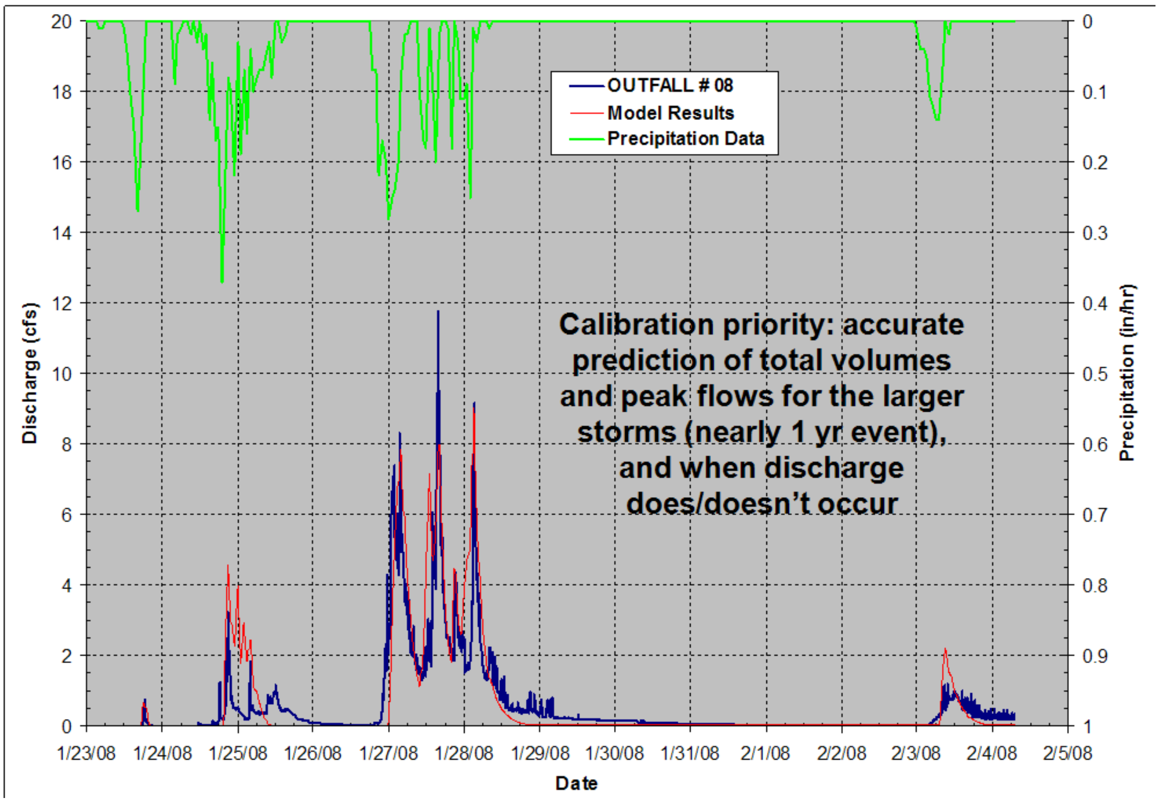


Figure 6. Comparison of SWMM model predictions vs measured flow at Outfall 008 for Jan/Feb 2008 (approx. 1 year 24-hour event occurred on 1-27-08)

DESIGN STORM ALTERNATIVES ANALYSIS

It should also be noted that as design storm depth increases, runoff volume (and therefore ENTS storage volume or size) increases at an even greater rate due to the increased fraction of runoff associated with larger storm events. To understand this relationship between design storm size and ENTS size, a sizing chart has been prepared. **Figure 7** compares the recommended site-specific design storm 24-hour depth versus other storm sizes and the resulting volume of treatment that would be required for a detention basin ENTS at Outfall 008. While 0.8 acre-feet of basin storage volume is needed to capture and treat 100% of runoff from the 2.5 inch 1-year design storm event, 2.2 acre-feet of basin storage volume is needed to capture and treat 100% of runoff from the 3.1 inch 2-year design storm event. Therefore, to increase from 65% to 85% runoff capture (a 31% increase, with percent capture values taken from Figure 1b), the required basin storage volume must increase from 0.8 to 2.2 acre-feet, or <u>a 175% increase in required</u>

basin storage volume. This is roughly a 1 to 6 ratio of percentage benefit (in terms of percent runoff capture) to percentage increase in required basin storage volume.

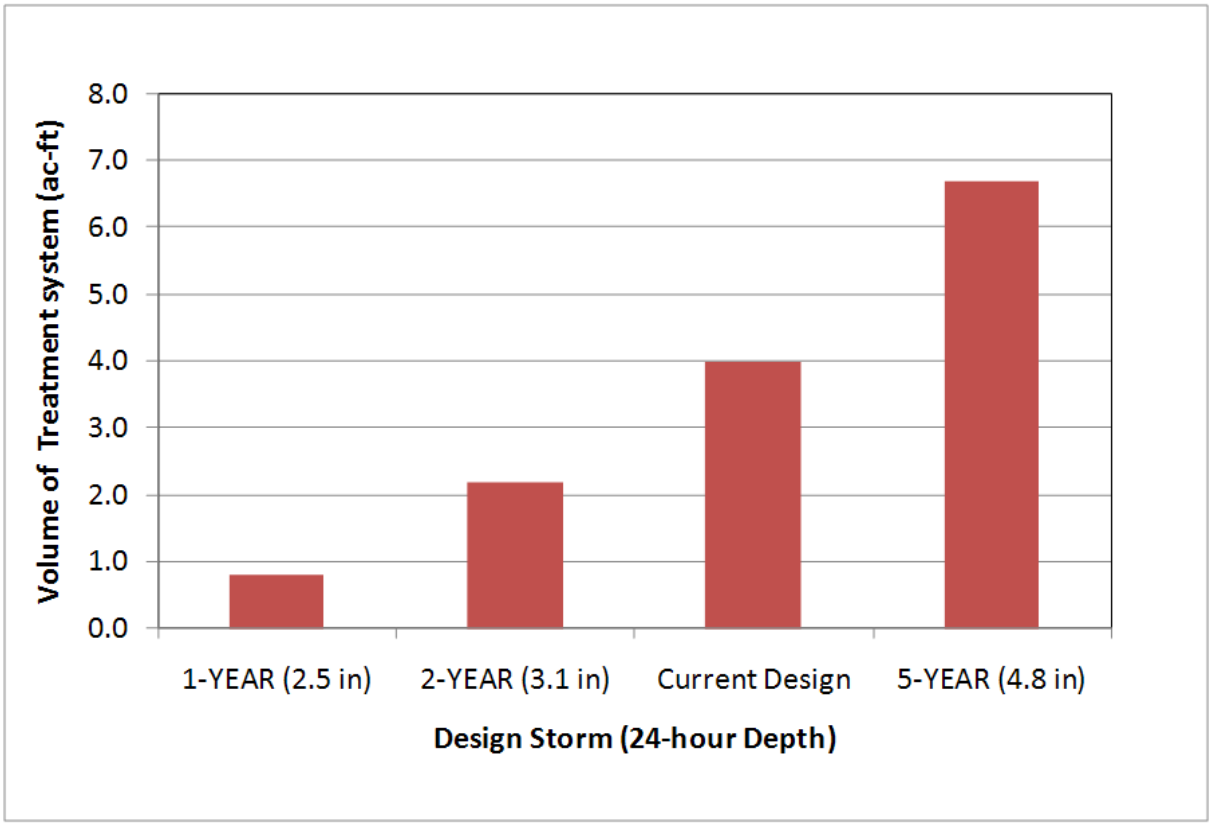


Figure 7. Minimum required storage volume[7] vs design storm size for a hypothetical detention basin at Outfall 008

Figure 8 demonstrates this concept graphically for the example of hypothetical in-line detention basins with dams located at Outfall 009 that are sized to capture the runoff volume from the 1-year and 5-year 24-hour events. It should be noted that these dam heights are based on water ponding depth necessary to meet the minimum storage volume required to fully capture runoff

[7] For the purpose of this conceptual chart, the minimum required basin storage volume for each design storm depth is determined through iterative SWMM modeling for each storm event, with the antecedent soil moisture condition assumed to be equal to field capacity (i.e., as if a recent storm had previously occurred, but soils no longer fully saturated). This assumption is consistent with the Modrat methodology as described in the 2006 Los Angeles County Department of Public Works' (LACDPW) Modrat methodology as described in the 2006 LACDPW

from these design storm events, and assume a drain time of 18 hours. Actual dam design would require geotechnical, grading, and other engineering design investigations that would likely result in larger dam heights. Therefore these dam heights should be considered minimum heights necessary to capture runoff from these events.

It should be noted that a detention basin (which allows for sedimentation as the primary pollutant removal mechanism) alone would be inadequate for achieving the final NPDES permit limits for stormwater discharges a Outfalls 008 and 009, therefore treatment trains have been proposed[8]. For the ENTS project in the 008 and 009 watersheds, the proposed treatment trains consist of detention basins followed by bioretention basins, or vegetated media filters that will provide filtration of stormwater, allowing for the removal of finer particles and dissolved constituents[9]. The bioretention basins will provide increased pollutant removal capacity but will result in a treatment train that is approximately double the footprint of a detention basin alone. So, at their current proposed size, the facilities are already quite large due to the combination of ENTS treatment components.

Two example treatment systems that were considered by the Panel as they developed their recommendation for the design storm include conceptual facilities at Outfall 009 and 008. At Outfall 009, the periodically-flooded area footprint for a hypothetical dam (with a mechanical water treatment system) would need to increase over three times to provide the necessary additional storage and treatment for the 5-year event versus the 1-year event. This would result in significant, but potentially still mitigable loss of native riparian and upland habitats and oak trees within the construction and/or ponded area footprints, as well as potential temporary and permanent but mitigable impacts to special-status plant and wildlife species. The estimated areas that would be periodically flooded are 0.57, 0.94, and 1.9 acres to provide storage necessary to contain runoff from the 1-, 2-, and 5-year design storm scenarios, respectively. The distance of

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Hydrology Manual. Similarly, the event simulations assumed LACDPW’s 24-hour hyetograph or rainfall distribution.

[8] In the case of the 009 watershed, due to its large size and engineering/construction constraints at the outfall, multiple distributed ENTS have been proposed throughout the watershed rather than a singular treatment system located at the outfall. Therefore, these analyses of treatment systems at Outfall 009 are hypothetical and for design storm comparison purposes only.

[9] A side consequence and potential environmental issue of these in-line treatment systems will be to dramatically reduce natural sediment loads from the watersheds. This issue was addressed in the hydromodification section of the ENTS hydrology report being submitted to Ventura County as part of the environmental documentation and assessment of impacts for the project. Mitigation measures, including long-term downstream channel cross-section monitoring and removal of instream berms after site cleanup in 2020, were proposed for this issue. Larger ENTS sizing could further increase the capture of sediments that could potentially make this issue more problematic.

the channel that would be periodically flooded would extend approximately 420, 520 and 700 feet for the 1-, 2-, and 5-year design storm scenarios. Due to its storage volume and dam height, the 5-year design storm scenario would result in the need to conduct a Department of Dam Safety review, which would in turn require an EIR to be completed. The estimated potential greenhouse gas emissions over a 10-year lifetime basis are 2,800, 6,800, and 22,500 tons of CO_2 for the three scenarios[10]. Given the above, it was determined that the 1-year scenario would be the preferred one of the three hypothetical examples. However, due to Regional Board and Panel direction to employ ENTS within the 008 and 009 watersheds, the potential geotechnical and other feasibility issues associated with this concept, and the uncertainty in permitting the project within the timeline specified in the CDO, this dam and treat option at Outfall 009 was not pursued.

For Outfall 008, the periodically-flooded area footprint for a treatment train ENTS would need to increase about 4 times to provide the necessary additional treatment for the 5-year event versus the 1-year event. This would result in significant, but potentially still mitigable temporary and permanent impacts to native riparian and upland habitats and oak trees within the construction and/or ponded area footprint, as well as potential temporary and permanent but mitigable impacts to special-status wildlife species. The estimated areas that would be periodically flooded are 0.19, 0.38, 0.52, and 0.80 acres to provide storage necessary to contain runoff from the 1-year, 2-year, 90 percent capture-based sizing (which is greater than the 2-year design storm), and 5-year design storm scenarios, respectively. The distance of the channel that would be periodically flooded would extend approximately 200, 280, 320, and 430 feet for these four sizing scenarios. None of the design storm scenarios would result in a Department of Dam Safety review due to the relatively small drainage area. The estimated potential greenhouse gas emissions over a 10-year lifetime basis are 1,000, 1,200, 1,500, and 1,700 tons of CO2 for these four sizing scenarios. Given the above, it was estimated that the 1-year, 2-year, and proposed 90 percent capture-based sizing scenarios could be implemented within the timeline specified in the CDO. In this case a treatment train that is sized to the 5-year design storm may be possible as well, but with less assurance due to increased impacts.

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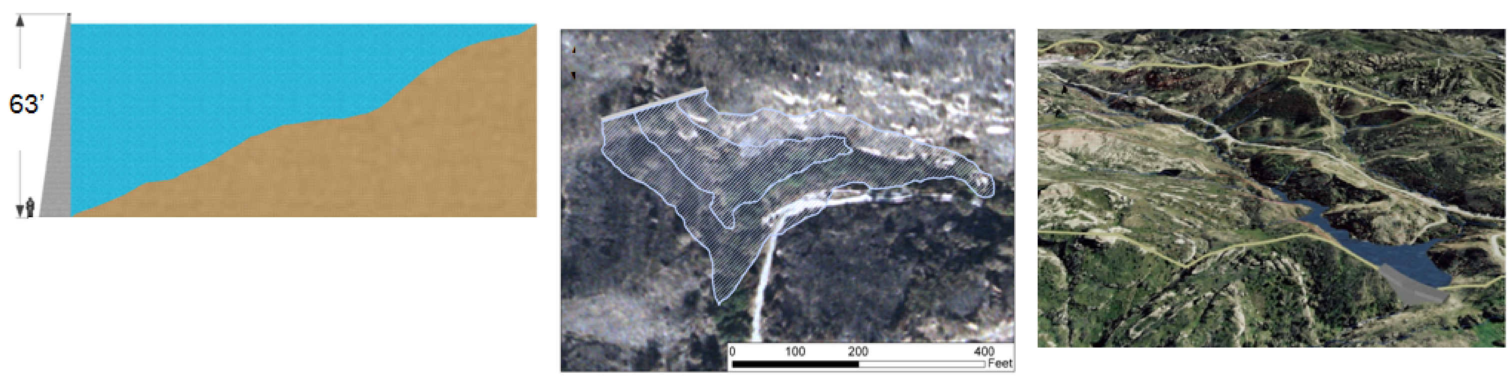
[10] CO2 calculations include emissions from construction equipment, trucks for transport of construction materials, estimated treatment systems power requirements (where applicable), and CO2 emissions generated during production of construction materials (by assuming 400 lbs CO2/CY concrete as the primary contributor). Emissions generated from fuel consumption in transportation and construction equipment was estimated on a per gallon of diesel and gasonline basis using numbers reported by the *SCAQMD Annual Emission Report 06-09*. Emissions generated from electricity use was calculated based based upon numbers reported in the Energy Information Administration's *California State Electrical Profile* (2006). Material transport volumes (which translate to truck trips) for the impoundment dam scenarios include the volume of the roller compacted concrete (RCC) dams plus general site grading for the water treatment plant/pump station complex. Material transport volumes for the ENTS design include disposal of excess cut soil and import of clean fill and aggregate.

SIZING BASIS: **1 YEAR EVENT**
5.5 AC-FT STORAGE, 30 FT DAM, 0.6 AC FLOODED AREA, 420 LINEAR FT RIPARIAN INUNDATION.

SIZING BASIS: **5 YEAR EVENT**
39 AC-FT STORAGE, 63 FT DAM, 1.9 AC FLOODED AREA, 700 LINEAR FT RIPARIAN INUNDATION



*** Inner Hatched Area represents 1 year event footprint.**

Figure 8. Conceptual rendering of dam height alternatives at Outfall 009

Finally, **Tables 2 and 3** are provided to summarize the peak flow and runoff volumes for various recurrence interval 24-hour storm events for both the pre- and post-project conditions (respectively) for Outfalls 008 and 009. This information is also summarized in the ENTS hydrology report (Geosyntec, 2008a). Note that runoff volumes are slightly reduced due to increased evapotranspiration in the ENTS, the reduction in paved areas (asphalt removal projects), and infiltration where it was deemed allowable – such as at the culvert maintenance locations and Outfall 008 – where it is deemed protective of groundwater quality and unlikely to impact existing contaminated groundwater plumes. These tables demonstrate that the ENTS will achieve a significant reduction in peak flow rates and that peak flows and runoff volumes increase dramatically by storm size.

Table 2. SWMM Peak Flow and Total Volume Results – Outfall 008

Recurrence Interval (yr)	Depth (in)	Pre-ENTS		Post-ENTS		Percentage Change
		Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)
1	2.5	5.6	**1.1**	1.5	1.1	-73%
2	3.1	14.6	**2.9**	2.5	2.8	-83%
5	4.8	39.4	**10.1**	19.5	10.1	-51%
10	5.7	52.4	14.8	43.9	14.8	-16%
25	7.0	69.9	21.4	67.9	21.4	-3%
50	8.0	83.3	26.4	81.2	26.4	-3%
100	9.0	97.0	31.4	94.8	31.4	-2%

Table 3. SWMM Peak Flow and Total Volume Results – Outfall 009

Recurrence Interval (yr)	Depth (in)	Pre-ENTS		Post-ENTS		Percentage Change
		Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)
1	2.5	36.8	**9.1**	10.6	8.2	-71%
2	3.1	81.0	**20.8**	24.9	19.5	-69%
5	4.8	230.0	**72.5**	125.9	70.5	-45%
10	5.7	322.8	107.6	260.9	105.2	-19%
25	7.0	448.3	159.1	380.4	156.2	-15%
50	8.0	540.9	198.5	470.8	195.0	-13%
100	9.0	633.9	237.8	585.9	234.6	-8%

CONCLUSION

The Panel's final recommendation for a site-specific design storm for implementation in the SSFL NPDES permit for stormwater discharges is the **1-year recurrence interval event** (i.e, a storm of this size is anticipated to occur once every year, on average, based on the period of record for a local representative rain gauge) based on the Panel's directed analyses and considerations summarized above. The 1-year storm corresponds to 2.5 inches for the 24-hour duration event or 0.6 inches for the 1-hour duration intensity. Specifically related to the Panel's scope to develop ENTS for the Outfall 008 and 009 watersheds, the Panel recommended that the ENTS facilities be sized as large as feasible (and in all cases, greater than the 1-year 24-hour event) – while considering other environmental impacts, schedule, and physical site constraints – with a minimum sizing criterion (or design basis) of 90% long-term runoff volume capture. The Panel also recommended ENTS facilities that provide treatment redundancy, or multiple treatment opportunities, through treatment trains (where unit processes operate in series) or through downstream ENTS that receive treated water from facilities further upstream in the watershed.

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