Civil Engineering

Land Planning

Hydrology/ Flood Control

Geotechnical Engineering

Public Works Services

Storm Water Management

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LOW IMPACT DEVELOPMENT PLAN
CHIEF FARMS
50 W. NINE MILE CANYON ROAD
INYO COUNTY, CALIFORNIA

Prepared For:

ZAMORA DESIGN WORKSHOP
3215 San Marino Street, #7
Los Angeles, California 90006

Date: November 2016

Project: 6082.60

Approved: _____
Robert W. Anderson, PE, JD, CPESC, CPSWQ, CMS4S, CESSWI
RCE 58383, Exp. 12-31-20

LOW IMPACT DEVELOPMENT PLAN
50 W. NINE MILE ROAD
PEARSONVILLE, CALIFORNIA

EXECUTIVE SUMMARY

RJR Engineering & Consulting, Inc. (RJR) has prepared this study to address the application of the Low Impact Development requirements set forth by Inyo County, for the proposed agricultural improvement project (herein referred to as "Project Site") located at 50 W. Nine Mile Canyon Road. The proposed improvements for this project include minor grading, gravel parking lot and drive isles, concrete foundations, greenhouses and pre-manufactured buildings. This report presents results of the stormwater quality mitigation study performed by RJR for these improvements.

The scope of this study is to characterize the hydrologic and hydraulic conditions of the improvement area, determine the treatment flow rates, and determine the potential pollutants of concern, pollutant loading and analysis of appropriate mitigation measures which will be implemented into the proposed design. Mitigation measures will be selected and sized based on the geotechnical characteristics, modeling and infiltration testing performed by BSK Associates.

At the present time no existing storm water mitigation is located on the subject property and any stormwater runoff from within the site sheet flows east across the site. The proposed project will incorporate the use of permeable drive isles/parking, an infiltration basin and an agricultural runoff tank.

Directed surface flow, area drains, catch basins and underlying drainage facilities across the remainder of the site will collect and convey stormwater to the proposed infiltration basin. Greenhouse runoff will be directed to the agricultural runoff tank where water will be pumped and trucked off to a proper disposal site.

It should be noted that this report has been prepared solely as a low impact development plan for the grading and drainage improvements prepared by RJR Engineering. The hydrology and hydraulic calculations are based on the survey provided by others, visual field measurements, and grading/drainage plans designed by RJR Engineering. This analysis pertains solely to the conveyance of surface water, the related drainage devices and the storm water management system and does not include any analysis or assumptions relating to downstream conditions. All recommendations described herein are based on hydraulic and hydrologic analysis. Any changes in design or failure to address the outlined recommendations or civil engineering design elements will alter the calculations and render this report void.

1.0 SITE DESCRIPTION

The property is located at 50W. Nine Mile Canyon Road in Inyo County. The site is situated on the south west corner of Highway 395 and Nine Mile Canyon Road.

The property totals approximately 18.43 acres. The proposed improvements will occur in the north west corner of the property and will disturb a total area of approximately 1.95 acres. The development area topography consists of a relatively flat pad and ascends from approximately 2550 feet at the east to approximately 2560 feet at the north west corner (See site Plan). Nine Mile canyon and the surrounding area contain no storm drain and stormwater flows are mainly alluvial fan sheet flows.

Photograph 1.1: Aerial Photo of Project

2.0 STORM WATER MANAGEMENT

Low Impact Development (LID) is a sustainable practice that benefits water supply and contributes to water quality protection. LID approaches site drainage and stormwater management in a manner to maintain the site's pre-development hydrology by using design techniques that infiltrate, filter, store evaporate and/or detain runoff close to the source of the rainfall.

In Order to reduce runoff pollution and volume from private and publicly-owned properties planned for development, LID design is implemented to ensure that new developments/ redevelopments or construction projects incorporate design elements, such as post-construction BMPs, construction BMPs, and low impact development strategies, and that existing properties adopt good housekeeping practices.

No available design manual was available from Inyo County at the time of this study. RJR utilized the San Bernardino "Technical Guidance Document for Water Quality Management Plans" as a basis for this analysis and design.

The following projects and associated triggers within new development projects/activities are subject to the requirements of permit. (San Bernardino, TGM)

New-Development Projects

- *New Development projects that create 10,000 square feet or more of impervious surface (collectively over the entire project site) including commercial, industrial, residential housing subdivision, mixed use and public projects. This category includes development projects on public and private land, which fall under planning and building authority of the permitting jurisdiction.*

Since the project site improvements include the creating of 10,000 square feet or more of impervious surface area the entire project will require mitigation.

Existing Site Conditions

Total Property Area:	(18.43 acres)
Impervious Area:	(0.04 acres) (0.5%)
Pervious Area:	(18.39 acres) (99.5%)

*Note: Conditions are based on the entire property boundary. Small areas of existing concrete walls make up the impermeable area.

Proposed Site Conditions

Total Property Area: (18.43 acres)
Impervious Area: (0.42 acre) (2.3%)
Pervious Area: (18.01 acres) (97.7%)
Disturbed Area: (1.95 acre)

3.0 POTENTIAL STORM WATER QUALITY CONCERNS

The proposed project site will include potential pollutant sources from roof runoff, vehicle parking areas, vehicle access paths, agricultural fertilizer/chemical storage and agricultural runoff from within the greenhouses. Pollutants of concern will consist of nutrients such as phosphorus and nitrogen from the proposed greenhouses. Oils and grease will be present in the vehicle access ways and parking area. A list of pollutants of concern is listed below.

Pollutant	Source/Impact
Sediment (Silt and Sand), Trash & Debris	Sediment production is expected to be minimal due to the placement of gravel over the proposed site. Construction activities will have a large risk of sedimentation. Trash and Debris is expected to be nominal.
Pesticides & Herbicides	Source – Greenhouse Activities: The proposed greenhouses will be indoors and protected from rain events. Irrigation runoff will be captured and conveyed via a dedicated drainage system which will be directed to an agricultural runoff tank. The tank shall be pumped into trucks and disposed of at an authorized disposal site in accordance with federal, state and local regulations.
Organic Materials	Source – Greenhouse Activities: Greehouse activities will be contained indoors and not exposed to the elements. Limited outdoor movement/transport/disposal of organic materials will occur in the normal course of business. Risk of organic material pollution is anticipated to be minimal.
Metals	Source – Employee vehicles and atmospheric deposition from building roofs. Metal production is expected to be minimal.
Oil/Grease/Petroleum	Source – Parking Area. Exposure from vehicles is expected to be minimal. Parking is limited to employees.
Nitrogen and Phosphorus	Source – No site landscaping is proposed and agricultural activities will be contained within the green houses. Fertilizers will have limited exposure to the elements during movement/transport/disposal between storage and the greenhouses.
Oxygen Demanding Substances	Source – No onsite landscaping is anticipated and impacts are anticipated to be nominal
Bacteria and Viruses	Source – Landscaping/Lawn Areas. No landscaping/lawn or public gathering areas are proposed. Impacts are anticipated to be nominal.

4.0. L.I.D. HYDROLOGY DATA

Compliance with the LID requirements requires that the Design Capture Volume (DCV) be mitigated. The DCV is determined by the 85th percentile, 24 hour storm event, or the 0.75" – 24 hour storm event, whichever is greater. The precipitation evaluations are as follows:

85th Percentile, 24 Hour Rain Event Calculations

The DCV for the 85th Percentile, 24-hour storm event was determined by utilizing the NOAA isohyetal data as well as the calculations provided within the San Bernardino County WQMP.

STEP 1: Compute the area, in square feet, for the disturbed area (DA).

Disturbed Area = 1.95 Acre (84,942 sq.ft.)

STEP 2: Compute the disturbed area runoff coefficient as a function of the DA imperviousness (i), using the following regression equation (ASCE and WEF, 1998).

$$C = 0.858 * i^3 - 0.78 * i^2 + 0.774 * i + 0.04$$

Where:

i = 0.22 (22%)

$$C = 0.858 * 0.22^3 - 0.78 * 0.22^2 + 0.774 * 0.22 + 0.04$$

$$C = 0.858 * .011 - 0.78 * 0.0484 + 0.774 * 0.22 + 0.04$$

$$C = 0.18$$

STEP 3: Identify the 2 year, 1 hour rainfall depth for the DA from the NOAA Atlas 14 isohyet map.

2-year, 1-hour rainfall depth = 0.285 inches

NOAA Atlas 14, Volume 6, Version 2
Location name: Inyokern, California, USA*
Latitude: 35.8416°, Longitude: -117.8766°
Elevation: 2598.65 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.064 (0.052-0.079)	0.087 (0.071-0.109)	0.122 (0.098-0.153)	0.152 (0.122-0.192)	0.198 (0.154-0.257)	0.236 (0.180-0.313)	0.279 (0.208-0.377)	0.325 (0.237-0.452)	0.395 (0.276-0.569)	0.453 (0.307-0.674)
10-min	0.091 (0.074-0.114)	0.125 (0.101-0.156)	0.175 (0.141-0.219)	0.218 (0.175-0.275)	0.284 (0.221-0.369)	0.339 (0.258-0.449)	0.399 (0.298-0.541)	0.466 (0.339-0.648)	0.565 (0.396-0.816)	0.649 (0.440-0.967)
15-min	0.110 (0.089-0.138)	0.152 (0.123-0.189)	0.211 (0.171-0.265)	0.264 (0.212-0.333)	0.343 (0.267-0.446)	0.410 (0.313-0.543)	0.483 (0.360-0.654)	0.564 (0.410-0.783)	0.684 (0.479-0.987)	0.785 (0.532-1.17)
30-min	0.151 (0.122-0.188)	0.208 (0.168-0.259)	0.290 (0.234-0.362)	0.362 (0.290-0.456)	0.470 (0.366-0.611)	0.561 (0.428-0.743)	0.662 (0.494-0.896)	0.773 (0.562-1.07)	0.937 (0.656-1.35)	1.08 (0.730-1.60)
60-min	0.207 (0.168-0.259)	0.285 (0.231-0.356)	0.397 (0.321-0.497)	0.496 (0.398-0.626)	0.645 (0.501-0.838)	0.770 (0.587-1.02)	0.908 (0.677-1.23)	1.06 (0.771-1.47)	1.29 (0.900-1.85)	1.48 (1.00-2.20)
2-hr	0.305 (0.247-0.380)	0.404 (0.327-0.504)	0.547 (0.441-0.684)	0.672 (0.538-0.847)	0.857 (0.666-1.11)	1.01 (0.772-1.34)	1.18 (0.881-1.60)	1.37 (0.993-1.90)	1.63 (1.14-2.36)	1.86 (1.26-2.77)
3-hr	0.373 (0.302-0.465)	0.491 (0.397-0.612)	0.657 (0.530-0.822)	0.803 (0.643-1.01)	1.02 (0.791-1.32)	1.20 (0.913-1.59)	1.39 (1.04-1.88)	1.60 (1.17-2.22)	1.91 (1.34-2.75)	2.16 (1.47-3.22)
6-hr	0.509 (0.413-0.635)	0.667 (0.539-0.832)	0.888 (0.717-1.11)	1.08 (0.866-1.36)	1.36 (1.06-1.77)	1.59 (1.21-2.11)	1.84 (1.37-2.49)	2.11 (1.53-2.93)	2.50 (1.75-3.60)	2.81 (1.91-4.19)
12-hr	0.651 (0.528-0.812)	0.872 (0.706-1.09)	1.18 (0.952-1.48)	1.44 (1.16-1.82)	1.83 (1.42-2.37)	2.13 (1.63-2.83)	2.47 (1.84-3.34)	2.82 (2.05-3.92)	3.33 (2.33-4.80)	3.74 (2.54-5.57)
24-hr	0.844 (0.750-0.969)	1.17 (1.03-1.34)	1.61 (1.43-1.86)	1.99 (1.75-2.31)	2.53 (2.14-3.04)	2.96 (2.46-3.64)	3.42 (2.77-4.31)	3.92 (3.08-5.08)	4.62 (3.48-6.24)	5.18 (3.78-7.26)
2-day	0.992 (0.881-1.14)	1.40 (1.24-1.61)	1.96 (1.74-2.26)	2.44 (2.14-2.83)	3.10 (2.63-3.73)	3.64 (3.02-4.47)	4.20 (3.40-5.29)	4.80 (3.78-6.22)	5.63 (4.25-7.62)	6.31 (4.60-8.83)
3-day	1.07 (0.946-1.22)	1.52 (1.35-1.75)	2.15 (1.90-2.48)	2.68 (2.35-3.12)	3.42 (2.90-4.11)	4.01 (3.33-4.92)	4.62 (3.74-5.82)	5.27 (4.15-6.84)	6.19 (4.67-8.37)	6.92 (5.05-9.70)
4-day	1.12 (0.994-1.29)	1.61 (1.43-1.85)	2.29 (2.02-2.64)	2.85 (2.50-3.32)	3.65 (3.09-4.39)	4.28 (3.55-5.26)	4.94 (4.00-6.22)	5.64 (4.44-7.31)	6.62 (4.99-8.95)	7.40 (5.39-10.4)
7-day	1.20 (1.07-1.38)	1.73 (1.54-1.99)	2.47 (2.19-2.85)	3.10 (2.72-3.61)	3.99 (3.38-4.80)	4.70 (3.90-5.77)	5.44 (4.40-6.85)	6.22 (4.90-8.06)	7.32 (5.53-9.90)	8.20 (5.98-11.5)
10-day	1.24 (1.10-1.42)	1.79 (1.59-2.06)	2.57 (2.27-2.96)	3.23 (2.84-3.76)	4.18 (3.55-5.03)	4.94 (4.10-6.07)	5.73 (4.64-7.22)	6.58 (5.18-8.53)	7.78 (5.87-10.5)	8.73 (6.36-12.2)
20-day	1.38 (1.23-1.59)	2.02 (1.79-2.32)	2.93 (2.59-3.37)	3.71 (3.25-4.31)	4.84 (4.11-5.83)	5.76 (4.79-7.08)	6.74 (5.46-8.49)	7.78 (6.13-10.1)	9.25 (6.98-12.5)	10.4 (7.60-14.6)
30-day	1.56 (1.39-1.79)	2.28 (2.02-2.62)	3.32 (2.94-3.83)	4.23 (3.71-4.92)	5.56 (4.71-6.68)	6.63 (5.51-8.15)	7.78 (6.30-9.80)	9.00 (7.08-11.7)	10.7 (8.09-14.5)	12.1 (8.82-16.9)
45-day	1.77 (1.57-2.04)	2.60 (2.31-2.99)	3.80 (3.36-4.38)	4.85 (4.26-5.64)	6.41 (5.44-7.71)	7.69 (6.39-9.45)	9.04 (7.32-11.4)	10.5 (8.25-13.6)	12.5 (9.44-16.9)	14.1 (10.3-19.8)
60-day	1.97 (1.75-2.27)	2.88 (2.55-3.31)	4.21 (3.72-4.85)	5.37 (4.72-6.25)	7.10 (6.02-8.54)	8.52 (7.07-10.5)	10.0 (8.13-12.6)	11.6 (9.15-15.1)	13.9 (10.5-18.8)	15.7 (11.4-21.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

STEP 4: Compute the P6 mean storm rainfall depth in inches for the DA by multiplying the 2-year, 1-hr rainfall depth by the appropriate coefficient (a_1) for the climatic region.

$$P_6 = P_{2yr,1hr} * a_1$$

(Valley = 1.4807, Mountain = 1.909, or Desert = 1.2371) per San Bernardino TGM.

$$P_6 = 0.285 \text{ inches} * 1.2371 \text{ (desert region)}$$

$$P_6 = 0.35$$

STEP 5: Calculate the design capture volume (DCV), in cubic feet, as a function of the total DA, in square fee; the runoff coefficient (C), the P^ rainfall depth, in inches; and the regression constant to account for drawdown time (a2 = 1.582 for 24-hr drawdown, or 1.963 for 48-hour drawdown). Drawdown time is the maximum amount of time that runoff can be stored in a BMP to ensure sufficient capacity to treat subsequent storm events.

The following equation computes the DCV.

$$DCV = DA * C * a2 * P_6 / 12$$

$$DCV = 84{,}942 \text{ sq.ft.} * .18 * 1.963 * 0.35 / 12$$

$$\mathbf{DCV = 875.39 \text{ ft}^3}$$

Therefore, the 85th Percentile 24-hour storm event results 875.39 cubic feet of Design Capture Volume.

Site Infiltration Testing

Percolation testing was conducted by BSK Associates[1] on September 17, 2020. Two percolation tests were conducted in test borings in the area of the proposed leach field. The tests were conducted in accordance with the Inyo County Department of Environmental Health Services.

Test results observed yielded 4.4 minutes per inch at P-1 and, 5.71 minutes per inch at P-2. The BSK percolation results have been included in Appendix C for reference.

[1] Geotechnical Engineering Investigation, BSK Associates (September 30, 2020)

Groundwater

Groundwater was not encountered at the site by BSK Associates. Based on the analysis by BSK on historical groundwater elevation data, the groundwater elevation is approximately 310 feet below the surface. Therefore, groundwater is not an impact or design consideration regarding the shallow surface LID designs.

5.0 L.I.D. DESIGN SCHEME & CALCULATIONS

Based on the infiltration testing results, site location and geologic conditions, the site is suitable for infiltration BMP measures. RJR has selected a location of an open surface infiltration basin location just south of the proposed leach field and the infiltration test locations.

Infiltration Basin

Infiltration BMPs capture, hold and allow stormwater runoff to infiltrate into the subsurface. The BMPs are designed to hold a specific volume of runoff and do not allow for discharge until the design volume is exceeded. RJR has designed an infiltration basin, consisting entirely of naturally pervious site soils with a flat bottom. An energy dissipating inlet is provided to control entering flows. In addition an emergency overflow provision has been added. The basin has been designed with a forebay as "pretreatment" to allow settling of suspended solids. The flows then enter the main basin area which allows for the infiltration of the runoff within 48 hours.

Infiltration Basin Sizing calculations[2]

$$V_{retained} = P_{design} / 12 * SA_{inf} * (T_{drawdown} + T_{fill})$$

Where:

P_{design} = design percolation rate (in/hr), field measured infiltration divided by Safety factor. (P1 = 4.4 minutes per inch (13.8 in/hr)

SA_{inf} = infiltrating surface area (ft^2)

$T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours

T_{fill} = duration of storm when infiltration is occurring as basin is filling (hrs), default is 3 hours.

[2] San Bernardino WQMP Manual Table 5-4. The table references the Riverside County LID BMP Manual. The Excel spreadsheet for the Infiltration Basin calculation was utilized and provided in Appendix A for reference.

The infiltration basin size will be based on the Design Capture Volume, 875.39 ft^3 (section 4.0) and the volume of the increased runoff due to the proposed site impervious areas, 171 ft^3 (see project hydrology report). Therefore the infiltration basin will be sized to infiltrate a total volume of 1050 ft^3.

$$1050\ ft^3 = 13.8 / 12 * SA_{inf} * (48 + 3)$$

$$1050\ ft^3 = 13.8 / 12 * SA_{inf} * 51$$

$$1050\ ft^3 = 0.135 * SA_{inf}$$

$$SA_{inf} = 370\ ft^3$$

Required Infiltration Basin Surface Area = 370 ft^3

INFILTRATION RATE	DRAWDOWN TIME	DURATION OF STORM	REQUIRED BASIN VOLUME	DESIGNED BASIN VOLUME
13.8 In/Hr	48 Hrs.	3 Hrs.	370 ft^3	395 ft^3

The Infiltration area shall include the following;

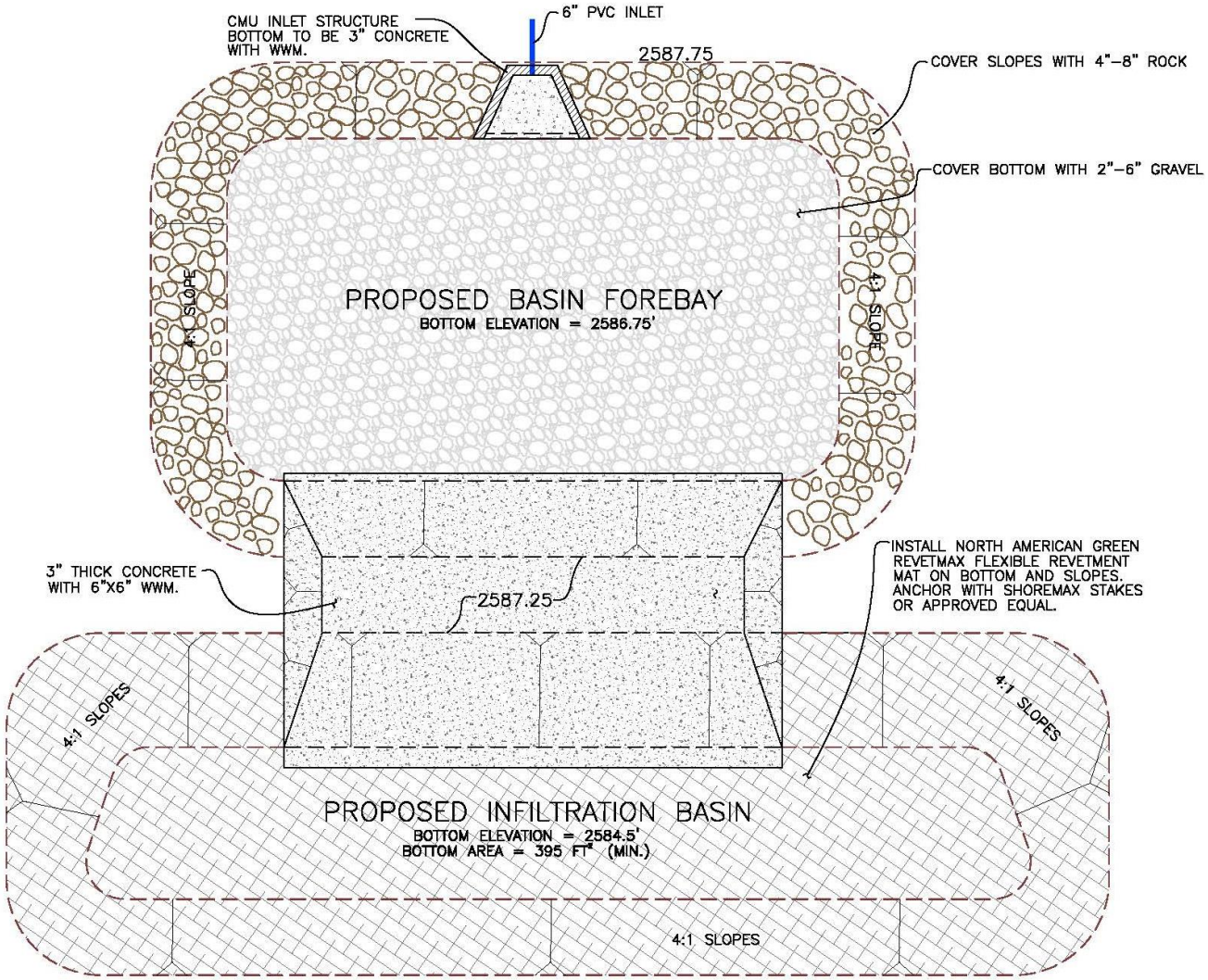
- The infiltration basin shall have a minimum depth of 12" and a freeboard of 6". Total depth = 18"
- The infiltration basin shall be lined with a permanent erosion control mat (North American Green RevetMax or approved equal.

Pre-Treatment

In order to preserve the effectiveness of the infiltration basin, larger particles and debris should be removed from the stormwater entering the infiltration area. The following design elements have been included within the proposed improvements in order to limit siltation and debris.

A pre-treatment forebay has been included in the proposed design to allow for siltation to settle out. In addition to the forebay, the site has been designed to limit siltation by including gravel across the pad and filter fabric

1. A pre-treatment forebay has been included in the proposed design to allow for siltation to settle out.
2. The pad area for the proposed project will be covered in a gravel



Infiltration Basin Detail

5.2 BMP Design Summary

The treatment/infiltration BMP designed herein meets and exceeds the requirements set forth by the County of Inyo. The infiltration planter has been sized to treat stormwater runoff for the project site as well as mitigate increased runoff from the development.

The infiltration planter will retain the runoff from the site and allow the flows to infiltrate into the subsurface. In the event of larger storm events, the basin will overflow and sheet flow in a natural condition across the site.

6.0 BMP OPERATION AND MAINTENANCE

Source Control BMPs

Source control BMP measures are aimed at activities that produce contaminants that can be picked up by storm water runoff. These BMP measures can greatly reduce this risk and shall be implemented by the owner/property manager to reduce stormwater pollution.

a. Regular Sweeping of all open hardscape areas and raking/cleaning of landscape areas on a weekly basis to prevent dispersal of pollutants that collect on these surfaces.
b. Trash and recycling containers shall in covered containers and kept clean to prevent potential source of bacteria and other pollutants from entering the storm drain system.
c. Minimal use of pesticides and fertilizers to the maximum extent practical.
d. Clean up of spills, leaks, etc from vehicles, cleaning supplies, trash enclosures, etc.

BMP Maintenance and Repairs

All BMP features and drainage devices shall be operated, monitored, and maintained for the life of the project and at a minimum, all structural BMPs shall be inspected, cleaned-out, and where necessary, repaired, at the following minimum frequencies:

1. Prior to October 15th each year
2. During each month between October 15th and April 15th of each year.
3. At least twice during dryer months (April 16 through October 15 of every year), and after all storm events which occur during this time period.

Inspection

The BMP shall be observed by a PE or CPESC/CPSWP any time infiltration appears to be significantly reduced, major repairs are made or if any other issues arise.

Servicing of PVC Drainage Pipes

The inlet structures throughout the site shall be inspected in accordance with the schedule above for evidence of clogging. If PVC pipes are suspected to be clogged, the lines should be cleaned of any necessary blockage.

7.0 SUMMARY

RJR has selected the use of a drainage scheme that utilizes a pvc pipe drainage system which conveys runoff to a soft bottom infiltration basin system. The system will infiltrate the required volume as specified in the project civil plans. Test results reveal that the underlying soil infiltrates at a conservative rate and therefore maintains proper storage depth while at the same time ensuring contact residence time to ensure proper, filtration, and adsorption, etc. to address and mitigation pollutants of concern.

The full stormwater quality volume will collect in the infiltration system and be allowed to percolate allowing natural hydrologic functions. As such, the proposed BMP will provide effective stormwater/ sediment/ pollutant mitigation in conformance with the requirements of the Inyo County.

It should be noted that this report has been prepared solely as a preliminary low impact development / stormwater quality management analysis for the proposed site and drainage improvements and is based on the engineering Site Plan designed by RJR Engineering. This analysis pertains solely to the conveyance of surface water, the related drainage devices and the storm water management system and does not include any analysis or assumptions relating to downstream conditions. All recommendations described herein are based on hydraulic and hydrologic analysis. Any changes in design or failure to address the outlined recommendations can alter the subsequent calculations and render this report void.

8.0 References

1. County of San Bernardino, Technical Guidance Document for Water Quality Management Plans, June 21, 2013.

1. NOAA Atlas 14, Volume 6, Version 2.0