Caltrans Construction Stormwater Pollution Prevention Training

Introduction to Construction Stormwater Pollution Prevention Program

Module 1

CTSW-OT-07-171.15.1

Introduction: Your Facilitators

- Who am I?
- What is my background?
- What is my stormwater background?

Introduction: About You

- Who are you?
- What is your stormwater background?
- What do you want to learn from this class?

Introduction: Course Administration

- Sign-in / Attendance Forms
- Breaks
- Restrooms
- Emergency Exits
- Classroom Etiquette

Why Are You Here?

- To Learn About Past and Current Regulatory Issues
- To Comply With Permit Requirements for Training
- To Review Caltrans' General Requirements for Water Pollution Control on Construction Sites

Course Highlights

- Introduction
- Impacts of Stormwater Pollution
- Pollutants Associated with Construction Activities
- Laws and Regulations
- Erosion Process
- Overview of Temporary Construction Site BMPs

Glossary

- **BMP** - Best Management Practice
- **CPD** - Construction Procedure Directive
- **CSWC** - Construction Storm Water Coordinator
- **EPA** - Environmental Protection Agency
- **NPDES** - National Pollutant Discharge Elimination System
- **NRDC** - Natural Resources Defense Council
- **NSSP** - Non-Standard Special Provision
- **RWQCB** - Regional Water Quality Control Board

Glossary

- **SAP** - Sampling and Analysis Plan
- **SP** - Standard Plan
- **SSP** - Standard Special Provision
- **SWMP** - Storm Water Management Plan
- **SWPPP** - Storm Water Pollution Prevention Plan
- **SWRCB** - State Water Resources Control Board
- **WPCM** - Water Pollution Control Manager
- **WPCP** - Water Pollution Control Program

Introduction

Introduction

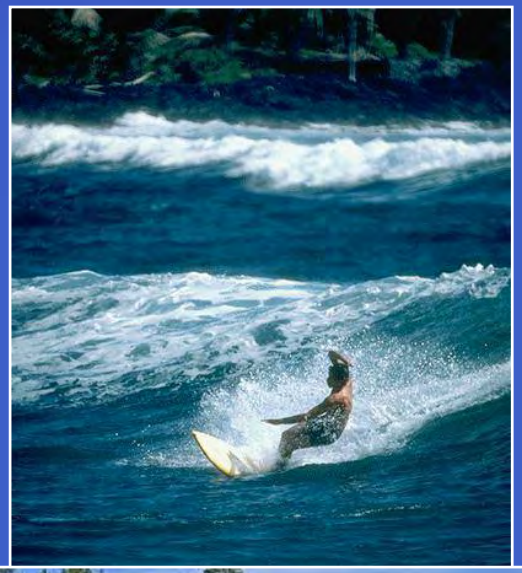
Why is clean water so important?

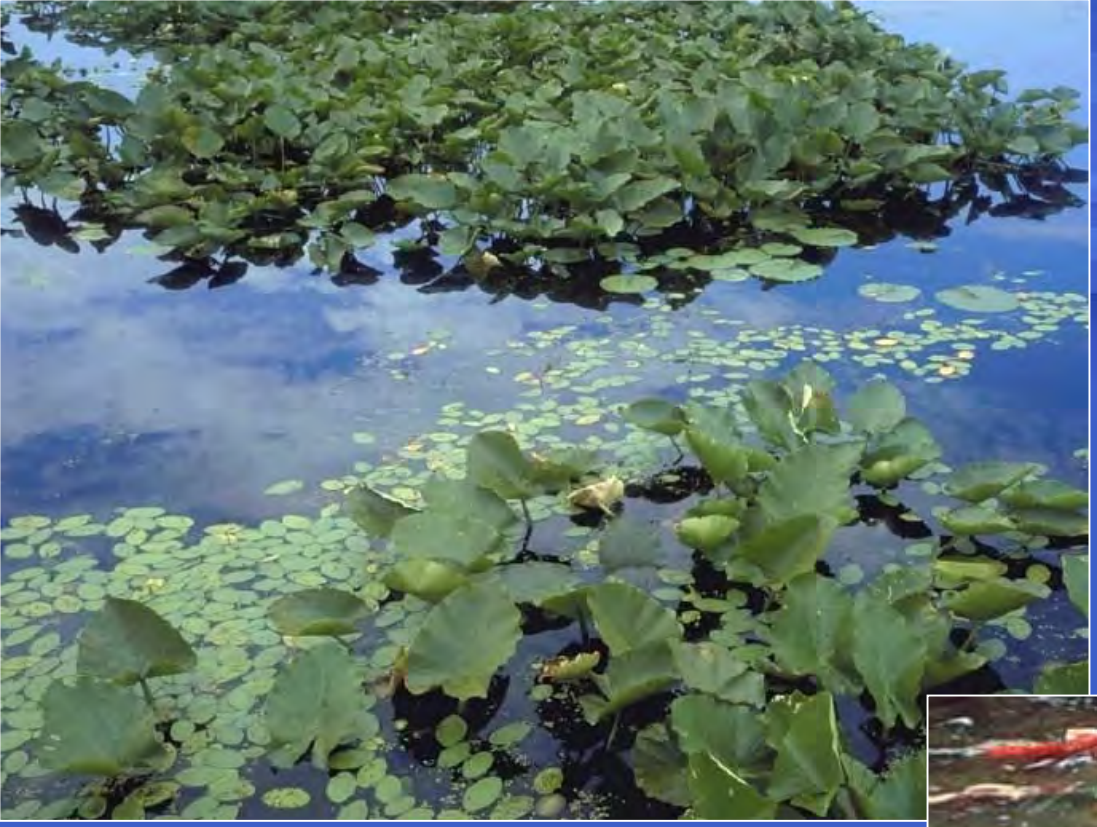
ALL the essential elements of life depend on it.

Introduction

Water Pollution Prevention

- Overall Purpose
  - To Reduce Potential Environmental and Human Health Impacts
  - Comply with State and Federal Laws
  - Highest and Best Beneficial Use of Water Resources





Plants –
(and smaller organisms)

Fish -

Waterfowl -

Wildlife -

Livestock

and People.

All of these life forms depend on clean water for their existence.

Stormwater/Non-Stormwater

- **Stormwater:** Water that is on site that comes from rain or snow melt.

- **Non-stormwater:** Water that is on site that comes from everything but rain or snow melt (vehicle washing, dust control, irrigation, water line flushing, groundwater, etc.).

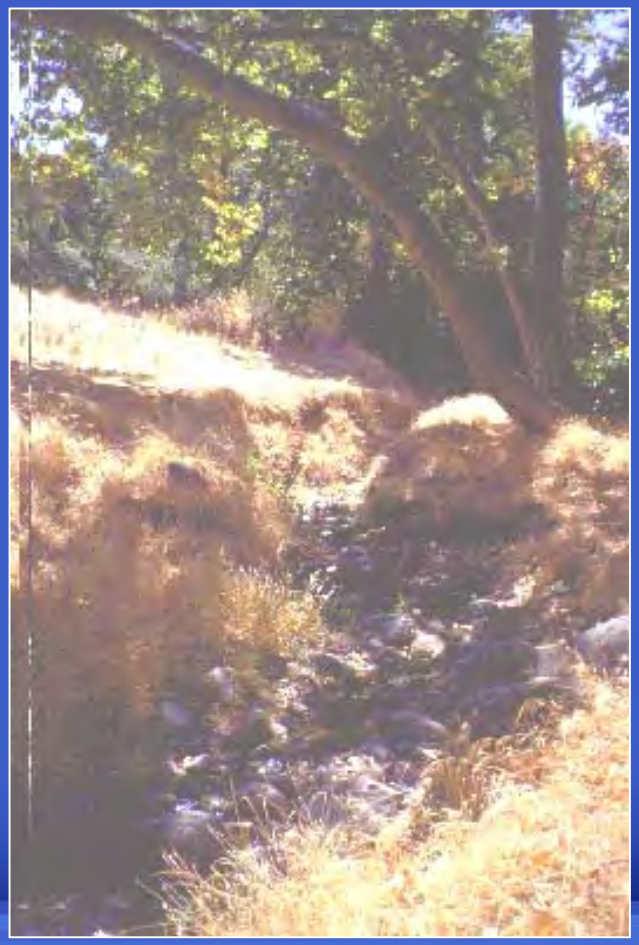
Water Body/Water of the State/Water of the U.S.

- **Water Body (SWMP):** Includes creeks, rivers, reservoirs, lakes, wetlands, lagoons, estuaries, bays, and the Pacific Ocean, and tributaries thereto.

- **Water of the State (Porter-Cologne):** "… any water, surface or underground, including saline waters, within the boundaries of the State…"
  – includes estuaries, deltas, rivers, creeks (including seasonal or intermittent), wetlands, ponds, grassy swales

Water of the State

- This seasonal creek is a “water of the state,” regardless of when it flows.



This seasonal wetland is also a “water of the state.”

Water of the U.S.

- **Water of the U.S. (CWA):** Territorial seas, coastal and inland lakes, rivers, streams, wetlands, and intermittent streams (e.g., some USGS Blue Line Streams)

Course Highlights

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Impact of Construction Activities

- Pre-constructed site generally in state of equilibrium
- Construction activities may disrupt equilibrium
- Underlying soils and exposed rock control natural erodibility and revegetation
- Water may exacerbate erosion or aid in revegetation

Impact of Construction Activities

- Large areas of soil are disturbed
- Existing drainages are altered
- Slope steepness is increased
- Existing vegetation is removed
- Impervious surfaces are increased
- Topsoil is removed

Sediment is, by far, the most common pollutant on roadway construction projects

Impacts

Construction Site Pollutants

Erosion and Sedimentation

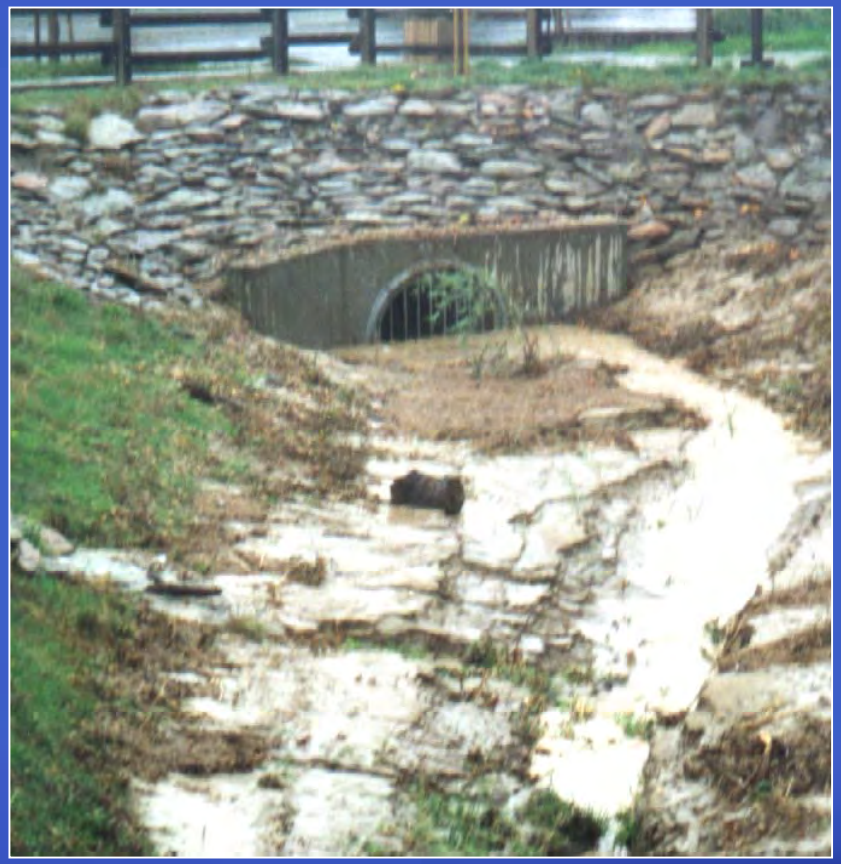
Construction Wastes

Uncontrolled erosion has enormous impacts on ecosystems.

Let's look more closely at this stream, which was adversely impacted by sedimentation from a construction site.

Sedimentation may lead to...

Cleanup Costs



Declining Fisheries

Dredging Costs

Impaired Recreational Water Use

Economic Impacts and Loss of Tourism

Aesthetic Losses

Impacts

- Forty percent of all U.S. waters are not fishable or swimmable, according to the U.S. EPA

- "Even a partial accounting shows that hundreds of millions of dollars are lost each year….due to urban stormwater pollution"

  Natural Resources Defense Council

Impacts

- "On a unit basis, construction sites export sediment at 20 to 1,000 times the rates of other land uses."

According to the EPA

Impacts

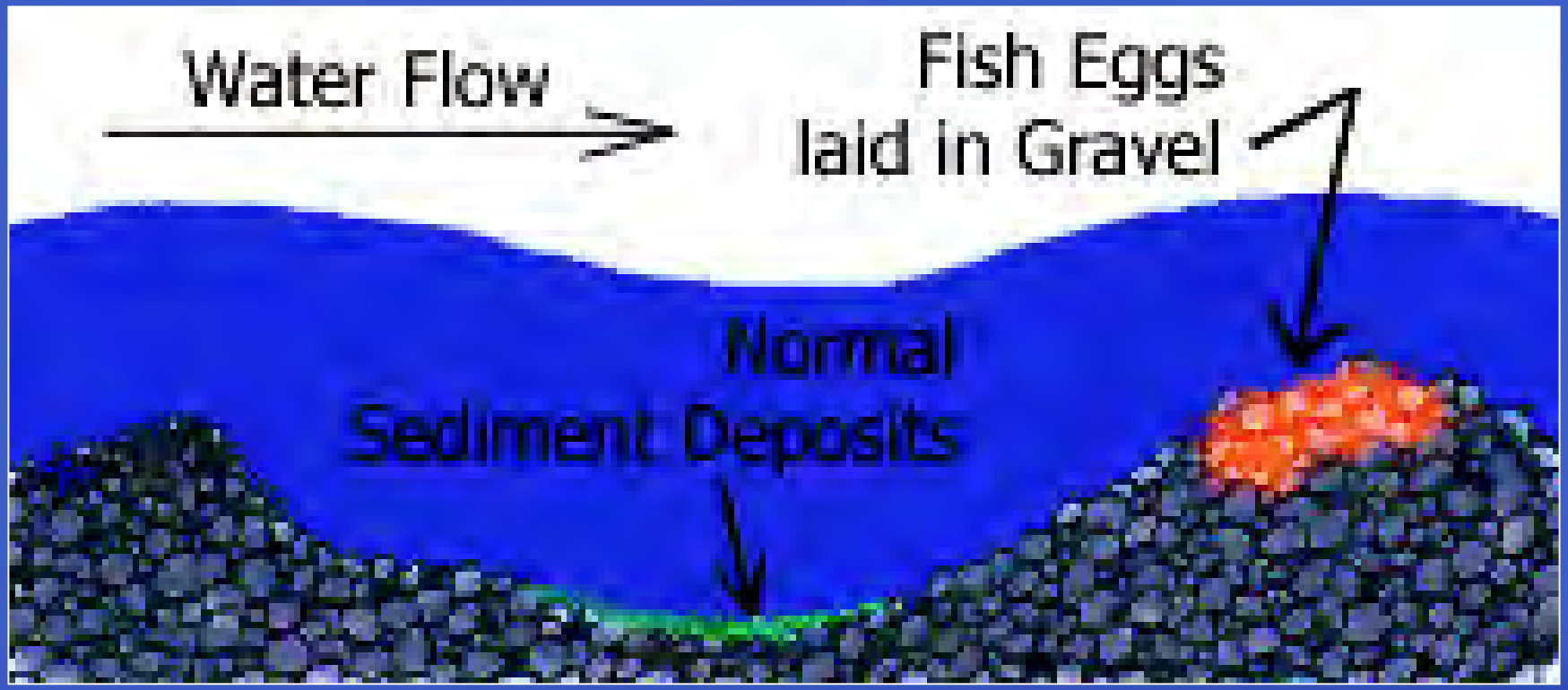
- "An estimated 80 Millions Tons of solids are discharged annually from construction sites into receiving waters"

According to the EPA

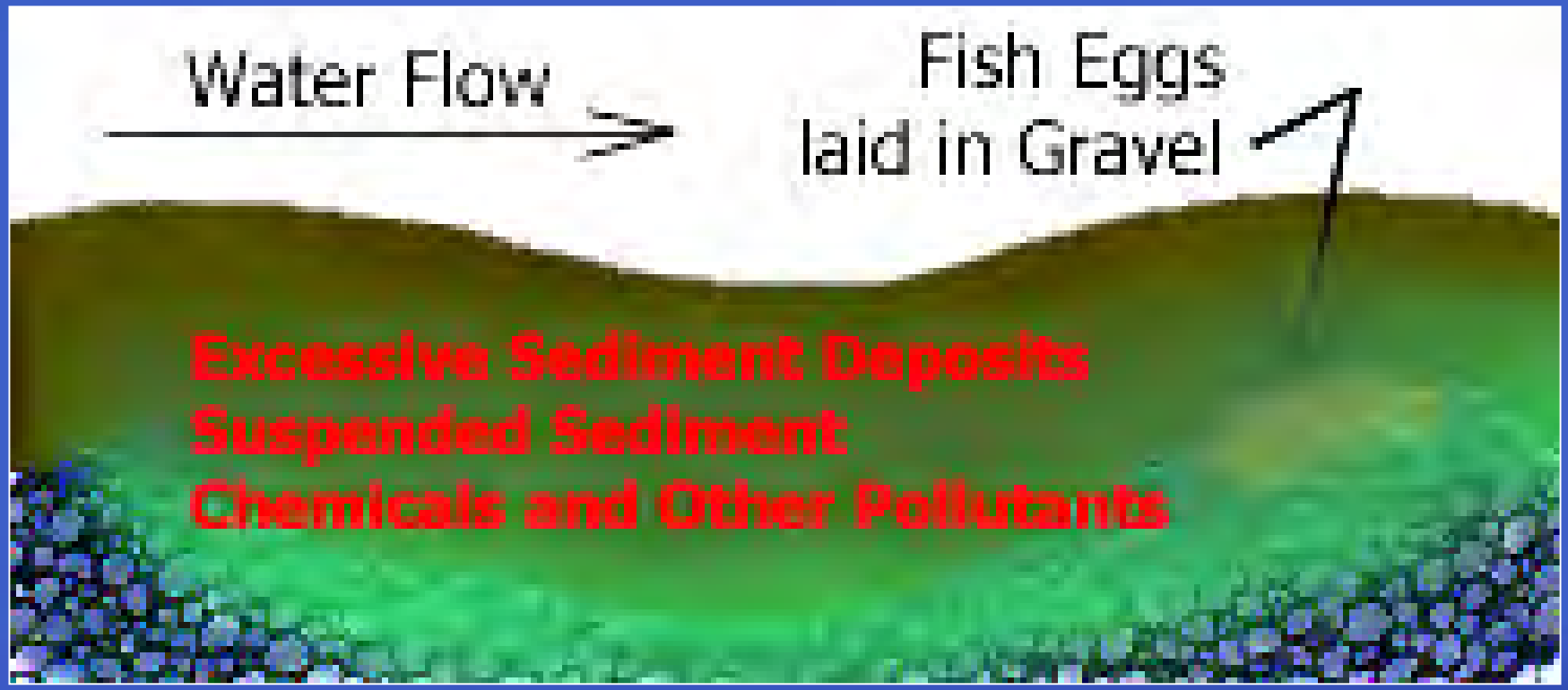
Impacts

- Sediment, the most common pollutant washed from construction sites, clogs the gills of fish, blocks light transmission and increases ocean water temperature …..harming aquatic life, and disturbing the food chain

A healthy stream



A stream impacted by sedimentation and chemicals caused by erosion and toxic chemical releases from a construction site



Impacts

- One gallon of oil has the potential to contaminate up to one million gallons of water

StormWater/CleanWater protection program

Course Highlights

- Introduction
- Impacts of Stormwater Pollution
- ***Pollutants Associated with Construction Activities***
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Activities Potentially Contributing Sediment

- Clearing and grubbing operations
- Mobilization of material, personnel, and debris
- Grading and earthwork operations
- Excavation operations
- Demolition of existing structures
- Dewatering operations
- Soil importing and stockpiling
- Bridge and culvert construction
- Paving operations
- Landscaping operations

Stormwater pollution can be many things...

- **Soil, Dirt, and Sediment**
- **Paints and Solvents**
- **Pesticides/Herbicides**
- **Fertilizers**
- **Detergents**
- **Plaster or related products**
- **Concrete compounds**
- **Asphalt compounds**
- **Petroleum products**

  fuel, oil, and grease
- **Hazardous chemicals**

  acids, lime, glues, adhesives, and curing compounds

And others...

Common Pollutants on the Construction Site

- Vehicle fluids
- Asphalt and Portland cement concrete materials and waste
- Joint and curing compounds
- Paints, solvents, and thinners
- Wood products
- Metals and plated products
- Fertilizers, herbicides, and pesticides
- Sand blasting waste
- Green waste from vegetation removal
- Sanitary waste
- Wastewater/waste from concrete washout operations

Pollutants of Concern

Toxic Chemicals

Pollutants of Concern

Exposed Materials

Pollutants of Concern

Pollutants of Concern

Nutrients

Pollutants of Concern

Oxygen Demand

Pollutants of Concern

Oil and Grease

Pollutants of Concern

Illegal Discharge

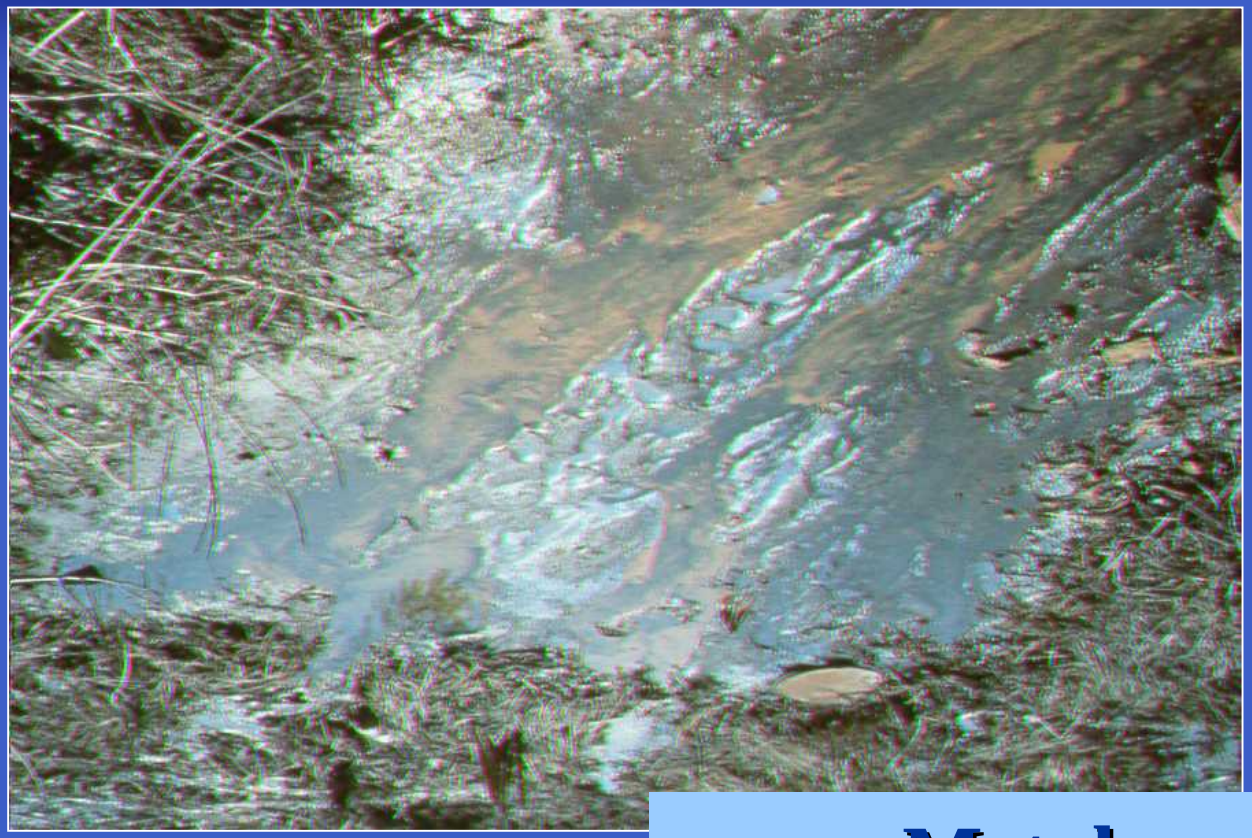
Pollutants of Concern

Hydrocarbons

Pollutants of Concern

Litter

Pollutants of Concern



Metals

Pollutants of Concern

Chlorides

Pollutants of Concern

Elevated Temperatures

Course Highlights

- Introduction
- Impacts of Stormwater Pollution
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- ***Laws and Regulations***
- Erosion Process
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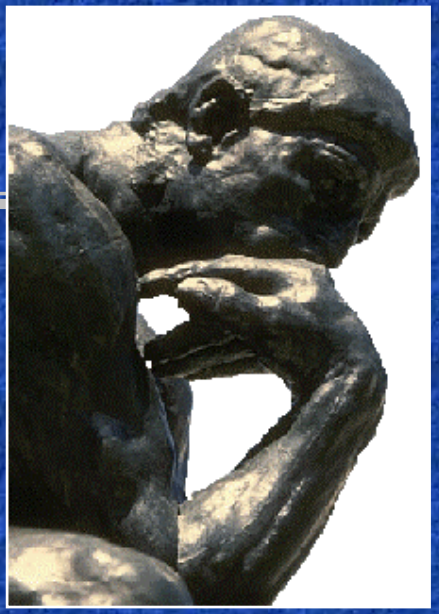
Laws and Regulations

- Introduction
- **The Law**
- **Permits**
- **Regulatory Fines**
- **Manuals and Specs**
- **Role of the Players**

Introduction

- ⇒ ***Introduction***
- ⇒ **The Law**
- ⇒ **Permits**
- ⇒ **Regulatory Fines**
- ⇒ **Manuals and Specs**
- ⇒ **Role of the Players**

What You Will Learn



- Why Water Pollution Should be Prevented
- Monetary Fines are Real
- Which Documents Govern on Caltrans Construction Sites
- Roles and Responsibilities

The Law

- ⇒ Introduction
- ⇒ ***The Law***
- ⇒ Permits
- ⇒ Regulatory Fines
- ⇒ Manuals and Specs
- ⇒ Role of the Players

The Law

- 1972 Federal Clean Water Act (CWA)
  - Amend to Prohibit Any Discharge of Pollutants from a Point Source
- 1987 Amendments to the CWA
  - Added Section 402(p) Establishing the Framework for Regulations Regarding Municipal and Industrial Discharges
- 1990 EPA Published Final Regulations
  - Established Permit Requirements for Stormwater Discharges Associated with Industrial (Including Construction) Activities
- 1992 California's General Permit was Adopted – 02 Permit
  - Established Requirements for Discharges Associated with Construction Activities
  - Amended 1999, modified in 2001 to establish sampling and analysis requirements for section 303(d) listed water bodies and 2003
- 1999 Caltrans NPDES Permit was issued – 03 Permit
- Local MS4 Permits

Permits

- ⇒ Introduction
- ⇒ The Law
- ⇒ ***Permits***
- ⇒ Regulatory Fines
- ⇒ Manuals and Specs
- ⇒ Role of the Players

Permits

- General Construction Permit CAS000002 - The '02 permit
  - The 02 Permit was amended in 2001 to include monitoring, and in 2003 to cover 1 acre or more soil disturbance
- Caltrans NPDES Permit CAS000003 - The '03 permit
  - The 03 Permit requires that Caltrans' construction program complies with the General Construction Activity Permit for construction sites that disturb 1 acres or more
  - Both permits can be viewed and downloaded from the State Water Resources Control Board website, www.swrcb.ca.gov
  - Local MS4 Permits

1999 General Construction Permit

- General Permit renewed in 1999
- Expanded BMP requirements
- Expanded monitoring requirements
  - Site inspections
  - Before, during and after storms
  - Repair, replace, maintain BMPs
  - Document inspections and certify compliance annually

General Permit Challenged

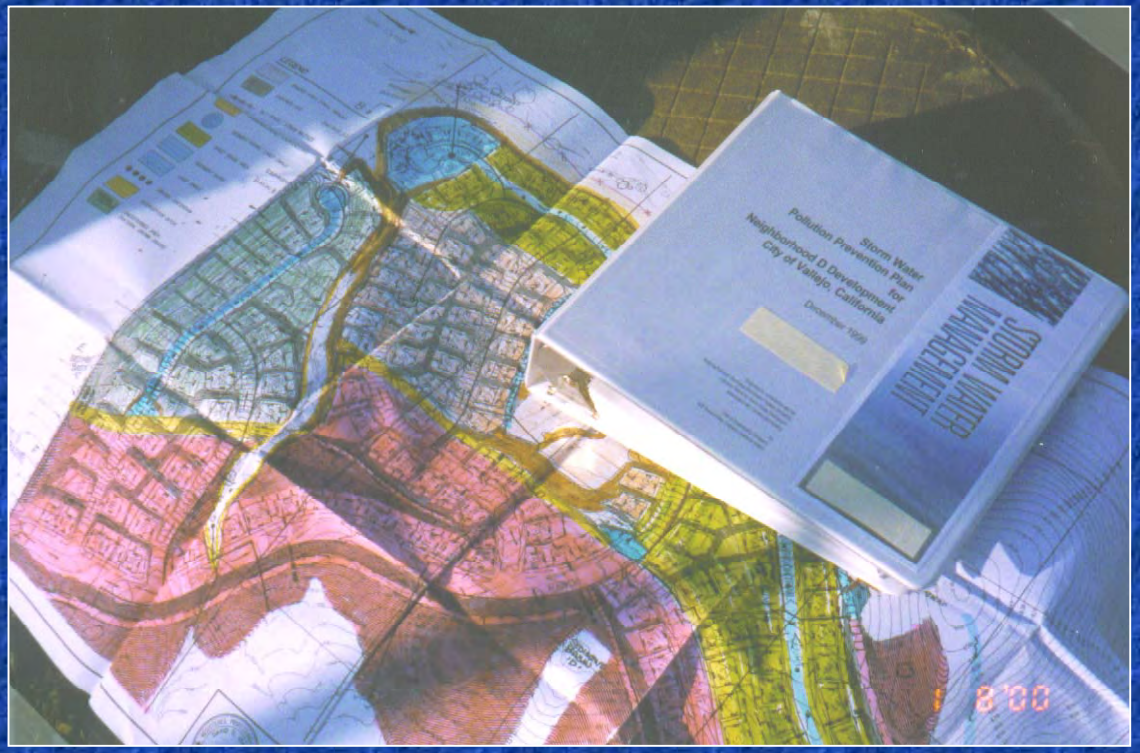
- Cited the absence of sampling and analysis requirements for:
  - Stormwater discharges to water bodies listed as impaired for sediment-related pollutants
  - Pollutants that are known to occur on construction site that may not be visually detectable in stormwater discharges.

April 2001 Modifications

- Apply to all construction sites
- Two criteria:
  - 303(d) listed water bodies (sedimentation/siltation/turbidity)
  - Non-visible pollutants
- General Permit scheduled for renewal in 2007

The objective of the General Permit is to eliminate discharges from the construction site to storm drains and water bodies.

This is achieved by developing and implementing an effective Stormwater Pollution Prevention Plan for the site.



SWPPP Minimum Requirements

- Identify pollutant sources or potential pollutant sources that may impact stormwater discharges.
- Implement Construction Best Management Practices (BMPs) that achieve the performance standards of Best Available Technology economically achievable/Best Conventional Pollutant Control Technology (BAT/BCT) to reduce or eliminate stormwater pollution.

(We will cover disucss BMPs later today)

A general outline for a SWPPP

I. Title Page
II. Certification Page
III. Amendments
IV. Table of Contents
V. Introduction
VI. Source Identification
    I. Topography Map
    II. Site Map

Continued….

A general outline of a SWPPP cont.

VII. Narrative Descriptions

I. Site Estimates and Descriptions of On Site Soil

II. Pollutants Likely to be Present in Stormwater Discharges

III. Toxic Materials

IV. Erosion and Sediment Control Practices

V. Non-Stormwater Management

VI. Maintenance, Inspection and Repair of Structural Controls

VII. Spill Prevention and Control

VIII. Post-Construction Stormwater Management (Permanent)

IX. Personnel Training

X. Lists of Contractors/Sub-Contractors

XI. Other Plans

XII. Monitoring and Documentation

Topographic and site maps

can be used to graphically depict locations of:

1. Areas of soil disturbance
2. Surface water locations
3. Areas of existing vegetation to be preserved
4. Drainage patterns and slopes as they will appear after major grading is completed
5. Areas and methods of storage for soils, materials and wastes
6. Vehicle and equipment storage and service areas
7. Existing and planned paved areas and buildings
8. Location and type of post-construction control practices

SAMPLE WPCD TITLE SHEET WITH LEGEND

SAMPLE
WATER POLLUTION CONTROL DRAWINGS (WPCDs)
FOR
ROUTE BB
STAGE 1
ANYTOWN, ANY COUNTY
CALTRANS CONTRACT NO. 00-00000
PREPARED BY:
ZZZ CONSTRUCTION COMPANY

LEGEND

- WM-8 Cocrete Wash-Out Area
- SC-10 Storm Drain Inlet Protection
- Environmentally Sensitive Area
- Surface Flow Direction
- Pipe/Underground Flow Direction
- WM-7 Contaminated Soil Management
- WM-8 Concrete Waste Management
- NS-8 Vehicle & Equipment Cleaning
- NS-9 Vehicle & Equipment Fueling
- NS-10 Vehicle & Equipment Maintenance
- SS-2 Preservation of Existing Vegetation
- SS-4 Hydroseeding
- SS-6 Straw Mulch
- SS-5 Soil Binders
- TC-1 Stabilized Construction Entrance/Exit
- SS-11 Slope drains
- SS-9 Earth Dike/Drainage Swales and Lined Ditches
- SC-4 Check Dams
- SC-1 Silt Fences
- SC-3 Sediment Traps
- SC-5 Fiber Rolls
- Stormwater Discharge Location

GENERAL WATER POLLUTION CONTROL NOTES

1 THE INFORMATION ON THESE DRAWINGS ARE ACCURATE FOR WATER POLLUTION CONTROL PURPOSES ONLY.

2 THE INFORMATION ON THIS PLAN IS INTENDED TO BE USED AS A GUIDELINE FOR THE CONTRACTOR AND SUBCONTRACTORS TO INSTALL WATER POLLUTION CONTROL DEVICES AT GENERAL LOCATIONS THROUGHOUT THE SITE. THESE DRAWINGS ARE TO BE USED IN CONJUNCTION WITH THE NARRATIVE SECTION OF THE STORM WATER POLLUTION PREVENTION PLAN (SWPPP).

3 FIELD CONDITIONS MAY NECESSITATE MODIFICATIONS TO THESE DRAWINGS.

4 PERMANENT EROSION CONTROL WILL BE INSTALLED AS AREAS ARE DETERMINED TO BE SUBSTANTIALLY COMPLETE.

SAMPLE WPCD NOTE: DO NOT SIMPLY COPY THE FOLLOWING NOTES FOR PROJECT SPECIFIC USE. COPYING TEXT FROM THESE SAMPLE WPCDs DOES NOT NECESSARILY MEET NPDES PERMIT REQUIREMENTS. USE PROJECT SPECIFIC NOTES.

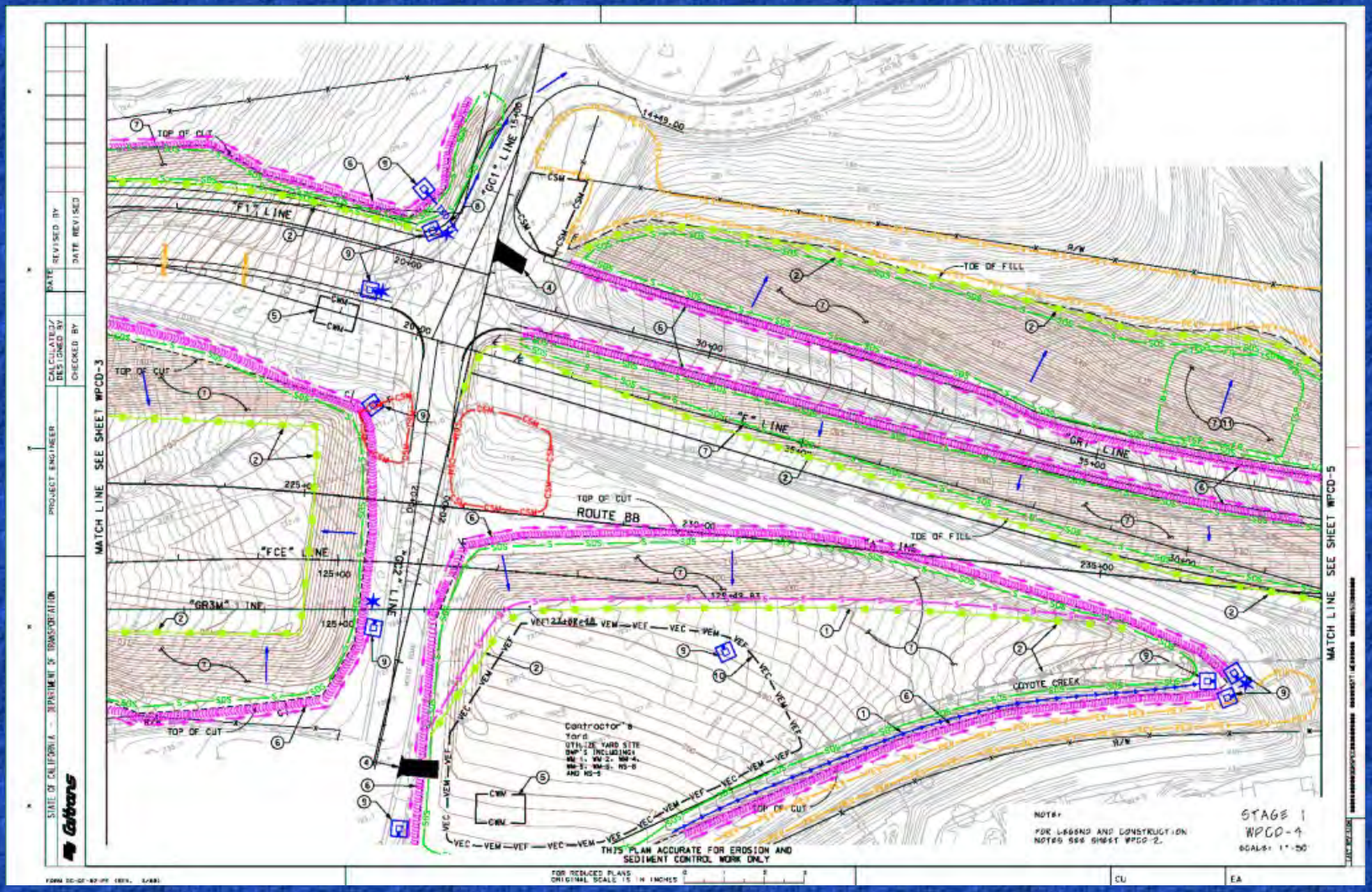
STORM WATER POLLUTION CONTROL CONSTRUCTION NOTES:
(LOCATIONS OF CIRCLED NUMBERS ARE SHOWN ON THE WPCD SHEETS)

1. Rock check dams
2. Silt fence
3. Gravel bag check dams
4. Stabilized construction entrance/exit.
5. Concrete Waste Management. See WPCPD-13 for contractor proposed alternate concrete washout detail.
6. Earth berms installed during excavation staging.
7. Surface roughening required on all slope areas before applying soil binders (on active slope or roadway) and/or straw mulch (on inactive slopes only). Inactive slopes greater than 60 feet in height will be hydroseeded.
8. Temporary slope drain without energy dissipation.
9. Sediment trap.
10. Combined Vehicle Cleaning, Fueling and Maintenance area.
11. Fiber rolls.

WPCD-1

ZZZ CONSTRUCTION COMPANY	WATER POLLUTION CONTROL DRAWINGS TITLE SHEET			
DRAWN D.J.D.				
APPROVED	SIZE A	SCALE NONE	DATE 11/00	REV 0	SHEET 1 OF 1

SAMPLE WPCD SHEET (BMP SYMBOLS PER TITLE SHEET)



Impaired Water Bodies

- States must develop list of impaired water bodies
- States identify impaired waters through a public process
- EPA approves the list, which is known as the 303(d) list
- The 303(d) list is revised every three years
- State develops Total Maximum Daily Loads (TMDLs) that limit pollutant discharges to water body
- Lists are available by State or Region from the SWRCB, RWQCBs and online at:

  http://www.waterboards.ca.gov/tmdl/303d_lists.html

Some Water Bodies Impaired for Sediment in Northern California

SWRCB REGION	CALTRANS DISTRICT	WATER BODY NAME
1	1	Trinity River, South Fork
1	1	Elk River
1	1	Russian River
1	1	Jacoby Creek
1	1	Mad River
2	4	Tomales Bay
2	4	Napa River
2	4	Butano Creek
2	4	Lagunitas Creek
2	4	Pescadero Creek
2	4	Petaluma River

Some Water Bodies Impaired for Sediment in Northern California

SWRCB REGION	CALTRANS DISTRICT	WATER BODY NAME
2	4	San Francisquito Creek
2	4	Sonoma Creek
2	4	Walker Creek
3	5	Moss Landing Harbor
3	5	Aptos Creek
3	5	Bean Creek
3	5	Bear Creek (Santa Cruz)
3	5	Boulder Creek
3	5	Branciforte Creek
3	5	Elkhorn Slough
3	5	Fall Creek

Some Water Bodies Impaired for Sediment in Northern California

SWRCB REGION	CALTRANS DISTRICT	WATER BODY NAME
3	5	Love Creek
3	5	Moro Cojo Slough
3	5	Mountain Charlie Gulch
3	5	Morro Bay
3	5	Casmalia Creek
3	5	San Vicente Creek
3	5	Shuman Canyon Creek
5	2	Fall River
5	2	Humbug Creek
5	6	Panoche Creek
6	9	Truckee River

Some Water Bodies Impaired for Sediment in Northern California

SWRCB REGION	CALTRANS DISTRICT	WATER BODY NAME
6	10	Heavenly Valley Creek
6	3	Squaw Creek
6	3	Lake Tahoe
6	3	Blackwood Creek
6	9	Bridgeport Reservoir
6	3	Bronco Creek
6	2	Clearwater Creek
6	9	East Walker River
6	9	Gray Creek (Nevada County)
6	9	Hot Springs Canyon Creek
6	2	Ward Creek
6	3	Wolf Creek (Alpine County)

Some Water Bodies Impaired for Sediment in Southern California

SWRCB REGION	CALTRANS DISTRICT	WATER BODY NAME
4	7	Mugu Lagoon
4	7	Calleguas Creek
4	7	Las Virgenes Creek
4	7	Malibu Creek
4	7	Medea Creek
4	7	Triunfo Canyon Creek
8	8	Rathbone (Rathbun) Creek
8	8	Upper Newport Bay
8	8	Big Bear Lake
9	11	San Elijo Lagoon
9	11	Los Penasquitos Lagoon
9	11	Agua Hedionda Lagoon
9	11	Buena Vista Lagoon

303(d) Listed Water Bodies

- If a construction site directly discharges to a water body that is on the 303(d) list as impaired for sedimentation/siltation/turbidity, sampling is required.

Stormwater permitting is not the only regulation in effect for construction sites:

You may need to comply with one or all of the following:

- National Environmental Protection Act (NEPA)
- California Environmental Quality Act (CEQA)
- Local grading and erosion control ordinances
- US Army Corps of Engineers: Clean Water Act Section 404 permit
- California Regional Water Quality Control Board: Clean Water Act Section 401 Certification
- California Department of Fish and Game Streambed Alteration Agreement (Agreement 1602)
- California Air Quality Management District (AQMD) permit

Who Enforces These Laws?

- EPA
- SWRCB / RWQCB
- Other Agencies
- **Private Citizens**
  - NRDC
  - Baykeepers
  - Other Watchdog Groups

Enforcement

WHY REGULATORS ENFORCE STORMWATER REGULATIONS

1. We are mandated by the California Water Code to protect waters of the state and their beneficial uses

2. To prevent unfair business practices:

- Developers who are breaking the law should not have an economic advantage over conscientious developers; enforcement helps to keep the playing field level

3. Third parties can sue builders, state, and local governmental agencies for failing to enforce these regulations:

- These lawsuits are viable, because they are based in the law (under Clean Water Act)
- These lawsuits are becoming more common as environmental problems become more widespread and more dangerous

Informal Enforcement

When RWQCB inspectors initiate informal enforcement action, it can take the following forms:

- Verbal Warning
- Staff Enforcement Letter
- Notice of Violation (NOV) – compels action within a timeframe

Formal Enforcement

- Notice to Comply – fix-it ticket
- Notice of Stormwater Noncompliance – issued after failure to follow a Notice to Comply
- Cleanup and Abatement Order (CAO)
- Cease and Desist Order (CDO)– Stoppage of work on your site until damage can be assessed and mitigated
- Administrative Civil Liabilities (ACL)
- Attorney General/District Attorney referral

What If We Don't Comply?

- Fines to $37,500 Per Day / Occurrence – Per CWA
- Fines to $25,000 Per Day and $25 a gallon – per Porter Cologne Act

Administrative Civil Liability (Monetary Penalties)

- Failure to Submit a Notice of Intent for Coverage under the appropriate stormwater NPDES permit.
  - **Minimum $5,000 plus recovery of staff costs**
- Violation of Permit Terms or Basin Plan Prohibitions
  - **Minimum amount is the economic savings of the violation**

Regulatory Fines

- ⇒ Introduction
- ⇒ The Law
- ⇒ Permits
- ⇒ ***Regulatory Fines***
- ⇒ Manuals and Specs
- ⇒ Role of the Players

CAO* May 2003 – Caltrans District 11

*Cleanup and Abatement Order

- "…discharged sediment, gravel, and sediment-laden water into Soledad Canyon Creek and Los Penasquitos Creek…"
- "On at least eleven occasions …by not implementing Best Management Practices (BMPs); implementing inappropriate BMPs; and/or by not adequately maintaining BMPs…"

CAO May 2003 – Caltrans District 11 (Continued)

- Ordered to implement and maintain combination of erosion and sediment control BMPs to prevent the discharge of sediment, gravel, and sediment-laden water.
- Ordered to develop and implement a water quality monitoring plan for the duration of the project:
  - Monitoring sites upstream, downstream, and within construction project site for Total Suspended Solids, Settleable Solids, Suspended Sediment Concentration, and Turbidity
  - Quarterly reports including photo documentation, narrative describing "all actions, BMPs, inspections, and maintenance," water quality monitoring data, various site maps for the reporting period, etc.
  - Upon project completion, final report providing analysis of cumulative, short-term, and long-term impacts to water quality and beneficial uses due to its discharges

CAO* July 2006 – Caltrans District 2

*Cleanup and Abatement Order

- Dirt berm failure at the top of the fill at Windy Point Disposal Area
- "…discharged earthen materials, soil, sediment, sediment-laden and turbid storm water to surface waters…"
- "…2,748 cubic yards of material slid down a hill at Windy Point, 654 cubic yards of material was retained below the original slope and 2,094 cubic yards of material was discharged from Windy Point…"

$500,000

ACL* 2004 – CALTRANS DISTRICT 5

*Administrative Civil Liabilities

- Highway 101/156 Interchange in Prunedale
- Settlement reached included:
  - Caltrans pay monetary fine of $7,500
  - Caltrans pay for and provide training workshop 3 times each year for 5 years
  - Training workshops made available to any permittees and municipalities in the Central Coast Region
  - Each workshop must accommodate 50-75 attendees.

$7,500+

ACL August 2006 – Developer

- Final disposition still pending
- Three NOVs issued January - December 2005
  - Discharges of sediment-laden water to creeks
  - Erosion and sediment control BMPs not installed or not maintained
  - Employees on site not properly trained

$600,000

Video Presentation

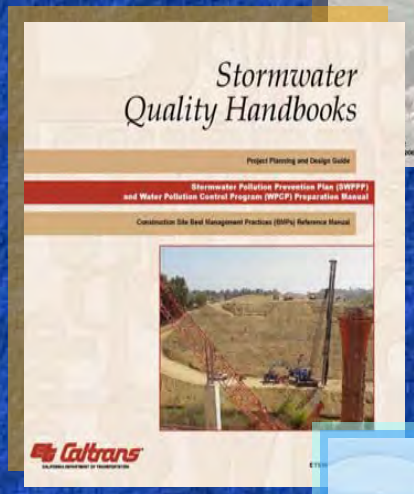
- Play Video “Hold on to your Dirt”

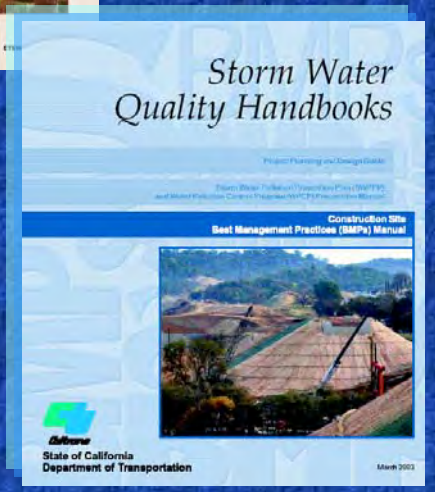
Manuals and Specs

- ⇒ Introduction
- ⇒ The Law
- ⇒ Permits
- ⇒ Regulatory Fines
- ⇒ ***Manuals and Specs***
- ⇒ Role of the Players

Manuals

- Caltrans Storm Water Quality Handbooks
  - ⇒Project Planning and Design Guide
  - ⇒SWPPP/WPCP Preparation Manual
  - ⇒Construction Site BMPs Reference Manual
- Construction Manual
- BMP Field Guidance Manual
- Dewatering Guide
- Guidance for Temporary Soil Stabilization

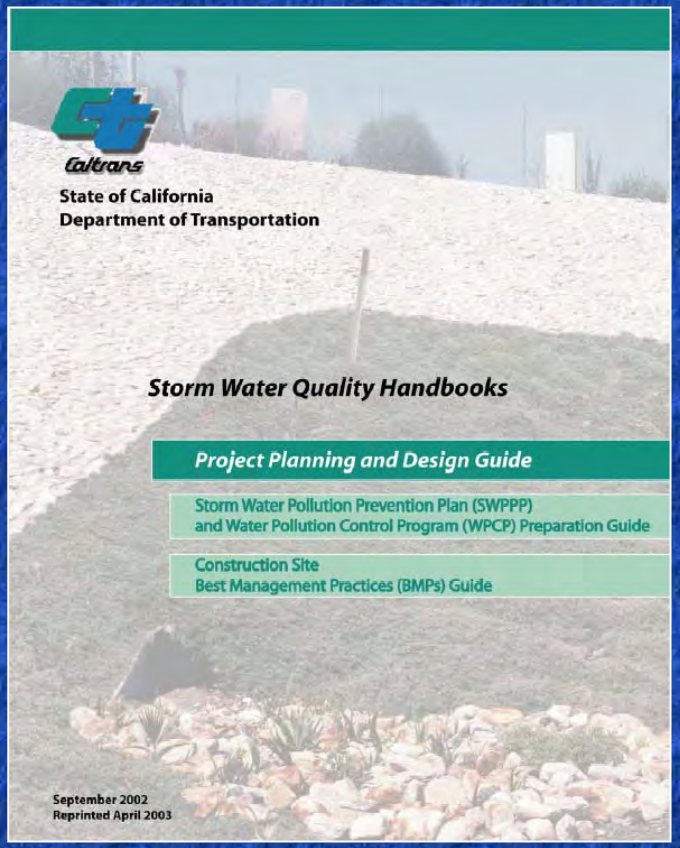




Manuals

Project Planning and Design Guide

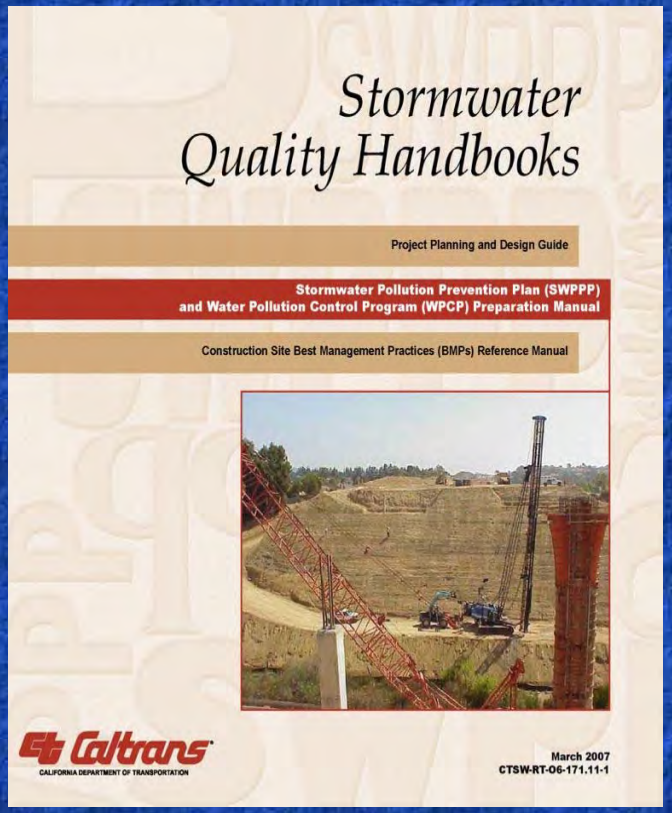
- ⇒ Provides design guidance for incorporating BMPs into projects
- ⇒ Addresses key regulatory, policy and technical requirements
- ⇒ Describes overall process for selecting and designing BMPs



Manuals

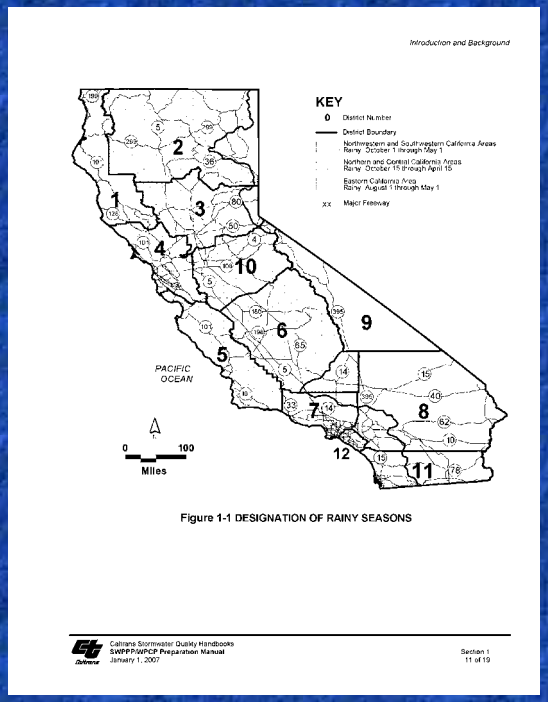
SWPPP / WPCP Preparation Manual

- Guides Caltrans staff and contractors through the process of preparing a SWPPP or a WPCP
- Provides “SWPPP/WPCP Templates” to standardize plans



Manuals

- Implementation Requirements:
- See SWPPP/WPCP Preparation
  - Figure 1-1
  - Tables 1-2, 1-3, and 1-4



Introduction and Background

Figure 1-1 DESIGNATION OF RAINY SEASONS

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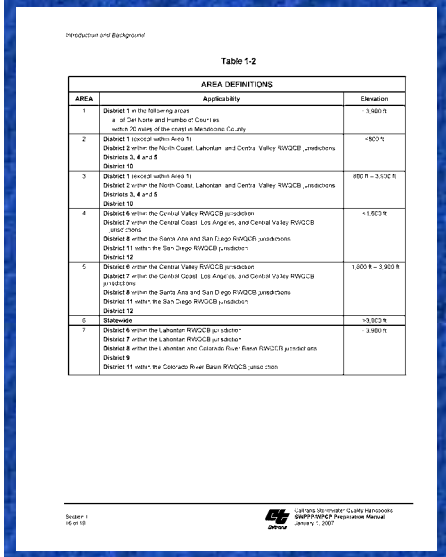

Introduction and Background

Table 1-2

AREA DEFINITIONS		
AREA	Applicability	Elevation
1	District 1 in the following areas a. all Del Norte and Humboldt Counties within 20 miles of the coast in Mendocino County	3,000 ft
2	District 1 except within Area 1 District 2 within the North Coast, Lahontan, and Central Valley RWQCB jurisdictions Districts 3, 4 and 5 District 10	<500 ft
3	District 1 except within Area 1 District 2 within the North Coast, Lahontan, and Central Valley RWQCB jurisdictions Districts 3, 4 and 5 District 10	500 ft – 3,000 ft
4	District 6 within the Central Valley RWQCB jurisdiction District 7 within the Central Coast, Los Angeles, and Central Valley RWQCB jurisdictions District 8 within the Santa Ana and San Diego RWQCB jurisdictions District 11 within the San Diego RWQCB jurisdiction District 12	<1,500 ft
5	District 6 within the Central Valley RWQCB jurisdiction District 7 within the Central Coast, Los Angeles, and Central Valley RWQCB jurisdictions District 8 within the Santa Ana and San Diego RWQCB jurisdictions District 11 within the San Diego RWQCB jurisdiction District 12	1,500 ft – 3,500 ft
6	Statewide	>3,000 ft
7	District 6 within the Lahontan RWQCB jurisdiction District 7 within the Lahontan RWQCB jurisdiction District 8 within the Lahontan and Colorado River Basin RWQCB jurisdictions District 9 District 11 within the Colorado River Basin RWQCB jurisdiction	≥ 1,500 ft

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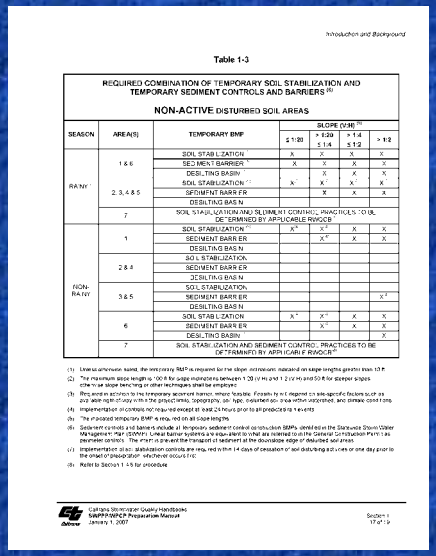

Introduction and Background

Table 1-3

REQUIRED COMBINATION OF TEMPORARY SOIL STABILIZATION AND TEMPORARY SEDIMENT CONTROLS AND BARRIERS (6)

NON-ACTIVE DISTURBED SOIL AREAS

SEASON	AREA(S)	TEMPORARY BMP	SLOPE (V:H) (7) ≤ 1:20	> 1:20 ≤ 1:4	> 1:4 ≤ 1:2	> 1:2
RAINY	1 & 6	SOIL STABILIZATION (1)	X	X	X	X
		SEDIMENT BARRIER (2)	X	X	X	X
		DESILTING BASIN (3)		X	X	X
	2, 3, 4 & 5	SOIL STABILIZATION (1)	X (4)	X (4)	X (4)	X
		SEDIMENT BARRIER		X	X	X
		DESILTING BASIN				
	7	SOIL STABILIZATION AND SEDIMENT CONTROL PRACTICES TO BE DETERMINED BY APPLICABLE RWQCB (8)				
NON-RAINY	1	SOIL STABILIZATION (1)	X (5)	X (5)	X	X
		SEDIMENT BARRIER		X (5)	X	X
		DESILTING BASIN				
	2 & 4	SOIL STABILIZATION				
		SEDIMENT BARRIER				
		DESILTING BASIN				
	3 & 5	SOIL STABILIZATION				
		SEDIMENT BARRIER				X (5)
		DESILTING BASIN				
	6	SOIL STABILIZATION	X (5)	X (5)	X	X
		SEDIMENT BARRIER		X (5)	X	X
		DESILTING BASIN				X
	7	SOIL STABILIZATION AND SEDIMENT CONTROL PRACTICES TO BE DETERMINED BY APPLICABLE RWQCB (8)				

(1) Unless otherwise noted, the temporary BMP is required for the slope and lengths indicated on slope lengths greater than 10 ft
(2) The maximum slope length is 100 ft for slope inclinations between 1:20 (V:H) and 1:2 (V:H) and 50 ft for steeper slopes
(3) Required in addition to the temporary sediment barrier, where feasible. Feasibility will depend on site-specific factors such as available right-of-way within the project limits, topography, soil type, disturbed soil area within watershed, and climatic conditions
(4) Implementation of controls not required except at least 24 hours prior to all predicted rain events
(5) The indicated temporary BMP is required on all slope lengths
(6) Sediment controls and barriers include all temporary sediment control construction BMPs identified in the Statewide Storm Water Management Plan (SWMP). Linear barrier systems are equivalent to what are referred to in the General Construction Permit as perimeter controls. The intent is to prevent the transport of sediment at the downslope edge of disturbed soil areas
(7) Implementation of soil stabilization controls are required within 14 days of cessation of soil disturbing activities or one day prior to the onset of precipitation whichever occurs first
(8) Refer to Section 1.4.5 for procedure

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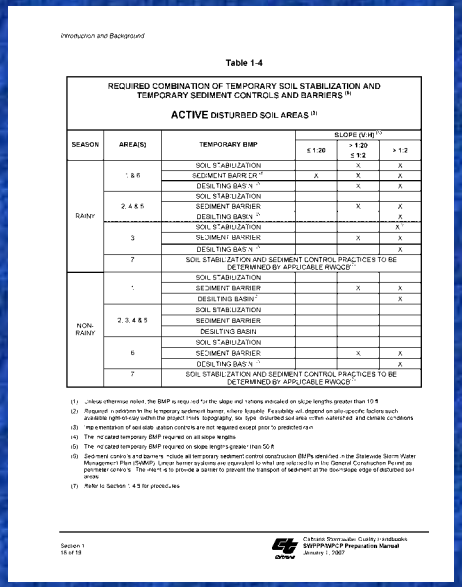

Introduction and Background

Table 1-4

REQUIRED COMBINATION OF TEMPORARY SOIL STABILIZATION AND TEMPORARY SEDIMENT CONTROLS AND BARRIERS (6)

ACTIVE DISTURBED SOIL AREAS (1)

SEASON	AREA(S)	TEMPORARY BMP	SLOPE (V:H) (7) ≤ 1:20	> 1:20 ≤ 1:2	> 1:2
RAINY	1 & 6	SOIL STABILIZATION		X	X
		SEDIMENT BARRIER (2)	X	X	X
		DESILTING BASIN (3)		X	X
	2, 4 & 5	SOIL STABILIZATION			
		SEDIMENT BARRIER		X	X
		DESILTING BASIN (3)			X
	3	SOIL STABILIZATION			X (5)
		SEDIMENT BARRIER		X	X
		DESILTING BASIN (3)			X
	7	SOIL STABILIZATION AND SEDIMENT CONTROL PRACTICES TO BE DETERMINED BY APPLICABLE RWQCB (8)			
NON-RAINY	1	SOIL STABILIZATION			
		SEDIMENT BARRIER		X	X
		DESILTING BASIN (3)			X
	2, 3, 4 & 5	SOIL STABILIZATION			
		SEDIMENT BARRIER			
		DESILTING BASIN			
	6	SOIL STABILIZATION			
		SEDIMENT BARRIER		X	X
		DESILTING BASIN			X
	7	SOIL STABILIZATION AND SEDIMENT CONTROL PRACTICES TO BE DETERMINED BY APPLICABLE RWQCB (8)			

(1) Unless otherwise noted, the BMP is required for the slope and lengths indicated on slope lengths greater than 10 ft
(2) Required in addition to the temporary sediment barrier, where feasible. Feasibility will depend on site-specific factors such as available right-of-way within the project limits, topography, soil type, disturbed soil area within watershed, and climatic conditions
(3) Implementation of soil stabilization controls are not required except prior to predicted rain
(4) The indicated temporary BMP required on all slope lengths
(5) The indicated temporary BMP required on slope lengths greater than 50 ft
(6) Sediment controls and barriers include all temporary sediment control construction BMPs identified in the Statewide Storm Water Management Plan (SWMP). Linear barrier systems are equivalent to what are referred to in the General Construction Permit as perimeter controls. The intent is to prevent the transport of sediment at the downslope edge of disturbed soil areas
(7) Implementation of soil stabilization controls are required within 14 days of cessation of soil disturbing activities or one day prior to the onset of precipitation whichever occurs first
(8) Refer to Section 1.4.5 for procedure

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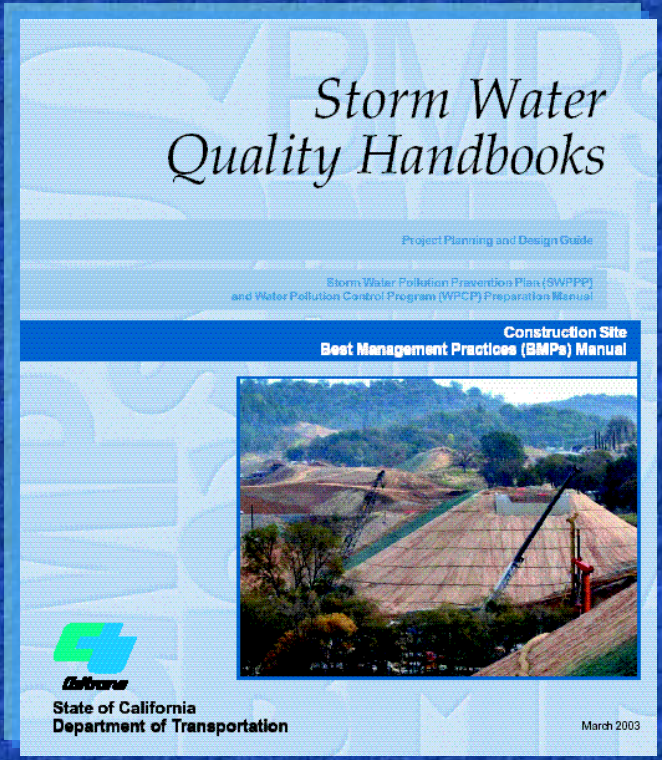
Manuals

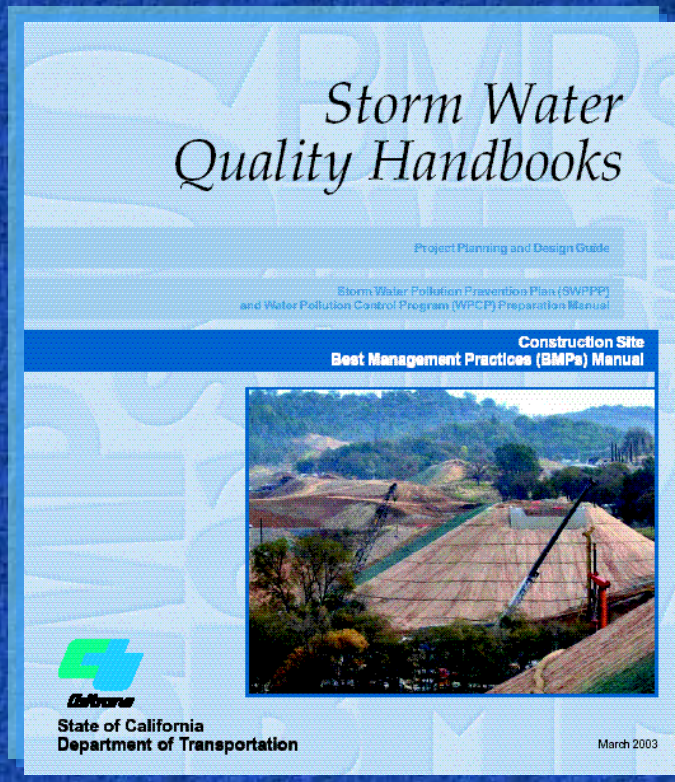
Construction Site BMPs Reference Manual

- Guidelines for the selection and implementation of construction site BMPs
  - Rainy Season
  - Procedures for Rainfall Area 7
  - BMP Placement on Slopes
  - Rainfall Area Definitions



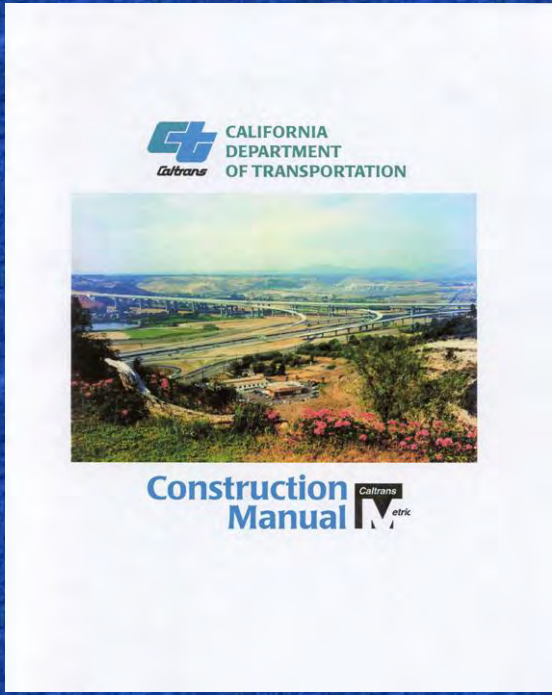
Manuals

- **Construction Site BMPs Reference Manual**
- Guidelines for the selection and implementation of construction site BMPs (cont.)
  - Erosion Control and Sediment Control Requirements for DSAs
  - Selection of Temporary Soil Stabilization and Sediment Controls
  - BMP Working Details
  - BMP Inspections
  - New BMPs



Manuals

- Construction Manual
  - Chapter 7 - Environmental
    - **7-104B Water Pollution Control**
    - **7-105 Permits**
    - **7-106 Environmental Hazards and Safety Procedures**
    - **7-107 Hazardous Spills**



Get Manual online at: http://www.dot.ca.gov/hq/construc/manual2001/or hard copies are available from Caltrans Publications

Manuals

- **BMP Field Guidance Manual**

State of California
Department of Transportation

Construction Site
Best Management Practice
(BMP)
Field Manual
and
Troubleshooting Guide

CTSW-RT-02-007

January 2003

Get Manual online at:

http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

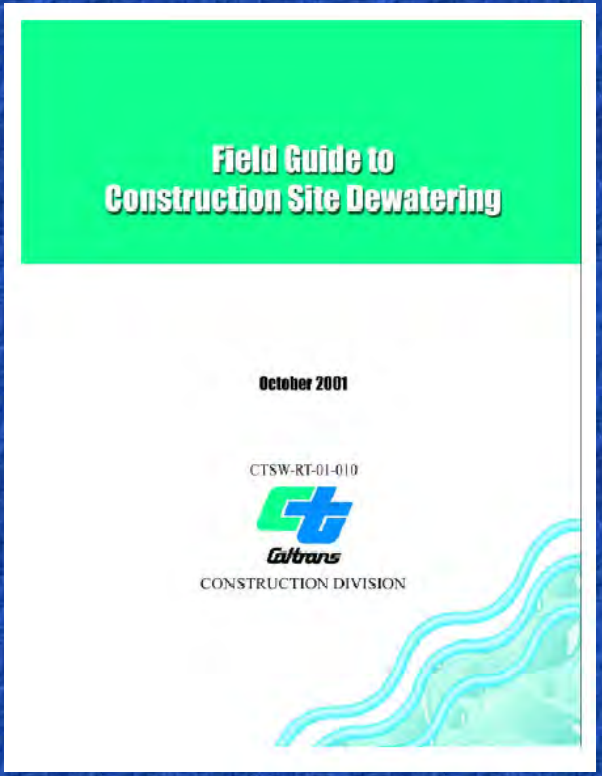
or hard copies are available from Caltrans Publications

Manuals

- BMP Field Guidance Manual
  - "Tool Box" for field personnel
  - Principles of Erosion and Sediment Control
  - Trouble Shooting Guide – Photos of correct / incorrect BMP installations
  - BMP Selection Installation and Maintenance

Manuals

- Dewatering Guide



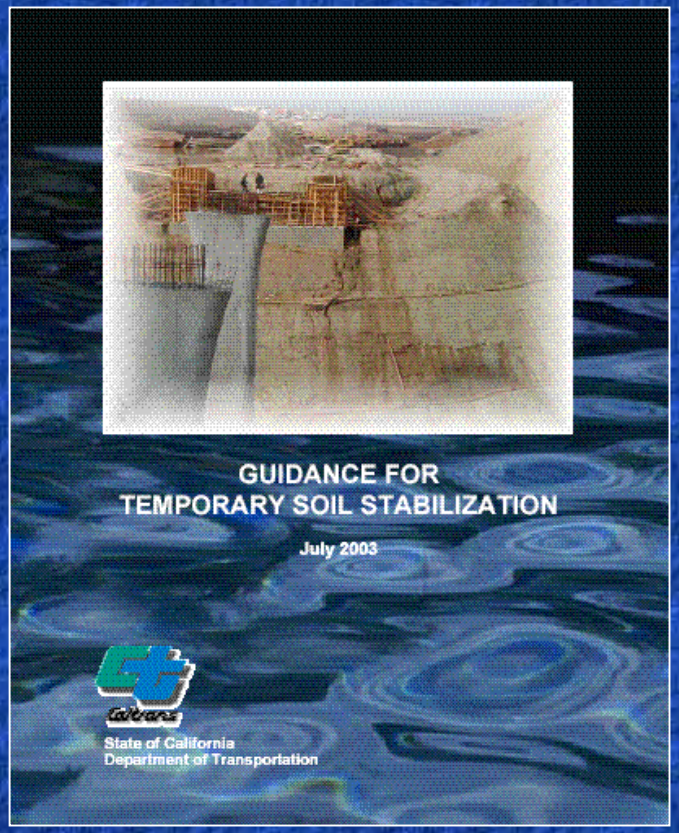
Get Manual online at:

http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

or hard copies are available from Caltrans Publications

Manuals

- Guidance for Temporary Soil Stabilization



Get Manual online at:

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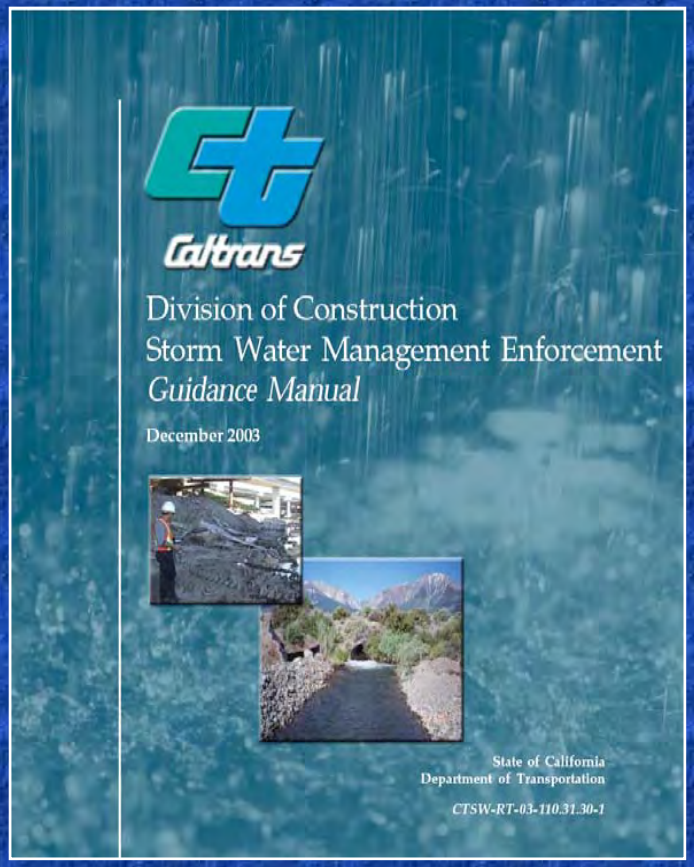
or hard copies are available from Caltrans Publications

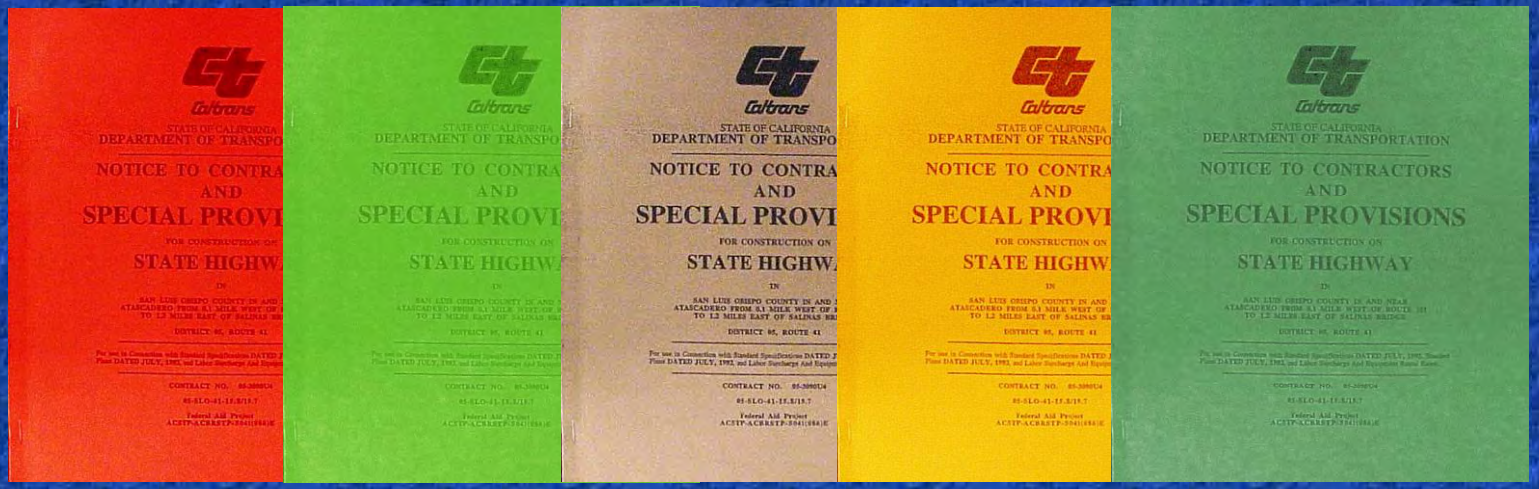
Manuals

- Storm Water Management Enforcement Guidance Manual



Specifications

- Caltrans Standard Specifications, Section 7-1.01G
- Contract Special Provisions, Section 10
- Project Plans



Role of the Players

- ⇒ **Introduction**
- ⇒ **The Law**
- ⇒ **Permits**
- ⇒ **Regulatory Fines**
- ⇒ **Manuals and Specs**
- ⇒ ***Role of the Players***

Role Of The Players

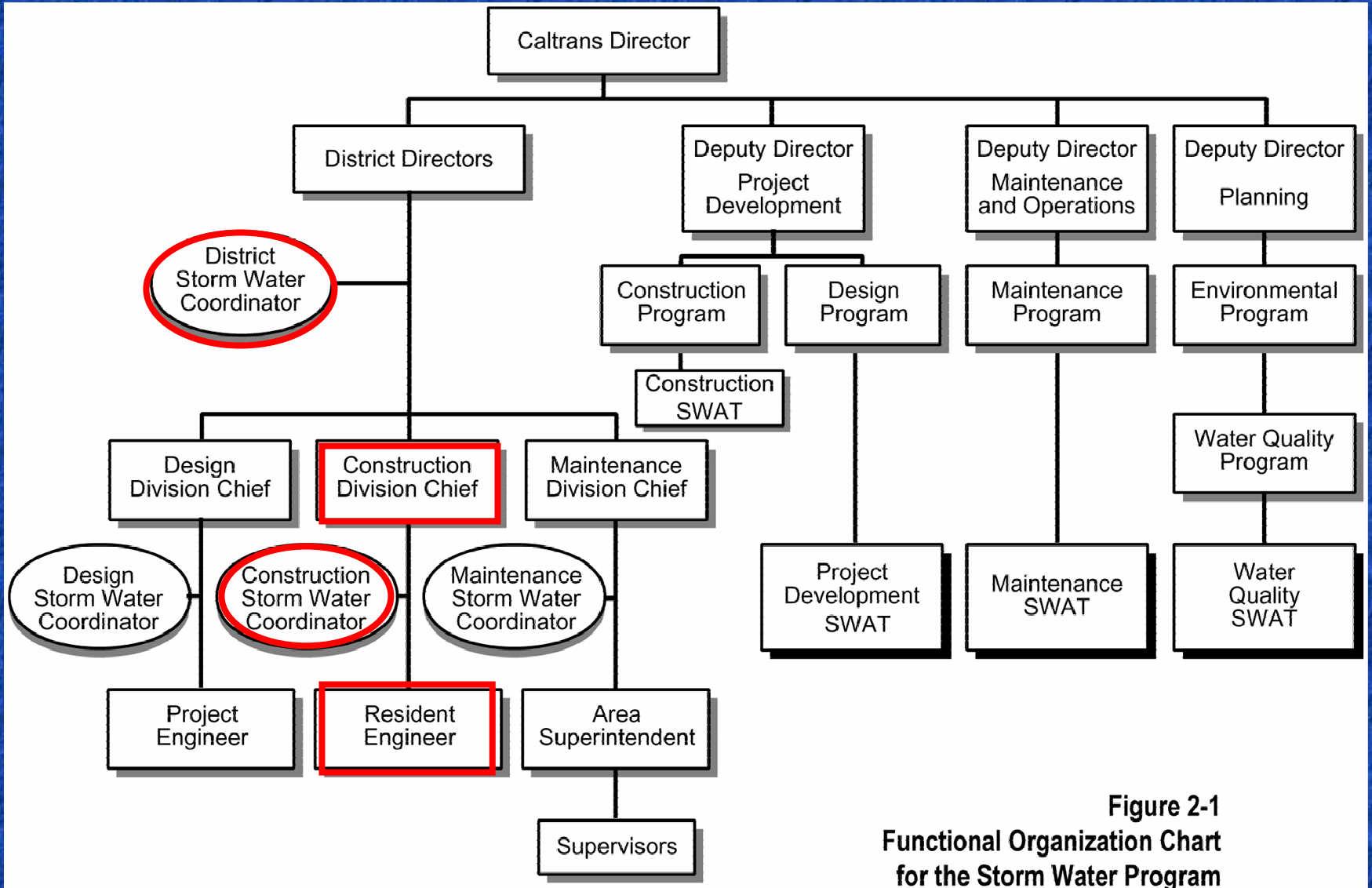
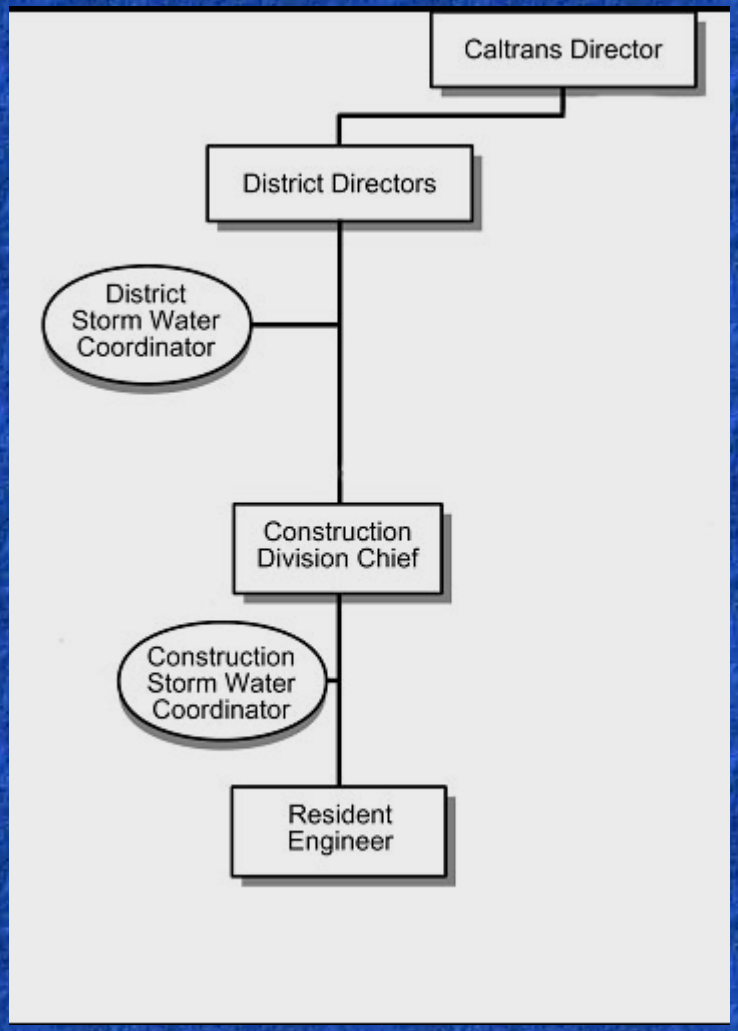


Figure 2-1
Functional Organization Chart for the Storm Water Program

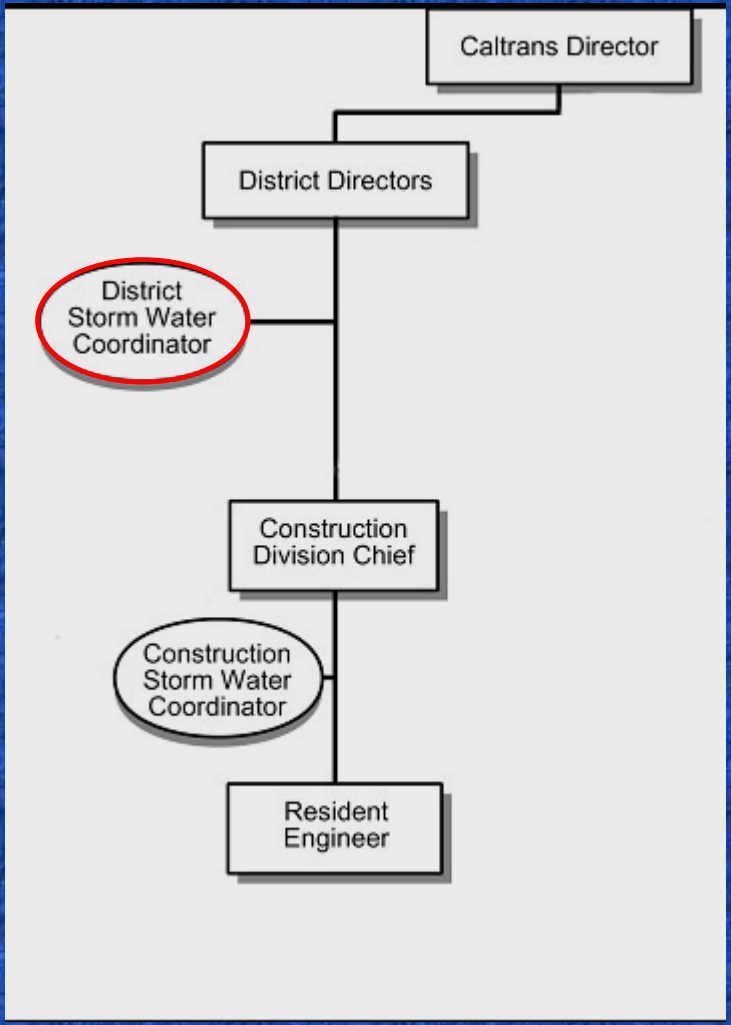
Role Of The Players

- District NPDES Storm Water Coordinator
- District Construction Division Players
  - Construction Division Chief
  - Construction Storm Water Coordinator (CSWC)
  - Resident Engineer (RE)



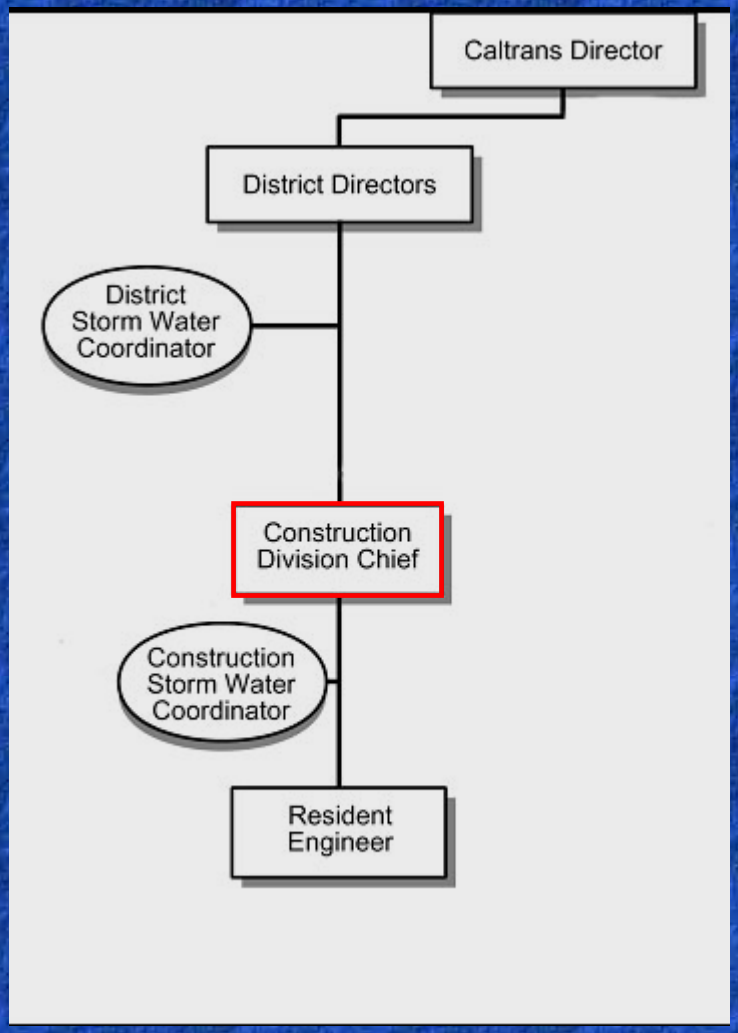
District NPDES Storm Water Coordinator's Role

- Liaison for the HQ Water Quality Program
- Liaison activities include:
  - Conduct meetings relating to stormwater management issues with other District Coordinators and MS4 Permittees
  - Communications with the RWQCB representatives
  - Assist the District Divisions - Maint., Design, Const.



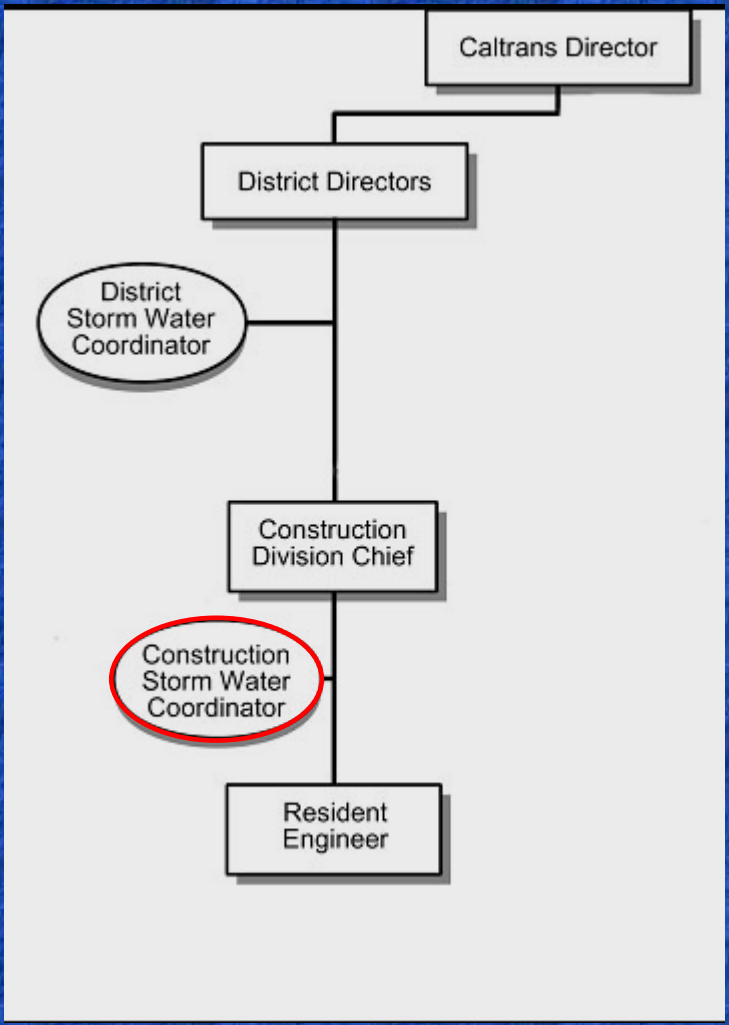
Construction Division Chief's Role

- Implementation of policies, procedures, personnel and equipment
- Includes ensuring compliance with all elements of the SWMP for entire Construction Division



Construction Storm Water Coordinator's Role

- Conducts inspections to assist the RE with water pollution control compliance
- Assist the RE with reviewing the SWPPP / WPCP for adequacy
  - Keep RE up to date on new requirements

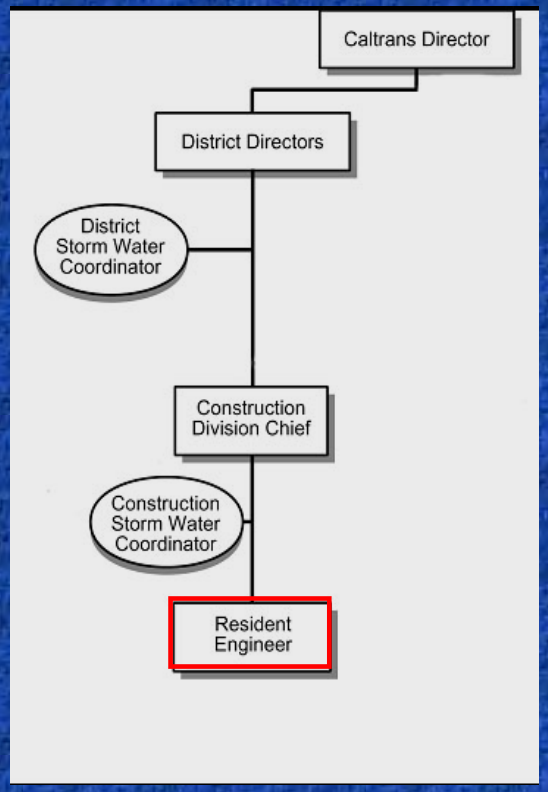


Construction Storm Water Coordinator

- In addition to already stated functions:
  - Assist during pre-construction meetings
  - Information and training source
  - Liaison with other District personnel during construction
  - Liaison to the NPDES Storm Water Coordinator

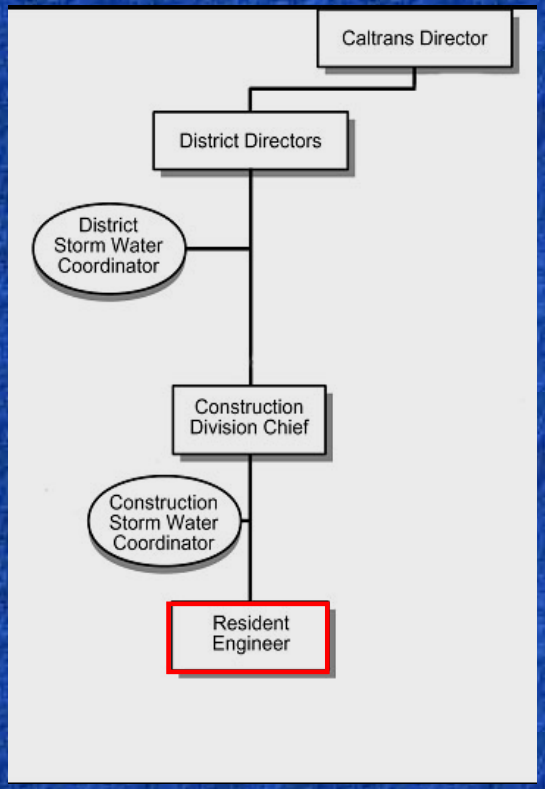
Resident Engineer's Role

- Administers construction contracts
- Responsible for ensuring water pollution control compliance for the contract
- Approves SWPPP/WPCP
- Responsible for ensuring inspections are conducted
- To submit Notice of Completion of Construction (NCC)



Resident Engineer's Role (cont.)

- Oversees contractor self-monitoring
  - Forwarding non-compliance documentation
  - Maintaining documentation
  - Impose sanctions for non-compliance of the contract



Closing Comments

What we learned

- **Why water pollution should be prevented**
- **Monetary fines are real**
- **Which permits, specifications, and manuals govern on Caltrans construction sites**

Closing Comments

- **Please take these final thoughts with you**
  - **Read the Caltrans Manuals**
  - **Understand the requirements**
  - **Use the resources available:**

    - CSWC
    - Manuals
    - Consultants

Course Highlights

- Introduction
- Impacts of Stormwater Pollution
- Pollutants Associated with Construction Activities
- Laws and Regulations
- ***Erosion Process***
- Overview of Temporary Construction Site BMPs

The Erosion Process

- ***The Erosion Process***
  - **Geology and Soils**
  - **Factors That Influence Erosion**

What is Erosion and Sedimentation

- Soil erosion is the process by which soil particles become detached by water, wind, or gravity and are transported from their original location.

What is Erosion and Sedimentation

- Sedimentation is the deposition of the eroded material

Natural Erosion

Natural erosion is generally considered to be due to the influence of climatic forces on the surface of the earth.

Accelerated Erosion

Accelerated Erosion =

natural erosion x human activities

What can accelerate erosion problems?

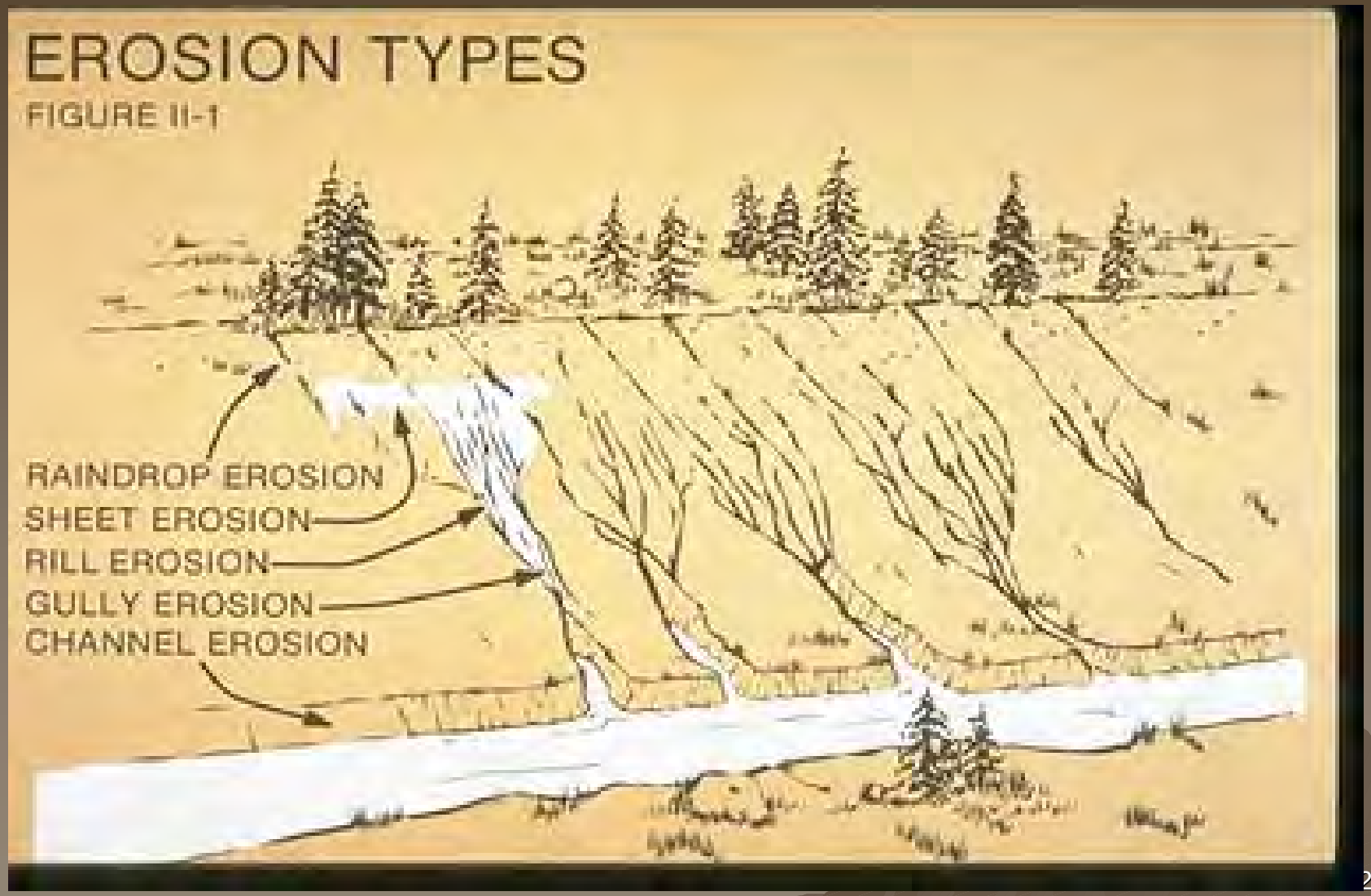
- removal of surface cover
- increased imperviousness (i.e., paving) that increases runoff
- exposure of more erodible soil

Types of Erosion

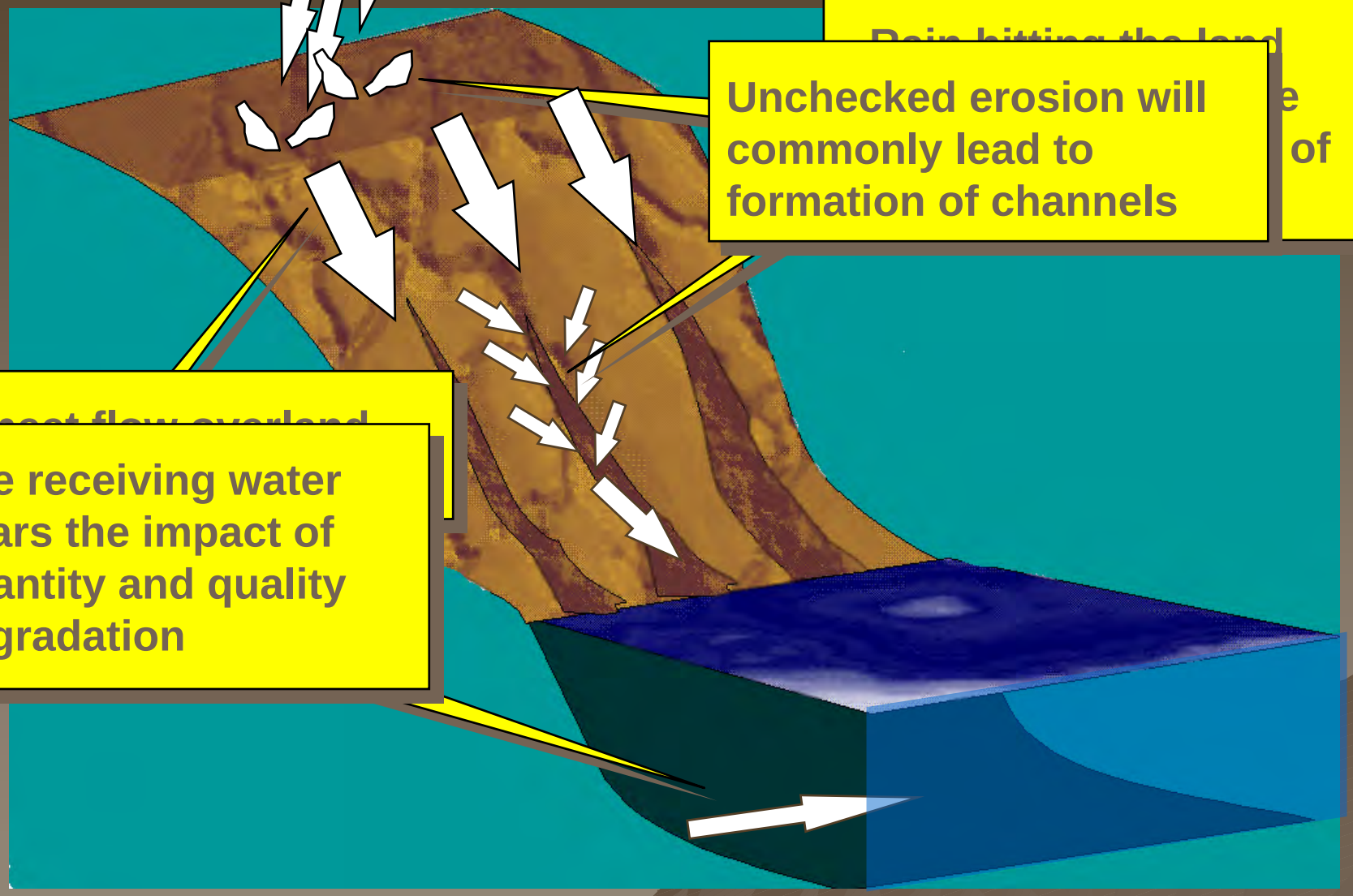
- Splash Erosion (Raindrop)
- Sheet Erosion (Overland Flow)
- Rill Erosion
- Gully Erosion
- Channel Erosion

Concentrated Flow

Types of Erosion



The Erosion Process

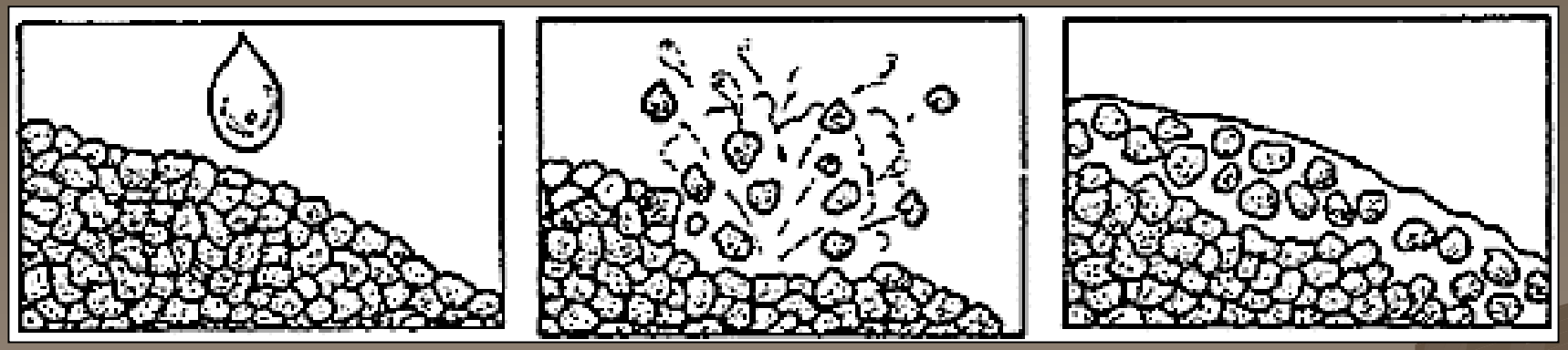


Unchecked erosion will commonly lead to formation of channels

The receiving water bears the impact of quantity and quality degradation

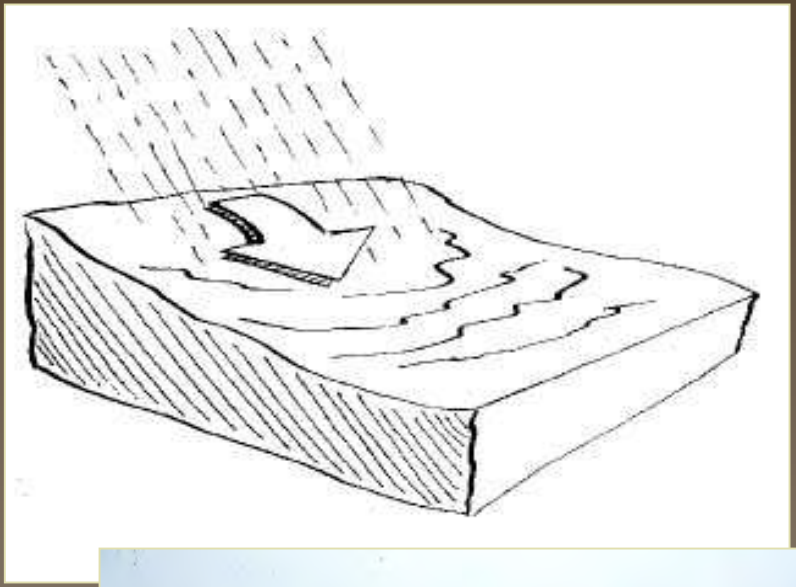
Splash Erosion

- Rain drops striking bare soil directly
  - Detaches soil particles
  - Particles can then be transported by the action of water and/or wind



Sheet Erosion (Overland Flow)

- The removal of a uniform thin layer of soil by raindrop splash or water run-off
- Surface film of water 1/16” – 1/8” deep
- This process may occur unnoticed on exposed soil even though raindrops are eroding large quantities of soil
- This process eventually becomes more dramatic via the formation of rills and gullies



Rill Erosion

- Shallow surface flows that become condensed
- Increased velocity and turbulence.
- Well-defined tiny channels
- The rate of rill erosion can be approximately 100 X greater than sheet erosion

Gully Erosion

- Accumulating runoff becomes concentrated and forms small rills throughout the soil
- Several rills may form throughout a slope and eventually may join together to form Gullies
- The rate of gully erosion can be approximately 100 X greater than rill erosion

Channel Erosion

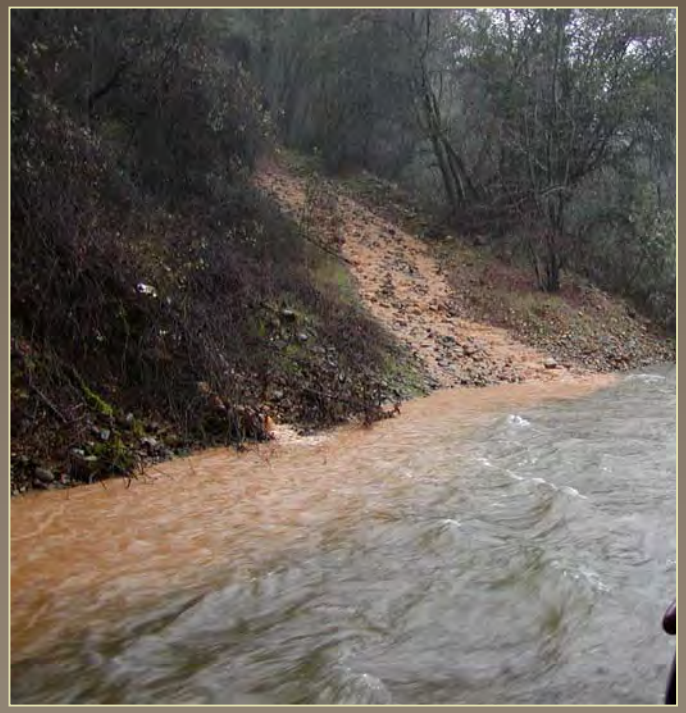
- Results from increased volume, velocity and or duration of flow, and concentration of flow - primarily from increased impervious surfaces.
- Channel erosion occurs in areas where tributaries, storm drains and or culverts flow into unprotected channels

Slope Failure

Left unattended, erosion can cause catastrophic failure of roads or other facilities.

Sedimentation / Turbidity

- Solid particulate matter, that is in suspension, is being transported (Turbidity), or has been moved from its site by air, water, gravity or ice and has settled elsewhere (Sedimentation)



Wind Erosion

- Most common in arid and semi-arid regions, but can occur in any region during construction
- Occurs when wind $\geq$ 8-9 mph above dry, bare ground
- Fine particles become suspended, coarser particles bounce and slide

Wind Erosion

- Both short-term and long-term control for wind erosion can be provided by temporary dust control measures during construction, and vegetative/structural measures such as those provided for rainfall erosion protection

Erosion Control

- Any practice that protects the soil surface and prevents the soil particles from being detached by rainfall, wind or human activity.

- Erosion control, therefore, is a source control that treats the soil as a resource that has value and should be kept in place.

Sediment Control

- Any practice that traps the soil particles after they have been detached and moved by wind or water.
- Sediment control measures are usually passive systems that rely on filtering or settling the particles out of the water or wind that is transporting them.

Which are More Effective?

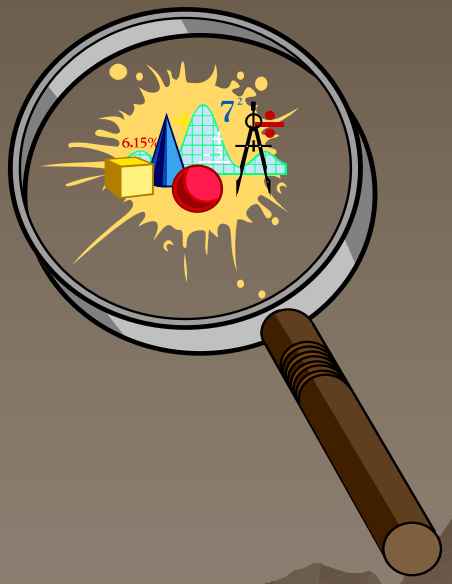
- Erosion controls are preferred
  - keep the soil in place
  - enhance the protection of the site resources
- Use erosion controls as the primary protection, with sediment controls as a secondary system.

Geology and Soils

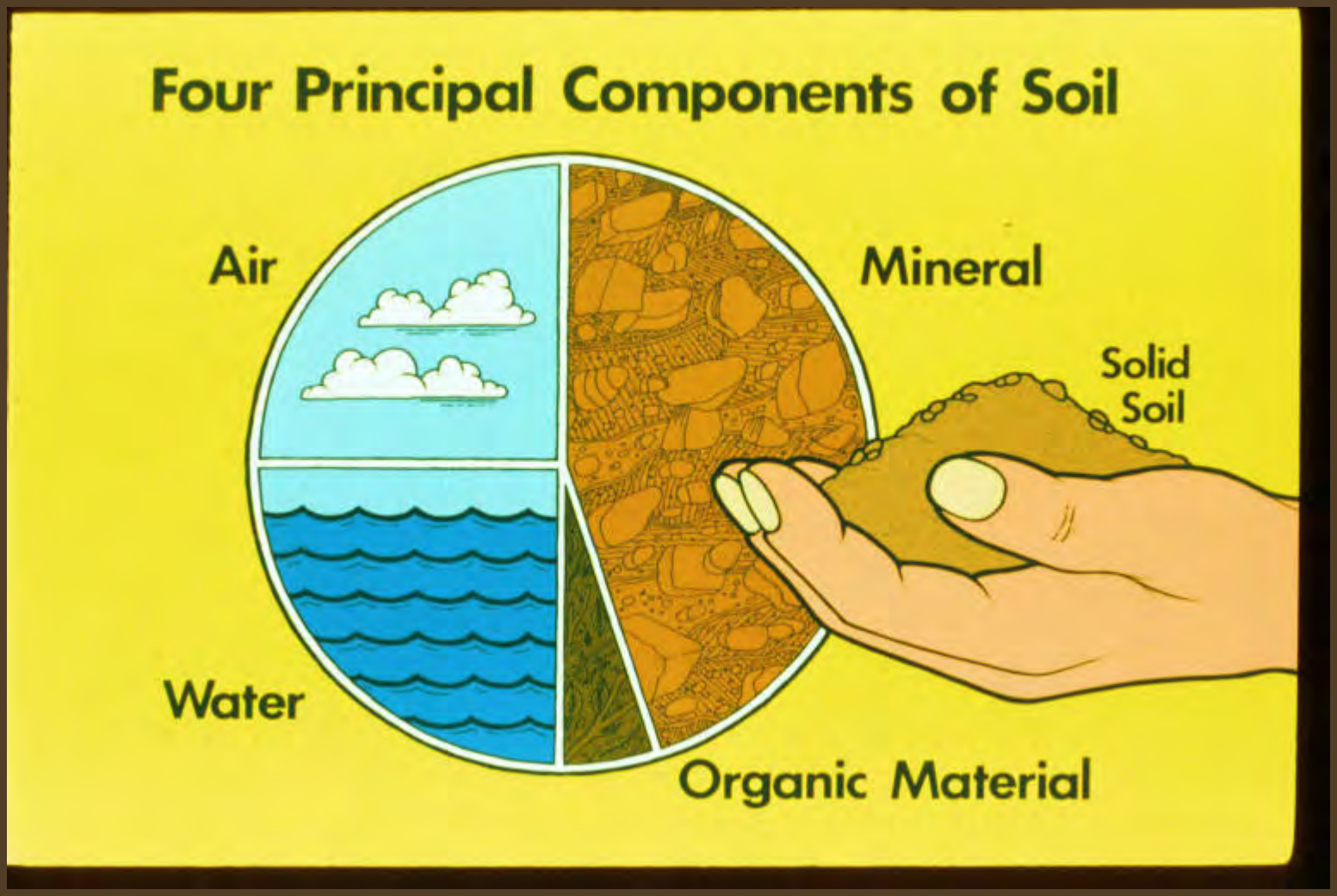
- **The Erosion Process**
  - ***Geology and Soils***
  - **Factors That Influence Erosion**

Geology and Soils

- It is important to understand the underlying geology and soils when selecting construction site BMPs
- BMPs function differently with different geologic and soils conditions



Soil Types


Four Principal Components of Soil
Air
Mineral
Solid Soil
Water
Organic Material

Definition of Soil

- Mineral or organic material on the surface of the Earth
- Conditioned by soil forming factors that enable it to provide a natural medium for plant growth
- Provides the basis for life on the planet
- Good soil is a scarce resource

Parent Material Origins

- Three main types of parent geologic materials
  - Igneous
  - Sedimentary
  - Metamorphic

Obtaining Soils Data

- Soil surveys are too crude to do erosion and pollution control planning
- Perform sieve analysis to get sand and silt composition
- Perform hydrometer analysis to define clays
- Information on nutrient content is useful for planting and fertilizer specification
- U.S. Geological Survey website: usgs.gov

Cut & Fill Slopes

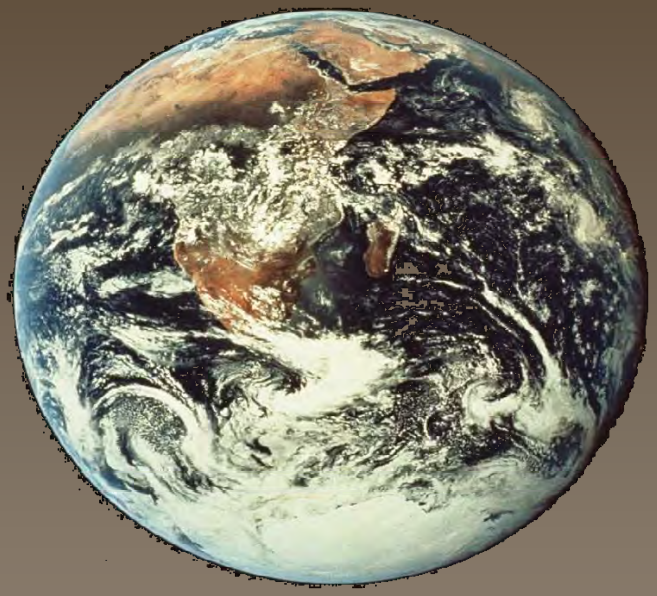
- Alteration of natural landforms adjusts the dynamic equilibrium of the slope and may lead to failure
  - unsupported bedding planes
  - reducing forces at toe of slope
  - failure of compacted fill to bond with underlying material
- Relevant to many Caltrans projects

Cut & Fill Slopes

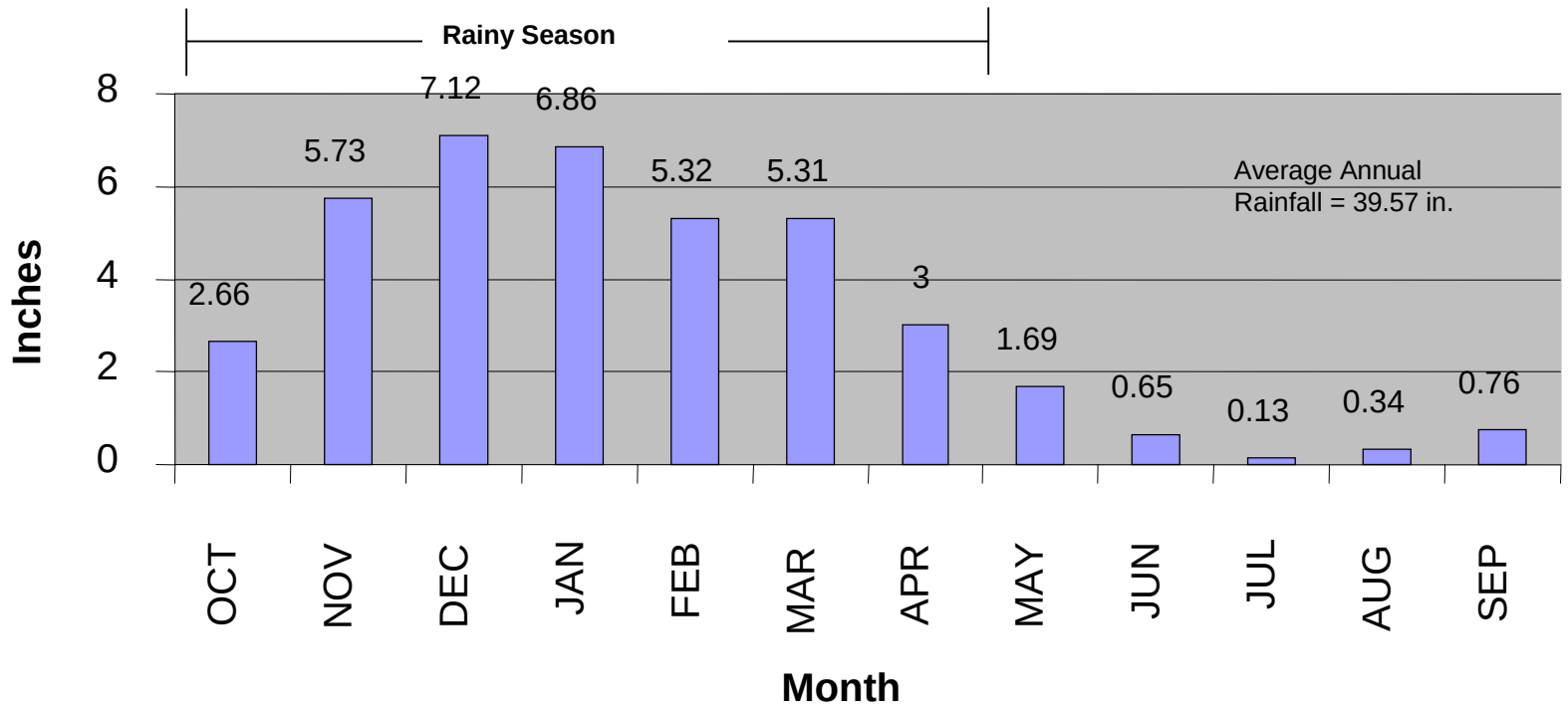
Cut & Fill Slopes

Climatic Forces

- Temperature and Moisture
  - Rainfall
  - Snow

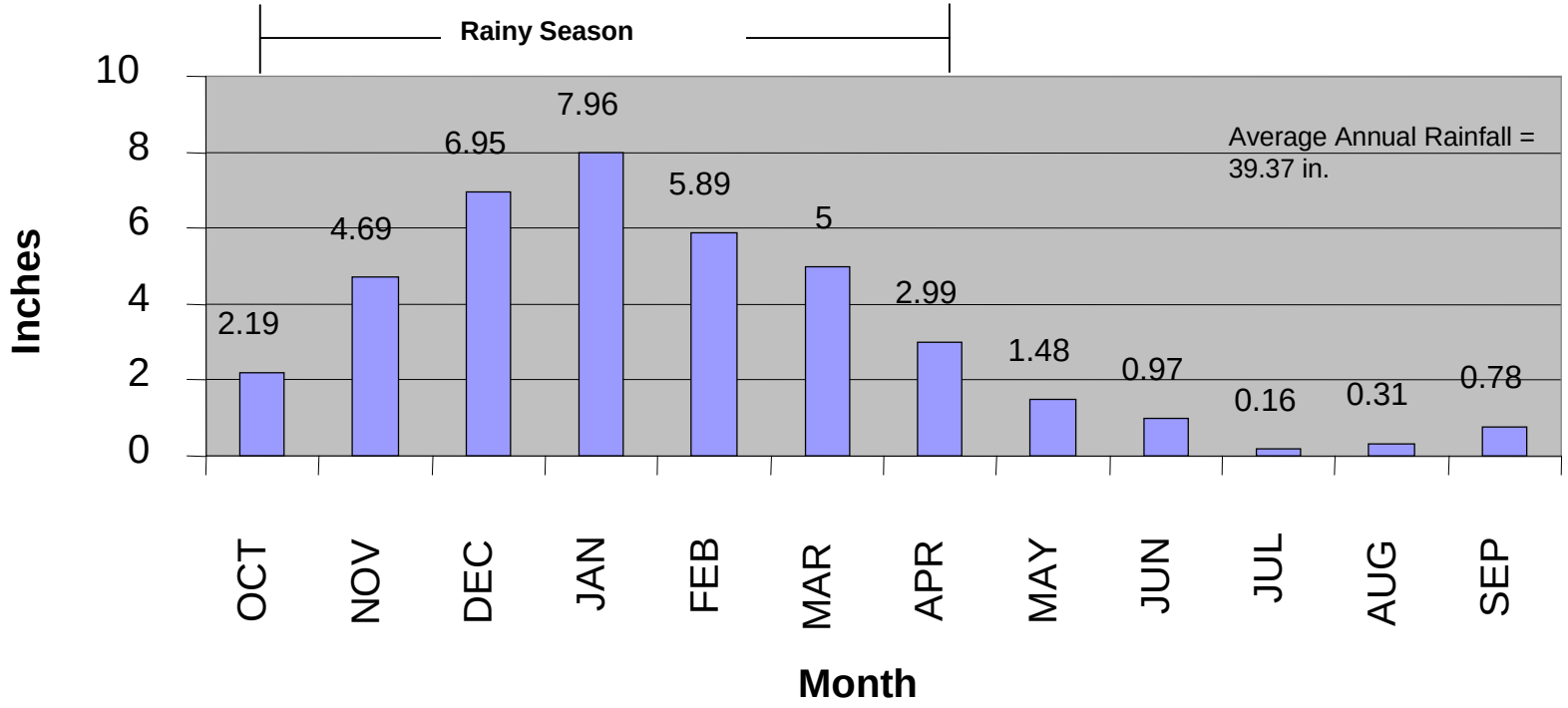


District 1 Rainfall Distribution

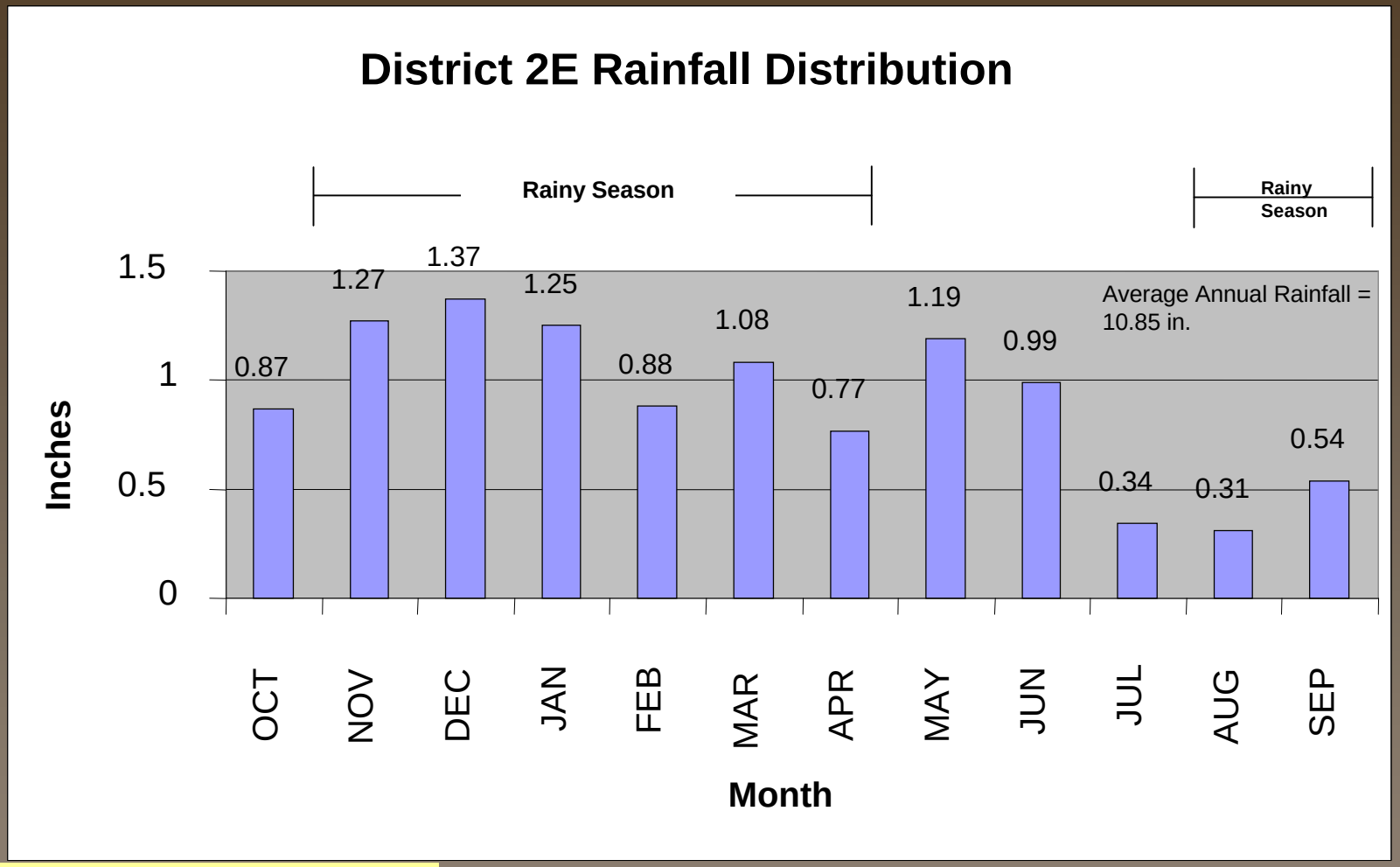


Source: Eureka WSO City, California
Period of Record: 7/1/1948 to 12/31/2005

District 2W Rainfall Distribution

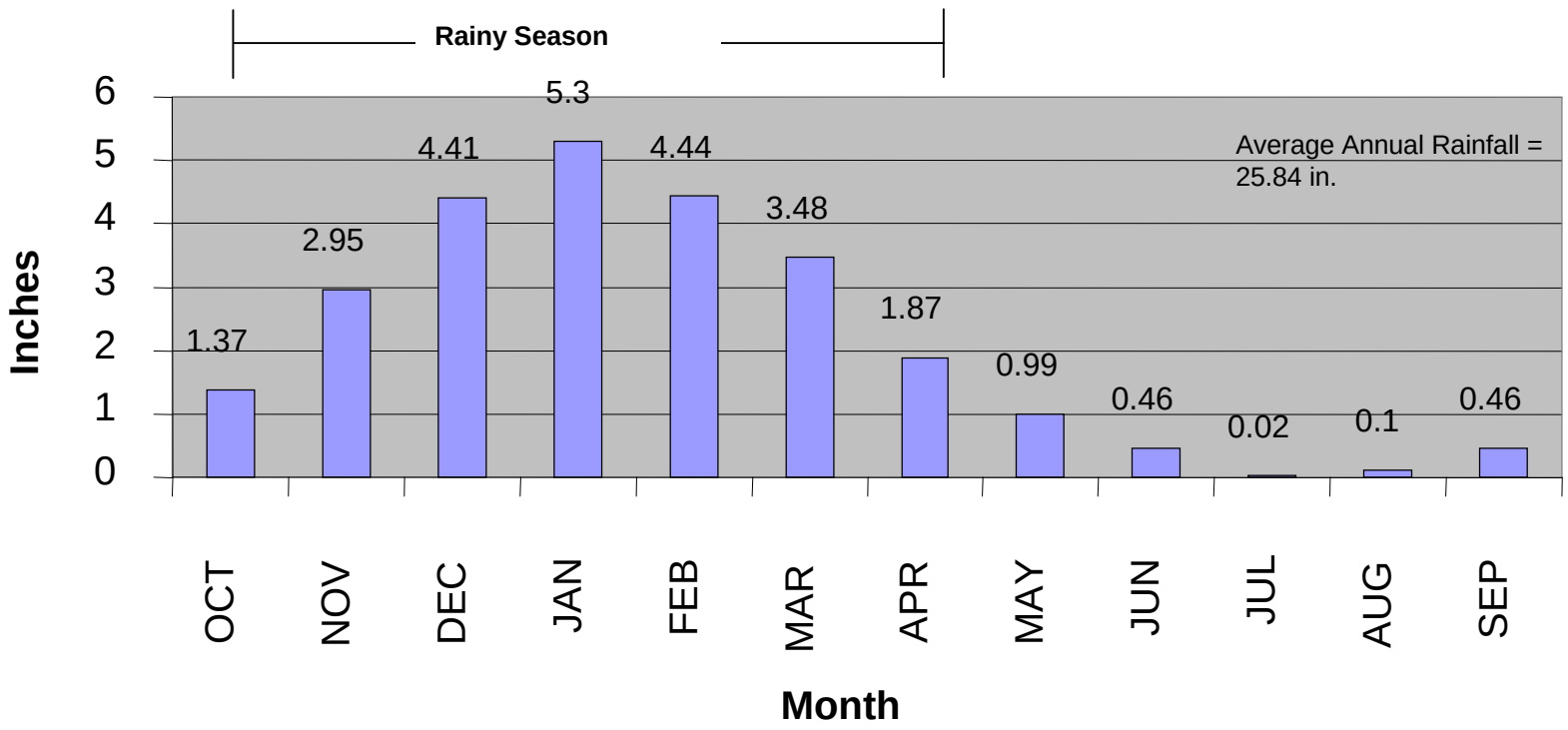


Source: Redding, California
Period of Record: 1/11/1931 to 4/30/1979



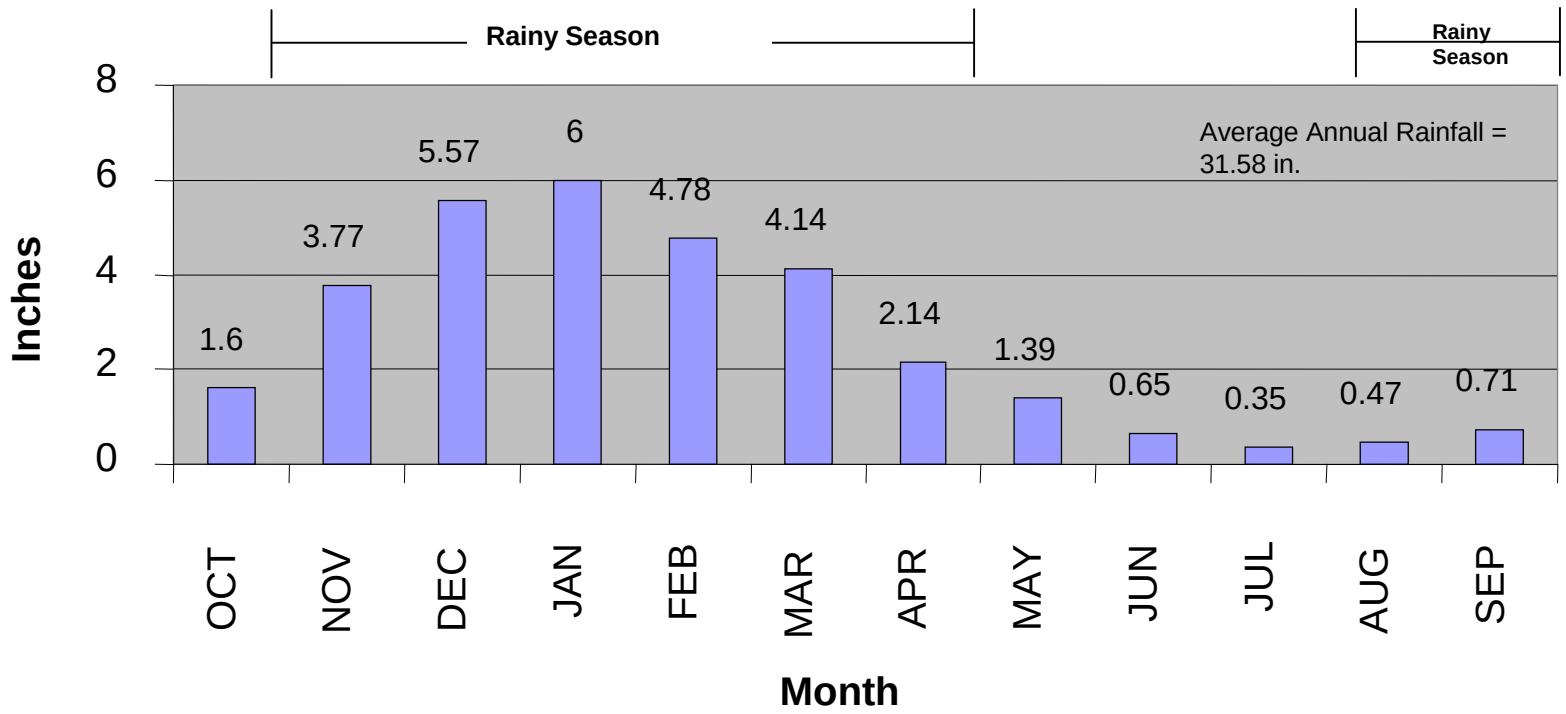
Source: Termo 1E, California
Period of Record: 8/1/1948 to 3/31/1999

District 3W Rainfall Distribution

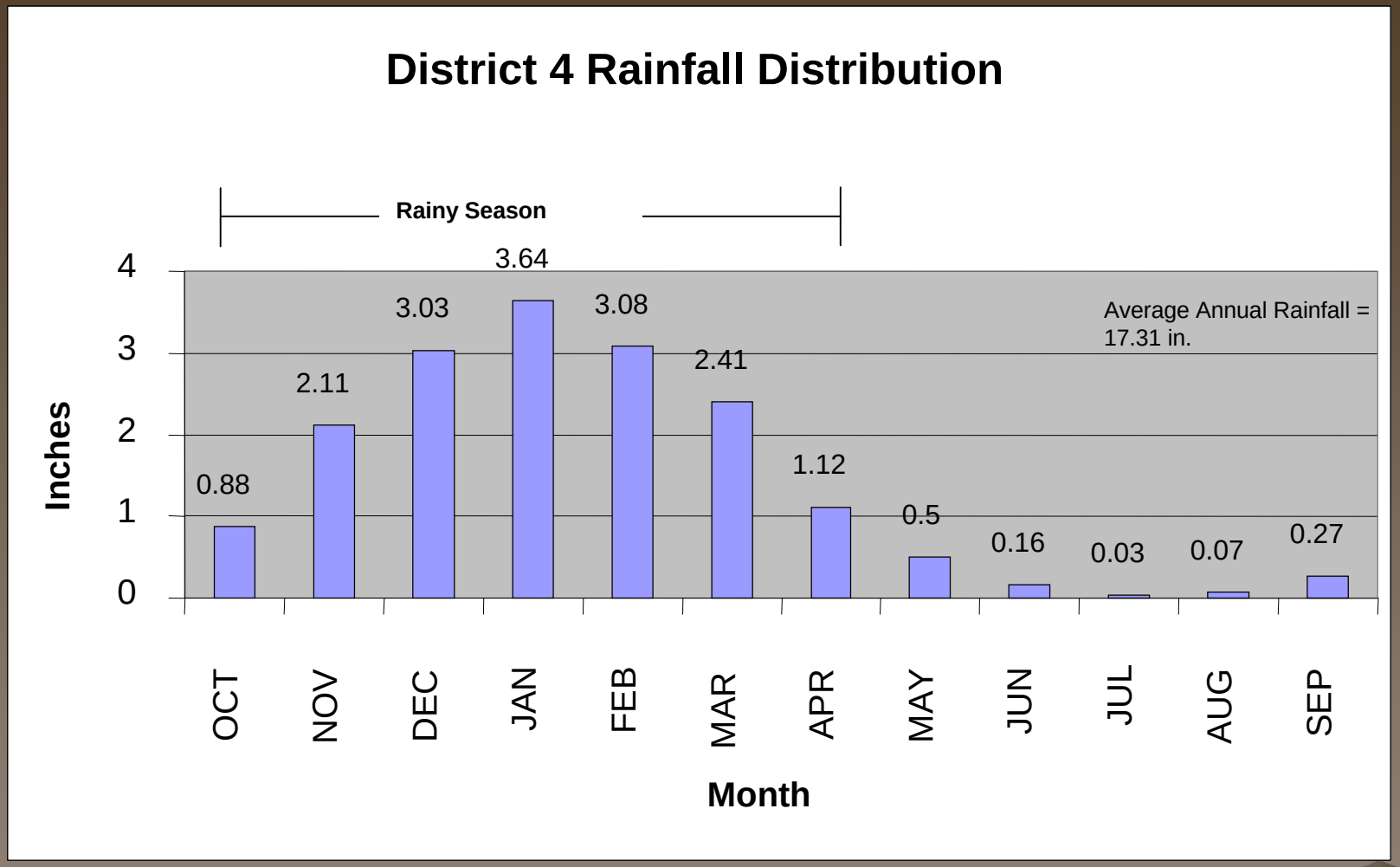


Source: Chico Experiment Stn, California
Period of Record: 1/8/1906 to 12/31/2005

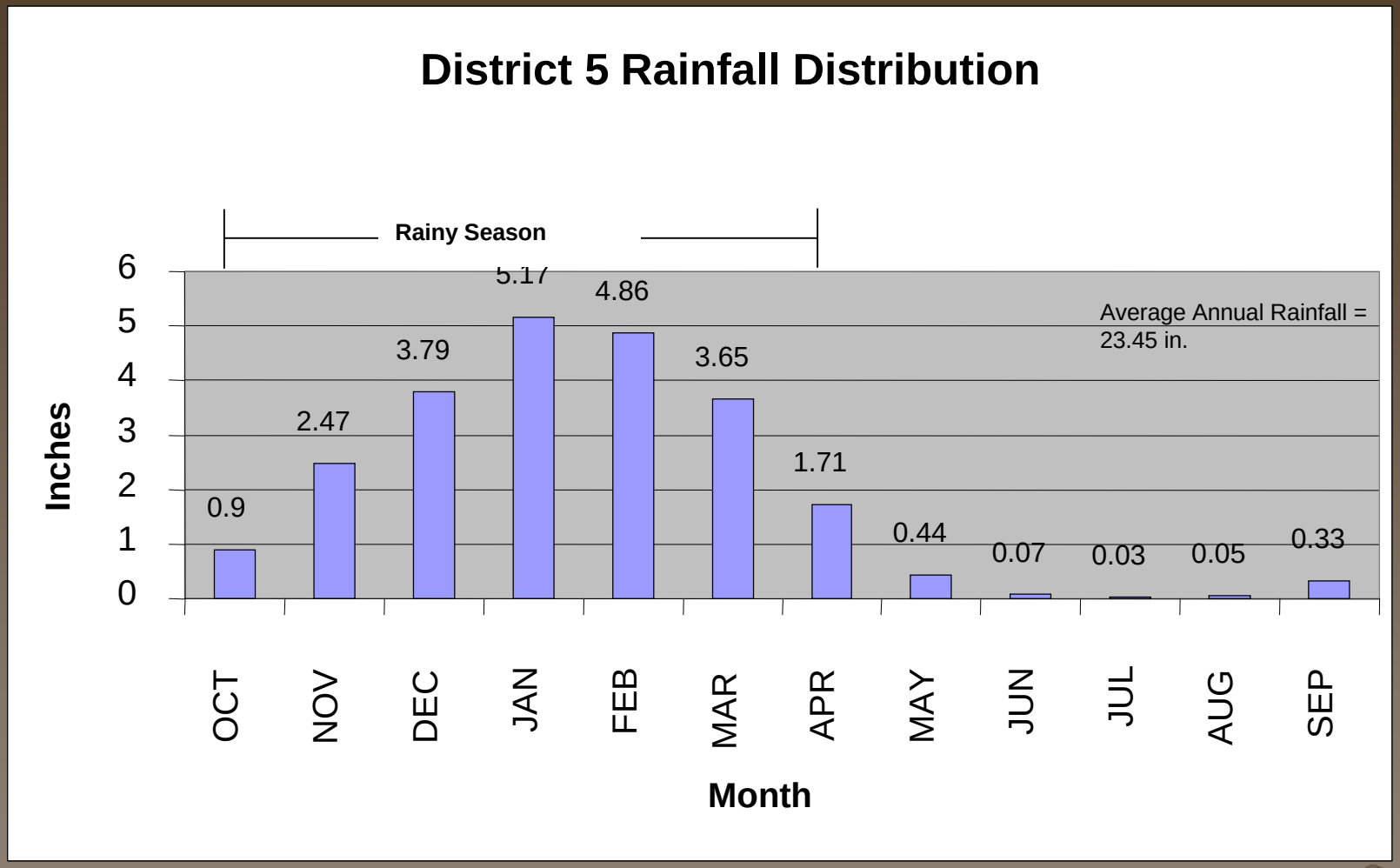
District 3E Rainfall Distribution



Source: Truckee Ranger Stn, California
Period of Record: 7/1/1948 to 12/31/2005

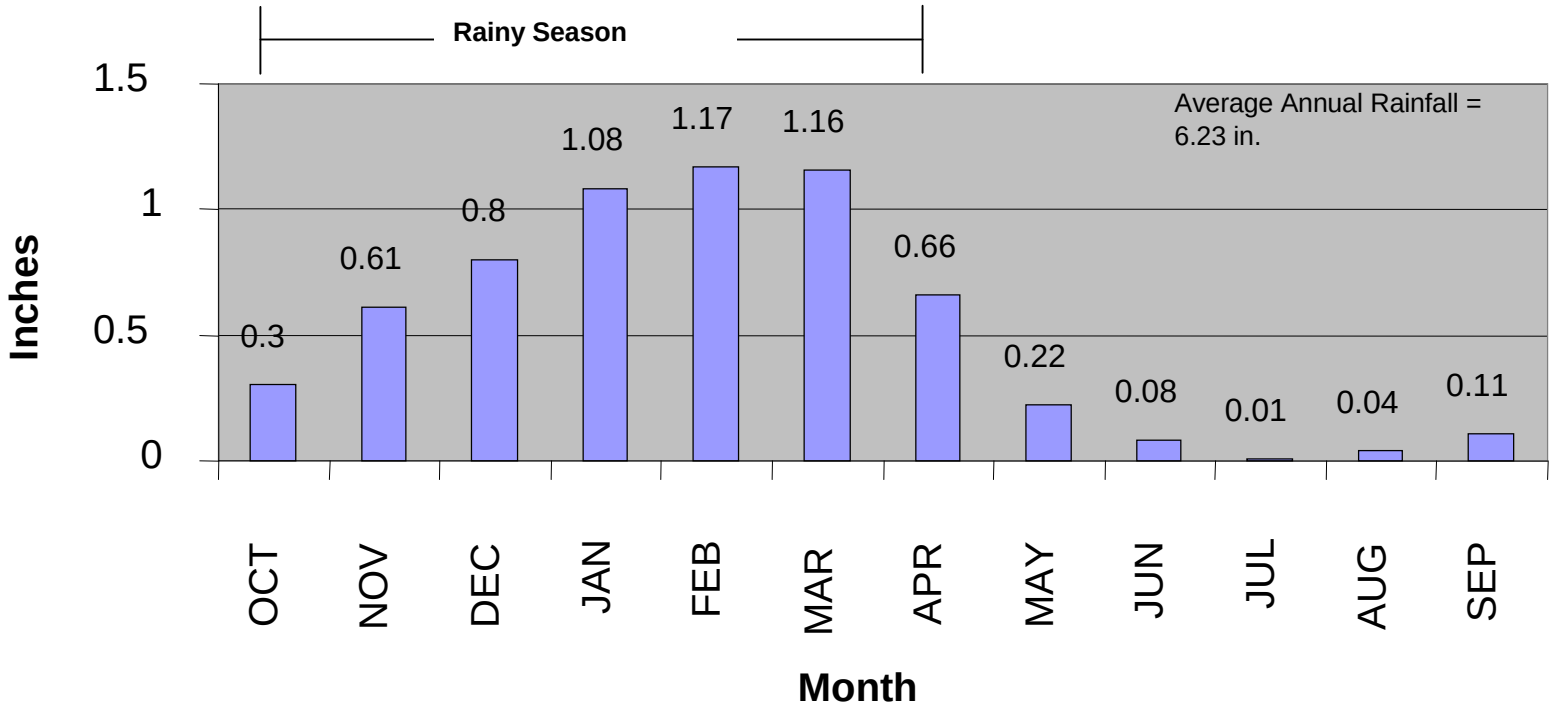


Source: Sacramento FAA Arpt, California
Period of Record: 1/1/1941 to 12/31/2005



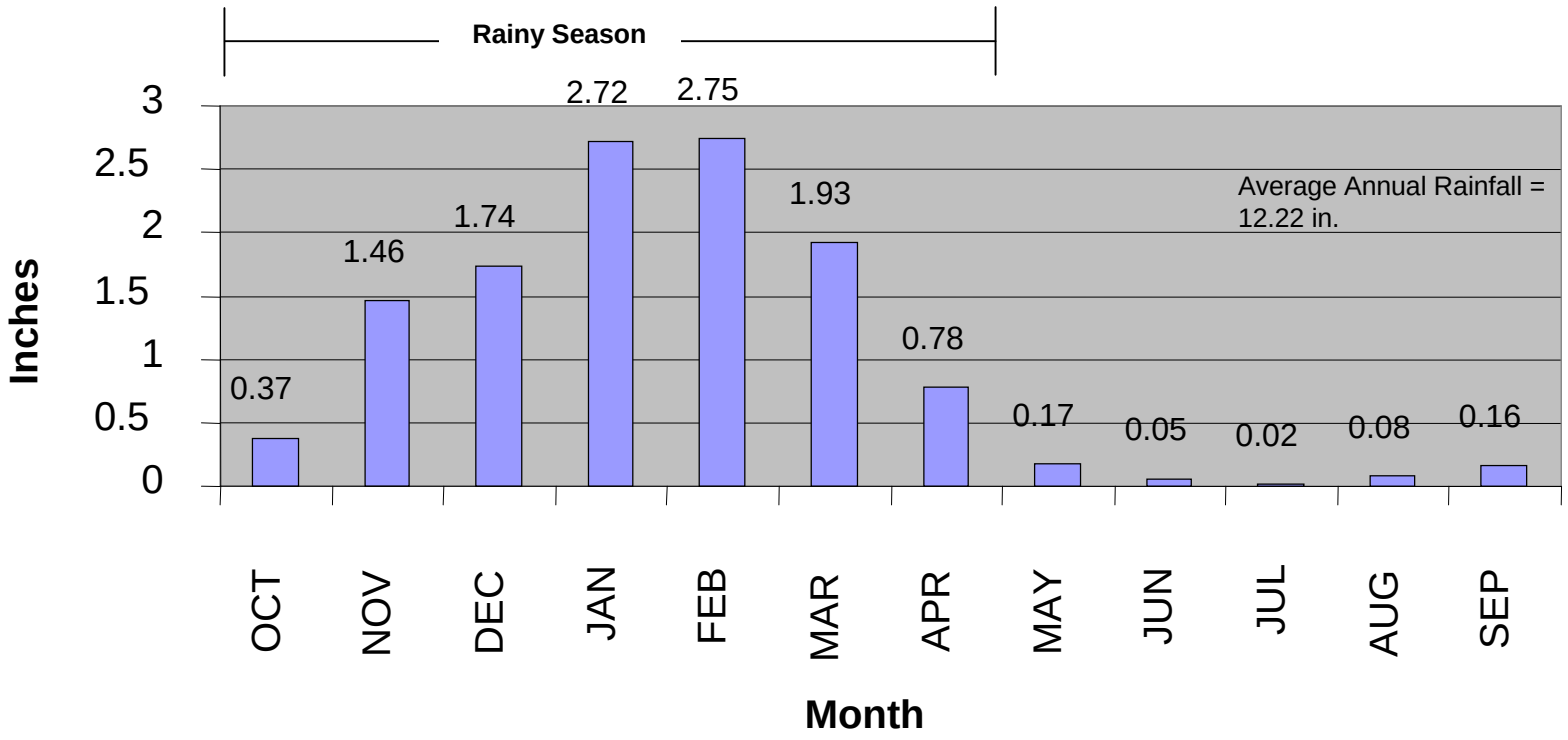
Source: San Luis Obispo Polytec, California
Period of Record: 7/1/1948 to 12/31/2005

District 6 Rainfall Distribution



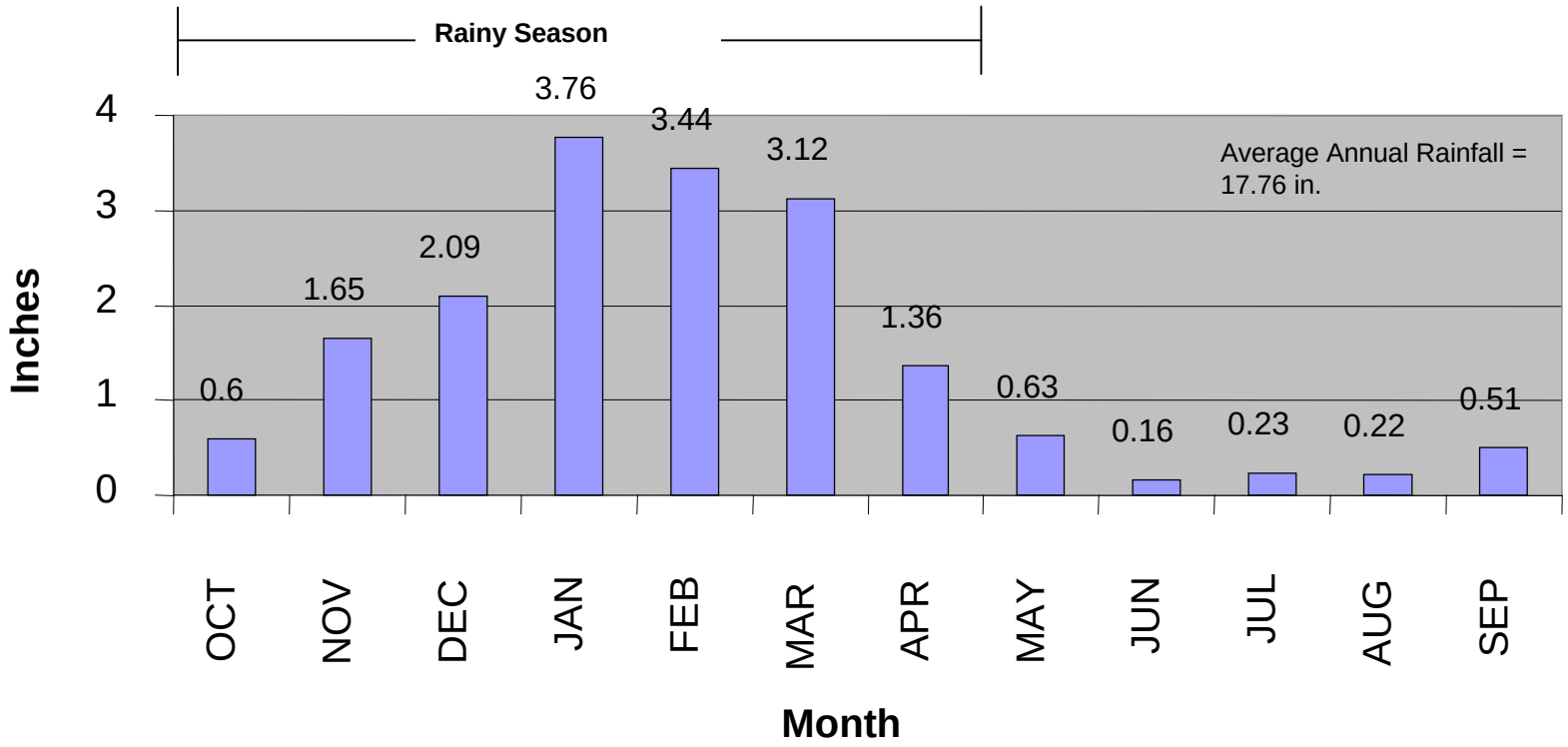
Source: Bakersfield WSO Arpt, California
Period of Record: 10/1/1937 to 12/31/2005

District 7 Rainfall Distribution

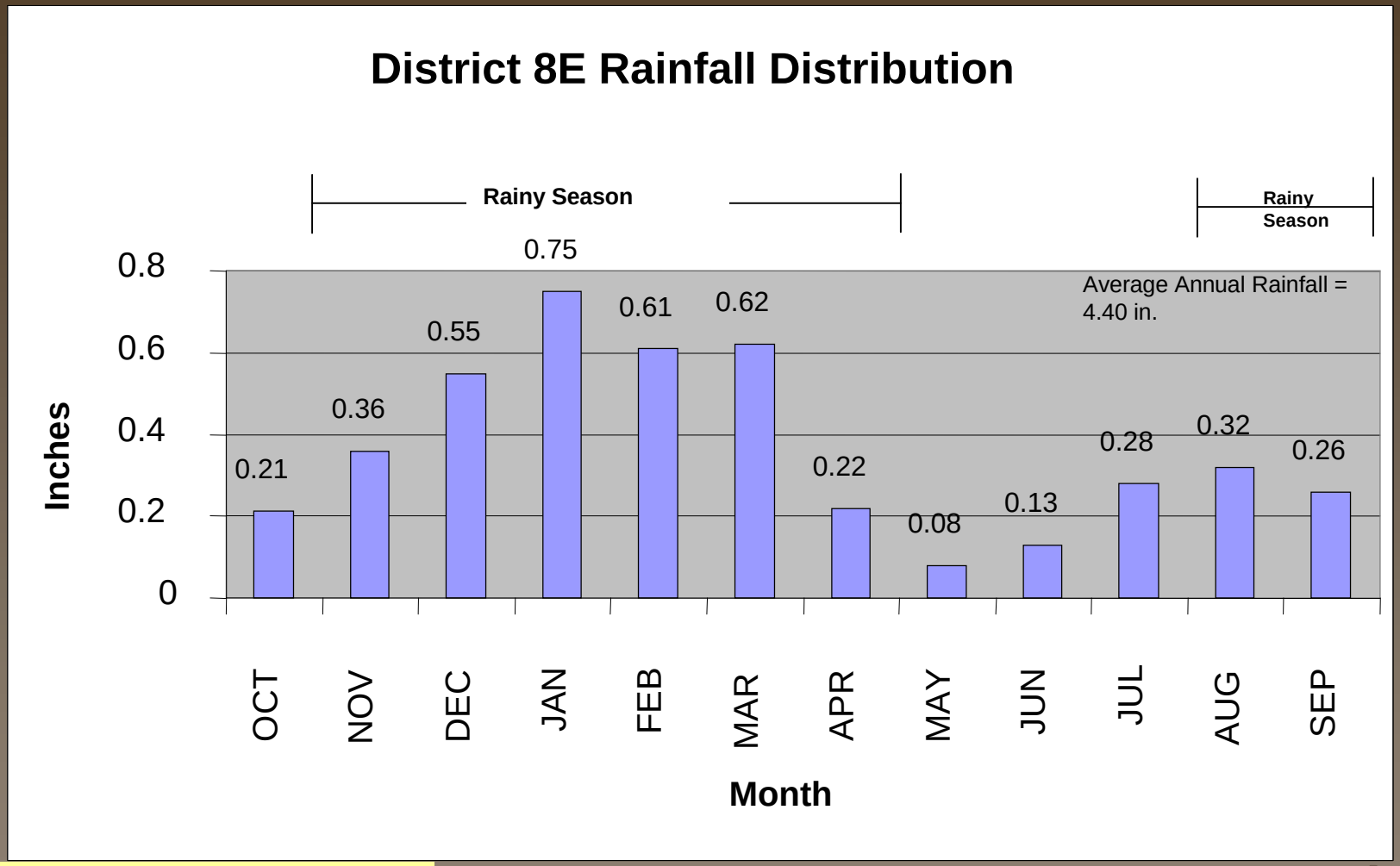


Source: Los Angeles WSO Arpt, California
Period of Record: 1/1/1914 to 12/31/2005

District 8W Rainfall Distribution

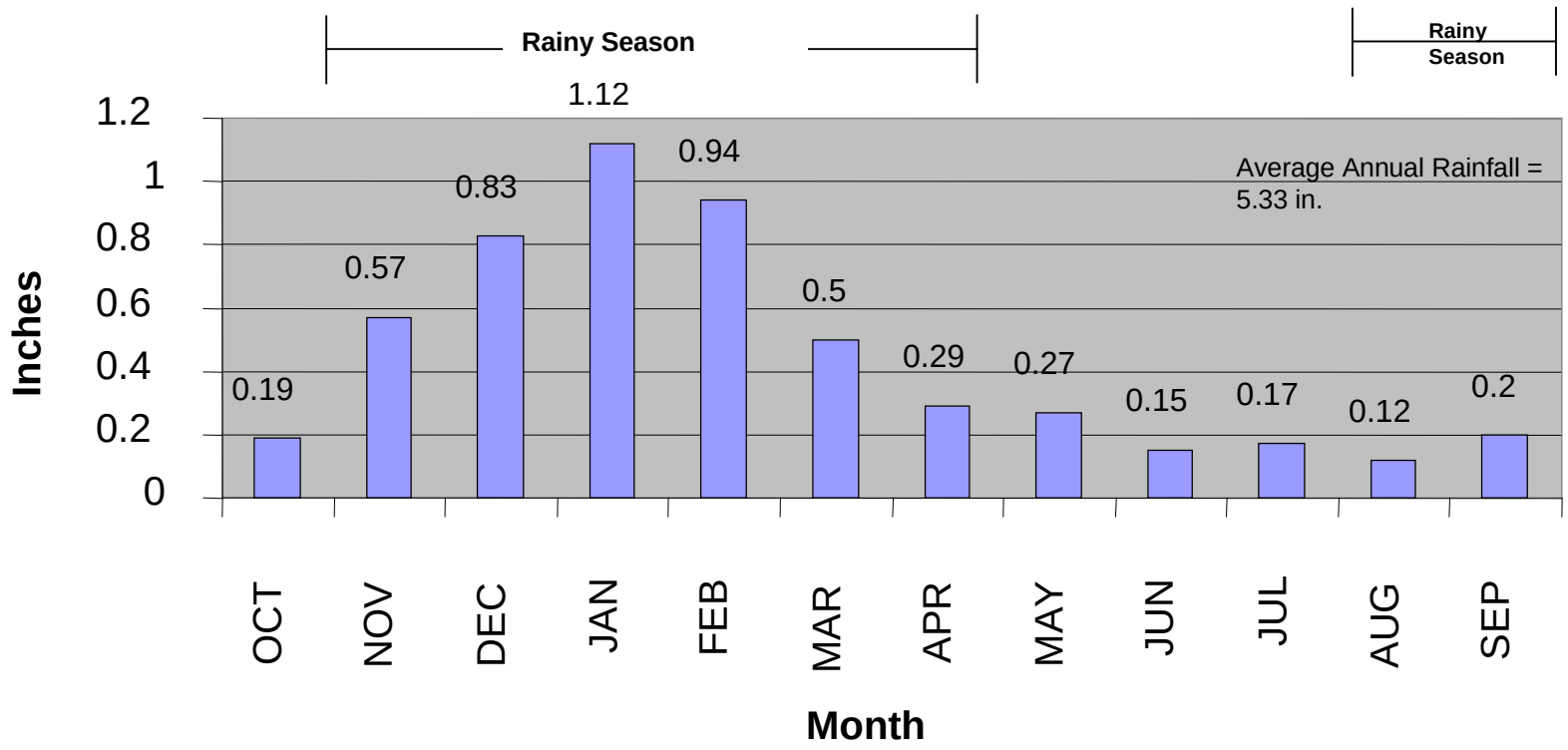


Source: Beaumont 1E, California
Period of Record: 7/1/1948 to 12/31/2005



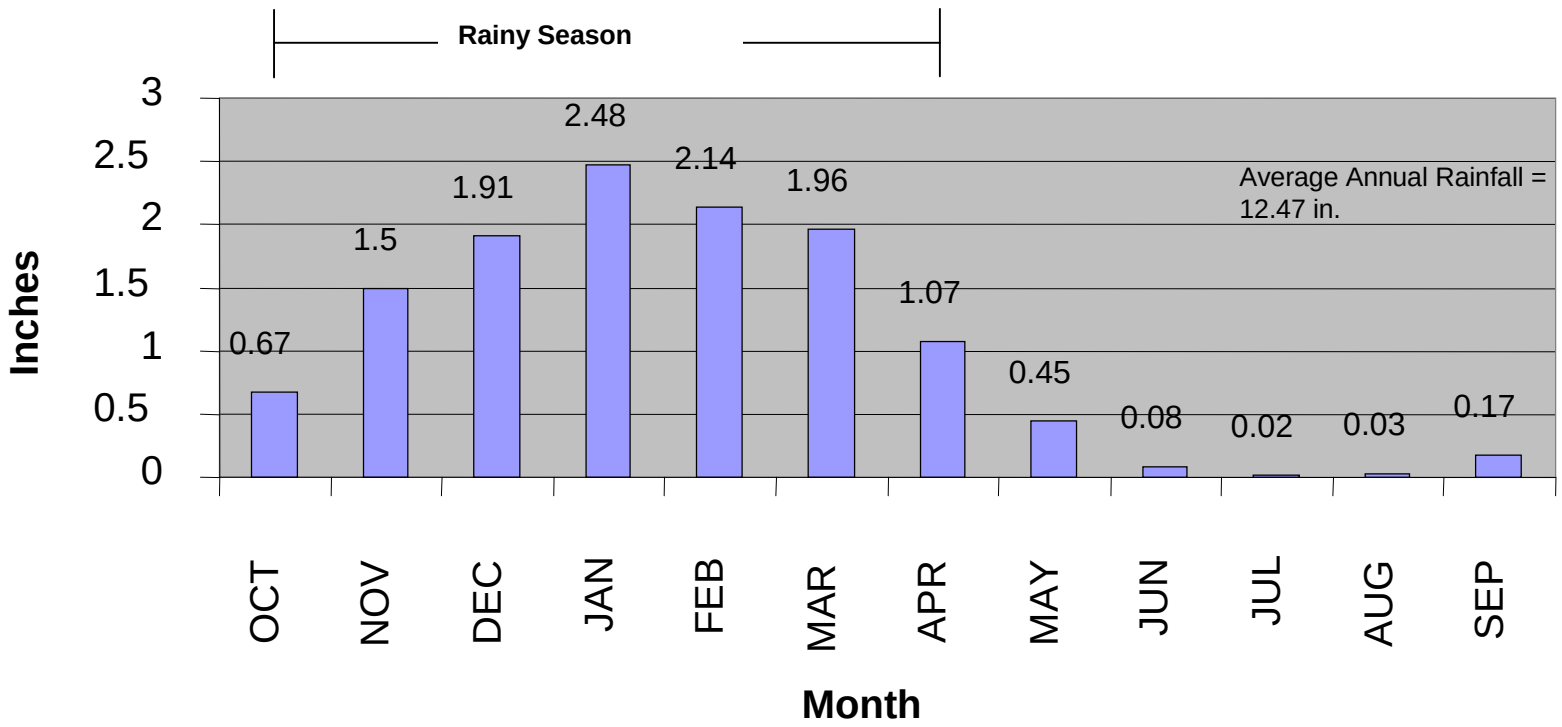
Source: Barstow, California
Period of Record: 1/6/1913 to 3/31/1980

District 9 Rainfall Distribution



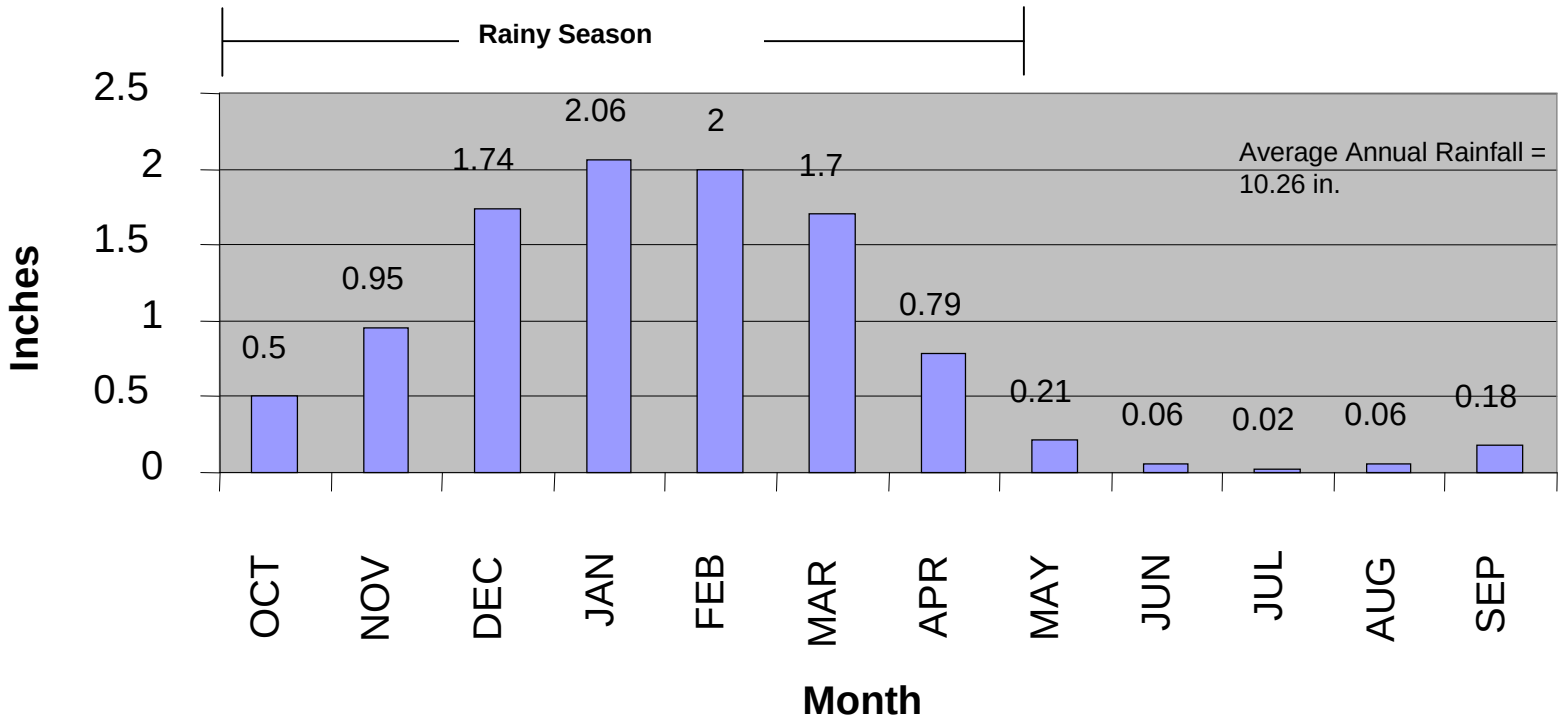
Source: Bishop WSO Airport, California
Period of Record: 7/1/1948 to 12/31/2005

District 10 Rainfall Distribution



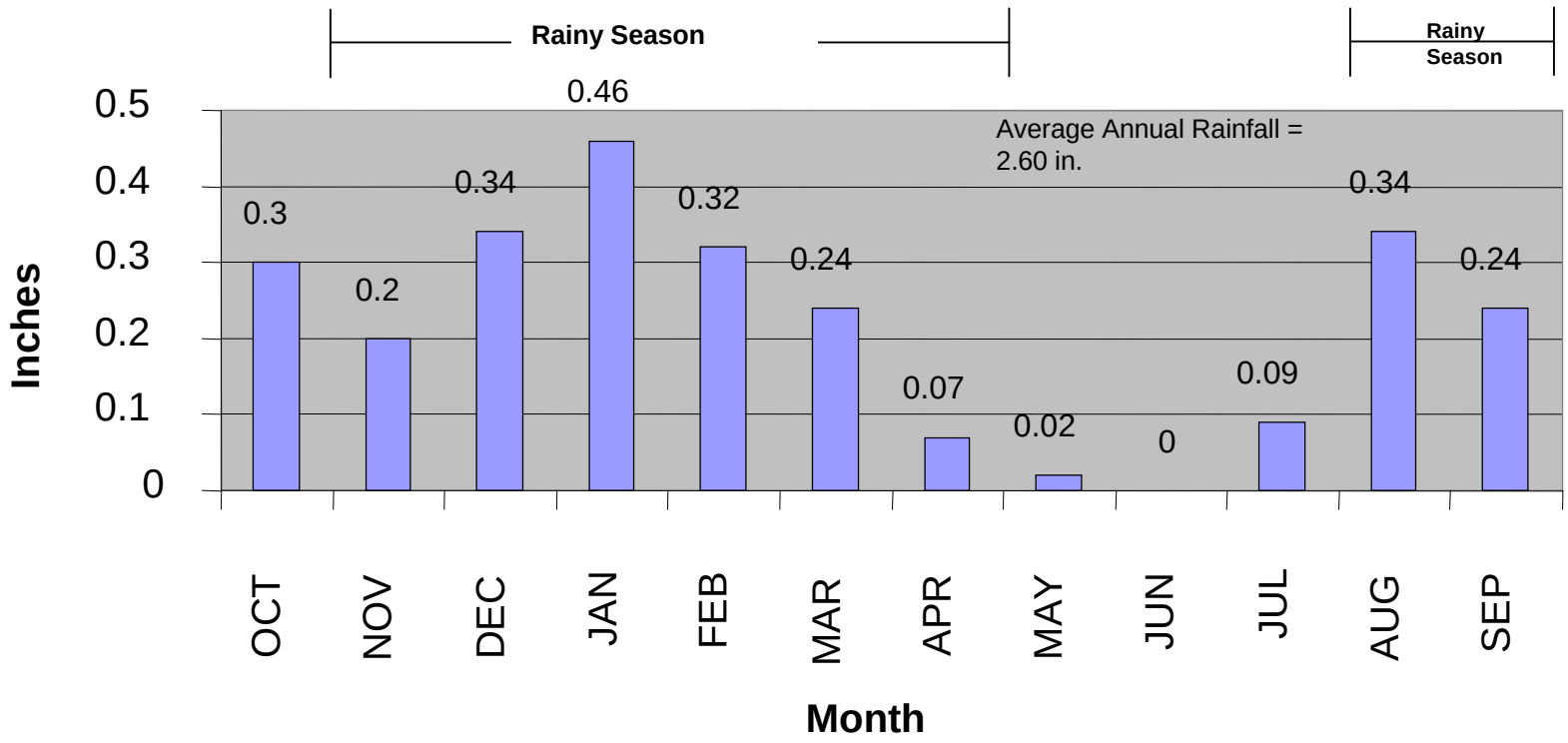
Source: Merced Municipal Arpt, California
Period of Record: 7/1/1948 to 12/31/2005

District 11W Rainfall Distribution



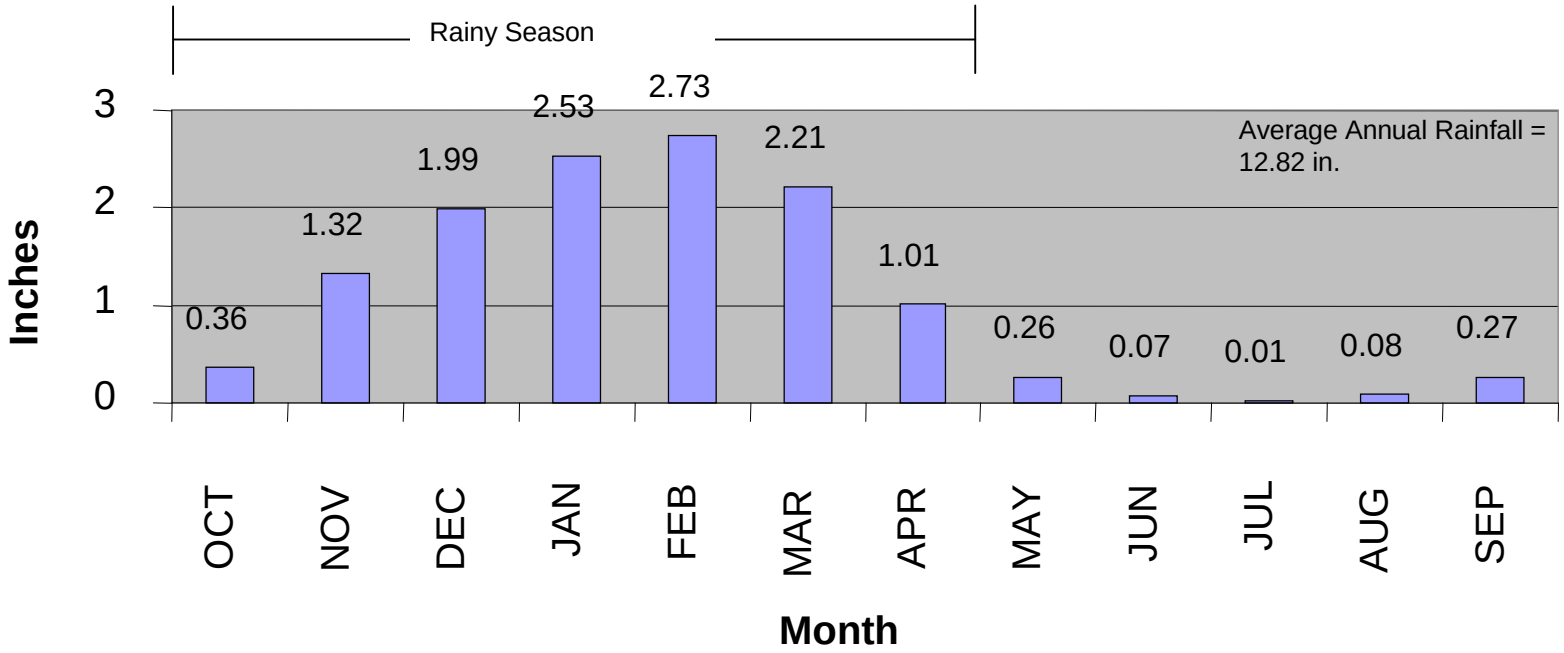
Source: San Diego WSO Airport, California
Period of Record: 1/1/1914 to 12/31/2005

District 11E Rainfall Distribution



Source: El Centro 2 SSW, California
Period of Record: 7/1/1948 to 12/31/2005

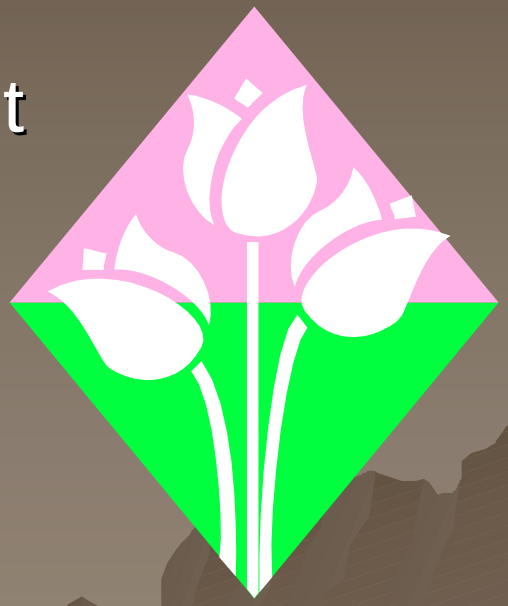
District 12 Rainfall Distribution



Source: Tustin Irvine Ranch, California
Period of Record: 12/1/1927 to 6/30/2003

Biological Forces

- Influence Soil Formation by:
  - Connecting atmosphere to soil
  - Providing organic residue for cycling
  - Assist in weathering of parent materials



Soil Transport and Settling

- Effectiveness of sediment control processes depend on the rate solids can be settled (settling velocity)
- Settling velocity must be greater than the transport velocity through the control device (e.g., silt fence, sedimentation basin)
- Particle size is the main influence on settling velocity

Soil Transport and Settling

- Settling velocity of a spherical particle in “ideal” settling is a function of the square of particle diameter
- Therefore, halving diameter reduces settling velocity by about four times; settling the smaller particles requires a sediment basin four times as large as needed to capture the larger particles
- It is only feasible to capture the medium silts and larger – **the reason why sediment control is far less effective than good erosion prevention**

Sediment Basin Design

- Sediment basin(s) shall be designed using the following equation:

$$A_s = 1.2\ Q/V_s$$

Where:

A_s = Minimum surface area for trapping soil particles of certain size

V_s = Settling velocity of the design particle size chosen

Q = Discharge rate measured in cubic feet per second

Source: NPDES General Permit, Waste Discharge Requirements (WDRs) for Discharges of Storm Water Runoff Associated with Construction Activity

Soil Transport and Settling

Settling Velocity and Settling Pond Size in Relation to Soil Particle size

Particle Size (in)	**Settling Velocity (ft/sec)**	**Required Surface Area (ft^2 per cfs)**
0.0195 (coarse sand)	0.19	6.3
0.0098 (medium sand)	0.08	15
0.0039 (fine sand)	0.023	52
0.0019 (coarse silt)	0.0062	193
0.0008 (medium silt)	0.00096	1,250
0.0004 (fine silt)	0.00024	5,000
0.0002 (clay)	0.00006	20,000

Factors That Influence Erosion

- **The Erosion Process**
  - **Geology and Soils**
  - ***Factors That Influence Erosion***

Topography

- Geographic relief is basic consideration when designing temporary BMPs
- Slope steepness and length are major factors
- Watershed topography affects erosion rate and sediment transport
- Steep slopes typically result in rapid runoff
- South-facing slopes may erode more because of temperature fluctuations and ground cover

Vegetation

- Affects rainfall and runoff by:
  - Dissipating impact energy
  - Slowing runoff
  - Spreading runoff
  - Promoting infiltration

- Greater canopy development = Greater erosion protection
- Canopy related to height and percent cover

Hydrologic Soil Groups

- Soil properties influence the relationship between rainfall and runoff since soils have different rates of infiltration.

- Based on infiltration rates, the NRCS has divided soils into four hydrologic groups (A through D):

Group A- Low runoff potential; mostly deep well drained sands and gravels

Group B- Moderately low runoff potential; deep soils of moderately fine to moderately course texture

Hydrologic Soil Groups

Group C - Moderately high runoff potential; soils with a layer impeding downward movement of water

Group D - High runoff potential; mostly clay or with a permanent high water table or a confining clay layer or bedrock near the surface

Universal Soil Loss Equation

These five factors (R, K, LS, C and P) are the primary factors that influence erosion.

$$A = R \times K \times LS \times C \times P$$

Application of Universal Soil Loss Equation

- In the 1970s Caltrans sponsored a paper on revising the Universal Soil Loss Equation for roadway construction projects.
- Some factors were substituted and the result could be applied to the time of exposure rather than annually.

Revised USLE (RUSLE)

- The NRCS released a modified version of the USLE in 1994.
- The equation itself is similar to the USLE, but the methods of calculation are more complex, and it lends itself more to computer applications than the USLE.
- It includes factors for urban development.

Five Primary Factors

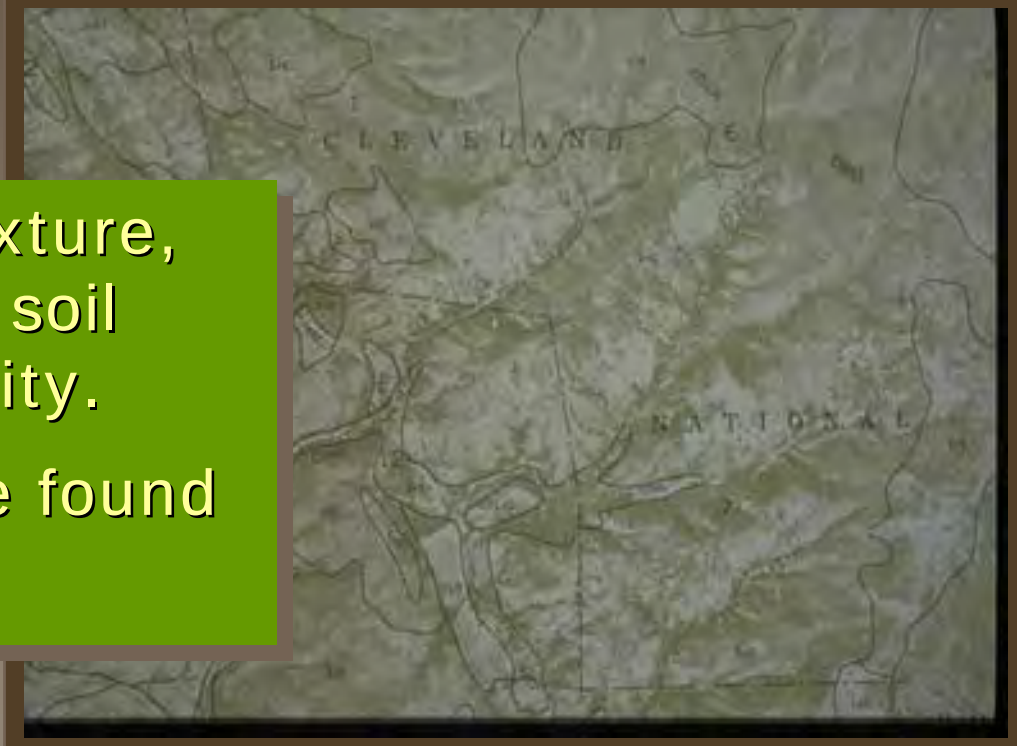
- Rainfall/Climate (R)
- Soil Erodibility (K)
- Slope length and steepness (LS)
- Cover (C)
- Conservation practices (P)

Rainfall/Climate (R)

- Droplet size is important from the aspect of splash erosion
- Storm patterns
- Types of vegetation native to the area
- Vegetation morphology and growth
- Rainfall characteristics
- Average annual soil temperatures

Soil Erodibility (K)

- Soil erodibility is the propensity for soil particles to become detached by actions of water or wind.



K is a function of soil texture, organic matter content, soil structure and permeability.

Numerical values can be found in USDA/NRCS tables.

Slope Length and Steepness (LS)

- The degree to which slope length and steepness (LS Factor) play in erosion can be calculated using USDA/NRCS charts.

Aspect or orientation of a slope is important with respect to:

- vegetation establishment
- moisture content

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e.g.,
e.g.,
33% slope); or degrees (18° slope).

Cover (C)

- The rate of erosion is related to the amount of permanent or temporary cover.

Cover (C)

- The functions of cover are to:
  - reduce rainfall impact on soil
  - slow surface runoff velocities
  - enhance infiltration
  - trap sediment with vegetative shoots
  - reinforce soil structure with roots
  - promote permanent vegetation establishment

Conservation Practices (P)

- Conservation practices are controllable, imaginative, experience-driven and interactive measures.

- They can:
  - enhance the factors of cover and soil texture
  - mitigate the influence of rainfall and runoff
  - modify flow path length and steepness

Course Highlights

- Introduction
- Impacts of Stormwater Pollution
- Pollutants Associated with Construction Activities
- Laws and Regulations
- Erosion Process
- ***Overview of Temporary Construction Site BMPs***

Temporary Construction Site BMPs

- **General Overview**

Construction Site Water Pollution Prevention

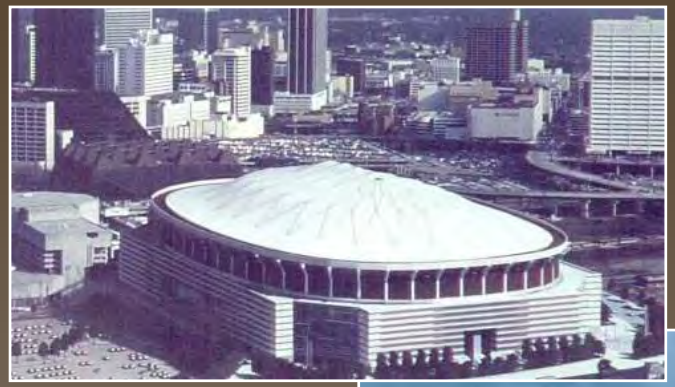
- Minimizes the potential impact that construction activities may have on water bodies and protects their beneficial uses (swimming, fishing, water supply, etc.) for future generations.

Water Pollution Control Strategies

- Prevent stormwater contact with the construction site
- Protect disturbed soil areas (DSAs) from erosion
- Minimize sediment in stormwater before discharge
- Prevent stormwater contact with other pollutants
- Prevent non-stormwater discharges

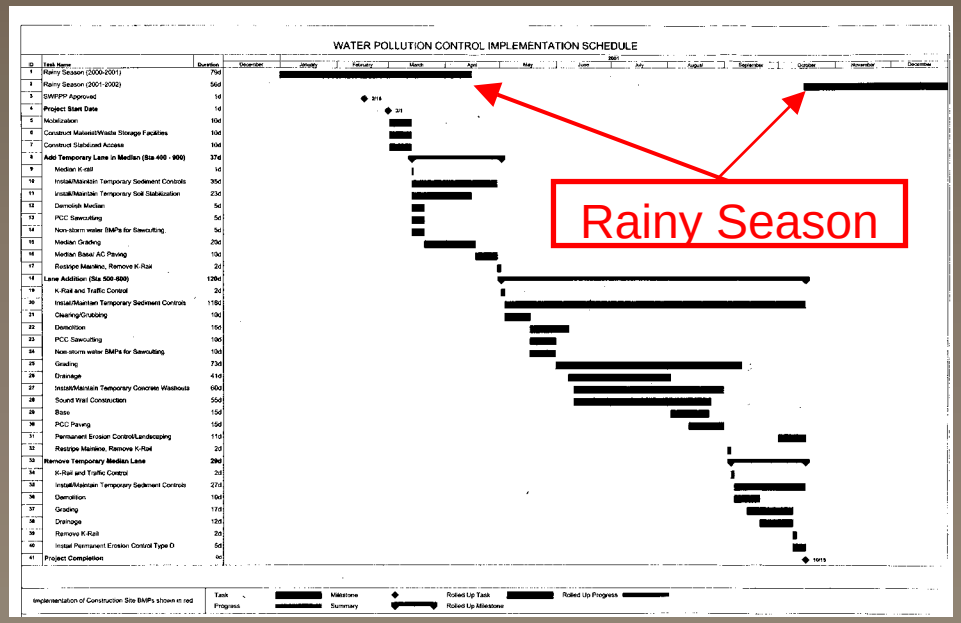
Prevent Stormwater Contact With The Construction Site

- Stormwater from the sky - Rainfall
- Stormwater from adjacent areas - Run-on



Prevent Stormwater Contact With The Construction Site

- A BMP that is practicable to protect DSAs from rainfall is:
  - Scheduling



Prevent Stormwater Contact With The Construction Site

- BMPs practicable to protect DSAs from run-on are:
  - Earth dikes/drainage swales and lined ditches
  - Sandbag Barriers

Lined Ditch

Sandbag Barriers

Protect Disturbed Soil Areas From Erosion

- BMPs to protect DSAs from erosion are:
  - Temporary soil stabilization
  - Top of slope dikes
  - Slope drains
  - Gravel bag berms or fiber rolls

Temporary Soil Stabilization

Erosion Control Blanket

Hydraulic Mulch

Slope Drains

Fiber Rolls

Minimize Sediment In Stormwater Before Discharge

- Sediment Barriers
  - Silt Fence
  - Sandbag barrier
  - Straw bale barrier
  - Fiber Rolls
  - Gravel Bag Berm
- Sediment/Desilting Basins and Sediment Traps

Silt Fence

Sandbag Barrier

Straw Bale Barrier

Fiber Rolls

Gravel Bag Berm

Sediment/Desilting Basin

Prevent Stormwater Contact With Other Pollutants

- Minimize storage and non-essential activities
- Store materials/wastes in watertight containers
- Cover stored materials and wastes
- Prevent run-on
- Clean up spills of materials and wastes

Prevent Non-Stormwater Discharges

- Paving and concrete waste
- Dewatering operations
- Vehicle and equipment cleaning, fueling, maintenance
- Sanitary/septic waste
- Runoff from dust control
- Materials or chemicals leaks and spills
- Pile Driving
- Material and Equipment over water
- Structures demo over water

Caltrans Construction Stormwater Pollution Prevention Training Classes

- 1- Introduction to Construction Stormwater Pollution Prevention Program (8 hours)
- 2- Construction Site BMPs and Field Applications (16 hours, prerequisite 1)
- 3- Water Pollution Control Contract Administration, Inspection and Maintenance (8 hours prerequisite 1,2)
- 4- Construction Site Dewatering (6 hours, prerequisite 1,2)
- 5- Sampling and Analysis (4 hours, prerequisite 1,2)
- 6- SWPPP Review (8 hours, prerequisite 1,2)

Questions