Preliminary Drainage Study

FOR

TPM 10-001
Plum Family

Mailing Address:

Terry and Paula Plum
P.O. Box 8208
Mammoth Lakes, CA 93546
Phone (760) 924-5603

Date of Report: January 2011

Job No. 332.013

Engineer:
triad/holmes associates

Post Office Box 1570
Mammoth Lakes, Ca 93546
Phone: (760) 934-7588
Fax: (760) 934-5619
triad@THAinc.com
David Laverty, LS, Principal
Tom Platz, RCE, Principal

Paul E. Roten, P.E. C56891, Vice President

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APPENDIX

1. [1]Excerpts from the Town of Mammoth Lakes 2005 Storm Drain Master Update, May 2005, Boyle Engineering Corporation, including Exhibit 8.7, area 2.5 plan
2. Design Manual, Mammoth Lakes Storm Drainage and Erosion Control, Prepared for Mono County Public Works Department, July 1984, Brown and Caldwell and Triad Engineering, excerpts as referenced
3. Water Quality Control Plan for the Lahontan Region, North and South Basins, prepared by the State of California, Regional Water Quality Control Board, Lahontan Region, Chapter 4.8

PRELIMINARY DRAINAGE STUDY
TPM 10-001

1. Project Description

a. General Project Scope and Location

The project site is LLA Parcel 3 of Lot Line Adjustment 08-001, located in the Old Mammoth area in the town of Mammoth Lakes, Mono County, California. The site is on and accessed from a proposed driveway extended from Tamarack Street.. The site is approximately 6 miles southwesterly from the intersection of State Route Highway 203 (SR 203) and US 395.

Project is located as follows:

Figure 1.1

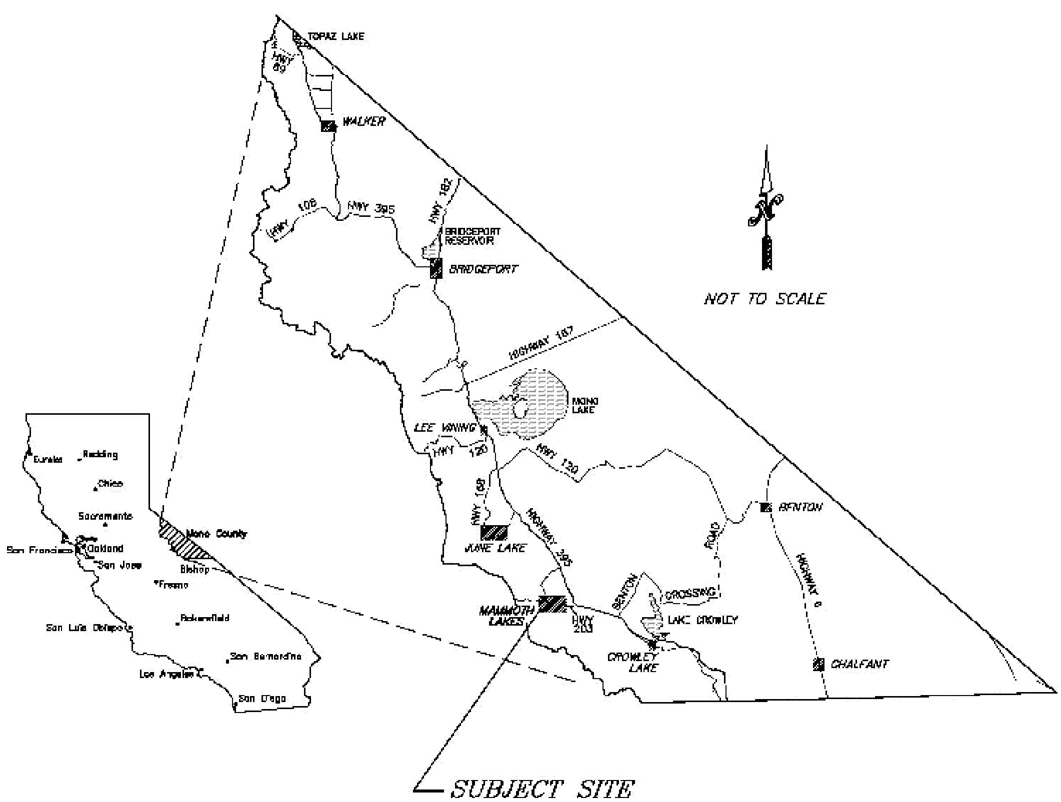
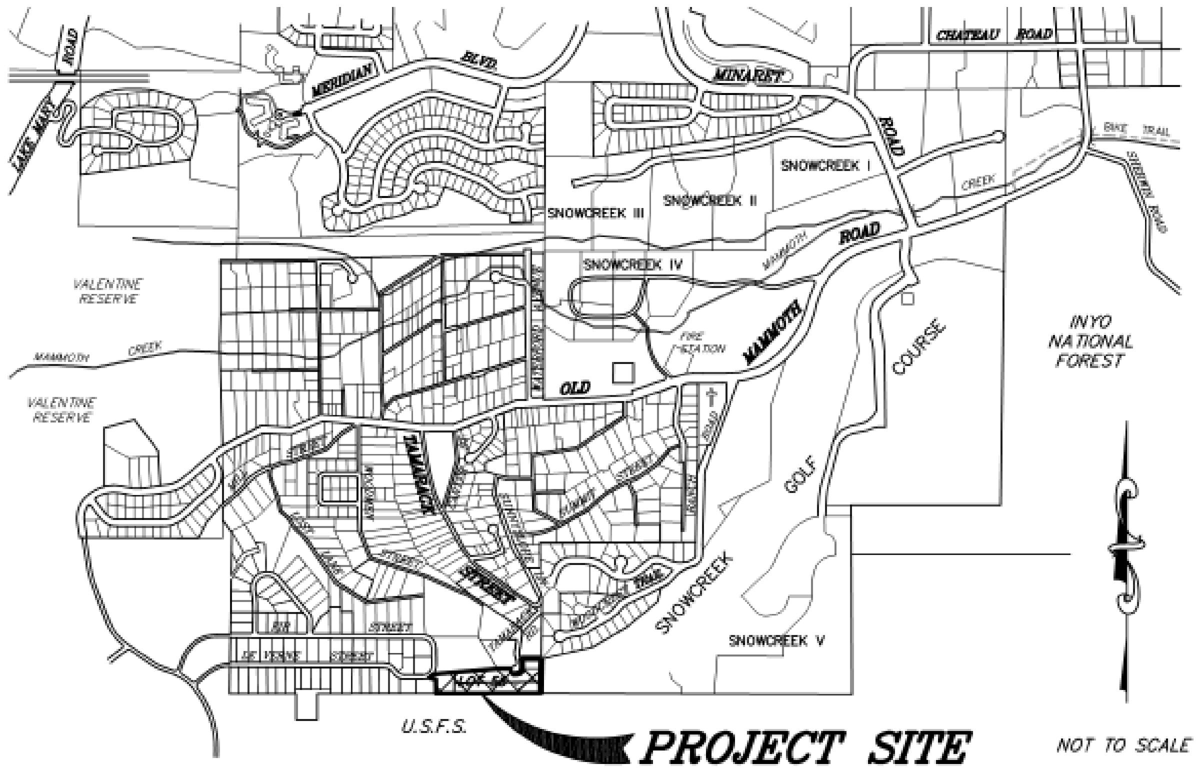


Figure 1.2



The project site is zone RR, Rural Residential. To the west and north of the site are lots and residential dwellings in the Old Mammoth area, also zoned RR; to the north there are some portions that are Rural Residential (Equestrian), Residential Multi-Family 1 and 2 (RMF-1 and RMF-2) and Residential Single Family (RSF) as well. To the east of the site is Snowcreek Golf Course which is zoned Resort (R). To the south of the site is United States Forest Service (USFS) land.

The site encompasses approximately 4.39 acres (191,203 square feet (sf)). The proposed project consists of dividing the existing LLA Parcel 3 of LLA 08-001 into four separate parcels for future single-family residential development. A driveway is proposed to access each of the proposed easterly parcels. The proposed driveway will also include construction of proposed utilities. Appendix A, Exhibit 3 shows the plan view of the proposed improvements.

Construction activities for the project include the construction of the proposed road and utilities. Associated grading and drainage facilities will be constructed during the road improvements.

b. General Topography, Vegetation and Soils

The site generally slopes from the west to the east. The elevations range from approximately 8,310 feet at the northwest corner down to approximately 7,942 feet at the southeast corner. The slope of the lot varies, from approximately 6% to 70%. The site consists of sagebrush scrub, rabbit brush, and assorted pines and firs - natural vegetation for the Town of Mammoth Lakes and the eastern Sierra Nevada area. The existing topography of the site is shown in Appendix A, Exhibit 1.

This project is not located on a receiving water. The existing conditions of the site allow storm runoff to sheet flow, generally from the west towards the easterly property line. There is offsite tributary runoff to the site from the west; there are two tributary areas to the west of the proposed road improvements. The northerly area is approximately 3.7 acres. The southerly tributary area is approximately 6.4 acres. The project will not disturb any wetlands or blue-line streams. Soils are granular, typical of SCS Type "B." based on the "Design Manual, Mammoth Lakes Storm Drainage and Erosion Control[2]".

c. Project Hydrology/Hydraulics

The site is located Drainage area 2.5.1 as shown on Exhibit 8.7 of the 2005 Storm Drain Master Plan Update. The runoff rate for this site is based on Table 3-1A of the above report, and would be a combination of Natural and Single Family Residence. The anticipated flow rate for 20 and 100 year intensity storms is shown below:

Land Use Type	20-Year	% of land use type	20-year this site	100-Year	% of land use type	100-year this site
Natural	0.23	50%	0.12	0.43	50%	0.215
Single Family Residence	0.65	50%	0.33	1.30	50%	0.65
High Density Residence	1.14			1.90		
Commercial	1.22			1.93		
runoff rate this site	20 year		0.44	100 year		0.865

This project is not located in a flood zone based on the Flood Insurance Study, prepared in 1992, for the Federal Emergency Management Agency, for Town of Mammoth lakes, California Mono County area.

2. Report Scope and Objective

The objective of this drainage report is to identify sources of storm water runoff, and estimate quantities of storm water runoff for both pre- and post-development conditions for 20 and 100-year intensity storm events. The report presents preliminary design requirements for storm drainage facilities to collect, convey and retain storm water runoff, generated from both off-site and on-site, at required levels.

3. Design Methods and Assumptions

Runoff rate calculations are based on the Town of Mammoth Lakes 2005 Master Plan Update (Master Plan[1]). On-site drainage facilities including inlets, storm drain pipes, earth swales, and storm drain manholes are be designed for 100-year storm intensity. Refer to Appendix B for hydraulic calculations.

Retention facilities have been designed based on the Water Quality Plan for the Lahontan Region[3] to contain 1 hour of a 20 year intensity storm, which is assumed to be 1 inch (0.83 feet) * Area (square feet) * C (infiltration coefficient). Because the retention facilities will be designed to contain the first flush or contaminated runoff, the conveyance systems have been designed to contain the maximum peak flows without reduction for retention. There will be some reduction in peak flow due to these retention systems, so the conveyance systems are conservatively sized.

Consistent with requirements of the Town of Mammoth Lakes, retention / infiltration systems are designed to retain storm water runoff from the site for 1 hour of a 20-year intensity storm as defined by the Water Quality Control Plan for the Lahontan Region[3] [i] (1 inch/hour).

4. Existing Hydrologic/Hydraulic Conditions

The Town of Mammoth Lakes Storm Drainage System (TMLSDS) is made up of underground and surface storm drainage facilities. Tributary sub-areas within the Town, and existing and proposed drainage facilities within each sub-area, are identified in the Master Plan[1].

Drainage from this Sub-area is located on the south side (Mammoth Creek side) of an easterly trending ridge that separates the Murphy Gulch and the Mammoth Creek drainage systems. Mammoth Creek is listed for metals in the State Water Resources Control Board 303 (d) list.

Currently, the runoff from the site and its tributary area sheet flows from the west to the east. The runoff continues east of the site and eventually enters the TMLSDS. There are no existing or proposed drainage facilities for this portion of Sub-area 2.5.1. Since the Master Plan[1] flows shown are noted to be for future build out conditions, this site is considered in the Master Plan[1] and the runoff rates identified therefore include buildout. Downstream facilities are adequate for this project in its built out condition.

The drainage that affects the site has been divided into two drainage areas, Area 1, north and Area 2, south. These areas include both on and off site runoff. These areas are shown on the attached Exhibit 1 in Appendix A. The runoff rates are shown in the table below, based on the rates determined in section 1. c.

	Existing		
Tributary Area	**Acres**	**Q20**	**Q100**
1 (north)	4.05	1.78	3.50
2 (south)	8.93	3.93	7.72
Total	12.97	5.71	11.22

5. Proposed Drainage Facilities

Since the runoff rates selected are based on the developed condition identified in the 2005 Master Plan, there is no alternative runoff rate for the Post Development condition. The use of a "cellular grassed paver" driveway, an infiltration system and a level spreader outflow are measures that are being used to limit impervious surfaces, maintain infiltration, and allow sheet outflow.

The proposed site is shown on Exhibit 3 in Appendix A. The following outlines the general runoff design guideline (hydraulic calculations are included in Appendix B):

- Runoff will be allowed to flow across the site, to a swale located along the east side of the "cellular grassed paver" driveway.
- The swale will vary in size to a maximum depth of less than 1 foot to accommodate the maximum runoff rate of 11.22 cfs during a storm of 100 year intensity.
- This swale will have intermittent inlets into the retention system located directly beneath it.
- Inlets shall be sized to accommodate the 20 year intensity storm rates at a minimum. The maximum runoff rate that must be intercepted by any inlet is 3.93 cfs. It is anticipated that inlets will be 2 foot by 2 foot max placed at a frequency to collect required runoff flow (capacity 3.94 cfs). Final inlet design shall be set during preparation of improvement plans.
- Inlets will be directly connected to the retention system.
- The retention system will be a longitudinal 18 inch Hancor pipe that will also act under low flow conditions to convey runoff to the south portion of the site. It is anticipated based on present calculations that the north area will required 320 feet of 18 inch Hancor retention system, and the south will require 200 feet of 18 inch Hancor retention system, as indicated in section 6 below. Final retention design shall be set during preparation of improvement plans.
- Retention systems will be connected with an 18 inch pipe to direct overflow to the downstream outlet.

- Runoff will be allowed to exit in a level spreader located adjacent to the golf course. Exit spreader shall be designed to flow the entire 11.22 cfs 100 year runoff rate.

6. Retention / Infiltration Systems

As required by the Lahontan Basin Plan, retention / infiltration systems collect and infiltrate the 20-year, one-hour storm flow generated from the project paving, landscaping and natural areas. Retention areas are shown on Exhibit 2 of Appendix A. Total runoff storage volume required for the Area 1 portion of the new road improvement site is 533 cubic feet; for Area 2 it is 610 cf. Retention storage is not being provided for existing streets. Storage volume will provided by the Hancor piping in area 2 (south) for both area 1 and area 2 at 949 cubic feet.

Both the onsite runoff and the offsite tributary runoff are proposed to be directed to the retention basin in Area 2. Once the basins reach their capacity, the overflow will flow out via the inlet of the drywell the overflow will be allowed to sheet flow to the east.

7. Erosion Protection Plan

In general, site disturbance and grading shall be limited as much as possible. Graded areas shall be protected against erosion once they are brought to final grade.

An Engineered Grading Plan shall be submitted for grading activities. The Project shall comply with the National Pollution Discharge Elimination System (NPDES) requirements for construction projects, the MOU between the Town of Mammoth Lakes and Lahontan Regional Water Quality Control Board (LRWQCB), and the Town Municipal Code. Construction activities subject to these requirements shall include clearing, grading, and disturbances to the ground such as stockpiling or excavation, but not including regular maintenance activities performed to restore the original line, grade, or capacity of the facility.

The Grading Plan shall be designed and incorporate Best Management Practices (BMPs) into plans and Storm Water Pollution Prevention Plan SWPPP as required. All temporary off-site Best Management Practices (BMPs) are required to be removed in the Town right-of-way after October 15th or before April 30th each year. The applicant shall maintain the BMP's on-site at all times and shall conform to the permits during construction.

8. Summary and Conclusion

Final drainage facilities designed and selected will determined during preparation of improvement plans. Drainage facilities shall be designed to handle the required flows. The criteria followed during the design process shall address issues such as safety, erosion protection and water quality.

Infiltration facilities will be added per Town of Mammoth Lakes and Lahontan Regional Water Quality requirements. The project proponent is proposing erosion resistant surfaces over improved areas. Runoff entering the site from offsite will directed to exit in the vicinity of the adjacent golf course which has been generally the historic drainage path.

The area of disturbance for this project is greater than 1 acre, so this project is subject to the requirements of the National Pollution Discharge Elimination System (NPDES) for construction projects enforced by the State Water Quality Control Board – Lahontan Region.

Though the requirements of permits are not anticipated, work shall conform to conditions of the Army Corp of Engineers, Lahontan Regional Quality Control Board, and State of California Fish and Game. Any work done in this area shall conform to Federal, State, and local requirements.

This site is not located in a 100 year floodzone. Foundations shall be installed in conformance with the most recent building codes to limit any potential for drainage runoff entering the structures and limit potential damage to foundations.

Both the on-site and off-site storm drainage facilities must be maintained to continue to work as designed. Particular items requiring maintenance include, but are not limited to, cleaning of the grates, removal of foreign materials from storm drainage pipes, maintenance as necessary to outlet facilities, and repairs as necessary to damaged facilities. Special attention should be paid to a storm drain at the northern part of the site, which has a slope of 0.7%. This storm drain will required more frequent maintenance due to its low incline. Additionally, snow removal must be performed in a way so as not to restrict drainage collection in gutters, inlets, and flow paths.

[1]The Town of Mammoth Lakes 2005 Storm Drain Master Update, May 2005, Boyle Engineering Corporation.

[2]Design Manual, Mammoth Lakes Storm Drainage and Erosion Control, Prepared for Mono County Public Works Department, July 1984, Brown and Caldwell and Triad Engineering

[3]Water Quality Control Plan for the Lahontan Region, North and South Basins, prepared by the State of California, Regional Water Quality Control Board, Lahontan Region.

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APPENDIX A

FIGURES

Preliminary Drainage Study

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APPENDIX B

HYDRAULICS

Swale Capacity

Swale Capacity	
Q= 12.03 cfs **V= 10.7 fs**	
Q=AR$^{2/3}$(1.486/n)s$^{1/2}$	**12.03**
A=area of full swale	1.125
A1=area of below water surface	1.125
R=Hydraulic Radius	0.34
n=Manning's roughness coefficient	0.015
s=slope(ft/ft)	0.05
top width of swale	3
top width at water surface	3
bottom width	0
side slope	0.5
d=depth of swale	0.75
d1=depth of water in swale	0.75
Wetted Perimeter	3.354102

Catch Basin Inlet Capacity

Grate Inlet		Sump Grate			
Q= 3.94 cfs		**H= 0.30 feet**		**H = 4 inches**	
Wier	Inlet Capacity (y<0.4 feet), $Q=3Py^{3/2}$				3.9
Orifice	Inlet Capacity (y>1.4 feet), $Q=0.6A(2gy)^{1/2}$				5.1
Q=quantity of runoff, cfs					**3.9**
P=perimeter, ft					8.0
y=depth of flow at inlet, ft					**0.30**
A=total area of clear opening, sf					1.92
Opening Ratio					0.48
g=acceleration due to gravity, 32 ft/s^2					32.2
Total area					4
L=length, in					24
W=width, in					24

These calculations are based on the Hydraulic Engineering Circular No. 12, Chapter 8.1. Generally, under 0.4 feet of depth it is assumed that a catch basin operates under weir conditions. At depths over 1.4 feet catch basins operate under orifice conditions. In between, the typical assumption is to calculate both considerations and use the more conservative. Under sump conditions, the perimeter is the entire perimeter of the catch basin. Under non sump conditions, the perimeter is the leading edge, usually two sides.

Typical pipe - all areas

Total site flow during 100 year storm can be conveyed in pipe at 1% slope .		
	enter	calced
Pipe Diameter (inches)	18	18
Pipe Diameter (feet)		1.50
Slope (s)	0.01	
Friction Factor(n)	0.012	
Depth (inches)		18
Depth (feet)		1.50
Depth (percentage)	100%	100%
Area		1.77
Wetted Perimeter		4.71
Hydraulic radius		0.38
Quantity (cfs)		**11.38**
Quantity (gpm)		5109.5
Velocity (fps)		**6.44**

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APPENDIX C

RETENTION / INFILTRATION BASIN

triad/holmes associates
civil engineering
land surveying
mammoth lakes • bishop • redwood city • napa
san luis obispo • lompoc • pleasanton

Calc'd By:	**per**
Job No.:	**332.013**
Date:	**2011 jan 3**

Runoff Volume and Drywell Sizing Calulation

based on Lahontan RWQCB Design Parameters

TPM 10-001

Area 1 Site Retention

Input:

Rainfall Intensity				
	1	in/hr =	0.083	ft/hr
Percolation Rate				
	0	in/hr =	0.00	ft/hr

Tributary Area:

				Runoff Coefficient	
Roof Area	0	SF	0%	0.95	Roof Area
Pavement Area	3832	SF	37%	0.90	Pavement Area
Gravel/Aggregate Area	0	SF	0%	0.80	Gravel/Aggregate Area
Concrete	0	SF	0%	0.90	Unpaved Industrial Area
Landscaping Area	6558	SF	63%	0.45	Landscaping Area
Total Area	**10390**	**SF**		**0.62**	**Average Runoff Coefficient**

Average Runoff Volume = Total Area * Average Runoff Coefficient * Rainfall Intensity * 1 Hour

Average Runoff Volume = 533 CF

triad/holmes associates
civil engineering
land surveying
mammoth lakes • bishop • redwood city • napa
san luis obispo • lompoc • pleasanton

Calc'd By:	**per**
Job No.:	**332.013**
Date:	**2011 jan 3**

Runoff Volume and Drywell Sizing Calulation

based on Lahontan RWQCB Design Parameters

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Area 2 - Site Retention

Input:

Rainfall Intensity	1	in/hr =	0.083	ft/hr
Percolation Rate	0	in/hr =	0.00	ft/hr

Tributary Area:				Runoff Coefficient	
Roof Area	0	SF	0%	0.95	Roof Area
Pavement Area		SF	0%	0.90	Pavement Area
Cellular Grassed	13500	SF	85%	0.50	Gravel/Aggregate Area
Concrete	0	SF	0%	0.95	Unpaved Industrial Area
Landscaping Area	2300	SF	15%	0.25	Landscaping Area
Total Area	**15800**	**SF**		**0.46**	**Average Runoff Coefficient**

Average Runoff Volume = Total Area * Average Runoff Coefficient * Rainfall Intensity * 1 Hour

Average Runoff Volume = 610 CF

Stormwater Retention / Detention
System Sizing Worksheet
For Multiple Diameter and Length Laterals

LandMax System Sizing

Version 5.5

Project	Lot 56, RS 36-123
Location	Mammoth Lakes, CA
Job Number	01.322.013
Engineer	Triad/Holmes Associates
Email Address	triad@THAinc.com
Information	North Storage Section
Date	6/29/2006

System Type	Retention
Header Type	Sure-Lok
System Spacing	Standard

Design Storage Volume (DSV) 943 cf

(enter a value and the table to the right will give an approximate number of sticks needed per pipe diameter)

Perforated Headers?	Yes No
Include Headers in Storage Volume Calc?	Yes No
Header Diameter	18
Number of Headers	1
Stone Porosity (%)	33
Additional stone layer allowing storage **ASV** (in)	14

	Lateral Diameter (in)	Lateral Length (ft)	Sticks of pipe per lateral	Number of Laterals
Group 1	18	220	11.0	1
Group 2	36	0	0.0	0
Group 3	36	0	0.0	0

	Storage Volume				Approximate System Size		
	Component			Total System			
	Product Volume	Stone[1]	ASV[2]	Retention	Width	Length	Footprint[4]
	cf	cf	cf	cf	ft	ft	sf
Header	0	0		0			
Group 1	389	303	256	949	3	222	666
Group 2	0	0	0	0	0	0	0
Group 3	0	0	0	0	0	0	0
TOTALS	**389**	**303**	**256**	**949**			**666**

Excavation information								
	Pipe Diameter	Width	Length	Height[3]	Excava-tion[5]	Stone Backfill[6]	ASV[2]	Rolls of Filter fabric[7]
	in	ft	ft	ft	cyd	cyd	cyd	
Group 1	18	5	224	3.3	140	40	50	1
Group 2	0	0	0	0.0	0	0	0	0
Group 3	0	0	0	0.0	0	0	0	0
				Total	140	40	50	1

Approx quanity of pipe based on DSV	
Dia	**Feet**
12	503
15	369
18	274
24	173
30	110
36	81
42	61
48	46
54	36
60	30

Pipe Information			Stone Porosity		
ID	**OD/ Width**	**Volume**	**40%**	**35%**	**33%**
in	**in**	**cf/lf**	**cf/lf**	**cf/lf**	**cf/lf**
12	14.2	0.79	1.08	0.95	0.89
15	17.7	1.23	1.33	1.16	1.09
18	21.5	1.77	1.67	1.46	1.38
24	28.4	3.14	2.32	2.03	1.92
30	36.0	4.91	3.69	3.23	3.04
36	41.4	7.07	4.50	3.94	3.71
42	48.0	9.62	5.93	5.19	4.89
48	55.0	12.57	8.11	7.09	6.69
54	61.0	15.90	9.98	8.73	8.23
60	67.3	19.63	11.52	10.08	9.51

Notes

* Estimated volumes are based on a flat detention system.
* This worksheet is for estimations purposes only and should not take the place of a comprehensive engineering design
1 **Stone** cf = 6" below the pipe to the top of the pipe and the stone between the rows.
2 **ASV** = Additional Stone volume from the additional layer of stone.
3 **Height** = pipe OD + 18" (6" below the pipe + 12" above the pipe) Does not account for additional base or final fill on project.
4 **Footprint** = The area of the system, additional area is required for proper installation.
5 **Excavation** = length x width x height; additional excavation is required for deeper systems
6 **Stone Backfill =** 6" below the pipe to the top of the pipe and the stone between the rows.
7 **Rolls =** Hancor Terrifiber Nonwoven 15' wide by 300' long with 1' overlap

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APPENDIX D

REFERENCE MATERIAL

B. Procedure A Development

Two types of rare event precipitation-runoff conditions pertain to the meteorological characteristics of the Town and need to be considered jointly. They are subject to two physically distinct events: a rainfall-only condition and the rainfall-on-snow condition, referred to as the summer and winter conditions, respectively. The idea that one should consider each condition separately and then choose the most extreme result is a sound one and will be adopted in this study as well.

The methodology used to determine peak flows is based on the Rational Formula

$$Q = CiA$$

Where:

Q	=	the discharge measured in cfs
C	=	the runoff coefficient, having no physical dimensions
i	=	the rainfall intensity measured in inches per hour
A	=	the area of the watershed basin measured in acres

The above formula is simply a version of the "continuity equation" in the study of hydraulics. Any consistent set of units may be chosen, however the customary units for Q, i, and A are cubic feet per second (cfs), inches per hour (in/hr), and acres (ac) respectively. For this particular choice of units, the product CiA is to be multiplied by a small correction factor of 1.008, which is often neglected in view of the probabilistic nature of hydrologic calculations mentioned above.

It was observed from the 1984 study that flows within the local storm drains experience little attenuation. In other words, individual hydrographs from individual storm drains have nearly coincidental (in time) peaks when a flow confluence occurs. This finding from the 1984 study helps to provide a simple way to determine peak discharge values. Additionally, the assumption of no attenuation is a conservative one.

While it is true that any point on a stream has a watershed area associated with it, one should not compare watersheds having widely ranging area values. Former procedures specified in the 1984 study allow for areas within the town to have an area anywhere between 0 and 1,600 acres, which is too much of a variation. Problems with comparing a 10 acre subarea with a 1000 acre subarea are obvious in that calculated times of concentrations (t_c) would be vastly different. Hence for this updated study a standard of 40-80 acres is taken as the range of watershed size used to apply cfs/acre peak values[3]. In practice, developers within subareas (if more than one subarea is involved a weighted average should be taken) of this order of magnitude can design systems for their projects using the cfs/acre values that are called out in this study (see **Table 3-1A**).

Another fact that applies to storm drains in the Town is that peak flows within the local storm drain system occur at a time much earlier than offsite flows in major streams. Hence, storm drain design in the Town is mainly independent of offsite drainage and drainage methodology (with the exception of conveyance structures that route large offsite watersheds). For those properties that are affected by large offste watersheds, a reduction factor may be applied, as shown in **Table 3-1B**.

In order to develop a "cfs/acre" approach in lieu of a detailed hydrograph for storm drain flows, a lower bound for cfs/acre value within the Mammoth Basin was first established for comparative purposes. By the term "lower bound", we mean that the estimates made by the following analysis are expected to be less than cfs/acre values that actually apply within the Town for the purpose of pipe design. Such an estimate has some value, since it acts as a safeguard against the use of values that would result in the design of conveyance systems that are inadequate for a given return period.

From the Federal Emergency Management Agency (FEMA) Flood Insurance study [6], it was estimated that the 100-year[4] discharge rate for Mammoth Creek was 640 cubic feet per second (cfs) for a tributary watershed area of 13.12 square miles (8,397 acres) at a stream location taken 650 feet downstream of Old Mammoth Road. Hence for this

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3 This standard is used in several communities within the State of California, including Los Angeles [5] and Ventura Counties.

4 A 10-year storm is defined as a storm event that is equaled or exceeded every 10 years on average. Another way to define a 10-year storm is to say that the probability of an event of having a 10-year magnitude or more has a 1/10 chance in a given year. Likewise, a 100-year storm is defined as a storm that is equaled or exceeded every 100 years on average. The 100-year storm can alternatively be defined by saying that the probability of an event of having a 100-year magnitude or more has a 1/100 chance in a given year [7].

watershed, a cfs/acre ratio is equal to 640/8397 ≈ 0.076 cfs/acre for 100-year conditions. This value is clearly low since it includes an extremely large and predominantly natural watershed (consisting of subareas including portions of the Town) subject to the attenuation process. From the same study, it was estimated that the 100-year discharge rate for Mammoth Creek increased from 350 cfs to 610 cfs between Waterford Street upstream and a point 650 feet upstream of Minaret Road downstream. The increase in the watershed area between these two stations is given as 0.49 square miles (314 acres) and lies within the Town. For this watershed from Waterford Street to 650 feet upstream of Minaret Road, the cfs/acre ratio is equal to (610 – 350)/314 ≈ 0.828 cfs/acre for 100-year conditions.

Next, a statistical analysis was made of the cfs/acre data contained in the 1984 study. Not surprisingly, a strong dependence (on cfs/acre rates) was found on the degree of natural land cover. This data was applied to the individual subareas delineated in this study for the purpose of obtaining a reasonable estimate of cfs/acre value for particular land use types, and were adjusted for consistency. These values were conservatively estimated to be those as given in **Table 3-1** below:

Table 3-1A. Applicable cfs/acre Values by Land Use Type

Land Use Type	20-Year	100-Year
Natural	0.23	0.43
Single Family Residence	0.65	1.30
High Density Residence	1.14	1.90
Commercial	1.22	1.93

Table 3-1B. Reduction Factors for Large Basins

Drainage Area (acres)	Reduction Factor
80	1.00
100	0.97
200	0.88
500	0.77
1,000	0.69
2,000	0.63
5,000	0.55
7,744	0.52

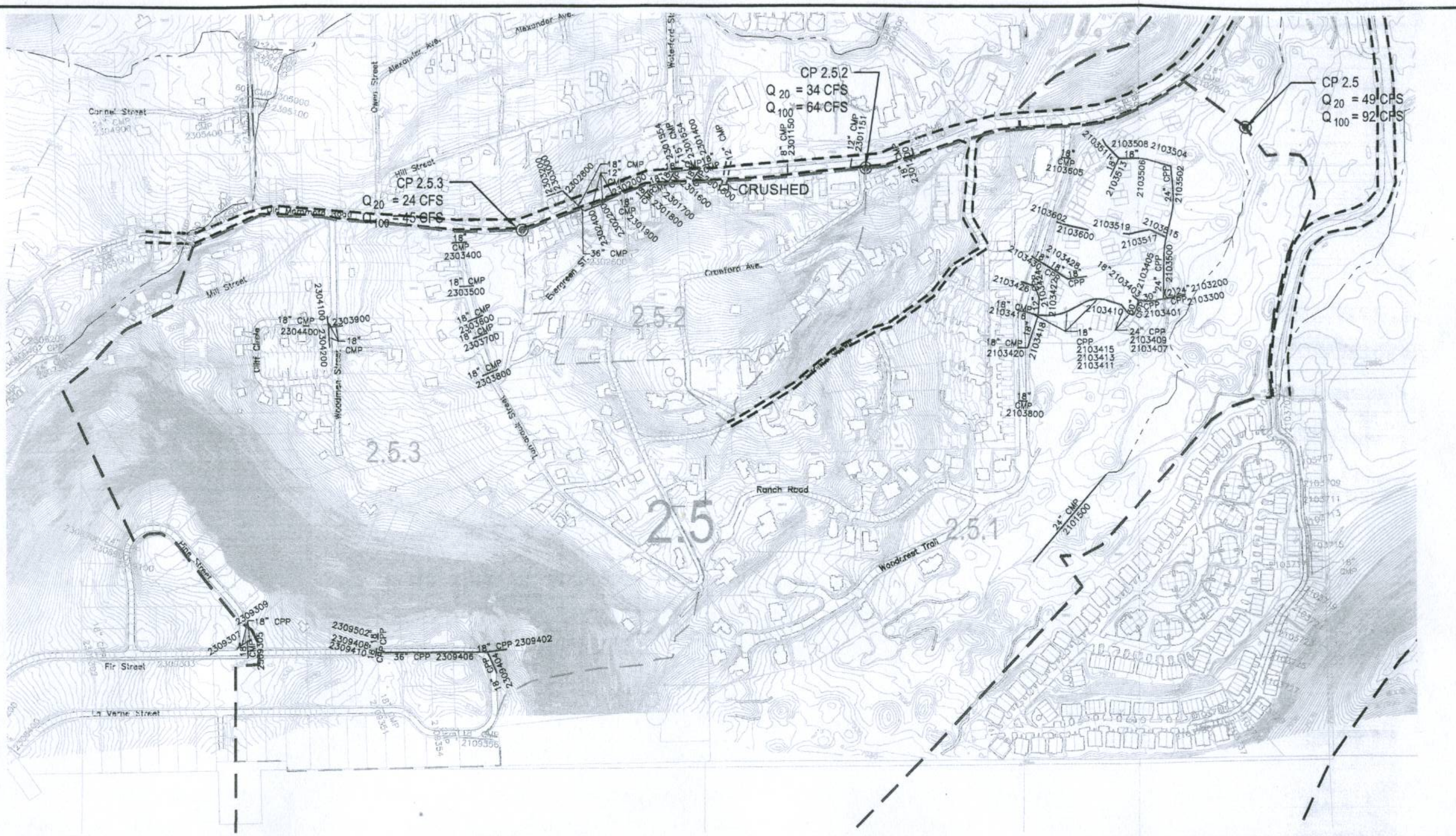
The values for the tables above were determined primarily for the purpose of determining the discharge values within the elements of the storm drain system as outlined in Section 5.

C. Procedure B Development

Procedure B is intended for use in larger, natural areas. A flow-frequency analysis approach was adopted, based on the flow data available and the ease with which it could be applied. Sufficient concurrent precipitation and runoff data were not available to develop a hydrograph method with reasonable accuracy.

The flow out of a large, natural basin in the Mammoth Lakes area has two principal components--snowmelt and rain flood flows. In general, flow records indicate that the peak flows in Mammoth Creek at Highway 395 are produced by snowmelt. Extreme rainfall events may produce short-term peaks on an annual hydrograph, which is dominated by flows produced by snowmelt. This situation is typical of major basins on the eastern side of the Sierra Nevada.

The mean daily flow records for Hot Creek at Highway 395 were used to develop the flow-frequency relationships. Snowmelt flows were segregated from rain flood flows by plotting flow-frequency relationships separately for rainy and non-rainy periods.



NOTES:

1. FLOWS SHOWN ARE TOTALS FOR FUTURE BUILD OUT CONDITIONS.

LEGEND

- MAJOR WATERSHED BOUNDARY
- DETAILED DRAINAGE WATERSHED BOUNDARIES
- FLOWLINE
- STORM DRAIN, EXISTING
- STORM DRAIN, RECOMMENDED
- CURB AND GUTTER, EXISTING
- CURB AND GUTTER, RECOMMENDED
- WATERSHED COLLECTION POINT, CP
- 30" RECOMMENDED PIPE REPLACEMENT OR NEW PIPE. (RED SHADING = PRIORITY 1, YELLOW SHADING = PRIORITY 2)
- 10 NEW PIPE ID

200' 100' 0 200' 400'
SCALE IN FEET

BOYLE

TOWN OF MAMMOTH LAKES

AREA 2.5 PLAN

VT-M01-100-01 | MAY 2005 | EXHIBIT 8.7

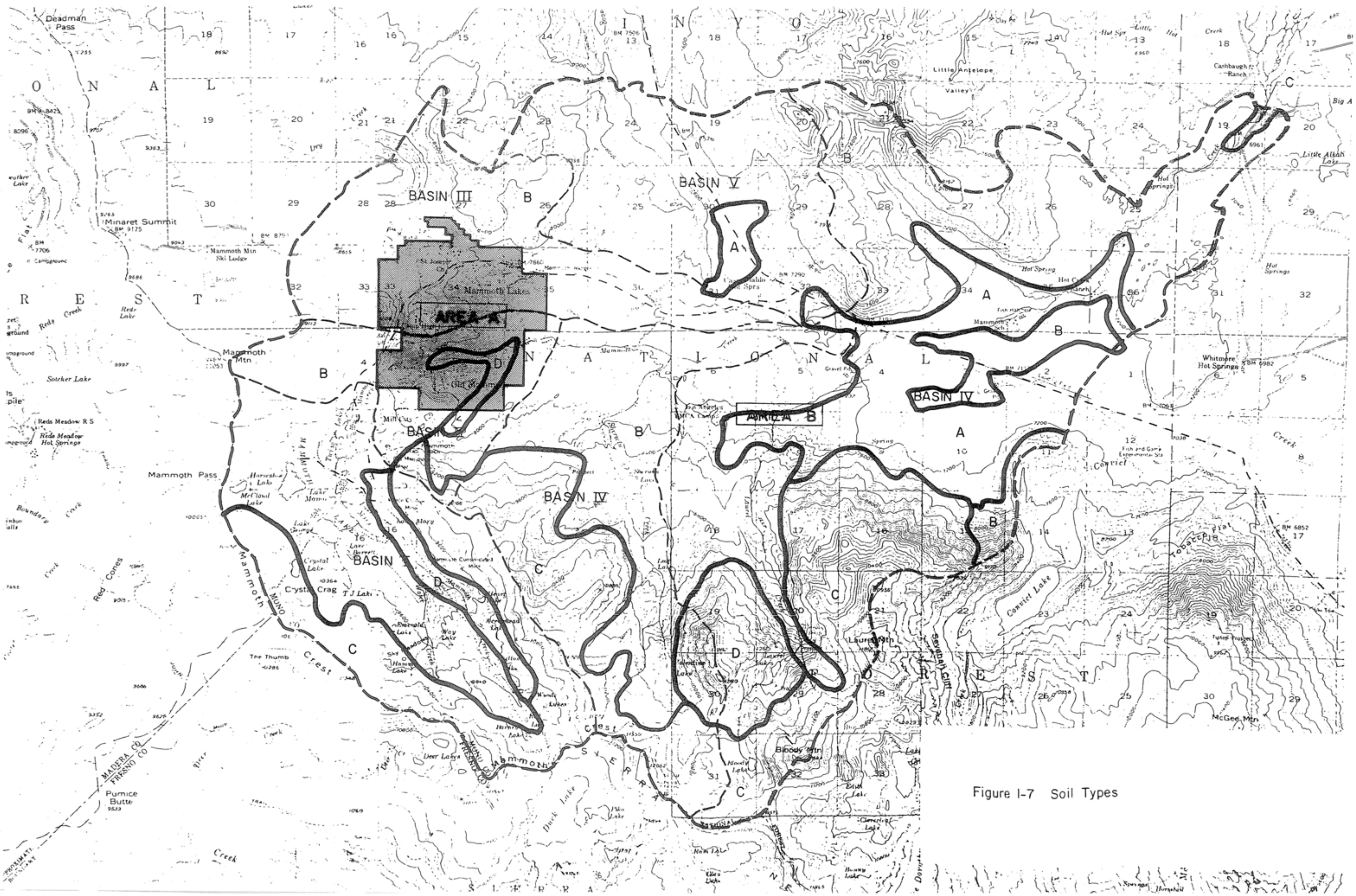


Figure I-7 Soil Types

4.8 LAND DEVELOPMENT

The construction and maintenance of urban and commercial developments can impact water quality in many ways. Construction activities inherently disturb soil and vegetation, often resulting in accelerated erosion and sedimentation. Stormwater runoff from developed areas can also contain petroleum products, nutrients, and other contaminants.

This section contains a discussion of the potential water quality impacts expected to result from land development activities, followed by control measures to reduce or offset water quality impacts from such activities.

Construction Activities and Guidelines

Construction activities often produce erosion by disturbing the natural ground surface through scarifying, grading, and filling. Floodplain and wetland disturbances often reduce the ability of the natural environment to retain sediment and assimilate nutrients. Construction materials such as concrete, paints, petroleum products, and other chemicals can contaminate nearby water bodies. Construction impacts such as these are typically associated with subdivisions, commercial developments, and industrial developments.

Control Measures for Construction Activities

The Regional Board regulates the construction of subdivisions, commercial developments, industrial developments, and roadways based upon the level of threat to water quality. The Regional Board will request a Report of Waste Discharge and consider the issuance of an appropriate permit for any proposed project where water quality concerns are identified in the California Environmental Quality Act (CEQA) review process. Any construction activity whose land disturbance activities exceed five acres must also comply with the statewide general NPDES permit for stormwater discharges (see "Stormwater" section of this Chapter).

The following are guidelines for construction projects regulated by the Regional Board, particularly for projects located in portions of the Region where erosion and stormwater threaten sensitive watersheds. The Regional Board recommends that each county within the Region adopt a grading/erosion control ordinance to require implementation of these same guidelines for all soil disturbing activities:

1. Surplus or waste material should not be placed in drainageways or within the 100-year floodplain of any surface water.
2. All loose piles of soil, silt, clay, sand, debris, or other earthen materials should be protected in a reasonable manner to prevent any discharge to waters of the State.
3. Dewatering should be performed in a manner so as to prevent the discharge of earthen material from the site.
4. All disturbed areas should be stabilized by appropriate soil stabilization measures by October 15th of each year.
5. All work performed during the wet season of each year should be conducted in such a manner that the project can be winterized (all soils stabilized to prevent runoff) within 48 hours if necessary. The wet season typically extends from October 15th through May 1st in the higher elevations of the Lahontan Region. The season may be truncated in the desert areas of the Region.
6. Where possible, existing drainage patterns should not be significantly modified.
7. After completion of a construction project, all surplus or waste earthen material should be removed from the site and deposited in an approved disposal location.
8. Drainage swales disturbed by construction activities should be stabilized by appropriate soil stabilization measures to prevent erosion.
9. All non-construction areas should be protected by fencing or other means to prevent unnecessary disturbance.
10. During construction, temporary protected gravel dikes, protected earthen dikes, or sand bag dikes should be used as necessary to prevent discharge of earthen materials from the site during periods of precipitation or runoff.

11. Impervious areas should be constructed with infiltration trenches along the downgradient sides to dispose of all runoff greater than background levels of the undisturbed site. Infiltration trenches are not recommended in areas where infiltration poses a risk of ground water contamination.

12. Infiltration trenches or similar protection facilities should be constructed on the downgradient side of all structural drip lines.

13. Revegetated areas should be continually maintained in order to assure adequate growth and root development. Physical erosion control facilities should be placed on a routine maintenance and inspection program to provide continued erosion control integrity.

14. Waste drainage waters in excess of that which can be adequately retained on the property should be collected before such waters have a chance to degrade. Collected water shall be treated, if necessary, before discharge from the property.

15. Where construction activities involve the crossing and/or alteration of a stream channel, such activities should be timed to occur during the period in which stream flow is expected to be lowest for the year.

16. Use of materials other than potable water for dust control (i.e., reclaimed wastewater, chemicals such as magnesium chloride, etc.) is strongly encouraged but must have prior Regional Board approval before its use.

Specific Policy and Guidelines for Mammoth Lakes Area

To control erosion and drainage in the Mammoth Lakes watershed at an elevation above 7,000 feet (Figure 4.8-1), the following policy and guidelines apply:

Policy:

A Report of Waste Discharge is required not less than 90 days before the intended start of construction activities of a **new development** of either (a) six or more dwelling units, or (b) commercial developments involving soil disturbance on one-quarter acre or more.

The Report of Waste Discharge shall contain a description of, and time schedule for implementation, for both the **interim erosion control measures** to be applied during project construction, and **short- and long-term erosion control measures** to be employed after the construction phase of the project. The descriptions shall include appropriate engineering drawings, criteria, and design calculations.

Guidelines:

1. Drainage collection, retention, and infiltration facilities shall be constructed and maintained to prevent transport of the runoff from a 20-year, 1-hour design storm from the project site. A 20-year, 1-hour design storm for the Mammoth Lakes area is equal to 1.0 inch (2.5 cm) of rainfall.

2. Surplus or waste materials shall not be placed in drainageways or within the 100-year flood plain of surface waters.

3. All loose piles of soil, silt, clay, sand, debris, or earthen materials shall be protected in a reasonable manner to prevent any discharge to waters of the State.

4. Dewatering shall be done in a manner so as to prevent the discharge of earthen materials from the site.

5. All disturbed areas shall be stabilized by appropriate soil stabilization measures by October 15 of each year.

6. All work performed between October 15th and May 1st of each year shall be conducted in such a manner that the project can be winterized within 48 hours.

7. Where possible, existing drainage patterns shall not be significantly modified.

8. After completion of a construction project, all surplus or waste earthen material shall be removed from the site and deposited at a legal point of disposal.

9. Drainage swales disturbed by construction activities shall be stabilized by the addition of crushed rock or riprap, as necessary, or other appropriate stabilization methods.

10. All nonconstruction areas shall be protected by fencing or other means to prevent unnecessary disturbance.

11. During construction, temporary erosion control facilities (e.g., impermeable dikes, filter fences, hay bales, etc.) shall be used as necessary to prevent discharge of earthen materials from the site during periods of precipitation or runoff.

12. Revegetated areas shall be regularly and continually maintained in order to assure adequate growth and root development. Physical erosion control facilities shall be placed on a routine maintenance and inspection program to provide continued erosion control integrity.

13. Where construction activities involve the crossing and/or alteration of a stream channel, such activities shall be timed to occur during the period in which streamflow is expected to be lowest for the year.

Land Development/Urban Runoff Control Actions for Susan River Watershed

1. To protect riparian vegetation and wetlands from land disturbance activities, the Regional Board shall recommend that Lassen County and the City of Susanville require new development or any land disturbing activities to include buffer strips of undisturbed land, especially along the Susan River and its tributaries.

2. The Regional Board, with assistance from the City of Susanville and the California Department of Transportation (Caltrans), should conduct monitoring of the Susan River and Piute Creek within the City of Susanville to assess impacts from urban runoff. Control measures should be planned and implemented based on the results of the monitoring. The monitoring plan should be developed to identify nonpoint sources needing control. Monitoring proposals will be submitted by the Regional Board, and work will be conducted as resources allow and as the Susan River gains priority.

3. The Regional Board shall encourage and assist other agencies in watershed restoration efforts along the Susan River.

4. The Regional Board shall encourage the City of Susanville and Lassen County to adopt a comprehensive grading ordinance. These ordinances should require, for all proposed land disturbing activities, the use of Best Management Practices to reduce erosion and stormwater runoff, including but not limited to temporary and permanent erosion control measures.

5. The Regional Board shall encourage the City of Susanville, Lassen County and Caltrans to implement Best Management Practices to reduce erosion and stormwater runoff when constructing and maintaining roads, both paved and unpaved, under their jurisdiction.

Road Construction and Maintenance

Road construction activities often involve extensive earth moving, including clearing, scarifying, excavating for bridge abutments, disturbing or modifying floodplains, cutting, and filling. Additionally, the potential for land disturbance exists from construction materials, equipment maintenance, fuel storage facilities, and general equipment use.

Once constructed, impervious road surfaces create another source of water pollution. Oils, greases, and other petroleum products, along with such toxic materials as battery acid, antifreeze, etc., may be deposited along the road surfaces. These contaminants become suspended or dissolved in any stormwater runoff that is generated on the road surfaces. Unless otherwise treated, these contaminants will flow toward local surface or ground waters. (See "Stormwater" section of this Chapter.)

Road maintenance can be potentially threatening to water quality in a number of ways. Below-grade culverts slowly fill with sediment and are cleaned out periodically, sometimes by flushing accumulated sediment into downstream drainageways. Grading of shoulders and drainageways can detach sediments and increase the risk of erosion into nearby surface waters. Road surfaces may be repainted or resealed with materials that harden quickly, but which can be washed off while still fresh by stormwater runoff.

In the winter, roads are often snowy, icy, or wet. To reduce winter road hazards, maintenance crews may remove the snow or ice, apply sand to provide added traction, and/or apply deicing chemicals to melt the snow and ice. Sand is rapidly dissipated or crushed by the traffic, and must be replaced frequently. Great quantities of sediment enter drainageways and/or surface waters due to this practice. Snow may be removed mechanically via snowplow or snowblower. This practice is not particularly detrimental to water quality in itself, but the snow often carries substances from the roadway when removed. Sediments, chemical deicers, and vehicle fluids may travel much farther than they would otherwise, possibly reaching area surface waters. Ice and small accumulations of snow may be removed with chemical deicers. The deicer in widest use is rock salt (sodium chloride), due to its low cost, high availability, and predictable results.

Winter road maintenance was brought to the forefront in 1989 when significant numbers of roadside trees in the Lake Tahoe Basin suddenly started dying. The public outcry caused many environmental groups and regulatory agencies, including the Regional Board, to look more closely at what had been a more or less unscrutinized, unregulated process in the past. Data began to show that Caltrans was using very high amounts of salt each winter, and the figure seemed to increase from one year to the next. The consensus of the various regulatory agencies was that Caltrans should reduce salt use, explore various alternate deicers, and monitor the impacts of salt applications on soil, water, and vegetation. Salt use decreased significantly from 1989-1992, due to more careful application procedures and to drought conditions.

At least three alternate deicers have been explored: calcium magnesium acetate, potassium acetate, and magnesium chloride with corrosion inhibitors. These products have shown some promise, but further study is required. The cost to switch to an alternate deicer will be significant. The road departments are unwilling to make the switch unless an alternate deicer is demonstrably better environmentally, will not require too much adjustment on the part of the maintenance crews and equipment, and will actually do an effective and predictable job when applied.

However, Caltrans' monitoring of vegetation showed minimal and temporary salt accumulation within the vegetation. During the spring, any salt that had accumulated in the vegetation was flushed out from the plant material. The impacts of chemical deicers on fish and wildlife within the Lahontan Region have not been studied.

Control Measures for Road Construction and Maintenance

(Additional control measures for roads are included in the "Stormwater" section of this Chapter.)

The Regional Board regulates road construction and maintenance projects within the Lahontan Region, concentrating efforts on major construction and construction in sensitive areas. Major construction projects and those projects in sensitive areas are most often regulated under individual WDRs, and are routinely inspected. Less significant projects may be issued conditional waivers of WDRs. The Regional Board has also adopted road maintenance waste discharge requirements for some county governments in the Region. Road construction and maintenance in the Lake Tahoe Basin is also regulated under municipal NPDES Stormwater Permits (see Chapter 5).

For all road projects, the Board requires that construction be conducted in a manner which is protective to water quality, and that, at the end of a given project, the site be restabilized and revegetated. These requirements are detailed in a Management Agency Agreement with Caltrans regarding the implementation of BMPs. Additionally, all road projects are to be in compliance with the Caltrans Statewide 208 Plan (CA Dept. of Transportation 1980), which was approved by the State Board in 1979. This Plan contains a commitment to implement BMPs, but does not include great detail on the BMPs themselves. The State Board should encourage Caltrans to update its 208 plan to provide such detail, with particular attention to:

- stormwater/erosion control along existing highways

- erosion control during highway construction and maintenance

- reduction of direct discharges (e.g., through culverts)
- reduction of runoff velocity
- infiltration, detention and retention practices
- management of deicing compounds, fertilizer, and herbicide use
- spill cleanup measures
- treatment of toxic stormwater pollutants

Since much of the implementation of BMPs on highways is done by Caltrans' contractors, the selection of qualified contractors and ongoing education of construction and maintenance personnel on BMP techniques are particularly important.

In the Lake Tahoe Basin, all governmental agencies assigned to maintain roads are required to bring all roads in the Lake Tahoe Basin into compliance with current "208" standards within a specified time schedule. That is, all existing facilities must be retrofitted to handle the stormwater runoff from the 20-year, 1-hour storm, and to restabilize all eroding slopes. The twenty-year time frame for this compliance process ends in 2008.

The Regional Board should allow salt use to continue as one component of a comprehensive winter maintenance program. However, the Regional Board should continue to require that it be applied in a careful, well-planned manner, by competent, trained crews. Should even the "proper" application of salt be shown to cause adverse water quality impacts, the Regional Board should then require that it no longer be used in environmentally sensitive areas, such as the Lake Tahoe Basin. Similarly, should an alternate deicer be shown to be effective, environmentally safe, and economically feasible, its use should be encouraged in lieu of salt.

Figure 4.8-1
OWENS HYDROLOGIC UNIT