PURPOSE OF DESIGN GUIDELINES

These design guidelines are intended to provide information related to design of onsite infiltration systems in the East Shed of West Sacramento’s Bridge District. These guidelines are intended to be used by site developers and their consulting engineers to assist in understanding their onsite infiltration obligations, the design requirements for a typical onsite system and methods for analysis of non-typical systems. Specifically these guidelines are intended to provide the following:

- Introduction, summary of a prior study results and public infiltration system
- Infiltration obligations for individual parcels
- Design details for a typical onsite infiltration system
- Requirements for design of the system details beyond the typical details provided
- Methods for system performance verification

SECTION A – PRIOR STUDY RESULTS AND THE PUBLIC SYSTEM

A.1.1 - INTRODUCTION

The Bridge District is a redevelopment area in the City of West Sacramento located west of the Sacramento River, south of Tower Bridge Gateway, and generally north of US Highway 50 (US 50). The District was originally primarily an industrial area and is in the process of redevelopment to a residential and commercial area. The initial redevelopment efforts focused on a portion of the District and were guided by drainage plans prepared by Wood Rodgers in 2009. The existing trunk drainage system serving the District was generally constructed prior to 1970 and was not adequate for conveyance of current design storm flows. It was recognized that the soil in the District generally had a high infiltration rate and subsurface infiltration was introduced as a method to provide both flood control and water quality treatment. Exhibit A shows the location map of the watersheds in the project area and minor watershed (or parcel shed) boundaries for the East Shed, under post-project conditions.

A.1.2 - SUMMARY OF PRIOR STUDIES AND THE PUBLIC INFILTRATION SYSTEM

Wood Rodgers developed draft Drainage Technical Memoranda No. 1-5 (dated April 2, 2009; May 8, 2009; June 5, 2009; July 10, 2009; and August 12, 2009, respectively) defining the
existing runoff conditions, as well as outlining alternatives for detaining and discharging runoff to the existing City channel or to the Sacramento River. Technical Memorandum No. 6 (TM 6), dated January 12, 2010, describes the development and implementation of a subsurface infiltration system for the East Shed. Refer to Exhibit A for the location of the East Shed. While the studies for the area include the East Shed, West Shed and South Shed, only the East shed has been identified at this time as a candidate for use of infiltration. Detailed future studies of the West Shed and the South Shed will be required to determine what mitigation, if any, is required for these areas.

The maximum 100-year flow from the combined East and South Sheds under pre-project conditions at Jefferson Boulevard is approximately 60 cfs which is roughly equivalent to the capacity of the downstream existing drainage system. This was identified as a critical flow rate and mitigation was required to maintain it. Although much of the site was rendered impervious by industrial enterprises, utilizing the infiltration capacity of the underlying soils was considered achievable and desirable. Based on geotechnical field testing, it was recommended that an infiltration rate of three inches per hour can be used for design purposes.

Infiltration beds beneath the sidewalk areas within the public right-of-way were selected as the preferred method to provide mitigation of flows and water quality treatment. Wood Rodgers laid out the catchment area utilizing the street and the parcel layout currently planned for the project area. The location of the sidewalk infiltration beds and the subshed areas served by each bed is shown in Exhibit B. As an example, sub shed 700B has a drainage shed area of 1.8 acres and a gross sidewalk frontage area of 0.154 acres. The sidewalk area includes such things as tree wells and utility boxes which are subtracted from the gross sidewalk area to yield a net sidewalk infiltration area of 0.136 acres.

The sidewalk infiltration system generally consists of a crushed drain rock section, with an internal manifold system to evenly distribute the storm drainage runoff. The manifold is connected to street drainage inlets and provides stubs to parcels for future connection. The sidewalk infiltration system is capable of handling the majority of runoff volume for both 100-year and 200-year storms from the majority of the East Shed. A relief drainage system has been included to serve areas not suitable for infiltration drainage and to provide for capacity in excess of the infiltration system’s capacity. Weir structures have been included in the infiltration system design to allow overflow to the relief drainage system in the event of a failure of an individual infiltration bed or a storm event that exceeds the capacity of the infiltration system. A primary separation system has been constructed to remove debris and sediments from the runoff prior to entering the infiltration beds. Details of typical infiltration beds within the sidewalk area are shown in Exhibit C-1 and Exhibit C-2.

While the sidewalk infiltration areas identified in TM 6 and shown in Exhibit B provide the majority of the infiltration required, there are subsheds in the East Shed with inadequate
sidewalk area along their street frontage to provide infiltration. These subsheds require an onsite infiltration area, which in combination with the sidewalk infiltration area provide adequate infiltration. These additional onsite infiltration areas are identified on Exhibit B. As an example, subshed 700B requires an additional onsite infiltration area of 1500 square feet. The size of the onsite infiltration area specified assumes on an onsite system design identical to the sidewalk infiltration system.

Three areas were identified within the East Shed that would not be served by infiltration and are shown on Exhibit B. The first two areas are the sewer lift station site adjacent to US 50 and the US 50 off ramp. Infiltration is not an option for these subsheds and they will drain directly to the relief conveyance system. The third area is a groundwater clean up area near the intersection of State and Central Streets. At the time the studies were prepared groundwater clean up was underway and infiltration was not advisable so the relief conveyance system was sized to accommodate unmitigated runoff from this area. In the future it is anticipated groundwater clean up will be complete and infiltration may become a requirement in this area. Because infiltration is not provided for this area onsite water quality treatment will be required for development.

The groundwater beneath the project site is variable and heavily influenced by the adjacent Sacramento River and high groundwater levels have potential to affect the performance of the infiltration system. However, from a study using data from two rain gauges near the project area (Woodland and Sacramento) and a stream elevation gauge upstream of the project, Wood Rodgers concluded that the high river levels and peak storm events are relatively non-coincident with, and independent of, each other. While there is risk that the two events could occur concurrently and result in diminished infiltration rates, the risk was considered low.

A.1.3 - SUMMARY OF WEST SHED AND SOUTH SHED

The West Shed and South Shed are not planned at this time to include infiltration and are not subject to these design guidelines but these sheds were included in the studies prepared for the Bridge District and are summarized here for information only. Both sheds are shown in Exhibit A.

In the Draft Drainage Technical Memorandum No. 3 (TM 3), dated June 5, 2009, Wood Rodgers evaluated the existing drainage and unmitigated proposed development conditions for the West Shed. The level of existing development within the West Shed is much closer to build-out than is the East Shed, and the increment of new (proposed) development is smaller; however, there are increases in localized flooding that occur under ultimate conditions for the West Shed, as described in TM 3. No solution for mitigation of this development in the West Shed was determined in TM 3. It is possible that, with further testing of the soil, infiltration may be a consideration; however, it is unknown at this time if permeable and unsaturated soils exist at the levels found in the East Shed. There is currently very little hydraulic interconnection between
the East and West Sheds, so a separate analysis can be performed in the future to determine a mitigation strategy and if infiltration is a solution.

The South Shed will continue to drain to the California Department of Transportation (Caltrans) drainage facilities. The level of imperviousness in the South Shed does not change significantly due to the heavy imperviousness currently on the site. This area south of US 0 is currently proposed to drain as it does today to the Caltrans right-of-way facilities. Onsite infiltration or other forms of mitigation are planned to supplement this drainage condition to improve attenuation and further reduce impacts to the existing Caltrans and downstream existing drainage facilities in Jefferson Boulevard.

A.1.4 - SUMMARY OF HYDROLOGIC AND HYDRAULIC MODELING

To fully evaluate the effectiveness of infiltration, detailed hydrologic and hydraulic calculations were required and were included with TM 6. As each area has the potential of draining uniquely, and given that the amount of direct tributary area and the amount of immediately available infiltrative area must correlate, the catchment areas were further refined utilizing the street and parcel layout currently planned for the project area. This included a shed breakdown of areas considered tributary to each street and sidewalk segment. The hydrologic calculations utilized Sacramento County hydrology standards (adopted by the City of West Sacramento) using a 100-year, 24-hour storm distribution to determine if peak and volume conditions could be met with infiltration facilities.

Geotechnical testing resulted in a recommended unit rate for infiltration of three inches per hour. The downstream portion of the East Shed, characterized as the “500 series” in the sub-shed labeling, has not been tested for infiltrative parameters, and a rate of 1.5-inches per hour was assumed in this area. At the time this area is developed testing should be done to determine an appropriate infiltration rate.

The XPSWMM model surrogates the infiltration areas as pumps and the capacity of the pump is taken as the flow rate through these areas. The maximum allowable storage depth of the infiltration beds is 24-inches although the average depth of the crushed rock section is 30-inches. A crushed rock void ratio of 40 percent is based on typical specifications for crushed rock. From a run of XPSWMM model, it was found that additional onsite storage area is necessary in those areas where the 24-inch storage depth was exceeded. These additional onsite storage areas needed are shown in Exhibit B. The drainage pipe system in the public right-of-way acts as a relief system and is designed to convey flows not accommodated by the infiltration system and also provides a back-up in the event of a failure of an individual infiltration bed.

Utilizing the infiltration rate of three inches per hour, the sidewalk infiltration design shown in Exhibit C-1 and Exhibit C-2 and the additional onsite infiltration shown in Exhibit B, the
XPSWMM modeling found the system recovered completely within approximately three hours from the end of the storm.

A.1.5 - INTERIM INFILTRATION BASINS

The first phase of infrastructure construction consists of a major portion of the roadway infrastructure, with full parcel development draining to the roadways coming at a later date. Interim infiltration basins were constructed on site to capture runoff before reaching the sidewalk infiltration system. These basins and the modeling results supporting their sizing are shown in Exhibit D. The interim infiltration basins are intended to attenuate flow, trap debris and generally keep the sidewalk infiltration system in good condition until development occurs. At the time of the site development the interim infiltration basins will be filled and site drainage will go to the sidewalk infiltration system.

SECTION B – ONSITE INFILTRATION OBLIGATIONS

B.1.1 – ONSITE INFILTRATION OBLIGATIONS

Onsite infiltration obligations consist of two components. The first onsite infiltration component is referred to as “additional onsite infiltration” and is a component for parcels that don’t have adequate sidewalk infiltration. For these parcels the additional onsite infiltration is required to meet the mitigation requirements of the individual subshed. The additional onsite obligations are shown on Exhibit B. The second onsite infiltration component is referred to as “supplemental onsite infiltration”. The supplemental onsite infiltration component is 10% of the overall site infiltration requirement and is intended to provide a supplement to the mitigation requirements. Supplemental onsite infiltration may be reduced or eliminated in cases where the total parcel requirement (additional plus supplemental) exceeds 10%. In these cases the supplemental infiltration requirement may be reduced or eliminated such that the total parcel requirement does not exceed 10%. In no case shall the total parcel requirement be less than 10%. In no case may the additional onsite infiltration requirement be reduced or eliminated. Exhibit E shows in tabular format both the additional, supplemental and total onsite infiltration obligations for each of the parcels. As an example, subshed 730B requires an additional onsite infiltration area of 250 square feet and an adjusted supplemental onsite infiltration area of 150 square feet for a total onsite infiltration obligation of 400 square feet.
C.1.1 – ONSITE INFILTRATION DESIGN GUIDELINES

Onsite infiltration design shall be done in general conformance with the following guidelines. Several of the guidelines here are shown in the typical onsite infiltration plan in Exhibit F-1 and Exhibit F-2.

- Infiltration systems sizing shall be consistent with the onsite obligations shown in Exhibit E.
- Square footage obligations shown in Exhibit E are applicable to systems designed with parameters similar to those of the sidewalk infiltration system including storage volume, design infiltration rate, distribution capability, connection to a relief system.
- Alternative infiltration system design may be considered but demonstration that the performance of the alternative design meets the obligation is required. Alternative designs and methods for demonstrating performance are covered in Section D.
- All systems shall require a double cylinder infiltration test performed by a registered geotechnical engineer to verify that the soils meet the design infiltration rate of 3 inches/hour. Design rates in excess of 3 inches/hour shall not be used even if soils tests yield results exceeding 3 inches/hour.
- Sites that have infiltration test results that are less than 3 inches/hour can either use a lower rate as recommended by a registered geotechnical engineer or can remove and replace soil below the infiltration bed to achieve a rate of 3 inches/hour. Removal and replacement shall extend to a minimum of 2 feet below the bottom of the infiltration bed and shall be performed in accordance with the recommendations of a registered geotechnical engineer.
- Infiltration bed subgrade shall be inspected by a registered geotechnical engineer prior to construction to ensure that is meets the design infiltration rate of 3 inches/hour. The geotechnical engineer shall provide a letter to the City confirming that the infiltration bed subgrade soils are consistent with those tested on site and found to meet the design rate. As an alternative, the geotechnical engineer may perform a double cylinder infiltration test on the subgrade soils to confirm they meet the design rate.
- The bottom slope of a subsurface infiltration bed shall have a cross slope that measures 1.5% or less to encourage uniform water distribution and infiltration.
- Protect the subsurface infiltration area from excessive compaction prior to installation that would reduce the infiltration rate. Infiltration beds should not be placed on recent fill or compacted fill.
• Each infiltration bed must be constructed with a means of capturing debris and sediment prior to entering the infiltration bed in order to prevent these materials from reaching the distribution manifold piping and eventually clogging the subsurface infiltrative aggregate layer and soils. Capture methods may be filters on inlets to catch debris and sumps on inlets to capture sediment and other particles that pass the inlet filter.

• The infiltration bed shall be wrapped in non-woven geotextile filter fabric as recommended by a registered geotechnical engineer.

• The subsurface infiltration bed should be comprised of a 30-inch section of clean crushed drain rock (ASTM No. 57) or other suitable material recommended by a registered geotechnical engineer. The bed material shall be uniformly graded, clean-washed, and contain at least 40 percent void space. Test data shall be provided to demonstrate the void ratio is satisfied. Void ratios of less than 40% shall be compensated for by increasing the size of the infiltration bed to maintain the required storage volume.

• Design shall include features that allow access to the manifold system at entry and exit points for cleaning and maintenance.

• The manifold system shall consist of perforated pipe with a minimum diameter of 8 inches that shall provide a minimum dispersal rate of 1.5 times the design infiltration rate. Pipes should lay flat along the bed bottom and provide for uniform distribution of water. A portion of the perforations shall be located on the bottom of the pipe to prevent ponding of water in the pipe. Perforations shall be distributed throughout the elevation profile of the pipe to allow flow to disperse at an increasing rate as water level rises.

• The outlet point from the infiltration bed shall be equipped with a structure with an elevated release point that allows the design storage volume of the infiltration bed to fill prior to release to the sidewalk infiltration system. The structure shall provide a subsurface release for the system in the event of a failure of the infiltration bed or a storm event that exceeds the infiltration capacity but will prevent water from passing through before the design storage volume has been filled. Exhibit F-2 includes typical sample details.

• Site development that includes only a portion of a subshed area is required to provide their portion of the onsite infiltration obligation. Partial subshed development shall be required to demonstrate that the remaining subshed can access the sidewalk infiltration system and accomplish the remaining onsite infiltration obligation.

• Site development is required to follow subshed boundaries outlined on Exhibit B. Site development that extends across subshed boundary lines is required to direct drainage to the sidewalk infiltration areas in a manner consistent with the subshed boundaries shown on Exhibit B.
• Site development drainage plans shall distribute drainage evenly to the stubs provided from the sidewalk infiltration manifold system. Stub locations are shown on Exhibit B and on the improvement plans for the Bridge District Phase 1 Infrastructure. Even distribution to the stubs provided is intended to evenly distribute flows to the sidewalk infiltration bed and not concentrate flows into one portion of the bed.

• Onsite drainage system hydraulic grade lines shall be based on the elevation of the release from the sidewalk infiltration system to the relief drainage system. Elevations of these release points can be found in the details of the infiltration system on the plans for the Bridge District Phase 1 Infrastructure.

• Onsite drainage design shall direct an appropriate portion of the watershed to the onsite infiltration basin. The following example for subshed 700B demonstrates the appropriate portion to be directed to the onsite infiltration bed.

| Sidewalk infiltration area | = 5916 sf |
| Additional onsite infiltration | = 1500 sf |
| Supplemental onsite infiltration | = 0 sf |
| Total infiltration | = 7416 sf |

| Onsite portion of Infiltration | = 1500 sf |
| = 20% of infiltration |

| Total 700B water shed area | = 1.83 acres |
| Onsite portion of watershed directed to onsite infiltration area | = 0.37 acres |
| = 20% of watershed |

SECTION D – INFILTRATION SYSTEM PERFORMANCE VERIFICATION

D.1.1 – INFILTRATION SYSTEM PERFORMANCE

All onsite infiltration systems designs are required to be supported by analysis that demonstrates infiltration capacity and performance are consistent with the onsite obligation shown in Exhibit E. System designs that are consistent with the master planning and the typical system design shown in Exhibit F-1 and Exhibit F-2 can easily be shown and verified to be in compliance. Alternative onsite infiltration designs can be used but they must be in general compliance with the design Guidelines in Section C and must also be supported by analysis that demonstrates they provide infiltration capacity consistent with the onsite obligation shown in Exhibit E. This section divides infiltration systems into 4 types and discusses methods for
demonstrating compliance and provides additional development guidelines as needed. The purpose of this section is to simplify the methods for demonstrating and verifying compliance where possible.

Shed areas with infiltration obligations in excess of 3,000 sf are restricted to either Method 1 or Method 4. This restriction is in place for two reasons: (1) Larger shed areas generally include additional infiltration areas which are critical to the performance of the overall system and (2) Methods 2 and 3 include approximations to simplify calculation of requirements that are not appropriate for use in determining the size of the larger additional infiltration areas. This restriction applies to shed areas 130, 132, 140, 160, 162, 180B and 640B.

**D.1.2 – METHOD 1 - SYSTEMS CONSISTENT WITH TYPICAL DESIGN**

Onsite infiltration systems consistent with the infiltration obligations in Exhibit B and Exhibit E and consistent with typical design details shown in Exhibit F-1 and Exhibit F-2 can easily be demonstrated to provide adequate performance and capacity by meeting the following criteria.

- Demonstrates that soils are suitable for infiltration and meet design infiltration rate of three inches per hour.
- Provide an infiltration square footage area consistent with area shown in the master planning.
- Provide a system utilizing details generally consistent with the typical details in Exhibit F-1 and Exhibit F-2 including a 30-inch thick infiltration bed section with a 40% void ratio, perforated manifold pipe and adequate access and outlet features.
- Provide connection points to the sidewalk infiltration system consistent with the shed boundaries in the master planning and consistent with the goal of even distribution flows.
- Demonstrate that onsite infiltration and sidewalk infiltration system connections can be provided to any undeveloped remainder of the shed. In the case of parcels with existing street frontage service via existing pipe stubs shall be demonstrated.
- Generally comply with the design guidelines of Section C.

**D.1.3 – METHOD 2 - SYSTEMS CONSISTENT WITH TYPICAL DESIGN BUT WITH VARIANCE IN STORAGE AND INFILTRATION COMPONENTS**

Due to site development constraints, some system designs may utilize the typical design details shown in Exhibit F-1 and Exhibit F-2 but will vary the vertical and horizontal dimensions of the bed. An example of this would be a system with reduced infiltration bed square footage but with a deeper infiltration bed. This system would have a larger storage volume and a smaller infiltration area but could still provide the same performance as the system shown in the master planning. Generally, if the infiltration area is decreased the storage needs to be increased to
compensate and maintain the required performance level. The inverse is also true – if the storage volume is decreased the infiltration area must be increased to maintain performance. Onsite infiltration systems that utilize the typical design details shown in Exhibit F-1 and Exhibit F-2 but vary the infiltration and storage components can be demonstrated to provide adequate performance by meeting the following criteria.

- Demonstrates that soils are suitable for infiltration and meet design infiltration rate of three inches per hour.
- Provide horizontal and vertical bed dimensions that can be shown on Exhibit G to provide the equivalent performance level as the infiltration bed described in the master plan. See Sample Problem #1 in Section E for an example.
- Provide a system utilizing details generally consistent with the typical details in Exhibit F-1 and Exhibit F-2 including an infiltration bed section with a 40% void ratio, perforated manifold pipe and adequate access and outlet features.
- Provide connection points to the sidewalk infiltration system consistent with the shed boundaries in the master planning and consistent with the goal of even distribution flows.
- Demonstrate that onsite infiltration and sidewalk infiltration system connections can be provided to any undeveloped remainder of the shed.
- Generally comply with the design guidelines of Section C.

D.1.4 – METHOD 3 - SYSTEMS NOT CONSISTENT WITH TYPICAL DESIGN OR MASTER PLANNING

Due to site development constraints, some system designs may not utilize the typical design details shown in Exhibit F-1 and Exhibit F-2 and may not be consistent with the infiltration area shown in Exhibit B and Exhibit E. These systems would generally be considered to be alternative designs and would be subject to review by the City or a by consultant selected by the City. These systems must be demonstrated to meet the following criteria to the satisfaction of the City Engineer.

- Demonstrates that soils are suitable for infiltration and meet design infiltration rate of three inches per hour.
- Demonstrate the system serves the portion of the subshed area intended in the master planning.
- Demonstrate the system meets the minimum performance level of the infiltration system described in the master planning. Depending on the system design, this may be done through the infiltration and storage rates on Exhibit H-1 and Exhibit H-2. See Sample Problem #1 for an example.
• Provide connection points to the sidewalk infiltration system consistent with the shed boundaries in the master planning and consistent with the goal of even distribution flows.
• Demonstrate that onsite infiltration and sidewalk infiltration system connections can be provided to any undeveloped remainder of the shed.

D.1.5 – METHOD 4 - SYSTEMS OVER 3000 SF AND NOT CONSISTENT WITH TYPICAL DESIGN OR MASTER PLANNING

Parcels shown in the master planning as needing 3000 square feet or more total onsite infiltration are required to demonstrate consistency with master planning through either Method 1 or Method 4. This applies to shed areas 130, 132, 140, 160, 162, 180B and 640B. Method 4 is applicable in cases where the proposed system does not utilize the typical design details shown in Exhibit F-1 and Exhibit F-2 and is not consistent with the infiltration area shown in Exhibit B and Exhibit E. Due to the large size of the systems on these parcels Methods 2 and 3 are not sufficient to verify compliance. These systems would generally be considered to be alternative designs and would be subject to review by the City or a by consultant selected by the City. These systems must be demonstrated to meet the following criteria to the satisfaction of the City Engineer.

• Demonstrates that soils are suitable for infiltration and meet design infiltration rate of three inches per hour.
• Demonstrate the system serves the portion of the subshed area intended in the master planning.
• Demonstrate the proposed system performance is consistent with the performance level of the infiltration system described in the master plan through XPSWMM modeling of the 100 year 24-hour storm.
• Provide connection points to the sidewalk infiltration system consistent with the shed boundaries in the master planning and consistent with the goal of even distribution flows.
• Demonstrate that onsite infiltration and sidewalk infiltration system connections can be provided to any undeveloped remainder of the shed.

SECTION E – SAMPLE PROBLEM

E.1.1 – SAMPLE PROBLEM #1

Shed area i700B
Runoff Area = 1.83 acres
Required infiltration area = 7416 sf
Net sidewalk infiltration area provided = 5916 sf
Additional onsite infiltration area = 7416 - 5916 = 1500 sf
Supplemental onsite infiltration area = 1.83 x 0.01 = 800
Total onsite infiltration area = 1500 + 800 = 2300 sf
2300 sf > 10% of site require so adjust supplemental infiltration area to 0 sf
Total onsite infiltration area = 1500 + 0 = 1500 sf
Watershed area served by additional onsite infiltration area = (1500/7416) x 1.83 = 0.37 acres
Watershed area served by supplemental onsite infiltration area = (0/7416) x 1.83 = 0.00 acres
Total watershed area served by onsite infiltration = 0.37 + 0.00 = 0.37 acres

Method 1 Verification
Provide 1500 sf of infiltration bed area generally consistent with the typical details and design guidelines of Section C.

Method 2 Verification
Assume proposed infiltration design is consistent with the typical onsite infiltration details and includes a 1050 sf infiltration bed with increased depth to compensate for the reduced area.

Area factor = (1050/1500) = 0.70
From Exhibit G depth factor = 1.81 (see sample problem point on Exhibit G)
Typical storage depth = 24”
Required storage depth = 24 x 1.81 = 43.5”
Typical details and design guidelines of section C apply.

Method 3 Verification
Assume an alternate design is proposed that is not consistent with the typical onsite infiltration details but is consistent with the design guidelines of Section C. Assume the design includes a 1050 sf infiltration contact area with the soil and an undetermined storage volume.

Infiltration rate = (1050 sf) x (3 in/hr) x (1 ft/12 in) x (1 hr/3600 s) = 0.073 cfs
Prorate infiltration to a 1.0 acre shed for use on Exhibit H-2: (0.073 cfs) x (1.00/0.37) = 0.20 cfs
From Exhibit H-2 required storage volume = 4400 cf
Prorate storage volume to 0.37 ac shed: (4400) x (0.37/1.00) = 1628 cf
Assume void ratio = 0.40
Infiltration bed volume = (1628/0.40) = 4070 cf
Infiltration bed depth = (6050/1050) = 46.5”
Design guidelines of section C apply.

Method 2 and Method 3 verifications are intended to be approximations and as such the results of the sample problem for the verifications are considered sufficiently similar.
Method 4 Verification
Method 4 is not applicable to a shed of this size.

**E.1.2 – SAMPLE PROBLEM #2**

This sample problem is similar to #1 but uses a larger infiltration area and results in a smaller storage volume.

Shed area i700B
Runoff Area = 1.83 acres
Required infiltration area = 7416 sf
Net sidewalk infiltration area provided = 5916 sf

Additional onsite infiltration area = 7416 - 5916 = 1500 sf
Supplemental onsite infiltration area = 1.83 x 0.01 = 800
Total onsite infiltration area = 1500 + 800 = 2300 sf
2300 sf > 10% of site require so adjust supplemental infiltration area to 0 sf
Total onsite infiltration area = 1500 + 0 = 1500 sf
Watershed area served by additional onsite infiltration area = (1500/7416) x 1.83 = 0.37 acres
Watershed area served by supplemental onsite infiltration area = (0/7416) x 1.83 = 0.00 acres
Total watershed area served by onsite infiltration = 0.37 + 0.00 = 0.37 acres

Method 1 Verification
Provide 1500 sf of infiltration bed area generally consistent with the typical details and design guidelines of Section C.

Method 2 Verification
Assume proposed infiltration design is consistent with the typical onsite infiltration details and includes a 2250 sf infiltration bed with increased depth to compensate for the reduced area.

Area factor = (2250/1500) = 1.50
From Exhibit G depth factor = 0.54
Typical storage depth = 24"
Required storage depth = 24 x 0.54 = 13.0"
Typical details and design guidelines of section C apply.

Method 3 Verification
Assume an alternate design is proposed that is not consistent with the typical onsite infiltration details but is consistent with the design guidelines of Section C. Assume the design includes a 2250 sf infiltration contact area with the soil and an undetermined storage volume.
Infiltration rate = (2250 sf) x (3 in/hr) x (1 ft/12 in) x (1 hr/3600 s) = 0.156 cfs
Prorate infiltration to a 1.0 acre shed for use on Exhibit H-2: (0.156 cfs) x (1.00/0.37) = 0.42 cfs
From Exhibit H-2 required storage volume = 2750 cf
Prorate storage volume to 0.37 ac shed: (2750) x (0.37/1.00) = 1020 cf
Assume void ratio = 0.40
Infiltration bed volume = (1020/0.40) = 2550 cf
Infiltration bed depth = (2550/2250) = 13.6”
Design guidelines of section C apply.

Method 2 and Method 3 verifications are intended to be approximations and as such the results of the sample problem for the verifications are considered sufficiently similar.

Method 4 Verification
Method 4 is not applicable to a shed of this size.
LIST OF EXHIBITS

Exhibit A – Watershed Location Map
Exhibit B – Watershed Infiltration Areas
Exhibit C – Typical Sidewalk Infiltration Design
Exhibit D – Interim Infiltration Basins
Exhibit E – Onsite Infiltration Obligation Table
Exhibit F – Typical Onsite Infiltration Design
Exhibit G – Typical Infiltration Design Performance Chart
Exhibit H – Alternative Infiltration Design Performance Chart
THE BRIDGE DISTRICT

BRIDGE DISTRICT INFILTRATION DESIGN GUIDELINES EXHIBIT C-1

CITY OF WEST SACRAMENTO, CALIFORNIA

FEBRUARY, 2013

LEGEND:

- AREA OF CRUSHED DRAIN ROCK
- PERFORATED DRAIN PIPE
- RELIEF DRAIN PIPE SYSTEM
- INFILTRATION BOX (2'x2') DET 11/SW-9A
- INFILTRATION INLET (2'x4') DET 6/SW-9A

TYPICAL SIDEWALK INFILTRATION - PLANVIEW

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS

3301 C St, Bldg. 100-B Tel 916.341.7760
Sacramento, CA 95816 Fax 916.341.7787
THE BRIDGE DISTRICT
BRIDGE DISTRICT INFILTRATION DESIGN
GUIDELINES EXHIBIT C-2
CITY OF WEST SACRAMENTO, CALIFORNIA
FEBRUARY, 2013

LEGEND

POROUS CONCRETE SIDEWALK, 6"

CONVENTIONAL PCC SIDEWALK, 4" OR PCC ROADWAY

TEMPORARY NATIVE SOIL COVER, 4"

3/4" CRUSHED ROCK

CLASS 2 AGGREGATE BASE

GEOTEXTILE FABRIC MIRAFI 160N OR EQUAL PER GTECH RECOMMENDATIONS

TYPICAL SECTION - SIDEWALK INFILTRATION
# ONSITE INFILTRATION OBLIGATION SUMMARY

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Prepared by: Wood Rodgers, Inc
## ONSITE INFILTRATION OBLIGATION SUMMARY

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**Notes:**

1. The supplemental infiltration requirement is typically 10% of the overall site requirement which results in approximately 1% of the site area. The area shown here has been reduced or eliminated in cases where additional infiltration is required.
2. Total onsite infiltration is the sum of the additional and supplemental requirements and in no case shall be less than 10% of the overall shed requirement or 1% of the shed area.

- Shaded cells indicate areas with insufficient sidewalk infiltration area and resulting additional on-site infiltration requirements.
- Shaded cells indicate the 500 series of shed areas west of Fifth. Infiltration testing was not done for this area. A rate of 1.5" per hour was used. This need to be verified at the time of development.
THE BRIDGE DISTRICT

TYPICAL ONSITE INFILTRATION DETAIL

EXHIBIT - F-2

CITY OF WEST SACRAMENTO, CALIFORNIA

FEBRUARY, 2013

DEFINITIONS

48° DISCHARGE MANHOLE, SEE TYPICAL DETAIL

12" DISCHARGE PIPE

END PERFORATED PIPE 2' INSIDE INFILTRATION BED

CRUSHED ROCK, 40% VOIDS, GEOTEXTILE FABRIC CONTAINMENT

12" PERFORATED PIPE GRID

12" INLET PIPE

BEGIN PERFORATED PIPE 2' INSIDE INFILTRATION BED

FINISH GRADE

OPEN END FOR RELEASE, ELEV AT TOP OF STORAGE VOLUME

45° MANHOLE

DISCHARGE PIPE TO DRAINAGE SYSTEM

TEE, SIZE PER PLAN

ATTACH TO WALL W/ 2 STAINLESS STEEL STRAPS

REMOVABLE CAP

OUTLET PIPE FROM INFILTRATION BED

PROFILE

ONSITE INFILTRATION BED

HORZ: 1"=10'
VERT: 1"=5'

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS

3301 C St, Bldg. 100-B  Tel 916.341.7760
Sacramento, CA 95816  Fax 916.341.7767
Method 2 System Performance Verification

Equivalent Performance Curve for varying Ratios of Storage Volume and Infiltration Area

**Example Point:** Storage Depth increased to 159% of Master Plan depth. Infiltration area can be reduced to 75% of Master Plan Area without a reduction in Performance.

**Sample Problem # 1:**
Area Factor = 0.70
Depth Factor = 1.81

Graph Not Applicable for Ratio Beyond 2.0
Method 3 Performance Level Verification
Runoff Hydrograph in a Typical Shed of 1 Acre - 100-yr 24-hr Storm

- **Example:** Infiltration Capacity = 0.5 cfs

- **Example:** An infiltration rate of 0.5 cfs requires a storage volume of 2500 ft^3.

- **Example:** 12700 ft^3 is infiltrated from the runoff when the Infiltration Capacity is 0.5 cfs.

- **Example:** The Runoff Hydrograph generated by a 100-yr and 24-hr storm for typical site shed development of 1 acre.

- **Volume required to be stored during the 24-hour period after the storm.**

EXHIBIT H1
Method 3 Performance Level Verification
Storage Volumes Required under different Infiltration Rates
in a typical Shed of 1 Acre

Sample Problem # 1:
Infiltration rate = 0.2 cfs
Required Storage Volume = 4400 ft $^3$

Example Point:
Infiltration rate = 0.5 cfs
Required Storage Volume = 2500 ft $^3$